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ham radio magazine

- fixed-tuned LF converter
- an interview with Dr. Kenneth Davies of NOAA
- a simplex autopatch
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focus on communications technology

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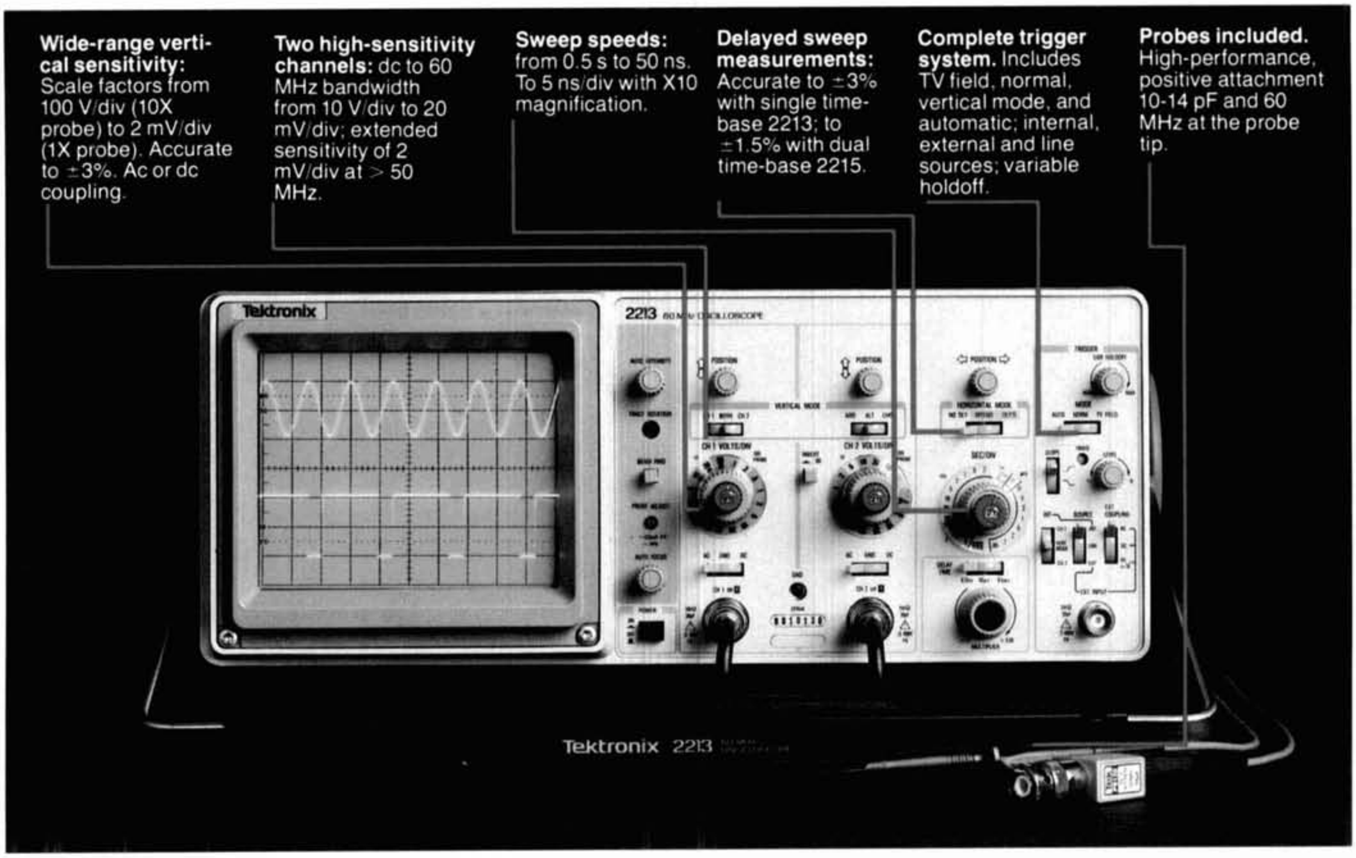

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contents

REFLECTIONS

An Amateur must have the permission of a TV broadcaster before he can buy equipment to get on a certain Amateur band? That's the decision of a California Superior Court judge in Sacramento County! Of course the issues involved are not nearly so simple as stated above. But whatever the background and however compelling the arguments favoring such a decision, the fact that any commercial enterprise has been given control of the activities of an FCC-licensed Amateur has to be of grave concern to all Amateurs. Here's what happened:

A Multipoint Distribution Service (MDS) in Sacramento, California — California Satellite Systems — went to court for a preliminary injunction against a Sacramento Amateur-equipment distributor and several others for "unfair competition," alleging they were selling equipment for receiving the MDS company's 2150-MHz subscription TV signals, and thus unjustly depriving it of revenue. The judge concurred, despite testimony about the nearby 2300-MHz Amateur band and an in-court demonstration of 2300-MHz Amateur equipment. In granting the injunction, which strictly forbids any of the defendants from selling *any* equipment *capable* of being used to receive 2150-MHz MDS TV, the judge included a proviso that such equipment could be sold to a licensed Amateur or "experimenter in microwave frequency transmissions." The section of the injunction order of serious concern to Amateurs is the requirement that prior approval (at no charge) must be obtained from the MDS company before such a sale can be made.

The case, of course, brings up many questions about individual and business rights. The problems of scrambled UHF TV "pirating," and the private reception of both MDS and satellite TV, are currently receiving plenty of attention from both the trade press and — as in this case — the courts. "Rights" mean different things to different people. There's one school of thought that holds that "anyone who doesn't want me to enjoy his radio/TV transmission should keep them off my property." This viewpoint has considerable popular support. A drive-in theater operator who sued to prevent neighboring home-owners from enjoying his movies from their back yards would be laughed out of court. Yet in St. Paul, Minnesota, a federal district judge ordered a home-owner to take down his MDS receiver or start paying the company a subscription fee!

One remedy for "pirate" subscription-TV reception that has been widely employed is legal sanctions against the manufacture and sale of equipment. In California this led the state legislature to pass a law prohibiting not only the sale of decoders but also of any components that could be used in their manufacture! Court injunctions against decoder sale and manufacture, and even the distribution of decoder kits, have been granted in a number of actions across the country; but in this case the judge has taken the process one onerous step further.

In this case, the application of such legal principles as "prior restraint" and "presumption of guilt" must be questioned. The possessor of a Technician or higher class Amateur license has been granted the right to operate on all VHF and higher frequencies by the FCC. However, in Sacramento this right, at least with respect to the 2300 MHz band, can be subject to the whim of a commercial enterprise — a commercial enterprise that has no interest whatsoever in the furtherance of Amateur Radio but has a very real interest in keeping any and all "amateurs" (note the small "a") and other experimentally inclined individuals away from "their" portion of the spectrum. To their credit, California Satellite Systems' lawyer has contacted Westlink asking the Amateur community for suggestions as to how both their interests and ours can best be protected. Any suggestions can be sent to us here in Greenville, and we'll see they get to the law firm.

However good the intentions of the MDS firm in this case, this decision is one that cannot be allowed to go unchallenged. If it stands, then why not give a channel 2 TV station the right to determine what kind of 6-meter gear is sold in its viewing area, and to whom? After all, 6-meter Amateur interference could drive viewers to other channels, thus depriving the station of revenue. Or why not let a cable system operator establish quiet hours for his area's 2-meter operators, since cable channel E (145 MHz) is used for extra-charge special events on many systems?

The Personal Communications Foundation, the ARRL, and many concerned individual Amateurs are closely following the developments in Sacramento. We must not let such a fundamental intrusion on the rights of licensed Amateurs remain unchallenged.

Joe Schroeder, W9JUV
associate editor

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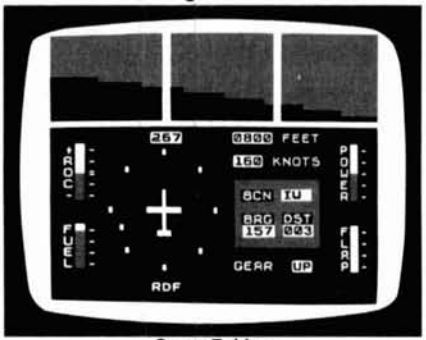

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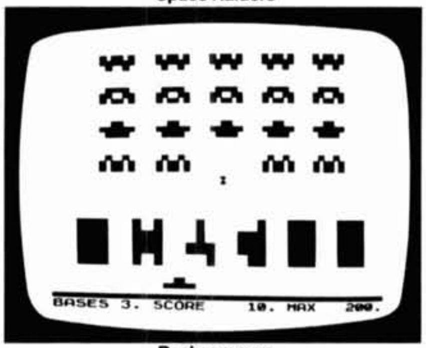

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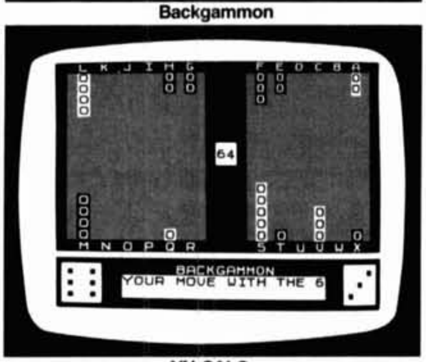

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comments

no-code license

In the September, 1982, issue of ham radio, *the publisher and editor-in-chief of* ham radio, *Skip Tenney, W1NLB, and associate editor Joe Schroeder, W9JUV, presented an editorial in which they advocated that Amateurs look into the merits of the FCC's proposed no-code Amateur license. As expected, the response was swift and emotional. By far the majority of those who responded to the editorial were opposed to any kind of code-free license.*

Presented below are excerpts from some of the letters received.

The decision and dilemma of a no-code license is a two part question: fact and emotion. Let's examine some thought-provoking aspects of this question.

What is the value or purpose of Morse code? There is only one! In a marginal reception situation, the ear/thought process can interpret an on/off tone more effectively than the complex communication of the human voice. For this very reason, all military communication specialists are required to learn code. Said simply, anyone using code can get a message through where voice is unintelligible. It is also fact that on/off rf generation equipment (both sending and receiving) is simpler to develop, understand, and build than voice generation techniques.

The second part of the no-code license proposal appears to be the emotional half. I am a ham! Not everyone can be one, because they don't have the determination, intelligence, skill, and guts to work to be a member of our fraternity. I'm pleased to be a member of a group of people who are elite and have done something to make them stand out in a crowd. Our country was founded and has grown on the principle that the best succeed and thank God we can all work to achieve what we want.

Are these questions important? What is the purpose of Amateur Radio? If you are part of a group whose lives depend on "getting the message through" (military or public service), or if you believe in the principle of our ability to "be what we want to be" (freedom), then the answer is yes.

As a final note please observe that I have underlined work many times. True appreciation of anything in life — be it mental, spiritual, or physical — is rewarded directly to the amount of effort expended by the recipient. Anything given to us quickly loses its real value without exception. Time and again we are reminded that each of us only truly enjoys what we have earned. — William E. Martin, WB4KSP.

The code requirement is the only thing keeping more lids from Bashing their way into Amateur Radio. The code represents discipline. Even if a person never uses the code once he gets his license, he has demonstrated the fact that he has the discipline necessary to be a qualified ham. Once a person learns the code he does not easily forget it. It is a skill to be proud of having.

I doubt if any ham really believes the code is outmoded, as some computer-oriented proponents would have us believe. I doubt if any ham really believes the code is an impossible stumbling block for youngsters.

There are only two reasons why a person cannot learn the code: 1) lack of interest (he really doesn't want to be a ham); or 2) laziness (he would rather be given something than earn it).

Sorry, gentlemen, you're wrong on this one. If we wind up with a no-code license, it will be due to publishers, manufacturers, and dealers . . . not because of their interest in Amateur Radio, but rather due to their pursuit of the almighty dollar. — Ken Piletic, W9ZMR.

It is perfectly ridiculous to require that computer-oriented young people, and busy young engineers with endless demands on their time, learn the code which they may never use. We urgently need these bright energetic young people in the Amateur service, and we are not attracting enough of them.

Most Amateurs oppose the no-code license because they do not want Amateur Radio to sink into a CB-type chaos. But well-conceived examinations, honestly administered, should safeguard against that. Others oppose a no-code license on the grounds that anyone can learn the code; these well-meaning people simply do not understand the problem.

It is unfortunate that the ARRL, because of the shortsighted view of most of its members, can be counted

continued on page 54

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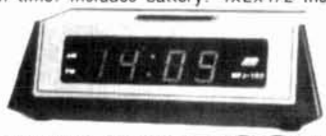

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presstop de W9JUV

AMATEUR INTRUSIONS INTO THE OFF-LIMITS 10.109-10.115 MHz portion of the new 30-meter band have resulted in complaints from the governmental agencies affected and concern in the FCC. With Amateurs from other nations using the slots forbidden to U.S. Amateurs, it's easy to slip into violation. When such an intrusion is heard, please warn the violator with a quick long-distance call to help preserve our good relations with the agencies that have legitimate access to those frequencies.

Activity On The New Band Has Been Steady but not heavy, with most users reporting it is more like 40 than 20. DX has been reasonably available, with several U.S. stations reporting more than 40 countries worked and several more near WAS by the end of November.

BURBANK (ILLINOIS) OFFICIALS HAVE FINALLY RESPONDED to their residents' suit challenging the community's anti-tower and RFI ordinance. The city, in a motion to dismiss the complaint, challenged the federal court's jurisdiction and claimed the city has a right to control "nuisances" such as RFI and antennas. A status hearing is set for December 13.

BEACON FREQUENCIES AUTHORIZED BY THE FCC FOR "AUTOMATIC" (unattended) control in its early November report and order are 28.2-28.3, 50.06-50.08, 144.05-144.06, 220.05-220.06, 222.05-222.06, 432.07 - 432.08, and all Amateur frequencies above 450 MHz. Manual control (attended) beacons are permitted on all Amateur frequencies. Beacon transmitters are limited to 100 watts input under the new rules, which become effective January 3, 1983.

ARRL ASSUMPTION OF THE EXAMINATION PROGRAM as proposed in its late October petition is believed to be seeing some modification by the League itself during the comment period, which closed November 29. The League's Executive Committee has also agreed to ask the Commissioners to delay consideration of a no-code license for 18 months, in order to avoid injecting such a controversial issue into the already complex problems that Amateur administration of the exam program is certain to create.

Whether Or Not The League's Exam Proposal becomes the basis of the new exam process, the Commission's own timetable, as well as financial considerations, seem to insure that the transfer will have to be accomplished by next fall.

Amateur Participation In Monitoring And Enforcement activities could well precede our taking over the examination program. ARRL's Interference Task Force has been working on the details of a cooperative effort between FCC's Field Office Bureau and Amateur volunteers for some time, and with minor revisions in the well-established OO program it could be up and running in a few months. Much of such a program would be "advisory" to individual Amateurs, as with present OO notices. However, with respect to deliberate violators, the volunteer monitors' job would be to make it as easy, quick, and inexpensive as possible for the Commission enforcement staff to build an effective case against a flagrant violator.

FCC'S NOVICE EXAM PROPOSAL to permit the examiner to create and grade the written as well as code portions, PR Docket 82-727, has comments due February 15, reply comments March 15.

Comments On The FCC's Logbook Elimination Proposal, PR Docket 82-726, are due by January 14. Reply comments on that item are due February 14.

In A Related Move, The FCC Has Dropped The Requirement that stations in the Aviation Services maintain logbooks.

A NEW RUSSIAN SATELLITE, ISKRA 3, WAS LAUNCHED November 18 from the Salyut 7 spacecraft. At presstime only CW telemetry on its 29.583-MHz beacon had been heard from Iskra 3, which is believed to carry a 21.23-21.27 MHz in, 29.58-29.62 MHz out transponder like its predecessor, Iskra 2. Iskra 3's altitude is about 360 km, and period 91.6 minutes.

Phase IIIB's Launch Is Now Definitely Set For Next April on Arianne's L6 launch. In addition, the Air Force has responded favorably to a proposal that Phase IIIC be given a ride on an Air Force launch some time in 1984. As a result, AMSAT's budget is being stressed severely. Members are strongly urged to renew their memberships promptly. Some worthwhile AMSAT goodies are still available; Box 27, Washington D.C. 20044 has details.

1983 OSCAR Orbital Prediction Calendars that include RS-5 through 8 as well as OSCAR 8 are now available from Project OSCAR, Box 1136, Los Altos, California 94022. U.S. postpaid price is $10; they're $12 overseas.

FINAL WARC IMPLEMENTATION COMMENTS ARE BEING SOUGHT by the Commission in an NPRM adopted at its November 18 agenda meeting. The actual 300-page document and comment due dates should be released by mid December, but those areas of most interest to Amateurs are final rules for 10 MHz, availability of 18, 24, and 902 MHz, and moving the frequency below which CW ability is required down to 30 MHz. No surprises are expected in the Amateur Radio portions of General Docket 80-739; a 60-day comment period is expected.

ELIMINATION OF CB LICENSING IS EXPECTED TO BE DECIDED ON by the commissioners in an early December meeting. Expectations are, that despite strong opposition from CB user groups such as REACT, requirements for both CB and radio control licensing will be dropped.

NEW THIRD PARTY TRAFFIC AGREEMENTS WITH ST. VINCENT (J8) AND GRANADA (J3) have been announced by the FCC, just in time for Caribbean winter holiday travel.

first report on new band propagation

Experiments and observations on the 10, 18, and 24 MHz bands

The Federal Communications Commission licensed the experimental station KK2XJM on August 25, 1981, for the purpose of conducting experiments on the 10.100-10.150, 18.068-18.168, and 24.890-24.990 MHz WARC bands. These bands are intended for Amateur use in the future. A license on these bands authorizes operation at a maximum of 30 watts ERP and 2.8 A3J emissions. [U.S. Radio Amateurs were permitted to use 10.100-10.109 MHz and 10.115-10.150 MHz, at a maximum power level of 250 watts with A1 or F1 transmissions, as of October 28, 1982, at 3 p.m. Eastern Daylight-Saving Time.]

One main reason for the experiment on these bands was to gather and analyze reports received from (mostly Amateur) listening stations. The analysis techniques we used, and the results obtained from the reports, are presented in this article.

Because the results of the experiment depended greatly on listener response, we generated and distributed publicity announcing the experiment and its authorization by the FCC, and we described the information needed from listeners and how it should be reported. This publicity was followed at intervals by detailed schedules of our broadcasts. *QST* and *World Radio* published the complete announcement, *ham radio* covered the information in an editorial, and extracts and schedules were also published in *73*, *CQ*, *Florida Skip* (a regional magazine), and several local club newsletters.

The response we received from listening stations was encouraging. Many people phoned or sent letters, requested schedules, asked for information on the equipment to be used, and wanted to know how to provide reception reports.

preliminaries

Before starting the experiment, we conducted a number of sweeps on the 10, 18, and 24.5 MHz bands to determine signal levels and types and to select operating frequencies. **Fig. 1** shows a result typical of these scans. Signals are shown as blocks for teleprinter, multi-channel signals, and voice or music, and as lines for unmodulated carriers. Some of the carriers represent no-information transmission periods of stations that were active at other times. We found gaps at times, but all frequencies on 10 MHz were in use at some period of the day.

Conditions were similar on 18 and 24.5 MHz, but the average number of stations on the air was lower, and periods of heavy use were shorter. It was not uncommon to find only six signals on these bands, half with no modulation.

A better picture of band use developed as the experiment progressed. Spectrum scans were made by W1RN at the ARRL Lab in Newington, Connecticut, as an aid. A pattern of full occupancy during others was evident; we also noted that a few signals were very strong, but there were long periods when most signals were not much above the noise level.

We couldn't identify all the signals present; stations appeared without identification, transmitted coded signals by voice or CW, and then disappeared. We didn't try to copy teleprinter signals, which alternated as keyed or non-keyed carriers without Morse transmissions.

After studying the scan results, we scheduled initial operations on 10.140, 18.108, and 24.930 MHz. These are each 40 kHz above the low edge of the WARC bands. This uniformity was actually a low priority; the prime consideration was to avoid frequencies occupied either by very strong signals or by any signals most of the time. And we wanted to select frequencies most likely to be detected by typical Amateur installations, as well as those on which interference would be a likely problem. Determining the interference potential to existing band users by an Amateur signal was one of the main reasons for conducting this experiment.

By R.P. Haviland, KK2XJM (W4MB), 2100 S. Nova Road, Box 45, Daytona Beach, Florida 32019

Although it soon became clear that there was no real reason to use frequencies other than those first selected, it did appear that some attempt should be made to simulate the Amateur condition of no assigned frequency. We did this by introducing a small offset from the selected frequency. Normally the offset was kept to a fraction of a kHz, but we did use a few offsets of up to 5 kHz.

experimental equipment configuration

The equipment we used is summarized in **fig. 2**. The transmitter is an SBE 33, using new band crystals, and rf coils paralleled by additional inductors to provide the necessary tuning range. The tune circuit was modified to provide an adjustable carrier level and to permit switching or keying.

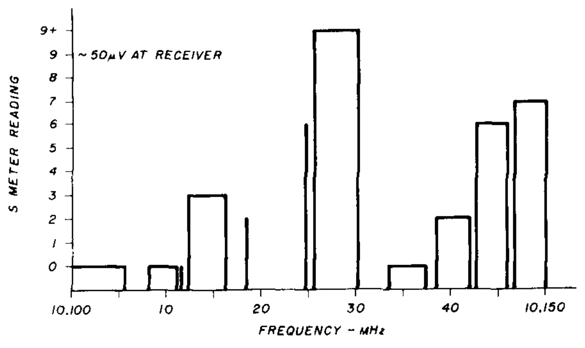


fig. 1. 10-MHz-band signals on September 20, 1981. Wide blocks are single or multi-channel Teletype™, the narrow block is SSB, and the lines represent carriers.

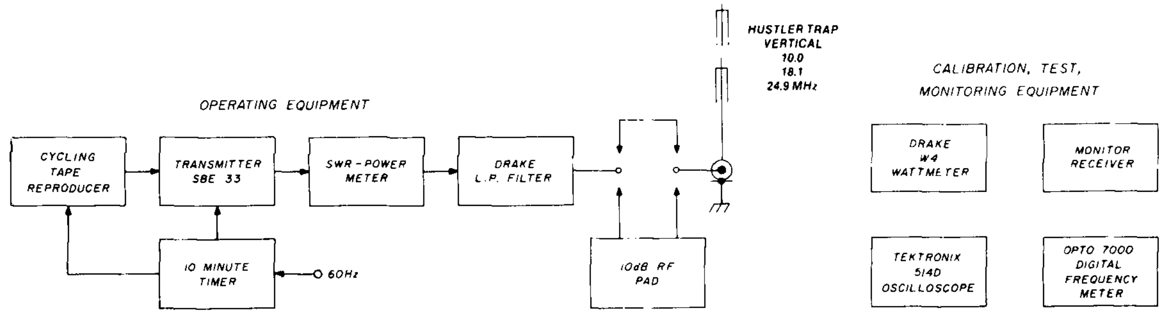


fig. 2. Block diagram of experimental configuration.

We retuned the antenna, a commercial (Hustler) trap vertical, to the center of the WARC bands by adjusting the capacity sleeve of each trap. Section lengths were adjusted for minimum SWR at the selected frequencies. The antenna was mounted at the center of a 36 × 56 foot metal roof. The ground connection to the roof was primarily capacitive: a screen approximately three feet square with six end-terminated radials eight to thirty feet long. An rf check of the roof showed essentially uniform current distribution at the perimeter.

The transmitter operation was controlled by a ten-minute timer, the minutes indicator of an experimental digital clock. We used a nine-minute carrier followed by one minute of identification by USB voice. The identification was made by a recorded voice announcement of fifteen or thirty seconds' duration on an endless tape. For ease of copy, the XYL (W4LDY) made the tapes. The identification tape was not locked to time.

We monitored power and frequency continuously. A 10-dB pad (2-watt carbon resistors in oil), was inserted in the transmitter output for low power. This also served as a dummy antenna.

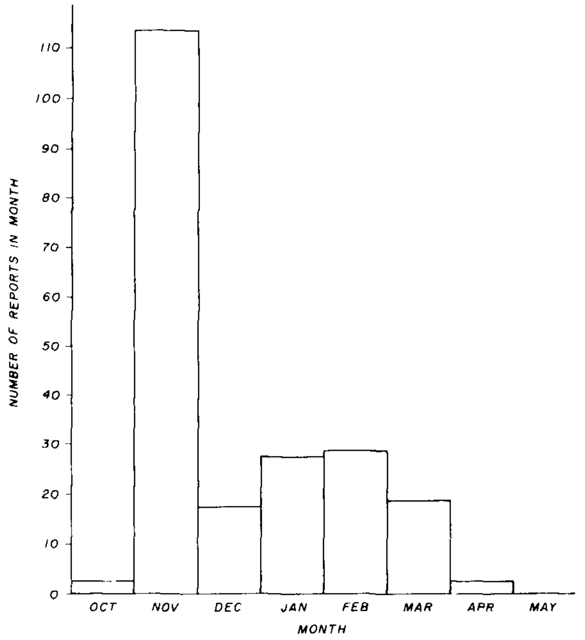


fig. 3. Distribution of reports by month.

Band use and emitted signal quality were monitored by a transceiver, originally a Kenwood TS-820, later a TS-830. We began operating on October 3, 1981, at a power level of 3 watts ERP on 10.140 MHz. The signal was a single steady carrier interrupted every ten minutes, beginning at two minutes past the hour, by a voice announcement. We operated continuously from October 4 through October 12, and then for seventy-two hour stretches (Friday through Sunday, UCT) beginning October 19 and continuing till September, 1982.

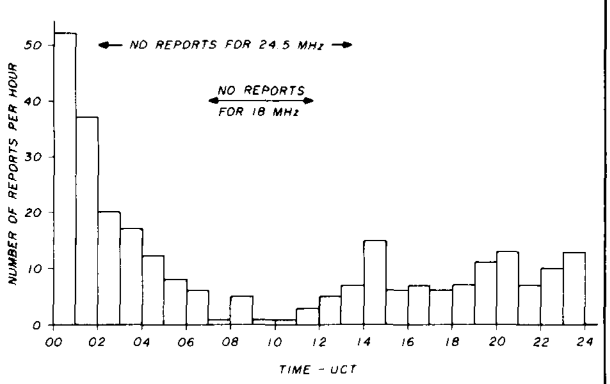


fig. 4. Distribution of reports by time of day. The period from 02 to 12 hours is nighttime at transmitter site.

We increased power to 30 watts on November 3, and instituted a regular rotating schedule for operations on all bands on December 2. During our first four weeks on the new bands, operation was also on 3 watts ERP, rising to 30 watts ERP thereafter.

quantitative results — general

A total of 168 individual reports were received. Of these 131 were for a single time and frequency. The remaining thirty-seven were for multiple times, up to approximately thirty. The total data base consists of 274 entry items: this number is smaller than we'd hoped for, but good enough to give reasonably accurate results.

