NOVEMBER 1981
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HAM RADIO HORIZONS

ham radio magazine

designer's challenge:

RECEIVER OF THE FUTURE

tempo does it again

THE WORLD'S FIRST 440 MHz SYNTHESIZED HAND HELD RADIO

Tempo was the first with a synthesized hand held for amateur use, first with a 220 MHz synthesized hand held, first with a 5 watt output synthesized hand held...and once again first in the 440 MHz range with the S-4, a fully synthesized hand held radio. Not only does Tempo offer the broadest line of synthesized hand helds, but its standards of reliability are unsurpassed...reliability proven through millions of hours of operation. No other hand held has been so thoroughly field tested, is so simple to operate or offers so much value. The Tempo S-4 offers the opportunity to get on 440 MHz from where ever you may be. With the addition of a touch tone pad and matching power amplifier its versatility is also unsurpassed.

The S-4...$349.00
With 12 button touch tone pad...$399.00
With 16 button touch tone pad...$419.00
S-40 matching 40 watt output 13.8 VDC power amplifier...$149.00

Tempo S-I

The first and most thoroughly field tested hand held synthesized radio available today. Many thousands are now in use and the letters of praise still pour in. The S-1 is the most simple radio to operate and is built to provide years of dependable service. Despite its light weight and small size it is built to withstand rough handling and hard use. Its heavy duty battery pack allows more operating time between charges and its new lower price makes it even more affordable.

Tempo S-5

Offers the same field proven reliability, features and specifications as the S-1 except that the S-5 provides a big 5 watt output (or 1 watt low power operation). They both have external microphone capability and can be operated with matching solid state power amplifiers (30 watt or 80 watt output). Allows your hand held to double as a powerful mobile or base radio.

S-30...$89.00* S-80...$149.00*

*For use with S-1 and S-5

Tempo S-2

With an S-2 in your car or pocket you can use 220 MHz repeaters throughout the U.S. It offers all the advanced engineering, premium quality components and features of the S-1 and S-5. The S-2 offers 1000 channels in an extremely lightweight but rugged case. If you're not on 220 this is the perfect way to get started. With the addition of the S-20 Tempo solid state amplifier it becomes a powerful mobile or base station. If you have a 220 MHz station, the S-2 will add tremendous versatility.

Price...$349.00 (With touch tone pad installed...$399.00)
S-20...$89.00

Specifications:

Frequency Coverage: 440 to 449.995 MHz
Channel Spacing: 25 KHz minimum
Power Requirements: 9.6 VDC
Current Drain: 17 ma-standby 400 ma-transmit (1 amp high power)
Antenna Impedance: 50 ohms
Sensitivity: Better than .5 microvolts nominal for 20 db
Supplied Accessories: Rubber flex antenna 450 ma ni-cad battery pack, charger and earphone
RF output Power: Nominal 3 watts high or 1 watt low power
Repeater Offset: ± 5 MHz

Optional Accessories for all models

12 button touch tone pad (not installed): $39 • 16 button touch tone pad (not installed): $48 • Tone burst generator: $29.95 • CTCSS sub-audible tone control: $29.95 • Leather holster: $20 • Cigarette lighter plug mobile charging unit: $6

TEMPO VHF & UHF SOLID STATE POWER AMPLIFIERS

Boost your signal. . . give it the range and clarity of a high powered base station. VHF (135 to 175 MHz)

Drive Power	Output	Model No.	Price
2W	130W	130A02	$209
10W	130W	130A10	$189
30W	130W	130A30	$199
2W	80W	80A02	$169
10W	80W	80A10	$149
30W	80W	80A30	$159
2W	50W	50A02	$129
2W	30W	30A02	$ 89

UHF (400 to 512 MHz) models, lower power and FCC type accepted models also available.

Please note, as of Dec. 1, 1980 we will occupy our new world headquarters building with a new Los Angeles address and phone number.

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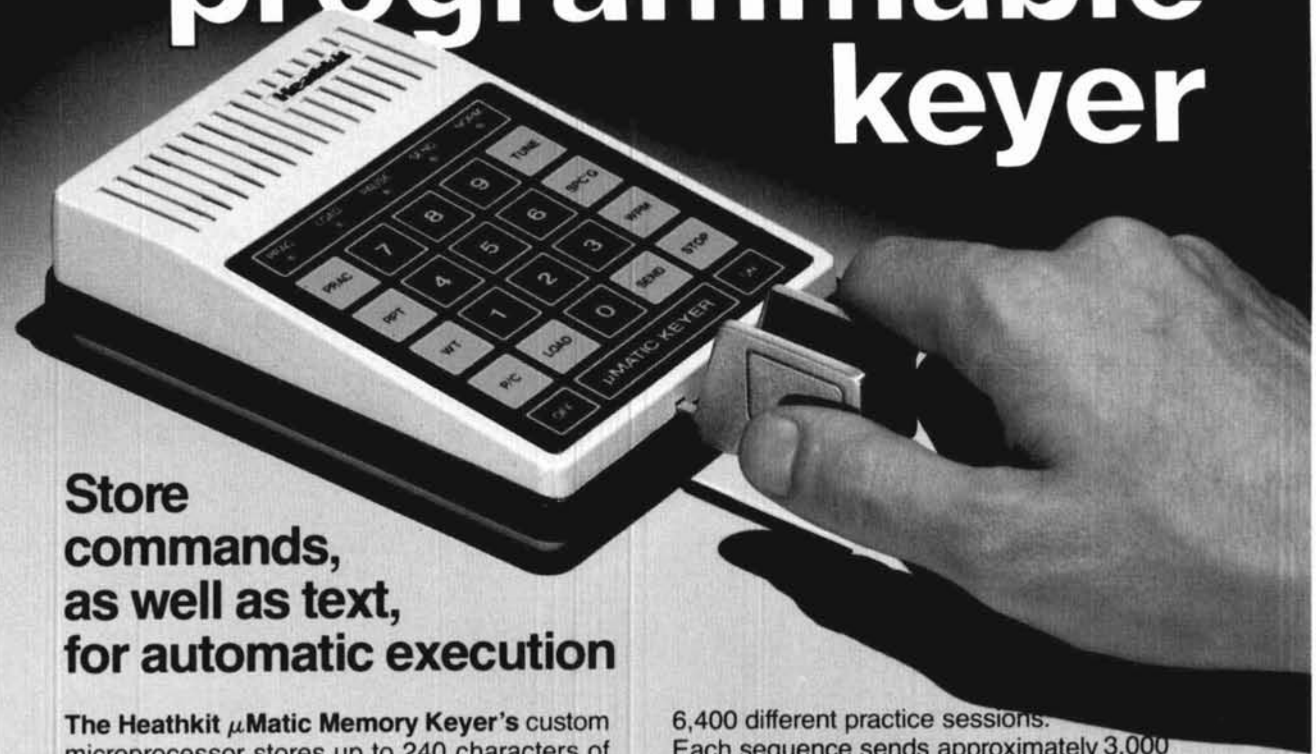
Introducing the first fully programmable keyer



Store commands, as well as text, for automatic execution

The Heathkit μMatic Memory Keyer's custom microprocessor stores up to 240 characters of text or commands. *Variable-length buffers* eliminate wasted memory space. "Command strings" allow text to be stored in several buffers, then strung-together in any sequence for most efficient use of memory. Command strings can also select speed, weight, spacing and auto-repeat count.

No external key to buy

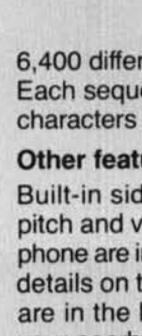
Integral capacitive "touch" paddles unplug and store in their own compartment inside the Keyer when not in use. Left handed? A touch of the keypad and the paddles are reversed. Choose any speed between 1 and 99 words per minute, and any of 11 weight settings. Special rear-panel jack connects mechanical paddle.

Great code practice machine, too

A "practice" mode sends random code groups of random length and selectable types for a total of 6,400 different practice sessions. Each sequence sends approximately 3,000 characters before repeating.

Other features:

Built-in sidetone oscillator and speaker have pitch and volume controls. Phone jack and earphone are included for private listening. Complete details on the great new μMatic Memory Keyer are in the latest Heathkit Catalog. Or see it at your nearby Heathkit Electronic Center.*



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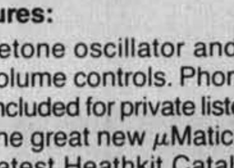

Where Heathkit products are displayed, sold and serviced. See your telephone white pages for locations.

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contents

Observation & Opinion

Now is your chance to make a real contribution to Amateur Radio. The FCC has authorized the operation of an experimental beacon on the new WARC bands of 10.100-10.150, 18.068-18.168 and 24.890-24.990 MHz. As you read this, the beacon will have been in operation about a month, and quantitative information is needed regarding the reception of signals.

The experiment is intended to permit Amateurs to become familiar with the characteristics of these bands, which will help to simplify the scheduled future change-over to full Amateur use. The experiment will improve Amateur use of these new parts of the spectrum and will provide data on sharing between different services. An important element is obtaining data on propagation under weak-signal conditions, typical of natural disaster situations. It should be remembered that this use is one of the major reasons for these new authorizations, the first in many years.

The experiments will include two types of emission, three operating modes and two time phases. Basic emission is unmodulated carrier (AØ), which will be interrupted each ten minutes for an SSB (2.8A3J) identification and announcement. The voice announcement will occur at 2, 12, 22 . . . minutes past the hour. The announcement will be of the form, "This is FCC-authorized experimental station KK2XJM, Daytona Beach, Florida. QSL via W4MB. Next operation will be repeated on __________ MHz starting on __________," and will be repeated. The announcement will be made by a woman, as the timbre of the female voice makes speech easier to recognize under unfavorable conditions.

Initial operations will commence about the first of October, using 3 watts ERP on the 10-MHz band. Depending on results, the operating schedule will include the 18- and 24-MHz bands. Later phases will include operation at 30 watts ERP, with sequencing from band to band, sometimes weekly and sometimes daily, as needed to make optimum use of the bands for propagation experiments both worldwide and to specific areas.

The licensee for the experiment is Bob Haviland, W4MB. Bob is well qualified for this important task. He has been an Amateur for 50 years and has participated in numerous CCIR and ITU conferences and preparatory work. He was chairman of the 28-1215-MHz allocation subcommittee of the FCC's WARC Advisory Committee for Amateur Radio, project engineer of the program that placed the first radio transmitter beyond the ionosphere, and has worked extensively on communications and broadcast satellites. Bob published the first known proposal for an Amateur Radio experiment on a satellite. Additionally, he has been on a number of DXpeditions, having operated from four continents. And, not incidentally, Bob has been a prolific contributor to *ham radio*, having published some nine articles over the years.

The success of the experiment will depend on participation by Amateurs and shortwave listeners, and on their reports. Information needed is the date, time and location of reception, strength of the beacon signal and other signals on the band, and the type of receiving installation including, of course, the antenna. All reports will be acknowledged by a QSL card.

In addition to reception reports, proposals for special tests will be welcomed, subject to the limitations imposed by the license and by regulations for experimental stations. KK2XJM is not authorized to communicate with Amateur stations; however, reports, requests for schedules and proposals for experiments may be sent to W4MB's *Callbook* address.

This venture is a fine opportunity for everyone to contribute to the advancement of Amateur Radio. A QSL card from W4MB acknowledging participation in the experiment certainly should become a valuable reminder of an important phase of Amateur-Radio development.

Alf Wilson, W6NIF
editor

ICOM IC-720A

Multi mode operation includes CW/AM/SSB/RTTY — Normally used side band selected automatically.

Simple to use Dual VFO's standard Data transfer button for marking a frequency of interest and storing it in unused VFO.

Continuously variable power from 10W to full power — speech processor — LDA channeling module included provides auto band changing capability when increasing your power using the IC-2KL broad banded solid state linear.

Broadbanded solid state transceiver operation on the 9 amateur HF bands — Readout of mode in use and VFO — Status LEDs for push button functions.

General coverage receiver from 0.1KHz to 29.999.9MHz — Split VFO operation — Frequency memorized in standby VFO.

Use of RF/ALC switch in conjunction with the internal top hatch cover switches allows monitoring relative RF Out, SWR, collector current and ALC.

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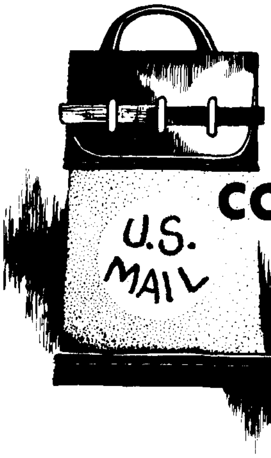
All stated specifications are approximate and subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions.



comments

work the Pacific

Dear HR:

I would like to inform your readers of the basic Work The Pacific award, which is issued for thirty confirmed contacts on the WTP country list. It's available to any licensed Amateur Radio operator and to SWLs.

Mode, band, power level, and other endorsements will be made upon request with the original application only. The award is printed in four colors on a beautiful parchtone bond.

For more information, please contact me at the address below.

Award Manager, C.H.C.
Scott R. Douglas, Jr., KB7SB
P.O. Box 46032
Los Angeles, California 90046

zero beat

Dear HR:

The July, 1981, issue of *ham radio* arrived today. Naturally, the point of first reading was the "Observation and Opinion" page relative to transceivers and zero beating. Oddly, the timing was in itself a true zero beat for a project completed several weeks ago on a unique (and modified) circuit by Jerry Assard, KA1EVW, which appeared in the March, 1979, issue of *Electronic Design News*, entitled "Lamps Monitor Beat Frequency."

I built the device with modifications stemming directly from my totally home-brewed rig, which demanded some strange and totally unique approaches both to transceive and shift-band transmissions that many of the rare DXers employ.

The basic capability of the Assard system may well be adapted to any number of other uses related to and stemming from the article. I will be happy to supply the complete circuitry (with full credit to Jerry Assard for his original and fine thinking) to any ham interested in applying this useful tool. Please send a self-addressed, stamped envelope to P.O. Box 6175.

Gene Shapiro, WØDLQ
Leawood, Kansas 66206

more free inductors

Dear HR:

In my recent CW filter articles (*QST*, December, 1980, and *ham radio*, April, 1981), I stated that I was serving as liaison between the Chesapeake and Potomac Telephone Company of Maryland and the Amateur fraternity, assisting in the distribution of surplus telephone line 88-mH loading coils. These inductors are being given to Radio Amateurs free (except for my shipping expenses) as a public service by the C & P Telephone Company.

I've processed more than fifty requests for inductors so far, but now the initial response to these two articles is quieting down. I would appreciate it if you would mention in your magazine that I still have inductors (88-mH inductors in a five-inductor stack form). They are available to anyone interested in applying them to Amateur Radio filtering applications. Write to me at my *Callbook* address explaining your need and proposed application. A stamped, self-addressed envelope must be included for my reply with further instructions.

Ed Wetherhold, W3NQN
Annapolis, Maryland

antenna restrictions

Dear HR:

Most people worry only about the zoning ordinances and building permits that may be needed for the installation of ham antenna systems. But it's necessary to check your deed and the title to your land to see whether there are any protective covenants that prohibit the placing of any tower, pole, or similar structure on your own property. These restrictions will also appear in the title search of your property when you buy a home.

You may not be aware that you waived your rights (or you may not have been aware of your rights) when you made settlement on your house and land, legally binding yourself to these protective covenants. These covenants were originally designed to protect all the homeowners in your housing development for esthetic reasons, to enhance the neighborhood's appearance and to keep property values from declining. These covenants may be part of the land and deed for as long as 10 to 25 years, and, at that time, they may be automatically renewed for another 10 to 25 years unless changed by the members of your housing development. Violation of any one or more of these covenants could result in litigation against you by a neighbor or neighbors, and much time and money spent in the courtroom.

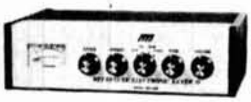
These covenants are another blow against the ham radio operator, who may not even be able to use his own land for the installation of his dream antenna farm. It appears that more and more single-home housing developments, townhouses, twin homes, duplexes, condominiums, and apartments are placing more and more antenna restrictions on their buildings for esthetic reasons, and in turn these restrictions are slowly taking away your rights.

Take it from one who has been that route and knows from first-hand experience. Check the agreement of sale and deed before you sign on that dotted line. Don't spend hundreds, or thousands, of dollars in the courtroom, or be forced by a judicial court order to dismantle your antenna system.

Robert N. Wilderman, K3SRO
Lansdale, Pennsylvania

MFJ KEYERS

Uses Curtis 8044 IC. Iambic operation, dot-dash memories, weight control, solid state keying. RF proof.



$79⁹⁵

The MFJ-408 Deluxe Electronic Keyer sends iambic, automatic, semi-automatic, manual. Use squeeze, single lever or straight key.

Speedmeter lets you read speed to 100 WPM.

Socket for external Curtis memory, random code generator, keyboard. Optional cable, $4.95.

Iambic operation with squeeze key. Dot-dash insertion. **Semi-automatic "bug" operation** provides automatic dots and manual dashes.

Dot-dash memory, self-completing dots and dashes, jam-proof spacing, instant start. **RF proof.**

Solid-state keying: grid block, solid state xmtrs.

Front panel controls: linear speed, weight, tone, volume, function switch. 8 to 50 WPM.

Weight control adjusts dot-dash space ratio; makes your signal distinctive to penetrate QRM.

Tone control. Speaker. Ideal for classroom.

Function switch selects off, on, semi-automatic/manual, tune. Tune keys transmitter for tuning.

Uses 4 C-cells. 2.5 mm jack for power (6-9 VDC). Optional AC adapter MFJ-1305, $9.95.

Eggshell white, walnut sides. 8x2x6 inches.

MFJ-406, $69.95, like 408 less speedmeter.

$49⁹⁵

New MFJ-401 Econo Keyer II gives you a reliable, full feature economy keyer for squeeze, single lever or straight key.

Has sidetone, speaker, volume, speed, internal weight and tone controls. Sends iambic, automatic, semi-automatic, manual. Tune function. Dot-dash memories. 8-50 WPM. "On" LED. Use 9V battery, 6-9 VDC, or 110 VAC with optional AC adapter, MFJ-1305, $9.95. 4x2x3½".

Reliable solid state keying. Keys virtually all solid state or tube type transmitters.

$64⁹⁵

MFJ-405 Econo Keyer II. Same as MFJ-401 but has built-in single paddle with adjustable travel. Also jack for external paddle. 4x2x3½".

Optional: Bencher Iambic Paddle, $42.95; 110VAC adapter, MFJ-1305, $9.95. **Free catalog.**

Order from MFJ and try it. If not delighted, return within 30 days for refund (less shipping).

One year unconditional guarantee.

Order yours today. Call toll free 800-647-1800. Charge VISA, MC. Or mail check, money order. Add $4.00 each for shipping and handling.

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Box 494, Mississippi State, MS 39762

MFJ VLF CONVERTER

Receive 10-500 KHz on Ham rig or SWL receiver.

$79⁹⁵

Plug this MFJ VLF Converter between your antenna and Ham transceiver or SWL receiver and tune the VLF 10-500 KHz band.

Hear weather, ship-to-shore CW traffic, RTTY, WWVB, navigation beacons, 1750 meter no license band, European broadcast, and more.

MFJ-332 Ham version converts 10-500 KHz to 28.010 to 28.500 MHz. Also adds standard broadcast band on 28.5 to 29.7 MHz. **MFJ-331 SWL version** converts to 4.010 to 4.500 MHz.

Read frequency directly on your receiver (ignore MHz).

Low noise amplifier, 6 pole lowpass filter, double balanced mixer, crystal oscillator gives very sensitive and stable, BCB interference-free signals.

On/off-Bypass switch. LED for power. SO-239 coax connectors. 3x4x1 inches. Black, eggshell white aluminum cabinet. 9-18 VDC or 110 VAC with optional AC adapter, MFJ-1312, $9.95.

VLF/MW/SWL Antenna Tuner

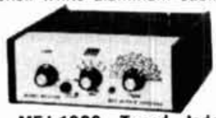
Greatly improves 10KHz to 30 MHz reception.

$69⁹⁵

This MFJ-955 VLF/MW/SWL preselecting antenna tuner greatly improves reception of 10KHz thru 30 MHz signals, especially those below 2 MHz.

Lets you peak desired signals while rejecting interference. Reduces overload, background noise, crossmodulation, and intermodulation. VLF signals come roaring in.

Switch between two antennas and two receivers. Bypass position connects antenna directly to receiver. 5½x2x3 inches. Black, eggshell white aluminum cabinet.



$79⁹⁵

MFJ-1020 Tuned Indoor Active Antenna. Can often exceed reception of outside longwire. Covers 300 KHz to 30 MHz. Has telescoping antenna. Minimizes intermod, provides RF selectivity, reduces noise. Also use as preselector.

Order from MFJ and try it. If not delighted, return within 30 days for refund (less shipping).

One year unconditional guarantee.

Enjoy VLF. Order yours today. See dealer or call MFJ toll free 800-647-1800. Charge VISA, MC. Or mail check, money order. Add $4.00 each for shipping and handling.

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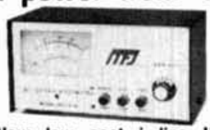
MFJ SWR/ WATTMETERS

MFJ HF SWR/Wattmeter reads SWR, forward, reflected power from 1.8-30 MHz.



$49⁹⁵
MFJ-814

New low cost in-line HF SWR/Wattmeter.

MFJ-814 lets you monitor SWR, forward, reflected average power in 2 ranges from 1.8 to 30 MHz. Read 200/2000 watts forward, 20/200 watts reflected power. SWR, 1:1-6:1.

Easy push-button switch operation: has power/SWR, high/low range, forward/reflected push-button switches. SWR sensitivity control.

Lighted meter (requires 12V). Rugged aluminum eggshell white, black cabinet. 6¼x3¼x4¼". SO-239 coax connectors, 2 color meter scale.

MFJ VHF SWR/Wattmeter/ Field Strength Meters

$29⁹⁵
MFJ-812

New low cost VHF operating aids.

MFJ-812, $29.95: Read SWR from 14 to 170 MHz to monitor antenna and feedlines.

Read forward and reflected power at 2 meters (144-148 MHZ). 2 scales (30 and 300 watts).

Read relative field strength from 1 to 170 MHz. Binding post for field strength antenna.

Easy push-button operation: has forward/reflected and SWR/field strength push-buttons.

Aluminum eggshell white, black cabinet. 4¼x2¼x2¾". SO-239. 2 color meter scale.

MFJ-810, $24.95: similar to MFJ-812 less field strength function.

MFJ "Dry" 300 W and 1 KW Dummy Loads.

$64⁹⁵ **$26⁹⁵**

MFJ-262 **MFJ-260**

Air cooled, non-inductive 50 ohm resistor in perforated metal housing with SO-239 connectors. Full load for 30 seconds, de-rating curves to 5 minutes. **MFJ-260 (300 W).** SWR: 1.1:1 to 30 MHz, 1.5:1 for 30-160 MHz. 2½x2½x7". **MFJ-262 (1KW).** SWR 1.5:1-30 MHz. 3x3x13".

MFJ-10, 3 foot coax with connectors, $4.95.

Order from MFJ and try it. If not delighted, return within 30 days for refund (less shipping).

One year unconditional guarantee.

Order yours today. Call toll free 800-647-1800. Charge VISA, MC. Or mail check, money order. Add $4.00 each for shipping and handling.

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presstop

THE ARRL DIRECTORS CONSIDERED organizational changes proposed by the Long Range Planning Committee, the Central Division Recall, changes in subbands and bandplans, a new ARRL periodical, its Washington representation, and a host of other topics when it met in Newington September 9-10.

The Long Range Planning Committee proposed an extensive reorganization of the League at the state and local level, with a newly created post of Section Manager for each of the 73 sections, creation of division steering committees, and redesign of the Advisory Committees with a representative from each division serving on each AC. This program was endorsed by the board, which asked for specific plans, cost information, and implementation timetables for consideration at the next board meeting.

The Central Division Recall and Bylaw 20 were both considered at length, but no action was taken on various proposed changes in the recall bylaw because of the pending recall vote. However, the board did vote to permit Director Metzger to include a statement in his own behalf with the recall ballot (along with statements by the ARRL and the Indiana Radio Club Council), an addition that was agreed to by the Executive Committee.

The Proposed 160 Meter Bandplan (August QST) was adopted unanimously based on the very favorable response to the article in QST, but the previously passed motion to expand 40-meter Extra phone privileges was withdrawn. The board also voted unanimously to petition the FCC to expand General-class phone on 75 down to 3860, and to permit the "automatic control" of beacons. It also adopted 20-kHz channel spacing for the 144.5-145.5 repeater subband, and requested completion of bandplans for both 6 meters and 23 cm in time for the 1982 annual meeting of the board.

A New Beginner/Novice Periodical may be in the offing. The General Manager, Membership Affairs Committee, and Plans and Programs Committee were directed to study the feasibility of such a publication with a report due at the first 1982 board meeting. The board also voted to establish a separate ARRL publications price list for members buying them from Headquarters, to go into effect no later than January, 1983.

Improved Washington Liaison efforts, the tightening of the regulations for single-mode DXCC awards, the extension of all current Advisory Committee appointments pending further consideration of the Long Range Planning Committee's recommendations on AC makeup, and even a review of the usefulness of the "T" in RST CW reports were also voted on in this far ranging session.

OBSCENE LANGUAGE ON THE AIR should no longer be an FCC problem, the Commissioners voted September 17 in a wide-ranging recommendation to Congress for changes in the Communications Act. Although most of the Commissioners' proposals dealt with the regulation of broadcasting, proposals pertaining to the question of obscenity will affect the Amateur service (and other services) as well.

The Commissioners Voted unanimously to drop their right to revoke a station license for violation of obscenity statutes, and voted 4 to 2 in favor of amending Section 326 to strip the Commission of "any power of censorship over the content of communications." With obscene or other objectionable language no longer a concern of the Commission, any prosecution of foul-mouthed Amateurs would then go to the Justice Department.

A NEW RFI SOURCE is beginning to cause problems to Amateurs, particularly in rural areas. The troublesome device is the CMH, a multiplexer that provides eight multiplexed voice channels over a conventional phone line. The problem is in its switching-type power supply, which operates at 79 kHz and generates harmonics well into the VHF spectrum. These harmonics are radiated through the phone lines it is tied into.

CMH-Generated Interference shows up on the bands as slightly unstable signals that appear every 79 kHz.

THE "PLAIN LANGUAGE" AMATEUR RULES rewrite may be turning out to be a dead issue. In a letter to a Lincoln, Nebraska, Novice (KAØJYZ), Senator Barry Goldwater, K7UGA, stated that, "The rules changes in language have been stopped for the time being, and I think when we get better acquainted with the new head of the FCC we can forget all about them."

With The ARRL And Many Individual Amateurs lukewarm or even opposed to the rewrite as it is now proposed, the Goldwater opposition may very well be the signal of the demise of the rewritten Amateur rules.

BOB STANKUS (KESWICK SALES) pleaded not guilty to 22 counts of mail fraud at his first appearance before the judge on July 6. After some discussion between the lawyers, however, he decided to change his plea to guilty on 11 of the 22 counts in return for having the other 11 charges dropped. The court is now awaiting a probation report on Stankus, and after the report is received he will be sentenced for his part in the "bargain" TS-520S mail-order sale scheme.

1981 WINNERS OF THE EIGHT SCHOLARSHIPS that were administered by the Foundation for Amateur Radio are KAØDGT, WB7RVP, WA1WFA, WA2CUN, KA7BWC, KA5BOU, and KA2DYC. Congratulations to all.

communications receivers

for the year 2000

Part 1: New designs, microprocessors, input filters, and mixers

Some changes have occurred since my paper[1] appeared on optimum design for high-frequency communications receivers:

1. The sunspot cycle has given better propagation conditions.

2. Manually operated receivers have become "intelligent" with the advent of built-in microprocessors.

3. Receiver dynamic range has been increased with better amplifiers and mixers.

4. Blocking problems have diminished with better synthesizers.

5. Better dynamic performance of filters has improved reception on crowded frequencies (note that *dynamic* selectivity is not the same as *static* selectivity, which is discussed later).

6. Frequency resolution and acquisition have increased dramatically.

7. Up conversion avoids gaps in frequency coverage. Many new receiver designs use an LO and intermediate frequency higher than the highest frequency of reception.

8. Lowpass filters in the receiver front end, combined with suboctave filters, tunable circuits, or both, obtain constant image and i-f suppression. Such design guarantees image-response suppression and substantially reduces LO re-radiation.

9. As the output oscillator in a synthesizer has a range of less than 2:1, design of these oscillators has become simpler.

In retrospect I find that my earlier predictions have been substantially correct and that advances in technology, specifically in digital techniques and microprocessor design, have been much faster than in rf-circuit design.

What can we expect in the future? Let's look at today's communications-receiver technology in terms of the year 2000.

receiver specifications

Communications receivers are best described by their specifications. **Table 1** shows data for a communications receiver covering 10 kHz-30 MHz, and **table 2** shows specifications for a communications receiver covering 20 MHz-1000 MHz. These are clearly general-coverage receivers, and one may ask, What does this have to do with ham radio?

Most engineers working on Amateur receivers have had experience in commercial design, and while I've always said that the crowded ham bands are a greater challenge to the receiver designer (this holds true only for the shortwave area), general-coverage

By Ulrich L. Rohde, DJ2LR, 52 Hillcrest Drive, Upper Saddle River, New Jersey 07458

receivers monitor *all* frequencies and, therefore, must be able to survive this hostile environment — a real design challenge.

In terms of energy, there is now really more energy available for injection into the antenna of a VHF/UHF receiver than at the input of a VLF/HF receiver; and the dynamic range requirements for VHF/UHF receivers are now even higher because the noise floor is substantially lower than in receivers for the shortwave bands.

new approaches in design

Fig. 1 is a block diagram of a VLF/HF receiver with microprocessor control and other features. It's not very likely that this receiver will be smaller or better designed in coming years.

As we shall see later, dynamic range is determined by a) the mixer and the LO drive (a question of drive power and therefore power consumption), or by b) the dynamic range of the amplifiers (again, it becomes a question of power consumption versus dynamic range).

Let's look at the block diagram. As the receiver must handle extremely large signals at times (to the point where the input circuit can be burned out), an input attenuator is a good protective device.

Modern receivers should have a self-test circuit and, therefore, we find in the block diagram (from the Rohde & Schwarz EK070 receiver) a built-in noise generator that allows one to monitor the signal over the entire receiver.

One of the ten input filters may be automatically selected and determined by the synthesizer. The incoming frequency is up converted to a first i-f of 81.4 MHz, where a crystal filter (12 kHz) narrows the number of frequencies fed to the second mixer. The two mixers use several filters and amplifiers. The output is taken at the second mixer and is available for a panoramic adapter.

As in all modern receivers, independent sideband detection is required. Two complete i-f strips and two filters are included, one for upper and one for lower sideband. For all other modes, only one channel of the i-f is used.

The AGC must be individually determined for each channel. To be able to have passband tuning and to select different combinations of bandwidths and BFO frequencies, the BFO must be synthesized. Note that the synthesizer for the first and second LO, as well as that for the BFO, are fairly complex. This is a result of the requirement for extreme high dynamic range, low-noise sideband performance, fast switching speed, and spectral purity (high reference-signal suppression and no other unwanted frequencies).

In addition to the familiar modulation schemes, there are a number of digital modes such as ASCII, Baudot, and pulse-code modulation (both a-m and fm). (In many cases, these signals are scrambled and are not available for immediate detection.)

A clever scheme allows a 12.5-kHz output that can be connected to a tape recorder — unidentified signals can be recorded and stored for later detection. In addition to these features is a built-in RTTY demodulator, including an indication of center frequency for the RTTY demodulator that eliminates the need of an oscilloscope for tuning.

microprocessors and receivers

We have heard much about microprocessor applications in receivers, and many of us use 2-meter transceivers or other equipment that incorporates microprocessors. What does the microprocessor actually do for us? The microprocessor automatically handles certain routines such as scanning of frequencies written into memory. After the microprocessor has put these frequencies into the receiver's memory, one can determine the field strength from the AGC line, compute this into absolute microvolts, dB above 1 microvolt, or dBm, as required. Also, the microprocessor can control the synthesizer and take care of all the arithmetic. The synthesizer frequency and the frequency on the display of the receiver are not the same; this offset can be taken into consideration by the microprocessor.

The built-in self-check of a shortwave receiver will allow monitoring of certain functions to make sure the receiver is operating properly. This brings up several important questions:

1. Are we not trading flexibility and reliability for automation?

2. Is the microprocessor now such an important part that, once it fails, nothing will work anymore?

3. Can we repair microprocessor-based communications receivers?

There is no question that test instruments required to service microprocessor-based instruments are more expensive and demand more training for repair technicians, and the price for the components of the computer system are not low enough to justify discarding questionable integrated circuits.

I believe that there are still two extremes that will remain for a while at least. The Rohde & Schwarz EK070 receiver (photo), is designed for the future; and, as mentioned earlier, even in the year 2000 we will not be able to make the rf portion much better, insofar as improvements over the last five years have been much less dramatic than those from 1960 through 1975.

The Rohde & Schwarz EK070 receiver.

Another photo shows the Model HF1030 VLF/HF communications receiver (formerly from Communications Products Corporation — now being manufactured and sold by Cubic Communications Corporation). This receiver is in the $6,000 price range, while the Rohde & Schwarz EK070, depending upon the options, costs between $14,000 and $20,000.

Rf characteristics such as intercept point, image suppression, blocking, and switching speed for both receivers are comparable — only housekeeping and utility functions such as memory, built-in RTTY demodulator, and self-check are different. It is therefore the decision of the user how much he wants to spend and what type of receiver he wants.

