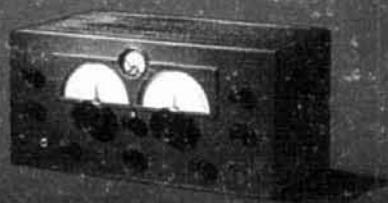


OCTOBER 1978 / \$2.00

# ham radio

magazine



STORE

COUNT

NOTCH

SELECTIVITY

2.3 1.8 1.5 1.3



MAIN/MA  
MAIN/ALT  
OFF/MAIN

NOTCH

DIAL LOCK

212796  
KHZ

71139

14213.8

SPECIAL  
4th Annual Receiver Issue



Shown with accessory touch tone pad

# 800

## channels in the palm of your hand

**Tempo presents the  
S1 SYNCOM...the world's  
first synthesized 800  
channel hand held  
transceiver**

This amazing pocket sized radio represents the year's biggest breakthrough in 2-meter communications. Other units that are larger, heavier and are similarly priced can offer only 6 channels. The SYNCOM'S price includes the battery pack, charger, and a telescoping antenna. But, far more important is the 800 channels offered by the S1.

The optional touch tone pad shown in the illustration adds greatly to its convenience and we have available a 30 watt solid state power amplifier designed to give the SYNCOM S-1 the flexibility of operating as a mobile and base station as well.

#### SPECIFICATIONS

Frequency Coverage: 144 to 148 MHz  
 Channel Spacing: Every 5 KHz  
 Power Requirements: 9.6 VDC  
 Current Drain: 17 ma - standby 400 ma - transmit  
 Batteries: Ni-cad battery pack included  
 Antenna Impedance: 50 ohms  
 Dimensions: 40 mm x 62 mm x 165 mm (1.6" x 2.5" x 6.5")  
 RF Output: Better than 1.5 watts  
 Sensitivity: Better than .5 microvolts

#### SUPPLIED ACCESSORIES

Telescoping whip antenna, ni-cad battery pack, charger.

#### OPTIONAL ACCESSORIES

Touch tone pad, tone burst generator, CTCSS chips, Rubber flex antenna

Price ... \$349.00 (or with touch tone pad ... \$399.00)

Tempo also offers a complete line of solid state power amplifiers, pocket receivers, the FMH-2, 5 & 42 portables, the VHF/ONE PLUS mobile transceiver, and the FMT-2 & FMT-42 remote control mobile transceiver. All available from Tempo dealers throughout the U.S.

Call or write for full information.

11240 W. Olympic Blvd., Los Angeles, Calif. 90064 213/477-6701  
 931 N. Euclid, Anaheim, Calif. 92801 714/772-9200  
 Butler, Missouri 64730 816/679-3127

# Henry Radio

Prices subject to change without notice

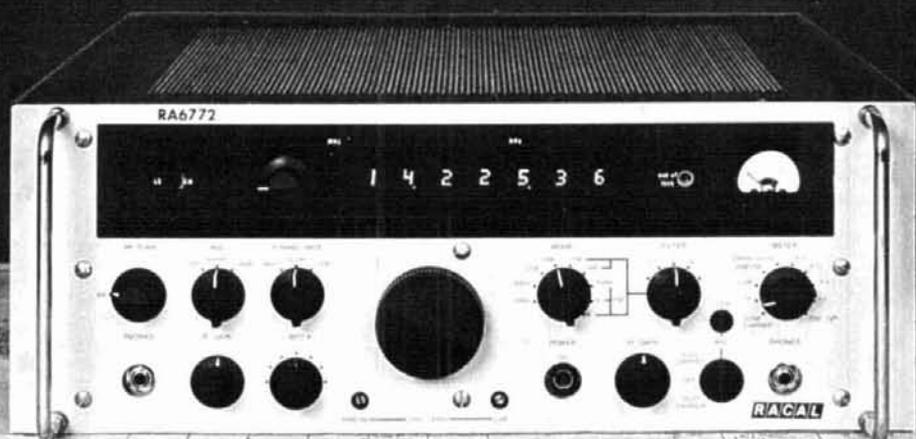
# For The "Professional" Amateur.

The RACAL RA6772. In use by Military and Government organizations the world over, this outstanding receiver is now available to the serious amateur operator.

Superb performance on the entire amateur band as well as all other bands. Frequency range of 15kHz to 30MHz with tuning increments in 10Hz steps. The RA6772 synthesized LF/MF/HF communications receiver, direct from the manufacturer. Call or write for details on this exceptionally fine equipment.

**RACAL**  
COMMUNICATIONS, INC.

5 Research Place, Rockville, Maryland 20850 • (301) 948-4420 • Telex 898-456 • Cable RACAL USA



# This NEW MFJ Versa Tuner II . . .

has SWR and dual range wattmeter, antenna switch, efficient airwound inductor, built in balun. Up to 300 watts RF output. Matches everything from 1.8 thru 30 MHz: dipoles, inverted vees, random wires, verticals, mobile whips, beams, balanced lines, coax lines.



NEW, IMPROVED MFJ-941B HAS . . .

- More inductance for wider matching range
- More flexible antenna switch
- More sensitive meter for SWR measurements down to 5 watts output

**BRAND NEW**

## \$89<sup>95</sup>

**Transmitter matching capacitor.** 208 pf. 1000 volt spacing.

**Sets power range,** 300 and 30 watts. Pull for SWR.

**Meter reads SWR and RF watts** in 2 ranges.

**Efficient airwound inductor** gives more watts out and less losses.

**Antenna matching capacitor.** 208 pf. 1000 volt spacing.

Only MFJ gives you this MFJ-941B Versa Tuner II with all these features at this price:

**A SWR and dual range wattmeter** (300 and 30 watts full scale) lets you measure RF power output for simplified tuning.

**An antenna switch** lets you select 2 coax lines direct or thru tuner, random wire/balanced line, and tuner bypass for dummy load.

**A new efficient airwound inductor** (12 positions) gives you less losses than a tapped toroid for more watts out.

**A 1:4 balun** for balanced lines. 1000 volt capacitor spacing. Mounting brackets for mobile installations (not shown).

With the **NEW MFJ Versa Tuner II** you can run your full transceiver power output — up to 300 watts RF power output — and match your



**ANTENNA SWITCH** lets you select 2 coax lines direct or thru tuner, wire/balanced line, dummy load.

transmitter to any teedline from 160 thru 10 Meters whether you have coax cable, balanced line, or random wire.

You can tune out the SWR on your dipole, inverted vee, random wire, vertical, mobile whip, beam, quad, or whatever you have.

You can even operate all bands with just

one existing antenna. No need to put up separate antennas for each band.

**Increase the usable bandwidth** of your mobile whip by tuning out the SWR from inside your car. Works great with all solid state rigs (like the Atlas) and with all tube type rigs.

**It travels well, too.** Its ultra compact size 8x2x6 inches fits easily in a small corner of your suitcase.

This beautiful little tuner is housed in a deluxe eggshell white Ten-Tec enclosure with walnut grain sides.

**S0-239 coax connectors** are provided for transmitter input and coax fed antennas. Quality five way binding posts are used for the balanced line inputs (2), random wire input (1), and ground (1).

## NEW 300 WATT MFJ VERSA TUNER II'S: SELECT FEATURES YOU NEED.

**NEW MFJ-945 HAS SWR AND DUAL RANGE WATTMETER.**

**\$79<sup>95</sup>**



Same as MFJ-941B but less 6 position antenna switch.

**NEW MFJ-944 HAS 6 POSITION ANTENNA SWITCH ON FRONT PANEL.**

**\$79<sup>95</sup>**



Same as MFJ-941B but less SWR/Wattmeter.

**NEW MFJ-943 MATCHES ALMOST ANYTHING FROM 1.8 THRU 30 MHz.**

**\$69<sup>95</sup>**



Same as MFJ-941B, less SWR/Wattmeter, antenna switch, mounting bracket. 7x2x6 in.

## ULTRA COMPACT 200 WATT VERSA TUNERS FOR ALL YOUR NEEDS.

**MFJ-901 VERSA TUNER MATCHES ANYTHING, 1.8 THRU 30 MHz.**

**\$59<sup>95</sup>**



Efficient 12 position air inductor for more watts out. Matches dipoles, vees, random wires, verticals, mobile whips, beams, balanced lines, coax. 200 watts RF, 1:4 balun, 5x2x6 in.

**MFJ-900 ECONO TUNER MATCHES COAX LINES/RANDOM WIRES.**

**\$49<sup>95</sup>**



Same as MFJ-901 but less balun for balanced lines. Tunes coax lines and random lines.

**MFJ-16010 RANDOM WIRE TUNER FOR LONG WIRES.**

**\$39<sup>95</sup>**



1.8 thru 30 MHz. Up to 200 watts RF output. Matches high and low impedances. 12 position inductor. S0-239 connectors. 2x3x4 inches. Matches 25 to 200 ohms at 1.8 MHz. Does not tune coax lines.

For Orders

# Call toll-free 800-647-1800

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

Order today. Money back if not delighted. One year unconditional guarantee. Add \$2.00 shipping/handling. For technical information, order/repair status, in Mississippi, outside continental USA, call 601-323-5869.

Order By Mail or Call TOLL FREE 800-647-1800 and Charge It On



## MFJ ENTERPRISES

P. O. BOX 494  
MISSISSIPPI STATE, MISSISSIPPI 39762

# ham radio

magazine

OCTOBER 1978

volume 11, number 10

**T. H. Tenney, Jr., W1NLB**  
publisher

**James R. Fisk, W1HR**  
editor-in-chief

**editorial staff**

Martin Hanft, WB1CHQ  
administrative editor

Charles J. Carroll, K1XX  
Patricia A. Hawes, WA1WPM  
Alfred Wilson, W6NIF  
assistant editors

Thomas F. McMullen, Jr., W1SL  
Joseph J. Schroeder, W9JUV  
associate editors

**publishing staff**

C. Edward Buffington, WB1AMU  
assistant publisher

Fred D. Moller, Jr., WA1USO  
advertising manager

James H. Gray, W1XU  
assistant advertising manager

Susan Shorrock  
circulation manager

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

**subscription rates**

United States: one year, \$12.00  
two years, \$22.00; three years, \$30.00

Canada: one year, \$14.00  
two years, \$26.00; three years, \$36.00

Europe, Japan, Africa:  
(via Air Forwarding Service)  
one year, \$25.00

North America, South America, Australia  
and Asia (except Japan):  
(via Surface Mail)  
one year, \$18.00

**foreign subscription agents**

Foreign subscription agents are  
listed on page 117

Microfilm copies  
are available from  
University Microfilms, International  
Ann Arbor, Michigan 48106  
Order publication number 3076

Cassette tapes of selected articles  
from *ham radio* are available to the  
blind and physically handicapped  
from Recorded Periodicals  
919 Walnut Street, 8th Floor  
Philadelphia, Pennsylvania 19107

Copyright 1978 by  
Communications Technology, Inc  
Title registered at U.S. Patent Office

Second-class postage  
paid at Greenville, N.H. 03048  
and at additional mailing offices  
Publication number 233340



## contents

**10 high-frequency  
communications receiver**

Norman J. Foot, WA9HUV

**26 low-noise  
432-MHz preamplifier**

Albert J. Ward, WB5LUA

**30 tracking calculations  
for superhet receivers**

Courtney Hall, WA5SNZ

**34 CW signal processor**

William B. Jones, W7KGG

**38 low-noise 30-MHz preamp**

James R. Fisk, W1HR

**42 1296-MHz local oscillator**

Paul C. Wade, WA2ZZF

**51 evaluating oscillator  
sidebands**

Ulrich L. Rohde, DJ2LR

**60 synthesized high-frequency  
local-oscillator system**

Raymond C. Petit, W7GHM

**68 reciprocating detector**

Stirling M. Olberg, W1SNN

**74. RTTY demodulator**

John M. Loughmiller, KB9AT

**80 high-sensitivity preamp  
for frequency counters**

Paul R. Kranz, W1CFI

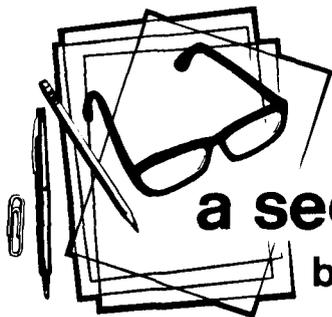
**84 twin-diode  
microwave mixer**

James L. Dietrich, WA0RDX

**89 two-meter preamplifier**

Herbert L. Bresnick, WB2IFV

- |                              |                             |
|------------------------------|-----------------------------|
| <b>4 a second look</b>       | <b>6 letters</b>            |
| <b>142 advertisers index</b> | <b>98 new products</b>      |
| <b>120 coming events</b>     | <b>8 presstop</b>           |
| <b>117 flea market</b>       | <b>142 reader service</b>   |
| <b>132 ham mart</b>          | <b>105 stolen equipment</b> |
| <b>94 ham notebook</b>       |                             |



## a second look

by Jim Fisk

**Our society is a very mobile one**, and with the recently lowered air fares, more people than ever before are traveling by air. It's only natural for the vhf-fm operator, with his portable fm rig, to question the possibility of using his equipment on commercial flights.

It is popularly believed that all you have to do is obtain the captain's permission to operate; surely your little two-watt fm rig is not going to cause any interference with the high-powered radio equipment used on board the aircraft. However, this is not the case — according to the Federal Air Regulations, approval must be obtained from the air carrier (airline) and not the pilot in command. However, once approved by the air carrier, the permission of the captain in command must *also* be obtained to operate equipment aboard a particular flight.

Shortly after World War II, portable Japanese fm broadcast receivers appeared on the market, and passengers started using them aboard commercial flights. At the same time, aircraft navigation radios started doing strange things, and it didn't take long to determine that the interference was being caused by rf radiation from the portable fm receivers. The aircraft radios literally went wild, and at least two aircraft accidents were attributed to interference of this type.

When it was determined that this interference was present, the FAA promulgated new regulations, paragraph 91.19 of the Federal Air Regulations. This paragraph states that no electronic device may be operated aboard a commercial airliner *except* heart pacemakers, voice recorders, hearing aids, calculators, electric shavers and electric watches, unless the device has been approved by the air carrier or operator. The regulation further states that *the captain of the aircraft does not have the authority to authorize such operation*.

Consider, for a moment, what might happen if such operation were allowed. Suppose you have been operating all across the country, and your plane is about to land. A passenger with a briefcase telephone sitting across from you has been watching you operate. About 10 minutes before landing, he decides to call his wife. Unfortunately, his radio telephone transmits right in the middle of the glide slope spectrum. As soon as his transmitter is keyed, the glide slope indicator cross pointer goes up or down, and the autopilot follows it. That could be disastrous.

As an airliner flies across the country, the pilot changes frequency every 5 minutes or so. If several fm operators are on the same flight, only one can talk at a time, so some may decide to switch to other frequencies. When you figure out all of the i-f and carrier frequencies of the aircraft radios, plus the amateur gear, plus all the possible mixing products, you can appreciate the magnitude of the problem.

A few years ago a well known vhf-fm operator prevailed upon an airline to test his Motorola HT in one of their aircraft so he could operate during a flight he planned to take. After months of correspondence and personal meetings with airline communications people (many of whom were amateurs), the airline agreed to run the necessary tests. On the appointed day the aircraft was removed from line operation and the test began; it took three hours and four men to complete. The HT caused no interference, and the amateur received a letter authorizing the operation of *that* HT on *that* particular trip in only *that* type of aircraft. It's easy to understand why the airlines, who are trying to cut costs, are not enthusiastic about testing an individual's vhf-fm equipment.

Many fm operators continue to ask the captain's permission to operate, and he may give it, not realizing the possible bind he is putting himself in; he could have his license suspended or he could be fired. Don't put him in that position, and don't subject yourself and other passengers to a situation which could be hazardous to all on board.

Remember, you may not cause any interference during the trip, but the ILS glide slope receiver is used only during the last few minutes of flight, so interference may not be noticed until it's too late!

**Jim Fisk, W1HR**  
editor-in-chief



ICOM

ICOM WEST, INC.  
Suite 3  
13256 Northrup Way  
Bellevue, Wash. 98005  
(206) 747-9020

ICOM EAST, INC.  
Suite 307  
3331 Towerwood Drive  
Dallas, Texas 75234  
(214) 620-2780

ICOM CANADA  
7087 Victoria Drive  
Vancouver B.C. V5P 3Y9  
Canada  
(604) 321-1833

HF/VHF/UHF AMATEUR AND MARINE COMMUNICATION EQUIPMENT

DISTRIBUTED BY:

All ICOM radios significantly exceed FCC specifications limiting spurious emissions.



ICOM  
stacks it all  
in your favor.



## comments

### zip-cord feedlines

Dear HR:

I feel that the article by W7RXV (*ham radio*, April, 1978, page 32) deserves a rebuttal. First, I doubt the accuracy of Fruitman's measurements on the coax. As a practicing antenna engineer, I have made rather precise measurements of the loss of both RG-58 and RG-8. The numbers that have repeated themselves time and time again are very close to 2.0 dB/30 meters for RG-58 at 20 MHz and 1.0 dB at 4 MHz. Thus, for a 20-meter run, Fruitman should have measured 20 per cent (versus his claimed 58 per cent) transmission loss at 20 MHz. The other numbers are off by a proportionate percentage.

More serious, however, is Fruitman's apparent disregard of measurement and use techniques between coaxial cable and balanced-wire line. When he says "the zip cord came down and the RG-58 went up" one must be a bit suspicious that the two different types of transmission cable were fed from the same connector. Moreover, one must then ask if he used the same measurement technique for both coax and twinlead without the use of baluns. Had he made the blunder of not using the twinlead properly, the errors he reports would be expected. The loss is not in the twinlead, but in the VSWR mismatch.

I have used lamp (zip) cord on the lower bands with reasonable results. Of course, you can't go out and buy just any old zip cord and hook it up without going through a bit of in-

vestigation. The impedance of zip cord varies from about 70 ohms (for the light duty wire) to about 30 ohms for the super-heavy duty cord. Loss is a bit better than the normal 75-ohm twinlead.

Jim Weir, WB6BHI  
VP Engineering  
Radio Systems Technology  
Grass Valley, California

### 51J product detector

Dear HR:

I would like to thank Bill Orr, W6SAI, for the fine article in the February, 1978, issue of *ham radio* which showed how to add a product detector to a Collins 51J receiver. I made this modification to my receiver and am very pleased with the change.

However, I did run into a problem which evidently did not crop up when Mr. Orr made his conversions. I found that when I turned up my audio gain, the receiver immediately started motor-boating. Investigation revealed it was not motor-boating, but was hash pick up from the filter unit of the power supply. I tried replacing the plug-in type filter capacitor, but this did not cure the problem. I finally had to add a 10- $\mu$ F filter capacitor at the junction of the screen and plate resistors.

Frisco Roberts, K5CE  
Corpus Christi, Texas

### pi networks

Dear HR:

The article by Irv Hoff, W6FFC, in the June, 1978, issue of *ham radio* on pi network design was well done and fulfilled a need for those interested in building equipment. However I'd like to point out one minor discrepancy in an otherwise excellent article that may cause some confusion. On page 63, Irv points out that an rf

choke should be used at the antenna output of any pi or pi-L network. All well and good, but nowhere in the article does the author indicate *how* this rf choke should be connected. Perhaps it is implicit in the text, but I think that a simple addition to **fig. 3** showing how to connect the choke would be appropriate. The rf choke should be strapped between the antenna output connector and *ground*. The choke is essential in such a circuit in series with the network output!

