ham radio magazine

APRIL 1981 / $2.50

incorporating HAM RADIO HORIZONS

S-LINE OWNERS' REPORT

Henry Radio's New World Headquarters

After more than 30 years in the same location, Henry Radio in Los Angeles has moved to a beautiful new "World Headquarters" to better serve our amateur, commercial and industrial customers in Southern California, all over the United States and indeed the world.

Our new headquarters are just a few blocks from the Olympic Boulevard location where we have been meeting and assisting our good friends for these many years. All the famous Henry services are still available...only more so. The world's broadest line of amateur communication equipment plus the Henry line of high power HF linear amplifiers, solid state VHF and UHF amplifiers, our own Tempo line of synthesized hand helds for amateur use at 144, 220 and 440 MHz as well as commercial channelized handhelds and solid state amplifiers all FCC typ accepted, and finally a broad line of industrial an medical RF power supplies and plasma generator providing reliable continuous duty HF and VHF in th power range of 500 to 10,000 watts.

Henry Radio has come a long way in the 53 year since we first began serving the amateur fraternity. I the same personalized manner we have alway greeted our customers, we say "thank you" to all c our thousands of loyal customers whose support ha allowed us to come so far and we say "hello" fron our new "world" headquarters to all those thousand of customers throughout the world that we intend t serve in the years to come.

Please let us know how we can assist you.

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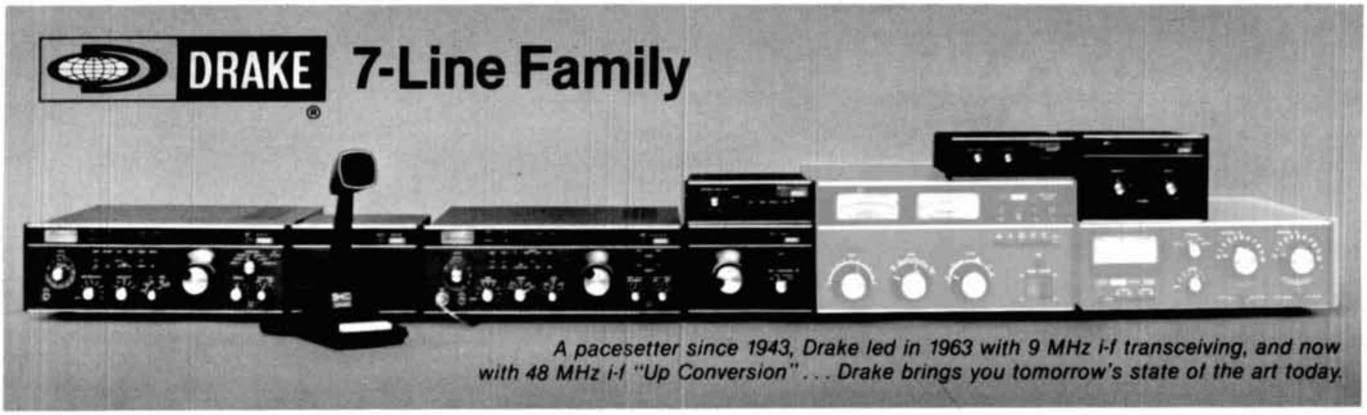

Model 1528

Drake L7

Continuous Duty
160-15* Meters

2kW Linear Amplifier

Temperature-controlled design for "key-down" operation over a wide frequency range.

2 kW PEP, 1 kW cw, RTTY, SSTV operation—all modes full rated input, continuous duty cycle.

160-15* meter amateur band coverage, plus expanded ranges for any future hf band expansions or additions within FCC rules. These ranges also include increased coverage for MARS, embassy, government, or other such services.

The Drake L7 utilizes a pair of Eimac 3-500 Z triodes for rugged use, and lower replacement cost compared to equivalent ceramic types.

Accurate built-in rf wattmeter, with forward/reverse readings, is switch selected. Calibrated 300/3000 watt scales.

Temperature controlled two speed fan is a high volume low noise type and offers optimum cooling.

Adjustable exciter agc feedback circuitry permits drive power to be automatically controlled at proper levels to prevent peak clipping and cw overdrive. Front panel control.

By-pass switching is included for straight through, low power operation without having to turn off amplifier.

Bandpass tuned input circuitry for low distortion and 50 ohm input impedance.

Amplifier is comprised of two units—rf deck for desk top and separate power supply.

Operates from 120/240 V-ac, 50/60 Hz primary line voltage.

DRAKE L7 SPECIFICATIONS

• **Frequency Coverage***: Ham bands 160 through 15 meters*. Non-amateur frequencies between 6.5 and 21.5 MHz may be covered with some modification of the input circuit. • **Plate Power Input:** 2000 watts PEP on ssb and a-m. 1000 watts dc on cw, RTTY, and SSTV. • **Drive Power Requirements:** 100 watts PEP on ssb and 75 watts on cw, a-m, RTTY, and SSTV. • **Input Impedance:** 50 ohms. (Bandpass tuned input) • **Output Impedance:** Adjustable pi-network matches 50 ohm line with SWR not to exceed 2:1. • **Intermodulation Distortion Products:** In excess of −33 dB. • **Wattmeter Accuracy:** 300 watts forward and reflected, ±(5% of reading + 3 watts). 3000 watts forward, ±(5% of reading + 30 watts). • **Power Requirements:** 240 volts 50-60 hertz 15 amperes, or 120 volts 50-60 hertz 30 amperes. • **Tube Complement:** Two of 3-500Z or 8802/3-500Z or 3-400Z. • **Dimensions: Amplifier** 13.69"W x 6.75"H x 14.25"D (34.8 x 17.1 x 36.2 cm). **Power Supply** 6.75"W x 7.88"H x 11"D (17 x 20 x 28 cm). • **Weight:** Amplifier 27 lbs (12.25 kg), **Power Supply** 42.5 lbs (19.3 kg).

**Export model includes coverage of the 10-meter Ham Band.*

Model 1539

Drake Matching Networks MN7 and MN2700

Models 1538 and 1539

- **Frequency Coverage:** 1.8 - 30 MHz
- **Antenna Choice:** Matches antennas fed with coax, balanced line (use optional B-1000 Balun), or random wire.
- **Antenna/By-Pass Switching:** Allows matching unit by-pass regardless of antenna in use, and selects various antennas.
- **Extra Harmonic Reduction:** Employs "pi-network" low pass filter type circuitry for maximum harmonic rejection.
- **Built-in Metering:** Accurate Rf Wattmeter and VSWR Reading, pushbutton controlled from front panel.
- **Input Impedance:** 50 ohms resistive.
- **Power Capability:** MN7—250 watts average continuous duty (0-300 W scale). MN2700—1000 watts average continuous duty (2000 watts PEP). (0-200 or 0-2000 W scale).
- **Dimensions:** MN7—13.1"W x 4.53"H x 8.5"D excluding knobs and connectors (33.26 x 11.5 x 21.6 cm). MN2700—13.1"W x 4.53"H x 13"D excluding knobs and connectors (33.26 x 11.5 x 33 cm).
- **Weight:** MN7—10 lbs (4.5 kg). MN2700—11 lbs (5 kg).

Drake MN7 and MN2700 Specifications

• **Frequency Coverage:** 1.8 to 30 MHz. Band Switch marked for 160, 80, 40, 20, 15, and 10 meter amateur bands; however, frequency coverage between amateur bands is possible by using the nearest band positions with a small reduction in matching capability. • **Input Impedance:** 50 ohms (resistive). • **Load Impedance:** 50 ohm coaxial with VSWR of 5:1 or less at any phase angle (3:1 on 10 meters). 75 ohm coaxial at a lower VSWR can be used. • **Balanced Feedlines:** With the Drake B-1000 accessory balun, which mounts on rear panel, tunes feed point impedances of 40 to 1000 ohms, or 5:1 VSWR referenced to 200 ohms (3:1 on 10 meters). • **Long-Wire Antennas:** Feed point impedances up to 5:1 VSWR referenced to 50 ohms. Also, 5:1 referenced to 200 ohms with the Drake B-1000 accessory balun (3:1 on 10 meters). • **Meter:** Reads VSWR or forward power. • **Wattmeter Accuracy:** ±5% of reading ± 1% of full scale. • **Insertion Loss:** 0.5 dB or less on each band after tuning. • **Front Panel Controls:** Provide for the adjustment of resistive and reactive tuning, antenna switching, band switching, VSWR calibration, and selection of watts or VSWR calibration, and selection of watts or VSWR functions of the meter. • **Rear Panel Connectors:** The rear panel has four type SO-239 connectors (one for input and 3 for outputs), three screw terminal connections (for long-wire and open-wire feeder systems), and a ground post.

Specifications, availability and prices subject to change without notice or obligation.

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More Details? CHECK—OFF Page 114

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contents

Observation & Opinion

It's getting to be that time again. The end of a long winter. The ground is beginning to thaw. Trees are starting to green up. Time to start thinking about antennas. And here I am, a displaced Californian, in the incredibly beautiful part of the country known as New Hampshire. In California I'd had to contend with problems such as zoning ordinances, a small city lot, and neighbors with marginal TV and stereo sets and a suspicious attitude toward ham radio operators.

But now, after some 45 years of hamming, suddenly it's different. I have some freedom: a location miles from the nearest city, rolling green hills sloping toward a huge lake, no maze of high-voltage wires, no manmade interference. This spring I'll put up the ideal antenna.

But what's the "ideal" antenna? After reading Jim Lawson's series in *ham radio*, one might consider the Yagi beam to be the ideal antenna. But to perform well, the Yagi requires, among other things, a tower of substantial height. This means bucks. Or, one might consider the quad antenna (also bucks and problems with construction).

So, I have decided that the ideal antenna for me is the long wire. It requires *lots* of wire and *lots* of real estate. But I'm fortunate. I have plenty of room for installation and a reel of surplus annunciator wire — enough for ten wavelengths on the 20-meter band. According to the technical literature, a wire ten wavelengths long will produce a gain of 7.5 dB over a dipole, a very respectable figure indeed.

OK, you say, how do you rotate it or change its direction for DX? Answer: you don't. If the antenna is long enough and pointed in the general direction of the highest concentration of the foreign Amateur population, the long wire will not only provide excellent DX results off both ends, but will also produce sidelobes that will cover intermediate directions.

This theory was proved last summer, when I first erected a long wire soon after arriving in New Hampshire. That long wire was only about three wavelengths on 20 meters. It was oriented due north and south; the low end of the antenna was only about 25 feet above ground. With low power (10 to 15 watts) I worked everything I could hear on 20 meters, both on short and long path. The long-path openings were few but produced some excellent contacts.

So this spring I'll put up a long wire, ten wavelengths long, on 20 meters, running north and south, and I'll feed it with the legal maximum power. Some muscles will be required to get it up into the trees (I'll enlist the aid of my staff). Watch out, Bob Locher! I'm out to give you the business!

The end of this month brings the ever-popular Dayton Hamvention. It will be interesting to see how this year's show turns out. Despite sounds of doom and gloom expressed by some in the industry, there are signs of hope. I hear rumors that several manufacturers are planning to announce new product lines at the show. That should be something to look forward to. The fact that almost all of the major names in Amateur Radio will be at Dayton should make for an enthusiastic crowd.

This will be the first year I've had a chance to visit the Dayton show. In all my years with *ham radio* I've been living on the West Coast and couldn't attend. But this year I'll be at Dayton with an open mind and megabytes of memory storage. I want to talk to *you*, our reader, to get your feelings about the new *ham radio*: what you like and dislike about it; what you'd like to see in it. I want to talk to industry leaders, look for new authors, try to find a few bargains in the flea market (more antenna wire), and just rap. Dayton will be extremely important to me as editor of *ham radio*; but it will be more important to *you*, our readers. Because you can tell me what you want to see in issues to come.

Look me up. I'll be there to listen to you. We need you and you need us. See you at Dayton!

Alf Wilson, W6NIF
editor

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TAKE ANOTHER LOOK AT THE POPULAR MOBILE TWINS . . . IC-260A AND IC-255A.

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- ★ Memory scan.
- ★ Programmable band scan.
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Speed Range (WPM)	2-99	1-99	1-99	1-99	2-99	8-50	5-50+	?	8-50
Memory Capacity (Total Characters)	500			500		400	100/400	400	
Message Partitioning	Soft			Soft		Hard	Hard	Hard	
Automatic Contest Serial Number	Yes			Yes		No	No	No	
Selectable Dot and Dash Memory	Yes	Yes		Yes	Yes	No	No	No	No
Independent Dot & Dash (Full) Weighting	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Calibrated Speed, 1 WPM Resolution	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No
Calibrated Beacon Mode	Yes			No		No	No	No	
Repeat Message Mode	Yes			No		Yes	Yes	Yes	
Front Panel Variable Monitor Frequency	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Message Resume After Paddle Interrupt	Yes			Yes		No	No	Yes	
Semi-Automatic (Bug) Mode	Yes	Yes		Yes	Yes	No	No	No	No
Real-Time Memory Loading Mode	Yes			Yes		Yes	Yes	No	
Automatic Word Space Memory Load	Yes			Yes		No	No	Yes	
Instant Start From Memory	Yes			Yes		No	No	Yes	
Message Editing	Yes			Yes		No	No	No	
Automatic Stepped Variable Speed	No	No	No	Yes	No	No	No	No	No
2 Presettable Speeds, Instant Recall	No	No	No	Yes	No	No	No	No	No
Automatic Trainer Speed Increase	Yes	Yes	Yes						No
Five Letter or Random Word Length	Yes	Yes	Yes						No
Test Mode With Answers	Yes	Yes	Yes						No
Random Practice Mode	Yes	Yes	Yes						Yes
Standard Letters, Numbers, Punctuation	Yes	Yes	Yes						Yes
All Morse Characters	Yes	Yes	Yes						No
Advertised Price	$199.95	$129.95	$99.95	$129.95	$79.95	$139.95	$ 99.50/ $139.50	$229.00	$129.95

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MT-1P (portable version of MT-1) with batteries, charger, earphone	$139.95
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Ask a friend how he likes his AEA keyer compared to anything else he has ever tried, then JUDGE FOR YOURSELF. See the AEA keyer and trainer family at your favorite dealer.

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comments

Dear HR:

Several things are distressing about buying and selling the answers to the Amateur license examinations, as you mention in your December editorial. I hope the matter will eventually be settled by having the FCC copyright its future Amateur tests. I hate to see Mr. Bash get rich and famous when the main thing that attracts anybody to "his" stuff is precisely the fact that he didn't write it! He only compounds his dishonesty by posing as a rebel voice against the stingy, oppressive Federal regulators — it's all a sales pitch.

But even you somehow seem to react as if an easy way out were being offered. Anybody who buys on this assumption is begging to be taken advantage of, since memorizing answers is actually the single most difficult way to prepare for a technical examination. The only way to make it easy is to learn to understand the subject matter, surely not an unfair requirement for a radio operator's license.

I myself took up Amateur Radio in 1979 and now have my Extra class license, yet I'm no electronics expert — only an interested student who isn't afraid of a multiple-choice examination. In my opinion, Bash and his supporters are treating our whole tradition of self-training — one of the best things about this hobby — with scorn.

David Satz, N1AWG
Cambridge, Massachusetts

Dear HR:

W6SAI's article in the September, 1979, issue of *ham radio* concerning problems with the Collins KWM-2 transceiver was helpful to me in curing relay problems with my 32S-1 transmitter. The power relay, K1, would sometimes trip as soon as the tubes warmed up, causing the transmitter to turn on. But frequently K1 would not turn on hard enough to trip the antenna relay, K2. It seemed to me this problem was brought about by stray rf tripping the VOX relay actuator tube, V11A, a 6U8A.

After examining the circuit carefully, I decided to shield R75, the grid resistor of VOX amplifier tube, V14A, a 12AT7. I felt this resistor might be developing a current from stray rf and feeding the amplifier. Next, following W6SAI's suggestion, I installed a 2-watt, 4700-ohm resistor between pin 1 (plate) of VOX relay actuator tube V11A and K1. Finally, I replaced the two 68k 2-watt resistors composing R89 in the cathode circuit of V11A with three 100k, 2-watt resistors, because the other resistors had shown signs of overheating.

These modifications seem to have completely cured my 32S-1 of relay trouble, and I thought they might be of interest to others who operate Collins S-line equipment.

Frisco Roberts, K5CE
Corpus Christi, Texas

Dear HR:

This letter concerns an article in *ham radio* entitled "Navigational Aid for Small-Boat Operators" by Henry Keen, (September, 1980, pages 46-47).

While we appreciate Mr. Keen's effort to provide information regarding navigational aids for boaters, we are concerned that the system described would be in violation of the Commission's rules. For example, Mr. Keen states in the last paragraph of his article, "I suspect that such a system might operate, for example, in one of the 20-kHz slots that appear in the CB spectrum." We do not feel that this would be possible or advisable for the following reasons.

Specifically, the proposed use of two beacon transmitters would not be in accordance with Section 95.401, Rule 22(a) of the Citizens Band Radio Service Rules which limit CB communications to telephone only. In addition, Rule 23(a)(4) of the same section forbids the transmission of one-way communications by a CB station. Further, Mr. Keen's reference to the involvement of a marine operator raises other questions regarding operator qualifications and equipment control. We also should add that while Mr. Keen is a licensed Amateur, his proposed system would not be licensable in the Amateur Radio Service. Nor do we know of any other Commission service which could license the suggested navigational aid as proposed.

We are bringing this information to your attention so that you may alert your readers to the regulatory difficulties involved in the proposed system and to warn them against purchasing radio equipment that is not licensable.

Robert L. Cutts, Chief
Spectrum Management Division
Federal Communications Commission
Washington, D.C.

Dear HR:

To an old-timer who used loop modulation on 10 meters in 1932 and learned fm during World War II under Fred Budleman and Fred Link (Link Radio Co.), the article on amplitude compandored sideband (ACSB) is nothing short of exciting. But can't we find a better name for it?

Am and fm are short, descriptive titles. SSB, or better, SB, or *sideband*, have a nice ring. NBVM is as cumbersome as the implementation of the technique. With full apologies to Dr. Lusignan, "amplitude compandored sideband (ACSB)," has zero appeal. Furthermore, it omits an important part of the technique: the pilot tone.

A more descriptive, easier-to-handle title is compressed piloted sideband (CPS). This might be shortened to compiloted sideband modulator (CSM). Let's start the new baby off with a good name.

Jack Geist, N3BEK
Silver Spring, Maryland

presstop

ARRL WILL DISCOURAGE 18 AND 24 MHZ "experimental" or beacon operation by U.S. Amateurs, the League's Executive Committee agreed recently. A number of Amateurs have applied to the FCC for Special Temporary Authorization to transmit on the two future Amateur bands, as is being done by the two Canadians who are working on 10 MHz. But with the uncertainty about when either 18 or 24 MHz will become available, it was felt that any such preliminary Amateur operations would encourage others without STAs to follow suit. The negative reaction that such unauthorized operations could generate, it was felt, would more than outweigh any possible benefit.

AMATEURS OPERATING 420-450 MHZ in the vicinity of military installations in the Southwest and Florida got a nice break from the FCC at its agenda meeting on February 11. Acting on a petition from AMSAT to permit a power increase from the present 50 watts DC input in those areas, the Commissioners decided, with the agreement of the Air Force, that an increase to 1000 watts EIRP was acceptable. There is a stipulation, however, that the transmitting antenna be directed at least 10 degrees above the horizon. In addition two new restricted areas, both of 50 miles radius, were added at Otis Air Force Base in Massachusetts and Beale Air Force Base in California. Other restricted areas are described in Part 97.61(b)(7) of the rules.

HMR COMMUNICATIONS IS BEING SUED for $150,000 by the Commonwealth of Pennsylvania in a suit filed February 18. In a news release, the state said HMR and its officers, Henry M. Robbins, Jr., and Sr., and Alice B. Robbins, "have repeatedly and continuously violated provisions of the state unfair trade practice and consumer protection law." Specific charges include representing HMR as a "million dollar" electronics company when in reality it is literally a "garage" operation. "HMR has misrepresented the nature and number of its customers, its size and assets, the names and qualifications of personnel, quality of equipment, delivery time, terms and conditions of sale, and warranty provisions." The state's Bureau of Consumer Protection says it has evidence that the Robbinses have not acted in the interest of the corporation but rather in their own personal interest in their dealings.

The Suit Asks the Westmoreland County Common Pleas Court to order HMR and the Robbinses to make restitution to all of the more than a dozen complainants, plus pay the state a civil penalty of $150,000.

FCC'S NEW FORM 610 IS CAUSING enough Amateurs problems that a significant number of the forms are being returned without action. Principal confusion with the August, 1980, version (the only one now valid) is with questions 2A-2J: 2A should be checked only if there are no changes, 2G only if there is any change in name, such as dropping "Jr." (the former name must also be provided), and 2H and/or 2I, which must be checked if the mailing address or station location are changed. Questions 3 through 17 must also be answered, and failure to include the original or a photocopy of the license is also bouncing a number of applications.

A BIZARRE MURDER ON PALMYRA that took place during the 1974 KP6KR Kingman Reef DXpedition and involved the DXpedition group has just come to light in Hawaii. A young couple had run aground off Palmyra and were helped ashore by the DXers before they moved on to Kingman. An older retired couple, the Johnsons, arrived at Palmyra while KP6KR was operating on nearby Kingman and then disappeared without a trace.

A Month Later The Young Couple arrived in Hawaii on Johnson's yacht, repainted with no registration numbers. They were arrested, tried and convicted of piracy and related charges—but not murder, as no trace of the Johnsons was found. WA9UCE (now N6RJ) testified for the prosecution at their trial.

The Johnsons' Bodies have now turned up in a drum in Palmyra's lagoon. On February 23, the convicted pirates were indicted for murder.

FCC WILL CERTAINLY SUFFER as a result of expected governmental austerity under the Reagan administration. The Commission has been told by the Office of Management and Budget to expect to cut permanent positions by 8%, with 5% to go this year and 3% more in fiscal 1982. According to Broadcasting magazine, that amounts to a staff reduction of 160. Just where in the FCC those people will come from remains to be seen, although it's almost certain to affect Amateur Radio matters.

220 MHZ WAS SPARED, but the Commissioners did give 216-220 MHz to the proposed automated inland waterways communications systems (IWCS). The initial proposal for IWCS had triggered protests from the Amateur community when a purported typographical error specified 216-225 MHz as one of the options for the new system.

In An Unusual Move, the Commission adopted only those technical standards for IWCS that would serve to protect adjacent TV channel 13. Actual operational standards are to be proposed by potential IWCS users and suppliers.

MFJ Super Keyboards

5 MODES: *CW, Baudot, ASCII, memory keyer, Morse code practice.* **TWO MODELS: MFJ-496, $339.95.** *256 character buffer, 256 character message memory, automatic messages, serial numbering, repeat/delay.* **MFJ-494, $279.95.** *50 character buffer, 30 character memory, automatic messages.*

MFJ brings you a pair of 5 Mode Super Keyboards that gives you more features per dollar than any other keyboard available. You can send CW, Baudot, ASCII. Use it as a memory keyer and for MORSE code practice.

You get text buffer, programmable and automatic message memories, error deletion, buffer preload, buffer hold, plus much more.

MODE 1: CW

The 256 character (50 for 494) **text buffer** makes sending perfect CW effortless even if you "hunt and peck."

You can preload a message into the buffer and transmit when ready. For break-in, you can stop the buffer, send comments on key paddles and then resume sending the buffer content.

Delete errors by backspacing.

A meter gives buffer remaining or speed. Two characters before buffer full the meter lights up red and the sidetone changes pitch.

Four programmable message memories (2 for 494) give a total of 256 characters (30 for 494). Each message starts after one ends for no wasted memory. Delete errors by backspacing.

To use the **automatic messages,** type your call into message A. Then by pressing the CQ button you send CQ CQ DE (message A).

The other automatic messages work the same way: CQ TEST DE, DE, QRZ.

Special keys for KN, SK, BT, AS, AA and AR.

A lot of thought has gone into human engineering these MFJ Super Keyboards.

For example, you press only a one or two key sequence to execute any command.

All controls and keys are positioned logically and labeled clearly for instant recognition.

Pots are used for speed, volume, tone, and weight because they are more human oriented than keystroke sequences and they remember your settings when power is off.

Weight control makes your signal distinctive to penetrate QRM.

MODE 2 & 3 (RTTY): BAUDOT & ASCII

5 level Baudot is transmitted at 60 WPM. Both RTTY and CW ID are provided.

Carriage return, line feed, and "LTRS" are sent automatically on the first space after 63 characters on a line. This gives unbroken words at the receiving end and frees you from sending the carriage return. After 70 characters the function is initiated without a space.

All up and down shift is done automatically. A downshift occurs on every space to quickly clear garbled reception.

The buffer, programmable and automatic messages, backspace delete and PTT control (keys your rig) are included.

The ASCII mode includes all the features of Baudot. Transmission speed is 110 baud. Both upper and lower case are generated.

MODE 4: MEMORY KEYER

Plug in a paddle to use it as a deluxe full feature memory keyer with automatic and programmable memories, iambic operation, dot-dash memories, and all the features of the CW mode.

MODE 5: MORSE CODE PRACTICE

There are two Morse code practice modes. Mode 1: random length groups of random characters. Mode 2: pseudo random 5 character groups in 8 separate repeatable lists (with answers).

Insert space between characters and groups to form high speed characters at slower speed for easy character recognition.

Select alphabetic or alphanumeric plus punctuation. You can even pause and then resume.

MORE FEATURES

Automatic incrementing serial number from 0 to 999 can be inserted into buffer or message memory for contests.

Repeat function allows repetition of any message memory with 1 to 99 seconds delay. Lets you call CQ and repeat until answered.

Two key lockout operation prevents lost characters during typing speed bursts.

Clock option (496 only) send time in CW, Baudot, ASCII. 24 hour format.

Set CW sending speed before or while sending.

Tune switch with LED keys transmitter for tuning. Tune key provides continuous dots to save finals. Built-in sidetone and speaker.

PTT (push-to-talk) output keys transmitter for Baudot and ASCII modes.

Reliable solid state keying for CW: grid block, cathode, solid state transmitters (-300V, 10 ma Max, +300V, 100 ma Max). TTL and open collector outputs for RTTY and ASCII.

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More Details? CHECK—OFF Page 114

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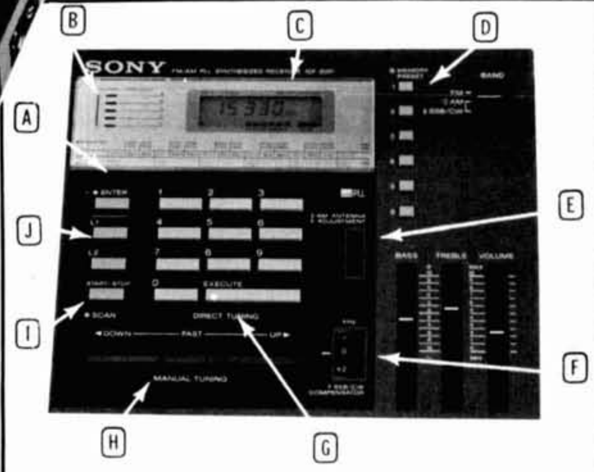

A Enter Button	**F** SSB/CW Compensator
B Signal Strength Indicator	**G** Execute Bar
C Liquid Crystal Display	**H** Manual Tuning Buttons
D Memory Preset Buttons	**I** Scan Button
E Antenna Adjustment Dial	**J** High/Low Limit Buttons

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- **Continuous Scanning of LW, MW, SW, & FM Bands**
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SPECIFICATIONS

CIRCUIT SYSTEM: Fm Superheterodyne; AM Dual conversion superheterodyne. **SIGNAL CIRCUITRY:** 4 IC's, 11 FET's, 23 Transistors, 16 Diodes. **AUXILIARY CIRCUITRY:** 5 IC's, 1 LSI, 5 LED's, 25 Transistors, 9 Diodes. **FREQUENCY RANGE:** FM 76-108 MHz; AM 150-29,999 KHz. **INTERMEDIATE FREQUENCY:** FM 10.7 MHz.; AM 1st 66.35 MHz., 2nd 10.7 MHz. **ANTENNAS:** FM telescopic, ext. ant. terminal; AM telescopic, built-in ferrite bar, ext. ant. terminal. **POWER:** 4.5 VDC/120 VAC **DIMENSIONS:** 12¼ (W) X 2¼ (H) X 6¾ (D). **WEIGHT:** 3 lb. 15 oz. (1.8 kg)

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More Details? CHECK—OFF Page 114

Collins Owners' Reports:

the S-line

A survey of owners' opinions on the Collins 32S-line transmitter and 75S-line receiver

In April of 1980, *ham radio* magazine published a questionnaire directed at the owners of Collins radios: the KWM-2/2A transceiver, the 32S-line transmitter, and the 75S-line receiver. The results of the transceiver portion of that questionnaire were printed in the March issue. This month, we are presenting our findings on the 32S and 75S transmitter/receiver pair, based on the 210 completed questionnaires received.

the good features

Like the reports we received on the KWM-2/2A, reports on Collins S-line gear have been overwhelmingly favorable. For example, 74 percent of those surveyed rated Quality of Workmanship a 10 on a scale of 1 through 10. That's an astonishing figure. Also ranking very high were Durability, which received a rating of 10 from 70 percent of those who replied, and Reliability, which was rated 10 by 65 percent of the respondents to our survey.

Other features of the Collins S-line praised by many S-line owners were stability, audio quality, ease of maintenance, receiver selectivity, and dial accuracy. See **table 1** for the full story. It's clear that these solid and dependable Collins radios are highly thought of by the hams who own them, and that they have retained their reputation for quality down through the years despite all of the technological wonders that have come along since these radios were first designed. Here are some of the comments we received to the question, What is the rig's best feature?

table 1. What is the rig's best feature?*

	percent
Reliability	45
Stability	27.5
Receiver performance	17.5
Dial accuracy	15
Clear audio	15
Selectivity	12.5
Signal quality	12.5
Ease of maintenance	12
200-Hz CW filter	11
Ease of tuning	10
Durability	8.5
Sensitivity	8.5
Wide frequency coverage	7.5
Resale value	5
Service manual	3
No TVI	2.5

*Many respondents gave more than one response.

By Martin Hanft, WB1CHQ, Production Editor, *ham radio* magazine

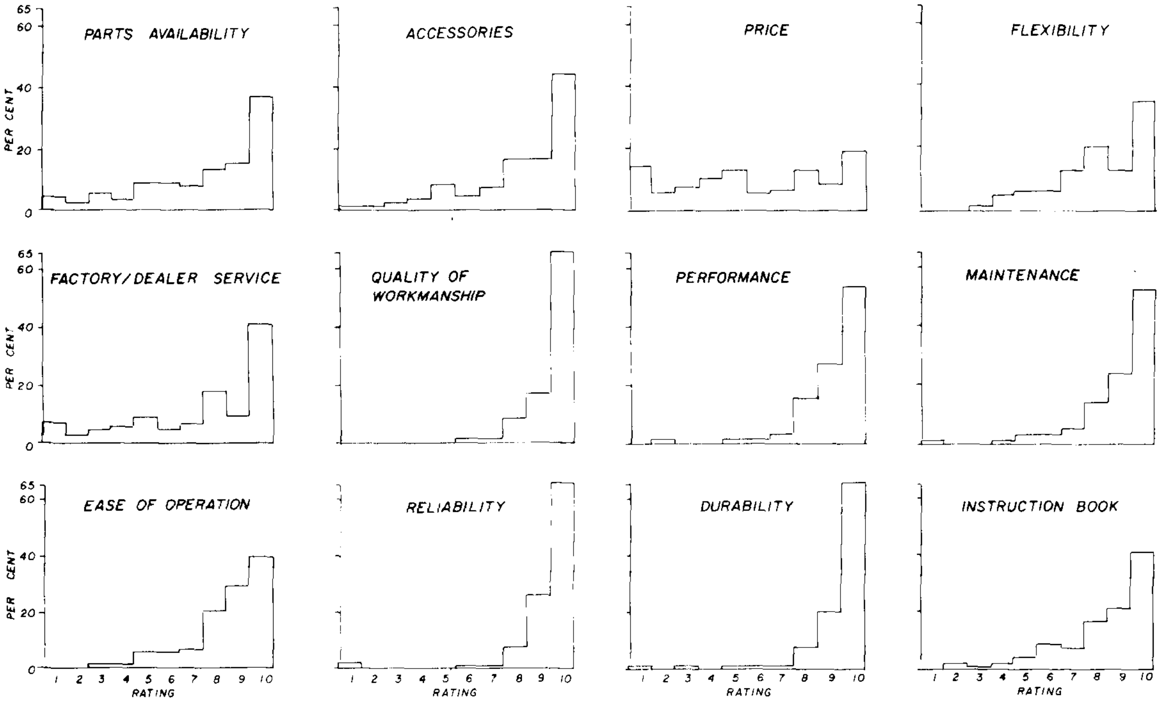


fig. 1. Ratings of the S-line transmitter/receiver pair, from 1 (poor) to 10 (perfect).

"Wide frequency coverage for MARS, easy to operate, and very reliable." — W3PE

"Receiver is top of list when peaked and holds up over long periods of use. There's very little aging of components. Signals may be equaled but not beaten in quality." — W5CAE

"Total reliability under adverse conditions, ease of service, dial accuracy and stability of both frequency and operation. Also the ability to cover frequencies between 3.2 and 30 MHz without modification — or trading it in for another rig!" — W5USI

"Day in and day out reliability." — WA6T

"Outstanding sensitivity on all bands, and it does not have the constant hiss of solid-state receivers. Crisp audio (no mush)." — K6ITL

"This rig is reliable, no question about it. I expect it to perform every time I turn it on and it does. Also, the inter-connect for transceive operation is a plus." — WDØEOT

"Selectivity and ability to operate without strong signals blocking the receiver. I work 80 and 40 CW the most, and I've yet to find a receiver that can outperform the 75S-3B on these bands." — N2DL

"Excellent receiver and transmitted audio. I have modified my receiver according to Jim Fisk's article about cascading filters. I've also added some solid-state-equivalent "Tubesters" in certain areas: agc, audio, VFO, and crystal calibrator." — VE3UP

"Miles of band spread." — W3EHA

"Ease of operation. Sixteen years old yet it competes favorably with present-day designs. Holds resale value. Minimum upkeep and repair." — W6MIR

"Front-end overload characteristics. It does not give up and die in a strong signal environment, the way the vast majority of current solid-state receivers do. The 200-Hz CW filter is the best I've ever used." — W6JD

"Reliability. But also outstanding for quality construction, frequency stability, and re-set accuracy." — W7AY

"One of the best thought-out designs ever. Extremely stable — clean signal. Does everything it was meant to do, *well*. One of the most maintainable rigs ever. A real classic in my book." — WAØTWH

"Collins uses top-quality switches, making for long, trouble-free life. I have used all of the popular top radios and I still keep coming back to the Collins even though it doesn't have all the fancy features. It can't be beat."

"Does not drift. When I tune in on a certain frequency it stays on that frequency. It has a very good tone. I get good reports from most QSOs. One man even said to me, 'I bet you're using a Collins.' " — WBØJJJ

"The best feature of the S-line has always been its quality of construction, which has led to a record of reliability and dependability unparalleled in Amateur equipment. It should be borne in mind that the S-line is not, strictly speaking, Amateur equipment, as there are probably more units in government and commercial service than in Amateur use." — WAØFYG

"Reliability, good signal quality, stability." — K9KER

"Overall quality. Good sensitivity and selectivity. Extremely durable and easy to service." — K4NYK

"Never had any trouble with it. Superb workmanship and quality control." — WB7VOR

"Rejection tuning (variable noise blanker)." — KH6BD

"I can tune in WWV on Monday, turn it off and turn it back on on Friday and WWV will still be zero beat." — K4KAE

"Trade-in value." — K9GEL

"A ham could easily become an appliance operator with a rig this well built." — K3JHB

"Dial readout and mechanism, rugged construction, and neat, uncluttered layout." — W1EED

"Highly durable: works 3:1 SWR all day with no problems." — KA6JJK

"I believe that it is impossible to name one feature that is best, but, if I had to, I believe it would be reliability and quality of construction. What other rigs can you name that after twenty years are still state-of-the-art and operational?" — WD8BTU

"Ease of operation, dial accuracy, and consistent power over a wide range of frequencies." — W6DPD

on the other hand

Despite the almost overwhelming praise for the Collins S-line gear, there were also some criticisms. But not many. More than 55 percent of our respondents told us that there are no worst features to the S-line, or if there is one they haven't found it yet. That's quite a recommendation. Others, however, mentioned difficulty of tuning (and the time involved), being limited to 200-kHz tuning, problems with the agc, lack of R.I.T., and the expense of replacement parts. **Table 2** sums up the story.

table 2. What is the rig's worst feature?*

	percent
None	55.5
Use of phone-plug-tipped cables	17
200-kHz tuning	14
Replacement tubes	12
Time spent tuning up	11
No R.I.T.	10
VOX	9
AGC	8
Incomplete coverage 28-30 MHz	7
Not solid state	6
Frequency offset	5
Expense of parts	4
Price	4
Relays	8

*Many respondents gave more than one response.

Here are some sample responses to the question, What is the rig's worst feature?

"Some erratic VOX operation. Hard to change antenna relay." — W3PE

"Use of phono connectors in back for interconnection and accessories results in a rat's nest of cabling and risk of damage by wrong connection." — WA4GWG

"Coverage of only 200 kHz on the VFO dial."