The frequency range of 20-1000 MHz requires higher dynamic performance and more scanning and searching capabilities. The absolute bandwidth of this frequency range is much wider; and for frequency searching or frequency hopping, more requirements are demanded of the frequency synthesizer. The fm capability requires more bandwidth choices. A typical example is the Rohde & Schwarz ESM500 receiver. Its performance characteristics are listed in **table 2.**

We have heard so much about increased performance capability that we will want to look at several circuits and see how these improvements are achieved. But, one note of caution: microprocessors have become a national obsession, and a device not having a built-in microprocessor is not considered modern — a misleading notion! The microprocessor is nothing more than a device that can execute instructions sequentially and at fast speed.

Standard circuits with normal gate decoding do everything in parallel; for practical purposes there is no execution delay. As the microprocessor becomes overloaded speed and flexibility are lost. To write extremely long programs for microprocessors in assembly language requires substantial knowledge in programming and debugging. As a result, the present tendency is to break up the tasks by using a central microprocessor; for reasons of speed, a 16-bit unit such as the Motorola 68000 is used, as well as several independent processors in slave mode — the most popular are the 8085 or, for smaller tasks, the 8748 or 8749.

The microprocessor is not always a necessity, and the tradeoff between cost and speed introduces another hazard. Every microprocessor requires an internal clock. Sometimes these clocks are at frequencies that cannot be generated from the master standard and, therefore, additional frequencies occur, generating radio interference and spikes inside the receiver. It becomes a major task to shield and insulate one or more microprocessors and their switching noise from the outside.

The HF1030 receiver is a good example where flexibility is obtained by a parallel BCD bus that controls the entire receiver and does not require a microprocessor. Even the LED display is not multiplexed. A receiver that can go down to 10 kHz will probably pick up this switching noise, then the additional shielding required can be more expensive than the reduction in cost by using a microprocessor over conventional logic. Some companies offer programmable logic-array ICs, which would take an intermediate position between the logic and the microprocessor system.

input filters

Current receiver designs generally use a highpass/lowpass filter combination. Typically, a 1.6-MHz highpass is used to suppress incoming signals, and a 30-MHz lowpass filter is used to provide image rejection and prevent oscillator re-radiation. We therefore have a window almost 30 MHz wide that can lead to several second-order intermodulation distortion products.

Cubic Communications HF1030 receiver.

table 1. Specifications of a modern VLF/HF receiver.

frequency range	10 kHz to 30 MHz	
frequency setting	a. quasi-continuously by rotary switch in increments of 10 Hz/100 Hz/1 kHz	
	b. digital entry via keyboard	
	c. remote control via data interface (setting time 50 ms)	
readout	7-digit liquid crystal display	
resolution	10 Hz	
frequency drift		
after 10 minute warmup	$<3 \times 10^{-7}$ at +25°C	
within one day	$<3 \times 10^{-8}$	
caused by aging	$<1 \times 10^{-6}$/year	
in rated temperature range	$<3 \times 10^{-7}$	
types of emission	A1 (CW, A2 (MCW), A3 (a-m)	
	A2H, A3H (AME) }	(SSB) upper
	A2A, A3A }	and lower
	A2J, A3J }	sideband
	A3B, (ISB),	
	F1 (FSK)	
with telegraphy demodulator	F4 (facsimile)	
	F6	
antenna input	Z_{in} = 50 ohms, BNC female connector	
VSWR	<3	
permissible input voltage	≤ 10 V EMF	
oscillator reradiation	< 10μV at antenna input with 50-ohm termination	
sensitivity*	for 10 dB (S + N)/N, 0.2 = 30 MHz	
with A1, B = 300 Hz	<3μV EMF	
with A3, B = 6 kHz, m = 60%	<2.0μV EMF	
with A3J, B = 3.1 kHz	<0.75μV EMF	
preselection	0 to 0.5 MHz; lowpass filter	
	0.5 to 1.5 MHz; bandpass filter — 8 suboctave filters between 1.5 and 30 MHz	
intermediate frequencies		
1st i-f	81.4 MHz, B = 12 kHz	
2nd i-f	1.4 MHz	
i-f selectivity	3dB bandwidth (minimum)	60 dB bandwidth (maximum)
	± 75 Hz	± 225 Hz
	± 150 Hz	± 375 Hz
	± 300 Hz	± 750 Hz
	± 750 Hz	± 1875 Hz
	± 1.5 kHz	± 3.75 kHz
	± 3 kHz	± 7.5 kHz
	± 6 kHz	± 50 kHz
	+0.3 to +3.4 kHz	−0.3 to +4.0 kHz
	−0.3 to −3.4 kHz	+0.3 to −4.0 kHz
interference immunity, nonlinearities		
intermodulation*		
d_3 within A3J sideband	>46 dB down, wanted signals 2 × 10 mV EMF	
d_3, Δf ≥ 30 kHz	>70 dB down, unwanted signals 2 × 100 mV EMF	
d_2 (1.5 to 30 MHz), Δf ≥ 30 MHz	>70 dB down, unwanted signals 2 × 100 mV EMF	
blocking*	<3 dB signal attenuation, wanted signal 1 mV EMF, m = 30%/1 kHz; unwanted signal 1 mV EMF, Δf ≥ 30 kHz	

table 1. Specifications of a modern VLF/HF receiver (cont.)

cross-modulation*	< 10% modulation transfer; unwanted signal 200 mV EMF, m = 30%/1 kHz; wanted signal 1 mV EMF, Δf ≥ 20 kHz
desensitization*	20 dB SINAD; wanted signal 30 μV EMF, B = 3.1 kHz; unwanted signal 300 mV EMF, Δf ≥ 30 kHz
inherent spurious signals	< 0.5 μV equivalent EMF
spurious responses	> 90 dB down at Δf ≥ 30 kHz
image frequency rejection	> 80 dB
i-f rejection	> 90 dB
rf gain control, switchable	MGC MGC + AGC AGC
control range	> 100 dB
AGC error	< 4 dB (1μV to 100 mV EMF)*
attack time	5 ms (level jump + 60 dB)
decay time (switchable)	0.4 s/1.8 s (level jump − 60 dB)
BFO	variable in 100-Hz steps over ± 3.1 kHz
attenuation at i-f output	> 50 dB referred to i-f level
F1 demodulator	
limiting factor	> 40 dB
line spacing	50 to 1000 Hz
keying speed	1 to 100 bauds
signal distortion	< 5% at 100 bauds
single current	40 to 60 mA, variable; EMF = 60V
double current	in compliance with CCITT V.28
outputs	
1st oscillator 81.4 to 111.4 MHz	0 dBm, 50 ohms
2nd oscillator 80 MHz	0 dBm, 50 ohms
1-MHz output	50 mV into 50 ohms
switchable to 1-MHz external reference input	30 to 500 mV into 50 ohms
2nd i-f 1.4 MHz	50 mV into 50 ohms
recording output 12.5 kHz	0 dBm, 600 ohms
panoramic output 1.4 MHz	B = 12 kHz
af line outputs 600 ohms	floating
output level	− 10 to + 3 dBm, adjustable
distortion	< 1% with A3J
af output 5 ohms (headphones output 100 ohms)	
output level	1 W (12 mW, can be attenuated)
distortion	< 5%
signal characteristics	
af response (overall)	< 3 dB from 300 to 3400 Hz
af S/N ratio	> 40 dB SINAD with 1 mV EMF
phase noise ratio with A3J	> 75 dB with > 300 Hz spacing and 1 Hz measuring bandwidth, 1 mV signal EMF
remote control	interface in compliance with IEC and CCITT
IEC bus	IEC 625-1, 24-way connector (Amphenol); functions: T5, L3, SR1, RL2
or (depending on order number)	
RS232C	CCITT V.24, switchable to CCITT V.10 (RS 423) 110/200/300/600/1200/2400/4800/9600 bauds
code	ASCII 7 bits

*without 20-dB attenuator pad

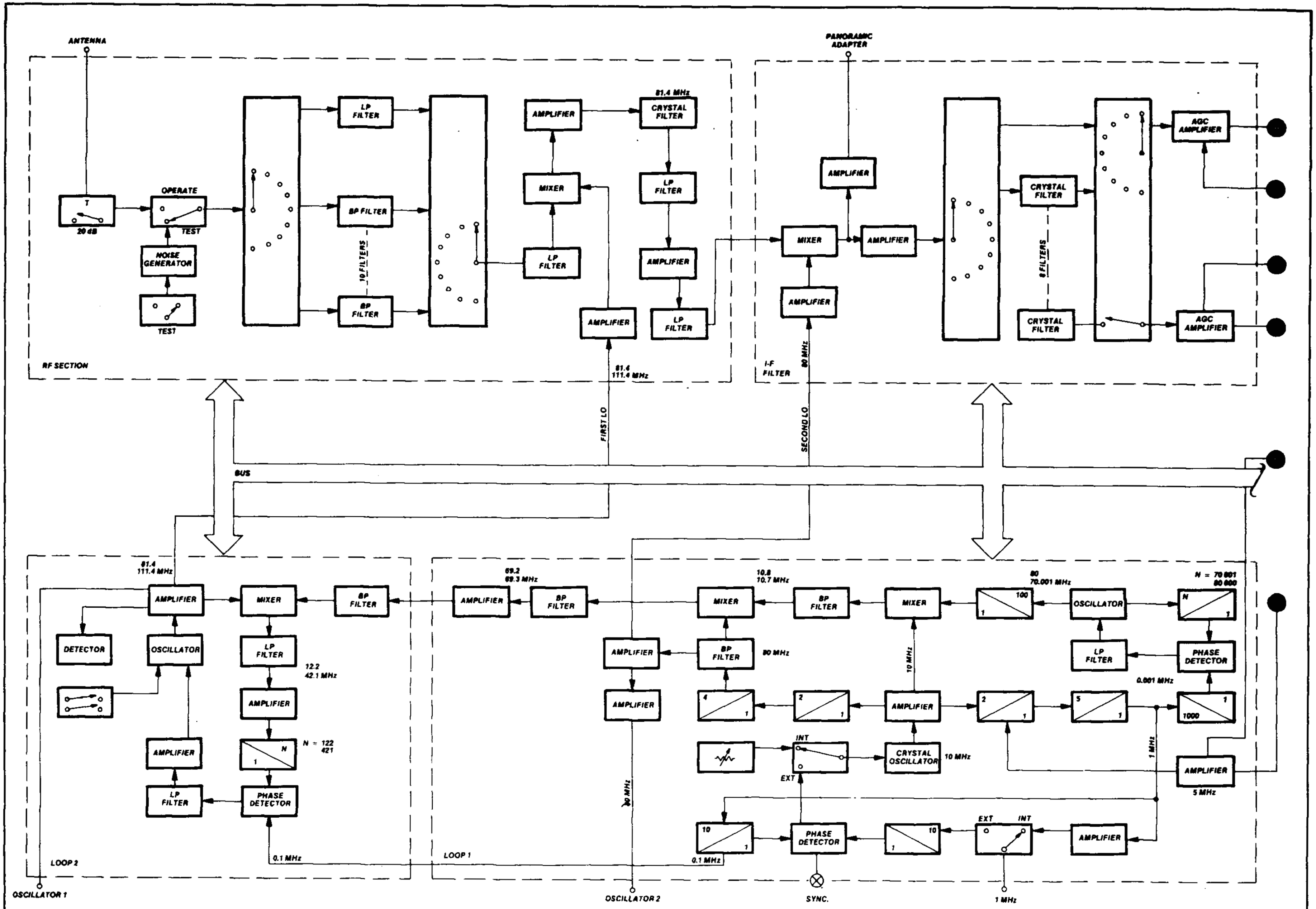

fig. 1. Block diagram of the Rohde & Schwarz EK-070 VLF/HF receiver.

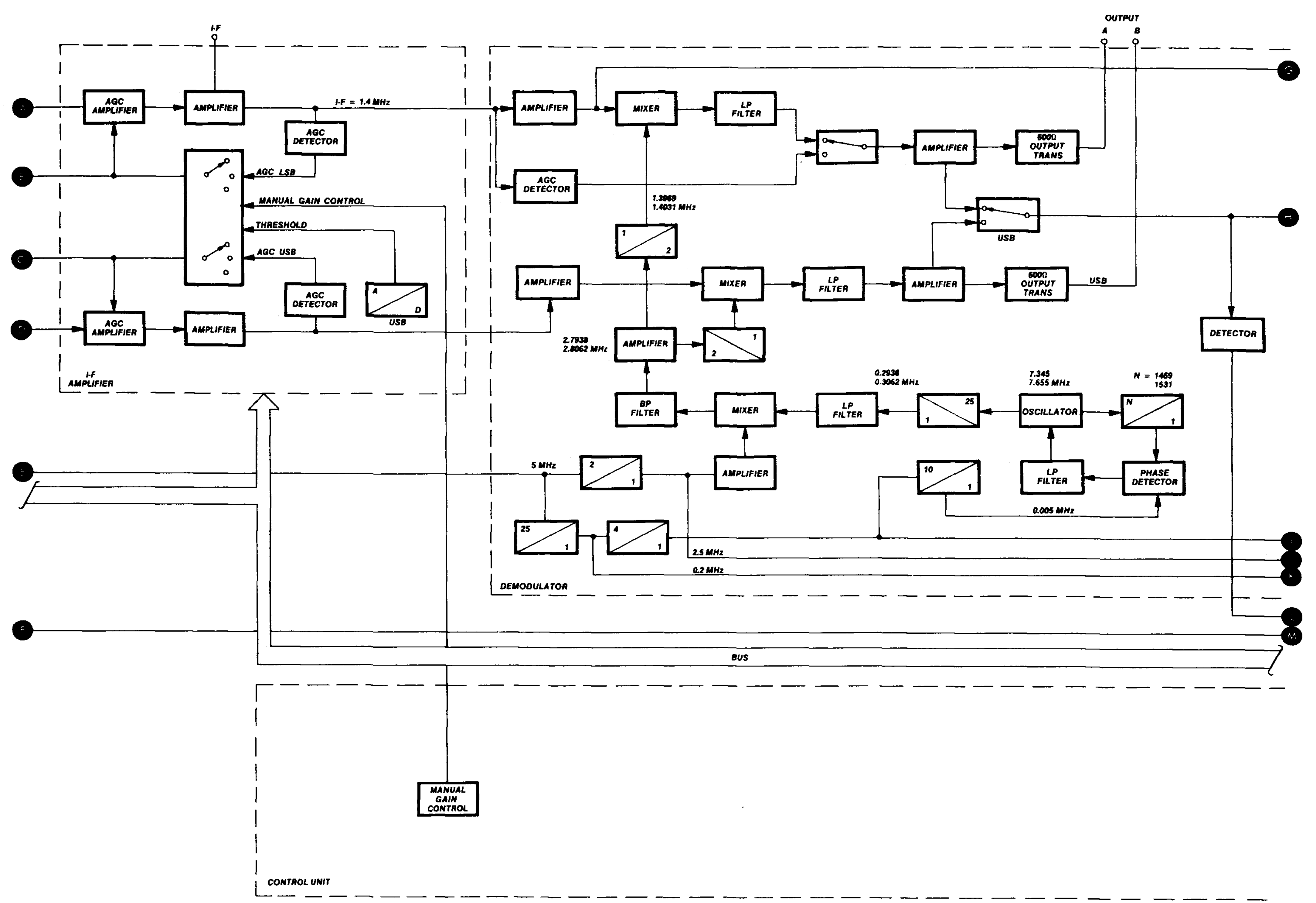

fig. 1-2. Block diagram of the Rohde & Schwarz EK070 VLF/HF receiver (continued).

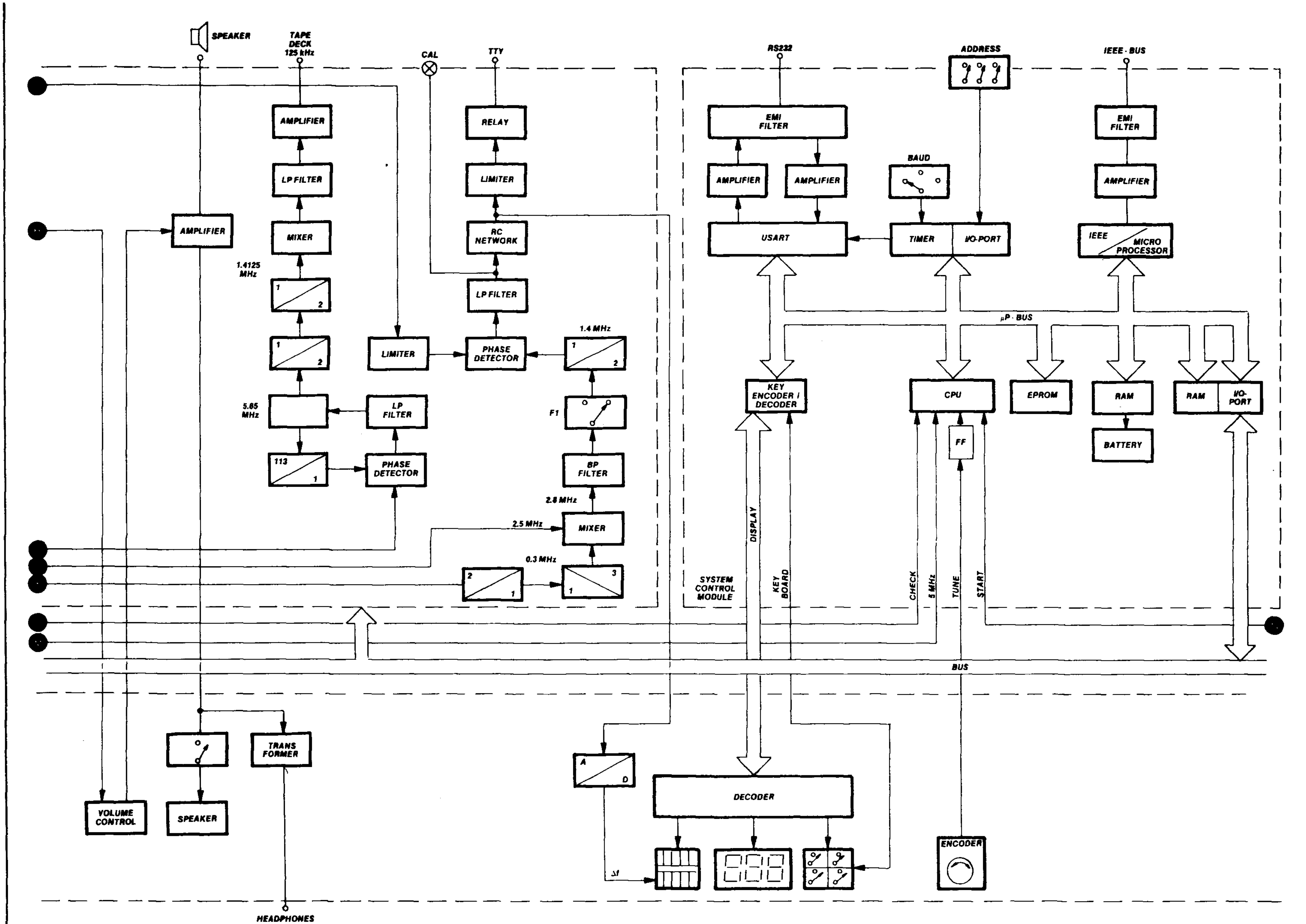

fig. 1-3. Block diagram of the Rohde & Schwarz EK070 VLF/HF receiver (continued).

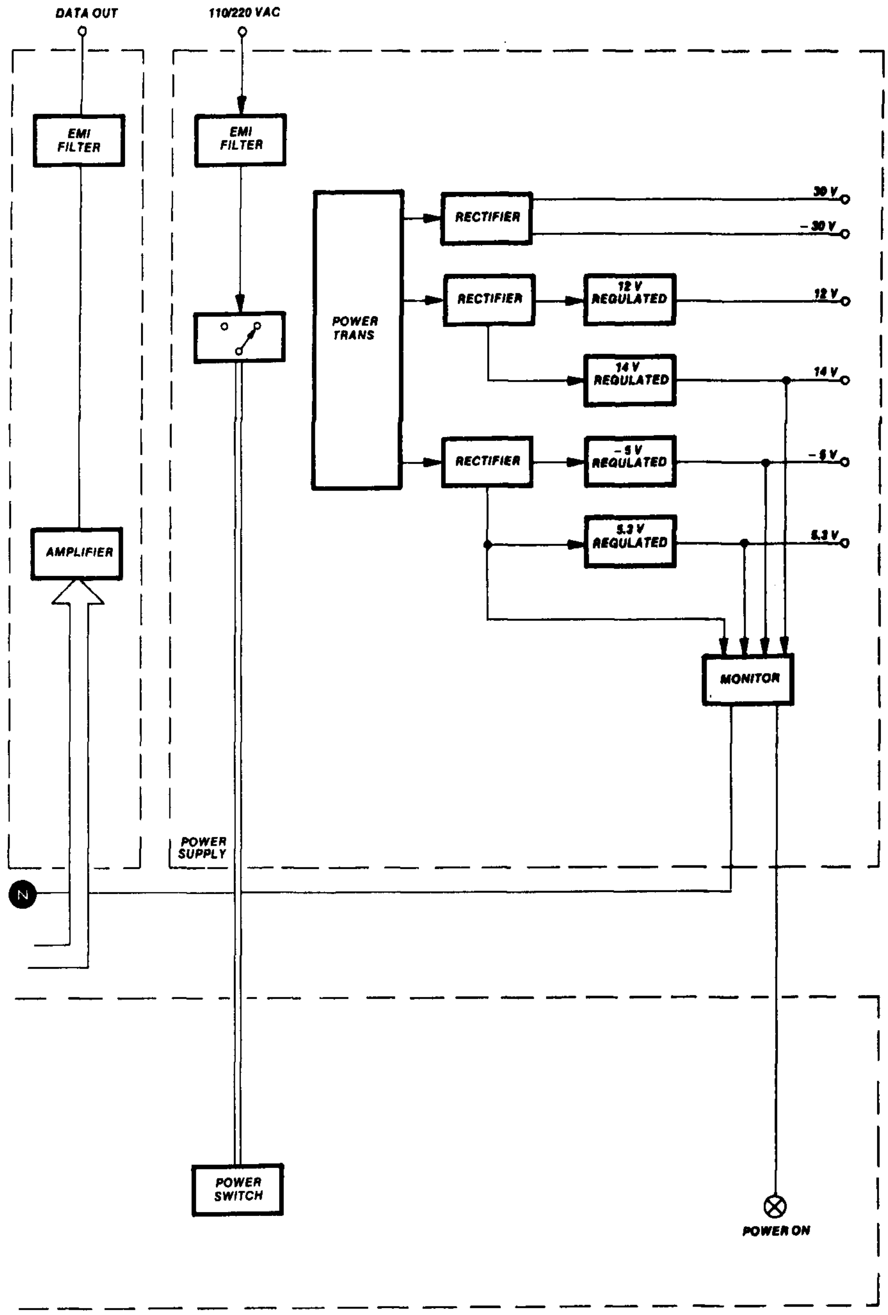

fig. 1-4. Block diagram of the Rohde & Schwarz EK070 VLF/HF receiver (continued).

The second-order intermodulation distortion, defined as $F_1 \pm F_2$ or $F_2 \pm F_1$, can be filtered with suboctave bandpass filters. The third-order intermodulation distortion products generated from $2 \times F_1 \pm F_2$ and/or $2 \times F_2 \pm F_1$ for close spacing, such as 10 kHz or closer, cannot be filtered. However, since there are so many signals present at the same time, the input bandwidth should be as narrow as possible.

Fig. 2 shows a solution that combines bandpass filters from 1.5-10 MHz and two input tracking filters from 10-30 MHz. Note the large number of tuning diodes in parallel. This is because no diodes are available that have the required high capacitance. In addition, intermodulation distortion products are reduced if the energy is distributed over more capacitance. Four-to-one stepdown transformers are used.

Because the tuned circuit operates at low impedance, both sides of the tuned circuit operate at 50 ohms. This input filter, despite the tuning diodes, does not degrade the 30-dBm intercept point of the following stage. Therefore this preselector is transparent as far as intermodulation distortion of any kind is concerned. Relays are necessary to avoid distortion from the switching diodes.

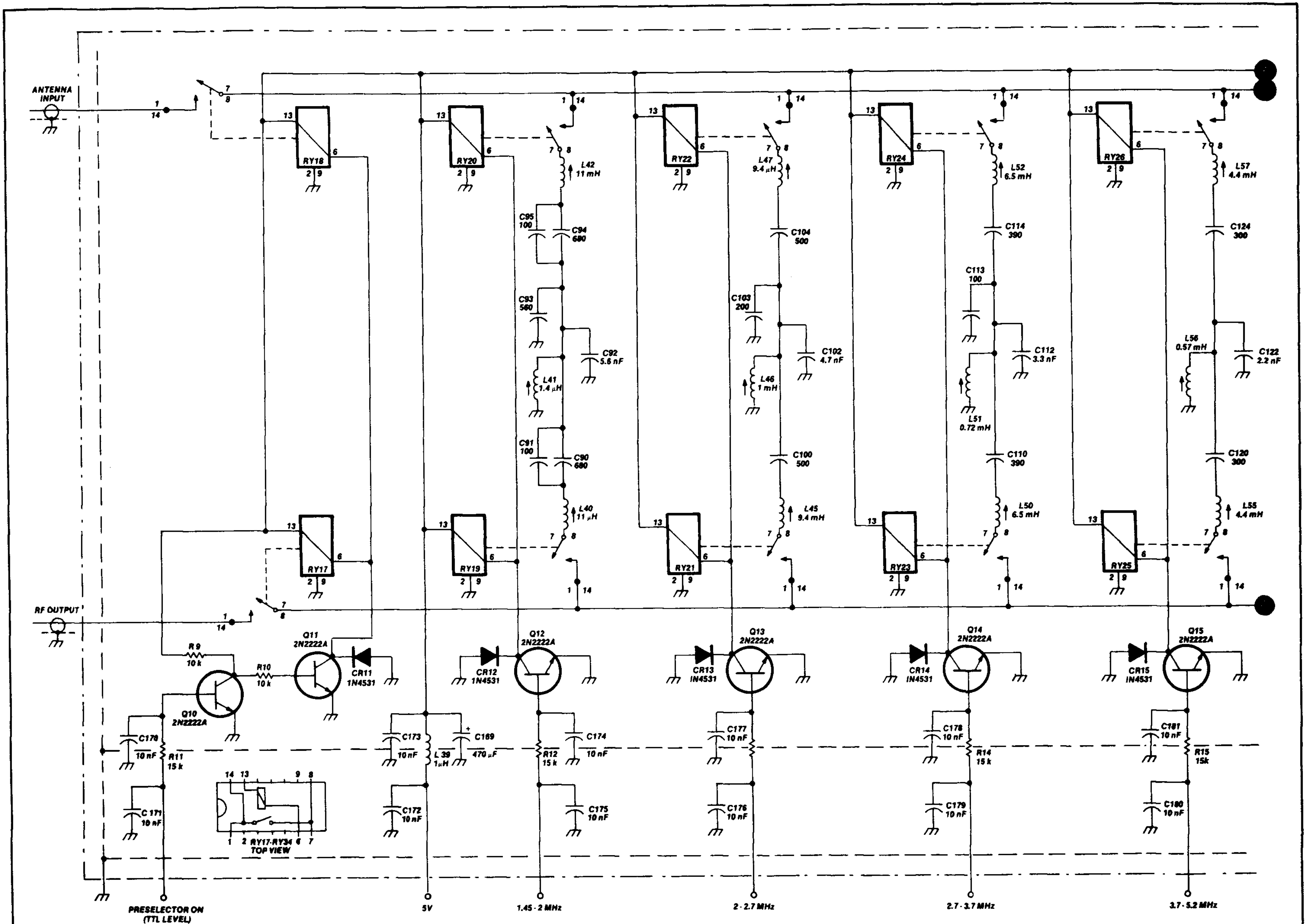

fig. 2. The rf input stage of a modern receiver using six bandpass filters and two varactor-tuned input filters.

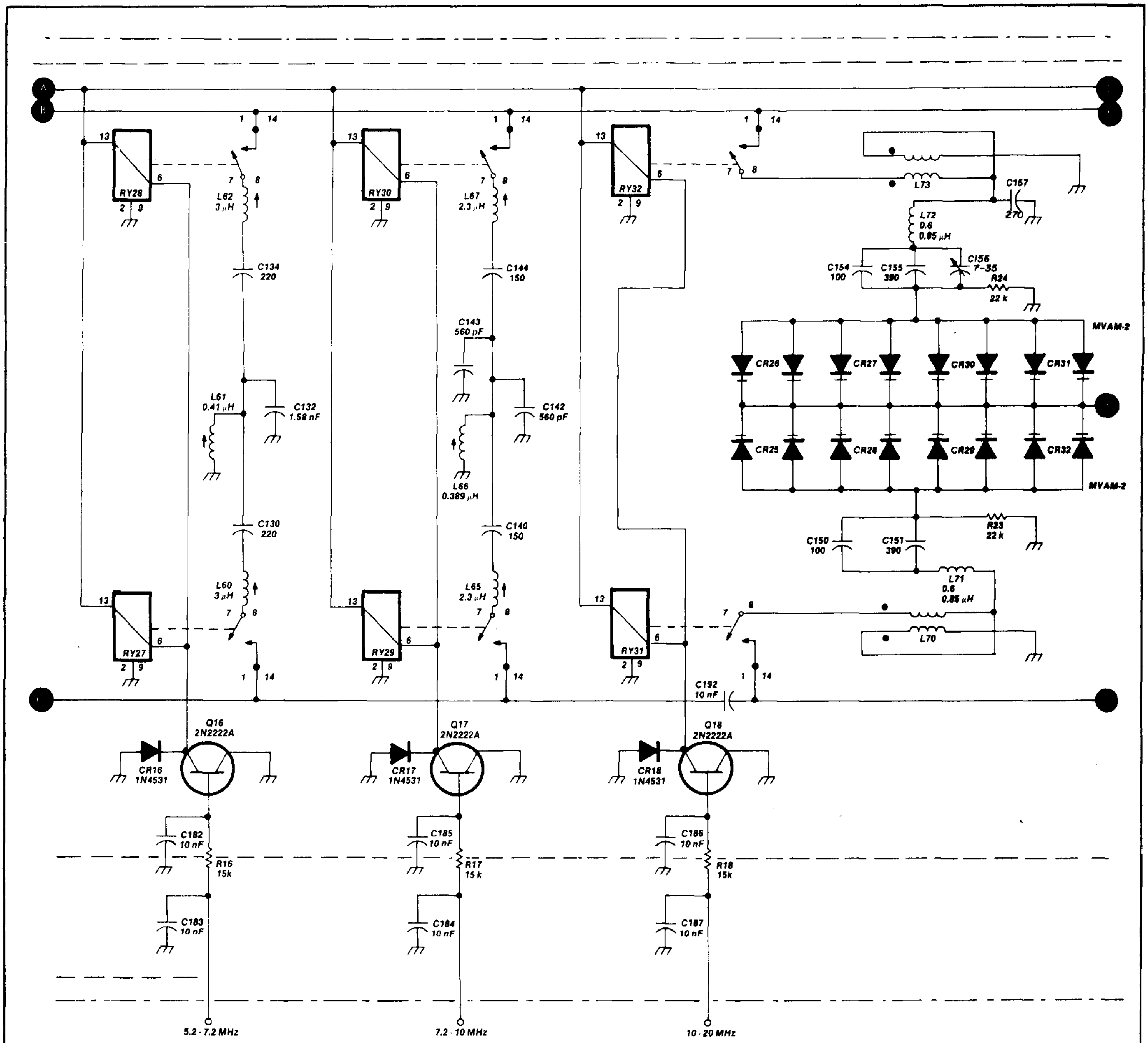

fig. 2-2. The rf input stage of a modern receiver using six bandpass filters and two varactor-tuned input filters (continued).

