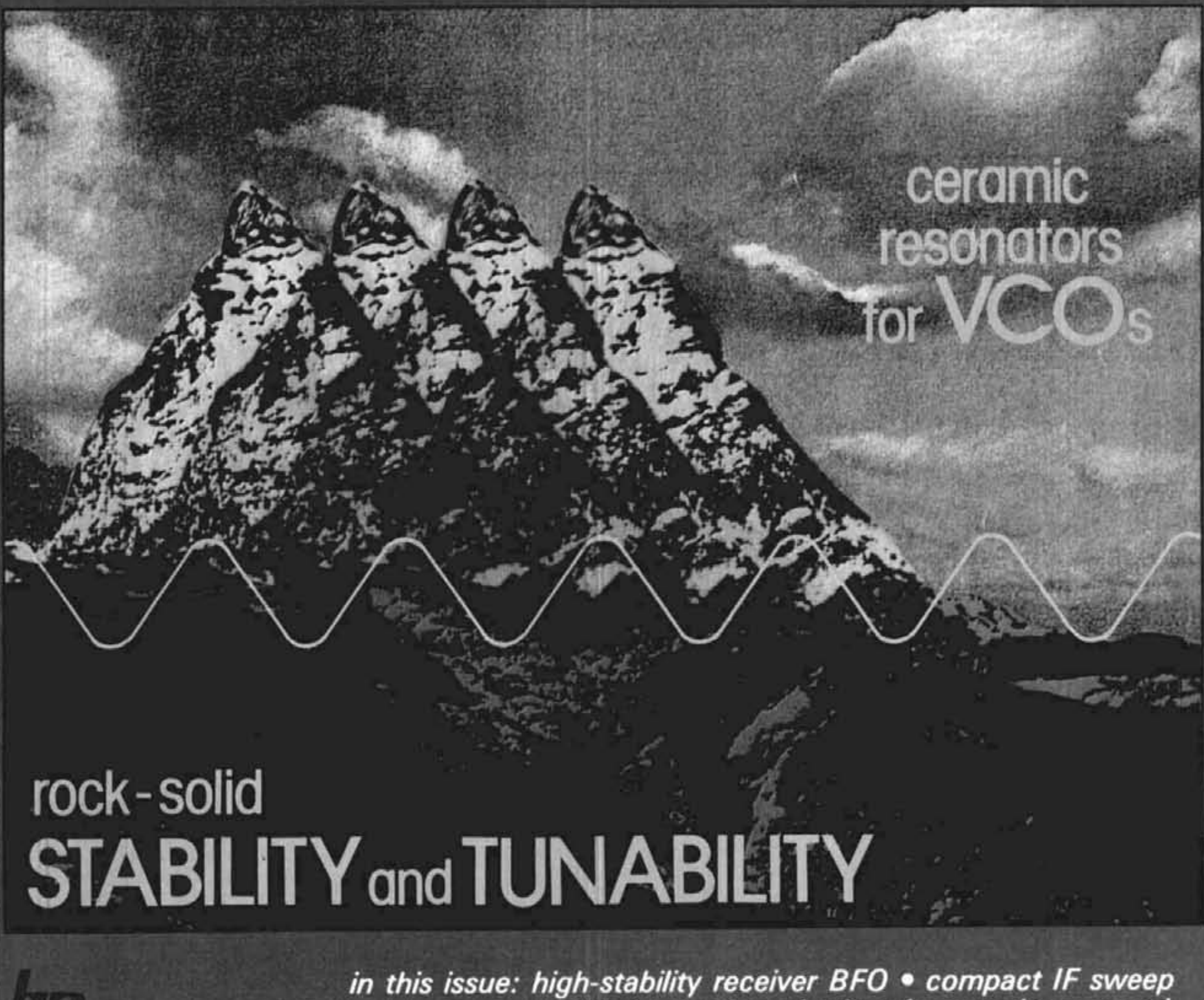
JUNE 1985 / $2.50

ham radio magazine



focus on communications technology

in this issue: high-stability receiver BFO • compact IF sweep generator • graphical selection of mixer frequencies • speed up your code • designing Yagis with the C-64 • inexpensive elevation indicator • automatic temperature control • wind your own transformers — inexpensively • plus W6SAI, W1JR, KØRYW, and the Guerri report

NEW!

ICOM HF Trans...

IC-735

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.

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.

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.

Simplified Front Panel

The large LCD readout and conveniently located controls enable easy operation, even in the mobile environment. Controls which require rare adjustment 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.

✓ 101

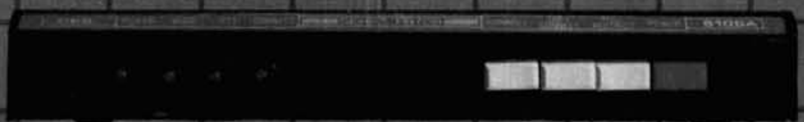
ICOM

First in Communications

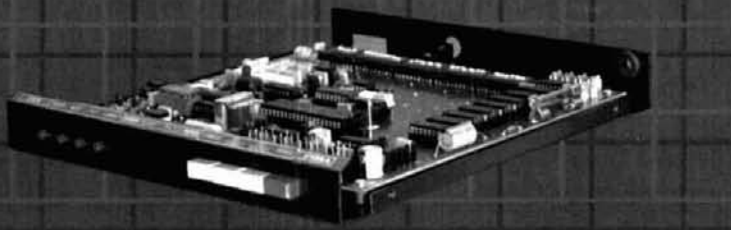
ICOM America, Inc., 2380–116th Ave NE, Bellevue, WA 98004 / 3331 Towerwood Drive, Suite 307, Dallas, TX 75234

All stated specifications are approximate and subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions. 735485

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, CW ID and much more.

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

What To Look For In A Phone Patch

The best way to decide what patch 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.

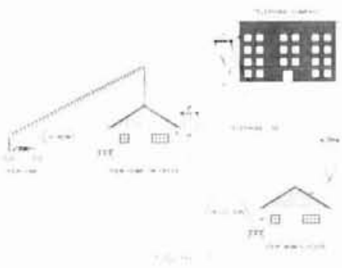
ONLY SMART PATCH HAS ALL OF THE ABOVE.

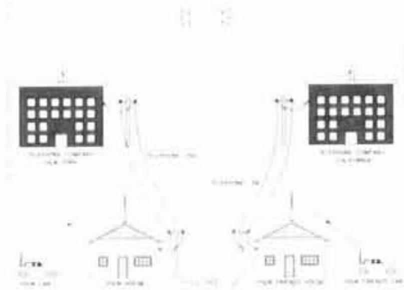
Now Mobile Operators Can Enjoy An Affordable Personal Phone Patch. . .

- 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!





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**

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...pacesetter in Amateur radio

"Digital DX-terity!"

TS-430S

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.
- **Superb interference reduction**
  Eliminate QRM with the IF shift and tuneable notch filter. A noise blanker supresses ignition noise. Squelch, RF attenuator, and RIT are also provided. Optional IF filters may be added for optimum interference reduction.
- **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 • AT-230 base station antenna tuner • 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 deluxe desk mic., with UP/DOWN switch • SW-2000 SWR/power meter • SW-100A SWR/power/volt meter • PC-1A phone patch • HS-4, HS-5, HS-6, HS-7 headphones

KENWOOD

TRIO-KENWOOD COMMUNICATIONS
1111 West Walnut Street
Compton, California 90220

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Specifications and prices are subject to change without notice or obligation.

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REFLECTIONS

our own miniseries

Anyone who watches TV has seen, I'm sure, at least one miniseries — be it *The Thorn Birds, Wallenberg,* or *SPACE.* Well, *ham radio* is pleased to bring you another. . . but with this one, happily, you won't have to wait until the next evening to see the continuation. We call it "sources for everyone."

Sources are popular items for Radio Amateurs. In fact, I defy you to show me a transmitter or transceiver that doesn't have at least one. In this issue we examine three different kinds of sources, each useful in its own way and each simple enough to be built by the "average" ham (whoever he may be).

Our first source — described in Al Helfrick's article, beginning on page 18 — answers the paradoxical question, What is rock-stable, yet varies in frequency? It's a voltage-controlled oscillator that uses a ceramic resonator for the frequency determining element. To say it's as stable as a crystal oscillator would be an exaggeration, but it does offer a significant improvement in stability over a conventional LC type device. Throw in the additional advantages of low microphonics, high *Q,* low cost in a small package, and you begin to get an idea of why both the author and I are interested in this device. Though it can be varied in frequency, its variation is limited by the series and parallel resonant frequencies of the resonator, which is about 7 percent. (Not bad considering the insignificant frequency pulling capability of a crystal oscillator.)

If we do need that high stability, Peter Bertini shows us how we can achieve it by using two crystal oscillators in a Colpitts configuration. The author, in designing BFO circuits, found an alternative to using expensive BFO crystals while still retaining the versatility of a variable BFO. In this application (a receiver BFO), very little frequency shift is needed, and it's nicely achieved by varying the voltage on the varactor elements. The difference frequency of the two crystals becomes the exact center of the variable frequency range needed. Tie that concept in with normal good oscillator design practices and we're left with a useful circuit that's inexpensive and quite stable.

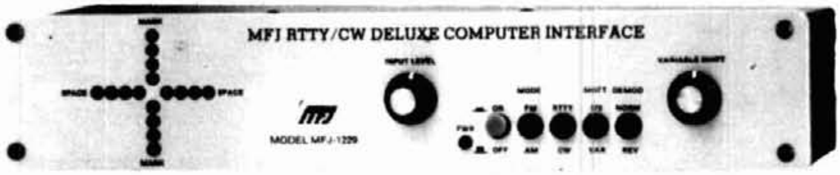
The conclusion of this miniseries came out of a need for a simple and practical sweep generator that can be swept across a broad frequency range, yet still exhibit good linearity and constant output. From the Netherlands comes an article by Hans Evers, who discovered an old circuit — described perhaps for the first time — in a 1949 issue of *Wireless World.* The circuit, known as the Butler oscillator, is varied in frequency through control of an out-of-phase RF current that excites a (secondary) coil coupled to the main inductive element, thereby producing an effective turns cancellation. This current, in turn, is controlled through the unbalancing of a differential amplifier. All in all, an interesting technique.

If you like this miniseries, let us know we'll be glad to bring you others. What subjects would you like us to cover?

Rich Rosen, K2RR
Editor-in-Chief

NEW FROM MFJ

MFJ'S MOST ADVANCED RTTY/ASCII/AMTOR/CW COMPUTER INTERFACE HAS FM, AM MODES, LED TUNING ARRAY, RS-232 INTERFACE, VARIABLE SHIFT TUNING, 170/850 Hz TRANSMIT, MARK-SPACE DETECTION.



MFJ RTTY/ASCII/CW software on tape, cables for C-64/VIC-20.

MFJ-1229
$179.95

Engineering, performance, value and features sets MFJ's most advanced RTTY/ASCII/AMTOR/CW computer interface apart from others.

FM (limiting) mode gives easy, trouble-free operation. Best for general use, off-shift copy, drifting signals, and moderate signal and QRM levels.

AM (non-limiting) mode gives superior performance under weak signal conditions or when there are strong nearby stations.

Crosshair mark-space LED tuning array simulates scope ellipse for easy, accurate tuning even under poor signal-to-noise conditions. Mark and space outputs for true scope tuning.

Transmits on both 170 Hz and 850 Hz shift.

Built-in RS-232 interface, no extra cost.

Variable shift tuning lets you copy any shift between 100 and 1000 Hz and any speed (5-100 WPM RTTY/CW and up to 300 baud ASCII). Push button for 170 Hz shift.

Sharp multi-pole mark and space filters give true mark-space detection. Ganged pots give space passband tuning with constant bandwidth. Factory adjusted trim pots for optimum filter performance.

Multi-pole active filters are used for pre-limiter, mark, space and post detection filtering. Has automatic threshold correction. This advanced design gives good copy under QRM, weak signals and selective fading.

Has front panel sensitivity control.

Normal/Reverse switch eliminates retuning while checking for inverted RTTY. Speaker jack. +250 VDC loop output.

Exar 2206 sine wave generator gives phase continuous AFSK tones. Standard 2125 Hz mark and 2295/2975 Hz space. Microphone lines: AFSK out, AFSK ground, PTT out and PTT ground.

FSK keying for transceivers with FSK input.

Has sharp 800 Hz CW filter, plus and minus CW keying and external CW key jack.

Kantronics software compatible socket.

Exclusive TTL/RS-232 general purpose socket allows interfacing to nearly any personal computer with most appropriate software. Available TTL/RS-232 lines: RTTY demod out, CW demod out (TTL only), CW-ID in, RTTY in, PTT in, key in. All signal lines are buffered and can be inverted using an internal DIP switch.

Metal cabinet. Brushed aluminum front. 12½x2½x6 inches. 18 VDC or 110 VAC with optional AC adapter, MFJ-1312, $9.95.

Plugs between rig and C-64, VIC-20, Apple, TRS-80C, Atari, TI-99 and other personal computers. Use MFJ, Kantronics, AEA and other RTTY/ASCII/AMTOR/CW software.

MFJ MULTI-FUNCTION TUNING INDICATOR

MFJ-1221 $79.95

Greatly improve your RTTY copying capabilities. Add a crosshair LED Tuning Indicator that makes tuning quick, easy with pin-point accuracy. **Add** mark and space outputs for scope tuning. **Add** LEDs that indicate 170, 425, 850 Hz shifts. Great for copying RTTY outside ham bands. **Add** sharp mark and space filters to improve copy under crowded/weak conditions. 170, 425, 850 Hz shifts. **Add** Normal/Reverse switch to check for inverted RTTY without retuning. **Add** output level control to adjust signal into your terminal unit. **Add** a limiter to even out signal variation for smoother copy.

Unit plugs between your tuner and receiver. Mark is 2125 Hz, space is 2295, 2550 or 2975 Hz. Measures 10x2x6 in. and uses floating 18 VDC or 110 VAC with AC adapter, MFJ-1312, $9.95.

24/12 HOUR CLOCK/ID TIMER

MFJ-106
$19.95

Switch to 24 hour UTC or 12 hour format! Battery backup. ID timer alerts every 9 minutes after reset. Red .6 in. LEDs. Synchronizable to WWV. Alarm, Snooze function. PM, alarm on indicators. Gray/Black cabinet. 110 VAC, 60 Hz.

MFJ ELECTRONIC KEYER

MFJ-407
$69.95

MFJ-407 Deluxe Electronic Keyer sends iambic, automatic, semi-auto or manual. Use squeeze, single lever or straight key. Plus/minus keying. 8 to 50 WPM. Speed, weight, tone, volume controls. On/Off, Tune, Semi-auto switches. Speaker. RF proof. 7x2x6 inches. Uses 9 V battery, 6-9 VDC or 110 VAC with AC adapter, MFJ-1305, $9.95.

MICROPHONE EQUALIZER

MFJ-550
$49.95

Greatly improves transmitted SSB speech for maximum talk power. Evens out speech peaks and valleys due to voice, microphone and room characteristics that make speech hard to understand. Produces cleaner, more intelligible speech on receiving end. Improves mobile operation by reducing bassy peaks due to acoustic resonances. Plugs between mic and rig. 4 pin mic jack, shielded output cable. High, mid, low controls provide ±12 db boost or cut at 490, 1170, 2800 Hz. Mic gain, on/off/bypass switch. "On" LED. 7x2x6 inches. 9 V battery, 12 VDC or 110 VAC with adapter, MFJ-1312, $9.95.

MFJ ANTENNA BRIDGE

MFJ-204 $79.95

Trim your antenna for optimum performance quickly and easily. Read antenna resistance up to 500 ohms. Covers all ham bands below 30 MHz. Measure resonant frequency of antenna. Easy to use, connect antenna, set frequency, adjust bridge for meter null and read antenna resistance. Has frequency counter jack. Use as signal generator. Portable, self-contained. 4x2x2 in. 9 V battery or 110 VAC with adapter, MFJ-1312, $9.95.

MFJ PORTABLE ANTENNA

MFJ's Portable Antenna lets you operate 40, 30, 20, 15, 10 meters from apartments, motels, camp sites, vacation spots, nearly any electrically clear location where space for a full size antenna is a problem.

A telescoping whip (extends to 54 in.) is mounted on self-standing 5½x6¼x2¼ inch Phenolic case. Built-in antenna tuner, field strenght meter, 50 feet RG-58 coax. Complete multi-band portable antenna system that you can use nearly anywhere. Up to 300 watts PEP.

MFJ-1621
$79.95

MFJ 24 HOUR LCD CLOCKS

$19.95 **MFJ-108**

$9.95 **MFJ-107**

Huge 5/8 inch bold black LCD numerals make these two 24 Hour clocks a must for your shack. Choose from a dual clock that features seperate UTC and local time display or a single clock that displays 24 Hour time. **Mounted in a brushed aluminum frame,** these clocks feature huge 5/8 inch LCD numerals and a sloped face for across the room viewing. Easy set month, day, hour, minute and second function. Clocks can be operated in an alternating time-date display mode. MFJ-108, 4½x1x2 inches; MFJ-107, 2¼x1x2 inches. Battery included.

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More Details? CHECK—OFF Page 126

✓ 103

IC-02AT

IC-2AT

IC-02AT

ICOM 2-Meter Handhelds

If you want a 2-meter handheld with exceptional features, quality built to last and a wide variety of interchangeable accessories, take a look at the ICOM IC-02AT and IC-2AT handhelds.

Frequency Coverage. The IC-02AT covers 140.000 through 151.550MHz and the IC-2AT, 141.500 through 149.994MHz...both include frequencies for MARS operation.

IC-02AT Features. ICOM's top-of-the-line IC-02AT handheld has the following outstanding features:

- DTMF direct keyboard entry
- LCD readout
- 3 watts standard, 5 watts optional (with IC-BP7 battery pack)
- 10 memories which store duplex offset and PL tone (odd offset can be stored in last 4 memories)
- Frequency dial lock
- Three scanning systems: priority, memory and programmable band scan (selectable increments of 5, 10, 15, 20 or 25KHz)

IC-2AT Features. The IC-2AT is ICOM's most popular handheld on the market. The IC-2AT features a DTMF pad, 1.5 watts output and thumbwheel frequency selection. The IC-2A is also available and has the same features as the IC-2AT except DTMF.

Accessories. A variety of slide-on battery packs are available for the IC-02AT and IC-2AT, including the new long-life 800mAh IC-BP8 which can be used with both handhelds.

Other accessories include the HS-10 boom headset, HS-10SB PTT switchbox, HS-10SA VOX unit (for IC-02AT) and an assortment of battery pack chargers.

The IC-02AT and IC-2AT come standard with an IC-BP3 NiCd battery pack, flexible antenna, AC wall charger, belt clip, wrist strap and ear plug. See the IC-02AT and IC-2AT 2-meter handhelds at your local ICOM dealer.

Often imitated, never duplicated.

ICOM

First in Communications

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All stated specifications are approximate and subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions. 02AT185

When the FCC changed the rules, EIMAC was prepared for continuing HAM operations.

The FCC changed the allowable output power for linear amplifiers in amateur radio service. Hams can now run at 1500 watts PEP into an antenna. EIMAC was right there to meet requirements with its 3CX1200A7 tube.

Low-cost replacement for small spaces.

RF cabinets of many linear amplifiers currently use the EIMAC 3-500-Z tubes. The new 3CX1200A7 for design takes size into consideration and, by design, is recommended as a single, low-cost replacement for a pair of EIMAC 3-500-Z tubes for new amplifier designs.

General Specifications

The EIMAC 3CX1200A7 is a high-mu, compact, forced air cooled triode for zero-bias class AB2 amplifiers.

- 2.9″ dia. x 6.0″ long
- Plate dissipation: 1200 watts
- Glass chimney SK-436 available
- Standard EIMAC SK-410 socket available

More information is available on the new EIMAC 3CX1200A7 tube from Varian EIMAC, or any Electron Device Group worldwide sales organization.

Varian EIMAC
1678 S. Pioneer Road
Salt Lake City, Utah 84104
Telephone: 801 • 972-5000

Varian AG
Steinhauserstrasse
CH-6300 Zug, Switzerland
Telephone: 042 • 23 25 75

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varian

presstop de W9JUV

AMATEUR RADIO WILL FLY WITH THE SPACE SHUTTLE IN JULY after all, NASA has announced. However, astronaut Tony England, WØORE, will be limited to 2-meter operation only, as the installation of additional Amateur antennas for other bands in the shuttle's payload bay turned out to be too costly as well as a logistically difficult task.

Slow-Scan TV Is The Big Addition On This Shuttle Flight; it's even quite likely that SSTV transmission time will exceed that for voice, with scenes from inside the spacecraft to be sent during orbits when WØORE is busy with other tasks and can't be on the air for voice contacts. Both FM voice and SSTV will be via 2-meter hand-held radios, using the same window-mount antenna used by W5LFL in his pioneering operation.

Little If Any "General" 2-Way Operation Is Planned for this flight. Instead, WØORE's contact emphasis will be with school and club groups, to provide the maximum Amateur involvement. The ARRL will act as liasion to schedule such contacts; contact them in Newington for details. Pre-flight publicity and media contact during the flight will also be handled by the ARRL, but primarily through the League's Washington office.

NASA Expects WØORE To Be On For Between 10 And 20 Passes, and is currently working out his scheduling. A principal limitation will be access to the shuttle's overhead window, which won't be available at all for Amateur antenna use until the middle of the fourth day of the flight. At presstime launch was still scheduled for mid-July.

THE 24-MHZ BAND WILL BECOME AVAILABLE AND 30 METERS "OFFICIAL" JUNE 22, the FCC decided April 25. The new 24890-24990 kHz slot is for General and higher, with phone above 24930; power will be 1500 W PEP. 30 meters remains CW/RTTY only, General and above limited to 200 W PEP. No action was taken on 420 MHz changes or the new 902 MHz band.

International Broadcast Stations May Use 7.1-7.3 MHz In Region 3 (Pacific) areas it administers, the FCC decided April 4. In its Report and Order on Mass Media Docket 84-706 the Commission did specify, however, that broadcast stations operating under the new ruling must beam transmissions away from Region 2. The effective date was May 16.

Expanded 40-Meter Phone Privileges For Caribbean Area Amateurs are proposed in a new FCC Notice of Proposed Rulemaking. In PR Docket 85-104 Amateurs in U.S.-licensed areas of the Caribbean would have their phone band extended down to 7075 kHz; in its proposal the FCC is looking for Amateur input on how the additional frequencies should be utilized.

Comments On PR Docket 85-104 Are Due At The FCC June 17; Reply Comments July 17.

VOLUNTEER EXAMINER COORDINATOR PERFORMANCE MAY SOON be the subject of critical FCC review, now that the program has been on line for a year. Criteria to be used in the review will probably include activity, pass rates, adherence to the rules, integrity, and quality of the paperwork provided to Gettysburg. Some VECs are not expected to fare very well.

A Visit To Gettysburg For VEC Representatives is also being considered, probably for sometime in August. Such a visit would provide the VECs and FCC licensing people an excellent opportunity to discuss each other's problems and review procedures.

DeVry Is Actively Seeking VEs Throughout The U.S., following its accreditation as a national VEC. Interested VEs should call Jim Georgius, W9JUG, at DeVry between 12 noon and 7 PM Chicago time, at (312) 929-8500, ext. 251.

"AUTOMATIC REMOTE CONTROL" FOR AMATEUR OPERATIONS ABOVE 29.7 MHZ has been proposed by the FCC in PR Docket 85-105. Expanding on an ARRL petition that had sought automatic control for Amateurs using digital communications, the Commission is actually looking for Amateur input as to just how far the concept of automatic control should be extended.

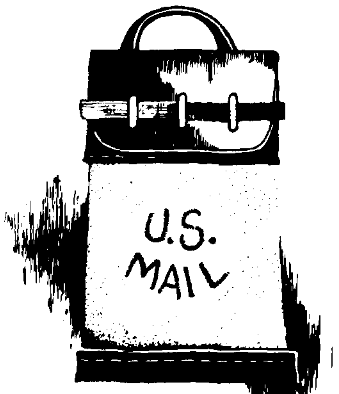
Comments On PR Docket 85-105 Are Due at the FCC June 25, and Reply Comments July 25.

THE COMMENT PERIOD ON FCC'S "NATIONAL FREQUENCY COORDINATOR" proposal is being extended at the request of the ARRL. The new dates had not yet been set at presstime.

AMATEUR RADIO'S SPACE PROGRAM WILL BE THE SUBJECT of the Teleconferencing Radio Net (TRN) June 14. Top AMSAT satellite specialists such as W3IWI, W6SP, WA2LQQ, W3XO, K8OCL, and others will participate in the comprehensive program, which will almost surely include the latest news on WØORE's forthcoming Space Shuttle operation.

Over 200 Repeaters Across North America Now Provide TRN programs to their users; any repeater group wishing to join the TRN should write Timothy Lowenstein, WAØIVW, TRN Net Manager, c/o Midway ARC, Box 1231, Kearney, Nebraska 68847-1231.

DAYTON HAMVENTION'S "AMATEUR OF THE YEAR" IS W8ACE/4, John Willig, who's being recognized both for his role as "father" of the Hamvention back in 1951, and for his continuing efforts in maintaining the "Dayton Net" that meets three times weekly to keep former Daytonians in touch with each other. The Hamvention's Special Achievement Award went to Judy Frye, KG8P, for her leadership role setting up DARA's VEC program; the Technical Excellence Award was presented to Rich Whiting, WØTN, for having developed the Teleconferencing Radio Net. Congratulations to all for well-deserved honors!



comments

How can Amateur Radio be improved? Here's what some readers suggested in response to questions raised by K2RR and N1ACH in "Reflections" (February and March, 1985). **KA1LBO**

I'd like to see us stop all the concern for increasing *numbers* of hams and instead, try to improve the quality of operators we already have.

Vern A. Weiss, WA9VLK
Kankakee, Illinois

. . . I would like to see the spirit of Amateur Radio as it was in the 1930's restored: *service,* experimentation, operating skill, courtesy, and good fellowship.

I. L. McNally, K6WX
Sun City, California

. . . There seems to be an age of curiosity — maybe between 10 and 15 — when a youngster is thirsty to drink up the experience of the adult world. At that age the young person is curious about the entire world. We, the adults, can "turn that kid on" to electronics, computers, cameras, art, or music — or they can turn on to drugs. It's up to us. . . . My point is that we must make a solid effort to get into the elementary schools, into the summer camps, into the neighborhood community centers, to "turn on" the kids of America to the fun of our hobby. This will, in turn, capture the talents of our youth and reignite the spirit that put a man on the moon!

Marvin Feldman, WG4Q
Annandale, Virginia

In days past, there was a "romance of the airwaves" — the excitement of doing what ordinary people could not do — *and you could do it,* if you knew enough and worked hard enough.

We need to find a new romance, a new excitement.

John Telford, W3TJ
Swampscott, Massachusetts

Here's what I think is important right now — more important than technical development, if we have to choose: *we must learn how to lobby.* We hams must learn individual and group lobbying techniques. Lobbying is power, and groups have more power than individuals.
[We have to] get our emergency nets working and then let the public know what we're doing for them. When the public needs communications for various activities, we should *overwhelm* them with support, and then publicize our contribution.

Ken Uthus, KT7E
Nine-mile Falls, Washington

The way I entered ham radio was via SWL activities. I was in junior high school and could not afford anything but a receiver. I still listen to SW on a day-to-day basis and enjoy it. Perhaps emphasizing such activities will stimulate interest. . . .

Thomas M. Hart, AD1B
Dedham, Massachusetts

. . . What Amateur Radio needs is a new frontier. . . . Why not put the total emphasis on space [communications]? Maybe radio telescope operation. Let's restore the adventure of Amateur Radio to attract the new breed of high-tech communicators.

Fred N. Ackerman, W3JHN
Silver Spring, Maryland

I've been a ham for 54 years. . . . Ten years ago I got the SSTV bug and the biggest thrill from ham radio, ever. What happened to SSTV articles in most of the magazines?

Francis M. Duffy, AB3J
Johnstown, Pennsylvania

My main operating interest is CW. I perceive considerable anti-CW pressure these days . . . more publicity and development for very narrow band synchronous CW would help . . . also improvement in the political climate for this mode. . . .

To my mind, hand-sent Morse is more basic than BASIC.

Bruce Boyd, W3QA
Ellicott City, Maryland

Let's stop recruiting non-technical people into our fraternity. . . . Let's try to appeal to an average level of technical expertise — on upward.

Mike Kitsko, K6VGQ
Cerritos, California

A link is needed between HF, DX, 2 meters, CB, SSTV, etc. A geostationary satellite could do just that.

Greg Waits, WB6EPE
Anaheim, California

The number of licensed Amateur Radio operators may be declining statistically but I feel sure that there are many others out there just as enthusiastically involved as we are here. The new VEC program will reverse the [negative] trend. . . . Amateur Radio clubs all over the country can and will take advantage of the VEC program to promote and assist with the licensing of new Amateur Radio enthusiasts.

Let's not be too concerned with declining numbers. It's only temporary. We, the members of the World Amateur Radio Fraternity, will see to that.

Bob Ruedisueli, W4OWA
Vienna, Virginia

. . . You may want to consider that the new 10-year license (term) will skew the figures.

John D. Gallivan III, N4DGS
Fairfax, Virginia

. . . What's wrong with Amateur Radio? Not a damn thing . . . it's just *different.*

Michael Vuksich, WØVEV
Duluth, Minnesota

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- SP-230 external speaker.
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- YK-88C (500 Hz) or YK-88CN (270 Hz) CW filter for 8.83 MHz IF.
- KB-1 deluxe heavyweight knob.

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- KB-1 deluxe VFO knob.
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More information on the TS-830S and TS-530SP is available from authorized Kenwood dealers.

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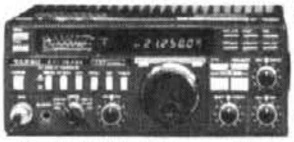

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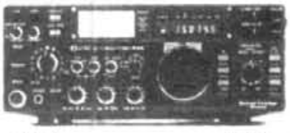

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voltage controlled oscillator uses ceramic resonators

Try these old favorites in tuned circuits

Since the earliest days of radio and electronics the LC tuned oscillator was the circuit of choice whenever a wide tuning range was needed. When stability was paramount, the crystal oscillator reigned supreme.

Over the years the frequency controlling element has changed; oscillators controlled by cavities, surface acoustic wave (SAW) devices, YIG (*Y*ttrium *I*ndium *G*arnet) and other garnets, and a host of other specialized devices have been developed. Very often a system design would benefit from an oscillator that had the tuning range of an LC oscillator and the stability of a crystal oscillator.

The phase-locked synthesizer is a system in which the accuracy and stability of a quartz crystal is transferred to a wide frequency range oscillator, permitting a large number of accurate and stable frequencies to be generated. Even in this application, the flaws of an oscillator cannot be totally eliminated. If the oscillator suffers from phase noise, microphonics, or other spurious outputs, some vestiges of these problems will remain.

The voltage controlled oscillator can be constructed from any type of oscillator, but is typically an LC oscillator with a varactor diode as part or all of the tuning capacitance. This gives the broadest tuning range but seldom exceeds a ratio of 2:1. At the other end of the spectrum (minimum tuning range), a crystal oscillator with varactor tuning provides excellent stability, very low phase noise, and freedom from microphonics, but has very limited tuning range. A rule of thumb for a variable crystal oscillator is a frequency variation of no more than 0.1 percent total. If the frequency were limited to 20 MHz (this is approximately the limit for fundamental mode crystals), the total variation would be 20 kHz. For higher frequencies, overtone crystals must be used and the ability to pull the frequency of an overtone crystal is considerably less than that of a fundamental mode crystal.

ceramic oscillator provides compromise

Somewhere between the crystal oscillator (which can hardly be moved at all in frequency) and the LC oscillator (which has a broad variation in frequency but suffers from phase noise and microphonics) is the ceramic resonator oscillator. The ceramic resonator is not a new device; for many years ceramic resonators have been the heart of the ceramic filter, which is primarily used for wideband FM IF systems found in entertainment radio and television receivers. The ceramic resonator as a single tuned circuit is finding applications in timing circuits, replacing more expen-

By Albert D. Helfrick, K2BLA, R.D. 1, Box 87, Boonton, New Jersey 07005

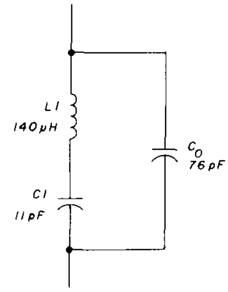

fig. 1. Equivalent circuit of a 4-MHz ceramic resonator.

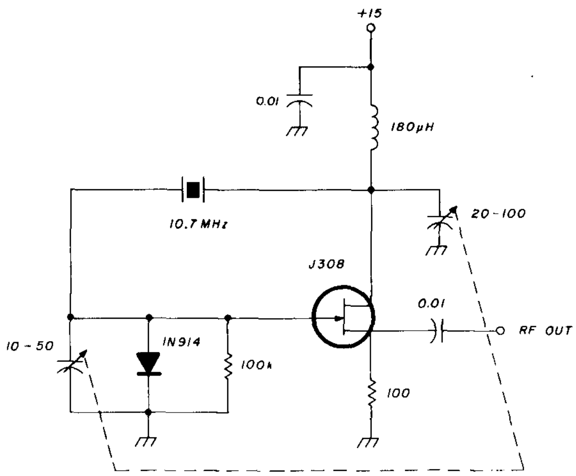

fig. 2. Mechanically-tuned Pierce oscillator.

sive quartz crystals in those applications in which the extreme precision and stability of the quartz resonator is not required.

Although the ceramic resonator is similar to a quartz crystal, there are several important differences. The equivalent circuit of the ceramic resonator shown in **fig. 1** is identical to the quartz crystal except that the parameter values are somewhat different. The series resistance is on the order of 6 ohms for a 4-MHz resonator, which compares to a quartz crystal's 15 ohms. This lower value at first appears to indicate a higher Q than with the quartz crystal if it weren't for the value of the equivalent inductance, which is typically 140 microhenries. In a quartz resonator at a frequency of 4 MHz, the equivalent inductance could easily be on the order of 1 henry, which is some 7000 times higher. This results in the quartz crystal having a Q of as high as 500,000. In the ceramic resonator a series capacitance of 11 pF provides the series resonant frequency while a 76-pF shunt capacitance, plus any circuit capacitance provides the parallel resonant frequency. The Q of the equivalent circuit is on the order of 600.

advantage of the ceramic resonator over the LC oscillator

There are two inherent advantages in using a ceramic resonator rather than a conventional LC tuned circuit. First, it is nearly impossible to build inductors in the 140 μH region that are small in size and exhibit Qs of 600. Typically a 140-μH inductor has a Q of one-tenth that of a ceramic resonator. Secondly, a 140-μH inductor, in order to be of reasonable size, would use a tightly coupled ferrite core. The core would be attached to a shielded can and fitted with an adjuster. This would translate mechanical movement of the core into changes in the inductance and distributed capacitance. An oscillator constructed with this type inductance would tend to be microphonic.

There are broad variations in the parameters of ceramic resonators, especially when resonators of different frequencies are compared. However, ceramic resonator Qs will generally range from 500 to 5000, values not achieved using conventional LC tuned circuits.

The significant disadvantage of the ceramic resonator as an oscillator tuned circuit is the ability of the resonator to be varied in frequency. Ceramic resonators are typically operated in parallel resonance, which is characterized by the resonant frequency of the equivalent inductance resonating with the two equivalent capacitances, C_0 and C_1. The 76 pF capacitance shown in **fig. 1** is internal to the resonator and cannot be altered in any way. Consider a situation in which a varactor is placed across the resonator to vary the frequency. The highest possible resonant frequency (f_p) when operating the resonator as a parallel resonant circuit occurs when there is *no* external capacitance. This produces a resonant frequency of:

$$f_p = \frac{1}{2\pi \sqrt{\dfrac{L_1 C_0 C_1}{C_0 + C_1}}} \quad (1)$$

There is a practical limit to how much external capacitance can be placed across the resonator, but for the purpose of gaining insight into how far the resonator can be theoretically pulled, assume the external capacitance can be as high as infinity. With infinite external capacitance, the parallel resonant frequency approaches the series resonant frequency (f_s) which is:

$$f_s = \frac{1}{2\pi \sqrt{L_1 C_1}} \quad (2)$$

determining range of operation

If the ratio of the highest frequency to the lowest frequency were taken, the result would be:

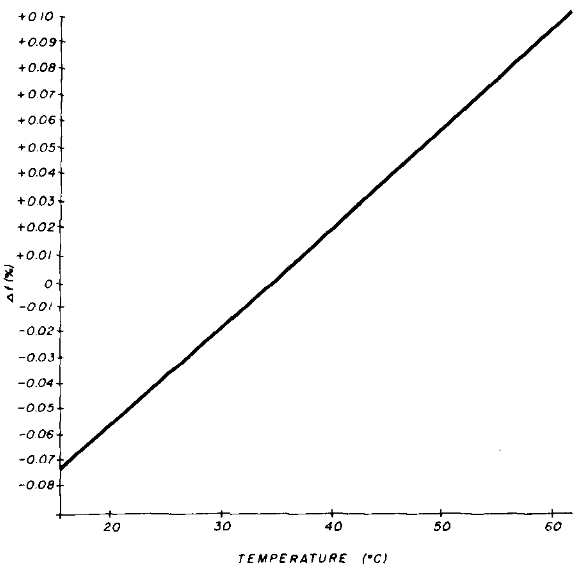

fig. 3. Temperature-induced frequency variation of mechanically-tuned resonator oscillator.

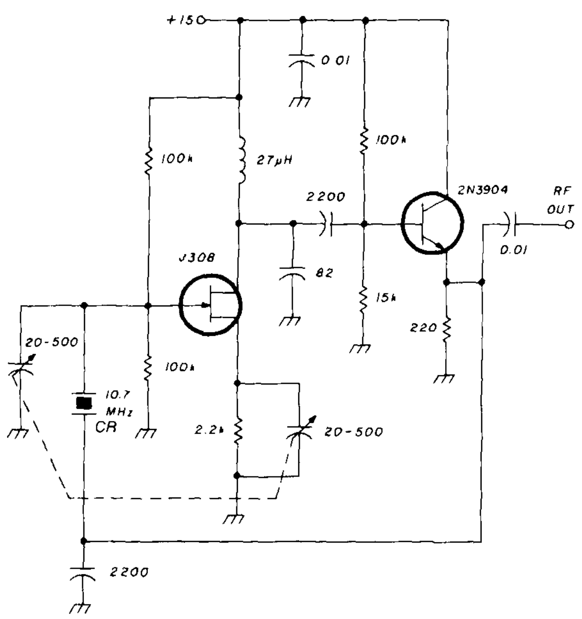

fig. 4. Mechanically-tuned ceramic resonator oscillator.

$$\frac{f_p}{f_s} = \sqrt{\frac{C_0 + C_1}{C_0}} \qquad (3)$$

Using the typical values shown in **fig. 1**, the maximum frequency range (and consequently change from nominal frequency) is about 7 percent total for a 4-MHz resonator. Compared to the quartz crystal, this is a very large variation but rather insignificant to the octave or more variation available from an LC oscillator.

The previous discussion determined the maximum theoretical variation. However, it is not possible to apply an external capacitance from zero to infinity. The lower value of capacitance is limited by the circuit capacitance and the residual capacitance of the varactor. This discussion examines varactor tuned oscillators, but there is residual capacitance in mechanical capacitors as well. In addition, there are practical limits to the upper bound of the external capacitance and from empirical data this can be safely taken to be three times the equivalent shunt capacitance of the resonator. When a large amount of external capacitance is used, the dissipation factor of the external capacitor becomes a critical parameter in the amount of energy that can be transferred into the ceramic resonator. As a design example, assume the minimum external capacitance is 30 pF and three times the internal 76 pF or 228 pF is the maximum capacitance that is allowed. This would result from a varactor diode variation of about 200 pF. If the residual circuit capacitance is 10 pF exclusive of the varactor capacitance, the varactor diode capacitance must vary from 20 pF to 218 pF. This requires a tuning ratio of 10, which is attainable from a hyper-abrupt junction diode. The typical frequency variation would be about 3 percent or approximately 120 kHz at 4 MHz.

comparing actual circuits

To test the theory and to assess the ability of the ceramic resonator to serve as the frequency controlling element of an oscillator, several conventional capacitor-tuned oscillators were constructed. One example is shown in **fig. 2**. The ganged variable capacitor tunes both the gate and drain of the FET oscillator and thus maintains a constant feedback ratio. This oscillator produced a tuning range of 190 kHz from 10.7 MHz, the specified resonant frequency of the oscillator, to 10.89 MHz. This simple circuit, also illustrated a design limitation of the ceramic resonator — frequency drift with temperature.

Ceramic resonators are frequency-stabilized over temperature by using special −4400 ppm/degree C ceramic capacitors as the feedback elements. Although the temperature characteristic of the mechanical capacitor was not known, it did *not* correct the frequency drift and the results are shown in **fig. 3**. In spite of its frequency dependence on temperature, the oscillator had some important characteristics. The oscillator had a low level of phase noise and was relatively immune from microphonics. It is these two characteristics that make the oscillator attractive as a VCO for a phase locked loop frequency synthesizer where the temperature dependence can be eliminated.

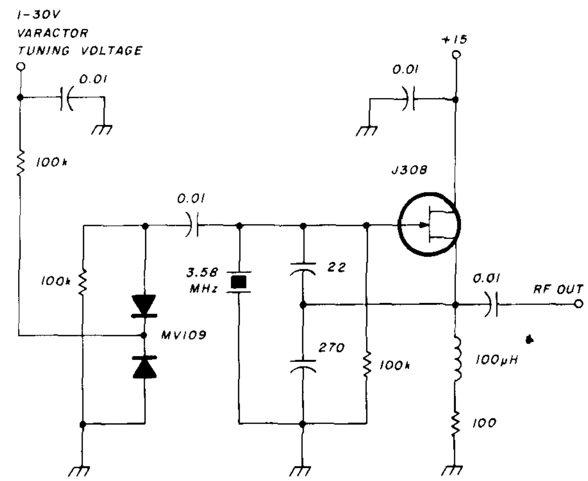

fig. 5. Colpitts oscillator using varactor tuning and a 3.58-MHz resonator.

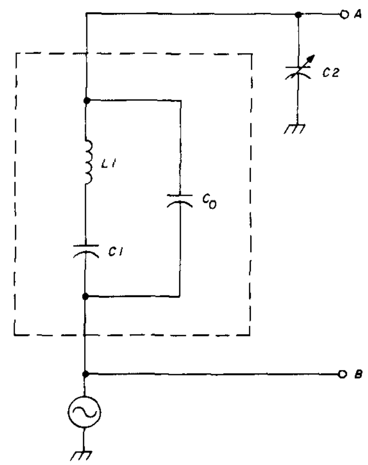

fig. 6. Ceramic resonator circuit with AC voltage source and capacitive load.

