OCTOBER 1985 / $2.50

ham radio magazine

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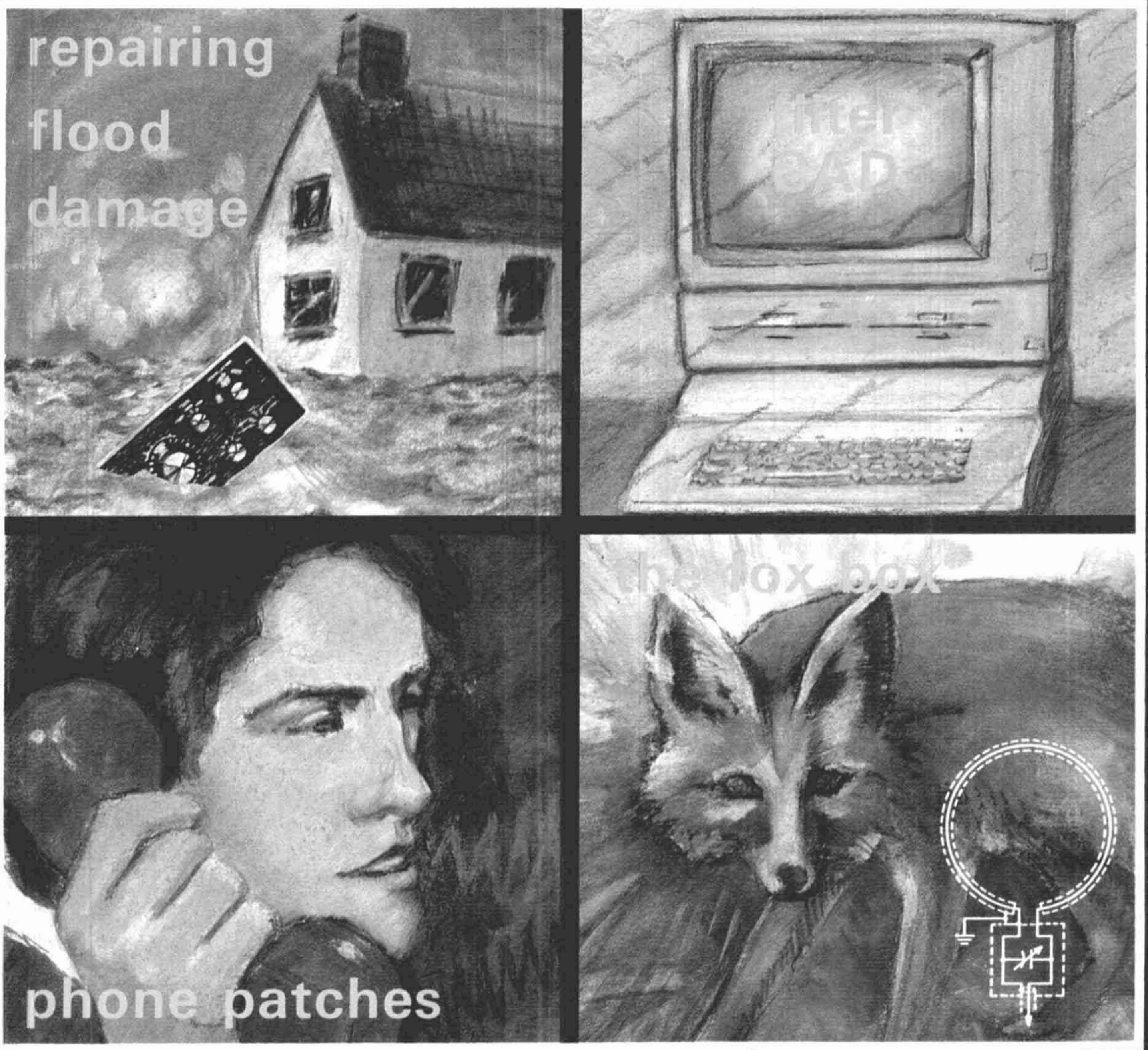


ICOM 25-1300MHz Plus!

IC-R7000

ICOM's commercial quality scanning receiver...Top quality at a gem of a price.

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

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

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

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

Other Outstanding Features:

- FM wide/FM narrow/AM/upper and lower SSB modes
- Six tuning speeds: 0.1, 1.0, 5, 10, 12.5 or 25KHz
- Dual color fluorescent display with memory channel readout and dimmer switch
- Compact Size: 4-3/8"H x 11¼"W x 10⅞"D
- Dial lock, noise blanker, combined S-meter and center meter
- Optional RC-12 infrared remote controller
- Optional voice synthesizer. When recording, the voice synthesizer automatically announces the scanned signal frequency.

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

See the IC-R7000 receiver at your local authorized ICOM dealer. Also available is the IC-R71A 0.1-30MHz general coverage receiver.

ALL THIS AT A PRICE YOU'LL APPRECIATE.

✓ 103

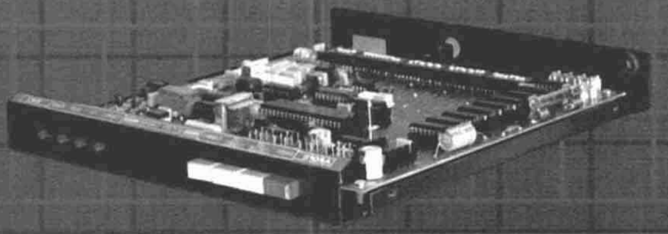
ICOM

First in Communications

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

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.

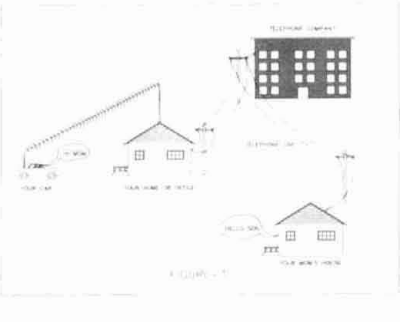
ONLY SMART PATCH HAS ALL OF THE ABOVE.

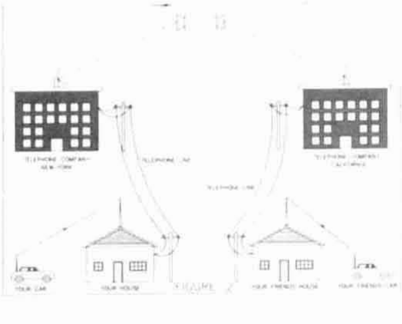
Now Mobile Operators Can Enjoy An Affordable Personal Phone Patch. . .

- 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.*

CES®

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

Handy Handful...

TR-2600A/3600A

Kenwood's TR-2600A and TR-3600A feature DCS (Digital Code Squelch), a new signalling concept developed by Kenwood. DCS allows each station to have its own "private call" code or to respond to a "group call" or "common call" code. There are 100,000 different DCS combinations possible.

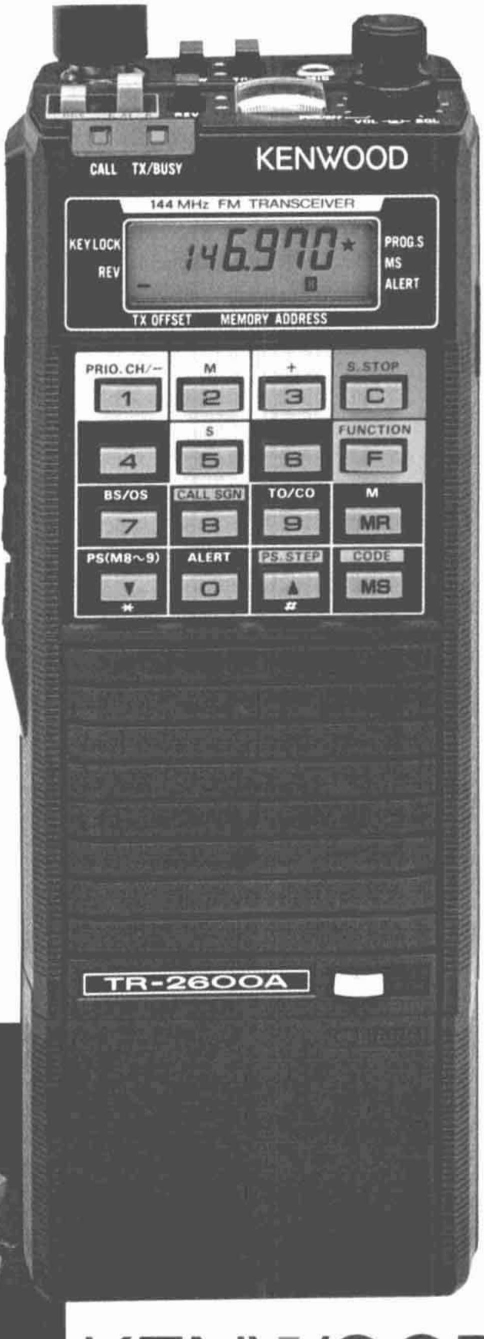
- **Simple to operate**
  Functional design is "user friendly." Built-in 16-key autopatch encoder, TX STOP switch, REVerse switch, KEYboard LOCK switch, high efficiency speaker.
- **Large LCD**
  Easy to read in direct sunlight or in the dark with convenient dial light that also illuminates the top panel S-meter.
- **Extended frequency coverage**
  Allows operation on most MARS and CAP frequencies. Receive frequency range is 140-160 MHz. (TR-3600A covers 440-450 MHz.)
- **Programmable scan**
  Channel scan or band scan, search for open or busy channels.
- **SLIDE-LOC battery case**
- **10 Channels**
  10 memories, one for non-standard repeater offsets.
- **2.5 watts high power, 350 mW low**
  TR-3600A has 1.5 watts high or 300 mW low.

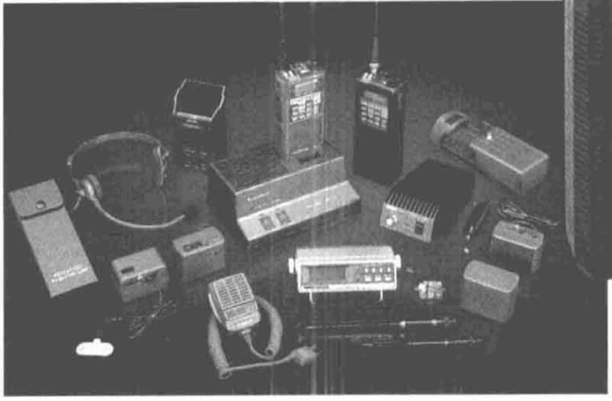
The Kenwood TR-2600A and the TR-3600A pack "big rig" features into the palm of your hand. It's really a "handy handful"!

Optional accessories:

- TU-35B built in programmable sub-tone encoder
- TB-2530 2-m 25 W RF power amp.
- ST-2 base stand/charger
- MS-1 mobile stand/charger
- PB-26 Ni-Cd battery
- DC-26 DC-DC converter
- HMC-1 headset with VOX
- SMC-30 speaker microphone
- LH-3 deluxe leather case
- SC-9 soft case with belt hook
- BT-3 AA manganese/alkaline battery case
- EB-3 external C manganese/alkaline battery case
- RA-3 2-m telescoping antenna
- RA-5 2-m/70-cm telescoping antenna
- AX-2 shoulder strap w/ant. base
- CD-10 call sign display
- BH-2A belt hook

More TR-2600A and TR-3600A information is available from authorized Kenwood dealers.





KENWOOD

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

TR-2600A shown. TR-3600A is available for 70 cm operation.
Complete service manuals are available for all Trio-Kenwood transceivers and most accessories.
Specifications and prices are subject to change without notice or obligation.

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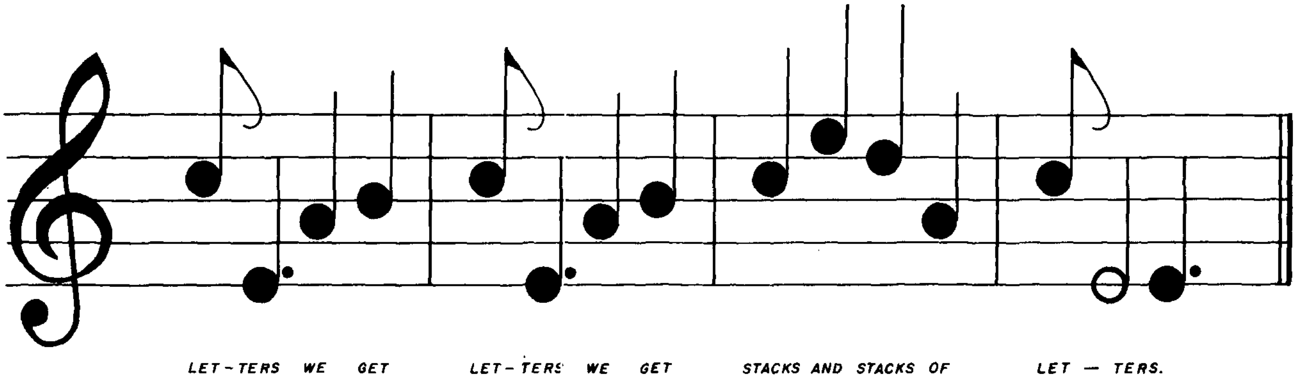


Dear Richie . . . Except for the name, the song's the same. I remember spending many an evening with my family, watching Perry Como on the Dumont. Towards the end of the program, mailmen would mysteriously appear, dump several large sacks of letters on the floor, and then disappear again, leaving Perry Como alone with those thousands of letters.

Sometimes at *ham radio* I feel that I'm in Mr. Como's situation. Every day we receive short letters and long letters from readers, asking or telling about simple subjects, easily grasped, and more complex subjects that send me to the quietude of my library. Club newsletters, new product announcements, DX news, and other written communications add to the pile.

Mind you, I'm not complaining. Quite honestly, I love to receive mail. As I'm sure I've mentioned many a time, reading material is like food to me — nay, like the breath of life itself. However (sorry, no "buts"), I've found that there *is* a limit to the number of hours in a day (it took me forty years to figure this out) . . . and though one should, in the name of efficiency, "prioritize," I must confess to a particular weakness: I believe that if someone's taken the time to write to the editor of *ham radio*, I want to take the time and care to respond. The reply might be shorter than you might like it to be — and it may take a long time in coming — but come it will.

There are a few things you can do to help make sure that you'll get an answer in a timely manner when you write. Here are a few suggestions:

DOUBLE SPACE your letter, regardless of whether you type, print, or knock it out on your word processor. Doing this makes your letter much easier to read and leaves room for me to scribble notes in between your lines.

Limit your comments to a SINGLE SUBJECT. Send as many letters as you like, but limit each one to one topic only. Sometimes several readers will comment on the same thing — for example, an error in a formula (although, of course, we rarely make mistakes). I can research your question and get an answer to you more expeditiously this way. (The DXers among you will appreciate this. When you've worked that rare one on several bands, don't you send separate cards for each one to make it easier on the QSL manager or the poor guy filling out those thousands of cards?)

Keep the LENGTH of you letter to a maximum of 400 words if you can. I understand that this may be difficult in some cases, but try. Make a game out of getting to the point quickly. (Now if only I could learn to do that!)

Clearly indicate if you'd like us not to PUBLISH your letter. I can't guarantee that we'll print your letter (if that's what you'd like), but I promise that if you say "do not print," your letter will not be printed. (If that's the case, please feel free to broach any subject. I don't embarrass easily.) One fine point: unless you tell us that you don't want your letter published, we'll assume we have your permission to publish it.

Don't be afraid that what you have to say may not be important, or that your letter might be too short (Grace à Dieu!). I started this editorial with very little to say, and look at it now.

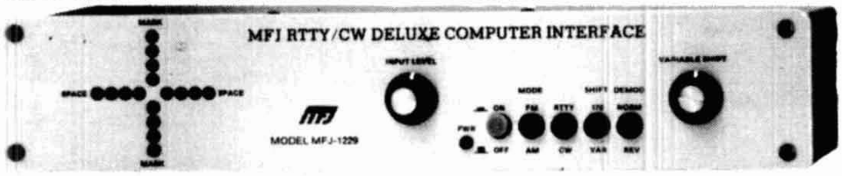
Remember, that if nothing else, *ham radio* is a conduit of your thoughts and interests. Its content is gathered and published to meet your needs. The more readers we hear from the more accurate our understanding of your interests will be.

To the hardy few who've read this far, please write. And be patient. A response from this office *will* come.

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.

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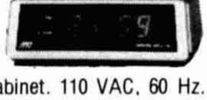
Switch to 24 hour UTC or 12 hour format! Battery backup. ID timer alerts every 9 minutes after reset. Red .6 in. LEDs. Synchronizable to WWV. Alarm, Snooze function. PM, alarm on indicators. Gray/Black cabinet. 110 VAC, 60 Hz.



MFJ ELECTRONIC KEYER

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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.

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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
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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 5½x6¾x2¼ 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
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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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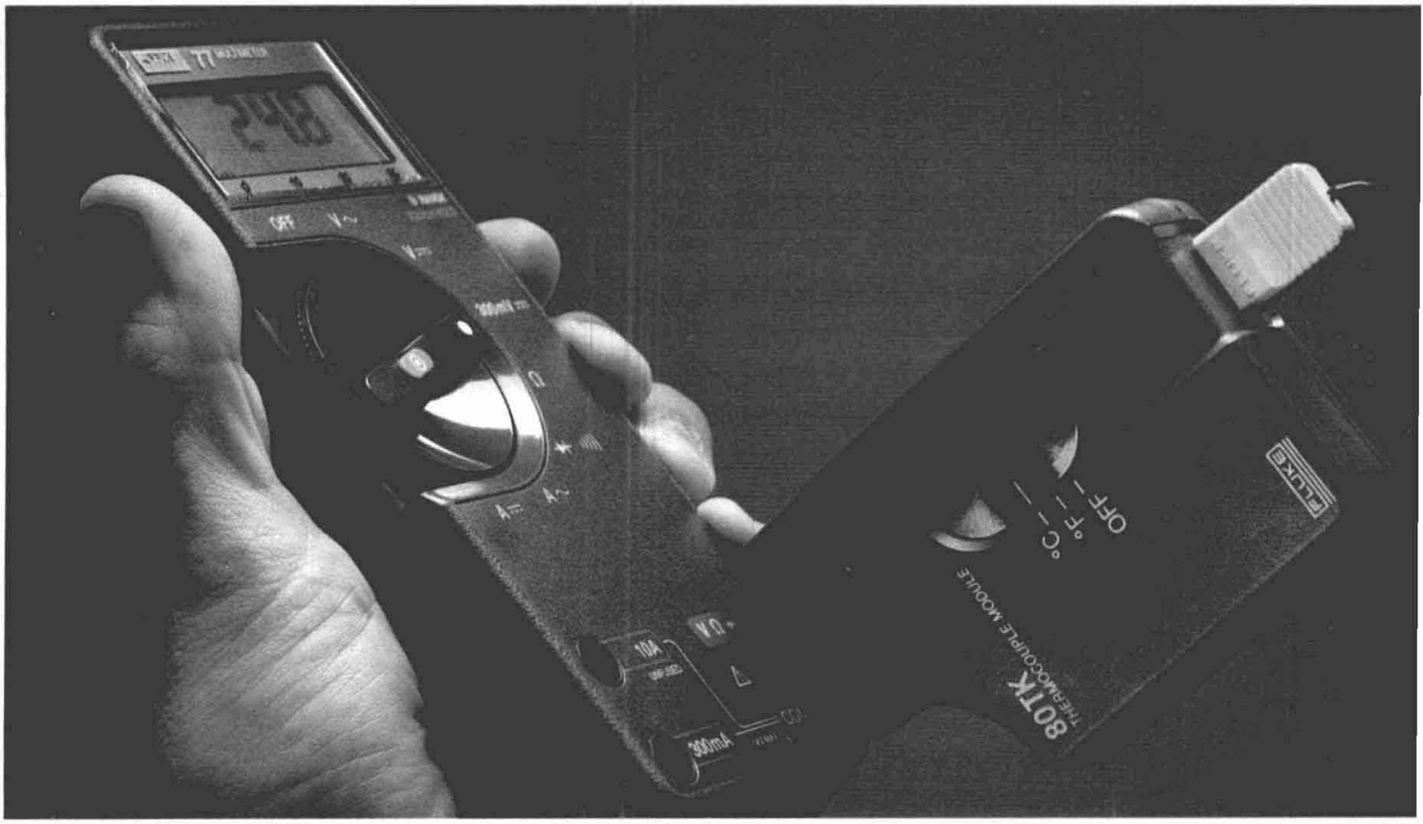
The best DMM in its class just got better.



The Fluke 80TK.
One innovation leads to another.

First there was the 70 Series, which set a new standard for low-cost, high-performance, Fluke-quality multimeters.

And now, another first. The Fluke 80TK K-type Thermocouple Converter. A temperature measurement device that adds instant temperature measurement capabilities to the 70 Series DMMs.

Or any DMM, for that matter.

Feature for feature, the versatile 80TK is the most affordable unit of its kind. For quick comparison readings, it can measure °C or °F at the flick of a switch. It includes a built-in battery test. And the availability of 3 Fluke probes give you the flexibility to measure any form of temperature, from freezer to furnace, with just one base unit.

No other thermocouple converter we know of offers DMM users so much for so little. Just $59, including a general-purpose bead probe.

So even if you don't own a Fluke 70 Series multimeter, the 80TK will help the DMM you're now using measure up when things get hot. Or cold.

For your nearest distributor, call toll-free **1-800-227-3800, ext. 229,** day or night. Outside the U.S., call 1-402-496-1350, ext. 229.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

Surface, immersion and general-purpose probes with "mini" thermocouple connectors are available for the Fluke 80TK.

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Temperature Measurement Range
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comments

more Novice privileges

Dear HR:

Back when the original Novice license was created, it included phone privileges on the high end of 2 meters. This was dropped because the new Novices were talking their 1-year, non-renewable tickets away. Now that the Novice ticket is a 10-year, renewable affair, maybe some thought should be given to letting the Novices back on 2 meters. . . . Interference the Novice may cause is easier to track down on 2 and does not propagate over the entire planet. Loading 2 meters with Novices might even force the development of modern commercial repeater techniques to increase the capacity of the voice repeater systems as well as development of the other VHF bands. . . .

The new license would allow Novices the same operating privileges as the Technicians, so they could operate packet, RTTY, CW, SSB, FM, or anything else that strikes their fancy and is legal.

This new Novice license would mean that Novices could work on public service and disaster communications while their interest is high (as was yours when you first got your license, remember?) and they're motivated to get involved. And they could also work on HF when they wanted to. The Techs will scream since many really aren't living up to the purpose of their license — the development of all the VHF spectrum — but are instead just living on 2 meters.

It would be nice if the ARRL would make holding at least one Novice class per year a requirement of affiliated clubs (forgiving schools — it's tough enough for those). Maybe also have a minimum passing rate of, say, 30 percent or three new Novices per year. Something like that, anyway. They want growth — this will help.

William E. Newkirk, WB9IVR
Melbourne, Florida

can anyone help?

Dear HR:

I am 31 years old, a General Class ham, and handicapped with multiple sclerosis. I am unable to work, so my wife supports us and our two little girls, ages 6 and 8. On our very limited income the purchase of new or used equipment is impossible.

Maybe there is someone in your readership who has some equipment they haven't used in a while, but is still in working condition, that they would be willing to donate. I need a good transceiver (solid-state or tube) or transmitter and receiver, power supply, and VHF/UHF radios, and any station accessories, such as microphone, watt/SWR meter, etc.

I can assure you that any equipment anyone donates will be put to good use and appreciated very much. Thank you for your time and effort on my behalf. God Bless you.

John T. Statham, N5HTQ
1506 Sheila Drive
McComb, Mississippi 39648
(601) 684-9558

service note

Although R.L. Drake no longer manufactures Amateur Radio products, service is still available. We're at 540 Richard Street, Miamisburg, Ohio 45342 (513 866-3211).

William A. Frost, WD8DFP
Service Manager
R.L. Drake Company

presstop de W9JUV

33 CM HAS BECOME THE NEWEST U.S. AMATEUR BAND, open for use 0001Z September 28, 1985, about the time you read this. All modes, for Technician class and above, are permitted in the 902-928 MHz slot, though Amateurs may not interfere with other band users (principally Industrial, Scientific, and Medical). Due to government needs, the band is not available in Colorado, Wyoming, or within the White Sands (NM) Missile Range; 33 cm Amateur stations within 150 miles of the Range borders are also limited to 150 watts PEP.

First Extensive Use Of 33 CM Is Likely To Be On FM, using 903-905 MHz rigs developed for use by the Japanese Personal Radio Service. A few are already in the U.S., and quite a few are believed to be in inventory in Japan since the number of Japanese users has not met the makers' expectations. W9JUV checked out a pair late last year on an FCC experimental license, and the Amateurs who had a chance to operate with them found their sophisticated selective calling and other features fascinating though absorption by foliage severely restricted their ground-level range. Unfortunately their frequency scheme conflicts with that developed by ARRL's VUAC, which places weak signal, beacon, linear translator and digital users in the 903-905 MHz portion of the new band and FM simplex at 906-907 MHz.

On The Same Date U.S. Amateurs Lost 420-430 MHz Above "line A," an imaginary line that runs across the country 50 miles south of the Canadian border. This provides a buffer zone for Canadian 420-430 MHz Land-Mobile activity, by a 1982 U.S.-Canadian agreement.

A NATIONAL ORGANIZATION OF VOLUNTEER EXAMINER COORDINATORS was probably the most significant result of the FCC's VEC meeting in Gettysburg August 9. 16 VECs, essentially all of the most active, were represented at the all-day session in which the FCC, for all intents and purposes, finished passing the Amateur examination ball to the Amateur VECs.

Though The FCC's Day-Long Meeting Was Itself Rated "Highly Successful" by all parties, it was at an informal post-session rehash Friday night that the seeds were planted for the national VEC group. Tentatively named the "Coalition of Amateur Radio Examiners" (CARE), the new group is considering such things as mutual accreditation of each other's Volunteer Examiners, developing a common examination pool with cooperative printing and stock-piling, and cooperation in scheduling of exams. Membership in CARE will be open to any FCC-accredited VEC and to any individual Volunteer Examiner even if the VE's VEC is not a CARE member.

Development Of The CARE Organization Is Continuing Rapidly; W9JUG at DeVry can provide additional information for those interested. A national VEC net, to discuss the VEC program in general and CARE in particular, now meets Sundays on 14173 kHz at 1700Z.

EXTENSIVE AMATEUR OPERATION FROM SPACE IS PLANNED for the Space Shuttle's Flight 61A, scheduled for liftoff October 16. The European crew includes Amateurs PE1LFO, DB2KM, and DD6CF, who'll operate on both 2 meters and 70 cm with antennas mounted on the Shuttle's surface instead of using the makeshift window antenna of previous flights.

Operation On The 10 Or 15 Meter Bands Is Also Being Considered, to provide new and useful information on HF propagation through the ionosphere. At press time it appears these operators will be permitted much more on-the-air time than any previous astronauts.

A U.S.-JAPANESE RECIPROCAL LICENSING AGREEMENT HAS BEEN SIGNED, according to the August 9 issue of Japan Times. Under U.S. reciprocal licensing rules, Japanese "no-code" license holders will have the same operating privileges here as they have in Japan—above 30 MHz. Japanese will not be the first "no-coders" to operate in the U.S., however, as a number of the other 65 countries with whom we have such agreements also have a no-code license. Since the Amateur population of Japan is so large, with so many holding a no-code license, a noticeable influx of Japanese reciprocal license holders can be expected.

8N1AAA Through 8N1XZZ Is The Callsign Block Reserved For U.S. Amateurs licensed in Japan. The new agreement, the result of extended negotiation (the U.S. is the first nation to establish a reciprocal agreement with Japan), should become effective in September.

CALIFORNIA'S PROPOSED BILL OUTLAWING 800-MHZ SCANNERS has been substantially tempered thanks to the efforts of attorney N6AHU and others. California Senate Bill 1431 still prohibits the "malicious" use of 800 MHz equipment designed specifically to eavesdrop on cellular radio, but includes exemptions for Amateurs and scanner buffs.

A Similar Threat Has Appeared On The National Scene, however, as a "discussion draft" of a U.S. House of Representatives bill that would broadly extend present restrictions against wiretapping to all forms of electronic communications.

Telephone Company Concern Over Privacy Of Cellular Communications is believed to have spawned this new bill, tentatively titled the "Electronic Surveillance Act of 1985," as was the case with the California legislation.

USE OF 432 MHZ AS A RELAY FREQUENCY FOR COMMERCIAL TV VIDEO has been requested in a request for waiver filed with the FCC by a Lake Havasu (AZ) low-power TV station owner. Comments on the TV station owner's request (which he claims has local Amateur support) are due October 10; Replies are due October 28. Refer to PRB-2; include four copies plus original

JORDANIAN AMATEURS WILL USE THE JY50 PREFIX November 7-21 in celebration of the 50th birthday of King Hussein, JY1. Extensive activity on 160 through 10 meters, plus OSCAR, is promised, with five JY50 QSO (10 in Europe) good for a special award.

L U X O R 9 9 0 0

THE INTELLIGENT SATELLITE TELEVISION SYSTEM

THE LUXOR 9900 KNOWS

Where all the satellites are

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

Where all the channels are

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

All about stereo Hi-Fi sound

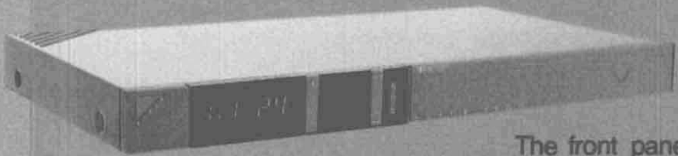
5 audio modes, factory programmed to individual transponders, deliver the right sound system automatically when a channel is selected. Dozens of audio subcarriers can be added to the program for audio only hi-fi enjoyment (including Dolby® Noise Reduction) in addition to television.

ALL YOU NEED TO KNOW IS WHAT SHOW YOU WANT TO WATCH

L U X O R 9 9 0 0

NOW LUXOR HAS UNIFIED SATELLITE, VIDEO, AUDIO AND COMPUTER TECHNOLOGY IN A SINGLE INTEGRATED HOME SATELLITE TV SYSTEM

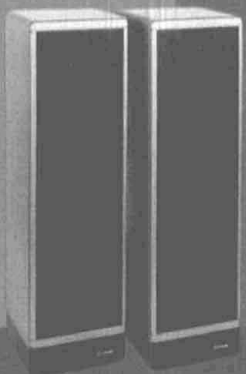
So advanced it's as easy to operate as an ordinary TV



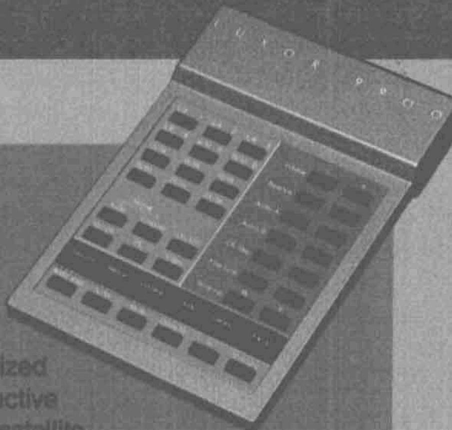
The front panel LED display tells you what satellite you're on, what channel you're watching, what sound system you're receiving and a signal bar graph indicates signal strength. All functions are controlled from the hand-held wireless remote.

The sky is alive with the sound of music

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



Simple, clear and color-coded



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

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

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

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

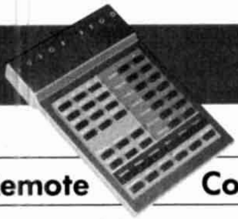
Here is the best of Scandanavian design and high technology. Because Luxor is a leading European manufacturer of satellite products, TV's, audio hi-fi systems, and computers, the company is able to combine these technologies in the advanced 9900 series. After all, Luxor has been a leader in radio, television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

The perfect companion

The Luxor Model 9995 Block Satellite Receiver is designed and built to function as an add-on receiver to Luxor 9900 multiple TV's installations. This low cost manually operated receiver offers independent channel selection for TV's located throughout the house. The 9995 can also be used as a stand-alone receiver for both C-Band and Ku-Band reception.

LUXOR HAS ADVANCED THE STATE-OF-THE-ART TO THE POINT OF ELEGANT SIMPLICITY FOR THE CONSUMER AND THE TECHNICIAN

Each electronic innovation is incorporated to aid ease of operation, assure high performance reliability, and maintain outstanding quality of both picture and sound.



9900 Block Receiver

Control Functions

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

Programs

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

Video Functions

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

Audio Functions

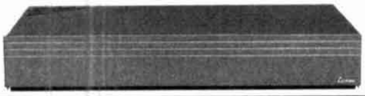
+ Audio subcarrier frequency read-out.
• Wide/Narrow Bandwidth selection.
+ Remote audio volume control.
+ Remote stereo balance control.
+ Remote Dolby® on/off
+ 5 audio modes–2 mono, 2 matrix, and discrete stereo. Automatic multiplex selection.
• Built-in stereo processor.
+ Direct loudspeaker drive.

9902 Remote Sensor

• Controls satellite system from any room.
• Low-cost add-on for other TV's.
• Comes complete with hand-held IR remote control.

9901 Remote Control

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



9904 Actuator Interface

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

9906/9907 Stereo Loudspeakers

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

9995 Block Satellite Receiver

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

+ Denotes new features available only on 9900 series products.

Luxor High-Performance Microwave Block Downconverters

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

Luxor Sales And Technical Services Throughout America

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600 108th Ave. N.E., Bellevue, WA 98004

✓ 108

computer-aided
audio filter design

No adjustments necessary — just build it and it works

Audio filters are a simple, inexpensive way of realizing very high selectivity without any modifications to the transceiver (or receiver). A number of commercial audio filters are available, and many articles provide designs.

But I wanted an audio filter with specific features, including a very well-defined audio passband for CW applications; single-chip design (to minimize wiring); battery operation, with the lowest possible current drain to maximize battery life; and small size, for headphone-only operation. I also wanted to design and build this filter in just a weekend or two, and have fun doing it.

Although the "weekend or two" evolved into about two months of evenings and weekends, the project turned out to be both entertaining and educational.

Because I knew that two-pole bandpass or low-pass filters are very easy to design, I expected the project to be brief. The design equations are, after all, available in many reference books,[1] and I've listed them in **fig. 1** for convenient reference. Given the desired center frequency, *Q*, and gain, the correct Rs and Cs are easily calculated, (**fig. 1**). But a good audio filter requires that a number of two-pole filters be cascaded. So the question arises, what should the center frequency, *Q*, and gain of each two-pole section be? Should only bandpass sections be used, or should low-pass sections also be included? In other words, it's easy to design one stage, but it's not at all clear how to design three or four stages and know what the overall bandpass characteristics will be.

I approached this problem by writing a program for the Apple II+ that allows the user to enter four sets of *Q*, *H* (= gain), and *FØ* (= center frequency or corner frequency). Each filter may be either a bandpass or low-pass type. The program then evaluates the response of up to four filters over a user-designated band, in 10 Hz increments. The combined response of the four filters is then plotted on the screen using the high resolution graphics mode. This allows a detailed examination of the overall filter bandpass curve before it's built.

trial-and-error

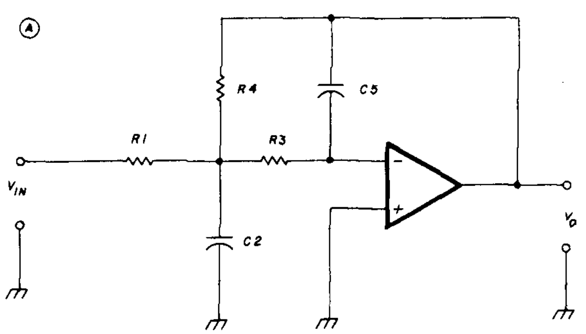
This method, then, is essentially a computer-aided trial-and-error process. Four sets of parameters are selected, and the computer plots the response. If one side of the plot is "sagging," the gain, *Q*, or center frequency can be changed and the new response plotted. It isn't very long before one gets a feel of what's going to happen when a given parameter is changed.

By trying various combinations of *Q*, *H*, and *FØ* it takes surprisingly little time to obtain a filter that has a very flat top, and very steep skirts. Typically, it takes about ten tries; each takes less than 5 minutes. This means that a filter can be designed in about an hour. **Figure 2** shows the bandpass characteristics of a three-stage design that was done using the above process.

One might ask whether filters synthesized using this technique are the best of all possible filters that can be designed using up to four stages. This question may be addressed by comparing the results obtained using this method with the response of an ideal filter having an absolutely flat passband and infinitely steep skirts. It seems to me that passband flatness of better than 1/4 dB is pointless because you can't hear it — 1/4 dB is not perceptible to the human ear. For practical purposes, therefore, this filter is as good as the best obtainable as far as passband flatness is concerned.

However, it is possible, and even probable, that better skirts can be achieved using different filter parameters or perhaps four stages instead of only three. It becomes a question of how much time one is willing to put in to achieve the desired improvements.

By Dana F. Geiger, KE2J, 42A Sandy Hollow Road, Port Washington, New York 11050



Low-pass filter

Given: $H_0, \alpha, \omega_0\ (=2\pi f_0)$

Select: $C2 = C$

Calculate: $K = \frac{\alpha^2}{4(H_0 + 1)}$

Select: $C5 \le K \cdot C2$

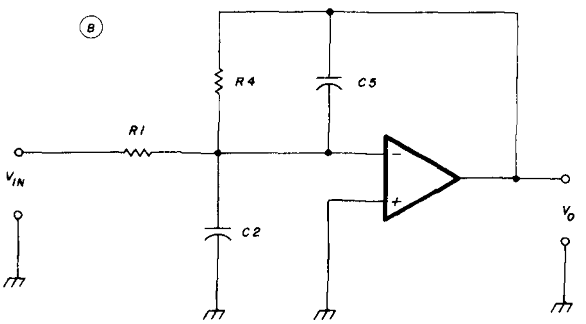
Recalculate: $K = \frac{C5}{C2}$

Calculate: $R4^* = \frac{\alpha}{2\omega_0 C K}\left[1 \pm \sqrt{1 - \frac{4(H_0 + 1)K}{\alpha^2}}\right]$

Calculate: $R1 = \frac{R4}{H_0}$

Calculate: $\frac{1}{\omega_0^2 \cdot C^2 \cdot R4 \cdot K}$

*This equation is incorrect in reference 1, but has been corrected above.



bandpass filter

Given: $H_0, Q, \omega_0\ (=2\pi f_0)$

Select: $C = C3 = C4$

Calculate: $R1 = \frac{Q}{H_0 \omega_0 C}$

$R2 = \frac{Q}{(2Q^2 - H_0)\omega_0 C}$

$R5 = \frac{2Q}{\omega_0 C}$

fig. 1. Design equations for single, two-pole (*A*) low-pass and (*B*) bandpass filter.

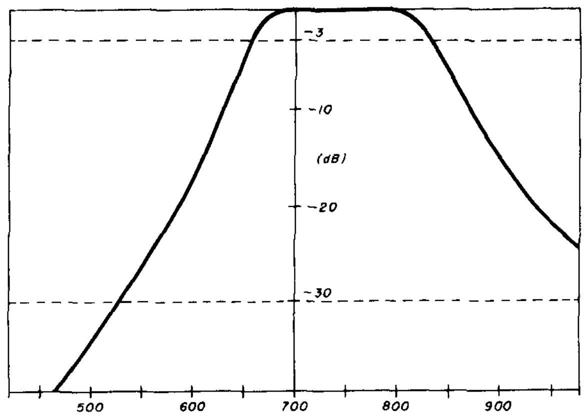
It's tempting to choose high *Q*s to improve the skirts. But this presents a potential problem because high *Q*s cause ringing. The rule of thumb I developed for choosing *Q* is:

$$Q = 10 \cdot F\emptyset$$

where $F\emptyset$ = *center frequency in kHz.*

Example: At F0 = 500 Hz, the maximum *Q* is 5. ($Q = 10 \cdot 1/2$ kHz).

This rule of thumb is derived by calculating that at 40 WPM CW, a dot is about 25 ms long. This implies that the transient response of each stage of the filter should decay within 2 to 3 ms (= 1/10th of 25 ms), ensuring that the CW will not be stretched out by the decay time of the filter stages.



filter 1: center frequency = 820 Q = 10 gain = 1
filter 2: center frequency = 670 Q = 10 gain = 1
filter 3: center frequency = 740 Q = 5 gain = 1
center scale frequency = 700
maximum gain = 0.197313292

bandpass characteristics of a three stage filter
filter 1: center frequency = 820 Q = 10 gain = 1
filter 2: center frequency = 670 Q = 10 gain = 1
filter 3: center frequency = 740 Q = 5 gain = 1
center scale frequency = 700
maximum gain = 0.197

fig. 2. This shows plot of three cascaded bandpass filters (two poles each).

From the equation for a bandpass filter (see reference 1), it is known that the decay time constant is:

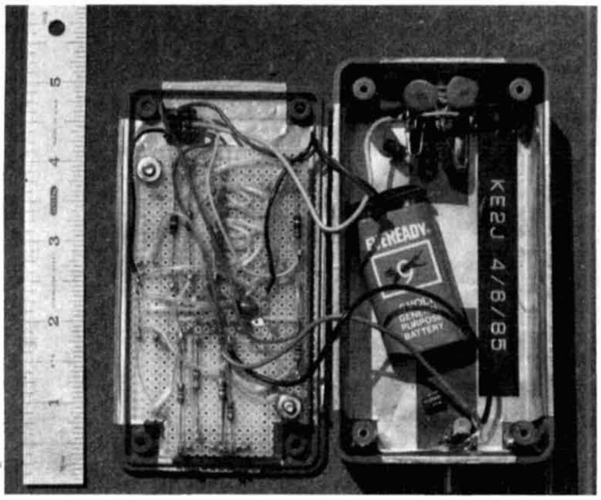
$$decay\ time\ constant = \frac{2 \cdot Q}{(2 \cdot \pi \cdot F\emptyset)} \qquad (1)$$

With the decay time constant selected at about 3 ms, the above rule of thumb follows. This is really a somewhat conservative rule, and serves only as a guide. In the above example, a *Q* of 10 is still not unreasonable, but a *Q* of 25 or 50 will create a music synthesizer, not an audio filter.

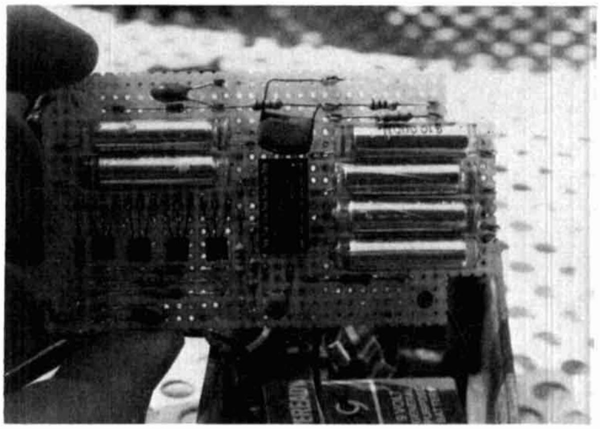
The 3 dB width of the filter was selected as somewhere between 150 and 200 Hz because it seemed to me that it would be difficult to tune in a signal with a substantially narrower filter bandwidth. A 200 Hz width represents only a very small rotation on the transceiver main tuning dial. Furthermore, there is a limit to how narrow the bandwidth can be made for a given CW speed. 200 Hz seems to be quite effective in practice.

After calculating the values of resistors and capacitors for the filter (using the design equations in **fig. 1**), it was not surprising that the calculated values were not standard 5 percent parts. However, the closest standard 5 percent values were substituted and the analysis program was then used to recalculate the filter parameters.

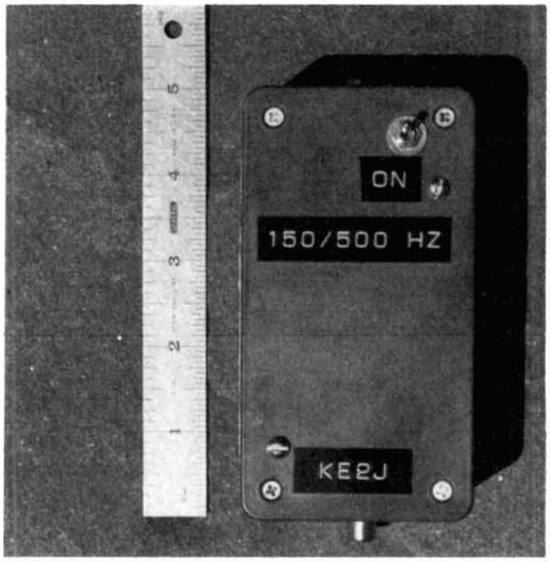
This resulted in filter parameters that differed slightly from the originally synthesized values. For example, the initial *Q* of 10 became 9.9. To be sure that the



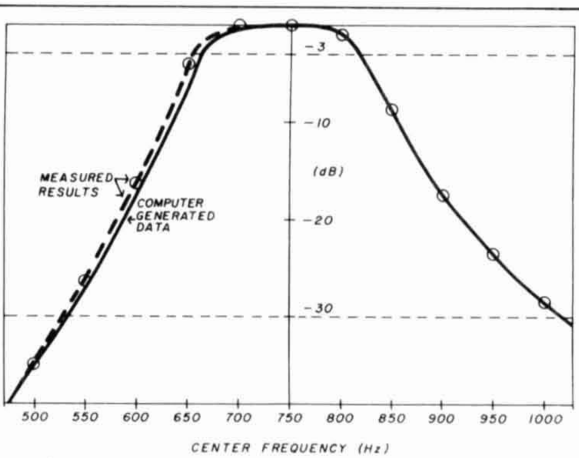
Simple construction techniques include point-to-point wiring on perfboard.



Heart of circuit is contained in centrally located 14-pin DIP.