Similar input tracking filters are possible in the VHF/UHF range. The general finding is that PIN-diode attenuators, as sometimes used, limit the dynamic range to about + 10 or + 15 dBm. In transceiver application, it's possible to use the lowpass sections of the transmitter, and one has only to add highpass filter sections to obtain bandpass characteristics. The highpass sections must be calculated so that they operate together with the lowpass section (see reference 2).

input mixers

We now find a major struggle between semiconductor manufacturers and rf engineers regarding the

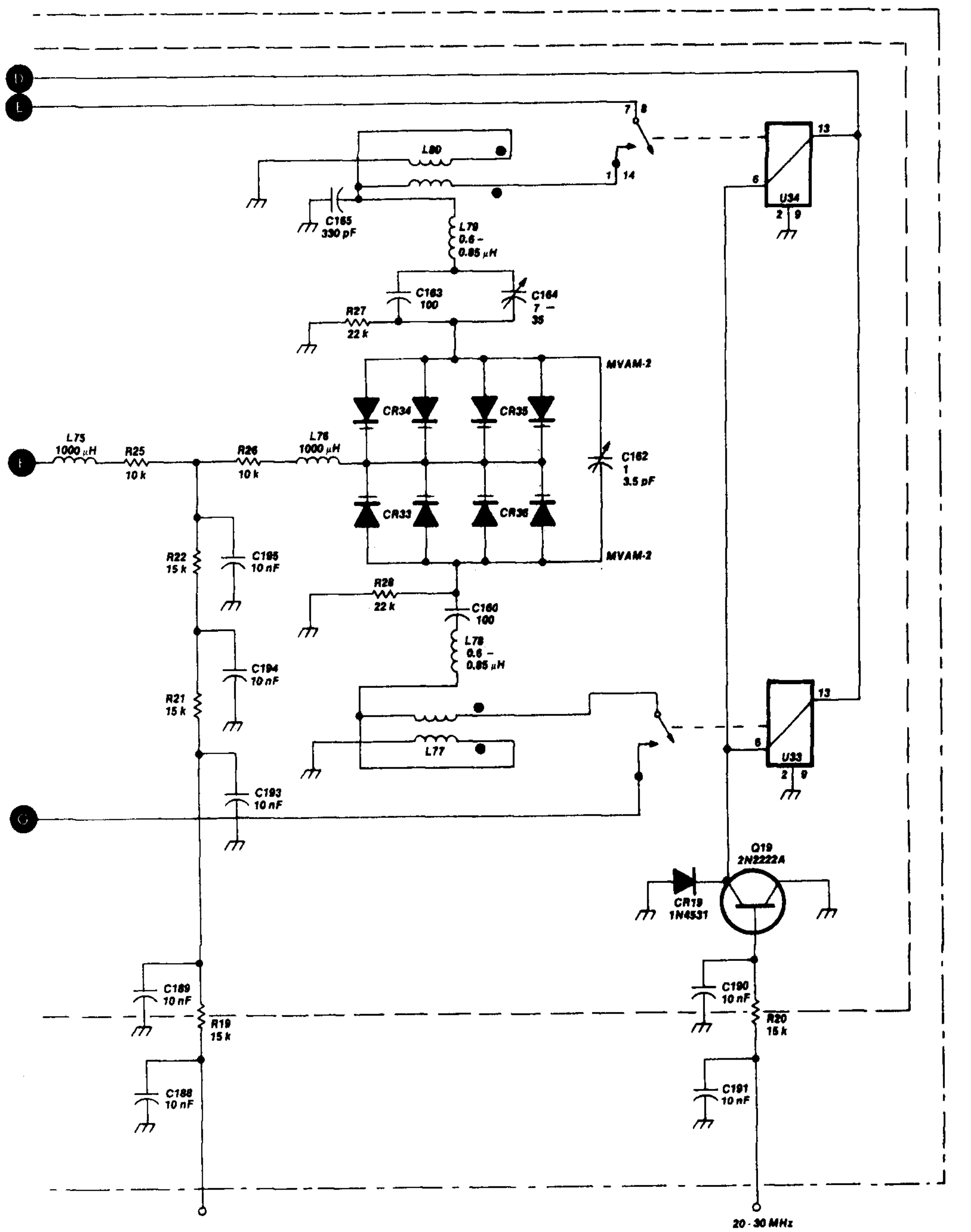

fig. 2-3. The rf input stage of a modern receiver using six bandpass filters and two varactor-tuned input filters (continued).

best mixer design. There is no question that we must use a double-balanced mixer to minimize the number of unwanted frequencies at the mixer output. Four solutions are currently available. These include the use of:

1. Bipolar active mixers.
2. Diode mixers.
3. FET active mixers.
4. Passive FET mixers in the switching mode.

Plessey has recently introducted the first really high-level double-balanced mixer, and several attempts have been made to use it. (Probably the best summary is published in the January, 1981, issue of *QST* by Doug DeMaw.) It appears that, while the Plessey SL6440C is suitable for synthesizer or other application, its use in high-performance receivers is limited. The reason for this is discussed in the following paragraphs.

Mixer noise figure. Let's assume that the manufacturer's specifications for this Plessey device are valid: noise figure 10 dB, gain 4 dB, and intercept point +30 dBm. The mixer must operate into a stage that has a noise figure of less than, say, 3 dB. If a crystal filter or other device is inserted between the two stages, the mixer will have unity gain, as the filter losses will compensate for the mixer gain. We therefore can add the two noise figures and obtain a noise figure of 13 dB. This is done under the assumption that the stage following the first amplifier after the mixer does not contribute to the noise figure.

Let's do the same with a diode mixer, such as that developed for the HF1030 receiver, which contains two diode bridges, as shown in **fig. 3**. This mixer has an intercept point of +30 dBm, and with two signals of zero dBm applied to the input it generates two intermodulation distortion products of more than 60 dB, attenuated relative to the input signal. The mixer requires +17 dBm LO drive and has 6-dB insertion loss. The following amplifier again will have 3-dB noise figure, and, to make absolutely sure that the mixer is always terminated precisely with 50 ohms, no filters are inserted between the two devices.

As shown in my previous papers, a field-effect

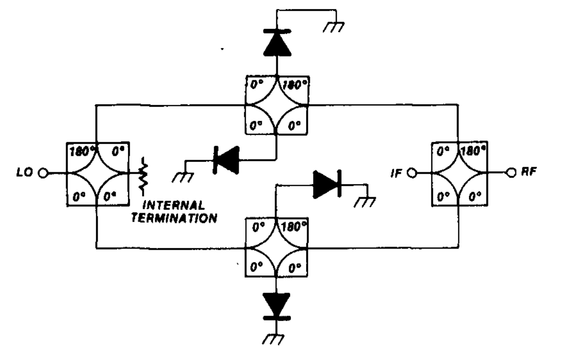

fig. 3. Schematic diagram of double-balanced mixer with two diode bridges, Model CPC106, developed for the HF1030 receiver.

table 2. Specifications of a modern VHF/UHF receiver.

frequency range	20 to 1000 MHz
frequency setting	a. quasi-continuous with rotary knob; the tuning speed increases with the speed of rotation b. from keyboard on front panel c. entered from internal memory d. entered from external computer
resolution	1 kHz/10 Hz (SSB)
readout, digital (can be shifted by 3 digits in SSB operation)	6-digit display for receive frequency, 6-digit display for frequency entered from keyboard or stored frequency value, 2-digit display for storage location
error of frequency setting	$\pm 1 \times 10^{-8}$ (or external standard frequency, 10 MHz)
antenna input	50-ohm, type-N socket
oscillator reradiation with 50-ohm termination	$< 1 \mu V$ corresponding to −107 dBm
input filters	tracking filters
frequency setting storage capacity	99 frequencies and their respective type of demodulation and i-f bandwidth
loading of storage	frequency entered from keyboard or current receive frequency, including type of demodulatio[illegible] i-f bandwidth
scanning operation	up to 99 stored frequencies can be c[illegible]ally scanned; halts automatically if frequency is occupied; scanning operation continued after preselected period of time at the push of a button
scanning time	Typically 50 ms per stored frequency
S/N ratio ($V_{in} = 1 \mu V$, $f_{mod} = 1$ kHz, i-f bandwidth 30 kHz, af filter on)	

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Allow 30-60 days for delivery after receipt of order due to the high demand for this product.

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7-Band, 50 Channel • Alpha-Numeric • No-crystal scanner • AM Aircraft and Public Service bands. • Priority Channel • AC/DC

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The new *Bearcat* 350 introduces an incredible breakthrough in synthesized scanning: Alpha-Numeric Display. Push a button—and the Vacuum Fluorescent Display switches from "numeric" to word descriptions of what's being monitored. 50 channels in 5 banks. Plus, Auto & Manual Search, Search Direction, Limit & Count. Direct Channel Access. Selective Scan Delay. Dual Scan Speeds. Automatic Lockout. Automatic Squelch. Non-Volatile Memory. Reserve your *Bearcat* 350 today!

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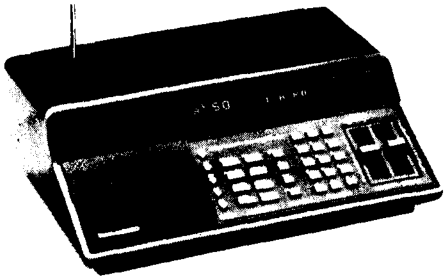
The *Bearcat* 300 is the most advanced automatic scanning radio that has ever been offered to the public. The *Bearcat* 300 uses a bright green fluorescent digital display, so it's ideal for mobile applications. The *Bearcat* 300 now has these added features: Service Search, Display Intensity Control, Hold Search and Resume Search keys, Separate Band keys to permit lock-in/lock-out of any band for more efficient service search.



NEW! Bearcat® 350

More Details? CHECK—OFF Page 102

Bearcat® 250

List price $429.95/**CE price $269.00**

6-Band, 50 Channel • Crystalless • Searches Stores • Recalls • Digital clock • AC/DC Priority Channel • Delay • Count Feature

Frequency range 32-50, 146-174, 420-512 MHz.

The *Bearcat* 250 performs any scanning function you *could possibly want. With push button ease you can* program up to 50 channels for automatic monitoring. Push another button and search for new frequencies. There are no crystals to limit what you want to hear. A special search feature of the *Bearcat* 250 actually stores 64 frequencies and recalls them, one at a time. Overseas customers should order the *Bearcat* **250FB** at $379.00 each. This model has 220 V AC/12 V DC power supply and 66-88 MHz low band coverage.

NEW! Bearcat® 20/20

List price $449.95/**CE price $279.00**

7-Band, 40 Channel • Crystalless • Searches AM Aircraft and Public Service bands • AC/DC Priority Channel • Direct Channel Access • Delay

Frequency range 32-50, 118-136 AM, 144-174, 420-512 MHz.

The *Bearcat* 20/20 automatic scanning radio replaces the *Bearcat* 220 and monitors 40 frequencies from 7 bands, *including aircraft*. A two-position switch, located on the front panel, allows monitoring of 20 channels at a time.

Bearcat® 210XL

List price $349.95/**CE price $219.00**

6-Band, 18 Channel • Crystalless • AC/DC

Frequency range: 32-50, 144-174, 421-512 MHz.

The *Bearcat* 210XL scanning radio is the second generation scanner that replaces the popular *Bearcat* 210 and 211. It has almost twice the scanning capacity of the *Bearcat* 210 with 18 channels plus dual scanning speeds and a bright green fluorescent display. Automatic search finds new frequencies. Features scan delay, single antenna, patented track tuning and more!

Bearcat® 160

List price $299.95/**CE price $184.00**

5-Band, 16 Channel • AC only • Priority Dual Scan Speeds • Direct Channel Access

Frequency range: 32-50, 144-174, 440-512 MHz.

Would you believe...the *Bearcat* 160 is the least expensive *Bearcat* crystalless scanner.

This scanner presents a new dimension in scanning form and function. Look at the smooth keyboard. No buttons to punch. No knobs to turn. Instead, finger-tip pads provide control of *all* scanning *operations, including On/Off, Volume and Squelch. Of* course the *Bearcat* 160 incorporates other advanced *Bearcat* features such as Priority, Direct Channel Access, Dual Scan Speeds, Lockout, Scan Delay and more.

NEW! Bearcat® 100

The first no-crystal programmable handheld scanner.

Allow 60-120 days for delivery after receipt of order due to the high demand for this product.

List price $449.95/**CE price $299.00**

8-Band, 16 Channel • Liquid Crystal Display Search • Limit • Hold • Lockout • AC/DC

Frequency range: 30-50, 138-174, 406-512 MHz.

The world's first no-crystal handheld scanner has compressed into a 3" x 7" x 1¼" case more scanning power than is found in many base or mobile scanners. The *Bearcat* 100 has a full 16 channels with frequency coverage that includes all public service bands (Low, High, UHF and "T" bands), the 2-Meter and 70 cm. Amateur bands, *plus* Military and Federal Government frequencies. It has chrome-plated keys for functions that are user controlled, such as lockout, manual and automatic scan. Even search is provided, both manual and automatic. Wow...what a scanner!

The *Bearcat* 100 produces audio power output of 300 milliwatts, is track-tuned and has selectivity of better than 50 dB down and sensitivity of 0.6 microvolts on VHF and 1.0 microvolts on UHF. Power consumption is kept extremely low by using a liquid crystal display and exclusive low power integrated circuits.

Included in our low **CE** price is a sturdy carrying case, earphone, battery charger/AC adapter, six AA ni-cad batteries and flexible antenna. For earliest delivery from **CE**, reserve your *Bearcat* 100 today.

Bearcat® 5

List price $134.95/**CE price $94.00**

4-Band, 8 Crystal Channels • Lockout • AC only

Frequency range: 33-50, 146-174, 450-508 MHz.

The *Bearcat* 5 is a value-packed crystal scanner built for the scanning professional — at a price the first-time buyer can afford. Individual lockout switches. Order one crystal certificate for each channel.

Bearcat® Four-Six ThinScan™

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Frequency range: 33-47, 152-164, 450-508 MHz.

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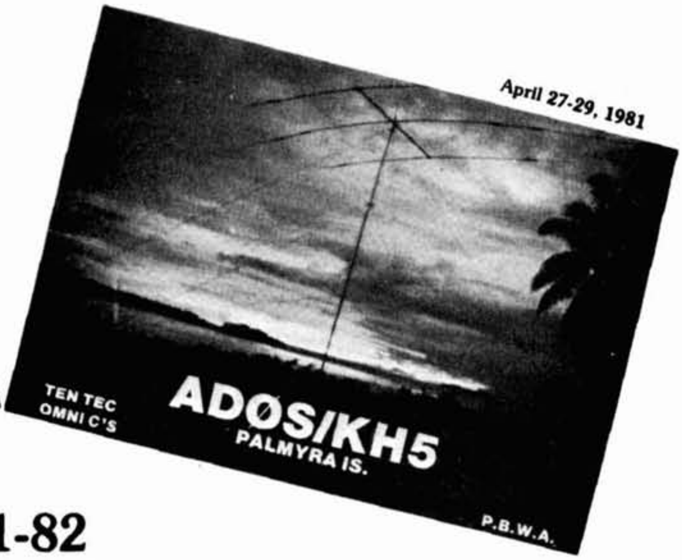
table 2. Specifications of a modern VHF/UHF receiver (cont.).

a-m (m = 0.5)	≥ 10 dB
fm (deviation 10 kHz)	≥ 20 dB
total noise figure (including af section)	9 dB typical
oscillator phase noise (at 20 kHz from the carrier)	120 dB/Hz typical
fm noise suppression	
(3-kHz deviation, f_{mod} = 1 kHz, V_{in} = 1 mV)	50 dB typical
intercept point 2nd order	50 dBm typical
3rd order	12 dBm typical
image frequency rejection	> 90 dB
i-f rejection	> 90 dB
i-f bandwidth (3 dB)	2.3 kHz, 8 kHz, 15 kHz, 30 kHz, 100 kHz, 300 kHz, 2 MHz
demodulation	a-m, fm, SSB
squelch	S/N ratio and adjustable carrier squelch circuits (both can be switched off)
af filter	300 Hz to 3.3 kHz; can be switched out
gain control AGC	i-f control for V_{in} < 80 dB (μV) rf/i-f control for V_{in} < 120 dB (μV)
MGC	i-f control 80 dB rf 40 dB; can be switch selected
AFC	digital tracking of signals of unstable frequency (can be switch off)
indication	
level	on moving-coil meter in dB (μV)
frequency offset	on moving-coil meter; sensitivity of offset meter matched to bandwidth
panoramic display	
i-f panoramic display	
sweep width	200 kHz
resolution	4.5 kHz
amplitude display	logarithmic approximately 80 dB
screen area	4 cm × 3 cm
rf panoramic display and broadband i-f display	
rf sweep width	entire reception range (500 MHz, maximum) and/or a particular section of it; superposition of frequency marker for receiver tuning
i-f sweep width	2 MHz maximum
amplitude display	linear or logarithmic 80 dB (10 dB/cm)
internal testing facilities	
continual test	monitoring of subassemblies; error signaled with code number
loop test	triggered by pressing a button; automatic testing of complete receive section including the af section and all LED displays
outputs	level, offset, af (600 ohms), a-m video, fm video, i-f (10.7 MHz, 2-MHz broadband, 50 ohms, 10 dB above input level, without AFC) i-f (10.7 MHz, narrowband, with AFC, 50 ohms, 10 mV), inputs/outputs for panoramic adapter EZP, COR (Carrier Operated Relay): coupled with squelch; dropout time internally adjustable
inputs	external control voltage, squelch response threshold
remote control (via IEC bus or RS232C interface)	all important functions, input and output



More Details? CHECK—OFF Page 102

transistor such as the CP643 operated at 20-30 mA will have about 50 ohms input impedance and will have no reactive components. This combination results in a total noise figure of 8 dB; and as the double-balanced mixer has some insertion loss, the intermodulation distortion products are now determined by *mixer performance* — not by the following amplifier.

In the case of the active mixer with the Plessey IC, even if we remove the filter and allow no noise contribution from the amplifier following the mixer, the noise figure is 10 dB, or 2 dB worse; and as the device has gain (zero dB gain is more than a 6-dB loss), we now must look at the intermodulation distortion products generated in the amplifier, which was not necessary in the previous case. Altogether, it becomes apparent that the passive double-balanced mixer, from a systems approach, is a better choice.

IMD. Let's consider the active Plessey mixer or the active FET mixer — using four FETs either in a quad package such as the U350 (apparently discontinued by Siliconix) or a dual-FET version and measure the intermodulation distortion as a function of frequency offset between the two carriers. We may be able to verify the intercept point between +20 and +30 dBm over a narrow range, but as the filter bandwidth is reached, and the input impedance of the filter following the active mixer changes, other changes also occur.

Most elliptical filters become high-impedance devices (unless simple tuned circuits are used); and as the impedance rises at the output of the active mixer, so does the intermodulation distortion product. In effect, we must sweep the mixer over the range of interest to make sure that intermodulation distortion does not occur or is at an acceptable level.

The use of a passive mixer terminated by a grounded-gate field-effect transistor, or an amplifier using the "noiseless feedback" approach, ensures intermodulation distortion products independent of frequency offset. The design of the Rohde & Schwarz ESH2 laboratory receiver combines these requirements. **Fig. 4** shows the input rf section of the ESH2, which offers this superior performance.

FET mixers. The current trend is to use field-effect transistors in the passive mode, or as switching devices in the mixer. **Fig. 5** shows a possible configuration. The FET acts as a fast switch. It has a much more defined square-law characteristic than any other device. The diode ring mixer generates its intermodulation distortion when it is about to open or close and has a high-order, nonlinear transfer characteristic; the FET does not suffer from this occurrence.

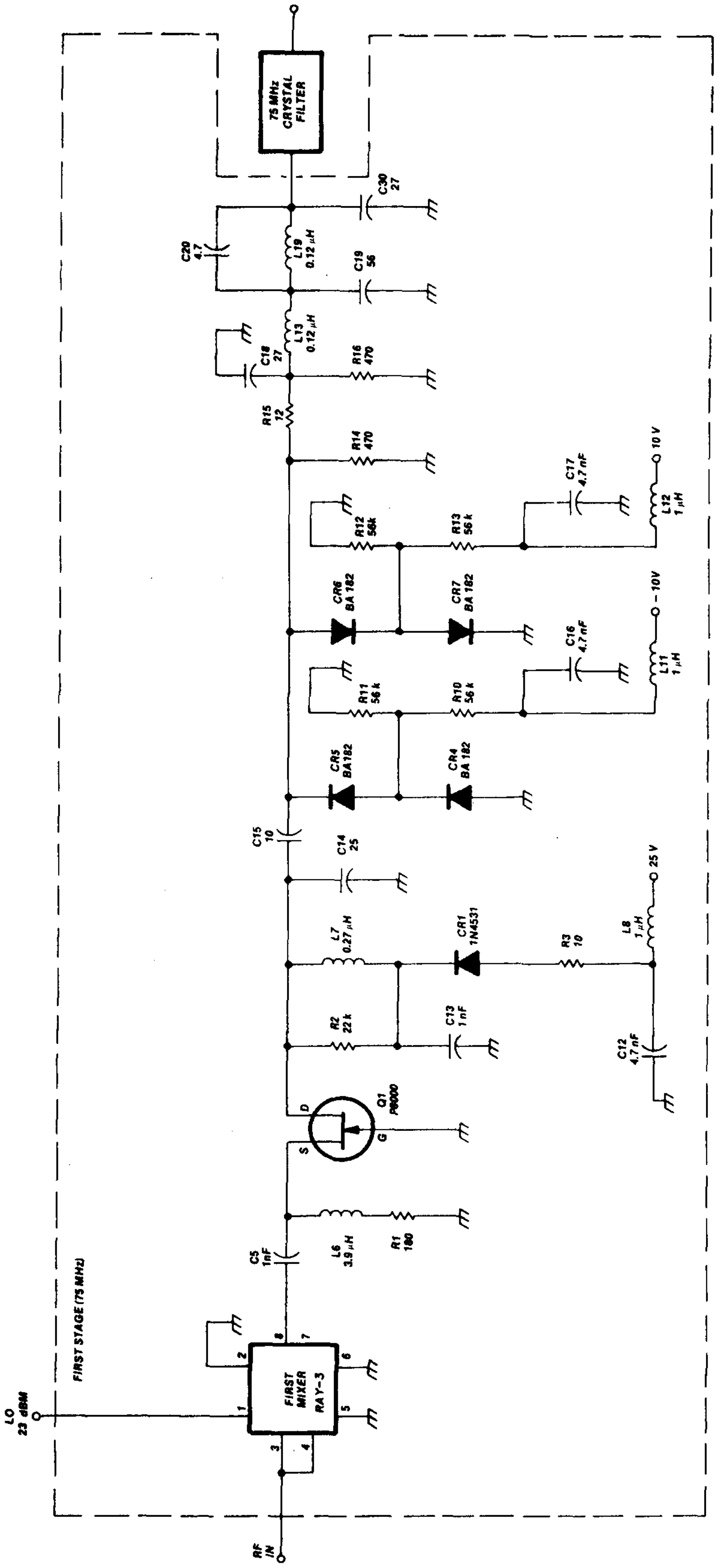


fig. 4. Input rf section of the Rohde & Schwarz ESH2 receiver.

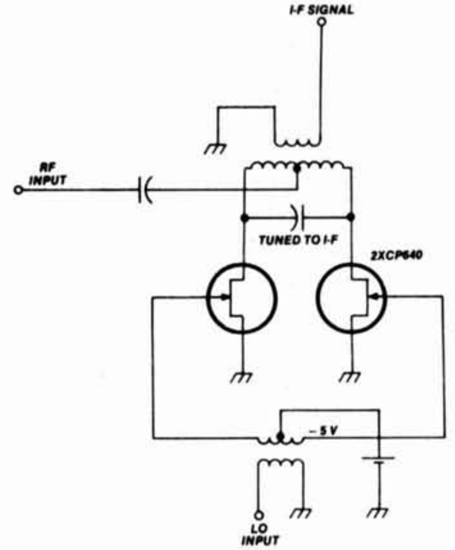


fig. 5. Passive FET mixer for extremely high intercept point.

With suitable bias applied, the intercept point can be as high as +40 dBm with little difficulty in reproduction. This technique is currently used by the Racal RA6790 receiver and by the AGC Telefunken E1700 receiver.

The disadvantage of this circuit is cost, as the LO-drive level must be as high as 23 dBm, and the matching of the device is fairly critical.

VMOS transistors have been used lately in mixers. It appears that these devices are slightly unstable. I had Doug DeMaw's mixer on loan and had some difficulties with it. Unfortunately, the ARRL wanted it for other projects, and I couldn't finish my testing; but I understand that it was tested by an independent source and they confirmed the instability if the mixer is not terminated with a pure resistance. In addition, the VMOS device, being an enhancement field-effect transistor, is slightly more noisy than the junction field-effect transistor. We are now beginning to try new circuits, including a combination of power field-effect transistors, such as the U320 or the CP640, which should give promising results.

In the second part of this article, we will look at feedback amplifiers, including the noiseless feedback circuit; i-f filters; i-f detectors; and frequency synthesizers including the fractional-N design.

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ham radio

understanding performance data of high-frequency receivers

Check over these definitions before you buy a new receiver

When reading manufacturer's data sheets or product reviews for receiving equipment, one encounters terms such as dynamic range and intermodulation distortion, covering essential features of high-frequency receivers but not generally known to Amateurs. Let's go through an example of high-frequency transceiver or receiver specifications and see what the terms really mean.

sensitivity

First we read that the "receiver sensitivity is 0.25 μV at 10-dB S/N," where S/N stands for signal-to-noise ratio. This information tells us that we need a 0.25-μV signal at the receiver antenna input to obtain an audio-output signal, S, of 10 times (10 dB) the audio-output power of the internally generated receiver noise, N. This value (0.25 μV) is typical for the sensitivity of a good receiver; much lower figures (higher sensitivity) are rare except in commercial grade equipment.

noise floor

The internally generated circuit noise in the receiver is usually represented as the rf input signal level that produces the same audio output power as the noise. This level is, for practical purposes, the minimum-discernible signal that can be detected in a receiver. This signal level is called the noise floor and is generally expressed in decibels below one milliwatt power, or −dBm. Since 0.25 μV from a 50-ohm antenna into a receiver whose input is matched to 50 ohms impedance equals −119 dBm, the noise-floor level in the example case is about −129 dBm, a common value for a manufactured Amateur high-frequency receiver. Homebuilt equipment can sometimes improve on this figure, and values below −140 dBm have been measured.

receiver noise

Receiver noise is a function of, among other things, receiver bandwidth. If we assume that the sensitivity of 0.25 μV was specified for a bandwidth (passband) of 2.5 kHz as used for SSB work, the

By Jan K. Moller, K6FM, 3653 Texas Avenue, Simi Valley, California 93063

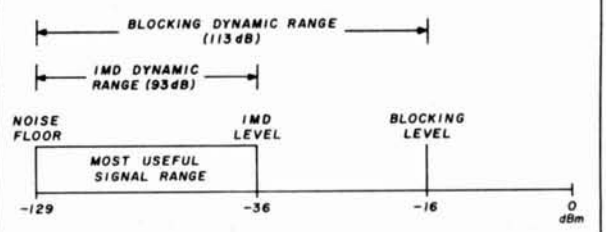

fig. 1. Performance characteristics for the receiver example discussed in the text. Shown are IMD dynamic range (93 dB) and blocking dynamic range (113 dB).

reduction of the bandwidth with a filter for CW to, say, 500 Hz, will improve the receiver's apparent sensitivity. The reason is that, by reducing the bandwidth five times, you reduce the amount of noise coming through the receiver and effectively lower the noise floor 7 dB. The new level, in our example −136 dBm, makes it possible for you to receive a correspondingly weaker CW signal, about 0.1 μV, with the same 10-dB signal-to-noise ratio as the SSB signal first mentioned. Anyone who has operated such a narrow bandwidth receiver will remember how quiet it seems and how you can pick out really weak ones.

IMD and desensitization

The ability of a receiver to handle a wanted signal in the presence of strong adjacent signals is of greatest importance in today's crowded Amateur bands. Two phenomena are most significant, intermodulation distortion, or IMD, and blocking, or desensitization of the receiver. IMD is caused by the mixing, because of imperfections in the receiver front end, of wanted with unwanted signals outside but near the receiver passband. The result is interfering signals in the passband; most dominantly they are the third-order mixing product of two unwanted signals. (Example: two unwanted signals with frequencies f_1 and f_2, mixing product $f_i = 2f_1 - f_2$; if $f_1 = 14{,}060\ kHz$ and $f_2 = 14{,}040\ kHz$, then $f_i = 14{,}080\ kHz$. The same is true for $f_i = 2f_2 - f_1 = 14{,}020\ kHz$.)

IMD dynamic range

Returning to the sample specs — they state that "third order IMD is better than −36 dBm." According to definition, this says that, if the receiver is tuned to frequency f_i, a resulting signal of this frequency will be audible 3 dB above the receiver's noise level when incoming signals f_1 and f_2 are at the −36 dBm level (about 50 dB over S9). Such a weak f_i signal is just barely recognizable in the noise. This information permits the calculation of IMD dynamic range, the difference between the noise-floor level and the IMD measured level; here it is 93 dB for an SSB bandwidth.

This number is one of the most important characteristics of a receiver in that it specifies the range of signals that can be handled with essentially no undesired spurious responses. Other effects, such as blocking and crossmodulation, occur mainly outside this range of signals, see **fig. 1**. A good receiver is expected to have an IMD dynamic range of at least 80-85 dB, and slightly better for a CW bandwidth.

The IMD effect is basically caused by the mixer, and one measure of receiver performance is obtained in the following manner. If the mixer i-f output of the desired signals, as well as the IMD product, are plotted against rf input, the two lines will intersect at a certain output level, **fig. 2**. Note that the two straight lines will have to be extrapolated to intersect, as this usually occurs at such high rf input levels that mixer gain compression (see below) takes place. The intersection level of output is called the third-order or IMD intercept (point), and is expressed in dBm. This point defines essentially the intermodulation performance of the receiver front end for all signal levels and thus becomes a figure of merit. Typical IMD intercept values range between −5 and 25 dBm — the higher numbers indicating better performance.

gain compression and blocking

Blocking, or desensitization, is the result of a very

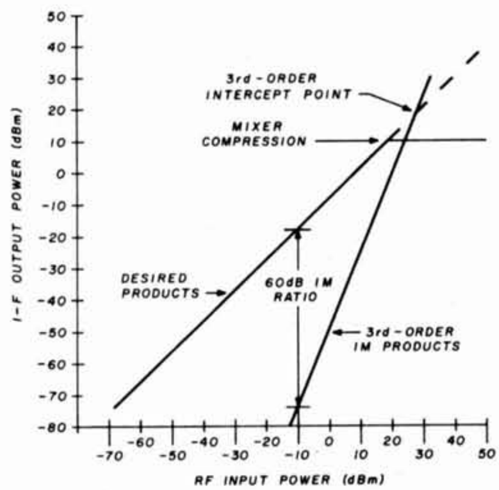

fig. 2. Third-order intercept point is determined by extrapolating the desired product curve beyond the mixer compression point and intersecting it with the third-order IM-product curve. (From the *ARRL Radio Amateur's Handbook*, 1981.)

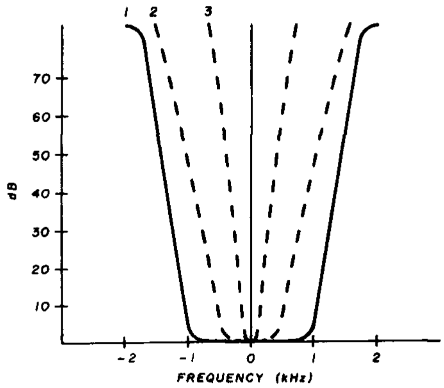

fig. 3. Typical i-f response curves. Curve 1: Built-in 2.4-kHz filter. Curve 2: Added 500-Hz filter. Curve 3: Alternate 250-Hz filter.

strong signal outside the receiver's i-f passband causing loss of gain; that is, gain compression. The blocking signal level is defined as the rf input voltage 20 kHz off frequency that causes the audio output of a weak desired signal (S5 or so) to drop by 1 dB. Typical signal levels are 20-25 dB above the third-order IMD level but this quantity is rarely stated in receiver specifications. Sometimes the expression "blocking dynamic range" is used. This is the difference between the noise floor level and blocking signal level. In the example case, this value typically would be 113-118 dB (related bandwidth should be stated).

cross modulation

Cross modulation occurs when the modulation of an adjacent strong signal appears on a desired strong signal in the millivolt range. The effect is rarely measured for Amateur receivers, where the interest is centered on small-signal performance. Also, IMD products would probably have been encountered in the receiver during such operating conditions. Many modern receivers contain a switchable front-end attenuator to minimize the unwanted effects of strong-signal reception.*

SSB selectivity

The sample receiver specs state that the receiver SSB selectivity is "2.4 kHz at −6 dB and 3.6 kHz at −60 dB." These numbers show a) the width of the receiver passband at 6 dB below the peak of the i-f curve (2.4 kHz) and 60 dB down from the peak (3.6 kHz) and b) the depth and the shape or form factor of the gate through which your desired signals can pass, **fig. 3**. The shape factor is defined as the ratio between the receiver bandwidth at −60 dB and −6 dB; in this case it is 1.5.

Receiver selectivity is largely established in the i-f circuits and, depending upon the characteristics of the i-f filters and signal leakage, the passband curve can be quite narrow and have steep sides down to 80 or 90 dB below the peak. A steep curve with sides going as low as possible before flattening out is desirable in that adjacent i-f signals are better suppressed, causing less interference and background hash. A receiver with a square-shaped passband curve down to −90 dB will appear much quieter than one that begins to flatten out at −60 dB.

CW selectivity

For CW operation, most high-quality receivers offer a number of narrow passband options, which are achieved by installing additional i-f filters. One of the example receiver options provides a selectivity of 500 Hz at −6 dB and 820 Hz at −60 dB. These values are average narrowband figures, and an experienced CW operator may even choose a higher selectivity such as 250 Hz at −6 dB and 500 Hz at −60 dB. Similar options exist for SSB operation by i-f filter replacement, but the bandwidth is rarely reduced below 1.8 kHz at −6 dB because of loss of voice quality. Instead, efforts are made to make the i-f passband steeper and improve out-of-band i-f signal suppression with more complex filters, possibly cascading several units.

image suppression

Because most Amateur communications receivers are superhets, two specifications relate directly to their conversion design. In the mixer, the undesired sum (or difference) of incoming-signal and local-oscillator frequencies, the image signal, is suppressed by the combined action of a high first i-f, the tuned circuits preceding the mixer, and good shielding. The sample specs state, "Image ratio better than 60 dB," which is entirely sufficient for Amateur use, in which most antennas are tuned to the operating frequency or a harmonic thereof.

i-f rejection

The receiver i-f is also susceptible to false signal pickup. The i-f circuit shielding and the tuned circuits before the mixer (tuned to the desired signal frequency) prevent outside signals at the intermediate frequency from entering the receiver. According to the sample specs, "i-f rejection better than 80 dB," a very satisfactory value, as the i-f is not a harmonic of, nor does it fall on, any Amateur band.

frequency stability

One essential quality is frequency stability. Modern solid-state oscillators have largely overcome stability

*Try reducing the rf gain. Most receivers have an rf gain control. Editor problems in Amateur equipment. The example receiver specifies frequency stability as, "Within 100 Hz during any 30-minute period after 1 hour of warm-up." This magnitude of drift would, at most, appear as a very, very slow change of tone pitch, barely noticeable on CW, and would be entirely satisfactory.

summing up

Of all these performance characteristics, which are the most important? Well, I live near Los Angeles, where a lot of strong local signals seem to fill every DX band.