A second mechanically-tuned oscillator was constructed and is shown in **fig. 4**. One of the problems associated with an oscillator using a ceramic resonator and, to a certain extent, a crystal resonator, is that when a large amount of external capacitance is added the amount of feedback is reduced and oscillation can become unsteady (stops oscillating). The oscillator shown in **fig. 4** represents an attempt to alleviate this problem. A dual 500-pF capacitor was used as the tuning element across a 10.7-MHz resonator. The gain of the FET amplifier was varied by increasing the capacitance from the source to ground using half of the dual capacitor. As the capacitance across the resonator is increased, the gain of the amplifier also increases and the oscillations are stable over the entire 500 pF range of the capacitor. The tuning range of this oscillator was 325 kHz at 10.7 MHz.

A varactor-tuned Colpitts oscillator as shown in **fig. 5** was constructed to evaluate the ability of the ceramic resonator to serve as a VCO. A 4-MHz resonator was tested, and the results agreed substantially with theory. Using a pair of hyper-abrupt varactor diodes, it was possible to obtain nearly a 100 kHz frequency shift, which agrees with the theoretical calculation of 120 kHz. With a large variation in capacitance an unsteady oscillatory condition was evident. This is because the feedback capacitors were much smaller than the maximum capacitance of the varactors. It is mandatory that the fixed capacitances across the ceramic resonator be kept to an absolute minimum.

In the development of an oscillator that provides a maximum frequency shift using a ceramic resonator as the tuned circuit, consider the circuit shown in **fig. 6**. The equivalent circuit of a ceramic resonator is shown in series with an AC voltage source and an external capacitance which represents the varactor. Since the impedance of the voltage source is zero, the external varactor capacitance is essentially in parallel with the internal capacitance, C_0. The voltage at point *A* is exactly out of phase with the voltage at point *B* at the parallel resonant frequency of the inductor, L_1, and $C_0 + C_2$ in series with C_1. Only one resonant circuit is shown in **fig. 6**. The usual series resonant circuit of L_1 and C_1 is not a factor here. If there were a resistance between point *A* to ground, in parallel with C_3, there would be a second point at which the phase of the voltage at *A* would be the same as the voltage at point *B*, and that would occur at the series resonant frequency determined by L_1, and C_1.

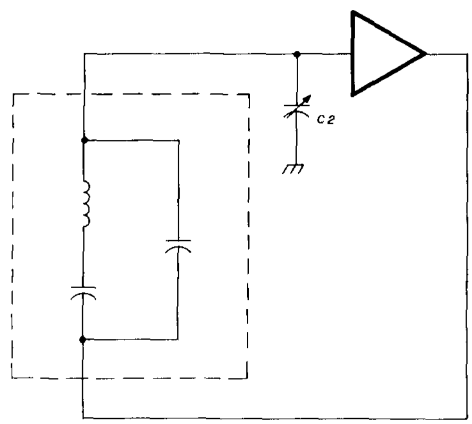

fig. 7. Ceramic resonator oscillator.

Figure 7 shows the equivalent circuit of the ceramic

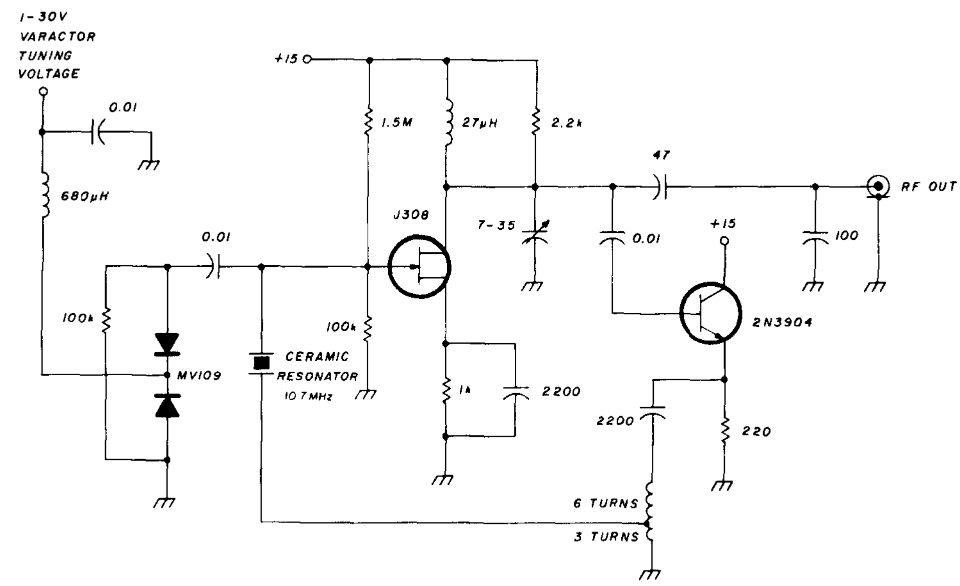

fig. 8. Varactor-tuned 10-MHz ceramic resonator oscillator.

resonator except that the AC voltage source has been replaced with the output of an inverting amplifier and point *A* from the equivalent circuit of **fig. 6** has been connected to the input of the inverting amplifier. To satisfy the Barkhausen criteria for sustained oscillations, the total phase shift around the loop should be 0 degrees, which will occur at the parallel resonant frequency of **fig. 6**. In addition, the total loop gain should be zero dB, which can be satisfied by the buildup of self bias, which automatically reduces the circuit gain, as in the case of any classical oscillator. For C2 to have the greatest effect on the oscillator frequency, the input capacitance of the amplifier must be as small as possible and the output impedance of the amplifier as low as possible.

The oscillator shown in **fig. 8** satisfies the criteria for a low output impedance and small input capacitance. The FET input amplifier has fixed bias with source feedback. This provides a very high input impedance with very low capacitance. The FET amplifier drives an emitter follower which, in spite of the fact that it has a low output impedance, feeds a transformer with a 3:1 turns ratio for a nine-fold impedance reduction. The result is an impedance at the ceramic resonator of a few ohms maximum.

The varactor-tuned ceramic resonator oscillator has a significant frequency-temperature coefficient, as would be expected in light of the results of **fig. 3**, and is shown in **fig. 9**. The tuning range of the VCO is approximately 232 kHz, with a temperature coefficient of 350 Hz per degree centigrade. When using this circuit as a VCO, the entire 232 kHz range cannot be used because some of the tuning range must be sacrificed

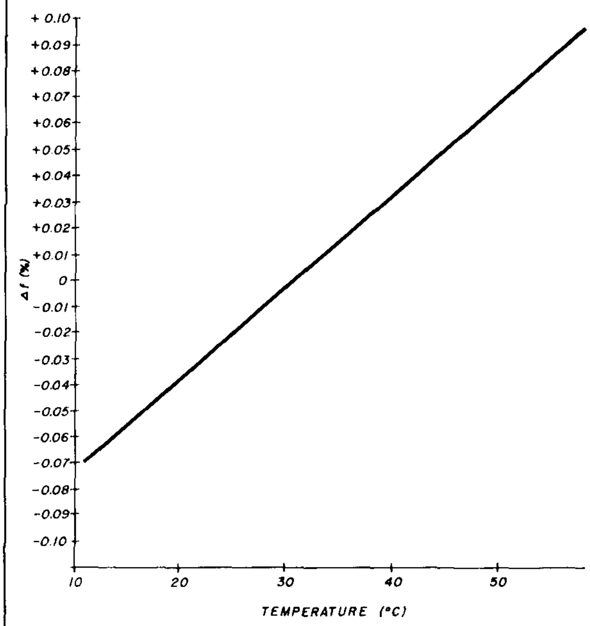

fig. 9. Temperature dependence of frequency for the varactor-tuned oscillator shown in *fig. 8*.

for the temperature dependence. If the required tuning range were 200 kHz, leaving 32 kHz for temperature variation, the resulting temperature variation would be more than 90 degrees C, which is sufficient for any Amateur application.

It may appear that a temperature compensating ceramic capacitor could be used for the reduction of

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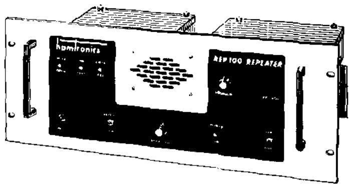

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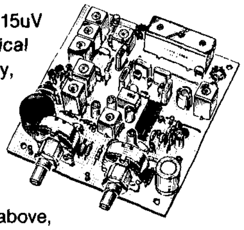

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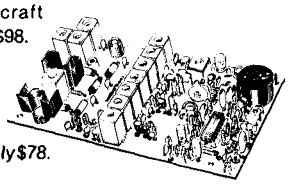

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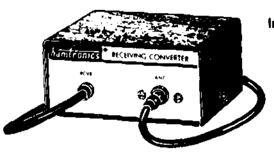

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146-148	28-30
144-148	50-54
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220-224	144-148
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220-224	50-54
222-224	28-30

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28-30	220-222*
50-54	220-224
144-146	50-52
50-54	144-148
144-146	28-30

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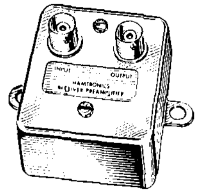

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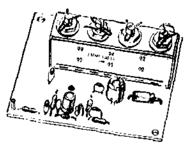

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HRA-( )	150-174 MHz	$54
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temperature dependence. This is done for single-frequency oscillators, but the use of a shunt capacitance for temperature compensation will reduce the amount of frequency variation possible. In an oscillator with a large tuning range, temperature compensation must be achieved with a phased locked loop or other external means of frequency stabilization.

To what advantage is the ceramic resonator oscillator when it has a significant frequency-temperature coefficient and has a tuning range of only a few percent? First the phase noise of the ceramic resonator oscillator is excellent, as shown by the spectrum analyzer photograph in **fig. 10**. It would be nearly impossible to create a spectrum this clean with a conventional LC tuned oscillator. In addition, the freedom from microphonics is excellent. As a test, the fourth harmonic of the 10 MHz VCO shown in **fig. 8** was received with a VHF/FM monitor receiver. This receiver is designed to function with 5-kHz peak frequency deviation, and because the fourth harmonic is being tuned a 1.25-kHz peak deviation will produce the full audio output in the receiver. The oscillator was tapped with a pencil and absolutely no audio was heard from the receiver. This is certainly not a scientific test, but to gain some insight into how this compares to a conventional LC oscillator, the printed circuit board in the monitor receiver was tapped and produced a loud clang in the receiver. In fact, if the volume of the monitor receiver were advanced to nearly full scale, a steady howl would emanate from the speaker because of acoustic feedback from the speaker to the local oscillator. Although the test was not scientific, it is clear that the ceramic resonator oscillator is quite free from microphonics.

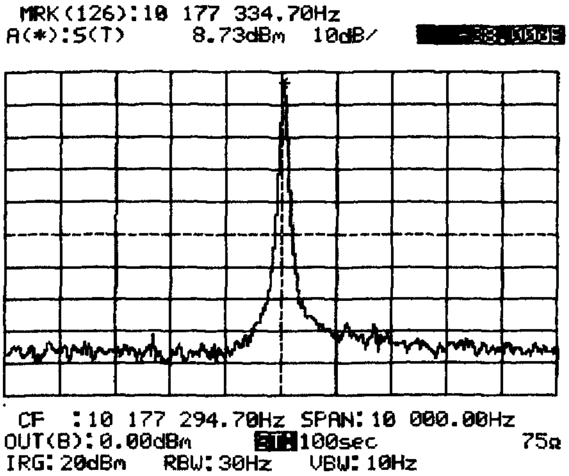

fig. 10. Spectrum analyzer photograph of a ceramic resonator VCO without a phase locked loop. The VCO's actual performance is difficult to determine due to the noise floor and resolution limitations of the instrument.

applications

There are many applications for a narrow band low-noise oscillator. An obvious choice is to provide a VCO for a narrow range synthesizer such as a single Amateur-band frequency source. The new 10 MHz band is an obvious choice, since the VCO shown in this article is directly applicable. Another application is shown in **fig. 11**. Here the ceramic resonator oscillator is used in a frequency synthesizer with 100 Hz resolution. The 10-MHz range of the ceramic resonator is translated to the 6-meter Amateur band by heterodyning it with a 40-54.6 MHz phase locked frequency synthesizer. Because of the rather high (100

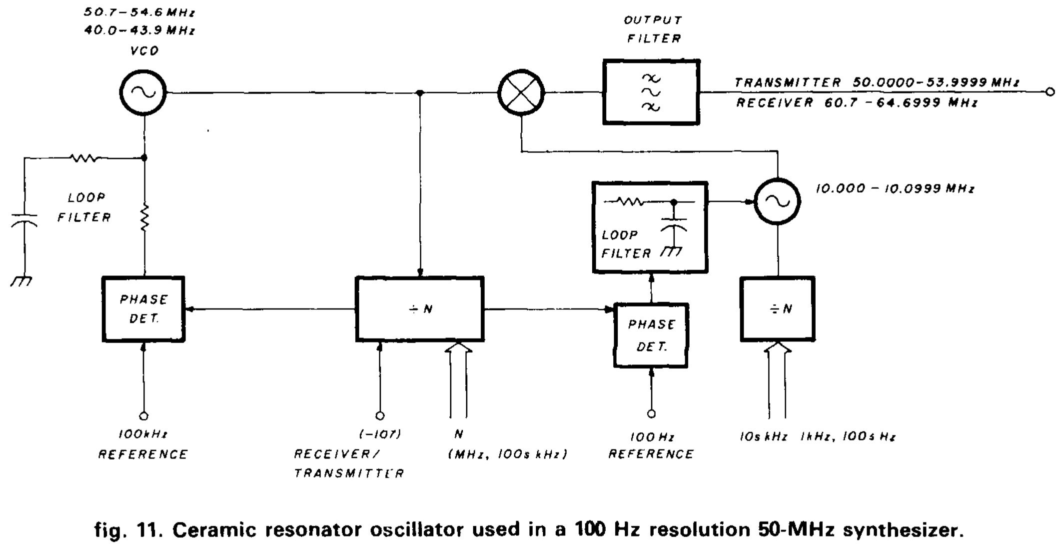

fig. 11. Ceramic resonator oscillator used in a 100 Hz resolution 50-MHz synthesizer.

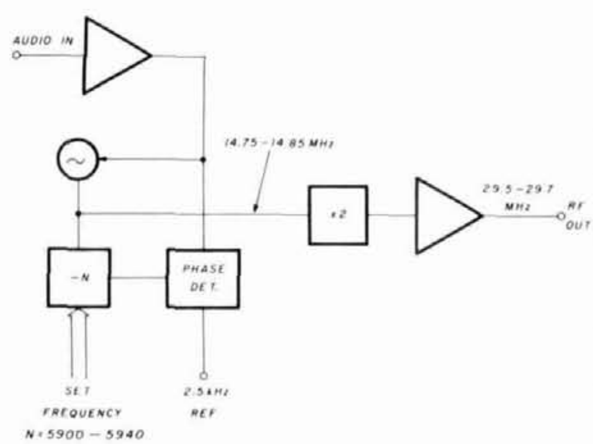

fig. 12. A 20-meter FM transmitter using a ceramic resonator oscillator.

kHz) reference frequency used for the higher frequency synthesizer, the microphonics and phase noise from that synthesizer can be reduced to negligible amounts. The relatively low frequency of the 100 Hz reference of the second phase locked loop does not allow for the loop to remove any microphonics of the inherent low-microphonic VCO using the ceramic resonator. Any synthesizer using a low frequency reference can benefit from the ceramic resonator oscillator.

A second application is shown in **fig. 12**. This example shows a 10-meter FM transmitter using a ceramic resonator. The basic 15-MHz frequency of the ceramic resonator oscillator is doubled to 29.5-29.7 MHz and synthesized using a 2.5 kHz reference. As in any FM transmitter where the phase locked loop is modulated directly, the loop bandwidth is restricted to a frequency below the audio frequency range, which opens up possibilities for microphonics and phase noise. This is demonstrated in most synthesized FM VHF equipment by the fact that despite putting in epoxy or other compound, the VCOs are often microphonic and noisy.

The ceramic resonator oscillator has proved to be an interesting device for several applications and it is suspected that other applications will appear. No attempt was made to temperature-compensate the basic oscillator circuit. It is possible that a thermistor or other temperature sensing device could be used in conjunction with the varactor tuning voltage to reduce the temperature dependence of the ceramic resonator to an acceptable amount. In addition to its use in an oscillator circuit, the ceramic resonator has important applications in any circuit in which a conventional LC tuned circuit would be used.

ham radio

More Details? CHECK — OFF Page 126

a high-stability BFO for receiver applications

Two VCXOs work together to provide high performance

The lower frequency IF (under 500 kHz) remains popular for many receiver applications, generally as the last IF of a single or multi-conversion scheme.

A typical Amateur application will usually require two or three discrete BFO frequencies — one for each sideband and one for CW. Good mechanical filters, either imports or surplus models made by Collins-Rockwell, are readily available. Unfortunately, while good filters are available, their companion BFO crystals are seldom offered; custom-made BFO crystals for under 500 kHz can be obtained, but only at a premium price.

Many hams have avoided the high cost of crystals by designing variable BFOs to take their place. While this is a reasonable alternative, there are disadvantages. If, for example, the filters will do double duty in the transmitter portion of a transceiver, BFO crystals would have to be used in order to ensure predictable filter performance. Most filter manufacturers specify the filter 20-dB attenuation points as the recommended BFO frequencies for SSB operation. Shifts in the BFO frequency could cause loss of carrier suppression or an undesired audio bandpass. A synthesized BFO circuit for 9-MHz IFs was described in *ham radio* several years ago, but it did not have provisions for variable tuning.[1] For certain receiver applications — especially for radioteletype (RTTY) or serious CW work — a variable BFO is a desirable feature. But we are still at the mercy of the long and short-term drift characteristics of a free-running LC oscillator. In light of the considerable investment a homebrewer makes for a set of decent filters, it would be false economy to compromise an otherwise good receiver by using a second-rate BFO design.

alternative approach — two 15-MHz oscillators

I've been building a general coverage receiver for about five years — it's one of those low-priority projects that just sits on the back burner and is worked on only during periods of extreme ambition. During my last brain-storming session I tackled its BFO circuits. My particular application required a variable frequency source between 5.593-5.597 MHz (for passband tuning) and the ability to preset for sideband generation in a planned companion exciter that would make use of the receiver's BFO, VFO, and HFO signals.

In designing the BFO circuits, I found an alternative to using expensive BFO crystals that would retain the versatility of a variable BFO. While my circuit uses two oscillators in the 15-MHz range, the particular frequencies are not of primary importance. (It would be wise, however, to avoid frequencies that fall on other receiver IFs or in the main tuning ranges.) Plated crystals in the 10 to 22-MHz range (fundamental frequency) will work the best; surplus crystals using pressure-plate mounts are not recommended.

What is important is that the frequency difference of the two crystals is in the exact center of the variable-frequency range we desire. I ordered two CS-1 grade crystals from International Crystal Manufacturing Co.,* and they seemed to be quite willing to match the error of the two crystals during production. This BFO system is readily adaptable to other popular IF filters in the 5, 8, or 9-MHz ranges by simply inserting the proper crystals into the circuit.

Both crystals are used in identical Colpitts circuits (**fig. 1**), except in that the frequencies are varactor controllable to a small degree. The total BFO shift is at least 4 kHz using the fundamental mode. This shift can be increased to about 6 kHz by installing 1.0 μH inductors (molded chokes) in series with the crystals. A circuit for overtone crystals in the 40-50 MHz range is shown, (**fig. 2**). The maximum frequency excursion is considerably lower — typically 1.5 kHz. Series inductance can be used to increase the tuning range of

By Peter J. Bertini, K1ZJH, 20 Patsun Road, Somers, Connecticut 07061

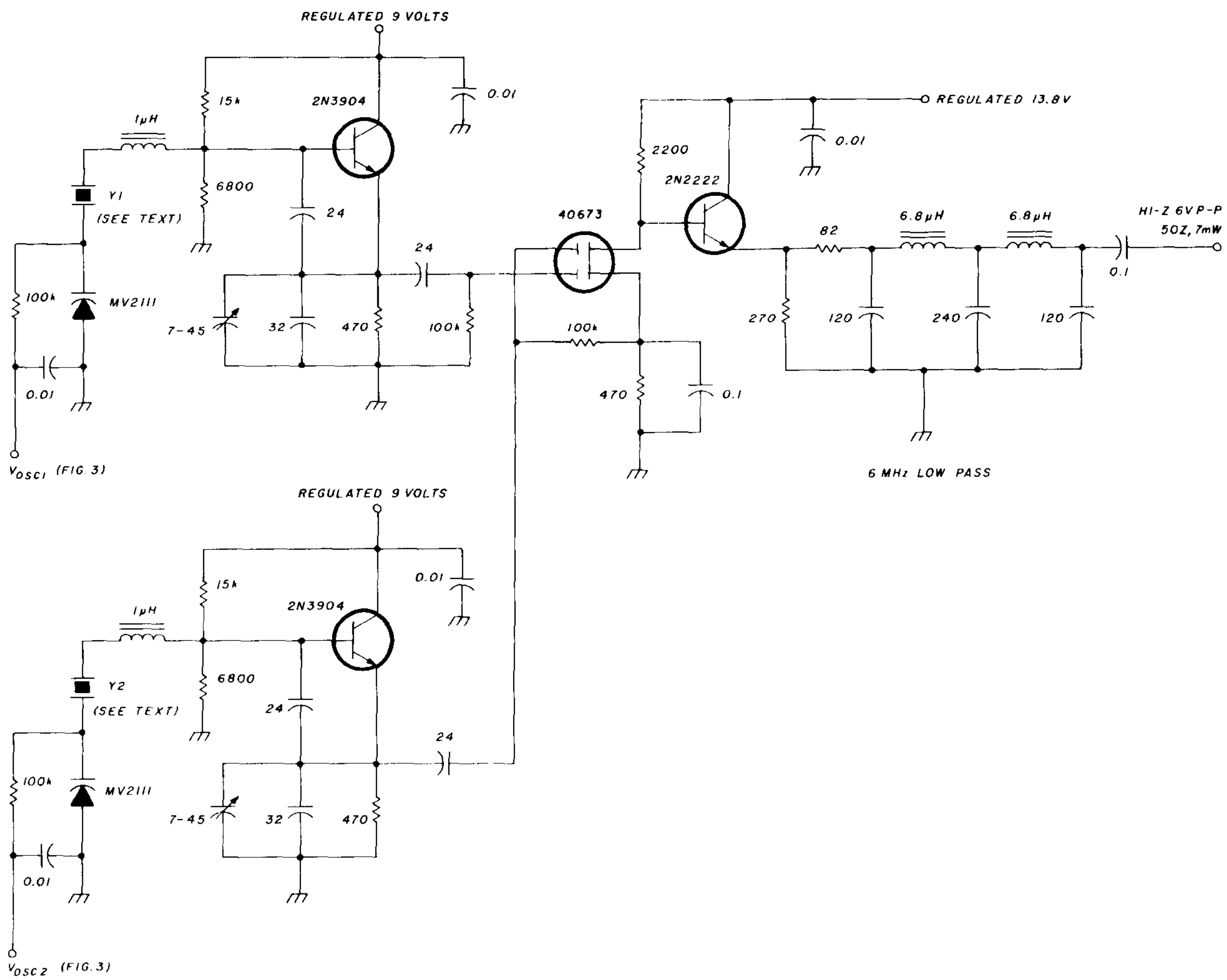

fig. 1. Complete VCXO schematic. Shown are the fundamental mode oscillators, the mixer stage, and buffer. As described in the text, crystals Y1 and Y2 are in the 10 to 22 MHz range. International Crystal type CS-1 3rd overtone crystals (ICM No. 471360) were operated on their fundamental mode in this circuit.

the overtone mode slightly, but the inductors should not be greater than 0.5 µH. It is likely that most BFO requirements can be met with approximately a 1.5-kHz tuning range.

With both varicap control inputs tied to 1/2 V_{CC} the BFO output should be at the exact difference frequency. If a small error exists it can be trimmed out by careful adjustment of the 45-pF trimmers in the Colpitts feedback network. Initially both trimmers should be set at midpoint, and any required trimming accomplished by adjusting both trimmers equally in opposite directions. NPO capacitors should be used in the oscillators. The oscillators should be powered from a 9 to 10 volt regulated source. Either a zener or three-terminal regulator will serve here.

*International Crystal Manufacturing Co., 10 North Lee, Oklahoma City, Oklahoma 73102.

SSB requires few kHz frequency change

Some common VCXOs (Variable Crystal Oscillators) use both variable capacitive and inductive elements to achieve a wider pulling range. Typically these circuits become somewhat unstable at the tuning extremes. In this BFO design, we require only a few kHz tuning range to meet most SSB BFO requirements. In my circuit two oscillators are pulled in opposing directions, effectively doubling the range normally expected from a single oscillator. Producing the two varactor tuning voltages could be accomplished using a dual-ganged potentiometer, but I chose the more elegant approach of using an IC voltage inverter to drive one of the oscillator varicap diodes. This permits the use of a single-stage variable potentiometer to control both oscillators. At first glance, the circuitry used to accomplish this may appear to be more involved than necessary. This will be explained in greater detail further into this article (see **fig. 3**).

The mixer is a 40673 dual-gate MOSFET. An emitter-follower buffer stage provides about +7 dBm (5 mW) when driving a 50-ohm load; or about 6 volts P-P driving a high-Z termination. The low-pass filter shown is optimum for outputs in the 5-6 MHz range. These values can be scaled for other IF ranges. Suitable filters can be found in tables appearing in handbooks or electronic data books.

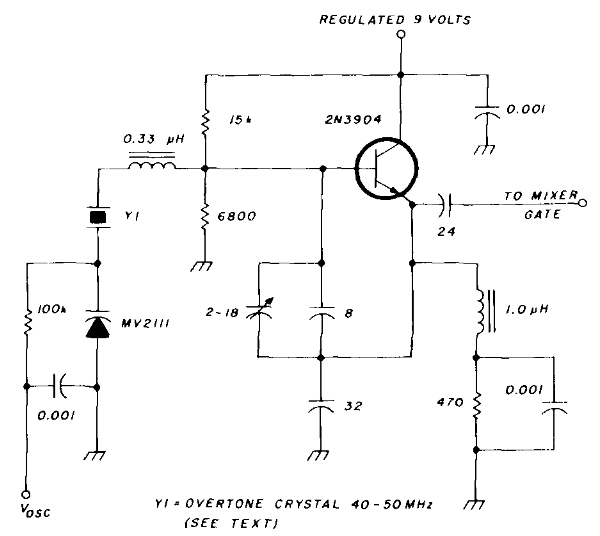

fig. 2. Optional overtone oscillator circuit for use in the BFO. Crystals again are ICM CS-1 (No. 471360) 3rd overtone cuts in the 40 to 50-MHz range. Using this overtone circuit, the maximum BFO tuning range will be limited to about 2 kHz.

good performance at low cost

Although not shown in the schematics, it would be simple to switch trimpots into the circuit in place of the tuning potentiometer to permit generation of fixed discrete BFO frequencies. Thus, one could switch automatically to a preset BFO frequency during transmit and have either preset or manual control of the BFO during receive. The real beauty of this circuit is in the long and short-term stability it ensures. Because of aging or temperature cycling, crystal or component variations should result in a nearly identical positive or negative frequency shift in both oscillators, but the desired difference-frequency will be closely maintained. Control voltages should be taken from a regulated low-noise source for best results. The noise-floor of this BFO will be better than most free-running designs, contributing to better post-filter IF noise performance.

The cost of this circuit compares favorably with the cost of individual low-frequency crystals. While the unit shown was built for 5.595 MHz, the basic scheme is useful for other HF and MF frequencies. The circuit is also useful for a variable frequency source in other

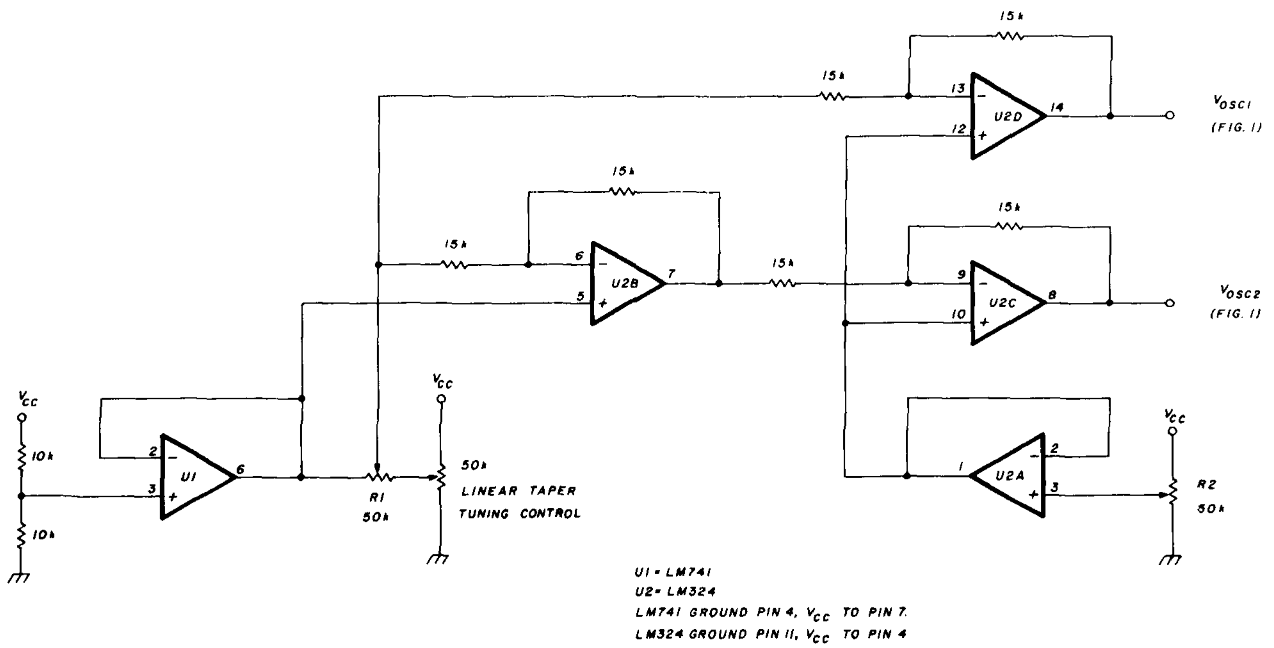

fig. 3. Control tuning voltages are provided by this circuit. The settings for R1 and R2 are discussed in the text. Shielded leads should be used to carry the voltage-oscillator signals to prevent incidental FM modulation from external AC field.

applications requiring good stability over a small frequency range, such as LOs for IF-variable passband or bandwidth tuners, or perhaps as a fine frequency-shifter in some PLL designs.

initial adjustments

The varicap diodes do not exhibit a linear change in capacitance for a given change in voltage over the entire available VCXO tuning range. Some empirical "cut-and-try" adjustments will be needed to obtain the desired results. The greatest change in varicap capacity occurs in the first few volts of tuning bias voltages; this is also the area of greatest non-linearity. Higher tuning voltages will result in smaller tuning ranges, while the tuning linearity will improve. Trimpot R1 sets the DC gain of the op amps (to control the maximum shift of the varicap tuning voltage). The op-amps should be powered from a well-regulated 15 to 24 volt supply. Maximum tuning range will be obtained with the higher voltage.

Trimpot R2 sets the DC offset of the two op amps used to drive the varicaps (to set the DC voltage at which the tuning voltage will start and end). The LM324 op amps were used because of their ability to reach near the power supply bus voltages (V_{CC} and ground) extending the tuning voltage range to those limits.

Trimpot R1 is adjusted to set the desired voltage swing for the varicap tuning produced by the full rotation of the tuning potentiometer. Trimpot R2 is used to set the bias point of the varicaps (the voltage mid-point between the tuning-voltage extremes). Regardless of the setting of R2, the center-tuning voltage for the two varicaps will be the same. For example, assume R1 was set for a 2-volt range, and R2 was set for a center-tuning voltage of 4 volts. The result would be that the noninverted varicap would swing from 3 to 5 volts, while the inverting varicap tuning voltage conversely would swing from 5 down to 3 volts, for a full rotation of the tuning potentiometer. If R2 were set for 7 volts tuning-center, the varicap tuning voltages would be from 6 to 8 volts and 8 to 6 volts, respectively. At first this may appear to be trivial, but remember that the tuning curves for the varicaps is not a linear function. This circuit ensures that any non-linearity of tuning — on either side of center — will be the same, or symmetrical to each other. Thus, the related panel markings would be symmetrical and more pleasing to the eye, and the "tuning-feel" more natural.

reference

1. Raymond C. Petit, W7GHM, "Phase-Locked 9-MHz BFO," *ham radio*, November, 1978, page 49.

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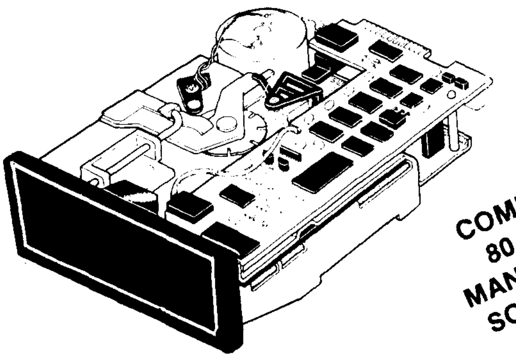

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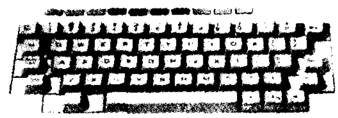

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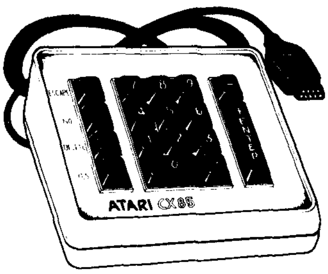

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a compact
IF sweep generator

A stable frequency source with excellent linearity and constant output level

In a sweep generator for the lower IF and HF bands, tuning diodes, or "varicaps" generally don't produce sufficient frequency swing with acceptable linearity. On the other hand, other methods of frequency sweeping — for example, frequency conversion, reactance circuits, and mechanical tuning — may cause the cost and complexity of a home-brew project to increase to the point of being both unaffordable and impractical.

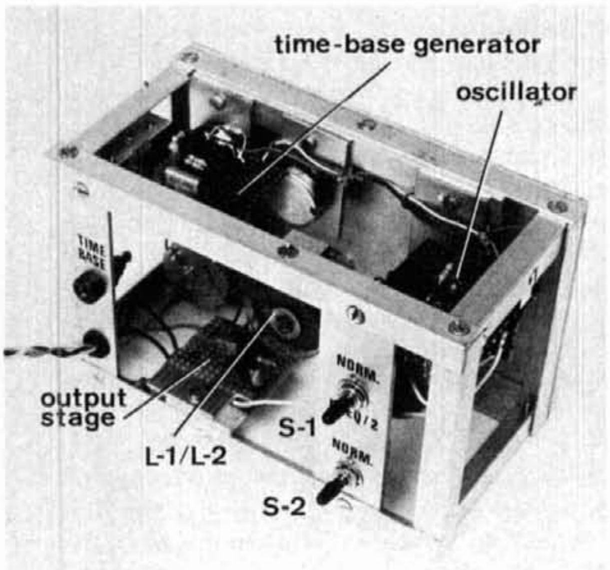
That is why, after coming across an old and half-forgotten oscillator circuit, I was pleasantly surprised to find that a large frequency sweep with good linearity isn't that difficult to build, as this simple little test instrument shows.

To keep the sweep generator as practical and uncomplicated as possible, I decided to use only one frequency band (100 to 200 kHz), using the harmonics of the basic signal for higher frequencies. This approach offers the advantage of using only one coil, without any switching circuit. It also permits the use of a simplified power output stage, which requires only an ordinary low-power transistor.

The principle of using harmonics works out very well. Because the frequency of a measured filter is generally known, confusion about the correct frequency is unlikely. In addition, the waveform of the output signal cannot alter the response of the filter under investigation. Interference from other than the wanted harmonic is not possible either, because the next harmonic is always at least 100 kHz away.

By making the sweep generator deliver pulses rather than sine waves, another advantage comes to light: it's easy to keep the output level of the different harmonics constant, regardless of frequency variations, by simply maintaining the wave form (duty cycle) of the pulse signal.

The little frequency sweeper has already demonstrated its value — not only by aligning IF strips in my equipment, but also by inspiring me to carry out several interesting experiments with crystal filters that would otherwise be very difficult to do.



Inside view of the IF sweep generator. Circuit simplicity and ordinary components provide a versatile test instrument.

how it works

The principle of the variable oscillator is based on a vacuum tube circuit originally described by K.C. Johnson in the April/May, 1949 issue of *Wireless World*. Although it has been revived in solid-state form since that time, the circuit never really caught on for reasons perhaps best expressed by Johnson himself: "It would appear," he said, "that most people do not believe that it could ever work."

The circuit is basically that of a Butler oscillator (**fig. 1A**) tuned to a frequency determined by L1 and C1. In the sweep oscillator, L1 is made electrically variable by what is known as "turns cancellation." This is achieved by coupling the coil to another coil, L2, which passes an RF current of opposite phase.
The magnitude of this out-of-phase current depends upon the imbalance of a differential amplifier (**fig. 1B**).

For example, when applying more negative voltage to its base, the gain of Q1 is reduced and Q2 is conse-

By Hans Evers, PA0CX/DJ0SA, Am Stockberg 15, D-5165, Hürtgenwald, West Germany

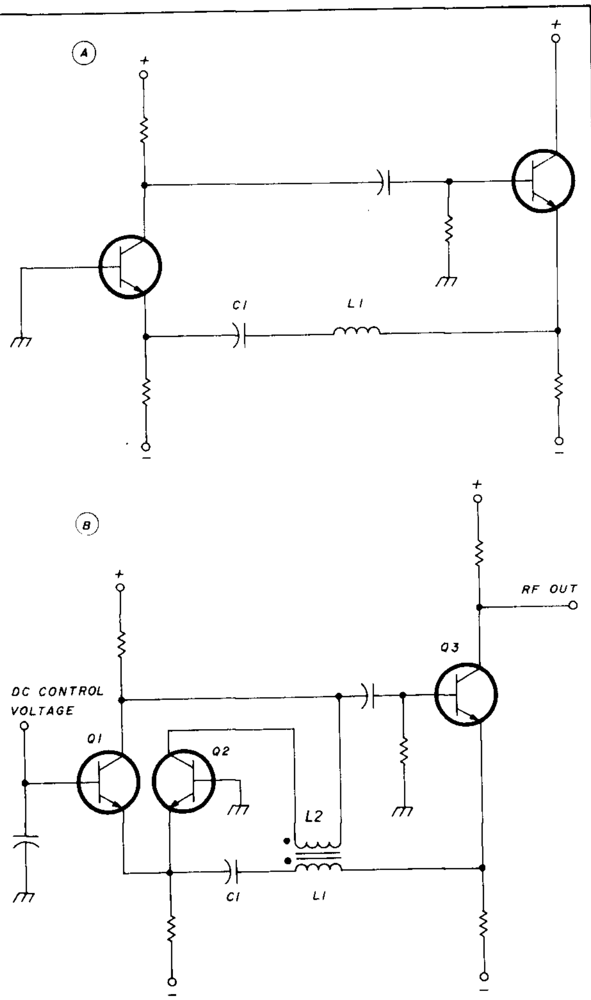


fig. 1. Heart of the sweep generator is based on the Butler oscillator, *A*. In the voltage-controlled oscillator, *B*, the effective coil inductance is controlled by "turns cancellation."

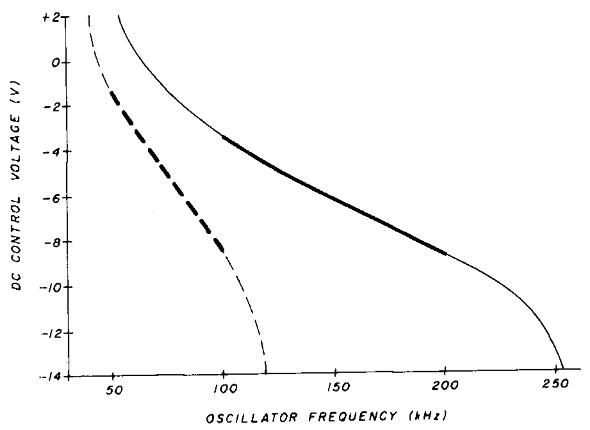


fig. 2. Oscillator basic frequency as function of DC control voltage, with C = 3750 pF. Dotted curve: C = 7500 pF.

quently increased, thus increasing the RF current through the coupling coil, L2.

As the direction of this RF current opposes the current through L1, the inductance of the frequency-determining L1 is effectively reduced, with the result that the oscillator frequency rises.

The more turns on L2, and the tighter the coupling between L2 and L1, the more frequency deviation can be accomplished. Therefore, the principle has nothing to do with the magnetic properties of the coil as such, and the obtainable frequency variation is greater with powdered iron or ferrite toroids than with ordinary air-wound coils, only because the core material permits the "cancellation" coil to assert a stronger influence on the tuning element.

After some experimenting it soon becomes clear that this is a remarkable circuit. Not only can frequency variations be made unusually large; the frequency linearity is also quite spectacular, as **fig. 2** shows. The total range of the oscillator covers frequencies up to a ratio as great as 1:5, including a range of 1:2 with excellent linearity.

Those who would like to experiment a little further with this "smart" circuit, may find it interesting to know that though the closely coupled coils are bound to introduce some stray capacitance, this does not prevent the circuit from working at much higher frequencies. Note that the RF voltages developed on the coils are of the same order: at the right-hand side they are connected to the same emitter follower. Indeed, the principle turns out to be useful for oscillators covering even the highest HF bands.

oscillator

The differential amplifier allows the tuning to be controlled from two independent sources. The base of Q1 is controlled by potentiometer R2 CENTER FREQ, while the base of Q2 receives its control voltage from the time-base generator (**fig. 3**). This provides a simple solution for making the sweep width symmetrical around the center frequency, regardless of amplitude. As the frequency/voltage sensitivity remains constant over the entire CENTER FREQ range, the output of the saw-tooth generator can be calibrated as Δ FREQ, which remains valid for all settings of CENTER FREQ.

A high-quality potentiometer is recommended for R2. In fact, it is a type with very thin and closely wound resistance wire; however, a good-quality, large-size carbon potentiometer would also do the job.

