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ham radio magazine

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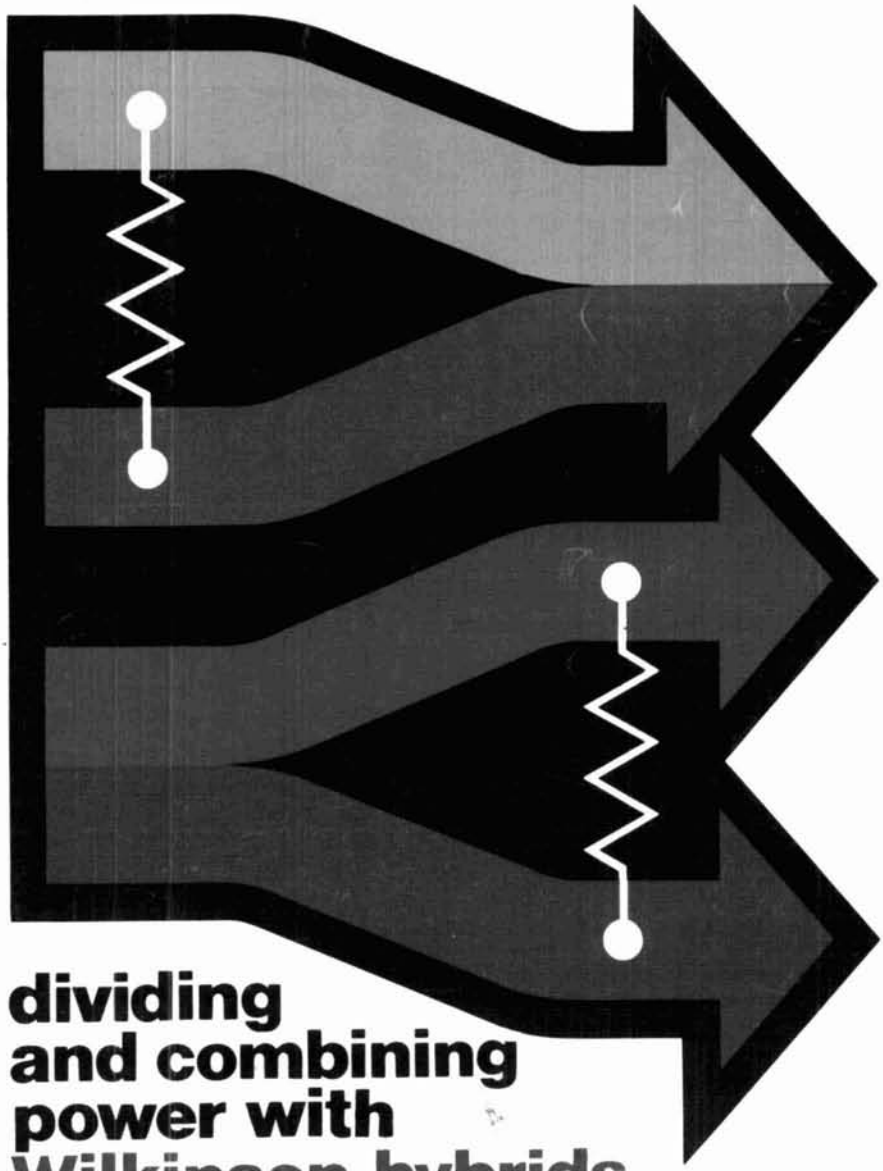

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The TR7A and R7A offer performance and versatility for those who demand the ultimate!

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New! Both 2.3 kHz ssb and 500 Hz cw crystal filters, and 9 kHz a-m selectivity are standard, plus provisions for two additional filters. These 8-pole crystal filters in conjunction with careful mechanical/electrical design result in realizable ultimate rejection in excess of 100 dB.

New! The very effective NB7 Noise Blanker is now standard.

New! Built in lightning protection avoids damage to solid-state components from lightning induced transients.

New! Mic audio available on rear panel to facilitate phone patch connection.

• **State-of-the-art design** combining solid-state PA, up-conversion, high-level double balanced 1st mixer and frequency synthesis provided a no tune-up, broadband, high dynamic range transceiver.

R7A Receiver

• **CONTINUOUS NO COMPROMISE 0 to 30 MHz frequency coverage.**

• **Full passband tuning (PBT).**

New! NB7A Noise Blanker supplied as standard.

• **State-of-the-Art features** of the TR7A, plus added flexibility with a low noise 10 dB rf amplifier.

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* Patent pending

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JANUARY 1982

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contents

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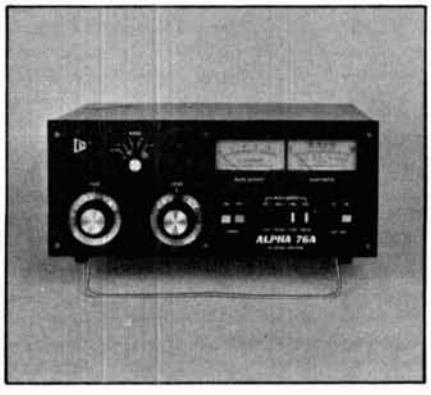
Most maximum-legal-power linears come with a 90-day warranty. Big deal.

Every ALPHA amplifier comes with a full TWO YEAR warranty—eight times what's provided by other manufacturers of so-called "2 kW PEP" models.

Sure, you can buy a cheaper linear . . . but is that what you really want? Will it give you the "full power with no time limit" confidence that's made ALPHAs famous? The confidence we demonstrated by running a stock ALPHA 76A key-down at 1,000 watts d-c input for 900 straight hours? The confidence that comes from hearing all those ALPHAs in the big contests and knowing their



truly remarkable record; not one ALPHA built since 1975 has ever burned up a transformer under those brutally severe operating conditions?

When that **other** full-tilt linear is barely 91 days old, it's out of warranty and its owner is on his own. But you and your ALPHA are just becoming fast friends, still protected for a year and nine months to come by ETO's superb (limited) warranty.

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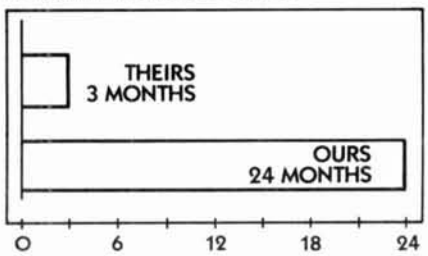

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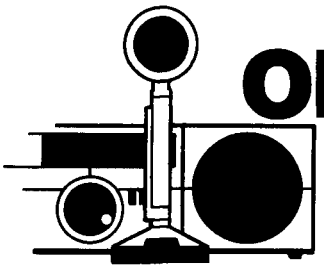

Observation & Opinion

Short circuits. You've seen this column in *ham radio* from time to time and in other Amateur Radio magazines under a different heading. It all means the same thing: *errors*. Errors creep into articles almost regardless of how much care is used — in proofreading, editing, and preparing artwork. It's Murphy's law at work, something we all must live with.

We receive letters from readers who bring technical inaccuracies to our attention, and we appreciate such information. It helps keep us on our toes so that we can maintain the standard of excellence that *ham radio* has enjoyed for thirteen years. Keeping errors to a minimum, however, is really a joint effort between our editorial staff and our authors. I thought you might be interested to learn a bit about how that joint effort works.

When I review a submitted article for possible publication, the first things I look for are originality and interest to our readers. If the contribution meets these requirements, I next look for completeness and attention to detail. The article is then examined for obvious technical errors.

The errors that are not so obvious cause the real problems. A misplaced or mislabeled component on a schematic diagram can blow an entire project. Is it a 0.01-μF or a 0.1-μF capacitor? Is it an earth or chassis ground? Such seemingly minor errors have a way of being noticed at the last minute, generally when the magazine is about ready to go to the printer.

Our authors help us reduce the error count by carefully checking their copies of the typeset article. When it is at all possible, we ask that our authors ask a knowledgeable second party to go over the article and look for errors. I've seen cases where an error has been consistently overlooked by many people, only to appear in print despite careful inspection.

We sometimes get complaints from authors who say that a schematic prepared by our artist was not laid out in the same way the submitted version was. There is a very good reason for this. Because of page-size restrictions, drawings must sometimes be redrawn to fit the available space. In such cases the drawing must be checked by all concerned with special care to avoid omissions and circuit errors.

Another source of possible errors is math equations. Although we don't have a staff of mathematicians available to check manuscripts, we are able, in most cases, to track down errors and to locate any incomplete or inconsistent definitions of terms. We try to make our authors understand that we depend on them for unambiguous mathematical material. It's obvious, for example, that there's a difference between $\sqrt{2/2}$ and $\sqrt{2}/2$, yet such an error was found in the final page proofs of an article scheduled for one of our winter issues. In this case it was an error in typesetting — but an important one. Fortunately, with careful checking, we caught it.

We recognize the reader's disappointment when he has built a circuit only to discover it doesn't work because of an error in the article. When we learn that an error has gotten by us, we try to schedule a short circuit item in a timely manner, but it's not always possible to include the correction in the issue immediately following a published article. Sometimes a month or two go by before we even learn of an error. For this we ask your indulgence; the correction will appear just as soon as possible.

I've written this essay on short circuits to emphasize the fact that we are trying our utmost to produce a magazine of articles that will instill confidence in the reader. I have tried to explain some of the problems that, with careful attention to detail and our author's help, can be minimized. Our goal is no short circuits. We probably won't achieve perfection, but we intend to come very close. That's our New Year's resolution.

Alf Wilson, W6NIF
editor

comments

geostationary satellites

Dear HR:

I am writing to tell you that I enjoyed "Locating Geostationary Satellites" by Walter Pfiester, W2TQK, in the October, 1981, *ham radio*. I feel, however, that several minor additions would add to the utility of the program for those that might use it on repeated occasions. The addition of labels and a routine for entering data would save keystrokes and allow more rapid manipulation of data. For my own use, the modifications would be as follows:

step	key
000	LBL
001	A
002-068	As in existing listing
069	LBL
070	B
071	STO
072	OO
073	R/S
074	LBL
075	C
076	STO
077	01
078	R/S
079	LBL
080	D
081	STO
082	02
083	R/S
084	LBL
085	E
086	CMS
087	FIX
088	3
089	R/S

The key codes were not included in my listing because the program was set up on a SR-52 and the key codes are not identical. The program would be recorded on a magnetic card for use with the SR-52 or TI-59 and used as follows:

(1) Read Card (SR-52 or TI-59 only, key in program for TI-58 or 58C)
(2) Initialize, Press E, Display reads 0.000
(3) Enter parameters in any order
  (a) Earth station latitude, Press B
  (b) Earth station longitude, Press C
  (c) Spacecraft longitude, Press D
(4) Find azimuth and elevation, press A (display azimuth), then press R/S to display elevation.

All other comments and notes are the same but a saving of six keystrokes is achieved.

Mac Mayercik, W2TI
High Bridge, New Jersey

Novice playgrounds

Dear HR:

I am in complete agreement with the views expressed in the October, 1981, editorial. In addition, I believe that the Novice bands have — on the whole — become more like playgrounds than training grounds ever since the FCC allowed renewable Novice tickets. But, be that as it may, higher-class hams should lend a helping hand to those Novices whose operating practices are conspicuous by their lack of know-how in proper procedures. A good place to begin is to advise Novices (and others, too) of the true meaning of "R."

Bill Morris, WA5MUF
Denton, Texas

best best regards regards

Dear HR:

The points in your "Observation and Opinion" in the October issue of *ham radio* were well taken. However I believe you did not go far enough. Beginners are not the only ones to use poor practices. Those of us who have been on the air for many years sometimes make the beginners sound good. A few examples:

73's..This is a double plural, as 73 means best regards. To wish someone best 73s means best best regards regards. Not very grammatical!

Phonetics: There are two generally accepted phonetic codes. One is the ITU phonetic alphabet; the other is usually called the phonetic code and is more popular. Some operators have been heard to mix the two, or use them alternately. The practice of using both the letters and the phonetics can be very confusing to the listener. Another poor practice is making up your own phonetics using names of cities or countries. This creates a false idea of where the station is located. But probably the most objectionable is the fugitive from the CB bands who is cute in choosing his own phonetics, such as "southern fried chicken" for SFC.

Proper operating habits can make this great hobby much more rewarding for all of us.

Howard B. Mouatt, W6BQD
Palm Desert, California

Hamvention slide show

Dear HR:

As a result of many requests from radio clubs for program material on the Hamvention, the Dayton Amateur Radio Association has developed an audio-visual slide show. The program runs for twelve minutes and is suitable for showing at club meetings. The show depicts one Amateur's activities at the three-day affair. It will give the first-timer an idea of what to expect, and will bring back many memories to the regular Hamvention visitor.

Use of the program is free, but a security deposit is required to ensure reasonable turn-around time.

For additional information write Hamvention Slide show, Box 44, Dayton, Ohio 45401.

Bob McKay, N8ADA
Editor, RF Carrier
Dayton Amateur Radio Assoc.

MFJ SWR/ WATTMETERS

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

$49.95
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

$29.95
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.

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

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$26.95
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).

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MFJ SHORTWAVE ACCESSORIES

NEW Indoor Tuned Active Antenna. Rivals, can even exceed reception of outside long wire.

Rivals long wires

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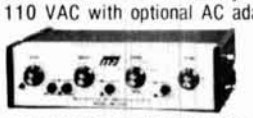
MFJ-1020 NEW INDOOR ACTIVE ANTENNA sits on your desk ready to listen to the world. Rivals, can often exceed, reception of outside long wire. Unique **Tuned** Active Antenna minimizes intermod, provides RF selectivity, reduces noise outside tuned band. Also use as preselector for external antenna. Covers 300 KHz to 30 MHz in five bands. Adjustable telescoping antenna. Controls: Tune, Band Selector, Gain, On-Off/Bypass. LED. FET, bipolar circuitry. Phono jack for external ant. 6x2x6 inches. 9-12 VDC or 9 V battery for portable use. 110 VAC with optional AC adapter, $9.95.



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MOBILE SWL CONVERTERS to hear the shortwave world while you drive. **MFJ-304** ($69.95) covers 19, 25, 31, 49 meter bands. **MFJ-308** ($89.95) adds 13, 16, 41, 60 meters. Two dual-gate MOSFETS give excellent sensitivity, selectivity with car receiver. Push button band selector. Tune with car radio. Plugs between antenna and radio. 12 VDC. **304** is 5¼x1¼x4". **308** is 6¼x1¼x5". **Free catalog.**

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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.

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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.

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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.**

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More Details? CHECK—OFF Page 98

presstop

THE FCC'S AMATEUR RULES REWRITE has been killed. In an open FCC meeting on Thursday, November 12, the commissioners agreed unanimously to forego the controversial rewrite in view of the overwhelming opposition to PR Docket 80-279 by the Amateur community.

Most Of The Approximately 1400 who filed comments on the proposal opposed it. Many cited the question-and-answer format as being both irritating and unnecessary, along with their other objections to specific points or seeming omissions. Leading the opposition was the ARRL, which condemned the rewrite saying it would turn the Amateur service into a "sophisticated Citizens Band Service." The League joined with many others in criticizing the elimination of the present basis and purpose of Amateur Radio as well as the proposed renaming of the Service.

The Possibility Of A Future Rewrite by Amateurs themselves was left open by the Commission in its decision, which noted the FCC's rewrite effort should prove helpful in the event such a project is undertaken later.

Other FCC Actions Possible in the near future will likely concern the extension of SSTV and facsimile to all phone frequencies, and expansion of the present phone bands.

10 MHZ WON'T BE AVAILABLE to U.S. Amateurs when the WARC 79 provisions go into effect January 1, though Amateurs in a number of other countries will greet the new year on the new band. The British will be on 30 meters January 1, and for a while the Home Office had agreed to give them limited privileges on 18 and 24 MHz as well. However, that agreement has now been rescinded.

ARRL DIRECTOR ELECTIONS in two divisions have been declared null and void by the League's Executive Committee, and will be rerun. The two divisions are the Pacific, where the incumbent's statement exceeded the specified limits, and the Great Lakes, in which the incumbent's statement did not appear the way he had intended. Though initially the Executive Committee had decided to proceed with the election, its members decided in a later meeting that the League staff should have resolved the problem before the ballots went out so a new ballot was needed.

New Ballots Were Mailed to members in both divisions about December 1, with counting of the ballots scheduled to take place on January 20. The new ballots are for the directors election only; the Pacific Division vice director race will still be decided by the votes cast with the original ballots, while in the Great Lakes Division there was only a single candidate for vice director.

Duplicate Ballots have been mailed to all League members who reported nonreceipt of the original mailings, but in a number of cases (including the entire state of Hawaii) the original ballots did eventually show up after having been lost in the postal system for over three weeks. A few of those receiving two ballots have been found to have returned both, so now all ballots from the ZIP codes where duplicate ballots were sent are being checked to weed out any duplicated votes.

THREE NEW RUSSIAN AMATEUR SATELLITES could be launched at any moment, according to a number of European sources, possibly in a spectacular triple launch. All three are supposed to have Mode A transponders, plus a unique "robot" transponder that responds to an appropriate call by sending back the caller's callsign, a signal report, and possibly the serial number of the contact. The robot frequencies (in/out) are reported as 145.82/29.32, 145.83/29.33, and 145.84/29.34 respectively for the three birds. Transponder bandpasses start 40 kHz above the two robot frequencies.

OSCAR 9 (UoSAT) Checkouts continue well, with the CCO camera sending a test pattern over the weekend. Final satellite stabilization procedures are due to begin, after which the gravity gradient boom will be extended.

OSCAR 8 Is Also Working Well, though Mode A users are being bothered by both current strong ionospheric attenuation of the downlink signal and an increasing number of terrestrial stations operating in the 29.4-29.5 downlink passband. Two-meter simplex stations in the 145.85-146.00 passband are also bothering users.

AMATEUR RADIO'S FATE, insofar as the FCC is concerned, may rest with the forthcoming report of the Commission's "Program Evaluation Task Force." The task force, made up of FCC staff members, has been reviewing all commission activities to determine what programs could be cut back or eliminated. Such cutbacks would be alternatives to the 12 percent across-the-board cut that is presently planned. Either way, the Amateur community appears destined to lose out, particularly in exams and in enforcement. With FCC services certain to be cut, the provisions of Senator Goldwater's S.929 that would permit Amateurs to assist the FCC in exam administration and enforcement take on new importance.

CANADIAN CUSTOMS EXEMPTIONS for Amateur equipment have just been extended to include equipment that is termed "primarily" for Amateur use. Previously, exemptions applied only to equipment solely for Amateur use, resulting in (for example) Amateur transceivers with general coverage receivers not receiving the exemption.

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SAROC™

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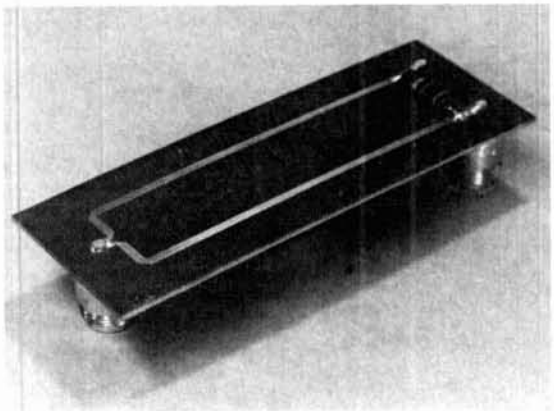
More Details? CHECK—OFF Page 98

Solution for dividing or combining power using matching sections made of coaxial cable, lumped constants, and microstripline

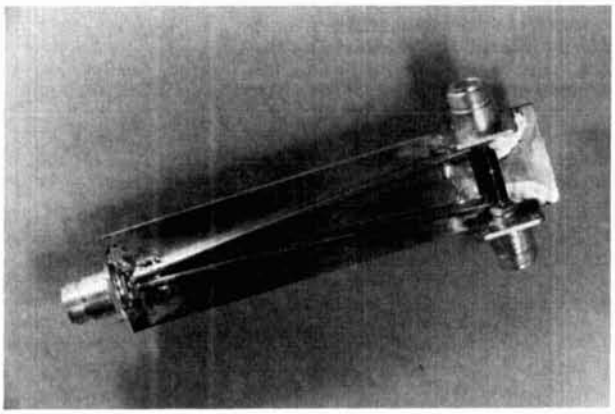
Wilkinson hybrids

Have you ever needed to divide power, or possibly combine power, at the same or at a different impedance? A device called the Wilkinson Hybrid[1,2,3] can do this and more. The beauty of this device lies in its ability to combine two inputs while providing high isolation between the ports over a wide bandwidth. It's simple to construct and almost lossless. The circuit can be constructed in at least three forms: lumped elements, coaxial lines, and microstrip. Often the Amateur wishes to build an amplifier with an output power level that exceeds the capability of a single device. Thus, the most common use of the Wilkinson Hybrid is to split equally exciter power feeding two transistors then recombine the output power at the antenna connector, **fig. 1**.

We will examine the Wilkinson Hybrid mainly at VHF and UHF. By doing this, we can decide the best form of quarter-wave impedance-matching device to use. We will see that the use of lumped constants at low frequencies will give way to coaxial structures that must also give way to microstrip as the frequency is increased. We will examine the agreement between experimental models and the theoretical predictions.



Wilkinson Hybrid using printed circuit board.



Wilkinson Hybrid using semi-rigid coaxial lines.

construction

The Wilkinson Hybrid shown in **fig. 2** is constructed with coaxial cable. The sum port serves either as the input connector for splitting power, or as the output port when used for combining the power at the side ports. Because the coaxial lines are connected together at the sum port, each coax line must pre-

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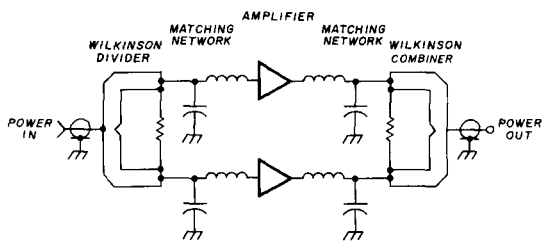


fig. 1. The Wilkinson Hybrid splits drive power then recombines the output power from the amplifiers.

sent a 100-ohm impedance, so that the parallel equivalent impedance will be 50 ohms. The other end of the coax must present 50 ohms at the side port. The characteristic impedance, Z_o, of a quarter-wave matching transmission line should be equal to the geometric mean of the end impedances:

$$Z_o = \sqrt{100 \times 50} = 70.7\,ohms \qquad (1)$$

If one wishes to transform a sum-port impedance of 50 ohms to an output-impedance of 25 ohms, for example, the line's characteristic impedance would then be:

$$Z_o = \sqrt{100 \times 25} = 50\,ohms \qquad (2)$$

(A handy value thanks to the ready availability of 50-ohm coax.)

A balance resistor is placed between the side ports. Its value is equal to twice the value of the side-port impedance. This resistor absorbs any unbalance in power levels or phase difference between the two side ports.

return loss

Let's digress for a moment and discuss another way of expressing standing wave ratio (SWR), known as return loss. Return loss, R, is the ratio of power in the incident (forward) wave to that in the reflected wave expressed in decibels:

$$R(dB) = 10\log_{10}\frac{incident\ power}{reflected\ power} \qquad (3)$$

$$= 10\log_{10}\frac{Pf}{Pr}$$

It has the same components as our old friend SWR:

$$SWR = \frac{1 + \sqrt{Pr/Pf}}{1 - \sqrt{Pr/Pf}} \qquad (4)$$

When you think about it, return loss is exactly what you measure, converted to dB, when you place a thru-line™ Bird wattmeter into the line. If a termination is very good, the return loss is high. If, however, the termination is totally reflective, such as an open or a short circuit, the return loss is zero. If a 3-dB attenuator is placed in front of the short circuit, the return loss is 6 dB. This loss occurs because the incident power receives an initial 3-dB loss in the pad, is totally reflected at the short circuit, and receives an additional 3-dB reduction before appearing as the reflected power back at the input.

input match

The input match of a Wilkinson is quite attractive: greater than 20 dB return loss (SWR ≤ 1.2:1), over any Amateur band. Even if one of the side ports is shorted or blows open (such as in the case of a catastrophic failure of a transistor), the input return loss will fall to only 6 dB (SWR = 3:1). This is easily seen as the round-trip (return) loss of a wave traveling in the shorted side of the hybrid. The wave receives the initial 3-dB power split, is totally reflected at the short circuit, and receives the additional 3-dB reduction going back on the quarter-wave line. This excellent input match helps to keep the driver amplifier from becoming detuned or unstable.

The input return loss for several forms of the Wilkinson Hybrid is shown in **fig. 3**. The widest bandwidth occurs when the quarter-wave line is 70.7 ohms. Return loss is also shown for 73-ohm (RG-59/U) and 75-ohm (RG-11/U) coaxial cable (because they are readily available). I have also shown the input match for a single- and a double-section lumped-constant hybrid. We can see from the graph that it's best to use coax or microstrip[4] with an impedance as close as possible to 70.7 ohms. But Amateurs will rarely notice the difference between RG-59 or 70-ohm semi-rigid coaxial cable.

Even though we look at the use of the Wilkinson at VHF, it performs just as well at lower frequencies. Dana Atchley[5] uses this technique at 80 meters to combine the power from several elements in a 360-

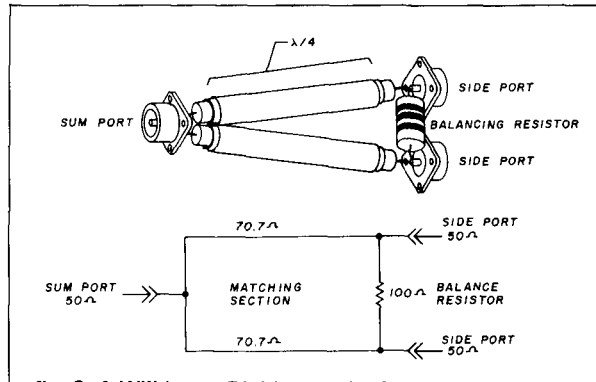


fig. 2. A Wilkinson Divider can be formed by two quarter-wave coaxial lines and a balancing resistor.

degree steerable vertical phased array. To determine how well the Wilkinson will perform at lower frequencies, merely multiply the center frequency of the band by the normalized frequencies at the bottom of each graph.

isolation

If one connects two transistors in parallel to double the available power, problems usually develop. The input and output resistance will be halved, while the shunts reactance will be doubled. This situation will decrease bandwidth, increase temperature sensitivity, and decrease stability. If one transistor has a slightly higher current gain, a phenomenon known as "power hogging" will occur: this is an unstable condition wherein there is uneven load-sharing, and one transistor tries to accept all the available drive.

With a Wilkinson Hybrid *isolation* is obtained between the side ports. Therefore, if the impedance of either transistor fed by the hybrid is slightly different, or if the impedance changes with drive, no change occurs at the other port. Even if one transistor fails, the other transistor will hardly notice the added load.

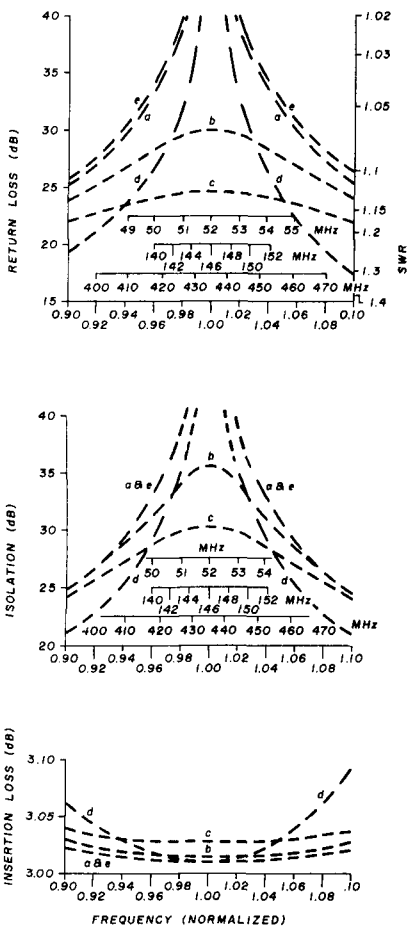


fig. 3. Theoretical return loss, isolation, and insertion loss with matching sections: curve a: 70-ohm lines; b: 73-ohm lines; c: 75-ohm lines; d: single-section lumped constants; e: double-section lumped constants.

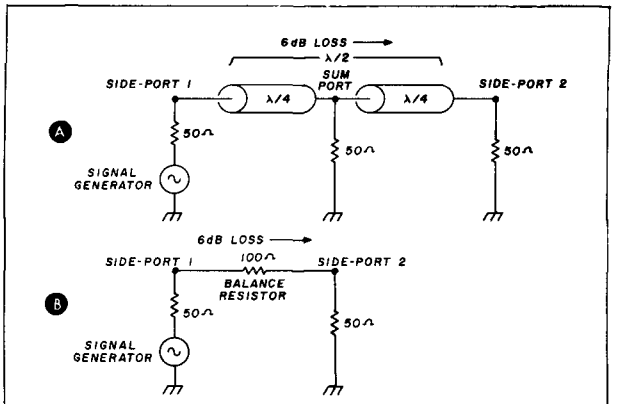


fig. 4. Loss in quarter-wave-line path, A, is equal to the loss in the balancing resistor path, B.

Isolation, being a loss between the side ports, is measured by applying power to one of the side ports and detecting the power at the other port (assuming the sum port is properly terminated). A signal from one side port travels in two directions. The signal traveling toward the sum port, **fig. 4A**, undergoes a 6-dB loss before appearing at the other side port. The path through the balance resistor, **fig. 4B**, also undergoes a 6-dB reduction. Thus the two paths recombine with equal amplitude; however, the cable path is one-half wavelength, or 180 degrees, longer than the resistor path. Thus the power from one side port is completely cancelled at the other port.

If the sum port is not terminated properly, the isolation will be degraded. A signal from one side port travels toward the sum port, receiving a 3-dB loss. It then encounters the return loss of the sum port termination before receiving an additional 3-dB loss going to the other side port. Therefore, the isolation, I, due to a mismatch at the sum port is:

$$I = T_s + 2D \qquad \textbf{(5)}$$

Where T_s is the return loss of the sum termination, and D is the power division of the hybrid (3 dB). If the return loss of the termination placed at the sum port is 20 dB ($SWR \leq 1.2{:}1$), the side port isolation will be 26 dB.

The isolation over the Amateur bands, **fig. 3**, should be greater than 30 dB. If one side port is badly terminated, the reflected power will be 30 dB down at the opposite side port.

insertion loss

The insertion loss of a Wilkinson Hybrid should be

3.01 dB, with one-half the power arriving at each side port. Any difference in power is either absorbed by lossy dielectric, reflected to the sum port, or absorbed in the equalizing resistor. The insertion loss of a Wilkinson should be less than 3.1 dB throughout the band, which represents a loss of only 0.1 dB. The insertion loss increases only slightly, **fig. 3**, when the quarter-wave line departs from the ideal value of 70.7 ohms.

experimental models

Several models were constructed to verify the predictions of **fig. 3**. The physical length of a quarter-wave transmission line, $\lambda g/4$, is given by:

$$\lambda g/4 = \left(\frac{C}{f}\right)\left(V_f\right)\left(\frac{1}{4}\right) \qquad (6)$$

where C is the speed of light (2.998 × 10^{10} cm/second), f is frequency in hertz, and V_f is the velocity factor. The velocity factor for several materials is given in **table 1** with the physical length of a quarter-wave section in centimeters. This data is useful for constructing either coaxial or microstrip transmission-line models. The 1/16-inch (1.6-mm) thick glass epoxy (G10) and Teflon-fiberglass printed wiring board is double-clad with 1 ounce of copper. The width of a 70.7-ohm line for the G10 board is 53 mils (1.4 mm) and 94 mils (2.4 mm) for Teflon-fiberglass.

The results using 70-ohm semi-rigid coaxial lines and printed microstrip quarter-wave lines are shown in **fig. 5**. The agreement is quite good at 432 MHz and 1296 MHz. Next, I tried using RG-59 coax to determine what effect a variation in line impedance might produce, **fig. 6**. I was able to achieve a return loss of better than 25 dB, isolation better than 30 dB, and an insertion loss lower than 3.1 dB over the 6-meter, 2-meter, and 75-cm bands. This speaks well for using readily available 73-ohm coaxial cable.

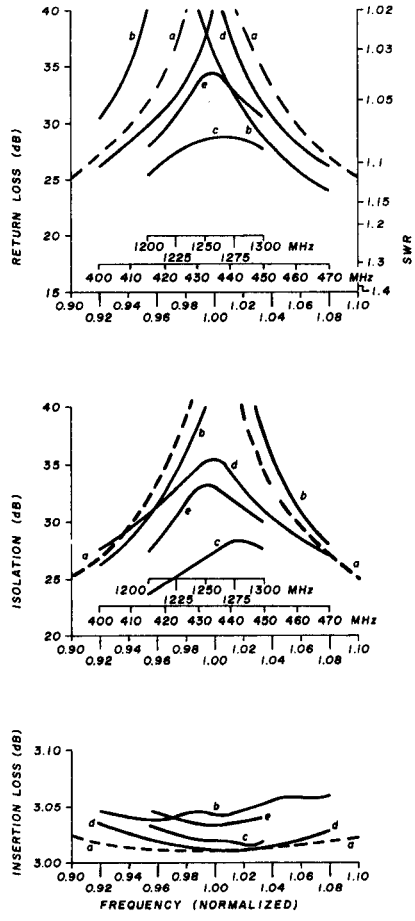


fig. 5. Performance of a Wilkinson Divider using 70-ohm quarter-wave lines: curve a: theoretical; b: 70-ohm semi-rigid lines at 432 MHz; c: 70-ohm semi-rigid lines at 1296 MHz; d: 70-ohm microstrip at 432 MHz; e: 70-ohm microstrip at 1296 MHz.

