build this compact 75-meter monoband transceiver

stable LO's for microwave receivers • 10-80 meter homebrew receiver • adding digital frequency readouts to transceivers • scanner for CB-to-10 meter conversions • external receiver product detector • build a handy RF probe • plus W6MGI, W1JR, W6SAI, W9JUV, and K0RYW
ICOM Introduces the iC-R71A

The World Class World Receiver

ICOM introduces the IC-R71A 100kHz to 30MHz superior-grade general coverage HF receiver with innovative features including keyboard frequency entry and wireless remote control (optional).

This easy-to-use and versatile receiver is ideal for anyone wanting to listen in to worldwide communications. With 32 programmable memory channels, SSB/AM/RTTY/CW/FM (opt.), dual VFO's, scanning, selectable AGC and noise blanker, the IC-R71A's versatility is unmatched by any other commercial grade unit in its price range.

Keyboard Entry. ICOM introduces a unique feature to shortwave receivers...direct keyboard entry for simplified operation. Precise frequencies can be easily selected by pushing the digit keys in sequence of frequency. The frequency will be automatically entered without changing the main tuning control.

Superior Receiver Performance. Passband tuning, wide dynamic range (100dB), a deep IF notch filter, adjustable AGC (Automatic Gain Control) and a noise blanker provide easy-to-adjust clear reception even in the presence of strong interference or high noise levels. A preamplifier allows improved reception of weak signals.

32 Tunable Memories. Thirty-two tunable memories more than any other general coverage receiver on the market, offer instant recall of your favorite frequencies. Each memory stores frequency, VFO and operating mode, and is backed by an internal lithium memory battery.

Options. FM, RC-11 wireless remote controller, synthesized voice frequency readout, IC-CK70 DC adapter for 12 volt operation, MB-12 mobile mounting bracket, two CW filters, FL32-500Hz and FL63-250Hz, and high-grade 455kHz crystal filter, FL44A.
What To Look For In A Phone Watch

The best way to decide what a phone watch is right for you is to first decide what a patch should do. A patch should:

- Give complete control to the mobile, allowing full break in operation.
- Not interfere with the normal operation of your base station. It should not require you to connect and disconnect cables (or flip switches!) every time you wish to use your radio as a normal base station.
- Not depend on volume or squelch settings of your radio. It should work the same regardless of what you do with these controls.
- You should be able to hear your base station speaker with the patch installed. Remember, you have a base station because there are mobiles. ONE OF THEM MIGHT NEED HELP.
- The patch should have standard features at no extra cost. These should include programmable toll restrict ( dip switches), tone or rotary dialing, programmable patch and activity timers, and front panel indicators of channel and patch status.

**ONLY SMART PATCH HAS ALL OF THE ABOVE.**

Now Mobile Operators Can Enjoy An Affordable Personal Phone Patch...

- Without an expensive repeater.
- Using any FM tranceiver as a base station.
- The secret is a SIMPLEX autopatch. The SMART PATCH.

**SMART PATCH Is Easy To Install**

To install SMART PATCH, connect the multicolored computer style ribbon cable to mic audio, receiver discriminator, PTT, and power. A modular phone cord is provided for connection to your phone system. Sound simple? . . . IT IS!

**With SMART PATCH You are in CONTROL**

With CES 510SA Simplex Autopatch, there's no waiting for VOX circuits to drop. Simply key your transmitter to take control.

SMART PATCH is all you need to turn your base station into a personal autopatch. SMART PATCH uses the only operating system that gives the mobile complete control. Full break-in capability allows the mobile user to actually interrupt the telephone party. SMART PATCH does not interfere with the normal use of your base station. SMART PATCH works well with any FM transceiver and provides switch selectable tone or rotary dialing, toll restrict, programmable control codes, CWID and much more.

To Take CONTROL with Smart Patch - Call 800-327-9956 Ext. 101 today.

**How To Use SMART PATCH**

Placing a call is simple. Send your access code from your mobile (example: '73). This brings up the Patch and you will hear dial tone transmitted from your base station. Since SMART PATCH is checking about once per second to see if you want to dial, all you have to do is key your transmitter, then dial the phone number. You will now hear the phone ring and someone answer. Since the enhanced control system of SMART PATCH is constantly checking to see if you wish to talk, you need to simply key your transmitter and then talk. That's right, you simply key your transmitter to interrupt the phone line. The base station automatically stops transmitting after you key your mic. SMART PATCH does not require any special tone equipment to control your base station. It samples very high frequency noise present at your receivers discriminator to determine if a mobile is present. No words or syllables are ever lost.

**SMART PATCH Is All You Need To Automatically Patch Your Base Station To Your Phone Line.**

Use SMART PATCH for:

- Mobile (or remote base) to phone line via Simplex base. (see fig 1.)
- Mobile to Mobile via interconnected base stations for extended range. (see fig 2.)
- Telephone line to mobile (or remote base).
- SMART PATCH uses SIMPLEX BASE STATION EQUIPMENT. Use your ordinary base station. SMART PATCH does this without interfering with the normal use of your radio.

**WARRANTY?**

YES! 180 days of warranty protection. You simply can't go wrong. An FCC type accepted coupler is available for SMART PATCH.

Communications Electronics Specialties, Inc.
P.O. Box 2930, Winter Park, Florida 32790
Telephone: (305) 645-0474 Or call toll-free (800)327-9956
Up Front and Center!

TR-7950/7930

The exceptional front-end selectivity and sensitivity, coupled with Kenwood's excellent audio section, gives you lots to hear! Compact design makes this transceiver at home in the shack or on the go!

- Large, easy-to-read backlit LCD readout.
  Indicates receive/transmit frequency, frequency offset, sub-tone selection, memory status. An LED readout indicates S & RF units, REVERSE, CENTER TUNING, PRIORITY, and ON AIR.
- Programmable scanning, with center-stop tuning.
  Microprocessor technology allows you to scan the entire 2 meter band, or just a small portion of it. Scanning stops on the center frequency during band scan—a Kenwood exclusive!
- 21 Multi-function memory channels.
  The TR-7950/7930 "remembers" frequency offset, and optional subtone channels. Memories 1-15 are for simplex and "normal" repeater operation. Memory pairs 16/17 and 18/19 are for "odd-ball" splits. Memories "A" and "B" store upper and lower band scan limits. The radio "beeps" when memory channel 1 is selected.
- Extended frequency coverage.
  Covers 142.000-148.995 MHz in 5-kHz steps. Repeater offsets are automatically selected in accordance with the ARRL 2 meter band plan. The front panel "CS" key may be used to allow manual changes in offset.
- Multi-function keyboard.
  The 16-key DTMF pad can also be used for direct frequency entry, sub-tone selection, memory address and scan programming. The keyboard is illuminated for night time use.

TR-7950 optional accessories:
- TU-79 three frequency tone unit
- PS-430 power supply
- KPS-12 fixed-station power supply for the TR-7950
- KPS-7A fixed-station power supply for the TR-7930
- SP-40 mobile speaker
- SP-50 mobile speaker
- MC-55 mobile microphone
- MC-46 16-key autopatch
- UP/DOWN microphone
- SWT-1 2 m. 100 W antenna tuner
- SW-100A/B power meters
- PG-3A noise filter

More TR-7950/7930 information is available from authorized Kenwood dealers.
contents

13 a compact 75-meter monoband transceiver
Rick Littlefield, K1BQT

29 high stability local oscillators for microwave receivers and other applications
Cornell Drentea, WB3JZO

40 10 through 80-meter homebrew receiver
Robert Thompson, N1BFV

54 VHF/UHF world
Joe Reisert, W1JR

67 ham radio techniques
Bill Orr, W6SAI

75 practically speaking
Joe Carr, K4IPV

83 digital frequency readout using the Commodore 64
Clifford J. Bader, W0NNL

98 a scanner for CB to 10-meter conversions
Robert K. Baker, W2FMY, and Gary Bischoff, KB2GA

107 external product detector improves receiver performance
Alan Nusbaum, W6GB

115 build a handy RF probe
Keats A. Pullen, Jr., W3QOM

140 the Guerri report
Ernie Guerri, W6MGI

142 advertisers index and reader service

8 comments

92 DX forecaster

136 ham mart

129 new products

5 reflections

138 flea market
This may be the world's most popular 3 KW roller inductor tuner because it's small, compact, reliable, matches virtually everything and gives you SWR/Wattmeter, antenna switch, dummy load and balun — all at a great price!

Meet "Versa Tuner V". It has all the features you asked for, including the new smaller size to match new smaller rigs-only 10¾"Wx4½"Hx14 7/8"D.

Matches coax, balanced lines, random wires—1.8 to 30 MHz; 3 KW PEP—70 dB isolation at 450 MHz; 2000 and 2000 watts). Meter light requires 12 VDC. Optional AC adapter. MFJ-1312 is available for $9.95.

6 position antenna switch (2 coax lines, through tuner or direct, random/balanced line or dummy load). SO-239 connectors, ceramic feed-throughs, binding post grounds.

Deluxe aluminum low-profile cabinet with sub-chassis for RFI protection, black finish, black front panel with raised letters, tilt bail.

Accurate meter reads SWR plus forward and reflected power in 2 ranges (200 and 2000 watts). Meter light requires 12 VDC. Optional AC adapter. MFJ-1312 is available for $9.95.

MFJ's Best VERSA TUNER

MFJ-949C $149.95

MFJ's best 300 watt tuner is now even better! The MFJ-949C all-in-one Deluxe Versa Tuner II gives you a tuner, cross-needle SWR/Wattmeter, dummy load, antenna switch and balun in a new compact cabinet. You get quality convenience and a clutter-free shack at a super price.

A new cross-needle SWR/Wattmeter gives you SWR, forward and reflected power—all in a single glance. SWR is automatically computed with no controls to set. Has 300 and 3000 watt scale on easy-to-read 2 color lighted meter (needs 12 V).

A handsome new black brushed aluminum cabinet matches all the new rigs. Its compact size (10x 3 x 7 inches) takes only a little room.

You can run full transceiver power output—up to 300 watts RF output—and match coax, balanced lines or random wires from 1.8 thru 30 MHz. Use it to tune out SWR on dipole, yagis, long wires or verticals, beams and quads.

A 300 watt 50 ohm dummy load gives you quick tune ups and a versatile six position antenna switch lets you select 2 coax lines (direct or thru tuner), random wire or balanced line and dummy load.

A large efficient airwound inductor—3 inches in diameter—gives you plenty of matching range and less losses for more watts out. 100 volt tuning capacitors and heavy duty switches gives you safe arc-free operation. A 4:1 balun is built-in to match balanced lines.

Order your convenient package now and enjoy.

MFJ's Smallest VERSA TUNER

MFJ-901B $59.95

MFJ's smallest 200 watt Versa Tuner matches coax, random wires and balanced lines continuously from 1.8 thru 30 MHz. Works with all solid state and tube rigs. Very popular for use between transceiver and final amplifier for proper matching. Efficient airwound inductor gives more watts out. 4:1 balun for balanced lines. 5 x 2 x 6 inches. Rugged black aluminum cabinet.

MFJ's Random Wire TUNER

MFJ-1601E $39.95

MFJ's ultra compact 200 watt random wire tuner lets you operate all bands anywhere with any transceiver using a random wire. Great for apartment, motel, camping operation. Tunes 1.8-30 MHz. 2 x 3 x 4 inches.

MFJ's Mobile TUNER

MFJ-945C $79.95

Designed for mobile operation! Small, compact. Takes just a tiny bit of room in your car. SWR/dual range wattmeter makes tuning fast and easy. Careful placement of controls and meter makes antenna tuning safer while in motion.

Extends your antenna bandwidth so you can operate anywhere in a band with low SWR. No need to go outside and readjust your mobile whip. Low SWR also gives you maximum power output of your solid state rig—runs cooler for longer life.

Handles up to 300 watts PEP RF output. Has efficient airwound inductor, 1000 volt capacitor spacing and rugged aluminum cabinet. 8½ x 6 inches. Mobile mounting bracket available for $5.00.

TO ORDER OR FOR YOUR NEAREST DEALER, CALL TOLL-FREE

800-647-1800

Call 601-323-5869 in Miss. and outside continental USA Telex 53-4590 MFJ STKV
Yesterday, September 20, a massive earthquake struck Mexico City. Early reports from the networks and wire services told of massive damage in Mexico City, with 25 per cent of the downtown area totally destroyed, and thousands of deaths and injuries. Ships have been reported missing and a tsunami wave has severely damaged part of the Mexican coastline. All modes of communications — save one — are down and authorities have no idea of when service might be restored.

The one mode that’s still functioning is Amateur Radio. I’ve spent quite a while listening to the emergency traffic being passed on a number of frequencies; I’m quite impressed with how effectively and efficiently health and welfare traffic is being passed. But there’s a personal sense of urgency to my listening this time: my youngest brother is in Mexico City, and my family and I have no way of knowing if he’s all right.

Yes, the State Department has a hotline that we can call for information. But the volume of calls received has shut the system down. We’ve contacted the Red Cross, but they’re too busy passing more important medical traffic.

So how do I — or others — use Amateur Radio to find out about the safety of relatives and friends? I’m afraid I really don’t know. I usually have the world at my fingertips with just the flip of a switch and the twist of a dial. But right now I feel just about totally helpless in trying to get the information I want.

Propagation into the Mexico City area isn’t favorable at this time, and I’m reluctant to jump into a pile-up and add to the confusion. But that’s about the only way I’ll be able to get a message to the Mexican stations. . . .

There’s got to be a better way! Would somebody please tell me what it is?

Craig Clark, N1ACH
Assistant Publisher

Craig’s initial feeling of helplessness is completely understandable. The circumstances — a natural disaster that, within 60 seconds, killed thousands, injured many, and caused catastrophic damage to buildings and other structures — is something one doesn’t deal with on a daily basis. So it’s hard to pull from your experience and function immediately.

Several things are reasonably certain: all conventional power and most telephone service is gone. Few reliable means of communicating with the outside world are available. This is where Radio Amateurs come in — and what a service they provide! Just after the Mexico City earthquake, several stations were on the air. One in particular that I heard was XE1VIC, manned by Vic and Sergio, who did a yeoman’s job in passing health and welfare information, medical emergency traffic, and high-level government phone patches.+

With this in mind, what can you do to find out about the safety of a relative or friend known to be in a particular area when disaster strikes?

LISTEN CAREFULLY. If there’s any activity from the devastated area, someone as competent as XE1VIC is likely to be on the air. If you don’t hear such a station, continue listening. Chances are good that other Amateurs, in your country will have information and be discussing it.

IF YOU DON’T HEAR, ASK. Once again, someone will probably know something.

THINK. For the distances involved, time of day, and propagation, one particular band will be optimum. Try it. XE1VIC was 59+ into New Hampshire on 80 meters for hours.

LISTEN FOR INSTRUCTIONS. The control station will make it very clear as to how he wishes to proceed. Many stations will be attempting to contact him. Though it may seem like contest operation at times, remember that a disaster has occurred, and discipline is essential.

BE BRIEF. Once you’ve gotten the traffic handler’s attention, give the information required — nothing more, nothing less. Decide beforehand how you might be able to help.

ACCEPT THE RESPONSE GIVEN. Once he contacted the requested relative or friend, XE1VIC kept his side of the conversation short and sweet. Most of the time the news was very good, and in every case he was extremely reassuring. Remember that many other stations are concerned about their loved ones, too.

OTHERS WILL HELP PASS YOUR MESSAGE. In this case, stations in the Houston area acted in this capacity.

Every emergency, of course, is different. These are just a few suggestions that have been applied in the past and appear to work.

Rich Rosen, K2RR
Editor-in-Chief

Note: Craig’s brother returned home safely on September 23.

XE1VIC was just one of many Mexican stations that should be commended. In addition, the list of U.S. and international stations that contributed to the success of this traffic handling situation in a calm and controlled manner is long, and one we should be quite proud of — proving once again how Radio Amateurs rise to the occasion and provide a real service.

November 1985
AMATEUR RADIO'S RESPONSE FOLLOWING MEXICO CITY'S DISASTROUS EARTHQUAKE was, in short, simply overwhelming! Almost before the first major tremors ended, a number of Mexico City stations were on and handling emergency traffic with the U.S. As the hours wore on and the damage became apparent, the activity multiplied—but even after health and welfare input began, and despite a variety of message handling techniques, turnout was generally quite fast. W9JUV's first two Friday afternoon inquiries came back "We're all OK!!" from XEUUSA in under five minutes! Amateur Radio's media exposure was also fantastic due to the complete breakdown in commercial communications, which left the Amateur Service as the media's only source of earthquake news for a number of hours.

Media Abuse Of Amateur Radio Was Also Extensive, unfortunately. Not only was there the usual "XEWXX, I have Newt Newshawk of NNUT-TV in the shack to ask you some questions," but all of the networks and news services invaded the Amateur bands for their coordination and logistical efforts! Heard on 20 meters Sunday were equipment requests, personnel assignments, even arguments about overtime and the special menu needs of a network anchor! To its credit, NBC's Mexico City station did take health and welfare traffic and made phone calls when not otherwise occupied; inquiries to the others triggered responses that they were too busy on network business to make casual contacts! The FCC is very much interested in this media incursion, and would appreciate receiving specific reports and tapes on it.

On Clarifying Limits Of Amateur Radio Was Quickly Apparent—anxious friends and relatives of persons living in or visiting Mexico City had no idea of how to locate hams willing to relay messages. Though churches, community centers, the Red Cross, and even some Amateur Radio dealers were often able to make referrals, what's badly needed—before another such catastrophe strikes—is a well advertised, accessible conduit through which the public can reach Amateur Radio operators able to communicate with loved ones abroad.

Despite Such Problems, However, Amateur Radio Has Never Served People Better or made a deeper, more favorable impression on the public than it has during Mexico City's agony. "Well done!" to all involved, both those actively participating and the many "stand-bys."

STATE AND LOCAL REGULATIONS MAY NOT PRECLUDE AMATEUR COMMUNICATIONS, the FCC declared in its September 16 decision on PRB-11. Responding to the ARRL's July, 1984, request for a Declaratory Ruling limiting local limitations on Amateur operations and stations, the FCC affirmed "a strong federal interest in promoting Amateur communications" and cited Amateur Radio's value in "providing emergency communications" and "a reservoir of trained operators, technicians and electronic experts," as well as furthering international goodwill. In summary, they said: "State and local regulations that operate to preclude Amateur communications in their communities are in direct conflict with federal objectives and must be preempted."

Though They Did Not Specify Any Minimum Antenna Height, the Commission further stated, "...local regulations which involve placement, screening, or height of antennas based on health, safety, or aesthetic considerations...must be crafted to accommodate reasonably Amateur communications (with minimum practicable regulation.)"

Though The Lack Of A Specific Height Will Cause Some Amateurs Problems, the FCC's action is certainly going to help the vast majority. Also not covered are Amateurs who've signed restrictive covenants, since those are private contracts entered into voluntarily.

Congratulations To The Commissioners And FCC Staff for a courageous decision, since their favorable ruling for Amateur antennas and operations will undoubtedly be cited by other services who'd also like to get out from under the yoke of local regulation.

POSSIBLE FEDERAL SANCTIONS AGAINST "ELECTRONIC EAVESDROPPING" are close to being introduced in the U.S. House of Representatives by Rep. Kastenmeyer. In his "Electronic Communications Privacy Act of 1985," Rep. Kastenmeyer proposes restricting the monitoring of any transmission by "wire, radio, electromagnetic, or photoelectric system..." with exceptions for communications "readily accessible to the public," stations for general public use, distress signals, police or fire, and Amateur or CB stations. Penalties for commercial violators could be $25,000 and a year in prison, others $5,000 and six months.

Though The Goal Is Almost Surely The Protection Of Cellular Radio, the effect on Amateurs and others with a general interest in radio communications could be serious.

APPLICANTS WHO FLUNK AN AMATEUR EXAM NEEDN'T WAIT 30 DAYS to retake the exam, the FCC decided September 16. In its decision to eliminate the waiting period entirely, the Commission agreed a delay had little benefit and dropping it could permit applicants who failed the first day of a two-day hamfest to review problem areas for a second-day try.

DPOSL WILL BE THE CALLSIGN FOR THE UPCOMING EUROPEAN STAFFED SPACEFLIGHT, now set for launch about October 30th on Space Shuttle Flight 61-A. They will listen on 437.125, 437.225 and 437.275 MHz, transmit on 437.325 and 437.375 MHz, and 145.525, 145.550, or 145.575 MHz. 145.575 down, 437.275 MHz up will be the normal pair.

Rumors Of 10 Or 15-Meter Operation Still Persist at presstime; an operating schedule for DPOSL has not yet been released.
You may not be able to solve the world's problems. But at least you can listen.

The Panasonic Command Series: With double superheterodyne tuning, you'll hear the world loud and clear.

Now it's easy to listen in on the world's hot spots. With the Panasonic RF-B600 Command Series FM/LW/MW/SW receiver.

Its advanced microcomputer-controlled tuner lets you preset up to nine different frequencies. And reach them at the touch of a button. Or, press the appropriate buttons and tune in any desired frequency with direct-access digital tuning. It'll lock right in to every signal with a PLL quartz-synthesized tuner. Once tuned in, the Panasonic double superheterodyne system helps deliver a clean, consistent signal.

There's even built-in auto-tuning to let you scan the shortwave band automatically, as well as manually. All this means you can tune in Berlin, pick up Paris, or locate London in an instant. Without dialing all over the band.

Both the RF-B600 and the RF-B300 are packed with features and built to go anywhere. The Panasonic Command Series offers something for everyone. With equipment sophisticated enough to impress the most avid enthusiast, and automatic features that get you where you want to be. Fast. There's a whole world out there that's waiting to be heard. Tune in to it with the Panasonic Command Series.

Panasonic®
just slightly ahead of our time."
practically speaking

Dear HR:

Joe Carr, K4IPV, is off to a fair start with his new column, “Practically Speaking.” The first (September, page 67) was good reading. I have to disagree with him, however, when he says, “The first time to think about repairs is when you’re unpacking the new rig.”

Wrong.

The first time to think about repairs is before the rig is bought. The unpacking stage is too late.

Before plunking down several kilobucks for one of the so-called state-of-the-art transceivers being marketed these days, ham operators need to give serious, careful thought to the crucial question of servicing and maintaining the rig(s) under consideration. Is that aspect of ownership going to cost an arm, a leg and another part of the anatomy — to say nothing of the time spent without the rig while it is being repaired?

Are all those gongs, whistles, and bells really worth it? Does one truly need rigs that scan, memorize, and do all sorts of other gimmicks?

Two years ago two friends here returned from a national Amateur Radio convention, each with a new rig. One, who purchased the latest offering from Brand X had to return the rig to the factory once while it was still under warranty and twice since then. He is no slouch at troubleshooting or repair, but the complicated circuitry was more than he could handle. Labor, parts, and shipping charges thus far have totaled more than one-third the original cost of the transceiver, and he has been without it almost 60 days altogether.

My second friend brought home a shiny, new Brand Z transceiver. It was almost a pure vanilla rig with no gong, whistles, or bells. It has sat in his shack and has worked, day in and day out. What few repairs have been needed were done quickly, easily and inexpensively. He said he decided on that rig because of the ease and simplicity of operation.

Practically speaking, which do you think was the more practical?

Fred Conavita, W5QJM
Austin, Texas

audio filter design

Dear HR:

Instead of transforming the normalized values of a five-branch Butterworth low-pass prototype design to get a five-branch high-pass as discussed in Stefan Niewiadomski’s article, “Passive Audio Filter Design,” part 2, October, 1985, a simpler procedure would be to use standard-value capacitor (SVC) filter tables to select an appropriate design. The fact that the SVC capacitor design values are exactly identical to the commercially available standard values simplifies construction. For example, a “near-Butterworth” 500-ohm design with a VSWR of 1.023 and a 3-dB cutoff frequency of 487 Hz (within 3 percent of the desired 500 Hz cutoff frequency) is available with standard values of C1,5 = 0.82 μF and C3 = 0.33 μF. L2,4 = = 96.2 mH. The 20-dB and 40-dB attenuation frequencies are 330 and 214 Hz. Some SVC filter tables appear in The ARRL 1985 Handbook, (pages 2-40 through 2-44) and a more complete selection will appear in the next edition of the Radio Handbook, edited by Bill Orr, and to be published soon by Howard W. Sams and Co., Inc. The SVC filter tables were also published in the record of the IEEE 1985 International Symposium on Electromagnetic Compatibility held in Wakefield, Massachusetts from August 20-22. ham radio readers should therefore understand that the preferred procedure for designing simple passive LC filters, such as generally required by the Radio Amateur, is to use SVC filter tables. The procedure explained by Niewiadomski should be used only when there is a specific requirement for a specific response type and a precise cutoff frequency.

Ed Wetherhold, W3NQN
Annapolis, Maryland

J-pole or Zepp?

Dear HR:

K1WWW is right, (see “J-pole or Zepp,” Comments, ham radio, February, 1985, page 8). The J-pole antenna described in KD8JB’s earlier ham radio article* is a Zepp antenna.

The Zepp antenna, named for the Zeppelin airship, on which it was originally used, is not a 3/4-wave antenna operating against a 1/4-wave counterpoise as KD8JB mentioned in the reply comments.

The classical Zepp antenna, now more than 75 years old, is a full-wave current-fed antenna with a 1/4-wave section folded over on itself. This leads to a 1/2-wave end-fed radiator with 1/4-wave matching transformer. The antenna at first was a balloon antenna (fig. 1) and looked like an inverted J-pole dangling from the airship. In the beginning the matching transformer and the radiator hung in a straight line. Later on the matching transformer was set at right angles to the radiator. This low-voltage input feed arrangement was a remarkable improvement over the dangerous practice of using a high-voltage feed in the presence of the oxyhydrogen-gas with which the balloons were filled.

Alois Krischke, DJ6TR/OE8AK
Munich, West Germany

*See “All-metal, 2-meter J-pole Antenna,” ham radio, July, 1984, page 42.
THE INTELLIGENT SATELLITE TELEVISION SYSTEM
Where all the satellites are

Up to 36 satellite locations can be programmed for instant recall. The antenna controller is integrated into the satellite receiver. The hand-held remote control activates a 3-speed actuator action which precisely locates the satellite and fine tunes the antenna position for maximum signal reception.

Where all the channels are

Every channel on every satellite is individually factory programmed prior to delivery. All audio and video information is ready for recall automatically. As new channels are added they can be added to the program. The 9900 is ready to receive individual channel selection information for up to 864 separate selections.

All about stereo Hi-Fi sound

5 audio modes, factory programmed to individual transponders, deliver the right sound system automatically when a channel is selected. Dozens of audio subcarriers can be added to the program for audio only hi-fi enjoyment (including Dolby® Noise Reduction) in addition to television.

ALL YOU NEED TO KNOW IS
WHAT SHOW YOU WANT TO WATCH
NOW LUXOR HAS UNIFIED SATELLITE, VIDEO, AUDIO AND COMPUTER TECHNOLOGY IN A SINGLE INTEGRATED HOME SATELLITE TV SYSTEM

So advanced it's as easy to operate as an ordinary TV

The front panel LED display tells you what satellite you're on, what channel you're watching, what sound system you're receiving and a signal bar graph indicates signal strength. All functions are controlled from the hand-held wireless remote.

The sky is alive with the sound of music

Luxor loudspeakers bring new life to TV audio, mono or stereo, and much more. Satellite audio sub-carriers broadcast a wide range of music for audio only. These optional high quality 6-speaker sets (3 per side) are available in passive or active models with sound power up to 40 W per channel. They are specially magnetic shielded for close location to your TV set.

Here is the best of Scandinavian design and high technology. Because Luxor is a leading European manufacturer of satellite products, TVs, audio hi-fi systems, and computers, the company is able to combine these technologies in the advanced 9900 series. After all, Luxor has been a leader in radio, television and electronic technology since 1923.

Simple, clear and color-coded

The Luxor hand-held remote is clearly organized to make life easy. Distinctive color sections present satellite and channel selection functions, tuning functions and switching functions. For most viewing however, video and audio delivery will be automatic. When a channel is selected, the exclusive Luxor Micro-Step™ Tuning System (LMS) automatically seeks out the right signal within that channel's frequency. The receiver automatically compensates for any form of frequency drift due to climate or transponder variances.

An internal TI filter can be assigned to individual channels to minimize terrestrial interference.

And a discrete parental lock-out can eliminate one or more individual channels on a single satellite, as desired.

That's it. Advanced Luxor technology has produced a system so simple to operate, yet complete enough to satisfy the most fanatic videophile and audiophile. For the technician, the Luxor 9900 even has its own diagnostic system built-in and ready at the touch of a button.

The perfect companion

The Luxor Model 9995 Block Satellite Receiver is designed and built to function as an add-on receiver to Luxor 9900 multiple TV's installations. This low cost manually operated receiver offers independent channel selection for TV's located throughout the house. The 9995 can also be used as a stand-alone receiver for both C-Band and Ku-Band reception.
Each electronic innovation is incorporated to aid ease of operation, assure high performance reliability, and maintain outstanding quality of both picture and sound.

9900 Block Receiver

Control Functions
+ Integrated satellite receiver and antenna controller.
  • C-band (4 GHz) and Ku-band (12 GHz) capable.
  • Remote control switchable.
  • Satellite direct access.
  • Transponder direct access.
  • Built-in A/B switch.
  • "Normal" button return to factory pre-set values.
  • Built-in polarator driver.
  • Non-volatile memory unaffected by power outages.
  • Remote sensor interface.

Programs
+ Factory programmed for individual transponders on each satellite.
  • Automatic correct audio system factory programmed for each satellite and each transponder.
  • Program capacity up to 864 individual selections, audio video matched and fine tuned.
  • Self-diagnostic microprocessor.
  • LED display of satellite, channel, audio video system and signal strength.

Video Functions
+ Luxor Micro-Step™ tuning system (LMS).
  • Baseband audio and video output for VCR or monitor.
  • Baseband input for either video sources.
  • Built-in Linearity control.
  • Built-in programmable TI filter.
  • Raw video (unfiltered, unclamped) for descrambler connection.

Audio Functions
+ Audio subcarrier frequency read-out.
  • Wide/Narrow Bandwidth selection.
  • Remote audio volume control.
  • Remote stereo balance control.
  • Remote Dolby® on/off.
  • 5 audio modes-2 mono, 2 matrix, and discrete stereo. Automatic multiplex selection.
  • Built-in stereo processor.
  • Direct loudspeaker drive.

9901 Remote Control

+ Full-function, color-coded IR wireless remote control.
  + Remote ON/OFF.
  + Discrete parental lock-out for individual channels.
  + Remote mute.
  + Volume control.
  + Channel UP/Down.
  + Audio lock-out.
  + Antenna fine tune.
  + Satellite selection.
  + Channel selection.
  + Divided into 4 easy-to-read segments: Satellite selection, channel selection, tuning functions, switching functions.

9904 Actuator Interface

+ 36V power supply to antenna drive.
  + Surge protected.
  + Voltage spikes protected.
  + Design coordinated with 9900.
  + Can be wall-mounted out of sight.

9906/9907 Stereo Loudspeakers

+ Passive or active models.
  + Up to 40 W per channel.
  + 3 elements per side: tweeter, mid-range and woofer.
  + Automatic ON/OFF.
  + LED indicators: standby and active.
  + Complete with line cable feed.

9995 Block Satellite Receiver

+ Add-on "slave" to 9900 multiple TVs installations.
+ Can function as a stand-alone block receiver;
  • C-band and Ku-band reception.
  • Manually operated channel selection.
  • Video fine tune. AFC defeat.
  + Built-in V/H switch.
  + Built-in antenna switch for satellite or local reception.
  • Preprogrammed audio frequencies 6.2 and 6.8 MHz.
  • Audio frequency selection 5.0 to 8.0 MHz.
  + Wide/narrow audio bandwidth selection.
  + Raw video output (unclamped, unfiltered) for descrambler connection.
  + External TI Filter input.
  + Skew control.
  + Polarator One control output.
  + Denotes new features available only on 9900 series products.

Luxor High-Performance Microwave Block Downconverters

Designed and constructed for continuous reliable performance, each Luxor unit is individually inspected and tested against all specification requirements. The Block Downconverter (30 dB gain min.) is used in conjunction with an LNA. The LNAB Block Downconverter (60 dB gain min.) is an LNA and a Block Downconverter in one compact package. Each unit is weather-tight, rust-proof and fully warranted.

Luxor Sales And Technical Services Throughout America
1-(800) 245-9995
Canada: Evolution Technology (416) 335 4422
Mexico: Klan SA 52 83 789 015

Luxor (North America) Corp.
600 108th Ave. N.E., Bellevue, WA 98004
a compact 75-meter monoband transceiver

Modular design yields 30 watts PEP and high performance

This article describes a compact monoband SSB transceiver that employs broadband techniques, IC building blocks, and an FET power chain. A detailed block diagram that shows all module interconnections is shown in fig. 1. As an extension of an earlier receiver project, the design provides all of the basic features required for convenient operation. The receiver section offers excellent sensitivity and selectivity, audio-derived AGC, an S-meter, headphone or speaker operation, and above-average audio quality. The transmitter has amplified ALC and delivers 30 watts PEP to a 50-ohm load. The completed package is about the size of a 2-meter FM transceiver, measuring 2 x 5 x 6 inches (5 x 12.7 x 15.25 cm) and weighing about 2 pounds (1 kg).

Circuit description

The transceiver employs a single conversion frequency plan with a 9-MHz IF and a 5.0-MHz VFO. Receiver preselection is provided by a two-section bandpass filter (see fig. 2). Additional HF rejection is obtained from the transmitter's low-pass filter. Receiver mixer U1 is an active DBM which has been biased for maximum gain. Mixer output is fed to crystal sideband filter FL1 through a simple diode switching network.

IF stage U2, shared by the transmitter, provides 45 dB of gain with an AGC range of about 70 dB. Gain for the entire receiver is controlled via U2's AGC line. Automatic control is audio-derived from the output of audio amplifier U4. Manual control is provided by a voltage divider circuit. During the receive cycle, the two control voltages are gated onto the AGC line through diodes. The output of IF amplifier U2 is simultaneously fed to product detector U3 and transmit mixer U7. U3, an active DBM product detector, provides audio detection and additional system gain.

Since gain is controlled exclusively through IF amplifier U2, audio amplifier U4 operates at full gain (see fig. 3). U4 provides 400 mW of output — more than enough to drive the transceiver's small built-in speaker. Attenuation is provided for speaker protection and for headphone operation.

AGC voltage is sampled from the output of U4, detected, and fed to DC amplifier Q1. The RC time constant of Q1 is switched to provide slow release time during receive, and fast release time during transmit. Q2 provides additional amplification of the control signal, sets the AGC threshold for U2, and drives meter M1. M1 functions as an S-meter during receive and as an ALC indicator during transmit. The entire receiver section operates from a 12-volt source with an average current drain of only 50 mA on receive.

By Rick Littlefield, K1BQT, Box 114 Barrington, New Hampshire 03825

A small heatsink is sufficient for intermittent SSB operation, but area should be increased for CW operation. Mounting FL1 on rear panel saves internal space.
Low-Z microphone amplifier U5 is a standard op-amp circuit which develops the necessary audio voltage to drive balanced modulator U6 (see fig. 4). Like all other mixing devices in the transceiver, U6 is an active DBM. Provisions are made to unbalance the device when carrier is needed for RF chain or antenna tuner adjustment. The output of U6 is fed through a diode switching network to sideband filter FL1 and IF amplifier U2. As noted earlier, ALC voltage is applied to U2 during transmit to maintain high transmitter output without driving the RF chain into saturation.

Transmit mixer U7 combines the IF signal from U2 with VFO drive to produce 75 meter output (a CW-only design would substitute BFO drive for the IF signal). The output of U7 is buffered and amplified by
fig. 2. Receiver module. All phasing and combining of transformer leads is done via the circuit board layout. Transformer leads are simply inserted as shown.

Receiver, exciter, and audio modules are located in the top compartment of the cabinet. VFO is in a separate front compartment.

pre-driver Q3 (see fig. 5). If CW operation is anticipated, keying can be added to this stage by simple modification. Output can be reduced for QRP operation by adjusting the bias on gate No. 2. The output of Q3 is filtered by a two-section bandpass filter. Driver Q4, an inexpensive HEXFET, develops 300 mW PEP — enough power to drive PA Q5. A three-element low-pass filter reduces harmonic content prior to final amplification.

The final amplifier Q5 is a Motorola T-MOSFET operating in class AB (see fig. 6). At 4 MHz, this 28-volt device operates at approximately 70 percent efficiency, provides 20 dB of gain, and delivers 30 watts PEP into a 50-ohm load. The output of Q5 is transformed to 50 ohms through 4:1 balun T5 and fed into a 7-element Chebyshev low-pass filter. A diode detector at the LPF input samples amplifier output for ALC (see fig. 7).

All transmit and receive mixing functions are handled by active DBMs, devices which require no more
than 100 mV of injection. Consequently, drive demands on the VFO and BFO are minimal. VFO Q6 is a popular Hartley JFET circuit which is buffered by source follower Q7 (see fig. 8). An optional VFT control aids fine tuning. BFO Q8 is a simple unbuffered crystal oscillator (see fig. 9). If the transceiver is modified for 20 or 15-meter operation, the BFO output should be carefully matched to its load and filtered for harmonic content.

The PA is the only stage requiring a 28-volt source. An on-board monolithic voltage regulator reduces supply voltage to the other stages. The compact 28-volt
ICOM 25-1300MHz Plus!

ICOM introduces the IC-R7000 advanced technology 25-2000MHz continuous coverage communications receiver. With 99 owner programmable memories, the IC-R7000 covers low band, aircraft, marine, business, FM broadcast, amateur radio, emergency services, government and television bands.

Keyboard Entry. For simplified operation and quick tuning, the IC-R7000 features direct keyboard entry. Precise frequencies can be selected by pushing the digit keys in sequence of the frequency or by turning the main tuning knob.

99 Memories. The IC-R7000 has 99 memories available to store your favorite frequencies, including the operating mode. Memory channels may be called up by simply pressing the Memory switch, then rotating the memory channel knob, or by direct keyboard entry.

Scanning. A sophisticated scanning system provides instant access to most used frequencies. By depressing the Auto-M switch, the IC-R7000 automatically memorizes frequencies in use while the unit is in the scan mode. This allows you to recall frequencies that were in use.

Other Outstanding Features:
- FM wide/FM narrow/AM/upper and lower SSB modes
- Six tuning speeds: 0.1, 1.0, 5, 10, 12.5 or 25KHz
- Dual color fluorescent display with memory channel readout and dimmer switch
- Compact Size: 4-3/8"H x 11-1/4"W x 10-3/8"D
- Dial lock, noise blanker, combined S-meter and center meter
- Optional RC-12 infrared remote controller
- Optional voice synthesizer. When recording, the voice synthesizer automatically announces the scanned signal frequency.

Specifications guaranteed from 25-1300MHz. No additional module required for coverage to approximately 2.0GHz.

See the IC-R7000 receiver at your local authorized ICOM dealer. Also available is the IC-R71A 0.1-30MHz general coverage receiver. ALL THIS AT A PRICE YOU'LL APPRECIATE.
fig. 8. VFO module.

fig. 9. BFO module.

fig. 10. The transceiver's compact power supply measures only 4 x 3 x 3 inches (10 x 7.6 x 7.6 cm). The design is simple, and can be built entirely from off-the-shelf Radio Shack components.

fig. 11. External power supply schematic.

fig. 12. Transceiver on-board regulator.

external power supply and schematic shown in figs. 10 and 11, respectively, was built from off-the-shelf Radio Shack components. The output of transformer T1 is bridge rectified, filtered, and regulated by pass transistor Q1. Adjustable regulator U1 drives the base of Q1 to set output voltage and to provide additional electronic filtering. An on-board regulator is also incorporated in the transceiver (fig. 12).

construction

The boards for this project were laid out in modular strips to facilitate modification during the design pro-
fig. 13. Receiver module.
A complete kit containing all parts, etched pre-drilled circuit boards, punched, painted enclosure, and assembly manual is available from Radiokit, Box 411, Greenville, NH 03048
fig. 15. Exciter module.
**9 MHz CRYSTAL FILTERS**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Application</th>
<th>Bandwidth</th>
<th>Poles</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>XF-6A</td>
<td>SSB</td>
<td>2.4 kHz</td>
<td>5</td>
<td>$63.15</td>
</tr>
<tr>
<td>XF-6B</td>
<td>SSB</td>
<td>2.4 kHz</td>
<td>8</td>
<td>$72.05</td>
</tr>
<tr>
<td>XF-6B-01</td>
<td>LSB</td>
<td>2.4 kHz</td>
<td>8</td>
<td>$95.90</td>
</tr>
<tr>
<td>XF-6B-02</td>
<td>USB</td>
<td>2.4 kHz</td>
<td>8</td>
<td>$95.90</td>
</tr>
<tr>
<td>XF-6B-10</td>
<td>SSB</td>
<td>2.4 kHz</td>
<td>10</td>
<td>$125.65</td>
</tr>
<tr>
<td>XF-8C</td>
<td>AM</td>
<td>3.75 kHz</td>
<td>8</td>
<td>$77.40</td>
</tr>
<tr>
<td>XF-8D</td>
<td>AM</td>
<td>5.0 kHz</td>
<td>8</td>
<td>$77.40</td>
</tr>
<tr>
<td>XF-9E</td>
<td>FM</td>
<td>12.0 kHz</td>
<td>8</td>
<td>$77.40</td>
</tr>
<tr>
<td>XF-9F</td>
<td>CW</td>
<td>500 Hz</td>
<td>4</td>
<td>$54.10</td>
</tr>
<tr>
<td>XF-9N</td>
<td>CW</td>
<td>500 Hz</td>
<td>8</td>
<td>$95.90</td>
</tr>
<tr>
<td>XF-9H</td>
<td>CW</td>
<td>250 Hz</td>
<td>8</td>
<td>$131.20</td>
</tr>
<tr>
<td>XF101</td>
<td>IF Noise</td>
<td>15 kHz</td>
<td>2</td>
<td>$17.15</td>
</tr>
</tbody>
</table>

**10.7 MHz CRYSTAL FILTERS**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Application</th>
<th>Bandwidth</th>
<th>Poles</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>XF107-A</td>
<td>NBFM</td>
<td>12 kHz</td>
<td>8</td>
<td>$67.30</td>
</tr>
<tr>
<td>XF107-B</td>
<td>NBFM</td>
<td>15 kHz</td>
<td>8</td>
<td>$67.30</td>
</tr>
<tr>
<td>XF107-C</td>
<td>WBFM</td>
<td>30 kHz</td>
<td>8</td>
<td>$67.30</td>
</tr>
<tr>
<td>XF107-D</td>
<td>WBFM</td>
<td>36 kHz</td>
<td>8</td>
<td>$67.30</td>
</tr>
<tr>
<td>XF107-E</td>
<td>Pro/Data FFM</td>
<td>40 kHz</td>
<td>8</td>
<td>$67.30</td>
</tr>
<tr>
<td>XF107-F</td>
<td>FM</td>
<td>14 kHz</td>
<td>4</td>
<td>$30.15</td>
</tr>
</tbody>
</table>

Export inquiries invited. Shipping $3.75.

