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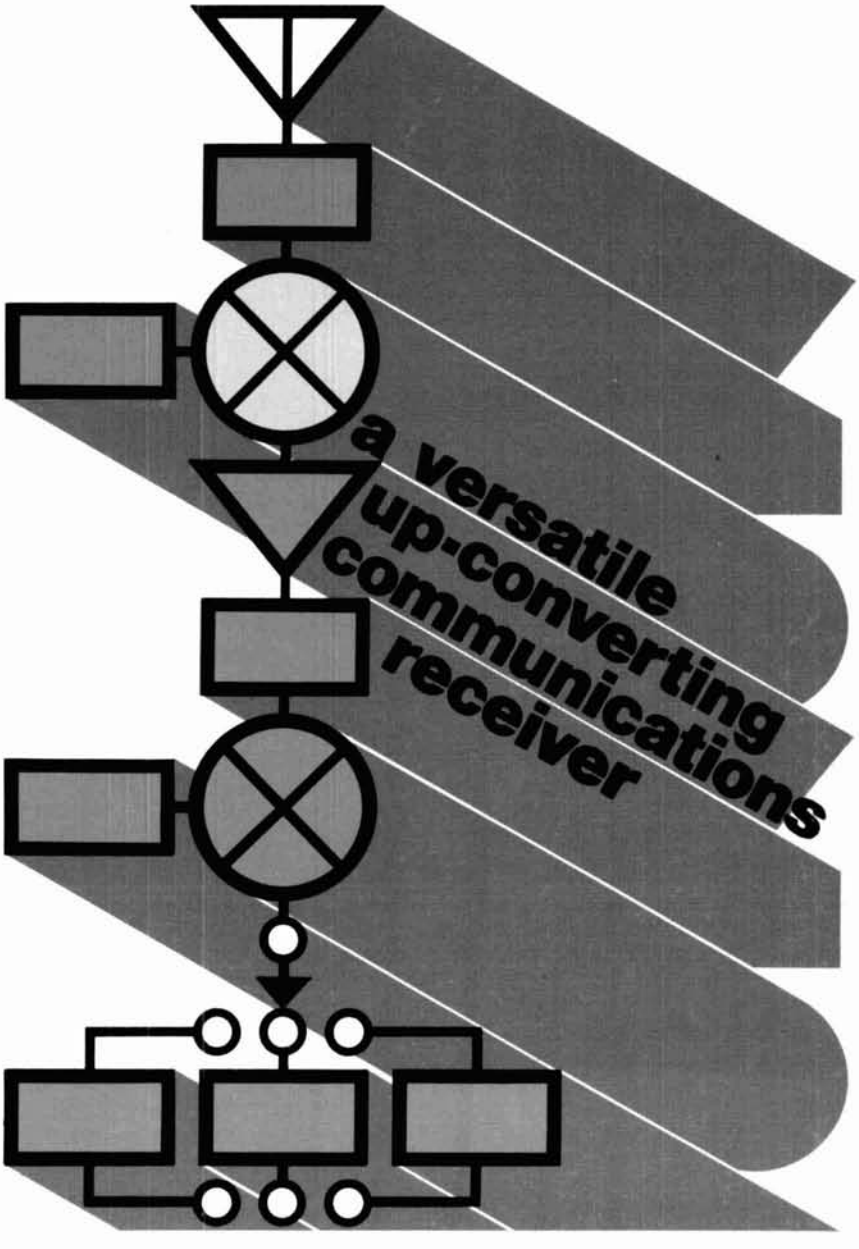
ham radio magazine

- review of 2-meter handhelds
- operation upgrade: part 8
- digital approach to odd splits: the ICOM IC-2AT
- VHF and UHF synthesizers



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ham radio

magazine

JULY 1982

volume 15, number 7

ham radio magazine
is published monthly by
Communications Technology, Inc
Greenville, New Hampshire 03048-0498
Telephone: 603-878-1441

subscription rates

United States: one year, $19.50
two years, $32.50; three years, $42.50

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contents

Observation & Opinion

By now it's no secret to the American public that government services are being drastically cut by the Reagan administration's efforts to control government spending. It is also well known among knowledgeable Amateurs that those cuts have severely affected our friends at the Federal Communications Commission. The effects of the FCC's belt-tightening efforts are growing to the point where it's now considered likely that Commission administration of the Amateur exam program will be drastically curtailed if not eliminated altogether by the year's end.

Fortunately, timely provisions for filling this void are contained in the Communications Act rewrite bill originally introduced by Senator Barry Goldwater, K7UGA, and presently under consideration in the House of Representatives as HR 5008. Under the provisions of this bill, the FCC would be permitted to delegate both monitoring and exam administration responsibilities to the Amateur Radio community; this could, in theory, solve the problem. However, in its present form, the House Communications Act rewrite bill includes language which would prohibit anyone working for an organization involved in the production or distribution of any Amateur gear or Amateur Radio training materials from preparing or contributing to any Amateur Radio examination program.

Although this amendment does make sense — any organization that publishes training materials would be perceived by prospective Amateurs as having the "inside track" if it also were administering the exams — the amendment would also prevent the one organization in the country capable of taking over and handling a program of this magnitude from taking part in it. Whether that amendment will survive in the Congress, or how such potential conflicts of interest can be surmounted if it doesn't, remains to be seen. In the meantime, let's consider the potential benefits of an examination program administered by Amateurs.

Back in the good old days of Amateur Radio, the FCC was able to staff its field offices with well-qualified technical people, many themselves licensed Amateurs. These were the people who gave you the exam, and when they said you'd passed you knew you'd earned your license! Today, although the FCC still has many highly qualified people on its staff, these people are much too valuable to be looking over the shoulders of would-be Amateurs sweating over their exams. Exams are administered by clerical help, which is why there's no longer a CW sending test (who'd listen?), and why the CW receiving test is fill-in-the-blank and written exams are "multiple guess." At the same time there are well-founded fears that the proliferation of so-called cheat books — exam study guides that are nothing more than lists of the exact questions and answers out of the FCC's current exams — are creating a generation of Amateur appliance operators with no real knowledge of radio or electronic theory.

If Amateurs are going to take over exam administration (and it seems certain that they are), we as Amateurs have a golden opportunity to restore integrity to a program that's been seriously eroded in recent years. We've got an opportunity to break away from the simplistic multiple choice exam and go in new and innovative directions in the testing of new Amateurs. We could bring back essay-type questions, reinstitute the CW sending test, and even go to an interview exam where an applicant would discuss specified exam topics with a panel, which would then decide whether the applicant was ready either to become an Amateur or to upgrade. There is truly no end to the possibilities!

It is a golden opportunity, and whether we're prepared for it or not we're going to have to be ready with something — and very soon. Let's discuss it with other Amateurs, particularly those involved in licensing classes, and ask our League directors what they are doing about it in Newington. Like it or not, we're soon going to be in the exam business. We'd better be prepared!

Joseph Schroeder, W9JUV

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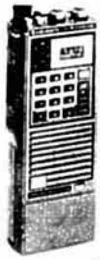

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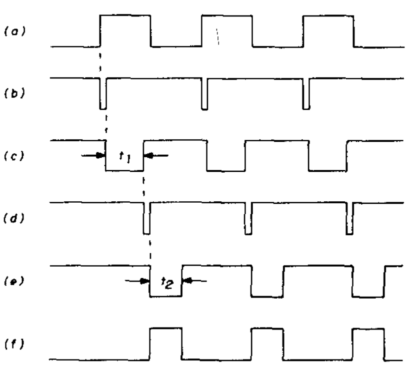
More Details? CHECK—OFF Page 92

comments

Woodpecker blanker

Dear HR:

"Blanking the Woodpecker, Part Two: A Practical Circuit" by David Nicholls, February, 1982, *ham radio*, *is an excellent article.* Nicholls writes in a clear manner, and it is exciting to see a high-performance blanker built around three CMOS chips.



The timing diagram (**fig. 6**) is confusing, however, in that it depicts waveforms (b) and (d) occurring prior to the signals from which they are derived, waveforms (a) and (c), respectively. I am enclosing a corrected timing diagram. It's really a minor error.

Robert K. Zimmerman, NP4B
Arecibo, Puerto Rico

IC2AT power supply

Dear HR:

I had decided to design a mobile power supply for my IC2AT handheld 2-meter transceiver. I started reading the article by Gil Weiss, WB3JJF, (February *ham radio*) and decided not to design the power supply. After looking into the article more thoroughly I discovered a mistake.

The last sentence in the first paragraph under **construction** says, "If a spike greater than 12 volts should occur, the zener will shunt the circuit to ground and blow the fuse." My analysis is that the circuit does not perform in that manner. I figure the circuit will have 12 volts at the V_{out} if the zener is fast enough to go into regulation when the spike occurs and before the spike disappears. It is very possible the fuse will not blow.

The author could use a crowbar circuit using an SCR and set it to a threshold point to short and blow the fuse if spikes should occur.

Henry R. Leggette, WB4MNW
Memphis, Tennessee

I am providing the following in response to Mr. Leggette's questions concerning the circuit performance of the fuse and zener diode relative to high voltage spike protection.

This arrangement has been in print in several ham radio publications in similar circuits for various HT applications and is recommended by at least one major manufacturer of mobile equipment. I have discussed and questioned the circuit with other hams, including electrical engineers, and have gotten a variety of responses. The zener will conduct and blow the fuse, but for a very short period of time the spike does appear at the regulator output and, in my opinion, could damage a rig. The problem here is that most hams, including myself, do not have the sophisticated test equipment necessary to analyze this type of circuit performance where short-time-duration measurements become critical.

My prototype unit contained the zener protection for insurance, as shown in the article, but I have built subsequent units without the diode and they have been functioning fine. Transient voltage spikes in mobile operation can be best avoided by (1) wiring the regulator or equipment directly to the car battery, which provides natural surge suppression, and (2) shutting down the equipment when starting the vehicle since this is when spikes usually occur. Additionally, with all of the mobile gear in operation the instances of voltage spike or surge damage appears to be quite rare.

Although crowbar circuits are normally associated with ac power supplies, it appears that an SCR circuit could be used here, but the same question arises regarding potential damage by the spike in the few nanoseconds required to trip the SCR.

Any light that can be shed on this topic by other readers would be appreciated.

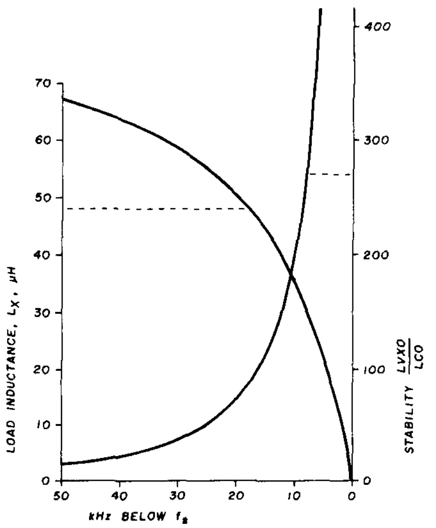
Gil Weiss, WB3JJF
Bensalem, Pennsylvania

phantom-coil VXO

Dear HR:

In my article (page 66 of the January issue), I failed to see that one of my marbles was nicked until after it was out of the bag.

While the curves of **fig. 1** are of the right general shape, both are too inaccurate to use for design purposes. Anyone reading the design example, page 68, must wonder where the numbers are coming from. Below is a copy of the correct graphs for **fig. 1**:



Corrected graph for fig. 1, page 67, of the January, 1982, issue. (HC6/U crystal, 40-meter LVXO. $C_o = 6\,pF; r = 250.$**)**

Additionally, I've noticed that after a year of operation the oscillator would occasionally fail to start. The cure was to substitute the RCA 3N212 for Q1. This transistor has a much larger g_m, and should take care of the problem indefinitely.

Frank Noble, W3MT
Bethesda, Maryland

More Details? CHECK—OFF Page 92

presstop

THE FCC HAS EXTENDED THE COMMENTARY CUTOFF DATE ON P.R. DOCKET 82-83 to August 16th. Docket 82-83 is the twin bill that proposes expanding U.S. 20-meter phone privileges to 14.150 MHz, and also requests input from Amateurs regarding phone expansion on other bands and incentives toward license upgrading. The ARRL had requested an extension to permit Amateurs time to read the full text of the proposal prior to filing comments. The text appears in the May issue of QST magazine, and the League asks that Amateurs read it and then convey their views to the ARRL Plans and Programs Committee, their Division Director and the FCC.

A CLAIM OF TEN CLEAR REPEATER AND EIGHTEEN SIMPLEX CHANNELS on 220 MHz, plus similar clear channels on 10, 6, 2, and 3/4 meters is being made by a contingent of Mexican Amateurs attending two recent meetings of the 220 SMA of Southern California. According to their spokesman, Amateur VHF/UHF repeater operation in Mexico has been directed by their government onto specific channel pairs as outlined in a reputedly formal agreement between Mexico, Canada, and the United States. The Mexicans claim they must move to these channel pairs shortly or face the confiscation of their repeater stations. Also, they state that the agreement calls for the channels to be kept totally void of U.S. operation for 150 miles from the border. WLR made an extensive check with the FCC and the State Department in Washington and the Canadian Department of Communications, in parallel with a similar investigation by the 220 SMA, and could find no evidence that such an agreement between any of the three governments has ever been negotiated. (The State Department did say that it was possible such an agreement was worked out by another Agency, and that they might not yet have been advised of any formal agreements either pending or reached.) The Mexicans, however, have provided 220 SMA with partial documentation from their government that there is such an agreement, and that all parties are expected to abide by it. As to the eighteen simplex channels, the Mexican Amateurs claim that these are also included in the accord, along with similar allocations elsewhere in the VHF/UHF spectrum.

AMATEUR RADIO'S PARTICIPATION IN THE 1984 OLYMPIC GAMES will be organized by a committee operating under the auspices of the Los Angeles Area Council of Radio Clubs. The League's Southwest Division Director, Jay Holladay, W6EJJ, announced formation of the committee, which is to be headed by Tom Rothwell, K6ZT, and will include W6ABW, WB6UIA, W6ZH, WB6ZEB, N2YQ, and Jay as members. The committee will oversee every aspect of Amateur Radio's involvement in and support of the '84 games. Amateurs from outside the Los Angeles area who are planning to attend the Olympics and who might want to take part in what now appears may become a massive communications effort are advised to contact Director Holladay. Due to the logistics of the Games and the large area to be covered, the help of a large number of Radio Amateurs will be needed.

THE TRANSMITTERS CAUSING INTERFERENCE in the 440-MHz region, referred to in the April issue of PRESSTOP, have been tentatively identified as a type of navigational aid called Syledis. Syledis is a medium-range positioning system that operates between 420 and 450 MHz. Syledis is described as "an along-shore navigation system with the accuracy of the best radio-positioning systems."

A NEW RUSSIAN AMATEUR SATELLITE was put into orbit in May when two Cosmonauts pushed the 62-pound Iskra 2 through the airlock of their Solyut 7 spacecraft. Tass reported the communications satellite, believed to translate signals from 15 to 10 meters, was created with the help of "young scientists and Amateur Radio enthusiasts" from the U.S.S.R. and several of its allies. This is probably the first working satellite put into orbit from a manned spacecraft.

H.R. 5008 IS REPORTEDLY OUT OF THE HOUSE TELECOMMUNICATIONS SUBCOMMITTEE virtually intact. The House version of Senator Goldwater's FCC revision bill (S-929) permits the Commission to set minimum RFI susceptibility standards for consumer electronic products. After going through the Committee to the full House for approval, it must be reconciled with the Senate version before going to President Reagan for his signature. Strong opposition to this provision is expected from the powerful EIA lobby.

A SECRET AMATEUR RADIO STATION MAY BE OPERATING IN THE FALKLAND ISLANDS. Although the Argentine military ordered all ham gear turned over to them in April, Gary Jordan, WA6TKT, listened to a QSO signing a VP8 prefix claiming to be from that area. We have been unable to confirm whether or not the station was legitimate.

ULRICH L. ROHDE, president of Rohde & Schwarz Sales Co., Inc. has announced his resignation effective June 30, 1982. He will pursue career goals in the fields of consulting and education. Dr. Rohde has been a frequent contributor to ham radio, and we wish him the best of luck.

A NEW HOUR-LONG AMATEUR RADIO TV PROGRAM is being aired every Sunday in New York City. Named "Network Two New York," the show is produced by Larry Horn, N2NY, and is carried live on cable channel D at 2:00 PM. Long range plans call for this program to be made available nationwide via satellite. Contact N2NY at 415 E. 80th St., New York City for more details.

More Details? CHECK—OFF Page 92

versatile communications receiver

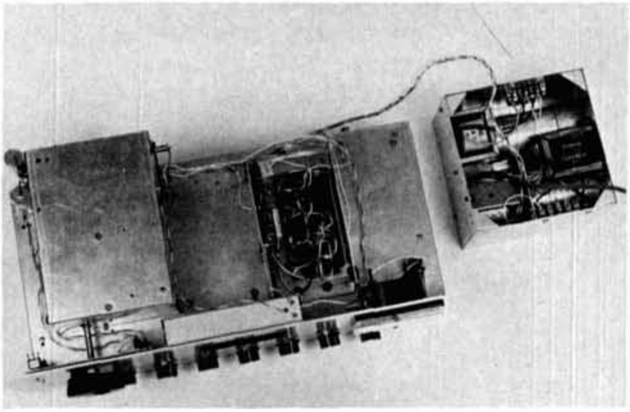
An up-converting design featuring a synthesized LO and digital readout

The trend in communications receivers in recent years has been toward up-converting superheterodynes with some sort of synthesized local oscillator and a digital readout. Several designs have been presented in the Amateur literature, and many units of commercial equipment are using the technique. The up-converting receiver can offer excellent performance but has been heretofore nearly impossible for the Amateur to build because of the difficulty in obtaining parts. In this design, great care has been taken to use parts that are available as catalogue items from manufacturers or from surplus sources. The design is adjustable to use parts that are available.

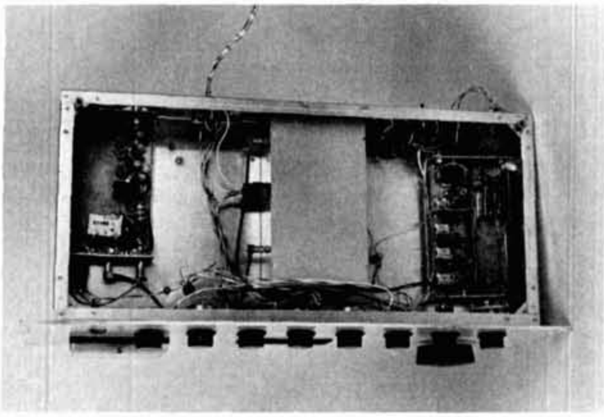
the up-converting technique

For those unfamiliar with the up-converting receiver, the name is derived from the fact that the first i-f is above the highest frequency tuned by the receiver. Thus, all input frequencies are converted up in frequency to the first i-f. For a receiver covering all of the high-frequency Amateur bands, this intermediate frequency is around 30 MHz or even higher. Since the image of a superheterodyne receiver is separated from the desired signal by twice the i-f, a high-fre-

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



Top view of the receiver. The large box to the left is the VFO assembly, while the smaller box with cover removed is the synthesizer. Power supply is at far right.



Underneath the receiver. The box in the center with the cover attached is the second mixer. The front-end module is to the far left and the i-f amplifier is at the far right (covers removed).

quency receiver covering 0 to 30 MHz with an i-f of 30 MHz or greater would have an image band from more than 60 MHz to above 90 MHz. A lowpass filter is all that is required to remove these image frequencies.

Earlier and more conventional superheterodyne designs required a bandpass filter that had to be tuned with the local oscillator or "tracked" with the tuning control. For digitally controlled or synthesized receivers this is not a desirable characteristic. The lowpass filter in the up-converting receiver is fixed for the entire range of frequencies covered by the receiver.

From the simple description, it would appear that the up-converting receiver would be easy to build and a great beginner's receiver. Unfortunately, there are some problems unique to the receiver that require some specialized components.

First, the frequency of the first i-f, being greater than 30 MHz, makes it impossible to achieve the narrow selectivity required for CW or SSB reception at the first i-f. Therefore, a second conversion is required to reduce the i-f to a frequency where narrow crystal or mechanical filters can be used. The up-converting high-frequency communications receiver almost always uses dual or triple conversion. Secondly, the local-oscillator frequency is also very high and requires some form of crystal-controlled stabilization, such as a frequency synthesizer. Thirdly, since a lowpass filter is used preceding the mixer, the range of input signals fed to the mixer is very great, which increases the chances of harmful second- and third-order intermodulation. No rf amplifier is used and a good quality mixer, such as a double balanced diode mixer, reduces the generation of mixer distortion products. The application of modern components and techniques can easily control the disadvantages of the up-converting receiver.

overall receiver scheme

Fig. 1 shows the block diagram of the up-converting receiver excluding the power supply. The signal from the antenna is first passed through the 30-MHz lowpass filter to remove the image frequencies, which in this case are above 150 MHz. The double-balanced mixer provides the first conversion, using the output of the synthesizer as the local oscillator. This is the only local oscillator that is variable, and all receiver tuning is done with the synthesizer. The output of the mixer feeds the first i-f amplifier without any selectivity. Since the entire band of input frequencies is present at the mixer and the first i-f amplifier, these two circuits will have more influence over the dynamic range of the receiver than any other section. The 75-MHz first i-f filter is immediately after the first i-f amplifier and feeds the second mixer. Since the bandwidth of a 75-MHz filter is on the order of 20 to 40 kHz, there is a chance of intermodulation being generated in the second mixer, although not nearly as great as in the first mixer. In addition, there is a possibility of having some gain from the antenna to the input of the second mixer. Therefore, for signals closer than about 20 kHz, the dynamic range of the receiver is dependent on the second mixer.

The i-f filters immediately follow the second mixer, and the frequency of the second local oscillator will be determined by the center frequency of the filters used. The majority of the receiver's gain is obtained at the second i-f and is divided into two sections. The i-f preamplifier provides about 10 dB or so of gain and does not have AGC action. The main purpose of

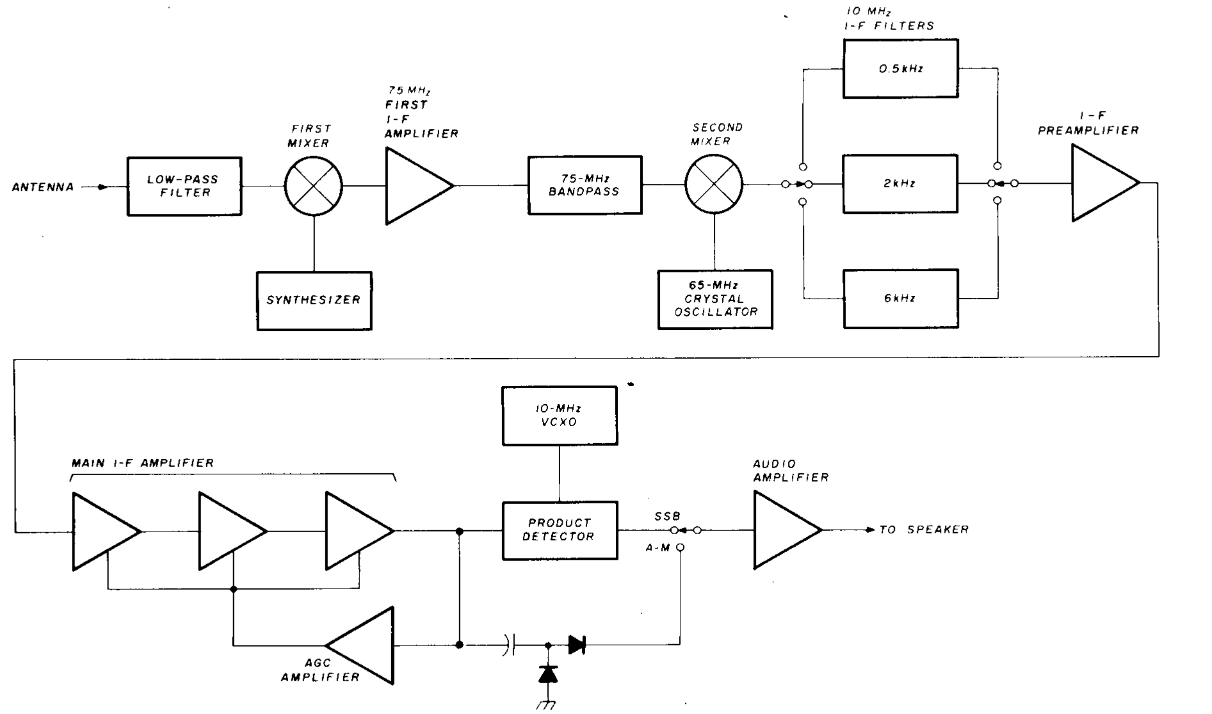


fig. 1. Block diagram of the up-converting receiver excluding power supply and audio amplifier. Lowpass filter preceding the mixer removes image frequencies, which are above 150 MHz. Second mixer is a dual-gate FET circuit, which obtains its LO signal from a fifth-overtone crystal oscillator. Each of the three i-f amplifiers provides about 20 dB gain.

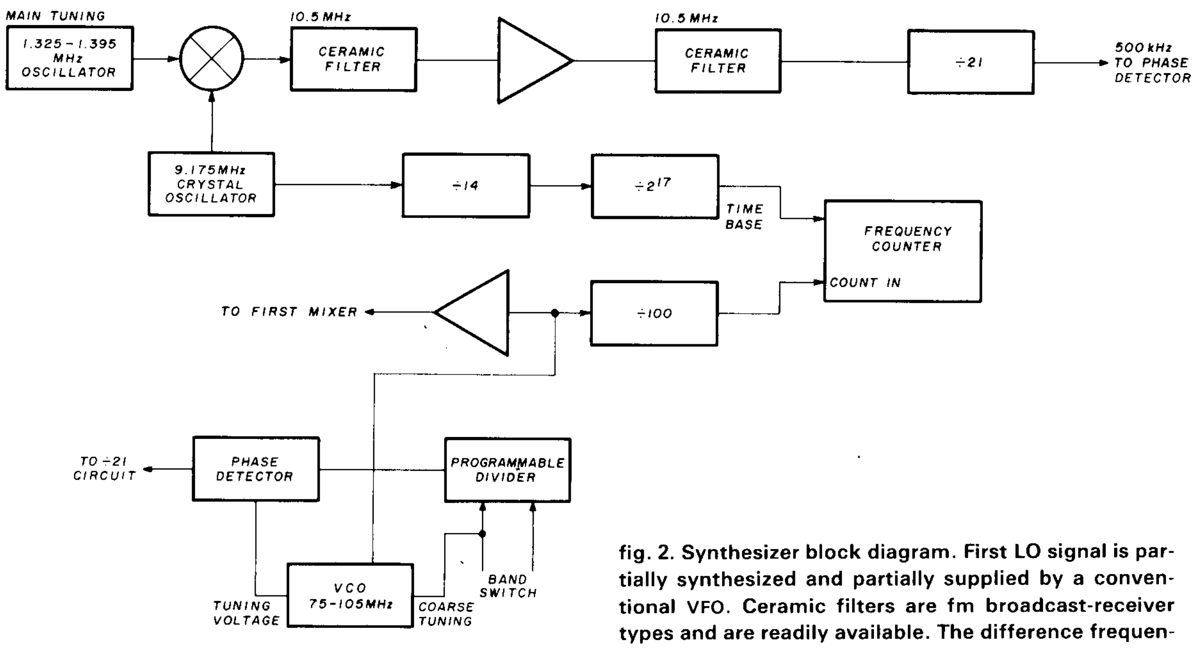


fig. 2. Synthesizer block diagram. First LO signal is partially synthesized and partially supplied by a conventional VFO. Ceramic filters are fm broadcast-receiver types and are readily available. The difference frequency between the VFO and crystal oscillator controls a phase-locked-loop LO, which operates between 75 and 105 MHz.

this stage is to match the impedance of the filters to 50 ohms to drive the cable that connects the i-f preamplifier to the main i-f amplifier. Three dual-gate FET i-f amplifiers are used for the majority of the i-f gain and gain-control action. A simple carrier-operated AGC system is used, while both a diode detector and a product detector are supplied for SSB/CW/RTTY or a-m detection. The BFO is a voltage-tuned crystal oscillator that is pulled far enough in frequency to cover both upper and lower sidebands. The actual frequency of the crystal will depend on the center frequency of the filters used. A low-power audio amplifier constructed from a single IC is all that is required to drive a small loudspeaker.

The stability, dial accuracy, tuning rate, and, to some extent, the dynamic range of a receiver is a function of the local oscillator signal. In this receiver, the first local oscillator signal is the controlling factor and is supplied from a frequency synthesizer as shown in the block diagram of **fig. 2**. The local oscillator signal is partially synthesized and partially supplied from a conventional VFO. I wanted to obtain the infinite resolution that only a variable oscillator can achieve, while obtaining the frequency accuracy and stability that only a phase-locked loop can achieve — all of this with readily available parts. The technique chosen was to heterodyne a crystal oscillator with a much lower frequency VFO and use the difference frequency to control a phase-locked-loop local oscillator between 75 and 105 MHz.

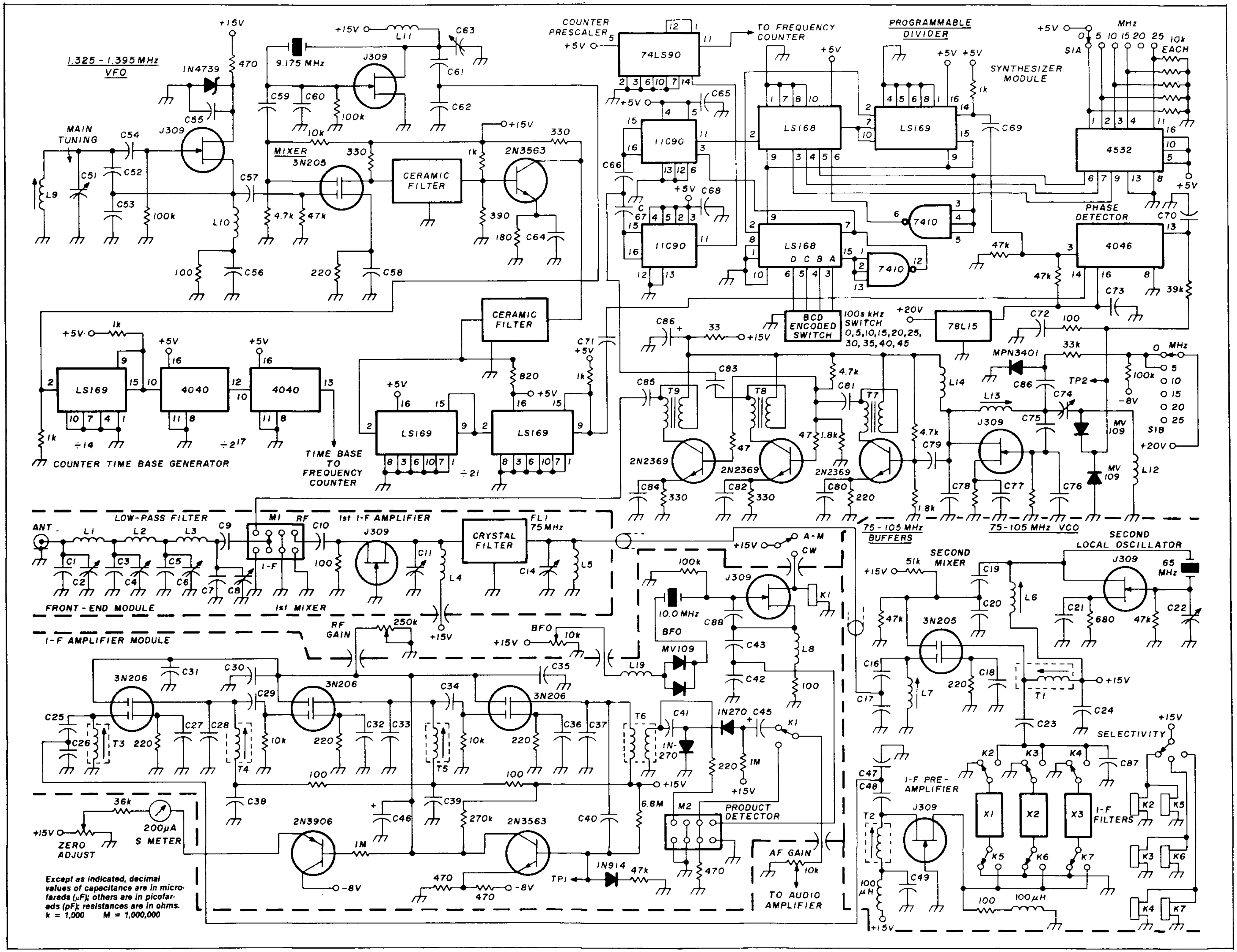
Referring to **fig. 2**, a VFO operating between 1.325 and 1.395 MHz is heterodyned with a crystal oscillator operating at 9.175 MHz. The difference frequency, which covers the range between 10.5 and 10.57 MHz, is filtered with ceramic filters and divided down to 500 kHz with standard TTL logic. It is important that the difference frequency be carefully filtered for low-noise performance. The ceramic filters are intended for use in fm broadcast receivers and are readily available.

The nominal center frequency of ceramic filters varies considerably when they are manufactured and are color coded into selected groups. The filter used in the synthesizer has a center frequency of 10.64 MHz and is coded with a black dot by most manufacturers of these filters. The passband of these filters is sufficiently wide to pass the desired 10.5-MHz signal but narrow enough to reject the undesired 7.85 MHz image. The 9.175-MHz crystal is divided down to 5 Hz for use as a time base for the frequency counter. The 500-kHz output from the digital divider is used as a reference for a phase-locked loop. A 75- to 105-MHz oscillator is phase locked in 500-kHz steps to this reference using standard pulse swallowing techniques. Since the frequency of the 500-kHz reference is slightly variable as controlled by the VFO, the frequency range between the even 500-kHz steps can be covered.

There is one significant disadvantage to this method of local oscillator generation; the tuning rate for the 500-kHz bands is different. For example, if the VFO allows the receiver to be tuned 500 kHz on the lowest-frequency band, (0-500 kHz) the range on the highest band would be 700 kHz. Since the actual fre-

fig. 3. Schematic diagram (page 16) of the up-converting receiver. Circuit is composed of six modules, all of which are built into shielded boxes. X1-X3 are 10-MHz monolithic selectivity filters, but the more common 10.7-MHz filters may be used by changing the second LO crystal frequency to 64.3 MHz for a 10.7-MHz i-f. Parts list is below.

C1,C3,C5,C7	*75-pF mica 50 V*
C2,C4,C6,C8 C22,C63,C74	*7-35 pF ceramic trimmer*
C9,C72,C73	*0.1-μF ceramic 50 V*
C10,C11,C14,C15,C38, C39,C41,C49,C54,C56, C57,C58,C59,C64,C65, C68,C69	*0.01-μF ceramic 50 V*
C17,C20,C42	*220-pF mica 50 volt*
C16	*33-pF mica 50 volt*
C18,C21,C26,C27,C29, C30,C32,C34,C35,C36, C47,C66,C67,C70,C80, C81,C82,C83,C84,C85, C87	*1000-pF ceramic 50 V*
C23,C25,C28,C33, C37,C40,C48,C60	*56-pF mica 50 V*
C19,C43,C44,C88	*39-pF mica 50 V*
C45,C86	*10-μF 25 V*
C46	*3.3-μF 25 V tantalum*
C51	*20-pF gear driven variable (see text)*
C52,C53,	*330-pF mica 50 V*
C86	*10-pF mica*
C75,C76	*15-pF mica 50 V*
C78	*39-pF mica 50 V*
C79	*2.2-pF ceramic NPO*
FL1	*Piezo Technology 4171F 4-pole crystal filter*
L1,L3	*13 turns on Micrometals T50-10 core No. 26 wire*
L2	*14 turns on Micrometals T50-10 core No. 26 wire*
L4,L5	*14 turns on Micrometals T20-10 No. 32 wire*
L6,L7	*1-μH slug-tuned coil*
L8,L10,L15, L17,L18	*330-μF rf choke*
L9	*75-μH slug-tuned coil*
L11	*6.8-μH rf choke*
L12,L13	*0.22-μH*
L14	*2.2-μH rf choke*
L16	*5.6-μH rf choke*
T1,T2,T3, T4,T5,T6	*10.7-MHz i-f coil, 4.5 μH nominal (see text)*
T7,T8,T9	*7 turns primary and secondary bifilar wound on an Indiana General CF-101 ferrite core*
M1,M2	*double-balanced mixers (Mini Circuits Labs SRA-1)*
X1,X2,X3	*i-f selectivity filters (see text)*



Except as indicated, decimal values of capacitance are in microfarads (μF); others are in picofarads (pF); resistances are in ohms. k = 1,000 M = 1,000,000 quency is read by a frequency counter, the display would not be in error, but the tuning rate would change accordingly. This problem was simply solved by using a tuning rate slightly slower than optimum at the lowest frequency and just a bit fast at the highest range and using a very smooth tuning capacitor. With this arrangement, the tuning rate difference is hardly noticeable and certainly not objectionable. Because the phase-locked loop reference frequency is 500 kHz, and since the actual tuning is performed with a VFO, the loop is easy to design and gives excellent performance. Receiver stability depends on the stability of the VFO, which must be carefully designed. On the highest frequency band, the frequency drift of the VFO is multiplied by a factor of ten relative to the received frequency; but because the VFO operates at only 1.3 MHz, it is not difficult to reduce the frequency drift to an acceptable level.

the circuit

Implementing the block diagram into a working receiver was done with great care to produce a receiver *that could be constructed* by the Amateur with parts available everywhere. The schematic, **fig. 3**, shows the majority of the receiver. The power supply and audio amplifier are diagrammed in **fig. 4**. A detailed

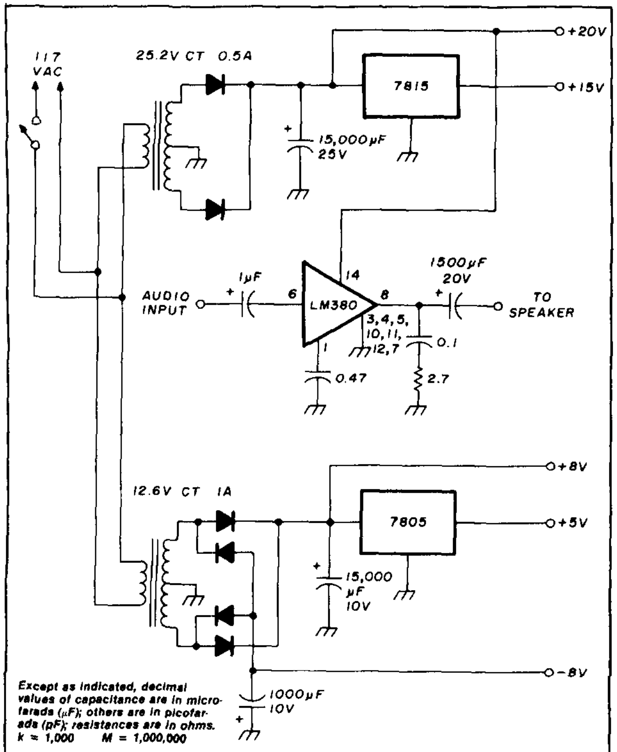


fig. 4. Power-supply and audio-amplifier schematic diagram. This module is built into a separate box away from the receiver circuits to isolate the largest source of heat and to prevent frequency instability.