After I determined that the transceivers I was interested in comparing had the desired bands, digital frequency readout, and other general features, the first special consideration I looked for became the receiver's blocking characteristics and IMD dynamic range. Fortunately, this matter has recently been given a great deal of attention by two competing manufacturers of high-frequency transceivers, as well as the ARRL product review team. Consequently, the data were readily available in *QST* and from the manufacturers and their data sheets.

My second special consideration was receiver selectivity. A basic SSB passband curve with a shape factor of 1.5 or less and straight sides down to −90 dB or lower would be most desirable. Additionally, a front-panel, switchable, narrowband CW filter with narrow bandwidth is a must. Should the receiver also have variable i-f bandwidth control, so much the better. The third special consideration is mechanical rigidity and front-panel layout.

I gave items such as sensitivity, image and i-f rejection secondary consideration, mostly because, in today's competitive market, solid-state circuits have almost universally forced to the fore good designs. The better high-frequency transceivers all seem to have more than enough sensitivity and, instead, become limited by atmospheric and manmade noise when in actual use.

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ham radio

ham radio TECHNIQUES

Bill Orr W6SAI

One of the nicest aspects of writing for *ham radio* is the interesting mail I receive. There's always something new in antennas, and this column is partially devoted to unusual antenna designs sent to me by other Amateurs. Let's start with an interesting 2-meter antenna from "down under."

the SLY beam

The SLY (Suspended Long Yagi) beam for 2 meters was developed by VK4ALE (now a Silent Key) and described in a recent issue of *Amateur Radio*, the excellent journal of the Wireless Institute of Australia. Briefly, the SLY beam is an inexpensive, portable Yagi antenna for Field Day operation. A plan view of the SLY antenna is shown in **fig. 1**. The supporting structure is made of two spreaders between which lengths of Dacron line are strung. (Nylon line should not be used because it stretches and causes the antenna to sag. It is also expensive.)

The Yagi elements are spaced along the two lines as shown and are held in position by small elastic rings cut from neoprene tubing (or similar dielectric material). The elements can be slipped into position and adjusted, as the rings provide a positive grip to the line yet permit easy movement of the element if required.

The two lines are attached to wooden spreaders, which are suspended in position with rope halters. The beam is pulled up into position between two fixed points and the halter ropes tied off.

Number of elements and feed system? Well, VK4ALE used 20, 25, and 30 elements at various times and even tried 32 elements—the overall length of the Yagi being about 75 feet (23 meters). Measurements on the 32-element job indicated a power gain of about 21 dB over a dipole, and the measured beam pattern at a distance of 200 miles was 35 miles wide (322 and 56 meters respectively). Not bad performance for an inexpensive, portable antenna.

One-eighth-inch (3-mm) aluminum tubing is suggested for the elements, or aluminum clothesline wire can be used. Element lengths and spacings used by VK4ALE are given in **fig. 1**, or Yagi dimensions provided in the various publications[1,2] can be used. Any of the common feed systems are applicable.

VK4ALE suggests that the completed beam be rolled up on a lightweight drum or cylinder for ease of transport, otherwise problems may be encountered in unravelling the assembly.

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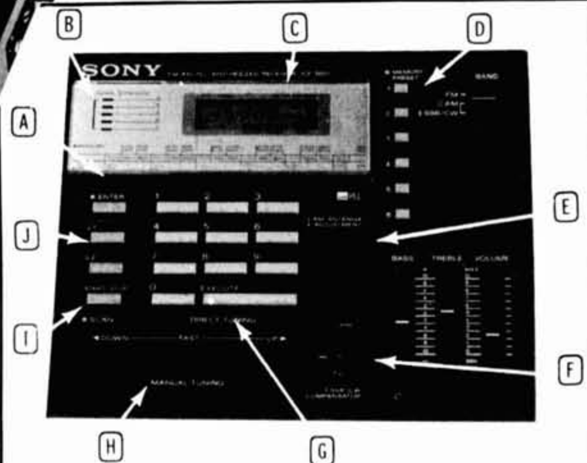

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B Signal Strength Indicator
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SPECIFICATIONS

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 102

Alas, life grows more complex, even against our best intentions. VK5EK brings our attention to that particular folly in his letter to the editor published in a recent issue of *Amateur Radio*. Al speaks about a low-power, solid-state transmitter design, *similar* to the one shown in chapter 6 of ARRL *Handbook*.

Al says, "If we are trying to overcome the 'black box' syndrome by inducing people to build their own equipment, then we will maximize our chances of success by presenting simple, cheap projects.

"Good applied engineering is concerned primarily with securing a stipulated design objective in the simplest and cheapest manner.

"Your 5-watt CW transmitter fails dismally in this regard, and is a stunning example of solid-state technology gone berserk.

"I present an alternative circuit which will do the same job (**fig. 2**). Your circuit has about 100 components, mine has fewer than 25. Most of your components would be purchased new; most of mine can be salvaged from an old black and white TV set (save the crystal and plate-tuning capacitor). I could build mine from scratch and have it working in one hour if I set my mind to it, or I would take two or three hours if I wanted a pretty appearance. Yours could hardly be built in less than four or five nights. You price yours at $50 (including crystal). I price mine at nil cost (excluding crystal and assuming a modest junk box).

"Your rig has a VXO and the capability for battery operation, which mine does not; but mine will readily work into any standing-wave ratio.

"Solid-state technology affords commercial manufacturers cheap, large-scale production and it is ideally suited to logic and nonlinear applications. But for transmitters, transverters, receivers and converters of practical simplicity, valves (tubes) remain incomparably superior for one-of-a-kind, home-built projects."

yesterday's technology

An interesting viewpoint indeed!

It is certainly true that tubes and old-time components, including defunct television receivers, are readily available at flea markets. In fact, *QST* magazine has run several articles in the past on using TV components salvaged from old, defunct receivers to build ham gear. And it is also true that some circuits can be built more inexpensively and quickly using tubes.

However, VK5EK misses one important fact of life that cannot be denied, and that is that the great majority of today's Amateurs have been brought up in a solid-state world and vacuum-tube technology is alien to them. It may seem simple to old timers, but tube technology can be puzzling and obscure to many of today's younger Amateurs. Vacuum-tube technology is no longer taught in colleges, and information on tubes is rapidly disappearing from Amateur magazines and handbooks. So while VK5EK has a valid point in extolling vacuum-tube simplicity, he is talking to an audience that, sadly, is deaf to his plea.

While I am on the soap-box, I might as well discuss another bête noire of Amateur Radio: amplitude modulation. A-m, or "ancient modulation" as it is derisively called by some, has largely disappeared from the Amateur bands. That allows a great improvement in spectrum conservation, and the loss of heterodyne interference between phone carriers is a tremendous step forward in improved communications ability.

But an unwanted effect of sideband use is that amplitude-modulation techniques are largely unknown by today's Amateurs. How many recently licensed Amateurs have knowledge of a class-B plate modulation system? Or the more recently developed pulse-duration modulation technique? Or the various high-efficiency amplitude-modulation systems including grid modulation? Or the famous Doherty-modulated amplifier?

Like it or not, a large percentage of

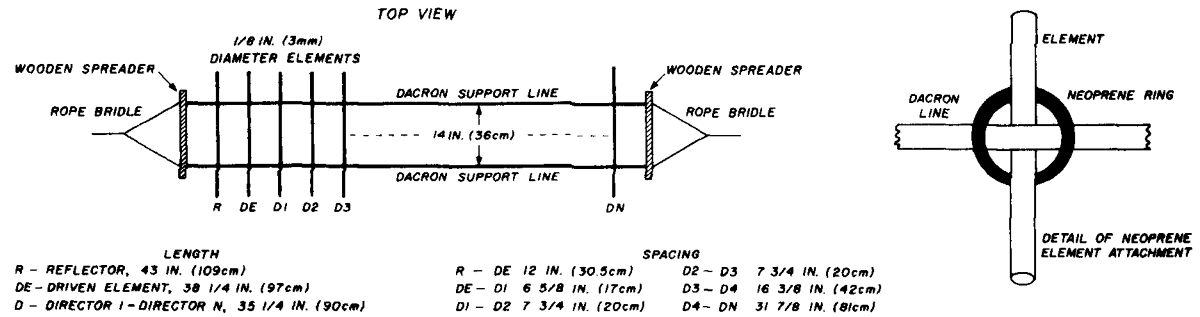

fig. 1. The SLY (Suspended Long Yagi) array of VK4ALE has been built with as many as 32 elements. This compact, flexible 2-meter beam is suspended from two Dacron* lines run between wooden spreaders. Directivity is to the right. All elements are held in position along the lines by rings cut from flexible Neoprene tubing. VK4ALE's dimensions are shown, but other reliable beam dimensions may be used. *The driven element, DE, is fed by conventional means.*
Any non-stretch line may be used.** ***Editor

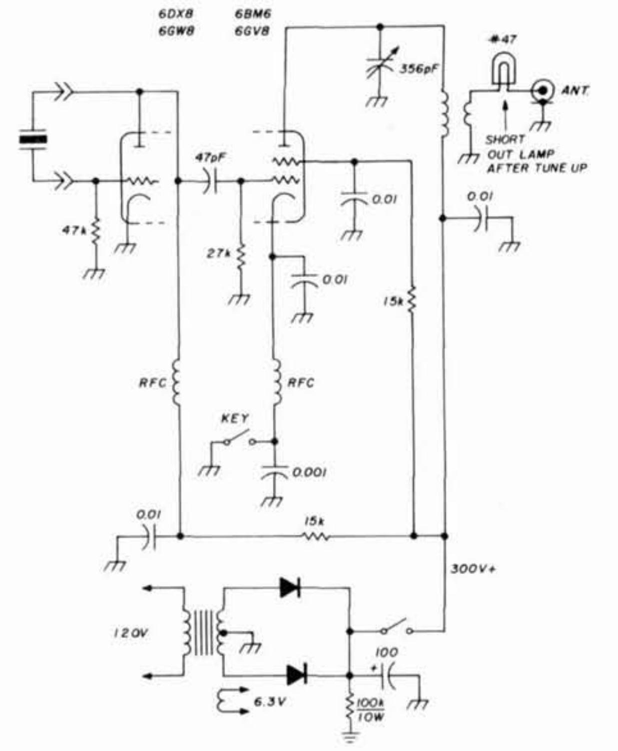

fig. 2. VK5EK's tongue-in-cheek reply to the modern QRP solid-state transmitter. Why use six expensive transistors and about 100 components when one tube and two diodes, plus a handful of flea-market components will do the job? Old-timers will certainly remember low-power transmitters of this general type. (Drawing adapted from *Amateur Radio* magazine, a publication of the Wireless Institute of Australia.)

communication in today's world is carried on by amplitude modulation. You don't believe me? Then just tune across the broadcast band or the many shortwave broadcast bands. All of these signals are amplitude modulated.

Banning amplitude-modulated signals from the Amateur bands might be a movement toward spectrum conservation, but it would further restrict the Amateur's knowledge in an important technology that forms a large portion of today's communication world. Plenty of space exists on 160, 10, and 6 meters for amplitude-modulation equipment, and it would be unwise to ban this basic form of intelligence transmission from the world of Amateur Radio.

a 5-band sloper antenna

Here's an antenna that works well on all bands. It was shown in *The Canadian Amateur* magazine[3] and designed by VE3CPU (**fig. 3**). Basically, it is one-half of a regular trap dipole antenna. A metal tower is used as a ground counterpoise. Only one trap is required, so a trap kit can be split with a friend who also wants to build this simple antenna. The antenna is fed with a coaxial line, the shield of which is grounded to the tower and the inner conductor is attached to the sloper wire.

VE3CPU points out that the antenna is quite directive on the higher-frequency bands, and swinging the bottom of the antenna about 90 degrees makes a big difference in signal strength at a distant location. He estimates the power gain over a dipole to be about 2.5 to 3.0 dB on 20, 15, or 10 meters.

As with all slopers and multi-band antennas, adjustment of the length of the tip section may be required to resonate the antenna at the design frequency on 80 meters.

radio-frequency interference (RFI)

RFI! It's hell if you have it. It can ruin your enjoyment of Amateur Radio by interfering with television and radio reception, disrupting communication circuits, causing false beats in electronic heart pacers, and by causing all other manner of equipment malfunction. Radio Amateurs are at once the cause and victim of RFI, as are CBers and all other users of electronic equipment.

Look at these numbers. In the United States in 1980 there were more than:

- 8,200 broadcast and fm stations
- 970 television stations
- 15,000,000 CB transmitters
- 360,000 Amateur Radio stations
- 210,000 aviation transmitters
- 7,800 radar transmitters
- 300,000 industrial radio transmitters
- 115,000 police and fire department radio transmitters
- 36,000,000 two-way portable radio transceivers plus millions of microwave ovens, X-ray machines, electric motors, light flashers and dimmers, welding machines, neon signs, diathermy machines, plastic formers, industrial welders, and so on.

And that's not all. Radio and television receivers themselves can cause objectionable RFI! The problem is that all radio receivers, transmitters, and pieces of electronic equipment are potential sources and victims of RFI. Anything run by electricity can cause RFI.

No wonder that electronic bedlam surrounds us, and it is a wonder that anybody can hear anything on the radio or see anything on television considering the vast number of interference-generating devices in our environment.

the sources of RFI and the victim

Remember, all cases of RFI involve two things: the source of the interference and the victim of the interference. For a complete cure of RFI, the interference must be suppressed at the source and the victim (the receiver, stereo equipment, or whatever) must be protected, or otherwise modified in such a way as to reject the interference. This is a large order, and little is being done to solve the growing problem. Information about RFI and its cures is hard to come by, RFI sources are obscure, and a lot of misinformation compounds an otherwise complex problem.

the RFI investigator

In recent years a whole new industry has grown up, largely unknown to most Radio Amateurs: the investigation and suppression of RFI. Electromagnetic compatibility studies and control standards have been created, largely by the military, to safeguard their communications circuits. Courses are available on electromagnetic compatibility and a new career opportunity — that of RFI investigator — has opened up for select, knowledgeable individuals. The job of the investigator is to investigate RFI complaints, track the interference to its source and resolve the problem. Only a handful of RFI investigators are at work in the United States today.

One of the pioneers in this field is a Radio Amateur, Bill Nelson, WA6FQG, who is well known nationwide for his extensive work in RFI investigation, encompassing over two decades of experience. During his long career, WA6FQG has tracked down countless sources of RFI and has lectured to Amateur and CB clubs and conventions on the causes and cures of RFI. Bill is now a consultant to power utilities on RFI problems, including RFI suppression and training of RFI investigators.

Just recently Bill completed an all-inclusive handbook on RFI, which covers the subject in detail.* It is an indispensable reference for all Radio Amateurs, CBers, and the everyday citizen troubled by RFI.

I've personally known WA6FQG for many years and have been greatly interested in his career in this unique work. And I have helped him arrange his handbook and get it published. It's now ready — over 240 pages of valuable information dealing with all facts of RFI.

An advance copy of the *Interference Handbook* was sent to Barry Goldwater, K7UGA, (U.S. Senator from Arizona and Chairman, Senate Communications Subcommittee). After reading the book, Barry said, "This informative handbook covers the entire field of RFI from A to Z. It will be a tremendous help to me and my staff as we work on communications legislation in Congress. Thanks for your help in this matter."

Another accolade for the new *Interference Handbook* came from David Fogarty, Senior Vice President of Southern California Edison Company. He said, "Written by a power-company investigator with 33 years of experience, this book is a reliable guide to the causes and cures of power line interference . . . contains absorbing case histories."

So there you are. Perhaps this new handbook will help you with your RFI problems. As I said before, RFI is hell if you have it. And if you don't have it today, chances are you will have it tomorrow!

Interference Handbook, by William R. Nelson, WA6FQG; Editor William I. Orr, W6SAI; 247 pages; $8.95 plus $1.00 shipping — available from Ham Radio's Bookstore, Greenville, New Hampshire 03048.

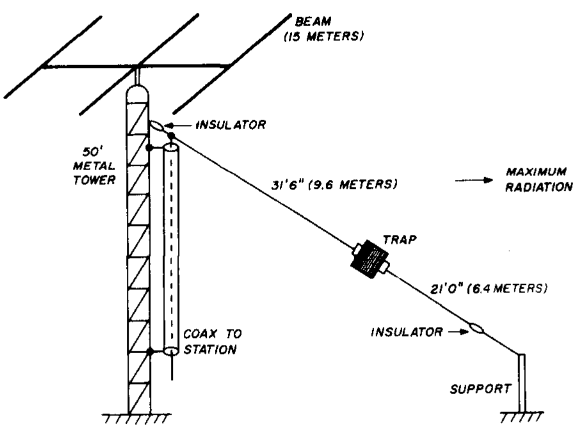

fig. 3. The 5-band sloper antenna of VE3CPU as described in reference 3. The antenna is used on bands between 10 and 80 meters. It is one-half of a regular trap dipole using a metal tower as a ground counterpoise. One trap dipole kit makes two antennas, so you can split a kit with a friend who also wants this antenna. Braid of coax is grounded to top and bottom of tower, and center conductor connects to the sloper wire.

references

1. William I. Orr, W6SAI, *Radio Handbook*, 22nd edition, Editors & Engineers Division of Howard W. Sams Co., Indianapolis, Indiana.

2. *The Radio Amateur's Handbook*, 58th edition, American Radio Relay League, Newington, Connecticut.

3. *The Canadian Amateur*, Box 356, Kingston, Ontario K7L 4W2, Canada.

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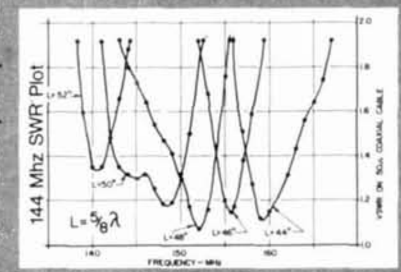

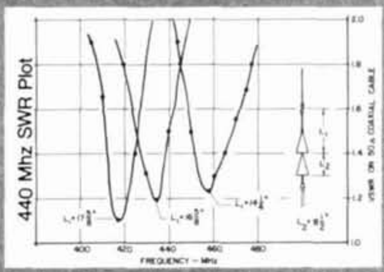

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add-on selectivity for communications receivers

A new audio filter design featuring sharper cutoff for SSB and better skirt selectivity for CW

The message of this article is that really effective audio filtering can work wonders to improve the performance of today's high-frequency receivers. First, however, we must consider just what the problems are that have to be solved.

A fact of life in high-frequency communications today, especially on the Amateur bands, is congestion. The problem is probably most acute for Amateur SSB transmissions. For a number of reasons, ranging from changing propagation conditions to sheer congestion, it's rare for an SSB station to have an undisturbed channel for long.

SSB interference

Normally, one SSB signal overlaps to a greater or lesser extent with others. The overlap can vary all the way from two stations being on identical frequencies *to a medium overlap, where the off-tune interfering* station causes characteristic high-pitched "monkey chatter." This can be either in the background or the foreground, depending on the relative strengths of the desired and undesired signals. Off-tune interference on the other side of the passband similarly causes a low-pitched version of monkey chatter. Other interference frequently encountered during SSB operation includes overlap with out-of-band intermodulation products (splatter) from over-driven and hence nonlinear SSB power amplifiers, single heterodyne whistles, CW and RTTY transmission, and broadcast stations operating in Amateur bands (particularly on the 40-meter band). Other kinds of strange noises come and go, ranging from the notorious Russian woodpecker to common interference from local electrical equipment.

CW interference

The effect of congestion on CW Morse code transmissions is similar in the sense that all the same interference sources are common. A difference is that CW transmissions don't actually overlap each other to any noticeable extent (sending speeds are low enough that sideband spread is very slight). On the

By Dr. D. A. Tong, G4GMQ, Datong Electronics Limited, Spence Mills, Mill Lane, Bramley, Leeds LS13 3HE, England

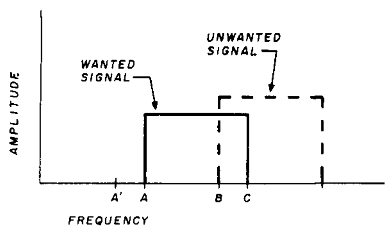


fig. 1. Solid curve shows frequency band (A to C) occupied by desired signal. The dashed curve represents the band occupied by a partially overlapping interfering signal. For optimum separation of the two signals, the receiver should accept only signals between A and B, and the cutoff at frequency B must be as sharp as possible. Point A′ is the distance that the lower cutoff, A, would move in so-called passband tuning (see text).

other hand, congestion causes the separate CW transmissions to be very close together and spacings of 200 Hz and less are not uncommon.

Users of other less-common transmission modes, such as radioteletype (RTTY) and slow-scan television (SSTV), are also affected by the same interference sources and are possibly even more vulnerable since the raw data is not prefiltered by the human brain before its message content is processed.

Another important source of interference is pulse noise, typically from car ignition systems, but this will not be considered further here since noise-blanking systems handle this kind of interference very effectively.

From the discussion above we can distinguish the following separate interference situations:

1. Broadband interference affecting a broadband transmission.

2. Narrowband interference affecting a broadband transmission.

3. Broadband interference affecting a narrowband transmission.

4. Narrowband interference affecting a narrowband transmission.

Each of these four cases requires different countermeasures if the receiver is to give the best possible separation of desired from undesired signals. Let's now consider these requirements in turn.

case 1 — broadband signals, broadband interference

This situation presents the most difficult problem and is typified by an SSB speech signal with other off-tune SSB signals superimposed. The situation can be represented as in **fig. 1**, in which the solid curve shows the typical frequency band occupied by the wanted signal, while the dashed line shows that of an interfering signal. Clearly, the amount of interference experienced will depend on the receiver bandwidth. The distance from **A** to **C** represents the normal receiver bandwidth (typically 2.1 kHz). If the bandwidth were reduced to **AB**, then all the interference would be eliminated with only slight effect on the desired signal.

To obtain maximum benefit from a bandwidth reduction under these conditions, it's essential that the cutoff at the edge of the passband be very sharp. A slow cutoff would give a greater reduction in the wanted signal for a given reduction in the interfering signal. A cutoff at least as sharp as that of a multipole crystal filter is desirable.

An alternative to merely shifting the upper cutoff frequency of the filter passband (that is, **C** to **B** as above) is to shift the whole filter passband. This is the so-called i-f shift, or passband tuning technique. Then, if the upper cutoff point moves from **C** to **B**, the lower cutoff would move an identical distance (that is, **A** to **A′** in **fig. 1**). This will remove the interfering signal; but it will also allow signals on the other side of the desired signal to enter the passband. Since the desired signal will normally have interference on both sides, i-f shift is only a partial solution.

We conclude, therefore, that for receiving broadband signals in the presence of broadband noise we need:

1. Independently adjustable upper and lower cutoff frequencies.

2. Very steep sides to the overall response curve — at least as steep as those in SSB-type crystal filters and preferably steeper.

case 2 — broadband signals, narrowband interference

Here the typical example is SSB reception in the presence of a loud whistle. If the frequency of the whistle is near the edge of the desired audio frequency response, a filter of the type discussed in the previous section can be used. However, if the whistle is near the middle of the audio band, decreasing the upper cutoff frequency (or increasing the lower one) will remove the whistle — but will also eliminate too much of the desired signal.

A better solution here is to use a notch filter. This is a filter that passes all frequencies except a narrow range centered on the notch frequency. By moving the notch until it coincides with the undesired whistle, the latter can be removed without significantly affecting the desired signal.

The conclusion is, therefore, that we need a narrow-bandwidth notch filter whose center frequency can be tuned over the full receiver bandwidth. A self-tuning notch filter designed especially for this purpose, the Datong Model FL1, has been described (reference 1).

case 3 — narrowband signal, broadband interference

The narrower the desired signal, the easier it is to filter it from broadband interference. Consider, for example, two transmissions with equal peak power. One is a CW signal; the other a SSB speech signal. The energy in the latter is, on average, spread over a bandwidth of typically 2.4 kHz (the so-called speech bandwidth), while that in the former is concentrated on *one* frequency (assuming normal sending speeds). If the CW signal is passed through a filter of 200-Hz bandwidth, all of the CW signal will pass through, but only 200/2400, or one twelfth, of the SSB signal will emerge.

Now, if the bandwidth is then narrowed to only 50 Hz, the ratio becomes 1:48. The point is that, provided the bandwidth reduction does not encroach on the frequency components in the desired signal, a continuous improvement in signal-to-noise ratio will result as the bandwidth is reduced.

In the case of CW signals, the minimum usable bandwidth depends on the sending speed. Reducing the bandwidth increases the rise and fall times of the dots and dashes. When these rise and fall times become comparable to the duration of a dot, the dots merge into each other and the signal becomes a blur. At typical sending speeds this blurring effect does not cause problems until the bandwidth is below 50 Hz, so that, compared with a receiver using a SSB-width filter (say, 2.4 kHz), an improvement approaching 50 to 1 is practicable through bandwidth reduction. This is why a good CW filter can easily retrieve a CW signal that's almost buried in a SSB signal when listening using only the SSB filter.

case 4 — narrowband signal, narrowband interference

The most common example of this condition is two closely spaced CW signals. Any of the filtering methods described so far are suitable in principle. For example, a wide passband could be used but positioned to just cut off the undesired signal; or a notch filter could be used to remove it. However, conditions seldom remain constant for more than a few seconds, and one interfering signal can soon be joined by many others. Because of this problem, it's convenient to use a narrowband filter centered on the signal of interest. Some operators prefer to use a passband with a pointed top, while others may prefer a more rectangular shape. The latter can be useful in net operations where not every station is exactly on the correct frequency.

Also subject to personal preference is the question of skirt selectivity. Some operators prefer to hear only the signal of interest (that is, single-signal reception); others prefer to have some indication of what is present on adjacent frequencies.

Before summarizing the requirements for a CW filter, we must consider the question of how the filter is controlled. For SSB reception, separate adjustment of the upper and lower cutoff frequency is desirable. For CW reception, this is not ideal. It's much better if the center frequency of the passband and the passband width can be separately and smoothly varied and in such a way that the two controls *do not interact*. Thus one should be able to select a particular bandwidth and move this constant-width window to any point in the overall receiver passband. Because of the very wide range of conditions that are likely to be encountered, CW filters having continuous adjustment are far more effective and pleasant to use than those with a limited number of switched settings.

In summary, for CW reception the following features are desirable:

1. The receiver bandwidth should be continuously and independently adjustable in width and center frequency.

2. The filter pass-band shape should be selectable between flat and peaked.

selectivity at i-f or af?

Conventionally, most of the selectivity in a receiver is concentrated at the intermediate frequency (i-f). This is a matter of practical convenience. It's easier to make an effective high-frequency filter if its frequency is fixed, and this is why the superheterodyne receiver rapidly superseded the tuned-radio-frequency (TRF) type.

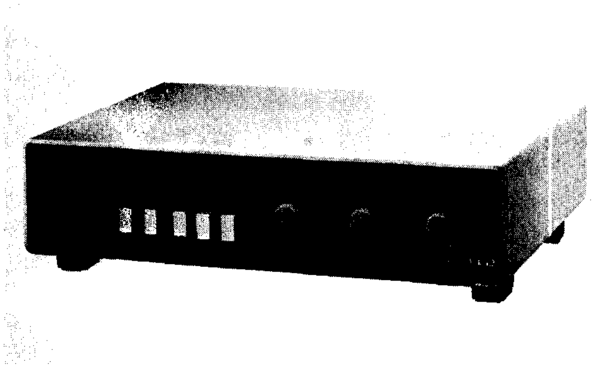
Provided a receiver is linear throughout, the overall selectivity is the product of *all the separate sections in the system*. Thus, in a SSB/CW receiver all stages, including the final detector are, in theory at least, linear; and the selectivity could be located in the rf, i-f, or audio sections with equal effect. In practice, however, it's desirable to have *as much selectivity as possible as near to the input as possible*. This is because real circuits, especially mixers, are not perfectly linear, and strong unwanted signals can combine to form mixing products that can interfere or obscure the desired signals.

In most modern receivers, a good filter is used at the i-f, and an automatic gain control system is used to control the gain ahead of the main filter to avoid overload effects. This means that extra selectivity can be placed at *any point* in the receiver system *after* the main filter without running into problems caused by overload. Thus, by taking advantage of the protection afforded by a good SSB crystal filter and good AGC, an audio filter can be used very successfully at the output of a receiver. If the audio filter's bandwidth is less than that of the main filter, the overall receiver bandwidth will then be controllable *by the audio filter.*

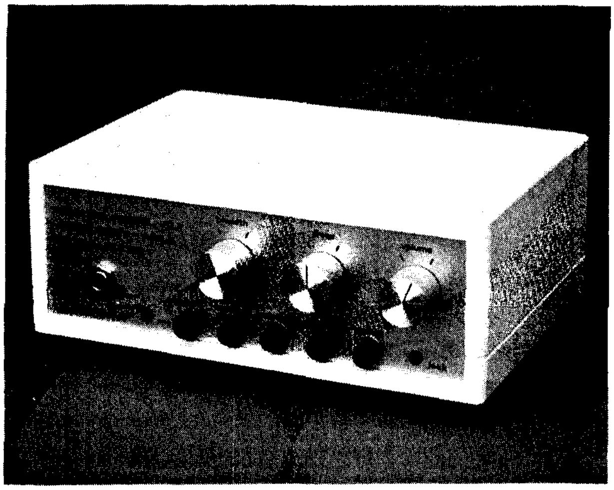
is audio filtering really as effective as i-f filtering?

The short answer to this question is yes, whenever a product detector is in use (for example, for CW, SSB, RTTY, or a-m received as SSB). When a linear detector is used (that is, a product detector), selectivity after the detector is exactly equivalent to selectivity before the detector. So that, for example, if you wish to separate two signals of slightly different frequency you could do it equally well before or after such a detector. On the other hand, when the same signals are processed by an envelope detector (as for normal a-m), the two signals emerge mixed with sum and difference products. Thus, although very useful results are obtained, a complete separation is not possible using filtering after an envelope detector.

One other difference between pre- and post-detector filtering is that in the latter case the bandwidth of the receiver as presented to the AGC circuit is wider than the overall bandwidth. This means, for example, that if you are selecting one CW signal from the receiver's output using a narrow audio filter, another



Datong's Model FL2 contains three linearly voltage-tuned filters: a five-pole elliptic function lowpass, a similar highpass, and a two-pole peak or notch. The three filters can be tuned independently with separate knobs, or ganged to simulate a bandpass filter with independent center frequency and bandwidth controls. Precise tracking by all twelve poles of filtering is achieved by using pulse-width modulation techniques to simulate twelve identical voltage-controlled resistors.



The Datong Model FL1 audio filter, as well as being a variable CW filter with noninteracting center frequency and bandwidth controls, can also automatically locate, track and notch out single interfering heterodynes. It continually searches from 300 to 3000 Hz and needs only about two seconds to achieve lock. Notch bandwidth in the AUTO mode can be only 20 Hz. The notch is therefore inaudible while searching.

stronger signal inside the receiver's i-f passband could cause the apparent strength of the desired signal to vary due to AGC action. The effect causes no particular problem, however, since even when it does occur it sounds very similar to fading caused by normal propagation effects.

a new audio filter design for communications receivers

We have discussed the basic filtering requirements for communications receivers and have established that conventional SSB crystal filters by no means represent the last word in performance capability. We have also established that extra selectivity can be conveniently and effectively added to a receiver in its audio output circuit.

We now discuss a new audio filter design, Model FL2, which has recently been introduced by Datong Electronics Limited specifically to improve existing communications receivers in the ways already outlined. Model FL2 contains three quite complex and independent active audio filters. Each is tuned by a control voltage, and the linear frequency versus voltage curves are accurately matched to allow ganged operation. The filters comprise:

1. A five-pole elliptic-function lowpass filter.

2. A five-pole elliptic-function highpass filter.

3. A two-pole filter with independent peak and notch (that is, band-pass and band reject) outputs.

Five pushbutton switches select any of the various operating modes previously discussed. The switches connect the three filters in the correct combinations and also determine how the three filter control voltages are to be derived from the three panel controls.

Each filter is built from state-variable multiple op amp subsections using 1 percent metal-film resistors and polystyrene capacitors. Such filters have excellent immunity to variations in the active elements. This, and the precision passive components, give good tracking capability and long-term stability. A total of twenty-two op amps are involved in the filter sections, and an additional six op amps are involved in the control functions.

The nominal over-all gain of the filter is unity, and a 2-watt audio power stage is included. This means that the complete filter can be easily installed between the loudspeaker and audio output stage of existing receivers. Altogether, the system uses twenty-one integrated circuits, most of which contain multiple functions.

performance details

The five-pole elliptic-function low and highpass filters were designed to have a minimum stop-band rejection of 40 dB. Each filter has two frequencies of infinite attenuation in the stop-band. If the filter cutoff frequency (that is, the −1 dB point) is given by fC, then for the lowpass filter the infinite attenuation frequencies are at $1.29 fC$ and $1.85 fC$; and for the highpass filter they are at $0.55 fC$ and $0.78 fC$. Similarly the −40 dB points on the filter responses are reached at $1.25 fC$ for the lowpass and $0.8 fC$ for the highpass.

These filter responses are illustrated in **fig. 2A**, which shows the calculated response for high and lowpass filters in cascade, with cutoff frequencies at 500 Hz and 2500 Hz respectively. In both cases it is clear how the closeness of the first null response to the cutoff frequency gives a high rate of cutoff.

At a cutoff frequency of 2 kHz, for example, the rate of cutoff is 40 dB in 500 Hz for the lowpass filter. Similarly, if the highpass filter is set to a cutoff frequency of 500 Hz, the rate of cutoff below 500 Hz is 40 dB in only 100 Hz. For comparison, commercial SSB crystal filters tailored to good-quality Amateur-band communications receivers have typical rates of cutoff of 40 dB in 600 Hz. Model FL2 therefore has an appreciably sharper cutoff than typical SSB crystal filters.