The distribution of reports over time is shown in **fig. 3**. The small number received in October is a result of low power and a lack of publicity. Changing these factors resulted in a great increase in the number of reports for November. Thereafter, we believe the novelty of reporting was gone, and only the truly dedicated have continued to report. All reports are acknowledged with a special QSL card.

quantitative results — effect of times

The distribution of reports correlated with time of

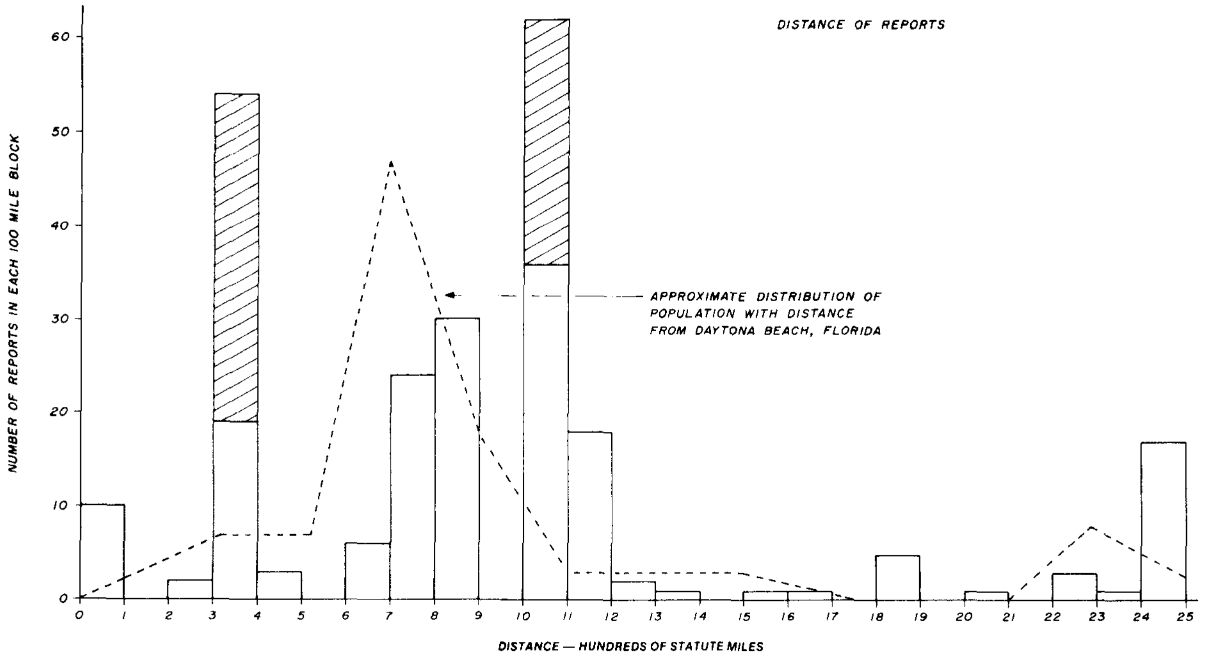


fig. 5. Distribution of reports by distance from the transmitter site. The shaded areas represent reports by two dedicated Amateurs. The dotted curve is the distribution of U.S.A. population from the transmitter site. Note the strong suggestion of skip zones.

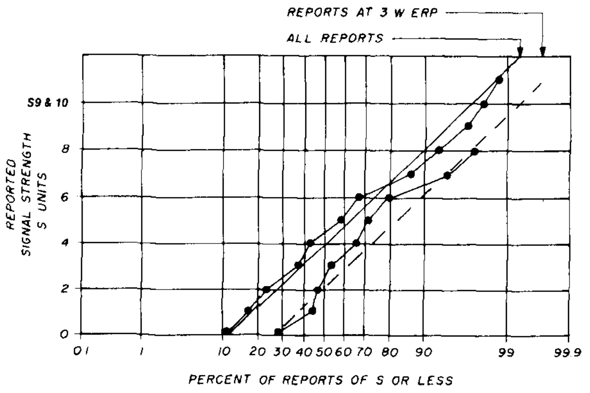


fig. 6. Distribution of signal strength reports. The horizontal scale is for the normal or Gaussian distribution.

day is shown in **fig. 4**, by block for each hour. The reason for the large number of reports at 00-01 hours UCT appears to be that those hours are good for listening (early evening for the U.S.A.) — and also improved propagation at 10 MHz. The low between 07 and 11 hours UCT is understandable, since most listeners are sleeping, and propagation during those hours on 18 and 24 MHz is not as good, as indicated by the no-report bars. The number of reports on these bands, however, is not a major factor in the overall distribution.

The curve indicates that the 10-MHz band will be usable almost twenty-four hours a day during part of the solar cycle. The band at 24.5 MHz resembles 10 meters in performance, being dependent on daylight and high solar activity.

quantitative results — distance effects

The number of reports as a function of distance is shown in **fig. 5**; the reports are separated into zones one-hundred miles wide. (Note that in two of these zones, from one-third to two-thirds of the report entries are from a single Amateur station. The influence of this repeated reporting can be estimated by disregarding the cross-hatched areas of the bars at 300-400 and 100-1100 miles.)

The data strongly suggests the presence of skip zones, with maximum signal strength at 350, 950, 1850, and 2450 miles. This finding, however, could be the result of uneven population distributions. To check this, we calculated the distance from the transmitter to each state capital (we assumed that the largest population concentration of the population of the state is at this distance). The population distribution that results is shown as the dashed curve in **fig. 5**. (While a distribution of Amateurs with distance would be more representative, the percent of Amateurs and shortwave listeners does not appear to vary widely from state to state.)

Comparing the population and report distributions confirms that skip processes are at work here. The block at 350 miles appears to correspond to one-hop (sporadic) E, those at 950 and 1850 to one and two-hop E, and the block at 2450 miles possibly to three-hop E, but more likely to one-hop F-layer propagation. These reports are for all the bands, but they are dominated by 10-MHz reports. The number of reports at 18 and 24.5 MHz were too few to permit the evaluation of the effects of distance.

signal strengths

The distribution of signal strength reports is summarized in **fig. 6**. For all reports on all bands, the median signal report is approximately S4, and nearly fifty percent of the reports fall between S2 and S6. This distribution approximates the normal, or Gaussian curve, very closely, although in principle the curve is bound at the low signal end and essentially unlimited at the upper.

Reports at the three-watt input level are also plotted, and lie almost exactly two S-units, or a nominal 10 dB, below the curve for each. The number of reports at this power level is not, however, sufficient for a really good estimate to be made.

The signal strength distribution over the three bands is shown in **fig. 7**. The median signal on the two higher bands lies approximately one S-unit below signals at 10 MHz, and shows somewhat greater propagation variability. Under strong signal condi-

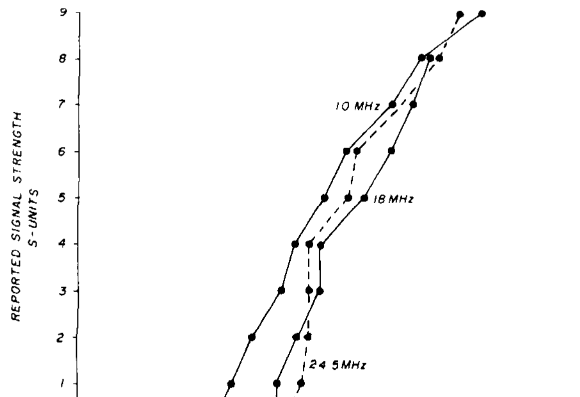


fig. 7. Comparison of distribution of reported signal strengths for the three bands used in this experiment.

tions, however, levels on all the bands are essentially the same.

These observations suggest that signals on 10 MHz are less affected by most propagation disturbances than will those on the higher bands. (This is also noticeable on 14 MHz, when compared with 21 and 28 MHz.) Considerably more data is needed, however, to confirm this factor. Listening stations' use of less efficient antennas (than a resonant half-wave) might account for the lower signal levels reported.

solar and geomagnetic activity

The National Bureau of Standards' K index was used to measure propagation conditions. Although there were a few periods of very good or very poor propagation, the general conditions ranged from average to below average.

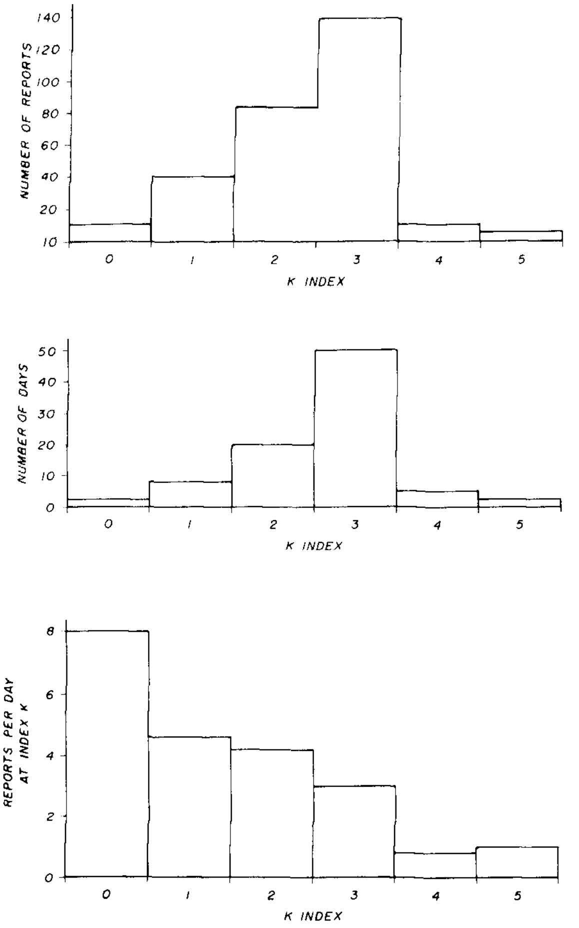


fig. 8. Effect of propagation disturbance on the number of reports received. The bottom curve, giving the reports per day at a given index, is the best indicator of propagation effect. Curves for 18 and 24.5 MHz are similar.

The effect of propagation conditions at 10 MHz is shown in **fig. 8**. The largest number of reports received were for $K = 3$, with a very few reporting K exceeding 3. The ratio, or number of reports per day of a given index, appears to be a better measure of the effects of propagation. The bottom chart shows this, and indicates a marked decrease in the number of reports received as the K index increases. In comparison with the excellent conditions $(K = 0)$, average conditions $(K = 2)$ reduce the number of reports to one-half, and poor conditions $(K = 4\text{-}5)$ reduce the number to around one-eighth.

The pattern for the 18 and 24 MHz bands is similar, with a greater reduction in reports as propagation becomes poorer. This reduction corresponds to subjective observations on the effects of poor conditions.

The effects of conditions on signal strength are shown in **fig. 9**. Three conditions are adduced: excellent, average, and poor, which correspond to K index values of zero, 1-3, and 4 or more, respectively. Signal level differences of 1 to 1.5 S-units between groups are indicated. (Separate observations suggest that F-layer propagation is very poor at $K = 4$ and E-layer at $K = 5$ or greater. Many more observations are required to separate out the various propagation effects.)

receiving equipment

In general, the receiving equipment used by reporting stations was not as sophisticated as the average Amateur band receiver. Most receivers were either all-band receivers, often of the WW II class, or recent-model receivers with WARC band provisions. However, that is not considered to have been a major factor in signal reception.

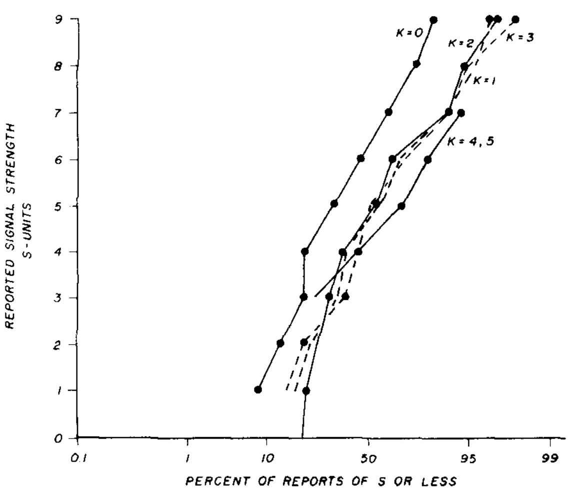


fig. 9. Distribution of reported signal strength by propagation index.

Antennas used by reporting stations (not always optimized for the new bands) included:

inverted-V	76
multiband dipoles	49
long wire	31
verticals	19
wire, (not long)	12
Yagi beams	11
quad-delta beam loops	4
indoor antennas	4

Of these, the long wire and multiband dipoles, and possibly the inverted vees, can show gain, but the rest will give near isotropic performance or worse. For example, the long wire antenna reports were about one S-unit stronger, on the average, with half the reports between S3 and S7. The other half of all reports were between S 1.9 and 6.1, indicating a 5 dB gain for the wire antennas. This suggests the average antenna used in reception was not far from zero dB gain. Indoor antennas could easily be twenty or more dB below isotropic.

Studies reported in *Ham Radio HORIZONS*, July, 1980, page 18, indicate that few Amateur stations on the high-frequency bands use antennas of essentially dipole gain. The average station uses a beam of about 7-8 dB gain, a three-element Yagi or equivalent. Combined beam plus height may run to 15 dB or so for exceptionally equipped stations.

These factors indicate that signal reports in a well-established Amateur Service on these bands will be higher than reported here, resulting from improved equipment alone. The antennas likely to be used would be loaded two or three-element Yagis, showing an effective gain of about 5 dB. Accordingly, it appears that our results should be adjusted upward by about 5-7 dB when applying them to typical (future) operational conditions.

interference

Evaluating interference is an important part of this experimental program. First, interference caused by the experimental station to existing users: No reports of interference to an existing band user were received. This is not surprising; it was the predicted result. In fact, the power limit of 30 watts ERP was set to give a 10-dB margin over the "negligible risk of interference" point of typical existing services, based on CCIR values of required S/N, error rates, fade margin, and typical installation. That no interference has been reported is a good indication that calculated interference values are at least reasonably close to experienced values.

It should be noted that operating frequencies were chosen to be in a low occupancy, but not clear, part of the band, just because of the need for interference data. That this was an effective choice is shown by

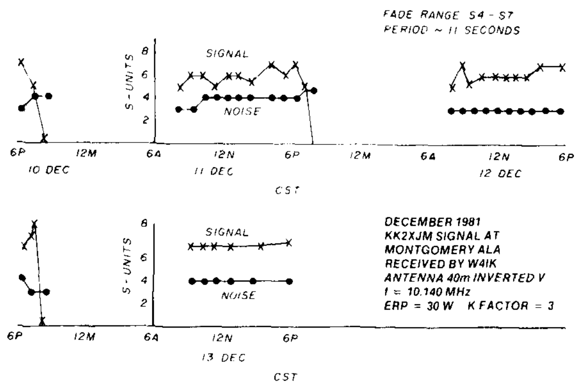


fig. 10. Signal and noise levels at a station 350 miles from the transmitter. Note the sharp decrease in signal shortly after sunset.

the fact that over twenty percent of the reports indicate interference to the experimental signals by existing users.

The relationship between signal, noise, and interference is summarized in **fig. 10**. It shows typical signal and noise levels for a 10-MHz signal received via one-hop E transmission. A decrease in signal strength at sunset is notable. Even at this short distance, 380 miles, the maximum S/N ratio was no more than 30 dB, the usual value being 10-15 dB. Signal levels at this distance should be regarded as marginal for SSB, good for CW.

The interference potential is illustrated in **fig. 11**, which shows a reported band scan for a period of no beacon operation, start-up, and sunset fade. At no time did the maximum beacon signal exceed the level of adjacent signals, being 2-3 dB lower under best beacon-signal conditions. The sunset fade did change the levels of adjacent stations somewhat, when compared with earlier conditions, but the effect was very small compared with that on the beacon signal. (The other signals present were not identified. Since the strength did not usually change appreciably at sunset, they might have arrived via the F layer.)

other experiments

The experimental program described here is one of several in progress. Other stations involved are these:

KK2XGH	Silver Springs, Maryland
KM2XDU	Rye, New York
KM2XDW	Menlo Park, California
KM2XDX	New York, New York

Experimental transmissions are continuing. Major changes that have been made at KK2XJM are power increase to 100 and 300 watts ERP, and scheduling

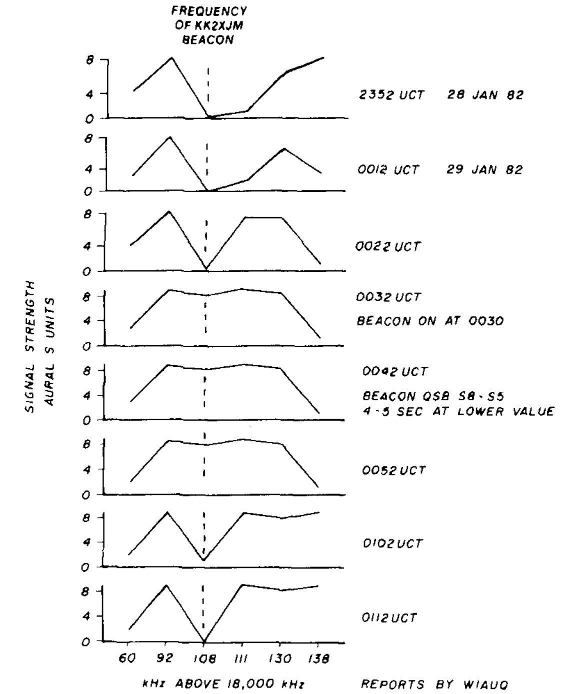


fig. 11. Behavior of experimental signal, and adjacent signals at a distance of about 1200 miles.

band use to approximate the OWF to selected areas. Test results have not yet been compiled for these changes.

conclusions

Our findings are summarized by noting that no unexpected conditions occurred. Propagation effects and signal levels are mostly very close to the predicted average values. One possible conclusion is that a viable and reliable international (greater than 2500 miles) Disaster-Emergency Communication Service* on 10 MHz cannot be established using SSB at 30 watts ERP. This is clearly shown by the paucity of international reports, by the low S/N ratio at 1100 miles and low signal level at 2500 miles under average conditions, and by the lack of service reliability.

This finding confirms the propagation calculations we filed with the experimental license application. These show, for just usable service, operator to operator, average conditions, with a dipole receiving antenna, the following transmitter ERP requirement:

path	time	mode	power, CW	power, SSB
London-Azores	Sunset	E-layer	0.4 W	26.3 W
Washington-Paris	Noon	F-layer	8.2 W	213.8 W

*The benefits of such a service was a major factor in securing these new bands as an Amateur allocation.

For a reliable service, power should be increased by about 10 dB for quality, by a further 10 dB for fade margin, and by another 6 dB for worldwide paths.

It appears that power levels of 1500 watts ERP are needed for reliable worldwide CW disaster/emergency service with dipole antennas (typical of emergency conditions). The level could be reduced to about 300 watts if inter-station relay or a beam antenna for reception were used. A highly reliable worldwide SSB emergency service appears to require unreasonably high powers, although a useful regional service could be established with powers of 200-600 watts ERP.

A second conclusion is that a power level of 30 watts ERP, either AØ or A3J, is below the level which would cause harmful interference on the 10 MHz band. This finding confirms interference calculations. For example, consider a path with 1000 km E-layer winter night propagation, a total of ten interfering signals per 0.3 kHz (CW) or 2.8 kHz (SSB), and CCIR recommended performance. For a signal service reliabilty of 99.99 percent (FSK) or ninety percent (commercial voice), the allowable ERP of *each* interfering station is:

situation wanted/unwanted	CW/CW	CW/SSB	SSB/CW	SSB/SSB
allowable ERP	154 W	912 W	309 W	1830 W

The allowable radiated interference level varies roughly as the square root of the number of stations of equal power (or as the RMS equivalent if different power), due to statistical variations, in modulation, timing, arrival phase and path attenuation. Interfering signal power could be increased about 20 dB at noon. A 10-dB increase in the allowed interference level would reduce service reliability of the desired signal to about fifty percent.

The fact that SSB emissions may be allowed higher power has surprised some. This is due in part to the difference in duty cycle: -17 dB assumed for the normal voice versus -3 dB for average CW. Another difference is in the effect of the number of signals present in the passband, and the percentage of the total radiated power accepted by the receiver. In a service with distributed interference sources and random frequency use, the measure of interference potential is power per unit of bandwidth. Emitted bandwidth alone is not important.

Several weeks of operation at 100 watts and 300 watts ERP have passed since the period this report was based on, again with no reports of harmful interference. This offers further confirmation of the above evaluation. Additional results will be reported on later.

ham radio

a fixed-tuned LF converter

An add-on project to let your 80-meter receiver explore new worlds

Many commercial and military signals can be received by using this simple converter. It is compatible with most commercial transceivers where a direct frequency readout of the 80-meter band is displayed on the tuning dial. A block diagram of the system is shown in **fig. 1**. For digital-readout transceivers, read the frequency by subtracting 3.5 MHz. The converter covers as low as 3 kHz and up to 240 kHz, the low-end cut-off frequency being determined by the receiver used as a tunable i-f (see **fig. 2**).[1]

the circuit

Parts for the converter were available in my junk box and through local distributors such as Radio Shack. The converter is designed to be operated with a long wire antenna, 100 feet or greater, although results have been fairly good with shorter wires (with some sacrifice in weak-signal reception). An active antenna can be used to increase sensitivity.

As shown in the circuit diagram, **fig. 3**, the input circuit is a six-element Chebyshev lowpass filter which is directly coupled to the FET mixer, Q_1. The CR1 and CR2 diode arrangement protects Q_1 from strong transients such as those created by lightning. The local oscillator is a simple 3.5-MHz Pierce crystal oscillator. An output match to the receiver is provided by an emitter follower, Q_2. Total current drain is less than 3 mA. A 9-volt transistor battery can provide over one year of service under normal use. No degradation of operation was observed even when the battery output dropped to 4.5 volts.

construction

The complete converter, including a 9-volt transistor battery, is mounted in a standard 5 × 2½ × 1½-inch (130 × 65 × 39 mm) utility box. A BNC connector can be used for the i-f output (I used a readily available SMA connector), and a standard banana jack serves for the antenna input. Circuit layout is not critical — a 2 × 3-inch (51 × 76 mm) perfboard can be used for component mounting.

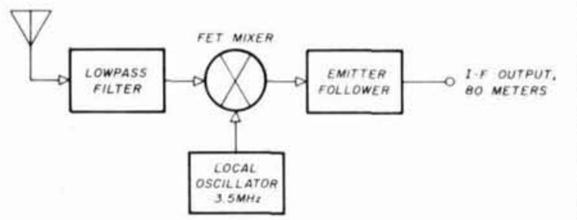


fig. 1. Block diagram of the lf converter.

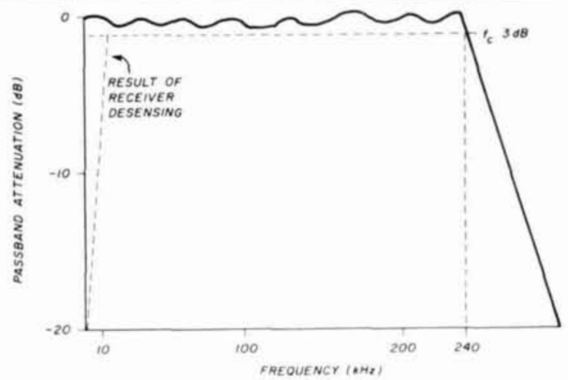
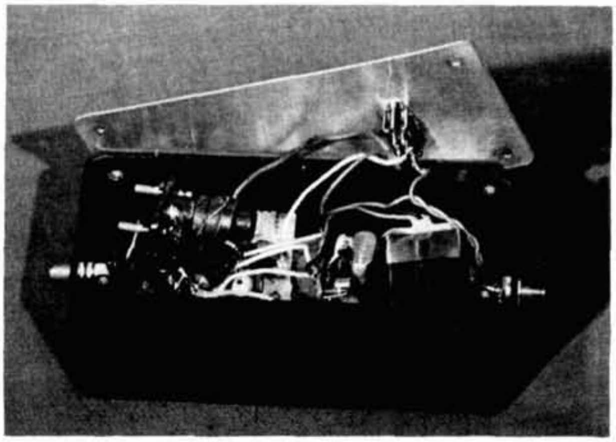


fig. 2. Front-end filter response and tuning range of the 80-meter receiver.



The perf-board and components easily fit into a small utility box with plenty of room for a 9-volt battery.

By S.J. DeFrancesco, K1RGO, 17 Jeffrey Rd., East Haven, CT 06512

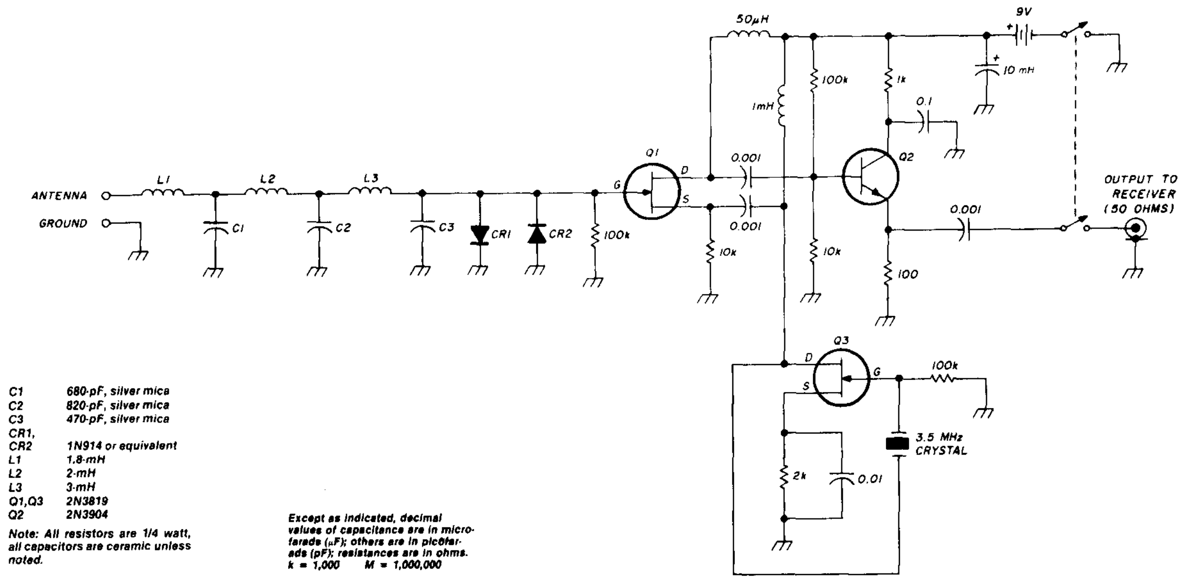


fig. 3. Schematic diagram of the lf converter. Coils used were from surplus two-way radio i-f cans (292 kHz). Rf chokes of proper value will work as well.

table 1. Some signals that have been heard from the East Coast in the LF Spectrum.*

Frequency	Station	Location
12 kHz	OMEGA	–
16-17 kHz	JXZ, GBY	Norway
60 kHz	WWV time signal	Colorado, USA
100 kHz	Loran C	–
120-150 kHz	TTY, CW, Military	East Coast, USA
150-180 kHz	Foreign broadcasts	Mostly European
160-190 kHz	1 watt experimental beacons	East Coast, USA (beacons received over 200 miles)
192 kHz	SFI	San Francisco, CA
194 kHz	TUK	Block Island, RI
215 kHz	CLD	–
233 kHz	GN	–
240 kHz	MMK	–

***Editor's note:** For those interested in studying low-frequency propagation, a good source of frequency and station-location information is the Sectional Aeronautical Chart used by aircraft pilots. Some of the non-directional beacon stations are on frequencies as low as 200 kHz, and they operate continuously. All have an identifier (usually on CW), and some provide local wind, weather, or air-traffic information by voice announcements. Go to your nearest airport and ask the FBO (Fixed-Base Operator — he sells/rents/services small planes) for the VFR chart that covers your area. Get one with a scale of 1:500,000. Each chart has a guide to adjoining areas, so you can pick up enough to cover a large part of the country for a small fee. If you are not familiar with the terms used on the chart, ask the FBO to point out a couple NDBs for you. They are usually indicated by a dot, surrounded by a circular dotted area, and have the location/frequency/identification legend enclosed in a nearby rectangular magenta-colored box.

evaluation

I have obtained very good results using the Yaesu FT101EE receiver and my 160-meter antenna (260-foot long wire). The antenna is connected directly to the input of the converter, and the auxiliary antenna input on the Yaesu is connected to the converter's i-f output. Light-dimmer noise is greatly reduced by the noise blanker in the Yaesu, making perceptible most of the weak signals that were otherwise masked by the noise.