It is the oscillator's stability that determines the highest usable harmonic of the sweep generator. In practice this may be more than 10 MHz, providing that the following precaution is taken: the frequency stability can be improved considerably by joining Q1 and Q2 with "super-glue" and then wrapping the pair in

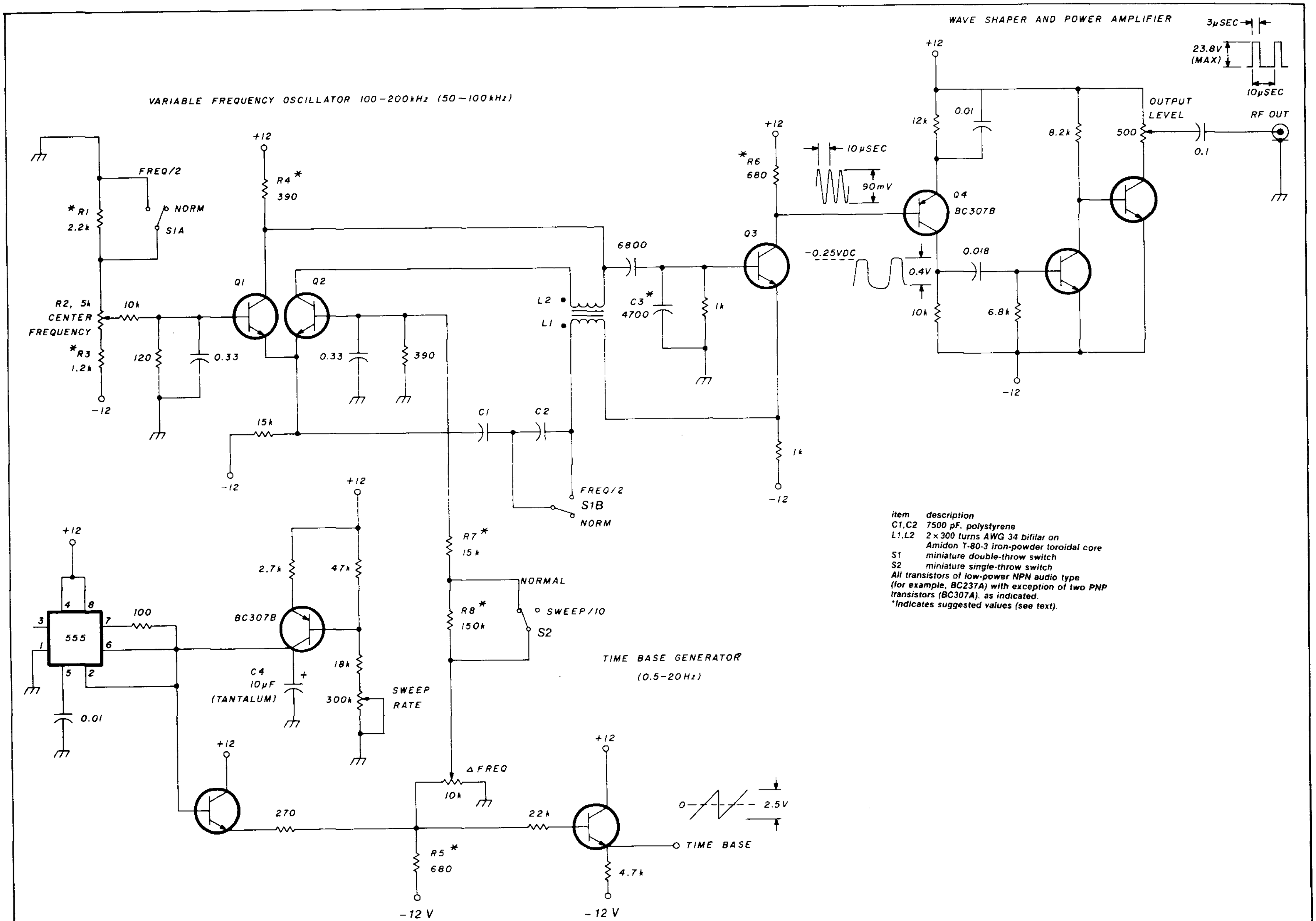


fig. 3. Schematic diagram of the compact IF sweep generator.

item	description
C1,C2	7500 pF, polystyrene
L1,L2	2 × 300 turns AWG 34 bifilar on Amidon T-80-3 iron-powder toroidal core
S1	miniature double-throw switch
S2	miniature single-throw switch

All transistors of low-power NPN audio type (for example, BC237A) with exception of two PNP transistors (BC307A), as indicated.
*Indicates suggested values (see text).

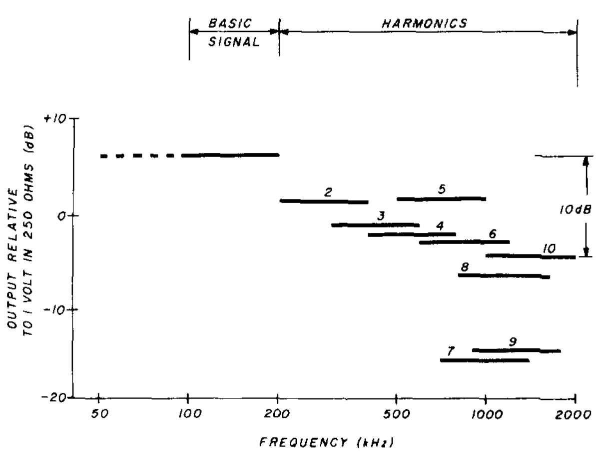


fig. 4. Effective output level of basic signal and its harmonics up to 2 MHz.

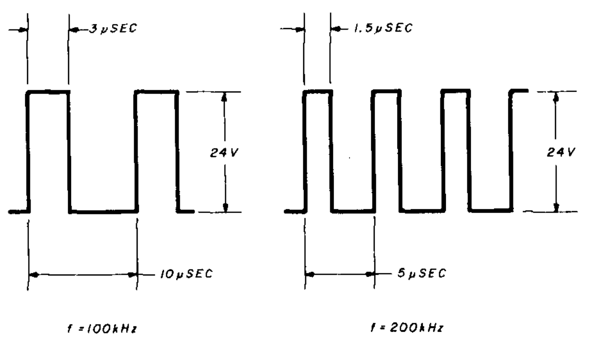


fig. 5. Output waveforms of the sweep generator. Left at 100 kHz, right at 200 kHz. As with varying frequency the duty cycle remains constant. The RF power level does not alter within the tuning range of each harmonic.

thin copper wire, and finally soldering the total into one solid metal blob. This assures that the two transistors will remain at virtually the same temperature, while their common, relatively heavy thermal mass prevents fast frequency drift.

In applications in which the sweep generator is used for sweeping filters at frequencies lower than 100 kHz, the basic range of the oscillator may be dropped to 50 to 100 kHz at the expense of a slight deterioration in frequency linearity. Double-throw switch S1 shorts one of the tuning capacitors and also shorts a resistor in series with the CENTER FREQ potentiometer. This enables the oscillator to work on half frequencies within the linear portion of the control range.

The calibration of both CENTER FREQ and Δ FREQ could be done very accurately by listening to the harmonics of the oscillator with a communication receiver.

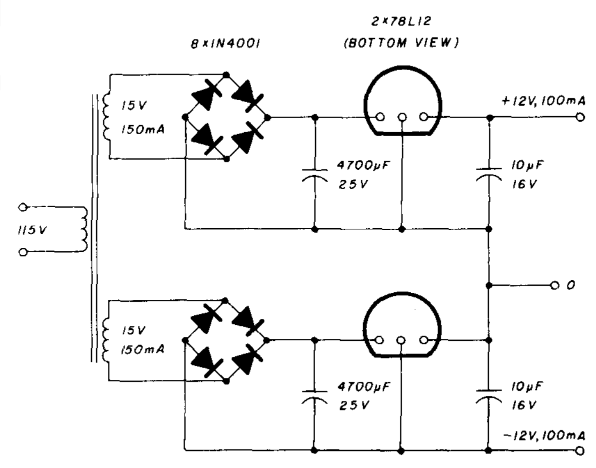


fig. 6. Power supply for sweep generator.

time base

The sawtooth generator circuit enables sweep rates from twice a second, for slowly sweeping sharp-edged responses from crystal filters without the risk of ringing effects, to 20 Hz, permitting a flicker-free oscilloscope display.

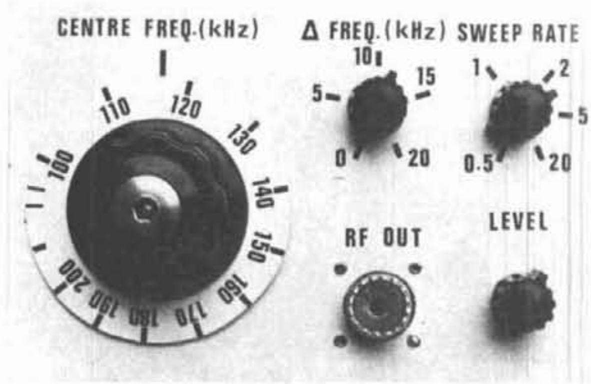
To keep the frequency deviations symmetrical around the center frequency, R5 may need some correction. Also the values given for R7 and R8 are approximate, as these resistors determine the Δ FREQ calibration.

When using a harmonic of the basic oscillator signal, not only does the frequency increase, but the indicated Δ FREQ value must also be equally multiplied. At higher frequencies the sweep width may consequently become too large and therefore impractical. Thus a provision was necessary for dividing the sweep width by a factor 10 in the form of R8. Normally this extra series resistor remains shorted by S2.

wave-shaping circuit

This circuit produces the harmonics of the oscillator signal. As a general rule, the widest harmonic spectrum may be created by generating the shortest pulses. However, the shorter the pulses, the less power each harmonic contains. After some experimenting (to compensate for my insufficient experience with Fourier-analysis techniques) I decided to aim for an output pulse with a duty cycle of about 30 percent. This is not too difficult to obtain and results in an overlapping spectrum of output signals, the levels of which remain — at least up to 2 MHz — within a 10-dB range (**fig. 4**). Only above 2 MHz does the effective output tend to drop beyond this range.

The signal strength of each individual harmonic is a different matter. It should remain constant during



IF sweep generator has a frequency range of 1:2 with excellent linearity.

the sweeping process. To make this possible, not only the amplitude but also the duty cycle of the rectangular waveform must remain constant, regardless of frequency.

A satisfactory sine wave can be obtained from the oscillator section by trimming R4 and C3. At the same time, a constant amplitude is maintained over the full frequency range. Q4 conducts mainly on the tops of this sine wave. These tops are then amplified and clipped, which results in a rectangular waveform (**fig. 5**). The surface of these pulses (amplitude X time) stays constant, regardless of frequency. This assures a constant output level of each harmonic.

The pulse characteristic of the output signal permits the use of an ordinary low-power transistor for the output stage. Functioning as an electrical switch, rather than an analog amplifier, the transistor must handle neither appreciable voltage nor current at any common moment in time. This explains how a perfectly cool little 200 mW transistor is capable of delivering the total output power (basic signal plus all harmonics together) of almost 1 watt.

The output impedance of the final stage depends on the setting of the OUTPUT LEVEL potentiometer. At maximum setting, the output impedance is equal to half the value of the potentiometer; that is, 250 ohms. Still, the sweep generator can be safely loaded with 50 ohms impedance without upsetting anything. Only an amplitude over 50 ohms will drop to one-fifth; that is, about 5 volts.

power supply

The power supply (both +12 volts and −12 volts at about 65 mA) may be very simple (**fig. 6**), using 78L12 voltage regulators. The hum level must be low, because any ripple on Q1 and Q2 control voltages causes frequency modulation. Although the toroidal coil L1/L2 is relatively insensitive to stray fields, it may nevertheless pick up hum from a nearby transformer,

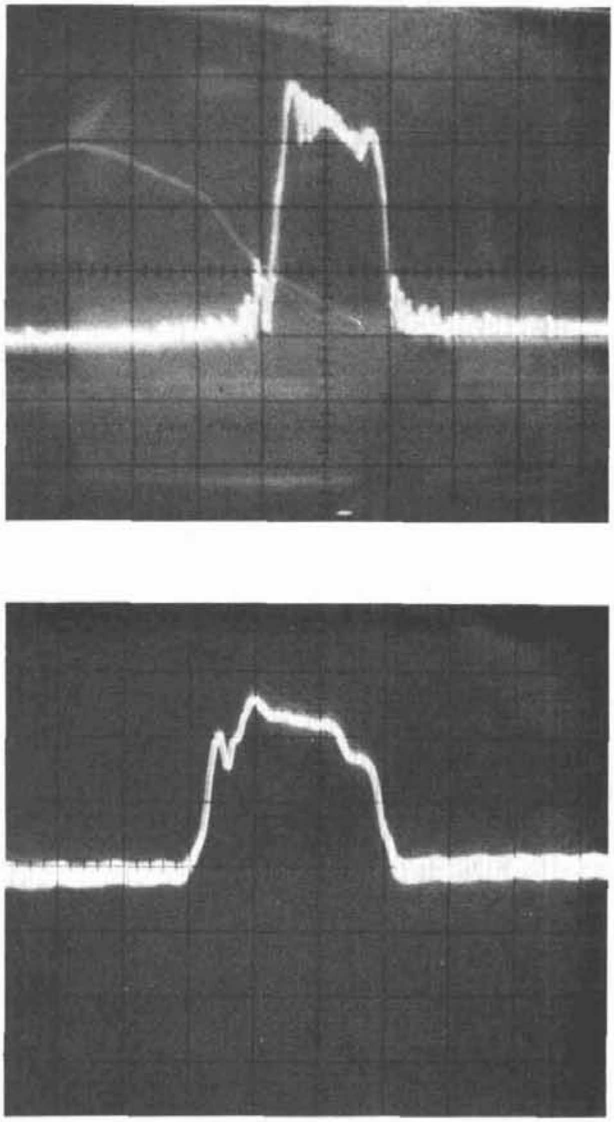


fig. 7. *Top*: Response of IF amplifier with 9 MHz crystal filter in HF transceiver. Sweep rate 4 Hz. *Bottom*: poorly matched mechanical bandfilter in 455 kHz IF amplifier (Collins F455-J-31). Sweep rate 4 Hz.

causing a rippling oscilloscope display. It is for this reason that the power supply has not been incorporated into the sweep generator itself, but is instead connected at the end of a 3-wire lead.

The RF detector for this sweep generator is a simple diode detector. Two examples using this detector are shown in **fig. 7**. However, the value of the measurement can be enhanced considerably by using a logarithmic detector instead. This permits an amplitude display on a decibel scale, over several decades, if necessary. (A simple version of such a logarithmic detector will be the subject of a forthcoming article in *ham radio*.)

ham radio

graphical selection of mixer frequencies

See, at a glance, any spurious that might cause problems

Selecting the proper mixer frequencies can be a real problem. Often a lengthy trial-and-error procedure yields unsatisfactory results because of too many spurious signals in the passband. The graphical technique described here will deliver more accurate results in less time and with less difficulty. Some plotting is required, and a simple calculator will help with the math.

background

When two frequencies, f_1 and f_2, are combined in a mixer, the nonlinear action of the mixer produces a series of products that have the form:

$$P = Mf_1 + Nf_2 \qquad (1)$$

where M and N are positive or negative integers, and P is the frequency of the combination. In ordinary mixer use, a bandpass or low-pass filter removes all but the desired product P, called the desired output frequency, or f_0. Generally, the larger M and N are, the smaller the amplitude of P. Then, too, the farther a particular P is from f_0, the less interference it will cause. One way to measure the frequency separation is to use the percentage separation, S, given by:

$$S = 100\frac{P - f_0}{f_0} \qquad (2)$$

Now, if f_1 is always chosen as the smaller of f_1 and f_2, then the ratio f_1/f_2 can be given by:

$$f_1/f_2 = \frac{-S + 100(N - 1)}{S - 100(M - 1)} \qquad (3)$$

where $f_0 = f_2 + f_1$

$$\text{or } f_1/f_2 = \frac{S + 100(1 - N)}{S + 100(1 + M)} \qquad (4)$$

where $f_0 = f_2 - f_1$

Equations 3 and **4** are used to plot the spurious components, or spurs; **eq. 3** is used for sum spur charts, and **eq. 4** is used for difference spur charts. The case for N = M appears as a vertical line on the sum chart at S = 100(N − 1), and the case for N = −M appears as a vertical line on the difference chart, also at S = 100(N − 1).

conversion of fixed frequencies

Figure 1 shows a graph with several spur plots for f_1 = 3 MHz and f_2 = 18 MHz. Which ones need to be plotted? Well, that depends on how stringent your requirements are. Once you determine how low the spurs must be, you need plot only the spurs which

By G. Timothy Anderson, W2HVN,
902 Ashburn Street, Herndon, Virginia 22070

table 1. Typical values of spurious levels in a double-balanced mixer. Values shown are in dB below desired output. Here, f_2 is the local oscillator frequency.

	f_2	$2f_2$	$3f_2$	$4f_2$	$5f_2$	$6f_2$
$6f_1$	90	90	90	90	90	90
$5f_1$	80	90	71	90	68	90
$4f_1$	90	86	80	88	85	86
$3f_1$	64	69	50	77	47	74
$2f_1$	73	74	70	71	64	69
f_1	0	35	13	40	24	45

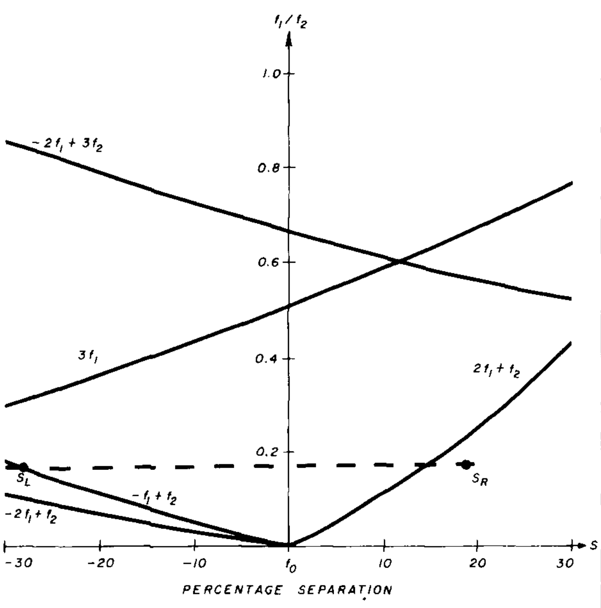


fig. 1. Spur chart for fixed-frequency conversion example: $f_0 = f_2 + f_1$.

might exceed that level. Some manufacturers provide tables of spur levels for different values of M and N.* **Table 1** shows some typical values.

To use a spur chart such as shown in **fig. 1**, you must somehow represent the bandwidth of the system. In **fig. 1**, this is done by plotting a dashed line representing an output frequency range for a given f_1 and f_2. The end points are denoted by S_L and S_R.

$$S_L = 100\frac{f_{0L} - f_0}{f_0} \quad \textbf{(5)}$$

and

$$S_R = 100\frac{f_{0R} - f_0}{f_0} \quad \textbf{(6)}$$

*Mini-circuits, P.O. Box 166, Brooklyn, New York 11235, and Watkins-Johnson Company, 3333 Hillview Avenue, Palo Alto, California 94306, for example, furnish tables of this kind.

where f_{0L} and f_{0R} are, respectively, the low and high ends of the output passband. S_L and S_R are the abscissa values; the ordinate value, f_1/f_2, is already known. Refer again to **fig. 1**. If, for example, an output passband of 10 MHz is chosen, from 15 MHz to 25 MHz, then $S_L = -28.6$ and $S_R = 19.0$. The ordinate is $f_1/f_2 = 3/18 = 0.17$. Note that two of the spurs intersect the bandwidth line, $-f_1 + f_2$ and $2f_1 + f_2$. This means that these two spurs are in-band harmonics. If the bandwidth was narrowed to, say, 5 MHz (18.5 MHz to 23.5 MHz), then the end points would be closer together and the spurs would be outside the passband. Note that if the slope of the filter is known, the attenuation of the out-of-band spurs can be calculated because **fig. 1** indicates how far out on the filter skirt the spurs are located. Of course, there is still the problem of the 18-MHz signal in the output. It, too, is a spur, and must be taken into consideration since it will be down probably no more than 50 dB.

conversion of bands of frequencies

Now that I've discussed a specific case with fixed frequencies, let's consider the general case — converting one band of frequencies to another band of frequencies where f_1, f_2, and f_0 have different bandwidths. Suppose you want to convert 300 MHz ±10 MHz to 200 MHz ±15 MHz by mixing with 100 MHz ±5 MHz. You have f_{1L} = 95 MHz, f_{1H} = 105 MHz, f_{2L} = 290 MHz, f_{2H} = 310 MHz, f_{0L} = 185 MHz, and f_{0H} = 215 MHz. First you'll outline the region you want to be free of spurs. (In general, this takes the shape of a hexagon with slightly curved sides. Since the curvature is slight, you can assume straight lines to ease the computations and still retain good accuracy.) This is done by using **eqs. 5** and **6** to calculate the corner points. Different combinations of the high and low extremes of f_1 and f_2 are used to find each particular f_0. Here's how to do it (remember — $f_0 = f_2 - f_1$ here).

Calculate: S_L using f_{1L} and f_{2H}
S_L using f_{1H} and f_{2H}
S_L using f_{1H} and f_{2L}
S_R using f_{1H} and f_{2L}
S_R using f_{1L} and f_{2L}
S_R using f_{1L} and f_{2H}

These calculations produce the numbers shown in **table 2**, and the six points 1 through 6 in **fig. 2**; the dashed lines define the desired spur-free area. For this combination of frequencies, two spurs cross the hexagon. Either of two things can be done to resolve this. You can change the frequencies or try a high-level mixer with reduced drive, which will result in fewer spurs.

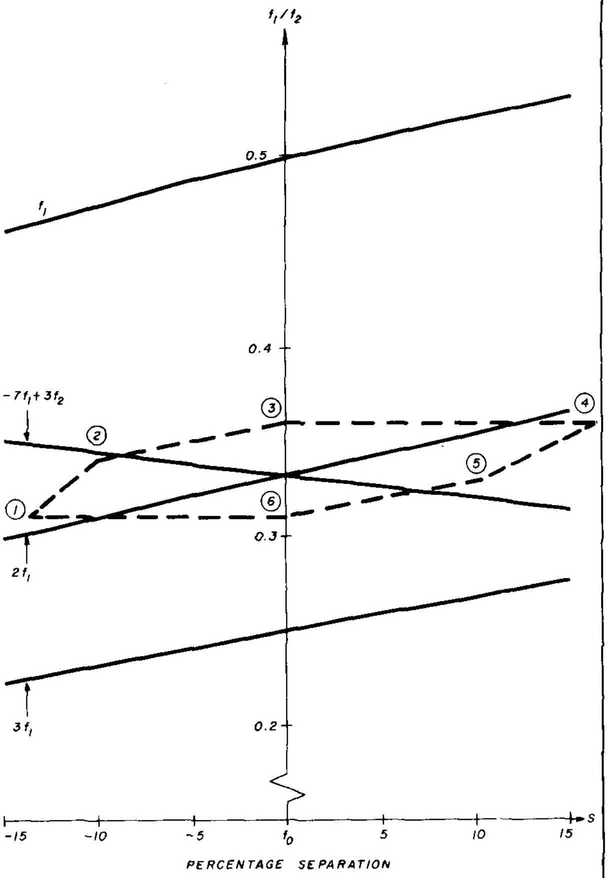


fig. 2. Spur chart for conversion of bands of frequencies — $f_0 = f_2 + f_1$. The circled numbers (1-6) are those referred to in the text and listed in *table 2*.

table 2. Values for points 1 through 6 in *fig. 2*.

point	S_L	S_R	f_1/f_2
1	−13.95	—	0.31
2	−9.76	—	0.34
3	0.00	—	0.36
4	—	16.22	0.36
5	—	10.26	0.33
6	—	0.00	0.31

As a final example, let's try upconverting 28-32 MHz to 50-54 MHz by mixing with 22 MHz. Here, f_1 has zero bandwidth ($f_{1L} = f_{1H}$). This produces the dashed line (---) shown in **fig. 3**. Two things are evident: the hexagon is now a quadrilateral (because one of the frequencies, f_1, has zero bandwidth), and one of the spurs cuts through this quadrilateral. If you select a different combination — say, $f_1 = 22.5$ MHz and $f_2 = 27.5 - 31.5$ MHz — then you get a quadrilateral as shown by the dashed-and-dotted line (---) in **fig. 3**. This new area is spur-free so the filtered output will be free of spurs.

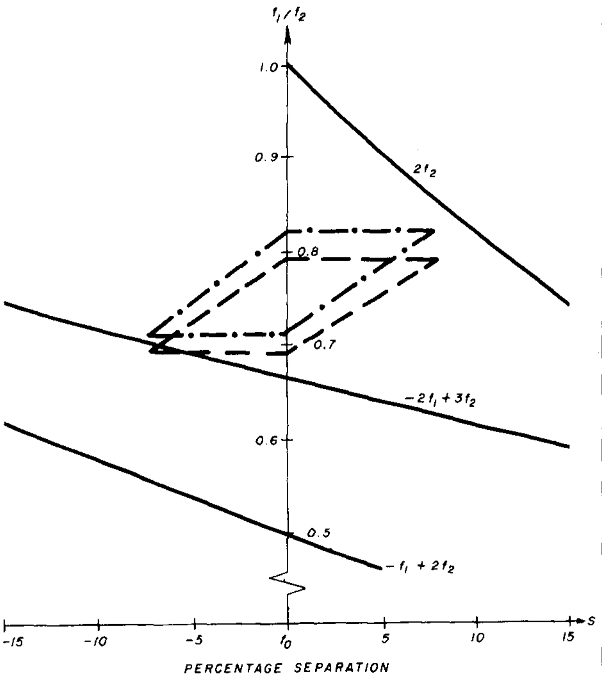


fig. 3. Spur chart with f_1 having zero bandwidth — $f_0 = f_2 + f_1$.

appendix

Equation 2 can be rewritten to give:

$$P = \frac{f_0 S}{100} + f_0 \qquad (7)$$

For the case when $f_0 = f_2 + f_1$, inserting **eq. 1** in **eq. 7** yields $P = M(f_0 - f_2) + Nf_2$, or

$$f_2 = \frac{P - Mf_0}{N - M} \qquad (8)$$

Equation 8 can be used in the expression for f_1/f_2 to eliminate f_2:

$$f_1/f_2 = \frac{f_0 - f_2}{f_0} = \frac{Nf_0 - P}{P - Mf_0} \qquad (9)$$

Now, if **eq. 7** is inserted into **eq. 9**:

$$f_1/f_2 = \frac{Nf_0 - (f_0 S/100 + f_0)}{f_0 S/100 + f_0 - Mf_0}$$

$$= \frac{-S + 100(N-1)}{S - 100(M-1)} \qquad (3)$$

If $f_0 = f_2 - f_1$, a similar procedure gives:

$$f_2 = \frac{P + MF_0}{N + M} \qquad (10)$$

$$f_1/f_2 = \frac{P - Nf_0}{P + Mf_0} \qquad (11)$$

and

$$f_1/f_2 = \frac{S + 100(1 - N)}{S + 100(1 + M)} \qquad (4)$$

reference

1. M.Y. Huang et. al., "Select Mixer Frequencies Painlessly," *Electronics Design*, No. 8, April 12, 1976, pages 104-109.

ham radio

Morse code computer tutor

Let your VIC-20 help you upgrade

For many Amateurs, it isn't theory or rules and regs that make upgrading difficult — *it's the code*. Jumping from a plateau of 10 words per minute or 18 words per minute seems impossible.

Satisfying these code requirements is even more difficult if you don't get enough practice. If CW isn't your favorite mode of operation, you're not likely to push yourself to practice on the air. Practice with code tapes can be productive — until you start memorizing them. And W1AW's code practice, while useful, may not always match your schedule or be strong enough to copy.

With this program (**fig. 1**), you can turn your VIC-20 personal computer into your own personal Morse code computer tutor. This tutor will give you all the practice you ask for at any time, at any speed, and always at Q5 conditions.

what the program does

The computer tutor sends groups of 20 random Morse code characters at any user-selectable speed starting at 4 words per minute. You type in the characters as they are sent. After the twentieth character the tutor identifies the random characters it has sent, and then lists your responses and your score. A particular advantage of this system of practice is that it forces you to copy Morse code with a keyboard; without a keyboard, few people can transcribe code at speeds greater than 25 WPM.

how the program works

After printing a sign-on message the program inputs the user-selected speed in **line 5**. **Lines 6** through **9** initialize certain variables such as character counter, correct response counter, and character strings. **Lines 20** through **91** are subroutines that store all the dot/dash patterns and their printable equivalents.

The selection of the random character and its conversion into Morse code begins at **line 100**. Here the program generates a random number between 1 and 36 inclusive. **Lines 110** through **120** use the random number to select one of 36 characters — the letters

```
1 REM MORSE CODE COMPUTER-TUTOR
  BY LAWRENCE G SOUDER, N3SE
2 PRINT "■I WILL SEND A GROUP OF TWENTY CHARACTERS.
  FOR  SCORE HIT RETURN."
3 PRINT "HOW MANY WORDS PER    MINUTE DO YOU WANT?"
5 INPUT V
6 S = 27-V
7 C=0
8 Z=0
9 K$="": T$=""
10 GOTO 100
20 C$=".-A"
21 RETURN
22 C$="-...B"
23 RETURN
24 C$="-.-.C"
25 RETURN
26 C$="-..D"
27 RETURN
28 C$=".E"
29 RETURN
30 C$="..-.F"
31 RETURN
32 C$="--.G"
33 RETURN
34 C$="....H"
35 RETURN
36 C$="..I"
37 RETURN
38 C$=".---J"
39 RETURN
40 C$="-.-K"
41 RETURN
42 C$=".-..L"
43 RETURN
44 C$="--M"
45 RETURN
46 C$="-.N"
47 RETURN
48 C$="---O"
49 RETURN
50 C$=".--.P"
51 RETURN
52 C$="--.-Q"
53 RETURN
54 C$=".-.R"
55 RETURN
56 C$="...S"
57 RETURN
58 C$="-T"
59 RETURN
60 C$="..-U"
61 RETURN
62 C$="...-V"
63 RETURN
64 C$=".--W"
65 RETURN
66 C$="-..-X"
67 RETURN
68 C$="-.--Y"
69 RETURN
70 C$="--..Z"
71 RETURN
72 C$=".----1"
73 RETURN
74 C$="..---2"
75 RETURN
76 C$="...--3"
```

fig. 1. N3SE program for Morse code training and practice on the VIC-20.

By Lawrence G. Souder, N3SE, 4539 Manayunk Avenue, Philadelphia, Pennsylvania 19128

```
77 RETURN
78 C$="....-4"
79 RETURN
80 C$=".....5"
81 RETURN
82 C$="-....6"
83 RETURN
84 C$="--...7"
85 RETURN
86 C$="---..8"
87 RETURN
88 C$="----.9"
89 RETURN
90 C$="-----0"
91 RETURN
100 R=INT(RND(1)*36)+1
103 IF C=20 GOTO 500
105 IF R > 21 GOTO 120
110 ON R GOSUB 20,22,24,26,28,30,32,34,36,38,40,42,
    44,46,48,50,52,54,56,58,60
115 GOTO 130
120 ON R-21 GOSUB 62,64,66,68,70,72,74,76,78,80,82,
    84,86,88,90
130 T$=T$+RIGHT$(C$,1)
131 C=C+1
134 C1$=RIGHT$(C$,1)
135 GOTO 200
140 GOTO 100
200 L=LEN(C$)
205 L=L-1
210 N=1
220 M$=MID$(C$,N,1)
230 N=N+1
240 GOSUB 400
250 IF L>=N GOTO 220
260 FOR X=1TO10*S:GET L$
262 IF L$<>""THEN K$=K$+L$
265 NEXT X
270 GOTO 100
400 S1=S
410 IF M$="-" THEN S1=7*S
420 POKE 36878,15
430 POKE 36875,240
440 FOR X=1TOS1*2: NEXTX
450 POKE 36878,0
460 FOR X=1TOS:GET L$
464 IF L$<>""THEN K$=K$+L$
468 NEXT X
470 RETURN
500 INPUT R
505 FOR X=1 TO 20
510 IF MID$(T$,X,1)=MID$(K$,X,1) THEN Z=Z+1
520 NEXT X
525 PRINT "■"
527 PRINT
530 PRINT T$
540 PRINT K$
545 PRINT
550 PRINT "YOUR SCORE IS ";100*(Z/20);"%"
560 PRINT "AGAIN AT SAME SPEED?"
570 INPUT R$
580 IF R$="Y" GOTO 7
582 PRINT "AT DIFFERENT SPEED?"
584 INPUT R$
586 IF R$="Y" GOTO 3
590 END
```

A through Z and the numerals 0 through 9. For example, from the random number 7 these lines will select the character "G," which is held in **line 32**.

Before the dot/dash patterns are sent in Morse code, **line 130** separates the printable character from its Morse elements and saves it to be printed later. For example, it separates the letter "G" from the string "— —.G". **Lines 131** through **265** take each dot and dash and call up a subroutine to output a tone of the proper duration. This subroutine is in **lines 400** through **470**.

*The heart-shaped graphic character in lines 2 and 525 is used to clear the screen in the VIC-20.

Two FOR-NEXT loops produce the delays for the dots and dashes and for the spaces between dots, dashes, and characters. During these delay loops the program inputs any response from the user. After 20 characters have been sent, **lines 500** through **550** compare the random characters sent with the responses typed in and print out both strings of characters along with the user's score. Then **lines 560** through **586** ask the user whether more practice is desired at the same speed, at a different speed, or not at all.

modifying and adapting the program

You might improve the program by adding some of the other characters such as punctuation. Do this by adding character string statements after **line 91**. Then extend the range of the random number generator by the same amount. For example, if you want to add a comma, add these lines after 91: 93 C$ = "— —..— —,"; 94 Return. Then change the random number generator in **line 100** to: 100 R = INT(RND(1)*37) + 1 to make its range 1 through 37 inclusive.

Now there's no excuse to put off upgrading. With this computer tutor you can get as much code practice as you need at any time — and improve your typing skills, too.

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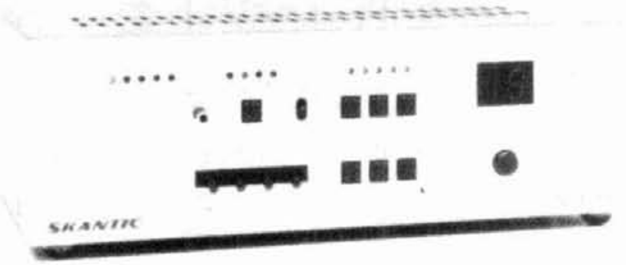

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More Details? CHECK—OFF Page 126

✓ 126

ham radio TECHNIQUES

As this issue went to press, U.S. Amateurs received FCC approval to operate on the new 12-meter band (24.89-24.99 MHz) as of June 22. Unfortunately, we're approaching a sunspot minimum and the band will be relatively worthless for long-distance skip communication. But all is not lost — good contacts can be had by sporadic-E skip, and once in a while an unusual burst of activity from the sun will open the band for DX for a few hours. In any event, it's a good idea to get on the band and enjoy this new chunk of spectrum as soon as operation is authorized.

I've monitored the band for years and have heard plenty of DX when conditions were good. Over 40 countries are licensed for operation on the 12-meter band. See how many of them you can hear and work! Even at the low point of the sunspot cycle, the north-south path isn't bad, and you should be able to work some South American Amateurs when the band opens up.

antennas for 12 meters

Amateurs who have an "all-band" antenna with a tuner at the operating position can get on the band immediately. Others will have to improvise. One quick way to get on the air is to string up a dipole or inverted-V to your tower and feed it with a separate coax line as shown in **fig. 1**. The higher you can get it in the air, the better the results.

Another easy-to-erect antenna is a ground plane **(fig. 2)**. As in the case of the dipole, the higher you can erect it, the better it will work. If you have time to build a beam for the band, **fig. 3** provides dimensions for a quad antenna and **fig. 4** provides Yagi information.

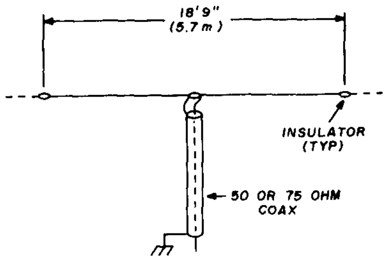


fig. 1. Get on the new 12-meter band quickly with this dipole or inverted-V antenna.

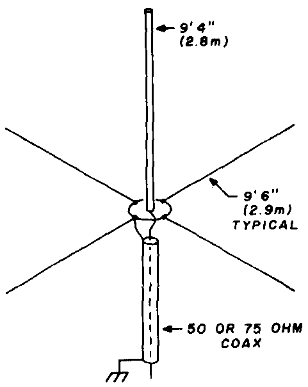


fig. 2. Simple ground plane for the new 12-meter band. Vertical portion is made of 3/4-inch aluminum tubing. Radials are No. 14 wire.

the G8PO "JAWS" antenna

G8PO has discussed an interesting variation of the quad loop that has provided superior results on 7 MHz **(fig. 5)**.[1] Mast height is less than that required for the conventional loop as the bottom portion is bent out of the vertical plane. The antenna is fed at one corner by a gamma match system to provide a good match to a coax line. Antenna polarization is vertical.

The lower portion of the loop has three conductors in parallel, running nearly horizontal to the ground. Tests indicated improvement in performance over the England-New Zealand test path and some front-to-back signal discrimination became apparent.

Checks against a conventional loop over the same path showed that the regular loop was consistently weaker during many contacts. The forward gain of the JAWS antenna was estimated to be 3 dB or better, and the front-to-back ratio was about 6 dB.

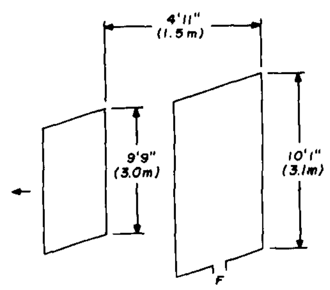


fig. 3. Two-element quad for the 12-meter band. Driven element is fed at point *F* with 50 or 75-ohm coax line.

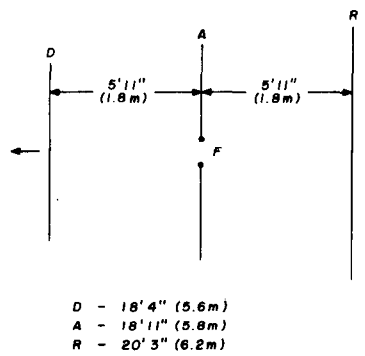


fig. 4. Dimensions for 12-meter beam made out of 1-inch tubing with 7/8-inch tip sections. Feedpoint resistance at *F* is about 20 ohms.

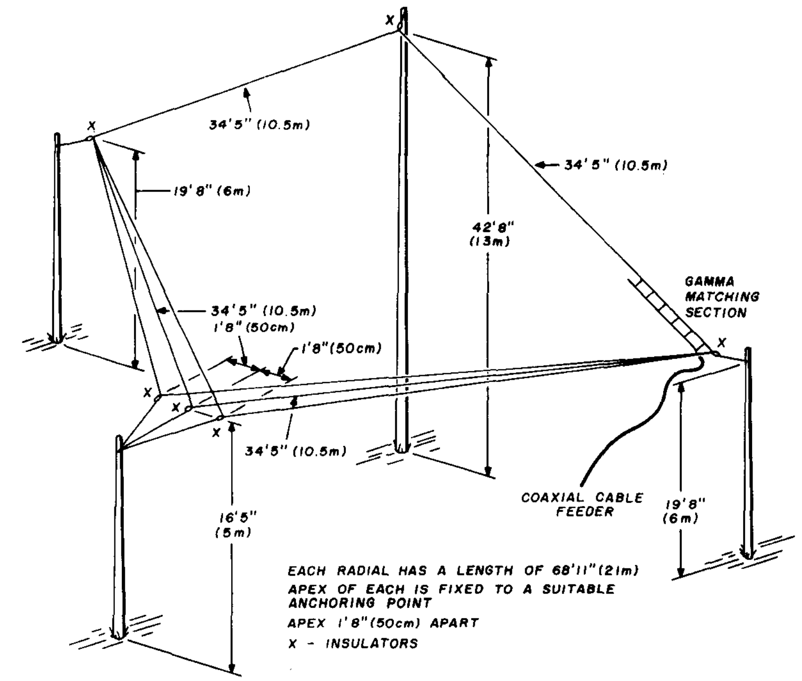


fig. 5. The G8PO "JAWS" Antenna for 40 meters. Directivity is to the left through the apex of the three parallel-connected wires. (*Figure courtesy RSGB.*)

The gamma match is made of wire, with the gamma section measuring about 6.5 feet (1.98 meters) long and spaced away from the loop wire about 4 inches (10 cm). The gamma capacitor is 200 pF.

the multiband antenna

Independent experimenters have discovered that altering the shape of a driven element can change the harmonic resonance without appreciably altering the fundamental resonant frequency of the antenna. This is a good technique to use for a two-band antenna. A typical linear element of uniform diameter, unfortunately, does not exhibit resonance on the exact harmonic frequencies because of end effects. A 7-MHz dipole, for example, is *not* resonant in the 21-MHz band.

However, by changing the shape of the element, the third harmonic resonant frequency can be lowered without changing the fundamental frequency to any great extent. The principle is illustrated in **fig. 6**. The vertical antenna element *A* exhibits a quarter-wave resonance at 3.6 MHz. By formula, the antenna is 65 feet (19.81 meters) high. The third harmonic resonance, by formula, falls at 11.6 MHz. The actual third harmonic of 3.6 MHz, however, is 10.8 MHz. Thus there is a difference of 800 kHz between the actual third harmonic of the fundamental frequency and the third harmonic resonance of the vertical.

If the vertical resonance at the third harmonic region could be "pulled" down to 10.1 MHz, then the antenna could operate in the 30-meter ham band (10.1 to 10.15 MHz). Can this be done without disturbing the resonance in the 80-meter band?

Figure 6B shows the technique to accomplish this. The antenna element is made "fatter" near the area of maximum third harmonic voltage. This provides additional capacitance to ground at this frequency. On the fundamental frequency, the voltage is much lower at this point in the antenna element and the capacitive effect to ground is much less. In this manner the third harmonic resonance frequency is lowered *without too much effect on the fundamental frequency*.

Shown in **fig. 7** is an antenna developed by K6KBE for two-band operation. A three-legged tower having a very thin upper portion and a tapered lower section, this antenna shows resonance on both the 80 and 160-meter bands **(fig. 8)**.

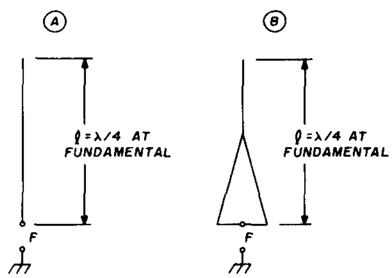


fig. 6. Antenna *A* shows classic response on fundamental and third harmonic. Antenna *B* exhibits lower-than-normal resonance on third harmonic while fundamental resonant frequency remains virtually unchanged.

The tower is 132 feet (40.2 meters) high with a base 12 feet (3.66 meters) on a side. The design frequencies are 1.85 and 3.7 MHz. The SWR across the 160-meter band is less than 1.8:1 at the band edges and below 1.5:1 from 3.5 to 3.9 MHz, rising to 2.3:1 at 4 MHz.