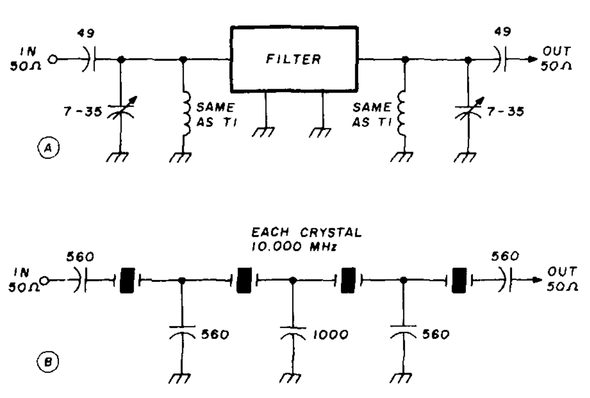


fig. 5. Matching networks for the i-f filters. The network for the monolithic filters is shown at A. Values of components are determined by the filters used (see text). The 500-Hz CW filter, B, is made from four fundamental-mode crystals, which are calibrated for series-mode operation and have a series resistance of less than 30 ohms.

schematic of the selectivity filters is shown in **fig. 5**, and the frequency counter in **fig. 6**.

Front-end components. The input signal from the antenna is first passed through a seven-pole lowpass filter with a cut-off frequency of about 30 MHz. Toroid inductors are used to provide a high ultimate rejection to signals outside of the passband. Also, variable capacitors are used to tune the filter to exactly the proper passband shape. The first mixer, which immediately follows the lowpass filter, is a standard-level prepackaged mixer. In this receiver the mixer port called "I-F" is used for the input rf signal. This is because the lowest frequency at which the receiver is capable of operating is about 10 kHz, and the rf port on most mixers cannot operate at this low frequency. The remaining two ports, the LO and rf ports, operate above 75 MHz and do not suffer from this problem. The output of the mixer feeds the 75-MHz i-f amplifier, a grounded-gate amplifier without tuning on the input, which provides a good termination for the balanced mixer. The output of the first i-f amplifier is matched to the 75-MHz monolithic crystal filter. The overall gain from the antenna to the output of the 75-MHz filter is between zero and 3 dB.

Second mixer and i-f selectivity section. Since there is essentially no overall gain from the antenna to the input of the second mixer, I decided that the second mixer should have some gain, and the dual-gate FET circuit shown in **fig. 3** was chosen. A simple fifth-overtone crystal oscillator was used for the LO for the second conversion from 75 MHz to 10.0 MHz. About 15 dB of gain is available from the mixer before the signal is fed into the i-f filters.

Switching of the i-f filters is done with relays for

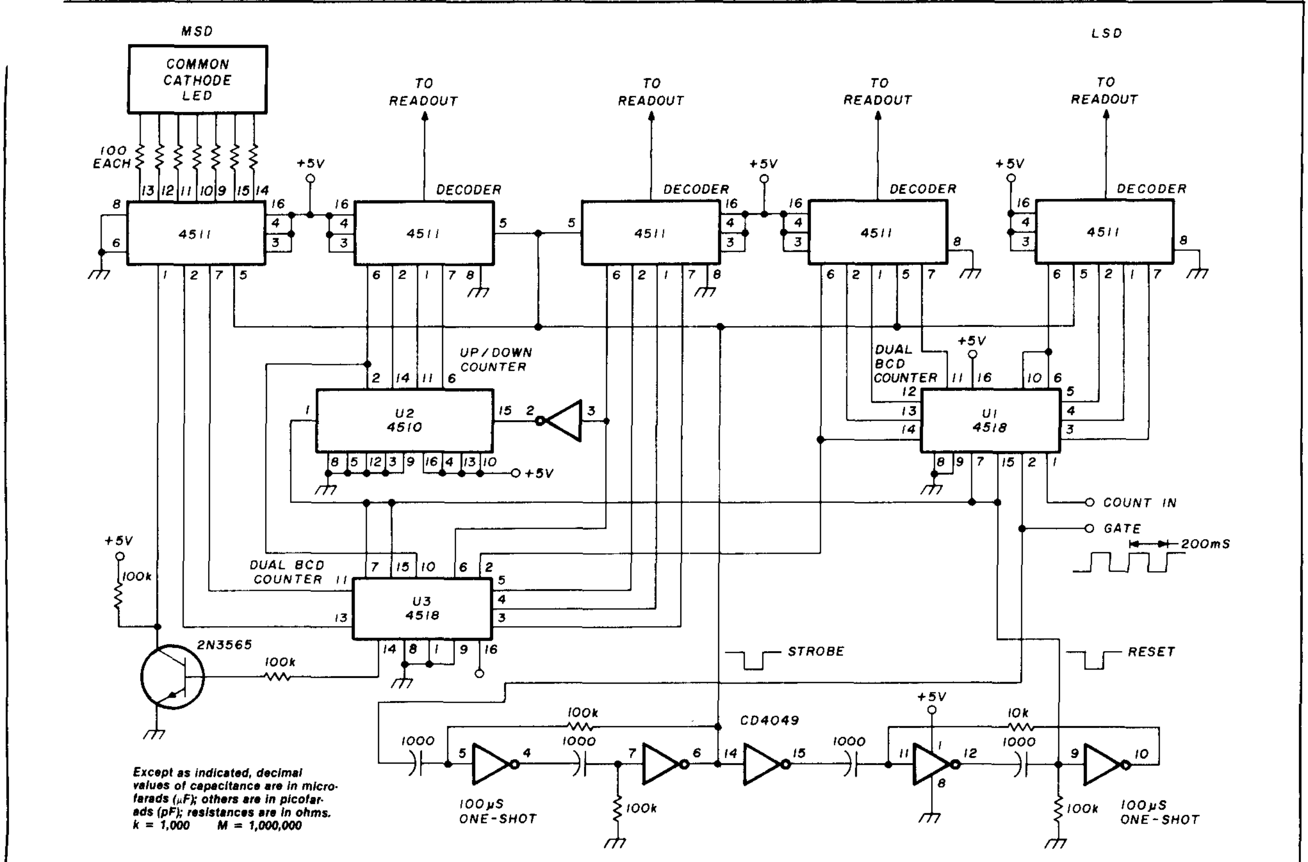


fig. 6. Schematic diagram of the frequency-counter section. This circuit automatically subtracts the first i-f from the counted frequency.

several good reasons. First, the relays allow for simple front-panel switch connections. The selectivity switch has only three wires that carry only dc. Second, it simplifies the layout of the receiver, because the selectivity switch can be mounted anywhere relative to the filters. And, finally, the shielded sealed relays allow for a very high ultimate attenuation by reducing the amount of feedthrough around the filters. PIN diodes would be a modern substitute, but a good supply of sealed relays were available to me. The choice of the second i-f was also dictated by what was available. The unusual 10.0-MHz i-f was chosen to make use of a set of filters for that frequency. Nine MHz or 10.7 MHz would be more common frequencies and may be used by changing the second LO crystal to 64.3 MHz for a 10.7-MHz i-f or 66 MHz for a 9-MHz.

The blocks X1, X2, and X3 in **fig. 3** represent the filters and circuitry to match them to 50 ohms. **Fig. 5** shows the matching circuitry for the 10.0-MHz monolithic filters I used. The 10-MHz filters will not be readily available, but standard 10.7-MHz filters use a very similar matching network. Most filter manufacturers provide a test circuit to match their filters to 50 ohms for evaluation, and these circuits will work in the receiver. The 500-Hz filter, also shown in **fig. 5**, is constructed from four fundamental-mode crystals. These crystals are calibrated for series mode and should have a series resistance less than 30 ohms, which is typical for most good-quality crystals. The output of the i-f filter is terminated with a grounded-gate FET preamplifier, which feeds the main i-f amplifier through a 50-ohm line. The overall gain from the antenna to the output of the second mixer module is about 20 dB.

I-f amplifier demodulator. The majority of the receiver gain is obtained at 10.0 MHz in the i-f amplifier module through three dual-gate FET amplifiers. Each stage provides about 20 dB of gain and at least 30 dB of AGC cutback per stage. The output of each amplifier is tuned to reduce the noise level of the i-f system. The AGC system is a carrier-operated type using a transistor as a detector, and also provides additional gain in the AGC loop. The AGC hold capacitor, C46 is discharged rapidly through the collector of the AGC transistor and charged slowly through the 270k resistor connected to the power supply. The rf gain control determines the maximum gain of the receiver but does not disable the AGC action. A buffer amplifier isolates the S-meter load from the AGC line.

The BFO for the product detector is a voltage-tuned crystal oscillator. A frequency variation of about 1.5 kHz either side of the nominal 10.0 MHz is achievable with the two paralleled varactors as shown. The audio output from either the product detector or the diode detector is selected by a relay, the coil of which is connected to the BFO power supply so that the audio is automatically switched from the diode detector to the product detector whenever the BFO is energized. Again, the availability of sealed relays was the driving force behind this arrangement.

Frequency counter. The actual received frequency of the receiver is the local oscillator frequency minus 75 MHz. Originally, a single chip counter was used to count and display only the last three digits of the frequency. A major problem with this counter was interference due to multiplexing of the readout digits. Noise was heard in the receiver on the lower frequencies. Since the receiver is capable of operating down to 10 kHz, the lower 100 kHz or so was practically useless.

A second counter was constructed, shown in **fig. 6**, without multiplexing the display. In addition, the entire frequency is displayed to the last kHz. U1, U2, and U3 (**fig. 6**) are binary-coded decimal counters making up the five-decade range required. U1 and U3 are conventional dual BCD counters, while U2 is a presettable counter. As in any conventional counter the input frequency is gated, and the resulting count is strobed into the displays. However, the counter is not reset to zero but to 0500, which effectively subtracts 5 MHz from the count. The additional 70 MHz is subtracted by wiring and inverting the data connections to the tens-of-MHz readout decoder input. Five sections of a hex inverter are used as a dual one-shot to provide the reset and strobe signals.

Synthesizer. Even though great efforts were taken to simplify the synthesizer, it is probably the most complex part of the receiver. Basically two separate units make up the synthesizer: the VFO module and the synthesizer module. Referring to **fig. 3**, the VFO is a standard Colpitts circuit operating from 1.325 to 1.395 MHz. The stability of the oscillator is ensured by using polystyrene and mica capacitors and providing a separate zener-regulated supply voltage. No buffer amplifiers are used since the VFO feeds the high input impedance of a dual-gate FET mixer circuit.

The second gate of the dual-gate FET mixer is fed from a 9.175-MHz Pierce oscillator. The drain of the mixer is terminated with 330 ohms and feeds a ceramic filter. A buffer amplifier feeds a second ceramic filter, which drives a TTL divide-by-21 circuit. The output of the divide by 21 is 500 kHz to 503 kHz for the synthesizer. In addition, the 9.175-MHz crystal oscillator frequency is divided by 1.835×10^6 to provide a 5-Hz reference for the frequency counter.

The synthesizer module contains the programmable divider, the VCO and the phase detector for the local oscillator. The VCO is a Vackar circuit that drives a buffer amplifier, which in turn drives two parallel amplifiers. One amplifier feeds the mixer and the other feeds two ECL counters. One ECL counter is a part of a divide-by-100 circuit for the frequency counter, while the other ECL counter is the dual module prescaler for the programmable divider. The mode counter is programmed by the 500-kHz bandswitch, which is a BCD-encoded switch and presets the inputs to the 74LS168 counter directly. The 5-MHz bandswitch programs the main counter through a priority encoder. In addition, the 5-MHz switch switches a fixed capacitor into the VCO at frequencies below 10 MHz.

construction

The receiver is constructed behind a standard 7-inch (18-cm) rack panel and is divided into seven modules. The following segments are built into shielded boxes: front end, second mixer, i-f amplifier, synthesizer, counter and VFO. The seventh module, the power supply, is built into a separate chassis to remove as much heat from the receiver as possible.

A 3 × 7 × 17 inch (7.6 × 18 × 43 cm) chassis is fastened to the rack panel by using the hardware from the front panel controls, and the shielded subassemblies are mounted to the top and inside of the chassis. Most of the front-panel controls pass only dc, so it is possible to place the switches anywhere that's convenient and run the wires any distance to the appropriate subassembly. It is important that all of the circuits be properly shielded. Feedthrough capacitors were used for power and low-frequency signal lines, and rf connectors and coaxial cables were used for all other signal lines. This is especially important for the digital subsystems, the counter, synthesizer and VFO.

Double-sided PC board stock was used for making all the rf circuits, while the digital circuits were constructed on universal DIP plugboard.

Front end. The front end module is constructed in a 5-1/2 × 3-1/8 × 1-1/4 inch (14 × 8 × 3 cm) box and contains the front-end lowpass filter, first mixer, first i-f amplifier, and the first i-f filter. The toroid inductors are fastened to the PC board with silicone ıer, and the filter is arranged in a straight line to ıinimize the amount of feedthrough at VHF. The double-balanced mixer can be practically any standard mixer available with a 7-dBm local oscillator requirement and is soldered directly to the PC board with its pins up. The first i-f amplifier is constructed close to the mixer and the 75-MHz filter.

Second mixer module. The second mixer is constructed in a 6 × 3-1/2 × 2 inch (15 × 9 × 5 cm) aluminum box. Enclosed in this box is the second mixer and local oscillator, all of the i-f filters, their switching and the i-f preamplifier. Shields are inserted between the filters to prevent feedthrough. Six relays do the job of switching the i-f filters and great care was taken not to allow the wires that connect the relay coils from passing near the input and output of the filters. This would allow signals to be passed along the wire and destroy the ultimate attenuation of the filter. One advantage of using the relay is that no switch shaft need pass from the front to the rear of the filter to provide this leakage path.

Tuned circuits at the second i-f are required. These were constructed from standard 10.7-MHz i-f coils with external capacitors. Since the i-f used in my receiver was 10.0 MHz, external capacitors were required to resonate the i-f transformers. If the i-f is 10.7 MHz, the standard i-f transformers will work well without any modification. If the second i-f is 9.0 MHz, the i-f transformers will have to be further padded with external capacitors. Some sort of shielded inductor is required for the tuned circuit to prevent instabilities and signal leakage. These tuned circuits are used at the output of the second mixer, in the two monolithic filter matching networks, and the output of the i-f preamplifier.

I-f amplifier module. The i-f amplifier box is 5-1/2 × 3-1/8 × 1-1/4 inches (14 × 8 × 3 cm) and contains the three i-f amplifiers, BFO, and product detector. The same i-f transformers used throughout the receiver are used as interstage coupling in the i-f amplifier. In addition, shielding between the i-f stages is required to prevent oscillations. Most important, the shielding between the BFO and the i-f amplifier must be complete, otherwise energy from the BFO will enter the i-f amplifier and cause undesirable cutbacks in the AGC system.

The AGC is a carrier-operated system that is used on both a-m and SSB/CW and can be degraded by BFO leakage. In my receiver, it was possible by experimenting with shield locations to reduce the BFO leakage to a point where the S-meter will hardly move when switching the receiver from a-m to SSB. If the cutback is slight the degradation will go unnoticed, but if the cutback is several S-units, the receiver will not be able to copy weak signals.

The BFO uses a crystal oscillator that is tuned with a varactor diode. The BFO frequency as a function of the shaft rotation of the potentiometer is not linear, and only part of the rotation is used to set the BFO frequency as can be seen from the photograph of the front panel.

VFO module. The VFO module is housed in a 5 × 7 × 3-inch (13 × 18 × 7.6-cm) aluminum box and is mounted on top of the chassis with the tuning shaft protruding from the front panel. The capacitor used will determine the design of the actual VFO circuit. The capacitor used on my receiver was obtained surplus and had an attached motor drive. The total number of turns from end to end was 50, which explains the necessity for the motor. The size and position of the VFO box, as well as the design of the VFO, will be determined by the capacitor. The 9.175-MHz crystal oscillator, mixer, 10.5-MHz amplifier, divide-by-21 circuit and the time-base divider for the frequency counter are all contained in the VFO module. It is important not to allow any of the signals to leak from the box as they will cause spurious responses. All connections to the box are made through either feedthrough capacitors or coaxial cables.

Synthesizer and frequency counter. A 6 × 3-1/2 × 2-inch (15 × 9 × 5-cm) aluminum box encloses the synthesizer, which contains the programmable divider and phase detector for the first local oscillator; the VCO; and the divide-by-100 prescaler for the frequency counter. The number of connections into and out of the module is large, and they should be bypassed whenever possible to prevent radiation of spurious signals.

The rf output for the local oscillator is made through a 50-ohm cable, and the 500-kHz reference connection from the VFO box is made with shielded cable. The band switches, which are actually a part of the synthesizer, are mounted on the front panel.

The frequency counter is constructed in a 5-1/2 × 3-1/8 × 1-1/4-inch (14 × 8 × 3-cm) aluminum box and is mounted on the front panel with the readouts exposed through a cutout. In my receiver, the first two LED readouts (the MHz and tens of MHz) are red, while the remaining three readouts are yellow. This makes the dial easy to read and improves the esthetics.

Power supply and chassis. The power supply is mounted in a separate box away from the rest of the receiver to remove the largest source of heat and prevent instability. The regulators are mounted within the chassis to reduce ground loops. The audio amplifier is also mounted within the chassis, but away from the VFO. All the connections to the front panel controls are either dc signals or audio frequency, which allows complete flexibility in the front panel layout and wiring. In fact, many of the functions of the receiver can be remotely programmed. A special scale was created for the S-meter. Instead of the conventional S-units and dB above S9, the signal strength meter was calibrated in microvolts. The meter was disassembled and the original meter markings sanded smooth with fine aluminum oxide paper. The face was painted a flat black, and new calibrations were applied using dry transfer letters. The recalibrated meter was then sprayed with a coat of clear lacquer. The front panel is painted white with all of the trim in black.

receiver alignment

The receiver should be aligned with a sweep generator and an oscilloscope. It is possible, however, to get a reasonable alignment with a CW signal generator and a voltmeter.

The first section to align is the input lowpass filter. The sweep generator output should be applied to the receiver's antenna jack and an rf detector placed at the output of the filter in lieu of the balanced mixer. Tune the filter so that it is as flat as possible with minimum loss. Additional alignment of the front-end subsystem is done after the synthesizer is operational.

The second mixer and local oscillator are aligned by feeding a 75-MHz sweep signal to the input while applying the rf detector to the output connector. Adjust the 65-MHz oscillator by tuning the slug while monitoring the gate voltage. Tune for maximum gate voltage while checking that the oscillator starts each time power is applied. Once the oscillator is operating, select the broadest i-f filter and tune T1 and T2 for maximum signal output. Then, tune the filter matching networks for the least passband ripple on each filter.

Many sweep generators will not have enough stability to sweep the filters accurately. If this is the case, the filters may be aligned using a CW generator manually swept across the filter frequency. Depending on the filters used, the gain of the second mixer module should be about 10 dB.

The i-f amplifier/detector module is aligned next using the sweep generator. No rf detector is required for the alignment of this stage, as the a-m detector may be used. The AGC is disabled by shorting TP1 to ground, and the i-f amplifier is tuned to the same center frequency as the i-f filters. A signal of only a few microvolts should be visible on the oscilloscope, so be sure to keep the level of the sweep generator low.

The frequency synthesizer may be aligned without the use of the sweep generator. Connect the synthesizer to the proper output of the VFO box and place both band switches to the 29.5-MHz band. The phase-locked loop should be locked, which is evident by monitoring the control voltage at point TP2. Adjust L13 for a control voltage of 14 volts. Place the band switch to zero MHz, and adjust C74 for a control voltage reading of 2 volts. Be sure that the synthesizer phase-locked loop locks on all bands from zero to 29.5 MHz. Also, turn the main tuning control and band switches to 30.0 MHz to be certain that the loop locks at the maximum frequency.

The remaining alignment of the front end will require the synthesizer to be connected to the first mixer. Apply an input sweep generator frequency anywhere from a few MHz to 30 MHz, and set the receiver band switches to the corresponding setting. Place the rf detector at the output of the front-end box, and adjust C11 and C14 for a symmetrical and flat response of the 75-MHz filter. The gain from the input to the output of the front-end box should be about 0 dB.

This completes the alignment of the receiver, and once all of the modules have been interconnected, the receiver should function.

If the receiver has been carefully constructed, there should be a minimum of birdies. Most notable is the 500 kHz VFO output, the crystal oscillator in the VFO box at 9.175 MHz, and the BFO at 10.00 MHz. Other spurious signals may appear, depending on the effectiveness of the shielding and filtering. Strong spurious signals not mentioned should be investigated to determine their source.

modifications and additions

Several modifications may be made to the receiver to enhance and improve its operation while retaining the basic form of the unit. Improvement in dynamic range can be obtained by replacing the standard-level double-balanced first mixer with a high-level unit, providing an increase in local-oscillator level. One very promising modification would be the substitution of an active balanced mixer such as the recently introduced SP-6440 from Plessey semiconductors. This chip has a third-order intercept of +30 dBm, which is hard to beat, even with a high-level diode mixer. It is also possible with the active mixer to obtain about 10 dB gain as opposed to the usual 6 dB loss, which results in an additional 16 dB gain. Using any sort of higher-level mixer, and certainly using an active mixer, would require that the second mixer be improved. At the very least, the second mixer could be changed to a double-balanced diode mixer, but this would seriously degrade the over-all gain of the receiver. If the active mixer is used in the front end, the additional gain of the front-end mixer can make up for the loss from substituting a diode mixer in the second mixer slot. The most elegant solution would use the double-balanced active mixer in both locations and eliminate the first i-f amplifier.

Another possibility for modification is to change the first i-f. Although the 75-MHz filter is a catalogue item and is easy to interface with the frequency counter, the 75-MHz frequency is a bit higher than optimum. With the increase in up-converting receiver designs, crystal-filter manufacturers will no doubt be making filters in the 40-50 MHz range available for reasonable prices. One such possibility is a 45-MHz unit manufactured by Piezo Technology for fm communications equipment. It would be easy to rewire the tens-of-MHz digit in the frequency counter, change the second local-oscillator crystal, and to reprogram the divider in the synthesizer to cover 90-150. The only major disadvantage of the lower first i-f would be an increase in the tuning-rate problem. Two major advantages would occur: the lower i-f filter has a considerably narrower bandpass and would improve the intermodulation from close-in signals, and the frequency stability would be improved.

Some accessories have either been developed or are planned to be developed for the receiver that are not necessarily modifications to the basic receiver but allow for additional operating modes and conveniences. A frequency-lock circuit will be added to the VFO to provide extreme frequency stability. The frequency-lock circuit will allow the receiver to be phase locked to a crystal on any frequency tuned by the VFO. The frequency-lock circuit will be energized by pressing a lock push switch mounted near the tuning control and disabled by pressing an unlock switch. The electronics for the lock circuit will be installed inside of the receiver cabinet and consists of about seven integrated circuits.

An antenna tuner/preamplifier for use in the 100-kHz to 500-kHz range has been built to improve the performance of the receiver with short reactive antennas on the lower-frequency bands. The 50-ohm input of the receiver makes it difficult to obtain adequate signal strength below 500 kHz, but the tuner provides a method of tuning out the reactance and matching the antenna to the receiver's 50-ohm input.

The final and almost obvious accessory for the receiver is a matching transmitter. Such a device is planned, not as a stand-alone transmitter, but as a transceiving adapter. This adapter will contain a 75-MHz CW/SSB generator, mixer, and power amplifier. The adapter will use the synthesizer and frequency counter from the receiver for its local oscillator and frequency readout. Receiver incremental tuning must be added to the receiver, and this is most easily done by placing a varactor across C22 and tuning the varactor from the front panel of the transceiving adapter.

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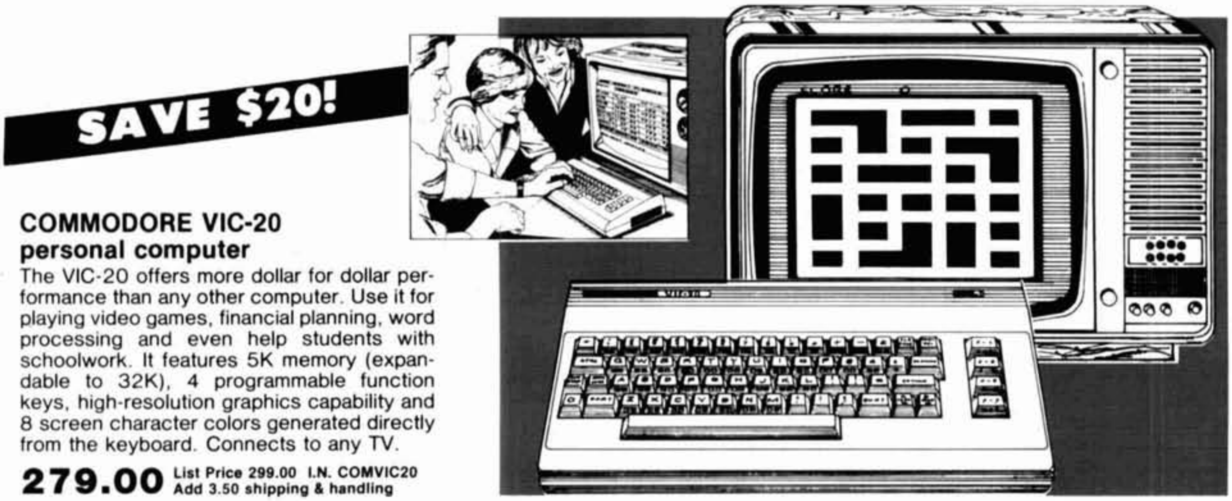

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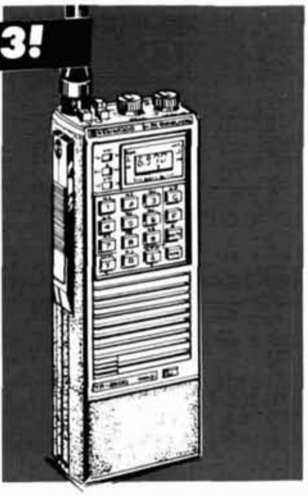

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More Details? CHECK—OFF Page 92

design of the digital components of VHF and UHF synthesizers

A discussion of multimodulus prescalers for use with IC programmable dividers

The use of digital frequency synthesis is now common in commercially made transceivers for use on the VHF and UHF bands. This article discusses some aspects of the design of programmable counters for use in VHF and UHF synthesizers. It is illustrated by reference to the family of frequency synthesizers manufactured by Plessey Semiconductors, Ltd., and concludes with a description of a BASIC computer program that may be used to design frequency synthesizer dividers for use at VHF and UHF.

A basic frequency synthesizer is shown in **fig. 1**. It consists of a voltage-controlled oscillator (VCO), a programmable divider, a phase detector, a low-pass filter (LPF) and a stable reference-frequency source. The design of the VCO is the most critical part of the design process, closely followed by the design of the LPF. Attention must also be paid to isolating the VCO, by buffer amplifiers or otherwise, from both the output port and the input to the divider. These problems, however, are outside the scope of this article.

The action of the synthesizer is quite simple: the output from the VCO (which is the output signal of the synthesizer) is divided by n in the programmable divider and compared with the reference signal in the phase comparator. The output of the phase comparator controls the frequency of the VCO. The system is thus a phase-locked loop (PLL) acting to maintain the divider output in phase with the reference input. The VCO frequency is stabilized at n times the reference frequency (that is, $F_{out} = nF_{ref}$) where n is the division ratio of the programmable divider.

It is evident that if we alter n by unity, the output of the VCO will change by F_{ref}. Thus we may use such a synthesizer to generate a number of channel frequencies that are all multiples of the reference frequency. In VHF and UHF synthesizers, channel spacings of 5 to 50 kHz are normally required — synthesizers with channel spacings down to 1 Hz or less may be built, but these would normally use multiloop techniques and are beyond the scope of this article.

output-frequency considerations

The use of integrated circuits is fundamental to the design of this type of synthesizer. The VCO, the phase comparator and the LPF may all be built using discrete components, but using discrete components for a complex circuit such as a programmable divider would entail quite unacceptable penalties of size, cost, reliability, and power consumption. However, the use of integrated circuits at once presents us with a problem: integrated circuit programmable dividers use CMOS, NMOS, or TTL technology and are unable to operate at frequencies higher than 25 MHz (or per-

By James M. Bryant, G4CLF, 16, Church Road, St. Marks, Cheltenham GL51 7AN, England

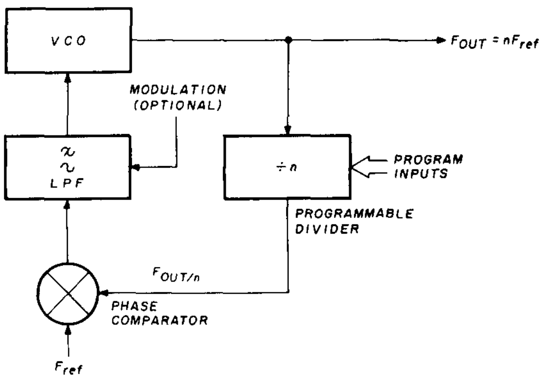

fig. 1. The elements of a basic frequency synthesizer.

haps a little more in the case of Schottky TTL). This is not nearly high enough for use in VHF or UHF synthesizers.

Fig. 2 offers a solution to the problem. A fixed VHF or UHF prescaler, with a division ratio of m, is inserted between the VCO and the programmable divider. This indeed reduces the output frequency to one that the programmable divider can accept, but it introduces a number of new problems. It is, however, widely used since fixed dividers using ECL technology are available with input frequencies of up to 1.8 GHz.

Two of the minor problems of this approach are power consumption (ECL is generally a high-power process) and interfacing. The major, and intractable, one is the effect on F_{ref}. As is obvious, the introduction of fixed prescaling changes the synthesizer law to $F_{out} = mnF_{ref}$. If the same channel spacing is needed, the reference frequency must be reduced by a factor of m (which will generally lie between 10 and 256). This complicates the design of the LPF, makes the time required for the synthesizer to lock greater by a factor of m, and, unless extreme care is taken in the VCO design, markedly worsens the noise and reference sideband levels in the synthesizer output.

mixer synthesizer

In applications where this degradation of performance is unacceptable, the use of a mixer synthesizer is often considered. This technique is shown in **fig. 3**. The VCO output is mixed with a signal of frequency F_M and the difference frequency ($F_{out} - F_M$) is applied to the programmable divider through an LPF.

Such a system has a number of advantages: F_M may be switched to give i-f and repeater shifts, the power consumption is not usually very high, and it is easily understood. However, it has disadvantages as well: the overall system stability depends on two oscillators with outputs of F_{ref} and F_M, the noise level in both the second oscillator and the mixer is critical for system performance (the noise in the reference oscillator is less important because F_{ref} is usually divided from the reference oscillator through a long divider chain), and the system is more complex. Nevertheless, many synthesized transceivers use this technique even though a better one exists: multimodulus prescaling.

multimodulus prescalers

The simplest form of multimodulus prescaler is the two-modulus prescaler (sometimes called a "swallow counter") illustrated in **fig. 4**. The system works as follows: when the system starts counting, the two programmable counters are reset to zero. The pre-

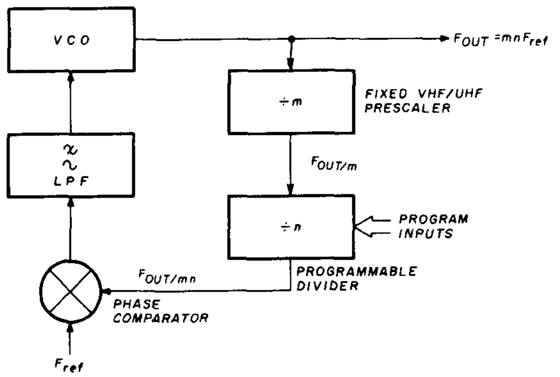

fig. 2. Synthesizer with a fixed prescaler, which is inserted between the VCO and programmable divider. Prescaler reduces the VCO output frequency to one that the divider can accept.

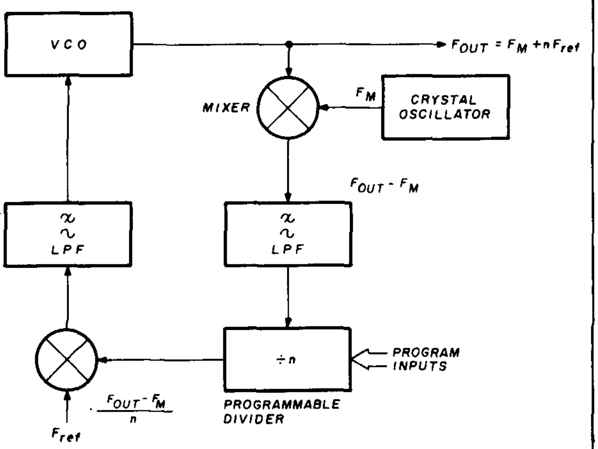

fig. 3. Mixer synthesizer. The VCO output is mixed with a signal of frequency F_M, and the difference frequency ($F_{out} - F_M$) is applied to the divider through a low-pass filter.

scaler divides the VCO output by $(m + 1)$ and its output pulses increment both programmable counters. When the count reaches a the prescaler modulus is changed to m and the a counter stops at this point; $a(m + 1)$ cycles of the input frequency have been counted. The n counter continues to count the prescaler output until its count reaches n when it passes a pulse to the phase comparator, both counters are reset, the prescaler reverts to $(m + 1)$ ratio and the cycle restarts. In the second half of the cycle the system counts $(n - a)m$ cycles of the input frequency. Thus a full cycle of the counter delivers one output pulse for each $a(m + 1) + m(n - a)$ input cycles. A little algebra reduces this expression to $nm + a$, so the division ratio is $nm + a:1$.

The whole system thus acts as a VHF or UHF programmable counter, although the fully programmable counter need only work at a few MHz, allowing the use of CMOS, NMOS, or TTL. Also, although two programmable counters are required each is less complex than the one in **fig. 2**, so in fact the overall complexity of the system in **fig. 4** is only slightly greater than that in **fig. 2** and it has all the advantages of VHF or UHF programmable counting.

There are, of course, some drawbacks. The division ratios of a two-modulus prescaler will normally be between 10/11:1 and 100/101:1, and it is evident that ratios of over 20/21:1 will be required at VHF if the input to the programmable counter is to be at a low enough frequency for the use of CMOS or NMOS.

For an $m/m + 1:1$ prescaler the a counter must be programmable over a range of m. The n counter must always divide by a larger number than the a counter. So for full programmability the total system division ratio must be equal to, or greater than, m^2. This sets a lower frequency limit to the use of such

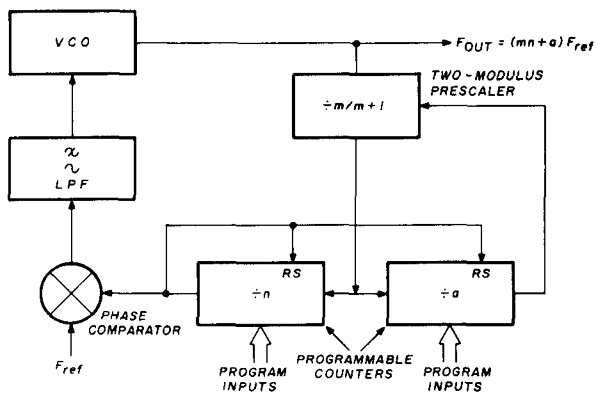

fig. 4. Synthesizer using a two-modulus prescaler. The prescaler divides the VCO output by $(m + 1)$ or m and its output pulses increment both counters.

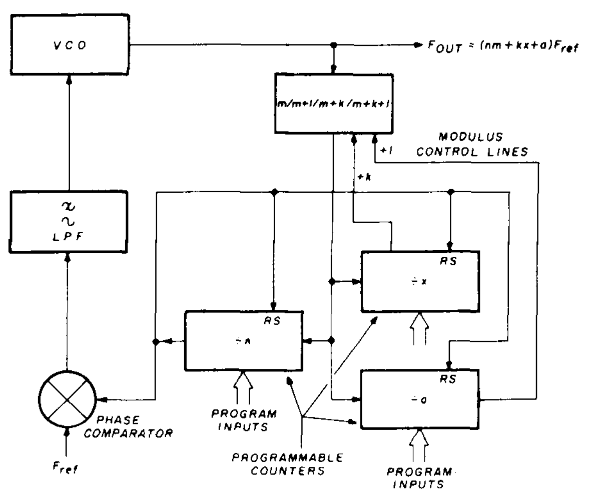

fig. 5. Synthesizer using a four-modulus prescaler for wider tuning ranges.

synthesizers. For example, with 25-kHz channel spacing and a 40/41 prescaler, the minimum division ratio is $40^2 = 1600$ and thus the minimum frequency is 40 MHz. Generally the programmable counter sets limits that are higher than these theoretical minima.

If wider tuning is required, four-modulus prescaling may be used. A typical system is shown in **fig. 5**. Here the prescaler has four moduli: $m/m + 1/m + k/m + k + 1$, which are set by $+1$ and $+k$ control lines. There are three programmable counters, and the conditions that limit the ratios are:

1. a must count over a range of k.

2. x must count over a range of $\frac{m + k + 1}{k}$.

3. n must count not less than the minimum value of a or k.

For a 55/56/63/64 prescaler this sets a division ratio limit of 512, which allows 25-kHz channel synthesis to go up from 12.8 MHz. Again, in practical systems, the programmable counter will generally set higher minima. The overall division of this system is $mn + kx + a$, where n is the count in the n counter, x is the count in the x counter, and a is the count in the a counter.

Integrated circuit two- and four-modulus VHF and UHF counters have been available for some time, as have general purpose CMOS and TTL programmable counters. Only recently have dedicated LSI circuits become available that can interface directly with two- and four-modulus prescalers. The next part of this article describes some integrated circuits designed by Plessey Semiconductors, Ltd., for use in VHF and

UHF synthesizers using the techniques described above.