In the 0 to 12-kHz portion of the spectrum, which was at one time used for missile detection, you can hear 60-Hz power-line harmonics, as well as whistlers, chirps, and pops caused by atmospheric phenomena. Some of the activity, starting from 12 kHz (3.512 MHz on your receiver) to 240 kHz, is shown in **table 1**. Low power (1-watt CW) experimental beacons and QSOs can also be heard in the 160-190 kHz band. I have heard HS, Fairfield, CT, 165 kHz; FY, Long Island, NY, 186 kHz; KEN, central NJ, 185.6 kHz; BIL, central NJ, 185.9 kHz; and WI in Owings, MD, 186.2 kHz. All signals were very readable (depending on local noise conditions, of course).

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ham radio

Introducing Corsair

A New No-Compromise HF Transceiver

The CORSAIR is an extraordinary new HF transceiver. Every function operates without compromise. New unique features make it a delight to operate.

A new front end provides extreme sensitivity, low internal noise and high dynamic range to bring weak signals to life. For even greater overload prevention, the integral rf preamplifier can be switched out. More effective than the usual rf attenuator.

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technical forum

Welcome to the *ham radio* Technical Forum. The purpose of this new feature is to help you, the reader, find answers to your questions, and to give you a chance to answer the questions of your fellow Radio Amateurs. As a new feature, the Technical Forum will be shaped by the type and number of letters we receive from you. Do you have a question? Send it in!

I am interested in developing an acoustical filter for CW. In the 1920s or early '30s, in QST*, there was an article about an acoustical filter, but I have been unable to find that article again.*

What I would like to make is an acoustical filter that I could add to ear plugs. The early QST *article was just such a device. Since my ears are not the same with regard to loss, I could make a pair of filters and match the gain to each ear.*

I realize that my problem is of a specialized nature but the subject of acoustical filters is still an interesting answer to CW filtering. — Howard O. Lorenzen, W7BI.

Your memory is excellent. The article you are referring to appeared in the August, 1928, issue of *QST* on pages 23-29. It featured a detailed explanation of the theory behind and the operation and application of these filters. It is entitled "Acoustic Wave Filters and Audio Frequency Selectivity," by R.B. Bourne, 1ANA.

The article clearly illustrates the wealth of technical information developed fifty-four or more years ago that's still applicable to Radio Amateurs today. That is the point *ham radio* magazine was making in our December "Reflections" editorial: reflections of past achievements that should be remembered, used, and built upon.

A few years ago I purchased a frequency meter LM14-Type 74028, built by Loral Electronics. Unlike the normal BC221 frequency meter, this unit uses one each of valve types 77, 6A7, and 76. For some time now I have been wishing to convert the unit to solid state using fets and have commenced doing so, attempting to adapt modifications to the BC221 type which uses two 6SJ7 and one K8-type valve. However, I have run into trouble in getting the variable oscillator to oscillate on the high band and am still attempting to get the crystal to oscillate.

No doubt over the years several ham radio operators have converted the LM series with this old type of valve and I write to you to see whether any such circuit has been published in your magazine. — Harry Hendriks, VK2ZHX.

One Amateur has reworked the same unit you have. Floyd K. Peck, K6SNO, in his article "More on Solid-State Conversion of BC-221/LM Frequency Meters," provides a solution replete with circuit and mechanical modifications. It appeared in the December, 1979, issue of *QST* on page 59. Floyd modernized his BC-221 using a 2N3819 for the solid-state VFO and MPF102 for the modulation mixer. In addition, he mounted the conversion parts in the bases of old 5-, 6-, and 7-pin tubes.

I am using an X-band mixer in a configuration that includes a 1N23WE diode followed by a 2N5179 i-f amplifier. The best noise figure I am able to achieve is 12 dB. Do you know of a lower noise diode in the same package as the venerable 1N23? Would a new Schottky barrier diode be a direct replacement? — Hilary McDonald, Jr., N5AX.

Several possibilities exist, but first it's necessary to mention that low-noise operation requires that the diode work into a well-matched circuit and that it be followed by a low-noise i-f amplifier. Lack of either might be contributing toward your 12 dB noise figure.

Specifically Microwave Associates specs their 1N23WE diode at 7.5 dB and their 1N23WG at 6.5 dB when operated into a well-matched circuit followed by 1.5 dB NF i-f amplifier. Finally, Hewlett Packard's Microwave Semiconductor Division specifies their Schottky barrier diode #5082-2713 at 6.0 dB under the same operating conditions and circuit. It is sold as a double-prong, type-49 package for $32.00 in quantities of 1 to 9.

Thanks go to Jack Lepoff at HP's Microwave Semiconductor Division and John Minck at the Stanford Park Division for the information.

ham radio

graphic azimuth and elevation calculator

A quick and accurate way to locate the geostationary satellites without a calculator

After I spent several weeks calculating the azimuth and elevation for the GOES series of weather satellites in many different locations, I decided there had to be a better way to do it than punching out the program over and over on my calculator. With a few moments of thought and an idea from a Meteostat (the European weather satellite) newsletter, I sat down to draw a simple graph which could be used to estimate the azimuth and elevation of ground stations for any of the geostationary satellites quickly. Since all the geostationary satellites are in the same orbits (except for their longitude), the only variable on the graph from satellite to satellite is the longitude difference between the ground station and satellite.

Many articles have been written describing the calculations needed to track the low orbit satellites (such as the OSCAR series).[1,2,3] The most popular of these is the Oscarlocator[4] graphical technique. This method is popular because the clear plastic overlay lets the operator quickly estimate the satellite location without lengthy computations. Even though minicomputers are rapidly invading the ham shack, few of us have been able to implement the real-time programs which show satellite azimuth and elevation as the satellite passes overhead.

simple geostationary calculations

All these complicated calculations are avoided with the geostationary satellite. These satellites orbit the earth 23,000 miles from the equator and make one orbit in exactly 24 hours. This keeps the satellite over a fixed spot on the earth. To the earth-bound observer the satellite appears fixed in the sky. Thus, once the antenna is fixed on the satellite no further antenna pointing is required. This is especially useful for unattended earth stations for TV and communications.

By Noel J. Petit, WB0VGI, 725 E. 51st Street, Minneapolis, Minnesota 55417

The major disadvantage of the geostationary satellite is that the tremendous distance between the earth and the satellite requires high-power transmitters and sensitive receiver systems to communicate reliably. Most satellite ground stations use parabolic dish antennas to receive the UHF and microwave signals from the satellites. Parabolic dish and other high-gain antennas have narrow beam widths, on the order of a few degrees. To estimate the width of the antenna beam use the following expression:

$$\textit{width (in degrees from half power point to half power point)} = \frac{70^\circ \times \textit{wavelength}}{\textit{antenna diameter}}$$

Both the wavelength and antenna diameter must be in the same units. For example, both must be in centimeters. The beam width for a 2-meter diameter dish at 1691 MHz (17.74 cm wavelength) would be:

$$W = \frac{70^\circ \times 17.74\,cm}{200\,cm} = 6.2^\circ$$

This is a fairly large beam width; with such a large width, the calculation of the antenna azimuth and elevation need not be very accurate to initially find the satellite in the sky. Even a 3-meter diameter dish at 4.0 GHz (7.5 cm wavelength), where the present TV satellites transmit, has a 1.75° beam width. Knowing the azimuth and elevation within one degree is sufficient to find the satellite and then the signal-strength meter can be used to accurately align the antenna.

A graphical means of estimating the azimuth and elevation to a stationary satellite should therefore be accurate enough for most Amateur applications. **Fig. 1** is such a graph. The straight vertical and horizontal lines on the chart are lines of longitude difference and latitude, respectively. The curved lines radiating from the center of the chart are lines of azimuth to the satellite in 10° increments. The curved lines concentric to the center of the chart are lines of elevation to the satellite.

elevation, azimuth

Elevation is the angle from the horizon to the satellite. If the satellite is directly overhead, the elevation would be 90°. Elevation runs from 0° at the horizon to 90° directly overhead (the zenith in astronomical terms).

Azimuth is a bit more complex. Azimuth is the angle measured in degrees clockwise from true north. Looking north you are looking along the 0° line of azimuth. Looking east you are looking along the 90° line of azimuth and so on. From the 0° azimuth at north the measurement goes the full 360° around to north again; therefore, west is 270° azimuth, for example. All azimuth measurements to stationary satellites from the northern hemisphere will be between 90° and 270° since all the satellites lie to the south.

With the meaning of azimuth and elevation in mind, look at **fig. 1**. The first number you need is the ground station's latitude. Locate this latitude on the chart. For purpose of example, let us use Minneapolis at 45°N latitude. This would fall somewhere on the horizontal line half way between 40° and 50°N in the upper half of the chart.

Next, determine the longitude of the satellite and the ground station. I'll choose GOES-Central for my satellite example, at 107°W longitude. Minneapolis is located at 91°W longitude. Thus, the satellite is 16° west of the ground station. On **fig. 1** find the vertical position of the −16° longitude line. If the satellite is west of the ground station use the negative side of the chart and if the satellite is east of the ground station, use the positive side of the chart.

The correct location of Minneapolis is noted on the chart with a cross (+). The elevation of the antenna can be interpolated by noting that the + is between the 40° and 30° elevation rings — a little closer to the 40° ring than the 30° ring. Thus, the elevation of the antenna should be about 36°. The + is close to the 200° azimuth line — about one-fifth of the way to the 210° line, so the azimuth of the antenna would be about 202°.

The actual calculation for the GOES-Central satellite is *elevation* = *35.77°* and *azimuth* = *202.06°*, from a ground station in Minneapolis. The graph

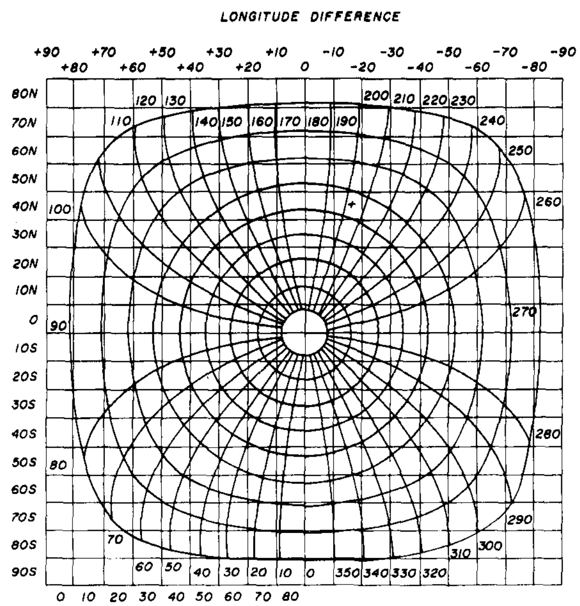

fig. 1. Azimuth and elevation calculation graph for geostationary satellites.

table 1. Geostationary weather satellite status as of January 1, 1982.

spacecraft designation	longitude	status
Meteosat	0°	operational — controlled by the European Space Agency
GOES-5	75°W	operational — GOES-East
GOES-2	107°W	operational — GOES-Central
GOES-1	127°W	standby
GOES-3	130°W	standby
SMS-1	131°W	standby
GOES-4	135°W	operational — GOES-West
GMS	140°E	operational — controlled by the Japan Space Agency

technique is accurate enough to use for most small antennas, but its big advantage is that there is little chance of making an error in calculation with this method.

A fairly complete list of the geostationary satellites can be found in a recent issue of *ham radio.*[5] However, the GOES-series of satellites is not accurately presented. Three GOES satellites are operational at any time. There may be any number of standby satellites in orbit in case the operational satellites experience a failure. Each satellite has two names (much like the naming system chosen for the OSCAR satellites). One name (like GOES-2 or SMS-2) designates the piece of hardware from the development stage to the time it was put in orbit. The other name designates the satellite when it is in use in space. **Table 1** lists the present status of the geostationary weather satellites in orbit as of January 1, 1982. This list includes the Japanese and European satellites which function much like the GOES satellites.

With this simple chart you can easily find the stationary satellites in the sky and tune in on the world of space communications.

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ham radio

an interview with Dr. Kenneth Davies

Dr. Davies of NOAA discusses magneto-ionic effects and their relevance to radio propagation

Dr. Kenneth Davies, one of the leading experts in the field of magneto-ionic studies, has provided guidance in that field since 1949. At present, in his capacity as chief of the Research Division of the Space Environment Laboratory of NOAA, he supervises a technical staff involved in solar-terrestrial (interplanetary, magnetospheric, ionospheric, and atmospheric) studies.

During the past thirty-three years Dr. Davies has worked on projects investigating high-latitude ionospheric absorption and the use of oblique-incidence, pulsed ionosondes. At the famous CRPL (Central Radio Propagation Laboratory), he pioneered the high-frequency Doppler technique used for studying transient ionospheric phenomena. In addition, he was the principal investigator of the NASA/NOAA ATS-6 radio beacon project, which involved placing a frequency-, amplitude-, and polarization-stable transmitter on a geostationary satellite. The ATS-6 space platform provided continuous measurements of the electron content of the ionosphere.

Dr. Davies, author or co-author of over one hundred publications, is perhaps best known for his book *Ionospheric Radio Propagation*, which has become a standard reference in the field. While his professional credentials are very impressive, they are surpassed by his congeniality, his concern, and his ability to explain complex phenomena in terms a layman can understand. He is truly a scientist of highest magnitude.

ham radio magazine is pleased to introduce the first in a series of technical interviews with experts in various fields of communications. In this issue we are presenting excerpts from a two-hour interview with Dr. Kenneth Davies of the National Oceanic and Atmospheric Administration in Boulder, Colorado. Dr. Davies answers questions regarding radio phenomena that affect all Radio Amateurs.

This series will continue, in later issues, with discussions with experts in other related fields of direct interest to hams. The comments of our readers are welcomed.

ham radio: I understand that your chief interest lies in magneto-ionic studies. What is that?

Dr. Davies: Magneto-ionic studies deal with the propagation of electro-magnetic waves, more specifically, radio waves in a plasma (ionized medium) under the influence of an external magnetic field, the *magnetic field of the earth*. When a radio wave enters the ionosphere it splits into two waves, an ordinary wave (O) and an extraordinary wave (X). The waves are reflected at different heights, travel with different speeds, and, most importantly, are absorbed differently. Generally, the extraordinary wave is absorbed more than the ordinary wave, especially near what is known as the gyrofrequency. (See glossary.)

hr: How does a radio wave leaving an antenna know whether it's going to end up as an O or X wave?

Davies: Basically, it doesn't know until it gets to the ionosphere. When a radio wave enters the ionosphere it moves the electrons there. The electrons bob up and down in reaction to the electric vector of the wave — very much like a cork in water when a wave passes by. They start oscillating. In the presence of a magnetic field they *can't* oscillate back and forth linearly. The electron motion is twisted by the

By Rich Rosen, K2RR, technical editor, *ham radio* magazine

action of the earth's magnetic field. On average, half the electrons rotate one way and half the other. The energy is divided roughly 50/50, but not always. There are certain circumstances in which the wave can become all X or O or you can intentionally polarize the wave to achieve this.

Suppose you were at the geomagnetic equator. If you pointed your antenna in a north-south direction all the energy would go into exciting the O wave because the electric vector is parallel to the magnetic field vector. If you try to move an electron along a magnetic field at that location it behaves as if there were no field. (*Ed Note:* $\bar{F} = q\bar{v} \times \bar{B}$ where $\bar{F}$ = *force on electron, zero in this case,* q = *charge,* $\bar{v}$ = *velocity vector* and $\bar{B}$ = *magnetic field vector — the cross product of two in-line vectors = O*).

Now, at or near the gyrofrequency (approximately 1.5 MHz), the extraordinary wave is very heavily damped. If you use a vertical radiator at installations near the equator with East-West and West-East propagation you will excite the X wave. (*Ed Note:* This is of particular importance to South American, African, and other 0° latitude hams operating on 160 meters.)

hr: It's important in Amateur Radio for example because a number of hams who are very interested in DXing use both horizontally and vertically polarized antenna systems.

Davies: That is what magneto-ionic theory is all about. Understanding fading is important if one is to understand radio wave behavior. The fact that signals fluctuate can be related to O and X ionospheric theory. The O and X waves travel by slightly different paths which change as the sun rises and sets. When the two waves beat, deep fading occurs (as at sunrise).

Fading can also result from wave reflection from different ionospheric layers, and sometimes even different reflections from the same layer. This can be explained in terms of layer movement producing phase differences (including 180 degrees) between components of the same wave.

satellite communications is affected by propagation phenomena

Davies: Trans-ionospheric propagation (propagation through the ionosphere as occurs in satellite to ground communications) provides another example of O and X wave phenomena. A linearly polarized wave emitted from a satellite is decomposed into O and X waves that travel at slightly different velocities and increasing phase separation. The combined wave of constructively interfered components is equivalent to a rotating electric vector (changing polarization). The ionosphere changes both daily and seasonally, and the signal polarization with it. During the morning, for example, the electric vector may rotate in one direction and during the afternoon in the other. Over a long period of time conservation must occur; the net rotation must be zero.

hr: It sounds like the length of the rotation period might be related to some very basic phenomena.

Davies: Yes. If conditions on the sun and in the earth's atmosphere were stable then the polarization change — say from 00 hours one night to 00 hours the next — would not exist. In practice, that doesn't happen. The reason for this is partly that the sun varies from day to day, and therefore conditions are different, and also that the atmosphere is different: The upper atmosphere is very much like the lower atmosphere; there are winds up there. There are irregularities. These winds vary and affect the electron density.

hr: Are we talking about a completely random process?

Davies: You know that's our tendency. People have a tendency to say that if you can't explain something it's random. The answer is that this looks random until you understand what is causing it. These conditions are not random in the sense that they fluctuate for a reason. The reason is that the sun varies. As ionized particles from the sun approach the earth they set up electric fields from dawn to dusk across what's called the magnetosphere, the outer region of the earth's atmosphere. This active field in turn affects the plasma in the ionosphere. So a varying sun causes, through several intermediate steps, ionospheric variations. If we knew more about the detailed physics of the sun, this process might no longer be considered "random."

hr: I differentiate between a process that is completely random and one that appears to be random but is really not — or is everything causal? That is, we just don't know the cause?

Davies: This is my point. I would say that everything that happens in the ionosphere, as far as we know, happens for a definable reason.

hr: I'm thinking of the fact that you can build what's called a random-number generator. That is truly random. Or is that causal as well?

Davies: One source of random signals produced electrically is just a hot wire: the random motion of electrons in a resistor. But again it's random in the sense that there are a very large number of them, all of them moving in different directions. We cannot specify what any one electron is doing. You can specify the aggregate changes but you can't specify one.

solar activity indicators

hr: What are the best indicators of solar activity? I understand that ultraviolet, as a measurement technique, is preferred over the 10.7-cm flux readings (see glossary).

Davies: An indicator of solar activity is the sunspot number. Sunspots, darker and cooler areas on the sun, were discovered by Galileo about 1610, and measurements of them have been made more or less continuously since the early 18th century, about 1715. These numbers show distinct cycles, the most prominent of which is the eleven-year cycle. There are longer cycles and there are shorter variations. For example a shorter variation of twenty-seven days is related to the rotation of the sun, as seen from the earth.

What we call the sunspot number is determined by a simple formula that gives a lot of weight to groups of sunspots:

$$R = K(10g + s)$$

where R = sunspot number
K = correction factor
g = number of groups of sunspots
S = number of individual sunspots

The question is, How good an index is this? Obviously, two different observers might see different groups on the sun. One observer might say that two groups exist — another observer that it's only one big group. Consequently any individual value of sunspot number is subjective. But if you have a sufficient number of observers over a long enough period of time, then you obtain an index which is at least roughly independent of individual preference; that is, the various biases cancel out.

hr: Why 10X (weighting) for a group (of sunspots)?

Davies: I don't know the exact historical reason for this, but it has to depend on a belief by solar astronomers (not ionospheric) that groups are more important than individual spots. It has been found that the critical frequencies of the ionospheric layers vary roughly linearly with sunspot number. This is important since sunspot numbers enabled people, in the early days, to project into the future. They could see a long series of cycles and predict what the next one was going to be.

Systems have been developed for predicting future sunspot cycles. One of these developed at CRPL is the McNish-Lincoln method. Data from an ascending cycle enables you to predict, fairly reasonably, sunspots for the next year or so.

hr: Could they have predicted cycle 21's demise based on its rise?

Davies: I'm not sure how long they took to predict the peak, but the prediction was very good for this cycle once it started. Now there are departures. You know this was a steep cycle. And there are differences, perhaps ten or twenty units. However, in general there is close correspondence between the predicted and measured curves.

hr: Cycle 21 (present cycle) had a twelve-month maximum moving average of a little over 160. A very nice cycle. And this one, what a beauty (looking at cycle 19) with 201 smoothed sunspot numbers.

Davies: That's the grand-daddy of them all.

hr: It was an interesting time to be an active Radio Amateur.

Davies: That's right, 1958. (Cycle 19 was the largest modern recorded sunspot cycle, peaking late '57, early '58.)

hr: What about ultraviolet as a measurement tool?

Davies: Let's go back to sunspots for a moment. Why should sunspots be related to anything in the ionosphere? They are just black patches on the sun. To answer the question, let's look at how the ionosphere is formed. The F-region of the ionosphere is caused mostly by solar radiation in the region of 300 to 1200 Å (Angstrom unit = 10^{-10} meters). The EUV (Extreme Ultra-Violet) of the sun's radiation ionizes the oxygen in the upper atmosphere. But you can't measure that from the ground, since it's all absorbed in the ionosphere. If you look at these radiations from satellites above the ionosphere, you find that there's a high correlation between them.

hr: Which satellites? You mean satellites in geostationary orbit?

Davies: Orbiting satellites appreciably above the maximum of the F-layer.

X-rays, on the other hand, having wavelengths of roughly 1-10 Å, come through the F-region. They have much more penetrating power and ionize the D and E-regions. An important point (hams take note!) is that over a sunspot cycle the EUV can increase by a factor of perhaps ten from low to high sunspot number, whereas the X-ray flux may increase by a hundred or a thousandfold during that same period.

hr: No wonder my 3.8-MHz signals get so absorbed during the sunspot cycle peak.

Davies: There's a much bigger solar factor variation of X-rays than there is of EUV. As you go further into the longwave part of the spectrum this becomes even more noticeable. For example, in the visible part of the spectrum there's hardly any change. The solar constant, the amount of energy falling on one square meter, doesn't change very much, less than approximately ½ to 1 percent.

Solar flares are another important category of emissions from the sun that affect terrestrial conditions. They are shorter-term fluctuations lasting from several minutes to days. A sudden ionospheric disturbance, a direct effect of X-rays from flares, can cause a radio blackout. The D-region experiences a tenfold increase in ionization. The D-region is important because, even though there are fewer electrons there than in the F-region, there are many collisions with neutral molecules. Remember that when a radio wave enters the ionosphere, the electric vector sets electrons in motion and, normally, if there were no collisions that energy would be restored, since a moving electron radiates. However, if the electron hits a molecule the energy that's re-radiated is basically converted into heat (from the motion) and radio noise; that is, random, electro-magnetic noise is generated. Once a collision takes place, the electron loses energy, and in the D-region these collisions occur often. This is the region where the energy is absorbed from the radio wave.

hr: What about the 10.7-cm flux?

Davies: The 10.7-cm flux technique is a good measurement. It has several advantages. First, unlike the sunspot number, it is a measurable quantity. Secondly, it penetrates the earth's atmosphere and can be measured on the ground. You don't have to see the sun. On a cloudy day it can still be measured.

hr: How accurately can you measure this?

Davies: It can be measured to roughly 0.1 percent.

hr: One thing still confuses me. It's possible in approaching cycle 21 minimum to have an SSN (twelve-month moving average) of 20 or 30 or less and yet on any particular day to have a high solar flux indication. Which should a communicator follow more closely, the SSN or flux measurements?

Davies: I would think that the 10.7-cm flux is probably the best index because of the reasons I've already given.

hr: Is it possible to have a fairly heavily ionized ionosphere even during a time of solar minimum?

Davies: Yes it is. Even at a sunspot minimum, severe magnetic and ionospheric storms can occur. In speaking of storms, by the way, these are disturbances produced by particles impinging on the earth that affect electrons stored around the earth. When a disturbance occurs in the solar wind, these particles accumulate near the earth, accelerate, and plunge into the earth's atmosphere. They are stored in the magnetosphere, the Van Allen radiation belt. These storms are very important from a radio communications point of view because they are the most destructive of all the ionospheric effects. They can last for two or three days and cause the critical frequencies (maximum frequencies) to drop by a factor of two or three, which means the spectrum available to communicators is reduced. This is particularly noticeable in high latitudes, near the auroral zone, because that's where the particles are.

hr: Does it enhance PCA (polar cap absorption)?

Davies: Yes, generally, but not always. Polar cap absorption events are due to energetic protons over the polar caps — but *inside* the auroral ring. Whereas storms *start* in the auroral zones. Storms are much more important than PCAs.

PCAs are relatively rare. You get a few per solar cycle and they're confined to high latitudes where the density of population is low. Some people mistakenly label an ionospheric storm as a PCA when they really mean ionospheric storms. Ionospheric storms are due to the arrival of particles of lower energy; not millions of electron volts, but a few thousand EV.

In a severe ionospheric storm energy is dumped into the auroral zone but the effects are carried by atmospheric circulation to low and middle latitudes where they can play havoc with radio communications by depressing the upper frequencies.

hr: I saw a report of a storm's effects lasting up to fourteen days.

Davies: That's right, especially in the lower ionosphere. It's called the storm after-effect and disturbs very-low-frequency navigation systems like Omega. Although the storm has died away as far as magnetic disturbances are concerned, the storms after-effects persist in the ionosphere.

cycle 21 characteristics

hr: We have talked briefly about cycle 21. Is it more or less typical, or has it surprised people?

Davies: It's taken many people by surprise. And the reason is this: Although it's a relatively big cycle with respect to ionization, so far as disturbances and storms are concerned it's relatively modest. It's not what we would have expected. Until this year, when we have had some disturbances, the number of storm effects have been small given the size of the cycle. The reason we're surprised, of course, is really that we don't know much about the solar cycle; that is, our sample of previous solar cycles is relatively limited. That is why we need to continue observations of the sun and related geophysical effects.

hr: Where are we in the cycle right now?

Davies: We're about halfway down the declining part of the cycle.

hr: What would our smoothed sunspot twelve-month moving average be?

Davies: The latest sunspot number for June, 1982, was 110.

hr: That's still very high.

Davies: But then the month before it was down to 81. Whereas the month before that it was up to 122. Yes it is high.

hr: For January, 1983, for example, which is when this information will be published, what do you estimate?

Davies: In January we can probably expect numbers of the order of 90.

hr: Do most cycles go down to 5 or 10 (SSN) regardless of their maxima? Cycle 19, for example?

Davies: Yes roughly. They go down to about 10, some go to 5. Big cycles can be followed by small minima. Cycle 18, which began in 1944, was a big cycle with a very low minimum.

hr: How do people predict future cycles based on past cycles?

Davies: There are a number of ways. One way is to take a time series analysis of previous cycles, reducing it into simpler terms or waves with different periods. Then predict the future by getting equations for each of these waves. This is a purely mathematical approach.

hr: An orthogonal series like a Taylor or Fourier?