**MICROWAVE MODULES VHF & UHF EQUIPMENTS**

Use your existing HF or 2M rig on other VHF or UHF bands.

**LOW NOISE RECEIVE CONVERTERS**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1691 MHz</td>
<td>MM1691-137</td>
<td>$249.95</td>
</tr>
<tr>
<td>1296 MHz</td>
<td>MM1296-144G</td>
<td>$149.95</td>
</tr>
<tr>
<td>432/435 MHz</td>
<td>MM432-28/5</td>
<td>$74.95</td>
</tr>
<tr>
<td>435-7 TV</td>
<td>MM439-Ch</td>
<td>$89.95</td>
</tr>
<tr>
<td>220 MHz</td>
<td>MM220-2B</td>
<td>$74.95</td>
</tr>
<tr>
<td>144 MHz</td>
<td>MM144-28</td>
<td>$59.95</td>
</tr>
</tbody>
</table>

Options: Low NF (2.0 dB max., 1.25 dB max.), other bands & IF's available.

**LINEAR TRANSVERTERS**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Power Output</th>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1296 MHz</td>
<td>10 W output, 2M in</td>
<td>MM1296-144-G</td>
<td>$299.95</td>
</tr>
<tr>
<td>432/435 MHz</td>
<td>10 W output, 10 M in</td>
<td>MM432-28/5</td>
<td>$269.95</td>
</tr>
<tr>
<td>144 MHz</td>
<td>10 W output, 10 M in</td>
<td>MM144-28</td>
<td>$179.95</td>
</tr>
</tbody>
</table>

Other bands & IF's available.

**LINEAR POWER AMPLIFIERS**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Output Power</th>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1296 MHz</td>
<td>20 W output</td>
<td>MM1296-20-L</td>
<td>$439.95</td>
</tr>
<tr>
<td>432/435 MHz</td>
<td>100 W output</td>
<td>ML432-100</td>
<td>$369.95</td>
</tr>
<tr>
<td>435-7 TV</td>
<td>50 W output</td>
<td>ML439-Ch</td>
<td>$199.95</td>
</tr>
<tr>
<td>220 MHz</td>
<td>30 W output</td>
<td>ML432-30-LS</td>
<td>$209.95</td>
</tr>
<tr>
<td>144 MHz</td>
<td>200 W output</td>
<td>ML144-200-L</td>
<td>$374.95</td>
</tr>
<tr>
<td>144 MHz</td>
<td>100 W output</td>
<td>ML144-100-L</td>
<td>$239.95</td>
</tr>
<tr>
<td>144 MHz</td>
<td>50 W output</td>
<td>ML144-50-LS</td>
<td>$149.95</td>
</tr>
<tr>
<td>144 MHz</td>
<td>30 W output</td>
<td>ML144-30-LS</td>
<td>$109.95</td>
</tr>
</tbody>
</table>

All models include VOX T/R switching, 2M models 1 or 3W drive, others 10W drive.

Shipping: FOB Concord, Mass.

**ANTENNAS**

**420-450 MHz MULTIBEAMS**

<table>
<thead>
<tr>
<th>Element</th>
<th>Bandwidth</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 Element</td>
<td>70/70/70</td>
<td>$39.95</td>
</tr>
<tr>
<td>48 Element</td>
<td>70/70/48</td>
<td>$69.95</td>
</tr>
<tr>
<td>88 Element</td>
<td>70/70/48</td>
<td>$89.95</td>
</tr>
</tbody>
</table>

**144-148 MHz J-SLOTS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 x 10 Twisted</td>
<td>$69.95</td>
</tr>
<tr>
<td>10 x 10 Twisted</td>
<td>$69.95</td>
</tr>
</tbody>
</table>

**UHF LOOP YAGIS**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1250-1350 MHz</td>
<td>MM1296-20-L</td>
<td>$49.95</td>
</tr>
<tr>
<td>1560-1750 MHz</td>
<td>MM1691-20-L</td>
<td>$59.95</td>
</tr>
</tbody>
</table>

Order Loop-Yagi connectors extra: Type N $14.95, SMA $5.95

Send 44¢ (2 stamps) for full details of all your VHF & UHF equipment and KVG crystal product requirements.

(617) 263-2145
SPECTRUM
INTERNATIONAL, INC.
Post Office Box 1084
Concord, MA 01742, U.S.A.

---

wire. Prepare all FT cores in advance by smoothing the corners and applying two coats of clear nail polish (FT cores are usually epoxy coated and require no preparation). Since most toroid devices have delicate leads that are easily broken, they should be mounted last and glued securely to the board with Ambroid™ cement.
The transceiver can be packaged to suit the builder. The larger cabinet shown here provides more panel space and room for a larger speaker.

Because the VFO circuit is vulnerable to thermal and mechanical instability, its construction requires special attention. These hints should be followed to insure satisfactory performance:

- Use NPO capacitors in the tank circuit wherever possible — the thermal characteristics of silver mica capacitors are often unpredictable.
- To immobilize VFO inductor windings, dip or paint the coil in clear nail polish and sandwich it to the board between fiber washers with a non-inductive screw.
- To insure smooth tuning, the main VFO variable should be a ball-bearing design with either a built-in or external reduction drive.
- The calibration trimmer should be a miniature air-variable (ceramic trimmers drift).
- When installing the VFO module, make all leads connecting external VFO components as short and rigid as possible.
- To avoid thermal instability, locate the VFO away from heat-generating stages such as the PA and the voltage regulator.
Shield the VFO compartment against strong RF fields.

Locate the transceiver's T-R relay away from the VFO compartment. If located too close, the relay's magnetic field will produce an unwelcome frequency shift.

The only other stage requiring special care during construction is the final amplifier. To prevent the possibility of VHF parasitics, strip-line construction is used and components are soldered directly to the top of the board. To insure strong solder connections, each lead should have a short 90-degree bend at its end in order to make flat contact with the board's surface. The transistor should be mounted first. The MRF-13B is an unprotected MOS device, and I recommend using a grounded iron and wrist-strap to prevent static build-up during installation. Once the module is completed, the circuitry will protect the device.

The transceiver cabinet is a bi-level design fabricated in a custom sheet-metal shop. While this packaging contributes to the appearance and small size of the finished unit, much simpler cabinetry is perfectly acceptable as long as a few basic conditions are met. First, all recommendations to insure VFO stability should be observed. Second, the PA module should be mounted to the inside of the back panel with a suitable external heatsink provided on the opposite side. Additional heatsink area is required for extended phone, RTTY, or CW operation. Finally, the VFO and BFO should be fully shielded.

In any modular project, interstage wiring can become a nightmare if the wire is prone to breakage or is difficult to handle. Selecting only highly flexible small-diameter wire and shielded cable keeps interstage harnesses small and manageable. I have found that lavaliere microphone cable is smaller and much
easier to handle than RG-174 miniature coax. Mounting boards on 1/4-inch standoffs also contributes to a neat layout, since this provides space for interstage wiring to pass underneath. Once the modules are mounted and interstage wiring is completed, testing and alignment can begin. Power distribution and T-R switching should be thoroughly checked first, since an error here could damage components.

alignment

Fixed capacitor values in the VFO tank may require some substitution to establish the desired operating range (5000 kHz to 5200 kHz for 4000 to 3800 kHz operation). Once this range is established, a tuning dial can be calibrated. A frequency counter facilitates the calibration process. Once the VFO dial is calibrated, receiver alignment can proceed. Use fig. 21 to locate the calibration and alignment controls.

- Connect the receive and transmit mixers to the VFO, and adjust RVFO for 100 mV RMS output.
- Connect the product detector and balanced modulator to the BFO, and adjust CBFO for an operating frequency of 9001.5 kHz. Adjust RBFO for an output of 100 mV RMS.
- Set the receiver AGC threshold by adjusting RTSH for 5 volts as measured at TP1. Zero the S-meter via RZRO.
- Set the receiver gain fully clockwise for maximum gain and adjust IF transformer T2 for a peak in background noise.
- Connect a 50-ohm antenna and tune the VFO to 3900 kHz. Peak bandpass filter trimmers C1 and C2 for maximum sensitivity.

The receiver should now be fully functional. Check AGC action by tuning in an extremely strong SSB signal. If the audio cracks and distorts at full gain, the AGC is under-controlling IF stage U2. Increase AGC gain via RAGC to eliminate this condition. If the audio "pumps" on voice peaks or motorboats with no signal, the opposite conditions exist and AGC gain should be decreased. Meter sensitivity control RSEN should be adjusted so that extremely strong signals register in the upper 10 percent of the scale.

To prepare for transmitter alignment, disconnect the 28-volt supply line from the final amplifier board. Terminate the output of the driver with a 47-ohm resistor and connect a scope across the termination. Microphone gain RMIC should be set fully off, and predriver gain RDRV set to the middle of its range (maximum gain). Tune the VFO to 3900 kHz.

- Key the transmitter and activate the carrier insert switch. Adjust IF transformer T2 and bandpass filter trimmers C3 and C4 for maximum output.
- Key the transmitter and adjust RBAL for minimum carrier output. A receiver tuned to the output frequency may provide a better null indication.
- Connect a 500-ohm dynamic microphone and advance RMIC to 75 percent. Speak into the microphone and watch the scope for signs of instability ("grass" or parasitic oscillations on the waveform). The pattern may show flat-topping on voice peaks, since the ALC is not yet functional.

If instability or parasitics are observed, find their source before going on. Check the RF amplifiers in isolation, and check IF amplifier U2 (reducing the value of the 10-kilohm resistor across the primary of T1 should tame unstable operation in U2). If operation is normal through the driver stage, alignment can continue.

- Connect the 28-volt supply line to the final amplifier board through an ammeter. Short the amplifier's input terminal to ground. Key the transmitter, and adjust RSET for an idling current of 250 mA. Note that this adjustment is sensitive to changes in supply voltage. If the power supply voltage is changed significantly at a later date, the bias should be re-set.
- Remove the driver termination, unshort the input to the PA, and hook up the driver. Connect a 50-ohm dummy load to the output of the transceiver. Place a single turn pick-up loop through balun T5, and connect it to the scope. The driver low-pass filter and bandpass responses are shown in figs. 22A, B.
fig. 21. Calibration and alignment controls.
• Key the transmitter and speak loudly into the microphone, adjusting \( R_{\text{ALC}} \) for maximum transmitter output. The scope pattern should show flat-topping on voice peaks. If saturation does not occur, increase microphone gain until it does. If the final cannot be saturated, system gain is low and a problem exists (check the AGC threshold voltage at TP1 first; if set above 5 volts, transmitter gain is reduced).

• To set ALC level, close-talk the microphone and adjust \( R_{\text{ALC}} \) to the point where flat-topping just disappears. The ALC meter should deflect past mid-scale on voice peaks and a power meter should indicate an average output of 10-15 watts.

This completes transceiver alignment.

**performance**

The transceiver was tested to see if performance approximated industry standards and met FCC regulations for spectral purity. Receiver noise floor was measured at \(-120\) dBm. Selectivity reflected the published specifications of filter FL1. AGC held a 60 dB change in signal strength to a 3 dB change in audio output. AGC attack was a bit slow, resulting in some audible “cracking” on extremely strong signals. This condition is not uncommon in simple audio-derived systems. Overall receiver audio quality was judged excellent when compared against a popular imported multi-band transceiver. Tests for receiver intermodulation distortion were not conducted.

At 30 watts PEP output, transmitter IMD was measured at \(-30\) dB. Second and third harmonics were \(-47\) dB and \(-55\) dB, respectively. Saturation occurred at 35 watts PEP. Transmit audio reports were generally excellent, but microphone selection was an important factor. Low-Z broadcast dynamics produced the best overall quality, but an inexpensive mobile microphone provided a bit more “punch” under difficult band conditions. The MRF-138 final amplifier survived open and shorted port conditions without damage, indicating acceptable immunity to high SWR.

**operation**

The transceiver’s small size makes it a natural for traveling, or for use as a second station at home. Mine resides in a corner of the family room on a small writing desk, close to the wood stove, kitchen, and other comforts of home. On-air performance has been very gratifying. Using an inverted-V antenna at 50 feet, I have worked all U.S. call areas, operated contests, controlled nets, and elbowed my way through evening QRM with excellent regularity. In evaluating the transceiver’s effectiveness, it is important to remember that dropping transmitter output from 100 watts to 30 watts reduces the received signal less than 1 S-unit. Under most band conditions, this is not significant.

**conclusion**

My goal was to design and build a simple monoband SSB transceiver that would be compact, easy to replicate, and powerful enough to provide reliable communication on 75 meters. Off-the-shelf components and contemporary design techniques were employed wherever possible to make the job easier. The transceiver described in this article is my third, and carries with it the experience of the first two. With minor modifications, the design should be transferable to other bands. I hope this article will encourage others to take the plunge and build — there’s no magic involved, and the enjoyment that comes from operating a homebrew rig is fantastic.

**references**

PACKET RADIO . . .  
... THE FASTEST GROWING PART OF AMATEUR RADIO TODAY

is already providing high speed, error free, communications on many amateur bands for qso's, data transmission, emergency traffic, dx'ing, traffic nets, mailboxes, endless experimentation, and soon... satellite operation.

networks continue to grow, as does the number of hams who enjoy this new and exciting mode. The increasingly popular PACKETERM IPT is contributing to phenomenal growth in amateur packet radio by providing a full function packet terminal in a compact, portable unit...

ALL YOU NEED FOR PACKET OPERATION

IS A PACKETERM IPT AND YOUR RIG !

designed for true portability, the IPT is equally at home in your ham shack or (with its optional carrying case) trekking in the country for battery powered hilltopping!

A single cable connects to your transceiver....that's all there is to it!
Use it with your base station, mobile, or with your HT on that hilltop!!!

FEATURES: * 9 inch portable terminal and full function tnc combined

** 66 commands available - the most widely used, field proven programming.

** Built-in LSI modem; 300 or 1200 baud, 200 or 1 kHz audio shift

** stores setup parameters with power off - uses lithium battery

** custom "beacon" text -- your call, qth, etc. in permanent memory

** 74 key, full travel keyboard with 14 function keys for commands, calls, etc.

** printer port - RS232C serial

** optional printer, carrying case, and dc adaptor (13.8 VDC)

-Packeterm-

Box 835, Amherst, NH 03031
(603)-673-6630

PRICES: IPT COMPLETE $995

PRINTER $349

DC ADAPTOR $125

TNC (BOARD ONLY) $275

28 November 1985
high stability local oscillators for microwave receivers and other applications

Phase-locked approach offers greater stability

This article describes a reliable phase-locked loop originally designed for the first conversion of a radio astronomy microwave receiver and applicable for general microwave receiver use and to other HF, VHF, and UHF phase-locked applications as well. Its design evolved from one of my earlier efforts incorporated in a fully synthesized, general coverage HF transceiver as shown in fig. 1.

Local oscillators used for conventional microwave (TVRO) such receivers are usually open loop and are installed outdoors as part of the first converter, known as the "head end" and located at the feed point of a parabolic dish antenna. They normally exhibit gross frequency instability (typically ±1.5 MHz) due to their free running characteristics, which are affected by ambient temperature changes as well.

The two types of open-loop local oscillators most commonly used for this application are the free running tuned cavity and the crystal controlled multiplier type. This article deals with the second approach, which allows an already-clean multiplier chain to lock on a much more stable reference frequency strategically located away from the elements. Consequently, the unit can be used under varying temperature conditions and will follow a remote reference source kept indoors for good stability.

The synthesizer uses a simple version of a type-one crystal-controlled phase-locked-loop operating at 88 MHz. Its output is divided by a fixed modulus divider involving emitter-coupled-logic (ECL) and transistor-transistor-logic (TTL) circuits. The division number \( N \) is fixed at 88 and followed by an exclusive OR digital phase detector that closes the loop through a simple low-pass filter as shown in fig. 2.

In order to obtain the desired microwave frequency, the output of the oscillator running at exactly 88 MHz is used to drive a times-12 multiplier such as described by Paul Shuch, N6TX. Other multiplications are possible for even higher frequencies. The reference frequency can be supplied to the synthesizer from the back end of the receiver via fiber optics or coaxial cable communication links (depending on the distance; digital line drivers may be required in the latter). With this approach, a remotely located temperature-compensated crystal oscillator (TCXO) that acts as a time base will maintain the short and long term frequency stability of the 88-MHz crystal oscillator through the phase-locked technique. The stability of the multiplier chain in the microwave receiver will thereby also be favorably affected. High initial stability and spectral purity would be required to compensate for the magnifying effect of the multiplier. My circuit used a 4-MHz TCXO manufactured by McCoy Electronics for the reference oscillator. This part guarantees ±5 \( \times \) 10^{-7} (±0.5 PPM or ±2 Hz at 4 MHz) Hertz per year. This represents an ultimate stability for the remotely located L-band local oscillator of ±6 Hertz, respectively.

The circuit design of the synthesizer is simple (although making one work is another story) as shown in fig. 3. A highly stable 88-MHz (0.001 percent) fifth overtone crystal was chosen to guarantee initial start-up almost on frequency before locking occurs. It is

By Cornell Drentea, WB3JZO, 7140 Colorado Avenue North, Brooklyn Park, Minnesota 55429

November 1985
fig. 1. Application of fixed VHF phase-locked-loops in a fully-synthesized HF transceiver. The VHF loop described here is used twice (88 MHz and 90 MHz for the BFO) in order to ensure full synthesis for the entire radio.
used in a series resonant Colpitts oscillator with one side of the crystal grounded. I selected the Colpitts design because of its well known circuit stability and predictability. The output of the oscillator is then amplified and converted to the ECL level required by the 95H90 divide-by-11 device.

An ECL-to-TTL level shifter circuit follows the 95H90 and additional division is obtained with three divide-by-2 sections of 74LS74 devices.

The divided-down 1-MHz input to the phase comparator 74L86 (slow L logic was chosen here to keep the output as quiet as possible) is compared against a true 1-MHz reference available from the back end. The exclusive OR phase detector was chosen as a perfect application for this type of phase-locked-loop because the crystal controlled Colpitts oscillator is guaranteed to start almost on frequency and within the capture range of this particular type of phase detector which is only 2π. Other important criteria for choosing this type of phase detector were the 50 percent duty cycle of the signals present at its inputs and the high reference frequency (1 MHz), all design requirements for successfully using an exclusive OR gate as a phase detector.

When the loop is locked, the output of the phase detector is a 50 percent duty cycle square wave at twice the reference frequency; in this case it is 2 MHz as shown in fig. 4. This output is averaged by the simple RC low-pass filter with a corner frequency (ωc) of about 16 Hz and is finally presented to the Amperex varactor diode BB-109, which acts as a variable capacitor steering the crystal oscillator in lock. Under locked conditions, the averaged DC output of the phase detector equals half of the TTL supply voltage, or about 2.5 volts DC. When this occurs, the divided 1-MHz signal present at one of the phase detector inputs lags reference 1-MHz signal present at the other input.

---

*Among many ECL dividers, the 95H90 or its equivalent, the Plessey SP8040 can be programmed to be divide-by-10 or 11, or both in high resolution dual modulus phase-locked-loops.*

---

**fig. 2.** Block diagram of the phase-locked-loop as used in a stable microwave local oscillator located at the low noise block converter (LNB) outdoors. The 1 MHz reference frequency is derived from an indoor TCXO.
fig. 3. Circuit diagram of the phase-locked-loop. A fifth overtone series-tuned Colpitts oscillator was chosen for stability. The design results in simple and effective exclusive OR phase detectors and low-pass filter. The relatively high 1 MHz reference allows for clean and stable LOs (see text).
fig. 4. (A) Locked condition. (B) Out-of-lock conditions for a synthesizer using the exclusive OR phase detector. The output of the low-pass filter is a 2.5 volts DC signal (see text).
Fig. 5. (A) The synthesizer circuit was frozen to -78 degrees F with cooling spray. (B) After calibration the phase-locked-loop remained locked over the entire temperature range. The divided 1 MHz square wave shown at the top follows the reference frequency at the bottom by -90 degrees, which represents a 0-degree phase error (see text).

Inject a 2.5 VDC level at the 10 kilohm resistor (which is part of the low-pass filter. The best way to do this is to use a couple of batteries in series through a 10-kilohm linear potentiometer voltage divider to insure a pure DC voltage. With the circuit board heated to 80-degrees F (a 100-watt lamp on top of the circuit will do well), adjust L1 and L2 for resonance at the fifth overtone of the crystal as measured on a frequency counter. Observe the position of the cores. Cool the circuit to -78 degrees F with a dry cooling spray. Adjust L1 and L2 again for resonance. (The circuit should still work at this temperature; according to calculations, the transistor junctions will reach only about -40 degrees F.) To accomplish this, selected parts have been used in the prototype. Again, observe the new position of the cores.

Wait until the circuit returns to room temperature and readjust L1 and L2 midway between the two positions. Remove the 2.5 VDC voltage from the low-pass filter and reconnect the loop back at A.

The circuit should now lock every time power is turned on and lock should be maintained over the entire temperature range. This can be verified through repeating the above procedures with the loop closed.

Figures 5A and B show the "brassboard" of the synthesizer and how phase locking was maintained under freezing conditions. For convenience a lock indicator was incorporated in the design as shown in Fig. 3.

An out-of-lock condition would be indicated by the blinking LED, should recalibration become necessary.

Fig. 6. Spectrum analyzer tests performance of the phase-locked-loop.

by approximately 90 degrees (delay is introduced by the additional circuitry) which corresponds to a zero phase error. The secret of the entire circuit is L1 and L2, which are calculated to resonate the Colpitts oscillator on the fifth overtone of the crystal. Additional "tweaking" may be required to bring the circuit into resonance due to local stray elements. High Q aluminum cores were used in my prototype for best results.

Adjustments

With the loop line disconnected at A (see fig. 3),
New rigs and old favorites, plus the best essential accessories for the amateur.

Newest Rigs, Best Beams, Awesome Accessories.

3621 FANNIN ST
HOUSTON, TX. 77004-3913
CALL FOR ORDERS 1-713-520-7300 OR 1-713-520-0550
ALL ITEMS ARE GUARANTEED OR SALES PRICE REFUNDED.

EQUIPMENT
Kenwood.... Call for prices on all Kenwood
New Antennics UTU-XT.... 319.00
Yaesu 2700-RH.... 529.00
Icom IC735.... 749.00
Four box price IC-735.... 2800.00
Kenwood TS940S, Contestasters delight Call
Ten-Tec 2510 Satellite.... 489.00
Icom R7000 25-2000 MHz.... Call
Alpha (ETO).... List 15%
Icom 271A, 27A.... Call
Icom IC3200.... 489.00

SERVICES
Alignment, any latest model rig.... 50.00
Flat fee Collins rebuild.... Call

ACCESSORIES
Heil HC3/HC4/HC5.... Stock
Heil BM 10 Boom Mike headset.... 53.95
Heil HCS Control Box/Interface.... 199.95
CSES 510 Smart Patch.... 349.00
FLUKE 77 auto-ranging digital multimeter.... 115.00
Shure 444D Mic.... 54.95
Bird 43 Wattmeter.... Call
Bird Elements, H/59.00, H/48.00.... Stock
Special Ameo Pre-Amps.... 10% Off
Daiwa CN6200, 20-200, 2000W.... 109.95
Collins 500Hz Filter, F45505, new.... 95.00
Sanyo AA Nicads, tabs.... 2.50
2, 4, 5, 6, 8 pin mic plugs.... 4.00
Fox Tango.... 10%
Tenna High
By D C Sales, Fits Class 1, 2 Hitches. Adapts existing hitches on truck/any truck to any HF antenna. 3/8 x 24 thread. No holes, complete unit.... 29.95
Daiwa CN630 Multi-140 450/200 watt.... 129.00

KEYS
Bencher & Vibroplex.... Less 10%
Vibroplex Carrying Case.... $20.00 w/key purchase
MFJ Super Keyboard #496.... 199.95

TUBES
GE6146B.... 11.95
Eimac 3-500Z.... 109.95
GE Industrial Tubes.... Call
GE 12BY7A.... 6.00
GE 6J56C.... 11.95
Collins & Drake Replacement Tubes.... Stock

BOOKS
Hayden, Computer Programs For Amateur Radio.... 16.95
We also stock SAMS, TAB, ARRl, RGB, Radio Publs & Ameo books.... Call
CALRAD 65-287 SWR, Relative Power Meter.... 32.95
3-150 MHz, KW +

PACKET/PICKIT!
AEA PK64.... 199.00
AEA PK60.... Soon

KANTRONICS PACKET.... 199.00
CP100 vs CP1 Worth the difference? Yes!!.... Call
ICOM 271A Great Packet Radio.... Call

ANTENNAS
AFX2B, V2S, 2MVC-5, ISOPOLE.... 44.95
A4.... 289.95
402CD.... 279.95
New Cushcraft LAC-3 Lighting Arrestor.... 7.95
215VB New, 15EL, 2MBeam.... 79.95
AOP-1, Complete Oscar Antenna.... 149.95
Butternut, HF5V, 80-10 Vertical.... 125.00
HF5V, 80-40 Vertical.... 125.00
Butterfly Antenna.... 169.95
HF4B, previous HF3B.... 169.95
Hustler G7-144.... 119.95
Barke & Williamson All Band Dipoles.... Less 10%
Ham4 Rotator, T2X, CD45-2.... Call
KLHF World Class Series Antennas.... Call Don
Cushcraft's 40-20d, hottest selling 40 meter beam band, easy assembly.... 279.95

OTHER ANTENNAS
Larsen Kulduck.... 17.00
Valor 75-100 complete mobile antenna.... 79.95
Avanti ASP151 3G, thru glass 2M.... 33.00
Anteco 25, 25, 48, Mount, Comp.... 25.00
Stoner (McKay-Dymek) DA100D Receiving Antenna.... 190.00
Philly Stran.... Call

SURPLUS
2.5A/1000P1V.... 29c Each or 19.00/100
0015/10K.... 1.95
3N201.... 95
4 Inch ferrite rod.... 1.95
Sanyo AAA Nicads tabs.... 2.50/each
Close out on rigs and accessories... All the time.... Call
Close out Curtis Memory M480.... $50.00/each
24Pin IC Sockets.... 25
365PF two gang cap.... 1.95

BELDEN
9913 low loss, solid center, foil/braid shield.... 45c/ft
8214 RG8foam.... 45c/ft
8237 RG8.... 40c/ft
8267 RG213.... 34c/ft
8000 14Ga stranded copper ant. wire.... 13c/ft
8448 8 conductor rotor cable.... 31c/ft
9405 Heavy duty, 2-16 Ga. 6-18 Ga.... 52c/ft
9258 RG6x.... 19c/ft
8403 Mic Cable, 3 condctr & shield.... 80c/ft
100 Feet 8214 w/ends installed.... 45.00
8669 7/16" tinned copper braid.... 1.10/ft
International Rite RG214, non-nil, good cable.... 70c/ft

AMPHENOL
8315P-PL259 Silverplate.... 1.25
UG176 reducer RG6X.... 30
8313 Double Female UHF.... 2.00
82-51 N Male.... 3.00
82-97 N Female Bulkhead.... 3.00
New 82-202-1006 N-Male fits 9913.... 5.00

ROHN
1/4" E.H.S. Guy cable, Rohn US.... 250.00
3/16" E.H.S. cable.... 210.00
1/4" Guy Cable, 6100#7 x 7 strand.... import.... 15c/ft.
3/16" Guy Cable, 3700#7 x 7 strand.... import.... 12c/ft.
3/8 x 6 E&J Turnbuckle.... 7.95
1/4" Wire clips.... 50
Porcelain 500D Guy Insulator (3/16).... 1.69
Porcelain 502 Guy Insulators (1/4).... 2.99

USED EQUIPMENT
All equipment, used, clean, with 90 day warranty and 30 day trial. Six months full trade against new equipment. Price refunded if not satisfied.

POLICIES
Minimum order $10.00. Mastercharge, VISA, or C.D. All prices FOB Houston, except as noted. Prices subject to change without notice. Items subject to prior sale. Call any-time to check the status of your order. Texas residents add sales tax. Dats all folks.

SPECIAL TELEPHONE OFFER
Call our numbers and when you place your order, we'll deduct a dollar off. And don't be shy. Ask tough questions. Our guys are more than order takers—they know the radios and the equipment.

DON'S CORNER
Those devoted Yaesu fans out there—the FT101E certainly had a lot of supporters—should be pleased to know that Yaesu is just about to come roaring back into the marketplace. This means new products, stronger advertising and maybe—just maybe—a price promotion or two. Yaesu started to get serious about computer control of rigs with their ultra-boxes—idea—so you might expect to see more tricks with computer control. Now—when will these guys get wise enough to have the code written for the big 4 machines in amateur radio—Radio Shack, Commodore, Apple, and IBM. Contact Madison for the latest in Yaesu all the time. Another one how about a dual banded hand-held. Two meters and 430 for openers. Certainly the technology is available... and the market is ready. First one to market with this product will move a lot of radios.

73&Good DX

DON
fig. 7. (A) Block diagram of an elegant 9 MHz BFO as used in a fully synthesized HF transceiver. The signal is derived from a dual 90 MHz phase-locked-loop similar to the one presented here (see text).

(B) Signal processing for the 9 MHz BFO. The 90 MHz derived signal is conditioned before it is applied to the active mixer product-detector/modulator.
AMATEUR TELEVISION
NEW 70 CM ATV TRANSCEIVER
ALL YOU NEED IN ONE BOX
$299 delivered
TC70-1

- FULL COLOR, SOUND, & LIVE ACTION just like broadcast TV. Get on this exciting amateur video mode at our affordable ready to go price.
- WHAT IS REQUIRED FOR A COMPLETE OPERATING SYSTEM? The TC70-1s downconverter outputs to any TV on ch 3 for receiving. Connect a good 70 cm antenna and low loss coax. Plug in any composite video source you want to transmit; Camera, VCR, computer, etc. Plug in any low-z dynamic mic or use color camera mic for Standard 45.5 MHz TV sound. Connect to 13.8 vdc for base, mobile, or portable. See chapt. 20 1985 ARRL Handbook. That's it!
- WHAT CAN YOU DO WITH THE TC70-1 ATV TRANSCEIVER? Show the shack, projects, computer program listings, home video tapes, repeat Space Shuttle audio and video if you have a TVRO, repeat SSTV or RTTY. Weather Radar, daily public service events such as parades, marathons, races, CAP searches and rescues... the list goes on. DX depends on antennas and terrain; typical 1 to 40 miles. We have video compensated RF linear amps for 20 ($119) or 50 ($189) watts pep for greater DX.
- FEATURES: Small 7x7x2.5" Push to Look (PTL) TRS switch. GAAset downconverter tunes 420-450 MHz Band. Two switch selected video & audio inputs... RCA phone jacks and 10 pin color camera jack. Xmit video monitor output. Over 1 watt pep RF output on one or two (add $15)selected crystal controlled frequencies. 439.25, 434.0, or 426.25 mhz.

CALL OR WRITE FOR OUR CATALOG for more info or who is on in your area. We stock antennas, modules, and everything you need on ATV.

TERMS: Visa, MC, or cash only UPS CODs by phone or mail. Checks must clear bank before shipment. Price includes UPS surface shipping in cont. USA. Others add $3. Transmitting equipment sold only to licensed Tech class or higher amateurs, verifiable in 1985 call book or copy of new license.

(318) 447-4565 m-f 8am-6pm pst.
P.C. ELECTRONICS
2522 Paxson Lane
Arcadia CA 91006

HOW DO RECEIVERS REALLY PERFORM? READ THIS BOOK.

$18.50 + $1.50 shipping
Available Sept.
VISA Mastercards accepted

GILFER SHORTWAVE
52 PARK AVE. • PARK RIDGE, NJ 07656 • Ph 201/391-7887

If the circuit is to be used at room temperature, such as in an HF or VHF/UHF receiver, no indicator should be required. Other status reporting features are possible and can be remotely monitored at the back end of the microwave receiver.

This synthesizer represents an effort of several weeks of design and “brassboarding.” It began with the use of a 54S124 dual VCXO integrated circuit that was intended to work at 85 MHz, but was not successful for my application because of the crystal frequency restrictions and the limited upper frequency range for this device.

The new design will work to about 140 MHz (1680- 
MHz LO output when used with the N6TX multiplier, and beyond with other multipliers). Its limitations are the fabrication of crystals at VHF frequencies and the rather small size of L1 and L2 at the higher frequencies.

This design represents a practical approach to clean and stable local oscillators. Phase and amplitude noise have been measured to be at least -70 dB/Hz at ±100 Hz from the desired carrier (see fig. 6). Discrete spurious components were better than -60 dB, while the wide band noise was at least -70 dB measured with a 10-kHz bandwidth.

These specifications depend on the application of sound RF design techniques and may vary according to the circuit components selected. Although a synthesizer layout is not provided in this article, compartmentalization of modules in a true “synthesizer fashion” is highly recommended.

As suggested at the beginning of this article, other than microwave applications of this synthesizer are possible. Among them are beat frequency oscillators (BFO) and fixed oscillators used in multi-loop fully synthesized HF and VHF/UHF receivers and transceivers, as shown in fig. 1. Figure 7A shows the block diagram of a 9-MHz BFO application as used in my HF transceiver. Figure 7B shows the circuit details of the digital to analog portion of the BFO which provides the proper injection to an active product detector/modulator in my transceiver. Many other applications are possible.

references

ham radio
must liquidate at far below dealer cost!

the computer

- Snap-on computer keyboard: 64 K RAM, 20 K ROM.
- Full size typewriter keyboard. Upper and lower case letters, numerals, symbols, reverse characters, cursor control keys, 4 function keys, programmable to 8. Music synthesizer with 3 independent voices, each with 9 octaves range. Input/output ports accommodate user, serial, RAM cartridge, joystick, external monitor, phone modem.
- Built-in disk drive: Intelligent high speed with 5 ½ floppy disk recorder, 170K formatted data storage. 35 tracks, 16K ROM. Uses single sided, single density disk. Serial interface. Second serial port to chain second drive or printer.
- Built-in color monitor: Displays 40 columns x 25 lines of text on 5” screen. High resolution. 320 x 200 pixels. 16 background, 256 colors available. Multitude of subjects available in stores across the nation!

Original List Price $995.00
Liquidation Priced at $388

the printer

- Print method: Bi-directional impact dot matrix.
- Character matrix: 6 x 7 dot matrix.
- Characters: Upper and lower case letters, numerals and symbols. All PET graphic characters.
- Character codes: CRM ASCII code.
- Print speed: 60 characters per second.
- Maximum columns: 80 columns.
- Character spacing: 10 characters per inch.
- Line feed spacing: 6 lines per inch in character mode or 8 lines per inch selectable. 9 lines per inch in graphics mode.
- Line feed speed: 5 lines per second in character mode. 7.5 lines per second in graphics mode.
- Paper feed: Friction feed.
- Paper width: 4 ½” to 6 ½” width.
- Multiple copies: Original plus maximum of two copies.
- Dimensions: 13”W x 8”D x 3½”H. WT.: 6lbs. Power: 120V AC, 60 Hz.

Original List Price $200.00

the software

"Easy Script": One of the most powerful word processors at any price! Cut re-typing, create documents from standard paragraphs, do personalized letters, see and change a document before it is printed. Instruction manual has extensive training section that simplifies use... even for someone who has never used a computer or word processor before.


Original List Price $73.98
Liquidation Price $24

BUY INDIVIDUAL UNITS OR GET THIS ULTRA-FAMOUS SYSTEM AT ONE LOW PACKAGE PRICE!

TOTAL Package Price $488

Compatible with above Computer System (Not included in package price.)

JOYSTICKS (Set of 2)
- Liquidation Price $18 pr.

64K MODEM
- Mfr. List: $124.95
- Liquidation Price $19

SEND ME THE ITEMS I HAVE LISTED BELOW Price subject to change after 80 days. Sales outside continental U.S. are subject to special conditions. Please call or write to inquire.

<table>
<thead>
<tr>
<th>Item No.</th>
<th>#</th>
<th>Item</th>
<th>Price S/H</th>
</tr>
</thead>
</table>

C.O.M.B. CO.

Authorized Liquidator

14605 28th Ave. N., Minneapolis, MN 55441-3397

November 1985
Even the beginner can build and understand these circuits.

If you're looking for a ham band receiver that combines good performance with simplicity of construction and low cost, read on — because this article is for you. This receiver covers the 80, 40, 20, 15, and 10 meter bands and can easily be modified to include the WARC bands or other shortwave segments between 3 and 30 MHz.

This project evolved in response to discussions with other hams about the deplorable decrease in the number of new Amateurs. Traditionally, a large part of our newcomers have come from the ranks of high school students; at one time, young people interested in the electronics almost inevitably gravitated to Amateur Radio because it was easy to get into, with little technical knowledge and only a small investment required. In recent years, the computer hobby with its inexpensive, easily accessible hardware — has provided similar easy entry.

Many hams have expressed the opinion that entry-level equipment has become too expensive and that construction articles now seem to deal with equipment that is complex, expensive to build, and requires a great deal of technical sophistication to construct. This started me to thinking about what it would take to build a receiver for the main ham bands that would provide good performance, yet be simple and inexpensive to build.

the VFO is important

In the 1950's and 60's most receivers used oscillators that switched coils for each band. In later years, however, multiple conversion schemes used crystal oscillators to establish each band and one non-switched oscillator as the variable frequency element to tune within each band. Many receivers now use frequency synthesized oscillators. These latter two concepts, while improving stability, unfortunately increase cost and complexity by a substantial amount.

Recalling more recent commercial rigs, such as the Atlas series, that used switched coil oscillators, I wondered how difficult it would be to design and construct a VFO that had acceptable stability for SSB reception (see fig. 1). After deciding it was worth a try, I chose 9 MHz as the IF because of the wide availability of good, inexpensive crystal filters at this frequency. For maximum utility I wanted coverage of both the CW and SSB portions of each band. The VFO covers 500 kHz on 80 through 15 meters and over 1 MHz on 10 meters. As we will see later, these ranges can be easily changed to suit the user's preference.

The choices for the IF and band ranges determine the VFO frequencies as follows:

<table>
<thead>
<tr>
<th>band meters</th>
<th>VFO frequency MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>12.5-13.0</td>
</tr>
<tr>
<td>40</td>
<td>16.0-16.5</td>
</tr>
<tr>
<td>20</td>
<td>5.0-5.5</td>
</tr>
<tr>
<td>15</td>
<td>12.0-12.5</td>
</tr>
<tr>
<td>10</td>
<td>19.0-20.0</td>
</tr>
</tbody>
</table>

Varactor diode tuning of the VFO was chosen because it helps eliminate hard-to-find mechanical

By Robert Thompson, N1BFV, 4 Owens Brook Circle, Simsbury, Connecticut 06070
variable capacitors as well as the mechanical linkage they require. It also allows size reduction by eliminating the bulk of a variable capacitor and allows significant reduction in the overall mechanical complexity of the VFO unit. One disadvantage of varactors, however, is that they require a tuning voltage as close to pure DC as possible. I therefore decided to use a 9-volt alkaline battery on the prototype. This led to thoughts of running an entire receiver on batteries, in the interest of even greater simplicity.

Since the VFO frequencies for 80 and 15 meters are close, one coil was used for both (see Table 1). The VFO coils could have been switched electrically with diodes, but doing so would have taken about 30 mA of additional current from the main battery supply. A rotary switch was chosen for current economy.

**board construction**

The VFO, the frequency counter, the BFO, the bandpass filter, and the IF unit are all constructed in a similar fashion. With the method used here you can actually build any unit in the same or less time than it takes to design and etch a printed circuit board. (One main advantage of etched boards, however, is saving time on successive boards — but since I seldom build more than one of any particular project, PC boards are not time-effective for me.)