From **fig. 4** it will be seen that a two-modulus prescaler has input and output ports and a control line that is used to alter the division ratio. The input may be balanced or unbalanced (two-line or one-line), but the output and the control will normally work at CMOS/TTL levels. Similarly the four-modulus prescaler shown in **fig. 5** is almost identical in general structure except that it has two control lines instead of one.

Plessey prescalers

Plessey Semiconductors makes a number of two- and four-modulus prescalers, which are listed in **table 1**. Those of particular interest to the frequency synthesizer designer are the SP8793, SP8906, and SP8901. These will be described in detail.

The SP 8793 is a two-modulus divider with ratios of 40/41. It has CMOS/TTL control and output interfaces and an ac-coupled input with an input impedance of around 500 ohms. It requires 100 mV peak-to-peak input to operate correctly. One of its most useful features is its low power consumption: only 4 mA at 5V (20 mW). It may also be operated from an unregulated supply, 6.8 to 12V, using its own internal regulator. Its upper frequency limit is 200 MHz.

The SP8906 is a four-modulus divider with ratios of 239/240/255/256 and an upper frequency limit of 512 MHz. Again, it has CMOS/TTL interfaces for control and output and an ac-couple input. The SP8906 is not a low-power circuit, requiring some 80 mA at 5V (400 mW). The SP 8901 is an SP8906 with a built-in divide-by-two prescaler capable of working with inputs up to 1 GHz. It also has a consumption of 400 mW. The prescaler, being fixed, causes the channel spacing to be twice the reference frequency, but this is a small penalty to pay for a two-chip synthesizer capable of working at up to 1 GHz.

At frequencies over 1 GHz, separate prescalers or mixing techniques must be used. Use of the Plessey Semiconductors SP8619 with an SP8906 allows the design of synthesizers that work up to 1.8 GHz. The SP8619 is a divide-by-four prescaler that will operate up to 1.8 GHz and can drive an SP8906. Synthesizers using this combination have, of course, a channel spacing of four times reference frequency.

The highest output frequency from an SP8906 or SP8901 is $512/239\ MHz = 2.142\ MHz$. Such a frequency will be within the capabilities of CMOS or TTL logic families. TTL uses a large amount of power and has largely been replaced at frequencies below 4-6 MHz by CMOS, which has a leakage current, when not switching, of a few microamperes. When switching at a frequency of several MHz, however, the current consumption of CMOS rises and studies have shown that a programmable counter working with an input frequency of 2 MHz will use less power if built using NMOS than if built with CMOS. It will also be far smaller.

CMOS uses both P-channel and N-channel MOS devices (hence CMOS or complementary MOS) and therefore requires three or four diffusions during manufacture. Its system of active loads also results in CMOS logic occupying much larger areas of silicon chip than a similar circuit in NMOS or PMOS. These processes have an additional advantage of requiring only one diffusion step during manufacture. This combination of smaller silicon areas and fewer diffusion steps makes NMOS circuits smaller and less expensive than CMOS ones performing the same function. In the limit it means that more complex circuits may be built with NMOS than with CMOS. Plessey has therefore chosen to use NMOS for its NJ8811 and

table 1. Plessey multimodulus prescalers.

device	moduli	frequency (MHz)	control input	output
SP8720	3/4	300	ECL	ECL
SP8692	5/6	200	TTL/ECL	TTL/ECL
SP8740	5/6	300	ECL	ECL
SP8741	6/7	300	ECL	ECL
SP8691	8/9	200	TTL/ECL	TTL/ECL
SP8743	8/9	500	TTL/ECL	ECL
SP8690	10/11	200	TTL/ECL	TTL/ECL
SP8647	10/11	250	ECL	TTL/ECL
SP8643	10/11	350	ECL	ECL
SP8685	10/11	500	TTL/ECL	ECL
SP8680	10/11	600	TTL/ECL	TTL/ECL
SP8785	20/22	1000	ECL	ECL
SP8786	20/22	1300	ECL	ECL
SP8793	40/41	200	TTL	TTL
SP8792	80/81	200	TTL	TTL
SP8906	239/240/255/256	512	TTL	TTL
SP8901	478/480/510/512	1000	TTL	TTL

NJ8812 synthesizer circuits, which are illustrated in **figs. 6** and **7** respectively.

The circuits contain all the logic circuits of a frequency synthesizer with the exception of the VHF/UHF multimodulus counter and the channel programming logic. Otherwise they are complete: programmable dividers, reference divider and phase comparator on a single chip. They also contain a data buffer to enable them to be used with a four-bit data highway for programming. This means that, while they will generally be programmed by means of a ROM and a channel switch, they are compatible with microprocessor-based programming systems as well.

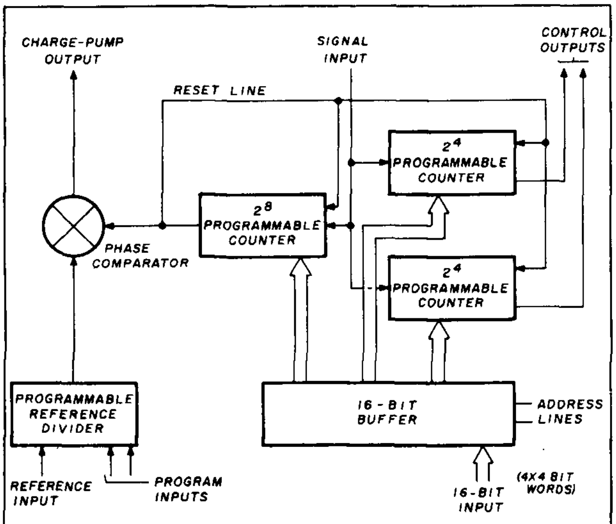

fig. 6. The Plessey NJ8811 synthesizer circuit. All logic is included except for the UHF/VHF multimodulus counter and channel programming circuits.

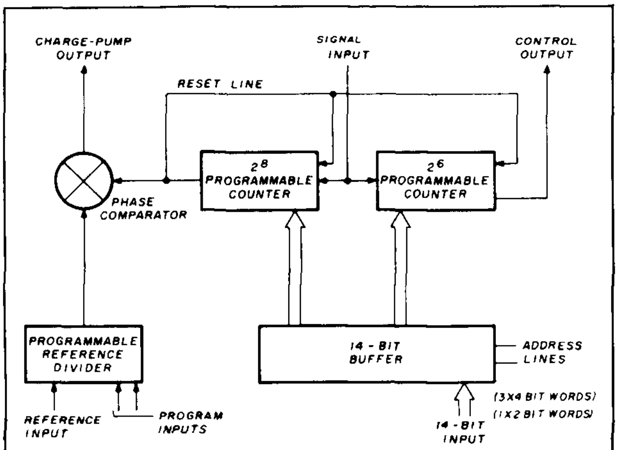

fig. 7. The Plessey NJ8812 synthesizer, which is almost identical to the NJ8811 but is designed to be used with the SP8793 as its prescaler in low-power applications up to 200 MHz.

programming systems as well

The NJ8811 is designed to interface, in the type of synthesizer shown in **fig. 5**, with the SP8906 or the SP8901. Using the first pair (SP8906 + NJ8811), a synthesizer may be designed to operate in the range of 40-512 MHz. The programmable reference divider, which uses four state input lines to allow the programming of sixteen reference divider ratios with only two program control lines, allows the choice of sixteen channel spacings from a single, standard, 4.8-MHz reference input. (In the interest of stability the reference oscillator is not included on the chip.) These channel spacings include 30, 25, 20, 15, 12.5, 10, 7.5, 6.25, 5, 3.75, 3.125, and 2.5 kHz. When the NJ8811 is used with the SP8901 both channel spacings and frequency ranges are doubled.

The NJ8812 is almost identical to the NJ8811 but is designed to be used with the SP8793 as its prescaler in low-power synthesizers at frequencies up to 200 MHz. The NJ8811 and NJ8812 draw only 8 mA at 5V. The combination of NJ8812 and SP8793 has an average power of some 50-60 mW, which makes it ideal for use in hand-portable radios where battery life is important.

computer program

A BASIC program is available that may be used to design VHF and UHF synthesizers using the integrated circuits described in the article.* The program is in two parts: the first requests the frequency limits, channel spacing, injection mode and other details of the required synthesizer and determines which circuits should be used and how they should be connected. It also considers the choice of reference frequency and reference division ratio with a view to minimizing reference harmonics in the working band. The second half of the program requests details of the individual channels required and provides ROM programming information for them.

The program was written for a Commodore PET 2001-8 desktop computer, although it will no doubt run in any BASIC machine with minor modifications. The extremely compact form used for the program, combined with the lack of REM statements, is due to memory limitations of the machine involved. The program runs with fewer than 300 bytes of the memory unused. If a large machine were available, no doubt the program could be edited to be more easily understood; but in its present form it works well and is a very useful aid in the design of frequency synthesizers in the VHF and UHF range.

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tandem pi networks

Analysis of 3000:50 ohm matching networks with emphasis on second-harmonic attenuation

In an earlier article[1] the input impedance characteristics versus frequency for commonly used pi and pi-L networks were shown and discussed. It was shown that the pi-L is considerably sharper than one would expect from the design Q (normally taken as 10), so that a design Q of 8 or even 7 results in an acceptable design.

Further study has now been made of the *current* response of several representative pi, pi-L, and tandem pi networks, with particular reference to the second-harmonic attenuation. (Current response is the magnitude and phase angle of the ratio of output current into a 50-ohm resistive load to an assumed input current to the network.) As in the earlier article[1] this has been done using a program written for the HP-34C programmable calculator. The following discussion centers mainly on the 3000:50-ohm matching networks of various Qs and configurations.

second-harmonic considerations

For a design Q of 10, the conventional shunt-capacitor pi network (−300 ohms input, 321.6 ohms series inductance, and −60.5 ohms output) has a second harmonic response of −33.4 dB. In other words, with 1 kW at the fundamental, there can still be about 0.47 watt radiated at the second harmonic. This assumes, of course, a) that there is appreciable harmonic content in the original wave, which would only be the case with class-C amplifiers driven hard for high efficiency and a low conduction angle, and b) that the *load* at the second harmonic remains a pure resistance of 50 ohms. With modern linears, the situation is not that bleak, and unless a multiband antenna is used, it is rare that the second-harmonic impedance would remain at 50 ohms resistive.

With the pi-L, again with a design of Q of 10 and shunt capacitors, the second-harmonic response improves to −47.3 dB. Dropping the Q to 8 reduces the response to −45.9 dB. This is more than adequate even for a class-C amplifier, since 40 dB represents an attenuation of 10,000.

network input elements

One is tempted, then, to use a pi-L network with shunt *inductance* at the input, and with series capacitance for the first series element. The reason is that the shunt-feed rf chokes used in high-power amplifiers are often trouble producers. They may burn out with a flashover, the pancake types crawl together due to the magnetic forces involved, and there are numerous unwanted responses in most rf chokes that can give rise to parasitics. Using series feed (inductance for the input reactance of the matching network), one not only gets away from the rf choke by feeding plate voltage directly to the coil, but the series dc blocking capacitor is eliminated as well, because the series capacitor in the network can stand off the dc. (The usual bypass at the power-supply end of the input coil is, of course, still required — and now more than ever).

For a design Q of 10, the 3000:50 ohms inductance-input pi-L would have values $X_1 = 300$, $X_2 = -194$, $X_3 = -63.8$, and $X_4 = 129.9$ ohms. But the

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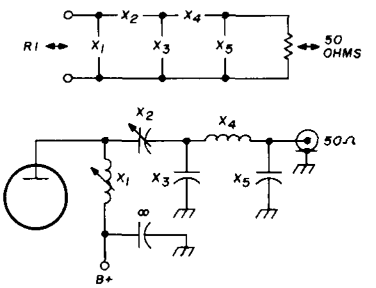
table 1. Tandem pi designs with inductance input (values in ohms).

Q	R_1	X_1	X_2	X_3	X_4	X_5
	3000	600.0	−399.8	−59.3	97.3	−32.6
	2750	550.0	−361.4	−56.3	93.9	−31.6
5	2500	500.0	−323.4	−53.3	90.2	−30.6
	2250	450.0	−285.9	−50.1	86.4	−29.5
	2000	400.0	−248.9	−46.8	82.3	−28.3
	3000	500.0	−328.9	−48.8	83.1	−25.7
	2750	458.3	−297.5	−46.4	80.1	−25.7
6	2500	416.7	−266.4	−43.9	77.0	−24.3
	2250	375.0	−235.6	−41.3	73.7	−23.5
	2000	333.3	−205.3	−38.6	70.1	−22.7



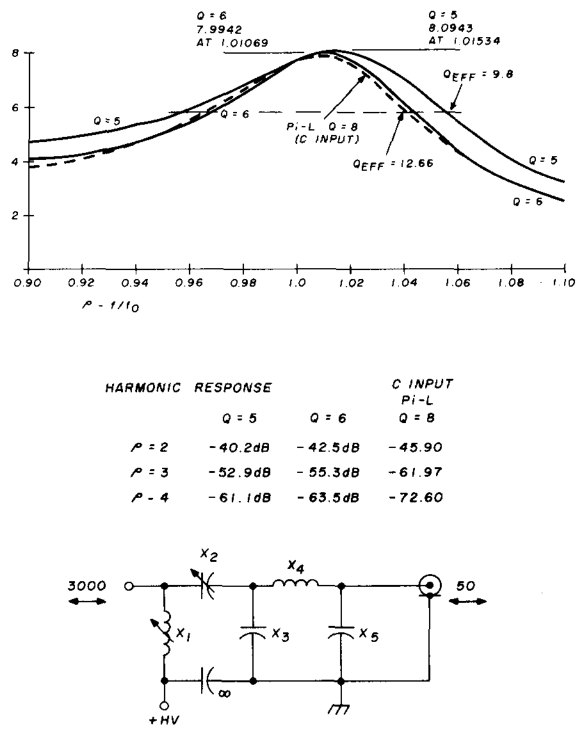


fig. 1. Inductance-input tandem-pi network i_o/i response, 3000:50 ohms impedance transformation.

second-harmonic attenuation of this network is only 32.9 dB — slightly less than the conventional pi. Compared with the shunt-capacitance pi-L, it is really disappointing: 32.9 dB versus 47.3 dB.

the tandem pi configuration

So this leads to the consideration of a *tandem-pi* network. Another program was developed for the HP-34C (for a copy, send an SASE to *ham radio*, Greenville, NH 03048), to yield the reactance values for the tandem pi, based on the assumptions of a) equals Qs and b) equal transformation ratios for each pi section. **Table 1** gives the values for two inductance-input tandem-pi designs for design Qs of 5 and 6 and five different, but typical input resistances all matching to 50 ohms. Design Qs of 5 and 6 were found acceptable in terms of effective Q (measured by the frequency difference between frequencies for 70.7 percent of the maximum current ratio) and also in terms of second-harmonic attenuation.

Taking the 3000:50 ohm tandem pi as typical, the current response curves (magnitude and phase) are shown in **fig. 1**. The second-harmonic attenuation is −40.2 dB and −42.5 dB, respectively, for the two Q values, and the effective Q is 9.8 and 12.66. The curve for a capacitor-input pi-L, $Q=8$, is shown for comparison.

Note from **table 1** that the *variation* in the fairly low shunt reactances, and even in the second inductance, is not great over the range of input resistances. Thus only the input inductance, X_1, and the first series capacitor, X_2, would have to be made variable over any appreciable range for a given band; the others could either be fixed at some average value or be trimmed by a relatively small variable across them.

Thus if one has a roller coil as large as 28 microhenries (80 meters) for X_1, and a 15-220 pF high-voltage variable for X_2, the remainder of the network can probably be fixed for any given band. The voltage across X_3 would be only about 650 volts rms for a 1-kW linear, and across X_5 it would be about 250 volts rms.

So by the addition of essentially one more component (X_5) over the pi-L, an acceptable harmonic attenuation and effective Q can be obtained using shunt inductance at the input of the tandem-pi matching network. This, then, saves one high-voltage blocking capacitor and the usual shunt-feed rf choke. The penalty, of course, is a variable inductance for the input coil, and a coil that is at high-voltage dc potential. Whether this trade-off is acceptable depends on the user.

reference

1. R.W. Johnson, W6MUR, "Response of pi, pi-L, and Tandem Quarter-Wave-Line Matching Networks," *ham radio*, February, 1982, page 12.

ham radio

owners survey:
2-meter handhelds

The most popular 2-meter handies are evaluated by the readers of *ham radio* magazine

Two-meter handheld radios have become very popular. Aside from their obvious value for emergency and public-service work, there is great appeal to the idea of being able to communicate over wide distances with a portable little radio small enough to clip onto your belt. Wherever you go, whether it's into the woods on a camping trip or out on the lake for a day of fishing or just down to the store for a quart of milk, instant communications is always at hand.

Portable radios, of course, have been around for many years. The difference is that now, with the combination of IC microminiaturization, frequency synthesizers, and a network of repeater stations, handheld portables can offer reliable communications over wide areas. Working into a good repeater, a handheld 2-meter transceiver can put you in touch with Amateurs virtually anywhere within an area of thousands of square miles. Today's handhelds are lightweight, small, and — best of all — inexpensive when compared with most Amateur transceivers.

The purpose of this reader survey was to find out what the Amateurs who own them think of each of the seven most popular synthesized 2-meter handhelds. Perhaps the opinions of other Amateurs will help you decide which 2-meter handheld is the one for you. The seven radios reported on were the Santec HT-1200, the Tempo S-1 and S-5, the Icom IC-2AT and 2A, the Yaesu FT-207, and the Kenwood TR-2400. Here are the results.

Editor's Note: Several of these handheld rigs have been superseded by later models. We feel that the information presented here is still very useful, however, both to hams thinking of buying a used rig as well as to those who want information on the basic radios, which remain essentially unchanged by most minor modifications.

By Martin Hanft, KA1ZM, Managing Editor, *ham radio* magazine

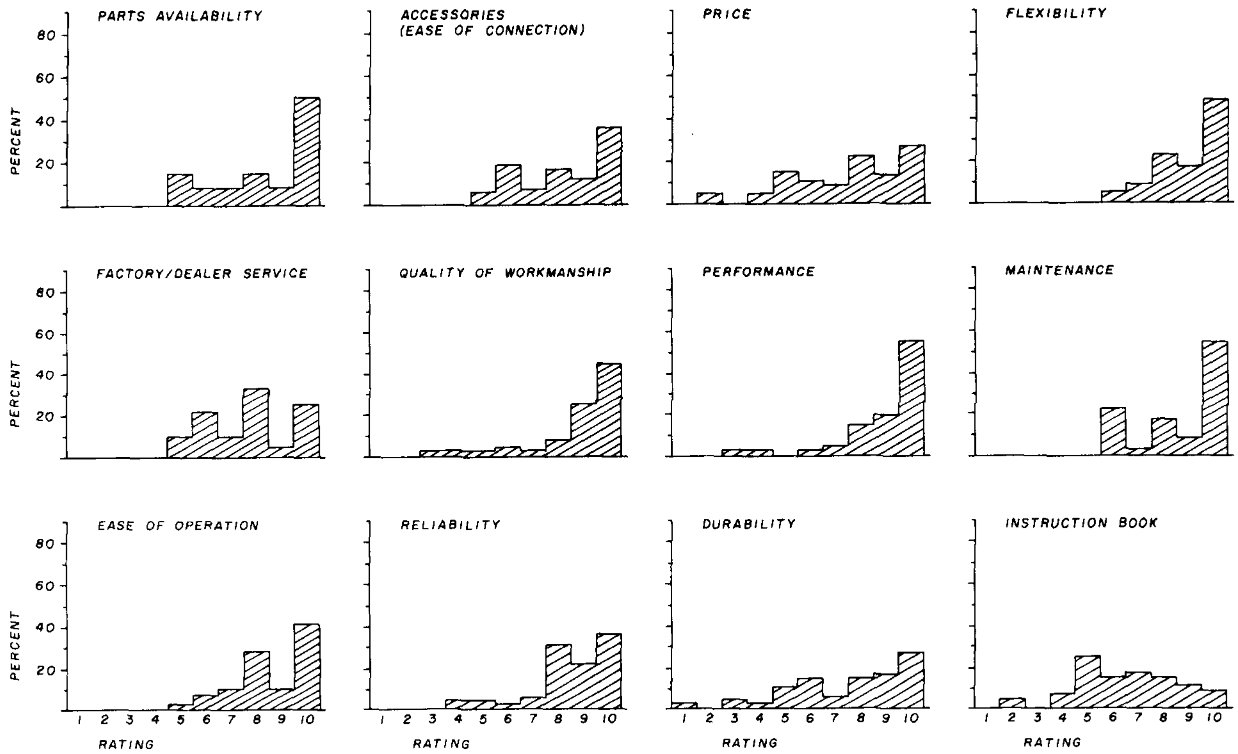


fig. 1. Owners' opinions on the Santec HT-1200.

Santec HT-1200

The HT-1200 is a fully synthesized, 3.5-watt rig with scan and search features plus ten memories. It has a sixteen-key keyboard and LED frequency readout. Fifty-nine usable reports were received on the Santec HT-1200.

Of the owners of the HT-1200 who responded to this questionnaire, fifteen percent were Technicians, twenty-nine percent were Generals, forty-one percent were Advanced-class, and fifteen percent Extras. Ninety-five percent had purchased the radio new. Sixty-five percent bought their radio from a dealer, while only twenty percent bought from a mail-order company. About eleven percent bought their rigs from an 800-number. Ninety-three percent of those who responded, when asked if they would buy from the same source again, said that they would.

When asked whether this was their primary or backup 2-meter fm rig, fifty-two percent indicated that it is their backup rig.

When asked, What is the best feature of this rig?, fifty-one percent mentioned the frequency-scanning ability of the radio. A close runner-up in the percentages, with forty-three percent, was the pre-programmed memory. Thirty-six percent mentioned the high/low power feature of the radio, and fourteen percent made mention of the sixteen-key keyboard. Other aspects of the radio that received praise were its versatility, small size, and out-of-band capability. Note that many respondents listed more than one "best feature."

When asked to list the worst feature of the HT-1200, twenty-seven percent replied that the battery life is too short, and that the batteries must be changed or recharged too often. This was to prove to be a complaint common among the users of all the handhelds reviewed. Of course, some rigs will draw more current than others, and with some handhelds changing battery packs is more of a chore than it is with some others. But owners of all the most popular handhelds seem to feel that the batteries drain too fast. Another problem common to all the handhelds is that the nickel-cadmium batteries don't give much warning before they become discharged and fail. This is a problem inherent to Ni-Cd batteries.

Twenty percent of the HT-1200 owners faulted the radio for having an LED frequency readout that is virtually impossible to read in bright sunlight. Several also mentioned the added battery drain associated with the use of LEDs (as opposed to liquid-crystal displays).

The third most common complaint mentioned by owners of the HT-1200 (ten percent) was the lack of a belt clip. Other "worst" features mentioned by smaller percentages were inadequate instruction book, lack of an external dc input, and difficulties getting used to the operation of the radio.

To the question, Have you had any problems?, fifty-three percent answered no. Of those who did report having had problems, the most common com-

Santec HT-1200

General

Power consumption: RX 90 mA (45 mA squelched); TX 900 mA (high), 500 mA (low)
Dimensions: 68 × 170 × 47 mm (2.7 × 6.7 × 1.9 inches)
Weight: 700 g (1.5 lbs.)
Memory channels: ten
Odd splits: yes
Readout: LED
Scanning: yes

Transmitter

Power output: 3.5 watts/1 watt

Receiver

Sensitivity: 0.35 μV for 12 dB SINAD
Selectivity: ±7.5 kHz at 6 dB down; ±15 kHz at 60 dB down
Audio output: not specified

Features

Four modes of automatic scan and search, up/down variable scan steps, keyboard entry of frequencies, 16-button Touchtone pad, flexible antenna, Ni-Cd pack, charger, earphone, strap

Options

Case, speaker/mike, mobile charger, desk charger, subtone unit, remote speaker, battery packs

plaint (mentioned by fourteen percent) was trouble with the audio quality. A variety of other problems showed up in the survey, each mentioned by fewer than four percent of the respondents. These included a few instances of battery-pack problems, some trouble with dial lights, birdies, blown final, and hum.

Twenty-six percent of the owners of the HT-1200 reported that some servicing had been done on their radios, and, among those who had had service work performed, seventy-three percent said that the service was satisfactory. Eighty-eight percent said that they had been able to obtain all the accessories and parts they needed, and eighty-five percent said that they had been satisfied with those accessories.

The accessory most popular with owners of the HT-1200 was the leather case (73 percent). Fifty-seven percent reported buying an additional (whip) antenna, and fifty-two percent purchased a speaker/mike. Forty-three percent bought desk or mobile chargers as accessories, and twenty percent bought additional battery packs. Another popular accessory was the belt clip.

Question 17 asked respondents to rate the radio, scored from one to ten, on the basis of Ease of Operation, Reliability, Durability, Instruction Book, Factory/Dealer Service, Quality of Workmanship, Performance, Maintenance, Parts Availability, Accessories, Price, and Flexibility. The results are tabulated in **fig. 1**.

To the final, and most important, question, Would you buy this rig again?, eighty-nine percent replied yes.

Tempo S-1/S-5

The Tempo S-5 differs from the S-1 in that it produces five watts power (or 1 watt when switched to low power). Both models come with twelve-key Touchtone pad and telescoping quarter-wave whip. One hundred and fifteen usable reports were received on the Tempo S-1/S-5. Twenty percent of those responding were Technicians, thirty-two percent were Generals, forty percent were Advanced-class, and eight percent were Extras.

Among the owners of the S-1/S-5, seventy-eight percent had bought the radio new, with sixty-four percent buying their rig from a dealer, thirteen percent from a mail-order house, fifteen percent from another individual, and about five percent buying from 800-numbers. Ninety percent of those responding said that they would buy from the same source again. Fifty-two percent said that this radio is not their primary 2-meter fm rig, but rather is a backup radio.

When asked to list the best feature of the Tempo S-1/S-5, twenty-eight percent responded by mentioning the small size of the radio. Twenty-three percent mentioned ease of operation, and sixteen percent mentioned the radio's durability. Also ranking

Tempo S-1/S-5

General

Power consumption: RX 120 mA (17 mA squelched); TX 400 mA (S-5)
Dimensions: 62 × 165 × 40 mm (2.5 × 6.5 × 1.6 inches)
Weight: 482 g (1.1 lbs.)
Memory channels: none
Odd splits: no
Readout: thumbwheel
Scanning: no

Transmitter

Power output: 2 watts (S-1); 1 or 5 watts (S-5)

Receiver

Sensitivity: better than 0.5 microvolts nominal for 20 dB
Selectivity: ±6 kHz bandwidth at least 6 dB down; ±12 kHz bandwidth at least 60 dB down
Audio output: at least 750 milliwatts on internal speaker with less than 10% distortion

Features

Telescoping whip antenna, plug-in charger, earphone, Ni-Cd pack

Options

Leather holster, 16-button Touchtone® pad, helical antennas, amplifiers, cigarette lighter charger, tone encoders

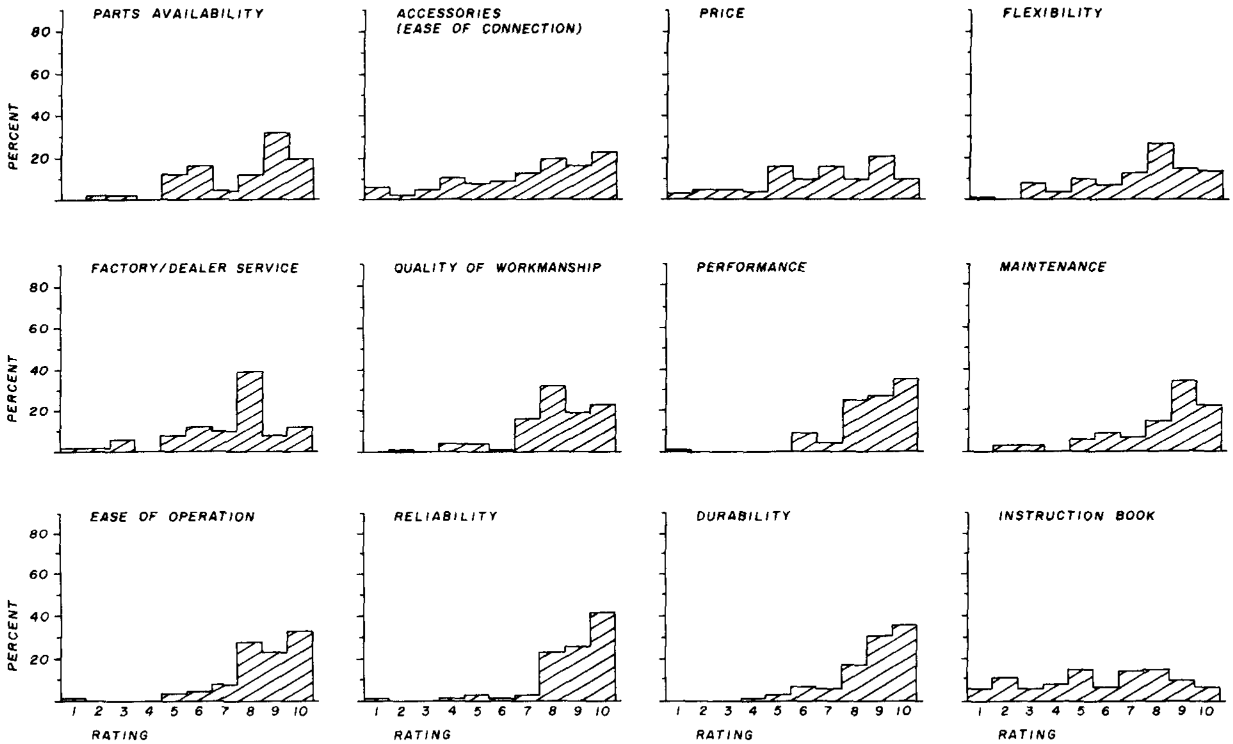


fig. 2. Owners' opinions on the Tempo S-1/S-5.

high were the synthesizer (fifteen percent), the light weight of the radio (fourteen percent), and the radio's dependability (twelve percent).

When asked to list the worst feature of the radio, thirty percent of those responding mentioned the external-antenna jack connection, which does not use a BNC-type connector and thus can be inconvenient when connecting an external antenna. The second most frequently mentioned "worst" feature of the radio was difficulty in changing batteries and the lack of a separate battery pack. Other "worst" features included, once again, the fact that the batteries don't last long enough (twenty percent), dirt collecting in the frequency-control wheels (nine percent), and the plastic case not being of heavy enough construction (seven percent).

To the question, Have you had any problems?, forty-eight percent replied no. Among those who did report problems the most common sources of trouble were blown finals (eight percent), wiring intermittents (eight percent), and failed chips (four percent).

Twenty-nine percent of those responding said that they had had some service work performed on the radio, and among those who had, ninety-three said that the work was satisfactory.

As to accessories for the S-1/S-5, the most common accessory purchased was a rubber-duck-type antenna, which was bought as an accessory by forty-five percent of those who bought the S-1/S-5. The second most common accessory was the leather case (twenty-five percent), followed by the speaker/mike (fifteen percent), a charger (fourteen percent), a 12-volt adapter (fourteen percent), and a belt clip (thirteen percent). To the question, Have you been able to obtain all the accessories and parts you need?, ninety percent answered yes. Eighty-five percent said that they were satisfied with the accessories they had bought.

For a numerical scoring of how the S-1/S-5 was rated by our readers, see **fig. 2**.

To the question, Would you buy this same rig again?, seventy-four percent of our respondents answered yes.

ICOM IC-2A/2AT

The ICOM IC-2A and 2AT (Touchtone® version) has a high (1.5 watts)/low (0.15 watt) power feature and comes with a "rubber duck" antenna. Two hundred and thirty-four usable responses were received from our readers, of whom twenty-two percent were Technicians, eighteen percent Generals, thirty-eight percent Advanced-class, and twenty-two percent Extras.

Ninety-eight percent of the owners of the 2A/2AT had bought the radio new. Sixty-two percent purchased the radio from a dealer, and twenty percent bought the radio from mail order. Only twelve percent purchased the rig from an 800-number. Ninety-five percent said that they would buy from the same source again.

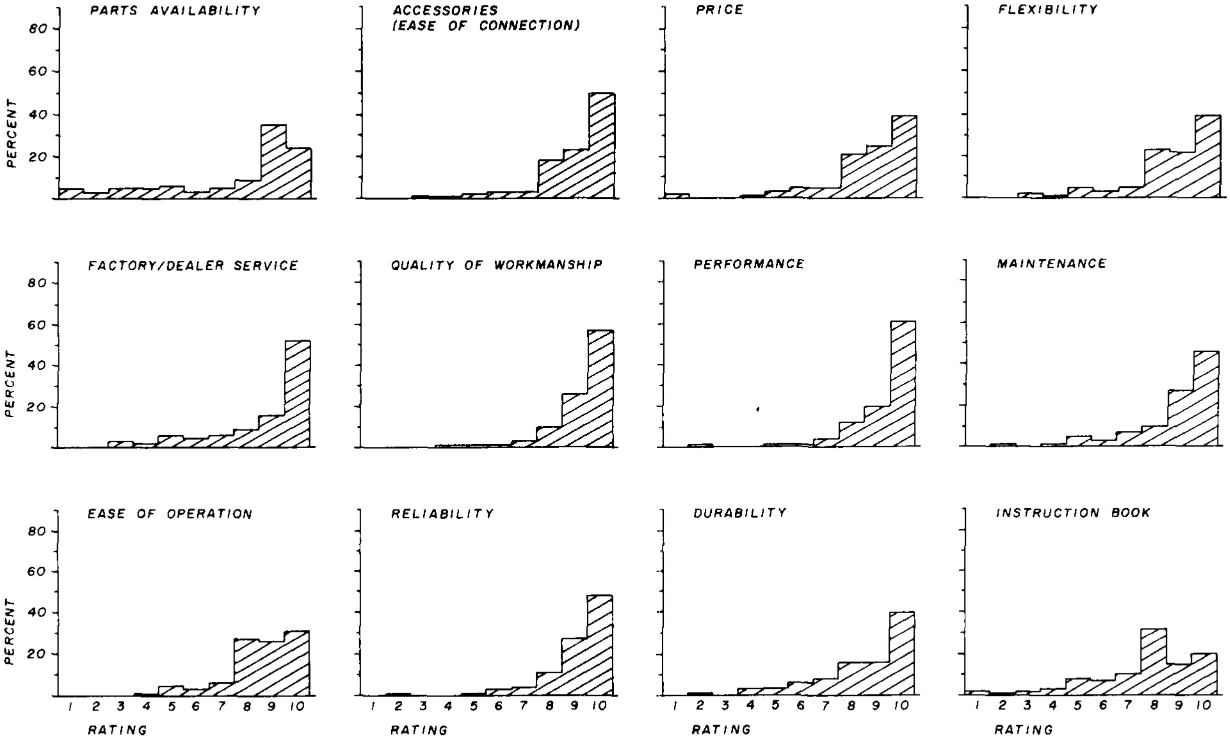


fig. 3. Owners' opinions on the ICOM 2A/2AT.

When asked whether the rig is their primary or backup 2-meter fm radio, the responses were roughly evenly split, with fifty-two percent using the radio as a backup 2-meter rig.

ICOM 2A/2AT

General

Power consumption: RX 130 mA (20 mA squelched);
TX 550 mA (high), 220 mA (low)
Dimensions: 65 × 165.5 × 35 mm (2.6 × 6.5 × 1.4 inches)
Weight: 490 g (1.1 lbs.)
Memory channels: none
Odd splits: no
Readout: thumbwheel
Scanning: no

Transmitter

Power output: 1.5 watts/0.15 watt

Receiver

Sensitivity: less than 0.5 μV for 20 dB noise quieting
more than 26 dB S + N + D/N + D at 1 microvolt
Selectivity: ±7.5 kHz at 6 dB down; ±15 kHz at 60 dB down
Audio output: more than 300 mW

Features

Flexible antenna, Ni-Cd pack, wall charger, earphone, wrist strap, belt clip

Options

Cigarette lighter cord, base stand charger, speaker/mike, case, dc regulator, battery packs and cases

In response to the question, What is the rig's best feature?, the most common response was small size, which was mentioned by fifty-four percent of those responding. Thirty-one percent mentioned the quick-change battery packs, which make it possible to insert fresh batteries without taking the radio apart. Fourteen percent mentioned ease of operation, and eleven percent mentioned price as a best feature. The quality of the receiver was mentioned by ten percent, and audio quality and reliability were each mentioned by about eight percent.

When asked, What is the rig's worst feature?, our respondents mentioned switch positions on the back of the radio most often (twenty percent), and the fact that the switches are too close together. Seventeen percent said that the batteries drain too fast, and eleven percent mentioned that the audio output is too low to be heard well in noisy environments. About eight percent mentioned difficulty in getting accessories, and an equal number said that there is no room for PL in the 2AT. (Recently, Communications Specialists, 426 West Taft Avenue, Orange, CA 92667 has come out with a programmable, sub-audible tone encoder that fits inside the 2AT and sells for about $30.00.) A small number of respondents mentioned intermod and difficulty in reading the numbers on the frequency wheels.

To the question, Have you had any problems?, sixty-six percent said no. About six percent mentioned problems with intermittents, and another five percent mentioned wiring problems or shorts. There were a few instances of blown finals, Touchtone pad difficulties, charging problems, and bad capacitors, but the percentages were each well below five percent.

Sixteen percent of those responding said that some service work had been done on their radio, with sixty-six percent of that service work done by the manufacturer, twenty-six percent by the dealer, and the remainder by other sources. Eighty-nine percent of those who had service work performed were satisfied with the work done.

The accessory most popular among owners of the Icom 2A/2AT was the speaker/mike, which was purchased by fifty-two percent of those responding. Nearly as many, fifty-one percent, purchased extra battery packs. Thirty-seven percent bought a charger, and twenty-eight percent a dc power adapter and dc regulator. Eight percent purchased a case, and seven percent a quarter-wave antenna.

See **fig. 3** for a numerical scoring on the Icom 2A/2AT.

Finally, when asked, Would you buy this same rig again?, an impressive ninety-six percent replied yes.

Yaesu FT-207

The Yaesu FT-207 is a 2.5-watt, fully synthesized radio that features LED digital display, memory, and scanning capability. One hundred and twenty-six reports were received on the FT-207. Of those responding, twelve percent were Technicians, thirty-one percent Generals, forty percent Advanced-class, and seventeen percent Extras.

Ninety-four percent of those who reported on the FT-207 had bought their radios new. Fifty percent bought them from a dealer, twelve percent by mail order, twenty-five percent from an 800-number, and the remainder from other sources. When asked if they would buy from the same source again, eighty-nine percent said that they would.