Completed unit measures less than 3 × 5 inches (7.6 × 12.7 cm).



computer generated vs measured bandpass characteristics

filter 1: center frequency = 808	Q = 9.9	gain = 1.01
filter 2: center frequency = 671	Q = 9.9	gain = 0.98
filter 3: center frequency = 740	Q = 5.0	gain = 1.08

center scale frequency = 750
maximum gain = 0.246

measured results (see schematic)

frequency (Hz)	output volts	dB = 20 log [output volts / peak volts]
500	1.8 mV	−35.00
550	4.8 mV	−26.40
600	15.4 mV	−16.30
650	63.6 mV	−4.00
700	100.6 mV	−0.01
750	99.2 mV	−0.13
800	89.5 mV	−1.02
850	36.4 mV	−8.80
900	13.8 mV	−17.30
950	6.8 mV	−23.40
1000	3.8 mV	−28.50
716 (peak)	100.7 mV (max)	0 (reference)

maximum gain (at 716 Hz) = $\frac{100.7\text{ mV}}{116.8\text{ mV}} = 0.86^*$

(V_{in} = 116.8 mV at all frequencies)

*circuit contains an amplifier — see schematic (fig. 4).

fig. 3. The "y" axis has been placed at 750 Hz by using the manual mode in the plotting program.

overall filter characteristics didn't change substantially, the transfer function was replotted using the program. If significant departures were observed, closer values of resistors were synthesized using parallel combinations of resistor pairs. The replotted bandpass curves, shown in **fig. 3**, can be compared to the original plots in **fig. 2** to demonstrate how the use of practical parts has changed the filter.

filter circuit

The filter circuit is shown in **fig. 4**. The nomenclature for the resistors and capacitors follows that in reference 1. The entire circuit draws 1.3 mA from the 9 volt battery, while delivering full volume into 8 ohm headphones.

The performance was measured using a digital voltmeter (true RMS), a digital counter, and a function generator. In **fig. 3**, the actual response is plotted over the computer generated response.

The nastiest problem was the presence of RFI in the headphones during transmit. W2CXK suggested lining the inside of the plastic box with copper foil. (A metal box is probably best for the enclosure.) It was also necessary to use RF filters at both the input and output to totally eliminate the RFI.

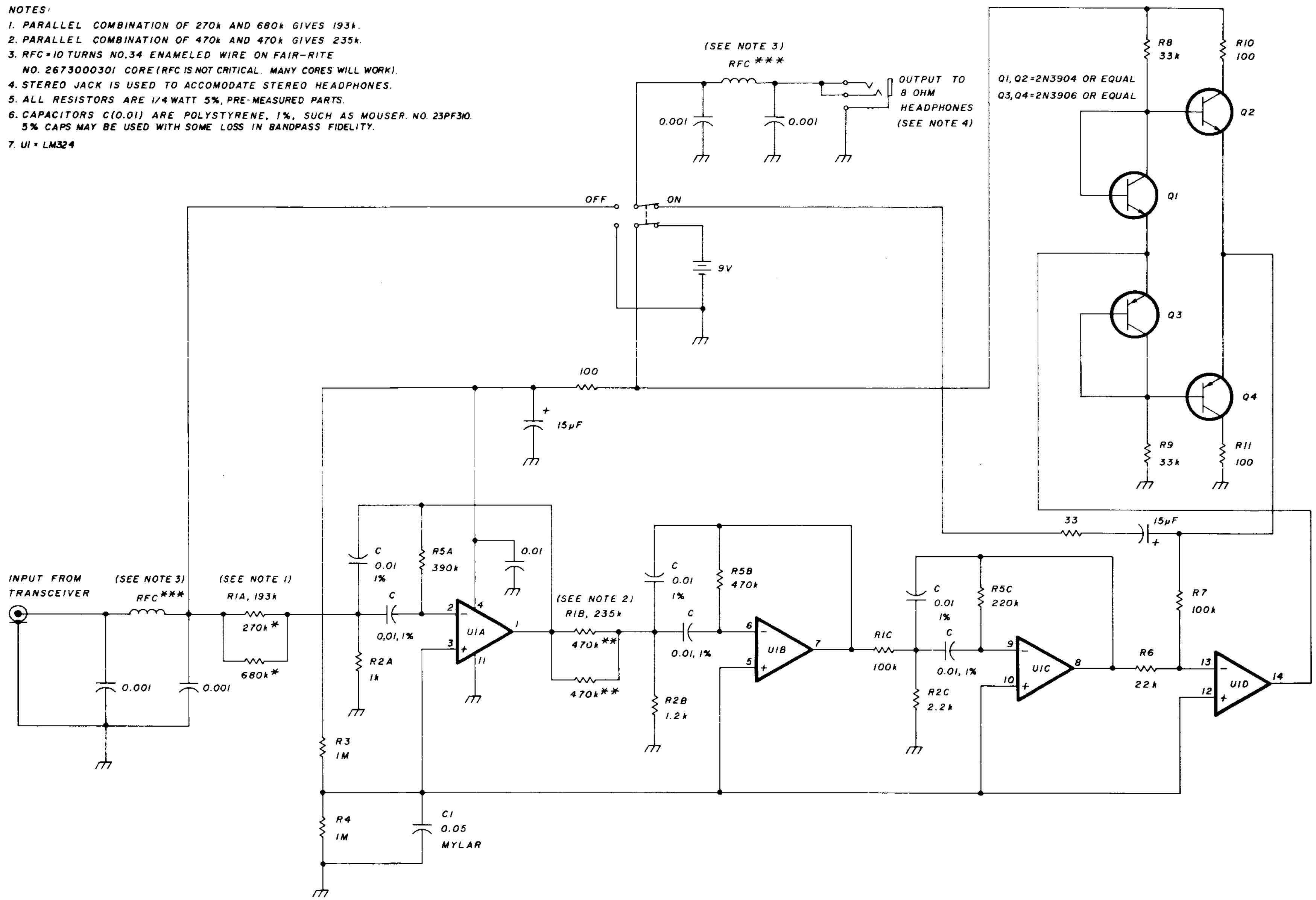


fig. 4. Schematic of audio filter.

```
10 X = FRE (0)
20 PRINT : PRINT
30 PI = 3.1415926
40 TEXT : HOME
50 DEF FN L(X) = LOG (X) / LOG (10)
60 REM LOG(X) IS THE NATURAL LOG IN THIS BASIC. LOG (10) IS THE NATURAL
   LOG OF 10 (ABOUT 2.3). L(X) IS THE LOG TO THE BASE 10, AS REQUIRED IN
   THE PROGRAM.
70 DEF FN H(W) = H0 / SQR (1 + (Q ^ 2) * (W / W0 - W0 / W) ^ 2)
80 DEF FN LP(W) = (H0 * W0 ^ 2) / SQR (W ^ 4 + (AL ^ 2 - 2) * (W ^ 2) *
   (W0 ^ 2) + (W0 ^ 4))
90 REM ******************************
100 REM ENTER FILTER CHARACTERISTICS
110 INPUT "TODAY'S DATE:";D$
120 INPUT "HOW MANY FILTER SECTIONS? (1,2,3 OR 4): ";FS
130 IF FS = 1 THEN T2 = 0:T3 = 0:T4 = 0: GOTO 180
140 IF FS = 2 THEN T3 = 0:T4 = 0: GOTO 180
150 IF FS = 3 THEN T4 = 0: GOTO 180
160 IF FS = 4 THEN 180
170 HOME : GOTO 120
180 PRINT "***** FILTER 1 *****"
190 INPUT "BANDPASS OR LOWPASS?(B OR L):";T$
200 IF T$ = "B" THEN INPUT "CENTER FREQUENCY=";F1: INPUT "Q=";Q1: INPUT
   "GAIN=";H1:T1 = 1: GOTO 230
210 IF T$ = "L" THEN INPUT "CORNER FREQUENCY=";F1: INPUT "ALPHA=";A1: INPUT
   "GAIN=";H1:T1 = 2: GOTO 230
220 HOME : GOTO 180
230 IF FS = 1 THEN GOTO 410
240 PRINT : PRINT "***** FILTER 2 *****"
250 INPUT "BANDPASS OR LOWPASS?(B OR L):";T$
260 IF T$ = "B" THEN INPUT "CENTER FREQUENCY=";F2: INPUT "Q=";Q2: INPUT
   "GAIN=";H2:T2 = 1: GOTO 290
270 IF T$ = "L" THEN INPUT "CORNER FREQUENCY=";F2: INPUT "ALPHA=";A2: INPUT
   "GAIN=";H2:T2 = 2: GOTO 290
280 GOTO 240
290 IF FS = 2 THEN GOTO 410
300 PRINT : PRINT "***** FILTER 3 *****"
310 INPUT "BANDPASS OR LOWPASS?(B OR L):";T$
320 IF T$ = "B" THEN INPUT "CENTER FREQUENCY=";F3: INPUT "Q=";Q3: INPUT
   "GAIN=";H3:T3 = 1: GOTO 350
330 IF T$ = "L" THEN INPUT "CORNER FREQUENCY=";F3: INPUT "ALPHA=";A3: INPUT
   "GAIN=";H3:T3 = 2: GOTO 350
340 GOTO 300
350 IF FS = 3 THEN GOTO 410
360 PRINT : PRINT "***** FILTER 4 *****"
370 INPUT "BANDPASS OR LOWPASS?(B OR L):";T$
380 IF T$ = "B" THEN INPUT "CENTER FREQUENCY=";F4: INPUT "Q=";Q4: INPUT
   "GAIN=";H4:T4 = 1: GOTO 410
390 IF T$ = "L" THEN INPUT "CORNER FREQUENCY=";F4: INPUT "ALPHA=";A4: INPUT
   "GAIN=";H4:T4 = 2: GOTO 410
400 GOTO 360
410 PRINT : PRINT
420 INPUT "STARTING FREQUENCY=";FB
430 INPUT "ENDING FREQUENCY=";FE
440 ARG = INT (FE - FB) / 10
450 IF ARG < = 0 THEN GOTO 420
460 DIM R(ARG)
470 PRINT : PRINT "CENTER FREQUENCY OF GRAPH"
480 PRINT
490 PRINT "ENTER 'M' FOR MANUAL"
500 PRINT "(ANY OTHER CHARACTER DEFAULTS"
510 PRINT " TO AUTOMATIC.)"
520 GET M$
530 IF M$ = "M" THEN INPUT "CENTER FREQ=";FC
540 REM ***********************************
550 FOR F = FB TO FE STEP 10
560 W = 2 * PI * F
570 Q = Q1:H0 = H1:W0 = F1 * 2 * PI:AL = A1
580 IF T1 = 1 THEN G1 = FN H(W): GOTO 600
590 IF T1 = 2 THEN G1 = FN LP(W): GOTO 600
600 IF T2 = 0 THEN G2 = 1: GOTO 640
610 Q = Q2:H0 = H2:W0 = F2 * 2 * PI:AL = A2
620 IF T2 = 1 THEN G2 = FN H(W): GOTO 640
630 IF T2 = 2 THEN G2 = FN LP(W): GOTO 640
640 IF T3 = 0 THEN G3 = 1: GOTO 680
650 Q = Q3:H0 = H3:W0 = F3 * 2 * PI:AL = A3
660 IF T3 = 1 THEN G3 = FN H(W): GOTO 680
670 IF T3 = 2 THEN G3 = FN LP(W): GOTO 680
680 IF T4 = 0 THEN G4 = 1: GOTO 720
690 Q = Q4:H0 = H4:W0 = F4 * 2 * PI:AL = A4
700 IF T4 = 1 THEN G4 = FN H(W): GOTO 720
710 IF T4 = 2 THEN G4 = FN LP(W)
720 R((F - FB) / 10) = G1 * G2 * G3 * G4
730 PRINT "R(";F;")=";R((F - FB) / 10)
740 NEXT F
750 REM ********************************
760 REM FIND THE LARGEST RESPONSE (LEAST ATTENUATION) IN THE BAND.
770 MAX = R(0)
780 FMAX = FB
790 FOR N = 0 TO ARG - 1
800 X = N + 1
810 IF R(X) > R(N) THEN MAX = R(X):FMAX = X * 10 + FB
820 PRINT N
830 NEXT N
840 REM CONVERT TO DB WITH REFERENCE TO THE LARGEST SIGNAL.
850 FOR N = 0 TO ARG
860 X = R(N) / MAX: REM NORMALIZE
870 R(N) = 20 * FN L(X)
880 PRINT N,R(N)
890 NEXT N
900 REM ****************************
910 REM PLOT AXES
920 HGR : HCOLOR= 3
930 HPLOT 140,0 TO 140,159: REM Y AXIS
940 HPLOT 0,0 TO 0,156: REM LEFT BORDER
950 HPLOT 279,0 TO 279,156: REM RIGHT BORDER
960 HPLOT 0,156 TO 279,156: REM X AXIS
970 HPLOT 0,0 TO 279,0: REM TOP BORDER
980 FOR N = 1 TO 27: REM X AXIS TICS
990 REM SCALE FACTOR IS 2HZ PER PIXEL. THEREFORE IN 140 PIXELS, 280 HZ I
   S DISPLAYED ON EITHER SIDE OF THE CENTER FREQUENCY
1000 REM A TIC EVERY 10 HZ
1010 HPLOT 140 + 5 * N,156 TO 140 + 5 * N,157
1020 HPLOT 140 - 5 * N,156 TO 140 - 5 * N,157
1021 REM : 3DB AND 30DB LINES
1022 HPLOT 140 + 5 * N,12
1023 HPLOT 140 - 5 * N,12
1024 HPLOT 140 + 5 * N,120
1025 HPLOT 140 - 5 * N,120
1030 NEXT N
1040 REM A LARGE TIC EVERY 50 HZ
1050 FOR N = 1 TO 5
1060 HPLOT 140 + 25 * N,0 TO 140 + 25 * N,2
1070 HPLOT 140 - 25 * N,0 TO 140 - 25 * N,2
1080 HPLOT 140 + 25 * N,156 TO 140 + 25 * N,159
1090 HPLOT 140 - 25 * N,156 TO 140 - 25 * N,159
1100 NEXT N
1110 FOR N = 0 TO 152 STEP 4
1120 HPLOT 139,N TO 141,N
1130 HPLOT 0,N TO 1,N
1140 HPLOT 278,N TO 279,N
1150 NEXT N
1160 REM Y AXIS TICS AND LINES
1210 HPLOT 138,40 TO 142,40
1220 HPLOT 0,40 TO 2,40
1230 HPLOT 277,40 TO 279,40
1240 HPLOT 138,80 TO 142,80
1250 HPLOT 0,80 TO 2,80
1260 HPLOT 277,80 TO 279,80
1261 HPLOT 138,120 TO 142,120
1262 HPLOT 0,120 TO 2,120
1263 HPLOT 277,120 TO 279,120
1270 REM X AXIS SCALE FACTOR IS 2HZ/PIXEL
1280 REM Y AXIS SCALE FACTOR IS 10DB/40 PIXELS
1290 REM ******************************
1300 REM PLOT THE RESPONSE
1310 FF = FMAX
1320 IF M$ = "M" THEN FF = FC
1330 FOR N = 0 TO 54
1340 X = 5 * N + 5
1350 F = FF - 270 + 10 * N
1360 IF F > FE THEN 1480
1370 IF F < FB THEN 1480
1380 Y = 4 * ABS (R((F - FB) / 10))
1385 REM FACTOR OF 4 BECAUSE THERE ARE 4 PIXELS PER DB. THIS ESTABLISHE
   S THE SCALE FACTOR ON THE SCREEN.
1390 IF Y > 159 THEN 1480
```

fig. 5. Plotting program listing.

fig. 5. (continued)

```
1400 YL = Y - 2:YU = Y + 2
1410 XL = X - 2:XU = X + 2
1420  IF YL < 0 THEN YL = 0
1430  IF YU > 159 THEN YU = 159
1440  IF XL < 0 THEN XL = 0
1450  IF XU > 279 THEN XU = 279
1460  HPLOT XL,Y TO XU,Y
1470  HPLOT X,YL TO X,YU
1480  NEXT N
1490  PRINT "CENTER FREQ=";FF,"GAIN=";MAX
1500  PRINT "PARAMETER HARDCOPY? (Y OR N)"
1510  GET Y$
1520  IF Y$ = "Y" THEN  GOSUB 1570
1530  IF Y$ = "N" THEN 1550
1540  GOTO 1500
1550  END
1560  REM ***************************
1570  REM  MAKES HARDCOPY OF PARAMETERS.
1580  PR# 1: REM  TURN ON PRINTER
1590  PRINT D$
1600 H0 = H1:Q = Q1:F = F1:AL = A1:T$ = "FILTER1:"
1610  IF T1 = 1 THEN  GOSUB 1810: REM  FOR BPF
1620  IF T1 = 2 THEN  GOSUB 1860: REM  FOR LPF
1630  IF T2 = 0 THEN 1670
1640 H0 = H2:Q = Q2:F = F2:AL = A2:T$ = "FILTER2:"
1650  IF T2 = 1 THEN  GOSUB 1810
1660  IF T2 = 2 THEN  GOSUB 1860
1670  IF T3 = 0 THEN 1710
1680 H0 = H3:Q = Q3:F = F3:AL = A3:T$ = "FILTER3:"
1690  IF T3 = 1 THEN  GOSUB 1810
1700  IF T3 = 2 THEN  GOSUB 1860
1710  IF T4 = 0 THEN 1760
1720 H0 = H4:Q = Q4:F = F4:AL = A4:T$ = "FILTER4:"
1730  IF T4 = 1 THEN  GOSUB 1810
1740  IF T4 = 2 THEN  GOSUB 1860
1750  PRINT
1760  PRINT "CENTER SCALE FREQUENCY=";FF
1770  PRINT "MAXIMUM GAIN=";MAX
1780  PR# 0: REM  PRINTER OFF
1790 X =  FRE (0)
1800  END
1810  REM  **************************
1820  REM  PRINT ROUTINE FOR BPF'S
1830  PRINT
1840  PRINT T$;"  CENTER FREQ=";F;"  Q=";Q;"  GAIN=";H0
1850  RETURN
1860  REM **************************
1870  REM  PRINT ROUTINE FOR LPF'S
1880  PRINT
1890  PRINT T$;"  CORNER FREQ=";F;"  ALPHA=";AL;"  GAIN=";H0
1900  RETURN
1910  REM **************************
```

I have used this audio filter on the air with my FT101ZD, which has very good selectivity by itself. Yet the audio filter provides a very substantial improvement in reading the CW signals through QRM or QRN. It is important to have a means of switching the filter in and out during a normal QSO. Even a small amount of drift of either station will throw the signal out of the passband. It is then necessary to revert to wideband operation (that is, filter off) to find the other station again! This is accomplished with the on/off switch shown in the schematic. The signal is directly routed to the headphones in the "off" position

```
10  TEXT : HOME
20 X =  FRE (0)
30  PRINT : PRINT
40 PI = 3.1415926
50  PRINT "SELECT THE DESIRED FUNCTION BY NUMBER
60  PRINT
70  PRINT "1) DESIGN BANDPASS"
80  PRINT
90  PRINT "2) ANALYZE BANDPASS"
100  PRINT
110  PRINT "3) DESIGN LOWPASS"
120  PRINT
130  PRINT "4) ANALYZE LOWPASS"
140  PRINT
150  PRINT "5) EXIT"
160  GET S
170  ON S GOTO 210,400,620,930,610
180  GOTO 10
190  REM ******************************
200  REM  BPF DESIGN
210  HOME
220  INPUT "GAIN=";H0
230  INPUT "Q=";Q
240  INPUT "CENTER FREQUENCY (HZ)=";F0
250 W0 = 2 * PI * F0
260  INPUT "SELECT C(UF)=";C
270 C = C * 10 ^  - 6
280 R1 = Q / (H0 * W0 * C)
290 R2 = Q / ((2 * Q ^ 2 - H0) * W0 * C)
300 R5 = 2 * Q / (W0 * C)
310  PRINT "R1=";R1
320  PRINT "R2=";R2
330  PRINT "R5=";R5
340  PRINT "ANOTHER DESIGN? (Y OR N)"
350  GET Y$
360  IF Y$ = "Y" THEN  GOTO 210
370  IF Y$ = "N" THEN  GOTO 10
380  GOTO 340
390  REM  ***************************
400  REM  BPF ANALYSIS
410  HOME
420  INPUT "R1(KOHM)=";R1
430 R1 = R1 * 10 ^ 3
440  INPUT "R2(KOHM)=";R2
450 R2 = R2 * 10 ^ 3
460  INPUT "R5(KOHM)=";R5
470 R5 = R5 * 10 ^ 3
480  INPUT "C(UF)=";C:C = C * 10 ^  - 6
490 H0 = 1 / (2 * (R1 / R5))
500 W0 =  SQR ((1 / (C * C * R5)) * ((1 / R1) + (1 / R2)))
510 A = 1 /  SQR ((1 / R1 + 1 / R2) * R5)
520 Q = 1 / (2 * A)
530  PRINT "GAIN=";H0
540  PRINT "Q=";Q
550  PRINT "F0=";W0 / (2 * PI)
560  PRINT "ANOTHER EVALUATION (Y OR N)?"
570  GET Y$
580  IF Y$ = "Y" THEN  PRINT : GOTO 420
590  IF Y$ = "N" THEN 10
600  GOTO 560
610  END
620  REM *************************
630  REM   LPF DESIGN
640  INPUT "LOW FREQ GAIN (H0)=";H0
650  INPUT "ALPHA (<2)=";AL
660  INPUT "BREAKPOINT FREQ=";F
670 W0 = 2 * PI * F
680  INPUT "C2 (UF)=";C
690 K = (AL ^ 2) / (4 * (H0 + 1))
700  PRINT "CHOOSE C5 <=";K * C;" (UF)"
710  INPUT "C5 (UF)=";C5
```

fig. 6. Design/analysis listing **(continued on page 22).**

FALCON COMMUNICATIONS

THE ONE NAME YOU NEED TO KNOW IN SOLID STATE POWER AMPLIFIERS

All Mode Bipolar Mobile Amplifiers

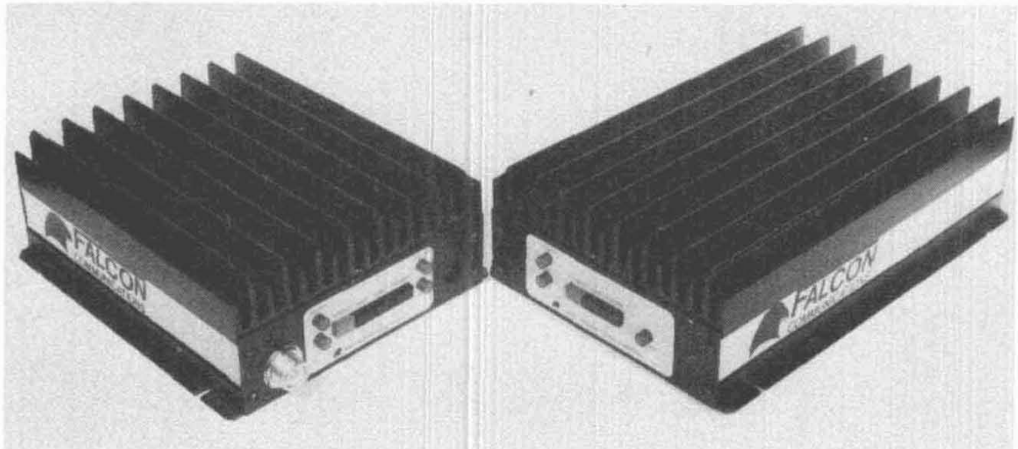
5123 *150 Watt 2 Meter Amplifier. 25 Watts in = 150 +* out; 10 in = 90 out. Optional Rx Preamp. **List $235**

5124 120 Watt 1¼ Meter Amplifier. 30 Watts in = 120 out. 10 in = 80 out. Optional Rx Preamp. **List $240**

5125 100 Watt 70 Cm Amplifier. 30 Watts in = 100 out; 10 in = 40 out. **List $305**

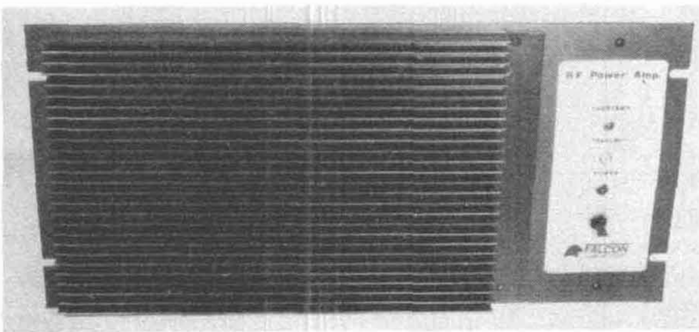
5121 150 Watt 2 Meter HT Amplifier. 2 Watts in = 150 + out; 1 in = 90 out. Optional Rx Preamp. **List $285**

5122 150 Watt 2 Meter Multi Purpose Amplifier. *10 Watts in = 150 + out; 10 in = 50 out.* Optional Rx Preamp. **List $275**



MOSFET Base/Repeater Amplifiers

These all mode amplifiers, with the low noise advantages of MOSFETs, require a 13.6 Vdc power source (except as noted). Mounted on an 8¾" rack panel with a large heat sink, they are designed for continuous duty at full power output when cooled with a small, customer supplied, fan. Mounting provisions and control thermostat are supplied.



4111 100 Watt 2 Meter Amplifier. 20 Watts in = 100 out; 10 in = 90 out; 2 in = 30 out. **List $335**

4112 100 Watt 1¼ Meter Amplifier. 25 Watts *in = 100* out; 10 in = 70 out; 2 in = 25 out. **List $335**

5113 50 Watt 2 Meter Amplifier. 6 Watts in = 50 out; 2 in = 25 out. No fan needed. **NEW** **List $275**

4114 *100 Watt 2 Meter Amplifier.* 2 Watts in = 100 out; 1 in = 80 out. **List $395**

5142 100 Watt 70 Cm Amplifier. 30 Watts in = 100 out; 10 in = 40 out. Bipolar, not MOSFET. **NEW** **List $415**

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PO Box 8979
Newport Beach, CA 92658
(714) 760-3622

```
720 IF C5 > K * C THEN  PRINT "TRY AGAIN..": GOTO 700
730 K = C5 / C
740 C = C * 1E - 6
750 D =  SQR (1 - 4 * K * (H0 + 1) / AL ^ 2)
760 R4 = (AL / (2 * K * W0 * C)) * (1 + D)
770 S4 = (AL / (2 * K * W0 * C)) * (1 - D)
780 R3 = 1 / ((W0 ^ 2) * K * (C ^ 2) * R4)
790 S3 = 1 / ((W0 ^ 2) * K * (C ^ 2) * S4)
800 R1 = R4 / H0
810 S1 = S4 / H0
820  PRINT "R1=";( INT (1000 * R1)) / 1E6;" KOMS"
830  PRINT "R3=";( INT (1000 * R3)) / 1E6;" KOHMS"
840  PRINT "R4=";( INT (1000 * R4)) / 1E6;" KOHMS"
850  PRINT "******** OR ********"
860  PRINT "R1'=";( INT (1000 * S1)) / 1E6;" KOHMS"
870  PRINT "R3'=";( INT (1000 * S3)) / 1E6;" KOHMS"
880  PRINT "R4'=";( INT (1000 * S4)) / 1E6;" KOHMS"
890  PRINT "ANOTHER DESIGN? (Y OR N)"
900  GET Y$
910  IF Y$ = "Y" THEN 620
920  GOTO 10
930  REM  ****************************
940  REM  LPF ANALYSIS
950  INPUT "R1 (KOHMS)=";R1
960  INPUT "R3 (KOHMS)=";R3
970  INPUT "R4 (KOHMS)=";R4
980  INPUT "C2 (UF)=";C2
990  INPUT "C5 (UF)=";C5
1000 R1 = R1 * 1E3:R3 = R3 * 1E3:R4 = R4 * 1E3
1010 C2 = C2 * 1E - 6:C5 = C5 * 1E - 6
1020 H0 = R4 / R1
1030 W0 =  SQR (1 / (R3 * R4 * C2 * C5))
1040 AL = ( SQR (C5 / C2)) * ( SQR (R3 / R4) +  SQR (R4 / R3) + (1 / R1) *
      SQR (R3 * R4))
1050  PRINT "GAIN=";H0
1060  PRINT "CORNER FREQ=";W0 / (2 * PI)
1070  PRINT "ALPHA=";AL
1080  PRINT "ANOTHER ANALYSIS? (Y OR N)"
1090  GET Y$
1100  IF Y$ = "Y" THEN 930
1110  GOTO 10
```

fig. 6. (continued).

the plotting program

The program proceeds in the following sequence:

- Information is requested by the program, and *Q*, gain, and center frequency are entered for up to four filter sections. The desired frequency range and placement of the "y" axis are also entered.
- The response is calculated over the frequency range in 10-Hz increments and stored in an array.
- The largest response is determined.
- Each element of the array is normalized and converted to dB with respect to the largest array element.
- The results are plotted on the high-resolution graphics screen. The "y" axis is marked in 1 dB steps, and 1 pixel is 1/4 dB. Therefore, the resolution is 1/4 dB. The "x" axis is marked in 10 Hz steps. Each pixel represents 2 Hz; hence the resolution is 2 Hz per pixel.
- The "y" axis is always in the middle of the screen, and there is always a span of 280 Hz on either side of the "y" axis. The program prints out the frequency corresponding to the "y" axis, which calibrates the graph.
- In the automatic mode, the graph is plotted so that the maximum response is always on the top of the "y" axis. This ensures that the most significant points will appear. In the manual mode, the "y" axis frequency is specified by the user. This allows examination of points outside the 560 Hz span, or placement of the "y" axis at the center of the response curve, even if it's not the peak.

A listing of the plotting program is provided in **fig. 5**, and the design/analysis program is listed in **fig. 6**. An Apple II+ disc (5-1/4 inch, DOS 3.3) with the program and design notes may be ordered from Electronics Unlimited, 42A Sandy Hollow Road, Port Washington, New York 11050. The price is $25 (postpaid).

reference

1. J.G. Graeme, G.E. Tobey, and L.P. Huelsman, PhD., *Operational Amplifiers — Design and Application*, McGraw Hill, 1971.

ham radio

✓ 112

✓ 113

the fox box
a direction-finding tool

Add this compact unit to your 2-meter rig and catch that fox — quickly

This is a circuit intended for 2-meter fox hunting. This inexpensive and easy-to-build device, nicknamed the "Fox Box," is a remote signal-strength meter and wide-range variable front-end attenuator that, when needed, quickly attaches to your 2-meter FM transceiver. Because this article is written for beginners as well as experienced hunters, I've also included a photo and construction details for a simple, low-cost, two-element 2-meter quad. I claim no originality for these circuits, except perhaps for some refinements that I have made after doing numerous modifications to friends' radios. Similar schemes have been circulatng among fox hunting groups for some time.

Let's consider the two basic parameters a fox hunter works with: directivity and signal strength. Directivity is provided by either a manually-orientated antenna array, or via the use of an automatic doppler-shift system.[1,2] In either case the radio's internal S-meter is used to indicate signal strength. Unfortunately the limited dynamic range, and compressed nonlinearity on strong signals, of most FM radio metering circuits requires the use of an external attenuator to limit the signal levels reaching the receiver. The Fox Box allows precise control of the receiver gain to assist with the antenna orientation.

After using the Fox Box for a short time the fox hunter develops a feel for distance based on experience with the meter readings and the amount of attenuation required. Fox hunts are won or lost in the last mile; hunters without good attenuators are often misled into looking for the fox far from the actual hiding place. They're still half a mile out and have full-scale readings regardless of where they point their antennas.

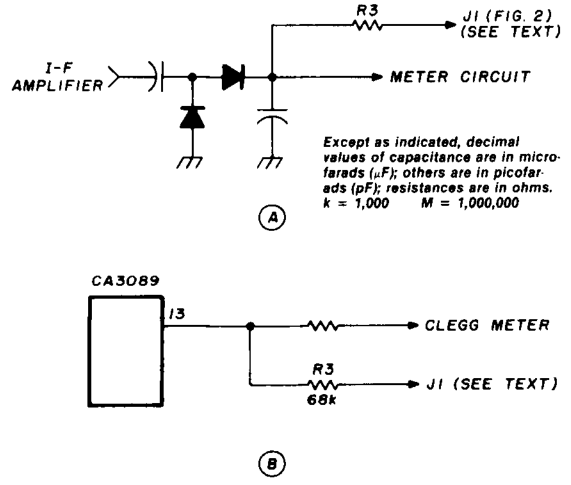

fig. 1. Representative 2 meter FM transceiver (meter) detector circuits: (*A*) commonly used by ICOM, Kenwood, Yaesu, KDK, and Azden. R3 is determined empirically; refer to *table 1* and text. (*B*) Clegg FM-DX uses the CA3089 FM system IC. 68 kilohms is about optimum for the Radio Shack 50 μA meter.

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a better way

Many hunters rely on external attenuators using resistive elements to reduce strong signals. But most external attenuators are at best cumbersome, and the minuscule S-meters adorning FM transceiver front panels are at best useless. LED bargraph displays fare no better, their resolution is coarse, and often the display will not show signals that are plainly audible. External attenuators suffer from other problems. Stray RF pickup (through the power leads and through leaks in the radio enclosure) limit the amount of external attenuation that may be used. Hunters, in the heat of competition, have forgotten about their inline attenuators and attempted transmissions, only to be rewarded with a wisp of smoke and charred resistors. The Fox Box eliminates these problems.

will it work on my radio?

The external metering and attenuator control box built for a Clegg FM-DX transceiver is shown in **photo 1**. I've also provided details for several popular transceivers (see **fig. 1, table 1**). This selection is not arbitrary — these radios best exemplify all of the variations encountered while modifying several other different transceivers.

table 1. Resistors (as specified in owner's manuals or in service manual schematic diagrams) that must be rerouted for the external attenuator modification.

transceiver	resistors
Azden PCS2000	R4, R5, R10
Clegg FM-DX	RX-8 feed
Clegg FM-28	RX-8 feed
ICOM IC-22S	R7, R13
KDK FM2025	R4, R13, R17*
Kenwood TR7950	R7, R15, R21
Kenwood TR7850	R5, R13
Kenwood TR7600/25	R41, R34, R35

*Denotes resistors involved in third stage.

The Fox Box will work on any 2-meter transceiver using MOSFET devices in the front-end circuits. It should work as well on JFET circuits, too, although this has not been tried. Some transceivers made in the 1960s and early 1970s used bipolar technology in the first RF stages; a different approach will have to be used in these vintage radios. Several likely methods of controlling bipolar front-end stages are noted in this section.

the internal attenuator

The internal attenuator circuit is a very useful modification. The Fox Box provides only a DC control level for setting the attenuation, and all RF remains contained within the radio (see **figs. 2, 3, 4**). Most FM transceivers use two dual-gate MOSFET devices in the front end — the first as the RF amplifier and followed by another in the first-mixer stage. Some radios have a third MOSFET, employed as a post-mixer amplifier, after the first crystal filter. When present, this stage may also be placed under attenuator control (more on these radios later). **Figure 3** is a generic receiver front-end circuit, representative of the almost universal approach followed by VHF FM transceiver manufacturers.

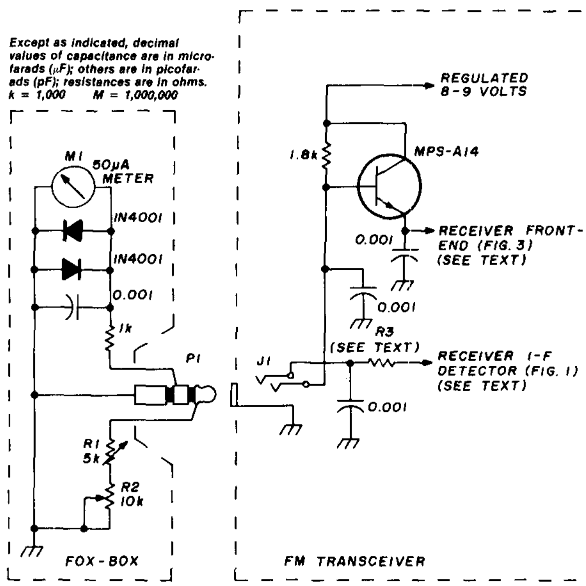
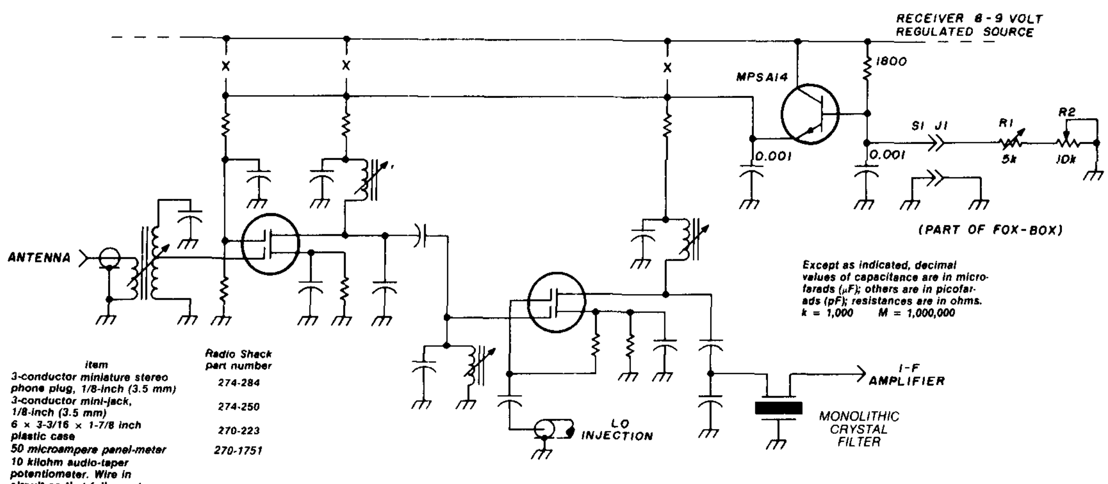


fig. 2. Fox-Box circuit includes remote box with auxiliary meter and attenuator (see *photo 1*) and FM transceiver interface. Diodes and a 1000-ohm current limiting resistor protect the meter from accidental damage. Trimpot R1 (5 kilohms) is optional, (see text). In the modified radio, resistor R3 sets the full-scale reading for meter M1. The active circuit components for the attenuator are mounted in the radio.

A regulated voltage source, normally between 8 and 9 volts, powers these stages. By changing this voltage the receiver's gain is controllable over a very wide range. While this is a brute-force approach, it is also very effective. The attenuator modification consists of installing a MPS-A14 Darlington transistor in series with the supply voltage to these stages. Forward bias, supplied through a base-to-collector fixed resistor, keeps the transistor in full-conduction, thus permitting normal receiver operation with the Fox Box disconnected. When the Fox Box is in use its internal potentiometer, in conjunction with the fixed-value resistor, forms a variable voltage divider, the MOSFET's supply voltage can then be set from about 7 volts down to zero volts for full attenuation (**fig. 2**).



Item	Radio Shack part number
3-conductor miniature stereo phone plug, 1/8-inch (3.5 mm)	274-284
3-conductor mini-jack, 1/8-inch (3.5 mm)	274-250
6 × 3-3/16 × 1-7/8 inch plastic case	270-223
50 microampere panel-meter	270-1751
10 kilohm audio-taper potentiometer. Wire in circuit so that full counter-clockwise (CCW) rotation is equal to minimum resistance: full attenuation	271-1721
5-kilohm trimpot (see text)	271-217

fig. 3. Typical 2-meter receiver front end includes internal attenuator installation details.

A few comments on attenuation systems for bipolar stages: one possibility involves shunting the base-bias resistors. The RF amplifier will probably be biased for class A operation, and the bias will most likely be developed across a resistive voltage divider. An external potentiometer may then be used to lower the forward bias, thus reducing the stage gain dramatically. A good rule of thumb is to use a resistance three to four times the value of the base-to-ground resistor. For example, if a 5.6 kilohm resistor is used, a 20 kilohm potentiometer will work well for the attenuator control. Normally the base-biasing resistors will be cold — that is, no RF will be on them. If they're in the RF path, suitable RF decoupling chokes and bypass capacitors will be needed. **Figure 4** shows suggested attenuator installations for bipolar RF stages.

the remote signal-strength meter

The Fox Box also contains the external S-meter (**photo 1**), an inexpensive, 2-1/2 inch (6.33 cm) movement, large enough so that small signal-strength variations are readily observed. With a sufficiently long cable attached, the Fox Box attenuator and meter permit quick antenna orientation while away from the mobile-radio installation. (My relative signal-strength metering circuit is shown in **fig. 2**.) Most FM transceiver signal-strength display circuits use two diodes in a voltage-doubler configuration to sample the RF levels at the IF stage output (**fig. 1A**). The Clegg FM-DX transceiver is an exception: it uses an RCA CA3089 chip for the IF amplifier, FM detector, and meter driver. Pin 13 of the CA3089 produces an increasing voltage proportional to the input signal. The Radio Shack meter is a 50-μA movement — a series current-limiting resistor (R3) is used between the meter and IF detector. About 68 kilohm is needed for the FM-DX (**figs. 1B**, and **2**). In all cases the resistor is fine tuned to produce a full-scale reading with a full saturation input signal. Sometimes the no-signal meter reading will idle above the zero mark; this is normal for some radios and results from detected noise produced by some high gain IF systems. Full-scale external meter deflection can be best set via the initial use of a 200-kilohm trimpot for R3 in transceivers that use a diode detector. Once the correct resistance value is determined, a fixed-value resistor may be substituted for the potentiometer. When the Fox Box is used the rig's internal signal strength readings may be lower than normal due to the loading effect of the external meter.

installing the Fox Box

Modifying radios for the internal attenuator requires some dexterity. The Clegg FM-DX is the easiest because its RF amplifier and mixer are on one circuit board; one lead (the one with blue insulation) brings the power into these circuits. Since the forward-bias for gate 2 of the MOSFETs must be controlled as well as the drain voltage, it's important to be sure that all of the resistors carrying power to these stages are lifted from the V_{CC} runs and rerouted to the MPS-A14 emitter. Only the resistor lead connected to the V_{CC} supply run is lifted. With the resistor standing vertically, a length of hookup wire is tack-soldered to the free lead. A length of heatshrink tubing over the resistor and hookup wire junction keeps things neat. The MPS-A14 can be mounted on a three-terminal solder-lug phenolic strip — install the strip where space permits.

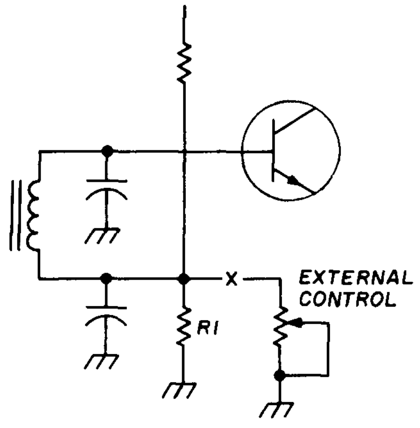


fig. 4. RF gain control scheme for tranceivers using bipolar transistor front ends. Unlike the MOSFET attenuator, no supply voltage variation is used; instead the base biasing voltage is shunted through an external potentiometer. The value for the potentiometer is typically four to five times higher than the base-to-ground biasing resistor (R1).

Sometimes only one resistor per stage need be rerouted — look for a single low-value resistor that provides voltage to a stage, such as in the KDK FM-2025, where resistor R4 (47 ohms) supplies power to RF amplifier Q1. Again, in the FM-2025, for mixer-stage Q2 only resistor R13 (220 ohms) is rerouted. Gate 2 bias is developed from a voltage divider (comprised of R4 and R15) located on the FET's source side of R13. **Table 1** references owner-manual schematics supplied with the Azden PCS-2000, Kenwood 7950, 7850, and 7625, KDK FM-2025, and Clegg FM-DX and lists the resistors required for each of these models. (If your radio is not one of those listed, studying **fig. 3** will help in determining the resistors involved in your transceiver. If you send me (at my home address) a good copy of your schematic, I'll circle the appropriate resistors — an SASE *must* accompany your request.)

inside the fox box: variations and adjustments

The schematic for the internal attenuator is shown in **fig. 2.** Part of the circuit involves two resistors: R2, the Fox-Box front panel control used for setting the desired attenuation level, and trimpot R1, which is used only in radios with three stages under attenuation control. The maximum attenuation will be more than required, R1 sets the maximum attenuation level. When operating three stages near maximum attenuation, the squelch may open. For some radios this is normal, because these stages may contribute a large portion of the total receiver gain and reducing their gain will affect noise operated squelches. There was one minor shortcoming with this attenuator. When approaching maximum attenuation, some users mentioned that the control became very nonlinear and touchy to adjust. In retrospect, I had been using linear potentiometers and found that audio-taper potentiometers proved the better choice. The potentiometers must be wired so that maximum attenuation occurs at the CCW position.

interconnecting the transceiver and the Fox Box

The Fox Box is connected to the radio via a three-conductor cable using a miniature 1/8-inch (3.5 mm) three-conductor "stereo" plug. One lead is the common-ground return for the attenuator and meter, and the remaining leads carry the meter and attenuator signals. Use enough cable to allow you to leave the car, Fox Box in hand, so you can move about while orienting the directional antenna. This is the real beauty of this device — it allows you to do some DFing *outside* the car. With the Fox Box disconnected, the radio reverts to normal premodification operation. Never connect or disconnect the adapter while the radio is on.

Some hams may have reservations about drilling the mounting hole for the 1/8-inch stereo jack. If the external speaker jack isn't used, and no future use is contemplated, the jack may be removed, or taped and left in the radio. Some radios, such as the Clegg FM-DX, have 9-pin accessory jacks, and spare pins are often available. Some deterioration of receiver dynamic-range may occur when using the attenuator. This has not been observed in actual use — but with the reduced mixer-stage voltage levels it is a possibility.

All necessary components can be obtained at electronic supply stores for under $20. Installation typically takes only three or four hours.*

using the Fox Box

The internal attenuator, at full attenuation, will give about a half-scale reading from a 25-watt mobile 10 feet (3.04 meters) away. In many hunts the fox has been hidden in a high-reflection area, effectively eliminating the doppler and Yagi competition. When this has happened I've been able to get in using just the attenuator and S-meter provided in the Fox Box — as the fox is talking, the meter indicates whether you're within a few thousand feet of its location, and whether approaching or leaving its location.

*If you're interested in this adapter, but feel ill-at-ease about tearing into your radio, I'm willing to do the work in my service shop at the going rate. Write, enclosing an SASE, and we'll work out the details.