Davies: Fourier usually, or a new method, developed in the NOAA laboratory by Dr. Paul, called anharmonic frequency analysis. It provided a very good estimate for cycle 21. But, depending on what prediction method you use, you can come up with very different cycles.

hr: If, to predict cycle 21, you were to take all the previous cycles up to 21 and then do your Fourier or anharmonic frequency analysis, what would be the results?

Davies: It turned out that the maximum sunspot numbers predicted by that technique did, in fact, prove to be around 160 (cycle 21).

We're still a long way from an understanding of the sun, which is what we need to be able to predict. You must remember that all these methods tend to be recipes, not true understanding.

hr: Will we ever be able to accurately predict cycles? Let's look into the future. Is there any reason to believe that we will understand all the processes both quantitatively and qualitatively well enough to be able to say, "Cycle 475 is going to have a peak of . . ."?

Davies: Yes, I think that is possible in principle. After all, think of astronomy and how we can predict satellite and planetary orbits with extremely good accuracy. There's reason to hope that, given enough effort, the secret will be unlocked. At the moment we don't know if we're doing the right thing. We have to wait for a Newton . . .

extraplanetary effects on earth

hr: We talked about sudden ionospheric disturbances. Are there other causatives, such as planetary conjunctions?

Davies: Yes, I think it was Mr. Nelson of RCA who hit upon a method by which he predicted disturbances on the basis of planetary alignment. He said that when the planets were lined up on one side of the sun storms would occur. The interesting thing is this: it seems that he predicted a few of these storms within a number of days. But statistically, these methods do not stand up to scrutiny. The question I have asked people who criticize this is the following: If you could predict the big ones, isn't that important — much more important than missing out on the small ones?

less well known ionospheric layers

hr: Are there layers other than D, E, and F?

Davies: There have been some claims for a C-layer which is formed about 60 km up, caused by cosmic rays and is therefore always present. There is another phenomenon seen on ionograms during a storm when the critical frequency of a regular F_2 is greatly diminshed: a little kink appears very high up and is called a G-layer. It's probably not a distinct layer but is a phenomenon that occurs, let's say, at special times only.

hr: Would it correspond to the normal height of the F-layer? Or is it even higher?

Davies: It's difficult to say how high it is because on an ionogram some of the apparent height is caused by retardation underneath. It's not a true height of reflection. The height is actually lower than the height you see on the ionogram.

hr: We're talking virtual heights on an ionogram?

Davies: Yes, virtual heights. During solar eclipses, in certain parts of the world, the F_1-layer tends to break up into F_1 and $F_{1\frac{1}{2}}$. Then the E-layer at times has little kinks in it called the E_1-layer and the E_2-layer. But you must remember that these are not necessarily physical phenomena. They are the appearances of traces on the ionogram.

hr: Are new techniques and instruments now available that will help us differentiate between an apparent and an actual height?

Davies: The new digital ionosondes (conventional sounders are analog) will help us interpret the results. What they will tell us is where the signals actually come from: whether they arrive from vertically above the sounder or off to one side. What the new sounders will therefore do is help us interpret the structure of the ionosphere. That will help.

We've found that some of these "extra" layers are not extra layers. They are layers off to one side at the same height — perhaps parts of another layer. (As an example, if you're 45 degrees off vertical and get a reflection from a hundred kilometers away, you might see another trace at 140 km. Without any other information it's possible to interpret that as a layer at 140 km.)

A greal deal of effort in the 1940s and 50s was put into interpreting echo traces on ionograms. Without full knowledge, it's a very frustrating exercise and in many cases fruitless.

A technique that gives the true height of the ionospheric layer directly is the incoherent scatter technique, in which radio power is scattered by individual electrons. This requires very large and expensive systems, and there are only about six of them in operation.

modes of propagation

hr: Most Radio Amateurs are familiar with the terms one-hop, two-hop via the E or F-layer, but what about M-type: $F_2 - E_S - F_2$ and some of the lesser known modes?

Davies: Well, for example, in trans-equatorial propagation, there's evidence that you can get, because of distortion of the ionosphere, an equatorial anomaly. You can get two reflections off the ionosphere without an intermediate ground reflection. It happens in the evening hours around the equator. There are relatively few of these mechanisms of propagation that are really well documented and well founded.

There have been suggestions that transequatorial propagation is really due to ducting — ducts which go way out, well above the ionosphere, and trap energy.

hr: Well above the ionosphere?

Davies: Yes, or into the upper parts of the ionosphere.

hr: When you say well above, what are you referring to? 500 km?

Davies: Maybe 500, 1000, or 2000 km. But it's not as great as Whistler waves, which are VLF waves, audio-frequency-type waves, which can go out to very large distances, like 30,000 km.

long delayed echoes

hr: It is said that there's a phenomenon called LDE (long-delayed-echo), approaching a second. Do you know of any reason for an LDE that long?

Davies: It's not a field I've closely followed. Plasma physicists say that there is some instability — a storage in the plasma — that takes a long time to release. The people who have studied it insist that these echoes are real. They have coded the signals and claim that they have received real long-delayed returns.

Maunder minimum

hr: Is there evidence today to indicate that the Maunder minimum actually did occur, or is it felt that it was merely a result of lack of recording capability?

Davies: I think that there is evidence that there was a Maunder minimum. It's not likely to have been simply a lack of data.

hr: Is it probable that future generations will see a Maunder minimum?

Davies: I would say yes. It's certainly quite possible. It could happen many times in fact. It could happen the next cycle. Who knows what the next cycle is going to be?

sidescatter

hr: Can you explain the reason for signals sometimes deviating from great circle paths? One example that I recall is the U.S./Europe path via North Africa. Is this a well-known, often-occurring condition?

Davies: Yes, I think it is. It's been known for many years that signals from Europe often appear to come from directions roughly in the mid Atlantic or North Africa, the Sahara region. One suggestion has been made that this occurs when the direct path say from Europe to North America passes through a disturbed auroral zone. If that zone is disturbed, the direct path through the auroral zone is cut out. But you still receive a signal across the Atlantic. It is reflected off the coast of Africa; that is, it hops down to Africa, scatters there, and then across the Atlantic. That bent path is too far south for the storm to affect it. That has been documented and is a possible explanation.

hr: Are there other explanations for sidescatter?

Davies: I think that's the primary one. The other possibility for a signal coming off the great circle path is ionospheric irregularities, particularly field-aligned ones. Irregularities in the ionosphere tend to be field-aligned because electrons can move easily along the field but not across it, creating sheets or columns of ionization. If the geometry is right you get perpendicular reflection.

twilight-zone propagation

hr: What is twilight zone (gray-line) propagation? It's a term Radio Amateurs use to explain a non-great-circle path that provides an unexpected opening.

Davies: I know that people claim RTW echoes are signals received long distances along the twilight zone, or earth's day/night dividing line. It seems to be some form of ducting.

forecasting and predicting

hr: Can you explain the difference between the terms forecasting and predicting?

Davies: Yes. When people talk about predicting, they mean long-term: predicting what the critical frequencies will be next year or the year after or during the next sunspot cycle. This is done for long-range planning purposes: what frequencies you should request, what antenna should you design, angles of takeoff, arrival, and so on. Propagation conditions for the long term are usually referred to as predictions.

Forecasting on the other hand is usually thought as short term, in terms of solar flares.

forecasting solar flares

Davies: To forecast solar flares, we must keep a watch on the sun all around the world and report what happens when a solar flare has occurred by optically viewing the shape and features of the sun. These are solar features such as plages, magnetic configurations, etc. We measure the way the solar magnetic fields become distorted. It's an energy build-up at these active regions of the sun. When this occurs we also receive other information from the sun, solar radio emissions for example. One way of forecasting a PCA is by observing the shape of the spectrum, the so-called U-spectrum wherein the flux has a U (or dip) in the microwave region. There's a minimum in the spectral distribution.

HR: Just prior to the disturbance?

Davies: Yes. We look at the sun in visible light and X-rays. X-rays are very important. X-rays are classified C(s), M(s), and X(s), in which an X flare is a large flare which causes short-wave fadeout (the system was developed in the Space Environmental Services Center). This is one of the best ways we now have of measuring the size of a flare and its ionospheric effects. It's possible to have a big flare optically that may have almost no effect on the earth.

hr: Is this because it misses the earth?

Davies: No. It may be because the spectral content is different. Remember you can have two large flares: one has strong X-ray burst components that ionize the D-region and cause blackout; the other flare, which looks the same in visible light, may not have the X-ray components.

Also, the other point you've raised is valid. The earth must be in the proper position to be hit by the particle burst. We don't know at the moment what the relationship is between the visible appearance of a flare and its particle output. That is something that we must determine.

future of forecasting

hr: Let's look ahead twenty years. Do you see a considerable improvement, based on the work that is occurring right now in the lab, in terms of forecasting?

Davies: Well, unfortunately no. The outlook is very bleak I must admit. Under the President's budget all research, for example, in this lab, Space Environmental Research, will be abolished.

tools of the trade

hr: Can you briefly describe the function of the following instruments: auroral radar, Faraday polarimeter, digital ionosonde?

Davies: An auroral radar is a fixed-frequency radar which bounces signals off ionization in the auroral zone.

A Faraday polarimeter is a device that measures the rotation of the electric vector of a wave and, hence, the electron content of the ionosphere.

A digital ionosonde is a recording instrument that provides standard amplitude and height information (as in conventional ionosondes) and parameters that can be used to determine polarization, phase, and direction of arrival of the signals.

hr: Can't these ionosonde tasks be accomplished using conventional instrumentation?

Davies: Yes, separately. The new digital sounders enable all of these to be done together. That's the big advantage of the new system.

The major thing that we are able to do with new information is determine where the signals come from — and therefore what the horizontal gradients in the ionosphere are. The ionosphere is neither a flat nor a concentric medium.

For example, there's a mid-latitude trough (depression in electron density) in the F-region just below the auroral zone. It's very important, since it distorts the ray path of over-the-horizon radars.

interest in hf

hr: This naturally brings us to my next question. Why is there renewed interest in hf?

Davies: It's related to the obvious advantages of hf. The installations cost less and the system is useful for long distances. There was a feeling in the 60s, when geostationary satellites were beginning to be used, that our radio communications problems had been solved. We thought we could get rid of ionospheric effects by going to satellite communications — the ionosphere would have no effect. But the ionosphere does have an effect, even at these frequencies, in the form of scintillation; even up to 6 GHz. Also, of course, from a vulnerability point of view, satellites are perhaps more vulnerable than the ionosphere to an enemy action. You can wipe out a satellite, but it's more difficult to wipe out the ionosphere.

hr: You mentioned that the ionosphere is extremely forgiving.

Davies: Yes, I think this is true of the entire earth. It recovers from abuse. We pollute the ionosphere intentionally and unintentionally. Huge electron depletions have been noted during the launches of Saturn rockets for example. Thousands of kilometers are affected.

hr: Temporarily?

Davies: Yes, perhaps for an hour or two at night. The sun replenishes it. Even though huge quantities of O_2, H_2, and water are put into the atmosphere, these are natural constituents. They don't do long-term damage.

future of hf

hr: What's the future for the high frequencies?

Davies: I think they will always be with us. I can remember when I started my professional career, people said to me the high frequencies are dead. That was thirty years ago.

glossary

10.7-centimeter flux — *Solar radio noise flux at 2800 MHz that is indicative of the degree of E-layer ionization.*

Maunder minimum — A name applied to a period of approximately 70 years in the late seventeenth and early eighteenth centuries, during which solar activity is believed to have been unusually low.

Gyrofrequency — Gyrofrequency, also called the gyromagnetic frequency, is a frequency derived by the formula below that describes the motion of an electron in a magnetic field. In the ionosphere, where the magnetic field intensity is roughly 0.5 gauss, the gyrofrequency is approximately 1.5 MHz.

$$f_H = \frac{1}{2\pi} e/m\,B$$

where f_H = gyrofrequency
e = the charge on an electron
m = the mass of an electron
B = magnetic field intensity

ham radio

remote-site receivers
and repeater operation

A system for selecting the strongest signal from remote-site receivers

Repeaters are usually built for mobile and hand-held use. Usually the repeater transmitter has a 20 dB power advantage over a hand-held. At the same time, the received signal at the repeater is reduced by this same figure. This means we can hear the repeater transmitter much better than the repeater receiver hears the hand-held.

One of the easiest ways to equalize coverage is to install remote receivers (commonly referred to as satellites). This concept has been used successfully for many years on commercial fm systems, providing full quieting signals over an entire metropolitan area.

satellite operations

A remote receiver system places receivers in locations distant from the main repeater transmitter site. The remote receivers relay the weaker signals back to the transmitter via UHF links. The ideal system, shown in **fig. 1**, uses three remote receivers feeding one transmitter. Since the receivers are located away from the transmitter, you can run higher transmit output power without desense.

So far this seems fairly simple; however, the big problem is designing an effective voting system where the transmitter site will vote (select) the strongest, fullest quieting signal. In commercial systems voting becomes very elaborate, almost impossible for Amateur repeater groups to maintain and afford. *Motorola* uses a system of encoding tones at various levels in which an elaborate gate system selects the receiver hearing the best signal.

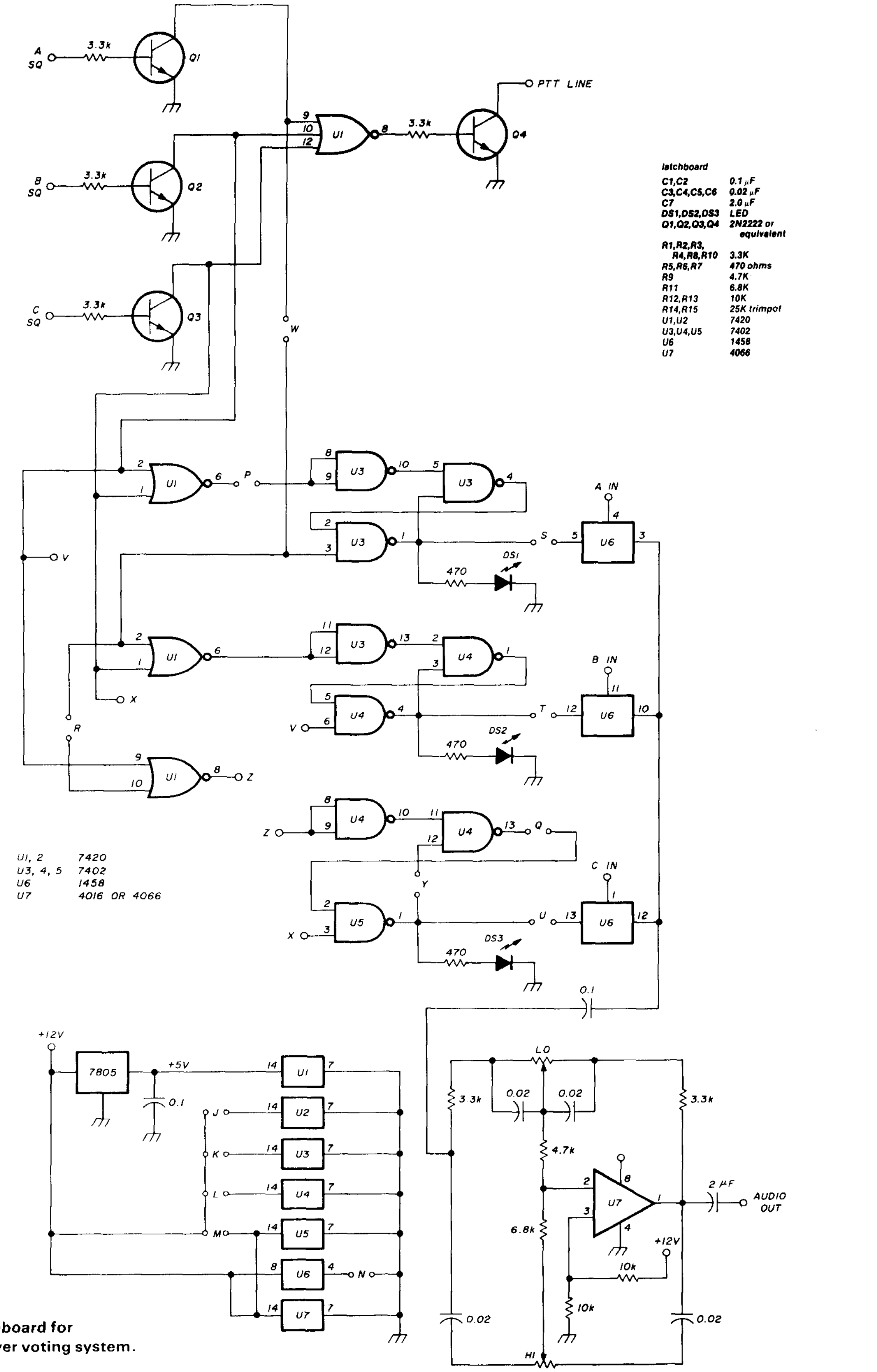
Many Amateur repeater groups could use multiple receiver site systems, however, to date there has not been much in the way of a simple and inexpensive voting system described in Amateur literature. This article describes a very simple voting system that will allow three remote receivers to feed one transmitter with the best quieting signal. It has served our Marissa, Illinois, repeater system very well.

The transmitter site contains three link-receiver boards which operate on the 220 MHz band. These boards were removed from Midland Model 13-509 220 MHz transceivers while the corresponding transmitters were used at the three receiver sites. At WD9GOE each of the 220 MHz receiver boards were mounted on a separate chassis with proper connectors to plug in to a main frame. This allows for easy installation and quick service should malfunctions occur. All three receivers are exactly alike except for the operating frequency. Each 220 MHz transmitter operates on separate frequencies. WD9GOE/R uses 30 kHz separation between the three link frequencies.

voting secret is time

The secret to this simple voting system relies on the time it takes the 2-meter receiver to turn on the link transmitter. A full quieting signal turns the link on immediately. A signal that is −10 dB quieting or

By Bob Heil, K9EID, #2 Heil Industrial Blvd., Marissa, Illinois 62257



latchboard

C1,C2	0.1 µF
C3,C4,C5,C6	0.02 µF
C7	2.0 µF
DS1,DS2,DS3	LED
Q1,Q2,Q3,Q4	2N2222 or equivalent
R1,R2,R3, R4,R8,R10	3.3K
R5,R6,R7	470 ohms
R9	4.7K
R11	6.8K
R12,R13	10K
R14,R15	25K trimpot
U1,U2	7420
U3,U4,U5	7402
U6	1458
U7	4066

fig. 1. Latchboard for three-receiver voting system.

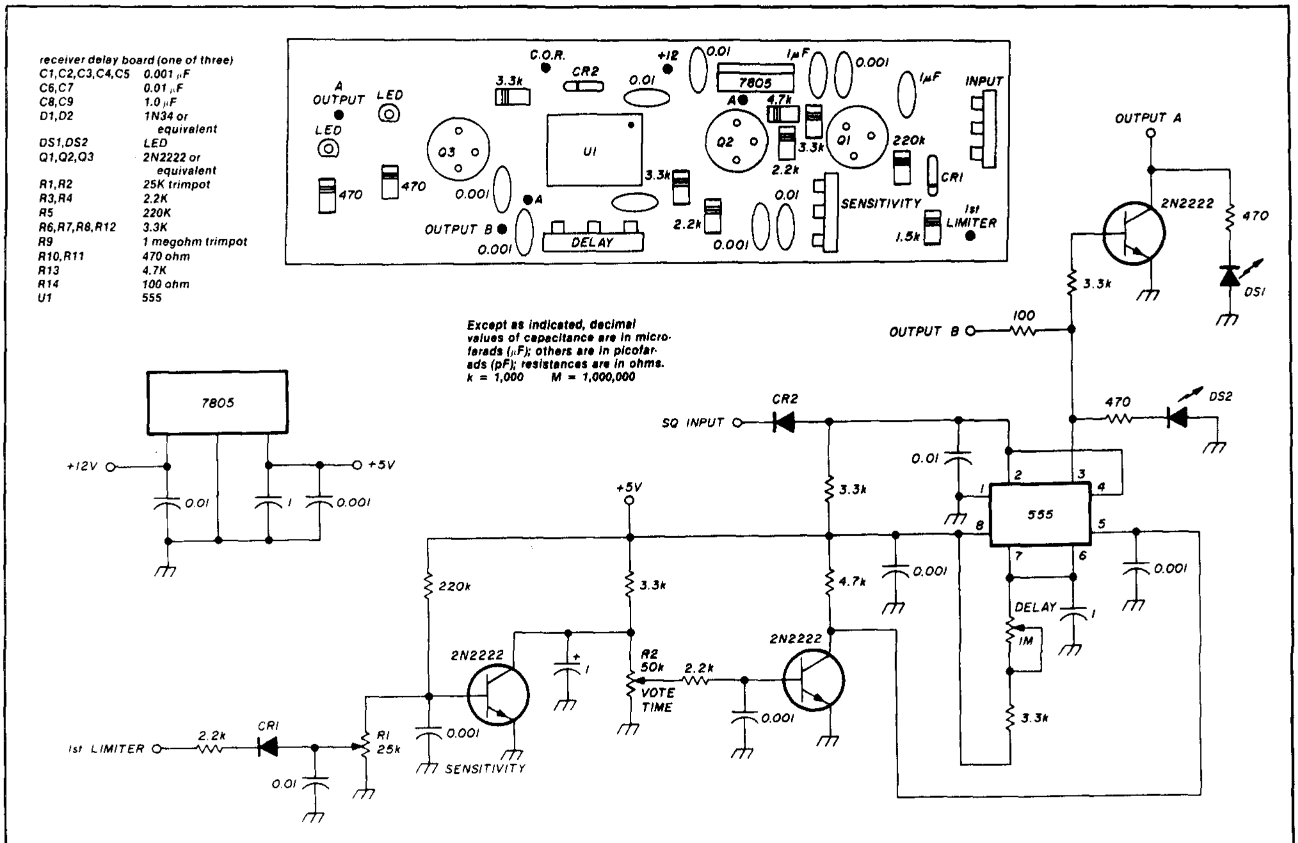


fig. 2. Satellite receiver delay board.

less delays the link transmitter from turning on for up to 0.5 second. Therefore, the first signal the transmitter receives will be the best quieting. When using multiple receiver sites, it is best to adjust the squelch controls of each remote receiver a little tighter than normal.

latching logic

At the transmitter site, the three link receivers' squelch turns on a dc switch that feeds a series of gates. The gate series accepts the first signal and locks out the other two. This type of priority latching system allows a mobile system to key up more than one of the receiver sites and, as the signal jumps from one site to another, will automatically switch sites. The gates ultimately turn on the PTT transistor switch which keys the transmitter (**fig. 1**).

The audio from the three receivers is selected by a 4066 switch. It switches the audio very smoothly. An active audio equalizer which allows loss in frequency response or level during the link process to be made up provides the system with excellent audio quality. The audio mixer/equalizer is an active device that can provide plus or minus 12 dB of dynamic range between 300 and 2000 Hz.

receiver delay board

The delay board used at each two-meter receiver site uses one LM555 timer IC and three NPN transistors (**fig. 2**). The limiter voltage from the receiver is fed to the VCO input (pin 5), and the squelch line is fed to the pin 2 control input. If the limiter current is high, meaning the receiver is hearing a very strong signal, the 555 turns on immediately. As the limiter voltage drops, which means a weaker signal is being heard, the 555 will delay turning on for 0.5 second or more. This delay can be adjusted with the 1M pot connected with pin 7 of the 555.

Alignment of the delay board is simple. Read the voltage at the pin 5 test point. Set R1 fully clockwise and R2 fully counterclockwise. Set R3 for a one-second key-up delay. With no signal input, pin 5 will be about 1 volt below VCC. Apply a full quieting signal to the receiver and adjust R2 until pin 5 reads 0.025 volt. Still applying signal, adjust R1 to decrease sensitivity. Decrease R1 enough to raise pin 5 by 0.2 volts, giving a reading at pin 5 at about 0.45 volt. With no signal, pin 5 should read about 3.5 volts. This level is dependent upon the value of VCC. Adjust R3 for the desired delay.

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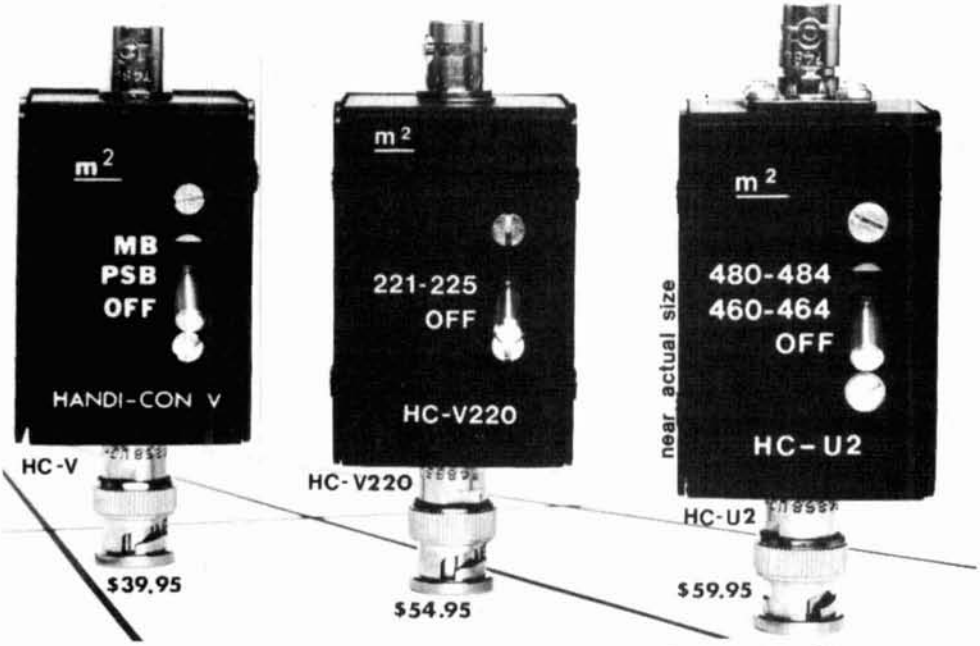

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The output keying transistor of the delay board will key the 220 link transmitter so no other COR or logic is necessary at the receiver site. The delay board is small enough to mount inside a Motorola or GE receiver strip.

The accuracy of the 555 timing sequence is critical. A normal LM555 is useful from 0 degrees to 70 degrees C. Signetics makes a military spec LM555 which guarantees operation from −70 to +125 degrees C. Use of this device is highly recommended.

link benefit

This system gives one side benefit. Users of 220 equipment will be able to work two meters with their 220 gear by operating on one of the link frequencies, providing they can hear the link from the main receiver and the transmitter site receiver can hear them. Caution should be observed because there may be times a hand-held or mobile station may key a remote receiver no one is listening to. It is best to be able to monitor all three links to be safe.

link antenna system

The Marissa system operates their three receivers on a battery back-up system. Only 1 or 2 watts of link power is used and this feeds a seven-element Yagi. After much experimentation, we found that by using horizontal polarization for the link antenna system, we were able to improve the signal-to-noise ratio because most manmade noise is vertical in polarization.

battery warning beeper

Each receiver site has a warning beeper that activates when the site goes on battery power. One location high atop a grain silo loses commercial power at 5 p.m. each day and all day Sunday. A large tractor battery powers the site when the line voltage is off. To warn the control operators and tech crew that the site is on battery power, a beep sounds every 15 seconds when that receiver site is activated. The tone level is adjusted so it does not interfere with the received signal. Two 555 timers are used to do this (see **fig. 3**).

temperature problems

The first winter the system was used turned out to be a real challenge for the tech crew. The 220 rigs were built by Uniden in 1973 and 1974 and marketed under several names. At that time the marketing people thought the 220 band was going to be given to the CB service. The units were not designed to be used in extreme temperature changes. The biggest problems encountered when using them as link components is frequency shifts.