To the question, Is this your primary or backup 2-meter fm rig?, the split was an even 50-50.

When asked to list the best feature of the Yaesu FT-207, thirty-four percent mentioned the frequency-selection ability and the scanning feature of the radio. Twelve percent voted for ease of operation, and another twelve percent mentioned the switchable power feature of the radio. About ten percent mentioned the four memories, and seven percent the small size of the radio.

When asked to list the worst feature of the radio, forty-six percent replied that the worst feature is difficulty reading the LED display when the radio is in direct sunlight. Forty-four percent said that the batteries do not last long enough. Seven percent of those reporting said that the keyboard is too small, and

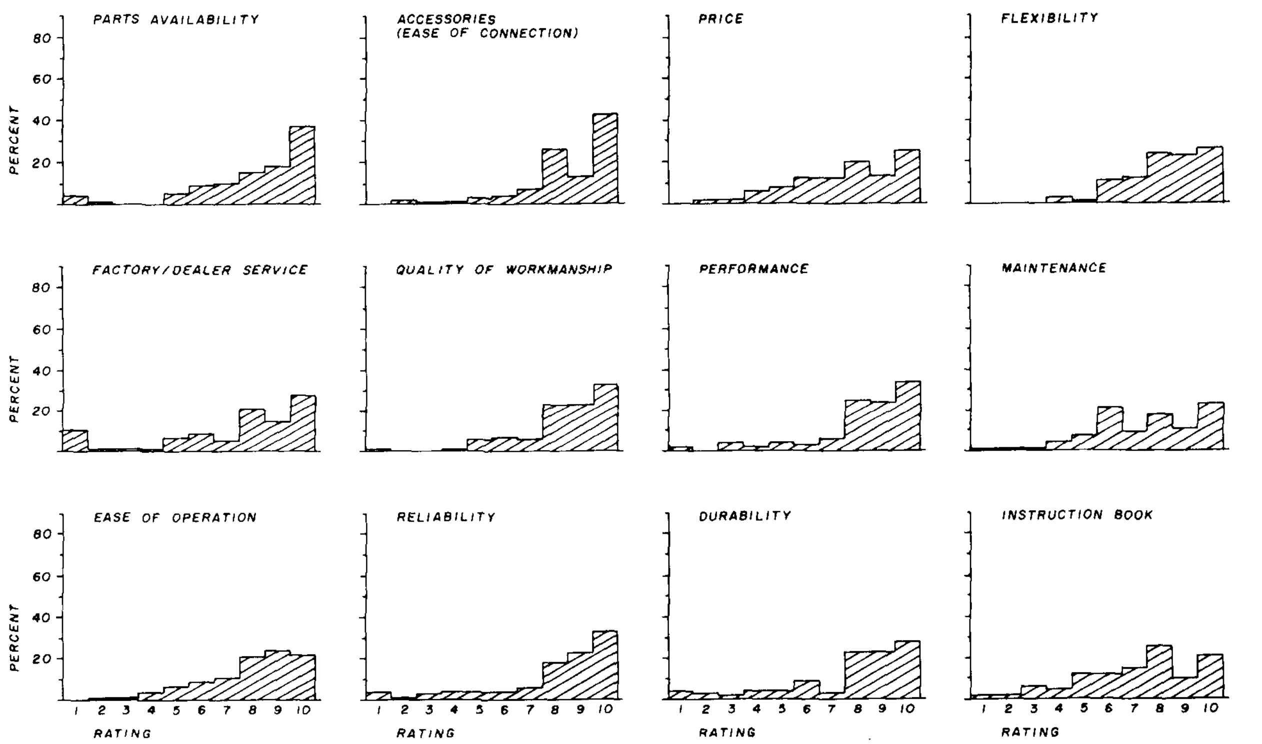


fig. 4. Owners' opinions on the Yaesu FT-207.

Yaesu FT-207

General

Power consumption: RX 150 mA (35 mA squelched, display off); TX 800 mA (high), 250 mA (low)
Dimensions: 68 × 181 × 54 mm (2.7 × 7.1 × 2.1 inches)
Weight: 680 g (1.5 lbs.)
Memory channels: four
Odd splits: yes
Readout: LED
Scanning: yes

Transmitter

Power output: 2.5 watts/200 mW

Receiver

Sensitivity: 0.31 μV for 20 dB quieting
Selectivity: ±7.5 kHz at 60 dB down
Audio output: 200 mW at 10% THD

Features

Keyboard entry of frequencies, up/down manual scan or auto scan for busy/clear channels, 10-kHz scanning steps, flexible antenna, Ni-Cd pack, charger

Options

Quick charger, speaker/mike, tone squelch, case, battery packs, charger, dc adapter, mobile bracket

smaller percentages (less than five percent each) complained of the inability to resume scanning and problems with battery contacts.

To the question, Have you had any problems?, fifty-two percent responded no. The most commonly mentioned problems were hum on the transmitted signal and difficulties with the memory function, mentioned by seven and six percent respectively. Five percent reported microprocessor problems, and although there were a variety of other difficulties mentioned, no other single difficulty was reported by more than four percent.

Thirty-three percent of the FT-207 owners reported that some servicing had been done on their radio, and seventy-one percent of those who had had service work done said that the work was satisfactory.

Ninety-six percent had been able to obtain all the accessories that they needed, and ninety percent said that they were satisfied with those accessories. The most popular accessory was the charger and mobile converter, purchased by thirty-nine percent of those responding, followed closely by the speaker/mike with thirty-seven percent. Thirty-three percent bought an extra battery pack, and thirty-two percent a quarter-wave or five-eighths antenna. Other popular accessories included a case (fifteen percent) and amplifier (seven percent).

Fig. 4 shows the result of the tabulation of the answers to question 17, which asked owners to score the radio in twelve categories of performance.

To the question, Would you buy this rig again?, seventy-five percent answered yes.

Kenwood TR-2400

The Kenwood 2400 is a scanning radio that has ten-channel memory, LCD digital readout, and rf output of 1.5 watts. One hundred and thirty-four usable reports were received on the TR-2400. Twenty-one percent of the owners responding were Technicians, fourteen percent were Generals, forty-seven percent were Advanced-class, and eighteen percent were Extras.

Ninety-two percent of the TR-2400 owners reported that they had bought their radios new. Fifty-five percent of those responding had bought the radio from a dealer, eighteen percent by mail order, seventeen percent from an 800-number, and six percent from another ham. Ninety-three percent said that they would buy from the same source again.

The TR-2400 was the primary 2-meter fm rig for forty-six percent of those responding, a backup rig for fifty-four percent.

To the question, What is the rig's best feature?, thirty-five percent of those responding said that it is the ease of frequency selection and the ten memories. Twenty-two percent mentioned the scanning ability of the radio, and the synthesized circuitry was mentioned by twenty percent. The ±600 kHz reverse switch and the LCD readout each received mention

Kenwood TR-2400

General

Power consumption: RX 28 mA; TX 500 mA (Note: Backup memory, power OFF 2 mA)
Dimensions: 71 × 192 × 47 mm (2-13/16 × 7-9/16 × 1-7/8 inches)
Weight: 740 g (1.62 lbs.)
Memory channels: ten
Odd splits: yes
Readout: LCD with lamp
Scanning: yes

Transmitter

Power output: 1.5 watts

Receiver

Sensitivity: Less than 0.2 μV for 12 dB SINAD
Selectivity: ±12 kHz at 6 dB down; ±24 kHz at 60 dB down
Audio output: more than 200 mW

Features

LCD arrow indicators, up/down manual scan, automatic memory scan, RX/TX reverse switch, two lock switches, flexible antenna, Ni-Cd battery pack, ac charger, hand strap, earphone

Options

Quick-charge base stand, quick charger, case, battery pack, belt hood, speaker mike

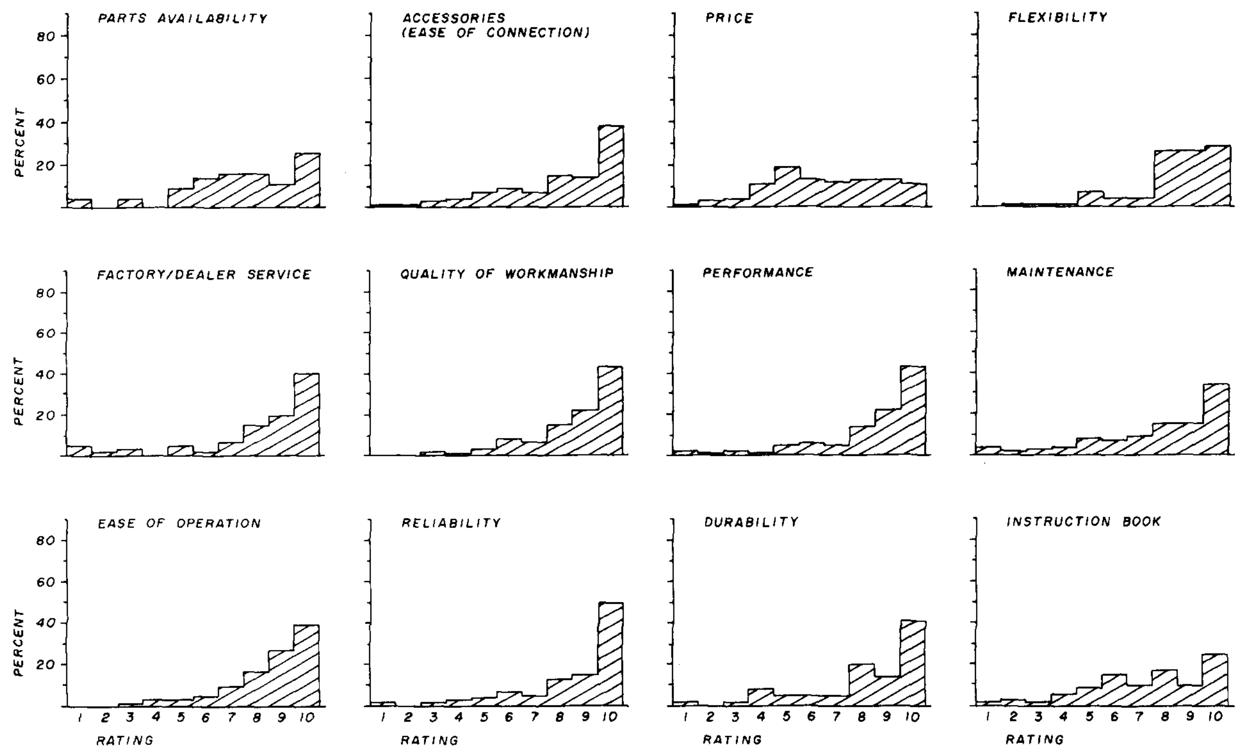


fig. 5. Owners' opinions on the Kenwood TR-2400.

by about fifteen percent of the owners of the TR-2400. The radio's general reliability, ability to make odd frequency splits, and the fact that it does not require many accessories were all mentioned by roughly ten percent of those responding.

In response to the question, What is the rig's worst feature?, seventeen percent said that the worst feature is the short battery life. Fifteen percent said that the scanning rate is too slow, and fourteen percent mentioned difficulty in changing batteries. About ten percent of those responding said that the worst feature is the lack of a high/low power switch, and about eight percent said that the radio is too big. Eight percent also faulted the radio for its lack of an S-meter. Six percent said that the radio is too heavy.

When asked what problems they had had with the TR-2400, forty-three percent of those responding said none. Ten percent mentioned bad solder connections, and eight percent mentioned noise in the audio. There were a few instances of charging difficulties, intermittents and loose screws, but none of these was mentioned by more than five percent of those replying.

Forty-one percent reported that some service work had been done on their radios, with eighty-four percent of those who had work done reporting that the service had been satisfactory. Ninety-one percent of the owners of the TR-2400 said that they had been able to get all of the accessories they needed, and ninety percent said that they were satisfied with the accessories they purchased.

The most popular accessory with owners of the TR-2400 was the speaker/mike, purchased by thirty-eight percent of those responding. Thirty-five percent reported buying the quick charger. Twenty-eight percent bought the leather case, and twenty percent bought additional battery packs. Other popular accessories included the base stand (eighteen percent) and an external whip antenna (sixteen percent).

Responses to question 17, which rates the radio in each of twelve categories of performance, are shown in **fig. 5.**

To the question, Would you buy this rig again?, eighty-three percent said yes.

It's hoped that this review of some of the most popular 2-meter synthesized handhelds will help you to decide which radio is the right one for you. All are different, and all have their advantages and disadvantages. All of these radios, however, are marvels of advanced technology and miniaturization. They're handy for emergency communications use, field use, or as a backup for the base station. And most of all, they're a lot of fun to use.

In an upcoming issue, *ham radio* will be asking its readers to send in their opinions of, and experiences with, linear amps. Be on the watch for it.

ham radio

ham radio TECHNIQUES

Bill Orr W6SAI

Just before a 160-meter contest the other day, I was listening to determine how good (or bad) DX conditions were. It was early evening and there wasn't much activity around the DX portion of the band. While tuning around 1800 kHz, I suddenly ran across a signal just outside the band edge. I thought it was a ham skirting too close to the edge, but the signal sounded odd and resembled a one-sided conversation. Upon close examination, it turned out to be a frequency-modulated carrier with one side of a telephone circuit on it!

More tuning around revealed several similar fm signals that popped on and off in the 1700 to 1800 kHz range. One such signal, quite loud, sounded like a teen-ager having a long conversation about girl friends, homework, and borrowing "the old man's car" for a hot date. During one long-winded conversation (of which I could only hear one side) the address of the speaker was given. It turned out to be a home about three miles away!

What were these mysterious telephone calls? I logged eight or nine of them between 1700 kHz and 1810 kHz. Some voices were weak; others were very strong. Obviously, they were all within a few miles of my antenna. Inquiries among my ham friends revealed nothing. No one other than myself had noticed the mysterious transmissions and no one knew where they came from or the reason for them. What was going on?

In the next few days I talked at random to other 160-meter operators. They had not noticed the signals, but they quickly found some when I told them to look just outside the low edge of the band. Once or twice, a signal was found just on the band edge, or slightly inside the band.

The mystery was quickly solved when I found an electronics magazine which gave a complete run-down on a relatively new device: the cordless telephone (**fig. 1**). This is a device which connects to the phone line and provides a remote two-way terminal for the user. Various models provide pushbutton dialing, a memory bank for several dozen phone numbers, number redialing, mute switch, and other attractive bells and whistles.

The particular cordless phone that I'd heard is a design that has a base station that transmits an fm signal in the frequency range of 1.6 MHz to 1.8 MHz and receives in the range of 29 MHz and/or 49.8 MHz to 49.9 MHz. The most commonly used frequencies are 1.665 MHz and 29.255 MHz. Alternatively, a channel in the 49-MHz range is commonly used in the United States instead of the 29-MHz channel.

Experience has shown that these units are audible over a several-mile range on the so-called 160-meter channel. The advertised operating range is said to be 100 to 200 meters and this is probably so, because of the limitations of the 49-MHz link and the small receiving antenna used for the low-frequency link. One manufacturer[1] states, "Our model has an effective operating range of less than 100 meters, and is considered an indoor model. The market will not increase until we can push up the operating range to one to 10 kilometers." Another manufacturer is developing a model with an operating range of 1,000 meters for production in 1982.

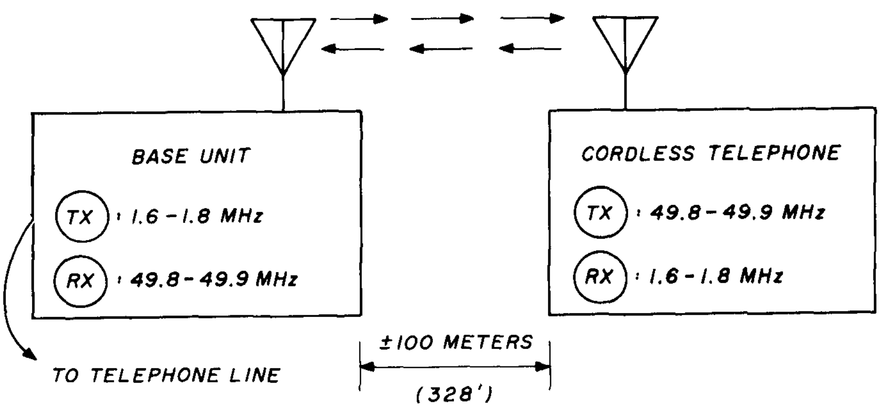


fig. 1. Typical "cordless telephone," model CP-911, marketed by Wenping International under the "Silware" brand name. A U.S. buyer is now applying for FCC approval of this system. Wenping hopes to introduce an improved model with a guaranteed range of 3280 feet (1000 meters).

the future of the cordless telephone

What will the future bring? Some models of the cordless telephone operate near the Amateur 160-meter band, and a few of these may operate dangerously close to the low band edge.

Until now, there has only been a small trickle of cordless telephones into the United States. The Asian manufacturers anticipate a rush of orders from the United States when the FCC deregulation comes into effect this year. An executive of a large electronics company in Japan says, "We are currently negotiating for long-term orders until 1984, with quantities of up to 150,000 sets per year . . . The end of the Bell System domination will reflect the real demand in the U.S. market, but an FCC approval will always be a must for entry to the U.S. Market." Another manufacturer says, "Industrial sources say that the FCC plans to open new frequency bands, perhaps including UHF, for cordless telephone, so we shall do nothing until the position in the U.S. market is clearer."

Another manufacturer of telephones says, "We shall soon be shipping about 2,500 units per month to Radio Shack in the United States." The manufacturer breaks down sales of cordless telephones as 50 percent to the U.S., 40 percent to Italy, the U.K., and France, and 10 percent to South Africa. And finally, a Taiwan company says that U.S. buyers have asked them to expand production to handle orders of 150,000 units per month. A large proportion of the units produced will be of the "cordless" variety.

It is obvious that, with a good receiving antenna, an Amateur can hear these devices over a distance of a few miles. And on the other hand, will legitimate 160-meter Amateur operation cause interference to these devices?

As of today the number of cordless telephones entering the U.S. is but a trickle. What will happen in the next few years when the trickle becomes a flood? Will tomorrow's phones continue to use the "160-meter" channel? Or will they be switched to the UHF region? And what will happen when a kilowatt ham rig opens up on 160 meters? How many cordless telephones will it wipe out?

The cordless telephone falls under FCC jurisdiction as described in Part 15, Subpart D, of the Rules and Regulations. Paragraph 15.152 states that if a low-power communication device causes interference to another service, it must cease operation until the interference is eliminated. Fine words, but what can be done when the country is flooded with cordless telephones? There will undoubtedly be more to this story and it will be interesting to see in what portion of the radio spectrum these space-age devices will eventually find a home. The future of the cordless phone looks bright. Its relationship with other services in the radio spectrum, particularly the Amateur Service, is still an open question.

the 10-MHz Amateur (?) band

Listening to the so-called 30-meter Amateur band during the first few months of 1982 has been a frustrating experience. Amateur activity worldwide in the band has been quite low. For the first, heady days after January 1, quite a few stations were active on the band, notably English and Australian Amateurs. But, as the days dragged on, and U.S. hams were prohibited from using the band, interest lagged and now the band is sparsely occupied.

The star performer seems to be C6ABA on Abaco Island in the Bahamas. Gordon has been on the air almost daily, working every 10-MHz Amateur he can hear. Another outstanding signal that showed up in early February was DL2GG/YV5 in Venezuela. Many's the time his sharp CW signal has pinned the meter on my receiver. The two American beacon signals, KK2XJM (K4MB) and KK2XGH (N4DR), are on almost daily, and it is rumored that another, experimental, station may be on the band by the time this appears in print.

All in all, about seventy Amateur calls have been logged on the band, covering about twenty-five countries. A few "bootleggers" have been noted, but these pop on and off quickly and don't seem to be a problem. A few DX-minded 30-meter operators call "CQ 20" and listen for re-

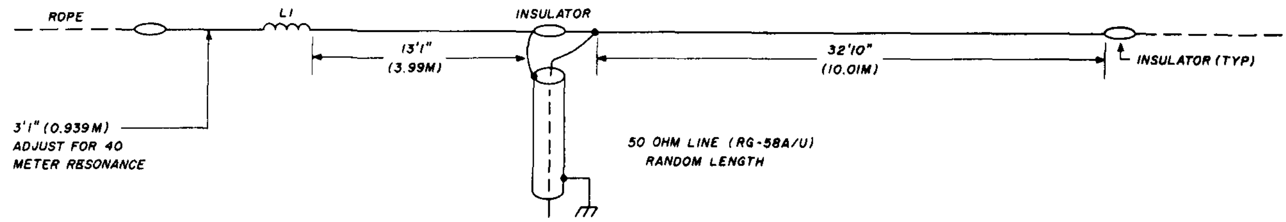


fig. 2. The JA3CZV two-band dipole for 40 and 15 meters, as revised by K6URI. Coil L1 is 115-1/2 turns No. 16e, 1 inch diameter, 6-3/8 inch winding length. Coaxial joint at center insulator should be waterproofed by wrapping of vinyl electrical tape covered by a coating of RTV sealant. (Note: make sure RTV is free from acetic acid to prevent corrosion — read the label!)

plies near 14,075 kHz. And many times the 30-meter ham will call CQ time after time with no reply.

While U.S. Amateurs are barred from the band, some activity goes on in this frequency span from the other services. Radio Moscow has an English-speaking station on 10,120 kHz, and there are a few RTTY stations sputtering away at various hours. In addition, there are some Mexican point-to-point SSB stations near the top end of the band that appear now and then.

By far the most interesting occupants of the 30-meter band are the "spook" stations. These signals, signing no calls, or signing fictitious calls, were plentiful early in the year. One or two on SSB read off five-digit number lists, one list being in German! Most of the spooks are on CW, sending lists of five-digit number blocks. One or two spooks, very loud ones, send code groups in Cyrillic characters — possibly Russian stations.

An intriguing group of spooks inhabit the high end of the assignment. They converse among themselves, and any self-respecting Radio Amateur would blush at the poor operating techniques these stations exhibit. Here's hoping they are not "ours"! Working at about 10 WPM, these spooks make a bumbling effort to contact each other. The signals are a good S7 with little fading, so the stations can't be far away, nor are they far from each other. But they call and call, send QSA?, and generally stumble about, generally not even establishing good contact. Finally, they give up and close down, or move elsewhere. One evening somebody (an Amateur?) moved on the frequency and broke the two spooks and asked QSA? This really disrupted things and the poor spooks had a terrible time getting their act together. So far as I know, this particular net spends plenty of time calling, but very little time transmitting any meaningful information. Perhaps they should try the long-distance telephone! (They disappeared from the band about mid-March.)

So there you are. The yet-to-be-used 30-meter Amateur band is a wasteland. Here's hoping it will soon be put to use by the Amateur Service! And that probably won't happen until the State Department and the FCC get their act together and release the frequencies. Don't give up hope (yet).

the 40-10 meter antenna revisited

Some time ago, I published the details of a Japanese antenna designed by JA3CZV for operation on 7 and 21 MHz (**fig. 2**). The original design[2] was said to provide good performance on the two bands. Essentially, it is a 40-meter dipole with one portion loaded to provide a 15-meter section isolated from the antenna tip by the coil. Mike, K6URI, tried this antenna and came up with a new set of dimensions that seem to provide improved performance. As shown in the illustration, this antenna provides an SWR below 1.9-to-1 over a 150-kHz range on 7 MHz. At resonance, the SWR is very close to unity. The resonant frequency is adjusted by changing the tip section, which can run from 2 ft. 7 in. (79 cm) to 3 ft. 3 in. (1 m). This adjustment depends upon the size of the antenna insulator used and the proximity of the antenna to nearby objects.

On 15 meters, the SWR runs below 1.8-to-1 over the range of 21,050 to 21,400 kHz, with the SWR at the resonant frequency very close to unity.

the new Radio Handbook

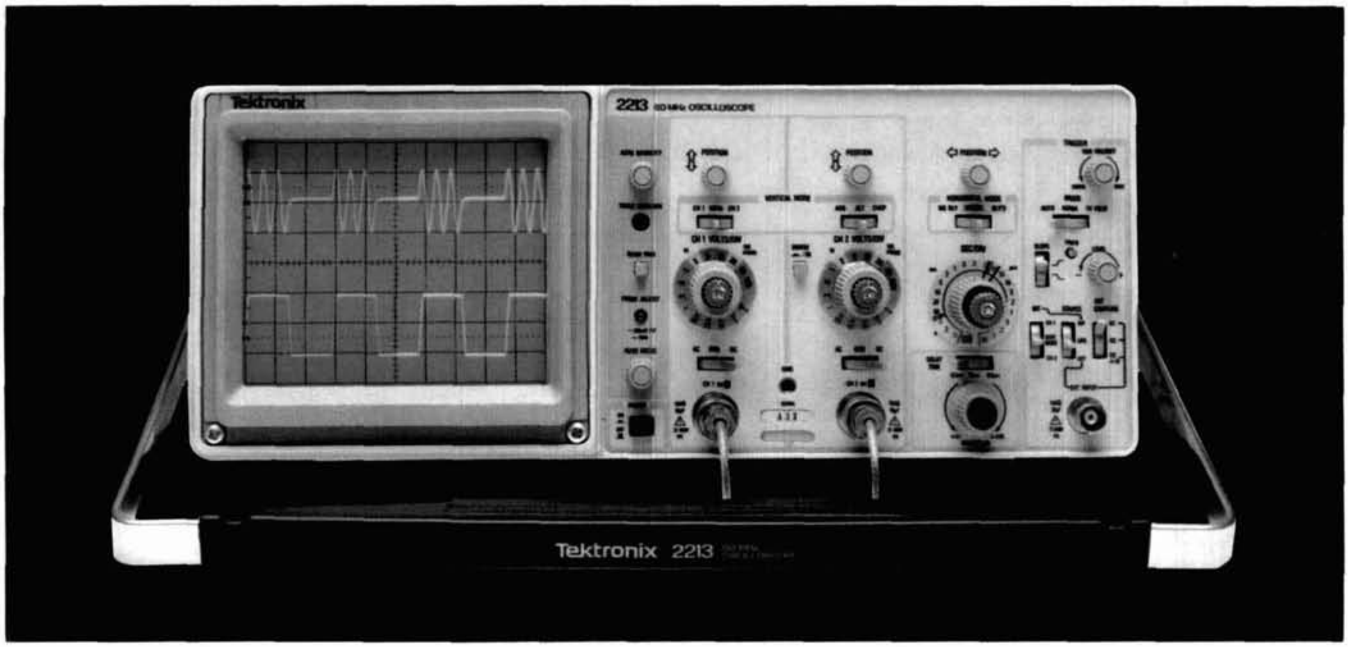
I'm pleased to tell you that the new, twenty-second edition of the *Radio Handbook* has been published by Howard W. Sams Co., Inc., 4300 West 62nd St., Indianapolis, Indiana 46268. It is available through the Ham Radio Bookstore and many distributors worldwide. This 1200-page, hardbound handbook covers communications from A to Z. The new edition includes up-to-date information on transmitting and receiving equipment and antennas of all types, and it is written in language you can understand. I think it is a *great* handbook! (I should. I'm the editor!) I hope you enjoy reading the new *Radio Handbook* as much as I enjoyed compiling it.

references

1. "Telephones: makers optimistic as U.S. permits imports for retail sales," *Asian Sources Electronics*, January, 1982, pages 10-38, 114-136, 200-208, 218-230. Published by Trade Media Ltd., Box 1786, Kowloon Central, Hong Kong.

2. William I. Orr, W6SAI, "Antennas — facts and fiction," *CQ*, December, 1978.

ham radio



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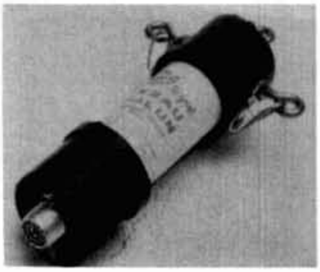

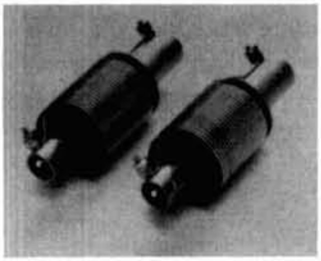

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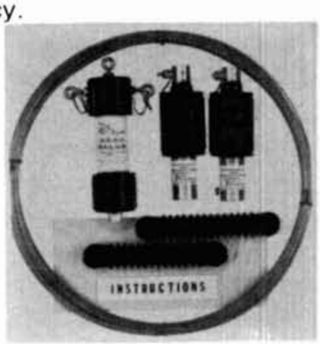

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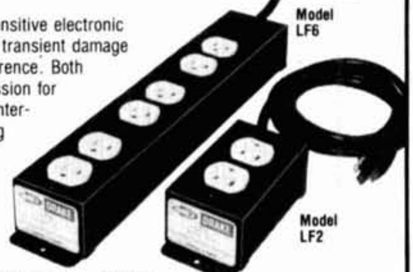

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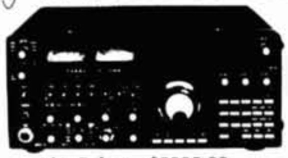

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DON'S CORNER

This is the first installment of an all new Don's Corner. I'm going to review, from my side of the fence, the good and bad of the radios I sell. I want to tell you about the radios and how they function, service, ease of operation and resale values. I'll also include plenty of helpful hints and tips to make your radios work better for you. I may not make myself too popular BUT — I want you to get the radio you want. I don't want you to buy based solely upon my recommendation or how our ads portray the radios I sell. So here goes —

- The Rockwell/Collins KWM-380 — an expensive radio but true to Collins' standards. It won't be superseded by a new unit next month.
- Yaesu FT-ONE — Close to the KWM-380 but not enough out yet to get feedback.
- Kenwood TS-930 — Should be available by the time this ad is run. Auto antenna tuner is an interesting new feature.
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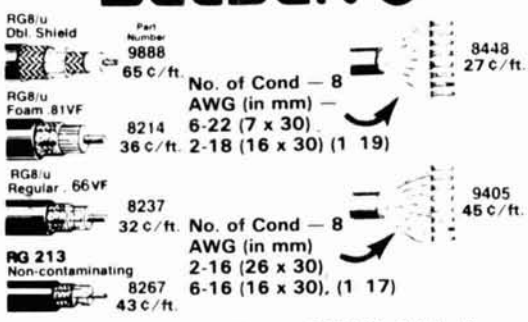

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TR-2500

BIG performance, small size, smaller price!

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

TR-2500 FEATURES:

- Extremely compact 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 NiCd pack.
- LCD digital frequency readout.
- Ten memories includes "MO" memory for non-standard split repeaters.
- Lithium battery memory back-up, built-in, (est. 5 year life).
- Memory scan.
- Programmable automatic band scan allows upper and lower frequency limits and scan steps of 5 kHz and larger (5, 10, 15, 20, 30 kHz ... etc) to be programmed.
- UP/DOWN manual scan.
- Repeater reverse operation.
- 2.5 W or 300 mW RF output. (HI/LOW power switch).
- Built-in tunable (with variable resistor) sub-tone encoder.
- Built-in 16-key autopatch.
- Slide-lock battery pack.
- Keyboard frequency selection.
- Covers 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.

CONVENIENT TOP CONTROLS

Standard accessories:

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

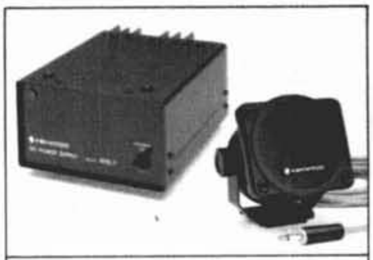
Optional accessories:

- VB-2530 25 W RF Power amp, BNC-BNC cables, and mounting bracket, supplied.
- MS-1 13.8 VDC mobile stand/ charger/power supply.

Optional accessories:

- ST-2 Base station power supply and quick charger (approx 1 hr.)
- TU-1 Programmable "DIP switch" (CTCSS) encoder.
- SMC-25 Speaker microphone.
- LH-2 Deluxe leather case.
- PB-25 Extra Ni-Cd battery pack, 400 mAH, heavy-duty.
- BT-1 Battery case for AA manganese or alkaline cells.
- BH-2 Belt hook.
- WS-1 Wrist strap.
- EP-1 Earphone.

NEW



Optional accessories:

- KPS-7 DC power supply for TR-9130 base station operation. 7 A intermittent, 6 A continuous, protection circuit built-in.
- SP-40 compact mobile speaker. Only 2-11/16 W x 2-1/2 H x 2-1/8 D (inches). Handles 3 watts of audio.
- TK-1 AC adapter for memory back-up (not shown).

TR-9130

All mode (FM/SSB/CW) 25 watts, plus...!!!

The TR-9130 is a powerful, yet compact, 25 watt FM/USB/LSB/CW transceiver, featuring six memories, memory scan, memory back-up capability, automatic band scan, all-mode squelch, and CW semi break-in. Available with a 16-key autopatch UP/DOWN microphone (MC-46), or a basic UP/DOWN microphone.

TR-9130 FEATURES:

- 25 Watts RF output on all modes, (FM/SSB/CW).
- FM/USB/LSB/CW all mode. The mode switch, with the digital step (DS) switch, determines the size (100 Hz, 1 kHz, 5 kHz, 10 kHz) of the tuning step.
- Six memories. On FM, memories 1-5 for simplex or ±600 kHz offset, using OFFSET switch. Memory 6 for non-standard offset. All six memories may be simplex, any mode.
- Memory scan. Scans memories in which data is stored.
- Internal battery memory back-up, using 9 V Ni-Cd battery, (not KENWOOD supplied). Memories are retained approx. 24 hours, adequate for the typical move from base to mobile. External back-up terminal on the rear.
- Automatic band scan. Scans within whole 1 MHz segments (ie., 144.0-144.999 MHz).
- Dual digital VFO's.
- Transmit frequency tuning while transmitting, for OSCAR operations.
- Squelch circuit, all modes (FM/SSB/CW).
- Repeater reverse switch.
- Tone switch.
- CW semi break-in circuit with sidetone.
- Digital display with green LED's.
- Compact size and lightweight. 170 (6-11/16) W x 68 (2-11/16) H x 241 (9-1/2) D mm (inch). 2.4 kg (5.3 lbs.) weight.
- Covers 143.9 to 148.9999 MHz.
- HI/LOW power switch. 25 or 5 watts on FM or CW.
- Transmit offset switch.
- High performance noise blanker.
- RF gain control. • RIT circuit.

KENWOOD

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

SELECT YOUR FAVORITE FEATURE

Yes, the **CT2100** has the features you want – and built-in, too! The **CT2100** has been designed by the RTTY people at HAL for optimum operator convenience. No "hidden" keyboard controls to remember – it's all on the front panel, arranged for serious operators. Why settle for a compromise or imitation when you can have the **CT2100**? Compare feature for feature; you'll find that the **CT2100** offers the most performance and flexibility for your dollar.

- **Send or receive ASCII, Baudot, or Morse code**
- **RTTY and Morse demodulators are built-in**
- **RTTY speeds of 45, 50, 74, 100, 110, 300, 600, and 1200 baud – ASCII or Baudot**
- **Four RTTY modems: "high tones", "low tones", "103 Modem tones", and "202 Modem tones"**
- **Three shifts for high and low tones (170, 425, and 850 Hz)**
- **Crystal-synthesized transmit tones**
- **Send and receive Morse code at 1 to 100 wpm**
- **Characters displayed on 24 line screen**
- **Choose either 36 or 72 characters per line**
- **2 pages of 72 character lines or 4 pages of 36 character lines**
- **Split-screen for pretyping transmit text**
- **Audio, current loop, or RS232 data I/O**
- **Printers available for hard-copy of all 3 codes**
- **On-screen RTTY tuning bar plus LED indicators**
- **ALL ASCII control characters; half or full duplex**
- **Brag-tape storage of 8-256 character messages in MSG2100 EPROM option**
- **Two programmable HERE IS messages**

Write or call for more details. See the CT2100, KB2100, Printer, and Video Monitor at your favorite HAL dealer.

HAL

HAL COMMUNICATIONS CORP.

BOX 365
URBANA, ILLINOIS 61801 217-367-7373

The ultimate team...the new Drake "Twins"

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

TR7A Transceiver

• **CONTINUOUS FREQUENCY COVERAGE** — 1.5 to 30 MHz full receive coverage. The optional AUX7 provides 0 to 1.5 MHz receive plus transmit coverage of 1.8 to 30 MHz, for future Amateur bands, MARS, Embassy, Government or Commercial frequencies (proper authorization required).

• **Full Passband Tuning (PBT)** enhances use of high rejection 8-pole crystal filters.

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.

New! Standard ultimate selectivity choices include the supplied 2.3 kHz ssb and 500 Hz cw crystal filters, and 9 kHz a-m selectivity. Capability for three accessory crystal filters plus the two supplied, including 300 Hz, 1.8 kHz, 4 kHz, and 6 kHz. The 4 kHz filter, when used with the R7A's Synchro-Phase a-m detector, provides a-m reception with greater frequency response within a narrower bandwidth than conventional a-m detection, and sideband selection to minimize interference potential.

• **Front panel pushbutton control** of rf preamp, a-m/ssb detector, speaker ON/OFF switch, i-f notch filter, reference-derived calibrator signal, three agc release times (plus AGC OFF), integral 150 MHz frequency counter/digital readout for external use, and Receiver Incremental Tuning (RIT).

The "Twins" System

• **FREQUENCY FLEXIBILITY.** The TR7A/R7A combination offers the operator, particularly the DX'er or Contester, frequency control agility not available in any other system. The "Twins" offer the only system capable of no-compromise DSR (Dual Simultaneous Receive). Most transceivers allow some external receiver control, but the "Twins" provide instant transfer of transmit frequency control to the R7A VFO. The operator can listen to either or both receiver's audio, and instantly determine his transmitting frequency by appropriate use of the TR7A's RCT control (Receiver Controlled Transmit). DSR is implemented by mixing the two audio signals in the R7A

• **ALTERNATE ANTENNA CAPABILITY.** The R7A's Antenna Power Splitter enhances the DSR feature by allowing the use of an additional antenna (ALTERNATE) besides the MAIN antenna connected to the TR7A (the transmitting antenna). All possible splits between the two antennas and the two system receivers are possible.

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

DRAKE

See your Drake dealer or write for additional information.

