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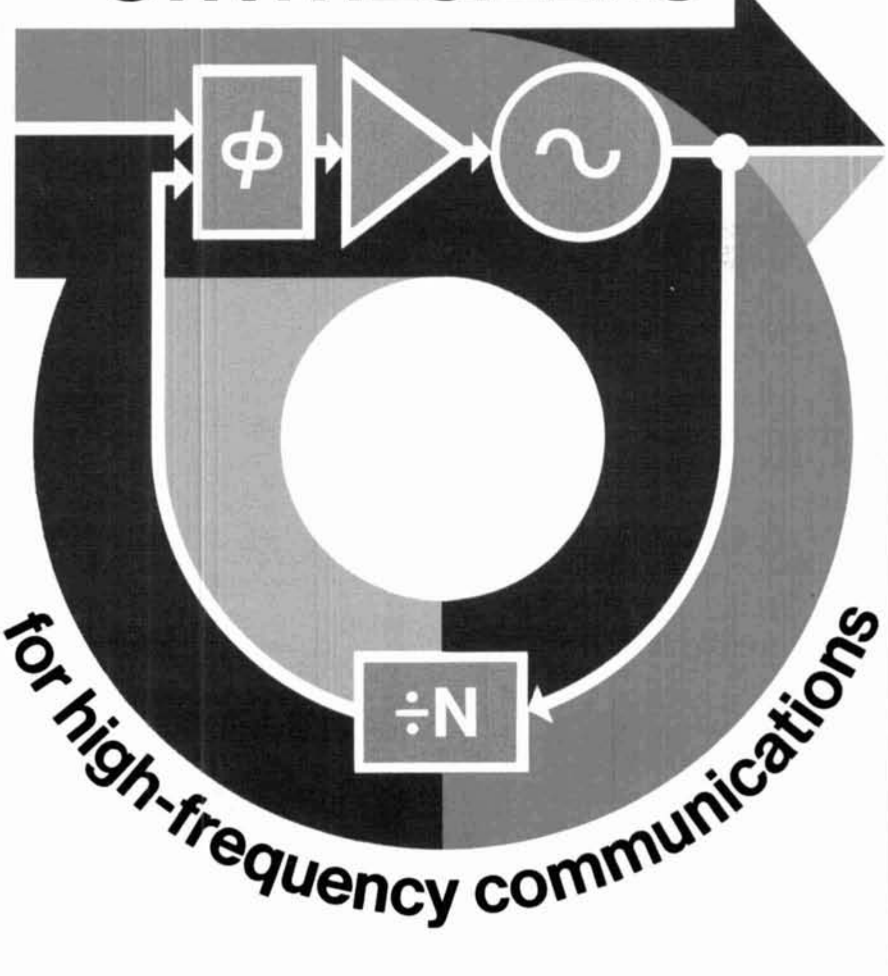


focus on communications technology

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# ham radio
magazine

## AUGUST 1983

volume 16, number 8





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# contents

# REFLECTIONS

## SPECIAL REPORT: W5LFL and SPACELAB STS-9

*A three-hour teleconference call on June 9 brought together representatives of NASA, AMSAT, the broadcasting industry, and several key figures in Amateur Radio publishing. The subject: the 9-day STS Spacelab Mission of Dr. Owen Garriott, W5LFL. While this page is normally reserved for the editorial — and was scheduled this month to include the 1983* ham radio *Reader Survey — we gladly postpone both in order to bring you details of the project.*

**For the first time in the history** of the space program, individual citizens will be able to talk directly with an astronaut *in space* when NASA mission specialist Dr. Owen Garriott, W5LFL, attempts to contact as many Amateurs worldwide as possible during the last five days of the STS-9 spacelab mission, scheduled for launch on September 30.

W5LFL will be able to operate only during his leisure time periods, expected to be one hour per day, for a mission total of five hours. He will transmit on the even minutes for one minute and listen on the next odd minute while logging and tape recording what he hears. He will then acknowledge call signs heard on the next even minute. It is expected that he will QSO approximately 500 hams worldwide and be heard by 300,000. The ARRL will act as QSL manager and provide acknowledgements for all verified QSOs and SWL reports.

The equipment aboard the spacecraft will be a multichannel black box transceiver capable of 5 watts output from its battery power. The station, located on the aft flight deck of the space shuttle orbiter Columbia, will use a printed circuit loop antenna mounted on the upper crew compartment window.

Operation will take place on uplink frequencies (earth to space) of 144.910-145.470 (possibly no higher than 145.190) in 20 kHz steps while the downlink frequencies (space to earth) will be 145.510-145.770 (2 or 3 specific frequencies will be chosen), also in 20 kHz steps. Mode of operation will be 2-meter fm (split).

The 57-degree inclination, 90 minute, 155 mile altitude orbit will enable most of the earth's land mass to be (line-of-sight) visible from the spacecraft during a typical day, though any specific location will have an 8-minute maximum pass.

AMSAT recommends that ground station equipment consist of no more than a 10-15 watt 2-meter transceiver feeding a high lobe (80-90 degrees would be ideal) turnstile antenna mounted above any obstructions. They do not recommend using more elaborate antennas (such as a cross-Yagi).

A combined effort on the part of many individuals and organizations,* this project is the result of a joint proposal by the ARRL and AMSAT to NASA. Earlier proposals to place an Amateur Radio transceiver aboard an orbiting U.S. spacecraft date back to the early '70s, when a project called "SKYLARC" — Skylab Amateur Radio Communications — was planned but scrubbed because it came too late in the development of the program. The present proposal was recently accepted by NASA, with the only restrictions related to non-interference with higher priority mission objectives, systems and, of course, safety.

Starting in mid-July the ARRL is expected to provide a 900 telephone number for the latest orbital information. Other sources of information are NASA itself, which will provide a timetable (flightline) of the operation, and Westlink, whose report can be heard by calling (213) 465-5550.

The ARRL is also planning a videotape presentation featuring Dr. Garriott. Hosted by NBC's Roy Neal, it will document the role of Amateur Radio and Amateur Radio operators throughout the STS-9 mission.

This is truly a unique occasion for Radio Amateurs to show the world how they can contribute to technology and public awareness. Each Amateur will provide quite some service if he is able to acquire the signal, tape record it and contact the local media with details of the QSL and perhaps even a recording of any voice contact. Reporters may want to play the tape over their broadcast stations or transcribe it for newspaper use.

So clean up the shack, tape record everything you hear, and *good luck*!

**Rich Rosen, K2RR**
**Editor-in-Chief**

***credit where it's due**

A short list of just some of the people instrumental in bringing about this effort is definitely in order: General James Abramson, Assistant Administrator of NASA, who gave final approval for Amateur operation on the mission; Bernie Glassmeyer, W9KDR, ARRL Space Program Manager; Peter O'Dell, KB1N, ARRL Public Information Coordinator; Steve Mendelsohn, WA2DHF, CBS technician and Vice-Director of the Hudson Division of the ARRL; Rich Moseson, N2BFG, Associate Producer, CBS News; Bill Tynan, W3XO, VHF Contributing Editor, QST; Roy Neal, K6DUE, NBC Science Editor; Vern Riportella, WA2LQQ, AMSAT President-Elect; and Bill Pasternak, WA6ITF, Editor, Westlink Report.

# presstop de W9JUV

FCC'S "NO MAILBACK" NOVICE EXAM PROPOSAL WAS APPROVED June 29 by the Commissioners and goes into effect by the end of August. Under the new procedure, proposed in PR-Docket 82-727, a General Class or higher Amateur will make up a Novice exam from a bank of 200 FCC approved questions, then both administer and grade it himself. He'll then simply advise FCC's Gettysburg office if the applicant passes, and they'll issue a license.

The New Procedure Should Cut Licensing For A Novice to a fraction of its current turnaround time, and save the Commission a good deal of money as well. The list of 200 questions and procedural detail should be ready for distribution by mid-July.

"Business Communications" Was Another Issue Addressed at that same meeting, resulting in the adoption of an "Interpretive Order." A new paragraph has been added to Rules Part E (Prohibited Practice) which states simply that business communications are prohibited and then defines business communications as "...any transmission...to facilitate the regular business or commercial affairs of any party." which is the definition now found in (Amateur section) Part 97.114(c). Its application was also specifically extended to overseas third-party traffic.

FCC's Proposal To Change Power Limits And Measurements from dc input to rf output may also make it to the Commissioners' agenda before they adjourn for August recess.

The Ancient Issue Of Amateur "Broadcasting" may also turn up on the Commission agenda in the near future. Most recently at issue was the rebroadcast of Space Shuttle communications, but the question of what constitutes "broadcasting" in the Amateur Service and when an Amateur "broadcast" is justified has never been formally addressed by the FCC.

Informal Comments And Suggestions On The Broadcasting question could prove helpful at this time, when the issue is still in the discussion stage. Contact Personal Radio Branch Chief John Johnston or Private Radio Bureau Chief James McKinney.

CONTACTS WITH W5LFL/SPACE DURING SKYLAB'S OCTOBER VOYAGE will necessarily be quite limited, with no more than 500 lucky Amateurs likely to hear their calls to space acknowledged by Astronaut Owen Garriott as he passes overhead. An operating procedure has already been established (see this month's editorial for this and other technical information).

Final Details Will Become Available as the late September launch date approaches. Check ARRL bulletins, AMSAT nets, and Westlink's 213-465-5550 line after mid-September.

OSCAR 10 IS UP AND LOOKING GOOD, following a textbook Ariane launch at 1159Z June 16. 17 minutes into launch OSCAR 10 separated, entering a highly elliptical temporary orbit. Due to a less than ideal attitude the first thrust motor burn was delayed until the end of June; the last burn (to final orbit) should be mid- to late-July, after which the Mode B transponder will be turned on. Model L (1268 to 436 MHz) won't be turned on until later.

OSCAR 10's 145.810 MHz Beacon Has Been Putting Out an excellent signal, with a five minute CW "status report" every hour and half hour and telemetry data in between. Due to the 200 by 39,000 kilometer elliptical orbit, the beacon has been audible in the midwest for more than 8 hours at a time with slowly changing azimuth and elevation bearings.

THE FUTURE OF THE VOLUNTEER AMATEUR EXAM PROGRAM has been clouded by an apparent ARRL policy change incorporated in its Reply Comments on the exam program NPRM, PR Docket 83-27. Their new position, which is reported to have taken the Commission by surprise, is that the League wouldn't participate in the volunteer program unless it was permitted to recover costs of operating the program by charging applicants an examination fee.

Sen. Barry Goldwater, K7UGA, Whose Communications Act Rewrite provided the means for setting up the volunteer program, has just told WA6ITF of Westlink that he is completely opposed to any such fee. Goldwater does, however, support the League against "No-Code."

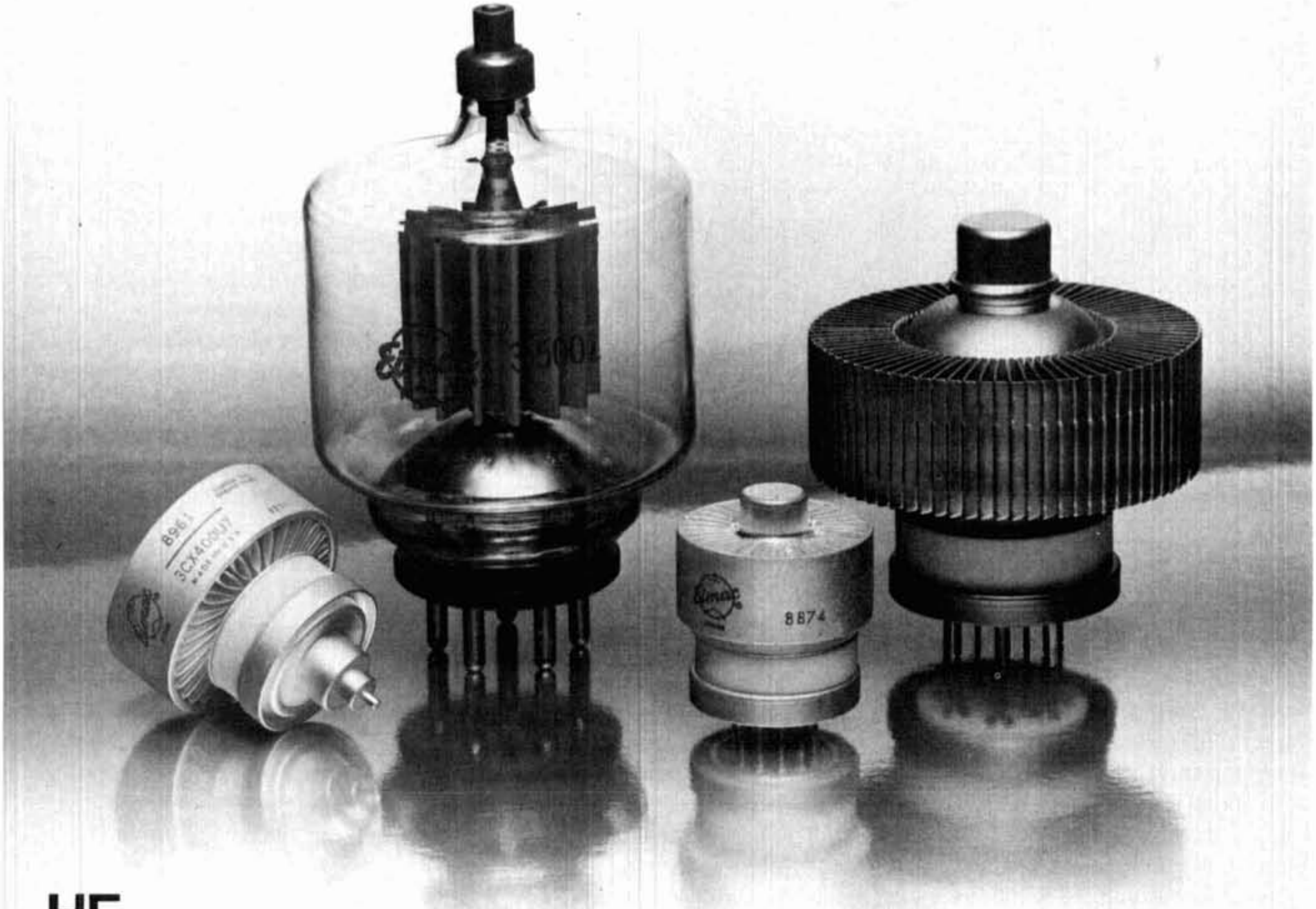
AMSAT WILL OPPOSE OPENING 29-29.5 MHZ TO REPEATERS, as proposed in FCC's PR Docket 83-485. Comments were due July 25, and Reply Comments will be due August 24.

ALL AMATEUR LOG KEEPING REQUIREMENTS HAVE BEEN DROPPED by the FCC, including those concerning logging of repeater autopatches and even overseas third-party traffic. Though an Amateur may still keep a log for his own use, it's no longer a Part 97 requirement.

However, Some Related Information Previously Required under Part 97.103 must still be kept but has been moved to other parts of the rules. Examples include much of the information pertaining to remotely controlled stations and their security.

In A "Streamlining" Move, The FCC Has Also Adopted a number of other rules changes. A station operating ATV or RTTY, for example, now need identify only in the mode in which he's operating. An interim permit may now be renewed, and the rules now spell out the right of the Commission to inspect an Amateur station.

ERIC SHALKHAUSER, W9CI, PASSED AWAY June 9. He was one of the few remaining active Amateurs from before WWI and among his many accomplishments were his designs of the RME 69 and 70 plus many other outstanding receivers and converters for Amateurs.






More Details? CHECK—OFF Page 108

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# comments

## no code

**Dear HR:**

Isn't all this wailing against a "no-code" license a little illogical?

Code became a licensing requirement because all radio communication then was by code. Today, almost none is. Only a few Amateurs and a handful of outmoded commercial and maritime services use CW and code.

In today's hyper-electronic age, requiring code proficiency in order to operate a radio-telephone (which is all most hams want to do) is like making you learn to ride a motorcycle well in order to get a license to drive an automobile. Silly, eh?

Some people like motorcycles. They're fun, I'm sure. And they get you where you want to go, like automobiles do. But there the resemblance ends. The number of motorcycles in use probably compares with the number of automobiles in use in about the same ratio as the number of active CW stations compares with the number of active SSB stations. CW is fun, and I was a "CW Forever" ham for fifty-four years until I was given a mike. And CW provides communications, like SSB. But again — there the resemblance ends.

Once, you had to know code to use radios. Today you don't. The great majority of newly licensed hams forget the code as soon as they get on the air. Many never even own a telegraph key.

It would seem that those hams most outspoken against the "no-code" license simply feel that everybody should suffer like they did *because* they did. Human, perhaps, but illogical.

Forcing people to learn code has not filled our CW bands. Count the CW signals any time of the day between 14000 and 14200, and the SSB carriers between 14200 and 14350 and see how they compare. Sad, isn't it? Do we want to lose all that unused space to some other (and more pressing) service — and we will, you can bet on it — or stop pushing an anachronism and let the 'phones use it for expansion, as is now happening?

To paraphrase an old saying, "You can force a ham to learn the code, but you can't make him use it." Let's get smart.

**Bill Lippman, W6SN**
**Pacific Palisades, California**

## converting TV

**Dear HR:**

The article by Carl Gregory, K8CG, (*ham radio*, April, 1983) on converting TV sets to video monitors for computer use was well done and informative, but he missed an important (and very simple) method of improving performance.

A couple of years ago I found myself in need of a video monitor for computer and high resolution VCR use and I too decided to convert a TV set. Don Lancaster covers the subject beautifully in Chapter 8 in his *TV Typewriter Cookbook*. Following his instructions, I converted a Motorola 20TS chassis. It worked well, but showed the same defects as K8CG's "simplest approach" solution — mainly, blurred pixels in computer use.

The situation was vastly improved by simply including another Lancaster suggestion: shorting out the 4.5 MHz sound trap in the output of the final video amplifier. As long as the sound trap is in the circuit, the set's video response has a big hole in it. With the short rise times in the computer generated signal, such a gap in response can be fatal.

I will not deny that K8CG's approach using an external video amplifier tied directly to the CRT cathode is superior (especially in terms of contrast and the best possible video bandwidth), but for those of us who are essentially too lazy to go that route, the sound trap refinement will make the easier route adequate for most purposes. Both the Betamax and TRS-80 Model I seem to be happy with the simpler approach, and so am I.

**Tom Adams, K9TA**
**Marinette, Wisconsin**

## CATVI

**Dear HR:**

After seeing all the articles written in various magazines last year on CATVI, I did not think it could happen to me. I felt an underground cable system should be virtually problem-free.

I am now involved with a complaint to the FCC and writing this letter to warn other hams one more time. You need to keep a constant surveillance on your cable system for leaks. One of the easier frequencies to watch is 145.250 and 144.0 if you're on an HRC system. To be sure of the frequencies used, contact your local cable office and ask the engineer in charge. A new cable installation can easily cause TVI to your entire neighborhood if it is not installed correctly. Also keep in mind that your cable system does not have to use a ham band frequency before you can cause interference to a cable system.

**Ron Hooper, WB4NMA**
**Gainesville, Georgia**

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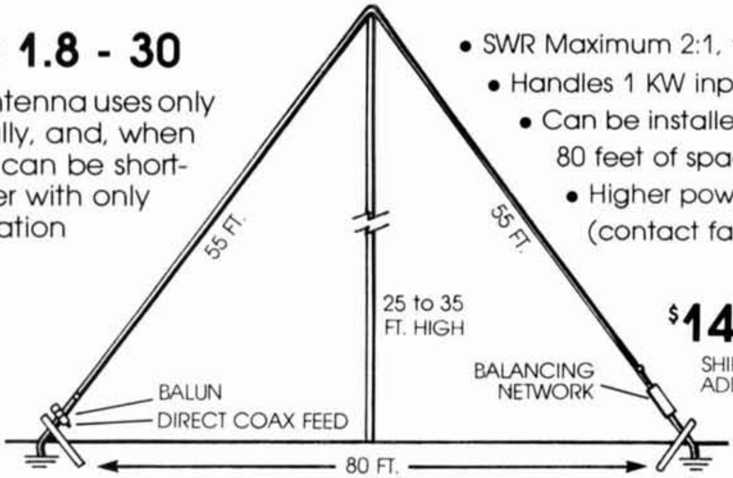


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Demystifying
PLL synthesizer design

# rf synthesizers
## for high-frequency communications:
## part 1

**PLL frequency synthesis** has become the dominant frequency generation technique in modern communications equipment as a result of the increased availability of PLL oriented ICs. This, in turn, has enabled the design of compact-low-power, inexpensive synthesizers. While this technology has been accessible for some time, it's necessary to understand how PLL synthesizers work before trying to design or build one.

### the phase-locked loop

There are three basic circuit blocks in a PLL: the phase detector, the loop filter, and the voltage-controlled oscillator (VCO), as shown in **fig. 1**.

In a PLL two signals at the phase detector input are in phase and therefore matched in frequency. Should they not be in phase, the phase detector generates an error signal which is filtered and passed to the VCO to correct the phase difference. At all times the loop tries to maintain zero phase difference between the phase detector input signals. A synthesizer is formed through the addition of a frequency divider to the basic PLL, (**fig. 2**). A zero phase error at the phase detector input occurs when the VCO is operating at a frequency

$$f_{VCO} = Nf_{REF}$$

Since $\div N$ is a programmable divider, the $VCO$ can oscillate at any frequency within its range as long as that frequency is a multiple of $f_{REF}$, simply by changing $N$.

**Fig. 3** illustrates a synthesizer designed to tune from 5.000 to 5.500 MHz in 1 kHz steps, using a 1 kHz reference oscillator and a programmable divider with a range of 5000 to 5500.

### phase detector

The phase detector can be built around either analog or digital circuitry. However, since it is easier to design the PLL around digital phase detectors than around analog phase detectors, only the digital phase detectors will be discussed.

Digital phase detectors use gates and flip-flops to detect phase and frequency differences. Their output are pulses whose average value is a dc voltage that is dependent on phase difference. A plot of voltage output versus phase difference input of a phase detector is shown in **fig. 4**.

From **fig. 4**, phase detector gain, $K_\phi$, is defined as:

$$K_\phi = \frac{\Delta V_{OUT}}{\Delta\theta_{IN}}$$

where $\Delta V_{OUT}$ is the averaged phase detector output voltage change and $\Delta\theta_{IN}$ is the input phase difference in radians.

**By Craig Corsetto, WA6OAA,** 4312 Marlowe Drive, San Jose, California 95124

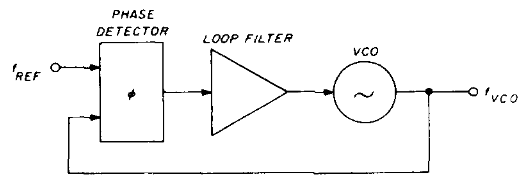


fig. 1. Basic PLL circuit blocks.

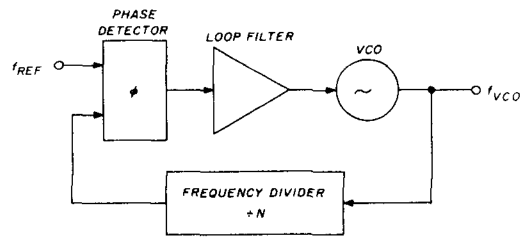


fig. 2. Circuit blocks for simple PLL synthesizer.

In **fig. 4**, $K_\phi$ is:

$$K_\phi = \frac{5V - 0V}{2\pi - (-2\pi)} = \frac{5V}{4\pi}$$

$$\approx 0.397 \text{ volts/radian}$$

$K_\phi$ is usually given in the manufacturer's specifications or in the applications notes for the device.

## VCO

The VCO is an oscillator whose frequency is controlled by an externally applied voltage, $V_T$. For good phase noise performance the VCO usually employs an LC or crystal resonator because of the high **Q** of these components.

The VCO has a gain term, $K_{VCO}$, which is the amount of frequency change, $\Delta f_{VCO}$, caused by a change in voltage $V_T$, on the VCO tune line.

$$K_{VCO} = 2\pi \frac{\Delta f_{VCO}}{\Delta V_T}$$

Since varactor diodes have nonlinear capacitance versus voltage characteristics, $K_{VCO}$ is not constant over the VCO frequency range. Therefore, two values of $K_{VCO}$ should be specified at the two ends of the VCO range.

**Fig. 5** illustrates how $f_{VCO}$ varies with $V_T$, over a frequency range of 5.000 to 5.500 MHz.

$$K_{VCO} = 2\pi \frac{\Delta f_{VCO}}{\Delta V_T}$$

$$K_{VCO}(5.0\,MHz) = 2\pi \frac{(5\,MHz - 4.9\,MHz)}{(1.75 - 1.25)}$$

$$\approx 1.257\,(10^6)\ rad/sec/volt$$

$$K_{VCO}(5.5\,MHz) \approx 2\pi \frac{(5.6\,MHz - 5.5\,MHz)}{(9.30 - 7.00)}$$

$$\approx 0.2732\,(10^6)\ rad/sec/volt$$

## programmable divider

The programmable divider is a digital circuit that provides simple programmable integer frequency division. Frequency division is possible to beyond 1 GHz using available ICs.

The gain of the programmable divider is:

$$K_N = \frac{1}{N}$$

Since $K_N$ is a function of $N$, two values of $K_N$ must be specified. For example, a synthesizer is required to tune 5.00-5.50 MHz in 10 kHz steps. If a simple loop is designed as in **fig. 2**, then the reference frequency will be 10 kHz and:

$$N(5\,MHz) = \frac{5\,MHz}{10\,kHz} = 500$$

and $K_N(5\,MHz) = \frac{1}{N} = 0.002$

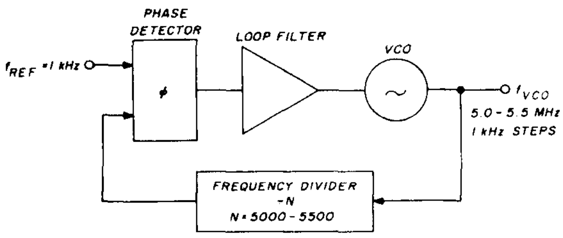


fig. 3. A 5.000-5.500 MHz synthesizer that tunes in 1 kHz increments.

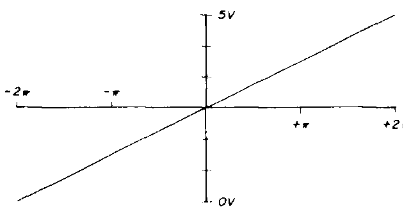


fig. 4. CD4046 phase detector transfer function.

$$N(5.5\,MHz) = \frac{5.5\,MHz}{10\,kHz} = 550$$

and $$K_N(5.5\,MHz) = \frac{1}{N} \approx 0.00182$$

Programmable dividers are often programmed from microprocessors, thumbwheel switches, or digital counters which may also drive a display.

## loop filter

The loop filter is always the last circuit to be designed because it requires values of $K_\phi$, $K_{VCO}$, and $K_N$ to determine component values. The other information needed is $\omega_\beta$, or loop bandwidth, and $\xi$, or damping factor. As a rule

$$\omega_\beta \leq \frac{2\pi f_{REF}}{100} \text{ and } 0.7 < \xi < 5 \text{ with } \xi = 1$$

a commonly chosen value.

The loop filter provides two important functions — it filters the error voltage from the phase detector so that the VCO receives a "clean" tune voltage (any signal or noise on the VCO tune line would modulate it), and it controls the loop parameters. It controls loop stability, determines lock time, and influences the synthesizer phase noise and spurious signal performance. Because of its important effect on loop performance considerable attention should be placed on careful filter design.

The active loop filter described in **fig. 6** provides better control over loop parameters than passive filters.

Component values for $R_1$, $R_2$, and $C_1$ are calculated as follows:

$$\omega_\beta \leq 2\pi \frac{f_{REF}}{100} \tag{1}$$

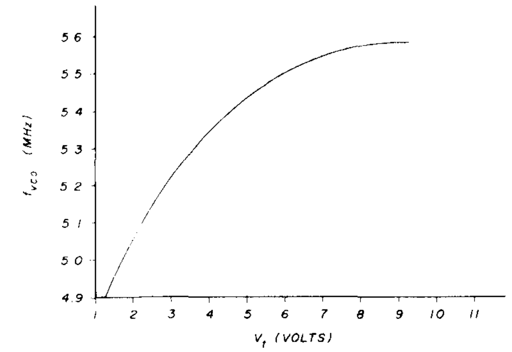


**fig. 5. Example of $f_{VCO}$ versus $V_t$ showing nonlinear transfer function due to varactor diodes.**

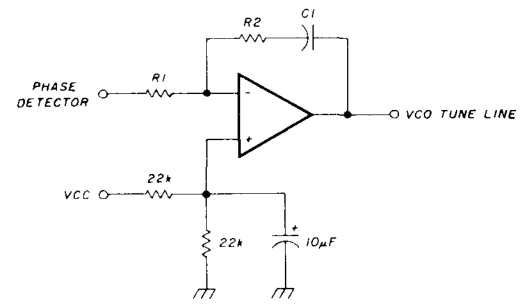


**fig. 6. Op-Amp integrator used as active loop filter.**

$$\omega_n = \frac{\omega_\beta}{\sqrt{2\xi^2 + 1 + \sqrt{(2\xi^2 + 1)^2 + 1}}} \tag{2}$$

$$t_1 = R_1C_1 = \frac{K_\phi K_{VCO} K_N}{(\omega_n)^2} \tag{3}$$

Where $K_{VCO}$ and $K_N$ are evaluated at the highest VCO frequency,

$$t_2 = R_2C_1 = \frac{2\xi}{\omega_n} \tag{4}$$

Choose a common value for $C_1$, such as 2.7 $\mu$F, and then calculate $R_1$ and $R_2$ to determine whether they come close to common component values.

$$R_1 = \frac{t_1}{C_1} \qquad R_2 = \frac{t_2}{C_1} \tag{5}$$

For example, a synthesizer required to tune from 5.000-5.500 MHz in 1 kHz increments might appear as in **fig. 7**.

A CD4046 used as the phase detector has a $K_\phi$ of 0.397 volts/radian. The VCO is the same one described earlier where $K_{VCO} = 1.257$ to $0.273 \times 10^6$ *radians/second/volt*.

With the loop locking at 5.000 MHz,

$$N = \frac{5\,MHz}{1\,kHz} = 5000 \text{ and}$$

$$K_N = \frac{1}{5000} = 200 \times 10^{-6}$$

With the loop locking at 5.500 MHz,

$$N = \frac{5.5\,MHz}{1\,kHz} = 5{,}500 \text{ and } K_N = \frac{1}{5500} =$$

$$181.82\,(10^{-6})$$

With a reference frequency of 1 kHz and $\xi = 1$, enough information is now available to design the loop filter.

Evaluating **eqs. 1-5** we obtain:

$$\omega_\beta \leq 2\pi \frac{1\ kHz}{100} \text{ or } \omega_\beta \leq 62.83\ rad/sec$$

$$\omega_n = \frac{62.83}{\sqrt{2(1)^2 + 1 + \sqrt{[2(1)^2 + 1]^2 + 1}}}$$

$$\approx 25.3\ rad/sec$$

$$t_1 = R_1C_1 = \frac{(0.398)(0.2732)(10^6)(181.82)(10^{-6})}{(25.3)^2}$$

$$\approx 30.89\ ms$$

$$t_2 = R_2C_1 = \frac{2(1)}{(25.3)} \approx 79.1\ ms$$

letting $C_1 = 2.7\ \mu F$ then:

$$R_1 = \frac{30.89\ ms}{2.7\ \mu F} = 11.4\ kilohms$$

$$\approx 12\ kilohms$$

$$R_2 = \frac{79.1\ ms}{2.7\ \mu F} = 29.29\ kilohms$$

$$\approx 33\ kilohms$$

If $R_1$ and $R_2$ had not come close to convenient values, then another value of $C_1$ would have been tried and $R_1$ and $R_2$ recalculated.

With loop filter components calculated, (see **fig. 8**) a quick check is required to ensure proper loop operation with the chosen filter component values at both extremes of the synthesizer frequency range.

At $f_{VCO} = 5.000\ MHz$

$$t_1 = R_1C_1 = (12\ kilohms)(2.7\ \mu F) = 32.4\ ms$$

$$t_2 = R_2C_1 = (33\ kilohms)(2.7\ \mu F) = 89.1\ ms$$

$$\omega_n = \sqrt{\frac{K_\phi K_{VCO} K_N}{t_1}}$$

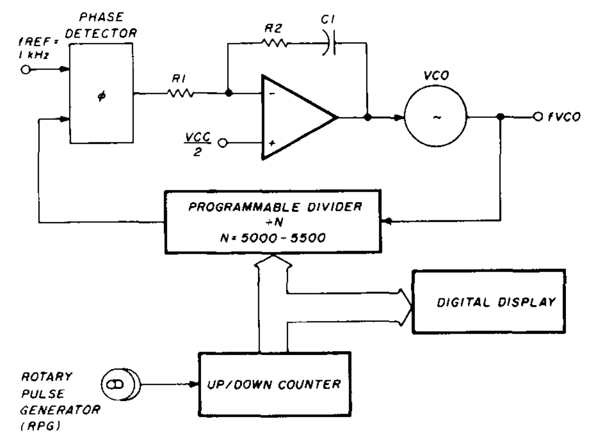


**fig. 7. Synthesized VFO example loop.**

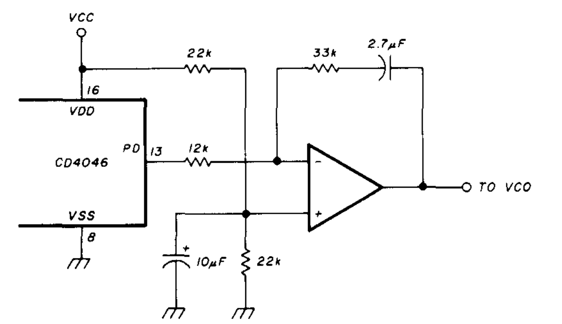


**fig. 8. Simple Op-Amp integrator loop filter for example loop.**

$$= \sqrt{\frac{(0.398)[(1.257)(10^6)][(200)(10^{-6})]}{32.4\ ms}}$$

$$= 55.57\ rad/sec$$

$$\xi = \frac{(\omega_n)\ t_2}{2} = \frac{(55.57)\ 89.1\ ms}{2} = 2.47$$

With $\xi$ greater than 0.7 the loop is considered stable.

At $f_{VCO}$ = 5.500 MHz

$$t_1 = 32.4\ ms$$

$$t_2 = 89.1\ ms$$

$$\omega_n = \sqrt{\frac{(0.398)\ [0.2732\ (10^6)]\ [181.82(10^{-6})]}{32.4\ ms}}$$

$$= 24.7\ rad/sec$$

$$\xi = \frac{24.7\ (89.1\ ms)}{2} = 1.1$$

Both $\omega_n$ and $\xi$ are indeed very close to the design values; therefore, so will $\omega_\beta$. The loop is definitely stable at both extremes of the synthesizer range and therefore at all points in between. This synthesizer should work fairly well.

## conclusion

This first article demonstrates basic PLL synthesizer theory and design. Future articles will provide a more thorough explanation of the PLL and show more accurate methods of design. Methods to improve performance and test the loop will be included.

In the final article a 5.000-5.500 MHz synthesizer design will be presented. Performance of the completed synthesizer will then be compared with the initial design goals.

**ham radio**

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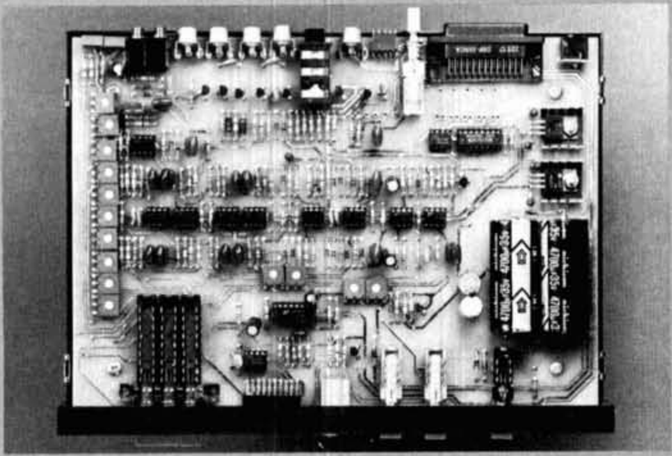

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# Amateur packet radio: part 2

## Understanding the TNC

**This article describes** the inner workings of a terminal node controller (TNC), with emphasis on those aspects which are novel and useful to others interested in implementing digital radio systems. The discussion is based on the TNC designed by the Tucson Amateur Packet Radio Corporation (TAPR).[1]

As shown in **fig. 1**, the TNC is essentially a special-purpose microcomputer. In many ways it is very much the same as any small computer system in that it contains a central processor, memory, and input/output (I/O) sections. The TNC differs from the average home computer in its I/O design, however, and we shall focus on these features.

The TAPR TNC uses a 6809 microprocessor, with 24K bytes of read-only memory (ROM) for program storage, and 6K bytes of read-write memory (RAM), for message buffers and other temporary data. The serial I/O port conforms to the EIA RS-232-C specification and is used to communicate through a terminal or with a computer. A dual 8-bit parallel I/O port is available for auxiliary use. A crystal-controlled clock provides system timing for various parts of the TNC.

The components of the TNC that make it a packet radio controller, and that could be added to a personal computer for a home-brew system, are the HDLC controller and the **mod**ulator/**dem**odulator (**modem**). The HDLC controller is an LSI circuit which provides a convenient means for implementing much of the level 1 and level 2 protocol discussed in part one of this series (*ham radio*, July, 1983). It acts as a bidirectional digital port between the computer and the modem.

Equivalent to an RTTY terminal unit, the modem is a key part of the TNC, and contains the interface circuit that ties the computer to the station radio. It generates tones whose level can be adjusted for compatibility with the radio used, and its audio can be keyed to generate a Morse code station identification. The circuitry provides transmitter PTT line keying and a fail-safe timer to prevent excessively long key-down. The demodulator can be easily configured to accept audio from different radios, and includes LED level indicators for adjusting the receiver volume.