A. Wilson, W6NIF  
Encinitas, California

### phased antenna

Dear HR:

After looking at some of the beams (especially 40 meters) I came up with a cheaper way to get a signal to the West Coast, especially at night. The idea was copied from some of the other antennas — it's very easy to make. It uses half-wave dipoles in phase, and gives a nice bi-directional antenna. Taking in the velocity factor of RG-8, which is 0.66, I took  $492 \times 0.66$  and divided that by the frequency  $7.250 \text{ MHz} = 44' 9''$  for my phasing lines, one for each dipole.

I use a minimum of 1/8-wavelength spacing (16' 1"). I found very little difference between 1/4-wave and 1/8-wave spacing. I've checked it with several stations and, with a friend to compare signal reports with, I ran 500 W PEP while he ran the full 2 kw PEP. I averaged 2 to 3 S-units more than he did all the time. This same thing was tried on 75, and I got the same results. The stations on the West Coast gave me the best signal report. I hope this works as well for others as it has for me.

Jerry Thacker  
Francisco, Indiana

*Escape the rat race... try 440 MHz FM!*



**2 METERS IS GREAT! THAT'S WHY EVERYBODY IS ON THE BAND (SO IT SEEMS), AND YOU WILL HEAR THE POPULAR KENWOOD TR-7400A AND TS-700SP TRANSCEIVERS ON ALL THE REPEATERS AND SIMPLEX FREQUENCIES. BUT SOMETIMES YOU WISH THE BAND WERE NOT SO POPULATED... SO YOU COULD GET A WORD IN EDGEWISE... OR MONITOR A RELATIVELY QUIET CHANNEL FOR A FRIEND OR TWO... OR HEAR SIGNALS WITH LESS NOISE... OR USE A SOPHISTICATED REPEATER OR REMOTE BASE WITH BETTER COVERAGE. 440 MHz IS THE ANSWER. IT WILL SURPRISE YOU. IT WILL PENETRATE BUILDINGS WHERE 2 METERS WON'T, AND OFTEN YOU CAN EVEN WORK OUT FROM UNDERGROUND GARAGES... WHERE 2 METERS IS DEAD! BEST OF ALL, IT'S EASY TO GET ON 440 MHz (70 CM)... WITH A KENWOOD TR-8300 TRANSCEIVER. HIGH QUALITY IS CRITICALLY IMPORTANT ON UHF BANDS, AND THE TR-8300 IS JUST WHAT YOU NEED TO MEET ALL TECHNICAL REQUIREMENTS. IT FEATURES:**

- 10 watts RF output (switchable to 1 watt)
- 23 crystal-controlled channels (3 supplied)
- 445.0-450.0 MHz transmit range
- 442.0-447.0 MHz receive range
- Transmitter and receiver adjustable over any 5-MHz segment from 440 to 450 MHz
- 5-section helical resonator and 2-pole crystal filter in IF to reject intermod
- SWR protection in final amplifier
- Excessive-voltage and reverse-polarity protection circuits
- 0.5  $\mu$ V for 20 dB quieting sensitivity
- Better than -60 dB spurious radiation
- 20 KHz (-6 dB), 40 KHz (-70 dB) selectivity
- Monitor switch that lets you check modulation and frequency "netting"
- Call CH switch that activates optional CTCSS (subaudible tone) function
- Large S meter

***Move up to 440 MHz today... with a Kenwood TR-8300... for more reliable communications!***

# presstop

BALLOON MOBILE AMATEUR RADIO provided the Double Eagle II with vital communications as the 112 foot high balloon became the first free-air craft to cross the Atlantic. The balloonists, operating as W50CP on 14325 kHz, maintained contact with their ground crew in Bedford, Massachusetts, using an Atlas transceiver.

Though None Of The Three balloonists were themselves Amateurs, there were Amateurs (including W50CP) in the Eagle II's ground support crew. The Atlas had been taken along for compact, lightweight backup communications, and when the crew found themselves without other communications halfway through their trip, their emergency use of Amateur frequencies under paragraph 1381 of the International Radio Regulations was not inappropriate.

Another Adventurer, Naomi Uemura, JG1QFW, was in Washington in late August for a press conference and a celebration of his accomplishment: reaching the North Pole solo. With much of the trip's communications burden carried by Amateur Radio, lots of good PR should result.

THE FCC'S BAN ON 10-METER LINEARS came an important step closer to being challenged when the ARRL filed, in late August, a Petition for Review of the controversial decision in the United States Court of Appeals, District of Columbia Circuit. This in effect gives the League 45 days in which to prepare a brief on the matter, and, with the League Executive Committee meeting at mid month, the final decision on just how far they'll carry the matter should be made then.

Amateur Use Of ASCII for RTTY is the sole subject of the Notice of Inquiry and further Notice of Proposed Rule Making on the "Bandwidth Docket" — 20777. The NPRM will propose adding ASCII to the permitted emissions for Amateurs, while the NOI will ask what specific standards should go into the new rules. Comment Due Date on this Notice of Inquiry and NPRM is November 15, with Reply Comments due December 16.

The FCC-Amateur Media Meeting proposed for this month will probably be devoted to Amateur exams — content, study guides, exam administration both in and out of the FCC, and the like. Dates are available at Gettysburg, but it could be further delayed if a 10th Notice of Inquiry on WARC 79 requires a meeting of the Advisory Committee on Amateur Radio, which could be held at the same time.

A SIGNIFICANT ANTENNA VICTORY has been achieved by W6QOL. The pro-Amateur Radio decision in this case, rendered by the Federal District Court, prohibits the city of Placentia, California, from limiting W6QOL's antenna to 25 feet.

By Its Decision, that court directly contradicted the California State Court's decision that Cerritos, California, had the right (in the N6QQ case) to limit an Amateur's antenna height. Thus it appears that the Supreme Court, which declined to rule last spring on the N6QQ decision, will again become involved in the battle, as there are now contradictory decisions that must be resolved in the same area of law.

Another Antenna Battle appears to have been won in Farmington, Michigan, a Detroit suburb. Despite strong objections from home owners, the Farmington Heights Planning Commission has come out in favor of tripling the permitted height of radio towers from the present 25 to 75 feet. In a new ordinance sent to the city council, the planning commission proposed increasing the maximum to 75 feet, but with the proviso that the tower height could be no more than half the width of the lot.

1979 ARRL DX CONTEST, having been reduced by the Board of Directors to one weekend per mode, will be held in March with the first weekend for phone and the third for CW. Preference for February dates from large numbers of U.S. stations has been strong, citing building low-band noise from spring storms as a major problem. But, an informal poll of overseas participants indicated a preference for March dates.

DURING TORRENTIAL RAINS that brought death and destruction to south and central parts of Texas, Amateurs served a vital communications role. Nearby Amateurs received first word of the disaster at 6:00 AM on August 2, when K5RZD called into San Antonio via repeater to ask for helicopter evacuation of flood survivors from Medina. At about the same time, the U.S. Weather Service was calling EC WA5RNV asking for Amateur communications help. Until the waters started to recede late in the weekend, an estimated 100 Amateurs worked around the clock providing much needed communications for rescue workers and survivors. In addition to providing disaster communications, a number of Amateurs monitored flood gauges throughout the affected countries to provide Weather Service Chief Hydrologist George Kush with vital data for predicting which areas were threatened and needed to be evacuated.

THE FIFTH 2-METER "WAS" has been earned by K1WHS thanks to K9SS and his Idaho operation.

ANYONE DESIRING CATV cable and/or connectors per the Woods article in September, ham radio, should send a self-addressed, stamped envelope to Box 7111, Phoenix, Arizona 85011.

# A Blend of Art and Amplifier

There are certain times when amplifiers transcend their function and approach the status of art. An amplifier as a reliable source of power is fundamental, an amplifier as an artful precision instrument is unique.

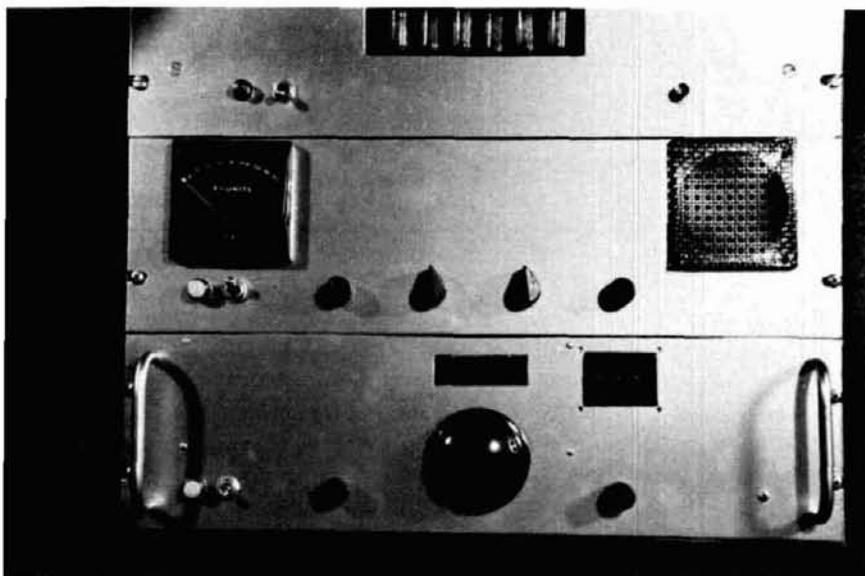
The DTR-2000L achieves this uncommon standard by employing the most powerful final tube legally permitted in the amateur service. The world famous Eimac 8877. Then, following through with features such as a vacuum impregnated power transformer, continuous duty power supply, hi-lo power switching, pressurized forced air cooling, harmonic suppression far exceeding FCC specification, dual meters for monitoring plate voltage and current.

We are confident you'll agree that the DTR-2000L is an exciting blend of art and amplifier. Now available at Dentron dealers throughout the world.

- Covers 160-15 meters & most MARS freqs.
- Continuous 1KW input CW, SSTV, RTTY, 2KW PEP SSB
- Built-in adjustable ALC
- Easily changed 117V or 234V AC, 50-60 Hz
- FCC TYPE ACCEPTED
- DTR-2000L suggested price \$1099.50



**Dentron**®  
Radio Co.  
2100 Enterprise Parkway  
Twinsburg, Ohio 44087  
(216) 425-3173



## digitally programmable high-frequency communications receiver

High-frequency receiver  
for 1-30 MHz  
features up conversion,  
frequency synthesis,  
and novel digital control  
of the rf  
and mixer circuits

The high-frequency communications receiver described here includes a unique digital interface that provides it with unusual capability. The receiver covers selected portions of the high-frequency spectrum between 1.8 and 30 MHz with the aid of a frequency synthesizer that is an integral part of the digital display. Coverage includes all of the amateur bands, two bands which include WWV, several of the international short-wave broadcast bands, and most of the CB band. Coverage is not limited to these bands. In fact, the basic scheme is such that the receiver can be set up to cover the entire range from 1.8 to 30 MHz.

### development

This unusual receiver was developed strictly as a hobby over a period of about a year. The object was to design and build a high-performance breadboard model that could be controlled from the front panel through a digital interface. In many respects, the result represents a radical departure from conventional receiver design. Once the basic scheme was conceived, it was only a matter of building up the

By Norman J. Foot, WA9HUV, 293 East Madison Avenue, Elmhurst, Illinois 60126

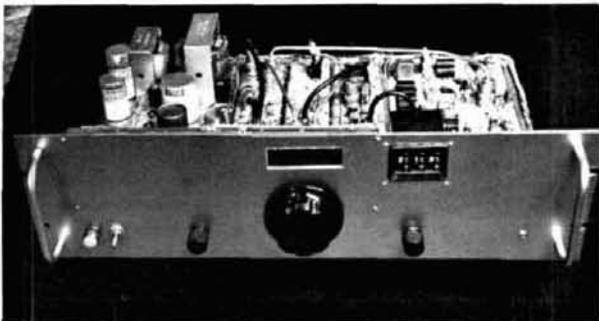
various functional blocks, integrating them, connecting the interface, and checking out the entire system. At first blush this seemed easy, but assuredly it was not.

It is difficult to describe all of the details of the programmable receiver in one magazine article. Therefore, this article will include a general description of the overall scheme with the aid of functional block diagrams, so that a clear understanding of the basic idea will be gained. An overall wiring diagram of the frequency counter is not included, but special emphasis will be given to the circuits associated with the frequency synthesizer. Other circuits that will be described are those considered to be unique, such as logic control and the high-frequency oscillator.

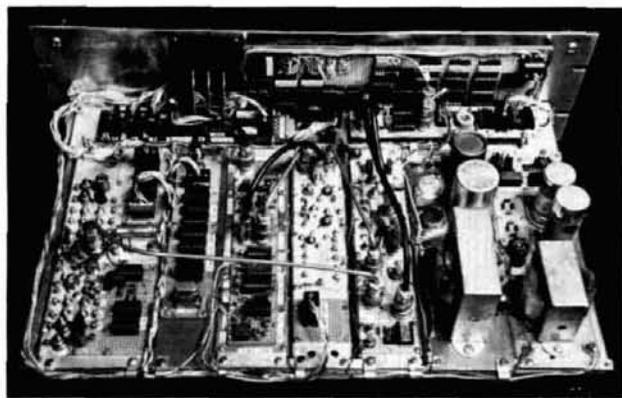
### general description

To simplify the development process, the decision was made to divide the receiver into physical sub-assemblies or modules, each including circuitry that logically belongs together. Each individual module was fitted with BNC connectors for rf and i-f interconnections, and 14 pin DIP sockets were used for logic and power. While this modularized approach added considerably to physical size and circuit complexity, it provided a way to easily and quickly remove modules to facilitate debugging, modifications, and repair. Pertinent test points were included on each module. Extender cables were used to operate the receiver with one or two modules removed from the main frame.

The modules are mounted on a pair of  $28 \times 43 \times 5$  cm ( $11 \times 17 \times 2$  inch) aluminum chassis, each equipped with a standard 13.3-cm (5-1/4-inch) high relay rack panel. The lower deck houses the circuits that function to select and display the frequency to which the receiver is tuned, and to convert incoming signals to 32 MHz. The upper deck contains the final mixer and all of the 1650 kHz i-f, mode select, detection, and audio circuitry. These two decks are re-



Construction of the 32-MHz deck which includes the main tuning control, frequency display, thumbwheel switches, and rf gain control.



Rear view of the 32-MHz deck showing the perf-board construction.

ferred to as the 32-MHz and the 1650-kHz decks.

Now that the design has been confirmed by the working breadboard model, it should be a relatively simple matter to physically reconfigure the receiver to fit into a single, standard-size enclosure.

No printed-circuit layouts have yet been prepared. All of the digital circuits were assembled by hand using pieces of perforated epoxy fiberglass with a hole matrix on 2.5-mm (0.1-inch) centers, such as Vector 169P84. Component parts were hand wired and soldered using a combination of wire wrap technique and no. 26 (0.4 mm) tinned copper wire insulated with Teflon sleeving.

A major challenge for those wishing to reproduce this receiver is to reduce the counter and other IC boards to printed circuits. The counter board alone includes 27 integrated circuits of which six are LED displays. The total IC count is 71. There are a total of 13 DIP sockets used for power, and three sets of 8 DIP switches. In addition, there are 34 transistors including series pass regulators in the power supplies, and 44 diodes including switching and power supply rectifiers and zener regulators.

The overall gain of the receiver from antenna to product detector output is approximately 122 dB when all controls are set for maximum. Overall sensitivity is  $0.2 \mu\text{V}$  for 10 dB S + N/N ratio, which is more than adequate for most high-frequency requirements.

The front panel of the 32-MHz deck has a three-digit thumbwheel for band and band segment selection, a vfo knob for tuning 100-kHz band segments, and a six-digit seven-segment LED display which indicates the antenna frequency to within  $\pm 100$  Hz. The accuracy of the readout is based on a 1.0 MHz crystal clock which is zero beat with WWV. There is also a unique antenna trimmer, an rf gain control, pilot light, and power switch.

The 1650-kHz deck includes a mode switch which

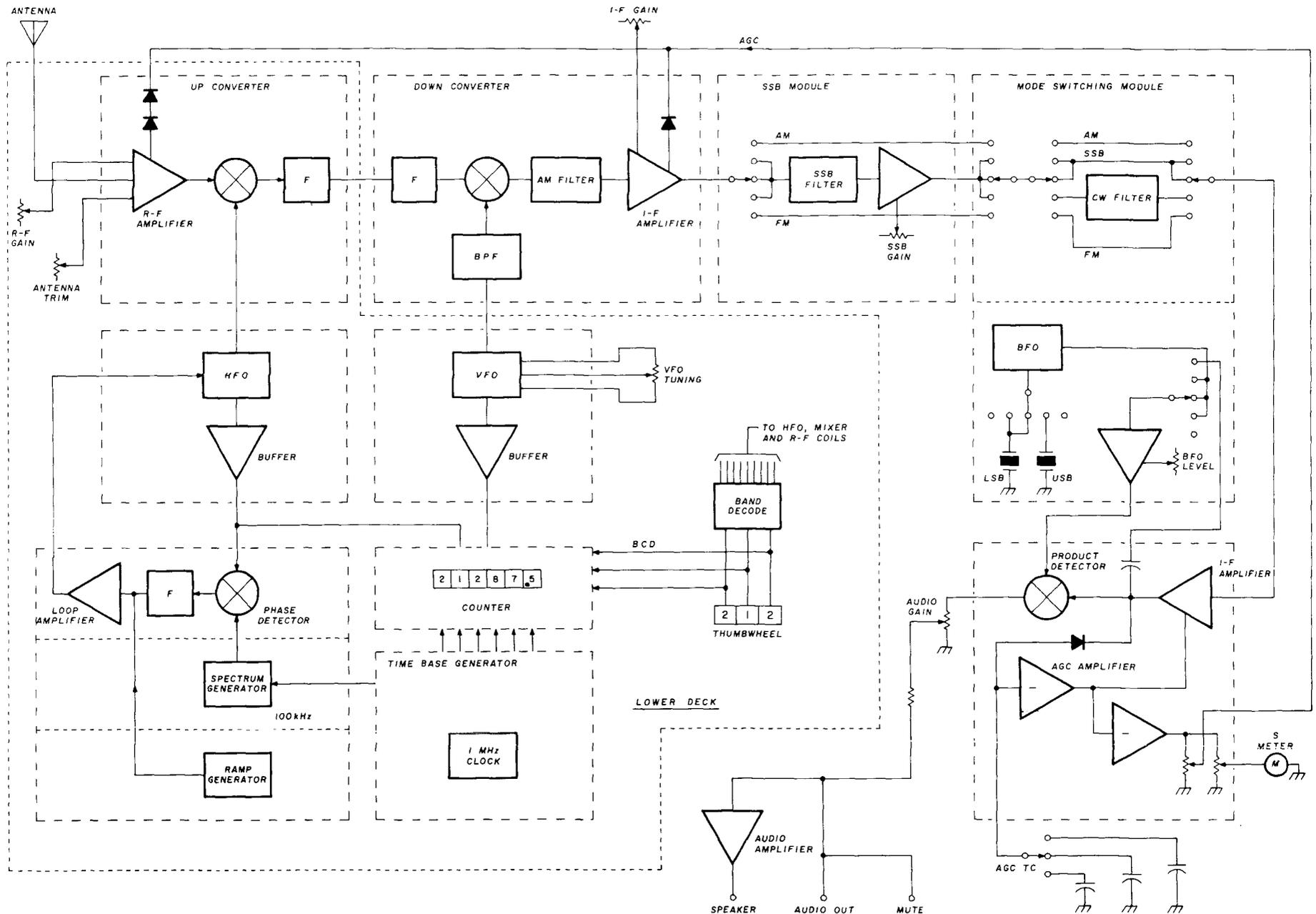


fig. 1. Simplified block diagram of the digitally programmable high-frequency communications receiver, showing the modular construction. The receiver features up conversion to 32 MHz, a frequency synthesizer, and diode-switched front-end and mixer circuits.