"Can't think of any." — W2MDB ex-1JY

"Price." — W4YY

"S-meter circuit can't hold setting for 10 minutes." — KH6GMM

"Tubes are getting harder to replace." — K9UQN

"Lack of noise blanker." — W6DPD

"Tubes." — N2AQS

"No noise blanker — it is very susceptible to impulse noise interference. Also, tube design is not as sensitive as some of the more modern solid-state designs." — K9AUB

"Can't receive all of 10 meters, even with three plug-in crystals. Poor factory service and availability of parts." — WB6GFJ

"The large number of crystals required to cover the bands." — VE3BGV

"Lack of sensitivity on 10-meter band." — WA5NOM

"High cost of mechanical filters." — K4TTO

"Tubes becoming hard to find." — W5CAE

"None." — WØPEN

"Time required to tune up transmitter." — WA6T

"Servicing is the pits. Invariably, the part you need to get to is buried under six wires, three capacitors, and a big resistor." — WDØEOT

"Retuning transmitter after small amounts of movement within a band." — N2DL

"No R.I.T." — K1MNC

"Lack of ability to receive on the transmitter PTO, no passband tuning, and transceive on CW is not possible because of 1350-kHz offset." — WØYK

"Tunes only 200 kHz." — K1MOU

"Lenghty tune-up procedure when changing bands." — K6MC

"Lack of rf input attenuator in receiver." — W6NTJ

"With this system you have a desk full of equipment and a rat's nest of patch cables behind it. You'd think they'd have a harness for those cables or a military-type connector with a dozen or so pins." — WB2MXZ

"Cost." — W5AG

"Cost of parts is much too high. For example, $40 for a spinner knob for the VFO." — WB4DOR

"Unable to use transmitter VFO for receive. Vacuum tubes: heat, size, pi-network final tank circuit, etc. — all those things that go along with vacuum-tube radios." — K4NYK

"The VOX controls are inside the transmitter." — KH6BD

"Lack of R.I.T. function in transceive, power consumption, and heat." — K4KAE

problems

Again, the largest percentage of respondents answered *none* to the question, Have you had any problems? Those that did have problems to report mentioned such things as having to replace capacitors or tubes, TVI, hum, and power supply problems. For the complete rundown, see **table 3**. Below are some of the comments.

table 3. Problems.

	percent
None	43
Tubes	23
Replace small component	13
Ac power supply	5
Relays	5
VOX	4
Alignment	2
Drift	2
AGC	2
Other	1

"VFO in 75S-3C went sour when the receiver was about 1½ years old. Linearity was bad (slug changed). I had to buy a rebuilt VFO for $75." — K6RK

"VOX relay draws high current, thus requiring a series resistor. Driver 6CL6 runs hot (it was fixed with a heat-dissipating shield)." — W3DSE

"Dial slipping required some work. Poor contacts on RCA connector. Replaced high-voltage rectifiers and added vent fan." — WB6AJR

"None." — WA7RCR

"VOX on the transmitter and mechanical filter on the receiver." — W6KOM

"Worn dial mechanism (due to use), a bad resistor in the VOX circuit (32S-3), and a bad electrolytic capacitor. All problems well within expectations of the equipment and due to normal use." — K4SE

"Open relay contacts in 32S-3 transmitter require cleaning about every four or five years. Some routine tube failures." — W5AL

"After 19 years of almost daily use a resistor in the VOX circuit failed." — W2VJN

"Minor component and tube failures." — W6GQC

"Bandswitch needed cleaning after exposure to salt water! No other problems." — K6ITL

"Doesn't tolerate SWR over 2:1. Blows out trimmer capacitors in pi-section. Twice replaced rectifier tubes in power supply." — K7AGC

"Band-change switch contacts become corroded in time and require cleaning." — W4YY

"Shorted plate capacitor in amplifier circuit, which caused rectifiers to burn out. Insulation of ac line in transmitter breaking down and shorting." — W6BSO

"Diode in 516F-2 bias supply went bad after one year. Three of the 6U8 tubes became gassy." — WA5NOM

"CW spotting switch causing intermittent in power output. Contacts needed cleaning and adjustment." — K6MBV

"Extreme instability in VOX due partly to heat in R88 and R140 of 32S-3. Audio distortion on 80 meters due to rf feedback into mike circuit." — WB8SRR

"Dial slipping and backlash in 75S-1 receiver PTO. 32S-1 transmitter neutralization sometimes tricky on 10 meters." — WA4GWG

"Defective BFO as received from factory — promptly repaired." — W8IM

"Tube replacement." — K2OB

"The three-section, 40-μFd capacitor in the power supply of the 75S-3B mounts on an aluminum chassis. You can not solder the can to achieve a good ground. This has presented an intermittent hum problem that can be temporarily solved by wiggling the capacitor. Also, have had an intermittent pulling of the receiver VFO. Occasionally, calibration is about 6 kHz low on the VFO dial." — WDØEOT

"Capacitor failure, bad diode, and relay failure." — W3IJ

"Blown resistor in microphone audio switch." — VE3WP

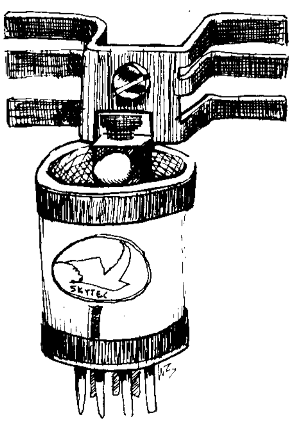
"In the 13 years I have had Collins, I have replaced only one 6146 tube and one small capacitor in the VOX circuit, which I repaired myself. No servicing needed." — WØVUU

"In the seven or eight years that I have owned the S-line and the 15 years that I have owned a 75A-4, other than an occasional tube there have been no component or mechanical failures." — VE3UP

related findings

Table 4 shows the accessories purchased most often by owners of the Collins S-line. Heading the

making your Collins S-line solid state



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A large number of Collins S-line owners express concern over the fact that their rigs use tubes. In fact, tube failure was the single largest problem encountered with these radios. Even though problems such as these are easily solved, they are problems nonetheless. For that reason, owners of Collin S-line equipment may be interested to learn about solid-state devices that are now available, devices designed specifically to replace the tubes in the 32S transmitter and 75S receiver with solid-state circuitry.

Each solid-state tube replacement — or Tubester, as they are called — plugs neatly into the socket of the tube it replaces. The Collins 75S receiver will operate completely normally with only one Tubester replacing a tube, or with any mix of Tubesters and tubes, or with all Tubesters. The same is true of the 32S transmitter, except that it is not feasible to replace the driver or power amplifier tubes.

The complete installation and touch-up alignment takes only a few minutes and requires no special tools or test equipment. No modifications need be made in transmitter or receiver, and the installation procedure is simple and clearly explained. Operation and performance of the radios remain essentially unchanged.

Heat reduction is substantial with the use of Tubesters; in the case of the 32S transmitter, there is a 50 percent reduction in wasted power and heat during STANDBY. Reports from owners of Tubesters have been very favorable, and in fact, one of the Amateurs at ham radio *has been using Tubesters for a year and is very happy with them. His only complaint is that, on cold winter nights, he can't warm his hands over the glowing filaments. (Note that Tubesters are designed for S-Line equipment only.)*

list, with a percentage rating of 27, is CW filters. Other items mentioned include crystal pack, linear amplifier, station control, and tuner. Ninety-seven percent of those responding said that they had been able to obtain the accessories they wanted, and an astounding 99 percent were satisfied with the accessories they purchased.

To the question, Have you had the rig serviced?, only 45 percent replied that they'd had service work done, a finding much in keeping with the high score the S-line received for durability and reliability. Of those who did have service work done, 92 percent said the work was satisfactory. To the question, What antenna do you use most?, 59 percent reported that they use a beam. Wire antennas accounted for 33 percent, with all others filling the remaining 8 percent.

table 4. Accessories.

	percent
Filters	27
Amplifier	9
Station control	8
Crystal pack	8
Microphone	7
Wattmeter	7
Tuner	7
Rf processor	6
Q multiplier	5
Phone patch	4

would you buy one again?

To this all-important question, the response was a resounding 80 percent yes, 20 percent no. These figures are even higher than the yes/no ratio for the KWM-2 (73 yes/27 no). Most of those who said that they would not buy the S-line again cited as reasons high price, problems with tubes, and lack of up-to-the-minute, solid-state features. But for each Amateur who would not buy S-line again there were four who would — with no doubt about it. Many owners of Collins equipment are fiercely devoted to their equipment — and to the Collins name. A great number of respondents said that they would own nothing less than Collins.

All in all, it seems safe to say that the Collins S-line and KWM-2 are well liked — very well liked. They are exceptionally reliable and well-built pieces of radio gear that have withstood the test of time and still command a high price. Owners of Collins radios are generally convinced that, for dependability and durability, their equipment is top-of-the-line.

ham radio

high-performance CW filter

Network synthesis provides new applications for surplus toroidal inductors

Most Radio Amateurs are familiar with the surplus 88- and 44-mH toroidal inductors used as loading coils on the telephone lines. Hundreds of these inductors are contained in cylindrical steel "loading pots" that can be seen mounted on telephone poles along suburban and country roads. These loading pots vary in diameter from 8 to 16 inches (20 to 40 cm) and in length from 1.6 to 6.6 feet (0.5 to 2 meters). Occasionally, after repairing or scrapping a length of line, the telephone company discards these loading pots when they can't be salvaged for re-use.

background

Enterprising Amateurs are sometimes able to obtain these surplus loading pots and remove the inductors for use in audio-frequency filtering applications. During the past fifteen years, these inductors have found their way into many audio-filtering applications such as CW, speech and RTTY filters. A partial list of published articles illustrates the many ways in which these surplus inductors have been used by the Radio Amateur (references 1-13).

During the same fifteen-year period, observant Amateurs have seen the network synthesis method of filter design gradually replace the image-parameter design procedure developed by Otto Zobel in 1923. Filter designs are now possible which previously were not available. For example, the image-param-

By **Edward E. Wetherhold, W3NQN,** Honeywell, Incorporated, Signal Analysis Center, P.O. Box 391, Annapolis, Maryland 21404

eter design procedure requires the addition of *m*-derived matching sections at each end of a prototype pi or T-intermediate section. These matching sections are required to transform the image impedance of the prototype network to a form that can be terminated with a common resistor. In addition to providing a suitable means of terminating the filter, the matching sections also produce a desirable abrupt rise in attenuation, with an attenuation peak at a frequency equal to 1.25 times the cut-off frequency of the prototype section (for $m = 0.6$).

For non-stringent filtering applications, however, the image parameter filter is unnecessarily complex. For example, there are many applications where an increase in attenuation of between 6 and 8 dB per octave for each element is sufficient. With the development of network synthesis, it's now possible to design simple lowpass (or highpass) filters having a simple ladder configuration of alternating shunt Cs and series Ls for the lowpass configuration (or vice-versa for the highpass configuration) that can be terminated directly in resistors without the need for special end-matching sections. The Butterworth and Chebyshev designs are examples of this filter type, and they are frequently used when ease of construction is of prime importance (see references 14, 15, and 19).

By combining the use of these high-quality surplus toroidal inductors with modern filter design techniques, it's possible to build high-performance passive LC audio filters that once were unattractive because of high cost, or the difficulty of design and construction. This article discusses the design and construction of a CW filter using eleven of the surplus toroidal inductors. The filter is easy to build, and its performance is comparable to that of many of the expensive active filters currently available.

loading inductor types and descriptions

Every loading inductor, regardless of type, has two separate and equal windings wound on a molybdenum-permalloy toroidal core with an outside diameter of about 1 inch (2.5 cm). Depending on the inductor type and the connection of the two windings, four different values of inductance are available. The most commonly available inductor has 88 mH in the series-aiding connection and 22 mH in the parallel-aiding connection. (Remember that when doubling the turns of an inductor the inductance is quadrupled, because inductance varies as the square of the number of turns. Thus, by connecting the two windings together in series-aiding, the turns are doubled, and the inductance is approximately quadrupled.) Because the magnetic coupling between the two separate windings of the inductor is not perfect, the inductance in the series-aiding connection is slightly less than 88 mH. A typical measured value is 85.7 mH. This value will be used in the filter design to be discussed. The less-common type has an inductance of 44 and 11 mH in the series and parallel connections.

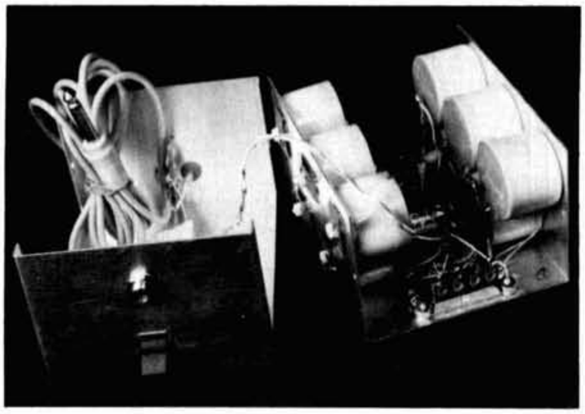
These 88- and 44-mH inductors are found in at least two different forms. One form is an unpotted stack of five inductors encased in a cardboard or sheet-metal cylindrical case, with a terminal board along its length to which all the inductor windings are connected (see reference 5 for details). These inductors can be easily removed from the stack by prying open the case and cutting loose the leads from the terminal board. Because the inductors are unpotted, any number of turns can be added or removed to obtain any odd inductance value that might be required for a particular filter design. This capability of obtaining a particular inductance value is necessary when the filter cut-off frequency and termination resistance must be a specific value, for example 750 Hz and 600 ohms.

The 88-mH surplus loading inductor is also found in a potted form. The potted inductor has two separate 22-mH windings terminated in four insulated wires, which exit the potting compound (see **fig. 1**). The potting compound is tough and hard. Any attempts to remove the inductor from its potted container will result in damage to the inductor windings. The photo illustrates what happened when I tried to break open the potting compound. Because the inductor windings can't be freed from the potting compound, the inductor must be used in an application requiring either the 88- or 22-mH values. This means that, if the center frequency of a bandpass filter is selected to be a specific value, the bandwidth and termination resistance of the design must be allowed to vary. This is a compromise that must be accepted if the fixed 88-mH inductor is to be used — not particularly objectionable. I will show that these compromises are not unreasonable.

By using modern filter design procedures and the 88-mH potted inductor, high performance CW filters can be designed and constructed where the fixed inductor value is not a disadvantage. The following paragraphs explain the design procedures for obtaining a CW filter for any desired center frequency.

design criteria and procedures

Previously published inductance-capacitance CW filter designs used either one or three resonant circuits (see references 6, 9, and 10). In the two cases



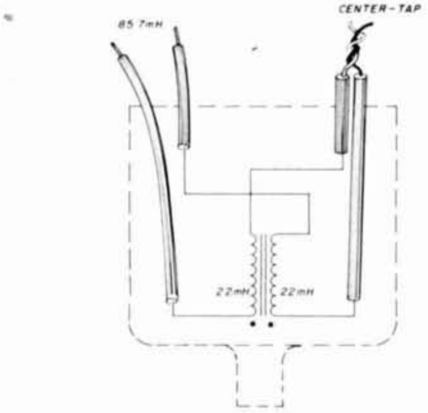


fig. 1. The schematic diagram shows the inductor connections inside the potted case, and the external connection (series-aiding) required for 85.7 mH. The photograph shows the unsatisfactory results of removing the inductor from its potted container. The leads are connected in series aiding for 85.7 mH.

where only one resonant circuit was used, the skirt selectivity was not adequate to warrant serious consideration by the experienced CW operator. The three-resonator filter was better, but it still lacked sufficient selectivity. The design discussed in this article has five resonant circuits, and the resulting selectivity finally provides the performance that the experienced CW operator can appreciate.

Filter center frequency. Because all but one of the filter inductors have a fixed value of 85.7 mH (the reason why the value is not 88 mH was previously explained), it's necessary that the bandwidth (BW) and termination resistance (R_t) be permitted to vary and be dependent on the selected value of the center frequency (f_c). This criterion was used because the designer will want to select a particular f_c, while BW and R_t are of less interest and can be left to fall where they may. Fortunately, for center frequencies between 500 and 800 Hz, BW and R_t values are quite reasonable for the intended filtering application. (Frequencies below 500 Hz are difficult for most CW operators to hear, and for f_c values above 800 Hz, BW becomes a little too broad.)

Filter Q. The widely published filter expert Anatol Zverev states that a very good bandpass filter can be made when its components have a Q not less than twenty times the ratio of f_c/BW_3, where BW_3 is the 3-dB bandwidth. (See reference 16, page 21.) From experience, I've found that satisfactory bandpass filters can be constructed even if the Q is only ten times the f_c/BW_3 ratio. Since the inductor Q used in the construction of this filter varies between 25 and 40 over the frequency range of interest (500-800 Hz), and since the approximate required inductor Q for a satisfactory design is a constant of 30 (the f_c/BW_3 ratio is a constant 3.05 for all designs), I expect that this application of these surplus inductors will be quite practical.

The bandpass filter design is based on a transformation of a five-element (C in/out) Chebyshev low-pass filter having a reflection coefficient (RC) of 6.3 percent. This RC value was chosen because the bandpass filter center inductor is *exactly* one-half the inductance of the end inductors. Thus, if the end inductors are of the 88-mH nominal value, the center inductor can be the standard 44-mH type.

Fig. 2 shows the schematic diagram of the bandpass filter, including the component values for an f_c of 655.4 Hz. In addition to this design, twenty-four other designs have been calculated for f_cs between 496-1087 Hz; they are listed in **table 1**. **Table 1** data were computer calculated and are based on the **eqs. 1-6** given in **Appendix A**. The tabulated values of C1,5 have been selected to include the standard-catalog capacitor values of 0.25, 0.27, 0.33, 0.47, 0.56, 0.68, 0.82, and 1 μF, with other values slightly above and below the standard values. The other component values and frequency *vs.* attenuation data are included to give an indication of the ranges of values that may be expected.

C1,C5	0.688 μF	L3	42.85 mH ct
C2,C4	0.172 μF	L2,L4	4(85.7) = 342.8 mH
C3	1.376 μF	R_t	1110
f_{center}	655.4 Hz	$R_t/4$	277.5
L1,L5	85.7 mH ct		

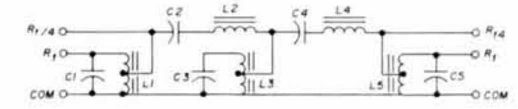


fig. 2. The schematic diagram gives component values of a CW bandpass filter designed for a center frequency of 655.4 Hz. The text explains why L1 and L5 are less than the expected value of 88 mH.

table 1. CW filter parameters for various center frequencies.

F-center (Hz)	C1,5 (μF)	C3 (μF)	C2,4 (μF)	R-term (ohms)	BW-AP (Hz)	BW-3 (Hz)	F-LO(3) (Hz)	F-HI(3) (Hz)	F-LO(30) (Hz)	F-HI(30) (Hz)
1087	.250	.50	.0625	1841	286	357	924	1280	826	1431
1066	.260	.52	.0650	1805	280	350	906	1255	810	1403
1046	.270	.54	.0675	1772	275	343	889	1232	795	1377
1027	.280	.56	.0700	1740	270	337	873	1210	781	1352
961	.320	.64	.0800	1627	253	315	816	1132	730	1265
946	.330	.66	.0825	1602	249	310	804	1114	719	1246
932	.340	.68	.0850	1579	245	306	792	1098	708	1227
802	.460	.92	.1150	1357	211	263	681	944	609	1055
793	.470	.94	.1175	1343	208	260	674	934	603	1044
785	.480	.96	.1200	1329	206	257	666	924	596	1033
733	.550	1.10	.1375	1241	193	240	623	863	557	965
726	.560	1.12	.1400	1230	191	238	617	855	552	956
720	.570	1.14	.1425	1219	189	236	612	848	547	948
664	.670	1.34	.1675	1125	175	218	564	782	505	874
659	.680	1.36	.1700	1116	173	216	560	776	501	868
655	.688	1.38	.1720	1110	172	215	557	772	498	863
604	.810	1.62	.2025	1023	159	198	513	711	459	795
600	.820	1.64	.2050	1017	158	197	510	707	456	790
597	.830	1.66	.2075	1010	157	196	507	703	453	785
549	.980	1.96	.2450	930	144	180	466	647	417	723
544	1.000	2.00	.2500	920	143	178	462	640	413	716
538	1.020	2.04	.2550	911	141	177	457	634	409	708
533	1.040	2.08	.2600	903	140	175	453	628	405	702
518	1.100	2.20	.2750	878	136	170	440	610	394	682
496	1.200	2.40	.3000	840	130	163	422	584	377	653

Design procedure. After selecting a desired value of f_c, use the following procedure to find the filter component values. (See **Appendix A** for design equations.)

1. Find the desired approximate f_c in the first column of **table 1**.

2. Note the required value of C1,5 (**fig. 2**) in the second column, and from a group of about ten capacitors having the proper *nominal* value, select two having a measured capacitance within 1 percent of each other.

It isn't necessary to find the exact tabulated capacitance value, as any slight difference in capacitance between the selected value and that tabulated will only cause a slight shift in the center frequency. The important thing is that C1 and C5 *must* be within 1 percent of each other. (A digital capacitance meter, capable of measuring to an accuracy of 0.1 percent, is recommended.)

3. In a similar manner, select C2 and C4 with a value equal to one quarter of C1 (see **eq. 5B, Appendix A**). If necessary, parallel additional capacitors to obtain the required capacitance within 1 percent.

4. Select one capacitor for C3 with a value equal to twice that of C1 (see **eq. 5A, Appendix A**) and within 1 percent of the required value.

5. Connect the parts in accordance with the schematic diagram of **fig. 2**.

6. The shifted value of f_c corresponding to the selected value of C1,5 can be calculated from **eq. 1B**.

7. Calculate the R_t value from **eqs. 4C** and **4D**.

8. The bandpass response can be approximated from the values given in **table 1**, or the response can be calculated from the equations given in **Appendix A**.

As an example, the parameters of the filter design in **fig. 2** are listed in **table 1** for $f_c = 655\ Hz$.

CW filter performance

Before starting the construction of this filter, you want some assurance that the selectivity is adequate. This performance characteristic can best be appreciated by referring to a plotted attenuation *versus* frequency response curve. **Fig. 3** shows both measured and calculated relative attenuation responses of the filter in **fig. 2**. I plotted the response on a linear scale to more accurately and clearly define the individual points on the response curve, compared with plot-

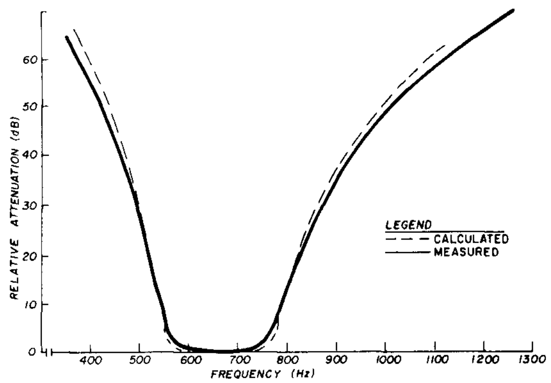


fig. 3. Measured and calculated attenuation responses of the CW filter in fig. 2. The measured response differs slightly from the calculated response because the resistive losses of the filter were not included in the calculations.

ting the response on semi-log paper, where the upper range becomes too compressed for good accuracy. Note the good agreement between calculated and measured values. This agreement indicates that the design procedure is valid, and the inductors are capable of producing a usable filter. The measured insertion loss (not indicated in the plot) is less than 3 dB at the center frequency, which is typical for a filter of this complexity and inductor Q.

Fig. 4 shows the filter response in a semi-log plot, which includes the audio frequency range of a typical communications receiver for comparison. Note that the frequencies below 400 Hz and above 1 kHz are attenuated by more than 50 dB. You should now be convinced that this filter has satisfactory selectivity. Further consideration can now be given to its construction.

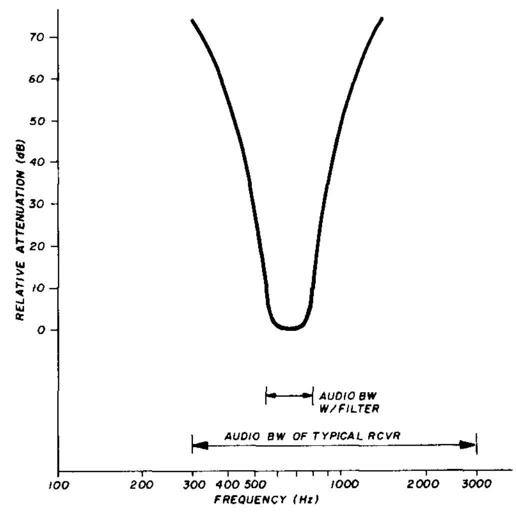


fig. 4. CW filter attenuation response is shown in a semi-log plot relative to the audio bandwidth of a typical Amateur receiver. About 75 percent of the undesired audio bandwidth is attenuated 30 dB or more.

construction

The filter was assembled in a 3×4×5 inch (7.6×10×12.7 cm) aluminum box. This box is available from either LMB, No. T-F 779, or BUD, Type CU-3005A, at a nominal cost. There is just enough mounting area on the side of the U-shaped chassis to mount five potted inductors, side-by-side. The other five inductors are mounted on the other side. Holes were punched or drilled in the sides of the chassis, and the shafts of the potted inductor cases were held in place with Tinnerman clips. The 44-mH inductor, terminal strip, and capacitors were mounted on the bottom of the U-shaped chassis.

Fig. 1 shows how the potted inductor leads are connected to obtain the 85.7-mH value. The junction of the soldered leads also provides the centertap connection for L1 and L5. The other two leads were interconnected with the other inductor and capacitor leads in accordance with the schematic diagram of **fig. 2**. After the connections were soldered and taped, the interconnecting inductor leads were positioned along side the potted inductors — no terminal strips are necessary in this case.

The mating portion of the aluminum box contains the audio input cable and terminal strip, audio output phone jack, matching resistors, and the dpdt bypass/through switch. The two filter halves are interconnected with a three-wire cable. With a little care in component placement within the aluminum box, the separate halves of the box will fit together with no interference between the mounted components.

Inductor L3 is most conveniently obtained with a standard 44-mH surplus inductor. The measured value of L3, as received, is actually 42.9 mH; this is the value required for the filter construction. The inductance of the series-aiding connection of the two 11-mH windings is slightly less than the expected 44-mH value because of less-than-perfect magnetic coupling between the two coils. This inductor value is in short supply and is available from only one advertised source.*

It's also possible to modify an unpotted 88-mH inductor, where the number of turns removed depends on the inductor winding configuration. Two winding configurations are currently available — one

*M. Reed, Box 74, Soquel, California 95073. Delivered cost is five inductors for $5.

in which two identically colored windings are wound on separate halves of the toroidal core with two cardboard spacers separating the windings; the other in which the windings are bifilar wound, round-and-round, on the core with two differently colored wires.

The inductor with the two-color bifilar winding has almost perfect coupling between the windings, and this type of 88-mH inductor is recommended for modification to obtain the desired centertapped 42.9-mH value for L3. This inductor is available in a five-inductor stack.†

To modify the bifilar-wound inductor, remove 113 turns from each winding (total turns removed are 226). Connect the start of one color winding to the finish of the other color winding. This junction is the inductor centertap; the other two ends connect across C3 (**fig. 2**).

The 88-mH inductor with two separate windings of identically colored wire is also available from either of the two previously mentioned sources. However, because of its less-than-perfect coupling between windings (about 95 percent), the separate-winding inductor is less preferable than the bifilar-wound inductor for this filtering application. To modify the separate-winding inductor to get the L3 value, remove 110 turns from each winding (total turns removed: 220).

how to get free potted 88-mH inductors

Through the cooperation of the Chesapeake and Potomac Telephone Company of Maryland, I have obtained a large number of potted 88-mH inductors. These inductors were given to me by the telephone company with the understanding that I would distribute the inductors at no cost (except for packing and shipping expenses) to Radio Amateurs for use in their communications activities. The C&P Telephone Company is aware of the public service performed by the Radio Amateur and wishes to foster this important Amateur activity by making these surplus inductors available to those who can use them. The recycling of these high-quality inductors is another example of how responsible industries are attempting to recycle our country's natural resources. (Each surplus inductor, if individually purchased on the commercial market, would cost more than $8.) The CW filter described in this article is a perfect application for these inductors, and those interested in CW communications (CW-QRP net operators, especially) are encouraged to write to me requesting these inductors and to build this filter.

I am serving as liaison between the C&P Telephone Company and Radio Amateurs for distribution of these surplus inductors. First priority for inductor delivery will be given to Amateur-Radio clubs active in some form of community service or civil defense work, and located in the area serviced by the C&P Telephone Company (Maryland, Virginia, West Virginia, and Washington, D.C.). Second priority goes to any club active in some form of community service. To obtain the free inductors, the club president or secretary should write to me requesting a specific number of inductors for a particular application. For example, if four club members wish to construct the CW filter, 40 *potted inductors* should be requested, and the names and call signs of the individuals who will receive the inductors must be included. Those not affiliated with an Amateur Radio club may obtain free inductors by writing and providing details about their application. The priority of their request will be determined from the information they provide.

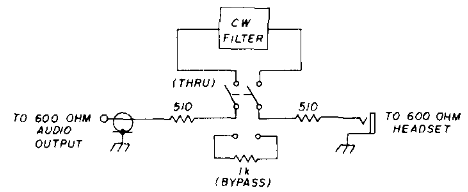


fig. 5. The addition of 510-ohm resistors in series with the filter input and output terminals provides the required filter terminations (1110 ohms) for a 600-ohm audio system. An exact match is not necessary, and any termination within ±20 percent of the design value will give satisfactory results.

Each request *must be accompanied with a stamped self-addressed envelope*. My response will include packing and shipping costs. If more requests are received than there are inductors on hand, requests will be filled in order of priority until more inductors are received. All requests should be addressed to: Edward E. Wetherhold, W3NQN, 102 Archwood Avenue, Annapolis, Maryland 21401.

installation and operation

For satisfactory filter performance, some attempt must be made to terminate both ends of the filter in a resistive load approximating within 20 percent the design value of R_t or one-quarter of R_t. **Fig. 5** shows a suitable terminating procedure for the filter of **fig. 2** (where $R_t = 1110\ ohms$) in an audio system having

†TYPETRONICS, Box 8873, Fort Lauderdale, Florida 33310; $3 per stack plus a shipping charge of $1.75 for the first stack and $0.80 for each additional stack. Be sure to specify the preferred inductor type as *scramble-wound red and green wire coils*.

an impedance of 600 ohms. Of course, there will be some signal loss caused by the two 510-ohm series resistors, but the loss is not excessive, and it is easily corrected by simply increasing the receiver audio gain control. A 1k ohm resistor is wired across the THRU/BYPASS switch to prevent an undesired increase in headset level when switching from the THRU to BYPASS position.

Other values of filter R_t may be similarly achieved by the addition of proper series resistance. To do this, however, you must either know or determine the impedance of the receiver audio output and of the headset. In some instances, it may be necessary to add resistance in parallel with the filter input and output to obtain the desired filter termination resistance.

Vacuum-tube receivers usually have an audio output impedance of 600 ohms, while the modern transistorized communications receivers may have an output impedance of between 4 and 8 ohms. When the receiver output impedance is very low, the addition of series resistance may not be feasible, because the audio output stage may not be able to provide sufficient output to overcome the excessive signal loss caused by the high value of series resistance. In this case, a matching transformer, such as the Radio Shack 273-1380 or equivalent, 8/1000 ohms center-tapped, should be connected with appropriate series resistors to provide a suitable match. A small 115/6.3-volt filament transformer may also be used, since it has a suitable turns ratio for transforming a 4-ohm source to around 1300 ohms, which is within the recommended ±20 percent range of termination resistance (1000-1600 ohms) for f_c values from about 600-950 Hz.

In addition to my experiences, several other Radio Amateurs have constructed this five-resonator filter design in which either the ten potted inductors described in this article or two five-inductor stacks were used.[20] In either case, the users were satisfied with the filter performance, and in many instances the filter made it possible to continue contacts which otherwise would have been lost. The filter bandwidth is wide enough to slightly shift the CW beat note within the filter passband, but the bandwidth is narrow enough to provide the required selectivity for effective communications.

summary

The advantages of filter design using network synthesis were briefly discussed, and a design example was given for a passive five-resonator bandpass filter suitable for CW application. To minimize cost, surplus inductors were used, and procedures for obtaining ten of the 88-mH potted inductors at no cost (except for packing and shipping expenses) were explained. Performance of the completed filter was thoroughly documented with two attenuation response plots, and a table of filter component values and response parameters was included for center frequencies between 496-1087 Hz. A photograph showed how the filter components could be assembled in a standard 3×4×5-inch (7.6×10×12.7 cm) aluminum box. A detailed appendix of design equations provided information so the interested reader could apply the design principles to other filtering requirements. Background material and sources of additional information were provided in a reference listing of twenty books and articles.

acknowledgments

I gratefully acknowledge the assistance of Frank Noble, W3MT, for constructing a filter in accordance with the instructions provided in this article, and for providing comments and improvements based on his construction and operating experiences. I also gratefully acknowledge the efforts of Joseph Gutowski of EWC, Inc., and Rex Cox of Honeywell, Inc., for their review of the article.

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appendix A

design equations for the bandpass filter of *fig. 2*

$$f_c = 1/[2\pi\sqrt{L1\,C1}] \quad \text{(1A)}$$

where f_c = center (geometric mean) frequency (Hz)
$L1$ = inductance (Henries)
$C1$ = capacitance (Farads)

$$f_c = 543.66/\sqrt{C1} \quad \text{(1B)}$$

where $C1$ = capacitance (μF)
$L1 = 85.7\ mH$

$$C1 = 295{,}569.4/f_c^2 \quad \text{(1C)}$$

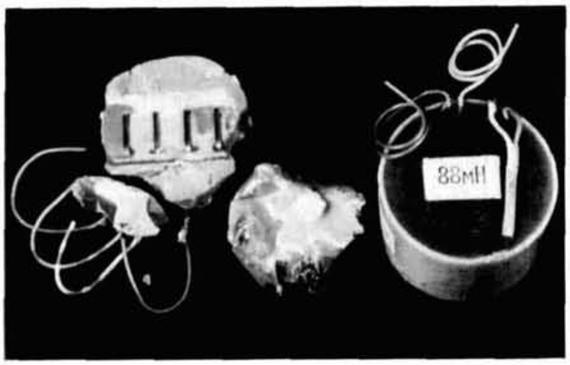
where $C1$ = capacitance (μF)
$L1 = 85.7\ mH$
f_c = center frequency (Hz)

$$f_c = \sqrt{f_{LO_x} f_{HI_x}} \quad \text{(1D)}$$

where all frequencies are in Hz, and f_{LO_x} and f_{HI_x} are the lower and higher frequencies at the "x" attenuation level on the filter attenuation response curve (see **fig. A-1**).

$$BW_{A_p} = f_c\sqrt{(G1\,G2)\,(L1/L2)} \quad \text{(2A)}$$

where $G1$ and $G2$ are the lowpass filter element values normalized for an f_{co} of one rad/sec and one-ohm terminations.
$L1$ and $L2$ are in Henries
A_p is the peak level (dB) of the passband attenuation ripple.
BW_{A_p} is the bandwidth (Hz) at the A_p attenuation level (see **fig. A-1**)



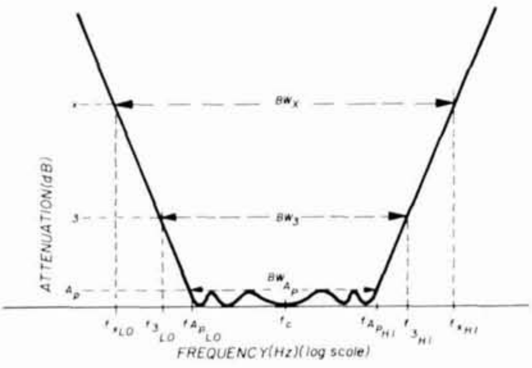


fig. A-1. A typical attenuation versus frequency response of a bandpass filter includes the parameters defined in *Appendix A*.

$$BW_{A_p} = 0.25 f_c\sqrt{G1\,G2} \quad \text{(2B)}$$

where $L1/L2 = 0.0857/[(4)(4)(0.0857)] = 0.0625$

$$BW_{A_p} = 0.26285 f_c \quad \text{(2C)}$$

where $G1 = 0.8265$ and $G2 = 1.3375$ for a 5-resonator Chebyshev bandpass filter with reflection coefficient $(RC) = 6.3$ *percent*

$$BW_3 = 1.248\,BW_{A_p} \quad \text{(3A)}$$

where BW_3 = 3-dB bandwidth of a BP filter for a 5-resonator Chebyshev BP filter with $RC = 6.3$ *percent*

$$BW_3 = 0.328 f_c \quad \text{(3B)}$$

$$R_t = 2\pi\,(BW_{A_p})\,(L2/G2) \quad \text{(4A)}$$

where R_t = termination resistance (ohms). See **equations 2A, B, C** for values of $L2$ and $G2$.

$$R_t = 6.4415\,BW_{A_p} \quad \text{(4B)}$$

for $L2/G2 = 16\,(0.0857)/1.3375 = 1.3712/1.3375 = 1.0252$

$$R_t = 920.5/\sqrt{C1} \quad \text{(4C)}$$

where $C1$ = capacitance (μF)
R_t = resistance (ohms)

$$R_t = 1.69314 f_c \quad \text{(4D)}$$

where f_c and R_t are in Hz and ohms for $L1 = 85.7\ mH$

$$C3 = 2(C1),\ L3 = (L1)/2 \quad \text{(5A)}$$

where C and L are in μF and mH

$$C2 = (C1)/4,\quad L2 = 4(L1) \quad \text{(5B)}$$

See **fig. 2** for location of all Cs and Ls

$$BW_x = \Omega_x\,(BW_{A_p}) \quad \text{(6A)}$$

where BW_x and BW_{A_p} are the filter bandwidths at the "x" and A_p attenuation levels, and Ω_x is the normalized bandwidth at the "x" attenuation level relative to the bandwidth at the A_p attenuation level; that is, $\Omega_x = (BW_x)/(BW_{A_p})$

$$f_{LO_x} = -b_x + \sqrt{f_c^2 + b_x^2} \quad \text{(6B)}$$

where $b_x = (BW_x)/2$

$$f_{HI_x} = f_{LO_x} + BW_x \quad \text{(6C)}$$

See **eq. 1D** for the definitions of f_{LO_x} and f_{HI_x}.