I use epoxy material punched with holes on a 0.1-

![VFO schematic](image-url)
### Table 1. VFO Coil Data

<table>
<thead>
<tr>
<th>Coil Number</th>
<th>Band</th>
<th>Turns on 1/4&quot; Form</th>
<th>Frequency Range (MHz)</th>
<th>Wire No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>80</td>
<td>21</td>
<td>12.5-13.0</td>
<td>26</td>
</tr>
<tr>
<td>L2</td>
<td>40</td>
<td>15</td>
<td>16.0-16.5</td>
<td>26</td>
</tr>
<tr>
<td>L3</td>
<td>20</td>
<td>48</td>
<td>5.0-5.5</td>
<td>32</td>
</tr>
<tr>
<td>L4</td>
<td>10</td>
<td>10</td>
<td>19.0-20.0</td>
<td>22</td>
</tr>
</tbody>
</table>

*Coil form: Milbon 69043 used but any good 1/4-inch (0.635 cm) ceramic form should be suitable.

---

Inch grid and clad with copper on one side, widely available from mail order suppliers. Insulated circular pads for IC pins and other components are cut with a pad cutter tool, either by hand or with the tool in a drill.

For the VFO I disassembled a single-pole, six-position rotary switch and mounted a 3-inch (7.6 cm) square piece of the epoxy material between the switch wafer itself and the switch index mechanism. Three holes were drilled in the material: one for the switch shaft and two that coincide with the wafer mounting screws on the switch itself. (You may have to obtain mounting screws a little longer than those that come with the switch to allow for the 1/16 inch (0.16 cm) thickness of the copper clad board.)

Next cut appropriate pads for the coils and the VFO circuitry. Use T-44 push-in pins for terminals such as transistor connections and all input and output connections. The four coils are mounted on the front (non-copper-clad) side of the board by passing their leads through and soldering to the pads on the other side which directly connect to the switch. The coil bodies are then covered with clear Silicone II, an adhesive that bonds them firmly to the board and prevents any movement of either the coil bodies or the windings on the coils. This is extremely important in that it is a significant factor in the frequency stability of the VFO. All wiring on the VFO should be direct and rigid, especially the jumper on the switch for the 80-meter position. Sound VHF wiring practices should be followed.

**VFO Adjustment**

After wiring is completed, a test jig should be assembled as indicated to determine the values of the series voltage-dropping resistors necessary to have the tuning control, a 10 turn, 50 kilohm potentiometer, cover the desired range of frequencies (see fig. 2).

VFO adjustment proceeds as follows:

- Connect a frequency counter to the VFO output.
- Set the VFO to the 10 meter position.
- Set S1 on the test jig to the HI position (at end of potentiometer R_A).
- Adjust R_A so that the VFO frequency is about 10 kHz above the upper limit wanted — for example, on 80 meters set R_A so that the VFO output is 13.010 MHz.
- Put S1 in the LO position at the end of R_B.
- Adjust R_B until the VFO output is about 10 kHz below the lower limit wanted — for example, on 80 meters set R_B so that the VFO output is 12.49 MHz.
- Put S1 back to the HI position and recheck the frequency. Since these settings interact it may be necessary to repeat the procedure. Measure the values of R_A and R_B and use fixed resistors of those values on the bandswitch.
- Repeat this procedure for the remaining band positions on the VFO. It may be necessary to adjust the coil slugs to obtain the required range. On 40 meters it may be necessary to place an approximately 68 kilohm resistor in series with the 9-volt source and R_A.

Because it's unlikely that your unit will require the

---

![Left side view shows bandswitch and ganged VFO switch. Vertical board in center is BFO; VFO board and coils are mounted vertically against rear panel.](image_url)

![fig. 2. Test jig for determining the tuning voltage divider series resistors for each band.](image_url)
fig. 3. Bandpass filter schematic.

50 OHM INPUT FROM ANTENNA

L3, L4 60 turns No. 38 on 1/4-inch diameter
Link = 5 turns

L5, L6 25 turns No. 38 on 1/4-inch diameter
Link = 5 turns

L7, L8 25 turns No. 38 on 1/4-inch diameter
Link = 4 turns

L9, L10 20 turns No. 28 on 1/4-inch diameter
Link = 4 turns

L11, L12 15 turns No. 28 on 1/4-inch diameter
Link = 4 turns

All coils close wound
All diodes IN914

FERRITE BEAD

OUTPUT TO MIXER

510
same values of series resistors as mine because of differences that will occur in many components, I advise going through the procedure. I also recommend using alkaline batteries for both 6 and 9-volt supplies. Because of other connections to the 9-volt supply, six AA cells are used; the 6-volt supply consists of four D cells.

**bandpass filters**

These components are enclosed in a separate unit made entirely of copper-clad punched board. The two coils for each band are placed next to each other on 1/4-inch (0.635 cm) centers. Six volts applied to a band terminal forward biases the respective diodes and allows signals from the antenna to pass through the resonant circuit. The use of diodes, while drawing additional current, significantly reduces the mechanical problems associated with rotary switches.

Adjustment proceeds in the following order:

- Connect an antenna to the input and a receiver to the output.
- Set the receiver to 80 meters.
- Apply 6 volts DC to the 80-meter terminal.
- Set the receiver frequency 1/4 of the way up from the bottom of the band, at approximately 3.625 MHz.
- Adjust one of the 80-meter bandpass coils for maximum received signal (or noise).
- Move the receiver to a frequency 1/4 of the way down from the top end of the band, at approximately 3.875 MHz.
- Adjust the other 80-meter bandpass coil for maximum response.
- Repeat as necessary to compensate for interaction.
- Do the same for the remaining four bands.

These settings will establish filter response across the entire bands. If you’re primarily interested in either SSB or CW, the coils can be peaked accordingly. If you don’t have a receiver or cannot borrow one, it’s possible to peak the bandpass filters with the receiver itself, once completed.

**BFO**

This unit is constructed on a separate board but could be placed on the IF board. Using an available crystal filter translated to a USB BFO frequency of 9.000 MHz and an LSB BFO frequency of 9.0030 MHz (see fig. 3). Normal (i.e., non-inverted) sideband in this receiver uses the 9.000 MHz BFO crystal, so no readout offset is necessary. In the reverse sideband position the readout will be off by 3 kHz. The BFO circuit uses series resonant crystals. L1 and L2 are 10.7 MHz IF transformer primary windings (4 $\mu$H) with the resonating capacitor removed. The 260 and 220 pF capacitors are polystyrene and the 100 pF capacitors are silver mica. To adjust, connect a counter to the output and apply 6 volts DC to the BFO oscillator desired. Adjust the corresponding series inductance for the correct output frequency.

**IF board**

This board contains the double-balanced mixer, crystal filter, IF amplifier, and audio stages (see fig. 4). The only adjustment here is to peak the slug in T1 for maximum signal. T1 is also a 10.7 MHz IF transformer with an external capacitor to bring it down to 9.0 MHz. RF derived AGC is internally generated in the Plessey SL6700 IC. U4 is a Texas Instruments TL442 double-balanced mixer. Connection of pins 3 and 12 result in a 500-ohm output impedance to match the crystal filter. If your filter has a different input impedance you may have to design an appropriate matching network. Application of 9 volts to the mixer is necessary to achieve adequate gain. U6 is an audio preamp and U7 provides up to a quarter watt of audio output to an 8-ohm speaker or headphones. The SL6700 has a maximum voltage rating of 7 volts.

**frequency counter**

This unit uses LCD and CMOS components because both draw little current and also because we need to count frequencies up to 20 MHz (see fig. 5). The least...
fig. 4. IF and audio section schematic.
REGULATED POWER SUPPLIES
Magnetically Regulated Available from 5V to over 1000V with current range from 50 to over 100A. Designed to supply large peak current demands.
Electronically Regulated Voltage range is 0 to 50V with a current range of up to 20A. Ideal for critical laboratory or service applications requiring tight regulation with low hum and noise.
significant digit reads out in hundreds of Hertz because of a 10 millisecond gate provided by U2 and its associated crystal. This, and the counter chip, U3, are Intersil ICs. (It's important to note that Intersil also manufactures a 7207 A. It's only through the use of the 7207—without the "A"—and the specified crystal frequency that the 10 millisecond gate time can be obtained, so be careful when ordering.)

Note that U1 is a high-speed version of the CMOS type 4049. Because the latter type will not function up to 20 MHz, the 74HC4049 is used instead.

The liquid crystal display is a Hamlin type 3906. It's a little tricky to identify pin 1; to do so just hold the display in front of you and move it so that light reflects off its face. You'll notice the outlines of the 8s that are the digits. Look for the three decimal points between the 8s. Rotate the display if necessary so that the decimal points are at the bottom. The left end pin on the top row is pin 1. These both connect to the display backplane (see table 2).

The counter is constructed on two pieces of perforated board 2-1/2 inches (6.35 cm) square, separated from each other and the receiver front panel by 1/2 inch (1.27 cm) threaded metal standoffs at each corner. The socket for the 7224 IC is a low profile type and is nested inside the socket strips for the LCD. These strips are merely the halves of a 40-pin IC socket separated by cutting it lengthwise with a hacksaw.
PICK A COMPUTER INTERFACE TO MATCH YOUR NEEDS

COMPUTER PATCH™ MODEL CP-1

The AEA Model CP-1 Computer Patch has earned a solid reputation for being the best overall interface value on the market today. We at AEA have now reaffirmed what our competitors already know; for the money, the CP-1 cannot be beat! That is why we have chosen to leave the popular CP-1 in our product line and to introduce new computer interface/terminal units with differing features and performance at different prices.

MICROPATCH™ MODEL MP-1

The new AEA model MP-1 Micropatch represents the best features and performance available for under $140.00. Featuring true dual-channel filtering of Mark and Space tones with an AM detector and Automatic Threshold Correction (ATC) circuit, the MP-1 is in a totally different performance class than competitive units that often have only a single channel filter or no filtering at all.

The MP-1 also offers a high performance CW capability. With respect to the CP-1, overall performance is nearly as good; but the CP-1 offers a few more advanced features such as variable shift tuning, RS-232 option, and a more advanced tuning indicator.

COMPUTER PATCH MODEL CP-100

The new CP-100 Computer Patch offers all the following exciting features in addition to the CP-1 features:
• 170, 425, 850 Hz Calibrated Shifts for Transmit and Receive
• 75 to 1000 Hz Variable Receive Shift Range
• Normal and Reverse FSK Outputs
• Input AGC
• Direct Coupled Automatic Threshold Control
• Front Panel Squelch
• Discriminator Style Tuning Indicator
• Current Loop Option
• Built-in Monitor Speaker
• Baud Rate Switch
• Improved AM Detector

AEA Brings you the Breakthrough!

VHF COMMUNICATIONS
915 North Main Street
Jamestown, New York 14701 (716)664-6345
the same. Remove the clip lead from the 7224. Leading zeros will now be blanked on the display.

general construction notes

The receiver is built in an aluminum enclosure available from Radio Shack (see table 3). A slightly larger box would have allowed placement of the batteries inside. The band switch is a three-pole, six-position rotary mounted on the front panel. A coupling joins the end of its shaft to the VFO switch shaft. The 9-volt battery pack is attached to the chassis bottom with self-adhesive Velcro strips from Radio Shack. This sturdy arrangement allows easy removal for battery replacement. Four D cells in a holder mounted on the outside rear wall of the receiver supply 6 volts. A jack on the front panel provides audio for external speaker or headphones. All circuits and functional modules are extensively decoupled with ferrite beads and capacitive bypassing. The receiver has no birdies and the decoupling is probably a significant factor. Small diameter RG-174/U coax is used for all signal interconnections as well as to and from the volume control. The only totally shielded unit is the bandpass filter unit. The IF gain control carries DC and does not require shielding.

changes

Few designs remain unchanged for long. Were I to build this one again, I would consider making some

These two sockets are mounted on unclad perfboard. The rear board is copper clad and contains the signal processing and gating ICs, U1, and U2. Because of the relatively high frequencies involved, this board must be copper clad.

Upon completion of the counter wiring connect a clip lead between pin 29 on U3 and ground. For test purposes this will cause all digits to appear as zeros with no signal input. Connect the 6 volts to the counter; application of voltage greater than 6.5 to U3 could destroy the IC. The purpose of the 1N5914 in the counter is to reduce the 6 volts slightly. Four zeros should appear on the display with a decimal point between the least significant zero and the next one.

To calibrate the counter, run a short length of RG-174/U coax from the output of the BFO to the counter input. Connect an external frequency counter to the same point. Adjust the 30 pF trimmer capacitor at U2 until the last four digits of the two counters are

---

<table>
<thead>
<tr>
<th>table 2. 3906 and 7224 designations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3906 pins</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>20 1B 1A 21</td>
</tr>
<tr>
<td>19 1C 1F 22</td>
</tr>
<tr>
<td>18 1D 1G 23</td>
</tr>
<tr>
<td>17 1E 2B 24</td>
</tr>
<tr>
<td>16 DP 2A 25</td>
</tr>
<tr>
<td>15 2C 2F 26</td>
</tr>
<tr>
<td>14 2D 2G 27</td>
</tr>
<tr>
<td>13 2E 28</td>
</tr>
<tr>
<td>12 3B 29</td>
</tr>
<tr>
<td>11 3C 3A 30</td>
</tr>
<tr>
<td>10 3D 3F 31</td>
</tr>
<tr>
<td>9 3E 3G 32</td>
</tr>
<tr>
<td>8 4DP 33</td>
</tr>
<tr>
<td>7 4C 4B 34</td>
</tr>
<tr>
<td>6 4D 4A 35</td>
</tr>
<tr>
<td>5 4E 4F 36</td>
</tr>
<tr>
<td>4 5G 37</td>
</tr>
<tr>
<td>3 38</td>
</tr>
<tr>
<td>2 39</td>
</tr>
<tr>
<td>1 BP 40</td>
</tr>
</tbody>
</table>

*Use this decimal point

---

<table>
<thead>
<tr>
<th>table 3. Parts and source list.</th>
</tr>
</thead>
<tbody>
<tr>
<td>part</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>Hamlin 3906 LCD, MV2115</td>
</tr>
<tr>
<td>diodes, 74HC4049, J308, 741, LM386, 10.7 MHz IF transformers, Vector board</td>
</tr>
<tr>
<td>Intersil 7224 counter IC</td>
</tr>
<tr>
<td>6.5536 MHz crystal</td>
</tr>
<tr>
<td>Intersil ICM7207 IC</td>
</tr>
<tr>
<td>Texas Instruments TL442 IC</td>
</tr>
<tr>
<td>Plessey SL6700 IC</td>
</tr>
<tr>
<td>BFO crystals</td>
</tr>
<tr>
<td>Enclosure, battery holders, miscellaneous parts</td>
</tr>
<tr>
<td>Radio Shack</td>
</tr>
</tbody>
</table>

---

November 1986
changes. First, this receiver is designed with VFO frequencies chosen so that, for conventional SSB practices, a 9 MHz USB filter and one BFO oscillator and crystal would probably be adequate for most users. Given the current drawn from the D cells, the batteries will probably last their shelf life; it may be possible to change to C cells to save weight and volume. Perhaps the two sets of batteries could be changed to one set of eight C cells with a voltage regulator for the 9 volts and a direct tap for the 6 volts. One change I would definitely make would be separate 80 and 15 meter VFO coils. This would make it much easier to set the required frequency range on both bands.

Other than the 10 pF NPO capacitors across each VFO coil, no further temperature compensation was done since stability at that point was adequate for my purposes. VFO stability could be further enhanced, especially at the higher VFO frequencies. I would also build the VFO in a separate, shielded enclosure, because there is a slight frequency shift when the receiver cover is removed. This small portable receiver meets all my original goals: simplicity, low cost, and good performance. These are exactly the characteristics which make this receiver ideal for newcomer and old-timer alike.

I'll be happy to respond to any questions accompanied by an SASE. (Send to Author's address —Ed.).
Please enter my gift subscriptions to HAM RADIO Magazine as follows:

**FIRST SUBSCRIPTION $19.95**

**TWO OR MORE SUBSCRIPTIONS $16.95 EA. SAVE $3.00**

(you can also renew your own subscription at this low rate)

<table>
<thead>
<tr>
<th>FIRST</th>
<th>Name</th>
<th>Call</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td></td>
<td></td>
</tr>
<tr>
<td>City</td>
<td>State</td>
<td>Zip</td>
</tr>
<tr>
<td>new</td>
<td>renewal</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SECOND</th>
<th>Name</th>
<th>Call</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td></td>
<td></td>
</tr>
<tr>
<td>City</td>
<td>State</td>
<td>Zip</td>
</tr>
<tr>
<td>new</td>
<td>renewal</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THIRD</th>
<th>Name</th>
<th>Call</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td></td>
<td></td>
</tr>
<tr>
<td>City</td>
<td>State</td>
<td>Zip</td>
</tr>
<tr>
<td>new</td>
<td>renewal</td>
<td></td>
</tr>
</tbody>
</table>

- □ Start or □ Renew my own HR subscription.
- □ Enclosed is a check or money order for $_________ for subscriptions. (use separate envelope)

- □ VISA □ MasterCard □ Bill me later

Acct. #

Expires MC Bank #

My Name Call

Address

City State Zip

Prices U.S. only. Inquire about foreign rates
*Tis best to give as well as receive.

(especially before our January price increase!)

One Year/12 issues

$19.95

**SAVE* OVER 10%

First Gift

OR

$16.95 **SAVE* 25%

FOR TWO OR MORE SUBSCRIPTIONS OR EXTENSIONS INCLUDING YOUR OWN

*One-year subscriptions will be $22.95 after January 1, 1986.

A gift card will be sent if your order is received before December 13, 1985.

Giving Ham Radio is both fun and thoughtful.

And at the receiving end of a Ham Radio gift subscription, it’s remembered all year long as a token of your friendship.

We have a super busy year planned for 1986, just take a look at a sampling of what your special Amateur friends(s) will see in their 12 big gift issues next year: The very latest in state-of-the-art projects and technical discussions, our Annual Antenna issue in May and our Receiver issue in November, computers, monthly columns by Orr, Stonehocker, Reisert, and Guerri plus much, much more.

There’s no time like the present to give the gift of HAM RADIO Magazine to that “hard to buy for” ham friend. While you’re at it, why not treat yourself to another year of HR and save $3 off our regular rate and $6 off our new rate.

Please use handy bind-in card.

Greenville, NH 03048
Prices US only
high dynamic range on 2 meters

In last November's VHF/UHF World column1 we discussed high dynamic-range (HDR) with emphasis on circuitry for the 6-meter band. Judging from the correspondence I've received and the quantity of parts ordered from Proto Parts,* the interest in this subject is quite high. There were also plenty of inquiries for information about a companion 2-meter down-converter.

Further work has been conducted since reference 1 was published. Much of this new work, which primarily dealt with antenna pattern improvements, local oscillator phase noise studies and problems with the IF or receiver, was presented at the Dayton Hamvention.2

*Proto-Parts (formerly Proto Fab), 74 Wedgemere Drive, Lowell, Massachusetts 01852.

Since time is precious, I'll keep this month's column short and to the point, concentrating almost entirely on the design of a 2-meter HDR receiver down-converter as shown in block form in fig. 1. The material in reference 1 will not be repeated except as required. Further information on this very interesting subject will be published as time permits.

preamplifiers

Let's start by assuming that you've read references 1 and 2. Let's go directly to the preamplifier stage. Common semiconductor devices used on 2-meter preamplifiers include bipolar transistors, JFETs, dual-gate MOS FETs and GaAs FETs. All of these can attain excellent noise figures (less than 2 dB) and more than sufficient gain (12 to 30 dB!).

High gain is not too compatible with high dynamic range since the higher the gain, the more likelihood of compression, overload, and IMD (intermodulation distortion). Furthermore, overdriving the mixer, which results in a lower dynamic range, can result from too much gain in the stage preceding the mixer.1

The HDR transformer-coupled lossless feedback preamplifier described in reference 1 can be used as shown to cover the entire frequency range from 1.5 to 200 MHz with almost no loss of dynamic range and only a slight increase (0.5 to 1.0 dB) in noise figure at the higher end of this frequency range. Hence this circuit is highly recommended for a 2-meter HDR preamplifier. However, it requires proper input and output filtering similar to the scheme shown on the 6-meter converter to prevent responding to the entire HF/VHF spectrum! (More on this shortly.)

![Block diagram of a 2-meter HDR receive-type down converter](image)

fig. 1. Overall block diagram of a 2-meter HDR receive-type down converter. Note 1: If the transmitter LO port is unused, terminate it with a 50-ohm load.
fig. 2A. Schematic diagram for a recommended JFET 2-meter preamplifier with moderate dynamic range. Gain is 11 dB and noise figure is 1.5 to 2 dB typical.

dBm (10 to 25 milliwatts), which is more than sufficient for most applications.

A JFET preamplifier offers another advantage in that it has some "built-in" selectivity from its associated matching circuits so it can be operated without additional input or output filtering. Two of these amplifier circuits in cascade will usually have more than adequate selectivity to do the job as is. The circuit I use has been around many years and was discussed in reference 4. The recommended circuit and values for 2 meters are shown in fig. 2.

If you don't want to build all the extra filtering associated with the bipolar lossless feedback circuit and can sacrifice a small amount of dynamic range, you can use the JFET circuit shown in fig. 2. If only a single stage is used, the overall noise figure of the converter will be approximately 4 dB, hardly a problem for most types of operation. This sure beats many commercial transceivers that usually have a 7-10 dB or higher noise figure along with poor dynamic range and phase noise to boot! Two JFET preamplifier stages can be cascaded for moderate

fig. 2B. Bottom view of preamplifier showing recommended construction technique. The preamplifier can be built on the cover of a Pomona 2417, Bud CU123, or equivalent cast box. (See text for other details.)

Dual-gate MOSFETs — and GaAs FETs as well — are not recommended for HDR since they have too much gain. Both are excellent for very low noise figures. The output compression point for GaAs FETS is poor for HDR (+6 to +8 dBm or 4 to 6.3 milliwatts). If you use them they should have built-in bypass relays so they can be switched out of the circuit if there are strong signals present that limit the dynamic range.

One of my favorite quick-and-dirty preamplifiers uses a JFET. I particularly like the U310, a low-cost, readily available JFET. Caution: don't use the J310, a plastic TO-92 version of this device, above 100 MHz. The plastic package has too much internal inductance in the gate lead and the device will be potentially unstable at 2 meters and above.

The U310 can deliver good performance from 50-450 MHz with a typical gain of 11 to 13 dB, a reasonable noise figure (1.5 to 3 dB), and very good dynamic range. The typical output compression point is not as high as the HDR lossless feedback circuit and is typically in the range of +10 to +14 dBm (10 to 25 milliwatts), which is more than sufficient for most applications.

A JFET preamplifier offers another advantage in that it has some "built-in" selectivity from its associated matching circuits so it can be operated without additional input or output filtering. Two of these amplifier circuits in cascade will usually have more than adequate selectivity to do the job as is. The circuit I use has been around many years and was discussed in reference 4. The recommended circuit and values for 2 meters are shown in fig. 2.

If you don't want to build all the extra filtering associated with the bipolar lossless feedback circuit and can sacrifice a small amount of dynamic range, you can use the JFET circuit shown in fig. 2. If only a single stage is used, the overall noise figure of the converter will be approximately 4 dB, hardly a problem for most types of operation. This sure beats many commercial transceivers that usually have a 7-10 dB or higher noise figure along with poor dynamic range and phase noise to boot! Two JFET preamplifier stages can be cascaded for moderate

fig. 2C. Typical shield to be placed across Q1. Note 1: Solder both sides of shield to the ground plane where shown.
is used, additional filtering will be required just ahead of the mixer as discussed in reference 1. A recommended three-section band-pass filter is shown in fig. 5. A plot of its filter characteristics is shown in fig. 6. It has a fairly symmetrical passband shape and only a moderate loss — 1.3 to 1.5 dB. Typical half-power bandwidth is 10 MHz, and the 10 and 30 dB down bandwidths are typically 15 and 33 MHz, respectively.

The loss in this band-pass filter will not degrade noise figure significantly if it is preceded by at least 9 to 10 dB of preamplifier gain. This filter should provide more than adequate selectivity for a high performance 2-meter receiving converter.

mixers

Various types of mixers were discussed in reference 1. The double balanced mixer (DBM) is highly recommended. The MiniCircuits Labs TAK-1H or equivalent is highly recommended for 2 meters. Other mixers, shown in table 1 of reference 1, are also acceptable. The lower drive DBMs such as the SRA-1 will reduce dynamic range but still may be more than sufficient for most applications.

The DBM circuit in reference 1 is very wideband and already covers frequencies through 500 MHz so it will not be duplicated here. Don't leave out the diplexer; it's very necessary. Also, since the 2-meter band is much higher in frequency, the use of a 14-MHz IF is discouraged since it won't offer sufficient image rejection without extensive filtering.

local oscillator

A Colpitts series-mode oscillator similar to the one discussed in references 1 and 7 is highly recommended. Since the typical IF for a 2-meter converter is 28-30 MHz, a 116-MHz local oscillator is recommended. Don't use a 58-MHz oscillator with a frequency doubler; it will make breakthrough from TV and FM stations a potential problem. Don't be "penny wise and pound foolish." Remember — this is
THE LAST WORD IN PERFORMANCE

Superb audio quality - Virtually no phase noise - 16-pole crystal filter - Variable bandwidth
- PBT - Continuous tuning audio filter plus notch filter - Dual noise blanker - Built-in memory keyer - Low noise RF preamp - Dual speed QSK - Five function meter - Fully AMTOR compatible - No power "foldback" into high SWR - All solid-state broad band design - Built-in speech processor - American made, full one year warranty

Corsair II
HF TRANSCEIVER

See your dealer or write

TEN-TEC, INC.
SEVIERVILLE, TENNESSEE 37862
**VISAIMASTER CARD**
FREE SHIPPING S.A.S.E. FOR OUR
"BENCH-TESTED" MON-FRI 9 AM - 6 PM CENTRAL TIME
ON MOST RIGS FOR CASH!
S.A.S.E. FOR OUR "BENCH-TESTED" USED EQUIPMENT LISTING

NEW! ICOM R7000 RCVR
Covers continuous 25 MHz to 2 GHz
99 memories--scans--etc., etc.

**INVENTORY REDUCTION PRICED TO GO!**
We must make room for your trade-ins. Check now for lowest prices on previously owned bench-tested equipment!

**INVENTORY REDUCTION PRICED TO GO!**
We must make room for your trade-ins. Check now for lowest prices on previously owned bench-tested equipment!

**NEW! ICOM R7000 RCVR**
Covers continuous 25 MHz to 2 GHz
99 memories--scans--etc., etc.

**TOWERS by ALUMA**
**HIGHEST QUALITY ALUMINUM**
• TELESCOPING (CRANK-UP)
• GUYED (STACK-UP)
• TILT-OVER MODELS
Easy to install. Low Prices.
Crank-ups to 100 ft.

**Nano Fast Coax Protection**
We have the right Impulse Suppressor to keep your system up and operational.
Over 36 Models From DC to 2.5 GHz.
50, 75, 93 and 300 Ohms
Bulkhead Mountability
20,000 Amp capability
Throughput Energy in uJ.
0.1 dB loss • 1.1 to 1 VSWR

**Protectors**
• GaAs Fet Front End
• Cellular Transmit
• DC Injector/Pickoff for
Tower Top Preamp
• Cable TV
• Closed Circuit TV • NEMP
• Marine • Military
• Coaxial Data (TwinAx)
• Power Supplies-120VAC
• Power Line • Microwave
• Telephone Line
• Voltage Breakdown Tester

**SHOULDN'T YOU HAVE A POLYPHASER IMPULSE SUPPRESSOR ON YOUR LINE?**

Phone: (702) 782-2511
RCA TELEX: 272718 POLYPHASER

**PolyPhaser Corporation**
1425 Industrial Way
P.O. Box 1237
Gardnerville, NV 89410

**58 November 1986**
a high-performance HDR receiving converter!

Since the frequency of the oscillator is much higher than in the 6-meter converter, the tuned components had to be modified. The final oscillator circuit and a suitable power amplifier are shown in figs. 7 and 8. It will provide the necessary 100 milliwatts of power. (More on this later.) Again, a low-level output is provided for a transmitting up-converter.

postamplifiers

The low-noise postamplifier using the lossless feedback circuit described in reference 1 is recommended without changes, so it won’t be duplicated here. Note how the modular approach discussed in references 1 and 7 has paid off. If you have the mixer and post-amplifier from the 6-meter converter, all you have to do is to change the local oscillator and front end, and away you go on 2 meters.

construction tips

Once again, the modular approach is recommended, with each separate circuit packaged in a shielded box. The circuits can be built above a double-clad printed circuit type of material as described in reference 1. The boards can be attached to the cover of the boxes with the connectors. This method provides excellent grounding, and the components can be soldered directly to the board where grounding is required.

The three-section band-pass filter must be carefully laid out so that mutual coupling will not cause pass-band ripple. This can be accomplished if the individual coils are all wound in the same direction and placed at least 1/2 inch (12.7 mm) apart.

The U310 preamplifier circuit, if used, should be carefully laid out with shielding in mind. First a hole should be drilled near one side of the center of the circuit through the PC board. Its diameter should be 0.191 inches (4.85 mm), the diameter of a No. 11 drill. Next, place the U310 in the hole upside down and quickly solder the gate lead to ground as well as the tab on the U310 can. This provides additional input to output isolation. Next place a shield with a notch for the transistor leads across the JFET to isolate the input and output circuits as shown in fig. 2.

Leads in the oscillator should be kept short, especially those going to the crystal and its associated components. Also, it’s wise to place the oscillator in a box separate from the LO amplifier so that any heat generated by the amplifier will not affect the stability of the oscillator. This has a secondary benefit: if the oscillator is separate, it can be used directly with a standard (+5 dBm or 7 milliwatt) DBM until you upgrade to the high-level DBM.

tune-up

First connect all the modules together as a full converter per fig. 1. Then connect an appropriate 2-meter antenna to the input of the converter. If the oscillator is functioning, noise and possibly signals will be heard.

The local oscillator should be tuned for maximum output as indicated on an RF power meter. Don’t detune the oscillator for frequency “netting”; this...

- Makes Upgrading of Morse Skills Easy and Fun
- Does Away With Drudgery
- Skilled Operators Enjoy the Realism
- Operate Anytime—Requires Only a Commodore C-64 (or C-128) and A TV Set
- Removes the "Mystery" of what to Say in On-the-Air Contacts
- Excellent Practice for Beginners and Old "Pro's"
- Standard Format and Common Abbreviations Used for All Exchanges
- Send Morse with your keyboard
- Select Appropriate QRM and QRN Levels
- Select the Portion of the "Band"—Novice or Low End

will decrease frequency stability. If only a diode detector is available, place a 3 to 10-dB attenuator pad on the output of the oscillator and the diode detector on the output of the pad.

If a normal range DBM is used, connect the LO directly to the DBM. If an HDR DBM is used, connect the LO to the LO amplifier with a piece of coaxial cable and measure the available power. It is not critical, but should be between 50 to 150 milliwatts for the HDR mixer configuration.

If the lossless feedback preamplifier is used, it doesn't require tuning but the input and bandpass filters do. The input filter can be peaked on a weak signal or tuned for minimum VSWR on a low-power test set-up. The bandpass filter is best tuned on a sweep set-up, but again could be tuned for maximum signal strength without a great loss in performance.

If the U310 preamplifier is used, first set the input capacitor for nearly minimum capacitance. Next peak the output capacitor for maximum gain or noise when in a typical circuit. The typical gain should be 11 to 12 dB. If noise figure measurement gear is available, tune the input circuit for the best noise figure. Sometimes this can be done at local VHF/UHF conferences, especially when noise figure measurement contests are conducted.

**performance**

At first, performance may not seem spectacular. In fact, the gain may seem low despite the noise figure available. If you can borrow a noise figure meter, check the performance so you'll know you're where you should be. You should be able to hear just...
Introducing the BUTTERFLY™
Beam from Butternut!

The HF4B Compact, 2-element Beam for 20–15–12–10 meters

Compact Size
The HF4B’s 12½-foot elements and 6-foot boom are ideal for home-station use and for weekend retreats, condos, apartments and other places where oversized beams are prohibited. Its light weight (17 pounds) means it can be turned with a tv rotator, yet it is robustly constructed in the best tradition of our world-famous Butternut verticals.

Performance
The HF4B BUTTERFLY™ has not sacrificed performance for compactness. Its unique design with fanned elements and L-C circuits avoids use of power-robbing traps yet provided high-efficiency operating on all bands. The BUTTERFLY™ outperforms anything in its class.

The HF4B offers an SWR of 1.5:1 or less at resonance. Its 2.1 bandwidth is 200 kHz on 20 meters, 450 kHz on 15, 1.7 MHz on 10, and across the entire 12 meter band. And it will handle the legal power limits both CW & SSB. Gain is at least 3 dB on 20, 4.5 dB on 15 and 5 dB on 10 & 12 meters. Front-to-back is up to 18 dB on 10, 12 and 20m, and up to 15 dB on 15m.

See your authorized Butternut dealer
about anyone who’s working into your area, if your antenna gain is sufficient.

In the presence of strong signals, you will immediately notice the improved performance. Now you’ll see why I’ve previously stressed that the IF will ultimately be the limiting device! If you used the modular approach, the circuits can be swapped at will as you step up in performance. Also, should you ever suffer a failure, repair or bypassing is easily accomplished. It may even be smart to incorporate a bypass switching arrangement to switch out the IF postamplifier when high level signals are present.

summary

This month’s column again stressed improved performance that is within the means and skill level of most Amateurs. Those who have tried these approaches have been pleasantly surprised. It’s nice to know that you’re keeping up with the state-of-the-art! When good gear is used, contacts are more enjoyable and the weak ones are easier to work.

references

2. Joe Reisert, W1JR, "High Dynamic Range," 1985 Dayton Hamvention, April 27, 1985. (Copies are available from W1BOS, for a nominal fee.)

important VHF/UHF events

November 2: Peak of Taurids Meteor Shower predicted at 0930 UTC
November 2-3: ARRL International EME Contest
November 3: Peak of Casseoids Meteor Shower predicted at 0930 UTC
November 12: EME Perigee
November 17: Peak of Leonids Meteor Shower predicted at 0300 UTC
November 23-23: ARRL International EME Contest
December 2: 7-11 PM Local, 2-meter SWOT Contest (contact K5IS for details)
December 11: EME Perigee
December 13: Peak of Geminids Meteor Shower predicted at 0650 UTC
December 21: Peak of Ursids Meteor Shower predicted at 2200 UTC
December 21: ± 1 month, winter peak of sporadic-E propagation

ham radio

62 November 1985
Kantronics out "SMARTrs" the competition

Presenting three intelligent, versatile, compatible terminal units.

"SMART" means an internal microprocessor is used to improve performance and add versatility. The "Smart" Kantronics TU's can transmit and receive CW/RTTY/ASCII/AMTOR or Packet when combined with your computer and transceiver.

Any computer with a serial RS232 or TTL port can connect directly to a Kantronics TU. A simple terminal program, like one used with a telephone modem, is the only additional program required. Kantronics currently offers Packet and UTU Terminal Programs for IBM, Kaypro, Commodore 64, VIC 20, and TRS-80 Models III, IV, and IVP. Disk version $19.95. Cartridge $24.95.

UTU The Universal Terminal unit (UTU) is the original "Smart" amateur TU. CW, RTTY, ASCII, and AMTOR can all be worked with this single unit. Switched capacitance filters and LED display tuning make using the UTU easy for even the Novice. 12 Vdc 300mv power supply required. Suggested retail $199.95.

UTU-XT The UTU-XT is an enhanced version of the UTU. Programmable baud rates, tone frequencies, and tone shifts give special versatility. Automatic Gain Control and Threshold Correction circuits greatly enhance sensitivity and selectivity. A RTTY signal detect circuit mutes copy with no carrier, and the CW filter center frequency and bandwidth are programmable. Power supply is provided. Suggested retail $359.95.

Packet Communicator Kantronics joined the Packet Radio revolution with the Packet Communicator. The unit is an AX.25/Vancouver compatible TNC with features not found in other units, including Direct TTL connection for easy hookup to the VIC-20 and Commodore 64. With our onboard modem you can select either Bell 202 or 103 tones for VHF/UHF or HF work. Power supply is provided. Suggested retail $219.00.

For more information contact your local Kantronics dealer or write:

Kantronics
1202 E. 23rd Street (913) 842-7745
Lawrence, Kansas 66046
CASH IN on your old Channel Elements

For the past fifteen years, ICM has been replacing original crystals in elements sent to us by our customers. Our crystals carry an unusual guarantee—they are guaranteed FOREVER when used in the equipment for which they were designed.

Upon receipt, elements are tested, repaired, and parts replaced if required to assure that they are working properly. The crystal is installed and checked for trimmability. The output is checked to see that it meets original specs. Elements that are actively modulated are tested under load conditions. The element is subjected to temp vs frequency tests and compensated using computer controlled test chambers. After compensation, all tests are repeated to insure proper operation of the element.

Please call or write for more information.

International Crystal Manufacturing Co., Inc.
Box 26330 Oklahoma City, OK 73126-0330
(405) 236-3741 Telex 747-147
ANOTHER BREAKTHROUGH FROM AEA

Packet + RTTY = Pakratt™ PK-64.

If you've read about packet, or are already into it, you know how exciting it is. With the hot new Pakratt PK-64 we've just brought a new dimension to packet. The Pakratt PK-64 is a complete, fully assembled and tested packet radio controller which, together with a Commodore 64 or 128 computer, can convert your shack into a packet operations center.

And we've included a new version of our advanced MBA-TOR™ software to make it the first packet controller with AMTOR, Baudot, ASCII and Morse. But an even more exciting part of the Pakratt controller is its great price.

Incredibly Simple To Set Up

Just plug the Pakratt controller into the C-64's game cartridge slot, add a mic connector for connecting to your particular transceiver, and you're set.

If you're anxious to try it out, our new "quickstart" manual section can get you on the air in under 1/2 hour.

Simply Powerful

The versatile Pakratt controller shows messages and connect status simultaneously on your Commodore with a unique split-screen display. And it lets you send letter-perfect text from the text editor software while monitoring incoming messages. The 20K byte QSO buffer stores more than 20 video screens of text! Disk commands let you save specific operating parameters for quick set-up for emergency services, clubs, and multiple frequency use. And the Pakratt controller's standard, TAPR style modem gives you 300 and 1200 baud operation with great HF/VHF performance.

We can't possibly list all of the important features of Pakratt here. But the absolutely best part of the Pakratt PK-64 is that it's at your dealer now. So stop reading, run down to your local dealer, and check Pakratt out. Because the real challenge will be to find one after the other hams see it.

Pakratt PK-64, Packet Power from AEA. At amateur radio dealers everywhere.

PK-64 shown with HF modem option. Computer not included.

PK-64 shown with HF modem option. Computer not included.

PK-64 shown with HF modem option. Computer not included.

PK-64 shown with HF modem option. Computer not included.

PK-64 shown with HF modem option. Computer not included.
The Problem Solver...

The RF Wattmeter Model 81000-A from Coaxial Dynamics, Inc. does more than provide accurate RF measurements. Testing of transmission lines, antennas, connectors, filters and related components can reveal unknown problems and assure optimum equipment performance.

The 81000-AK Wattkit features this easy-to-read RF Wattmeter (pictured here), with its optional carrying case and an array of elements and accessories. Coaxial Dynamics elements can be purchased separately for use in other manufacturer's Wattmeters. For more information on the 81000-A Wattmeter or any of the complete line of Coaxial Dynamics RF products and OEM components please contact Coaxial Dynamics, Inc.

Coaxial Dynamics, Inc.
18210 Industrial Parkway, Cleveland, OH 44135 • (216) 267-2233
Outside Ohio, WATS: (800) Coaxial, Texas: 918-930

Custom Communication Consoles
Personal, Commercial, Industrial & Governmental Applications
Any shape & size to fill a corner or a room. Special design features & services are:
- Replaceable front panel, for equipment changes. Precisely cut front panel holes by computerized equipment. Computer aided design for: Floor plan lay-out, & console design. Design assistance, on-site analysis & installation are available.
- Constructed from plastic laminated birch plywood & black anodized aluminum extrusions.

Contact: Larry Kusher, WA6BKIC/4, President
BCS, Inc., 5817 SW 21 Street, Hollywood, FL 33023 (305) 989-2371

Popular PA 19
Wideband Preamplifier

- Over 8,000 sold
- 0.5 - 200 MHz
- 19 dB gain
- 50 Ω input/output
- For receivers, counters, transmitter amp stages
- Built, tested & ready-to-go
ONLY $9.95 + $1 shipping

New Pocket Sized
500 MHz Freq. Counter

- Fits in your shirt pocket
- Uses 1 9-volt battery
- 4 digit LED readout. 6 digit resolution
- 1 MHz - 500 MHz
- Great addition to shack and toolbox
ONLY $49.95 + $2 shipping

Digitrex
1005 Bloomer
Rochester, MI 48063
West Coast Distributor
R. Lukaszewicz
2610 Alaminos Drive
Saugus, CA 91350
(605) 252-8027

November 1986
the mystery of the tapered element

I received an interesting letter in the mail the other day. It seemed some of the DXers were having a lively discussion on the effects of taper on the elements of a Yagi beam antenna. Recently published information on tapered elements seemed to indicate that a severely tapered element could actually be longer than a half-wavelength yet still be resonant.

The letter writer concluded that it was reasonable to see that a "thick" element is shorter than a "thin" element, but it was beyond the realm of possibility that a tapered element could be longer than either a "thin" or "thick" element.

My friendly inquirer closed his letter by saying that a "longer-than-normal resonant element of the tapered variety contradicts the laws of Nature. Say it isn't so!"

the background

This was an interesting letter. Is it possible to have a tapered element physically longer than a half-wavelength at a given frequency, yet resonant at that frequency? A little insight into basic antenna theory might provide the answer. To quote the ARRL Antenna Handbook:

The shortest length of wire that will resonate to a given frequency is one just long enough to permit an electric charge to travel from one end to the other and then back again in the time of one RF cycle. If the speed at which the charge travels is equal to the velocity of light, 300,000,000 meters per second, the distance it will cover in one cycle will be equal to this velocity divided by the frequency in cycles per second, or

\[ \lambda = \frac{300,000,000}{f_{(Hz)}} \]

in which \( \lambda \) is the wavelength in meters. Since the charge traverses the wire twice, the length of wire needed to permit the charge to travel a distance \( \lambda \) in one cycle is \( \lambda/2 \), or one-half wavelength.