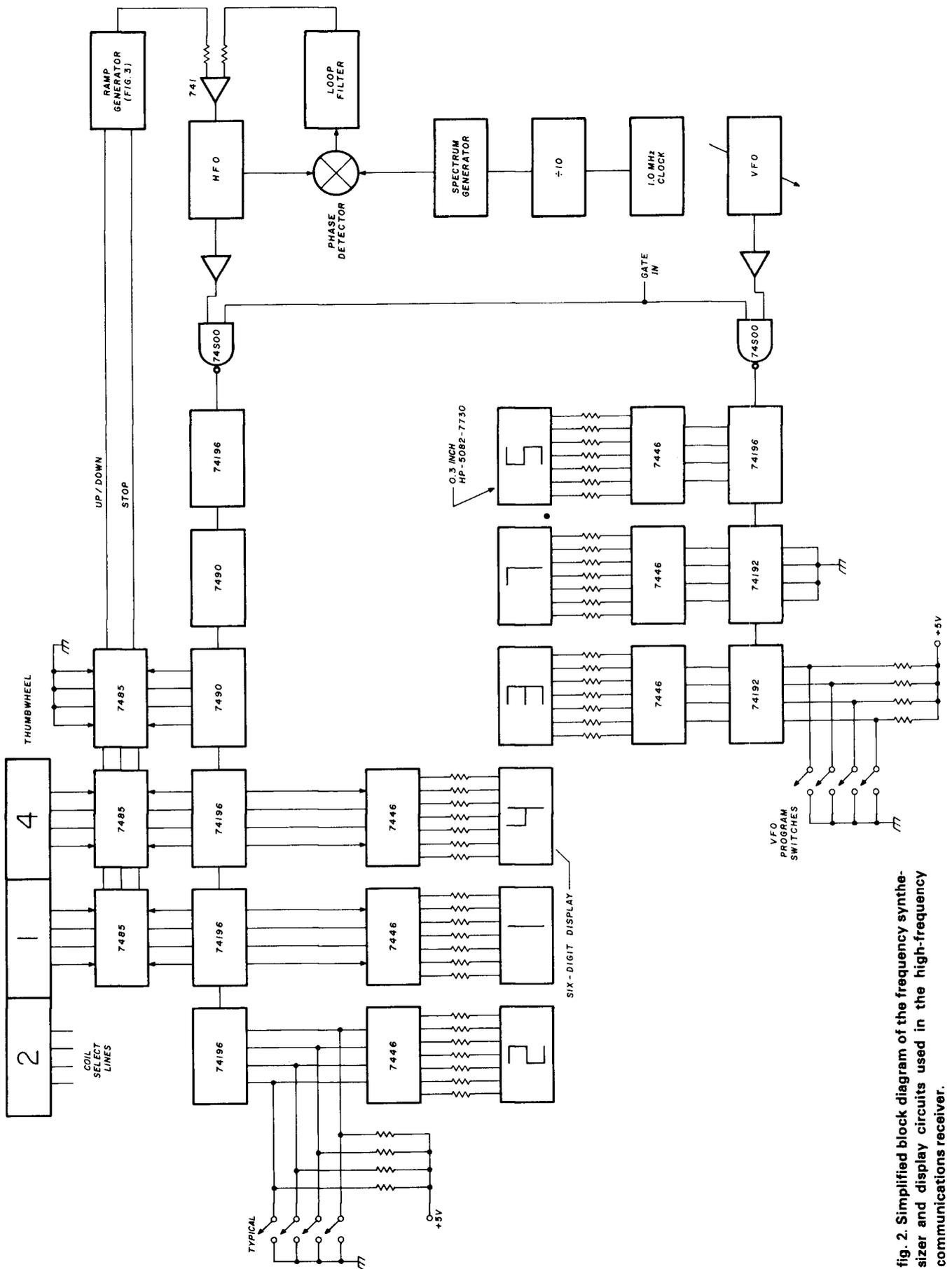


fig. 2. Simplified block diagram of the frequency synthesizer and display circuits used in the high-frequency communications receiver.

allows selection of a-m, USB, LSB, CW, or fm; agc release switch, S-meter, audio gain control, i-f gain control, pilot light, power switch, and a small loud speaker. Each deck includes its own regulated power supply.

Both the band-select thumbwheel switches and the mode switch output TTL compatible binary codes. The bandswitch thumbwheels provide a cer-

### basic receiver design

The ground rules for high performance in a general-coverage receiver were elegantly described by Wayne Ryder, W6URH, in his recent *ham radio* article.<sup>1</sup> He discusses the design criteria for general coverage, and gives illustrations of up-conversion schemes designed to minimize interference from the various radio services.

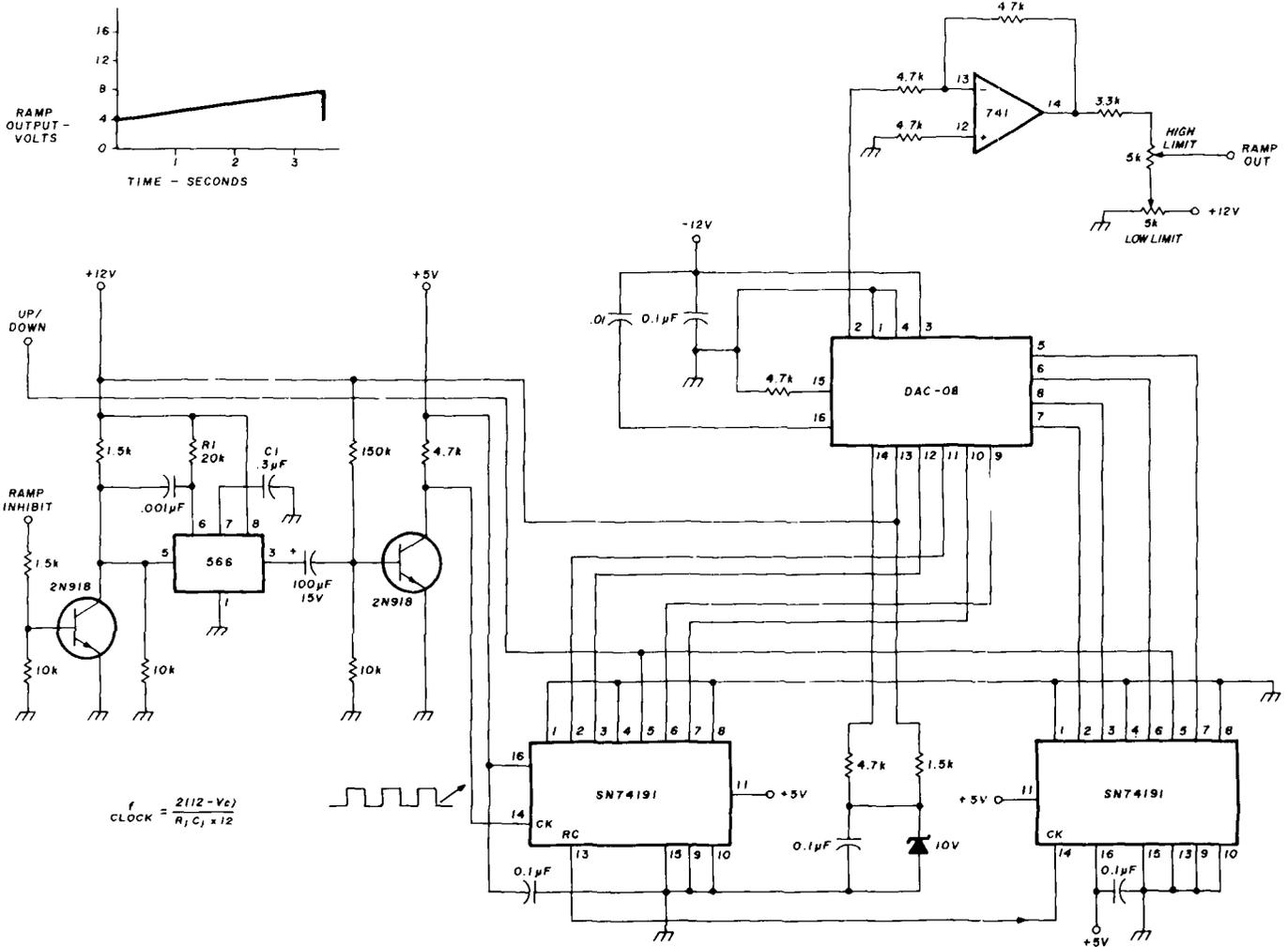


fig. 3. Ramp generator used to control the high-frequency oscillator. The tuning ramp is derived from a 566 function generator and a pair of 74191 up/down counters which drive an 8-bit digital/analog converter. All DIP packages are shown as viewed from the bottom.

tain amount of redundancy, since the TENS, UNITS, and TENTHS MHz displays always agree with the decimal numbers programmed into the thumbwheel windows. This verifies that the receiver has indeed responded correctly to the command. If an invalid command is entered, such as 1.5 MHz, for example, the audio output and display are gated off until such time as a valid command is programmed.

The programmable receiver described here is also designed for general coverage, although the model I built covers selected portions of the high-frequency spectrum. It is a double-conversion system with the first i-f above and the second i-f below the tuning range. The choice of 32 MHz as the first i-f places the first local oscillator (hfo) between 33.8 and 61.9 MHz; therefore, the image band is between 65.8 and



**High-frequency oscillator module.** The band-select signals are connected through the DIP socket.

93.9 MHz. Although this choice may not be optimum in terms of possible interference from local TV or fm stations, the tuned front-end rf circuitry provides sufficient image rejection so that this kind of problem has not been encountered, even though I live near a major metropolitan area.

To adequately describe the programmable nature of this receiver, it is first necessary to explain the block diagram shown in fig. 1. The front end includes an rf amplifier and first mixer. The rf input signal is up-converted to the first i-f, which has a pass-band covering 31.9 to 32 MHz. The hfo signal is derived from the frequency synthesizer and operates from 33.8 to 61.9 MHz. The vfo for the second converter tunes continuously between 30350 and 30250 kHz to down-convert the 32-MHz signals to 1650 kHz.

The digital readout uses six seven-segment LED displays. The three left-hand digits respond to a

counter driven by the hfo; the three right-hand digits are driven by the vfo. Programmable counters are used so the display corresponds to the antenna frequency rather than either the vfo or the hfo. The TENS, UNITS, and TENTHS of MHz are selected by the setting of the thumbwheel. The TENS, UNITS, and TENTHS of kHz digits read from 0.00 to 99.9 as the vfo knob is turned clockwise across its range. Thus, the thumbwheel serves as the bandswitch while the vfo knob bandspreads 100-kHz band segments.

The first conversion scheme is described analytically as follows:

$$f_{hfo} = f_s + 32000 \text{ (frequencies in kHz)}$$

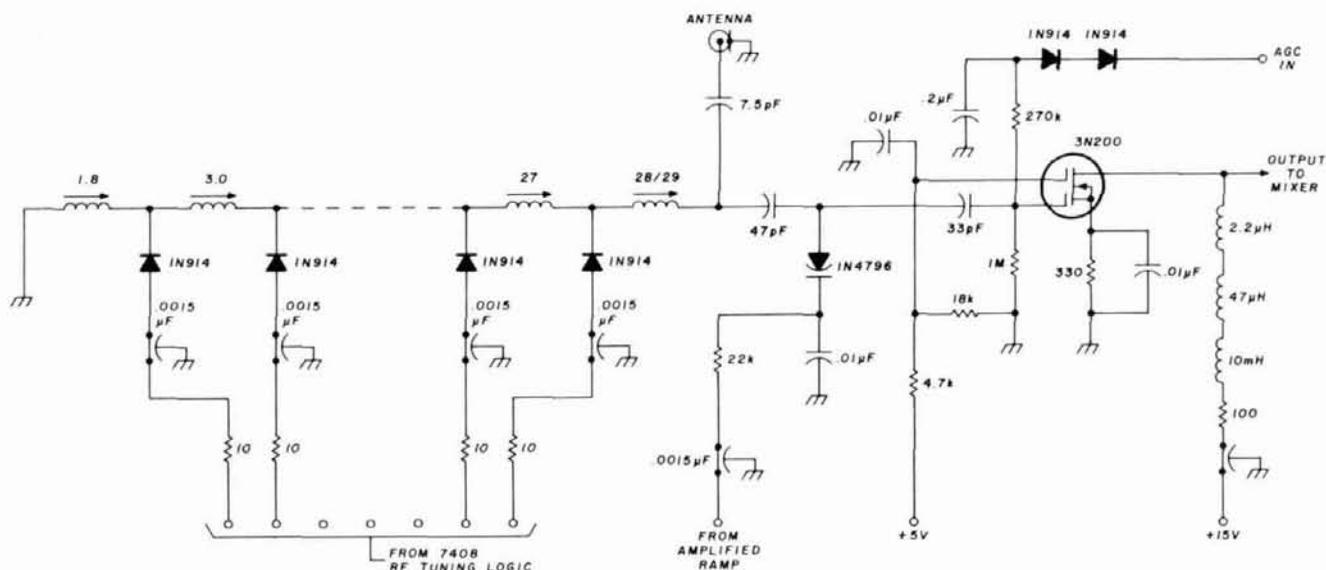
where  $f_s$  is the signal frequency at the low end of a 100-kHz band segment. For example, if the receiver is tuned to 1800 kHz, the hfo will be phase-locked to  $1800 + 32000 = 33800$  kHz. The hfo setting for the 28.0 MHz band segment would be 60000 kHz.

The second converter down-converts the 32000 to 31900 kHz i-f band to 1650 kHz. This requires a vfo that tunes from 30350 to 30250 kHz, in that order, so that an up-converted signal that falls within the 32-MHz passband will be down-converted to 1650, depending on the setting of the vfo. Therefore, the overall conversion scheme is:

$$f_s(\text{low end}) = f_{hfo} - 1650 - 30350$$

$$f_s(\text{high end}) = f_{hfo} - 1650 - 30250$$

For example, if the digits set into the thumbwheels



**fig. 4.** Schematic diagram of the diode-switched rf amplifier. Band selection is accomplished by providing forward current to the 1N914 diodes to short circuit portions of the inductor to ground. Similar arrangements are used in the mixer and high-frequency oscillator.

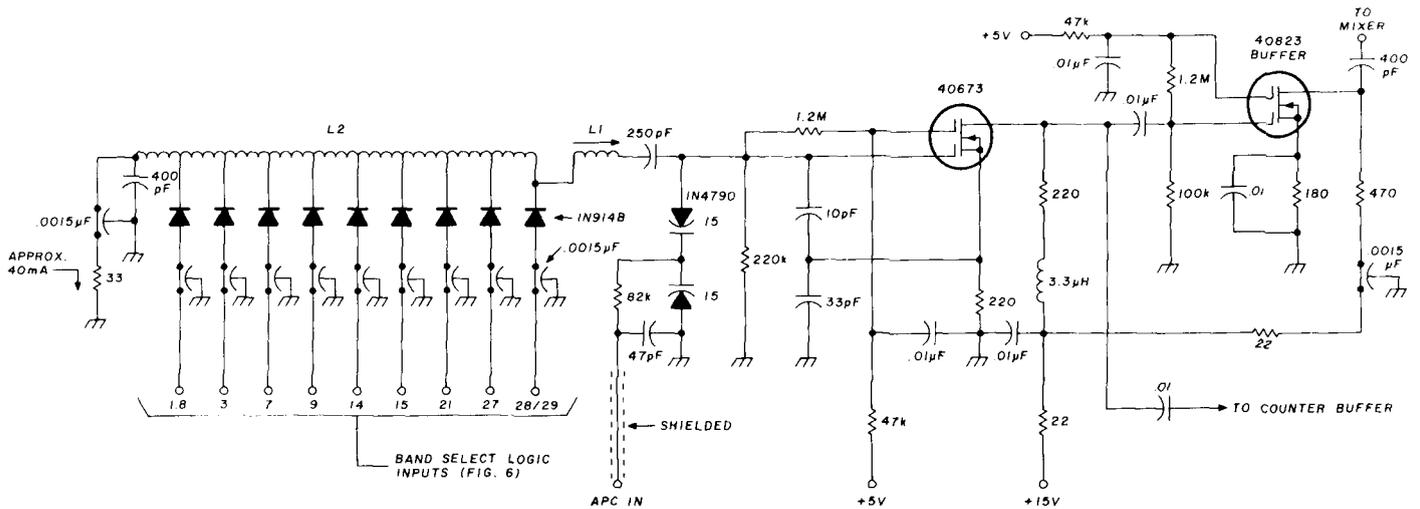


fig. 5. Circuit diagram of the digitally controlled high-frequency oscillator. Band-select logic is similar to that used in the rf amplifier and mixer circuits in that forward-biased diodes are used to change the value of L2.

are 141, the hfo frequency is 46100 kHz and the vfo tunes from 14100 to 14200 kHz.

Special care was given to the design of the vfo since it is free running and operates at a relatively high frequency. The design goal was for less than  $\pm 2$  kHz drift during the first ten minutes of warmup, and less than  $\pm 100$  Hz thereafter. Short-time drift and phase jitter were reduced to negligible values by careful bypassing and post regulation of the power supply.

A series of experiments were performed which were aimed at synthesizing the vfo, to provide it with 10-Hz steps in conjunction with a front-panel tuning knob. However, the approach using continuously variable vfo tuning was selected because of its infinite resolution which gives the operator that "smooth" feel. The ten-turn potentiometer used for vfo tuning gives more than adequate resolution, and allows ssb signals to be tuned in quickly and easily. One turn of the vfo knob represents 10 kHz of tuning range. The RIT control was added primarily for use in net operation.

The i-f circuits following the second mixer are fairly conventional, with the possible exception of the AM3705 analog multiplexers, which are used for mode switching. Changing modes is accomplished with a front-panel switch that outputs 3-bit binary words to drive the multiplexers located at appropriate places in the receiver. These multiplexers perform such functions as bypassing the ssb filter when operating a-m, selecting the upper or lower sideband bfo crystal, and inserting the narrow CW crystal filter into the rf chain in the CW mode. While the switching functions are illustrated on the block diagram by

conventional switch symbols, all switching is actually done by binary control from the panel.

The i-f amplifier is a Motorola MC1590G which drives MC1596G product detector. This combination is ideal because it allows a single product detector to be used for a-m, ssb, and fm. The 1590 provides more than 60 dB of agc. In this receiver the agc range is extended by using delayed agc on both the rf and i-f preamplifier stages, the longest delay being associated with the rf stage.