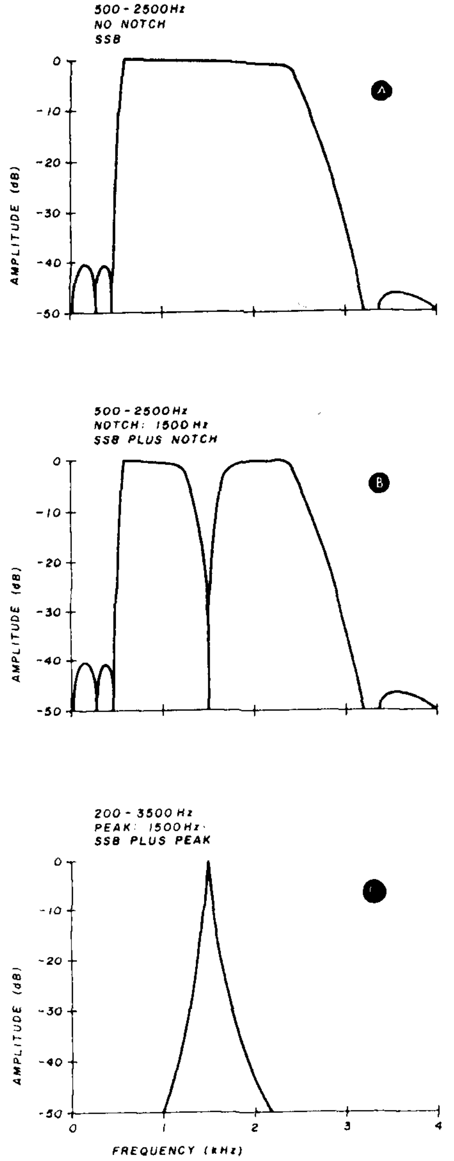


fig. 2. Theoretical response curves for Model FL2. These curves (and those in *figs. 3, 4,* and *5*) were obtained by using an HP-85 computer to solve the complete transfer function for Model FL2. Actual production units give very similar results. This is demonstrated, for example, by the actual response curves measured by Gunter Schwarzbeck and published in his independent and very detailed test report in *CQDL* (see reference 2). All three graphs have the lowpass filter set to 2500 Hz and the highpass to 500 Hz. A shows the response in SSB mode, B shows response in SSB + NOTCH mode with notch set to 1500 Hz, and C shows response in SSB + PEAK mode with same knob settings.

application to SSB reception

When the SSB button is pressed, the high and low-pass filters are connected into the circuit and their cutoff frequencies are independently controlled by the center and right-hand knobs respectively (photo). The tuning range for each filter is 200 to 3500 Hz, so that any desired bandpass characteristic can be obtained with the same general shape as that of **fig. 2A**.

When the **SSB + NOTCH** button is pressed, the high and lowpass filters behave in the same way; but in addition, the notch filter is connected in series and can itself be independently tuned by the left-hand knob over the same range of 200 to 3500 Hz. The notch width is fixed at 200 Hz at the − 6 dB point and remains constant as the notch frequency is varied. An example of this mode is shown in **fig. 2B**.

Tuning a notch to a weak heterodyne can be difficult, and in such cases **SSB + PEAK** can be selected. In this mode, the peak output from the notch/peak filter is selected, and the filter can then easily be tuned onto the unwanted whistle. The 6-dB bandwidth in this mode is 200 Hz. After tuning onto the whistle, **SSB + NOTCH** would be reselected. The **SSB + PEAK** response corresponding to **fig. 3B** is shown in **fig. 2C**.

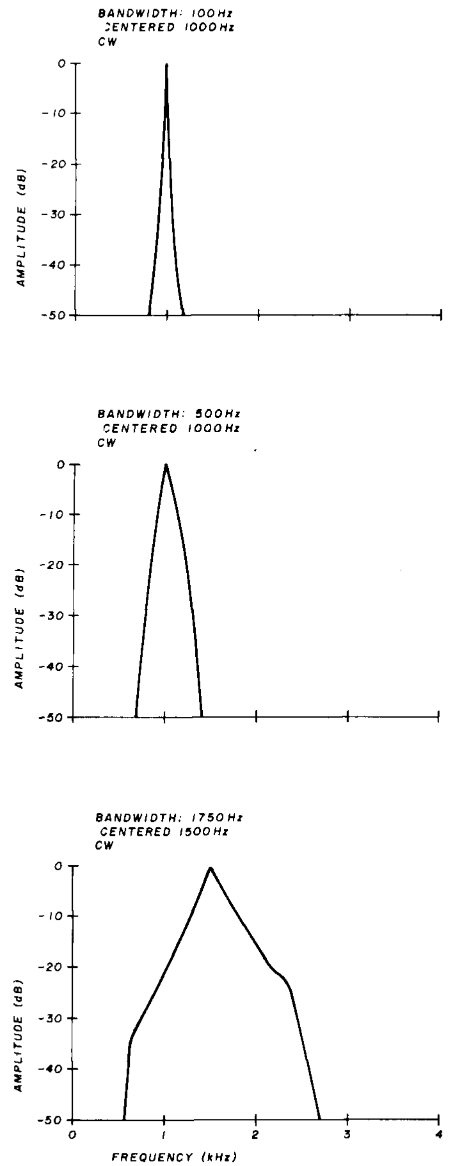


fig. 3. Three examples of the response in the CW mode. In this mode the response is a superimposition of two curves, one as in *fig. 2A* and the other as in *fig. 2C*. Note the center response and extremely good skirt rejection.

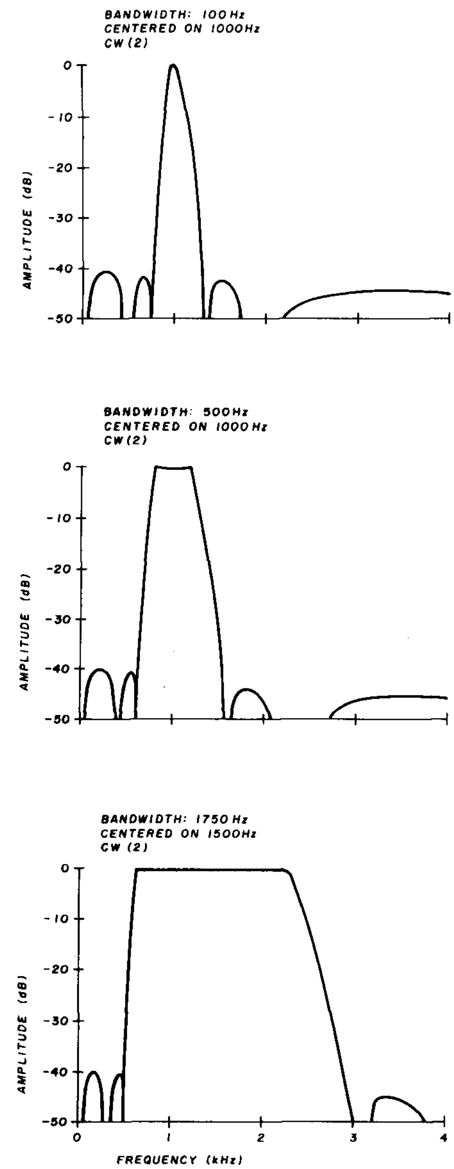


fig. 4. Three examples of the response in the CW(2) mode. The control settings correspond to those in *fig. 3*; and, in fact, the responses in *fig. 3* are those of *fig. 4* combined with the response of a two-pole peaking filter (as in *fig. 2C*). Note the relatively square passband. These curves are also typical of those obtainable in the SSB mode (but of course using different knob settings). Note also the two-notch stop-band responses characteristic of the five-pole elliptic function filters.

The SSB mode would also normally be the correct choice for a-m and fm reception and possibly also for SSTV. It could, of course, also be used for any other mode such as CW and RTTY, but a more convenient tuning method is provided for these modes as described in the next section.

application to CW and RTTY reception

Two CW modes are provided. They differ primarily in the shape of the response curves. Common to the two CW modes is that the high and lowpass cutoff frequencies are controlled by analog circuitry to simulate a composite bandpass filter whose center frequency and bandwidth are independently controllable. In these modes the center knob controls the center frequency from 200 to 3500 Hz, and the right-hand knob controls the bandwidth from 100 to 1750 Hz. As the center frequency is varied, the bandwidth remains constant; and similarly, the center frequency is independent of the bandwidth (subject always to the condition that the lower cutoff frequency can never go lower than 200 Hz and the upper cutoff frequency cannot exceed 3500 Hz).

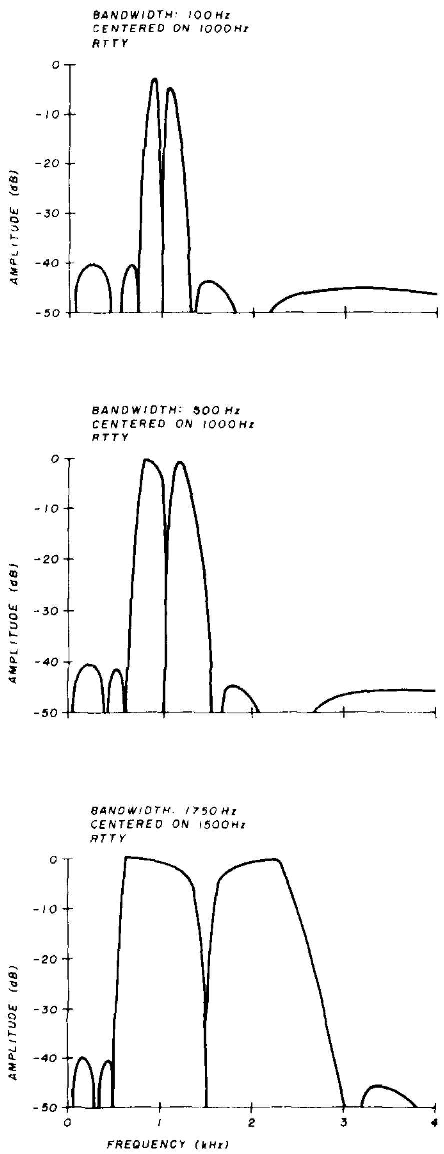


fig. 5. Responses obtained by selecting the RTTY mode but with the same knob settings as in *fig. 4*. The center notch width varies in sympathy with the overall bandwidth setting.

To prevent confusion in panel markings, those which apply only to tuning of the type just described are printed in yellow, while those referring to SSB-type tuning or to both are in white.

The main CW mode is selected by pressing the **CW** button. This connects the two-pole peaking filter in series with the high and lowpass filters. The bandwidth of the peaking filter is ganged with the separation between the high and lowpass cutoff frequencies, and both are controlled by the bandwidth control (right-hand knob).

Composite response curves are illustrated in **fig. 3**, which shows the overall responses at skirt bandwidths of 100, 500, and 1750 Hz. In all cases a domed center response is combined with extremely good far-out stop-band rejection. The domed center response makes it easy to tune a CW signal to the center of the filter passband, since one merely tunes for maximum signal. The bandwidth can then be widened or narrowed symmetrically about the signal as desired without the need to retune. The 6-dB bandwidth varies from 70-700 Hz as the skirt bandwidth moves between its extreme values of 100 and 1750 Hz.

This passband shape is considered optimum for most CW reception, but an alternative, CW(2), is provided by simultaneously pressing the two buttons **CW** and **SSB**. The high and low filters are then controlled as in CW, but the peaking filter is disconnected. The result is a rectangular response shape exactly as obtained in the SSB mode; but since it is a "yellow" mode, the filters are still controlled by the center frequency and bandwidth controls. This effect is shown in **fig. 4** for the same control settings as for the CW curves. The CW(2) mode is especially suitable for use with CW nets or for RTTY reception.

A third "yellow"-mode RTTY is obtained by pressing both **CW** and **SSB + NOTCH** buttons. Here the filters are controlled in the same way as for the CW mode, but the two-pole filter is now used as a notch filter, and the notch width is ganged with the bandwidth function. The result is the passband shape shown in **fig. 5**. This is suitable for wide-deviation

RTTY signals — the central notch giving increased immunity to interference.

other features

When using Model FL2 it is interesting to be able to determine the improvement due to the filter by comparing the signal before and after filtering. Once a desired filter mode is selected, by simultaneously pressing the two buttons **SSB** + **PEAK** and **SSB**, only the high and lowpass filters are left in circuit, and their cutoff frequencies are held at their lower and upper limits respectively. In other words, the bandwidth is expanded to maximum, and the effect is virtually equivalent to no filtering when used with normal communications receivers. Alternatively, when the **OFF** button is pressed the input signal is connected straight through to the output terminal, and power is removed from the filter. Since the overall gain is unity, no changes to volume level will be required.

A front panel headphone jack is included on the FL2; the loudspeaker output terminal is disconnected when phones are used. A second output connector is also included to allow a tape-recorder connection.

closing remarks

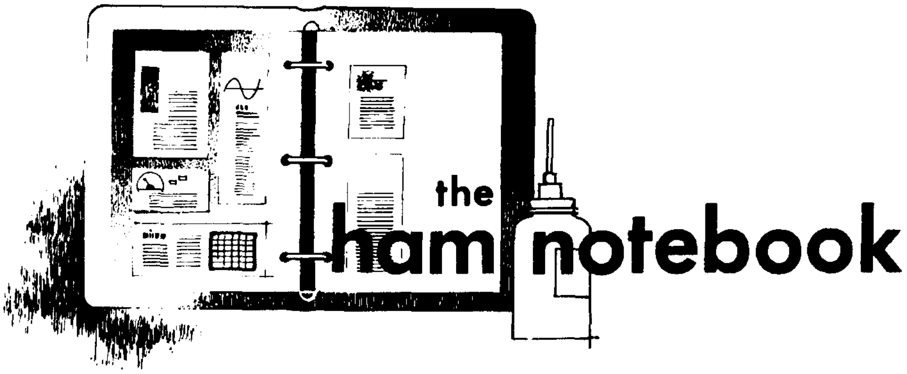
It is traditional that most passband shaping in communications receivers be carried out by the i-f filter. However, now that virtually all communications receivers feature good basic selectivity, effective AGC, and linear product detectors, it makes good sense to perform final bandwidth shaping in the receiver's audio section. Model FL2 was designed to take full advantage of this situation and offers a versatility of performance that would be very difficult to achieve at i-f. Yet, since it is an audio filter, it can be retrofitted to any existing receiver without any internal connections required.

Compared with previous audio filters, Model FL2 gives far sharper cutoff for SSB and better skirt selectivity for CW. This results from the comparatively large number of filter sections — twelve — all of which track precisely together to maintain the desired elliptic function response. Previous filters approaching this level of complexity have not been freely tunable, while previous tunable filters have been restricted to only relatively few sections.

references

1. D.A. Tong, G4GMQ, "Audio Filters as an Aid to Reception — With Special Reference to the Datong Frequency-Agile Audio Filter Model FL1," *Radio Communication*, February, 1978, pages 114-118.
2. Gunter Schwarzbeck, DL1BU, "Testbericht: NF — Filter Datong FL2," *CQDL*, February, 1981, pages 56-59.

ham radio



interesting preamplifier for 144 MHz

What's so interesting about this 2-meter preamp? It doesn't have the lowest noise figure of any of the 2-meter preamps I've tested. It doesn't have the highest gain, although it has more than enough gain for any practical application. And it doesn't have the sharpest bandpass characteristic, although it's better than many other low-noise preamplifiers.

The interesting feature of this preamp is that it combines low noise figure, *reasonable* gain, and good bandpass characteristics with *low cost*. The NE73437 bipolar transistor (Q1, **fig. 1**) sells for only $1.75 (in 1-9 quantities), and the entire preamp can be built for under $10.

Q1	NE73437
C1,2,4	5-25 ceramic variable
C3	1-10 air variable
L1,2	5 turns No. 20 (0.8 mm) AWG 1/4" × 3/8" (6.5 × 9.5 mm)
CA,B,C,D	500 pF disc
CE	0.01 μF disc
NF	1.03 dB
G_{fe}	22 dB
G_r	−40 dB

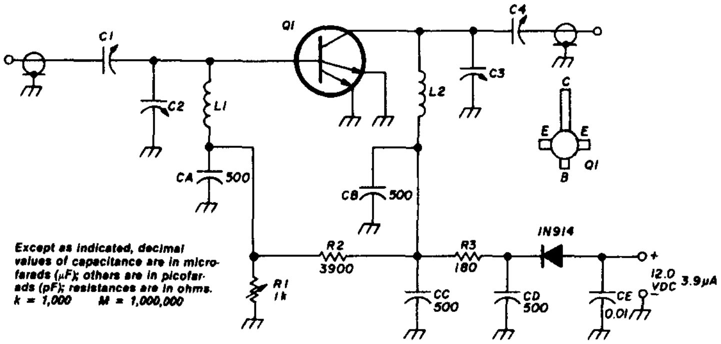


fig. 1. Schematic diagram of preamplifier.

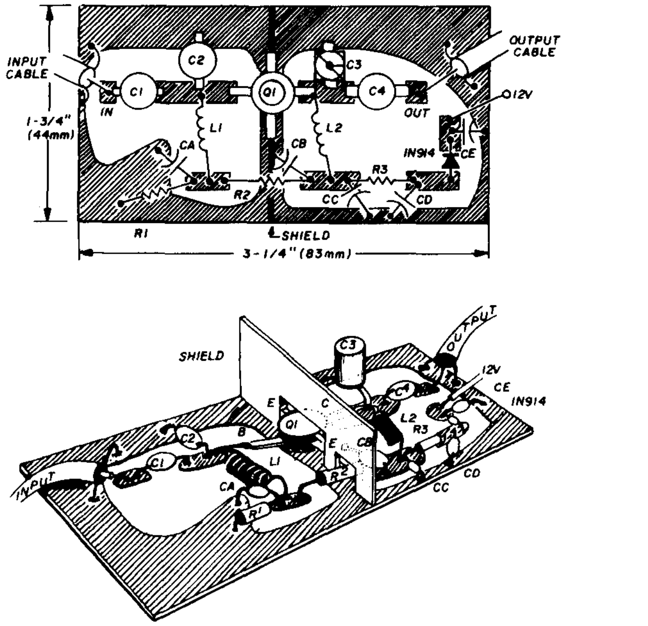


fig. 2. PC board and component layout. Note that the NE73437 device package has three equal-length leads and a longer (collector) lead. The base lead is opposite the collector lead.

performance

The schematic is shown in **fig. 1**; the layout in **fig. 2**. Specifications, when tuned for *minimum noise figure*, are:

1. Noise figure, 1.0 dB.

2. Forward gain, 22 dB.

3. Reverse gain, 40 dB, with a gain margin (reverse gain minus forward gain, a measure of stability) of 18 dB.

The gain response (bandwidth) is shown in **fig. 3**. Note the expanded plot showing the region between 140 and 150 MHz. Overload and intermodulation characteristics are shown in **fig. 4**.

My experience has been that the first stage of a receiver is almost never overloaded (except in very special and rare situations, which most of us never have to worry about), and that a −1 dB point, P_{-1}, of −20 dBm of input power, with a third-order intercept point at I_3 of 18 dBm is, at least, adequate for most stations. The gain and noise figure of this preamplifier are good enough for all but moonbounce work, in which situation this unit makes an excellent second stage. You can use several feet of coaxial cable between first and second stages, and at least 100 feet of RG-8/U between this preamp as a second stage and a receiving converter without concern over insufficient gain or second-stage degradation of system noise.

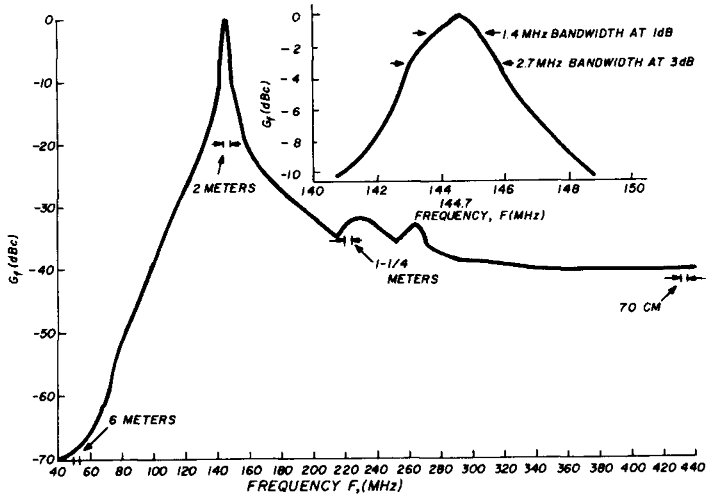


fig. 3. Preamplifier frequency response.

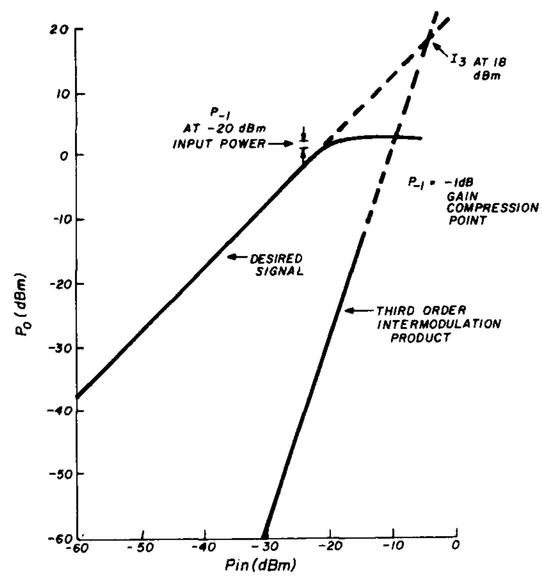


fig. 4. NE73437 preamplifier input/output and intermodulation response.

construction

A single-sided PC board layout is shown in **fig. 2**. Use good vhf wiring practices (short leads) and make sure a shield is used as shown; a shield box should also be used around the unit.

The NE73437 is built in a plastic package, having a collector lead longer than the pair of emitter leads to either side of it, or the base lead opposite it. Make sure to solder both of the emitter leads to ground and to place the shield over the emitter leads, but only after soldering the rest of the components in place. No other special precautions were found to be necessary.

tune up

Connect a 12 Vdc source to the preamp and set the bias pot (R1) for a total preamp current of about 4 mA. Adjust C1,C2,C3 and C4, in any order, for maximum gain. If you have access to a noise generator setup, tweak C1 and C2 for lowest noise figure. The weak-signal reception method can also be used to tweak for best noise figure. The preamp can be modified for use at 220 and 432 MHz.

The device is available from California Eastern Labs, 3005 Democracy Way, Santa Clara, California 95050 (CEL supplied much appreciated data and samples for the prototype of this preamplifier). I will answer all questions upon receipt of a self-addressed, stamped envelope.

Geoffrey H. Krauss, WA2GFP

"Comm-packed."

NEW

BIG performance... small size... smaller price!!!

TR-2500

The TR-2500 is a compact 2 meter FM handheld transceiver featuring an LCD readout, 10 channel memory, lithium battery memory back-up, memory scan, programmable automatic band-scan, Hi/Lo power switch and built-in sub-tone encoder.

TR-2500 FEATURES:

- **Extremely compact size and light weight**
  Measures 66 (2-5/8) W x 168 (6-5/8) H x 40 (1-5/8) D, mm (inches). Weighs 540 grams (1.2 lbs) with Ni-Cd pack. (Photo shown, actual size).
- **LCD digital frequency readout**
  Easy to read in direct sunlight or dark (with lamp switch). Low current drain. Shows frequencies and memory channels, plus four "Arrow" mode indicators.
- **Ten channel memory**
  Nine memories for simplex or ±600 KHz offset. "M0" memory for non-standard split frequency repeaters.
- **Lithium battery memory back-up**
  Built-in Lithium battery (estimated 5 year life) maintains memory when Ni-Cd pack is fully discharged or removed.

CONVENIENT TOP CONTROLS

- **HI/LO power output selection**
  Allows operation at 2.5 watts or 300 mw RF output.

Actual size

- **Memory scan**
  Scans only channels in which frequency data is stored. Stops on busy channel, resumes scan approximately 2 seconds after signal ceases.
- **Programmable automatic band scan**
  Upper and lower frequency limits and scan steps of 5 KHz and larger (5, 10, 15, 20, 30 KHz, etc.) may be programmed. Scan locks on busy channel, resumes approximately 2 seconds after signal ceases.
- **UP/DOWN manual scan**
  Up/Down manual scan in 5 KHz steps.
- **Built-in tuneable sub-tone encoder**
  Sub-tone encoder, with activate switch, tuneable (variable resistor) to desired CTCSS tone. Optional TU-1 programmable (DIP-switch) encoder accessory available.
- **Built-in 16 key autopatch encoder**
  16 keys provide telephone dual tone modulation.
- **"SLIDE-LOC" battery pack**
  Slides into position, locks into place.
- **Reverse operation**
  Shifts receiver to transmit frequency, and transmitter to receive frequency.
- **Keyboard frequency selection**
  Sets operation frequency across full range.
- **Extended frequency coverage**
  Covers 143.900 to 148.995 MHz in 5 KHz steps.
- **Optional power source**
  Using optional MS-1 mobile or ST-2 AC charger/power supply, radio may be operated while charging. (Automatic drop-in connections.)
- **High impact plastic case**
  Provides extra strength to resist damage.
- **Battery status indicator**
  Flashes to indicate low battery charge level.
- **Two lock switches**
  Prevent accidental frequency change and accidental transmission.

Standard accessories included:

- Flexible rubberized antenna with BNC connector
- 400 mAH heavy-duty Ni-Cd battery pack
- AC charger
- Plugs for external microphone and speaker

More information on the TR-2500 is available from all authorized dealers of Trio-Kenwood Communications 1111 West Walnut Street, Compton, California 90220.

KENWOOD

...pacesetter in amateur radio

Optional accessories:

- ST-2 Base station power supply and quick charger (approx. 1 hr)
- MS-1 Mobile stand/charger/supply
- TU-1 Programmable sub-tone (CTCSS) encoder
- SMC-25 Speaker microphone
- LH-2 Deluxe top grain cowhide leather case
- PB-25 Extra Ni-Cd battery pack, 400 mAH, heavy duty
- BH-2 Belt hook
- WS-1 Wrist strap
- EP-1 Earphone
- ______ RF power amplifier (To be announced later.)

MS-1

ST-2

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

up-conversion receiver for the high-frequency bands: part one

Build it — try it out.
Does it set a new standard for performance?
You be the judge

author's note
The object of this two-part construction project is strictly educational. I wanted to see if it was possible to produce a fairly good unit with readily available parts and, if so, to go on to design and construct a transceiver. Because of this, the module construction was done in breadboard fashion. There are no board layouts available, but some of the photos show typical construction techniques used throughout.

After a ten-year hiatus of little Amateur Radio activity, my S-line equipment started to look old when compared with the transceiver ads in the magazines. Surely, radios that looked this good must outperform my 20-year-old units. But which one to buy? With a well-equipped lab at my disposal, I decided to check out some available units. The results were generally disappointing, in my opinion. Except for third-order intermod performance, my old box full of tubes ran rings around the new solid-state units.

One of the new units I checked out had a strong front end but lacked sensitivity, very poor AGC characteristics, and produced a lot of hum and noise if an external audio filter wasn't used.

Another unit had excellent sensitivity, adequate overload characteristics, and good AGC; but synthesizer phase noise was excessive.

A third unit had an excellent operating "feel" and sound for DXing and contesting but had a soft front end.

A fourth unit wasn't considered for testing because of its poor reliability, as reported by a number of owners. Little testing was performed on the transmitters, although two of the units had key clicks and one had a slight chirp on CW; also its ALC characteristic was poor.

The digital readout and no-tuning features sold me on the solid-state rigs, but I couldn't decide on which compromise to make. So I constructed this receiver as a breadboard project to see if a full-blown transceiver effort was feasible. By constructing this receiver, I could concentrate on the *basic performance* characteristics and leave the frills for later, or leave them out completely.

design

The basic configuration is shown in **fig. 1**. Up conversion eliminates the need for tunable filters at the front end. With this conversion method, adequate image rejection can be obtained with a simple low-

By George Cutsogeorge, W2VJN, Plasma Physics Laboratory, Princeton University, P.O. Box 451, Princeton, New Jersey 08544

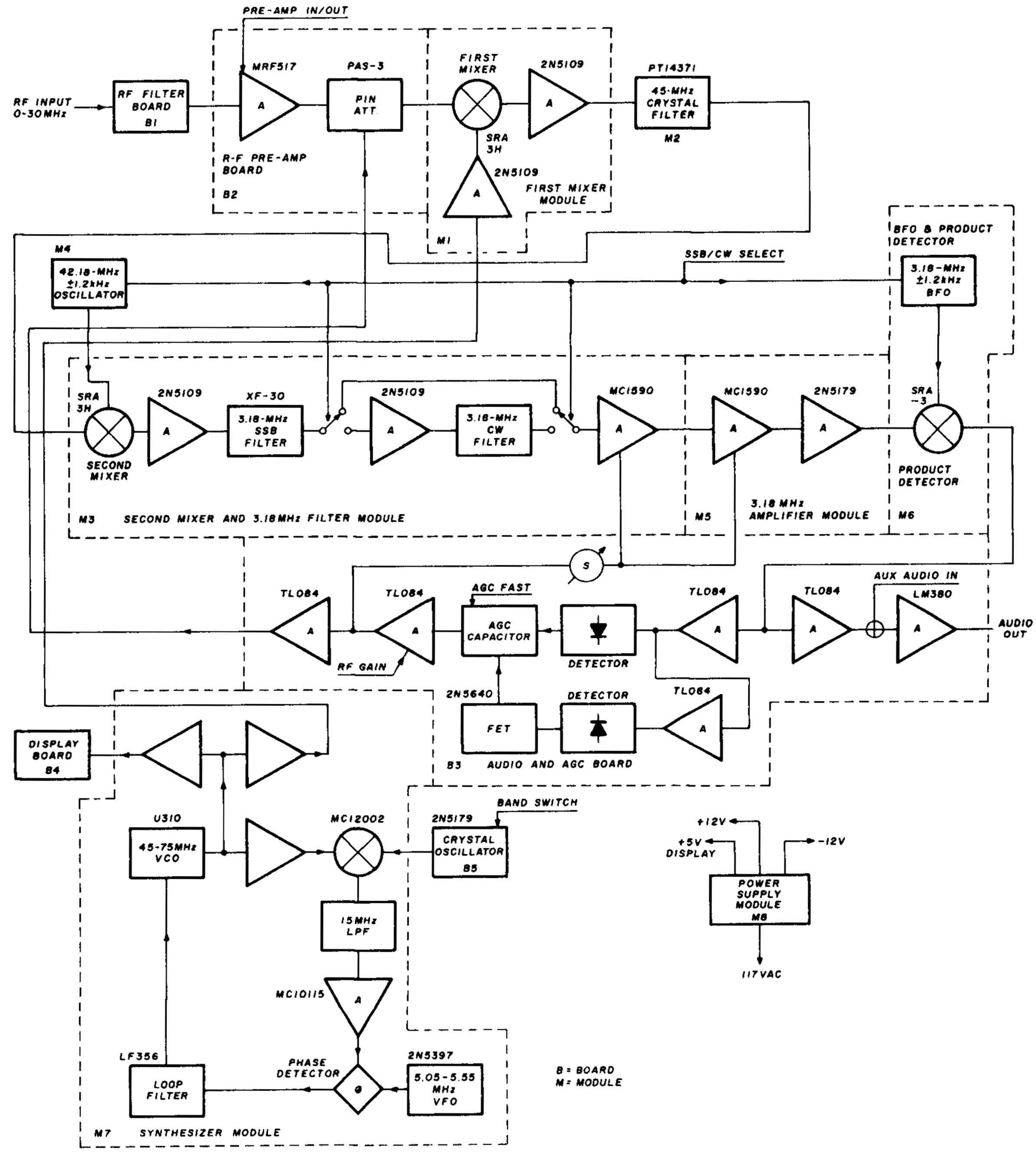


fig. 1. Block diagram of the up-conversion receiver. Breadboard construction techniques were used to allow changes in circuitry as the design developed.

pass filter. The input filters are followed by an rf stage. This stage may be switched in when high sensitivity is required, or it may be switched out when maximum resistance to overload is needed. The high sensitivity is useful on a quiet 10-meter band or when an inefficient antenna is used.

An electronically variable attenuator between the rf amplifier and first mixer reduces the signal level for high-amplitude signals. The first mixer uses 17-dBm injection and provides a third-order intercept of 25 dBm. The first i-f is at 45 MHz. A small amount of gain is inserted to maintain an adequate front-end noise figure.