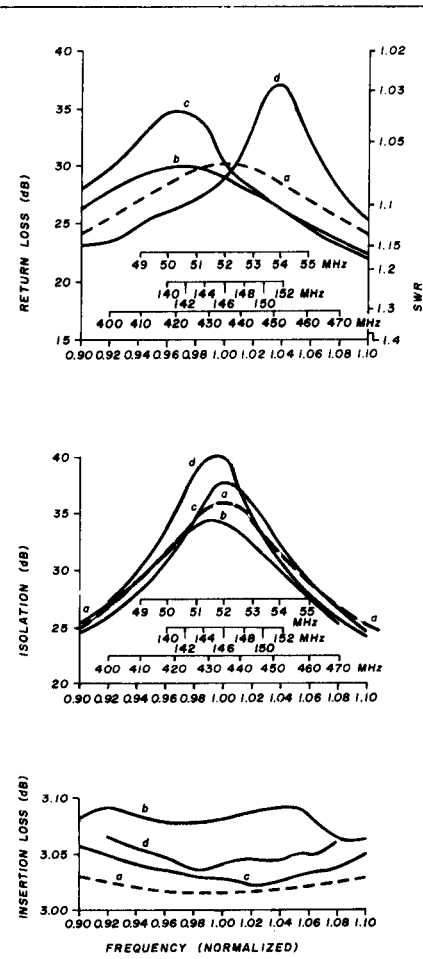


fig. 6. Performance of a Wilkinson Divider using RG-59/U (73-ohm) coax: curve a: theoretical; b: 50 MHz; c: 144 MHz; d: 432 MHz.

lumped constants

A quarter-wave matching section may be synthesized from lumped constants using a pi model according to **fig. 7A**. Because the quarter-wave sections are paralleled at the 50-ohm summation port, each section must present a 100-ohm input impedance, **fig. 7B**. The other end of the quarter-wave section will equal the side-port impedance of 50 ohms. Substituting a value of 90 degrees for **B** we see that $Z_a = Z_b = -j70.7$ and $Z_c = +j70.7$. We can thus solve for the component values by simply inserting the proper operating frequency, f, into these formulas:

$$L = \frac{Z_C}{2\pi f} = \frac{70.7}{2\pi f} \text{ henries} \quad (7)$$

table 1. Velocity factor for several dielectric materials and physical length of a quarter-wave section.

material	velocity factor V_f	frequency (MHz) 52	146	222	435	1296
		quarter-wave line length, cm (inches)				
solid poly RG11, 59r	0.66	95.0 (37.4)	33.8 (13.3)	22.3 (8.8)	11.3 (4.45)	3.8 (1.5)
foam poly	0.80	115.3 (45.4)	41.1 (16.2)	27.0 (10.6)	13.8 (5.4)	4.6 (1.8)
solid Teflon	0.69	100.0 (39.4)	35.6 (14.0)	23.3 (9.2)	12.0 (4.7)	4.0 (1.6)
glass epoxy (E = 4.8)	0.54	77.8 (30.6)	27.7 (10.9)	18.2 (7.2)	9.3 (3.7)	3.1 (1.2)
Teflon (E = 2.55)	0.70	100.9 (39.7)	35.9 (14.1)	23.6 (9.3)	12.1 (4.8)	4.1 (1.6)

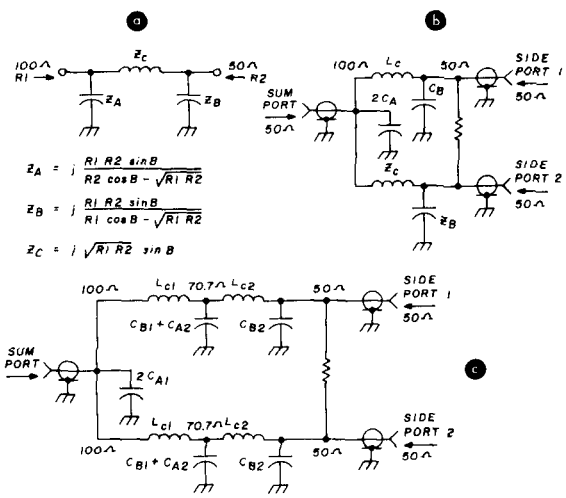


fig. 7. A pi section of lumped constants, A, forms the quarter-wave section in a single-section Wilkinson Hybrid, B, and eighth-wave matching sections in a double-section Wilkinson Hybrid, C.

$$C = \frac{1}{Z_A 2\pi f} = \frac{1}{(70.7)(2\pi f)} \text{ farads} \quad (8)$$

If we want a wider bandwidth device, we must divide the quarter-wave section into smaller, eighth-wavelength segments, **fig. 7C**. The intermediate impedance between the eighth-wavelength sections is equal to the geometric mean, 70.7 ohms, of 100 ohms and 50 ohms.

Using the equations in **fig. 7A** for $R1 = 100 \text{ ohms}$, $R2 = 70.7 \text{ ohms}$, $B = 45 \text{ degrees}$, we find, for the first pi section:

$$Z_{A1} = -j147 \text{ ohms}$$
$$Z_{B1} = -j374 \text{ ohms}$$
$$Z_{C1} = j59.5 \text{ ohms}$$

For the second pi section, where $R1 = 70.7 \text{ ohms}$, $R2 = 50 \text{ ohms}$, and $B = 45 \text{ degrees}$:

$$Z_{A2} = -j104 \text{ ohms}$$
$$Z_{B2} = -j264 \text{ ohms}$$
$$Z_{C2} = j42.0 \text{ ohms}$$

The results of several experimental models are shown in **fig. 8**. The capacitors were fixed values. The coils were adjusted to resonance using a grid-dip meter after shorting the side ports to ground and leaving the sum port open. This arrangement formed a one-half-wave tank circuit. With a single-section hybrid, the input return loss is better than 25 dB, the isolation better than 25 dB, and the insertion loss less than 3.1 dB over the 6- and 2-meter bands. The two-section lumped-constant Wilkinson did even better but was more difficult to adjust for resonance and symmetry.

amplitude and phase unbalance

When a Wilkinson Hybrid is used as a power splitter, each side-port output will have equal amplitude and phase, provided the ports are reasonably terminated. When the Wilkinson is used to combine the output power from two transistor amplifiers, the input power delivered to the two side ports may not be equal or in phase. This may be due to differences in transistor gain and internal phase shift. The power at the sum port will then be less than the sum of the two input powers. The percentage difference from this ideal sum of the two powers is given by:

$$n = \left(0.5 + \frac{\sqrt{r}\cos\theta}{r+1}\right) \times 100 \text{ percent} \quad (9)$$

where n is the output power, r is the power ratio of the two input powers, and θ is the phase angle between them. If the two input signals are in phase but differ in amplitude, the **eq. 9** reduces to:

$$n = \left(0.5 + \frac{\sqrt{r}}{4+1}\right) \times 100 \text{ percent}, \quad \textbf{fig. 9A (10)}$$

Thus we can see that, even for an input power ratio of 2:1 (3 dB), the output power will be down only 0.13 dB, or we will have 97 percent of the sum of the two input powers. If the amplitudes are balanced, but the phase of the two input power differs, then,

$$n = \left(0.5 + \frac{\cos\theta}{2}\right) \times 100\,percent, \quad \textbf{fig. 9B} \quad (11)$$

Thus we can see that, for an input phase difference of even ± 15 degrees, the output power will be down just 0.07 dB, or we will have 98 percent of the available power. For a combination of a power unbalance of 2:1 and a phase unbalance of ± 15 degrees, we would suffer a total loss of only 0.2 dB, leaving 96 percent of the original power.

balance resistor

If the power or phase relationships are not equal in the side ports, a voltage will appear across the balance resistor. If one transistor should fail completely, one-fourth of the normal total sum port power would be absorbed by R1. This is the same as saying that one-half of the power is available after losing one amplifier.

Under typical conditions, the power will be balanced to within 2:1, and the phase will be within 15 degrees. This condition represents a maximum power reduction of 0.2 dB. One-half of the power will be absorbed in a balance resistor. When combining the outputs of two 50-watt transistors, 1.5 watts will be dissipated in the balance resistor.

The use of a 2-watt carbon balance resistor (with nearly zero lead length) was compared with the use of a stripline resistor at 432 MHz. Only when the re-

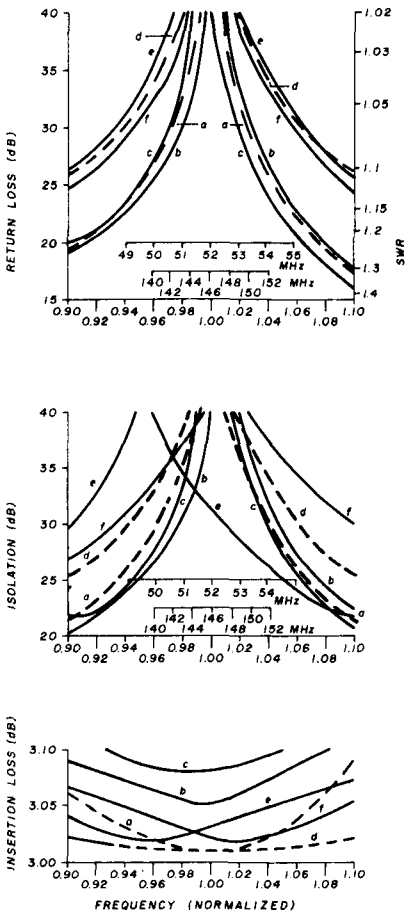


fig. 8. Performance of a Wilkinson Divider using lumped constants: curve a: theoretical; b: 50-MHz single section; c: 144-MHz single section; d: theoretical double section; e: 50-MHz double section; f: 144 MHz double section.

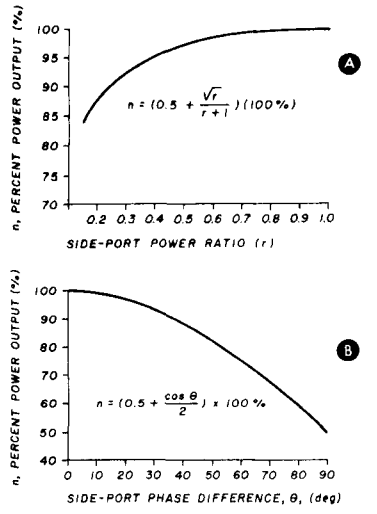


fig. 9. Percentage output power remains at greater than 97 percent of the sum of the two inputs, A, for side port power ratios to 2:1. The power output remains greater than 97 percent, B, for phase differences ± 20 degrees.

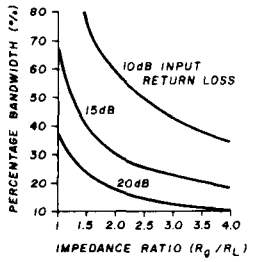
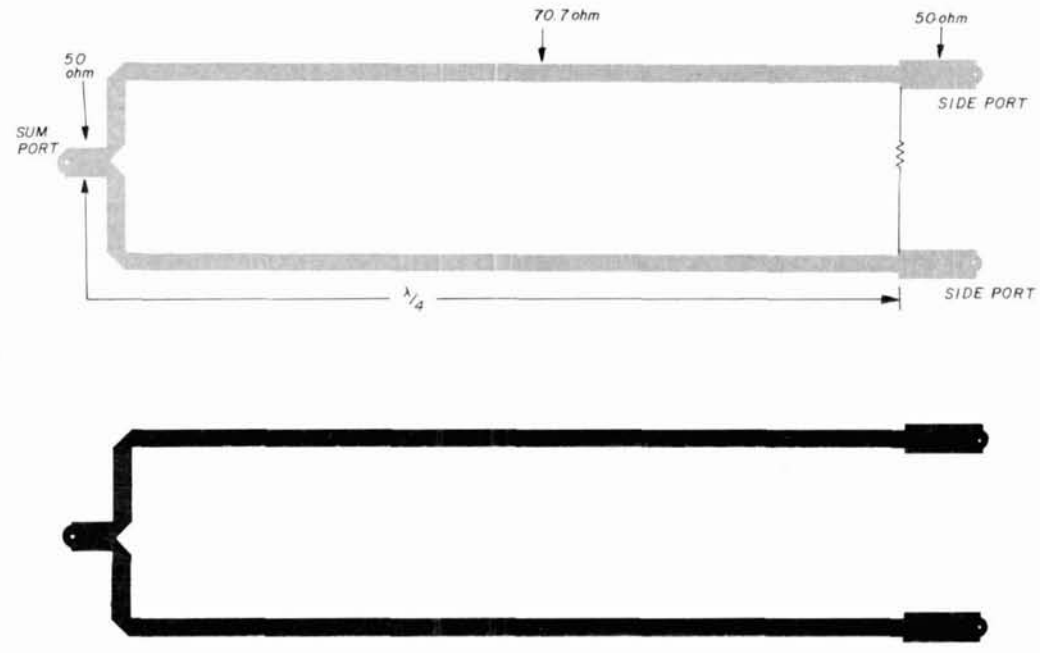


fig. 10. Percentage bandwidth decreases as the impedance transformation of a Wilkinson Divider increases.



PC-board layout for the Wilkinson Hybrid.

turn loss or isolation exceeded 40 dB did any difference appear. Thus, the need of a stripline resistor is mainly for combining high-power loads.

input/output impedances

We have chosen to use 50-ohm input/output impedances because of the measurement simplicity for verifying input impedance, insertion loss, and isolation. Often the Amateur must transform the 50-ohm input impedance of an amplifier under construction to an intermediate value of, say, 12.5 ohms. Antenna combiners also often combine the power from two elements into a 50-ohm output. The experimental results coincided so well with the predicted values that one can feel confident in a design incoporating an impedance transformation whose performance is not as easily verified using standard test equipment.

The percentage bandwidth is:

$$\frac{(f\,high - f\,low)}{f\,center} \times 100\,percent \qquad \textbf{(12)}$$

However, it decreases with an increase in impedance transformation ratio, **fig. 10**. For an impedance ratio of 4 (50 to 12.5 ohms), the percentage bandwidth decreased from 37 to 10 percent while maintaining an input return loss of better than 20 dB ($VSWR \leq 1.2{:}1$).

conclusion

We have examined several media for use as quarter-wave matching sections in the Wilkinson Hybrid. For low-frequency operation, where the length of coaxial cable would be bulky, lumped elements might be the best choice. By using RG-59 coaxial cable (73-ohm impedance), the circuit departs only slightly from optimum performance. Coaxial cable is usually replaced by microstrip at 432 MHz and 1297 MHz.

We have compared the experimental models with theory and have shown good agreement. The designer should feel confident to simply calculate the physical length of coax and expect a return loss of more than 20 dB, an insertion loss of less than 3.1 dB, and an isolation of more than 25 dB.

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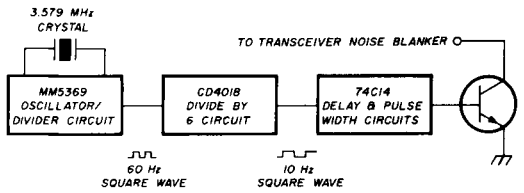

fig. 1. Block diagram of a synchronous noise blanker circuit. (See appendix for notes on devices.)

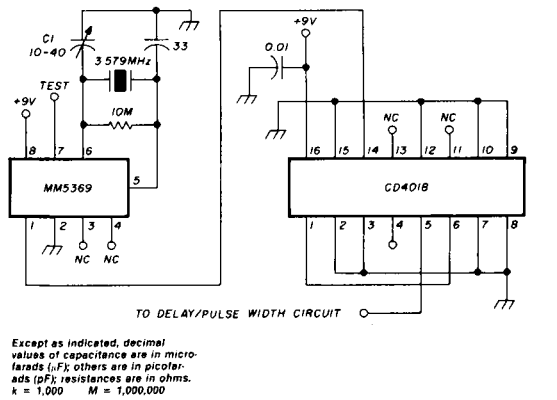

fig. 2. Oscillator/divider circuit.

broadened by the narrow selectivity stages. The circuit is designed to be connected into transceiver noise blankers of the type that operate by reverse biasing diodes in a series gate. The circuit should operate without changes on the TS-520, TS-820 and earlier models on the ICOM 701, and any rigs using similar blanker circuits, with minimal modifications to the rig. It has been used to good effect on my ICOM 701 for several months.

how it works

A block diagram of the circuit is shown in **fig. 1**. An MM5369 oscillator/divider integrated circuit, of the type used in many quartz clocks, together with a 3.579-MHz color TV crystal is used to generate an accurate 60-Hz square wave (reference 1). This signal is digitally divided by six by the CD4018 CMOS IC, resulting in a crystal-locked 10-Hz square wave. This 10-Hz signal is processed through a series of inverting CMOS Schmitt triggers (all contained in one 74C14 IC), the details of which are described below. The output of these stages is used to turn a transistor off and on. It is the collector of this transistor that is connected to the transceiver noise blanker, upon which it imposes a 10-Hz blanking pulse. The circuit diagram for the oscillator/divider stage is given in **fig. 2**.

delay and pulse-width circuits

To understand the workings of the 74C14 circuit, which forms the essence of this blanker, it is necessary to delve briefly into the arcane digital world of CMOS. Many Amateurs seem to have a fear of digital circuits and prefer to stick with good old analog tubes and transistors. There is really no good reason for this, as in many ways digital circuits are more predictable than analog ones. For those with no experience in CMOS, the *CMOS Cookbook* by Don Lancaster (reference 2) is a very good introduction. The operation of the 74C14 circuit is described in Chapter 4 of that book, and divide-by-six circuit in Chapter 6.

The easiest way to understand how the 74C14 circuit works is to look at what needs to be done to blank the Woodpecker. As described in the previous article, the object of this circuit is to provide a blanker control signal that is exactly synchronized with the Woodpecker. It should turn off the blanker gate only while the Woodpecker pulse is present, leaving the rest of the time between pulses for the desired signal to come through.

Thus we need a variable delay circuit to allow us to synchronize the blanking with the Woodpecker, and a means of varying the output pulse so that it blanks for no longer than necessary. It turns out that both these functions can be served by the same type of circuit, which Lancaster refers to as the "half monostable."

Consider the circuit in **fig. 3**. If a square wave is fed to the input, and the RC time constant is much shorter than the period of the square wave, the RC circuit differentiates; that is, it gives a positive spike when the input goes up, and a negative spike when the input goes down. As some CMOS circuits don't like negative input voltages, a diode is used to short out the negative spike. If this positive pulse is fed to a Schmitt trigger circuit (CMOS or otherwise) the output will be a narrow positive pulse, in synchronization with the rising edge of the input square wave.

If the RC time constant of the circuit is about the same as the period of the input square wave, however, the output is going to look like a sagged square wave; that is, the dc level does not decay very much

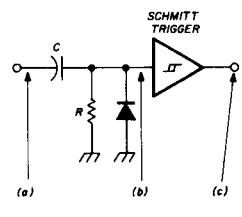

fig. 3. Half-monostable circuit.

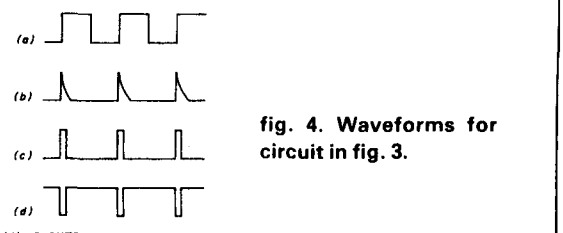

fig. 4. Waveforms for circuit in fig. 3.

before the square wave goes down again. Again, the diode cuts off the negative part of the wave. The waveforms are shown in **fig. 4.**

If this type of decaying square wave is fed to a Schmitt trigger, the output is a much broader pulse whose width is set by the point where the decaying voltage goes below the triggering level. As before, the beginning of the Schmitt output pulse is synchronized with the rising edge of the input square wave. Now if we make the resistor R a potentiometer, the RC time constant can be varied, and thus the width of the output pulse from the Schmitt trigger can be varied. It is most important to understand this, as the whole functioning of the synchronous blanker depends on this operation.

If you look up the specification sheet for the 74C14 in reference 1, you will notice that it contains six separate inverting Schmitt trigger circuits. Two points arise from this. The first is to point out the economy of using CMOS — only one IC is needed — and the second is that the output from an inverting Schmitt trigger is the inverse of an ordinary one. Thus, in a circuit such as **fig. 3**, the output of the inverting Schmitt trigger is positive all the time except for a brief drop to zero volts at the rising edge of the input square wave.

Okay, that should provide enough background to look at how the whole delay/pulse width circuit works. The circuit diagram for the delay and pulse width circuits is given in **fig. 5**.

The first stage in the delay/width circuit is a half-monostable (that is, as in **fig. 3**) using an inverting Schmitt trigger and a very short RC time constant (0.2 millisecond). The output from this stage is a brief negative-going spike synchronized with the rising edge of the input 10-Hz square wave.

The next stage is a half-monostable with a longer, variable RC time constant. The input to this is a square wave with a very high mark-to-space ratio; that is, almost all mark and no space. This waveform decays in the same way as described above, and the output from the inverting Schmitt trigger is a negative-going pulse whose width is variable from nearly zero to 0.1 second. The start of this pulse is also synchronized with the rising edge of the 10-Hz square wave input to stage 1.

Stage 3 is similar to stage 1: a half-monostable with a short, fixed RC time constant (0.2 millisecond). As before, the output is always positive except for a short drop to zero at the rising edge of the output from stage 2. Note now, however, that the output from stage 3 is synchronized not with the input to stage 1, but with the point where the decaying wave-

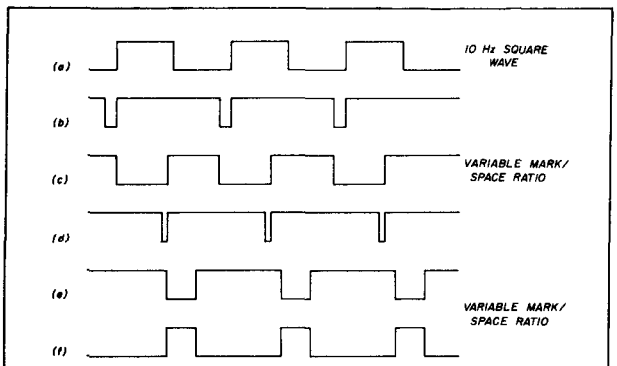

fig. 6. Waveforms for circuit in fig. 5.

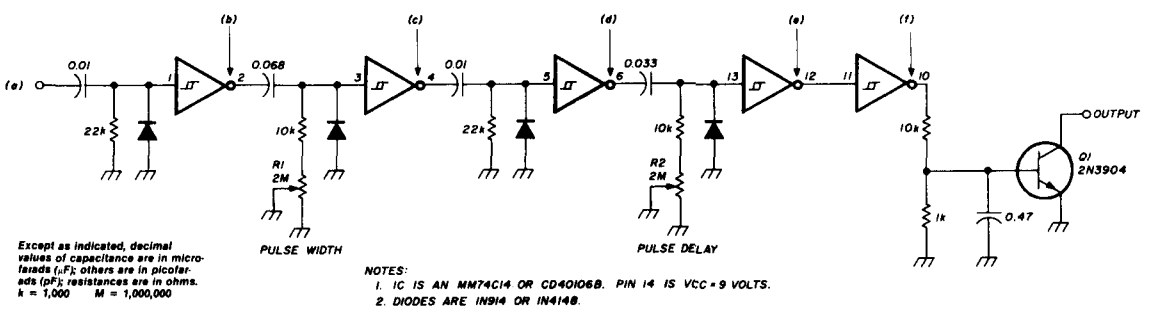

fig. 5. Delay and pulse-width circuits. Each device should be bypassed with a 0.01 μF ceramic capacitor with short leads.

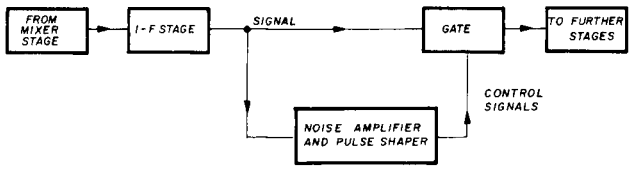

fig. 1. Block diagram of a conventional noise blanker.

been shown conclusive that this works, and any apparent success probably results from the Woodpecker's intrinsic inclination to move frequency of its own accord. One thing is certain, however, and that is that the dits make the interference even worse.

To understand why the majority of existing noise blankers are not too effective in silencing the Woodpecker, one must consider the type of noise that they were designed to blank. In nearly all cases, this is car ignition type noise: typically of high amplitude and of short duration (that is, 0.5 milliseconds or less). The blankers work in the following way: early in the i-f stage of the receiver, usually before narrow selectivity is introduced, the noise pulse is detected through a noise amplifier that selects only high-amplitude signals with rapid rise times coming from the mixer stages. The amplified noise pulse is shaped into a control signal that is used to turn off a gate of some sort — usually by means of reverse-biasing diodes through which the signal has to travel to proceed further into the receiver. Thus the receiver is turned off temporarily, for the duration of the noise pulse.

In a well-designed blanker, the noise pulse is cut off almost as soon as it begins. The receiver is turned off for only a short time, and, unless the noise pulses are very frequent, the net effect is virtually inaudible as far as the desired signal is concerned. A block diagram of the circuit is shown in **fig. 1**.

The Woodpecker, on the other hand, consists of pulses of fairly long duration — typically 15 milliseconds — which do not have a particularly fast rise time, and which are composed of a range of spikes of variable amplitude. While most noise blankers do chop some of the Woodpecker pulse, this is usually nowhere near enough to give effective blanking. (You can see the blanker working if you connect an oscilloscope to the gate.) The main problem with conventional noise blankers is that when it is horrendously strong, the Woodpecker signal is not sufficiently different from desired signals in ways that the blanker can distinguish.

What is probably one of the best conventional blanker circuits designed to silence the Woodpecker was published in *ham radio* by Ulrich L. Rohde, DJ2LR, in June 1980.[3] It is claimed to be effective against the Woodpecker, by dint of a very high-gain noise amplifier. However, the circuit is quite complex and requires significant modification to existing receiver circuitry.

another way

If conventional noise blankers are limited in their ability to deal with the Woodpecker, what alternative approaches are available? To answer this, it is best to look again at the characteristics of the Woodpecker itself. There are three principal characteristics which distinguish it from desired signals:

1. The transmission consists of intense, evenly placed pulses.
2. The transmission bandwidth is wide — usually 50 kHz.
3. The pulse repetition frequency is constant, and a very precise frequency.

The first two of these characteristics have been noted in earlier articles on the Woodpecker. The Rohde circuit makes use of the first of the characteristics to generate a blanking signal in the conventional way.

What does not appear to have been noticed before is the stability of the PRF of the Woodpecker. This is usually exactly 10.000 Hz — to an accuracy of at least 1 part in 100,000 on the night I measured it. Other PRFs are used from time to time, particularly 16 Hz, and sometimes 20 and 32 Hz. There may be others as well. However, all of them have one thing in common: they are extraordinarly precise.

This discovery leads to a completely new approach to silencing the Woodpecker: the synchronous blanker. The concept of the synchronous noise blanker is not new: M.J. Salvati[4] proposed in 1974 a circuit to blank power-line interference spikes, using a control signal derived from the line voltage itself. Taken one step further this idea can be used on the Woodpecker. In the circuits to be discussed in this and the following articles, a crystal-locked 10-Hz (or 16-Hz, etc.) signal is generated (quite separately from the Woodpecker). This signal is then phase shifted to synchronize it with the incoming Woodpecker pulses; it is this signal that is used to blank a noise gate to silence the Woodpecker.

The circuit is shown in general terms in the block diagram of **fig. 2**. It works as follows: The output of a high-frequency crystal oscillator is divided down

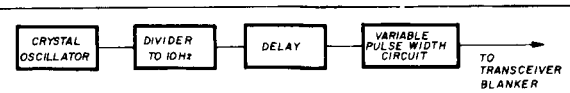

fig. 2. Block diagram of a synchronous noise blanker circuit.

digitally to give a 10-Hz crystal-locked waveform. This signal is fed to a digital delay circuit, then to a circuit that generates an output pulse of variable width. This pulse is used to control a noise gate in the conventional manner.

In operation, the delay circuit is adjusted manually to synchronize it with the offending Woodpecker pulses. The blanking control pulse width is set so that it is just sufficient to mute the receiver for the duration of the Woodpecker pulse. As the Woodpecker stays in synchronization with the control pulse, there is no need to alter the sync control once set, unless another Woodpecker comes on that is out of sync with the first. Similarly, the width control does not need to be adjusted under the same circumstances.

It must be mentioned that this circuit is not perfect. Part of the trouble stems from the fact that the Woodpecker pulses are quite long compared with normal noise pulses, and when they are blanked out, one can hear the "gaps." Mostly this is not objectionable, however. The only real problem occurs when the Woodpecker pulses are long and "shaggy." Under these circumstances, one has to cut out too much of the desired signal for it to be readable. Readability starts to deteriorate noticeably when 25 percent of the audio is blanked. But under these circumstances nothing can help!

Fortunately, when the Woodpecker is at its worst, the pulse width is often quite narrow, and a synchronous blanker is very effective. On occasions, it can reduce the interference from S-9 + 20 to SØ (yes, zero).

In the following articles, two forms of a synchronous blanker will be described. The first can be attached to most existing transceiver noise blankers, with the blanking signal used to control the existing gate.

The second form of blanker to be described was designed for transceivers and receivers with no existing or suitable blanking circuitry. In this case the blanker plugs into the headphone output of the rig, and requires no tinkering with the rig's innards. With the second circuit, of course, no blanking is done in the i-f stages, and consequently the Woodpecker is still capable of swamping the AGC. Despite this shortcoming the circuit is quite effective.

references

1. *Jane's Weapons Systems*, 1978-79.
2. Graeme Willingham, "The Russian Woodpecker," *Amateur Radio Action*, issue 12, page 25.
3. Ulrich L. Rohde, DJ2LR, "Woodpecker Noise Blanker" *ham radio*, June, 1980, page 18.
4. M.J. Salvati, "Synchronous Noise Blanker Cleans Up Radio Signals," *Electronics*, June 13, 1974, page 104.

ham radio

More Details? CHECK—OFF Page 98

2-meter transverter

Add a new band to your high-frequency transceiver with this hybrid circuit

The easy way for the owner of a high-frequency transceiver to get on VHF SSB is with a transmitting converter, or *transverter*. The essentials of a typical VHF transverter are shown in **fig.1**. A common heterodyne oscillator is used for both up conversion of the transmit signal and down conversion of the received signal. The 10-meter band is the customary intermediate frequency as it provides the widest tuning range on most transceivers, and its relatively high frequency favors good image rejection. A 2-meter transverter requires a local oscillator at 116 MHz to transform 28-30 MHz to 144-146 MHz.

In the block diagram I assume that the transceiver has a separate low-power output port from its driver or exciter. If this has not been provided by the manufacturer, it's usually a simple matter to so modify the transceiver. It's also advisable to add a switch that will remove heater voltage or supply voltage from the transceiver final amplifier when the transceiver is used with a transverter.

tubes versus transistors

The 2-meter transverter described here is a hybrid, which employs both tubes and transistors. It might be argued that tubes are now obsolete for all except high-power applications, but for Amateur work tubes have one important virtue: they're tough. Tubes are very forgiving of mistakes. A wiring error or accidental voltage transient can wipe out a transistor in less than a millisecond, whereas tubes will survive extreme overloads for a matter of minutes — plenty of time to locate a fault and correct it before the tube is destroyed. This is not so important where tubes can be replaced with inexpensive transistors, but VHF power devices are still far from inexpensive.

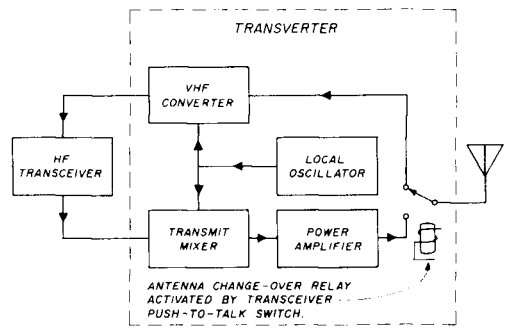

fig. 1. A transverter uses a common local oscillator to provide both up and down frequency conversion to the desired VHF band. Good linearity must be maintained in both transmitter mixer and power amplifier to ensure an undistorted transmitted signal.

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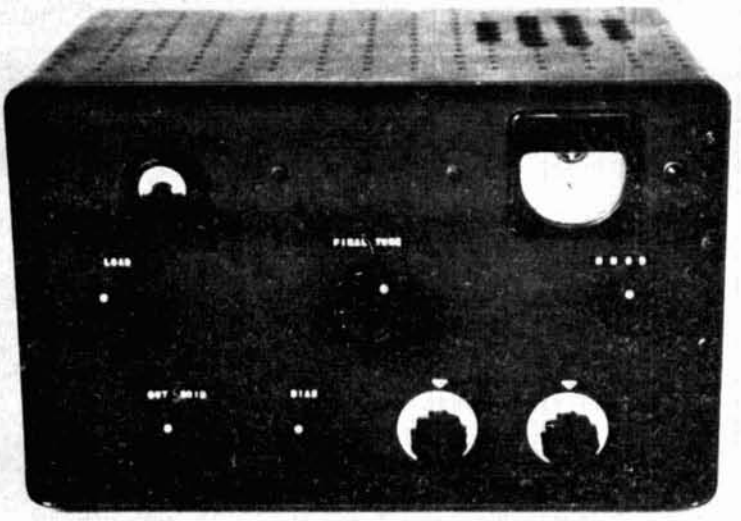
local oscillator

The heart of the transverter is the LO, and this circuit should be constructed first. A transverter local oscillator must supply considerably more rf power than a VHF converter LO, since a transmitting mixer typically requires an injection level of a few hundred milliwatts. In this 2-meter transverter, the LO, or heterodyne oscillator, constitutes a small, solid-state, 116-MHz exciter with a power output of about 1/8 watt.

Fig. 2 shows the LO circuit. The 58-MHz crystal oscillator, *Q1*, drives a push-push doubler, *Q2* and *Q3*, which doubles to 116 MHz and drives *Q4*, a class-C power amplifier. Feedback for *Q1* must pass through the series-tuned circuit, *L3-C1*. This high *L:C* ratio circuit resonates at 58 MHz and prevents the third-overtone crystal from oscillating on its fun-



The cabinet is 8.5 inches high by 13 inches long by 9 inches deep (21.6 by 33 by 23 cm). Meter at left reads either rf output voltage or PA grid current. The two flanged knobs at lower right are for adjustment of C4 and C5.

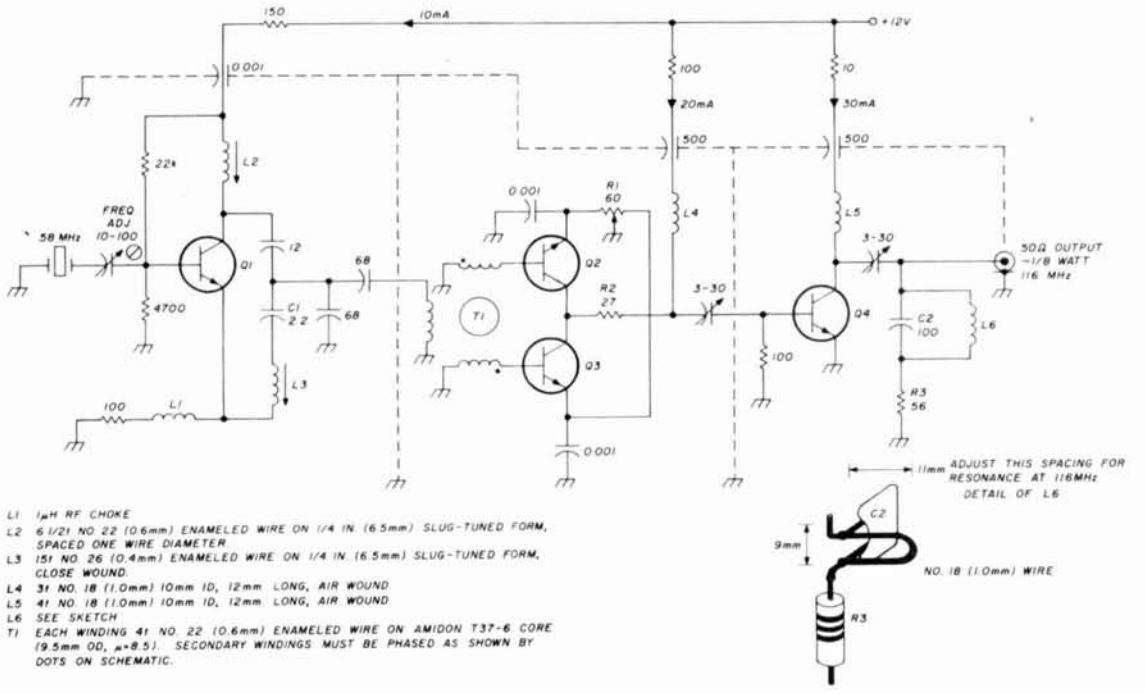


fig. 2. The heterodyne oscillator uses four transistors. Q1 is a 2N2222A, Q2 and Q3 are 2N2369As, and Q4 is a 2N5109. All variable capacitors are mica compression trimmers.