The top 44 feet (13.41 meters) of the antenna consists of a flexible aluminum whip, 2 inches (5.08 cm) in diam-

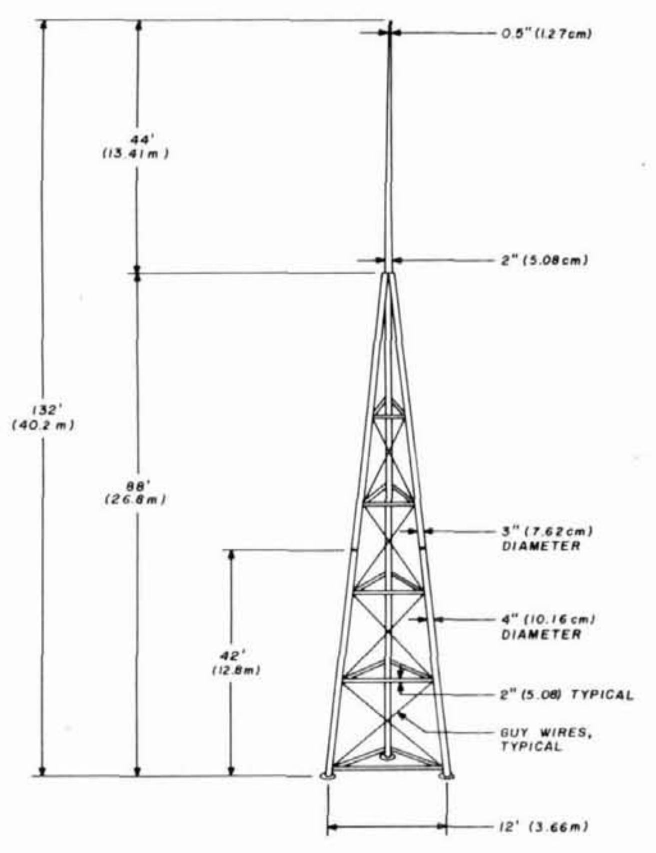


fig. 7. Details of 160/80-meter vertical antenna at K6KBE. Three-legged tower is 88 feet (36.88 meters) high with 44 foot (13.41 meter) whip on top.

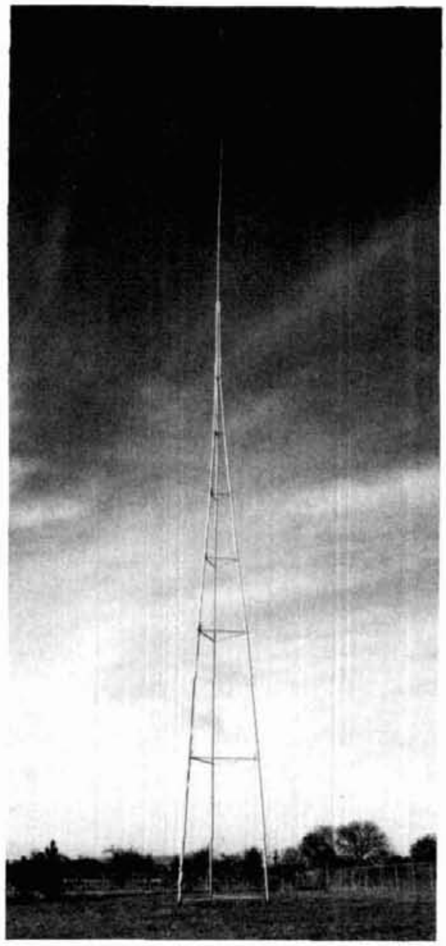


fig. 8. The self-supporting 160/80-meter vertical antenna at K6KBE.

eter at the butt, tapering to 0.5 inch (1.27 cm) at the tip. The whip is actually 2 feet (61 cm) longer than this, with the extra length forming the joint to the main tower, which is 88 feet (26.82 meters) high.

The bottom 42 feet (12.8 meters) on the tower is made of aluminum tubing 4 inches (10.16 cm) in diameter, with a 0.093 inch wall thickness. The top portion [to the 88 foot (26.8 meters) level] is made of 3-inch (7.62 cm) diameter tubing having a 0.063 inch wall. The cross-guys are made of 0.25 inch (1.27 cm) aircraft cable. Turnbuckles permit the assembly to be tightened by the assembler until a very rigid structure is achieved.

Anyone who has heard K6KBE's signal on 80 or 160 meters knows this antenna works!

speaking of radials . . .

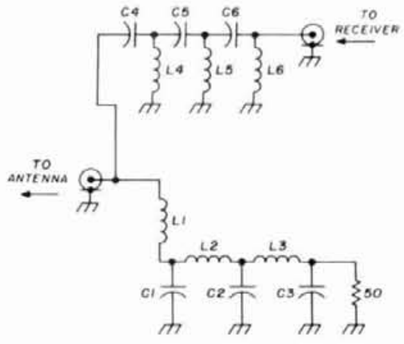
I just got a note from WA6BAN telling me more about his experiments with his 40-meter vertical ground plane antenna. He put it up with three radials, setting the base of the antenna a few feet above ground level. After he achieved resonance, he measured the feedpoint resistance with a General Radio RF Bridge. The result was about 58.3 ohms. He added a few more radials and the feedpoint resistance dropped to 53 ohms. Three more radials brought the resistance down to 51 ohms. Finally, he added more radials until he had eleven, and the feedpoint resistance dropped to 45 ohms.

His conclusion was that when the ground plane antenna is mounted close to the surface of the ground, you need "a lot more" than eleven radials to approximate a feedpoint impedance of 36 ohms. W2FMI, in his classic *QST* series on ground plane antennas,[2] came to the conclusion that sixty radials were required when they were laid on the surface of the ground.[3] When elevated radials are installed a few feet above the ground, it is possible that fewer will do the job. The correct number seems to be between eleven and sixty! (Anybody out there have a closer "fix" on this?)

broadcast filter for 160 or 80 meters

If you live in a residential or urban area, you can experience severe crosstalk and overload problems from local broadcast stations if you attempt to operate on 160 or 80 meters. (A friend of mine, located a few miles away from a local broadcast station, measured over 4 volts of RF pickup on his 80-meter vertical antenna. It completely locked up his receiver.)

Designed by K6KBE, the filter shown in **fig. 9** is an adaptation of the



Except as indicated, decimal values of capacitance are in microfarads (μF); others are in picofarads (pF); resistances are in ohms. k = 1,000 M = 1,000,000

	160M	80M
C1	3385	1862
C2	2318	1275
C3	500	275
C4	1242	683
C5	1242	683
C6	2554	1404
L1	7.5	4.1
L2	7.5	4.1
L3	3.64	2.0
L4	2.75	1.5
L5	4.01	2.2
L6	18.63	10.2

C - pF L - μH

fig. 9. Broadcast filter for 160 or 80 meters.

absorption filter originally used where suppression of harmonic energy is desired. In its original configuration, there are two complementary filters consisting of a high pass section terminated in a resistor and a low pass section to pass the desired signal. In this case, the reverse idea is used so that all energy *below* cutoff is routed to a dummy load while all energy above is allowed to pass.

The cutoff frequency for the 160-meter filter is 1.65 MHz; for the 80-meter filter, it's 3 MHz.

references

1. This material is extracted from "The G8PO JAWS Antenna," by Cdr. J.E. Ironmonger, G8PO, *Radio Communication*, November, 1984, pages 954-957. (Don't ask me what JAWS stands for — I can't figure it out either!)
2. Jerry Sevick, W2FMI, "The ground-image Vertical Antenna," *QST*, July, 1971, page 16.
3. For more information on ground radials and verticals in general see the K2BT series of articles on phased arrays, *ham radio*, May, June, July, October, December, 1983 and May, 1984 — Ed.

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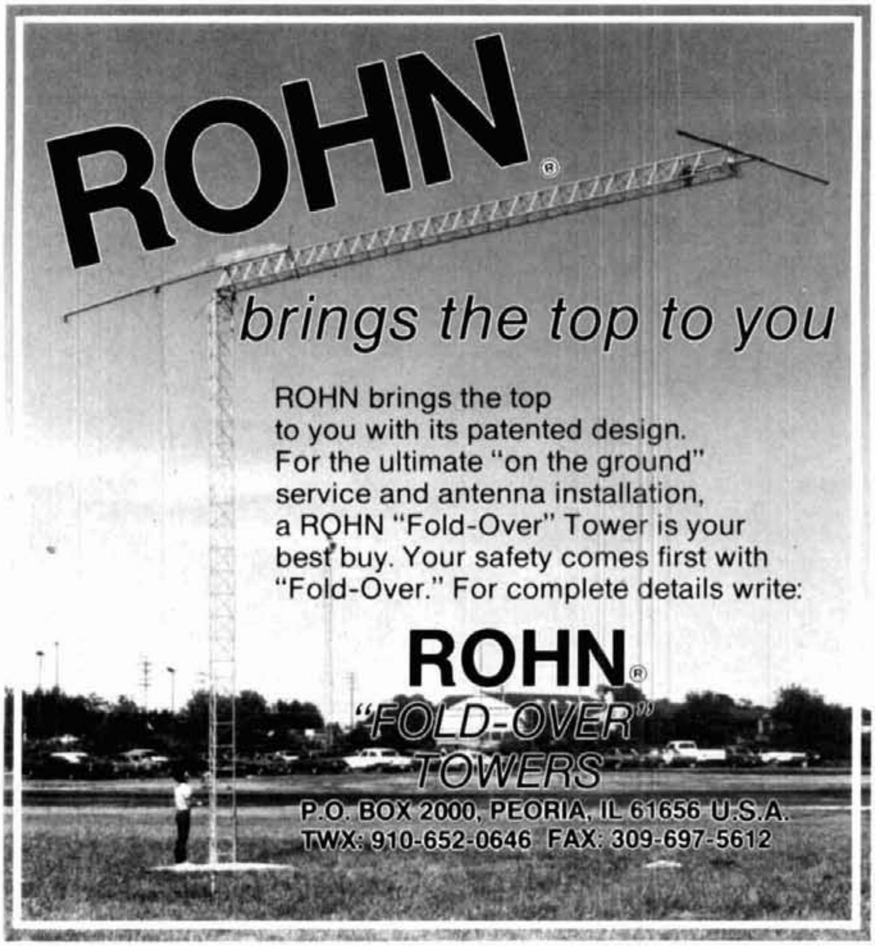

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designing Yagis
with the Commodore 64

See how gain and F/B can remain high across the entire band

In 1980, *ham radio* published a series of articles by W2PV on Yagi design.[1] As an avid DXer and a member of Potomac Valley Radio Club, I'd crossed paths with W2PV under contest conditions many times. He always had a fantastic signal, and after reading his series I realized why. W2PV was using superior antennas, all positioned at the correct height above ground.

Through computer research, W2PV showed that merely stating the mechanical length of an element of a Yagi beam does not actually reflect its true resonant frequency, especially when tapered elements are involved. He has also showed that tuning the reflector 5 percent below and the director 5 percent above the band center makes a poor beam. Commercial antenna specifications usually indicate maximum gain, maximum front-to-back ratio, and an SWR curve. But what they don't tell you is that the maximum gain and maximum front-to-back ratio do not occur at the same frequency, nor do they occur in the band center. They also don't tell you that as you tune away from these frequencies, the gain and maximum front-to-back ratio can fall off rapidly, indicating that although you may have 8 dB of gain at some frequency, you may only have 3 dB of gain near the band edges, depending on the tuning of the parasitic elements.

W2PV demonstrated that gain is primarily dependent on boom length and not on the number of elements on the boom, especially in the 1/4 to 3/4 boom length range. In addition, a naturally high front-to-back ratio occurs on a 1/4 wavelength boom and odd multiples thereof. He carefully designed his Yagis so that they would maintain a high gain and high front-to-back ratio over a 4 percent bandwidth, which will cover all of 15 and 20, most of 40, and a good portion of 10 meters. In order to do this the parastic elements must be tuned closer to the driven element reducing the SWR bandwidth. This is a small price to pay for maintaining almost maximum gain over the whole band. For example, the reflector of his three-element monobander is tuned 1.7 percent below the central design frequency and the director is tuned 4.2 percent above. He also proved that the resonant frequency of a tapered element could be very accurately determined.

About a year ago I wrote a program in BASIC using the formulas and data in the W2PV articles. With it you can turn your commercial antennas or scrap aluminum tubing into W2PV super beams. The program (**fig. 1**) is in simple BASIC with no peek or poke statements, and runs on the Commodore 64 computer.

program description

Lines 100-450 are a brief history of the program and instructions to the user. The type of beam you are designing is entered in **lines 460-500**. The actual lengths and diameters of each element are entered on **lines 550-620**, while the subroutine **lines 5000-5040** prints the inputs to the screen. **Lines 2000-2040** place data into the *A* array and if the average diameter calculated on **line 670** is 0.875 the date in *A* array is dumped into *R* array. If the average diameter is not 0.875, then new data is calculated in **lines 2100-2200** and placed into *B* array. Then *B* array is dumped into *R* array via **lines 2210-2220**. The element half-length that you are trying for per the central design frequency you entered earlier

By Alan Hoffmaster, WA3EKL, 929 Andrews Road, Glen Burnie, Maryland 21061

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fig. 1. WA3EKL program for designing 10, 15, and 20-meter Yagis with the Commodore 64.

```
100 PRINT"MONO BAND ANTENNA DESIGN"
102 DIMC$(3),B$(4)
104 PRINT:PRINT"DO YOU WISH INSTRUCTIONS(Y/N)";:INPUTC$
106 IFC$="N"THEN450
108 PRINT
110 PRINT"THIS PROGRAM WAS WRITTEN USING THE FORMULAS PUBLISHED IN 1980 HAM RADIO"
112 PRINT"MAGAZINE AND WRITTEN BY W2PV WHO PROVED MATHEMATICALLY AND EXPERMENTAL
114 PRINT"THAT ANTENNA ELEMENT RESONATE FREQUENCY LENGTH IS NOT A SIMPLE"
116 PRINT"CALCULATION ESPECIALLY WHEN TAPERED ELEMENTS ARE INVOLVED."
120 PRINT
130 PRINT"MECHANICAL RECOMMENDATIONS"
140 PRINT"20 METER BOOM SHOULD BE 3 OR 4 INCH DIAMETER ALUMINUM IRRIGATION"
150 PRINT"PIPE DEPENDING ON LENGTH."
160 PRINT"ELEMENTS SHOULD BE TAPERED SEGMENTS FROM 1 1/4 INCH TO 1/2 INCH"
165 PRINT"DIAMETERS OF 6061 T6 SEAMLESS TUBING OR EQUIVALENT."
182 DIMI$(3)
185 PRINT:PRINT"TO CONTINUE INSTRUCTION PRESS RETURN";:INPUTI$
190 PRINT:PRINT"10-15 METER BOOMS SHOULD BE MADE OF 2 INCH ALUMINUM IRRIGATION PIPE.'
200 PRINT"ELEMENTS SHOULD BE TAPERED FROM 7/8 INCHES TO 5/8 INCH DIAMETERS OF"
205 PRINT"6061 T6 SEAMLESS TUBING OR EQUIVALENT."
210 PRINT:PRINT"ELECTRICAL RECOMMENDATIONS."
215 PRINT"FOR MAXIMUM FRONT TO BACK RATIO USE A 1/4 WAVELENGTH BOOM ON A 3 ELEMENT"
220 PRINT"BEAM AND 3/4 WAVELENGTH BOOM ON A 4,5 OR 6 ELEMENT BEAM."
225 PRINT"EQUALLY SPACE ALL ELEMENTS ALONG THE BOOM REQUARDLESS OF LENGTH."
230 PRINT"FOR A GOOD 2 ELEMENT BEAM USE A BOOM LENGTH OF .150 WAVELENGTH."
240 PRINT"FOR A GOOD 3 ELEMENT BEAM USE A BOOM LENGTH OF .300 WAVELENGTH."
245 PRINT:PRINT"TO CONTINUE INSTRUCTIONS PRESS RETURN";:INPUTI$
250 PRINT:PRINT"IMPORTANT ALL TOTAL LENGTH DIMENSIONS WILL BE ELEMENT HALF LENGTH"
255 PRINT"MEANING THE LENGTH OF THE ELEMENT MEASURED FROM THE BOOM OUT TO THE"
260 PRINT"TIP OF THE ELEMENT. ENTER ELEMENT SEGMENT LENGTHS AND DIAMETERS JUST"
265 PRINT"AS THEY WILL BE ASSEMBLED STARTING WITH THE LARGEST DIAMETER SEGMENTS"
270 PRINT"(WHICH CROSSES OVER THE BOOM) TO THE SMALLEST DIAMETER SEGMENT AT THE"
275 PRINT"ELEMENT TIP. THE OBJECT IS TO ADJUST THE ORIGINAL SEGMGNT LENGTHS SO"
280 PRINT"THAT THE TOTAL EQUIVALENT LENGTH IS EQUAL TO OR VERY CLOSE TO THE"
285 PRINT"NORMALIZED LENGTH FOR THE PARTICULAR ELEMENT YOUR ARE WORKING ON."
290 PRINT"TO CONTINUE PRESS RETURN";:INPUTI$
295 PRINT"WHEN THE COMPUTER ASKS YOU FOR THE INFORMATION ENTER IN THE INFORMATION"
300 PRINT"THEN PRESS RETURN. NOTHING WILL HAPPEN UNTIL YOU PRESS RETURN. IF"
305 PRINT"NOTHING HAPPENS IMMEDIATELY. WAIT. THE COMPUTER MAY BE THINKING."
310 PRINT:PRINT"TO CONTINUE PRESS RETURN";:INPUTI$
450 PRINT:PRINT"ENTER CENTRAL DESIGN FREQUENCY IN MHZ";:INPUTCDF
460 RL=11811.024/CDF:REM RESONATE LENGTH IN INCHES
470 PRINT"ENTER NUMBER OF ANTENNA ELEMENTS 2,3,4,5 OR 6";:INPUTP
480 IFP<2ORP>6THEN470
490 PRINT"ENTER BOOM DIAMETER";:INPUTBD
496 BC=(BD/2)*0.0625:REM BOOM CORRECTION
500 PRINT"ENTER NUMBER OF ANTENNA SEGMENTS";:INPUTN
505 X=0
510 DIML((N-1)),D((N-1)),F((N-1))
520 FORE=0TO(N-1)
530 L(E)=0:D(E)=0:F(E)=0
540 NEXTE:REM CLEAR ARRAYS
550 PRINT:PRINT"ENTER(IN INCHES) LENGTH OF SEGMENT";:INPUTA
560 L(X)=A
570 PRINT"ENTER(IN INCHES) DIAMETER OF SEGMENT";:INPUTB
580 D(X)=B
590 GOSUB5000
600 X=X+1:REM STEPPING DATA INTO L ARRAY
610 IFX=NTHEN630
620 GOTO550:REM ENTERING IN SUCCESSIVE LENGTHS AND DIAMETERS
630 GOSUB4000
640 FOREE=0TO(N-1)
650 TD=TD+D(EE)
660 NEXTEE
670 AD=TD/N
680 GOSUB2000
690 GOSUB3000
700 T=0:G=0:REM CLEAR TOTAL
710 FORY=0TO(N-1)
720 T=T+L(Y):REM ADD SEGMENT LENGTHS
730 PRINTL(Y);"INCHES LONG",D(Y);"INCHES DIA."
740 NEXTY
750 PRINT:PRINTT"INCHES=TOTAL ORIGINAL LENGTH"
770 O1=0:O2=0:W=0
780 R1=AD/(2*RL):REM = RADIUS OF CENTER SEGMENT
790 D1=D(G)
800 R2=D1/(2*RL):REM = RADIUS OF SUCCESSIVE ELEMENTS
810 G=G+1:REM STEPPING THRU SEG. DIAMETERS.
820 K1=1/R1
830 K2=1/R2
840 M=((43.03*(LOG(K2)/LOG(10))-32))/((43.03*(LOG(K1)/LOG(10))-32))
850 O2=(L(W)*1.57079632)/T+O1:REM O2 IN RADIANS
860 FO=(SIN(2*O2)-SIN(2*O1))/((2*O2)-(2*O1))
870 O1=O2
880 SA=((M+1/M)/2+(M-1/M)*FO/2)*L(W)
890 F(W)=SA:REM PLACE EQUIVALENT LENGTHS INTO F ARRAY
900 W=W+1:REM STEPPING THRU F ARRAY
910 IFW=NTHEN930
920 GOTO780:REM LOOP TO CALCULATE EACH SEGMENT LENGTH
930 S=0:REM CLEAR EQUIVALENT LENGTH TOTAL
940 FORZ=0TO(N-1)
950 S=S+F(Z):REM ADD EQUIVALENT LENGTHS IN F ARRAY
960 NEXTZ
970 PRINT:PRINTS"INCHES=TOTAL EQUIVALENT LENGTH
972 PRINT:PRINT"HARDCOPY(Y/N)"
973 GETZ$:IFZ$=""THEN973
974 IFZ$="Y"THENGOSUB5090
980 PRINT"DO YOU WISH TO CHANGE A SEGMENT LENGTH(Y/N)";:INPUTB$
990 IFB$="N"THEN1170
1000 PRINT"ENTER NUMBER OF SEGMENTS YOU WISH TO CHANGE COUNTING FROM THE BOOM OUT"
1010 INPUTV
1100 IFV<1ORV>NTHEN1000
1130 PRINT"ENTER NEW SEGMENT LENGTH(IN INCHES)";:INPUTU
1140 L(V-1)=U
1150 GOSUB3000
1160 GOTO700
1170 PRINT"(CLR)":REM CLEAR SCREEN
1180 PRINTP;"ELEMENT BEAM AT ";CDF;"MHZ"
1190 PRINT
1200 FORTT=0TO(N-1)
1210 PRINTL(TT);"INCHES LONG",D(TT);"INCHES DIA."
1212 GOSUB9000
1220 NEXTTT
1230 PRINT:PRINT"WRITE DOWN ELEMENT LENGTHS APPEARING ON THE SCREEN AND ADD THE"
1235 PRINT"FOLLOWING CORRECTIONS TO THE OUTER MOST ELEMENT, FOR FINAL LENGTH."
1250 PRINT
1260 PRINT"ON 20 METERS ADD ";BC+0.66;"INCHES"
1270 PRINT"ON 15 METERS ADD ";BC+0.44;"INCHES"
1280 PRINT"ON 10 METERS ADD ";BC+0.24;"INCHES"
1285 GOSUB10000
1296 END
2000 DIMA(13),B(13)
2005 FORH=0TO13
2010 A(H)=0:B(H)=0
2020 NEXTH:REM CLEAR A AND B ARRAYS
2030 A(0)=0.49366:A(1)=0.49801:A(2)=0.49693:A(3)=0.49994
2035 A(4)=0.49528:A(5)=0.4705:A(6)=0.48963:A(7)=0.48366:A(8)=0.4804
2040 A(9)=0.48028:A(10)=0.469:A(11)=0.46798:A(12)=0.45232:A(13)=0.44811
2050 DIMR(6),DE(6),DR(6)
2060 FORQ=0TO6
2070 R(Q)=0:DE(Q)=0:DR(Q)=0
2080 NEXTQ:REM CLEAR R, DE, DR
2090 IFAD=0.875THEN2240
2100 RA=0.875/(2*RL)
2110 RB=AD/(2*RL)
2120 KA=1/RA
2130 KB=1/RB
2140 FORJ=0TO13
2150 F1=(1-((10.7575*(LOG(KA)/LOG(10)))-8)↑-1)/(2*A(J))
2160 XX=((215.15*(LOG(KA)/LOG(10)))-160)*((1/F1)-F1)
2170 AA=XX/((215.15*(LOG(KB)/LOG(10)))-160)
2180 F2=(-AA+((AA↑2)+4)↑0.5)/2
2190 B(J)=(1-((10.7575*(LOG(KB)/LOG(10)))-8)↑-1)/(2*F2)
2200 NEXTJ
2210 R(2)=B(0):R(3)=B(1):R(4)=B(2):R(5)=B(3):R(6)=B(4):DE(2)=B(5):DE(3)=B(6)
2215 DE(4)=B(7):DE(5)=B(8):DE(6)=B(9)
2220 DR(3)=B(10):DR(4)=B(11):DR(5)=B(12):DR(6)=B(13)
2230 GOTO 2260
2240 R(2)=A(0):R(3)=A(1):R(4)=A(2):R(5)=A(3):R(6)=A(4):DE(2)=A(5):DE(3)=A(6)
2245 DE(4)=A(7):DE(5)=A(8):DE(6)=A(9)
2250 DR(3)=A(10):DR(4)=A(11):DR(5)=A(12):DR(6)=A(13)
2260 RS=(RL*R(P))/2:REM REFLECTOR NORMALIZED 1/2 LENGTH
2270 DE=(RL*DE(P))/2:REM DRIVEN ELEMENT NORMALIZED 1/2 LENGTH
2280 DR=(RL*DR(P))/2:REM DIRECTORS NORMALIZED 1/2 LENGTH
2290 RETURN
3000 PRINT"(CLR)"
3010 PRINTP;"ELEMENT BEAM AT";CDF;"MHZ"
3020 PRINT
3030 PRINTRS;"INCHES=NORMALIZED REFLECTOR 1/2 LENGTH"
3040 PRINTDE;"INCHES=NORMALIZED DRIVEN ELEMENT 1/2 LENGTH"
3050 PRINTDR;"INCHES=NORMALIZED DIRECTORS 1/2 LENGTH
3060 RETURN
4000 PRINT:PRINT"PLEASE WAIT I'M THINKING"
4010 RETURN
5000 PRINT"(CLR)":REM CLEAR SCREEN
5010 PRINTP;"ELEMENT BEAM AT";CDF;"MHZ"
5020 FORAB=0TO(N-1)
5030 PRINTL(AB);"INCHES LONG",D(AB);"INCHES DIA."
5040 NEXTAB
5050 RETURN
5090 IFZ$="N"THEN6090
6000 OPEN1,4,0
6005 PRINT#1:PRINT#1:PRINT#1:PRINT#1:PRINT#1
6010 PRINT#1,"MONO BAND ANTENNA DESIGN":PRINT#1
6020 PRINT#1,"CENTRAL DESIGN FREQUENCY";CDF;"MHZ":PRINT#1
6030 PRINT#1,P;"ANTENNA ELEMENTS":PRINT#1
6040 PRINT#1,BD;"INCHES BOOM DIAMETER":PRINT#1
6050 PRINT#1,N;"ANTENNA SEGMENTS":PRINT#1
6060 PRINT#1,T;"INCHES TOTAL ORIGINAL LENGTH";PRINT#1
6070 PRINT#1,S;"INCHES TOTAL EQUIVALENT LENGTH":PRINT#1
6080 CLOSE1
6085 GOSUB8000
6090 RETURN
7040 RETURN
8000 IFZ$="N"THEN8060
8010 OPEN1,4,0
8020 PRINT#1,RS;"INCHES=NORMALIZED REFLECTOR 1/2 LENGTH"
8030 PRINT#1,DE;"INCHES=NORMALIZED DRIVEN ELEMENT 1/2 LENGTH"
8040 PRINT#1,DR;"INCHES=NORMALIZED DIRECTORS 1/2 LENGTH":PRINT#1
8050 CLOSE1
8060 RETURN
9000 IFZ$="N"THEN9040
9010 OPEN1,4,0
9020 PRINT#1,L(TT);"INCHES LONG";D(TT);"INCHES DIA."
9030 CLOSE1
9040 RETURN
10000 IFZ$="N"THEN10070
10010 OPEN1,4,0
10015 PRINT#1
10020 PRINT#1,"ADD CORRECTIONS TO OUTER MOST ELEMENTS, FOR FINAL LENGTH"
10030 PRINT#1:PRINT#1,"ON 20 METERS ADD";BC+0.66;"INCHES"
10040 PRINT#1,"ON 15 METERS ADD";BC+0.44;"INCHES"
10050 PRINT#1,"ON 10 METERS ADD";BC+0.24;"INCHES"
10055 PRINT#1:PRINT#1:PRINT#1:PRINT#1:PRINT#1
10060 CLOSE1
10070 RETURN

READY.
```

is calculated in **lines 2260-2280. Lines 770-970** calculate the resonant half-length of the element you have created by the lengths and diameters you entered earlier. **Lines 972-974** and **5090-10070** print a hard copy if you answer "Y" to the hard copy prompt.

You'll see printed on the screen the type of Yagi you have selected, the resonant half length each element should be (the "normalized" length) the mechanical length/diameter of each segment, and the actual electrical half-length of the element you've created. The program will now allow you to change individual segment lengths until your element's electrical half length equals the normalized half-length. You then add a small correction to the outermost segment (due to boom diameter and boom to element clamping system) to get the final element half-length.

W2PV broke the center of the driven element and used a balanced feed. I have used the gamma match successfully.

results

Three monoband Yagis have been constructed

design example 1: 3-element Yagi
f_o: 14.175 MHz
boom: 2 inches

element	length (inches)
normalized reflector	207.495860
normalized driven	204.066957
normalized director	195.621141

segment specifications

diameter (inches)	length (inches)
1.25	36
1.125	50
0.875	37
0.75	20
0.625	44
0.5	16
0.375	12.75

total original length
= 215.75 inches
total equivalent length
= 207.51345 inches

design example 2: 6-element Yagi
f_o: 14.175 MHz
boom: 2 inches

element	length (inches)
normalized reflector	206.378917
normalized driven	200.239937
normalized director	187.061662

segment specifications

diameter (inches)	length (inches)
1.25	36
1.125	50
0.875	37
0.75	20
0.625	44
0.5	16
0.375	11.5

total original length
= 214.5 inches
total equivalent length
= 206.397459 inches

Note 1: In each example, element has seven segments and last dimension is length before final correction due to boom clamping.

Note 2: If you cannot achieve the above numbers out to at least five places to the right of the decimal point, especially the normalized length and the total equivalent length, go back and check your program. Close is not good enough. Small inaccuracies are multiplied many times as segment lengths change.

using the program. When mounted on towers, not one resonated more than 4 kHz from the central design frequency. But the only way to really test an antenna is in actual combat — i.e., under contest conditions: the CQWW phone contest yielded 1.68 million points in 1983 and 2.43 million points in 1984. From 1983 to 1984, nothing changed except the antennas; all primary Yagis were homebrewed, using this program, and the secondary antennas were commercial beams redimensioned from the program.

W2PV hoped that others would build his superior beams and report the results. I've built them and am pleased to report that their performance is far better than any commercial antenna I've ever used from my QTH.

acknowledgement

Because this was my first attempt at programming, my sincere thanks are due to my XYL, N3DPB, who gave a few pointers on programming, and to WA3HQX, who converted my original program to the Commodore format. The program has been converted into Apple, Atari, IBM PC, and Radio Shack Color formats. Copies of these listings are available from me for one dollar (copying cost) plus a business-size SASE with 39 cents postage.

reference

1. James J. Lawson, W2PV, "Yagi Antenna Design," *ham radio*, January, February, May, June, July, September, October, November, December, 1980. (Back issues are available from *ham radio* at $3 each. Contact Ham Radio's Bookstore, Greenville, New Hampshire 03048.)

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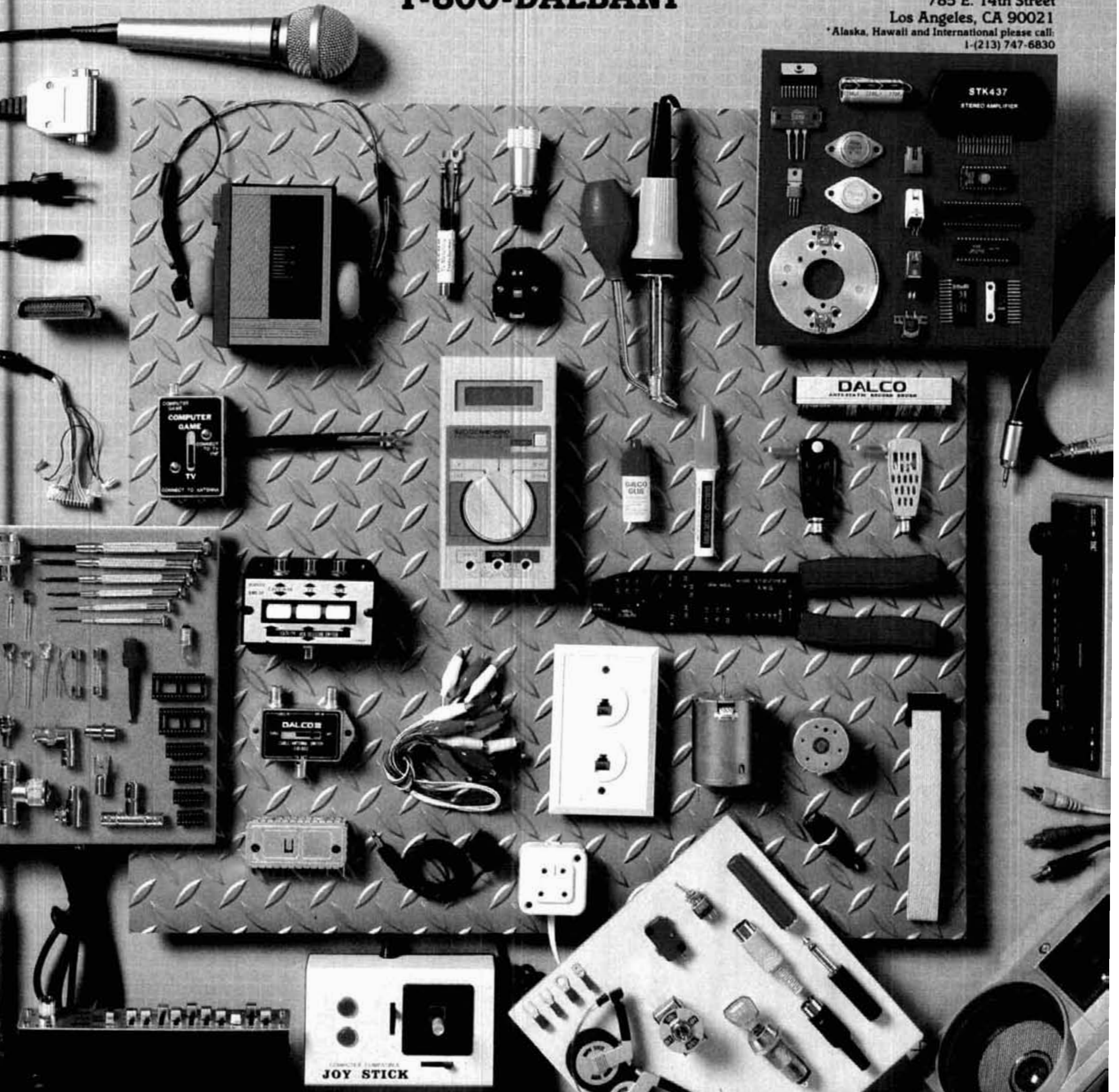


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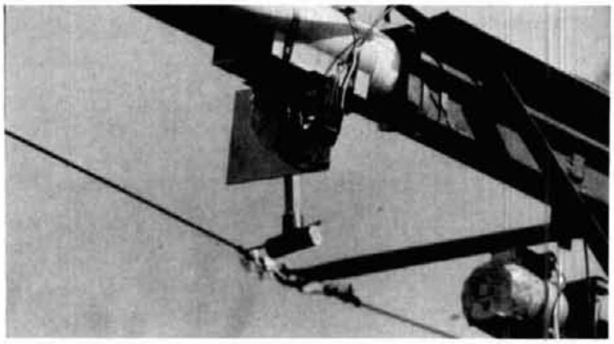
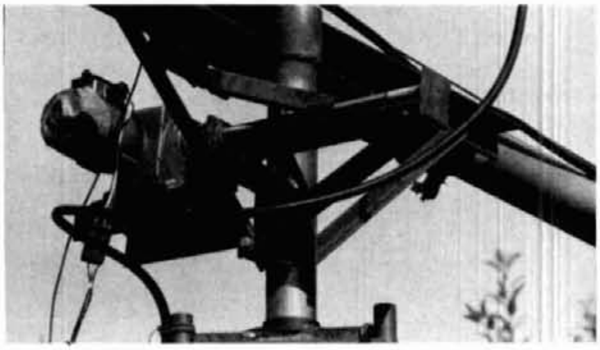
the weekender

an inexpensive elevation indicator



Simple method of converting elevation angle to a voltage. Note weather-resistant housing.



Elevation drive: reversible gear motor turns leadscrew of 3/4-inch all-thread.

If you have a high input impedance ($\geq$1 Megohm) multimeter — preferably digital — and a single-turn, precision, linear taper potentiometer, then you have everything you need to make an inexpensive, accurate elevation indicator for OSCAR EME applications.

After discarding my store-bought elevation rotator in favor of a heavy-duty home-brew model, it became necessary to provide some means to determine where the antenna was pointing without having to "eye-ball" the moon and the antenna. This resulted in the construction of the indicator shown in **photos A** and **B**.

By George Chaney, W5JTL, 218 Katherine Drive, Vicksburg, Mississippi 39180

The digital multimeter is used to read 0 to 0.9 volt, corresponding to 0 to 90 degrees in elevation. R2, a precision potentiometer, is used as a voltage divider, with the indicating voltage read off the moving arm of the potentiometer. It is mounted on a piece of heavy-duty circuit board, of any convenient size with three-wire cable, preferably shielded, running from the antenna to the indicating unit in the ham shack. A suitable bracket for mounting it to your antenna may be soldered to the PC board.

Assuming your potentiometer is in the 5 to 10 kilohm range, required current will be less than 1 mA. Ordinary zinc-carbon cells are quite satisfactory for this purpose; in fact, they will probably die of old age if switch S1 is used. Voltage regulation is not necessary. R1, used to drop the voltage to approximately 3.6 volts, is connected to terminal 3 of the precision potentiometer for calibration purposes as the batteries gradually discharge (see **fig. 1**).

construction

Because most precision potentiometers don't have threaded bushings around the shaft output, it will probably be necessary to use a good adhesive (Super-Glue,™ contact cement or epoxy) or a clamp to mount the potentiometer to the PC board. A 6-inch (15 cm) length of 3/8-inch (0.95 cm) square key-stock is recommended for the pendulum shaft. A 1/4-inch (0.64 cm) hole (assuming the potentiometer shaft is 1/4 inch) is drilled through the key stock, about 1/2 inch (1.3 cm) from the top end. Immediately above this, and at a right angle to the 1/4-inch (0.64 cm) hole, drill a hole to accommodate a No. 8 machine screw. Then cut a hacksaw slit from the top end of the key-stock into the 1/4-inch (0.64 cm) hole so as to provide a clamp around the potentiometer shaft when the No. 8 machine screw is inserted and tightened with a nut.

The pendulum weight may be made of any convenient material that will provide sufficient weight without too much bulk. I used a 3/4-inch plumbing-type copper T-fitting filled with lead (see **fig. 2**). Its estimated weight is about 10 ounces (283 grams).

As shown in **photo A** the potentiometer is enclosed for weather protection. The enclosure is made of very thin (about 0.010 inch) (0.25 mm) double-sided PC board, soldered in place. The opening is so oriented that protection is provided when the antenna is elevated. Similar protection on the shaft-pendulum side of the PC board is advisable, although I chose not to take this step. I did put some silicone grease in this opening, however, and even after one year had no problems, despite the occurrence of a severe storm with baseball-size hail. An automotive trailer light con-

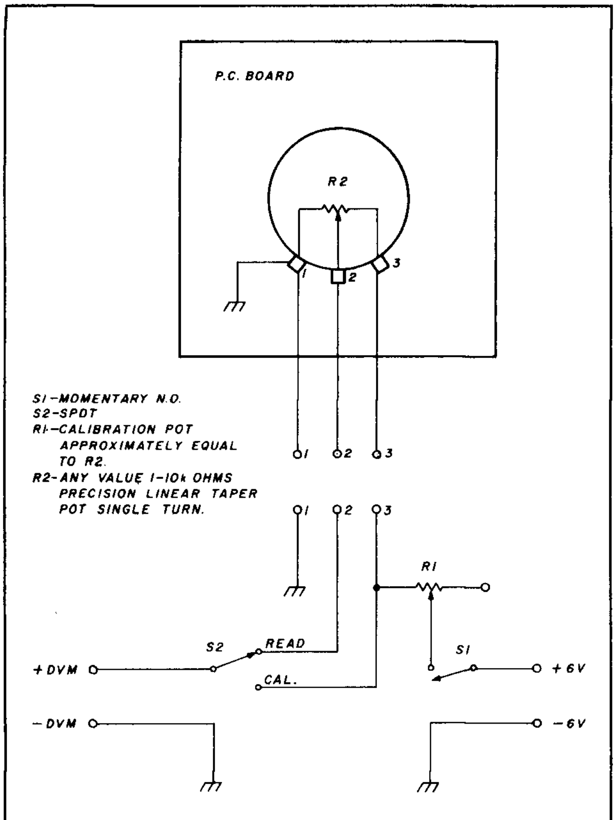


fig. 1. Elevation indicator wiring diagram.

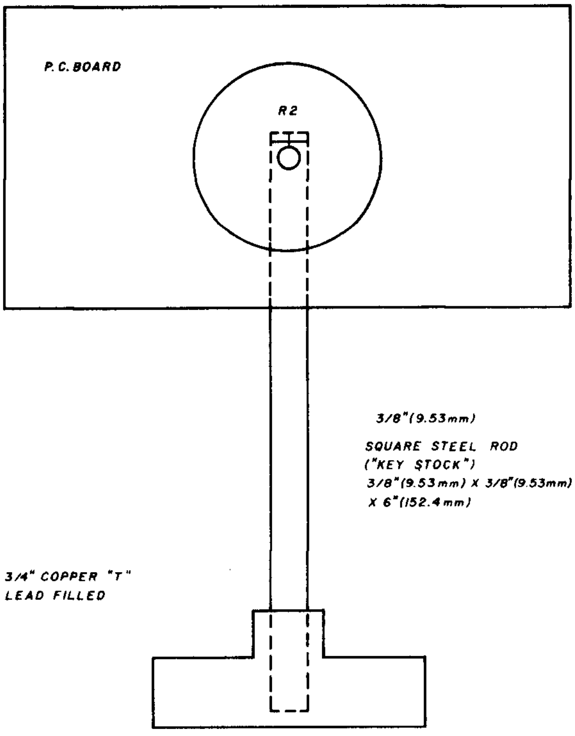


fig. 2. Construction details, R2 assembly.

nector is used for the wiring (as a quick make/break interface).

The read-out portion, shown in the bottom part of **fig. 1** was built in a small box, fabricated from circuit board, large enough to hold the batteries, switches and resistor R1. Although I used four D cells, I think smaller batteries, such as size AA, should be satisfactory. Since it is only occasionally necessary to monitor elevation visually, I would suggest that S1 be a normally open momentary pushbutton switch to be depressed only when readout is desired. S2 is a single pole, double throw switch. It is normally left in the "Read" position and is connected to the lead going to the variable arm of R2. Suitable pin plugs are provided for the new leads at the +DVM and −DVM points.

calibration

All the precision potentiometers that I'm familiar with permit continuous rotation, do not have mechanical stops, and offer almost 360 degrees (of rotation) of usable variable resistance. The potentiometer should be oriented on the PC board (or the pendulum adjusted) so that the arm terminal of the potentiometer, reads "0" voltage when the bottom edge of the PC board is horizontal and increases progressively to a reading of 0.900 volt when the bottom edge is vertical. A carpenter's level, with the bubble carefully centered during adjustments, with the circuit board holding the potentiometer and the pendulum in a vice, or otherwise strongly secured, will provide sufficient accuracy.