The agc voltage is tapped off the agc amplifier and fed to an op amp; the op amp drives both the delayed agc circuits as well as the S-meter. This approach provides a simple way of using a 0-1 mA meter as the S-meter. Calibration of the S-meter was accomplished by inserting a Kay attenuator in the i-f circuit, feeding a signal to the antenna, and recording the deflection of the S-meter for various attenuation values. Full scale is adjusted by a potentiometer on the op-amp output, while zero is set by removing the antenna and adjusting the agc gain control associated with the MC1590.

A GE PA-237 integrated circuit is used as the audio amplifier; this drives a small speaker behind the panel of the 1650 kHz deck. This is an optional feature which admittedly was added for esthetic purposes to balance the front panel arrangement. Generally the output of the product detector is used to directly drive a stereo amplifier, although the built-in speaker allows the receiver to be used independently.

That part of the overall functional block diagram (fig. 1) which is inside the dotted lines belongs to the 32-MHz deck. It is primarily involved with the counters and display, the hfo and vfo, and the digital inter-

face. The balance of this article will concentrate primarily on the details of these circuits, which collectively are the heart of the frequency synthesizer.

### function of the counter

The counter plays an important role in controlling the hfo frequency, and it also provides the outputs to drive the display. Fig. 2 is a block diagram which illustrates the basic scheme, but for clarity some of the functional circuits have been omitted. For example, DIP switches mounted on the counter board are used to program the TENS, UNITS, and TENTHS MHz counters. Only one set of these switches is shown in fig. 2. Logic inputs such as GATE, LOAD, and RESET circuits have been omitted. An excellent article by WB2DFA, which appeared in *ham radio*<sup>2</sup>, illustrates

many of the counter, logic, display, and time base generator circuits, some of which are used in this programmable receiver. Wiring diagrams of some of the more sophisticated up/down programmable counters will be described later. An article by Phillip Rand, W1DBM, in *QST*<sup>3</sup> is recommended if you want a better understanding of these circuits.

For the receiver described here to work properly, it is necessary that the hfo be phase locked to harmonics of 100 kHz derived from the 1.0 MHz clock. It is absolutely essential that the hfo be locked to the correct harmonic or line number. This is automatically accomplished by means of a ramp which tunes the hfo to within a few kHz of the correct spectral line. By definition, the hfo is part of a frequency synthesizer that has the capability to output any one of 281

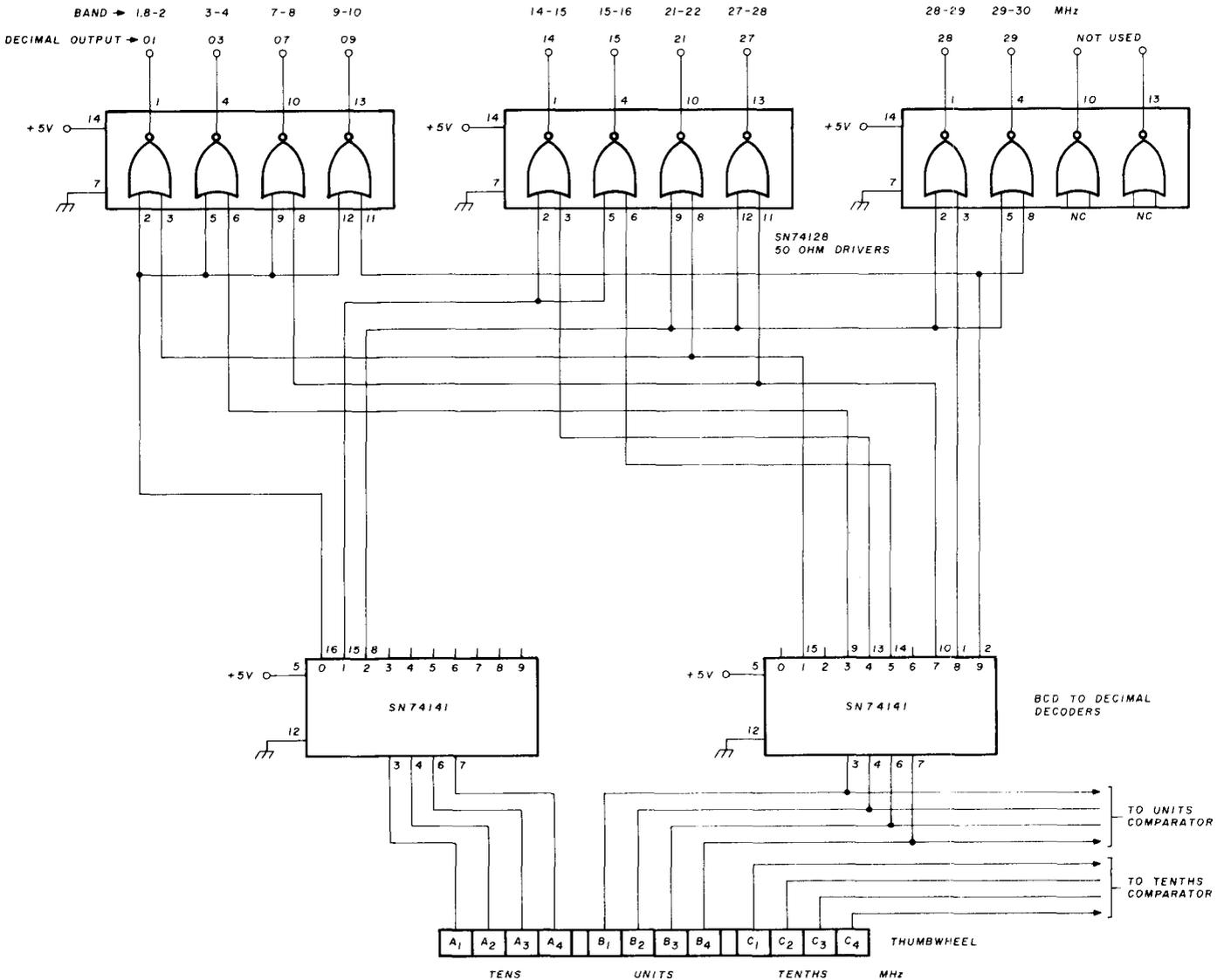


fig. 6. Digital band selector circuit provides binary commands for coil switching in the rf amplifier, mixer, and high-frequency oscillator. To maintain circuit tracking, the same voltage ramp is used to tune all three circuits.

table 1. Low band edge high-frequency oscillator (hfo) frequencies.

input signal frequency (MHz)	hfo frequency (MHz)
28.00	60.00
27.00	59.00
21.00	53.00
15.00	47.00
14.00	46.00
9.00	41.00
7.00	39.00
3.00	35.00
1.80	33.80

frequencies between 33.8 and 61.9 MHz. Specifically, these are 33.8, 33.9, 34.0, . . . 61.7, 61.8, and 61.9 MHz. In the breadboard receiver I built, 91 of these outputs are available, corresponding to a total frequency coverage of 9200 kHz. It is not difficult to modify the system to include additional bands or to change existing bands to cover other frequency ranges.

binary numbers counted, the ramp is inhibited. At this time, the hfo is close enough to the desired 100-kHz line that there can be no ambiguity. In theory, the frequency error immediately prior to lock-up is never more than 6.19 kHz, although in practice it may be slightly larger. Fig. 2 includes functional blocks which illustrate how coarse tuning is accomplished in association with the display counter. Note that the third comparator which is associated with the HUNDRETHS hfo MHz is hard wired to respond to zero. This counter stage is not associated with the display.

The tuning ramp is derived from a 566 function generator and a pair of 74191 up/down counters which drive an 8-bit DAC (digital to analog converter). The DAC provides infinite memory. When the ramp is interrupted, the ramp voltage corresponding to the value needed to coarse tune the hfo is retained indefinitely, or until a new frequency is programmed. Fig. 3 is a schematic diagram of the ramp generator. Up/down and inhibit logic signals are derived from the cascaded comparators. With this approach, it is

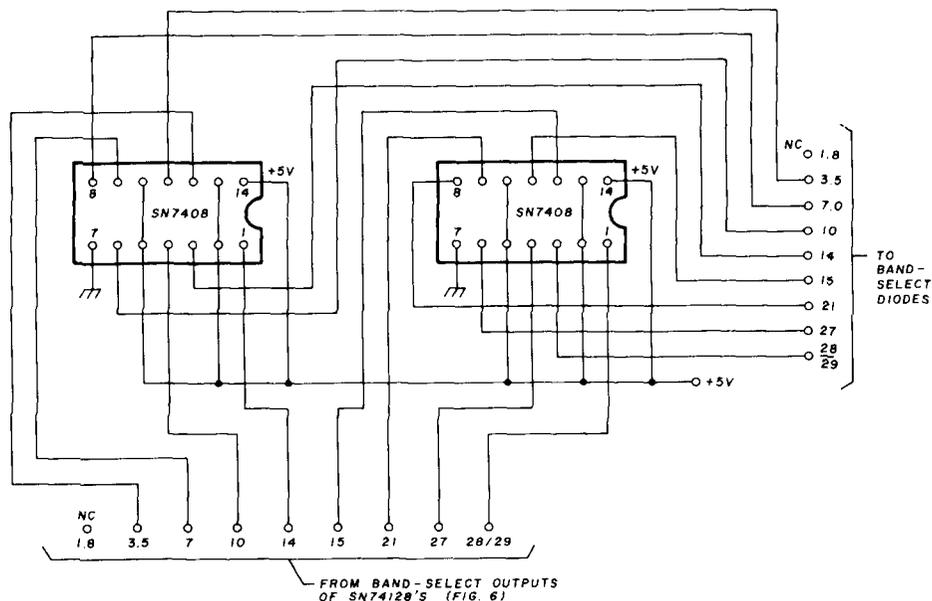


fig. 7. Schematic showing the use of 7408 two-input AND gates to drive the switching diodes in the rf amplifier and mixer circuits to reduce fan-out loading on the 74128 drivers in the band selector (fig. 6). Since the same tuning ramp controls the control signals to the hfo, mixer, and rf amplifier, tracking is maintained.

The key to synthesizer operation is the combination of programmable hfo counters and associated comparators. An 8-bit number is fed to the UNITS and TENTHS MHz comparators from the front panel thumbwheels when the desired frequency is dialed. A voltage ramp is enabled which tunes the hfo in the direction of the dialed frequency. When coincidence occurs between the binary numbers dialed and the

not possible for the hfo to lock to any 100 kHz line other than the correct one. A momentary interruption of power, or any other condition that unlocks the hfo, causes a repeat of the phase lock action.

### front end tuning

A schematic diagram of the rf amplifier is shown in fig. 4. The rf coils are wired in series with 1N914s

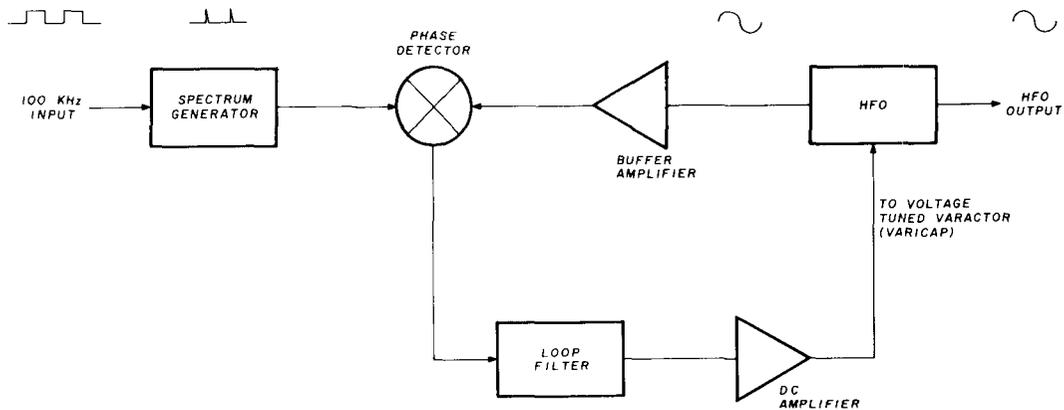


fig. 8. Functional block diagram of the phase-locked loop used in the receiver. The hfo provides one of two signals to the phase detector; the other input from the spectrum generator provides 100-kHz signals throughout the hfo tuning range. Loop bandwidth is about 10 kHz.

located at coil junctions which provide short circuits to ground. A particular band is selected by providing forward current to one of the diodes by band-select logic circuits which will be described. The rf circuit is typical of the mixer and the hfo, each having similar band selecting diodes. The ramp which tunes the hfo is also used to tune the rf and mixer coils.

### hfo tuning and control

Since the hfo operates at a much higher frequency than the rf and mixer stages, rather than using separate coils for each band, a single coil wound with no. 14 (1.6 mm) tinned wire is used as shown in fig. 5. The inductance is self-supporting except for a polyethylene foam strip which is glued to one side of the coil with epoxy cement to make it rigid. The switching diodes are soldered to the coil at appropriate

locations. Because of the inductance of the diode leads and the manner they are dressed away from the hfo coil, the correct diode locations are found by cut and try at first, those corresponding to the highest frequency bands being most critical. Each tap is adjusted so that lock up occurs with a ramp voltage of approximately 4.0 volts at a frequency corresponding to the low end of the particular band. Table 1 lists the low end hfo frequencies corresponding to each of the 1.0 MHz bands in the receiver.

Start by dialing 28 MHz, and adjust the inductance of L1 until the hfo locks up at 60000 kHz with approximately 4.0 volts of ramp. Next, with 27 MHz programmed, adjust the position of the 27 MHz diode on L2 until lock up occurs with about 4 volts of ramp. Repeat this process, proceeding toward the 160-meter band. An auxiliary counter can be used to con-

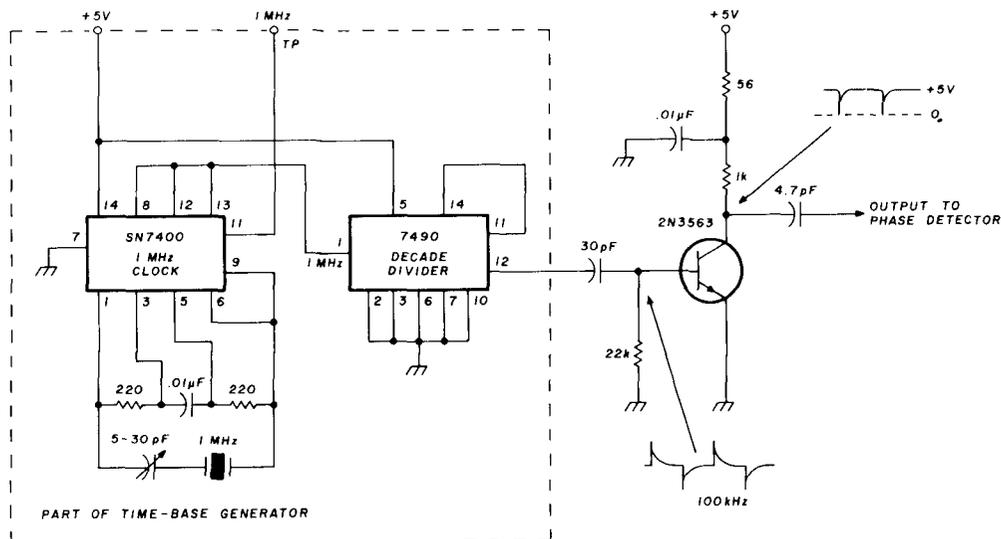


fig. 9. Spectrum generator used in the phase-locked loop (fig. 8) to generate narrow pulses spaced 100 kHz apart.

firm that the hfo locks up at the proper frequencies. If the hfo counters are properly programmed, the digital readout will agree with the thumbwheel numbers.

### programming the counters

The TENS and UNITS MHz hfo counters are programmable. Two sets of DIP switches mounted on the back of the counter board contain the programming switches. Four of these switches are used to program each hfo counter stage.

Each counter can be programmed to initiate its count at any number from zero through 9. This is a means of advancing each digit to agree with the corresponding antenna frequency digit. If the heterodyne scheme described here is used, the TENS MHz counter should be programmed to 0111 (7) and the UNITS MHz stage for 1000 (8). The TENTHS MHz stage is hard wired to 0000 (zero).

The TENS kHz vfo counter is programmed for 0101 (5) while the UNITS and TENTHS kHz stages are hard wired for zero. In some heterodyne schemes, such as one which uses a 455 kHz i-f, the UNITS kHz stage should also be programmable.

### band-select logic

The traditional way to change bands and select signals is by means of mechanical devices such as multi-wafer switches and ganged variable capacitors, although some CB and 2-meter receivers have employed frequency synthesizers for channel selection. More recently, high-frequency receivers have come on the market which use frequency synthesizers and digital displays. These are relatively expensive, but ultimately most high-frequency receivers will be manufactured this way.

Equipment for CB and 2 meters covers relatively narrow frequency bands. For example, a 40-channel

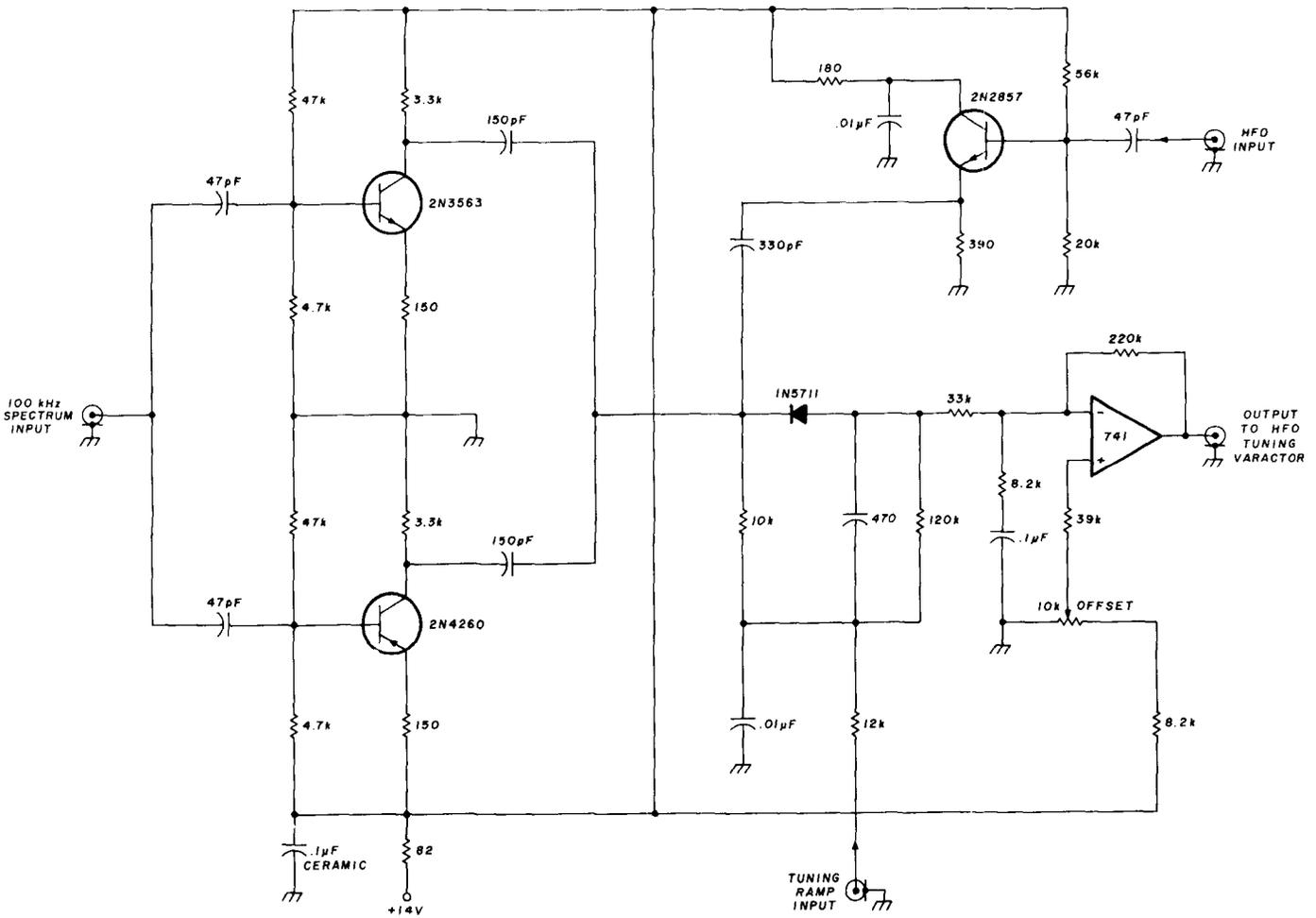


fig 10. Parametric phase detector developed by WA9HUV. The circuit uses a pair of fast complementary switching transistors to provide the required phase inversion without transformers. The gain of the 741 op amp is set at about 15 dB.