Since the speed of light is a universal constant, either the frequency can be adjusted to a given wire length, or the wire length can be adjusted to a given frequency. Finally, by changing from the metric system to the English system and dividing the formula by two, the familiar and useful formula for a half-wavelength in space is:

\[ L = \frac{492}{f_{(MHz)}} \]

where \( L \) is length in feet of a half-wavelength for a frequency, \( f \), in MHz.

The final step is to take into account the ratio of length to diameter of the conductor. The smaller the ratio, the shorter the antenna will be for a given electrical length. This is illustrated for tubing elements in the graph fig. 1.

A length-to-diameter ratio of about 4,000 to 1 is appropriate for a wire antenna in the HF range. A length-to-diameter ratio of, say 250 to 1 could apply to a resonant element made of aluminum tubing. The tubing element would be about 97 percent as long as a wire element for the same frequency. It is possible, then for a "thick" element to be quite a bit shorter than a
"thin" wire element, or than the free-space dimension of a radio wave of a given frequency. No argument so far, is there?

what the broadcasters found out in 1934

In 1924 Stuart Ballantine showed that, for a given amount of radiated power, the field strength at the horizon would be greatest when the vertical antenna (over a good ground) was 0.64 wavelength high. This was the concept behind the popular 5/8-wavelength vertical antenna.

This was of immense benefit to broadcast stations because it allowed them to have a signal about 40 percent greater than that provided by a 1/2-wavelength antenna fed the same power. During the period between 1925 and 1930, many broadcast stations in America and Europe switched over to the new antenna design.

In attempts to obtain this optimum situation the broadcaster had to erect a tower more than twice as high as had been used previously. Two types of tower designs were available, as shown in fig. 2. The type A installation consisted essentially of two towers placed base-to-base and held in a vertical position by four or more guy wires. The type B design was more conventional, with the four tower legs mounted on base insulators. No guy wires were required.

After using these towers for some months it became apparent that the results achieved were not consistent with theory. The promised gain failed to materialize, and the unwanted, high angle radiation was not appreciably reduced. In May, 1934, extensive tests were run on the radiation pattern of WABC (in Wayne, New Jersey), using an airplane to provide vertical pattern plots. The results were discouraging (fig. 3).

The next step was to measure the current distribution along the tower. In the case of the type A design, the 5/8 wavelength tower should have the current distribution shown by curve A of fig. 4. But the measured current actually resembled curve B! The current distribution did not resemble the sinusoidal curve predicted by theory, nor was there a current reversal approximately a 1/2-wavelength from the top end of the antenna! The top portion of the antenna carried very little current and the bottom portion of the antenna nearest the ground carried most of the current.

H.E. Gihring and G.H. Brown of the RCA Victor Company ran tests on antenna models built to scale for a wavelength of 4 meters. The tests on the models duplicated the results found by measurement on the larger broadcast antennas. The clue was that the current distribution on the tower was non-sinusoidal, and the rules that applied to normal antennas with sinusoidal current distribution did not apply to towers of irregular cross section!

Armed with this information, tests were run on the type A tapered antenna tower at WCAU (in Philadelphia, Pennsylvania). This tower has an additional 100-foot shaft protruding out of the top. They found little current in the shaft and, again, no reversal of current at the half-wave point along the tower.

The final check was to build a 4-meter model antenna out of wire having a constant cross-section. They reported "substantial agreement" between theoretical and observed values.

problem defined how to solve it

Gihring and Brown had proved that it would be desirable to make the cross-section of the 5/8-wave antenna constant if it were to obey the theoretical laws and deliver the anticipated power gain. They proved this in simple fashion. They made a wooden framework the same size as the maximum tower cross-section for the WCAU tower and dropped wires down to the corners of a square frame placed at the base of the tower (fig. 5). Voila! Even with as few as four wires, the current distribution on the tower approximated the desired sinusoidal waveform and the radiation pattern proved to be what was predicted for the 5/8-wave antenna height.

So there it was. By summer, 1935, broadcasters had started to shift away from self-supporting towers in favor of uniform cross-section, guyed towers. And these are the tower designs that are in use today by the majority of broadcast stations around the world.

the taper effect

Although they had a different goal
in mind, Gihring and Brown had defined and described the so-called "taper effect" — that is, that normal assumptions about antenna length do not apply when the antenna element is not uniform in cross-section throughout its length. The antenna can be "thick" or "thin" and all is well, but when it's tapered, all sorts of strange things seem to happen!

### the discoveries of W3MWC and W6KPC

While the tapered tower effect was well-known in the broadcast industry, it remained unknown to the Amateur fraternity in general. The taper problem did not apply to VHF beam antennas, it seems, because most of them were made of a single section of tubing for each element and no taper was present. Even conventional 6, 10, and 20 meter beams had little, if any, taper. For experimenters who built HF beams with tapered elements, the puzzling results and poor beam performance could not be linked to the conventional element dimensions in use.

As far as I know, the first discussion of element taper in Amateur literature was presented by my good friend Frank Clement, W6KPC. Frank found that his 14 MHz driven element ended up 17 feet 2 inches (5.23 meters) long because of the extreme taper. (Note that the element is longer than the conventional electrical half-wavelength.)

There the matter rested until 1967, when Jim Berger, W3MWC, attempted to build a 3-element, 40-meter beam with tapered elements. In a letter to *QST*, Jim noted that he had to lengthen his elements to make the antenna work properly. The tapered driven element ended up 71 feet (23.6 meters) long (again, much longer than the conventional electrical half-wavelength.)

### W2PV defines and solves the problem

Aided by data from W6KPC, I derived a simple chart that provided a correction factor for a tapered element, based upon the maximum and minimum diameters of the element. It proved to be practical, and a few beams with tapered elements were designed from my data with good results. However, I had no mathematical proof that my supposition was correct.

I pushed the matter to the back of my mind until the late Jim Lawson, W2PV, published a mathematical explanation of element taper in his monumental series of articles in *ham radio*. The computer program he suggested was quickly compared against my heuristic (cut-and-try) data and I was pleased to find excellent agreement. A variation of the original program has since been published in *ham radio*.

### and the answer is

Yes, it is entirely possible for a "half-wave" element to be longer than predicted by conventional formulas if the element in question has a nonsinusoidal current distribution along it. One of the most common examples (there are others) is the simple tapered element having a non-uniform diameter along its length. But the means are now at hand to predict this aberration and to compensate for it.

### the 80-meter Yagi at OH1RY

Build an 80-meter Yagi antenna? Impossible. But Peter Kolehmainen, OH1RY did it! The antenna is shown in figs. 6 and 7. This monster is atop a 92-foot (30.6 meter) high tower placed on the crest of a 60-foot (18 meter) hill, making the beam about 150 feet (46 meters) above the surrounding territory. The boom length (including the tip guying supports) is 72 feet (22 meters) long. The antenna itself weighs about a half-ton (454 kg).

Element taper? The element is 6 inches (15.24 cm) in diameter at the boom, tapering to 1/2-inch (1.27 cm) diameter at the tips! As you can imagine, this provides some bizarre element lengths. The driven element is 135.5 feet (41 meters) long for resonance at 3.8 MHz. The first photo shows Peter squatting on the driven element, which is hinge-mounted to heavy insulating plates bolted to the side of the boom. The weight of the element is supported by the small "mast" and guy wire assembly behind him (I wonder where the photographer was standing when this picture was taken?)

If you look at the photo of the beam, you'll see Peter standing atop the antenna, dwarfed in size by the monster he has created!

Does the antenna work? Just listen for OH1RY and judge for yourself!
good reading from Canada

Our neighbor to the north, Yuri Blanarovich, VE3BMV, is the editor of a publication that all Amateurs (especially DXers) should be aware of. A first-class production Radiosporting covers all aspects of contest and DX operating — antennas, equipment, station operation, stories of DXpeditions — the works! I enjoy every issue of this publication. If you're interested in it, contact Yuri at Box 65, Don Mills, Ontario, Canada M3C 2R6. (I wish somebody would explain the British and Canadian postal code system!)

references


achievable for
144 MHz, 220 MHz, 440 MHz
Ask for our spec sheet and
radiation pattern plots, or
visit your favorite AEA
dealer for more information.

(Prices and specifications subject to change without notice or obligation)

AEA
Advanced Electronics Applications, Inc.
P.O. Box C-2150
Lynnwood, WA 98036
(206) 775-7373
TELEX 692496
AEA INTL. UW

RECEIVE OSCAR 10 TELEMETRY
Complete Kit
$134.95
plus $3.00 shipping and handling.

PSK DEMODULATOR —
decodes satellite's housekeeping status reports, environmental data collected and plain text bulletins

INPUT —
audio output of SSB receiver or cassette player.
OUTPUT —
RS232 compatible serial bit stream at 1200 baud.
Take it with you.

ShackMaster™ puts your home station in the palm of your hand. Whether portable, mobile, around the yard or around town you'll be linked through your handheld to your high performance equipment at home. Even call home from any Touch-Tone phone and operate. Scan the bands, change modes, select antennas, turn gear on and off – all from your Touch-Tone keypad. Check into nets, work skeds, ragchew and DX without being tied down to the shack.

Exchange electronic mailbox messages with your family – like “I'll be late”, or “All is OK”. Or talk with your family directly through ShackPatch™, with you in remote control of your home station. Report traffic accidents or disabled motorists through your home phone while mobile or portable with PersonalPatch™.

All the power of your home station (and more) really can follow you anywhere. . . to find out more about ShackMaster™ just write, send us your QSL, or call and talk with us at 408-749-8330.
THOUSANDS OF SATISFIED
CUSTOMERS WORLDWIDE

H AM
RADIO
OUTLET

ALL MAJOR BRANDS IN STOCK

KENWOOD HAND-HELDs
TR-2600A Deserves its well-earned reputation as the leading HT
TH-21AT/41AT
Only 2 4"W, 4 7/8"H, 1 1/4"D
Outstanding performers in an ideal package size
CALL FOR PRICE

TOLL-FREE PHONE
INCLUDING ALASKA AND HAWAII

US TOWER
TRANSMISSION
Formerly Transair Tower Co

MA-49 40' TUBULAR H.D. MAST
Regular $745
SALE $549
MA-550 55' TUBULAR H.D. MAST
Regular $1245
SALE $899

- Why You Should Buy
1. Will handle 10 Sq. Ft. 50 mph
2. Pleases neighbors with tubular streamlined look
3. In stock for quick delivery
4. Other models at great prices
FREE SHIPMENT
MOST ITEMS, U.P.S. SURFACE.

ICOM IC-27A
SUPER-COMPACT 2 METER MOBILE
ALSO IC-27H HIGH POWER VERSION
AND IC-37A, 220MHz
IC-47A, 70CM
S A V E !
CALL FOR LOW, LOW PRICE

ICOM
SIMPLEX-REPEATER-SATELLITE
IC-271H
2 METERS • 400 WATTS • ALL MODE
IC-471H
430-450MHz • 75 WATTS • ALL MODE
CALL FOR YOUR SPECIAL PRICE

Tri-Ex TOWER SALE
W-51 $899
51' CRANK-UP 9 SQ'
ELH 23D 2 MTR 30 W
CALL FOR PRICE

THE VERY BEST DEAL ON EVERY COUNT!

YAESU
FT-757GX
TOP-OF-THE-LINE HF TRANSCEIVER
PAY REGULAR PRICE $1799.95
CALL FOR YOUR LOW, LOW PRICE

FT-726R
Free UPS Surface

FT-2700H
NEW! 2M/70CM TRANSCEIVER

FT-209RH
CALL FOR GREAT PRICES

KENWOOD TS-940S
CALL FOR GREAT PRICES

PAY REGULAR PRICE

THOUSANDS OF SATISFIED
CUSTOMERS WORLDWIDE

H AM
RADIO
OUTLET

ALL MAJOR BRANDS IN STOCK

KENWOOD HAND-HELDs
TR-2600A Deserves its well-earned reputation as the leading HT
TH-21AT/41AT
Only 2 4"W, 4 7/8"H, 1 1/4"D
Outstanding performers in an ideal package size
CALL FOR PRICE

TOLL-FREE PHONE
INCLUDING ALASKA AND HAWAII

US TOWER
TRANSMISSION
Formerly Transair Tower Co

MA-49 40' TUBULAR H.D. MAST
Regular $745
SALE $549
MA-550 55' TUBULAR H.D. MAST
Regular $1245
SALE $899

- Why You Should Buy
1. Will handle 10 Sq. Ft. 50 mph
2. Pleases neighbors with tubular streamlined look
3. In stock for quick delivery
4. Other models at great prices
FREE SHIPMENT
MOST ITEMS, U.P.S. SURFACE.

ICOM IC-27A
SUPER-COMPACT 2 METER MOBILE
ALSO IC-27H HIGH POWER VERSION
AND IC-37A, 220MHz
IC-47A, 70CM
S A V E !
CALL FOR LOW, LOW PRICE

ICOM
SIMPLEX-REPEATER-SATELLITE
IC-271H
2 METERS • 400 WATTS • ALL MODE
IC-471H
430-450MHz • 75 WATTS • ALL MODE
CALL FOR YOUR SPECIAL PRICE

Tri-Ex TOWER SALE
W-51 $899
51' CRANK-UP 9 SQ'
ELH 23D 2 MTR 30 W
CALL FOR PRICE

THE VERY BEST DEAL ON EVERY COUNT!

YAESU
FT-757GX
TOP-OF-THE-LINE HF TRANSCEIVER
PAY REGULAR PRICE $1799.95
CALL FOR YOUR LOW, LOW PRICE

FT-726R
Free UPS Surface

FT-2700H
NEW! 2M/70CM TRANSCEIVER

FT-209RH
CALL FOR GREAT PRICES

KENWOOD TS-940S
THOUSANDS OF SATISFIED
CUSTOMERS WORLDWIDE

HAM RADIO OUTLET

ALL MAJOR BRANDS IN STOCK

ICOM IC-R71A
SUPERIOR GRADE
GENERAL COVERAGE
RECEIVER
Regular $799
SALE! $629.95
$599.95

TOLL-FREE PHONE
INCLUDING ALASKA AND HAWAII

ICOM IC-735
THE LATEST IN ICOM'S LONG LINE
OF HF TRANSEIVERS
CALL FOR LOW, LOW PRICE

ICOM IC-37A
HAND-HELD
IC-02AT IC-2AT IC-3AT
IC-04AT IC-4AT
AT GREAT LOW
LOW PRICES
FREE SHIPMENT
MOST ITEMS. U.S. SURFACE.

LATEST EDITION
IC-3200A DUAL BANDER
COVERS BOTH 2 METERS
and 70 CM
CALL FOR LOW,
LOW PRICE

6 STORE BUYING POWER!

PERSONALIZED SERVICE
BOB FERREDO, MGR
746 DANA HWY
ANAHEIM, CA 92801
(714) 761-3033, (213) 860-2040,
Between Disneyland & Knott's Berry Farm.

BURLINGAME, CA 94010
990 Howard Ave.,
(415) 342-5757.
5 miles south on 101 from San Fran. Airport.

OAKLAND, CA 94609
2811 Telegraph Ave.,
(415) 451-5757,
Highway 24 Downtown. Left 27th off-ramp.

PHOENIX, AZ 85015
1702 W. Camelback Road,
(602) 242-3515,
East of Highway 17.

SAN DIEGO, CA 92123
5375 Kearny Villa Road,
(818) 988-6046
(714) 761-3033.
Highway 163 and Clairemont Mesa Blvd.

VAN NUYS, CA 91401
625 Sepulveda Blvd.,
(818) 988-6046
San Diego Freeway at Victory Boulevard

Prices, specifications, descriptions subject to change without notice. Calif. and Arizona residents please add sales tax.
THE MOST AFFORDABLE RECEIVER
ALSO HAS THE MOST IMPRESSIVE PERFORMANCE FEATURES
AND GIVES THEM TO YOU AS STANDARD EQUIPMENT!

<table>
<thead>
<tr>
<th>Band</th>
<th>Kit</th>
<th>Wired</th>
</tr>
</thead>
<tbody>
<tr>
<td>10M, 6M, 2M, 220</td>
<td>$680</td>
<td>$880</td>
</tr>
<tr>
<td>440</td>
<td>$780</td>
<td>$980</td>
</tr>
</tbody>
</table>

FEATURES:
- SENSITIVITY SECOND TO NONE: 0.15uV (VHF), 0.2uV (UHF) TYP.
- SELECTIVITY THAT CAN'T BE BEAT! BOTH 8 POLE XTAL FILTER & CERAMIC FILTER FOR > 100dB at ± 12KHz. HELICAL RESONATOR FRONT ENDS TO FIGHT DESENSE & INTERMOD.
- OTHER GREAT RECEIVER FEATURES: FLUTTER-PROOF SQUELCH, AFC TO COMPENSATE FOR OFF-FREQ TRANSMITTERS. SEPARATE LOCAL SPEAKER AMPLIFIER & CONTROL.
- CLEAN, EASY TUNING TRANSMITTER; UP TO 20 WATTS OUT (UP TO 50W WITH OPTIONAL PA).

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Antenna Input Range</th>
<th>Receiver Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNG-28</td>
<td>28-32</td>
<td>144-148</td>
</tr>
<tr>
<td>LNG-432</td>
<td>432-434</td>
<td>28-30</td>
</tr>
<tr>
<td>LNG-220</td>
<td>220-224</td>
<td>164-448</td>
</tr>
<tr>
<td>LNG-50</td>
<td>50-448</td>
<td>28-30</td>
</tr>
<tr>
<td>LNG-144</td>
<td>144-448</td>
<td>28-30</td>
</tr>
<tr>
<td>LNG-160</td>
<td>160-448</td>
<td>28-30</td>
</tr>
<tr>
<td>LNG-220</td>
<td>220-224</td>
<td>144-448</td>
</tr>
<tr>
<td>LNG-432</td>
<td>432-434</td>
<td>144-448</td>
</tr>
<tr>
<td>LNG-800</td>
<td>800-960</td>
<td>144-448</td>
</tr>
</tbody>
</table>

LOW-NOISE PREAMPS

Hamtronics Breaks the Price Barrier!

FEATURES:
- Very Low Noise: 0.7 dB VHF, 0.8 dB UHF
- High Gain: 18 to 28 dB, Depending on Freq.
- Wide Dynamic Range for Overload Resistance
- Latest Dual-gate GaAs FET, Very Stable

MODEL | TUNES RANGE | PRICE
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LNG-28</td>
<td>26-30 MHz</td>
<td>$49</td>
</tr>
<tr>
<td>LNG-50</td>
<td>46-56 MHz</td>
<td>$49</td>
</tr>
<tr>
<td>LNG-144</td>
<td>137-150 MHz</td>
<td>$49</td>
</tr>
<tr>
<td>LNG-160</td>
<td>150-172 MHz</td>
<td>$49</td>
</tr>
<tr>
<td>LNG-220</td>
<td>210-230 MHz</td>
<td>$49</td>
</tr>
<tr>
<td>LNG-432</td>
<td>400-470 MHz</td>
<td>$49</td>
</tr>
<tr>
<td>LNG-800</td>
<td>800-960 MHz</td>
<td>$49</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>For VHF, Model XV2</th>
<th>Antenna Input Range</th>
<th>Receiver Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-30</td>
<td>144-148</td>
<td></td>
</tr>
<tr>
<td>28-39</td>
<td>145-148</td>
<td></td>
</tr>
<tr>
<td>28-50</td>
<td>50-52</td>
<td></td>
</tr>
<tr>
<td>27-24</td>
<td>144-444</td>
<td></td>
</tr>
<tr>
<td>27-24</td>
<td>144-444</td>
<td></td>
</tr>
<tr>
<td>28-30</td>
<td>144-448</td>
<td></td>
</tr>
<tr>
<td>28-30</td>
<td>144-448</td>
<td></td>
</tr>
<tr>
<td>28-50</td>
<td>50-54</td>
<td></td>
</tr>
<tr>
<td>28-50</td>
<td>50-54</td>
<td></td>
</tr>
<tr>
<td>28-30</td>
<td>144-146</td>
<td></td>
</tr>
<tr>
<td>28-30</td>
<td>144-146</td>
<td></td>
</tr>
</tbody>
</table>

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

ACCESSORIES

- MO-202 FSK DATA MODULATOR. Run up to 1200 baud digital or packet radio signals through any FM transmitter. Automatically keys transmitter and provides handshakes. 1200/2200 Hz tones. Kit only $45.
- DE-202 FSK DATA DEMODULATOR. Use with any FM receiver to detect packet radio or other digital data in “202” mode. Provides audio conditioning and handshakes. Kit only $38.
- COR-2 KIT With audio mixer, local speaker amplifier, tail & time-out timers. Only $38.
- COR-3 KIT As above, but with “courtesy beep”. Only $58.
- CWID KITS 166 bits, easily field programmable, clean audio. Kit only $66.
- A16 RF TIGHT BOX Deep drawn aluminum case with tight cover and no seams. 17 x 8 x 2 inches. Designed especially for repeaters. $20.
- DTMF DECODER/CONTROLLER KITS. Control 2 separate on/off functions with touchtones, e.g., repeater and autopatch. Use with main or aux. receiver or with Autopatch. Only $90.
- SIMPLEX AUTOPATCH. Use with your FM transceiver. System includes DTMF & Autopatch modules above and new Timing module to provide simplex autopatch and reverse autopatch. Complete system only $200/kits. Call or write for details.
tracking the hideous intermittent: part 1 — mechanical intermittents

Repair problems are never fun, especially since they take us off the air more times than not.

Probably the nastiest, meanest, and most contemptible of all repair problems are the intermittents. These come and go, usually occurring when it's least convenient. They almost never occur when you're ready to troubleshooting; you stand there, instrument probes in hand and brain engaged, only to find the darn set working properly. You turn your back, set the probes down, and — zot! — the trouble reappears momentarily and then disappears again.

Although I'm the first to admit that finding intermittents sometimes falls into the unholy realms of sorcery and witchcraft, certain things can be done to enhance the probability of success. There's no such thing as a universal procedure for locating intermittents because different kinds of equipment have somewhat different requirements. To keep things simple, we'll limit the scope of this discussion to troubleshooting a high-frequency SSB transceiver with receive problems.

where to look

One thing you can do is educate yourself about the kinds of parts and faults most likely to create intermittent symptoms. Very high on the list are switches and relays. Because these devices are mechanical, they're subject to wear and tear. You'll find dirty internal electrical contacts, poor spring tension, and other faults causing intermittent symptoms. In many cases, a session with a pencil eraser on the contacts or a squirt of contact cleaner (for example, Blue Stuff) will work wonders. In other cases, however, only replacement will solve the problem.

Another potential sore spot is potentiometers. These components are variable resistors in which a shaft-operated wiper electrode rubs against a wire-wound or carbon resistance element. If either the element or electrical contact on the wiper gets dirty, then operation can become intermittent. Unless the dirt has physically damaged the resistance element (as sometimes happens, especially on carbon elements), a simple squirt of contact cleaner will solve the problem. Be especially aware of potentiometers that normally pass direct current (DC) through the wiper connection. I recall a 1963/64 car radio model in which cost-conscious engineers eliminated a coupling capacitor from the volume control and audio preamplifier circuit, thereby making the volume control resistance part of the preamp transistor's bias network. Passing the DC bias through the control generated a massive warranty problem for the manufacturer as those volume controls were chewed up by the truckload!

The printed circuit board (PCB) is another common source of intermittent problems. Two forms of the problem are common: poor solder joints and damage, sometimes hidden, to the board. Both types of fault are especially aggravated in hot parts of the equipment: near power transistors, rectifiers, vacuum tubes, power resistors (2 watts and above), lamps and so forth. These areas sometimes can be identified by discoloration of the PCB (We'll discuss PCB problems in a moment.)

In vacuum tube equipment, the tube socket can produce intermittent problems. If the tube pins or the socket contact (fig. 1) lose tension, then an intermittent connection results. These faults can be repaired in most cases. If dirt is the problem, remove the tube and gently clean its pins with a dime store ink eraser, spray the pins with a clear contact cleaner, and reinsert the tube into the socket. Next, pull the tube out of the socket and then reinsert it four or five times in a row. This action will clean the socket. Wait a hal
GLB ELECTRONICS presents

THE FIRST CONTROLLER DESIGNED FOR PORTABLE AND SOLAR-POWERED STATIONS

- LOW 25 mA Current drain.
- Designed for portable or solar-powered stations.
- Miniature size—Lightweight
- Rugged all metal, shielded enclosure.
- On-board Lithium Battery RAM backup.
- On-board watchdog for reliability.
- Standard DB-25 Connectors.
- Output signal indicates "Connected" Status.
- Does not require squelched audio.
- Comes with 8K of RAM.
- Remote Command Mode for Unattended operation.
- Hardware command lockout for security.
- Commands compatible with our Model PK1.
- Retains all other features of the Model PK1.
- Extra I/O lines for special applications.

Power requirement:
9 to 15 Volts DC @ 25 mA typical

Dimensions:
4.6 X 5.90 X 1.0 inches

Total Weight:
12 ozs.

PK1L—Wired and Tested
List— $239.95
Amateur net— $209.95

AVAILABLE OCTOBER 15, 1985

Call or write GLB for options or Information.
hour or so for the cleaner to dry, then turn the rig on to evaluate the results. If the intermittent remains, re-tension the socket contacts with either a tiny screwdriver tip or other sharp-pointed tool.

Components can be the source of some maddening intermittents. Unfortunately, some component problems tend to heal themselves the instant a probe is attached (especially semiconductors). Be especially wary of plastic packaged transistors, tubular (non-mylar) capacitors, and resistors. These components account for a large portion of the problems.

Shielded IF and RF transformers (fig. 2A) are frequent sources of intermittent faults. The coil wire attaches to the lugs on the base, and these sometimes break (see fig. 2B). In some cases, a careful worker can repair these transformers; it's merely a matter of resoldering — you'd be surprised how many escape the factory unsoldered!

finding the intermittent

The first step, crucial to quick success, is observation. Define in your mind what the rig is doing wrong, what functions are affected, and whether it happens on both receive and transmit. Narrowing down the possibilities allows you to restrict your efforts to a certain few stages, once you determine which stages may or may not be affected. For example, if the problem happens on SSB but not CW, or on receive but not on transmit, we can then infer that the problem is probably not in a stage that is common to both affected modes. Deciding which stages are likely candidates depends on understanding your transceiver; do a block diagram analysis and read any circuit descriptions provided by the manufacturer.

Some intermittents occur under vibration, touching, or thumping. A certain number of such problems are due to bad switches and potentiometers. A little light tapping with an insulated probe, a little jiggling, or visual inspection will often locate the source of the problem.

Visual inspection involves examining every joint on the PCB with a 10X or so magnifying glass under adequate light. Examine the board two ways: first with the light shining on the soldered side, then with the light shining through the PCB from the component side (fig. 3). In the latter case, subsurface cracks in the PCB material can break a joint or track. Even if the joint or track appears normal it should be reworked.

Visual examination takes a certain amount of practice; one needs to develop a "small eye," that is, the ability to see defects where others would see a "normal" joint.

I usually inspect PCBs with a bottle of fingernail polish or a grease pencil handy. Especially on large boards, each apparent anomaly is marked so that I can find it easily later on. This habit is especially useful when using a magnifier because the glass will distort your perception of space.

Shotgun soldering is especially useful when the area of the intermittent is known, when the PCB is small, or when nothing else seems to work. I can recall another mobile radio receiver problem in which the VHF front-ends PCB had a high "bad joint" intermittent rate, but were difficult to remove and replace. In that case, the more elegant "visual inspection" method was not cost effective, so we pulled the PCBs, soldered every joint, and tinned every track. Rarely did this method fail on that particular problem.

At this point let me digress a little bit to answer the purists who would criticize this approach. I admit that the elegant method is to find the single bad joint or broken track and repair only that. Unfortunately, this approach can be time-consuming and may even be impossible. While the purist "super-tech" is messing around trying to analyze which joint is bad, I'm going to fix the rig! Commercially, the shotgun approach is more profitable — and to Amateurs it means getting back on the air sooner.

Next month: Tracking down thermal intermittents.
WORLD SOCIETY FOR THE PROTECTION OF ANIMALS

When DISASTER Strikes
YOU May be the Animals’ Only Hope

The World Society for the Protection of Animals (WSPA), a nonprofit organization with offices around the globe, takes action to help animals in crisis, responding in times of fire, flood, earthquake, volcanic eruption, oil spills, and civil unrest.

To assure the quickest response to these disasters, WSPA needs the help of ham radio operators in the United States and abroad who can relay critical information to and from international trouble spots.

WSPA is the only organization officially recognized by the United Nations as a consultant on animal disaster issues. We urgently need you and your radio. To register as an animal-emergency operator, simply fill out the coupon and mail it to WSPA, Western Hemisphere Regional Office, 29 Perkins St., POB 190, Boston, MA 02130. We’ll be depending on you when animals are in jeopardy.

When DISASTER Strikes
YOU May be the Animals’ Only Hope

The World Society for the Protection of Animals (WSPA), a nonprofit organization with offices around the globe, takes action to help animals in crisis, responding in times of fire, flood, earthquake, volcanic eruption, oil spills, and civil unrest.

To assure the quickest response to these disasters, WSPA needs the help of ham radio operators in the United States and abroad who can relay critical information to and from international trouble spots.

WSPA is the only organization officially recognized by the United Nations as a consultant on animal disaster issues. We urgently need you and your radio. To register as an animal-emergency operator, simply fill out the coupon and mail it to WSPA, Western Hemisphere Regional Office, 29 Perkins St., POB 190, Boston, MA 02130. We’ll be depending on you when animals are in jeopardy.

When DISASTER Strikes
YOU May be the Animals’ Only Hope

The World Society for the Protection of Animals (WSPA), a nonprofit organization with offices around the globe, takes action to help animals in crisis, responding in times of fire, flood, earthquake, volcanic eruption, oil spills, and civil unrest.

To assure the quickest response to these disasters, WSPA needs the help of ham radio operators in the United States and abroad who can relay critical information to and from international trouble spots.

WSPA is the only organization officially recognized by the United Nations as a consultant on animal disaster issues. We urgently need you and your radio. To register as an animal-emergency operator, simply fill out the coupon and mail it to WSPA, Western Hemisphere Regional Office, 29 Perkins St., POB 190, Boston, MA 02130. We’ll be depending on you when animals are in jeopardy.
Everything from Superman III to Super Bowl XX.

Everything you always wanted to see on television but were afraid you'd never get.
Over one hundred channels of spectacular entertainment. Of crystal clear reception.
Throughout the house. 24 hours a day.
With no monthly fees. No cable TV.
Come see the entire line of Uniden Satellite Television Systems. It's legal.
It's affordable. And it's a whole new world of television. Right in your own backyard.

Uniden®
Satellite Television Systems

Satellite Television Systems
2410 Ridge Road West
Rochester, New York 14626
716-225-6130
1-800-824-5014
Sales

VIDCOM
Satellite Comm.

17 Industrial Street
Rochester, New York 14614
716-454-3630
1-800-824-5014
Service
The ARRL 1986 Handbook for the Radio Amateur takes over where the 1985 Edition left off. Each of the 40 chapters has had some revision, and there are more than 500 new or revised figures. The new edition will contain 1184 pages — way up from last year’s count of 1024. Many key chapters with “hot” topics among today’s radio amateurs have been completely revised and rewritten. In fact the new material represents 532 text pages.

An understanding of digital electronics is a must these days since such circuitry has so many practical applications in station control, frequency synthesis, telemetry, word processing and other information-handling systems. The Digital Basics chapter will help you to understand what is going on in everything from simple keyers to sophisticated microcomputers. Packet-radio enthusiasts will find the most up-to-date information available in the Digital Communications chapter. There are new sections on data interfacing and modems, 50 new and revised figures, plus an expanded bibliography and glossary.

The Special Modulation Techniques chapter has the latest on spread-spectrum. On the fun side, we’ve added a new section on remote control of model aircraft and vehicles.

On the practical side, you will find many of the 27 new projects described in October QST. There are new power amplifiers for 1.8, 50, 144 and 1296 MHz, plus preamplifiers and transverters for the VHF/UHF enthusiast. The new digital PEP Wattmeter - SWR Calculator will be one of the most popular projects.

We’ve only scratched the surface in describing what is the standard manual of RF communication. Over 5.7 million copies of The Handbook have been published in 63 editions since 1926. The new edition is must reading for today’s radio amateur!

The 1986 Handbook will be available in November. Paperbound prices are $18.00 in the U.S., $19.00 in Canada and elsewhere. Cloth prices are $27.00 in the U.S. and $29.00 elsewhere. Prices in U.S. funds. Foreign remittance should be in the form of an international money order or a check drawn on a bank account in the U.S.
The new ICOM IC-735 is what you've been asking for... the most compact and advanced full-featured HF transceiver with general coverage receiver on the market. Measuring only 3.7 inches high by 9.5 inches wide by 9 inches deep, the IC-735 is well suited for mobile, marine or base station operation.

**Ultra Compact**

The new ICOM IC-735 is what you've been asking for... the most compact and advanced full-featured HF transceiver with general coverage receiver on the market. Measuring only 3.7 inches high by 9.5 inches wide by 9 inches deep, the IC-735 is well suited for mobile, marine or base station operation.

**Superior Performance**

It's a high performer on all the ham bands, and as a general coverage receiver, the IC-735 is exceptional. The IC-735 has a built-in receiver attenuator, preamp and noise blanker to enhance receiver performance. PLUS it has a 105dB dynamic range and a new low-noise phase locked loop for extremely quiet rock-solid reception.

**More Standard Features**

Dollar-for-dollar the IC-735 includes more standard features... FM built-in, an HM-12 scanning mic, FM, CW, LSB, USB, AM transmit and receive, 12 tunable memories and lithium memory backup, program scan, memory scan, switchable AGC, automatic SSB selection by band, RF speech processor, 12V operation, continuously adjustable output power up to 100 watts, 100% duty cycle and a deep tunable notch.

**Simplified Front Panel**

The large LCD readout and conveniently located controls enable easy operation, even in the mobile environment. Controls which require rare adjustments are placed behind a hatch cover on the front panel of the radio. VOX controls, mic gain and other seldom used controls are kept out of sight, but are immediately accessible.

Options. A new line of accessories is available, including the AT-150 electronic, automatic antenna tuner and the switching PS-55 power supply. The IC-735 is also compatible with most of ICOM's existing line of HF accessories.

See the IC-735 at your authorized ICOM dealer. For superior performance and innovative features at the right price, look at the ultra compact IC-735.

**First in Communications**

ICOM America, Inc., 2380-116th Ave NE, Bellevue, WA 98004 / 3331 Towerwood Drive, Suite 307, Dallas, TX 75234

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

Real-voice message system
For any repeater or base

Now you can communicate vital information even when the station you are calling is not on the air — with Message Master. Message Master is a solid state voice recording system which can record messages just by listening to you speak, store messages in memory, and deliver messages on demand. If you can't be there to deliver your messages let Message Master deliver them for you - any messages in any language and in your own voice!

Message Master connects easily to any radio system for remote access: repeaters, base stations, even transceivers. It can even be connected to an autopatch device to exchange messages between your radio system and the telephone network.

Message Master is a multi-user system with mailbox style personalized message service for a hundred users. With 8 minutes of message storage it can store hundreds of messages simultaneously making it ideal for large, active repeater groups.

Would you like your callsign identifications, tail messages, and bulletin messages sent in real-voice? Message Master can send them too. Record several identification messages and it will even send a different ID each time. Almost like magic, Message Master knows when to send identifications and tail messages so it needs no special control signals from your base or repeater.

Call or write for further information before you make another wasted call.

Commercial users: Ask for a brochure on the Message Master Electronic Dispatcher with group and all call messaging.

- Create messages just by talking. Message Master's 'real-voice' technique saves YOUR VOICE in digital memory to deliver messages in your own voice, language and dialect.

- Mailbox-style operation gives individual message delivery service to 100 system users.

- Easily added to any repeater or base station for remote operation with only four connections.

- Special features include callsign identifications, tail messages, and bulletin messages.

- Digital message storage provides instant playback of stored messages.

- Modular memory meets your exact needs from 2 to 8 minutes of total message storage.

Serving all your repeater needs

- Mark 4 Repeaters and Repeater Controllers are THE PERFORMANCE LEADERS with real voice, more autodial numbers, more synthesized voice and more features.

- Mark 3 Repeaters offer the winning combination of high performance and high value.

- LR-1 Repeaters boast superb RF circuitry at an economical price.

- MR-4 Receivers with 7 helical resonators are the only receivers to choose in harsh RF environments.

- PA-100 Amplifiers with rugged TMOS power FETs give you a continuous duty high power signal.

COMING SOON: A 4-channel receiver voting system which operates on true signal-to-noise ratio to extend your coverage by linking to remote receivers.

KENDECOM INC.
MICRO CONTROL SPECIALTIES
23 Elm Park
Groveland, MA 01834
(617) 372-3442
digital frequency readout using the Commodore 64

A $\div$ by 16 prescaler designed for the Argosy I can be adapted to other transceivers.

Although digital frequency readout is clearly a major advance in Amateur transceiver technology, many excellent rigs that offer most of the other advantages typical of state-of-the-art gear don't have digital readout. Yet it seems ridiculous to replace a good piece of equipment because of this one shortcoming. If you have such a rig, you might want to consider adding a digital frequency display as an accessory.

This can be done through the purchase or construction of a frequency counter, but such gadgets tie up both station space and dollars, and without special hookups can display only transmitted frequencies. Furthermore, when the station already contains a computer and monitor, it seems redundant to add yet another display with its associated batch of electronics.

I was doing a good job of break-in CW with a Ten-Tec Argosy and a Commodore 64 serving as a CW keyboard. With conditions becoming more and more difficult as the sunspot number fell, the need for sharp filters and "on-the-nose" schedules became too acute to be ignored, and the analog dial of the Argosy fell short of what was needed. Accordingly, I decided to make the computer display the required information.

Fortunately, the C64 contains an array of hardware timers that operate independently off the central processor and can be accessed through the user port. It also contains a stable frequency reference in the form of the machine clock. The timers perform the comparison of unknown and reference frequencies. The mathematics necessary to display the operating frequency, formulated in BASIC, run in real time in order to provide a continuous readout. The system is easy to implement and debug, performs beautifully, and is readily adaptable to other popular transceivers.

timer

The timers are part of two 6526 Complex Interface Adapter (CIA) integrated circuits contained in the machine. One of the two ICs is dedicated primarily to the keyboard interface, but its timers are partly accessible through the user port. The second CIA is dedicated to the user port and the serial interface, and its functions are fully accessible.

The timers are 16-stage binary counters that can be preset to any count between 1 and 65,535. They count down from the preset value and deliver an output when the count passes zero. Thus, they can divide an input frequency by any integral number within their range. Furthermore, they can be cascaded by appropriate instructions to form a longer counter chain.

The signal counted can be either an external input or the machine clock. The latter runs at 1.022727 MHz and is derived from a master crystal oscillator that also generates the color subcarrier in a TV.

The counting rate is limited to about 500 kHz by the internal mechanics of the interface chip. It is therefore necessary to bring the frequency to be measured down into the range below 500 kHz. However, an aliasing effect permits moderate extension of the limit with appropriate modification of the programmed mathematics.

By Clifford J. Bader, W3NNL, 1209 Gateway Lane, West Chester, Pennsylvania 19380
**design considerations**

A key requirement for digital frequency readout is precise gating of the counter that records the frequency to be measured. This would be difficult to do if the gating were done through software, since the machine cycle times for executing BASIC instructions are a significant fraction of the counting period required. Fortunately, the designers of the CIA arranged for direct access of the timer output through the user port, without intervention by the computer's processor; thus, one timer can be used to precisely gate another by the addition of simple external circuitry, and the result can be examined by the computer at its leisure.

In general, neither the transmitted nor the received frequencies are present as a steady-state signal (except in the case of a direct-conversion system), so an indirect method of determining the frequency must be used. Since most modern gear uses a master oscillator covering a fixed range, in conjunction with crystal-controlled heterodyning oscillators for the various bands, it is generally satisfactory to measure the master oscillator frequency and to apply appropriate corrections to the display. The stability of the heterodyning system is usually good enough to make the correction a constant factor, and no significant error results from warm-up or temperature changes.

My Argosy oscillator operates in the 5-MHz region, as do the oscillators in many other transceivers. To get the frequency below the 500-kHz limit, the frequency to be measured must be reduced by a factor of better than 10. Translation through a mixer could be used, giving an output of 0 to 500 kHz as the oscillator covers 5 to 5.5 MHz, but an additional crystal oscillator would be needed and the mixer output circuit would have to be broadbanded over the range from DC to 500 kHz.

It's easier to use a frequency divider in the form of a simple integrated-circuit counter. For example, a four-stage binary counter divides by 16, giving an output frequency range of 312.5 kHz to 343.75 kHz as the input varies from 5 MHz to 5.5 MHz.

An obvious disadvantage of the divider is the loss of precision associated with the compressed frequency range. The precision can be regained, however, by lengthening the counting interval by an equivalent factor. Normally, achieving 100-Hz resolution — which is typical of most digital readout transceivers — would require counting for 0.01 second; with the divide-by-16 prescaler, the time must be lengthened to 0.16 second or more. Fortunately, a repetition rate of two or three
times per second is fast enough for a useful real-time readout, so the divider scheme is practical. It is easy to implement, requiring only the binary counter and a transistor buffer-driver to amplify the small amount of RF taken from the 5-MHz transceiver oscillator. Power can be taken from the computer’s user port.