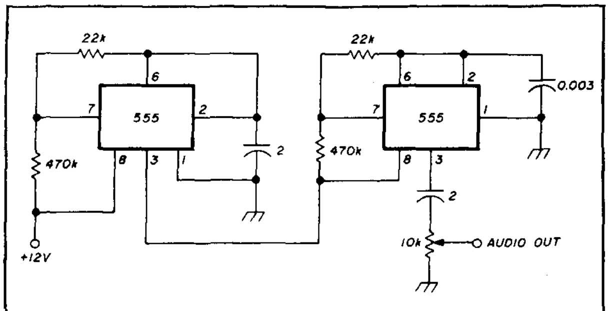

fig. 3. Emergency power indicator.

The problem is the TR-29 oscillator transistor circuit. It was found to be very unstable when operated below 30 degrees fahrenheit. A simple cure was to mount two small grain of wheat pilot lamps (removed from the front panel of the rig) as close as possible around TR-29. Hold them in place with silicone rubber compound. A 200-ohm resistor is used in series with the lamps to lengthen filament life. This was done around the crystal also. You could install a crystal oven but the pilot lamp trick works well and is much more economical.

WD9GOE/R

The system at Marissa has three receiver sites. One is thirty-five miles north of the repeater near Scott Air Force Base. The main site is five miles from the repeater transmitter, and the third, thirty-five miles south at Pickneyville. All receivers are Motorola Motran M series. The repeater transmitter runs 200 watts on 147.210 MHz using a General Electric CP-5 final with a 4CX250B. The system has been in operation for about three years and works very well. A similar system is in operation at Gillespie, Illinois, in WR9ACD/R, built by Jim Heyen. We have spent countless hours and shared many ideas on the design of this system.

It is normal to hear two-way hand-held communication across a 50 to 60 mile path. Mobiles enjoy solid 70 to 80 mile coverage. The system also has an elaborate link system with ten-meter fm, and six- and two-meter SSB. It also has voice identification and information tapes, time machine, autopatch, and several other features.

The remote voting receivers have helped to more than triple the coverage of our repeater system. They are inexpensive and require little, if any, maintenance, and will be a worthwhile addition to any system.

ham radio

The complete kit of drilled PC boards, all parts and instructions are available for $82.00 (plus $3 shipping) from Heil, Ltd., P.O. Box 68, Marissa, Illinois 62257. **Editor**

the simple simplex autopatch

Mix a transceiver, some parts and ingenuity to build this simple device

Many repeaters in the Amateur service employ a method of accessing the telephone system. Usefulness of this autopatch feature is reduced if the repeater is often used for normal communications. It is my experience that commercial autopatch systems are very costly and home-brew units can get quite complicated. A simpler and cheaper autopatch may be built around an available VHF/UHF transceiver by using a different method.

the simplex concept

The most expensive part of a repeater autopatch is the repeater itself. A significant cost reduction is realized by using simplex communication; transmitter and receiver do not have to operate simultaneously. This concept eliminates many problems since no antenna duplexer is needed, only one antenna is required, and a standard transceiver may be used.

The simplex concept has a problem: if the telephone side of the conversation is being transmitted by the patch, how does it determine when the primary user wants to talk? When should the system switch to receive?

One common design in commercial systems switches to receive whenever the person using the telephone stops talking. The person using the radio is now free to begin transmitting into the patch. This method is unsuitable in Amateur radio service since the ham must have complete control over all rf transmission, including the autopatch.

Another method of transmit/receive control is to switch the patch transceiver periodically into a brief receive window. The window checks the frequency for presence of a carrier, presumably signifying that the ham user wants to talk. If the carrier is present, the patch will remain in the receive mode until the carrier disappears. If no carrier is present during the receive window, the patch system immediately resumes transmitting until the next window test. No part of the telephone conversation is lost if these windows are brief.

A complete simplex autopatch system consists of four major components: the controller and telephone interface, the transceiver, a power supply, and an antenna. This article describes the controller in detail and shows how a complete system can be built around an ICOM IC-230 transceiver.

The controller is a dedicated unit and *not* microprocessor-based. I found that standard TTL provides a simpler control unit that is easy to trouble-shoot. Those of you without access to a PROM programmer will be relieved to know that this project does not require memory programming!

The patch circuitry is relatively simple but boasts such useful features as an automatic identifier, timeout circuitry, and full monitor capability. It can still be used as a normal transceiver even though the rig requires some squelch modification.

the controller

The control unit is the heart of the simple simplex autopatch. It performs the connect and disconnect functions between telephone and transceiver. It also generates the receive window for transmit/receive control and provides the CW identifier. Time-out circuitry and an audio monitor are included.

The controller is the small chassis on top of the IC-230 in **fig. 1** and operates from the same 12 Vdc supply as the transceiver. My system is powered by a battery to avoid problems when power is not available.

A block diagram of the controller is shown in **fig. 2**

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with the main schematic in **fig. 3**. Identifier, reset, and power supply sections are detailed in **fig. 4**. **Fig. 5** shows the inside view of the controller chassis. Three tone decoders control telephone line connect and disconnect. The timeout section will switch the system to standby if the patch remains on for about two minutes with no incoming signal interruptions. The receive window generator section is described later.

fig. 1. The Simplex Autopatch System. The autopatch controller is the small chassis on top of the ICOM IC-230 2-meter transceiver. The battery is optional and allows continued operation after power failure.

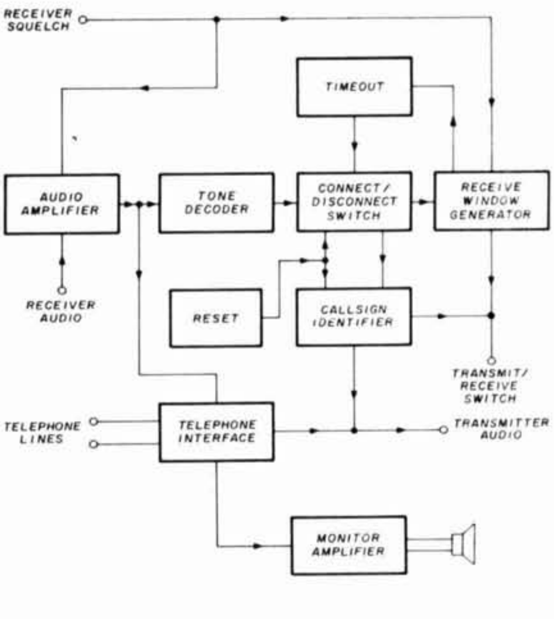

fig. 2. The autopatch controller circuit block diagram.

audio

Transceiver audio is taken from the receiver's discriminator so that audio into the controller is independent of the transceiver volume control setting. This low-level audio signal is amplified by U1 and sent to the telephone line through transmit/receive relay K2 and isolation transformers T1 and T2. Receiver audio also goes to monitor amplifier U2 and three tone decoders, U5 to U7.

Telephone line connection is from the red and green wires through line-connect relay K1. One line isolation transformer with 600 ohm impedance on each winding is normal. I used two Radio Shack units wired back-to-back, since they were inexpensive and easy to find.

The 567 tone decoder has a reputation for false triggering. I made an attempt to improve reliability in two ways: first, transistor Q1 turns off U1 whenever the receiver is squelched so that noise cannot activate the decoders. Second, the 567 switching speed is slowed by the 10 μF capacitor to pin 1 of each chip. The tone must be present for about one-third second to activate the decoders.

beginning the control sequence

U9A in **fig. 3** is a D-type flip-flop that holds the most recent tone command, either connect or disconnect. A connect command is applied directly to the preset input while the disconnect command resets U9A through its clock input, pin 3. The clear input at pin 1 is activated by the $\overline{\text{RESET}}$ (from **fig. 4**) or the time-out from U12. This configuration saves a gate since the $\overline{\text{RESET}}$ and disconnect signals, while performing the same function, are applied to different pins on the flip-flop. Gate conservation is important: every gate in any package is in use!

It should be noted that HI and LO markings in **fig. 3** are the TTL logic levels for the particular function. Audio amplitude levels are given later under control circuit alignment.

Flip-flop U9B is set each time a connect or disconnect command is decoded.* When either command disappears and the receiver squelch is on via inverter Q2, gate U4D starts the identification (ID) sequence by clearing U19B (**fig. 4**). U9B is cleared through D5 when the ID begins. This interconnection causes an automatic ID transmission at the beginning and end of each time period the patch is used. If each phone call is limited to ten minutes, identification requirements are fulfilled.

Telephone line connect relay K1 will pick up when both bases of Q6 and Q7 are pulled low. This occurs when the patch has been activated (U9A set) and the

*U8B and U8A will OR high inputs without inverting the output; when either output returns low, U4A output goes high to clock U9B on the positive-going edge. **Editor**

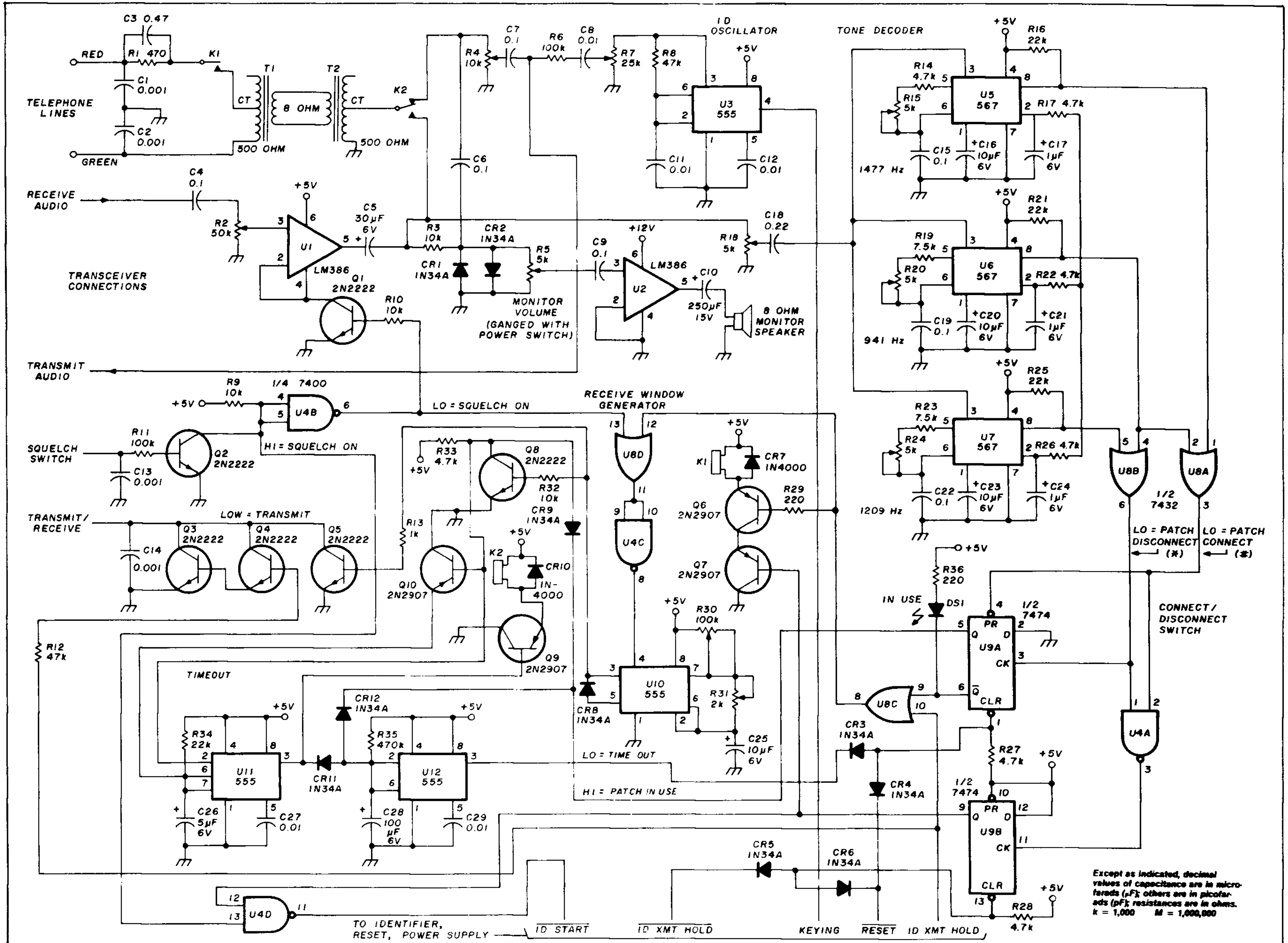

fig. 3. Autopatch controller main circuitry, including all interface connections to the transceiver and telephone line.

table 1. Parts List.

Resistors, 1/4 Watt, 10 percent unless noted	
R1	470, 1/2 Watt
R2	50K trimmer potentiometer
R3,R9,R10,R32	10K
R4	10K trimmer potentiometer
R5	5K panel-mount potentiometer
R7	25K trimmer potentiometer
R8,R12,R38	47K
R6,R11	100K
R13	1K
R14,R17,R22,R26, R27,R28,R33,R40,R41	4.7K
R15,R18,R20,R24	5K trimmer potentiometer
R16,R21,R25,R34	22K
R19,R23	7.5K
R29,R36	220
R30	100K trimmer potentiometer
R31	2K trimmer potentiometer
R37	680
R39	470K
Capacitors, μF, 15 V Disc unless noted	
C1,C2	.001, 250 V minimum, disc
C3	.47
C4,C6,C7,C9	0.1
C5	30, 6 V electrolytic
C8,C11,C12,C27, C29,C33,C35	.01
C13,C14	.001
C15,C19,C22	0.1 polystyrene or metal film, temperature stable, Radio Shack 272-1053
C16,C20,C23,C25	10, 6 V electrolytic
C17,C21,C24,C31, C32,C34	1, 6 V electrolytic
C18	0.22
C26	5, 6 V electrolytic
C28	100, 6 V electrolytic
C30	1, 15 V electrolytic
Transistors	
Q1,Q2,Q3,Q4, Q5,Q8	2N2222 or equivalent NPN
Q6,Q7,Q9,Q10	2N2907 or equivalent PNP
Integrated Circuits	
U1,U2	LM386N-1
U3,U10,U11,U12, U14,U17	LM555J
U4,U16	7400
U5,U6,U7	LM567N
U8	7432
U9	7474
U13	LM309K
U15	7473
U18	7493
U19	7476
U20,U21	74154
Diodes	
CR1 to CR6,CR8, CR9,CR11,CR12	1N34A or equivalent germanium
CR7,CR10	1N4000 or equivalent
DS1,DS2	16 mA LED, panel-mount
K1,K2	SPDT contacts, 5 Vdc coil, 56 ohms, Radio Shack 275-216
S1	SPST push button
S2	SPST 1 Ampere (ganged with R5
T1,T2	1000 ohm C.T.: 8 ohm, Radio Shack 273-1380

ID sequence has finished transmitting (U9B clear and U8C-10 low). K1 drops out on a disconnect command when U9A is cleared.

the receive window

Timer U10 is wired as an astable multivibrator, operating when the patch is activated and the receiver squelch is on (U10-4 high through U4C and U8D). When the timer output at pin 3 is high, it turns on the patch transmitter through Q5. The transmit/receive line is also held low for transmit during the ID sequence via Q4 and Q3.

If the squelch is tripped during the window provided by the low period of U10-3, reset pin 4 is brought low and turns off timer U10. The receiver will remain on. R30 adjusts the length of the receive window and R31 sets the time between windows. The diode on pins 3 and 5 of U10 ensures that the first pulse of the timer is the same length as all subsequent pulses.

Note that this circuit requires the transceiver to provide a low voltage level for receiver squelch and that the transmit control line should also be at a low voltage level. If your transceiver requires opposite levels, transistor inverter circuits such as Q2 (low current) or Q5 (high current) may be used for the correct level.

The squelch line should *stay* at the squelch-on level during transmit. This is the case for most transceivers, but if your rig is different, additional squelch gating is required.

time-out circuit

The time-out circuit will shut off the autopatch if it is allowed to transmit continuously for about two minutes. Timer U11 is configured as a missing pulse detector; output is high during transmit. While U11-3 remains high, the input voltage to the Schmitt trigger (U12) will gradually increase to three and a third volts through R35 and C28. U12-3 will go low when this

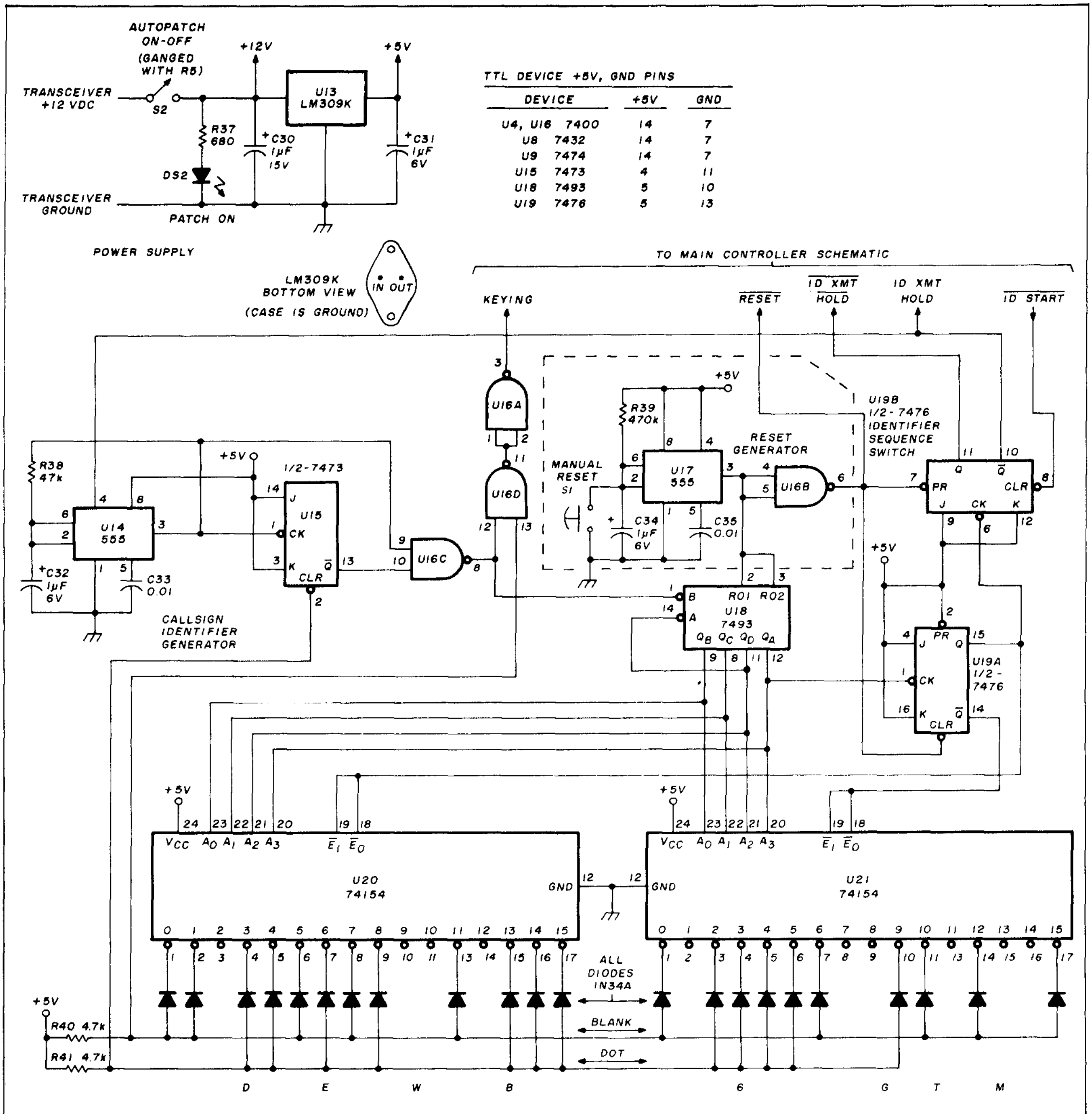

fig. 4. Identifier, reset, and power supply circuits of the autopatch controller. The identifier is programmed for the author's callsign.

voltage is reached, turning the patch off by clearing U9A.

Interrupting the pulses into U11 before two minutes have elapsed will allow C28 to discharge rapidly through CR11 and U11. The time-out cycle is reset. This occurs each time the receiver remains unsquelched longer than the pulse width set by R34 and C26. That width must be longer than the receiver window set by R31. I chose the values of R34 and C26 for any reasonable window width; they should not require adjustment.

You may be wondering why the time-out circuit appears so complex. Why not connect the inverted squelch directly to R35 and C28? The IC-230 and some other transceivers will momentarily unsquelch the receiver when the transmitter turns off during the receive window. This has the effect of periodically discharging C28 and makes the time-out feature use-

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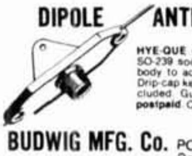

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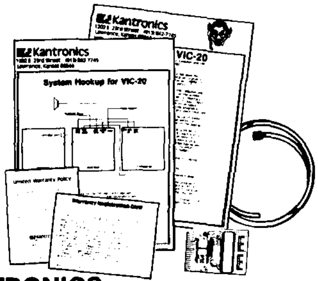

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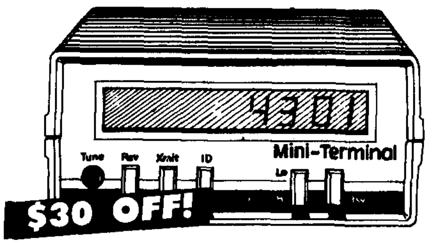

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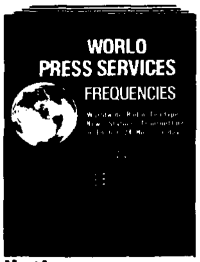

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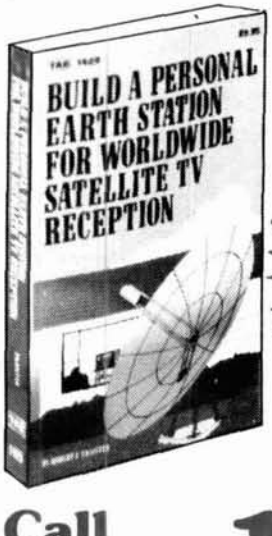

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less. I designed the time-out circuit to trigger from the window pulses generated by U10 so the circuit will work with all squelch configurations.

Transmit/receive relay K2 connects the telephone line to the transceiver microphone input when picked up. K2 is energized by U11 through Q9. CR9 prevents K2 from being energized when the patch is idle.

identifier

The identifier in **fig. 4** is a diode-programmable circuit based on a design by K2OAW.[1] Operation has been described adequately in the reference, so I will only cover changes to the original.

The two TTL oscillators of the original were replaced by 555 timers at U14 and at U3 (**fig. 3**), each wired as a minimum-component astable multivibrator. This eliminates start-up problems sometimes experienced with TTL R-C oscillators. R38 controls the ID sending rate and a value of 47K sets the maximum permissible rate of twenty words per minute.

Diode programming of the ID sequence is straightforward. Begin at pin 1 of U20 and connect diodes to the blank or dot lines. No diode and no pin connection produces a dash. DE followed by my call sign is shown as an example.

The 1N34 diodes in both schematics must remain germanium types for a low forward-voltage drop. Silicon diodes have a higher forward voltage and the logic zero level may be too high for proper operation.

U3 in **fig. 3** generates a 1.5 kHz square wave when the KEYING line is high. Increasing R8 will reduce the frequency. The IC-230 microphone input circuitry filters out the square wave harmonics so the tone sounds like a sine wave. With a transceiver other than the IC-230, check if the ID is audible 15 kHz or more from the carrier center frequency. If audible, add a low-pass filter at the output of U3 or replace the circuit with a sine wave oscillator.

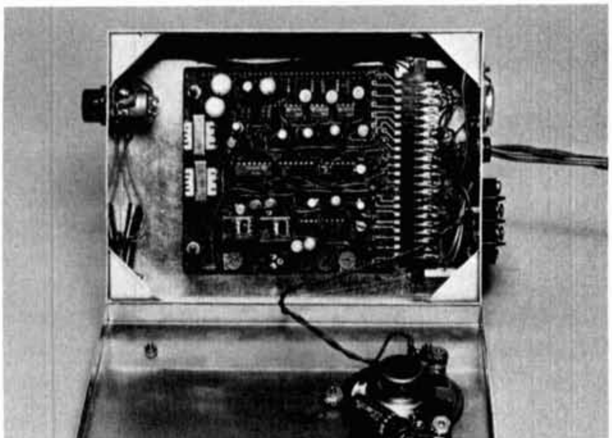

fig. 5. Inside view of the controller chassis. The top circuit board contains almost all of the circuitry of *fig. 3* and mounts by standoffs. Second board is hidden.

reset circuitry and power supply

U17 in **fig. 4** generates a power-on reset for the entire control circuit. The manual reset is a push-button mounted on the controller back panel. The initial state of counter U18 and all flip-flops except the divide-by-two circuit of U15 is reset by U17 and U16B.

Power supply input is in parallel with the transceiver 12 Vdc supply and the autopatch controller adds one-half Ampere to this source. Fuse ratings should be set accordingly. U13 provides regulated +5 Vdc for the TTL and timer circuitry.

construction

The control circuit was built on two separate plug-in boards secured with spacers. I used Radio Shack 276-154 and 276-157 boards with 44-pin edge connectors (276-1551). The monitor speaker is mounted on the detachable bottom plate.

The chassis front panel holds the on-off switch (S2), monitor volume control (R5), in-use indicator DS1, and power indicator DS2.

Fig. 6 shows the chassis rear panel with regulator U13, manual reset push button switch S1, and the telephone interface terminal strip. Transmit and receive audio lines are brought through the grommet and should be shielded cable.

TTL devices may be 74LS types. Two 555 timers may be replaced by a single 556 dual timer with appropriate pin connection changes. All diodes except CR10 and CR7 must be germanium types to avoid exceeding the 0.8 volt logic zero level.

the transceiver

Although my system uses a slightly modified IC-230, other transceivers should work as well if they can shift rapidly between transmit to receive and back to transmit. The rapid change is a requirement of the receive window. This requirement unfortunately excludes many synthesized-frequency units; the synthesizer voltage-controlled oscillator cannot shift transmit and receive frequencies rapidly. The IC-230 is frequency-synthesized but uses fixed-frequency oscillators for the 10.7 MHz first i-f offset.

The IC-230 allows an acceptably-short receive window with no modifications to the solid-state transmit/receive switch. Some autopatch controllers require modification of this switch so that the receiver

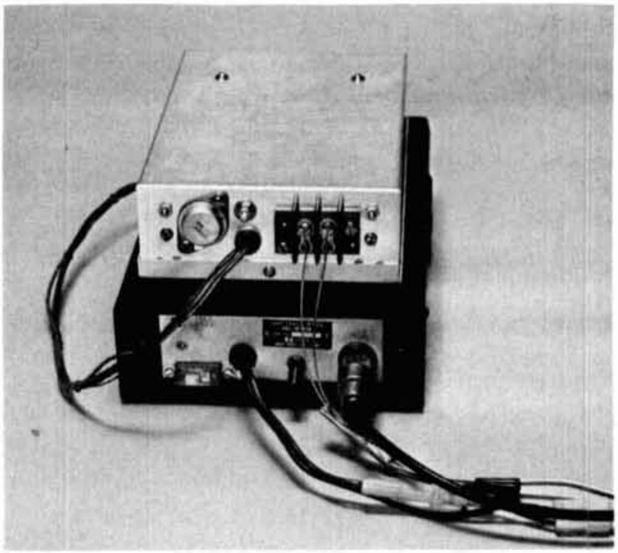

fig. 6. Rear view of the system. The back panel of the chassis contains regulator U13, the manual reset push button, and a terminal strip for the telephone line. The speaker of the IC-230 is disabled by a dummy plug in the external speaker jack to eliminate squelch action noise. The slide switch added to the IC-230 is a modification not needed for the autopatch.

is always on. This makes the rig unsuitable for normal transceiver use: audio feedback occurs during transmit.