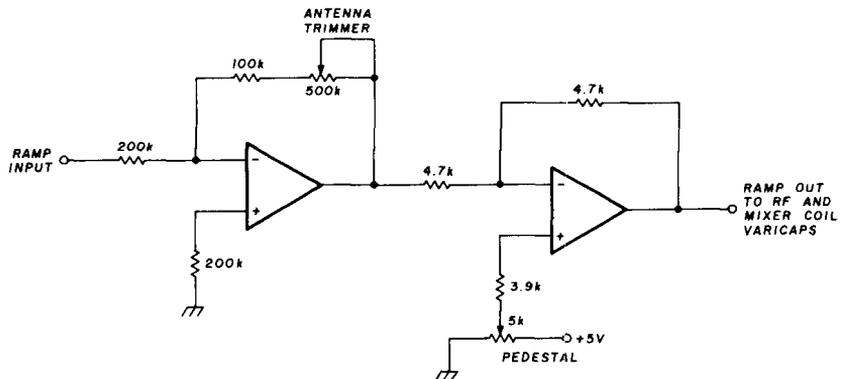


fig. 11. Unusual antenna trimmer circuit used in the receiver maintains tracking with the rf amplifier and mixer circuits.

CB receiver covers a frequency band having a high to low frequency ratio of about 1.6 per cent. By contrast, the high-frequency portion of this programmable receiver covers 33 per cent of the high-frequency band between 1.8 and 30 MHz. The technique of band changing through front panel thumb-wheel switches, together with band-selecting diodes, allows a wide range of frequencies to be covered with relative ease.

The binary commands not only perform the rf, mixer, and oscillator coil switching function, but they program the comparators as well. A pair of SN74141 BCD to decimal decoder drivers and three SN74128 current drivers are used to provide TENS and UNITS MHz band-switching logic signals. The circuit of fig. 6 shows how this is done. Note that the TENS 74141 provides a MHz logic output of 0, 10, or 20. The UNITS MHz 74141 provides a logic signal output corresponding to any number between zero and nine. The 74128s are current sources which are wired so that any one of 12 possible sets of coil selections can be made, although only ten of these are used.

To select 80 meters, for example, 03 is dialed. This provides BCD logic signals which turn on the 03 driver. The current supplied from this driver forward biases the appropriate 1N914 hfo diode, thus selecting the hfo coil corresponding to the 3.0 to 4.0 MHz band. Assuming 3500 kHz (035) is programmed, the ramp tunes the hfo until its frequency reaches 35500 kHz where it becomes phase locked. The vfo now tunes the band segment, 3500 to 3600 kHz.

The same 74128 logic signals are used indirectly to select the 3.0 to 4.0 MHz rf and mixer coils. SN7408 quad two-input AND gates driven from the 74128s supply current to the front end coil diodes to reduce fan out loading on the 74128s, as shown in fig. 7.

Note that the rf and mixer coils are tuned with the same ramp that tunes the hfo. This is how the rf and hfo circuits are made to track; details will be given later.

## phase-locked loop

Having developed a way to coarse tune the hfo, the task of phase locking the hfo to the correct harmonic of 100 kHz becomes a relatively simple matter. Fig. 8 is a block diagram which illustrates a second-order phase-locked loop such as the one employed here. The hfo, which is part of the closed loop, provides one of two signals for the phase detector. The other input to the phase detector is external to the loop and includes a spectrum of signals spaced 100 kHz apart. This spectrum extends across the hfo frequency range from 33.8 to 61.9 MHz.

The bandwidth of the closed phase-locked loop is limited to about 10 kHz so that there can never be an ambiguity between line selection. The loop can recognize only one line at a time, in spite of the fact that there are at least 281 individual sine-wave signals fed into the phase detector from the spectrum generator. Since it is not necessary to provide a way for selecting individual spectral lines, the spectrum generator, illustrated in fig. 9, is quite simple and consists of only a single transistor and a few discrete components.

The crystal clock and decade divider are part of the time-base generator. The 2N3563 transistor serves as a very fast switch which provides very narrow (16 ns) pulses to the phase detector. These narrow impulses include fairly uniform distribution of individual sine-wave signals extending from 100 kHz to well above 60 MHz. R-C coupling circuitry is arranged to reject most of the unneeded signals below 33 MHz; pulse shaping and parasitic capacitance causes the amplitudes of these signals to roll off rapidly above 60 MHz. It is necessary to shield the spectrum generator to prevent these signals from getting into the front end of the receiver. Otherwise, they will appear as markers at each end of each band segment.

## phase detector

A survey of the various types of PLL ICs available to perform the phase detection function was disap-

table 2. Tuning voltage for the front end and high-frequency oscillator.

input frequency (kHz)	tuning voltage (volts)	hfo frequency (MHz)	tuning voltage (volts)
7000	4.00	39.0	4.00
7100	4.51	39.1	4.25
7200	5.09	39.2	4.53
7300	5.75	39.3	4.85
7400	6.47	39.4	5.20
7500	7.29	39.5	5.60
7600	8.11	39.6	6.00
7700	9.14	39.7	6.50
7800	10.16	39.8	7.00
7900	11.40	39.9	7.60
21000	4.00	53.0	4.00
21100	4.16	53.1	4.20
21200	4.32	53.2	4.40
21300	4.50	53.3	4.64
21400	4.65	53.4	4.82
21500	4.86	53.5	5.09
21600	5.08	53.6	5.36
21700	5.30	53.7	5.64
21800	5.55	53.8	5.95
21900	5.80	53.9	6.27

pointing in terms of the requirements imposed by the programmable receiver. In many cases frequency response was the limiting factor — in others the cost was too high. Some earlier PLL chips that might have had promise were no longer available; more recent types are not only expensive, but also require considerable peripheral circuitry. I decided to settle for a homebrew design.

The phase detector used for the phase-locked loop is an original circuit which I developed. It uses a pair

of fast complementary switching transistors which perform the required phase inversion without the need for transformers. This makes the circuit simple and very broadband as well. The circuit is shown in fig. 10. The complementary transistors would normally produce zero output, since the transistors are complementary and one output is 180° out of phase with the other. However, the hfo signal, which has a relatively large peak-to-peak amplitude, modulates the transistor collectors. If the relative phase of the hfo is other than 90° relative to the reference signal, one of the outputs tends to be suppressed while the other is enhanced. For this reason, the phase detector is referred to as a parametric phase detector. The hfo is the element that controls the amplitudes of the other two signals. The amount of unbalance depends on the relative phase of the hfo signal and the reference signal. When that angle is 90°, the outputs are equal and cancel.

The input to the Schottky diode acts as a common summing junction for the three signals: the zero reference, the 180° reference, and the hfo. If the output of the detector is plotted as a function of the phase angle, a discriminator type of curve results. Note that the phase detector curve sits on top of a pedestal which results from rectification of the relatively large hfo signal. This is unimportant since it is compensated for by the offset potentiometer associated with the op amp at the phase detector output. Furthermore, the offset adjustment allows the voltage for the tuning varactors to be set to the proper value for the low end of each hfo band.

When the hfo is not locked the output of the phase

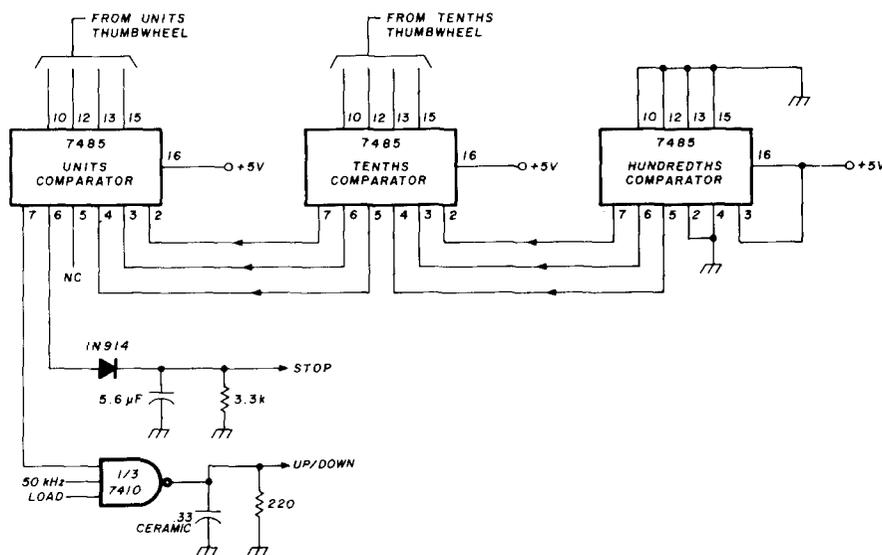


fig. 12. Simplified diagram of the cascaded comparators and their output filtering. This circuit provides the ramp sweep stop and directional steering commands to the 74191 up/down counters in the ramp generator (fig. 3).

detector is a sine wave at a frequency equal to the difference between the reference signal and the hfo. Lock up occurs almost instantaneously and is difficult to see on an oscilloscope.

The gain of the op amp is set to about 15 dB. If the phase-locked loop has a tendency to oscillate, the gain of this stage can be reduced by lowering the value of the 220k feedback resistor. It is not recommended that any of the other component values in the phase detector be changed.

### spurious signals

In spite of care in shielding the spectrum generator, it was necessary to shield the rf section of the receiver carefully and to apply bypassing capacitors rather extensively at each terminal of the DIP power connector and at the BCD inputs to reduce these signals to levels below the ambient antenna noise.

Spurious signals which were much more difficult to control resulted from products of the hfo and vfo. Even though these signals are applied to separate mixers and are not intended to be associated, both the hfo and vfo signals are converted to TTL compatible levels in the counter where intermixing and harmonic generation results. These spurs can be classified as follows:

$$M(vfo) - N(hfo) = 1650 \text{ kHz}$$

The strongest spur occurs where  $M=2$  and  $N=1$  at 27025 kHz. A smaller spur occurs at 14330 kHz where  $M=3$  and  $N=2$ ; a relatively weak spur was found at 7012.5 kHz where  $M=4$  and  $N=3$ .

The ideal way to eliminate these spurious signals is to install a bandpass filter between the first mixer output and the second mixer input. This filter should cover a band from 31.9 to 32.0 MHz and should have sharp skirts. Some excellent filter design articles are included in the list of references.<sup>4,5</sup>

### antenna trimmer

The circuits associated with the antenna trimmer bear little resemblance to conventional antenna trimming circuits. However it is a very effective technique which has the added advantage that tracking between the hfo and the rf circuits is accomplished at the same time.

The voltage ramp that tunes the hfo is also fed to the rf and mixer tuning varactors. A front panel potentiometer control serves as the antenna trimmer. It operates in conjunction with the circuit described in fig. 11 which includes a pair of op amps.<sup>6</sup>

The way in which the antenna trimmer works is best illustrated by an example. First, set the thumbwheels to select 7.0 MHz (070). The ramp voltage

frequency to be displayed	hfo frequency
01800	33800
02000	34000
03000	35000
04000	36000
05000	37000
06000	38000
07000	39000
08000	40000
09000	41000
10000	42000
11000	43000
.	.
.	.
.	.
16000	48000
17000	49000
18000	50000
19000	51000
20000	52000
21000	53000
.	.
.	.
.	.
26000	58000
27000	59000
28000	60000
29000	61000

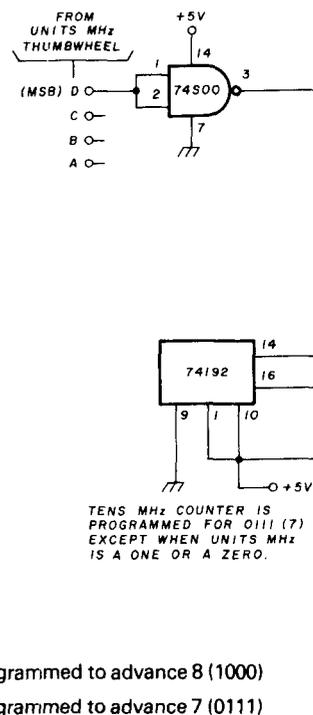
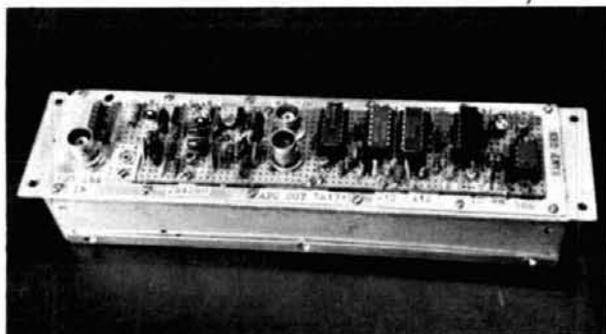


fig. 13. Logic correction circuit which resolves a minor problem with the TENS MHz counter. When an 8 or 9 is programmed, the TENS MHz counter and corresponding display advances one extra digit because the TENS MHz digit advances. An example is given in the text.

corresponding to the low end of each band is approximately 4.0 volts, which is the value required to phase lock the hfo to 39000 kHz. As can be seen in table 2, as the hfo is incremented from 39000 to 39900 kHz (which tunes the receiver from 7000 to 7900 kHz), its tuning voltage increases from 4.0 to 7.6 volts. Based on the sizes of the varicaps used and the total circuit capacitance, the rf and mixer varicaps require a tuning voltage range of 4.0 to 11.4 volts to tune from 7000 to 7900 kHz. Thus, the change in ramp voltage for the front end must be amplified by the op amp by a factor of 2.055 to achieve tracking with the hfo.

The situation is different in the 21000-21900 kHz band where the hfo tuning ramp varies from 4.0 to 6.27 volts. However, the rf and mixer circuits only need a variation of 4.0 to 5.8 volts. Therefore, for the amateur 15-meter band, the ramp slope must be amplified by a factor of 0.7929. The antenna trimmer control automatically makes this gain adjustment when it is adjusted for resonance or maximum signal strength. The 5k pedestal control is set to provide 4.0



Construction of the module containing the spectrum generator (left), phase detector (center), and ramp generator (right).

volts output corresponding to the low end of each band. Once this adjustment has been made, it does not have to be readjusted.

### front end alignment

The antenna trimmer circuit provides a convenient way to align the front end coils. Start the alignment with 10 meters and proceed in numerical order down to 160 meters. This will avoid interaction between coil inductance settings. The pedestal potentiometer is first set for 4.0 volts output corresponding to the low end of the band. The front end coils are then aligned. Next, the high end of the band is programmed by means of the thumbwheel switches and the antenna trimmer is adjusted for maximum rf gain. Without changing the setting of the antenna trimmer, realign the rf coils at the low end of the band. Again, check the antenna trimmer setting at the high end. Several iterations of this kind are required until the inductance of the coils is set so that tracking is achieved without having to radically change the antenna trimmer setting when going from the low to high end of the band.

The same procedure is repeated for each of the other bands. Once the coils have been aligned in this manner, very little adjustment of the trimmer should be required after the initial adjustment when a new band segment is selected.

### comparators

The ramp sweep stop and directional steering commands are derived from the three hfo comparators as previously explained. Sweep control is accomplished by cascading the SN7485s as shown in fig. 12. Since the 74191 up/down counters in the ramp circuit need only a single up/down command, pin 5 of the 191s are tied high. However, when the ramp is enabled, if the up/down logic level is low, the counters count up, which increases the ramp voltage. Therefore, the MORE THAN cascaded output of

the 7485s is connected to pin 5 of the 191s. The EQUALS output which stops the ramp is high only when all of the 12 counter bits agree with the bits programmed, including the hard wired HUNDRETHS MHz bits.

Since the counters operate in two modes, namely COUNT and DISPLAY, the bits are changing during the COUNT mode, causing the comparators to output fluctuating logic data. To overcome this problem, both of the cascaded comparator outputs are modified to provide suitable output logic signals. These relatively simple circuits are shown in fig. 12. Because of the requirement to filter these control signals, there is a finite delay between comparator coincidence and application of the logic commands. This sets an upper limit to the ramp sweep rate because some overshoot of the hfo frequency results. If the sweep rate is too fast, overshoot will be sufficient to change the comparator output signals before the sweep circuit is stopped, which means that the sweep lock circuit will keep oscillating and lock up will never occur.

A total ramp sweep interval of about two to four seconds is satisfactory. Only when changing bands is there any noticeable delay in hfo lock up. When incrementing the thumbwheel switches from one band segment to another, there is no noticeable delay.

There is a trivial problem that is related to the TENS MHz counter. Whenever either an 8 or 9 MHz is programmed, the TENS MHz counter and corresponding display advances one extra digit because the corresponding TENS MHz digit advances. To avoid this problem, the simple logic circuit shown in fig. 13 is used. This circuit prevents the TENS MHz counter

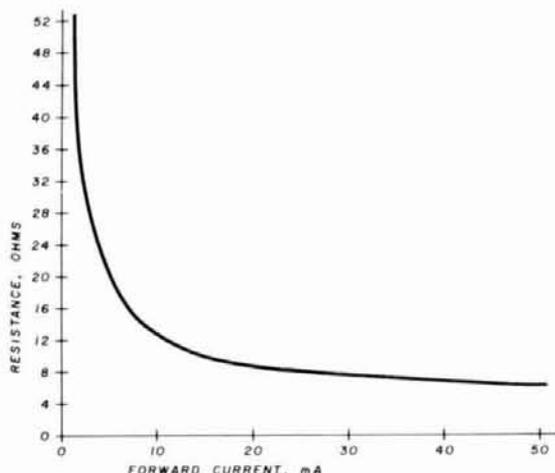


fig. 14. Resistance of a forward-biased 1N914 diode at 1 kHz, as measured with a GenRad 1650B impedance bridge. Diode resistance is important because it affects the  $Q$  of the tuned circuits used in the receiver.