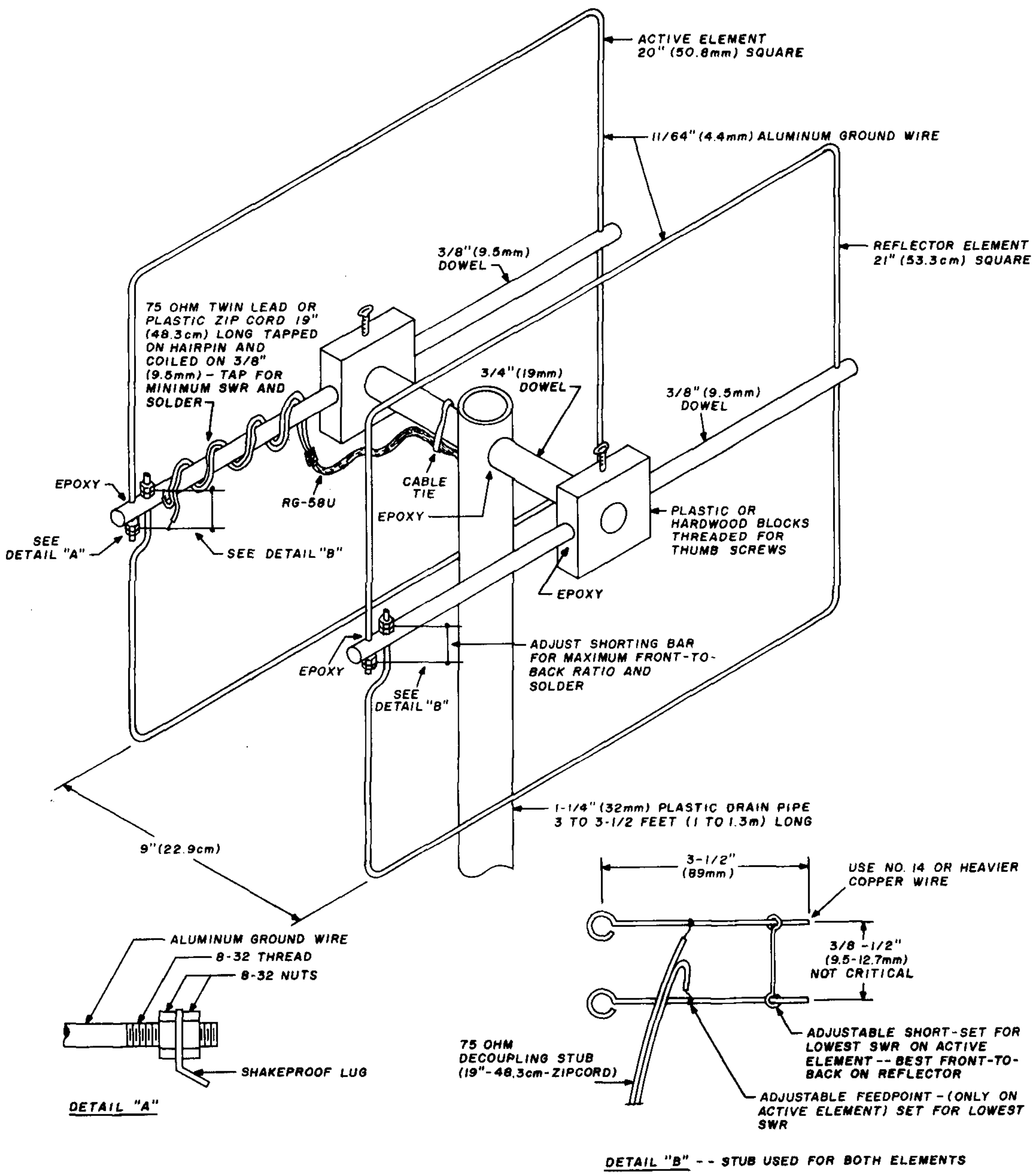


fig. 5. Light and durable quad for hidden transmitter hunting. A variety of materials may be used for the boom and masting — wooden doweling or PVC pipe are a few good choices. The elements are made from either aluminum ground or copper wire. Note the 75-ohm decoupling section wrapped on the driver boom. (Figure courtesy WA3TNO.)

K3TS two-element 2-meter quad antenna

As promised, here are the details for a simple DFing antenna. This design is the work of Tom Stewart, K3TS. A detailed mechanical drawing of the antenna is shown in **fig. 5**. Tom reported that the antenna did quite well while hilltopping and in mobile operation. Tom also designed the mobile antenna mount pictured in **fig. 6**. This mount allows the driver to steer the antenna while the car is moving. The lower (bottom) mount is inserted between the window glass and rubber sealer, while the upper mount is screwed (*using short screws!*) or otherwise affixed to the window frame. For installation in frameless windows, or "no-holes" mounting, the upper bracket is fastened to the end of a single rooftop carrier positioned directly above the door-mounted unit.

Portable antennas can take a beating during fox hunts. K3TS uses aluminum wire for his quad elements. This allows the antenna to "give," without damage, so that when a low branch or other obstruction bends the elements they may be easily reshaped. (Softdrawn copper antenna wire might prove better — it can be soldered, thereby avoiding the problems of making good electrical connections to aluminum wire.) The closed loop design results in little antenna interaction from the presence of the car's body. Using K3TS's design, one need only loosen the thumbscrews and rotate the antenna elements 90 degrees for horizontal polarization (feedpoint top or bottom).

Do not omit the all important 75-ohm decoupling section. This decoupler was first suggested by E.M. Brown, in *CQ* back in 1952. The front-to-back ratio will suffer if not used. Plastic insulated zipcord or speakerwire can be used in lieu of the 75-ohm twinlead. The 75-ohm twinlead is tightly wound, without overlaps, along the length of the element support dowel. The coax-to-twinlead junction is as close to the boom-to-element T-block as possible.

tuning the antenna

Begin the alignment by removing the reflector assembly from the boom. Tune the quad by adjusting the balun position on the feedpoint hairpin, while alternately adjusting the hairpin shorting-stub, for minimum SWR. (Don't expect a "perfect match" with this antenna; an SWR of 1.5:1 is acceptable.) The initial settings given in **fig. 5** are a good starting point. (Use miniature fleaclips on the balun and shorting-bar to aid in the initial positioning.) When the driven element is properly adjusted, the reflector is installed. The shorting stub on the reflector hairpin is then set for the best front-to-back ratio (or null). The antenna produces 6 dB forward gain with upwards of 25 dB of front-to-back ratio.

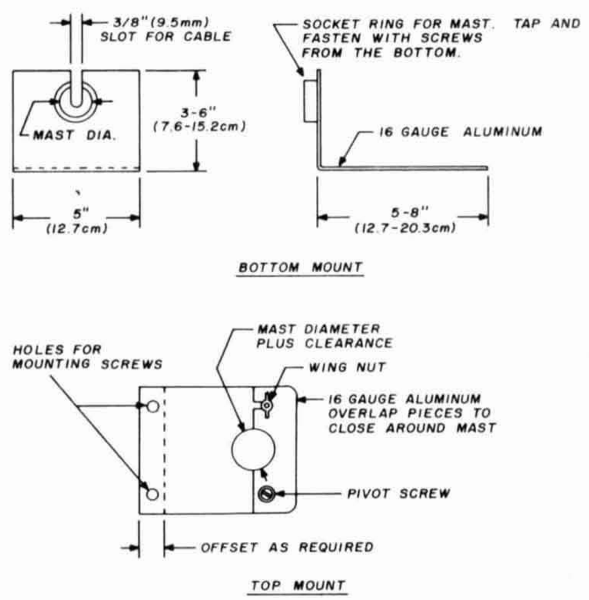


fig. 6. Simple mounting brackets, made from 16-gauge aluminum, permit operation of the quad while vehicle is in motion. (Figure courtesy WA3TNO.)

performance

The Fox Box is shown in **photo 1**. The antenna was built by Bob, KA1IQD — a closeup of it is shown in **photo 2**.

Photo 1. The K1ZJH Fox Box external metering and attenuator control box.

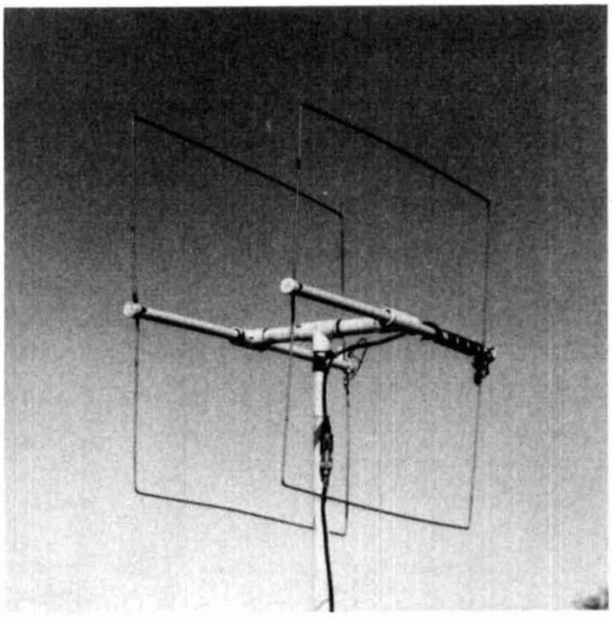


Photo 2. Closeup view of the K3TS quad as built by Bob, KA1IQD. Bob used PVC tubing and stainless steel wire for constructing his quad. Numerous copies of the original design have been successfully completed by area hams using various materials and construction techniques.

Although this is a good beginner's antenna, many experienced hunters swear by it. Don't be misled by its small size and simplicity. (Bob, KA1IQD, and I recently used his Fox Box and quad to locate a spurious signal jamming a local repeater input frequency on 147.600 MHz. The source of the signal turned out to be a mast-mounted TV antenna booster located several miles from the repeater site.) I was very impressed with the antenna and found it easy to use.

getting started

A few tips for the prospective fox hunters reading this: first, as with anything new, a little hands-on experience will help you to become a proficient DF'er. Make several practice runs using the attenuator before going on a hunt — this will give you a "feel" for its operation. To start, have a friend hide nearby while you and a partner use your DF'ing gear to locate him. Because the driver's only concern must be the safe, legal, and proper operation of the motor vehicle, a team of two people works out best; let your partner read the maps and interpret headings while underway.

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1. Terrance Rogers, WA4BVY, "A DoppleScant," *QST*, May, 1978, page 24.
2. David Cunningham, W7BEP, "DF Breakthrough!" *73*, June, 1981, page 32.

ham radio

building and using phone patches

From simple to elegant, patches help make the connection

In telephone company parlance, a patch is any connection between a phone line and another communications device, whether it be a radio, a tape recorder, a data device (such as a modem), or even another phone line.

Radio Amateurs, on the other hand, tend to limit the meaning of "patch" to the connection of transmitters or receivers to the phone line for phone conversations. But there's more to it — Amateurs can and do use phone patches for purposes other than telephone conversations. One particularly effective application is for checking TVI and RFI complaints; simply set the transmitter on VOX, go to the site of the interference complaint, and then key your transmitter via the phone line. Doing this will indicate whether your transmitter is or is not the source of the problem. If it is, you can use this method to test the measures you've taken to correct the problem.

A phone line is, simply speaking, a 600-ohm balanced feed device — which also happens to be how professional audio can be described. Most modern Amateur transmitters have 600-ohm unbalanced inputs; most cassette recorders have a 600-ohm unbalanced input; the "tape" outputs on home stereos are also 600-ohm unbalanced. All this makes patching relatively simple. While there are various degrees of sophistication and complexity in patching, in an emergency, patches can be easily put together using readily available components. Before starting to build a patch, however, it might be helpful to read last month's article on understanding phone lines.[1]

the simple patch

The simplest way to patch a phone line to another piece of equipment is to use a couple of capacitors to block the phone line DC. While this simple approach will work in a pinch, it will tend to introduce hum to the line because of the unbalance introduced. The capacitors used should be nonpolar, at least 2μF, and rated at 250 volts or better (see **fig. 1**).

To hold the line, the patch should provide a DC load by means of a resistor (R6) or by simply leaving a phone off the hook. The receiver output may need a DC load (R7) to prevent the output stage from "motorboating." Use two capacitors to maintain the balance.

With all patches hum can be lessened by reversing the phone wires. A well-made patch will have no discernible hum.

the basic phone patch

Because a phone line is balanced and carries DC as well as an AC signal, a patch should include a DC block, a balun, and a DC load to hold the line. The best component for doing this is a 600-ohm 1:1 transformer such as those used in professional audio and for coupling modem signals to the phone line, available from most electronics supply houses. Old telephone answering machines are also a good source of 600-ohm transformers. Some transformers are rated at 600:900 ohms or 900:900 ohms; these are also acceptable. Make sure that the transformer has a large enough core, because DC current will be flowing through it. (Some small-core transformers become saturated and distort the signal.)

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In section 68.304 of the FCC Part 68 regulations, it states that a coupling transformer should withstand a 60 Hz 1kV signal for one minute with less than 10 mA leakage. For casual use this may seem unimportant, but it provides good protection against any destructive high voltage that may come down the phone line, and into the Amateur's equipment. A 130 to 250 volt Metal Oxide Varistor (MOV) across the phone line will provide further protection if needed.

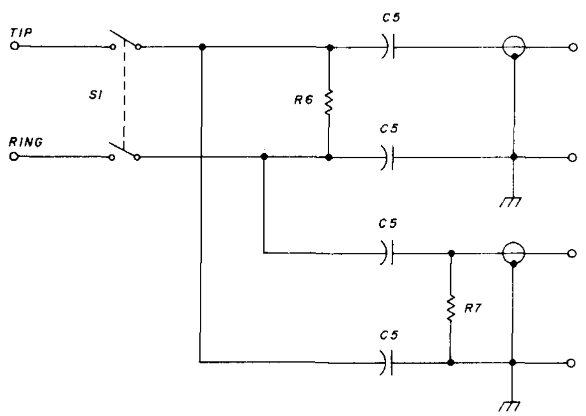

fig. 1. Simple phone patch.

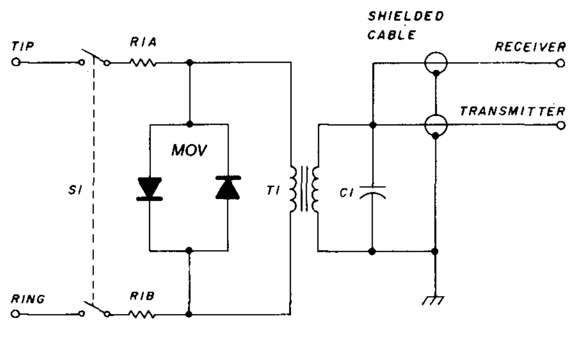

fig. 2. Basic phone patch.

The DC resistance of the transformer winding may be so low that it hogs most of the phone line current. Therefore, while using a phone in parallel for monitoring and dialing — which is recommended — the audio level on the incoming line may be too low. Resistors R1A and R1B (see **fig. 2**) will act as current limiters and allow the DC to flow through the phone where it's needed. If possible, these resistors should be carbon composition types.

To keep the line balanced, use two resistors of the same value and adjust the values by listening to the dial tone on a telephone handset. There should be little or no drop in volume when the patch transformer is switched across the phone line.

One of these transformers, or even two capacitors, can be used to patch two phone lines together, should there be a need to allow two distant parties to converse. There will be losses through the transformer so the audio level will degrade, but with two good connections this will not be a problem.

On the other side of the transformer — which could be called the secondary winding — choose one pin as the ground and attach the shields of the microphone and headphone cables to it. Attach the inner conductors to the other pin. The receiver output will work well into the 600-ohm winding, and if transmitting simplex or just putting receiver audio on the line there will be no crosstalk or feedback problems. In some cases, the audio amplifier in a receiver does not have enough output to feed the phone line at an adequate level; this can be handled by using the transformer with two secondaries (see the "improved" patch below) or by coupling a 8:1-kilohm transformer between the audio output and 600-ohm transformer. If RF is getting into the transmitter input, a capacitor (C1) across the secondary should help. A good value for the lower bands and AM broadcast interference is 0.1 μF. For higher frequencies, 0.01 μF usually gets rid of the problem. Unshielded transformers are sensitive to hum fields and building any patch into a steel box will help alleviate hum as well as RFI.

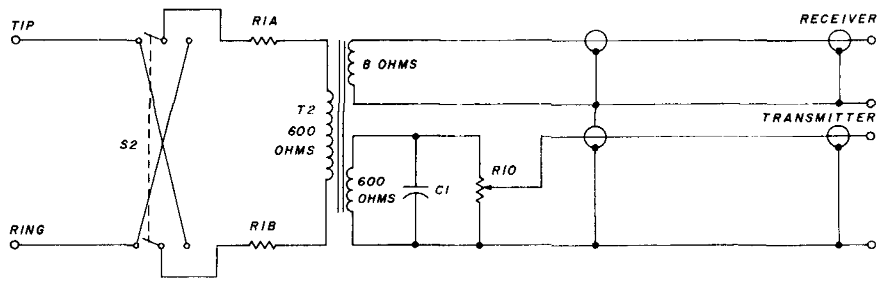

fig. 3. Improved phone patch.

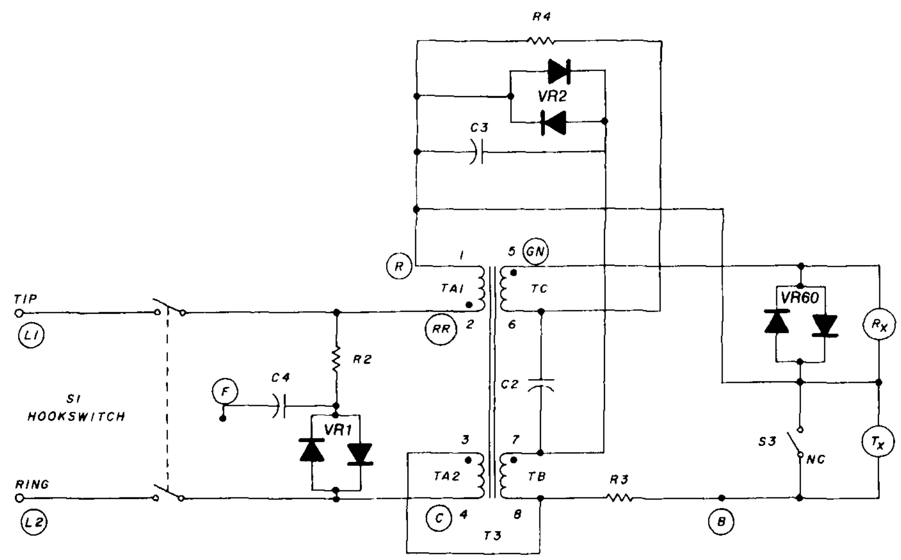

fig. 4. Typical network (United States). Note: circled letters are marked on network interconnection block terminals.

the improved phone patch

Several enhancements can be made to the basic phone patch to improve operation. The first is the addition of a double-pole double-throw switch to reverse the polarity of the phone line to reduce hum. This may not be necessary with a patch at the same location with the same equipment, but if it is, experiment with the polarity of the transformer connections and adjust for the least hum. Most of the time the balance will be so good that switching line polarity makes no difference. The switch should have a center "off" position or use a separate double-pole single-throw switch to disconnect from the line. The two secondaries on the "improved" patch (**fig. 3**) should be checked for balance by connecting the receiver and transmitter and checking for hum while transmitting and receiving. Switch the shield and inner conductors of the secondaries for minimum hum.

Many transmitters do not offer easy access to the microphone gain control. There may also be too much level from the patch to make adjustment of the transmit level easy. Placing R10 across the transformer allows easy adjustment of the level. It can be set so that when switching from the station microphone to the patch the transmitter microphone gain control does not need to be adjusted. This will also work on the basic 600-ohm 1:1 transformer. Most of the time a 1 kilohm potentiometer — logarithmic if possible — will work well. If not, a linear potentiometer will do. A 2.5-kilohm potentiometer may provide better control.

deluxe operation and VOX

Using VOX with a phone patch may cause a problem with receive audio going down the line and into the transmit input, triggering the VOX. There may not be enough Anti-VOX adjustment to compensate for this. The usual solution for this problem is to use a hybrid transformer, a special telephone transformer with a phasing network to null out the transmit audio and keep it off the receive line. Most telephones employ a similar transformer and circuit so that callers will not deafen themselves with their own voices. These devices are called "networks" (see **figs. 4** and **5**).

A network can be removed from an old phone and modified into a deluxe patch, or the phone can be left intact and connections made to the line and handset cords. The line cord should be coupled to a 600-ohm 1:1 transformer to keep the ground off the line. Note, in the network schematics, that the receiver and transmitter have a common connection; when coupling into radios or other unbalanced devices, make this the ground connection.

There may be confusion about terms used in the network. The telephone receiver is receiving the phone line audio, and the transmitter is transmitting the caller's voice. For phone patch use, a telephone receive line is coupled to the transmitter and the transmit line is coupled to the radio receiver. This is a fast way to put together a phone patch and may be adequate for VOX use.

A better patch can be built by using a network

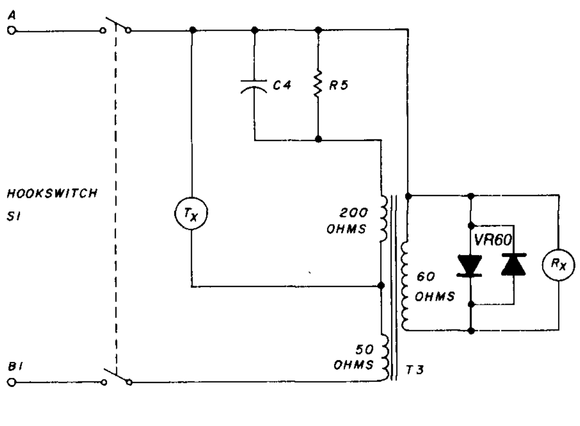

fig. 5. Typical European network.

removed from a phone or purchased from a local telephone supply house. This approach offers the added advantage of being able to adjust or null the sidetone. The circled letters in **figs. 4** and **6** refer to the markings on the network terminal block. These letters are common to all United States networks made by Western Electric (AT&T), ITT, Automatic Electric, Comdial, Stromberg Carlson, and ATC.

To make the sidetone adjustable, remove R4 (R5 in European networks) and replace it with R11 (for European networks use R12). The Western Electric Network comes point-to-point wired and sealed in a can; the other networks are mounted on PCBs. To remove R4 from the Western Electric network, the can has to be opened by bending the holding tabs. Don't be surprised to find that the network has been potted in a very sticky, odious paste that has the texture of hot chewing gum and the odor of unwashed shirts. [This material — alleged to be manufactured according to a secret formula — will not wash off with soap and water. The phone company has a solvent for it, but because one of the secret ingredients is said to be beeswax, ordinary beeswax solvents such as gum turpentine, mineral turpentine (paint thinner or white spirit) and kerosene will work.] To remove the bulk of the potting compound, heat the opened can for 30 minutes in a 300 degree F (148 degree C) oven, or apply heat from a hot hairdryer or heatgun. You can also put the can out in the hot sun under a sheet of glass. Don't use too much heat because the plastic terminal strip may melt. Even with a film of compound remaining on it, the network can be worked on.

using a patch

For efficient use, a patch should have a telephone connected in parallel with it. This enables the operator to dial, answer, and monitor calls to and from the patch, as well as use the handset for joining in conversations or giving IDs.

One useful modification to the control telephone is adding a mute switch to the handset transmitter. This allows monitoring calls without letting room noise intrude on the line. It's also a good modification for high noise environments, where ambient noise enters through the handset transmitter and is heard in the receiver, masking the incoming call. Muting the transmitter makes calls surprisingly easy to hear. The mute switch can be a momentary switch used as a "Push-To-Talk" (PTT) or a Single Pole Single Throw (SPST) mounted on the body of the phone for long-term monitoring. The switch should be wired as Normally Closed, so that the transmitter element is muted by shorting across it (see **fig. 4**). This makes the mute "clickless." If the monitor phone uses an electret or dynamic transmitter it should still be wired as shown in **fig. 4**.

Transmit and receive levels on the phone line are a source of confusion that even telephone companies and regulatory agencies tend to be vague about. The levels, which can be measured in various ways, vary. But all phone companies and regulatory agencies aim for the same goals: enough level for intelligability, but not enough to cause crosstalk. The most trouble-free way to set the outgoing level on the patch is adjust the feed onto the phone line until it sounds slightly louder than the voice from the distant party on the phone line. If the level out from the patch is not high enough, the distant party will ask for repeats and tend to speak louder to compensate for a "bad line." In this case, adjust the level to the patch until the other party lowers his or her voice. The best way to get a feel for the level needed is to practice monitoring on the handset by feeding a broadcast station down the phone line to another Amateur who can give meaningful signal reports. It's difficult to send too much level down the phone while monitoring because the signal would simply be too loud to listen to comfortably. The major problem is sending too little signal down the line.

Coupling the phone line into the radio transmitter is not much more difficult than adjusting a microphone to work with a radio transmitter. Depending on the setup, the RF output indication on a wattmeter, the ALC on the transmitter or even listening to the transmitted signal on a monitor receiver will help in adjusting the audio into the radio transmitter. Phone lines can be noisy, and running too much level into the transmitter and relying on the ALC to set the modulation can cause a fair amount of white noise to be transmitted. Watching the RF output while there are no voice or control signals on the line will help in adjusting for this. VOX operation can alleviate the problem of noise being transmitted during speech pauses.

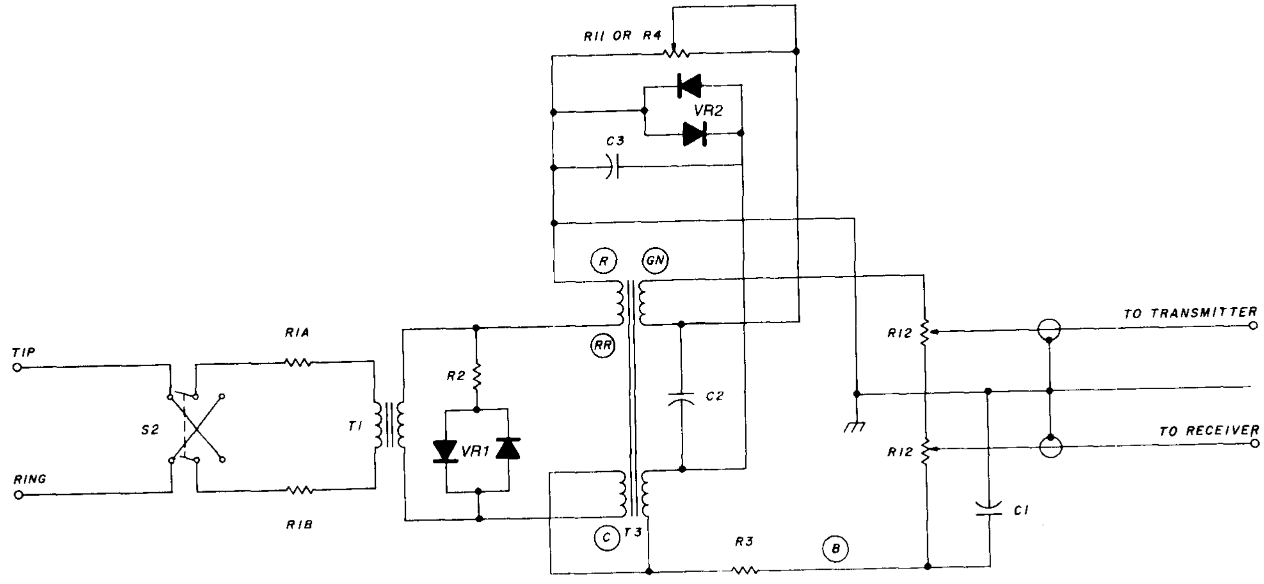

fig. 6. Deluxe phone patch. (Note: while *ham radio* designates varistors as *CR*, telephone companies customarily use the designation *VR*. — Ed.)

item	description
C1	0.1 μF (see text)
C2	1.5 to 2.0 μF (depending on manufacturer)
C3	0.47 μF not used in all networks
C4	0.1 μF
C5	2.0 μF 250 volt mylar film (see text)
MOV	130 to 250 volt MOV (see text)
R1A,B	100 to 270 ohms (see text)
R2	180 to 220 ohms (depending on manufacturer)
R3	22 ohms
R4	47 to 110 ohms (depending on manufacturer)
R5	1 kilohm
R6	1 kilohm (see text)
R7	10 ohm (see text)
R10	1 kilohm potentiometer (see text)
R11	200 ohm potentiometer (see text)
R12	2 kilohm potentiometer (see text)
S1	DPST or hookswitch
S2	DPDT, center off (see text)
S3	NC momentary switch (see text)
T1	600 ohm 1:1 transformer
T2	600 ohm primary. 600 ohm and 8 ohm secondary (see text)
T3	network transformer
VR1,VR2	silicon carbide varistor or back-to-back zener
VR60	

fig. 6. Parts list.

A hybrid patch used for VOX operation needs to be adjusted carefully for good performance. If it has a null adjustment, this should be set before adjusting the VOX controls. Using a separate receiver/transmitter setup is the easiest way to adjust the patch. The phone line should be attached to a silent termination: the easiest way to do this is to dial part of a number; another way to do it is call a cooperative friend. Tune the shack receiver to a "talk" broadcast station or use the BFO as a heterodyne. With the transmitter keyed into a dummy load, set the null adjustment potentiometer R11 (R12 for European phones) for a minimum RF output on the transmitter. Using a transceiver, place an oscilloscope or audio voltmeter across the microphone input terminals and, while receiving a signal, adjust for the lowest voltage. For proper operation, it's important that the phone be connected to the patch during these adjustments since the hybrid relies on all inputs and outputs being terminated.

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ham radio

More Details? CHECK—OFF Page 140

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passive audio filter design, part 2: highpass and bandpass filters

A highpass filter with high attenuation at 60 and 120 Hz — and some common bandpass filter design problems

The simplest highpass filter possible is a single capacitor. But if you think that a capacitor is fairly useless as a highpass filter, consider the circuit shown in **fig. 1**. A voltage source, V_S, of resistance R_S, is driving a low-pass filter through a capacitor, C_H. The source and termination impedances of the filter are R_S and R_T respectively, which we will assume are equal.

As the frequency (of the voltage source) increases, the reactance of C_H decreases. Eventually a point is reached where the reactance of C_H is so low that it is insignificant compared to R_S. The combination of C_H and the low-pass filter will therefore have a bandpass response in which C_H attenuates low frequencies and the low-pass filter attenuates high frequencies. The low frequency attenuation will, of course, be fairly modest but can have a useful effect when applied to a filter such as the practical 1-dB/50-dB elliptic low-pass described earlier.[1]

Figure 2 shows simulated results of how the response of the 1-dB/50-dB filter is modified by various preferred values of C_H. Also shown for comparison is the unmodified response; that is, with C_H short-circuited. With $C_H = 0.22\ \mu F$, considerable attenuation of low frequencies is obtained, but C_H is still effective (i.e., it introduces a reactive term) at almost 2 kHz, which considerably narrows the bandwidth of the total network. As C_H increases, the response above 2 kHz follows the low-pass response more closely, and the low-frequency attenuation is reduced. One useful value of C_H is 2.2 μF, which produces a significant reduction in the passband ripple when compared with the unmodified low-pass response. The mismatch in

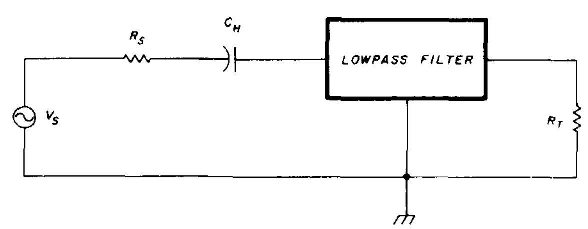


fig. 1. Combining a series capacitor and low-pass filter provides composite bandpass response.

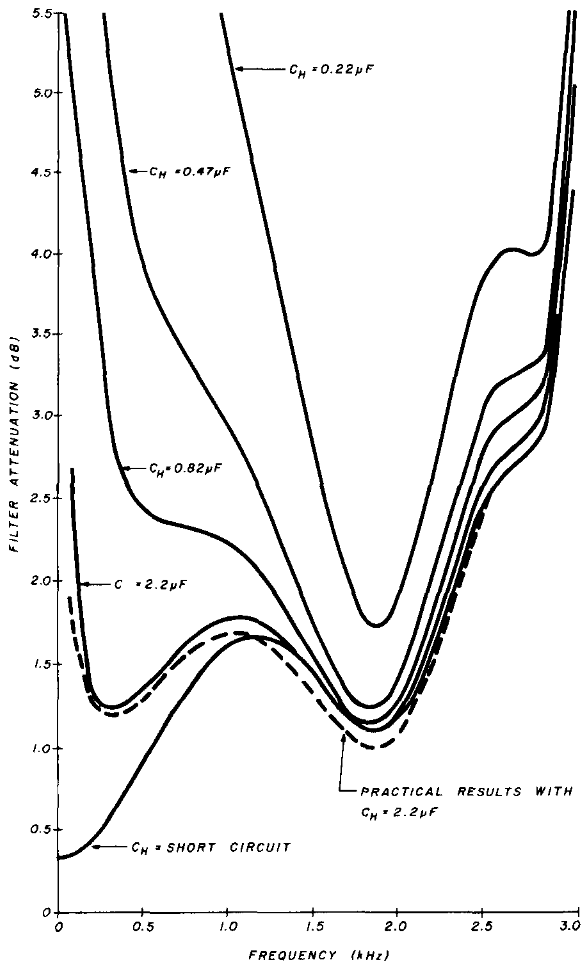


fig. 2. 0-3 kHz response of 1-dB/50-dB five-branch elliptic low-pass filter with various values of input capacitor, C_H showing simulation and practical results.

By Stefan Niewiadomski, 29 Mackinley Avenue, Stapleford, Nottingham, England NG9 8HU

the drive impedance to the filter caused by the reactance of C_H does not cause a drastic degradation in performance. Only the frequency-dependent variable effect by C_H is evident in the combined response.

Practical results with C_H equal to 2.2 μF are also plotted in **fig. 2**, and they show close agreement with the simulated results. Although no great attenuation of unwanted low frequencies (such as 60 Hz and 120 Hz) is obtained, it is recommended that the 1-dB/50-dB low-pass filter be used in conjunction with a 2.2 μF input capacitor to reduce the passband ripple. A compact Siemens metalized polyester 2.2 μF capacitor* is available and is preferable to a polarized capacitor, which would have a greater tolerance.

I will now describe an improved highpass filter that provides high attenuation at 60 Hz and 120 Hz and at unwanted lower speech frequencies. **Figure 3** shows the circuit diagram of the filter, with and without resistors to simulate the low-Q inductors.

This filter is a five-branch Butterworth highpass with a theoretical response rolloff of 30 dB per octave. Highpass filters are generally designed by transforming a lowpass prototype, and this procedure is described in appendix A of this article.

Table 1 shows the component values of the original 1-ohm, 1-rad/sec low-pass filter;[2] the 1-ohm, 1-rad/sec transformed highpass; the scaled 500-ohm, 500-Hz highpass with theoretical values and ideal inductors; the 500-ohm, 500-Hz highpass with rounded values

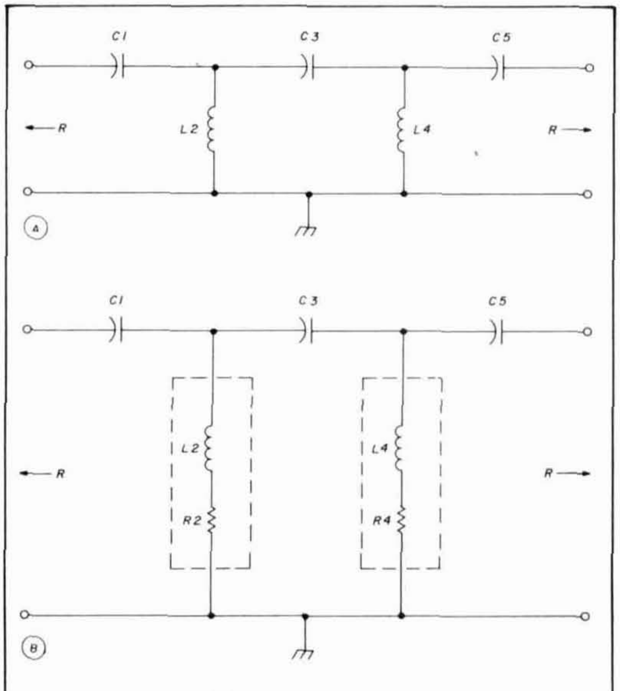
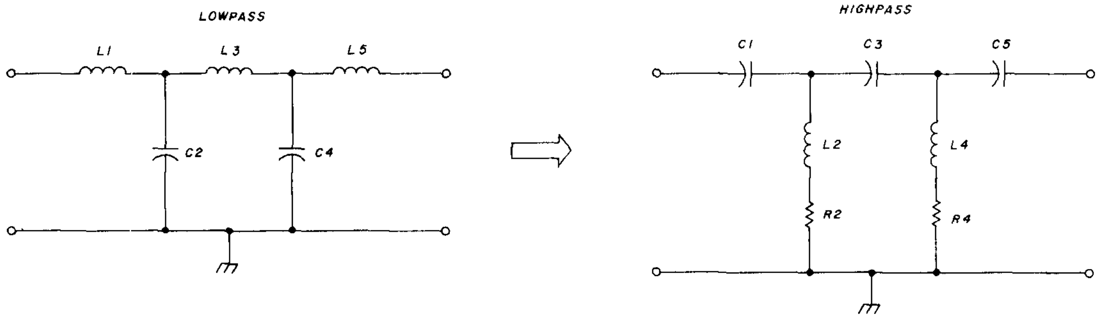


fig. 3. Butterworth five-branch highpass filter. (A) Schematic of filter with ideal inductors, (B) schematic of filter with real inductors.

*Digi-Key part no. E1225, 2.2 μF/100V.

table 1. Component values of Butterworth five-branch highpass filter. 500 ohm, 500-Hz values are obtained by multiplying 1 ohm, 1 rad/sec values by 6.366 × 10^{-7} for capacitors and 0.1592 for inductors.

low-pass prototype component	1 ohm, 1 rad/sec value	highpass transformed component	1 ohm, 1 rad/sec value	500 ohm, 500 Hz theoretical value ideal inductors	500 ohm, 500 Hz rounded value ideal inductors	500 ohm, 500 Hz rounded value real inductors
L1	0.618 H	C1	1.618 F	1.030 μF	1 μF	1 μF
C2	1.618 F	L2	0.618 H	98.34 mH	100 mH	100 mH
L3	2.000 H	C3	0.500 F	0.3183 μF	0.33 μF	0.33 μF
C4	1.618 F	L4	0.618 H	98.34 mH	100 mH	100 mH
L5	0.618 H	C5	1.618 H	1.030 μF	1 μF	1 μF
		R2	—	0 ohms	0 ohms	82 ohms
		R4	—	0 ohms	0 ohms	82 ohms



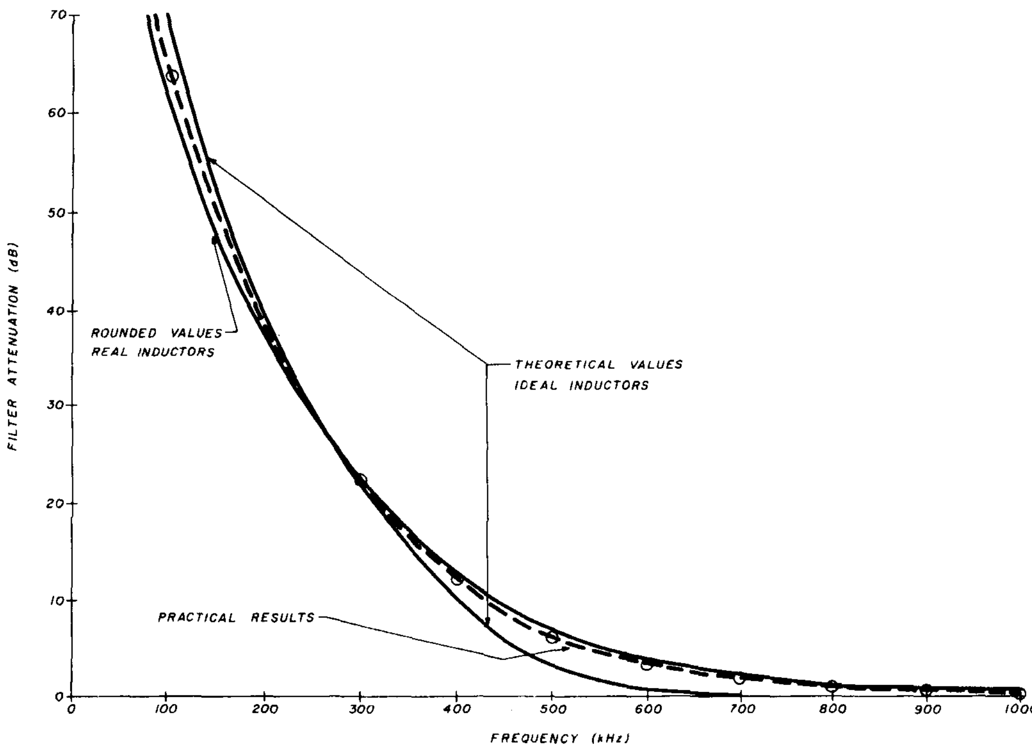


fig. 4. 0-1 kHz response of 500-Hz Butterworth highpass filter showing simulation and practical results. (*A*) theoretical values, ideal inductors; and (*C*) practical results —O— —O— —O—.

and ideal inductors; and the 500-ohm, 500-Hz highpass with rounded values and real inductors.

A cutoff frequency (defined as the 3-dB attenuation frequency for Butterworth filters) of 500 Hz means that any 120-Hz input component (which is more than 2 octaves below the cutoff frequency) will be attenuated by more than 60 dB. Any 60-Hz input will be attenuated (theoretically) by more than 90 dB, as it is another octave below 120 Hz. More than half the total power of speech lies below 450 Hz,[3] so using a 500 Hz cutoff highpass filter at the audio input to a transmitter will result in a considerable saving in power. Intelligibility of speech will not be influenced; however, for better quality speech, a cutoff frequency of perhaps 300 Hz would be more appropriate. If desired, the reader can scale the 1-ohm, 1-rad/sec highpass values to 500 ohms, 300 Hz, by multiplying the capacitors by 1.061×10^{-6} and the inductors by 2.65×10^{-1}. Rounding the answers will then give practical values for the components.

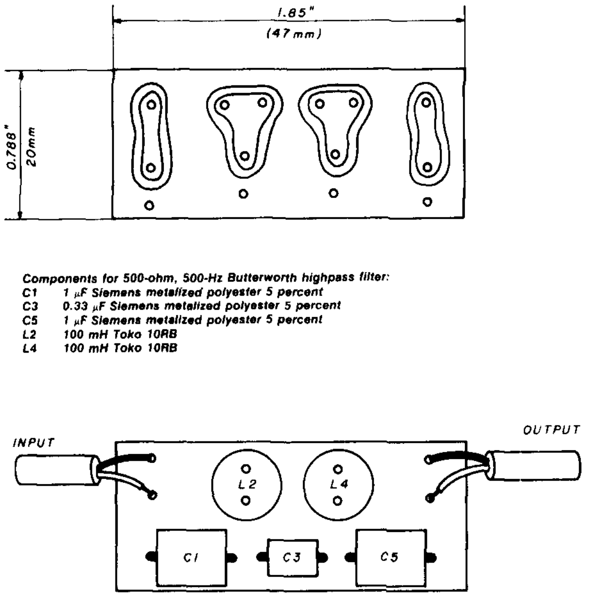


fig. 5. PC board foil pattern and component placement for five-branch Butterworth highpass filter.

The 0 to 1 kHz response of the 500-ohm, 500-Hz highpass filter is shown in **fig. 4**. Curve A is the theoretical value, real-inductor response and the 3-dB attenuation frequency is 500 Hz, as predicted. The 30 dB and 60dB attenuation frequencies are 250 Hz and 125 Hz respectively, giving the classical five-branch Butterworth response.

A curve of the rounded values, ideal-inductor response has not been plotted in **fig. 4** because simulations indicated that it deviated from curve A by no more than 0.8 dB at any frequency.

Curves B and C are the simulated rounded values, real-inductor response, and the measured response, respectively. These two curves follow each other closely. One effect of the low Q inductors is rounding

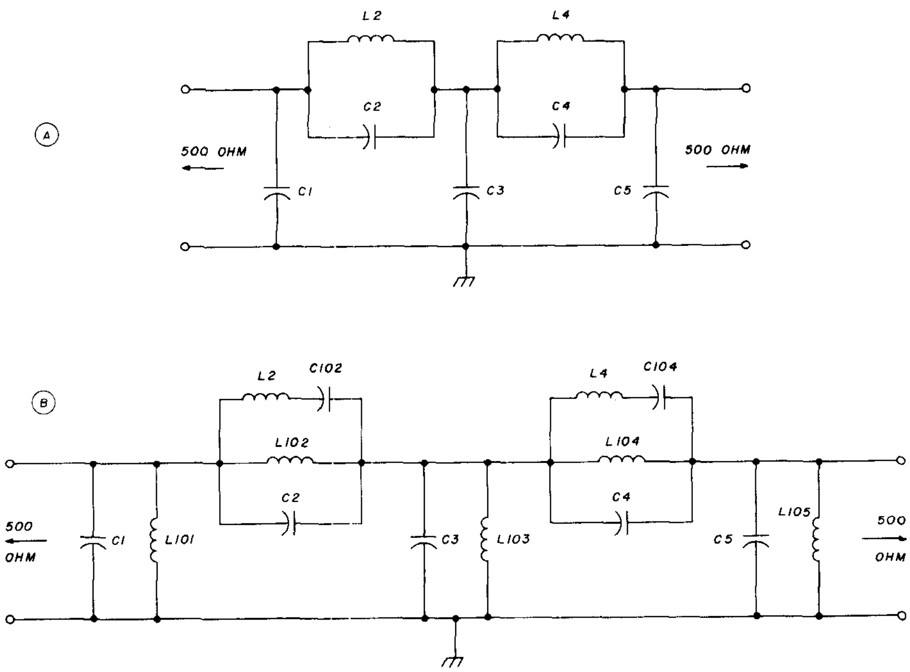


fig. 6. Elliptic bandpass filter transformation procedure. (*A*) Schematic of 1-dB/50-dB 3-kHz lowpass prototype, (*B*) schematic of 1-dB/50-dB 300-3300 Hz bandpass filter.