One shortcoming of nearly every transceiver is a slow squelch. **Fig. 7(A)** shows the squelch switching circuit in the IC-230, similar to those in other transceivers. Rectified noise enters the base of Q7 to force the collector low, turning off subsequent audio stages and quieting the speaker. Squelch action is slow because C18, C20, and C23 must either charge or discharge each time the squelch changes state. Reducing their values to those in parentheses will speed squelch action considerably.

C21 is an additional low-pass filter element for power to the receiver audio section. Reducing its value will allow the receiver to turn on faster during the controller receive window.

The AF module on the IC-230 chassis bottom contains these capacitors and may be located with the aid of **fig. 7(B)**. In exchange for greater controller complexity, the squelch modification may be avoided altogether by building a separate fast-acting squelch within the controller.

The remaining transceiver modification is that of bringing out the signals needed by the controller. The IC-230 accessory socket provides three of these in addition to ground and +12 Vdc. The squelch switch is the only signal not factory-wired to the socket shown in **fig. 7(C)**. ICOM does provide a connector pin on the AF module, as pointed out in **fig. 8**. A wire from this point will replace the existing accessory socket pin 1 wire and complete the controller interface.

For transceivers without an accessory socket, the microphone input and push-to-talk connections can be made at the microphone connector. Occasionally test pins are provided for discriminator and squelch switch outputs.

primary power and antenna

It may be prudent to use a high-capacity battery in place of the usual line-powered dc supply. It could be on a constant trickle charge and would allow operation during power outages. My system is powered by a 20 Ampere-hour Globe Gel/Cell® and is capable of eight hours continuous transmit after commercial power failure.

In most cases the antenna system should be omnidirectional with as much gain as possible. Remember

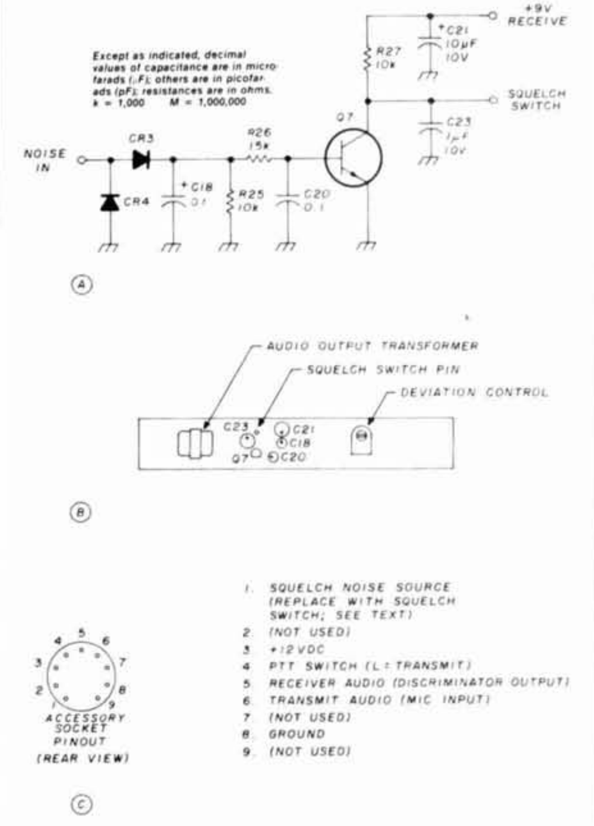

fig. 7. Squelch gating circuit on the AF module in the IC-230 shown in A. Capacitor values in parentheses are changes to shorten the controller's receive window. B shows the locations of components on the AF module. Accessory connector pin connections for the IC-230 are given in C.

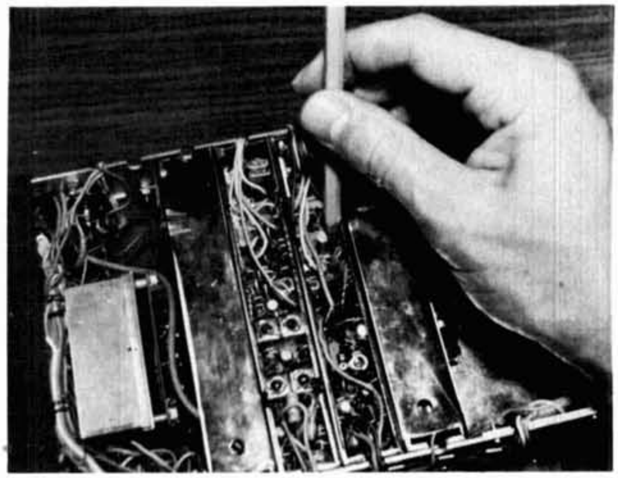

fig. 8. The pencil tip points to the squelch switch pin on the AF module underneath the transceiver.

that the type and location of the antenna is extremely influential toward ultimate coverage area of the autopatch.

control circuit alignment

The only alignment required is the adjustment of nine trimmer potentiometers. R30 and R31 control the receive window, R2 adjusts receiver output into the telephone line, and R4 sets the telephone line level into the transmitter. R18 controls the tone decoder input level while R15, R20, and R24 adjust the individual decoder center frequencies. Decoder frequency stability is dependent on the type of capacitors used for C15, C19, and C22; polystyrene or metal-film types are recommended. R7 sets the ID tone volume.

R2 is set high enough to activate the telephone company's tone-dialing circuitry. R18 is then adjusted for about 100 millivolts audio on pin 3 of each decoder.

An accurate audio generator is handy for aligning the decoders. Lacking this, you can generate the proper tones by the two-button technique on your tone pad. Pressing both * and # produces 941 Hz, * and 7 gives 1209 Hz, while # and 9 will generate 1477 Hz.

operation

Mobile operation is quite convenient. Transmit your call first, then send a # tone. The autopatch will ID as soon as your carrier disappears, then send a dial tone (from the telephone connection) interrupted by the periodic receive window. Wait about a second after initiating your carrier to ensure the system has switched to receive, then send the desired telephone number.

When the conversation is completed (remember the 10-minute limit), send a * to disconnect the patch. Sending a # in place of the * will initiate another call. In either case, the system will ID again when your carrier drops. Should the patch remain on for about two minutes with no received signals, it will time-out and return to standby mode.

Both sides of a conversation may be monitored through the speaker at the autopatch fixed location. Pushing the reset button will return the system to standby. The transceiver may be operated normally by turning off the controller.

Although the system is called a simplex autopatch, it will work as well on an unused repeater channel. This has an advantage of increased privacy since each side of the conversation is on a different frequency.

conclusion

The purpose of this control circuit is to permit a simple, inexpensive, easy-to-construct method for taking advantage of the ability to make telephone calls from mobile or portable transceivers. The system lacks security since anyone who knows or guesses the simple access code can make telephone calls. Three general security methods have been used with autopatches: a complex access code, providing zero and one first-digit lockout, or adding subaudible encoding.[2] Anyone with a tape recorder and some patience can decipher a long access code, so this method is not very secure.

Although requiring more gating and tone decoder circuitry, the zero-one lockout method may be best if the autopatch is to be an open system. Subaudible tone access will provide increased security by limiting patch access.

This autopatch has been in use for several months and I have not experienced problems with it. If you have any suggestions for improving the system, please let me know.

references

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ham radio

continued from page 8

on to oppose a no-code license. Several ARRL directors have told me privately that they favor such a license but must oppose it because the members they represent are against it. The same is no doubt true of some ARRL staff members.

Japan, Sweden, and England, among others, have had a no-code license for years and the sky has not fallen. Seventeen other countries require only code "recognition," not reception, for licenses. A number of these licensees go on to learn the code, upgrade their licenses, and use additional modes and frequencies.

The FCC deserves the respect and thanks of thoughtful Amateurs for pursuing this issue in an effort to strengthen the Amateur service and help to ensure its usefulness and its future. — Stuart D. Cowan, W2LX, KM2XDU.

I am astounded, amazed, and dismayed at your September, 1982, editorial position on the code-free license. Your remark that the time has come to discard the "what's good enough for grandpappy is good enough for you" mentality is indicative of your complete lack of understanding of Amateur Radio today and as of yesterday.

Gentlemen, Amateur Radio is not simply another hobby. The creation of a no-code license would be contrary to one of the fundamental traditions of Amateur Radio. Whether or not the prospective licensee plans to operate his station on CW, RTTY, computer, or telephone is unimportant. Learning the code, in the beginning of his interest in Amateur Radio, introduces him to an activity steeped in many traditions; and, to the requirement that such activity be in the public interest, convenience and necessity. The code requirement is the first thing that separates the licensed Radio Amateur from the unlicensed tinkerer and the CB operator, licensed or unlicensed.

Many of us, the writer included, began a professional career in communications via the Amateur Radio route. Even as a teenager we appreciated the importance of our earned entry into the world of Amateur Radio. We became part of a highly special, unique group, with associations of tremendous importance in our chosen career, associations never to be forgotten. — Byron H. Kretzman, W2JTP.

I seriously question your reasons for endorsing a no-code license. We don't need a "larger and faster growing" Amateur population of the quality we have already seen after the recent CB craze. The existing exams are lenient enough, not to mention the multiple choice CW part! To me, anyone who cannot pass a multiple choice CW "test" of 5 WPM is not capable or deserving of being called a ham. When other modes of communication have failed, CW has been used. I would hate to hear about a situation where a ham would not be able to respond to or initiate an emergency message on CW.

The bottom line is your bottom line in your next to last paragraph: "Consider just how such a license could be incorporated into our Amateur structure without cheapening what we've got." — Alan J. Blank, W1BL.

I want to take this opportunity to congratulate you and Joe Schroeder for your joint editorial that appeared in the September, 1982, issue. It was high time that someone told it as it is. I also hold an Extra, have a 30 WPM CP, and still use my old Vibroplex — but, I have a computer and a fairly well equipped small lab, so I don't think I have "given up" trying to stay with the state-of-the-art.

Also, I constantly argue that the FCC test should be slanted more toward R&R, operating procedures, etc., and only the minimum technical questions relating to determining if a transmitter is operating properly. As a graduate E.E., I think some of the questions presently used are slanted toward the hiring exam for an electronics technician, not a ham operator! — John P. Weber, Jr., K4JW.

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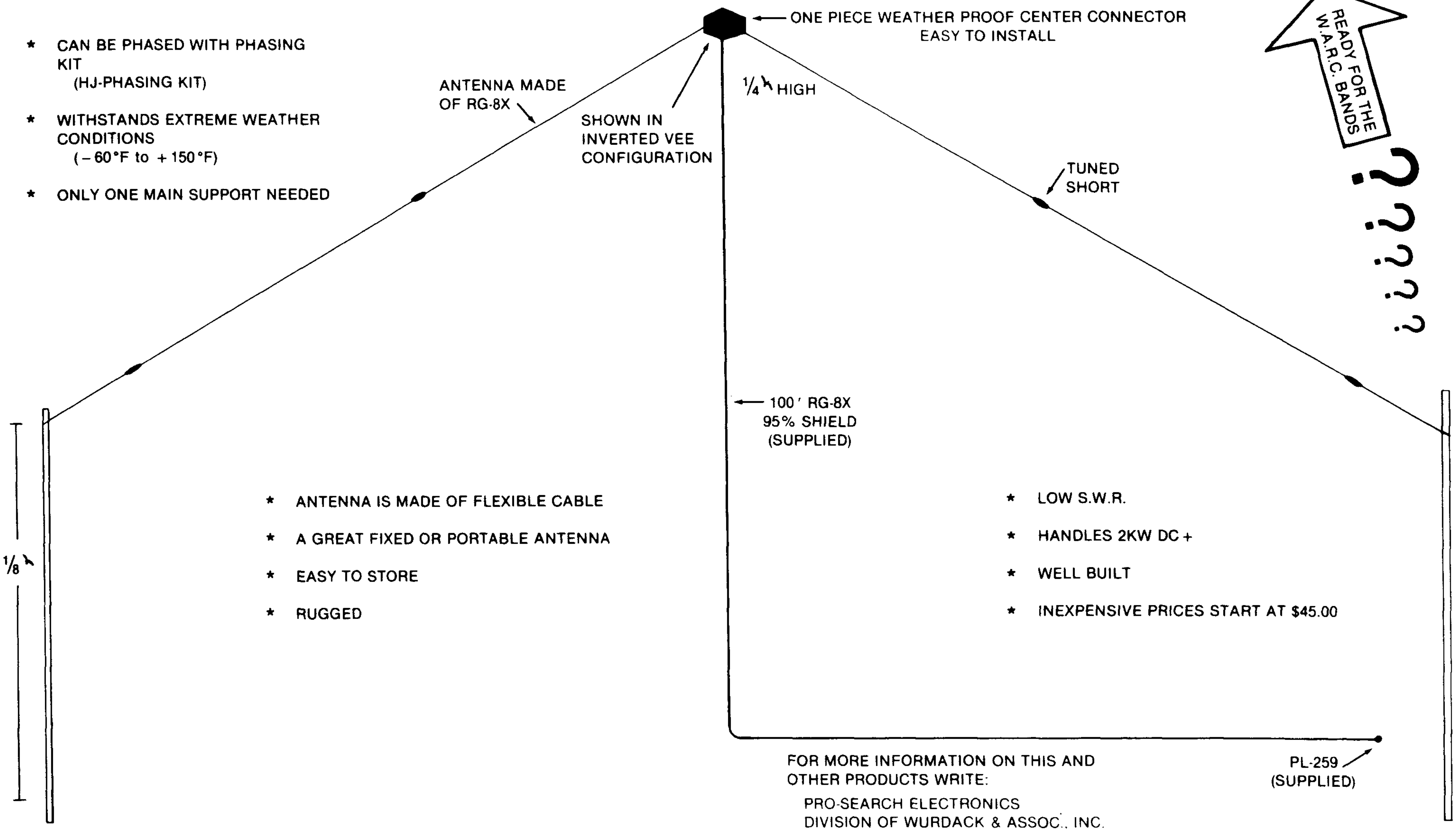

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logic mate

A simple, convenient IC trouble-shooting aid

The Logic Mate (LM) is an IC trouble-shooting aid that combines the features of a logic monitor and IC tester in a single, compact unit. Inserted between an IC and its circuit socket, it allows pin connection switching, displays pin voltages, and provides output loading. Power is obtained from the main circuit socket and ranges from 5 to 15 volts.

The LM works with all saturating-logic families such as TTL, CMOS, DTL, ECL, plus many linear ICs. U1 pin voltage swings may not be enough with ECL or linear ICs, but all disconnect and forcing inputs operate properly.

about the circuit

Fig. 1 shows the schematic for one of two identical boards in the LM. The plug/header pins connect to the circuit under test while the test socket holds the IC. Pin numbers are indicated for one side of a sixteen-pin dual in-line package (DIP); pin numbers in parentheses indicate the other side.

Two eight-pole, single-throw DIP switches are on the plug/header end. S1 is labelled DISC and allows an individual pin to be disconnected and isolated from the main circuit. S2 is labelled 1-0 and grounds the IC pin under test for a logic 0; resistors R9 through R16 provide a pull-up for logic 1 with any S2 open.

A light-emitting diode (LED) array provides displays of each IC pin under all supply voltage conditions. One DS8654 octal display driver is used for eight LEDs. Individual current limiting for each LED is provided by R1 through R8 and overall current regulation is provided by Q1, CR1, and R17. Without overall regulation, the LED intensity would be too low at 5 volts if the series resistors were selected for 15 volt supplies. Alternately, a correct current at a 5 volt supply would cause too much current at 15 volts and LED life would be reduced.

Individual LEDs need 8 to 12 mA for decent intensity. An LED will drop a relatively constant voltage when conducting. A series resistor selected for 10 mA at a 5 volt supply would cause about a 25 mA LED current at 15 volts.

CR1 is cut off at a 5 volt supply but Q1 conducts via base current through R17 for the LED common cathode return. At higher supply voltages, CR1 conducts and the base of Q1 tracks the increase in voltage. Emitter potential follows base potential for a relatively constant return, or sink current for the LEDs. The emitter return connection provides a low-impedance sink to prevent interaction between different combinations of indicating LEDs.

The octal display driver was designed for a common-cathode display and can source up to 50 mA on each output. The DS8654 will operate in a 4.5 to 33 volt supply range, conservative for this design. Supply voltage is obtained from the main circuit on pin 16 and alternate means are explained later.

construction

Two boards are required. You can etch your own or purchase a pair of etched boards with plated-through holes. If you etch your own, you must solder R9-R16 and U1 pins 1 through 9, and pin 14 on *both* sides of the board. Boards without plated-through holes also require through-board jumpers as indicated in **fig. 2**.

By Paul Selwa, N9CZK, 61 East Tilden Drive, Brownsburg, Indiana 46112

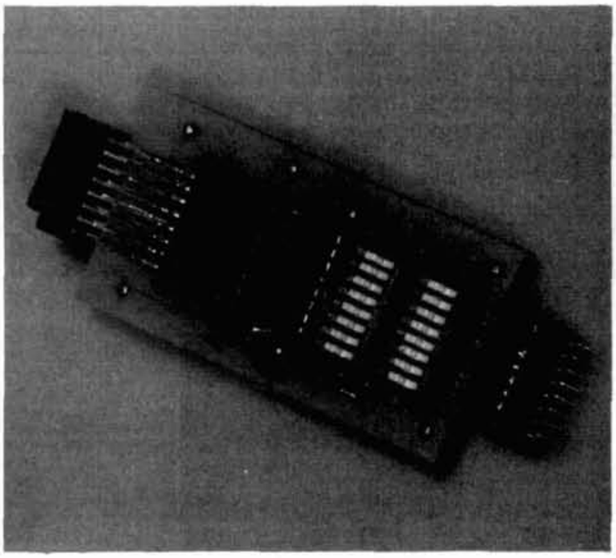
Figs. 2 and 3 indicate R1 to R8 and R9 to R16 as single-inline packages (SIP). SIP resistor packs can be replaced by individual quarter-watt resistors mounted on end. The common connection above the board is made to each SIP end pad; the ninth resistor in each SIP pack is unused and shorted as indicated by the dashed lines in **fig. 1**. Each SIP pack may be mounted in either direction.

The etch pattern and purchased boards allow for three types of LED arrays. The AMP array indicated in the parts list is in DIP form with 0.3-inch pin row spacing. The anode is marked with an A and a dot is at pin 1. The Litronix array has a 0.1-inch row spacing and cathodes are marked with a cross bar. Individual Dialight LEDs mount side-by-side on 0.2-inch spacing. All LEDs must have the anode pins adjacent to U1.

Each board must be jumpered to match the plug/header and test socket pin row. Jumper G must be installed for the board with pins 1 through 8. Ground is obtained from plug pin 8. The board for pins 9 to 16 should have jumper V installed.

Note that jumper V goes directly to S2-8. The reason is two-fold: you cannot accidentally ground the main circuit supply at pin 16, and that pin may be isolated if the supply is not at that pin. The occasional need to ground pin 16 may be accomplished with a clip lead.

Probing points for the main circuit plug/header end are wires soldered on the foil side. I recommend



Top view of one of two completed boards.

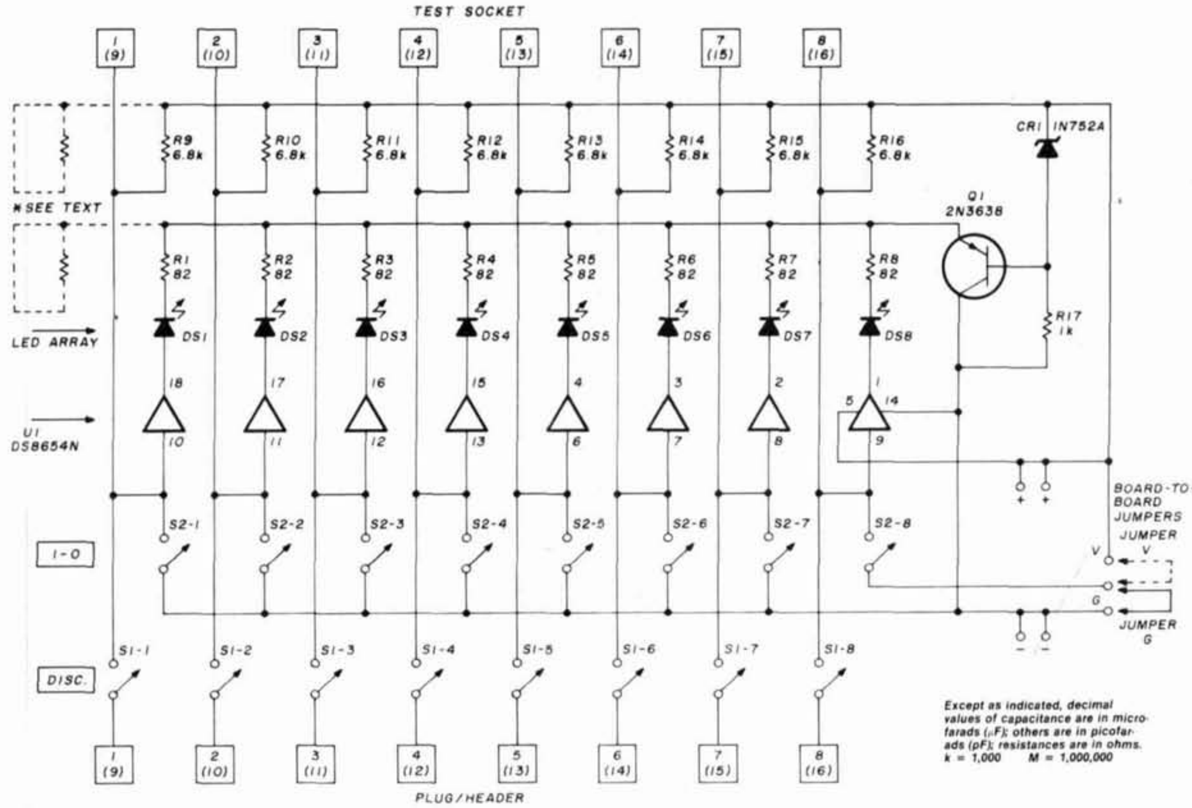


fig. 1. Schematic of one of two identical boards. See text for jumper placement and resistors in dotted lines. LED indicators may be an array or individual units as given in the parts list.

using wire-wrap pins for stiffness and this applies to inter-board jumpers in the final assembly.

final assembly

Both boards are mounted foil-side with both boards inside the header pin rows. I would suggest final assembly in the order following: First, solder two header pins to one board with connecting wires passing through the split in each pin. Take care that header and board connections line up.

Second, insert four board-to-board jumper wires at the pads marked + and − in **fig. 3** and solder them to the first board. Make them perpendicular to the board and long enough to pass through the pads of the second board.

Third, place the second board so the header end is inside the header pins and the board-to-board jumpers pass through the same + and − pads. Recheck alignment and avoid shorts between boards. Solder the board-to-board jumpers when satisfied.

The final step is to solder the test socket to the board. Leave enough socket tail outside the board for probe points. Stiff board-to-board jumpers provide enough support strength for both boards. Additional support is gained with two more jumpers at the unconnected X pads.

A socket on the plug/header will protect the pins between tests. Another option is a zero insertion-force socket for the test socket.

operation

The LM plug/header pin 16 should mate with main circuit socket pin 16 for the positive supply voltage (pin 14 on most 14-pin DIPs). Ground connection is made by closing both S1 and S2 for the ground pin. Pin 8 is the usual ground for a 16-pin DIP, pin 7 for a 14-pin DIP. Remaining pins are controlled by S1 for disconnect or S2 for logic 1 or 0.

For non-standard power and ground connections, a pin ground is always obtained by closing both S1 and S2. The supply pin should have S1 closed and S2 open with the supply voltage clipped to the + board-to-board jumpers. Pin 16 must have its S2 open for a non-standard supply pin; pin 16 may have a main circuit driver and closing that S2 to the supply can destroy that part of the main circuit. Closing S2 of any pin connected to the main circuit supply would yield an unscheduled test of the power supply current limiter!

This description has assumed a positive voltage for the supply with a ground for the return. The LM will also work with negative voltages: consider the LM's + line as the most-positive potential of the main circuit and the − line of the LM as the most-negative. (A negative main circuit supply would require reversal of the V and G jumpers. — Editor's note.)

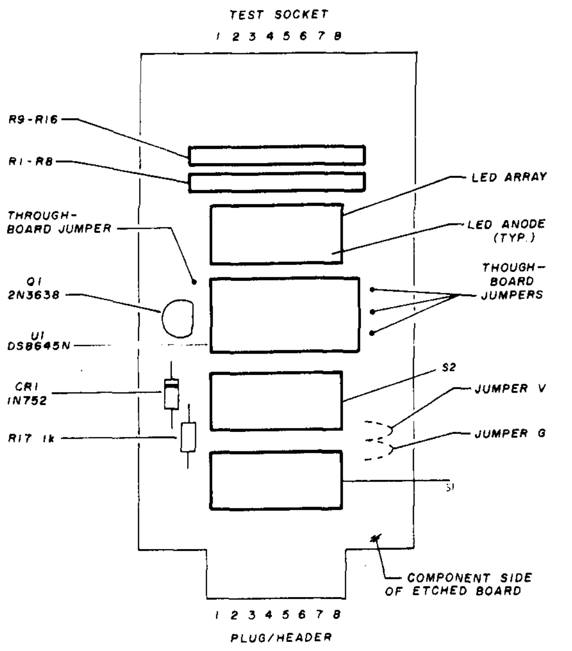


fig. 2. Component placement on each board with foil pattern given in *fig. 3*. See text for jumper placement and use of pads marked +, −, and X.

Parts List for One Board of the Logic Mate

CR1	*1N752A zener diode*
DS1 to DS8	*Choice of:* *(1) AMP Inc. 435733-7* *(1) Litronix LD468* *(8) Dialight 555-3003*
Q1	*2N3638 PNP transistor*
R1 to R8	*82 ohm, 10-pin SIP resistor pack, Bourns 4310R-101-820 or equivalent*
R9 to R16	*6800 ohm, 10-pin SIP resistor pack, Bourns 4310R-101-682 or equivalent*
R17	*1000 ohm, 1/4 Watt, 5 percent resistor*
S1,S2	*Eight-position DIP switch*
U1	*National Semiconductor DS8654N octal display driver*
Test Socket	*Aries A221 or equivalent (wire-wrap tails)*
Plug/Header	*Aries A103 or equivalent*

some examples of operation

One way to isolate a suspect IC pin is to bend it out of contact. This can damage the IC connection even if the IC was good before bending. A better way is to insert the LM and use the appropriate S1 disconnect switch to isolate the pin. The pin is not damaged and the built-in pull-up resistor allows checking of open-collector outputs.

The LM is a logic state monitor if all S1 disconnect switches are closed and all S2 switches opened. The

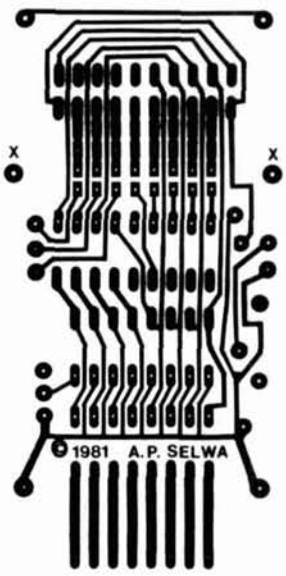


fig. 3. Foil-etch patterns for each double-sided, copper-clad board. Drilled, etched, and plated-through boards are available from PRS Electronics.