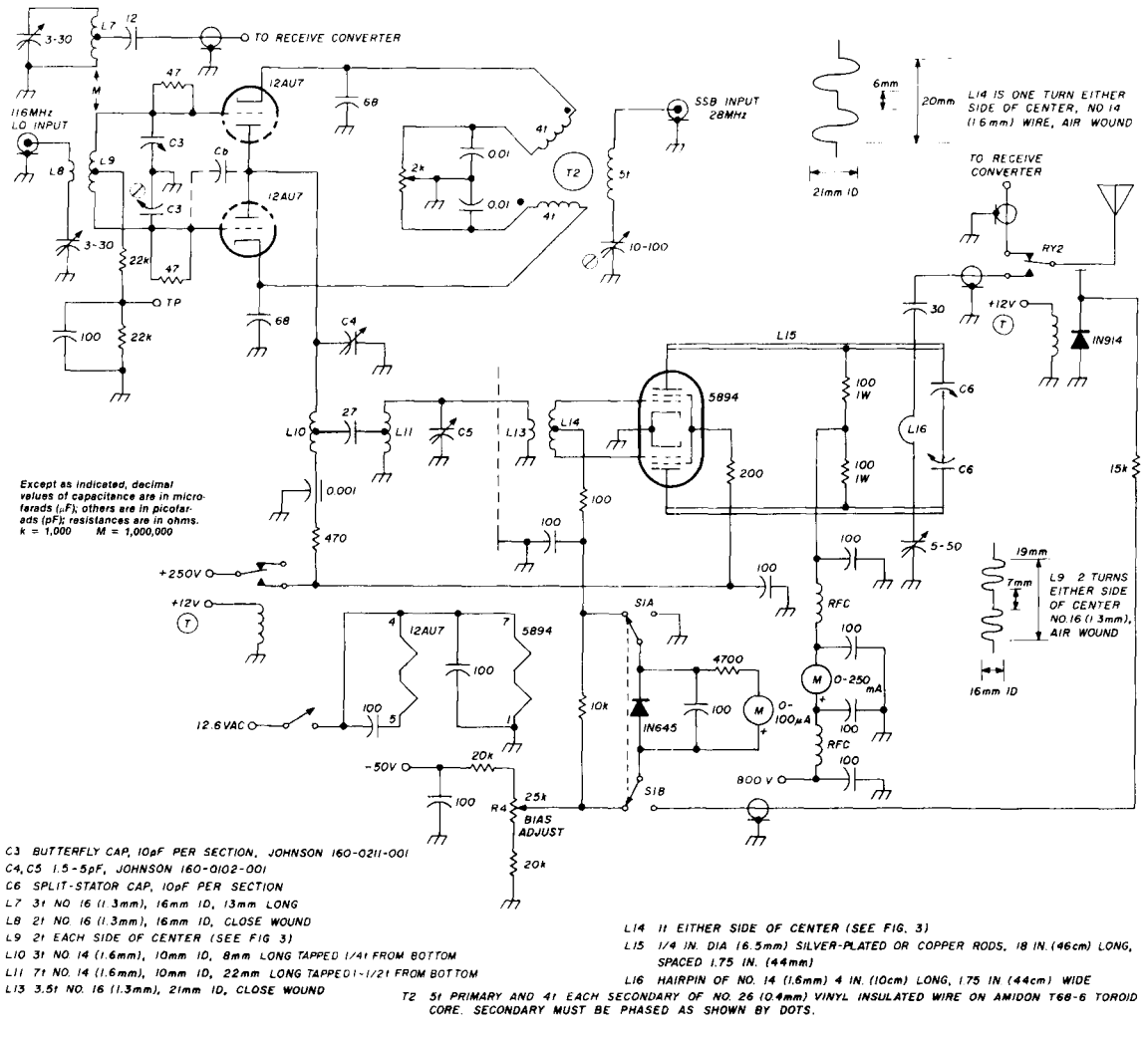


fig. 3. Transmit mixer and final amplifier. Relays RY1 and RY2 are actuated by the transceiver push-to-talk switch. The 3-30 pF capacitors connected to L7 and L8 are mica compression trimmers. The 47-ohm parasitic suppressors connected to the 12AU7 grids are 1/4-watt resistors shunting 3/4 inch (19 mm) of the No. 22 (0.6 mm) wire that connects C3 to the 12AU7 grid pins. Balancing capacitor C_b is explained in the text.

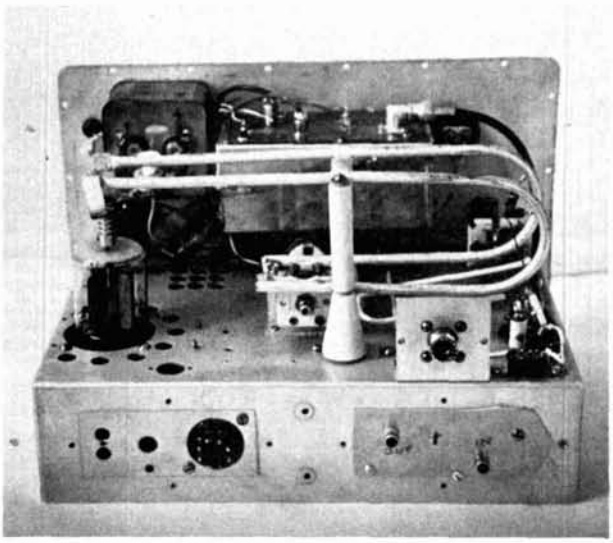
damental. It can be set to frequency with a grid-dipper by temporarily connecting *C1* across *L3*.

Potentiometer R1 can be adjusted to balance *Q2* and *Q3* for minimum third harmonic (174 MHz) output. Resistor *R2* is a parasitic suppressor. The purpose of *C2*, *L6*, and *R3* is to load the output of *Q4* at all frequencies except 116 MHz, and thereby discourage parasitics. The extremely low L:C ratio combination of *C2-L6* is parallel resonant at 116 MHz and thus prevents power loss into *R3* at the desired frequency.

The LO output is loaded by the 12AU7 transmit mixer (**fig. 3**), and *Q4* should be stable with the 12AU7 heater turned either off or on; or for that matter, under any load conditions. The LO is best checked for parasitics with a spectrum analyzer; if one is not available a tunable UHF receiver can be used. Enough 116-MHz drive should be available to produce at least 1 mA of grid current from the 12AU7 mixer, or 22 volts measured at the test point.

transmit mixer

The 12AU7 transmit mixer shown in **fig. 3** is a *doubly* balanced mixer. Most vacuum tube mixers described in Amateur literature to date have been either singly balanced, or simple unbalanced types. What is worse, the singly balanced mixers are usually balanced for the high-frequency signal, not the LO



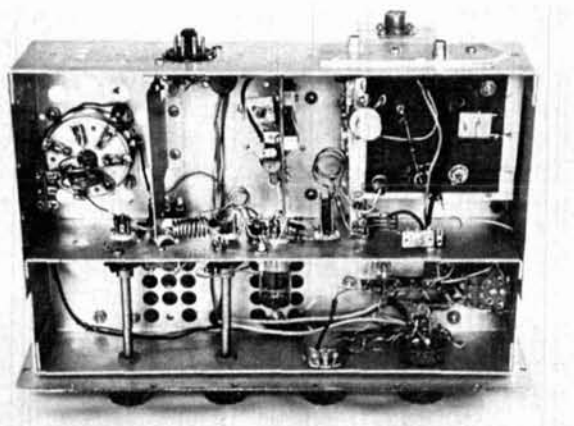
The 5894 plate lines have been bent back upon themselves to save space. Metal box behind plate lines houses the receive converter.

signal. **Fig. 4** shows the difference. No particular advantage results from a mixer that is balanced with respect to the transceiver output since there is little chance that 28-MHz energy will get through the 144 MHz tuned circuits and be radiated by the antenna. But it is important that the mixer be balanced with respect to the LO port to suppress the 116-MHz signal.

The 12AU7 balanced mixer requires about 1/2 watt PEP of 28-MHz drive from the transceiver. The 144-MHz output is linear up to a level of about 1 watt — more than enough power to drive the 5894 class AB_1. Perfect rf balance of the 12AU7 requires equal grid-to-plate capacitances in the two triode sections. The mixer will work well with unequal capacitances but will not completely reject the LO. If desired, the two sections can be equalized by adding a small capacitor to the triode section with the lesser C_{gp}. Two short insulated wires twisted together will provide enough capacitance (C_b in **fig. 3**).

The trimmer capacitor in series with the primary of *T2* can be adjusted for minimum SWR at 29 MHz as measured with a sensitive (low power) reflectometer or impedance bridge.

Three tuned circuits are used between the mixer and the 5894 grids. It might have been possible to get by with two, but the extra filtering certainly does no harm. One of the three is the grid coil of the 5894, *L14*, which broadly resonates to 145 MHz with the



Underchassis view. Controls at lower left are, from left, the 5894 grid control, C5; 12AU7 plate control, C4; bias-adjust pot, R4; and the grid-meter switch. The 5894 PA tube-base compartment is at upper left. Shielded box at upper right houses the heterodyne oscillator.

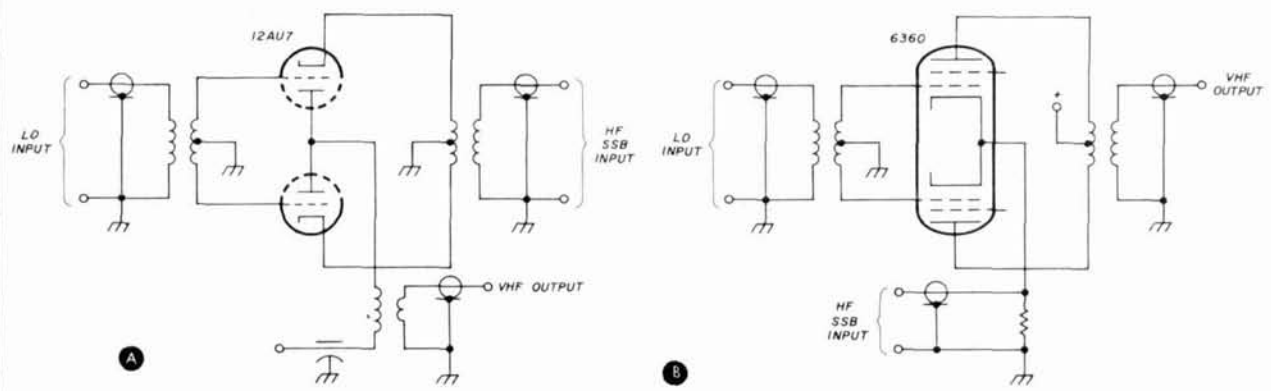


fig. 4. The right and wrong ways to make a balanced mixer. Shown at (A) is a doubly balanced mixer with a push-pull LO input and single-ended output, which isolates the LO from the output port. At (B) is the way it is usually done, push-pull in and push-pull out, which provides no isolation for the LO in the output.

5894 input capacitance. The other two, *C4* and *C5*, are separately tunable by front panel controls. These two capacitors could have been ganged into one control, but I did not bother to do so because large frequency changes are not frequent at my station. The position of the swinging link, *L13*, should be experimentally optimized with respect to *L14* for maximum grid drive to the 5894.

final amplifier

Stability of the 5894 final required that plate current be fed to the half-wave plate line through the two 100-ohm, 1-watt resistors shown in **fig. 3**. These resistors will not absorb any significant amount of 144-MHz power provided they are tapped onto the line at the point of minimum rf voltage. The exact point can be determined by sliding a screwdriver blade along the line and noting the point where detuning is minimum.

The 100-microampere grid meter can be switched to also function as an rf output meter, or line sampler, for tune-up. Rf voltage is rectified by the 1N914 diode, which is very loosely coupled to the coax output connector. The 1N645 diode across the meter terminals prevents meter damage from accidental over-deflection.

Resting plate current of the 5894 is set between 35 and 40 mA by adjusting the dc grid bias to the vicinity of minus 26 volts. The bias adjustment pot, *R4*, is a front-panel control. Ten-meter drive is normally adjusted so that grid current appears on only occasional voice peaks.

The position of the output coupling link is critical, and should be adjusted for maximum output to a 50-ohm matched nonreactive load under full drive conditions; that is, with about 50 microamperes of 5894 grid current.

receive converter

Fig. 5 shows the down converter, consisting of the rf stage, *Q5*, and the mixer, *Q6*. Bipolar transistors have a poor reputation for cross modulation immunity, but no problems with cross modulation have yet been experienced. There are many low-noise transistors that could have been used in the rf stage; the Microwave Associates K6001 was used only because it happened to be on hand. No neutralization was found to be necessary, and the noise figure turned out good without much time spent on adjustments. Collector current of the rf stage is about 1 mA, and the mixer runs at about 0.5 mA. The rf stage collector current can be disconnected by a front-panel switch, S3, to prevent cross modulation from strong signals. This switch is also useful for ascertaining that the received signal is actually a 2-meter station, and not 10-meter leak-through.

The three tuned circuits ahead of the mixer provide about 40 dB of image rejection. The image band is in TV channel 6, and 40 dB will not be enough in strong channel 6 areas. If trouble is experienced with channel 6 interference, an 87-MHz trap can be added to the converter input.

The 116-MHz injection for *Q6* is picked off *L9* by a very loosely coupled tuned circuit (*L7* in **fig. 3**). Less than a milliwatt of injection is needed. Mixer performance can be tested by disconnecting collector voltage from *Q5*. When this is done, receiver noise output should drop by at least 10 dB.

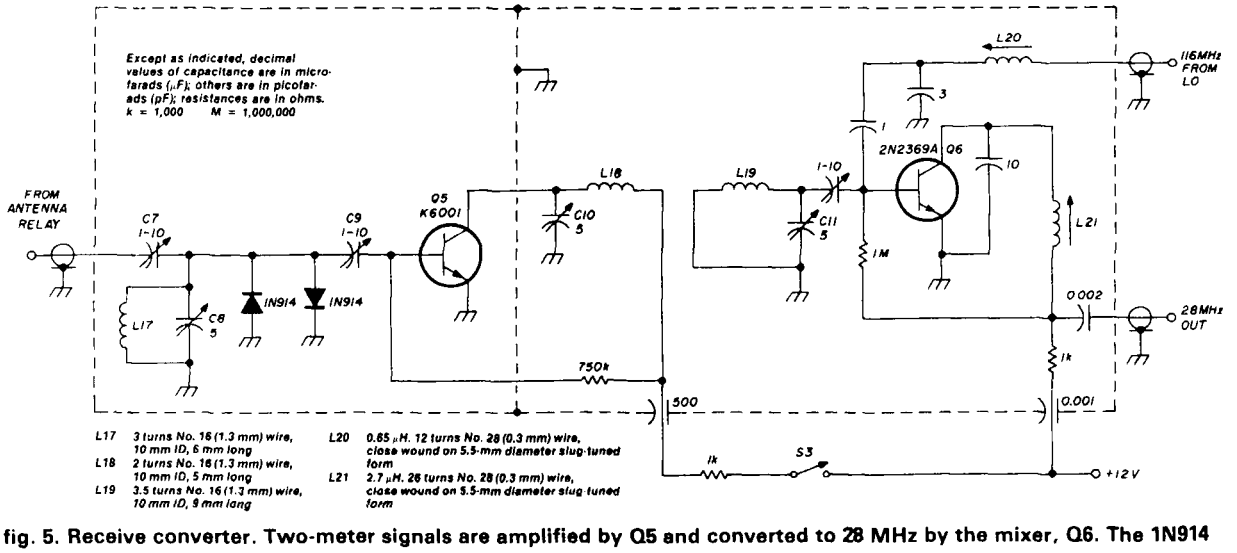


fig. 5. Receive converter. Two-meter signals are amplified by Q5 and converted to 28 MHz by the mixer, Q6. The 1N914 diodes at the input are for overload protection.

The three trimmer capacitors *C8*, *C10*, and *C11* are peaked for maximum gain at 145 MHz. Capacitors *C7* and *C9* are adjusted for minimum noise figure from a 50-ohm source; these adjustments will not coincide with maximum gain.

power supply

The transverter requires 12 Vdc at about 65 mA, 12.6 Vac at 1.2 amps for heaters, 250 Vdc at about 30 mA, minus 50 Vdc at 1 mA for bias, and 800 Vdc at about 150 mA peak. If your transceiver is a tube type, or uses tubes in the final, these voltages can be obtained from the transceiver power supply, since the transceiver final will not be used when transverting. Also needed is a 12-Vdc source controlled by the transceiver push-to-talk switch for the transmit-to-receive change-over relays, RY1 and RY2.

construction

Old timers will recognize the cabinet and chassis as the remains of a Viking 6N2, a 6 and 2 meter a-m/CW rig manufactured by E.F. Johnson in the 1950s. However, any chassis of similar size can be used. The 6N2 was stripped down almost completely; about the only items left intact were the 5894 socket, the plate lines (which were shortened 2 inches, or 5 cm), and the plate-current meter. When rebuilt, the front panel ended up with a couple of empty holes; these were filled in with body putty, sanded smooth, and the panel repainted.

The usual common-sense VHF construction practices should be adhered to. Most of the rf bypass capacitors are 100 pF, as this value, with short leads, is approximately series resonant at 2 meters. The receive converter is built on double copper-clad circuit board and housed in a completely shielded box. The heterodyne oscillator is built on a 3 by 4 inch (7.6 by 10 cm) circuit board and placed in a shielded compartment located on the underside of the chassis to keep it away from final-amplifier rf. This also keeps it away from most of the heat, which would cause frequency drift of the crystal oscillator.

results

A spectrum analyzer was used to search for spurious products in the 0-300 MHz range. All were found to be more than 50 dB below full output. On-the-air reports of audio quality have been unanimously favorable.

The rig has been used on the air for some months now and many enjoyable contacts made. Without qualification it can be said that if you haven't tried VHF SSB, you are missing one of the best operating modes available to the Amateur.

ham radio

operation upgrade: part 3

The third part in a continuing series designed to help you upgrade your ticket

The first two articles in this series provided information that should aid you in understanding electrical and radio theory, and in upgrading your license. They discussed what are known as passive devices. Passive devices do not do much by themselves to change things, but rather react to an application of energy, in a linear manner. The term *linear*, applied to electrical devices, means that if you increase the current through them, or the voltage across them, their fields will increase proportionally. But they do nothing too startling when in use.

Some examples of passive linear devices are resistors, wires, inductors, transformers, choke coils, and capacitors. Take a resistor for example. When current flows through it, it heats up. Of course, it also decreases the current flow in any circuit in which it is placed, and when current flows through it a voltage-drop is developed across it that can be quite useful. A wire develops a magnetic field around it when current flows through it. Such a magnetic field can be increased by coiling the wire. Transformers and choke coils are two applications of coiled wires that make use of the magnetic fields created by current flow. When a capacitor is charged, by applying a voltage across it, an electrostatic field is developed between its plates. The energy that charges the plates and creates the electrostatic field can be stored and used at a later time.

In this article we will discuss some of the active electrical devices and their uses. Active devices alter the voltages or currents applied to them in some way. Usually, the resulting currents and voltages are nonlinear, or distorted in waveshape to a greater or lesser extent. Just for historical interest we will discuss the vacuum devices first. Except as final amplifiers and in oscilloscopes, vacuum tubes are playing a smaller role in radio each year.

vacuum diodes

In our first article, it was pointed out that if a metal plate is placed inside a lamp globe that has all of the air pumped out of it, a diode, or two-element vacuum tube, is created. The basic use of such a diode is rectification; that is, changing alternating currents to pulses of one-way or direct current (dc). A diode of this type, as used in a simple *power supply* circuit, is shown in **fig. 1**.

In this power supply the transformer has a 1:2 turns ratio. If 120-volt ac is applied to the primary (which has fewer turns), 240 volts ac will appear across the secondary. Since we normally talk about ac in effective, or RMS, terms, this means that the peak voltage across the secondary will be 240 times 1.414 (factor for converting RMS to peak), or about 340 volts. When the top of the secondary (connected to the plate) is made 340 volts positive with respect to the bottom, electrons being given off by the hot

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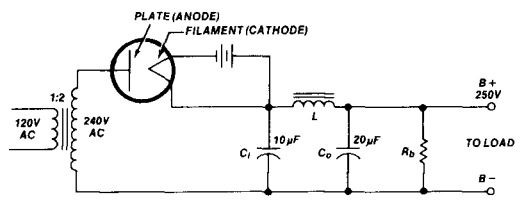


fig. 1. Vacuum diode used as a rectifier in a simple half-wave rectified power supply.

filament (cathode) are attracted to the plate (anode). When the filament loses electrons it pulls others through the iron-core choke coil, through the *bleeder* resistor, R_b, and from the negatively charged (excess electrons) bottom of the transformer. This completes the electric circuit and allows current to flow through it, including the resistor. The voltage-drop developed across the resistor will be the output voltage of this power supply, and may range from nearly 340 volts dc down to perhaps 220 volts dc, depending on how much current is being drawn out of the supply by the load connected across it.

The output from this power supply is affected by several factors. For one thing, the current flowing will be pulsating dc. Only on the ac half cycle of the secondary, when the diode plate is positive, can current flow through the tube. If the plate is negative, no current can flow because the plate is not hot and does not give off electrons the way the filament does. The pulsating dc sees quites a bit of inductive reactance (X_L) in the choke coil in series with the circuit. The opposition effect of X_L to varying or pulsating currents tends to prevent the current pulses from ever achieving their maximum possible value. Also, the capacitors across the circuit charge up to whatever voltage is developed across the circuit at any given time. Both the bleeder resistor and the inductive reactance of the choke prevent the output capacitor, C_o, from charging instantaneously. As a result, a full 340 volts never appears across the circuit output. The more current the load demands (the lower its effective resistance), the less the voltage that can be developed across the capacitors and the less will be the output voltage of the power supply. Within limits, the larger the capacitance values used the closer the output voltage will approach the secondary's peak value.

Although the current in the transformer secondary is pulsating, the effect that the charging and discharging of the capacitors through the inductor and resistor have is to smooth the voltage across R_b to a slightly varying dc, or to a nearly smooth dc if the load demand is light. However, the heavier the load the lower the output voltage and the greater the variation in the output voltage. Can you see that, if the job of a power supply is to supply a smooth dc voltage and current to a load, this one may not do the job under heavy loads?

The circuit shown in **fig. 1** is known as a half-wave rectifier because it uses only half of each ac cycle fed to it. Furthermore, the circuit as shown is not very practical because the filamentary cathode is being heated by a battery. It would be much simpler to add a second low-voltage secondary to the transformer and use this *tertiary* (third) winding to heat the cathode, as shown in **fig. 2**.

A rectifier-filter circuit that you are very likely to find in much older ham equipment is the center-tapped transformer full-wave rectifier power supply shown in **fig. 2**. In this circuit, on one half-cycle of the ac, one diode plate is positive and current flows upward through R_b and the filter capacitors charge. On the other half cycle the other diode plate is made positive and again current flows upward through R_b. Since current flows both to the load and to charge the filter capacitors on both half-cycles of the power line ac, the circuit is known as a full-wave rectifier. Actually, transformer secondary current flows only in pulses. The pulses charge the filter capacitors with energy which is stored until required. This energy can be fed to the load from the capacitors whenever the secondary ac voltage is less than the voltage to which the capacitors are charged, otherwise the transformer is supplying energy to the load.

Fuses may be found at either of the points marked *X*. They will protect against damage caused by short circuits in the load circuit, or if the capacitors short out, or if the tubes or choke short to ground.

vacuum triodes

The development of the three-element, or triode, vacuum tube made possible the great gains achieved

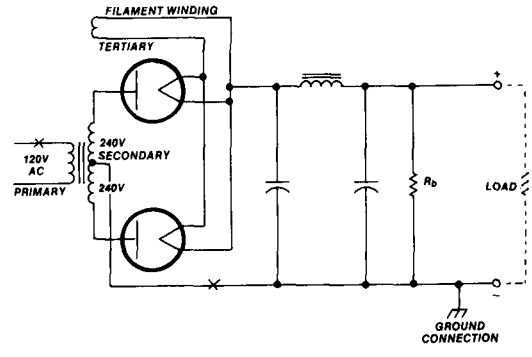


fig. 2. Full-wave center-tapped vacuum diode power supply with a π-type capacitive input filter.

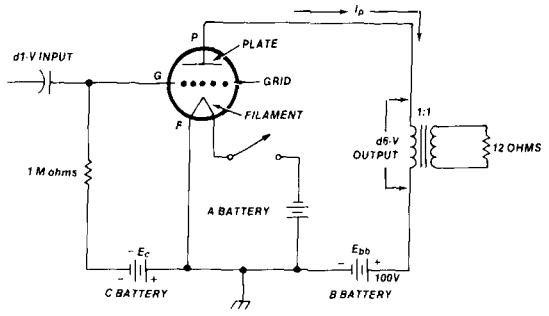


fig. 3. Basic filament-type triode af amplifier stage.

in the early days of radio. Essentially all radio equipment made before about 1955 used vacuum tubes of the triode type or improvements on the triode. Even today, many of the higher power transmitter amplifiers have one or more vacuum tubes as the active devices in them.

When it is desired to produce an ac voltage higher than is available, it's possible to use a transformer with a step-up ratio. But when you want to have a greater ac *power* output than is available from an antenna (or other ac source), it's necessary to use an amplifying device of some kind. This is where the triode idea comes into use, whether it be in the form of a vacuum triode or a semiconductor triode-type device. First, let's see how one of the older types of vacuum triodes worked.

If a vacuum diode has a gridwork of fine wires inserted between the filament and the plate, with a connecting wire brought outside (as indicated in **fig. 3**), the result is a triode tube. You can see that any electrons moving from the hot filament to the plate must pass through the holes between the wires of the grid. If the grid wires have no electrical potential (voltage) applied to them, the electron flow to the plate will not be affected to any great extent. If, however, the grid is given a slightly negative charge with respect to the filament by connecting the negative terminal of a "C" battery to the grid, electrostatic lines of force are developed from grid to filament. Since these lines of force are being developed in a direction opposite to the electrostatic lines developed by the "B" battery from filament to plate, they oppose electron flow to the plate and the plate current (I_p) becomes lower. As the C-battery "bias" voltage is made more negative, the plate current decreases further. If the bias is made negative enough, the I_p can be cut off completely.

If the B battery has 100 volts and it takes only -10 volts of C battery bias ($-E_c$) to cut off or reduce the I_p to zero, then the grid is ten times more effective in controlling plate current than the plate circuit supply voltage (B+, +B, or E_{bb}) is. It is said that the triode has an amplification factor, or mu (μ), of 10. This implies that 1 volt ac applied between grid and cathode will produce a 10-volt variation in whatever is used as the load in the plate circuit. This could not be attained, however, unless the plate load impedance were infinite ohms, which would mean the circuit would not work. In practicable circuits, the amplification, or *gain*, of such a circuit is usually only a little more than half of the mu value of the tube. You can expect that a 1-volt variation in the input or grid circuit of a 10μ tube will produce approximately 6 volts of varying voltage-drop across the output or plate circuit load. Such a voltage increase could also be accomplished by using a 6:1 ratio step-up transformer of course. But let's see what the *power* advantage of the tube will be over the transformer.

First, the input circuit current of **fig. 3** can be found by Ohm's law to be $I = E/R$, or 1/1,000,000, which is one millionth of an ampere (1 μA). The power input is therefore $P = EI$, or 1(0.000 001), or one millionth of a watt (microwatt, or μW). If the output transformer has a 1:1 ratio, then both the varying dc of the primary and the ac voltage induced into the secondary would be 6 volts. If the load is 12 ohms, the power fed to this output load will be $P = E^2/R$, or $6^2/12$, or 3 watts. This is a power gain of 3,000,000 times by using the triode tube! Such a power gain is possible only because the grid circuit is negatively biased and is collecting no electrons from the cathode. If the grid is allowed to become positive, grid current (I_g) will flow, and power will be lost in the grid circuit. The power gain of the circuit would decrease greatly. Actually, when a triode tube is used as an rf power amplifier in a transmitter, usable power gains of only 10 to 50 are the general result. But that is still 10 to 50 times better than can be provided by any transformer.

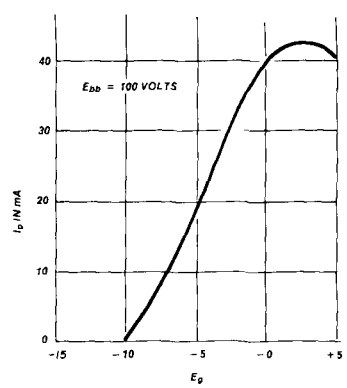


fig. 4. E_gI_p curve of a triode vacuum tube.

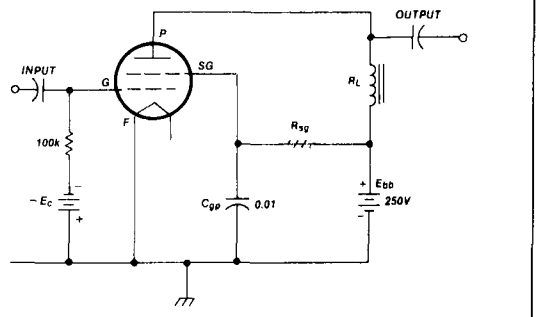


fig. 5. Basic tetrode af amplifier using an af choke as the plate circuit load.

In radio and electronics, circuit operations are often visually explained in terms of curves on graphs. A curve showing how the plate current of a triode will increase as the grid bias voltage is varied is shown in **fig. 4**. We say that the dc plate current is plotted against grid bias (using both negative and positive grid circuit potentials in respect to the cathode in this case). The curve shows that with −10 volts bias the plate current is reduced to zero (cuts off). With -5 volts $-E_g$, the I_p is about 18 milliamperes. At zero bias the I_p is about 40 mA. When the bias becomes positive the I_p increases with an increase in positive bias, but then no longer increases and begins to decrease as the bias increases. At this last point we say that the plate circuit is *saturated*. The triode is passing all the plate current it can with the filament at its present temperature. Higher filament current would release more electrons from the cathode and more I_p would result, but this might shorten the filament life, or even burn out the filament wire. Note that the plate supply voltage, E_{bb}, is a constant 100 volts on the graph. Changing E_{bb} would shift the curve to the left or right, but the curve would still have the same general shape.

tetrodes and pentodes

While you will probably not be asked much about vacuum tubes on license tests, it is important that you understand something about the multigrid tubes called tetrodes and pentodes, since they are often used in linear amplifiers for Amateur transmitting systems and are used in most of the older transmitters, receivers, and test equipment you might be using.

One of the difficulties with triode tubes when used in rf ac amplifiers is the capacitance between the grid and plate elements. Both of these elements are metal and they are separated by a vacuum dielectric, thus creating a low-capacitance capacitor. This capacitance can feed amplified high or radio frequency (rf) ac in the plate circuit back into the grid circuit, which is then reamplified to the point that the circuit starts generating ac instead of just amplifying it. This is great if you are building an oscillator (rf generator), but is definitely not desirable when all you want to do is to amplify an ac signal. One method of cutting down on this regenerative, or positive, feedback is to install a second grid between the first *control grid* and the plate, as indicated in the tetrode, or four-element, VT symbol in **fig. 5**. The second grid is known as a *screen grid*. With a screen grid in a tube, any amplified ac is now fed back to the screen grid, and since this element is usually bypassed to cathode (ground) with a relatively large capacitance (0.01 μF), the fed-back ac goes harmlessly to ground and does not get to the grid to produce trouble. Whereas practical voltage gains of perhaps 100 or so are possible with triodes, with tetrodes the gains can be two or three times this value. The screen grid is always connected to a B+ value, either equal to the plate value, or to some lesser voltage value (usually by using a screen grid resistor, R_{sg}). The screen grid also draws current from the "space-charge" electrons around the hot cathode, and represents a power loss to the tube. This is because these electrons do not find their way through the output or plate circuit and the load.

In addition to the power loss when using a screen grid, there is another difficulty. The high positive potential of the screen grid accelerates the electrons on their way to the plate so much that some of them strike the plate hard enough to bounce two or more electrons off the plate surface. These electrons liberated from the plate may move to the screen grid and never flow through the output circuit load. This is also a loss to the output of the tube. Such an undesirable "secondary emission" (the cathode produces the primary emission) can be prevented from moving back toward the screen grid by properly engineering the geometry of the wires of the two grids. If this is done, the primary emission current is formed into intense beams of electrons which sweep any secondary emission electrons back to the plate where they can flow through the load. A tube constructed in this manner is called a *beam power tetrode*, and is the usual multigrid tube used in Amateur linear amplifiers.

Another way of preventing secondary emission electrons from moving to the screen grid is to put a third grid, called a "suppressor grid," in between the screen grid and the plate and applying a zero (cathode) potential to it, as in **fig. 6**. The zero potential area in front of the plate tends to slow the primary emission electrons so that they do not hit the plate with enough velocity to produce secondary emission. If any is produced, the zero potential area will slow them and they will not have enough velocity to

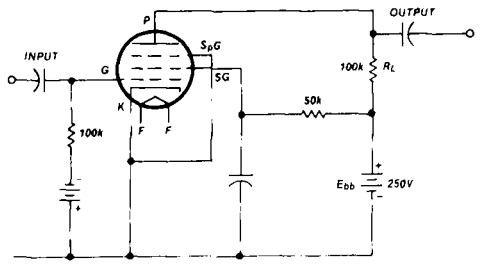


fig. 6. Basic pentode af amplifier using a cathode-type tube.

get to the screen grid. This forms a *pentode* (five-element) tube. Pentodes have even greater gain than tetrodes, and are found in most of the high-frequency amplifier stages of almost all vacuum-tube Amateur equipment in use today.

You will note that **fig. 6** also shows an improvement on the simple filament by the addition of a cathode covering around it. If power line ac is used to heat a filament the alternating current produces a continual heating and cooling of the filament wire, which produces a slight variation of the I_p at a frequency twice that of the filament ac. This produces a nasty hum component in the output current of the stage. By encasing the filament wire in a metal cathode sleeve painted with a substance which liberates electrons easily, the variations of filament temperature are not apparent in the slowly heating and cooling cathode sleeve, and the I_p no longer has the undesirable hum component in it. Most VTs use heater-cathodes, very few use simple filaments.

Many of the smaller, modern, low-power or "receiving" vacuum tubes have seven pins protruding from the bottom of a tubular glass envelope which may be about 3/8 × 1-3/4 inches (18 × 45 mm) in size. When VTs are manufactured with two or more devices in one envelope (twin-triodes, diode-pentodes, and so forth), they usually have nine pins at the base of a tubular glass envelope measuring either 7/8 × 1-3/4 inches (21 × 45 mm), or 7/8 × 2-1/2 inches (21 × 62 mm). Transmitting and high-power VTs will be considerably larger, and some may have metal fins attached to their plate, as the external part of the encapsulating shell or envelope. This allows the plates of these tubes to be air cooled by convection or by fans, making possible greater power output from smaller tubes. When the plate is inside a glass envelope, cooling depends on the radiation of heat energy through the glass, which limits the dissipation of heat developed on the plate by plate current (electrons striking the plate). Some tubes are built with metal envelopes to allow their internal elements to be shielded from external fields, but most glass tubes must have metal shields slipped over them to provide shielding. The shields must be grounded to the equipment chassis or the ground connection of the circuit.

solid-state diodes

Today very few if any Amateur Radio power supplies will use vacuum or mercury vapor (gaseous) rectifier diodes. Semiconductor or solid-state diodes are used almost exclusively. Although solid-state diodes may not withstand as much inverse or reverse voltage (negative voltage to the anode) as will high vacuum diodes, several solid-state diodes can be used in series. This does away with the requirement for heating filaments and greatly increases overall efficiency as well as decreasing size and weight of equipment.

There are two semiconductor materials commonly used in the manufacture of solid-state devices. One is silicon, the other germanium. By themselves, in pure crystalline (intrinsic) form, both silicon and germanium are fairly good insulators at room temperatures. However, if an impurity such as arsenic or phosphorus is added to them during the development of the crystals, a semiconductor is formed which has considerably less resistance. In this case, the semiconductor material acts as if it has some free electrons (negative charge), and is therefore called N-germanium or N-silicon. If warmed, such semiconductors shake loose their electrons much more easily and have still less resistance. If cooled their resistance increases.