The slightest upward movement of the antenna should result in a voltage indication of 0.001. After the zero point has been established, things can be permanently secured. Using the carpenter's level, move the assembly so that the bottom edge of the circuit board is vertical. With S2 in the "Read" position, adjust R1 to give a reading of 0.900 volt, which corresponds to an elevation of 90.0 degrees. The unit is now calibrated and will indicate changes of 0.1 degree, to an accuracy of 0.5 degree. When the potentiometer pendulum assembly is mounted on the antenna, it is necessary only to level the bottom edge in the zero position, with the antenna horizontal, in order to maintain calibration. After the 90.0-degree position has been established and initially calibrated, put S2 in "Calibrate" position and note the indicated voltage. It is advisable to record this for later reference. You are now assured that you will be in calibration when R1 is adjusted to give this reading, while in the "Calibrate" position. For maximum accuracy, the tower must be perfectly vertical, and the vertical rotational axis perfectly horizontal.

conclusion

The author makes no claim of originality in this type of elevation readout, although I have seen nothing as simple as this one. Most others use three-turn potentiometers with 10.8 volts, with readouts taken from some midrange, such as 1.000 to 1.900 volts, and some means of removing the first digit. The readout described here is simple, inexpensive, and accurate. Invariably, with my EME array adjusted according to a computer-predicted position, I can sight down the boom of one of the antennas and know its direction will be "rifle scope" accurate.

Caution: I assume, but do not know, that all DMMs have a high input resistance, so as not to unduly load the portion of R2 between the arm and ground. If your DVM does not have a high resistance input, do not use it.

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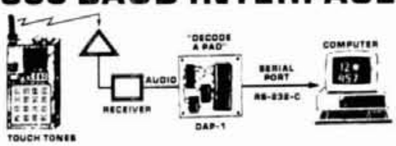

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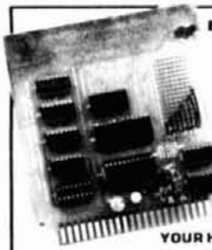

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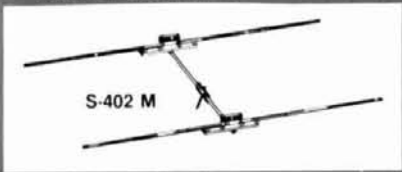

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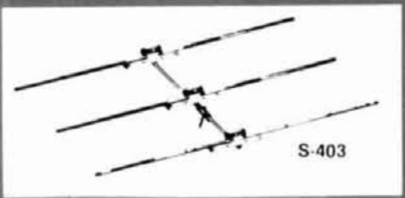

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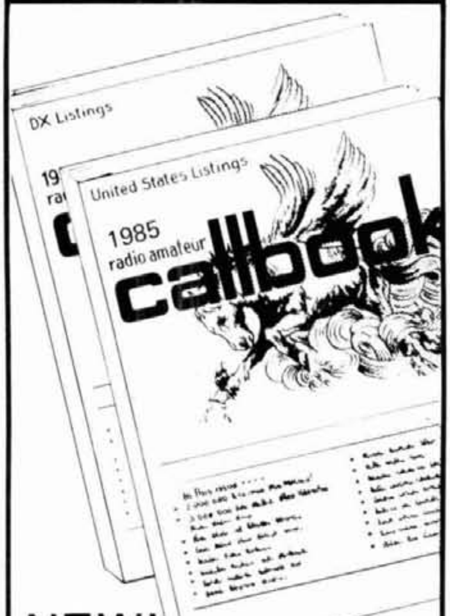

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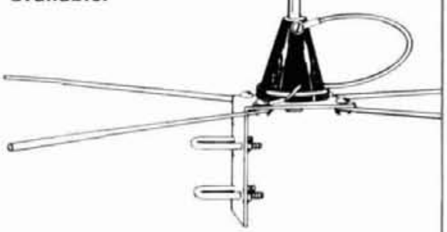

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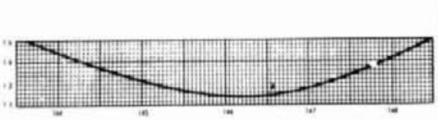
ASSEMBLED WEIGHT (approx.): 1 lb. 12 oz.
HEIGHT (approx.): 4 ft.



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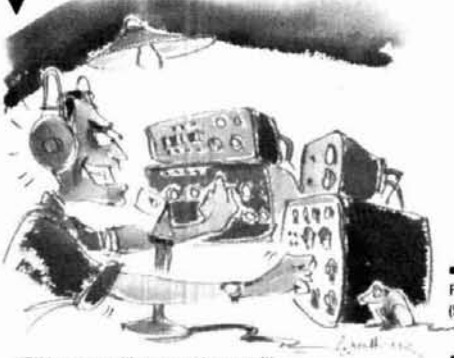

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The only problem with this arrangement is that a 200-watt amplifier draws a great deal of current and gets very hot, especially during the summer in our garage. A large muffin fan mounted at the back of the amplifier cooled it to a reasonable level, but I still had to go out to the garage to turn the fan on every time I wanted to use the amplifier. Although this procedure worked fine, it was an annoying task.

One day some DX suddenly appeared on 146.52. Without thinking, I grabbed my handie talkie and proceeded to make a 1200-mile contact on direct! Fantastic!

Yes, it was . . . until the transistors in the amplifier unsoldered themselves. Fortunately, the transistors themselves weren't ruined — I don't know why — and I was able to repair the damage. But I obviously needed a better method of controlling the temperature of the amplifier without having to remember to turn on the fan and without having to waste electricity by leaving the fan running all the time.

The thermostatically controlled AC outlet box described herein solved the problem. It features an adjustable thermostat built around a Motorola MC3423 overvoltage protection IC, a remote temperature sensor, and visual indicators of the state of the thermostat and the presence of AC voltage at the outlet. A flip of the front panel switch allows the thermostat to detect a falling temperature rather than a rising one, thus enabling the box to be used to turn on a heater or crystal oven during the winter months.

theory of operation

Figure 1 is a schematic of the thermostatically controlled outlet box. The heart of the circuit is U1, an MC3423. This IC was originally designed to function as an overvoltage protection device for DC power supplies. Normally, R6 and R7 would be two resistors placed across the output of the power supply. If the power supply voltage exceeds a critical amount (determined by the values of R6 and R7), pin 8 of the MC3423 goes high (approximately 2 volts $<$VCC). Normally, pin 8 would be connected to the gate of an SCR that had been bridged across the terminals of the supply. Voltage on the gate would cause the SCR to conduct, shorting the power supply and blowing a fuse or tripping a circuit breaker.

However, this very versatile IC can function as a thermostat by using an NTC (negative temperature coefficient) thermistor for R7. Using a potentiometer for R6 allows the thermostat circuit to be adjusted. When the power supply's voltage is constant, the resistance of R7 changes with temperature and "fools" the MC3423 into sensing an overvoltage condition, sending voltage to pin 8. As R7 warms up, its resistance falls. A greater value for R6 means a lower temperature will trigger U1 on, while lowering the value of R6 raises the temperature at which U1 triggers.

Substituting a PTC (positive temperature coefficient) thermistor for R7 — that is, a thermistor whose resistance decreases as its temperature decreases — would allow one to sense falling temperatures instead of rising ones. However, PTC thermistors are difficult

By Douglas Rowlett, WB5IRI, 2603 North Brompton, Pearland, Texas 77584

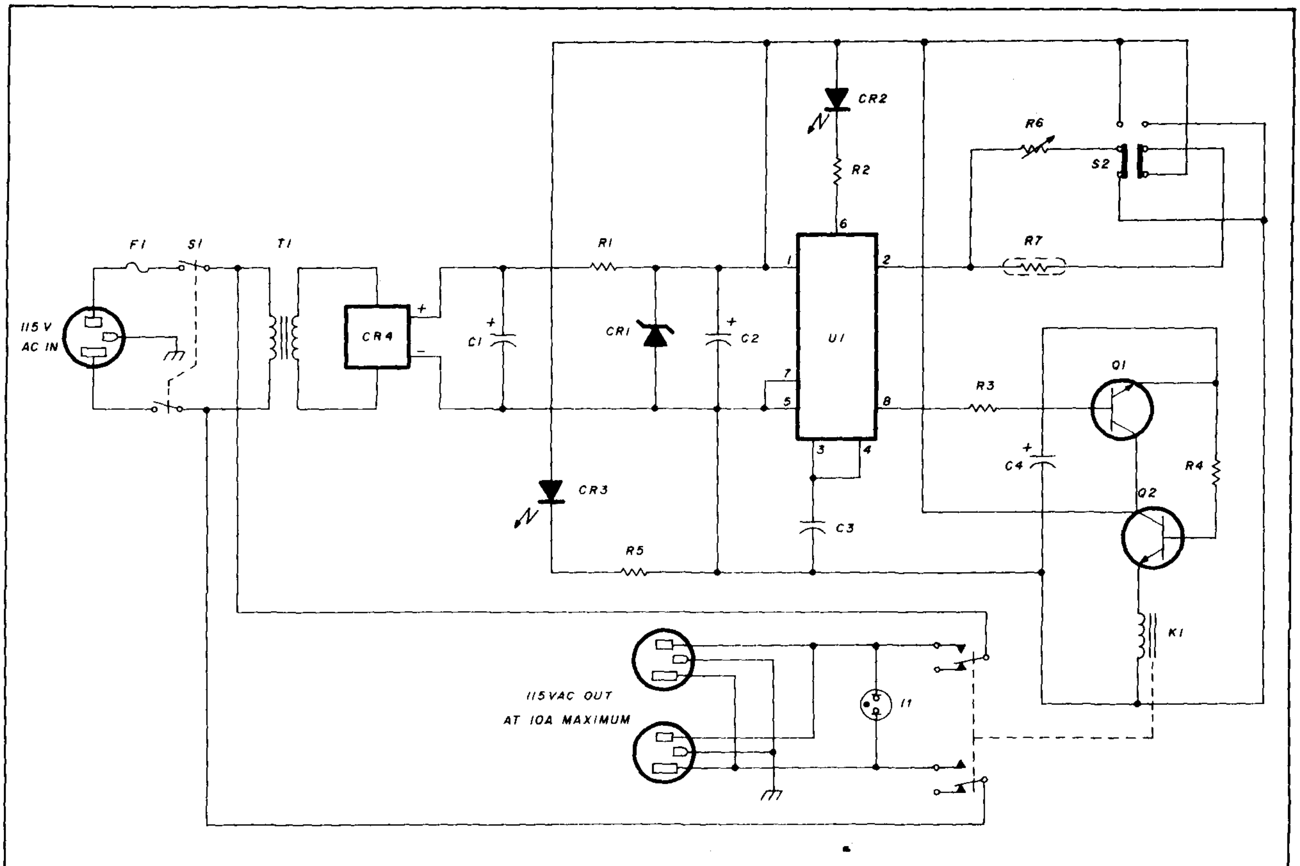

fig. 1. Schematic diagram of the thermostatically controlled outlet box.

item	*description*
C1	*3000 µF, 35-volt electrolytic*
C2	*100 µF, 35-volt electrolytic*
C3	*0.1 µF disc ceramic*
C4	*330 µF, 35-volt electrolytic*
CR1	*13-volt, 5-watt zener diode (RCA SK-13 or equivalent)*
CR2	*amber LED*
CR3	*green LED*
CR4	*bridge rectifier, 50-volt, 1 ampere (RS 276-1161 or equivalent)*
F1	*10-ampere fuse*
I1	*miniature red neon lamp assembly (RS 272-708 or equivalent)*
K1	*DPDT relay, 10-ampere contacts at 125 VAC, 12-volt coil (RS 275-218 or equivalent)*
Q1,Q2	*2N2222 transistors or equivalent*
R1	*75 ohms, 5 watts*
R2	*270 ohms, 1/2 watt*
R3	*10 kilohm, 1/4 watt*
R4	*15 kilohm, 1/4 watt*
R5	*270 ohms, 1/2 watt*
R6	*50 kilohm, panel mount potentiometer*
R7	*NTC thermistor, 1/4 watt, 10 kilohms at 70 degrees F (FR-1001A or equivalent)*
S1	*DPST toggle switch, 10-ampere contacts*
S2	*DPDT miniature slide switch*
T1	*12.6-volt, 300-mA transformer (RS 273-1385 or equivalent)*
U1	*MC3423 overvoltage protection IC*

to find in my area, and they are more expensive than NTC thermistors. S2 provides a simple way around this problem. Flipping S2, a DPDT slide switch, reverses the order in which R6 and R7 are connected to the power supply. As R7's temperature falls its resistance increases, thus allowing U1 to trigger when the temperature of R7 falls to a point determined by R6.

When U1 triggers it sends voltage to the base of Q1, a 2N2222, which conducts and allows voltage to be applied to C4 and the base of Q2, another 2N2222. C4 charges and Q2 conducts, thus keying relay K1, which applies 115 VAC to the dual outlet. Anything plugged into the outlet, such as a fan or heater, then turns on. U1 also turns on CR2, an amber LED, through pin 6, giving a visual indication that the triggering temperature has been reached. When the temperature changes to the point at which R7 can no longer hold U1 in its triggered state, U1 removes voltage from pin 8 and turns off CR2. C4, however, continues to energize K1 for approximately 1 minute, which prevents constant cycling of the relay and the devices connected to the dual outlet. Changing the value of C4 results in a fairly linear change in relay hold-in time for K1. For example, doubling the listed value of C4 gives a hold-in time of approximately 2 minutes, while halving the value of C4 gives a hold-in time of approximately 30 seconds. I1, a small red neon indicator across the contacts of K1, provides a visual indication that the outlet is "live," even when CR2 indicates that U1 is not in its triggered state.

Transformer T1 and CR4, C1, CR1 and C2 provide a regulated operating voltage for the thermostat. A regulated voltage is not really necessary for this circuit, and CR1 and C2 could be omitted with little performance degradation. However, since U1 is really a voltage-sensing device rather than a temperature-sensing device, a regulated voltage across R6 and R7 insures that changing line voltages will not affect the temperature at which U1 triggers.

Capacitor C3 prevents line transients from triggering U1 by setting the IC's internal delay time. Increasing the value of C3 increases the time during which an "overvoltage" condition can exist before U1 triggers. If this thermostat is to be operated in an environment where transients can be picked up by the internal or external wiring, such as near a transmitter, the value of C3 may have to be increased to prevent false triggering of U1. Since the duration of transients will vary from location to location, you will have to determine the best value for C3 yourself. I have had to go as high as 0.5 μF in some locations, such as near a 2-kW homebrew amplifier.

Relay K1 has contacts rated at 125 VAC, 10 amperes maximum. Thus, F1 is a 10-ampere fuse intended primarily to protect K1 from damage if the load at the dual outlet becomes excessive. Of course, any relay can be used at K1, but using a relay with a lower coil impedance than 160 ohms may necessitate using a heftier transistor at Q2. Any relay you use, however, must be able to be energized by the voltage across T1. A relay whose contacts can handle more current may be necessary, in addition to a heftier switch at S1, if the thermostat is to be used to control some devices, such as space heaters, that draw large amounts of current when first turned on. The value of F1 would also have to be increased in such an instance. In the interests of safety, however, *do not, under any circumstances, omit F1*, and be certain that it is placed on the "hot" side of the AC line, not on the "neutral" side.

construction

Construction of the thermostat and outlet box is fairly straightforward, and layout is entirely noncritical. All the components, including T1 and K1, will fit on one small circuit board, with the exception of R7. This is covered with heat-shrink tubing and attached to the end of a piece of RG-174U miniature coax for remote sensing. R6, CR1, CR2, I1, S1, S2, and the AC outlet are mounted on the front panel. **Figure 2** is a photograph of the completed outlet box with the cover removed.

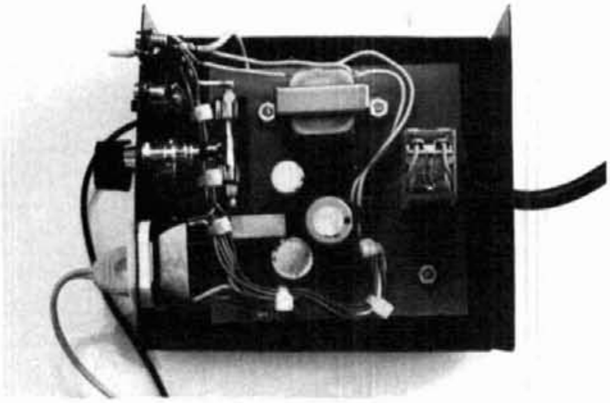

fig. 2. Internal view, with top cover removed. F1, T1, and K1 are mounted near the top of the board. U2 is barely visible beneath the wiring at the lower left corner of the board.

fig. 3. View of the front panel. Coiled black wire contains thermistor R7 (covered with heatshrink tubing) at one end.

I suggest using sockets for CR4 and U1 to make replacement, if ever needed, easier. In addition, you should use at least No. 12 wire from the AC line to K1 and from K1 to the dual outlet.

operation

Using the thermostat box is easy. Just plug it into a 115 VAC outlet and supply power through S1 (see **fig. 3**). The green LED should come on, and the amber LED and red neon indicator may come on at this time. If they do, adjust R6 until the amber LED goes out; a minute later I1, the red neon indicator, should go out as C4 discharges and K1 opens. *Once again, remember that whenever I1 is on, 115 VAC is present at the dual outlet, and I1 provides a visual warning of the presence of potentially lethal voltage.*

Now set S2 to the condition you wish to monitor — that is, either rising or falling temperature. Place R7 at a convenient point where it will be exposed to the temperature you wish to control. For example, the sensor can be placed between the fins of an amplifier's heatsink. Plug a fan into the outlet on the front panel, and adjust R6 until CR2 and I1 come on when the amplifier becomes hot enough to need cooling. As the fan blows cool air across the amplifier's heatsink, R7 will cool off and CR2 will go out. The fan, however, will continue to run for one minute.

That's all there is to it. As the amplifier heats up, the thermostat will turn on the fan to cool things down. When the amplifier is not is use, the fan will remain off.

other uses

This device can be used anywhere around the shack or the house where you wish to sense a rising or falling temperature. For example, it can function as a freezer alarm by plugging a 115 VAC alarm bell into the outlet and adjusting the thermostat to trigger whenever the temperature rises above 32 degrees F. It can be used to turn on a crystal oven when the temperature inside an oscillator falls below 80 degrees F (27°C). It can even be used to turn on a floor fan or space heater whenever the temperature in your shack rises or falls to uncomfortable levels. Anywhere you need to monitor a rising or falling temperature and turn on some device at a critical point, this thermostat will come in handy.

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104	116	128	140	152	164	176	188	200	212	224	236	248	260	272	284	296	308	320	332	344
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106	118	130	142	154	166	178	190	202	214	226	238	250	262	274	286	298	310	322	334	346
107	119	131	143	155	167	179	191	203	215	227	239	251	263	275	287	299	311	323	335	347
108	120	132	144	156	168	180	192	204	216	228	240	252	264	276	288	300	312	324	336	348
109	121	133	145	157	169	181	193	205	217	229	241	253	265	277	289	301	313	325	337	349
110	122	134	146	158	170	182	194	206	218	230	242	254	266	278	290	302	314	326	338	350
111	123	135	147	159	171	183	195	207	219	231	243	255	267	279	291	303	315	327	339	
112	124	136	148	160	172	184	196	208	220	232	244	256	268	280	292	304	316	328	340	

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VHF/UHF WORLD

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protecting equipment

Spring is typically the season in which most VHF/UHFers dust off their gear and get ready for all those good tropospheric and sporadic-E openings. It's also the time of year when static electricity and lightning tend to increase. Between the increased operating activity and the forces of nature, equipment failures can and do happen! Whether the result of carelessness or the ravages of nature, damage to expensive equipment can be frustrating. But with proper know-how and a little bit of effort, failures can be anticipated and prevented.

Many types of failures can affect Amateur equipment. — in-band RF, out-of-band RF, low frequency and supply transients, the forces of nature, damage in physical handling, and component overstressing are just a few.

in-band RF

Probably the prime source of failure in Amateur VHF/UHF equipment, in-band RF most often affects receivers. Simply put, the receiver input stage is subjected to RF on the frequency of interest at a level that exceeds the breakdown of the first active device. With the proliferation of solid-stage receivers over the last decade — especially on 70 cm and above, where high transmitter power (1000-1500 watts output) is required, — this phenomenon is now quite common. The primary reasons for this type of failure are inadequate T/R (transmit/receiver) relay isolation and improperly timed relay sequencing.

relay isolation

Most Amateurs use T/R relays that are either the bladed or the lever arm type. The bladed type (**fig. 1A**) is the most common and is similar to the everyday low-frequency relay except in that a moving arm is built into a coaxial airline structure. The contacts are capacitance junctions and the spacing between the moving contact and the input or output connector contact determine the isolation between the transmitter and receiver. There are many tradeoffs with this type of relay because the spacing and the size of the contacts determine the isolation, VSWR, and power handling capability of the relay.

If the capacitance across the relay junction is known, the isolation can be calculated using the following formula:

$$isolation = 10 \log_{10} [1 + (X_c/2Z_0)^2] \quad (1)$$

where isolation is in dB, X_c is the capacitive reactance of the junction, and Z_0 is the transmission line impedence, typically 50 ohms. For example, a typical relay junction has a 0.1 pF capacitance. Therefore, at 500 MHz the capacitive reactance is 3180 ohms and the isolation will be approximately 30 dB. (For those who do not want to work out the mathematics, **fig. 2** shows isolation versus capacitance values.) Note that the isolation across a purely capacitance junction decreases approximately 6 dB every time the frequency is doubled. Consequently, a relay with 40 dB of isolation at 2 meters will have only approximately 30.5 dB of isolation at 70 cm — quite a decrease!

Some relay designers add a set of grounding contacts across the open circuited contacts (**fig. 1B**). This can significantly increase the isolation. However, this places a short circuit across the attached device, typically a low-noise preamplifier. This may cause transients when switching or oscillations while in the transmit mode.[1]

The lever arm relay configuration (**fig. 1C**) is more complex and hence more costly, but has higher isolation because this construction increases the spacings between the input and open circuited port of the relay. However, it is likely to have a lower power handling capability than the bladed type.

The relays most often used by Amateurs (and often found at flea markets) include the Amphenol 300, Dow-Key DK-60, M/A-Com 7524, and the Transco "Y." Typical isolation versus frequency is shown in **fig. 3** for some of the types mentioned. A typical solid-state receiver will withstand 10 milliwatts or +10 dBm (dB above a milliwatt) at its input without damage. Therefore, at an RF power level of 1500 watts (+62 dBm), a relay with at least 52 dB of isolation should be used.

The Transco type-Y relays I've purchased at flea markets have shown high insertion loss on one or both of the paths. This is easily checked with an ohmmeter. When the contacts are energized, the resistance should be less than 1 ohm. Try cycling the relay several times to check for intermittencies, a common occurrence.

If the resistance is high, unscrew the appropriate connectors with a narrow-width open end wrench (if the relay has set screws on the connectors, remove them first). Then burnish the contact point on the end of the connectors. Next, reach inside the center compartment and burnish the complementary contacts. (Better yet, remove all three connectors, carefully noting the position from which each was taken.) Clean all internal contacts and connectors and as a final measure use solvent or flux remover on all contacts to eliminate any film. Then rotate the connectors 120 degrees so that a different connector is placed in each position; this will increase the likelihood that each connector contact will be at a new and clean point. Retest the contact resistance. If you have a good RF test setup, measure the insertion loss. It should be less than 0.2 dB through 450 MHz. Isolation is seldom a problem.

All the relays just metioned are available with type "N" connectors, the preferred connector type for 2 meters and higher frequencies. However, this connector type is power-limited to approximately 500 watts at 500 MHz and commensurately lower at higher frequencies. I know that many Amateurs are exceeding this power level on "N" connectors; if you're one of them, keep your VSWR low and never try to "hot switch" RF power.

relay configurations

Some of the relays mentioned will not provide the isolation necessary to protect receivers, especially on the higher frequency bands. Therefore, a second relay is often cascaded with the T/R relay (see **fig. 4A**) to further increase receiver protection.[1]

Because this second relay is switching low power, it doesn't have to be a high power type. Often relays with BNC connectors are used at the lower frequencies and SMA connectors at UHF. Furthermore, this relay doesn't have to have high isolation since the primary T/R relay is capable of providing most of the needed attenuation.

If two relays with similar isolation are connected back-to-back with the shortest possible connection, the combined isolation is only 6 dB greater than the single relay isolation.[1] If the same two relays are placed an electrical quarter wavelength apart at the operating frequency, the isolation will

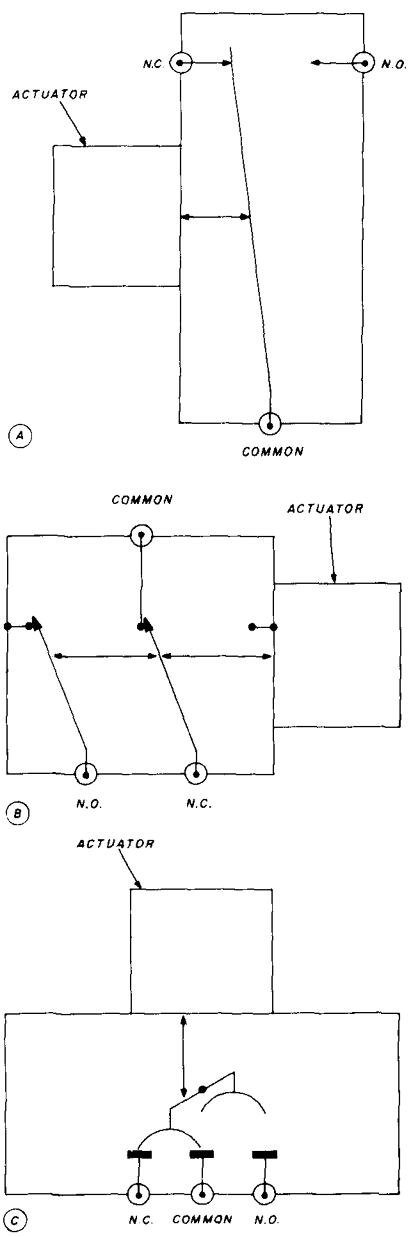

fig. 1. Common types of coaxial relay switches: *(A)* bladed, *(B)* bladed with additional shorting contacts, and *(C)* lever arm.

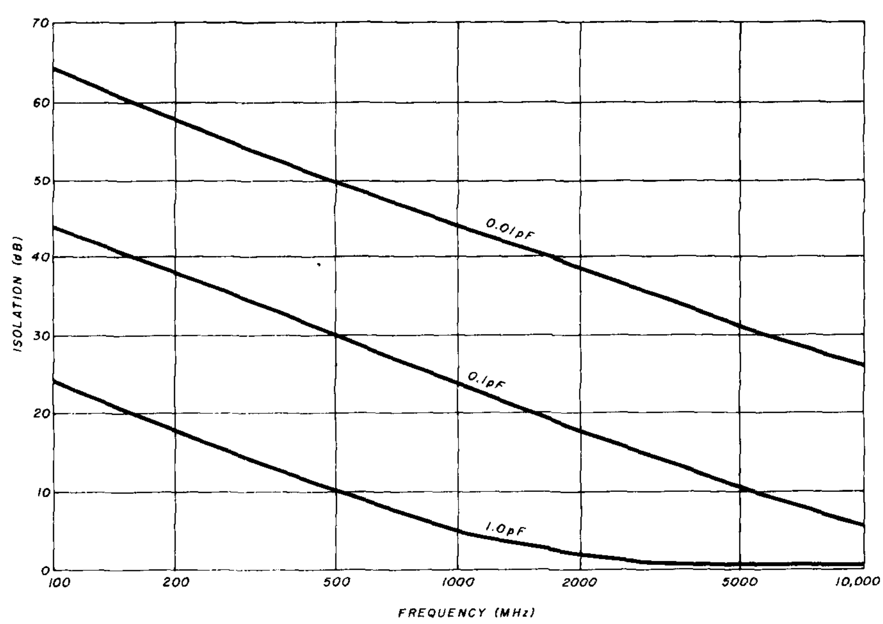

fig. 2. Isolation versus frequency when a capacitor is connected in series with a 50-ohm transmission line per *eq. 1*. Other capacitance values can be interpolated.

be approximately 6 dB greater than the combined relay isolation. For example, if two relays each with 30 dB of isolation are connected is cascade, the theoretical maximum isolation will be 66 dB.

*Never use one-half wavelength spacing between T/R relays since the attenuation can theoretically go to 0 dB (***fig. 5***).[2] For practical and theoretical considerations, one-tenth wavelength spacing is all that is recommended because it will keep losses at a minimum and decrease isolation by about only 6 dB from the maximum possible!*

Figure 5, an updated version of the one shown in reference 1, will yield typical isolation values at a glance for a 30-dB isolation relay (the example discussed at the beginning of this article).

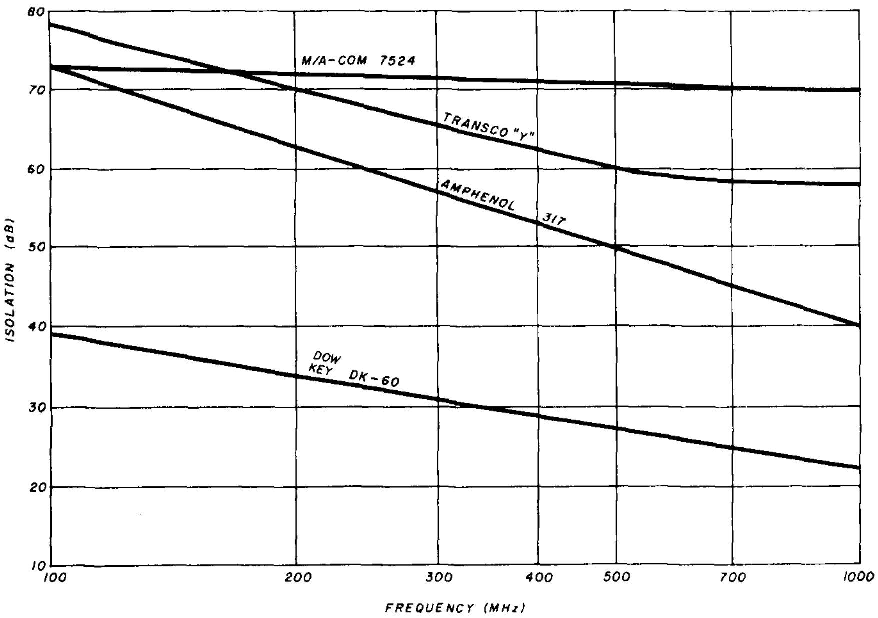

fig. 3. Typical values of isolation on some of the more popular T/R relays used by Amateurs.

Other values of isolation can be calculated. The relay capacitance must first be measured or calculated using **eq. 1**. Then use the following equations:

$$isolation = 10 \log_{10} 0.25 \; [4 + (2X_N \cos\theta \; - \; X_N^2 \sin\theta)] \quad (2)$$

where isolation is in dB, X_N is per **eq. 3** (below), and θ is the electrical spacing of the relay contacts in degrees.

$$X_N = \frac{Z_0}{2\pi f C} \quad (3)$$

where f is the frequency of operation in Hz, C is the open-circuited capacitance of the relay contacts in farads, and Z is the transmission line impedance in ohms.

remote preamplifiers

Remotely located or antenna-mounted preamps are becoming very popular, especially on 2 meters and up, on OSCAR 10, and on EME. The dual relay scheme illustrated in **fig. 4A** is highly recommended in these applications. Note that the preamplifier is terminated with a 50-ohm load when in the transmit mode, not a short or open circuit as discussed earlier in this article and in reference 1.

Finally, all T/R relays should have adequate time to switch before any transmitter power is applied. This is easy to accomplish if a high-voltage

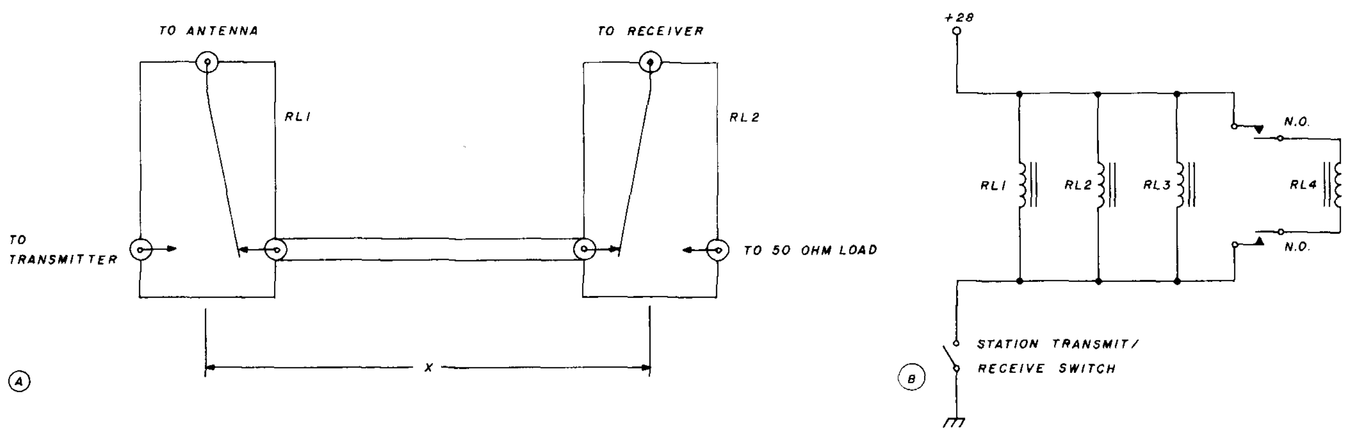

fig. 4. Recommended relay switching schemes. (*A*) see text for explanation of relays. Distance "X" should typically be 0.1 to 0.25 wavelength as explained in text. (*B*) RL3 is a typical DC type relay with double pole contacts. RL4 is the high-voltage relay in the transmitter power supply. (See text for further explanation.)

HF Equipment	Regular	SALE
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EX-243 Electronic keyer unit	50.00	
IC-730 8-band 200w PEP xcvr w/mic	829.00	569^{95}
FL-30 SSB filter (passband tuning)	59.50	
FL-44A SSB filter (2nd IF)	159.00	144^{95}
FL-45 500 Hz CW filter	59.50	
EX-195 Marker unit	39.00	
EX-202 LDA interface; 730/2KL/AH-1	27.50	
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EX-205 Transverter switching unit	29.00	
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HM-10 Scanning mobile microphone	39.50	
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FL-52A 500 Hz CW filter (2nd IF)	96.50	89^{95}
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FL-44A SSB filter (2nd IF)	159.00	144^{95}
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MB-12 Mobile mount	19.50	

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FL-52A 500 Hz CW filter (2nd IF)	96.50	89^{95}
FL-53A 250 Hz CW filter (2nd IF)	96.50	89^{95}
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TS-32 CommSpec encode/decoder	59.95	
UT-15 Encoder/decoder interface	12.50	
UT-15S UT-15S w/TS-32 installed	79.95	

VHF/UHF mobile multi-modes	Regular	SALE
IC-290H 25w 2m SSB/FM xcvr, TTP mic	549.00	479^{95}
IC-490A 10w 430-440 SSB/FM/CW xcvr	649.00	579^{95}

VHF/UHF/1.2 GHz FM	Regular	SALE
IC-27A Compact 25w 2m FM w/TTP mic	369.00	319^{95}
IC-27H Compact 45w 2m FM w/TTP mic	409.00	359^{95}
IC-37A Compact 25w 220 FM, TTP mic	449.00	299^{95}
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IC-120 1w 1.2 GHz FM transceiver	499.00	449^{95}
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6m portable	Regular	SALE
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BP-10 Internal Nicad battery pack	79.50	
BP-15 AC charger	12.50	
EX-248 FM unit	49.50	
LC-10 Leather case	34.95	
SP-4 Remote speaker	24.95	

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IC-02AT for 2m	349.00	289^{95}
IC-04AT for 440 MHz	379.00	319^{95}
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IC-2AT with TTP	269.50	199^{95}
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BP-8 800mah/8.4V Nicad Pak - use BC-35	62.50
BC-35 Drop in desk charger for all batteries	69.00
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Accessories for both models	Regular
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BP-3 Extra Std. 250 mah/8.4V Nicad Pak	29.50
BP-4 Alkaline battery case	12.50
BP-5 425mah/10.8V Nicad Pak - use BC35	49.50
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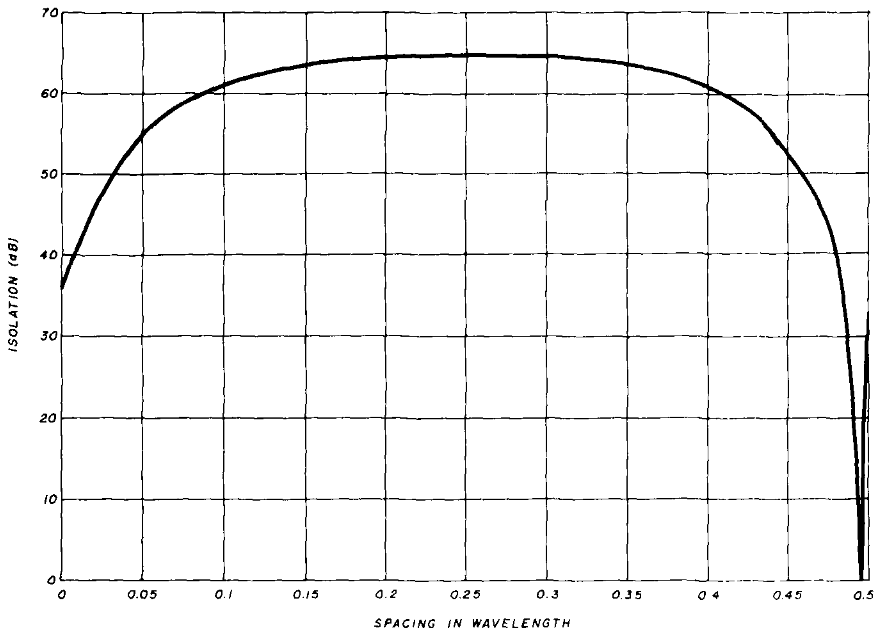

fig. 5. Additional isolation available from cascade-connected relays with a connecting transmission line.

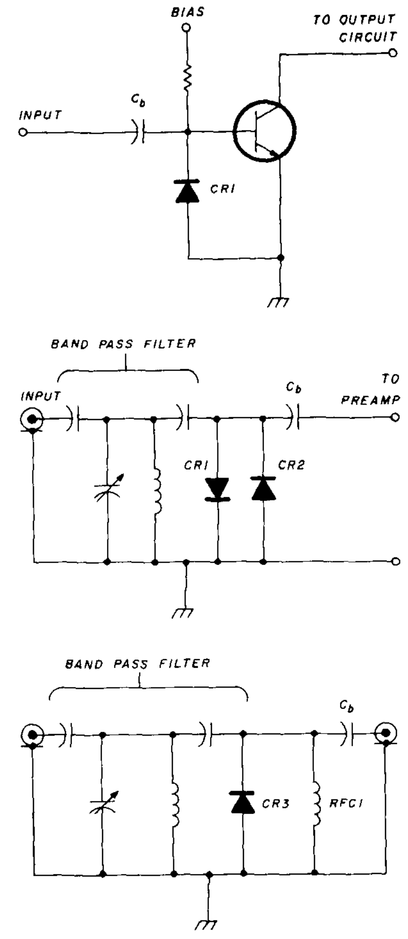

fig. 6. Typical recommended diode protection schemes for receivers. C_B is a blocking capacitor. CR1 and CR2 are hot-carrier types as described in text. CR3 is a PIN diode. RFC1 is an RF choke for DC return.

relay is used in the transmitter as discussed in February's column.[3] I've often seen complex circuitry that relies on R/C time constants and such. Timing capacitors, especially of the electrolytic type, are often unreliable and may decrease in capacitance as they age.

Figure 4B is a simple semi-foolproof way to add some time delay sequencing with the addition of only one low-cost DC relay. In this scheme, the extra relay will have to first close, which will add about 10 milliseconds delay before power is applied to the high voltage relay. When the T/R switch is opened, the high voltage relay loses power immediately and turns off.

One last caution is in order. Many modern transceivers, HF and VHF/UHF alike, can inadvertently transmit a short burst or pulse of RF either when they're first turned on or when they're switching modes. Depending on the station configuration, this could spell disaster to an inline preamplifier that is not properly protected.

input limiters

Relays are fine, but you may want some extra built-in protection. A simple low-power limiter was described in reference 4. A low-cost hot carrier diode is placed across the base to emitter junction of the bipolar transistor as shown in **fig. 6A**. This type of limiter will protect only up to about 1 watt. Hot carrier diodes used as limiters should have a low junction capacitance and a low forward resistance. For example, the M/A Com MA4882 or NEC ND4981-7E are recommended. The Hewlett Packard 5082-2810 and its equivalents are not recommended since the laboratory tests I conducted showed that they have a high resistance at increased current.

Often I see back-to-back diodes indiscriminately placed across the input of a receiver. Out-of-band signals — for example, FM, TV, and broadcast — can often induce enough voltage at a receiver input to drive these diodes into conduction and cause spurious signals to appear. Point contact diodes are the most susceptible, followed by hot-carrier and then silicon types. Therefore, if you use limiter/protection diodes at a receiver input, they should be located after a band-pass filter as shown in **fig. 6B**. Remember, hot carrier diodes can handle only up to about 1 watt of incident power.

Finally, commercial designers frequently use PIN diode limiters, especially above 500 MHz (see **fig. 6C**). These unique diodes turn on quickly, then drop to a very low resistance and reflect the incident RF. Most PIN diodes are able to handle much more power than hot carrier diodes. Most microwave diode suppliers manufacture these devices, but discussion of a recommended device and circuitry will have to wait for a future column.

out-of-band protection

The input protection schemes just mentioned are not always sufficient. Other RF problems can inadvertently occur from out-of-band signals. For instance, some years ago I advocated the use of an "idiot" diode in preamplifiers to prevent application of improperly polarized power supplies.[4] Eventually I placed idiot diodes into all my preamplifiers.

No preamplifier failure has ever occurred from improper supply polarity. However, soon after installing the idiot diodes, I began experiencing random burnout, especially on my J-FET preamplifiers, which are usually quite rugged. I tried all types of input filtering, without success. This random problem continued for over a year. Finally I realized that the burnout occurrences increased during the winter, a time of low electrical storm activity and the time of year when I spend many hours DXing on the low end of 80 meters.

With the help of a digital voltmeter, a second operator, and careful measurements, I found that the 80-meter RF was coupling to my 12-volt power supply leads going into my preamplifiers. The idiot diode was rectifying the RF and adding it to the 12 volts from the supply! In one case, the actual DC at the drain of a 2-meter preamplifier was 26 volts with the 80-meter kW in operation.[5] The reason this probably did not affect my bipolar preamplifiers was that they also had zener diode biasing, which limited the voltage across the device.[4]

The solution is simple. Place a 0.1 μF ceramic disc capacitor — remember, this is low frequency — on the DC line where it enters each preamplifier. (Larger capacitance values are not recommended because they may not act as a good RF bypass.) Any RF trying to enter the power line to the preamplifier is now bypassed and no longer seen by the idiot diode. The only failure I've experienced since that time was in a preamplifier that I forgot to bypass!