COMING SOON: New RV75 Synthesized VFO Compatible with TR5 and 7-Line Xcvrs/Rcvrs

• **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

R. L. DRAKE COMPANY • 540 Richard Street, Miamisburg, Ohio 45342 • Phone (513) 866-2421 • Telex 288-017

* Patent pending

HAM CALENDAR

July

SUNDAY | MON | TUES | WED | THUR | FRI | SATURDAY

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 [illegible] P M
	Fast Code Practice	MWF 4 P M 10 P M TTh 9 A M TThSS [illegible] P M
	CW Bulletins	Dy 5 P M 8 P M [illegible] P M MTWThF 10 A M
	RTTY Bulletins	Dy 6 P M 9 P M 12 P M MTWThF [illegible] 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 TThSS 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 TThSS 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

1 (THUR)

CARF CANADA DAY CONTEST 1

ARRL CRRL MIDWEST CONVENTION [illegible] SK Canada 1 3

2 (FRI)

3 (SATURDAY)

HANNIBAL ARC 2ND ANNUAL SPECIAL CERTIFICATE The Na[illegible] Tom Sawyer Days [illegible] 3 4 **

WEST VIRGINIA STATE CONVENTION Jackson's Mill Contact WA8GYO 3 4

VENEZUELAN PHONE CONTEST 3 4

4 (SUNDAY)

BONFIELD IL CENTENNIAL CELEBRATION Commemorative Amateur Radio Station 4 **

HIGH PLAINS ARC SPECIAL EVENTS STATION K7YPT At [illegible] amie WY starting 0000Z July 4 to 0000Z July 6 4 5 **

5 (MON)

6 (TUES)

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)

7 (WED)

WEST COAST BULLETIN 9PM PDT 8PM PST [illegible] UTC 7

8 (THUR)

9 (FRI)

10 (SATURDAY)

19TH ANNUAL INTERNATIONAL HAMFEST At International Peace Gardens between Dunseith ND and Boissevain Manitoba at the Canadian pavilion on the north side of the Gardens For information [illegible] WD0GMD or AD0GRC 10 11

SOUTH MILWAUKEE ARC SWAPFEST 82 At the American Legion Post 434 Oak Creek WI For more information contact South Milwaukee ARC P O Box 102 South Milwaukee WI 53172 10

RACINE MEGACYCLE CLUB S SPECIAL EVENT STATION W9UDU W9UDU will be operating from the city of Racine's harbor during Salmon A Rama 10 18 **

NITTANY ARC HAM FESTIVAL For more information contact NARC, P O Box 614 State College PA 16801 10

TEXOMA ARC Will operate K5GOD from Denison, TX, to commemorate the city's Western Days 10 11 **

IARU RADIOSPORT 10 11

11 (SUNDAY)

BATAVIA HAMFEST by the Genesee Radio Amateurs At Alexander Firemen's Grounds Route 98, Alexander NY Contact Batavia Hamfest c/o GRAM, Inc Box 572, Batavia, NY 14020 11

INDIANA STATE AMATEUR RADIO CONVENTION In conjunction with the Indianapolis Hamfest and Computer Show at the Marion County Fairgrounds Contact Indianapolis Hamfest Box [illegible] Indianapolis IN 46201 11

ANNUAL SOUTH DAKOTA HAMFEST Sponsored by the Black Hills ARC at Surbeck Center SD School of Mines & Technology Rapid City SD For information contact WB0PWA Black Hills ARC 4822 Capitol Rapid City SD 57701 10-11

HAMFEST 82 Sponsored by the Maple Ridge ARC at Maple Ridge Fairgrounds 30 miles east of Vancouver BC Contact Maple Ridge ARC, Box 292 Maple Ridge, BC V2X 7G2 10-11

12 (MON)

13 (TUES)

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)

14 (WED)

HARRISBURG ANNUAL FIRE CRACKER HAMFEST at the Shiremanstown VFW Picnic Grounds Exit 27 Interstate 81 Sponsored by the Harrisburg ARC Contact KA3H[illegible] 14

VENEZUELAN CW CONTEST 14 15

15 (THUR)

16 (FRI)

GLACIER WATERTON HAMFEST At Three Forks Campground East Glacier MT Contact WB7ODJ 1540 Fifth Ave Havre MT 59501 16 18

EASTERN MICHIGAN ARC SPECIAL EVENTS STATION For the 1982 running of the Port Huron to Mackinac Yacht Race Contact K8DD 16 18 **

17 (SATURDAY)

WAPAKONETE, OH, RESERVOIR AMATEUR RADIO ASSOCIATION Will operate K8QYL from 1300Z July 17 to 9499Z, July 18 For more information contact K8QYL 17 **

NEW HAMPSHIRE FM ASSOCIATION FLY IN 3rd largest electronic flea market, located at the Manchester Municipal Airport Contact K1WPM or W1KGZ 17

LANE COUNTY HAM FAIR Oregon National Guard Armory 2515 Centennial Eugene Contact WA7MOK 17 18

A5 MAGAZINE WORLDWIDE SSTV DX CONTEST 17-18

INTERNATIONAL QRP CONTEST 17-18

18 (SUNDAY)

17TH ANNUAL WOOD COUNTY HAM-A-RAMA Wood County Fairgrounds, Bowling Green, OH Contact Wood Co ARC c/o S [illegible] (SASE), P.O. Box 73, Luckey, OH 43443 18

ZERO BEATERS ARC HAMFEST Missouri's oldest hamfest Washington, MO, Fairgrounds Contact Rich Noelke Rt 3 10 Richard Dr Washington, MO 63090 18

8TH ANNUAL HALL OF FAME HAMFEST Nimishillen Grange 6461 Easton St., Louisville, OH Contact WA8SHP 18

RANGE WIDE HAMFEST Gunn Park, 6 miles north of Grand Rapids Contact WD0AAF, 736 Crystal Springs Rd Grand Rapids MN 55744 18

LAPORTE COUNTY SUMMER HAMFEST County Fairgrounds Laporte IN Contact P O Box 30, Laporte IN 46350 18

19 (MON)

20 (TUES)

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)

21 (WED)

WEST COAST BULLETIN 9PM PDT 8PM PST 0400 UTC 21

22 (THUR)

23 (FRI)

ARRL NATIONAL CONVENTION Cedar Rapids IA 23-25

24 (SATURDAY)

TREATY CITY ARA Special Event Station of W8UM will be operated from the site of the Annie Oakley Days celebration Contact T C A R A Box 91 Greenville OH 45331 24-25

MT BEACON ARC ANNUAL HAMFEST Arlington Sr H S, Poughkeepsie NY For more information contact WA2ZCN (SASE) 24

SKI COUNTRY ARC FIRST ANNUAL SWAPFEST Colorado Mtn College Bldg 1402 Blake Ave Glenwood Springs Contact WA0BBI 24

NOARSFEST Lorain County Fairgrounds Wellington, OH Contact NOARSFEST, P O Box 354 Lorain OH 44052 24

RESERVOIR ARA Will operate W8DN during the Celina Lake Festival Contact W8DN P O Box 268 Celina OH 45822 24 **

25 (SUNDAY)

BALTIMORE RADIO AMATEUR TELEVISION SOCIETY S BRATS Maryland Hamfest Howard County Fairgrounds about 15 miles west of Baltimore Contact BRATS, P O. Box 5915 Baltimore MD 21208 25

AMATEUR RADIO PUBLIC SERVICE ASSOCIATION of St. Joseph County will hold its 4th annual Swap & Shop Contact N8DDU 25

RADIO AMATEUR TRANSMITTING SOCIETY (RATS) Nashville Hamfest Computerfest at Exhibition Hall Nashville Municipal Auditorium Contact RATS P O. Box 2892, Nashville, TN 37219 25

HAMFEST WV'S "BIGGIE" TSRAC Wheeling WV Hamfest Contact TSRAC, Box 240 RD 2, Adena, OH 4390[illegible] 25

COUNTY HUNTERS CW CONTEST 25 26

26 (MON)

27 (TUES)

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)

28 (WED)

29 (THUR)

30 (FRI)

AMATEUR RADIO COUNCIL OF ARIZONA S 32ND ANNUAL HAMFEST Fort Tuthill Fairgrounds Flagstaff Contact W7WGW 30-31

31 (SATURDAY)

25TH REUNION OF VHF RADIO AMATEURS OF THE OKLAHOMA CENTRAL 6 METER CLUB Send name, address, and present call to T W Stevens, W5VCJ Reunion will be held at the same time as the Oklahoma City Ham Holiday 31

TANK AUTOMOTIVE COMMAND ARC W8JPW special events station to commemorate the 41st year of the Detroit Arsenal 31 **

RADIO AMATEUR MEGACYCLE SOCIETY'S 20TH ANNUAL ILLINOIS QSO PARTY contact RAMS K9CJU 31 Aug. 1 **

***SEE COMING EVENTS**

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	.45	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	.89	74LS251	.99
74LS22	.35	74LS138	.89	74LS253	.99
74LS26	.35	74LS139	.89	74LS257	.89
74LS27	.35	74LS151	.89	74LS258	.69
74LS28	.35	74LS153	.89	74LS260	.69
74LS30	.35	74LS154	1.75	74LS266	.69
74LS32	.35	74LS155	.89	74LS273	1.95
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

CA—LINEAR

CA3010H	.99	CA3060N	3.25	CA3089N	3.75
CA3013H	2.15	CA3080H	1.25	CA3096N	3.95
CA3023H	3.25	CA3081N	2.00	CA3130H	1.39
CA3035H	2.49	CA3082N	2.00	CA3140H	1.25
CA3039H	1.35	CA3083N	1.60	CA3160H	1.25
CA3046N	1.30	CA3086N	.85	CA3401N	.59
CA3059N	3.25			CA3600N	3.50

CD—CMOS

CD4000	.39	CD4041	1.49	CD4098	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

OPTO ELECTRONICS

A-AMBER — LEDS — G-GREEN
R-RED Y-YELLOW C-CLEAR

DIFFUSED BI COLOR/TRI-STATE — POINT SOURCE (RED) — DIFFUSED — DIFFUSED — WIDE ANGLE DIFFUSED — DIFFUSED — POINT SOURCE — DIFFUSED — DIFFUSED TRIANGLE — DIFFUSED RECTANGULAR

LED Mounting Hardware

Mounts in panels up to .125" thick. Drill .257" diameter hole (F Drill). Can be used with XC22, XC111, XC526, XC556 Series from .180" to .200 Dia. (Black plastic, chip and ring)

Part No.		100+
LMH 200	8/$1.00	.08 ea.

—DISPLAY LEDS—

Part No.	Size	Color	Description	Price
MAN 1	.270	Red	C.A. (LHDP)	$2.95
MAN 2	.320	Red	5x7 Alphanumeric (TIL305)	4.95
MAN 52	.300	Green	C.A. (LHDP)	.99
MAN 54	.300	Green	C.C. (RHDP)	.99
MAN 72	.300	Red	C.A. (LHDP)	.75
MAN 74	.300	Red	C.C. (RHDP)	1.25
NSN 74L	.300	Red	C.C. (LHDP)	.99
MAN 82	.300	Yellow	C.A. (LHDP)	.49
MAN 84	.300	Yellow	C.C. (RHDP)	.99
MAN 3620	.300	Orange	C.A. (LHDP)	.49
MAN 3630	.300	Orange	C.A. (±1) Over Flo	.99
MAN 4610	.400	Orange	C.A. (RHDP)	.99
MAN 6610	.560	Orange	C.A. (RHDP) 2 Digit	.99
MAN 6630	.560	Orange	C.A. (±1) 1½ Digit	.99
MAN 6640	.560	Orange	C.C. (RHDP) 2 Digit	.99
MAN 6650	.560	Orange	C.C. (±1) 1½ Digit	.99
MAN 6680	.560	Orange	C.A. (RHDP)	.99
MAN 6710	.560	Red	C.A. (RHDP) 2 Digit	.99
MAN 6740	.560	Red	C.C. (RHDP) 2 Digit	.99
MAN 6750	.560	Red	C.C. (±1) 1½ Digit	.99
DL 34M	.110	Red	C.C. (4 Digit Bubble) RHDP	.49
DLO 304	.300	Orange	C.C. (RHDP)	1.25
DLO 307	.300	Orange	C.A. (LHDP)	1.25
DLG 500	.500	Green	C.C. (RHDP)	1.25
DLG 507	.500	Green	C.A. (RHDP)	1.25
DL 704	.300	Red	C.C. (RHDP)	1.25
DL 707	.300	Red	C.A. (LHDP)	1.25
DL 747	.630	Red	C.A. (LHDP)	1.49
DL 750	.630	Red	C.C. (LHDP)	1.49
FND 360	.362	Red	C.A. (RHDP)	.75
FND 367	.362	Red	C.C. (RHDP) FND 359	.75
FND 500	.500	Red	C.C. (RHDP) FND 503	.99
FND 507	.500	Red	C.A. (RHDP) FND 510	.99
TIL 308	.270	Red	Numerical Display w/Logic	10.95
TIL 311	.270	Red	4x7 Hexadecimal w/Logic	10.95
5082-7300	.600	Red	4x7 Numeric (RHDP)	$22.00
5082-7302	.600	Red	4x7 Numeric (LHDP)	22.00
5082-7304	.600	Red	Over Flo (±1) for 5082-7300-02	19.95
5082-7340	.600	Red	4x7 Hexadecimal (0-9/A-F)	22.50
5082-7432	.110	Red	C.C. (2-Digit/3-Bubble)	.29
HDSP-3401	.800 20mm	Red	C.A. (RHDP)	1.50
HDSP-3403	.800 20mm	Red	C.C. (RHDP)	1.50
HDSP-3406	.800 20mm	Red	C.C. (RHDP) ±1 Over Flo	1.50

Many Other Displays Available   Send for New Catalog

OPTO-ISOLATORS

H11C3	SCR Output Opto-Isolators	$1.19
LIT-1	Single Chan. 20% CTR, 2500V (MCT 2/4N25)	.69
4N28	Single Chan. 10% CTR, 500V (Photo Transistor)	.69
4N33	Single Chan. 500% 1500V (Photo Darlington)	1.25
MOC3010	Optically Isolated Triac Driver	1.25

LITRONIX-NATIONAL Stick Display Sale

LIMITED QUANTITY!

LED NUMERIC ARRAYS

PART NO.	DIGIT SIZE (RED)	FORMAT	DRIVE Comm. Cathode/Comm. Anode	OVERALL SIZE	PRICE	SALE PRICE!
NSA196	.100 (9 Bubble Stick)	888888	C.C. 6 Digit Multiplexed	2"L x .72"H x .27"D	1.59	2/.99
NSA198	.100 (9 Bubble Stick)	88888888	C.C. 8 Digit Multiplexed	2"L x .72"H x .27"D	.69	2/.99
NSA298	.100 (9 Bubble Stick)	888888888	C.C. 9 Digit Multiplexed	1.90"L x .72"H x .27"D	.69	2/.99
NSA1150	.100 (9 Bubble Stick)	8 88 88	C.C. 5 Digit Multiplexed	2"L x .72"H x .27"D	.49	2/.59

MULTI-DIGIT LED NUMERIC DISPLAYS

PART NO.	DIGIT SIZE	FORMAT	DRIVE	OVERALL SIZE	PRICE	SALE PRICE!
NSN373	.3 No Decimal	88	C.C. 2 Digit Direct	.80"L x .80"H x .225"D	.60	2/.79
NSN374	.3 No Decimal	88	C.C. 2 Digit Direct	.80"L x .80"H x .225"D	.79	2/.99
NSN502	.5 No Decimal	88	C.A. 2 Digit Direct	1.40"L x 1.14"H x .32"D	1.09	2/1.49
NSN781	.7	88	C.C. 2 Digit Multiplexed	1.2"L x 1.26"H x .3"D	1.10	2/1.59
NSB2100	.3	8888 8888	C.C. 8 Digit (10 Spaces)	1.5"L x .60"H x .25"D	.75	2/.89
NSB3001	.3	8888	C.C. 4 Digit Multiplexed	1.5"L x .60"H x .25"D	.75	2/.89
NSB3882	.3	888	C.A. 3½ Digit Multiplexed	1.60"L x .60"H x .225"D	.99	2/1.49
NSB3411	.3	8888	C.C. 4 Digit - Colon/PM Indicator	3"L x 1 13/16"H x 3/16"D	.79	2/1.19
NSB3852	.3	88 88 88	C.C. 6 Digit - AM/PM, Feature Ind.	3"L x 1.10"H x 7/32"D	2.95	2/3.95
NSB3864	.3	88888888	C.C. 8 Digit Multiplexed	3"L x 1 3/32"H x 3/16"D	2.95	2/3.95
NSB3881	.5	8888	C.C. 4 Digit Multiplexed	1.58"L x .80"H x .225"D	2.95	2/4.95
NSB5882	.5	888	C.A. 3½ Digit Multiplexed	1.58"L x .80"H x .225"D	2.96	2/4.95
NSB5441	.5	88 88	C.A. 4 Digit AM/PM, Colon Ind.	3.00"L x 1.10"H x .282"D	2.96	2/3.95
NSB5881	.5	8888	C.C. 4 Digit Multiplexed	1.50"L x 1.00"H x .280"D	2.96	2/5.95
NSB5882	.5	8888	C.A. 4 Digit Multiplexed	1.50"L x 1.00"H x .280"D	2.96	2/5.95
NSB5917	.5	8888	C.C. 4 Digit Multiplexed	3.00"L x 1.00"H x .282"D	2.48	2/3.49
NSB5922	.5	88888	C.C. 5 Digit Multiplexed	3.00"L x 1.10"H x .282"D	3.48	2/4.95
NSB7823	.7	888888	C.C. 6 Digit Multiplexed/Direct	3.80"L x 1.35"H x .282"D (3/8" pins)	3.95	2/4.95
DL2300	.3	88	C.C. 2 Digit Multiplexed	13/16" x 7/8" x 1/4"	.79	2/.99
DLG2536	.5 (Green)	88	C.A. 2 Digit Multiplexed	1 6/16" x 1 1/2" x 6/16"	.69	2/1.19
DL3130	1.0	888	C.A. 3 Digit Multiplexed	2 3/4" x 1 13/16" x 6/16"	2.26	2/3.49
DL4600	.5	8888	C.C. 4 Digit, MPX, Colon	3 3/16" x 1 1/4" x 6/16"	1.95	2/2.95
DL4607	.5	8888	C.C. 4 Digit, MPX, Colon	3 3/16" x 1 x 6/16"	1.75	2/2.95
DLG4507	.5 (Green)	8888	C.C. 4-Digit Non-Multiplexed	3 3/16" x 1 x 6/16"	4.95	2/7.95
DL4609	.5	8888.	C.C. 4 Digit Multiplexed	2" x 1 6/16" x 5/16"	1.49	2/1.95
DL4620A	.5	8888	C.C. 4 Digit Non-Multiplexed	3 3/16" x 1" x 6/16"	2.49	2/2.95

COMPUTER GRADE CAPACITORS

1¢ SALE!

MFD	WVDC	PRICE	MFD	WVDC	PRICE	MFD	WVDC	PRICE
250	150	1.95	7,000	80	4.95	27,000	10	2.95
500	200	2.49	10,000	15	2.95	32,500	25	4.95
1,250	3	.99	10,000	18	3.95	40,000	25	5.95
1,500	25	1.95	11,000	19	4.95	42,000	10	4.95
1,500	50	2.95	13,000	16	2.95	43,000	10	5.95
2,000	10	2.95	14,000	13	2.95	45,000	5	5.95
2,100	200	2.95	14,000	35	3.95	52,000	20	5.95
2,250	100	3.95	18,000	10	3.95	55,000	15	5.95
2,300	33	2.95	20,000	20	2.95	58,000	20	5.95
2,500	15	2.95	21,000	15	3.95	65,000	10	7.95
3,000	25	1.95	22,000	15	4.95	73,800	5	7.95
3,600	40	3.95	23,000	7	1.95	80,000	15	9.95
4,500	50	3.95	23,000	10	2.95	90,000	10	8.95
5,500	25	4.49	23,000	20	3.95	120,000	15	10.95
6,100	40	2.49	24,000	20	2.95	160,000	10	8.95

1¢ Sale!

OVER 200 OTHER VALUES AVAILABLE   BUY ONE, THE SECOND UNIT IS 1¢ MORE

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

JUMPER AND CABLE ASSEMBLIES

Custom Jumpers!   *Custom Cables!*

STANDARD DIP JUMPERS

All jumpers use low profile dip plugs with heavy duty pins for repeated disconnect applications.

JAMECO Part No.	AP Cross-Reference	No. Pins	Description	Wire Length	Price
DJ14-1	924102-12	14	single end	12"	$1.79
DJ14-2	924102-24	14	single end	24"	2.05
DJ14-3	924102-36	14	single end	36"	2.35
DJ14-1-14	924108-12	14	double end	12"	3.20
DJ14-2-14	924106-24	14	double end	24"	3.49
DJ14-3-14	924106-36	14	double end	36"	3.79
DJ16-1	924112-12	16	single end	12"	1.85
DJ16-2	924112-24	16	single end	24"	2.19
DJ16-3	924112-36	16	single end	36"	2.59
DJ16-1-16	924116-12	16	double end	12"	3.35
DJ16-2-16	924116-24	16	double end	24"	3.69
DJ16-3-16	924116-36	16	double end	36"	4.05
DJ24-1	924122-12	24	single end	12"	2.69
DJ24-2	924122-24	24	single end	24"	3.39
DJ24-3	924122-36	24	single end	36"	3.95
DJ24-1-24	924126-12	24	double end	12"	4.79
DJ24-2-24	924126-24	24	double end	24"	5.29
DJ24-3-24	924126-36	24	double end	36"	5.89

JAMECO Part No.	AP Cross-Reference	No. Pins	Description	Wire Length	Price
DJ40-1	924132-12	40	single end	12"	5.89
DJ40-2	924132-24	40	single end	24"	6.79
DJ40-3	924132-36	40	single end	36"	7.69
DJ40-1-40	924136-12	40	double end	12"	10.95
DJ40-2-40	924136-24	40	double end	24"	11.89
DJ40-3-40	924136-36	40	double end	36"	12.79

STANDARD DB25 SERIES CABLES

Now you can order DB25 P or S connectors with the cable necessary to fit your application. Choose from our standard flat cable in 4 foot lengths. **Call today.**

STANDARD CABLES

Part No.	Cable Length	Connectors	Price
DB25P-4	4 feet	1-DB25P	$ 9.95 ea.
DB25S-4	4 feet	1-DB25S	10.95 ea.
DB25P-4-P	4 feet	2-DB25P	16.95 ea.
DB25P-4-S	4 feet	1-DB25P/1-DB25S	17.95 ea.
DB25S-4-S	4 feet	2-DB25S	18.95 ea.

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INTERSIL

* Evaluation Kits

Part No.	Function	Price
7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	24.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	29.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	13.95
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter CA	12.95
7217AIPI	4-Digit LED Up/Down Counter CC	14.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band-GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.95
8212CPA	Volt Ref/Indicator	2.95

74C

74C00	.39	74C95	1.59	74C221	1.95
74C02	.39	74C107	1.89	74C240	2.25
74C04	.39	74C151	2.95	74C244	2.25
74C08	.39	74C154	3.95	74C373	2.49
74C10	.39	74C157	2.25	74C374	2.59
74C14	.75	74C160	1.69	74C901	.69
74C20	.39	74C161	1.60	74C903	.69
74C30	.39	74C162	1.49	74C911	10.95
74C32	.39	74C163	1.69	74C912	10.95
74C42	1.39	74C164	1.59	74C915	1.69
74C48	1.95	74C173	1.39	74C917	10.95
74C73	.79	74C174	1.39	74C922	5.49
74C74	.79	74C175	1.19	74C923	5.75
74C85	1.95	74C192	1.69	74C925	7.50
74C86	.99	74C193	1.69	74C926	7.50
74C89	6.95	74C195	1.59	80C95	.79
74C90	1.29			80C97	.79
74C93	1.29				

LINEAR

LH0002CN	6.85	LM340T-5	1.25	NE571N	3.95
LM10CLH	4.50	LM340T-12	1.25	LM703CN	.89
LM11CLH	4.75	LM340T-15	1.25	LM709N	.29
LH0070-OH	4.95	LM341P-5	.75	LM710N	.79
TL071CP	.79	LM341P-12	.75	LM711N	.79
TL072CP	1.39	LM341P-15	.75	LM723N	.69
TL074CN	2.49	LM342P-5	.69	LM733N	1.00
LH0082CD	35.80	LM342P-12	.69	LM739N	1.19
TL082CP	1.19	LM342P-15	.69	LM741CN	.35
TL084CN	2.19	LM348N	1.25	MC1741SCG	3.00
LH0094CD	36.80	LM350K	5.75	LM747N	.79
LM300H	.99	LF351N	.60	LM748N	.59
LM301CN	.35	LF353N	1.00	LM1014N	2.75
LM302H	1.95	LF355N	1.10	LM1310N	1.95
LM304H	1.95	LF356N	1.10	LM1458CN	.59
LM305H	.99	LM358N	1.00	LM1488N	1.25
LM307CN	.45	LM359N	1.79	LM1489N	1.25
LM308CN	1.00	LM370N	4.49	LM1496N	1.95
LM309H	1.95	LM373N	3.25	LM1556V	1.75
LM309K	1.25	LM377N	2.95	LM1800N	2.95
LM310CN	1.75	LM380N	1.25	LM1871N	5.49
LM311/CN	.90	LM381N	1.95	LM1872N	5.49
LM312H	2.49	LM382N	1.79	LM1877N-9	3.25
LM317MP	1.15	LM384N	1.95	LM1889N	3.20
LM317T	1.75	LM386N-3	1.29	LM1896N	1.75
LM317K	3.95	LM387N	1.45	LM2002T	1.49
LM318CN	1.95	LM389N	1.35	LM2877P	2.05
LM319N	1.95	LM392N	.69	LM2878P	2.25
LM320K-5	1.35	LF398N	4.00	LM2896P-1	2.25
LM320K-12	1.35	LM399H	5.00	LM3189N	2.95
LM320K-15	1.35	TL494CN	4.49	LM3900N	.69
LM320T-5	1.25	TL496CP	1.75	LM3905CN	1.25
LM320T-12	1.25	NE510A	6.00	LM3909N	1.15
LM320T-15	1.25	NE529A	4.95	LM3914N	3.95
LM323K	5.95	NE531H	3.95	LM3915N	3.95
LM324N	.99	NE536H	6.00	LM3916N	3.95
LM329DZ	.65	NE540H	6.00	RC4136N	1.25
LM331N	3.95	NE544N	4.95	RC4151NB	3.95
LM334Z	1.30	NE550A	1.30	RC4194TK	6.95
LM335Z	1.40	NE555V	.39	RC4195TK	5.49
LM336Z	1.75	LM556N	.99	LM4500A	3.25
LM337T	1.95	NE564N	3.95	ICL8038B	4.95
LM337MP	1.15	LM565N	1.25	LM13080N	1.29
LM338K	6.95	LM566CN	1.95	LM13600N	1.49
LM339N	.99	LM567V	1.25	75138N	1.95
LM340K-5	1.35	NE570N	4.95	75450N	.89
LM340K-12	1.35			75451CN	.39
LM340K-15	1.35			75492	.89

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50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
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22 pf	.08	.06	.05	.0047μF	.08	.06	.05
47 pf	.08	.06	.05	.01μF	.08	.06	.05
100 pf	.08	.06	.05	.022μF	.09	.07	.06
220 pf	.08	.06	.05	.047μF	.09	.07	.06
470 pf	.08	.06	.05	.1μF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

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

+20% DIPPED TANTALUMS (Solid) CAPACITORS

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

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.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

operation upgrade:
part 8

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

Previous articles of this series have explained in simple terms the fundamentals of linear devices in electrical circuits, active devices of several types (diode devices, triode devices, etc.), and a few simple radiotelegraph (CW) transmitters. In this article we will look at a variety of forms that radiotelegraph receivers might take.

A CW transmitter generates a radio frequency (rf) ac, usually amplifies it, controls it in such a way that it will transmit dots and dashes of rf energy (with a key), feeds the rf ac to an antenna, and radiates the rf energy into the atmosphere.

basic detector circuits

What can be done at a receiving point to make a radiated CW signal audible to a listener? Well, first we need a receiving antenna. With an antenna wire up in the air, any rf waves passing across it will induce an rf ac of their frequency into it. But what will make this received signal audible? How about a pair of earphones between antenna and ground, as in **fig. 1a**? No good. The only frequencies we can hear are between about 16 Hz and 20 kHz, but the lowest ham band frequency is 1.8 MHz. So, even with 1.8 MHz ac flowing in the earphones, the earphone's metal diaphragms cannot vibrate that fast, and we couldn't

By **Robert L. Shrader, W6BNB,** 11911 Barnett Valley Road, Sebastopol, California 95472

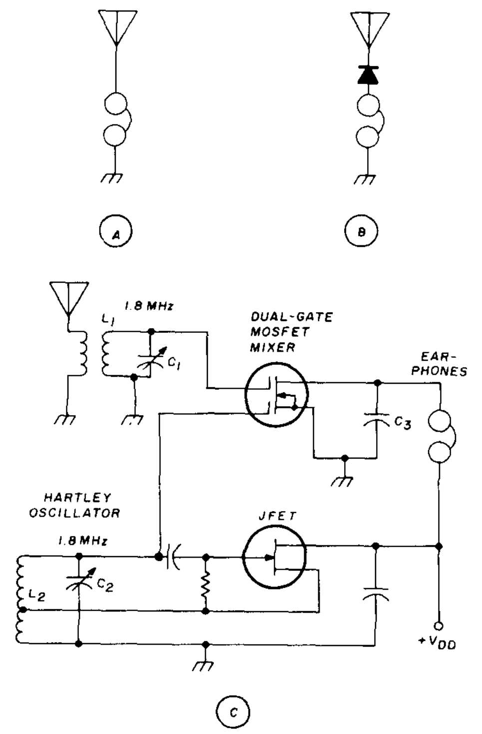

fig. 1A: **Earphones in series between antenna and ground. B: Rectifying detector will not make CW signals readable. C: Heterodyne detector for CW reception.**

hear it if they did. The earphones (or a loudspeaker) will need an ac of a frequency less than 20 kHz or a dc that is varying at a rate of less than 20 kHz for them to produce a sound wave that we can hear.

OK, let's try a diode in series with the earphones and antenna, as in **fig. 1b**. This gives us a rectified ac, or 1,800,000 pulses per second of dc flowing through the phones (assuming a 1.8-MHz signal being received). Can we hear these pulses? No, but this dc should be able to either pull in the earphone diaphragms a little or allow them to swing outward a little, depending on the polarity of the dc developed by the rectification. If the transmitted signal is being keyed, at the receiving point the earphone diaphragms might swing in and stay there until the signal stops, at which time they will swing back out again. We might hear this as weak clicks if the received signal is CW, but few of us could decipher what the clicks were saying. We need something that will produce some kind of a tone during the time the signal is being received, and none when the signal ceases. (This circuit *would* demodulate modulated signals.) Let's try heterodyning, or translating the 1.8 MHz ac down to some audio or audible frequency (af) that we can hear with the circuit shown in **fig. 1c**.

Now we are getting into the nitty gritty of a radio receiver. The antenna circuit consists of the antenna, the primary coil of the rf transformer, and ground. The secondary coil is tuned to the desired radio wave's frequency, 1.8 MHz in our case. When the tuned circuit is resonant to this frequency a maximum value of any received signal of this frequency will be fed to the upper gate of the dual-gate MOSFET mixer. (Both gates will affect the drain current, or I_D, flowing down through the earphones.) Below the mixer is a good old Hartley JFET oscillator that can be tuned across 1.8 MHz. Some of its rf ac is fed to the lower MOSFET gate. What is going to happen now? *Well, if the input signal is 1,800,000 Hz and the Hartley is tuned to 1,801,000 Hz*, then both of these frequencies will be affecting the I_D. As a result, the I_D has the following frequency components in it: 1.8 MHz, 1.801 MHz, 3.601 MHz (sum), and 0.001 MHz, which is 1000 Hz (difference frequency).

What effect will these four frequencies have on the earphones? Since the earphones cannot respond to the three radio frequencies, they can respond only to the 1000 Hz, which is a pleasant af tone for a listener (it should be heard as a pure sine wave tone). Actually C_3 is selected to act as an rf bypass or filter capacitor to prevent the three rf signals from getting to the earphones, but will have almost no effect on the lower audio frequency component. It might have a value between 0.0005 and 0.002 μF. What values might L_1, L_2, C_1, and C_2 have? You can figure this out from the resonant formulas given in Part 2 of this series. Consider the variable capacitors as having 100 pF at maximum, and compute the necessary inductance needed to resonate at the low frequency end of the 1.8-MHz band (1.8 to 2 MHz). (Sure sounds simple. Try it. Go ahead, we dare you!) If you determine this, then how much would the variable capacitor have to be reduced to tune to the 2-MHz bandedge?

Suppose the Hartley circuit is tuned to 1,799,000 Hz instead of 1.801 MHz. What do you think the earphones would respond with now? Since the received signal is still on 1.8 MHz it would beat against 1.799 MHz and produce a 1 kHz signal again. Right? What if the Hartley is tuned to 1.8005 MHz? Does 500 Hz agree with your computations? Again, this is a very pleasant tone to listen to. You will probably always tune your receiver to CW tones ranging from about 400 to 1000 Hz, unless you are trying to get away from QRM (interfering signals). Suppose the Hartley is also tuned to 1.8 MHz. What would you hear now? The answer is nothing, because the two signals are now zero beat. This means the beat difference is zero Hz, which cannot be heard, of course. Actually, as you tune across a CW signal it will first be heard as a high pitched whistle (3 to 10 kHz, depending on the af filters in your receiver). As you continue to tune the tone descends lower and lower until a zero beat is reached. Past zero beat the tone will appear again and increase in frequency as you continue to tune until it is no longer audible. With this simple heterodyne, or beat detector, the tones on both sides of zero beat will be equal in amplitude. You could tune to either side of zero beat and copy a CW signal equally well.

We have used a dual-gate MOSFET as the mixer because it is one of the best, but you could also use the BJT mixer of **fig. 4** of Part 7, or a triode, or a pentode, or even a diode. So there are a lot of possibilities, but we have space to cover only a few of the basic ideas. If you worked the problems given two paragraphs above, did you come up with an L value of about 75 μH? And a reduction of C to about 80 pF? If you did not, how about trying them now?

a TRF receiver

The first really successful sensitive detector for CW signals was a simple triode VT Armstrong oscillator with earphones in the plate circuit. With an antenna coupled to the LC circuit and with the circuit in oscillation, beat tones could be heard in the earphones. However, when it was in oscillation it actually transmitted signals, sometimes for many miles.

Unfortunately, the simple detectors never produce a very loud signal in earphones or in a loudspeaker. What is needed is some amplification. If an rf amplifier is added between the antenna and the detector it does three things. (1) It amplifies any signal to which it is tuned. (2) It adds another tuned circuit which makes the receiver more selective. This means it can select one signal better out of several on nearby frequencies. (3) It prevents oscillations of an oscillating detector from being coupled into the antenna and radiating an unwanted signal.

An rf amplifier allows much weaker signals to be brought up to earphone volume, but the signals are still just at earphone volume. What is needed further is an audio frequency amplifier or two to make the detected signal strong enough to operate a loudspeaker. A block diagram of a possible tuned-radio-frequency (TRF) amplifier receiver is shown in **fig. 2.** If an autodyne (self-heterodyning) detector, such as the oscillating Armstrong, is used, then the local oscillator circuit shown dashed would not be necessary. The first variable resistor indicates an rf volume or gain control to prevent strong received signals from overdriving the detector. The second variable resistor is an af gain control to regulate how much signal is fed to the loudspeaker.

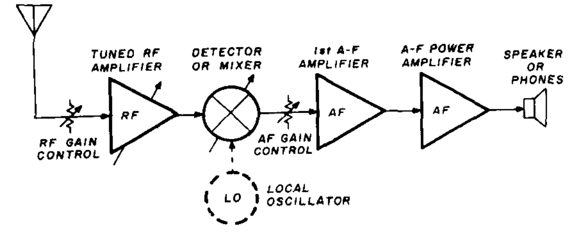

fig. 2. Block diagram of a TRF receiver for CW.

If the TRF is an all-semiconductor receiver, the rf amplifier might be a JFET or a MOSFET. The detector will be a dual-gate mixer or a JFET Armstrong oscillator with some means of controlling oscillation strength, and there will probably be two BJT stages of af amplification. If the TRF is an all VT receiver, the rf amplifier would be a pentode, the detector either a triode Armstrong oscillator circuit, or a pentagrid converter (mixer tube) with a triode or pentode Hartley local oscillator, followed by a triode first rf amplifier and a beam power tetrode as the af PA.

a CW superheterodyne

TRF receivers were the popular Amateur receivers of the early thirties. They are still a fairly good form of receiver for use in the LF, the MF, and in parts of the high-frequency spectrum. If the bands are not too crowded they can be used quite successfully up to at least 7 MHz. Above this they may not be sensitive enough and may be too broad to be very useful. What is needed is a receiver that has the same bandwidth (selectivity) and gain (sensitivity) on all of the Amateur bands. A double-heterodyne or superheterodyne (superhet) system answers these requirements.

A block diagram of a simple CW superheterodyne is shown in **fig. 3.** Can you see that if the 450-kHz i-f amplifier(s), second detector and BFO were left out you would have a TRF receiver? In a superheterodyne, signals from the antenna are amplified by the rf amplifier as in the TRF. But the signal into the first detector or mixer is heterodyned by a local oscillator and translated to a medium (MF), or intermediate frequency (i-f), of 450 kHz in this particular receiver (different frequencies are used as the i-f in different superhets). From here on the circuitry is similar to that of the TRF again. The 450-kHz i-f is fed to a 450-kHz mixer detector so that the second local oscillator, which in this application is called a beat-frequency oscillator (BFO), can produce an audio beat tone on CW signals, which can then be amplified as in the TRF.

The arrows through the high-frequency rf amplifier, the high-frequency mixer, and the high-frequency local oscillator symbols indicate that these three stages must be tuned for optimum operation. The dashes between arrows indicate that the tuning de-

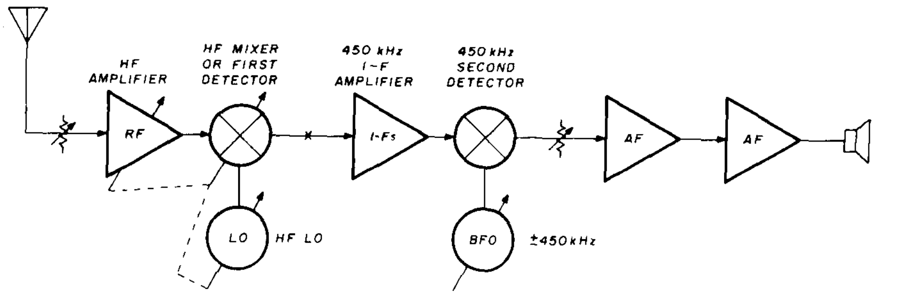

fig. 3. Block diagram of a superheterodyne for CW.

vices are all ganged (tuning capacitors are on a common shaft, for example). The 450-kHz i-f stages and the second detector are all fixed-tuned to 450 kHz and left that way. The beat-frequency oscillator might be tunable from about 447 kHz across 450 kHz to about 453 kHz in many superhets, and may be fixed tuned or switchable in others. The af amplifiers are untuned of course, although a low-pass or bandpass filter may be added before or after the af gain control to limit received signals to a maximum af of perhaps 500 Hz for CW (3 kHz for phone).