If the dopant, or impurity, is gallium or boron, the semiconductor acts as if it lacks an electron and has a somewhat positive charge, and is called P-germanium or P-silicon. The crystals have a few areas which appear to lack electrons. These areas are considered to be positive holes. While holes do not move, if an electron moves into a hole area the area from which it came is left with a more positive hole. Germanium usually has a lower resistance than sili-

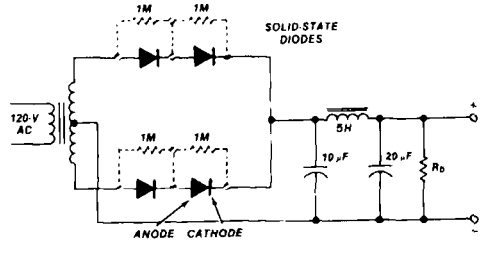


fig. 7. Solid-state diodes used in a center-tapped high voltage power supply. Dashed equalizer resistors would normally be used.

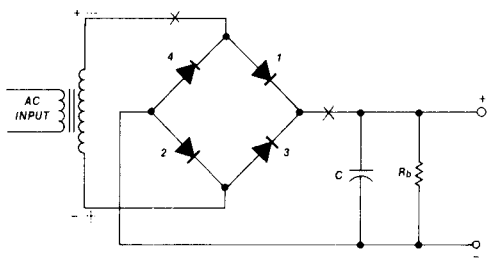


fig. 8. Solid-state bridge rectifier circuit used to provide an unregulated dc output.

con, but silicon is less fragile and is the more generally useful material. Other semiconductor materials are also used.

When an N-silicon and a P-silicon crystal are grown together, the junction between them has some of the N-material electrons moving into the P-material holes. This develops a zero charged barrier area at the junction. Germanium as the semiconductor requires about 0.3 volt to overcome the barrier potential; silicon requires about 0.6 volt. If higher voltages are applied to these diodes, with a negative potential to the N-material and positive to the P-material, current will flow through the device easily. If the applied voltage is reversed, the barrier area is increased in width and no current can flow through the junction and the diode. In this way the PN junction acts as a diode, rectifying ac that is applied across it. PN-junction diodes have peak-inverse-voltage (PIV) ratings of from a few volts up to about 1000 volts. For higher voltage operation several diodes may be connected in series, cathode-to-anode. Often a 1-megohm resistor is connected across each diode to act as a voltage divider to ensure equal voltage-drop across all diodes during inverse peak voltage times. The diagram of **fig. 7** shows solid-state diodes in a center-tapped full-wave rectifier-filter power supply, similar to the VT circuit shown in **fig. 2**. Two series diodes are shown in each leg of the circuit to provide greater PIV protection. (Adding 0.01 μF capacitors across the diodes sometimes reduces buzzing sounds in nearby receivers.) Don't forget, electron current flows in a direction opposite to the arrow of the solid-state rectifier symbol, which means an upward current through R_b.

With solid-state diodes, a full-wave bridge rectifier circuit can be used which does not require a center-tap connection on the transformer secondary, **fig. 8**. With the secondary polarity as shown (+ at the top and − at the bottom), electrons are attracted to the top of the winding through diode 1, through R_b, through diode 2, and from the negative potential at the bottom of the transformer. The voltage-drop across R_b resulting from this current charges capacitor C. On the next half cycle (+ at the bottom and − at the top of the transformer, shown dashed), electrons are drawn up through R_b and through diode 3 to the bottom of the secondary, and out the top and through diode 4 to R_b, again charging C in the same polarity. This results in full-wave pulsating dc flow in the transformer and a reasonably steady or smooth dc voltage across C as the output of the supply.

When used for relatively high voltage and low current circuits, such as vacuum tube equipment, the filter may be a π-type with an input and output C of perhaps 10 to 20 μF, and a choke coil (5 to 10 H) as shown in **figs. 1**, **2**, and **7**. More often, in the low voltage and relatively higher current supplies used with solid-state devices, only a single filter capacitor such as C is used. It may have capacitance values of from 1000 to more than 10,000 μF. Because of the low impedance of such large capacitors to the first ac pulse to be rectified at turn-on, either a small iron core choke or a 1 or 2 ohm current-limiting resistor should be included in the circuit at either of the points marked X. In all of these supplies the output voltage will drop when the load is increased. Power supplies of this type may work well for loads that do not change, but for changing loads (CW, SSB) their voltage regulation may be inadequate. We say that they have too high an impedance.

FCC test topics

The following Novice class FCC test topics are discussed in this article, but should be understood by Technician/General and Advanced class license applicants also:

- vacuum tubes, appearance, applications, symbols.

The following Technician/General FCC test topic is discussed in this article, but should be understood by Advanced class license applicants also:

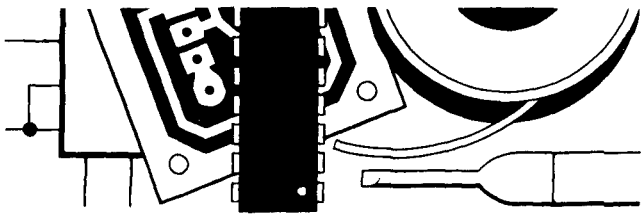
- power supplies using solid-state diode rectifiers.

In the next installment, part 4 of Operation Upgrade, I will be discussing diodes of the following types: zener, tunnel, varactor, hot-carrier, junction, point-contact, PIN, light-emitting, neon, and point-contact. Transistors of the following types will also be discussed: NPN, PNP, junction, unijunction, power, germanium, and silicon.

Part 4 will also include an introduction to the following topics: silicon-controlled rectifiers, triacs, voltage regulator circuits, both discrete and integrated, and voltage regulators with pass transistors and zener diodes to produce a given output voltage.

ham radio

the weekender



wireless 220-MHz to 2-meter converter

Looking for something to do this weekend? Here's an easy, low-cost way to add 220-MHz reception to your programmable scanner or 2-meter handheld — without modification.

The availability of low-cost, multiband programmable scanners has provided an easy way to monitor local multiband repeater activity. Most programmable scanners cover the 440-MHz band and some, if not all, of the 2-meter band. In many areas all channels of a scanner could be easily used to monitor local repeaters. However, the one disadvantage of most programmable scanners is that they don't cover the 220-MHz band.

With 220-MHz activity growing, the capability of adding 220-MHz band coverage to your programmable scanner — with no wired connections or physical mods — would be a big plus! This article shows you how to do this, based on the guidelines listed below. The techniques can also be used to add 220-MHz coverage to a programmable, scanning, 2-meter handheld transceiver; but for the sake of simplicity I use the term *scanner* in this article.

conversion guidelines

To preserve the original desirable features of the scanner, I offer the following guidelines as requirements for making the conversion:

1. Performance of the scanner on the existing band or bands must not be degraded.

2. Ability to use the self-contained antenna or antennas of the scanner must be maintained.

3. No physical modifications shall be made to the scanner. If add-ons are required, no wire connections between the add-on and the scanner shall be made.

4. Any add-ons must be self-powered.

5. 220-MHz band sensitivity must be adequate for reception of local repeaters.

6. It must be possible to "lock out" 220-MHz band reception.

7. Cost must be reasonable.

This list of guidelines may appear tough to meet, but fortunately there's a simple solution.

By Bob Witmer, W3RW, 79 Blaine Avenue, Leola, Pennsylvania 17540

theory of operation

The solution I came up with meets all requirements listed except that two "birdies" occur in the VHF low and high bands — one in each. There's a way to move these around if they fall on channels active in your area — more about this later.

The wireless converter consists of just what the name implies — a receiving converter with no wire connections to the receiver. In other words, antennas are used on both input and output of the converter.

This technique works because the signal-level path loss between two close antennas (receiving converter output and scanner input) is compensated by the conversion gain of the typical receiving converter to produce usable overall sensitivity, although it's not as good as that which would be obtained if a direct rf connection were used.

detailed description

The 220-MHz to 2-meter wireless converter I constructed (**fig. 1**) consists of a receiving-type 220-MHz to 2-meter converter packaged in a metal chassis, an ac-power supply (or battery dc source if portable operation is desired), and input and output antenna jacks. In my converter, a BNC antenna jack is mounted in the center of the top of the chassis for the 220-MHz input, and an SO-239 UHF connector is mounted on the rear panel of the chassis for the 2-meter band output.

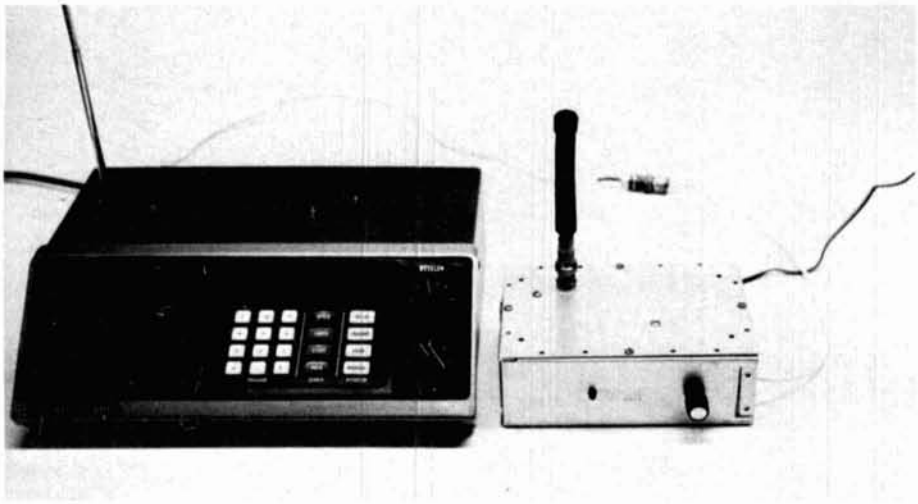
receiving converter

The receiving converter I used in my wireless converter was home built, but any standard receiving converter with the right input and output frequency ranges will work. For example, Hamtronics, Inc. has a 220- to 144-MHz receiving converter, Model CA220-2, which covers the desired frequency bands.

local-oscillator frequency

I chose a 77-MHz LO frequency so that it would be easy to identify received signals between the two bands (a 224.90-MHz input signal would appear as a 147.90-MHZ output signal) and also keep the 220-MHz converted signals within the range of most 2-meter fm receivers.

You may want to select a different LO frequency if the output band of your converter falls in the frequency range of a strong local 2-meter repeater. In my case, a local-coverage 223.94-MHz output repeater is converted to 146.94 MHz. Fortunately, in



The wireless 220-MHz converter alongside a programmable scanner. The converter input antenna in this version is a rubber ducky, and the output antenna is a 33-inch (82.5-cm) length of coax with the braid stripped back about 19 inches (47.5 cm).

my area, there are no strong repeater outputs on 146.94 MHz. If this is a problem, and the scanner you are planning to use has the coverage range, you could change the local oscillator frequency up or down, which would shift the corresponding output frequency band by the same amount. For example, if a local-oscillator frequency of 79 MHz were chosen, an input-frequency-band signal of 223.94 MHz would show up in the output band at 144.94 MHz.

birdies

As mentioned previously, the wireless converter may add birdies or spurs to those the scanner already has (depending on the type of receiving converter you use). Most manufacturers list these spurs in their instruction manual. Where these new birdies fall is determined by the local-oscillator frequency that is selected. For example, in my converter, with a LO frequency of 77 MHz, I have birdies at 38.5 MHz *(actual crystal frequency = 77 MHz ÷ 2)* and at 154 MHz *(2 × 77 MHz)*. Where I live these birdies don't interfere with active channels I wish to monitor; if they did, a slight change in the converter's local-oscillator (crystal) frequency would change the frequency where the birdies appear.

Finally, LO frequencies in the 73- to 75-MHz range probably should be avoided because their third harmonics fall in the 220-MHz band.

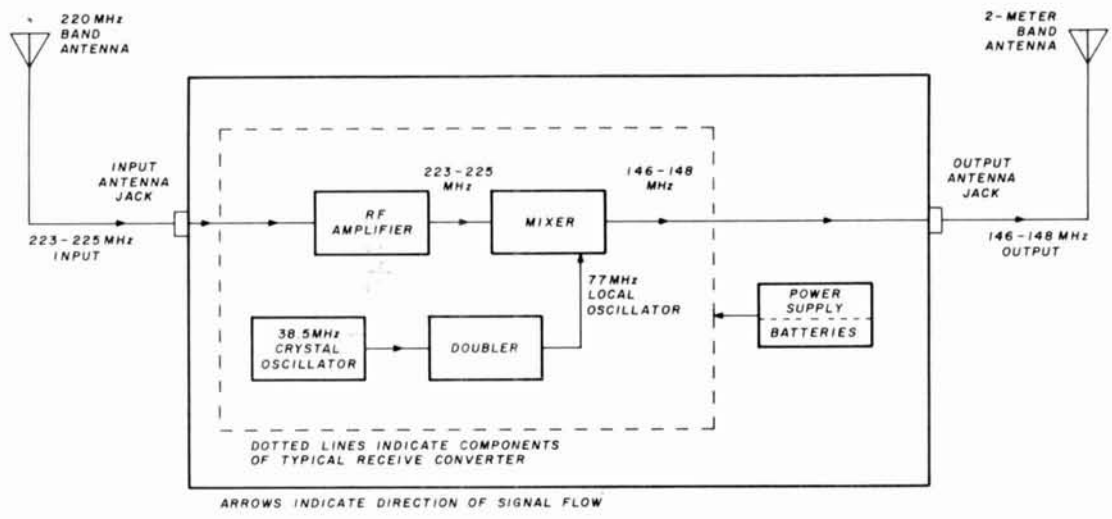
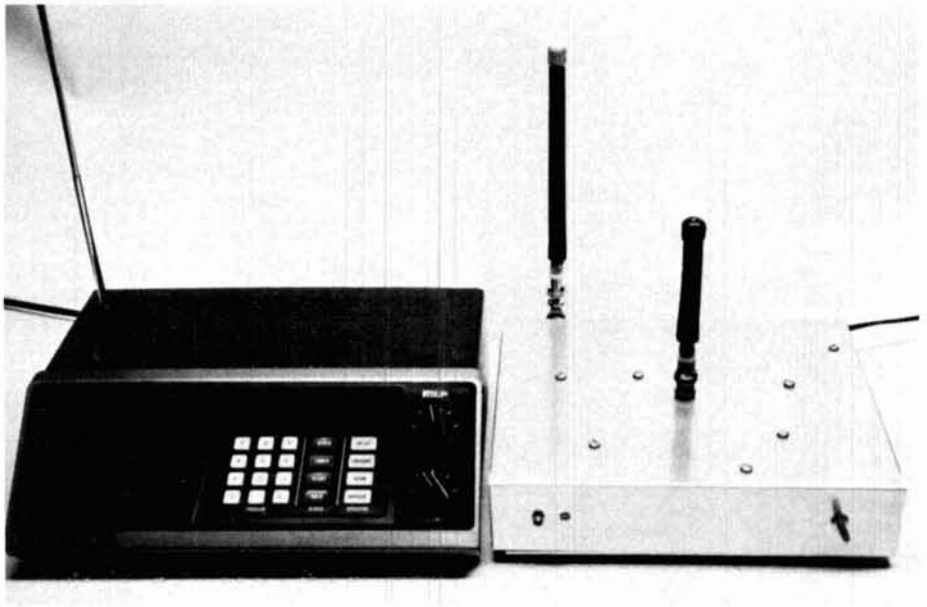


fig. 1. 220-MHz to 2-meter wireless converter block diagram.



A "de-luxe" version of the converter using rubber ducky antennas for input and output.

antennas

I chose a self-contained, 220-MHz antenna (rubber duck) on the input to preserve the portability of the converter, since this makes mobile operation with a 2-meter handheld possible. Reception will be improved greatly if an external 220-MHz antenna is used for the input. A full-length quarter-wavelength whip could also be used. A 2-meter rubber-duck antenna could be used on the output of the converter, although I used a 33-inch (82.5-cm) piece of coax with the braid stripped back approximately 19 inches (47.5 cm).

installation and operation

For best performance, the scanner should be located close to the wireless converter's output antenna. (Place the scanner on top of the antenna if a coax-wire type of antenna is used.) After the antennas are connected and the scanner and converter are placed close together, the scanner and wireless converter can be powered up and the scanner programmed for the 220-MHz repeater frequencies you wish to monitor. To determine these frequencies, subtract the converter local-oscillator frequency from the desired 220-MHz frequency. For example, if the 220-MHz repeater frequency is 223.94 MHz (as in my case), subtracting the LO frequency of 77 MHz puts the scanner receive frequency at 146.94 MHz. If you don't know the local-oscillator frequency of your converter, it can be determined by subtracting the low (or high) end of the output frequency band from the corresponding input-band frequency. For example, if the input upper frequency is 225 MHz and the output upper frequency is 148 MHz, the LO frequency would be 77 MHz.

If you tire of listening to 220 MHz activity, all you need do is turn off the power to the wireless converter to lock out 220-MHz-band reception.

other applications

If the 220-MHz signals you're monitoring are strong, and you position the converter's output antenna somewhat vertically, you can walk away from the wireless converter — in my case one or two rooms away in the house — with a 2-meter handheld receiving on the converter's output frequency and still be able to copy the signal.* This can be useful for monitoring, since chatter from a programmable scanner is often objectionable to others; and with a handheld, you can monitor the converter's output using an earphone with the scanner off.

As mentioned previously, most of this article addresses programmable scanners; but a programmable scanning-type 2-meter handheld could also be used with the converter in a similar way to add 220-MHz receive coverage to existing 2-meter coverage.

10- or 6-meter fm

This technique can be used to add 10- or 6-meter fm-band coverage — the other Amateur bands that most programmable scanners don't cover. Just select a receive-type converter with the desired input and output frequencies, add antennas and a power source, follow the guidelines in the article, and you're ready to go.

ham radio

*It is important that the converter's output is not strong enough to interfere with other equipment. **Editor.**

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
SN7411N	.29	SN7489N	1.75	SN74172N	4.95
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
SN7421N	.29	SN7496N	.69	SN74180N	.79
SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74104N	.89	SN74184N	2.49
SN7426N	.29	SN74105N	.89	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74190N	1.25
SN7428N	.49	SN74109N	.39	SN74191N	1.25
SN7430N	.25	SN74116N	1.95	SN74192N	.89
SN7432N	.29	SN74121N	.39	SN74193N	.89
SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
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
SN7446N	.79	SN74144N	3.49	SN74279N	.79
SN7447N	.69	SN74145N	.79	SN74283N	1.49
SN7448N	.79	SN74147N	1.95	SN74284N	3.95
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
74LS09	.35	74LS113	.49	74LS241	1.49
74LS10	.35	74LS114	.49	74LS242	1.49
74LS11	.39	74LS122	.89	74LS243	1.49
74LS12	.35	74LS123	1.25	74LS244	1.49
74LS13	.59	74LS125	.59	74LS245	2.95
74LS14	.99	74LS126	.59	74LS247	1.19
74LS15	.35	74LS132	.99	74LS248	1.19
74LS20	.35	74LS133	.89	74LS249	1.19
74LS21	.35	74LS136	.49	74LS251	.99
74LS22	.35	74LS138	.89	74LS253	.99
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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
74LS33	.59	74LS156	.89	74LS279	.89
74LS37	.45	74LS157	.89	74LS283	.89
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
74LS54	.35	74LS168	1.19	74LS367	.69
74LS55	.35	74LS169	1.19	74LS368	.69
74LS73	.45	74LS170	1.95	74LS373	1.95
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

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CD4000	.39	CD4041	1.49	CD 4098	2.49
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
CD4009	.49	CD4047	2.50	CD4511	1.29
CD4010	.49	CD4048	1.35	CD4512	1.49
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
CD4021	1.39	CD4069	.45	CD4562	11.95
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	CD4723	1.95
CD4026	2.95	CD4075	.39	CD4724	1.95
CD4027	.69	CD4076	1.39	MC14409	17.95
CD4028	.89	CD4078	.55	MC14410	18.95
CD4029	1.49	CD4081	.39	MC14411	15.95
CD4030	.49	CD4082	.39	MC14412	15.95
CD4034	3.49	CD4093	.99	MC14419	7.95
CD4035	.99			MC14433	15.95
CD4040	1.49			MC14538	2.49
				MC14541	1.95

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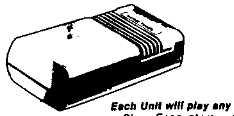

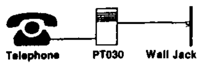

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- Colonel Bogey
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- Twinkle, Twinkle Little Star
- Deutschlandlied
- God Save the Queen
- Close Encounters
- Happy Birthday
- Wedding March
- Jingle Bells
- Auld Lang Syne
- Soldiers Chorus
- Sailor's Hornpipe
- Chargel
- Greensleeves
- Lorelei
- Eyes of Texas
- Star Spangled Banner
- Oranges and Lemons
- Wilhelmus
- Mozart Sonata
- Pomp & Circumstance
- William Tell Overture
- Bach Toccata in D Minor
- Shave and a Haircut
- Blue Danube Waltz
- Beethoven's 5th
- La Marseillaise

FEATURES

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XC556C	.200" clear	4/$1	XC209Y	.125" yellow	4/$1
XC22R	.200" red	5/$1	XC526R	.185" red	5/$1
XC22G	.200" green	4/$1	XC526G	.185" green	4/$1
XC22Y	.200" yellow	4/$1	XC526Y	.185" yellow	4/$1
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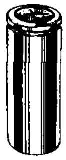
MAN 2	5x7 D.M.—red	.300	4.95	DL704	C.C.—red	.300	1.25
MAN 3	C.C.—red	.125	.25	DL707	C.A.—red	.300	1.25
MAN 52	C.A.—green	.300	.99	DL728	C.C.—red	.500	1.49
MAN 54	C.C.—green	.300	.99	DL741	C.A.—red	.600	1.25
MAN 71	C.A.—red	.300	.75	DL747	C.A.—red	.600	1.49
MAN 72	C.A.—red	.300	.75	DL750	C.C.—red	.600	1.49
MAN 74	C.C.—red	.300	1.25	DLO847	C.A.—orange	.800	1.49
MAN 82	C.A.—yellow	.300	.49	DLO850	C.C.—orange	.800	1.49
MAN 84	C.C.—yellow	.300	.99	DL33B	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	4x7 Numeric (RHD)	.600	22.00
MAN 6740	C.C.—red—DD	.560	.99	5082-7302	4x7 Numeric (LHD)	.600	22.00
MAN 6750	C.C.—red ± 1	.560	.99	5082-7340	4x7 Hxdcl. (0-9/A-F)	.600	22.50
DLO304	C.C.—orange	.300	1.25	4N28	Photo Xsistor Opto-Isol.		.69
DLO307	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

COMPUTER GRADE CAPACITORS



MFD	WVDC	PRICE	MFD	WVDC	PRICE	MFD	WVDC	PRICE
250	150	1.95	10,000	15	2.95	24,000	20	2.95
500	200	2.49	10,000	16	3.95	27,000	10	2.95
1,250	3	.99	11,000	19	4.95	32,500	25	4.95
1,500	25	1.95	11,000	55	5.49	40,000	25	5.95
1,500	50	2.95	11,000	50	5.95	43,000	10	5.95
2,000	10	2.95	13,000	16	2.95	50,000	20	7.95
2,250	100	3.95	14,000	13	2.95	52,000	20	5.95
2,300	33	2.95	14,000	35	3.95	55,000	15	5.95
2,500	15	2.95	18,000	10	3.95	58,000	20	5.95
3,000	25	1.95	20,000	20	2.95	65,000	10	7.95
3,600	40	3.95	26,000	55	3.95	73,000	5	7.95
4,500	50	3.95	21,000	15	3.95	80,000	15	9.95
5,500	25	4.49	23,000	7	1.95	90,000	10	8.95
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6,800	50	4.95	23,000	20	3.95	200,000	3	12.95

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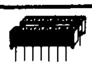
LOW PROFILE (TIN) SOCKETS



	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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.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
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3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.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	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	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

Questions and Answers

Entries must be by letter or postcard only. No telephone requests will be accepted. All entries will be acknowledged when received. Those judged to be most informative to the most Amateurs will be published. Questions must relate to Amateur Radio.

Readers are invited to send a card with the question they feel is most useful that appears in each issue. Each month's winner will receive a prize. We will give a prize for the most popular question of the year. In the case of two or more questions on the same subject, the one arriving the earliest will be used.

Why is 60 Hz the standard power-line frequency in this country? — Fred Hegstrom, WA4IEG.

Well, simple questions can turn out to be tough to find the answer to.

Thomas A. Edison used dc to generate power for his illuminating business. The long distance-transmission of dc is inefficient, and Edison soon found that his 110-volt lamps didn't give much light when operating at 85 volts, the result of voltage drops along the line, differences in loads and so forth. So he hired a young engineer by the name of Nikola Tesla, who had plans for an alternating current dynamo that would eliminate the commutator and brushes needed for dc dynamos.

Tesla felt that ac could be transmitted more efficiently by stepping up the voltage through a transformer, having less ohmic losses in the transmission line, and stepping down the voltage again at the user's end.

Tesla told Edison that he could vastly improve existing dc dynamos and Edison said, "There is $50,000 in it if you can." Tesla worked long hours, developed twenty-four different types of dynamos, then asked Edison for his money. Edison replied, "You don't understand our American humor," and reneged on the offer. Tesla quit.

He couldn't get work in the electrical industry at this time and had to go to work digging ditches to keep alive. But his foreman recognized that Tesla was an educated and talented man, so he helped him get financing so that Tesla could form his own company, the Tesla Electric Company. Once in business for himself, Tesla produced three complete ac systems, for single, two, and three phase generation, and the transformers for voltage conversion and also the motors to drive the machines.

Different from Edison, who was an "intuitive" inventor, Tesla was a theoretician who worked out the basic mathematical theory underlying his inventions; and he had already come to the conclusion that the optimum frequency to use was 60 cycles/second. He filed for and was granted seven basic U.S. Letters Patents on his inventions, and was asked to lecture before a meeting of the American Institute of Electrical Engineers in May, 1888. This lecture became a classic in the electrical engineering field.

Meanwhile, George Westinghouse, who had invented the air-brake for railroad cars, was also in the business of making lighting equipment, in competition with The Edison Electric Co. The Westinghouse Electric Co. used a frequency of 133-1/3 cycles per second. This was a result of using an eight pole generator and running it at a shaft speed of 2000 RPM $(f = RPM/60 \times pole\text{-}pairs)$ or $f = 2000/60 \times 8/2 = 133\text{-}1/3$ CPS. This system used crude transformers of limited capacity, and required a transformer in each house-to-house connection! George Westinghouse recognized the value of Tesla's work and offered him $1,000,000 for his patents, a royalty of $1/horsepower for each generator and motor he built, plus a generous salary to work for him in Pittsburgh, Pennsylvania. Testla accepted.

At one time in this country we had 133-1/3, 125, 83-1/3, 66-2/3, 60, 50, 40, 30, and 25 cycle power — not to mention a few "odd-ball" frequencies! Remember that the first generators were belt driven from steam engines, making it possible to run the generators at a fairly high speed. With the advent of direct drive-engines (and later, turbines) and also the use of hydro-generators directly connected to low-speed shafts, it became apparent that many pole-pairs would be needed to generate higher frequencies. We still use some 25 cycle power, generated primarily at steel mills to drive very large slow-speed motors for rolling mills. And the first hydro plants were 25 cycles. But the flicker of an incandescent lamp (and today, a fluorescent lamp) at the rate of 50 times/sec (2f) is below the rate at which persistence of vision in the human eye can make the light seem steady.

Edison battled the use of high-voltage ac to the end. He conducted experiments by electrocuting dogs and horses to show that ac was more lethal than dc, and when the state of New York had their first legal electrocution using ac on the electric chair, the "dc lobby" considered this a victory.

But when Westinghouse supplied the power, using ac, for the Chicago World's Fair of 1893, and then got the contract for the Niagara Falls hydroelectric plant, which transmitted power to Buffalo, New York, twenty miles away, the ac vs dc battle was over.

In short then, we have 60 Hz as the standard frequency in this country because of a Serbian immigrant named Nikola Tesla — the father of the induction motor and polyphase transmission. He also did some work in the wireless transmission of power, but that's another tale.

When using a short antenna, why is it after tuning the rig and using an antenna tuner to reduce the SWR I can't get full power forward? — Christopher B. Hays, WBØLPV.

The key word here is *reduce* the VSWR. If the antenna tuner is capable of handling a wide range of complex loads, it should be able to present 50 or 75 ohm *resistive* load to the transmitter pi-network output circuit, even if you use the proverbial "wet-noodle" for an antenna. My computer said "Insufficient Data" — you didn't say whether you are using a true rf watt meter or a "reflectoscope" (Monimatch, etc.) calibrated in watts.

The antenna "tuner" is just another impedance matching device, as the pi-network in your transmitter is also an impedance matching device, for transforming the load (antenna terminal) impedance to the proper load for tubes or transistors in the final.

Incidentally, I'll wager your "tuner" is a form of transmatch; it doesn't tune the antenna at all, unless it's mounted at the feed point. Don't worry about VSWR or forward power — just tune up for minimum reverse, keep your plate current within limits, and away you go!

P.S. Since you are using six Slinkys indoors, what do you tell the guy you're working that your antenna is? I used the screens on a porch in a condo for nine months and got tired of trying to explain what I was using.

When a ham gives you a report and says his S-meter reads 5 dB over S-9, what is he saying? I am familiar with the decibel and the math needed to calculate it, but I don't understand S-units — Lloyd A. Mullens, KA4LTK.

Forget about trying to use your knowledge of decibels when dealing with receiver S-meters! At one time, it was hoped that 50 microvolts from a signal generator applied to a receiver would make its S-meter read S-9. Each S-unit was 6 dB in voltage, that is, a 25-μV signal would be S-8, doubling it (6 dB) would be S-9. Above S-9, the meters are usually calibrated in 10-dB increments.

There are many factors that influence these meter readings. First, the receiver input impedance can vary from band to band, and even within a band. So a generator that gives us a voltage into 50 ohms may in fact be looking into a very different impedance. (Remember the dB correction for different impedances?) Next, we have dynamic problems resulting from the fact that the meter gets its voltage from the AGC system, which may be audio or rf derived — this, coupled with the fact that the meter's mechanical ballistics will give vastly different readings between receivers tuned to the same signal.

Since there are no standards for the S-unit, the subject of "specmanship" by the manufacturer enters the picture: how were the receiver's sensitivity and bandwidth determined? If you want to use a device to collect meaningful readings (say for antenna work), use a good field-strength meter, not a receiver.

In your own mind, you'll know that a report of less than S-9 means, "I can hear you"; over S-9 means, "My gosh, but you're strong"; and, of course, a rare DX station is always 5×9, even though you're not sure of his call.

In building my 80-meter inverted vee, I am limited to a small space, and I would like to know if I can wrap part of each leg around a circular form? — Johnny R. Carter.

Yes, the part of the antenna that's wound into a coil acts as an extension of the antenna. In the typical 40/80 meter trap antenna, the trap consists of a coil (usually 2-3 inches in diameter) shunted by a capacitor; this forms a parallel resonant circuit at 40-meters, making the antenna look as though it's only as long as the distance between traps. But when the antenna is operated a 80-meters, these coils make the antenna look longer than it actually is, hence the term *loading coils*.

Wind the coils, locating them a few feet from the end insulators. Of course make the total length of the antenna longer than formula, and prune it to length for a specific frequency by using an antenna noise bridge, "antenna-scope," or other device to determine resonance. Remember, antennas at this frequency have a high Q and the bandwidth for SWR limits of 2:1 are quite small. Pick an operating frequency, and prune the antenna for it.

The highest voltages on this antenna will appear at its ends, so don't put the coil right at the end where it could arc over between turns. Cut-and-try is the best bet here — an inverted vee is merely a dipole (72 ohms) whose feed point impedance is lowered by angling it from the vertical and horizontal.

Since you are going to the trouble of making up the coils, why don't you make them into traps so you get a 40/80 inverted vee? You can take the ends and make them vertical or bend them out at some other angle to get the required length in your available space.

Why do manufacturers and others use 2125 Hz and 2295 Hz for RTTY when lower frequencies, such as 800 to 1100 Hz, are better? — Arthur I. Kelley.

Are these lower frequencies really better? Let's see.

In 1955 the FCC permitted Amateurs to use FSK on the high-frequency bands, with a frequency shift of 850 Hz ±50 Hz. In terms of AFSK, let's take this 850-Hz shift and divide by two; that's 425 Hz. This is the center of the mark-space shift. Now, the fifth harmonic of 425 is 2125 Hz and the seventh harmonic is 2975 Hz. The original requirements were tough, but using Lissajou figures on a scope you could get fairly accurate calibration, at least for the 850 spread between mark and space.

It was found that narrow shifts had advantages, so the FCC amended the R&R's to say "a shift up to 900 Hz." So, leaving the mark tone at 2125 Hz, for a 170-Hz shift we get 2195 Hz for space.

Now, when using AFSK with a good SSB transmitter (using a mechanical filter or high-quality multipole crystal filter), the sideband suppression is good using the 2125-2975 or the narrow 2125-2195 split; the harmonics of these frequencies fall outside the passband of the transmitter. If we used your suggestion of, say, 800 Hz for mark, its second harmonic of 1600, its third harmonic of 2400, and probably to some degree its fourth harmonic of 3200 Hz would be transmitted simultaneously. Now, aside from the unnecessary intelligence (and power) transmitted, unless you can impose very stringent harmonic requirements on your mark/space oscillator, it is wiser to raise the frequency so these harmonics fall outside the transmitter's passband. The advantage of using the same frequency for the various shifts is obvious.

More Details? CHECK—OFF Page 98

a neglected antenna
for 40 and 80 meters
Remember the open-wire, center-fed Zepp?

A superior antenna has been overlooked in this age of drooping doublets and other wire antennas. The antenna system described here is the open-wire, tuned-feeder, center-fed dipole, otherwise known as the center-fed Zepp.

qualifications and assumptions

In the description that follows, I assume that an antenna for 40 and 80 meters should be designed to be compatible with the classic sky-wave (vertical) radiation angles for these frequencies, and that omnidirectional coverage is desired. Also assumed is that an impedance match close to 1.0 is desired between 3.5 and 4.0 MHz and between 7.0 and 7.3 MHz.

The tuned-feeder, center-fed dipole antenna is not for routine contacts into ZL-land, but neither are the 40- and 80-meter bands. The tuned-feeder, center-fed dipole will not replace a rotary beam for point-to-point communications. However, the rotary beam will not replace an omnidirectional antenna for multistation, close-in contacts. Thus, the neglected design described here is best suited for short-haul distances that can be covered on the 40- and 80-meter Amateur bands.

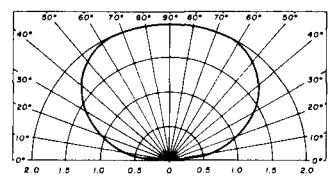
A properly designed tuned-feeder, center-fed dipole antenna, elevated one-quarter wavelength above ground, is unsurpassed for short-haul 80-meter operation. Such an antenna can be matched between 3.5 and 4.0 MHz and provides a high angle of radiation, which is desirable for low-frequency, omnidirectional communications.

This same 80-meter antenna provides a 30-degree vertical radiation angle when tuned to 40 meters. The 40-meter mode does, however, exhibit deep broadside nulls. The purpose of this discussion is to show how the perpendicular, or broadside, nulls can be switched from the sides of the antenna, leaving the antenna with a near-omnidirectional pattern.