High-pass or bandpass filters are always recommended ahead of a receiver because they prevent RF, especially at HF, from entering the input of the preamplifier.[6,7] When selecting a filter, a capacitor input type is recommended per reference 8. Filters that use a shunt inductor at the input (such as a loop on a cavity filter) are not recommended because they usually have insufficient attenuation at lower frequencies.

low frequency and supply transients

Several types of failure modes are induced at low frequencies, especially in power supplies. One type is spikes or transients on the AC mains. Laboratory tests show that 500 to 1000 volt transients are always occurring, especially when motors or inductive devices are turned on and off. A shunt capacitor across the AC line helps, but is usually insufficient protection.

Zener diodes are often too slow to turn on and usually have limited power handling capacity. Modern protection devices such as the MOV (metal oxide-varistor) were specifically designed to operate at high frequencies and clamp incoming spikes similar to the action of a back-to-back zener diode. Such devices are inexpensive (less than $1.75) and readily available for 130 and 230-volt AC power. General Electric part No. V130LA10A or V250LA20A are suggested units for 130 and 250 volts AC, respectively. Radio Shack stocks similar MOVs. I highly recommend that you place one of these devices across the primary of all power supply transformers after the fuse as shown in **fig. 7A**.

General Semiconductor Industries, Inc. makes several products under the names TransZorb™ and ThyZorb.™ These devices, available from 5 to 700 volts, are particularly noted for their speed and power handling capability.[10] They can also be used across AC lines and wherever fast-acting zener diodes are desirable.

For many years I've been preaching that you should always use a dedicted power supply for all receiver circuits.[6] Using a preamplifier power supply for relays is not recommended. When relays are deenergized, inductive spikes are produced — and these can easily destroy a preamplifier if it's connected to the same supply. Even if you use a separate relay supply, it's best to place a 1N4004 or equivalent diode reversely polarized across all DC relay coils, T/R relays included (unless they're AC types) as shown in **fig. 7B**.

The manner in which solid-state devices are biased can also be a failure mechanism. The use of three terminal voltage regulators with protection diodes is highly recommended.[9] I strongly suggest the addition of a limiting resistor, however small (20 to 100 ohms is suggested), in series with each solid-state device to lower dissipation in case of runaway biasing. As another precaution, place a zener diode a few volts above the power supply voltage after the resistor. It will also serve as an idiot diode since most zeners have less than 1.0 volt drop when biased opposite to convention. These schemes are shown in **fig. 7C**.

AC line filters

Brute-force line filters are also recommended, especially to prevent damage from large surges typical of lightning strikes. A 50 to 100 μH inductor should be placed in series with the AC line where it comes into the ham shack and followed by an MOV or TransZorb™ of the appropriate rating as shown in **fig. 7D**. Note that the inductor must have an air core. Ferrite cores or rods will saturate and become ineffective if a large surge voltage should be induced onto the AC lines by a lightning strike.

the forces of nature

So far we've been talking mainly about protection against common man-made causes of burnout. But natural forces, in the form of static electricity or lightning, can be extremely destructive. Although statisticians assure me that even in the worst lightning-prone areas such as central

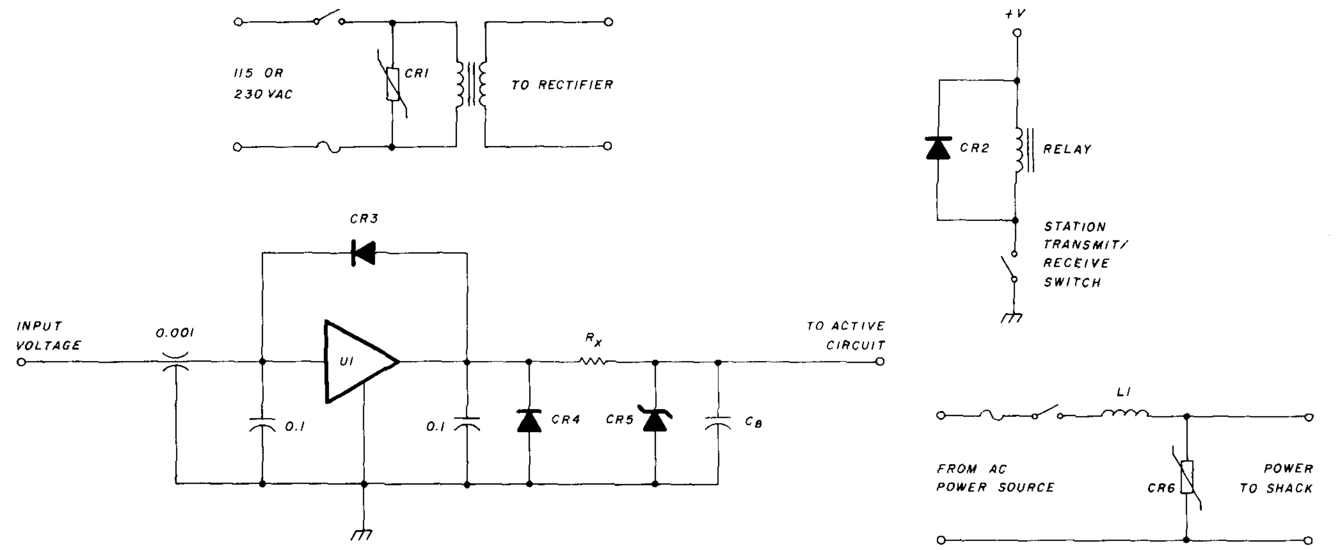

fig. 7. Recommended power supply protection schemes. C_B is a blocking capacitor. CR1 and CR6 are MOV type protection diodes. CR2, 3 and 4 are 1N4004 or equivalent (see text) and *CR5 is a zener diode approximately 2 volts above the operating voltage of the* circuit. R_X is typically 20 to 100 ohms (see text). L1 is a 50 to 100 μH RF choke made from 120 to 170 turns of No. 18 AWG or larger (depends on current to be drawn) enamel coated wire spaced wire diameter on a 1-inch (2.54 cm) diameter wooden dowel.

Florida, lightning strikes the same place only once every 10 years, *don't trust your luck*. My station has been hit more than once; the worst strike occurred in the Santa Clara Valley in California, a normally low probability area.

Because lightning protection has often been discussed in Amateur publications,[10] I will highlight only those problems that most affect VHF/UHFers. Experts tell me that when lightning strikes within 1000 feet (300-meters) of your equipment, damage will result. Even a 1-mile (1.6 km) separation from a lightning strike can result in damage caused by line voltage surges. Many simple techniques can be used to lessen or prevent lightning destruction to Amateur equipment; while some have been amply discussed in the literature, others have not, and I want to share them with you.

proper grounding is important

First, all antenna feeds should have a built-in ground return. This can often be incorporated as part of the feed system: for example, a "T" match or the balun connected to a metal boom or mast. The voltage breakdown of air at sea level with low humidity and room temperature between two flat surfaces is approximately 70 to 75 kilovolts per inch (28 to 30 kV/cm). A needle point, on the other hand, will break down at about 26 to 30 kV per inch (10-12 kV/cm). Therefore, a "Blitzbug"™ type of lightning arrestor installed in each transmission line will add an additional safety factor. Since this type of device has a point spacing of about 0.02 inch (0.05 mm), it should fire at 500 to 700 volts and handle reasonable follow-on current. The most common type of Blitzbug™ available is fitted with UHF connectors, but usable, with low VSWR, to about 450 MHz.

SVPs (surge voltage protectors) are becoming very popular. Basically they consist of a pair of electrodes properly spaced and hermetically sealed in a rare gas field. Breakdown voltages of 70 volts and up with low shunt capacitance (0.5 to 2 pF) are now available. Several manufacturers offer them for insertion in transmission lines. Remember that SVPs, while fairly quick to turn on, will not prevent damage from the large or sustained current typical of a direct hit as effectively as the Blitzbug.™

For best lightning protection it may be best to install both types of devices in cascade in your feedlines and spaced about one-tenth wavelength apart such as discussed in the relay section of this column. *In all cases, each of these devices should have a separate low-impedance ground return (see below).*

towers

Towers should never be higher than necessary. The highest object in a given local area, after all, is especially vulnerable to lightning strikes. Each time the height of a tower is doubled, the chance of its experiencing a direct hit increases by a factor of 4!

In the "good old days" lightning rods were installed on the rooftops of homes and tall buildings. I always thought they were meant to provide a discharge path, but some of my old-

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timer friends tell me that they may in fact work in the opposite way, emitting electrons and thereby repelling or at least decreasing the probability of a direct strike! In this regard, the same experts tell me that a blunt or ball-shaped object would be a better way to ground a strike. I don't know which is correct. Maybe someone reading this column can enlighten us.

Regardless of the outcome of this question, all towers and antennas should be well grounded for lightning protection. A single ground rod is not sufficient. Two ground rods may be even less effective than expected because when they're positioned close together electrically, they couple to each other. Therefore, I recommend *at least* two ground rods spaced 10 to 15 feet (3 to 5 meters) apart, close to the base of a tower but at least 2 feet (60 cm) from any concrete used in the installation.

All ground rods should be at least 5 to 8 feet (1.5 to 2.5 meters) long, with a minimum diameter of 5/8 inch (16 mm). Always use high quality, well plated grounding rods (available from most electrical supply houses). Small low-cost ground rods often rust and become poor grounds after the first or second rain storm!

Grounding rods should be connected to the tower with a heavy (No. 6 AWG or larger) solid copper wire. This wire should be kept as straight as possible so that it forms a low impedance path for lightning (as just discussed). Keep all bends to a minimum. Also *keep ground return wires away from other wires or cables to minimize any coupling effects.*

A strong bonding connection should be made where the grounding wire connects to the tower and the rod. The inductance of the wire and its ability to handle the peak current of a direct lightning strike are very important. [I had a single aluminum 1/8 inch (3 mm) diameter ground wire that exploded open when hit by lightning. You should have seen the damage in the shack as the strike found other discharge paths!]

Lightning usually travels in a straight line. Therefore, whenever possible, bring all transmission lines away from your tower at right angles and in a reverse direction as shown in **fig. 8A**. This will cause any lightning to go directly to ground rather than down the transmission line, since the bend will act as a high impedance. In addition, you can loosely coil up to 3 to 5 turns of your feedline in a 4 to 8 inch (10 to 20 cm) diameter, depending upon the minimum bending radius, to act as an RF choke (see **fig. 8B**).

Remember that a direct hit can cause an extremely large current (20 to 100,000 amperes!) to flow. *Enclosing all transmission lines within an iron water pipe or tube (such as EMT) that is just a bit larger than the diameter of the line will considerably diminish the induced current. This is because of the limiting of the magnetic field by the steel (ferromagnetic material) tubing as shown in* **fig. 8C**. The preferred method is to use 20 feet (6 meters) of tubing for each line, but even a single 5-foot (1.5 meter) tube will help. If several shorter tubes are used, they need not be grounded or connected together. For economy's sake, several transmission lines can be placed inside a single tube. If this method is used and the tower is well grounded, the lightning will take the lowest impedance path — directly to the ground rods instead of through the ham shack!

When connecting transmission lines to a piece of gear, especially when rack mounted, bring the cables vertically from the floor level. Connect a suitable outside ground (such as the one just suggested for towers) to each shield at the floor level and at the base of the cabinet. This prevents the lightning from climbing vertically into the equipment.

lightning, static and RF

While a direct hit is hard to prevent and even more difficult to divert entirely, these suggestions will at least limit damage and perhaps prevent it entirely. Other measures can also help.

One of the best methods to protect equipment is to use a bandpass filter

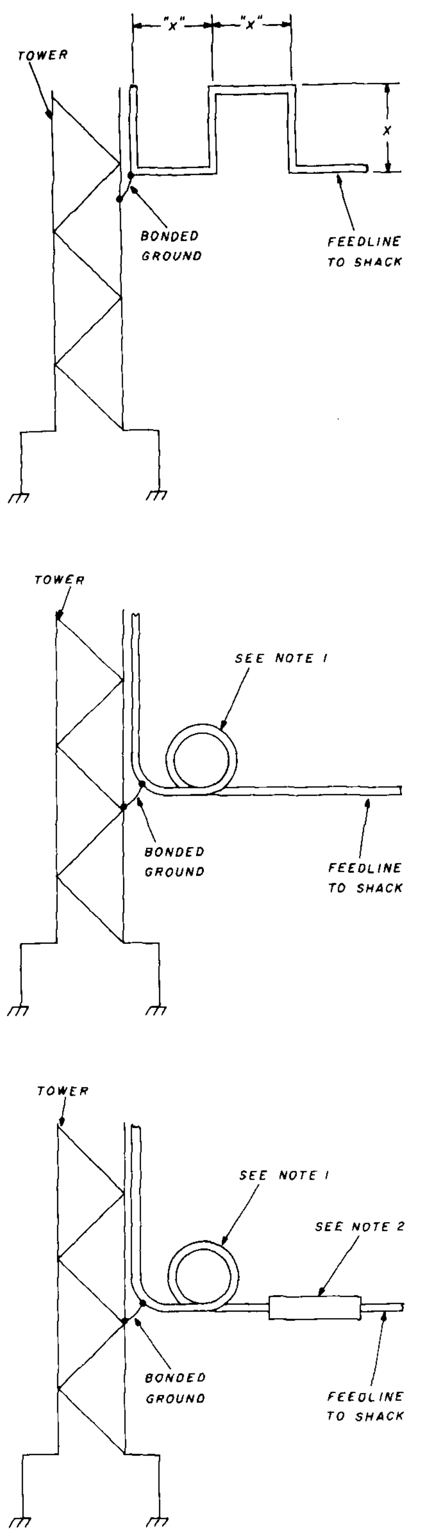

fig. 8. Typical methods for diverting lightning on transmission lines that are coming down a tower. "X" is typically 1 to 2 feet (30 to 60 cm). *Note 1:* feedline wound to act like an RF choke (see text). *Note 2:* steel conduit (see text for size).

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(as described above). This is suggested because lightning is primarily a low-frequency phenomenon — i.e., below 30 MHz. A high-pass or band-pass filter (see **fig. 9A** with a high attenuation at lower frequencies will significantly decrease the energy entering a receiver. Unfortunately, this may not always be possible for those operating on the HF bands!

Likewise, keep all coupling capacitors at a minimum. A capacitance reactance of 2 to 5 ohms at the frequency of operation should be used. This would suggest the use of no more than 200 pF at 70 cm. When low noise transistors first became available for 70 cm operation, many preamplifiers were accidentally destroyed when connected to automatic noise figure meters that used a gas tube noise generator. This failure was caused by large coupling capacitors that responded to the low frequency transient emitted by the firing of the gas tube. When low value capacitors were used, the problems diminished considerably. Fortunately, modern automatic noise figure generators use solid-state diodes that don't have this problem.

The placing of a 5 to 10 kilohm resistor across your receiver inputs as shown in **fig. 9B** will also help, especially in elimination of static.[9] It's standard practice in the CATV industry to place 510,000-ohm resistors in shunt with drop cables (the ones that go to your home), presumably to bleed off any charge buildup.

Another technique is the use of a shorted quarter-wave stub. A coaxial "T" connector is placed in the transmission line and the stub is connected and grounded as shown in **fig. 9C**. This stub is a high impedance at the frequency of use. Therefore it has low loss, but is a DC short for any static or lightning.

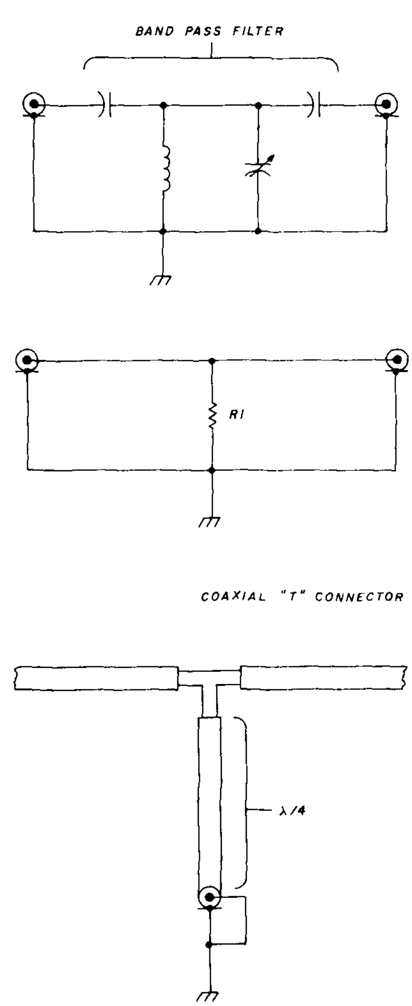

fig. 9. Other preamplifier protection schemes. R1 is typically 10 kilohm resistor.

physical handling

We may do all of the foregoing without paying attention to some of the basics such as using extreme care in handling and connecting equipment. All power supplies should be measured for proper voltages and should preferably be in operation when they are connected to the equipment. Some HF transceivers have external power supplies that put out high peak voltages when first turned on. Manufacturers recommend that the power supply should be turned on before the transceiver; this procedure should be reversed when ceasing operation. It is also recommended that whenever you connect a power supply, the ground return should be connected first. If not, the return current may flow through any coax cables back to the power supply and induce a spike or spark into the amplifiers. Transmission lines sometimes store a charge. Therefore, always discharge both sides of any incoming trasnmission lines to chassis ground before connecting them to the input of a receiver.

components

Component abuse or overstressing is one of the biggest problems faced by Radio Amateurs. Many of the failures I hear about are not induced by lightning or by RF, but rather by the user who is trying to milk the last bit of performance from a device. *Solid state devices, especially those of the low-noise type, should never be operated at voltages, currents, or power dissipation levels beyond the manufacturer's specifications*! The importance of using protective diodes and zener diodes as well as current limiting resistors, as discussed above, cannot be overstressed. Likewise, all resistors should be sufficiently derated in power.

Capacitors, especially on a receiver input, should have adequate breakdown voltages. I've noticed that the CATV industry uses 1000 volts or higher breakdown voltages on all their capacitors on the input and output circuits. Surely they know something about lightning — they have thousands of miles of transmission lines all over the world!

summary

In this month's column, I have described many of the types of failure mechanisms that can plague an active VHF/UHF Amateur. They range from carelessness and unwise short-cuts to events beyond our control. This column is not meant to alarm you; in fact, the opposite is true. If you understand the limitations of your equipment and the outside stresses and forces that can be placed upon them, you can take adequate protective measures using some or all of the techniques mentioned in this column. Taking short-cuts on grounding, filtering, and switching is "penny-wise and pound foolish."

One final remark: some of the protection devices described may be destroyed if you're unfortunate enough to suffer a failure or lightning strike.

However, the cost of replacing these devices is usually far less than the cost of replacing the equipment they protect! Remember, it's virtually impossible to protect yourself from a direct lightning hit but it is possible to minimize the destruction.

acknowledgements

I'd like to thank Leroy May, W5HN, a great old-time VHF/UHFer, who, by his letter to me several years ago, encouraged me to write on this subject.

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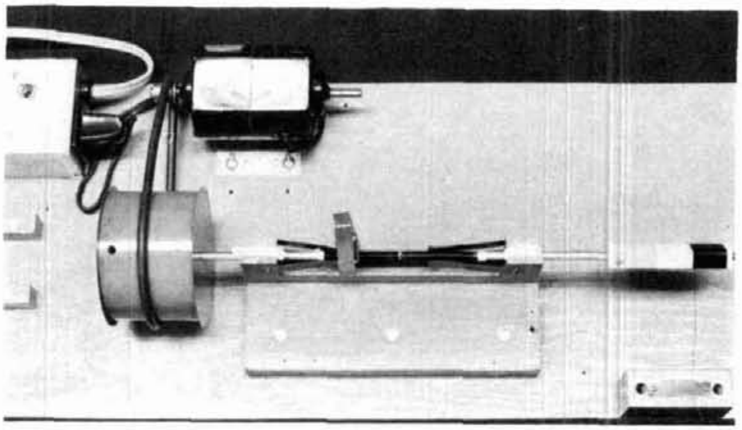
important VHF/UHF events:

June 1:	*EME Perigee*
June 5:	*Predicted peak of the Arietids meteor shower (1930 UTC)*
June 8-9:	*ARRL VHF QSO Party*
June 15:	*Predicted peak of the June Lyrids meteor shower (0400 UTC)*
June 21:	*Mean date for the two month annual peak of sporadic-E propagation*
June 29:	*EME Perigee*
June 29-30:	*SMIRK 6-meter Contest*
July 20:	*± two weeks, look for 2-meter sporadic E openings*
July 20-21:	*CQ VHF WPX Contest*
July 25:	*EME Perigee*
July 27-29:	*Central States VHF Conference, Tulsa, Oklahoma (Contact WØRRY/5)*
July 28:	*Predicted peak of Delta Aquarids meteor shower (0300 UTC)*

ham radio



Overall view of the coil winder set up to wind No. 30 enameled wire on a form approximately 0.8 inch (20 mm) × 0.43 inch (11 mm) × 2 inches (51 mm) long. About half of the winding length has been filled and the clothespin is clamped on the screw thread that causes the main shaft to traverse from left to right; the winding progresses from right to left. The mini-box at upper left is an SCR motor controller, and the two wood blocks at left are for later addition of a turns counter as explained in the text.

wind your own transformers — inexpensively

Novel approach produces high quality, low-cost replacements

I've seen many excellent articles on rewinding transformers in the home workshop. Valuable information for calculating the number of turns per volt relating to core size, insulation, varnish dipping, and space available was included, but in each of these articles it always seemed that in order to complete the project, it was necessary to somehow hold the coil in one hand and the wire in the other and just wind away. Many authors noted, of course, that the methods were really not suited to coils with a large number of turns of small wire, but were ideal for the larger sizes of wire, such as might be found powering the lower voltage transistor circuits popular in recent years.

This article describes a home-brew coil winding machine that will wind wire uniformly and neatly. It can be built from readily available, inexpensive parts. Most of the parts can be found right at home; the rest are available at reasonable prices. The only equipment necessary is a small drill press, a table saw, and the usual hand tools found around the hamshack. A 3 to 4 inch-circle cutter attachment for the drill press will save a lot of time.

background

Several years ago, when I experimented briefly with Amateur Television, I acquired a 12-year-old television camera with a bad power transformer. At first I thought it would be a simple matter to order a replacement transformer, but my enthusiasm faded when the manufacturer told me they'd stopped stocking parts years ago. My interest diminished even more when I learned that a professionally rebuilt replacement that would fit in the available space and meet the electrical requirements would cost $200.00.

My conscience wouldn't allow me to junk a perfectly good TV camera, and there was no way I'd spend more for a transformer than I'd invested in the whole camera. For years I'd toyed with the idea of a home-brewed coil winder; it seemed its time had finally come.

how it works

Small transformers are wound on a fairly complicated piece of machinery that rotates the form, or

By **C.F. Hooper, W4GDW**, 1457 Young Avenue, Clearwater, Florida 33516

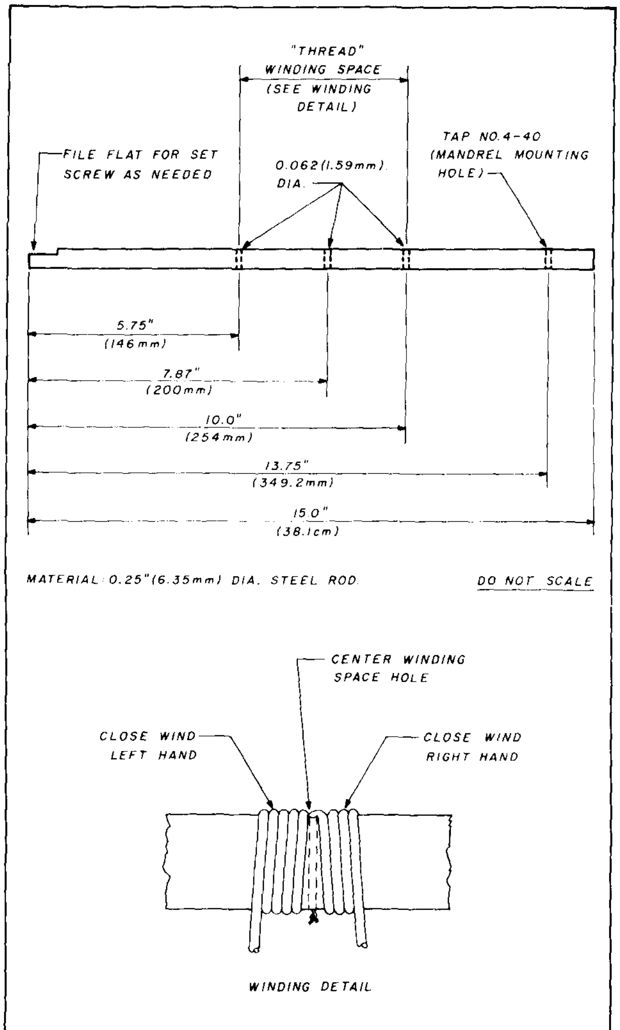


fig. 1. Dimensions of main shaft of coil winder.

mandrel, on which the wire is being wound. While the form makes one revolution, the feed guide moves the same distance as the diameter of the wire (plus perhaps a fraction of that distance for clearance). Such a winding lathe has a large selection of gears available so that the lead screw is turned at just the right rate to accomplish this motion. A transformer winding machine costs thousands of dollars — and the average ham obviously doesn't wind coils often enough to justify that expense.

It would be fairly easy for an Amateur to assemble a device that would merely rotate the coil form, but the mechanism necessary to move the wire guide at precisely the proper rate — unless you already have a lathe with many gears — gets much too complicated for a homebrew project.

In searching for ways to solve the problem inexpensively, it occurred to me that the shaft on which the coil form was mounted could do the lengthwise moving, while the wire feed point remained stationary. As I began to think about having lead screws made for each size of wire and the many other details, I realized I could use the wire itself for the lead screw! Normally you'd have a little bit of the size wire you were going to wind left over. So why not form the lead screw threads right on the shaft by simply winding on a single layer of wire for each direction of feed, securing it in place if necessary? It's fairly easy to close wind on a round rod, even with small wire; besides, you do it only once for each size of wire you're going to wind.

The shaft is made to move lengthwise while rotating by mounting a pair of pads of resilient material on strips of metal fastened to the bearing posts, close to the shaft but not touching, on either side. When feeding is desired, a clothespin is used to clip over the pads to bring them in contact with the "threads." There are two sets of these pads, one for each direction of feed, so when ready to reverse wire feed, you simply stop the rotation and move the clothespin to the other pair of pressure pads, insert and wrap the paper insulation layer over the layer just wound (securing it temporarily with masking tape if needed), and then restart winding with feed in the other direction. I designed my winder around 0.25-inch (6.35 mm) steel rod, and to accommodate an actual winding length of 1.8 inch (46 mm), which means that a 2-inch (51 mm) long winding form can be handled with a little space at each end. I wanted to have a winding shaft for each wire size to be used to save for use again with that particular size. This means, of course, that when you've finished winding one wire size, you remove the drive pulley and the winding form, mount them on another rod made up for the next wire size, and reinstall the unit into the bearings. The "bearings" are simply wood posts with a slot sawed into the top in which the winding shaft lies, leaving it free to slide lengthwise as well as to rotate.

The shaft is powered by an old sewing machine motor (complete with pulley, if possible) made to be variable in speed by the inclusion of an SCR speed controller built from a diagram in the General Electric Company SCR manual.[1] Similar circuits can be found in the handbooks; a plain old Variac — or even the foot control from the sewing motor — would do.

construction

Main shaft. The main winding shaft is made from 0.25-inch (6.35 mm) steel rod, with a flat filed on one end for the drive pulley set screw, three small holes for securing the "thread" winding, and a tapped hole for attaching the coil form and mandrel. (When buying the rod, be sure to select the straightest and smoothest you can find; its dimensions are shown in **fig. 1.**) It seems wise to postpone placing the winding on the shaft until the winder is complete enough to be used

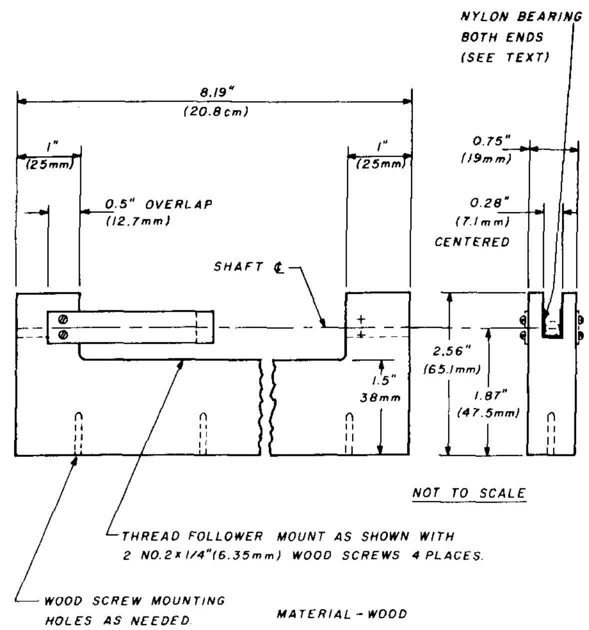


fig. 2. Bearing block details.

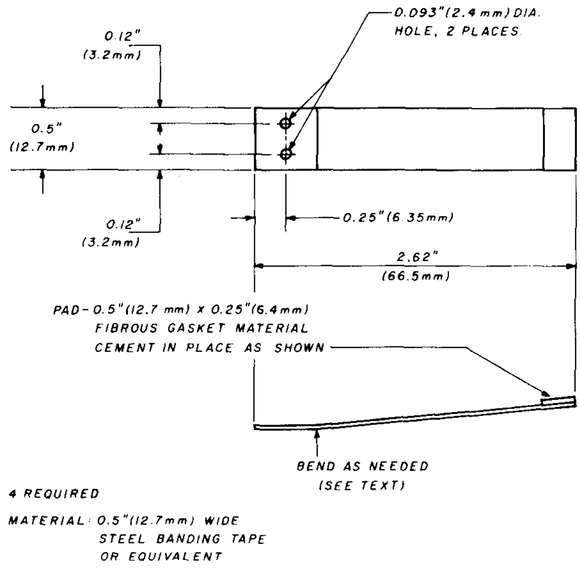


fig. 3. Thread follower details.

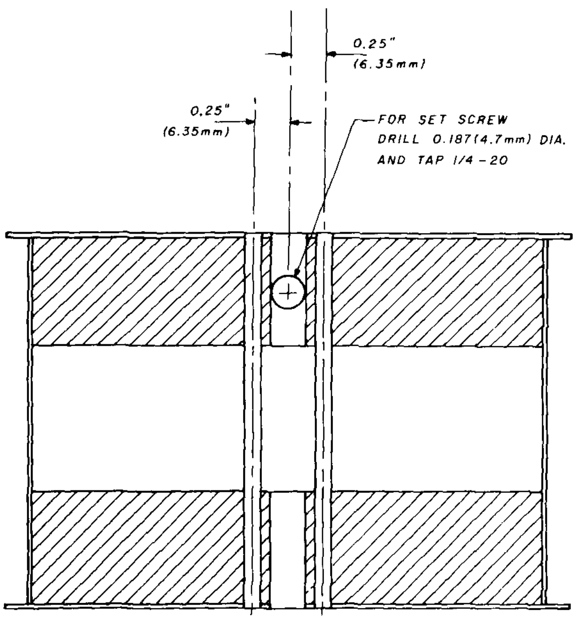
so that the motor can rotate the shaft for you. For the finer sizes — perhaps No. 30 and smaller — the wire can be cemented to the shaft to avoid an accident during winding. After cleaning with alcohol, I used a very thin coat of epoxy cement (not the "quick setting" type) applied to the winding space before winding on the wire. After winding, I carefully removed the excess from the outside of the winding with a cotton ball and denatured alcohol. The outside surface of the wire should be clean enough so that the follower pads can "feel" the individual turns.

Bearing and thread follower support. Dimensions for this part are shown in **fig. 2**. The bearings were constructed from a piece of ordinary 3/4-inch (1.90 cm) thick board. Note that the slots that form the bearings are slightly larger than needed to accept the main shaft rod; this is to permit lining the slot with several thicknesses of nylon fabric as needed to act as a low friction bearing. The shaft should not bind or be loose and wobbly, but should turn freely as well as slide lengthwise freely.

Screw thread follower. This part is made from ordinary 1/2-inch (13 mm) wide steel banding, such as used for strapping crates. If steel strapping isn't available, pieces can be cut from a tin can. Four pieces are mounted on the bearing posts so that they contact the wire "screw thread" when the clothespin is clipped over them. These are detailed in **fig. 3**, and the photo of the entire winder shows them clearly. The pads cemented to the pieces are important; they should be made from a resilient material that will "sink into" the grooves between the "screw thread" wires when pressed against them. I used automobile gasket material — the kind used for mounting water pumps and such. The note "bend as needed" in **fig. 3** means that after installing, a bit of judicious bending is in order so that no contact is made until the clothespin is clamped on. When it is, it should contact as many turns of the "thread" as possible.

Drive pulley. I fabricated this part by cutting two discs from 5/8 inch (15.9 mm) particle board using the circle cutter in the drill press, truing them up by mounting them on a 0.25-inch bolt in the drill press, as if it were a lathe. I turned the cutting bit in the circle cutter so the disc being cut had straight sides, not the hole. (In the absence of a circle cutter, a sabre saw would probably do the job if, after cutting, you then mount the discs in the drill press and straighten up their sides with a sanding block — they should run as true as possible. I slipped the two pieces on a rod (for alignment), spaced for the width of the drive pulley, and, using epoxy, then cemented the thin aluminum around them to form a drum, using several rubber bands to hold them until the epoxy set. Then the flanges were cemented onto the ends of the pulley. (Incidentally, if a circle cutter is used in the drill press, clamp the work piece down securely and be sure to follow all the safety rules.)

Both the drum surface and the end flanges were cut from discarded aluminum offset printing plates. Although only between 0.010 inch (0.25 mm) and 0.012 inch (0.30 mm) thick, this metal works nicely. It should be available inexpensively from print shops or news-



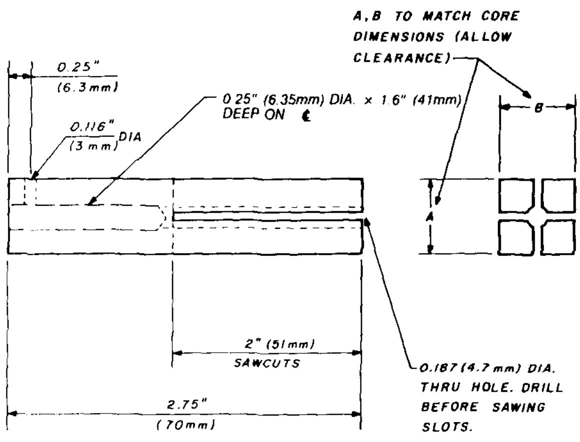
2.5 × 11.5 inch (6.35 × 29.2 cm) of 0.010 to 0.012 inch (0.25 to 0.3 mm) thick aluminum sheet (used printing plate). Position end disks on 0.25 inch (6.3 mm) rod for alignment. Wrap around end disks, cemented with epoxy (including overlap). Secure with sufficient rubber bands until set. Align carefully so aluminum sheet does not overhang disks.

End disks (2 needed): Make from particle board or plywood, 0.6 to 0.75 inch (15 to 19 mm) thick. Diameter: 3.5 inch (89 mm) with 0.25 inch (6.35 mm) hole in center.

2 holes all the way through, 0.125 inch (3.2 mm) diameter. Insert 2.5 inch (6.35 mm) long × 0.125 inch (3.2 mm) OD brass tubing and cement (for later addition of a turns counter). Drill these after assembly is complete.

2 flanges needed, 3.87-inch (98 mm) diameter with 0.25 inch (6.35 mm) hole in center. Make from aluminum sheet or thin, stiff cardboard. Cement to end disks.

fig. 4. Dimensions for drum parts and fabrication.



Select stiff, straight wires at least 5.5 inches (14 cm) long and small enough to slide freely in the brass tubing lined holes through the drive pulley (old bike spokes).

Position counter so that ends of counter drive wires are about 0.125 inch (3.2 mm) from nearest side of bearing block.

Build up counter shaft with tape. Place wires on opposite side and tape wires in place so their centers are 0.5 inch (12.7 mm) apart.

Make counter support block so that center of counter shaft is at same height as center of winding shaft and aligned with it. Block should be removable to enable changing rod.

fig. 5. Coil Mandrel.

papers. Since the drive belt should never reach the edge of the pulley, the flanges aren't really necessary, but they look nice.

The hole for the set screw that secures the pulley on the shaft is tapped edgewise in the particle board (1/4-20), and so far the threads haven't stripped out. As an additional feature, I installed two pieces of 1/8 inch (3.27 mm) OD brass tubing (cut from discarded ball point pen refills) opposite each other on about 0.5 inch (12.7 mm) diameter and lengthwise through the pulley (avoid the set screw!). This was to provide the addition of a counter with a couple of stiff wires taped to its shaft that could be inserted inside these holes and slide freely as the shaft moved back and forth. Dimensions for the drum parts and fabrication are shown in **fig. 4**. If one should want to add a counter as mentioned above, a sketch showing how I did it is shown in **fig. 5**.

Base and layout. I used a piece of 1/2 inch (12.7 mm) plywood, thickened to 1 inch (25.4 mm) around the edges, measuring approximately 26 × 10 inches (66 × 25 cm), as a base for the entire coil winder. Any convenient layout is satisfactory. I mounted the shaft bearing against an additional piece of wood the same length, using small nails and glue, providing a "lip" that could be mounted from the top side. Otherwise, mounting with wood screws up from the bottom side of the base into the bottom edge of the bearing should do the job. The drive belt won't be specified, but many are available that will work. The motor should be positioned so that the belt is just tight enough to run without slipping. Too tight a belt will cause obvious problems. A sewing machine shop would be the best place to look for a suitable drive belt; other sources might include jewelers or other craftsmen who could supply the belting used to run smaller lathes. This type of belting comes in a continuous length. A suitable piece is cut and the ends are joined together by heating.

The direction of rotation should be considered. In

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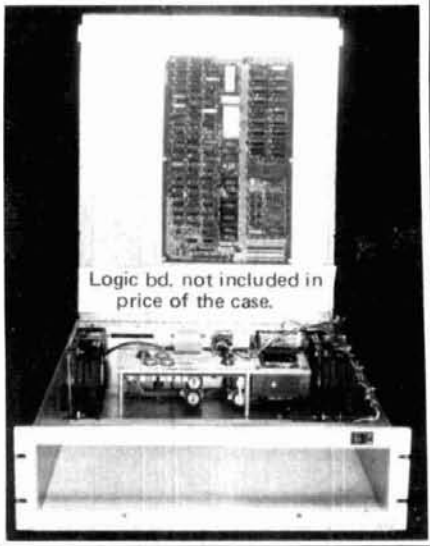
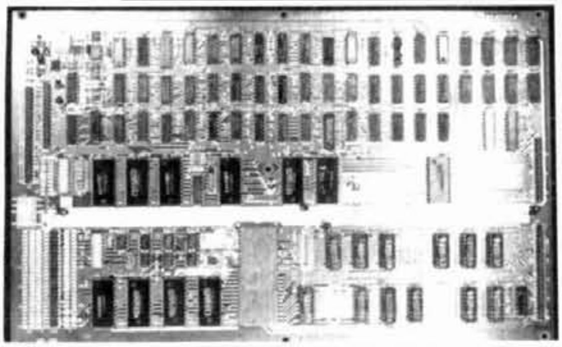


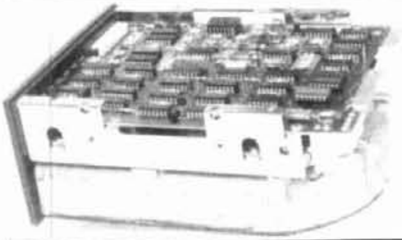
Dual 8" F. D. D. Case by SMS w/ POWER ONE Power Supply & Cooling Fans

We were very fortunate to find these beautifully designed & constructed rack mount disc drive cases in the surplus field. These cases were made for Scientific Micro Systems for their FT Series of equipment. They are manufactured from heavy guage steel w/ a cast metal designer bezel. They were designed to house 2 8" floppy or hard drives. We offer you the case with the following components & features: hinged cover with restraining cable for simplified servicing of the interior components, 2 muffin fans for assured cool operation, studs for mounting the controller card listed below, and a heavy duty Power One power supply (their model no. CP 281A). The outputs of the power supply are as follows: +5 vdc 11 amps, +24 vdc 3.5 amps, +12 vdc .25 amps, -12 vdc .25 amps, & –5 vdc .25 amps. The input to the power supply is 115/230 vac 50/60 Hz. and is both filtered and fused. This assembly must have originally sold for well over $300.00 each ! Only 25 on hand, so order early or be left out on this super bargain ! Shpg. wt. 38 lb. SPL-479-35 $135.00 each

Scientific Micro Systems IBM 3740 Compatible 8" FDD Controller Card



The SMS FD 0502 8" floppy disc drive controller is a complete preprogrammed controller for single or double density recording on either single or dual headed disc drives. It performs control functions required to transfer data between 1 to 4 drives and a host system, performs all formatting functions required to read and write data and utilizes both IBM single and double density standards to achieve up to 630 Kilobytes of storage per disc surface. Some features are: programmable sector size, 128, 256, 512, or 1024 bytes, jumper selectable drive type, block transfer mode, sector buffer, overlapped head seek, on board General Purpose Host Interface with asynchronous 19 TTL signal lines for eight bit host system and input of only 5 vdc 6 amps. This board provides a direct interface to the following drives: Shugart 800 –2/850, Pertec 511, Memorex 550/552, MFE 751B, Qume Data Trak and similiar drives. These boards were removed from the above cabinets which were in service prior to our reception of them. The manufacturers price on these IBM compatible boards is currently $900.00 each. These boards all appear to be in excellent condition. If more information is needed, please call us. Shpg. wt. 3 lb. SPL 480 $150.00



SEAGATE TECHNOLOGY ST 506 5¼" HARD DRIVES

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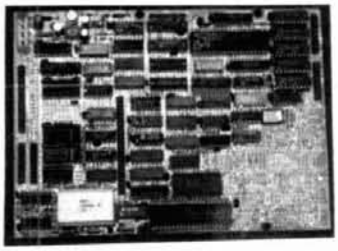

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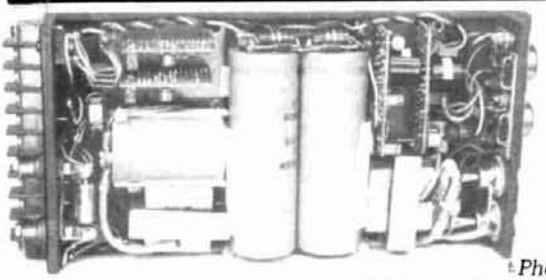
Finally, affordable, intelligent disc drive controllers are available at low, low surplus prices. The OMTI 20C controller boards we offer are unused, late style, surplus from a now defunct system house. OMTI is a division of Scientific Micro Systems. These boards will handle up to (2) 5¼ inch Winchester type hard drives that utilize a standard 34 pin SASI interface. Perfect for using with the above Seagate ST 506 drive, or other hard drives from 5 megabytes of storage on up. The controllers have buffered slew/seek modes, overlapped seeks, auto seek & verify, extensive fault detection, auto head & cylinder switching, full sector buffering, 256/512 bytes/sector, 33 or 18 sectors/track (jumper selectable), programmable disc parameters and much more. The board runs on +5 vdc & +12 vdc.. We supply users manual & pinout data. Guaranteed O. K..
Shpg. wt. 3 lb. OMTI 20 C $150.00 each 2/$275.00 Qty. pricing available.