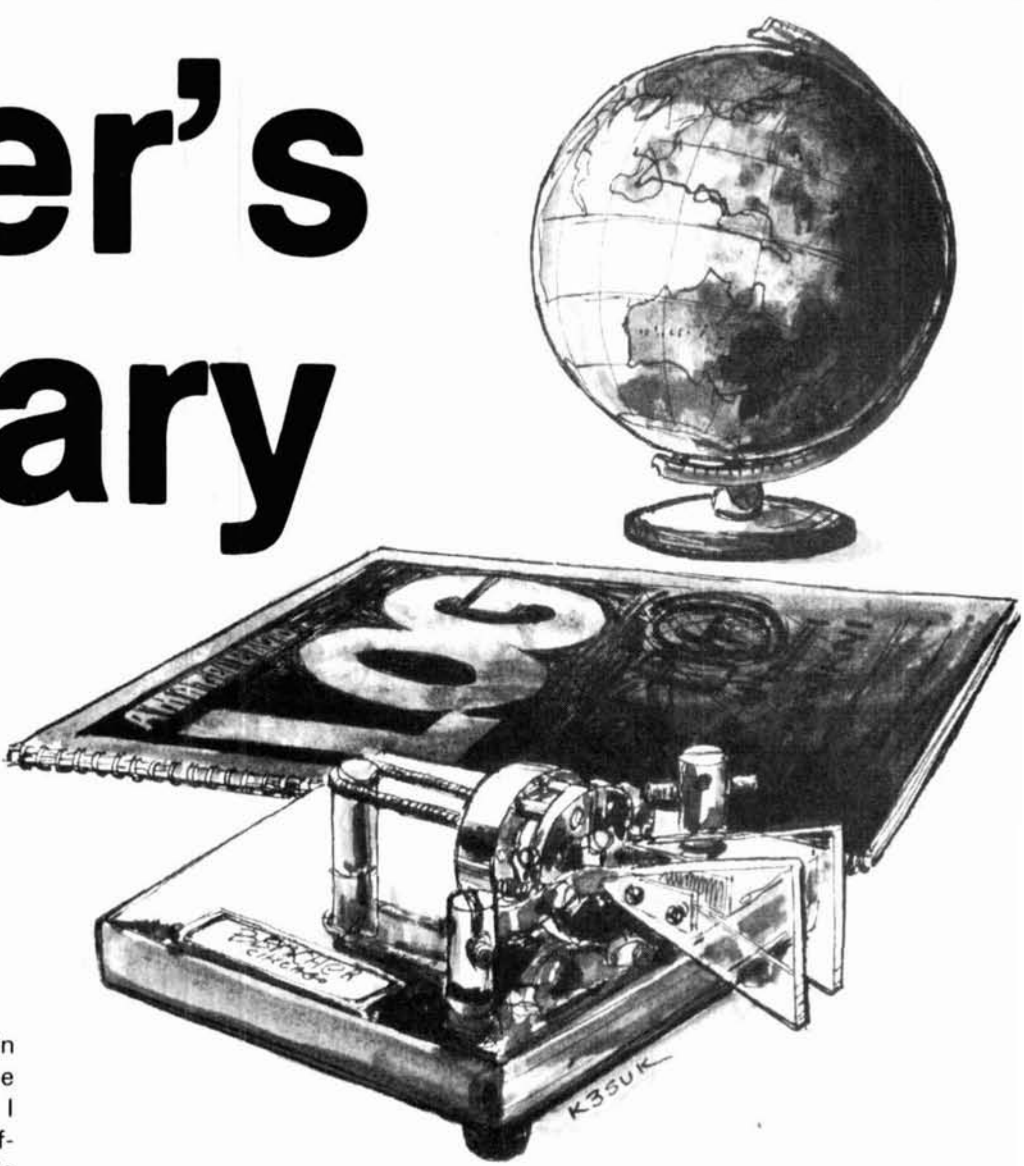
The attenuation levels for eleven values of Ω_x are listed in **table A-1** for a five-resonator Chebyshev filter with $RC = 6.3$ *percent*. To find BW_x corresponding to a particular Ω_x and for any given f_c, calculate BW_{A_p} (using **eq. 2C**), then calculate BW_x (using **eq. 6A**).

table A-1. Attenuation (dB) as a function of Ω_x.

Ω_x	attenuation
1.00000	0.0173
1.24800	3.0000
1.33800	6.0000
1.40000	8.3000
1.60000	15.6000
2.00000	27.2000
2.11665	30.0000
2.50000	38.0000
3.00000	46.5000
4.00000	59.6000
4.50000	64.9000

ham radio

DXer's diary



By Bob Locher
W9KNI

Getting up at 5 AM is a pain: a pain everywhere in my body. I turn off the insistent alarm clock as quickly as I can to avoid disturbing my long-suffering wife more than necessary. I lie back again to rest my complaining muscles, sore from yesterday's gardening. She says:

"Hey! If you're going to the trouble to set the clock for 5 AM, you'd better get up!" I snap back from dreamland — she's right. Poor thing — she's wide awake now, while I'm barely alive. *She* should be the DXer!

I groan and swing my feet out of bed.

"Thanks, kid. I'm up now."

"Think nothing of it, my man." We laugh, and I start fumbling for my bath robe and slippers.

I flip on the switches on the gear and head back to the kitchen for my wake-up cup of coffee. In minutes I'm slumped in front of the receiver, only half awake, shivering a little. But I sip the coffee, and its warmth helps me slowly focus my thoughts.

I start tuning 20. The band is very quiet; only a few signals, and these mostly buried in the mud. Hey, there's one a little stronger — let's copy him and see where he is. OK, it's VK4RF. Boy, he's not very strong. Bob, you turkey, why don't you try turning the antenna to the west instead of north? Sometimes I'm so dumb even *I* notice it. I haul the antenna around, but the VK4 is gone now. So I tune on.

According to responses from our readers, Bob Locher's adventures in the DX world are extremely popular. Here's yet another episode in Bob's trials and tribulations. Looks like brother Murphy and his laws were operative this time. But no fear! Perserverance and dedication will really pay off. Try and try again! **Editor.**

The band sounds a lot better now; many more signals. I find several loud VKs. There's a ZL, nice signals, too. OK, there's ZK1CT; a nice catch, but I already have him. I hear a weak signal — I switch in the audio filter and tune him in better — oh! OK, it's YU3DX, probably trying to help open the long path.

I look over my blackboard where I keep notes on the various DX stations I'm chasing. There it is, taking up a quarter of the board:

VK9NV 14042 at 1117Z 4/19
14047 at 1140Z 4/22
14064 at 1157Z 4/25
(reports all gleaned from my DX bulletins.)

The pattern is pretty clear. The VK9 likes 1100 Zulu, so here I am plighting my troth, as it were.

This VK9 has been a real hard-luck story for me, with hours and hours of lost sleep piled up, and absolutely nothing to show for it. No wonder DXers grow gray hair.

If I get up at 5 AM on Tuesday, Wednesday, and Thursday, next week's bulletin is full of reports on his operations Monday and Friday. If I get up every night for a week, that's the week he's on vacation, or his antenna falls down. My buddies all catch him one night — the week *I* was on vacation! If I get up every night at 1100Z the week after *he returns from vacation*, he starts operating at 0900Z instead of 1100Z. If I discover that he has a sked with his QSL manager, a VK6, at 1000Z, sure enough — we get a disturbance and the band is dead.

But hope, the lifeblood of a DXer, springs eternal. Maybe today's my chance, in this forsaken hour of the dawn.

I move the receiver dial to 14040 and begin an intensive tune up the band. As I cross each signal, I try to identify it as to its possible location. The only strong signals I'm hearing are VKs and South Pacific stations. The weaker signals are faint Europeans, back-scatter Americans and Canadians, and the occasional crooked-path JA.

I have some other clues of my prey besides hints of his operating habits. His name is Nigel. He has a very clean, pretty fist, but doesn't appear to be any speed demon. His signal is clean, and of average strength for the VKs and ZLs. I obtained all this information from my pals who worked him and from the bulletins.

His QTH, Norfolk Island, lies off the eastern coast of Australia and is an easy propagation shot, which compounds the difficulties. It means that there are more hours of the day that the path is open; more hours to watch. And all at the wrong times. Like at 1100 Zulu.

Finally, I'm really beginning to wake up. I keep tuning. Signals seem to be building slowly as sunrise approaches. There's VK5FM calling CQ. There's a weak signal — yes — it's JA0CUV/1. There's a louder one — "NAME HR TREVOR," and another, "QTH SYDNEY? SYDNEY."

I hear "579 HR IN PORT MORESBY," "CQ CQ DE VK6RU," "73 SK N6RJ DE H44PT." The band really is in pretty nice shape. I look at the dial calibration — 14082. I spin the receiver back down the band. Guess I'll try starting at 14030 this time. I start my climb back up the band.

A thought hits me. I pick up my 2-meter microphone. "Hey, anybody alive out there? Here's W9KNI."

"Yeah, good morning Bob. W9KNI here's K9BG. What are you doing up at this hour?"

"Hey, good morning Jerry. Yeah, I guess it's morning. I'm looking for VK9NV, again. I'm tuning 20 CW for him. What are you doing up?"

"I thought I'd have an early look around 80 CW. I still need that zone 29 on 80, and VK6RU has been down there, so I'm told. But all I hear on 80 is loud QRN, and KH6XX, and he's not very strong. So I'm working over 40 CW now."

"Yeah, OK Jerry. Well, don't waste your time on VK6RU; I heard him here on 20 a couple of minutes ago calling CQ. Guess 80 must be no bargain at his end either this morning."

"OK, Bob, thanks. But 40 isn't too bad; I'm hearing lots of ZLs and VKs, and some good JA signals, too. If I hear that VK9, I'll call you for sure. W9KNI from K9BG."

"Fine, Jerry and thanks. If I hear anything good on 20, I'll call it in. K9BG from W9KNI."

My coffee cup is empty, so I run upstairs for a refill and am back at the rig in a few moments. Signals seem to continue to build up. I glance out the basement window, to see the first glimmer of the approaching dawn. I begin to tune up the band again. There sure are a lot of VKs on. But wait! It's Friday morning here and they are on the other side of the date line, so it's Friday evening there and they're starting their weekend. Sure wish I was. No wonder there are so many of them out.

I continue to try to identify signals. The clues I have are a big help; when I hear "OP HR TREVOR" I know it isn't my boy Nigel. "QTH HR DARWIN" means QTH here *isn't* Norfolk Island. I listen to all CQs but usually have to wait only a few seconds before the station calling signs his call.

With more and more signals coming up, it's slow going. I glance at the clock. It's 5:35, 1135 Zulu. If my intelligence information is correct, he certainly should be on by now. I keep tuning, inspecting every signal closely. Some I can dispose of in a moment; others take several minutes before I obtain an adequate identification. And there's one QSO going at 14055 where the two stations are breaking back and forth without exchanging call signs.

Unfortunately, one of the two stations in the QSO perfectly meets the profile I'm using, to the extent that I can observe and glean information from what I hear. Nice, clean steady fist, average signal strength, and having a good old-fashioned ragchew with his buddy. "WX HR DRY TODAY." That's no help. Being dry is relative, it could be a dry day anywhere. If the mystery station had said it was snowing, I could tune on with confidence, because snow on Norfolk Island is highly unlikely!

I continue to listen for a few minutes, but no call signs. I can't afford to stay here too long — if one of the stations isn't the VK9 — and the odds are certainly against it — the

VK9 might be 5 kHz away and I'd never know it.

I decide to make note of the frequency and set my transmitter VFO on it and move on. That way I can keep jumping back to check out that QSO in hopes of finally catching a call sign.

My 2-meter radio squawks, "H44PT, H44PT Seven Oh Two Nine, Seven Oh Two Nine, that's H44PT, Seven Oh Two Nine, from K9BG." Hmmm. So that H44 on Guadalcanal moved to 40. OK. I was thinking of taking a look at 40, but with Jerry there watching, I'll concentrate on 20.

I zip back to the mystery QSO. Phooey — they're still going strong, and no ID. The worst of it is that a rare station who wanted a ragchew with his pal would do it exactly *that way* to avoid attention; but that's no guarantee that *these* fellows are rare.

I tune further up the band again. Lots of signals, but no goodies. I jump back to the mystery QSO.

"OK GEOFF TNX FOR KEEPING SKED QSP 88 TO HELEN ES 73 UR KIND SELF CU NEXT WEEK." Hah! One of them's signing clear. I check my VFO to see that I'm zero beat. I'm ready. "CHEERS VK6RZ DE VK7OT SK."

Rats! Nothing there for me.

The basement lights blink: a signal from my wife that she wants to talk to me. I lift up the headphones.

"Bob, I've made a cheese omelet and some sausage. Would you like some breakfast?"

Any remaining resolve to rough it out on the line of scrimmage instantly evaporates.

"Great. I'd love some. I'll be there in a second."

"OK, I'll pour you some fresh coffee."

I pick up the 2-meter microphone. "Jerry, I'm going to get some breakfast. Call me if you find anything. I'm leaving the volume turned up. K9BG from W9KNI."

"OK, Bob. Go ahead. I'll be here a while. W9KNI from K9BG."

An omelet, sausage, and hot coffee; a real treat compared to my usual roll eaten at my desk.

"No luck, huh?" my wife asks, as she sets my plate in front of me.

"No, I think I'm snakebit on that one. How come you're up so early?"

"Once the clock went off I couldn't go back to sleep, so I thought I'd fix us a nice breakfast since we're both up."

I'm nearly finished with my breakfast when my 2-meter radio howls from the basement, "Hey, Bob! W9KNI, there he is! Hurry. W9KNI from K9BG. He's on 7019 calling CQ!"

In a very few seconds I'm in front of the rig, swallowing the rest of my sausage. I grab the 2-meter microphone. "OK, Jerry, thanks. I'm getting tuned up. If no one comes back to him, why don't you work him to hold him on the frequency? K9BG from W9KNI."

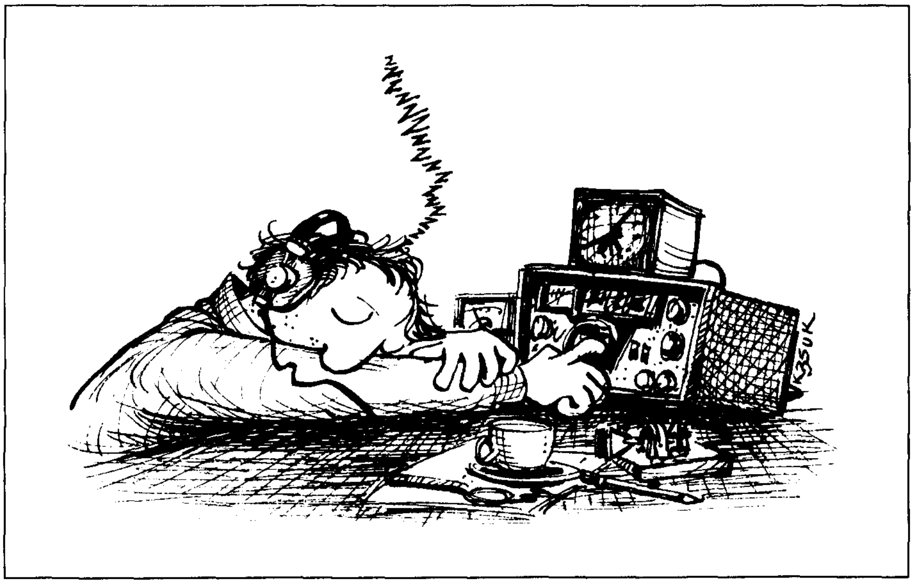
"OK, he's signing now."

I yank the receiver bandswitch down to 40 and spin the dial to 7019. With the other hand I switch the bandswitches on the exciter and the linear. Then I turn the antenna switch and preset the dials for a fast tune up.

"OK, Bob. He's got two or three people calling him. Hear him OK?"

I have the receiver on him now. Yes, there he is. "KØMM KØMM DE VK9NV GM OM..."

"OK, Jerry, I hear him. Thanks a lot." I move my VFO a couple of kHz above him and start tuning. The linear plate current, grid current, and rf output start climbing as I advance the exciter drive control. Then, it happens: suddenly, no output! Hey — almost at the same instant, the acrid, smoky smell of a hot component burning assails my nose. Startled, I look at the exciter, just in time to see a column of smoke dissipating over the final-amplifier compartment of the exciter. Oh, no!



"He's signing clear, Bob. Are you ready?"

"Ugh. Jerry, my rig just blew up. I smell smoke from something, I don't know what. I'm going to try to fix it as fast as I can. K9BG here's W9KNI."

"Gosh, Bob. Sorry to hear that. You *are* snakebit with that guy. I'll let you have at it. W9KNI from K9BG clear."

"Thanks, Jerry."

It's panic time. If I'm quick, maybe I can fix the rig while he's still on. Plug in the soldering iron. Grab the Phillips screwdriver, the side cutters, the needle nose pliers and the solder from the tool kit. Grab the VOM. Unplug the exciter. Pull off the coax cable and the control cables. *Jeez!*

Lift the top lid. Out come the two screws there. Put them on top of the receiver so they won't get lost.

Up on its back. Off come the feet. OK, turn it over again. There, OK. Gingerly, now, slide it out of its case. There, OK. Now up on its side.

I don't have to look far to see the source of the smoke. Underneath the final compartment I find a charred, blackened corpse of a 2-watt resistor. Must be a part of the screen circuit. There's no hope of reading the value. The color-coding stripes are only blackened faint scars on the blistered body.

I put the VOM across the part. Hmmm. I get a reading approaching one megohm, probably from other circuit elements. I yank the manual for the rig out of the file drawer and open it to the circuit. Then I begin draping the schematic foldout across the table. I find the section showing the final and fold the drawing mostly back up, so that I don't cover all my tools. Time, precious time!

Yes, there is a 2 watter. Let's be sure it's the one. Yes, it appears to be the only one in the final cage. And yes, it goes from that pin terminal 3 with the jumper to the other tube, and to the tie point where that point oh-one disc cap is. Yes, that's *got* to be the part. OK, it's an 18k resistor.

I jump over to the work bench and pull down the coffee can marked *resistors*. Lessee here. "Bad boys..." OK. Brown, Gray, Orange. Sure hope that I have one. That isn't the most common value.

I dump the contents of the can across the table. Hey, there's one! Maybe my luck is turning after all. I grab it and almost instantly I'm back at the rig. I look at the leads of the burnt resistor. While the ends of its leads are not particularly inaccessible, I decide to use the existing leads of the old resistor to carry the new component, in the interest of speed.

Snip, snip, with the side cutters, and the old resistor is out. A few moments work with the needle nose pliers, and the new resistor is supported by the leads of the old one. A touch with the soldering iron on each end, and the part is in. I cut the ends off it, then slap the ohmmeter across the circuit. OK, it's showing 17k ohms. Close enough. I unplug the soldering iron, and slide the tools out of the way.

I know I'm cheating a bit. I'm making the supposition that my rig problem is *only* and *completely* the failed resistor. If there's another problem that caused the resistor failure, I've done nothing to find it.

I know I'm gambling — but if I'm to have any chance to snag that VK9, the rig has got to work *now*. The time necessary to check out the adjacent circuitry would surely cost me any chance of a shot at the VK9.

OK. I set the rig on its bottom and frantically start plugging in the various cables — coax, keyer, AC, PTT line, linear control. Forget the cabinet; I'll just be careful to keep my fingers out of it and put it back in later. Nobody watches TV at this hour of the morning anyhow.

With all the cables plugged in, I switch on the rig. So far, so good; the VFO dial face lights up, as does the meter pilot lamp.

"Hey, W9KNI from K9BG. Bob, are you having any luck?"

"OK, Jerry. I just replaced a smoked resistor and the rig is warming up. I haven't tested it yet. Is he still there?"

"Yes, he is, but he's a little bit weaker. I think he's workable, though."

"OK, if the rig works I should be ready now. Cross your fingers! K9BG from W9KNI."

I close the push-to-transmit switch. The relays pull in. Uh oh! No plate idling current showing on the exciter meter. That's a bad sign. I start to apply a little drive. Just then I hear a faint click, and a puff of smoke rises from the back of the rig.

Rats. *Aaaagh. Ah, Phoooey.* Darn. Son of a gun. Heck. Aw, shucks. Ouch! (Actually, that's not what I said, but, you know...)

Well, I gambled and lost. I would do it again the same way under the same circumstances.

"Hey Bob, he just went QRT. He said he'd be back tomorrow though. Did you get your rig working?"

"No, Jerry, but thanks. It figures. I really am snakebit on that guy. Well, I hope I can fix the rig by then. Hey, it's after seven. I have to get dressed and get out of here. I'm late. See you tomorrow, Jerry. Thanks for your help. K9BG here's W9KNI, clear. Good morning."

"OK, Bob. Hope you get it going OK tonight. 73, have a good day. W9KNI from K9BG, clear."

I turn off everything, and head up the stairs. It's going to be a long day — but it can only get better from here. And there's always tomorrow.

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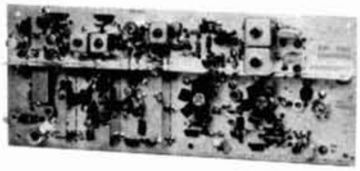

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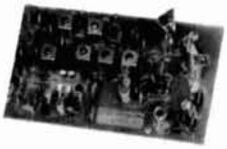

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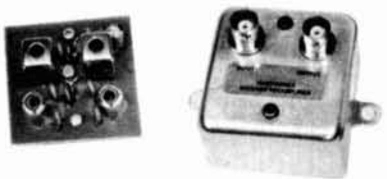

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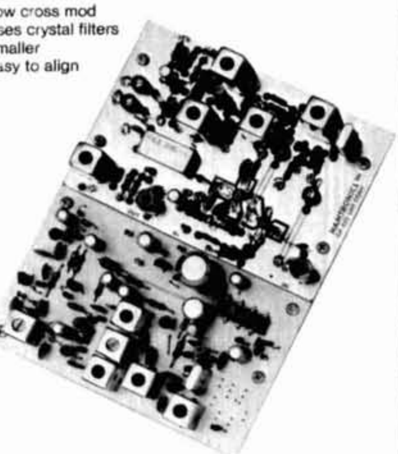

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More Details? CHECK—OFF Page 114

transient protection
for the Collins 516F-2 power supply

Solid-state devices provide improved efficiency and reliability

Power supply failures *that seem unexplainable* have been experienced by most of us at one time or another. In our haste to get back on the air, we probably resolved the problem by inserting a new tube, a capacitor of higher voltage rating, or a larger fuse. It is the intention of this article to emphasize an ever-present danger of catastrophic failure from voltage transients, and to recommend power supply modifications that reduce that danger.

I've heard that if the cost of transient protection is considered to be high, then so is the cost of a good safety belt. It is true that the replacement costs for new transformers, rectifiers, and meters may be relatively high by comparison.

The Collins 516F-2 power supply was selected as the subject of this article primarily because more than 30,000 of these units are believed to be scattered around the Amateur community. In this article, application of transient protection and substitution of silicon rectifier assemblies for hard vacuum tubes is explained, using the 516F-2 as an example. The information is general enough, however, that it can be applied to most power-supply modifications.

At a minimum, modification should include the addition of primary transient protection. The poor 5R4, as used in the 516F-2, was rarely if ever run within its ratings; this should be reason enough for substituting silicon rectifiers for hard vacuum tubes when

An interesting coincidence came to our attention regarding the low-voltage potential of the Collins 516F-2 power supply. Paul Pagel, N1FB, made modifications to his supply using virtually the same method as described by W6AD. However, while working beneath the power-supply chassis, N1FB added a 100-volt, 1-watt zener (HEP Z0438) between R8 and R9 junction and ground. This device held the bias voltage to within a volt or so of its set value, whereas before this addition the bias voltage wandered considerably with the changing transformer load during CW keying. Editor.

By **Ozzie Jaeger, W6AD,** P.O. Box 685, 803 Seacliff Drive, Aptos, California 95003

modifying any power supply for transient protection.

Like antennas, transient protection is a subject often discussed but not always well understood. This article is not intended to rectify that situation; instead, it provides the important, basic facts in a simple manner, so that modifications can be made without need of complex charts or mathematical formulas.

This article answers the following important questions:

1. What changes are needed to the supply?

2. Where do I get the materials, and how much will they cost?

need for transient protection

Suppression devices (or clippers, if you prefer) are used to protect against possible damaging effects of power line or internally generated transient voltages. These transients have been known to cause complete destruction of semiconductor as well as tube devices. Damage occurs when transient voltages exceed the maximum limits of power supply components. The sources of these transients are well known and are not discussed in detail here. They generally occur as a result of the familiar basic relationship:

$$e_L = -L\,di/dt \qquad (1)$$

where e_L = voltage across inductor (volts)
L = inductance (henries)
i = current (amperes)
t = time (seconds)

This equation can be interpreted to mean that anything causing rapid switching of a high current is liable to generate a troublesome transient. Typical examples are:

1. Energizing or de-energizing a transformer primary (turning the supply on or off)

2. Connecting or disconnecting secondary loads

3. Semiconductor switching, such as by an SCR, or reverse recovery transients in the rectifiers themselves

4. External disturbances from motors, solenoids, or relays that share the same power line

Transients of widely varying magnitudes are found in all electrical systems; some of them can be highly damaging.

circuit applications

There are several methods of transient suppression; some are more effective than others, depending on circuit complexity. Only the one which lends itself best to Amateur applications (that is, low cost, ease of installation, and parts availability) is considered appropriate for modification of the 516F-2 power supply. Before that choice is identified, the various techniques are briefly discussed.

Transient protection methods are classified as follows:

1. RC networks

2. Silicon voltage limiters

3. Metal oxide varistors

4. Selenium suppressors

RC networks. These are relatively inexpensive and provide excellent performance when used in conjunction with other means of transient protection. RC components are often quite large, especially when connected across the secondary of the power-supply transformer. Nevertheless, they are used widely in applications from small power supplies for transistors or integrated circuits to hard contact starter/contactor applications. For design purposes, the maximum energy expected to be present during a transient should be known. Energy is expressed as:

$$E_{max} = 1/2\,Li^2 \text{ or } 1/2\,CV^2 \qquad (2)$$

where E_{max} = $1/2\,Li^2$ or $1/2\,CV^2$
V = voltage (volts)
C = capacitance (farads)

A typical RC circuit is illustrated in **fig. 1**. A small ac current flows through this circuit under steady-state operating conditions. In the event of a transient, large currents flow for brief periods. The resistor reduces the secondary circuit Q and absorbs some of the transient energy. I feel that the complex details needed to provide design information for the RC circuit is probably not of interest to most Amateurs. However, those wishing further details should send a self-addressed, stamped envelope to the author.

Other types of suppressors are often used in combination with RC networks to provide better suppression. When used with the MOV (metal oxide varistor) or break-over diodes, the RC network provides a higher level of energy absorption. The tradeoff here is one of economy, since the combination allows

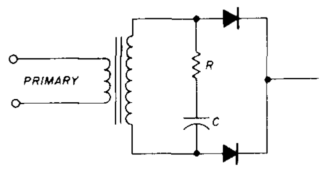


fig. 1. Circuit of a typical RC transient suppressor.

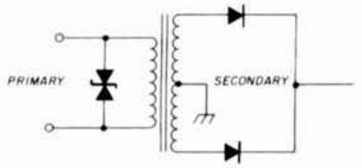


fig. 2. Circuit diagram showing a transient suppressor connected across transformer primary.

lower-voltage power supply components to be used.

Special silicon voltage limiters. These devices consist of back-to-back avalanche diodes (zeners) constructed on a single substrate. In the circuit, one diode is always in the conducting mode, while the other is in the blocking mode, as illustrated in **fig. 2.** Much more can be said about this device and its excellent protection characteristics, but despite its good points, it is much too expensive for typical Amateur equipment. The silicon limiter is temperature sensitive; special care should be taken to ensure adequate heat sinking to keep its case temperature below about 260 F (125 C).

Metal oxide varistors. These are zinc oxide/bismuth oxide ceramic devices. When used for transient protection, varistors act as clippers of incoming transients or transients caused by switching transistors. The power dissipation capability and current and voltage ratings are temperature dependent, so it's important to know the ambient conditions under which they will be operated. The manufacturers derating curves are generally available and should be consulted to establish temperature compatibility.

Metal oxide varistors also have a high capacitance characteristic, which limits their use to relatively low frequencies; however, since most Amateur applications use power-line frequencies, this should present no problem.

Selenium transient suppressors. Probably the type best suited for Amateur applications, selenium suppressors provide transient protection because of their sharp reverse voltage breakdown characteristics. They are available in either dc (polarized) or ac (nonpolarized) types, and each has an rms and dc rating of 24 volts per cell. When the unit is connected across the transformer primary (where most of the units will be used), it will draw a small, constant amount of current. However, in the event of overvoltage, a much larger amount of current will be drawn through the device for a very short period of time; this will limit the maximum voltage applied to the transformer primary, thereby possibly preventing a catastrophic failure of a rectifier or filter component on the secondary side.

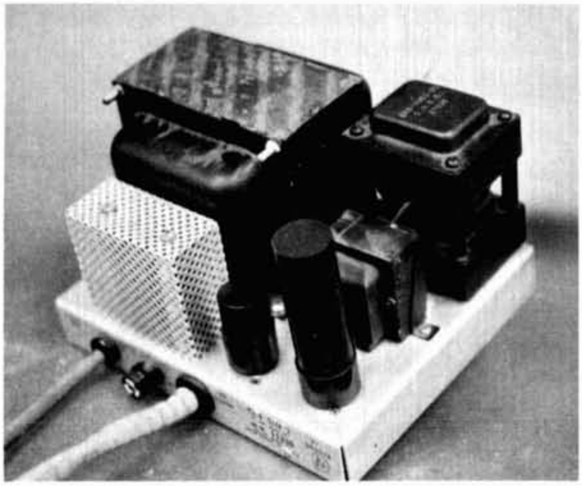
Selenium suppressors are available either in the axial lead or series metal plate type. Ninety percent of existing Amateur equipment includes power supplies in the 25-400 watt range. The small axial lead suppressors are entirely satisfactory for these units. If space permits, or in case you're interested in protecting a really large power supply, the 1-inch, 1½-inch, or even the 2-inch selenium units should be used. It may be comforting to know that the large Voice of America broadcast station transmitters, with ac primaries up to 480 volts, use selenium suppressors exactly like those shown in the photographs. In addition, many large steel mills and foundries, and broadcast and TV stations use selenium suppressors of this type in their high-voltage power supplies. The fact that selenium suppressors are used in mountain-top and other difficult-to-reach telephone installations is testimony to their effectiveness.

Selenium units operate effectively in ambient temperatures up to 120 F (49 C). This characteristic should not be a problem for Amateur equipment. Finally, selenium suppressors have an energy-absorbing ability that is measurably better than that of any of the other devices discussed.

modifying the 516F-2

The importance of adding transient protection to power supplies has now been established, and the selenium type has been selected as the best choice for Amateur use; therefore, modification of the 516F-2 can now be described. Proceed as follows:

1. Remove blue wire from pin 2 on V2 (5U4 socket)



The Collins 516F-2 power supply after modification. The silicon replacement rectifiers substitute for the rectifier tubes.

2. Mount a new 25-watt, heat-sink-type resistor on back chassis apron between V1 and V2 sockets (100 to 200 ohms)

3. Connect blue wire taken from pin 2 of V2 to the end of the new resistor being added

4. Connect other end of resistor to pin 2 of V2

5. Wire axial lead transient suppressor across transformer primary. Make the connections to one side of the fuse (ring section, not tip) and to the triple tie-point that already contains two black wires

6. Plug in the 5U4 and 5R4 silicon rectifier replacement units

After completing the modification (**fig. 3**) you'll find that the low voltage will be approximately the same as originally, but there will be 40 to 60 additional volts on the 6146 plates. To bring the static current back to its original value, readjust the bias pot.

While there is no danger in applying an additional 50 volts or so to the 6146s, the higher voltage that would be obtained in the low-voltage circuits could be disastrous. This explains why the 25-watt resistor is added in step two of the modification instructions. If you succumb to the temptation to leave this resistor out, you may achieve slightly higher power output, but you also guarantee shorter tube life. Considering the presently high cost of vacuum tubes, these extra few watts may be very expensive.

After completing the modification, you may notice that applying high voltage while the equipment is still warm may cause the multimeter to momentarily pin itself. To avoid possible damage to the meter assembly, a silicon meter protector should be installed across the meter terminals. This should consist of a pair of back-to-back 1-amp silicon diodes. These diodes should be chosen to have matching forward voltage drops.

The system including the power transformer will now run considerably cooler, because the two hard vacuum tubes have been eliminated. Also, the filament voltage at the receiving end of the long power cable will be closer to the proper value.

In case you decide to home-brew your own silicon plug-in rectifier units, first consider the actual operating voltages and select the diodes accordingly. A rule of thumb that will keep you out of trouble with a full-wave rectifier is the following: use silicon rectifiers whose PIV (peak inverse voltage) rating is equal to three times the total secondary rms voltage. This rule includes an adequate safety factor if you also include transient protection. In the 516F-2 supply, the rms voltage between pins 4 and 6 of the 5R4 with 120

Close-up of underside showing the rectifier sockets and the new 25-watt resistor mounted on the rear apron.

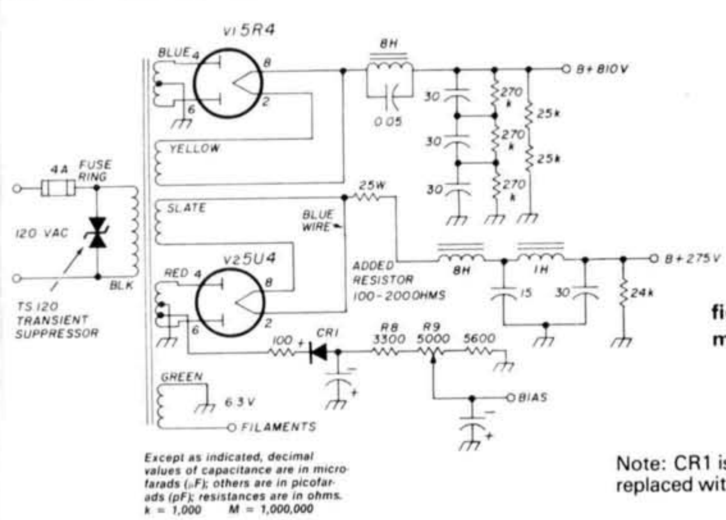
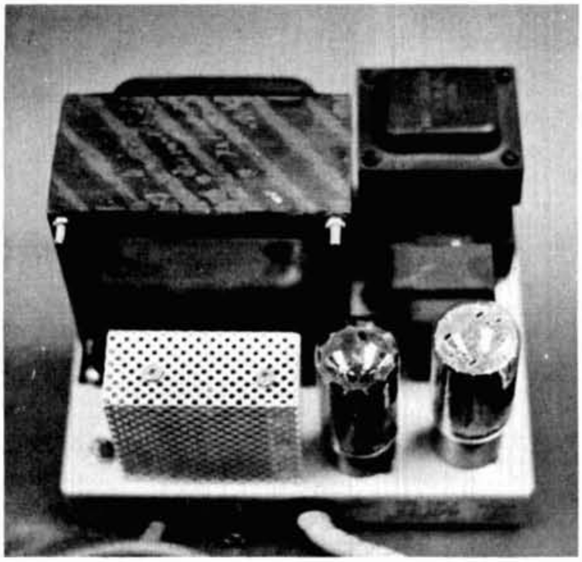


fig. 3. Circuit diagram of 516F-2 power supply with modifications.

Note: CR1 is a selenium rectifier that is subject to aging. It can be replaced with a silicon diode.



Top view of Collins 516F-2 power supply before the modification.

volts across the primary is approximately 2,050 volts. Using our rule of thumb, the PIV rating of the silicon rectifiers used to substitute for the 5R4 should be no less than 6,000 volts.