The versatile-interface adapter (VIA) block includes two 8-bit parallel I/O ports which communicate with the nonvolatile (RAM) semi-permanent storage, read user-settable switches, and control the modem. It also includes two counter-timers which provide interrupts for software timing and a programmable clock signal for the HDLC controller. The nonvolatile RAM, a Xicor NOVRAM™ which stores 32 bytes of information without battery or other standby power, represents a new technological achievement that should have wide application in Amateur Radio.[2]

### modem and radio interface

**Fig. 2** shows the radio and audio interface circuitry. Receiver audio output is buffered by one-half of U6 dual op amp. Provision is made at jumper JP9 for attaching a load resistor in place of the speaker. The audio passes through an LED limiter/level-indicator

> The TAPR TNC will soon be available in the form of bare boards, documentation, and partial or complete parts kits. Please send an SASE to TAPR, P.O. Box 22888, Tucson, Arizona 85734, for details on price and availability, as well as further information on packet radio.

By **Margaret Morrison, KV7D,** and **Dan Morrison, KV7B,** 4301 E. Holmes, Tucson, Arizona 85711, and **Lyle Johnson, WA7GXD,** 5971 S. Aldorn Drive, Tucson, Arizona 85706

to the MF-10 dual switched-capacitor audio input filter, which is configured as a highpass section followed by a lowpass section. Both sections operate in Mode 3, as described by the manufacturer,[3] with a clock input of 115.2 kHz produced by the TNC system clock. The response of the filter is optimized for typical transceiver combinations using a computer-aided design procedure.[4]

The necessity for this filter is dictated by the audio spectrum of 1200 Hz and 2200 Hz NRZI data at 1200 baud. This spectrum, shown in **fig. 3**, suggests that ideally the system should exhibit flat response from below 500 Hz to above 2900 Hz. In fact, the typical overall response measured using a pair of 2-meter fm transceivers is shown in **fig. 4A**. Without proper filtering the rolloff shown prevents data from being demodulated much above 600 baud. The filter with the eight programming resistors shown (slightly different from those on the TAPR Beta TNC) restores the response to that shown in **fig. 4B**, and seems a good compromise for a wide variety of fm rigs.

The filtered audio is demodulated by the XR2211, which is configured as recommended by Exar[5] for demodulating 1200 Hz and 2200 Hz 1200 baud data, except for the lock-detect filter at pin 3. For better immunity to false lock indications this filter's time constant was increased. In addition to digital data from pin 7, the lock detect signal at pin 5 is required by the software to monitor channel activity.

The MF-10/XR2211 demodulator combination works well with a wide variety of fm transceivers. However, the lowest bit error rates for a given degree of receiver quieting will be achieved only by custom tailoring the input filter to produce the proper response for a specific transceiver pair. Normal experience is that data will be received perfectly under "full quieting" conditions, but deteriorates rapidly as the noise level goes up.

Data originating on the TNC at the TxD output of the WD-1933 generates phase-continuous AFSK via the XR2206 modulator. As in the case of the demodulator, Exar's recommended values were used for loop components.[5] A control signal generated by the TNC's VIA under software control is used at point E to key the AFSK signal on and off. This permits the software to generate the CW identification and to eliminate modulator output except when actually sending packets. The modulator output is buffered by the second section of U6 before going to the microphone input of the transmitter.

The remaining circuitry of **fig. 2** grounds the radio's PTT line to key the transmitter whenever the WD-1933 MSCOT output is brought low. To prevent channel lockup a NE555 one-shot "watchdog" times

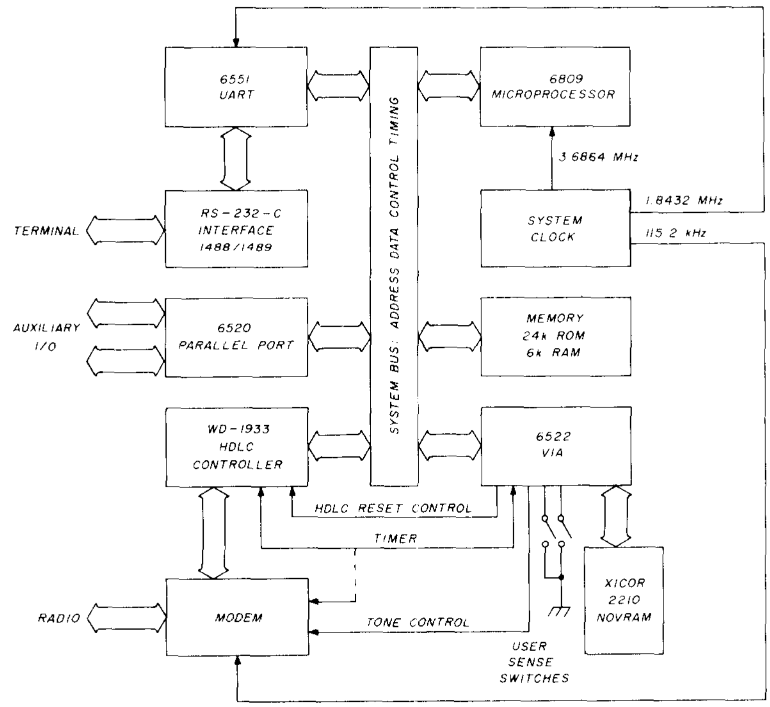



**fig. 1. Block diagram of the TAPR Beta TNC, showing system architecture.**

out after approximately 14 seconds, and $\overline{\text{MSCOT}}$ must be toggled high to restore PTT operation. This simple circuit has proven invaluable.

## special digital hardware

The TAPR TNC includes digital circuitry that sets it apart from ordinary personal computers. Some de-

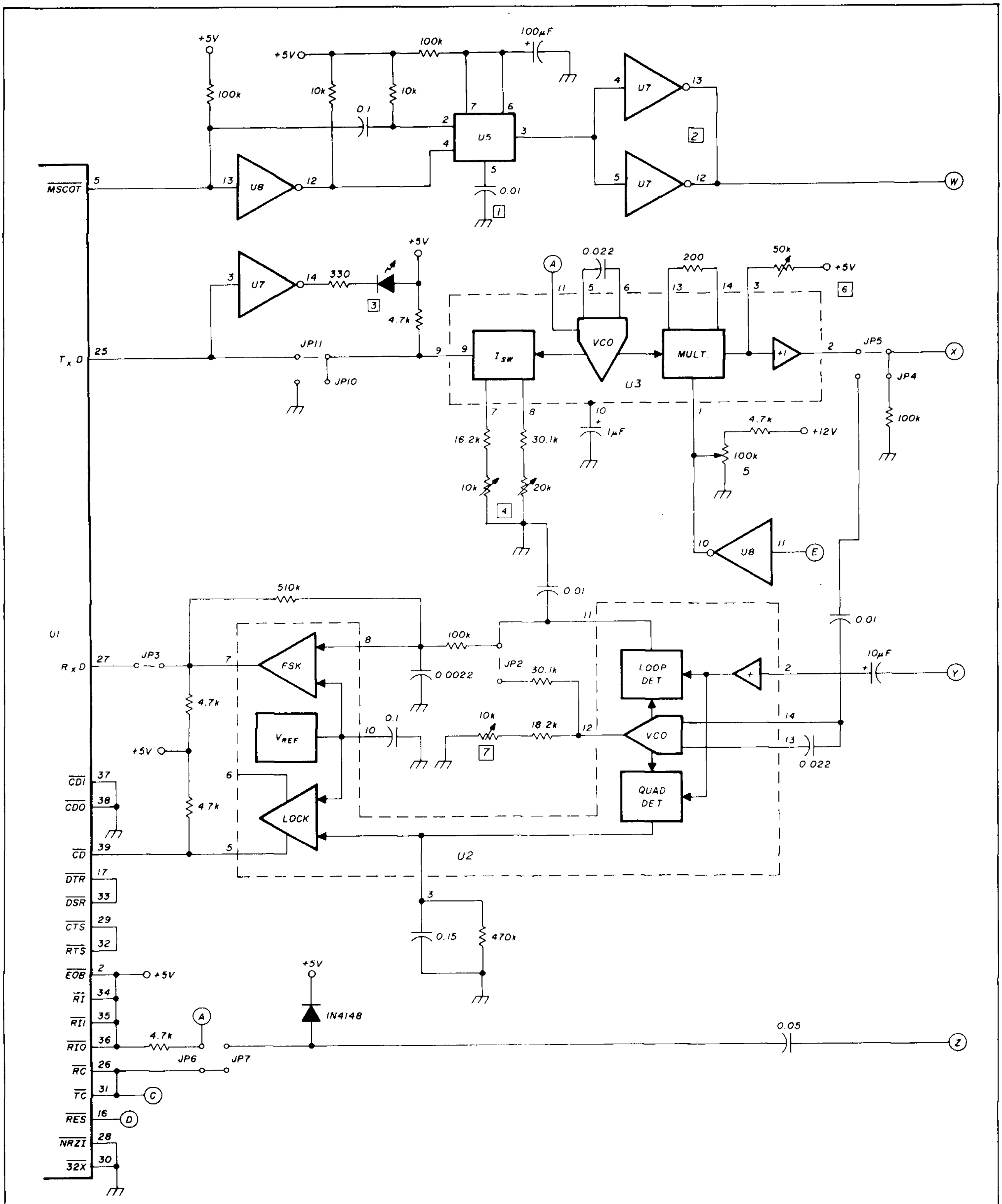
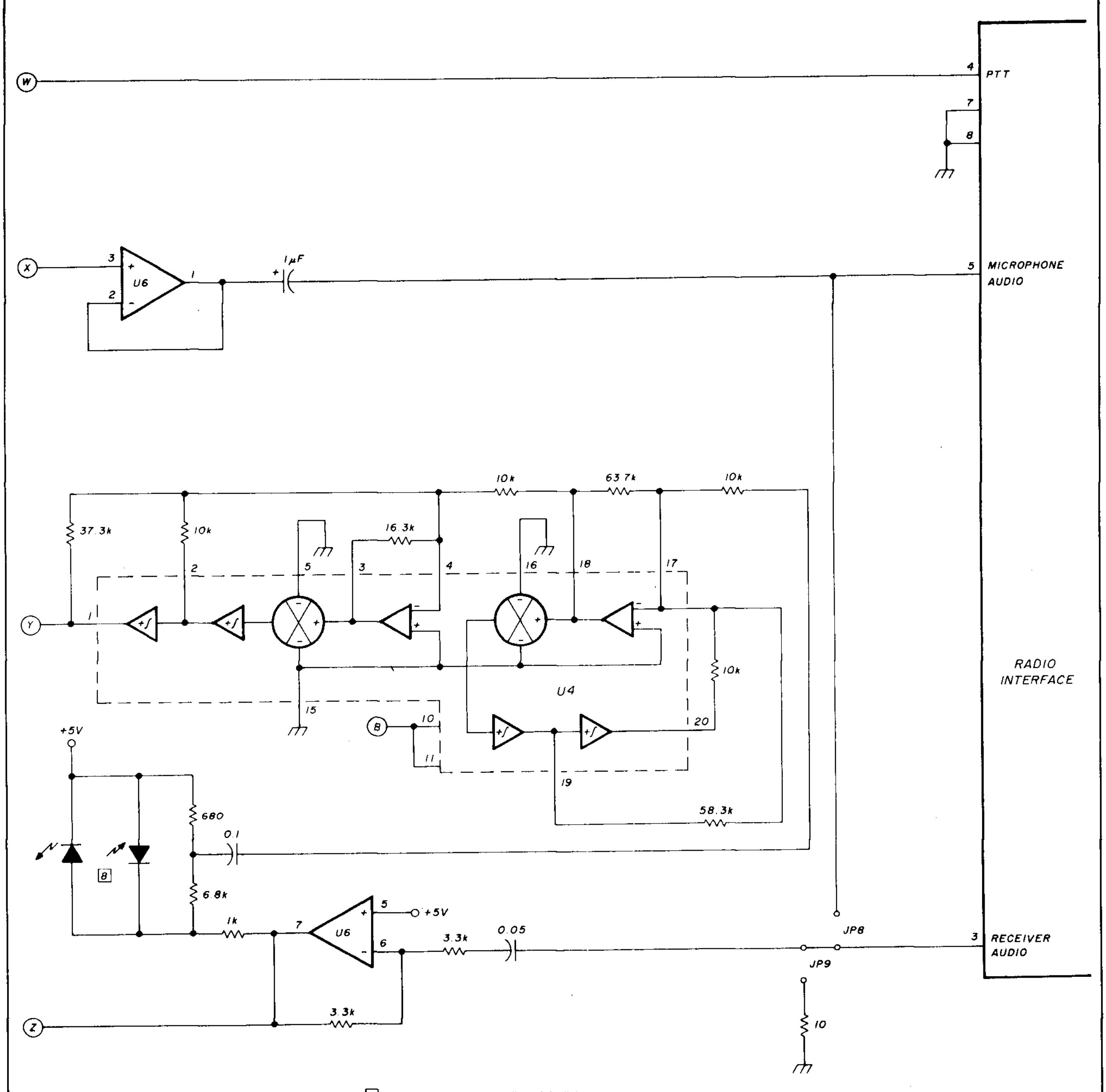



fig. 2. Schematic of the radio interface portion of the TNC, showing the modem components, input filter, and PTT circuits.

tails of these circuits will now be discussed; if you have a TNC, this information will help clarify some of its design considerations. Should you choose to homebrew a packet adapter for your computer, the discussion will serve as an example.

The most important such chip on the TNC is the HDLC controller. There are several HDLC controller chips on the market today, and more are being introduced regularly. This is fortunate for the would-be TNC designer, because the HDLC chip relieves him of a fairly complex hardware design (typically 19 SSI and MSI ICs) or an equivalently complex software




| | |
|---|---|
| U1 | WD-1933 HDLC controller |
| U2 | XR2211 demodulator |
| U3 | XR2206 modulator |
| U4 | MF-10 switched-capacitor filter |
| U5 | NE555 timer |
| U6 | CA3240 dual op amp |
| U7 | XR2203/ULN2003 Darlington driver array |
| U8 | 7406 open collector hex inverter |

| | |
|---|---|
| 1 | Approximately 15 second "watchdog" timer |
| 2 | PTT driver |
| 3 | Transmit data indicator |
| 4 | Adjustment for modulator frequencies |
| 5 | Adjustment for no-tone null |
| 6 | Modulator amplitude adjustment |
| 7 | VCO center frequency adjustment |
| 8 | Input level indicator-clipper |

| | |
|---|---|
| A | Modulator oscillator connection to JP6<br>Connects to VIA timer input for calibration |
| B | MF-10 clock input at 115.2 kHz from system clock |
| C | VIA timer input/output<br>Operation: HDLC clock input from VIA timer output<br>Calibration: Modem signals to VIA timer input |
| D | HDLC reset from VIA control output |
| E | Modulator tone switch from VIA control output |

fig. 2. cont.

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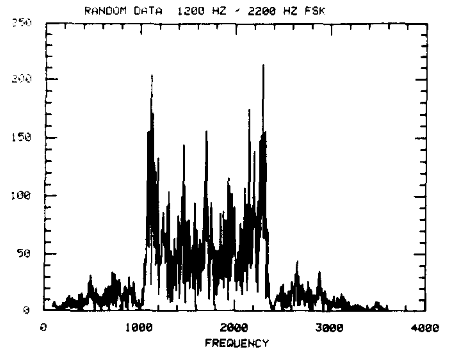



**fig. 3. Sound spectrum of a one-second burst of 1200 Hz/2200 Hz 1200 baud random NRZI data. This data was generated and analyzed by computer.**

program (in assembly language) to implement those parts of the HDLC protocol standard adopted by the overwhelming majority of packeteers.

As mentioned in the previous article, the most frequently used digital signalling technique employs Non-Return to Zero, Inverted (NRZI) encoding. This means that a digital zero is encoded as a transition from a high to a low or vice-versa, while a one is passed as the absence of a transition. The result of this, along with "bit-stuffing" (in which a zero is inserted by the sending station after five consecutive ones and stripped out at the receiving end), is that the clock signal can be recovered from the data stream. A phase-locked clock is necessary to ensure proper recovery of the data in this synchronous data mode, since the data must be latched in the middle of a bit and not, for example, just as a transition occurs.

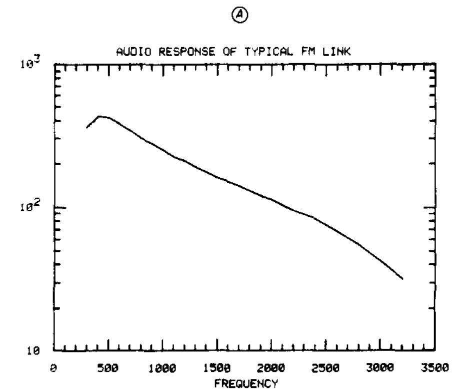
Clock recovery is fairly straightforward using a phase-locked loop (PLL). Fortunately, the NRZI scheme is also widely used in the commercial world, so a few manufacturers have included a Digital PLL (DPLL) on their HDLC controller chips. In order to minimize the number of chips used in the TNC, both the VADCG and the TAPR designs incorporate these HDLC controllers.

Among single-channel devices, only the Intel 8273 and the Western Digital 193X series incorporate the DPLL, and the TAPR TNC uses the WD-1933, as it is generally about half the price of the Intel device. Of course, nothing is free, and some special considerations apply when interfacing this chip to a microcomputer. The software must take account of the inverted data bus of the WD-1933 which treats zeros as ones and vice-versa. In addition, the interrupt lines must be buffered and inverted prior to connection to the control bus. Furthermore, this chip requires a baud rate clock 32 times the data rate (for 1200 baud this means a 38.4 kHz clock) to drive the DPLL when using the NRZI mode, and also requires a special reset signal to be applied after the baud rate clock has been applied.

In exchange for these interfacing considerations, the HDLC controller provides automatic generation of pre-frame and post-frame flag bytes for synchronization, transparent bit-stuffing on transmit and unstuffing on receive, recovery of the clock signal from the incoming data stream, calculation of the Frame Check Sequence (FCS) used to validate data integrity on both transmit and receive, and automatic detection and reporting of errors in sending or receiving a frame. All in all, the usefulness of these LSI devices more than compensates for any interface difficulties.

In order to supply the HDLC controller with the needed reset and clock signals, and to provide other services, the TAPR TNC incorporates a 6522 Versatile Interface Adapter (VIA). This unit contains a pair of 8-bit parallel ports, which can be set on a bit-by-bit basis for input or output. Two of the four handshaking lines provided are used as single-bit control outputs. A pair of 16-bit counter-timers are also provided.

One of the control lines is used to provide a soft-



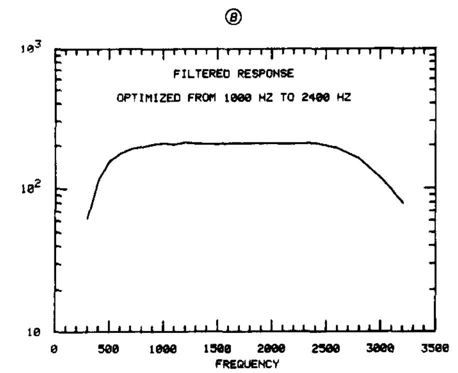




**fig. 4A. Measured frequency response using a pair of 2-meter FM transceivers. fig. 4B. The same frequency response after filtering. The filter design was optimized for the range 1000 Hz to 2400 Hz.**

ware controlled reset to the HDLC chip, while the other is used to effect a tone on-off command to the modem. This allows generation of an easily-copied CW station identification, as well as enabling an operator to insert a voice signal over the channel without disconnecting the TNC from the radio.

Two lines of one of the 8-bit ports (port B) connect to the internal 16-bit counter-timers. One timer is used as a software-controllable baud rate generator for the HDLC chip. This not only allows the operator a simple means for control of the baud rate, it also allows generation of non-standard baud rates, such as the 400 baud used in the AMSAT Phase III satellite.

The other timer is used for calibrating the modem frequencies and for primary system timing. From this clock are derived all the various clocks that must be updated for proper operation of the packet station of which the TNC is an integral part.

Two lines on the VIA are used to test the settings of a pair of switches on the board. These switches may thus be read by the software and are presently being used to tell the TNC whether to use the default parameter settings found in the system EPROM or whether to take these parameters from NOVRAM.™

The remaining lines from the VIA parallel port are used for the NOVRAM™ interface. This helps prevent accidental alteration of NOVRAM™ parameters, as well as easing system bus timing constraints. The NOVRAM™ is a nibble-oriented device, meaning that its data bus is only 4 bits wide, rather than the 8-bit bus width of the host microprocessor. It also has six address lines and four control inputs. The control lines allow for device selection, read/write control of data between the RAM portion of the chip and the data bus, recall of the contents of the Electrically Eraseable Programmable Read Only Memory (EEPROM), and storing of data from RAM into EEPROM.[2]

The presence of the NOVRAM™ permits long-term storage of parameters peculiar to the station, such as the call sign and terminal characteristics. In addition, infrequently adjusted parameters, such as those associated with the timing of data retries and other link activity, may be stored. Without such a long-term storage function there are only two choices. Either the operator must enter all necessary information every time the unit is powered up (which is not too practical), or the various parameters must be "burned-in" at assembly time, meaning that the operator must have his EPROMS erased and re-programmed every time he wants to change baud rates, call sign, station ID, and so forth.

## controller software

The software present on the TAPR TNC is organized on two levels. The High Level Routines (HLRs) implement the machine-independent logical processes associated with protocol decisions and response to user commands. These routines know nothing of the hardware details of the TNC and, in fact, are written in a transportable high level language (Pascal). As the HLRs require data transfers or status information they call subroutines contained in the Low Level Routines package (LLRs), and leave the nitty-gritty details of interrupt service, terminal editing features, and timer maintenance to the LLRs. The LLRs, naturally, are written in 6809 assembly language, and are definitely not transportable. However, the logical organization of the LLRs is universal and should serve as a model for other implementations of packet radio.

The HLRs can be divided roughly into two major parts. One implements the command protocol, allowing the user to request connect and disconnect packets, control the digital-relay function of the station, and perform other tasks as necessary. For the TAPR TNC, this section consists of a command parser which compares a string of characters from the terminal with a list of commands and takes appropriate action when a match is found. In addition to issuing connect and disconnect packets, the user can alter program parameters, save the parameters in nonvolatile RAM, display current parameter values, identify in Morse code, change input mode, or enter a special service routine. For maximum flexibility in a test environment, the parser controls some sixty parameters, including the operator's call sign, terminal attributes, input editing features, radio interface characteristics, packet baud rate, and timing parameters[6].

The other part of the HLRs is a procedure which implements the packet radio protocol. This section assembles and disassembles packets, maintains information about the link status (for example, to whom you are connected), keeps track of unacknowledged outbound packets, acknowledges inbound packets, and sends supervisory packets as required by whatever protocol is implemented. This routine watches a clock to time retransmissions of unacknowledged packets, formulates input from the terminal into packets, and passes the contents of received packets to the terminal.

Both sections of the HLRs depend on the LLRs to maintain buffers and perform I/O under interrupt control. The LLRs also update clocks on receipt of timer interrupts and service the non-volatile RAM. When the program is required to transmit a message to the terminal or to send a packet, the information is actually loaded into a buffer to be sent when the peripheral component is ready. Similarly, the program reads incoming information not directly from the peripheral, but from a buffer. The presence of complete messages to be read is signalled by flags set by the low-level input routines. This makes it relatively easy to implement the protocol in a high-level programming language without direct access to the peripheral devices.[7]

The utility of the HLR/LLR separation cannot be overemphasized. It allowed, for example, the two sections of the HLRs (command parser and packet protocol generator) as well as the LLRs to be developed independently by three people, in two different cities, on three different computers, prior to the final integration onto the TNC.

## program structure

The structure of the packet protocol section of the HLR is shown in **fig. 5**. This procedure is part of an infinite loop in which all routines alternately check for tasks to be done.

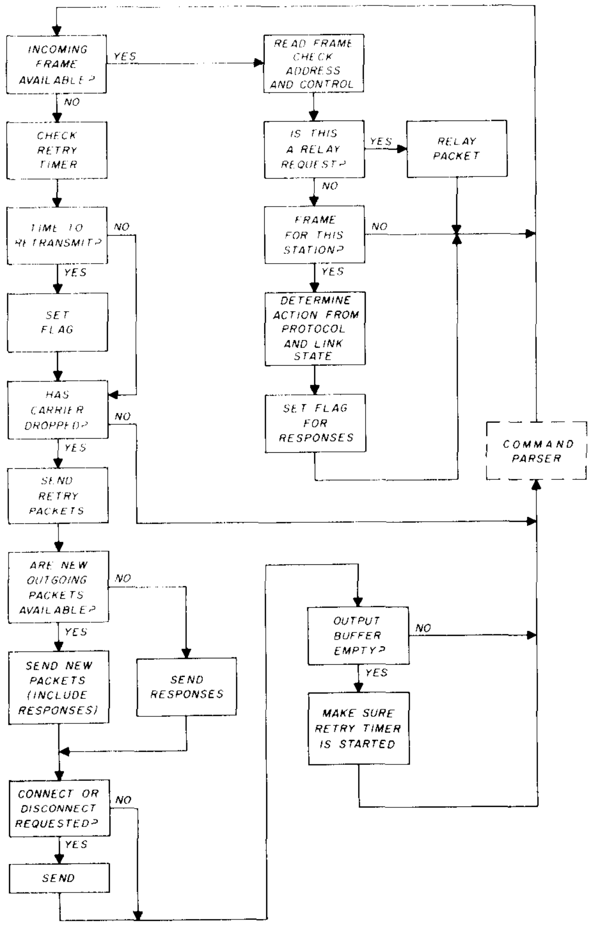



**fig. 5. Flowchart for operation of the packet protocol HLR routine.**

The first half of the procedure is concerned with reading incoming packets and determining the appropriate action to take. The action taken on receipt of a packet addressed to this station is determined by the protocol.[1,8] Several possible *link states* are defined, which are stages in the communication sequence starting with a connect request and ending with a disconnect request. For each type of packet received (specified by the CONTROL field) there is a prescribed action depending on the link state. If the action involves sending a packet – say, an acknowledgment – a flag is set for the second half of the procedure. When all incoming packets have been read, the clock is checked to see if packets have been sent which should have been acknowledged by now.

The second half of the packet protocol procedure, which sends outgoing packets, is entered only if the frequency is clear, indicating that all packets of a group have been received. This is determined by monitoring the demodulator carrier detect signal. Outgoing packets are formulated with header information and moved to the outgoing packet buffer following any packets being retried. Acknowledgments are sent as part of the control information with these packets if possible; otherwise, a special acknowledgment packet is sent. Finally, any special supervisory packets requested either in the first section of the procedure or by the user are sent. When transmission is complete, the clock is started for packets which should be acknowledged.

## I/O management

The interrupt-driven I/O routines contained in the LLRs basically form a simple operating system for supporting the HLRs.[9] In order to isolate the main program from the details of the hardware, all input and output is done through buffers. Since the HLRs do not examine incoming data until an entire line or packet has been received, terminal support such as character echoing, line-feed insertion, and response to character, line, and packet delete instructions (implemented by single editing characters) are managed by the low-level interrupt routines.

The structure of a typical buffer is shown in **fig. 6**. There are four buffers, input and output buffers for terminal and radio data, each of which is accessed by an insertion pointer and a removal pointer. An input buffer, for example, has an insertion pointer which is advanced by an LLR interrupt routine as data is read from a peripheral device, and a removal pointer which is advanced by the HLR as it reads the data. All buffers are circular, meaning that when a pointer reaches the top of the buffer space it is moved back to the bottom. Input buffers require additional pointers to mark the beginning of a string which may be deleted by an editing command from the terminal, or

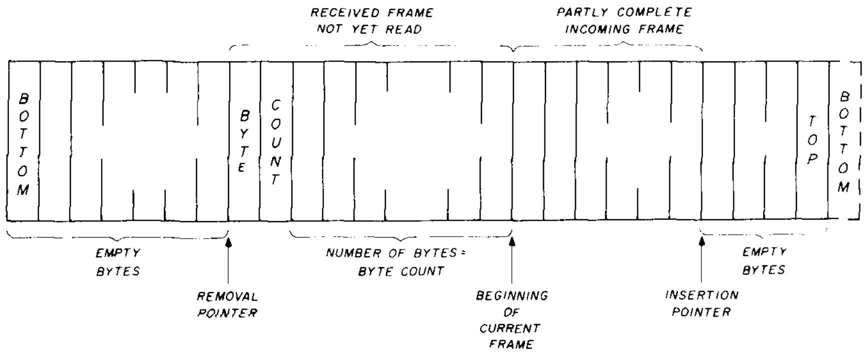



**fig. 6. A typical data buffer, showing pointers, and order of placement of data. The buffer shown is the packet input buffer, and is similar to the other buffers.**

in the case of the packet input buffer, by an error occurring during receipt of a packet. Since a data string can be any length, the end of a packet or command line must be marked, either by a special character in the buffer or by a byte count at the beginning of the string.

## interrupt handling

Only one hardware interrupt-request input of the 6809 microprocessor is used in the TAPR design — all interrupt lines are wire-ORed together. This means that when an interrupt occurs, each peripheral which could have generated it must be queried in turn, and an appropriate routine selected from a dispatch table when the cause of the interrupt is identified. Since more than one device could be in need of service at once, the order in which the devices are queried determines the interrupt priorities, which are as follows:

1. UART (terminal) input
2. UART output
3. VIA timer interrupt
4. HDLC (radio interface)
5. Parallel port input
6. Parallel port output

The serial input port is given highest priority, since if a character is not read before a new one is received, it is lost. The radio I/O interrupts are placed relatively low, since servicing the WD-1933 chip is complex and potentially time-consuming. Data lost in either direction due to slow service of this chip will be detected as an error, and the packet will be retransmitted. If the parallel port is used for user I/O, it should be serviced last, since full "handshaking" is used, and a sending device will not send new data until the old data has been read.

The timer interrupt is generated as the timer counts down past zero. By examining the count, the service routine can determine the actual elapsed time and compensate for any delay caused by conflict with other interrupts. For this reason, the priority for servicing the timer interrupt is arbitrary. Compensation must be made for the fact that the two count bytes are read at different times.

The timer interrupt service routine has a special function. After the software counters have been updated, a general housekeeping routine is entered. Time elapsed since a carrier drop is monitored and a packet transmission may be started from this routine. The CW station identification is also sent at appropriate intervals, and the timer routine toggles the audio signal on and off to produce dits and dahs.

The WD-1933 HDLC controller generates interrupts for the following seven conditions:

Receive Interrupts (by priority)
- Data received
- Received message without errors
- Received message with errors
- Change in carrier detect state

Transmit Interrupts (no priority)
- Data requested
- Transmitted message without errors
- Transmitted message with errors
  - (Abort signal sent automatically)

Since they may potentially be present in any combination, and querying the chip resets most conditions, all conditions must be checked on each interrupt. The only difficulty results when logically inconsistent or out-of-place interrupts occur. For example, the presence of both "Received message without errors" and "Received message with errors," or a carrier-detect change while the transmitter is keyed, may occur. This is solved by ordering the receive interrupt priority as shown. Carrier detect can be ignored during transmission.

Transmit interrupts present a different sort of problem. The WD-1933 transmits HDLC frames automatically, but it must be commanded to send each section of the frame — flags, data, and frame-check sequence. While the transmit function is active, it generates regular interrupts. These are "Data request" if the data function is commanded, and otherwise "Transmit end of message." These interrupts are treated as equivalent, and the interrupt service function is determined by the progress of the packet being transmitted.

## conclusion

In the first article of this series we described packet radio and the protocols in general use. In this article we have presented some details of the actual implementation of these concepts.

The TNC design presented represents the culmination of nearly two years of intensive effort by several Amateurs. These efforts resulted in both the formation of Tucson Amateur Packet Radio, a nonprofit R&D corporation of over 300 members worldwide, and the design and distribution of the TAPR TNC.

The TNC design was subjected to a Beta test with 172 boards placed at 19 sites. This test served to provide many useful improvements. Perhaps most importantly, it exposed literally thousands of Amateurs to this exciting new mode. We expect that soon there will be a rapid expansion in the use of this mode among Amateurs, and hope that you will join it.

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# testing baluns

**In recent years baluns** have become widely used in the antenna systems of most Amateur stations. Because of their popularity, many companies manufacture and advertise baluns regularly; their relative simplicity encourages many Amateurs to wind their own. Unfortunately, very little has been published about the performance requirements of baluns or even about which performance parameters are important. The performance characteristics of baluns *can* be measured, however, and by testing baluns according to the procedures described, users can learn what to expect from the baluns they install in their own antenna systems.

The tests described apply primarily to the familiar 1:1 transmission line balun of either the toroidal or ferrite rod type (see **fig. 1**), but may also be coincidentally appropriate for the 4:1 auto-transformer type balun.

Generally more than one test can be used to measure a given parameter. Most tests can be performed using equipment available to Amateurs. The choice of test will depend, to some extent, on whether the balun is purchased or homemade, since this will determine what terminals are available for testing. Because some tests require that the tertiary winding be disconnected from the top section of the main winding, not all tests can be applied to a purchased balun. All commercial baluns are factory-sealed and cannot be opened without breaking their cases; consequently, it is impractical to open the tertiary junction. With a homemade balun, all tests can be made before the tertiary winding is connected to the circuit.

## balun operation

A balun serves two principal purposes. First, it provides two equal and opposite voltages to a balanced load with respect to ground. Second, the balun provides isolation between the balanced load (usually a dipole antenna) and an unbalanced transmission line (coaxial cable). Of particular importance is isolation between the coaxial outer conductor and the half of the dipole connected to the outer conductor. If this isolation is not adequate, then this half of the antenna essentially extends down the outside of the coaxial outer conductor and into the ham shack. This, of course, is undesirable. **Fig. 2** shows the problem graphically.

Your transmitter is actually a generator that drives a coaxial transmission line which is connected to a dipole. Assume the polarity is such that a current, $I_1$, flows into the center conductor from the left half of the dipole; an equal and opposite current, $I_2$, flows up the inside of the outer conductor. At the junction point between the outer conductor and the right half of the dipole, current $I_2$ divides.

Because of skin effect at radio frequencies, the inside and outside of the outer coaxial conductor may be thought of as two separate conductors. The division of the current $I_2$ into $I_3$ and $I_4$ depends on the relative impedances of the right half of the dipole and the impedance of the path down the coaxial outer conductor into your ham shack and through the power wiring to ground. If this length is an odd number of half wavelengths, the impedance will be low compared to the impedance of one-half a dipole (usually taken to be about 35 ohms). Much of the current $I_2$ will flow back down the outside of the coaxial and $I_4$ will be relatively high. Consequently $I_3$ will be low and different from $I_1$. In addition to causing the antenna to be fed asymmetrically, the outside of the coaxial can also be "hot" inside the shack, which not only creates operational problems, but introduces a safety hazard as well. However, if the length down the outside of the coaxial to ground is

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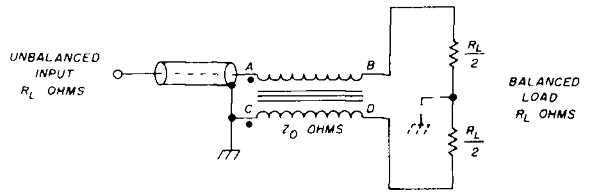


**fig. 1. Typical 1:1, two-winding, transmission line balun. The characteristic impedance, $Z_0$, of the winding should be as close as practical to $R_L$. This balun will provide isolation, but not a balanced output unless the center-tap of the balanced load is grounded.**

an odd number of 1/4-wavelengths, this impedance will be relatively high, forcing $I_4$ to be small in comparison to $I_3$ and the balancing dipole. The balun provides isolation between the right half of the dipole and the outside of the coaxial, and at the same time provides equal and opposite voltages and currents to the two halves of the dipole. Let's see how a 1:1 transmission line balun accomplishes these objectives.

## 1:1 balun

The simplest form of the 1:1 transmission line balun is shown schematically in **fig. 1**. Here a transmission line with a characteristic impedance ($Z_0$) is wound on a rod or toroidal ferrite core. One end of the winding is connected to the coaxial cable; the other end is connected to the balanced load, as shown. The characteristic impedance of the winding should be as close to that of the coaxial line and the load resistance as practical. One popular balun design[1] uses small 50-ohm coaxial (RG-141) wrapped around a 2-1/2 inch diameter (6.25 cm) toroid.

A commonly held view is that the inductance of the winding provides isolation and guarantees balanced voltages across the balanced load. Unfortunately, both these conditions may not occur in this design. The generator currents ($I_1$ and $I_2$ in **fig. 2**) are equal and opposite; hence there is no magnetic flux developed in the toroid and the inductance of the balun is essentially zero. The balun merely acts like an extra length of transmission line.

Assume an unbalanced condition, with current $I_4$ (**fig. 2**) flowing. Since there is no equal and opposite current flow, a magnetic flux will develop. If the inductance of the balun is sufficient, then the resulting counter EMF will limit $I_4$ and effectively isolate the balanced and unbalanced sides of the balun. The balun will therefore provide isolation. Counter EMFs will also develop on the inside of the coaxial shield and on the coaxial inner conductor; these will be in series opposition and do not affect the balun's operation.

Unless the center-tap of the balanced load is grounded or a tertiary winding is used, there is no ground reference point on the balanced side and no guarantee that the balanced side output is actually balanced with respect to ground. The degree of balance, if any, depends on parasitic inductances and capacitances and is not under control of the user. The only way the user can guarantee a balanced output is to actually ground the center-tap of the load. The lack of balance on a two-winding balun has been verified by actual measurements.[2]

To guarantee balanced output voltages and adequate isolation, it is necessary to provide a path for magnetizing current. Ruthroff[3] has stated that with the balanced load disconnected, there must be dc continuity between the unbalanced input and ground. The two-winding balun does not provide this continuity.