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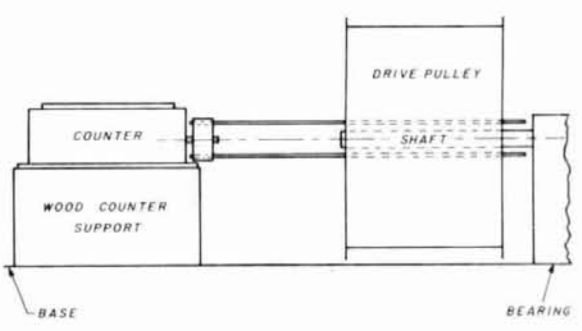

fig. 6. Method of coupling counter to winding shaft while still retaining freedom of lateral shaft movement.

my opinion the top of the shaft should be moving away from you when you stand in front of the winder; this facilitates inserting insulation papers and observing the wire as it winds on.

Wire tension and feeding. In keeping with the idea of building something for practically nothing, the winding wire is fed onto the coil over a block of wood (see lower right in photo of completed unit) between two pieces of felt clamped in place by a short strip of metal held in position by small wooden screws. Glue one piece of felt to the piece of metal and one to the top of the wood block, and adjust wire tension by tightening or loosening the screws. Tension should be maintained as uniformly as possible all during the winding of a coil; too much tends to "crunch up" the layers already wound underneath, and too little leaves the wire already wound free to move around or slip out of position. A much more elaborate wire tensioning system would be preferred, but this method will hold the wire in position accurately enough for now. Feeding the wire off the end of the supply spool helps to avoid any additional drag.

Winding mandrel or form. I made this of wood cut to match the core size of the transformer, and with a hole diameter in one end to fit on the winding shaft, and in the other to accept a No. 10 screw (push in), and with saw cuts so that when the screw is removed, the mandrel shrinks a little to allow coil removal. To be safe, I included some paper shims — when the coil is finished, it's too late to discover that it won't go over the core! (See **fig. 6** for details.)

General. Once this winder is in operation, it will become apparent that the lateral position of the shaft is rather delicate, so be careful to see that nothing gets in its way while winding. Once a set-up was made, I tested it by having the shaft run back and forth several times under power and with the follower pads clamped on just to make sure everything was in order before actually starting the winding. This also helps the follower pads to match the shape of the wire screw thread.

A thin coat of lubricant such as petroleum jelly on the screw thread winding is suggested.

One more precaution should be mentioned. Since not all enameled wire of a given copper size has the same thickness of enamel on it, the best course to follow is to use wire from the same spool for both the screw thread winding and the coil, if not, make sure the wire for the thread is *not smaller* in overall diameter than that used for the wire to be wound.

I was able to wind over 2300 turns of No. 42 enameled wire on a coil without any problems, and found that it could be run at over 200 RPM as long as the speed was brought up gradually. (In case you're wondering, I was able to rewind the power transformer for the TV camera — and it's still working!)

This design could easily be adapted to provide for greater winding lengths than the 1.8 inch (46 mm) I have provided for. Just remember to increase the space between the bearing posts and the overall length of the shaft rod to allow for the extra lateral movement needed.

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ham radio

DX FORECASTER

Garth Stonehocker, KØRYW

sporadic-E propagation

During the summer months, the sun, almost directly overhead, produces more ions in the lower ionosphere than it does in winter. These ions support short-skip propagation — even *multiple* short-skips. The geomagnetic field clusters and forces these overly abundant ions into cloud-like patches known as sporadic-E (E_S). These patches, which form in a thin-dense layer about 60 miles (100 km) above the earth, give rise to strong, mirror-like signal reflections over short-skip distances of 600 to 1200 miles (1000 to 2000 km).

Because E_S is related to the summer sun, the best locations for working these E_S openings are in the Northern Hemisphere from June through September and in the Southern Hemisphere during its summer, December through March. In each hemisphere the best E_S is found on either side of the geomagnetic equator; it's especially good where the geomagnetic equator is farthest from the geographic equator, giving greater distance and force for formation. These special areas are South-east Asia in the Northern Hemisphere and South America in the Southern Hemisphere, with the former the better of the two. This is because the sun's maximum level of ion production occurs in the D and E layers (37 to 62 miles, or 60 to 100 km) above the earth at 23 degrees latitude, directly under the sun. As the ionization travels (in movement known as *diffusion* or *drift*) from this maximum to less dense areas, E_S is bunched by field-strength variations. When ions move, they can move only parallel to the geomagnetic field lines, not perpendicular to them. (See cross-section views of the earth's magnetic field lines in **fig. 1**, particularly those lines connecting the northern and southern hemispheres.) **Figure 2**[1] shows the movement of E_S patches across the United States. The E_S patches are the variation (bunching) of ions caused by changes in the geomagnetic field strength modulating and forcing the ions in their north-south movement. In these two special areas of maximum separation between equators, the modulating force and the distance over which to bunch are greatest, so more E_S patches are formed.

last-minute forecast

DX conditions for the higher frequency bands, 10 through 30 meters, are expected to be very good during the first and last weeks of the month when the solar flux could be high. (Verify this daily by checking WWV at 18 minutes after each hour.) During the middle weeks of the month, the lower frequency bands should engage interest for some short skip daytime and DX at night. Geomagnetic disturbances are expected on June 6th and 16th. The moon will be full on the 3rd, and closest approach (perigee) will

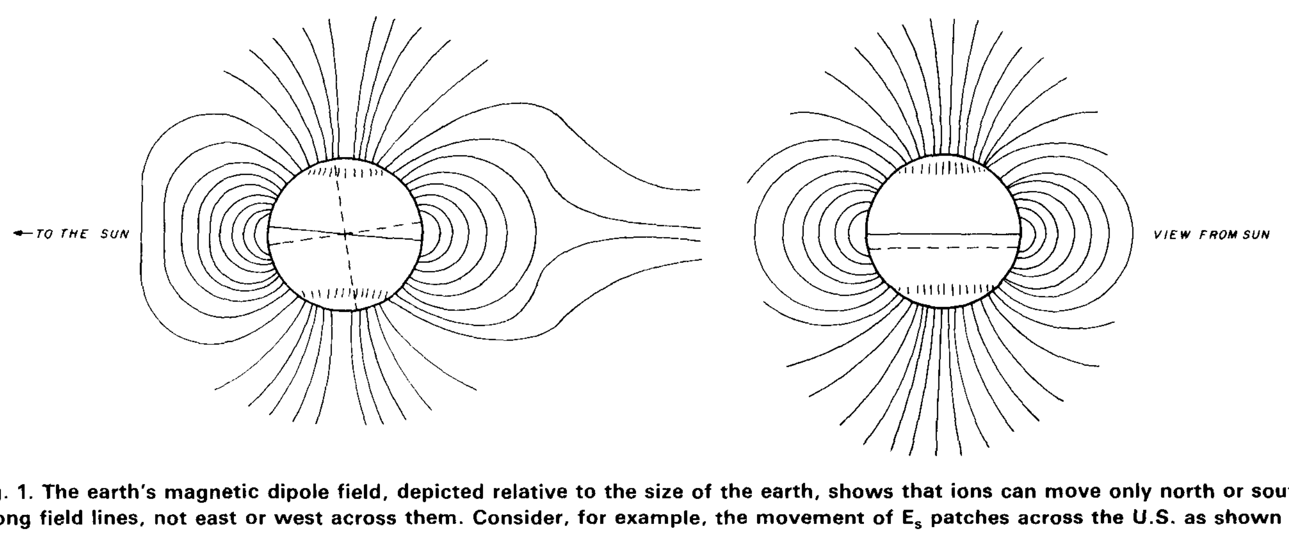

fig. 1. The earth's magnetic dipole field, depicted relative to the size of the earth, shows that ions can move only north or south along field lines, not east or west across them. Consider, for example, the movement of E_S patches across the U.S. as shown in figure 2.[1]

JUNE

WESTERN USA

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

MID USA

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

EASTERN USA

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

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.

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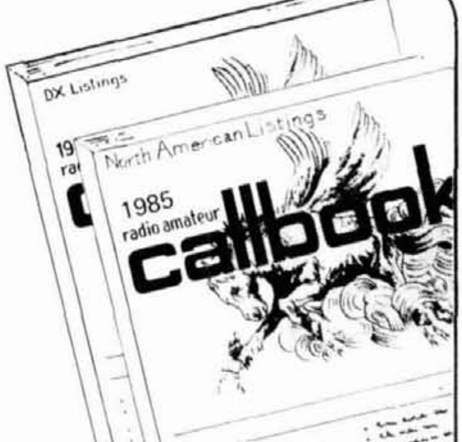

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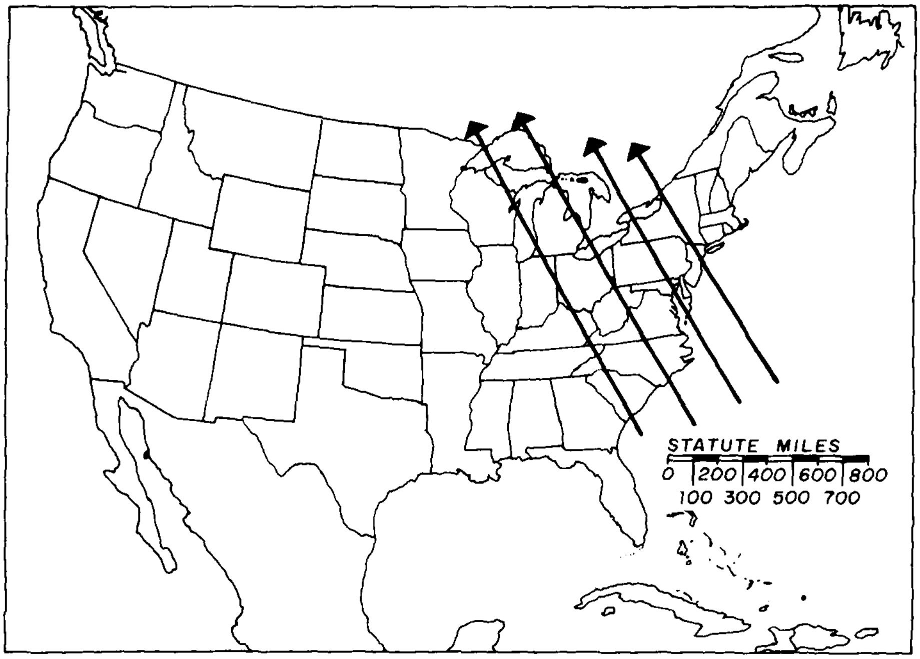

fig. 2. Clouds producing sporadic-E propagation generally travel from southeast to northwest at approximately 180 miles (280 km) per hour, moving in a relatively straight line.

occur on the 1st and 29th. Summer solstice is on the 21st at 1044 UTC. The Aquarid meteor shower starts about the 18th, peaks about the 28th, and lasts until about August 7. The *maximum radio-echo rate* will be 34 per hour.

band-by-band summary

Six meters will provide occasional openings to South Africa and South America around noontime by short-skip E_S.

Ten meters will provide long-skip conditions in the afternoon during the peak times of the 27-day solar cycle. Otherwise, look to sporadic-E short-skip and multihop openings around local noon for DX on these bands. (Transequatorial evening openings do not usually occur in the summertime.)

Fifteen and twenty meters, almost always open to some part of the world, will be the main daytime DX bands. Twenty meters will stay open on long southern paths into the night, though 15 will drop out in the late afternoon. Operate on 15 first, then move down to 20 meters later. DX is 5000 to 7000 miles (8000 to 11,200 km) on these bands. There may be some long one-hop transequatorial propagation.

Thirty and forty meters are both daytime and nighttime bands. Intermediate distance operation (1000 to 1500 miles, 1600 to 2400 km), in any direction is considered daytime DX. Nighttime DX on these two bands may be expected to occur over greater distances than on 80 meters and, like 80, will follow the darkness path across the sky. Signal strength and distances covered are reduced on days of high solar flux values. In addition, no 30-meter openings will take place during the pre-dawn hours on the morning after these high radio flux values.

Eighty and one-sixty meters will exhibit short-skip conditions during daylight hours and lengthen for DX near dark. Eighty meters will open to the east just before your sunset swing more to the *south* as *midnight* approaches, and end up in the Pacific areas during the hour or so before dawn. (One-sixty opens later and ends earlier.)

references

1. Joe Reisert, W1JR, "The VHF/UHF Primer: An Introduction to Propagation," *ham radio*, July, 1984, page 14.

ham radio

"FILTERS"

COLLINS Mechanical Filter #526-9724-010 MODEL F455Z32F

455KHZ at 3.2KHz wide. May be other models but equivalent. May be used or new. $15.99

ATLAS Crystal Filters

5.595-2.7/8/LSB, 5.595-2.7/LSB 8 pole 2.7KHz wide Upper sideband. Impedence 800ohms 15pf In/800ohms 0pf out.	19.99
5.595-2.7/8/U, 5.595-2.7/USB 8 pole 2.7Khz wide Upper sideband. Impedence 800ohms 15pf In/800ohms 0pf out.	19.99
5.595-.500/4, 5.595-.500/4/CW 4 pole 500 cycles wide CW. Impedance 800ohms 15pf In/800ohms 0pf out.	19.99
9.0USB/CW 6 pole 2.7KHz wide at 6dB. Impedance 680ohms 7pf In/300ohms 8pf out. CW-1599Hz	19.99

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455KHz at Center Frequency of 453.5KC. Carrier Frequency of 455KHz 2.36KC Bandwidth.

Upper sideband. (ZU)	19.99
Lower sideband. (ZL)	19.99

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SDK	SCH-113A	11.2735MHz	10.00
TAMA	TF-31H250	CF 3179.3KHz	19.99
TYCO/CD	001019880	10.7MHz 2pole 15KHz bandwidth	5.00
MOTOROLA	4884863B01	11.7MHz 2pole 15KHz bandwidth	5.00
PTI	5350C	12MHz 2pole 15KHz bandwidth	5.00
PTI	5426C	21.4MHz 2pole 15KHz bandwidth	5.00
PTI	1479	10.7MHz 8pole bandwidth 7.5KHz at 3dB, 5KHz at 6dB	20.00
COMTECH	A10300	45MHz 2pole 15KHz bandwidth	6.00
FRC	ERXF-15700	20.6MHz 36KHz wide	10.00
FILTECH	2131	CF 7.825MHz	10.00

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CERAMIC FILTERS

AXEL	4F449	12.6KC Bandpass Filter 3dB bandwidth 1.6KHz from 11.8-13.4KHz	10.00
CLEVITE	TO-01A	455KHz+-2KHz bandwidth 4-7% at 3dB	5.00
	TCF4-12D36A	455KHz+-1KHz bandwidth 6dB min 12KHz, 60dB max 36KHz	10.00
MURATA	BFB455B	455KHz	2.50
	BFB455L	455KHz	3.50
	CFM455E	455KHz +-5.5KHz at 3dB , +-8KHz at 6dB , +-16KHz at 50dB	6.65
	CFM455D	455KHz +-7KHz at 3dB , +-10KHz at 6dB , +-20KHz at 50dB	6.65
	CFR455E	455KHz +-5.5KHz at 3dB , +-8KHz at 6dB , +-16KHz at 60dB	8.00
	CFU455B	455KHz +-2KHz bandwidth +-15KHz at 6dB, +-30KHz at 40dB	2.90
	CFU455C	455KHz +-2KHz bandwidth +-12.5KHz at 6dB , +-24KHz at 40dB	2.90
	CFU455G	455KHz +-1KHz bandwidth +-4.5KHz at 6dB , +-10KHz at 40dB	2.90
	CFU455H	455KHz +-1KHz bandwidth +-3KHz at 6dB , +-9KHz at 40dB	2.90
	CFU455I	455KHz +-1KHz bandwidth +-2KHz at 6dB , +-6KHz at 40dB	2.90
	CFW455D	455KHz +-10KHz at 6dB , +-20KHz at 40dB	2.90
	CFW455H	455KHz +-3KHz at 6dB , +-9KHz at 40dB	2.90
	SFB455D	455KHz	2.50
	SFD455D	455KHz +-2KHz , 3dB bandwidth 4.5KHz +-1KHz	5.00
	SFE10.7MA	10.7MHz 280KHz +-50KHz at 3dB , 650KHz at 20dB	2.50
	SFE10.7MS	10,7MHz 230KHz +-50KHz at 3dB , 570KHz at 20dB	2.50
	SFG10.7MA	10.7MHz	10.00
NIPPON	LF-B4/CFU455I	455KHz +-1KHz	2.90
	LF-B6/CFU455H	455KHz +-1KHz	2.90
	LF-B8	455KHz	2.90
	LF-C18	455KHz	10.00
TOKIN	CF455A/BFU455K	455KHz +-2KHz	5.00
MATSUSHIRA	EFC-L455K	455KHz	7.00

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2N5836	3.45	40281 RCA	10.00	BFX86	2.50	J02000	10.00
2N5842	8.45	40282 RCA	20.00	BFX89	1.00	J02001	25.00
2N5847	19.90	40290 RCA	2.80	BFY11	2.50	J04045	24.00
2N5849	20.00	40292 RCA	13.05	BFY18	2.50	KD5522	25.00
2N5913	3.25	40294 RCA	2.50	BFY19	2.50	KJ5522	25.00
2N5916	36.00	40341 RCA	21.00	BFY39	2.50	M1106	13.75

Toll Free Number
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(For orders only)

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MHz electronics

3802 North 27th Ave., Phoenix, AZ 85017

RF TRANSISTORS (CONTINUED)

M1107	$16.75	MRF458	$20.70	NE02160ER	$100.00	SD1009	$15.00
M1131	5.15	MRF464	25.30	NE021350	5.30	SD1009-2	15.00
M1132	7.25	MRF466	18.97	NE13783	61.00	SD1012	10.00
M1134	13.40	MRF472	1.50	NE21889	43.00	SD1012-3	10.00
M9116	29.10	MRF475	3.10	NE57835	5.70	SD1012-5	10.00
M9579	6.00	MRF476	3.16	NE64360ER-A	100.00	SD1013	10.00
M9580	7.95	MRF477	20.00	NE64480 (B)	94.00	SD1013-3	10.00
M9587	7.00	MRF479	8.05	NE73436	2.50	SD1013-7	10.00
M9588	5.20	MRF492	23.00	NE77362ER	100.00	SD1016	15.00
M9622	5.95	MRF502	1.04	NE98260ER	100.00	SD1016-5	15.00
M9623	7.95	MRF503	6.00	PRT8637	25.00	SD1018-4	13.00
M9624	9.95	MRF504	7.00	PT3127A	5.00	SD1018-6	13.00
M9625	15.95	MRF509	5.00	PT3127B	5.00	SD1018-7	13.00
M9630	14.00	MRF511	10.69	PT3127C	20.00	SD1018-15	13.00
M9740	27.90	MRF515	2.00	PT3127D	20.00	SD1020-5	10.00
M9741	27.90	MRF517	2.00	PT3127E	20.00	SD1028	15.00
M9755	16.00	MRF525	3.45	PT3190	20.00	SD1030	12.00
M9780	5.50	MRF559	1.76	PT3194	20.00	SD1030-2	12.00
M9827	11.00	MRF587	11.00	PT3195	20.00	SD1040	5.00
M9848	35.00	MRF605	20.00	PT3537	7.80	SD1040-2	20.00
M9850	13.50	MRF618	25.00	PT4166E	20.00	SD1040-4	10.00
M9851	20.00	MRF626	12.00	PT4176D	25.00	SD1040-6	5.00
M9860	8.25	MRF628	8.65	PT4186B	5.00	SD1043	12.00
M9887	2.80	MRF629	3.45	PT4209	25.00	SD1043-1	10.00
M9908	6.95	MRF641	25.30	PT4209C/5645	25.00	SD1045	3.75
M9965	12.00	MRF644	27.60	PT4556	24.60	SD1049-1	2.00
MM1500	25.00	MRF646	29.90	PT4570	7.50	SD1053	4.00
MM1550	10.00	MRF648	33.35	PT4577	20.00	SD1057	10.00
MM1552	50.00	MRF816	15.00	PT4590	5.00	SD1065	4.75
MM1553	50.00	MRF823	20.00	PT4612	20.00	SD1068	15.00
MM1607	8.45	MRF846	44.85	PT4628	20.00	SD1074-2	18.00
MM1614	10.00	MRF892	35.50	PT4640	20.00	SD1074-4	28.00
MM1810	15.00	MRF894	46.00	PT4642	20.00	SD1074-5	28.00
MM1810	15.00	MRF901 3 Lead	1.00	PT5632	4.70	SD1076	18.50
MM1943	1.80	MRF901 4 Lead	2.00	PT5749	25.00	SD1077	4.00
MM2608	5.00	MRF902/2N6603JAN	15.00	PT6612	25.00	SD1077-4	4.00
MM3375A	17.10	MRF902B	18.40	PT6619	20.00	SD1077-6	4.00
MM4429	10.00	MRF904	2.30	PT6708	25.00	SD1078-6	24.00
MM8000	1.15	MRF905	2.55	PT6709	25.00	SD1080-7	7.50
MM8006	2.30	MRF911	2.50	PT6720	25.00	SD1080-8	6.00
MM8011	25.00	MRF965	2.55	PT8510	15.00	SD1080-9	3.00
MPSU31	1.01	MRF966	3.55	PT8524	25.00	SD1084	8.00
MRA2023-1.5	42.50	MRF1000MA	32.77	PT8609	25.00	SD1087	15.00
MRF134	10.50	MRF1004M	31.05	PT8633	25.00	SD1088	22.00
MRF136	16.00	MRF2001	41.74	PT8639	25.00	SD1088-8	22.00
MRF171	35.00	MRF2005	54.97	PT8659	25.00	SD1089-5	15.00
MRF208	11.50	MRF5176	24.00	PT8679	25.00	SD1090	15.00
MRF212	16.10	MRF8004	2.10	PT8708	20.00	SD1094	15.00
MRF221	10.00	MSC1720-12	225.00	PT8709	20.00	SD1095	15.00
MRF223	13.00	MSC1821-3	125.00	PT8727	29.00	SD1098-1	30.00
MRF224	13.50	MSC1821-10	225.00	PT8731	25.00	SD1100	5.00
MRF227	3.45	MSC2001	30.00	PT8742	19.10	SD1109	18.00
MRF230	2.00	MSC2010	93.00	PT8787	25.00	SD1115-2	7.50
MRF231	10.00	MSC2223-10	245.00	PT8828	25.00	SD1115-3	7.50
MRF232	12.07	MSC2302	POR	PT9700	25.00	SD1115-7	2.10
MRF237	3.15	MSC3000	35.00	PT9702	25.00	SD1116	5.00
MRF238	13.80	MSC3001	38.00	PT9783	16.50	SD1118	22.00
MRF239	17.25	MSC72002	POR	PT9784	32.70	SD1119	5.00
MRF245	35.65	MSC73001	POR	PT9790	56.00	SD1124	50.00
MRF247	31.00	MSC80064	35.00	PT31083	20.00	SD1132-1	15.00
MRF304	36.00	MSC80091	10.00	PT31962	20.00	SD1132-4	12.00
MRF306	50.00	MSC80099	3.00	PTX6680	20.00	SD1133	9.50
MRF313	11.15	MSC80593	POR	RE3754	25.00	SD1133-1	10.00
MRF314	29.21	MSC80758	POR	RE3789	25.00	SD1134-1	2.50
MRF315	28.86	MSC82001	33.00	RF35	16.00	SD1134-4	12.00
MRF316	55.43	MSC82014	33.00	RF85	17.50	SD1134-17	12.00
MRF317	63.94	MSC82020M	130.00	RF110	21.00	SD1135	10.25
MRF412	18.00	MSC82030	33.00	S50-12	23.80	SD1135-3	12.00
MRF420	20.12	MSC83001	40.00	S3006	15.00	SD1136	12.50
MRF421	25.00	MSC83003	82.00	S3007	10.00	SD1136-2	12.50
MRF422	38.00	MSC83005	70.00	S3031	22.00	SD1143-1	10.00
MRF427	17.25	MSC83026	POR	SCA3522	5.00	SD1143-3	17.00
MRF428	63.00	MSC83303	POR	SCA3523	5.00	SD1144	4.00
MRF433	12.07	MSC84900	60.00	SD345	5.00	SD1145-5	15.00
MRF449/A	12.65	MT4150	14.40	SD445	5.00	SD1146	15.00
MRF450/A	14.37	MT5126	25.00	SD1004	15.00	SD1147	15.00
MRF452/A	17.00	MT5596(2N)	99.00	SD1007	15.00	SD1188	10.00
MRF453/A	18.40	MT5768(2N)	95.00	SD1007-2	15.00	SD1189	24.00
MRF454/A	20.12	MT8762	25.00	SD1007-4	15.00	SD1200	1.50
MRF455/A	16.00	NE02136	2.00	SD1007-5	15.00	SD1201-2	15.00

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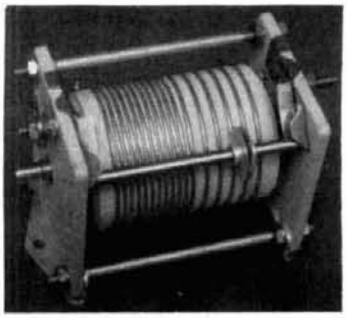
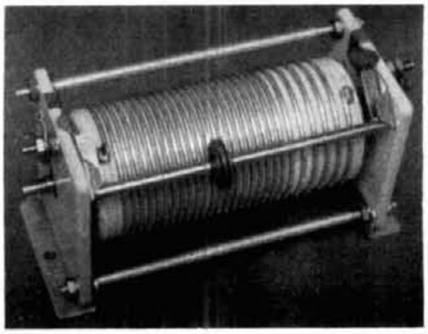
E.F. JOHNSON ROLLER INDUCTORS

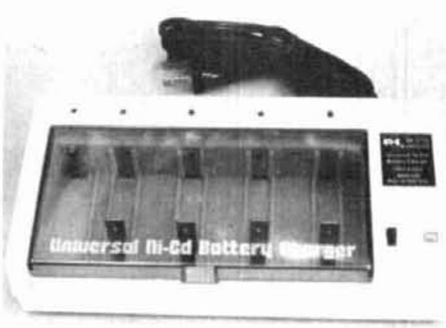


MODEL 229-0201-01
10UH at 3AMPS MAX. $36.99



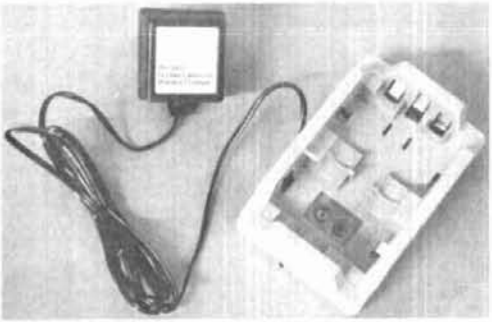
MODEL 229-0202-01
18UH at 5AMPS MAX. $44.99

NI-CAD BATTERY CHARGERS



UNIVERSAL CHARGER $19.99

MALLORY CHARGER $23.99



EVEREADY CHARGER $9.99

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UNELCO,SEMCO,ARCO METAL CLAD MICA CAPACITORS

Standard Size					Micro Size	
3.9	14	33	62	175	5	25
4.7	15	34	68	180	6	27
5	18	36	75	200	7	33
5.1	20	38	80	220	8	36
6.8	22	39	82	240	9	51
7	24	40	100	250	12	62
8.2	25	43	110	300	15	
9.1	27	44	120	360	16	
10	27.5	47	123	470	18	
11	28	50	125	500	20	
12	30	51	140	820	22	
13	32	56	150	1000	24	

********NOTE ALL VALUES LISTED IN PICO FARAD********

PRICE INFORMATION
1 to 10 $ .90ea. 11 to 51 $.80ea. 52 to 102 $.70ea.
103 and up call

****

GOULD NI-CAD BATTERIES

AA size 1.25v at 500mahr	new	a	$ 1.99
D size 1.25v at 4 AMPHR	new	h	7.49

GENERAL ELECTRIC NI-CAD BATTERIES

AA size 1.25v at 500mahr	new	a	2.99
195194 3.75v at 100mahr	new		1.99
AA size 3.75v at 100mahr	new	a	2.99
AA size pack of 10 12.5v at 450mahr	used	a	5.99
Sub C Pack of 10 12.5v at 2.5Amphr	new	c	9.99

UNION CARBIDE NI-CAD BATTERIES

193817 3.75v at 225mahr	new	a	2.99

GLOBE GEL-CELL BATTERIES

2v at 8AMPHR GC280	new	g	5.99
12v at 20AMPHR GC12200	new	g	49.99
12v at 23AMPHR GC12300	new	g	54.99

EAGLE PICHER GEL-CELL BATTERIES

12v at 1.5AMPHR CF12V1.5	new	d	11.99

GATES SEALED RECHARGEABLE LEAD ACID BATTERIES AND PACKS

2v at 2.5AMPHR D Cell	new	b	5.99
8v at 5AMPHR 4 X Cell	used	f	14.99
12v at 2.5AMPHR 6 D Cells	new	f	24.99
18v at 2.5AMPHR 9 D Cells	new	f	29.99

GENERAL ELECTRIC SEALED REACHARABLE LEAD ACID BATTERIES AND PACKS

6v at 2.5AMPHR 3 D Cells	used	e	10.00
12v at 2.5AMPHR 6 D Cells	used	e	19.99
12v at 5AMPHR 6 X Cells	used	e	24.99

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RF Transistors (continued)

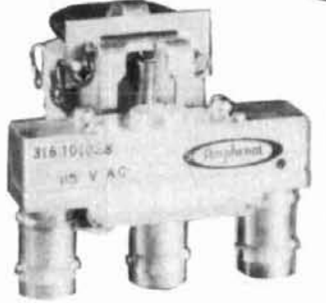
SD1202	$10.00	SD1304-8	$ 2.50	SD1451-2	$15.00	SRF1427	$50.00	SD1244H17	25.00	SD1410-8	21.00	SD1536-1	41.00	SRF2917	15.00
SD1212-8	4.95	SD1305	3.00	SD1452	20.00	SRF1431	40.00	SD1262	15.00	SD1413-1	18.00	SD1539H	100.00	SRF2918	15.00
SD1212-11	4.95	SD1307	3.00	SD1452-4	24.00	SRF1834	40.00	SD1263	15.00	SD1416	28.00	SD1542H1	170.00	SRF2919	15.00
SD1212-16	4.95	SD1308	1.00	SD1453H1	20.00	SRF2053-3	60.00	SD1263-1	15.00	SD1422-2	24.00	SD1544	26.00	SRF3071FF	50.00
SD1214-7	5.00	SD1311	1.00	SD1454-1	48.00	SRF2092	50.00	SD1272	10.95	SD1428	24.00	SD1545	33.00	SS4006	25.00
SD1214-11	5.00	SD1317	8.00	SD1477	35.00	SRF2147	22.00	SD1272-1	10.95	SD1428- 6084	12.00	SD1546H1	55.00	SS4152	15.00
SD1216	12.00	SD1319	2.50	SD1478	21.00	SRF2225	15.00	SD1272-2	10.95	SD1429-2	15.00	SD1561	79.00	TA7686	15.00
SD1219-4	15.00	SD1345-6	5.00	SD1480	53.00	SRF2264	25.00	SD1272-4	10.95	SD1429-3	14.90	SD1574-1	6.95	TA8559	15.00
SD1219-5	15.00	SD1347-1	1.00	SD1484	1.50	SRF2265	100.00	SD1278	13.75	SD1429-5	15.00	SD1575	6.95	TA8561	15.00
SD1219-8	15.00	SD1365-1	2.50	SD1484-5	1.50	SRF2281	5.00	SD1278-1	13.75	SD1430	12.00	SF4557	25.00	TA8562	15.00
SD1220	8.00	SD1365-5	2.50	SD1484-6	1.50	SRF2371	15.00	SD1278-5	13.75	SD1430-2	18.00	SK3048	5.00	TA8563	15.00
SD1220-1	9.50	SD1375	7.50	SD1484-7	1.50	SRF2347	50.00	SD1279-1	18.00	SD1434	28.00	SL501-59	15.00	TA8564	15.00
SD1220-9	8.00	SD1375-6	7.50	SD1488	22.85	SRF2356	38.00	SD1279-3	18.00	SD1434-5	28.00	SL501-173	15.00	TA8894	15.00
SD1222-8	16.00	SD1379	15.00	SD1488-1	28.00	SRF2378	16.00	SD1281-2	8.00	SD1434-9	28.00	SM7714	5.00	TIS189	3.55
SD1222-11	7.50	SD1380-1	1.00	SD1488-7	27.00	SRF2572	25.00	SD1283	10.00	SD1438	26.00	SRF112	15.00	TP312	2.50
SD1224-10	18.00	SD1380-3	1.00	SD1488-8	28.00	SRF2584	40.00	SD1283-2	10.60	SD1441	56.00	SRF395	50.00	TP1014	5.00
SD1225	18.00	SD1380-7	1.00	SD1499-1	36.00	SRF2597	25.00	SD1283-3	10.00	SD1442	15.00	SRF750	36.00	TP1028	15.00
SD1225-1	15.00	SD1405	21.00	SD1511H1	75.00	SRF2741	40.00	SD1283-4	10.00	SD1444	3.25	SRF769H	20.00	TRW3	5.00
SD1229-7	10.95	SD1408	25.00	SD1520-2	18.00	SRF2747	40.00	SD1289-1	15.00	SD1444-8	3.25	SRF887K3	2.50	TXVF2201/HP	450.00
SD1229-16	10.95	SD1409	18.00	SD1522-4	33.00	SRF2767H	40.00	SD1290-4	15.00	SD1444-9	3.25	SRF989K	15.00	V222-2	25.00
SD1232	4.00	SD1410	18.00	SD1528-1	24.00	SRF2821	25.00	SD1290-7	15.00	SD1446	4.03	SRF1005	50.00	V4101E	20.00
SD1240-8	15.00	SD1410-3	21.00	SD1528-3	34.00	SRF2822/2N6603	11.50	SD1300	1.25	SD1450-1	28.00	SRF1018	5.00	V415	5.00
SD1244-1	14.00	SD1410-6	21.00	SD1530-2	38.00	SRF2857	20.00	SD1301-7	3.00	SD1451	15.00	SRF1074	50.00		

Relays

BNC To Banana Plug Coax Cable RG-58 36 inch or BNC to N Coax Cable RG-58 36 inch.

$7.99 or 2 For $13.99 or 10 For $50.00

$8.99 or 2 For $15.99 or 10 For $60.00



Amphenol
Part # 316-10102-8
115Vac Type BNC DC to 3 GHz.

$29.99

COAXIAL RELAY SWITCHES SPDT

FXR
Part # 300-11182
120Vac Type BNC DC to 4 GHz.
FSN 5985-543-1225

$39.99

FXR
Part # 300-11173
120Vac Type BNC Same
FSN 5985-543-1850

$39.99

TERMS: DOMESTIC: Prepaid, C.O.D. or Credit Card
FOREIGN: Prepaid only, U.S. Funds, Money Order, or Cashier's Check Only.

C.O.D.: Acceptable by telephone or mail. Payment from customer will be by Cash, Money Order, or Cashier's Check. We are sorry but we cannot accept personal checks for C.O.D.'s. C.O.D.'s are shipped by air only and thru United Parcel Service.

CONFIRMING ORDERS: We would prefer that confirming orders not be sent after a telephone order has been placed. If company policy necessitates a confirming order, please mark "CONFIRMING" boldly on the order. If problems or duplicate shipments occur due to an order which is not properly marked, the customer will be held responsible for any charges incurred, plus a 15% restock charge on the returned parts.

CREDIT CARDS: We are now accepting MASTERCARD, VISA, AND AMERICAN EXPRESS

DATA SHEETS: When we have data sheets in stock on devices we will supply them with the order.

DEFECTIVE MATERIALS: All claims for defective materials must be made within 30 DAYS after receipt of the parcel. All claims must include the defective material (for testing purposes), a copy of our invoice, and a return authorization number which must be obtained prior to shipping the merchandise back to us. This can be obtained by calling (602) 242-8916 or sending us a postcard. Due to Manufacturer warranties we are unable to replace or issue credit on items which have been soldered to or have been altered in any way. All return items must be packed properly or it will void all warranties. We do not assume responsibility for shipping and handling charges incurred.

DELIVERY: Orders are usually shipped the same day they are placed or the next business day, unless we are out of stock on an item. The customer will be notified by post card if we are going to backorder the item. Our normal shipping method is UPS or U.S. Mail depending on size or the weight of the package. Test Equipment is shipped only by air and is freight collect, unless prior arrangements have been made and approved.

FOREIGN ORDERS: All foreign orders must be prepaid with a Cashier's Check, or Money Order made out in U.S. FUNDS ONLY. We are sorry but C.O.D. is not available to foreign countries and letters of credit are unacceptable as a form of payment. Further information is available on request.

HOURS: Monday thru Friday 8:30 a.m. to 5:00 p.m. Saturdays 8:30 a.m. to 4:00 p.m.

INSURANCE: Please include 25¢ for each additional $100.00 over $100.00. UPS ONLY. All insured packages are shipped thru UPS only. If you wish to have it shipped through the post office there is a $5.00 fee which is additional to the shipping, handling and insurance.

OPEN ACCOUNTS: We regret that we do not issue open accounts.

ORDER FORMS: New order forms are included with each order for your convenience. Additional order forms are available on request.

PARTS: We reserve the right to substitute or replace any item with a part of equal or comparable specification.

POSTAGE: Minimum shipping and handling in the U.S., Canada, and Mexico is $3.00 for ground shipments, all other countries is $5.50. Air rates are available at the time of your order. All foreign orders please include 25% of the ordered amount for shipping and handling. C.O.D.'s are shipped AIR ONLY.

PREPAID ORDERS: Orders must be accompanied by a check.

PRICES: Prices are subject to change without notice.

PURCHASE ORDERS: We accept purchase orders only when they are accompanied by a check.

RESTOCK CHARGES: If parts are returned to MHZ ELECTRONICS, INC. due to customer error, the customer will be held responsible for all fees incurred and will be charged a 15% RESTOCK CHARGE with the remainder in CREDIT ONLY. The following must accompany any return; A copy of our invoice, return authorization number which must be obtained prior to shipping the merchandise back. Returns must be done within 10 DAYS of receipt of parcel. Return authorization numbers can be obtained by calling (602) 242-8916 or notifying us by post card. Return authorizations will not be given out on our 800 number.

SALES TAX: ARIZONA residents must add 6% sales tax, unless a signed ARIZONA resale tax card is currently on file with us. All orders placed by persons outside of ARIZONA, but delivered to persons in ARIZONA are subject to the 6% sales tax.

SHORTAGE OR DAMAGE: All claims for shortages or damages must be made within 5 DAYS of receipt of parcel. Claims must include a copy of our invoice, along with a return authorization number which can be obtained by contacting us at (602) 242-8916 or sending a post card. Authorizations cannot be on our 800 number. All items must be properly packed. If items are not properly packed make sure to contact the carrier so that they can come out and inspect the package before it is returned to us. Customers which do not notify us within this time period will be held responsible for the entire order as we will consider the order complete.

OUR 800 NUMBER IS STRICTLY FOR ORDERS ONLY (800) 528-0180. INFORMATION CALLS ARE TAKEN ON (602) 242-8916 or (602) 242-3037.

MHz electronics

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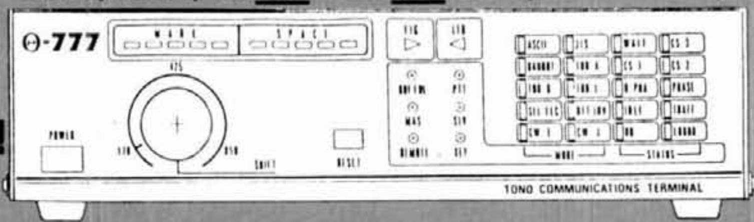

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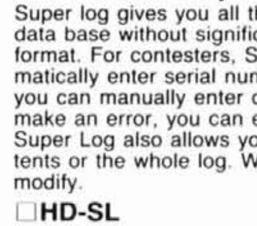

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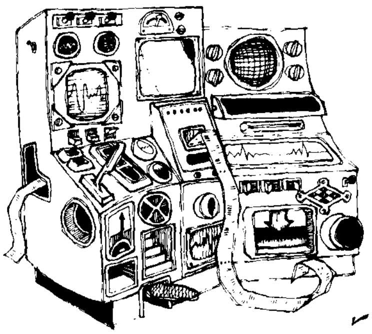

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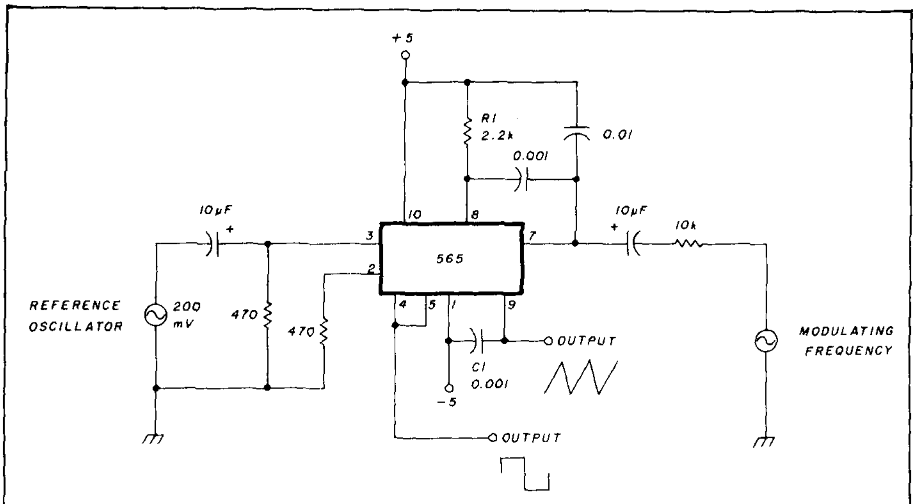

fig. 1. Schematic diagram of the experimental PLL phase modulator.

Resistor R1 and capacitor C1 establish the approximate operating modulation frequency where f ≅ 1.2/4R1C1. The reference or input frequency should be adjusted until lock is obtained as described below. If desired, the input signal can be provided by a crystal-controlled oscillator (this is one of the chief advantages of phase modulation).

Lock can be determined by observing the input frequency on one channel of a dual-trace scope and the VCO frequency on the other channel. Pin 9 of the 565 should be used to observe the VCO frequency because a triangular waveform is available at this point. Pins 4 and 5 provide the normal square-wave outputs of the chip, but the fast rise and fall times make it hard to see what is happening to the waveforms at this level.