For the low voltage supply, the silicon rectifiers should be rated at 2,500 volts or more. The rule is based on the fact that one diode is conducting while the other is back-biased; this means the back-biased diode sees the full secondary voltage, whose peak value is 1.414 times the rms voltage. We multiply this number by two to provide a safety factor. The safety factor takes into account transients that will exist despite transient protection but which will be reduced in amplitude. Computed in this way, the silicon diodes should last indefinitely.

In summary, this article has defined and dealt with transient protection in a simple and uncomplicated manner. Modification of the Collins 516F-2 has been the subject for modification, but other supplies may be modified in a similar fashion.

Silicon rectifiers are not as forgiving as vacuum tubes. They do not provide early warning by glowing red — they simply die. On the other hand, silicon operates cooler and is more efficient.

The silicon rectifiers in your power supply can last a lifetime if their PIV rating is adequate and if the supply includes transient suppression.

Components needed to make the modification can be obtained from OZ-COMM Co., P.O. Box 685, 803 Seacliff Drive, Aptos, California 95003. Send a self-addressed, stamped envelope for further information.

ham radio

ham radio TECHNIQUES

Bill Orr W6SAI

Happy birthday 10 meters. March 7, 1981 marks the fifty-third anniversary of the opening of the 10-meter Amateur band. Can you imagine what Amateur Radio was like in 1928, particularly before the 10-meter band was opened for Amateur communications?

The International Radiotelegraph Conference, held in Washington, D.C., in 1927, set the pattern for Amateur Radio that lasts until this day. Gone were the huge Amateur bands informally assigned in the "useless" high-frequency spectrum. In their place were new, narrow bands and a new system of Amateur calls to indicate nationality. Amateur Radio had narrowly escaped the fate recommended by the Canadian delegation to the Conference, "...(I do) not think that Amateurs should ever be given any wavelengths that are known to be useful for any commercial or government communication, and...they should always be obliged to stay within territory...regarded as completely useless...."

From this grim atmosphere Amateur Radio grew and prospered.

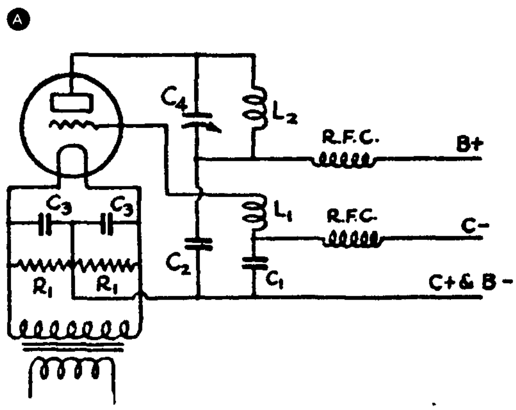
Impossible to see at the time was the future benefit to Amateur Radio of a brand-new band assigned for "Amateur experimental" purposes at 28,000 to 30,000 kilocycles. In the 1928 *QST* editorial discussing the Conference and its immense changes to Amateur Radio, the new "10-meter band" was mentioned only in passing. After all, everyone knew it was a quasi-optical, "line-of-sight" band and probably worthless, otherwise it wouldn't have been tossed to Amateur Radio, as a bone is tossed to a dog.

Of greater concern to the average Amateur was the fact that the 40-meter band had been slashed from 7,000 to 8,000 kilocycles (to 7,000 to 7,300 kilocycles), and the 20-meter band had been severely cut from the assignment of 14,000 to 16,000 kilocycles (to 14,000 to 14,400 kilocycles). How could you cram more than 16,000 Amateurs into bands only a few hundred kilocycles wide?

The February, 1928, editorial in *QST* summed it all up: "We didn't get as great privileges as we wanted or as great as we think we were entitled to, but we got all that we were able to, with loyal and powerful assistance from our government. Some of our (ARRL) members do not understand how the attitude of foreign governments could have any effect upon what our government does for us. They forget that radio is an international affair and that it has to be governed by international treaties."

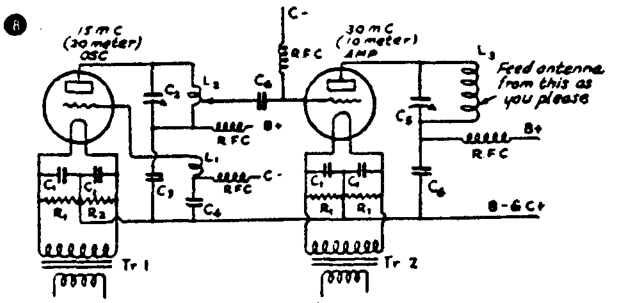
welcome to 10 meters

For several years experiments had been conducted by Amateurs "on the 5 meter wave" of about 50,000 kilocycles (50 MHz). Aside from cranky receivers and erratic transmitters, the band looked promising for short-range work. A few Amateur experimental stations had been given authority to work on 10 meters in 1927, but with dubious results. The new band was a complete blank. And it couldn't be used by Amateurs until April first. The only bright outlook



10-METER OSCILLATOR THAT WILL WORK WELL, AS WILL A LOT OF OTHER KINDS

C1 and C2 Stopping condensers, had better be of mica and with capacity of 200 picos or more.
C3 By-pass condensers. Good if large enough.
C4 100 picos max. will serve.
L1 Cut and try.
L2 One 3" turn of tubing or strap firmly screwed to C4.
R.F.C. 2" windings No. 36 double silk or single cotton on ¼" core.
Feed the antenna from L2 by any method you like.



AN OSCILLATOR-AMPLIFIER TRANSMITTER USING TWO TUBES OF THE SAME SORT WITH THE SAME B AND C VOLTAGES BUT NOT FROM THE SAME SOURCES

There must be a separate B supply at least and it is best to use separate filament transformers. Do not use centertaps on transformers but use resistance centertaps instead as shown.

L1 Cut and try—depends mostly on the tube.
L3 & 2nd L2 One turn copper srip or tube, diameter 3" as a start.
C1 Bypass condensers, large enough.
C2 Depends on the tube, 200 picos maximum may do.
C3, C4 and C6 Stopping condensers, must stand plate voltage, plus some r.f. and should have capacity of 200 picos or so.
C5 100 picos max. is enough here.
R.F.C. For the oscillator ⅜" diameter and 2" long with winding of one layer No. 36 double silk or single cotton. For the amplifier reduce diameter winding to ¼". Put the chokes at the job—not a foot away.

fig. 1. A simple oscillator using a UX-210A or 210 tube was suggested as a beginner's transmitter for 10 meters, B. As the caption indicates, specific information was rather sketchy. In B, an oscillator-doubler transmitter provided better stability (it was hoped). No reason was given as to why separate power supplies were recommended. Using these circuits, there must have been rf all over the shack! (Drawings reproduced from the May, 1928, issue of *QST*.)*

was that two experimental stations, ef8CT (France) and nu2JN (U.S.A.) had made contact on 10 meters on January 1, 1928. Perhaps the band *did* have DX capabilities (or maybe it was just a freak contact). Only time would tell. As far as was known, only seven Amateurs had been authorized for experimental tests on 10 meters. Plenty of listening had been done but few reports of contacts made.

A small squib in the back pages of April, 1928, *QST* announced the official opening of the 10-meter band. The May, 1928, editorial enlarged upon the new band, commenting, "It is generally thought to be worthless because something happens to waves shorter than 12 or 13 meters, which keeps them from producing useful signals even at the antipodes except under rare or freakish conditions. Eminent engineers have told us that the secret of the 10-meter band lies in devising a method of *controlling the angle of radiation*, (italics mine) that if we can find this we will have 10 meters tamed. No more fertile field for the Amateur experimenter was ever offered. Lasting fame and glory awaits the successful."

A few hints were given for getting on the new band.[1] A modest beginner's transmitter circuit was shown in *QST* (**fig. 1**). This one-tube oscillator worked directly on 10 meters. Either a UX-201A or a 210 could be used, depending upon available plate voltage. As you can see, specifications were comfortably vague, and the builder was advised to listen for the second harmonic of commercial radiotelegraph station WIK, which fell close to the center of the 10-meter band. As to the receiver, almost anything would work, it was said. "Just take turns off the detector coil until you heard WIK."

10-meter results!

April 1, 1928, was the big day. The first two-way 10-meter contact was between nu6UF (Knowles, California)

*Note the quaint captions on these drawings: one of the many devices that made *QST* so enjoyable in the old days. *Editor, W6NIF*

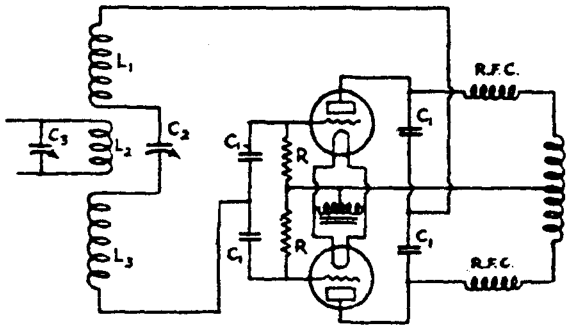


fig. 2. The nu8EX transmitter used for the first two-way 10-meter contact had a pair of 210 tubes in a self-rectified oscillator circuit. Alternating current at line frequency was applied to the plates of the tubes from the transformer at the right of the circuit (secondary only shown). With the low-C tank circuit and ac plate supply, the transmitter note must have been terrible! But it was good enough to do the job. (Drawing reproduced from the August, 1928, issue of *QST*).

FULL-WAVE SELF-RECTIFICATION IS USED BY 8EX WITH THIS REINARTZ CIRCUIT ARRANGEMENT

and nu8EX (Cleveland, Ohio). The whereabouts of the original 8EX is unknown, but 6UF is active, on the air, and a close friend of mine. I called Bill Eitel (W6UF, now WA7LRU) on the telephone and asked him if he still recalled that historic contact. He did, and he told me all about it, and this is what he said, as near as I can recall:

"I remember it all very clearly. I was living in Knowles, California, in the foothills of the Yosemite. There was a big granite quarry in Knowles. All the granite for the Los Angeles city hall came from Knowles.

"One day I got a large, natural, quartz crystal from a creek in the quarry. It was about 8 inches long and 2 inches in diameter. A friend working in the quarry cut it into several rectangles on a stone saw, then I cut it into rough crystal blanks with hacksaw blades and carborundum. From one of the blanks I cut a good 160-meter crystal. It took days of work to get a crystal that oscillated, but I did it. The original crystal was anchored in plaster of Paris so it could be placed into the saw. Once I got a blank, it took many hours of grinding on a plate to make a useable crystal.

"The transmitter began with a type 210 tube oscillator on 160 meters followed by four 210 doubler stages, to 10 meters. Everything was tuned up with a homemade wavemeter. The final amplifier tube was a 203A at first, but I quickly substituted an 852 at about 100 watts input. I had a 10-meter vertical antenna and also a long-wire antenna.

"I remember that 8EX had a 210 oscillator. His transmitter was described in *QST*, (**fig. 2**). He used 60-cycle ac on the plates of the 210s. The signal was very rough. His signal strength was about R6 (S6 to new-

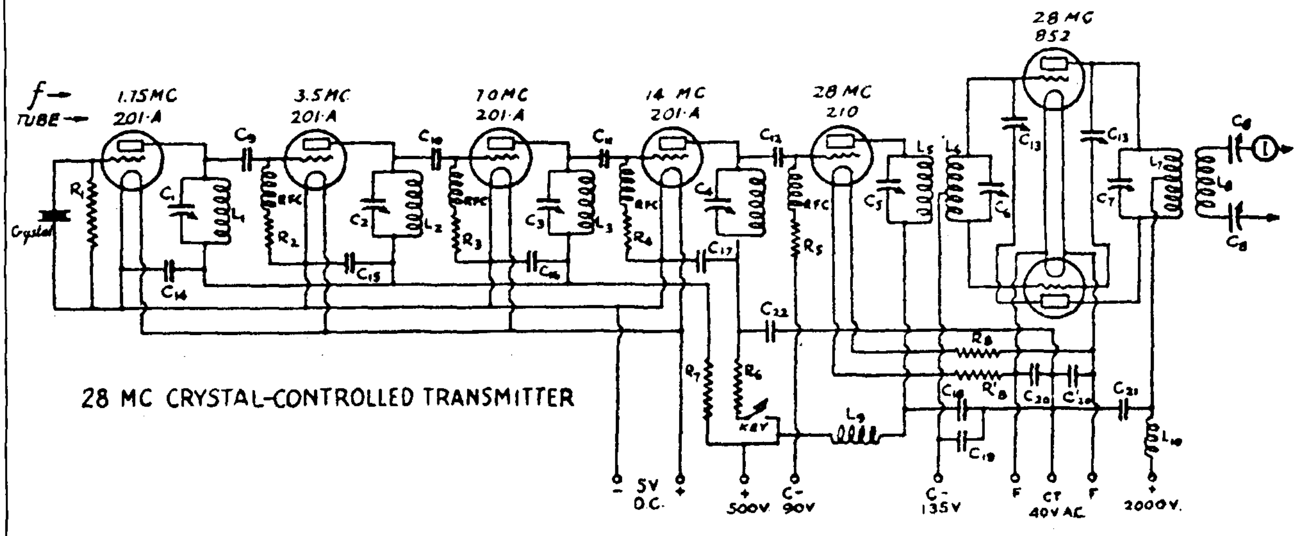


fig. 3. The pace-setting transmitter used for early 10-meter tests at W1XM. Four doubler stages provided 28-MHz excitation from a 1.75-MHz crystal. Because of capacitive coupling between stages, it is surmised that many spurious harmonic frequencies were present at the exciter output. Inductive coupling to the final amplifier (hopefully) eliminated birdies. The nu6UF transmitter resembled this, except that only one 852 was used in the final stage. (Drawing reproduced from the November, 1928, issue of *QST*).

comers), and we were in contact for about an hour.*

"My greatest satisfaction was in tests run later in the year and into 1928 with W1CCZ, on Cape Cod. This beautiful station was a result of work done by the Massachusetts Institute of Technology, by Paul Hendricks and E.C. Crossett, on whose estate the station was located. W1CCZ had a 500-watt transmitter and a four-element Yagi beam — unheard of in those days.

"The W1CCZ beam was unique in that it was movable in *elevation*. It was thought that high-angle signals were the answer to reliable communications on 10 meters. Many tests were run with the beam pointed up at 10 degrees from vertical, which seemed to provide the best results.

"One of the transmitters used in the MIT program operated under the call W1XM (**fig. 3**). My transmitter was somewhat like this, except I used 210s all the way and only a single 852 in the final stage. And I only had 1000 volts for the 852. I never had much luck with that bottle."[2]

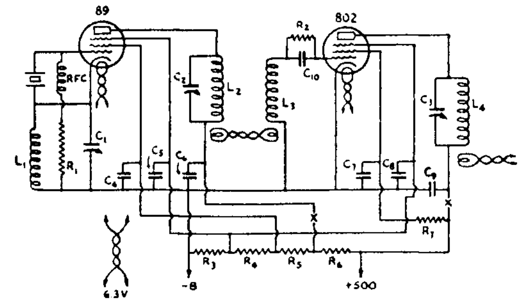
interest lags in 10 meters

The year 1929 was a watershed year for 10 meters, as the sunspot cycle was on a rapid decline. Just as things seemed to be picking up and intercontinental DX was on the horizon, the bottom dropped out of the band. Interest lagged, and few signals were heard on 10 meters until 1935, when the sunspot cycle was again on the upswing. The band seemed to come back to life in the fall. The first WAC (Worked All Continents) on 10 meters was made by ZS1H (Union of South Africa). Things were beginning to pay off for a bunch of hardy experimenters, who had remained active on the band over the past three lean years.

QST said, "A band so universally considered dead that early DX work was practically forgotten has suddenly come to life, rewarding in good measure the few who struggled along on it with meagre results."

Worldwide DX conditions led to a flock of WAC certificates, and the first phone WAC was achieved by W6FQY in San Jose, California. Ten meters was alive and kicking!

Seven years had brought about a revolution in radio transmitting and receiving equipment. Gone was the regenerative receiver and self-excited oscillator. New crystal-controlled transmitters were available (**fig. 4**), and practical details were available for building a 10-meter rotary beam antenna (**fig. 5**).



—CIRCUIT OF THE 89–802 LOW-POWER TRANSMITTER OR EXCITER

C_1—365-μμfd. variable (Cardwell Midway, Type MR-365-BS).
C_2—50-μμfd. variable (Cardwell Midway, Type MT-50-GS).
C_3—20-μμfd. variable (Cardwell Midway, Type MT-20-GS).
C_4 to C_9, inc.—.002-μμfd. mica condensers.
C_{10}—100-μμfd. mica.
R_1, R_2—50,000 ohms, 1-watt.
R_3—10,000 ohms, 1-watt.
R_4, R_5—10,000 ohms, 10-watt.
R_6—3500 ohms, 10-watt.
R_7—25,000 ohms, 25-watt.
L_1—10 turns No. 14, spaced to occupy winding length of 1⅛ inches.
L_2—10 turns No. 14, spaced to occupy winding length of 1 inch.
L_3—20 turns No. 24 on 1-inch diameter tube, winding length 1 inch.
L_4—7 turns No. 14, spaced to occupy winding length of ¾ inch.
L_1, L_2 and L_4, coil diameter 1⅜ inches. One-turn link on same tube as L_3, closely coupled to ground end. One-turn link coupled to L_2 made of hookup wire.

fig. 4. This two-tube, 10-meter transmitter of 1936 is modern enough to do a good job on the band today. The 802 pentode amplifier is capable of 40 watts input. A 7-MHz crystal was used. Cathode circuit of the 89 oscillator tunes to about 10 MHz to provide correct feedback. Plate circuit is tuned to 14 MHz, and 802 is a frequency doubler to 28 MHz. (Drawing reproduced from the January, 1936, issue of *QST*.)

getting on 10 meters

In 1935 I attempted to get on 10 meters. It was a laborious process. I finally got my homemade receiver working so I could hear 10-meter stations. I was amazed at the outstanding signals pouring in from all over the world.

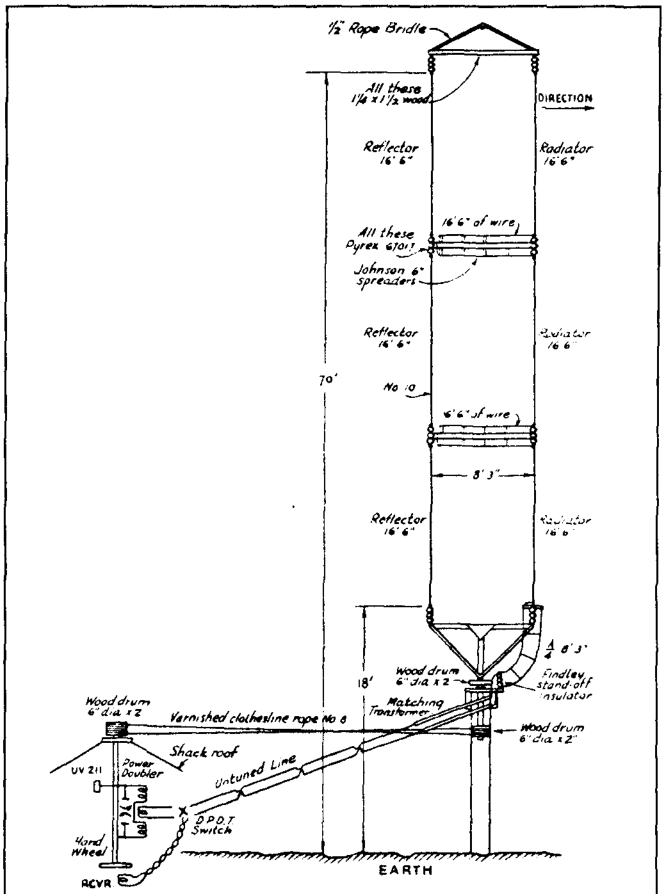
Getting the transmitter on 10 meters, however, was another matter. When it finally seemed to be working, I had no luck at all in working stations I could hear.

Call after call brought no results. Finally, a local Amateur called me on the phone and told me that I had tuned up on the third harmonic of my 40-meter crystal and was on 15 instead of 10 meters! I was loud and clear in a portion of the spectrum in which an Amateur band didn't yet exist!

I soon corrected my error and finally hit the 10-meter band. But I spent several nervous weeks waiting to see if I would get a citation from the FCC for my conduct. Luckily, the 15-meter region was void of any activity, and the FCC probably didn't waste time monitoring the wasteland.

The reappearance of DX on 10 meters was a mystery to most

*The back-to-back, self-rectified transmitter in **fig. 2** was also popular in commercial circles as late as 1938. I was the chief (and only) operator on a tuna boat working out of San Diego in that year. The transmitter used a pair of UX852 tubes in a circuit almost identical to that shown in **fig. 2** but designed to work on the 36-, 24-, and 18-meter marine bands. The transmitter was enclosed in a SQUARE-D™ switchbox, which was mounted on the bulkhead in the radio shack. Power was supplied from a 500-cycle alternator. Thus the signal wasn't as broad as that from 8EX's rig, which operated from 60-cycle ac; however, it had a good whine and made the coastal stations sit up and take notice. **Editor, W6NIF**



DETAILS OF W6JN'S ANTENNA

fig. 5. One of the first 10-meter rotary beam antennas was used at W6JN. Composed of three half waves in phase with reflectors, the array was suspended from a wooden telephone pole. It probably provided gain equivalent to today's 3-element Yagi. In 1936 when large beams on 10 meters were unknown, it must have been a block-buster! (Drawing reproduced from the April, 1936, issue of *QST*).

Amateurs who had never heard of the sunspot cycle. But in the years before World War II, the band was red hot with DX from all over the world booming in. No doubt the popularity of 10 meters helped fuel the boom in Amateur Radio in the late 1940s. Every stateside DX-minded ham wanted to work the rip-roaring signal of K6MVV (later KH6AR) in Hawaii!

10 meters after the war

November, 1945, was the red-letter day. The FCC announced the restoration of Amateur Radio on the high frequencies. The post-war 10-meter band was from 28.0-29.7 MHz, with phone work, in the United States, from 28.1-29.5 MHz. Frequency modulation could be used above 28.95 MHz. The portion of the old band, from 29.7-30.0 MHz had, regrettably, been lost in the post-war reallocation of frequencies.

Rapidly, 10-meter Amateur stations were popping up all over the world, many of them run by GIs using military rigs. Some of the well-known calls were EA1D (Madrid Airfield), P1X (Holland), W8CJR/XU (China), W6NSL (Japan) and ZC6NX in Palestine.

The U.S. Marine Base at Tsingtao, China, in particular, was very active on 10 meters, with more than twenty XU stations on the air at one time or another.

Rarer DX was there for the sharp-eared DX hunter. W4YA/XZ on the Burma Road was on as well as G6CU/ZC2 on Christmas Island. Also included was Mr. DX himself, Reg Fox, AC4YN, in Lhasa, Tibet!*

the bright new world — of sunspots

Almost unnoticed in the clamor to get back on the air was an historic article in *QST*, which outlined wartime research into hf communications and the sunspot cycle.[3] Research conducted before the war by the National Bureau of Standards and the Carnegie Institute was continued, with greater impetus, during the war by the armed forces. A method of predicting radio conditions, with respect to the sunspot cycle, had evolved.

Amateurs engaged in military communications during the war quickly realized that the frequencies above 20 MHz were capable of long-distance communications. The military fm band, centered at about 35 MHz, opened up day after day for long-distance Pacific DX. Operators in Borneo eavesdropped on communications from Iwo Jima, and shipboard operators on the way to Okinawa were amused by complaints from Ulithi, in the Marshall Islands, that the ship "short range" fm transmission circuits were breaking up local harbor communications. Other transmissions up to 4,000 miles (6,500 km) were noted over various Pacific circuits in the 35-MHz range.

Much of the unusual DX could be explained by the sunspot cycle and solar activity. Propagation studies revealed how much of the 10-meter DX work was possible, and charts were available whereby propagation predictions could be made for the future. Best of all, the sunspot count

*I have AC4YN's card for a two-way contact on 14 MHz dated April 2, 1947. Not for sale. **Editor, W6NIF** was on the rise, promising great 10-meter DX until at least 1952!

10 meters in the 50s

By 1953 the 10-meter band was back in the doldrums. The sunspot cycle had taken its count, and hams looked elsewhere for DX. W1JPE (now W1DX) summed it all up:

No more about ye DX bands,
Do DXers pushe and pulle,
Or talk about YJs, PKs,
Or toss about Ye Bulle

Ye sunspot count hath gummed ye game
Ye bands are dry as snuffe
And many a hearty soul, no doubt,
Has learned how to do without,
Excepting Thee and Me, Olde Scout,
Who never worked Ye stuffe.

the great sunspot cycle peak of 1957-58

And come back it did! After a few arid years, 10 meters came back to life in the fall of 1955, just as the experts predicted! And again, there was a revolution in equipment on the band; single sideband had arrived to stay. The band had perked up in the spring and was going full blast by fall. As the sunspot count increased and the MUF (Maximum Usable Frequency) continued to rise toward 50 MHz, many 10-meter operators noted that a *too-high* sunspot count could produce ill effects on the 10-meter band, and the great sunspot cycle peak in the winter of 1957 didn't seem to produce super-DX on the 10-meter band, although the band remained open until the late evening hours.

DX was good, however, and exotic stations such as JT1AA (Mongolian People's Republic) were present, and Soviet Amateurs showed up on 10 meters in great numbers. And, as it had since the beginning of sunspot measurements by the Chinese before the birth of Christ, the sunspot cycle started its inexorable down turn, reaching a nadir during the winter of 1964.

10 meters today

The period between 1964 and 1976 represents Cycle 20 of the sunspot count, which started with Cycle 1, based on measurements made in 1750. The present Cycle, 21, is at, or near, a peak, and the 10-meter band is alive with activity. This band is expected to remain active and capable of sustaining long-distance communications well into 1986. By then, when the sunspot cycle has dropped to a new low, it's possible that relay satellites may be in orbit to take up the slack. Time will tell.

survey of the 10-meter band area

Meanwhile, a lot can be learned from a close examination of the 10-meter band and its environs. Below 10 meters, ranging from 26.5 MHz to the low edge of 10 meters, is a bewildering mixture of illegal CB operation. By concensus, most out-of-band a-m CB operation occurs between 26.5 MHz and channel 1. From channel 40 up to (and sometimes including) the low edge of 10 meters, the frequencies are chock-full of SSB activity. At times, the QRM is extremely heavy, especially when the channels are open to worldwide communications. A look-see over this range by one unaware of the activity comes as a shocking surprise.

One day last fall, over a period of four hours, I logged over 30 countries on CB, which were operating outside the assigned channels. Stations as far away as Italy and Australia came rocking in, with plenty of callers in the United States!

The 10-meter band itself has a few surprises. During the afternoon hours, the third harmonic of the Radio Moscow home service in the 9-MHz broadcast band is clearly heard on the West Coast. Stations as far inland as Tashkent come through. The stations seem to be spaced about every 100 kHz, starting with a harmonic on 28.0 MHz and running upwards of 28.8 MHz.

Above the top end of 10 meters, normally a preserve for Amateur fm from 29.5-29.7 MHz, lie the commercial fm channels extending higher in frequency from 29.7 MHz. However, at 29.705 MHz I could hear a special broadcast station in Israel, beamed to the Soviet Union. The transmitter power was 20 kW and the over-the-pole signal was a good band marker for European openings in the spring of 1980. So far the station has not shown up.

Finally, there is growing activity at the high end of 10 meters as interest in fm grows. The calling frequency is 29.6 MHz, with repeater inputs every 20 kHz below that, to 29.52 MHz. The output channels are 100 kHz higher than the input and fall above 29.6 MHz.

It's an eerie feeling to bring up a repeater on the East Coast from California and work European and South American signals through it. And the hams on the East Coast can work Australia and New Zealand through repeaters in California! Some repeaters have an input on 144 MHz, and it's common to hear hams on 2 meters working DX on 10 meters through a repeater while walking around with a handheld rig.

And so it goes. The 10-meter band has come a long way from the early days when nu6UF opened the band with his historic QSO. A salute, then, to 10 meters and happy birthday! Here's to more and better 10-meter activity until old sol takes over the band sometime in 1986. I'll see you on Ten!

references

1. Kruse, "Getting Started at 30 Megacycles," *QST*, May, 1928.
2. I wonder if the trouble Bill Eitel had with the 852 influenced him to go into the tube business in a few years! Bill and Jack McCullough, W6CHE, were instrumental in designing the HK-354 transmitting tube at Heintz and Kaufman Company in the early 30s. Then they went on to found Eitel-McCullough, Incorporated, the manufacturer of the famous EIMAC power tubes.
3. Conklin, "The Bright New World of Sunspots," *QST*, January, 1946. (Bill Conklin, then W3JUX, is now licensed as K6HA).

ham radio

X-band calibrator

How to get started on the 10-GHz Amateur band

This article describes a frequency calibrator for use with Amateur X-band transceivers such as the Microwave Associates Gunnplexer®. The calibrator is simple to build and makes communications over long-haul, non-optical paths easy to accomplish.

the Gunnplexer

The Microwave Associates Gunnplexer is a great device with which the Amateur can explore the challenging frontier of microwaves. The Gunnplexer includes a Gunn-diode oscillator, which is used for both the transmitter and receiver local oscillator. A Schottky diode and ferrite circulator are used as the receive mixer (**fig. 1**). A varactor diode mounted in the Gunn-diode oscillator cavity provides approximately 100 MHz of transmit and receive tuning variation (plus frequency modulation). All that's required for operation is 8 or 10 Vdc for the Gunn-diode,* 0-20

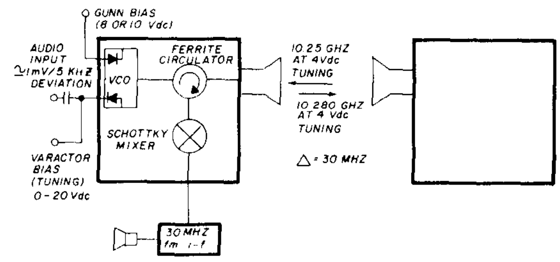


fig. 1. The Gunnplexer consists of a Gunn-diode oscillator, which serves as both the transmitter and receiver local oscillator, and a Schottky diode and ferrite circulator which are used as the receiver mixer.

*Some units require 8 Vdc and some 10 Vdc. The required voltage should be marked on the unit.

By Steve J. Noll, WA6EJO, 1288 Winford Avenue, Ventura, California 93003

Vdc for varactor tuning, and an fm receiver for the i-f. Audio is coupled into the varactor for modulation. The i-f is 30 MHz.[1]

Gunnplexers have been available in pairs set to the standard split of 30 MHz. One unit is mechanically tuned so that, with 4 Vdc of varactor bias (tuning voltage), the Gunn-diode oscillator output is 10.280 GHz. The second unit is similarly set to 10.250 GHz with 4 Vdc bias. The difference of these two frequencies is the "standard" i-f of 30 MHz.

The tuning range of a typical 10.250-GHz Gunnplexer is approximately 10.22 to 10.32 GHz. A typical 10.280-GHz unit covers approximately 10.25-10.35 GHz. These are the Gunn oscillator frequencies, so the receive frequencies will be 30 MHz above and below.

the problem

Two problems become apparent after one has had some experience with the units over long paths. One is aiming the antennas when the location of the other unit is not precisely known. Eventually the operator graduates from the basic 17-dB horn antenna supplied with the Gunnplexer to high-gain parabolic reflectors. With high gain comes narrow beamwidths; that is, about 2-1/2 degrees for a 3-foot (1-meter) dish and 1-1/4 degrees for a 6-foot (2-meter) dish. This certainly can make aiming over non-optical paths very difficult.

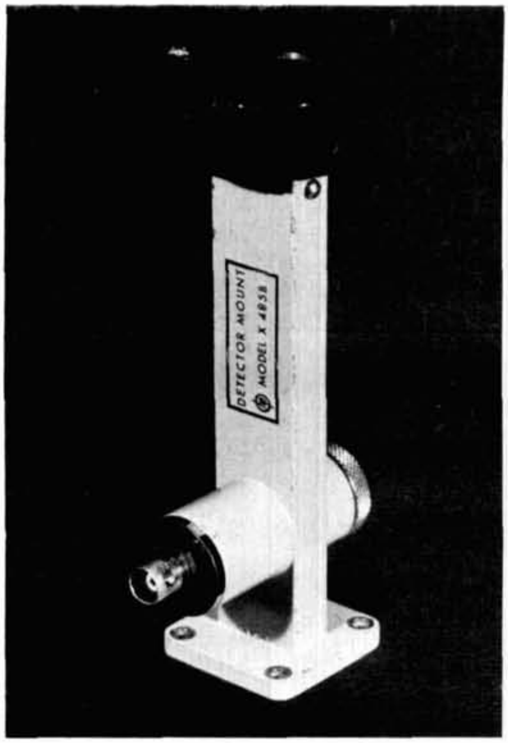
The second problem is finding the signal. This problem can be worse than the first, especially when the signal is weak. The 100 MHz of tuning is quite a bit. You can easily tune by a weak signal even when ten-turn pots are used for tuning. Narrow i-fs that are used to increase range add to the problem. It is desirable to have the full 0-20 Vdc tuning range available to be compatible with any other person's Gunnplexer; that is, to be sure to be within his tuning range.

These two problems of aiming and tuning are definitely additive. They make an attempt at a long-distance contact a formidable task. However, solve one problem and the other becomes much easier.

the solution

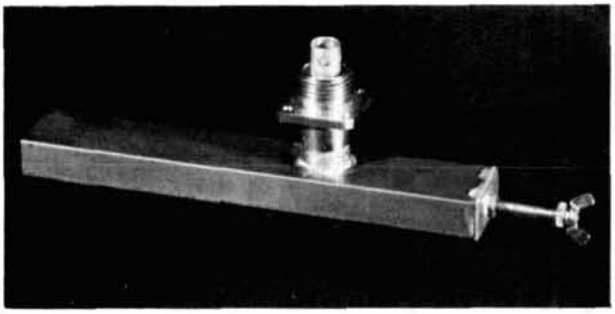
The use of compass and map will get you in the ballpark on aiming, but usually not right on. Frequency calibration would solve the tuning problem. An X-band frequency counter would be nice, and also unaffordable — especially insofar as one would be required at each end of the path. An X-band crystal-controlled multiplier chain with perhaps a Snap diode output circuit would do the trick too. But it would also be a trick to build.

All hope is not lost, however. There is a very simple and inexpensive way to solve the problem using the crystal-controlled multiplier chain approach.

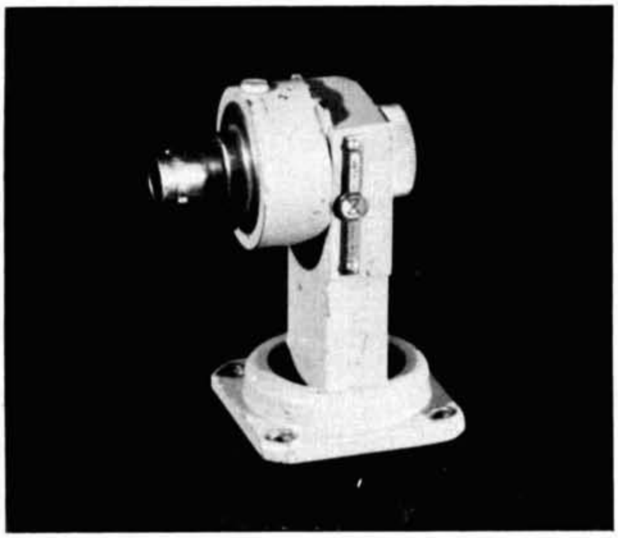


HP-X485B tunable detector mount.

If one feeds some relatively low-frequency rf into a common microwave mixer diode, such as a 1N23, all sorts of things will come out: a comb, of sorts, is generated. The objective in this case is to get a detectable output in X-band within the tuning range of the Gunnplexer. Too many outputs within the tuning range can lead to confusion, however. One or two are sufficient. A single-output crystal calibrator would not be all that helpful. With it you could tune two Gunnplexers exactly on the same frequency, but that's not what you want. A 30-MHz difference is needed between the two units. Two stable calibration signals are desired: one within the tuning range of each Gunnplexer but also 30 MHz apart from each other.



Tunable waveguide diode mount with TWT or BWO N connector.



DeMornay Bonardi waveguide detector mount.

the calibrator

Luck is with us. It just so happens that if you pump 146.52 MHz into a microwave mixer diode (in a suitable mount) you will get a 70th harmonic output of 10.2564 GHz. This is well within the tuning range of the 10.250-GHz Gunnplexer and is probably within the tuning range of the 10.280-GHz unit. The 69th harmonic (10.10988 GHz) and the 71st harmonic (10.40292 GHz) are outside the tuning ranges of both Gunnplexers. This eliminates any possible confusion due to more than one calibration signal within the tuning range.

Most Amateurs should have no trouble coming up with a signal on 146.52 MHz. But we still need another signal in X-band 30 MHz away from the 70th harmonic of 146.52 MHz.

Luck is with us again. Another 2-meter fm frequency which is common in some parts of the U.S. will give us a signal fairly close to that which is needed. 146.94 MHz x 70 equals 10.2858 GHz, a 29.4 MHz difference from the 146.52-MHz harmonic. Two Gunnplexers calibrated to these signals would be tuned 29.4 MHz apart. A slight touch of the tuning knob would correct the 600-kHz error. That's not much of an error at X-band!