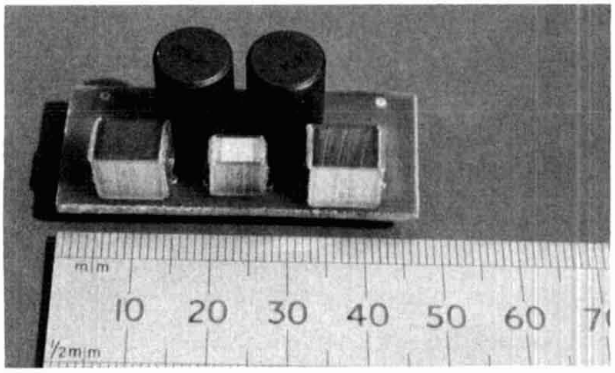


fig. 7. Experimental five-branch Butterworth highpass filter.

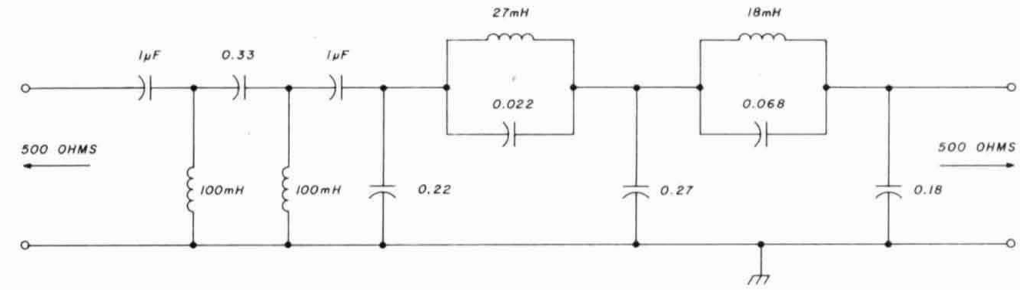


fig. 8. Schematic of the bandpass filter formed from the 500-ohm, 500-Hz Butterworth and 1-dB/50-dB elliptic lowpass filters.

of the passband edge, the attenuation at 500 Hz being 6 dB rather than the theoretical 3 dB. The filter also still has a loss of approximately 1 dB at 1 kHz.

Figure 5 shows the PC board foil pattern and component layout for this highpass filter, and **fig. 7** is a photograph of my prototype.

bandpass filters

The modern approach to bandpass filter design is by transformation of a low-pass prototype, as described in appendix B.[4] This method results in a symmetrical response and if the prototype low-pass filter were elliptic, then the bandpass will also be elliptic, having passband ripple and minima of attenuation in the lower and upper stopbands.

I want to demonstrate some drawbacks of this technique, using the 1-dB/50-dB lowpass filter described earlier as the prototype. The specification of the bandpass filter to be designed is:

passband ripple (A_P)	1dB
stopband minimum attenuation (A_S)	50 dB
ripple cutoff frequencies	300 Hz, 3300 Hz
50-dB stopband attenuation bandwidth	4221 Hz
source impedance	500 ohms
load impedance	500 ohms

The following points should be noted about this filter. First, the passband bandwidth of the bandpass filter (3 kHz) is the same as that of the low-pass prototype. Secondly, the 50-dB stopband attenuation bandwidth of the passband filter is the same as that of the low-pass prototype (4221 Hz). Thirdly, the passband ripple (A_P) and minimum stopband attenuation (A_S) are identical to those of the prototype. Normally, for speech processing, an upper cutoff frequency of 3 kHz would be chosen, but I have not selected a 2700-Hz low-pass prototype for transformation because I want to illustrate only the problems that can be encountered with this approach, not produce a practical design.

Figure 6 shows the schematics of the low-pass prototype and the final, transformed bandpass filter.

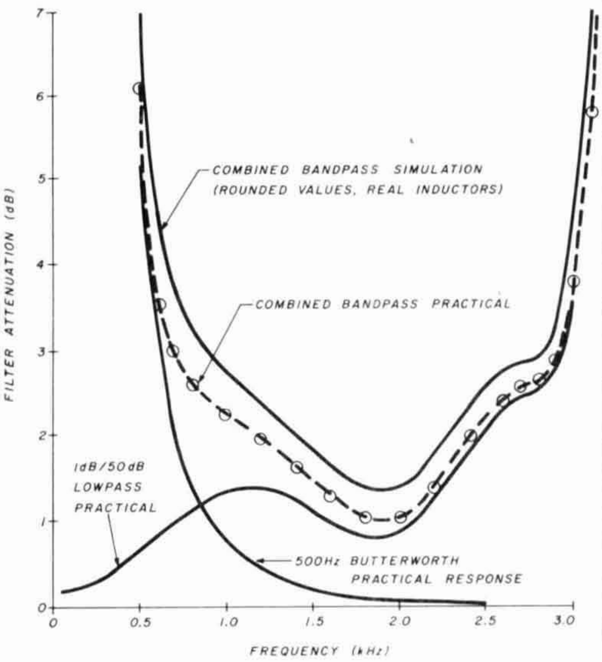


fig. 9. 0-3 kHz response of 500-Hz Butterworth highpass filter with 1-dB/50-dB five-branch elliptic low-pass filter, showing simulation and practical results. (Low-pass and highpass responses also shown.)

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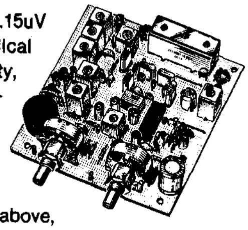

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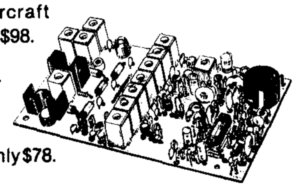

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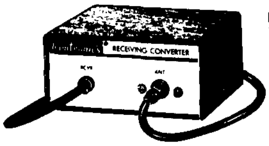

		Antenna Input Range	Receiver Output
		28-32	144-148
		50-52	28-30
		50-54	144-148
		144-146	28-30
		145-147	28-30
		144-144.4	27-27.4
		146-148	28-30
VHF MODELS		144-148	50-54
		220-222	28-30
Kit with Case	**$49**	220-224	144-148
Less Case	**$39**	222-226	144-148
		220-224	50-54
Wired	**$69**	222-224	28-30
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		432-436	50-54
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	28-29	145-146
	28-30	50-52
	27-27.4	144-144.4
	28-30	220-222*
	50-54	220-224
	144-146	50-52
	50-54	144-148
	144-146	28-30
For UHF, Model XV4 Kit $99 Wired $169	28-30	432-434
	28-30	435-437
	50-54	432-436
	61.25	439.25
	144-148	432-436*

*Add $20 for 2M input

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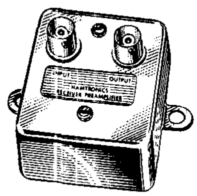

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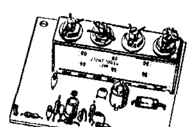

Model	Tuning Range	Price
HRA-144	143-150 MHz	$49
HRA-220	213-233 MHz	$49
HRA-432	420-450 MHz	$59
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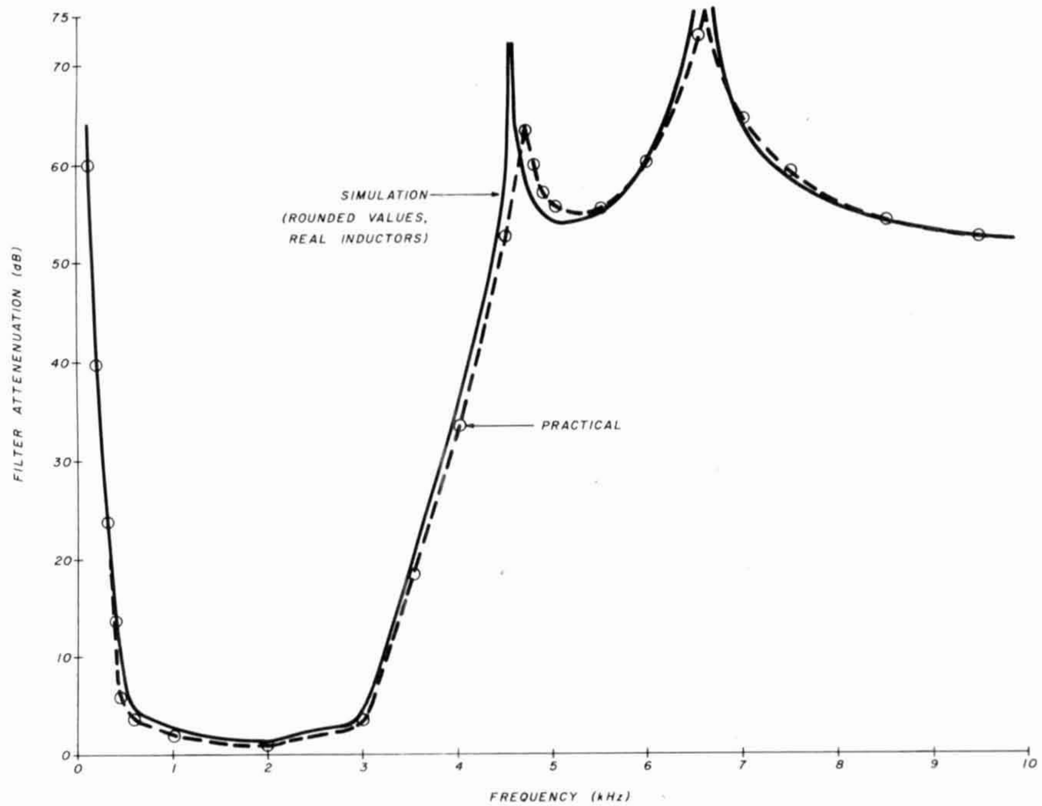

fig. 10. 0-10 kHz response of 500-Hz Butterworth highpass filter with 1-dB/50-dB five-branch elliptic low-pass filter, showing simulation.

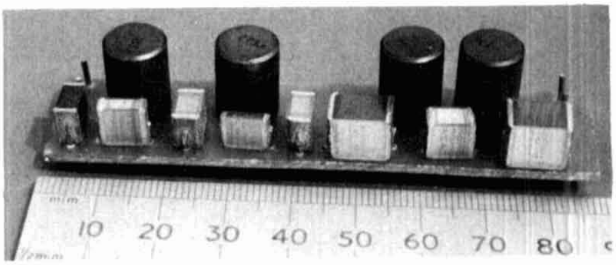

fig. 11. Experimental 500-Hz Butterworth highpass filter with 1-dB/50-dB five-branch elliptic low-pass filter.

Capacitors C1 through C5 have inductors L101 through L105 in parallel and inductors L2 and L4 have capacitors C102 and C104 connected in series. The value of each additional component has been calculated to resonate with the original component at the geometric mean of the lower and upper ripple cutoff frequencies. That is, if the lower and upper ripple cutoff frequencies are $f1$ and $f2$, then the geometric mean, $f\emptyset$ is given by:

$$f\emptyset = \sqrt{f1 \cdot f2}$$

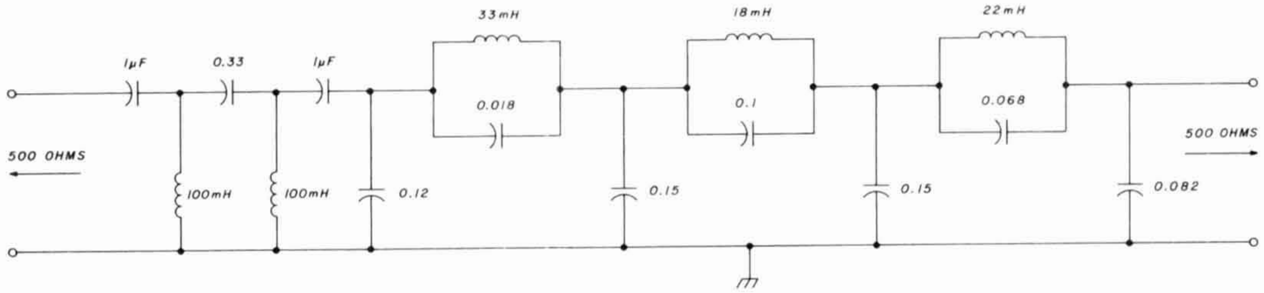

fig. 12. Schematic of the bandpass filter formed from the 500-ohm, 500-Hz Butterworth and 0.18-dB/50.1-dB elliptic low-pass filters.

For this filter, *f0* is equal to 995 Hz. Taking C1 (0.2051 μF) as an example, L101 is made equal to 124.7 mH, giving the resonant frequency of 995 Hz. **Table 2** shows the low-pass prototype and bandpass filter component values.

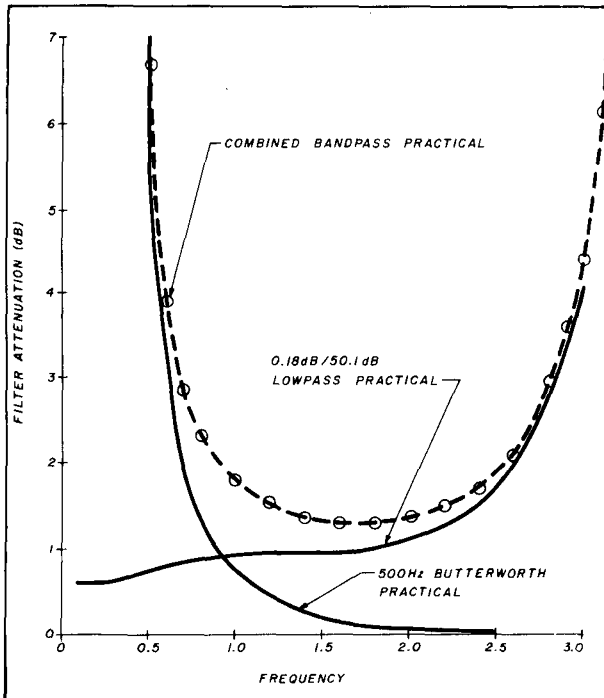

fig. 13. 0-3 kHz response of 500-Hz Butterworth highpass filter with 0.18-dB/50.1-dB seven-branch elliptic low-pass filter, *showing measured response.* (Low-pass and highpass responses also shown for comparison.)

The simulated bandpass filter has the expected response, indicating a valid design procedure. There are methods of simplifying the circuit by further transformation, but these considerably complicate the design procedure.

There are two problems with this bandpass filter design technique, however. The first is that it results in several awkward value components. In this example, L102 (1.08 H) and L104 (385.2 mH) would be difficult to wind if homemade inductors were used. C102 (1.003 μF) and C104 (1.28 μF) are also rather high values. This problem becomes worse if a more complex low-pass prototype is used. Consider, for example, the 0.18-dB/81-dB low-pass filter previously described: choosing an inductor to resonate at 995 Hz with C2 (6897 pF) would require a value of 3.71 H!

The second problem is caused by the filter's symmetry of response. In the example considered, the low-frequency response is probably too good for speech filtering applications, and the penalty paid is the excessive number of components (seven capacitors and seven inductors) required for the final filter. It would be useful if the high- and low-frequency responses could be selected separately, both in rolloff rate and type. For example, for speech filtering, and rapid rolloff elliptic low-pass response would be ideal, along with a more modest Butterworth highpass response. This is exactly my approach to bandpass filter design. It is generally thought that intermediate buffering

table 2. Component values of 1-dB/50-dB elliptic low-pass prototype and transformed bandpass filter.

3 kHz low-pass prototype component	value	300-3300 Hz bandpass filter component	value
C1	0.2051 μF	C1	0.2051 μF
		L101	124.7 mH
C2	0.0237 μF	C2	0.0237 μF
		L102	1.081 H
C3	0.2538 μF	C3	0.2538 μF
		L103	100.8 mH
C4	0.0664 μF	C4	0.0664 μH
		L104	385.2 mH
C5	0.1735 μF	C5	0.1735 μH
		L105	147.2 mH
L2	25.5 mH	L2	25.5 mH
		C102	1.003 μF
L4	19.9 mH	L4	19.9 mH
		C104	1.286 μF

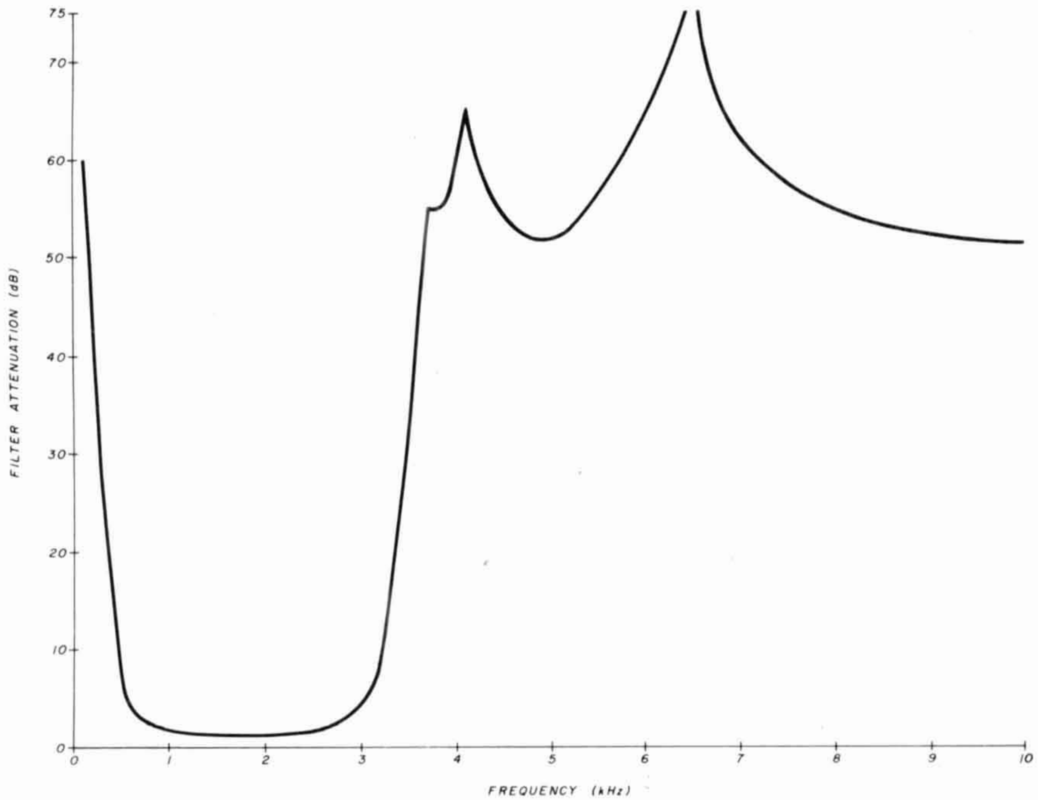

fig. 14. 0-10 kHz response of 500-Hz Butterworth highpass filter with 0.18-dB/50.1-dB seven-branch elliptic low-pass filter, showing practical results only.

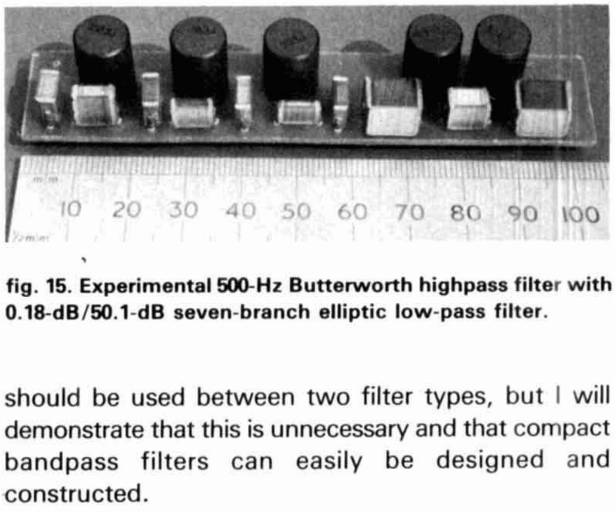

fig. 15. Experimental 500-Hz Butterworth highpass filter with 0.18-dB/50.1-dB seven-branch elliptic low-pass filter.

should be used between two filter types, but I will demonstrate that this is unnecessary and that compact bandpass filters can easily be designed and constructed.

Since three low-pass and one highpass (excluding the single capacitor) filters have already been described, they will be used to form bandpass filters. **Figure 8** shows the schematic of the 500-ohm, 500-Hz Butterworth highpass cascade with the 1-dB/50-dB elliptic low-pass filter. The component values shown are rounded from the original filters.

Figure 9 shows the 0 to 3-kHz response and **fig. 10** the 0 to 10-kHz response of the resulting bandpass filter. Only the simulated response with rounded values and real inductors is plotted, along with the practical results obtained. The practical results for the highpass and low-pass sections are also shown in the range 0 to 3 kHz for comparison with the bandpass response. Below approximately 750 Hz, the bandpass filter follows predominantly the highpass section response, and above 1.5 kHz the response is predominantly that of the low-pass section. Between these frequencies, the response is very nearly the algebraic sum of the separate sections. The practical bandpass filter has 3-dB cutoff points (measured with respect to the insertion loss of 1 dB at 1.9 kHz) of approximately 675 Hz and 3 kHz.

A detailed PC board foil pattern and component layout are not shown for this filter, but a photograph of the completed filter is shown in **fig. 11**. I simply took the two original layouts (**part 1**, **fig. 7** and **part 2**, **fig. 5**) and joined them together. Incidentally, it makes no difference to the response whether the highpass or low-pass section comes first.

The same procedure has been applied to the 500-ohm, 500-Hz Butterworth highpass and the 0.18-dB/50.1-dB elliptic low-pass filters in the schematic shown in **fig. 12**. The response of the resulting bandpass design is shown in **figs. 13** and **14**. Reduced passband

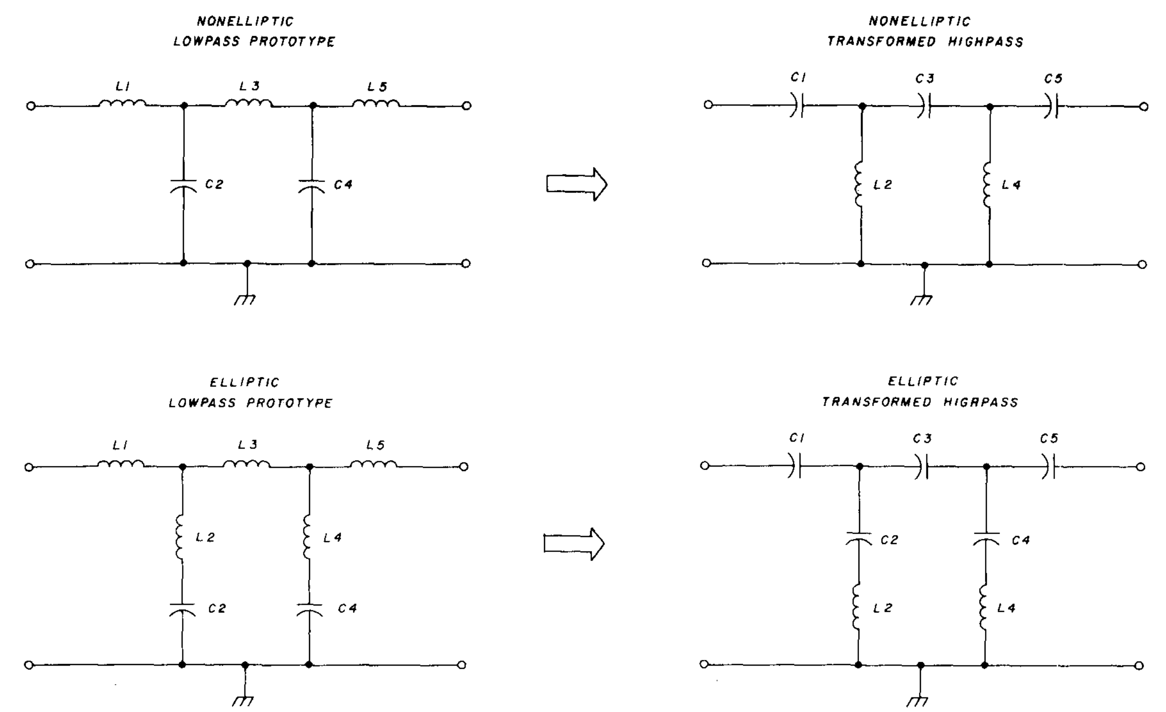

fig. A1. Schematics of low-pass-to-highpass transformations showing (A) non-elliptic filter, and (B) elliptic filter.

ripple and improved low-pass rolloff are evident because of the superior low-pass filter used.

A photograph of this bandpass filter is shown in **fig. 15.** Again the PC board layout is a combination of the two separate filter layouts (**part 1, fig. 13,** and **part 2, fig. 5.**) Either of these two bandpass filters would form an excellent post-detector filter in a superhet or direct conversion receiver.

appendix A
low-pass to highpass transformation

Figure A1 shows a typical nonelliptic low-pass-to-highpass filter transformation and a typical elliptic low-pass-to-highpass filter transformation. Note that in both cases the minimum capacitor implementation has been chosen for the low-pass prototype, so that minimum inductor design will result for the highpass filter.

In both cases, the new component values are obtained by use of the formulas:

$$C1\ (highpass) = \frac{1}{L1\ (low\text{-}pass)}$$

$$L2\ (highpass) = \frac{1}{C2\ (low\text{-}pass)}$$

where capacitors and inductors have their 1 ohm, 1-rad/sec values. The final values are obtained by scaling to the desired highpass filter impedance and cutoff frequency, as shown in part 1, appendix A.

appendix B
low-pass-to-bandpass transformation

A low-pass prototype is first selected which has the same bandwidth as the desired bandpass response. The geometric mean (f0) of the lower (f1) and upper (f2) cutoff frequencies for the bandpass filter is then determined by:

$$f0 = \sqrt{f1 \cdot f2}$$

Each capacitor in the low-pass prototype is then transformed into a capacitor/inductor parallel combination as shown in **fig. B1A** and each inductor is transformed into an inductor/capacitor series combination, as in **fig. B1B.** In the case of the capacitor transformation, the new inductor value is chosen to resonate with the original capacitor at f0. In the case of the inductor transformation, the new capacitor value is chosen to resonate with the original inductor at f0.

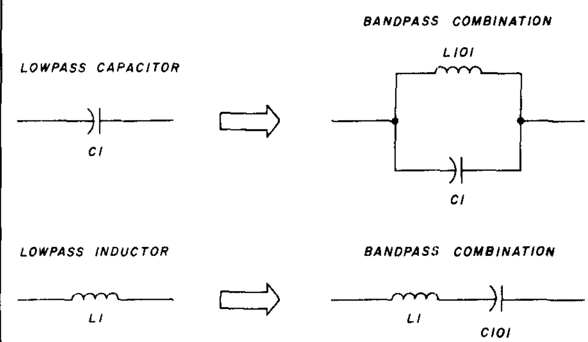

fig. B1. Schematics of low-pass-to-bandpass transformation showing (A) capacitor transformation, and (B) inductor transformation.

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build a fail-safe digital clock

Don't lose count when the power fails

Although digital clocks have simplified keeping track of time accurately, they present some problems not encountered with synchronous-motor analog clocks. When line power is lost, for example, the mechanical display of motor-driven clocks provides a non-volatile memory that stores the time at the instant of power loss. Once line power returns, the motor restarts and continues counting the cycles. Unless an extremely accurate measurement of time is needed (for keeping a meteor scatter schedule, for example) the clock must be reset only when major power failures lasting more than a few minutes occur. With digital clocks that run on line power, however, even a momentary power dropout results in a complete loss of time.

alternatives for standby power

With synchronous-motor-driven analog clocks there's no simple way of providing for a standby power source when line power is lost. Electronic clocks, on the other hand, offer alternatives. You can, of course, power the clock with a battery, but this creates other problems: over long periods the time-base oscillator frequency error will cause any error in time to increase. Crystal aging, frequency sensitivity to changes in battery voltage and temperature, as well as the initial accuracy of the oscillator frequency all contribute to timing errors that will eventually require the clock to be reset.

A better choice is to combine the best features of line power and battery operation. Line power can be used to provide an accurate long-term time base, keep the battery charged, and allow the use of a light-emitting diode (LED) display. Battery power can be used to power the clock when line power is lost, with a crystal-oscillator time base for keeping time. A logic circuit detects the presence or absence of line power and puts the clock in the appropriate operating mode. Additional logic allows you to override the automatic changing of the clock time base and run with the crystal oscillator for accurate short-term time keeping. The clock design presented here has these features and has proven itself in over a year of continuous operation.

contribution options

Besides building the entire clock — including the crystal oscillator time base, logic, circuit and battery backup — as a project, the design information can be used for any clock using the MM5314 IC or its close relatives, the MM5309, MM5311, MM5512, MM5313, and MM5515. Existing clocks using this IC can be modified to add the crystal oscillator, logic, circuit, and battery without great difficulty. Another option is to start with a digital clock kit and simply add the new components*.

Others may want the clock to run only on the crystal-oscillator time base rather than switch between it and line power. The numerous design alternatives available allow you to choose the features that you want.

clock functions

The different functions of the clock are controlled by the logic circuit (see **table 1**). A schematic is shown in **fig. 1**. The crystal oscillator and divider IC run con-

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*Two kits that provide a starting point are No. JE701 and No. JE747, from Jameco Electronics, 1355 Shoreway Road, Belmont, California 94002.

table 1. Logic control definitions.

function	control	logic 1	logic 0
run/hold	S1	run	hold
slow set	S2	normal	slow set
fast set	S3	normal	fast set
4/6 digit	S4	4 digits	6 digits
time base	S5A	normal	display enable
	S5B	normal	crystal oscillator
display enable	S6	normal	enabled
12 hr/24 hr	U1-pin 10	24 hour	12 hour
50 Hz/60 Hz	U1-pin 11	50 Hz	60 Hz

tinuously to eliminate any startup and shutdown transients that would degrade time-keeping accuracy. The missing pulse detector monostable selects either line power or the oscillator 60-Hz signal for the clock time base, based on the presence or absence of line power. A switch input to the logic allows the monostable control to be overridden so that the crystal oscillator provides the clock time base even when line power is present.

To conserve battery power the logic normally disables the display when line power is lost. A nonlatching, normally open pushbutton switch enables the display during battery operation so that the time can be read if desired. A two-pole switch selects the crystal oscillator time base. One pole disables the 60-Hz signal from line power so that the monostable times out and allows the 60-Hz signal from the oscillator/divider to run the clock. The other pole parallels the display enable switch and keeps the display on when running in the crystal-oscillator time-base mode.

The run/hold switch stops the clock from counting when setting the time. Two nonlatching, normally open pushbutton switches allow fast and slow time set: fast set advances the time at one hour per second; slow set advances it at one minute per second. Another switch selects either a four-digit (hours and minutes) or a six-digit (hours, minutes, and seconds) time display. The seconds display is necessary when setting the clock, but is distracting when logging or recording time; more than once I've found myself writing down the wrong four digits on the log sheet.

The clock IC can display time in either a 24-hour or 12-hour format. If a 12-hour format is desired, pin 10 of U1 should be grounded. Two LEDs are used as colons between the hours digit and tens of minutes digit on the display. Besides giving the unit a more clock-like appearance, the LEDs serve as pilot lights. When line power is lost, only the display digits are disabled by the clock IC. The colons remain lit to show that the clock is in the battery mode and operating.

circuit details

Power supply. The AC line circuit follows standard design and safety practices. A three-wire plug and cord are used, with the ground wire (green) connected to the clock's metal case. A transient suppressor, V1, protects the MOS and CMOS ICs from high amplitude voltage transients. C1 filters transient high-frequency components as well as any RF that may be on the power wiring. (If your line power is extremely contaminated with transients, it may be necessary to add small inductors to the power lines to give the capacitor a higher impedance to work against.) I included a fuse to prevent failure in the clock from creating a fire hazard and protect the transient suppressor from failing under long-term high-voltage conditions.

The transformer has a 12.6 volt RMS secondary with a current rating of 200 mA. The rectified output voltage under load should be in the range of 11 to 16 volts. The LED display draws the major portion of the current in the clock. The 200 mA rating is the minimum for the transformer because of LED display loading. Higher current transformers should be used if space is available. A diode bridge rectifier is used with the filtering provided by C2. The filter capacitor also makes the transition between line power and battery power smoother by slowing down the voltage rate of change. A smaller value capacitor, C3, is in parallel with the filter capacitor to bypass any residual power transient high-frequency components or RF signals. Another capacitor, C17, provides additional bypassing.

Battery supply. The NiCad battery circuit also includes a trickle charging resistor, R1, and a blocking diode, CR5. R1 gives a trickle current equal to a hundredth of the battery capacity. The battery has a capacity of 65 mA per hour, which requires a trickle current of 0.65 mA to maintain full battery charge. The normal slow charge rate is 7mA for 14 hours. If other types of rechargeable batteries are used, be sure to change the value of R1 to obtain the correct trickle charge current.

When the battery is powering the clock, the current will flow through CR5 to avoid the high resistance path through R1. A diode keeps the voltage drop to a minimum. With the time display disabled, the clock circuit draws about 8 mA, so approximately 8 hours of continuous battery operation is possible. The absolute minimum supply voltage for the clock is probably under 5 volts, so that the readily available 9 volt NiCad battery can be used.

Clock integrated circuits. The clock IC requires external components to drive and multiplex the LEDs in the time display. This multiplexing is necessary to reduce the peak current drawn by the display and reduce the number of pins required on the IC. If the six digits with their seven segments were driven direct-

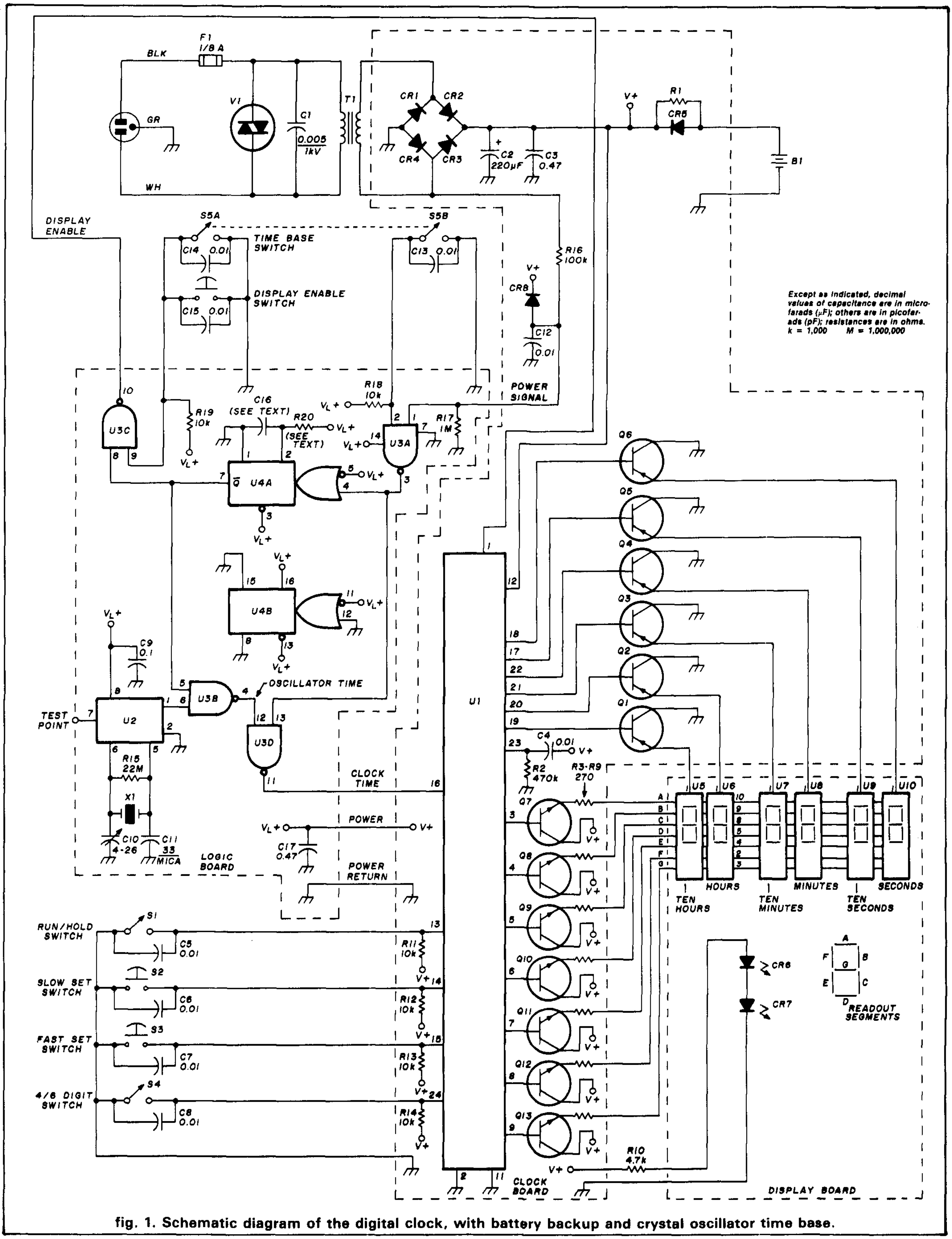

fig. 1. Schematic diagram of the digital clock, with battery backup and crystal oscillator time base.


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ly, 42 logic lines would be required. By wiring all the digit segments in parallel and multiplexing, only 13 logic lines are needed. Seven outputs are for the seven segments in each LED digit and six outputs for the six digits. The logic inside the clock IC keeps track of which digit is being enabled and turns on the correct segments. The digits are scanned at a rate of approximately 1 kHz. The multiplex frequency is determined by C4 and R2, and is approximately equal to 3/(R2xC4). The display driver devices are general-purpose switching transistors. The LED segment currents are determined by R3 through R9.

The external clock controls have bypass capacitors across their switches to reduce any RF pickup or switch bounce transients. The pullup resistors at the clock IC allow the bypass capacitors to follow the operating voltage when changing between line supply and the battery. The input resistances of the clock IC are high because of the P channel MOS construction.

The capacitor holds the lower battery voltage while the clock IC is running on the higher line supply voltage, and misinterprets that as a logic 0 instead of a logic 1. Before the pullup resistors were added, the clock gained exactly one minute every time it went from battery to line supply power because of the capacitor storage time. Since the capacitor memory time depends on its value and the input resistance of the clock IC, it was easier to add the pullups than to fine tune each clock for proper operation. The pullup resistor values are much smaller than the clock IC input resistance. The time constant is 0.1 millisecond to prevent false logic conditions caused by power transitions.

Oscillator/divider. The oscillator/divider, U2, provides a crystal oscillator-based 60-Hz output. The division ratio is fixed at 59,659, so a variable capacitor sets the oscillator frequency to the exact value of 3,579.540 kHz. A buffered oscillator output is available when setting the frequency to avoid test equipment loading effects. If you don't have an accurate frequency counter to set the oscillator, or if crystal time-base accuracy is not critical, variable capacitor C10 can be replaced with a fixed 33 pF mica capacitor. To gauge the accuracy you need, remember that a 1-Hz oscillator frequency error will amount to a 8.81-second time error over the course of a year. Crystal frequency tolerances will be about ±300 Hz from their nominal value, with aging contributing a long-term downward drift of 3-7 Hz/year. The frequency of the oscillator also depends on its supply voltage. My unit had a sensitivity of approximately 10 Hz/volt over the range of 6 to 12 volts. If battery backup is your main operating mode, adjust the crystal oscillator frequency while running on battery power.

Logic. The 60-Hz line power time-base signal is taken from one side of the power transformer secondary. A low-pass filter consisting of R16 and C12 attenuates high-frequency transient components that might get into the clock circuit and the time base. A diode clamp, CR8, protects the input to U3 by preventing the input voltage from exceeding the supply voltage by more than a diode drop. A high value resistor, R17, provides a DC path to ground for the capacitor. The resistor prevents the leakage currents through the diode clamp or rectifier diodes from charging C12, which would create a false logic 1 indication to U3 when operating from the battery. Schmitt trigger NAND gate U3A converts the analog 60-Hz signal from the low-pass filter into a digital signal that is used in the logic circuit. The other input to U3A selects the crystal oscillator 60-Hz signal for the clock time base by applying a logic 0.

Monostable U4 is the heart of the logic circuit since it makes the decision that controls the enabling of the crystal oscillator time base and the disabling of the display. The monostable is used as a missing pulse detector by making it retriggerable with a pulse width slightly longer than the period of the 60-Hz input. By making the monostable retriggerable, its $\overline{Q}$ output will stay a logic 0 as long as the line supply is providing 60-Hz signals, since the pulse width is longer than the input signal period. When line power is lost, the monostable times out and the $\overline{Q}$ output changes to a logic 1, which allows the crystal oscillator/divider output signal to toggle the output of U3B at a 60-Hz rate.

Since the accuracy of the monostable pulse width is important, a precision version of the regular CMOS dual monostable is used for U4. The device is specified to have a timing error of less than ±2 percent over its operating temperature range. To take advantage of the monostable accuracy the values of the two external timing components, C16 and R20, must also be accurate and stable. Metal or carbon film resistors, rather than composition resistors, should be used because they are available in 1 percent tolerances and are stable with respect to ambient temperature and moisture conditions. Polycarbonate or NPO ceramic capacitors are suitable for the timing capacitor application. Other types of capacitors using dielectric materials such as mylar, polyester, or Teflon® should be suitable in this application over the expected range of ambient room temperatures. General-purpose ceramics, as well as electrolytic and tantalum capacitors, should not be used for the timing capacitor because their values will change with temperature, time, and applied voltage.

Because the monostable pulse width is equal to the product of C16 and R20, a wide range of component values can be used. While the application literature from the different monostable producers regarding the range of component values is conflicting, the resistor value can go from a minimum value of 5 kilohms to a maximum value of 10 megohms. The capacitor values are allowed to go from a minimum of 5000 pF to a maximum of 100 μF. For capacitor values above 0.5 μF, a diode from the timing resistor-capacitor junction to the supply voltage is recommended to protect the monostable. The minimum resistor value is determined by the current sink capabilities of the monostable, while the maximum value is limited by the leakage currents in the monostable and printed wiring board. The minimum capacitor value is limited by the parasitic capacitances associated with the monostable and the printed wiring board, while the maximum is limited by the current sink capabilities of the monostable.

Other components outside these two ranges will allow the monostable to operate, but the pulse width will differ from the formula value. The design pulse width for the monostable is 19.0 milliseconds, about 14 percent longer than the 16.7 millisecond period of a 60-Hz signal. The longer pulse width duration allows for a 3 percent error in monostable timing accuracy, a 2 percent error in timing resistor value and a 10 percent error in timing capacitor value. The component value ranges are wide enough to eliminate any parts procurement problems. If the exact values needed cannot be obtained, the monostable pulse width can be made longer than 19.0 milliseconds without having a significant effect on clock operation. The only drawback to increasing the monostable pulse width is that the dead time in the transition between line power time base and crystal oscillator time base will increase slightly. Designing the correct monostable pulse width was preferred instead of building the circuit then going through a time-consuming testing process to select the correct resistor value.

The remaining three Schmitt trigger NAND gates, U3B, U3C, and U3D, are for logic functions involving the operation of the time display and time-base selection. Ordinary NAND gates would be suitable in these three applications if the logic is changed for any reason. The design goal for the clock circuitry was to keep the number of parts to a minimum, so the logic was built to make do with the single quad NAND IC. Other logic modes can be included by the addition of different gates.

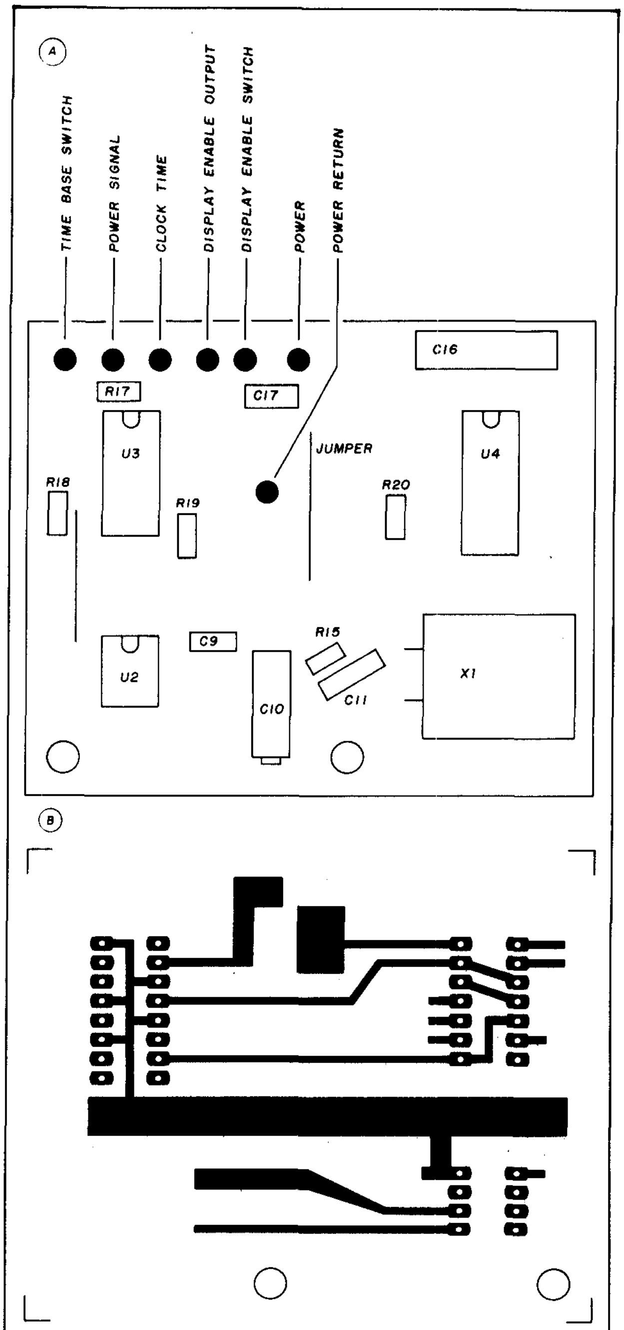

fig. 2. Digital clock PC logic board. (*A*) parts layout; (*B*) wiring pattern (actual size).

modifying clocks

With the MM5314 clock IC, modifying a clock or kit is very simple. Most of the work lies in mechanical areas. The locations of the new circuits, battery, and switches must be determined using the available clock volume and the existing installed components. The first step in the electrical modifications is to wire the battery with its blocking diode CR5 and changing resistor R1. The existing clock circuit board should have enough room to mount the diode and resistor, as well as numerous places to pick up a power return connection for the battery's negative lead. A push-pin drill and a No. 66 bit (0.031 inch/0.79 mm) can be used to make holes in the printed wiring board for new component leads. A small piece of copper foil with an adhesive backing can be used to make a junction point for the battery's positive lead, the resistor, and the diode.

table 2. Parts list.

component	description
B1	Nicad battery (GE No. GC-9B or Radio Shack No. 23-126)
C1	0.005 μF, 1 kV ceramic
C2	220 μF, 25 volt electrolytic
C3-C17	0.47 μF, 25 volt ceramic
C4-C8	0.01 μF, 25 volt ceramic
C9	0.1 μF, 25 volt ceramic
C10	4-26 pF variable
C11	33 pF, 25 volt mica
C12-C15	0.01 μF, 25 volt ceramic
C16	0.1 μF $\pm$10 percent polycarbonate (see text)
CR1-CR5	silicon rectifier diode (1N4002)
CR6-CR7	light emitting diode (MV50)
CR8	small signal silicon diode (1N914 or 1N4148)
F1	fuse 1/8 ampere
Q1-Q6	PNP switching transistor (2N3906 or 2N2907)
Q7-Q13	NPN switching transistor (2N3904 or 2N2222)
R1	7.5 kilohm (see text)
R2	470 kilohm
R3-R9	270 ohms
R10	4.7 kilohm
R11-R14	10 kilohm
R15	22 megohm
R16	100 kilohm
R17	1.0 megohm
R18-R19	10 kilohm
R20	191 kilohm $\pm$1 percent precision film resistor (see text)
S1-S4	single pole, single throw toggle switch
S2,S3,S6	single pole, single throw, normally open nonlatching pushbutton switch
S5	double pole, single throw toggle switch
T1	power transformer 12.6 volt/200 mA (Radio Shack No. 273-1385)
U1	MM5314 clock integrated circuit
U2	MM5369AA oscillator/divider
U3	CD4093B quad NAND Schmitt trigger
U4	MC14538B dual precision monostable
U5-U11	LED seven segment common cathode digit (FND No. 70, DL704, MAN 74 or Radio Shack No. 276-067)
V1	transient suppressor (GE No. V130LA10)
X1	color burst crystal, 3.58 MHz (Radio Shack No. 272-067)

After the battery has been charged, the battery backup mode can be tested by unplugging the line cord. If the clock shows the time it displayed when unplugged, the battery is doing its job. (The time display may dim, but this is expected because the battery voltage is lower than the line-supply voltage.) When plugged back in, all clock functions should return to normal. There should be no jumps in the time displayed by the clock as it's unplugged or plugged back in. The battery must be disconnected, and the clock unplugged, whenever additional modifications or changes are made to the clock.