The big advantage of the superhet over the TRF is the i-f amplifier(s). Actually, there are usually two or more i-f amplifiers, all tuned to the same frequency, 450 kHz in our case. At 450 kHz the tuned i-f transformers can be engineered to provide a passband (bandwidth) of as little as 10 kHz, perhaps. The more tuned transformers (one in each i-f stage) the steeper the skirts of the passband developed. Since each of the i-f stages is an amplifier, a superhet will have much more gain or sensitivity than is possible with a TRF. Furthermore, the rf and first detector can be quite broad but the relatively narrow bandpass response of all of the i-f transformers sets the selectivity of the receiver to about 10 kHz regardless of which ham band is being received.

If a narrower passband is desired, a crystal bandpass filter may be added between the first detector and the first i-f, at the point marked X. If such a filter has a passband of 500 Hz, that will determine the maximum bandwidth of the receiver. Such a narrow passband is excellent for CW reception. The 10-kHz bandpass might be usable for a-m signals, but is really nearly twice as wide as the recommended 6-kHz limit for Amateur a-m transmissions. For SSB signals a bandwidth of 2.8 kHz is desirable.

If the input signal is translated to a 50-kHz i-f, amplifier bandpass can be decreased from 10 kHz to perhaps 3 kHz. Unfortunately this develops another difficulty called "images." If the received signal is at 7.1 MHz and a 50-kHz i-f strip is used, the local oscillator could be at either 7.15 MHz or at 7.05 MHz. At 7 MHz it is difficult to produce high gain rf amplifiers with 6-dB-down passbands much under 100 kHz. As a result, if the LO is at 7.15 MHz it will beat against the 7.1-MHz signal and produce a 50-kHz i-f as it should. But another Amateur transmitting on 7.05 MHz would also feed through the broad rf amplifier and mixer tuned circuits with only a little attenuation (reduction) and show up in the i-f channel also, be detected, and develop strong output signals in the loudspeaker. So, you would hear two loud signals at the same time. The undesired signal is always twice the i-f, or twice 50 kHz in this case, from the desired signal (7.1 MHz). It is called an image frequency signal, or just an image.

Let's go back to using 450 kHz as the i-f. If the desired station is on 7.1 MHz, then the LO frequency might be 7.1 + 0.45 MHz, or 7.55 MHz. Now, the image signal would be twice 0.45 MHz, or 0.9 MHz across the desired signal, or at 6.65 MHz. If there were a strong signal at 6.65 MHz (not an Amateur signal in this case), it might also be able to squeeze a little of its signal through the rf and mixer tuned circuits and develop a weak image in the i-f strip and in the second detector.

If an i-f strip is developed at 2.5 MHz or higher it will usually place any image frequency so far away (twice 2.5 is 5 MHz) that the front end (rf and mixer) LC circuits of the superhet will prevent almost any image signal from getting into the i-f strip and second detector. However, a 2.5-MHz i-f has a very broad passband, perhaps 30 to 40 kHz. It is possible to use a double conversion superhet, first using a 2.5 MHz i-f strip to eliminate images, then translating this signal down to a 50-kHz i-f strip and second detector to develop a narrow (3-kHz) passband.

Rather than fool around with double conversion and two different i-f strips, modern receivers may use a single 9-MHz i-f strip (which by itself would be very broad), but insert a narrow-band 4- to 8-pole (section) crystal filter just before the first i-f stage. Only signals which are accepted by the crystal filter with its narrow passband can reach the i-f amplifiers and be fed to the second detector, regardless of how broad the i-f passband may be. The high frequency of the i-f prevents images, and the crystal filter ensures narrow bandwidth. By switching in different crystal filters the passband of the receiver can be changed from perhaps 200 Hz for CW, to 2.8 kHz for SSB, to 6 kHz for a-m, to 15 kHz for fm, and so on.

the beat-frequency oscillator

The operation of the BFO of a superheterodyne can determine how well signals will be received. Its duty is to beat against, or heterodyne, signals coming through the i-f strip to the second detector. The graph of **fig. 4** shows a possible 2-kHz passband of a 450-kHz i-f strip of a superhet. Signals translated to exactly 450 kHz will pass through the i-f strip with maximum amplitude. Those 1 kHz to either side will be weaker by 6 dB (half the voltage). Signals 2 kHz from the center of the i-f passband will be very weak. It can be said that the passband response or bandwidth is 2 kHz at 6-dB down, or that the 6-dB passband is 2 kHz wide. At 60 dB down (one thousandth the voltage) it might be 20 kHz wide.

If the BFO is tuned to exactly 450 kHz, any CW signal tuned by the receiver front end to come in on the center frequency of the 450 kHz i-f strip would be at zero beat and nothing would be heard of it except possibly some clicks. If the front end were tuned 1 kHz higher or lower, the incoming signal in the i-f strip would be at either the 449 or the 451 kHz points, and the signal would be heard as a 1-kHz tone, but 6 dB weaker than it could be. To produce the loudest 1-kHz tone from the signal, the BFO should be tuned to 451 (or 449) kHz. Now, as the receiver front end is tuned so that the received i-f signal moves across the i-f strip from 449 to 451 kHz, the audible beat tone would change from a medium strong 2000 Hz signal to a strong 1000 Hz signal, and down to a zero beat. As the front end continues to tune past zero beat, the response of the beat tone frequency rapidly decreases on the other side of zero beat (shown by the rapid drop-off of the curve) and would be many dB weaker than the tones produced when the signal was between 449 and 451 kHz. If the skirts of the i-f filter were steep enough, the beat signals on the high side of 451 kHz might not be heard at all. This is called *single signal reception*. It prevents hearing each CW signal twice when tuning across them. You would hear them twice if the BFO were in the middle of the i-f filter frequency, and also twice with simple regenerative detectors, or with TRF receivers.

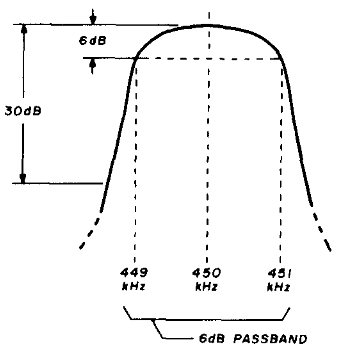

fig. 4. Possible response curve of a 450-kHz i-f strip.

receiver noise

The job of a receiver is to select some desired signal out of the millions of signals passing across its antenna, to amplify and detect just that one signal, and deliver it to a loudspeaker or earphones. Along with this signal there will be both external (picked up by the antenna) and internal (in the receiver) noises. The external noises, from lightning crashes (QRN), power leaks, opening and closing of electrical contacts nearby, and so forth are brought into the receiver by the antenna. If you disconnect the antenna and connect a resistor having an impedance the same as the rated impedance of the receiver input (50 ohms, for example), any noise you hear when you turn up the receiver gain controls must be generated in the receiver, mostly in the first rf amplifier and possibly some from the mixer. These are the most significant noises of a receiver because all other amplifier stages amplify them. Such internal noise is generated by random electron motions in the input stage resistors or in the first and perhaps the second active devices themselves. With an antenna on the receiver the relation of the received signal *power* to the noise *power* of the receiver is called the signal-to-noise ratio, or S/N.

The noise figure (NF) of a receiver is the ratio of the input S/N at the antenna input to the output S/N from the loudspeaker, or $NF = (S_i/N_i)/(S_o/N_o)$. In general, the narrower the bandwidth of a receiver the less noise that will be amplified, and the better the S/N and NF.

On the high-frequency Amateur bands, the external noises brought in by the antenna may completely mask the internal noises developed by the receiver itself, and will determine how weak a signal can be received adequately. On the VHF through microwave bands, there is usually little manmade and external noise and the internal noises generated at the input stages of the receiver determine how weak a signal can be picked up and made to produce readable output signals.

undesirable effects

Under high-gain operation of your receiver, a strong nearby station 10 to perhaps 50 kHz away from the signal to which you are listening may cause desensitization of your receiver. Such signals are accepted by the broad front end and may produce a change in amplifier bias values, resulting in a lower received signal volume. Reduction of the rf gain control, or decoupling the antenna somewhat, will usually prevent or decrease such desensitization.

You may sometime be listening to a CW station on perhaps 7030 kHz. Up band at 7040 and 7048 kHz there are two other strong local stations in two separate CW QSOs with other stations. When they are both on the air at the same time their two signals push through the rf amplifier and into the mixer of your receiver and produce a beat at their difference frequency of 8 kHz down from 7040, or at 7032 kHz, which you hear as an audible tone. (You will also be able to hear them if you tune to about 7056 kHz.) Again, reduction of the rf gain will usually stop this type of interference. Remember, it is the fault of your receiver, not the fault of either of the two stations, which is producing interference for you.

the S-meter

Most Amateur receivers have an S-meter operating off the last i-f stage or the second detector stage to indicate the strength of received signals. The S-units are often calibrated in 6 dB steps (twice the voltage). An S4 signal should be 12 dB weaker (1/4 the input voltage) than an S6 signal. These meters may be fairly accurate on one band but rarely are correct on all of the Amateur bands. They do indicate in relative terms which signals are stronger and which are weaker. S-meters are calibrated in S-units from SØ to S9. An S9 signal would be 6 × 9, or 54 dB above the threshold of the noise generated internally in the receiver. A receiver should have the ability to adequately reproduce a received signal at least 40 to perhaps 50 dB over S9. It is said that such a receiver has a dynamic range of 96 or 106 dB.

Often, manmade noises will register as a steady S2 or S3 signal, making all signals weaker than this unreadable. In a very quiet location signals can often be copied which do not move the S-meter needle at all. The question then is, What kind of a signal report do I give these signals? Theoretically, an SØ should mean no signal strength at all.

Signal reports given by Amateurs are known as RST reports. The R stands for readability, from 1 to 5, with 5 being perfectly readable. The S stands for strength, from Ø to 9, with 9 being very strong. The T stands for tone, from 1 to 9, with 9 being a very pure tone. If there is some ripple in the power supply it may produce some hum modulation and would result in a T8 signal. Greater hum would be a T7. A T6 would be a slightly raspy tone. A T5 would be a very raspy tone, and so on. A 599 report is the best you can give. However, a 599C indicates chirpy keying. A 579 is an easily read relatively strong signal. A 499 indicates either there is interference, fading, or you cannot read the other operator because of poor keying. A 439 indicates most information is being copied but a rather weak signal. A 5Ø9 would have to indicate an extremely weak signal with no noise level, but 100 percent copyable.

You should always consider S-meter reports as approximations. In any case, it is not unusual for a signal to vary or fade up and down by five S-units in a few seconds. You can give either the peak S-meter reading as the report, or an average reading, but tell the other operator which report you are using. Most operators would prefer to hear the peak readings. They look much better in their log books.

FCC test topics

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

- vacuum tube applications and symbols
- quartz crystal applications
- block diagram of the stages of a simple receiver capable of A1 reception
- zero-beating a received signal
- RST signal reporting system

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

- transformer applications and symbols
- frequency translation, mixing
- bandwidth
- decibels

The following Advanced-class FCC test topics are discussed in this article, but should be understood by Extra class license applicants also:

- detectors, mixer stages
- oscillators, applications
- receiver desensitizing
- signal-to-noise ratio
- rf and i-f amplifier stages

For additional information on these subjects you can refer to *Electronic Communication*, or to *Amateur Radio Theory and Practice*, by Robert L. Shrader, W6BNB, McGraw-Hill Book Company, available through Ham Radio's Bookstore.

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Clipperton-L Linear Amplifier: 160-15m w/some MARS; 2KW PEP SSB, 1KW DC CW, RTTY/SSTV; (4) 572B's, 65-150w drive; Size: 14½"W x 6"H x 14½"D; 42 lbs.

GLA-500 VHF Amplifier: 144-150 MHz; 500 Watts Input PEP SSB; SSB 50%; CW, FM-35%; 115-120 or 230-240 VAC 50/60 Hz.; 1-4CX250B Metal/Ceramic Tetrode; 11"W x 5½"H x 11"D; 31 lbs.

Clipperton T Antenna Tuner: 2 KW Tuner; 1.8-30 MHz Continuous; Tunes coax, wires or balanced line; 14¾"W x 6"H x 14½"D; 22 lbs.

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New channels may be added through the use of diode arrays

a digital approach to odd splits for the ICOM IC-2A(T)

The IC-2A(T) is a basic handheld 2-meter transceiver. Its features include both simplex and duplex modes with the standard ± 600 kHz split, and in the 2AT a Touch Tone™ pad is included. Simplicity adds to ruggedness, and the unit takes care of 99 percent of the needs of most people.

But what about the need in certain locations to operate in a duplex mode that is neither ± 600 kHz? How about those that have a need to operate MARS or CAP repeaters?

There are three basic requirements that must be met when modifying any handheld. First, whatever is added must be able to fit into the few crevices left when the unit is buttoned up without anything being smashed or bent grotesquely. Therefore mod "X" must be as small as possible.

Secondly, the modification must do only what it's supposed to do and no more. It must not interfere with the normal operation of the rig in any way not intended. This also means it should not unnecessarily restrict access for maintenance. Some apparently believe that once their mod is installed and working, the unit will never break.

Last, and most important, the mod must be simple. There is not much room to work in, and the risk of construction errors must be minimized.

This discussion covers the details involving the ICOM unit; however, the principle is easily adapted to other types if they use static BCD frequency entry.

theory of operation

A detailed block diagram of the PLL is shown in **fig. 1**. Controlling the frequency of the VCO is the divide-by-N chip IC1. Its inputs are generated by simple BCD thumbwheel switches, and the design of the PLL allows the value shown on the switches to equal the received frequency in megahertz. Of special interest is the switching arrangement for the PLL local oscillator. During receive the output of one crystal is used to mix with the VCO output, and the resulting intermediate frequency is fed to IC1. The result is that the VCO locks onto the receiver's first injection frequency divided by two. During transmit another crystal is switched to take the place of the first. This causes the PLL i-f to change frequency and the phase detector, upon detecting the change, sends an error voltage to the VCO, causing it to make up the difference caused by changing crystals. Shifting the VCO in this way allows the PLL to control the carrier frequency directly.

Changing crystals also offers a handy way to de-

By Jim Campton, N7AAD, 3001 South 288th, No. 182, Federal Way, Washington 98003

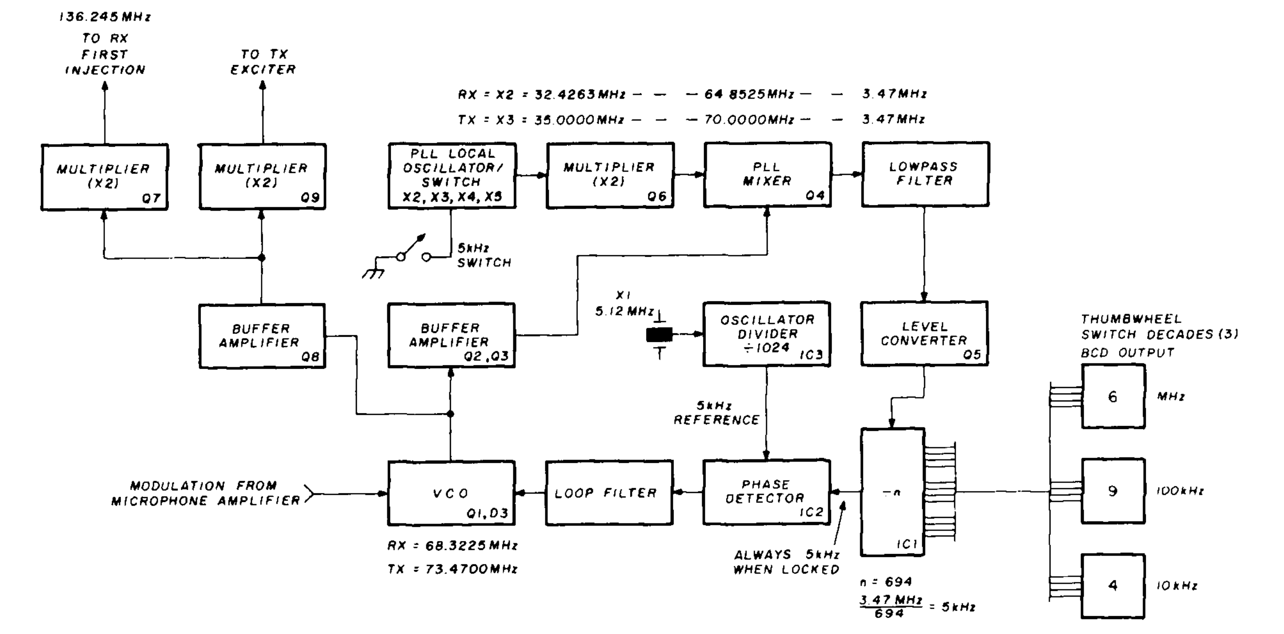

fig. 1. Block diagram of the PLL circuitry, which controls transmit and receive frequencies in the ICOM IC-2A.

rive the standard offsets from fixed thumbwheel switches without the added expense of CMOS adder circuits, since only two offsets are necessary. However, if an extra odd offset or two are needed, adding more crystals with their associated components is not the answer. Aside from being impractical, it is unnecessary since all that is required is to change the inputs of IC1 appropriately each time you want the VCO to change frequency.

Practically speaking, if the separation between a repeater's input and output frequencies is not 600 kHz, then chances are pretty high that the pair is not related to any other pair, making it unique. Thus you can wire the transmit frequency into the transceiver with a diode array leaving only the problem of switching.

IC1 has internal pulldown resistors on its inputs leaving any unconnected at a low or ground potential. If all the lines from the various arrays are OR-tied to each input, as shown in **fig. 2**, the transmit 5 volts and receive 5 volts can be used for switching any array at any time. (The thumbwheel switches can be treated as just another array.)

The number of new channels that can be added is limited by the size of the diodes, the skill of the technician and the means of switching available. I used an 8-pin dual inline package having four SPST switches. These can be used for other purposes besides switching diode arrays. Control of subaudible tone frequencies is just one possibility.

One of the switches will have to be used to control the 5-kHz digit on transmit, leaving the original switch to control 5 kHz in receive if the transmit and receive frequencies differ in the kilohertz digit, since the smallest step the PLL can synthesize is 10 kHz

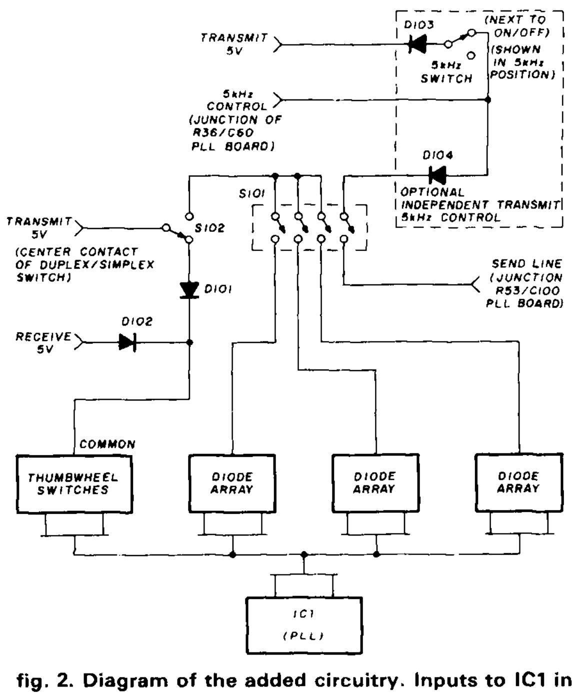

fig. 2. Diagram of the added circuitry. Inputs to IC1 in the IC-2A phase-locked loop are changed by switching in diode arrays to provide odd offset frequencies.

without a change in the PLL local-oscillator frequency.

Fig. 3 shows the chart to convert the desired frequency into binary-coded decimal and a sketch representing the pins of IC1.

construction

Construction can be simple. However, adding more than one channel will require installation of an additional set of swtiches, which means putting a hole in the case. Such a project should be left to those who have, at minimum, a set of hand tools, clamps and a decent drill press. I used a miniature milling machine, an item to which not everybody has access; but with a steady drill press and a carefully made jig, holes of complex shape can be easily machined to close tolerances if the material to be used is soft.

Disassemble the transceiver by removing the four screws holding the battery plate using a No. 1 Phillips-head screwdriver. Then, using a No. 0 Phillips, remove the screws holding the case halves together. Remove the rear half and set it aside. Use caution when pulling the front since the microphone and speaker wires are attached and if the Touch Tone ™ pad is installed, further restriction is caused by the flex cable plugged into the main board. Carefully remove the plug and lay the front case half beside the chassis. Remove the two screws holding the chassis together with a No. 1 Phillips and unfold the chassis.

Locate IC1 on the PLL board. (The PLL board is the one without the big hole.) Desolder and carefully remove the flex board from its position over IC1. Remove the now unconnected pins from around IC1, one at a time, by clamping the free end and heating the foil side joint and pulling it through gently from the component side. After removal of the pins, be sure the plated-through holes are free of solder and debris.

	D_X	C_X	B_X	A_X
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

1 = DIODE
0 = NO DIODE

(A)

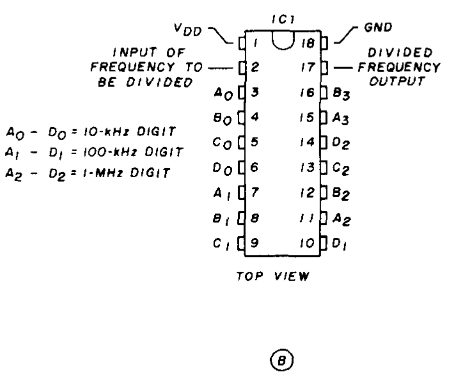

fig. 3. A: Matrix for converting decimal to BCD format. Sketch in B shows the function of the pins on IC1.

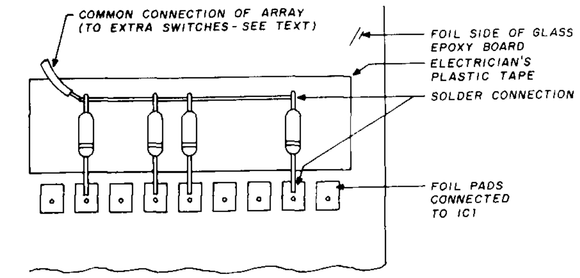

fig. 4. Example showing a diode array connected to IC1. The finished array is covered with tape, and the next array is installed over the first.

Next insert silicon diodes, such as 1N4148s, cathode-side down into the holes left by the pins. Solder the diodes as close to the board as possible. Next, thread the anode leads into the flex cable holes that will be over each diode when the cable is properly reinstalled. Each diode takes the place of one of the removed pins. Push the cable end firmly over IC1 and solder the leads after making sure that none are crossed. Bridge both gaps on the cable traces with solder.

Locate the thumbwheel frequency selector switches at the other end of the flex cable. The flex cable is reinforced by a thin phenolic board that is used as a stiff backing material for the soldered connections between the foil traces and the switch terminals. To this board is attached a green wire and either a brown or blue jumper. Cut or desolder the wire and remove it leaving nothing loose to accidentally short out.

If power were applied now the rig would operate normally in a range of 141.000 MHz to 149.995 MHz.

The thumbwheel switches have been wired to allow several diode arrays to be attached directly to the input leads of IC1 as shown in **fig. 4. Fig. 5** shows how to connect the arrays to the switches.

If more than one array has been installed or if the kilohertz digit must change during transmit, a hole must be cut in the rear case half to accommodate the switch package as well as the smaller hole necessary for the SPDT switch. **Fig. 6** outlines a method of cutting rectangular holes with a drill press. Cut a plywood block a little larger than the case and attach the plastic cover to the wood so that the drill bit in the press is perpendicular to the surface to be drilled when the block is resting on the smooth side of a larger piece of plywood that is attached to the press's table. Next nail a fence around the point where the bit's long axis intersects the plywood so that the fence's internal dimensions are equal to the dimensions of the small block, plus the dimensions of the DIP, minus the diameter of the drill bit to be used. A

1/16-inch (2-mm) drill bit is about as small as can be used without being too delicate. A smaller-diameter end mill is preferred. Only after lining up the table and practicing on scrap plastic to test the fit should an attempt be made to cut the cover.

Make the hole for S102 by using a high-speed drill and carving out a hole identical to the three already there. Using a sharp hobby knife, cut away a half circle in the top of the escutcheon plate to allow free movement of the switch when the case is installed.

One last detail is the antistatic modification to prevent accidental static discharge from damaging the rig. Typically the shortest path for static is through the serial-number plate and through the ungrounded

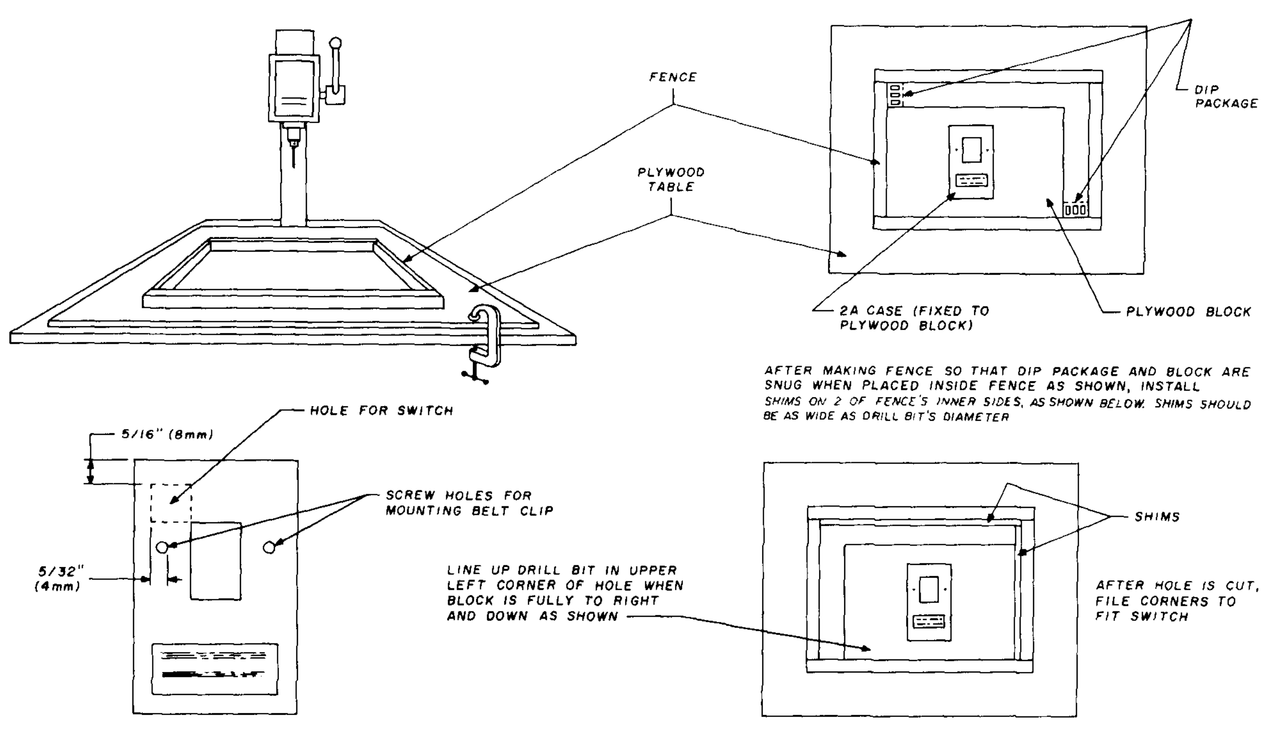

fig. 5. Illustrating the physical location of switches and arrays in the IC-2A.

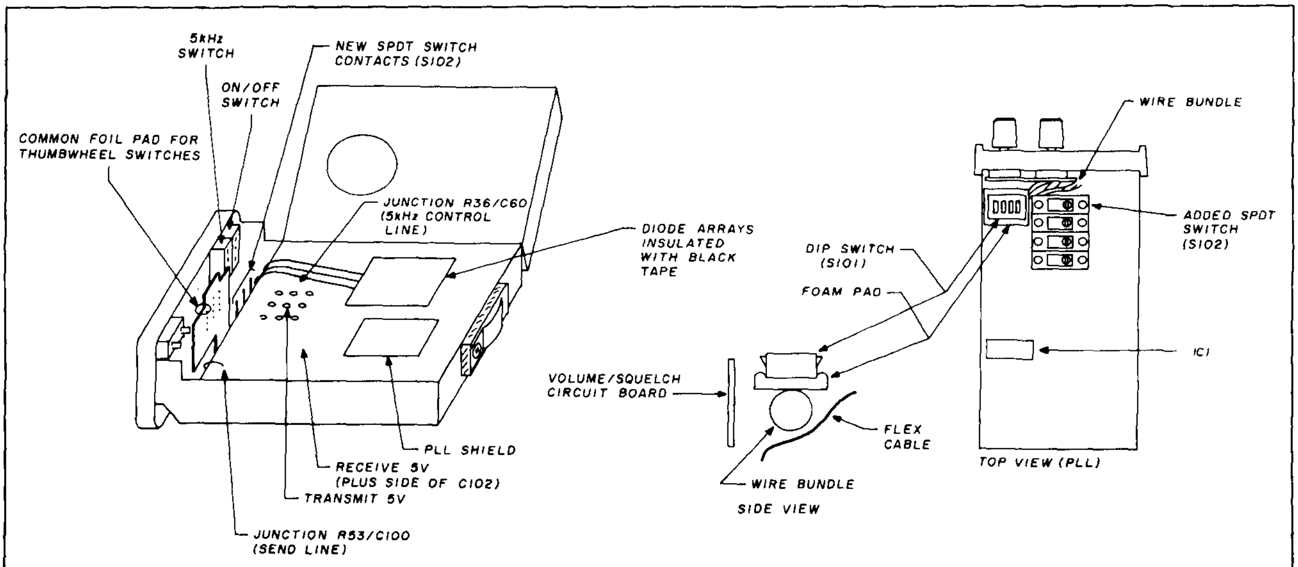

fig. 6. Equipment setup for cutting holes into the transceiver case to accommodate switches and diode arrays.

case of X3 where it disperses through the surrounding components, usually IC3 and/or Q8. The solution is to ground the case of X3 to either of the two transformer cans next to it by means of a solder bridge.

checkout and operation

It would be worthwhile to test the rig and give it a last visual inspection before reassembly. Check wires for clearance by gently closing the chassis and looking for obstructions. Connect a wattmeter, dummy load and frequency counter to the BNC connector on the top of the 2A. Connect the ground of the power supply to the braid of the coax and clip the positive lead to the battery terminal on the bottom. The supply voltage can be 6 to 11 volts with 8.4 volts being nominal. An ammeter may be used to learn much about what is happening inside but is not necessary.

Turn on the unit and check to see that it operates normally and then check to see if the modification performs as expected. If a fault is detected, check the wiring for shorts and the diodes for leakiness. Above all, use caution and think before acting. The 2A is no place to become reckless.

If operation is satisfactory, close the chassis and inspect closely for pinched wires before tightening the two chassis screws. Plug in the Touch Tone™ pad if present and lower the front half into place while making sure the speaker and microphone wires are not binding. Be sure the chassis PTT arm is not caught on a ledge and can touch the microswitch when depressed.

Put all the SPDT switches in their mechanical mid positions. Slide the plastic PTT lever into the grooves of the rear case half and fit it to the rig. When correctly installed, all the seams are together and the PTT lever operates correctly. When this state occurs, keep the case squeezed firmly together and install the battery plate on the bottom. Be sure to tighten the four screws firmly, but do not over tighten.

After installing the two side screws, give the unit one more checkout on the dummy load. Make sure all switches are fully to one side or the other.

conclusion

While spending a minimum of time and money you can enhance the value of your rig by adding up to four permanent memories that do not require any holding current. Furthermore, if only one or two channels are desired, the remaining two SPST switches can be used to control the frequency of a subaudible tone encoder. The possible combinations are limited only by the needs and the imagination of the individual. Successfully enhancing your rig sets you a step closer to the goal of perfect operation.

ham radio

More Details? CHECK—OFF Page 92

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the ham notebook

By feeding the $\overline{\text{1-Hz}}$ input to the other four-input NAND gate (labeled IC6B) instead of the 1-Hz input, the reset pulse can be generated on the next 2-Hz pulse, well in advance of the next gate-enable pulse.

Note that, in my design, the latch and reset pulses are negative instead of positive-going. If desired, a 4082 dual four-input AND gate can be used instead of the 4012 to produce positive latch and reset pulses.

some advice

Don't use the 4017 or 4018 in place of the 4518, as they will not produce the proper duty cycle ratio for the 2-Hz waveform. Also, the 74C107 dual J-K flip-flop cannot be substituted for the 4027, since it isn't a positive edge-triggered device.

reference

1. R.S. Naslund, W9LL, "Counter Control Pulses," *ham notebook, ham radio*, April, 1980, page 70.

David H. Bevel

CMOS timing circuit for frequency counters

This frequency-counter timing circuit uses CMOS ICs. It was inspired by a similar circuit using TTL ICs that appeared in an earlier issue of *ham radio*.[1]

When the article in reference 1 appeared, I was designing a frequency counter and I needed just such a circuit. However, the TTL circuit was of little use to me, so I created a CMOS version to meet my requirements. I thought that others might be interested in a CMOS version of this timing circuit, so here it is.

the circuit

My CMOS version is shown in **fig. 1**. Pulses of 10 Hz, which in my counter are derived from a LM5369 and a 4017 CMOS counter, are divided by six and enter one-half of a 4518 dual synchronous divide-by-ten counter. The 4518 divides by five by using the 1 and 4 binary-coded weighted outputs to provide a reset pulse through a 4011 two-input NAND gate. This action produces the 2-Hz output and performs the equivalent function of the 7490 divide-by-five counter.[1]

The divide-by-two portion of the 7490 is accomplished by a 4027 J-K flip-flop, IC5, which divides the 2-Hz output to 1 Hz. The other half of IC5 divides the 1-Hz signal to 0.5 Hz. The output of pin 15 of IC5B is used for the gate pulse.

operation

At this point my circuit differs in operation from Mr. Naslund's. Instead of inverting the 2-Hz pulse to generate the latch and reset pulses, the $\overline{\text{1-Hz}}$ and 1-Hz pulses are used for this purpose. By following the timing diagram, **fig. 2**, you can see that the latch pulse appears only when inputs A, B, C, and $\overline{D}$ are high at IC6A, and that this action occurs only at the end of the gate pulse.

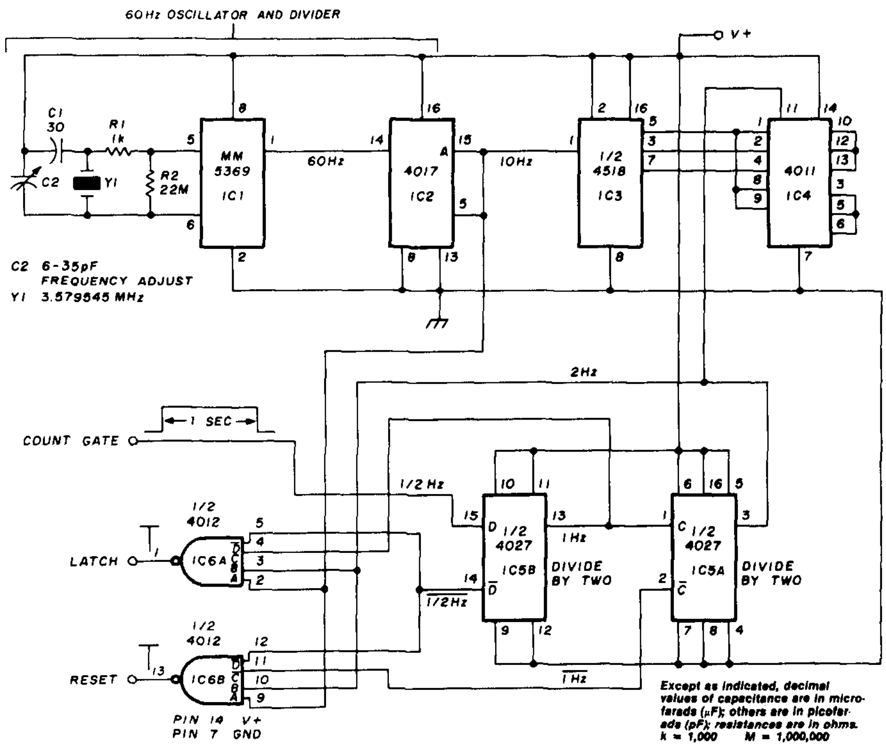
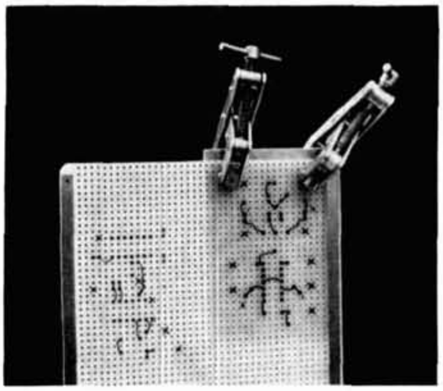


fig. 1. CMOS frequency-counter timing circuit inspired by a previous article in *ham radio*[1] using TTL devices.

printed circuit layout and drilling template

Neatness is not one of my natural abilities. As a result, some of my printed circuit board layouts have resembled my junkbox. Rather than give up, or spend hours laying out draftsman-quality boards, I devised the following fast, cheap, and neat method to do both the layout and drilling work. The wiring layout is made using a felt-tip marking pen on standard perforated board having holes on 0.1-inch centers (that's 2.5 mm for you metric fanatics). The orderly array of holes almost forces a neat appearance and matches the pin pattern of dual in-line package integrated circuits.



Perf board is used as a template for drilling PC boards.

The board is then clamped to the copperclad printed-circuit board as shown in the photograph. Once clamped, it is easy to drill through the circuit board using the perforated holes as guides. And the perforated board can be used to drill several circuits one at a time. I have not experienced any noticeable wearing on the perforated board from repeated use. In fact, after the circuit board or boards are drilled — and if I do not expect to make any more copies — I can merely erase the circuit layout from the perforated guide board and it is ready for use with another circuit. Making a photocopy of the template before erasing is an easy way to record the circuit. After the printed circuit board is drilled, I apply the resist pattern with a resist pen and etch the board with ferric chloride.