In order to guarantee balanced output voltages as well as provide adequate isolation, a tertiary winding, EF (see **fig. 3**), must be added. Note that the polarity of the tertiary winding is reversed.

If the voltage at the unbalanced input is V volts, the voltage at point B is V/2 volts since point B is halfway down the winding AB-FE with V/2 volts being developed in each winding. This is better shown when **fig. 3** is redrawn as an auto-transformer

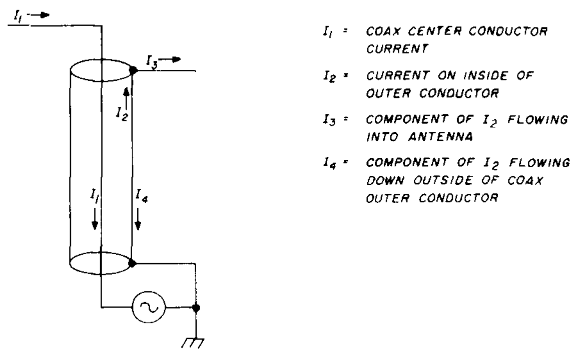


**fig. 2. Lack of adequate isolation between antenna and feedline causes $I_2$ to divide into $I_3 + I_4$.**

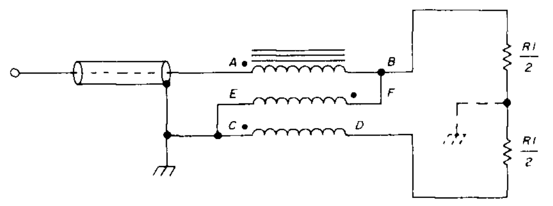


**fig. 3. A 1:1 transmission line balun with a tertiary winding E-F. This design provides both isolation and balanced output voltages.**

as shown in **fig. 4**. This arrangement guarantees that the balanced output voltages are balanced with respect to ground, provided that the coupling between tertiary and main windings is "tight."

Though **fig. 4** is drawn as an auto-transformer, the balun is nevertheless a transmission line device. Signal currents flow only through the transmission line windings and the input impedance/load impedance relationship follows the transmission line equation and not the auto-transformer law. With this thought in mind we will move on to the actual tests.

## dc ohmmeter test

One of the simpler tests, to determine if the balun has a tertiary winding or not, is one that should be performed on any purchased balun. That test is important because a tertiary winding is absolutely essential if the balun is to work properly with most antennas.

This test consists simply of measuring the dc resistance between the unbalanced input terminals and ground with the balanced terminals open-circuited (see **fig. 5**). If a tertiary winding is present, this resistance should be a few tenths of an ohm and will appear on most ohmmeters as a short-circuit. An open circuit reading indicates no tertiary winding.

Using an accurate ohmmeter or Wheatstone bridge can provide other information. With the unbalanced side open-circuited, measure the dc resistance between each balanced load terminal and the grounded side of the unbalanced terminal. Each of these resistances should be one-half the value obtained in the first test. The success of this test ensures that each of the windings is the same length and that the balun is reasonably well balanced, at least in regard to dc.

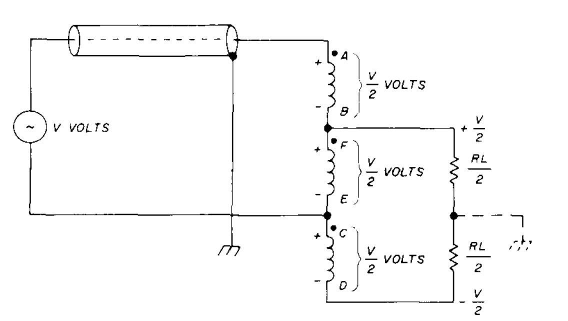


**fig. 4. A 3-winding transmission line balun drawn as an auto-transformer. Though shown as an autotransformer it is still a transmission line device. The input versus load impedance relationship follows the transmission line equation and not the transformer law.**

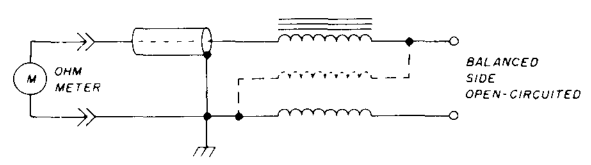


**fig. 5. Ohmmeter test to determine if balun has a tertiary winding.**

## characteristic impedance

One of the most important parameters of any transmission line balun is its characteristic impedance which should be the same as the characteristic impedance of the transmission line with which the balun will be used. If too great a difference between these impedances exists, use of the balun may *cause* more problems that it cures.

There are several ways of measuring the characteristic impedance of a balun. The method used will depend on the measuring instrument available and on whether or not the balun is store bought or homemade.

Perhaps the most straightforward method of measurement is to take advantage of the fact that the characteristic impedance can be found by taking the square root of the input impedance with the far end open-circuited and short-circuited or:

$$Z_0 = \sqrt{Z_{oc} Z_{sc}}$$

While this approach is theoretically straightforward, it presents instrumentation problems. At some frequencies, the input impedance of the line will have a very high or very low resistive and/or reactive component for either an open- or short-circuited condition at the far end with one or more of these components outside the range of the measuring instrument. If it is possible to find a frequency or a test instrument where both open- and short-circuit measurements can be made, this method provides a convenient way to determine the characteristic impedance of the balun.

It is important to note that this test can *not* be used with a tertiary winding connected. If the balun is homemade, make the test with the tertiary winding in place but not yet connected to the main windings. If the balun is commercially made, you may have to figure out a way to open the balun and disconnect the tertiary winding. If this is not practical, use a different measuring technique.

A second method which does not put such severe requirements on the test equipment but is more time consuming is to measure the input impedance of the

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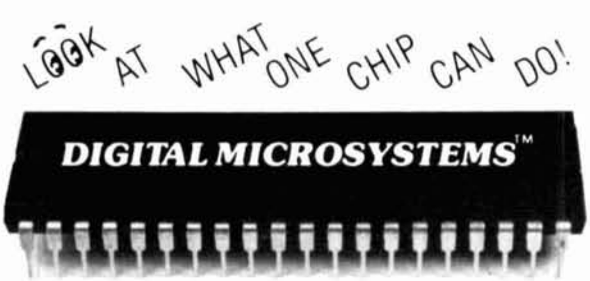


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balun with an arbitrary load impedance as the electrical length of the line changes, or place the value of load resistance across the balanced load that you think the balun characteristic impedance is, or that you would like it to be. Then measure the input impedance of the balun across the frequency range and see how close your guess was. **Fig. 6** shows the input impedance of a transmission line balun with four different values of load resistance: 65, 76, 84, and 101 ohms.

Starting at the top, notice that the input impedance with the 101 ohm load rolls off at higher frequencies. At first glance this roll-off appears as normal high-frequency drop off. However, looking at the 65-ohm load line, we see a "roll up" in the input impedance as the frequency increases. These two input impedance characteristics suggest the impedance inverting effect of a 1/4-wave transmission line whose characteristic impedance, which is what we are trying to find, is between 65 and 101 ohms.

Looking between 65 and 101 ohms, we see that the 84 ohm line rolls off slightly while the 76 ohm load response is practically flat — only a very slight roll-up. This indicates that the characteristic impedance of the balun is just above 76 ohms. If these measurements were made beyond a 1/4-wavelength, the slope of the curves would reverse and the frequency for a 1/4-wavelength could be determined. My equipment does not go high enough in frequency to do this, however.

If a General Radio 821 Twin-Tee admittance bridge[4] or similar instrument is available, a third approach may be used that gives not only the characteristic impeda ce but the electrical length of the winding as well. If the physical length of the winding (in inches or meters) is known, the velocity coefficient of the winding can also be determined from this data.

This test is based on the fact that a short-circuited transmission line 1/8-wavelength long has an inductively reactive input impedance equal to the characteristic impedance of the line. Similarly, if the far end is open-circuited, the input impedance presents a capacitive reactance equal to the characteristic impedance. This can be seen by examining the transmission line equation for the short-circuited case, which is the simplest:

$$Z_{in} = Z_0 \frac{Z_r \cos X + jZ_0 \sin X}{Z_0 \cos X + jZ_r \sin X}$$

when $Z_r = 0$ (short circuit load)

then $Z_{in} = Z_0 \dfrac{jZ_0 \sin X}{Z_0 \cos X} = jZ_0 \tan X$

when $X = \lambda/8 \text{ or } 45^\circ$,

then $(\text{since } \tan 45^\circ = 1)\ Z_{in} = jZ_0$

The open-end and short-circuit values of reactance are plotted versus frequency on the same piece of graph paper; the reactance at which they intersect is the characteristic impedance of the balun. An example of this is shown in **fig. 7**. Also, the frequency of intersection is the frequency at which the balun is 1/8-wavelength long. The electrical length at any frequency can easily be determined from this.

If the physical length of the line is known, the velocity coefficient of the transmission line, k, can be determined by calculating the 1/8-wavelength of the intersection frequency in free space and dividing this into the measured length of the balun winding.

$$k = \frac{\text{measured length winding}}{\text{calculated length } \lambda/8 \text{ free space}}$$

Because this test cannot be used when the tertiary winding is connected, it can be used only on homemade baluns or commercial baluns where the tertiary winding can be opened.

The limitations on the test equipment are that the impedance measuring device must be capable of measuring impedances with high resistive components and measuring reactive components in the range of the expected characteristic impedance at the frequency where the balun is 1/8-wavelength long.

## winding inductance

The balun winding inductance is important because it determines the frequency range over which the balun can be used and also determines balun isolation. In general, the winding reactance should be about five times the characteristic impedance for a general purpose balun. You may want to use a factor of ten times the characteristic impedance for a precision or an instrument balun, however.

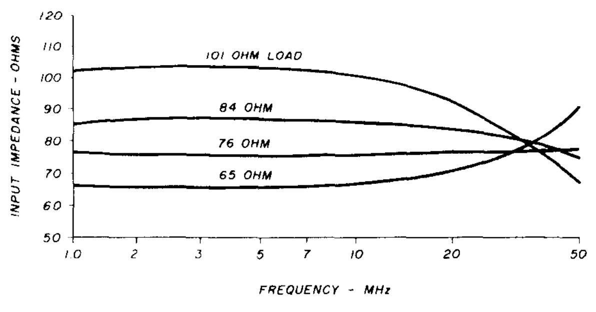


**fig. 6. Input impedance versus frequency for 65, 76, 84, and 101 ohm load resistors.**

As the frequency increases, the balun impedance increases until the inductance resonates with the stray capacity across the inductance. At this frequency, the impedance of the winding and the isolation are the highest. As the frequency is further increased, the impedance becomes capacitively reactive and decreases until series resonance occurs and the winding is effectively a short-circuit. The balun is obviously worthless at this frequency as the balun develops no isolation between the balanced and unbalanced sides. There is no problem in operating the balun through parallel resonance, but it should not be operated above the frequency where the impedance falls below about five times characteristic impedance. **Fig. 8** shows a typical inductance curve.

To perform this test, the tertiary winding must be disconnected so you may not be able to make these measurements on a commercial balun. The test arrangement is shown in **fig. 9**.

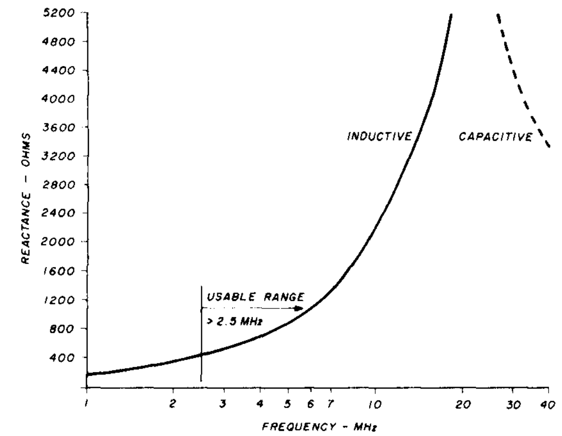


**fig. 8. A typical balun reactance versus frequency characteristic. Isolation is at least five times the characteristic impedance from 2.5 MHz to above 40 MHz.**

## coefficient of coupling

The coefficient of coupling between the main winding and tertiary winding is important because it affects the degree of balance of the balanced output and also limits the high frequency response. To measure the coefficient of coupling, the tertiary winding must be disconnected from the main winding; again, this will restrict the testing to homemade baluns. The procedure is simple; measure the inductance of the main winding as described in the preceding test, with the tertiary winding open-circuited and again with the tertiary short-circuited. Use the equation:

$$k^2 = 1 - \frac{L_{sc}}{L_{oc}}$$

Values of $k$ — not $k^2$ — should be at least 0.98 to 0.99. If the coefficient of coupling is less than about 0.98, you should expect problems, especially if broadband operation and/or a mismatch condition exists. Since this test involves measuring the inductance of the main winding, it is convenient to do it simultaneously with the inductance test.

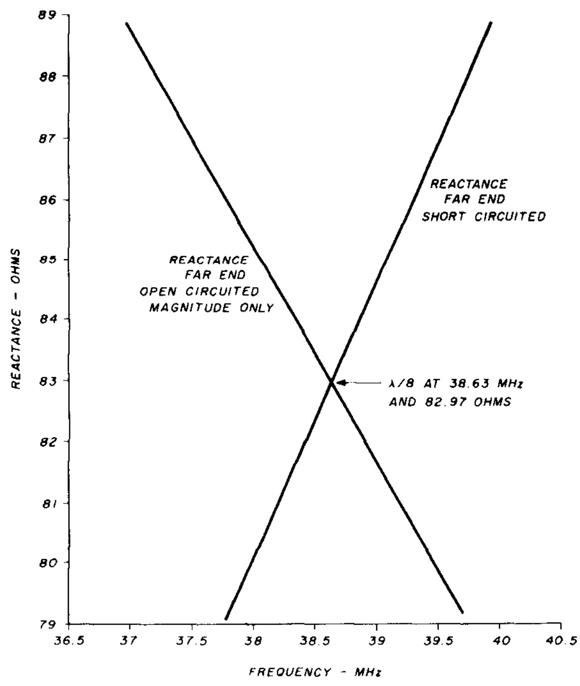


**fig. 7. Open/short circuit curves of a balun transmission line showing a characteristic impedance of 82.97 ohms and a l/8 length at 38.63 MHz.**

## achieving a balanced output

A very important performance characteristic of any balun is the degree of balance of the balanced output (assuming a balanced load). Fortunately, the test for this is easy to do, and a number of different approaches are possible.

The simplest and most direct approach is to measure the rf voltage between each side of the balanced load and ground over the frequency range of interest. If the input voltage is held constant, any unbalance or variations in the transmission through the balun will be apparent.

Another approach is to use a dual channel oscilloscope with one channel connected to each of the balanced terminals. This has the advantage that phase differences between the two halves of the balanced output can also be measured by the horizontal displacement of the two traces.

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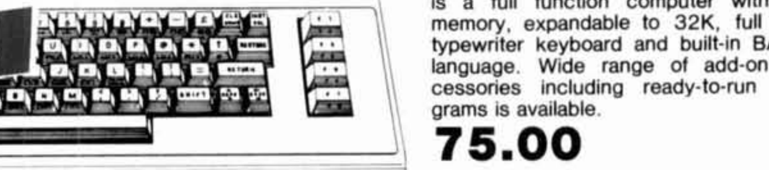



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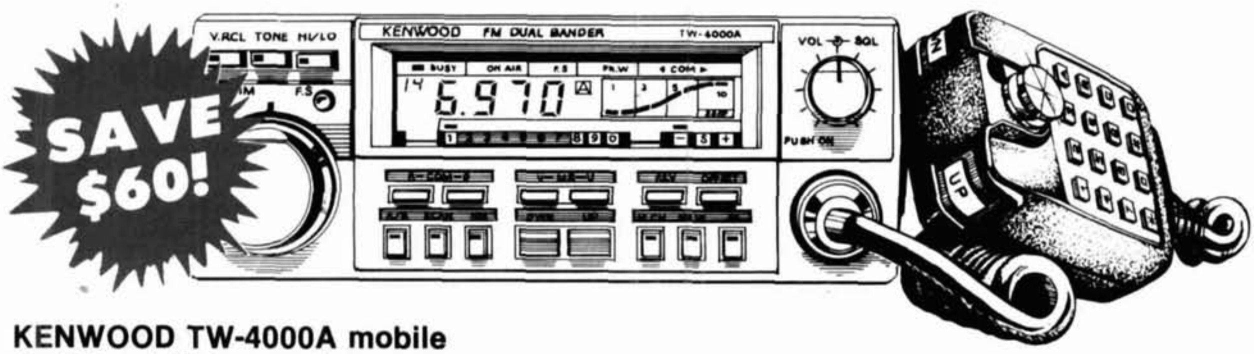


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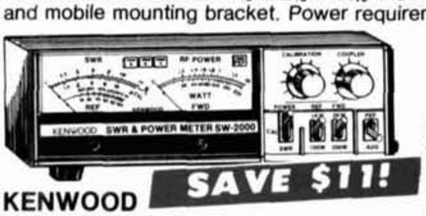


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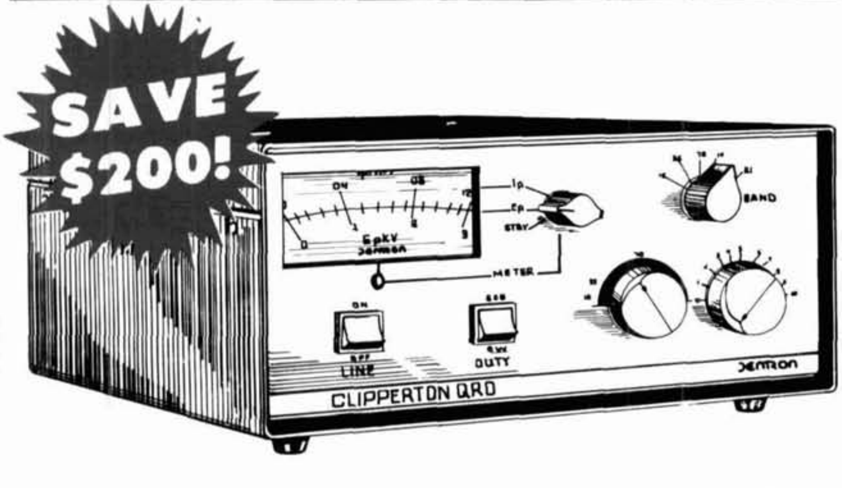


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More Details? CHECK—OFF Page 92

✓157

A variation on this test is convenient for measuring the electrical length of the winding; connect one scope channel to the balun input (unbalanced input) and the second channel to the high side of the balanced output of the balun. The balanced voltage to ground at this point should be one-half the input voltage for a 1:1 balun. You will probably want to synchronize the scope on the channel connected to the balun input. The electrical length of the winding can be determined from this measurement from the horizontal displacement of the two traces. Scopes with vertical channel responses of 30, 45, and even 60 MHz are now readily available to Amateurs, making this an attractive method.

The ideal method of measuring the balance is to use a Hewlett-Packard model 8405A vector voltmeter; this instrument measures the magnitude of two voltages and the phase angle between them. Unfortunately, this is a $5000 instrument and very few Amateurs can afford to spend this much for a voltmeter. If you are employed in electronics, see if your lab has one; it's a common instrument in rf labs. The vector voltmeter can also be used to determine the electrical length of the balun.

Another simple and useful test for estimating the degree of balance is to use a balanced load impedance composed of two resistors in series, with each resistor being one-half the value of the desired balanced load. The input impedance is then measured with the center-tap of these resistors both grounded and open-circuited. If the balun and load are well balanced, there will be no change in the input impedance of the balun when the center-tap of the load is grounded or ungrounded. By "grounding the center-tap," I mean connecting the center-tap to the grounded terminal of the unbalanced input. When I have performed this test on a well-designed balun, I have found that the change in input impedance is always less than the width of the calibration line of the dial.

As the balance test must be made with the balun in its final operating configuration, it can be made on commercial baluns as well as homemade ones. This is one of the simplest and most effective tests I am aware of for determining the effectiveness of a balun. As the balun test involves only measurements of input impedances, it is convenient to check balance when the input impedance is measured. To demonstrate the benefit of a tertiary winding, try making this test on a 1:1 balun without a tertiary winding.

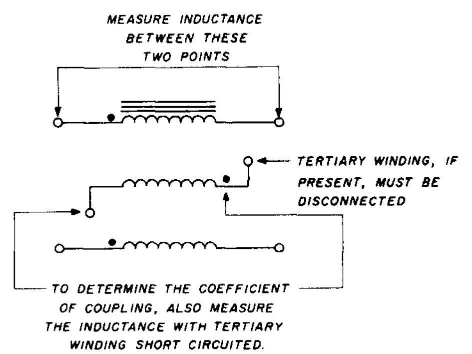


**fig. 9. Circuit for measuring balun inductance and calculating the coefficient of coupling between main and tertiary windings.**

## short-circuit test

This test was first described by Reisert.[1] Readers have often called it to my attention after publication of my previous articles about baluns.[2,4,5] Basically, this test is intended to give an estimate of the isolation provided between the balanced and unbalanced sides of the balun.

This test is performed by measuring the input impedance at the unbalanced terminals with a normal balanced load connected to the balanced side. The input impedance is again measured when each of the balanced terminals is shorted to ground. If baluns provided perfect isolation, there would be no change in the measured input impedance; but because nothing is perfect, some change in input impedance should be expected. Despite extensive reading in the field, I have not yet discovered what constitutes an acceptable change in input impedance, but I would assume that a change of ten percent or less is acceptable. This would suggest that the series impedance of the balun is at approximately ten times its characteristic impedance.

However, this test must be approached with extreme caution. First, if the balun has a tertiary winding, shorting the high side of the balanced terminal to ground will also short-circuit the tertiary winding. As the tertiary winding is tightly coupled to the main windings, this will effectively short-circuit the main winding, thereby ruining the balun action. If the balanced-load center-tap is grounded, shorting either side to ground will also short-circuit one-half of the load resistance, which will obviously affect the input impedance.

My principal objection to this test, however, is that the test conditions alter the operating conditions of the balun. Grounding either balanced terminal provides a path for the magnetizing current (a dc path to ground) and also increases the voltage across the main winding by a factor of two — from V/2 volts to V volts where V is the unbalanced input voltage. For these reasons, I am not convinced that this test is really a reliable indication of balun performance.

### core saturation

One final test that should be mentioned is magnetic saturation of the core. I have not tried this test myself, but it's easy enough to perform, at least in theory. Wrap three or four turns of insulated wire around the balun core and connect it to an oscilloscope. If the waveform on the scope is a sine wave, the core is not being saturated. The test must obviously be made at full power while connected to the actual load. This presents some practical as well as safety problems.

### summary

I have briefly discussed the purposes and operation of a 1:1 transmission line balun and described seven tests that can be used to measure the characteristics of the balun. The tests include:

1. tertiary winding (using an ohmmeter)
2. determination of characteristic impedance
3. isolation determination by winding inductance
4. balance
5. coefficient of coupling of tertiary winding
6. electrical length
7. core magnetic saturation

The tests described above do not appear to require specialized test equipment or training and I feel that balun vendors should list the various technical parameters as do manufacturers of other products. This information would benefit the users because they would be better able to choose the balun that best met their requirements. Perhaps if balun manufacturers were to share their test results with consumers by including technical specifications in their promotional materials, users could be spared some of the time and effort testing requires. Armed with such information, users would be better able to choose the balun that best meets their needs.

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**ham radio**

# ham radio TECHNIQUES

Bill Orr W6SAI

**Last winter and spring** the West Coast experienced severe weather with flooding, land slides and heavy property damage. Radio Amateurs supplied emergency communications in many cases. One important point learned by all concerned with these emergencies is that disasters occur suddenly and unexpectedly. Advance preparation is absolutely essential. In general, communications from home stations were of little use; hand-helds and portable stations carried the larger portion of the communications burden.

During these emergencies, many emergency communication coordinators found that the common "rubber duck" antenna on the hand-held unit was not suitable for emergency use. A better antenna was needed, but it had to be inexpensive and also rugged. A successful emergency antenna had been developed in Arizona for the Scottsdale Amateur Radio Club and the Arizona Repeater Association, and that design has been copied for use by the Red Cross and other emergency communications organizations.

## the 2-meter J-pole

As described by Jack Hanny, KB7CH, of Scottsdale, the emergency J-pole antenna is light enough to be rolled up and carried in a tool box or emergency kit.

The J-pole is made from a 55½-inch section of TV "ribbon" twin lead. A ¼ inch of insulation is removed at one end (**fig. 1A**) and the wires soldered together. 16 inches above the short, a piece of the ribbon line is notched out and one lead is cut open. A ¼ inch of wire is removed. The break is then taped or covered with heat-shrink tubing.

The next step is to measure 1½ inches from the shorted end of the ribbon line and then carefully trim away the insulation to expose the two wires. Be careful not to nick the wires. The feedline is attached at this point (**fig. 1B**). Solder the center conductor of a random length of RG-58/U coaxial cable to the long wire of the ribbon line and solder the braid of the coax to the short conductor.

Jack made his coaxial cable about 12 feet long and placed a matching plug for his hand-held unit at the free end of the line. He wrapped the short section of ribbon line to the coaxial cable with string and covered the joint with tape or heat-shrink tubing.

The last step is to punch a small hole in the insulating web at the opposite end of the ribbon line and tie a section of heavy string to the top end of the antenna. This makes it possible to support the antenna from the branch of a nearby tree. An extra length of RG-58/U cable can be made up with matching connectors to be used if the antenna is to be hung from a greater height.

## more on the sloper

A lot of words have appeared about slopers during the past decade. There's no doubt that it works, but the theory behind this unusual antenna is obscure. In brief, the sloper is simply a ¼-wavelength (approximately) wire, fed at the top end supported by the station antenna tower or mast. The bottom end of the wire is anchored a few feet above ground. The coaxial center conductor feeds the wire at the top, with the shield of the line attached to the metal tower, which apparently works as a ground point.

Dick, WD4FAB, has broadbanded a sloper by increasing its effective diameter with a four-wire cage (**fig. 2**). The bottom ends of the four wires must be interconnected; if they are not, each of the individual wires will take on its independent characteristics, resulting in some unpleasant bumps in the SWR curve. The WD4FAB sloper is suspended at the 50-foot point on a 58-foot-high tower.

## comparing an inverted-V with a 5-band trap vertical

Jim, KW2W, compared a 5-band trap vertical to an 80-meter inverted-V used with an antenna tuner for operation between 80 and 10 meters. Jim says he has a very good location for a vertical — on a sandy beach, only about two feet above the salt water level. The soil beneath the antenna is always moist with salt water. The 5-band vertical was mounted atop a 10-foot pipe driven

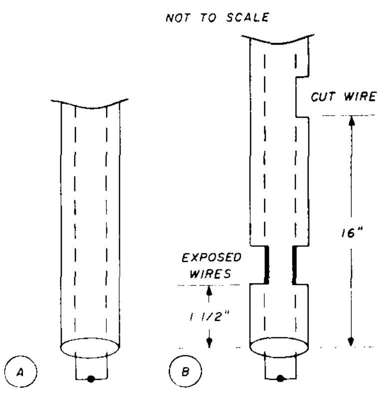


fig. 1. Construction details, 2-meter J-pole antenna.

into the soil and had two resonant radials for each band, for a total of 10 radial wires. The inverted-V was cut for the middle of the 80-meter band. The center of the antenna was about 50 feet high and the ends were about 15 feet high.

Over a period of time, Jim concluded that manmade and atmospheric noise was much less on the inverted-V and that reports received nearly always favored the inverted-V over the vertical.

Jim said, "I feel there's an antenna for every location — meaning that what works well in one place may work poorly someplace else. Antenna experimentation for a given location is worth the effort. The question of which antenna is better is really not applicable; the question of which antenna, *for a given location*, will perform better, is more precise."

## the no-code license — a brief history

The present FCC proposal for a VHF/UHF "no-code" license brings back memories to old timers who remember the 1932 uproar over a similar suggestion.

1932 was a critical year for Amateur Radio. At the depths of the Great Depression, millions were out of work and industry was at a standstill. Many young men with plenty of time but little money turned to the fascinating hobby of shortwave listening. For a few dollars, or even less, an old battery-operated radio could be torn down and rebuilt into a simple shortwave receiver. Many newspapers carried columns about shortwave reception and shortwave clubs were founded for avid young listeners all over the country.

These enthusiastic SWLs soon discovered the Amateur bands, particularly the phone stations. Amplitude modulation was exclusively used for voice transmission in those days and the signals could be readily received on a one or two tube receiver.

A direct result of the SWL hobby was an expanded interest in Amateur Radio. Thousands of listeners yearned to be Amateurs and would have been — except for the bothersome task of learning the Morse code! Why was the knowledge of code required for "radiophone" operation, especially on the "ultra-high" frequencies above 10 meters?

The interest in a no-code license came to a head in May, 1932, when *Short Wave Craft* magazine, edited by Hugo Gernsback, announced the formation of the "Short Wave League" (**fig. 3**) devoted to "the Amateur who is not interested in code, but who is interested in the transmission of voice only." The Short Wave League had no dues or membership fees. The charter of the League was vague, but the editorial in the issue announcing the formation of the League was specific: the goal was to be the lifting of the code restriction on the Amateur "extra-short wavelengths." The May, 1932, editorial in *Short Wave Craft* promised that if "a sufficient number of letters were received, they would form a basis of negotiations between the League and the Federal Radio Commission."

In this manner the request for a no-code VHF license was created. Looking back, it seems unclear whether the Short Wave League was merely a gimmick to increase magazine circulation, or in fact represented an authentic desire for a no-code Amateur license. For a year or so *Short Wave Craft* was full of angry letters to

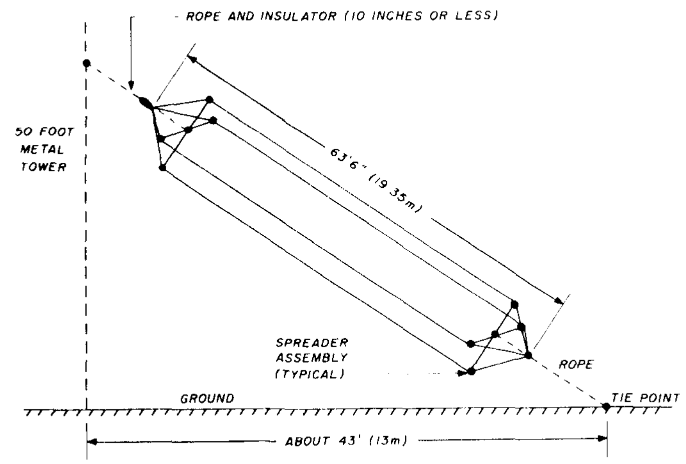


**fig. 2. 80-meter WD4FAB broadband sloper. Spreader assemblies are made of 36-inch long fiberglass tubes. The four antenna wires are tied together about 24 inches past each spreader assembly. A nylon line may be required from the crossover point of the spreader to the outer insulator to prevent bowing. The SWR plot of the antenna falls below 1.4-to-1 at 3.5 MHz; 1.25-to-1 at 3.8 MHz and 1.4-to-1 at 4.0 MHz. Feedpoint resistance of the antenna may be changed by altering the slope angle. The resonant frequency is adjusted by changing length — no climbing necessary!**


**SHORT WAVE LEAGUE PLATFORM**

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*2.—To assist authorities in the apprehension of criminals and in general crime prevention through the instrumentality of short waves.*

*3.—To demand enactment of new regulations enabling operators of phone transmitters to be licensed without code requirments, below 6 meters.*

*4.—To bring together short wave enthusiasts by promoting comradeship among them.*

*5.—To eliminate man-made static, the greatest enemy of short waves.*

**fig. 3. The battle for the no-code Amateur license was fought — and lost — by the "Short Wave League" in 1932. The platform of the League makes interesting reading today. Point 2, which seems unusual today, had meaning in 1932. Police radio was in its infancy and many local police organizations relied upon Radio Amateurs to relay messages for them. But the real purpose of the League was point 3, the no-code license for the "ultra-high" frequencies. As for point 5, we are still working on that problem today! (Material reprinted from *Short Wave Craft* magazine).**

the editor expressing various views, pro and con, on the no-code proposal. It is interesting to note that arguments used then were strikingly similar to those used today. The principal difference between the situation in 1932 and that of today seems to be that the early no-code proposal was apparently a grassroots movement sponsored by the magazine and supported by many of its readers. The Federal Radio Commission (the predecessor of the FCC) had nothing to do with the launching of the proposal. Moreover, it seemed to have given little thought to it, since no official comment was made on the matter. Most Amateurs — and *QST* — ignored the uproar, hoping it would go away. And, sure enough, it did. The fad of shortwave listening died out quickly and by 1934, *Short Wave Craft* magazine turned pro-Amateur and the no-code proposal was forgotten for a few years.

The next no-code license uproar occurred shortly after World War II when the FCC proposed a "Citizen Radio Service" to be placed in the 400 MHz region. The proposal was greeted with little enthusiasm by hams and non-hams alike because no *commercial equipment was available* for the band. Furthermore, because of the very high frequency chosen, any homemade rigs were of the "squawk-box," super-regenerative type, which had poor sensitivity and selectivity.

Faced with a likely failure, the FCC *next proposed to expand the un*wanted VHF CB service into the so-called "industrial-scientific-medical" frequency range at 27 MHz, heretofore used by Radio Amateurs on a secondary basis. Radio Amateurs and others protested the plan, predicting that the FCC wouldn't have the manpower, desire or ability to police the operation properly. How true that prediction turned out to be! And as the MUF rose, providing long distance contacts at 27 MHz, CBers quickly discovered that with modified ham gear, linear amplifiers and big antennas, they could work worldwide DX just like real radio hams! And best of all, the FCC couldn't really catch them — especially if they had no license at all and their names weren't in the FCC computer! No-code license? Why worry about that when no license at all was necessary?

## refighting the battle of 1932

Little was heard of the no-code proposal until a few years ago when it began to surface once again, possibly resurrected because of the monumental CB problem that arose about 1976. The CB channels exploded with activity after CB radio received national publicity during a truckers' strike. Unlicensed CB activity spread beyond the authorized channels, until today it occupies the spectrum from about 26 MHz to 27.99 MHz.

One solution to the CB problem was to give CBers another band. The 220 MHz ham band was proposed, but protests from Amateurs and the military finally defeated the idea. Probably without recalling the 1932 hassle, and with the hope of solving the CB problem, the FCC proposed a no-code license for Radio Amateur operation on certain VHF bands, re-*opening the old argument that had* been settled decades ago.

Why has this idea resurfaced after 50 years? Is there a grassroots move-*ment for a no-code license? Are the* CBers enthusiastic about a no-code license? Are the Radio Amateurs enthusiastic about a no-code license? *As far as I can determine*, the answer to these questions is *no*.

If this conclusion is correct, who, then, wants a no-code license? (All eyes turn toward the FCC.)

The present problem, as I see it, is more fundamental than whether or not a no-code license structure is established. The root of the matter is *who will control the destiny of Amateur Radio in the United States?* Do Amateurs have a voice in their own destiny? A dangerous precedent can be set if the FCC ignores the feelings of the majority of Radio Amateurs and forces a new class of Amateur into existence, flaunting the time-honored foundation of Amateur Radio itself.

It would be easy to establish a no-code Amateur group. But, once created, it would be impossible to disband it. The speed at which the undertaking advances provides little time for reflection or judgment of the long-term possibilities.

The Morse code has been with us for a long, long time. It may be scoffed at by those who don't know it; on the other hand, it could be considered a badge of honor to those of us who use it and appreciate it. I think it would be a mistake of the first magnitude if a complete new class of Amateur licensee were to be artificially created who had no "feel" for the majestic scope of Amateur Radio — the Morse code included.

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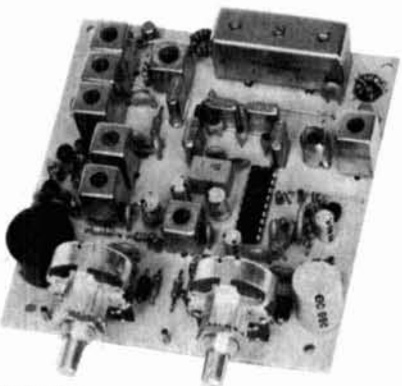

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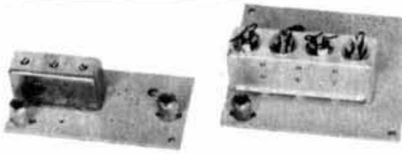

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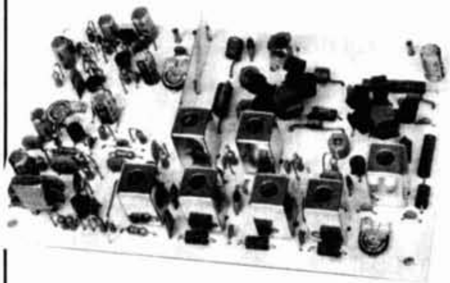

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# antenna carriage
## and track pole mount

Mounting a rotatable antenna on a utility pole can be easy, inexpensive

**Some ingenious ways have been devised** to raise antennas. These have included mounting a stationary mast on a rotatable base; digging a hole, setting a pole, and then cranking the mast up and down; raising and lowering a mast through the roof; making a tiltable mast, using gin poles; and using a mast with telescoping sections.

The technique I've devised consists of stringing two cables vertically on a utility pole, 10 inches apart. A pulley at the top of the pole serves as a sheave for the steel cable that raises and lowers the antenna-bearing carriage. The carriage rides up and down the vertical cables.

### access to the top

Mounting the pulley requires the use of an extension ladder tall enough to reach the top of the pole. Start by mounting a curved block of wood on the top rung of the ladder as shown in **fig. 1**. This prevents the ladder from sliding sideways while positioned at the top of the pole. The base of the ladder should be secured by lashing it to stakes driven into the ground. Use guy ropes to keep the ladder from swaying.