Adding the oscillator/divider and logic involves three steps. The first is to connect the power and power return to the board, and connect the three-mode logic switches. The next step is to connect the display enable logic signal to pin 1 of the clock IC, U1. If this pin on the clock IC is floating, or connected to the supply with a pullup resistor, just connect the logic signal. When the pin is connected to the supply, the connection must be broken before connecting the logic signal. Operation of the logic circuit can be tested at this point before completing the modifications. Connecting the battery, and unplugging the clock, will power up the circuit. If the time display is on, changing the position of the time base switch, S7, should disable it. With the 60-Hz line power signal not yet connected, there is no input to trigger the monostable, so the logic should disable the time display. Once the display is off, pushing display enable switch, S6, should cause it to come on.

The last modification step is to disconnect the 60-Hz signal into pin 16 of the clock IC, U1. The clock should have a network similar to R16, C12, and CR8 to filter and clamp the input to the clock IC timing input. Break the connection of this network to pin 16, and connect the clock time signal from U3 pin 11 to U1 pin 16. Then connect the network junction to U3 pin 1 to complete the modification. The clock can now be set to the correct time, the crystal oscillator frequency set, and the remaining logic features tested.

construction details

A painted aluminum case houses the clock's electronics. A 3 × 6 × 4-inch (7.62 × 15.24 × 10.16 cm) deep case provides ample room for the three boards, battery, power transformer, and logic control switches. Smaller cases could be used, but mechanical layout and assembly would be more difficult. As shown in **fig. 1**, the three boards are divided by function. One board contains the clock integrated circuit, rectifier, and display driver circuits. The second board contains the LED digits and colon, with the last board containing the oscillator/divider and logic circuits. A complete parts list is provided in **table 2**. My clock was assembled from purchased clock and display circuit boards, so only the oscillator/divider, and logic components are shown, (**fig. 2**). The board is single-sided, copper-clad material. The copper layer is the top, or component side, and is used as the ground. Copper foil tape on the glass-epoxy side of the board is for wiring runs. The wiring layout was kept to one side of the board at the expense of using jumper wires for crossing runs. Mounting holes are at the bottom of the board, with terminals at the top for wiring the board to the remainder of the clock circuits.

One unexpected problem was that the ambient room light made it difficult to read the time display at certain viewing angles and also made the display printed wiring board and the LED DIPs visible. The solution was to cut a piece of red acetate to fit behind the clear acrylic plastic windows in the case. The color of the acetate matches that of the LED display so that the digits can be read, but exterior light is filtered out. *Commercially available display bezels use colored or* smoked plastic covers to cut glare, but are more expensive than colored acetate.

operation

Once the clock has been wired, and the logic operation checked, there isn't much left to do. The oscillator frequency should be measured after a few months of operation and reset if aging has lowered the frequency. Only yearly frequency checks are necessary after that because the aging rate will reach its asymptote. The battery should be checked and inspected periodically for leakage or failure; the simplest way to check the battery is to unplug the clock and see if it works under battery power.

Since the clock is portable, it can be carried to a new location without resetting. But keep in mind that some of the components will not operate properly under extreme temperature conditions. Most commercial-grade ICs are specified for operation between 32 degrees F and 158 degrees F (0-70 degrees C) so if you take it out in the cold weather the clock should be insulated or heated. After setting the oscillator frequency of my own clock at work, where a very accurate calibrated frequency counter was available, I transported it home in 0 degree F (− 16 degrees C) weather. The clock IC held the time it displayed when I left the building because the cold stopped the crystal oscillator. Once back home, the oscillator warmed up and started, leaving me with a half-hour hole to account for. If outdoor or automotive operation of the clock is planned, the components should be either industrial (− 13 to + 185 F/ − 25 to + 85 C) or military (− 67 to + 257 F/ − 55 to + 125 C) temperature range rated to ensure proper operation.

conclusion

Adding a battery power backup and crystal oscillator time base to line-powered digital clocks is a practical way to overcome their operating problems when line power drops out. This clock has been running for a year and a half — including successful battery-powered operation through three long outages totaling 11 hours, and through plenty of shorter dropouts — without being more than 10 seconds off from WWV time.

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The fact that the Computer Patch Interface unit by Advanced Electronic Applications, Inc. is known as the best value on the market is no accident. The CP-1 was designed by Al Chandler, K6RFK (PHD-E.E.), an active RTTY user since 1963.

Given a cost per unit budget for the CP-1, Al designed as much performance as possible into the Computer Patch, including a unique new tuning indicator, referred to by one of our customers as the "Dead Eye Dick" tuning indicator. This indicator is ideal for RTTY and CW, in that it is both fast to tune and (within 10 Hz) as accurate as scope tuning. It also performs under poor signal to noise conditions in which other indicators provide no useful data.

Al's variable shift tuning was designed to move the space filter center frequency from 2225 Hz to 3125 Hz without changing the bandwidth (by varying the Q of the filter). All this is accomplished using a precision ganged potentiometer to assure proper tracking of the multiple filter stages. We could have used a pot costing a tenth as much by simply using a two-pole filter design, but we feel the advantage of a sharper filter reduces the noise bandwidth significantly and allows the variable shift control to be used like passband tuning for extra elimination of adjacent channel interference.

Some manufacturers are concerned that amateurs might try calibrating their own equipment and, therefore, have used non-adjustable components, which results in sub-optimal performance. Although more costly, trimpots used in AEA equipment allow factory adjustment for performance to design specifications. Competently designed active filter circuits need not be adjusted after leaving the factory; however, for specialized use the owner can easily change filter parameters.

Mindful of the fact that many of our customers are new to RTTY, Al made the CP-1 tuning as forgiving as possible, while providing the most critical operator a piece of equipment in which he could be proud. Even old "pro's" are surprised at the poor signal conditions under which the CP-1 will still provide good copy.

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The newly released Yaesu FRG-9600 receiver represents a significant advance in price/performance capability: it's the first communications grade receiver to offer all-mode capabilities, computer interface, frequency synthesis and broad coverage — 60-905 MHz. The receiver design is based on the use of already designed TV and FM modules and integrated circuits. These subassemblies have been combined in a very small package that gives good performance and makes for a highly flexible bench receiver.

There are few things, however, that one might wish had been done differently: the image rejection is modest and poses some problems in RF-dense urban areas. This problem is compounded by front-ends that have good sensitivity but poor large-signal handling capability. Band selection data is available at a connector on the back panel, but the VCO tuning voltage is not available. This makes the use of external tracking filters difficult to implement. Finally, incorporating one additional conversion to allow reception of the 0.1-60 MHz range would have resulted in a receiver with outstanding coverage and flexibility.

As one of the early users of this receiver, I decided to add an external HF converter that would cover the range 0.1-60 MHz, thereby *giving the receiver an overall range of 0.1 to 905 MHz.*

basic converter scheme

In the HF part of the spectrum, very large signals are available at the antenna terminals because of the size of the antennas used. It was determined, therefore, that a converter with good large-signal performance was essential. Image rejection problems can be easily handled by using an up-converter. (An up-converter simply means that the first IF is higher than the highest received frequency.)

In this case, the frequency range 0.1 to 60 MHz is converted to 100.1 to 160.0 MHz, permitting the display of the FRG-9600 to be read directly in MHz by simply ignoring the most significant digit (the 1 in 100 MHz). Unwanted mixing products are reduced about 20 dB by the use of a commercial double balanced mixer. Overall gain of the converter is about 0, which retains the original sensitivity characteristics of the receiver. Finally, all the antenna switching is automatic when the converter is activated. The basic converter block diagram is shown in **fig. 1**.

circuit description

The complete schematic diagram for the converter is shown in **fig. 2**. Power is provided from the auxiliary 8 volt RCA phono jack on the back panel of the FRG-9600. This jack can deliver 8 volts at 200 mA, more than enough for the converter. Power is applied through switch S1 and a protective diode. When the converter is off, relay K1 is not energized and the antenna connection from the VHF/UHF jack on the converter is straight through to the FRG-9600. When S1 is closed, the converter is activated and K1 is energized, switching to the HF antenna and the output of the up-converter.

Signals from the HF antenna jack are applied to a

By Ernie Guerri, W6MGI, *ham radio*, Greenville, New Hampshire 03048

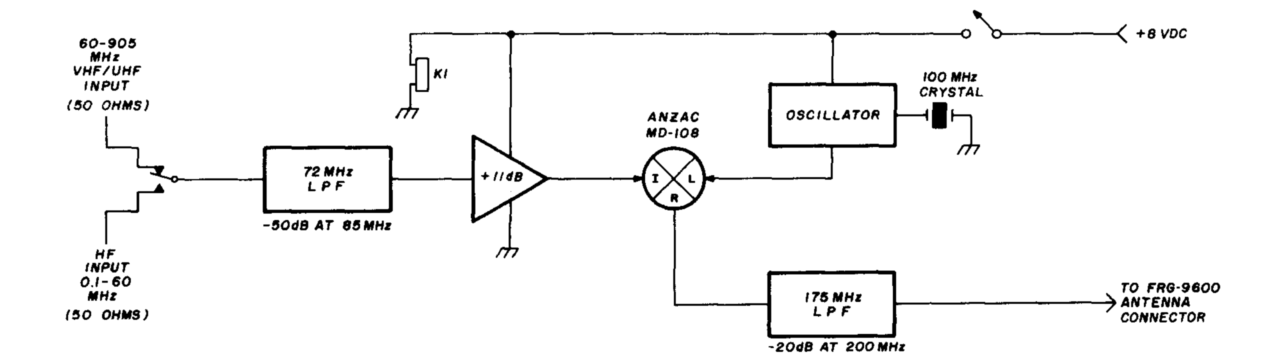

fig. 1. FRG-9600 HF converter block diagram.

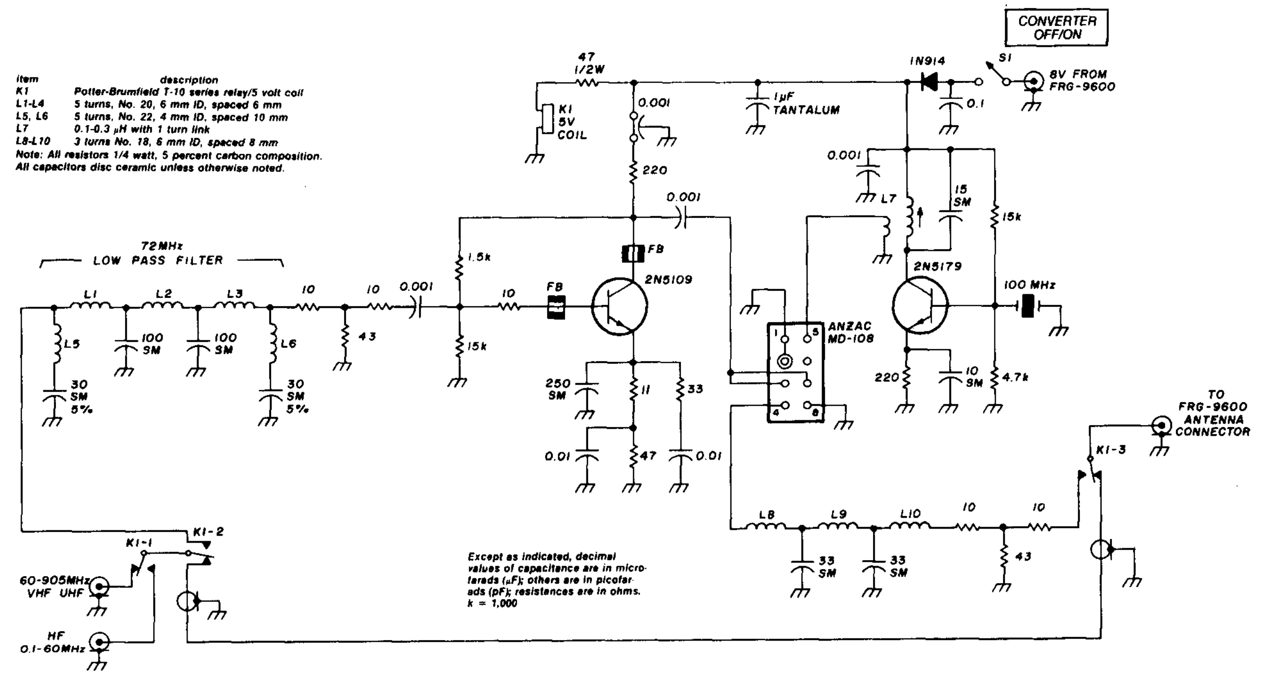

fig. 2. FRG-9600 HF converter 0.1-60 MHz.

low-pass filter and broadband large-signal amplifier. The amplifier stage uses a 2N5109, which is designed for low distortion, large-signal CATV applications. Note the rather complex network in the emitter of the 2N5109. This network shapes the overall response of the amplifier stage, making it quite flat from about 1-90 MHz. Gain of this stage is approximately 11 dB, and the noise figure is about 4 dB — more than adequate for general purpose HF work. The RF stage can handle input signals of approximately 0 dBm before any observable compression takes place.

The input filter is absolutely essential to the operation of the converter. Because the output of the converter is in the middle of the commercial FM band, it's important that FM signals through the RF amplifier be heavily suppressed. The input filter has a cutoff frequency of 72 MHz and is down 50 dB at 85 MHz. The filter should be built in close compliance to the design shown. The use of silver mica capacitors is a must, and they should have the shortest leads you can work with. Be sure that L2 is oriented 90 degrees to L1 and L3 so that no coupling takes place between any of the inductors. This same precaution applies to the inductors in the output filter. Note that these filters are terminated by a simple resistive pad to assure that their characteristics are preserved with reactive terminations.

Because the 2N5109 is capable of considerable gain well into the VHF region, good VHF practice should be followed in layout and construction. All capacitor leads should be as short as possible. Ferrite beads on the base and collector leads suppress any tendency the stage might have to oscillate at VHF. The prototype showed no instability under any operating conditions. The mixer and local oscillator are straightforward. The 2N5179, used with a 100 MHz series resonant crystal will deliver about +8 dBm of LO power to the mixer — just right for the MD-108. This particular oscillator design is not very low-noise, but it's easy to use and adjust, and phase noise is not a major consideration in this application. Simply adjust the slug in L7 until the oscillator starts reliably each time. If you have an RF voltmeter, adjust L7 for maximum signal at pin 5 of the balanced mixer.

The Anzac MD-108* is a low cost general purpose mixer good to several hundred MHz. Other general purpose units should perform equally well. Since the mixer creates products and harmonics of the input signals, some precautions are in order. Because we're using the mixer to up-convert, the RF and IF ports are reversed from their normal order (see **fig. 1**). The output is taken at pin 4, and consists of some HF feedthrough, plus the mixing products of 100 MHz. The 175 MHz low-pass filter assures that we do not hear products that would otherwise be repeated, with diminished amplitude, every 100 MHz throughout the receiver tuning range.

construction and comments

Construction details are best left to each user. I used an LMB CR-800 enclosure that matches the appearance of the FRG-9600 nicely, but any *well-shielded* box will serve as an adequate enclosure. Construction on a piece of epoxy-glass circuit board material is simple and effective. Lay out the circuit more or less as the schematic is drawn, and you should have no problems. I strongly recommend using the exact component values shown for best results. Be sure that the cable from the converter to the FRG-9600 is high-quality coax to prevent signal leakage that would reduce the effectiveness of the low-pass filters.

The individual filters, active circuits, and the completed converter were characterized using a Tektronix 7L14/TR502 spectrum analyzer/tracking generator combination.

*Check pin designations carefully, several different configurations exist. RadioKit will provide a complete kit of parts, including PC board.

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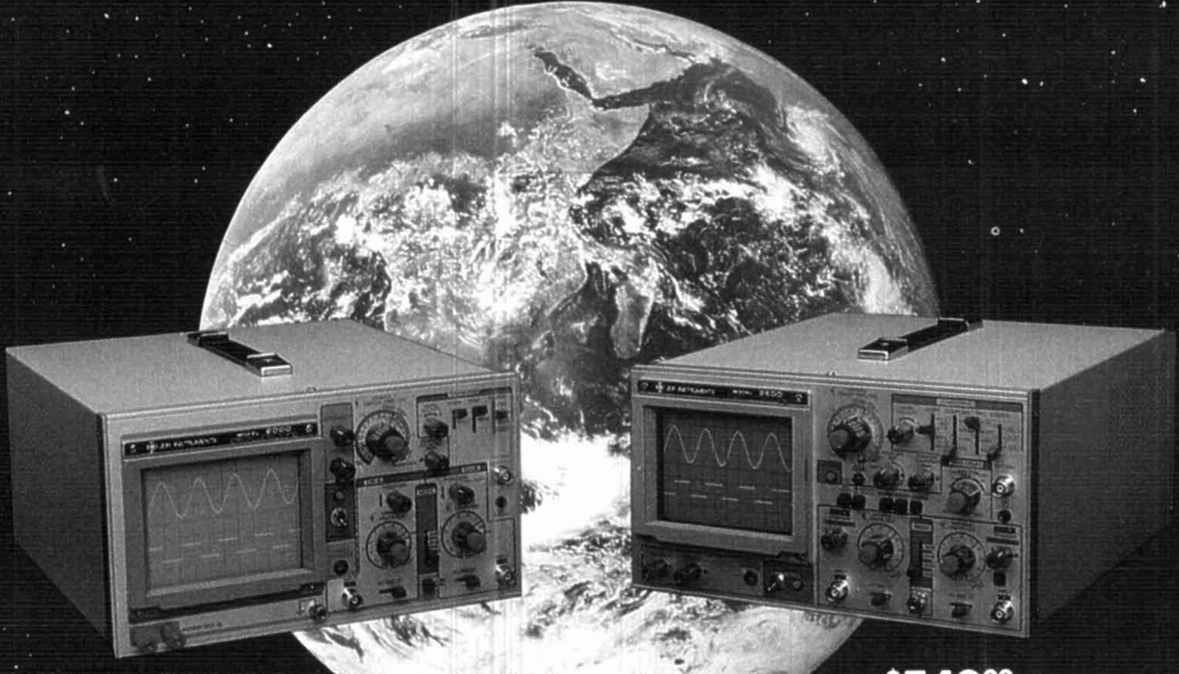

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Accessories. A variety of slide-on battery packs are available for the IC-02AT and IC-2AT, including the new long-life 800mAh IC-BP8 which can be used with both handhelds.

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.

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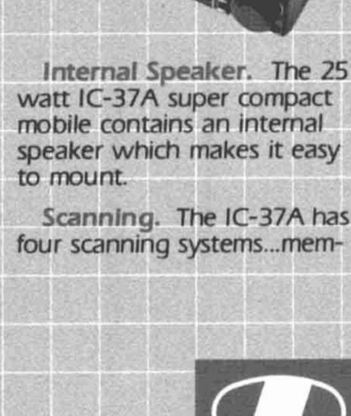

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Bill Orr W6SAI

first, the bad news

"How long will we have to wait until the sunspot cycle improves?" More and more Amateurs are migrating to the low frequency bands as the popular, higher-frequency DX bands are becoming more spotty. Ten meters is nearly deserted, except for an occasional north-south opening and some wandering ignition noise. And 15 meters isn't much better! Even 20 meters is a pale imitation of its former robust self.

Predicting when the sunspot minimum arrives and when the new sunspot cycle begins is a chancy business best left to the experts. A good guess indicates that sometime between winter, 1986, and spring, 1987, may be the turning point at which we move on to the next new cycle.

But several months of the new cycle must elapse before the high-frequency bands will come alive. Fall 1987 may be a good time to take the 10-meter beam out of mothballs and get it up in the air. That's two years away!

Meanwhile, there's a migration to the lower frequency bands and hams are turning to dipoles, inverted-Vs, delta loops and slopers. Certainly, some big DX "guns" have full-size 40 and 80 meter beams, but such monster antennas are out of the question for most operators.

now, the good news

Although we can't fool Mother Nature, there's still a lot of DX and good operating pleasure left on the "DC bands." As far as DX goes, many operators have made DXCC and won other juicy awards on both 40 and 80 meters. And I understand that Wal, W8LRL, has over 200 countries to his credit on 160 meters!

One of the better newsletters about 160-meter DX is published by Ivan Payne (VE3INQ). Send two IRCs and a business-sized envelope to Box 276, Station A, Weston, Ontario, Canada M9N 3M7 for this 22-page bulletin that will prove to you that DX is alive and well on 160 meters.

Along this line, Ivan's newsletter describes a simple 160-meter DX antenna, sketched in **fig. 1**, used at VS5RP by Bob Parkes (P29BR). Basically, it's a short, vertical antenna top-loaded by a single wire and inductively coupled by a toroid transformer to a coax line.

Bob recommends using from 25 to 40 radials. In his particular location, taking ground resistance into effect, he estimates the antenna's efficiency to be about 40 percent.

With regard to the radials few Amateurs can lay out 135-foot (40.7-meter) quarter-wavelength, 160-meter radials. The solution is to simply do the best you can. Several ground rods at the antenna feedpoint are useful, as well as a square of 1-inch (2.54 cm) mesh chicken wire laid on the ground. Dennis Peterson, N7CKD, uses a 30-foot square of chicken wire for a 160-meter ground screen plus other random ground connections to a metal fence.

The Canadian Top Band News also points out that long-path openings occur on the 160-meter band, citing the contact between AA1K (Delaware) and YB5AES (Indonesia) at 2205Z in October, 1984, as well as the contact between VE1ZZ (Nova Scotia) and 9M2AX (Malaysia) at 2323Z in January, 1985.

Finally, it should be pointed out that there's a 160-meter net active on Saturdays at 1600Z on 14.260 MHz and also on Tuesdays and Thursdays on 1840 kHz at 0400Z. DX and antennas are the main topics of conversation.

Speaking of antennas. . .

a very compact antenna for 160 meters

You can't get a full-size dipole up on 160 meters? You have a poor ground? You can't make a low resistance ground connection? Join the club! Most Amateurs have one or more of these problems. Unless you live in the middle of a large salt marsh, you're going to have to make compromises in your "top band" antenna system.

Some lucky Amateurs have enough space to squeeze in a large vertical antenna and lay out a number of radials. And others can erect loaded dipoles, or some form of Marconi antenna with a good ground system. But what about the rest of us?

A friend of mine wanted to get on 160 meters. He had about 55 × 25 feet (16.76 × 7.61 meters) in his backyard to work with, and his ground was terrible — rocky, sandy soil.

The only simple solution I saw was to erect a highly-loaded dipole antenna about 50 feet (15.2 meters) long. That would fit in the available space, and the dipole doesn't rely upon a ground connection to function properly. Such an antenna is shown in **fig. 2**.

The design is based upon a readily

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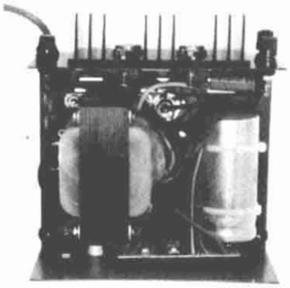

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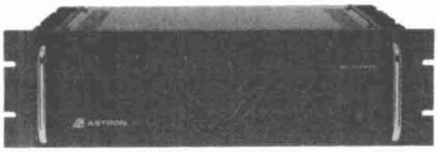

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RM-50A	37	50	5¼ × 19 × 12½	50
RM-35M	25	35	5¼ × 19 × 12½	38
RM-50M	37	50	5¼ × 19 × 12½	50

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MODEL RS-7A

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RS-4A	3	4	3¾ x 6½ x 9	5
RS-7A	5	7	3¾ x 6½ x 9	9
RS-7B	5	7	4 × 7½ × 10¾	10
RS-10A	7.5	10	4 x 7½ x 10¾	11
RS-12A	9	12	4½ x 8 x 9	13
RS-20A	16	20	5 x 9 x 10½	18
RS-35A	25	35	5 x 11 x 11	27
RS-50A	37	50	6 x 13¾ x 11	46

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RS-20M	16	20	5 x 9 x 10½	18
RS-35M	25	35	5 x 11 x 11	27
RS-50M	37	50	6 x 13¾ x 11	46

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- Current limit adjustable from 1.5 amps to Full Load

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VS-20M	16	9	4	20	5 x 9 x 10½	20
VS-35M	25	15	7	35	5 x 11 x 11	29
VS-50M	37	22	10	50	6 x 13¾ x 11	46

RS-S SERIES

MODEL RS-12S

• Built in speaker

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

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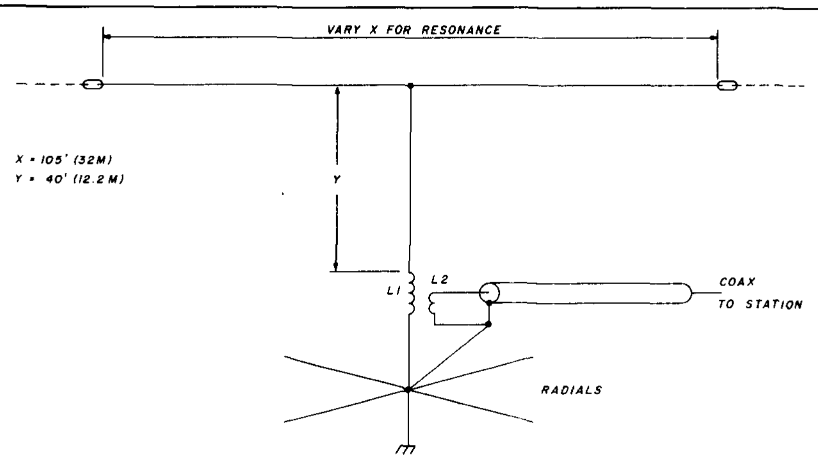


fig. 1. 160-meter antenna at VS5RP. L1, 28 turns No. 14 enamel; L2, 20 turns No. 14 enamel. Both L1 and L2 are wound on a 2-inch (5.08 cm) toroid, μ = 10 (Amidon T-200-2 or equivalent). Vary turns of L2 for best match.

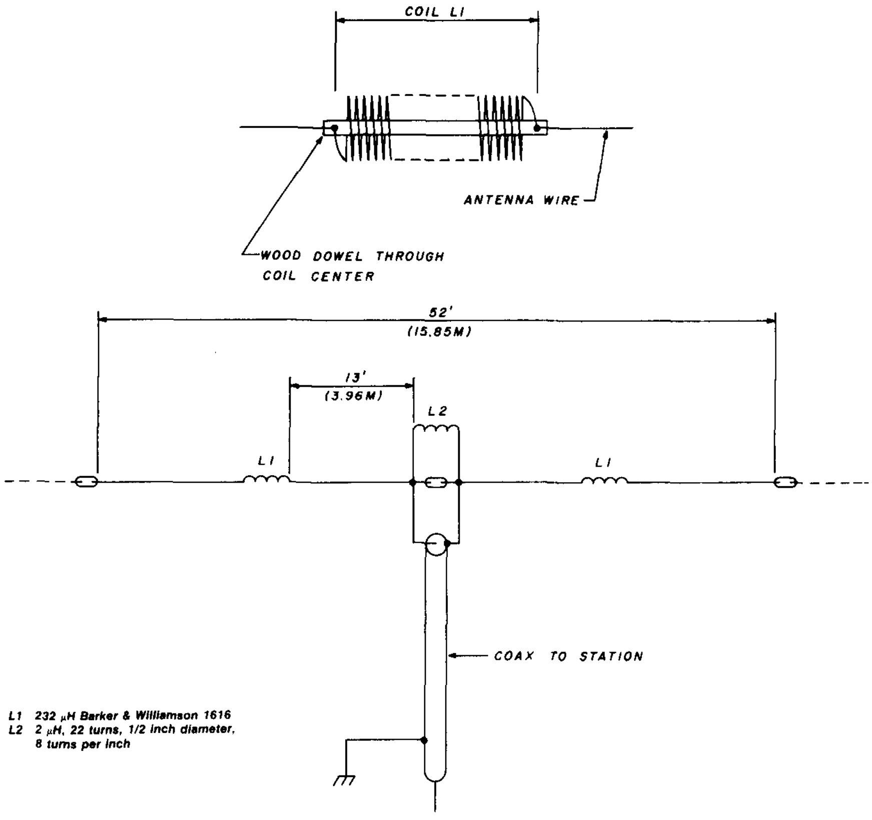


fig. 2. Assembly data for 160-meter "mini-dipole."

available, high efficiency loading coil: the Barker & Williamson* 1616 inductor. This coil is air-wound, 2 inches (5.08 cm) in a diameter and 10 inches (25.4 cm) long. It has 16 turns per inch of tinned copper wire. (It's also available with Formvar® coated wire, which should provide somewhat better efficiency than the tin plating when the coil is used in antenna service.)

Two of these ready-wound coils are used in this antenna, one in the middle of each leg. Since the coils are somewhat fragile, they're supported on an insulator made of a wood dowel rod cut to the same length as the coil. The ends of the antenna wires are passed through small holes drilled in the dowel, removing tension from the concentric coil.

The radiation resistance of the antenna is about 3 ohms, but the feedpoint resistance is close to 20 ohms, due to the loss of the coils. This results in an antenna efficiency of about 13 percent. This may make purists who have experienced little loss in their high-frequency antennas shudder, but the 160-meter band is a different matter and most of the small antennas used by Amateurs on this band exhibit a comparable degree of efficiency. The radiated signal, then, is about 8 dB down from that of a 100 percent efficient antenna (a dipole, for example).

A simple matching coil is placed at the center of the antenna to match it to a 50-ohm coax line. When properly adjusted, the antenna has a bandwidth of about 25 kHz between the 2:1 SWR points on the feedline.

antenna adjustment

The first step after building the antenna is to sling it up between two temporary points, allowing it to sag down until the center feedpoint can be safely reached from the top of a step ladder. The halves of the antenna are shunted with a two or three-turn link coupled to a dip oscillator. The resonant frequency of the antenna is carefully measured (with the aid of a calibrated receiver) and the antenna tip sections trimmed equally, a few inches at a time, until the antenna is resonant at your design frequency. (This one was cut for 1820 kHz.)

The pickup coil is removed and another coil is installed for matching to the coax feedline. The antenna is erected in its final operating position. The number of turns in the matching coil is then adjusted until unity SWR is obtained at some frequency near the design frequency. You'll find that the presence of the coil tends to detune the antenna a bit, and by the time

*Barker & Williamson, 10 Canal Street, Bristol, Pennsylvania 19007.

you've achieved a good match, the resonant frequency of the antenna will have moved.

The final step is to readjust the tip sections equally until the resonant frequency is back where you want it.

The whole process sounds tedious, but it's really not. The experimental antenna was built at an easy pace over one weekend and all adjustments were made during one morning of the following weekend.

And the antenna works fine! Granted, bandwidth of operation is restricted and antenna efficiency is low. However, running 150 watts input, contacts across the continent have been made on the band and, unless attention is drawn to the unusual antenna, most operators "on the other end" will assume you have a full-size dipole, judging from the reports my friend has received with his little antenna.

using an antenna tuner

Smart 160-meter operators know that a narrow-band antenna such as this compact dipole can be "pulled" in frequency by using an antenna tuner at the station end of the coax feedline. The very high off-resonance SWR exhibited by the antenna can be reduced to an acceptable value by the tuner. Experiments have shown that the antenna, with a simple tuner, permits operation over 100 kHz of the 160-meter band., And that's not bad for such a midget!

keep TVI to a minimum!

Two words of caution on this familiar topic: try *not* to run the antenna parallel to the house wiring system. It's easy to couple power from any 160-meter antenna into the house electrical wiring, but doing this can cause TVI, RFI, and other undesired reactions. In addition, since the coil loss of the antenna is high, don't try to run a lot of power into it. A good limiting figure for this antenna is 150 watts, so it will work OK with your exciter, but you'll burn up your antenna coils if you run your linear amplifier into it.

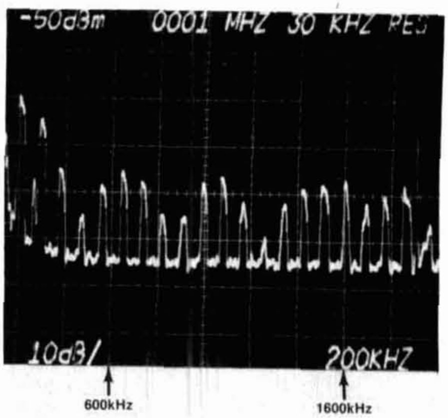


fig. 3. RF lighting device emissions (courtesy *Broadcast Engineering*).

I understand Barker & Williamson can supply coils with LEXAN® insulation instead of cellulose acetate or plexiglass. The extra cost of LEXAN is justified because it's impervious to the ultra-violet radiation from the sun that quickly destroys the plastic supports in the regular coils. A LEXAN-insulated coil wound with Formvar-coated wire sounds like the ideal inductor for any long-life loading coil exposed to the weather.

the RF light bulb

In my June, 1984, column I mentioned the possibility of RFI from the next generation of light bulbs. Although the subject lay dormant for months, the threat is real. In a recent issue of *Broadcast Engineering*, M.C. Rau, of the National Association of Broadcasters, wrote:

The pending introduction of RF lighting technology will significantly cut energy costs, by replacing the ubiquitous incandescent light bulb with RF devices. Unfortunately, many RF lighting devices emit energy at AM broadcast frequencies, both over the air and through the power line [**fig. 3**]. *A current FCC Notice of Inquiry is exploring the issues of lighting, the need for regulation of such equipment, and interference protections to be provided to the AM radio service.*

If RF lighting significantly increases interference over existing devices, NAB should act to ensure that the FCC adopts regulations carefully designed to protect the AM radio service.[1]

Well said! But a glance at the right-hand portion of the plot of **fig. 3** shows that RF emissions continue well above 1600 kHz, into the HF spectrum and probably the 160-meter and 80-meter Amateur bands.

It would be well for some enterprising Radio Amateurs who have appropriate facilities at hand to examine RF light bulbs, to see what problems they produce in the HF spectrum. NAB is doing a good job — as far as they go — but they have little interest above 1600 kHz. A word to the wise. . .

the 2-meter EME directory

I have additional copies of the 16-page 144 MHz EME Directory of active "moonbounce" participants compiled by Lance Collister, WA1JXN. You can obtain a copy by sending four first-class postage stamps (or four IRCs) to me at EIMAC, 301 Industrial Way, San Carlos, California 94070. (Don't send an envelope — we have oversize ones especially for this directory.)

reference

1. Michael A. Rau, "Charting a Course for A.M. Improvement," *Broadcast Engineering*, April, 1985.

ham radio

short circuit

tapered vertical

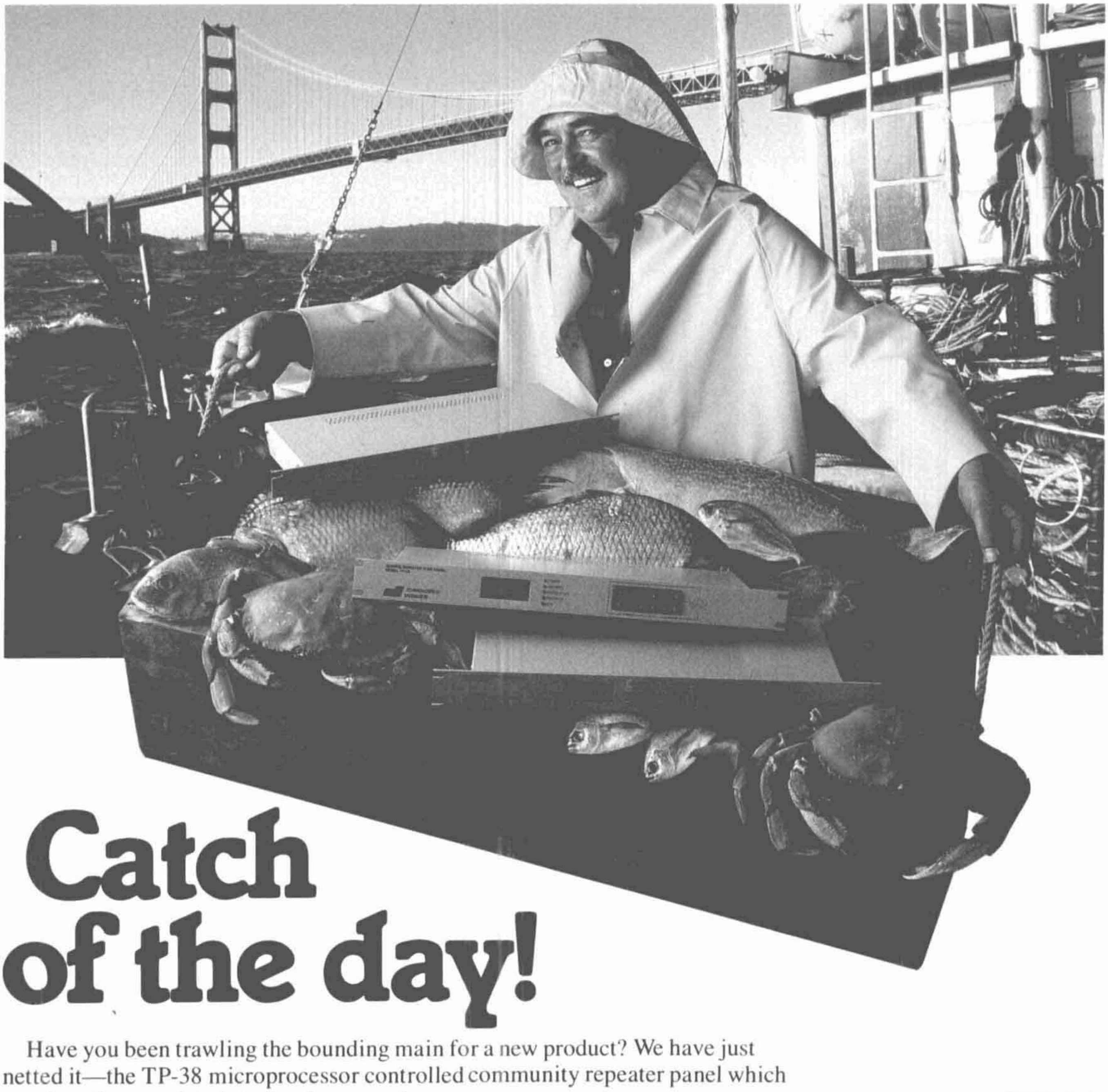
A misplaced parenthesis in "Calculating the Impedance of a Tapered Vertical" (K3OQF, August 1985, page 25) resulted in an incorrect calculation in **eq. 1**. The corrected equation should read as follows:

$$Z_0 = 60 \ln\left(\frac{2L}{b}\right) + 60\left(\frac{t}{b-t}\right)\cdot \ln\left(\frac{t}{b}\right)$$

Upon substituting values on page 26, Step 1

$$Z_0 = 60 \ln\left(\frac{2\cdot 720}{1.5}\right) + 60\left(\frac{0.375}{1.5-0.375}\right)\cdot \ln\left(\frac{0.375}{1.5}\right) = 384.3$$

All the other formulas and evaluations are correct. (TNX N6DH — Ed.)



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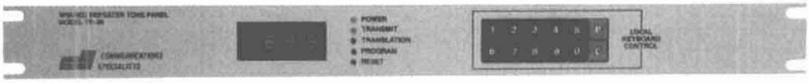

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★ RECOMMENDED READING — OF INTEREST TO ALL

VHF/UHF WORLD

Joe Reisert W1JR

transmission lines

When I first started this column almost two years ago, I made a list of the most important subjects that VHF/UHF/SHFers talk about. One was transmission lines, a subject I've only passively addressed in prior columns. Since I'm often asked to suggest a transmission line to someone, I thought this would be a good time to review the whole gamut of transmission line characteristics. Tradeoffs and data is presented so that you can select the optimum transmission lines for your applications.

Transmission line losses can be just as important as antenna gain, especially to the VHF/UHF/SHFer. If the same transmission line is used for both the receiver and transmitter, each dB of loss reduces the system capabilities by 2 dB (1 dB on receive sensitivity and 1 dB on transmitted power).

Often an antenna mounted preamplifier is used, especially on EME, to circumvent the received signal loss. This can be a costly and complex solution that helps only on the received signal.

transmission line types

There are many types of transmission lines. The most common are coaxial cable and balanced line on the lower VHF/UHF frequencies and waveguide on the SHF frequencies. Microstrip and stripline are types frequently used in low power and receiver type circuits. Lesser known or used types are the "G" line and Yagi types.

transmission line characteristics

Everyone knows that the purpose of a transmission line is to transfer power from one place to another. But most forget that a transmission line is nothing more than a low-pass filter.

Figure 1A shows the equivalent circuit of a balanced line, while **fig. 1B** shows the same for an unbalanced line. If the values of L and C are known, the impedance can be determined as follows:

$$Z = \sqrt{\frac{L}{C}} \qquad (1)$$

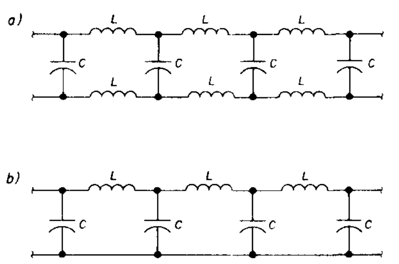

fig. 1. Representative circuits for a transmission line: (a) balanced line and (b) unbalanced, such as coaxial line.

where Z is the characteristic impedance and L and C are the inductance in henries and capacitance in farads per unit length, respectively, of the transmission line. For example, if the L is 73 nanohenries and the capacitance is 29 pF for the same unit length (12 inches or 30.5 cm), the characteristic impedance is approximately 50 ohms. Terminating this line in 50 ohms will yield a 1:1 VSWR.

parallel balanced lines

This type of transmission line is often referred to as open wire or twinlead (**fig. 2A**). Well known and widely used in the past, it's seldom used nowadays except in stacking harnesses.[1] Open wire lines are usually inexpensive to make or purchase. Also, if properly constructed, the insertion loss is usually quite low.

The impedance of an open wire line is a function of the spacing of the wires, the dielectric between them, and the diameter of the conductors. The correct formula for determining the impedance of a symmetrical open wire line with air as a dielectric is:

$$Z_0 = 120 \cosh^{-1} \frac{b}{a} \qquad (2)$$

where a is the diameter of the conductors and b is the center-to-center spacing of the conductors in the same unit of measure as a (**fig. 2A**).

However, if the spacing is much greater than the conductor diameter (the usual case), a simpler formula can be used:

$$Z_0 = 276 \log_{10} \frac{2b}{a} \qquad (3)$$

From these formulas it is obvious that the most practical impedances are between 200-600 ohms. To prevent feedline radiation, the spacing should not exceed 0.05 wavelength at the frequency of operation. Despite rumors to the contrary, open wire lines do not radiate power even when the VSWR is high if the lines are properly constructed and kept well balanced.

On the negative side, balanced lines must be kept as straight as possible and away from nearby objects. Bends should be gradual, typically less than 45 degrees, and other adjacent lines or objects should be at least 2 to 3 times the width of the line away. This is a practical problem when multiple antennas or transmission lines are present and especially if a rotator is involved. Furthermore, open wire lines are often affected by moisture and insulator contamination, especially if the VSWR is high on the line. Therefore, the number of insulators should be kept at a minimum commensurate with maintaining proper spacing.

Twin lead is an acceptable type of balanced transmission line, but because it has a dielectric, it's typically lossier than open wire line. And unless you use the heavy duty type (such as

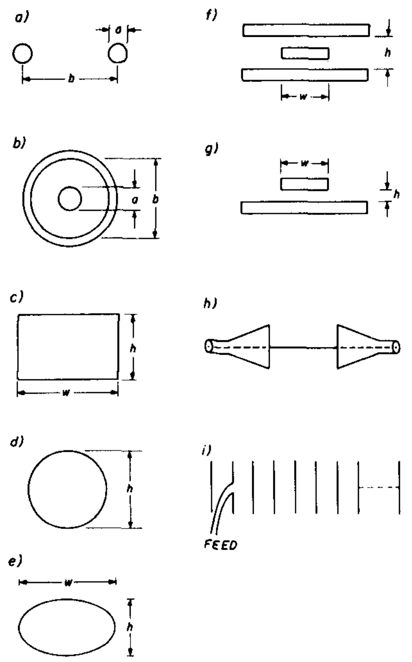

fig. 2. Typical transmission lines and their important dimensional parameters: (a) open wire line; (b) coaxial line; (c) rectangular waveguide; (d) circular waveguide; (e) elliptical waveguide; (f) stripline; (g) microstrip; (h) G line; (i) Yagi line.