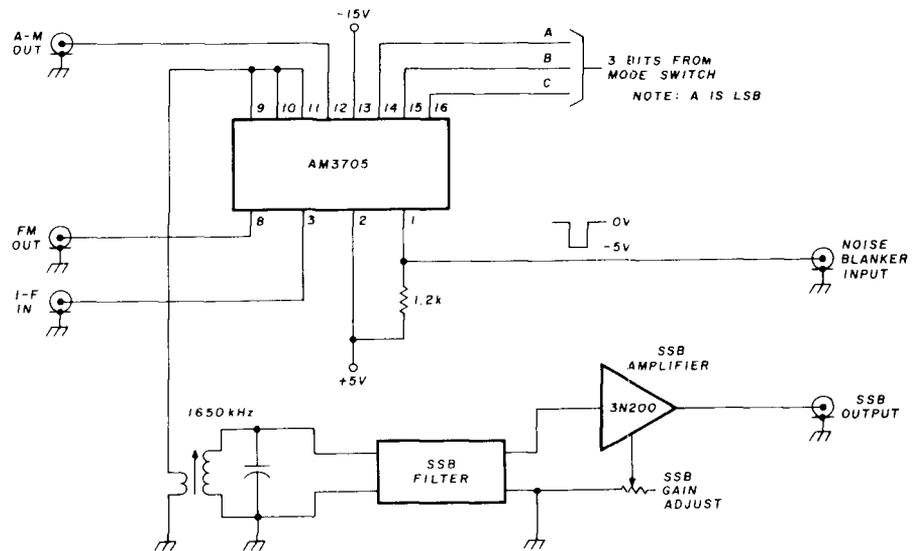


fig. 15. Diagram of the ssb mode select used in the receiver. This is typical of the analog multiplexing circuits operated from the front-panel.

from advancing whenever the UNITS hfo digit is a one or a zero. When dialing 27.0 MHz, for example, the hfo frequency is 59 MHz, but when 28 MHz is dialed, the hfo advances to 60 MHz. This change in the most significant digit from 5 to 6 would normally advance the display from 27 to 38. The logic circuit of fig. 13 solves this problem.

### switching diodes

As previously explained, 1N914 diodes are used for front end and hfo coil switching. This approach was found to be both simple and effective. It should be recognized, however, that the forward resistance of the diode has a tendency to reduce the  $Q$  of the tuned circuits. To minimize this effect, the  $L/C$  ratio of the front-end coils has been made as large as possible. Fig. 14 shows the diode resistance as a function of forward current. Note that the resistance drops to about 6 ohms at a current of 40 mA, and any further increase in current has a small effect on resistance. Some simple calculations show that with a circuit capacitance of 20 pF at 28 MHz, if the loaded circuit  $Q$  is 50 without the diode, it drops to 23 with the diode; this both increases the rf bandwidth and reduces gain. It was found that  $Q$  and gain could be increased to acceptable levels if parallel-connected diode pairs were used with the 10-meter coils.

The effect of the switching diodes is less pronounced on the lower bands (it is practically negligible at 1.8 MHz). It is possible to control front-end gain so that it is nearly the same on all bands by adjusting the currents in the diodes.

### mode-select circuitry

The circuit of the ssb mode-select circuit is shown in fig. 15. This is typical of each of the analog multi-

plexing circuits operated from the front-panel mode switch. While only five outputs are used, the switch has 8-pole capability.

### summary

The development of this programmable receiver was a much more formidable task than I originally envisioned. The receiver as it exists presently represents a first phase effort, and much yet remains to be done in terms of refinement. The basic idea has been proven to be sound, however, and the result is a high performance breadboard receiver of advanced design.

It is hoped this article will provide other experimenters with new ideas and incentives to try their hand at something radically new. Additional circuit details can be made available to those hearty experimenters who are interested in duplicating this receiver in part or as a whole. Please send me a self-addressed, stamped envelope for further details. Readers' suggestions and constructive criticism are welcomed.

### references

1. W. Ryder, W6URH, "High Performance General Coverage Communications Receiver," *ham radio*, November, 1977, page 10.
2. J. Pollack, WB2DFA, "Six Digit 50-MHz Frequency Counter," *ham radio*, January, 1976, page 18.
3. P. Rand, W1DBM, "A Versatile Digital Frequency Display," *QST*, November, 1977, page 21.
4. D. Lancaster, "The Butterworth Filter Cookbook," Parts I and II, *CQ*, November and December, 1966.
5. E. Wetherhold, W3NQN, "Modern Filter Design for the Amateur," *QST*, September, 1969, page 42.
6. Stout and Kaufman, *Operational Amplifier Circuit Design*, McGraw-Hill, New York, New York, 1976.
7. F. Gardner, *Phaselock Techniques*, Jan Wiley & Sons, New York, New York, 1976.
8. D. Nelson, WB2EGZ, "What's This We Hear About Op Amps?," *ham radio*, November, 1969, page 6.

ham radio

# super low-noise 432-MHz preamplifier

Construction of a  
low-noise bipolar transistor  
preamplifier which offers  
0.8 dB noise figure  
with 15 dB gain

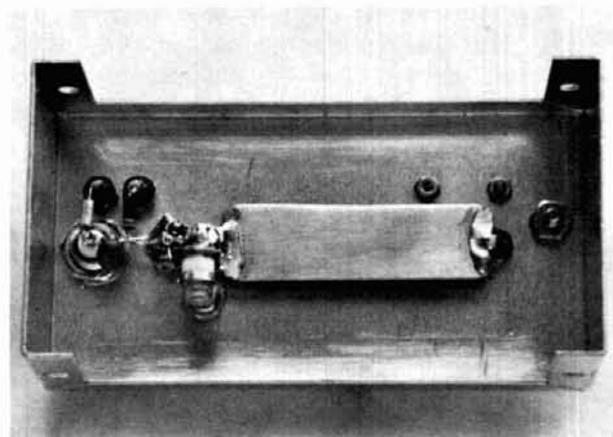
The heart of any successful moonbounce (EME) system is the low-noise preamplifier which precedes the receiving converter. On 144 MHz, an overall system noise figure of less than 1.0 dB seldom increases receiver sensitivity significantly because of the high sky noise temperatures of 300° to 400° K. On 432 MHz, however, sky noise temperatures of 10° to 20° K are possible; this means that decreasing the overall system noise figure below 1 dB significantly improves receiver sensitivity.

Until recently the popular Fujitsu FJ203 and the Fairchild FMT4575 bipolar transistors have yielded the lowest noise figures at 432 MHz — typically 1.25 dB. The Texas Instruments MS2110, although not as well known, also produces noise figures as low as 1.1 dB at this frequency. Shigeru Sando, JH1BRY, introduced an excellent 432-MHz preamplifier using NEC's V244 GaAs fet which opened the eyes of many moonbouncers.<sup>1</sup> With its impressive 0.6-0.7

dB noise figure, it beat everything else at the noise-figure contests. However, its cost of \$120 makes it a luxury for most amateurs.

Recently NEC introduced a new bipolar device, the NE64580, which is rated at 0.8 dB noise figure at 500 MHz. At \$92 each, it appeared to be a mighty competitor to the V244. Even better, the people at NEC came out with the NE64535 at a cost of only \$17 in single quantities;\* it is rated at 1.6 dB noise figure at 2 GHz with an  $f_T$  of 8.5 GHz. At 500 MHz, the NE64535 has a rated noise figure of 0.8 dB.

The NE64535 uses the same chip as the NE64580 but is mounted in a less expensive hermetically sealed *Micro-X* package. This article discusses the design of a 432-MHz preamplifier that uses this



Construction of the low-noise 432-MHz preamplifier, showing the placement of the stripline resonator. Output connector J1 is to left; input SMA connector is partially hidden by the piston capacitor C1.

\*The device is manufactured by the Nippon Electric Company (NEC) in Japan and is being marketed by California Eastern Laboratories (CEL), Post Office Box 915, One Edwards Court, Burlingame, California 94010. Cost is \$17 each in quantities of 1-9, decreasing to \$15 each for quantities of 10-99.

By Al Ward, WB5LUA, RR2, Box 65A,  
McKinney, Texas 75069

device to obtain measured noise figures as low as 0.8 dB. The original design was based on the more expensive NE64580, but identical results have been achieved using the NE64535.

At the 1977 convention of the Central States VHF Society in Kansas City, Missouri, this preamplifier measured only 0.1 dB higher noise figure than the V244 GaAs fet entered by K2UYH; all other bipolar entries had approximately 0.3 to 0.4 dB higher noise figures. At 432 MHz, this decrease in noise figure over other bipolar devices results in a significant increase in receiver sensitivity.

Since I was intrigued by the fact that Shigeru Sando was able to use a parallel tuned circuit on the input to his V244 preamplifier and still achieve a low noise figure, I decided to try something similar. I wanted to obtain a low-loss match for minimum noise figure and still achieve adequate selectivity so I wouldn't require an external cavity.

The final design uses a parallel tuned circuit with capacitive coupling on the input (fig. 1). To minimize circuit losses I used a low-loss microstrip line rather than a lumped inductor. Resistive loading is used on the output and will be discussed later. I am presently using this preamplifier without an external cavity and have experienced no problems with intermodulation. Since the preamplifier is capacitively coupled at the input, greater rejection of unwanted signals will occur below 432 MHz. When the preamplifier is adjusted for minimum noise figure at 432 MHz, 10 dB of rejection is typically obtained at 200 MHz, 26 dB at 100 MHz, and 40 dB at 50 MHz. In all but the worst of environments this should be adequate.

At my location, for example, a broadband FJ203 preamplifier cannot be used without a cavity, whereas the NE645 preamplifier has given no problems at all (my location is within 15-20 km of fm and TV transmitting antennas). If external filtering is required, a cavity filter with 0.2 dB loss described by Joe Reisert<sup>2</sup> will increase the noise figure to only 1.0 to 1.2 dB, which is still a worthwhile improvement.

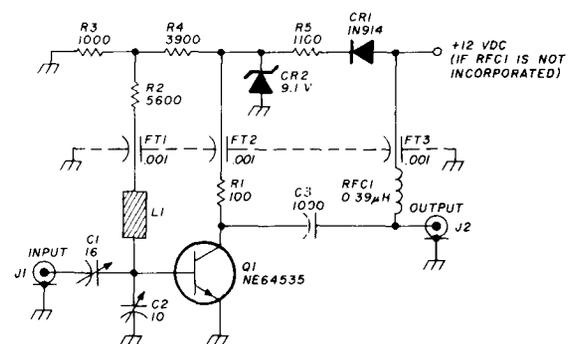
## design

Lacking any sort of tables describing the optimum source impedance required for minimum noise figure, I initially designed the input circuit for maximum gain using the published  $s$  parameters for the device. The input circuit was then optimized for lowest noise figure with a Hewlett-Packard HP-342A automatic noise figure meter. The resultant circuit uses a microstrip line with a characteristic impedance of 70 ohms.

An attempt was made to tune the output circuit to increase selectivity, but, as expected, completely stable operation was not obtained. As with most

microwave bipolar transistors operated in this frequency range, maximum available gain is so high that oscillations are common. Stable operation of this device was finally achieved with resistive loading. This method of stabilizing 432-MHz preamplifiers was suggested in an earlier article on the FMT4575.<sup>2</sup> However, the selection of the 100-ohm collector resistor was not arbitrary; in addition to stabilizing the preamplifier, it also serves to provide a better match to the post-amplifier. Resultant output vswr of this preamplifier should be less than 2.0:1. When using a post-amplifier with a variable match at the input, no problems have been incurred in obtaining stable operation.

While optimizing noise figure, I required some



- C1 0.8-16 pF air variable (Johanson 5200 series)
- C2 0.8-10 pF air variable (Johanson 5200 series)
- C3 1000-pF mica or ceramic disc (not critical)
- CR1 1N914 or 1N4148 silicon diode
- CR2 9.1-volt zener (1N757)
- FT1-FT3 470-1000 pF feedthrough capacitors
- J1 SMA coaxial connector
- J2 BNC coaxial connector
- L1 microstrip line 15 mm (0.6 in.) wide, 53 mm (2.1 in.) long, mounted 5 mm (0.2 in.) above chassis
- RFC1 0.39- $\mu$ H miniature rf choke

fig. 1. Schematic diagram of the low-noise preamplifier for 432 MHz; typical noise figure is less than 1.0 dB. The NE64535 transistor is manufactured by Nippon Electric Company (NEC) and costs \$17 in small quantities.

method of varying the dc bias conditions to determine their effect on noise figure. The bias circuit I used allows optimization of both  $V_{CE}$  and  $I_C$  for minimum noise figure by varying resistors R2 and R5. This method uses both voltage feedback and a constant base current source to ensure dc stability.<sup>3</sup> (Bias circuit design using this arrangement is discussed on page 39.)

The data sheet for the NE64535 specifies  $V_{CE} = 8.0$  volts at  $I_C = 7.0$  mA. It was found experimentally that minimum noise figure at 432 MHz occurs at a  $V_{CE}$  of

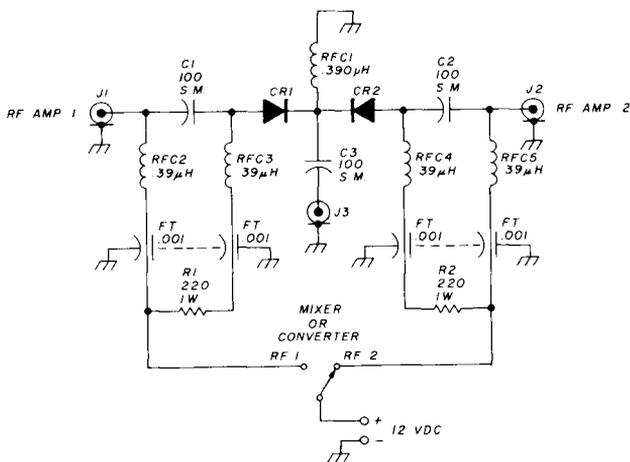


fig. 2. Combination bias tee/PIN diode switch used to operate separate preamplifiers for 432-MHz EME and tropo. The PIN diodes (CR1 and CR2) are Microwave Associates type MA47110.

6.0 volts with  $I_C$  approximately 4-5 mA. The new operating conditions decreased noise figure by about 0.2 dB. Although not as critical as the input match, the dc operating conditions can also be optimized for lowest noise figure at a particular operating frequency.

Zener diode CR2 was incorporated mainly to protect the collector-emitter junction, since the device has a maximum  $V_{CE}$  rating of only 12 volts. Not only

table 1. PIN diode switch performance on three vhf amateur bands.

frequency	insertion loss	isolation
144 MHz	0.25 dB	22 dB
220 MHz	0.60 dB	20 dB
432 MHz	1.20 dB	16 dB

does it protect the device as you optimize bias conditions, but it also protects the transistor from transients that may be present on the 12-volt supply line.

For maximum effectiveness, the preamplifier should be mounted at the antenna. With RFC1 installed in the circuit, +12 volts can be conveniently run up the receive coax. At my station I use separate preamplifiers for EME and tropo operation feeding a common mixer, so I needed a convenient method of switching between preamplifiers. Since good mechanical coaxial relays are expensive, I devised the combination bias tee/switch arrangement shown in fig. 2. The switching elements are inexpensive, readily available PIN diodes.

When the PIN diodes are forward biased with 50 mA of current, their insertion loss is slightly less than 1.25 dB at 432 MHz. With no bias applied, the isola-

tion between ports is 16 dB. Isolation is defined as the insertion loss to the off port. Since +12 volts is switched between preamplifiers at the same time that the control bias is transferred, tuning interactions between the EME and tropo preamplifiers are kept to a minimum.

The isolation can be improved by applying reverse bias to the PIN diode in the off port leg. The reverse bias decreases the diode capacitance, thereby increasing the isolation to the off port. The amount of reverse bias that can be applied is limited by the reverse breakdown voltage specified for the diode. Since a dual polarity power supply is not available at my station, I chose not to reverse bias the PIN diode. There are many versions of the PIN diode switch that could be used to increase isolation — but they are beyond the scope of this article.

The usefulness of the PIN diode switch can be extended to switching various local oscillators that supply injection to a broadband double-balanced mixer for multiband operation. As shown in table 1 the combination bias tee/PIN diode switch arrangement performs even better at lower frequencies. The PIN diode used here is a Microwave Associates MA47110 available for 99 cents in small quantities.

## construction

The preamplifier is built in a 108 × 57 × 38 mm (4-1/4 × 2-1/4 × 1-1/2 inch) Minibox, which is both inexpensive and readily available. The rf circuitry is mounted on the inside while all the bias components are mounted on the top of the minibox (figs. 3 and 4). This allows greater isolation between the rf and dc components than if all components were mounted inside the enclosure.

The microstrip line, 15 mm (0.6 inch) wide and 53 mm (2.1 inches) long is mounted approximately 5 mm (0.2 inch) above the chassis. The corners are rounded off to a radius of 1.5 mm (1/16 inch) to minimize the discontinuities at the end of the microstrip line. The 0.001- $\mu$ F feedthrough capacitor is used as a

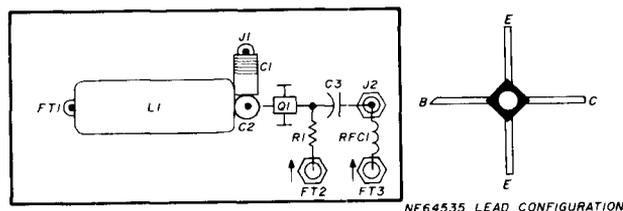


fig. 3. Layout of the rf components in the low-noise 432-MHz preamplifier. The input network is formed by C1, C2, and L1; the output network consists of R1 and C3. Bias circuitry is installed on the outside of the Minibox enclosure (see fig. 4).

support for one end of the microstrip line; the opposite end is soldered to the Johanson variable capacitor, C2. The input matching capacitor, C1, is soldered directly between the input connector and capacitor C2. An SMA-type connector is used on the input. Its small size and low loss make it a must for low-noise operation. A less expensive BNC type connector is used on the output.

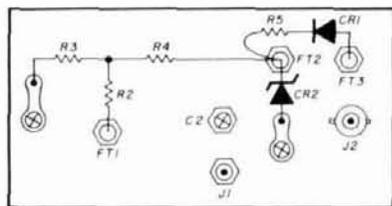
To facilitate direct grounding of the two emitter leads, I used two solder lugs bolted to the chassis to serve as tie points. The lugs are cut off so they stand up from the chassis about 3 mm (0.1 inch). This allows enough area to conveniently solder the emitter leads. Keep the emitter leads on the device full length.

The leads on C3 and R1 must be as short, and as far away from the input circuitry, as possible to reduce any chance of feedback. If the preamplifier is built according to the layout in **fig. 3** no shield will be required between the input and output circuitry.

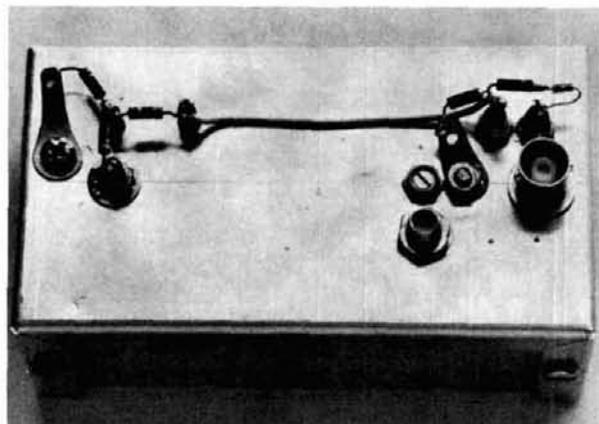
When using a Minibox as an rf enclosure, be sure to scrape off any paint or any other nonconductive film that may be on the areas where the two halves of the enclosure meet. This is best done before assembly has been started, and is necessary to achieve a good rf-tight enclosure. Be sure to use all four screws supplied with the Minibox.