The computer program for performing the readout and display handles a number of functions. First, it arranges the timers for the task at hand. Then it starts the count cycle running and monitors for completion of the cycle. Next it obtains the resultant count and performs the mathematics necessary to deduce the oscillator frequency from the count. It applies the appropriate corrections for the band and mode in use, as input by the operator. Finally, it displays the resultant figure on the screen, and initiates a new cycle. Despite all this activity, the program is a short one, requiring fewer than 50 lines of typing and only a few seconds to load from tape or disk.

**system implementation**

The readout system is shown in fig. 1. Timer A of the user port divides the machine clock frequency by 65,536. When its count passes zero a pulse is delivered to user port timer B. The latter is preset to a count of 2; when it also indicates an underflow (at a clock count of $65,536 \times 3 = 196,608$), line PB7 (Pin L) of the user port switches from plus 5 volts to zero volts. This voltage transition gates off the external counter.

The counting interval is $196,608/1,022,727 = 0.192239$ second.

Counter B of the keyboard interface CIA counts the input pulses delivered from the external divide-by-16 prescaler through Pin 4 of the user port. It is preset to 65,536 at the start of each cycle and counts down until the external signal is gated off.

The schematic of the external prescaler is shown in fig. 2. The binary counter is a TTL 74197, which is capable of 70-MHz operation. There are numerous other possible choices, including some CMOS varieties; however, with the latter it may be necessary to run the prescaler at a higher voltage than 5 volts to achieve the 5 MHz counting speed. This would in turn lead to power supply and interfacing complications.

A cursory glance at the transistor buffer circuit suggests that it violates all the rules of stable biasing for amplifiers. So it does, but the objective is not linear reproduction of the signal, but rather the development of a square wave drive from a hundred millivolts or so of sinusoidal signal. Thus, it is permissible to operate the stages at a small degree of either saturation or cutoff. The resistor values shown keep the 2N2222s in such a state.

The coupling to the transceiver is through a simple capacitive pickoff and a 3-foot (0.9 meter) shielded cable to the prescaler. The loss in signal caused by the voltage-divider effect of the cable capacitance is made up by the two-stage amplifier in the prescaler.

---

**fig. 2.** Prescaler schematic. Bias resistor values are chosen for a small amount of saturation or cutoff. Stage delivers square wave drive from about a hundreded millivolts of sinusoidal signal.
The advantage of this approach is that it requires no active hardware inside the transceiver and produces no large-amplitude square waves near the transceiver’s receiver circuitry.

In my Argosy, the 39 pF capacitor is connected to the output (rearmost) terminal of the PTO assembly and a shielded cable is run from there to one of the spare RCA jacks on the rear panel. Many transceivers have the VFO signal already available on the back panel and require no internal modification. In general, the pickoff point should be at the output of the VFO buffer, and the rig should be checked after connection of the prescaler to make sure that there is no loss of output.

The prescaler is located close to the user port and enclosed in a small aluminum box (fig. 3) to prevent radiation of harmonics of the scaled-down frequency every few hundred kilohertz throughout the spectrum. Such radiation is also suppressed by the 0.001-μF capacitor from the prescaler output to ground, which slows down the edges of the square wave going into the port.

At W3NNL, the prescaler shares the user port with an MFJ-1228 CW/RTTY interface, and is piggybacked on the latter (fig. 4). There is only one port line (Pin L) in conflict, and a switch is provided to transfer it from frequency readout to the MFJ. I have also combined a CW keyboard program (not shown) with the frequency readout.

In the absence of such a piggyback scheme, it will be necessary to procure a connector with the required 0.156-inch (4-mm) contact spacing. These seem to turn up at hamfests only in much longer sizes than the 24-pin variety needed for the user port; however, the excess length is easily removed with a hacksaw.

**computer program**

The BASIC program shown in fig. 5 can be followed using the memory map presented in the C64 Programmer’s Reference Guide. Lines 110 through 290 are concerned with acquiring the operator-specified band and mode, and defining the pre-established correction factors. The section from line 300 through 420 sets up the timers, runs the count cycle, and calculates the frequency. The remainder of the program is devoted to formatting and displaying the output and starting a new cycle.

The timer interface uses POKE and PEEK statements directed to the appropriate addresses. The count in timer B of the keyboard CIA is picked off in two eight-bit bytes, and the number of pulses is calculated and multiplied by a factor which yields the original input frequency to the prescaler. The low-edge oscillator frequency is subtracted from the input frequency, and the lower edge of the band in use is added. Finally, corrections unique to the individual transceiver are either added or subtracted; these corrections take care of crystal-tolerance errors in the heterodyne frequencies, deliberately introduced offsets such as those used in the Argosy to avoid birdies, and shifts in the received and transmitted frequencies dependent on the mode of operation selected (CW or either sideband).

The correction consists of a term K representing the conversion-oscillator related effects, a factor D representing the offset between CW and normal sideband operation, and a multiple of D which is the shift incurred when the reverse sideband is selected. Of course, if only one mode is to be used, D may be omitted from the selection statements and from the frequency equation of line 400, and the mode select routines of lines 130-160 and 270-280 can be omitted. The value of K can be determined for the mode of interest.

Several tasks are associated with formatting and display. The screen is cleared and the “FREQ =” leader is printed, followed by the frequency, a wide space, and the mode entered. To avoid a string of meaningless extra digits after the decimal point, the computed frequency is rounded off to the nearest 0.1 kHz. To eliminate the visually unpleasant sensation produced by the C64’s dutiful suppression of the decimal point and following zero on integral kilohertz readings, some jockeying is performed to tack the point and zero back on. Finally, compensation is made for the leading-zero suppression, which occurs when tuning from above 10 MHz, to below 10 MHz, and which would otherwise shift the display left and expose a spurious right-hand digit.

The above action is repeated every few hundred milliseconds, except that the screen is left uncleared after the first cycle. Clearing produces flicker and is unnecessary unless the format changes.

For the display to work properly, it is imperative that
PERFORMANCE
THAT IS OUT OF THIS WORLD...

$389.00
MODEL 2000 20MHz
DUAL TRACE

$549.00
MODEL 3500 35MHz
DUAL TRACE DELAYED SWEEP

...AT A DOWN TO EARTH PRICE

At last! Truly affordable test equipment with no compromise in design, and features you would expect to find only on oscilloscopes costing hundreds of dollars more! JDR Instruments presents two, new, high-performance models backed by a two year warranty and technical support which is only a phone call away. Perfect for the technician or advanced hobbyist, both models feature Dual Trace capability and a variety of operating and triggering modes, including CH-B Subtract and X-Y operation.

MODEL 2000 has a 20 MHz bandwidth and 20 calibrated sweeps ranging from .2s to .2μs. A convenient built-in component tester provides additional diagnostic power.

MODEL 3500 features a 35 MHz bandwidth and exceptional 1mV/DIV sensitivity. Delayed sweep and variable holdoff allow stable viewing of complex waveforms.

ORDER TOLL FREE
800-538-5000
800-662-6279 (CA)

JDR INSTRUMENTS
1224 South Bascom Avenue
San Jose, California 95128 (408) 995-5430

COPYRIGHT 1985 JDR INSTRUMENTS. EARTH PHOTO COURTESY OF NASA. THE JDR INSTRUMENTS LOGO IS A REGISTERED TRADEMARK OF JDR MICRODEVICES. JDR INSTRUMENTS IS A TRADEMARK OF JDR MICRODEVICES.
the display portion of the program be typed exactly as specified, including all embedded punctuation marks.

**correction factor determinations**

When the program is first typed, lines 180 through 280 should be omitted. The missing lines may be entered after determining the \( K \) and \( D \) factors as described below.

If the correct nominal low-edge oscillator frequency has been entered on line 290, the indicated frequency will be somewhere within 10 kilohertz or so of the true value when the program is run and WWV, CHU, or the crystal calibrator is tuned in. Before starting the correction factor procedure, the calibrator should be checked to make sure it is accurately tuned to the standard-frequency station.

To determine \( K \) for a given band, only one measurement is necessary. With the rig set in the normal sideband position for the band in use, the crystal calibrator should be tuned to zero beat. The frequency indicated by the display should be noted and subtracted from the actual frequency of the calibrator harmonic. The result is the value of \( K \). This operation should be repeated for each band or bandswitch segment and the numbers recorded for entry into the program (don’t forget the minus signs where applicable).

Next, the transceiver should be set for CW and the calibrator harmonic tuned for the proper CW pitch rather than for zero beat. The direction and magnitude of the change in indicated frequency should be noted. The change will normally be about 0.8 kHz. An accurate value can readily be determined if the rig has a sharp audio or crystal filter. If a separate receiver is available, a still more accurate measurement can be made by noting the display reading when the transceiver is placed in the transmit mode and zeroed in the external receiver with a known reference. The RIT or OFFSET control should be set to zero for this measurement.

The value of \( D \) obtained is positive if the indicated frequency decreases as compared to the zero beat setting, and negative if it increases. By way of example, in the program (fig. 5) at 10 MHz the indicated frequency with WWV at zero beat in the SSBN (normal sideband) mode was 10010.8 kHz, leading to a \( K \) of minus 10.8. With the WWV carrier peaked in the audio filter, the indicated frequency increased another 800 Hz to 10011.6 kHz, yielding \(-0.8\) for \( D \). The numerical value of \( D \) holds for all bands, but the sign changes as the rig implements CW on different sides of zero beat.

Finally, the opposite sideband should be selected and the zero-beat procedure followed. The correction determined should be divided by \( D \) to give the multiplier used in line 280. Again with reference to fig. 5, my display read 10014.2 in the reverse (USB) mode, or 3.4 kHz higher than SSBN. This is 4.25 times as large as the CW correction and in the same direction, so the multiplier in line 280 becomes 4.25.

**operation**

The program asks for entries of the band in MHz and the mode (0 for CW, 1 for normal SSB, and 2 for reverse SSB). It then displays the frequency to the nearest 0.1 kHz and the mode in use. A flickering of the display between two adjacent tenths digits indicates that the frequency is approximately halfway between the two values.

The readout follows the incremental tuning on receive and shows the transmitted frequency when the key is pressed or the mike activated. If there is considerable RF in the station the readout may be erratic on transmit, but will work if the drive is decreased to reduce the spurious RF.

To change the band and/or mode in use, press the f1 key. This restores the prompts and starts the process again.

**adaptation to other transceivers**

As described, the program and hardware should work with the Ten-Tec Omni as well as the Argosy. However, a number of other transceivers use upper/lower sideband selection rather than normal/reverse for the band in use. In general, its merely necessary to change the format, substituting LSB and USB for SSBN and SSBR. Proper choice of correction factor values and algebraic signs will then produce equivalent performance.

Of more concern is the VFO frequency and its relationship to output frequency. Both the Kenwood TS520S and the Yaesu FT101E use backward tuning VFOs’ that is, the low-band edge corresponds to maximum VFO frequency. This requires modification of the frequency equation of line 420 to read:
DRIVE BELTS

22/44 EDGE CONNECTOR
PC style $2.60 each 10 for $22.00
22/44 EDGE CONNECTOR
solder lug style $2.50 each 25 for $62.50
28/56 EDGE CONNECTOR
PC style $2.50 each 10 for $25.00
36/72 EDGE CONNECTOR
PC style $3.00 each 10 for $30.00
50/110 EDGE CONNECTOR
PC style $4.50 each 10 for $45.00

PARALLEL PRINT CONNECTORS

DB-15 PLUG $2.75
DB-15 SOCKET $4.00
DB-15 HOOD $2.75
DB-25 PLUG $2.75
DB-25 SOCKET $2.75
DB-25 HOOD $2.75

TRANSISTORS
2N7005 4 for $1.00
2N7022 3 for $1.00
2N2222 3 for $1.00
2N2904 3 for $1.00
2N3174 2 for $1.00
2N3552 1 for $0.50
2N5630 1 for $0.50
PMD 104X0 1 for $1.00
PMD 105 1 for $1.00
PMD 106 1 for $1.00
TIP 1 100 for $4.00
TIP 125 75 for...

SPECIAL PRICE TRANSISTOR 2N3552 250 ea. $1.00 each 50 for $4.00
SPECIAL PRICE TRANSISTOR 2N3552 250 ea. $1.00 each 50 for $4.00

COMPUTER GRADE CAPACITORS

2,000 mfd/200 VDC 1% 10 each $2.00 each
3,600 mfd/40 VDC 1% 10 each $1.00 each
6,400 mfd/60 VDC 1% 10 each $1.25 each
9,700 mfd/9 VDC 1% 10 each $1.50 each
31,000 mfd/15 VDC 1% 10 each $2.50 each
72,000 mfd/24 VDC 1% 10 each $5.75 each
165,000 mfd/6 VDC 1% 10 each $1.75 each

Tri Supply Power Supply

Compact, well-regulated switching power supply designed to power Texas Instruments components equipment.

INPUT 14 - 25 vac @ 1 amp
OUTPUT 12 VDC @ 500 ma.
5 VDC @ 1 amp
24 VAC @ 200 ma.
SIZE 1/4 x 5/8 x 1/2" high
$5.00 each

D.C. CONVERTER

MINI-BOX

Electrically black Wear-resistant hard
Pomona #2104

D.C. CONVERTER

7 CONDUCTOR RIBBON CABLE

3 amp constant, 4 amp surge $18.00 each
3 amp constant, 4 amp surge $25.00 each

SOUND AND VIDEO MODULATOR FOR TI. COMPUTER

TI U315B1-1 Designed for use with TI. computer. Can be used with video monitors. Built-in A/B switch. Channel 2 or 4 selection switch Operates on 12 volts. Hookup diagram included $15.00 each

8" P.A. SPEAKER

C T. Model BBD379
3 ohm magnet
Typical response range 100 - 10,000 Hz
Master rating 15 watts max
Drilled to mount one matching transformer $5.00 each

CASES 10 each $20.00

SLIM LINE COOLING FANS

BENDER TWIN FAN 100 each $25.00

PACKET 5 for $10.00

MINIATURE 5 VDC RELAY

FULERTON 50DC-24 10 each $10.00
50 DC-24 10 each $10.00

3/8" SPEAKER

5 ohm, alnico magnet, full range speaker. Drilled to mount one matching transformer $2.50 each for $20.00

SPRING LEVER TERMINALS

Two terminal, brass-encased terminals for 24" x 24" space. $1.00 each

CASSETTE MECHANISM

New, stereo cassette mechanism includes record/playback and erase heads. 2-VDC motors and 5-VDC solenoids, pitch-wheels and other mechanical parts. Would cost several times our selling price if purchased.
The program in fig. 5 will accommodate oscillator frequencies from about 2.7 to 8 MHz. Frequencies below 2.7 MHz can be handled if line 410 is omitted.

**final comments**

The most likely causes for failure of the system to operate are typing errors in the program or a problem in the prescaler. If the latter is running, it should be possible to hear harmonics at multiples of the divided-down frequency if the receiver antenna is brought near the circuit board. An analog DC voltmeter will read about 2.5 volts when connected to Pin 12 of the 74197.

Some experimentation with preamplifier base resistor and input coupling capacitor values may be necessary if the VFO output is very low.

One very quickly becomes addicted to the circuit, to the extent that the rig is never on unless the computer is first fired up. It is satisfying to be able to set the display to 14000 kHz on a seemingly dead-meter band and have one of the beacon stations pop right out in the center of the audio passband.

**acknowledgements**

Thanks are due to Earle Lewis, W3JXX, Fritz Hauff, W3NZ, and Dick Briner, WB3GVU, for furnishing the Kenwood and Yaesu manuals. The photographs were taken by my son-in-law, Herb Hoppe, Jr.

**ham radio**

The program in fig. 5 will accommodate oscillator frequencies from about 2.7 to 8 MHz. Frequencies below 2.7 MHz can be handled if line 410 is omitted.

**final comments**

The most likely causes for failure of the system to operate are typing errors in the program or a problem in the prescaler. If the latter is running, it should be possible to hear harmonics at multiples of the divided-down frequency if the receiver antenna is brought near the circuit board. An analog DC voltmeter will read about 2.5 volts when connected to Pin 12 of the 74197.

Some experimentation with preamplifier base resistor and input coupling capacitor values may be necessary if the VFO output is very low.

One very quickly becomes addicted to the circuit, to the extent that the rig is never on unless the computer is first fired up. It is satisfying to be able to set the display to 14000 kHz on a seemingly dead-meter band and have one of the beacon stations pop right out in the center of the audio passband.

**acknowledgements**

Thanks are due to Earle Lewis, W3JXX, Fritz Hauff, W3NZ, and Dick Briner, WB3GVU, for furnishing the Kenwood and Yaesu manuals. The photographs were taken by my son-in-law, Herb Hoppe, Jr.

**satellite television receiver semikit**

with dual conversion downconverter

**features:**

- Infrared remote control tuning
- AFG, SAW filter
- RF or video output
- Stereo output
- Polorator controls
- LED channel & tuning indicators

Install six factory assembled circuit boards to complete.

**semikit**

$300.00

Completed downconverter add $100.00

Completed receiver and downconverter add $150.00

**james walter satellite receiver**

2697 nickel, san pablo, ca 94806 tel. 415-724-0587
winter DX season

November through February constitutes the winter DX season. Because the D and E regions of the ionosphere receive less energy from the sun in the northern hemisphere during this time, less ionization occurs. Therefore, the daytime attenuation of radio signals is lower in winter than during the rest of the year.

Attenuation is a result of signal energy being absorbed by ions in the D region (35-50 miles or 60-80 km) above the earth. The amount of absorption is related to the zenith angle* to the sun from the points where your path crosses this D region. And on any propagation path, absorption increases with the number of transits of the D region and varies inversely with frequency. So in working DX, it pays to use the higher frequency bands to obtain more distance per hop (resulting in fewer transits) and less signal loss.

This is why we generally think of 6, 10, or 15 meters for DXing. But in winter, particularly near sunspot minimum, we have the opportunity to work DX on the lower frequency bands with lower signal loss, day or night, than at any other time of the year. But you can't always count on it; signals traveling a high latitude path may be poor for several days at a time. This is known as the winter anomaly.¹

Along with the lower signal attenuation, the QRN decreases as fewer local thunderstorms pass through your area and the large thunderstorm areas near the equator move further south, requiring more than one hop to get to us. This decreases the noise some 6-8 dB, which is particularly noticeable on the 160, 80, and 40-meter bands.

Even though ion production in the D, E, and lower F regions is lower, ions are better able to diffuse and drift upward along the geomagnetic field lines into the F region. This layer is the major factor in defining the maximum usable frequency. In winter this maximum usable frequency rises rapidly as the sun rises each day, peaking just after noontime, then diminishing during the afternoon, evening, and through the night to a low value just before dawn the next day. The exception to this situation is for locations nearer to the equator, where the ionization continues to drift and diffuse upward during the afternoon and evening to become the transequatorial maximums described in my October, 1983 column.² The maximum usable frequency peak reached each day and the depth of the predawn minimum frequency of the next morning are related to the solar flux of the day. The higher the flux that day, the higher the frequency peak and the lower the dip the next morning.

Another advantage during the winter season is that the geomagnetic field is least disturbed during November and December. This manifests as least variation of the magnitude and direction of the geomagnetic field lines in an hour's time. This translates into fewer periods of QSB during these months.

last-minute forecast

The first and second weeks of November are expected to favor the higher HF bands, 10 through 30 meters. The solar flux is expected to be higher at this time of the month and result in higher MUFs. If the geomagnetic field is also disturbed at this time then transequatorial propagation on southern paths should also be expected. More hours of darkness, less QRN, and stable signal conditions give an edge to the lower bands for east-west and northern DX contacts this time of year. The lower HF bands are expected to be best the last two weeks of the month. You can update this forecast daily by listening to the time and frequency radio station, WWV, or 2.5, 5, 10, 15, and 20 MHz at 18 minutes after each hour. When the solar flux, as announced, is below 75 and the geomagnetic A is less than 15 or K is less than 4 the lower bands should be best. If the geophysical indices are higher, consider using the higher HF bands instead.

The Taurids meteor showers will occur from October 26 to November 22, with a maximum count of ten per hour from the 3rd through the 10th of November. Lunar perigee is on the 12th, and a full moon falls on the 27th. A total (totality of 1 minute 59 seconds duration) eclipse of the sun is calculated to be visible on November 12th way down in the Antarctic regions. It starts south of Africa at 1209 UT and moves to the tip of South America, ending at 1612 UT. The bands open to Antarctica on the accompanying propagation chart should lower to 40 meters and then recover during the above time period on eclipse day. Try for a contact!

band-by-band summary

Ten, twelve, and fifteen meters, the day-only DX bands, will be open from morning to early evening almost every day, and to most areas of the world. The openings on the higher of these
<table>
<thead>
<tr>
<th>Name</th>
<th>Call</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td></td>
</tr>
<tr>
<td>City</td>
<td>State</td>
</tr>
</tbody>
</table>

Please use before December 31, 1985

November 1985
The italicized numbers signify the bands to try during the transition and early morning hours, while the standard type provides the MUF during "normal" hours.

* Look at next higher band for possible openings.

November 1985
bands will be shorter, occur closer to local noon, and provide paths mainly to the southern hemisphere with a possibility of transequatorial openings.

Twenty, thirty, and forty meters are both day and night bands. Twenty is the maximum usable band for DX in the northern directions these days during the daytime, then teams up with 30 meters to fill in through the night for the day-only bands. Forty meters becomes the main over-the-pole DX daytime band, with some hours covered by 30. This path may be affected by anomalous absorption during a few days of the month.

Eighty and one-sixty meters, the night-only DX bands, will exhibit short-skip propagation during daylight hours, then lengthen for DX at dusk. These bands follow the darkness path, opening to the east just before your sunset, swinging more to the north-south near midnight, and ending up in the Pacific areas during the hour or so before dawn. Eighty is the maximum usable band for some night hours now during sunspot minimum; consequently, signal strength and signal quality can be expected to improve. One-sixty may also be better. Remember the DX windows of 3790-3800, 1825-1830, and 1850-1855 kHz.

references
The "Flying Horse" has a great new look!
It's the biggest change in Callbook history!
Now there are 3 new Callbooks for 1986.
The North American Callbook lists the amateurs in all countries in North America plus those in Hawaii and the U.S. possessions.
The International Callbook lists the calls, names, and address information for licensed amateurs in all countries outside North America. Coverage includes Europe, Asia, Africa, South America, and the Pacific area (exclusive of Hawaii and the U.S. possessions).
The Callbook Supplement is a whole new idea in Callbook updates. Published June 1, 1986, this Supplement will include all the activity for both the North American and International Callbooks for the preceding 6 months.
Publication date for the 1986 Callbooks is December 1, 1985. See your dealer or order now directly from the publisher.

- North American Callbook
  - Incl. shipping within USA: $25.00
  - Incl. shipping to foreign countries: 27.60
- International Callbook
  - Incl. shipping within USA: $24.00
  - Incl. shipping to foreign countries: 26.60
- Callbook Supplement, published June 1st
  - Incl. shipping within USA: $13.00
  - Incl. shipping to foreign countries: 14.00

SPECIAL OFFER
- Both N.A. & International Caliboks
  - Incl. shipping within USA: $45.00
  - Incl. shipping to foreign countries: 53.50

* * * * * * * * * *
Illinois residents please add 6½% sales tax. All payments must be in U.S. funds.

1986 CALLBOOKS

A quarter-wave antenna is great for range. But it's too tall for most VHF handheld applications. So Larsen® has cut the quarter-wave down to size, without taking any shortcuts in design or construction.
The Larsen HQ (helical-quarter-wave) Kulduckie® antenna stands just slightly taller than a helical type, but measures up to almost full quarter-wave performance. The helical design below gives it stability and keeps it short—nine to twelve inches. The flexible quarter-wave on top extends the range and allows it to bend 180°. Larsen offers ten different VHF HQ series antennas in the 136 to 174 MHz range, to work with most popular handheld radios. So whether you're calling for help, or just shooting the breeze, you can be sure that Larsen Kulduckie antennas will never run short on performance.

Larsen Antennas
The Amateur's Professional

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

IN USA: Larsen Electronics, Inc.
17611 5th Ave
PO Box 6799
Tacoma, WA 98409

IN CANADA: Canadian Larsen Electronics, Ltd.
154 West 6th Ave
Vancouver, B.C. V6B 1K3
604-872-8517

LARSEN, KULROD, and KULDUCKIE are REGISTERED TRADEMARKS OF LARSEN ELECTRONICS, INC.
There have been many articles on CB-to-10 meter conversion projects over the last few years, one of which was an excellent article by MacFarquhar and Grant\(^1\) in which they described the steps necessary to convert a Citizens Band AM radio to an FM transceiver operating on 10 meters. In this article, we show how to replace their 40-position channel selector switch with some digital logic that adds the ability to scan up to 20 channels. In addition, we described a way to obtain a 100 kHz offset for repeater work without using a second crystal. All the other features of MacFarquhar and Grant's original modification are preserved.

If you already have a converted CB, enough information is provided here to build the scanner; if you're starting the project from scratch, the MacFarquhar and Grant article will be necessary.*

**circuit description**

Since the CB was designed for mobile operation, the converted radio must use a mobile power source or operate from a 13.8 volt DC power supply. Power supplies are available commercially at surplus stores, and many excellent articles on building your own have been published.

Rather than build a separate +5 volt supply for the scanner, we borrowed a few mA from the +5 volt supply in the CB. Low-power components were selected to minimize the load on the existing CB radio power supply.

The scanner and control circuit requires only six integrated circuits and can be built on a 3 × 3 inch (7.6 × 7.6 cm) card. A diode encoder is used to program the operating frequencies. This gives the advantage of being able to select any of ten frequencies and more importantly, gives one a choice of crystals (frequency) to use.

A schematic diagram of the scanner section is shown in fig. 1. U1 is a decade counter with a built-in binary to decimal decoder. The outputs feed the diode encoder and indicator LEDs. The input to U1 comes from oscillator U2 (in the scan mode) or flip-flop U3A (in the single step mode). The other half of U3 is used to offset the frequency by 10 kHz. The frequency of the original CB is controlled by a Phase Locked Loop integrated circuit, or PLL IC. The diode encoder converts the ten decimal outputs from U1 to four control inputs to the PLL. The four control inputs cause the PLL to change its output frequency and the receive/transmit frequency of the radio. U4A is used to monitor the squelch of the radio and stop the scan when a signal breaks the squelch.

A Type 555 oscillator (U2) is used to provide a scan step to the counter. The 7555 is a CMOS version of the 555 timer; its operation is identical except that the 7555 draws much less current. Radio Shack carries a TLC-555 which is also low current.

---

*Reprints are available from *Ham Radio*, Greenville, New Hampshire 03048, for $3.00 each.

---

**By Robert K. Baker, W2FMY, 263 Washington Avenue, Saugerties, New York 12477, and Gary Bischoff KB2GA, 1358 Charles Hommel Road, Saugerties, New York 12477**
The oscillator is cut off by grounding pin 4 or 5. Pin 5 is connected to S3, the SCAN/LOCK switch. Pin 4 is controlled by U4A, a comparator. When the radio receives a signal that breaks the squelch, the voltage at Q120 collector goes up, forcing the output of U4A low, stopping the oscillator. The other half of U4 is used to drive a "busy" light for visual indication when a signal is present.

The diodes at the input to the counter form an OR circuit so that inputs to either diode will step the counter. U3A is a debouncer for the STEP switch, which should be a push button or spring loaded toggle. U3A is used on an R-S flip-flop — even though it is a D-type device — by wiring the switch contacts directly into the Reset and Set inputs.

If S2 is closed, the output of U3B will be held in RESET state, forcing a logic zero to PLL control pin P0. Frequency coverage will be ten "even" frequencies — 29.50, 29.52 through 29.68 MHz. If S2 is open, U3B will be toggled by the end carry from the counter each time the counter counts ten pulses or wraps around. When the output of U3B is high, frequency coverage is shifted up 10 kHz to cover the “odd” frequencies of 29.51, 29.53 through 29.69. The circuit will alternately scan the even then odd channels while S2 is open. When the frequency is shifted up, the high level at U3 pin 9 turns Q11 on, lighting the +10 kHz LED.

The ten outputs from the CD4017 counter drive 10 LEDs in addition to feeding the encoder. Q1 through Q10 (and Q11) can be almost any general purpose NPN small signal transistor such as a 2N2222 or 2N3904. The 4.7 kilohm base resistors were chosen to provide about 1 mA of base current, which allows practically any transistor to be used. Note that there is only one dropping resistor (1K) used for the ten LEDs since only one LED is on at a time. The current for the LEDs comes from the 13.8 volt source.

A diode encoder is used to convert from a decimal number to the digital data required by the CB PLL chip to select different frequencies. Figure 2 shows the encoder used with our selected output frequencies and crystal frequency.

Figure 3 shows a transmit offset circuit that can be added to obtain the —100 kHz offset required for repeater access. Two boards were built using the crystal switching scheme described by MacFarquhar and Grant. They worked fine, but the price of the 10.795 MHz crystal exceeded the price of the CB board. A simple circuit was therefore developed to make use of the existing counter U1 when working through a repeater. The circuit (fig. 3) consists of two cascaded timer circuits, where U5 is a one-shot enable for oscillator U6. When the microphone PTT switch is depressed, the voltage on the CB point 14 goes positive and is inverted by Q13. The resulting negative shift at the collector of Q13 is coupled via the 470 pF capacitor to a diode gate and to the input of U5. The negative spike at pin 2 triggers U5, allowing oscillator U6 to send five pulses to the CD4017 clock input via the diode, which becomes the third leg of the existing OR circuit. When the PTT switch is released, the negative going level change at CB point 14 is coupled through the 0.01 microfarad capacitor to the input of U5 and another string of five pulses is sent to the 4017 counter. The circuit is disabled for simplex operation by grounding pin 4 of U5.

The pulse rate of U6 is about 240 microseconds. It is enabled for about 1 millisecond by U5. The time that U5 enables U6 must be set carefully. When the entire scanner is operating, the pulse width of U5 can be trimmed by selecting the proper value for R\textsuperscript{x}. Use a potentiometer or a decade box and lower the value of \textit{R\textsubscript{x}} until four pulses are output from U6. The pulses can be counted by using the PTT switch and observing the LEDs. Note the value at which the pulses change from five to four. Raise the value of \textit{R\textsubscript{x}} until six pulses are observed. Note this value and install a fixed resistor for \textit{R\textsubscript{x}} that is about halfway between these two values. If the 0.005 \textmu F capacitor is accurate \textit{R\textsubscript{x}} should be around 150 kilohm. A mylar capacitor should be used in this circuit.

frequency and crystal selection

The following explanation is provided to explain frequency control and how to use an available crystal. The CB Phase Locked Loop (PLL) was designed to operate in the range of 2.24 to 2.68 MHz. Attempting to operate the PLL outside this design range may require modification of the PLL lowpass filter.\textsuperscript{4}

The present ARRL 10-meter FM band plan covers the range of 29.50 to 29.70 MHz. The national calling frequency is 29.60 MHz (similar to 146.52 on 2 meters). Repeater outputs are on 29.62, 29.64, 29.66, and 29.68, with their inputs 100 kHz lower on 29.52 through 29.58. 29.50 is used as another simplex frequency. The CD4017 decade counter forms the heart of the scanner and gives us access to all ten frequencies. The ten additional frequencies are obtained by using a flip-flop to program the low order bit on the CB's PLL. The ten "odd" frequencies are presently all simplex frequencies.

To see how a crystal is chosen, we start at the required output frequency and work backward. If, for example, 29.6 MHz is the output frequency selected, the PLL VCO is mixed with a 10.695 MHz crystal oscillator to generate the transmit frequency. Our 29.6 MHz target requires that the VCO operates at 29.60 + 10.695 or 40.295 MHz. This in turn is mixed with the third harmonic of another crystal oscillator (Q105 on
## Deluxe Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency</th>
<th>Power</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC-02AT</td>
<td>2m</td>
<td>150W</td>
<td>349.00</td>
</tr>
<tr>
<td>IC-04AT</td>
<td>2m</td>
<td>50W</td>
<td>289.00</td>
</tr>
</tbody>
</table>

## Regular Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency</th>
<th>Power</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC-2A</td>
<td>2m</td>
<td>25W</td>
<td>59.00</td>
</tr>
<tr>
<td>IC-2BAT</td>
<td>with TIP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC-3AT</td>
<td>2m</td>
<td>20W</td>
<td>299.50</td>
</tr>
<tr>
<td>IC-4AT</td>
<td>440 MHz</td>
<td>20W</td>
<td>299.50</td>
</tr>
</tbody>
</table>

## Accessories for Deluxe Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency</th>
<th>Power</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC-48A</td>
<td>2m</td>
<td>50W</td>
<td>39.00</td>
</tr>
<tr>
<td>IC-48B</td>
<td>2m</td>
<td>10W</td>
<td>30.00</td>
</tr>
<tr>
<td>IC-48C</td>
<td>2m</td>
<td>1W</td>
<td>25.00</td>
</tr>
</tbody>
</table>

## Accessories for Regular Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency</th>
<th>Power</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC-242</td>
<td>FM</td>
<td></td>
<td>39.00</td>
</tr>
<tr>
<td>AG-25</td>
<td>FM</td>
<td></td>
<td>84.50</td>
</tr>
<tr>
<td>HM-9</td>
<td></td>
<td></td>
<td>34.50</td>
</tr>
<tr>
<td>HM-10</td>
<td></td>
<td></td>
<td>19.50</td>
</tr>
<tr>
<td>SM-6</td>
<td></td>
<td></td>
<td>39.00</td>
</tr>
<tr>
<td>RC-10</td>
<td></td>
<td></td>
<td>35.00</td>
</tr>
<tr>
<td>MB-18</td>
<td></td>
<td></td>
<td>19.50</td>
</tr>
</tbody>
</table>

## Other Accessories

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency</th>
<th>Power</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC-70A</td>
<td>2m/440</td>
<td>30W</td>
<td>29.95</td>
</tr>
<tr>
<td>FL-34</td>
<td>5.2 kHz</td>
<td>49.50</td>
<td></td>
</tr>
<tr>
<td>HI-12</td>
<td>Extra hand</td>
<td></td>
<td>39.50</td>
</tr>
<tr>
<td>SM-6</td>
<td>Desk microphone</td>
<td></td>
<td>39.00</td>
</tr>
<tr>
<td>FL-30</td>
<td>2.8 kHz wide</td>
<td></td>
<td>39.00</td>
</tr>
<tr>
<td>FL-33</td>
<td>AM filter</td>
<td></td>
<td>31.50</td>
</tr>
<tr>
<td>FL-70</td>
<td>2.8 kHz wide</td>
<td></td>
<td>39.00</td>
</tr>
<tr>
<td>HM-12</td>
<td>Extra hand microphone</td>
<td></td>
<td>39.00</td>
</tr>
<tr>
<td>SM-6</td>
<td>Desk microphone</td>
<td></td>
<td>39.00</td>
</tr>
<tr>
<td>RC-10</td>
<td>External frequency controller</td>
<td></td>
<td>35.00</td>
</tr>
<tr>
<td>MB-18</td>
<td>Mobile mount</td>
<td></td>
<td>19.50</td>
</tr>
</tbody>
</table>

For a limited time!

With the purchase of an IC-27A/H or IC-47A/H get the matching PREAMP* for only $1.00 Extra.

---

**Order Toll Free:** 1-800-558-0411

**AMATEUR ELECTRONIC SUPPLY Inc.**

4828 W. Fond du Lac Avenue; Milwaukee, WI 53216 - Phone (414) 442-4200

---

**HOURS:** Mon. thru Fri. 9-5:30; Sat. 9-3

**Milwaukee WATS line:** 1-888-558-0411

**Phone:** (414) 442-4200

**Outside Wisconsin:** (262) 752-0411

**Inside Milwaukee Metro Area:** (414) 442-4200

**Outside Ohio:** 1-800-321-3594

**Outside Florida:** 1-800-327-1917

**Order Toll Free:** 1-800-558-0411

In Wisconsin (outside Milwaukee Metro Area) 1-800-242-5195

**AMATEUR ELECTRONIC SUPPLY Inc.**

4828 W. Fond du Lac Avenue; Milwaukee, WI 53216 - Phone (414) 442-4200

---

**AES BRANCH STORES**

**WICKILFIE, Ohio 44092**

28940 Euclid Avenue

Phone (216) 585-7388

Outside Ohio 1-800-321-3594

**ORLANDO, Fla. 32803**

32803 Courtyard Avenue

Phone (305) 894-2405

Outside Florida 1-800-327-1917

**CLEARWATER, Fla. 33757**

28940 Euclid Avenue

Phone (813) 461-4267

No Nationwide WATS

**LAS VEGAS, Nev. 89106**

33575 S. Las Vegas Blvd.

1072 N. Rancho Drive

Phone (702) 647-3114

No in-State WATS

Outside Nevada 1-800-634-6227

**CHICAGO, Illinois 60630**

5456 W. North Avenue

Phone (312) 634-5191

Outside Illinois 1-800-621-5802

---

**Associate Store**
the CB). The difference frequency is filtered and applied to the PLL. This frequency must fall in the range of 2.24 to 2.68 MHz.

When we started this project, we had about a dozen crystals left over from an earlier 10-meter club project. These crystals were marked 12.61333 MHz and had been ordered for a PLL using a reference frequency of 5 kHz rather than 10 kHz. The scheme we used required the crystal to operate up or down one third of a 5 kHz step or 1.67 kHz. We found the oscillator (Q105) more agreeable to being "rubbered" up than down, and had no trouble reaching 12.615 MHz. This frequency would have resulted in having to shift down to 10 kHz from 29.7 to reach 29.69 and not being able to use 29.50, which was clearly not desirable. By reducing C118 to 15 pF we were able to move the frequency up to 12.61833 MHz. Two units were built with crystals of 12.61833 MHz and they worked fine with the original value of C118.

The crystal's third harmonic of 37.855 MHz, when subtracted from the VCO frequency of 40.295 MHz, yields a difference of 2.44 MHz. To match at the 10 kHz PLL reference frequency, the PLL divider must divide by 244. The divide number is controlled by applying logic levels to the PO-P8 inputs of the PLL. Note that the PLL chip has internal pull-down resistors on these inputs. An open circuit is a logic zero, and a logic 1 is obtained by pulling an input up toward +5 volts.

We can develop a truth table based upon our choice of crystal. The P inputs of the PLL have binary "weights" with P0 having a value of 1, P1 having a
Table 1. Truth table.

<table>
<thead>
<tr>
<th>Desired frequency (MHz)</th>
<th>VCO F (MHz)</th>
<th>Mixer F (MHz)</th>
<th>Divider**</th>
<th>PLL program pin values</th>
</tr>
</thead>
<tbody>
<tr>
<td>29.50</td>
<td>40.195</td>
<td>2.3400</td>
<td>234</td>
<td>P8 P7 P6 P5 P4 P3 P2 P1 P0</td>
</tr>
<tr>
<td>29.51</td>
<td>40.205</td>
<td>2.3500</td>
<td>235</td>
<td>0 1 1 1 0 1 0 1 1 1</td>
</tr>
<tr>
<td>29.52</td>
<td>40.215</td>
<td>2.3600</td>
<td>236</td>
<td>0 1 1 1 0 1 1 0 1 1</td>
</tr>
<tr>
<td>29.53</td>
<td>40.225</td>
<td>2.3700</td>
<td>237</td>
<td>0 1 1 1 0 1 1 0 1 1</td>
</tr>
<tr>
<td>29.54</td>
<td>40.235</td>
<td>2.3800</td>
<td>238</td>
<td>0 1 1 1 0 1 1 0 1 1</td>
</tr>
<tr>
<td>29.55</td>
<td>40.245</td>
<td>2.3900</td>
<td>239</td>
<td>0 1 1 1 0 1 1 0 1 1</td>
</tr>
<tr>
<td>29.56</td>
<td>40.255</td>
<td>2.4000</td>
<td>240</td>
<td>0 1 1 1 1 0 0 0 0 1</td>
</tr>
<tr>
<td>29.57</td>
<td>40.265</td>
<td>2.4100</td>
<td>241</td>
<td>0 1 1 1 1 0 0 0 0 1</td>
</tr>
<tr>
<td>29.58</td>
<td>40.275</td>
<td>2.4200</td>
<td>242</td>
<td>0 1 1 1 1 0 0 0 0 1</td>
</tr>
<tr>
<td>29.59</td>
<td>40.285</td>
<td>2.4300</td>
<td>243</td>
<td>0 1 1 1 1 0 0 0 0 1</td>
</tr>
<tr>
<td>29.60</td>
<td>40.295</td>
<td>2.4400</td>
<td>244</td>
<td>0 1 1 1 1 0 1 0 0 1</td>
</tr>
<tr>
<td>29.61</td>
<td>40.305</td>
<td>2.4500</td>
<td>245</td>
<td>0 1 1 1 1 0 1 0 1 1</td>
</tr>
<tr>
<td>29.62</td>
<td>40.315</td>
<td>2.4600</td>
<td>246</td>
<td>0 1 1 1 1 0 1 0 1 1</td>
</tr>
<tr>
<td>29.63</td>
<td>40.325</td>
<td>2.4700</td>
<td>247</td>
<td>0 1 1 1 1 0 1 1 1 1</td>
</tr>
<tr>
<td>29.64</td>
<td>40.335</td>
<td>2.4800</td>
<td>248</td>
<td>0 1 1 1 1 0 1 1 1 1</td>
</tr>
<tr>
<td>29.65</td>
<td>40.345</td>
<td>2.4900</td>
<td>249</td>
<td>0 1 1 1 1 0 1 1 1 1</td>
</tr>
<tr>
<td>29.66</td>
<td>40.355</td>
<td>2.5000</td>
<td>250</td>
<td>0 1 1 1 1 0 1 1 1 1</td>
</tr>
<tr>
<td>29.67</td>
<td>40.365</td>
<td>2.5100</td>
<td>251</td>
<td>0 1 1 1 1 0 1 1 1 1</td>
</tr>
<tr>
<td>29.68</td>
<td>40.375</td>
<td>2.5200</td>
<td>252</td>
<td>0 1 1 1 1 0 1 1 1 1</td>
</tr>
<tr>
<td>29.69</td>
<td>40.385</td>
<td>2.5300</td>
<td>253</td>
<td>0 1 1 1 1 1 1 0 1 1</td>
</tr>
</tbody>
</table>

Note 1: Q105 oscillator 12.61833 MHz new crystal.
Note 2: Oscillator × 3 = 37.85499 MHz.