K200), the power handling capability can be moderate to low. Furthermore, twin lead is often more affected by moisture than open wire line since it has a larger surface area.

coaxial transmission lines

Because of these problems with balanced lines, coaxial cable — in plentiful supply and in so many varieties — has become very popular. It can usually be bent and placed directly alongside other lines without the degradation associated with open wire or twin lead. The availability of accurate coaxial types of VSWR and power meters has further contributed to the use of this type of line.

Coaxial cables are often referred to as TEM (transverse electromagnetic) structures. They are an unbalanced type of transmission line. The impedance is a function of the dielectric as well as the ratio between the inside diameter of the outer conductor and the outside diameter of the inner conductor (**fig. 2B**). The impedance for an air dielectric coaxial transmission line can be readily calculated using the following equation:

$$Z_0 = 138 \log_{10} \frac{b}{a} \quad \textbf{(4)}$$

where a is the outside diameter of the inner conductor and b is the inside diameter of the outer conductor in the same units of measurement (**fig. 2B**). For example, if the inner conductor diameter is 0.25 inch (6.35 mm) and the inside diameter of the outer conductor is 0.572 inch (14.6 mm), the characteristic impedance of the line will be approximately 50 ohms.

As with the spacing of the open wire line, the inside diameter of the outer conductor limits the upper frequency of operation. Roughly speaking, the upper frequency limit of a coaxial cable, the point at which other modes will propagate, is reached when the circumference of the inner diameter of the outer conductor is greater than approximately 1 wavelength at the frequency of interest.

waveguide

There was a time when waveguide was used as low as 200 MHz! It is by far the lowest-loss type of transmission line but is very costly and physically large below SHF. Waveguide can be either rectangular, circular, or elliptical (**figs. 2C, D,** and **E**).

Although the rectangular type is the most common, it's difficult to work with and often is referred to as "plumbing." The most common rectangular waveguide is used in the dominant or TE 1, 0 mode.[2] It's usually twice as wide as high and covers only about an octave in frequency. The width would be about 1/2 wavelength at the lowest usable frequency.

Elliptical semi-rigid waveguide is becoming more popular especially on microwave links since it can be moderately bent without distorting the characteristics. Circular waveguide is usually used in the below cutoff mode. It's very often found in precision attenuators and on the air outlets of high-power vacuum tube transmitters.[3]

Nowadays, coaxial cables are overtaking the use of waveguide as high as 26 GHz primarily because they're easier to work with. For those more interested in waveguides, reference 2 or any waveguide manual is recommended.

strip transmission lines

Microstrip and striplines are becoming very popular especially in receiver circuits. Often they are improperly identified by Amateurs. The true stripline is configured like a sandwich (**fig. 2F**). Note that it has a top and bottom, so essentially it is completely shielded.

Microstrip is by far the most common type of printed transmission line and is like an open-faced sandwich (**fig. 2G**). The field is not constricted to just the region between the strip and the substrate. Some field lines exist from the top of the strip to the substrate. Hence it is somewhat more difficult to design if there are tuned lines or adjacent circuitry. Other strip type of transmission line variations such as suspended substrate are also used, but they are beyond the scope of this month's column.

lesser known transmission lines

Up to this time I have been concentrating on the more popular types of transmission lines. The "G" line (**fig. 2H**) is a frequently overlooked transmission line that has some very interesting properties.[4,5,6] Originally called a surface wave transmission line, it was later named after its inventor, the late Dr. Georg Goubau, who designed the first such line in 1950. It resembles the "string telephones" that many of us made and used when we were children.

This type of transmission line operates in the TE mode. The launcher is like a large cone. The incoming line, usually a 50-ohm line, is impedance matched at each end to a single wire that travels the full length of the transmission line, primarily in the magnetic field.

If the wave is properly matched into the launcher at the input end, it will travel along the single wire to the complimentary launcher at the opposite end. The attenuation will be extremely low provided that the launcher is properly fabricated, the impedance is matched and the correct wire is used.

Recently I had a chat with Warren Weldon W5DFU, who has done extensive work on a 23-cm tropo installation using this type of line.[7] He told me that the lowest loss line he constructed used No. 14 AWG (0.062 inch or 1.6 mm) Teflon™ covered 0.015 inch (0.38 mm) stranded wire that had only 1.2 dB per 100 feet (30.5 meters) of insertion loss at 23 cm! For those who can't afford expensive transmission lines on the UHF/SHF bands, this could be a real breakthrough.

At the ARRL National Convention in San Jose, California in 1965, Dr. Donald K. Reynolds, K7DBA, described a most interesting transmission line (**fig. 2**). It consisted of a Yagi-like structure analagous to the slow wave portion of a conventional long Yagi antenna. He indicated that if the proper spacing and element length were chosen (I believe he used 1/8 inch or 3.2 mm diameter wires approximately 0.4 wavelength long and spaced about 0.4 wavelength) that the line loss would be very low. He used a piece of flexible fiberglass to hold the rods. Although this type of structure could be frequency sensitive, it could have great potential, especially on monoband setups.

coaxial cable characteristics

So far in this column I've been talking in generalities, emphasizing that the coaxial cable type of transmission line is by far the most popular type at this time. Because this is true, I'll devote the rest of this column detailing other important things we should also know before we can select the optimum coaxial cable for our installations.

One of the first things that comes to mind is the dielectric. Typically speaking, air is the best dielectric because it has the lowest loss. However, this can be misleading. This is true only if the air is dry. Any moisture present will increase the loss dramatically.

One of the earliest coaxial cables was RG-8, which I believe was developed for radar installations during World War II. It turned out to have an impedance of 52 ohms. One of the advantages of a solid dielectric is that it is not likely to be affected by moisture.

The early dielectrics were principally made of polyethylene. Later the losses were decreased by using different types of foam. Some of the modern foams are almost as low-loss as air. But foam is not without its problems. Since it is usually softer than standard polyethylene, it can deform and even "cold flow." This is particularly true of Belden 8214 50-ohm line, so if you're using this type of line, don't bend it too sharply.

While on that subject, most coaxial cables have a minimum bend radius that should not be exceeded. It can be found on the manufacturers' data sheet, but as a rule of thumb, never bend a coaxial cable less than five and better yet ten times the cable diameter. For RG-8 type this would be approximately 2 to 14 inches (15 to 10 cm).

Some coaxial transmission lines are much better for bending. Rigid lines such as waveguides are not readily bendable. Don't be misled by the term "semirigid," because this type of cable is often very stiff and can usually be bent only once. Subsequent bends may break the outer shield. Generally the cable suitable for the jumper around a rotator are the ones that use a dielectric and braided shield such as RG-8/U and RG-213/U (more on this later).

attenuation and power

Probably the most important parameters when selecting a transmission line are insertion loss and power rating. Several factors affect these parameters, including impedance, size, dielectric, conductor material, and frequency of interest.

It is well known that the insertion loss of a transmission line is affected by the characteristic impedance. The lowest loss per unit length is between 180-220 ohms for open wire line, 70-75 ohms for microstrip and 75-80 ohms for coaxial cables. Coaxial transmission line loss versus impedance is shown in **fig. 3**. This is the principal reason the CATV industry uses 75-ohm impedances.

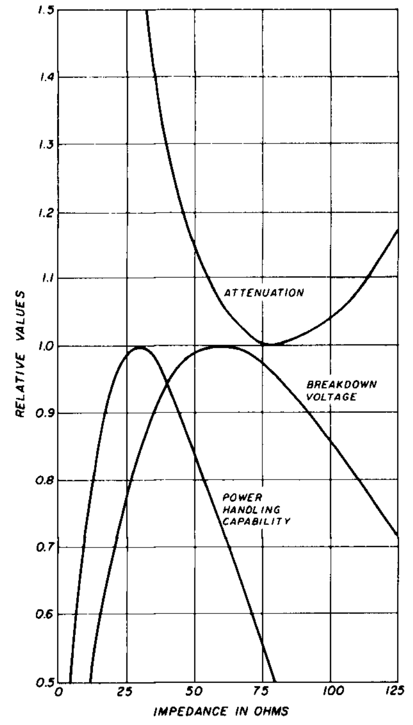

fig. 3. Some of the important parameters of a coaxial transmission line versus impedance such as attenuation, power handling, and voltage breakdown (adapted from reference 2).

Why isn't 75 ohms the Amateur standard, too? Well, there are other properties of coaxial transmission lines that also must be considered: power handling and voltage breakdown, for example. Note on **fig. 3** that the best power handling occurs in the vicinity of 30 ohms, while the best breakdown voltage is around 60 ohms. Hence the American standard of 50 ohms, a compromise between power and attenuation. (In some parts of Europe 60 ohms is the standard. Fifty ohms, however, is now becoming quite universally accepted, mainly because of all the test equipment and coaxial connectors available at that impedance.)

Material and size are also important: copper is the lowest-loss conductor;

aluminum has a higher loss but it is often used to minimize weight and cost. Frequently a copper-plated aluminum center conductor — such as found in the CATV industry — is used. The larger its physical size (as long as you don't exceed the cutoff frequency previously mentioned), the lower the loss and the higher the power handling capability. No wonder broadcast stations use such large transmission lines!

Coaxial transmission lines use many types of dielectrics. Using air as a dielectric can be an expensive proposition that often requires special connectors and a nitrogen pump to keep the air purged and hence non-contaminated.

Teflon™ dielectric cables such as the 0.141 numbered types of microwave semirigid coax are often used by Amateurs.[8] Recently RG-141/U and similar Telfon™ types of coaxial cable have become popular in situations where high power is required on a small diameter toroidal balun and on VHF/UHF antennas where a 1/2 wavelength balun is used.[9]

Modern foams are very low-loss dielectrics. This is particularly evident in the Belden 8214 and the newer 9914 RG-8 types of coax. The Andrew Corporation has introduced a dielectric called LDF (low dielectric foam) that rivals the loss of air lines. I'm sure that improvements will continue to be made as the requirements for smaller and lower loss coaxial cables increases.

Without a doubt, the most important question Amateurs are constantly asking is "Which coax is best?" This isn't an easy question to answer.

In order to help you decide, I prepared **table 1**. It lists most of the popular coaxial cables used by VHF/UHF Amateurs along with velocity factors. Insertion loss per 100 feet (30.5 meters) and maximum power ratings at 100 and 1000 MHz are also listed. These are manufacturers' typical ratings. A new coaxial cable in good condition should have an insertion loss that is equal to or less (but not much less!) than the figures shown.

You may ask what good the information is since it's specified only at 100 and 1000 MHz rather than on Amateur bands. Fortunately insertion loss increases at a somewhat logarithmic factor. To find the approximate insertion loss at a higher frequency for 100 feet (30.5 meters) of coaxial line, use the following straightforward equation:

$$I.L. = A\sqrt{\frac{F_H}{F_L}} \qquad (5)$$

where $I.L.$ is the actual insertion loss in dB, A is the attenuation in dB at the reference frequency (100 MHz in this case), F_H is the higher desired frequency and F_L is the lower or reference frequency (100 MHz). Total insertion loss per foot/meter is linear, so if you have half as much coaxial cable, the loss will be half that shown.

For example, if we want to determine the loss of 100 feet (30.5 meters) of RG-8/U coax at 432 MHz using **eq. 5**, it will calculate to be approximately 4.6 dB. (See **fig. 4** which relates insertion loss to frequency. A few representative coaxial cables are included.) If you know the loss of any coaxial cable at a specific frequency, all you have to do is place a dot on the graph where the frequency and loss are known. Then draw a line through the dot, parallel to the lines already shown. You now can determine the approximate loss at the frequency of your choice without any calculations at all.

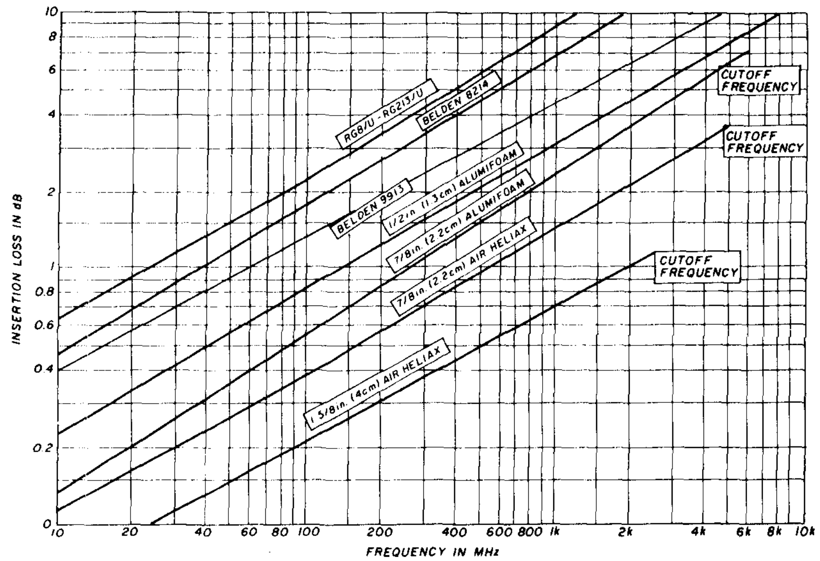

fig. 4. Attenuation versus frequency for 100 feet (30.5 meters) of some representative transmission lines. (See text for using this graph for other types of transmission line.)

Power handling is a more subjective rating, related to heating and breakdown. The rating can be approximated using the following equation:

$$P_X = P\sqrt{\frac{F_L}{F_H}} \qquad (6)$$

where P_X is the power rating at the desired frequency, P is the rating at a known low frequency, F_L and F_H is the desired higher frequency. For example, if we use the above example for RG-8/U, the power rating will be approximately 410 watts at 432 MHz. How many of you are exceeding this power level on 432 MHz?

Figure 5 shows power rating versus frequency for a few representative transmission lines. If you have a known power rating for another transmission line at a particular frequency, mark it on the graph, draw a line through the mark and parallel to those already shown, then read off the ratings at the desired frequency.

trade names

Some commercial transmission line

trade names are quite popular and often misused. The most common are Alumifoam™ and Heliax™. Alumifoam (often referred to as hardline) refers to a coaxial cable with a seamless aluminum outer shield and a low-loss foamed polyethylene dielectric. This type of feedline is quite common, especially in CATV systems.

Heliax is the trademark of the Andrew Corporation. In its early days, it resembled a helical or spiral corrugated outer shield, usually made of copper. The inner dielectric was either air or foam polyethylene and the center conductor was usually a copper wire or tubing.

In recent years the Andrew Corporation redesigned the foam type of Heliax and now uses an "annular" or concentric ring type of corrugation. This construction technique is supposedly less prone to moisture damage, since water seeping into the feedline would have more difficulty traveling down its walls than it would in the helical form of construction.

More recently the Andrew Corporation introduced an aluminum outer shield coax similar to the annular constructed line, but lower in cost and aimed mainly at the TVRO market. However, it has higher insertion loss than the standard copper shielded LDF types.

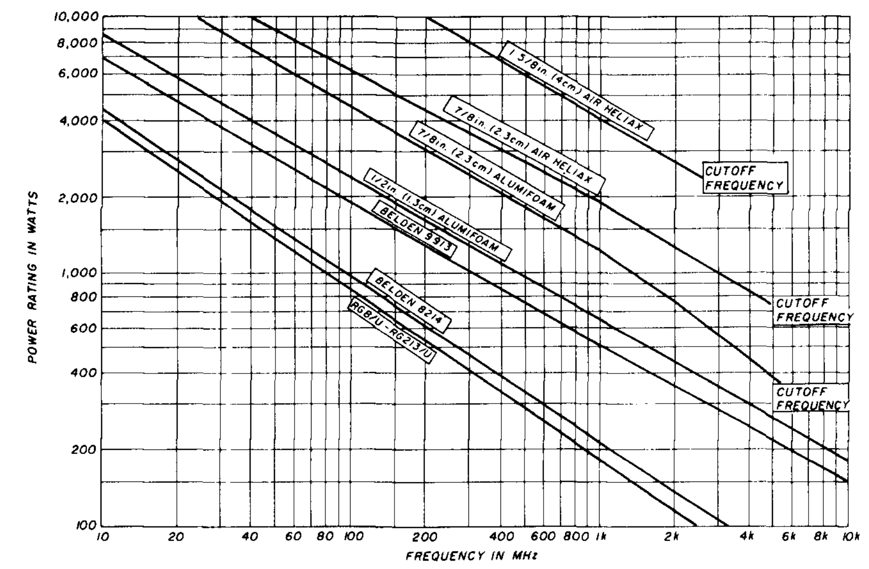

fig. 5. Power handling versus frequency for some representative transmission lines. (See text for using this graph for other types of transmission line.)

other mechanical considerations

The most common coaxial transmission lines are the braided and the solid shield. As suppliers have tried to lower costs, however, the number of strands in the braid has decreased remarkedly; as this decreases, so does the strength of the connection at the connector, resulting in increased insertion losses and decreasing shield effectiveness. At the same time, some of the better shielded types such as RG-214 have been priced right out of the Amateur market. In an attempt to offset these problems, some suppliers have introduced foil shielding, usually backed up by a few small strands of wire; although these changes are quite worthwhile, the shields are often hard to secure properly.

As mentioned before, flexible types of lines are recommended wherever bending or movement, such as around a rotator, are expected. Although these types usually have higher insertion loss, the Andrew Corporation has developed a special type of line called Superflexible Heliax,™ which has half the insertion loss of RG-8 or RG-213. In addition to the corrugated outer conductor, it has a stranded center conductor.

Most transmission lines can be buried without fear of water entry if they're free from nicks or holes in the outer sheath. The best types to bury are those that have a non-metallic outer protective jacket.

There's always the problem of getting the transmission lines into the shack. I use an ordinary clothes dryer vent and pass the feedlines right on through, stuffing an old rag into the rear of the vent to keep out rodents and lessen air flow.

Finally, there's the age-old question of contaminating versus non-contaminating jackets used on the typical polyethylene coaxial cables. Most RG-8 coax uses a contaminating jacket while RG-213/U doesn't. *Avoid the contaminating types of jackets at all cost. They're often slightly cheaper cables, but are not MIL SPEC. They start to deteriorate immediately, with sharp increases in insertion loss that can become disastrous in a few years. If you're not sure, don't buy it. If it's cheap, it's probably the contaminating type.*

connectors

Unfortunately, time and space will permit only a short discussion on this subject. I prefer type "N" connectors because they exhibit a good VSWR and reasonable power handling capability up to 500 MHz. *UHF connectors should be avoided at all cost, especially above 150 MHz. Not only are they poor on VSWR, but they often let in moisture.*

Hardline and Heliax types of coaxial cable require special connectors that are usually rather expensive but are necessary to preserve both the VSWR and integrity of the connection. This is particularly true of the air dielectric types. Failure to use the proper connector could allow moisture to enter and literally destroy the transmission line. Anyhow, why fight it? If

table 1. Typical characteristics of the most commonly used transmission lines by Amateur VHF/UHF/SHF'ers. Unless otherwise shown, all are 50 ohm types.

cable type	insertion loss in dB per 100 feet (30.5 meters) (see note 1) 100 MHz	1000 MHz	power handling in watts 100 MHz	1000 MHz	velocity of propagation
RG-58C/U	4.90	20.0	170	44	0.659
0.141 semirigid	3.60	11.6	2200	600	0.750
RG-8/U (note 2)	2.20	9.0	850	190	0.659
RG-213/U	2.20	9.0	850	190	0.659
Belden 8214	1.80	7.0	950	215	0.780
Belden 9914	1.60	6.0	1000*	250*	0.780
Belden 9913	1.40	4.5	1900	520	0.840
1/2-inch (1.3-cm) Heliax RG-268, RG-366/U	0.85	2.9	2200	570	0.790
1/2-inch (1.3-cm) Alumifoam RG-231/U, RG-331/U	0.82	3.1	2300	650	0.800
RG-17/U	0.80	3.8	3200	560	0.659
1/2-inch (1.3-cm) Air Heliax	0.80	2.7	2200	620	0.914
1/2-inch (1.3-cm) LDF Heliax	0.72	2.4	1900	530	0.880
7/8-inch (2.2 cm) Alumifoam RG-332/U, RG-333/U	0.55	2.3	4500	1250	0.800
3/4-inch (1.9-cm) ohm CATV	0.50	1.7	3300	950	0.800
7/8-inch (2.2-cm) Heliax RG-323/U, RG-324	0.50	2.1	4700	1200	0.790
1-inch (2.5-cm) 75-ohm CATV	0.40	1.4	4600	1200	0.800
7/8-inch (2.2-cm) LDF Heliax	0.39	1.4	5100	1400	0.890
7/8-inch (2.2-cm) Air Heliax	0.38	1.4	6100	1900	0.916
1-5/8-inch (4-cm) Heliax	0.30	1.4	9300	2000	0.790
1-5/8-inch (4-cm) LDF Heliax	0.23	0.9	14000	3500	0.880
1-5/8-inch (4-cm) Air Heliax	0.21	0.7	15000	4000	0.921

*Estimate.

Note 1. These are approximate maximum loss numbers for good quality new coax. In the case of air dielectric, these figures only apply if the cable is moisture free and is pressurized with dry air or nitrogen.

Note 2. The RG-8/U produced in recent years may have higher loss than noted.

you're using expensive line, use the proper connections and you won't lose what you've just gained!

Belden 9913 coax is becoming quite popular. However, the connectors are just becoming available and are quite expensive. In the meantime, UG-21B or Kings 59-207 connectors are recommended because they have an extra large and wide clamp that provides the necessary holding for the special foil and braid. In either case, the center pin of the connector has to be slightly enlarged with a drill, or the center wire of the coax must be filed down slightly, to gain access. The latter is *recommended.*

measurements

Always test each transmission line properly before installation. It's much easier to do this on the ground than after installation on a tower! Testing should be done with a VSWR/power meter such as the Bird Model 43 or equivalent. If you don't own one, plan to buy one and try to borrow one for the tests.

First connect the line under test to a good dummy load. Then place the VSWR/power meter between the output of a suitable transmitter and the transmission line to be tested. Next measure the VSWR looking into the line. It should be very low (typically less than 1.2:1 if the dummy load and the line are good).

Now measure the power going into the line under test. Then bypass the meter and place it at the load and again read the power. The difference in indicated power represents the insertion loss of the transmission line. If it's greater than the manufacturer's specifications, don't install it until you find the problem. After all, you don't want a dummy load between the shack and the antenna system!

Insertion loss always makes the VSWR of a load look better than it really is. In fact, a transmission line with a 10-dB insertion loss will indicate a 1.2:1 or better VSWR even if the line isn't terminated.[10]

If your feedline is lossy, how can you properly evaluate the VSWR of the antenna at the other end? The answer is that you can't unless you know the exact line loss and can calculate backward to determine the true load VSWR as described in reference 10.

Finally, if the VSWR on a transmission line is high, there's an additional "mismatch loss" over and above the feedline insertion loss.[11] Generally, if the VSWR is less than 3:1 at the load and the transmission line insertion loss is 3 dB maximum, this additional loss will be less than 1 dB. But who want to throw away any more hard to obtain dBs?

recommendations

We're now ready to make the final selection for our transmission line. First review the comments made earlier in this article and then study **table 1** and **figs. 4** and **5**. If possible, try to obtain manufacturer's specifications. Most transmission line manufacturers have extensive catalogs with all kinds of information about their products.

If a long transmission line is needed, a combination of types is permissible. For instance, hardline or Heliax can be used from the shack to the top of the tower and from the antenna down the mast joined around the rotator with a flexible type of line. Other combinations are also acceptable providing that the overall insertion loss of the sytem is within reason.

Power lost in transmission lines is gone forever. Although some installations use antenna-mounted preamplifers to lower the received signal loss, this does not make up for the transmitted signal loss. After all, who needs to heat up Mother Nature?

This brings up an important but subtle issue. A 3 dB insertion loss transmission line would require 3 dB more antenna gain to offset the loss. This would mean at least doubling the antenna size while halving beamwidth and probably more than doubling the wind load. This type of problem can usually be partially solved by using a larger, albeit more expensive, transmission line.

For example, at 432 MHz 100 feet (30.5 meters) of RG-8 or RG-213/U coax would have a loss of about 4.6 dB, as mentioned earlier. Replacing such a line with the same length of 7/8-inch (22-mm) hardline would lower the loss to 1.15 dB, a drop of almost 3.5 dB! The total cost of this change would probably be only an additional $50.00, much less than the cost of increasing the antenna gain by 3 dB! *Don't be penny wise and pound foolish. Larger low-loss feedlines will pay handsome dividends and more than offset their initial cost by the performance gain.*

A further cost savings idea is suggested. Many of us install one expensive low-loss transmission line for UHF/SHF and place a remotely activated coaxial relay at the top of the tower. The number of antennas that can be accessed is only limited by the number of poles on the relay.

Suitable relays are often found at flea markets at attractive prices ($25-50), especially if you count in the number of poles. In this configuration the actual cost of the transmission line and relay is divided by the number of antennas that are accessible. For example, even using only an ordinary two-position coaxial relay effectively almost halves the cost of the transmission line per band without sacrificing performance!

Talking to old timers can clue you into some of the problems inherent in the use of certain coaxial cables. RG-17 is such an example. On a long run (perhaps 100 feet or 30.5 meters), the coefficient of expansion of the inner conductor and the outer conductor can be quite different. If the temperature rises or falls considerably, the center conductor may expand or contract more than the outer jacket. The net result can be a broken center pin at the interface when heated or a retracted center pin that breaks contact during cold weather. Use an "LC" type connector since the standard N connector, a UG-167, tends to increase the severity of this problem.

If you opt to use CATV transmission line, proceed with caution; some 75-ohm connectors are available, but the coaxial types are usually scarce. If you use this type of line, make an impedance transformer at least at the shack end to get back to 50 ohms to match your VSWR meter, etc.[12] And beware — CATV transmission line, especially the type that Amateurs usually obtain, is typically specified up to 350 MHz. Often the VSWR will go out of specification just above this frequency although it may improve at some higher frequency. *Caveat emptor*. Test it at the frequency of interest before you install it!

I'll let you in on a secret. I often find and purchase 50-ohm hardline and Heliax at Amateur flea markets. Sure, the price may be higher (50 cents to a dollar per foot) than conventional transmission line and connectors more difficult to find (although sometimes they're included on the line), but look at the reduction in price from the manufacturer and the difference in performance! One line like this will give you at least 10 to 20 years of uninterrupted superior performance. Can the lower cost cable do this? I'll bet you'll spend more in the same period of time by replacing the cheaper brand every few years — without the performance advantage.

summary

I've covered plenty of miscellaneous material in this month's column. But a thorough understanding of the information presented in the test, graphs, and table will give you most of the tools necessary to select the optimum cable for your requirements.

So there you have it. Just remember that the primary guideline when selecting a suitable transmission line is *don't be penny wise and pound foolish.*

acknowlegements

Many thanks to Warren Weldon, W5DFU, for bringing the information on the G-line to my attention.

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important VHF/UHF events:

October 5-6:	*Mid-Atlantic States VHF Conference, Warminster, Pennsylvania (contact WA2OMY)*
October 5-6:	*International Region 1 UHF/SHF Contest*
October 9:	*Peak of Draconids Meteor Shower predicted at 0300 UTC*
October 15:	*EME perigee*
October 20:	*Peak of Orionids Meteor Shower predicted at 1100 UTC*
November 2:	*Peak of Taurids Meteor Shower predicted at 0930 UTC*
November 2-3:	*ARRL International EME Contest*
November 3:	*Peak of Casseopids Meteor Shower predicted at 0930 UTC*
November 12:	*EME perigee*
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111	123	135	147	159	171	183	195	207	219	231	243	255	267	279	291	303	315	327	339	
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repairing flood damage

***After four days of constant, heavy rains** the river crested 11 feet above flood stage and overwhelmed the best efforts of hundreds of bone-tired volunteers. Despite backbreaking, heroic efforts, the sandbag wall at the edge of town gave way under the relentless pressure of the angry river.*

Over the next 24 hours the water at your home QTH rose, completely flooded the basement, and gushed into the first floor to a height of 6 feet. Time was too precious to save anything but the family — all else was left behind. As the waters receded, the governor called out the National Guard to prevent looting, and you returned to recover what you could. You found your rig all but ruined, still damp and covered with mud.

Although most flood damage scenarios are not as dramatic as this one, we nonetheless hear of radio equipment that has, for one reason or another, taken a bath. Boating accidents, plumbing failures (Gee! Was that plastic pipe *really* running just above my radio set?) and a variety of other problems splash our rigs out of service. Fortunately, if the insurance company pays off well enough, you can go out and buy a new rig. But if the insurance company refuses to pay — "Sorry... wind-driven water damage excluded ..." — or if you don't have insurance, then you might want to take restorative action yourself. Even if the insurance company does pay, you can usually buy the rig back from them for salvage value. One guy I know received $325 for a two-year old transceiver and bought it back from the insurance company for $20. The company sent him a check for $305, and he kept the carcass.

Some of the steps I'll recommend may sound a little bizarre to you in terms of safety and comfort, but make more sense when you're faced with the possible loss of an expensive piece of equipment. Some of the steps — especially those involving baking the moisture out or using chemicals to clean the rig — might actually cause a little damage that will also have to be repaired. If *that* makes you nervous, it may help to remember that you cannot harm the radio any more: *it's already a total loss*! Any restoration is, therefore, pure gravy.

don't touch that dial!

The first thing to do is *refrain from turning the rig on*, even for a brief test to see whether it will or won't work. Satisfy yourself right now that even a short dunk causes fatal damage! Still, the all-too-natural urge is to see whether your rig survived the flood...*if it was immersed, then it didn't survive*!

So if your rig has been under water, remove the covers and give it a bath.

A bath?

I once lived in a seaport town where saltwater damage to electronic equipment was common. The shop where I worked part-time (while attending college) took in an $1800 UHF-FM taxicab radiotelephone set that had been immersed the night before during a storm; it seems that the saltwater river tributary had overflowed its banks enough to cover the radio, mounted in the trunk well. The first thing the shop owner did was take the transceiver out to the parking lot and give it a ten-minute shower with a garden hose. He'd lived in that town all his life, and had much experience with water-damaged radio gear.

(If the damage to your unit is due to saltwater, then do the cleaning job *immediately*. Don't delay; the longer salt residue remains in the equipment, the greater the corrosion damage will be.)

In some cases, it will be necessary to follow the shower with actual immersion. A friend of mine uses a 25-gallon tub, the kind you might use to bathe a large dog. In the tub, he mixes two to four quarts of a product like Lestoil, a small bottle (2 to 4 fluid ounces) of either fingernail polish remover or acetone (same stuff), and enough tap water to fill the tub all the way to the rim. He leaves the set in the bath for an hour, then pours out the solution and rinses the tub out thoroughly, refilling it with plain tap water. (Some people prefer to use distilled water, which is available in bottles in some areas). This second bath removes any residue left by the chemicals in the first bath.

Note: this Lestoil/acetone bath may damage some plastics. If this worries you, then use plain soapy water. It isn't quite as effective as solvent, but it works somewhat. Keep in mind that the damage will usually not prevent the rig from operating, and most plastic pieces can be replaced anyway. The rig is already a total loss, so don't worry about trivial secondary damage!

The next step is drying the unit out *thoroughly*. If you live in Arizona (yes, they have floods in the desert!), then simply leave the rig out in the sun for about a week. Everyone else will have to use some other method. The kitchen oven is a good bet, provided that it can be regulated to maintain a temperature of 125 to 130 degrees Fahrenheit (52-54 degrees Celsius). That range is low for a kitchen oven, and some ovens might not be able to remain that cool. Higher temperatures will dry the rig out faster, but will also melt some of the plastics used in the radio, so beware. The drying process takes several days — perhaps as long as a week.

Another way is to build a cardboard (or other material) box and use several hundred watts of incandescent lamps to provide heat. Use a thermometer in-

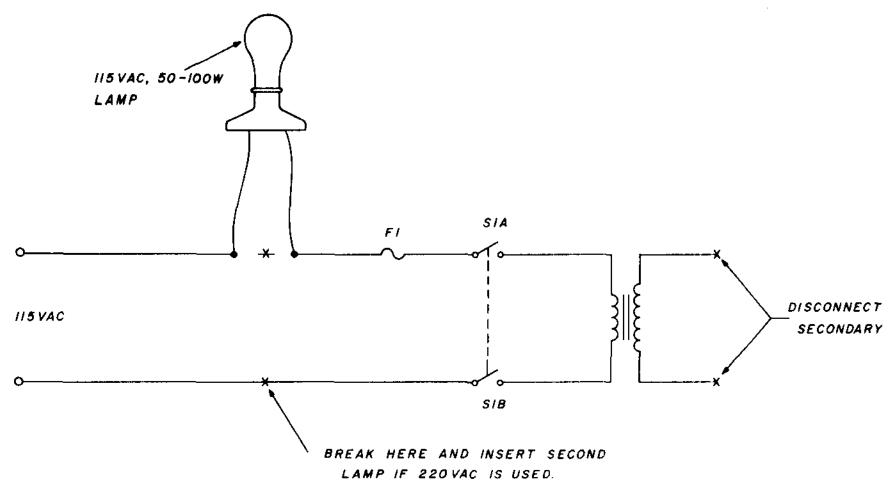

fig. 1. Method for driving moisture out of a high-voltage transformer.

side the enclosure to ensure that the 130 degree "melt limit" is not exceeded, and that the box doesn't catch fire. Again, as much as a week may be needed, although I have dried out a car radio that was dropped into fresh water (for a few minutes) in only one day.

preventing secondary damage

Now comes the big test! In some cases, the only way to test the equipment is to turn it on and look for smoke. I prefer a more conservative approach that sneaks up on it one step at a time. First I disconnect the internal DC power supply; this can be absolutely essential to the survival of the equipment being repaired, especially those with high voltage power supplies, such as certain transceivers and most linear power amplifiers.

Without connecting the rig to AC power, connect a bench power supply to the circuitry that was previously connected to the rig's internal power supply. It's essential to use a DC power supply that will provide the same voltage(s) as the original internal supply, and additionally (*this is important*) has a current limiter control. The output voltage is set to the DC voltage normally supplied by the rig power supply, and the current limiter control is set for a short-circuit current only a little above the normal operating current of the circuit under test.

Why go to such trouble? Because you want to prevent secondary damage. There's almost inevitably a short circuit or other condition that draws loads of current. If such a condition exists in the equipment, the internal power supply normally used will probably produce enough current to burn up components, printed wiring board tracks and other components. After the circuit is checked out, then we can check out the power supply and, if it's working, reconnect it.

The low-voltage DC power supply should be checked out separately, especially if it uses a series-pass regulator — almost all do these days. If the regulator circuit is not working, then one possible fault allows the rectifier output to be connected to the regulator output; this occurs when the series-pass transistor is either shorted or hard biased to full turn on. Since the rectifier voltage is always higher than the regulator output voltage, it can damage the circuits that were just pronounced healthy.

High voltage power supplies present special problems. Small amounts of moisture that are no problem in low voltage supplies will zap a high voltage supply into Never-Never Land. The special problem is the high-voltage transformer; extra drying may help, but if moisture has entered, then it may have to be replaced. **Figure 1** shows a method of drying a power transformer. A 115 volt AC lamp is placed in series with the primary of the high-voltage transformer. The current flow is sufficient to cause internal heat buildup, but not enough to zap the transformer if it is shorted. If the high-voltage power supply uses a 220 VAC primary circuit, one lamp should be placed in series with each AC hot line (see **fig. 1**).

Some remaining areas of concern, and probable damage, are those components where moisture can enter and remain hidden. Candidates include trimmer capacitors, air variable capacitors, IF and RF transformers, switches and potentiometers, paper capacitors, and electrolytic capacitors.

On trimmer capacitors, we can open the capacitor up to the minimum capacitance position (with the screw all the way out) and apply heat from a hair dryer or incandescent lamp for 10 or 15 minutes. Whether or not this step is necessary can be determined after the initial power-on test reveals a specific problem. Otherwise, you'll mess up the alignment of the rig for nothing. This step should not, therefore, be used merely as a matter of course, but only in response to a specific symptom.

Similarly, air variable capacitors may have corroded contact wipers between the rotor and stator, and this will be apparent when the rig is turned on.

Paper and electrolytic capacitors can absorb water, especially if they have a fiber or cardboard end cap. If the capacitor shows signs of being soggy, then replace it; capacitors are, after all, relatively inexpensive.

If a lot of scum remains on the printed circuit board, then spray clean it with Freon TF or a similar product. Use a small paint brush or a piece of cheesecloth to help loosen the scum.

Flood-damaged radios are often salvageable. However strange these methods may sound, they've been used successfully by professional service technicians for many years.

If you have a question, let me know. While I can't guarantee a personal answer, I will attempt to answer as many of your questions as possible in this column.

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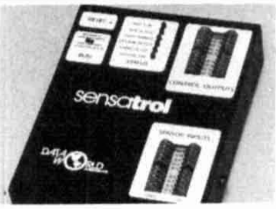

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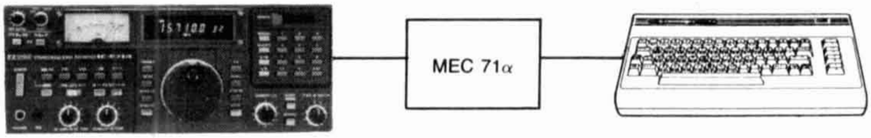

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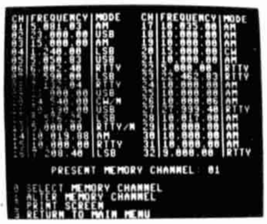

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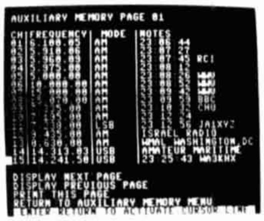

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Several years ago I undertook a project that involved the construction of a number of identical antennas for 144 MHz and 432 MHz. Through-the-boom insulated elements seemed to be the best method of construction, but I was not satisfied with the insulators available. Because I'm retired and have a fairly well equipped home machine shop, I decided to make my own.

After experimenting with a variety of materials, and after many weeks of work, I finally discovered that Teflon™ had all the properties I was seeking but one — low price. Teflon possesses a happy combination of ductility and elasticity, which, when combined with its superior insulation property, makes it ideal for my purposes. When installed in the boom, it will lock itself to the boom with a friction fit on the element holding it firmly in place.

The machine-made insulator is much faster and easier to make and install than the hand-made version. Its dimensions are shown in **fig. 1**; the body of the insulator, measuring 0.312 inch (0.79 cm) diameter at the shoulder, tapers about 0.005 inch (0.013 cm) toward the other end. They're made to fit 5/16 inch (0.794 cm) holes (through the boom) and 3/16 inch (0.476 cm) diameter elements. The hole through the center is 1/8 inch (0.318 cm). When placed in the 5/16 inch (0.794 cm) hole in the boom and expanded, the insulator forms an internal shoulder that locks it to the boom.

lathe-turned insulators

My first insulators were made from 3/8 inch (0.953 cm) diameter Teflon rod. With the Teflon held in the headstock chuck, a hole was drilled through the center with a 5/32 inch (0.397 cm) inch drill. A series of cuts was made using a 3/16 inch (0.476 cm) wide chisel-type cutting tool, leaving a 5/16 inch (0.794 cm) inch diameter body and 1/16 × 3/8 inch (0.159 × 0.95 cm) shoulder. The machining was done with the drill bit remaining in the Teflon to support it and keep it rigid. The individual insulators were then cut apart with an Xacto™ knife held against the shoulder with the stock rotating in the lathe. In this manner I could make about eight insulators at one time.

There was one problem, however. Because Teflon of this diameter is quite flexible, when the drill extends into the Teflon that lies beyond the support of the chuck jaws, it tends to "wander" and become eccen-

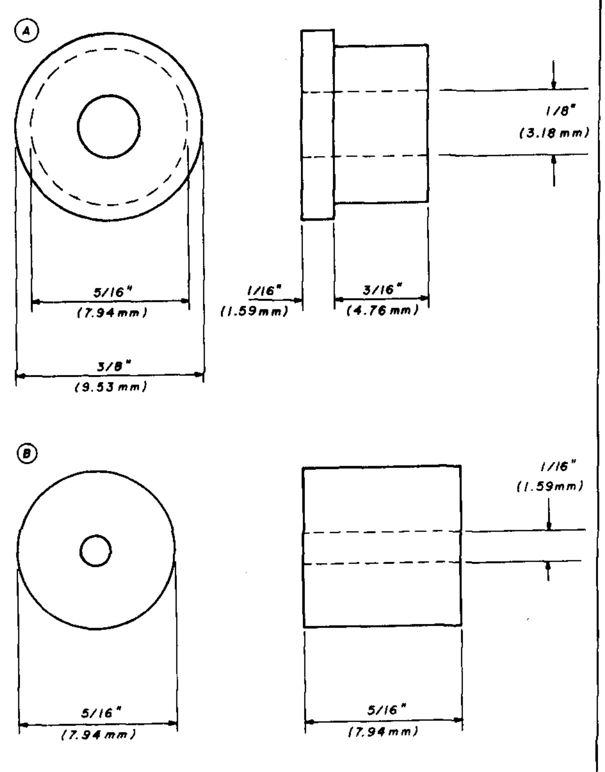


fig. 1. Teflon insulators: (*A*) machine-made, (*B*) hand-made.

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

*Polytetrafluorethylene

tric. At the time I was tapering the ends of the elements and simply driving them through the insulators, letting them expand in the boom. This approach worked quite well, and I still have some antennas in use that were assembled in this manner several years ago. I did not realize that Teflon would tolerate, without fracture, the degree of expansion I later discovered. Further research in my plastics supply catalog revealed that heavy-wall Teflon tubing is available (at almost double the price of the rod) in 3/8-inch OD and 1/8-inch ID. I bought some, tried it, and have used it as my basic material since then. With no holes to drill, my production rate skyrocketed. What had been a chore now became a pleasure.

The lathe configuration is illustrated in **fig. 2**. The heavy wall tubing is inserted through the chuck into the lathe spindle, extending approximately 2-1/2 inches (5.127 cm) out of the chuck. To support the Teflon during machining, use 1/8 inch (0.3175 cm) diameter drill rod, held in the tailstock chuck. Insert it in the center hole of the teflon tubing all the way to the headstock chuck. The drill rod acts as a mandrel to support the Teflon during turning and cutting processes, so there's no problem making ten insulators at one time. When finished they're simply removed from the mandrel, and the process is repeated.

It's not necessary to measure the shoulders for thickness. An "eye-ball" 1/16 inch (0.16 cm) is satisfactory. But it *is* necessary to measure the body and produce the insulators uniformly. I use a dial indicator caliper for this purpose. After turning a few, I take note of the cross-feed index. If I find that I'm getting uniform production, I put on a cross-feed stop, adjust it so that the cutting tool feeds into the work to the proper depth and can go no further. Thereafter, the cross-feed is fed in until it stops; it is then withdrawn, and the lathe carriage is moved forward 1/4 inch (0.635 cm). The process is repeated until the mandrel is full of insulators. (A skilled operator could easily turn out 200, and perhaps 300, insulators per hour.)

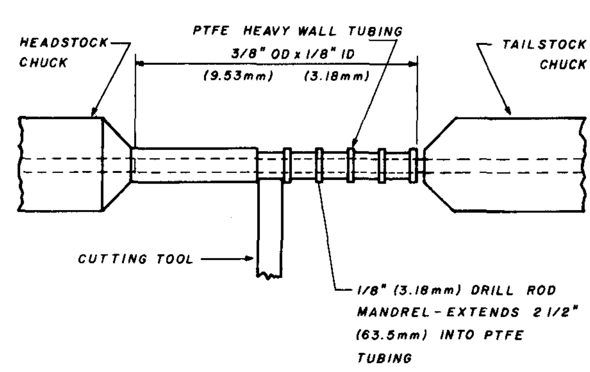


fig. 2. Metal lathe set-up for production of insulators. The cutting tool (chisel-type, 3/16-inch, 0.4763 cm) wide *is fed straight into the PTFE to reduce diameter to* 0.312 inch (0.792 cm). Shoulders are 1/16-inch (0.1588-cm) thick. (The drawing is expanded.) The clearance between the end of the Teflon and tail-stock chuck need not be more than 1/8-inch (0.3175 cm). After ten cuts have been made, insulators are separated by holding a sharp knife edge against the insulator "body" at the right-hand edge of each shoulder, with the work rotating in the lathe.

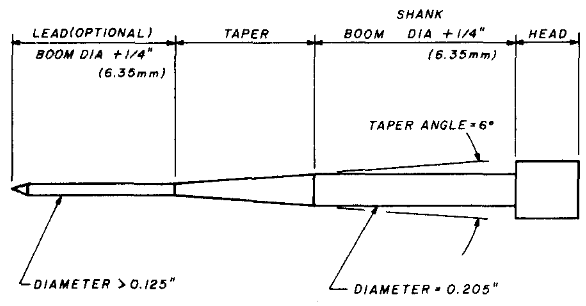


fig. 3. The expanding tool may be made of brass, bronze, aluminum, or steel. W5JTL uses a 1/4-inch (0.6350-cm) brazing rod.

installation

Insulators with a 1/8 inch (0.318 cm) center hole will require more than a slight taper of the element if the element is to be used for expansion. After much experimentation, I've concluded that a 6-degree included angle (3 degrees each side of center) taper is about optimum. This would result in reduction of the element diameter of nearly 1 inch (2.54 cm) at each end, and could adversely affect the design resonance, particularly at 432 MHz and above. My first expansion tools were 0.188 inch (0.476 cm) in diameter and less tapered — perhaps only 8 or 10 degrees; these occasionally produced sheared insulators. At the 1984 Central States VHF (CCSVHF) Conference, Jan King, W3GEY, expressed an interest in obtaining some of my insulators. I took him to my hotel room to give a demonstration of how to use them and — you guessed it — promptly sheared off a couple of them. Nevertheless, he left with a few hundred insulators and I came home and went back to the drawing board. I now make the expanding tools 0.205 inch (0.521 cm) in diameter, with a long taper. (These are illustrated in the drawings of **fig. 3**.) When withdrawn from the insulator, the hole immediately shrinks to 0.175 to 0.180 inch diameter and provides ample friction to hold the element.