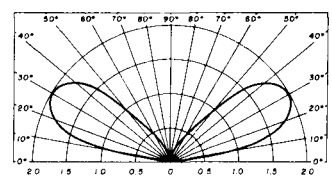
radiation patterns

A review of the *ARRL Antenna Book* shows that:

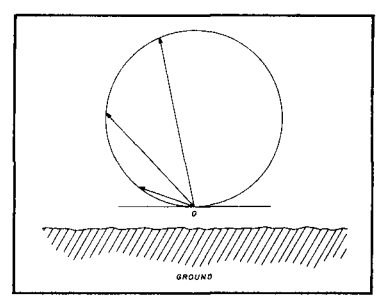
Horizontal antennas one-quarter wavelength high exhibit a vertical radiation pattern at an extremely high angle:*



Horizontal antennas one-half wavelength high exhibit a vertical radiation pattern of 30 degrees:



The radiation pattern of an antenna depends upon the angle of radiation considered:



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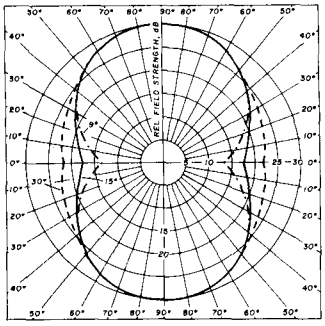
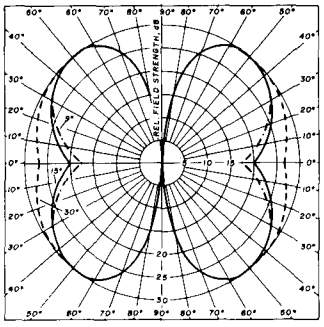
By Warren Amfahr, WØWL, 4309 70th Street, Des Moines, Iowa 50322

As shown by the arrows, the field strength *off the end of a dipole* will be quite different at different vertical radiation angles. (This fact is seldom remembered when discussing high-radiation-angle antennas.)

The radiation pattern of a horizontal half-wavelength antenna for a 30-degree vertical angle is:



The radiation pattern of a horizontal one-wavelength antenna for a 30-degree vertical angle is:



From these graphical representations of antenna radiation characteristics, it can be seen that:

a. The 80-meter halfwave dipole, one-quarter wavelength above ground has *maximum radiation* at an *extremely high* angle.

b. When the same antenna is tuned to 40 meters (one wavelength long at one-half wavelength above ground) the radiation angle is close to *30 degrees.*

c. The horizontal radiation pattern for this 40-meter configuration has *side nulls*.

antenna configuration and impedance matching

The diagram of an open-wire, tuned-feeder, center-fed dipole for 80 meters is shown in **fig. 1**. The typical matching impedance is approximately 70 ohms. With an ideal 65-foot (20-meter) antenna height, a 600-ohm open-wire feeder of this length works as a quarter-wave transformer and transforms

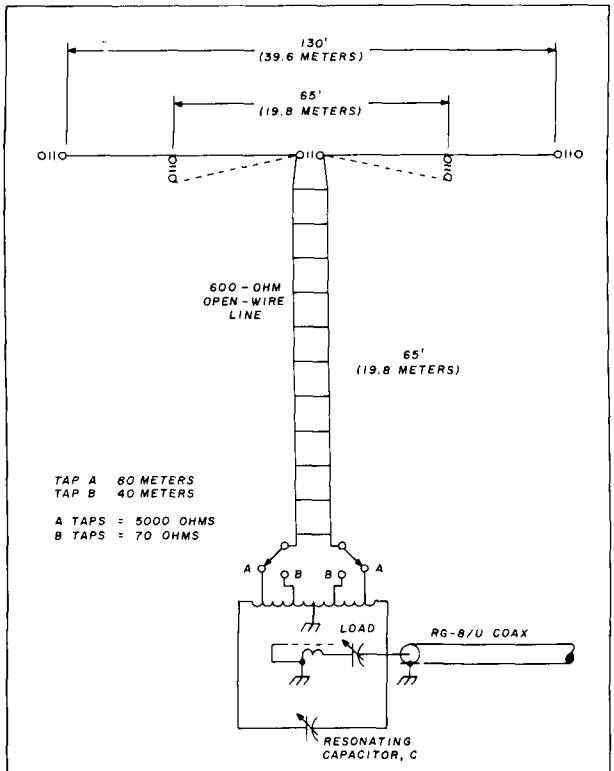


fig. 1. This center-fed dipole has an omnidirectional pattern with a 70-80 degree vertical radiation angle on the 80-meter band. On the 40-meter band, the antenna becomes a full wavelength long, with a vertical radiation angle of 30 degrees, but with a deep null normal to the plane of the wire. The omnidirectional pattern can be restored on 40 meters by adding a 40-meter dipole in parallel with the 80-meter dipole. See text for tuning instructions.

the 70-ohm center impedance to an impedance of approximately 5000 ohms. The antenna tuner is tapped to a 5000-ohm impedance on the tuner coil. (Other variations of tuner impedance matching are possible and are thoroughly covered in the *ARRL Antenna Book*.)

The 80-meter, tuned-feeder, center-fed dipole antenna becomes a full wavelength on 40 meters, with its center at a high-impedance point. At the same time, the feeder length at 40 meters becomes a half wavelength long, and the antenna-tuner impedance taps are essentially equal to those for 80 meters. The only change required in the antenna tuner, from 80 to 40 meters, is its resonant frequency. In practical applications, this is accomplished by a reduction in the capacitance value.*

*The initial 80-meter LC is usually resonated with large C and small L; then 40 meters can be resonated with low C and high L. In other words, the ideal LC ratio would be chosen at a frequency midway between 80 and 40 meters *and then only C (fig. 1) would be varied to cover the two bands.*

The antenna described here can, with changes in tuner L and C, become an efficient radiator for other harmonically related bands; however, any serious long-distance communications on the higher bands should be made with directional beams.

Two changes are required to eliminate the side nulls when the antenna is used on 40 meters:

1. The dipole must have a 40-meter halfwave resonant frequency, and

2. The antenna tuner must have a 70-ohm impedance tap.

With this optional configuration, the impedance taps will determine which antenna the halfwave open-wire transmission wire will properly match. The 70-ohm tuner impedance will transfer directly to the 70-ohm center impedance of the 40-meter halfwave dipole. The longer antenna, having a high impedance at the center, does not provide a match to the line and does not accept power. The 40-meter halfwave dipole section of the antenna will exhibit a 30-degree vertical angle of radiation, and the side nulls will disappear. A 600-ohm transmission line can be constructed of 14 gauge wire spaced by 5-inch-long wooden dowels boiled in paraffin. Also, small-diameter acetal rod makes excellent lightweight spacers.

concluding remarks

It's desirable to locate the tuner directly below the antenna center, then remotely tune the device through buried coax and control lines. An additional refinement might be a counterpoise a few inches over the soil. Since 600-ohm open-wire transmission line exhibits only 0.05 dB attenuation per 100 feet at 7 MHz when matched, a long line could be used between tuner and antenna. The line would, of course, require an odd quarter wavelength at 80 meters to match impedances.

The antenna tuner impedance taps can be easily switched by an antenna relay, and a tuning capacitor can be tuned with a gear reduction reversible dc motor. A coax center-lead series capacitor for loading adjustment could also be motor driven. Forward and reverse dc polarized lever switches at the operating position, used in conjunction with an SWR meter, can remotely tune the system to near perfection.

The tuned-feeder, center-fed dipole described here is not a compromise antenna. It requires space, height, and an antenna tuner. The rewarding return to the user of such a properly designed antenna is the knowledge that his antenna approaches perfection.

The most significant factor contributing to the superior performance of this antenna is that the antenna's vertical radiation angles closely match the ideal for the 80- and 40-meter bands.

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CT2100

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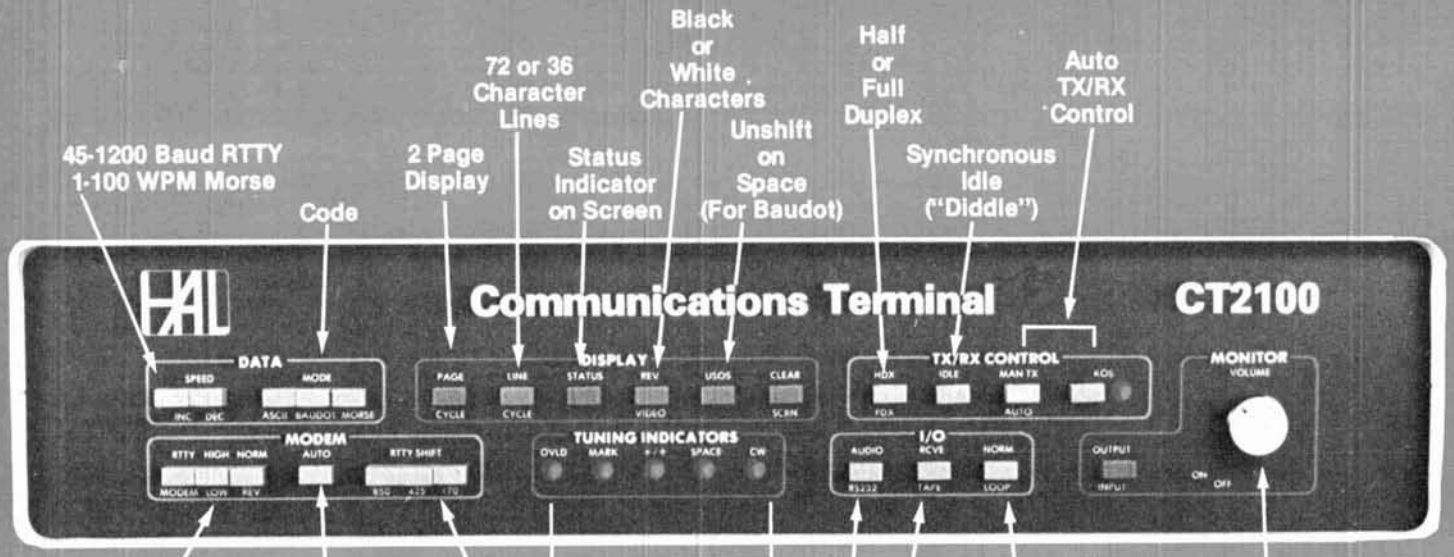

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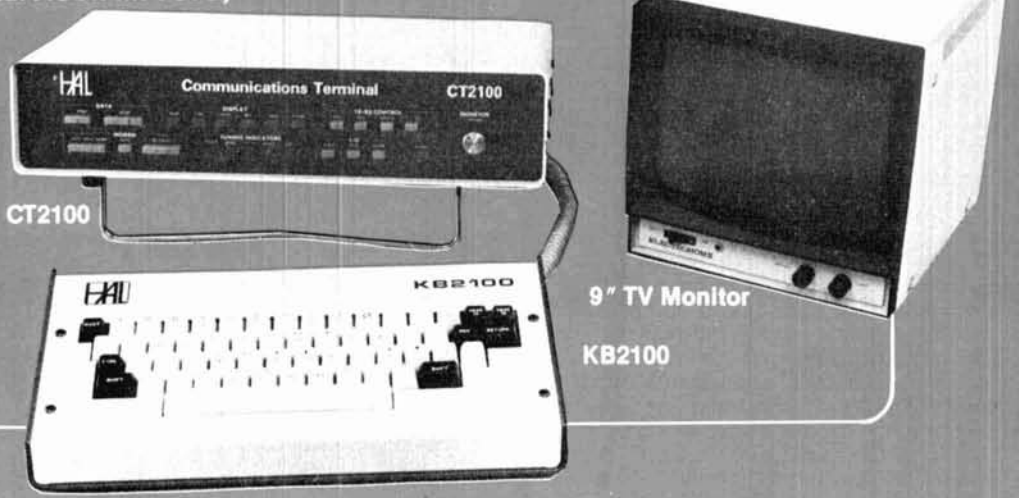

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HAM CALENDAR

January

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W1AW Schedule **October 25, 1981-April 24, 1982** MTWThFSSn = Days of Week Dy = Daily **W1AW code practice and bulletin transmissions are sent on the following schedule:** EST Slow Code Practice: MWF: 9 A.M., 7 P.M.; TThSSn: 4 P.M., 10 P.M. Fast Code Practice: MWF: 4 P.M., 10 P.M.; TTh: 9 A.M., TThSSn: 7 P.M. CW Bulletins: Dy: 5 P.M., 8 P.M., 11 P.M., MTWThF: 10 A.M. RTTY Bulletins: Dy: 6 P.M., 9 P.M., 12 P.M., MTWThF: 11 A.M. Voice Bulletins: Dy: 9:30 P.M., 12:30 A.M. CST Slow Code Practice: MWF: 8 A.M., 6 P.M.; TThSSn: 3 P.M., 9 P.M. Fast Code Practice: MWF: 3 P.M., 9 P.M.; TTh: 8 A.M.; TThSSn: 6 P.M. CW Bulletins: Dy: 4 P.M., 7 P.M., 10 P.M.; MTWThF: 9 A.M. RTTY Bulletins: Dy: 5 P.M., 8 P.M., 11 P.M.; MTWThF: 10 A.M. Voice Bulletins: Dy: 8:30 P.M., 11:30 P.M. PST Slow Code Practice: MWF: 6 A.M., 4 P.M.; TThSSn: 1 P.M., 7 P.M. Fast Code Practice: MWF: 1 P.M., 7 P.M.; TTh: 6 A.M.; TThSSn: 4 P.M. CW Bulletins: Dy: 2 P.M., 5 P.M., 8 P.M.; MTWThF: 7 A.M. RTTY Bulletins: Dy: 3 P.M., 6 P.M., 9 P.M.; MTWThF: 8 A.M. Voice Bulletins: Dy: 6:30 P.M., 9:30 P.M.					**BIG ISLAND ARC** – Worked All Hawaii Awards available to all licensed Amateurs. Contacts after 0000Z, any mode, any band. Three classes; class A – worked 100 HI stations; Class B – worked 50 HI stations; Class C – worked 25 HI stations. Address award applications to: Big Island ARC, P.O. Box 1688, Kamuela, HI 96743 – 1 **1**	**2**
HAMFEST SWAP & SHOP – First Sunday after New Year's Day at Century Center downtown on U.S. 33 North, South Bend, IN – 3 **3**	**WEST COAST BULLETIN** – 9PM PDT (8PM PST) 0400 UTC, 3540 UTC, A-1 22 WPM – 4 **4**	**AMSAT** East Coast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) **AMSAT** Mid-Continent Net 3850 kHz 8PM CST (0200Z Wednesday Morning) **AMSAT** West Coast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) **5**	**6**	**GIRL GUIDE ASSOCIATION'S JAMBOREE** – in Rotorua, New Zealand, from December 29th to January 7th. The call sign will be ZL1 G.G.A. and will operate on 80 meters (3.690 MHz), 40 meters (7.08 MHz), 20 meters (14.200 MHz), 15 meters (21.350 MHz), 10 meters (28.550 MHz). A QSL card will be sent to all contacts – 1-7 **7**	**8**	**73'S 40-METER PHONE CONTEST** – 9 **9**
OAK PARK ARC – Oak Park, MI, Swap & Shop at Oak Park High School. For more information, send SASE to Rob Numberick, WB8ZPN, 23737 Couzens, Hazel Park, MI 48030 – 10 **73'S 80-METER PHONE CONTEST** – 10 **10**	**11**	**AMSAT** East Coast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) **AMSAT** Mid-Continent Net 3850 kHz 8PM CST (0200Z Wednesday Morning) **AMSAT** West Coast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) **12**	**13**	**14**	**15**	**SARASOTA ARA INC** – Sarasota, FL. For more information contact J.S. Cook, WB4BZL, 2286 Hyde Park St., Sarasota, FL 33579 – 16-17 **SOUTHEASTERN LA UNIVERSITY ARC** – at Hammond, LA. For more information contact Ralph Shaw, K5CAV, Box 402, SLU, Hammond, LA 70402 – 16 **INTERNATIONAL SSTV CONTEST** – 16-17 **16**
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24 **31**	**25**	**AMSAT** East Coast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) **AMSAT** Mid-Continent Net 3850 kHz 8PM CST (0200Z Wednesday Morning) **AMSAT** West Coast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) **W1AW QUALIFYING RUN** – 26 **26**	**27**	**28**	**29**	**REF CONTEST (FRANCE, CW)** – 30-31 **CLASSIC RADIO EXCHANGE** – 30-31 **CQ 160-METER CONTEST (CW)** – 30-31 **30**

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Here is an exciting new device to improve your reception on 160, 80, the broadcast band, and on VLF.

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More Details? CHECK—OFF Page 98

TS-130S/V

"Small wonder"...speech processor, N/W switch, IF shift, digital display

The compact, all solid-state HF SSB/CW mobile or fixed station TS-130 Series transceiver covers 3.5 to 29.7 MHz, including the three new bands.

TS-130 SERIES FEATURES:

- 80-10 meters, including the new 10, 18, and 24-MHz bands. Receives WWV.
- TS-130S runs 200 W PEP/160 W DC input on 80-15 meters and 160 W PEP/140 W DC on 12 and 10 meters. TS-130V runs 25 W PEP/20 W DC input on all bands.
- Built-in speech processor.
- Narrow/wide filter selection on both CW (500 Hz or 270 Hz) and SSB (1.8 kHz) with optional filters.
- Automatic selection of sideband mode (LSB on 40 meters and below, and USB on 30 meters and above). SSB REVERSE switch provided.
- Built-in digital display.
- Built-in RF attenuator.
- IF shift (passband tuning).
- Effective noise blanker.

OPTIONAL ACCESSORIES:

- PS-30 base-station power supply.
- YK-88C (500 Hz) or YK-88CN (270 Hz) CW filter.
- YK-88SN (1.8 kHz) narrow SSB filter.
- AT-130 compact antenna tuner (80-10 meters, including three new bands).
- SP-120 external speaker.
- VFO-120 remote VFO.
- MB-100 mobile mounting bracket.
- PS-20 base-station power supply for TS-130V.

Optional DFC-230 Digital Frequency Controller
Frequency control in 20-Hz steps with UP/DOWN microphone (supplied with DFC-230). Four memories and digital display. (Also operates with TS-120S, TS-530S, and TS-830S.)

PS-30 SP-120 TS-130S VFO-120

SP-230 TS-830S VFO-230 AT-230

TS-830S

"Top-notch"...VBT, notch, IF shift, wide dynamic range

The TS-830S has every conceivable operating feature built-in for 160-10 meters (including the three new bands). It combines a high dynamic range with variable bandwidth tuning (VBT), IF shift, and an IF notch filter, as well as very sharp filters in the 455-kHz second IF. Its optional VFO-230 remote digital VFO provides five memories.

TS-830S FEATURES:

- LSB, USB, and CW on 160-10 meters, including the new 10, 18, and 24-MHz bands. Receives WWV.
- Wide receiver dynamic range. Junction FETs in the balanced mixer, MOSFET RF amplifier at low level, and dual resonator for each band.
- Variable bandwidth tuning (VBT). Varies IF filter passband width.
- Notch filter (high-Q active circuit in 455-kHz second IF.
- IF shift (passband tuning).
- Built-in digital display (six digits, fluorescent tubes), analog dial, and display hold (DH) switch.
- Noise-blanker threshold level control.
- 6146B final with RF negative feedback. Runs 220 W PEP (SSB)/180 W DC (CW) input on all bands.
- Built-in RF speech processor.
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OPTIONAL ACCESSORIES:

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- VFO-230 external digital VFO with 20-Hz steps, five memories, digital display.
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- YG-455C (500 Hz) or YG-455CN (250 Hz) CW filter for 455 kHz IF.
- YK-88C (500 Hz) or YK-88CN (270 Hz) CW filter for 8.83 MHz IF.
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CONVENIENT TOP CONTROLS

TR-2500 FEATURES:

- Extremely compact size and light weight 66 (2-5/8) W x 168 (6-5/8) H x 40 (1-5/8) D, mm (inches), 540 g, (1.2 lbs) with Ni-Cd pack.
- LCD digital frequency readout, with memory channel and function indication.
- Ten channel memory, includes "M0" memory for non-standard split frequencies.
- Lithium battery memory back-up, built-in, (estimated 5 year life) saves memory when Ni-Cd pack discharged.
- Memory scan, stops on busy channels, skips channels in which no data is stored.
- UP/DOWN manual scan in 5 KHz steps.
- Repeater reverse operation.
- 2.5 W or 300 mW RF output. (HI/LOW power switch.)
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- Built-in tuneable (with variable resistor) sub-tone encoder.
- Built-in 16 key autopatch encoder.
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- Extended frequency coverage; 143.900 to 148.995 MHz in 5 KHz steps.
- Optional power source, MS-1 mobile or ST-2 AC charger/ power supply allows operation while charging. (Automatic drop-in connections.)
- High impact plastic case.
- Battery status indicator.
- Two lock switches for keyboard and transmit.

STANDARD ACCESSORIES:

- Flexible rubberized antenna with BNC connector.
- 400 mAH heavy-duty Ni-Cd battery pack.
- AC charger.

OPTIONAL ACCESSORIES:

- ST-2 Base station power supply and quick charger (approx. 1 hr.).
- MS-1 13.8 VDC mobile stand/ charger/power supply.
- TU-1 Programmable "DIP switch" (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.
- BT-1 Battery case for AA manganese or alkaline cells (not Ni-Cd).
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- WS-1 Wrist strap.
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40 W, 15 memories/offset recall, scan, priority, autopatch (DTMF)

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TR-7850 FEATURES:

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- M14 ... memorize transmit and receive frequencies independently for non-standard offset. M0 ... priority channel, with simplex ±600 KHz or non-standard offset operation.
- Internal battery back-up for memories. Requires four AA Ni-Cd batteries, (not supplied).
- Extended frequency coverage, 143.900-148.995 MHz in 5 or 10 KHz steps.
- Priority alert. Beep alerts operator when signal appears on priority channel.
- Built-in autopatch encoder (DTMF). All 12 plus four additional DTMF signaling tones. (With simultaneous push of REV switch.)
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- Compact size.
- UP/DOWN manual scan of entire band and memories, using UP/DOWN microphone (supplied).
- Repeater reverse switch.
- Separate digital displays for frequency and memory channel.
- LED S/RF bar meter.
- Tone switch.

Matching accessories for fixed station operation:

- KPS-12 power supply (for TR-7850)
- KPS-7 power supply (for TR-7800)

SP-40

Compact mobile speaker
Only 2-11/16 W x 2-1/2 H x 2-1/8 D (inches)
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Clipperton-L suggested price $799.50.
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ham radio TECHNIQUES

Bill Orr W6SAI

Winter is here. The static level has dropped and the low frequency bands are alive with DX. In particular, the revivified 160-meter band is hopping. The recent FCC expansion of that band, in addition to all of the transceivers that cover 160, have brought about a high level of activity in a band previously dormant for most of the year.

One-sixty, of course, is where Amateur Radio got its start. The earliest DX was worked on that band. It was the dream of Amateurs in 1921 to make two-way contact across the Atlantic Ocean.

The first listening tests between British and American hams proved to be a failure because of both natural and manmade interference. It was not until December, 1922, that American signals were logged in Europe (Scotland). And quickly thereafter, more than thirty lucky Yankee hams were heard in England, Holland, and France.

But could European Amateurs be heard in America on the "short waves" of 200 to 300 meters? Yes, eventually they would. And finally, as history tells us, on the night of November 27, 1923, signals were exchanged between 1MO and 1XAM in the United States (Schnell and Reinartz) and 8AB (Deloy) in France.

And well might the participants in this historic contact have been proud! I heard the story direct from Reinartz and Deloy some years ago; it was a thrilling account of an exciting adventure in communications,

But was it really the first two-way Amateur QSO across the Atlantic?

I thought it was, and so it is written in Amateur history. But I came across an obscure letter to the editor of *QST* in the August, 1931, issue of that magazine that claimed otherwise. The letter was written to congratulate *QST* for having revived interest in what was at that time a sparsely populated 160-meter band. The story is an interesting one and — well, read it for yourself:

14. N. Michigan Ave.
Chicago, Illinois

Editor, QST*:*

I note the recent stir in QST *regarding the use of the 1715-kc. band and feel that you are greatly to be commended for trying to raise a little interest in this Amateur band. I would like to call to your attention the fact that successful communication has been carried over considerable distance in the past. D.A. Griffin, J.M. Tiffany and myself used to operate old NU2AGB in 1922 and '23 and used to work the Pacific Coast with ease. Our signals were consistently heard in Europe, too.*

Those efforts were crowned with success when we carried a two-way communication with British 2JL at Liverpool in October of '23. This, mind you, on a frequency of 1500 kc. with about 750 watts input to a Hartley oscillator. A Western Electric super was used as the receiver. J.M. Tiffany, at present operating 2CGK, was the operator on watch at this

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particular time and the work was corroborated by a ship's operator in mid-Atlantic. We are under the impression that this was the first amateur two-way work with Europe....

John H. Dodman, W9GA, ex-2AGB

Well, there it is. If this report is true, a lot of hallowed Radio Amateur history will have to be rewritten. Did 2AGB actually establish contact with British 2JL a month before the famous 1MO to f8AB contact? If so, why was the information buried until 1931?

Information traveled more slowly in those times, and unless a transatlantic cable of confirmation were sent it

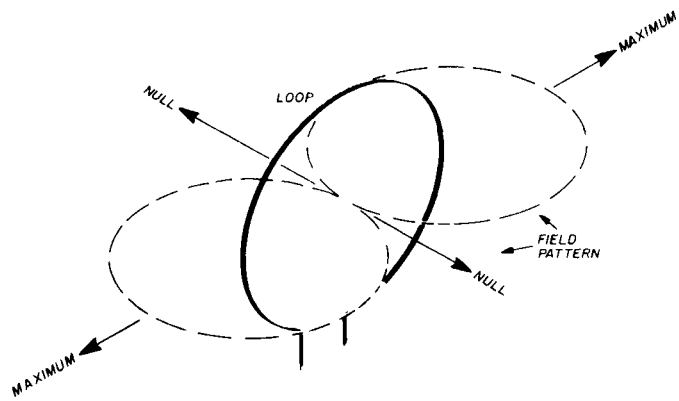

fig. 1. Field pattern of small loop as viewed from above. Maximum response is in the plane of the loop and nulls are at right angle to the loop. This is the reverse of the pattern of the larger "quad" loop whose maximum response is at a right angle to loop plane.

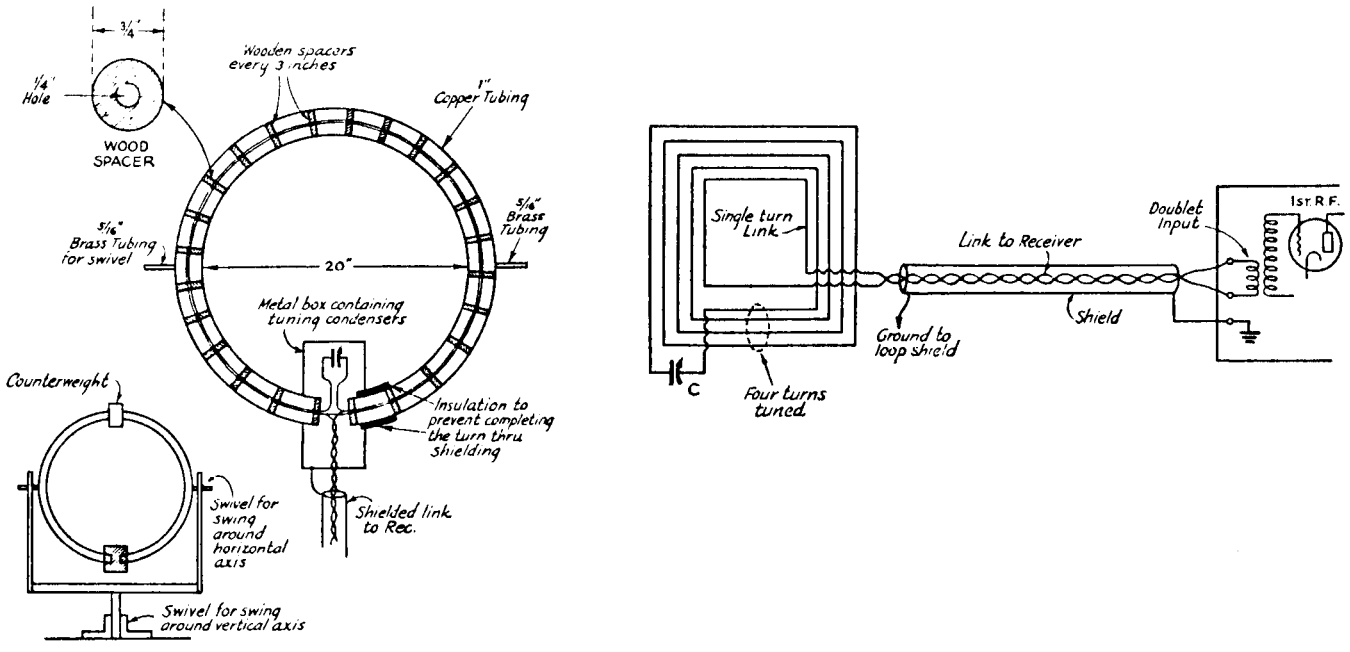

fig. 2. A reproduction of the 1938 *QST* drawings of the W6GPY receiving loop antenna for 160 meters. An electrostatic shield made of copper water pipe surrounds the four-turn loop. One end of the pipe is insulated from ground so as not to include a shorted turn adjacent to the loop. This deluxe design was movable in both azimuth and elevation and, by removing one turn from the loop, was capable of operation on 80 meters.

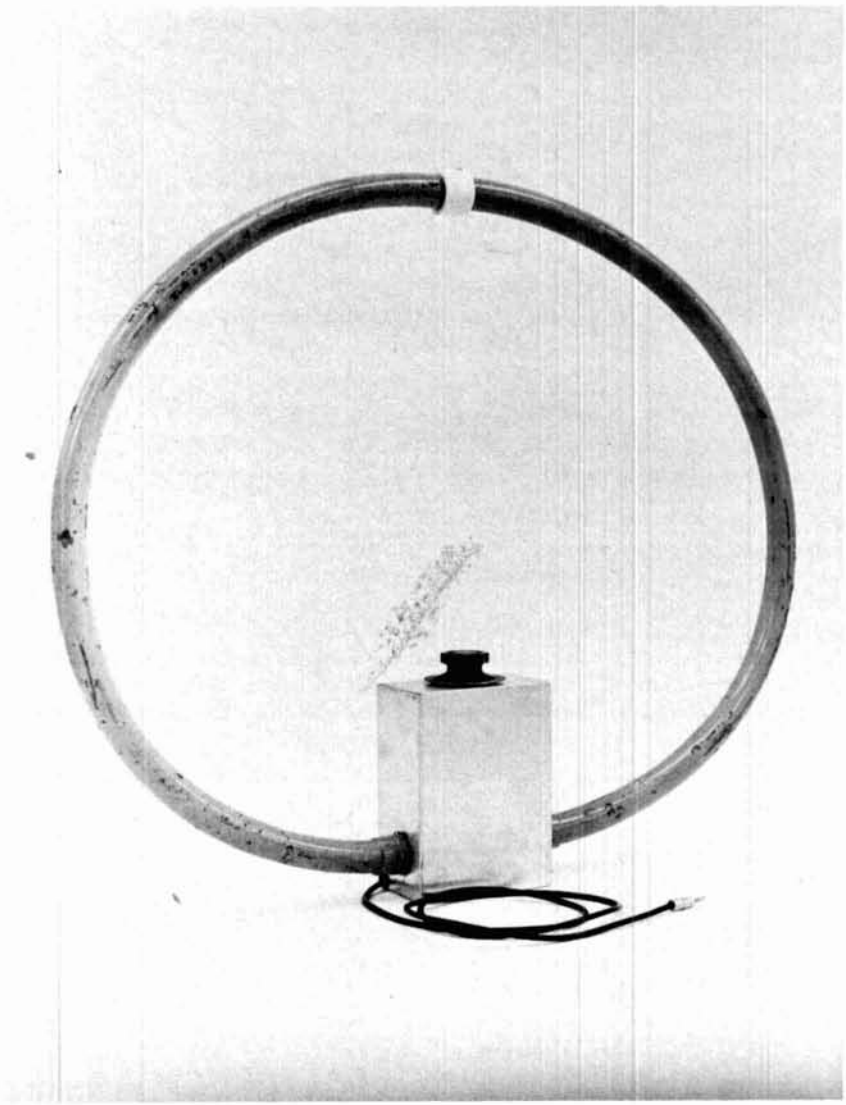

fig. 3. The W6PO version of the W6GPY receiving loop. Bob broke the electrostatic shield at the top with a section of phenolic material for ease of construction. The loop itself is made up of five turns of colored hookup wire, each wire having insulation of a different color. A sixth turn provides the coupling loop for the preselector. The wires are spaced within the 20-inch diameter assembly by phenolic washers. The loop wires are laid out and the washers slipped over them and tied in place. The wires are passed through the loop halves before assembly. Plumbing fittings are soldered to the copper tubing at the bottom to affix the loop to the 3 × 4 × 5 inch aluminum box. The tuning capacitor is atop the box and the coaxial cable to the receiver comes out the side of the box.

Connecting the individual loop wires in series is easy, as they are color coded. Depending upon the number of active turns, the loop can tune from 4 MHz down to about 1300 kHz. Three-quarter-inch-diameter copper water pipe is used for construction.

might have taken months to receive a confirming QSL card (just like today!).

In any event, there the matter rests. Deloy, Reinartz, and Schnell are Silent Keys. The calls 2AGB, 2CGK, and W9GA have been reassigned. The last clue is the present G2JL, still listed in the *Callbook*. Is the present license holder the operator of 2JL in 1923? I sent an air mail letter off to G2JL posing this question. So far, no reply has been received. I guess we'll have to wait a few more months to see if the October, 1923, contact is a valid contender for the first transatlantic QSO. Stay tuned in.

tuned loops for 160-meter reception

Interest in 160-meter operation has risen and fallen since the exciting days of 1923. As a result of the expansion of the band by the FCC a few months ago interest is reaching a new peak, with more and more stations coming on the band every day. Sad to say, a lot of newcomers give up in disgust at the racket they hear in their receivers: static, broadcast harmonics, and intermodulation, TV sweep oscillator QRM, and lots more.

Hams have grumbled about difficult receiving conditions on 160-meters for years — and a few of them have done something about it. One area of interest centers around the compact receiving loop antenna (**fig. 1**).

The small loop was very popular for general broadcast reception during the twenties but faded into obscurity, except for direction finding purposes, in the next few years.

The pattern of the small loop antenna resembles that of the dipole, being a figure-8 in the plane of the loop. The input resistance of the loop antenna is very low if the loop is small in terms of the wavelength. For typical receiving loops it is of the order of a few hundredths of an ohm. Moreover, because the area of the loop is small compared with the wavelength, loop pickup compared with that of a full-size antenna is greatly reduced. Receiving loops generally need from 15 dB to 20 dB signal "boost" before they can compare with a typical half-wave dipole antenna.

Why, then, use a loop? Mainly because the loop has two excellent signal nulls that can be used to knock down local signals, interference, or line noise. On DX signals the loop appears to be relatively nondirectional

because of the random polarization of the ionospheric-reflected signals. And because of the ability to virtually null out much local, manmade noise, the loop antenna can provide a superior signal-to-noise ratio in many circumstances.

In the case of natural static, if the null of the loop is aimed in the general direction of a storm the static level can be reduced substantially. On the West Coast, summer static seems to come from the central Canada areas, and placing a null of the loop in that general direction reduces bothersome static by several S-units.

Best of all, the tuned receiving loop can be rotated until it provides excellent rejection of those devilish signals from local TV receiver sweep oscillators that make reception miserable during the evening hours.

In order to be effective, the receiving loop must have an electrostatic shield about it to reduce coupling to the house wiring system — unshielded loops may provide good reception nulls as the handbook indicate, but when used indoors, as most loops are, they readily couple to the nearby electric wiring and pick up all kinds of unwanted noise directly from the power lines. The electrostatic shield helps prevent this.