Once lock is achieved, the input frequency should be adjusted until the reference oscillator frequency and the VCO frequency are in phase. Alternatively, the value of R1 and C1 can be adjusted to shift the phase of the VCO signal.

The next step is to apply the modulating frequency to the error voltage input pin. A very low frequency should be used at first. Observe the display on an oscilloscope, making sure the scope is triggered on the reference signal. If the circuit is working correctly, the reference signal should be steady and the VCO signal should shift slowly back and forth in phase. The VCO is now being phase modulated.

Try experimenting with different amplitudes of the modulating frequency. The amount of modulation should vary with the amplitude of the modulating frequency. If the modulation amplitude is too high, the VCO may lose lock.

The amount of modulation is somewhat limited in this circuit. If more modulation is needed, additional modulators may be added in cascade. The ouput of the first modulator must be taken from pin 4 or 5 and reduced in level to about 200 mW before being fed to the second modulator.

Another characteristic of phase modulators may also be observed. As the modulation frequency is increased, the amount of modulation also increases. (This is another advantage of a phase modulator over an FM modulator.) Pre-emphasis is built right into the circuit and does not have to be added externally.

I have found this circuit easy to build and helpful to students. It can be converted to FM by removing the reference oscillator.

I would be interested in hearing from other *ham radio* readers about applications using other chips at higher frequencies.

bibliography

Berlin, Howard M., *The Phase-Lock Loop Bugbook, with Experiments*, page 7-7 to 7-10. Capital City Press, Montpelier, Vermont, 1978.

Graham W. Stratford, VE3FHM

short circuits

June 1985

MINIMUF modification

The software code modification of the MINIMUF 3 propagation program provided in **fig. 2** of the February, 1985 "DX Forecaster" (page 75) contains an error. **Line 1774**, which reads **IF F2>F3 THEN 1779** should read **IF F2>F3 THEN 1780**.

June 1985

filter design

The program shown in N6JH's "Computer-aided Interdigital Bandpass Filter Design" (January, 1985, page 12) will correctly execute all examples given in the text and are applicable to any Chebyshev filter design. However, if a Butterworth design is desired (0dB entered as the desired ripple in the passband), the program will plot the attenuation graph incorrectly, although it will compute the mechanical details correctly. Changing **line 970** from **GOTO 1040** to **GOTO 1020** will correct this problem.

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DIGITAL AUTOMATIC DISPLAYS. All transceivers. Six 1/2" digits. 5" wide by 1-1/4" by 9" cabinet! Send $1.00 for information. Grand Systems, POB 2171, Blaine, Washington 98230. Canadians VE7LB.

2500 VOLT POWER SUPPLY. From two TV transformers, full wave 120 cycles. Send $1.00 postage & handling for schematic. You won't see this one in any books. Leverne Kalor, Rt. 1, Ogilvie, MN 56358.

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SYNCHROS, all types, quality Navy salvage, gears, bearings, excellent for beam position indication. SASE to Ted Stewart, 2157 Braemar Road, Oakland, CA 94602.

WANTED: National NC-101X. Will buy for cash or trade nice HRO Sr. For sale 75A4 Ser. No. 1479 $225. Prefer pick-up. Horace Goss, W2AB, Crosstrees Hill, Essex, CT 06426. Tel 203-767-8485.

WANTED: Mono and early stereo tube HiFi equipment. Marantz, Scott, Fisher, Eico, McIntosh, Dynaco, etc. Working or not, complete or parts. Jack Smith, 59 Mill Pond, N. Andover, MA 01845.

RUBBER STAMPS: 3 lines $4.50 PPD. Send check or MO to G.L. Pierce, 5521 Birkdale Way, San Diego, CA 92117. SASE brings information.

CHASSIS and cabinet kits. SASE K3IWK.

IMRA, International Mission Radio Association, helps missionaries. Equipment loaned. Weekday net, 14.280 MHz, 2-3 PM Eastern. Eight hundred Amateurs in 40 countries. Brother Frey, 1 Pryer Manor Road, Larchmont, NY 10538.

ELECTRON TUBES: Receiving, transmitting, microwave . . . all types available. Large stock. Next day delivery, most cases. Daily Electronics, PO Box 5029, Compton, CA 09224 (213) 774-1255.

RTTY-EXCLUSIVELY for the Amateur Teleprinter. One year $7.00. Beginners RTTY Handbook $8.00 includes journal index. P.O. Box RY, Cardiff, CA 92007.

RETAIL STORE being liquidated by mail auction. Parts, tools, test equipment, home supplies. SASE to ESI, Box 328, Mesa, AZ 85201.

Coming Events

ACTIVITIES

"Places to go..."

ILLINOIS: The DuPage Amateur Radio Club Hamfest/Computerfest, Sunday, July 14, Downers Grove American Legion Post 80. Gates open 8 AM. Tickets $3.00 available at the gate only. Large outdoor flea market and swappers row. Inside exhibits available. VEC exams. Plenty of parking. Food and drink available. Talk in on 146.52 simplex. For information SASE to W9DUP, PO Box 71, Clarendon Hills, IL 60514 or call (312) 971-3294 8 AM to 9 PM.

PENNSYLVANIA: Harrisburg Annual Firecracker Hamfest, Thursday, July 4. Sponsored by the Harrisburg RAC, Bressler Fire Co. picnic grounds, Exit 1 of I 283. Nearby motels and restaurants. Plenty of parking. Shaded pavillion with tables. Free tailgating. Admission $3.00. XYL and kids free. A test session for hams wishing to upgrade will be held nearby. Send check for $4.00 payable to ARRL-VEC with FCC form 610. Some limited walk-ins. For more details and table reservations: Dave, KC3MG, 131 Livingston St, Swatara, PA 17113 or (717) 939-4957.

OHIO: The 21st annual Wood County Ham-A-Rama, Sunday, July 14, Wood County Fairgrounds, Bowling Green. Gates open 8 AM. Free admission and parking. Trunk sales. Food available. Advance table rentals $5.00 to dealers only. Saturday setup until 8 PM. K8TIH talk in on 147.18 repeater and .52. For more information or dealer rentals SASE to Wood County ARC, c/o Craig Henderson, N8DJB, 7368 Scotch Ridge Rd., Pemberville, OH 43450.

MICHIGAN: The "85" U.P. Hamfest, July 27 and 28, St. Francis de Sales School, Manistique. Friday evening Fish Fry, set and eyeball for early arrivals. Saturday 6 AM to 5 PM. Banquet 6:30 PM. Sunday 8 AM to 2 PM. Registration $3.50. Free baby sitting. Table space $3.00 per 4' table. For more information: Debbie Barton, WD8IBT, 509 Range St., Manistique, MI 49854. (906) 341-5694 after 3 PM.

PENNSYLVANIA: The MURGAS ARC (K3YTL) will sponsor the annual Wilkes-Barre Hamfest, Sunday, July 7, rain or shine, 109th FA Armory, Market Street, Kingston (across the river from Wilkes-Barre). Set up 6 AM. General admission 8 AM. Registration $3.00. Women and children under 16 free. Tailgating $2.00 per space. Tables and commercial power available. Talk in on 146.01/.61 and 52 simplex. For further information write: Hamfest Committee, PO Box 1094, Wilkes-Barre, PA 18703 or call (717) 388-6863.

BRITISH COLUMBIA: The 33rd annual Pacific Northwest DX Convention, sponsored by the British Columbia DX Club, Saturday and Sunday, July 27 and 28, Richmond Inn, Richmond, British Columbia. DXers from all over the world will be here to visit, learn and swap stories about our favorite hobby. Send club rosters or labels for mailing to individual club members for further details about the convention. The labels will be used only for this purpose. See you in British Columbia! Ken Thompson, VE7BXG, Chairman, 12467 - 53rd Avenue, Surrey, BC V3W 1A4 or Andy Ponzini, VE7AHA, Publicity, 4551 Arthur Drive, Delta, BC V4K 2X4.

INDIANA: State ARRL Convention and Indianapolis Hamfest, Saturday and Sunday, July 13 and 14. Marion County Fairgrounds, I 74 and I 465. Flea Market, commercial vendors, free camper facilities and hookup available on grounds. Motels nearby. Gates open 6 AM. Tech forums, ARRL convention and banquet. Food service on grounds. Gate ticket $5.00 gets free parking and more. For further information: Indianapolis Hamfest, PO Box 11776, Indianapolis, IN 46201.

1985 BLOSSOMLAND BLAST, Sunday, October 6, 1985. Write "BLAST", PO Box 175, St. Joseph, MI 49085.

MAINE: The YL International Sideband System's annual Convention, June 27-30, Sugarloaf/USA, Kingfield. Accommodations are available for reasonable rates. RV parking. Besides the regular meetings, DX forum, etc there are planned tours of Rangeley Lake area and Sugerloaf/USA. For complete details and registration packet send business SASE, 37¢ to: Phyllis Davis, KA1JC, PO Box 805, Presque Isle, ME 04769.

NEW YORK: The Mt. Beacon Amateur Radio Club's Hamfest, Saturday, July 13, Arlington Senior High School, Poughkeepsie/Lagrange. Note date change. Doors open 8 AM. Tickets $2.00. XYL and children free. Tailgating space $3.00 (1 free admission). Table $4.00 (1 free table and admission). Auction 2 PM. Talk in on 146.37/97 and 146.52. For information: Julius Jones, W2IHY, RR2, Vanessa Ln, Staatsburg, NY 12580 or call (914) 889-4933.

INDIANA: The combined LaPorte-Michigan City Amateur Radio Clubs will sponsor Summer Hamfest, Sunday, July 14, at the LaPorte County Fairgrounds, State Road 2, West of LaPorte. 8 AM to 2 PM. Donation $3.00 at the gate. Paved parking. Indoor tables by reservation 40¢/ft to Box 30, LaPorte, IN 46350.

WISCONSIN: The Aug Claire Amateur Radio Club will hold its annual Hamfest, Saturday, July 13, 4-H Buildings, Eau Claire. 8 AM to 4 PM. Free tables and coffee. Tickets $2.00 in advance, $3.00 at door. Talk in on 31/91 and 52 simplex. For info, tickets, SASE to Gene Lieberg, KA9DWH, 2840 Saturn Avenue, Eau Claire, WI 54703.

OHIO: The Lancaster and Fairfield County Amateur Radio Club's annual Hamfest, Sunday, July 14, Fairfield County Fairgrounds. 8 AM to 4 PM. In memory of WB8VOA. Admission $3.00 advance, $4.00 at door. Tables $4.00 advance, $5.00 at door. Table space $3.00 advance, $4.00/door. Talk in on 147.03/63 or 146.52 simplex. Refreshments available. Plenty of parking. For more information write Lancaster ARC, Box #3, Lancaster, Ohio 43130.

OHIO: The 11th annual Hall of Fame Hamfest presented by W8ZX, Tusco ARC and W8AL, Canton ARC, July 14, Nimishillen Grange, 6461 Easton Street in Louisville. Registration $2.50/adv, $3.00/door. Mobile check in 146.52/52 and 147.71/12 call W8ZX. Large flea market, dealers, forums and more. Flea market parking $2.00 per vehicle. Deadline for table reservations is July 1. For more information or reservations: WA8SHP, Butch Lebold, 10877 Hazelview Ave., Alliance, Ohio 44601. (216) 821-8794.

WISCONSIN: The Oshkosh Amateur Radio Club in conjunction with the S.O.L.A.R. Assn. will host EAA hams for the 1985 convention, July 26 - August 2. Stop and rest, charge your batteries, leave messages, etc at the EAA Ham Shack located at the north end of the commercial exhibit area. Look for the red and white ARRL flag. On Saturday, July 27 at 3 PM, there will be a gathering for all EAA hams hosted by the Oshkosh ARC. We'll be serving bratwurst, burgers and refreshments free of charge. Bring your wives and kids. You're in for a treat! For further info: Forest Schafer, WD9IWL, 417 Willow St., Omro, WI 54963.

KENTUCKY: The Northern Kentucky Amateur Radio Club's "Hamorama '85", June 15 and 16, Best Western Vegas Convention Center, Erlanger. All indoors, air-conditioned and free parking. Vendor set up Friday evening, June 14 after 8 PM. Flea market set up after 6 AM both Saturday and Sunday. General admission 8 AM. Admission for both days $5.00 per person. Entire family for $8.00. Children under 16 free. Flea market tables $5.00 each for entire weekend. Talk in on 147.86/.26 or 147.975/.375. For information: John A. Thernes, WM4T, VP, NKART, 60 Locust Avenue, Covington, KY 41017. (513) 397-7425 days or (606) 331-0331 evenings.

MONTANA: The LYARS of Eastern Montana will hold the annual Fathers Day Picnic, June 16, National Guard Armory at the Glendive Fairgrounds. Registration at 8 AM. Potluck at 1 PM. Licensing exams are tentative pending interest. Camping hookups available. For information contact Dave Brueni, KC7AA, 215 Third St. H.P., Glendive, MT 59330.

WASHINGTON: The Apple City Amateur Radio Club's Hamfest, June 8 and 9, Rocky Reach Dam, 7 miles north of Wenatchee. Registration: Amateurs $5.00; others $1.00; under 12 free. Banquet dinner $7.00 per person by June 3. Talk in 146.07/67 or 146.49 simplex. For motel/dinner reservations contact any Wenatchee ham.

NEW JERSEY: The Raritan Valley Radio Club will hold its 14th annual Hamfest, Saturday, June 15, Columbia Park, Dunellen. Gates open 8:30 AM. Sellers spots $5.00 each, no tables supplied. Lookers $2.00 donation. Refreshment stand. Talk in on club repeater, W2QW/R 146.025/.625 and 146.52 simplex. Advance tickets may be purchased from any club member. For further information call Jack, W2IWK at (201) 756-2546 or Ted, WB2TKU (201) 725-3481 between 10 AM and 10 PM.

CALIFORNIA: The Satellite Amateur Radio Club will have its annual Swapfest and Barbeque, Union Oil Picnic Grounds, south of Santa Maria, on Father's Day, June 16. General admission 9 AM and the Barbeque will be served at 1 PM. Dinner and tickets adults $7.95, children 6-12 $3.50. Children under 6 free. Swap spaces $3.50 each. For information, tickets or reserved tables write: Satellite ARC Swapfest, PO Box 1753, Santa Maria, CA 93456.

NEW HAMPSHIRE: Fly in to New Hampshire's 2nd largest Amateur Radio/electronic flea market at Manchester Municipal Airport, Saturday, June 29. Starts 9 AM. Sponsored by the New Hampshire FM Association. Rain date Sunday, June 30. General admission $1.00 per person. Sellers $5.00 bring own table or tailgate. Commercial displays welcome. Refreshments available. Talk in on 146.52 FM. For further information Doug Aiken, K1WPM (603) 622-0831 or Peat Henriksen, WA1RCF, 123 Woodlawn Circle, Portsmouth, NH 03801 (603) 431-5432.

WYOMING: The Great Plains Repeater Association and the High Plains Amateur Radio Club are jointly sponsoring the 1985 Wyoming Hamfest, July 12, 13, and 14, Wyoming State Fairgrounds in Douglas. Distributor displays, indoor flea market, tables available. License exams, seminars, auction, banquet, breakfast and more. Ample RV parking w/out hookups. Plenty of motels. For information and money saving advance registration SASE to Doug DesEnfants, WA7WXQ, North Star Route, Torrington, WY 82240.

OREGON: The Northwest Division of the Mercury Amateur Radio Association will host the first annual MARA convention at Camp Ester Applegate, near Klamath Falls, June 20, 21 and 22. MARA will operate special event station W7UFM in conjunction with this event from 2000Z, June 20 to 2400Z June 22. For a special commemorative QST send large SASE to MARA, c/o Jack Jakoubek, KD7EZ, 477 Deep Creek Road, Chelhalis, WA 98532.

OHIO: The Magic Valley Chapter of the Idaho Socity of Radio Amateurs will host a Swapmeet on Saturday, June 15 from 9 AM to 5 PM at the Moose Lodge, 835 Falls Avenue, Twin Falls. Free admission. Swap tables $2.00. All indoors. FCC exams and ARRL reps. Talk in on 16/76. For further info write to PO Box 294, Twin Falls, ID 83303.

VIRGINIA: The Old Virginia Hams ARC announces its 11th annual Manassas Hamfest, June 2, Prince William County Fairgrounds, off Rt 234 1/2 mile south of Manassas. Gates open 8 AM. Tailgate setup 7 AM. Admission $4, under 12 free. Tailgaters $3.00 per space extra. YL program. CW proficiency awards. For information: Art Whittum, W1CRO, c/o Ole Virginia Hams ARC, PO Box 1255, Manassas, VA 22110. Tel (703) 361-4819.

MASSACHUSETTS: The ARRL Heavy Hitters Hamfest, July 20 and 21, Topsfield Fairgrounds, US Route 1, Topsfield. Indoor/outdoor flea market, food concessions, commercial exhibitors. ARRL forum, AMSAT show, CW and QSL contests, xmitter and rcver hunts, ATV demo, packet radio and musical coffeehouse (BYO instruments). Activities for non-hams. License exams, send completed Form 610, photocopy of current license and check for $4.00 payable to ARRL/VEC to: Topsfield Exams, c/o PO Box 71, Hanover, MA 02339 by June 20. Enclose SASE. Sorry no Novice exams. Free Saturday nite camping for tents and self-contained RV's. Nearby motels. Advance tickets $3.00. $4.00/door. Non-ham spouses and children free. Send check and SASE to Heavy Hitters Hamfest, PO Box 411, Waltham, MA 02254. For more information contact Russ Corkum, WA1TTV, 21 Thorndike Street, Arlington, MA 02174. Proceeds to benefit open Waltham repeaters, Handi-Hams and the Jimmy Fund. Talk in on 146.64 and 147.285.

THE CENTRAL OKLAHOMA COLOR OWNERS, a 278 member Radio Shack Color Computer users group, meets the second Saturday of each month at 9 AM at 10th Street and Hudson in Oklahoma City. The Club operates "COCONET", an open forum bulletin board system which can be reached at (405) 376-1494 24 hours a day, 7 days a week. The system contains COCO and FLEX operating system programs for download with no user connect fees.

WEST VIRGINIA: Wheeling Hamfest and Computer Fair, Wheeling Park, Sunday, July 21. Dealers welcome. Flea market, ARRL, AMSAT, SWOT, SMIRK booths. Family activities available at Park. Admission $3.00. To reserve space contact Jay Paulovicks, KD8GL, RD 3, Box 238, Wheeling, WV 26003. (304) 232-6796 or TSRAC, Box 240, RD 1, Adena, OH 43901 (614) 546-3930.

ILLINOIS: The Egyptian Radio Club's annual Hamfest, Sunday, June 9, 8 AM to 3 PM at ERC clubhouse and grounds. Free flea market space, approx. 10', available on first come, first served basis. Additional spaces $5.00. Tickets $1.00 advance, $2.00/door or 3/$5. Talk in on 146.16/76 or 146/52 simplex. For information SASE to Egyptian Radio Club, PO Box 562, Granite City, IL 62040.

CQ CONTEST: VHF'ers please note! The first annual CQ World Wide VHF WPX Contest is July 20-22, 50 thru 1296 MHZ. For details, logsheets, etc., write to SCORE, PO Box 1161, Denville, NJ 07834 or to CQ Magazine. We need your entry to make this a success.

OPERATING EVENTS

"Things to do..."

Colorado Six Meter Invitational Net Contest. 0000Z July 4 through 0300Z July 5. Exhange signal report, state, name and SIN number. Send SASE and log extracts for awards to WØETT, PO Box 6602, Denver, CO 80206 within 30 days of contest.

The Cape Fear Amateur Radio Society, of Fayetteville, NC will operate WA4YZF from 8-5 PM EDST around 7.235 MHz on Saturday, June 15 from the 17th annual National Hollerin' Contest in Spivey's Corner, NC. Certificate available upon receipt of your QSL along with $1.00 to help cover printing and postage. Send to Hollerin', WA4LZD, PO Box 332, Dunn, NC 28334. Allow 4 weeks for delivery.

The Tusco Amateur Radio Club, W8ZX, will operate from Fort Laurens Ohio State Memorial in conjunction with the Brigade of the American Revolution's re-enactment of 18th century military encampment 1400Z June 29 through 2200Z June 30. Special commemorative confirmation will be issued. Send legal SASE (3 IRC's for DX) and QSO info to William K. MacNealy, WD8LFM, RR# 1 DRH, Bolivar, OH 44612.

WEST COAST 160 Bulletin Summer SSB Contest. SSB July 13 to July 14. Time 0000 GMT 7/13/85 to 2359 GMT 7/14/85. Single operator only. Exchange RST, QTH. Class: subscribers, non subscribers. Log info: date, time, rst, QTH. Send logs to: R. Koziomkowski, 5 Watson Drive, Portsmouth, RI 02871 prior to August 31, 1985.

High Plains ARC will operate K7YPT at Historic Fort Laramie from 0000Z July 4 until 0000Z July 5. Phone — 3.850, 7.250, 14.250, 21.360, 28.550. CW — 50 kHz up from lower band edge. QSL for business SASE to: K7YPT, PO Box T, Torrington, WY 82240.

The Nazarene Amateur Radio Fellowship (NARF) will operate WAØHPW/6 to commemorate NARF's 25th anniversary during the General Assembly of the Church of the Nazarene in Anaheim, CA from June 22 to June 29. Frequencies will be 14.280, 14.305 and 21385 during daylite hours. There will be some 40 m activity. For a special QSL card, send SASE to WB6UCO, Robert Buck, 5162 W. Ave. L 12, Quartz Hill, CA 93534.

Colombian Independence Contest 1985, Saturday, July 13, 0000 GMT to Sunday, July, 14 2359 GMT. CW and phone, 1.8 thru 28. Exhange Signal report + serial number. Logs should be mailed no later than August 30, 1985 to L.C.R.A., c/o Direccion de Concursos y Diplomas, Apartado Aereo 584, Bogota, Colombia, Sur America.

The Hannibal Amateur Radio Club will again be celebrating National Tom Sawyer Days, in honor of Mark Twain's boyhood home town Hannibal, MO. Saturday, July 6 and Sunday, July 7. 1500-2100 UTC both days. Listen for WØKEM. For a certificate send large SASE and your QSL card confirming contact to Hannibal ARC, 2108 Orchard Avenue, Hannibal, MO 63401.

NEW products

IC- 3200A dual bander

ICOM has announced the IC-3200A 25-watt compact full-featured Dual Bander. With only 14 front panel controls, the IC-3200A is simple to use, yet offers these standard features: frequency coverage from 140.000 to 150.000 MHz on 2 meters and from 440.000 to 450.000 MHz on 70 cm; 5 kHz fully programmable offsets for MARS and CAP repeater operation; and 25 watts output on both bands. Its size is 5-1/2 × 2 × 8-1/2 inches. The unit also includes memory lockout and scanning capability. The price is $549.

For further information, contact ICOM America, Inc., 2380 116th Avenue, N.E., Bellevue, Washington 98004.

Circle #301 on Reader Service Card.

new Heathkit catalog

Over 400 electronic products in kit form, including the new HERO® JR. home robot, are featured in the latest Heathkit catalog.

HERO JR., the home and personal robot, is fully preprogrammed with speech output, light and sound sensors, and ultrasonic sonar, drive and steering motors, and an on-board computer system. He sings songs, plays games, recites nursery rhymes and can act as a security device and wake-up alarm.

The new GT-2218 HOTSHOT dialer is a unique one-number telephone dialer that quickly dials any telephone number up to 31 digits. It permits the use of alternate long distance service without the use of lengthy 13-digit phone and billing numbers and also allows an emergency number to be dialed by simply picking up the phone. The HOTSHOT features an easy-to-program memory that doesn't require battery backup since it is manually programmed.

Two new courses have also been added to the educational product line up: the EC-2001 Computer Fundamentals Course and the EE-1003 Analog Circuit Design Course.

For a free copy of the new Heathkit catalog, contact Heath Company, Dept. 150-510, Benton Harbor, Michigan 49022. (In Canada, contact Heath Company, 1020 Islington Avenue, Dept. 3100, Toronto, Ontario M8Z 5Z3.)

Circle #302 on Reader Service Card.

computer interface communications terminal

Amateur-Wholesale Electronics has announced its new *θ-777* computer-interface terminal, featuring RTTY, bit inversion, AMTOR modes ARQ, FEC and SEL-FEC, ASCII and CW, any speed, any shift (ASCII and BAUDOT).

The *θ-777* is a self-contained unit, with software, that allows reception and transmission with any computer or terminal that has RS232 or TTL I/O. The *θ-777* automatically decodes signals and displays mode, speed, and polarity on the CRT. Operation is simplified by the use of 28 Bar-LEDs and LEDs including a bar-graph tuning indicator that allows precise centering of received signals.

In BAUDOT and ASCII modes, communications speed can be set from 12 to 200 baud using the modem, or 12 to 600 baud using TTL level. RS232 or TTL level data connection is 100-2400 baud (ASCII) or 45.5-200 baud (BAUDOT). Morse speed can be varied from 5 to 100 WPM in 1-WPM increments and is fully autotrack on receive.

The *θ-777*, which measures 2-1/2 × 9 × 10 inches, operates from a power supply of 11 to 14 volts DC.

For more information, contact Amateur Wholesale Electronics, Inc., 8817 S.W. 129 Terrace, Miami, Florida 33176.

Circle #303 on Reader Service Card.

digital FSK data modules

With packet radio and other forms of digital data communications becoming so popular, Hamtronics, Inc. has announced two new modules to its line of VHF and UHF FM transmitters, receivers, and accessories. The new modules provide for data interface with radio equipment using the popular "202" modem format (1200/2200 Hz tones) at data rates up to 1200 baud on ordinary NBFM channels. In addition to modulating and demodulating the data pulses, these modules provide transmitter keying and full handshake facilities.

The MO-202 FSK Data Modulator is a PC board module measuring only 1-7/8 × 4 inches. It automatically keys the transmitter in response to a "request to send" input from the computer, and it provides a "clear to send" handshake 25 milliseconds later, after the transmitter and receiver have had time to respond. Relative levels of the 1200 and 2200 Hz space and mark tones are equalized to compensate for the EIA pre-emphasis in the transmitter for maximum signal range. The MO-202 is only $45 in kit form, and is easy to assemble and interface with Hamtronics® and other FM transmitters or transceivers.

The DE-202 FSK Data Demodulator is a PC board module measuring only 1-1/2 × 4 inches. It can be used with any FM receiver or transceiver to detect FSK transmissions and automatically provide a "receiver carrier detect" handshake to the computer when mark or space tones are present. A special frequency compensation circuit levels the two tones coming from the receiver to allow for maximum weak signal response. The DE-202 kit is only $38.

For further information, contact Hamtronics, Inc., 65-F Moul Road, Hilton, New York 14468-9535.

Circle #116 on Reader Service Card.

frequency list

Dennis Peterson, N7CKD, Publisher of *West Coast 160 DX Bulletin* has just released the 1985 edition of the World Top Band Frequency Allocations Listing. This comprehensive list includes both CW and SSB frequency allocations for 240 of the 315 current DXCC countries, listed in the DXCC format. The list can also be used as a 160-meter DXCC check sheet. U.S. price is $5.50 (via first-class mail) and $7.50 overseas (airmail).

For more information, contact Dennis Peterson, N7CKD, 4248 A Street, Space 609, Auburn, Washington 98002.

Circle #304 on Reader Service Card.

station manager

Station Manager/Advanced is a software system that utilizes micro computer technology to fulfill the information processing needs of an Amateur Radio station. Centered around the traditional station log, Station Manager/Advanced enables the Radio Amateur to handle the routine requirements of keeping accurate station activity records with maximum efficiency as well as instantly extracting information from the station's logs that would not be readily available using conventional manual methods. It also provides the user with the capability to easily manage several concurrent logs and a comprehensive method for logging contacts and maintaining log entries.

Station Manager/Advanced is designed to run on an IBM PC Jr., PC, or XT. Menu-driven and completely interactive, it prompts the user for all required input. Messages are displayed to indicate significant processing events and error conditions. Log entries are entered via the system keyboard through a prompt-driven input program. Once entered, log entries may be edited or deleted as required. The user may query the log entries in one of several ways. The results are displayed on the system console screen. A separate facility allows the user to print a variety of reports on the system printer. An additional feature is a special interactive update program to support QSL activities.

Station Manager/Advanced is the core of a planned series of software systems to enhance the enjoyment of your Amateur activities; to harness the power of the computer and bring your station records into the information age.

For more information, contact Omega Concepts, Inc., P. O. Box 615, Troy, Ohio 45363.

Circle #305 on Reader Service Card.

new handhelds

Two new radios are available from SANTEC: the ST-200ET (2 meters) and the ST-400ET (70 cm). Both are easy to use, thumbwheel frequency switched units designed to be compatible with accessories for handhelds you may already own. Both are backed by a comprehensive two-year extended service plan from ENCOMM.

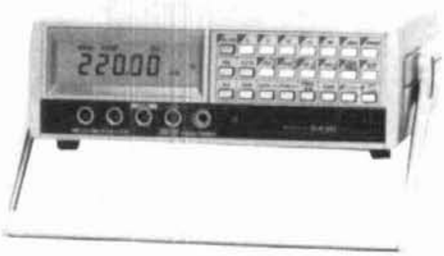
The ST-200ET is priced at $199.95 and the ST-400ET at $249.95.

For more information, contact ENCOMM, 2000 Avenue G, Suite 800, Plano, Texas 75074.

Circle #306 on Reader Service Card.

bench-style DMM

North American SOAR Corp. has announced its Model 5430 4-1/2-digit multi-function bench-style DMM. Microprocessor controlled using



SOAR Corporation's Custom LSI Chip Set, the 5430 is a 25,000-count DMM that enables users to obtain greater resolution than possible with ordinary 20,000 count units presently available.

Priced at $599, Model 5430 offers features previously unavailable in any other 4-1/2-digit DMM. It can measure DC voltage ±0.03 percent, true RMS AC voltage and current to 80 kHz, DC current and resistance from 0.01 ohms through 25 megohms. The 5430 is a dual-input frequency counter with resolution to 0.001 Hz. DC coupled to 10 MHz, it features period function as well. The input frequency can be attenuated from 1:1 to 1:1000. Temperature measurements can be made using a "K" type thermocouple ranging from −200 degrees C to 1200 degrees C with degrees F selectable. Decibel measurements from +60 dBm to −50 dBm with frequencies up to 80 kHz.

Special features include diode test, continuity beeper, data hold, peak hold with a DC acquisition time of 5 milliseconds and AC of 250 milliseconds; relative test, 3-1/2 digit select for fast survey measurements, and a comparator circuit for making Go, NO-Go tests, with comparator data output via a rear panel connector. All functions and ranges are touch-key selectable.

For further information, contact North American SOAR Corp., 1126 Cornell Avenue, Cherry Hill, New Jersey 08002.

Circle #307 on Reader Service Card.

solar panels

The ENCON Corporation has announced the release of three new photovoltaic panels: the SX-38, SX-42, and the SX-146 dual voltage-semicrystalline PV modules.

The solar cells are manufactured from semicrystalline silicon, a material developed by Solarex specifically for use in photovoltaic devices. Cells made from this material are highly efficient, stable, attractive, and inherently resistant to the "hot-spot" damage that can affect single-crystal cell under reverse-bias conditions.

Cell strings are laminated between sheets of ethylene vinyl acetate (EVA), Tedlar,® and a sheet of 1/8-inch tempered low-iron glass. This glass is self-cleaning in most climates, retains its excellent transmissivity indefinitely, and is extremely resistant to mechanical stress, including impact of hail up to 3/4-inch in diameter at terminal velocity. Furthermore, its temperature coefficient of expansion is well matched to the

NEW products

cells; this matching and the stress-relieved electrical cell connections ensures excellent service even in climates with severe daily temperature ranges.

The module is framed with corrosion-resistant extruded aluminum sections with an architectural grade anodized finish. This strong, attractive framing and laminating is moisture resistant and accepts compatible mounting hardware.

The typical peaks power outputs for the new SX series modules are as follows:

SX-38	40 watts, 16.2 VDC at 2.5 amperes
SX-42	43 watts, 16.5 VDC at 2.6 amperes
SX-146	47 watts, 18 VDC at 2.6 amperes

Panels can be wired for 6 VDC with a doubling of current output.

ENCON photovoltaic systems can be used for large or small Amateur Radio projects, repeater stations, computer back-up supplies, TVRO, cellular radio, as well as residential and commercial applications.

For more information, contact Paul Denapoli, WD8AHO, at ENCON Photovoltaics, 27600 Schoolcraft, Livonia, Michigan 48150.

Circle #309 on Reader Service Card.

block downconversion accessories

LUXOR North America Corp. has introduced four new block downconversion accessories for use with its Mark 2 Block Satellite Receiver. The four DC-passing accessories include a V/H (vertical/horizontal) switch, power divider, line amplifier, and 10-dB signal attenuator.

Early STV systems used downconverters, mounted at the antenna, that sent to the receiver only a single channel from the satellite at which the antenna was aimed. LUXOR'S new "block" system permits all channels (transponder signals) on a selected satellite to be cabled into the home at once. This allows simultaneous use of multiple block receivers tuned to different channels. Thus, using a shared antenna, an unlimited number of Mark 2 Block Receivers supporting TV sets in four different locations can be individually tuned to any channel available on a given satellite.

To split the incoming satellite signal between up to four receivers, each port of LUXOR'S Model 9758 4-way DC-Passing Power Divider passes direct current from the receiver to the LNB at the antenna, allowing full flexibility in switching receivers on and off. By cascading several Model 9758 splitters, an unlimited number of receivers can be hooked up to the same antenna.

The Model 9759 DC-Passing Line Amplifier amplifies the signal 20 dB to increase antenna-to-receiver cable length or the number of receivers served by one satellite antenna. Adding one amplifier allows approximately 200 more feet of RG6 cable.

The Model 9760 DC-Passing 10-dB Signal Attenuator is designed to reduce signal level for a short run in a system that required higher signal levels elsewhere.

LUXOR'S new block downconversion systems can be used in homes with multiple viewers who have differing tastes in programming, in multiple-family dwellings, and in SMATV (Satellite Master Antenna Television) applications.

For more information, contact LUXOR North America Corp., 600 108th Avenue, N.E., Suite 539, Bellevue, Washington 98004.

Circle #310 on Reader Service Card.

"G.I." mechanics tool bag

The legendary "G.I." Mechanics' Tool Bags are now available from Jensen Tools in a more durable fabric (Cordura® nylon) but with the same expandability and appeal as the old canvas duck models. The bags retain the traditional green color, over-sized metal zippers, and heavy-duty web straps of the originals. Two large pockets on the outside are divided into three handy compartments each, and close with industrial strength snaps. Eight interior pouches in the main compartment serve to organize and protect small tools and parts.

For more information and a free catalog of hard-to-find tools, tool kits and cases, contact Jensen Tools Inc., 7815 S. 46th Street, Phoenix, Arizona 85040.

Circle #311 on Reader Service Card.

Kenwood TR-50 transceiver

The Kenwood TR-50 is a battery pack mobile/portable 1200 MHz FM transceiver that covers from 1260 to 1300 MHz with a 1-watt output transmitter. It features repeater offset with reverse switch, five memory channels, program-

NEW products

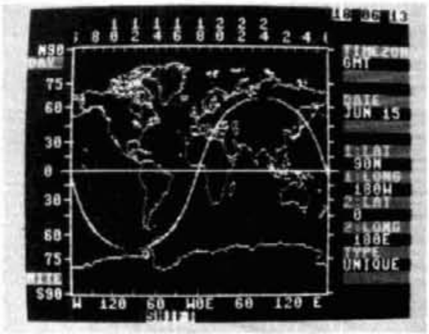
mable scanning, memory scan, a priority alert function, and RIT. "Odd splits" operation is possible using memory channel 5. The multi-function LCD panel indicates frequency, VFO A/B, repeater offset, S/RF/battery condition, and other keyboard functions.

The TR-50 comes complete with a rechargeable battery set and charger, shoulder strap, 16-key DTMF hand microphone, and an antenna on an adjustable mount. An external power cable is also included for mobile or base station supply operation.

For further information, contact Trio-Kenwood Communications, 1111 West Walnut Street, Compton, California 90220.

computerized DX EDGE®

Xantek has announced the availability of the DX EDGE® for the Commodore 64™ personal computer. With the new version, users of the Commodore 64™ will be able to see on-screen display of optimum QSO and reception possibilities, the Gray Line, sunrise and sunset times, and areas of the world in daylight and darkness. The display is a graphic presentation showing a detailed world map, not just a set of numbers.



The computerized DX EDGE gives all the DX advantages of the original plastic version, and additional flexibility as well. The DX EDGE finds unusual long range propagation paths by showing all the locations in the world where the sun is rising and setting at any time of year and time of day. (Excellent DX conditions often occur at these times.)

Easy to use, the DX EDGE works for all bands from 1.8 to 30 MHz. DX EDGE for the Commodore 64 is priced at $34.95. A single disk and full instructions are included.

For additional information, contact Xantek, Inc., P.O. Box 834, Madison Square Station, New York, New York 10159.

THE GUERRI REPORT

Ernie Guerri
W6MGI

predicting equipment failures

As electronic equipment becomes more complex, so too do the ways in which it can fail. This increased complexity requires greater circuit and component density; as more and more components have been squeezed into smaller spaces, the number of circuit interconnects, and hence the number of potential failure points, have also increased — by a factor of a thousand or more in just the past few years. Although we are finding ways to dramatically reduce component size and the amount of power required to perform discrete functions, the fact remains that every capacitor or resistor still has two connections, and each transistor, three . . . and so on.

Because of the small mass of modern components, shock and vibration failures are no longer the problem they once were. High circuit density now makes heat a major culprit in circuit failure. Although a modern component may have dimensions of only a few thousandths of an inch, and may dissipate only a few milliwatts, these characteristics may result in a component dissipation of several watts per square inch. Unless provision for removing the heat is made, component or device failure will occur.

An additional source of potential failure is the chemical and metallurgical processes used during fabrication. Assembling electronic circuits no longer consists of simply soldering together some tin, lead, and copper; a modern integrated circuit may require the amicable association of dozens of materials in a way that provides the opportunity for hundreds of different chemical interactions. The opportunity for one or more of these materials to contaminate nearby components is an important consideration in modern circuit failure analysis.

Because of the complexity of modern circuits, the possibility exists for thousands of combinations of potential failure mechanisms to occur in a single piece of equipment. Computers are now used to explore all of the possible relationships that could exist, and the ways in which they could promote failure. These techniques [known as diagnostic flow routines — Ed.] have become very sophisticated, and are deemed absolutely essential in military and space systems where no opportunity for repair may exist, and the consequences of failure can range from the merely disappointing and expensive to the catastrophic. The traditional method of expressing the likelihood of failure is called "mean time between failure" (MTBF); high-quality electronic equipment averages an MTBF of about 5000 hours.

These improvements in studying failure mechanisms and taking action to anticipate and prevent failure mean we can take a new transceiver out of the box, plug it in, and expect to use it for years without trouble.

new batteries promise more power, longer life

For most of us, carbon or alkaline batteries are the power source for portable equipment. "Exotic" means we spent some money and bought Nickel-Cadmium cells. However, in the world of battery developers there's some very snazzy stuff going on.

Before we examine some of the details, and their implications for Amateur Radio, let's recall some of the rules regarding the availability of energy. In general, the amount of energy we can get out of any process is a function of how active the molecules, or atoms, of the energy source can be made. Since molecular activity translates to temperature, there is a general relationship between temperature and energy release. All of the processes with which we are familiar span the range from absolute zero — where nothing happens — to fusion reactions at a few hundred million degrees C, where everything tends to come apart.

These principles apply very much to the world of chemical batteries, and in the last 15 years or so, they have inspired some dramatic developments. Three important applications that have supported these developments have included electric vehicles, space systems, and military equipment. Each

ADVERTISER'S INDEX AND READER SERVICE NUMBERS

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Limit 15 inquiries per request.

Please use before July 31, 1985.

of these applications requires large amounts of power (hundreds of kilowatts) to be delivered over sustained periods of time — i.e., several days. This means that their associated battery systems must either be very big or have high energy densities. Since big batteries are not very compatible with portable systems, high energy densities are required.

Some of the battery techniques that can provide these higher energy densities include nickel-zinc, zinc-bromine, sodium-sulphur, and lithium-metal sulphide. Nickel-zinc batteries fundamentally operate at room temperature and have been fabricated in forms similar to automobile batteries for electric vehicle applications. They typically have energy densities of four to five times that of comparable lead-acid devices. At the high end of the temperature scale, lithium-metal sulphide batteries operate at several hundred degrees centigrade, and can provide energy densities ten times that of the best lead-acid batteries. Although each of these battery types is commercially available for use in appropriate high-priced applications, all have proved too expensive for the operation of electric vehicles.

The most sophisticated developments in battery technology are devices using circulating fluids which depend on the chemical reaction of lithium thionyl chloride. Utilizing this technology, batteries that can deliver megawatts of power for several days have been developed. (As you might expect, you don't want to be around if you short one of these!)

On a more practical scale, the next few years could bring us rechargeable lithium cells that would enable handheld transceivers to operate satisfactorily for several months on a single charge. Bench-top transceivers with internal batteries capable of operating for several days, or weeks, are on the horizon. This would not only be a convenience for those who operate portable stations, but would also provide an important new impetus to the very function which justifies Amateur Radio — emergency operation.

ham radio

PICK A COMPUTER INTERFACE TO MATCH YOUR NEEDS

COMPUTER PATCH™ MODEL CP-1

MICROPATCH™ MODEL MP-1

COMPUTER PATCH MODEL CP-100

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

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✓ 196

The Nicest Things Come In Small Packages.

The SS-32HB is a new hybrid sub-audible encoder plucked from Communications Specialists' Hothouse. It has grown through a cross of the time tested SS-32, the subminiature SS-32M and space age micro circuitry. This programmable 32 tone encoder measures a scant .5 x 1.0 x .15 inches; no small wonder it allows the addition of continuous tone control to a bunch of hand held transceivers that lack space.

Why not snip your problems in the bud, with our fast, one day delivery and attractive one year warranty.

$29.95 each

✓ 197

COMMUNICATIONS SPECIALISTS

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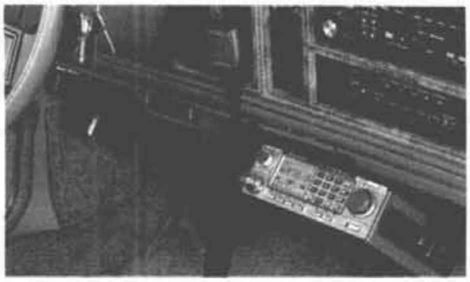
KENWOOD

...pacesetter in Amateur radio

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 backlighted 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 "OS" 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, subtone 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

Model TR-7950 (45 watts) shown. TR-7930 is identical, but with 25 watts output.
Complete service manuals are available for all Trio-Kenwood transceivers and most accessories.
Specifications and prices are subject to change without notice or obligation.

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

KENWOOD

TRIO-KENWOOD COMMUNICATIONS
1111 West Walnut Street
Compton, California 90220