A monolythic crystal filter at 45 MHz protects the

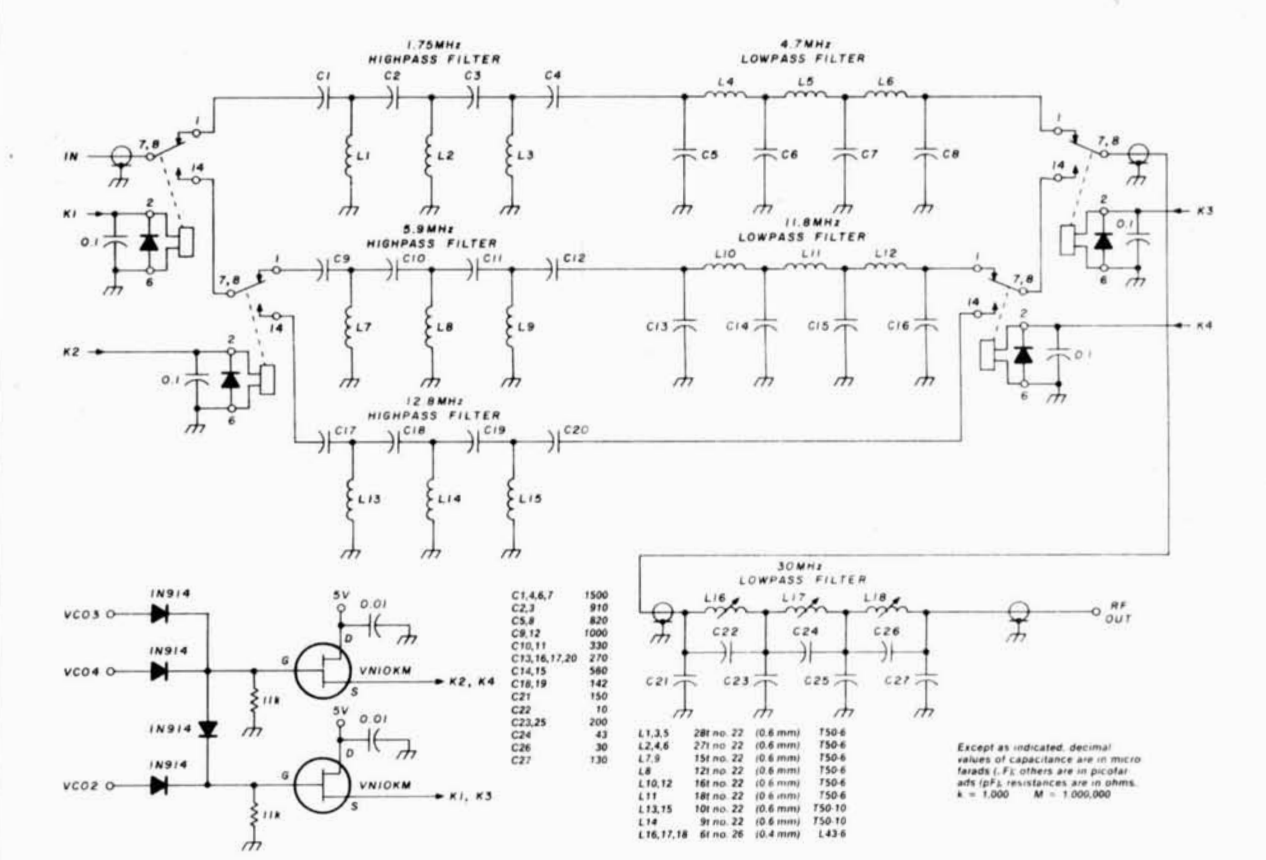


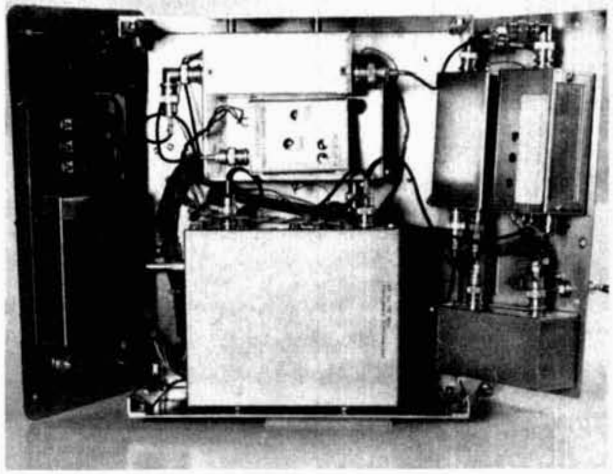
fig. 2. Rf-filter schematic (B1 board). Reed relays, which select the front-end filters, are controlled by the band switch.

second mixer from out-of-band signals. If good SSB and CW filters were available for 45 MHz, a second mixer wouldn't be necessary. This is not the case, however, so the main receiver selectivity is obtained at 3.18 MHz in the second i-f. The second mixer is also a high-level mixer and is driven at 13 dBm. Crystal filters are readily available for many different bandwidths at 3.18 MHz. A pair of MC1590s provide more than enough i-f gain and AGC range.

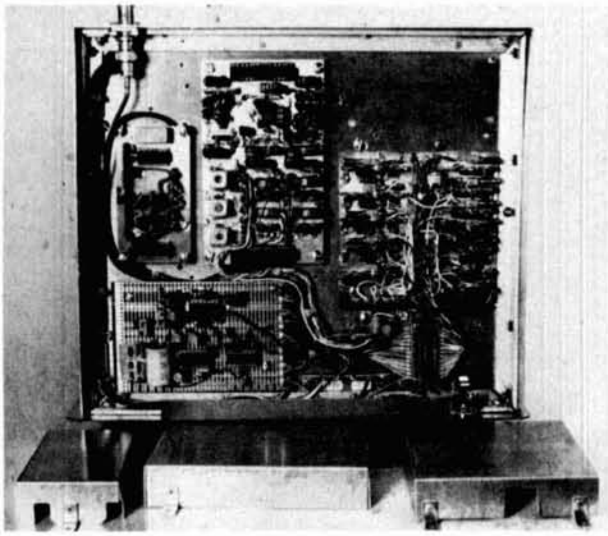
A 7-dBm drive-level, double-balanced mixer is used for the product detector. An audio amplifier completes the signal-path circuit. AGC voltage is derived from the audio signal and controls the second i-f amplifier gain and the front-end attenuator. A hang-type circuit is used.

Main receiver tuning is accomplished with a 5-MHz VFO. A 45- to 75-MHz VCO is phase-locked to the VFO in one-half megahertz bands. The VFO is heterodyned with a crystal oscillator operating 5.05 MHz below the minimum injection frequency required for the selected band.

For example, to cover the 7.0- to 7.5-MHz band the injection frequency must be 45.0 MHz higher, or 52.0 to 52.5 MHz. The crystal frequency required



Top view of receiver removed from its cabinet. The front and rear panels may be swung away from the main assembly for maintenance. Most modules above the deck are built in miniboxes. The large box houses the VFO, VCO, and phase detector board. On the left is the front panel showing the display module and the various controls. On the right is the rear panel holding the 45-MHz crystal filter, the first mixer and the BFO modules. At the top center are the second mixer, 48.18-MHz oscillator and 3.18-MHz amplifier modules.



Bottom view of receiver with shields removed. Small board in the upper left is the rf preamplifier. To its right is the filter board. On the right side is the crystal-oscillator board, and in the lower left is the audio-AGC board. All except the audio board are normally covered with aluminum shield boxes.

would be 46.95 MHz. The second-mixer injection is provided by a 48.12-MHz crystal-oscillator signal. Switching is incorporated to move the frequency to either 1.2 kHz or − 1.2 kHz for upper- or lower-sideband selection. The BFO provides 3.18 MHz ± 1.2 kHz for the product detector, and the switching is ganged with the 48.12-MHz crystal oscillator. A digital counter that subtracts 450,000 from the measured frequency monitors the VCO and provides a digital readout. The display may also be used externally as a test frequency counter.

table 1. Measured performance characteristics of the up-conversion receiver.

	frequency or mode	preamp out	preamp in
noise floor	SSB	− 128 dBm	− 132 dBm
	CW	− 133	− 141
blocking, CW:	2 kHz	148	146
desired signal − 70 dBm;	20 kHz	151	148
dB above noise floor	100 kHz	151	148
two-tone intermod, CW:			
second-order intercept		50 dBm	
third order intercept	10 kHz	− 1 dBm	− 12 dBm
	100 kHz	17 dBm	4.5 dBm
phase-noise degradation	3 kHz	2 dB	
of noise floor for	10 kHz	2 dB	
100 dB signal	20 kHz	3 dB	
	100 kHz	2 dB	
	250 kHz	0 dB	
image rejection		85 dB	
first i-f rejection		88 dB	
second i-f rejection		> 100 dB	
AGC threshold		2.8 μV	0.3 μV

performance characteristics

Table 1 shows the receiver's measured performance. Noise-floor measurements indicate a noise figure of 8 dB with the preamplifier in. While this is adequate for normal high-frequency operation, it could be reduced by minimizing the losses ahead of the first mixer.

The blocking performance is very good, and a rather large desired signal level was used to eliminate the effects of phase noise on the measurement. The third-order intercept was measured at two-tone spreads to show the effect of the 45-MHz crystal filter. The second-order intercept varies, depending on the front-end filter attenuation, but the number shown is typical.

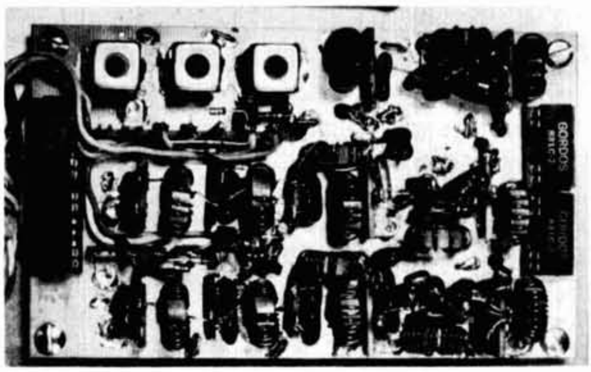
The receiver's phase-noise degradation is substantially less than that of other modern synthesized receivers I tested. This is due to this receiver's wide loop bandwidth in the synthesizer and the high-Q components in the 5-MHz VFO.

Image and i-f rejection are quite good although not as high as the filter alone should provide. Better shielding of the front-end modules and the use of miniature hardline to couple them would bring the rejection to greater than 100 dB.

front end

Front-end filters minimize out-of-band interference. See **fig. 2**. A 30-MHz Cauer lowpass filter is in line at all times. It is designed to provide 80-dB image rejection by itself and has a notch at the first i-f of 45 MHz.

A highpass, lowpass filter combination is switched in for frequencies below 1.75 and 4.7 MHz. This filter has 0.5-dB attenuation from 1.8 to 4.5 MHz and is down 50 dB below 1.1 MHz and above 7.4 MHz. A



Typical board construction as shown on the filter board. Terminal strips are soldered to PC material directly. Components are supported on strips and groundplane. Breadboard rf circuitry may be constructed rapidly with this technique.

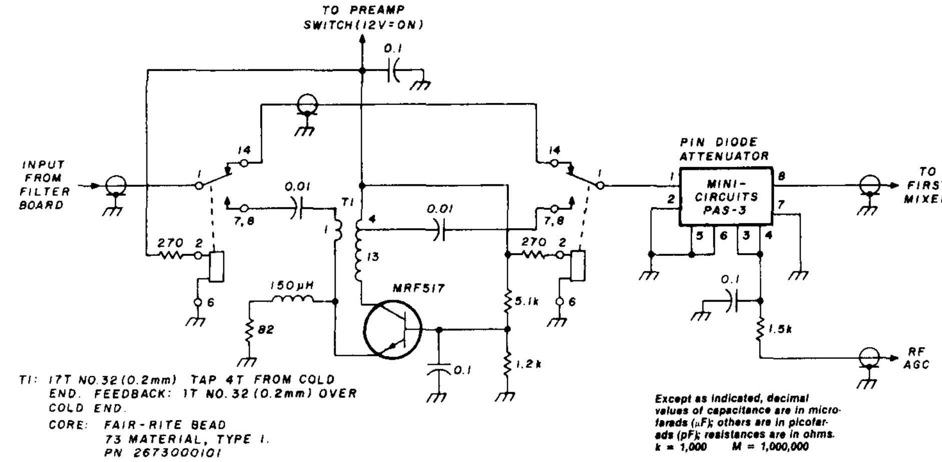


fig. 3. Rf pre-amplifier schematic (B2 board). Circuit uses transformer-coupled negative feedback and has a gain of 10 dB.

second set of highpass, lowpass filters covers 5.9 MHz to 11.8 MHz with 0.6-dB attenuation from 6.5 MHz to 11 MHz. This set is more than 50 dB down below 2.5 MHz and above 21 MHz. Finally, a highpass filter is used for frequencies above 12.8 MHz. The filter has less than 0.4-dB attenuation above 14 MHz and more than 50 dB below 7.5 MHz.

These filters are constructed on double-sided copper-clad board using Amidon coil forms. Reed relays are used to select filters and are controlled by the band switch. Relay drivers are VN10KM FETs (**fig. 2**).

The MRF517 amplifier, **fig. 3**, uses transformer-coupled negative feedback. It has a gain of 10 dB and is flat beyond 100 MHz. Reed relays switch the amplifier in and out.

AGC is applied with a Mini-Circuits PAS-3 PIN diode attenuator following the rf amplifier. This unit is not activated unless the signal level exceeds a threshold set on the audio-AGC board. It is adjusted to start attenuating if the input signal exceeds 100 μV. This attenuation reduces the signal level in the stages ahead of the 3.18-MHz i-f filters.

first mixer

The first-mixer-module schematic is shown in **fig. 4**. It contains a Mini-Circuits SRA3H mixer and two 2N5109 feedback amplifiers. One is used as an i-f post amplifier, and the other increases the synthesizer injection signal to 17 dBm. These 2N5109 amplifiers operate at 55 mA collector current. Clip-on heatsinks keep the transistor operating temperature down. Amplifier gain is about 14 dB, and the output compression point is 23 dBm. Input and output impedances are approximately 50 ohms. Frequency response is very flat, being down about 0.5 dB at 110 MHz, the upper limit of my test equipment. Third-order intercept measurements on this module indicate a level of 24 dBm. This is to be expected for this mixer amplifier combination. No degradation is apparent when the 45-MHz crystal filter is introduced. I had some concern that the feedback amplifier would

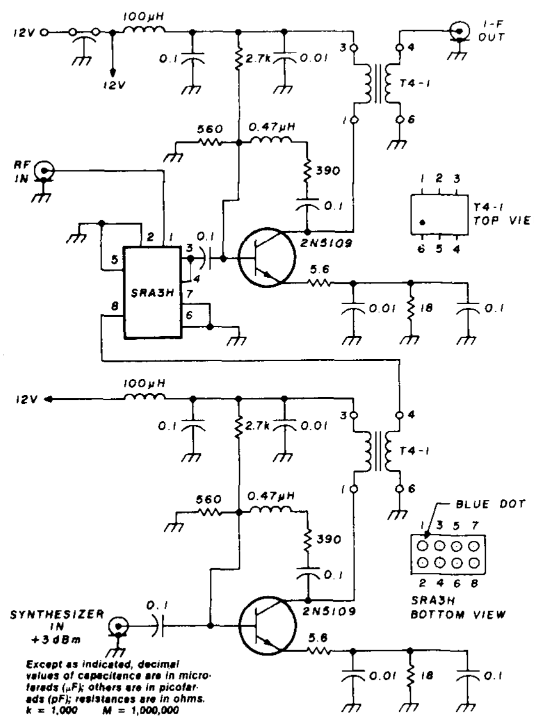


fig. 4. First-mixer schematic (M1 module). One of the 2N5109 feedback amplifiers is used as an i-f post amplifier, and the other increases the synthesizer injection signal to 17 dBm. Amplifier gain is about 14 dB; the output compression point is 23 dBm.

reflect an improper load for the mixer, out of the filter passband; however, the amplifier input impedance does not vary enough from 50 ohms to degrade the intercept point.

first i-f filter

The first i-f was placed at 45 MHz to enable the use of a standard Piezo Technology, Inc., monolithic filter. Their model 4371 is a four-pole unit in an HC-18 case. It has an advertised 3-dB bandwidth of 15 kHz with 1-dB ripple in the passband and a 3-dB loss. Aside from some sharp spurious responses, its ultimate rejection exceeds 50 dB. This filter has 7000-ohm input and output impedances, so networks are required to make it usable. See **fig. 5**. Considerable experimenting showed that achieving low insertion loss and good ultimate rejection at 45 MHz is not easy.

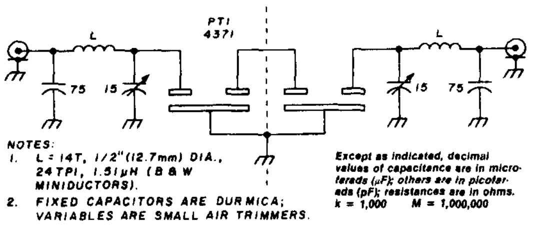


fig. 5. 45-MHz filter schematic (M2 module). The first i-f filter uses a standard Piezo Technology, Inc., monolithic 4-pole unit in an HC-18 case. The 3-dB bandwidth is 15 kHz with 1-dB ripple in the passband and a 3-dB loss.

The insertion loss is important to minimize the receiver noise figure while maintaining large signal capabilities. If the filter loss is excessive, the gain preceding the filter must be high enough to give a good noise figure, but that would reduce the large signal-handling capabilities of the receiver.

Pi matching networks were used at the filter input and output. Coils and capacitors of very high Q must be used to minimize insertion loss. B&W miniductors were used with small air trimmers and Dur Mica capacitors. Over-all loss, input to output, was held to

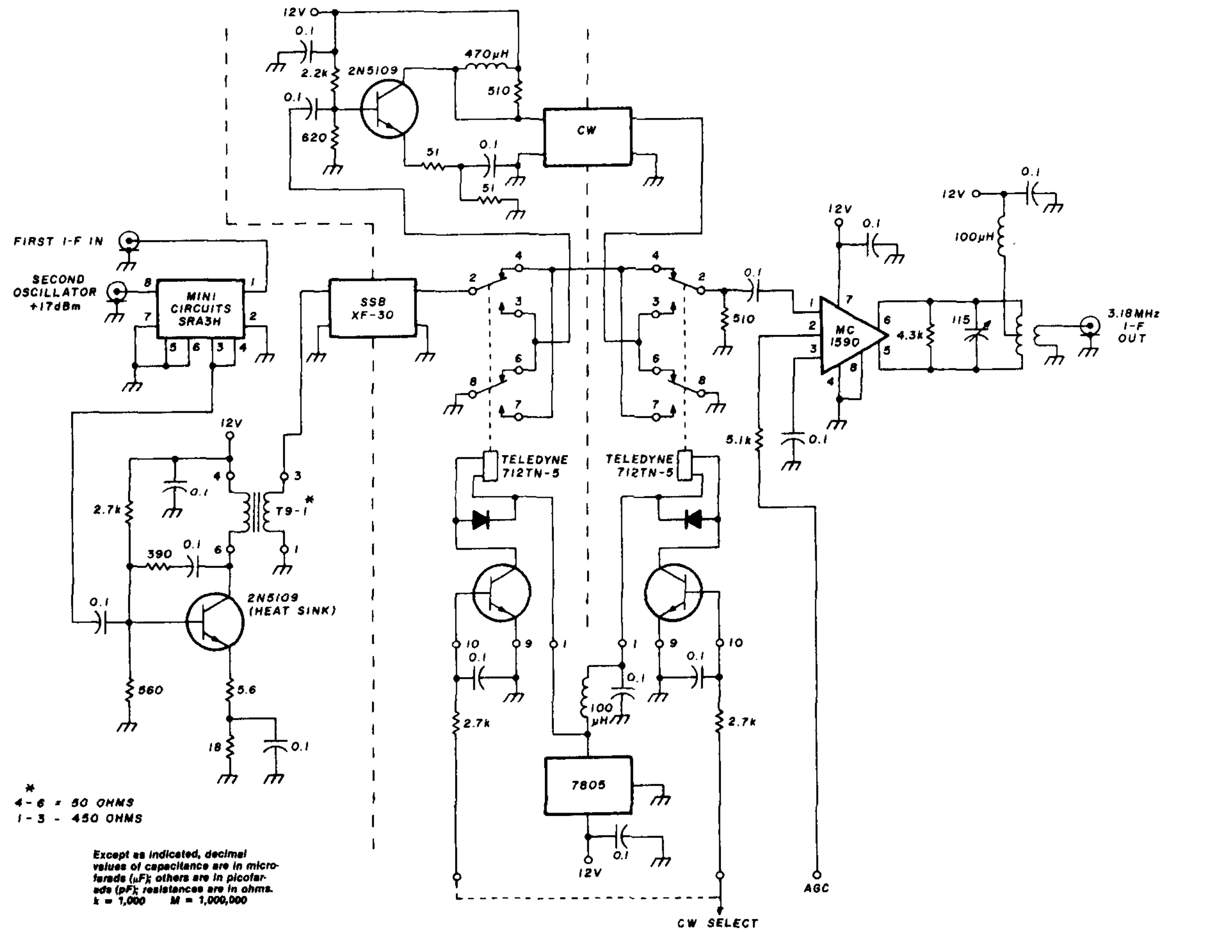
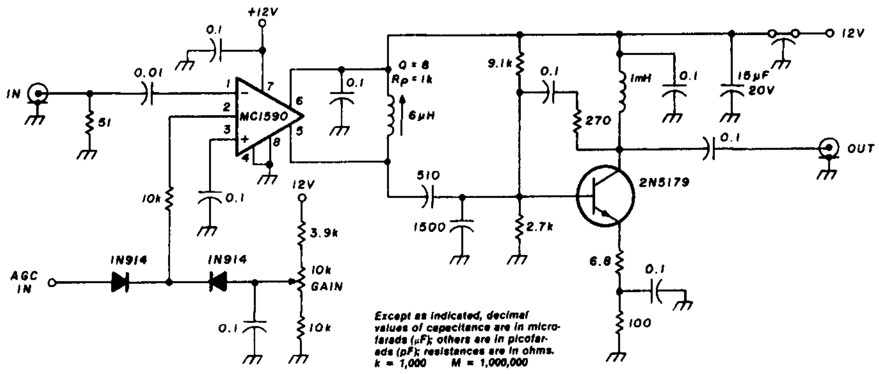


fig. 6. Second mixer and 3.18-MHz crystal filter schematic (M3 module). This high-level unit preserves good high-amplitude performance for frequencies within the 45-MHz filter passband.



NOTES:
1. SET GAIN TO 26dB, MAXIMUM GAIN = 32dB.
2. MEASURED: WITH TWO TONES AT -30dBm, EACH IMD IS -53dB; THEREFORE $TOI = -4 + \frac{53}{2} = 22.5$ dB OUT. WITH OUTPUT AT -10dBm PER TONE, IMD > -65dB.

fig. 7. 3.18-MHz amplifier schematic (M5 module). A second MC1590 and a 2N5179 feedback amplifier complete the i-f chain. They are mounted in a separate module to hold down the over-all gain per module.

less than 2 dB by this method. To achieve good out-of-band rejection, it was necessary to mount the 4371 directly under a solid copper shield that separates the input and output circuits. After considerable adjustment of component position, ultimate rejection of 70 dB was obtained.

second mixer

To preserve the good high-amplitude signal performance for frequencies within the 45-MHz filter passband, a high-level unit was used as the second mixer. A 2N5109 feedback amplifier follows the mixer and is designed to provide a 500-ohm drive signal for the XF-30 SSB crystal filter. A subminiature relay selects SSB or CW. When CW is selected, a 300-Hz crystal filter and a gain-equalizing amplifier are inserted into the signal line. The equalizer gain is adjusted to offset the CW-filter loss. After filtering, an MC1590 provides more i-f gain and AGC voltage. **Fig. 6** shows the schematic.

A second MC1590 and a 2N5179 feedback amplifier complete the i-f chain. They are mounted in a separate module to hold down the over-all gain-per-module. The schematic is shown in **fig. 7**. The maximum drive level to the product detector is held to − 10 dBm by the AGC system. The MC1590 cannot drive the mixer directly while maintaining low two-tone intermodulation. The feedback amplifier can produce − 10 dBm with very low distortion and allows the MC1590 to operate at less than − 20 dBm. This combination has third-order IMD products that are greater than 65 dB down at an output level of − 10 dBm per tone output. This amplifier is set to 26-dB gain but has a maximum of 32-dB gain available.

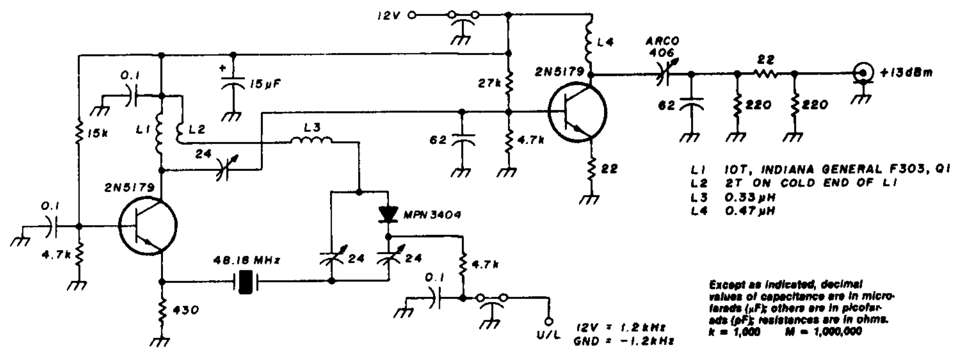


fig. 8. 48.18-MHz oscillator schematic (M4 module). Second-mixer injection is provided by this crystal oscillator. Output frequency may be shifted by a combination of a small capacitor and inductance in series with the crystal and by a second capacitor, which can be switched in with a PIN diode.

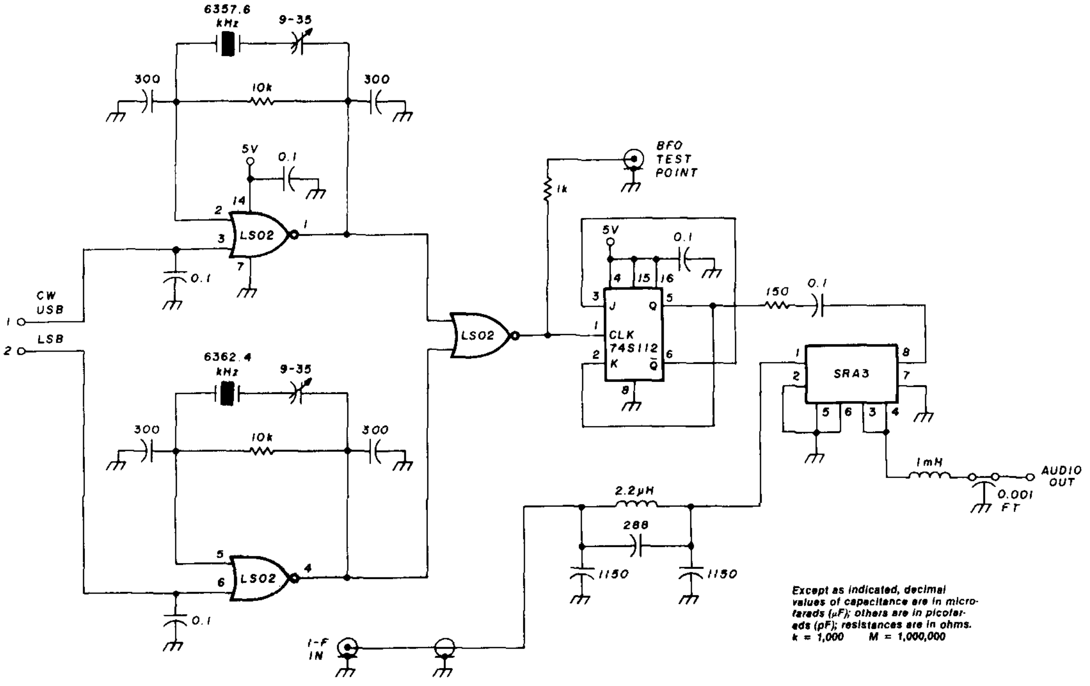


fig. 9. BFO and product-detector schematic (M6 module). The BFO consists of two crystal oscillators, one for LSB and one for USB/CW. An SRA-3 double-balanced mixer is used as the product detector. Unit gives excellent results when driven with a square-wave carrier.

second mixer injection

The second mixer injection is from a crystal oscillator operating at a nominal frequency of 48.18 MHz. See **fig. 8**. An offset equal to the BFO offset must be applied to this oscillator for USB/LSB selection to keep the signal frequency constant. By placing a small inductor and capacitor in series with the crystal the output frequency can be shifted 1.2 kHz. A second capacitor switched in with a PIN diode can then pull the frequency to 48,180-1.2 kHz. A buffer amplifier provides the power output to drive the second mixer.

BFO and product detector

An SRA-3 double-balanced mixer is used as the product detector. When driven with a square-wave carrier, this unit will give excellent results. For a −10 dBm input signal, the harmonic distortion is 44 dB down; with a −20-dBm input, the harmonics are better than 60 dB down. A Cauer filter is used on the i-f port to attenuate any harmonics generated in the i-f amplifier. If they are allowed into the product detector, they would be heterodyned to audio frequencies and create harmonic distortion.

The BFO consists of two crystal oscillators, as shown in **fig. 9**, one for LSB and one for USB/CW. Low-power Shottky two-input gates are used for the active elements. One input is biased into the linear region. The crystal is connected from gate output to input with a series frequency-adjusting capacitor. The two 300-pF mica capacitors complete the Colpitts configuration. The other gate input is used in the normal manner, to select the BFO frequency.

These oscillators run at twice the desired output rate so that a divider can be used to obtain a good square wave. A 74S112 flip-flop is used because of its small difference in propagation delay for positive- and negative-going edges. This unit drives the LO port on the SRA-3 through a dc blocking capacitor and a 150-ohm resistor. This is a simple but effective way to drive a mixer from a logic signal. A good square wave is necessary to minimize harmonic distortion. The third-order intercept of the mixer is increased somewhat by this technique.