John M. Franke, WA4WDL

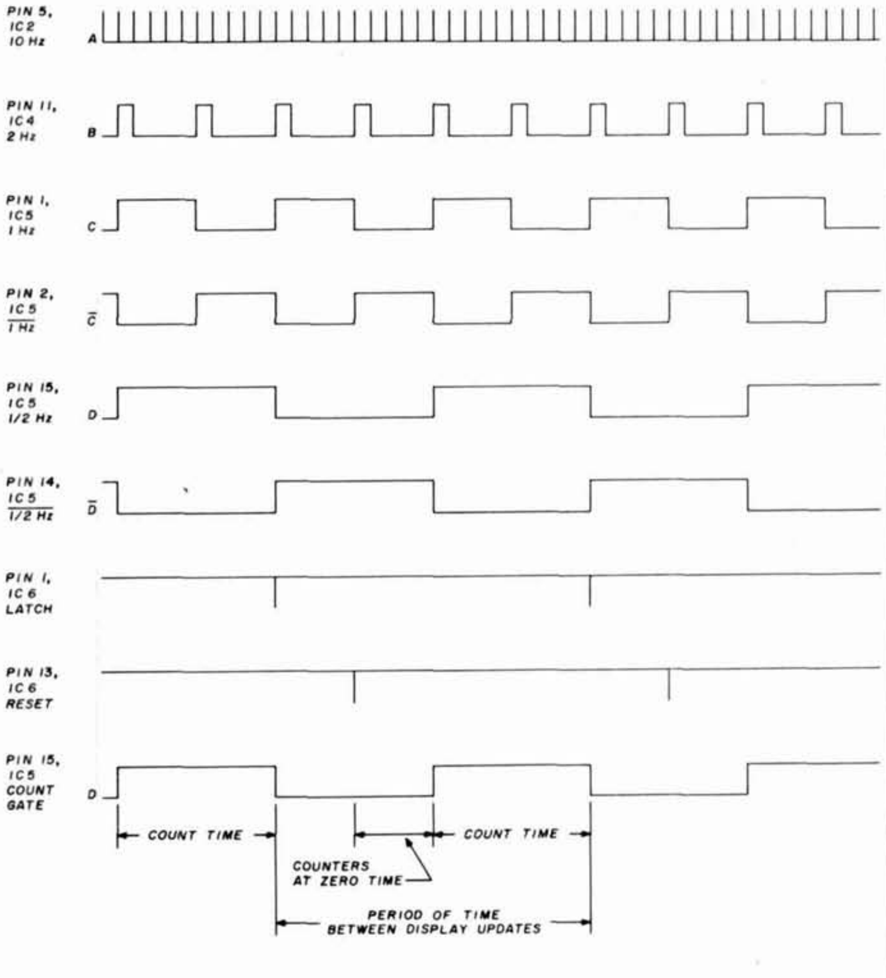


fig. 2. Timing diagram for the CMOS timing circuit.

flea market

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QSL ECONOMY: 1000 for $13. SASE for samples. W4TG, Box F, Gray, GA 31032.

QSLs — ALL NEW! Send for FREE samples. WA8NWG, 826 E. Bennett, Mt. Pleasant, MI 48858.

QSLS'S: NO STOCK DESIGNS! Your art or ours; photos, originals. 50¢ for samples & details (refundable). Certified Communications, 4138 So. Ferris, Fremont, Michigan 49412.

REPEATER — Micro Control Corp. 6502 Based Microprocessor controlled repeater with all options. 1 year old, mint condition. See review in July 1981 73 Magazine. Original cost $2100, sell $1500. (firm). Call 201-486-3849 evenings only. WA2ZDN.

MOBILE OPERATORS: Anteck's Mobile Antennas cover 3.2 to 30 MHz inclusive, with no coil changing. 50 Ohms input. Two models, the MT-1 MANUAL, MT-1RT REMOTE-TUNED from the operators position. Uses two Hyd. Pumps and Motors. MT-1 $129.95, MT-1RT $240.00 plus UPS postage. Check your local dealer or write for Dealer List and Brochure. ANTECK, INC., Route One, Box 415, Hansen, ID 83334. 208-423-4100.

SELL: Yaesu FT107M, DMS, PS107, CW filter, FC107, SP107P, YM-38. Butternut HF5V-III vertical. M&M Electronics MSB-1 audio filter. Charles (401) 722-7323.

WANTED: Micor and Mstr II Base Stations 406-420 and 450-470 MHz. Also 2 and 6 GHz solid state microwave equipment. AK7B, 4 Ajax Place, Berkeley, CA 94708.

TELEGRAPH keys wanted. Dick Randall, 1263 Lakehurst, Livermore, CA 94550.

AMP-LETTER: Devoted to designing, building, and operating Amateur Radio Amplifiers. Sample $2.00. AMP-LETTER, RR2 Box 39A, Thompsonville, IL 62890.

WANTED: Manuals for Clegg 22'er and Heath GR-91. Will pay copy charge and postage. Michael Hood, WD8CDD, 849 Dickinson S.E., Grand Rapids, MI 49507.

VHF COMMUNICATIONS MAGAZINE: A quarterly radio magazine, catering to VHF-UHF-SHF technology. Published in spring, summer, autumn, and winter. Subscription — $20 per year. Make check payable to: Selecto Inc., 372 Bel Marin Keys, Novato, CA 94947.

MOTOROLA — Wanted Circuit diagram and service manual for a Motorola high band transceiver, model U4300T-3100T, original or copy. Will pay reasonable costs. Michael Wachur, KA1YY, 243 Great Hill Rd., Ridgefield, CT 06877. (203) 438-7076.

TUBES, TUBES wanted for cash or trade. 304TL, 4CX1000A, 4PR60C, 7F7, 7N7, 53, 6L6M. Any high power or special purpose tubes of Eimac/Varian. DCO, 10 Schuyler Avenue, No. Arlington, NJ 07032. (800) 526-1270.

INTERFACE the TRS-80 Model III to the real world using the I/O port provided. Interface lights, bells, timers, relays, etc. Complete schematic with software examples. Send $10 to Ellcor Electric, West Union, IL 62477.

WANTED: Hammerlund HQ145. Call Arnie (212) 925-6048.

(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, PO Box 1405, 2503 G.E. Rd., Bloomington, IL 61701. (309) 663-2141.

"NEW" Kt5B Multi-band Dipole 80-10 (WARC), Mini-8 Coax $17.25/100', 450 Ohm open wire $14.75/100'. Details — Kilo-Tec, P.O. Box 1001, Oak View, CA 93022.

WANTED: Information on the "Gonset 2m sidewinder" Model 900A. Anyone with parts for this unit or where they can be had. Would be willing to purchase a non-opts unit for parts.

CONNECTICUT'S Ham Store — Rogus Electronics, 250 Meriden-Waterbury Turnpike, (Rt. 66) Southington. (203) 621-2252.

COLLECTOR GRADE laboratory instruments for sale: Rubicon, Leeds, Weston, G.R. Prices are tiny fraction of orig. cost, for disposal. Send SASE for detailed 6-pg. list. Also contains much modern equipment, Tektronix, H-P, G.R., parts, and more. Joseph Cohen, 200 Woodside, Winthrop, MA 02152.

WANTED: Surplus 1-3 kW HF transmitter type FRT-15, Collins TDH or equivalent, or higher power up to 20kW SSB not necessary. P.J. Plishner, 2 Lake Ave. Ext., Danbury, CT 06810. WA1LDU.

SOLA 3000W constant voltage ½% line regulator. Sinewave output. Cost $1385. Exc. cond. Sell for $385. F.O.B. J. Cohen, 200 Woodside, Winthrop, MA 02152.

RTTY JOURNAL-EXCLUSIVELY AMATEUR RADIOTELE-

TYPE, one year subscription $7.00. Beginners RTTY Handbook $5.00, RTTY Index $1.50. P.O. Box RY, Cardiff, CA 92007.

WANTED MILITARY SURPLUS RADIOS. *We need* Wilcox 807A or RT857/ARC-134, ARC-94, ARC-102, RT-712/ARC-105, ARC-114, ARC-115, RT-823/ARC-131 or FM622, ARC-164, RT-859/APX-72, 618T, RT-743/ARC-51, Antenna Couplers Collins 490T, CU-1658A, CU-1669A. Top dollar paid or trade for new amateur gear. Write or phone Bill Slep, 704-524-7519, Slep Electronics Company, Hwy. 441, Otto, N.C. 28763.

CUSTOM EMBROIDERED EMBLEMS — Your design, low minimum. Informational booklet. Emblems, Dept 65, Littleton, New Hampshire 03561. (603) 444-3423.

READERS wanting information about the Tesla Coil Builders Association SASE to TCBA, RD 3, Box 181, Glens Falls, NY 12801.

KNOW FIRST! Ham fanatics, you need The Pink Sheets — *twice-monthly award-winning Hot Insider Newsletter!* Ten pages, acclaimed best! Confidential facts, ideas, insights, news, technology, predictions, alerts! Quoted coast-to-coast! We print what you don't get elsewhere! $18.00 annually w/money back guarantee! Free sample — SASE (two stamps) W5YI, Box #10101-H, Dallas, TX 75207.

5VDC runs subassembly, decodes modulated/unmodulated CW. Both serial/parallel ASCII. Furnishes four control signals. $169. Telecraft Laboratories, Box 1185, E. Dennis, Mass. 02641.

OUR KEYERS turn difficult DX into logged contacts. SASE for information. Webco, Box 740211, Houston, Texas 77274.

MILITARY FM RADIOS and many accessories available. *For free catalog send SASE to H. Ancerys Communications*, PO Box 614, Antioch, CA 94509.

ICOM/KENWOOD owners. We have a newsletter for you. SASE please Users International Radio Club, 364H Kilpatrick Ave., Port St. Lucie, FL 33452.

KENWOOD TS180S complete w/Digital Memory system, CW and dual SSB filters, operating and service manuals, excellent. $600 or swap for Ten-Tec rig; Sony ICF-2001 digital AM/FM/SW scanning portable, $250. WA7ZYQ, 208-245-2070.

MANUALS for most ham gear made 1937/1970. Send $1.00 for 18 page "Manual List", postpaid. HI-MANUALS, Box R802, Council Bluffs, Iowa 51502.

BUGBOOK I: (Logic and memory experiments) original *edition for collectors, personalized autograph by author* Dave Larsen, WB4HYJ $9.95 pp. Dave Larsen, 844 Hutcheson Dr., Blacksburg, VA 24060.

DON'T GET STRANDED! Battery Watchdog's alarm informs you of excess power drain. $19.95. J.F. Ratcliff, *3600 Meadow N., Renton, WA 98056. SASE brochure.*

WANTED: Sinclair Black Watch. Complete, or as kit. Need not be working. Write with condition and price wanted to: C. Sarver, 256 West 88th Street, New York, NY 10024.

WANTED: Early Hallicrafter "Skyriders" and "Super Skyriders" with silver panels; also "Skyrider Commercial", early transmitters such as HT-1, HT-3, HT-19, and other Hallicrafter gear, parts, accessories, manuals. Chuck Dachis, WD5EOG, The Hallicrafter Collector, 4500 Rus*sell Drive, Austin, Texas 78745.*

POLICE-FIRE-AIRCRAFT SCANNERS. Bearcat, Regency, BC-100 $298.99. Frequency Directories. Shortwave receivers. Sony, Kenwood, Yaesu, Panasonic. True discount prices and free UPS shipping in the continental U.S. Write: *Galaxy Electronics, Box 1202, Akron, Ohio* 44309.

YAESU OWNERS: Join your International Fox-Tango Club, now in its eleventh year. Calendar year dues still only $8 US, $9 Canada, $12 airmail elsewhere. Don't miss out, get 1982 *top-rated FT Newsletters packed with mod*ifications monthly, catalog of past modifications, free advertisements, technical consultation, FT net (Saturdays, 1700Z, 14.325 MHz), more. Go Fox-Tango! To join, send dues to FT Club, Box 15944, W. Palm Beach, FL 33406.

SATELLITE TV Low noise amplifier! Build for under $100. Satisfaction guaranteed. Detailed, easy to follow fourteen page instruction manual $7.00. XANDI, Box 25647, Dept. 23, Tempe, AZ 85282.

HAM RADIO REPAIR, experienced, reasonable, commercial licensed. Robert Hall Electronics, P.O. Box 8363, San Francisco, CA 94128. W6BSH, (408) 292-6000.

FOR SALE: A complete Micor mobile radio, 25-50 MHz, with Systems 90 electronic siren and public address system. All equipment new, never installed. Comes with manuals, cables, covert antenna, 100 watt external speaker. Best offer. Write: Dean, P.O. Box 3403, APO New York, NY 09009.

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.

HAM-AD-FEST™ — Next 6 issues, $2.00. WA4OSR, Box 973, Mobile, AL 36601.

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.

SAFETY BELTS. $35.00 and up. Free information. Avatar Co., (W9JVF) 1147 - (H) N. Emerson, Indianapolis, IN 46219.

CONTESTERS: Package of programs designed for the ARRL DX, CQWW, CQWPX and IARU Radio Sport Contests produces scored, duped log, dupe sheet, QSLs and many valuable operator statistics. TRS-80 Model 1, 48k, 1 or more discs, MX-80 printer required. $69.95 plus tax non-refundable. Sample printout with SASE. P. Chamalian, W1RM, P.O. Box 1188, Burlington, CT 06013.

WANTED: New or used MS and coaxial connectors, synchros, tubes, components, military surplus equipment. Bill Williams, PO #7057, Norfolk, VA 23509.

VERY in-ter-est-ing! Next 5 issues $2. Ham Trader "Yellow Sheets", POB356, Wheaton, IL 60187.

CB TO 10 METER PROFESSIONALS: Your rig or buy ours — AM/SSB/CW. Certified Communications, 4138 So. Ferris, Fremont, Michigan 49412; (616) 924-4561.

AFC SEMI-KITS! Stop VFO drift. See June 1979 HR. $55.00 plus $3.00 UPS. Mical Devices, P.O. Box 343, Vista, CA 92083.

HAMS FOR CHRIST — Reach other Hams with a Gospel Tract sure to please. Clyde Stanfield, WA6HEG, 1570 N. Albright, Upland, CA 91786.

PURPLE HEART VETERANS: Organizing national Amateur Radio Chapter and Net to be affiliated with Military Order of the Purple Heart, Inc. For information and applications contact Clem Harris, KC5MM (ex WB5VDL), 6110 Pecan Trail Dr., San Antonio, TX 78249. (512) 699-1420.

BUY-SELL-TRADE. Send $1.00 for catalog. Give name, address, and call letters. Complete stock of major brands new and reconditioned amateur radio equipment. Call for best deals. We buy Collins, Drake, Swan, etc. Associated Radio, 8012 Conser, Overland Park, KS 66204. (913) 381-5900.

Coming Events
ACTIVITIES
"Places to go..."

ARIZONA: The Amateur Radio Council of Arizona will hold its 32nd annual Hamfest, July 30, 31, August 1, Fort Tuthill Fairgrounds, Flagstaff. Prizes, XYL activities, swapfest, transmitter hunt, speakers, forums, awards, entertainment on Friday and Saturday nights. Talk in on 147.870/147.270 portable repeater. Overnight camping available. For information: Wm. Oliver Grieve, W7WGW, 4301 N. 31st Avenue, Phoenix, AZ 85017 or call (602) 246-0200.

COLORADO: The Ski Country Amateur Radio Club's first annual Swapfest, July 24, 9 AM to 5 PM, Colorado Mountain College Building, 1402 Blake Avenue, Glenwood Springs. Admission $3.00. Tables $5.00. Flea market, commercial exhibitors, door prizes and refreshments. Talk in on 146.07/.67. For information: Frank WA0BBI, PO Box 280, El Jebel, CO 81628.

DELAWARE: The seventh annual New Delmarva Hamfest, Sunday, August 15, Gloryland Park, Bear. (5 miles south of Wilmington). Admission: $2.25 advance, $2.75 *gate. Tailgating $3.50. Some tables available or* bring your own. Refreshments available. First prize: Atari® Home Video Game system. Many other prizes. Talk in on 52 and 13/53. For info and a map SASE to Stephen Momot, K3HBP, 14 Balsam Rd., Wilmington, DE 19804. Make checks payable to Delmarva Hamfest.

FLORIDA: The Greater Jacksonville Hamfest Association's ninth annual Hamfest and ARRL Convention, August 7 and 8, Orange Park Kennel Club. FCC exams Friday, August 6 at Hamfest site. Apply to Atlanta FCC office ASAP. Hotel information: Jim Canfield, KD4CG, 996 *Dostie Cir., Orange Park, FL 32073. Advance registration* $3.50 from Robert J. Cutting, W2KGI, 1249 Cape Charles Avenue, Atlantic Beach, FL 32233. Door registration $4.00. Swap tables $12 per table both days through Andy Burton, NX4G, 5101 Younis Rd., Jacksonville, FL 32218. Talk in W4IZ on 146.16/.76 and 146.077/.67.

More Details? CHECK—OFF Page 92

ILLINOIS: The Fox River Radio League again hosts the Illinois State ARRL Convention as part of its annual Hamfest at the Kane County Fairgrounds, St. Charles, Illinois, August 22. Commercial exhibits, flea market, demonstrations, contests, forums, and hot food. Exhibitors, dealers, and vendors contact: G.R. Isely, WD9GIG, 736 Fellows Street, St. Charles, IL 60174. Tickets $2.00 advance, $3.00 at gate. For advance tickets send SASE: J. Dubeck, KA9HQY, 1312 Bluebell Lane, Batavia, IL 60510.

INDIANA: The LaPorte County Summer Hamfest, Sunday, July 18, County Fairgrounds, LaPorte. Good food, cold drinks and indoor selling area. Information and reservations: PO Box 30, LaPorte, IN 46350.

MARYLAND: The Baltimore Radio Amateur Television Society's BRATS Maryland Hamfest, Sunday, July 25, Howard County Fairgrounds, about 15 miles west of Baltimore. Indoor tables with a/c power $15 each; without a/c $10 each. Indoor tailgating $5 per space, outdoor $3 per space. Overnight RV hookups available. For information and reservations: BRATS, PO Box 5915, Baltimore, MD 21208.

MICHIGAN: The Black River Amateur Radio Club's 29th annual Southwestern Michigan VHF Family Picnic, Sunday, August 1, West Side County Park near Glenn. Registration only $1.00. Flea market space available. Pack your lunch and beach gear. For information: Ed Alderman, KI8Z, RR #2, Box 44, Lawrence, MI 49064.

MICHIGAN: The Amateur Radio Public Service Association of St. Joseph County will hold its 4th annual Swap and Shop, July 25, St. Joseph County Fairgrounds, Centreville. Doors open 8 AM. Tickets $2.00 advance, $3.00 gate. Indoor tables $2.00. Free trunk sales. Camping available, Saturday night only, $6.00. Talk in on 146.52. For information: Dennis Cutler, N8DDU, 3051 Z Avenue, Vickesburg, MI 49097.

MINNESOTA: Range Wide Hamfest, July 18, 10 AM to 4 PM, Gunn Park, 6 miles north of Grand Rapids. Prizes. Admission and tables free. Camping available. Talk in on 52 and 146.28-88. For information: Bob, WDØAAF, 736 Crystal Springs Road, Grand Rapids, MN 55744. (218) 326-2268 evenings.

MISSOURI: The Zero Beaters Amateur Radio Club's Hamfest, Missouri's oldster, Sunday, July 18, Washington Mo. Fairgrounds. Call in on Washington repeater 147.84/24. For information: Rich Noelke, Rt. 3, 10 Richard Dr., Washington, MO 63090.

MISSOURI: The St. Charles Amateur Radio Club's Hamfest '82, August 22, Wentzville Community Club. Prizes, contests, flea market, food and fun for all. Admission $1.00 per car. Advance tickets $1.00 each, 4/$3.00. Door $1.50 each or 4/$5.00. For tickets and information: SCARC Hamfest 82, c/o Mike McCrann, WDØGSY, 25 Elm St., St. Peters, MO 63376.

MONTANA: The 50th annual WIMU Amateur Radio Convention, August 6, 7 and 8, West Yellowstone Convention and Civic Center, West Yellowstone. Tech forums, transmitter hunts, CW contest, OSCAR, computers, swaps, dealers, treasure hunt, Chinese auction, bingo, ladies/kids activities. Saturday night banquet, entertainment and more. Talk in on 34-94, 28-88 and 3935 kHz. For information call Ron Moss, K7ENE. (208) 356-3742, Rexburg, ID.

MONTANA: The Glacier-Waterton Hamfest, July 16, 17, 18, Three Forks Campground, East Glacier. Pre-registration prior to July 1, $8.00. On site registration $9.00. Prizes include Azden PCS 3000 2m rig, Swan VHF SWR wattmeter and many more. Live music, bazaar, dealers, bingo, crafts, auction, ladies activities. Send registration to Beverly Nord, WB7UDJ, 1540 Fifth Avenue, Havre, MT 59501. Make checks payable to Glacier-Waterton Int. Hamfest.

NEW HAMPSHIRE: Fly-in to New Hampshire's 3rd largest electronic flea market sponsored by the New Hampshire FM Association, Saturday, July 17, Manchester Municipal Airport, 9 AM. Admission $1.00. Sellers $5.00 tailgate or own table. Refreshments available. Door prizes. Talk in on 146.52 FM and 124.9 AM. For information: Dick DesRosiers, W1KGZ (603) 668-8880 or Doug Aiken, K1WPM, 30 Meadowglen Dr., Manchester, NH 03103 (603) 622-0831.

NEW YORK: The Mt. Beacon Amateur Radio Club's annual Hamfest, July 24, 8 AM, Arlington Senior High School, Poughkeepsie. Admission $2.00 (XYL and your kids free). Tailgating $3.00 (1 free admission), table $4.00 (1 free table and admission). Free flea market tables indoors, door prizes, auction, refreshments. Talk in on 146.37/.97 and 146.52 simplex. For information, tickets, registration SASE to Walt Cotter, WA2ZCN, North Hillside Lake Road, Wappingers Falls, NY 12590 (914) 226-6636.

OHIO: The 17th annual Wood County Ham-A-Rama, Sunday, July 18, Wood County Fairgrounds, Bowling Green. Free admission and parking. Prize drawing tickets $1.50 advance, $2.00 gate. Trunk sales space available. Refreshments. Gates open 10 AM. K8TIH talk in on .52. For information: SASE to Wood Co. ARC, c/o S. Irons, PO Box 73, Luckey, OH 43443.

OHIO: NOARSFEST, Saturday, July 24, Lorain County Fairgrounds, Wellington. Donations $2.50 advance, $3.00 gate, children under 12 free. Admission ticket good for prize drawings. Flea market space $1.00 per car. Indoor exhibits. Refreshments available, 807's furnished by NOARS. Free overnight camping Friday, no hookups. Mobile check-in prizes til 1:00 PM. Mobile check in K8KRG, 146.52/52. Directions and information on 146.10/70. For tickets: NOARSFEST, PO Box 354, Lorain, Ohio 44052.

PENNSYLVANIA: The Mid-Atlantic Amateur Radio Club's annual J.B.M. Hamfest, Sunday, August 8, 9 AM to 4 PM, rain or shine, Route 309 Drive-In Theater, Montgomeryville. Tailgate setup 8 AM. Admission $2.50 plus $1.00 additional for tailgate space. Non-licensed XYLs and children free. Refreshments, raffles, door prizes and more. Talk in on WB3JOE/R, 147.66/06 or 146.52 simplex. For information: Mid-Atlantic ARC, PO Box 352, Villanova, PA 19085.

PENNSYLVANIA: The 45th annual South Hills Brass Pounders and Modulators Hamfest, August 1, 10 AM to 4 PM, South Campus, Community College of Allegheny County, Pittsburgh. Admission $2 or 3/$5. Computers, OSCAR and ATV demos, Flea Market. Talk in on 146.13/73 and 146.52. For information: Andrew L. Pato, WA3PBD, 1433 Schauffler Drive, West Homestead, PA 15120.

PLAYBOY RESORT at Great Gorge, McAfee, NJ — the place to relax and enjoy — see all the manufacturers' and dealers' exhibits — attend the vital and informative forums — renew old acquaintances and make new ones — all at the ARRL Hudson Division Convention, October 30-31. Send SASE now for complete details to HARC, Box 528, Englewood, NJ 07631.

TENNESSEE: The Radio Amateur Transmitting Society (RATS) will sponsor the Nashville Hamfest-Computerfest, Sunday, July 25, Exhibition Hall, Nashville Municipal Auditorium, James Robertson Parkway, Nashville. Indoors and air-conditioned. Doors open 8 AM. Admission $3.00. Refreshments. Talk in on .34/.94. For information: RATS, PO Box 2892, Nashville, TN 37219. (615) 459-2636 days. In Nashville 254-0088.

OPERATING EVENTS
"Things to do..."

JULY 10-11: The Texoma Amateur Radio Club will operate K5GQD from Denison, Texas, to commemorate the City's Western Days celebration. 1400Z, July 10 to 0100Z, July 11 and 1400Z to 2300Z, July 11. 80 thru 10 meters, lower end of the General phone bands. Certificate available for large SASE or 40C postage from K5GQD, 1303 E. Richards, Sherman, TX 75090.

JULY 10-18: The Racine Megacycle Club will operate W9UDU, a special events station during Salmon-A-Rama. W9UDU will be operating from the City of Racine's harbor. During the fishing contest, Racine is known as the Salmon Capitol of the World. 1100Z to 2300Z, July 10, 11, 17. 1100Z to 2000Z, July 18. Frequency: General portion of phone bands on 10, 15 and 20 meters. Go fishing for W9UDU and receive a special QSL. SASE to: W9UDU Racine Megacycle Club, c/o American Red Cross, Lakeshore Counties, 4521 Taylor Avenue, Racine, WI 53405.

JULY 16-18: The Eastern Michigan Amateur Radio Club will sponsor a special events station for the 1982 running of the Port Huron to Macinac Yacht Race; Friday, July 16 from 6 PM to 10 PM EDST; Saturday, July 17 and Sunday, July 18 from 10 AM to 10 PM EDST. SSB frequencies — 10 kHz inside lower edge on 75, 40 and 15 meter General Class phone bands. CW = 10 kHz inside lower edge of Novice bands. Two stations on SSB and one on CW are planned. For an 8" × 10", two-color certificate available for those contacting this station send business SASE to: K8DD, 1640 Henry, Port Huron, MI 48060.

JULY 17: The Wapakoneta, Ohio Reservoir Amateur Radio Association will operate K8QYL from 1300Z, July 17 to 0400Z, July 18 and again from 1300Z to 1900Z, July 18, from the birthplace of Neil Armstrong, the first man on the moon. Frequencies: Phone 3940, 7260, 14285, 21360, 28590 ± QRM. CW — 50 kHz up from bottom of the band at the beginning of the odd hours. Check-ins invited on K8QYL/R on 147.93/147.33. Certificate for QSL and SASE to: K8QYL, PO Box 268, Celina, Ohio 45822.

JULY 24-25: The Treaty City Amateur Radio Association will operate W8UMD as a special event station from the site of the Annie Oakley Days celebration, 1600Z, July 24 to 1600Z, July 25. W8UMD will operate 10 kHz up from bottom of the General band on 40 and 20 meters and will venture into the 40 meter Novice band occasionally. For a special certificate send business SASE and QSL to T.C.A.R.A., Box 91, Greenville, Ohio 45331.

JULY 24: Celina, Ohio, Reservoir Amateur Radio Association will operate W8DN from 1300Z to 1800Z from the Court House Lawn during the Celina Lake Festival. Frequencies: Phone — 3940, 7260, 14285, 21360, 28590 ± QRM. Check-ins invited on WB8FNB/R on 146.01/146.61. Certificate for QSL and SASE to: W8DN, PO Box 268, Celina, Ohio 45822.

JULY 31: The Tank-Automotive Command ARC will operate W8JPW to commemorate the 41st year of the Detroit Arsenal, home of the nation's first defense plant and the US Army Tank-Automotive Command. Frequencies: Phone 7.250-7.275; 21.400 and 146.55. Send 9 × 12 SASE for unfolded certificate to: W8JPW, US Army Communications Command, CCNC-TAC-M, 28251 Van Dyke, Warren, MI 48090.

JULY 31-AUG. 1: The Elmira area Amateurs will operate W2ZJ from Chemung County's 1st annual Good Neighbor Festival, 1300Z, July 31 thru 2100Z Aug. 1. Frequencies: 30 kHz up from lower edge of General phone band on 20, 40 and 80 meters. Send large SASE for a special certificate to A.R.S. W2ZJ, General Delivery, Elmira, NY 14904.

JULY 31 & AUGUST 1: The Green Mountain Wireless Society will be sponsoring a special event station to celebrate Calvin Coolidge's inauguration and to allow stations the opportunity for a Vermont contact. N-1-VT will operate from Calvin Coolidge State Park in Plymouth, Vermont, on 80 through 15 meters 10 kc up from bottom of the General portions of CW and phone bands. Novice 10 kc up from bottom of each band. For a certificate confirming QSO send large SASE to GWMS, PO Box 84, Rutland, VT 05701 by September 1, 1982.

JULY 31-AUGUST 4: VE3SAS Salvation Army Scouts will operate from Camp Madawaska, Victoria Lake, Northern Ontario, 80 to 10 meters, phone and CW, looking for other Boy Scouts stations. A special QSL card is available for contacts and SWL reports. SASE, 2-IRCs to VE3FOI, Dave Digweed, 12 Frederick Street, St. Catharines, Ontario L2S, 2S2, Canada.

JULY 31-AUGUST 1: The Radio Amateur Megacycle Society's 20th annual Illinois QSO Party. 1800Z July 31 to 2300Z August 1. Rest period 0500Z to 1200Z, August 1. All bands, CW and phone. Same station may be worked on each band and mode. No repeater contacts. Frequencies: Any frequency but look about 60 kHz from low end on CS; about 3975, 7275, 14275, 21375 and 28675 on phone and about 25 kHz from low end of each Novice band. Exchange RST and county, Illinois stations. All others RST and state or province or country. Send entries no later than September 15, 1982 to RAMS/K9CJU, 3620 N. Oleander Ave., Chicago, IL 60634. Include business SASE for results.

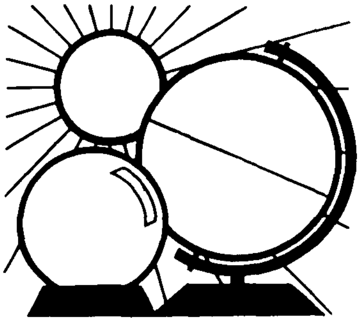
AUGUST 1-8: The Niagara Peninsula ARC will operate a special event station to help celebrate the 100th anniversary of the Royal Canadian Henley Regatta. VE3ROW will operate all bands 160-10 meters. For a special QSL, send log data to: VE3ROW, c/o NPARC, PO Box 692, St. Catharines, Ontario, Canada L2R 6Y3.

AUGUST 13-15: The Alliance (Ohio) Amateur Radio Club will be exhibiting emergency radio communications during Carnation Week at Silver Park. The public is invited to watch club members demonstrate their skills in this type of communications.

AUGUST 14-16: The Englewood Amateur Radio Association invites all Amateurs to participate in the 23rd annual New Jersey QSO Party. 2000 UTC Saturday, August 14 to 0700 UTC, Sunday, August 15. 1300 UTC Sunday, August 14 to 0200 UTC, Monday, August 16. Phone and CW considered same contest. Contact a station once on each band; phone and CW considered separate bands. No CW contacts in phone band segments. NJ stations may work other NJ stations, call "CQ New Jersey" or "CQ NJ". New Jersey stations identify by "DE NJ" on CW and "New Jersey calling" on phone. Suggested frequencies: 1810, 3535, 3900, 7035, 7135, 7235, 14035, 14280, 21100, 21355, 28100, and 28610. Suggest phone on even hours; 15 meters on odd hours; 160 meters at 0500 UTC. Exchange QSO number, RST and QTH. New Jersey send county for QTH. Send logs and comments to: Englewood ARA, PO Box 528, Englewood, NJ 07631-0528. Include #10 SASE for results.

AUGUST 21-22: The Huron County Amateur Radio Club will celebrate the 169th anniversary of the Battle of Lake Erie by operating from Perry's Victory and International Peace Memorial on South Bass Island in Lake Erie. WA8HUR will be on the air beginning 1000Z, August 21 to 0000Z, August 22. SSB frequencies: 3910, 7250, 14280, 21360 and 28550 kHz. CW at 40 kHz up from bottom of each HF band. Novice station at 3720 kHz and 7115 kHz. FM on 146.52 MHz. For a special QSL card after making a contact, send QSL and SASE to ARS KF80.

More Details? CHECK—OFF Page 92



DX FORECASTER

Garth Stonehocker, KØRYW

the summer ionosphere

The ionosphere is produced by ultraviolet radiation from the sun ionizing the constituents of the air in the D (80 km) and E (100 km) regions, and on up to about 180 km. The F region (250 km) is usually ionization moved along the geomagnetic field from elsewhere, mainly diffused up from below.

In our hemisphere, ion production is maximum in these D and E regions during the summer months. Remember that the sporadic E season (lots of ionization) is in the summer. Absorption and attenuation of signals in the lower frequency (40-160 meter) bands is the result of ionization in the D region, limiting propagation to 200-400 km during the day but then opening up to 2000 km at night. (The 200 km is in the summertime, the 400 km in the winter.)

The higher frequency bands (10-20 meters) are not much affected by increased summer absorption of signals because those frequencies are so high. But these bands have lower maximum usable frequencies (MUFs) in summer than winter, since the ionization is down lower. A good rule of thumb is that ionization is maximum either in the lower regions or upper regions but not both. Making up for lower MUFs, the longer hours of daylight in summer give more of the day with fairly high MUF. A flat-broad peak to the summer diurnal curve is seen, instead of the high-pointed peak of winter.

The solar flux value derived from measurements at 2800 MHz at Ottawa, Canada, is not ideal, because that frequency is not best for measuring the sun's ultraviolet radiation — but it's adequate. The readings date back to 1947 and can provide some useful sun-earth relationships (including substitute for sunspot number, SSN). And we use it as a daily solar predictor. The flux value is proportional to signal attenuation and E region MUF, and to the F region MUF after a time lag of two to three days. The Space Environment Service Center (SESC) in Boulder, Colorado, collects and broadcasts this information on WWV at 18 minutes after each hour. We hope they weather the budget cuts enough to continue. *Please write them!*

When is the flux/SSN really going to fall distinctly? The envelope of the superimposed curves of the past four to eleven years leads me to expect a drop from the eleven-year cycle peak of 200/140 monthly average. I expect it to hit 150/100 around October. We will see MUFs slowly decrease about twenty percent at mid latitudes in that same period of time. This will begin to change some of our DX operating habits. More later.

last minute forecast

The lower frequency bands (40 through 80 meters) are expected to offer good DX the first week and last few days of the month. The higher bands (10-20 meters) will improve to an excellent DX rating about the 18th to 20th of July. Disturbed days can enhance the rare DX openings about the 1st, 12th, 20th, and 28th. The middle pair may be of shorter duration than the other two longer disturbances.

A total eclipse of the moon is visible on July 6 from 0533 to 0929 UT in *the Americas and across to Australia.* The moon will be full on eclipse day and will be at perigee on the 19th. Also a partial eclipse of the sun is visible from 1719 to 2009 UT on July 20 in extreme northern Asia, northwestern Europe, northwestern North America, Greenland, Iceland, and the Arctic regions. The sun will be obscured forty-six percent at maximum.

Ten and fifteen meters will provide good worldwide DX during the daylight and early evening hours on most days of the month. Expect conditions to peak during the late afternoon, with long- and short-skip signals.

Twenty meters will be open to some area of the world for the entire twenty-four hour period on most days of the month. The band should peak in all directions just after local sunrise, and again toward the east and south during late evening hours. During darkness, the band will peak toward the west, in an arc from southwest through northwest, that will take in Pacific areas.

Forty meters can often provide good DX from sunset through darkness till just after sunrise, despite the atmospheric noise levels — provided you choose times when local thunderstorm-related static is at a minimum.