A few experimenters have used loops for Amateur service on 160-meters, and the purpose of this article is to provide the reader with two proven designs that may be duplicated with a minimum of effort. The loops are worth their weight in DXCC QSL cards if serious 160-meter operation is desired. Remember, if you can't hear 'em you can't work 'em!

the W6GPY 160-meter loop

The W6GPY loop was designed pre-war and described in the April, 1938, issue of *QST* (**fig. 2**). The loop consisted of four turns of hookup wire spaced within an electrostatic shield made of 1-inch (inside diameter) copper tubing. The diameter of the loop was 20 inches. The loop was

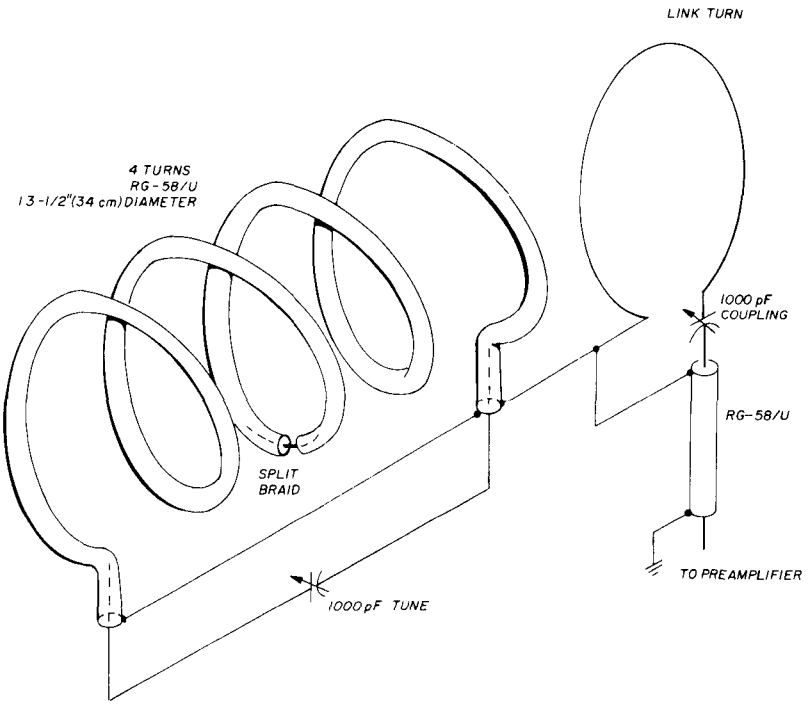

fig. 4. An oblique view of the W1FB loop as discussed in July, 1977, *QST* magazine. The loop is made of a 175-inch-long section of RG-58/U coaxial line. The shield braid is split at the center of the length and a section about 1-inch long removed. The line is then formed into a four-turn coil about 13-1/2 inches in diameter. The split in the shield is at the bottom of the coil, as are the connections. The outer braids are connected together as a common ground point and the inner conductor is tuned to resonance with a compression-type variable mica capacitor. A three-gang broadcast capacitor with a dial will provide a more comfortable tuning mechanism. The coax is formed into a four-turn coil and held in position with electrical tape. The pickup loop is made of insulated hookup wire and centered inside the coaxial coil. It is a good idea to tape the split braid at the center of the coil so a short does not occur at this point. The TUNE capacitor is adjusted for maximum signal strength. The COUPLING capacitor is decreased in value until a drop-off in signal strength is noted. Minimum coupling provides greatest loop selectivity.

tuned to resonance by a 350-pf capacitor and coupled to the receiver via a one-turn pickup coil and a low impedance, balanced transmission line. One end of the copper shield was insulated from ground to prevent shorting out the loop.

As for operation, the original W6GPY article said, "Loop antennas have very broad tuning characteristics when turned to the maximum signal, but are very sharp when turned to the minimum signal position. This means that the sharp minimum can be placed on a interfering signal or noise, and the broad maximum will allow the desired signal to come through."

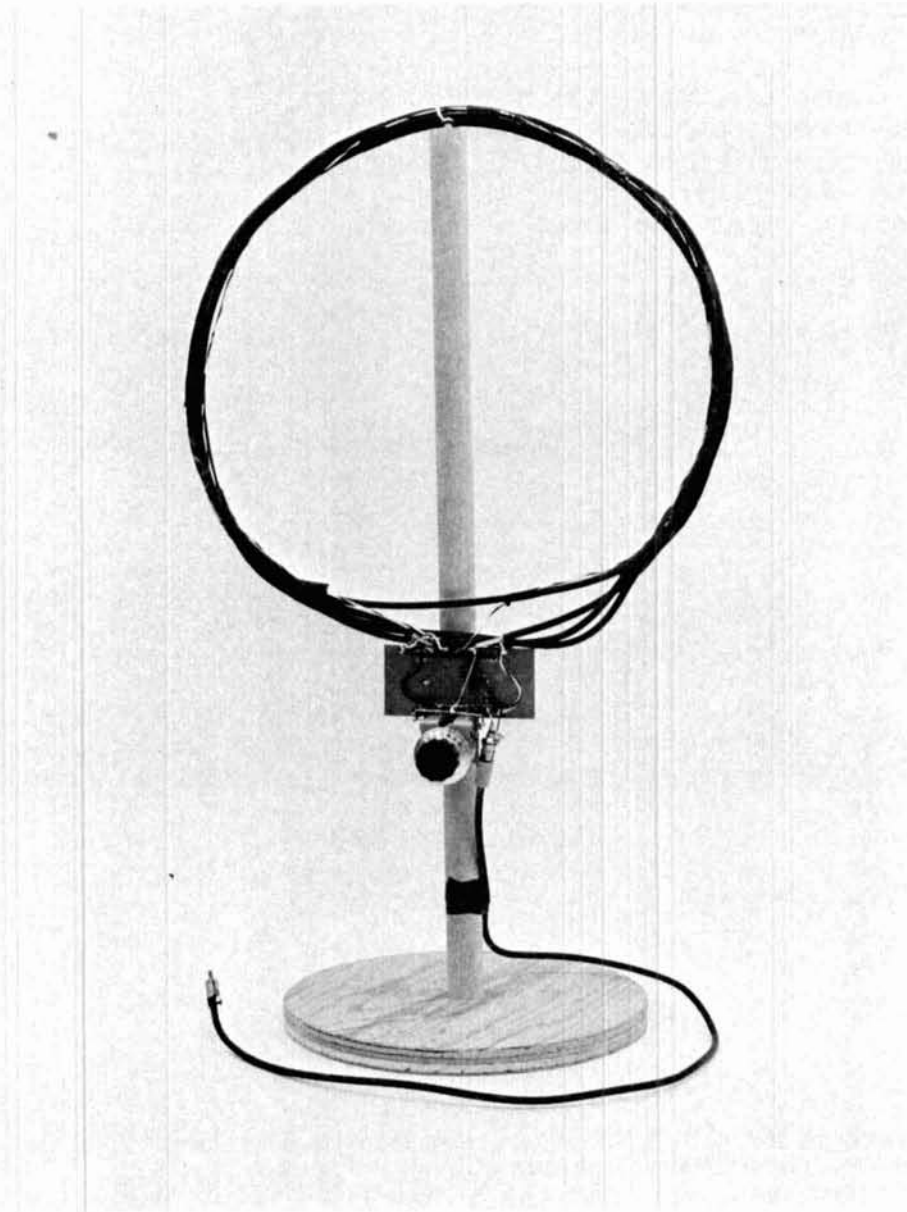

fig. 5. The "quick-and-dirty" version of the W1FB 160-meter receiving loop. Loop consists of four-turns of RG-58/U coax with a one-turn pickup loop made of hookup wire. Shield of coax line is broken at the center of the loop for 1 inch. The loop is resonated by a 500-pF capacitor (350-pF variable in parallel with 150-pF fixed). Series capacitor was replaced with fixed capacitor when correct degree of coupling to preselector was determined. Loop stand is made of wood dowel rod and circular plate cut from plywood. Assembly time — about an hour. Compact loop sits atop receiver.

The coming of war and cessation of Amateur activity in 1941 brought experimentation to a close and the subject of loops lay relatively dormant until the DX possibilities of the band were again explored between 1960 and 1965. My good friend W6PO had erected a 160-meter loaded ground-plane antenna and found to his dismay that while it was a "bear-cat" for transmission, it was nearly useless for reception — all he could hear was noise.

Remembering the W6GPY article, Bob built up a shielded loop (**fig. 3**) that is still in use today at W6SAI. To boost the gain of the loop, a small preamplifier was added between it and the receiver. Loop Q is quite high and the background noise peaks sharply as the loop is tuned through resonance. With the values given, the loop tunes from 1.4 MHz to about 3.2 MHz. The Q of the loop and the selectivity of tuning are poor above about 2.8 MHz.

The loop works extremely well sitting atop the receiver. The passband to the −3 dB points is about 20 kHz, so the loop must be accurately tuned for best signal. Null rejection is excellent and a S9 + 40 dB racket from a local TV receiver sweep oscillator can be knocked down to the noise level of the system, which registers about S4 during the summer, daylight hours. As expected, the "nose" of the loop is quite broad and, for most reception, the loop plane is left in an east-west position.

I used the loop for many months until W6PO started to make noises that he might want the loop back. So I decided to build my own receiving loop.

the W1FB receiving loop for 160 meters

The idea of bending copper tubing into a circle didn't appeal to me at all. Surely there must be a simpler way of building a shielded loop! Somewhere in the back of my mind I remembered a recent *QST* article about a 160-meter loop. A quick look through the

yearly indexes of *QST* seemed to reveal nothing. Finally, I started looking through the magazines issue by issue. I found what I was looking for in my July, 1977, issue of *QST*. The cutesy title, which was cryptic to me, was "Beat the Noise With A Scoop Loop." This excellent review of the W1FB loop experiments disclosed a simple, shielded loop made of coaxial cable. **Fig. 4** shows the electrical circuit of the loop, and a quick and dirty homemade replica of the loop is now in use at W6SAI (shown in **fig. 5**).

Thrown together in one afternoon, the W1FB loop performed nearly as well as the more complex W6GPY loop. Loop gain of the coaxial cable loop was somewhat lower than that of the bigger "copper tubing" loop. Bandwidth of operation was the same when the coupling capacitor was properly adjusted (approximately 350-450 pF). Rejection of signals at right angles to the plane of the loop was excellent. The only problem with this haywire loop was that it was self-supporting and after a few days the cable would droop and the loop would resemble a squashed hula-hoop. It was necessary to knead the cable back into the resemblance of a circle, at least for the esthetic value!

Earlier articles on receiving loops had stressed that the capacitance between the loop and the shield be held at a minimum for best results. The capacitance per foot of RG-58/U cable is quite high, so a second loop was built using low-capacitance RG-62/U cable. No appreciable difference in performance could be noted when the second loop was properly adjusted, so it would seem that the W1FB loop is satisfactory as is.

the loop preamplifier

Either loop design provides signals to the receiver that are about 15 to 20 dB below that provided by a good, outdoor antenna. Accordingly, a good, low-noise preamplifier having a gain of about 20 dB is required. A representative preamplifier is shown in the DeMaw article, or several are available on the market. The unit I used was the inexpensive AMECO PLF-2 picked up at a local flea market. Other suitable units are made by MFJ and Palomar.

using the receiving loop

It's easy. Tune the loop and preamplifier for maximum background noise. Adjust the position of the loop for maximum rejection of line noise, or TV sweep oscillator noise. Or, if noise is not a problem, adjust the loop for strongest received signal. As I said before, the loop pattern is extremely broad and the rejection null very sharp. It won't take long to adjust yourself to the operation of this valuable 160-meter accessory.

Don't overcouple the loop to the preselector or you will find it difficult to achieve loop resonance and loop tuning will interlock with preselector tuning.

other solutions to the receiving problem

The simple loop seems to be a popular receiving antenna for 160 meters. Some experimenters have tried a long wire (300 to 1000 feet) spaced a foot or two above the ground. Others have tried the more complex long-wire Beverage antenna. Many 160-meter DXers have a variety of receiving antennas, selectable at the rotation of a switch. A lot depends upon your local noise level. During the past summer, the 160-meter receiving test that seperated the men from the boys was the ability of W6s to hear the transmissions of ZD8TC on Ascension Island through the local QRN level. Both loop designs provided readable signals, whereas ZD8TC was uncopiable on a high, outdoor horizontal antenna. Reception of ZD8TC on a large ground plane was possible, at good signal strength, but the *readability* was much better with the small loop antennas, sitting atop the station receiver!

ham radio

Clegg AB-144 "All Bander" atop author's KLM-2700 2-meter transceiver. The KLM-2700 directly tunes 10 meters by means of an internal OSCAR receiver, so the AB-144 *isn't necessary for 10-meter* fm reception. The AB-144 up converter is used here to continuously receive 100 kHz to 30 MHz on the KLM-2700.

listening in on 10 fm

Tips for getting in on the action: 10-meter fm comes alive

Ten-meter fm activity, particularly in familiar 2-meter repeater style, is growing by leaps and bounds. The trend to 10 fm is encouraged by several factors, including the current sunspot peak, which makes 2-meter-type repeater DXing super fun, and the availability of several frequency-synthesized commercial fm transceivers, such as the Comtronix and the Azden PCS-2800.

I considered it a bit late in the sunspot cycle to get aboard with a major investment in another operating mode, yet I wanted to hear what was going on in this *hitherto unknown portion of the 10-meter* band (29.5-29.7 MHz). This led me to investigate several practical, low-cost methods of fm reception, which I'd like to share with others.

the KLM 2700

I have a KLM 2700 multimode fm transceiver, which has an internal 10-meter OSCAR receiver. I *found it would receive 10-fm signals very nicely*. The KLM radio has fairly low sensitivity on 10 meters. It's adequate for OSCAR satellite reception in the 29.3-29.5 MHz range but not spectacular. I found that the OSCAR receiver would, in fact, tune the *entire range* of 27-30 MHz, which includes the 27-MHz CB band as well as the so-called (and illegal) CB/HF range between the 27-MHz CB and Amateur 28-MHz bands.

Since sensitivity was low, I added a *Hamtronics* P9 preamplifier at a kit cost of only $12.95. This two-stage, grounded-gate preamplifier uses the new family of Siliconix super FETs, originally designed for UHF service. It *produces a gain of* 20-30 dB with a noise figure of 1.5-2 dB. The sensitivity on 10 meters was truly astonishing. I tucked the small PC board into a corner of the transceiver near the 10-meter antenna coax input connector on the rear apron and

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connected the board to the nearest 12 Vdc point. Simple? You bet!

The KLM 2700 radio is primarily an fm rig, so all that's necessary to demodulate 10-fm signals is to set the transceiver to one of the two fm modes (narrow or wideband), and tune the VFO to the proper frequency. Since the 10-meter receiver was intended for OSCAR reception only, direct-readout 10-meter dial calibrations are not provided. You must make a conversion chart or logging table to cover the 10-meter band.

It happens that the repeater band, which straddles 29.5-29.7 MHz, is found at VFO dial settings between 145.95 (29.5 MHz) and 146.15 (29.7 MHz); the popular 29.6-MHz simplex, or calling, frequency is found in the center of the range, at 146.05 MHz.

You can also tune the four repeater channels (29.520-29.580 MHz input or 29.620 MHz-29.680 MHz output) by switching to the synthesized, digital-readout mode and cranking through this range in 20-kHz steps.* This sounds very complicated, but as any KLM 2700 owner knows it's really simple. Needless to say, 10-meter fm reception is superb on the very slightly modified KLM.

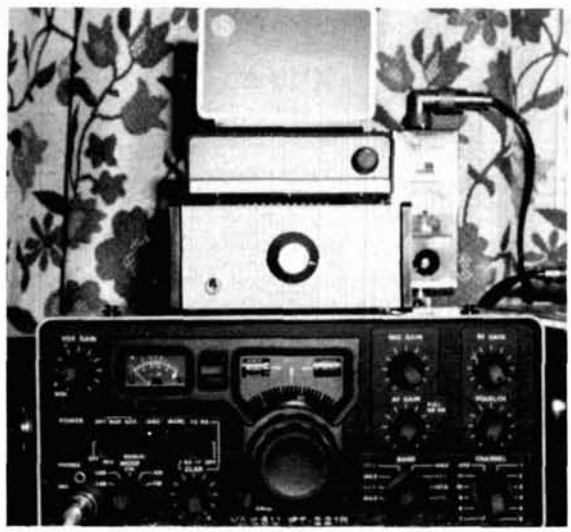
the TS-700S

An alternative route I followed in gearing up for 10-fm reception involved using a Kenwood TS-700S multimode transceiver in conjunction with a Clegg AB-144 "All Bander" up converter. The TS-700S, like the KLM 2700, is capable of first-rate 10-fm reception. This is made possible by the AB-144, which receives signals in the low-frequency, medium-frequency, and high-frequency ranges (100 kHz-30 MHz) and *up converts* them to one of the four, 1-MHz, 2-meter ranges of the TS-700S. I've found this unit to be absolutely outstanding for general-coverage SWLing and broadcast-band DX chasing without a separate communications receiver. With the up converter, all-band reception performance is limited only by the quality of the 2-meter transceiver with which it is used — and the TS-700S is an excellent multimode rig.

The TS-700S 2-meter transceiver and 700S remote VFO. Author Thurber uses the Clegg AB-144 "All Bander" up-converter with this rig for low-frequency, medium-frequency, and high-frequency reception, and specifically to receive the 10-meter fm segment (29.5-29.7 MHz). The zero-center fm tuning meter and squelch control on the TS-700S are fully operational using this method.

To receive 10-meter fm, the AB-144 converter is set to the 26-30 MHz range, the TS-700S bandswitch is cranked to the 147-MHz range, and the transceiver is tuned between 147.5 and 147.7 Mhz, corresponding to 29.5-29.7 MHz in the 10-meter band. Good use can be made of the zero-center fm tuning meters and the squelch controls, which are fully operable on 10 meters on both transceivers. The TS-700S also has a built-in 2-meter preamplifier, which can help in pulling in weak fm signals by acting as an extra stage of i-f amplification. I've also used this arrangement with a Yaesu FT-221R transceiver with equally good results.

Another possibility, one I haven't tried, is to use a 10-meter converter such as the *Hamtronics* CA28, to up-convert the 10-meter band to 144-148 MHz. In conjunction with a multimode transceiver, complete 10-meter-band reception would, of course, be available — not just the fm segment.



One corner of author Thurber's station. The Clegg AB-144 "All Bander" up converter, shown immediately above the FT-221R transceiver, tunes the fm portion of 10 meters. Above the AB-144 is a digital-frequency readout unit for the transceiver. Author's callsign placard sits on top. Although the article describes the use of the Clegg AB-144 with the Kenwood TS-700S transceiver, the AB-144 works well with the Yaesu transceiver and should work equally well with other fm or multimode 2-meter rigs for 10-meter fm reception.

*10-fm repeater spacing is 20 kHz, and offset is 100 kHz. Four channel pairs are available for us. Simplex channels are 29.500 and 29.600 MHz.

Author's CB coaxial vertical antenna from Radio Shack gave a good account of itself on the 27-MHz CB band, Amateur 10-meter SSB and CW band, and on 29.6-MHz Amateur fm. It has since been replaced by a Cushcraft fm Ringo for optimum 10-meter performance.

antennas

Ten-meter receiving antennas are by no means critical. For two years I used a Radio Shack CB-style coaxial vertical antenna for all 10-meter work until it bit the dust in a recent household move. It was replaced by a Cushcraft AR-10 10-meter fm Ringo, a very attractive end-fed halfwave vertical antenna designed to resonate at 29.6 MHz. This antenna provides a very flat, 1:1 match to 50-ohm coax by means of a 10-inch (25.4-cm) diameter tuning-ring assembly and a coaxial stub matching device. The 3.75-dB-gain antenna can also be used on other portions of the 10-meter band. Somewhat less-expensive CB versions, the CR-1 and CX-1000, are also available.

The Amateur 10-meter band is truly fascinating (not to speak of the freaky illegal "CB DX band" just above 11 meters). I have given some ideas for getting in on the action with today's Amateur transceivers and some peripheral equipment. Now you're on your own. Who knows how long the present propagation conditions will last?

ham radio

More Details? CHECK—OFF Page 98

phantom-coil VXO

An artificial transmission line creates the illusion that a variable capacitor is the large variable coil required by a low-frequency VXO

The unit described here is used to replace the VFO in transmitters. In this application the VXO has high frequency stability and very small warmup drift.

Another application is to employ the VXO as a local oscillator for a direct-conversion receiver; such a receiver would have near crystal stability, so could give really useful reports on the frequency stability of incoming signals. Of course, the same VXO could also be used for transmitting if a dc transceiver were desired. A heterodyne arrangement where the VXO beats against a switch-selected set of crystals would have the advantages that a) stability would be better because both oscillators run continuously; b) break-in could be had by keying the mixer; and c) the frequency offset between transmit and receive could be obtained by switching capacitance across the appropriate crystal in the set. (I intend to produce a transceiver of this type for a QRP portable.)

A third possibility is the use of a VXO for the high-frequency oscillator in an fm receiver. This system would be virtually drift-free without the disadvantages of AFC systems.

types and characteristics of VXOs

The frequency of a crystal oscillator may be shifted over a restricted range by connecting variable reactances in series with the crystal. Since the frequency stability will decrease with frequency range, the designer must know the relationship between stability and range to arrive at a satisfactory arrangement for the intended application.[1] The CVXO, using variable capacitance only, always operates above series resonance for the crystal and is nearly as stable as a fixed crystal oscillator. But even with the greatest care in circuit design,[2] it is not possible to exceed a range of about 5 kHz on 40 meters if standard crystals are used.

On the other hand, the LVXO, using the equivalent of a variable inductance, can exceed a range of 50 kHz on the same band, but the stability will decrease with range as shown in **fig. 1**. Here the definition of stability is the percentage change in load reactance required to produce a given percentage change in frequency; it is shown in relation to a similar measure for the common LC oscillator. (By comparison, the CVXO is always at least 1000 times more stable than an LCO.) Also shown in **fig. 1** is the enormous inductance required to shift the frequency. The LXVO always operates below f_s, the series-resonant frequency of the crystal. Typically, f_s for 40-meter HC6/U crystals is 2 to 3 kHz below the frequency of operation with a 32-pF load capacitance; crystals may be ordered for specified values of f_s.

It is usual to obtain an effective variable inductance by connecting a large fixed inductor in series with a large variable capacitor. The minimum reactance of the capacitor must be small compared with the inductor's reactance, and its maximum must be equal to that of the inductor. This arrangement has a number of disadvantages:

1. A good coil must be inconveniently large mechanically on 7 MHz and lower frequencies

2. As a result of the large inductance, the self-resonance of the coil will be too close to the operating frequency, which will reduce the stability of the coil.

3. Because, near series resonance, the net reactance is the difference between two large numbers, the stability may be expected to suffer.

By Frank W. Noble, W3MT, 10004 Belhaven Road, Bethesda, Maryland 20034

4. Bizarre capacitor plate shapes are required to obtain reasonable frequency linearity.

reactance inversion

An improved tuning arrangement employs the reactance inversion properties of transmission lines. Consider an ideal line of characteristic impedance, Z_0, ¼ wavelength long, and terminated at the receiving end with a variable capacitor, C_T. According to Terman,[3] the impedance presented to the transmitting end is

$$Z = \frac{Z_0^2}{Z_T} = Z_0^2 j\omega C_T \equiv j\omega L_p \qquad (1)$$

where L_p is an equivalent or "phantom" inductance of value

$$L_p = Z_0^2 C_T \qquad (2)$$

Apparently the line has "inverted" a variable capacitance to a variable inductance. It is evident that L_p is linearly related to C_T, varying from the origin with a slope of Z_0^2. We may in theory adjust Z_0 to whatever value we please to obtain very large values of L_p for reasonable values of C_T. However, Z_0 for coaxial lines will not usually exceed 100 ohms, which is too small for our purposes. Also, real lines are very inconvenient mechanically on 40 meters.

Perhaps the simplest artificial line[4] is one-half of a "halfwave filter"; it consists of a single low-pass pi section with all reactances numerically equal at the operating frequency. Terminating this circuit with C_T as before, we have the circuit of **fig. 2**. Dispensing with the j operator, it is readily shown that

$$Z_1 = -\omega L \qquad (3)$$

and

$$Z_2 = \frac{\omega L}{\frac{C}{C_T} + 1} \qquad (4)$$

so that

$$Z = \omega \frac{L}{C} C_T \equiv \omega L_p \qquad (5)$$

from which

$$L_p = \frac{L}{C} C_T \quad \text{again the "phantom."} \qquad (6)$$

Note that L/C corresponds to Z_0^2 for a real line, but that it can have much larger values than are usual for coaxial lines. In contrast with real lines, the values of L and C for the "quarter-wave filter" are not independent. In every case

$$LC = \omega^{-2} \qquad (7)$$

so that

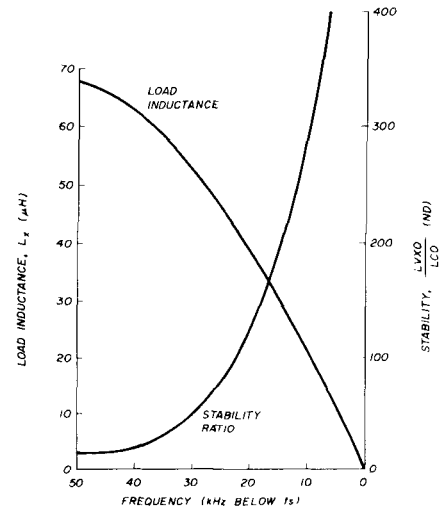


fig. 1. The LXVO can exceed a tuning range of 50 kHz on 40 meters, but the stability will decrease with range. Left-hand ordinate, equivalent load inductance versus frequency shift below crystal series resonance, f_s. Right-hand ordinate, stability ratio of the LXVO with respect to an LCO versus frequency shift below crystal series resonance. (HC6/U crystal, 40-meter LVXO. $C_0 = 6\ pF$; $r = 250$.)

table 1. Crystal list. All crystals are partially plated fundamental AT cuts, type HC6/U, specified for series-resonant frequency. (Available from JAN Crystals, 2400 Crystal Drive, P.O. Box 06017, Fort Myers, Florida 33906.)

crystal	frequency (kHz)
Y1	7010
Y2	7020
Y3	7030
Y4	7040
Y5	7050

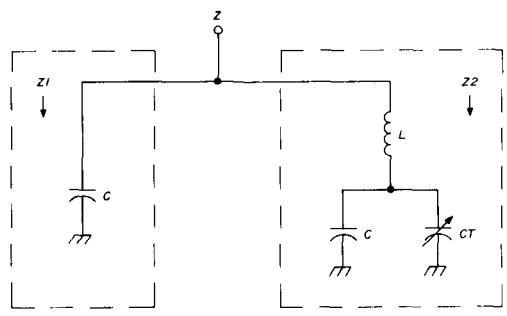


fig. 2. Circuit for an artificial quarter-wave transmission line terminated in a variable capacitor.

$$\frac{L}{C} = (\omega L)^2 = \frac{L_p}{C_T} = \frac{1}{(\omega C)^2} \quad (8)$$

whence

$$L = \frac{1}{\omega}\sqrt{\frac{L_p}{C_T}} \text{ and } C = \frac{1}{\omega}\sqrt{\frac{C_T}{L_p}} \quad (9)$$

From **eq. 6**,

$$C = \frac{L}{L_p} C_T \quad (10)$$

Also from **eqs. 6** and **8**,

$$Z_0 = \omega L = \frac{1}{\omega C} \quad (11)$$

where Z_0 is the characteristic impedance of the quarter-wave filter.

design example

We require an LVXO giving continuous coverage of the lower 50 kHz of 40 meters, and having a frequency stability at least 100 times better than an LCO. From **fig. 1** we find the maximum deviation for this stability is about 16 kHz. For convenience, we elect to reduce the deviation to 10 kHz, where the stability ratio is about 200; *i.e.*, about a fifth of the stability of a fixed crystal oscillator.

Also from **fig. 1** we find $L_x = 35.6\ \mu H$. To this must be added more inductance to cancel the reactance of the circuit to the right of Y_1 in **fig. 3**. Neglecting small effects,[5] the oscillator "looks" like the series combination of the coupling capacitors; *i.e.*, 110 pF. The additional inductance is 4.7 μH. Therefore, the inductance must range from 5 to 40 μH, approximately.

We arbitrarily assign $C_{T_{max}} = 245\ pF$. Then from **eq. 9**, $L = 9.16\ \mu H$, and from **eq. 10**, $C = 56.1\ pF$. The minimum value of C_T is that required to make $L_p = 5\ \mu H$, to cancel the input capacitance of the oscillator; $C_{T_{min}} = 31\ pF$.

The tentative design for the oscillator is given in **Fig. 3**. Note that we may include the left-hand C in the variable capacitance to save a part and to provide some additional inductance range to accommodate variations between crystals. (A semi-circular-plate, 365-pF air variable will be used in the final design to provide some latitude at both ends of the nominal range and to avoid the nonlinearities that occur near the extreme positions of a variable capacitor.)

inductance

By far, the most important consideration in this design is the quality of the pi-section inductance, since the filter uses air capacitors, and the oscillator input capacitors can be excellent (air, polystyrene, silver mica, etc.). The inductance requirements are:

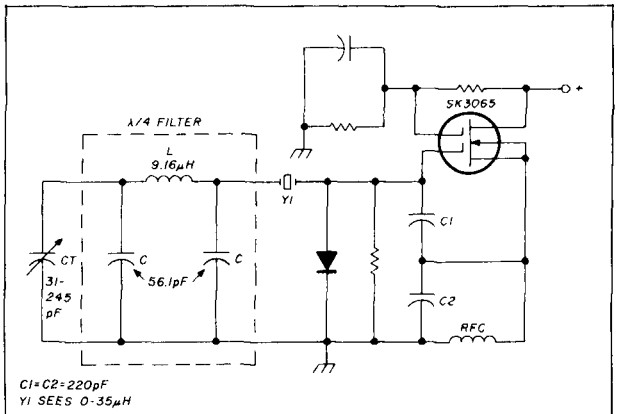


fig. 3. Tentative circuit for a VXO using an artificial quarter-wave line to transform a variable capacitor to a "phantom" variable inductance. The crystal "sees" an inductance that is variable continuously from zero to 35 μH by means of C_T. Omitting the left-hand C, the variable capacitor must have the range 87-301 pF approximately.

1. Low distributed capacitance, so self-resonance will be far above 7 MHz. For a given coil quality, the higher the self-resonance the more stable the coil will be. A long, slim, close-wound coil is desirable for this property.

2. High Q, so that the oscillator coupling capacitors can be large. The larger the coupling capacitors, the less effect their instability will have; more important, since they shunt the transistor, larger capacitors will reduce the effects of drift in the transistor capacitances and conductances, as is the case with the Clapp circuit. High Q and low distributed capacitance are not compatible; the latter is probably more important.

3. Small physical size, so that the field of the inductance can be contained within shielding of reasonable size.

4. Mechanical rigidity.

5. Small temperature coefficient. This requriement will be less important if the heat dissipated within the cabinet can be minimized and isolated from the coil.

In particular, any kind of ferrite or iron-core coil is to be avoided because the temperature coefficient will be poor, and the inductance may vary with signal level. The machine-wound B&W *Miniductor*™* coils are probably the best choice. Their chief drawback is

*Miniductor is a registered trademark of Barker and Williamson.

that they are very hard to cut apart without special equipment. I used an electrically heated razor blade at 100 watts. Even with this, the tendency is to come out short on turns because the end turn loosens from the heat.

I had on hand a B&W No. 3008 *Miniductor*, which is 5/8 inch (16 mm) diameter. It was cut at 35 turns, giving a finished length of 1-3/32 inches (27.8 mm). The formula inductance is 8.7 μH, and its self-resonance measures about 65 MHz. The calculated inductance at 7 MHz is about 8.8 μH, somewhat below the design value of 9.16 μH. (The effect of switch and socket capacitance, which I did not consider, is to reduce L_x — so, for once, I erred in the right direction.) Going back through the math, C becomes 58.3 pF and the variable ranges from 89 to 303 pF. The "characteristic impedance" of the finished "quarter-wave filter" is about 388 ohms.

final circuit

Referring to **fig. 4**, the transistors are all dual-gate MOSFETs, RCA SK3065 or equivalent. For Q1 we need a) low input capacitance and conductance so that transistor drift will have little effect, and b) high transconductance so that the coupling capacitors can be large, immunizing the circuit to transistor drift and minimizing the additional inductance mentioned above. The diode clamps the positive maximum of the signal slightly above ground, stabilizing the amplitude and the transistor input capacitance.[6] The second gate provides a convenient means of controlling gain.

For Q2 we need effective buffering and low output impedance to ensure stability of the following stage. For effective buffering, the very low input capacitance and conductance of the MOSFET is desirable; and, since the output impedance varies inversely with transconductance, the high g_m of the SK3065 gives it an advantage over the more commonly used JFET; the cost is comparable. This stage is direct-coupled to the oscillator, saving two parts. Since the dc component at the Q1 source is small, we simply increased the Q2's source resistor to compensate.

For Q3, we need additional buffering and voltage

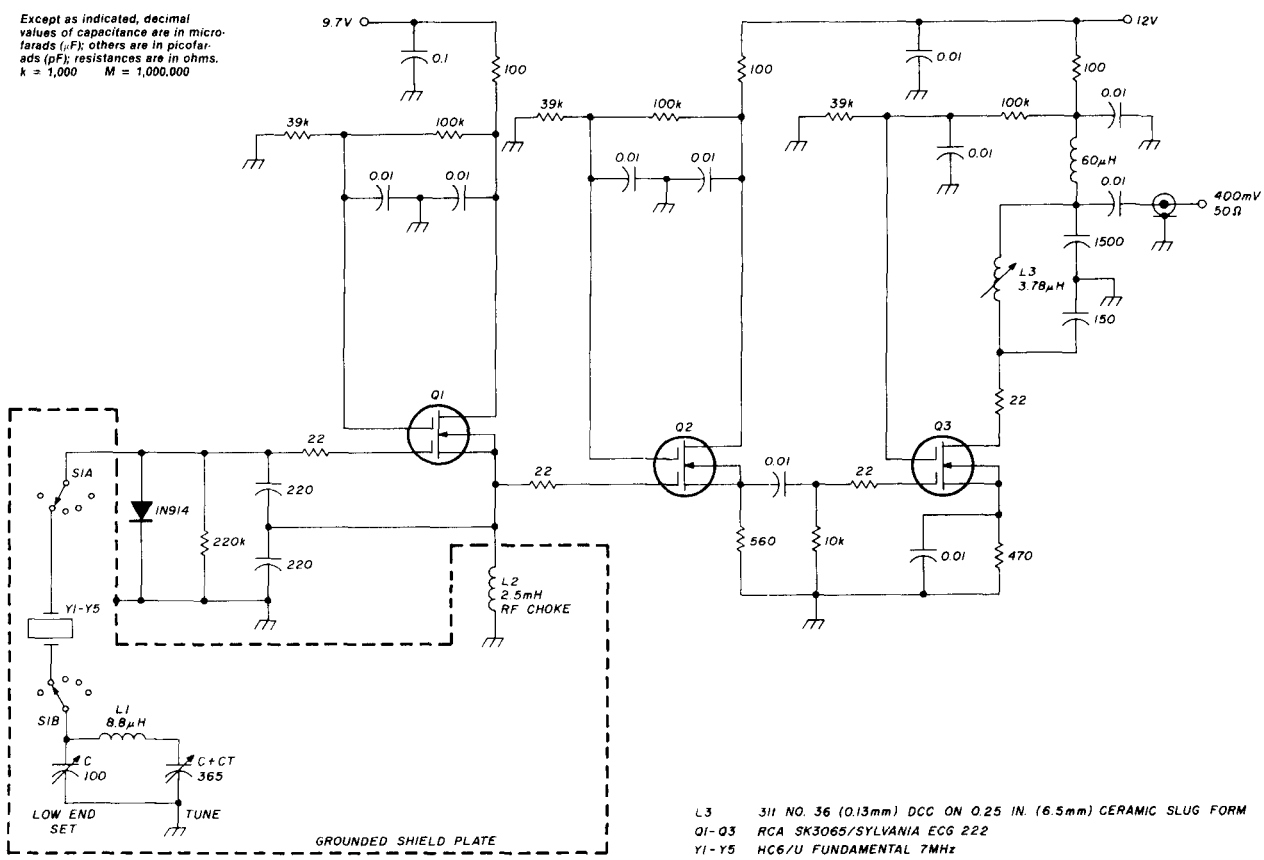


fig. 4. Author's design for the "phantom-coil" VXO, which is a first model to test the theory. Improvements are suggested in the text. Data for crystals Y1-Y5 appear in table 1.