### pulley and cables

Because the top of the pole is 8-1/2 inches (21.6 cm) in diameter, a 9 inch (22.8 cm) die-cast aluminum pulley is required. The pulley is attached to a pair of aluminum brackets and mounted with lag screws see (**fig. 2**). It may be necessary to use shims to keep the pulley in a vertical position if the top of the pole is not straight.

Both a support and winch cable are needed. The support cable is a single 70 foot (21.3 m) length of 1/4 inch (6 mm) flexible steel cable. The winch cable is about 75 feet (22.8 m) of 1/8 inch (3 mm) cable. A heavier carriage and antenna would require using a heavier winch cable.

**By Ira L. Simpson, KB3K,** 1201 Walters Mill Road, Forest Hills, Maryland 21050

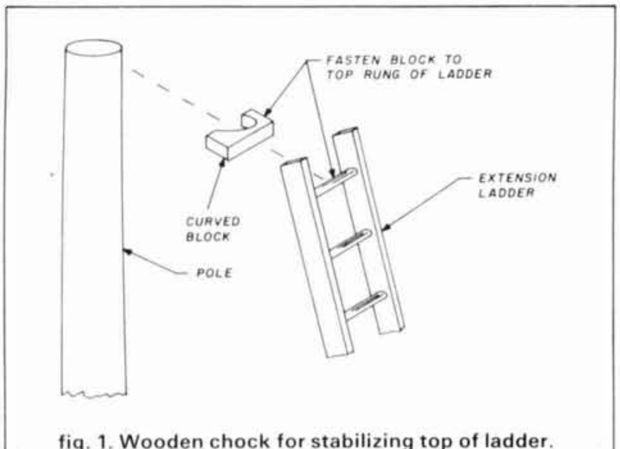


fig. 1. Wooden chock for stabilizing top of ladder.

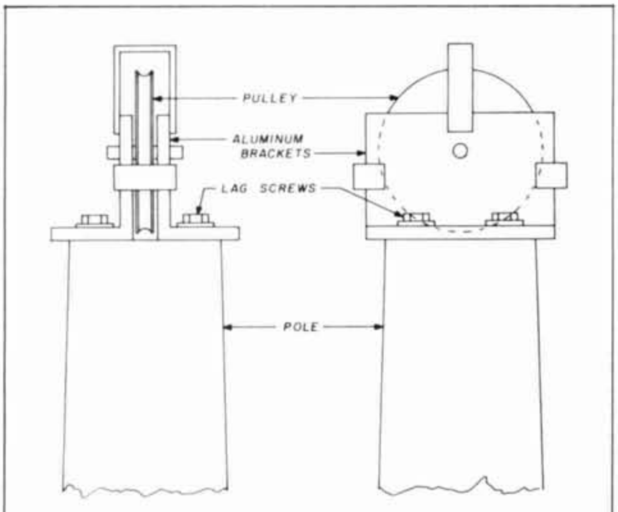


fig. 2. Details of assembly at top of pole.

## carriage

The carriage (**fig. 3**) is fabricated from ordinary slotted steel shelving upright strips available at hardware stores. Each strip is 4 feet (1.2 m) long. The steel support cables fit easily in the channels of these strips.

Lay the steel strips on a work bench 10 inches (25.4 cm) apart, the required spacing for the support cables. Bolt two metal supports at right angles to the strips at points one quarter and three quarters of the way up the carriage. Weld the two shelving brackets into the bottom slots of the uprights. Then bolt the bottom shelf to these brackets. Make six clips which will slide onto the upright carriage strips to hold the support cable securely in the groove when the carriage rides up and down the support cables. When mounting the carriage onto the support cables, hold these clips in place with cotter pins.

A spring-loaded plunger (**fig. 4**) is attached on the underside of the bottom plate. When the carriage is in position at the top of the pole, the plunger slides into a mating hole in the pole, to act as a safety catch in case the winch cable breaks. A nylon string is attached to the eye on the plunger assembly so it can be released from the ground.

## antenna mast guides

To stabilize the mast, a right angle bracket is installed at the top of the carriage. A hole slightly larger than the diameter of the mast is made in the bracket. A bearing plate is mounted over the hole while the mast is fitted into the rotor. The size of the bearing plate depends on the size of the mast; some measuring and alignment is necessary to assure that the rotor is correctly aligned with the hole in the top bracket and that the mast is straight.

## winch

The winch is mounted on the pole at shoulder level. Purchased from Montgomery Ward, mine was strong enough to pull about 1200 pounds (545 kg). It

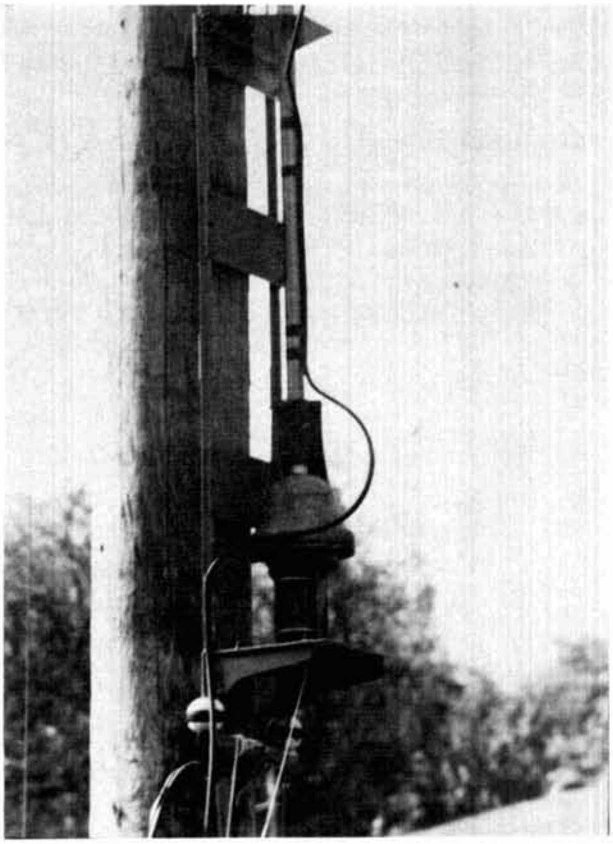

fig. 3. The carriage. Clip can be seen on the left upright. Notice the pipe at the top of the carriage. This was used to wrap the steel cable to the carriage. The two rubber balls mounted at the bottom are shock absorbers.

was spaced far enough away from the pole for the handle to clear and bolted to the pole with two 3/8 inch (9.6 mm) threaded rods. (Each of the two threaded rods should be ground to a point at one end and squared off to accommodate a wrench at the other end. Finished this way, each rod can be screwed into the pole by first drilling a hole slightly smaller in diameter and then using a wrench to turn the rod into the hole. A little grease may make the job easier.) When the rod is in place, cut away the excess length and mount the winch.

## vertical guide cable and cable spreader

To install the vertical guide cable on the pole, mount a top support bracket at the top of the pole using two 1/2 inch (13 mm) bolts made from threaded rod (**fig. 5**). The cable spreader (**fig. 5**) is lag bolted to the pole about 6 feet (1.8 m) from the ground. To fasten the turnbuckles install a triangular plate about 3 feet (0.9 m) from the ground using a 1/2 inch (13 mm) rod through the pole (**fig. 5**). Lay the 1/4 inch (6 mm) flexible steel carriage support cable in the top cable bracket and attach the turnbuckles to the ground end of the cables with the cable clamps. After the cable is installed and tightened, the carriage can be mounted and run up and down the pole a few times to assure proper operation.

## conclusion

This simplified method of assembly, using inexpensive and readily available materials, can be used to raise antennas to effective working heights.

My antenna stands 20 feet (6 m) high in its lowered position; in the raised position, it stands 40 feet (12 m) high. The pole to which it is attached measures 35 feet (10.6 m).

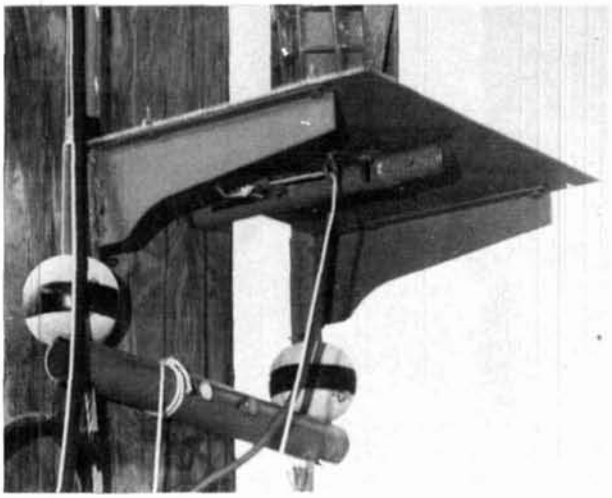

fig. 4. View of plunger assembly.

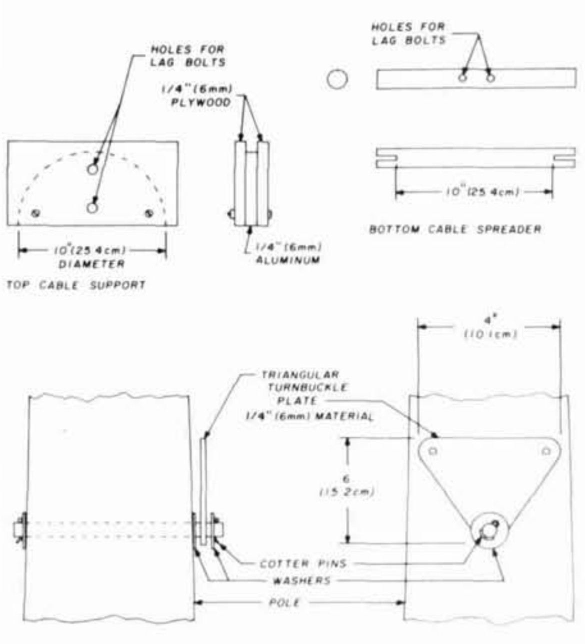


fig. 5. Construction details.

***materials list***

| *quantity* | *description* |
|---|---|
| *2* | *turnbuckles* |
| *4* | *cable clamps — 1/4 inch (6 mm) cable* |
| *3* | *cable clamps — 1/8 inch (3 mm) cable* |
| *1* | *9 inch (22.8 cm) pulley* |
| *1* | *hand operated utility winch* |
| *70 feet (21.3 m)* | *1/8 inch (3 mm) steel cable* |
| *75 feet (22.8 m)* | *1/4 inch (6 mm) flexible steel cable* |
| *30 feet (9.2 m)* | *nylon string* |
| *2* | *upright steel shelving strips* |
| *2* | *shelf brackets to fit strips* |
| *aluminum plate* | |
| *aluminum mast material* | |
| *steel plate* | |
| *lag bolts* | |
| *threaded rod with nuts (also known as All-thread)* | |
| *steel metal for brackets, braces, and clamps.* | |

A few details should be noted: be sure to prime and paint any metal parts subject to rust. Lubricate as necessary. Run a ground wire from the support cable and the winch, and install a ground rod at the base of the pole. The transmission line and rotor cable can be run underground to the shack, if you wish. Remember to rotate the antenna only in the raised position.

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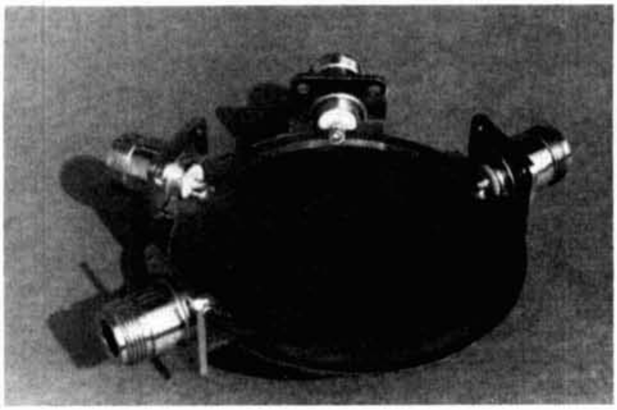
# the hybrid ring

## Using the "rat race" for power combining, splitting, and coupling



The experimental 1296-MHz hybrid ring with inexpensive type "N" launchers.

**The hybrid ring**, also known as the "rat race," is a device used either to divide or combine power at VHF and UHF. The hybrid ring is easily constructed using double-sided printed circuit boards; tolerances in dielectric thickness and etching accuracy are not critical. The hybrid ring's outputs, in one application, can be either equal amplitude in-phase or 180-degree out-of-phase signals, depending on the input port chosen. Or it can be used as a directional coupler with different power levels available at the output ports.

### defining a hybrid

In general, the impedance seen at any port on a hybrid is equal to the characteristic impedance of the transmission line if all of the remaining ports are properly terminated in this same impedance. Each pair of output ports must remain isolated from each other; the input ports must also remain isolated from each other. This is very important when power is to be divided equally to feed two power amplifiers, or when you wish to minimize local oscillator radiation during the combination of two signals (such as in a mixer hybrid.) The hybrid ring, or rat race, is a directional coupler that can be used to sample power trav-

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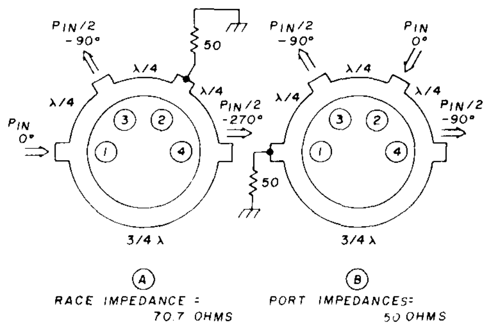


**fig. 1. The hybrid ring provides (A) two equal signals 180 degrees out of phase or (B) two in-phase signals.**

eling in different directions. It is simple to construct and very tolerant of line-width variations when microstrip transmission line is used. The power ratio at the output ports can be varied by varying the impedances of the interconnecting lines, and the simple hybrid ring can provide a good match and excellent isolation over a ±20 percent bandwidth. The size of the microstrip version of the hybrid limits its use to 432 MHz and above.

The simple hybrid ring consists of a ring of 70.7-ohm transmission line terminated in four places. The top view of the microstrip hybrid ring etched on a printed wire board is shown in **fig. 1A**. Three ports are separated by quarter-wavelength sections. The last transmission line is three-quarters wavelength long, adding up to a total circumference of 1.5 wavelengths.

The hybrid ring is commonly used to split or combine rf power, and if a signal is applied to port 1 of the ring, the power will be equally divided between ports 3 and 4; the phase relationship between the output signals will be 180 degrees. Power incident at port 2, **fig. 1B**, will also be equally divided between ports 3 and 4, but the two output signals will be of similar phase.

Hybrid ring operation can be understood by studying the simple power divider shown in **fig. 2A**. An input signal at port 2 is equally divided at the junction of the two quarter-wave lines. The transmission lines act as impedance transformers whose characteristic impedance is equal to the square root of the product of the end impedances. If the terminations are all 50 ohms, then the quarter-wave line transforms the output load of 50 ohms at port 3 and at port 4 up to 100 ohms at the input, port 2. The parallel combination of the input impedance (100 ohms) to each of the two quarter-wave lines at port 2 is equal to 50 ohms. This divider can also be used as a combiner if two identical signals of equal phase are applied to ports 3 and 4. This power divider is still not a true hybrid, because ports 3 and 4 have only 6 dB of isolation. In other words, a signal applied to port 3 will be 6 dB down when measured at port 4.

Additional transmission lines, **fig. 2B**, transform the simple power splitter into a true hybrid. Any power reflected at output port 3 due to a mismatch arrives at the other output port 4 by two paths. One signal travels one-half wavelength in a clockwise rotation from port 3. The counter-clockwise signal appears at port 4 delayed by a full wavelength. This half-wave difference in arrival time and equal path loss causes the two signals to cancel at port 4, with total cancellation resulting in highest isolation. The reflected signal from any mismatch at port 3 arrives at port 1, in phase from both circular paths, where it is dissipated. This port is designated the isolation port. A detector placed at this port indicates imbalance between the output ports. The input signal from port 2 cancels at port 1 because the clockwise and counterclockwise paths differ by one-half wavelength. If two equal signals with 180-degree phase

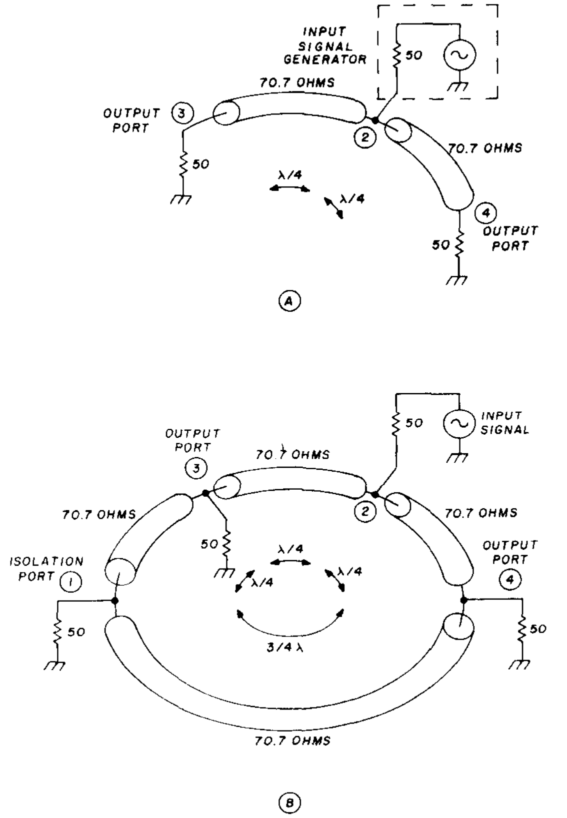


**fig. 2. The hybrid ring is formed by (A) an equal split power divider followed by the addition of a cancellation line (B) to provide port-to-port isolation.**

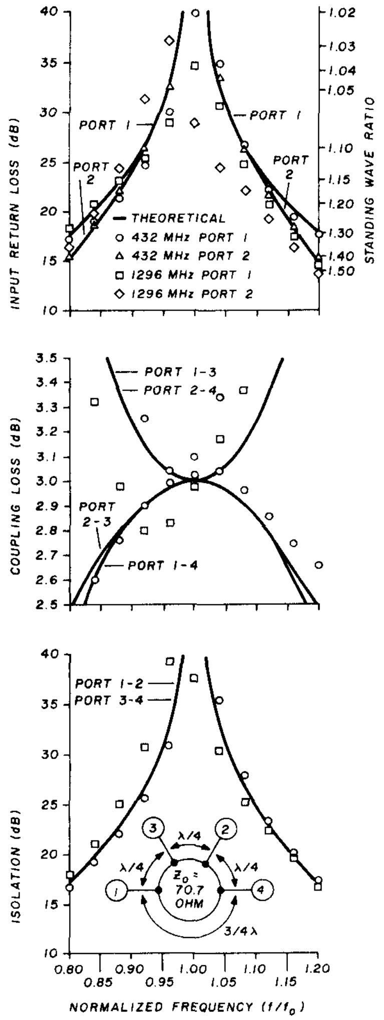


fig. 3. The theoretical response (solid line) of a 70-ohm hybrid ring is compared with experimental results using semi-rigid line.

difference are needed, the input signal can be changed to port 1 and the output taken from ports 3 and 4, as in **fig. 1A**.

## 70-ohm rat race

The impedance of the ring, or "race," is the port impedance multiplied by the square root of two ($50\ ohms \cdot \sqrt{2} = 70.7\ ohms$). The input match of the hybrid is given in terms of return loss, that is, the ratio of reflected power to incident power,

$$return\ loss = -10 \log_{10} (reflected\ power/forward\ power) \qquad (1)$$

The theoretical and experimental results of a 1.5-wavelength rat race are shown in **fig. 3**. The experimental results, using semi-rigid coaxial cable to form the race, are shown for 432 and 1296 MHz. The input return loss is greater than 20 dB (SWR ≤ 1.2:1) over a 20 percent bandwidth at port 1 or port 2. This means that only 1 percent of the input power is reflected at the input port. The hybrid ring displays an equal power split (3.01 dB) to within 0.25 dB over the same ± 10 percent bandwidth. This means that at 90 percent and at 110 percent of the center frequency the output power at one port is only 0.25 dB greater (6 percent unbalance) than at the other output port. The isolation between ports 3 and 4 is greater than 20 dB over the same bandwidth. Any mismatch at port 3 causes the reflected signal appearing at port 4 to be at least 20 dB down (1 percent of the reflected signal).

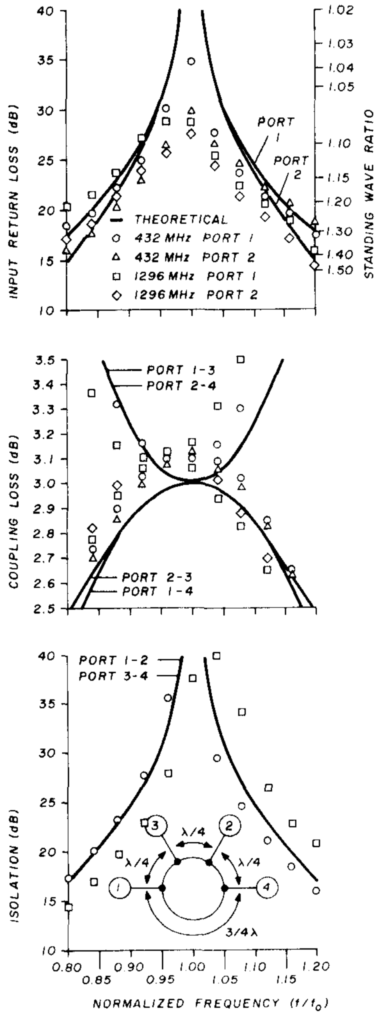


fig. 4. The experimental results using microstrip were also very close to the predicted values at 432 and 1296 MHz.

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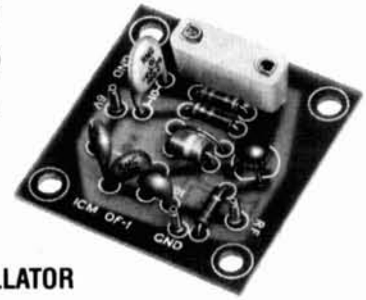


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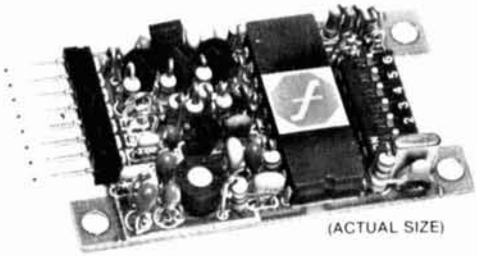

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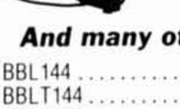

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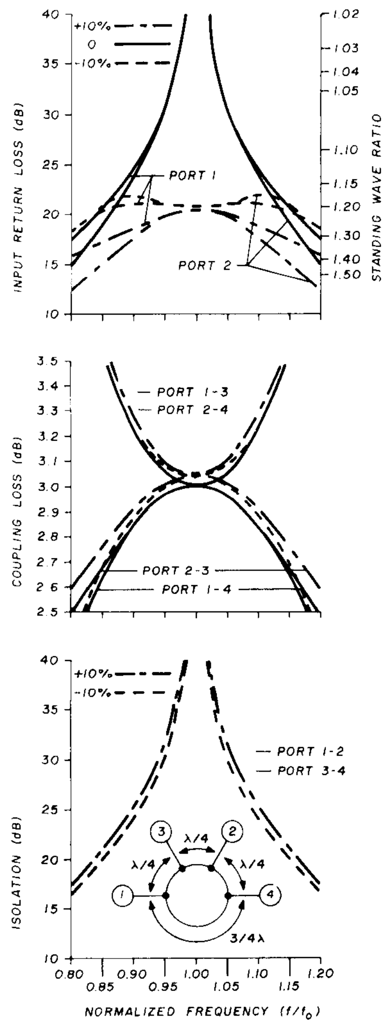


fig. 5. Variations in the impedance of the ring appears to have little effect on the operation of the hybrid ring.

A printed-circuit board version of the hybrid ring was also constructed, with the results shown in **fig. 4**. The width of a microstrip line on one-ounce, 1/16-inch thick, copper-clad Teflon-fiberglass board (e = 2.55) is 95 mils for 70.7-ohm line and 166 mils for the 50-ohm termination leads. The relative velocity of propagation in that board material for a 70.7-ohm microstrip line is 0.700; but it's only 0.688 for a 50-ohm line. The length of a quarter-wave line is thus shortened from its free-space value by this amount. The mean diameter of the ring is simply the average of the inner and outer diameters. The dimensions of hybrid rings for use at several UHF bands are given in **table 1**.

The effects of variations in the impedance of the ring are displayed in **fig. 5**. Variations of ± 10 percent in impedance produce only minor changes; the greatest change was in the input return loss. Still, the hybrid displayed an input return loss greater than 17.5 dB (SWR ≤ 1.3:1) over a 20-percent bandwidth. A variation of 10 percent in ring impedance corresponds to a line width range of from 77 mils to 113 mils about the desired value of 95 mils, for a one-ounce Teflon-fiberglass PC board. This amounts to an almost ± 20 percent variation in the width of the microstrip, much greater than expected.

The PC board version used homemade microstrip-to-coax launchers soldered directly to the ground plane. Type-N female chassis connectors (UG58A/U) were modified by hacksawing a notch, as shown in **fig. 6**. The hacksaw blade was held flat

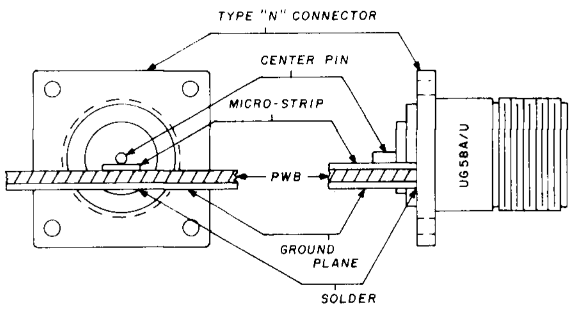



fig. 6. Inexpensive end launchers are formed by modifying common coaxial connectors.

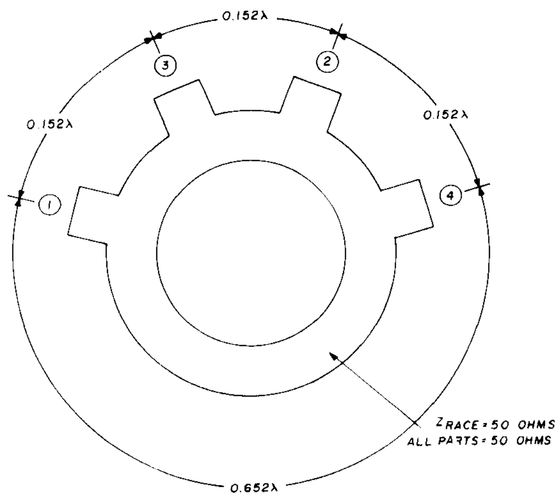



fig. 7. An equal-split hybrid ring can also be formed using 50-ohm transmission line.

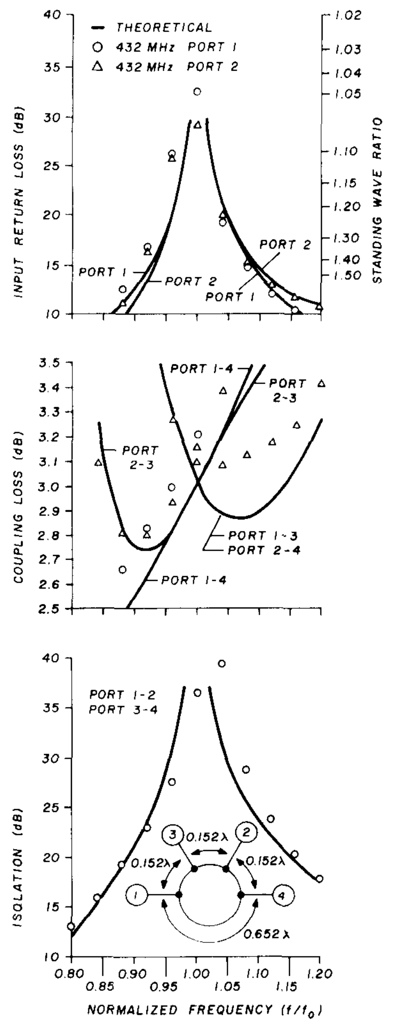



fig. 8. A hybrid ring formed using 50-ohm line microstrip operates over a much smaller bandwidth.

against the center conductor until it penetrated the flange. The PC board was then inserted into the slot and soldered using a 50-watt iron. The measured loss of two launchers mounted to a short microstrip was less than 0.1 dB, the return loss was greater than 32 dB (SWR ≤ 1.05) through 1296 MHz.

## 50-ohm rat race

If the rat race is constructed of 50-ohm coaxial cable, the cable lengths between each port are shorter, as shown in **fig. 7**.

$$Z\ line = Zo \tan \theta \qquad (2)$$

where $Zo$ is the characteristic impedance of the line (50 ohms) and $\theta$ is the electrical length in degrees.

$$70.7\ ohms = 50\ ohms \tan \theta \qquad (3)$$

$$\theta = 54.7\ degrees \qquad (4)$$

The short cable lengths required are 0.152 wavelength; (54.7°/360° = 0.152 wavelength). The cable section between ports 1 and 4 is one-half wavelength longer, 0.652 wavelength. The circumference is only 1.108 wavelengths for the 50-ohm rat race, compared to 1.5 wavelengths for the 70-ohm model. A disadvantage of this lower-impedance hybrid is in the reduced bandwidth, as indicated by the frequency response curves in **fig. 8**.

## uneven power-divide rat race

Output power ratios other than 1:1 are possible through selection of different transmission line impedances between the ports. A 10-dB coupler using this approach is illustrated in **fig. 9**. For a signal input P1 at port 1 and in-phase outputs at ports 3 and 4, the value of transmission line impedance is:

$$Z_1 = Z_0 \sqrt{P1/P3} \quad Z_2 = Z_0 \sqrt{P1/P4} \qquad (5)$$

where $P3$ is the output power at port 3 and $P4$ is the power output at port 4. The sum power from ports 3

**table 1. Hybrid ring dimensions for one-ounce, 1/16-inch thick, Teflon-glass board.**

| frequency (MHz) | 70 ohms one-quarter wavelength (inches) | 70 ohms three-quarter wavelength (inches) | 1.5λ mean diameter (inches) |
|---|---|---|---|
| 432 | 4.78 | 14.34 | 9.13 |
| 1296 | 1.59 | 4.78 | 3.04 |
| 2304 | 0.896 | 2.69 | 1.71 |

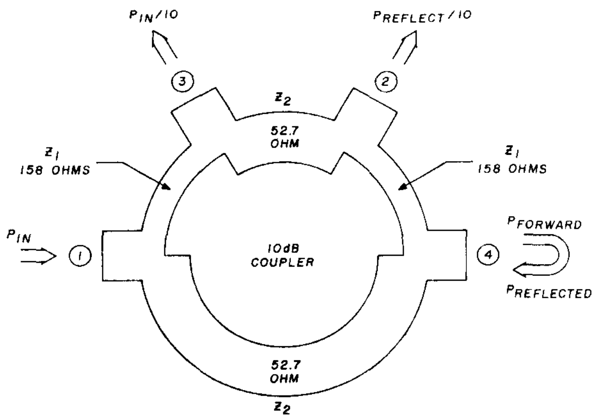



fig. 9. The power division is controlled by adjusting the ring transmission line impedance between ports.

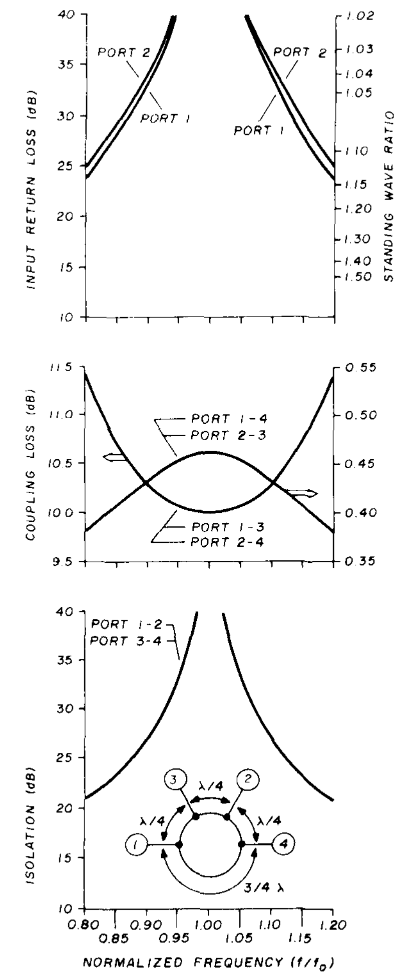


fig. 10. The theoretical response of the 10-dB coupler appears quite good over a 20 percent bandwidth.

and 4 must equal the input power. Constructing a 10-dB coupler, as an example:

$$Z_1 = 50\sqrt{1/0.1} = 158.1\ ohms \qquad (6)$$
$$Z_2 = 50\sqrt{1/0.9} = 52.7\ ohms$$

The output signal at port 3 is a sample of the input signal at port 1 with −10 dB of coupling. To use the hybrid as a directional coupler standing-wave-ratio meter, detectors are placed at ports 2 and 3. Forward power is detected at port 3 and reflected power at port 2. Both signals are sampled 10 dB down from true power. The theoretical response is shown in **fig. 10**. The line width for a 158-ohm line (10 mils) is just too thin, however, for Amateur etching.

## applications

The principal use for the hybrid ring is to split or combine power. If more power is needed from a power amplifier than a single transistor can handle, it is necessary to parallel two devices. To maintain stability the two devices must remain isolated from each other. The hybrid performs this function as indicated in **fig. 11**. By using the 180-degree ports, the amplifier operates in a balanced or push-pull manner as seen in **fig. 11A**. The input impedance is effectively four times as great as would be in the case of a single transistor with twice the power-handling capabilities. The case of an in-phase parallel amplifier is shown in **fig. 11B**. Comparison of the insertion loss between the two arrangements (assuming unity gain amplifiers) shows the broader bandwidth response of **fig. 12**, for the push-pull amplifier. If one amplifier should fail, the output power will drop to one-fourth the normal level. The remaining amplifier will deliver one-half its power to the antenna and the remaining one-half to the termination at the isolation port. If the input to either amplifier were to open or short, the input return loss at the hybrid input port 1 would drop to 6 dB (SWR ≤ 3:1).

When the rat race is used as a power splitter, each output will have equal amplitude and phase, provided the ports are reasonably terminated. When it is used to combine the output power from two transis-

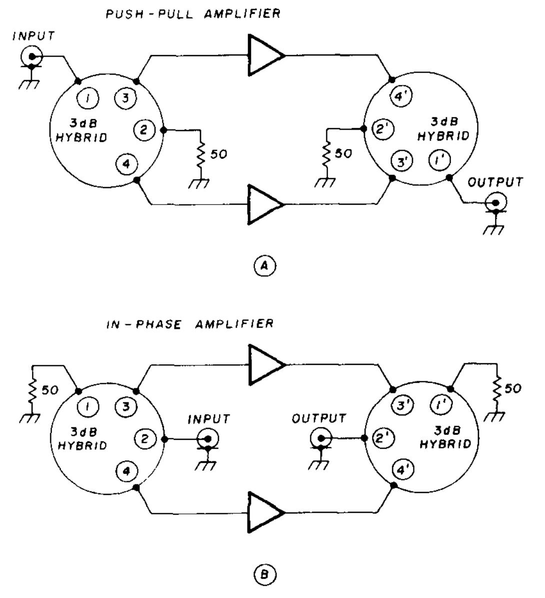
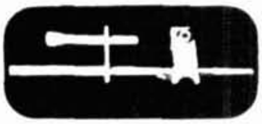



fig. 11. The hybrid ring may be used as a power splitter/combiner for a (A) push-pull amplifier or (B) an in-phase amplifier.

# CUE DEE

CUE DEE antennas are Quality Designed to ensure optimal performance and durability. Five (5) years written GUARANTEE against materials or manufacturing faults on all CUE DEE (Quality Designed) antennas.

*Element to boom mounting of CUE DEE VHF/UHF yagi antennas.*



*Driver element for 144 MHZ with pre-tuned gamma match.*

*SWR of CUE DEE 15144A and 15X144A*

*15144A, 15 el. long yagi 144MHz.*


**Specifications VHF antennas:**

| Antenna | 4144A | 10144A | 10X144A | 15144A | 15X144A |
|---|---|---|---|---|---|
| No. Elements | 4 | 10 | 2x10 | 15 | 2x15 |
| Gain | 8 dBd | 11.4 dBd | 11.4 dBd | 14 dBd | 14 dBd |
| Front / Back | 20 dB | 25 dB | | | |
| Front / Side | >40 dB | | | | |
| SWR | <1.5 / 1 | | | | |
| Aperture Angle E | 2 x 29° | 2 x 18° | 2 x 18° | 2 x 15° | 2 x 15° |
| Aperture Angle H | 2 x 46° | 2 x 24° | 2 x 24° | 2 x 16° | 2 x 16° |
| Impedance | 50 ohm | | | | |
| Mast Diameter | 50 mm | | | | |
| Boom Lenght | 1.1 m | 4.5 m | 4.55 m | 6.45 m | 6.5 m |
| Surface Area | 0.03 m2 | 0.12 m2 | 0.16 m2 | 0.18 m2 | 0.23 m2 |
| Weight | 1 Kg | 3 Kg | 3.4 Kg | 5 Kg | 5.5 Kg |
| Boom | | 3 sections | 3 sections | 4 sections | 4 sections |

**N-type connector** may be supplied upon request. SO 239-type connector is **delivered as standard** on all antennas.

**CUE DEE yagi antennas 144 MHz.**

CUE DEE antennas are designed to last for decades – the best possible aluminium alloy for this purpose is used (SIS 4212-06).