## operation

Connect the output of the preamplifier to the post-amplifier or converter with a short section of 50-ohm coaxial cable. Terminate the input with 50 ohms. With +12 volts powering the preamplifier, the total current drain should be 5 to 6 mA for lowest noise. The actual collector current will be about 1 mA less than the total current due to the current being drawn by resistors R3 and R4 in the bias circuit. At the rated 5-6 mA of current,  $V_{CE}$  will be 5-6 volts. Since the actual collector current drawn from the power supply is a function of the dc current gain ( $h_{FE}$ ) of the device, the value of R2 may have to be adjusted slightly to achieve the desired amount of collector current. To date, all of the devices tested have achieved similar operating parameters and lowest noise figure with-



**fig. 4.** Top view of the 432-MHz preamplifier showing the layout of the bias circuit.



**Top view of the 432-MHz preamp showing the layout of the bias resistors (see **fig. 4**). BNC output connector is at far right; SMA input connector is to the left.**

out any modifications to the bias network shown in **fig. 1**.

Optimizing the input network for lowest noise figure is most easily done with an automatic noise-figure meter, but precise tuning can still be achieved by using a weak-signal source or a simple noise generator. Start with C1 at about half capacitance and then minimize noise figure with C2. Increase C1 slightly and then repeak C2 for minimum noise figure. Do not increase the capacitance of C1 past the point where minimum noise figure occurs. Overcoupling with C1 broadens the frequency response of the preamplifier with no improvement in noise figure. Finally, peak the post-amplifier stage into the preamplifier for minimum noise figure.

All devices I have tested so far have yielded noise figures between 0.8 and 1.0 dB; associated gain at minimum noise figure varies from 14 to 16 dB. With the added selectivity and lower noise figure obtainable with this device, this preamplifier should make for a significant improvement in the reception of EME signals as compared with other bipolar devices presently on the market. It also does a good job of challenging users of GaAs fets at noise-figure measuring contests! After nine months of operating 432-MHz EME with this preamplifier, I am convinced that it has made a worthwhile improvement in the reception of weak signals.

## references

1. Shigeru Sando, JH1BRY, "Very Low-Noise GaAs Fet Preamplifier for 432 MHz," *ham radio*, April 1978, page 22.
2. Joseph Reisert, W1JR, "Ultra Low-Noise UHF Preamplifier," *ham radio*, March 1975, page 8.
3. Kenneth Richter, "Design DC Stability Into Your Transistor Circuits," *Microwaves*, December 1973, page 40 (see also Hewlett-Packard Application Note 944-1).

ham radio

# superhet

## tracking calculations

How to choose component values for tuning rf and local-oscillator stages in superhet receivers

**Superheterodyne receivers which** have ganged tuned capacitors for simultaneous tuning of the local oscillator and signal frequency circuits require a special design approach. When such circuits are correctly designed and adjusted, they are said to "track," meaning that each resonant circuit is correctly tuned for any frequency setting of the receiver's tuning dial. Errors in tracking, if large enough, cause loss of receiver sensitivity.

The following method of calculating component values for superhet tuning circuits is not new, but I've tried to reduce the procedure to its essentials. Interested readers who want to pursue the topic should review **reference 1**, which lists other works on the subject.

### the problem

**Fig. 1** illustrates what is to be accomplished. As the tuning capacitor is rotated, the receiver's input circuits must tune from the lowest signal frequency,  $f_1$ , to the highest signal frequency,  $f_2$ . At the same time, the local oscillator (LO) must tune to a frequency which is always equal to the signal frequency plus the intermediate frequency, the i-f being a constant

fixed frequency. Although circuits can be designed so the LO frequency is lower than the rf or signal frequency, the method described here requires that the LO be higher than signal frequency.\*

**Fig. 2** shows the component arrangements for the signal and oscillator tuning circuits. In the signal circuit,  $C_T$  represents the distributed capacitance of the coil, plus the minimum capacitance of the variable tuning capacitor, plus any fixed capacitance necessary to adjust the circuit. Capacitance  $C_G$  is the variable capacitance of one gang of the tuning capacitor used for the signal frequency.  $C_{Gmax}$  is the difference between minimum and maximum values of the variable capacitor. If a variable capacitor section can be adjusted from a minimum value of 10 pF to a maximum value of 365 pF, for example, then  $C_{Gmax}$  for that capacitor is 355 pF.

Capacitor  $C_{TL}$  in the oscillator circuit represents the distributed capacitance of the oscillator coil; its value is found by measuring the self-resonant frequency of the coil with a grid-dip meter; then, knowing the inductance, the capacitance may be calculated. In many cases, however,  $C_{TL}$  will be so small, compared to the other circuit capacitances, that it may be neglected.  $C_p$  is called the padder capacitor;  $C_{TC}$  represents the minimum capacitance of the oscillator section of the tuning capacitor plus any capacitance needed for correct adjustment;  $C_{GO}$  is the variable capacitance of the oscillator gang on the tuning capacitor.  $C_{Gomax}$ , used in the equations, is the difference between minimum and maximum values of  $C_{GO}$ . It is not required that the oscillator section of the ganged tuning capacitor have the same capacitance as the rf sections, but, for the equations here, its percentage of maximum capacitance vs. angle of shaft rotation should be the same as for the rf sections. In other words, the rotor plates of the capacitor should all have the same shape.

### design equations

Units for the following equations are microhenries for inductance, MHz for frequency, and picofarads

\*To reduce problems with spurious signals, the local oscillator should be above the signal frequency. Editor.

By Courtney Hall, WA5SNZ, 7716 La Verdura Drive, Dallas, Texas 75248

for capacitance. Equations are listed in the order in which they must be solved, so that values needed for a particular equation will have already been determined. It is first necessary to define the signal and i-f frequencies, then make a few preliminary calculations regarding their relationships. Also, the difference between minimum and maximum values of the tuning capacitor sections must be determined; this is best done with an accurate capacitance meter or bridge. I am hesitant to accept vendor's ratings, especially when buying variable capacitors on the surplus market.

- $f_1$  = minimum signal frequency
- $f_2$  = maximum signal frequency
- $f_i$  = intermediate frequency (i-f)

$$A = \frac{f_2}{f_1} \quad A^2 = \left(\frac{f_2}{f_1}\right)^2$$

$$B = \frac{f_2 + f_i}{f_1 + f_i} \quad B^2 = \left(\frac{f_2 + f_i}{f_1 + f_i}\right)^2$$

$$C_{Gmax} = C_{max} - C_{min}$$

$$C_{Gomax} = C_{omax} - C_{omin}$$

Values of components for the signal tuning circuit may be calculated as follows:

$$C_T = \frac{C_{Gmax}}{A^2 - 1} \text{ pF}$$

$$L = \frac{25330}{C_T f_1^2} \text{ } \mu\text{H}$$

For the oscillator circuit, there are two methods of calculation; one is for arithmetical-mean tracking, and the other is for geometrical-mean tracking. Arithmetical-mean tracking is probably best if the receiver tunes a relatively narrow range of frequencies, while geometrical-mean tracking should be used if the receiver tuning range is large, such as  $f_2/f_1 = 3$ . Again, some preliminary calculations are needed. For arithmetical-mean tracking, calculate:

$$r = \frac{A^2}{B^2} \left(\frac{3+A}{3+B}\right) \left(\frac{1+3B}{1+3A}\right)$$

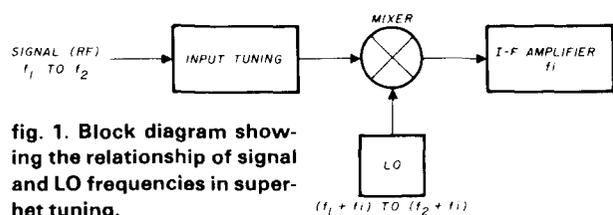


fig. 1. Block diagram showing the relationship of signal and LO frequencies in superhet tuning.

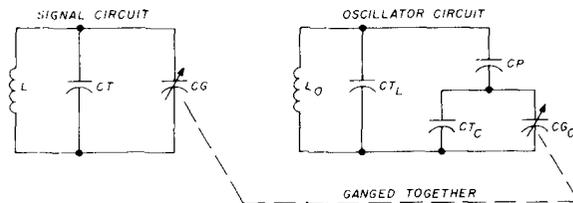


fig. 2. Component arrangement in superhet oscillator and signal tuning circuits. In some receiver designs two or more identical signal circuits may be used for preselection.

For geometrical-mean tracking, calculate:

$$r = \frac{A^2}{B^2} \left(\frac{2B + (1+B)(\sqrt{A})}{2A + (1+B)(\sqrt{A})}\right)$$

With the proper value of  $r$  determined, proceed as follows:

$$C_{Pmax} = \frac{C_{Gomax}}{r - 1}$$

$$C_{Tcmax} = \frac{C_{Gomax}}{rB^2 - 1}$$

$$C_{Pmin} = C_{Pmax} - C_{Tcmax}$$

$$C_P = (C_{Pmin} + C_{TL}) \text{ pF}$$

$$C_{Tc} = (C_{Tcmax} - C_{TL}) \text{ pF}$$

$$L_o = \frac{25330 C_{Pmin} C_{Pmax}}{C_{Tcmax} C_P^2 (f_2 + f_i)^2} \text{ } \mu\text{H}$$

### example

A receiver is wanted which will tune from 2.5 to 3.5 MHz, and the i-f is to be 0.455 MHz. To add a little safety factor, it is decided to make the tuning range 50 kHz wider on each end.

$$f_1 = 2.45 \text{ MHz}$$

$$f_2 = 3.55 \text{ MHz}$$

$$f_i = 0.455 \text{ MHz}$$

$$A = \frac{3.55}{2.45} = 1.449$$

$$A^2 = 2.1$$

$$B = \frac{3.55 + 0.455}{2.45 + 0.455} = 1.3787$$

$$B^2 = 1.9$$

A three-gang variable capacitor is available, and each section is measured to have a range of 10 to 365 pF. Therefore

$$C_{Gmax} = 365 - 10 = 355 \text{ pF}$$

table 1. Results of calculations to prove validity of the design approach (see figs. 3 and 4).

$C_G$ (pF)	$f_{osc}$ (MHz)	$f_{osc}-0.455$ (MHz)	$f_{sig}$ (MHz)	error (Hz)
0	4.0050	3.5500	3.5500	0
45	3.7812	3.3262	3.3257	500
90	3.5946	3.1396	3.1392	400
180	3.2994	2.8444	2.8443	100
270	3.0746	2.6196	2.6195	100
355	2.9054	2.4504	2.4497	700

The rf or signal section components may now be calculated:

$$C_T = \frac{355}{2.1-1} = 322.73 \text{ pF}$$

$$L = \frac{25330}{322.72 (3.55)^2} = 6.228 \mu\text{H}$$

For proper alignment, and to allow for tuning out stray circuit reactance, the inductor should be slug-tuned, and  $C_T$  should have an adjustable component. Remember also that the calculated value of  $C_T$  includes the minimum capacitance of the variable tuning capacitor. With these things in mind, the rf tuning circuit could be designed as shown in fig. 3. The 10-pF minimum capacitance of the tuning capacitor, plus the 43-pF setting of the trimmer, plus the 270-pF fixed capacitor add up to the calculated value for  $C_T$  of 323 pF. Distributed capacitance of the coil has been ignored, but its value can be no more than a few pF and can be easily compensated for by slight adjustment of the trimmer during alignment. Arithmetical-mean tracking is chosen for the oscillator circuit because of the modest tuning range.

$$r = \frac{2.1(3+1.449)}{1.9(3+1.3787)} \left( \frac{1+3 \times 1.3787}{1+3 \times 1.449} \right) = 1.0787$$

$$C_{Pmax} = \frac{355}{1.0787-1} = 4510.8 \text{ pF}$$

$$C_{Tcmax} = \frac{355}{1.0787(1.9)-1} = 338.2 \text{ pF}$$

$$C_{Pmin} = 4510.8 - 338.2 = 4172.6 \text{ pF}$$

Ignoring the distributed capacitance of the oscillator coil gives the following:

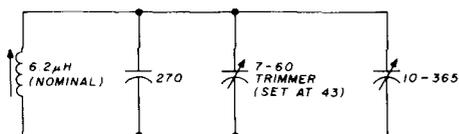


fig. 3. Design of the signal tuning circuit given in the example.

$$C_{TL} = 0$$

$$C_P = 4172.6 + 0 = 4172.6 \text{ pF}$$

$$C_{Tc} = 338.2 - 0 = 338.2 \text{ pF}$$

$$L = \frac{25330 \times 4172.6 \times 4510.8}{338.2(4172.6)^2 (3.55 + 0.455)^2} = 5.0478 \mu\text{H}$$

Using these calculated values, the actual oscillator tuning circuit could be set up as shown in fig. 4.

That takes care of the paper design, but is it correct? To find out, I used the calculated values of the capacitors and inductors, then chose several discrete values for  $C_G$  and  $C_{Go}$ , the sections of the variable capacitor, and calculated the resonant frequencies of the rf and LO circuits for each value. Table 1 shows the results.

For perfect tracking, each oscillator frequency minus 0.455 MHz should exactly equal the corresponding signal frequency. The errors are so small

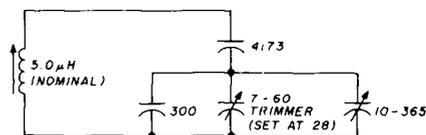


fig. 4. Design of the oscillator tuning circuit.

that they can be attributed to rounding off calculations in each step of the procedure; therefore, the overall method appears valid.

## remarks

No allowances are made for effects of coupling the resonant circuits to other circuit components, which will certainly have some impact. If the range of the adjustable components does not allow proper alignment and tracking, then the values of some components may have to be slightly changed. The small distributed capacitance ( $C_{TL}$ ) of the oscillator coil, which was ignored, causes slight errors in the calculated values of the oscillator padder,  $C_P$ , and trimmer,  $C_{Tc}$ , but  $C_P$  is so large that the error is negligible there, and  $C_{Tc}$  may be adjusted to compensate for the error.

Information on correct superheterodyne alignment techniques is available to amateurs elsewhere,<sup>2</sup> but the design equations presented here have, in my opinion, been too long absent from contemporary amateur literature.

## references

1. F. Langford-Smith, *Radiotron Designer's Handbook*, 4th edition, 1952, page 1002.
2. William I. Orr, W6SAI, *Radio Handbook*, 20th edition, 1975, page 19.31.

ham radio



## The HEATHKIT® HW-8 ...it works the world on a couple of watts!

In 1977 Norm North, WA1D3R, was assigned to Thule, Greenland. With him went his Heath HW-7, a dipole antenna, and a goal... work all 50 states!

Norm failed! But what he did accomplish in three months' time, with his HW-7 and the call OX5AB, is nothing short of amazing! Worked: 41 states, 30 countries, including a PY4 in Belo Horizonte, Brazil, and First Place, High-Band CW Greenland, in the '77 ARRL International DX Competition! Quite a record!

In Norm's words: "I honestly believe that I could have worked all states and perhaps DXCC if I had stayed in the Arctic a bit longer. This is quite a tribute to that little rig..."

We'd agree, and we bet Norm would have done even better had he been using a new Heath HW-8! Why? Because our engineers felt they could give you a much finer QRP rig than the HW-7. One with better sensitivity, lower hum and noise figures, an RF gain control, sharper preselector, switchable selectivity, more bands to operate, and even a bit more power!

They succeeded in a big way! And the result of their efforts is a truly superb CW transceiver for the QRP operator that costs just \$129.95\*...the Heathkit HW-8!

Why don't you take up the challenge? Build an HW-8 kit, then join the growing ranks of outstanding QRP operators, like Norm, who are proving you really can work the World on a couple of watts!

\*Price is mail order, F.O.B. Benton Harbor, MI. Prices and specifications subject to change without notice.

Catalogs also available at the 50 Heathkit Electronic Centers coast-to-coast (units of Schlumberger Products Corp.) where Heathkit products are displayed, sold, and serviced. Retail prices on some products may be slightly higher. See your phone book white pages.

### FREE Heathkit Catalog



HEATH

Schlumberger

Heath Company  
Dept. 122-460  
Benton Harbor,  
MI 49022

Gentlemen, please send me my free Heathkit Catalog.  
I am not on your mailing list.

Name

Address

City  State

AM-375A  Zip



## CW signal processor

A simple means  
for eliminating  
QRM from CW signals  
by using  
a phase-locked loop  
and audio oscillator

Almost from the very beginning of ham radio, there has been interference. With varying degrees of success, numerous devices have been designed to combat this problem. Modern technology has provided us with such things as narrow-bandwidth crystal filters, active audio filters, *Q*-multipliers, and acoustically resonant transducers, to name just a few.

There is another method of providing interference rejection for the CW operator, though it has been largely ignored except by a scant few. This involves the use of narrow-bandwidth, integrated-circuit tone decoders, or as shown in this article, the LM567.

The LM567 is a phase-locked-loop tone decoder which can be made to respond to a tone anywhere from less than 1 Hz to approximately 500 kHz. For my use, the range is adjustable from roughly 500 Hz to 1100 Hz. The bandwidth has been set to about 50 Hz either side of the center frequency. In other words, if the LM567 is set to a center frequency of 750 Hz, it will respond to any signal from 700 Hz to 800 Hz and ignore virtually all others.

### circuit description

A CW signal from the phone jack of a receiver is fed to the 8-ohm winding of T1 (see fig. 1). This transformer presents a low-impedance termination for the receiver audio stage, as well as providing a voltage step-up for the input of the LM567. The two 1N34A germanium diodes across the secondary limit the audio voltage to near the optimum value for the tone decoder. The three resistors and the capacitor connected to pins five and six determine the frequency range over which tones can be decoded. When a tone of the proper frequency is present at the input terminals, the output (pin 8) goes to ground and causes the LED to light.

The waveform at the output of the LM567 is sometimes a little ragged, and, for that reason, it is fed through one half of a 7413 Schmitt trigger. This stage transforms the output waveform to a square wave with very fast rise and fall times and also performs the inversion necessary for the following stage.

It wasn't until a prototype was constructed that a problem became known. The output of the tone decoder stays low for a few milliseconds after the input signal stops. The net result is to increase the "weight" of the keyed signal. That is, it decreases the spacing between code elements. To counteract this problem, a 1000-ohm resistor was connected between the output of the LM567 and the input of the 7413. Also, there is a 3.3- $\mu$ F capacitor from the input of the 7413 to ground. This combination delays

By William B. Jones, W7KGZ, 5319 Northeast 109th Street, Vancouver, Washington 98665

the switching time of the 7413 after the tone decoder goes low. The end result is to restore normal weight to the keyed signal. The values specified were experimentally derived and may be adjusted to suit individual tastes. The third stage is the familiar NE555 timer, wired as a keyed audio oscillator.