**divider** = \( \frac{(F_{OUT} + 10.695) - (3 \text{ oscillator}) MHz}{10 MHz} \)

Examination of the table reveals that the P0 input is a logic zero for all of the "standard" 10-meter FM channels, which happen to be represented by even numbers. Switching the P0 input to 1 (+) shifts the PLL up 10 kHz to ten "in between" frequencies which are odd numbers — 29.51, 29.53, 29.55, etc.

Table 1 also shows the frequencies at the VCO output and the mixer output. Note that the mixer frequency must fall in the range of 2.24 to 2.68 MHz for the PLL to operate correctly. Table 1 was derived from a spreadsheet program that does the mathematics involved with the crystal selection and frequency generation.† To check on the usability of a crystal, the user enters the crystal frequency and the highest output frequency desired; the program calculates the VCO output frequency, the mixer output frequency, the divider necessary to match the 10 kHz input to the PLL, and the PLL program pin values. The spreadsheet is useful for demonstrating what is happening in the circuit as well as for crystal and frequency selection.

To build the encoder, replace each + in the truth table with a diode. No diodes are needed for the - points on the table because of the pull-down resistors in the PLL.

**Construction**

The first step in building this radio should be to get the CB working as a CB. (The referenced articles cover this subject in detail.2,3,4) We took the additional step of inserting pins in the CB at the points where connections are to be made such as the speaker output, microphone input, and the volume and squelch potentiometers.

In addition to making the board easy to remove, we can interchange boards when problems arise. We found that the extra work was beneficial.

†A copy of the spreadsheet, written in Lotus 123 and VisiCalc for an IBM PC and compatibles, or in VisiCalc for Apples, is available from the authors. Send an SASE for information.
The board used for the modification was made by Cybernet when the CB craze was in full swing. Cybernet manufactured these boards for several manufacturers such as Hy-Gain, Kraco, and others.

We found some CB boards with wrong value components. If the phase locked loop cannot be made to lock by adjusting the VCO coil slug, check the value of R103 in the VCO circuit. The correct value is 1.5K, not 3.3K. Also, C101, which is buried in wax, should be 18 pF. (Some had a purple mark and measured 22 pF. If C101 is black, it’s OK. This is apparently a production change that works on 27 MHz but doesn’t work on the high end of 10 meters.)

We had a severe birdie problem on all 20 channels during tune-up of one of the first conversions that we built. The birdie was apparently caused by the 10.695 MHz offset oscillator’s being off in frequency. To prevent problems when the radio is being tuned up, all three oscillators must operate at the correct frequency. Radio Shack carries 3-10 pF trimmers (catalog No. 272-1338) that fit directly in the board; they are useful for adjusting the oscillators. Start with the 10.24 MHz reference oscillator. Loosely couple a frequency counter to the collector of transistor Q104. If the frequency is off, install a trimmer in location CT103 and try to move the frequency. C178 may have to be changed from 56 pF to a 39 or 43 pF capacitor. Set the frequency to exactly 10.24 MHz. To adjust the 10.695 MHz offset oscillator, connect the frequency counter to the emitter of Q109. Since the oscillator is not buffered, any appreciable capacitive loading will pull the oscillator frequency. We used a 10 to 1, low capacity oscilloscope probe to connect the counter. Install a trimmer in location CT102 and change C127 to a lower value. Adjust the CT102 for 10.695 MHz out with the transmitter keyed. Next connect the frequency counter to the dummy load at the output. Set up the P0-P8 PLL inputs to a known value such as 29.60 MHz and tune CT101 for the correct output, again with the transmitter keyed. If C118 must be changed, use the largest value that will permit CT101 to bring the oscillator to the desired frequency. This will make CT101 much less critical to adjust.
The scanner approach described above adds a new dimension to the CB-10 meter conversion by providing a simple yet versatile circuit. The digit offset control also has the capability of shifting up 100 kHz as well as down, in case you want to use the rig as a repeater — one local Amateur (Bob, W2XLI) answered a call in the repeat mode and managed to work a station in Mexico.

In addition to the communication possibilities of a low power 10-meter FM rig, many local Amateurs use the radio to monitor 10 meters for isolated band openings. A dedicated rig eliminates the need to change frequency to check conditions; the radio is set up to monitor several repeaters. With the sunspot cycle on the decline, 10 meter openings are more sporadic, and when they occur, it's nice to know about them.

The circuits covered in this article can be used as shown or they can be used as a starting point for other innovative designs. There are other ways of obtaining the correct frequencies using a scanner approach such as using a decade counter and an adder to go directly into the PLL, which would make it easy to add the repeater offset. That may be a subject for a future article.

references
Unadilla Amateur Antenna Baluns
For 20 years, preferred by Amateur, Commercial and Military Operators
First with built-in lightning arrester-minimizes TVI, maximizes power handling

W2AU 1:1 & 4:1
Only $17.95, UPS shipping & tax included

W2DU-HF
Only $19.95, UPS shipping & tax included

W2DU-VHF
Only $19.95, UPS shipping & tax included

W2AU Broadband Ferrite Core Baluns
For medium power (1000 watts RF min.) and broadband operation 3-40 MHz.
W2AU 1:1
* 50 to 50 or 75 to 75 ohms
* For dipoles, V’s, beams, quads
W2AU 4:1
* 200 to 50 or 300 to 75 ohms
* For high impedance antennas such as folded dipoles

W2DU Non-Ferrite Very High Power Baluns
W2DU-HF (High Power)
* 1.8–30 MHz
* 3000–9000 watts with 1:1 antenna SWR
* 1500–5000 watts with 2:1 antenna SWR

W2DU-VHF (High Power and Extended Range)
* 30–300 MHz
* 2000–4000 watts with 1:1 antenna SWR
* 1200–2400 watts with 2:1 antenna SWR

BONUS!
Free Win Your Order

Unadilla Amateur Antenna Baluns
For medium power (1000 watts RF min.) and broadband operation 3-40 MHz.
W2AU 1:1
* 50 to 50 or 75 to 75 ohms
* For dipoles, V’s, beams, quads
W2AU 4:1
* 200 to 50 or 300 to 75 ohms
* For high impedance antennas such as folded dipoles

W2DU Non-Ferrite Very High Power Baluns
W2DU-HF (High Power)
* 1.8–30 MHz
* 3000–9000 watts with 1:1 antenna SWR
* 1500–5000 watts with 2:1 antenna SWR

W2DU-VHF (High Power and Extended Range)
* 30–300 MHz
* 2000–4000 watts with 1:1 antenna SWR
* 1200–2400 watts with 2:1 antenna SWR

The Dandy Dipole
Quickly design and construct any of over 180 multi-band dipole variations, using traps. Wiring tables are included to take away the guesswork. Also includes dozens of practical details.

WARNING
SAVE YOUR LIFE OR AN INJURY

Base plates, flat roof mounts, hinged bases, hinged sections, etc., are not intended to support the weight of a single man. Accidents have occurred because individuals assume situations are safe when they are not.

Installation and dismantling of towers is dangerous and temporary guys of sufficient strength and size should be used at all times when individuals are climbing towers during all types of installations or dismantlings. Temporary guys should be used on the first 10' or tower during erection or dismantling. Dismantling can even be more dangerous since the condition of the tower, guys, anchors, and/or roof in many cases is unknown.

The dismantling of some towers should be done with the use of a crane to minimize the possibility of member, guy wire, anchor, or base failures. Used towers in many cases are not as inexpensive as you may think if you are injured or killed.

Get professional, experienced help and read your Rohn catalog or other tower manufacturers' catalogs before erecting or dismantling any tower. A consultation with your local professional tower erector would be very inexpensive insurance.

Purchase from any of over 300 dealers nationwide, or order direct

□ Send free catalog PC/84
□ W2AU 1:1 & W2AU 4:1 $17.95 ea.
□ W2DU-HF & W2DU-VHF $19.95 ea.
Total Order $...

Tax & UPS Shipping Included

Name ____________________________
Address __________________________
City State Zip __________________________
Phone ____________________________

□ AmEx □ VISA □ Mastercard
□ COD □ Check □ Money Order
To ORDER or request free full line catalog of baluns, antenna relays and antenna traps, call
1-800-523-0027

24 HOURS—7 DAYS A WEEK!

NY/H/N/CAN residents please use coupon or call collect 315-437-3953, 8–5 EST
1 week delivery for credit card & C.O.D., 2 weeks for personal check.

60 DAY MONEY BACK GUARANTEE

Unadilla Website
Division of Microwave Filter Company, Inc.
6743 Kinne Street, E. Syracuse, N.Y. 13057 HR11

HOT ROD ANTENNA

Achieve 1 or 2 dB gain over ANY ¼ wave two meter telescopic antenna. The AEA model HR-1 Hot Rod® antenna was designed by Dr. D.K. Reynolds (designer of the IsoPoie) to deliver maximum performance for any hand-held transceiver with a BNC fitting.

The factory-tuned HR-1 is 20% shorter, lighter and places far less stress on your hand-held connector and case. It will easily handle over 25 watts of power, making it an excellent emergency base or mobile antenna. In the collapsed position, the Hot Rod antenna will perform like a helical quarter wave.

The Hot Rod antennas can be expected to make the same improvement to hand-held communications that the IsoPoie brand antennas have made to base station operations. Why pay more when the best costs less?

Prices and Specifications subject to change without notice or obligation.

ADVANCED ELECTRONIC APPLICATIONS, INC.
P.O. Box C-2160, Lynnwood, WA 98036
(206) 775-7373
Telex: 152571 AEA INTL

AEA Brings you the Breakthrough!
AMA, MC, VISA & C.O.D.s WELCOME — FREIGHT FOB EVANSVILLE

For Orders and Price Checks Call 800-523-7731
Service Dept. 1-812-422-0252

AMEX, MC, VISA & C.O.D.s WELCOME — FREIGHT FOB EVANSVILLE

For Orders and Price Checks Call 800-523-7731
Service Dept. 1-812-422-0252
external product detector improves receiver performance

Add this circuit to your R390A or other older receivers

This unit is a combination of an IF amplifier, high stability local oscillator, wide dynamic range mixer and a separate audio amplifier circuit for SSB and CW reception. A stable high-current power supply is included so that the user needs only a speaker, a length of RG 58/U coax and a 120 VAC source of power. There is no need to re-enter the receiver past the IF output stage. The unit itself (fig. 1) is housed in an aluminum shielded cabinet.

Assembly and testing are straightforward. The only special equipment needed is a digital counter to set the oscilloscope and a 1 MHz heterodyne oscillator to the required frequency.

The construction and testing of each circuit should be done in the following order, completing each element before proceeding to the next:

- power supply
- audio amplifier
- VFO unit
- mixer-audio preamp (combined on board 3)

The power supply is a typical textbook assembly, with a three-terminal regulator. The bleeder R14 is used so that a constant load is placed on the power output at all times. To set the voltage, before AC is applied to the transformer, set R13 to the mid-point of the trimmer. Attach a voltmeter to the output point (at R14), apply 120 VAC to the primary of the transformer, observe the voltage at R14 and adjust trimmer potentiometer R13 to 12 volts. This circuit will need no further adjustments.

The assembly of the audio section has several important considerations. The TDA 2002 or TDA 2003 must have a 5-square-inch (12.7-cm²) heat sink. A piece of aluminum 2 inches (5 cm) per side and 2-1/2 inches (6.35 cm) long was used to sink the device. The sink can be grounded to the B minus (and cabinet), providing a current return path for power and an adequate sink for device heat. Each module of the working model was assembled on a 3 x 4 inch (7.6 x 10.6 cm) vector board, with push-pin mounting for components and sockets for the transistors.

Keep all leads as short as possible. The 5 PC leads were soldered to push pins staggered in alternate rows. The assembled module was speaker tested with an audio oscillator and an oscilloscope with satisfactory results. The low-frequency cut-off was about 100 Hz and the upper range fell off after 6 kHz.

The local oscillator was assembled on a separate vector board using a standard Colpitts design. Note that the oscillator/mixer portions are FET devices, and consequently are high impedance circuits. To prevent loading down, the circuit testing was done with 10X scope (probe) leads.

**frequency adjustments**

To set the center frequency to 455 kHz, first set the C2 capacitor to its mid-point. Set C1, the compression trimmer, also to about its mid-point. Measure the oscillator frequency at the output end of C7 with the counter set to 1 MHz range. The coil, L1, should have a tuned resonance of 455 kHz ± 50 kHz. Adjust the slug in L1 to a point well before it extends beyond the wind-

By Alan Nusbaum, W6GB, 13222 Ballad Drive, Sun City West, Arizona 85375

November 1986 107
fig. 1. External product detector schematic.

Parts list.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BNC</td>
<td>BNC male, chassis mounting</td>
</tr>
<tr>
<td>C1</td>
<td>20-100 pF trimmer</td>
</tr>
<tr>
<td>C2</td>
<td>5-20 pF SFL (&quot;butterfly&quot;) variable USB-LSB offset tuning</td>
</tr>
<tr>
<td>C3</td>
<td>390 pF, mica, 500 volt</td>
</tr>
<tr>
<td>C4</td>
<td>300 pF, mica, 500 volt</td>
</tr>
<tr>
<td>C5</td>
<td>500 pF, mica, 500 volt</td>
</tr>
<tr>
<td>C6</td>
<td>10 kilohm pF, ceramic, 50 volt</td>
</tr>
<tr>
<td>C7</td>
<td>100 pF, ceramic, 50 volt</td>
</tr>
<tr>
<td>C8</td>
<td>0.01 µF, ceramic, 50 volt</td>
</tr>
<tr>
<td>C9</td>
<td>1000 pF, ceramic, 50 volt</td>
</tr>
<tr>
<td>C10</td>
<td>5000 pF, ceramic, 50 volt</td>
</tr>
<tr>
<td>C11</td>
<td>1 µF, electrolytic, 50 volt</td>
</tr>
<tr>
<td>C12</td>
<td>1 µF, electrolytic, 50 volt</td>
</tr>
<tr>
<td>C13</td>
<td>50 µF, electrolytic, 10 volt</td>
</tr>
<tr>
<td>C14</td>
<td>0.01 µF, ceramic, 100 volt</td>
</tr>
<tr>
<td>C15</td>
<td>10 pF, 10 volt ceramic</td>
</tr>
<tr>
<td>C16</td>
<td>10 kilohm pF, ceramic, 50 volt</td>
</tr>
<tr>
<td>C17</td>
<td>1µF, electrolytic, 25 volt</td>
</tr>
<tr>
<td>C18</td>
<td>4700 µF, electrolytic, 50 volt</td>
</tr>
<tr>
<td>C19</td>
<td>470 µF, electrolytic, 100 volt</td>
</tr>
<tr>
<td>C20</td>
<td>0.1 µF, electrolytic, 50 volt</td>
</tr>
<tr>
<td>C21</td>
<td>1000 µF, electrolytic, 50 volt</td>
</tr>
<tr>
<td>C22</td>
<td>0.1 µF, electrolytic, 25 volt</td>
</tr>
<tr>
<td>CRB1</td>
<td>MDA970-1 Motorola</td>
</tr>
<tr>
<td>Cx</td>
<td>5 µF, 25 volt if the leads from regulator causes oscillation as seen on an oscilloscope</td>
</tr>
<tr>
<td>F1</td>
<td>Buss fuse, 1 amp, 120 VAC</td>
</tr>
</tbody>
</table>

Note: All resistors 5 percent

L1 J.W. Miller No. 23A474RPC
L2 1.2 mH, Miller No. 73F123AF
L3 1.2 mH, Miller No. 73F123AF
Q1 2N5486 Motorola
Q2 3N201 Motorola
Q3 2N2222 Motorola
R1 100 kilohm, 1/2 watt
R2 100 ohm, 1/2 watt
R3 100 kilohm, 1/2 watt
R4 10 kilohm, 1/2 watt
R5 100 ohm, 1/2 watt
R6 1.5 kilohm, 1/2 watt
R7 100 kilohm trimmer, 1/2 watt
R8 91 kilohm, 1/2 watt
R9 22 kilohm, 1/2 watt
R10 150 ohm, 1/2 watt
R11 3.9 kilohm, 1/2 watt
R12 270 ohm, 1/2 watt
R13 5 kilohm trimmer, 1/2 watt
R14 2 kilohm W.W., 5 watts
R15 100 kilohm potentiometer, 1/2 watt
R16 220 ohm, 1/2 watt
R17 2.2 ohm, 1/2 watt
R18 1 ohm, 1/2 watt
S1 DPST toggle switch
T1 115 volt primary, 17 volt, 2 ampere secondary
T2 455 kHz Miller No. 8812
U1 LM317K National

Note: All resistors 5 percent
The Ameritron AL-80A combines the time proven economical 3-500Z with a redesigned heavy duty tank circuit to achieve 70% efficiency from 160 to 15 meters. It has wide frequency coverage for MARS and other authorized services. Typical drive is 85 watts to give over 1000 watts PEP SSB and 850 watts CW RF output. A new Pi-L output circuit for 80 and 160 gives full band coverage and exceptionally smooth tuning. The AL-80A will provide a signal output that is within 1/2 "S" unit of the signal output of the most expensive amplifier on the market—and at much lower cost.

Size: 15½"D. x 14"W. x 8"H. Weight: 52 lbs.

NEW AMERITRON RCS-4 REMOTE COAX SWITCH

The Ameritron RCS-4 is a remote controlled coax switch that selects one of four antennas by supplying all control voltages through the coax feed line. The elimination of a control cable results in a neat and inexpensive installation.

The indoor control console has bright LED antenna selection indicators. The remote relay box is tower or mast mounted with a single clamp. The RCS-4 operates from 120 VAC and covers frequencies from 1.8 through 30 MHz at full legal power.

MICROWAVE EQUIPMENT

RMLA - 2.3
Single Stage, Low Noise Gas Fet Amplifier
$60.00

Optimum Transistor Noise Figure less than 5 dB, Associated Gain Greater Than 15dB at 2.3 GHz. Source/Load must be 50 ± 10 ohm Non-Reactive SMA Connectors. Requires ±5VDC Power with ±5VDC present when ±5VDC applied. Power Supply and Sequencing is not supplied. Zener Protection Unenclosed on 2" x 2" PC Board.

Price includes Shipping and Insurance when paid by check or money order. Change of C.O.D. orders, F.O.B., Brookfield, MO.

ROENSCHE MICROWAVE
R.R. 1, Box 1568,
BROOKFIELD, MISSOURI 64628

R-390A HF RECEIVER

Famous military receiver covers 0.5-32 MHz AM-PM in 31 one MHz bands using mechanical digital tuning. 455 KHz IF has four Collins mechanical filters for selectable 2-4-8-16 KHz bandwidth. 100 KHz calibrator. BFO. No covers. 115/230 VAC 60 Hz. 10½ x 16½ x 9½. 52 lbs. (UPS in 2 pkgs.). Used-reparable $335. Checked $355. Manual, partial repro $15.00.

PARTS FOR R-390A, used-checked:

<table>
<thead>
<tr>
<th>Part Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical filters 2 or 4 KHz</td>
<td>$35</td>
</tr>
<tr>
<td>Power supply less 2625 tubes</td>
<td>$30</td>
</tr>
<tr>
<td>Most other parts available, except meters. Write for listing.</td>
<td></td>
</tr>
</tbody>
</table>

Prices: F.O.B. Lima, O. - VISA, MASTERCARDEI Accepted. Allow for shipping. Send for New CATALOG. Address Dept. H. Phone: 416-227-6073
The ISOTRON
NO TUNERS!
NO RADIALS!
ANTENNAS FROM 160-10 METERS NO COMPROMISE!

Just a few comments from our satisfied customers:

"...I have used your 80/40 meter Isotron while stationed in Guantanamo Bay Cuba and it worked great... Dept. Of The Navy"

"On January 11 and 12 I got into the 73 magazine sSB contest. I didn't try for maximum number of contacts. Rather I tried for maximum number of states. In less than 3 hours total time I worked 55 states and Puerto Rico, that last one is about a 3000 mile haul from Aurora, Colorado. Not too bad for what looks like a bird feeder... Worth!"

"I just got my Isotron 40 on the air and it has surpassed my wildest expectations. My first evening QSO was with KB6KUG and walk—my second was with N7UG in Columbia, South America. The antenna sits on a 30 foot mast and that is it. My QRT reports have been great. Congratulations on developing the Isotron. I am spreading the word among my ham friends. I think it's a superb, compact antenna which has finally come! KB9AQP"

"About two months ago I bought an Isotron 80 and just recently got it out of the shack and up on a 20-foot pole. I am really intrigued by it and have been a lot of fun trying to convince other stations that it is only 28 inches high. I worked California when it was hanging by a string from the ceiling of the shack and it works even better on a pole... WREDF"

WHY NOT ENJOY THEIR OPERATING PLEASURE & GIVE US A CALL.
WE WILL LOOK FORWARD TO TALKING WITH YOU.

*40 METER: $52.95 PLUS $3.75 SHIPPING  80 METER: $63.95 PLUS $4.75 SHIPPING
80-40 Combination: $110.00 plus $8.50 Shipping
ASK FOR PRICES ON OTHER MODELS
* See review in October 23, 1984
BILAL COMPANY
5 S.R. 2, Box 62, Dept. 91
Eucha, OK. 74342
PH: 918-253-4094

DO YOU KNOW WHERE TO FIND REAL BARGAINS on NEW and USED ELECTRONIC Equipment?
You'll Find Them in the Nation's No. 1 Electronic Shopper Magazine
NUTS & VOLTS
Now in Our 5th Year

Nuts & Volts is published MONTHLY and features:
NEW STATE-OF-THE-ART PRODUCTS • SURPLUS EQUIPMENT • USED BARGAINS • LOW COST AD RATES • PRIVACY AND COMMERCIAL CLASSIFIEDS • NATIONAL CIRCULATION • NEW PRODUCT NEWS SECTION • AND A FREE CLASSIFIED AD WITH YOUR SUBSCRIPTION

SUBSCRIPTION RATES

<table>
<thead>
<tr>
<th>Subscription Period</th>
<th>3rd Class Mail</th>
<th>1st Class Mail</th>
<th>Canada &amp; Mexico (in U.S. Funds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>One Year</td>
<td>$10.00</td>
<td>$15.00</td>
<td>$18.00</td>
</tr>
<tr>
<td>Lifetime</td>
<td>$35.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ORDER NOW!

SEND: □ CHECK □ MONEY ORDER □ VISA □ MASTER CARD

TO: NUTS & VOLTS MAGAZINE
P.O. BOX 1111-H
PLACENTIA, CALIFORNIA 92670
(714) 632-7721

Name:
Address:
City:
State: Zip: Card No.
Exp. Date:

IF YOU'RE INTO ELECTRONICS, THIS MAGAZINE WILL SAVE YOU MONEY!
Dealer Inquiries Invited

VE Groups!
Individual VEs!
DeVRY Wants You!

Work with the VEC that was — and still is — one of the first (and best) in the VEC Program.

Upgrading? An SASE will bring you DeVRY exam dates and locations by return mail.

Call or write Jim Georgius, W9JUG, Director

DeVRY ARS VEC Program
DeVRY Institute of Technology
3300 North Campbell
Chicago, IL 60618
(312) 929-8500

162
ings, then fine tune by adjusting C1, while keeping C2 at its mid-range value. If leads have been kept short, the 455 kHz point should be found without difficulty. The open-air maximum drift as measured on a counter was less than 100 Hz at the end of 1 hour.

The oscillator output voltage through C7 was about 1.5 volts peak-to-peak, which is the required amplitude. If the voltage is greater than 1.5 volts, reduce the value of C7. The loading of this output by Q2 has negligible effect on the amplitude of the voltage.

A test for upper and lower sideband heterodyning is the most important aspect of a product detector circuitry.

With C2 set at its center point, the counter should still register 455 kHz. Adjust C2 slowly to a lower value of capacitance and frequency should increase to about 458 kHz. Move C2 to a higher capacitance (at the same excursion as above) and the frequency should drop to 452 kHz. Return the tuning to mid-point, 455 kHz.

Turn off the power.

Install Q2 (3N201) in the socket. Connect a stable signal generator set to 455 kHz to the signal input BNC connector. The amplitude of the signal should not exceed 100 mV peak-to-peak sine wave, unmodulated. Connect the scope to the output end of C11, which is the top of trimpot R7. Power up the circuit and sync the VFO with the signal generator so as to display a null on the scope. Swing C2 through its upper and lower excursions, verifying that the waveform remains linear through sum and difference mixing of the signals. The amplitude should be about 200 mV peak-to-peak (3-dB mixer gain). Move the scope probe to the output side of C17. Adjust R7 trimpot for an output of less than 500 mV peak-to-peak. There should be no distortion of the output signal. If all components have been wired correctly, the Pi-section filter C9, C10, and L3 will have removed all mixer by-products with just the product of the two oscillators displayed on the scope. Increasing the signal generator output to 250 mV peak-to-peak should not cause distortion of the output signal. Be aware that the voice products of a product detector vary over the speech range and signal strengths. High signal amplitudes should not distort. A reduction of the R7 gain potentiometer will reduce large signal distortion.

The MOSFET, Q2, can tolerate high signal levels without distortion, however Q3 can be overdriven. A distorted signal is not pleasant to listen to.

After these tests have been completed, you’re ready to assemble the power audio IC and hook up the R390A IF output connector.

The input and interconnect cabling was done with RG 217/U coax. The low frequencies of the system could have tolerated audio cords with equal success.

The builder can use edge card connect boards with matching sockets. This writer drilled holes in the vector board corners and fastened the boards with 4-40 screws and 1/2-inch (1.27 cm) aluminum spacers. It all works happily together and that’s what it’s all about.

modifying the R390A

Several changes can be made to improve sensitivity, and noise figure of the R390A receiver. The modifications are made to the IF module only.

Disconnect AC power to the R390A. The rear terminal board TB102 has a jumper between terminals 3 and 4. Disconnect this jumper and ground terminal 4 to the receiver frame. Connect a voltmeter between terminal 3 and ground. Carefully remove the aluminum shields covering T501, T502, T503, and Z503.

Drill 3/16 (0.476 cm) holes in the top center of these shield cans. Be sure to de-burr afterward since the aluminum is soft.

Inspect the IF transformer T501. Locate the resistors shunting the primary and secondary winding. Caution: The Litz wire connecting the inductors is very fragile and easily broken. The resistor values in my receiver were 47 kilohms but could be as low as 15 kilohms in other models. Clip out these resistors, and replace the shields and observe the AGC voltage. Switch the receiver on and set the function switch to AGC, note that the voltage measures approximately 28 volts in the 2 kHz selectivity position. When peaking T501, T502, T503, and Z503, the voltage should increase to 34 volts (minimum) if all tubes are working properly. Replace the jumper on the TB102 AGC line, connect the Product Detector Module and you’ll discover that you have a hot SSB receiver that rivals anything built today.

using it in other receivers

The application of the Product Detector-audio assembly is not limited to the type of receivers discussed in the text. If the IF frequency is other than 455 kHz, (such as the R-388), then the local oscillator coil can be chosen to work with the required matching IF. Miller coils cover most of the wanted ranges; the builder can also wind a coil to the frequency of interest. The old Hallicrafters receivers, as well as the Hammarlund, National, and RCA of WW2 vintage can regain their vigor, providing the first local oscillator is stabilized. Don’t scrap the old boat anchors just because they won’t copy SSB or CW like some of the newer radios. Add this stand-alone module and find out how good it was all along!

The author has several R390A receivers in restorable condition, with the manuals. They are laboratory units, not military surplus. A QSL card to WGGB will get details.—Ed

ham radio
JOIN AMSAT...Today

Amateur Radio Satellite OSCAR 10 provides:

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

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

AMSAT
P.O. Box 27
Washington, DC 20044
301 589-6062
Don’t buy from Hamtronics . . .

Unless you want the best possible equipment at the lowest possible price! ! !

The “wheeler-dealer” is back and he’s beating everyone else’s “deals.”
We all know there’s no such thing as a free lunch . . .
so How Can We Do This?
- We don’t run a lot of ads featuring sale items
- We don’t spend a lot of money on full-page ads
- We don’t have sales on just the fastest selling products
- We don’t short-cut you on service. We are a factory warranty repair facility for everything we sell!
- We don’t mail out free catalogs
- We don’t have a free WATS number.

You and every other Ham customer is paying for all these do-dads and sales gimmicks.

Hamtronics puts the savings into your pocket.

Hamtronics guarantees to meet or beat any advertised price on every item we sell.

Hamtronics Has It All!

Let Hamtronics be your Ham Radio equipment dealer. We’re celebrating our 35th year in the Ham business at the same location.

Hamtronics, Inc.
A DIVISION OF TREVOSO ELECTRONICS
4033 BROWNSVILLE RD., TREVOSE, PA 19047
(215) 357-1400

HALF-PRICE SALE!
Super SSB Filters for ICOM
Models IC-730/740/745, R-70/71.
COMPARE!
ICOM FL-44A 2 kHz, 45 kHz, 8 pole $159
FL-44A (Twin of FL-44A) . . . . . . . . . . SALE $79.50
- Characteristics equal or exceed those of FL-44A.
- Replaces the inferior mechanical filter.
- Easy drop-installation — complete instructions.
Limited Quantities — Get ‘em while they last!
GO FOX TANGO — TO BE SURE
SHIPPING: $3. Air $5 (US & Canada). $10 Elsewhere
Order by mail or phone. VISA/MC or COD Accepted.
Ask About Our Fine Filters for Many Other Rigs
FOX TANGO CORPORATION
Box 15944
W. Palm Beach, FL 33416
(305) 883-9587

RF Porta-Tenna
VHF/UHF Telescopic 1/4 & 5/8
Wavelength Antennas for
Hand-Held Transceivers &
Test Equipment

1/4 WAVELENGTH
Model No. Freq. Mhz. Description Price
196-200 144-148 5/16-32 stud w/spring $5.95
196-204 BNC connector w/spring 7.95
196-214 BNC connector 6.95
196-224 14-Up BNC conn. adj. angle 7.95
196 814 220-225 BNC connector 6.95

5/8 WAVELENGTH
191-210 5/16-32 for old TEMPO 22.95
191-214 BNC connector 19.95
191-219 PL-259 w/M-359 adap. 22.95
191-810 220-225 5/16-32 for old TEMPO 22.95
191-914 BNC connector 19.95
191-940 440-450 5/16-32 for HT-220 22.95
191-941 1/4-32 stud 22.95
191-944 BNC connector 19.95

Largest Selection of Telescopic Antennas. Write for Info. Prices are postpaid
via UPS to 48 States. For air delivery via UPS Blue add $2.25. Florida add 5% sales tax. Payment by M.O. or Cashiers
Check only.

RF PRODUCTS
P.O. Box 33, Rockledge, FL 32955, U.S.A.
(305) 631-0775

VOLUNTEER EXAMINATION
BOOKS & TAPES

- Novice Class Q&A Test Guide Package $9.95
- Technician Class Q&A Test Guide 19.95
- Advanced Class Q&A Test Guide 19.95
- Extra Class Q&A Test Guide 19.95
- 5 wpm Novice QSO Test Preparation Tape 9.95
- 5-wpm Speed Builder 9.95
- 7-10 wpm Speed Builder 9.95
- 10-12 wpm Speed Builder 9.95
- 12-15 wpm QSO & Numbers Speed Builder 9.95
- 13-15 wpm Random Dial QSO Builder 9.95
- 13 wpm General Class QSO Test Prep Tape 9.95
- 13-15 wpm Speed Builder 9.95
- 15-17 wpm Speed Builder 9.95
- 17-19 wpm Speed Builder 9.95
- 20-22 wpm Random Code Practice 9.95
- 20 wpm Extra Class QSO Test Prep Tape 9.95
- Test Guides Updated to New 85 Questions and Answers
- Slew Code Tapes Use 13 wpm Character Speed
- We Ship First Class Mail, Same Day
- Add $3.00 postage & handling for Test Guides. 50c P&H for each tape.
- 100% SATISFACTION OR MONEY BACK

GORDON WEST RADIO SCHOOL
2414 COLLEGE DR., COSTA MESA, CA 92626
Mon.-Fri. 10-4pm
(714) 549-5000

Quality Microwave TV Antennas

Multi-Channel 1.9 to 2.7 GHz
40db Gain True Parabolic 20" Inch Dish
Complete System $44.95 (Shipping Incl.)
Dealerships, Qty. Pricing, Replacement Parts

Phillips-Tech Electronics
P.O. Box 34772 • Phoenix, AZ 85067
(800) 847-7700 ($150 Credit all phone orders)
MasterCard • Visa • COD

NEW 20-PAGE CATALOG FREE
7 MILLION TUBES
Includes all current, obsolete, antique, hard-to-find receiving, transmitting, industrial radio TV types. LOWEST PRICES. Major brands in stock.
Unity Electronics Dept.
P.O. Box 213, Elizabeth, N.J. 07206

114 November 1985
build a handy RF probe

Build it simple—or more complex, for increased sensitivity

An RF probe is a useful instrument to have around the shack—if you can find one that’s sufficiently sensitive. This article will help you build your own, using solid-state Germanium or silicon diodes in simple circuits to provide the necessary sensitivity.

using diodes

Two principles must be understood in using diodes of all types: threshold of operation and detection sensitivity. Ideally, all diodes have a maximum sensitivity set by the diode equation:

\[ I = I_s \left\{ \exp \left( \frac{qV}{kT} \right) - 1 \right\} \] (1)

where \( I_s \) is the saturation current, which sets the threshold, \( q \) is the electron charge, \( k \) is Boltzman’s constant, and \( T \) is the absolute temperature (room temperature is about 290 degrees absolute), and \( V \) is the voltage. The expression \((q/kT)\) is extremely important in solid-state electronics and has a nominal value of 39. Its reciprocal is 0.026 volt.

The smaller the value of \( I_s \), the larger the threshold voltage required with any of these devices.* With the germanium diode, the threshold will occur at an anode-to-cathode voltage in the range of 0.1 to 0.25 volt, and with the silicon diode, 0.5 to 0.75 volt.

In practice, an operating current level between 0.1 and 1 mA is selected to compare various devices. In normal operation, the anode-to-cathode voltage at which the chosen level of current flows controls the minimum sensitivity of a diode probe.

Measuring current as a function of voltage in solid-state diodes, one finds a two-to-one change in device current with approximately 0.018 volt change in applied voltage. This is the sensitivity needed (see appendix).

Using a diode having a low threshold and full incremental sensitivity, as it can be called can improve the minimum sensitivity of an RF probe to allow the measurement of voltages in the 100 to 500 millivolt range. (This is why hot-carrier diodes are important.) The simplest circuit for using a high-threshold-sensitivity diode is shown in fig. 1. The input capacitor is selected so that its reactance \((I/\omega C)\) is small compared to the diode’s apparent resistance, and not more than the source impedance of the signal source. The resistance value in the output circuit should be large compared to the diode resistance, which is approximately \(0.026/I\) where \( I \) is in amperes. Such an RF probe can be used in some receiver alignment applications as well as many routine tuning problems, and it can be used with a sensitive analog meter or a digital voltmeter.

building a better probe

Reducing dependence on the threshold limitation results in better RF probes because of high inherent sensitivity of solid-state devices. To take advantage of this sensitivity, a fixed level of operating current must be introduced to overcome the threshold and then apply a signal voltage from a low-impedance source to achieve the current sensitivity solid-state devices are theoretically capable of delivering.

Possibly the easiest way to avoid the threshold problem is to use a transistor so that we can sense the current changes more easily. A circuit using the LM 334 controlled-current source is shown in fig. 2. An isolation resistance that reduces the voltage drop across the LM 334 to perhaps a volt and a half will separate the DC and RF circuits.

By Keats A. Pullen, Jr., W3QOM, 2807 Jerusalem Road, Kingsville, Maryland 21087

*The value of \( I_s \) is a function of the numbers of the charge carriers in undoped or intrinsic material. In undoped germanium, there are 1131 times as many carriers than in silicon. This leads to at least 0.180 volt more bias for the silicon diode than for the germanium.
COMPUTER TERMINAL BUILDING BLOCK $50.00
This is a great beginning for a computer terminal. It is a brand new, Panasonic, 9" TTL input monitor complete with its own self-contained, switching power supply, and a removable (four screws) triple output power supply. The whole assembly runs on 115/230 V, 50/60 Hz. Now for some specifics: 9" green phosphor, TTL input monitor, attached regulated 12 VDC, 1.5 A power supply used exclusively to run the monitor and an attached triple output switching power supply with outputs of 5 VDC @ 500 ma, and -12 VDC @ 500 ma. The assembly has mounting feet and should be a snap to make a case for. Comes with hook up data. New, factory boxed. We are offering this to you 4 ways:

- COMPLETE SET-UP AS SHOWN, including monitor, low voltage supply and triple output supply.
- TRIPLE OUTPUT SUPPLY ONLY, 3 Lbs. $15.00
- "9" MONITOR ONLY, (you supply low voltage input) 10 Lbs. $25.00
- "9" MONITOR W/LOW VOLTAGE SUPPLY ONLY, 12 Lbs. $40.00

ATTENTION:
SECURITY PERSONNEL
NATURALISTS
HOBBYISTS
NEW SEE-IN-THE-DARK EQUIPMENT!

STARLIGHT SCOPE
SPL-130A-39 $1,200.00
Optional Telephoto Lens
SPL-131A-39 $85.00
Optional Fitted Carrying Case
SPL-132A-39 $65.00

1/2 Height 1 MEGabyte Disc Drives
Here we go with another blockbuster buy on disc drives which should make the competition's head spin! We are offering brand new, Mitsubishi no. 4853, 1/2 height, 1 megabyte, mini floppy disc drives. These drives are beautiful. They are fully Sanyo or other computer. Each order will come with schematics and pin out data. SPL-85C-35 $175.00 each, 2/$350.00, 5/$1750.00

HIGH POWER SURVEILLANCE IR SCOPE
This Infra-Red scope was designed specifically for long range surveillance use. The built-in, totally invisible, 60 watt halogen lamp IR source is coupled with a premium grade type 6032 image converter tube, 265 mm f/2.2 lens, and 16 power military spec., color corrected eyepiece make this an ideal unit for viewing of clandestine activities or animals. The scope is capable of detection at more than 300 feet, recognition at 300 feet and positive facial identification at 150 feet. It runs on 12 VDC which makes it ideal for mobile use. It comes with a removable hand grip which allows for tripod mounting, 2 power cords for cigarette lighter or battery terminals, instructions and a 90 day warranty. Listed below are accessories which make this a very versatile instrument. The scope and accessories are new and guaranteed functional. Net wt. 5-1/4 Lbs. IR Scope part no. ELD Shpg. Wt. 7 Lbs. $735.00 ea.

ACCESSORIES:
12 VDC GELL BATTERY for above. Shpg. Wt. 6 Lbs. $35.00

Use with:

- IBM
- RADIO SHACK
- HEATH
- XEROX
- SANYO

MALE "T" to FEMALE "T" ADAPTER for CCTV, requires use of above male "T" f/1.6 adapter. Shpg. Wt. 1 Lb. $29.95

Free 72 page catalogue available or send $1.00 for 1st class service to P. O. Box 82 E. Lynn, Ma. 01904. Phone (617) 595-2275 to place your order by phone. MC, VISA, or American Express charge cards accepted.
A simple review of the principles underlying detection is included in the appendix.

The circuit shown in fig. 2 works as predicted, but it still is not optimum because very small current changes must be observed if sensitivity is to be optimized. For this, a reference voltage follower can be used, (fig. 3), resulting in a voltage-sensitive bridge. Full-scale indication on the output meter with output changes of 100 millivolts (the full-scale reading of the meter) can be achieved easily. This may correspond to as little as 30 mV of RF signal. The scale will not be linear, but will approach a square-law function.

Using the meter directly between the collector circuit of the detecting transistor and the voltage reference will also reduce the sensitivity of the detector. Two circuits that can do this, both reducing the current load on the detector output, are shown in fig. 4.

The basic problems are now solved. To minimize the loading the detector places on the source, a situation that is particularly important if the RF source has high-impedance characteristics, VMOS transistors such as the VN10KM can be used as an amplifier. These transistors are better used as wideband amplifiers, with the output taken in the drain circuit. A small amount of degeneration through the use of a source resistance is acceptable, although it does reduce the amplification. In no case should the amplification exceed ten, and it may be as small as 1.0 to 1.5. A possible circuit is in fig. 5.