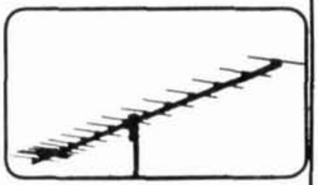
The booms are made of 28 mm tubing with 1.5 mm wall, with colour marks clearly indicating where to fit the elements. By using tubular boom, and a synthetic guy wire on the long yagis, the windload is reduced by a factor 0.66 compared to using square shaped material for boom and guying.

The driver element is made of 12 mm tubing and features a PTFE (Teflon) insulated gamma match which is pre-tuned at the factory and made for 50 ohm feeder with a PL 259 type connector. No further adjustments or power consuming balun needed. This matching system ensures a clean radiation pattern and transfers the power without losses.

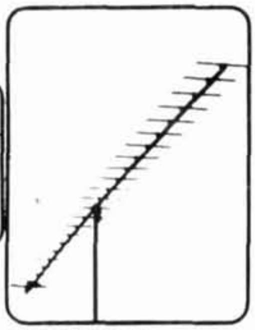
The parasitic elements are made of 6 mm solid rod and mounted to the boom with aid of a CUE DEE element washer, boom to element part and a screw. This, together with our intelligible assembly manual, makes an extreamly easy and solid assembly which assures the long life of a CUE DEE antenna ..........

**CUE DEE UHF antennas 432 MHz**

CUE DEE UHF yagi antennas use the same design as the VHF antennas (page 4) with a choice between eithter UHF (PI259) on N-type connector. The antennas are pre-tuned at the factory and need no further adjustments. No power loss due to a balun. CUE DEE antennas are durable and reliable – an antenna to enjoy for many years to come ..........



*CUE DEE 17432AN-AU*



*CUE DEE 25432AN-AU*

**Specifications UHF antennas**

| Antenna | 17432AN AU | 20432AN AU | 25432AN AU |
|---|---|---|---|
| No. Elements | 17 | | |
| Gain | 14.5 dBd | | |
| Front/Back | 25 dB | | |
| Front/Side | 40 dB | | |
| SWR | < 1.5 / 1 | | |
| Impedance | 50 ohm | 50 ohm | 50 ohm |
| Mast Diameter | 50 mm | 50 mm | [illegible] mm |
| Boom Length | 2.5 m | 3.3 m | |
| Surface Area | 0.05 m2 | | |
| Weight | 2 Kg | | |
| Boom | 2 sections | 2 sections | 3 sections |

TO BE ANNOUNCED

Note! 17432AU = 17 elements 432 MHz yagi with UHF connector
17432AN = 17 elements 432 MHz yagi with N connector

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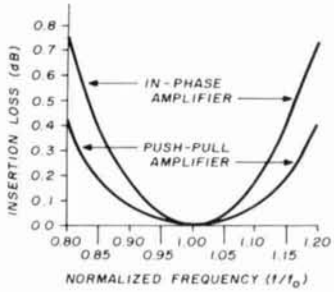



**fig. 12. The insertion loss of two hybrids is lower for push-pull connections.**

tor amplifiers, the input power delivered to the two input ports may not be equal or in phase. This may be due to differences in transistor gain and internal phase shift. The output power is then less than the sum of the two input powers. The percentage difference ($\eta$) of this ideal sum of the two powers is given by:

$$\eta = \left[0.5 + \left(\frac{\sqrt{r}\cos\theta}{r+1}\right)\right] \times 100\ percent \quad \textbf{(7)}$$

where $r$ is the power ratio of the two input powers, and $\theta$ is the phase angle between them. If the two input signals are in phase but differ in amplitude, the above equation reduces to:

$$\eta = \left[0.5 + \left(\frac{\sqrt{r}}{r+1}\right)\right] \times 100\ percent \quad \textbf{(8)}$$

For an input power ratio of 2:1 (3 dB), the output power will be down only 0.13 dB, or 97 percent of the sum of the two input powers. If the amplitudes are balanced, but the phase of the two input powers differs then,

$$\eta = \left[0.5 + \left(\frac{\cos\theta}{2}\right)\right] \times 100\ percent \quad \textbf{(9)}$$

For an input phase difference of even 15 degrees, the output power will be down just 0.7 dB, or 98 percent of the available power. For a combination of a power unbalance of 2:1 and a phase unbalance of 15 degrees between inputs, one would suffer a total loss of only 0.2 dB, leaving 96 percent of the original available power.

## references

1. Henry S. Keen, W2CTK, "High-Frequency Hybrids and Couplers," *ham radio*, March, 1978, pages 72-75.
2. James R. Fisk, W1HR, "Microstrip Transmission Line," *ham radio*, January, 1978, pages 28-37.

**ham radio**

# a digital audio filter
## for CW and RTTY

### Build a useful audio notch and bandpass filter

**This filter, designed around** the National MF10 integrated circuit, consists of CMOS (Complementary Metal Oxide Semiconductor) active filter building blocks. Each block, together with an external clock and a few resistors, can provide different filter functions such as notch or bandpass.

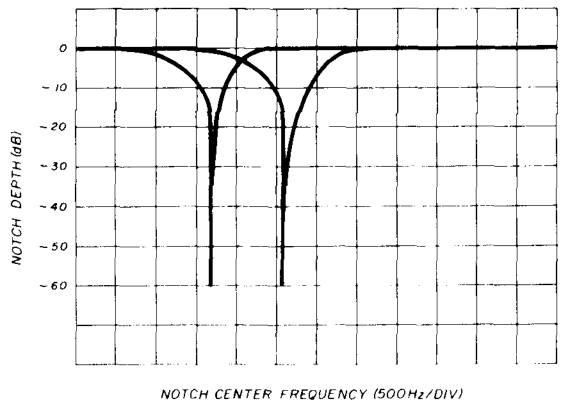



**fig. 1. Notch filter response can be translated in frequency by changing the clock rate.**

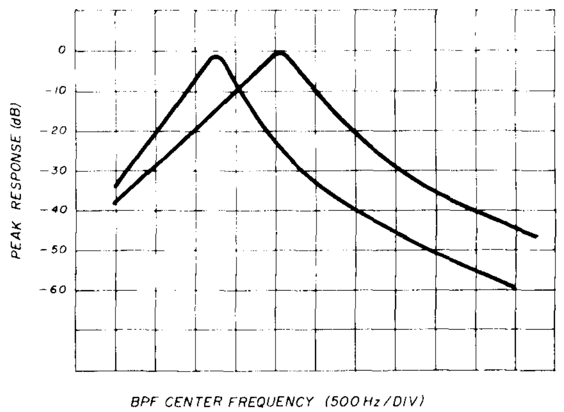
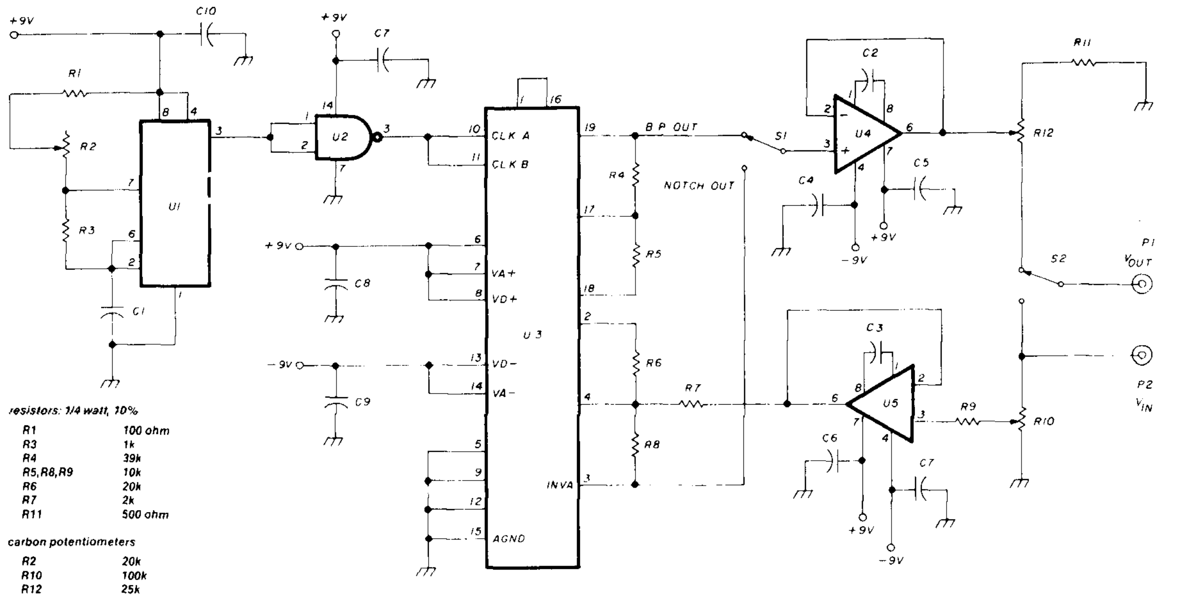



**fig. 2. Bandpass filter response at two different center frequency settings.**

A major advantage of this type of filter is that the notch and bandpass position is determined by the clock frequency. Therefore, by varying potentiometer R2 the notch or bandpass can be moved in position as shown in the spectrum analyzer photographs in **figs. 1** and **2**. **Fig. 1** indicates a notch filter response (notch depth approximately 60 dB) and **fig. 2**, the bandpass display displaced in two positions. The bandpass filter was adjusted for CW or RTTY operation.

**By Don Kadish, W1OER,** 135 Barbara Road, Waltham, Massachusetts 02134




| | |
|---|---|
| *resistors: 1/4 watt, 10%* | |
| R1 | 100 ohm |
| R3 | 1k |
| R4 | 39k |
| R5,R8,R9 | 10k |
| R6 | 20k |
| R7 | 2k |
| R11 | 500 ohm |
| *carbon potentiometers* | |
| R2 | 20k |
| R10 | 100k |
| R12 | 25k |
| *ceramic capacitors* | |
| C1 | 1500 pF |
| C2,C3 | 30 pF |
| C4,C5,C6,C7, C8,C9,C10 | 0.1 μF |
| *integrated circuits* | |
| U1 | National 555 timer chip |
| U2 | National CD4011AE |
| U3 | National MF10 |
| U4,U5 | National LF365N or equivalent |

fig. 3. Audio notch and bandpass filter schematic.

A 555 timer chip, U1, provides the variable clock input. U2 inverts the clock output to providing a TTL level into the clock inputs of U3. A switch, S1, is used to switch from notch to bandpass operation. R12 in conjunction with R11 is a volume control. A speaker or headphones can be directly driven by U4. An input volume control, R10, is used to prevent saturation of the filter stage U3. Once R10 is set it does not have to be adjusted further. U4 and U5 isolate the filter chip from the input and output connections.

## constructing and operating the filter

Construction is simple; neither layout nor component values are critical. However, use of decoupling capacitors on all ICs is good practice and minimizes the chance of high-frequency oscillations occurring. All components are mounted on a single-side copper clad vector board.

Filter operation requires connecting $V_{IN}$ to the audio output of a communications receiver through a phono jack and connecting $V_{OUT}$ to a speaker or headphones. Switch S2 to $V_{IN}$ in order to bypass the filter. Adjust the receiver audio gain control for comfortable listening, then switch S2 to $V_{OUT}$ to insert the filter. Adjust the sensitivity control, R10, for comfortable listening volume. Actually the only precaution necessary is to adjust the volume so that clipping of the filter stage does not occur. If clipping does occur, reduce the receiver audio gain until it sounds "clean."

On-the-air tests in the notch filter position gave excellent rejection of adjacent signals. RTTY operation in the bandpass mode is also very simple. Adjust R2 to the extreme end of the potentiometer (the end that accepts the mark and space tones). Except for an occasional adjustment of the volume control, further adjustment is unnecessary.

## dc supply voltages needed

Any positive and negative voltage between plus and minus 5 and plus and minus 12 should be satisfactory. Batteries can be used with this device. If low power drain is desired, substitute a CMOS timer (7555) for the 555 timer. All ICs should be of the CMOS type.

**ham radio**

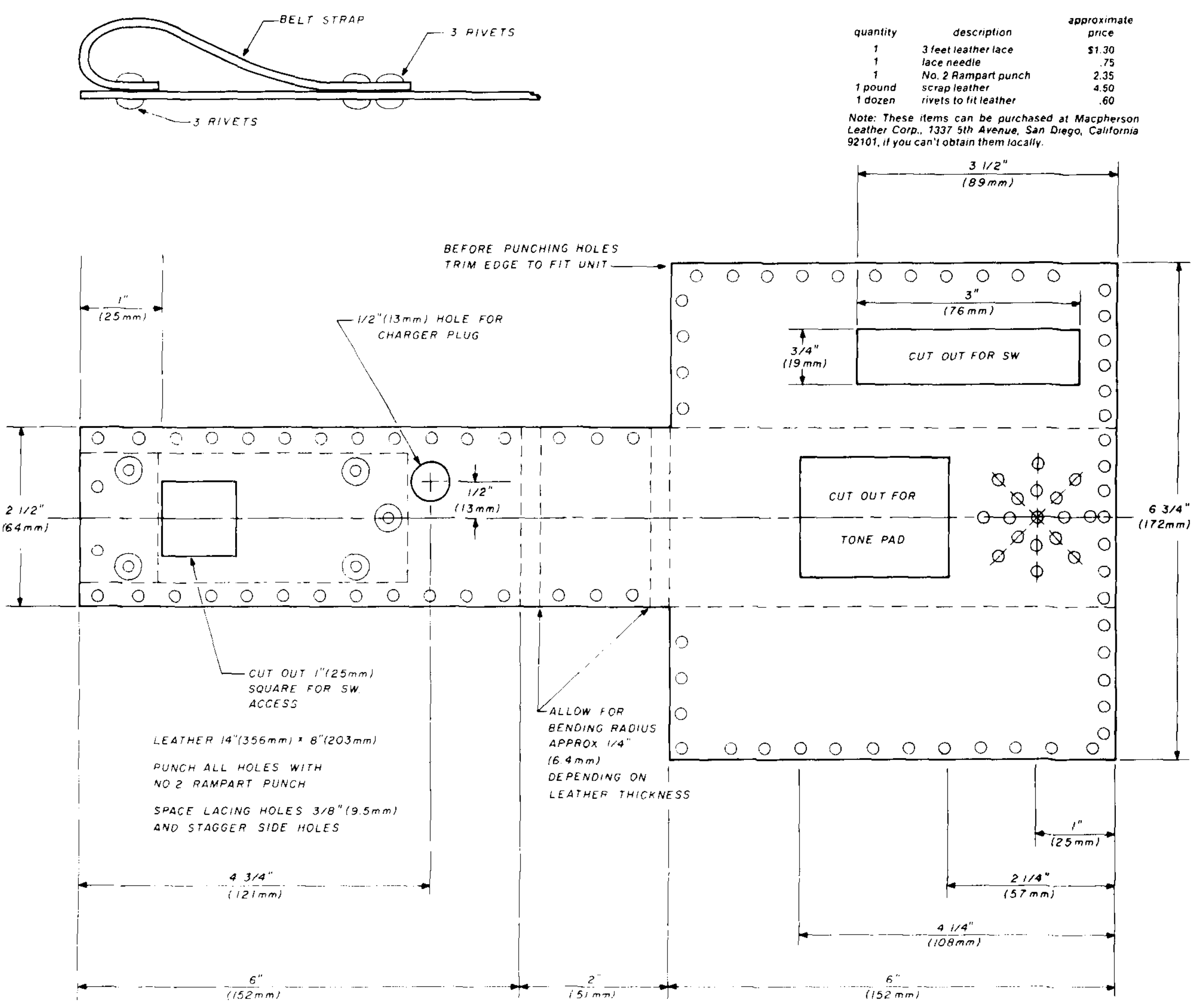
# the ham notebook

## carrying case for the IC2AT

To ease the crunch on my pocketbook after buying an ICOM 2AT, I made a leather belt carrying-case. It cost me a total of $11.45, which was a considerable saving, and I had a lot of fun making it!

If you have a leather store in your town, ask them for the scrap leather box. Go through it and find some nice black-dyed leather about one-eighth-inch thick. Draw the outline as shown, then soak the leather overnight to make it soft and workable. After cutting it out, bend the corners by placing it between two blocks of wood and tapping the edge with a rawhide mallet. Don't punch any holes until you have fitted the ICOM inside to see if all the dimensions are right. Trim off the surplus leather on the bent-up edges and punch holes with a No. 2 Rampart punch. Place the leather on the end grain of a block of wood, or it will dull the punch.

The holes should be 3/8-inch apart and staggered on the sides so the lacing will drop down each time you thread through a hole. Use leather lacing with a lace needle. Tie a figure-8 knot at the bottom of the lacing string and pull it up to the first hole. I laced mine starting at the bottom.




| quantity | description | approximate price |
|---|---|---|
| 1 | 3 feet leather lace | $1.30 |
| 1 | lace needle | .75 |
| 1 | No. 2 Rampart punch | 2.35 |
| 1 pound | scrap leather | 4.50 |
| 1 dozen | rivets to fit leather | .60 |

*Note: These items can be purchased at Macpherson Leather Corp., 1337 5th Avenue, San Diego, California 92101, if you can't obtain them locally.*

fig. 1. Pattern for belt carrying-case.

The holes for the rivets are also punched with the Rampart punch. (Be sure to buy rivets long enough to go through the leather.) I use a separate belt to carry my ICOM slipped through the belt holder. The belt strap is riveted to the case.

**Ed Marriner, W6XM**

## low-duty-cycle tune-up method for transmitters

Having found from sad experience that most final amplifier tubes experience damage and life shortening during tune-up, I decided to use my automatic electronic keyer as a duty-cycle device to cut down tube dissipation during this critical adjustment period. Put your transmitter in the CW position and set your keyer to send dots in the highest speed mode.* Because your transmitter is on only a fraction of the time, your average plate dissipation is low, and you will find it almost impossible to damage your tubes during tune-up. If you work phone often, you can leave your transmitter in the SSB condition and feed the keyer's audio side tone into your microphone input circuit. This is readily accomplished with a simple switch and a small variable potentiometer used to set your input at the desired voltage level. This method will save you the trouble of changing your transmitter mode switches from SSB to CW and back to SSB when you want to tune up. When you use this technique for phone, you avoid the necessity of yelling *AHHHHHHHHHH* into the microphone, a rather unscientific way of establishing a tune-up reference level.

If you do not have an automatic keyer, a relay connected to act as a buzzer with an RC time constant circuit can be used to provide an intermittent on-off low-duty-cycle keying signal. I prefer the automatic keyer, as the tone is a lot cleaner than when using the relay buzzer technique.

**William Vissers, K4KI**

*Use a dummy load at all times. — **Editor**

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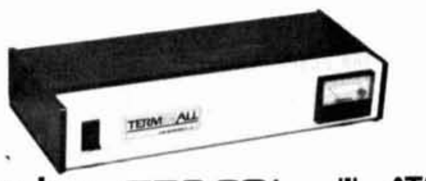

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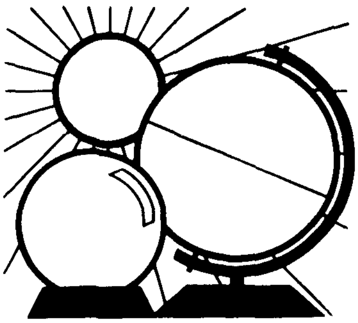

# DX FORECASTER

Garth Stonehocker, KØRYW

## last-minute forecast

DX conditions for August will depend on which of two solar longitudes is active. Recent information indicates that the lower hf bands (30-160 meters) will be best around the 9th and the higher hf bands (10-30 meters) about the 23rd. However, it's possible that just the reverse will occur. The deciding factor is the 10.7 cm radio flux readings obtained from WWV's broadcast at 18 minutes after the hour. When flux is above 120, use the higher bands. In either case, disturbed periods are expected around the 6th, 15th, and 27th of August with a three day spread on either side of each date.

The moon's perigee will occur on the 8th, with a full moon on the 23rd. The Perseids meteor shower occurs from the 10th to 14th, with its maximum on the 11th and 12th with better than fifty meteors per hour rate. This is an excellent shower.

## more on fading

Long duration (slow fade) signal level attenuation was discussed last month. We now consider shorter duration fading or QSB. Two ionospheric conditions (see last month's table, shortwave fadeout and MUF failure) are related to QSB. Listed in this month's table are fading characteristics with possible solutions for each type.

## shortwave fadeout (SWF) or ionospheric storm

SWF fading is caused by the geomagnetic field variations that modulate signal levels. The fades are deeper than those caused by solar variations and signal levels take longer to return to normal. The geomagnetic field variations are caused by an in-flux of solar wind particles during the daytime and trapped particles by night. Particles spiral down toward earth following geomagnetic field lines in the polar regions. Particle variations are transmitted to the ions and electrons in the ionosphere and consequently affect the signal level. This signal modulation occurs at its maximum penetration into the ionospheric layer during refraction providing clues of the state of the ionosphere. Higher latitude propagation paths (greater than 60 degrees — Auroral zone) suffer the most attenuation and QSB; transequatorial paths (geomagnetic equator) are next, and mid-latitudes the least during these storms. Night-time QSB is usually the worst. Auroral QSB is often fast enough to cause signal "flutter" and is associated with VHF auroral scatter propagation openings.

## MUF failure

Consider this: during an afternoon 15 meter opening from the states to South Africa, you note that there's a weak, long-duration fade on signals. After 15 minutes the QSB deepens and becomes even longer in duration. Signal peaks are louder (the result of focusing) and nulls quite a bit weaker. This is explained by the fact that the geomagnetic field separates transmitted energy into three components that travel their separate ways to the receiver. The energy components from the DXer's transmitter are beating against each other, almost like zero beating two audio frequencies, until they peak at the MUF, then both decrease in signal strength to a minimum level. This weaker signal is a result of ionospheric forward scatter and has a rough sounding note (see *QST* for January, 1982). Many times this signal is not heard since it is as much as 40 dB weaker than a normally propagated signal (near the MUF).

Another case where the signal takes multiple paths in the ionosphere is at a frequency lower than the MUF. This frequency is low enough (50 percent below the MUF) to propagate by the $F_2$, $F_1$, or E layer. A time delay of between 3 to 8 milliseconds occurs between the signals' arrival, causing RTTY pulse elongation errors in addition to its effect on DX signals. It's possible to be too close or too far from the MUF, with its resultant poor propagation conditions.

Often these modes of fading might exist simultaneously. However, when they can be heard separately, useful information is available for predicting near future DX conditions.

| type of "fade" | speed/ characteristics | best frequency to use | best time to operate |
|---|---|---|---|
| SID | slow | higher band | night/wait 2 hours |
| PCA | slow/all day | higher band | night |
| SWF | fast | lower band | day |
| MUF | slow/deep | lower band | early next day |

## AUGUST

### WESTERN USA

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GMT | 2300 | 2200 | 2100 | 2000 | 1900 | 1800 | 1700 | 1600 | 1500 | 1400 | 1300 | 1200 | 1100 | 1000 | 0900 | 0800 | 0700 | 0600 | 0500 | 0400 | 0300 | 0200 | 0100 | 0000 |
| PDT | 4:00 | 3:00 | 2:00 | 1:00 | 12:00 | 11:00 | 10:00 | 9:00 | 8:00 | 7:00 | 6:00 | 5:00 | 4:00 | 3:00 | 2:00 | 1:00 | 12:00 | 11:00 | 10:00 | 9:00 | 8:00 | 7:00 | 6:00 | 5:00 |
| ASIA FAR EAST (N) | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | — | — | — | — | — | — | — | — | — | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| EUROPE (NE) | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | — | — | — | — | — | — | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| S. AFRICA (E) | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | — | — | — | — | 20 | 20 | 20 | 20 | 40 | 40* | 30 | 30 | 30 | 30 |
| S. AMERICA (SE) | 15 | 15 | 15* | 15 | 15 | 15 | 15 | 15 | 15 | 20 | — | — | — | — | 20 | 20 | 20 | 20 | 20 | 20* | 15 | 15 | 15 | 15 |
| ANTARCTICA (S) | 15 | 15 | 20* | 20 | 20 | 20 | — | — | — | — | — | — | — | 30 | 30 | 30 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| NEW ZEALAND (SW) | 10 | 15* | 15* | 15 | 15 | 20 | 20 | — | — | — | — | — | 20 | 20 | 15 | 15 | 15* | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| OCEANIA AUSTRALIA (W) | 15 | 15 | 15 | 15 | 20 | 20 | 20 | — | — | — | — | 20 | 20 | 20 | 20 | 15 | 15 | 15 | 15 | 10 | 10 | 10 | 10 | 10 |
| JAPAN (NW) | 20 | 20 | 20 | 20 | 20 | 20 | — | — | — | — | — | — | — | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 15 | 15 | 15 |

### MID USA

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MDT | 5:00 | 4:00 | 3:00 | 2:00 | 1:00 | 12:00 | 11:00 | 10:00 | 9:00 | 8:00 | 7:00 | 6:00 | 5:00 | 4:00 | 3:00 | 2:00 | 1:00 | 12:00 | 11:00 | 10:00 | 9:00 | 8:00 | 7:00 | 6:00 |
| ASIA FAR EAST (N) | — | — | — | — | — | 20 | 20 | 20 | 20 | — | — | — | — | — | — | — | — | 20 | 20 | 20 | 20 | 20* | 20* | 20 |
| EUROPE (NE) | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | — | — | — | — | — | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| S. AFRICA (E) | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | — | — | — | 20 | 20 | 20 | 20 | 20 | 40 | 40 | 30 | 30 | 30 | 30 |
| S. AMERICA (SE) | 15 | 15 | 10 | 10 | 15 | 15 | 15 | 15 | 15 | — | — | — | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 15 | 15 | 15 | 15 |
| ANTARCTICA (S) | 20 | 20 | 20 | 20 | 20 | 20 | 20 | — | — | — | — | — | — | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 20 | 20 |
| NEW ZEALAND (SW) | 15 | 15 | 15 | 20 | 20 | 20 | 20 | 20 | — | — | — | — | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 15 | 15 | 15* | 15* | 15 |
| OCEANIA AUSTRALIA (W) | 15 | 15 | 20* | 20 | 20 | 20 | 20 | — | — | — | — | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 15 | 15 | 15 | 15 | 15 | 15 |
| JAPAN (NW) | 20 | 20 | 20 | 20 | 20 | — | — | — | — | — | — | — | — | — | — | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20* | 15 |
| CDT | 6:00 | 5:00 | 4:00 | 3:00 | 2:00 | 1:00 | 12:00 | 11:00 | 10:00 | 9:00 | 8:00 | 7:00 | 6:00 | 5:00 | 4:00 | 3:00 | 2:00 | 1:00 | 12:00 | 11:00 | 10:00 | 9:00 | 8:00 | 7:00 |

### EASTERN USA

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EDT | 7:00 | 6:00 | 5:00 | 4:00 | 3:00 | 2:00 | 1:00 | 12:00 | 11:00 | 10:00 | 9:00 | 8:00 | 7:00 | 6:00 | 5:00 | 4:00 | 3:00 | 2:00 | 1:00 | 12:00 | 11:00 | 10:00 | 9:00 | 8:00 |
| ASIA FAR EAST (N) | 20 | 20 | — | — | — | — | 20 | 20 | 20 | 20 | — | — | — | — | — | — | — | — | 20 | 20 | 20 | 20 | 20 | 20 |
| EUROPE (NE) | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 20 | 20 | — | — | — | — | — | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| S. AFRICA (E) | 20 | 20 | 20 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | — | — | — | 20 | 20 | 20 | 20 | 20 | 30 | 30 | 30 | 30 | 30 | 30 |
| CARIBBEAN S. AMERICA (SE) | 10 | 15* | 10 | 10 | 10 | 10 | 10 | 15 | 15 | 15 | 15 | — | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 15 | 15 | 15 | 15 | 15 |
| ANTARCTICA (S) | 20 | 20 | 20 | 20 | 20 | 20 | 20 | — | — | — | — | — | — | — | — | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| NEW ZEALAND (SW) | 15 | 15 | 15 | 15 | 20 | 20 | 20 | 20 | — | — | — | — | — | 20 | 20 | 20 | 20 | 20 | 20* | 15 | 15 | 15 | 15 | 15 |
| OCEANIA AUSTRALIA (W) | 15 | 15 | 15 | 15 | 20 | 20 | 20 | — | — | — | — | — | — | — | 20 | 20 | 20 | 20 | 20 | 15 | 15 | 15 | 15 | 15 |
| JAPAN (NW) | 20 | 20 | 20 | 20 | — | — | — | — | — | — | — | — | — | — | — | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |

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

## band-by-band summary

*Ten, fifteen, twenty, and thirty meters* will support DX propagation from most areas of the world during daylight and into the evening with a lengthened skip out to 2500 miles (4000 km) per hop. The amount of daylight is still near the yearly maximum, providing many hours of good DXing.

*Thirty, forty, eighty, and one-sixty meters* are the night DXer's bands. On many nights 30 to 40 meters will be the only usable band because of thunderstorm QRN, but signal strengths via Es short skip may overcome the static, when Es is available. Although Es is available in August, it should be tapering off toward next month. Try the pre-dawn hours for less QRN.

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## new solar index bulletin

A new monthly bulletin from the National Geophysical Data Center provides solar information including:

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More Details? CHECK—OFF Page 108

# antenna hinge

## A method of mounting your beam more easily with less help

**For more than thirty years** I have used a method of erecting a beam that enables me to put up the antenna either by myself or with a minimum of assistance. I use a simple hinge that permits a Yagi-type antenna to be changed from a horizontal to a vertical position with the removal of a single bolt (**fig. 1**). The hinge is made of two pieces of channel steel or aluminum, with the latter preferred since it's lighter.

The hinge should be as long as the top of the tower is wide. This ensures that when the antenna is tilted to a vertical position the bottom half of the antenna is parallel to the tower. The top half of the hinge should be at least 4 inches (102 mm) wide when you're using it with an antenna boom 2 inches (51 mm) in diameter; a larger-diameter boom requires a wider hinge. This is necessary so that the U bolts, muffler clamps, or the mounting method recommended by the beam manufacturer will give you enough clearance on the bottom of the top piece for properly tightening the nuts.

**typical hinge dimensions**

| bottom half | inches | (mm) | top half | inches | (mm) |
|---|---|---|---|---|---|
| length | 14 | (356) | length | 14 | (356) |
| width | 5 | (127) | width | 4 | (102) |
| height | 1-7/8 | (48) | height | 1-1/2 | (38) |
| thickness | 3/8 | (10) | thickness | 3/16 | (4.8) |

The bottom half of the hinge is positioned with the flat side down (channel up), and the top half, with the flat side up (channel down), is mated with the bottom half. In-line holes are drilled through both pieces approximately 3/4 inch (19 mm) from the ends. These holes should be slightly oversize to freely accept 1/2-inch bolts 6 inches (152 mm) long. This is all that is required at this time.

### hinge-to-mast mounting plate

The plate shown in **fig. 2** is cut from 3/16-inch (4.8-mm) steel that measures 17 × 14 inches (43.2 × 35.6 cm). It is almost necessary to have a machine shop fabricate it. In order to reduce weight, 4 × 12-inch (10.2 × 30.5-cm) triangles are cut from each side prior to making a 90-degree bend that provides a horizontal shelf 5 inches wide × 14 inches long (12.7 × 35.6 cm). This leaves a vertical section 14 inches wide at the top, 6 inches wide at the bottom, and 12 inches high (35.6 × 15.2 × 30.5 cm).

The bottom of the hinge can now be mounted to the 5 × 14-inch shelf using four 5/16-inch × 1-inch bolts. The holes are approximately 1-1/2 inches (3.8 cm) in from each end of the shelf and hinge.

### parts assembly

Mount a short section of the boom to the top half of the hinge. Mate the two pieces of the hinge and insert the hinge bolts. Remove one of the bolts and the position of the boom can now be changed from horizontal to vertical. Repeat the procedure by replacing the first and removing the second bolt. While this temporary section of boom is in place, two additional holes are required approximately 3 inches (7.6 cm) from each end of the hinge on both sides of the boom. Holes to accommodate 3/8-inch (9.5-mm) bolts are drilled through both pieces of the hinge and mounting shelf, clearing the boom.

After the antenna installation has been completed, the last thing to do before coming down the tower is to install the above bolts (3/8 × 2-1/2-inch) to join the hinge and mounting plate. Without the bolts, wind vibration could damage the hinge. Mark the hinge, top and bottom, so that the ends can always be correctly mated. If reversed, some of the holes might not be in alignment.

Check the antenna for balance before mounting it on the tower. If you balance it well, little effort will be

**By J.R. Yost, N4LI**, Route 3, Box 342, Mocksville, North Carolina 27028

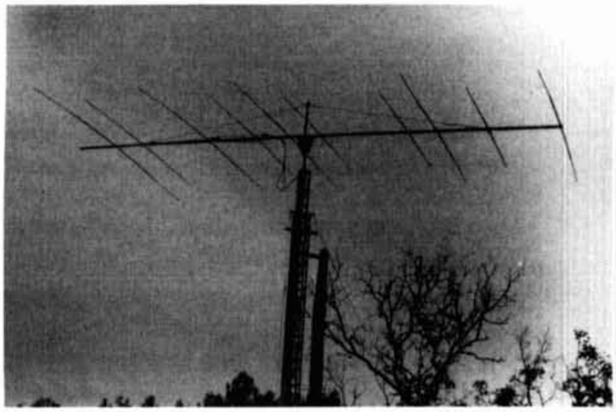

fig. 1. Beam antenna supported by the antenna hinge.

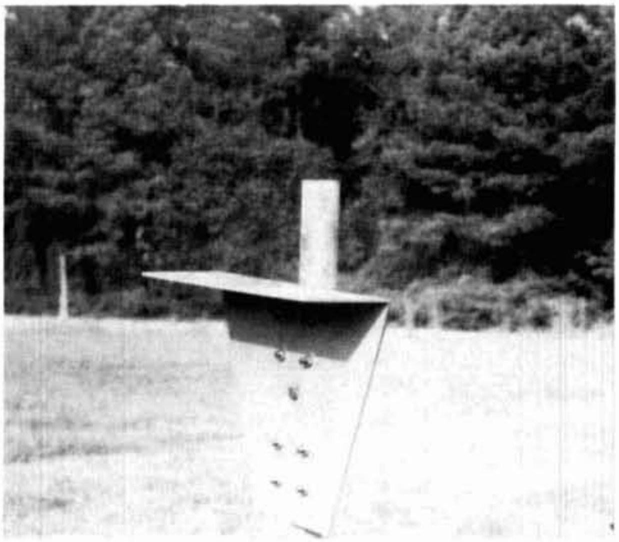

fig. 2. The hinge/mast mounting plate.

needed to change the antenna from a horizontal position to a vertical one.

## mounting the antenna

If the antenna weighs more than 50 pounds a gin pole is recommended. The antenna with all elements in place is positioned on the ground at the base of the tower with the boom at a right angle to the tower. The rope from the gin pole is tied to the boom near the end nearest to the tower. By pulling the rope you can stand the antenna on end and lean it against the tower. The rope tied to the boom can now be repositioned to a point 1 or 2 feet above the hinge. A helper on the ground can pull the antenna up the tower, assisted by one man near the top of the tower. The antenna is kept in a vertical position right up to the point where the bottom end of the hinge attached to the boom is at a right angle to the horizontal half of the hinge attached to the mast (**fig. 3**). At this point the holes in the two pieces of the hinge should be

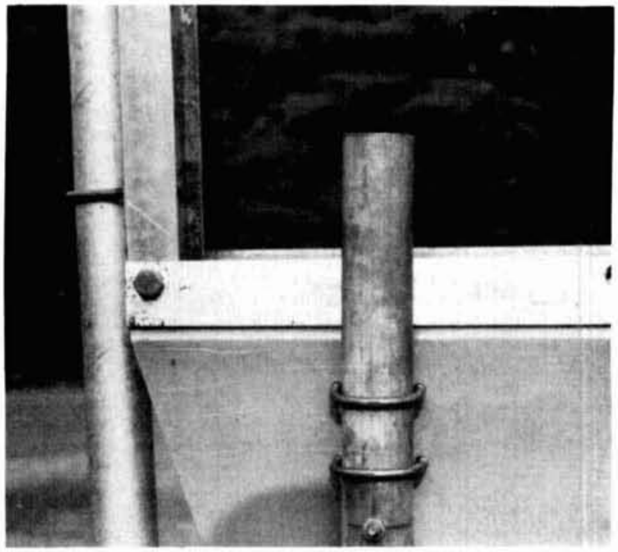

fig. 3. The hinge attached to the mast during erection of the antenna.

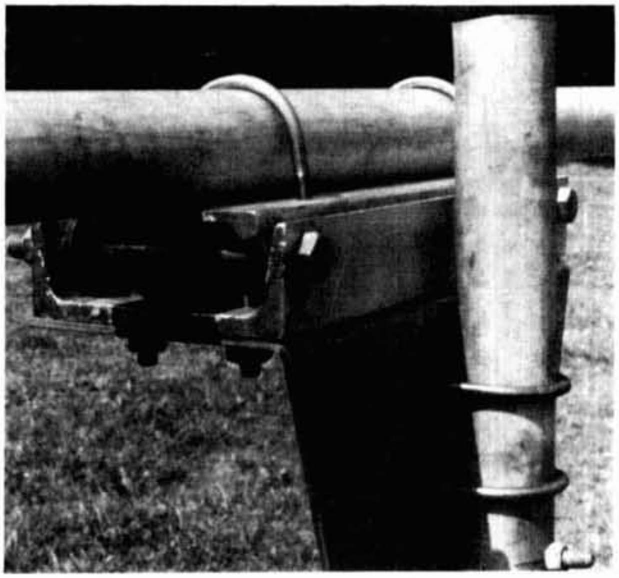

fig. 4. Bolts in place secure the hinge.

aligned and a hinge bolt inserted. With this bolt in place the antenna is secured to the antenna mast (**fig. 4**).