IC under test will operate the same as if plugged into the main circuit.

The LM can be an IC tester, isolated from the main circuit. Simply open all S1 switches except for power and ground and plug the LM into any convenient socket. The S2 1-0 switches allow control of all IC inputs.

Linear circuits can be checked by isolating pins with the disconnect switches. Pull-up resistors can provide loads and you can connect clip leads to the test socket probe points. Please note that a linear IC output may or may not indicate the same as a digital device: Voltage swing may be insufficient for the input of driver U1.

where to get parts

Etched, drilled, and plated-through circuit boards are available for $8.00 a pair from:

PRS Electronics
P. O. Box 274
Brownsburg, Indiana 46112.
(Indiana residents add 4% tax.)

The AMP LED array, Litronix LED array and the DS8654 are available COD from:

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forget memory

Ni-Cd memory myths discharged and facts unveiled

Ni-Cd memory myths rank with SWR stories and VHF intermod misunderstandings as the most common misconceptions in Amateur Radio. I've had hams tell me they know all Ni-Cds eventually get a memory problem because "it says so in the GE battery book." Not true!

The half-inch thick General Electric Ni-Cd handbook[1] devotes only three paragraphs to the topic of memory effect. Two paragraphs state and restate that "the memory effect does not manifest itself when the battery is discharged to random depths of discharge or overcharged for random amounts of overcharge time as is typically the case in most applications." That statement should relieve hams, not alarm them.

If your Ni-Cd cell voltage falls to zero quickly when discharging, the problem isn't memory effect. A memorized cell experiences voltage drops early in its discharge cycle, but instead of dropping to zero, it goes to the usual discharge cutoff point of around 1.0 volt. For the remainder of the discharge cycle, the cell still provides power but at an unacceptably low voltage.

Two General Electric engineers presented a scholarly treatise on the memory effect in the IEEE *Spectrum* magazine about five years ago.[2] They told how the effect was discovered in satellite test programs, where the cells received a carefully controlled charge/discharge regimen at a constant temperature for hundreds of cycles. Even then, the effect did not always appear in all types of cells. They concluded that "though sintered plate nickel-cadmium batteries can remember, the conditions necessary are almost *never* encountered in practice" (emphasis added). Sintered plate batteries are the kind we hams use.

So, if that isn't the problem, why didn't your last Ni-Cd pack last for a thousand charges? There are a couple of likely causes — cell reversal and sustained overcharge.

Do you stop talking the minute your HT's low battery indicator comes on? If you don't, you may be sending your pack to an early grave. Why? Not all cells in a Ni-Cd ppack are identical, nor do they reach complete discharge simultaneously. If one cell goes to full discharge first and you draw a medium-to-heavy load, the good cells attempt to charge the discharged cell in the reverse direction, which can damage it quickly, usually causing it to short. A short can be zapped out of a Ni-Cd, but full cell capacity is seldom restored. The zapped cell is likely to get reverse-charged again the next time the pack charge gets low.

Don't continue to use your rig once the low battery warning is present, or you may kill one or more cells through reverse charge. Also, if you've been trying to prevent the memory effect by frequently discharging the entire pack to zero with a single load, you can see that you're actually doing more harm than good.*

Now the other problem: can you really overcharge a battery with that little wall charger? Sure! Next time you take your battery off the charger, feel the pack (not the charger). Isn't it warm? Try it for two or three days! (On second thought, don't!) When the battery reaches full charge, and you keep putting current into it, the internal chemical reaction changes. The current from the charger begins to break down the water in the cell into hydrogen and oxygen. Much of it recombines, but even at typical slow-charge rates (about 0.1C), heat and pressure build up. When this happens, the cell's vent opens and it slowly dries out. If you're a typical HT user who uses only a fraction of the battery capacity each day, but charges it for 15 hours each night, you shouldn't be surprised if your batteries require replacing prematurely.

Extended slow-charging also can produce what the General Electric engineers call a sustained overcharge effect.[3] It's a depression of the discharge voltage at some point after a long overcharge, and is quite common. The longer the overcharge, the ear-

By Joe Moell, KØOV, Box 20-GJ, Fullerton, California 92633

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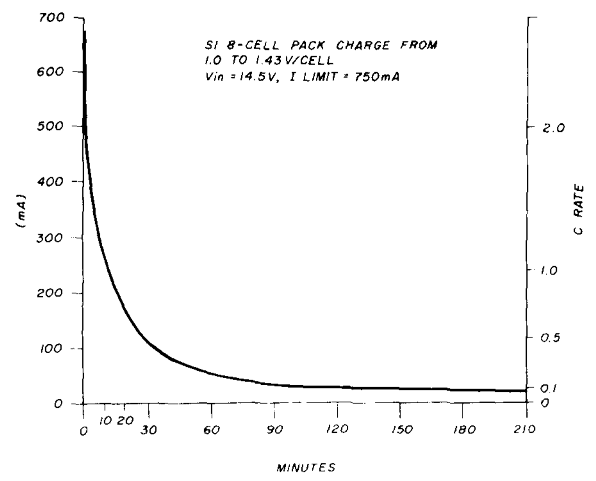

fig. 1. Charge current versus time for the taper charger described in the June, 1981, *QST*, by K0OV. Note the slow-charge current of 25 mA is reached at two hours, *and the current continues to decrease, protecting the* battery. This data was taken on a 250 mA-H pack used in early models. Rigs that use 450 mA-H packs will take longer to charge at this rate, but the maximum rate can be increased to compensate.

lier in the discharge cycle the step-down in voltage will occur. To the user it appears just like the memory effect described earlier, but is from a different cause. If your battery pack has shown symptoms of memory, chances are it's because it was overcharged. The traditional memory cure also works for the sustained overcharge effect.

What is needed is a way to stop charging the pack when a full charge is reached. W2GZD described such a slow charger in the October, 1981, *QST*.[4] When a specific voltage (1.43 volts per cell) is reached, the charger automatically cuts back to a trickle charge mode that doesn't cause heating.* That's nice for a radio that sits on a charger 24 hours a day, but what about the ham-on-the-go who needs a quick charge? A good, safe, fast-charge method was described in the June, 1981, *QST*.[5] The unit charges a pack fully in only a couple of hours, and has a meter that shows the charging progress (**fig. 1**). Even though this is a fast charger, the battery doesn't warm up because the current tapers down to a slow charge value automatically as full charge is approached. The radio can remain in use during the fast charge. With a unit like this, you get the best of everything, fast charge, long battery life, and convenience.*

One final caution about your charging system — beware of extreme temperature environments. At temperatures below about +5 degrees Celsius, overcharge quickly results in a buildup of hydrogen pressure which can result in cell damage. At very high temperatures, charging is not very efficient and cell temperature can rise to damaging levels during fast charging. In both extremes, the end point for charging is no longer 1.43 volts, meaning that a taper charger may not properly sense full charge. For best results, avoid trouble by doing your charging with the cells at or near room temperature. Don't leave your HT in a freezing car all night and charge it without allowing the cells to warm up first.

Here's how to make your Ni-Cds last:

1. Don't deliberately discharge packs to zero.

2. Don't continue to use your HT after the low battery indicator comes on.

3. Don't use a wall charger for more than 15 hours per charge.

4. Don't do a 15-hour slow charge on a battery that is only slightly discharged.

5. Do monitor pack voltage when slow-charging a partially discharged pack. Stop charging when voltage reaches 1.43 volts per cell, measured at room temperature with 0.1C charging current applied.

6. Don't charge your pack in freezing temperatures or in direct sunlight.

7. Don't continue to charge a battery if it gets warm during charging. Check for a shorted cell or misadjusted charger.

8. Do build or buy a taper charger for fast charging and operating with convenience and safety.

You won't need to worry about memory if you follow this advice.

references

1. General Electric Company, *Nickel-Cadmium Battery Application Engineering Handbook*, Second Edition, 1975, pages 7-8.
2. S.F. Pensabene and J.W. Gould, "Unwanted Memory Spooks Nickel-Cadmium Cells," *IEEE Spectrum*, September, 1976, pages 32-36.
3. General Electric Company, pages 6-9 and 6-12.
4. D.W. Potter, "Those NiCad Batteries and How to Charge Them," *QST*, October, 1981, pages 34-35.
5. J.D. Moell, "A Fast Charger and Regulator for the Tempo S-1," *QST*, June, 1981, pages 34-35.

ham radio

*Discharging the cells individually is recommended by some authors as a memory cure that won't cause cell reversal, but you should make sure the battery has the disease before applying the cure. Discharging cells deliberately in hopes of preventing memory is a complete waste of time and effort. This is the traditional memory cure.

*Many hams erroneously call their little wall charger a trickle charger. Actually, the wall charger performs a slow charge (about 0.1C). A true trickle charge (0.02C or less) is used only to keep a battery charged. See Chapter 5 of the General Electric book for more details on rates of charge.

*Don't confuse this circuit with regulators or battery beaters, which only operate the rig and don't charge the battery.

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ham radio TECHNIQUES

Bill Orr W6SAI

Long, long ago, in a galaxy far, far away, or so it now seems, the World Administrative Radio Conference set aside certain new, narrow, high-frequency bands for use by the Amateur Service. Since January a year ago, over sixty countries have permitted Amateur operation in one of these bands, 10.1 MHz to 10.15 MHz. But the United States — whose Amateurs spearheaded the effort at WARC to get the new bands — has dragged its feet on granting permission to operate in these bands. The reasons for the long delay make an interesting story, indeed.

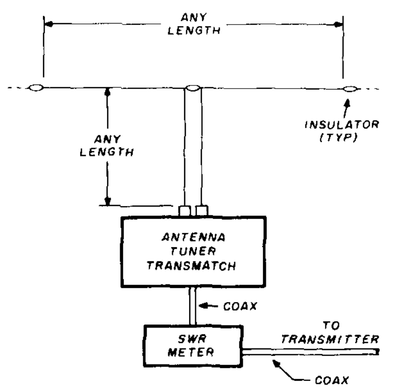

fig. 1. A center-fed wire serves as an all-band antenna when used with a suitable antenna tuner located at the station. Lengths of antenna and two-wire transmission line are not critical as long as overall length of wire is at least one-quarter wavelength at lowest frequency used.

Finally the combined efforts of the ARRL and a hot letter to the FCC from Barry Goldwater, K7UGA, opened the door and (as of this writing in September) it looks as if the 10-MHz band will be opened to U.S. Amateurs around the first of 1983, if not before. And that's good news for 1983!*

The 10-MHz band is full of interesting DX when conditions are good, and one of the first questions raised by prospective 10-MHz operators concerns antennas for the new band, particularly all-band antennas that will cover existing bands plus the new ones. That means coverage of the 160, 80, 40, 30, 20, 17, 15, 12, and 10 meter bands, now available on the bandswitch of many of the new transceivers!

simple all-band antennas

The first all-band antenna that comes to mind is the well-known center-fed long wire (**fig. 1**). Used with an open-wire transmission line and an antenna tuner at the station, this simple antenna will work well on any frequency within the range covered by the tuner. (The tuner is sometimes called a Transmatch.) The tuner is coupled to the station equipment via a coaxial line and SWR indicator.

A second simple wire antenna that will cover all the Amateur high-frequency bands is the end-fed wire (**fig. 2**). A pi-network composed of a rotary inductor and two capacitors matches the wire antenna to a 50-ohm system.

Users of the end-fed antenna know that under certain conditions the antenna will tune up well, but the shack will be full of rf and feedback. This can cause erratic operation of the equipment, TVI, and other unpleasant problems. The cause of the diffi-

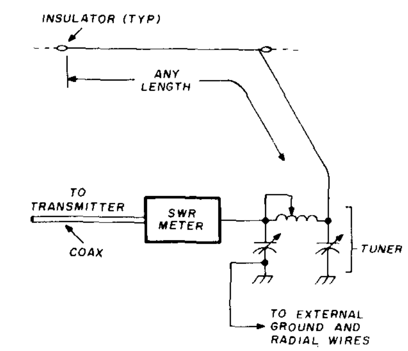

fig. 2. End-fed, random-length wire with simple pi-network tuner serves as all-band antenna. A good ground system is required with this antenna.

*As of 3 pm EDST, October 28, U.S. Amateurs were permitted use of 10.100-10.109 and 10.115-10.150 MHz using A_1, F_1 modes at a maximum power level of 250 watts.

culties is that the equipment is not at rf ground potential. Attaching a ground to the equipment usually doesn't help a bit, as the inductance of the ground wire upsets the situation even more. The use of quarter-wavelength radial ground wires cut to the operating frequency will solve this vexing problem. The radial ground wire is merely a length of insulated wire, free at the far end. It is cut to an electrical quarter wave at the operating frequency and affixed to the ground post of the equipment. The wire can be tossed on the floor behind the operating desk.

the Australian broadband dipole

One of the best all-band antennas in use is the so-called Australian dipole, which I briefly mentioned in an article in *CQ* magazine, October, 1974. After this article, the antenna sank into oblivion, at least in the United States.

In spite of this seeming lack of interest, the unusual antenna has continued to be used by Amateurs and commercial point-to-point services in other areas of the world. It eventually caught the attention of D.W. Harris (A22BX), the Deputy Director of Broadcasting (Engineering) at Radio Botswana in Southern Africa.

In common with many developing countries, Botswana has internal communications difficulties. Roads are often poor in rural areas and the telecommunications networks are hardly developed. As a result, the news service of Radio Botswana is an important facet in passing information from remote districts to the capital.

Harris decided to use high-frequency SSB transceivers for this purpose — along with broadband antennas — with provisions for patching tape recorders into the transceivers. (Drake TR-7 transceivers were used with the SL-4000, 4-kHz passband filter.)

The problem of a broadband antenna which could be easily built and installed was formidable, as it had to provide less than a 2:1 SWR across the operating range. An article on the "Broadband Travelling Wave Dipole" appeared in the April, 1974, issue of *Amateur Radio* (Australia), which described an interesting antenna developed for use in the Australian Outback for the Flying Doctor radio service.

Harris and his staff built several Australian dipoles and tried them out with varying success. Finally, a modification of the original design produced a noncritical, wideband antenna which, with a special balun, showed less than a 2:1 SWR from below 3 MHz to over 20 MHz. The antenna was useful up to 30 MHz, as shown in the SWR plot of **fig. 3.**

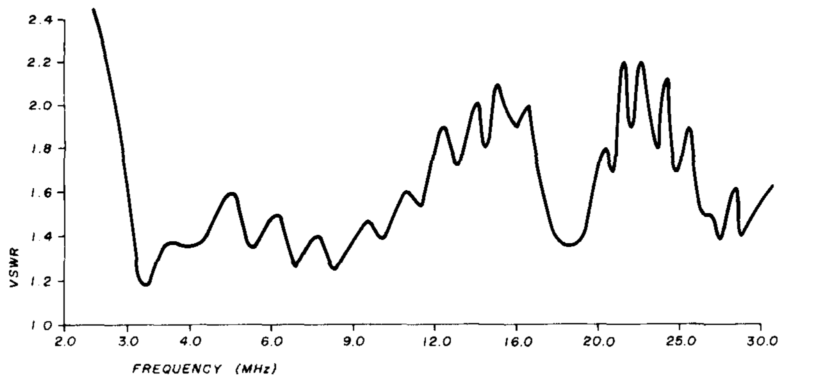

fig. 3. Measured performance of Australian Dipole, showing VSWR plotted against frequency every 0.5 MHz from 6 MHz to 30 MHz.

the modified Australian dipole

A simplified diagram of the A22BX version of the Australian dipole is

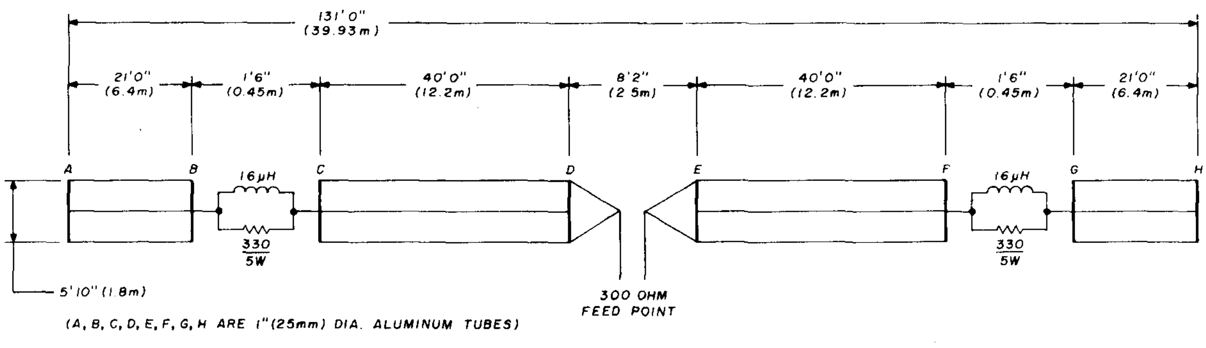

fig. 4. Three wire "flat-top" with loading networks provides broadband service between 2 MHz and 30 MHz. Antenna is fed with balun and coaxial line.

shown in **fig. 4**. Overall length is about 133 feet (40 meters). The antenna consists of a flat-top of three parallel wires, broken at intervals by simple loading networks placed in series with the wires. The feedpoint impedance of the antenna is about 300 ohms. A toroid transformer wound on an Amidon two-inch diameter red core was used to make the impedance transformation to a 50-ohm line (**fig. 5**).

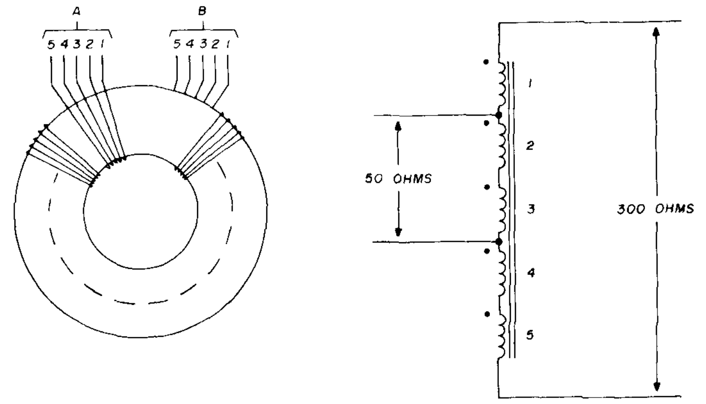

fig. 5. Transformer is wound on iron-powder toroid. Fourteen turns, each composed of five parallel wires, are wound on the core. Turns are interconnected as shown at right to provide 5/2 turns ratio (6.25/1 impedance ratio).

Details of antenna construction are shown in **fig. 6**. Hard-drawn copper wire is used for the flat-top to prevent stretching. The small networks are made of a 300-ohm, 5-watt composition resistor placed in parallel with a small inductor.

To hold the three wires of the antenna in position, yet allow easy handling on the ground, the networks are fastened to a framework that is big enough to attach the antenna wires to, as shown in the detail drawings. One-inch diameter PVC plastic conduit is used for the insulators. The aluminum spreaders were made from decorative aluminum L-shaped stock measuring about an inch wide and ½-inch thick, used for edging on Formica kitchen table tops. Small, 10-32 machine bolts, nuts, and hardware are used to hold the various strips and tubes together.

A22BX suggests using polypropy-

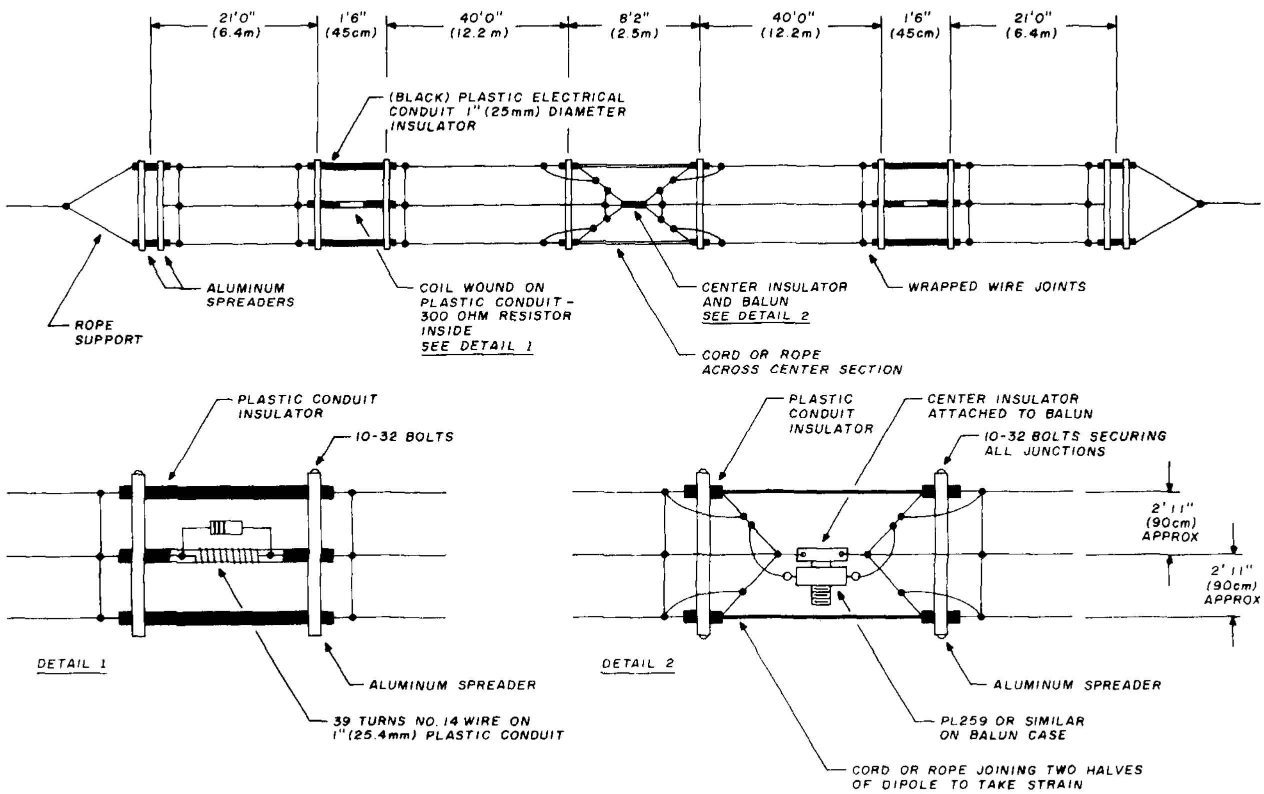

fig. 6. Assembly details for Australian Dipole.

lene plastic fiber rope in the antenna assembly to resist the effects of ultraviolet light. A suitable substitute rope is UV-resistant polyester material.

antenna installation

The SWR curve shown for this antenna was measured through about 75 feet (23 meters) of coaxial line, and the antenna was suspended in the air at about 40 feet (12 meters). As can be seen, the SWR was excellent up to 15 MHz, rising between 15 and 16 MHz to 2.1:1, then dropping down to low values up to 21.5 MHz, where two SWR peaks at 2.2:1 appear. The SWR curve then gradually drops off to a low value at 30 MHz. Undoubtedly the antenna is also suitable for operation above 30 MHz, but higher frequency measurements were not made.

The SWR can be adjusted around 16 and 22 MHz by varying the height of the antenna above ground, and for a permanent installation, the ends of the Australian dipole can be varied in height to smooth out the SWR curve by taking advantage of ground reflection.

the balun transformer

The matching transformer is wound on an iron-powder core having an outside diameter of two inches (5.08 cm). Inner diameter is 1¼ inches (3.18 cm). It is made by Micrometals Corp. and has the Amidon part number T-200-2. It is coded red, and has a permeability of ten. It is recommended for operation over the range of 1 MHz to 30 MHz. The core is also sold by J.W. Miller Division of Bell Industries as part number T200-2.

To prepare the core, wrap it with a layer of 3M brand (or equivalent) glass epoxy tape to prevent arcing between winding and core. A single winding composed of five parallel wires is placed on the core. No. 14 AWG Formvar-insulated (about 1-mm diameter) wire is used. Fourteen turns of the five-wire combination are wound on the core. The approximate length of wire used for each winding is about 5 feet (1.5 meters).

It is easier to wind the core than to explain how it's done. One set of wire ends is held in a vise and the five wires are smoothed out until they lie parallel. The parallel group of wires is stretched to remove kinks and then removed from the vise. The wires can be wound on the core all at once, or three wires can be wound on, followed by two, if that seems more convenient. In either case, the windings should all lie together.

When completed, continuity of each winding can be checked with an ohmmeter and the wire ends marked for convenience with a drop of epoxy paint. The last step is to interconnect the windings to get the proper transformation ratio. The windings are connected in series and the 300-ohm termination taken from the ends of the windings. The 50-ohm input points are tapped off between the ends of the second and third windings. This provides a turns ratio of 5:2 and an impedance transformation of 6.25:1.

When the transformer is completed it is given a coat of casting resin to protect it from the weather.

The transformer is attached to the center insulator of the antenna and a coaxial receptacle (SO-239), or a waterproof type-N connector, affixed to the balun terminals, and mounted to the center insulator.

When the antenna is completed, it should be raised in position and adjusted to provide the lowest value of SWR in the most important frequency regions of operation.

Note: This antenna is based upon a design by Dr. R.J.F. Guertier and G.E. Collyer of Antenna Engineering Australia (Pty.), Ltd. and was described in *Amateur Radio* (Australia), April, 1974. Information on the Australian Dipole is gathered from issues of *Amateur Radio*, the monthly publication of the Wireless Institute of Australia, Box 150, Toorak, Victoria 3142, Australia.

ham radio

the ham notebook

switching circuit

I own a Chevy Vega in which I installed an ICOM IC-255A. I quickly discovered the tiny internal speaker, which was aimed at the floor of the car, could not compete with car and road noise. I couldn't afford to reinsulate the car and the Hatchback design wouldn't support an external speaker. However, there was already one well-placed speaker in the car — the one used for the built-in a-m radio.

I could have installed a switch easily, but that would have generated another problem: 2 meters in the Las Vegas area is not teeming with activity. I only needed to use my car's built-in speaker when 2 meters was active. I needed to be alerted when my ICOM was receiving so I could switch the car's speaker from the a-m radio to the ICOM. Going one step further, why not find some way to automatically switch between receivers?

The IC-255A has an accessory socket that supplies 7 volts when the squelch is on. I tried using a transistor as a switch controlling a relay with my squelch voltage controlling the transistor. This was unsuccessful, it played havoc on my audio output from the ICOM. Dale Porray, AD7K, a local ham, came up with the perfect solution, using a voltage comparator circuit. The final circuit is shown in **fig. 1**.

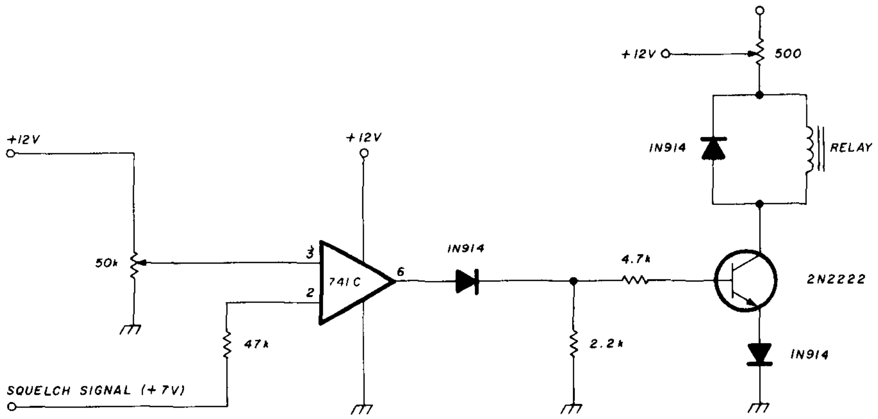

fig. 1. Voltage comparator circuit.