Two opposite side insulators may be installed in the boom at one time if the shank of the installing tool is long enough to go all the way through and the bottom side insulator is supported until it is expanded.

A "lead" section on the expander helps in alignment, but is not necessary. A length of wood measuring approximately 2 × 4 × 12 inches (5.08 × 10.16 × 30.48 cm) with a hole large enough to clear the expander, drilled about 3 inches (7.62 cm) deep [centered on the 2 inch (5.08 cm) side] is a valuable aid in insulator and element installation. It provides support for the bottom insulator during this process. The boom is placed on the wood with the two opposite side insulators in place. The expander is driven through both of them and extracted. The element — with the sharp corners at the end is rounded off 0.005 inch (0.013 cm) with a file or sandpaper — is then driven through until it protrudes an inch or two on the opposite side. Inspect it from the bottom side to make sure that it's centered in the bottom insulator before driving it all the way through. Centering the elements in the boom is done after all have been installed.

hand-made insulators

If you're making a single antenna and want only a few dozen insulators, they can be made without a lathe. Unfortunately, the heavy wall tubing (and it's not available as a stock item with a center hole smaller than 1/8 inch, or 0.318 cm) will not expand sufficiently to form its own shoulders and "stay put" when driving the elements through. Teflon rod of 5/16 inch (0.794 cm) diameter is readily available and is much less expensive than either 3/8 inch (0.953 cm) rod or tubing. All you have to do is drill a hole through the center of it and slice it off into individual insulators. This is easily done in a drill press. Place a short piece of straight metal rod 5/16 inch (0.794 cm) diameter in the drill press chuck. Put a drill press vise on the rod and tighten it with the rod in the vertical "vee" of the vise. You can now drill short pieces, up to about 1-1/2 inches (3.81 cm) long, through the center with sufficient accuracy for our purposes. Use a drill no larger than 3/32 inch (0.238 cm) and preferably 1/16 inch (0.156 cm). Cut the individual insulators about 5/16 inch (0.794 cm) long.

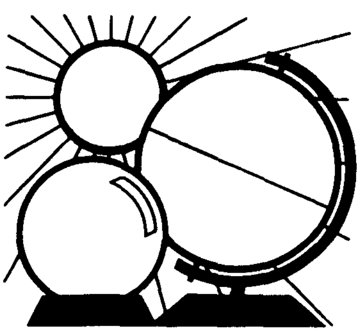
Installation is somewhat similar to the lathe turned insulators, except that they must be put in "bottom side" first. The expanding tool must have a point small enough to enter the smaller hole. Since greater forces are required in this installation, better support of boom and insulator is necessary. The insulator should be "half in and half out" of the hole in the boom during expansion. To maintain things in this position, a relief hole for the insulator is provided by fixing a piece of flat thin gauge metal (1/16 inch, or 0.159 cm, aluminum is OK) to the wooden block before drilling the hole for the expander. Then put a piece of 1/8 inch (0.318 cm) thick aluminum, with a 3/8 inch (0.953 cm) diameter hole through it, over the other metal piece, with the 3/8 inch (0.953 cm) relief hole centered over the expander hole. It can be held in place with glue. Place the boom with insulator in place, on the wooden block and centered over the 3/8 inch (0.925 cm) relief hole. Insert the expander through the vacant top hole in the boom and drive it through the insulator, expanding it. Withdraw the expander. Turn the boom over 180 degrees with insulator in place in what is now the bottom side, insert the expander through the previously installed insulator, and drive it through. It's now ready for element installation, in the same manner as the lathe turned insulators.

conclusion

I've made and disposed of several thousand of these insulators. Every user I've heard from has expressed complete satisfaction. The material cost for the handmade insulators should be no more than 4 cents each, if quantity price of Teflon is obtained. I've made and will continue to make the machine-made variety available to VHFers at that price.

Perhaps some one else can produce them more economically. I claim no proprietary rights and invite anyone so inclined to produce them; I'll be glad to furnish more detailed information to anyone wishing to produce them commercially.

ham radio



DX FORECASTER

Garth Stonehocker, K0RYW

sunspot cycle update

It's time for a six-month update on the progress of the 11-year solar cycle, and time for a look at what conditions might lie ahead. Could we be approaching the minimum?

First, consider the sunspot number (SSN) itself. Since our last update,* a slight increase of about 10 SSNs appeared in May 1985 and continued into June and July before decreasing to the present level.

One clue that indicates a SSN minimum is close occurs when sunspots of the new cycle appear on the sun's disk. For about two years the new spots are seen simultaneously with the old cycle's spots. This sighting of the new spots at high solar latitude, 30 to 35 degrees, and of opposite polarity to those in that hemisphere, occurs about a year before the minimum. This had not yet happened as this issue went to press.

Trends in the SSN 11-year cycle duration from minimum to minimum and the values of SSN at the minima are interesting to note. The cycles with higher values at their peak tend to be of shorter duration and have higher valued SSN minima following them (the peak). The present cycle 21 had a maximum monthly SSN of 165 (53 percent above the average) and consequently should end up being a short cycle (9.0 to 13.6 years, average = 11.1 years). The SSN minimum value (0 to 11.2, average = 5.1) should be higher than the average of 5.1. As of this month, the cycle is 9.3 years long, which is short compared to recent cycles, which varied from 10.17 to 11.4 years duration from minimum to minimum. Therefore, it's probable that only another eight to ten months will pass before we reach the SSN minimum; this puts the date of the SSN minimum somewhere between April and August, 1986. So the monthly average values are expected to decline slowly from the current 12 to about 6 or 7 by late summer of 1986.

Now let's look at the 10 cm solar flux as a predictor. Solar flux monthly averages decreased to 73.5 in October, 1984, and stayed within ±2 of 75 until May, 1985. Since flux is a direct energy measurement it is closely correlated with ionospheric effects. Also, daily values of flux can be used directly without smoothing; thus they are made available to us easily and quickly. In monthly averages of daily values the solar variation throughout the month is mostly eliminated because of the similarity of the lengths of the solar rotation (27 days) and a month (28-31 days). One value per month makes seasonal and annual solar effects easy to study. May, June, and July averages were up about five units, marking the return of greater 27-day cycle activity. The flux average was raised more by the activity than it could decrease since the decrease was limited, being so close to the lowest flux ever recorded (63) for a day. The lowest value of flux so far in cycle 21 was 68 on May 31, June 1, and June 26, 1985. The solar flux monthly average is expected to slowly rise or at least remain constant through the winter before decreasing those few remaining units after spring into summer. Solar flux minima tend to occur during summer when the sun is furthest away; the 27-day solar variation is often less in summer months. It is interesting to note that if the 27-day variation is absent the daily values come close to the monthly average near SSN minimum.

last-minute forecast

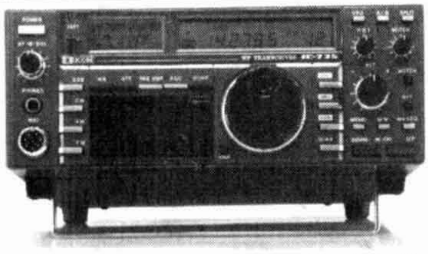
The higher HF bands are expected to be very good after the 12th and during the third week of October. It's probable that the solar flux 27-day maximum (as small as it is these days) will occur about that time. That, added to the beginning of the rise in solar flux to winter levels as the sun-earth distance shortens, may bring a good maximum. The higher band openings should be the result of long-skip transequatorial propagation, particularly if moderate geomagnetic disturbances appear at that time. Geomagnetic disturbances are most likely about October 21 to 27. The lower frequency bands 30 to 160 meters, should greatly improve as a result of decreased thunderstorm noise and lower attenuation. Both should provide increased DX range in the evenings. These lower bands should be best the third and fourth weeks of the month.

The Orionids meteor shower will be visible from the 15th to 24th of October, with a maximum rate of between 10 to 20 per hour on the 20th to 21st of the month. The moon is full on the 28th and perigee occurs on the 15th. A total eclipse of the moon on the 28th begins at 1515 UT in the Western Pacific along the countries of New Zealand, Eastern Asia and part of the Arctic. It will travel across the Indian Ocean, Africa, and Europe, ending in Iceland and Eastern Greenland at 1929 UT.

band-by-band summary

Ten, twelve, fifteen, and twenty meters will be open from morning to early evening almost every day, and to most areas of the world. The openings on the higher of these bands will be shorter and will occur closer to local noon. Transequatorial propagation on these bands will more likely occur toward evening during conditions of

*DX Forecaster, *ham radio*, April, 1985, page 84.



HF Equipment

	Regular	SALE
IC-735 Xcvr/SW rcvr/mic	849.00	749^{95}
PS-55 Power supply	160.00	144^{95}
AT-120 Automatic antenna tuner	TBA	
FL-32 500 Hz CW filter	59.50	
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	
EX-203 150 Hz CW audio filter	39.00	
EX-205 Transverter switching unit	29.00	
SM-5 8-pin electret desk microphone	39.00	
HM-10 Scanning mobile microphone	39.50	
MB-5 Mobile mount	19.50	
IC-720A 9-band xcvr/.1-30 MHz rcvr	1349.00	799^{95}
FL-32 500 Hz CW filter	59.50	
FL-34 5.2 kHz AM filter	49.50	
SM-5 8-pin electret desk microphone	39.00	
MB-5 Mobile mount	19.50	
IC-745 9-band xcvr w/.1-30 Mhz rcvr	999.00	779^{95}
PS-35 Internal power supply	160.00	144^{95}
EX-241 Marker unit	20.00	
EX-242 FM unit	39.00	
EX-243 Electronic keyer unit	50.00	
FL-45 500 Hz CW filter (1st IF)	59.50	
FL-54 270 Hz CW filter (1st IF)	47.50	
FL-52A 500 Hz CW filter (2nd IF)	96.50	89^{95}
FL-53A 250 Hz CW filter (2nd IF)	96.50	89^{95}
FL-44A SSB filter (2nd IF)	159.00	144^{95}
HM-10 Scanning mobile microphone	39.50	
SM-6 Desk microphone	39.00	
HM-12 Extra hand microphone	39.50	
MB-12 Mobile mount	19.50	

	Regular	SALE
IC-751 9-band xcvr/.1-30 MHz rcvr	1399.00	1199
PS-35 Internal power supply	160.00	144^{95}
FL-32 500 Hz CW filter (1st IF)	59.50	
FL-63 250 Hz CW filter (1st IF)	48.50	
FL-52A 500 Hz CW filter (2nd IF)	96.50	89^{95}
FL-53A 250 Hz 6W filter (2nd IF)	96.50	89^{95}
FL-33 AM filter	31.50	
FL-70 2.8 Khz wide SSB filter	46.50	
HM-12 Extra hand microphone	39.50	
SM-6 Desk microphone	39.00	
CR-64 High stability reference xtal	56.00	
RC-10 External frequency controller	35.00	
MB-18 Mobile mount	19.50	

Options: 720/730/745/751	Regular	SALE
PS-15 20A external power supply	149.00	134^{95}
EX-144 Adaptor for CF-1/PS-15	6.50	

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Options - continued	Regular	SALE
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EX-310 Voice synth for 751, R-71A	39.95	
SP-3 External base station speaker	49.50	
Speaker/Phone patch - specify radio	139.00	129^{95}
BC-10A Memory back-up	8.50	
EX-2 Relay box with marker	34.00	
AT-100 100w 8-band automatic ant tuner	349.00	314^{95}
AT-500 500w 9-band automatic ant tuner	449.00	399^{95}
AH-1 5-band mobile antenna w/tuner	289.00	259^{95}
PS-30 Systems p/s w/cord, 6-pin plug	259.95	234^{95}
OPC Optional cord, specify 2 or 4-pin	5.50	
GC-4 World clock .... **(Closeout!)**	99.95	79^{95}

HF linear amplifier	Regular	SALE
IC-2KL w/ps 160-15m solid state amp	1795.00	1299

VHF/UHF base multi-modes	Regular	SALE
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EX-106 FM option	125.00	112^{95}
BC-10A Memory back-up	8.50	
SM-2 Electret desk microphone	39.00	
IC-271A 25w 2m FM/SSB/CW xcvr	699.00	569^{95}
AG-20 Internal preamplifier*	56.95	
IC-271H 100w 2m FM/SSB/CW xcvr	899.00	759^{95}
AG-25 Mast mounted preamplifier*	84.95	
IC-471A 25w 430-450 SSB/CW/FM xcvr	799.00	699^{95}
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IC-471H 75w 430-450 SSB/CW/FM xcvr	1099.00	969^{95}
AG-35 Mast mounted preamplifier*	84.95	

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PS-35 Internal power supply for (H)	160.00	144^{95}
PS-15 External power supply	149.00	134^{95}
CF-1 Cooling fan for PS-15	45.00	
EX-144 Adaptor for PS-15/CF-1	6.50	
SM-6 Desk microphone	39.00	
EX-310 Voice sythesizer	39.95	
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	299^{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}
IC-47A Compact 25w 440 FM, TTP mic	469.00	399^{95}
UT-16/EX-388 Voice synthesizer	29.95	
IC-3200A 25w 2m/440 FM w/TTP	549.00	489^{95}
UT-23 Voice synthesizer	29.95	
IC-120 1w 1.2 GHz FM transceiver	499.00	449^{95}
ML-12 10w amplifier	339.00	299^{95}

6m portable	Regular	SALE
IC-505 3/10w 6m port. SSB/CW xcvr	449.00	399^{95}
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}
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IC-2AT with TTP	269.50	199^{95}
IC-3AT 220 MHz, TTP	299.95	239^{95}
IC-4AT 440 MHz, TTP	299.95	239^{95}

Accessories for Deluxe models	Regular
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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
BC-60 6-position gang charger, all batts **SALE**	**359.95**
BC-16U Wall charger for BP7/BP8	10.00
LC-11 Vinyl case	17.95
LC-14 Vinyl case for Dlx using BP-7/8	17.95
LC-02AT Leather case for Dlx models w/BP-7/8	39.95

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
CA-2 Telescoping 2m antenna	10.00
CA-5 5/8-wave telescoping 2m antenna	18.95
FA-2 Extra 2m flexible antenna	10.00
CP-1 Cig. lighter plug/cord for BP3 or Dlx	9.50
DC-1 DC operation pak for standard models	17.50
LC-2AT Leather case for standard models	34.95
RB-1 Vinyl waterproof radio bag	30.00
HH-SS Handheld shoulder strap	14.95
HM-9 Speaker microphone	34.50
HS10 Boom microphone/headset	19.50
HS-10SA Vox unit for HS-10 & Deluxe only	19.50
HS-10SB PTT unit for HS-10	19.50
ML-1 2m 2.3w in/10w out amplifier **SALE**	**79.95**
SS-32M Commspec 32-tone encoder	29.95

Shortwave receiver	Regular	SALE
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RC-11 Wireless remote controller	59.95	49^{95}
FL-32 500 Hz CW filter	59.50	
FL-63 250 Hz CW filter (1st IF)	48.50	
FL-44A SSB filter (2nd IF)	159.00	144^{95}
EX-257 FM unit	38.00	
EX-310 Voice synthesizer	39.95	
CR-64 High stability oscillator xtal	56.00	
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S. AMERICA	10	10	10	10	10	10	10	10	10	12	15	15	_20_	_20_	_20_	_20_	_20_	20	20	15	15	12	12	10	SE
ANTARCTICA	12	12	12	12	12	12	15	15	15	20	_20_	_30_	_30_	_30_	_30_	_30_	20	20	20	15	15	12	12	12	S
NEW ZEALAND	12	12	12	15	15	20	20	_20_	_30_	_30_	_20_	_30_	_30_	_30_	_30_	_30_	_30_	20	15	15	12	12	12	12	SW
OCEANIA AUSTRALIA	12	12*	12	15	20	20	20	_20_	_20_	_20_	_20_	_20_	_30_	_30_	_30_	_20_	20	20	20	20	15	15	12	10	W
JAPAN	20	20	20	20	20	30	_40_	_40_	_40_	_40_	_40_	_40_	_40_	_40_	40	40	40	40	40	40	30	30	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	_40_	_40_	_40_	_40_	_40_	40	40	40	30	30	20	20	20	20	_40_	_40_	_40_	_40_	_40_	40	40	40	30	30	N
EUROPE	40	40	30	30	30	20	20	20	20	20	20	20	20	20	_30_	_40_	_40_	_40_	_40_	_40_	40	40	40	40	NE
S. AFRICA	20	15	15	12	10	10	10	10	10	10	10	10	10	12	20	_30_	_30_	_30_	_30_	20	20	20	20	20	E
CARIBBEAN S. AMERICA	10	10	10	10	10	10	10	10	10	12*	12	15	15	_20_	_20_	_20_	_20_	_20_	20	20	20	15	12	12	SE
ANTARCTICA	12	12	12	12	12	12	15*	15	15	15	20	_20_	_20_	_30_	_30_	_30_	_30_	20	20	20	15	15	15	12	S
NEW ZEALAND	12	12	12	15	15	20	20	_20_	_30_	_30_	_30_	_30_	_30_	_20_	20	20	20	20	15	15	15	12	12	12	SW
OCEANIA AUSTRALIA	10	12*	12	15	20	20	_20_	_20_	_20_	_20_	_20_	_20_	_30_	_30_	_30_	_20_	_20_	20	20	20	20	20	15	12	W
JAPAN	20	20	20	20	30	_40_	_40_	_40_	_40_	_40_	_40_	40	40	_40_	_40_	_40_	40	40	40	40	40*	30	30	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.

highest solar flux and a disturbed geomagnetic field.

Thirty and forty meters will be useful almost 24 hours a day. Daytime conditions will resemble those on 20 meters. Skip distances and signal strength may decrease during midday on those days that coincide with the higher solar flux values. Nighttime DX will be good except after days of high MUF conditions and geomagnetic disturbances. Look for DX from unusual places on east, north, and west paths during this time. The usable distance is expected to be somewhat less than 20 in daytime and greater than 80 at night.

Eighty and one-sixty meters will exhibit short-skip propagation during daylight hours and lengthen for DX at dusk. These bands follow the darkness, opening to the east just before your sunset, swinging more to the south near midnight, and ending up in the Pacific areas during the hour or so before dawn on the path of your interest. The 160-meter band opens later and ends earlier than 80.

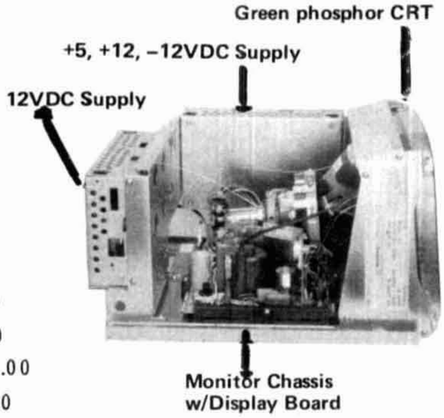
ham radio

John J. Meshna Jr., Inc.

P. O. Box 62 19 Allerton St. E. Lynn, Ma. 01904 Tel: (617) 595-2275

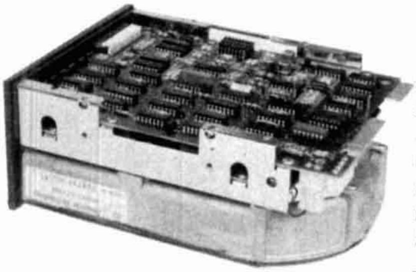
167

COMPUTER TERMINAL BUILDING BLOCK $50.00



This is a great beginning for a computer terminal. It is a brand new, Panasonic, 9" TTL input monitor complete with its own self-contained, switching power supply, and a removeable (four screws) triple output power supply. The whole assembly runs on 115/230 V, 50/60 Hz. Now for some specifics: 9" green phosphor, TTL input monitor, attached regulated 12 VDC, 1.5 A power supply used exclusively to run the monitor and an attached triple output switching power supply with outputs of 5 VDC @ 3.5 A, +12 VDC @ 500 ma, and –12 VDC @ 500 ma. The assembly has mounting feet and should be a snap to make a case for. Comes with hook up data. New, factory boxed. We are offering this to you 4 ways:

* COMPLETE SET-UP AS SHOWN, including monitor, low voltage supply and triple output supply. SPL-116-38, 14 Lbs., $50.00, 5/$225.00
* TRIPLE OUTPUT SUPPLY ONLY, SPL-117-38, 3 Lbs. $15.00
* 9" MONITOR ONLY, (you supply low voltage input) SPL-114-38, 10 Lbs. $25.00
* 9" MONITOR W/LOW VOLTAGE SUPPLY ONLY, SPL-115-38, 12 Lbs. $40.00



SEAGATE TECHNOLOGY ST 506 5¼" HARD DRIVES

The Seagate Technology ST 506 hard disc drive utilizes proven Winchester teacnology for reliable storage of up to 5 megabytes of formatted data. Some features of this very popular drive are: 5 megabit/second data transfer rate, simple floppy like interface, high speed band actuator & stepper head positioning, requires only +5 & +12 vdc, and same physical size and mounting paramters as a mini floppy drive. This Shugart compatible drive is the same as used on many home personal computers. Each drive is checked out prior to shipment. Comes with data. Only a few on hand, so order early.
Shpg. wt. 8 lb. ST-506 ~~$225.00~~ REDUCED! now only $175.00

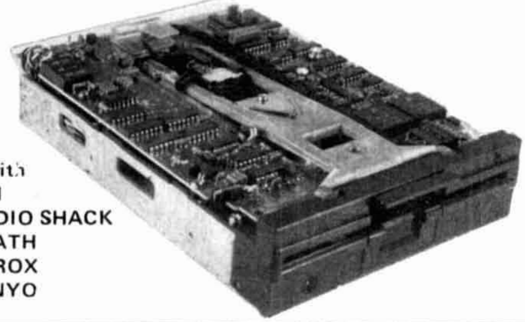
TI 99/4A Owners: *We are in the process of developing a Winchester Hard Drive subsystem for the Texas Instruments 99/4A. Please call or send SASE for further info.*

1/2 Height 1 MEGabyte Disc Drives

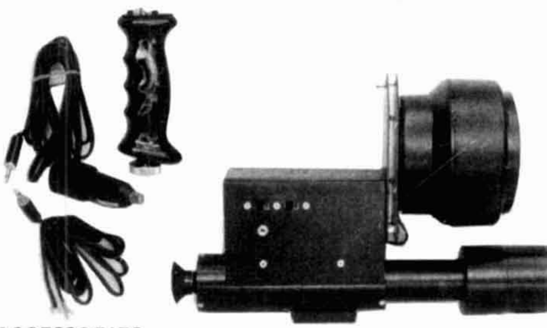
Here we go with another blockbuster buy on disc drives which should make the competion's head spin! We are offering brand new, Mitsubishi no. 4853, 1/2 height, 1 megabyte, mini floppy disc drives. These drives are beautiful. They are fully Shugart 34 pin compatible. All are double side, double density, 80 tracks per side units. Each runs on +5 vdc, .5 A and +12 vdc, .7 A. Just the drives to use with your IBM, Sanyo or other computer. Each order will come with schematics and pin out data.
SPL-85C-35 , $175.00 each $175.00 each, 2/$325.00, 5/$725.00

New, 75 watt power supply. +5vdc 5.5amps, +12vdc 4amps, –12vdc .3amps 115/230 input. Made by GI, fully enclosed, with schematic.
Shpg. wt. 4 lb. PS-10 $50.00

Use with
* **IBM**
* **RADIO SHACK**
* **HEATH**
* **XEROX**
* **SANYO**



HIGH POWER SURVEILLANCE IR SCOPE



This Infra-Red scope was designed specifically for long range surveillance use. The built-in, totally invisible, 50 watt halogen lamp IR source is coupled with a premium grade type 6032 image converter tube, 265 mm f4.2 lens, and 16 power military spec., color corrected eyepiece make this an ideal unit for viewing of clandestine activities or animals. The scope is capable of detection at more than 300 feet, recognition at 300 feet and positive facial identification at 150 feet. It runs on 12 VDC which makes it ideal for mobile use. It comes with a removeable hand grip which allows for tripod mounting, 2 power cords for cigarette lighter or battery terminals, instructions and a 90 day warranty. Listed below are accessories which make this a very versatile instrument. The scope and accessories are new and guaranteed functional. Net wt. 5-1/4 Lbs.
IR Scope part no. ELD Shpg. Wt. 7 Lbs. $735.00 ea.

ACCESSORIES:

12 VDC GELL BATTERY for above. Shpg. Wt. 6 Lbs. $35.00

BIOCULAR EYEPIECE which can be used in place of the standard eyepiece. This allows the scene being produced by the IR viewer to be seen by the operator up to 4 ft. away. 2 Lbs. $89.95

MALE "T" f1.6 CAMERA DAPTER for SLR cameras Shpg. Wt. 1 Lb. $129.00

MALE "C" to FEMALE "T" ADAPTER for CCTV, requires use of above male "T" f1.6 adapter. Shpg. Wt. 1 Lb. $29.95

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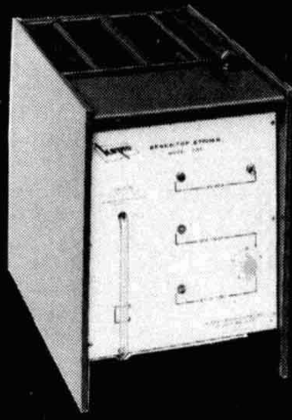

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Four lot price IC-735 ..... 2800.00
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Alpha ..... List – 15%
Icom 271A, 27a ..... Call

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Sanyo AA Nicads, tabs 2.50
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Fox Tango ..... – 10%
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By D.C. Sales, Fits Class 1, 2 Hitches. Adapts existing hitch on your car/truck to any HF antenna. 3/8 × 24 thread. No holes, complete unit 29.95

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Bencher & Vibroplex ..... Less 10%
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Epoxy diode ..... 29¢ Each or 19.00/100
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9405 Heavy duty, 2-16 Ga. 6-18 Ga. ..... 52¢/ft.
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8403 Mic Cable, 3 condctr & shield ..... 80¢/ft.
100 Feet 8214 w/ends installed 45.00
8669 7/16" tinned copper braid ..... 1.10/ft.
International Wire RG214, non-mil, good cable ..... .70/ft.

AMPHENOL

831SP-PL259 Silverplate 1.25
UG176 reducer RG8X ..... .30
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New 82-202-1006 N-Male fits 9913 ..... 5.00

ROHN

1/4" E.H.S. Guy cable, Rohn US, 1000 ft. 250.00
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1/4" Guy Cable, 6100#7 × 7 strand, import ..... 15¢/ft.
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All equipment, used, clean, with 90 day warranty and 30 day trial. Six months full trade against new equipment. Sales price refunded if not satisfied.

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

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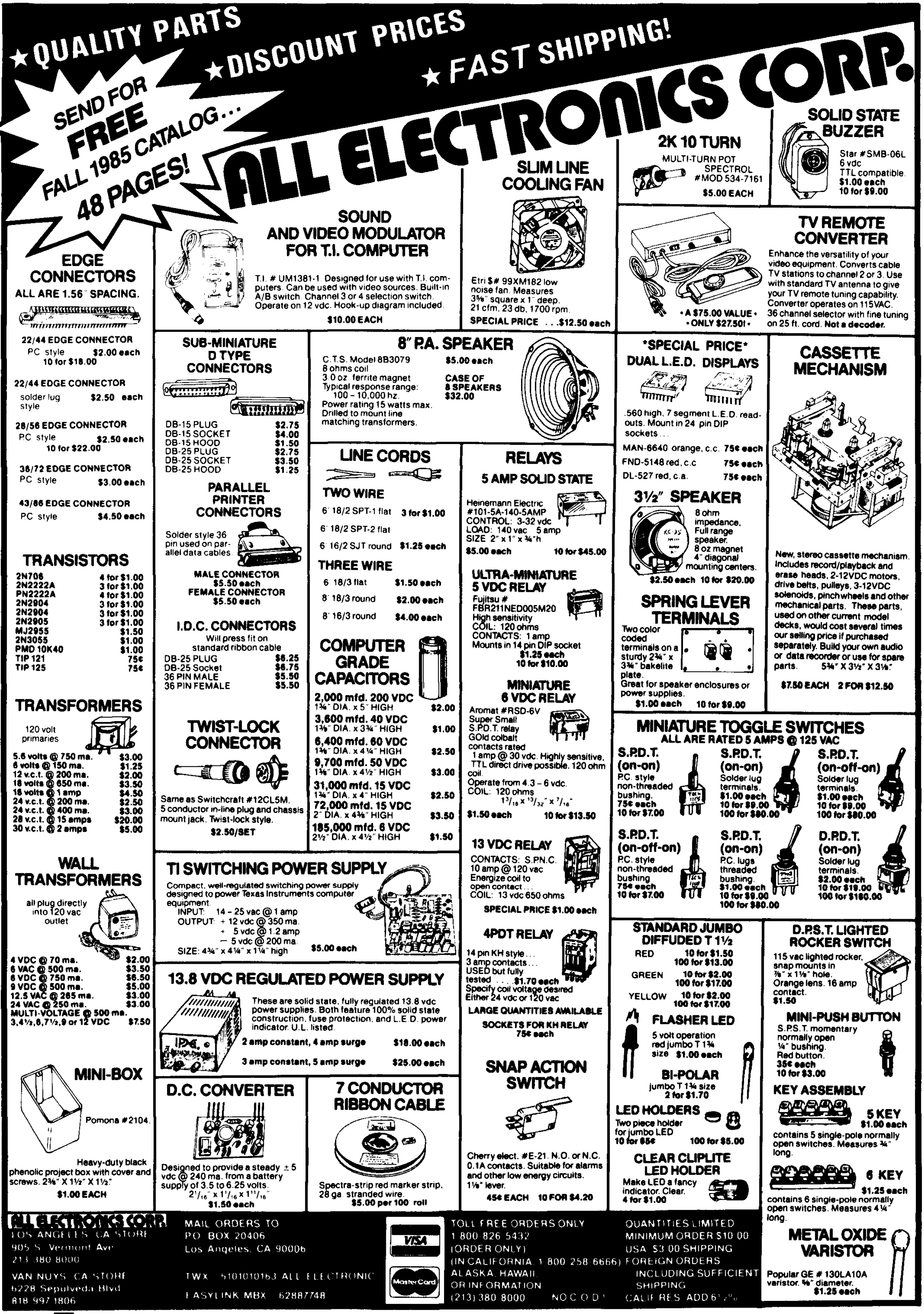
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6 vdc
TTL compatible.
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10 for $9.00
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$10.00 EACH
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Enhance the versatility of your video equipment. Converts cable TV stations to channel 2 or 3. Use with standard TV antenna to give your TV remote tuning capability. Converter operates on 115VAC. 36 channel selector with fine tuning on 25 ft. cord. Not a decoder.
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ALL ARE 1.56" SPACING.
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8 ohms coil
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Typical response range: 100 - 10,000 hz.
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MINIATURE 6 VDC RELAY
Aromat #RSD-6V
Super Small S.P.D.T. relay
GOld colbalt contacts rated 1 amp @ 30 vdc. Highly sensitive, TTL direct drive possible. 120 ohm coil.
Operate from 4.3 - 6 vdc.
COIL: 120 ohms
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Same as Switchcraft #12CL5M. 5 conductor in-line plug and chassis mount jack. Twist-lock style.
$2.50/SET
MINIATURE TOGGLE SWITCHES
ALL ARE RATED 5 AMPS @ 125 VAC
S.P.D.T. (on-on) P.C. style non-threaded bushing. 75¢ each 10 for $7.00
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all plug directly into 120 vac outlet
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Compact, well-regulated switching power supply designed to power Texas Instruments computer equipment.
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13 VDC RELAY
CONTACTS: S.P.N.C. 10 amp @ 120 vac
Energize coil to open contact...
COIL: 13 vdc 650 ohms
SPECIAL PRICE $1.00 each
4PDT RELAY
14 pin KH style...
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USED but fully tested ... $1.70 each
Specify coil voltage desired
Either 24 vdc or 120 vac
LARGE QUANTITIES AVAILABLE
SOCKETS FOR KH RELAY 75¢ each
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RED 10 for $1.50 100 for $13.00
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115 vac lighted rocker, snap mounts in ⅞" x 1⅛" hole. Orange lens. 16 amp contact.
$1.50
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These are solid state, fully regulated 13.8 vdc power supplies. Both feature 100% solid state construction, fuse protection, and L.E.D. power indicator. U.L. listed.
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S.P.S.T. momentary normally open ¼" bushing. Red button.
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a portable 2-meter beam

Briefcase antenna packs small, travels light

One recent Saturday morning, the topic at our ham club breakfast turned to the difficulty of keeping antennas up through Oklahoma's typical springtime season of frequent thunderstorms and occasional tornadoes. What we all wanted and needed, we decided, was a compact, truly portable 2-meter antenna that could provide reliable performance in virtually any setting.

In response to this challenge I developed an antenna that weighs less than a pound and stores in a space measuring less than 12 by 1-1/2 inches (30.5 × 3.81 cm). I chose a four-element Yagi beam because it is directional, can have vertical or horizontal polarization, and deliver respectable gain. Assemby and disassembly can be very quick. Once assembled, it can be hung from a tree in a campsite, suspended by fishing line and hooks in drapery and ceiling tiles, or hung in the living room, even during severe thunderstorms.

construction

The boom is constructed of a 45-inch (114 cm) piece of 3/8-inch (0.95-cm) OD thin wall aluminum tubing cut into four equal sections of 11-1/4 inch (28.6 cm) each. To join the boom sections together for assembly, make three pieces of solid aluminum 2 inches (5.1 cm) long and slide each inside the sections of boom tubing (see **fig. 1**) to restore the boom to its full 45 inch (114 cm) length. Where the boom sections join, measure 1/2 inch away from each side of the cut and drill a clearance hole vertically through the tubing and solid pieces to accommodate a 4-40 screw. A 4-40 × 3/4-inch (1.9 cm) screw is used to tie each section together. A standard 4-40 hex nut and washer are used on part of the assembly and washer and wing nuts to allow for quick assembly and disassembly on the other part (see **fig. 2**). When taken apart, the boom stores the reflector and director; the 4-40 screws and wing nuts hold the elements inside when stored.

Next turn the boom 90 degrees from the top/bottom plane to make the holes for the elements. Measure 3/4 inch (1.9 cm) from one end; this will be the location of the first element. Measure from this point 14-1/2 inches (36.83 cm) to the next point. Continue till all four element locations are marked. Then drill clearance holes for 4-40 screws perpendicular to the vertical holes for bolting the boom together. Next cut the heads off four 4-40 × 1-1/4 inch (3.18 cm) long screws. Insert them into the holes and secure with hex nuts and washers. The elements will be attached with these mounting screws.

The gamma match is made from a 6 inch (15.24 cm) piece of 1/4-inch (0.635 cm) tubing, a 6 inch (15.24 cm) piece of No. 14 insulated wire, a BNC connector and several brackets. First cut a piece of aluminum stock 1/2 × 1-1/2 inches (1.27 × 3.81 cm). Drill a clearance hole for the BNC connector. (Use a UG-1094/U connector.) Bend the stock into an L shape 1/2 × 1 inch (1.27 × 2.54 cm). Mount the connector in the bracket as shown in **fig. 1**. The shorting strap for holding the 6 inch (15.24 cm) piece of tubing to the driven element and tubing were made from aluminum stock. (On the first model, copper proved very satisfactory.) Solder one end of the No. 14 wire to the BNC connector and slide the tubing for the gamma match over it. Measure the stock for the shorting bar and bend and mount it to the driven element and 6 inch (15.24 cm) piece of tubing covering the gamma match wire; because the tubing will need to be moved during tuning, leave it slightly loose.

By John Eighmy, KB5QJ, 511 East 14th Street, Bartlesville, Oklahoma 74003

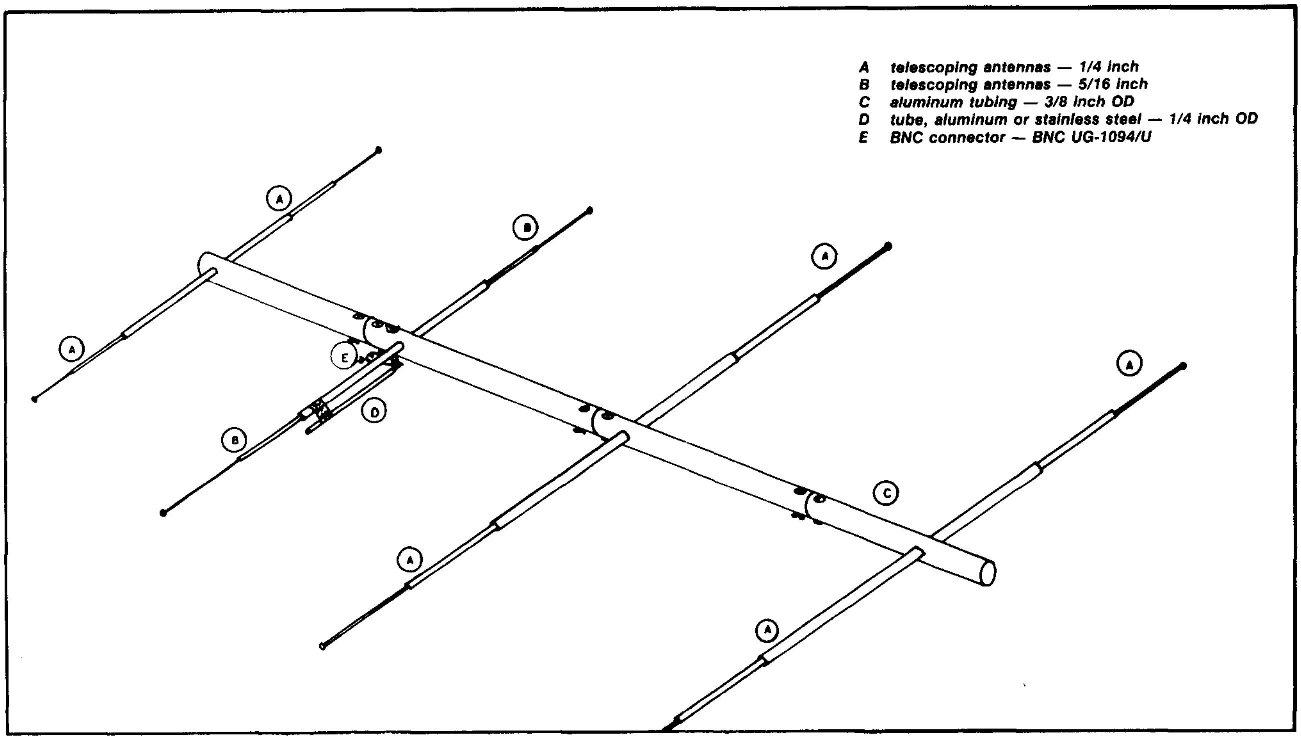


fig. 1A. Fully assembled 4-element 2-meter beam.

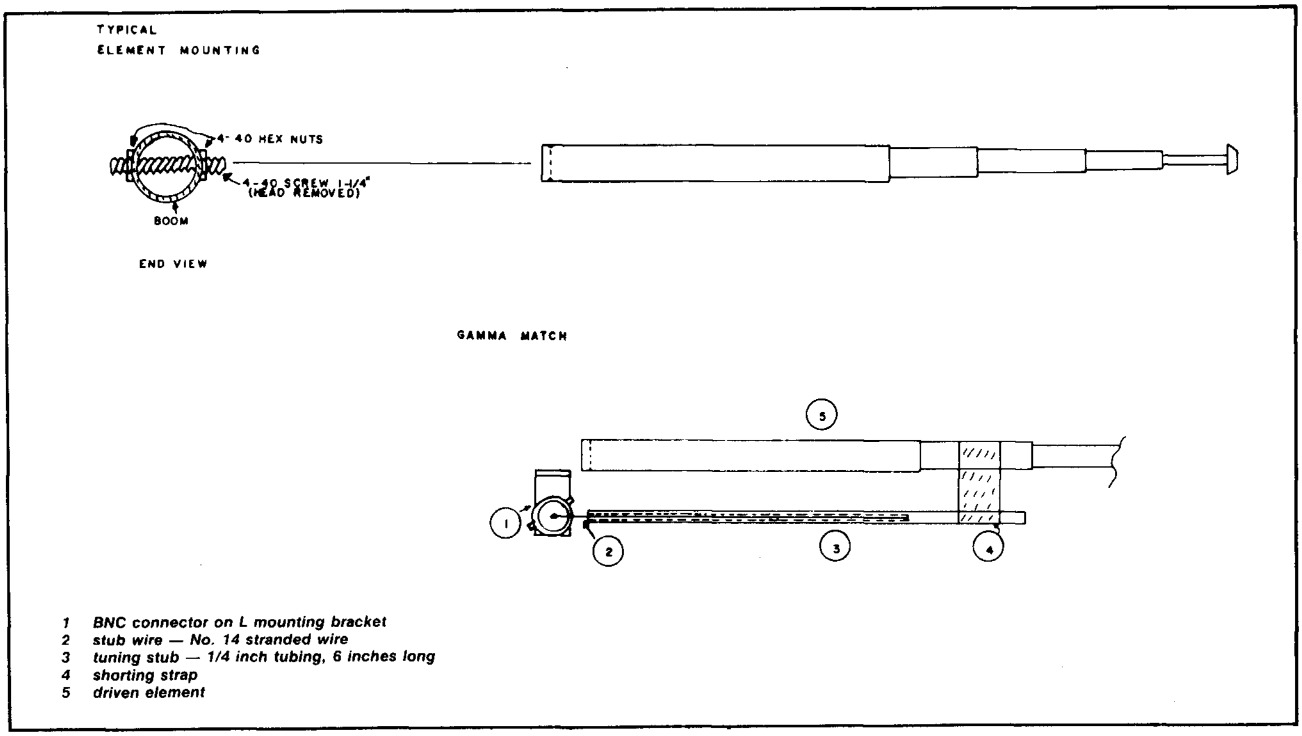


fig. 1B. Element mounting and gamma match details.

The bracket supporting the BNC connector should then be placed under the boom slightly behind the mounting screw for the driven elements. Drill a 4-40 clearance hole through the boom and the bracket. A 4-40 × 3/4 inch (1.9 cm) screw and washer with wing nut is used to allow disassembly to a small size.

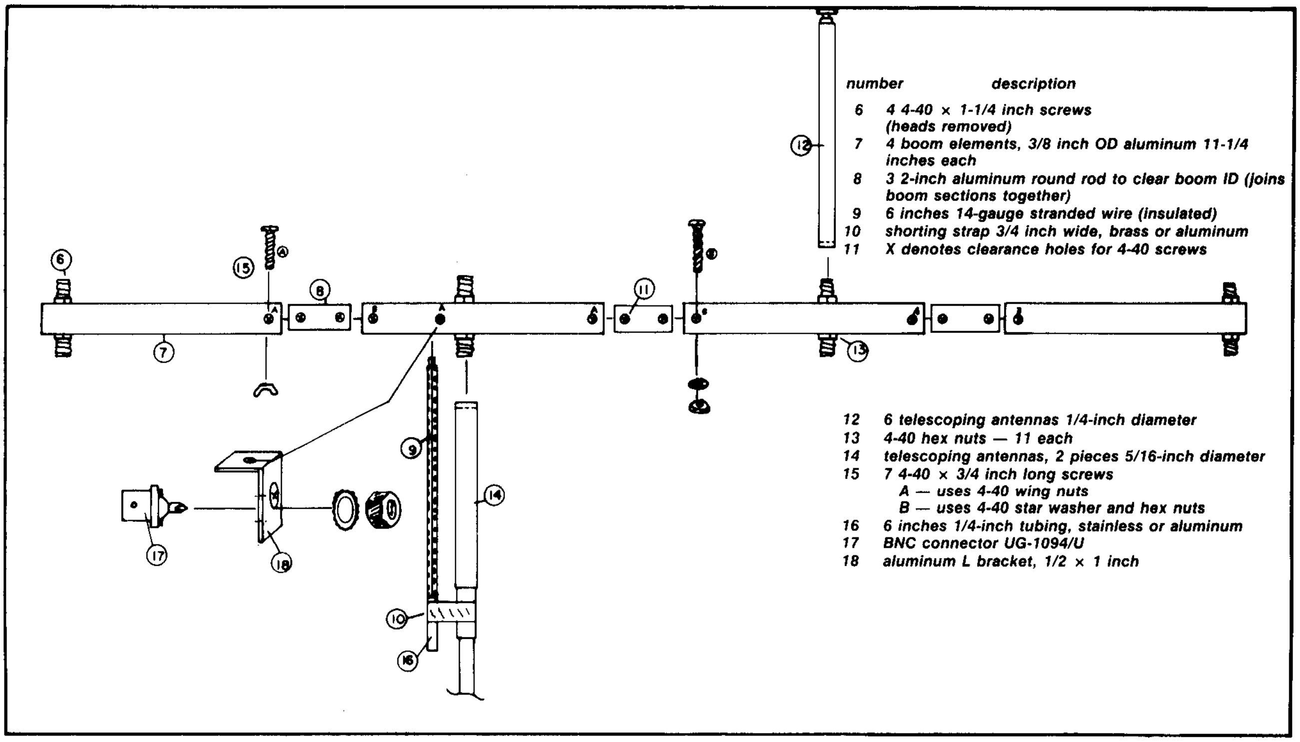


fig. 1C. Assembly details illustrates simplicity in construction and use.

Parts list.

telescoping antennas:

reflector-director (0.24″ diam.)	6 Mouser Electronics No. 43AR106, $1.19
driven (0.28″ diam.)	2 Mouser Electronics No. 43AR105, $1.94

Available from Mouser Electronics, 11433 Woodside Avenue, Santee, California 92071 ($5 service charge applied to orders under $20.)

Normally the whole gamma match is taken apart along with the one driven element to which it is attached for ease in reassembly.