## final note

Carefully plan your antenna installation. Write up each step to be taken including the tools needed. Always use a safety belt when working on the tower. Make sure there is no way for the antenna to get near a power line. And always have someone standing by, clear of the tower and the antenna, in case of an emergency.

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*Welcome to the* ham radio *Technical Forum. The purpose of this 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. Do you have a question? Send it in!*

*Each month our editors will select the best answer received to a question previously posed in Technical Forum. We'll send the writer a book from our Bookstore as a way of saying thanks.*

## measuring small values

I noticed that K9EBA (*ham radio*, February, 1983) was having trouble trying to measure small values of inductance, so I've decided to add my comments.

I built my own version of the inductance meter described by Ed Marriner, W6XM, in the April, 1982 issue of *ham radio*. Since I wanted to be able to measure values of *L* over a wide range, I decided the easiest way to do so was to use different rf frequencies, separating that function from the amplifier and meter amplifier. This meant I had to come up with a gain control on the input of the amplifier that did not cause detuning of the tuned circuit in the output of amplifier. (While the circuit shown, **fig. 1**, may not please the purists, it does work. Use no more signal than is necessary, however, in the interest of avoiding harmonic generation in the tuned amplifier.)

I found that sensitivity was poor when trying to measure values of *L* below 1 μH, so I wound a small air-wound coil in series with the unknown value of *L*. This increased sensitivity by making for a more favorable L/C ratio at maximum capacity setting of CT and helped tremendously. The size is not critical as long as you can still measure the desired minimum value of *L*; in my case this was 0.039 μH, as stamped on the case.

As you can see from the enclosed calibration chart for the highest band, 15 MHz (**fig. 2**), it is possible to cover from 3.3 μH down to 0.039 μH with one frequency; lower frequencies can be used to measure larger values of *L*. 300 kHz can be used to measure as high as 10 mH, the limit for most commonly used inductors, with readily available equipment covering larger values of *L*.

Do not use the small tuning capacitors normally found in small transistor broadcast receivers at CT. The dielectric tends to wear thinner, throwing calibration off, especially at the maximum capacity setting.

If you use a low cost signal generator for furnishing the frequencies to drive the amplifier, be sure to use minimum setting of output attenuator, since harmonic content is quite high on some of the less expensive generators and can cause false readings when trying to read values of unknown inductors.

I used frequencies as follows: 15 MHz, 3.3 to 0.039 μH; 5 MHz, 33 to 3.3 μH; 1.5 MHz, 500 to 33 μH; 600 kHz, 2.5 mH to 0.5 mH; 300 kc, 10 mH to 1 mH.

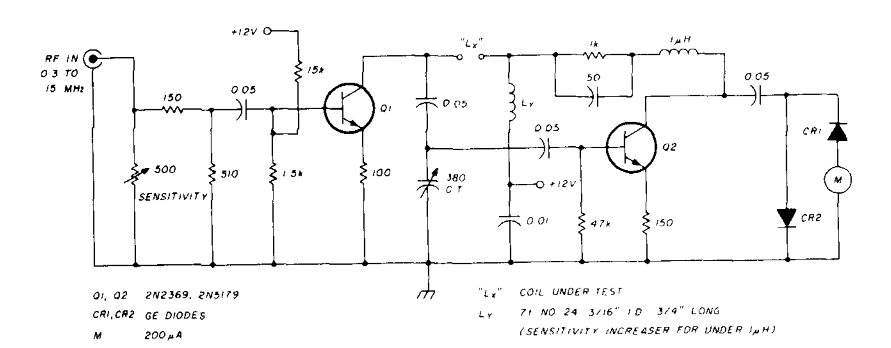


**fig. 1. Wide-range inductance meter schematic diagram.**

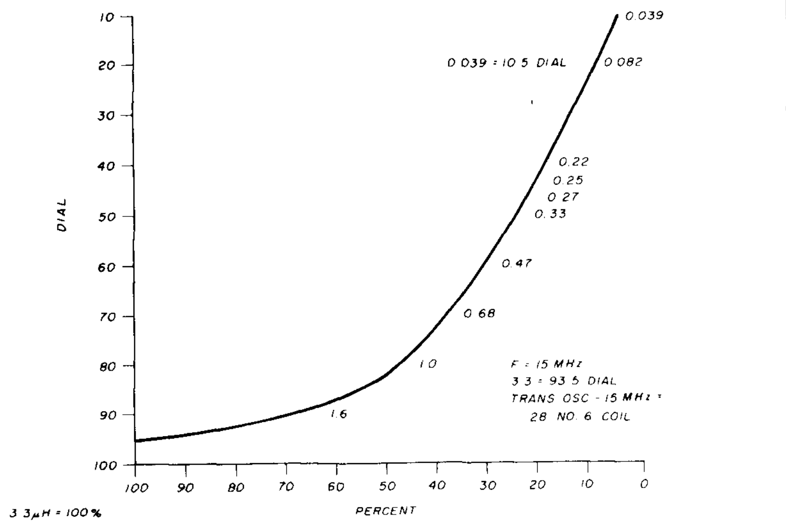


**fig. 2. 15 MHz inductance meter dial calibration.**

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In the schematic and on the calibration chart (**figs. 1** and **2**), to find unknown value of $L$, tune amplifier for maximum on the meter, with 15 MHz signal applied, then pick off the percentage reading that intersects with the dial reading. Multiply the maximum value of $L$ (3.3 $\mu$H) that equals 100 percent times the percentage thus found; i.e., 1.6 $\mu$H equals 49 percent. This is not strictly accurate, since 3.3 does not equal minimum, or zero setting of dial, but it does allow accurate matching, which is usually what is needed. One can tell which $L$ is the larger for sure, and that is a help.

On the calibration chart (**fig. 2**) the transfer oscillator 15 megacycle 28 #6 refers to the dipper coil used in the homegrown oscillator I built to use with this thing. Built in a beef stew can, it is an FET Seiler oscillator with buffer which drives the amplifier. (I also used a can to house the inductance measuring device.)

**John L. McDonald, W6SDM**

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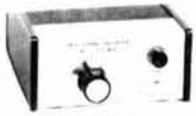

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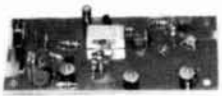

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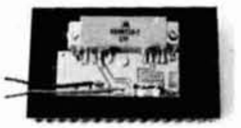

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## ACTIVITIES
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**ALABAMA:** The Central Alabama Amateur Radio Association's 6th annual Hamfest, Saturday and Sunday, August 27 and 28, at picturesque Huntington College Del Champ Student Center, Montgomery. Free admission and parking. Plenty of air-conditioned activities, flea market, DX forum, live RTTY demonstrations and more. Setup 0600, doors open 0800 to 1700 Saturday and til 1500 Sunday. Saturday night dutch treat buffet. Honored guest, G3MLO, Peter Weatherall. Talk in on 146.04/.64. For information or reservations: Hamfest Committee, 2141 Edinburgh Drive, Montgomery, AL 36116 or phone Phil at (205) 272-7980 after 1700 CDST.

**DELAWARE:** The eighth annual New Delmarva Hamfest, Sunday, August 21, Gloryland Park, 5 miles south of Wilmington. Admission $2.25 advance; $2.75 gate. Tailgating $3.50 with own table. Refreshments available. Talk in on 52 and 13/73. For imformation and map SASE to Stephen J. Momot, K3HBP, 14 Balsam Rd., Wilmington, DE 19804. Checks payable to Delmarva Hamfest.

**ILLINOIS:** The Hamfesters Radio Club is having its 49th annual Hamfest and Picnic, Sunday, August 14, Santa Fe Park, 91st and Wolf Road, Willow Springs, southwest of Chicago. Exhibits for OMs and YLs. Famous Swappers

Row. Tickets $3.00 at gate; $2.00 advance. For tickets send check or MO with SASE to Hamfesters, P.O. Box 42792, Chicago, IL 60642.

**ILLINOIS:** The Chicago Area Computer Hobbyist Exchange and Chicago Amateur Radio Club will hold a joint swapfest, August 21, 10 AM to 4 PM, Triton College, Fifth Avenue, River Grove, IL. For information call 545-3622.

**ILLINOIS:** The Shawnee Amateur Radio Association's Sarafest '83, Sunday, September 11, John A. Logan College, Highway 13 near Carterville. Displays, flea market, crafts. Doors open 7 AM, free coffee and donuts 7-8 AM. Admission $3.00 at door. Talk in on 146.25/.85; 146.52 simplex or 3.925 SARA Sunday net frequency. For information: William May, KB9QY, 800 Hilldale Avenue, Herrin, IL 62948 or any SARA member.

**INDIANA:** The Tippecanoe Amateur Radio Association's 12th annual Hamfest, Sunday, Aug 21, Tippecanoe County Fairgrounds, Teal Road and 18 Street, Lafayette. Grounds open 7 AM. Tickets $3.00. Large flea market, dealers, fun, refreshments. Talk in on 13/73 or 52. For information/tickets: Lafayette Hamfest, Route 1, Box 63, West Point, IN 47992.

**KENTUCKY:** The Bluegrass Amateur Radio Society will sponsor the Central Kentucky ARRL Hamfest, Sunday, 8 AM to 5 PM, August 14, Scott County High School, Longlick Road and US 25, Georgetown. Tech forums, awards, exhibits. Free outdoor flea market space. Tickets $3.50 advance, $4.00 at gate. For information/tickets: Edward B. Bono, WA4ONE, P.O. Box 4411, Lexington, KY 40504.

**MICHIGAN:** 7th annual Five County Swap-N-Shop, Sunday, August 28, Bentley High School, 1150 Belsay Road, Flint. 8 AM to 3 PM. Sponsored by the Genesee County RC, Bay Area ARC, Lapeer County ARRC, Saginaw Valley ARA, Shiawassee ARA. Refreshments, computer forum, trunk sales, free parking. Tickets $2.00 advance; $3.00 at door. Children under 12 free. For table reservations: Bill Cromwell, KU8H, 1204 Overland Drive, Lennon, MI 48449. (517) 288-5046.

**MISSOURI:** The St. Charles Amateur Radio Club's 8th annual Hamfest, August 28, Wentzville Community Club. Large open air flea market; indoor air-conditioned exhibits. Contests, food and fun. Parking $1 per car. Admission: $1 each, 4/$3 advance. At door $1.50 each, 4/$5. For tickets/information: SCARC Hamfest '83, PO Box 1429, St. Charles, MO 63301.

**MISSOURI:** The 2nd annual Ozarks ARC Congress and Swapfest, Sunday, September 11, Monett City Park, U. S. Hwy 60 and MO Hwy 37, Monett. Free admission. No charge for swappers or tailgaters. Covered dish picnic. Talk in on 146.37/.97, 146.52 and 7.250. For information: OARS, Box 327, Aurora, MO 65605.

**NEW JERSEY:** The fifth annual Gloucester County ARC Ham/Comp Fest, Sunday, August 28, Gloucester County College, Tanyard Road, Sewell, 8 AM to 3 PM. Setup 7 AM. Seminars, contests FCC exams. Tickets $2.00 advance; $2.50 door. Tailgaters and dealers $3.00 per parking space. Talk in on 146.52, 147.78/18 and 223.96/224.36. For information: GCARC Hamfest Committee, PO Box 370, Pitman, NJ 08071. (609) 456-0500 or 338-4841 days. (609) 629-2064 evenings.

**NEW JERSEY:** The Ramapo Mountain ARC's 7th annual flea market, August 20, Oakland American Legion Hall, 65 Oak Street, Oakland, 20 miles from GW bridge. Admission $1.00, non-ham family members free. Indoor tables $6.50; tailgating $3.00. For information: Tom Risseeuw, N2AAZ, 63 Page Dr., Oakland, NJ 07436. (201) 337-8389 after 6 PM.

**NEW YORK:** The annual Finger Lakes Hamfest, August 27, Trumansburg Fairgrounds, Rt 96, 12 miles NW of Ithaca. 8 AM to 5 PM. Admission $2.00 at gate. Flea market commercial exhibitors, boat anchor auction, refreshments and craft show. Talk in on 37/97 and 52. For information: Dave, W2CFP, 866 Ridge Road, Lansing, NY 14882.

**NEVADA:** Pacific Division ARRL Convention hosted by the Wide Area Data Group, August 19-21, at the MGM Grand Hotel, Reno. Tickets (for convention only) $7.50 advance; $10.00 at the door. With banquet and after-dinner sessions $35.00 advance; $37.50 at the door. Roy Neal K6DUE is guest speaker at the banquet along with Dave Sumner, ARRL General Manager and Vic Clark, ARRL President. Besides convention forums, swapmeet and exhibits, there'll be plenty of opportunity for sightseeing in this beautiful area. Take a cruise on Lake Tahoe, visit Harrah's Automobile Museum and, of course, there's Reno itself — "The Biggest Little City in the World".



**OHIO:** The 41st Findlay Radio Club's Hamfest, Sunday, September 11, Hancock Recreational Center, 3430 North Main St., Findlay. 6:30 AM to 5 PM. Admission $3.00 advance; $4.00 door. Arena tables $6.00 each. Outdoor flea market space $6.00. Talk in on 147.150/.75. For information: Dave Fleming, N8EOZ, PO Box 519, Findlay, OH 45840.

**PENNSYLVANIA:** The 46th annual South Hills Brasspounders and Modulators Hamfest, August 7 from 9 AM to 4 PM, South Campus of the Community College of Allegheny County, Pittsburgh. Tickets $3.00 each or 2/$5. Computers, OSCAR, ATV demos. Flea market. Talk in on 146.13/73 and 146.52 simplex. For information: Andrew Pato, 1433 Schauffler Drive, W. Homestead, PA 15120.

**PENNSYLVANIA:** The Central Pennsylvania Repeater Association's 10th annual Hamfest/Computerfest, August 28, adjacent to Hersheypark, Chocolate Town, USA. Registration $3.00. Wives and children free. Special reduced admission to Hersheypark for registrants' families. Indoor dealer and flea market, outdoor tailgating. 10 ft. indoor space $8.00 each; 8 ft. tables $4.00 each; single electric plug $1.00 each. Talk in on 145.47, 146.76 and 146.52. For information/registration: Timothy R. Fanus, WB3DNA, Hamfest Reservations, 6140 Chambers Hill Road, Harrisburg, PA 17111. (717) 564-0897 noon to 8 PM.

**PENNSLYVANIA:** The Tioga County ARC's 7th annual Hamfest, Saturday, August 20, 0800 to 1600, Island Park, Blossburg. Flea market, food and more. Talk in on 146.19/.79 and 146.52. For information: Tioga County ARC, PO Box 56, Mansfield, PA 16933 or John T. Winkler, WB3GPY, RD #2, Box 269, Wellsboro, PA 16901 on .19/.79.

**PENSYLVANIA:** The Mid-Atlantic Amateur Radio Club's annual Hamfest, Sunday, August 14, 9 AM to 4 PM rain or shine, Route 309 Drive-In Theater, Montgomeryville. Admission: $2.50 plus $1.00 for each tailgate space. Tailgate setup 8 AM. Plenty of parking, refreshments and more. Talk in on WB3JOE/R, 147.66/06 or 146.52 simplex. For information: write the Club, PO Box 352, Villanova, PA 19085.

**TENNESSEE:** The Lebanon Hamfest sponsored by the Short Mountain Repeater Club, Sunday, August 28, Cedars of Lebanon State Park, US 231, Lebanon. Outdoors only. Exhibitors bring own tables. Refreshments available. Talk in on 146.31/146.91. For information: Morris Duke, W4WXQ, 210 Disspayne Drive, Donelson, TN 37214.

**VIRGINIA/WEST VIRGINIA:** The Bluefield Hamfest sponsored by the East River Amateur Radio Club, Sunday, August 28, Brush Fork Armory-Civic Center, 9 AM to 3 PM. Admission $3.00. Large indoor flea market, dealers, computers, satellite TV and more. Paved parking, refreshments. Talk in on 144.89/145.49 and 146.52 simplex. For information: Don Williams, WA4K, 412 Ridgeway Drive, Bluefield, VA 24605.

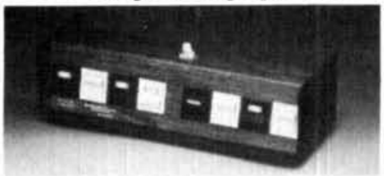
**VERMONT:** BARC International Hamfest, August 13 and 14.

**WASHINGTON:** The annual Hamfair of the Radio Club of Tacoma, Saturday and Sunday, August 13 and 14, Olson Auditorium, Pacific Lutheran University. Seminars, flea market, exhibits, contests, dinner and loggers breakfast. Tickets $5. Contact Grace Teitzel, AD7S, 701 So. 120th, Tacoma, WA 98444. (206) 564-8347.

**RADIO EXPO:** Sponsored by the Chicago FM Club, Saturday and Sunday, September 24 and 25, Lake County Fairgrounds, Routes 120 and 45, Grayslake, Illinois. Flea market opens 6 AM. Exhibits open 9 AM. Indoor flea market tables available at $5.00 per day. Tickets $3.00 advance, $4.00 at gate, good for both days. Seminars, tech talks, ladies' programs. Talk in on 146.16/76, 146.52 and 222.5/224.10. For information: SASE to Radio Expo 83, Box 1532, Evanston, IL 60204 or (312) 582-6923.

**ALABAMA:** Hospitality Hamfest, sponsored by the Mobile Amateur Radio Club, September 10 and 11, Al's Party Palace, 2671 Dauphin Island Parkway (1 mile off I-10). Doors open 9 AM. Admission free. Exhibits, swap tables, YL activities. Talk in on 146.22/82. For information: Jim Wilder, N4GUC, 424 Cody Road South, Mobile, AL 36609. (205) 343-7365.
















# OPERATING EVENTS

## "Things to do..."

**AUGUST 10-13:** The Cuyahoga Falls Amateur Radio Club will operate W8VPV/8 from the All-American Soap Box Derby, Akron, Ohio. 2300 to 0200Z, August 10-12 and 1500 to 2200Z, August 13. Frequencies: 3945, 7265, 14.240, 21.365 and 28.595 ± QRM. Novices and Technicians look 10 kHz up from lower band edge on the hour. For certificate send 2 units of postage to: Cuyahoga Falls ARC, PO Box 6, Cuyahoga Falls, OH 44222.

**AUGUST 13:** The Marin Amateur Radio Club will operate W6SG to commemorate the 50th anniversary of its founding. Operation will begin 1700 UTC and continue for the day. Bands, modes and frequencies: 20M CW, 14.065; 20M phone, 14.265; 15M CW, 21.065; 15M phone 21.365; 40M CW, 7.065; 40M phone 7.265.

**AUGUST 13:** The Tri-County Wireless Group will operate N8COY from the famous Grand Hotel's "Longest Porch in the World" on Mackinac Island, Michigan. Operation 1500-2300Z. SSB 7.280, 14.280, 21.380, 28.580 and FM 147.480. For a special QSL send QSL and regular SASE to N8COY.

**AUGUST 13 AND 14:** The Bergen Amateur Radio Association will operate K2TM from 1500 to 2400Z to mark BARA's 20th anniversary. Frequencies: 7.235, 14.275, 21.380, 28.610, 146.520. For a certificate send large SASE and QSL to K2UFM, Warren P. Hager, 31 Forest Drive, Hillsdale, NJ 07642.

**AUGUST 20 AND 21:** New Mexico QSO Party sponsored by the Albuquerque DX Association, 1800Z Saturday to 2100Z Sunday. Suggested frequencies: Phone 1.835, 3.985, 7.230, 14.280, 21.370, 28.570, 147.510. CW 1.805, 60 kHz from low end. Novice 25 kHz from low end. Work stations once per band/mode. Repeat QSO's allowed if NM station changes counties. Exchange: NM stations send signal report and county. Others send signal report and state, Canadian province or DXCC country. Scoring: Two points for each phone QSO, three for each CW QSO. NM times total of NM counties, states, provinces, countries worked. Others times total of NM counties worked. Single and multi-operator. Awards: Plaque to highest scoring NM station and non-NM station in each category. Mail entries by October 1 (include large SASE) to N5HH, Ed Graham, 12449, Regent NE, Albuquerque, NM 87112.

**AUGUST 27 AND 28:** The Rochester Amateur Radio Association (RARA) will operate an Amateur Radio station at Camp Good Days and Special Times, Camp Onanda, Canandaigua Lake, New York. This is a special camp for children who have cancer. Frequencies and bands: 80 meters, phone, 3900 and 3925 MHz, CW 3525 to 3550 MHz. 40 meters, phone, 7230 and 7250; CW 7025 and 7050 MHz. 15 meters, phone 21350 and 21375 MHz; CW 21025 and 21075. Also 2 meters FM locally. RARA members will use club call sign K2JD. SASE for a special certificate.

**SEPTEMBER 10:** The West Alabama Amateur Radio Society (WAARS) will operate special event station W4WYP in commemoration of the birthdate of college football's winningest coach, Paul "Bear" Bryant. 1300 to 2400Z. Frequencies: bottom 25 KC on General 40-15 meter phone band. Novices bottom 25 KC of Novice band. For a handsome commemorative certificate send $1 and large SASE to West Alabama ARS, PO Box 1741, Tuscaloosa, AL 35403.

**SEPTEMBER 10 AND 11:** Cray Valley Radio Society's 13th SWL Contest, 1800 GMT to 1800 GMT. Up to 18 hours logging allowed. Rest period must be shown. Multi-operators may log continuously. Contest open to anyone. Two sections and two categories. Phone and CW. Single/multi-operator. Bands: 1.8, 3.5, 7, 14, 21 and 28 MHz. Scoring: one point for each station heard times number of different countries heard on each band. A list of countries must be furnished and a separate log for each band. Call areas of the U. S. A., Canada and Australia will each count as a separate country. No CQ or QRZ calls allowed. Log sheets are available for large SASE from Owen Cross, G4DFI, 28 Garden Ave, Bexleyheath, Kent DA7 4LF. Entries to contest manager, G4DFI at above address NLT October 31, 1983. Certificates awarded at the discretion of the Cray Valley RS.

**SEPTEMBER 10 AND 11:** The Starved Rock Radio Club will operate club station W9MKS from their clubhouse in Oglesby, LaSalle County, Illinois. Operation will be on all Amateur bands. A special QSL is being designed for this occasion in celebration of 50 years of Amateur Radio in Central Illinois.

**SEPTEMBER 13-17:** The Southern Counties Amateur Radio Association (S.C.A.R.A.) is planning to have a special events station during the Miss America Pageant. Check September Ham Radio for details.

product

# REVIEW

## Alden's weather chart recorder kit

The weather — it's the one thing that affects us all equally. On a tranquil summer afternoon you can watch the sun heat the atmosphere and turn cottony white cumulus clouds into brutal cumulonimbus thunderstorms. Just a few months later comes the chill of winter. Whatever the conditions, there's little you can do except be aware and try to prepare for what comes next.

If you're like me, the evening weather report is probably the most important part of the day's news. But however encouraging or discouraging the prognosis is, there's always a lingering doubt about its accuracy.

There *are* other ways to forecast the weather in your immediate vicinity than watching the evening news or checking the color of the sunset.

Alden Electronics, one of the largest suppliers of radiofacsimile recorders, contacted us recently and asked if we would be interested in building and using one of their new Model 9321 Weather Chart Recorder kits. Because I've been interested in weather science since high school, I said I'd be happy to.

Alden sent a number of brochures describing their commercial product line. From what I saw and read, their capabilities seem to cover just about every aspect of the weather chart recorder field, from high frequency and telephone to direct-from-satellite reception.

A brief explanation may help clarify how and why radiofacsimile charts are important. Ships at sea can't tune in Willard Scott from the Today Show for the morning forecast. They depend solely upon broadcasts from fifty government-sponsored stations in more than twenty-five countries for status charts, forecast charts, satellite pictures, and ice flow charts, to name just a few sources of weather information. (Other sources include surface weather charts, surface wind analysis and prognosis, wave analysis, oceanographic charts, sea ice charts, and significant weather depiction charts.) Sometimes life-or-death decisions are based upon the information provided from these sources; for example, with up-to-date weather information, a ship at sea can steer safely away from a hurricane's path.

### the basics

The Alden 9321 is designed using commercially tested and proven circuitry. Relatively speaking it is mechanically very simple and has all the latest in state-of-the-art electronics. It is packaged in a rugged plastic case designed to withstand the rigors of a hostile environment. And, unlike other facsimile equipment I've used, the Alden unit is relatively quiet and free from smoke odor and fumes. (I remember reading about a facsimile recorder that required an extensive venting system to remove the foul odors that accompanied its operation.) Light and compact, it requires only a stable, general-coverage SSB receiver to be put on line.

The 9321 uses two motors to provide stylus scanning and paper feed. The first motor is a tachometer-controlled dc motor that sweeps the stylus across the paper while the second motor slowly plays the paper out of the easy-to-change paper cassette. The stylus scans across the paper; when an image is transmitted, a slight electrical current flows through the paper and causes the image to appear. The reason the Alden unit does not produce unpleasant odors is that its specially-designed moistened paper does not burn, but instead uses electron deposition to produce the image.

### the kit

As I unpacked the kit, I discovered that the shipping box is divided into twelve clearly marked compartments numbered to correspond to the twelve-step, easy-to-follow, illustrated instruction manual. Parts for each subassembly are clearly inventoried and identified to make the construction process as simple as possible. To ensure that the parts are not damaged in transit, they are carefully stored in plastic bags and wrapped in protective foam.

Assembly is basically mechanical, not electronic. Each step is carefully detailed, diagrammed, and explained in the forty-two page instruction manual. All of the electronics for the Model 9321 kit are factory assembled and tested, thereby taking advantage of the similarity to Alden's line of commercial facsimile recorders. Assembly involves nothing more than selection of parts, installation, and in some cases, physical alignment. All interconnections are either through ribbon connectors or sturdy nylon shell pin connectors. The only electrical work is the installation of the LEDs and switches in the control panel assembly.

Some kit builders may be disappointed that the electronics are preassembled and tested. But my feeling is that kit builders benefit from Alden's experience . . . and for most of us, anyway, the real reward comes when the unit is turned on and the first charts start to come off the recorder.

It took ten hours to put this kit together — not in one sitting, but rather during evenings within a one week span. Before turning the recorder on I ran a few tests to ensure that assembly had been done according to the manual. (Testing procedures are fully described with step-by-step instructions to make the process as simple as possible.)

Alden went to the trouble to include two very important and helpful booklets as part of their instruction manual. *The Worldwide Marine Radio Facsimile Broadcast Schedule* is a complete compilation of stations from around the world, and includes frequencies, transmission times, and schedules. Here on the east coast, the strongest U.S. station is the Navel Eastern Oceanography Center (NAM) in Norfolk, Virginia. NAM transmits weather data that covers the area east of the Mississippi River including the Gulf of Mexico, the Caribbean, and the northern half of the Atlantic Ocean. In addition to various status maps, they also transmit detailed computer-enhanced photos taken from the GOES geostationary satellites. These photos are taken using either infrared or visible light so they can be of use day or night.

Alden has also included a reprint of the Naval Eastern Oceanography Center's *Facsimile Product Guide*. The facsimile service from Norfolk can be broken down into four separate categories: atmospheric analysis, atmospheric prognosis, oceanographic analysis, and oceanographic prognosis. Each service is fully explained with a number of illustrations and examples included to assist in interpretation of information received.

As I mentioned earlier, there are over fifty stations transmitting up-to-date weather information from twenty-five different countries. Most of these stations transmit at 120 scans per minute at an Index of Cooperation of 576.

(The Index of Cooperation is an internationally agreed upon standard for expressing compatibility between transmitting and receiving equipment.) A few charts are transmitted at 288 IOC, but most are transmitted at 576; consequently, you'll be able to get good quality pictures from the Alden 9321 for the majority of facsimile frequencies. (The 288 IOC charts will be compressed when received on a 576 IOC recorder, but are still usable.)

### tuning

Facsimile broadcasts are normally transmitted on upper sideband. After you connect the unit to 120 volts ac and the audio output from the receiver, tune the receiver approximately 1900 Hz lower than the facsimile station's frequency to correctly position the facsimile sensing circuitry. For example: to correctly tune NAM on 3357, tune the receiver down to 3355.1 kHz. When you are correctly tuned, the two LEDs will be flashing. The green LED corresponds to white and is usually the one that will be lighted the most. The red LED lights only when a black image is transmitted.

At any given moment of the day, somebody, somewhere, is transmitting weather information. So it's likely that whenever you turn your unit on, you'll be receiving a chart — but perhaps not properly framed. If you turn your unit on and find that you've missed the framing signal, all you have to do is push the framing button and keep it depressed long enough to center the chart correctly.

The unit also incorporates an auto-start and auto-stop feature so there's no need to be present during the transmission of charts. Each broadcasting station transmits a signal shifting between 1500 and 2300 Hz at a 300 Hz rate for three to five seconds before beginning transmission of a chart. This tone triggers the auto-start. The framing signal at the beginning of each chart is a 1500 Hz tone for approximately 40 scan lines interrupted once each scan line by a 2300 Hz pulse. The auto-stop signal at the end of each chart is a signal shifting between 1500 and 2300 Hz at a 450 Hz rate for three to five seconds.

The first two charts I received were an atmospheric analysis chart and a GOES satellite picture. These gave clear details of an approaching storm, including its precipitation and cloud cover. They confirmed the weekend forecast, which was bad. I was fascinated by the upper air or steering current charts which came later on.

As I mentioned before, it's fun to try to second-guess the local weatherman. As it turned out, he was right. But I'm looking forward to being able to watch the weather as it develops and make my own forecasts.

Facsimile hasn't yet caught on as a popular mode of Amateur communication. Facsimile devotees are much like the RTTY and SSTV gang — they're relatively few in number, but very interested and quite active. The new Alden 9321 will go a long way toward popularizing facsimile in the Amateur ranks. I'm sure it will be only a matter of time before enterprising and knowledgeable tinkerers will be hard at work modifying this equipment to make it do more than even Alden could have imagined.

I've done a lot in Amateur Radio over the past sixteen years from 160 meter DXing to 2-meter fm. I can truthfully say that I've really enjoyed using the Alden 9321 Recorder. I'm sure you will, too.

For more information, contact Alden Electronics, Washington Street, Westborough, Massachusetts 01581. RS#301

N1ACH


## connector connection

Nemal Electronics, Miami, Florida, has been appointed a master distributor of Kings' coaxial and special connectors, including a unique line of Teflon™ insulated UHF, N and BNC connectors. Kings' Teflon™ connectors are rated from −60 to +165 degrees C at 1000 volts RMS.

The top-of-the-line PL259 is made using a special TR-4™ metal alloy that resists tarnish and enhances solderability. Retail price of the TR-4™ PL259 is $1.59. Other high quality but less expensive connectors are also available.

For more information or a catalog, contact Nemal Electronics, 1325 N.E. 119th Street, North Miami, Florida 33161. RS#302

## hf transceiver

ICOM has announced what it calls the most advanced, highest performing hf transceiver with general coverage receiver available to Amateurs today. The IC-751 features ICOM's new CPU, with internal battery memory back-up, provides many advanced features, such as 32 memories with memory storage of mode and frequency, and the scanning capability to cover large segments of the spectrum very slowly, or to scan the memories by selected

mode. The IC-751 provides instantaneous, silent, band selection and has a unique 3-speed tuning system. Other features included in the IC-751 are full break-in keying, passband tuning, notch filter, RIT and XIT with separate readout, fm built-in as standard, a very steep-sided FL44 sideband filter, continuously adjustable noise blanker levels, dual VFO operation, and all mode squelch. An easy-to-read two color fluorescent readout showing the frequency in white and the control functions in red, for low eye fatigue and high visibility in all ambient light conditions is standard. The IC-751 is equipped standard for operation from 12 volts dc, and there is an optional internal ac power supply. The IC-751 has an advanced receiver design that provides true competition-grade performance.

For further information, contact ICOM, 2112 116th Avenue, N.E., Bellevue, Washington 98004. RS#303

## improved antenna

Bilal's new Isotron 20 is easier to tune, more versatile in mounting, and covers a greater frequency range than previous models. The new model is omnidirectional and will handle the full legal limit of power. It's adjustable for resonance, weighs approximately two pounds, and measures only 21 inches in length.

The Isotron 20 requires a single coaxial feedline; no tuners or radials are necessary. Its small size makes the Isotron 20 ideal for travel or for use in limited space. The price is $49.95 plus $3.50 for shipping via UPS.

For further information, contact the Bilal Company, Star Route 2, Eucha, Oklahoma 74342. RS#304

## vhf converter

Trio-Kenwood has recently announced the release of an optional accessory VHF converter — the VC-10 — to accompany its highly sophisticated R-2000 communications receiver introduced last December. The VC-10 allows the R-2000 to receive signals in the 118-174 MHz range; through the use of microprocessor technology, frequencies in this range may be tuned, displayed, stored in memory, recalled, and scanned, using the R-2000 front panel controls and frequency display.

The R-10 installs easily on the rear panel of the R-2000.

Additional information is available from Trio-Kenwood Communications, 1111 West Walnut Street, Compton, California 90220. RS#305

# RECEIVE WEATHER CHARTS IN YOUR HOME!

## You can DX and receive weather charts from around the world.

Tune in on free, worldwide government weather services. Some transmitting sites even send weather satellite cloud cover pictures!

## You've heard those curious facsimile sounds while tuning through the bands — now capture these signals on paper!

Assemble ALDEN's new radiofacsimile Weather Chart Recorder Kit, hook it up to a stable HF general-coverage receiver, and you're on your way to enjoying a new hobby activity with many practical applications. Amateurs, pilots, and educators can now receive the same graphic printouts of high-quality, detailed weather charts and oceanographic data used by commercial and government personnel.

## Easy to assemble — Backed by the ALDEN name.

For over 40 years, ALDEN has led the way in the design and manufacture of the finest weather facsimile recording systems delivered to customers worldwide. This recorder kit includes pre-assembled and tested circuit boards and mechanical assemblies. All fit together in a durable, attractive case that adds the finishing professional touch.

## Buy in kit form and save $1,000!

You do the final assembly. You save $1,000. Complete, easy-to-follow illustrated instructions for assembly, checkout, and operation. And ALDEN backs these kits with a one-year limited warranty on all parts.

## Easy to order.

Only $995 for the complete ALDEN Weather Chart Recorder Kit.

To order, fill out and mail the coupon below. For cash orders enclose a check or money order for $995. Add $5 for shipping and handling in the U.S. and Canada, plus applicable sales tax for CA, CO, CT, IA, MA, NY, WI. (Export price is $1250 F.O.B. Westborough, MA. Specify 50 or 60 Hz.) To use your MasterCard or Visa by phone, call (617) 366-8851.

**ALDEN**ELECTRONICS

Washington Street, Westborough, MA 01581

NAME: ____________

CALLSIGN: ____________

ADDRESS: ____________

CITY: ____________ STATE: ______ ZIP: ______

☐ I've enclosed a check or money order for $995.00 and $5.00 for shipping and handling, plus applicable sales tax.

☐ Charge to: ☐ MasterCard ☐ Visa

ACCOUNT # (ALL DIGITS)

EXPIRATION DATE

SIGNATURE REQUIRED IF USING CREDIT CARD ____________

✓ 104

# NEW products

## microcircuit soldering kit

A kit including soldering iron, tips, and holder for precision microelectronic soldering is now available from the Ungar Division of Eldon Industries, Inc.

The Ungar 9375 Micro-soldering kit includes a three-wire handle, slimmer than those on earlier models, to facilitate close-tolerance soldering. A "Thermo-duric" heating element allows the heating elements to reach working temperature faster, recover more quickly, and use less energy, and last longer than other types of heating elements. Electric leakage, which could ruin microcircuits, is also said to be eliminated.


Three precision tips of differing configurations (needle-point, spade point, and screwdriver) are also included with the kit. Nine additional tips are available.

The handle, heater, and tip are all modular, permitting quick replacement or change. The price is $51.75.

Further information is available from the Ungar Division of Eldon Industries, Inc., 100 West Manville, Compton, California 90220. RS#306

## new from HAL

The HAL CT2200 is the successor to the popular CT2100 Communications Terminal. It offers all the features of the CT2100 plus keyboard programming of all eight "brag-tape" messages, programmable selective call control of the printer output, manual printer on-off control, non-volatile storage of HERE IS, "brag-tape" capability, selective call codes, and new rear panel connections for use with the ARQ1000. While the CT2200 is a new product that replaces the CT2100, a kit (including a new front panel) is available to enable CT2100 owners to update their units to CT2200 capability.


The CWR6750 is a receive-only RTTY and CW demodulator and display generator. The CWR6750 features a built-in 5 inch video display. Operating from +12 Vdc, this compact, portable unit is recommended for RTTY and CW short-wave listening.

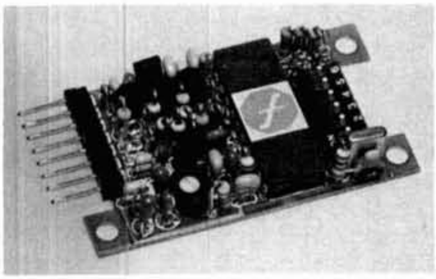
For further details, contact HAL Communications Corp., P.O. Box 365, Urbana, Illinois 61801. RS#307

## programmable CTCSS encoder/decoder

Ferritronics has announced the availability of the new P505A CTCSS Encoder/Decoder.

The unit features quartz-accurate frequency synthesis and DIPSWITCH programming to all 37 EIA sub-audible tone assignments.

A choice of plug on or soldered on lead set is offered to suit various mobile and portable applications of the unit, which measures 2.1 × 1.2 × 0.4 inches.



For further details, contact Ferritronics, Inc., 1319 Pine Avenue, Niagara Falls, New York 14301. RS#309

NEW products

## AMT-1 terminal unit

The AMT-1 terminal unit contains everything that is needed to convert an Amateur Radio station and personal computer (or ASCII terminal) into a fully operational data communications system. It combines modern circuitry (AFSK modulator/demodulator) with a microprocessor which handles AMTOR data transmission and also translates between AMTOR code and 8 unit, ASCII code.