This small error can be reduced or eliminated completely by one of several methods. If a crystal-controlled 2-meter handheld is being used, a crysal can be ordered on 146.94857 MHz for use with a standard 146.52-MHz crystal. If your handheld has both .52 and .94 crystals in it already, they could be tweaked so that they are the required 0.4285714 MHz apart at 2 meters to be 30 MHz apart at X-band *(70 x 0.4285714 = 30)*. Synthesized radios set at 146.515 MHz and 146.945 MHz would result in only a 100-kHz error at X-band. And of course, a VFO-controlled radio could be set at the desired frequencies too.

PRD 613M coaxial mount with waveguide-to-N adapter.

the diode multiplier

So far we have a simple source of rf that will give us the signals needed at X-band when suitably multiplied. Now comes the tricky part, right? Wrong! A diode multiplier is amazingly easy to build, but first let's consider some of the readymade choices: waveguide detector mounts and coaxial detector mounts.

Waveguide detector mounts work best. That is, they can put out a rather strong signal at X-band when 2-meter rf is fed into what is normally the output connector. A Hewlett-Packard X485B is a tunable X-band detector mount that accepts 1N21-1N23 type diodes, the latter being preferred. A mount that uses these inexpensive field-replaceable diodes, or crystals as they're often called, is very desirable. It is possible to burn out the diodes as a result of applying too much rf. The 1N21-1N23 series diodes has a maximum incident CW rf power rating of 250 mW.

The Hewlett-Packard 423A is a common coaxial mount that works fine as a multiplier. The 2-meter rf is fed into the BNC connector that is normally the output connector. A waveguide-to-N connector adapter affixed to the mount's N connector serves as the X-band antenna. Note that the diode element is not the easily replaceable 1N23 type, so due care

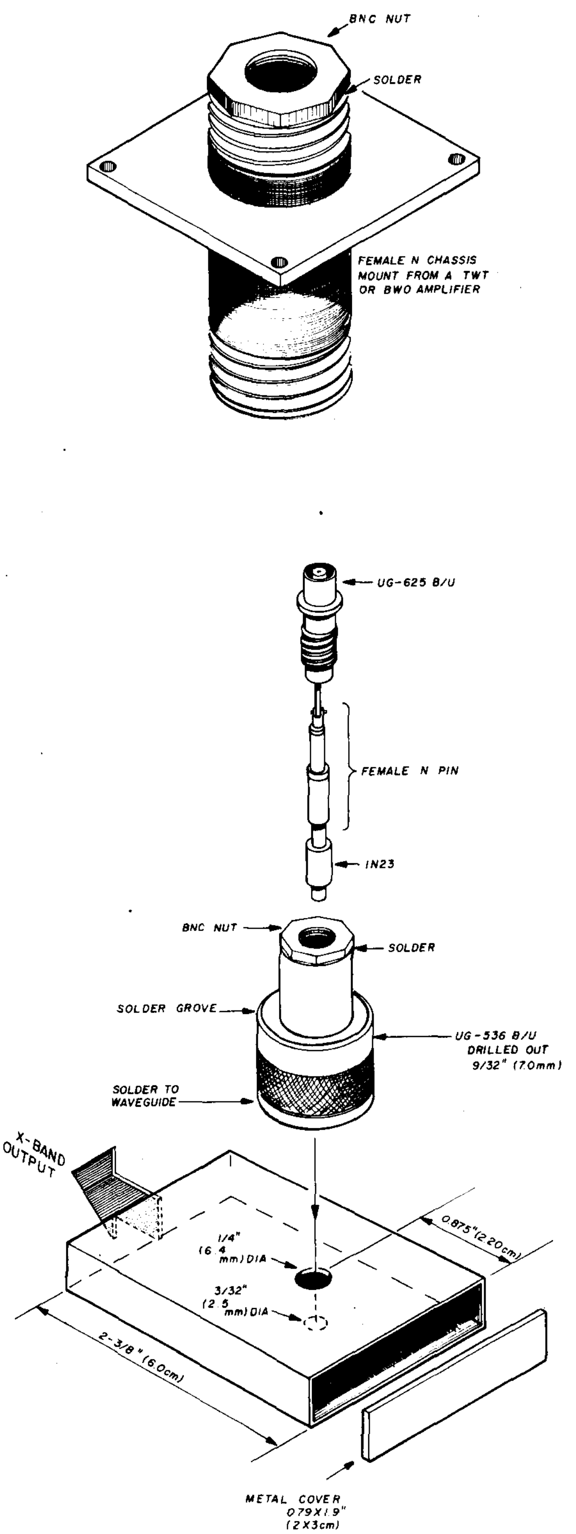


fig. 2. Simple X-band waveguide amplifier mount uses WR-90 waveguide and BNC connectors modified as shown. An alternative female N chassis mount may be made from a TWT or BWO amplifier. No need to drill out the connector in this design.

should be exercised!

A PRD 613M is a coaxial crystal mount with an easy-to-replace diode. It does not have nearly the output of the HP coaxial mount but is usable.

Many other mounts will also work. Each of the above-mentioned mounts was obtained on the surplus market for about $20. 1N23 diodes are very common in surplus microwave equipment and are available from surplus outlets such as Fair Radio Sales Co.* for about $1 each.

A diode in a package with a pin on each end is needed for the homebrew mounts. Some diodes have a cap on one end. Be sure to get the diode with a removable cap (it just pulls off); some diodes have non-removable caps.

building a waveguide diode mount

I've built several mounts, both waveguide and coaxial. Precision machining is not required. A hacksaw, file, propane torch, drill, and two bits are the only tools needed to make a waveguide mount. The materials required are, first, a few inches of brass or copper X-band waveguide. Such waveguide is designated WR-90, RG-52U, or WG-16. It measures 1 x 1/2 inch (2.54 x 1.26 cm) outside dimensions. This may be found surplus or from an outlet such as Lectronic Research Laboratories, Inc.† A small piece of PC board or other solderable flat metal is needed to close one end of the waveguide. A one-hole mounting BNC female connector (UG-625B/U) serves as the 2-meter rf input connector. A female chassis mount N connector supplies the center pin, which holds the 1N23 diode. A male N connector of the type that accepts small (RG-58/59) coax (UG-526B/U) or a female chassis mount N connector removed from a surplus BWO or TWT amplifier serve as a fixture to hold the BNC connector assembly to the waveguide.

A horn antenna may be built on the open end of the waveguide, or a flange may be affixed there for the attachment of a horn. This will give greater range, but it's not necessary. A Gunnplexer will hear the signal from a waveguide mount multiplier without a horn from several feet away.

construction

Cut a piece of waveguide 2-3/8 inch (6-cm) long or longer (refer to **fig. 2**). The length is not critical. File the ends square and remove any burrs. Drill a hole with a 3/32-inch (2.5-mm) bit in the center of the wide side of the waveguide 7/8 inch (2.20 cm) from one end. This is the only critical dimension. Drill this

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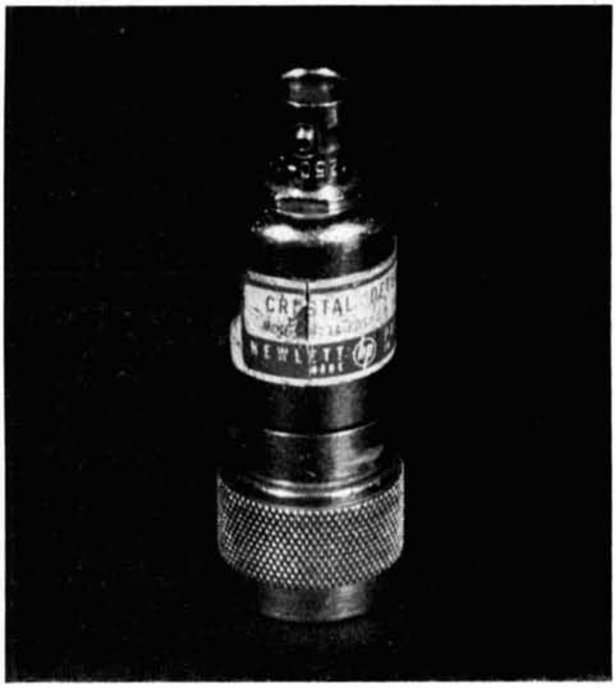
*1016 E. Eureka Street, P.O. Box 1105, Lima, Ohio 45802.

†Atlantic & Ferry Ave., Camden, New Jersey 08104.



HP-423A coaxial mount.

hole straight through both walls of the waveguide. One of these holes serves as the socket for one end of the diode; the other hole is the pilot hole for the next one. Drill a 1/4-inch (6.4-mm) hole through the pilot hole. Remove the burrs inside the waveguide with a small triangle file. Clean the area around the 1/4-inch (6.4-mm) hole with sandpaper.

If you're going to use a male N connector (UG-536B/U), remove the loose gasket, washers, and nut. They will not be needed. Drill a 1/4-inch (6.4-mm) hole straight through the connector to enlarge the existing one. Remove any burrs. If a connector from a BWO or TWT amplifier is used, it will not be necessary to drill a hole, as the existing hole is large enough (**fig. 2**).

Center the connector face down over the 1/4-inch (6.4-mm) hole. Solder the connector to the waveguide, using a propane torch. Also solder the groove on the male N connector so that the connector body will no longer rotate. Let the assembly cool.

Next lay a one-hole-mount BNC nut on the top of the N connector, centered over the hole that the coax normally enters. Solder the nut to the connector, taking care not to get solder in the nut threads.

A piece of PC board or sheet metal 3/4 x 1/8 inch (2 x 3 cm) is then soldered over the open end of the waveguide closest to the N connector.

Heat the center pin of a female chassis-mount N connector, such as a UG-58/U, until it can be pushed out of the plastic dielectric.* Alternatively, the center pin of Teflon dielectric N connector can be easily driven out with a hammer and pointed tool. Solder center pin to the protruding center pin of a one hole-mount BNC female connector (the slotted end of the pin faces outward).

It's now possible to push one pin of the mixer diode into the slotted pin on the BNC connector. Push the diode pin in about 1/16 inch (2 mm). Guide the protruding diode through the hole in the N connector into the waveguide. The diode pin is mated with the 3/32-inch (2.5-mm) hole as the BNC connector is screwed into the BNC nut. Tighten *finger-tight* only.

It may be necessary to adjust the length of the slotted pin if the same type of connectors weren't used and the diode doesn't seat properly. The X-band waveguide diode mount is now complete.

simple coaxial diode mount

I've devised a coaxial diode mount that has to be one of the simplest ever (**fig. 3**). It is actually closer to a waveguide mount in the way it operates. All that's required is a female uhf barrel adapter (PL-258) or an N barrel (UG-29B/U), a shell from a PL-259, a

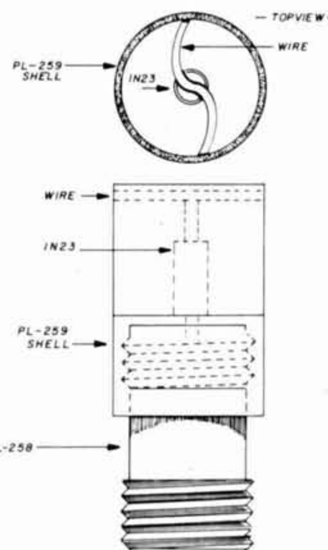


fig. 3. This coaxial diode multiplier mount is made from a female uhf barrel connector or an N barrel (UG-29B/U), a shell from a PL-259 connector, a piece of bare copper wire, and a 1N23 diode — simple and effective.

*Use caution in this operation. You can ruin connectors by applying too much heat. The idea is to apply heat to the N connector by waving the heat source (propane torch) back and forth over the connector while gently applying pressure to the dielectric material. At the right moment, the dielectric and center pin will pop out of the connector. Use too much heat, and you must go back to square one and start over. **Editor.**

15/16-inch (24-mm) piece of No. 12 AWG (2.1-mm) bare copper wire, and a 1N23 diode. Soldering is optional.

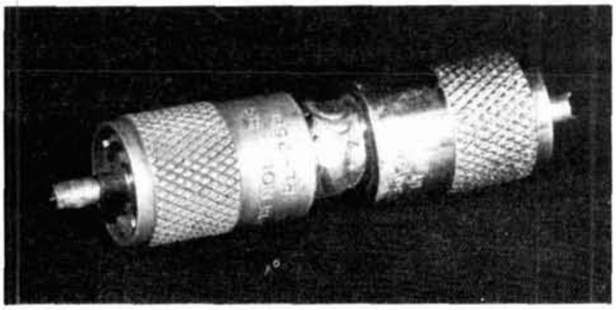
If an N barrel is used, push one pin of the diode 1/16 inch (1.2 mm) into one of the slotted pins of the barrel. If a uhf barrel is used, simply lay one end of the diode into one end of the barrel. Be sure that the metal end of the diode contacts the barrel pin. In some PL-258 models, the center pin is recessed enough so that the dielectric prevents contact.

Bend the wire into a **Z** shape so that it will lie inside the uhf connector shell with the ends resting on the shoulder. The shell is started once the barrel threads with the diode are in place. Hold the wire with needle-nose pliers inside the shell over the diode pin. Tighten shell to push the wire down onto the pin of the diode (the wire ends may be soldered to the shell shoulder if desired). The 2-meter rf input is connected to the other end of the barrel. If a barrel adapter isn't available, a female chassis mount connector may be used. The 2-meter rf input is then brought into the back of the connector through a coax cable.

numb i-f response

At this time, if your Gunnplexer and/or i-f is "numb," you may not be able to hear signals from any of the diode mounts described. A numb Gunnplexer is not uncommon. The Schottky diode mixer is easy to zap with stray voltages. Soldering to the *ungrounded* mixer connection pin, even with so-called "grounded" soldering stations, is a sure way to put your mixer diode in peril. The Schottky will not necessarily be completely open or shorted — it can remain halfway between and just be numb. Don't fret. If you blow it, just replace the Schottky diode with a 1N23. (I've measured less than 1-dB noise figure degradation by substituting a 1N23WE for the standard Schottky.)

A numb i-f will also cause problems. Try to make the stage as hot as possible in the noise-figure department. This is one of the few ways to improve the over-all sensitivity of the Gunnplexer. It may be necessary to run the 2-meter level into your diode mount near the maximum 250-mW level until improvements can be made in your system.



Attenuator.

I've been able to detect the X-band output of the homebrew 1N23 coaxial multiplier using a Gunnplexer with a 17-dB horn at a distance of 1 foot (30 cm) with a 2-meter drive level as low as 10 mW. The range of the same setup using 250-mW drive was over 50 feet (15 meters). This was a "hot" Gunnplexer and i-f. I was able to measure at least 2 dB of sun noise with a 2 1/2-foot (76-cm) dish.

attenuator

Whatever mount you choose, surplus or homebrew, an attenuator will be required to reduce the output of the 2-meter transmitter to a safe drive level. A 6-dB pad will decrease a 1-watt signal to 250 mW. A 10-dB pad will yield 100 mW — a good choice.

A power attenuator isn't necessary, as the power-handling ability of an attenuator is greatly increased if power is applied for a short duration. A 1/2-watt pad is fine for intermittent use at power levels encountered in 2-meter handheld transceivers.

As with detector mounts, attenuators are available on the surplus market or can be homebrewed. If you have a surplus pad in mind, be sure it's 50 ohms and that it will work at frequencies as low as 2 meters.

building an attenuator

A pi-network resistive attenuator requires only three resistors and is easy to construct. A table of attenuation levels and the required resistor values may be found in the ARRL *Electronics Data Book*.

I've built a 10-dB pad using two 1/2-watt, 100-ohm resistors and a 1/2-watt, 68-ohm resistor, plus two PL-259 connectors. Actually, a 10-dB pad requires 96.2-ohm and 70.7-ohm resistors, but the standard values I use yielded 9.5 dB with excellent VSWR. Construction details are shown in **fig. 4**.

calibrator system operation

The diode multiplier mount is connected through the attenuator to a 2-meter transmitter set at 146.52 or 146.94 MHz. The mount is pointed at the Gunnplexer antenna, and the varactor voltage is tuned until the calibration signal is found. You'll probably hear a loud audio feedback squeal when the signal is found.

Talking into the 2-meter rig should result in a copyable signal from the Gunnplexer receiver. It may be hard to believe, but you're actually talking on X-band with your 2-meter rig! Be sure to ID properly.

Mountaintop operation might go like this: **Station A** lets his 10.250-GHz Gunnplexer warm up a few minutes, then he tunes it to find the signal from his

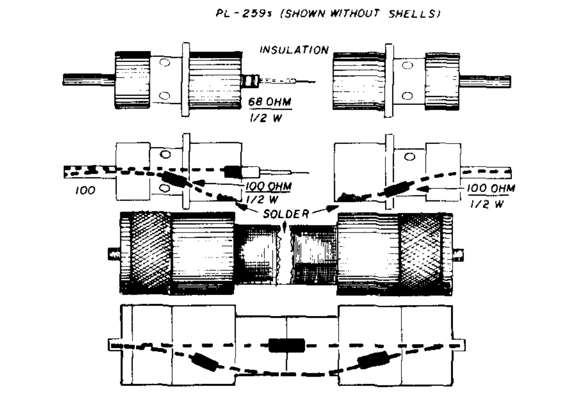


fig. 4. A 10-dB attenuator, again made from coax connectors. Three resistors form a pi network.

diode-mount, which is fed with a 146.52-MHz signal. (The mount is held several feet in from of the Gunnplexer antenna to avoid frequency pulling of the Gunn oscillator.)

Station B, on another mountaintop, does the same with his 10.280-GHz Gunnplexer using 146.94 (or 146.94857 MHz.) The two stations then may concentrate their efforts on aiming, varying their varactor voltage only 100 mV or so. Extra 2-meter handheld transceivers help establish communications.

The stations must be sure ahead of time that their respective Gunnplexers (a) will tune to, and hear, the calibrator signals, and (b) are *not* tuned to the signal image.

other uses

The calibrator does not, of course, have to be used only on .52 and .94 in the 2-meter band. The Gunnplexer may be calibrated throughout the 0-20-Vdc tuning range by selecting other 2-meter frequencies that will multiply into X-band.

The diode multiplier mount may also be used as a detector mount. I can measure well over 1 volt across the diode when either homebrew waveguide or coaxial mount is irradiated by the Gunnplexer output at close range. This is a very easy way to check the mount and the Gunnplexer oscillator.

acknowledgments

I'd like to thank WA6HCD and WA6IKO for their help in my X-band endeavors, as well as W6OAL for reviewing the manuscript.

reference

1. James R. Fisk, W1HR, "10-GHz Gunnplexer Transceivers — Construction and Practice." *ham radio*, January, 1979, page 26.

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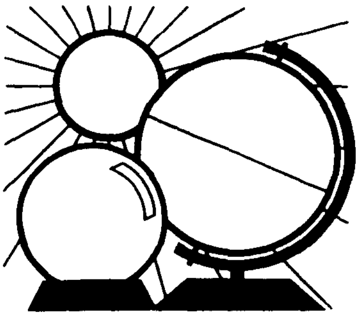


DX FORECASTER

Garth Stonehocker, KØRYW

last-minute predictions

April is a transition month. Propagation will be affected by solar activity that is influenced by the equinox period of sun/earth alignment (as mentioned last month). The periods from April 7 through April 14 and April 20 through April 23 may be geomagnetically disturbed. The beginning of the first period is expected to be disturbed by coronal-hole solar-wind emergence, then by solar-flare-released particles for the remainder of the first time period and for the entire second time period. The effects may be strong, since April is a continuation of the equinox period. However, the coronal-hole effect will not be as strongly developed as it will be a year from now, so the probability is not high that this disturbance will occur.

DX conditions will probably be very good in April because of the solar-cycle level, and activity will be high because of the close proximity of the equinox season. The ionosphere is proportioned for most of the ionization to favor the F region and high maximum usable frequencies (MUF) — therefore the higher hf bands. The winter generally has the sharpest daily MUF peaks, rising highest in February, March, or April in most years. Summers have the lower daily MUFs but are spread out throughout the greater number of hours of daylight. So, through this summer and next winter, the solar flux will probably be slightly lower than it is now. And it is then expected to continue to decrease as the end of the crest of cycle 21 begins a definite downward trend toward the minimum, about 1987.

band-by-band forecast

Six meters should provide frequent band openings with a peak during the early afternoon hours on many days. Trans-equatorial north-south paths will be the best. Your guide to possible openings will be strong openings on 10 meters and high values of solar flux.

Ten and fifteen meters will be loaded with good DX signals from morning until early evening hours almost every day. Times of geomagnetic disturbance will limit the number of signals heard, but listen carefully — they can be from very unusual places. Fifteen meters should be open later in the day than 10 meters. So, hit 10 first and finish off with 15. The lengthening of the daylight will be noticed as these bands open up a little sooner and stay open longer in the day.

Twenty meters will be the main daytime DX band, as it is almost always open to some part of the world. It opens to the east as the sun rises and extends into the late evening hours to the west. Geomagnetic disturbances do not affect the band as much as the higher ones, but still look for unusual trans-equatorial DX locations to be coming through once in a while. One-hop trans-equatorial DX of 5,000 to 7,000 miles (8,000 to 11,200 km) may be possible in the late evening hours during some of these unusual conditions.

Forty and eighty meters will have much short skip (750 miles or 1,200 km) during daylight hours and turn to DX after dark. Eighty-meter DX will more often be taken over by noise. Therefore, 40 meters will become the best nighttime DX band. Long skip (2,000 miles or 3,200 km) will open to the east soon after sundown, swing more to the south to Latin America about midnight, and end up to the Pacific areas during the hour or so before dawn. Some nights these bands will be as good as during the winter DX season. Watch the spring storm fronts mentioned last month. The coastal regions usually have the edge for working the rare DX on these bands. Don't let that stop you mid-U.S.A. DXers.

One-sixty meters will probably have many nights that remind one of last summer's noise. However, many good nights are left to work DX before this summer's noise comes to stay. Many stateside stations are fair game as DX on this band during this season.

ham radio

APRIL

WESTERN USA

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

MID USA

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

EASTERN USA

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

Questions and Answers

where in the world?

I have heard stations on the air signing "----/MM region 1," How do you know where to aim your beam for the various regions? Is there a map available? — John Engelien, N2BSD.

Almost any publication that includes the FCC Rules and Regulations, part 97 (Amateur Radio Service) has a map showing all three ITU regions. A reproduction is shown in **fig. 1**.

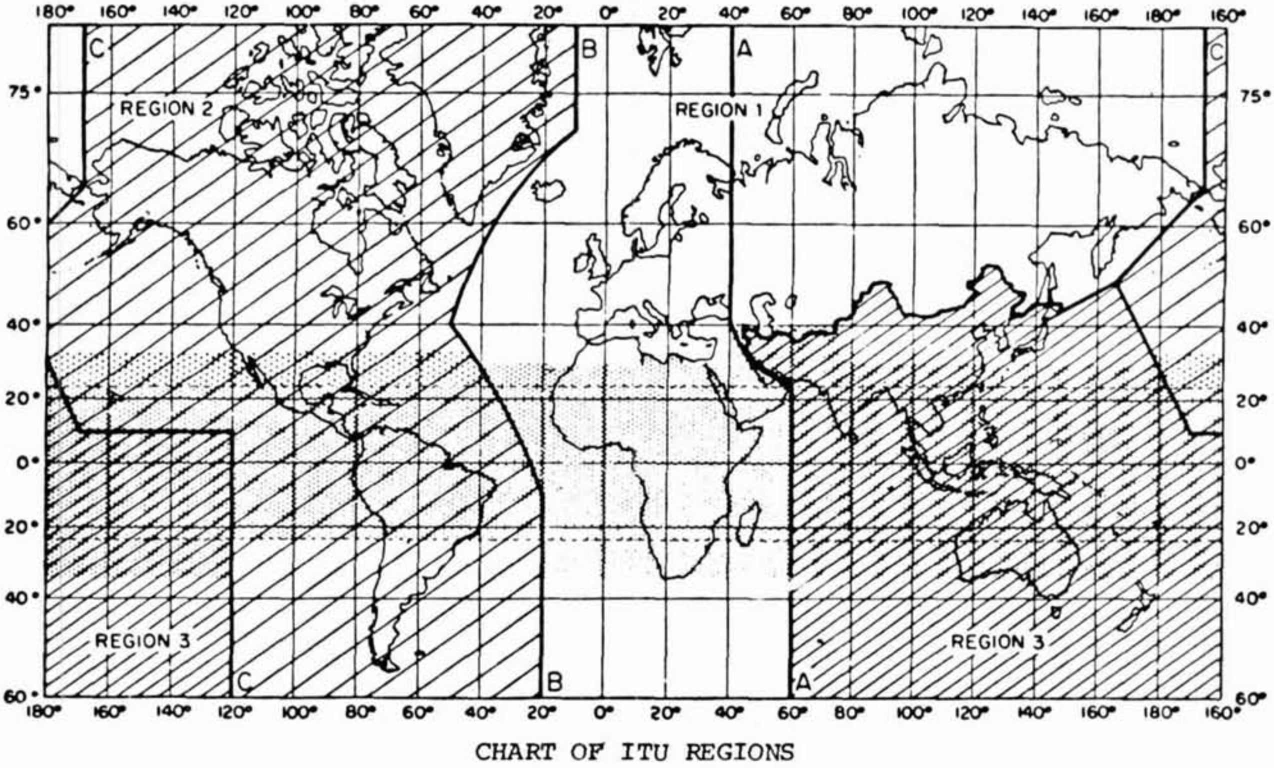
six meters

I hear very little about the 6-meter band, except stories about TVI and other problems. Is 6 meters the "black sheep" of the radio frequencies? Is it dependable for medium to long distances, and what is the dominant mode? — Peter Eldredge, KA1FJN.

Six meters is avoided in many areas of the country, especially near the large cities that have Channel 2 TV. Most TV sets cannot tell the difference between a 50-MHz signal and a 56-MHz one, so TVI is a real problem. (The problem can be resolved, but requires much effort in building filters, cleaning up rigs, and often much education of your neighbors — some hams figure it isn't worth the trouble.) Then, too, Channel 2 TV transmitters put out a lot of garbage below their allocated band, and that gets into Amateur receivers and further discourages any would-be DXers.

However, if Channel 2 is not available locally, then 6 meters can be a fascinating and useful band. It behaves much in the same manner 10 meters does, with good local coverage by ground wave in the evening. And often tropospheric and ionospheric skip creates openings that can reach to hundreds or thousands of miles. Like 10, however, the band varies with the sunspot activity, so will be less prone to DX openings in four or five years than it is right now.

Modes in use are principally CW and SSB on the low end, with a few of the "a-m forever" crowd around 50.5 MHz or so, and fm and repeaters in the upper two-thirds. There is a considerable amount of model-control activity to be found on the high end, using channels that fit nicely between repeater slots.



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no DX?

We have recently hit the peak of the sunspot cycle, and DX is great. What does the future look like for DX? Will there be any good DX to be found, and if so, on what bands? How about the new bands we got at WARC 79? — Kevin Foley.

DX will continue to be good for some time to come. True, we passed the peak in 1979, but it doesn't all stop abruptly. The downward slope of a sunspot cycle is gradual and filled with small bumps and ripples. DX conditions will decrease in the same manner. There will be excellent days, and dismal days, and it will keep our DX Forecaster on his toes predicting which will be which.

The openings will become a bit shorter, so you will have to be alert and ready to catch the good ones. Also, the openings will tend to become less frequent on the higher bands, but there'll always be something on 80, 40, and 20. Even 15 meters will have good activity for some time. Ten is good for two or three years before you'll notice much of a drop in openings.

The new bands will show a similar pattern, with the lowest one (10 MHz) being more reliable than our present 14 MHz, and the higher ones opening later and closing earlier. However, one of the most useful things we Amateurs can do with the new bands is to "fill in the gaps" in knowledge of propagation by careful observation and use of 10, 18, and 24 MHz.

So, don't despair. Good equipment and sharp operating skills will pay off during times of low sunspot activity.

remote SWR?

VSWR-meter instruction books say that SWR should be measured at the antenna because the coaxial cable can alter the readings, giving a better indication at the transmitter than actually exists at the antenna.

Since I use a matchbox, should I remote the SWR-sensing unit to the antenna for better accuracy? — Terry J. Taylor, WB5JFM.

To put it bluntly, NO!

Presumably, the matchbox is in your radio room, where you can reach the controls. If you were to put the SWR meter at the antenna it would see no change at all, no matter what you did to your matchbox (except to show wild fluctuations because there was more or less power getting through the matchbox).

For example, suppose you are using 50-ohm coax cable and the SWR meter is at the antenna. Also suppose the antenna is not properly adjusted (too long or too short). No amount of knob twisting on the matchbox will make any difference at the antenna. The 50-ohm cable still presents 50 ohms to the matchbox down in the radio room.

The SWR meter should be connected between your transmitter and the matchbox, after your antenna has been properly adjusted (see below). The purpose of the SWR meter, when connected as just described, is to provide an indication of a proper impedance match *at the transmitter*.

The time to put the SWR meter at the antenna end of the cable is when you are *building* your antenna, or tuning it up the first time you put it in the air. With the SWR meter in place and the transmitter sending low power up the line (just enough that you can get the calibrate function on the SWR meter to work right), work on that antenna. Shorten it, lengthen it, put in tuning stubs, a matching network, or whatever else the antenna handbooks say to do to it, but somehow make that SWR go down. Once you have a *reasonable* SWR, take the meter out of the line and put it down at the station between the matchbox and the rig as an aid to monitoring power output. If the SWR creeps up a bit from one end of the band to the other, don't worry about it — use the matchbox only to keep your rig happy — and enjoy your QSOs.

ham radio

More Details? CHECK—OFF Page 114

Rx for a Bad Day

Is it one of those dull gloomy days when even the birds are walking, and it's not a fit day to go out and put up that new sloper or inverted vee antenna you wanted to try? DX isn't coming through yet because the MUF isn't right, some jerk squirrel keeps kerchunking the repeater or plays tunes on the Touchtone® so that two meters isn't fun. Maybe the wind played havoc with your beam last night and now it looks like a limp pretzel or some modern art object, or maybe your rig blew up in the middle of a QSO or just before that sked with a rare station in some far off land.

Any fool knows all these things aren't going to happen to you at once. But if it is 'one of those days' maybe you can just forget the whole mess and brighten your and someone else's day a little by taking some time to think of a fellow ham you admire and respect to nominate for Dayton's "Amateur of the Year Award" for 1981. No, it's not too early to think about it. It does take a little time and effort to nominate some one for "Amateur of the Year."

What is the stature of this individual that we seek for recognition each year at Dayton?

First, he or she will be a well-respected person in the community; a leader, not only in amateur radio activity, but in civic activity as well. He will probably be licensed for at least 10 years or more for it is long term overall excellence in amateur radio that we are looking for.

His contribution to amateur radio may be in any of the hobby related areas. Possibly his greatest contribution is in the engineering field of our hobby, or his expertise may be in antenna design, some new type of modulation or an improvement to existing design, etc. Maybe he has contributed greatly to improvement of amateur regulations or possibly his contribution is the legal field of our hobby, a very important one these days. Get the idea? In short, an outstanding individual and amateur.

In 1974, another award was established, the "Special Achievement Award." This award is just what it would seem to be — an award for one-time special event or specialized activity by an amateur or group of amateurs. This activity may be in the engineering field — QRP — DXpeditions —net activity — emergency work or any one-time outstanding activity related to 'the amateur radio hobby.

Nominees for both of these awards may be from anywhere in the world, not just the U.S.A.

So! Don't just sit back and say, "Gee!, somebody ought to nominate that guy for "Amateur of the Year." Don't wait for George to do it. Give us all the details you can gather, especially activities that are directly attributable to him or her.

All nominations are carefully reviewed and are saved from one year to the next for future consideration and to allow some nominees to develop to their full potential. All nominations are considered for both awards, and the awards will be presented at the 1981 HAMVENTION Banquet.

So, have you nominated some one in the past? You may want to renominate him with update on recent activities or just send in update information on his latest accomplishments.

Do it now! Besides you may win a set of free tickets to the "HAMVENTION" for your nominee and yourself.

For more information or nomination blanks (not mandatory) write to the address below:

HAMVENTION P.O. Box 44 Dayton, Ohio 45401 Attention: Awards Committee	or	Bob Roettele, W8UNV Awards Chairman 1299 Hanes Road Xenia, Ohio 45385

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More Details? CHECK—OFF Page 114

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- Construction of antenna loading coils or multiband traps

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D-20	20	33′	24.95	20.95
D-15	15	22′	23.95	19.95
D-10	10	16′	22.95	18.95
Shortened dipoles				
SD-80	80/75	90′	31.95	27.95
SD-40	40	45′	28.95	24.95
Parallel dipoles				
PD-8010	80,40,20,10/15	130′	39.95	35.95
PD-4010	40,20,10/15	66′	33.95	29.95
PD-8040	80,40/15	130′	35.95	31.95
PD-4020	40,20/15	66′	29.95	25.95
Dipole shorteners - only, same as indicated in SD models				
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More Details? CHECK—OFF Page 114

portable shortwave converter

A companion for a receiver described earlier in *ham radio*

Converter front view. The power switch is a two-pole, three-position affair that switches the converter off and leaves the receiver operating as an independent unit. The converter weighs about 12 ounces (340 grams); current drain is 10 mA at 12 Vdc.

To judge by the amount *of mail pouring in,* it appears that the electronic simplicity of my portable monoband receiver project[1] has put it well within the reach of many homebrewers. A frequent inquiry, however, has been how to expand receiver coverage and tune in more bands.

While I've long maintained that a monoband set can be built with considerably fewer spurious responses than multiband affairs, I have to admit that some operators may live with in-band birdies better than I do. With this objective in mind, I conceived a converter designed to go together with the family of receivers of reference 1.

general considerations

The basic principles that determined the receiver design still hold true: the converter must be portable, have a small power drain, and be fully compatible with the GP-58 and 59 receivers described earlier.[1] (The GP-60 is a later version currently operational that was not included in the article at the time the original work was written.)

To make the project easy and compatible with the set, the MHz reading normally occurs on the receiver bandswitch, but when the converter is plugged in, the MHz reading is transferred from the receiver to the converter bandswitch. This keeps the design straightforward and minimizes the number of cables interconnecting the receiver to the converter.

design

Frankly, these sets were not designed with converter operation in mind, so I approached the downconverting scheme with some qualms, even though it proved out better than I'd initially expected. Since

By Jack Perolo, PY2PE1C, P.O. Box 2390, São Paulo, Brasil

the converter can cover (without bandswitching the front end) the range 7-22 MHz, the conversion is made to the receiver's 2.0-3.0 MHz tuning range. Taking as an example the reception of the 11-MHz band (25-meter shortwave broadcast), the overall conversion scheme appears in **fig. 1**.

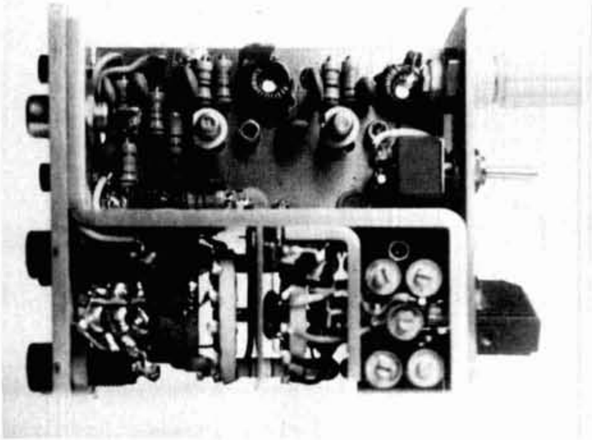
For the sake of experimentation, three different converters were built: the GP-63 is the one described here. It uses HC-25/U crystals and a miniature bandswitch to allow for more compact design. The circuit is not critical if the layout shown in the photos is followed.

construction

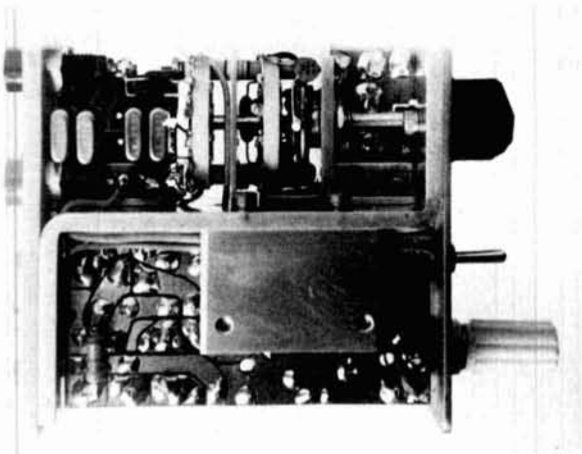
The photos show the GP-63 converter and give details for its duplication. Its schematic is given in **fig. 2**. Cabinet dimensions are 3.5 × 1 × 3.5 inches (90 × 25 × 90 mm). Cabinet material is 16-gauge stainless steel, formed on a 16-ton arbor press. The main chassis and back panel are 1/8-inch (3.2-mm) aluminum. The bandswitch shield is 1/32-inch (1-mm) aluminum. The printed circuit board is mounted on 1/4-inch (6.4-mm) pillars fastened with 4-40 (M3) Allen screws. To avoid rf interaction, the PC board is double sided. The bandswitch is a miniature unit by Centralab with ceramic wafers. All the parts are specified on the schematic and are easily available in the U.S.

power supply

A two-pole, three-position switch on the converter panel controls the 12-Vdc external power supply, allowing for an OFF position for both the receiver *and* the converter, a converter (CV) position when both receiver and converter operate, and a receiver (RX) position, when the converter is switched off and the receiver is used independently. Power consumption is about 10 mA at 12 Vdc, and it is drawn from the same supply of the receiver. To make the converter independent, a 9-volt battery might be used instead, but at the cost of a size increase for the converter cabinet.