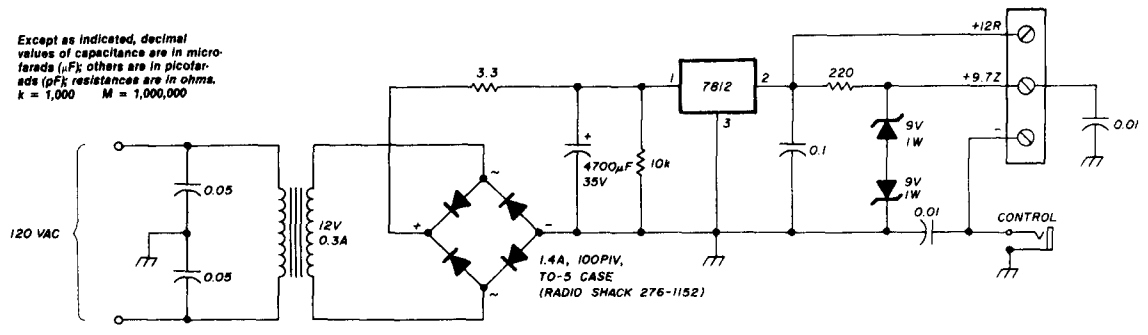


fig. 5. Power supply for the VXO. It was built in a separate enclosure to isolate the VXO from vibration and heat.

gain, $g_m\ Q\omega L$. Since the frequency range is small, it is hardly possible to get a too-large Q in the physically small output coil (Q must not exceed 140). The large drain resistance of the FET shunts the coil very little, and the large transconductance gives the device large voltage gain. In addition, the bypassed second gate reduces gate 1 to drain capacitance, tending to stabilize the stage and to isolate the output from the oscillator. The output circuit is a low-pass filter having an impedance transformation of about 100, providing a reasonable match of the transistor to 50-ohm coaxial cable. Q3 provides about 400 mV into 50 ohms.

power supply

Current requirement is small, so an ordinary zener regulator would suffice. However, the 7812 IC is inexpensive and offers better regulation, reduced ripple, and thermal shutdown. See **fig. 5**. The oscillator stage is supplied by a zener regulator of unusual type.[7] Since the temperature coefficients for zener and forward conduction are of opposite sign, the back-to-back connection of the two 9-volt zeners should have better temperature stability than a zener alone — and produce about 9.7 volts because of the forward drop in the lower diode. The shorting phone jack labeled **control** activates the oscillator from an external switch for spot and send functions.

mechanical details

The oscillator enclosure is a Bud cabinet No. AU-1029, measuring 4 by 5 by 6 inches (10 by 12.7 by 15 cm). The cover plates were replaced with 1/8 inch (3 mm) aluminum to stiffen the assembly. All parts were attached to the front panel using spacers where necessary. The crystals and other frequency-determining parts were separated from the amplifiers by a grounded shield plate; the oscillator leads were passed through small holes in the shield. The output coil is partially shielded by its mounting bracket and is physically separated, as far as possible, from the oscillator. The rf-output and power-supply leads pass through the back plate and are firmly held by a Romex™ clamp.

The power supply is housed in a small minibox separated from the main chassis. Elaborate bypassing and shielding are necessary to minimize rf pickup since the oscillator runs at very low level.

performance

To check the frequency stability, the setup shown in **fig. 6** was used. The offset between VXO and the crystal standard was adjusted to exactly 120 Hz, as shown by the butterfly Lissajous figure produced by the mixer output *versus* the power-line frequency. (Except for occasional phase shifts, the 60-Hz line frequency may be considered absolute.)

The offset is desirable because it tends to reduce pulling effects, that is, the tendency for the oscillators to synchronize. The pattern will rotate at the difference frequency, and the rotation will be smooth in the absence of pulling.

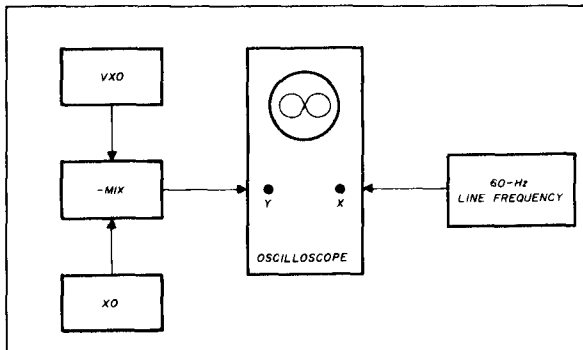


fig. 6. Block diagram of author's setup to test frequency stability of the VXO. Test procedure is described in the text.

The beat between the oscillators generally holds to within about 5 Hz over a one-hour period when both are stabilized. Since this is probably as good as the crystal standard, I conclude that the phantom-coil VXO is about on par with ordinary crystal oscillators.

The start-up drift of the VXO, measured against a stabilized standard crystal, is so small as to be unmeasurable with this scheme.

suggested improvements

The unit described here is a first model built to test the theory. Among the improvements to be considered are:

1. Increase the value of C_T so that an even smaller coil could be used. The ideal coil for 40 meters is about 6.25 μH, requiring $C = 82$ and $C_T = 526\ pF$ respectively. Allowing for some overlap, C_T should be a semi-circular-plate variable capacitor of about 640 pF — a part difficult to acquire.

2. Use the smaller B&W No. 3004 miniductor. This coil has better geometry for low distributed capacitance and is more convenient to use mechanically. The coil might be mounted more securely and placed farther from the shielding.

3. Double shield the oscillator and improve the buffering and bypassing. (This model is very sensitive to rf in the station.)

4. Place the output coil and choke in full shields. The fact that keying the output from open to short circuit produces measurable frequency shift means that the coupling between the output and the frequency-determining circuit is not as small as it should be. Link output might be preferable.

5. Use a larger cabinet, perhaps a 6-inch (15-cm) cube.

6. Use a low-ratio logging vernier dial.

I welcome communication with others who may wish to develop this idea further. Please include a self-addressed, stamped envelope with your comments.

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5. Landee et al, *Electronic Designers' Handbook*, McGraw-Hill, 1957, pages 6-9
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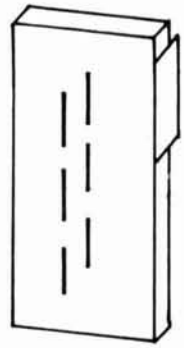

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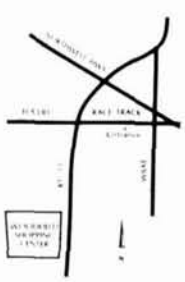

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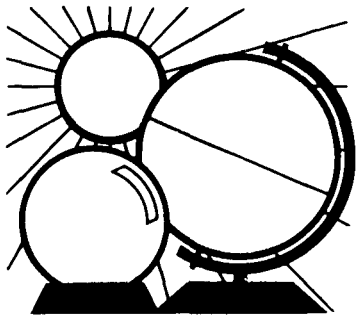

DX FORECASTER

Garth Stonehocker, KØRYW

last minute forecast

January is very similar to December in propagation and solar-terrestrial effects. The shortest days and the closest proximity to the sun come about at winter solstice, the last third of December. There is a normal lag in ionospheric effects, much like the lag in winter's tempeture averages, which are usually lower in mid-January than at December solstice. The ionosphere is a balanced energy system that takes time to adjust to seasonal changes. Thus we see a progressive but slow change month by month through the year.

The ionosphere demonstrates a fast steep rise in maximum usable frequency (MUF) along with the rising sun. The MUF reaches a high (sharply pointed peak) value just after noon, local time. It goes down after noon but not as steeply as it rose; the decay is a slower process than the build-up of ionization. If you're near the equator (±20 degrees magnetic latitude), the MUF may remain high until late evening. This accounts for the excellent one-long-hop trans-equatorial propagation of the winter months. The propagation maximum is about 2000 local time and is enhanced by disturbed geomagnetic conditions of an A figure greater than about 25 or a K of 4.

The DX forecast for January is that, after a slow start the first week, the second and third weeks of the month should be very good on the higher frequency bands, returning to fair the last week. Solar flares may spawn a short geomagnetic disturbance around the 15th and 18th. Other disturbances may be observed in the first and fourth weeks, when the better DX is expected on the lower frequency bands. Remember, though, that a bit of disturbance, when the geomagnetic field is varying, moving the ionization around, gives paths to unusual DX for short periods (15-30 minutes). Stay in there even though signals may be weak and fading.

Lunar perigee is on January 8 this month. There will be an intense but short meteor shower lasting a few hours some time between January 2nd and 4th. It is known as the Quadrantid shower.

Are you a new ham that has discovered the thrill of DX with that new rig you got for Christmas, or an old ham that has taken time out from years of rag chewing for a renewed go at DX chasing? Either way, you may be interested in the fundamentals of propagation and rules of thumb that will help you put that signal where you want it. Through the year you'll get just that by watching this column, and you'll get a monthly forecast of propagation conditions too. It may not make you an ionospheric physicist or a communications engineer; but it will enable you to have some fun trying to do your own forecasting — or just keep you abreast of what's going on as you work DX. If you're really interested in current conditions and forecasts, try subscribing to the biweekly *HR Report*. If you're interested in more forecasting details, you may write to me at Route 1, Box 36, Earlysville, Virginia 22936.

band-by-band summary

Six meters will open occasionally for F2 long skip by the trans-equatorial one-long-hop propagation mode (TEM). The openings will follow the sun during the day and into late evening. Geomagnetic disturbances will enhance this mode, as will a high solar flux.

Ten meters will have openings more often and of longer duration than will six meters. The openings could be TEM or regular F2 long skip during the 27 days of solar flux maximums. In either case it is a good time to talk to our friends down under. Openings may favor southern Africa, South America, and Australia — particularly southern Africa.

January

GMT	PST	WESTERN USA N	NE	E	SE	S	SW	W	NW	MST	MID USA N	NE	E	SE	S	SW	W	NW	CST	EST	EASTERN USA N	NE	E	SE	S	SW	W	NW
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0700	11:00	—	40	—	20	20	15	15	—	12:00	—	40	—	40	20	15	—	20	1:00	2:00	—	40	—	20	20	20	—	—
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1300	5:00	—	—	15	—	40	40	—	40	6:00	—	20	15	15	20	40	—	—	7:00	8:00	20	10	15	40	—	40	40	—
1400	6:00	—	15	15	20	40	40	40	40	7:00	20	15	15	10	—	40	—	—	8:00	9:00	20	10	10	15	—	80*	20	—
1500	7:00	—	15	15	20*	40	40	40	40	8:00	20	15	10	10	—	20	20	40	9:00	10:00	20	10	10	10	—	40	15	—
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		ASIA FAR EAST	EUROPE	S. AFRICA	S. AMERICA	ANTARCTICA	NEW ZEALAND	OCEANIA AUSTRALIA	JAPAN		ASIA FAR EAST	EUROPE	S. AFRICA	S. AMERICA	ANTARCTICA	NEW ZEALAND	OCEANIA AUSTRALIA	JAPAN			ASIA FAR EAST	EUROPE	S. AFRICA	CARIBBEAN S. AMERICA	ANTARCTICA	NEW ZEALAND	OCEANIA AUSTRALIA	JAPAN

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

Fifteen meters can have the same TEM modes as 6 and 10 meters. The openings should be frequent and long. Worldwide DX is prevalent from after sunrise until well after sunset, especially during the periods of high solar flux (listen to WWV at 18 minutes after the hour for reports on solar and geomagnetic conditions). A good practice when bands are open is to work the highest band that is open first, then drop down in frequency to catch each band until it closes.

Twenty meters will be open most days and nearly through the night to some areas of the globe, with long skips of 1000-2500 miles and plenty of short-skip of 1200 miles near midday. Both propagation modes follow the sun across the sky: east, south, then west. This is the workhorse of the bands for DX as well as traffic handling.

Forty meters is the transition band into all-night propagation as well as some short skip during the day. Most areas of the world can be worked from darkness till just before sunrise. Hops shorten on this band to about 2000 miles, but the number of hops can increase since signal absorption is low during the night.

Eighty meters is traditionally a rag-chewer's band but much DX work is also possible. The band operates much like 40 meters except that the hop distances shorten to about 1500 miles at night, and even shorter during the daytime. Noise from distance thunderstorms is so low as to make these bands a joy to work this time of year. The path direction follows the darkness across the earth (east, south, then west). Just wiggle in between the QRM.

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NOTICE: I will pay $1/oz. for gold-plated pins, connectors, transistor leads and PC board fingers. W6TWT, Ron Guard, 10105 Stern Ave., Cupertino, CA 95014. (408) 252-5067.

ATLAS DD6-C Digital Dial $120.00 plus $4.00 UPS. NEW, while they last. Mical Devices, P.O. Box 343, Vista, CA 92083.

FOR SALE: Heath SB-301, SB-401, SB-630 console, speaker and access. Best offer. Jim Taylor, K9JT, 6720 N. 75th St., Milwaukee, WI 53223. (414) 353-1977.

RTTY JOURNAL-EXCLUSIVELY AMATEUR RADIOTELETYPE, one year subscription $7.00. Beginners RTTY Handbook $5.00, RTTY Index $1.50. P.O. Box RY, Cardiff, CA 92007.

HEATH HW-101, *AC & DC PS, CW filter, excellent cond.* w/manuals $300/offer. Collins mech. filters, FA style. 455 kHz IF 6 kHz BW — $5.00 ea. 2.1 kHz BW — $20.00. Dave Wells, KD6TC, P.O. Box 27373, Oakland, CA 94602. (415) 531-2800.

BUSINESS WANTED: Entrepreneur/hams interested in buying an active electronics manufacturing business, preferably ham-related. Reply to J. Smallwood, Box 242, Blacksburg, VA 24060. 703-951-9030.

COLLECTION of Ham Radio magazine for sale. Issue #1 to April 1980. HR binders through '78. Excellent condition $200.00. Nick Adams, WA4YKV, 3009 N.E. 14th St., Gainesville, FL 32601.

RECIPROCATING DETECTOR Handbook, $10.50 ppd. Peters Publications, 19 Loretta Rd., Waltham, Mass. 02154.

SELL: Rare old radio books. SASE for list. Samkofsky, 1420 Mount Vernon Drive, Holiday, Florida 33590.

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FOR SALE: House full of Ham equipment. WSI SY33 triband antenna; WSI 33-6MK antenna modification kit; *I beam, 7 element 2m antenna; 42' tower; Yaesu 2m mem*orizer transceiver FT-227R; Kenwood 2m transverter TV-502; Kenwood transceiver TS-820; Kenwood remote VFO-820; Heathkit 2m transceiver HW-30; Hallicrafter RF power amp HT-33; CAI 1kw linear amp. CL-40; homemade equipment; cabinets; books; magazines; electronic equipment; antique radios including RCA radiola 60, Stromberg-Carlson triple range radio; parts; lots more. Must see for yourself. Lee Hecht, 75 Willis St., Northport, NY 11768. (516) 757-4671.

MANUALS for most ham gear made 1937/1970. Send $1.00 for 18 page "Manual List", postpaid. HI-MANUALS, Box H802, Council Bluffs, Iowa 51502.

HEATHKIT SB 301, CW/AM filters, SB 600 speaker, $200.00. Collins 32S3A transmitter, Heathkit HP23B power supply, 92 crystals, $600.00. Package $700.00. I ship UPS. Lyle McWilliams, WA@NOK, 103 South Landcaster, Raymore, MD 64083. (816) 331-5912.

SATELLITE TELEVISION: Information on building or buying your earth station. Six pages of what's needed, where to get it, costs, etc. $4.00 to Satellite Television, RD #3, Oxford, NY 13830. Build your own parabolic antenna. Book also available. Send SASE for details.

NOVICE SHACK STARTER! Heath HR-1680 Rcvr — $150; HS-1661 Spkr — $15; SBA-104-1 Noise Blanker — *$25. Package price* — $175. *Knight KG-620 VTVM* — $20; Heath IG-102 RF Signal Generator — $25. Both for $40. Heath HM-102 SWR/wattmeter — $30. I ship it all for $240! George Ritter, WB8EPE, (614) 587-7290 (work); (614) 366-3970 (home).

BUSINESS OPPORTUNITY — Manufacturer's Representative — Los Angeles based seeks business partner with electronic engineering background, fluency in foreign language an asset. Cover both S. Calif. and International market. Please mail resume to Ham Radio Magazine, Box 0, Greenville, NH 03048.

SOLAR PANELS: Surplus, big savings!! Several sizes to choose from. Ideal for repeater. Write or call for com-

plete info. Possible trade? Bob (K6CKD) 714-581-6369, 21946 Yellowstone Ln., El Toro, Calif. 92630.

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

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RUBBER STAMPS: 3 lines $3.25 PPD. Send check or MO to G.L. Pierce, 5521 Birkdale Way, San Diego, CA 92117. SASE brings information.

MOBILE IGNITION SHIELDING provides more range with no noise. Available most engines. Many other suppression accessories. Literature, Estes Engineering, 930 Marine Dr., Port Angeles, WA 98362.

CCC — Looking for Civilian Conservation buddies, contact Joseph Schwartz, 43-34 Union Street, Flushing, NY 11355. (212) 461-5933.

QSL ECONOMY: 1000 for $12. SASE for samples. W4TG, Box F, Gray, GA 31032.

ROHN TOWERS — Wholesale direct to users. All products available — write or call for price list. Also we are wholesale distributors for Antenna Specialists and Regency FM Radios. Hill Radio, P.O. Box 1405, 2503 G E Rd., Bloomington, IL 61701 (309) 663-2141.

TUBES, TUBES wanted for cash or trade: 340TL, 4CX1000, SCX1500. Any high power or special purpose tubes of Eimac/Varian. DCO, 10 Schuyler Avenue, No. Arlington, NJ 07032. (800) 526-1270.

TRADE: SBE-33, mint cond. 15-80 meters, solid state with tube driver and finals, built-in P/S with mike and manual. Want IC-2A handheld. Ray Schall, 1850 Olive Barber Rd., Coos Bay, OR 97420. 503-267-6064.

ATTN: ANTIQUE RADIO COLLECTORS. Two SCR-536 Army Signal Corp radio sets mfrd. May '45. Complete with original packing, spare tubes and manuals. Mint cond. Operating on 3.8 MHz using BC611 rec. & transmitter. Best offer over museum's collectors price. Will ship prepaid. Contact W3BAG, P.O. Box 183, Brad. Hts., MD 21714.

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FT-101E, fan, three filters SSB, 600, 250 installed. Includes spare tubes (originals ok), free UPS shipping. $675 firm. John Skubick, 791 - 106 Ave., Naples, FL 33940.

PICTURE QSLs — quality photo and standard cards. Free samples and information. Planet Publishing, P.O. Box B, Martinsville, IL 62442.

LIONEL LOCOMOTIVE COLLECTORS. Gage 027 one each: Engine 1110 and Engine 258 plus cars and controls. Mint condition. Best offer. W3BAG, John Murray, P.O. Box 183, Brad. Hts., MD 21714.

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MIRROR-IN-THE-LID, and other pre-1946 television set wanted. Paying 500+ for any complete RCA "TRK" series, or General Electric "HM" series set. Also looking for 12AP4, MW-31-3 picture tubes, parts, literature on pre-war television. Arnold Chase, WA1RYZ, 9 Rushleigh Road, West Hartford, Conn. 06117 (203) 521-5280.

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SAVE money, time: decode Morse automatically using microelectronic circuitry. Now only $169 assembled. 5vDC. Telecraft Laboratories, Box 1185, E. Dennis, Mass. 02641.

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

Coming Events

ACTIVITIES

"Places to go..."

FLORIDA: The Martin County Amateur Radio Association's annual Picnicfest, Hamfest, Saturday, January 30. 8 AM to 3 PM, Langford Park, Jensen Beach. Free admission. Picnic areas and children's playground available. For details: WA4GQY, Vern 305-334-6220. W4OST, Don, 305-286-0500. WA4GUH, Mike 305-334-6000 or 305-878-7111.

PLAYBOY CLUB: Plan ahead now to attend the ARRL Hudson Division Convention, October 30-31, 1982, at the Playboy Club, Great Gorge, McAfee, NJ. For info send SASE to HARC, Box 528, Englewood, NJ 07631.

ILLINOIS: The Wheaton Community Radio Amateurs Hamfest, Sunday, February 7, Arlington Park Race Track, Arlington Heights, NW of Chicago. Doors open 8 AM. Free flea market tables, hourly door prizes, special computer section. First prize: New Transceiver. Advance tickets $2.50; $3.00 door. Talk in on 146.94 and 146.01/.61. For info: SASE to Wheaton Community Radio Amateurs, P.O. Box QSL, Wheaton, IL 60187.

ILLINOIS: Wheaton Community Radio Amateurs Hamfest will be held February 7, 1982, at Arlington Park Race Track EXPO Center, Arlington Heights, Illinois. Free Flea Market tables and expanded floor space. Large commercial area including the new "computer" section. For commercial info call WB9TTE at 312-766-1684; for general info call WB9PWM at 312-629-1427. Clear paved parking. Awards. Tickets $3.00 at entrance, $2.50 in advance. Send SASE to WCRA, P.O. Box QSL, Wheaton, IL 60187. Talk-in on 146.01/61 and 146.94. Doors open 8 AM. Be There! — KA9KDC.

MICHIGAN: The 12th annual Livonia Amateur Radio Club's Swap 'n Shop, Sunday, February 28, 8 AM to 4 PM, Churchill High School, Livonia. Door prizes, refreshments, free parking, tables. Talk in on 146.52 simplex. Reserved table space available. For information SASE to: Neil Coffin, WA8GWL, Livonia ARC, P.O. Box 2111, Livonia, MI 48151.

SOUTH BEND, INDIANA Hamfest Swap & Shop, January 3, 1982, first Sunday after New Year's Day at Century Center downtown on U.S. 33 ONEWAY North between St. Joseph Bank Building and river. Industrial history Museum in same building. Half acre carpeted in one room. Tables $3 each. Four lane highways to door from all directions. Talk-in Freq: 52-52, 99-39, 93-33, 78-18, 69-09 and 144.83-145.43.

MICHIGAN: The Southfield High School Amateur Radio Club's annual Swap & Shop, January 17, Southfield High School, 24675 Lahser, Southfield. 8 AM to 3 PM. Admission: $2.00. Door prizes, food, parking. For information/reservation: Robert Younker, Southfield HS, 24675 Lahser, Southfield, MI 48034. (313) 354-8210.

MICHIGAN: The Oak Park Amateur Radio Club will hold a Swap and Shop, January 10, Oak Park High School, Oak Park Blvd., Oak Park. 8 AM to 3 PM. Admission: $2.00 PP. Under 12 free. Door prize, YL raffle, YL table, food, free parking. Talk in on 146.04/64 and 146.52 simplex. For information/reservation SASE: Rob Numerick, WB8ZPN, 23737 Couzens, Hazel Park, MI 48030. (313) 398-3189.

PENNSYLVANIA: Lancaster Hamfest, February 21, 1982 Guernsey Pavilion, Route 30 east of Lancaster. Admission: $3.00. XYLs and kids free. Doors open 0800. All inside spaces by advance registration only. Registration deadline, 10 February. Talk in on 146.01/61 or 146.52. For info: SERCOM, Inc., P.O. Box 6082, Rohrerstown, PA 17603.

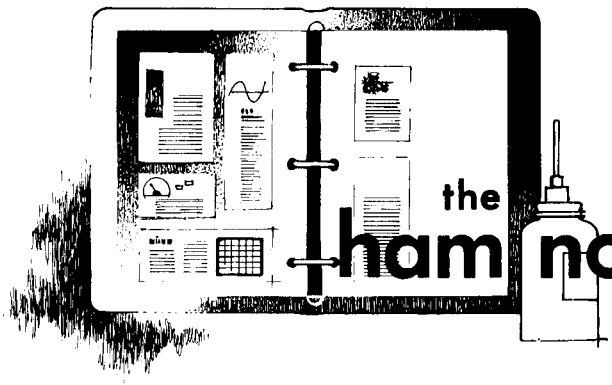
TENNESSEE: See World's Fair while attending 1982 Knoxville Hamfest and ARRL Delta Division Convention, Memorial Day Weekend (May 22-23). DX, computer, and technical forums: air-conditioned exhibit area; large indoor/outdoor flea market. For more information: (dealers, tickets, reservations) N4BAQ, 5833 Clinton Hwy., Suite 203, Knoxville, Tenn. 37912.

OPERATING EVENTS

"Things to do..."

JANUARY 17: The Phil-Mont Mobile Radio Club Station W3TKQ will be celebrating its 30th anniversary and commemorating the Club's association with the Franklin Institute and the birthday of Ben Franklin, Philadelphia's First Citizen. Station will operate 80 through 10 meters from 8 AM to 8 PM. A special QSL card/certificate for a SASE. Frequencies: lower edges of the General and Advanced bands.

More Details? CHECK—OFF Page 98



inexpensive CW filter

A minimum-component-count, three-pole passive CW filter is shown in **fig. 1**. Surplus unpotted 88-mH toroids are used. Two of the inductors are tapped at the junction of two windings. The full value of the third inductor is also used. The filter characteristics are listed in **table 1** for different capacitor values.

I've built this filter using 0.47-μF capacitors and have been using it with my direct-conversion receiver for over six months. It provides an inexpensive way to improve receiver selectivity.

Frequency response (**fig. 2**) has been measured using a 600-ohm generator and a 605-ohm resistor as a termination. I found that the filter sounds better when terminated in an emitter-follower with approximately 600 ohms input resistance than when driving high-impedance phones directly. You might want to build two of these filters: one to provide a high passband and one to provide a low passband.

Values were calculated from the work of Rife[1,3] and Wetherhold[2] using a minimum-cost approach.

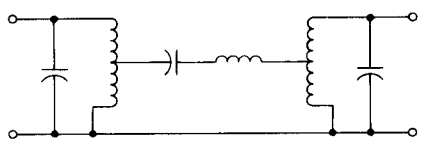


fig. 1. Passive CW filter: all three inductors are 88 mH. Three identical capacitors are used. See table 1 for characteristics.

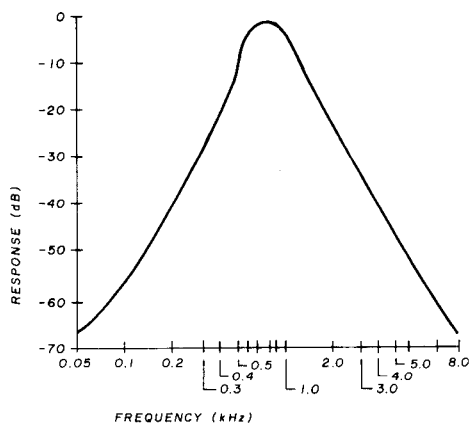


fig. 2. Response of the passive filter with 605-ohm resistive termination.

table 1. Calculated filter characteristics.

C (μF)	R (ohms)	bandwidth (Hz)	f_0 (Hz)	f_L (Hz)	f_H (Hz)
0.33	730	660	934	660	1321
0.47	612	553	783	553	1107
0.68	509	460	651	460	920
1.0	420	379	537	379	758
1.5	343	310	438	310	620

R = termination resistance
BW = 3-dB bandwidth
f_0 = center frequency $\sqrt{f_L f_H}$
f_L = lower cutoff frequency
f_H = upper cutoff frequency

references

1. D.C. Rife, WA2PGA, "Low-Loss Passive Bandpass CW Filters," *QST*, September, 1971, pages 42-45.
2. Edward E. Wetherhold, W3NQN, "Technical Correspondence," *QST*, January, 1972, page 56.
3. D.C. Rife, WA2PGA, "Technical Correspondence," *QST*, May, 1972, pages 56-57.

Jonathan Radovsky, WB1AFQ

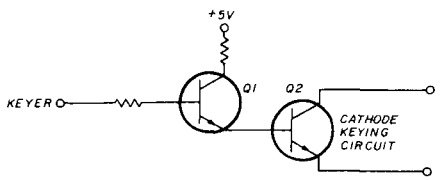
cathode keying with the Heath HD-1410

When World Radio Laboratories first produced the Meteor DSB 175 transmitter over fifteen years ago, we bought one. As in most of the equipment produced in those days, cathode keying was used. Because not many hams used electronic keyers then, this posed no real problem. Besides, the keyers that were in use were generally the tube type, so the current demands and voltages encountered in cathode keying were of little importance.

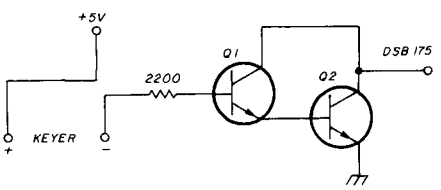
When the transistor finally made electronic keyers both affordable and commonplace they became, for many of us, almost essential pieces of equipment. Unfortunately, the voltage and current demands of the cathode keying circuits made it difficult to use the new solid-state keyers without buffering, usually with some sort

of relay. But the relay was generally bulky, often expensive, and hardly compatible with true QSK. The result was that much of this gear went quietly to the storage closet.

Realizing a need for a second CW position but lacking the funds for a whole new rig, we pulled the Meteor out of the closet and set about devising a way to key it with the HD-1410. We turned immediately to the *ARRL Handbook* for a suitable keying circuit and found this:



We soon found there's no way for this circuit to work with the 1410, since the keyer is just a switch. Consequently, all it does is connect Q1 base to ground, providing no voltage output. If you were to try this circuit, the frustration probably encountered would cause you to give up and to return your old transmitter to the back shelf of your closet. With a few minor changes, however, we produced a workable circuit adaptable to just about any keyer:



This circuit consists of a Darlington transistor, which uses the keyer to provide on-off bias, producing about 1.5 mA across the keyer. In fact, the power supply we used has no bleeder resistor, and the current drain is so low it will key the thing for several minutes after the supply is shut off, using the discharge current from the filter capacitors.

The cathode voltage-current values of the rig to be keyed will determine what you can use for Q2. We used an RCA transistor with a 300-V breakdown for the DSB-175, which should be sufficient for most rigs. The circuit is so small it can be placed inside most keyer cabinets, in a matchbox-sized cabinet, or permanently installed inside the old transmitter. Best of all is the fact that it allows the use of your favorite keyer with a fine old piece of equipment for less than what it will probably cost you for a relay.

David G. Boyd, K9MX and Max Boyd, N9MX

attaching PL-259 connectors to RG-58/U cable

If you use a lot of RG-58/U cable and PL-259 connectors, here's a much better way to connect the connector and cable. You'll need a special tool, the Buchanan C24, which is available from electrical-equipment supply houses.

1) Strip 25 mm (1 inch) of the cable insulation.

2) Slip the shield back over the outside of the cable wtihout unraveling the shield. Use a UG/176U adapter, which has a larger hole and much thinner walls.

3) Slide the adapter over the outside of the folded-back shield. Crimp with the special tool (Buchanan C24). Use just enough force to tighten.

4) Strip the cable center conductor about 6 mm (0.25 inch) from the adapter. This helps keep the solder from flowing too far into the PL-259, which could cause a short circuit.

5) Tighten the adapter into the connector. Solder the center conductor only.

This method of installation reduces the danger of wire "whiskers" shorting the cable, and it's fast and neat.

Felix W. Mullings, W5BVF

automatic repeater/ receiver sensitivity

Have you wanted a repeater to operate so that it will be somewhat desensitized until triggered? The circuit described here has been used commercially in a few applications, but I've never seen it used by Amateurs. One of the major problems with repeaters is that, being very sensitive (0.2-0.5 μV), they are prone to false triggering.

Fig. 3 is extremely simple. One of the i-f transistors must be chosen for purposes of changing sensitivity by changing the bias voltage of the base. In the G.E. Master Line (ER-41-C), I found that the high i-f transistor did the trick. R3 was fed 10 volts. The new circuit uses resistors R4, R5, R6, which compose a voltage divider. Potentiometer R7 selects a portion of the voltage depending on the setting of S2. With S1 in the normal position, 10 volts is fed to the receiver for maximum sensitivity. The relay operates with the transmitter on and changes receiver sensitivity to maximum with the transmitter on.

For example, suppose you decide to operate your repeater with a sensitivity set at 0.6 μV. A weak, varying

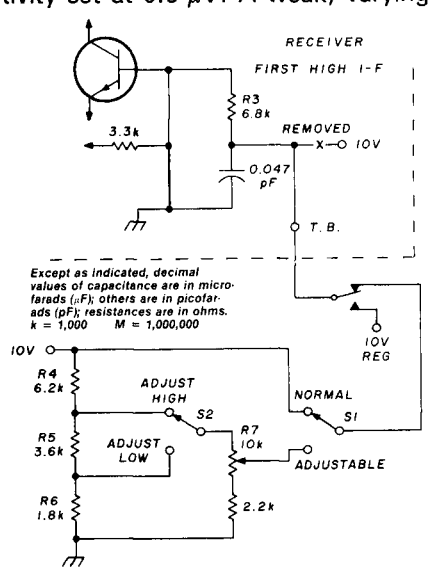


fig. 3. Simple circuit for desensitizing repeater receivers for weak input signals.

mobile signal might be coming in at 0.3 μV. It would not trigger the repeater until it reached 0.6 μV. If this signal faded, the repeater would stay at maximum sensitivity. It seems to me that, with the congested repeaters in some areas, this feature would be desirable.

Vern Epp, VE7ABK

metal cleaning with dip-type cleaners

Those who have occasion to clean brass, copper, silver, or gold may take advantage of some of the chemical cleaners that quickly strip surface oxidation. Numerous brand names are available. One is "e-z-est Jeweluster for Coins," formula H-907, from Products Research Company, Box 11115, Oakland, California 94611. Chemical dip cleaners can be obtained at coin dealers, silverware departments of larger department stores, and at some supermarkets. I purchased 142 grams (5 oz.) of the above product at a coin shop for about $2.

Either dipping the object into the liquid, or brushing it on in the case of larger surfaces, quickly strips surface oxides leaving the metal bright and shiny. It can then be soldered easily, or sprayed with protective acrylic varnish to prevent tarnishing. Take care in cleaning plated objects, however. Leaving the chemical on the metal too long will result in some surface metal loss. If in doubt, test a small area first. After cleaning, rinse the object thoroughly in running water to stop the chemical etching action.

Chemical composition may vary. However the active ingredient in the product mentioned is thiourea, $CS(NH_2)_2$, a chemical bleaching agent used in photography. Where large applications would make cost an important factor, it may be worthwhile to purchase thiourea from a chemical supply house. Above all, follow the manufacturer's instructions carefully.