An ASCII, RS232 interface has been chosen for the AMT-1 because of the extra CONTROL and ESCAPE code flexibility which this allows. Additionally, home computers and data terminals with ASCII interfaces are now available at reasonable prices.

In addition to AMTOR capability, the AMT-1 also transmits and receives standard RTTY and transmits CW (morse code). A fourth "Transparent" or "Direct" mode is available, which


connects the terminal directly to the modem. Using an ASCII terminal, it allows the AMT-1 to transmit and receive ASCII at any suitable Baud rate.

The modem incorporates an active 4-pole receive bandpass filter, feeding into an audio discriminator. It has a performance much higher than that normally offered by Amateur RTTY terminal units. Transmit tones are crystal controlled. Frequency shift is 170 Hz, using the U.S. recommended tone pairs:

2125 Hz (MARK) 2295 Hz (SPACE)

Full status indication is available via LED indicators on the front panel and in addition, a 16 LED tuning indicator has been incorporated. In AMTOR Mode, this acts as a gated frequency analyzer and makes tuning extremely simple.

No switches appear on the front panel of the terminal unit. All control is via ESC and CONTROL functions sent from the terminal or computer.

For complete information, contact Advanced Electronic Applications, Inc., P.O. Box C-2160, Lynnwood, Washington 98036. RS#308

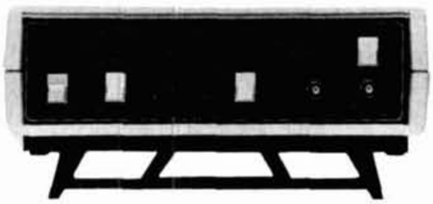
NEW products

## frequency counter

Global Specialties' new 1 GHz frequency counter, Model 6002, delivers accurate frequency measurement from 5 Hz to 1 GHz and also measures period from 100 ns to 200 ms. With three selectable resolutions (cycles averaged in the period mode), LED indicators, and simple push-button control, this unit offers uncomplicated operation as well as versatility. A 10 MHz crystal oven oscillator time-base assures ±0.5 ppm (10-40 degrees C), ±1 ppm/year stability.

Two front panel mounted, ac-coupled BNC input connectors provide flexibility in use. The *A* input accepts signals from 5 Hz to 100 MHz with an input impedance of 1 megohm at 20 pF and resolutions of 10 Hz, 1.0 Hz and 0.1 Hz. A switchable lowpass filter provides a 6 dB/octave roll-off at 60 kHz to facilitate audio and ultrasonic measurements. A ×100 multiplication mode is available to speed up measurement and display of frequencies in the 5 Hz to 10 kHz range. The *B* input accepts signals from 80 MHz to 1 GHz with an input impedance of 50 ohms at 10 pF with resolutions of 1 kHz, 100 Hz, and 10 Hz.

The front panel of the 6002 allows ready access to controls. Push-button controls include: Standby/On; Mode; Resolution; A/B input; and Lowpass Filter. The 8-1/2-digit display features leading zero blanking, bright 0.43-inch characters, and a contrast enhancement filter to ensure legibility in ambient light. LED indicators for "Gate Open," "Oven Ready," and "Overflow" provide additional user convenience, and a flip-up leg gives added flexibility for benchtop use.



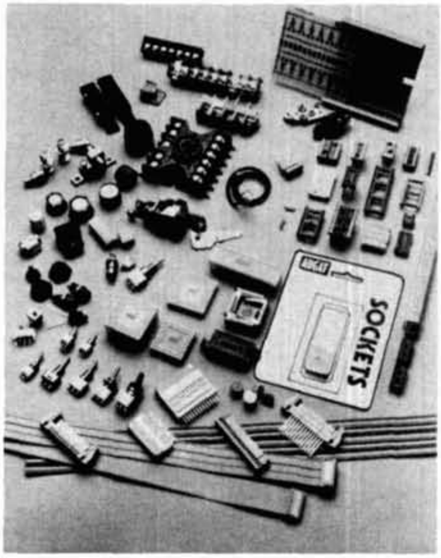
The 6002 can be used for audi-VHF in communications, data processing, process control, rf design, digital design, QC, and maintenance.

For additional information, contact Global Specialties, 70 Fulton Terrace, New Haven, Connecticut 06509-1942. RS#310

NEW products

## Augat packaged products

A major industrial manufacturer has announced the nationwide distribution of a complete line of specially-packaged industrial-quality electronic and electromechanical products for consumer use.




More than 600 styles of sockets, interconnection products, ribbon cable, and IDC products and accessories — including Alcoswitch switches, lamps, and knobs are now available to Amateurs.

A complete catalog is available. For information, contact Augat, Inc., 89 Forbes Boulevard, Mansfield, Massachusetts 02048. RS#311

## satellite receiver

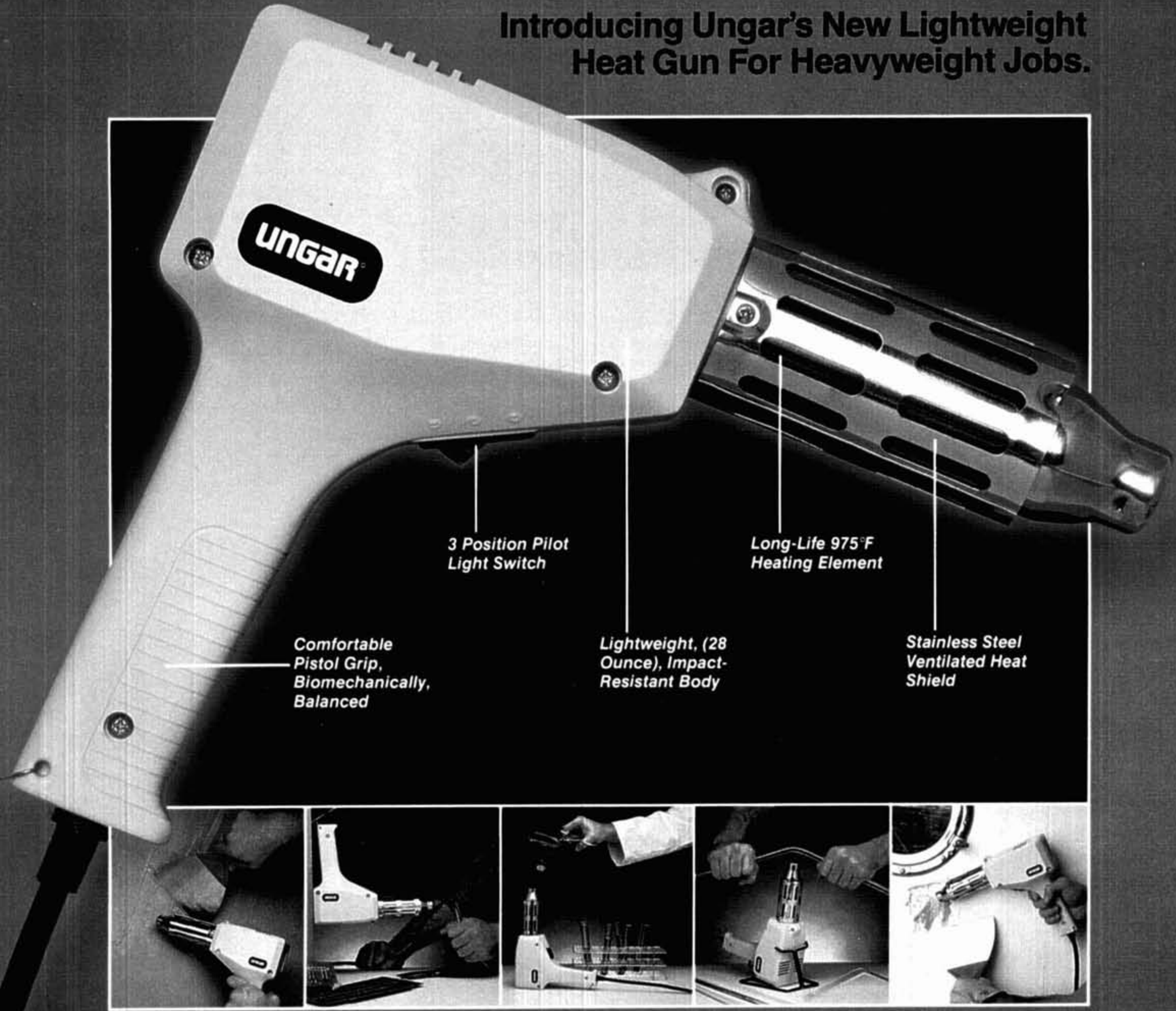
National Microtech, Inc., announces the addition of the Apollo Q-1 satellite receiver and down converter to its product line. The Apollo Q-1 satellite receiver/down converter carries a one-year warranty from National Microtech. It features push-button transponder selection, automatic polarity control, an audio-in signal strength meter display, and a built-in modulator. The Apollo Q-1 is packaged in a woodgrain cabinet with a sleek, black, anodized face plate. A separate down converter with integral LNA power block complete the package.

National Microtech is a leading national dis-

UNGAR®

# The Professionals' Choice.

## Introducing Ungar's New Lightweight Heat Gun For Heavyweight Jobs.




Cure Thermoset Adhesives — Shrink Tubing — Heat Liquids — Form Plastics — Peel Paint

At Ungar, we've designed the ultimate heat gun for the hard-working pro. Feature for feature, no other heat gun can make your job quicker, easier or safer.

To begin with, our new 6977 is the lightest heat gun of its kind (28 ounces). You can use it for hours on end with maximum control and minimum fatigue. The contoured handle provides a firm grip and remains cool at all times.

The 6977 is a high-temp, high air volume heat gun with power for the heaviest jobs. It delivers 975°F to the nozzle in seconds and is perfect for curing adhesives, forming plastics, shrinking tubing, peeling paint and just about any other tough job you'll ever run across.

And the 6977 can take it in the real world. The body is made of rugged, impact-resistant Valox® 855. It features a proven, reliable high-rpm motor, low noise operation, long-life heating element and a 6-foot, 3-conductor ground cord.

A wide range of optional attachments can provide additional versatility. The new Ungar 6977 heat gun . . . light years ahead of the competition, is Underwriter's Laboratory, Inc. listed. For more information, contact your local Ungar distributor or call Ungar in California 1-213-774-5950.

**UNGAR®**
Division of Eldon Industries, Inc.
Compton, California 90220

190



tributor of satellite equipment for the home TVRO and private cable industries. For more information on the Apollo Q-1, contact National Microtech, Inc., P.O. Drawer E, Grenada, Mississippi 38901. RS#312

## miniature high-voltage relay series

A low-cost miniature high voltage vacuum relay series with rated operating voltage of 5kV dc and continuous current carrying capability of 15 amperes has been announced by Kilovac Corporation.

The K42A Model has a SPST-NO contact arrangement and is ideal for use in digital antenna couplers where instant frequency hopping capability is desired, as well as in applications traditionally satisfied with open-frame or reed relays.

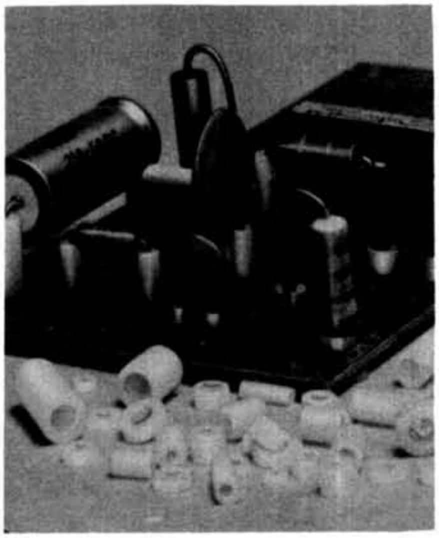
The new relays are the product of two years of development and testing. They represent the first in a planned low-cost line of mass-produced, in-stock miniature high-voltage vacuum relays for military and industrial applications. The K42A series relays are designed to meet the requirements of Mil-R-83725. The new ceramic relays are priced from $25 to $30 in quantities of 1000.


Kilovac designs and manufactures electromechanical relays for high voltage, high peak current applications, including medical electronics, ECM, communications, sonar and radar pulse forming networks, antenna switching and coupling, electrostatic coating, dielectric strength testing, laser and x-ray power supplies.

For further information, contact Kilovac Corporation, P.O. Box 4422, Santa Barbara, California 93103. RS#313

## universal spacers

Made from natural nylon per MIL-M-20693B, an expanded line of permanent spacers from



Bivar, Inc., gives users an extremely wide selection of tubular spacers for mounting PCB discrete devices in almost any lead pattern and elevation.

Simple in design and extremely easy to use, four basic ID/OD combinations with thicknesses ranging from 0.020 inch through 1.250 inches, in 0.005-inch increments, are available immediately from factory stock or within two weeks. There are 988 standard sizes to choose from, and special heights are also readily available.

The broad selection permits the user to choose the most suitable sizes for strength, elevation, and ease of assembly, as well as to provide for proper filleting and cleaning. Simplified mounting of devices with unusual configurations is easily accomplished.

A typical part, 902-070 (0.32-inch ID, 0.125-inch OD, and 0.070-inch thick), is priced at $10.00/K, in 10K lots. For further information, contact Bivar, Inc., 4 Thomas, Irvine, California 92714. RS#314

## self-contained keyer

A new *completely self-contained keyer* from Globalman features variable speed, monitor volume control, automatic or semi-automatic switch, and an on/off switch on the front panel. The other controls such as tone, output keying switch from transistor to relay, external speaker or earphones, battery option input jack, output terminals, fuse, and ac line cord are on the back panel.

The relatively heavy keyer is housed in a crackle-finished steel cabinet designed to remain stationary in use.

An unconditional guarantee covers materials and labor for one year from date of purchase, as long as the keyer is not dissembled or abused. Should malfunction occur, the factory will repair the keyer at no cost to the owner.

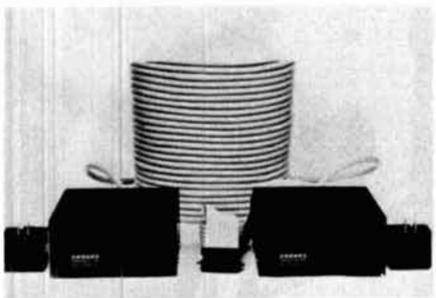
For further information, contact Globalman, Inc., El Toro, California 92630. RS#315

## cable stretcher

What do you do when your printer — with 15 feet of cable — is needed 50, 100, or 1000 feet away from your computer?

The new "cable stretcher" from Cronos can help keep your computer and printer in two-way communication without loss of speed or degradation of performance. Model 100LS consists of two heavyweight stretcher boxes, one at each end of the center cable.

The stretcher comes with 25 feet of twisted 15-pair cable (extra lengths may be ordered) up to 1000 feet. Each end terminates in a DB-37P connector. The interfaces weigh about 3 pounds each, use 3 VA of 120 volt 50-60 cycle power, and will operate in ambient temperatures of 0 to 70 degrees C. The size is 6-1/2 × 6-1/2 × 3-1/4 inches. Six feet of flat cable connecting stretcher to printer are supplied.



For more information, contact Cronos Engineering, Inc., 105 N.W. 43rd Street, Boca Raton, Florida 33431. RS#316

NEW products

## electronic grade coolant

A newly formulated electronic circuit/component coolant from Chemtronics is said to make thermal intermittent trouble shooting of electronic circuits components easier than ever. Applied as an aerosol spray, *Freez-It,*™ freezes to −65 degrees F (54 degrees C) instantly. Sprayed copper circuitry frosts and turns white, exposing hairline cracks in PC boards. Rapid chilling of suspected components allows individual components to be isolated for instrument testing. Defective resistors, transistors, capacitors, and other component parts may be quickly and easily identified.

*Freez-It* can also be used to prevent transformer burnout. If a transformer starts to smoke, spraying the transformer will keep wax, varnish and shellac from running and causing short circuits. It will also freeze adhesives for quick removal.

Other uses include low temperature testing of circuits and equipment, preventing cold solder joints and soldering delicate, heat sensitive components, and as an aid in shrink fit assembly.

The product can be used safely on plastics, rubber, paints, or metal and leaves no residue. It is also non-flammable, non-toxic and odor-

less. Active ingredients are 100 percent pure Freon 12. *Freez-It* has been tested to meet Federal Specification BB-F-1421.

A specially designed 3-way variable control valve controls the spray zone; a pinpoint application or wide area coverage can be selected. An extension tube is also supplied for difficult to reach areas.

*Freez-It* is supplied in 15 and 22 ounce aerosol spray cans.

For further information, contact Chemtronics, Inc., 681 Old Willets Path, Hauppauge, New York 11788. RS#317

## clamp-on ammeter adapter

The new Triplett Model 10-N clamp-on AC ammeter adapter is universally adaptable to any digital multimeter with 3/4 inch center banana plugs, 10m ohm input and a 200 mV ac

current range. Said to be ideally suited for in-field, non-interruptive circuit testing, the Model 10-N may be used with a line separator (Triplett Model 101), for single-conductor current measurements on two conductor cables.

Current ranges are 0-20 amps and 20-200 amps with an accuracy of ±3 percent. The range switch may be operated under load with no damage.

The spring-loaded clamp jaws permit simple one-hand operation. Model 10-N is molded from high-impact thermoplastic material to provide years of durable, trouble-free operation.

For further information, contact Triplett Corporation, One Triplett Drive, Bluffton, Ohio 45817. RS#318

## new Sinclair catalog

Sinclair Radio Laboratories, Inc., has released the new edition of their product information catalog. The 16-page booklet contains updated technical specifications on a full range of Sinclair's multicouplers, combiners, duplexers, and ferrite accessories. Copies are available from Sinclair Radio Laboratories.

For more information, contact Sinclair Radio Laboratories, Inc., 14614 Grover Street, Suite 210, Omaha, Nebraska 68144. RS#319

NEW products

## new Hamtronics® catalog

Hamtronics, Inc., announces publication of their 1983 catalog for the VHF/UHF/OSCAR enthusiast and two-way shops. The thirty-six page, two-color catalog features many new products, including fm repeaters, new VHF and UHF fm receivers, helical resonator preamps and filters, low-noise receiver preamps, and a UHF receiver for listening to the space shuttle. Also included are the popular fm transmitters and power amplifiers, VHF and UHF receiving and transmitting converters, VHF transceivers, and other products.

For a free copy, write to Hamtronics, Inc., 65F Moul Road, Hilton, New York 14468. RS#320

## tone signaling products catalog

The new product list from Communications Specialists includes their new direct plug-in CTCSS encoder-decoder boards for many


two-way radios, paging, two-tone sequential, and burst tone devices. For a copy of the list, contact Communications Specialists, Inc., 426 West Taft Avenue, Orange, California 92667. RS#321

## short circuits

### 6-meter amplifier

In the April, 1983, article by W2GN, "6-meter Amplifier," the two (parallel) plate blocking capacitors (**fig. 1**, page 73) are shown incorrectly wired. A correct installation would have them wired between the plate's copper strap and the inductor L as shown correctly done in **fig. 2** on page 74.

### remote control hf operation

The following corrections should be made to K5QY's article, "Remote Control hf Operations" (April, 1983):

The source of the eight-bit I/O card referred to on page 32 is Applied Engineering, Inc., P.O. Box 470301, Dallas, Texas 75247. The price is $62.00.

Line 3775 of K5QY's computer program (page 42) was omitted from the text. Line 3775 should read:

```
3775 IF T = 9 THEN DL = -.0001
```

In **fig. 4**, the center-tapped connection of the two series 0.01 $\mu$F telephone line shunt capacitors should only go to ground. The lower telephone line was inadvertently shown grounded.

### noise bridge

The 365 pF capacitor required for construction of K2BT's rf impedance bridge (March, 1983) can be obtained from Radiokit, Box 411H, Greenville, New Hampshire 03048, or from Mouser Electronics, 11433 Woodside Avenue, Santee, California 92071.

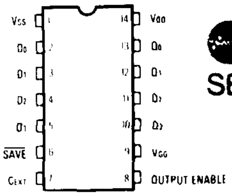
### keyer interface

In the February, 1983, article entitled "Low-Power Keyer and Interface," the following CMOS chips were used: type 4023 for U1, 4013 for U2, and 4001 for U3. Also, power (V+) is applied to pin 14 and GND to pin 7 of each chip.

# Electronic Emporium, Inc.

## 1614 West 12th Place Tempe, Arizona 85281

## 602-968-3858




**PLESSEY**
SEMICONDUCTORS

# MN9102

## NON-VOLATILE QUAD LATCH

The Plessey MN9102 is a non-volatile 4-bit data latch which uses MNOS transistors as memory elements to retain stored data in the absence of applied power. The data that is applied to the four inputs is written into the memory when the SAVE control is taken to a logic '0' level and the data subsequently appears on the four outputs. The stored data is also automatically restored to the outputs whenever power is re-applied to the device.

An OUTPUT ENABLE is also available, which when taken to logic '0' level presents a high impedance state on each data output line, permitting multiplexed operation.

The high voltage usually associated with MNOS memory devices is generated internally, requiring only a single external capacitor to act as a charge reservoir for supplying current when writing into the memory. The device therefore operates from standard voltage rails and requires no additional drive circuitry.

$5.45 each

### FEATURES

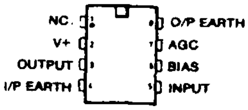
- Data Retention for One Year in the Absence of Applied Power
- Simple to Use
- Standard Power Supplies Only (+5V, —12V)
- CMOS/TTL Compatible
- 14-lead DIL Package
- Typically Ten Million SAVE Operations

### APPLICATIONS

- Metering Systems
- Elapsed Time Indicators
- Security Code Storage
- Last Channel Memory for Digital Tuning

# SL1612C

## RF/IF AMPLIFIERS




The SL1610C and SL1611C are low noise, low distortion, RF voltage amplifiers with integral supply line decoupling and AGC facilities. The SL1610C has a voltage gain of 10 and a bandwidth of 140MHz, while the SL1611C circuits have a 50dB AGC range with maximum signal handling of 250mV rms. As they are voltage amplifiers they have high input impedance and low output impedance.

The SL1612C is a low noise, low distortion, IF voltage amplifier similar to the SL1610C and SL1611C but having a voltage gain of 50, a bandwidth of 15MHz and only 20mW power consumption. It has a 70dB AGC range with maximum signal handling of 250mV rms.

### APPLICATIONS

- IF Amplifiers
- RF Amplifiers
- AGC-Controlled Amplifiers

### FEATURES

$4.04 each

- Low Noise
- Low Distortion
- 1V rms Output
- Wide AGC Range
- On-Chip Decoupling

# SL1621C AGC GENERATORS

The SL1621C is an AGC generator designed specifically for use in SSB receivers in conjunction with the SL1610C, SL1611C and SL1612C RF and IF amplifiers. In common with other advanced systems it generates a suitable AGC voltage directly from the detected audio waveform, provides a 'hold' period to maintain the AGC level during pauses in speech, and is immune to noise interference. In addition it will smoothly follow the fading signals characteristic of HF communication.

When used in a receiver comprising one SL1610C and one SL1612C amplifier and a suitable detector, the SL1621C will maintain the output within a 4dB range for a 110dB range of receiver input signal.

The SL1620C VOGAD (Voice Operated Gain Adjusting Device) is an AGC generator designed to work in conjunction with the SL1630C audio amplifier (particularly when the latter is used as a microphone amplifier) to maintain the amplifier output between 70mV and 87mV rms for a 35dB range of input. A one second 'hold' period is provided which prevents any increase of background noise during pauses in speech.

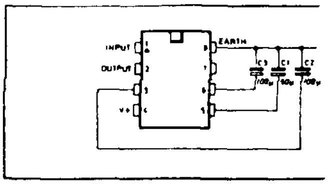



*Fig. 1 Pin connections (top view)*

$4.84 each

### FEATURES

- Wide Dynamic Range
- Speech Pause Memory
- Fast Attack/Adaptive Decay
- Only 4 External Components

# SL1623C

## AM DETECTOR, AGC AMPLIFIER & SSB DEMODULATOR

The SL1623C is a silicon integrated circuit combining the functions of low level, low distortion AM detector and AGC generator with SSB demodulator. It is designed specially for use in SSB/AM receivers in conjunction with SL1610C, SL1611C and SL1612C RF and IF amplifiers. It is complementary to the SL1621C SSB AGC generator.

The AGC voltage is generated directly from the detected carrier signal and is independent of the depth of modulation used. Its response is fast enough to follow the most rapidly fading signals. When used in a receiver comprising one SL1610C and one SL1612C amplifier, the SL1623C will maintain the output within a 5 dB range for a 90 dB range of receiver input signal.

The AM detector, which will work with a carrier level down to 100 mV, contributes negligible distortion up to 90% modulation. The SSB demodulator is of single balanced form. The SL1623C is designed to operate at intermediate frequencies up to 30MHz. In addition it functions at frequencies up to 120MHz with some degradation in detection efficiencies. The encapsulation is a 14 lead DIL package and the device is designed to operate from a 6 volt supply, over a temperature range of −30°C to +70°C.

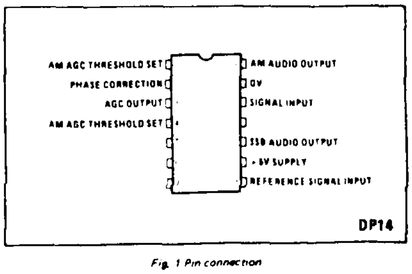



*Fig. 1 Pin connection*

$6.11 each

### ABSOLUTE MAXIMUM RATINGS

| | |
|---|---|
| Storage temperature | −30°C to +85°C |
| Ambient operating temperature | 0°C to +80°C |
| Supply voltage | −0.5V to +12V |

# SL748

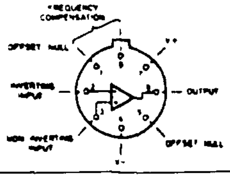
## PRECISION OPERATIONAL AMPLIFIER

The SL748 is a monolithic Precision Operational Amplifier. It is an excellent choice when performance versus cost trade-offs are possible between super beta or FET input operational amplifier and low cost general purpose operational amplifiers. The low offset and bias currents of the SL748 improve system accuracy in applications such as long term integrators, sample and hold circuits and high source impedance summing amplifiers. Even though the input bias current is extremely low, the SL748 maintains full ±30V differential voltage range. The internal construction utilizes isothermal layout and special electrical design to maintain system performance despite variations in temperature or output load. High common mode input voltage range, latch-up protection, short circuit protection and simple frequency compensation make the device versatile and easy to use.

### FEATURES

$6.72 each

- Low Offset Voltage and Offset Current
- Low Offset Voltage and Current Drift
- Low Input Bias Current
- Low Input Noise Voltage
- Large Common-mode and Differential Voltage Ranges



## UHF PROGRAMMABLE DIVIDERS ÷10/11

# SP8640A & B 200 MHz

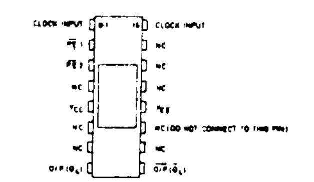
In frequency synthesis it is desirable to start programmable division at as high a frequency as possible, because this raises the comparison frequency and so improves the overall synthesiser performance.

The SP8640 series are UHF integrated circuits that can be logically programmed to divide by either 10 or 11, with input frequencies up to 350 MHz. The design of very fast fully programmable dividers is therefore greatly simplified by the use of these devices and makes them particularly useful in frequency synthesisers operating in the UHF band.

All inputs and outputs are ECL compatible throughout the temperature range: the clock inputs and programming inputs are ECL III-compatible while the two complementary outputs are ECL II-compatible to reduce power consumption in the output stage. ECL III output compatibility can be achieved very simply, however (see Operating Notes).

The division ratio is controlled by two $\overline{PE}$ inputs. The counter will divide by 10 when either $\overline{PE}$ input is in the high state and by 11 when both inputs are in the low state. Both the $\overline{PE}$ inputs and the clock inputs have nominal 4.3k Ω pulldown resistors to $V_{EE}$ (negative rail).

$7.12 each




NOTE UNUSED PINS (EXCEPT 8 AND 9) MAY BE CONNECTED TO $V_{EE}$. THIS WILL REDUCE CLOCK BREAKTHROUGH ON THE OUTPUTS PINS 8 AND 9 SHOULD BE LEFT OPEN CIRCUIT WHEN NOT IN USE. PIN 11 IS INTERNALLY CONNECTED AND MUST ALWAYS BE LEFT OPEN-CIRCUIT.

E5

*Fig. 1 Pin connections (top)*

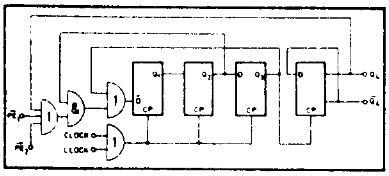


*Fig. 2 Logic diagram (positive logic)*

### FEATURES

- Military and Industrial Variants.
- 350 MHz Toggle Frequency
- Low Power Consumption
- ECL Compatibility on All I/Ps & O/Ps
- Low Propagation Delay
- True and Inverse Outputs

### ABSOLUTE MAXIMUM RATINGS

| | |
|---|---|
| Supply voltage $\lvert V_{CC} - V_{EE}\rvert$ | 8V |
| Input voltage $V_{in}$ (d.c.) | Not greater than the supply voltage in use. |
| Output current $I_{out}$ | 20mA |
| Max. junction temperature | +150°C |
| Storage temperature range | -55°C to +175°C |

**PLESSEY Semiconductors**

# SP4550/1

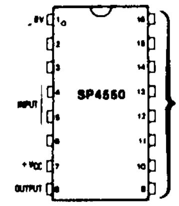
**1 GHz ÷ 256**

The SP4550/1 are part of the new range of Plessey Consumer high speed dividers which offer improved input sensitivity and higher input impedance.

The devices are intended for use in television frequency synthesis systems. They have a division ratio of 256 with a single, (SP4550) or complementary, (SP4551) ECL output and incorporate an on-chip preamplifier with a differential input. The input pins may be used as UHF and VHF inputs, with only a slight loss of sensitivity, if suitable drive circuitry is employed.

***FEATURES***

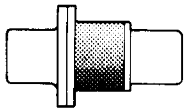
- On-chip wideband amplifier
- High input sensitivity
- High input impedance
- Low output radiation
- Single (SP4550) or complementary (SP4551) ECL output




$19.67 each

# Gunn Effect Diode

| Type | Peak Power Output (mW) | Frequency Range (GHz) | Typical Operating Current (A) | Typical Operating Voltage (V) |
|---|---|---|---|---|
| TE O3 | 10 | 8 12 | 110 | 7.5 |



$33.00 each

# SW300

## VESTIGIAL SIDEBAND FILTER

The SW300 is a two-channel Vestigial Sideband Filter which uses Surface Acoustic Wave (SAW) technology and is designed for use in TV Game circuits, or other applications where it is necessary to eliminate unwanted sideband radiation. Operation is specified for U.S. TV Channels 3 and 4 (61.25MHz and 67.25MHz respectively); the filter has one input for each channel and a common output intended to drive 75Ω loads. No tuning is required, and the device is supplied in a TO-8 type metal package for ease of shielding.

$9.44 each

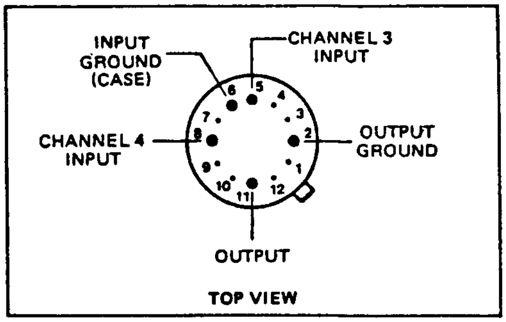



**Figure 1. Pin Connections**

### FEATURES

- Surface Acoustic Wave (SAW) technology
- U.S. TV Channel 3 (61.25MHz) and 4 (67.25MHz) Operation
- Low-loss at Intended $F_c$
- High Unwanted Sideband Rejection
- No Tuning Required
- High Stability
- No Additional Components Required
- Easily-shielded TO-8 Type Metal Package

# SL1626C

## AUDIO AMPLIFIER AND VOGAD

The SL1626C is a silicon integrated circuit combining the functions of audio amplifier with voice operated gain adjusting device (VOGAD).

It is designed to accept signals from a low-sensitivity microphone and to provide an essentially constant output signal for a 60dB range of input.

The encapsulation is an 8-lead plastic dual-in-line package and the device is designed to operate from a 6V ±0.5 volt supply, over a temperature range of -30°C to -70°C

$4.04 each

### FEATURES

- Constant Output Signal
- Fast Attack
- Low Power Consumption
- Simple Circuitry

### APPLICATIONS

- Audio AGC Systems
- Transmitter Overmodulation Prevention
- Speech Recording
- Level Setting Systems

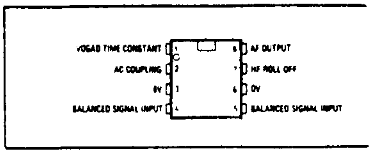



*Fig. 1 Pin connections (top)*

### ELECTRICAL CHARACTERISTICS

Test conditions (unless otherwise stated):

| | |
|---|---|
| Input frequency | 1kHz |
| Supply voltage | 6V |
| Temperature | +25°C |

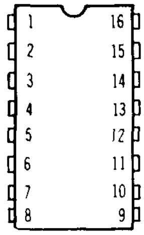
# SL6440 C

## HIGH LEVEL MIXER

The SL6440 is a high level mixer for use in Radio Communications and in applications requireing linear mixer.

The SL6440A is packaged in 16 lead ceramic DIL (DG) and the SL6440C in 16 lead plastic DIL (DP)).

$7.71 each




ELECTRICAL CHARACTERISTICS

Test conditions (unless otherwise stated):
Test circuit: Fig 2
Local oscillator input level 0dBm
Tamb = $-55^{\circ}$ C to $+125^{\circ}$ C (SL6440A)
$-30^{\circ}$ C to $+85^{\circ}$ C (SL6440C)
Vcc1 = 12V
Vcc2 = 10V
Ip = 25mA

FEATURES

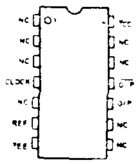
- + 30dBm Intercept Point
- Low Noise
- + 15dBm Compression Point (1dB)
- −55 o C to + 122 o C Temperature Range
- Programmable Performance
- Programmable Gain

ABSOLUTE MAXIMUM RATINGS

| | |
|---|---|
| Supply voltage, pins 3,4 and 14 | 15V |
| Power dissipation (package limitation) | 1200mW |
| Derate above 25°C | 8mW/°C |
| Storage temperature range | −65°C to + 150 °C |
| Programme current | 50mA |

# SP8616B 1 GHz ÷4

The SP8616 series of UHF counters are fixed ratio ÷ 4 asynchronous emitter coupled logic counters with, in the case of the SP8168 a maximum operating frequency in excess of 1GHz, over a temperature range of 0°C to +70°C. The input is normally capacitively coupled to the signal source but can be DC coupled if it is required. The two complementary emitter follower outputs are capable of driving 100Ω lines and interfacing to ECL with the same positive supply. The SP8616 series require supplies of 0V and −7.4V (± 0.4V).



FEATURES

- DC to 1GHz operation.
- 0°C to 70°C operation guaranteed at maximum specified frequency and over a wide dynamic input range.
- Complementary emitter follower O/Ps, ECL compatible.

$32.50 each

APPLICATIONS

- UHF Instrumentation, Including Counters and Timers
- Prescaling for UHF Synthesisers.

DUAL A/D COMPARATOR

• SP1651 $27.78 each

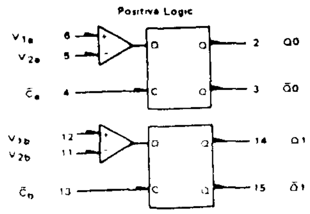
The **SP1650** and the **SP1651** are very high speed comparators utilizing differential amplifier inputs to sense analog signals above or below a reference level. An output latch provides a unique sample hold feature. The **SP1650** provides high impedance Darlington inputs, while the **SP-1651** is a lower impedance option, with higher input slew rate and higher speed capability.

Complementary outputs permit maximum utility for applications in high speed test equipment, frequency measurement, sample and hold, peak voltage detection, transmitters, receivers, memory translation, sense amplifiers and more.

The clock inputs ($\bar{C}_a$ and $\bar{C}_b$) operate from PECL III or PECL 10 000 digital levels. When $\bar{C}_a$ is at a logic high level, Q0 will be at a logic high level provided that $V_1 > V_2$ ($V_1$ is more positive than $V_2$). $\bar{Q}0$ is the logic complement of Q0. When the clock input goes to a low logic level, the outputs are latched in their present state.

Assessment of the performance differences between the **SP1650** and the **SP1651** may be based upon the relative behaviors shown in Figures 3 and 6.

Positive Logic




$V_{CC}$ = +5.0 V = Pin 7,10
$V_{EE}$ = −5.2 V = Pin 8
Gnd = Pin 1,16

- $P_D$ = 330 mW typ/pkg (No Load)
- $t_{pd}$ = 3.5 ns typ (SP1650) = 3.0 ns typ (SP1651)
- Input Slew Rate = 350 V/µs (SP1650) = 500 V/µs (SP1651)
- Differential Input Voltage: −5.0 V to +5.0 V (−30°C to +85°C)
- Common Mode Range: −3.0 V to +2.5 V (−30°C to +85°C) (SP1650); −2.5 V to +3.0 V (−30°C to +85°C) (SP1651)
- Resolution ≤ 20 mV (−30°C to +85°C)
- Drives 50 Ω lines

# SL6650C

## LOW POWER IF/AF CIRCUITS FOR NARROW BAND FM

**The SL6640 and SL6650 independently perform the IF/AF function of a low power FM receiver. Each circuit is a complete IF strip and consists of a pre-amplifier, limiting amplifier, quadrature detector, carrier squelch, DC volume control and audio output stage. The SL6640 and SL6650 differ in that the SL6640 features a power audio output stage (typically 250mW into 8Ω) whilst the SL6650 has a level audio output which drives high impedance loads (open collector output). With the SL6640 the demodulator and audio amplifier are muted by the squelch output. The SL6650 squelch output does *not internally mute the demodulator*, which means that it can be used for tone decoding. If, on the SL6650, the squelch function is not required then, with some additional circuitry, (see Fig. 6) a signal strength meter can be incorporated.**

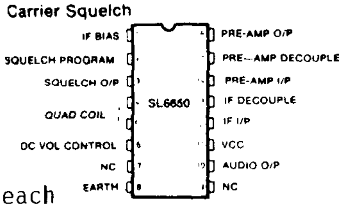
$5.00 each

**APPLICATIONS**

**Mobile radio**
**Hand Held Radio**

**FEATURES**

**Low Power**
**Purpose Designed for narrow band**
**Carrier Squelch**




# SP8757A

The SP8755 is a divide by 64 prescaler which operates from a standard 5V TTL supply and will drive TTL directly. The SP8755A operates over the full military temperature range (−55°C to +125°C).