Converter top view. The input toroid is on the printed circuit at upper right, followed by the rf transistor, mixer toroid, and mixer transistor to the left. Oscillator transistor is at the lower left-hand corner of the printed circuit. The central aluminum strip acts as converter chassis and shield. Below it at the right are the trimmers, followed by the two-wafer bandswitch, with shielding between them. The adjustment capacitors are at lower left, as are the power input/output jacks.



Converter bottom view. At upper right is the printed circuit supporting the rf trimmers, followed by the bandswitch and, at the left, the crystals (the 13-MHz crystal is missing). Below the central aluminum element is the lower part of the main printed circuit together with its supporting bracket.

conversion to other frequencies

By simple crystal replacement and proper front-end tuning, the converter can be adapted to receive the 14- and 21-MHz Amateur bands (3.5 MHz being received directly by the receiver without requiring external conversion).

An alternative option, perhaps of more interest to Radio Amateurs, could be to increase slightly the receiver coverage (as already mentioned in reference 1) and tune 3-8 MHz. By so doing, both the 80- and 40-meter bands would be covered by the receiver and, by winding fewer turns on the converter coils, would tune 14, 21, and 28 MHz.

Worthy of note is the converter output that is not tuned, its frequency being solely controlled by the input and crystal oscillator; this converter can therefore be easily used at frequencies different from those described here.

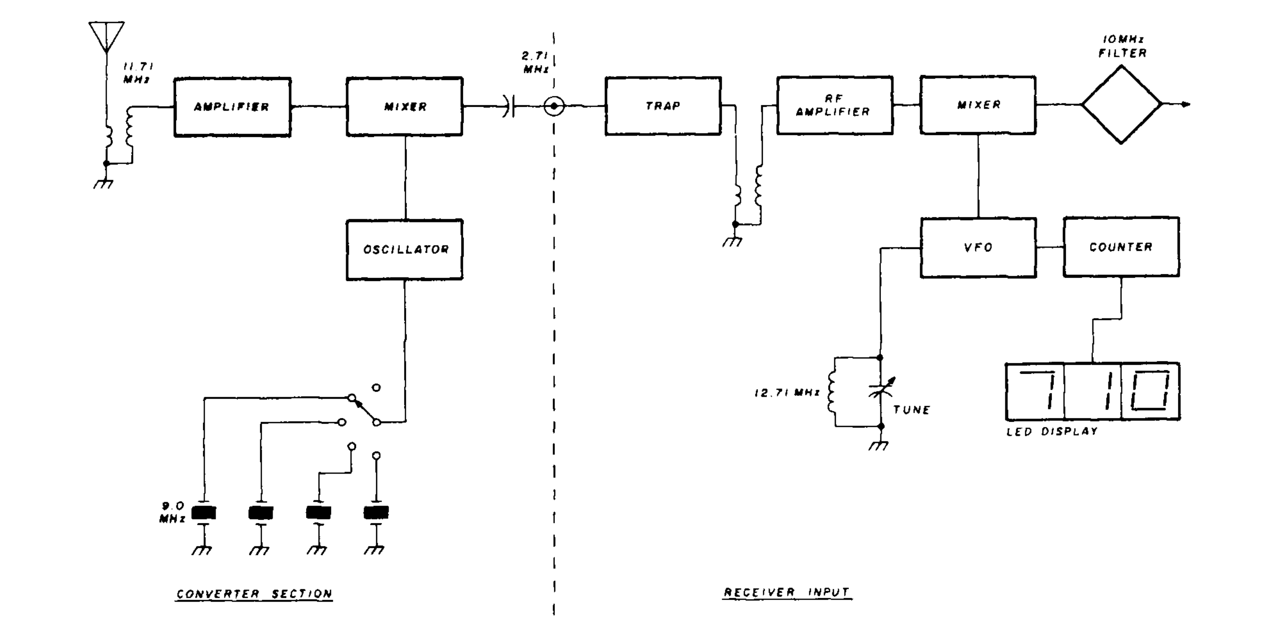
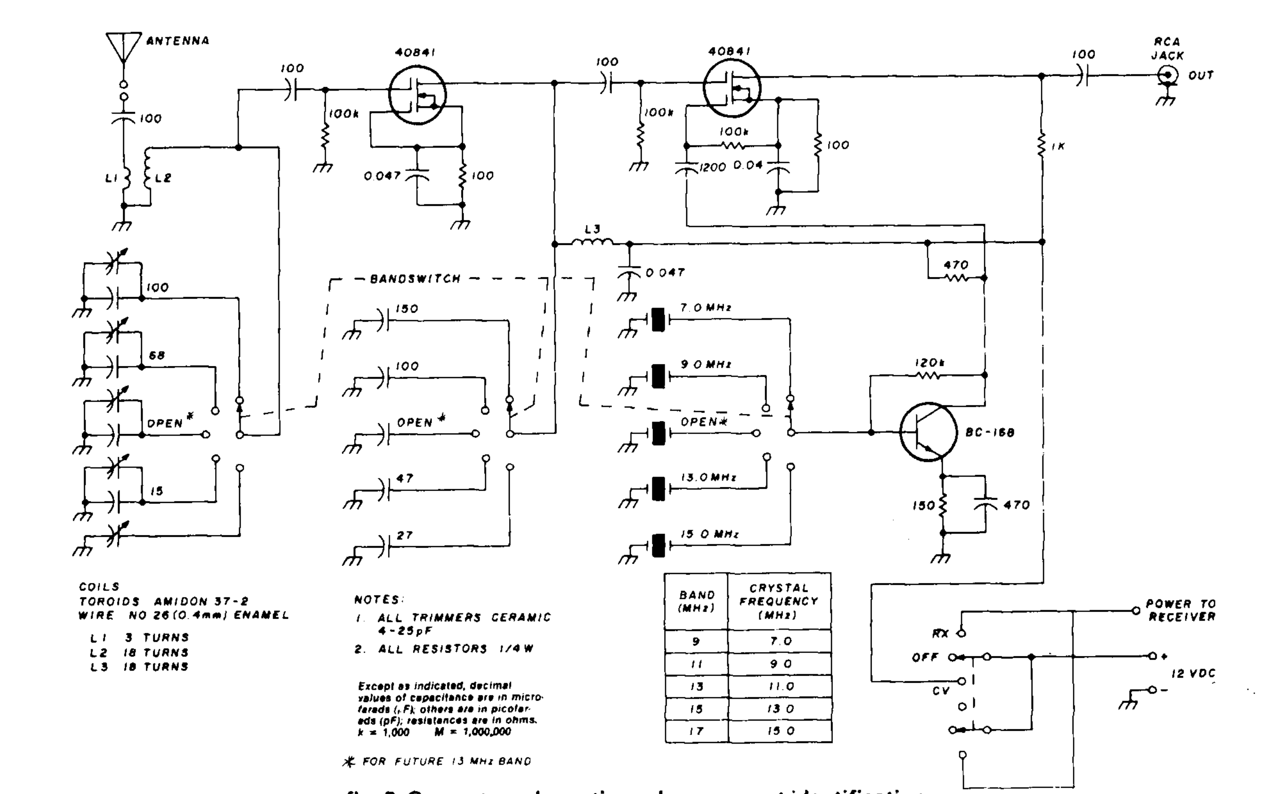


fig. 1. Conversion scheme of the GP-63/GP-60 converter/receiver combination. Set tunes the 2.0-3.0 MHz band and receives on 11.71 MHz.



BAND (MHz)	CRYSTAL FREQUENCY (MHz)
9	7.0
11	9.0
13	11.0
15	13.0
17	15.0

fig. 2. Converter schematic and component identification.

acknowledgment

As always, I'm deeply indebted to Maiso, PY2GP, for his continued counsel and support.

reference

1. J. Perolo, PY2PE1C, "Portable Monoband Shortwave Receiver with Electronic Digital Frequency Readout," *ham radio*, January, 1980, page 42.

ham radio

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Range:	1 MHz to 500 MHz
Sensitivity:	Less than 25 MV
Resolution:	100 Hz (slow gate) 1.0 KHz (fast gate)
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Power:	5 VDC @ 200 ma

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DC/AC volts:	100uV to 1 KV, 5 ranges
DC/AC current:	0.1uA to 2.0 Amps, 5 ranges
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More Details? CHECK—OFF Page 114

frequency modulator for a 2-meter synthesizer

Compatible modulation scheme for the CMOS circuit published earlier in *ham radio*

After my 2-meter synthesizer article appeared in *ham radio*[1] I received two letters indicating that my synthesizer, and probably others, cannot be used with certain radios. This is because these sets use a varactor diode in series with the crystal to produce direct fm, and this method will not work with an external oscillator. Many potential builders might be faced with this problem, so I decided to devise a compatible modulation scheme.

predesign

Methods of directly modulating the synthesizer were first considered then rejected, since the circuit boards would have to be modified. Also, I didn't think this approach would work too well anyway. Methods of modulating the synthesizer output were then studied. I breadboarded two quite different cir cuits. One of the two gave the desired performance.

The modulator chosen uses a varactor-tuned tank circuit. Passing a CW signal through such a tank circuit and varying the bias on the varactor results in variable phase shift, or phase modulation. This phase-modulated signal is then converted to fm.

Theory books show that phase and frequency modulation are the same, except that the deviation is independent of modulating frequency with fm and increases linearly with frequency in the case of pm if the modulating amplitude is *kept* constant. Changing pm to fm requires only that the modulating audio be passed through a rolloff filter and is easily achieved with a simple RC filter. The only other design problem is to rid the resulting fm signal of a-m components produced by the modulation process (see below).

modulator design

Fig. 1 is the schematic of the modulator, including an optional speech amplifier.*

---

*PC boards and many components are available from RADIOKIT, Box 416H, Greenville, N.H. 03048. Circuit boards for the synthesizer are also available.

By Tom Cornell, K9LHA, 3631 North 900E, Greentown, Indiana 46936

The input signal from the synthesizer is attenuated in the resistor divider network (R1, R2, R3) to prevent overdriving the varactor diode, CR1. Audio voltage and approximately 4 volts of bias are fed to the varactor through R7. The modulated output of the tank, L1 and CR1, is fed to three stages of a 7400 quad NAND gate, U1, to eliminate a-m produced by variable attenuation in the tank circuit. The first two stages of the 7400 (U1D, U1C) are biased to increase sensitivity, and the third stage (U1B) provides limiting as well as sufficient drive for the 2-meter transmitter. (You'll note that the same output circuit is used in the synthesizer.[1])

capacitor

C8 across bias resistor R5 rolls off the gain of the 7400 second stage to prevent oscillation during receive mode when drive is removed. This problem did not occur in the breadboard version (which, incidentally, used all four gates of the 7400), and only showed its ugly head after I had made the PC-board artwork and built a board — another proof of Murphy's Law!

To make sure the problem was resolved, I installed a socket in the modified circuit board and plugged in all the 7400s I had on hand. After adding capacitor C8, things calmed down with no drive except when a 74LSOO was used. Steer clear of them in this application!

Dual op-amp U2 comprises a speech amplifier, deviation limiter (clipper), and an output amplifier. Ac gain in both stages is set by heavy negative feedback. The value of R106 can be adjusted to suit a wide variety of microphones, and pot R110 sets the deviation level.

When the speech amplifier is used, R8 and R9 are omitted; these resistors provide bias for the varactor if the speech amplifier is not used. In this case, you may also eliminate the speech amplifier portion of the circuit board if this will help in packaging the modulator. Both 5- and 8-volt supplies may be swiped from the respective regulators in the synthesizer.

alignment

Alignment of the modulator requires only two adjustments. With the modulator connected to the output of the synthesizer, which is set to the center of its frequency range, adjust to produce peak output from the tank circuit. The diode detector probe used in tuning the synthesizer may be of use here. Connect it to one of the outputs of the 7400, and adjust L1 for peak dc voltage out of the probe. If the speech amplifier is used, set R110 for the desired deviation. At this point, you should be ready to use both the synthesizer and modulator with your rig; however, do observe the rig interface information contained in the synthesizer article.[1] Shielding the modulator would be good practice and may, in fact, be necessary.

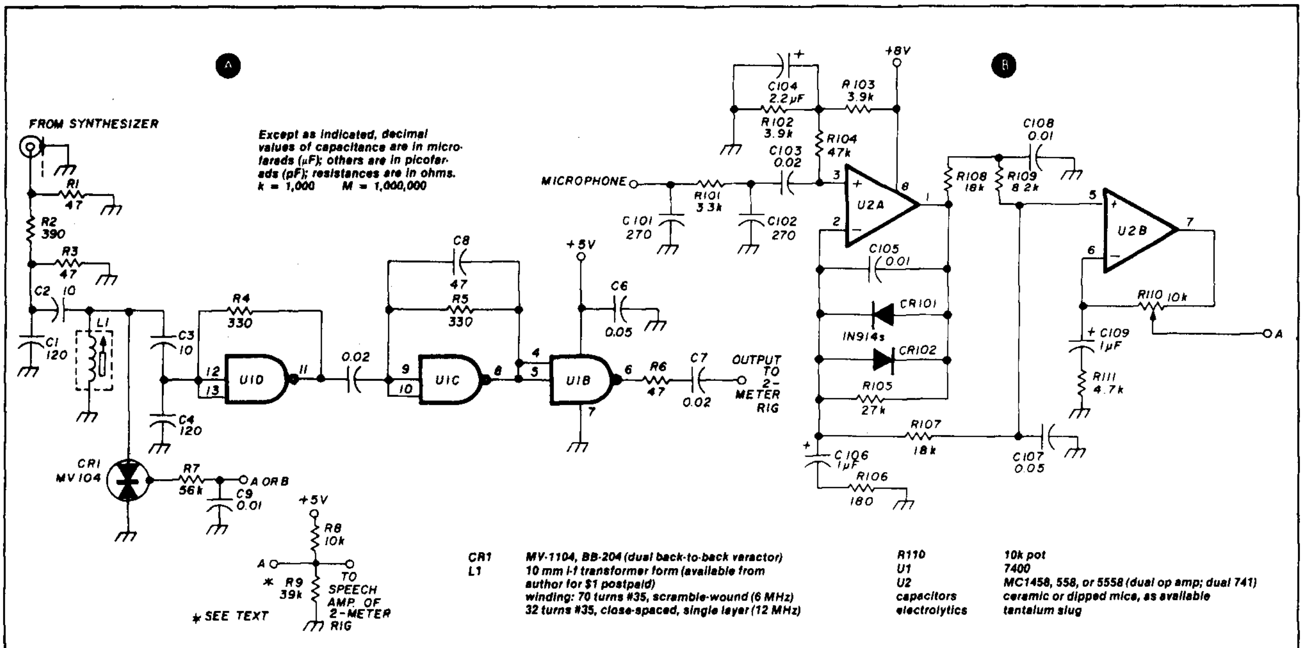
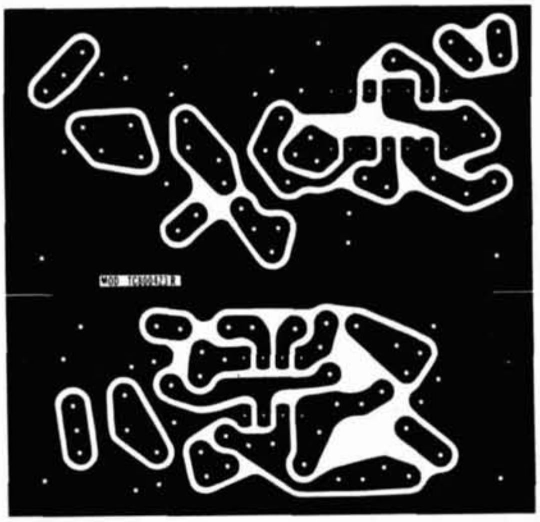
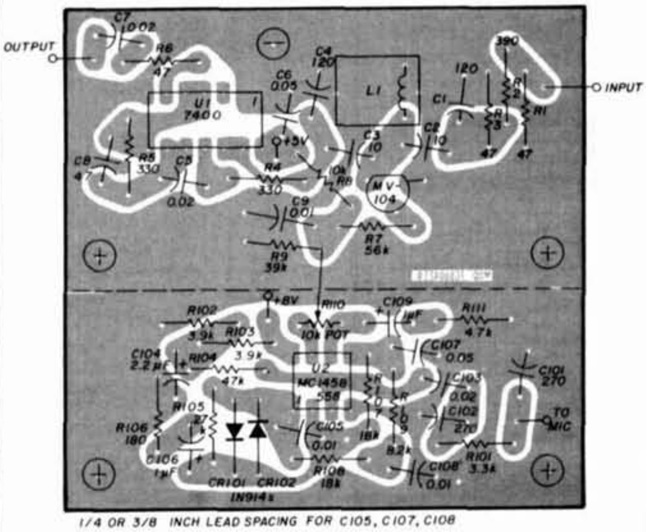


fig. 1. Schematic diagram of the modulator for the synthesizer (A) and an optional speech pre-amplifier, deviation limiter, and output amplifier (B).



Foil side of PC board.



Component side of PC board.

acknowledgment

I thank Budd, K2PMA, and Don, WA3AXS, for their helpful construction suggestions and information on interface problems with certain rigs, and Jim Fisk, W1HR (regrettably now posthumously) for his encouragement on this project. I'll be glad to answer any question if you will enclose a self-addressed, stamped envelope.

reference

1. Tom Cornell, K9LHA, "CMOS 2-Meter Synthesizer," *ham radio*, December, 1979, page 14.

ham radio

More Details? CHECK—OFF Page 114

transmission-line circuit design

for 50 MHz and above

Using distributed resonant circuits for vhf/uhf transmission lines — Part 5: design example for a 2-meter amplifier

This is the fifth and final part of an article on the design of vhf/uhf transmission lines using distributed resonant circuits. A practical design example is presented for a 2-meter amplifier based on general equations and design relationships[1] and basic design data for twelve common line configurations.[2,3,4]

design example

A 2-meter amplifier using 4CX250R tubes is to be constructed, and resonant-circuit transmission-line designs for the plate and grid circuits are required. The amplifier grid and plate circuits are to be contained in a space 17 inches (43.18 cm) wide, 6 inches (15.24 cm) deep, and 8-3/4 inches (22.23 cm) high (standard rack panel height). A 3-inch (7.62 cm) high chassis is available that is 13 inches (33.02 cm) deep and the correct width. The plate circuit enclosure extends 5 inches (12.7 cm) above the chassis. The tubes are mounted at the left end of the chassis, the grid circuit below the chassis, and the plate circuit

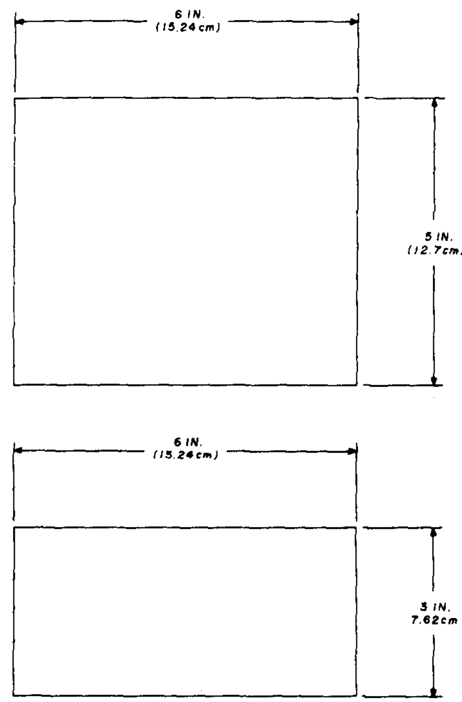


fig. 22. Plate (A) and grid circuit (B) cross-section for 4CX250R resonant circuits discussed in the design example.

By H.M. Meyer, Jr., W6GGV, 29330 Whitley Collins Drive, Rancho Palos Verdes, California 90274

above the chassis. Cross sections for grid and plate circuits are shown in **fig. 22.**

plate-line design

The tubes can be mounted horizontally or vertically. Horizontal mounting (**fig. 23**) permits capacitive coupling of tubes to line, which removes the dc plate voltage from the line. It's necessary to determine if the capacitance that can be obtained by the tube and plate line is adequate.

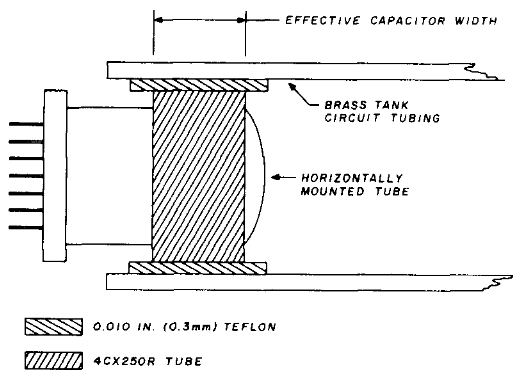


fig. 23. Capacitor formed by tube fin and plate line tube.

table 54. dielectric constant of commonly used insulation materials.

material	dielectric constant (ε)*
Gallium Arsenide	12.5
Epsilam-10 (0.025)	10.2±0.5
Epsilam-10 (0.050)	10.6±0.5
96%Aluminia	9.0
Glass (soda-lime)	7.0
Porcelain	6.5
Beryllia	6.5
Fosterite	6.3
Steatite	6.0
G-10 Epoxy Glass Board	4.6
Glass (Borosilicate)	4.6
Epoxy (paper base)	4.2
Phenolic (paper base)	4.0
Boron Nitride	4.0
Mylar	3.0
Nylon	2.9
Teflon Glass PC Board**	2.8-3.8
Teflon	2.4
Polyethylene	2.26
Air	≅1.0003
Vacuum	1.0

*100 MHz nominal
**See *Microwave Systems News*, March 1980, page 97, Specing Laminates," R. Webb, for exact details on GT and GX type material.

The width of the 4CX250R plate dissipation fin is 0.71 inch (1.80 cm), which provides a maximum capacitor area of 1.1431 square inches (7.38 square cm).

If 0.010 inch (0.0254 cm) Teflon insulation, which provides a good voltage insulation capability (600 volts/mil), is used between line and amplifier tube, use **eq. 13**[1] to calculate the capacitance. **Table 54** lists the dielectric constant values in descending order of ε for most commonly used insulation materials. From this table Teflon is 2.4. The capacitance obtained from using **eq. 13** is:

$$C_{pF} = (0.225)(2.4)\left[(1)\ \frac{1.1431}{0.010}\right] = 61.73\ pF \qquad \textbf{(58)}$$

At 144 MHz the equivalent reactance is 15.8 ohms. Considering the power levels involved for a pair of 4CX250R tubes this value is unacceptably high, because the rf current would probably exceed the Teflon dielectric dissipation factor. Consequently, a hard connection to the tubes is required for the plate circuit. Reactance values of 2 ohms or less are acceptable for power levels in the 2-kW PEP range. Also, for this frequency, there's no advantage in mounting the tubes horizontally; thus the simpler vertical mounting directly onto the chassis is to be used.

The minimum center-to-center tube spacing, using the Eimac SK-610 socket, is 2.8 inches (7.11 cm). If a reasonable amount of clearance from line to side wall is to be maintained, a value of 3 inches (7.62 cm) center-to-center is a good choice. From the original 17-inch (43.18-cm) width, 3 inches (7.62 cm) is subtracted, leaving a maximum of 14 inches (35.56 cm) to accommodate the plate line. If allowances are made for connection to the tubes and insulating the line from the chassis, a net maximum length of 13 inches (33.02 cm) remains.

The characteristics for a push-pull tube arrangement are shown in **fig. 24.** C_o is the output capacitance of each tube. The tube capacitances are in series across the plate line. The value of C_o for the 4CX250R is 5 pF maximum. Therefore, the capacitance shunting the line is 2.5 pF.

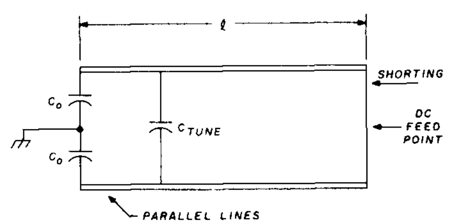


fig. 24. Push-pull configuration for parallel lines in air.

The next step is to calculate the value of Z_0 that results from the available length and the stray and tuning capacitance. The latter is assumed to be 7.5 pF. Using **eqs. 1** through **6** or the HP-67/97 *program* in **table 1**,[1] Z_0 is calculated as

$$C_{total} = \frac{C_{out}}{2} + C_{tune} \qquad \textbf{(59)}$$

for these conditions:

$$\begin{aligned} F &= 144\,MHz \\ length &= 13.0\,in.\ (33.02\,cm) \\ C_{total} &= 10\,pF \\ C_{tune} &= 7.5\,pF \\ C_{out} &= 5.0\,pF \end{aligned}$$

The following examples use the tables and figures provided. I assume that the programmable calculator will be used.

From **eq. 2** or **fig. 4**,[1] X_c for 10 pF is 110.5 ohms. Using **fig. 5**,[1] β is determined to be about 4.39 degrees/in. (6 degrees/cm) for 144 MHz. Therefore, $\beta \ell = 4.39 \times 13 = 57.2$ *degrees* and the tan $\beta \ell = 1.55$ from **fig. 3**.[1] Rearranging **eq. 1** for Z_0 yields

$$Z_0 = \frac{X_C}{\tan\beta\ell} = \frac{112}{1.55} = 72.25\,ohms \qquad \textbf{(60)}$$

This is a low value of Z_0 for parallel lines, indicating that the line length should be shorter to yield values of Z_0 between 150 and 400 ohms. If 150 ohms is chosen and X_C remains the same (112 ohms), tan $\beta\ell = \frac{112}{150} = 0.75$ and $\beta\ell$ is 36.87 electrical degrees long. Dividing by $\beta = 4.39$ *degrees/inch* gives $\ell = 8.4$ *inches* (21.33 cm). This says the 17-inch (43.18-cm) wide enclosure is very generous, and 13 inches (33.02 cm) would be adequate.

The physical dimensions of the line can be determined from **fig. 17**.[1] From the geometry of **fig. 23** and placing the line in the center of the cross section, $h = 2.5$ *inches* (6.4 cm) over the chassis ground plane. If copper water pipe with an outside diameter of 0.625 inch (1.59 cm) is used for the lines, $\frac{h}{d} = \frac{2.5}{0.625} = 4$. Entering the graph of **fig. 17** for a value of $\frac{h}{d} = 4$ and moving up to the $Z_0 = 150$-*ohm* line yields a $\frac{D}{h}$ value of 0.6. Therefore, D, the center-to-center spacing of the lines, is 0.6×2.5 or 1.5 inches (3.8 cm), an acceptable value. If other spacing is desired, other line diameters can be tried.

The disc tuning capacitor is calculated using **fig. 6**.[1] A variable capacitor of sufficient insulation can also be used; the choice is left to the reader.

Often the line is made intentionally longer and a shorting bar used to set the final operating point. That choice is not necessary if the data provided here are used.

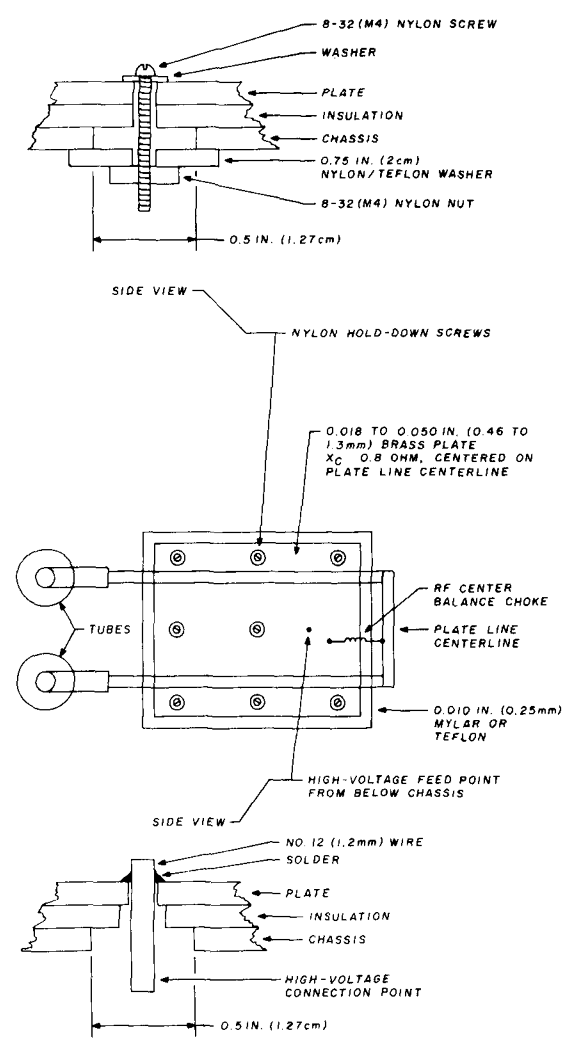


fig. 25. Plate bypass capacitor detail.

In **fig. 25**, the dc feed point is indicated. It is impossible to predict the exact rf balance point because of stray reactances. So, it is good design practice to insert a small rf choke at this point. Four turns of no. 12 wire, 3/8 inch (0.95 cm) in diameter and 0.5 inch (1.27 cm) long, are adequate. This permits the rf balance point to center itself at some point in the rf choke. The dimensions of this rf choke are not critical, but it should have a reasonably high Q. The highest rf choke Q is generally obtained when the wires are spaced a wire diameter apart — the pitch is equal to twice the wire diameter. Callendar's equation (reference 5) is readily used with this pitch to estimate coil Q:

$$Q = \frac{\sqrt{F}}{\frac{2.71}{a} + \frac{2.13}{\ell}} \quad (61)$$

where F = frequency (Hertz)
a = choke radius to center of turn (inches)
ℓ = choke length to center of first-to-last turn (inches)

This equation is accurate to within a few per cent and, for close-wound rf chokes, is high by a factor of almost two.

Reference 6 contains a comprehensive discussion of inductances, Q, and the calculation of single-layer solenoid choke parameters.

A further important consideration is the plate circuit rf bypass capacitor and its placement providing balanced, low-inductance rf current return paths to the tube cathodes. One of the better choices for a capacitor is a parallel plate type that uses the chassis as one of the capacitor plates and is centered under the line between the tubes and the line-support mechanism at the shorted end. The plate is secured to the chassis with insulating washers and nylon screws. **Fig. 25** shows a typical installation, with details for the high-voltage feedthrough insulation hold-downs. The capacitor reactance should be less than 1.5 ohms. At 144 MHz, a 5-inch (12.7 cm) by 7-inch (17.78 cm) plate, using 0.010 inch (0.25 mm) Teflon insulation, provides an 1890 pF capacitor with a reactance of 0.58 ohm. Note that the capacitor is placed so that the high plate rf currents find equal and balanced paths to the tube cathode. Using this technique, the high voltage feed point is cold to rf below the chassis. Make sure that the small balance inductor is soldered to a centerline point on top of the capacitor. Balanced rf currents produce stable amplification.

If a fixed rf bypass capacitor of appropriate quality is used, the same current balance considerations apply. The balancing rf choke is also required. This completes the plate line design. Refinements to final values can be readily made as desired.

grid-line design

The grid-line design proceeds in a manner similar to that of the plate-line design. However, the critical difference for most tubes is that input capacitance is quite high. The 4CX250R input capacity is 17.2 pF maximum for grounded cathode configurations. For the design configuration considered here, **fig. 24** applies. The net capacitance across the lines is 8.6 pF. Note that the push-pull configuration reduces the tube input capacitance by two over single-ended designs, a possibly important tradeoff for higher frequencies. If a dual 20 pF tuning capacitor is available, and it is assumed to be set at the 15-pF per section point, the net tuning capacitor is 7.5 pF in parallel with the tube capacitance of 8.6 pF for a total of 16.1 pF. At 144 MHz, from **fig. 4**,[1] this is about 50 ohms. Going back to **eq. 1**[1] and rearranging, $\tan \beta \ell = \frac{X_c}{Z_0}$. And assuming a Z_0 of 150 ohms, $\tan \beta \ell = \frac{50}{150} = 0.33$. Referring to **fig. 3**, the $\beta \ell$ length is 21.25 degrees, or 4.84 inches (12.29 cm), if β is 4.39 degrees/inch.

From the geometry described in **fig. 22**, $h = 1.5$ *inches* (3.81 cm), requiring the line to be centered in the chassis. If no. 10 wire (0.102 inch, 0.26 cm) is used for the line, $\frac{h}{d} = \frac{1.5}{0.102} = 14.71$. Referring to **fig. 17** and entering at a value of 14.71 for h/d provides a value of 0.13 for D/h. Solving for D, the center-to-center distance of the grid lines gives $D = 0.13h = 0.13 \times 1.5 = 0.2$ *inch* (0.51 cm). This is not a practical value, because the outside diameter spacing of the conductor leaves only 0.098 inch (0.25 cm) separation. If a Z_0 of 350 ohms is chosen, the length will change but the D will increase, from **fig. 17**, to $1.5 \times 0.7 = 1.1$ inches (2.67 cm), an acceptable value. The new line length is now calculated for $Z_0 = 350$ *ohms*, $\tan \beta \ell = \frac{50}{350} = 0.143$. Referring to **fig. 3**, this is about 10 degrees. Dividing by 4.39 (β degrees/inch) yields 2.28 inches (5.8 cm) line length.

It is clear that this design is now realizable. But electrical line lengths of 12 degrees or less are undesirable; the minimum value should be about 20 degrees. Remember the tuning capacitor we chose earlier and its setting of 7.5 pF net capacitance across the line? If that is reduced to 5 pF, the line length can be extended to an acceptable value.

As in the plate line, a balancing rf choke is used at the center point of the bias feed for the grids. Five turns of no. 16 wire, 0.25 inch (0.65 cm) in diameter and 0.5 inch (1.27 cm) long, are adequate. The same rules stated earlier for balancing rf currents apply here. The grid rf bypass capacitor is grounded on the centerline of the tubes and grid line. A parallel plate is not recommended for the grid because, in this case, it would interfere with the plate circuit bypass capacitor.

special consideration

If the 4CX250R tubes described here for 144 MHz use were considered for 432 MHz single-ended use, the input capacitance of 17.2 pF maximum places the first $\frac{\lambda}{4}$ point inside the tube header, even if the line Z_0 is chosen to be 10 ohms — a relatively impractical number. Because of the required line diameter and close spacing to the ground plane a coaxial tank is assumed. A simple solution is to use multiple $\frac{\lambda}{4}$ line

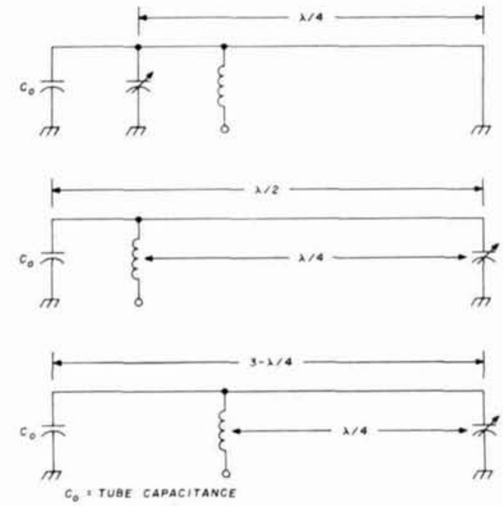


fig. 26. Line feed configuration for multiple λ/4 segments.

lengths as shown in **fig. 26**.

comments

The example presented is simple, but it does show the required iterative design process you can implement to achieve a specific solution. Much has been left unsaid. The shortened line at uhf and above due to device capacitance deserves an equally lengthy treatment, as does the microstrip design area, which was not discussed here at all.

acknowledgments

Comments by S. Harrison, WB6PKA, Dr. R.M. Searing, and T.C. McDermott, III, N5EG, are gratefully acknowledged. The most valuable contributions were provided by B.L. Reardon, to whom the author is singularly indebted.

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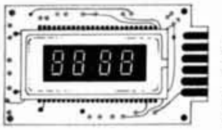

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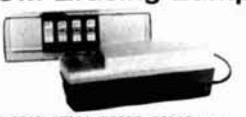

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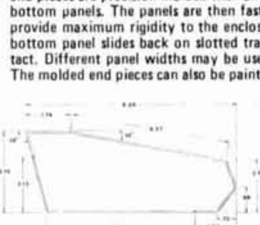

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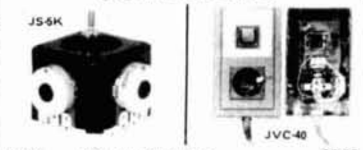

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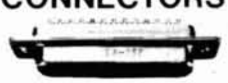

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improved receiver performance

for the Heathkit SB-104A

Modifications for better sensitivity, selectivity, and overload capability

The Heath SB-104A is a good transceiver. It can be made even better by incorporating the simple modifications described in this article. The modifications, if made according to the directions given, will provide significant improvements in:

1. Receiver sensitivity, especially on the 10- and 15-meter bands;
2. Receiver selectivity in the SSB mode;
3. Receiver strong-signal-handling capability.