Construction of the antenna is now complete. Assembly for testing and use will require eight telescoping whip antennas (see parts list). Re-tap the holes for the 4-40 screws in the ends to allow mounting on the boom.

tuning

To tune the antenna, assemble the boom, the elements, and the gamma match. Pull the director and reflector out to maximum length. Set the driven elements 19 inches (48.26 cm) apart. Then tune with the gamma match by sliding the shorting stub in and out and the 6-inch (15.24 cm) tubing over the No. 14 wire and adjusting the length of the driven elements. Once the SWR is determined for the frequency you plan to use, secure the gamma in place and measure the length of the driven elements. To simplify setting the length of the driven elements each time, paint a scale on the bottom of the boom to allow accurate positioning each time.

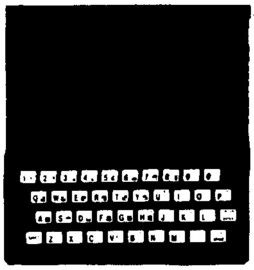
Storage is simple. Unscrew the elements from the boom. Take the gamma match and BNC bracket off. Unscrew the three wing nuts on the boom and remove the screws. Collapse the elements and slide them into the boom. Reinsert the screws, add the wing nuts, and a compact four-element beam is yours. Gain is about 4 dB. From here to Tulsa and other surrounding cities, it's possible to bring up repeaters on 1 to 2 watts of power.

Additional elements can be added by extending the boom to allow each element to be 14-1/2 inches (36.83 cm) from the last. Use your imagination as to ways to mount it for your own use.

Note: this idea was submitted to my employer, Phillips Petroleum Company, under a patent agreement. After lengthy review, it was released to me for the purpose of making it available for use by fellow Amateurs. Commercial use of this design is not permitted under the terms of the release letter signed by Phillips and dated June 2, 1982.

ham radio

More Details? CHECK—OFF Page 140



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More Details? CHECK—OFF Page 140

✓ 168

More Details? CHECK—OFF Page 140

✓ 208

the ham notebook

increased undistorted TS-930S headset audio

Many operators prefer headset operation employing a relatively high audio output level combined with low RF gain. This mode tends to preclude AGC capture from strong adjacent signals and tends to minimize noise. Using the very popular Kenwood TS-930S in this manner of operation, peak audio distortion is evident depending upon the particular headset, the signal levels, and the gain settings employed.

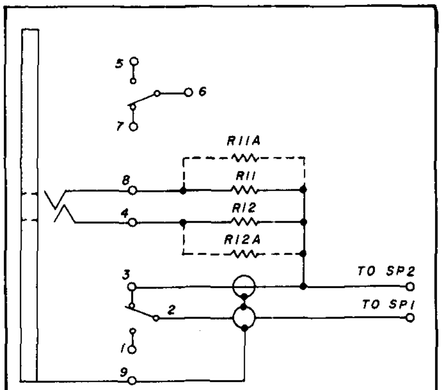

fig. 1. TS-930S headset jack circuit.

A simple solution to this condition is to decrease the value of the 1/2-watt, 100-ohm voltage divider resistors, R11 and R12, connected to the headset jack on the front panel as depicted in **fig. 1**. It is necessary to remove the triangular corner brace plate adjacent to the jack to gain access to the resistors. The plate is held in place by five easily removable screws. In my project, I paralleled each of the existing resistors, R11 and R12, with a 110-ohm 1/4-watt resistor, which resulted in at least 6 dB of additional audio without any noticeable distortion, even at uncomfortable levels.

An additional advantage of this modification for operators wishing to correct dissimilar auditory response is that by proper selection of the new, paralleling resistors, the dissimilar response can be easily corrected. This, however, will be possible only for those using stereo headsets, since the jack circuit was designed to accommodate both stereo and monaural headsets for a monaural output.

Using the external speaker jack on the rear panel was a first attempt to solve this problem. Although this approach provided audio, it revealed an unacceptable underlying white noise while using CW selectivity. External padding could be used to accomplish the same result as I obtained internally, but I prefer a "clean" fix, without any external connections, and the convenience of the continued use of the front panel jackset jack.

Marv Gonsior, W6FR

TR-2500/2600 2-channel programming

The instruction manuals for the Kenwood TR-2500 and TR-2600 describe how to program ten channels into the memory — but what if you wanted to listen to only two? I've found out that this feature comes in handy when I am monitoring the local emergency nets and don't want to scan any additional frequencies for fear the scan cycle will stop on something in which I have no interest. This is how it can be done following the procedure in the PROGRAM (BAND) SCAN:

Set the lower frequency you wish to receive.

Example:
1. Enter 6.640
2. Press "F" AND "#"

Set the highest frequency you wish to receive.

Example:
1. Enter 6.730
2. Press "F" AND "#"

Now repeat the second entry of the highest frequency.

Example:
1. Enter 6.730
2. Press "F" and "#"
3. Listen for the BEEP
4. Press "F" and "★"

Joel Eschmann, K9MLD

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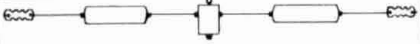

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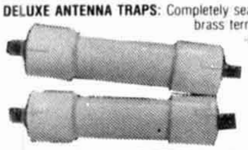

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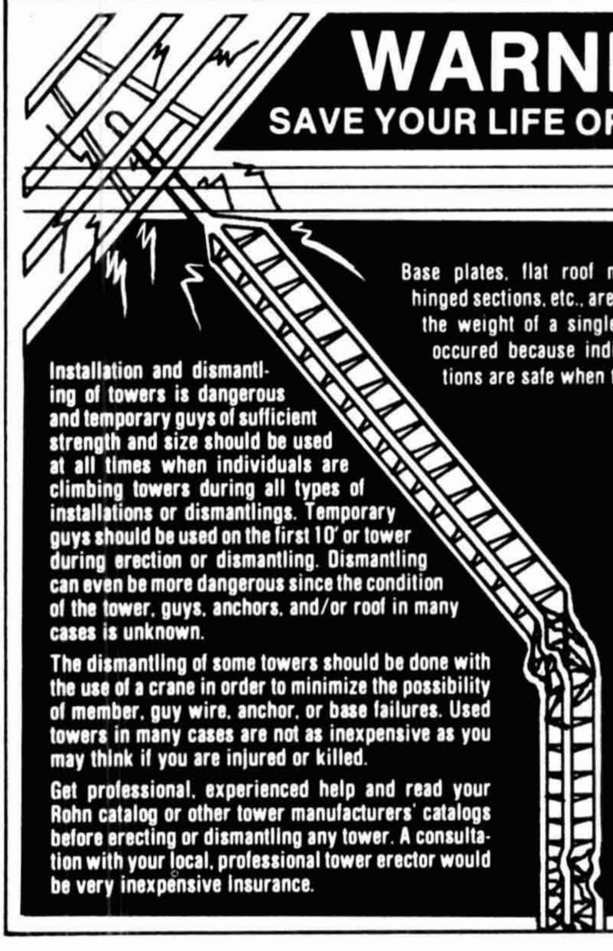

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product REVIEWS

meet Dr. QSO — on-the-air simulator — new from AEA

How many new licensees do you know who've never been on the air because of a real bad case of "key fright?" I can think of quite a few. Until now, I've never been certain of just what to tell them to encourage them to get them on the air.

AEA's new C-64 computer program, Dr. QSO, is a Morse code trainer that lets you simulate everyday Amateur communications without actually having a transmitter. When AEA's Dr. DX came out, I recall being utterly amazed at the realism of the unit — how it simulated, to practically the last detail, almost every aspect of on-the-air communications. The new Dr. QSO *has that same quality. It should be a real boon* to new licensees and prove to be a valuable training aid in Novice and upgrade classes.

All stations that you hear are generated randomly by the computer using currently issued call signs. At the lower end of the bands (the Extra sub-bands) you'll find code speeds similar to what you'd hear on any given night. As you move out of the Extra portion of the bands, you'll find that code speeds slow down until you get to the Novice band, where speeds range from about five to ten words per minute.

Conversations are very similar to those you would hear on the air. Signal reports and names are given, and equipment, the weather, locations, and antennas are all "discussed." Should you miss a piece of information, you can ask the computer for a repeat — and get one! You can also ask the station to slow down or speed up — and it does.

installation

Whenever you're working with a computer, it's a good idea to turn everything off before you insert a new program card into the machine, to eliminate the possibility of damage should there be any static charges. AEA recommends doing this with Dr. QSO, and it's good advice. The program card simply slips into the back of the computer, label side up.

Next, you plug a Morse code key into the back of the unit. You can use a straight key, bug or electronic keyer; electronic keyers are preferred. (Computer decoders sometimes have trouble deciphering a fist because of irregular characters and spacing.)

If you don't have a keyer, or just happen to prefer keyboard operation, press the British "pound" symbol. You can now communicate with Dr. QSO via keyboard.

program set-up

When the program is turned on, you'll see a transceiver at the top of the screen showing the frequency status of both the transmitter and receiver and level indicators for the volume and bandpass filter. You quickly realize that Dr. QSO comes very close to simulating a real transceiver.

Your next step is to load the text file and pick your operating aids. You select from either the cartridge (by pressing 0) or from custom messages on a disk (by pressing 1-9). Choose your code speed, set the volume, adjust the color and contrast levels on the monitor, and you're all set to go.

operation

A typical QSO looks like this:

CQ CQ CQ CQ CQ DE KB2NYA KB2NYA KB2NYA
KB2NYA DE KB2BOF KB2BOF <AR>
KB2BOF DE KB2NYA GE OM TNX FER CALL – UR RST 57N QTH IS OSSINING NY? OSSINING NY ES NAME IS CURLY CURLY – SO HOW COPY? <AR> KB2BOF DE KB2NYA K
. . . and so on.

Although the program seems to be capable of generating innumerable QSOs of virtually unlimited variety, it's also possible to write your own script. If you have a Commodore disk drive and elementary programming skills, you can write original QSOs and even trade with friends to make the Dr. QSO experience even more realistic. The user manual that accompanies Dr. QSO provides more than adequate instructions.

problem solving

With AEA's thorough documentation and high-quality parts selection and workmanship, there's no reason, really, to anticipate problems with Dr. QSO. Still, for questions or problems that may arise, AEA supports the program with a user hotline available during normal business hours (Pacific time, since AEA's headquartered on the west coast). Supplying your "software support number," furnished with every user's manual, gets you patient, knowledgeable assistance without delay. A parts list and diagram of the board are included in the manual so you can do your own troubleshooting, should the need ever arise.

questions

If you ever have the chance to sit down with this program at a Ham show, you may be tempted to "Ask Dr. QSO" for more information after just a few minutes of "communicating" with the imaginary Hams "created" for your operating pleasure and practice. Don't bother . . . Dr. QSO is, after all, just the software brainchild of some clever programmers at AEA. For information, you're better off writing to AEA at P.O. Box C2160, Lynnwood, Washington 98036-0918.

On the other hand, you might just try asking Dr. QSO . . .

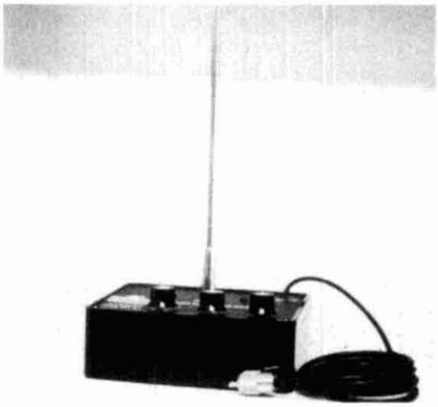
N1ACH and KA1LBO

Circle #301 on Reader Service Card.

MFJ 1621 portable antenna

Would you like to operate portable, but don't want the hassle of installing an antenna?

You won't have any more excuses if you have MFJ's new portable 40-10 meter antenna. Perfect for vacation trips — even DX'peditions — the small lightweight unit "telescopes" for easy stowing in a travel bag. The antenna also comes with 50 feet of coax so you can locate it *after* tune-up to minimize RF interference to your radio or other sensitive electronic equipment. The unit also includes a field strength meter to simplify tune-up.



general information

The MFJ portable antenna is really such a neat idea that I'm surprised it took so long for someone to market it. The unit uses a radiating element that's simply an expandable replacement antenna for auto or shortwave radios. The antenna is tuned by a series capacitor and parallel inductor to ground in a simple "L" configuration. The inductor switch is clearly marked by band with the approximate inductance that will be needed to tune the collapsible whip antenna. The tunable capacitor is also marked so you can establish "pre-sets" for easy tune-up.

MFJ recommends that you encase the antenna in plastic tubing to prevent electric shock if someone should inadvertently touch the antenna while transmitting.

specifications — MFJ 1621

telescoping whip	54 inches
box	5-1/2 × 6-3/4 × 2-1/4 phenolic
RG-58	50 feet
weight	approximately 2 pounds
power	300 watts PEP
bands	40-10 meters

installation

To use MFJ's portable antenna, all you need to do is attach the PL-259 to the back of your transceiver, set the inductor to the appropriate band, set the capacitor to mid-range and apply low power. Varying the capacitor should drop the SWR to less than 2:1. If it doesn't, change the inductor setting and try again. If more than one setting gives you a low SWR, use the one that gives you maximum power output.

Once this is accomplished, move the antenna away from your operating position — you're almost ready to start working DX. A final check to make sure your SWR is within limits is all that's required before you turn up the power (300 watts PEP maximum).

use

Setting up and tuning this antenna takes just a few seconds and is really quite simple. While no DX was worked during the test period — the bands were in very poor shape — signal reports were more than adequate for the kind of antenna being used. Potential users should not expect this antenna to perform as well as a full signal beam or dipole; it will, however, get you on the air with a more-than-acceptable signal.

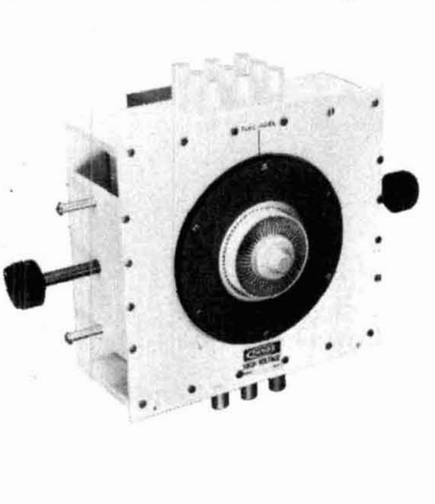
Priced at $79.95, the MFJ 1621 will give years of excellent performance and fun. Contact MFJ Enterprises, Inc., Box 494, Mississippi State, Mississippi 39762, for more information.

N1ACH

Circle #302 on Reader Service Card.

compact VHF power tubes

Varian EIMAC has unveiled four new VHF power tubes designed for power amplifier applications. Developed by Varian EIMAC's Salt Lake Division, the tubes provide improved performance in a compact design. The tubes include liquid-cooled models that use new highly effi-



NEW products

cient heat exchangers to significantly reduce the coolant flow requirements.

Of special interest to Amateurs is the EIMAC 4CX1500BC, a ceramic-to-metal, high-gain power tetrode for service in VHF TV and RF linear power amplifiers. Forced-air cooled with an anode dissipation of 1500 watts, its sophisticated internal structure allows it to operate at full ratings to 450 MHz.

For additional information or literature, contact Varian EIMAC, 1678 Pioneer Road, Salt Lake City, Utah 84104.

Circle #303 on Reader Service Card.

dual-band mobile elements

Larsen has launched a series of dual-band antennas for dual-band Amateur radios, while maintaining its usual high performance standards for both 2 meter and 70 centimeter Amateur bands. The new design incorporates a half-wave element for two-meter (144-148 MHz) Amateur band and collinear elements for 70 cm (440-450 MHz) Amateur band. One antenna conveniently serves both bands while delivering exceptionally high performance. The self-resonant design needs no ground plane, allowing mast installation on boats and base stations with standard Larsen BSA-K hardware.

For more information, contact Larsen Electronics, P.O. Box 1799, Vancouver, Washington 98668.

Circle #304 on Reader Service Card.

shared repeater tone panel

Communications Specialists has announced the introduction of its new TP-38 Shared Repeater Tone Panel. Microprocessor controlled, the TP-38 provides all 38 EIA standard CTCSS tones to allow up to 38 subscribers without the need to purchase additional cards or programming. All features are user-programmable and provided with each unit at one price. Built-in time and hit counters record the activity of all CTCSS tones on the repeater channel. The TP-38 has an ultra low current drain for solar or battery powered repeater sites, and is static and lightning protected. A non-volatile memory retains programming if a power loss occurs. A LED display (which may be turned off to conserve power) shows all received CTCSS tones when they occur, whether they are active in the panel or not. An automatic self-test is activated with each power-up. Any of the 38 available tones may be initiated from the repeater to call down a user for testing purposes. With the addition of the TP-DTMF, an optional, low cost DTMF module, all functions may be performed remotely, using a common 12 or 16-button touch-tone pad (secured with a five-digit security code). This allows any of the 38 tones to be remotely turned on or off, and allows the time and hit information to be interrogated remotely.

The TP-38 Shared Repeater Tone Panel and the TP-DTMF Remote Control Module are both available for immediate delivery from stock and are covered by a full one-year warranty. Prices are $595.00 for the TP-38 and $59.95 for the TP-DTMF.

A catalog and further information are available from Communications Specialists, Inc., 426 West Taft Avenue, Orange, California 92665-4296.

Circle #305 on Reader Service Card.

compact antenna

The Isotron 160 from Bilal Company is only 22 inches tall, 16 inches wide, and 15 inches deep. Although this may seem small, the Isotron 160 has a total surface area of over 900 square inches, 200 square inches more than a 1/2-wave dipole made from No. 12 wire. It has a tested bandwidth of 100 kHz within a 2:1 SWR and will handle the full legal limit of power. It is also adjustable anywhere on the 160-meter band.

Like Bilal's other models, the Isotron 160 does not require any tuning devices or radial system. The hardware is stainless steel and plated and comes complete except for the mast.

The price of the Isotron 160 is $149.95, plus $5.50 for shipping.

For further details, contact Bilal Company, S.R. 2, Box 62, Eucha, Oklahoma 74342.

Circle #306 on Reader Service Card.

HF slopers

Sultronics Amateur Radio announces the introduction of the "second generation" of its compact HF sloper antennas for the 160-80-40 meter bands. Featured are two models: the SS-2A Duoband Sloper which covers 80 and 40 meters, and is 45 feet long and the SS-3A Triband Sloper, which covers the 160-80-40 meter bands and is 60 feet long.

Both models feature standard 50-ohm coaxial feed and "no-trap" construction. Second generatin slopers use only stainless steeel hardware and have heavier duty No. 12 solid copper drawn wire for more strength and bandwidth, an Amphenol coax connector, and a heavy duty aluminum tower mounting bracket. Both models are easily tuned for resonance by following the illustrated instruction manual.

The SS-2A Duoband (80-40) Sloper is priced at $27.95, while the SS-3A Triband)160-80-40) Sloper is priced at $39.95 (ppd).

For more information, contact Sultronics Amateur Radio, 1587 U.S. 68 North, Xenia, Ohio 45385.

Circle #307 on Reader Service Card.

flea market

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ESTATE SALE for the family of N5CIP. All equipment in mint condition, some brand new. TR7, PS7, R7, MN2000, MN2700, WH7, P75, SP75, HAL 3100ASR, ST6000, AEA 150, IC271H, SPS20, TB5EM and other parts. Send SASE for complete list. Call KD5E (409) 632-5625 or (409) 634-4317.

FREE 3 month subscription. Send callsign to Westlink Report-H10, 28221 Stanley Court, Canyon Country, CA 91351. New only!

THE GOOD SAM HAMS invite RV operators to check in the Good Sam Ham net 14.240 ± Sundays 1900Z also 3.880 ± Tuesdays at 2359Z. Net control N5BDN, Clarksville, IN.

SCHEMATIC: Radio receivers 1920's/60's. Send brand name, model No., SASE. Scaramella, PO Box 1, Woonsocket, RI 02895-0001.

LET THE WORLD KNOW what you would really rather be doing! Get your "I'd rather be DXing" bumper sticker with "Amateur Radio" written down the sides. Red and black, vinyl and removable, so it won't hurt your car. $2.00 plus 50¢ postage to Bumper Sticker, PO Box 6349, Evansville, IN 47712.

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PHELPS DODGE duplexers for two meters, model No. 497, 6 cavity, $600 each. HAL ID-1A repeater ID'er, 19" rack mount, 110V power supply, $50. VHF Engineering two meter repeater complete with logic, $325. K1KYI, Richard Fairweather, Harrisville, RI 02830. (401) 568-3468 between 8-9:30 PM EDT.

2 METER AMP KIT: 8877 legal limit kit $395. 3CX800A7 900W kit $325. Also HV power supplies, CX600N relays, parts and EME newsletter. SASE for catalog. 2 Meter EME Bulletin, 417 Staudaher St., Bozeman, MT 59715

BACK ISSUES QST, 73, Ham Radio. Stamp for list. Koepke, 6 Katherine Rd., Albany, NY 12205.

WANTED: Regency XL2000 transceiver or new 10 channel 148-162 MHz or Wilson WH2510. PO Box 929, Blacksburg, VA 24060-0929. (703) 382-4458.

WANTED: Ten-Tec Argosy 525. Mike Kaufman, K6VCI, 107 Suffield Avenue, San Anselmo, CA 94960.

CABLE TV CONVERTERS DESCRAMBLERS. Jerrold, Hamlin, Zenith — many others. Factory units/lowest dealer prices. Complete illustrated catalog, $2.00. Pacific Cable Co., Inc., 7325-1/2 Reseda Blvd., Dept. 1005, Reseda, CA 91335. 818/716-5914.

NEW VLF 2 kHz-500 kHz products by K1RGO. L-101B VLF converter, L-201 VLF broadband preamplifier, L-400 VLF active antenna and more. Write for free catalog. LF Engineering Co., 17 Jeffry Road, East Haven, CT 06512.

ICOM AND KENWOOD SEPARATE NEWSLETTERS: 5 years of back issues! Now available TS930S & 430S users modifications supplement. Send 39¢ SASE for 12 page FREE Brochure to: International Radio, Inc., 1532 SE Village Green Dr., Suite L, Port St. Lucie, FL 33452.

HELP: Need schematic for Knight 2-meter transceiver Model TR-108. Will pay for copy. Ph. (209) 626-4219. KB6JDT, Donald M. Cox, 318 Park Blvd., Orange Cove, CA 93646.

SIGNAL GENERATORS, URM-25D, 10 kHz thru 50 MHz $245.00, URM-26B, 4 MHz thru 405 MHz $245.00, HP614A, 900 MHz thru 2100 MHz $345.00, HP618B, 3.8 GHz thru 7.6 GHz $375.00, HP608C 10 MHz thru 480 MHz $345.00, TS-510/U 10 MHz to 420 MHz $295.00. All lab calibrated. Have good stock so order today. We accept M/C, VISA, or check. FOB Otto. Immediate shipment. Phone Bill Slep 704-524-7519. Slep Electronics Company, Highway 441, Otto, NC 28763.

CABLE TV CONVERTERS & EQUIPMENT: Plans and parts. Build or buy. FREE information. C&D Electronics, 626 Flowerdale, Dept. HR, Ferndale, MI 48220.

TR-7 USERS: NB-7 Noise blanker (new) $65.00 ppd. HS-75 headset (padded) new $14.00 ppd. SL-300, SL-500 CW filter $55.00 ea. ppd. K3UKW, Tony Musero (215) 271-8898.

FOR SALE: Kenwood TR-7800 two meter transceiver $200.00/offer; Regency & Halicrafters 150-174 MHz receivers $15.00 each; Realistic SSB/AM CB $75.00. WB9YBM, Klaus Spies, 8502 Oketo, Niles, Illinois 60648.

ELECTRON TUBES — Radio & TV types 75% off list price — huge inventory! Also industrial types. Send for Free Catalog today or call Toll Free (800) 221-5802. Box HC, Transleteronics, Inc., 1365 — 39th Street, Brooklyn, NY 11218. See our display ad this issue.

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, New York 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.

CHASSIS and cabinet kits. SASE K3IWK.

CUSTOM MADE embroidered patches. Any size, shape, colors. Five patch minimum. Free sample, prices and ordering information. Hein Specialties, Inc., Dept. 301, 4202 N. Drake, Chicago, IL 60618.

CX7 REPAIRS. 415-549-9210.

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

TRS-80 Model I/III/IV owners. HF antenna design program calculated dimensions for dipole, yagi, and quad antennas. $14.95 (cassette) + $2.00 s&h to Cynwyn, Dept. H, 4791 Broadway, Suite 2F, New York, NY 10034.

OLD RADIO transcription discs wanted. Any size, speed. W7FIZ, Box 724 HR, Redmond, WA 98073-0724.

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.

RF DESIGN PROGRAM calculates stability, gain, noise figure circles, and more. For C-64 and IBM-PC, $29.95. Jim Allyn, N7JA, 7000 Litchford Road, #26, Raleigh, NC 27609.

AMATEUR RADIO CLASSES: Chelsea Civil Defense will sponsor evening classes at Chelsea High School starting October 16, 1985, for Novice (basic level ham license), and Tech/General licenses. Minimal cost for materials only. For information: Frank Masucci, 136 Grove Street, Chelsea, MA 02150.

Coming Events

ACTIVITIES

"Places to go..."

INDIANA: The Allen County Amateur Radio Technical Society's 13th annual Fort Wayne Hamfest, Sunday, November 10, 8 AM to 4 PM, Allen County Memorial Coliseum, Coliseum Blvd., U.S. 30. Indoor tables available $8.00, AC power extra. Premium tables with AC $20.00 each. Admission $3.50 advance, $4.00/door. Children under 11 free. Ladies' activities, forums, banquet Saturday night. Nearby motels and restaurants. VE exams Saturday, November 9 advance registration only. Talk in on 146.28/88. For information or reservations: AC-ARTS Hamfest, PO Box 10342, Fort Wayne, IN 46851.

GEORGIA: Ham Radio and Computer Expo '85, sponsored by the Alford Memorial Radio Club of Stone Mountain, Gwinnett County Fairgrounds, Lawrenceville, 20 minutes NE of Atlanta. Saturday November 2, 9-5; Sunday, November 3, 9-4. Admission $4.00 advance, $5.00/door. FCC license exams both days. Free cookout Saturday night. Activities for the whole family. RV sites with hookups on site. Talk in on 146.16/146/76. For information and reservations: Alford Memorial Radio Club, PO Box 1282, Stone Mountain, GA 30086. (404) 476-2944.

NEW JERSEY: Stateline Hamfest sponsored by the Stateline Radio Club, NY and NJ, November 16, St. Andrews School, 120 Washington Avenue, Westwood, NJ. Doors open 8 AM. Tickets $3.00/gate. Tailgaters $6.00/space. Vendors $10.00 advance by 10/31/85. $13.00/gate. VEC testing. Food and refreshments. Talk in on 146.835 K3LSA Rpt. For information: Stateline Hamfest, Stateline Radio Club, PO Box 325, Montvale, NJ 07656 or call Fred, N2ATI (201) 664-5320.

ILLINOIS: EARS, Inc. Hamfest, Sunday, November 10, Harlem Community Center, 900 Roosevelt Road, Machesney Park. Advance tickets $3.00/SASE. $4.00/door. Inside tables $5.00 each. Talk in on 146.01/.61. For information: EARS, Inc., PO Box 4291, Rockford, Il 61110.

IOWA: The Muscatine and Iowa City Amateur Radio Clubs will co-sponsor the SE Iowa Hamfest, Sunday, October 6, rain or shine, West Liberty Fairgrounds, West Liberty. Gates open 7 AM. Indoor/outdoor flea market. Saturday night camping available on grounds, nominal charge. ARRL/VEC exams, preregistration suggested. Tickets $3.00/advance and $4.00/gate. For further information KE0Y, Tom Kramer, 905 Leroy Street, Muscatine, IA 52761. (319) 264-3259.

OHIO: Marion Amateur Radio Club's 11th annual "Heart of Ohio" Ham Fiesta, Sunday, October 27, 0800 to 1600 hours, Marion County Fairgrounds Coliseum. Tickets $3.00/advance. $4.00/door. Tables $5.00. Check in on 146.52 or 147.90/30. For information, tickets or tables: Ed Margraff, KD8OC, 1989 Weiss Avenue, Marion, Ohio 43302. (614) 382-2608.

ALABAMA: S.P.A.R.C. 1st annual Swapmeet and Packet exhibit, Lee County Fairgrounds, US 431, October 19, Opelika/Auburn. 10 AM to 5 PM. Spaces $5.00 per vehicle advance; $7.00/gate. $1.00 gate donation. Free parking. Packet demonstrations by Bob McGwier, N4HY. Reservations contact: Ray, PO Box 2423, Opelika, AL 36803-2423. For information call Ray (205) 745-2838, Gene (205) 821-8010, Danny (205) 745-7455. Talk in on 147.06/66.

PENNSYLVANIA: RF Hill ARC's 9th annual Hamfest, Sunday, October 29, Pennsylvania National Guard Armory, Rt. 152, Sellersville. Indoor ($8) and tailgating ($6) space available. Sellers set 6 AM. Buyers admitted 8 AM. Tickets $3.00. Non-ham spouses and children free. For indoor spaces call WB3AIG (215) 674-4800, ext. 515. Tailgating space first come, first served. Talk in on 144.71/145.31, 146.28/88 and 146.52.

TENNESSEE: The 7th annual Amateur Radio and Computer Convention, October 26 and 27, new Convention and Trade Center, Chattanooga. Free admission. All indoors. VE exams both days. 8' flea market tables $6/day; $10/both days. Power $5 extra. Talk in on 146.19/.79. For information: Hamfest Chattanooga, PO Box 3377, Chattanooga, TN 37404 or call Nita Morgan, N4DON (404) 820-2065.

FLORIDA: The 10th annual South Florida ARRL Suncoast Convention, October 12 and 13, National Guard Armory, St. Petersburg. Note new location: QCWA luncheon Saturday. Luau Saturday night and Ladies' luncheon Sunday. Special demonstration on packet radio for beginners and advanced operators. VE exams Saturday morning. Registration $3.00. $4.00/door. For tickets and hotel rooms: FGCARC, 1556-56th Avenue N, St. Petersburg, FL 33703. Checks payable to FGCARC.

MINNESOTA: Hamfest Minnesota and computer Expo, sponsored by the Twin City FM Club, November 2, Richfield High School, 7001 Harriet Avenue S, 8 AM to 3 PM. Admission

$3.00/advance; $4.00/door. FCC exams, giant indoor flea market. Talk in on 16/76. For information: Clyde R. Green, N0DVP, 5406 Zealand Avenue N., New Hope, MN 55428 or Twin City FM Club, Box 555, Minneapolis, MN 55440.

MASSACHUSETTS: Giant electronics auction sponsored by the Hampden County Radio Association, November 1, Granger School, Feeding Hills starting 7:30 PM. Sponsor takes 10% commission on all sales. Proceeds benefit club projects including building an emergency communications system. No admission charge. Public invited. Refreshments available. For information: Ron Beauchemin (413) 739-5228.

TEXAS: The Austin Amateur Radio Club's Fall Swapfest, October 19, 8 AM to 1 PM, Manchaca Fire Hall, Manchaca, Farm Road 1626 west of IH-35. Covered and open-air spaces. Sellers may bring own tables. Indoor tables $2.00 each, first come, first served. Dealers welcome. Admission is free. Talk in on 146.19/.79 or 16.34/.94. For information: Jim Strohm, KA5UXC, 1743 Cricket Hollow Drive, Austin, TX 78758. (512) 837-5423 or 837-4352. SASE for map and information.

TENNESSEE: The 5th annual Tri-Cities Hamfest sponsored by the Johnson City and Kingsport Amateur Radio Clubs, October 19, Appalachian Fairgrounds, Gray. Forums, dealers, flea market and RV hookups. For information: Tri-Cities Hamfest, PO Box 3682 CRS, Johnson City, TN 37601.

MICHIGAN: 3rd annual Hamfest/Electronic Flea Market, October 27, Kalamazoo County Fairgrounds, Kalamazoo. Admission *$2.00/advance; $2.50/door. 8' table space $6.* Dealer setup 8:30 AM. Doors open 9 to 4. Ham license testing 10 AM, limited walk-ins. For tickets/tables: Ken, KA8RUA, 2825 Lake Street, Kalamazoo, MI 49001.

GEORGIA: Rome Hamfest sponsored by the Coosa Valley ARC, Sunday, October 6, Rome Civic Center, GA Highway 20. Admission free. Homemade Bar-B-Cue and stew. Camper parking available, no hookups. Inside tables $5, outside $3. Fun for the whole family. Talk in on 147.900/300. Contact Buddy Waller, NO4U, 24 Wellington Way, SE Rome, Georgia 30161. (404) 235-5417.

NEW HAMPSHIRE: Hosstraders annual Fall tailgate swapfest, Saturday, October 5, Deerfield Campgrounds. Donation $2 *per person sellers included. Profits benefit Shriners' Boston* Burns Center. Our May Swapfest gave $6,960. Friday night camping at nominal fee after 4 PM. Talk-in on .52 and 146.40-147.00. For information SASE to Norm, WA1IVB, RFD Box 57, West Baldwin, ME 04091.

OPERATING EVENTS

"Things to do . . ."

October 12: Hermiston Amateur Radio Club's KD7LC will be on the air 1800-0100Z and 1800-2200Z, October 13 to commerate the 104th anniversary of Lewis and Clark's visit to Hat Rock. To receive special certificate send 9x12 SASE to HARC, PO Box 962, Hermiston, OR 97838. November 10: In observance of Veterans' Week, members of the Hamfesters Radio Club, Chicago, will operate from the Robert K. Wade (K9CDH) Memorial Ham Shack, Hines VA Hospital using the Hines Club call K9WFN, 1500Z to 0300Z. 40, 20, 2m FM, 2m USB. For a certificate, send QSL and 9x12 SASE to Hamfesters RadioClub, Inc., Chicago, c/o Robert K. Wade Memorial Ham Shack, Hines VA Hospital, Hines, Illinois 60141.

October 12: Members of the Capeway Radio Club will commemorate the 350th anniversary of Plymouth County (Mass) from October to October 20. For a certificate send a large SASE with 39 cents postage and QSL to: Ray Witt, WA1OWQ, 62 Caldwell St., No. Weymouth, Mass. 02191

October 5: A special event station, KN5D, will operate from the annual International Hot Air Balloon Fiesta, Albuquerque, New Mexico, October 5 through October 13. Also a gateway station through Oscar 10, conditions permitting. QSL to KN5D, PO Box 997, Corrales, NM 87048.

October 27: Laurel ARC will operate special event station W3DQI, 1500Z to 2230Z to help celebrate the anniversary of the restoration of the Montpelier Cultural Arts Center of Montpelier Mansion in historic Laurel, MD. 8x11 certificate for SASE. QSL to LARC, PO Box 91, Annapolis Junction, MD 20701.

October 15: The Colquitt County Ham Radio Society will operate club station WD4KOW from the site of the 8th annual Sunbelt Agricultural Exposition, October 15, 16 and 17. 0900 to 1700 EDST each day. The Sunbelt Expo is at the Spence Field Airbase, near Moultrie, Georgia. A special QSL card is available for those making contact and sending a SASE.

October 19: JOTA — Scouts 28th annual Jamboree on the Air. Look for K2BSA, the BSA headquarters station in Dallas, *Texas and HB9S, the World Scout Headquarters in* Switzerland and other special call signs from many countries. Requests for certificates should go to Jamboree on the Air, 1325 Walnut Hill Lane, Irving, TX 75038 with large SASE. Encourage scouts in Amateur Radio.

October 26: The St. Peters, MO, ARC will operate 1700Z October 26 to 1700Z October 27 from the Daniel Boone Home, Femme Osage Valley, St. Charles County, to commemorate where Boon spent the last two decades of his life. Listen for KB0J. Certificate via Bob Goin, KA0IKU, 3112 Powder Horn Trail, St. Charles, MO 63301.

ADVERTISER'S INDEX AND READER SERVICE NUMBERS

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Limit 15 inquiries per request.

Please use before November 30, 1985.

THE GUERRI REPORT

Ernie Guerri W6MGI

RF effects — the good and the bad

We're all familiar with the convenient way in which microwave ovens quickly cook even large pieces of food. A little closer look at our friendly oven will reveal that considerable effort has gone into making sure that the microwave radiation doesn't leak out, and that the unit won't operate unless the door is closed and locked. There's good reason for this — human tissue is very sensitive to radiation, and the effects are cumulative.

The American National Standards Institute (ANSI) has developed a "whole-body" standard for human exposure to radiation (**fig. 1**).

There is not general agreement on the levels set in the ANSI standard, and these levels have not been adopted by the Environmental Protection Agency. Several countries have standards which are considerably more restrictive than ANSI's, and some permit levels of only 1/10th the U.S. amount. This lack of agreement only serves to emphasize that one should err on the side of conservatism in such a critical area.

It's important to note that the most dangerous frequency ranges include the Amateur bands from about 10 meters through 450 MHz, and that some parts of the body are more sensitive than others. Human eyes, for example, are several times more sensitive to RF than limbs. It would be wise for Amateurs who use handheld transceivers in the VHF/UHF region to make sure that their antennas are pointed well away from their faces when transmitting. Separate antennas are safest for power levels greater than 3 to 5 watts.

Similarly, care should be taken when sending high power to antennas mounted directly on the roof of a house; the field strength inside the house can easily exceed the ANSI limits. *Never* stand directly in front of a high gain VHF/UHF or microwave antenna when applying any appreciable power.

There are positive uses for the application of RF energy to the human body, however. Considerable work is being done to examine the therapeutic effects of various RF fields. The results are encouraging. Both thermal and non-thermal effects have been observed to diminish or eliminate tumors, and pulsed RF can enhance bone growth in the healing of fractures. Experiments in the 30 MHz region have shown that nerves and related tissues can actually regenerate when exposed to levels of about 50 mW/cm^2 — much higher than the ANSI whole-body standard.

It would appear that RF is like many of the chemicals our body needs. Delivered in just the right quantity, at just the right rate, they make us healthy. Misused, they can be dangerous.

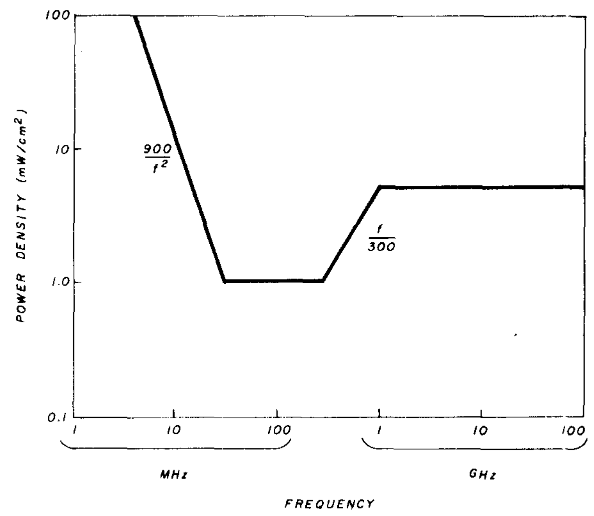

fig. 1. ANSI whole-body RF exposure.

solar cells achieve high efficiencies

We all know that solar cells make fine power sources for calculators and NASA vehicles. But we may soon realize a wider range of benefits from these long-touted devices. Tests at Sandia National Laboratories in New Mexico have confirmed that high temperature gallium arsenide cells can yield efficiencies of over 25 percent. Silicon cells housed in concentrators that focus light on the cell surface have demonstrated conversion efficiencies of 17 percent, with prospects for improvement of another 1 to 2 percent in the near future. The cost of the overall cell-lens assemblies is still high — nearly $10/watt in small quantities. However, with such significant improvements in efficiency, researchers can soon concentrate on ways to reduce costs and contemplate true commercialization of solar electric panels.

right on

The stirring vision of a pilot in the cockpit with a silk scarf, goggles, and only a compass to guide him, long ago gave way to an image of a much calmer environment, complete with autopilot. Then about 20 years ago the autopilot began to be replaced — on long flights — with inertial navigation systems (INS) offering typical errors of less than one degree/hour of drift.

Continued improvements have brought us to the point of laser beams illuminating reflective spheres only a few microns in diameter, as the main inertial element in a gyro. These little spheres spin at more than 200,000 RPM, which means that they don't drift much with time. Complex electronics keep track of the exact position of the sphere and correct the overall gyro accuracy by a position fix against a GPS (Global Positioning Satellite). The resulting navigation system permits flying intercontinental distances with only a few hundred meters of total course error. To top it off, laser gyros on a chip are expected to be available in 1988-89.

Now, imagine a modern Robin Hood with his sheaf of "smart" arrows — laser guided and microcomputer controlled, each with a memory for its specific target: deer, fox, rabbit . . . and so on. He wouldn't even have to *shoot* the arrows — just throw 'em — by the handful! What hath technology wrought?

ham radio

Invitation to Authors

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

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THINGS TO LOOK FOR *(AND LOOK OUT FOR)* IN A PHONE PATCH

- A patch should work with any radio. AM, FM, ACSB, relay switched or synthesized.
- Patch performance should not be dependent on the T/R speed of your radio.
- Your patch should sound just like your home phone.
- There should not be any sampling noises to distract you and rob important syllables. The best phone patches do not use the cheap sampling method. (Did you know that the competition uses VOX rather than sampling in their $1000 commercial model?)
- A patch should disconnect automatically if the number dialed is busy.
- A patch should be flexible. You should be able to use it simplex, repeater aided simplex, or semi-duplex.
- A patch should allow you to manually connect any mobile or HT on your local repeater to the phone system for a fully automatic conversation. Someone may need to report an emergency!
- A patch should not become erratic when the mobile is noisy.
- You should be able to use a power amplifier on your base to extend range.
- You should be able to connect a patch to the MIC and EXT. speaker jack of your radio for a quick and effortless interface.
- You should be able to connect a patch to three points inside your radio (VOL high side, PTT, MIC) so that the patch does not interfere with the use of the radio and the VOL. and SQ. settings do not affect the patch.
- A patch should have MOV lightning protectors.
- Your patch should be made in the USA where consultation and factory service are immediately available.

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PRIVATE PATCH III
GIVES YOU ALL OF THE ABOVE

BEWARE OF INFERIOR IMITATIONS.

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PRIVATE PATCH III

SIMPLEX SEMI-DUPLEX INTERCONNECT

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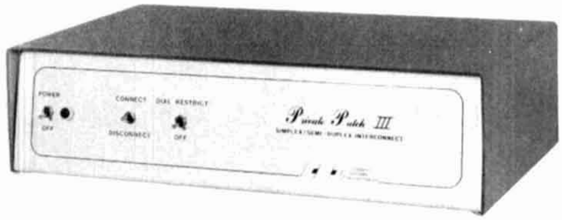


With an amazingly low price, the all new PRIVATE PATCH III is the most powerful personal phone patch system available. You can use it simplex, repeater aided simplex (from your base) or semi-duplex (at the repeater). That's right, you will never have to buy another patch. PRIVATE PATCH III does it all! There are many new and important features which were formerly only available in our top commercial models.

With a flick of the new connect switch you can patch your friends on the repeater into the phone system. One of them may need to report an emergency!

No hassles with busy signals! If you call a number that is busy, just put your MIC down and relax. PRIVATE PATCH III will disconnect automatically.

The new CW ID keeps you completely informed as to patch status. ID occurs when you access and again when you disconnect. ID is also sent after toll call attempts, all automatic disconnects, manual disconnect and when timeout is imminent. And of course your CW ID chip is free.

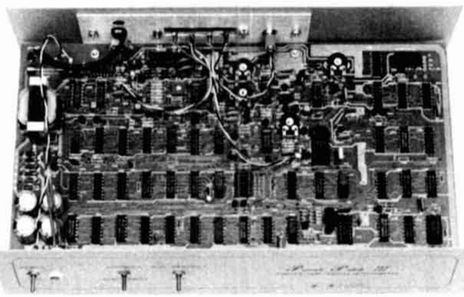
PRIVATE PATCH III does not interfere with the normal use of your base radio. A new audio pre-amp permits audio take off before the VOL. control. As a result, the VOL. and squelch settings do not affect patch operation. Of course you can also connect PRIVATE PATCH III to the MIC and EXT speaker jacks as before.

A new digit counting system makes the toll restrict positive even in areas where you do not have to dial "I" first. A secret five digit code disables the toll restrict for one toll call. Re-arm is automatic.

Additional new features: MOV lightning protection — Three digit access code (eg.★93) — Spare relay position on board — Plus former features: 3/6 minute timeout timer — Digital fast VOX (pat. pend.) — 115 VAC supply — Modular Jack and cord plus much more!

Please write or call for our four page brochure to get the complete story.

Options:
FCC approved coupler
12 VDC or 230 VAC power



Warranty? Yes, one full year!

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- **100% duty cycle transmitter.** Super efficient cooling system using special air ducting works with the internal heavy-duty power supply to allow continuous transmission at full power output for periods exceeding one hour.
- **Programmable scanning.**
- **Semi or full break-in (QSK) CW.**
- **Low distortion transmitter.** Kenwood's unique transmitter design delivers top "quality Kenwood" sound.
- **Keyboard entry frequency selection.** Operating frequencies may be directly entered into the TS-940S without using the VFO knob.
- **Graphic display of operating features.** Exclusive multi-function LCD sub-display panel shows CW VBT, SSB slope tuning, as well as frequency, time, and AT-940 antenna tuner status.
- **QRM-fighting features.** Remove "rotten QRM" with the SSB slope tuning, CW VBT, notch filter, AF tune, and CW pitch controls.
- **Built-in FM, plus SSB, CW, AM, FSK.**

Optional accessories:
• AT-940 full range (160-10 m) automatic antenna tuner • SP-940 external speaker with audio filtering • YG-455C-1 (500 Hz), YG-455CN-1 (250 Hz), YK-88C-1 (500 Hz) CW filters; YK-88A-1 (6 kHz) AM filter • VS-1 voice synthesizer • SO-1 temperature compensated crystal oscillator • MC-42S UP/DOWN hand mic.
• MC-60A, MC-80, MC-85 deluxe base station mics.
• PC-1A phone patch
• TL- 922A linear amplifier
• SM-220 station monitor
• BS-8 pan display
• SW-200A and SW-2000 SWR and power meters.

- **High stability, dual digital VFOs.** An optical encoder and the flywheel VFO knob give the TS-940S a positive tuning "feel."
- **40 memory channels.** Mode and frequency may be stored in 4 groups of 10 channels each.
- **General coverage receiver.** Tunes from 150 kHz to 30 MHz.
- **1 yr. limited warranty.** Another Kenwood First.

More TS-940S information is available from authorized Kenwood dealers.

KENWOOD

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