If greater sensitivity is required, a pair of high-frequency bipolar transistors can be used in a cascode arrangement after the VMOS transistor and before the input of the detection transistor to get an additional X10 voltage gain. A useful circuit for this is shown in fig. 6. This circuit should also be broadband. The output load resistance required will be approximately 260/\(i_c\), with collector current, \(i_c\), measured in milliamperes. The resulting unit will have a voltage gain of roughly 10, and can be built quite easily. It will extend the minimum sensitivity down to about the millivolt level. These amplifiers limit with input signals over about 10 millivolts, and will also rectify, distorting the input signal.

other applications

The buffered RF probe has a variety of applications of interest to Amateurs beyond its use in circuit testing. I have built one into a homebrewed Q meter, for example, and also into a low-frequency dip meter.
## VHF Shop

### Orders quotes - 1-800-HAM-7373

| RS-7A | 45 | RS-33A | 123 | RS-5A | 45 |
| RS-12A | 62.5 | RS-35M | 138.75 | RS-12M | 78.75 | VS-35M | 150 |
| RS-20A | 79.75 | RS-50A | 179 | RS-20M | 96.45 | RS-50M | 203.25 |
| VS-20M | 114.25 | VS-50M | 223.65 |

| KLM | 2M16LX/BX-220-LBX, 432-30LX-BX-90.9 | 2M14C-BX, 2M22C-108.5 |
| 435-16C-110.9 | 435-40C-144.9 |

### KENPROM ROTORS

| KR4007KR5,000 | 125 MHz54.5 |
| KR4500-2KR5600 | 247 MHz309.5 |

### HENRY AMPS

| 2 KD CLASSIC | 965.5 |
| 2002A/2004A Less Relay | 1250 MHz1350 |
| 3002A/3004A Less Relay | 2100 MHz2100 |

### AMP SUPPLY

| LK-500ZB | 1.097.5 |
| MIRAGE-FREE UPS BROWN ON ALL MIRAGE | |

### PARABOLIC

| A1015 - 225.5 | C-22A - 85 |
| B23A - 83.5 | C-106 - 169.5 |
| B215 - 245.5 | C-101 - 248.5 |
| B109 - 149.95 | D-1011 - 177.5 |
| B1016 - 225.9 | D-1013 - 275 |
| B3016 - 199.9 | D-3017 - 251 |
| MP-1 - .95 | |

**TOWNS FTA ANTENNAS ARE BACK! WE ARE THE EXCLUSIVE US DISTRIBUTOR INTRODUCTORY SPECIAL**

<table>
<thead>
<tr>
<th>1296/1296 QUAD ARRAY COMPLETE WITH 433MHz YAGI, &quot;H&quot; FRAME, POWER DIVIDER, PHASING LINES, CONNECTORS, TEERIAL APPLICATIONS</th>
<th>REGULAR PRICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 EL METER YAGI</td>
<td>95</td>
</tr>
<tr>
<td>21 EL 70cm YAGI</td>
<td>56</td>
</tr>
<tr>
<td>27cm OSCARTWIST</td>
<td>68</td>
</tr>
<tr>
<td>(ATV MODELS IN STOCK)</td>
<td></td>
</tr>
<tr>
<td>2 x 19 EL (365)</td>
<td></td>
</tr>
</tbody>
</table>

**35 enlarged broadside array antenna by TONNA (CALL FOR SPEC. SHEET!!!)**

| 13 EL 2MTR YAGI | 59 |
| 23 EL 292669 YAGI | 46.89 |
| 17 EL 2MTR SUPER YAGI | 88.36 |
| 66 EL 1286 SUPER YAGI | 68.62 |
| 19 x 19 el OSCAR ANTENNA 2M & 70cm on a COMANDBOOM GREAT | 75.25 |

**WATCH YOUR ADD FOR NEW LINES!!! FOR STACKING**

### THEY'RE ALL NEW FOR 1986!

Significant changes for 1986 mandate that all hams get both the North American and International Callbooks. **DXers and Contesters note** — Having both books is the only way you'll have all Foreign Amateur listings.

#### NORTH AMERICAN CALLBOOK

The old US Callbook has been expanded and now contains the lists of all hams in North America plus Hawaii and US Possessions. This improved operating aid has all the latest calls and QTH information available at press time and will be an invaluable reference guide. With calls from Panama to Greenland, every ham should have a copy of this new book in their shack. ©1985.

#### INTERNATIONAL CALLBOOK

The Foreign Callbook is no more! In its place, the new International Callbook includes all Amateurs outside the North American continent. All the latest callsigns and QTH's are listed to help ensure you get that prized QSL card. Universally recognized as the source of information. Order your's today. ©1985.

| CB-F86 | Softbound $20.95 |

Order Both and SAVE. Reg. Price $42.90

**SPECIAL PRICE**

**SAVE $2.95**

| CB-US86 | Softbound $21.95 |

**Books will be shipped in late November.**

Please enclose $3.50 to cover postage and handling.
The buffer FET can be the VN10KM mentioned above. (I have described an instrument for testing FETs in Design of Transistor Circuits, with Experiments.)

The field-intensity meter uses the cascode amplifier operating into the transistor metering circuit. I did not use the FET here because I assumed that the dipole antenna, consisting of two collapsible TV antennas, would have essentially a low-impedance output. (A suitable loop may be used instead, however.) The unit seems to work quite well.

The low-frequency dip meter must use variable-inductance tuning because a variable capacitor of appropriate size for this application would be much too large, and smaller ones would have too high reactance. The basic oscillator circuit I used is based on an emitter-coupled amplifier with a variable LM 334 current source for the base drive on both transistors, fig. 7. The oscillation level is set with a potentiometer across the LM 334 control points, and magnetic coupling is used to test a circuit. I have arranged the assembly so that I can plug in a variety of slug-tuned coils; the coils have slugs on threaded rods with a short piece of piano wire soldered in the screw slot. The drive consists of a piece of quarter-inch brass rod drilled and slotted to engage the wire. The frequency change is slow and smooth.

I can also tap off RF output from the FET buffer for frequency counting or use as a signal source. This unit easily fills the gap between audio and 2 MHz, the lower limit on most dip meters. The actual circuit is a combination of figs. 3, 4, and 7.

The Q meter used the same metering circuit as the dip meter for measuring RF. The RF source I use is a conventional inexpensive signal generator, except that I have tapped in on it prior to its normal output stage. These deliberately generate distorted waveforms to create harmonics in the output. You may wish to put an FET buffer between the oscillator and the special output to ensure better frequency stability. A suitable circuit for this is shown in fig. 8. About 10 millivolts of RF are needed by the Q meter input circuit.

The RF drive transistor that provides the RF signal to the measurement circuit should be a high-frequency bipolar transistor, and should provide a voltage gain of approximately 10 overall. (Only a hundredth of this is actually applied to the tuned circuit, 100 microvolts.) The full output is used to calibrate the circuit, and the part to control the tuned circuit. One is then matched against the other, based on oscilloscope calibration. A possible circuit is shown in fig. 9. Minimum Q sensitivity will be about 20. About 25 mA of collector current will be needed by the 2N2222 or 2N2369 to provide the required signal voltage. A Q test circuit is shown in fig. 10.

**calibration**

This calibration technique, done with an oscilloscope, can be used wherever minimum or maximum
deflection is insufficient to assure proper circuit operation, but an actual voltage value is required. The oscilloscope can be calibrated with a reference voltmeter and an AC signal. RMS calibration should be used. The low-frequency calibration is used, with the help of the oscilloscope, to calibrate sinusoidal signal well within the upper limit of the oscilloscope (1/2 to 1 MHz for a 5 MHz unit). This calibration then is transferred to the Q meter measuring circuit. The source calibration voltage for setting the Q meter reference input may be adjusted for 20, 50, and 100 millivolts for the reference excitation. This will make possible measurements of Q to 100, 200, and 500. In addition, the meter is calibrated for a series of input signals ranging from about 10 mV to 100 mV, at least every 10 mV, to provide the actual Q measurement. A special scale may be made for the meter if desired. Since the Q is proportional to the RF voltage generated, calibration is important.

**concluding remarks**

These simple probe circuits can easily be built into transmitters, and receivers in which critical tuning is required as well as into other useful test instruments. In all cases, it is important to minimize probe loading on the circuit being tested without simultaneously degrading sensitivity. The VMOS circuits are ideal for this purpose, and they do not limit as readily as bipolar transistors. Where either germanium or silicon diodes can provide adequate sensitivity, they, of course, are the component of choice, but they do have the excessive threshold voltage requirement that the current-stabilized transistor circuits can help overcome.

RF measurements have always been a stumbling block in the typical Amateur station, including mine. I can remember building a nice wavemeter that I was...
unrelated to calibrate. The described circuit techniques are a result of years of trying to solve similar problems inexpensively. Perhaps these ideas can help rekindle the experimental spark in other Amateurs, and help reverse the trend away from homebrewed equipment. You don’t have to be a mathematician or physicist to contribute to progress!

reference

appendix
Rectification is a change in the effective resistance (or conductance) of a diode as a function of its applied voltage. This difference causes distortion, and it is the distortion of the current-voltage relationship that converts an AC signal into some level of change of average current and average voltage.

Strictly speaking, the relationship between the current and the voltage in a diode is nonlinear, or exponential. But for small voltages, it “looks” like a square-law device. The basic relationship can be stated in terms of the equation:

\[ i = I_o \exp\left(\frac{qV}{kT}\right) = I_o \left(1 + \frac{qV}{kT} + \frac{q^2V^2}{2kT^2} + \ldots\right) \]  

(A1)

When \( V \) is set equal to \( V_o \sin(2\pi f t) \), the relationship becomes, if \( a = \frac{qV}{kT} \):

\[ i = I_o \left[1 + aV_o \sin(2\pi f t) + \frac{a^2V_o^2}{2}\sin^2(2\pi f t) + \ldots\right] \]  

(A2)

The third term in the brackets on the right converts to the form:

\[ (a^2V_o^2/4)(1 - \cos 4\pi f t) \]

and the DC term now is \((1 + a^2V_o^2/4)\). The term \(a^2V_o^2/4\) represents the DC shift due to detection, and the current peaks in the two directions are:

\[ I_o \left(1 \pm aV_o + a^2V_o^2/2\right) \]  

(A3)

The capacitor-input detector has a peak shift from \((1 + aV_o + a^2V_o^2/2) \times I_o\), to \((1 - aV_o + a^2V_o^2/2) \times I_o\). We filter out the \(V_o \sin 2\pi f t\) and the \(\cos 4\pi f t\) terms with the RC circuit. With the peak detector, the current change is \(I_o \left(a^2V_o^2/2\right)\), this is what we wish to read.

From the above relationships, it is possible to show that with the normal diode detector, a current change of 2:1 can be obtained with 18 millivolts peak-to-peak signal on a diode, and a DC shift between 8 and 16 percent may be generated, depending on whether square-law or peak detection is selected. The signal distortion is roughly 8 percent.

hamster radio
WHAT'S REALLY HAPPENING IN HOME SATELLITE TV?

A monthly of 100-plus pages—has everything you need to know about where to find equipment, how to install it, system performance, legal viewpoints, and industry insights! With your subscription to STV® you will receive a FREE LCD Calendar/Clock.

- Only $19.95 per year (12 monthly issues)
- $1.00 for sample copy

IF YOU HAVE A SATELLITE SYSTEM, THEN YOU REALLY NEED ...

OnSat

The best in satellite programming! Featuring:

★ All Scheduled Channels ★ Weekly Updated Listings
★ Magazine Format ★ Complete Movie Listing ★ All Sports Specials ★ Prime Time Highlights ★ Specials Listing and ★ Programming Updates!

- Only $45.00 per year (52 weekly issues)
- 2 Years $79.00 (104 weekly issues)
- $1.00 for sample copy

Visa® and MasterCard® accepted (subscription orders only). All prices in US funds. Write for foreign rates.

Send this ad along with your order to:

STV®/OnSat®
P.O. Box 2384—Dept. HR • Shelby, NC 28151-2384
SUBSCRIPTION CALLS ONLY TOLL FREE 1-800-438-2020

Tell 'em you saw it in HAM RADIO!
Rob, WA3QLS  Katherine, KA31YO  Paul, WA3QPX

Delaware
Amateur Supply

71 Meadow Road, New Castle, Del. 19720  302-328-7728
Factory Authorized Dealer! 9-5 Daily, 9-8 Friday, 9-3 Saturday

KENWOOD  YAESU  ICOM  TENTEC
MICROLOG  KDK  SANTEC  KANTRONICS

800-441-7008
Order & Pricing
New Equipment

Large Inventory

All Other Calls
302-328-7728

No Sales Tax
in Delaware!
One mile off I-95

More Details? CHECK—OFF Page 142
Ham Radio's Bookstore

ARRL Q&A LICENSE MANUALS
ALL LICENSE CLASSES NOW AVAILABLE!
ARRL Q&A License Manuals are keyed to the latest FCC Exam syllabus in use by the Volunteer Examiners. These books are written in an easy-to-read conversational style that enhances understanding without scaring the student away. All technical subject areas are explained in clear terminology and with plenty of illustrations, diagrams and schematics. Rules are also fully covered. Each book has the official ARRL multiple-choice question Pool with answers and a key to the FCC Exam syllabus for reference to other study publications. These are the study guides to have booked! 1985 1st Editions.

HR CODE TAPES
Formerly Kantronics Tapes
These code tapes have been designed by experts to help you learn code. Several different methods are available for all classes of license. Transcripts encoded for checking copy.

ANTENNA COMPENDIUM
edited by ARRL Staff
This book has more than 20 antenna articles that have never been published before. Subjects covered include: Quads, Yagis, Phased Arrays, Log Periodics, Subsurface Antennas. "The Old Spruce Antenna," as well as discussions on Smith Charts, antenna design, the G5RV multi-band antenna and antenna polarization. Great summer reading and full of ideas for Fall '85 antenna projects. © 1985, 1st Edition.

AMECO STUDY GUIDES
Designed for VEC Exams
AMECO Study Guides are taken from the FCC Amateur Exam syllabus, PR-1035 and have answers keyed to ARRL's recently released study material. These study guides are compatible with ARRL and all other VEC Exams. While nothing can guarantee that you will pass, AMECO Study Guides will make sure that you are fully prepared and ready to go when you sit down for the exam. Written in clear, concise, easy-to-read format, each question fully explained. Notice and General books cross referenced to AMECO's 102-01 for a more thorough explanation.

THE AMATEUR RADIO VERTICAL HANDBOOK
by Cpt. Paul H. Lee, USN (Ret.), NSPFL
This is the only book dedicated to the vertical antenna and will be of interest to all those using or looking to use the vertical design. Based upon the author's years of work with a number of different vertical antenna designs, you'll get plenty of theory and design information along with a number of practical construction ideas. Included are designs for simple 1/4 and 5/8 wave antennas as well as broadband and multi-element directional antennas. Paul Lee is an engineer and avid ham and is Amateur Radio's resident expert on the vertical antenna. © 1984, 2nd edition.

COMPUTER WIMP
BY John Bean
166 things I wish I had known before I bought my first computer. Based upon ten years of often frustrating experience, this light-hearted text is designed to help you learn about computers and to make intelligent decisions about their purchase. Author Bean first examines common pitfalls about purchasing a computer. He then examines warranties, how to deal rationally with manufacturers, to buy by mail, how to talk "technobabble" or computerese, how to avoid computer phobia, games, software piracy and much more. 1st edition 285 pages +1983 +1984 +1985 edition.

CONTEST LOG
This disk contains four different contest programs; ARRL Sweepstakes, Field Day, Universal WW Contest log, plus a duping checking routine. This program is designed for real time use. It automatically enters date, time, band and serial number for each contact. A 24-hour clock is displayed at the top of the VGT screen. When the contest is over, the program will print your results listing all duped and scored contacts in serial sequence with all necessary information as well as complete score at the bottom of the page.

MASTER LOG
Over three years of development went into this program. It creates a file of 2100 individual records with up to 13 different entries per record. Master Log can do a search and select based upon time, frequency, mode or any of the other variable parameters. It keeps track of DXCC and WAS status, prints QSL labels and can search its whole file in less than 5 seconds! Complete documentation is included to help you learn and use this truly state-of-the-art logging program.

COMMUNICATIONS SATELLITES
by Larry Van Horn
Here's the most exhaustive text ever written about communications satellites! Easy-to-read text along with plenty of pictures and illustrations make this new book a veritable gold mine of information. Nine chapters include: OSCAR, weather, domestic and international communications satellites, DBS, space shuttle, U.S. Military and space surveillance systems and Soviet space program. Also included are four appendices on satellite frequency cross references, satellite complement, current geostationary satellites and a bibliography. Must reading for all satellite users. © 1985 edition 216 pages.

THE COMPLETE DX'ER
by Bob Loccher, W9KNI
DX'ing can be as simple as turning on the radio and tuning across a band. Or it can be a full-blown activity; a band-study propagation reports, sunspot figures and the DX newsletter looking for toughies of information. The first part of this book is designed to teach the reader DX'ing fundamentals. Part two is for the "over 200 countries worked" operator and has plenty of handy tips, aids and ideas. Part three is full of more exotic hints for the "over 300 countries worked" operator. This book tells all and should be required reading before anyone starts their quest for DXCC. Even if you don't care about DXCC, Bob's easy-to-read style of writing is most enjoyable reading. © 1984, 1st edition.

COMMUNICATIONS PROGRAMS FOR THE RADIO AMATEUR
by Wayne Overbeck, N6NB, and Jim Steffen, K6AS
Here's the best source book of computer programs for 1 Radio Amateurs. Besides covering computer basics, this book gives you programs that will help you log, determine sunrise/sunset times, track the moon's passage across the sky, use Greyline propagation and set up record systems for WAT, DXCC and VUCC, or any other award. You can either buy the book alone or you can buy the book with the programs already on a disk. Take full advantage of your computer with this well written source book. © 1984, 1st edition, 327 pages.

COMPUTER PROGRAMS FOR THE RADIO AMATEUR
by Wayne Overbeck, N6NB, and Jim Steffen, K6AS
Here's the best source book of computer programs for 1 Radio Amateurs. Besides covering computer basics, this book gives you programs that will help you log, determine sunrise/sunset times, track the moon's passage across the sky, use Greyline propagation and set up record systems for WAT, DXCC and VUCC, or any other award. You can either buy the book alone or you can buy the book with the programs already on a disk. Take full advantage of your computer with this well written source book. © 1984, 1st edition, 327 pages.

COMMUNICATIONS SATELLITES
by Larry Van Horn
Here's the most exhaustive text ever written about communications satellites! Easy-to-read text along with plenty of pictures and illustrations make this new book a veritable gold mine of information. Nine chapters include: OSCAR, weather, domestic and international communications satellites, DBS, space shuttle, U.S. Military and space surveillance systems and Soviet space program. Also included are four appendices on satellite frequency cross references, satellite complement, current geostationary satellites and a bibliography. Must reading for all satellite users. © 1985 edition 216 pages.

THE COMPLETE DX'ER
by Bob Loccher, W9KNI
DX'ing can be as simple as turning on the radio and tuning across a band. Or it can be a full-blown activity; a band-study propagation reports, sunspot figures and the DX newsletter looking for toughies of information. The first part of this book is designed to teach the reader DX'ing fundamentals. Part two is for the "over 200 countries worked" operator and has plenty of handy tips, aids and ideas. Part three is full of more exotic hints for the "over 300 countries worked" operator. This book tells all and should be required reading before anyone starts their quest for DXCC. Even if you don't care about DXCC, Bob's easy-to-read style of writing is most enjoyable reading. © 1984, 1st edition.

COMMUNICATIONS PROGRAMS FOR THE RADIO AMATEUR
by Wayne Overbeck, N6NB, and Jim Steffen, K6AS
Here's the best source book of computer programs for 1 Radio Amateurs. Besides covering computer basics, this book gives you programs that will help you log, determine sunrise/sunset times, track the moon's passage across the sky, use Greyline propagation and set up record systems for WAT, DXCC and VUCC, or any other award. You can either buy the book alone or you can buy the book with the programs already on a disk. Take full advantage of your computer with this well written source book. © 1984, 1st edition, 327 pages.

Ham Radio has many other books in stock not shown here.
Call or write today for your free catalog or to place an order. (603) 878-1441 8-4 EST
Please enclose $3.50 with your order to cover postage and handling.
Holiday Special

Stocking Stuffers and Other Gift Ideas

BEAM ANTENNA HANDBOOK by WSSAI and W2LX
Completely revised and updated the Beam Antenna Handbook includes the very latest state-of-the-art design computer generated beam dimensions for the 40, 20, 17, 15, 12, 10 and VHF bands. It is an easy to use message generator. The Beam Handbook is packed with information on VHF, UHF and Amateur bands. Also included are easy to read diagrams. $9.95

1985-86 ARRL REPEATER DIRECTORY
You could call this book the "repeater bible". Close to 30,000 listings by state and region by state and region by state and region. All of the important details such as access codes, time of day, etc. are included. The reference section has been greatly expanded to include many new entries. $9.95

ARRL OPERATING MANUAL
Brand new 2nd edition. Just released and fully revised! This book tells you all about how to operate your station. Message handling, emergency traffic, tips for successful contesting and DXing are fully covered as well as new sections on digital communications and satellite operation. $29.95

SOFTWARE

RTTY MAILBOX MSO
for Vic 20 and C-64 Computers
Turns your Commodore home computer into a powerful, easy-to-use message handling system. Messages can be stored, read or deleted by either choosing RTTY signals or by using the computer's keyboard. Each message is listed in a directory by file name, along with date and time of message. The BASIC Assembly language software combines high speed with user friendly features and完全可以 controls your transceiver and receiver with automatic identification, an optional message printout and automatic transmission of date and time during MSO use. You can also use this program to operate direct RTTY and 60, 67, 75 or 100 wpm Speedo or 110 baud ASCII. Vic 20 needs 2k of memory to use this program.

VC-CP Use with AE ACP interface & equiv. $79.95
VC-MF Use with MFP interface & equiv. $79.95
VC-CT Use with Kantronics interface & equiv. $89.95

RF NOTES by WDM6DI
Here's an easy way to get answers for often asked electronic questions. RF NOTES contains programs written by RF consulting engineers that answer dB conversions, convert voltage, current or power levels to dB, dBm conversions, converts voltages or power levels to dBm and dBm to voltage or power. VSWR calculations, calculates VSWR and return loss after corrected and includes some useful formulas. Filter design, 14 different filter configurations including schematics (8 low pass, 4 high pass, 2 band pass and 2 band elimination circuits). Basic Microstrip and basic strip line design; and resonant circuits, design parameters and tuning resonant circuits. $99.95

Contender II Logging Database
This Commodore 64 program will meet just about every logging need you can imagine. It can be used as a contest log, general log or a dupe checker and can be used for all band WAS, WAZ or DXCC. The storage disk holds up to 2,000 exchanges and can be edited and updated simply and easily. Each entry contains callign, signal reports, automatic or manually entered time and date, band and mode as well as name and G7H. Contender will also print QSL's, mail labels and contest dupe sheets. The Contender USA-CA (three disks) is a Worked All Country database that saves time and hassle and a tremendous amount of paperwork.

CT-C Basic Contender (C-64) 1 disk $34.95
CT-CUSA Contender Plus USA-CA (C-64) 3 disks $49.95

Packet Radio Thru Software
AX.25 Protocol
You can get on Packet Radio two ways. One is with a sophisticated "black box." The other is by making your computer act like a "black box" by programming it in a high level machine language code. WAHCH has written a machine language program for the Radio Shack TRS-80 Models 1, 3 and 4 computer (Model 4 works with Model 3 disk while in Model 3 mode). This book has twelve chapters plus seven appendices that take you step by step through the process of setting your computer to first convert the digital information into a useable format and then to decode the information. © 1984, 3rd edition.

RE-AX Softbound $21.95
RE-MI Model 1 Disk $29.00
No Documentation included
RE-MIH Model 3 Disk $29.00
No Documentation included
RE-RC special book and disk (Specify disk, Mod. 1 or Mod. 3) $49.95

Computerized DX Edge
Generate your own Greyscale display. Xantexx has adapted their best selling DX Edge to the computer world and it comes at a very reasonable price. This computerized operating aid brings into your ham shack the ability to know and predict when and where DX is going to appear. When you are using the program, the computer will automatically update the information as the sun progresses across the face of the Earth. To make the computerized DX Edge even easier to use, the display is keyed to the DXCC list and the 40 QSO zones. Disk and documentation are just $34.95. This is something you've Got to have! © 1985

A EA M W UNIVERSITY
Contains a C-64 code training cartridge software package (no disk or cassette necessary).

ARRL’s Tune In The World With Ham Radio
Great New Way to study for your Novice License!

This brand new package contains all one needs to learn the code and theory for the Novice class Radio Amateur exam. Basic code is taught using a character by character teaching routine. Practice can be either with individual letters or in groups of up to nine characters. Proficiency is developed through practice sessions that can be progressively speeded up during the session, either random characters or fixed letter groups. Farnsworth (high speed characters, slow spacing) or slow speed sending. Xantexx has incorporated a vial game to make the learning process even more fun. You can also enter text from the keyboard for "customized" practice sessions or as an example of how code should sound. An analysis routine is included so that the computer can check one's progress in learning the code. ARRL Tune In The World booklet will give you all you need to know to pass the Novice theory and regulations exam. Great state-of-the-art teaching device. Sure to be a hit this fall. Get one now. It's a great holiday season gift!

AEA-MU (For C-64) $39.95
The Model DX-A combines the tremendous firepower of the quarter wave sloper with the wide bandwidth of a half wave dipole. Simple to install, quick to tune. Proven longhaul DX performance.

- Installs like an inverted-V dipole. One leg for 80 meters (67') and the other leg for 160/40 meters (55' ). Feds with a single 50 ohm coax. SO-239 connector provided on mounting bracket.
- Configuration provides wide bandwidth on all three bands. Typically 70 kHz on 160 meters, 200 kHz on 80 meters and full band on 40 meters. Much wider than most other loaded slopers, dipoles or verticals. Tuner usually not required.
- Model DX-A also operates on 30-17-12 meters. VSWR of less than 2.5:1. Easily matched with a tuner.
- High-power operation. Rated at 1500 watts P.E.P. output. No traps to break down. A single "ISO-RES" isolator-resonator is used in the 160/40 meter leg. 
- Current lobe up high for maximum radiation and excellent DX performance. Can be installed from 25 to 40' high.
- The Model DX-A Antenna is fully assembled, uses all stainless steel hardware, a UV-protected "ISO-RES" coil, #12 copper wire and is rated for severe environments. Specially coated wire disappears from your neighbors view.

$49.95

Available from your local Alpha Delta Dealer or add $4.00 shipping and handling (USA only).

P.O. Box 571 Centerville, OH 45459
(513) 435-4772 Orders • (513) 376-4180 Antenna Tech Info
"HAM HOTLINE"
THE PROVEN MONEymaker
The "Ham Hotline" is a complete mailing list of novice amateur radio operators and current hams who have renewed, upgraded or modified their FCC licenses. These ham enthusiasts have proven to be excellent prospects for radio equipment, accessories and publications.

The Hotline is UPDATED EVERY TWO WEEKS with an average of 8,000 names and addresses each month. And, because we know the Hotline is the most up-to-date amateur radio listing available, we'll guarantee 98% deliverability.

Target your sales efforts to your most likely buyers. Call DCC Data Service today and begin your subscription to the "Ham Hotline"... the proven moneymaker.

DCC Data Service
1990 M Street, N.W. Suite 610
Washington, D.C. 20036
Toll-free 1-800-431-2577
In DC & AK 202-452-1419

FREE CATALOG!
Features Hard-to-Find Tools and Test Equipment

Jensen's new catalog features hard-to-find precision tools, tool kits, tool cases and test equipment used by ham radio operators, hobbyists, scientists, engineers, laboratories and government agencies. Call or write for your free copy today.

JENSEN TOOLS INC.
7815 S. 46th Street
Phoenix, AZ 85040
(602) 968-6231

ROHN brings the top to you with its patented design.
For the ultimate "on the ground" service and antenna installation, a ROHN "Fold-Over" Tower is your best buy. Your safety comes first with "Fold-Over." For complete details write:

ROHN
"FOLD-OVER" TOWERS
P.O. BOX 2000, PECORIA, IL 61656 U.S.A.
TWX 910-652-0646 FAX 309-697-5612

Now You Can Receive The Weak Signals With The
ALL NEW AMECO PREAMPLIFIER

Model PT-2 is a continuous tuning 6-160 meter Pre-Amp and master power station control. It is specifically designed for use with a transceiver. The PT-2 contains new sophisticated control circuitry that permits it to be added to virtually any transceiver with no modification. No serious ham can be without one. Other features include: * Improves sensitivity and signal-to-noise ratio. * Boosts signal up to 26 db. * For AM or SSB. * Bypasses itself automatically when the transceiver is transmitting. * FET amplifier gives superior cross modulation protection. * Advanced solidstate circuitry. * Simple to install. * Provides master power control for station equipment.

Model PT-2 ... 117 V. 60 Hz.
Model PT-2E ... 220-240 V., 50-60 Hz.

AMECO EQUIPMENT CO.
275 Hillside Ave. Williston Park, N.Y. 11596

November 1985
TRoDUCING NEMAL ASTROSERVICE
GUARANTEED SAME DAY SHIPMENT OR WE PAY THE FREIGHT ON ORDERS OF $100 OR MORE FOR STOCK ITEMS RECEIVED PRIOR TO 12 NOON EASTERN TIME.

Factory Authorized Distributor for
COLUMBIA ELECTRONIC CABLES
DIVISION CAROL CABLE COMPANY

COAXIAL CABLES
Over 75 types in stock, available in full roll or cut to order. Nemal offers cable made to both military as well as commercial specifications including Teflon cables, Silver plated cables and high power RF cables.

MULTI CONDUCTOR CABLES
Large inventory of both shielded and non-shielded types from 2 to 120 conductor and from 10 to 24 Gauge. Jacket types available for specific applications including PVC, Polyethylene, and neoprene. Complete Columbia line.

SATELLITE CONTROL CABLE
ACTUATOR CABLES

<table>
<thead>
<tr>
<th>TYPE 4</th>
<th>TYPE 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - R66/U 18 Gauge, 96% Copper Shield</td>
<td>2 - R66/U 18 Gauge, 96% Copper Shield</td>
</tr>
<tr>
<td>2 @ 12 Gauge</td>
<td>2 @ 12 Gauge</td>
</tr>
<tr>
<td>3 @ 18 Gauge</td>
<td>3 @ 18 Gauge</td>
</tr>
<tr>
<td>4 @ 20 Gauge</td>
<td>Shielded plus Tinned Copper</td>
</tr>
<tr>
<td>Shielded plus Tinned Copper</td>
<td>Drain Wire</td>
</tr>
<tr>
<td>3 @ 22-Gauge Shielded plus Tinned Copper</td>
<td>Drain Wire</td>
</tr>
</tbody>
</table>

Direct Burial Black Polyethylene Jacket

- $79c FT
- $89c FT

Call for 1000 FT pricing

SATELLITE CONTROL CABLE SPECIALS

- RG8/U mil spec 96% copper shield polyethylene: $29/100’
- RG8/U (EQ Belden 8214) 96% copper shield foam: $31/100’
- RG58/U mil spec 96% copper shield polyethylene: $10/100’
- RG62A/U mil spec 96% copper shield 93 ohm: $14/100’
- RG213/U mil spec 96% copper shield noncontam: $36/100’
- RG214/U tinned copper-double shield: $65/100’

NEMAL ELECTRONICS INTL., INC.
12240 N.E. 14th Ave., No. Miami, FL 33161
Telephone: (305) 893-3924
TELEX 532362

*COMPLETE MULTICONDUCTOR LINE
*PRICING AVAILABLE FOR ALL QUANTITIES

*Also available Complete line of top quality connectors and SMATV equipment
FRANCHISED DISTRIBUTOR — KINGS CONNECTORS
Authorized Distributor: Amphenol, Blonder-Tongue, Cable Wave Systems, Tyton, B&K

Call or write for complete pricing
Butternut HF-2V vertical antenna

About seven years ago, Butternut burst on the scene with one of the first "new" antenna ideas for the Amateur market. Their HF-5V was a five-band, no-trap antenna that covered 80-10 meters. I was one of the first to get one for review and was very much impressed with its performance. In head-to-head competition with comparable antennas, the Butternut always was at least one S-unit stronger during on-the-air tests. Owners of Butternut's current model, the HF-6V, have told me that it does equally well.

Recognizing that the six-band HF-6V was a little short for 80 and 40 meters and the fact that the high bands are going to be at best marginal for the next few years, Butternut modified their basic antenna design to optimize performance on 80 and 40 meters. The net result is the HF-2V antenna. The HF-2V incorporates all of the design features of the HF-6V — stainless steel hardware, T-6061 aluminum tubing, for strength and a double-walled base section for even more structural integrity and no traps.

the antenna

As with any antenna project, the first task was to read the instruction manual from cover to cover and take a full inventory of all the parts and hardware. All you need to assemble the antenna is a blade screwdriver, pliers, and a knife. A set of nut drivers would also be handy.

Assembly is straightforward and should only take an hour or so to accomplish. Identification of parts and hardware is easy if you use the schematic diagram that comes with the unit. The antenna is constructed of telescoping aluminum with sections held together with stainless nuts and bolts.

The antenna is loaded four feet from the base with an L/C combination made of very heavy duty aluminum wire and high voltage transmitting mica caps. Since the antenna is almost a full quarter wave on 40, very little of the 40-meter coil is used to tune the antenna. Should there be too much inductance for 40, a shorting strap is provided. The antenna is impedance matched at the base with an adjustable coil.

about radials

A lot of fuss is made about radials for vertical antennas and rightly so. Many of those who install verticals constantly complain that the performance is less than was expected. In a major-
well as on 40 meters and have been quite impressed with its performance. On 80 the antenna has performed as well as my 1/4-wave sloper, and actually outperformed it in certain directions and conditions. When Ron Wright was on Tonga, A36E, I was able to work him through a fair-sized pileup without too much difficulty. Not being a fan of 40 meters, my operating experience there is admittedly spotty. But this antenna has performed very well and I’ve been able to work just about everyone I called.

The Butternut HF-2V is the perfect antenna for those who want good low band performance without investing a lot of time and money installing a larger antenna. It’s performance is comparable with a number of other antennas, and HF-2V owners will get years of excellent results with this antenna.

It’s interesting to note that the recent DXpedition by the Texas DX Society took a Butternut HF-2V to the island of Desesheo. Used with the optional TBR-160, it accounted for thousands of contacts on 80 and 160. The expedition members have reported that the antenna was a breeze to set up and performed flawlessly. I remember that during that operation, night after night, they came pounding through with perfectly Q-5 signals on 160.

**specifications**

- **weight**: 131 pounds/5.9kg
- **height**: 32 feet/9.75 meters
- **feedpoint impedance**: 50 ohms
- **VSWR at resonance**: 1.5:1 over a suitable ground
- **VSWR < 2:1**: 65 kHz on 80, full band on 40
- **power rating**: 2 kW PEP/1 kW CW (less with TBR-160)
- **wind no ice**: 80 MPH/125 kph when properly guyed

---

**MFJ-204 antenna bridge**

The MFJ-204 Antenna Bridge is designed to do three basic tasks: measure antenna impedance, measure resonant frequency, and to tune antenna tuners “off the air.” It’s a handy piece of test equipment that every ham should have. There are several reasons that an antenna bridge is a much more versatile tool than its cousin the noise bridge. The noise bridge is basically a wideband oscillator that can be used to roughly determine resonant frequency or impedance of an antenna. I say “roughly” because the wideband oscillator is difficult to use, is imprecise and can sometimes give misleading results. The antenna bridge, on the other hand, has a tunable oscillator that can be set to the precise frequency you want to work on. The MFJ 204 covers 1.6-2.5, 3.4, 7-11, and 13-30 MHz so you get full coverage of all HF Amateur Radio bands.

To measure antenna impedance, the first thing you do is set the oscillator to the frequency you want to work on. This is done by loosely coupling the antenna bridge to your receiver and listening for the beat note. You then connect the antenna bridge to the antenna to be measured and adjust the resistance control for a dip on the antenna bridge’s meter. Once you get this dip, you flip the bridge over and read the resistance from the factory-calibrated chart on the back of the unit. On my 160 vertical antenna, I measured an impedance of 35 ohms, just about where it should be.

Using the antenna bridge to both measure resonant frequency and tune an antenna tuner is pretty much the same process. When used with an antenna tuner, the antenna bridge eliminates one of the most annoying aspects of the hobby—the ubiquitous and infamous “tuner-upper.”

The MFJ 204 measures 2.1/2 x 2 x 7 inches and weighs just about a pound. It will run off a 9-volt battery or an optional 110-volt AC power supply. It’s covered by the standard MFJ 12-month warranty and should give many years of good, reliable service.

I’ve since used the antenna bridge on several antenna projects and have enjoyed its utility. As long as I can keep the review unit, I think I’ll let the noise bridge gather dust.

---

**computer interface**

The Computer Patch Model CP-100 Interface is a complete terminal unit for Morse, Baudot, ASCII, and AMTOR. It will interface a computer running communications software via TTL levels (RS-232 optional) to your radio. With the optional current loop provisions, the CP-100 can be used with a mechanical teleprinter also. The tuning indicator is a ten-segment bargraph featuring discriminator-type operation which graphically shows selective-fading and is ideal for AMTOR use (tuning ‘scope outputs are also available). The CP-100 also features a front panel squelch control which inhibits data to the computer when no signal is present (thus preventing print when receiving noise). Front panel selec-
20 MHz DUAL TRACE OSCILLOSCOPE
Unmatched quality at an unbeatable price, the Ramsey oscilloscope compares to others costing hundreds more. Features include a completely transistorized design, high-speed sampling capability, and a built-in automatic line-frequency generator. For general checking, TV trouble shooting, and wave-form measurements.

Price: $399.95

DIGITAL OSCILLOSCOPE
Unmatched performance with a broad bandwidth, high sensitivity, and high resolution. For general troubleshooting, TV trouble shooting, and wave-form measurements.

Price: $459.95

NEW RAMSEY 1200 VOM MULTITESTER
Compact and reliable, designed to service a wide variety of equipment. Features include: 
- 19 MHz bandwidth
- Universal scale
- ±0.1% accuracy
- Built-in thermometer
- 1 percent accuracy
- 2.5 percent accuracy
- Miniature calibrator
- High-impact plastic case

Price: $199.95

DIGITAL MULTITESTER
A versatile bench top counter with optional receiver frequency adapter, which turns the CT-50 into a digital readout for most any receiver.

Price: $169.95

ACCESSORIES FOR RAMSEY COUNTERS
- Telescopic whip antenna—BNC plug: $8.95
- High impedance probe, light loading: $10.95
- Low-pass probe, audio use: $13.95
- Tilt ball, for CT-70, 90, 125: 3.95

More Details? CHECK-OFF Page 142
Iron Powder and Ferrite
TOROIDAL CORES

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

Small Orders Welcome
Free ‘Tech-Data’ Flyer

AMIDON
Associates Since 1963

12033 Otsego Street, North Hollywood, Calif. 91607

In Germany, Elektronikladen, Wilhelm - Mellies Str 88 4930 Detmold 18, West Germany
In Japan, Teshiurak Electronics Company, Ltd 1 F 9, 2 Chome Naka Kanda, Chiyoda-ku, Tokyo, Japan

For the best buys in town call:
212-425-7700

Los Precios Mas Bajos en
Nueva York

TIME
November 1985

Iron Powder and Ferrite
TOROIDAL CORES

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

Small Orders Welcome
Free ‘Tech-Data’ Flyer

AMIDON
Associates Since 1963

12033 Otsego Street, North Hollywood, Calif. 91607

In Germany, Elektronikladen, Wilhelm - Mellies Str 88 4930 Detmold 18, West Germany
In Japan, Teshiurak Electronics Company, Ltd 1 F 9, 2 Chome Naka Kanda, Chiyoda-ku, Tokyo, Japan

For the best buys in town call:
212-425-7700

Los Precios Mas Bajos en
Nueva York

TIME
November 1985

new division

Nemal Electronics International has opened a new value-added division specializing in cable assemblies for the aerospace, data processing, and commercial markets.

With state-of-the-art production and test equipment, the new Nemal facility is capable of producing more than 1000 assemblies daily.

Nemal also maintains an extensive inventory of component parts and cables allowing for next-day delivery on a wide variety of RF and data cables, made and tested to exact customer requirements.

For additional information, contact Nemal Electronics International Inc., 12240 N.E. 14th Avenue, North Miami, Florida 33161.

Circle 8303 on Reader Service Card.

smart patch plus™

The new Smart Patch Model 5100 from C.E.S. combines the features of the original Smart Patch with an exciting new communications tool called “automatic remote.”

Installed in the home or office, model 5100 allows mobile or handheld radios the ability to make or receive telephone calls, as well as allow the operation of the base station in telephone fashion through the use of in-house telephones.

The base station radio can be selectively called by mobiles using touchtone encoders.

Special emergency features provide safety to those who face crisis while mobile. These features include EMERGENCY 911 AUTODIAL, as well as an included beeper box installed in the home or office that responds loudly to a user programmed code. A keylock on the front panel protects the user from unauthorized use.

Autopatch features include USER PROGRAMMABLE access codes, sophisticated toll restrict, and simplex operation, allowing the unit to work from base directly; no repeater is required. Only five connections to base station radio are required.

For further information, contact CES, Inc., P.O. Box 2930, Winter Park, Florida 32790.

Circle 503 on Reader Service Card.
Introducing... NAVAX
ON CALL
It's on duty when you're not.

OC-1 ONLY $59.95
Complete with Shipping/Handling USA

ON CALL is a complete selective call system so you don't have to monitor the frequency, or it can be used as a decoder for controlling equipment at the repeater site and at home.