Eighty meters can sometimes provide openings to DX areas during darkness and at sunrise, but signals will be weak and static will be strong. For these DX conditions, coastal stations often have a better chance of working DX than do stations in the center of large land masses.

ham radio

JULY

WESTERN USA

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

MID USA

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

EASTERN USA

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

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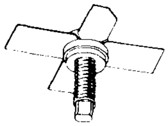

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MC4044P	3.00
MC4050P/74450P	12.25
MC4060P	5.32
MC4062P	3.43
MC4000F	8.87
MC4006F	8.33
MC4007F	8.43
MC4008F	6.16
MC4060F/74460F	7.57
MC4062F	7.00
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MC4307L	11.09
MC4312L	10.67
MC4318L/MC54148L	11.40
MC4322L	8.61
MC4350L/MC54450L	17.16
MC4300F	10.00
MC4307F	10.99
MC4316F	13.55
MC4322F	10.40
MC4323F	13.87
MC4350F	20.89
MC4362F	7.75
MC1303L	1.00
MC1306	1.27
MC1311	3.00
MC1330	2.50
MC1350	2.50
MC1351	1.43
MC1352	1.37
MC1358	2.50
MC1359	3.00
MC1393	1.76
MC1408L6	2.75
MC1414L	1.83
MC1414P	1.29
MC1435L	2.25
MC1436G	4.40
MC1437	2.25
MC1439	3.57
MC1461	
MC1468L	5.33
MC1469R	5.65
MC1496P	2.50
MC1511G	12.00
MC1535G	18.19
MC1539G	5.40
MC1550G	1.00
MC1552G	11.61
MC1558L	1.68
MC1560R	16.25
MC1569RB2	10.49
MC1590G	6.00
MC1709CG	.97
MC1710G	1.79
MC1711CL	1.03
MC1712CP	3.35
MC1723CP	.67
MC1733CL	1.35
MC1741G	1.50
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MC14530BCP	1.22
LM101AH	2.40
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LM111H	8.73
LM139A	12.13
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LM205	4.70
LM211	4.43
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LM270	7.55
LM301AP/H	.69
LM304H	1.20
LM307N	.55
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LM310H	1.10
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74S20	.59
74S22	.69
74S30	.59
74S37	.99
74S38	.99
74S40	.69
74S64	.89
74S65	.89
74S74	1.49
74S83	1.75
74S86	1.69
74S112	1.39
74S114	1.39
74S124	3.75
74S133	.89
74S134	1.90
74S138	3.95
74S139	3.95
74S140	1.29
74S151	1.95
74S153	2.75

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74S158	2.70
74S163	3.75
74S164	2.75
74S174	3.75
74S175	3.75
74S181	9.50
74S189	6.95
74S194	3.25
74S195	2.99
74S200	8.95
74S240	8.95
74S241	8.95
74S251	2.49
74S257	2.49
74S260	.99
74S280	3.95
74S283	4.70
74S287	3.95
74S373	3.49
74S374	3.49
74S474	9.00
Series 74	
7400	.39
7401	.49
7402	.27
7403	.27
7404	.27
7405	.28
7406	.28
7407	.28
7408	.31
7409	.28
7410	.27
7411	.34
7412	.34
7413	.44
7414	.90
7416	.34
7417	.34
7420	.27
7423	.34
7425	.34
7426	.34
7427	.34
7428	.34
7430	.28
7432	.34
7433	.34
7437	.34
7438	.34
7439	.39
7440	.29
7441	.99
7442	.99
7443	.99
7445	.99
7446	.99
7448	.84
7449	.99
7450	.28
7451	.28
7453	.28
7454	.28
7460	.44
7470	.39
7472	.42
7473	.41
7474	.42
7475	.42
7476	.42
7480	.64
7483	.60
7485	.70
7486	.44
7489	1.80
7490	.99
7491	.70
7492	.77
7493	.54
7494	.77
7495	.70
7496	.77
7497	.77
74100	1.04
74105	.37
74107	.58
74109	.37

74116	2.30
74120	2.00
74122	.64
74123	.64
74125	.49
74126	.62
74132	.74
74141	.74
74145	.67
74148	1.25
74150	1.04
74153	.72
74154	1.24
74155	.87
74157	.74
74158	1.70
74161	1.00
74163	.92
74164	1.02
74165	1.02
74166	1.25
74172	6.00
74173	.84
74174	.94
74175	.94
74177	.90
74180	.80
74181	1.80
74182	.80
74185	2.00
74186	10.00
74190	1.20
74191	1.20
74193	.90
74194	.90
74195	.90
74196	.90
74197	.90
74273	1.10
74279	.84
74283	2.20
74298	3.22
74366	.73
74367	.84
74368	.84
Series 74LS	
74LS00	.40
74LS01	.33
74LS02	.33
74LS04	.44
74LS05	.33
74LS08	.44
74LS09	.43
74LS10	.33
74LS11	.44
74LS14	1.30
74LS20	.31
74LS21	.43
74LS27	.44
74LS30	.31
74LS32	.44
74LS37	.84
74LS38	.44
74LS42	.84
74LS49	1.43
74LS51	.31
74LS54	.40
74LS73	.50
74LS74	.64
74LS75	.73
74LS76	.50
74LS85	1.24
74LS86	.50
74LS90	.80
74LS93	.80
74LS95	.93
74LS96	1.03
74LS107	.50
74LS109	.50
74LS112	.64
74LS123	1.24
74LS125	.94
74LS132	.84
74LS138	.94
74LS139	.68
74LS145	1.30
74LS151	.84
74LS153	.84

74LS155	1.24
74LS156	1.04
74LS157	1.04
74LS158	.80
74LS160	1.03
74LS161	1.20
74LS163	1.03
74LS164	.94
74LS165	.94
74LS173	.94
74LS174	1.04
74LS175	1.04
74LS181	2.25
74LS191	1.20
74LS193	1.03
74LS194	1.20
74LS195	1.00
74LS196	.94
74LS197	.94
74LS221	1.54
74LS240	3.04
74LS244	3.00
74LS245	8.95
74LS251	1.84
74LS253	1.03
74LS257	1.03
74LS258	1.03
74LS259	3.00
74LS266	.64
74LS273	1.80
74LS282	2.10
74LS283	1.15
74LS293	2.00
74LS298	1.34
74LS323	4.79
74LS353	1.70
74LS366	1.04
74LS367	1.04
74LS368	1.04
74LS373	2.80
74LS374	2.80
74LS378	1.33
74LS393	2.00
74LS670	2.34
4001	.34
4002	.34
4007	.34
4009	.64
4011	.34
4012	.34
4013	.54
4015	1.44
4017	1.24
4021	1.54
4023	.42
4024	.84
4025	.43
4027	.84
4028	1.04
4029	1.34
4030	.74
4040	1.34
4046	2.30
4049	.74
4050	.74
4052	1.15
4060	1.44
4069	.44
4081	.40
4093	1.04
7520L	1.35
75107	.84
75108	.84
75113	2.25
75115	
75123/8T23	1.49
75151	
75154	2.00
75350	
75368	2.95
75369	
75427	
75451	2.10
75452	2.10
75454	2.10
75480	
75492	.93

MODULES & SOLID STATE DEVICES

RCA CA3028A .... $1.00 each
Cascade Amplifier. DC-500 MHz

Analog Devices AD580 IC......... $1.00 each
Low drift voltage reference.
3-terminal device: V. out=2.5 V ± 1%
4.5 V < V. in < 30 V

MEM 631......................... $.50 each
Dual gate MOS Fet
Vds = 25V, Id = 30 mA
Mhos 800(min)

LM3909 LED Flasher IC .... $1.25 each

TCA440 AM Receiver IC .... $2.19 each
with RF, AGC, mixer, low current draw.

Microwave Pin Switching Diodes
MPN 3401 .... .52 each or 3/1.00

MRF511
1500 MHz, 7.3 dB noise at 200 MHz
Sale price at..................... $3.99 each

2N5179
900 MHz, 4.5 dB noise at 200 MHz
Sale price at...................... $.69 each

MEM 712 Fet $1.00

2N5638 Fet "N" Channel............ 3/$1.00

MPF102 Fet "N" Channel .... 3/$1.00

2N5458 Fet "N" Channel .... 3/$1.00

MC1590G .... $6.00 each
RF-IF Audio Amp. w AGE.

MC1550G .... $1.00 each
RF-IF Amp.

#W1605/MAC15-6 .... $1.00 each
TO-220 Triac, 15 Amps 400 V

CAPACITORS

Elpac Paper Caps................ $1.69 each
Part #CQ 20A104, .10 @ 2 KV

Sprague/Goodman Ceramic Caps. .. $.69 each
#GKR50000, 5.1 to 50 pF

Sprague/Goodman Piston Caps.... $1.99 each
#GGP12000, .8 to 12 pF

Erie #1270-016 .... $1.00 each
Min. attenuation: 50 dB from 200 MHz
to 10 GHz, 5000 pF 200 VDC

Erie #1201-785 .... $1.00 each
Min. attenuation: 50 dB from 100 MHz
to 10 GHz, 5500 pF 200 VDC

NEW Sanghmd Type 2A Caps ...... $1.00 each
#CM560333J, .033 MFD 600 VDC
1/2"H x 1 3/4"L x 1 1/4"W

New High Voltage Oil Filled Capacitor
Mfr. #4W308T, Mfr. - CSI
53.3 MFD, 3.5 KVDC, Length - 4 1/2",
width - 3 3/4", height - 11"
$29.99 each

Dip Tantalum Capacitors
15 MFD @ 25 VDC................. 7/$1.00

UNELCO CAPS

6.8pF	47pF	13pF	240pF
8.2pF	62pF	14pF	360pF
10pF	160pF	20pF	470pF
12pF	180pF	24pF	1000pF

-350V $1.00 each

TRIMMER CAPS

Sprague. Stable Polypropylene.
.50 each or 10/4.00
not sold mixed

1.2 to 13pF	3.9 to 40pF
2 to 30pF	3.9 to 55pF
3.9 to 18pF	

MOTOROLA RF MODULES

MHW 591
1 to 250 MHz frequency range, 35/36.5 dB gain. 13.6 VDC input. 700/100 output level 1 dB compression. 5 dB noise @ 250 MHz.

MHW592
1 to 250 MHz frequency range, 34.5/36 dB gain. 24 VDC input. 900/100 output level 1 dB compression. 5 dB noise @ 250 MHz.

MRF450 & MRF450A .... $13.80 each
4 Watts input. 50 Watts output.
11 dB gain, 13.6 VDC.

BFR91.......................... $1.65 each
5000 MHz
1.9 noise @ 500 MHz
16 dB gain @ 500 MHz

MRF901 .... $2.15 each
4500 MHz
2.0 noise @ 1000 MHz
10 dB gain @ 1000 MHz

MHW252 .... $39.99 each
.3 Watts input power
25 Watts output power
144-148 MHz, 19.2 Gp power gain
13.6 VDC input

MHW 612A .... $39.99 each
.2 Watts input power
20 Watts output power
146-174 MHz, 20 Gp power gain
12.5 VDC input

AIR VARIABLE CAPACITORS

.1- 10pF	189-6-1	1.50
.5- 12pF	160-107-16	1.50
.9- 15pF		1.50
1- 5pF	T-3-5 187-103-5	1.50
1.3- 6.7pF	189-502-4	1.50
1.4- 9.2pF	189-503-105	1.50
1.4- 13pF	193-3	1.50
1.7- 11pF	T6-5	1.50
1.7- 14pF		2/1.50
1.7-14.1pF	189-505-107	1.50
1.8- 9.2pF	189-509-105	1.50
1.8-11.4pF	545-043	1.50
1.8-16.7pF	189-506-103	1.50
2-19.3pF	189-507-105	1.50
2.1-22.9pF	189-509-5	1.50
2.2- 34pF	193-10-104	1.50
2.2- 34pF	193-10-6, 3/16"x3" shaft	2.50
2.4-24.5pF	189-509-5	1.50
3- 105pF	1000 VDC, 1/4"x6" shaft	4.99

HIGH VOLTAGE CAPS.

22 MFD @ 500 VDC	$1.69
150 MFD @ 450 VDC	$3.29
225 MFD @ 450 VDC	$4.29
600 MFD @ 360 VDC	
800 MFD @ 360 VDC	$2.99
850 MFD @ 330 VDC	$3.59
2000 MFD @ 350 VDC	$7.99 each
2000 MFD @ 450 VDC	$22.99 each
3200 MFD @ 350 VDC	$9.99 each
3100 MFD @ 450 VDC	$29.99 each
6200 MFD @ 150 VDC	$6.99 each
110,000 MFD @ 25 VDC	$6.99 each

ARCO CAPACITORS

# 304	100- 550pF	$1.50
# 400	.9- 7pF	$1.00
# 402	1.5- 20pF	$1.00
# 404	8- 60pF	$1.00
# 405	5- 80pF	$1.00
# 420	1- 12pF	$1.00
# 422	4- 40pF	$1.00
# 423	7- 100pF	$1.00
# 426	37- 250pF	$1.00
# 429	80- 300pF	$1.00
# 464	25- 200pF	$1.00
# 465	50- 380pF	$1.00
# 467	110- 580pF	$1.00
#2564	75- 280pF	$2.00
#4615	390-1400pF	$2.00

SEMICONDUCTORS SURPLUS

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

SEMICONDUCTORS SURPLUS

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

more capacitors

FEED THRU CAPACITORS

Solder Type .... 5/$1.99
3pF 47pF 1000pF
20pF 82pF 2000pF
27pF 100pF
Stud Mount - 1.5 KV .... $1.99 ea.
.01uF, 1000pF, 2200pF

DOOR KNOB CAPACITORS

100 pF @ 5 KV $3.99
470 pF @ 15 KV $3.99
Dual 500 pF @ 15 KV $3.99
680 pF @ 6 KV $1.99
800 pF @ 15 KV $3.99

CERAMIC CAPS.

.001 uF @ 10 KVDC .... .89
.001 uF @ 2 KV 4/1.00
.0015 uF @ 3 KV 3/1.00
.01 uF @ 4 KV .... .79
.01 uF @ 1.6 KV 4/1.00
.01 uF @ 1 KV 6/1.00
.05 uF @ 3 KV Electro-cube 3.99
.1 uF @ 2 KV Electro-cube 3.99

CHIP CAPS. $1.00 ea. or 10/$7.50

.033 pF	8.2 pF	47 pF
.047 pF	10 pF	51 pF
.068 pF	11 pF	56 pF
.01 pF	12 pF	62 pF
.3 pF	13 pF	68 pF
1 pF	15 pF	75 pF
1.2 pF	16 pF	82 pF
1.5 pF	20 pF	91 pF
1.8 pF	22 pF	100 pF
2.2 pF	24 pF	150 pF
2.7 pF	27 pF	300 pF
3.3 pF	30 pF	330 pF
3.9 pF	33 pF	1000 pF
4.7 pF	36 pF	1200 pF
5.6 pF	39 pF	1500 pF
6.8 pF	43 pF	1800 pF

PISTON TRIMMERS

.5 - 10 pF... LRC 682418 .... $1.99
.5 - 7.5 pF .... 2.99 ea. or 10/20.00
2 - 27 pF $2.99
.6 - 6 pF... SFD VCJ2819A $1.99
1 - 3 pF... SFD VCJ2281 .... $1.99
.5 - 12 pF... PCB mount $2.99
1 - 8 pF... SFD VCJ988 .... $1.50
SFD VCJ1983 .... $2.99
.8 - 12 pF... SGE7906 .... $1.99
.8 - 18 pF... 567-013 .... $2.99
.5 - 10 pF... PCB mount $1.29
1.2 - 10 pF... PCB mount $1.00
.2 - 1.5 pF... with 100 pF lap $1.99
.5 - 12 pF... PCB mount $2.99
.5 - 10 pF $1.99
.5 - 7.5 pF .... 2.99 ea. or 10/20.00
2 - 27 pF $2.99
.6 - 6 pF... SFD VCJ2819A $1.99
1 - 3 pF... SFD VCJ2881 .... $1.99

Miniature Ceramic Trimmers
.50 each or 10/$4.00

CV31D350	2 to 8 pF
HM00-4075-03	3.5 to 11 pF
300425	3.5 to 13 pF
E5-25A	5 to 25 pF
	5.1 to 40 pF
	3.5 to 15 pF
	5.2 to 40 pF
	2.5 to 6 pF

PANEL METERS

RF Power output 0-1000 scale
1 MA movement $5.99 ea.

Large 8" scale meter
50 MV movement $6.99 ea.

DC amp meter 0-1 Amp
#2MAS-DAA-001 $4.99 ea.

DC MA meter 0-5 MA
Emico $2.99 ea.

3 assorted 50 uA meter movements, one each: zero center, linear display, and signal strength 3/$8.99

CERAMIC COIL FORMS

CAMBION WITH SLUGS
LST-P/530-2020-03 .... $1.50
3/16"d x 1/2", 20-50 MHz
Green slug with hardware.

LST-H/530-1532-01 .... $1.50
3/16"d x 1/2", 1-20 MHz
Red slug with hardware.

LS6-E/530-1535-02 .... $1.50
1/4" x 3/4", 1-20 MHz
Red slug with hardware.

LST-H/530-2020-02 .... $1.99
3/16"d x 5/16" with terminals
1-20 MHz, red slug

PLST-1 530-1532-01 .... $1.99
3/16"d x 5/16" with terminals
.2-1.5 MHz

PLS5-B - 2 Cyl., 1-20 MHz $1.99
3/8"dia. x 5/8" with terminals and hardware, red slug

PLS5-C - 2 Cyl., .2-1.5 MHz $1.99
3/8" dia. x 5/8" with terminals
yellow slug

LST-1 - Yellow slug, .2-1.5 MHz $1.99

CERAMIC COIL FORMS - No Slug

#1 .... 3/16" x 5/8" 1.00
#2 .... 3/16" x 1/2" 1.00
#3 .... 1/4" x 5/8" 1.00
#4 .... 3/8" x 1" 1.00
#5 .... 1/2" x 1 1/2" 1.00

PAPER COIL FORMS - With Slug

#6 .... 1/4" x 3/4" 1.00
#7 .... 3/16" x 3/4" 1.00

VHF/UHF/MICROWAVE COMPONENTS

J-Fet #J310 .... 3/$1.00
N-Channel, 450 MHz. Good for UHF/VHF amplifiers, oscillator and mixers.

2N6083 .... $10.00 ea.
8.1 Watts input, 30 Watts output.
5.7 dB gain, 12.5 VDC

Motorola RF Amp. Modules .... $29.99 ea.
#544-4001-002
Similar to type MHW401-2
1.5 Watts output, .047 Watts input.
440-512 MHz, 15 dB gain, 7.5 VDC

TRW CA602/CA 2601BV .... $29.99 ea.
Microelectronics Broadband Amp.
15 to 270 MHz, 30 dB gain max.
30 VDC supply voltage

New Microwave Diode
Microwave Associates, Inc. - MA41482 and MA41482R, 10 GHz to 40 GHz

DIODES

1N4148/1N914
Switching diode
30/$1.00 or 100/$3.00

HEP 170
2.5 A, 1000 PIV
.20 ea., 100 for $15.00

HVK 1153
25 mA, 20,000 PIV
$1.00 ea., 10 for $8.00

Motorola MA 752 Rectifier
6 Amps, 200 PIV
4/$1.00

High-voltage diode EK500
5000 Volts, 50 mA
2/.99 each

DG-1005
1.5 A, 1000 PIV
.15 ea., 100 for $12.00

SCMS 10K
15 mA, 10,000 PIV
$1.69 ea., 10 for $12.50

Fairchild LEDs
FLV 5007 & 5009 red.
Case type TO-92.
6/$1.00

Motorola SCR
TO-92 Case, 0.8 Amp, 30 V.
Igt 0.2 Vgt 0.8.
Same as 2N5060.
4/$1.00 or 100/$15.00

10 KV at 1.5 Amps $3.99
High Voltage Diode

CRYSTALS

$3.00 each

5.120	10.010	11.855
7.3435	10.020	11.900
7.4585	10.030	11.905
7.4615	10.040	11.955
7.4625	10.0525	12.000
7.4665	10.130	12.050
7.4685	10.140	12.100
7.4715	10.150	16.965
7.4725	10.160	17.015
7.4765	10.170	17.065
7.4785	10.180	17.165
7.4815	10.240	17.215
7.4825	10.245	17.265
7.4865	10.595	17.315
7.4925	10.605	17.355
7.4985	10.615	17.365
7.5015	10.625	37.600
7.5025	10.635	37.650
7.5065	11.155	37.700
7.7985	11.275	37.750
7.8025	11.700	37.800
9.545	11.705	37.850
9.555	11.730	37.900
9.565	11.750	37.950
9.575	11.755	38.000
9.585	11.800	60.000
10.000	11.850	

CRYSTAL FILTERS

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

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.

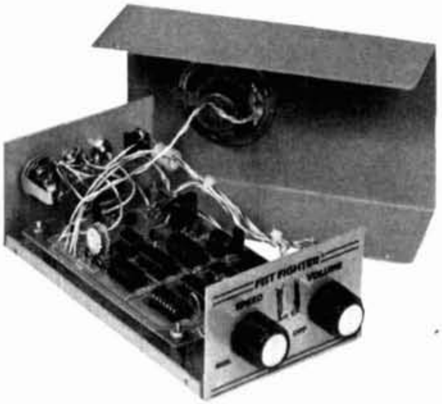
Our toll free number for *charge orders only* is 800-528-3611.

MINIMUM ORDER $10.00

NEW products

fist fighter keyer

Designed exclusively for straight-key users, the fist fighter is an electronic keyer that accurately times the length of dots, dashes, and the



spaces between them. The fist fighter uses a standard 1:3:1 timing ratio so that code sounds clean and crisp. No new hand motions are required, and an automatic tune-up feature is built in so that normal key-down tune-up is possible without the need for extra switches. Speed is variable from about three to over thirty WPM, and a built-in sidetone oscillator with variable tone is provided. The fist fighter uses CMOS digital circuits and it will key grid-block and solid-state transmitters/transceivers. It can be used as a code-practice oscillator and for teaching how to send code properly.

The fist fighter is available in two forms: kit ($59.95 plus $2.50 shipping and handling) and assembled/tested ($79.95 plus $2.50 S/H), each with a limited ninety-day warranty. Additional information and specifications are available from the Blacksburg Group, Box 242, Blacksburg, Virginia 24060; telephone 703-951-9030.

no-radial vertical

Cushcraft has introduced R3, the no-radial 10, 15, and 20-meter gain vertical antenna. R3 is perfect for limited-space applications like condominiums, apartments, mobile homes, and small urban lots. It is a half-wavelength, end-fed 22-foot radiator with remote tuning for broadband coverage. Installation is very simple with only one square foot of space needed. It can also be telescoped for easy carrying and storage.

Because of its unique design, R3 does not need tower, rotator, large support mast, or tuner. It is a complete antenna system for hams who are concerned about neat appearance and maximum performance.

R3 antennas are available through all major Amateur Radio dealers worldwide. For more information, see your local dealer or contact Cushcraft Corporation, P.O. Box 4680, Manchester, New Hampshire 03108; telephone 603-627-7877.

computer logging system

Compu-Log is a fully computerized logging system for the Amateur Radio operator looking for the competitive edge. Compu-Log provides a printed, scored and duped log complete with dupe sheet. Confirmation of contacts can be printed on address labels in alphabetical order by callsign for attaching to your QSL cards. In addition, many valuable contest and operator statistics can be printed. These include number of contacts each hour on each band and total contacts for each country on each band. For multi-operation stations, Compu-Log gives you a breakdown of the total operating time, indicating number of contacts, duplicates, and contact rate for each operator on each band, and cumulative totals.

Compu-Log is written for the TRS-80 Model I computer with 48k memory, at least one disk drive, and the Epson MX-80 printer. Modified versions for other printers and the TRS-80 Model III can be created.

Versions of Compu-Log for the CQ World Wide DX Contest and ARRL DC Contest are available now. Other versions for the CQ WPX and IARU Radiosport contests will follow shortly. While Compu-Log is written for use by U.S. stations, modified versions for non-U.S. stations can be created.

For more information, contact Contest Software, Peter Chamalian, W1RM, Savarese Lane, Burlington, Connecticut 06013.

IC-290A 2-meter mobile

ICOM announces the IC-290A 2-meter mobile VHF transceiver, priced at $549.00 including the HM8 Touchtone mike.

The IC-290A includes the following features: five memories plus two VFOs; priority channel; programmable offsets; 5 kHz or 1 kHz tuning; full-scanning capability; and fm USB/LSB/CW capabilities. The compact size of the IC-290A is another excellent feature: 6-11/16 × 2-1/2 × 8-5/8 inches.

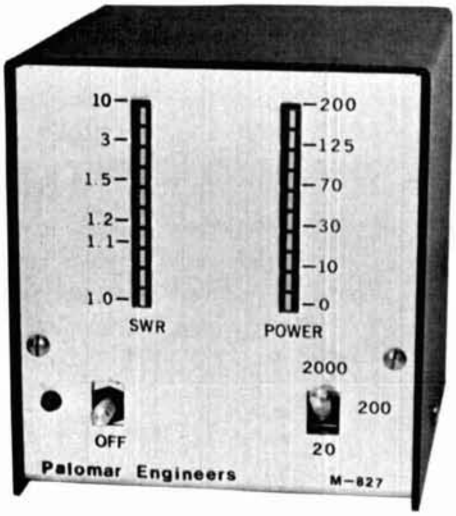
For more information, write ICOM, Suite 307, 3331 Towerwood, Dallas, Texas 75234.

automatic SWR meter

Palomar Engineers introduces the new M-827 SWR meter. This new meter computes SWR automatically and displays it on a light bar. The "sensitivity" knob has been elimi-

NEW products

nated. SWR reading is always correct regardless of power level, and the light bar follows changes instantly. A second light bar displays power. Unlike the analog panel meter it replaces, this meter follows with the speed of light so you can see all the SSB peaks.



The frequency range of the M-827 SWR meter is 1-30 MHz. Power ranges are 20, 200, and 2000 watts. The SWR scale is 1 to 10 with a logarithmic response that gives much improved resolution where you need it. The M-827 is a compact 4 × 4 × 5 inches with a brushed aluminum control panel, baton switches, and a black vinyl cover. The light bars are 2 inches long with a bright red display.

The M-827 SWR meter sells for $97.50. For further information write to Palomar Engineers, 1924-F W. Mission Road, Escondido, California 92025; telephone 714-747-3343.

Micro-RTTY

Kantronics is introducing the latest development in RTTY send/receive devices with the Micro-RTTY.

More Details? CHECK—OFF Page 92

NEW products

The Micro-RTTY converts CW from any keyer or keyboard into standard AFSK two-tone RTTY or two-tone CW ID. Micro-RTTY sends and receives RTTY at 60, 67, 75, and 100 WPM, plus ASCII 110 baud.

Special CW characters allow for entering Morse ID mode or sending a carriage return/line feed character without ever touching the unit. A printer attachment is also provided via a back panel connection.

The Micro-RTTY receives any shift of RTTY and displays the message on a ten-character, 3/8-inch high, vacuum-tube fluorescent display.

The package is small, just 2-1/2 by 5-1/2 inches and the 9-Vdc power supply is included.

For more information, contact Kantronics, 1202 E. 23rd Street, Lawrence, Kansas 66044.

Clutterfree modular consoles

Clutterfree modular consoles are made of industrial particleboard finished with Plyocite (polyester) overlays of pecan woodgrain. They are available in two models, single deck or double deck.

These modular consoles consist of seven to ten pieces and are shipped unassembled. Instructions and diagram are enclosed with each unit, (no

NEW products

special tools, glue, or nails are necessary). Assembly time is approximately twenty minutes. Dimensions: height single deck 42 inches; the equipment shelf is 14-1/4 inches front to back with a 9-7/8 inch clearance height; height double deck 50 inches, with clearance heights 8-1/2 inches between equipment shelves and desk top; console deck 16 inches deep at base, desk width 57 inches, depth 30

inches. Desk top is standard 29 inches from the floor, and the space between the pedestals is a generous 22 inches. The assembled weight is approximately 150 pounds, and the console top will support approximately 400 pounds with face plate.

The cost of the consoles is only $203.35 for the single deck, $312.70 for the double deck. The optional face plate can be purchased for an additional $15.10. Drawers are available for your console.

All orders will be processed within seven days. For more information, contact Clutterfree Modular Consoles, P.O. Box 5103, Tacoma, Washington 98405; telephone 206-759-1611.

More Details? CHECK—OFF Page 92

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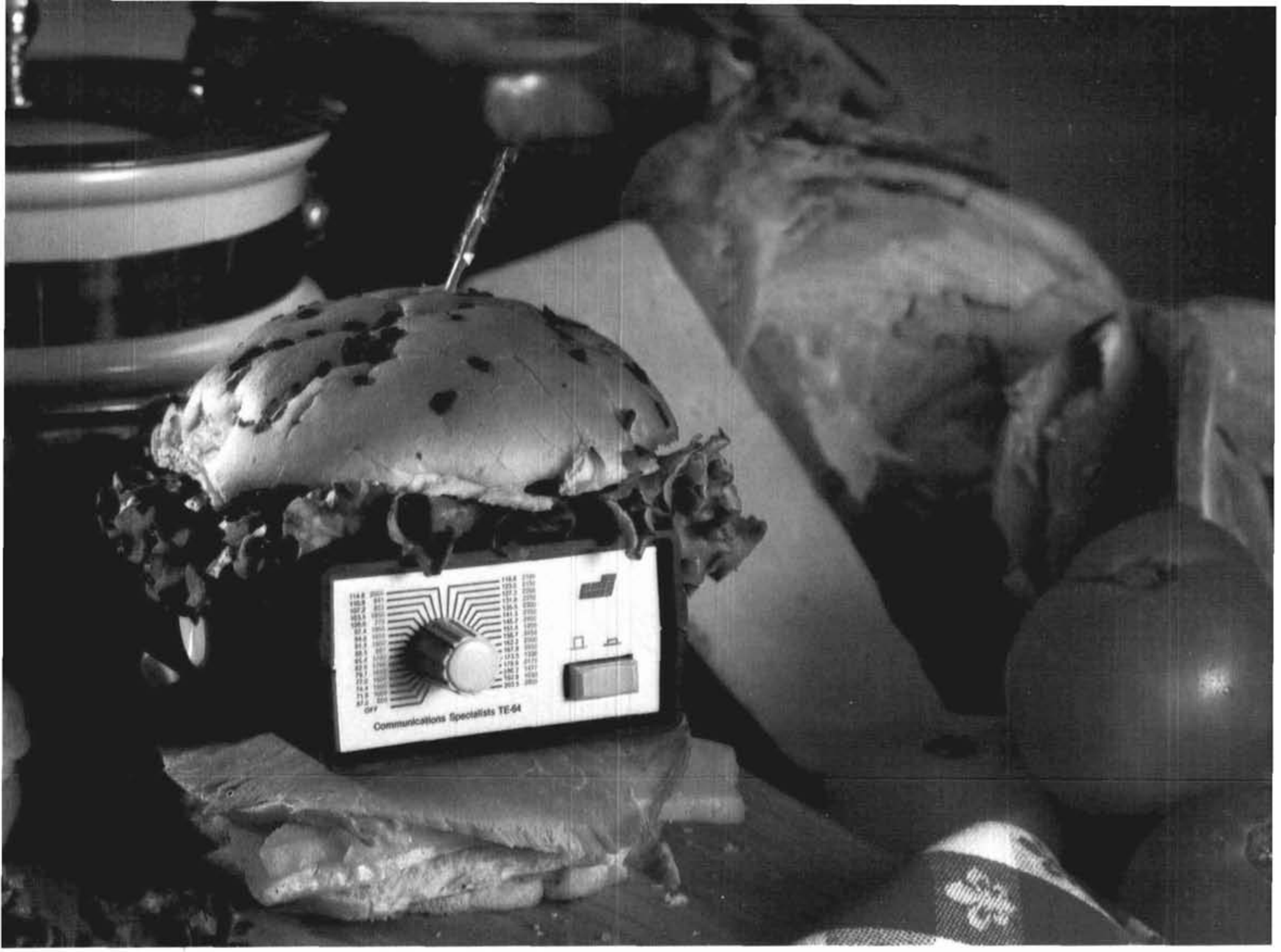
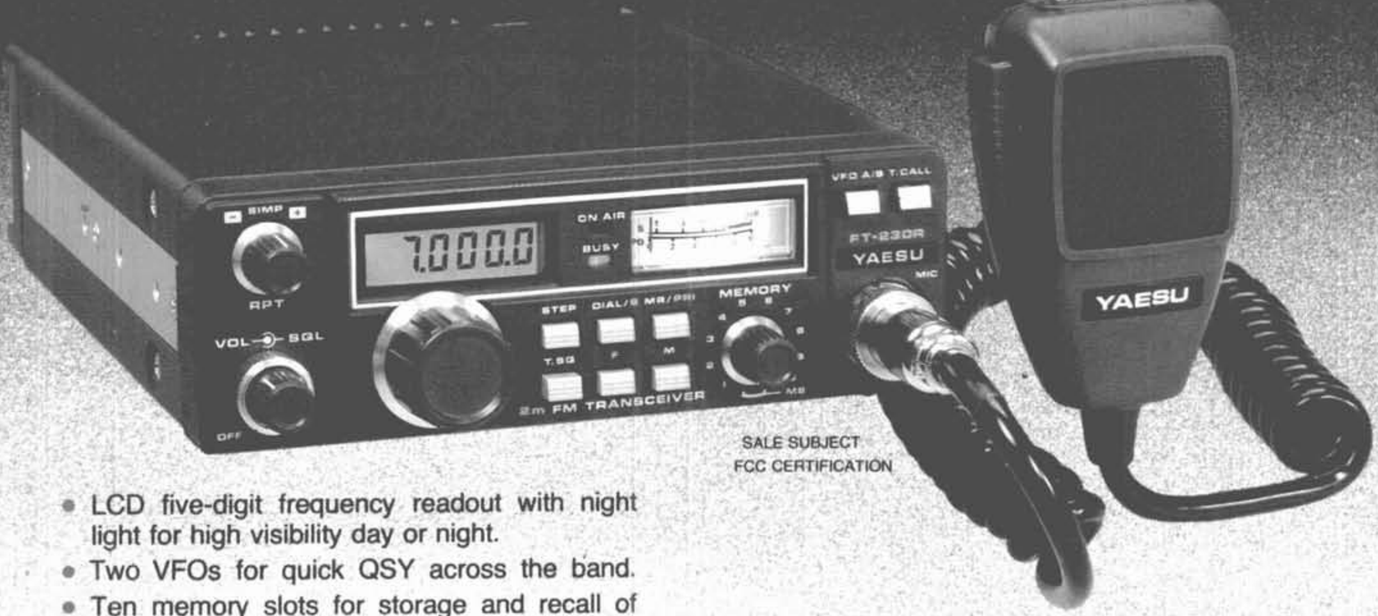

Communications Specialists TE-64

FT-230R: QUITE A SIGHT! (AND EASY TO SEE, TOO!!)

Sporting an all-new Liquid Crystal Display, the FT-230R is Yaesu's high-performance answer to your call for a very affordable 2 meter mobile rig with an easy-to-read frequency display! The FT-230R combines microprocessor convenience, a sensitive receiver, a powerful yet clean transmitter strip, and the new dimension of LCD frequency readout. See your Authorized Yaesu Dealer today — and go home with your new FT-230R!



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- LCD five-digit frequency readout with night light for high visibility day or night.
- Two VFOs for quick QSY across the band.
- Ten memory slots for storage and recall of favorite channels.
- Selectable synthesizer steps (5 kHz or 10 kHz) in dial or scanning mode.
- Priority channel for checking a favorite frequency for activity while monitoring another.
- Unique VFO/Memory Split mode for covering unusual repeater splits.
- Up/Down band scan plus memory scan for busy or clear channel. Scanning microphone included in purchase price.
- Full 25 watts of RF power output from extremely compact package.
- Built-in automatic or manual tone burst.
- Optional synthesized CTCSS Encode and Encode/Decode boards available.
- Lithium memory backup battery with estimated lifetime of five years.
- Optional YM-49 Speaker/Microphone and YM-50 DTMF Encoding Microphone provide maximum operating versatility.

FT-208R
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And don't forget! Yaesu has a complete line of VHF and UHF handheld and battery portable transceivers using LCD display!!!

FT-290R - 2 Meters
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FT-690R - 6 Meters
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482

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NEW

"DX-traordinary."

Superior dynamic range, auto. antenna tuner, QSK, dual NB, 2 VFO's, general coverage receiver.

TS-930S

The TS-930S is a superlative, high performance, all-solid state, HF transceiver keyed to the exacting requirements of the DX and contest operator. It covers all Amateur bands from 160 through 10 meters, and incorporates a 150 kHz to 30 MHz general coverage receiver having an excellent dynamic range.

Among its other important features are, SSB slope tuning, CW VBT, IF notch filter, CW pitch control, dual digital VFO's, CW full break-in, automatic antenna tuner, and a higher voltage operated solid state final amplifier. It is available with or without the AT-930 automatic antenna tuner built-in.

TS-930S FEATURES:

- **160-10 Meters, with 150 kHz - 30 MHz general coverage receiver.**
  Covers all Amateur frequencies from 160-10 meters, including new WARC, 30, 17, and 12 meter bands, on SSB, CW, FSK, and AM. Features 150 kHz - 30 MHz general coverage receiver. Separate Amateur band access keys allow speedy band selection. UP/DOWN bandswitch changes in 1-MHz steps. A new, innovative, quadruple conversion, digital PLL synthesized circuit provides superior frequency accuracy and stability, plus greatly enhanced selectivity.
- **Excellent receiver dynamic range.**
  Receiver two-tone dynamic range, 100 dB typical (20 meters, 500 Hz CW bandwidth, at sensitivity of 0.25 μv, S/N 10 dB), provides the ultimate in rejection of IM distortion.
- **All solid state, 28 volt operated final amplifier.**
  The final amplifier operates on 28 VDC for lowest IM distortion. Power input rated at 250 W on SSB, CW, and FSK, and at 80 W on AM. Final amplifier protection circuit with cooling fan. SWR/Power meter built-in.
- **Automatic antenna tuner, built-in.**
  Available with AT-930 antenna tuner built-in, or as an option. Covers Amateur bands 80-10 meters, including the new WARC bands. Tuning range automatically pre-selected with band selection to minimize tuning time. "AUTO-THRU" switch on front panel.
- **CW full break-in.**
  CW full break-in circuit uses CMOS logic IC plus reed relay for maximum flexibility, coupled with smooth, quiet operation. Switchable to semi-break-in.
- **Dual digital VFO's.**
  10-Hz step dual digital VFO's include band information. Each VFO tunes continuously from band to band. A large, heavy, flywheel type knob is used for improved tuning ease. T.F. Set switch allows fast transmit frequency setting for split-frequency operations. A=B switch for equalizing one VFO frequency to the other. VFO "Lock" switch provided. RIT control for ±9.9 kHz receive frequency shift.
- **Eight memory channels.**
  Stores both frequency and band information. VFO-MEMO switch allows use of each memory as an independent VFO, (the original memory frequency can be recalled at will), or as a fixed frequency. Internal Battery memory back-up, estimated 1 year life. (Batteries not Kenwood supplied).
- **Dual mode noise blanker ("pulse" or "woodpecker").**
  NB-1, with threshold control, for pulse-type noise. NB-2 for longer duration "woodpecker" type noise.
- **SSB IF slope tuning.**
  Allows independent adjustment of the low and/or high frequency slopes of the IF passband, for best interference rejection.
- **CW VBT and pitch controls.**
  CW VBT (Variable Bandwidth Tuning) control tunes out interfering signals. CW pitch controls shifts IF passband and simultaneously changes the pitch of the beat frequency. A "Narrow/Wide" filter selector switch is provided.
- **IF notch filter.**
  100-kHz IF notch circuit gives deep, sharp, notch, better than -40 dB.
- **Audio filter built-in.**
  Tuneable, peak-type audio filter for CW.
- **AC power supply built-in.**
  120, 220, or 240 VAC, switch selected (operates on AC only).
- **Fluorescent tube digital display.**
  Fluorescent tube digital display has analog type sub-scale with 20-kHz steps. Separate 2 digit display indicates RIT frequency shift.
- **RF speech processor.**
  RF clipper type processor provides higher average "talk-power," plus improved intelligibility. Separate "IN" and "OUT" front panel level controls.
- **One year warranty.**
  The TS-930S carries a one year limited warranty on parts and labor.

Other features:

- SSB monitor circuit, 3 step RF attenuator, VOX, and 100-kHz marker.

Optional accessories:

- AT-930 automatic antenna tuner.
- SP-930 external speaker with selectable audio filters.
- YG-455C-1 (500 Hz) or YG-455CN-1 (250 Hz) plug-in CW filters for 455-kHz IF.
- YK-88C-1 (500 Hz) CW plug-in filter for 8.83-MHz IF.
- YK-88A-1 (6 kHz) AM plug-in filter for 8.83-MHz IF.
- MC-60 (S-8) deluxe desk microphone with UP/DOWN switch.
- TL-922A linear amplifier.
- SM-220 station monitor.
- HC-10 digital world clock.
- HS-6, HS-5, HS-4 headphones.

More information on the TS-930S is available from all authorized dealers of Trio-Kenwood Communications
1111 West Walnut Street,
Compton, California 90220

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