**1200MHz ÷ 64**

**FEATURES**

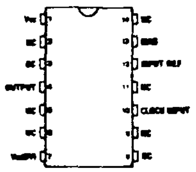
- TTL Compatible Output
- AC Coupled Input (Internal Bias)

**QUICK REFERENCE DATA**

- Supply Voltage: 5V
- Power Consumption: 270mW
- Temperature Range: A Grade: −55°C to +125°C; B Grade: −30°C to +70°C

**ABSOLUTE MAXIMUM RATINGS**

- Supply Voltage 8V
- Output Current ±30mA
- Storage Temperature Range −55°C to +150°C
- Max. Junction Temperature +150°C
- Input Voltage 2.5V p-p



$18.72 each

# SEMICONDUCTORS SURPLUS

2822 North 32nd Street/Unit #1 800-528 • 3611 602-956 - 9423 Phoenix, Arizona 85018

RECHARGEABLE GEL-CELL BATTERY
GLOBE # GC280: 2 VOLTS @ 8 AMP HOUR
2"w X 2"d X 3.75" $5.99ea. 6/$27.00

RECHARGEABLE GEL-CELL BATTERY
GLOBE-UNION #GC1260: 12Volts @ 6AMPHOUR
6"w X 3.25"d X3.75"h $29.99 each

ELPOWER GEL-CELL #EP680: 6VOLT@8AMPHOUR
4.25"w X2.75"d X 5.5"h $8.99each
RECHARGER for above: #BR680 $4.99 each

RECHARGEABLE LEAD-ACID BATTERY PACK
GATES #0810-0004: 12VOLTS @ 2.5 AMPHOUR
4"w X 3"h X 2.75"d USED/GOOD $7.99 each

RECHARGEABLE NI-CAD BATTERY PACK
GENERAL ELECTRIC # 41B001LD
14.4 VOLTS @ 1 AMP HOUR USED/GOOD
3.25"h X 2.75"w X 2"d $7.99 per pack

RECHARGEABLE NI-CAD BATTERIES OR PACKS
GE#195194 "L"shape: 3.6volts @ 100mahr.
GOULD#405408 2X "AA": 2.4V @ 600ma hour
GE #193029 1.875"X0.5"d 3.6V @ 100mahr
GE #41B901D06 as above but 2"x0.56"d
UNION CARBIDE #193817: 3.6V @225ma hour
YOUR CHOICE ----------- $2.99 EACH TYPE

RF COAX RELAY AMPHENOL #300-10099
SPDT, N-Connectors, 26VDC Coil
SIZE: 3.5" X 2" X 2.5" $49.99 each

RF COAX RELAY AMPHENOL #327-10582-3
SP3T, BNC Connectors, 26VDC Coil
SIZE: 2.5"w X 2"d X 2"h $39.99 each

RF COAX RELAY AMPHENOL #323-11506-3
SP4T, BNC Connectors,Four 26VDC Coils
SIZE: 3" X 2" X 1.5" $59.99 each

RF COAX RELAY AMPHENOL #300-11732
SPDT, BNC Connectors, 26VDC Coil
OVERALL SIZE: 1.375" Cube $39.99 each

RF COAX RELAY:AMPHENOL #360-11891-48
SPDT, BNC CONNECTORS, 115vac COIL,
SIZE: 1.75"d X 1.5"h X2.4"w $49.99 ea.

RF COAX RELAY:TRANSCO #1460-20, SPDT
TYPE SA303-U, N-CONNECTORS, 18 to 30vdc
COIL, SIZE: 6.5"h X 3"dia. $69.99 each

RF COAX RELAY QUANTATRON #SA90P10-1
SPDT, 22-30VDC Coil $39.99 each
OVERALL SIZE: 2" X 1.875" X 1.25"

RF COAX RELAY: DUAL COILS 26VDC, SPST
NORMALLY CLOSED, BNC CONNECTORS and 6"
COAX LEADS. 3 BRANDS AVAILABLE; state
1st choice! FXR,AMPHENOL,DANBURY-KNUD
SON. #300-11451 $39.99 each

RF COAX RELAY MINIATURE TYPE w/RG-58
MAGNECRAFT # W120X-14: 12" COAX LEADS
SPDT, 12VDC Coil. Conservatively rated
at 100Watts, Impedence Matched @ 50ohm
VSWR 1.25:1 (max) 0 to 470MHZ.
SIZE: 2'L X 1.75"W X 0.5" D $29.99 ea.

RF TRANSMISSION LINE SWITCH
TRANSCO #16500NAU12-15:N-CONNECTORS
28VDC COIL $59.99 each

VACUUM RELAY: JENNINGS #RC5A5101A24
10KV,25KW max. @30MHZ, 19 to 29VDC
COIL, 5.5" x 2.5" x 3.25" $139.99 ea.

VACUUM KEYING RELAY: #M-7470182
STRUTHERS-DUNN,INC. TYPE 78CCA101
28VDC, OVERALL SIZE: 5"X 4"X 3.5"
$29.99 each

Grigsby-Barton, Inc. #GB-604
12.5KVDC HIGH VOLTAGE RELAY
Maximum Contact Ratings: 12.5KVDC @ 50VA
Coil: 24VDC, 230 Ohms
SPST Contacts
High Voltage Probe Wire leads
onw is 8 inches, one is 10 inches
Quick Disconnect Coil Leads
Relay Size: 3¼" X 3/4" X 1 3/4"
$19.95 each

DELUXE SOLDER PENCIL IRON HOLDER
#50B-205 with tip cleaner sponge
$6.99 each

SOLDER REMOVER TOOL #50B-410
METAL and TEFLON CONSTUCTION
a well engineered tool! $9.99 each

MINI-NUTDRIVER SET w/TORQUE HANDLE and
CASE. SIZES: 5/64",3/32",7/64",1/8",5/32
$4.99 each

RF TRANSISTORS

| | |
|---|---|
| 2N2270 | $ .99 |
| 2N2857 | 1.55 |
| 2N2657JAN | 2.55 |
| 2N3553 | 1.57 |
| 2N3553JAN | 2.90 |
| 2N3866 | 1.30 |
| 2N3866JAN | 2.20 |
| 2N3925/ M9477 | 15.00 |
| 2N3948 | 5.00 |
| 2N3924/ 2270-3 | 3.35 |
| 2N3959 | 3.85 |
| 2N4072 | 1.80 |
| 2N4427 | 1.30 |
| 2N4877 | 1.00 |
| 2N4959 | 2.30 |
| 2N5070 | 18.40 |
| 2N5108 | 4.00 |
| 2N5109/ 107P80334 | 1.70 |
| 2N5583/2-2303/ SRF5314 | 4.00 |
| 2N5160 | 3.45 |
| 2N5179 | 1.00 |
| 2N5589 | 8.65 |
| 2N5590 | 10.35 |
| 2N5591 | 13.80 |
| 2N5635 | 10.95 |
| 2N5636 | 12.00 |
| 2N5641 | $ 9.20 |
| 2N5643 | 15.50 |
| 2N5645 | 13.80 |
| 2N5946 | 19.00 |
| 2N5862 | 57.50 |
| 2N5942 | 40.00 |
| 2N5944 | 9.20 |
| 2N6080 | 9.20 |
| 2N6081 | 10.35 |
| 2N6082 | 11.50 |
| 2N6083 | 13.25 |
| 2N6084 | 15.00 |
| 2N6095 | 12.00 |
| 2N6096 | 15.50 |
| 2N6097 | 17.25 |
| 2N6368 | 28.75 |
| MRF203 | 30.00 |
| MRF227 | 4.00 |
| MRF238 | 12.65 |
| MRF245/ 247 | 34.50 |
| MRF262 | 9.20 |
| MRF420A | 20.00 |
| MRF421 | 36.80 |
| MRF422 | 41.40 |
| MRF422A | 41.40 |
| MRF426A | 15.50 |
| MRF449 | 12.65 |
| MRF449A | 12.65 |
| MRF450 | 13.80 |
| MRF452 | POR |
| MRF453-185- 282 | 17.25 |

## IC SOCKETS

Solder Tail

| | |
|---|---|
| 8 pin | $0.10 |
| 14 pin | 0.10 |
| 16 pin | 0.14 |
| 18 pin | 0.18 |
| 20 pin | 0.20 |
| 24 pin | 0.22 |
| 28 pin | 0.25 |
| 40 pin | 0.50 |

Wire Wrap

| | |
|---|---|
| 10 pin | 0.35 |
| 14 pin | 0.35 |
| 16 pin | 0.40 |
| 40 pin | 0.99 |

## TRANSFORMERS

Triad F-23u Pri. 115VAC
output 10VCT @ 7AMPS
$12.99 each

Prem Enterprises, Inc.
#2EL2A01AA2AAAA Pri.120VAC
output 24VCT @ 230MA
$2.99 each

HATA #30468359 Pri. 117VAC
output 25.2VCT @ 2.8AMPS
$6.99 each

Electro Vector #E30554
input 110VAC
output dual 17V @ 1Amp
$5.98 each

Schott Corp. #67069940
input 117VAC
output 26.8VCT @ 660MA
26.8VCT @ 660MA
21.7VCT @ 1.1AMP
$9.99 each

## SOLID CARBIDE DRILL BITS

New & Used in Mixed Sizes
$1.25 each or 10/$9.00

TLO-22CP LOW POWER DUAL
AMPLIFIER $1.40 each

TLO-71CP BIFET LOW NOISE
AMPLIFIER .58 each

TLO-61CP BIFET LOW
POWER AMPLIFIER 72¢ ea.

CA3026 DUAL INDEPENDENT
AMPLIFIER $1.04

CA3028A CASCADE DC TO
500 MHz AMP $1.42

CA3036 DUAL DARLINGTON
AMPS. MATCHED LOW NOISE
TRANSISTORS $3.38

CALEX #21-30 SUBMINIATURE
POWER SUPPLY, +5VDC @
300mA + 1%, line and load
(NL to FL) regulation .1%
noise and ripple 2mVrms
temperature coefficient
.02% $12.99 each

## RELAYS

AMF/Potter Brumfield
#R10-E4274-1, 1.8K Ohms
24VDC Coil, 4PDT $2.99

Gould/Allied Control
#T351-CC-CC, 24VDC Coil,
680 Ohms, 4PDT $2.99

Omroh #MHE202PG-UA
12VDC Coil, 200 Ohm
DPDT, $2.99 each

RBM Controls #93-
507030-13300B, SPDT
12VDC, 100 Ohm Coil,
Cont. Rating, 10 Amp,
125VAC $4.99 each

**RBM Controls #93-
599606-14628A, 12VDC
Coil, 12 Amp DC Coil,
DPDT, good for RF
Switching, 5 Amps, Cont.
rating @ 125VAC, wet and
dry relay $9.99 each**

SN75427 DISPLAY DRIVER
Variable to 90VDC
$1.00 each

TELONIC ATTENUATOR
Model TC50A, has BNC
connectors for input
and output, 0-1db,
50 Ohm $39.99 each

50 WATT ZENERS
1N3313B 5% 14VDC $3.00
1N4554 10% 6-2VDC 2.50

ALCO PROXIMITY SWITCH
Magnetic Reed Type #RS-11
N.O. Type $2.59 each

ERIE #1270-016
5000pf, 200VDC MINI
ATTENUATION; 50 db
from 200 MHz to 10GHz
$2.01 each

ERIE #1201-785
5500pf, 200VDC Mini
ATTENUATION; 50 db
from 100 MHz to 10 GHz
$2.01 each

RFI POWER FILTERS
Corcom #F2543
1Amp, 115V/250VAC,
50-400Hz $2.99

Cornell Dubilier Elect.
NF10870-8, 10 Amps @
250VAC, 50/60Hz, has
3 connector 16AWG
power cord 15 ft. long
$9.99 each

Corcom #10B4, 10Amps
115/250VAC, 50-400Hz
$4.99 each

R.J.600D10, 10 Amps,
125/250VAC, 50-400Hz
$4.99 each

## VARIABLE CAPACITORS

| | | |
|---|---|---|
| ARCO 423 | 7 to 100pf | $1.00 each or 2/$1.75 |
| ARCO PC464 | 25 to 280pf | $1.00 each |
| ARCO PC402 | 1.5 to 20pf | $1.00 each or 2/$1.50 |
| C010ZZ/10 | .7 to 46pf | 79¢ each or 2/$1.10 |

## DUAL VARIABLE CAPACITORS

| | | |
|---|---|---|
| 075-014 Atlas | 1.2-30pf & 1.2-15pf | $3.99 |
| 075-013 Atlas | 9-55pf Dual | $3.99 |
| 075-012 Atlas | 1.1-175pf Dual | $3.99 |

## VARIABLE CAPACITORS

| | | |
|---|---|---|
| 272-1341 Archer | 8.5-365pf | $1.99 |
| ARCO 464X | 25-280pf | $1.00 |
| 2222-804-20024 | 2-25pf | 2/$1.00 |

## VARIABLE CAPACITORS

Cambion #563-7625-03 1.5 to 30 pf
¼" shaft, ½" long

| | |
|---|---|
| #80-526/ARCO 425 | 30-150pf |
| #B7311369/CVR-5 | 390-580pf |
| #80-527/ARCO 426 | 45-232pf |
| #80-528/ARCO 406 | 20-115pf |
| #80-529/ARCO 462 | 5-90pf |
| #E281001/ARCO 421 | 2-25pf |
| #2222-808-44121 | 2.1-120pf |
| #3L1-0003-03 | .9-50pf |
| #3731259-228 | .9-50pf |

$1.00 each or 2/$1.50

VARIABLE CAPACITORS
Dynatronics 1.5 to 23 pf 2/$1.00
Swallow CV05E300 2.3 to 27pf
2/$1.00

## FULL WAVE BRIDGES

| | | | |
|---|---|---|---|
| W04M | 1 Amp | 50V | $ .89 |
| 5P4 | 2 Amp | 200V | .99 |
| MDA204/3N256 | 2 Amp | 400V | 1.28 |
| SS-4 | 4 Amp | 600V | 1.39 |
| VH148 | 6 Amp | 100V | 1.00 |
| 75KBP005 | 1.5 Amp | 50V | 1.00 |
| MDA100A/3N246 | 1 Amp | 50V | 1.00 |
| MDA104A/3N249 | 1 Amp | 400V | 1.69 |
| VJ648X | 10 Amp | 600V | 2.69 |
| MDA990-6 | 27 Amp | 600V | 3.50 |
| 506342 | 25 Amp | 200V | 2.69 |
| MDA801 | 8 Amp | 100V | 2.00 |

## E. F. JOHNSON

| | | |
|---|---|---|
| #189-504-5 | 1.5 to 11.6 | |
| #189-505-5 | 1.7 to 14.1 | |
| #189-507-5 | 2 to 19.3 | |
| #189-508-5 | 2.2 to 21.9 | Any number |
| #189-509-5 | 2.4 to 24.5 | $1.00 each |
| #187-0103-005/T3-5 | 1.3 to 5.4 | |
| 187-0106-005/T6-5 | 1.7 to 11pf | |
| 274-0113-015 | 1.5 to 15pf | |
| 274-0040-025 | 2.5 to 40pf | |
| 274-0009-025 | 2.5 to 9pf | |

## CERAMIC FILTERS

| | | | |
|---|---|---|---|
| Murata CF260H | | 260KHz | $ 7.50 |
| " CFU455HZ | | 455KHz | 2.90 |
| " SFB455D | | 455KHz | 2.50 |
| " SFD455D | | 455KHz | 5.00 |
| " SFE10.7MA | Orange | 10.7MHz | 2.50 |
| " CFW455H6 | | 455KHz | 2.90 |
| " SFE10.7MA | Black | 10.7MHz | 2.50 |
| " SFE10.7MA | Red | 10.7MHz | 2.50 |
| " SFE10.7MA | Blue | 10.7MHz | 2.50 |
| " SFE10.7MA | White | 10.7MHz | 2.50 |
| Matsushira EFC-L455K41B | | 455KHz | 2.50 |
| " EFC-L455K40B2 | | 455KHz | 2.50 |
| PTI 1479 | | 10.7MHz | 20.00 |

## SILICON POWER TRANSISTORS *Germanium, °Darlington

| | | | | | |
|---|---|---|---|---|---|
| BU208 | VCEO 1500 | 5 Amps | NPN | TO-3 | $3.00 |
| 2N6307 | VCEO 300 | 5 Amps | NPN | TO-3 | 2.00 |
| MJ10005 | VCEO 400 | 20 Amps | NPN | TO-3 | 6.00 |
| MJ10006 | VCEO 350 | 10 Amps | NPN | TO-3 | 4.00 |
| 2N3055 | VCEO 60 | 15 Amps | NPN | TO-3 | .88 |
| 2N5886 | VCEO 80 | 25 Amps | NPN | TO-3 | 2.00 |
| 2N6569 | VCEO 40 | 12 Amps | NPN | TO-3 | .88 |
| MJ2955 | VCEO 60 | 15 Amps | PNP | TO-3 | 1.25 |
| 2N5302 | VCEO 60 | 30 Amps | NPN | TO-3 | 2.00 |
| MJ15012 | VCEO 250 | 10 Amps | PNP | TO-3 | 2.00 |
| 2N5880 | VCEO 80 | 15 Amps | PNP | TO-3 | 2.00 |
| °MJ4000 | VCEO 60 | 4 Amps | NPN | TO-3 | 2.00 |
| 2N5240 | VCEO 350 | 6 Amps | NPN | TO-3 | 1.25 |
| 2N4898 | VCEO 40 | 4 Amps | PNP | TO-66 | 1.25 |
| 2N3767 | VCEO 80 | 4 Amps | NPN | TO-66 | 1.25 |
| 2N3713 | VCEO 80 | 10 Amps | NPN | TO-3 | 1.25 |
| 2N3235 | VCEO 60 | 7.5 Amps | NPN | TO-3 | 1.25 |
| 2N3442 | VCEO 140 | 10 Amps | NPN | TO-3 | 1.25 |
| °MJE802 | VCEO 80 | 4 Amps | NPN | TO-126 | 1.00 |
| 2N6487 | VCEO 60 | 15 Amps | NPN | TO-220 | 1.00 |
| *2N301 | VCB 40 | | PNP | TO-3 | 2.00 |
| *2N2140 | VCB 75 | 2 Amps | PNP | TO-3 | 3.99 |
| *2N1099 | VCB 80 | 12 Amps | PNP | TO-36 | 6.99 |
| °PDM10K40/2N6057 | VCEO 60 | 12 Amps | NPN | TO-3 | 1.50 |
| °PDM12K40/MJ1000 | VCEO 60 | 8 Amps | NPN | TO-3 | 1.00 |
| MJE2955T | VCEO 60 | 10 Amps | PNP | TO-220 | .75 |

| LINEAR IC's | DESCRIPTION | PRICE |
|---|---|---|
| LM301H | | $1.25 |
| LM301N | Operational Amplifier | .48 |
| LM324N | Quad Operational Amplifier | .71 |
| LM555N | Timer | .33 |
| LM339 | Quad Comparator | .69 |
| LM380N-14 | Audio Power Amplifier | .90 |
| LM1889N | TV Video Modulator | 3.20 |
| CA3028H/AH | Communications Amplifier | 1.90 |
| CA3130E | FET Operational Amplifier | 1.50 |
| MC1306P | ½ Watt Audio Amplifier | 1.30 |
| MC1330P | Low Level Video Detector | 1.50 |
| MC1350P | IF Amplifier | .98 |
| MC1358P | IF Amplifier, Limiter, FM Detector, Audio Driver, Electronic Attenuator | 1.30 |
| MC1590G | RF/IF Audio Amplifier | 6.99 |
| MC1723P | Voltage Regulator | .62 |
| MC1709P | 14 pin Operational Amplifier | .73 |
| MC1741 | 8 pin Operational Amplifier | .56 |
| MC3302P | Quad Comparator | .80 |
| Data Sheets Available, price per page | | .25 |

| VOLTAGE REGULATORS | DESCRIPTION | PRICE |
|---|---|---|
| 7805/LM340T-5 | 5 Volt | $ .69 |
| 7808/LM340T-8 | 8 Volt | .69 |
| 7812/LM340T-12 | 12 Volt | .69 |
| 7815/LM340T-15 | 15 Volt | .69 |
| 78M05 | ½ Amp, 5 Volt | .33 |
| 7912/LM320T-12 | 12 Volt | .79 |
| 79M05 | ½ Amp, 5 Volt | .49 |
| 79M15 | ½ Amp, 15 Volt | .49 |
| LM317T | 1.2 to 37 Volt | 2.00 |
| 78H05CK | 5 Amp, 5 Volt | 5.00 |
| 78H12CK | 5 Amp, 12 Volt | 6.00 |

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CA3130E Wideband Amplifier $1.50

CA3160T Wideband Amplifier $1.50

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| MRF449/A | 30Watts | 3-30MHz | $12.65 |
| MRF450/A | 50 | 3-30 | 14.37 |
| MRF454/A | 100 | 3-30 | 20.12 |
| MRF455/A | 80 | 3-30 | 16.00 |
| 2N5589 | 3 | 175 | 9.77 |
| 2N5590 | 10 | 175 | 10.92 |
| 2N5591 | 25 | 175 | 13.80 |
| 2N6081 | 15 | 175 | 12.07 |
| 2N6080 | 4 | 175 | 10.35 |
| 2N6082 | 25 | 175 | 12.65 |
| 2N6083 | | 175 | 13.00 |
| 2N6084 | 40 | 175 | 15.00 |
| MRF901 | Microwave RF Amp | | 2.00 |
| BFR91 | Microwave RF Amp | | 1.00 |

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|---|---|---|---|
| T20-12 | 33¢ | T37-6 | 33¢ |
| T25-6 | 33¢ | T37-10 | 33¢ |
| T30-2 | 33¢ | T44-6 | 50¢ |
| T30-6 | 33¢ | T50-6 | 75¢ |
| T30-12 | 33¢ | T50-10 | 75¢ |
| T37-2 | 33¢ | T106-26 | 1.60 |

| | |
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| #43 Shield Beads | 4/$1.00 |
| #61 Toroid | 3/$1.00 |
| #43 Balum | 10/$1.00 |
| #61 Balum | 8/$1.00 |
| #61 Balum | 6/$1.00 |
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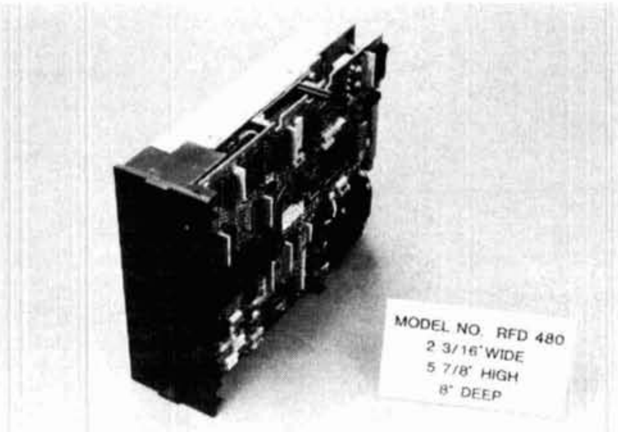


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**August 1983**

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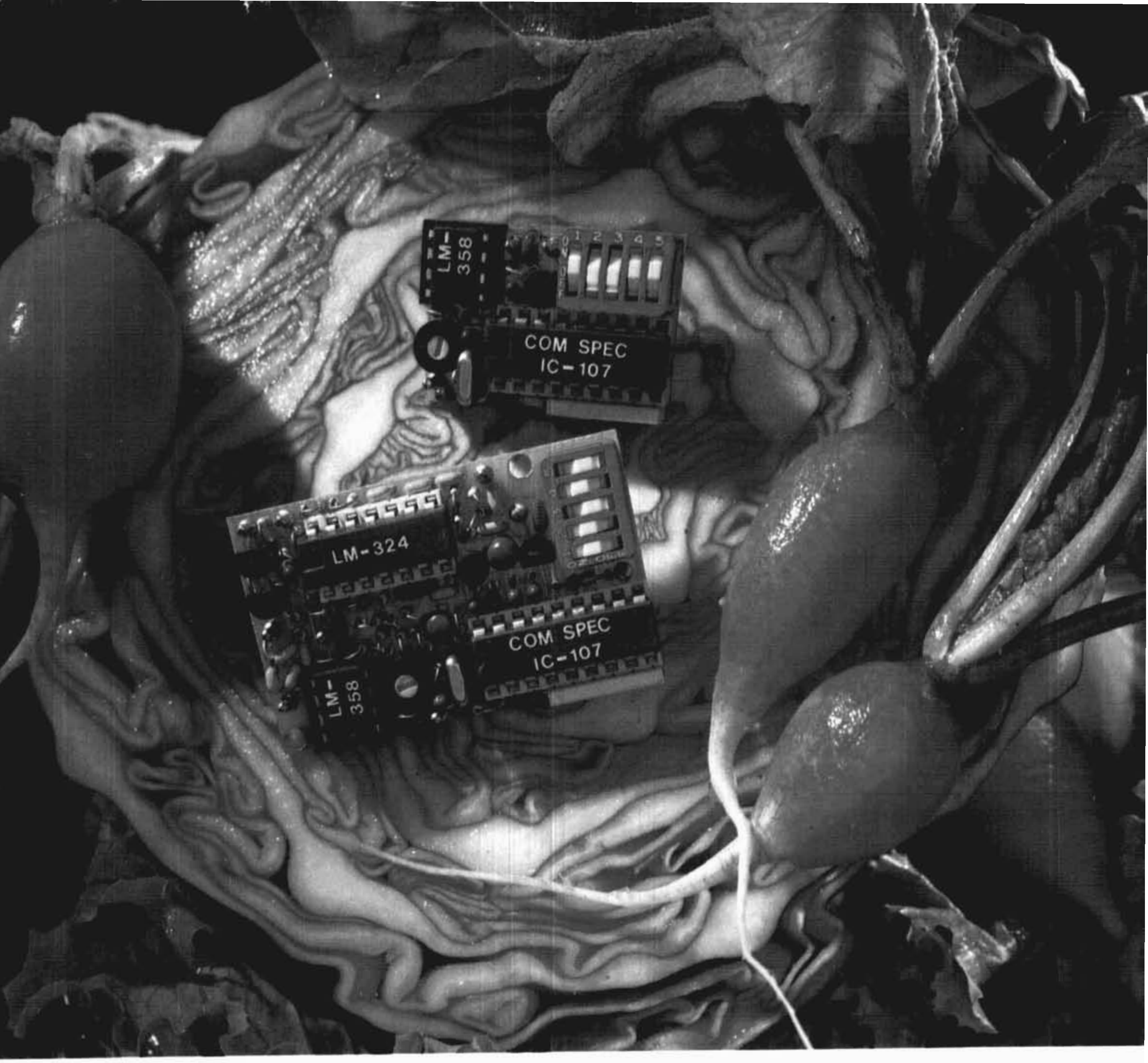


# A fresh idea!

Our new crop of tone equipment is the freshest thing growing in the encoder/decoder field today. All tones are instantly programmable by setting a dip switch; no counter is required. Frequency accuracy is astonishing ±.1 Hz over all temperature extremes. Multiple tone frequency operation is a snap since the dip switch may be remoted. Our TS-32 encoder/decoder may be programmed for any of the 32 CTCSS tones. The SS-32 encode only model may be programmed for all 32 CTCSS tones plus 19 burst tones, 8 touch-tones, and 5 test tones. And, of course, there's no need to mention our one day delivery and one year warranty.

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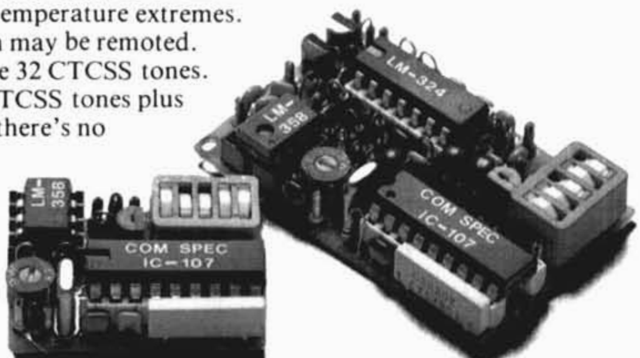


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SS-32 **$29.95**, TS-32 **$59.95**

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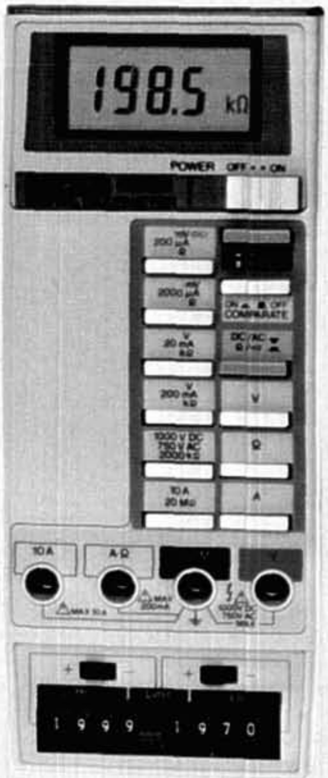
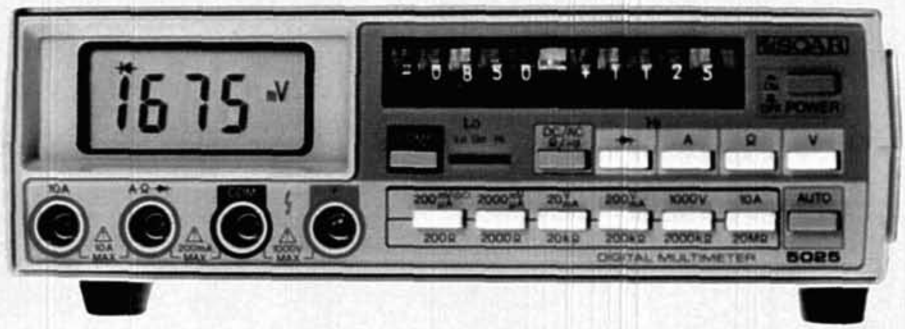
# NEW POWERFUL FLEXIBLE FAST RIGHT




**MODEL 5025**
**$239.00** (includes handle not shown)




**MODEL 3025**
**$179.00**

## SOAR CORP. MODELS 3025 & 5025

### NEW

The inside circuitry of these DMM's use SOAR CORP.'s custom 80-pin LSI chip to achieve a low parts count for long term stability and accuracy — outside, these units are housed in rugged ABS plastic cases, each designed for strength, durability and ease of use.

### POWERFUL

The 3025 and 5025 have a built-in comparator circuit that allows you to set a high and low limit for any function and range. This feature permits you to perform incoming component tests on items like resistors, right on through the confirming of logic levels in digital circuits. You don't even have to look at the readout since the beeper tells you if the measured value is within your pre-set limits — and it does it to an accuracy spec equal to that of the DMM's.

### FLEXIBLE

All of these advanced design models can be operated either auto or manual range.* You now have the best of two technologies available with the push of a switch. Models 3030 at $139.00 and 5030 at $169.00 are the same as the 3025/5025 but less comparator. Model 3050 less comparator and DCV accuracy of $\pm$ 0.5% is available for a modest $109.00 each. *except current

### FAST

You bet! In the manual range mode, all readings are displayed in one second or less, and around two seconds or less in the auto range mode. The continuity beeper sounds in less than a half second, we use tactile switches for fast positive function/range selection, and an easy access battery/fuse compartment make their inspection and replacement a snap.

### RIGHT

Sure it is! In addition to what we have already stated, these DMM's have 10 ampere AC/DC ranges, measure resistance from 0.1Ω through 20 MΩ, and they can withstand a surge of up to 6000V. The input impedance is a standard 10M Ohms except on the 200 mV range, where the input is a very high 1000M Ohms, so you don't load down your test circuit, therefore, improving low voltage reading accuracy. The DC accuracy spec. is $\pm$0.25% with calibration guaranteed for one year. The readouts have full annunciators so you know precisely the displayed value.

These SOAR CORP. DMM's are supplied with batteries, spare fuse and safety test leads, with one year parts and labor warranty. SOAR products are available from selected Distributors throughout North and South America.

**NORTH AMERICAN** SOAR corporation

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CHERRY HILL, N.J. 08002
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✓ 171

# Digital DX-terity...


## General coverage, Superior dynamic range, 2 VFO's, 8 memories, Scan, Notch... COMPACT!

# TS-430S

**The TS-430S combines the ultimate in compact styling with advanced circuit design and performance. An all solid-state SSB, CW, and AM transceiver, with FM optional, covering the 160-10 meter Amateur bands, it also incorporates a 150 kHz-30 MHz general coverage receiver having a superior dynamic range, dual digital VFO's, 8 memories, memory scan, programmable band scan, IF shift, notch filter, all-mode squelch, and built-in speech processor.**

TS-430S FEATURES:

- **160-10 meter operation, with general coverage receiver**
  With 160-10 meter Amateur band coverage, including WARC 30, 17, and 12 meter bands, it also features a 150 kHz-30 MHz general coverage receiver. Innovative UP-conversion digital PLL circuit, for superior frequency stability and accuracy. UP/DOWN band switches for Amateur bands or 1-MHz steps across entire 150 kHz-30 MHz range. Two digital VFO's continuously tuneable from band to band. Band information output on rear panel.
- **USB, LSB, CW, AM, with optional FM**
  Operates on USB, LSB, CW, and AM, with optional FM, internally installed. AGC time constant automatically selected by mode.
- **Compact, lightweight design**
  Measures only 10-5/8 (270) W x 3-3/4 (96) H x 10-7/8 (275) D, inches (mm), weighs only 14.3 lbs. (6.5 kg.).
- **Superior receiver dynamic range**
  Use of 2SK125 junction-type FET's in the Dyna-Mix high sensitivity, balanced, direct mixer circuit provides superior dynamic range.
- **10-Hz step dual digital VFO's**
  10-Hz step dual digital VFO's operate independently, include band and mode information. Different band and mode cross operation possible. Dial torque adjustable. STEP switch for tuning in 10-Hz or 100-Hz steps. A=B switch quickly shifts "B" VFO to the same frequency and mode as "A" VFO, or vice-versa. VFO LOCK switch provided. RIT control tunes VFO or memory. UP/DOWN manual scan possible using optional microphone.
- **Eight memories store frequency, mode, and band data**
  Memories store frequency, mode, and band data. Eighth memory stores receive and transmit frequencies independently. M.CH switch for operation of memory as independent VFO, or fixed frequency.
- **Lithium battery memory back-up**
  Estimated five-year life.
- **Memory scan**
  Scans memories in which data is stored.
- **Programmable automatic band scan**
  Scans programmed band width. Scan speed adjustable. HOLD switch interrupts band or memory scan.
- **IF shift circuit for minimum QRM.**
  IF passband may be moved to place interfering signals outside the passband, for best interference rejection.
- **Tuneable notch filter built-in**
  Deep, sharp, tuneable, audio notch filter.
- **Narrow-wide filter selection**
  NAR-WIDE switch for IF filter selection on SSB, CW, or AM, when optional filters are installed. (2.4 kHz IF filter built-in.)
- **Speech processor built-in**
  Improves intelligibility, increases average "talk-power."
- **Fluorescent tube digital display**
  Indicates frequency to 100 Hz (10 Hz modifiable).
- **All solid-state technology**
  Input rated 250 W PEP on SSB, 200 W DC on CW, 120 W on FM (optional), 60 W on AM. Built-in cooling fan, multi-circuit final protection. Operates on 12 VDC, or 120/220/240 VAC with optional PS-430 AC power supply.
- **All-mode squelch circuit, built-in**
- **Noise blanker, built-in**
- **RF attenuator (20 dB)**
- **Vox circuit, plus semi break-in with side-tone**


**Optional AT-250 Automatic Antenna Tuner**
Designed to match the TS-430S in size, color, and appearance. Functionally compatible with any HF transceiver of 200 watts PEP or lower. (Requires manual bandswitching.)
• Covers 160-10 meter incl. WARC
• ABC Automatic Band Changing System (when used with TS-430S) • SWR/Power meter • 4 antenna terminals • Built-in AC Power Supply.

**Other optional accessories:**

- PS-430 compact AC power supply.
- PS-30 or KPS-21 AC power supplies.
- SP-430 external speaker.
- MB-430 mobile mounting bracket.
- AT-130 compact antenna tuner, 80-10 m incl. WARC.
- FM-430 FM unit.
- YK-88C (500 Hz) or YK-88CN (270 Hz) CW filters.
- YK-88SN (1.8 kHz) narrow SSB filter.
- YK-88A (6 kHz) AM filter.
- MC-42S UP/DOWN hand microphone.
- MC-60A deluxe desk microphone, UP/DOWN switch.
- MC-80 UP/DOWN desk microphone.

More information on the TS-430S is available from all authorized dealers of Trio-Kenwood Communications, 1111 West Walnut Street, Compton, California 90220.

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*...pacesetter in amateur radio*

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