Robert Wheaton, W5XW

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RCA TRANSISTORS
80684
40235

AMPEREX/MOTOROLA
RF TRANSISTOR

BFR91	.75
MRF901	2.00

IC SALE

400CJ	.88
2805HC/1405A	1.00
74LS27	.25
P3101, 82525/ 74S289	1.00
SCL4013A, BE	.25
MC14001BCP	.25
MC14017BCP	.75
MC14012BCP	.19
MC14023BCP	.20
MC14027BCP	.39
MC14069BCP	.30
MC14093BCP	.60
MC3420P	1.00
MCM10152L	5.00
MC7408P	.19
74LS05PC	.20
AD580	1.00
8T01B	.60
CH164A	.25
CG388V	.25
74LS20F	.20
748SN	.39
DS0026CH	1.00
CD 4013BCN	.30
CD 4028AE	.49
CD 4040 BCN	.80
CD 4069CN/74C74	.30
MM74C74N	.40
CD 4015CN	.75
DS/DM 8839N	.60
DM 75L51N	.75
TLO-61CP	.30
SN7428N	.25
Z80CPU	4.99
2708-6	1.00
2516/2716	2.50
2732-6	10.00
2102	.50
2114-2 & 3	8/16.00
4104	8/16.00
D2116/4116	8/18.00
D8257	3.00
MC6845	10.00
Z80CTC	4.00
Z80SIO/O or /I	8.00
Z80PIO	4.00
74LS273	.80
74LS373	.80
74LS374	.80
74LS245	1.40
74LS367	.40
74LS14	.60
78M05	.39
78L05	.30
78L15	.30
78L08	.30
79L12	.49
LM317T	1.99
MC7808T/ LM340T-8	.49
7805/LM340T-5	.89
7812/LM340T-12	.89
7815/LM340T-15	.89
7824/LM340T-24	.89
D8202	20.00
D8212	1.00
D8214	2.00
8251	3.00
TMS1000NL	2.00
MC1306P	.75
MC1414L	.29
LM/SN1458V	.40
LM555V	.30
LM309K/7805CK	1.00
MC6852P	3.00
RC74LS51N	.15
SN74LS74N	.20
PT 1482B	2.00
EC 1422B	2.00
LA 4220 Sanyo	1.00
SN75427N	.30
N8T26N/MC6889	1.00
D3232/MC3232	1.00

DIPPED SILVER MICA

5pF	$.40	120pF	$.25
10pF	.25	150pF	.25
12pF	.30	210pF	.40
15pF	.30	250pF	.40
20pF	.25	330pF	.40
22pF	.25	470pF	.40
24pF	.25	500pF	.40
33pF	.25	560pF	.40
50pF	.25	620pF	.40
75pF	.25	820pF	.50
82pF	.25	6800pF	1.00
100pF	.25		

Quantity pricing also.

JFD Piston Caps
VCJ 2819A 1.00 each

House numbered AY5-2376
Keyboard encoder chip - 88 (keys)
same as KR 2376 6.99 each

5 Way DC Voltage Adapter
Selective voltage: 6, 9, and 12VDC.
Input voltage - 115VAC $9.99

WALL TYPE TRANSFORMERS

115 VAC input
6 VAC @ 10 MA 2.99
12 V @ 700 MA 4.99
15 V @ 300 MA 3.99

115 VAC & 220 VAC input
15 V @ 300 MA 3.99

DL-1416
4-Digit 16 Segment Alphanumeric
Intelligent Display with Memory,
Recorder, Driver $14.95 each

Fuse Holders
HKP type for 3AG .89 each

UHF Varactor Tuners - Sony
$19.99 each

Teledyne Serendip
Solid State Dip Relay
Part #A641-1 $2.49 each

Capacitor, Resistors & Diodes
Assortment
(All New) (Not Junk)
100 pcs. 4.00
250 pcs. 7.00
500 pcs. 12.00
1000 pcs. 20.00

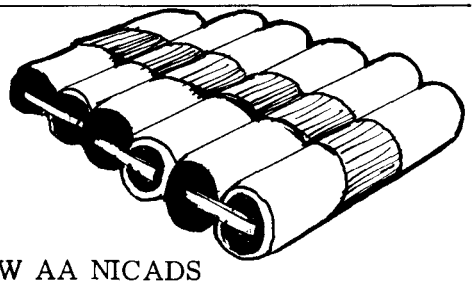
Hardware Assortment
1 pound mixed screws, standoffs,
washers, feet, insulator 5.00

IC Assortment
50 New IC's. Not Junk.
7400/S/LS Linear, DTL/RTL etc.
$10.00

TO-3 and TO-66 Used Power Transistors
High voltage switching in CRT's.
30 pcs. Good/Bad? 2.00
100 pcs. 10.00

IC, TTL-LS/S/Linear/MOS etc.
Used - some good/some bad. 50%
we buy are good!
400 pcs. 4.00
1000 pcs. 8.00

Electrolytic Caps.
All types (new).
50 pcs. 6.99



NEW AA NICADS
- GE Part #41B905HD11-G1
Pack of 6 for $5.00 OR 60 cells,
ten packs - $45.00

LED Display
FND 357 .362 red
C.C. 2/1.00

TIL312 LED Display
Red 2/1.29

Assorted Heat Sinks - 3 each.
For TO-3, TO-220, TO-66 & TO-5.
12/1.99

Assorted Potentiometers
"All new" not junk. Some with
switch, some with 1/4" shaft.
#S.S. 283 30 for 4.00
#S.S. 284 100 for 10.00

New Miniature Toggle & Rocker
Switch - 25 mix. $6.99

New Assorted Toroid Cores
10 big & small 4.00

CORRECTION — The prices noted below in bold type were incorrectly listed on page 85 in the December issue of Ham Radio. These bold prices are the correct ones and should be used when ordering from Semiconductors Surplus.

SEMICONDUCTORS SURPLUS

2822 North 32nd Street, #1 • Phoenix, Arizona 85008 • Phone 602-956-9423

ORDERING INSTRUCTIONS

Check, money order, or credit cards welcome. (Master Charge and VISA only.) No personal checks or certified personal checks for foreign countries accepted. Money order or cashiers check in U.S. funds only. Letters of credit are not acceptable.

Minimum shipping by UPS is $2.35 with insurance. Please allow extra shipping charges for heavy or long items.

All parts returned due to customer error or decision will be subject to a 15% restock charge. If we are out of an item ordered, we will try to replace it with an equal or better part unless you specify not to, or we will back order the item, or refund your money.

PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE. Prices supersede all previously published. Some items offered are limited to small quantities and are subject to prior sale.

We now have a toll free number, but we ask that it be used for *charge orders only*. If you have any questions please use our other number. We are open from 8:00 a.m. - 5:00 p.m. Monday thru Saturday.

Our toll free number for *charge orders only* is 800-528-3611.

MINIMUM ORDER $10.00

NEW CHERRY BCD SWITCH
New end plates
Type T-20 ..... 1.29 each

Johnson AIR Variables

$1.00 each

T-3-5	1 to 5 pF
T-6-5	1.7 to 11 pF
T-9-5	2 to 15 pF
189-6-1	.1 to 10 pF
189-502-Y	1.3 to 6.7pF
189-503-105	1.4 to 9.2pF
189-504-5	1.5 to 11.6pF
189-505-5	1.7 to 14.1pF
189-505-107	1.7 to 14.1pF
189-506-103	1.8 to 16.7pF
189-507-105	2 to 19.3pF
189-508-5	2.1 to 22.9pF
189-509-5	2.4 to 24.5pF
545-043	1.8 to 11.4pF

CRYSTAL FILTERS

EFCL455K13E	3.99
EFCL455K40B2	2.99
FX-07800L, 7.8 MHz	12.99
FHA103-4, 10.7 MHz	12.99

MURATA CERAMIC FILTERS

SFD 455D	455 KHz	2.00
SFB 455D	455 KHz	1.60
CFM455E	455 KHz	5.50
CFU455H	455 KHz	3.00
SFE 10.7MA	10.7 MHz	2.99

TEXAS INSTRUMENT TIL-305P
5 x 7 array alphanumeric display
$3.85 each

ARCO CAPS

304	100-550pF	1.50	469	170-780pF	1.40
400	.9-7pF	1.00	4615	390-1400pF	2.02
402	1.5-20pF	1.00	404	8-60pF	1.00
420	1-12pF	1.00	405	5-80pF	1.00
423	7-100pF	1.00	422	4-40pF	1.00
426	37-250pF	1.01	424	16-150pF	1.00
464	25-280pF	1.00	427	55-300pF	1.00
465	50-380pF	1.39	462	5-80pF	1.50
467	110-580pF	1.03			

TUBES

6KD6	5.00	6939	30.00
6LQ6/6JE6	6.00	6146	7.95
6MJ6/6LQ6/6JE6C	6.00	6146A	9.00
6LF6/6MH6	5.00	6146B/8298	9.99
12BY7A	4.00	6146W	12.95
2E26	4.69	6550A	10.00
4X150A	29.99	8908	14.00
4CX250B	45.00	8950	13.00
4CX250R	69.00	4-400A	145.00
4CX300A	109.99	4-400C	145.00
4CX350A/8321	100.00	572B/T160L	44.00
4CX350F/J/8904	100.00	7289	39.99
4CX1500B/8660	300.00	3-1000Z	229.00
811A	20.00	3-500Z	141.00
6360	4.69		

RF Transistors

MRF203	P.O.R.	MRF453	GE185 17.25	BFR96	2.20
MRF216	31.00	MRF454	19.90	BFW92A	1.15
MRF221	10.90	MRF454A	21.83	BFW92	1.00
MRF226	12.65	MRF455	16.00	MMCM918	14.30
MRF227	3.45	MRF455A	16.00	MMCM2222	15.65
MRF238	12.65	MRF458	19.90	MMCM2369	15.00
MRF240	15.50	MRF472	1.00	MMCM2484	15.25
MRF245	34.00	MRF474	3.00	MMCM3960A	24.30
MRF247	34.00	MRF475	2.90	MWA120	9.80
MRF262	9.20	MRF476, C1306	2.90	MWA130	9.80
MRF314	20.70	MRF477	11.50	MWA210	8.80
MRF406	13.80	MRF485	3.00	MWA220	9.08
MRF412	25.30	MRF492	23.00	MWA230	9.80
MRF421	36.80	MRF502	1.04	MWA310	8.80
MRF422A	41.40	MRF604	2.07		
MRF422	41.40	MRF629	3.45		
MRF428	46.00	MRF648	33.35		
MRF428A	46.00	MRF901	2.15		
MRF426	15.50	MRF902	8.00		
MRF426A	15.50	MRF904	3.00		
MRF449	12.65	MRF911	3.00		
MRF449A	12.65	MRF5176	3.00		
MRF450	13.80	MRF8004	2.10		
MRF450A	13.80	BFR90	1.30		
MRF452	15.00	BFR91	1.65		

TO-3 TRANSISTOR SOCKETS
Phenolic type..... 6/$1.00

NEW SIMPSON 260-7 $99.99

RG174/U - $15.00 per 100 ft.
Factory new

PLASTIC TO-3 SOCKETS
4/$1.00

CRYSTAL FILTERS
Tyco 001-19880 Same as 2194F
10.7 MHz narrow band
3 dB bandwidth 15 KHz min.
20 dB bandwidth 60 KHz min.
40 dB bandwidth 150 KHz min.
Ultimate 50 dB insertion loss 1 dB max.
Ripple 1 dB max. Ct. 0+/-5 pF 3600 Ohms
$3.99 each

78MO5
Same as 7805 but only 1/2 Amp
5 VDC .49 each or 10/$3.00

PL259 TERMINATION
52 Ohm 5 Watts $1.50 each

TRIMMER CAPS

Sprague. Stable Polypropylene.
.50 each or 10/4.00
not sold mixed
1.2 to 13pF
2 to 30pF
3.9 to 18pF
3.9 to 40pF
3.9 to 55pF

Carbide Circuit Board Drill Bits for PCB Boards
5 mix for $5.00

Johnson AIR Variables

1/4 x 2 1/2" shaft
$2.50 each

193-10-6	2.2 to 34 pF
193-	1.5 to 27.5pF
193-	.6 to 6.4pF

$1.00 each

160-107-16	.5 to 12 pF
193-10-9	2.2 to 34 pF
193-10-104	2.2 to 34 pF
193-4-5	3 to 30 pF

RF Power Device

MRF454 Same as MRF458
12.5 VDC, 3-30 MHz
80Watts output, 12dB gain
$ 19.90 ea.

E.F. JOHNSON TUBE SOCKETS

#124-0311-100 ..... 6.99 each
For 8072 etc.

#124-0107-001 ..... 13.99 each
For 4CX250B/R, 4X150A etc.

#124-0111-001 ..... 4.99 each
Chimney for 4CX250B/R and 4X150

#124-0113-001 and 124-0113-021
$12.99 each
Capacitor for #124-0107-001

#123-209-33 Sockets....6.99 each
For 811A, 572B, 866, etc.

UNELCO CAPS

6.8pF	47pF	
8.2pF	62pF	
10pF	120pF	
12pF	160pF	
13pF	180pF	
14pF	200pF	
20pF	240pF	
24pF	380pF	
33pF	470pF	
36pF	1000pF	
43pF	350V	$1.00 each

86 Pin Motorola Bus Edge Connectors

Gold plated contacts
Dual 43/86 pin .156 spacing
Soldertail for PCB..... $3.00 each

110VAC MUFFIN FANS

New $11.95
Used $5.95

J-Fet

J310 N-CHANNEL J-FET 450 MHz
Good for VHF/UHF Amplifier,
Oscillator and Mixers 3/$1.00

squelch tail eliminator

Circuit Electronics, Inc., introduces a new model tail chopper, model TC-2200. The board size is 1.75″ × 3.75″. It features temperature-compensated op-amps and digital logic, 6-dB sinad 10 millisec noise switch, maintains normal hysteresis, LED to indicate squelching, an on board 10-watt reed relay for the squelch.

Model TC-2200 can be connected to most repeaters to eliminate squelch tails. Also has squelch enable-disable function for the operation. The TC-2200 is a PC board assembled with instructions for repeater or mobile use. Model TC-2200 sells for $54.95.

For further information, contact: Ray L. Hruska, 621 Bishop, Salina, Kansas 67401.

voice controller

Remote control by voice via radio or telephone is now possible with the Covox Model I Voice Controller. Low cost and fully self-contained, this speaker-independent and noise-and-click-resistant system extracts the voicing component of speech from low-grade voice communication circuits in the same way a human listener does.

The primary measure of voicing duration is modified and corrected through cross-correlation with vowel sounds characterized by the spoken words *dih* and *dah*. Spoken Morse, Binary, or RTTY codes are reliably recognized with considerable tolerance of the particular speaker and voice channel quality. A 16-word vocabulary will control anything that can be switched: lights, a remote transmitter, garage doors, wheel chairs. Or use the fundamental pitch output for proportional control tasks, such as varying motor speed or dimming lights.

Priced at $389.00, the system comes complete with ac adapter, microphone, and users' manual. Contact Covox Company, P.O. Box 2342, Santa Maria, California 93455.

2.5-kW automatic antenna tuner

The Daiwa CNA-2002 marks a major advancement in antenna tuner technology with a compact, economical, and automatic 2.5-kW antenna tuner. The relatively small size of the CNA-2002 is made possible by a Daiwa breakthrough in high-voltage variable capacitor design.

The matching function of the tuner becomes automatic whenever the OPERATE button is pressed (5-50 watts of rf must be applied to the tuner). The internal detection circuitry detects forward and reflected power, and the resultant proportional dc voltage is applied to the motor-control amplifier which in turn drives the tuning motor. The tuning motor is connected to two variable tuning capacitors through a gear train using a 30:1 gear ratio. Automatic operation ceases when the SWR dips below 1.5:1. Two fine-tuning controls on the right-hand side of the CNA-2002 can be used to quickly lower the SWR to 1:1. The CNA-2002 performs its automatic tuning function in less than 45 seconds.

For more information, contact MCM Communications, 858 E. Congress Park Drive, Centerville, Ohio 45459.

power pocket

VoCom announced its latest addition at Radio Expo. For those who own the ICOM IC2A radios, they have developed a mobile mount called the Power Pocket® that incorporates some exciting new features.

First and maybe most importantly, the Power Pocket® contains an rf amplifier that will increase power output from several watts to 25 watts. The Power Pocket® also includes an audio amplifier and a big 4-inch speaker so that messages can be heard over road noise even when the windows are rolled down. Another benefit is that by using the Power Pocket® the IC2A's audio circuit can be run at significantly lower power for reduced battery consumption. But that's not all.

The Power Pocket® will charge the batteries in your IC2A! The spring loaded charger pocket accepts all ICOM power packs and ensures that firm positive contact exists for full battery charging. The charging function has an independent switch that allows you to charge the pack even if the amplifiers are turned off. Finally, the Power Pocket® contains a mic pre-amp that allows the IC2A to be used with either any standard mobile mike or the ICOM speaker/mike.

Units like the Power Pocket® are available for commercial service. Commercial users have found that the utility of their radio investment is significantly increased using units similar to VoCom's Power Pocket®. You will too if you pick up one of these units. Let the Power Pocket® add full mobile capability to your handheld IC2A. Contact VoCom Products Corporation, 65 E. Palatine Rd., Prospect Heights, Illinois 60070.

Hamtronics® catalog

Hamtronics®, Inc., announces publication of a new expanded June, 1981, catalog, full of goodies for the VHF/UHF/OSCAR enthusiast and two-way radio shops.

The 40-page, two-color catalog features a new five-channel, ten-watt VHF/fm transceiver, new COR and CWID modules for repeater builders, and new accessories, such as rf-tight enclosures for repeaters and power supplies. Also featured are the new T51 (VHF) and T451 (UHF) fm exciter modules. Many new ranges of transmitting and receiving converters have been added, as well as a series of receiving converters to extend the frequency coverage of scanners to new

military, satellite, and commercial bands. The catalog also includes the full line of Cushcraft and Larsen VHF and UHF antennas.

For your free copy, call 716-392-9430 or write to Hamtronics,® Inc., 65F Moul Rd., Hilton, New York 14468. (For overseas mailing, please send $2.00 or five IRCs.)

keyer chip

Not all Morse operators realize there are two basic types of iambic operation used in modern electronic keyers. Type "A," offered by the standard Curtis 8044, does not produce a following alternate element when a squeeze is released during an element (an element is a dot or dash). Type "B," employed by manufacturers such as Ten-Tec, Nye, Heath, the Accu-keyer, and others, does produce a following alternate element after squeeze release.

Curtis Electro Devices has designed a new IC called the 8044B (8044BM if the speedmeter function is included). Priced the same as the standard 8044 (and 8044M), the new chip is pin-for-pin compatible and can be used in any existing 8044 socket (or 8043 socket with slight modification). The 8044B is priced at $14.95 in single piece quantities, the 8044BM at $19.95; both are FOB factory and available from stock.

For further information, contact Curtis Electro Devices, Inc., Box 4090, Mountain View, California 94040.

DS2050 KSR terminal

The DS2050 KSR is a compact and low cost communications terminal for transmission and reception of Baudot, ASCII, and Morse codes (Morse receive optional). The functions of both an electronic data terminal and a high quality RTTY demodulator are combined in one compact cabinet. The DS2050 needs only the addition of a video monitor, Amateur transceiver, and antenna system to form a complete all-mode Amateur station. The received signals are displayed on the video screen in a 24-line by 72-

character-per-line format. Like its predecessor the DS2000, this terminal provides a top line status indication of selected operating modes and code and the exclusive HAL bright-dim display of received or transmitted text (bright for received, dim for transmitted). The terminal operates in word mode while transmitting so that typing errors (or misspelled words) may be edited at the keyboard before they are transmitted. A 255-character hidden transmit buffer allows pretyping of text to be transmitted even while receiving. Other features such as unshift-on-space (USOS) for Baudot reception, keyboard operated switch (KOS) for automatic transmit-receive control, synchronous idle (IDLE or "diddle"), and QBF and RY text messages are included in the DS2050. The DS2050 will operate at 45, 50, 57, 74, and 100 baud with the Baudot RTTY code; 110 or 300 baud with the ASCII RTTY/computer code, and 1-100 WPM Morse Code.

For more information, contact HAL Communications Corp., Box 365, Urbana, Illinois 61801.

antenna tuner

ICOM announces the new IC-AT500 and AT-100 Automatic Antenna Tuner. The Model IC-AT500 handles 500 watts; the IC-AT100 handles 100 watts.

A newly developed detector circuit detects resistance and reactance of the load, and controls powerful motors to automatically tune the two variable capacitors, thus making the tune-up time very short — usually less than three seconds. When the IC-720A or IC-730 (with the optional LDA unit installed) is used, band switching of the tuner can be controlled by the band switch of the IC-720/720A or IC-730. This tuner has dual accessory sockets, so the auto band switching function can be used with the IC-2KL linear amplifier at the same time. The matching circuit can be used for each band, so you are able to make quicky QSYs and enjoy trouble-free operation.

This tuner has four coaxial sockets for antennas, and selects the suitable antenna for each band automatically. When the power of this tuner is turned off, this tuner can be used as an automatic antenna selector. The IC-AT500/AT100 matches ICOM styling for base stations, and is very similar in size and appearance to the IC-2KL. This tuner can be used with 13.8 volts dc or 117 (or 230) volts ac.

The IC-AT100 price is $349.00, and the IC-AT500 price is $449.00. For more information contact ICOM, 2112 116th Ave. N.E., Bellevue, Washington 98004.

short circuits

satellite circuit

The program that appears in the article "Locating Geostationary Satellites" in the October, 1981, issue contains two errors. At the bottom of the second column, the key command STO should be moved down one place so that is to the left of 04. Also, in the same column, code 05 (second from the top) should read 65. Note that in the table on page 68 the satellites from Meteosat down should be listed in degrees west longitude.

Kenscan 74

Please note that, in the Kenscan 74 article that appeared in the January, 1981 issue, pin 16 of U3 was mislabeled pin 6, and pins 3 and 6 of U13 were reversed in the schematic.

memory keyer

The schematic and PC layout of the deluxe memory keyer (**figs. 2** and **6**) in the April issue should show the three display-driver counter ICs (U5D, U6D, and U7D) as 7490s, *not* 7493s.

2-meter synthesizer

An error appeared in the printed-circuit layout for the 2-meter synthesizer designed by K9LHA (December, 1979, page 14). The bottom part of **fig. 7** shows jumpers J1 and J2 connected to pin 12 of U6 (74197); these two jumpers should go to pin 13. The schematic of **fig. 5** is correct.

Sized and priced to suit all pockets

AR-22 DIGITALLY SYNTHESIZED VHF FM RECEIVER

STANDARD FREQUENCIES

141.000-149.995 MHZ (AR-22 Type-A)
* 146.000-154.995 MHZ (AR-22 Type-B)
151.000-159.995 MHZ (AR-22 Type-C)
* 156.000-164.995 MHZ (AR-22 Type-D)
161.000-169.995 MHZ (AR-22 Type-E)

Marked with (*) are subject to available supply

TECHNICAL DATA

- FREQUENCY COVERAGE: 131.000MHz to 179.995MHz
- MAXIMUM FREQUENCY COVERAGE: 8.995MHz without any degrading
- RECEIVING MODE: Frequency Modulation,16F3
- RECEIVER SYSTEM: PLL Frequency synthesized dual conversion superheterodyne
- USABLE SENSITIVITY: 0.2uV across 50-ohm at 12db SINAD
- AUDIO SQUELCH SENSITIVITY: 0.2uV at threshold squelch,adjustable
- SELECTIVITY: Adjacent channel rejection (±12.5kHz) greater than 60dB
- SPURIOUS AND IMAGE ATTENUATION: Less than 50dB
- FREQUENCY STABILITY: Within ± 10PPM over the operating temp. range
- IF FREQUENCIES: 1st 10.7MHz, 2nd 455kHz
- AUDIO OUTPUT POWER: 100mW into 8-ohm load at 10% THD
- POWER CONSUMPTION: 25mA at receiver squelched; 100mA at 100mW audio output power
- OPERATING TEMPERATURE RANGE: -10° C to +60° C
- BATTERY: Rechargeable NiCd battery pack, 4.9 volts and 225mAH
- PHYSICAL SIZE: 5¼" (H) X 2½" (W) X 1.0" (D) without knobs
- WEIGHT: 7.1 oz. (200 grams) with battery pack
- FREQUENCY SELECTION: 3 digits of digital push switches and slide switch
- PCB: Double sided glass-epoxy printed circuit board

Order today your AR 22, if you are not completely satisfied, return it within 15 days for your refund. (less shipping charge) add $2.50 for shipping charge. California residents add 6% sales tax.

SEND: Cashier's check, Money order, Master charge or Visa. UPS C.O.D.

DEALER INQUIRY IS INVITED

ALL TYPES

$150.00 with accesories

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TELEX: 655-306

GLB
HIGH PERFORMANCE PRESELECTORS

MODEL P50 to P500

- 50 - 500 MHz
- Ultimate rejection over 80 dB
- Five large helical resonators
- Low noise
- High overload resistance
- Typical rejection figures:
  ±600 kHz at 144 MHz: −30 dB
  ±1.6 MHz at 220 MHz: −40 dB
  ±5 MHz at 450 MHz: −45 dB
- The solution to interference, intermod and desens problems on repeaters
- 12V DC operation
- Dimensions only 1.6 x 2.6 x 4.75 excluding connectors
- Custom tuned to your frequency
- Low cost — only $69.95
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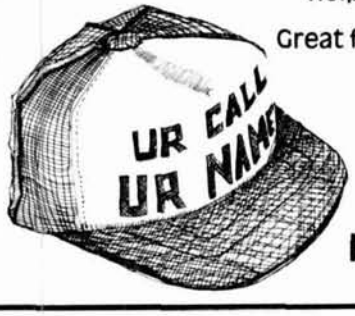

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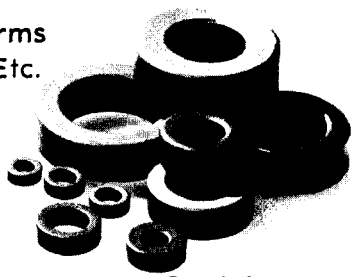

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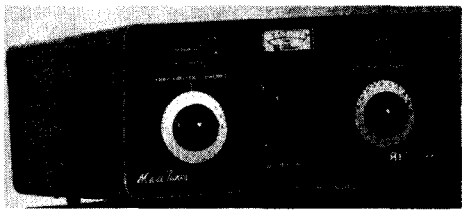

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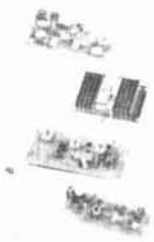

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18 wpm code for 20 minutes
22 wpm code for 20 minutes
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ORR BOOKS

BEAM ANTENNA HANDBOOK
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Recommended reading. Commonly asked questions like: What is the best element spacing? Can different yagi antennas be stacked without losing performance? Do monoband beams outperform tribanders? Lots of construction projects, diagrams, and photos. 198 pages. ©1977. 1st edition.

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by Bill Orr, W6SAI

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by William I. Orr, W6SAI and Stuart Cowan, W2LX

Contains lots of well illustrated construction projects for vertical, long wire, and HF/VHF beam antennas. There is an honest judgment of antenna gain figures, information on the best and worst antenna locations and heights, a long look at the quad vs. the yagi antenna, information on baluns and how to use them, and new information on the popular Sloper and Delta Loop antennas. The text is based on proven data plus practical, on-the-air experience. **The Radio Amateur Antenna Handbook** will make a valuable and often consulted reference. 190 pages. ©1978.

☐ **RP-AH** **Softbound $6.95**

ALL ABOUT CUBICAL QUAD ANTENNAS
by Bill Orr, W6SAI

The cubical quad antenna is considered by many to be the best DX antenna because of its simple, lightweight design and high performance. You'll find quad designs for everything from the single element to the multi-element monster quad, plus a new, higher gain expanded quad (X-Q) design. There's a wealth of supplementary data on construction, feeding, tuning, and mounting quad antennas. 112 pages. ©1977.

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CODE PRACTICE TAPES FROM HRPG — Practice copying Morse Code anytime, anywhere. Whether you're upgrading your present license or just trying to up your code speed, a large assortment allows you to choose exactly the kind of practice you need.

each tape $4.95 2/$8.95 3/$12.95

CODE PRACTICE TAPES

Here are three different straight code tapes consisting of randomly generated six character groups sent at different speeds. These tapes are excellent for building both the speed and copying accuracy needed for contesting, DXing and traffic handling.

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7.5 wpm code for 25 minutes
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15 wpm code for 25 minutes

☐ **HR-STC2 — $4.95**

15 wpm code for 50 minutes
22.5 wpm code for 35 minutes

☐ **HR-STC3 — $4.95**

25 wpm code for 20 minutes
30 wpm code for 20 minutes
35 wpm code for 20 minutes
40 wpm code for 20 minutes

HI/LO SERIES — Code Study Tapes

In this unique series, characters are sent at high speeds with long pauses between each character. For example, HLC4 (15/2.5 wpm) consists of characters sent at a 15 wpm rate, but with 2.5 wpm spacing between each character. These tapes are excellent for the beginner who wants to practice copying higher speed code without the frustration of constantly getting behind.

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22.5/2.5 wpm code for 80 minutes

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22.5/5 wpm code for 20 minutes
22.5/7.5 wpm code for 20 minutes
22.5/10 wpm code for 20 minutes
22.5/13 wpm code for 20 minutes

☐ **HR-HLC3 — $4.95**

15/5 wpm code for 28 minutes
15/7.5 wpm code for 28 minutes
15/10 wpm code for 28 minutes

☐ **HR-HLC4 — $4.95**

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More Details? CHECK—OFF Page 98

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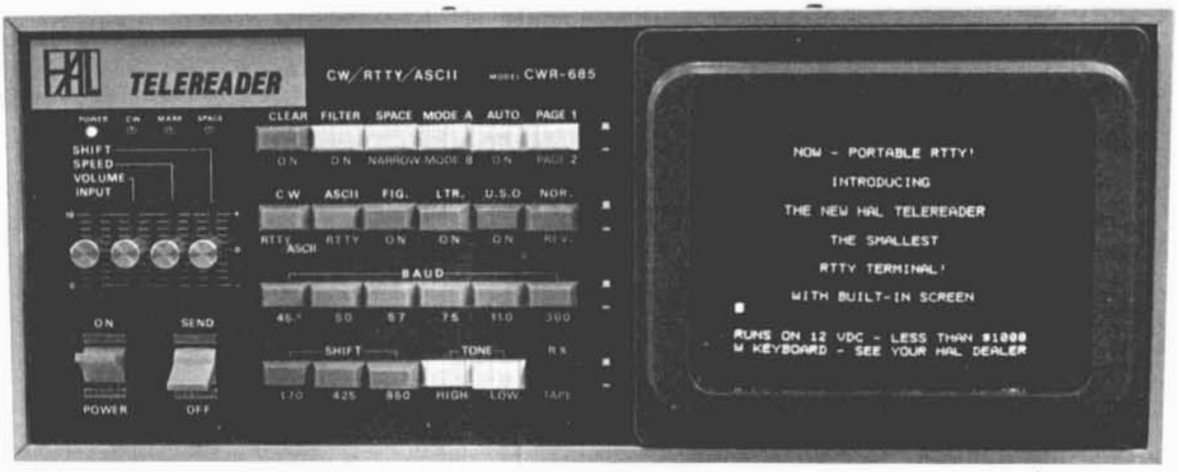
Loud and Clear.



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NO CUT CORNERS!

FT-208R - 2 Meters
FT-708R - 70 CM

LIQUID CRYSTAL DISPLAY
The LCD frequency readout provides high readability night and day, along with very low current drain.

KEYBOARD FREQUENCY ENTRY
All operating frequencies are entered from the front panel keyboard. Unusual repeater splits, scanning, and memory programming are all controlled via the keyboard.

UP/DOWN MANUAL SCAN
The FT-208R scans in either 5 kHz or 10 kHz steps, while the FT-708R steps are 25 kHz and 50 kHz. Automatic halting on a busy or clear channel is provided, with automatic pause and restart feature. Scan either the band or the memories.

LIMITED BAND SCAN
You can program upper and lower frequency limits, then command the transceiver to scan that segment or exclude that segment.

TEN MEMORY CHANNELS
The memories may be used for either simplex or repeater operation. No need to throw a "5 UP" switch for those 15 kHz channels, either!

LONG-LIFE MEMORY BACKUP
A Lithium cell provides the memory backup function. Now you won't dump memory when switching battery packs.

LOW CURRENT DRAIN
Typical standby current drain is 20 mA, for long battery life.

450 mAH BATTERY PACK
With more capacity than competing packs, the FNB-2 battery pack gives you those precious extra minutes of operating time that might prove critical in an emergency!

HI/LOW POWER SWITCH
In the high power position, the FT-208R packs a wallop at 2.5 watts output, while the Ft-708R output is 1 watt. Switch to low power for 1 watt output on the FT-208R, 200 mW on the FT-708R, for even greater battery life.

PRIORITY CHANNEL
A priority channel may be programmed from the keyboard, allowing you to check a favorite channel while operating on another.

AUTOMATIC BAND AND MEMORY SCAN WITH PAUSE/RESTART
Automatic scanning of the band or memories (or a segment of the band) with pause and restart feature.

16 BUTTON DTMF PAD
For autopatch operation, a 16 button dual tone pad is built into every FT-208R and FT-708R.

PROGRAMMABLE SPLITS
The popular ±600 kHz shift is standard (±5 MHz on the FT-708R) on the FT-208R. Odd splits of up to 4 MHz may easily be programmed from the keyboard. Additionally, a split memory/dial mode provides a third method of operating on unusual splits.

OPTIONAL 32 TONE CTCSS
Easy interface is provided to the synthesized SSY-32 CTCSS Encoder, providing all 32 common subaudible tones for repeater operation.

LOCK SWITCH
The keyboard lock switch allows you to disable entry from the keyboard, thus preventing inadvertent frequency change.

FULL LINE OF ACCESSORIES
A Yaesu tradition, a full line of accessories is available to maximize your enjoyment of the FT-208R and FT-708R.

For more than a quarter of a century, Yaesu has produced reliable, high-performance communications equipment for the Amateur and Land Mobile services. Contact us today for full information on our cost-effective line of HF, VHF and UHF transceivers — at Yaesu we want you to get your message across!

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New Drake TR5 Transceiver

far above average!

COMING SOON:
RV75 Synthesized VFO
featuring the Drake "VRTO"

• **Frequency Synthesized** for crystal-controlled stability • **VRTO (Variable Rate Tuning Oscillator*)** adjusts tuning rate as function of tuning speed. • **Resolution to 10 Hz** • **Three programmable fixed frequencies** for MARS, etc. • **Split or Transceive operation** with main transceiver PTO or RV75

* Patent pending

With the new TR5
versatility and value are spelled D-R-A-K-E . . .

DYNAMIC RANGE

The dynamic range of the TR5 is unexcelled by any transceiver in its class. The TR5's greater than 0 dBm third order intercept point (85 dB two-tone dynamic range) at 20 kHz spacing can be achieved only by the use of a passive diode-ring double balanced mixer. Drake was the first to bring this technology to the Amateur market with a high-level mixer in the TR7.

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When you purchase a TR5, or any Drake product, you acquire a product of the latest production techniques, which provide reliable performance.

Yet with a product as sophisticated as one of today's transceivers, after-sales service is a must. Ask any Drake owner. Our Customer Service Department has a reputation second to none.

ACCESSORIES

Drake is the only Amateur Radio manufacturer who offers a full complement of accessories to satisfy almost every desire the HF Amateur may have. This wide selection allows any operator to assemble a station which meets his needs, and assures compatible interfacing and styling instead of a desk full of equipment with a variety of styling and poor operation as a system.

KILOWATT AMPLIFIER

Everyone wants to be heard! The accessory L75 and its 3-500Z (1200 watts PEP input) and a decent antenna will do the trick. This rugged self-contained amplifier / power supply will put the TR5 on an even footing with the best of them.

ENGINEERING

The TR5 and all Drake Transceivers, are backed by the best in engineering. The TR5 is the result of an extensive engineering effort, combining proven past techniques and ideas with new state of the art concepts.

As a result, the TR5 will not be superceded by a new model every six months. It represents a true radio communications value that will provide many years of operating enjoyment.

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

See your Drake dealer or write for additional information.

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