The 741C monitors the difference between the squelch signal and the reference voltage obtained from the 50K pot. It also provides good isolation for the ICOM squelch circuit. Once a signal breaks the squelch, the 7 volts disappears and the 741C causes the 2N2222 to deactivate the control relay. The 500 ohm pot on the relay's hot side is adjusted to prevent the relay from latching up. By obtaining 12 volts from the automobile and *not* the IC-255A accessory socket, the circuit activates only when the car's ignition is on. Since my IC-255A is wired directly to the battery to supply continual voltage to the memory circuits and to provide operation when I'm not driving, I used the relay configuration shown in **fig. 2**. The relay I used is Radio Shack part # 275-206. The 10 ohm resistors are 2 watts.

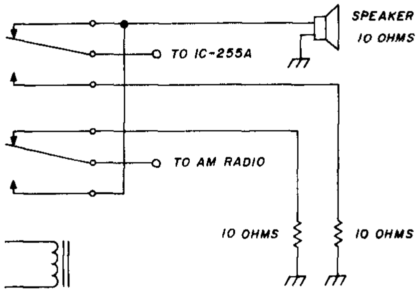

fig. 2. Continual voltage relays.

When the car's ignition is off, the IC-255A is wired directly to the car's speaker via the relay, and no unnecessary battery drain is made by operating the relay. When the car's ignition is on, I can enjoy listening to my car's a-m radio, knowing I will hear any signals coming through my IC-255A because my a-m radio will be muted.

This circuit can also be used to mute one radio in favor of another.

Construction and layout of the circuits are not critical. I used perfboard and direct wiring. I would recommend using an IC socket for the 741C. I got fancy when I wired the unit into the car: by using plugs and snap-on connectors, the entire unit can be removed and the speaker reconnected to the a-m radio in a matter of minutes.

This circuit is not unique to the IC-255A and can be applied to any receiver where a voltage is present when the squelch is on.

Fred Dahnke, WB6IQV

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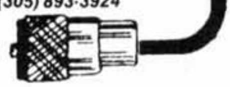

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More Details? CHECK—OFF Page 92

DX FORECASTER

Garth Stonehocker, KØRYW

last minute forecast

The higher frequencies (10-20 meter bands) are expected to provide excellent DX openings during the third week of this month. Openings will probably build up only the first two weeks and fall off the last week of the month. The lower frequency bands (nighttime, 40 to 160 meters) will probably have very good DX throughout the month and enhanced DX the first and last week. Disturbed conditions may be enhancing trans-equatorial paths and creating east/west path problems around the 5th, 14th, 24th, and 31st of the month.

Lunar perigee and full moon are on January 28 this month. There will be an intense but short meteor shower lasting a few hours some time between January 2nd and 4th. It is known as the Quadrantid shower.

Many of the DXers using the radio propagation quality formula (August, 1982, DX Forecaster) have expressed an interest in how the formula came to be. I thought I'd pass this along:

The North Atlantic Radio Warning Service (NARWS) of the National Bureau of Standards of the Department of Commerce provided this service via WWV broadcasts from World War II until 1978. The forecast was done for every six hours; that is, four times daily. The last two hours of monitoring of each six-hour period was the basis for the next six-hour forecast. Radio circuits crossing the North Atlantic were monitored and evaluated by the FCC, RCA, ITT, the Navy, the Coast Guard, the Canadian Broadcasting Corp., and NARWS. The forecast was also based on solar-geophysical and ionospheric conditions which were called and monitored by the NARWS.

Statistical analysis was done to keep the evaluations within standard-deviation limits. Mr. Harris, one of the forecasters, noticed over the years that two of the useful predictors were the radio flux values and geomagnetic A or K variability indices. He made computerized comparisons of flux values and variability indices to the observed radio quality monitored evaluations from 1947 (the start of Ottawa, Canada, 2800-MHz radio flux measurements). The mathematical formulation was obtained from these correlations. The calculated quality values from the formula were then compared with the observed quality values over the span of years from 1947 into the latter 1970s; they matched well in summer but toward each winter the calculated quality was greater than the observed. Therefore utilizing a modeling technique, the seasonal term, θ, was developed, using the day of the year and a cosine function to gradually lower the calculated number. An earlier version of θ was inadvertently given in August. The correct formula is: $\theta = 1.0 - 0.2625 \cos^2 0.49315X$.

An attempt was made to determine why θ was needed, but several effects could have been involved: enhanced sporadic-E signal strength in summer; lowered F2 region heights (therefore more hops required across the Atlantic) in the high latitude trough in winter; or higher winter absorption (known as the winter absorption anomaly) than the closer-sun higher radio flux can account for. These are postulations that have been proposed but not fully researched since it is very difficult to sort out individual geophysical mechanisms operating in such cases.

band-by-band summary

Ten meters will be open occasionally for F2 long skip by the trans-equatorial one-long-hop propagation mode (TEM). The openings will follow the sun during the day and into late evening. Geomagnetic disturbances will enhance this mode, as will high solar flux. Openings may favor southern Africa, South America, and Australia — particularly southern Africa.

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

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

JANUARY

WESTERN USA

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

MID USA

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

EASTERN USA

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

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

Food for thought.

Our new Universal Tone Encoder lends its versatility to all tastes. The menu includes all CTCSS, as well as Burst Tones, Touch Tones, and Test Tones. No counter or test equipment required to set frequency-just dial it in. While traveling, use it on your Amateur transceiver to access tone operated systems, or in your service van to check out your customers' repeaters; also, as a piece of test equipment to modulate your Service Monitor or signal generator. It can even operate off an internal nine volt battery, and is available for one day delivery, backed by our one year warranty.

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77.0 XB	100.0 1Z	131.8 3B	173.8 6A
79.7 SP	103.5 1A	136.5 4Z	179.9 6B
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85.4 YA	110.9 2Z	146.2 4B	192.8 7A
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Coming Events

ACTIVITIES

"Places to go..."

ILLINOIS: Wheaton Community Radio Amateurs Hamfest will be held February 6, 1983 at Arlington Park Race Track EXPO Center, Arlington Heights, Illinois. Free Flea Market tables and plenty of floor space. Large commercial area including computer section. For general info call W9JTO at 311-231-9524. Clear paved parking. Awards. Tickets $3.00 at entrance, $2.50 in advance. Send SASE to WCRA, P.O. Box QSL, Wheaton, IL 60187. Talk-in on 146.01/61 and 146.94. Doors open 8 AM. Be There! — KA9KDC.

INDIANA — SOUTH BEND: Hamfest Swap & Shop, January 2, 1982, first Sunday after New Year's Day at Century Center downtown on U.S. 33 Oneway North between St. Joseph Bank Building and river. Industrial History Museum in same building. Carpeted half acre room. Tables $3 each. Four lane highways to door from all directions. Talk-in freq: 52-52, 99-39, 93-33, 78-18, 69-09, 145.43, 145.29.

LOUISIANA: The Southeastern LA University and the Southeastern LA ARC are sponsoring a Hamfest on Saturday, January 15 on the SLU campus, Twelve Oaks Cafeteria from 9 AM to 3 PM. Free admission. Free swap tables.

MICHIGAN: The Southfield High School Amateur Radio Club's 18th annual Swap & Shop, January 30, Southfield High School, 24675 Lahser, Southfield, 8 AM to 3 PM. Admission $2.50. Reserved tables $18.00 in advance for two 8 ft. tables. All profits go toward electronic scholarships and to support the activities of Southfield HS Amateur Radio Club. For information/reservations: Robert Younker, Southfield High School, 24675 Lahser, Southfield, MI 48034. Telephone: (313) 354-7372, 8 AM to 10:30 AM; or (313) 354-8210 10:30 AM to 3 PM, Monday through Friday.

VIRGINIA: Richmond Frostfest '83. The annual winter Ham Radio and Computer Show will be held Sunday, January 16 at the State Fairgrounds, Richmond. General admission: $4.00. All indoor flea market and commercial exhibits. Major prizes in HF and VHF equipment and a minicomputer. Sponsored by the Richmond Amateur Telecommunications Society, P.O. Box 1070, Richmond, VA 23208.

OPERATING EVENTS

"Things to do..."

FEBRUARY 5: New Hampshire QSO Party sponsored by the Concord Brasspounders, Inc. Operating periods 1900Z February 5 to 0700Z February 6 and 1400Z February 6 to 0200Z February 7. 24 hours total. Awards mailing deadline March 12, 1983. Send your entry with large SASE for results and/or award to Concord Brasspounders, Inc., c/o Norman W. Littlefield, RFD 1, Buck Street, Box 323, Suncook, NH 03275, W1JBX.

JANUARY 15: WD2ALL will operate the Camp Ballou Scout Freezeout from the Camp Ballou Boy Scout Camp; 1400 to 1700, 1800 to 2200, and 2300 to 0100 GMT. Frequencies 10 kHz above lower edge of General phone bands and 25 kHz above lower edge of Novice bands. Also 146.55 simplex operation is planned. QSL with SASE to WD2ALL via callbook.

HAMFESTERS RADIO CLUB is celebrating its 50th anniversary in 1983. Look for club station W9AA on all bands. We will send a special QSL card for contacts this anniversary year. QSL to: Hamfesters Radio Club, P.O. Box 42792, Evergreen Park, IL 60642.

JANUARY 29: The fifth annual *Freeze Your Arctic Off* sponsored by the Ford Tin Lizzy Club from 1700Z to 1700Z, January 29 and 30. Look for AD8R/8 on 7.275, 21.380 and 146.58. For a certificate QSL to Box 545, Sterling Heights, MI 48077.

JANUARY 29: The Eau Claire, WI, ARC will operate K9EC/9 during the National 70 meter Ski Jumping and Nordic Combined Championship from 1400Z to 2300Z, January 29 and 30. Frequencies: CW — 52 kHz up from bottom edge. Phone — 3980, 7277, 14282, 21382, and 28620. SASE for certificate to N9AIX, P.O. Box 201, Altoona, WI 54720.

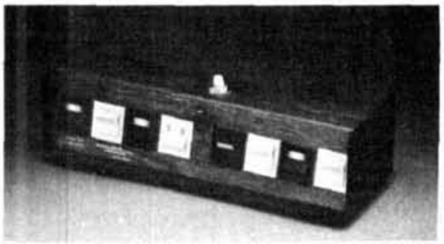
JANUARY 22: The West Virginia QSO Party sponsored by the WV State Amateur Radio Council, 1700Z January 22 to 1700Z January 23. Single operator only. Suggested frequencies: Phone 10 kHz from lower edge of General sub-bands; CW 35 kHz from low ends; Novice 35 kHz from low ends. Repeater contacts permissible. Mail logs by February 11 to K8BS, 950 Gordon Road, Charleston, WV 25303.

NEW products

surge protection and master control

Alpha Delta Communications has introduced the new Master AC Control Console (MACC) which features power surge protection and centralized control of several components. The MACC unit plugs into a single outlet, providing eight plug-in grounded outlets of its own — one hot, for a continuously powered application such as a clock and seven for individually controllable components.

The front panel has rocker switches for the individually controllable components, plus a master control rocker which allows the entire system to be turned on or off. Rockers are lit when on.



Alpha Delta's MACC uses three-stage automatically restorable circuitry to clip off power spikes and surges, and has a manually resettable circuit breaker for further protection. MACC is tested to IEEE pulse standards and rated at 15 amperes, 125 Vac, 60 Hz, 1875 watts continuous-duty total for the console.

MACC is priced at $79.95. For more information, contact Alpha Delta Communications, P.O. Box 571, Centerville, Ohio 45459.

X-Panda-Five

The X-Panda-Five makes your Hustler (or equivalent) into a five-band mobile antenna, with the appropriate coils added. When the X-Panda is installed with the proper resonators, you can change bands without stopping your vehicle. Each resonator, tuned to the desired frequency, eliminates the need for an antenna tuner.

Also, the X-Panda-Five adapter added to the Hustler or Hy-Gain antenna with the appropriate resonators and added ground planes will make an ideal antenna system for apartment houses and condominiums. It can also be used to make a multiband antenna system for vans, campers, motor homes, and travel trailers.

The X-Panda-Five will accept either regular or super-size resonators. For further information, contact JL Industries, P.O. Box 030413, Ft. Lauderdale, Florida 33303.

new TS830, TS930, R820 filter kit

Fox Tango Corporation announces a special high-quality matched-filter kit designed to significantly improve the selectivity of the Kenwood R820, TS830, and the new TS930 series. The Fox Tango filters (both 8-pole discrete crystal units instead of the original monolithic and ceramic types) each have a bandwidth of 2.1 kHz (net bandwidth of 1.99 kHz); a combined shape factor of 1.19; and an ultimate rejection greater than 110 dB. VBT may be used to narrow the operating i-f bandwidth to reduce QRM, (narrower bandwidths, usually given at −6 dB, help reduce adjacent channel interference) but the steepness of the filter skirts or shape factor (−60 dB BW divided by −6 dB BW) and their depth (ultimate rejection) are more important. If VBT is used to reduce the bandwidth to 1.99 kHz (to equal that of the FT filters without VBT), the shape factor of the original filters becomes 1.45 as compared with 1.19 — and the ultimate rejection is less than 80 dB as compared with more than 110 dB — both significant differences.

Regardless of the type of filters, the use of VBT in these receivers always reduces the shape factor. With VBT off, the characteristic curves of the two filters essentially coincide with one another, referred to as filter cascading. The combined shape factor is usually better than that of either of the two filters involved. When VBT is used, one filter characteristic is made to slide with respect to the other, and only the portion where they overlap represents the bandpass area. The cascading effect is lost and the resulting characteristic has the skirt of the first filter on one side and that of the second on the other.

Also, because of the rounded shoulders of the original filter characteristics, the overlap at narrower bandwidths has the effect of increasing the filter insertion loss: 5 dB versus 0 dB with FT filters at 500 Hz bandwidth; 10 dB versus 1 dB with FT filters at 300 Hz. The greater such losses, the lower the receiver sensitivity in the CW mode. The superior characteristics of the FT filters results in excellent performance in both the SSB and CW modes practically eliminating the need for the purchase of optional CW filters by all but the most serious CW operators.

There are significant advantages in not buying any CW filters. In addition to saving the cost of the CW filters, installation is simplified since the FT matched pair can be inserted directly into the holes provided for the CW filters. With this arrangment, the following operating options become possible: (1) FT filters for both RX and TX; (2) FT for RX, original Kenwood for TX; (3) FT for RX, switch-select FT or Kenwood for TX; (4) Switch-select FT or Kenwood for RX/TX. If CW filters have been (or are to be) used, the recommended arrangement is to replace the original SSB filters with the FT 2.1 matched pair. In this case only option 1 is possible. This installation is easy, no drilling or switching is required, and all parts are provided in the kit.

The matched pair filter kit, complete with detailed instructions, two 2.1 kHz Fox-Tango filters (guaranteed for one year), and all needed cables and parts is offered at an introductory price of $150 plus $3 for shipping ($5 for air). Send your order, specifying the rig with which the filters are to be used, to Fox Tango Corporation, P.O. Box 15944, W. Palm Beach, Florida 33406, or order by telephone: 305-683-9587.

450-MHz handheld

A second cousin to the popular IC-2/3A series, the IC-4AT provides coverage of the 440-MHz band. It is identical in appearance, size and operational features to the popular IC-2A/3A series. All accessories, including battery packs, chargers, microphone, etc., are completely compatible with the IC-2AT and IC-3AT series. The IC-4AT also includes a sixteen-button Touchtone® pad.

The IC-4A covers the 440-MHz band from 440.0 MHz to 449.995 MHz and is set up for both duplex and simplex operation. The power output is nominally 1.5 watts with the standard IC-BP3. The IC-4A system will come complete with IC-BP3 Ni-Cd battery pack, wall charger, belt clip, rubber duckie, and wrist strap. The IC-4A costs $269 and the IC-4AT is $299.

For more information, contact ICOM America, Inc., 2112 116th Ave. N.E., Bellevue, Washington 98004; telephone 206-454-8155.

universal programmable filter

Applied Invention has introduced Reticon R5620, a universal programmable active filter. The R5620 is a complex NMOS switched capacitor active filter (SCF) analog IC. It uses switched capacitor technology to synthesize a two-pole pair active filter that requires no external components and operates over the range of 0.05 Hz to 25 kHz. The five basic filter types — lowpass, highpass, bandpass, band reject, and all pass — can be used as well as a programmable sine-wave oscillator. The Q is set to one of thirty-two approximately logarithmically spaced values from 0.57 to 150 by five control pins (hard-wired or TTL/MOS logic levels). Center frequency is set by an external clock oscillator. The clock division ratio can

NEW products

be varied from 50 to 200 (two octaves) in logarithmic steps.

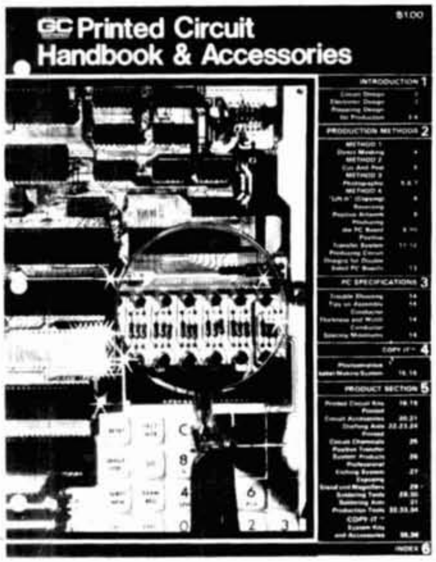
Switched capacitor filters are simply standard analog filters with fixed resistors replaced by time division variable-switched capacitors. This results in a highly stable filter which can be accurately tuned with only a variable clock source. The programmability of the SCF makes it very attractive for microcomputer-controlled synthesizers and other analog/digital system applications. Small quantity price of the Reticon R5620 is $8.00, with an application package available for an additional $2.00. Contact Applied Invention, RD2, Route 21, Hillsdale, New York 12520; telephone 518-325-3911.

new PC handbook

A new 40-page *Printed Circuit Handbook and Accessories Catalog* from GC Electronics, a division of Household International, features step-by-step instructions and diagrams and explains in careful detail how to produce professional-quality printed circuit designs.

This latest handbook is an enlarged and more complete version of the company's previous edition. It includes a variety of helpful information on how to produce both single and double sided printed circuit boards as well as PC specifications and trouble shooting tips. In addition, it pictures and describes more than 125 GC products.

Copies of the new PC *Handbook* (Cat. No. 22-100-HB) are now avail-



able through GC Electronics' distributors nationwide. For more information, contact GC Electronics, 400 S. Wyman, Rockford, Illinois 61101; telephone 815-968-9661.

simplex/duplex autopatch model

Current Development Corporation announces the Novax II Mobile Connection for interfacing radios to DTMF (TouchTone) and rotary dial telephones. In addition to the standard features of Novax I, the Novax II offers a four-digit access code; LED display; toll restrict; repeater use; and interfaces to rotary dial systems (for rotary dial telephones). Both units use a high speed switching technique that eliminates voice-activated switching problems.

For more information contact Current Development Corporation, Box 162, Tudman Road, Westmoreland, New York 13490; telephone 315-829-2785.

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FROM YOUR FRIENDS AT DENTRON... ENJOY!

Even Santa couldn't wait to get on the air with the latest fun and excitement from Dentron Radio...our new MLX MINI and the STATION ONE. Try the MLX Mini yourself, it's a monoband, HF transceiver that has all the performance of a big rig, yet it's small enough to fit in your stocking. Even the price is small, suggested retail $289.50. Get in on the fun with our new Station One, it's the perfect gift for Novices and QRPers alike. This 25W, 3 band, CW transceiver can be worked at home base or plugged into a 12V battery for mobile use. Suggested retail is $269.95. Gear up with Dentron for a Merry Christmas and a fun New Year.

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UNGAR

Modular Components...
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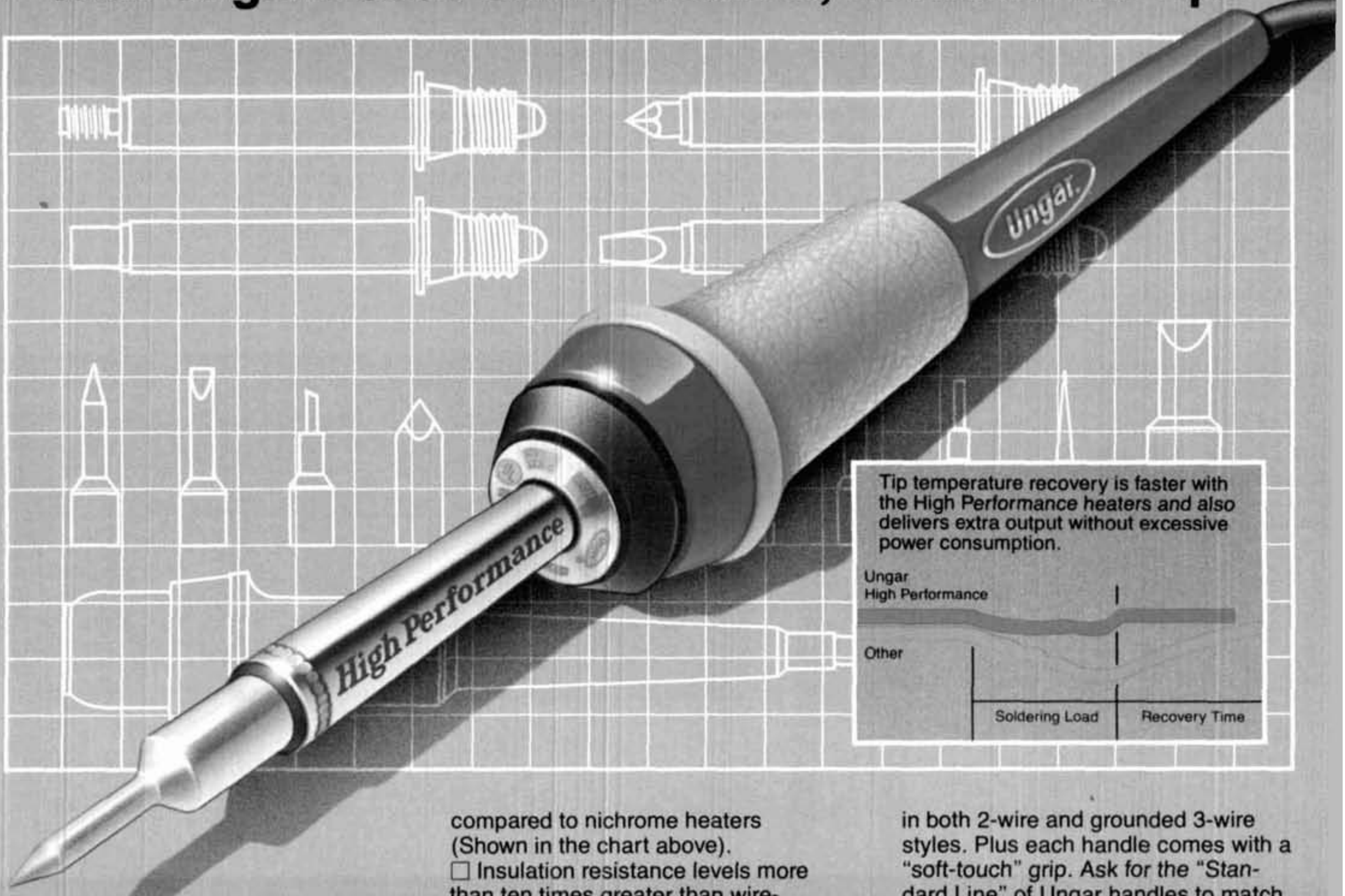
With Ungar's 3000 Series Heaters, Handles and Tips



When it comes to making a choice, Ungar gives you lots to choose from. We have one of the broadest lines of soldering components available to precisely meet your needs.

Take our lineup of heaters, handles and tips, for example. We've got you covered with a variety of heat ranges and tips so you can custom-design the soldering iron to fulfill your requirements.

15 NEW THERMO-DURIC™ HIGH PERFORMANCE HEATERS

Our 3000 Series heaters are the state-of-the-art in soldering today. Their improved performance is thanks to modern "thick film" technology, which has allowed the design of our exclusive, revolutionary THERMO-DURIC™ heater element.

The benefits include:

☐ Faster heat-up—typically 1.5 minutes vs. 2.5 minutes.
☐ Quicker temperature recovery compared to nichrome heaters (Shown in the chart above).
☐ Insulation resistance levels more than ten times greater than wire-wound elements. This means significant reduction in leakage currents that can damage sensitive micro-electronics.
☐ Lower power consumption—our 50 watt heater outperforms a conventional 80 watt iron.
☐ Less energy consumed at no-load idle temperatures—typically 15% less!
☐ Better results with thread-in and thread-on tips.

And that's not all!

You can choose from a wide selection of body styles. Ranging from integral tip models to the thread-in and thread-on styles. Plus each style is available in wattage ratings to cover soldering temperatures from approximately 700°F to 1,000°F.

HANDLES—WE OFFER YOU THREE CHOICES

To complement our 3000 Series heaters, we have three handles. They are perfectly balanced for added comfort and reduced fatigue. They're available in both 2-wire and grounded 3-wire styles. Plus each handle comes with a "soft-touch" grip. Ask for the "Standard Line" of Ungar handles to match up with the ultimate in heaters, the 3000 series!

SELECT FROM 15 TIPS

No matter your requirements, we've got the tip for you! Available in both thread-in and thread-on styles to mate with our 3000 Series heaters.

AND IT'S ALL MODULAR!

That's the beauty of the Ungar system. Every piece is modular, so if one unit wears, instead of buying a totally new soldering iron—simply replace that one component. Fast, Easy, and Economical. You have unparalleled flexibility to combine handle, heater and tips to create any one of 234 custom irons.

To find out more about this amazing lineup from Ungar, call the Ungar Hotline, toll-free 1-800-421-1538, in California, call collect, 1-213-774-5950.

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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 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 in 1-MHz steps. A new, innovative, quadruple "UP" 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, 50-kHz spacing, 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 circuits with cooling fan, SWR/Power meter built-in.
- **CW full break-in.**
  CW full break-in circuit uses CMOS logic IC plus reed relay for smooth, quiet operation. Switchable to semi-break-in.
- **Automatic antenna tuner, built-in.**
  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.
- **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.
- **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 slope of the IF passband, for best interference rejection. HIGH/LOW cut control rotation not affected by selecting USB or LSB modes.
- **CW VBT and pitch controls.**
  CW 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.**
  Six digit readout to 100 Hz (10 Hz modifiable), plus digitalized sub-scale with 20-kHz steps. Separate two digit indication of RIT frequency shift. In CW mode, display indicates the actual carrier frequency of received as well as transmitted signals.
- **RF speech processor.**
  RF clipper type processor provides higher average "talk-power," improved intelligibility.
- **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.
- SO-1 commercial stability TCXO (temperature compensated crystal oscillator). Requires modifications.
- MC-60A deluxe desk microphone with UP/DOWN switch, pre-amplifier, 8-pin plug.
- TL-922A linear amplifier (not for CW QSK).
- SM-220 station monitor (not for pan-adapter
- 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.

KENWOOD

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