Compare these features:
- 4 digit 16 tone sequential decoder programmable, 43,680 different codes.
- DTMF or ATI at 12-Volt D.C. operation.
- 1 AMP SPST relay output, momentary or latched for external paging device, such as Auto horn, tape recorder, speaker or audio etc.
- Flashing LED call indicator (Enables when your code has been accessed).
- Easy connection to any radio: "Reg. Trade Mark" or AT.
- Size 3.1 x 2.15 x 5 in.
- Can be used for clubs or emergency groups for help situations.

To Order Send
Check or Money Order To
MC/VISA Accepted
DEVELOPMENT
NY: Residents Add Sales Tax

CURRENT CORPORATION or Phone
Westmoreland, NY
1-315-733-3719

122

EXMET your source for Discounted Prime 6001-70201-16511 aluminum tubing and Rod that is stronger than steel and 1/3 the weight.

<table>
<thead>
<tr>
<th>OD &amp; Wall</th>
<th>Length</th>
<th>Price per Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/8&quot; x .065</td>
<td>12 ft</td>
<td>$12.50</td>
</tr>
<tr>
<td>7/8&quot; x .085</td>
<td>12 ft</td>
<td>$19.50</td>
</tr>
<tr>
<td>7/8&quot; x .085</td>
<td>12 ft</td>
<td>$21.75</td>
</tr>
<tr>
<td>1-1/16&quot; x .065</td>
<td>12 ft</td>
<td>$27.25</td>
</tr>
<tr>
<td>1-1/8&quot; x .041</td>
<td>12 ft</td>
<td>$33.00</td>
</tr>
<tr>
<td>1-1/8&quot; x .065</td>
<td>12 ft</td>
<td>$38.40</td>
</tr>
<tr>
<td>1-1/16&quot; x .065</td>
<td>12 ft</td>
<td>$48.00</td>
</tr>
<tr>
<td>1-1/2&quot; x .065</td>
<td>12 ft</td>
<td>$66.00</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>12 ft</td>
<td>$105.15</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$105.15</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$110.40</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$114.90</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$117.50</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$121.00</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$124.50</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$127.00</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$130.50</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$134.00</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$137.50</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$141.00</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$144.50</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$148.00</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$151.50</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$155.00</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$158.50</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$162.00</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$165.50</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$169.00</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$172.50</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$176.00</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$179.50</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$183.00</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$186.50</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$190.00</td>
</tr>
<tr>
<td>1-1/2&quot; x .125</td>
<td>24 ft</td>
<td>$193.50</td>
</tr>
</tbody>
</table>

Volume discounts on orders over $500.00. Other sizes of tubing and rod quoted upon request. Minimum order $50.00 tubing, $50.00 rod.

Policies: All prices FOB Tinsburg, OH. Payment is COD, or save COD charges by enclosing a check or money order with your order. OH residents add 5.1/2% sales tax.

Exmet, Inc.
2173 E. Aurora Rd., P.O. Box 117, Tinsburg, Ohio 44087
(714) 760-3622

The Commodore Ham Needs a Companion

Every Commodore Ham Needs a Companion!

From Jim Grubbs, KVEI.

The author of Commodore Post, Micro Wave Radio and Gateway to the World. QST Publishing recommends

THE COMMODORE HAM'S COMPANION

Includes:
- Over 80 sources for Commodore amateur radio software and hardware.
- A bibliography of over 60 magazine articles and resources about using Commodore machines in the ham shack.
- How to use your Commodore computer to join the pocket radio revolution.
- Where to find specialized programs for such things as slow scan television, satellite tracking and more.
- How to realize a dramatic increase in speed without learning machine language programming.
- Why the Commodore machines are the easiest to program.

14 chapters / 160-page paperback

Price: $15.95 or $25.00 First Class shipping and handling. Mastercard and Visa accepted.

P.O. Box 3042 • Springfield, IL 62706

A. Microwave Associates 10 GHz Gunnplexer. Two of these transceivers can form the heart of a 10 GHz communication system for voice, data, video or data transmission, not to mention mountaintop DXing! MAF7141-1 (pair of 10 mW transceivers) $251.95. Higher power units (up to 200 mW) available. B. Microwave Associates 24 GHz Gunnplexer. Similar characteristics to 10 GHz unit. MAF7120-2 (pair of 20 mW transceivers) $799.20. This support module is designed for use with the MAF7141 and MAF7830 and provides all of the circuits for a full duplex audio transceiver system. The board contains a low-noise, 30-MHz FMCW receiver, modulators for voice and FMCW operation, Gunn diode regulator and varactor supply. Meter outputs are provided for monitoring received signal levels, discriminator output and varactor tuning voltage. RMF120Y assembled and tested $1195.95. C. Complete, ready to use communication system for voice or FMCW operation. Ideal for repeater linking. A power supply capable of delivering 15 volts to +250 mA (for a 10 mW version), microphone, and headphone audio input/mediator are the only additional items needed for operation. The Gunnplexer can be removed for remote mounting to a tower or 2 or 4 foot parabolic antenna. TR100A (10 GHz, 10 mW) $999.95. Higher power units available. TR24GA (24 GHz, 20 mW) $659.95. Also available: horn, 2 and 4 foot parabolic antennas, Gunn, varactor and detector diodes, search and lock systems, oscillator modules, waveguide, flanges, etc. Call or write for additional information. Let ARR take you higher with quality 10 and 24 GHz equipment!
LEARN ALL ABOUT TROUBLESHOOTING MICROPROCESSOR-BASED EQUIPMENT AND DIGITAL DEVICES

Attend this 4-day seminar and master the essentials of microprocessor maintenance. Gain a firm understanding of microprocessor fundamentals and learn specialized troubleshooting techniques. Fee is $695.00.

CURRENT SCHEDULE
- Indianapolis, IN — November 12-15
- Oklahoma City, OK — December 3-6
- San Antonio, TX — December 10-13

MICRO SYSTEMS INSTITUTE
Garrett, Kansas 66032
(913) 898-4695

AMATEUR RADIO REPAIRS
SHOP OWNERS —
Interested in more work? Major manufacturer will establish service center nationwide. Well-equipped shop with qualified two-way Tech and accessibility to UPS are required.

If you would like to increase your shop’s income, please list your qualifications and reply care of:

Box 498
Greenville, NH 03048

SAVE YOUR EARS
WITH THIS HANDY SIGNAL ENHANCER

Hildreth Engineering
936 Azalea Drive
Sunnyvale, CA 94086

Tell ‘em you saw it in HAM RADIO!
Uncle Ben says...

"I give you much more than just the lowest price...

When you get that exciting new piece of equipment from me, you know you are going to be completely happy... I see to it, personally! I also give you earliest delivery, greatest trade-in allowances, my friendly assistance in every possible way.

Just ask any of the many thousands of hams all over the world who have been enjoying my friendly good service for over a half a century. 73, Uncle Ben, W2SOH

CALL ME...
(516) 293-7995

HARRISON
HAS THEM ALL!
KENWOOD

WRITE ME...
For my prompt, personal reply.

SEE ME...
At one of the world's largest Ham Supply Centers!

Kenwood TH21AT, 31AT, 41AT

Kenwood TS-430S

Kenwood TS-940S

Kenwood TS-711A (2m)
TS-811A (70 cm)

Kenwood TR-2600, TR-3600

HARRISON RADIO
2263 Route 110 (at Smith St.)
E. Farmingdale, NY 11735
1-(516) 293-7995

More Details? CHECK—OFF Page 142

November 1986
### California

C & A ROBERTS, INC.
18511 HAWTHORN BLVD.
TORRANCE, CA 90504
213-370-7451
24 Hour: 800-421-2258
Not The Biggest, But The Best — Since 1962.

FONTANA ELECTRONICS
8628 SIERRA AVENUE
FONTANA, CA 92335
714-822-7710
714-822-7725
The Largest Electronics Dealer in San Bernardino County.

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

### Connecticut

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

### Delaware

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

DEL CASTLE 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.

### Hawaii

HONOLULU ELECTRONICS
619 KEEAUMOKU STREET
HONOLULU, HI 96814
(808) 949-5564
Serving Hawaii & Pacific area for 53 years.

### 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
808 NORTH MAIN STREET
EVANSVILLE, IN 47710
812-422-0231
Discount prices on Ten-Tec, Cubic, Hy-Gain, MFJ, Azden, Kantronics, Santec and others.

### Massachusetts

James Millen Components by
ANTENNAS ETC.
16 HANSOM ROAD
ANDOVER, MA 01810
617-475-7831
Bezels, binding posts, capacitors, condensers, chokes, coils, ceramics, H.V. connectors, plate caps, hardware knobs, dials, scopes and grid dippers. Inquire SASE or visit.

### 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 Jersey

KJ1 ELECTRONICS
66 SKYTOP ROAD
CEDAR GROVE, NJ 07009
(301) 239-4389
Gene K2KJ1
Maryann K2RVH

### 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.

---

**Dealers:** YOU SHOULD BE HERE TOO!
Contact Ham Radio now for complete details.
AMATEUR ELECTRONIC SUPPLY
28940 EUCLID AVE.
wickliffe, OH (CLEVELAND AREA) 44092
216-585-7368
Ohio Wats: 1 (800) 362-0290
hours M-F 9:30-5:30, Sat. 9-3

UNIVERSAL AMATEUR RADIO, INC.
1280 AIDA DRIVE
REYNOLDSBURG (COLUMBUS), OH 43068
614-866-4267

HAMTRONICS, DIV. OF TREVOSE ELECTRONICS
4033 BROWNSVILLE ROAD
TREVOSE, PA 19047
215-357-1400

THE VHF SHOP
16 S. MOUNTAIN BLVD., RTE. 309
MOUNTAINTOP, PA 18707
717-474-0383
Lunar, Microwave Modules, ARCOS, Astron, KLM, Tama, Tonna-F9FT, UHF Units/Parabolic, Santec, Tokyo Hy-Power, Dentron, Mirage, Amphenol, Belden

SATELLITE TV
Buy from a ham and SAVE
ZTE Communications
Pocatello, Idaho
Complete System Packages are available at reduced prices. Call for quotes before you buy. Here are a few sample prices

- RECEIVERS - we pay UPS Shipping
Drake 324S with Down converter ........................ $290
Drake 424S with Down converter ........................ $418
Uniden UST 1000 with down converter .................. $235
Uniden UST 2000 with down converter .................. $235
Uniden UST 6000 with block down converter ......... $480
Uniden UST 7000 with BDC and 18 inch arm ......... $1008
STS SR-62$222
STS SR Block--$390
STS LSR with Actuator--$636
STS BDC--$99
JANEL BCR-2000 with Block down converter ......... $313
TOKI TR-99--$187
TOKI 150B with BDC--$292
- ANTENNAS - you pay shipping
Radyx 8.5 foot--$653
Radyx 10.5 foot--$632
Uniden 10.5 foot--$575

ZTE Communications is owned and operated by John Wilson, W2AUIW2VS. I am the only employee, I work out of my house, which means lower prices for you!!

Availabilty and prices are subject to change. Call John AFTER 5 PM mountain time. Telephone 1-208-237-1237 after 5 pm, no collect calls

AMATEUR ELECTRONIC SUPPLY
4826 W. FOND DU LAC AVE.
MILWAUKEE, WI 53216
414-442-4200
Wisc. Wats: 1 (800) 242-5195

Wisconsin

AMATEUR ELECTRONIC SUPPLY
4826 W. FOND DU LAC AVE.
MILWAUKEE, WI 53216
414-442-4200
Wisc. Wats: 1 (800) 242-5195

Outside Wisc: 1 (800) 358-0411
M-F 9-5:30
Sat 9-3

NEW NOW! FREE!
Rush me my copy of the Dick Smith Catalog. I enclose $1 to cover shipping.

Name ...........................................
Address ......................................
City ...........................................
Zip ...........................................

Dick Smith Electronics Inc.
P.O. Box 2341 Redwood City CA 94063

November 1986
NEW JERSEY: The 4th annual Jersey Shore Ham/Circuit/ Electronic Market, open November 3, 9 AM to 3 PM, Newport Civic Center, Neptune City, New Jersey. Tables $20 to $50; XYLs free; refreshments available. Table $8. Sales talk at 3:30 PM. Send payment to P.O. Box 192, West Long Branch, NJ 07764. (201) 222-3009.

LOUISIANA: The Twin City Hams are sponsoring a Hamfest, Saturday, November 9, West Monroe Convention Center, North 7th Street, West Monroe, LA. From 9 AM to 4 PM. Free swap tables. Amateur radio exams will be given. Talk on GO-5255 simplex. (318) 322-9933.

MASSACHUSETTS: The MIT UHF Repeater Association and the MIT Radio Society offer monthly Hamfests. The next one is on Wednesday, November 20, 7 PM. MIT room 1-134, 77 Mass Ave., Cambridge, MA. Reservations requested 2 days in advance. Contact Don Hellinger at (617) 253-5800/646-1641. Fee $4.00. Bring copy of current license, two forms of picture ID and complete form T-1000 from FCC in Boston (233-6609).

WISCONSIN: The Milwaukee Repeater Club is proud to sponsor the “6:01 Friendly Fest” on Sunday, November 24, Sycamore, WI. Say “Hi” to your fellow hams. For information: (315) 334-8739.

ILLINOIS: The Chicago Amateur Club will hold its annual Hamfest, November 24, 6 PM to 10 PM, Edgebrook Golf Course Field House, 6100 N. Central Ave., Chicago. For information: (312) 545-3822.

INDIANA: The Allen County Amateur Radio Technical Society will hold its annual Hamfest, Sunday, November 10, 8 AM to 4 PM, Allen County Memorial Coliseum, Coliseum Rd., Fort Wayne, IN. Table rentals available. $25.00 AC power extra. Premium tables with AC $20.00 each. Admission $3.00 advance, $5.00 door. Children under 11 free. Ladies' activities, games, banquet Saturday night. Nearby motels and restaurants. VE exams Saturday, November 9, advance registration available on request. Information: (219) 428-8888. For information or reservations: ACARTS Hamfest, PO Box 10342, Fort Wayne, IN 46835.

MICHIGAN: The Oak Park High School Electronics Club presents the 8th annual Swap N Shop, December 1, Oak Park High School, Oak Park, 4 PM to 7 PM. Admission $2.00. After 12:00 PM, $3.00. (313) 261-3169. Information: John Germain, Oak Park High School, 13701 Oak Park Blvd., Oak Park, MI 48225 or call (313) 996-2875.

OHIO: The Massillon ARC will sponsor “Auctionfest 85,” November 24, Mission K of C Hall, off Rt. 21, 8 AM to 5 PM. Sellers setup 7 AM. Admission $2.50 and $3.50 at the door. Table available at $7.00 per space. Refreshments and sit-down dinner. Free parking. Auction 11 AM. Talk in on W8NR, 147.765. (330) 773-1342. For information and reservations: MARC, PO Box 73, Massillon, OH 44646. (313) 261-3169.

NEW YORK: 7th annual "Ham-Central", Sunday, December 1, Main Hall, Lutheran School, Monches Rd., St. James, Long Island. Doors open 8:30 AM and run until 2 PM. Food and refreshments available. Information: (516) 694-1055. For reservations and information call after 6 PM Tom Yarmus, KN2GZ (516) 981-2709 or Andy Feldman, W62F KN (516) 988-3586.

FIRST US YL WINS SWEDISH AWARD. Emily Maytan, A2C, of Yonkers, NY, has become the first American YL to win the "150 SM" award for contacted countries. Only 659 other hams worldwide have previously won this award.

OPERATING EVENTS — "Things to do . . ." The Armed Forces Amateur Radio Network (AFARN) will operate from 0000Z November 10 to 2400Z November 11 to commemorate Veterans Day. CE: 80, 40, 20, 15, 10 meters; CW on 40 meters. Certificate available for contact with member. Send $10 to AFAF at WB9JVR, 901 W. Bosworth, Chicago, IL 60622. (312) 673-1967.

The Royal Jordanian Amateur Radio Association has announced plans for JY5O, a two-week celebration marking the 50th anniversary of King His Majesty, King Hussein, of Jordan. Plans include November 7 through November 21. For more information, send 300 free SWL certificates to 200 Free Swiss Licenses, P.O. Box 233, Amman, Jordan.

GLITCHWITCH — a robust, easily used transmission suppression network. It can be used to suppress spurious emissions in an AC powered receiver or transmitter. Glitchwitch is a simple, easy-to-use device that provides protection for equipment and data. The filter protects against both line-to-ground and line-to-line spikes and does not require a safety ground. Glitchwitch. Guard your gear.

QUADS — TOWERS — QUADS — TOWERS — QUADS

THE MEADOWLAKE Corp.
Dept. H, P.O. Box 497, Northport, New York 11768

NEW EQUIPMENT — RE-CONDITIONED AND LAB CALIBRATED

URM-25 SIGNAL GENERATOR, 10 KHZ TO 50 MHZ, lab calibrated, input 4.0 to +10 dBm, input 0 to 0 dBm, 50 ohm output, 0.5 to 0.01 V, 50 ohm output, 0.01 to 0.001 V.

URM-26 SIGNAL GENERATOR, 10 KHZ TO 50 MHZ, lab calibrated, input 0 to 0.5 V, lab calibrated, input 0 to 0.1 V, 50 ohm output, 0.01 to 0.001 V, 50 ohm output, 0.001 to 0.0001 V.

HP606A SIGNAL GENERATOR, 50 KHZ TO 65 MHz, lab calibrated, input 0.1 to 3 V, 50 ohm output, 0.001 to 0.0001 V, 50 ohm output, 0.0001 to 0.00001 V, 50 ohm output, 0.00001 to 0.000001 V.

HP606C SIGNAL GENERATOR, 10 KHZ TO 480 MHz, lab calibrated, input 0.1 to 3 V, 50 ohm output, 0.001 to 0.0001 V, 50 ohm output, 0.0001 to 0.00001 V, 50 ohm output, 0.00001 to 0.000001 V.

HP614A SIGNAL GENERATOR, 900 TO 3000 MHZ, lab calibrated, input 0.1 to 3 V, 50 ohm output, 0.001 to 0.0001 V, 50 ohm output, 0.0001 to 0.00001 V, 50 ohm output, 0.00001 to 0.000001 V.

HP614A SIGNAL GENERATOR, 1.8 TO 4.2 GHZ, lab calibrated, input 0.1 to 3 V, 50 ohm output, 0.001 to 0.0001 V, 50 ohm output, 0.0001 to 0.00001 V, 50 ohm output, 0.00001 to 0.000001 V.

HP614B SIGNAL GENERATOR, 3.8 TO 7.6 GHZ, lab calibrated, input 0.1 to 3 V, 50 ohm output, 0.001 to 0.0001 V, 50 ohm output, 0.0001 to 0.00001 V, 50 ohm output, 0.00001 to 0.000001 V.

HP614C SIGNAL GENERATOR, 7.6 TO 15.0 GHZ, lab calibrated, input 0.1 to 3 V, 50 ohm output, 0.001 to 0.0001 V, 50 ohm output, 0.0001 to 0.00001 V, 50 ohm output, 0.00001 to 0.000001 V.

SG-557/URM-52 SIGNAL GENERATOR, 3.8 TO 7.6 GHZ, lab calibrated, input 0.1 to 3 V, 50 ohm output, 0.001 to 0.0001 V, 50 ohm output, 0.0001 to 0.00001 V, 50 ohm output, 0.00001 to 0.000001 V.

SG-130 AIRCRAFT VOR/DME SIGNAL GENERATOR, 100 KHZ TO 1000 KHZ, lab calibrated, input 0.1 to 3 V, 50 ohm output, 0.001 to 0.0001 V, 50 ohm output, 0.0001 to 0.00001 V, 50 ohm output, 0.00001 to 0.000001 V.

JENR608 SWEEP GENERATOR, lab calibrated, 0.5 TO 1200 MHZ, 0.5 TO 500 MHZ, lab calibrated, input 1000 TO 500 MHZ, 250 TO 100 MHZ, lab calibrated, input 1000 TO 500 MHZ, 250 TO 100 MHZ, lab calibrated, input 1000 TO 500 MHZ, 250 TO 100 MHZ.

HP8551B/951B SIGNAL GENERATOR, lab calibrated, input 1000 TO 500 MHZ, 250 TO 100 MHZ, lab calibrated, input 1000 TO 500 MHZ, 250 TO 100 MHZ, lab calibrated, input 1000 TO 500 MHZ, 250 TO 100 MHZ.

THE MEADOWLAKE Corp.
Dept. H, P.O. Box 497, Northport, New York 11768

CHARGE YOUR CLASSIFIED ADS to your MC or VISA write or call HAM RADIO MAGAZINE Greenville, NH 03048 (603) 878-1441
new components and techniques for RF designers

When manufacturers offer new equipment, the resulting design is a complex function of expected market, engineering hours, and the availability of necessary technology and components. Fortunately for designers of RF equipment, new components are rapidly being developed to keep pace with the boom in telecommunications.

Among the more exciting developments in the semiconductor industry is the emergence of commercial Gallium Arsenide (GaAs) ICs. Both analog and digital functions are being implemented. The digital functions — prescalers, counters, memories, and shift registers — are capable of operation at 2 to 3 GHz, allowing the design of phase locked loops and frequency synthesizers at low microwave frequencies using only a few chips. The required interstage amplifiers are now also available as off-the-shelf GaAs IC amplifier blocks (Microwave Monolithic Integrated Circuits, or MMICs) covering octave (2:1) bandwidths with 10 to 30 dB of gain. These gain blocks are available from 50 MHz to over 18 GHz. Prices are high right now but we can expect dramatic reductions as sales volume increases.

In the realm of discrete devices, the High Electron Mobility Transistor (HEMT) is just now ready to emerge commercially. This improved class of GaAs FET can provide noise figures of about 1 dB at almost 10 GHz, with 8 to 10 dB of gain! Several companies have developed low-cost ICs based on HEMT concepts which would integrate large portions of complex microwave receivers into a single chip.

One of the most fundamental concepts in modern telecommunications is frequency translation, or mixing. Most receivers and transceivers have several conversions from one frequency or band to another. An important characteristic of the translation device is its ability to minimize the generation of unwanted products. Mixer development has now advanced to the point where we have image rejection mixers (the image is automatically suppressed by about 20 dB) well into the microwave region. There is a similar class called “termination insensitive mixers” that perform well even with highly reactive loads. The development of complex GaAs MMICs will soon permit the implementation of active frequency converters with high dynamic range, selectable image characteristics, and conversion “gain” instead of an insertion loss. We should see these devices — up to 4-5 GHz — readily available in the not-too-distant future.

Plain old resistors and capacitors are taking on a new look. Chip- and surface-mounted components with superb characteristics well into the microwave region are now available. The fact that most modern circuits operate at low voltage and power levels means that spacings and insulation can be very small. This in turn reduces the overall size of the component, and hence its parasitic inductance and capacitance. This trend will continue to provide more components with nearly perfect RF characteristics in the VHF/UHF and low microwave ranges.

Even coaxial cables continue to undergo substantial improvement. Semi-rigid coax with foil shielding, foam dielectric, and non-contaminating jacket is available at very affordable prices. This type of cable is usable to 500 MHz with losses of less than 0.1 dB/meter. Small diameter hardline is now available to the UHF/Microwave enthusiast on the surplus market, thanks to the huge quantities used by military and cable TV applications. These cables are nearly the ultimate in transmission lines; they boast very low losses well into the microwave region, 100 percent shielding, and closed-cell foam insulations with permanent water intrusion barriers. Properly installed, these cables can have a useful life of more than 20 years.

Some of the least heralded advances in component design have taken place in the realm of interstage filters. Multipole ceramic and crystal filters with flat passbands, steep skirts, and low spurious responses have become available at remarkably low prices. Made for virtually all of the standard IF frequencies (455 kHz, 10.7, 21.4, 30, and 45 MHz), these marvelous filters, buried deep in our equipment, give us selectivity and freedom from unwanted responses that would have been a dream just a few years ago.

The advances continue. Monolithic crystal filters with narrow bandwidths (5-15 kHz) have been fabricated at over 250 MHz. Surface Acoustic Wave (SAW) filters with good characteristics up to 1.5 GHz are now available commercially. The availability of these higher frequency filters means that next-generation equipment can use up-conversion (IF higher than the incoming signal) to give us image-free, single conversion (large dynamic range) performance.

As the spectrum becomes more intensely populated, we are fortunate that component designers and manufacturers are investing in the technology to assure that there will be room for all of us.
THE STANDARD OF EXCELLENCE

Definitely Superior!

AZDEN PCS-5000

COMMERCIAL GRADE

UNPRECEDENTED WIDE FREQUENCY RANGE: Covers 140.000-153.000 MHz in steps that can be set to any multiple of 5 kHz up to 50 kHz.

CAP/MARS/NAVY MARS BUILT IN: The wide frequency range facilitates use of CAP and ALL MARS FREQUENCIES including NAVY MARS.

TINY SIZE: Only 2 inches high, 5½ inches wide and 7½ inches deep!

MICROCOMPUTER CONTROL: Gives you the most advanced operating features available.

UP TO 11 NONSTANDARD SPLITS: COMPARE this with other units!

20 CHANNELS OF MEMORY IN TWO SEPARATE BANKS: Retains frequency, offset information, PL tone frequency.

DUAL MEMORY SCAN: Scan memory banks separately or together. ALL memory channels are tunable independently.

COMPARE!

MEMORY SCAN LOCKOUT: Allows you to skip over channels you don’t want to scan.

TWO RANGES OF PROGRAMMABLE BAND SCANNING: Limits are quickly reset. Scan ranges separately or together with independently selective steps in each range. COMPARE!

BUSY SCAN AND DELAY SCAN: Busy scan stops on an occupied channel. Delay scan provides automatic auto-resume.

DISCRIMINATOR CENTERING (AZDEN EXCLUSIVE PATENT): Always stops on frequency desired when scanning.

PRIORITY MEMORY AND ALERT: Unit constantly monitors one memory channel for signals alerting you when channel is occupied.

LITHIUM BATTERY BACKUP: Memory information can be stored for up to 5 years even if power is removed.

FREQUENCY REVERSE: Allows you to listen to repeater input frequency.

ILLUMINATED KEYBOARD WITH ACQUISITION TONE: Keys are easily seen in the dark, and actuation is positively verified audibly.

CRISP, BACKLIT LCD DISPLAY: Easily read no matter what the lighting conditions!

DIGITAL S/RF METER: Shows incoming signal strength and relative transmitter power.

MULTI-FUNCTION INDICATOR: Shows a variety of operating parameters on the display.

FULL 16-KEY TOUCHTONE PAD: Keyboard functions as auto-patch when transmitting.

MICROPHONE CONTROLS: Up/down frequency control and priority channel recall.

PL TONE GENERATOR BUILT IN: Instantly program any of the standard PL frequencies into the microcomputer. COMPARE!

TRUE FM, NOT PHASE MODULATION: Unsurpassed intelligibility and audio fidelity. COMPARE!

HIGH/LOW POWER: Select 25 watts or 5 watt output — fully adjustable.

SUPERIOR RECEIVER: Sensitivity is better than 0.15 microvolt for 28th-quieting. Commercial-grade design assures optimum dynamic range and noise suppression. COMPARE!

DIRECT FREQUENCY ENTRY: Streamlines channel selection and programming.

OTHER FEATURES: Rugged, dynamic microphone, built-in speaker, mobile mounting bracket, remote speaker jack, and all cords, plugs, keys and hardware are included.

EXCLUSIVE DISTRIBUTOR DEALER INQUIRIES INVITED FOR YOUR NEAREST DEALER OR TO ORDER:

AMATEUR-WHOLESALE ELECTRONICS TOLL FREE...800-327-3102

8817 S.W. 129th Terrace, Miami, Florida 33176 Telephone (305) 233-3631 Telex: 80-3356

MANUFACTURER:

JAPAN PIEZO CO., LTD.

1-12-17 Kamirenjaku, Mitaka, Tokyo, 181 Japan

Telex: 761-2422452
Listed below are the page number and reader service number for each company advertising in this issue. To get more information on their advertised products, use the bind-in card found elsewhere in this issue, select the correct reader service number from either the ad or this listing, check off the number, fill in your name and address, affix a postage stamp and return to us. We will promptly forward your request to the advertiser and your requested information should shortly arrive. If the card is missing, send all the pertinent information on a separate sheet of paper to: ham radio magazine, Attn: Reader Service, Greenville, NH 03048.

**ADVERTISER’S INDEX AND READER SERVICE NUMBERS**

<table>
<thead>
<tr>
<th>READER SERVICE #</th>
<th>PAGE #</th>
</tr>
</thead>
<tbody>
<tr>
<td>107</td>
<td>17</td>
</tr>
<tr>
<td>112</td>
<td>81</td>
</tr>
<tr>
<td>204</td>
<td>137</td>
</tr>
<tr>
<td>143</td>
<td>87</td>
</tr>
<tr>
<td>185</td>
<td>127</td>
</tr>
<tr>
<td>145</td>
<td>88</td>
</tr>
<tr>
<td>126</td>
<td>138</td>
</tr>
<tr>
<td>144</td>
<td>98</td>
</tr>
<tr>
<td>116</td>
<td>50</td>
</tr>
<tr>
<td>153</td>
<td>97</td>
</tr>
<tr>
<td>106</td>
<td>36</td>
</tr>
<tr>
<td>217</td>
<td>135</td>
</tr>
<tr>
<td>174</td>
<td>116</td>
</tr>
<tr>
<td>104</td>
<td>4</td>
</tr>
<tr>
<td>197</td>
<td>134</td>
</tr>
<tr>
<td>156</td>
<td>105</td>
</tr>
<tr>
<td>190</td>
<td>130</td>
</tr>
<tr>
<td>188</td>
<td>128</td>
</tr>
<tr>
<td>163</td>
<td>110</td>
</tr>
<tr>
<td>183</td>
<td>126</td>
</tr>
<tr>
<td>111</td>
<td>36</td>
</tr>
<tr>
<td>105</td>
<td>28</td>
</tr>
<tr>
<td>170</td>
<td>114</td>
</tr>
<tr>
<td>220</td>
<td>58</td>
</tr>
<tr>
<td>194</td>
<td>133</td>
</tr>
<tr>
<td>152</td>
<td>97</td>
</tr>
<tr>
<td>156</td>
<td>114</td>
</tr>
<tr>
<td>191</td>
<td>131</td>
</tr>
<tr>
<td>189</td>
<td>129</td>
</tr>
<tr>
<td>172</td>
<td>128</td>
</tr>
<tr>
<td>159</td>
<td>109</td>
</tr>
<tr>
<td>186</td>
<td>127</td>
</tr>
<tr>
<td>124</td>
<td>61</td>
</tr>
<tr>
<td>206</td>
<td>139</td>
</tr>
<tr>
<td>208</td>
<td>130</td>
</tr>
<tr>
<td>181</td>
<td>126</td>
</tr>
<tr>
<td>108</td>
<td>22</td>
</tr>
<tr>
<td>218</td>
<td>139</td>
</tr>
<tr>
<td>178</td>
<td>122</td>
</tr>
<tr>
<td>117</td>
<td>50</td>
</tr>
<tr>
<td>118</td>
<td>57</td>
</tr>
<tr>
<td>128</td>
<td>58</td>
</tr>
<tr>
<td>199</td>
<td>134</td>
</tr>
<tr>
<td>171</td>
<td>114</td>
</tr>
<tr>
<td>129</td>
<td>134</td>
</tr>
<tr>
<td>114</td>
<td>107</td>
</tr>
<tr>
<td>214</td>
<td>46</td>
</tr>
<tr>
<td>163</td>
<td>61</td>
</tr>
<tr>
<td>140</td>
<td>79</td>
</tr>
<tr>
<td>115</td>
<td>48</td>
</tr>
<tr>
<td>175</td>
<td>118</td>
</tr>
<tr>
<td>139</td>
<td>78</td>
</tr>
<tr>
<td>149</td>
<td>91</td>
</tr>
<tr>
<td>189</td>
<td>129</td>
</tr>
<tr>
<td>158</td>
<td>139</td>
</tr>
<tr>
<td>106</td>
<td>78</td>
</tr>
<tr>
<td>213</td>
<td>Cover II</td>
</tr>
<tr>
<td>216</td>
<td>137</td>
</tr>
</tbody>
</table>

**PRODUCT REVIEW/NEW PRODUCT**

<table>
<thead>
<tr>
<th>READER SERVICE #</th>
<th>PAGE #</th>
</tr>
</thead>
<tbody>
<tr>
<td>302</td>
<td>130</td>
</tr>
<tr>
<td>156</td>
<td>129</td>
</tr>
<tr>
<td>104</td>
<td>132</td>
</tr>
<tr>
<td>304</td>
<td>130</td>
</tr>
<tr>
<td>300</td>
<td>132</td>
</tr>
</tbody>
</table>

*Please contact this advertiser directly.

(800) 755-7673

**CP-100**

SOLID REPUTATION

- Dual Channel Filtering
- 170, 425, 850-Hz Calibrated Shifts for Transmit and Receive Functions
- 75 to 1000 Hz Variable Receive Shift Range
- Discriminator Style Tuning Indicator
- Baud Rate Switch
- Built-in Speaker
- Input AGC
- Improved AM Detector
- Direct-coupled Automatic Threshold Correction
- Normal and Reverse FSK Outputs
- Current Loop Option
- 12 VDC Operation, 117 VAC Power Supply Included

Prices and Specifications Subject to Change Without Notice or Obligation

ADVANCED ELECTRONICS APPLICATIONS, INC.
P.O. Box C-2160, Lynnwood, WA 98036
TELEX: 152571 AEA INTL
(206) 775-5733

$329.95 AMOUNT

-142 November 1985

-120 - 210
Eureka!

We just struck gold with a miniature, high-quality and very reliable DTMF decoder at a rock bottom price of $59.95. Our DTD-1 will decode 5040, 4 digit codes with the security of wrong digit reset. It contains a crystal controlled, single chip DTMF decoder that works great in bad signal to noise environments and provides latched and momentary outputs. Why carry that heavy gear when its size is only 1.25 x 2.0 x .4 inches and it comes with our etched in stone, legendary, one year warranty.

Instead of sifting through the field...searching, use our super quick one day delivery and cash in on a rare find.

$59.95 each

COMMUNICATIONS SPECIALISTS
426 W. Taft Ave., Orange, CA 92665-4296
Local (714) 998-3021 • FAX (714) 974-3420
Entire U.S.A. 1-800-854-0547
THINGS TO LOOK FOR (AND LOOK OUT FOR) IN A PHONE PATCH

- A patch should work with any radio. AM, FM, ACSB, relay switched or synthesized.
- Patch performance should not be dependent on the T/R speed of your radio.
- Your patch should sound just like your home phone.
- There should not be any sampling noises to distract you and rob important syllables. The best phone patches do not use the cheap sampling method. (Did you know that the competition uses VOX rather than sampling in their $1000 commercial model?)
- A patch should disconnect automatically if the number dialed is busy.
- A patch should be flexible. You should be able to use it simplex, repeater aided simplex, or semi-duplex.
- A patch should allow you to manually connect any mobile or HT on your local repeater to the phone system for a fully automatic conversation. Someone may need to report an emergency!
- A patch should not become erratic when the mobile is noisy.
- You should be able to use a power amplifier on your base to extend range.
- You should be able to connect a patch to the MIC and EXT speaker jack of your radio for a quick and effortless interface.
- You should be able to connect a patch to three points inside your radio (VOL high side, PTT, MIC) so that the patch does not interfere with the use of the radio and the VOL. and SQ. settings do not affect the patch.
- A patch should have MOV lightning protectors.
- Your patch should be made in the USA where consultation and factory service are immediately available.

ONLY PRIVATE PATCH III GIVES YOU ALL OF THE ABOVE

BEWARE OF INFERIOR IMITATIONS

PRIVATE PATCH III
SIMPLEX SEMI-DUPLEX INTERCONNECT

With an amazingly low price, the all new PRIVATE PATCH III is the most powerful personal phone patch system available. You can use it simplex, repeater aided simplex (from your base) or semi-duplex (at the repeater). That's right, you will never have to buy another patch! PRIVATE PATCH III does it all! There are many new and important features which were formerly only available in our top commercial models.

With a flick of the new connect switch you can patch your friends on the repeater into the phone system. One of them may need to report an emergency!

No hassles with busy signals! If you call a number that is busy, just put your MIC down and relax. PRIVATE PATCH III will disconnect automatically.

The new CW ID keeps you completely informed as to patch status. ID occurs when you access and again when you disconnect. ID is also sent after toll call attempts, automatic disconnects, manual disconnect and when timeout is imminent. And of course your CW ID chip is free.

PRIVATE PATCH III does not interfere with the normal use of your base radio. A new audio pre-amp permits audio take off before the VOL. control. As a result, the VOL, anc squelch settings do not affect patch operation. Of course you can also connect PRIVATE PATCH III to the MIC and EXT speaker jacks as before.

A new digit counting system makes the toll restrict positive even in areas where you do not have to dial "I", first. A secret five digit code disables the toll restrict for one toll call Re-arm is automatic.

Additional new features: MOV lightning protection — Three digit access code (eg. 93434) — Spare relay position on board — Plus former features: 3/6 minute timeout timer — Digital fast VOX (pat. pend.) — 115 VAC supply — Modular Jack and cord plus much more!

Please write or call for our four page brochure to get the complete story.

Options:
- FCC approved coupler
- 12 VDC or 230 VAC power

Warranty? Yes, one full year!

DEALERS

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

COLES COMMUNICATIONS
San Antonio TX

ERICKSON COMMUNICATIONS
Chicago IL

HAM RADIO OUTLET
Anaheim CA, Burlington CA, Oakland CA, Phoenix AZ, San Diego CA, Van Nuys CA

HENRY RADIO
Los Angeles CA, Anaheim CA, Butler MO

JUNS ELECTRONICS
Culver City CA, Reno NV

MIAMI RADIO CENTER CORP.
Miami FL

Mikes ELECTRONICS
FL Lauderale, Miami FL

NAG DISTRIBUTING CORP.
Miami FL

PACE ENGINEERING
Tucson AZ

THE HAM STATION
Evansville IN

CANADA:
DOLLAR ELECTRONICS
Vancouver, BC

CONNECT SYSTEMS INCORPORATED
(213) 373-6813
23731 Madison St., Torrance, CA 90505

ONLY PRIVATE PATCH III GIVES YOU ALL OF THE ABOVE

BEWARE OF INFERIOR IMITATIONS
Celebrate your buying decision with the money you've saved.

When it comes to getting maximum HF performance for your dollar, the choice is clear. Yaesu's FT757GX.

Nowhere else will you find so many HF features packed into one compact, mobile-ready package. At a price that's got the competition baffled.

For starters, each 757 includes an electronic keyer. 600-Hz CW filter. AM and FM modes. AF speech processor. And a 25-kHz marker generator. All at no extra charge.

And working the DX has never been easier with dual VFOs, single-button VFO/memory swap for split-frequency operation, eight memories, and push-button quick memory and band scan.

The 757 also lets you listen from 500 kHz to 30 MHz with its high-performance general coverage receiver. The transmitter covers 160 through 10 meters, including the new WARC bands, with 100 watts output on sideband, FM and CW.

CW buffs will enjoy the delights of full QSK operation. Plus the massive heatsink and duct-flow cooling system allow continuous RTTY operation for up to 30 minutes. Use the FP-757HD heavy-duty power supply option for continuous-duty applications.

And of course, there's the 757's highly attractive price. It's the perfect way to get all the HF performance you desire, with money left over to apply toward other ham gear. Perhaps a power supply for base station use. An antenna or antenna tuner. Or whatever else makes your operation complete.

So ask your dealer today about Yaesu's FT757GX. The most celebrated HF price/performer on the air.

Yaesu Electronics Corporation
6851 Walden Way, Paramount
CA 90723 (213) 633-4007

Yaesu Cincinnati Service Center
9070 Gold Park Drive, Hamilton
OH 45011 (513) 874-3100
Digital DX-terity—that outstanding attribute built into every Kenwood TS-430S lets you QSY from band to band, frequency to frequency and mode to mode with the speed and ease that will help you earn that dominant DX position from the shack or from the mobile!

- Covers all Amateur bands 160 through 10 meters, as well as the new 30, 17, and 12 meter WARC bands. High dynamic range, general coverage receiver tunes from 150 kHz to 30 MHz. Easily modified for HF MARS operation.

- Reliable, all solid state design. Solid state design permits input power of 250 watts PEP on SSB, 200 watts DC on CW, 120 watts on FM (optional), or 60 watts on AM. Final amplifier protection circuits and a cooling fan are built-in.

- Memory channels. Eight memory channels store frequency, mode and band data. Channel 8 may be programmed for split-frequency operation. A front panel switch allows each memory channel to operate as an independent VFO or as a fixed frequency. A lithium battery backs up stored information.

- Programmable, multi-function scan.

- Speech processor built-in.

- Dual digital VFOs.

- VOX circuit, plus semi break-in with sidetone.

Optional accessories:
- PS-430 compact AC power supply
- SP-430 external speaker
- MB-430 mobile mounting bracket
- AT-130 compact antenna tuner covers 80-10 meters, incl. WARC bands
- AT-250 automatic antenna tuner covers 160-10 meters, incl. WARC bands
- TL-300A 2 kW PEP linear amplifier
- FM-430 FM unit
- YK-88C (500 Hz) or YK-88CN (270 Hz) CW filters
- YK-88SN (1.8 kHz) narrow SSB filter
- YK-88A (6 kHz) AM filter
- MC-42S UP/DOWN hand mic.
- MC-60A/80/85 deluxe desk mics.
- SW-2000/200A SWR/power meters
- SW-100A SWR/power/volt meter
- PC-1A phone patch
- HS-4, HS-5, HS-6, HS-7 headphones

TRIO-KENWOOD COMMUNICATIONS
1111 West Walnut Street
Compton, California 90220

KENWOOD
...pace-setter in Amateur radio