These modifications, as well as a few others, have been developed over a two-year period with great care and attention to detail. Before snipping any wires, I strongly recommend that you fully understand what is being accomplished by each and every circuit change. In addition, the modified circuits should be studied and compared with the original Heath circuits.

receiver sensitivity improvements

In my opinion, the SB-104A suffers from inadequate sensitivity, especially on 10 and 15 meters. The six bandpass filters for the 80- through 10-meter Amateur bands, located on circuit board **G**, are diode switched. That is, when the radio is on a particular band, diodes on circuit-board **G** associated with the bandpass filter in use are forward-biased to provide a low-loss rf path for that band. The diodes do have some loss, however. These losses can be reduced by replacing diodes D701 through D704 (Heathkit parts designations); D707 through D710; D713, D714; and D717, D718 with Motorola MPN3401 PIN diodes,* which are intended for rf-switching use. (See **fig. 1**.)

To make the mods, first remove the original diodes, using a Solderwick.™ Install the new PIN devices in place of the original diodes. Pay attention to the polarity of the MPN3401s. These devices are in a square epoxy package; the end with the ridge, or high spot, is the cathode. The leads on the MPN3401 are very short, so they must be mounted on the foil side of the board.

mixer improvements

The next step is to replace the receiver mixers. The original first and second mixers on board **G** can be improved by substituting minicircuit Labs SBL-1 broadband mixers.†

These new mixers provide better isolation between ports and have less conversion loss than the original mixers. They also have good strong-signal-handling capabilities. They are commonly used in high-performance uhf receiving systems.

To make the mixer modification, first remove the Heath first mixer, consisting of T701 and T702 and diodes D719, D721, D722, and D723. Also remove capacitors C741 and C742. Apply some epoxy to the top of one of the SBL-1 mixers and cement it to the component side of the board, as indicated in **fig. 1**. The pins on the mixer should now be facing upward. Wire the mixer as shown using two 0.01-μF capaci-

---

*Available from Circuit Specialists, Box 3047, Scottsdale, Arizona 85257.

†Available from Advanced Receiver Research, Box 1242, Burlington, Connecticut 06013.

By Richard Tashner, N2EO, 163-34 21 Road, Whitestone, New York 11357

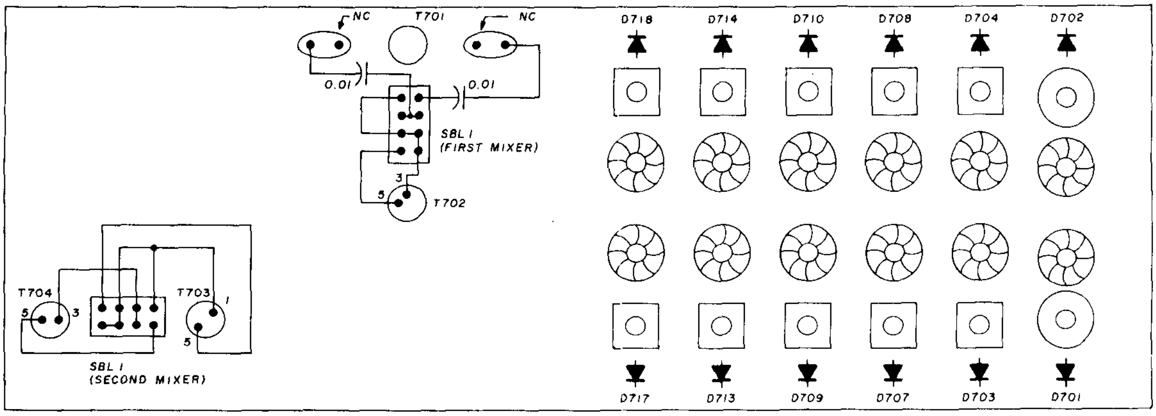


fig. 1. Circuit board *G* in the Heath SB-104A showing, at right, the locations of the original bandpass-filter switching diodes, which are replaced with MPN3401 PIN diodes to reduce loss through the circuit. The original first and second mixers on board *G* (center and left) are replaced with SBL-1 broadband mixers to reduce conversion loss and improve strong-signal-handling capability. Original Heath parts designators are shown.

tors. The capacitors connect from the mixer module to one of each of the indicated holes in the PC board.

Next remove the Heath second mixer by removing T703, T704, D724, D725, D726, D727, and epoxy the new SBL-1 second mixer to the board. Wire as indicated. No additional capacitors are needed on the second mixer, as they already exist on the PC board.

Finally locate transistor Q702. This transistor is a 2N5109, which is an epitaxial planar low-noise device. It is used as a post amplifier between the first and second mixers.

Remove R721, the 1-kilohm collector resistor and replace it with a 1-mH choke. Next remove R722, the 560-ohm emitter resistor, and replace it with a 100-ohm resistor. Finally replace C745 emitter bypass capacitor with a 0.01-μF disc capacitor.

The above modification serves two purposes. First, it increases collector current to about 100 mA, which greatly reduces the chances for the stage to clip on strong signals. (The 2N5109 is rated for an IC of 400 mA.) It also increases the stage gain, which is needed to overcome the losses of the second crystal filter.

At this point, reinstall board **G**. Turn on the SB-104A, and check out the receiver to make sure it's receiving on all bands.

Next pull out the board, install the extender board in the SB-104A along with board **G**, and retune the filters and second mixer trimmers according to the Heath operation manual. If a scope and sweep generator are available, the board may be sweep-aligned.

taming the noise blanker

The next step is to rewire the noise blanker as shown in **fig. 2**. This modification will allow the blanker to be totally removed from the signal path when turned off. I found that the blanker caused cross modulation, even when turned off, by virtue of its being in the signal path at all times as originally wired. The noise-blanker switch is a dpdt and no problems should be encountered in wiring it as indicated in **fig. 2**. Use shielded cable (RG-174/U).

improving SSB selectivity

To improve skirt selectivity on SSB, remove the original crystal filter from circuit board **E** and install a Fox Tango Corporation 33H2.1 filter* in its place. Mount the original SSB filter to the chassis just to the left of the VFO, directly in front of the noise blanker. I suggest that you measure the filter dimensions carefully; make a template, and tape it to the chassis before drilling the four mounting holes. Drill up from the bottom of the chassis.

The new filter is wired as shown in **fig. 2**, using two 15.5-μH coils and two 150-pF mica capacitors, which provide the proper impedance match for the filter.

further improvements

More modifications were made to the SB-104A to achieve the following goals:

*Available from Fox Tango Corporation, Box 15944, West Palm Beach, Florida 33406.

Notes.
1. Heath filter is remounted directly to chassis in front of noise blanker. Matching network is held in place by terminal strips bolted to filter mounting studs.
2. All shielded cable is RG174/U miniature coax.

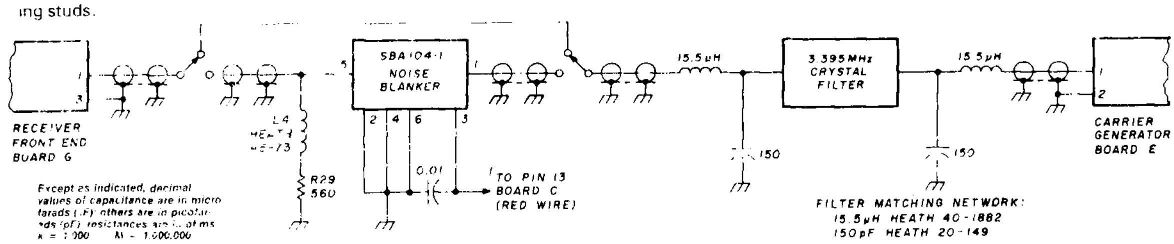


fig. 2. Block diagram showing cascaded filter system. A Fox Tango Corporation 33H2.1 filter is substituted for the original Heath crystal filter, which is relocated on the chassis as described in the text. Wiring changes to the noise blanker are also shown, completely removing it from the signal path when turned off.

1. To further improve strong-signal-handling capability
2. To improve the active audio filter
3. To reduce receiver hiss
4. To provide a slower AGC release time

Make the following changes to board **F**. Refer to **fig. 3**, which is a partial schematic of board **F**. (Parts designators are as shown in the Heath schematic.*) Proceed as follows:

1. R513. Remove the 2400-ohm resistor and replace it with a 1-meg resistor.

2. R502. Remove the 820-ohm resistor and replace it with a 1500-ohm resistor.

*As mentioned at the beginning of this article, it is important that you understand just what is being done when these modifications are made. *Before* attempting to make any changes, study the Heath schematics for the SB-104A and familiarize yourself with the original design so that you thoroughly understand how the changes are made, why they are made, what components are involved, and how to proceed without damaging the radio. The importance of this advice cannot be overly stressed.

3. R514. Remove the 620-ohm resistor and replace it with a 100-ohm resistor shunted by a 0.01-μF capacitor.

4. R517. Remove the 2400-ohm resistor and short the foil with a jumper.

5. R511. Remove and discard (or save for your junkbox).

6. R512. Remove the 4700-ohm resistor and replace it with a 1-mH choke.

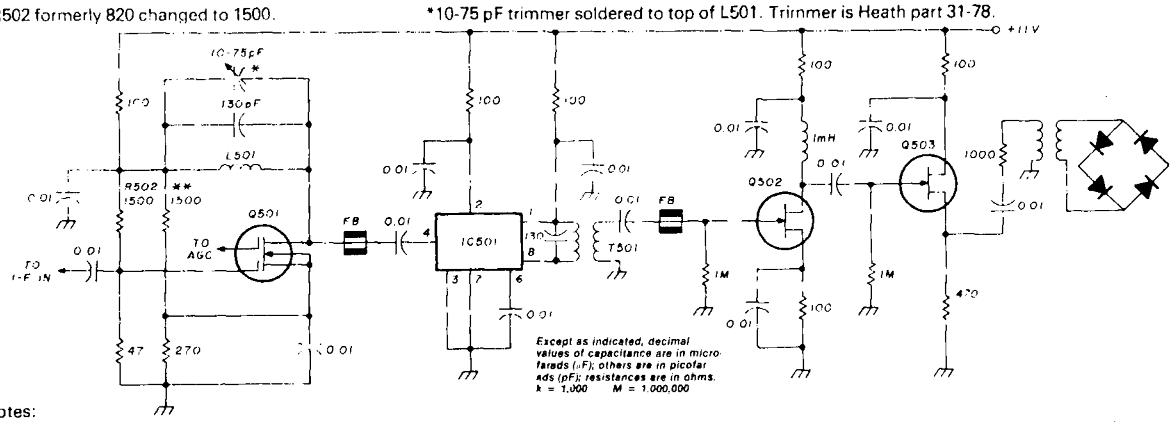
7. R516. Remove and discard.

8. R518. Remove the 10k resistor and replace it with a 1-meg resistor.

9. R572. Remove the 4700-ohm resistor and replace it with a 2200-ohm resistor.

10. R541. Remove the 1500-ohm resistor and replace it with a 1000-ohm resistor.

**R502 formerly 820 changed to 1500.
*10-75 pF trimmer soldered to top of L501. Trimmer is Heath part 31-78.



Notes:
1. Install Q502, Q503 as follows: *Gate* goes to former base lead. *Drain* goes to former collector lead. *Source* goes to former emitter lead on PC board.

fig. 3. Partial schematic of the SB-104A i-f/audio board *F* showing modifications to improve strong-signal-handling capability.

11. R545. Remove the 820k resistor and replace it with a 2.2-meg resistor.

12. R546. Remove the 5.6-meg resistor and replace it with a 33-meg resistor.

13. C535. Remove the 2.2-μF tantalum capacitor and replace it with a 5-μF, 15-volt electrolytic capacitor.

14. Q502, Q503. Remove and replace with 2N3819 JFETs. See note 1 on **fig. 3**.

On the right-hand upper corner of board **F**, from the component side of the board, locate the foil going to Q517 base and carefully drill a 1/16-inch (1.6-mm) or smaller hole through the base foil and the ground foil. Scrape off the green or blue coating around the holes and install a 0.1-μF Mylar capacitor in the two holes.

Locate coil L501 and remove the associated 100-pF mica capacitor. Replace it with a 130-pF mica capacitor.

Solder a 10-75 pF trimmer (Heathkit 31-78) across the pins of L501. Piggyback this trimmer on top of L501 by soldering the trimmer directly to the top of the pins on L501.

Install board **F** in the extender board in the SB-104A. Either peak the 10-75 pF trimmer for maximum noise, or, if a signal generator is available, put the rig on 80 meters and inject a signal into the antenna jack. Use only enough signal to get an S-5 or so meter reading. Peak the 10-75 pF trimmer for maximum S-5 meter reading. Use care not to saturate the i-f. Use only as high a signal level as is necessary.

Next, remove board **D** and change capacitor C441 (33pF) to 100 pF. This change increases HFO injection and reduces receiver overload. Reinstall board **D**.

Remove transmit audio regulator board **B**, and make the following changes:

1. Change R217 from 4700 to 2200 ohms.

2. Remove Q207 and replace it with a Radio Shack 276-2026 transistor.

The reason for these changes on board **B** is as follows. Q207 is the PTT switching transistor. When Q207 conducts, the relay in the SB-104A closes, and the unit is in the transmit mode. Before I changed the transistor, I'd had two failures of the Q207. For that reason, the Radio Shack device was installed; it's a tab-type transistor and is more capable of supplying the necessary collector current without premature failure.

If this change is made, you must reduce the value of R217 from 4700 ohms to 2200 ohms. If you don't plan to change Q207, leave R217 alone. When installing the new Q207, bend the leads of the transistor at a right angle and allow the transistor to lie over the top of IC202. This will allow PC board **B** to slip into its compartment in the chassis.

Additional changes to board **B**, which are optional, are as follows. R214, the collector resistor of audio transistor Q201, may be reduced from 33k to 15k. This change will eliminate asymmetrical clipping — which may cause slight audio distortion during transmit in some units — in Q201.

Capacitor C204, the 0.01-μF coupling capacitor on Q201's base, may be increased to a 0.1-μF Mylar. This change will increase the low-frequency response of the transmit audio. This is a personal preference. You may like the transmitter audio better one way than the other, so get some on-the-air checks from a few local stations and try the two different capacitor values.

Finally, one change suggested by Heathkit is as follows. Remove the ALC/filter board and change capacitor C887 on Q802's emitter to a 0.68-μF tantalum. If your rig is of late vintage, the 0.68-μF cap may already be installed.

test results after modification

Three other active Amateurs are located within a half mile of me. After modifications were made, I made on-the-air checks with two of these stations. I was able to tune my SB-104A 18-20 kHz away from the other stations' 60 dB over S-9 signals and only slight desensitization was noted. Stations as weak as S-3, 30 kHz away from the 60-dB over S-9 local SSB signals, were solid copy, and only a slight hiss was noted while the local station was transmitting. These tests were made with the noise blanker off.

The Heathkit SB-104A was also tested side-by-side with a top-of-the line Japanese transceiver. Both rigs were connected to a common antenna. The two units ran neck-and-neck as far as sensitivity was concerned. All bands, 80-10 meters, were tested. When the two rigs were tuned to the same station, the SB-104A had much less receiver hiss than the Japanese rig, which made the SB-104A much more pleasant to listen to. The modified AGC action was very pleasant to listen to. No pumping was present in the SB-104A after modification.

A comparative check of selectivity was also made on both units. Tuning the same station on upper sideband on the Japanese rig, and moving off frequency produced a high-pitched "Donald Duck" response that could be heard up to 3.5 kHz away from center frequency. However, on the SB-104A, tuning more than 2.8 kHz away from the center frequency produced a sharp cutoff of the signal, and the same signal that was heard 3.5 kHz away on the Japanese rig was undetectable on the SB-104A. The i-f shift control in the Japanese rig was purposely left in the center position and not used during the checks. Turning the i-f shift knob did not help the Japanese rig; however, the cascaded filters in the SB-104A were definitely doing their job. Before modification, the SB-104A exhibited lockup of the AGC, which would manifest itself with the S-meter hanging up at S-6 across large portions of the band when a strong local signal was on. After modification, this problem totally disappeared, and just a barely perceptible increase in hiss was noted.

some afterthoughts concerning the SB-104A

As mentioned, the tests were made with the SB-104A noise blanker turned off. Turning on the blanker still produces cross modulation. This is because the noise blanker keys on signal as well as noise. Because of the broadband nature of the rig, the blanker is subjected to 500 kHz or more of crowded spectrum when turned on, and it just can't handle that much signal. One answer to this problem is to put a monolithic crystal filter about 6 or 8 kHz wide ahead of the noise blanker. During the modifications, I placed the 2.1-kHz filter ahead of the noise blanker, and the cross modulation totally disappeared. However, the blanker became totally ineffective on noise spikes. Propagation through the filter caused the pulses to be rounded off, rendering the blanker ineffective. For this reason only a modest filter should be placed in front of the blanker so that the pulses will not be rounded off, and the spread range of signals presented to the blanker at any one time will be reduced.

I would greatly appreciate hearing from others who have done work in this area, and I will answer questions upon receipt of a self-addressed stamped envelope.

acknowledgments

I with to thank Vinney Maida, WA2EVS, for his helpful suggestions with this project. Thanks also to Brian Selman for drafting the diagrams. Finally, my thanks to David Fentem, WB4RRC, for his ideas in his "Heath 104 Series Information Sheet," dated August 31, 1979.

bibliography

Shuch, Paul, WA6UAM, "Circuit Packaging for UHF Double-Balanced Mixers," *ham radio*, September, 1977, page 41.

The Radio Amateurs Handbook, Chapter 8, "Receiving Systems," Chapter 9, and "VHF and UHF Receiving Techniques," ARRL, Newington, Connecticut, 1979.

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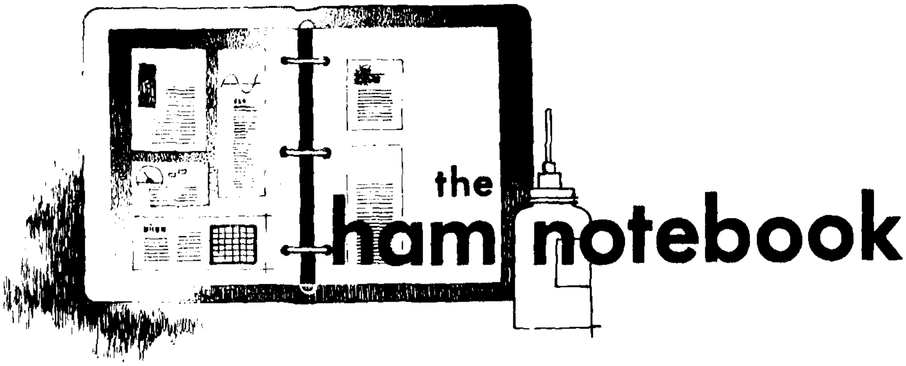

measuring receiver dynamic range: an addendum

In a previous article[1] I explored methods for determining performance of manufactured receivers using simple equipment and procedures. I'd like to update these data with the results of some further measurements (**table 1**).

table 1. Updated measurements of manufactured receiver performance in terms of local-oscillator phase noise. Data supplements those in reference 1.

receiver	two tone input (dBm)	blocking (dBm)	bandwidth (kHz) at a rejection of				S-meter (S9 level, μV, and linearity)
			60 dB	70 dB	80 dB	90 dB	
Collins KWM 380	−33	−40[4]	10.0[6]	15.6[6]	—[6]	—[6]	71 excellent
Drake TR7/DR7 No. 2 late	−34	−42[4]	3.9	4.3	4.6	4.8	63 good
Ten-Tec Omni-D No. 2	−38	−21	4.1	4.7	5.9	9.5	63 good
Drake TR7/DR7 No. 3 late	−39	−44[4]	4.3	4.9	5.6	—[6]	20 good
Drake TR7/DR7 No. 1 early	−41	−32	3.8	5.6	6.3	6.6	22 fair
Ten-Tec Omni-D, B series	−42	−21	4.0	5.0	6.5	11.4	71 good
Collins 75S3B late	−44	−20	4.5	5.1	5.8	6.3	250 good
ICOM IC-701 No. 1	−46	−26	5.2	9.4	15.4	—	20 poor
Swan Astro 102 BX	−46	−36	4.2	7.5	15.2	—	71 fair
Yaesu FT-107M	−46	−38	3.6	3.8	4.0	24	2 bad
Ten-Tec Omni-D No. 1	−48	−20	4.4	6.3	10.1	—	36 good
Ten-Tec 544 (Triton IV)	−48	−30	6.0	—	—	—	20 poor
ICOM IC-701 No. 2	−49	−45	7.4	—	—	—	35 fair
Swan Astro 150	−50	−30	4.4	5.1	12	—	89 fair
Atlas 350XL	−51	−28		4.0		7.0	150 poor
Collins 75S3B early	−51	−32					
CIR Astro 200	−52	−35					
Yaesu FT-101ZD No. 1	−53	−43	3.4	3.8	5.3	6.5	25 fair
Ten-Tec Century 21	−54	−20					
Yaesu FT-901DM	−56	−29	3.6	7.6	16.7	—	8 poor
Drake R4C	−57	−34[5]	4.0	4.5	4.6	4.6	16 good
Yaesu FT-101ZD No. 2	−57	−41	3.8	4.0	4.1	5.0	22 good
Ten-Tec Argonaut[1]	−58	−35	4.0	5.5	14	18	8 poor
Kenwood TS-820S	−60	−34					110 good
Kenwood R-820	−60	−42[4]	3.8	5.2	12	—	50 excellent
Kenwood TS-120S No. 1	−62	−40	4.1	8.0	—	—	50 fair
Yaesu FT-301S	−64	−36					30 poor
Heathkit SB-303[2]	−64	−41	4.4	6.0	9.0	10	70 good
Collins KWM2 No. 2	−65	−26	4.5	5.1	6.0	6.3	20 poor
Yaesu FT-101E	−65	−36					10 good
Signal One CX7A[3]	−66	> −6	3.2	6.3	7.1	7.1	20 excellent
Yaesu FT-301D	−68	−32					65 poor
Kenwood TS-520S	−72	−36					70 fair
Collins KWM2 No. 1	−74	−33					
Kenwood TS-120S No. 2 and No. 3	appx. −100	appx. −50					
OTHER EQUIPMENT							
Drake R7 preamp off	−31	−43[4]	4.2	5.0	6.0	—	50 excellent
preamp on	−42	−48[4]					
Kenwood TS-180S	−66	−50	4.2	4.3	4.5	4.8	80 good
	−71	−51	4.4	6.8	24	—	

Notes:

1 Modified for maximum selectivity.
2 Modified mixers.
3 Modified for maximum sensitivity.
4 LO phase noise is causing these low readings, also causes two-tone inputs to look better than they really are.
5 For a close-in signal, 4 kHz spacing.
6 Selectivity is being compromised by LO phase noise.

As you can see by examining **table 1**, the next area deserving attention is reduced local-oscillator phase noise. Several of the better radios could be much improved in the reciprocal mixing area, thus better use could be made of their excellent filters if the phase-locked loop bandwidth were reduced.

Another problem cropping up is the presense of *many* strong spurious responses when receiving a single strong signal, as in the selectivity test.[1] Almost every radio using a synthesized local oscillator has this problem. Equipment using a more conventional scheme is usually clean or has only an occasional spur.

Let's keep up the pressure on receiver manufacturers to do a better job in these areas.

reference

1. Sidney Kaiser, WB6CTW, "Measuring Receiver Dynamic Range," *ham radio*, November, 1979, page 56.

Sid Kaiser, WB6CTW

geostationary satellite bearings with the TI-58/59 programmable calculator

This TI-58/59 program will give the elevation and azimuth antenna bearings needed to acquire geostationary satellites for any location on earth. WB8DQT[1] gave an excellent description of the seven-step equation used, so I will give only the details needed for use with the TI-58/59 calculator.

The program takes from 4 to 9 seconds to run after E′ is pressed. Initial memory partitioning is adequate. Angular mode is degrees. Elevation and azimuth are displayed to the nearest tenth of a degree, close enough for any ham application. An elevation of 90 degrees is straight up so no azimuth is needed.

reference

1. Ralph E. Taggart, WB8DQT, "Microcomputers and Your Satellite Station," *73*, February, 1980.

Larry Kushner, WA6BKC

TITLE GEOSTATIONARY SATELLITE BEARINGS PAGE 1 OF 1 — TI Programmable **Program Record**

PROGRAMMER LARRY KUSHNER DATE JUNE 10, 1980

Partitioning (Op 17) 4,7,9,5,9 Library Module NONE Printer NO Cards 1

PROGRAM DESCRIPTION

THIS PROGRAM WILL CALCULATE THE ELEVATION & AZIMUTH ANTENNA BEARINGS NEEDED TO SEE GEOSTATIONARY SATELLITES. GIVEN: THE STATION LOCATION IN DDD.MMSS FORMAT AND THE SATELLITE SUBPOINT LONGITUDE IN DDD.d FORMAT, THE ELEVATION AND AZIMUTH WILL BE IN DDD.d FORMAT. IF THE ELEVATION IS A (-) NUMBER THE SATELLITE CAN NOT BE SEEN FROM YOUR LOCATION. THE EQUATION USED IS FROM FEB. 1980 73 MAGAZINE BY WB8DQT.

USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	READ MAG CARD SIDE 1			
2	ENTER STATION LATITUDE	26	A	26
3	ENTER STATION LONGITUDE	80.1	B	80.1
4	ENTER SATELLITE SUBPOINT LONGITUDE	135	C	135
5	RUN PROGRAM (ELEVATION WILL BE DISPLAYED)		E'	59.1
6	TO FIND AZIMUTH		E	168.3
7	TO FIND ELEVATION		D	59.1
8	ENTER NEXT SATELLITE SUBPOINT LONGITUDE	128	C	128
9	RUN PROGRAM (ELEVATION WILL BE DISPLAYED)		E'	29.5
	GO TO STEPS 2,3,4,5,6,7 AS NEEDED			
	FOR ALL NUMBERS ENTERED: + FOR °N, °W. - FOR °S, °E.			

USER DEFINED KEYS	DATA REGISTERS (INV ■)	
A STATION LATITUDE	0	0
B STATION LONGITUDE	1	1
C SATELLITE LONGITUDE	2	2
D ELEVATION	3 L	3
E AZIMUTH	4 D	4
A'	5 C THEN AZIMUTH	5
B'	6 ELEVATION	6
C'	7 SATELLITE LONGITUDE	7
D'	8 STATION LONGITUDE	8
E' RUN PROGRAM	9 STATION LATITUDE	9

LABELS (Op 08)

FLAGS 0 1 2 3 4 5 6 USED 7 8 9

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TITLE GEOSTATIONARY SATELLITE BEARINGS PAGE 1 OF 1 — TI Programmable **Coding Form**

PROGRAMMER LARRY KUSHNER WA6BKC DATE JUNE 10, 1980

LOC	CODE	KEY	COMMENTS
0	76	LBL	
	11	A	
	42	STO	
	09	09	
	91	R/S	
	76	LBL	
	12	B	
	42	STO	
	08	08	
	91	R/S	
10	76	LBL	
	13	C	
	42	STO	
	07	07	
	91	R/S	
	76	LBL	
	14	D	
	43	RCL	
	06	06	
	91	R/S	
20	76	LBL	
	15	E	
	43	RCL	
	05	05	
	91	R/S	
	76	LBL	
	10	E'	
	22	INV	
	87	IFF	
	07	07	
30	25	CLR	
	32	X-T	
	43	RCL	
	08	08	
	88	DMS	
	75	-	
	43	RCL	
	07	07	
	95	=	
	42	STO	
40	03	03	
	39	COS	
	65	X	
	43	RCL	
	09	09	
	88	DMS	
	39	COS	
	95	=	
	22	INV	
	39	COS	
50	47	STO	
	04	04	
	67	EQ	
	01	01	
	33	33	

LOC	CODE	KEY	COMMENTS
55	09	9	
	00	0	
	75	-	
	43	RCL	
	04	04	
60	95	=	
	38	SIN	
	75	-	
	93	.	
	01	1	
	05	5	
	01	1	
	03	3	
	95		
	55	/	
70	53	(	
	09	9	
	00	0	
	75	-	
	43	RCL	
	04	04	
	54	)	
	39	COS	
	95	=	
	22	INV	
80	30	TAN	
	58	FIX	
	01	01	
	52	EE	
	22	INV	
	52	EE	
	22	INV	
	58	FIX	
	42	STO	
	06	06	
90	43	RCL	
	09	09	
	88	DMS	
	30	TAN	
	55	/	
	43	RCL	
	[illegible]	[illegible]	
	30	TAN	
	95		
	94	+/-	
100	22	INV	
	39	COS	
	42	STO	
	05	05	
	69	OP	
	19	19	
	25	CLR	
	87	IFF	
	07	07	
	01	01	

LOC	CODE	KEY	COMMENTS
110	41	41	
	43	RCL	
	03	03	
	77	GE	
	01	01	
	20	20	
	03	3	
	06	6	
	00	0	
	75	-	
120	43	RCL	
	05	05	
	95	=	
	58	FIX	
	01	01	
	52	EE	
	22	INV	
	52	EE	
	22	INV	
	58	FIX	
130	61	GTO	
	01	01	
	49	49	
	00	0	
	42	STO	
	05	05	
	09	9	
	00	0	
	42	STO	
	06	06	
140	91	R/S	
	43	RCL	
	05	05	
	77	GE	
	01	01	
	48	48	
	61		
	08	8	
	00	0	
	42	STO	
150	05	05	
	43	RCL	
	06	06	
	91	R/S	

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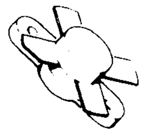

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MRF475

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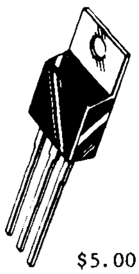

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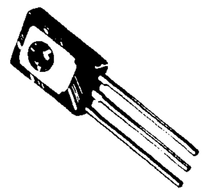

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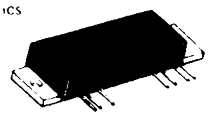

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1A[illegible]	Dual Trace Plug In	[illegible]
[illegible]	[illegible] Plug In	[illegible]
[illegible]	Sampling Plug In	[illegible]
[illegible]	[illegible] Plug In	[illegible]
[illegible]	High Gain Differential Comparator Plug In	[illegible]
[illegible]	Test Load Plug In [illegible] Main Frames	[illegible]
[illegible]	Wideband [illegible] Plug In	[illegible]
[illegible]	Sampling Unit With [illegible]PS Risetime DC to 1GHZ	[illegible]
[illegible]	AC Differential Plug In	133.00
[illegible]	Dual Trace Sampling DC to [illegible] Plug In	[illegible]
3S76	Dual Trace Sampling DC to [illegible]MHZ Plug IN	[illegible]
[illegible]	Sampling Sweep Plug In	[illegible]
3L10	Spectrum Analyzer [illegible] to [illegible]MHZ Plug In	[illegible]
[illegible]	Amplifier Plug In	[illegible]
[illegible]	Sweep Plug In	[illegible]
53B	Wideband High Gain Plug In	25.00
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[illegible]	Square Wave Generator [illegible]MHZ	[illegible]
[illegible]	Preamplifier [illegible]	[illegible]
[illegible]	AC Coupled Preamplifier	25[illegible]
[illegible]	Current Probe Amplifier	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	Program [illegible]	[illegible]
[illegible]	Trigger Countdown Head	[illegible]
[illegible]	[illegible] Dual Trace [illegible]MHZ Scope	[illegible]
[illegible]	Portable Dual Trace [illegible]MHZ Scope	[illegible]
503	DC to 450KHZ Scope Rack Mount	250.00
[illegible]	DC to [illegible]MHZ Scope Rack Mount	[illegible]
[illegible]	DC to [illegible]MHZ Scope	[illegible]
[illegible]	DC to 10MHZ Scope Rack Mount	[illegible]
[illegible]	DC to 10MHZ Scope Rack Mount	[illegible]

Scopes with Plug-in's

[illegible]	[illegible] Scope with a [illegible] Dual Trace Plug In [illegible] Sampling Plug In and a [illegible] Sweep Plug In, Rack Mount	[illegible]
[illegible]	DC to 10MHZ Dual Beam Scope with a 2A[illegible] Diff. and a 2A[illegible] Diff. Plug In's	[illegible]
[illegible]	[illegible] Scope with a [illegible] Dual Trace High Gain Plug In	[illegible]

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	60.00	6360	6.95
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	6939	14.7[illegible]
[illegible]	[illegible]	[illegible]	74.[illegible]	7360	12.[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	7984	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	8072	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	8106	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	8156	7.[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	8226	[illegible]
[illegible]	[illegible]	[illegible]	42.00	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	107.00	[illegible]	7.00	8908	9.00
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SELL: Swan 400 transceiver, external VFO, PS, key, mic., $250.00. KA4EVR, Phil Nigash, 325 Kelli, Farmington, AR 72730.

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NEW ZEALAND AMATEUR wishes to complete his "Ham Radio" collection. Requires 1968, 1969, 1970 complete and January 1971. Will purchase 1971 complete if offered. Reply stating years available and price required to: G. Moles, ZL2AKI, International Callbook Address.

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SUPER QRP with Direct Conversion's 5 watt transmitter kits. Write Direct Conversion Technique, Box 1001, Dept. 4FM, 535 No. Michigan Ave., Chicago, Illinois 60611.

WANTED: Motorola micor base stations. 406-420 MHz. AK7B, 4 Ajax Pl., Berkeley, CA 94708.

SATELLITE TELEVISION. HOWARD/COLEMAN boards to build your own receiver. For more information write: Robert Coleman, Rt. 3, Box 58-AHR, Travelers Rest, SC 29690.

TUBE TESTER, dynamic plate conductance, Jackson Elec. Inst. model 648S, new with latest roll chart, $75.00 or best offer. F.O.B. Fort Pierce, FL, F. Pierce, 403 Susan Dr., W4OZS.

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COMPUTER LOG program for TRS-80 cassette or disk. Contesters can check for duplicate entries in seconds. Search, sort, change, delete, display or print. $14.95 or send SASE for more info. dBf Engineering, 527 William, Scotch Plains, NJ 07076.

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WANTED: Service Manual/Wiring Diagram for Mallory Power Supply, Model 12RS140 manufactured by P. R. Mallory and Co., Inc., Indianapolis, Ind. John W. Shull, Sr., 1410 Wolverine, Anchorage, AK 99504.

ATLAS DD6-C and 350XL Digital Dial/Frequency Counters. $175.00 plus $3.00 UPS. AFC! Stop VFO drift. See June 79 HR. $65.00 plus $3.00 UPS. Mical Devices, P. O. Box 343, Vista, CA 92083.

MIDLAND 13-510 synthesized 2M FM 'xcvr., $239.00 with accessories and manual. CES 800ML scanner with manual, $55.00. W7TZO, Ray Schall, 1850 Olive Barber Rd., Coos Bay, OR 97420. (503) 267-6064.

WANTED: Help in completing the largest collection of Hallicrafter equipment in the world. Urgently needed are receivers with aluminum colored panels, back lighted plastic dials with "airplane" hands, early transmitters, unusual accessories, etc. Chuck Dachis, WD5EOG, "The Hallicrafter Collector," 4500 Russell Drive, Austin, Texas 78745.

DIRECT CONVERSION RECEIVER KITS. Write Direct Conversion Technique, Box 1001, Dept. 4FM, 535 No. Michigan Ave., Chicago, Illinois 60611.

WANTED: Junction box JB-29A from 522 for my collection. Weaver, W5PMX, 12404 Roadrunner, El Paso, TX 79934.

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WANTED: spare pair of Eimac 8875's. Send price and condition info to Lee Crocker, W9OY, 2901 Willowpark, Champaign, IL 61820.

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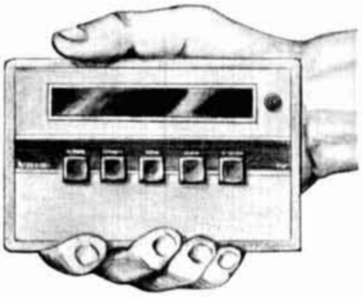

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More Details? CHECK—OFF Page 114

Coming Events

ACTIVITIES

"Places to go..."

CALIFORNIA: Santa Maria Amateur Radio Swapfest, June 14, 1981. Sponsored by the Satellite Amateur Radio Club. For info on prizes, swaptables, dinner tickets and much more, mail inquiries to: Santa Maria Swapfest, 1600 E. Clark #49, Santa Maria, CA 93455.

ILLINOIS: Radio Expo '81 sponsored by the Chicago FM Club will be held, rain or shine, on September 19th and 20th at the Lake County Fair Grounds, routes 45 and 120 in Grayslake. Grayslake is 30 minutes north of Chicago and 45 minutes south of Milwaukee. This year we will have a super large flea market with plenty of indoor and outdoor space, free with a gate ticket. Just bring your own table and chair or tailgate it. Parking is free. We will also have new camping sites complete with power hook-ups. There will be Ham seminars both Saturday and Sunday. YL's have a ladies program and door prizes both days. Only the best manufacturers of Ham and computer equipment and their distributors will be at our huge display building for you to meet and buy from. As in the past, Expo will be giving out thousands of dollars worth of prizes and admission tickets are good for both days. For advanced registration, send $3.00 per person and a #10 S.A.S.E. to Radio Expo Tickets, P.O. Box 1532, Evanston, Illinois. Tickets at the gate are $4.00 each. Kids under seven are free. For more information call (312) BST-EXPO. Talk-in on 146.16/.76, 146.52, and 222.5/224.10.