Next month, in the second half of this two-part article, I will describe the construction of the audio and AGC board, the synthesizer, and power supply.

ham radio

7400

SN7400N	.20	SN7472N	.29	SN74156N	.79
SN7401N	.20	SN7473N	.35	SN74157N	.69
SN7402N	.25	SN7474N	.35	SN74160N	.89
SN7403N	.25	SN7475N	.49	SN74161N	.89
SN7404N	.25	SN7476N	.35	SN74162N	.89
SN7405N	.29	SN7479N	5.00	SN74163N	.89
SN7406N	.35	SN7480N	.50	SN74164N	.89
SN7407N	.35	SN7482N	.99	SN74165N	.89
SN7408N	.29	SN7483N	.69	SN74166N	1.25
SN7409N	.29	SN7485N	.89	SN74167N	2.79
SN7410N	.25	SN7486N	.35	SN74170N	1.95
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SN7412N	.35	SN7490N	.49	SN74173N	1.39
SN7413N	.40	SN7491N	.59	SN74174N	.99
SN7414N	.69	SN7492N	.45	SN74175N	.89
SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
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SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.25
SN7444N	1.10	SN74142N	3.25	SN74251N	.99
SN7445N	.89	SN74143N	3.49	SN74276N	1.95
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SN7447N	.69	SN74145N	.79	SN74283N	1.49
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SN7450N	.20	SN74148N	1.29	SN74285N	3.95
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	SN74393N	1.49

74LS

74LS00	.29	74LS92	.75	74LS192	1.15
74LS01	.29	74LS93	.75	74LS193	1.15
74LS02	.29	74LS95	.99	74LS194	1.15
74LS03	.29	74LS96	1.15	74LS195	1.15
74LS04	.35	74LS107	.45	74LS197	1.19
74LS05	.35	74LS109	.45	74LS221	1.19
74LS08	.35	74LS112	.45	74LS240	1.49
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74LS10	.35	74LS114	.49	74LS242	1.49
74LS11	.39	74LS122	.89	74LS243	1.49
74LS12	.35	74LS123	1.25	74LS244	1.49
74LS13	.45	74LS125	.59	74LS245	2.95
74LS14	.99	74LS126	.59	74LS247	1.19
74LS15	.35	74LS132	.99	74LS248	1.19
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74LS26	.35	74LS139	.89	74LS257	.89
74LS27	.35	74LS151	.89	74LS258	.69
74LS28	.35	74LS153	.89	74LS260	.69
74LS30	.35	74LS154	1.75	74LS266	.69
74LS32	.35	74LS155	.89	74LS273	1.95
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74LS38	.39	74LS158	.89	74LS290	.99
74LS40	.35	74LS160	1.15	74LS293	.99
74LS42	.89	74LS161	1.15	74LS298	1.25
74LS47	.89	74LS162	1.15	74LS352	1.29
74LS48	1.15	74LS163	1.15	74LS353	1.29
74LS49	1.15	74LS164	1.15	74LS365	.69
74LS51	.35	74LS165	1.15	74LS366	.69
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74LS74	.45	74LS173	.99	74LS374	1.95
74LS75	.59	74LS174	.99	74LS375	.89
74LS76	.45	74LS175	.99	74LS386	.69
74LS78	.49	74LS181	2.95	74LS393	2.49
74LS83	.89	74LS190	1.25	74LS399	2.49
74LS85	1.25	74LS191	1.25	74LS670	2.49
74LS86	.49			81LS95	1.95
74LS90	.69			81LS97	1.95

74S

74S00	.45	74S124	3.95	74S243	3.25
74S02	.45	74S133	.55	74S244	3.25
74S03	.45	74S134	.69	74S251	1.45
74S04	.55	74S135	1.19	74S253	1.45
74S05	.55	74S136	1.75	74S257	1.35
74S08	.50	74S138	1.35	74S258	1.35
74S09	.50	74S139	1.35	74S260	.79
74S10	.45	74S140	.79	74S280	2.95
74S11	.45	74S151	1.35	74S287	3.25
74S15	.45	74S153	1.35	74S288	2.75
74S20	.45	74S157	1.35	74S373	3.49
74S22	.45	74S158	1.35	74S374	3.49
74S30	.45	74S160	2.95	74S387	2.95
74S32	.55	74S174	1.59	74S471	10.95
74S38	1.25	74S175	1.59	74S472	10.95
74S40	.50	74S188	2.95	74S473	10.95
74S51	.45	74S194	1.95	74S474	12.95
74S64	.50	74S195	1.95	74S475	12.95
74S65	.50	74S196	1.95	74S570	5.95
74S74	.75	74S240	2.95	74S571	5.95
74S86	.79	74S241	2.95	74S572	9.95
74S112	.79	74S242	3.25	74S573	9.95
74S113	.79			74S940	3.15
74S114	.79			74S941	3.15

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CA3013H	2.15	CA3080H	1.25	CA3096N	3.95
CA3023H	3.25	CA3081N	2.00	CA3130H	1.39
CA3035H	2.49	CA3082N	2.00	CA3140H	1.25
CA3039H	1.35	CA3083N	1.60	CA3160H	1.25
CA3046N	1.30	CA3086N	.85	CA3401N	.59
CA3059N	3.25			CA3600N	3.50

CD—CMOS

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CD4001	.39	CD4042	.99	CD4506	.75
CD4002	.39	CD4043	.89	CD4507	.99
CD4006	1.19	CD4044	.89	CD4508	3.95
CD4007	.25	CD4046	1.79	CD4510	1.39
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CD4011	.39	CD4049	.49	CD4514	3.95
CD4012	.25	CD4050	.69	CD4515	2.95
CD4013	.49	CD4051	1.19	CD4516	1.49
CD4014	1.39	CD4052	1.19	CD4518	1.79
CD4015	1.19	CD4053	1.19	CD4519	.89
CD4016	.59	CD4056	2.95	CD4520	1.29
CD4017	1.19	CD4059	9.95	CD4526	1.79
CD4018	.99	CD4060	1.49	CD4528	1.79
CD4019	.49	CD4066	.79	CD4529	1.95
CD4020	1.19	CD4068	.39	CD4543	2.79
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CD4022	1.19	CD4070	.55	CD4566	2.79
CD4023	.29	CD4071	.49	CD4583	2.49
CD4024	.79	CD4072	.49	CD4584	.75
CD4025	.23	CD4073	.39	CD14723	1.95
CD4026	2.95	CD4075	.39	CD14724	1.95
CD4027	.69	CD4076	1.39	MC14409	11.95
CD4028	.89	CD4078	.55	MC14410	18.95
CD4029	1.49	CD4081	.39	MC14411	15.95
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CD4035	.99			MC14433	15.95
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XC556C	.200"	clear	4/$1	XC209Y	.125"	yellow	4/$1
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XC22G	.200"	green	4/$1	XC526G	.185"	green	4/$1
XC22Y	.200"	yellow	4/$1	XC526Y	.185"	yellow	4/$1
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MAN 3	C.C.-red	.125	.25	DL707	C.A.-red	.300	1.25
MAN 52	C.A.-green	.300	.99	DL728	C.C.-red	.500	1.49
MAN 54	C.C.-green	.300	.99	DL741	C.A.-red	.600	1.25
MAN 71	C.A.-red	.300	.75	DL747	C.A.-red	.600	1.49
MAN 72	C.A.-red	.300	.75	DL750	C.C.-red	.600	1.49
MAN 74	C.C.-red	.300	1.25	DL0847	C.A.-orange	.800	1.49
MAN 82	C.A.-yellow	.300	.49	DL0850	C.C.-orange	.800	1.49
MAN 84	C.C.-yellow	.300	.99	DL338	C.C.-red	.110	.35
MAN 3620	C.A.-orange	.300	.49	FND358	C.C.+1	.357	.99
MAN 3630	C.A.-orange+1	.300	.99	FND357	C.C.	.357	.75
MAN 3640	C.C.-orange	.300	.99	FND500	C.C. (FND503)	.500	.99
MAN 4610	C.A.-orange	.400	.99	FND507	C.A. (FND510)	.500	.99
MAN 6610	C.A.-orange-DD	.560	.99	HDSP-3401	C.A.-red	.800	1.50
MAN 6630	C.A.-orange+1	.560	.99	HDSP-3403	C.C.-red	.800	1.50
MAN 6640	C.C.-orange-DD	.560	.99	HDSP-3406	C.C.-red+1	.800	1.50
MAN 6650	C.C.-orange+1	.560	.99	5082-7751	C.A., R.H.D. red	.430	1.25
MAN 6660	C.A.-orange	.560	.99	5082-7760	C.C., R.H.D. red	.430	1.25
MAN 6710	C.A.-red-DD	.560	.99	5082-7300	4x1 Numeric (RHD)	.600	22.00
MAN 6740	C.C.-red-DD	.560	.99	5082-7302	4x1 Numeric (LHD)	.600	22.00
MAN 6750	C.C.-red+1	.560	.99	5082-7340	4x1 Hxdcl. (0-9/A-F)	.600	22.50
DL0304	C.C.-orange	.300	1.25	4N28	Photo Xsistor Opto-Isol.		.69
DL0307	C.A.-orange	.300	1.25	LIT-1	Photo Xsistor Opto-Isol.		.69
DLG500	C.C.-green	.500	1.25	MOC3010	Optically Isol. Triac Driver		1.25

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- Wire Wrap Contacts

Part No.	Pins	Price	Part No.	Pins	Price
214-3592	14 pin	9.75	222-3596	22 pin	12.95
216-3593	16 pin	9.95	224-3597	24 pin	12.75
218-3594	18 pin	10.95	228-3598	28 pin	13.95
220-3595	20 pin	11.95	240-3599	40 pin	15.95

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

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ASST. 3	5ea.	470 Ohm 560 Ohm 680 Ohm 820 Ohm 1K	1.2K 1.5K 1.8K 2.2K 2.7K	50pcs.	$1.95
ASST. 4	5ea.	3.3K 3.9K 4.7K 5.6K 6.8K	8.2K 10K 12K 15K 18K	50pcs.	$1.95
ASST. 5	5ea.	22K 27K 33K 39K 47K	56K 68K 82K 100K 120K	50pcs.	$1.95
ASST. 6	5ea.	150K 180K 220K 270K 330K	390K 470K 560K 680K 820K	50pcs.	$1.95
ASST. 7	5ea.	1M 1.2M 1.5M 1.8M 2.2M	2.7M 3.3M 3.9M 4.7M 5.6M	50pcs.	$1.95

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7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	29.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.96
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	13.95
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.96
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter	12.95
7218CIJI	8-Digit Univ. LED Drive	10.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band-GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.95
8212CPA	Volt Ref/Indicator	2.95

74C

74C00	.39	74C95	1.59	74C221	1.95
74C02	.39	74C107	1.89	74C240	2.25
74C04	.39	74C151	2.95	74C244	2.25
74C08	.39	74C154	3.95	74C373	2.49
74C10	.39	74C157	2.25	74C374	2.59
74C14	.75	74C160	1.69	74C901	.69
74C20	.39	74C161	1.60	74C903	.69
74C30	.39	74C162	1.49	74C911	10.95
74C42	1.39	74C163	1.69	74C912	10.95
74C48	1.95	74C164	1.59	74C915	1.69
74C73	.79	74C173	1.39	74C917	10.95
74C74	.79	74C174	1.19	74C922	5.49
74C85	1.99	74C175	1.19	74C923	5.75
74C86	.99	74C192	1.69	74C925	7.50
74C89	6.95	74C193	1.69	74C926	7.50
74C90	1.29	74C195	1.59	80C95	.79
74C93	1.29			80C97	.79

LINEAR

LH0002CN	6.85	LM340T-5	1.25	LM702H	.79
LM10CLH	4.50	LM340T-12	1.25	LM703CN	.89
LM11CLH	4.75	LM340T-15	1.25	LM709N	.29
LH0070-0H	4.95	LM341P-5	.75	LM710N	.79
TL071CP	.79	LM341P-12	.75	LM711N	.79
TL072CP	1.39	LM341P-15	.75	LM723N	.49
TL074CN	2.49	LM342P-5	.69	LM733N	1.00
LH0082CD	35.80	LM342P-12	.69	LM739N	1.19
TL082CP	1.19	LM342P-15	.69	LM741CN	.35
TL084CN	2.19	LM348N	1.25	MC1741SCG	3.00
LH0094CD	36.80	LM350K	5.75	LM747N	.79
LM300H	.99	LF351N	.60	LM748N	.59
LM301CN	.35	LF353N	1.00	LM1014N	2.75
LM302H	1.95	LF355N	1.10	LM1310N	1.95
LM304H	1.95	LF356N	1.10	LM1458CN	.59
LM305H	.99	LM358N	1.00	LM1488N	1.25
LM307CN	.45	LM359N	1.79	LM1489N	1.25
LM308CN	1.00	LM370N	4.49	LM1496N	1.95
LM309H	1.95	LM373N	3.25	LM1556V	1.75
LM309K	1.25	LM377N	2.95	LM1800N	2.95
LM310CN	1.75	LM380N	1.25	LM1871N	5.49
LM311/CN	.90	LM381N	1.95	LM1872N	5.49
LM312H	2.49	LM382N	1.79	LM1877N-9	3.25
LM317MP	1.15	LM384N	1.95	LM1889N	3.20
LM317T	1.75	LM386N-3	1.29	LM1896N	1.75
LM317K	3.95	LM387N	1.45	LM2002T	1.49
LM318CN	1.95	LM389N	1.35	LM2877P	2.05
LM319N	1.95	LM392N	.69	LM2878P	2.25
LM320K-5	1.35	LF398N	4.00	LM2896P-1	2.25
LM320K-12	1.35	LM399H	5.00	LM3189N	2.95
LM320K-15	1.35	TL494CN	4.49	LM3900N	.69
LM320T-5	1.25	TL496CP	1.75	LM3906CN	1.25
LM320T-12	1.25	NE510A	6.00	LM3909N	1.15
LM320T-15	1.25	NE529A	4.95	LM3914N	3.95
LM323K	5.95	NE531H	3.95	LM3915N	3.95
LM324N	.99	NE536H	6.00	LM3916N	3.95
LM329DZ	.65	NE540H	6.00	RC4136N	1.25
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LM334Z	1.30	NE550A	1.30	RC4194TK	6.95
LM335Z	1.40	NE555V	.39	RC4195TK	5.49
LM336Z	1.75	NE556N	.99	LM4500A	3.25
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LM337MP	1.15	LM565N	1.25	LM13080N	1.29
LM338K	6.95	LM566CN	1.95	LM13600N	1.49
LM339N	.99	LM567V	1.25	75138N	1.95
LM340K-5	1.35	NE570N	4.95	75450N	.89
LM340K-12	1.35			75451CN	.39
LM340K-15	1.35			75492	.89

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50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.12	.10	.10

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (Solid) CAPACITORS

.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.45	.39
.22/35V	.39	.34	.29	3.3/35V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

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1.0/50V	.16	.14	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.15	.13	.12
10/25V	.18	.15	.11	1.0/50V	.15	.13	.12
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.17	.13	4.7/25V	.15	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.20	.18	.16
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.41	.37	.34	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

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More Details? CHECK—OFF Page 102

owners' survey — TR7

A survey of owners' opinions of the Drake TR7

This month, the *ham radio* readers' survey deals with the popular Drake TR7, certainly one of the most desirable high-frequency transceivers in recent years. One hundred and ninety-five completed and usable questionnaires were returned by our readers.

The Drake TR7 is a synthesized transceiver that provides continuous receive coverage from 1.5 to 30 MHz, and transmits on all Amateur frequencies currently assigned within this range. The circuit combines a frequency synthesizer with a PTO, and there is a 1-kHz dial and 100-Hz digital readout resolution. The receiver has full passband tuning, with a first i-f of 48.05 MHz. The radio features solid-state, no tune-up operation.

the good features of the TR7 . . .

In response to the question, What is the rig's best feature?, the most frequent answer was the general coverage aspect of the radio. Thirty-six percent of the respondents mentioned this capability and the high quality of the TR7 receiver, which was praised for both its sensitivity and selectivity. (Note that, with the optional Range Program Board, the TR7 will tune 0 through 30 MHz, and programmable, out-of-band transmit capability is available for other frequencies such as MARS, Embassy, Government, and the new WARC bands.) Several Amateurs said how much they enjoy being able to use the TR7 for SWLing.

Thirty-one percent of the respondents mentioned the broadband characteristics of the radio as among its best features (many — in fact, most, respondents listed more than one "best feature.") Because the radio is solid-state, there is no need for preselection tuning or transmitter adjustments. Many of the respondents to the questionnaire who had been accustomed to operating only tube-type radios were appreciative of this aspect of the TR7.

Other "best features" frequently mentioned were ease of operation (16 percent), flexibility (9 percent), good audio (9 percent), portability (8 percent), and the digital readout (7 percent). Here are some representative replies to the question, What is the rig's best feature?:

"Flexibility — it does everything! A-m is clear, and accessories all plug in together and work well." — AK0U

"General coverage receiver, ease of operation, passband tuning." — WD8JUB

"Hard-hitting, pleasing, clean CW receive note; ease of alignment." — KL7T

"Continuous coverage from 0 to 30 MHz." — AG8T

"Receiver is excellent, especially filters and passband tuning. Good physical layout, and easy to manipulate the controls. I like the full frequency ability — I do SWLing. Most flexible receiver to use: it's a real pleasure!" — AE2J

"The 0-30 MHz receiver. The receiver has excellent sensitivity and dynamic range. I often get solid copy after other stations give up. The no-tune QSY feature of the transmitter is excellent. Also very rugged output. My transceiver was once key down (at reduced power) for 20 hours with no detectable change to either the TR7 or its power supply." — AF4B

"Digitally programmed frequency selection. The rig will never be obsolete." — WB6QDS

"Flexibility: the ability to use many modes of oper-

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

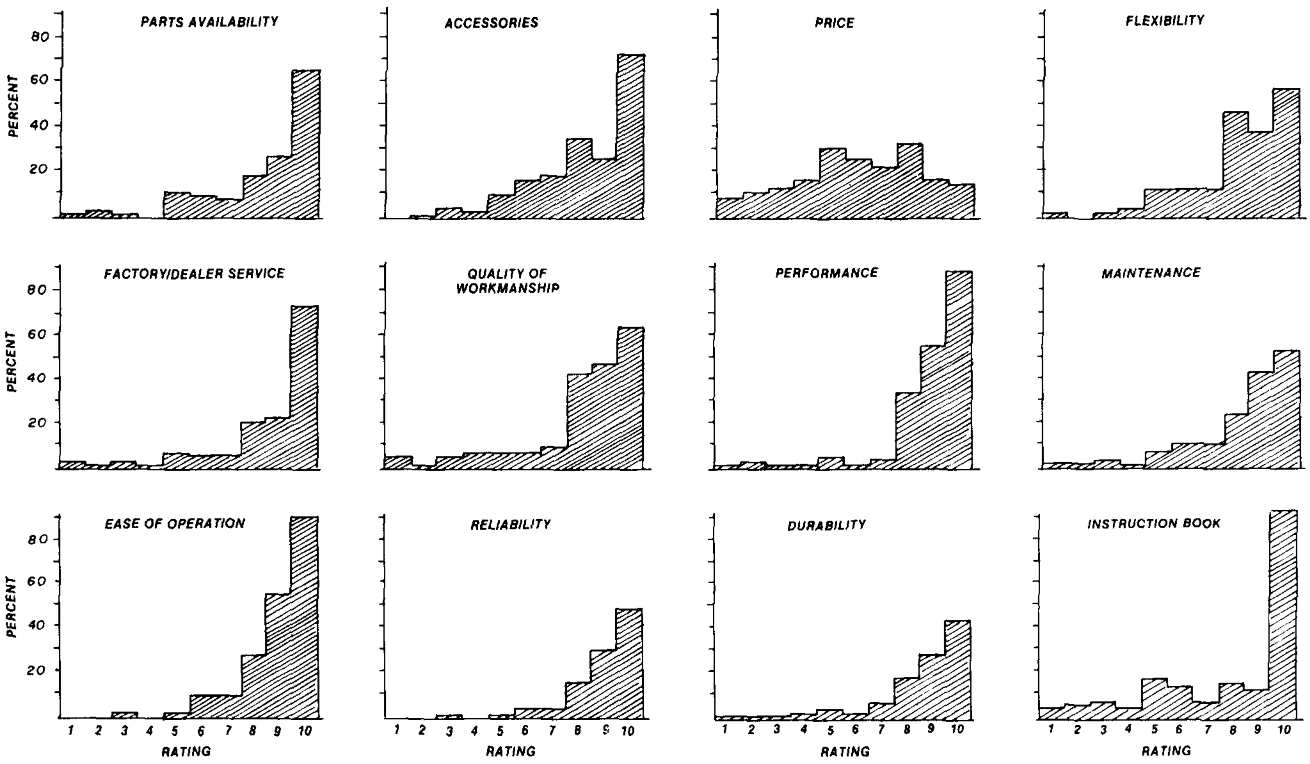

fig. 1. How the TR7 was rated, from 1 (poor) to 10 (perfect).

ation, wide frequency coverage, and the possibility of connecting many external components, such as receiver and linear amps, making the TR7 the central control point of the station."

"No tune-up. I use the passband tuning and the RIT often to get rid of QRM. I also use the STORE pushbutton for DX pileups." — N6XL

"Ease of operation. Transmit audio: Many stations comment that my audio is better than most and even more readable than others with the same signal strength." — W9KFQ

"Excellent receiver with passive front end and choice of receiver i-f filters. General coverage capability. Plug-in circuit boards. Ability to use digital display as frequency counter. Passband tuning. VOX controls on front of unit. Covers new bands and MARS." — W9UI

"Excellent skirt selectivity and dynamic range." — AA5O

"No tuning of output stages; RIT; built-in frequency meter; continuous coverage." — W4UI

"160-meter capability." — W6GAW

"Excellent receiver: Freedom from overload, IMD, and cross-modulation distortion. Flexibility: Can transmit and receive over whole hf spectrum; can also receive VLF." — N2MS

"Super receiver section. I have owned most of the popular rigs and I consider the TR7 the best transceiver available." — K3OX

"Good read-out, good passband tuning, and easy to work on or modify. Good general coverage performance; very stable; no warm-up or drift. Runs very cool with fan, which is very quiet." — W7UC

"It's hard to say which is best, it's got so many great features. Easy to operate; can be quickly disconnected from home station and put in car; great audio on transmit and receive. Easy to operate mobile: Very stable VFO on rough roads." — KA7AWS

table 1. Best feature. The percentage refers to the number of respondents who listed that feature as best. Note that many respondents listed more than one "best feature."

	percent
general coverage receiver	36
broadband qualities	31
ease of operation	16
good audio	9
flexibility	9
no tune-up	8
battery operation and portability	8
digital readout	7
stability	6
built-in frequency counter	6
clean CW	5
power output	4
good accessory connections	4

table 2. Worst feature. The percentage refers to the number of respondents who listed that feature as worst.

	percent
PTO drift	10
poor metering	9
auxiliary programming	7
service manual	6
front panel appearance	5
noisy receiver at minimum volume	5
size of pushbuttons	4
price	4
AGC always on	4
sensitivity to SWR	3

table 3. Problems. The percentage refers to the number of respondents who listed the problem on their survey form.

	percent
no problems	32
frequency drift	10
bad solder joints	6
PIN diode problems	6
tuning dial	5
bad transistor	4
rf in audio	2
low audio output	2
voltage regulator	1

table 4. Accessories. The percentage refers to the number of respondents who bought the accessory listed.

	percent
additional filters	31
remote VFO	18
fan	16
service manual	9
noise blanker	8
speech processor	8
external speaker	7
matching network	6
amplifier	4
wattmeter	4

table 5. Desirable additional features. The percentage refers to the number of respondents who would like to see the feature incorporated into the TR7.

	percent
notch filter	18
second VFO (now available as outboard accessory)	13
speech processor (now available as outboard accessory)	9
noise blanker (now available as accessory)	5
fixed sidetone volume adjust	5
phone patch jack	4
built-in power supply	4
fm mode	3
programmable memory	3
microcomputer interface	2

"Versatility — it works MARS on many out-of-band frequencies. The TR7's ability to reach anything from 1.5-30 MHz with no need for transmitter adjustments or receiver preselection makes it a *great* pleasure to operate." — WA4SHP

"Extremely accurate frequency readout — can operate with confidence, knowing I'm on frequency. Passband tuning operates just great! Comes in handy most of the time I'm operating. General coverage receiver adds to the enjoyment." — VE3LIQ

"Wide frequency range. The XYL enjoys SW broadcasts and I like to copy ship-to-shore CW on lf and hf. Very convenient for use in our travel trailer." — W8BH

. . . and the bad

In response to the question, *What is the rig's worst feature?*, the highest percentage of respondents, 10 percent, reported drift in the PTO. Nine percent complained about the metering on the rig — being not calibrated well or being ineffective — and about 7 percent did not like the STORE (frequency display) capability, finding no use for it. Other votes for the worst feature of the TR7 went to the service manual (for providing too little information), the looks of the front panel, the small size of the pushbuttons, and the price.

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

"The lack of explanation in the owners' manual on the best ways to use the passband tuning feature. I still have not convinced myself that I am using it properly on SSB. The owners' manual should offer more technical information on the rig. I had to purchase the service manual in order to find out what's inside the rig." — AIØW

"Has small, slow, frequency drift during the first hour from a cold start. After that it is very stable." — W7FSP

"Click in phones when switching from CW to SSB." — K5AS

"Price. Doesn't have fm mode. Doesn't have notch filter. Doesn't come with mike or 12-volt power plug." — WD8PAQ

"Haven't found any! I really can't say anything bad about this rig." — WA2MNG

"No break-in. No possibility of switching the AGC off." — OZ8SO

"No notch filter. Price." — AB6X

"SWR protection circuit is very sensitive and a really good matching network (tuner) is a must to achieve maximum output." — KM4U

"Price: A real nice radio but I think it is priced too high now at $1495.00." — KA2HYV

"Af gain control doesn't quiet the receiver." — DL7GK

"Drift during warm-up." — N2AQS

"There are just *no* bad features." — KH6JRZ

"No memories on second VFO. Poor quality dial mechanism."

"PTO drift."

"Counter reads out to only the nearest 100 Hz. Readout to nearest 10 Hz would be useful to meet military frequency standards (most are ±50 or ±25 Hz)." — WB2BOO

"Analog dial is hard to read." — Ed Clabough, Birmingham, Alabama.

"No phone-patch connection. I had to have mine modified." — K9ERO

"Low audio output." — K5FZ

"Weak audio." — W1OFZ

"Sensitivity to antenna SWR."

"No built-in notch filter. No way to completely defeat the AGC circuit." — W5AYZ

"As with all broadband solid-state no-tune radios, an antenna tuner/matchbox is required to match antenna, or rf shutdown will start about 3:1 SWR." — WB9HBH

"Sidetone not adjustable." — W3ODN

"Frequency creep." — W1AY

"Volume control can't completely cut off audio. Digital display hold button is useless. Auxiliary VFO shifts frequency when spot button is depressed." — WB9IWN

problems

Thirty-two percent of those completing questionnaires said they've had no problems with the TR7.

The most common problem encountered with the TR7, mentioned by 10 percent of the respondents to the questionnaire, was frequency drift. Other problems that cropped up were bad solder joints, leaky PIN diodes, problems with the tuning dial, and an occasional bad transistor. Bad solder joints were referred to by about 6 percent of those who replied. No other problems received significant attention from our respondents.

additional features

To the question, What additional features would you like to see built into a rig of this type?, the most frequent response was a notch filter, mentioned by 18 percent of the respondents. Next to the addition of a notch filter, the addition of a speech processor ranked high in the estimation of Amateurs responding. About 9 percent said that they would want to see some sort of speech processing incorporated into a rig of this type.

Other additional features that were mentioned were a phone-patch jack, programmable memories, a noise blanker, fm mode capability, a sidetone volume adjustment, an SSB squelch, and a built-in power supply.

accessories and related findings

The most popular accessory among owners of the TR7 is filters, which were purchased by about a third of those replying to the survey. However, we believe that about 75 percent of TR7 owners have actually purchased filters, which indicates that most of those responding to the survey didn't consider the filters as accessories. These include a-m, CW, and SSB filters. Next in popularity (18 percent) was a remote VFO, followed by speech processors, noise blankers, external speakers, and the service manual.

To the question, Have you had the rig serviced?, 51 percent answered yes and 49 percent no. Eighty-two percent of those whose rigs had been serviced said that the servicing was satisfactory. To the question, Have you been able to obtain all the accessories and parts you need?, 98 percent answered yes, indicating that Drake is certainly making their parts and accessories available to Amateurs. Ninety-four percent of those who purchased accessories were happy with them.

By license class, 45 percent of those responding to the questionnaire held an Advanced class ticket, 38 percent were Extras, 15 percent were Generals, and 2 percent were Technicians.

To the question, What antenna do you use most, 51 percent answered *beam*, 33 percent answered *wire*, 13 percent said *vertical*, and 3 percent replied *other*.

The following twelve categories were scored from 1 to 10 (with 1 being poorest, 4 to 6 average, and 10 perfect): Ease of Operation, Reliability, Durability, Instruction Book, Factory/Dealer Service, Quality of Workmanship, Performance, Maintenance, Parts Availability, Accessories (ease of connection), Price and Flexibility. The scores are reported in **fig. 1**.

would you buy one again?

That's the big question, and over 88 percent of the Amateurs responding answered yes. That's the highest positive response we've received thus far on any piece of high-frequency Amateur gear we've asked our readers about. Owners of the Drake TR7 are obviously very happy with their choice.

Next month, *ham radio* will present the results of its readers' survey on the Kenwood 520. This is a rig many Amateurs have asked to have reviewed, and the results should be interesting. Thanks to all who have participated by sending in a completed questionnaire.

ham radio

More Details? CHECK—OFF Page 102

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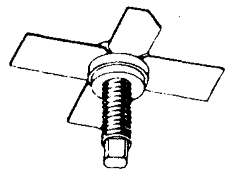
4CX1500B/8660	300.00	3-1000Z	229.00
811A	20.00	3-500Z	141.00
6360	4.69		

RF Transistors



MRF203	P.O.R.
MRF216	19.47
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MRF226	10.20
MRF227	2.13
MRF238	10.00
MRF240	14.62
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MRF247	28.87
MRF262	6.25
MRF314	12.20
MRF406	11.33
MRF412	20.65
MRF421	27.45
MRF422A	38.25
MRF422	38.25
MRF428	38.25
MRF428A	38.25
MRF426	8.87
MRF426A	8.87

MRF449	12.65
MRF449A	12.65
MRF450	11.00
MRF450A	11.77
MRF452	15.00
MRF453	13.72
MRF454A	21.83
MRF455	14.08
MRF455A	14.08
MRF474	3.00
MRF475	2.90
MRF476	2.25
MRF477	10.00
MRF485	3.00
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MRF502	.93
MRF604	2.00
MRF629	3.00
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MRF901	3.99
MRF902	9.41
MRF904	3.00
MRF911	4.29
MRF5176	11.73
MRF8004	1.39
BFR90	1.00

BFR91	1.25
BFR96	1.50
BFW92A	1.00
BFW92	.79
MMCM918	14.30
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MMCM2369	15.00
MMCM2484	15.25
MMCM3960A	24.30
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189-506-103	1.8 to 16.7pF
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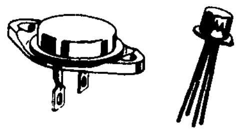

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2N5591	11.00
2N5635	5.44
2N5636	11.60
2N5637	20.00
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7.4585	7.4925	9.585	10.170	11.700	12.000	17.365
7.4615	7.4985	10.000	10.180	11.705	12.050	37.600
7.4625	7.5015	10.010	10.240	11.730	12.100	37.650
7.4665	7.5025	10.020	10.245	11.750	16.965	37.700
7.4685	7.5065	10.030	10.595	11.755	17.015	37.750
7.4715	7.7985	10.040	10.605	11.800	17.065	37.800
7.4725	7.8025	10.0525	10.615	11.850	17.165	37.850
7.4765	9.545	10.130	10.625	11.855	17.215	37.900
7.4785	9.555	10.140	10.635	11.900	17.265	37.950
7.4815						38.000

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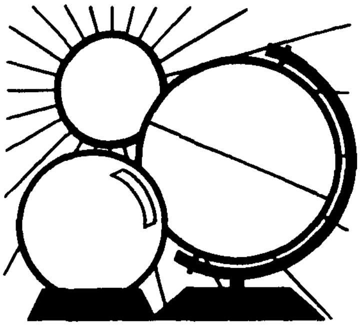
More Details? CHECK—OFF Page 102

More Details? CHECK—OFF Page 102



DX FORECASTER

Garth Stonehocker, K0RYW

last-minute forecast

The low-frequency bands, 160 through 40, will be the favored DX bands for the first two weeks of the month. The higher frequencies will then begin to improve and be very good for DX for the last week and a half. That means a good DX holiday, as well as the holiday of the plentiful harvest, for which we can be thankful. Disturbances, however, may develop about the 6th, 15th, and 26th. Remember: even though disturbance means signal strength and QSB problems on some paths, others may be a DX harvest of plenty. Keep looking.

November is a month of plentiful meteor showers going on from October 26 to November 22, with the shower maximum of ten per hour on the 3rd through the 10th. This shower is known as the Taurids. Lunar perigee is on the 12th, and full moon is the day before, the 11th.

November is often of special significance geophysically because of the quiet conditions of the geomagnetic field. November and December vie for being the quietest month of the year. By quietest is meant steadiness of the magnitude and direction at a point in the magnetic field as measured by a magnetometer (a very sensitive compass).

The variations of the geomagnetic field are described by the A figure on a daily basis. It is made from eight three-hour K figures. The K figure is the displacement from an average diurnal curve for an observing station during the three hours. Why does the geomagnetic field become more stable in winter (November, December, January)? One reason is the solar wind pressure against the earth's magnetic field (magnetosphere). Since the earth is closer to the sun in winter, the pressure at that time increases. This higher pressure around the magnetosphere holds it still — or tends to. In fact, the solar flux and geomagnetic field more often than not move opposite each other — except when the sun flares.

November is also the first month of the winter DX season. Although the hours of daylight in the Northern Hemisphere are quite short now, the ionospherically propagated frequencies rise rapidly with the rising sun each day. This maximum usable frequency (MUF) becomes very high, giving the 6-, 10-, and 15-meter bands a few afternoon and some evening hours of good DX.

The sunspot number (SSN) or solar flux is still high enough, now at the beginning of the decline of the SSN cycle, to produce openings on these bands. The high ionization piles up on both sides (±20 degrees) of the geomagnetic equator. A mound of ionosphere above Central America and northern Argentina allows trans-equatorial one-long-hop signals into the southern populated areas of South America. The late evening hours, 2000-2300 local time, are the optimum times for DX to our friends down south. A bit of geomagnetic disturbance even makes this type of propagation better.

The noise (QRN of the spring, summer, and fall thunderstorms) is about over by now. This lack of QRN now makes DXing in the lower bands of 80 and 160 meters a pleasure. So you can see why November ushers in the winter DX season, and now you have more time indoors to enjoy it.

band-by-band summary

Six meters will open occasionally for F2 long skip propagation with hops 1000 to 2500 miles long, and with many hops usable. The openings will follow the sun during the day and early evening.

Ten and fifteen meters will have openings similar to those on 6 meters, but more often and lasting longer. Worldwide DX is usual from after sunrise until well after sunset during periods of the 27-day solar flux maxima. Short skip of 1200 miles maximum distance is also possible, and will also be following the sun across the earth.

Twenty meters will be open most all days and nights to some area of the globe, with long skip, and some short skip. Distances and number of hops will be much like those on the 15-, 10-, and 6-meter bands.

Forty and eighty meters will be the most usable night-time bands for DX. Most areas of the world can be worked from dusk till just before sunrise. Hops shorten on these bands to about 2000 miles for 40 and 1500 miles for 80 meters, but the number of hops can increase since signal absorption in the ionospheric D region is low during the night. The path direction follows the darkness across the earth, similar to the higher bands following the sun. Daytime short skip can be used during the day and at night if low-height horizontal antennas (high take-off angle) are used. Vertical antennas over good ground systems give the lowest take-off angles for long skip on these bands.

One-sixty meters will be about like 80 meters and provide good stuff for the enthusiastic DXer who likes to work into the wee hours of the night and early morning hours — maybe you retired folks or swing shift workers.

ham radio

NOVEMBER

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	20	10	10	10	10	10	10
0100	5:00	10	20	15	10	15	10	10	10
0200	6:00	10	20	15	15	15	10	10	10
0300	7:00	10	—	15	15	15	10	10	15
0400	8:00	—	—	20	15	15	10	10	15
0500	9:00	—	—	20	15	15	15	15	20
0600	10:00	—	—	20	20	15	15	15	20
0700	11:00	—	—	20	20	20	15	15	20
0800	12:00	20	—	20	20	20	20	20	40
0900	1:00	20	20	20	20	20	20	20	40
1000	2:00	20	20	20	20	20	40	20	40
1100	3:00	20	—	—	40	20	40	20	40
1200	4:00	20	—	—	40	40	40	20	40
1300	5:00	20	—	—	40	40	40	40	40
1400	6:00	20	20	20	20	—	40	40	—
1500	7:00	20	20	15	15	—	40	20	—
1600	8:00	15	15	15	10	—	40	15	—
1700	9:00	15	15*	10	10	—	15	15	—
1800	10:00	15	15	10	10	15	10	15	—
1900	11:00	15	15	10*	10	15	10	15	20
2000	12:00	15*	15	10*	10	15	10	10	15
2100	1:00	10	20	10	10	15	10	10	10
2200	2:00	10	20	10	10	15	10	10	10
2300	3:00	10	20	10	10	15	10	10	10

MID USA

GMT	MST	CST	N Asia Far East	NE Europe	E S. Africa	SE S. America	S Antarctica	SW New Zealand	W Oceania Australia	NW Japan
0000	5:00	6:00	—	20	15	15	10	10	10	10
0100	6:00	7:00	—	20	15	15	10	10	10	15
0200	7:00	8:00	—	20	20*	20	15	15	10	15
0300	8:00	9:00	—	20	20	20	15	15	15	15
0400	9:00	10:00	—	40	20	20	15	15	15	20
0500	10:00	11:00	20	40	20	20	15	20	20	20
0600	11:00	12:00	—	40	20	40	20	20	20	—
0700	12:00	1:00	—	40	20	40*	20	20	20	20
0800	1:00	2:00	—	40	20	20	20	20	20	20
0900	2:00	3:00	—	40	20	20	20	20	20	20
1000	3:00	4:00	—	40*	—	40	20	20	—	20
1100	4:00	5:00	—	—	—	40	20	20	—	20
1200	5:00	6:00	20	—	—	20	20	—	—	—
1300	6:00	7:00	20	20	—	15	20	—	—	—
1400	7:00	8:00	20	20	10	10	—	—	20	—
1500	8:00	9:00	15	15	10*	10*	—	20	15*	—
1600	9:00	10:00	15	10	10	10*	—	20	15	—
1700	10:00	11:00	15	15	10	10	—	15	15	—
1800	11:00	12:00	15	15	10	10	—	10	15*	—
1900	12:00	1:00	15	15	10	10	15	10	15*	—
2000	1:00	2:00	15	20	10	10	15	10	15*	20
2100	2:00	3:00	—	20	10	10	10	15*	15	15
2200	3:00	4:00	—	20	15	10	10	15*	10	10
2300	4:00	5:00	—	20	15	15	10	10	10	10

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	20	15	15	15*	10	10	15
0100	8:00	15	20	20*	20	15	10	10	15
0200	9:00	—	20	20	20	15	15	15	20
0300	10:00	—	20	20	20	15	15	15	20
0400	11:00	—	20	20	20	15	15	20	20
0500	12:00	—	40	20	20	20	20	20	20
0600	1:00	—	40	20	20	20	20	20	20
0700	2:00	20	40	20	20	20	20	20	20
0800	3:00	20	40	40	40	20	20	20	20
0900	4:00	20	40	40	40	20	20	20	20
1000	5:00	—	—	—	40	—	20	20	—
1100	6:00	—	—	—	20	—	—	—	—
1200	7:00	—	—	10	10	—	—	—	—
1300	8:00	—	20	10	10	—	—	20	—
1400	9:00	20	15	10	10*	—	—	15*	—
1500	10:00	20	10	10*	10	—	—	15	20
1600	11:00	15	10*	10	10	—	20	15	20
1700	12:00	10	10	10	10	—	10	15	—
1800	1:00	10	15	10*	10	15	10	15	—
1900	2:00	10	15	10*	10	15	10	15	—
2000	3:00	—	15	10	10	10	10*	15	20
2100	4:00	—	15	10	10	10	10	10	15
2200	5:00	—	20	15	15	10	10	10	15*
2300	6:00	—	20	15	15	10	10	10	15

*Look at next **higher** band for possible openings.

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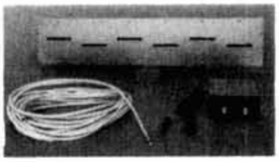

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Please add $1 for shipping.

Ham Radio's Bookstore
Greenville, NH 03048

NEW products

portable two meter quad

A new collapsible antenna has been introduced by Palomar Engineers. It extends the range of low power 2-meter transceivers by providing the gain and front-to-back discrimination of a two-element quad. It is ideal for boating, backpacking, mountaintopping and other portable applications, since it gives the gain of a linear amplifier but does not require additional battery power.

The entire beam assembly is housed in an 18-inch carrying case that will fit in a suitcase. For use, it unfolds to form a two-element full size quad complete with stablized mounting stand. The portable two-meter quad sells for $67.50. For further information write Palomar Engineers, 1520-G Industrial Avenue, Escondido, California 92025.

communications accessories brochure

A new four-page brochure describing communication acessories that are essential to operating excellence are now available from the J.W. Miller Division of Bell Industries in Compton, California.

Antenna tuners Model AT 2500 with 2500 watts PEP power capability and Model CNA-1001 for 500-watts PEP cover a frequency range of 3-30 MHz including the WARC bands. Direct-reading meters provide forward and reflected power indications and SWR. Models CN-720-B and CN-620-B cover 1.8-150 MHz, and Model CN-630 covers 140-450 MHz. Rf clipping that ensures low distortion is provided by the Model RF-440 speech processor. Adjacent-channel isolation of better than 50 dB at 300 MHz and 45 dB at 450 MHz is provided by the CS-201 two-posititon and CS-401 four-position coaxial switches.

Additional infomation may be obtained from Joe Johnson, J.W. Miller Division, Bell Industries, P.O. Box 5825, Compton, California 90224.

portable power systems

Heath Company announces the Heathkit GU-1820 portable power system. This lightweight alternator can produce up to 2200 watts of 120 Vac, 60-Hz power — enough to operate a ham station, an electric chain saw, or a refrigerator-freezer during a blackout. The GU-1820 is designed for ham radio clubs, home owners, civil defense, police and fire departments. It can also provide on-location power for construction and logging crews, campers, hunters, wood cutters, and others.

Mail order price is $479.95. Voltage is regulated to within ±5 percent, and frequency variations are limited to ±4 Hz, from no load to full load at 3600 RPM. Radio-frequency interference is eliminated by a resistive spark plug.

The five horsepower Briggs and Stratton gas engine can run up to 1-3/4 hours, at half load, on a tankful of regular gas, unleaded gas or gasohol. Noise is controlled by a low-tone muffler; to reduce sparking to a minimum, the optional GUA-1820-1 spark-arresting muffler ($3.95 mail order; required in California) is available.

For more information, contact Heath Company, Dept. 350-035, Benton Harbor, Michigan 49022.

2-meter amplifiers

Heath Company announces two new high-power amplifiers for Amateur Radio operators using the 2-meter band. The VL-2280 75-watt VHF base amplifier is suited for base or mobile use.

Both the VL-2280 and the VL-1180 amplifiers are designed to operate in all modes (single sideband, fm or CW), across the entire 144-148 MHz 2-meter band. Ten watts in produces 75 watts out. Antenna-to-receiver insertion loss is less than 0.6 db, and intermodulation distortion is less than 24 dB. Power output is kept stable across the entire band by broadband circuitry. Extra-large heatsinks provide enough cooling to make possible a 50-percent duty cycle. Keying can either be rf-sensed or remote.

The VL-1180, priced at $137.95 (FOB Benton Harbor, Michigan), operates on 13.6-Vdc mobile power. A special design allows the VL-1180 to be used in a car trunk or other out-of-the-way place.

For more information contact Heath Company, Dept. 350-056, Benton Harbor, Michigan 49022.

high-isolation coaxial relay

The Dow-Key Division of Kilovac Corporation has released for sale a new high-isolation SPDT coaxial relay. The model 66-23732 was developed primarily for use with cable television head-end equipment, and features the 75-ohm "F" female connectors, which provide a minimum of −100 dB isolation dc to 500 MHz. The relay comes equipped with 26.5-Vdc actuating coil and DPDT auxiliary contacts. Power capacity is 20 watts CW.

The relay is designed for video source switching, using the auxiliary contacts for audio follow-on. It has excellent rf characteristics for i-f switching, and the auxiliary contacts may be used for remote indication of the relay position. The same relay is ideal for rf switching to 500 MHz, and for use in remotely actuated or programmable switching modules. The model 66 is also available with a 12-Vdc coil, with or without auxiliary contacts. For further information contact: Kilovac Corporation, P.O. Box 4422, Santa Barbara, California 93103.

NEW products

heavy duty portable DMM

The new rugged HD-100 from Beckman Instruments, Inc., is made waterproof and dustproof to resist the elements. It can withstand the physical impact of accidental drops and has the kind of built-in input protections never before found in other DMMs.

Voltage inputs are protected to 1500 Vdc or 1000 volts RMS. Current ranges are protected to 2 amps/250 volts while resistance changes are protected to 500 Vdc. The O-ring sealed ABS plastic case is fire retardant with ribbed side walls that are twice as thick as in other meters. The bright NATO-yellow case is highly visible — easy to spot in a tool box or on a ledge before leaving a job.

For further information and complete specifications, contact your local electronics or meter distributor, electronics retail outlet or Beckman Instruments, Inc., Advanced Electro-Products Division, 2500 Harbor Blvd., Fullerton, California 92634.

catalog for power grid tubes

A quick-reference catalog for power grid tubes is available free from Varian/Eimac. The catalog lists tubes manufactured at Eimac's San Carlos and Salt Lake City sites. The San Carlos plant produces large ceramic/metal power grid tubes, cavities, and accessories. Glass power tubes, smaller ceramic/metal tubes, and a wide line of planar triode and X-ray tubes are manufactured in Salt Lake City.

Included in the catalog is an applications-oriented power grid tube selection guide for ease in making type selections. To receive the free, quick-reference catalog of Eimac power grid tubes, contact the nearest Varian Electron Device sales office or Varian/Eimac, 301 Industrial Way, San Carlos, California 94070.

station clock

The heart of the Zulu 3TZ is a microprocessor chip and memory that gives it greatly expanded capabilities. Besides the one local 12-hour time zone and two alternate 24-hour world time zones, the unit has a reminder I.D. timer that gives different tones at 8, 9, or 10 minute intervals. The IDer is resettable and accurate to plus or minus 0.1 second. Other features include large, orange 0.6 inch LED readouts for easy readability; quartz crystal timebase battery backup; ac or dc operation on 12 volts or 117 Vac with the wallplug transformer that is included.

Also useful is an appliance timer output that is synchronized with the local (12-hour) time that allows one on and one off shiftpoint per day. The manual explains how to connect the appliance-timer output to a relay or triac (not included) to control any external device. The unit can be made to display remote temperature using a silicon linear thermistor probe and a highly stable voltage-to-frequency circuit. The additional parts are available for $9.95. Contact Bullet Electronics, P.O. Box 401244, Garland, Texas 75040.

MBA reader-only

AEA, Inc., announces the introduction of a reader for Morse, Baudot, and ASCII operation. Designated the MBA-RO (reader only), it is a state-of-the-art device using a 32-character vacuum fluorescent alphanumeric display. The 32-character display allows for up to five words to be displayed at one time. This extended display is especially useful during high-speed copy.

The reader can copy up to 99 WPM for CW, 60-70-75 and 100 WPM for

More Details? CHECK—OFF Page 102

Baudot and ASCII at 110 and hand-typed 300 baud. The MBA incorporates automatic speed tracking, ensuring no loss of copy from rapid speed changes in signal reception. It uses a 12-Vdc external power supply, making it ideal for portable, mobile, or fixed operation. The MBA is compact and can be used with a hand key, bug, or electronic keyer.

For further information, contact Advanced Electronic Applications, Inc., P.O. Box 2160, Bldg. O & P — 2006-196th SW, Lynnwood, Washington 98036.

short circuits

wideband sweep generator

The following correction should be made to **fig. 2** in the article "Stable Wideband Sweep Generator," which appeared in the June, 1981, issue: The 100k resistor between R3 and pin 2 of the 741 IC should be connected between pins 2 and 6. The side of R3 that is shown connected to the 100k resistor should be connected to pin 6.

antenna bridge calculations

The following errors appeared in the program listed in K6GK's article in the March, 1981, issue (page 85).

Line 160 is missing an end bracket. Line 640 should have no bracket. Line 350 should read +1+2, not =1+1. Line 400 should read (A2*B1) not (A2+B1). Line 610 should read −I4, not I4.

Line 390 is an overlooked "garbage" term and can be scratched. The program "just growed" and can be shortened a bit, but it was submitted as is in the hope that it would stimulate interest in this approach.

G3LDO wire beam

Please note that in **fig. 7** of Bill Orr's article, "Ham Radio Techniques," in the January, 1981, issue, the dimension D should have been indicated on the drawing as the distance from the top of the vertical mast to the point at which the support rods cross.

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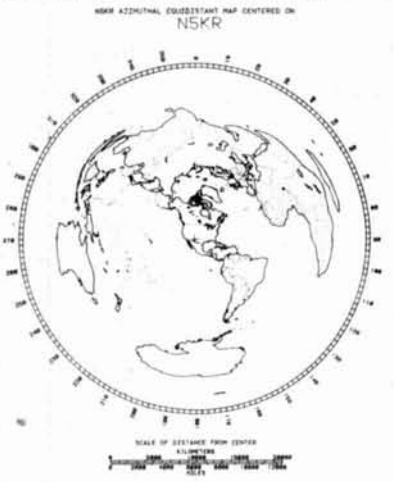

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Coming Events

ACTIVITIES

"Places to go..."

INDIANA: The Allen County Amateur Radio Technical Society's 9th annual Hamfest, November 15, 8 AM to 4 PM, Allen County Memorial Coliseum, Ft. Wayne. Admission: $2.50 advance, $3.00 door. Children 11 years and under free. Large flea market, forums, door prizes. Talk-in on 146.28/.88. Tables $6.00 each. Premium tables $20.00. For information or pre-registration: Allen County ARTS, P.O. Box 10342, Ft. Wayne, IN 46851. Att: Hamfest Committee.

MICHIGAN: The 16th annual Hazel Park Amateur Radio Club's Swap & Shop, Sunday, December 6, Hazel Park High School, Hughes Street, 9½ Mile Road, 1 mile east of I-75, Hazel Park. Tickets $2.00. Tables 75¢ per foot. Doors open 8 AM. Main prize drawing 2 PM plus hourly prizes. Grand prizes included with admission ticket. Talk-in on 146.52. For information: SASE to Jack Field, WA8UPU, 1444 E. Evelyn, Hazel Park, MI 48030.

MICHIGAN: The Oak Park High School Electronics Club's 12th annual Swap & Shop, Thanksgiving Sunday, November 29, Oak Park High School, Oak Park. Admission: $1.50 advance, $2.00 door. 8 ft. tables $5.00 advance, $6.00 door. Door prizes and refreshments. For tickets and reservations: SASE to Herman Gardner, Oak Park High School, 13701 Oak Park Blvd., Oak Park, MI 48237. Or call (313) 968-2675.

OPERATING EVENTS

"Things to do..."

DECEMBER 4, 5, 6. The Pike County Amateur Radio Club of Winslow and the Old Post Amateur Radio Society of Vincennes will operate a special events station from Santa Claus, Indiana. Call sign W9CZH. Time 0000 Z on December 4 through 2300 Z December 6. Frequencies: 21.410, 14.305, 7.270, 3.925. All SSB, 14.090-14.100 RTTY and 146.52 FM. A special QSL/XMAS card postmarked from Santa Claus post office sent upon receipt of SASE to Santa Claus, P.O. Box 111, Ireland, IN 47545.

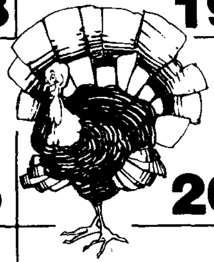
DECEMBER 5, 6, 7. The 17th annual Telephone Pioneers QSO party, 1900 UTC, December 5 through 0500 UTC, December 7. CW call CQTP. Phone call CQ Telephone Pioneers. Phone frequencies: 3.955-3.975; 7.265-7.285; 14.285-14.305; 21.355-21.375; 28.665-28.885; 50.10-50.25; 144.275-145.500 and 146.52. CW frequencies: 3.555-3.575; 7.055-7.075, 14.055-14.075; 21.055-21.075; 28.055-28.075; Novice/tech: 3.725, 7.125, 21.125, 28.125. Send logs by January 15, 1982 to: Ted Phelps, W8TP, John D. Burlie Chapter No. 89, Telephone Pioneers of America, c/o Western Electric, Dept. 45150, 6200 East Broad Street, Columbus, OH 43213.

More Details? CHECK—OFF Page 102

HAM CALENDAR

November

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
6TH ANNUAL U.S. MARINE CORPS MARATHON — beginning 0900 EST. Frequencies used will be: All 2-meter repeaters in the D.C. area; 10-meter FM & single-sideband in vicinity of 29.6 and 28.5 MHz; 15-meters in vicinity of 21.360 MHz; 40 meters in vicinity of 14.3 MHz; 40 meters in vicinity of 7.225 MHz. Operators who complete their QSO's with N3ES via W3NKF send their QSL cards to W3NKF, Code 9015, Naval Research Lab, Washington, D.C. 20375. 1 **DEFIANCE COUNTY HAMFEST & FLEA MARKET** — Defiance County Fairgrounds, Hicksville, OH. Contact Ed Ballard, Jr., WD8JVV. 1 **1**	**WEST COAST BULLETIN** — 8PM PST (0400UTC), 3540 KCS, A-1, 22 WPM. 2 **2**	**AMSAT** East Coast Net 3850 kHz 9:00 PM EDST (0100Z Wednesday Morning) **AMSAT** Mid-Continent Net 3850 kHz 9:00 PM CDST (0200Z Wednesday Morning) **AMSAT** West Coast Net 3850 kHz 8:00 PM PDST (0300Z Wednesday Morning) **3**	**YLRL ANNIVERSARY PHONE CONTEST.** 4-5 **4**	**5**	**6**	**ARRL SWEEPSTAKES (CW).** 7-8* **7**
R.F. HILL ARC 5TH ANNUAL HAMFEST — Sellersville National Guard Armory, Sellersville, PA. Contact K3TV for more information. 8 **8**	**9**	**AMSAT** East Coast Net 3850 kHz 9:00 PM EDST (0100Z Wednesday Morning) **AMSAT** Mid-Continent Net 3850 kHz 9:00 PM CDST (0200Z Wednesday Morning) **AMSAT** West Coast Net 3850 kHz 8:00 PM PDST (0300Z Wednesday Morning) **10**	**W1AW QUALIFYING RUN.** 11 **11**	**12**	**13**	**ESPERANTO (ILERA)** Details from G4MR, QTHR 14-15 **NORTH CAROLINA QSO PARTY.** 14-15 **EUROPEAN DX CONTEST** — see July *QST*. 14-15 **14**
ALLEN COUNTY AMATEUR RADIO TECHNICAL SOCIETY 9TH ANNUAL HAMFEST — Allen County Memorial Coliseum, Ft. Wayne, IN. Contact Allen County ARTS, P.O. Box 10342, Ft. Wayne, IN 46851. 15 **15**	**WEST COAST BULLETIN** — 8PM PST (0400UTC), 3540 KCS, A-1, 22 WPM. 16 **16**	**AMSAT** East Coast Net 3850 kHz 9:00 PM EDST (0100Z Wednesday Morning) **AMSAT** Mid-Continent Net 3850 kHz 9:00 PM CDST (0200Z Wednesday Morning) **AMSAT** West Coast Net 3850 kHz 8:00 PM PDST (0300Z Wednesday Morning) **17**	**18**	**19**	**20**	**W1AW QUALIFYING RUN.** 21 **ARRL SWEEPSTAKES** (phone). 21-22* **21**
22	**23**	**AMSAT** East Coast Net 3850 kHz 9:00 PM EDST (0100Z Wednesday Morning) **AMSAT** Mid-Continent Net 3850 kHz 9:00 PM CDST (0200Z Wednesday Morning) **AMSAT** West Coast Net 3850 kHz 8:00 PM PDST (0300Z Wednesday Morning) **24**	**25**	**26**	**27**	**CQ WORLDWIDE DX CONTEST (CW).** 28-29 **28**
OAK PARK HIGH SCHOOL ELECTRONICS CLUB 11TH ANNUAL SWAP & SHOP — Oak Park High School, Oak Park. For more information send SASE to Herman Gardner, Oak Park H.S., 13701 Oak Park Blvd., Oak Park, MI 48237. 29 **29**	**30**	**AMSAT** East Coast Net 3850 kHz 9:00 PM EDST (0100Z Wednesday Morning) **AMSAT** Mid-Continent Net 3850 kHz 9:00 PM CDST (0200Z Wednesday Morning) **AMSAT** West Coast Net 3850 kHz 8:00 PM PDST (0300Z Wednesday Morning) **31**				*See October *QST*.



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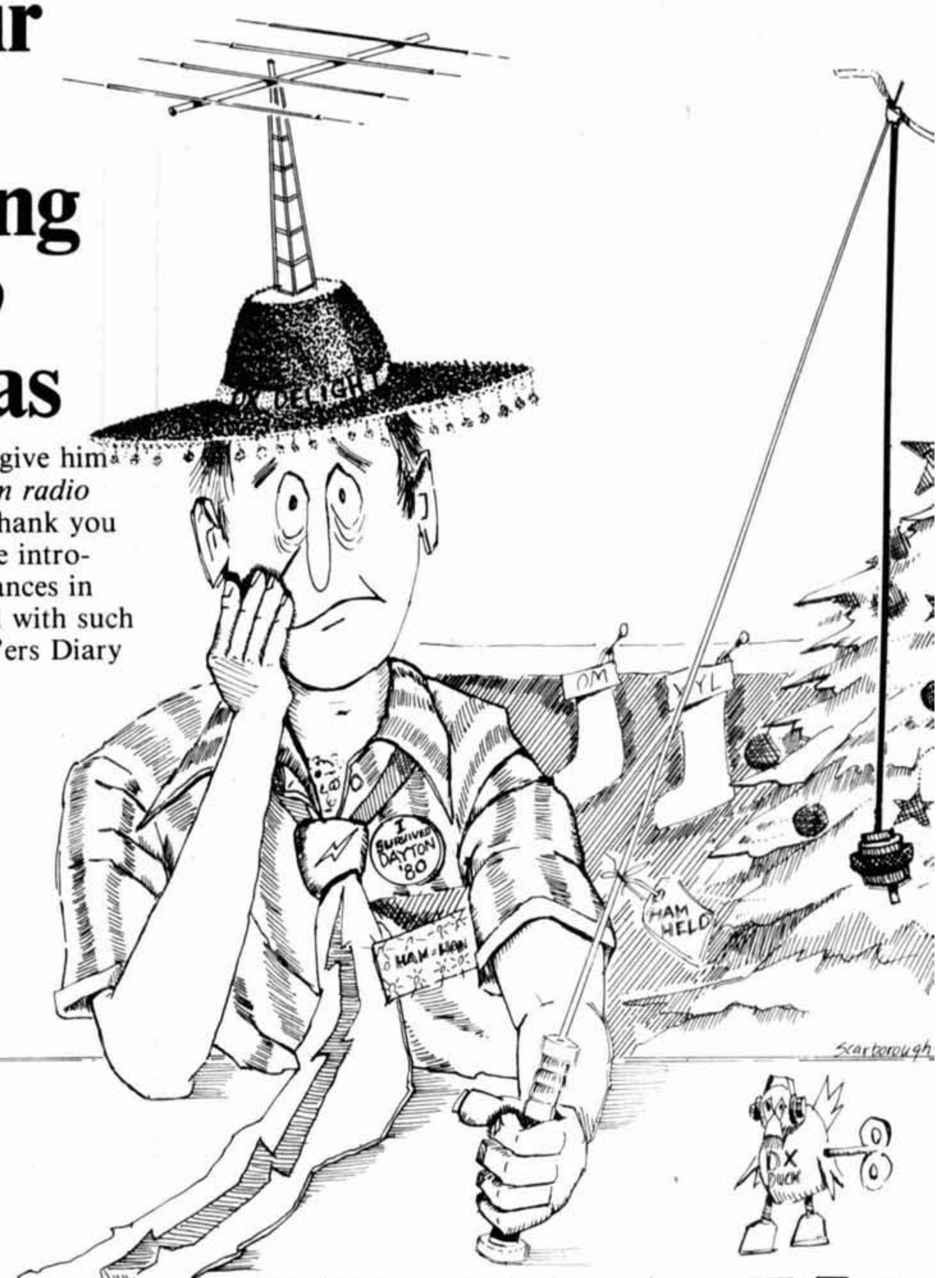

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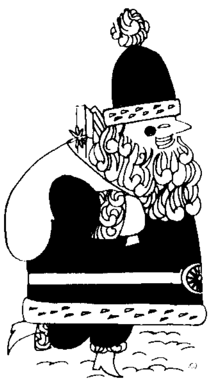

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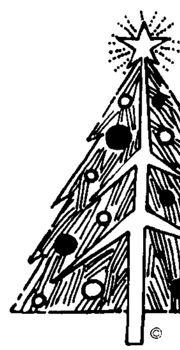

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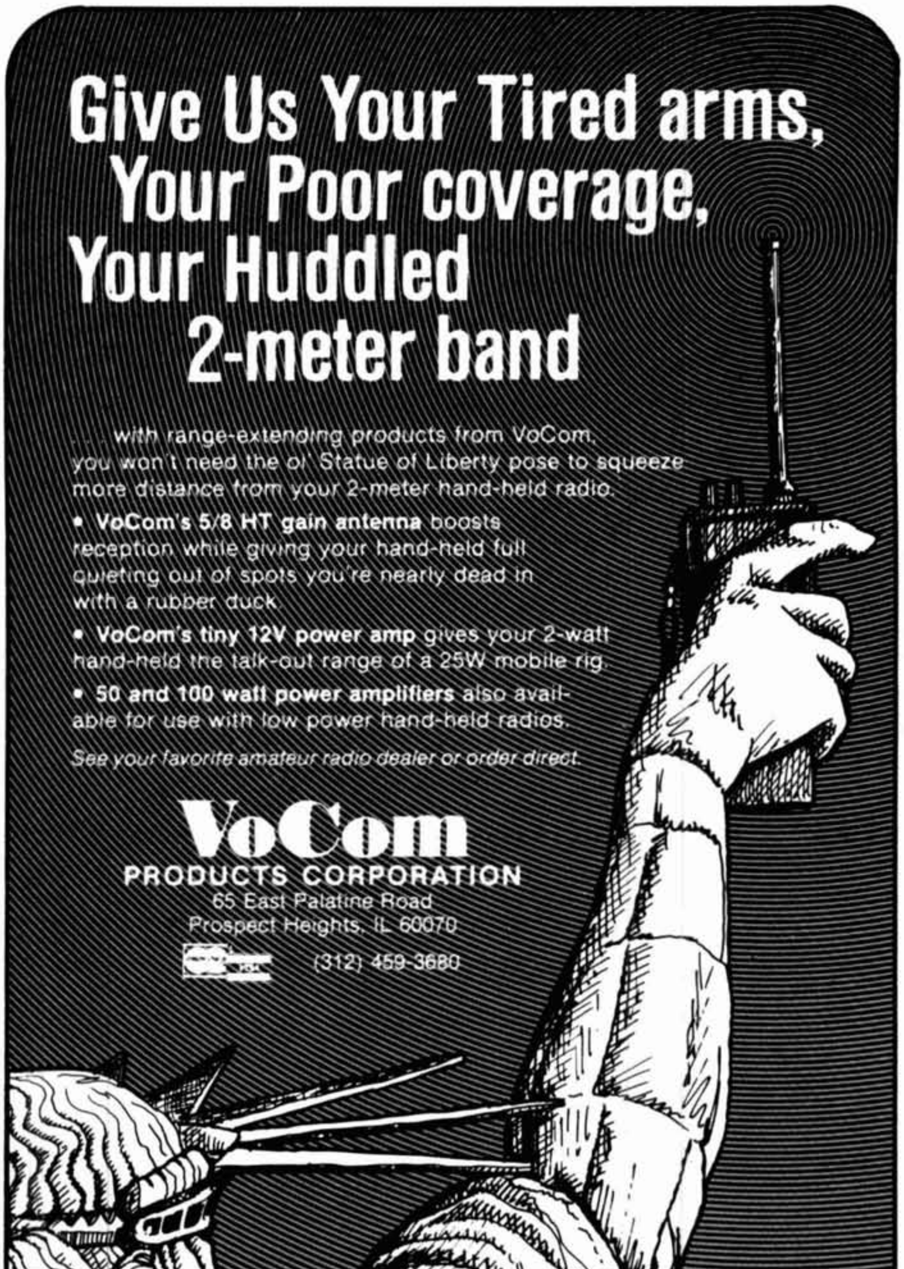

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November, 1981

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DRAKE 7-Line Family

A pacesetter since 1943, Drake led in 1963 with 9 MHz i-f transceiving, and now with 48 MHz i-f "Up Conversion"... Drake brings you tomorrow's state of the art today.

R7

Synthesized General Coverage Receiver

Model 1240

Full general coverage reception, 0-30 MHz, with no gaps or range crystals required.

Continuous tuning all the way from vlf thru hf. Superb state-of-the-art performance on a-m, ssb, RTTY, and cw—and it transceives with Drake TR7.

- **100% solid state broadband design,** fully synthesized with a permeability tuned oscillator (PTO) for smooth, continous tuning.
- **Covers the complete range 0 to 30 MHz** with no gaps in frequency coverage. Both digital and analog frequency readout.
- **Special front-end circuitry** employing the high level double balanced mixer and 48 MHz "up-converted" 1st i-f for superior general coverage, image rejection and strong signal handling performance.
- **Complete front-end bandpass filters** are included that operate from hf thru vlf. External vlf preselectors are not required.
- **10 dB pushbutton-controlled broadband preamp** can be activated on all ranges above 1.5 MHz. Low noise design.
- **Various optional selectivity filters** for cw, RTTY and a-m are switch-selected from the front panel. Ssb filter standard.
- **Special new low distortion "synchro-phase" a-m detector** provides superior international shortwave broadcast reception. This new technique permits 3 kHz a-m sideband response with the use of a 4 kHz filter for better interference rejection.
- **Tunable i-f notch filter** effectively reduces heterodyne interference from nearby stations.
- **The famous Drake full electronic passband tuning system** is employed, permitting the passband position to be adjusted for any selectivity filter. This is a great aid in interference rejection.
- **Three agc time constants** plus "Off" are switch-selected from the front panel.
- **Complete transceive/separate functions** when used with the Drake TR7 transceiver are included, along with separate R7 R.I.T. control.
- **Special multi-function antenna selector/50 ohm splitter** is switch-selected from the front panel, and provides simultaneous dual receive with the TR7. This makes possible the reception of two different frequencies at the same time. Main and alternate antennas and vhf/uhf converters may also be selected with this switching network.
- **The digital readout** of the R7 may be used as a 150 MHz counter, and is switched from the front panel. Access thru rear panel connector.
- **The built-in power supply** operates from 100, 120, 200, 240 V-ac, 50/60 Hz, or nominal 13.8 V-dc.
- **The R7 includes a built-in speaker,** or an external Drake MS7 speaker may be used.
- **Built-in 25 kHz calibrator** for calibration of analog dial.
- **Low level audio output** for tape recorder.
- **Up to eight crystal controlled fixed channels** can be selected. (With Drake Aux7 installed.)
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Specifications, availability and prices subject to change without notice or obligation.

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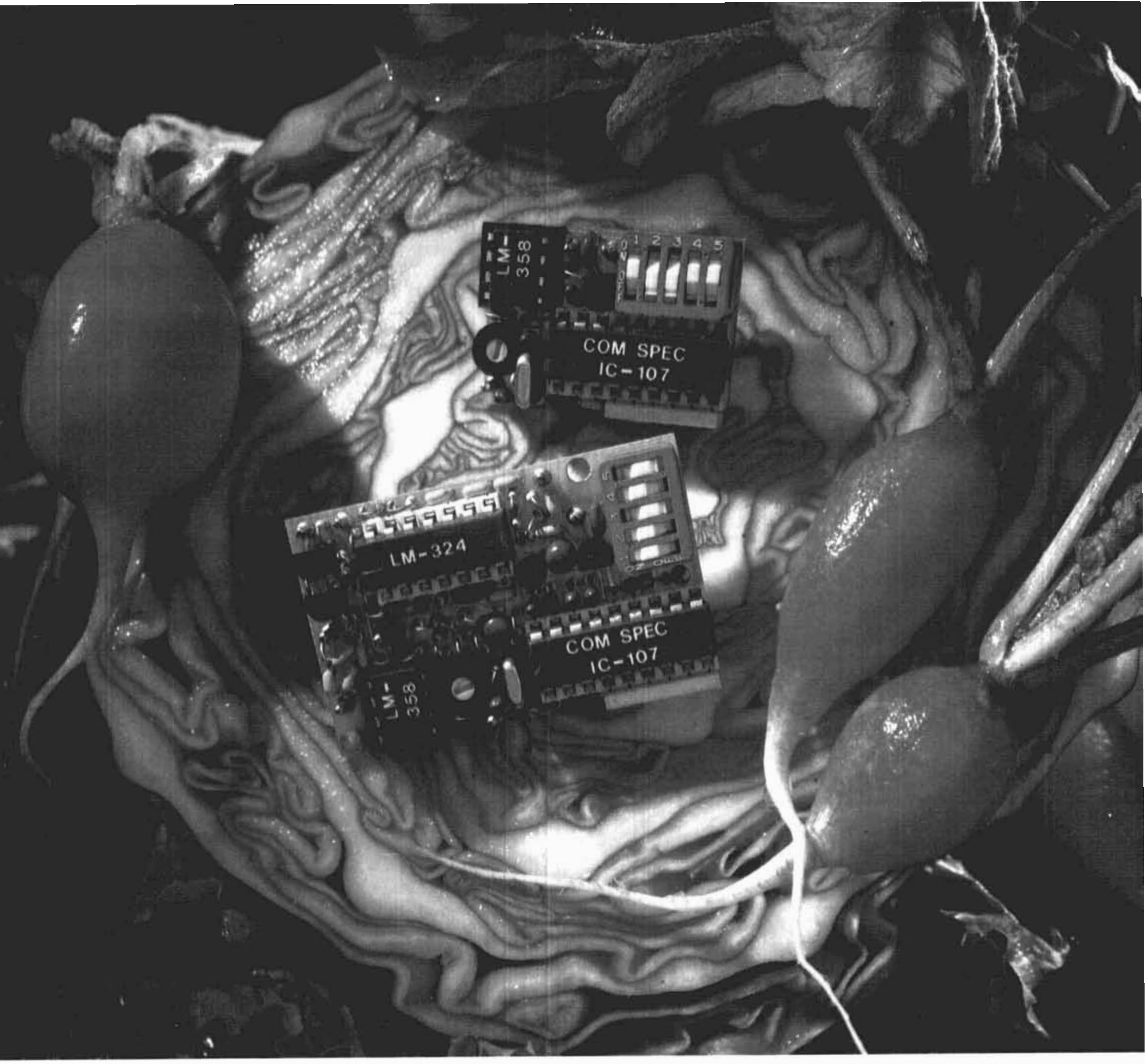

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- Unique tuning speed selection for quick and precise QSY, choice of 1 KHz, 100 Hz or 10 Hz tuning.
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ICOM

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