OHIO: The 12th annual B*A*S*H will be held on the Friday night of the Dayton Hamvention, April 24th at the Convention Center, Main and Fifth Streets. Admission is free. Food and C.O.D. bar. Live entertainment, super awards, and more. More info: Miami Valley FM Association, P.O. Box 263, Dayton, Ohio 45401.

OHIO: The Athens County A.R.A.'s annual Hamfest on May 17th at the Athens City Recreation Center, East State St. Talk-in on .34/.94. More info S.A.S.E. to: A.C.A.R.A., c/o Jeff White, WD8OXX, P.O. Box 767, Athens, Ohio 45701 or telephone Joe Follrod, WB8DOD (614) 797-4874.

ILLINOIS: 20th annual Moultrie A.R.K. hamfest on May 3rd at the Moultrie County 4-H center Fairgrounds. Talk-in on 146.94 and 146.055/.655. Write to M.A.R.K., P.O. Box 327, Mattoon, Illinois 61938.

INDIANA: The Wabash County A.R.C.'s 13th annual Hamfest on May 17th at the Wabash County 4-H Fairgrounds, Wabash. Talk-in on 7.63/.03 or .52 simplex. More info: S.A.S.E. to Dave Spangler, 45 Grant St., Wabash, Indiana 46992.

MASSACHUSETTS: South Shore Repeater Association's 5th annual auction on April 11th at the Central Junior High School, Broad St., Weymouth. Talk-in on 147.90/.30 machine. More info: S.A.S.E. to S.S.R.A., Town Hall Annex, 402 Essex St., Weymouth, Massachusetts 02188.

MASSACHUSETTS: Framingham Amateur Radio Association's annual Spring Flea Market on April 12th at the Framingham Police Station drill shed. Talk-in on .75/.15 and .52. More info: Ron Egalka, K1YHM, 3 Driscoll Dr., Framingham, Massachusetts 01701. (617) 877-4520.

MASSACHUSETTS: The Wellesley Amateur Radio Society's annual auction on April 18th at the Wellesley High School cafeteria on Rice St., Wellesley. Talk-in on .60/.03, .04/.64, and .52. Contact: Kevin P. Kelly, WA1YHV, 7 Lawnwood Pl., Charlestown, Massachusetts 02129.

MASSACHUSETTS: The Middlesex Amateur Radio Club's first annual indoor flea market on April 26th at the Wayland High School Commons Building in Wayland. Talk-in on 147.96/.36 and 146.52 direct. Advanced reservations ($6.00) to Irving Geller, WA1CDW, Apt. 8422A, 1450 Worcester Rd., Framingham, Massachusetts 01701.

MINNESOTA: The North Area Repeater Association's swapfest and exposition for radio amateurs and computer hobbyists on May 30th at the Minnesota State Fairgrounds in St. Paul. Talk-in on .16/.76 and .52. More info: Amateur Fair, P.O. Box 30054, St. Paul, Minnesota 55175.

MISSOURI: The P.H.D. Radio Association's 12th annual Northwest Missouri Hamfest and Missouri State ARRL convention on April 11th and 12th at the Kansas City Trade Mart. More info: PHD Amateur Radio Association, Inc., P.O. Box 11, Liberty, MO 64068. (816) 453-4774 or 452-9321.

MISSOURI: Indian Foothills A.R.C. 6th annual Hamfest on May 17th at the Saline County Fairgrounds building in Marshall, Missouri. More info: Phyllis French, WØWIE, Route 4, Box 168, Sedalia, Missouri 65301. (816) 826-8319 after 5 P.M. or KØBVB at (816) 886-2837.

COLORADO: The Rocky Mountain VHF Society's annual spring hamfest on May 17th at the Boulder National Guard armory, 4750 North Broadway. Talk-in on 146.16/.76 and 146.52. More info: Richard Ferguson, KAØDXM, 1150 Albion Rd., Boulder, Colorado 80303. (303) 499-2871.

CONNECTICUT: Fourth annual P.V.R.A. Flea Market on May 3rd at the George Penny High School in East Hartford, Connecticut. More info: Arnie, K1NFE, P.O. Drawer M, Plainville, Connecticut 06062.

FLORIDA: Annual "Conchfest" on May 16th and 17th featuring Conch Chowder, Conch Fritters, and a Conch Shell blowing contest. Tickets: $25.00/person and $15.00 for harmonics under twelve. Special rate at Sportsmen's Inn. More info: Key West A.R.C., P.O. Box 2371, Key West, Florida 33040.

ILLINOIS: The Rock River A.R.C.'s 15th annual hamfest on April 26th at the Lee County 4-H Center near Amboy. Talk-in, Dixon repeater .37/.97 simplex. More info: Chuck Randall, W9LDU, 1414 Ann Ave., Dixon, Illinois 61021. (815) 284-6380.

NEW ENGLAND: The Hosstraders will hold their Eighth Annual Tailgate Swapfest, Saturday, May 9, at the Deerfield, New Hampshire, Fairgrounds. Admission: one dollar, includes tailgating and commercial dealers. Profits benefit Boston Burns Unit of Shriners' Hospital for Crippled Children. Last year we donated $2058.16. Talk-in .52 and 146.40-147.00. Questions about New England's biggest flea market? SASE to Joe K1RQG, Star Route, Box 56, Bucksport, ME 04416, or Norm WA1IVB, RFD, Box 28, West Baldwin, ME 04091 or Bob W1GWU, Walton Rd., Seabrook, NH 03874.

NEW JERSEY: The 6th Trenton Computer Festival at Trenton State College, Trenton on April 25th and 26th. More info: TCF-81, Trenton State College, Hillwood Lakes, P.O. Box 940, Trenton, NJ 08625. (609) 771-2487.

NEW JERSEY: The DeVry Technical Institute WA2MDT A.R.C.'s 5th annual Amateur Radio and Computer Fleamarket on May 2nd at the DeVry Technical Institute, 479 Green St., Woodbridge, NJ. Talk-in on 146.52. More info call: Frank Koempel, WB2JKU, 634-3460 or Steve Hajducek, KA2IFX, 727-5962.

NEW YORK: The Southern Tier A.R.C.'s Hamfest on May 2nd on Route 17C, east of Owego. Talk-in on .16/.76 and .52. More info: D.R. Vasilow, W2EWO, Star Route 1, Box 35, Owego, NY 13827. (607) 687-1515.

NORTH CAROLINA: The Raleigh Amateur Radio Society's 9th annual Hamfest on April 12th at the Crabtree Valley Mall, U.S. 70 West, Raleigh. Talk-in (Saturday and Sunday) on 146.04/.64 and 146.28/.88. More info: R.A.R.S. Hamfest, P.O. Box 17124, Raleigh, NC 27619.

PENNSYLVANIA: Seventh Annual Northwestern Pennsylvania Hamfest, May 2, 1981, Crawford County Fairgrounds, Meadville, PA. Gates open 8 AM. Bring your own tables. $5 per table to display inside, $2 per car space outside. $3 admission, children under 12 free. Refreshments. Commercial displays welcome. Talk-in 04/64, 81/21, 63/03. Details C.A.R.S., P.O. Box 653, Meadville, PA 16335. Attn: Hamfest Committee.

PENNSYLVANIA: The Warminster A.R.C.'s 7th annual Ham Mart on May 3rd at the Middletown Grange Fairgrounds, Penns Park Rd., Penns Park. Talk-in on 146.52 simplex or W.A.R.C. repeater — 147.69/.09. More info: W.A.R.C., P.O. Box 113, Warminster, Pennsylvania or call Mark Hinkel, WA3QVU, (215) 657-7295.

SOUTH CAROLINA: The Blue Ridge A.R.S.'s annual hamfest on May 2nd and 3rd at the American Legion Fairgrounds, Highway 25 bypass in Greenville. More info S.A.S.E. to: B.R.A.R.S., 200 Walker Sp. Rd., Taylors, SC 29687.

TENNESSEE: The first Tri-Cities Hamfest on May 2nd and 3rd at the Appalachian Fairgrounds in Gray. Sponsored by the Bristol, Johnson City, and Kingsport A.R.C.s. More info: Tri-Cities Hamfest, P.O. Box 3682 CRS, Johnson City, Tennessee 37601.

WASHINGTON: The Inland Empire Swapfest on April 25th at the Spokane Interstate Fairgrounds' Floral Building in Spokane. Talk-in on 146.34/.94 and 146.52 simplex. More info S.A.S.E. to: Swap Fest, c/o Jan Thieman, KA7DUU, 7803 E. Mission, Spokane, Washington 99206.

WISCONSIN: The Ozaukee Radio Club's annual indoor swapfest on May 9th at the Cedarburg Community Center Gym on Washington Ave., 22 miles north of Milwaukee. Talk-in on 146.37/.97 and 146.52. More info S.A.S.E. to: Ozaukee Radio Club, P.O. Box 13, Port Washington, Wisconsin 53074.

WISCONSIN: Green Bay Mike and Key Club's swapfest on May 17th at the Ashwaubenon Recreation Center, Anderson Dr. Talk-in on 147.72/.12 and 146.52. More info: Swapfest Chairman, Robert Duescher, 1011 13th Ave., Green Bay, Wisconsin 54304.

OPERATING EVENTS

APRIL 24th - 26th: Special event station W8BI will operate from the Dayton A.R.A.'s communications van during the Dayton Hamvention. Certificates available, S.A.S.E. (large) to anyone contacting W8BI. Send QSL to W8BI, P.O. Box 44, Dayton, Ohio 45401. Frequencies: 14.295, 7.230, and 7.125 (CW). Times: 24th: 1800-2200 UTC; 25th: 1400-2200 UTC; and 26th: 1400-1800 UTC.

APRIL 24th - 26th: The St. Cloud MN ARC, in association with the city of St. Cloud, will issue a certificate to all amateurs who contact our special event station WØSV. Suggested frequencies 3.915, 14.305, 21.385, and 28.620 MHz. On phone listen for CQ St. Cloud 125th Birthday. Send your QSL with S.A.S.E. to George Frederickson, KCØT, R.R. 2, Box 352, South Haven, MN 55382.

MAY 2nd AND 3rd: The L'Anse Creuse A.R.C. of Mount Clemens, Michigan will operate from the Mount Clemens Train Depot from 1400 UTC May 2nd to 2000 UTC May 3rd. Boyhood home of Thomas Edison. Operation will be 14 kHz from the bottom of the General phone bands, 40 kHz from the bottom of the General CW bands and 15 kHz from the top of the Novice bands using the call sign W8LC. Special 8½ x 11 QSL certificates will be available to all stations worked. QSL with a size 10 or larger S.A.S.E. to L'Anse A.R.C., W8LC, P.O. Box 72, Utica, Michigan 48087.

MAY 6th AND 7th: The New York State QSO party from 1700 UTC on May 6th to 0500 UTC on May 7th and from 1200 UTC to 2359 UTC May 7th. Once on phone and once on CW. Signal report, serial number and New York county, state, providence or country. Phone: 3900, 7275, 14285, 21375, 28550. CW: 1810, 3560, 7060, 14060, 21060, 28060. Novice: 3725, 7125, 21125, 21825. Logs by June 16th. Send logs to: Mike Bucklaew, KA2KQP, 831 Dodge Rd., Getzville, NY 14068. Results S.A.S.E.

MAY 9th: Help us celebrate the Rogers, Arkansas Centennial Year on Saturday, May 9th, 1981 by working one of the Official Centennial Amateur Radio Stations. K5BP call letters will be used about 7,283 kHz LSB or 21,363 kHz USB from 1400 UTC to 2200 UTC. Send confirming QSL card with a #10 large S.A.S.E. to K5BP, Dept. 1881, Gen. Del., Rogers, Arkansas 72756 to receive an Official Centennial Certificate.

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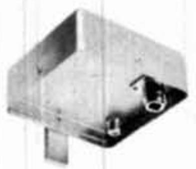

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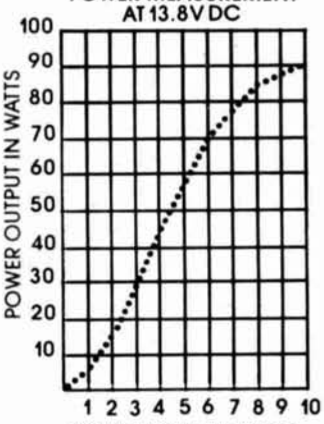

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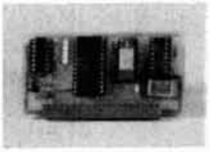

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NEW products

AEA CK-1 Morse Memory Keyer

Let's see. Paper, sharp pencils, check sheets, dupe log and coffee, plenty of it. It's Friday night, five minutes before the start of a 160-meter contest. I've finally got my station to the point that I feel I can be competitive with the big guns. But this year, I think I've got the edge on them. This year I have the new AEA CK-1 Morse Memory Keyer.

In past contests I've been limited to using a bug or straight key. Don't get me wrong, they're great to use, but in high-speed contesting I've never felt I was good enough to be competitive with them. Well, with all the new developments in chip technology, it was only a matter of time before some enterprising company designed a compact contest keyer. That company is Advanced Electronic Applications from Lynnwood, Washington.

description

The first impression one gets when opening the package is that instead of packing the CK-1 memory keyer, the dealer made a mistake and sent a pocket calculator. The keyer is extremely small, only 3.25 × 6 inches (8.3 × 15.2 cm) and very light, less than half a pound (0.22 kg). The layout is simple, with all switches, knobs and buttons easy to locate and operate. The keyboard is set up like a telephone Touch Tone™ pad. When you press the keys you get a positive feel, plus the keyer "bleeps" to let you know input has been made.

owner's manual

Probably the most important aspect of a product like this is the operating manual. Without a clear, concise set of instructions, operating the CK-1 would be impossible. AEA has gone to some time and trouble to put together one of the most complete instruction manuals I have ever seen. All keyer features are described completely, and all functions are explained step-by-step, with examples, so there can be no mistake when operating the keyer.

variable functions

One of my first thoughts was that since there was only one turnable control, you can't vary the sidetone, weighting, or speed. I was wrong. The CK-1 is like a microcomputer: you enter the appropriate data by hitting the appropriate sequence of numbers (buttons), and you can change the sidetone, weighting, or speed to whatever is most comfortable. You can also preset two speeds into the keyer. That's great when QSY'ing across the band and you want to either speed up or slow down.

memory

The most important operating feature of the AEA CK-1 is the variable-length memory. Ten separate memories can hold a total of approximately 500 characters. For the contest, I loaded a CQ into memory 1, signal report, section, and serial number into 2, and THANKS CU AGN into 3. Messages can be loaded in real time or automatically. In real time you send dots, dashes, and spaces. You've got to know exactly what you want to send, because if you pause, the CK-1 loads that pause. You can also load each memory automatically. When you stop sending, the memory stops loading information. This way, should you have any questions about what you're sending, you won't continue loading the keyer memory.

editing

Now, here is another real plus. Should you make a mistake, the CK-1 has an edit function that will eliminate the need to reload the entire memory. If you'd like to add something to an existing message, punch it up and let it run until you reach the point at which you'd like to add something. Stop the message by hitting either the paddle or # key. Set the keyer to MEMORY LOAD, press function keys * and 5, and, with the paddle, key in the change. Then switch back to MEMORY SEND and off you go again. To remove part of a message, set the keyer up as you would for an addition and run the memory to the point at which the deletion is to be made. Push * and 5 to program the keyer, then delete the remaining message. Just push # and it's done.

another feature

OK, now I have my CQ set up in memory 1, I've made memory 2 my RST, state, and serial number. Serial number? That's right. The CK-1 can automatically put an incremented serial number into any message register you'd like, 01 to 9999. To put the serial number into the keyer, load the message, then, at the point you want the serial number, push * and O and the serial number function is automatically initiated at 01. You can change that if you'd like to put any number in by pressing *, *, O, then the four-digit serial number. Sounds complicated, but it's really simple, easy, and fun.

Aha — there's a CQ. "PA0HIP DE N1ACH," I flash with the paddle. Got him. Press memory 2 and off goes the CK-1 "DE N1ACH. UR 599 599 NH NH DE N1ACH BK." I hit memory 3 for a quick 73 and tune some more. I never knew a contest could be this much fun.

Craig Clark, N1ACH

600-MHz prescaler

The TP 600 is a high-sensitivity prescaler which will extend the upper frequency limit of most frequency meters by a factor of 10, up to a maximum of at least 600 MHz. Input and output are via 50-ohm BNC connectors. Input impedance is nominally 50 ohms and input sensitivity better than 10 mV from 40 MHz to 600 MHz.

Power requirements are 6 to 9 Vdc from an external power supply or optional ac adapter. A lead is supplied fitted with the correct connectors to allow the unit to be powered from the auxiliary power socket fitted to Thandar frequency meters. Current consumption is 150 mA nominal, 170 mA maximum. Case size is 4.5 inches (114 mm) × 1.70 inches (43 mm) × 1.10 inches (28 mm); weight is 4.3 ounces (120 grams). This unit is available from stock, price $98. For further information, contact Henrick K. Gille, Energy Electronic Products, 6060 Manchester Avenue, Los Angeles, California 90045.

vhf omni-match

The LAR VHF Omni-Match takes a wide range of inputs, making antenna/feed lines look like nonreactive 50 ohms. The unit lowers SWR, for bigger output. It's versatile in the 144-174 MHz range, with continuous coverage of Amateur, marine, and private mobile radio bands. No switching.

The Omni-Match gives whole-band coverage on narrow-band antennas such as Yagis and quads. Just tune out the SWR. It's simple to install and tuned in seconds with only two controls. Write direct or contact your dealer. LAR Modules Limited, 60 Green Road, Leeds LS6 4JP England.

squeeze wrench

To use the Squeeze Wrench, just hold it in a stationary position and squeeze. Its strong torque action gets the job done fast and securely. For reverse action, just flip it over; it ratchets in either direction. The Squeeze Wrench comes in a 22-piece kit that contains both standard and metric sizes. The complete kit includes the Squeeze Wrench itself (9/16 inch and 14 mm); five standard size sockets: 1/4, 5/16, 3/8, 7/16, and 1/2 inches; five metric sockets: 9, 10, 11, 12, and 13 mm; two standard slot screwdrivers; two Phillips screwdrivers; six Allen wrenches, and one adapter for use with screwdriver and Allen wrench heads. All working components are heat treated to the highest standards.

The Squeeze Wrench kit comes with a lifetime warranty and guarantee of complete satisfaction or money back. Price is $24.95 per kit, postpaid, from Howard Products Company, Dept. HR, P.O. Box 57246, Dallas, Texas 75207.

high-voltage power transistors

Motorola announces a new series of silicon power transistors which extends the power handling capability of its plastic encapsulated devices above the 100-watt level. The new Motorola devices are packaged in the JEDEC TO-218AC plastic package, which has a large die mount and heat sink area. Like the familiar but smaller TO-220 plastic package, the TO-218 offers the convenience of single-sided mounting, thus reducing assembly labor costs.

The new series of plastic devices to be introduced by Motorola are the MJE4340 and MJE4350 series. These are complementary transistors with a continuous collector current rating of 10 amperes. V_{CEO} ratings range from 100 to 160 volts, and dissipate 125 watts. Contact Motorola Semiconductor Products, Inc., P.O. Box 20912, Phoenix, Arizona 85036.

ac power line protector

The series 2000 ac power line protector protects an entire facility from damage due to lightning and transient overvoltages. Protection is provided without power interruption. The protectors install at the main service panel (load side) and provide heavy-duty protection from lightning and transients that occur in tough industrial environments.

Operating in nanoseconds, the shunt-connected 2000 series protectors will vigorously clamp lightning and transient overvoltages on the ac lines to safe levels whenever the clamping threshold is exceeded. After each transient the protector recovers automatically — without power interruption. Nuisance circuit breaker tripping, so common with gas arrestors and crowbar devices, is eliminated. The 2000 series can withstand thousands of severe surges without degradation of electrical performance.

Long life and maintenance-free operation also make these units the perfect protector for remote and unattended stations, for facilities, or stations with no backup capabilities. The protectors are enclosed in a moisture-proof housing to ensure reliable operation in any environmental condition. Contact MCG, 160 Brook Avenue, Deer Park, New York 11729.

quartz digital clocks

Benjamin Michael Industries, Inc., announces the addition of the 173D Presentation Model clock to its line of quartz digital timepieces. The 173D contains two independent digital electronic clock movements. Greenwich Mean Time is displayed in 24-hour format on one clock and 12-hour time with AM/PM indicators on the other. Both large displays are of the LCD type. The 173D features quartz crystal accuracy along with one year of operation on a single, standard penlight battery. The clock features a solid walnut case which accentuates the rough cut, gold anodized, brushed aluminum face plate. Precious metal contact switches and brass hardware are used throughout.

The model 173D sells for $119.95 with keyways for wall mounting. A matching walnut desk stand may be ordered for an additional $9.95. Delivery is from stock within four weeks

Contact Benjamin Michael Industries, Inc., 65 East Palatine Road, Prospect Heights, Illinois 60070.

heavy duty towers

Designed especially with the ham operator in mind, Aluma Tower's new extra-heavy-duty aluminum tower has uprights and cross braces of 1-inch seamless drawn aluminum tubing, with stainless-steel aircraft cable connecting the telescoping sections. The mast is 2 inches in diameter × 8 feet long and is supplied bolted in place.

Aluma Tower's telescoping construction and tilt-up style enables it to withstand any weather conditions. Write Aluma Tower Company, 1639 Old Dixie Highway, Vero Beach, Florida 32960.

small-signal, low-noise transistors

TRW RF Semiconductors has published a new catalog containing detailed information on its family of 15 small-signal, low-noise transistors. Catalog 80 is a 52-page booklet that contains specifications, performance graphs, photographs, circuit diagrams, and package drawings and dimensions. All devices in the catalog are NPN silicon bipolar transistors with gold metallization.

Copies are available from any authorized TRW RF Semiconductors distributor or from Bernie Lindgren, Sales Manager, TRW RF Semiconductors, 14520 Aviation Boulevard, Lawndale, California 90260.

short-form rf catalog

TRW RF Semiconductors has published a large-format, 12-page, short-form catalog, number 503A, that lists basic specfications for 156 components.

Ten categories of products are shown, along with photographs and engineering drawings of each package type. There are an alphanumeric index and a cross-reference table.

Copies are available from any TRW RF Semiconductors sales office or authorized distributor, or from Dan Faigenblat, TRW RF Semiconductors, 14520 Aviation Boulevard, Lawndale, California 90260.

five-mode terminal

A five-mode sending terminal, by Curtis Electro Devices, offers keyboard origination of Morse, ASCII, and Baudot codes in addition to being a paddle keyer, code practice generator, and contest memory unit.

Features include a 256-key sending buffer and a 256-key soft sectored message memory with up to four callups. The two-key lockout and fully debounced keyboard offers all domestic, European, and many commercial prosigns for CW, all Baudot characters and upper and lower ASCII communications characters. Automatic line length control, word wraparound, hold, and backspace make sending easy and error-free. All LTRS and FIGS shifts are automatic in the Baudot mode.

Pot controls are provided for speed, weight, pitch, and volume, together with meter displays of Morse speed and buffer status. Output is via mercury relays for the keyline and PTT (or KOS) line. RTTY output is a loop switch. The message memories include three fixed preambles (CQ, CQ TEST, ID and QRS) plus up to four programmable memories.

Powered by either ac or +12 Vdc, the KB-4900 measures 12 × 8½ × 4½ inches and weighs 5 pounds. It is priced at $379.95 FOB the factory. Write Curtis Electro Devices, Inc., Box 4090, Mountain View, California 94040.

speech compressor/ expander

VSC Corporation has introduced the VSC Model AV3, which uses the Wollensak Bi-Peripheral Drive to insure long-term, reliable performance. A simple movement of the VSC speed control lever plays any standard audio cassette from 60 percent to 2½ times normal speed, or about 90 to 275 words per minute, without pitch distortion.

VSC operates by sampling the high-frequency speeded audio signal at subaudible rates and discarding every other sample. The remaining samples are then stretched out, returning them to their original frequencies and filling the gaps left by the discarded samples. These remaining samples are joined in a way that minimizes splicing noise. With VSC the actual "stretching" of the signal samples is accomplished with a variable delay line for which a low-noise bucket brigade device (BBD) can be used.

VSC speed listening is used by students, businessmen, and professionals who review recorded lectures, meetings, notes, professional updates, and dictation. The technology provides them with the flexibility to absorb recorded speech faster than the average person reads. Research shows that faster speeds increase concentration, which in turn improves comprehension. Additionally, the Model AV3 can provide high-speed inspection of printed circuit boards, wire wrapping matrices, cable harnesses and pin connections. Most importantly, VSC has virtually eliminated all proofing errors. The VSC Corporation expects the VSC feature to become popular on a wide array of audio equipment, including hand-held cassette players, auto cassette decks, telephone answering machines, dictating/transcribing units, and film and video editing equipment.

The Model AV3 offers separate tone control to adjust sound for maximum clarity and comfort, cue and review, digital tape counter, and remote pause control. An open cassette chamber makes loading a breeze and readily accepts minicassette adapters. Headphone, microphone and foot pedal jacks are included. The compact and impact-resistant speech compressor/expander comes with a handle and locking cover for easy portability and storage. This top-of-the-line VSC unit weighs 8.5 pounds and is available for $495 from VSC, 185 Berry Street, San Francisco, California 94107.

512-MHz digital frequency counter

Heath Company has announced the introduction of a new 512-MHz portable frequency counter, available either in kit form or assembled. The IM-2420 features four gate times and eight-digit resolution for precise readings. A period function gives cycle time in seconds, while the frequency ratio function provides the ratio between two input frequencies.

For more accurate measurements, a standby power switch can keep the crystal oven warm for maximum frequency accuracy. The oven is proportionally controlled to keep the internal time base within 0.1 part per million over a wide temperature range. The IM-2420 also has provisions for using external time base signals. Four gate times and a large, 0.43-inch-high, eight-digit LED display provide the resolution necessary to measure UHF signals. The IM-2420's 4-15 mV typical sensitivity allows counting of low-level signals. Trigger level control ensures stable counting when noise is present, and provides more accurate measurement of complicated waveforms. Frequency measurements can be made by direct connection, or by using the optional SMA-2400-1 swiveling telescopic antenna. The IM-2420 frequency counter can be wired for either 120 or 240 Vac operation.

The Heathkit IM-2420 512-MHz frequency counter is mail order priced at $239.95, F.O.B. Benton Harbor, Michigan 49022. A factory assembled and tested version, SM-2420, is also available, mail order priced at $299.95. Write Heath Company, Dept. 350-660, Benton Harbor, Michigan 49022. In Canada, write Heath Company, 1480 Dundas Highway East, Mississauga, Ontario L4X 2R7.

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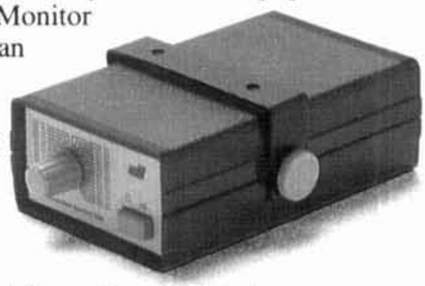

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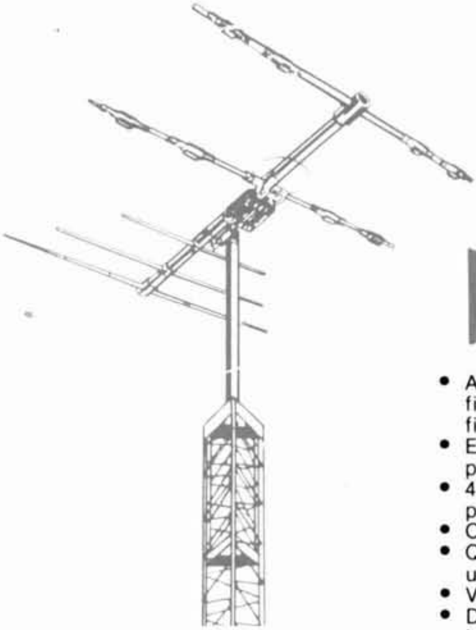

ETO ALPHA 77DX Amplifier

- Alpha 77DX: The ultimate amplifier for those who demand the finest.
- Eimac 8877 Tube — 1500 watts of plate dissipation.
- 4.4 KVA Hypersil®, removable, plug-in Transformer.
- Oil-filled, 25 mfd Filter Capacitor.
- QSK CW: Full break-in, (2) vacuum relays.
- Vacuum Tuning Capacitor.
- Ducted air cooling, large, quiet blower, computer grade.
- Warranty (limited) 24 months, tube by Eimac.
- Other ALPHA's: 78, 76CA, 76PA, 76A, 374A, 77SX (Export Only).

Telrex

LABORATORIES

"MONARCH" 10, 15, 20 Meter "Tri-Band" Model TB5EM/4KWP

signal/one CX-11-A Integrated Station

- POWER OUTPUT: 150 watts CW/SSB output all bands (2) MRF 422 Finals.
- OPTIONAL POWER OUTPUT: 200 to 225 Watts CW/SSB output
- SYNTHESIZED FREQUENCY COVERAGE: All amateur bands 1.8-30 MHz in full 1 MHz bands, plus 4 additional 1 MHz bands for future expansion.
- TWO PTO'S: Dual receiving, transceive on either, or split operation.
- QSK CW; Full break-in, vacuum relays. 300 Hz CW Filter built-in.
- SELECTIVITY: Two 8 pole plus one 4 pole filter deliver 20 pole 1.4:1 shape factor (6dB/60dB), plus post detection 1.5, 1.0, .4 and .1 kHz bandwidth.
- BUILT-IN A/C supply, 115/230V, 50/400 Hz, Hypersil® transformer. IF shift, noise blanker, RF clipping, CW keyer, notch/peak filter.
- SERVICING: Self service easiest of any transceiver by using gold-plated sockets for transistor and IC replacement.
- RELIABILITY: Less than 1% failure. 99% of problems resolved in field.
- QUALITY: All military and computer grade. 100% American made.
- PRICE $5900, mfg. by Signal/one Corp., Phoenix, AZ 85021.

Phone Don Payne, K4ID, for Special Prices, Brochure, and OPERATING EXPERIENCE on the CX-11A and Alphas.

PAYNE RADIO

Personal Phone — (615) 384-2224
P. O. Box 100, Springfield, Tenn. 37172

WARC BANDS FACTORY INSTALLED!

FT-707 is shown with optional FV-707DM VFO & Scanning Microphone

THE FT-707 "WAYFARER"

The introduction of the "WAYFARER" by Yaesu is the beginning of a new era in compact solid state transceivers. The FT-707 "WAYFARER" offers you a full 100 watts output on 80-10 meters and operates SSB, CW, and AM modes. Don't let the small size fool you! Though it is not much larger than a book, this is a full-featured transceiver which is ideally suited for your home station or as a traveling companion for mobile or portable operation.

The receiver offers sensitivity of .25 uV/10 dB SN as well as a degree of selectivity previously unavailable in a package this small. The "WAYFARER" comes equipped with 16 poles of IF filtering, variable bandwidth and optional crystal filters for 600 Hz or 350 Hz. Just look at these additional features:

FT-707 with Standard Features

- Fast/slow AGC selection
- Advanced noise blanker
- Built-in calibrator
- WWV/JJY Band
- Bright Digital Readout
- Fixed crystal position
- Factory-installed WARC bands
- Unique multi-color bar metering—monitors signal strength, power output, and ALC voltage.

FT-707 with Optional FV-707DM & Scanning Microphone

- Choice of 2 rates of scan
- Remote scanning from microphone
- Scans in 10 cycle steps
- Synthesized VFO
- Selection of receiver/transmitter functions from either front panel or external VFO
- "DMS" (Digital Memory Shift)

Impressive as the "WAYFARER" is its versatility can be greatly increased by the addition of the FV-707DM (optional). The FV-707DM, though only one inch high, allows the storage of 13 discrete frequencies and with the use of "DMS" (Digital Memory Shift) each memory can be band-spread 500 KHz. These 500 KHz bands may be remotely scanned from the microphone at the very smooth rate of 10 Hz per step.

The FT-707 "WAYFARER" is a truly unique rig. See it today at your authorized Yaesu Dealer.

YAESU
The radio.

381

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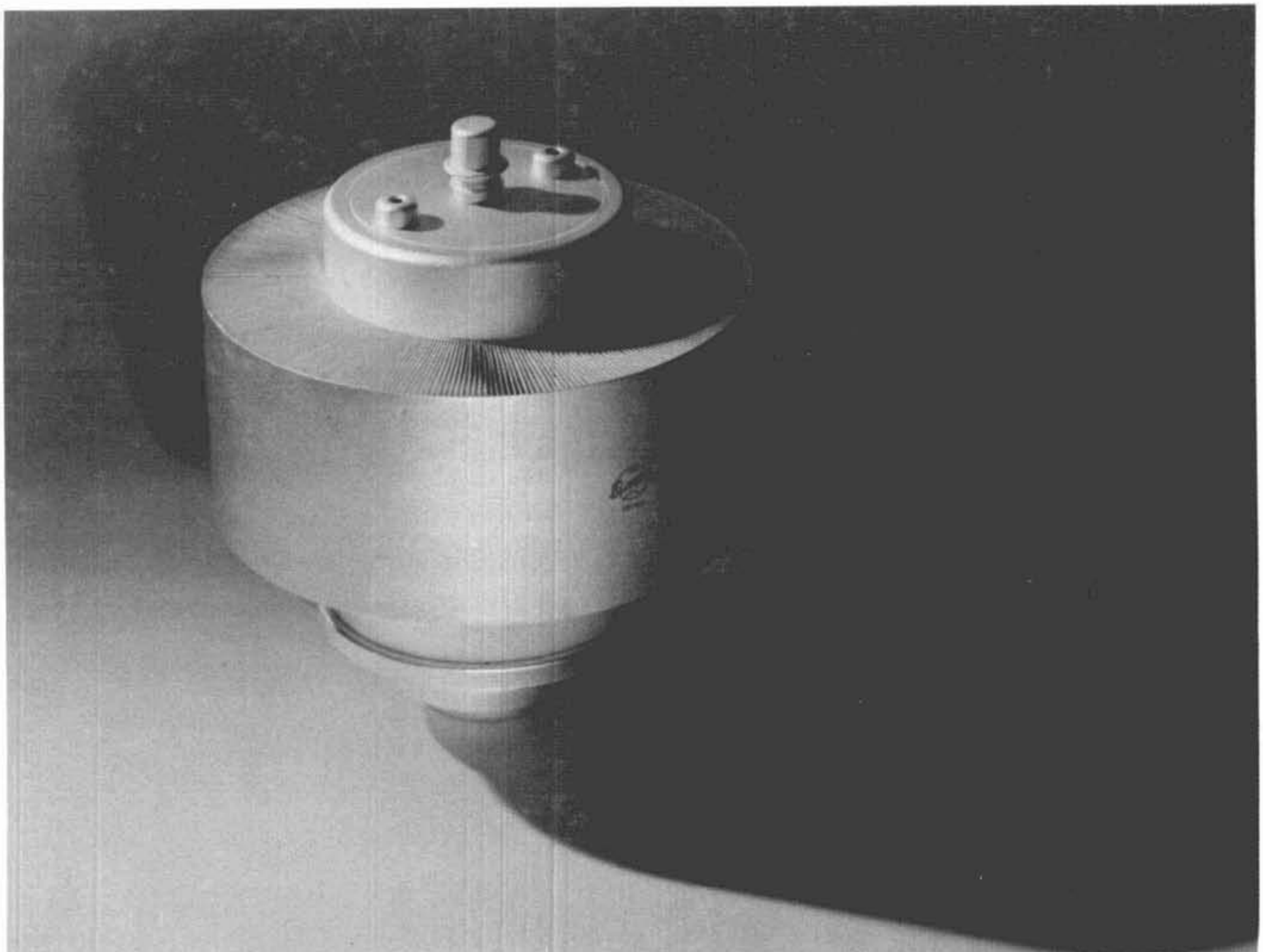
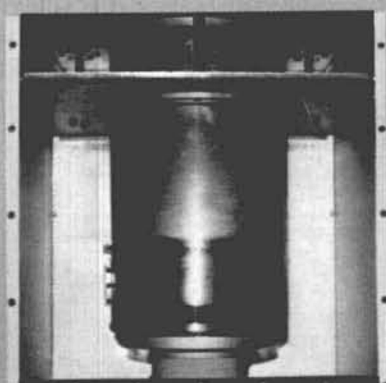


50 kW VHF power, greater efficiency. 4CX40,000G tetrode and cavities from Eimac.

Eimac's new CV-2200 series of practical, low-cost cavities are available now. Combined with Eimac's 4CX40,000G VHF tetrode, this efficient, compact package is recommended for FM broadcast service, VHF-television, particle acceleration and VHF radar.

Generating a measured power output of 60 kW, the 4CX40,000G tetrode offers power gains of 20 dB up to 218 MHz. High stability is achieved with the pyrolytic graphite grid structure. And a highly efficient, economical and quiet anode cooling system is inherent in its design.

Eimac supplies cavity and tube to match your requirements. We back it up with know-how and application engineering information.



50 kW FM broadcast cavity CV-2200 with 4CX40,000G tetrode.

More information is available from Varian Eimac Division. Or the nearest Varian Electron Device Group sales office. Call or write today.

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San Carlos, California 94070
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