In operation, a CW signal is tuned in on the receiver and the frequency control of the CW PROCESSOR is varied until the LED begins to blink in unison with the incoming signal. This indicates that the LM567 is tuned to the proper frequency and is decoding the CW being presented to it. Activating S1 will replace the live audio with the tone generated by the 555.

It takes approximately 10 to 15 millivolts of audio from the receiver to activate the tone decoder. This corresponds to a rather weak signal (S3 to S4 would be a fair guess) in most receivers. Obviously then, the CW PROCESSOR is quite sensitive and does not take a "block-buster" signal to make it work.

From time to time, you will encounter signals that shift frequency, fade into the noise, or become obliterated by stronger adjacent signals. As these situations occur, the CW PROCESSOR will stop responding to the signal, with the resultant loss of audio. The circuit shown in fig. 2 was added to automatically switch the output from the receiver back to the headphones, after an adjustable delay.

Once again, the NE555 timer is pressed into service, this time as a monostable multivibrator. The addition of a single PNP transistor transforms the circuit into a negative recovery monostable.<sup>1</sup> If this circuit is incorporated into the CW PROCESSOR, S1 will be replaced by the contacts on K1.

It should be pointed out that if a relay with a 5- or 6-volt coil is unavailable, it is quite permissible to substitute one with a 12-volt coil and operate the second NE555 from the 12-volt supply line. The circuit per-

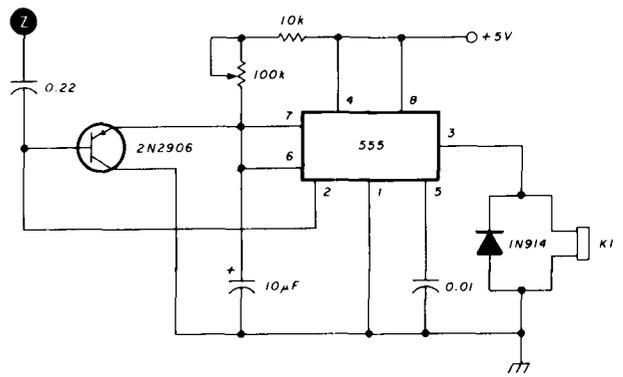


fig. 2. For periods when you experience loss of signal, this circuit will automatically switch back to live receiver audio after a suitable delay. If a relay with a 5-volt coil is not available, the circuit can also be powered from +12 volts.

formance is identical in either case. Of course, the additional NE555 is not absolutely necessary to the performance of the CW PROCESSOR, but it does add a considerable amount of operator convenience. Whether it is included or not is entirely up to the individual builder.

## construction

Because everything is operating at audio frequencies, layout and construction are definitely not critical. My version was constructed on a printed circuit board with hole spacings adjusted to suit the size of components on hand. Alternatively, perfboard and hardwired connections could be used with equally reliable results.

On the subject of parts and pieces, note that all of the necessary parts to build your own version of the CW PROCESSOR are listed in the Radio Shack catalog. Reasonable amounts of latitude may be taken

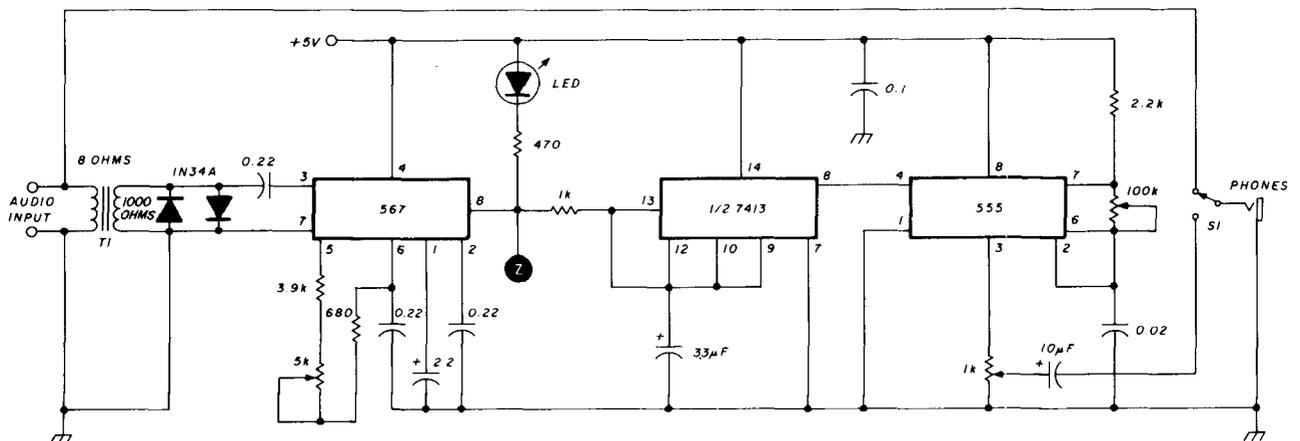
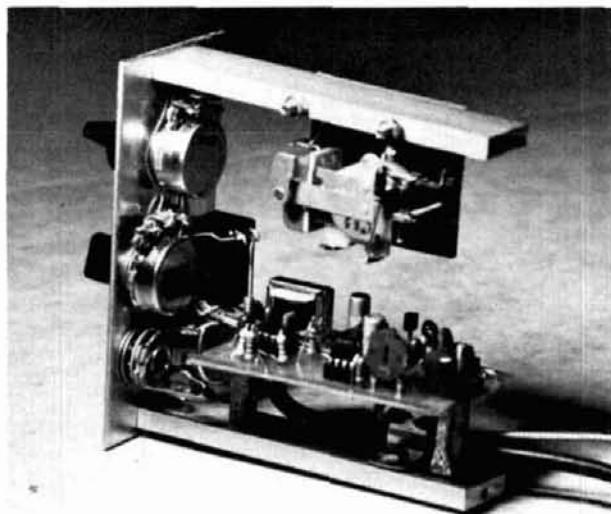


fig. 1. Schematic diagram of the signal processor. The 567 is a phase-locked loop which is configured to respond to tones from 500 to 1100 Hz. The Schmitt trigger reduces the weighting effect caused by the output of the PLL remaining low after removal of the audio signal. Since the processor requires a +5 volts, a simple 3-terminal regulator can be used to power the unit from a 12-volt line.



CW signal processor with the case removed, showing layout and construction. Relay is mounted on separate circuit board installed on top chassis rail; other circuit board is mounted on standoffs on bottom rail.

with regard to parts values since few are critical. However the capacitors associated with the LM567 and LM340 should be low-leakage types; tantalums are recommended as the best choice in this case.

The enclosure was garnered from the local surplus emporium and is pretty much a one-of-a-kind item. Any box large enough to accommodate the parts will be suitable. In the early developmental stages,

the CW PROCESSOR was operated with no enclosure at all and no problems were encountered. This would suggest the possibility of using a nonmetallic box instead of the more common aluminum cabinet.

### summary

The CW PROCESSOR is not a cure-all for all QRM problems; it does have its limitations. For example, the 100-Hz bandwidth talked about earlier is valid only for signals not exceeding approximately 300 millivolts at the input of the LM567. As is sometimes the case, you will be trying to copy an S5 signal with the CW PROCESSOR and an S9 signal only 200 Hz away will disrupt reception. Also, if you are trying to copy a heavily weighted CW signal, the CW PROCESSOR will aggravate the situation unless an absolute minimum of signal is presented to the input.

All things considered, however, using the CW PROCESSOR has been pure joy. Operator fatigue is greatly reduced by not having to listen to all of the garbage normally associated with ham band signals. It is amazing how well this device snatches a barely readable signal out of the noise and transforms it into the kilowatt-next-door category. Build one for yourself and see what a difference it makes at your station.

### reference

1. Don Lancaster, *TTL Cookbook*, Howard W. Sams, Indianapolis, 1974.

ham radio

## birdie suppression in the Swan 160X

The Swan 160X is a 400-watt PEP input transceiver for 160 meters. Unfortunately, it is no longer made. During its lifetime, there was little interest in the 160-meter band. Now, that interest is growing, the 160X is a prized piece of equipment for the "top band" enthusiast. A few 160Xs are available second hand, but they are quickly snapped up and do not stay on the dealer's shelves for any length of time.

A minor problem with the 160X is a birdie or cross-over product which falls in the passband of the receiver. It can be heard as a carrier, or heterodyne, at about 1834 kHz. Though not particularly loud, it can be very annoying when you're looking for a weak DX signal.

An investigation of the mixing technique in the 160X shows that the spurious signal is a result of unwanted mixer products from the VFO and the carrier oscillator, Q3. At spurious frequency of 1834 kHz, the carrier oscillator is at 5.500 MHz and the VFO is at 7.333 MHz. The third-order product of these two frequencies is:

$$\text{Birdie} = 3f_2 - 2f_1$$

where,

$$f_1 = 7.333 \text{ MHz}$$

$$f_2 = 5.500 \text{ MHz}$$

or,

$$16.500 - 14.666 = 1.834 \text{ MHz}$$

The birdie may be reduced to an amplitude by placing a trap tuned to 14.666 MHz in the output lead of the VFO. This is easy to accomplish since the output signal from the VFO appears at the accessory socket (J6) located on the rear apron of the 160X. It is merely necessary to break the lead in the plug and insert a small trap as shown in **fig. 1**. The trap can be made up of very small components and mounted directly to the pins of the plug, which should always be in place when an auxiliary VFO is not used. (Since, to my knowledge, an auxiliary VFO was never built for the 160X, this is a moot point!)

If a compression-type capacitor is used, the trap is easily adjusted by tuning the transceiver to 1834 kHz and adjusting the capacitor for minimum birdie response in the receiver.

Bill Orr, W6SAI

# REMEMBER WHEN...

... People wore highbutton shoes  
 ... Eisenhower was President  
 ... Hardly anyone operated on 220 MHz

## TIMES HAVE CHANGED

TPL COMMUNICATIONS has kept up with the changes and now offers to the many 220 MHz operators a wide variety of amplifiers.

### 220 MHz

Model	Power In	Power Out
*401	5 to 15W	30 to 45W
401B	1 to 4W	30 to 45W
*801	5 to 15W	60 to 90W
801B	1 to 4W	60 to 90W
*801C	15 to 30W	60 to 90W
*1301	5 to 15W	90 to 130W
*1301C	15 to 30W	90 to 130W

\* These models may be ordered with a repeater option

See these and other fine TPL amplifiers at your dealer listed below.

#### ACTION RADIO

Ave. Pinero 1271  
 Caparra Terrace, PR 00920  
 (809) 782-2126

#### AMATEUR RADIO SUPPLY

6213 13th Ave. South  
 Seattle, WA 98108  
 (206) 767-3222

#### AMATEUR ELECTRONIC SUPPLY

4828 W. Fond du Lac Ave.  
 Milwaukee, WI 53216  
 (414) 442-4200

#### AMATEUR RADIO CENTER

2805 N.E. Second Ave.  
 Miami, FL 33137  
 (305) 573-8383

#### ADIRONDACK RADIO SUPPLY

185 W. Main St.  
 Amsterdam, NY 12010  
 (518) 842-8350

#### BRITT'S 2-WAY RADIO SERVICE

2508 N. Atlanta Road  
 Smyrna, GA 30080  
 (404) 432-8006 (local)  
 (800) 241-9961 (toll free)

#### CW ELECTRONIC SALES CO.

1401 Blake St.  
 Denver, CO 80202  
 (303) 893-5525

#### E.I.S.C.

11305 Elkin St.  
 Wheaton, MD 20902  
 (301) 946-1088

#### ERICKSON COMMUNICATIONS

5935 Milwaukee St.  
 Chicago, IL 60646  
 (312) 631-5181

#### HAM-BUERGER

68 N. York Rd.  
 Willow Grove, PA 19090  
 (215) 659-5900

#### HAM RADIO CENTER

8340 Olive Blvd.  
 St. Louis, MO 63132  
 (314) 993-6060 (local)  
 (800) 325-3636 (toll free)

#### HAM RADIO OUTLET

2620 W. La Palma  
 Anaheim, CA 92801  
 (714) 761-3033  
 999 Howard Ave.  
 Burlingame, CA 94010  
 (415) 342-5757

#### HAM RADIO OUTLET

5375 Kearney Villa Rd.  
 San Diego, CA 92123  
 (714) 560-4900

13754 Victory Blvd.  
 Van Nuys, CA 91401  
 (213) 988-2212

#### H.E.M.E.C.

217 W. Gutierrez St.  
 Santa Barbara, CA 93101  
 (805) 963-3765

#### HONOLULU ELECTRONICS

819 Keeaumoku St.  
 Honolulu, HI 96814  
 (808) 949-5564

#### LONG'S ELECTRONICS

2808 7th Ave. South  
 Birmingham, AL 35233  
 (800) 292-8668 (local toll free)  
 (800) 633-3410 (out of state toll free)

#### MADISON ELECTRONICS SUPPLY

1508 McKinney  
 Houston, TX 77002  
 (713) 658-0268 (local)  
 (713) 497-5683 (nights)

#### N & G DISTRIBUTING

4545 NW 7th St.  
 Miami, FL 33126  
 (305) 443-6119

#### PORTLAND RADIO SUPPLY

1234 SW Stark  
 Portland, OR 97205  
 (503) 228-8647

#### RESCO

1506 Kanawha Blvd. E  
 Charleston, WV 25311  
 (304) 342-2470

#### SLEP ELECTRONICS CO.

Hwy. 441 - Franklin South  
 Otto, NC 28763  
 (704) 524-7519

#### THE COMM CENTER

9624 Ft. Meade Road  
 Laurel, MD 20810  
 (301) 792-0600

#### TOWER ELECTRONICS

24001 Alicia Parkway  
 Mission Viejo, CA 92675  
 (714) 768-8900

#### TRACY'S ELECTRONICS

5691 Westcreek Drive  
 Fort Worth, TX 76133  
 (817) 292-3371

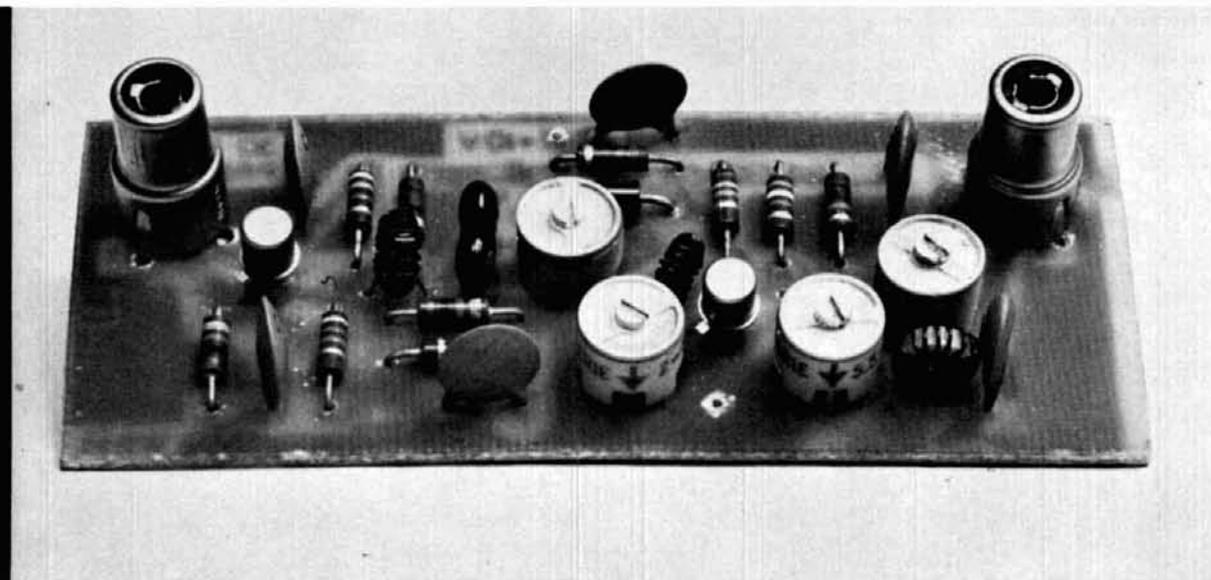
#### TUFT'S RADIO ELECTRONICS

209 Mystic Ave.  
 Medford, MA 02155  
 (617) 395-8280

talk  
 power  
 by **TPL**

COMMUNICATIONS INC. 1324 W. 135TH ST., GARDENA, CA 90247 • (213) 538-9814

Canada: Lenbrook Industries, Ltd., 1145 Bellamy Rd., Scarborough, Ontario M1H 1H5  
 Export: EMEC Inc., 2350 South 30th Avenue, Hallandale, Florida 33009



## low-noise 30-MHz preamplifier

A low-noise preamplifier which may be used to improve 10-meter receiver sensitivity, improve OSCAR communications, or extend Gunnplexer range

The apparent sensitivity of many communications receivers seems to fall off above about 25 MHz because of the lower levels of external galactic and external noise at these frequencies.<sup>1</sup> When the 10-meter band is wide open, this isn't particularly noticeable, but when propagation conditions are marginal additional sensitivity makes a big difference in DX performance.

A receiver which has an adequate noise figure on 20 and 15 meters may be marginal on ten; also, front-end circuits which have been optimized for the lower amateur bands don't always work as well as they should at 28 MHz. This is especially true with vacuum-tube rf amplifiers. Since 10 meters is open perhaps three years during the 11-year sunspot cycle, and then for only a few hours each day, it is understandable why the designers don't pay more attention to 10-meter performance.

If you operate on the vhf-uhf bands and use your receiver as a tunable i-f, noise figure is extremely important because it affects the noise performance of your vhf/uhf converter. Satellite communications can also be improved by better receiver sensitivity, and if you operate on 10 GHz with a Gunnplexer, you

By James R. Fisk, W1HR, *ham radio*, Greenville, New Hampshire 03048

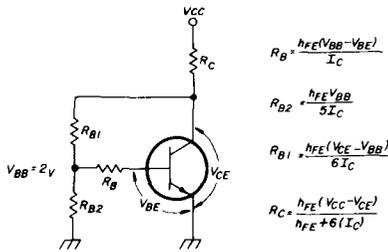


fig. 2. Dc bias circuit for vhf/uhf applications stabilizes collector current with voltage feedback through resistor  $R_B$  and maintains constant base current with  $R_{B1}$  and  $R_{B2}$ . A design example is given in the text.

can double your effective range by lowering your system noise figure by 6 dB.

### 30-MHz preamp

The 30-MHz i-f preamplifier shown in fig. 1 is based on a design by engineers at Microwave Associates using low-noise npn silicon planer transistors.\* These transistors exhibit excellent noise figure vs current characteristics, which results in extremely low noise figure and wide dynamic range. The circuit provides 19 dB gain with a noise figure of about 1.1 dB; compression of 1 dB occurs at an output of  $-7$  dBm. The 3-dB bandwidth of the preamplifier is 10 MHz, and the input is designed to match the 200-ohm source impedance of the Gunnplexer mixer diode. Circuits for matching the preamp to 50 ohms are discussed later in this article.

The noise figure of the Schottky mixer diode in the Gunnplexer is specified at 12 dB maximum, but many units are better than this. With careful design, proper impedance matching, and the use of an i-f preamplifier with a 1.0 to 1.5 dB noise figure, some users have reported system noise figures well below 10 dB. This represents a significant increase in reliable communications range.

\*Microwave Associates transistors are available from G. R. Whitehouse, Newbury Drive, Amherst, New Hampshire 03031.

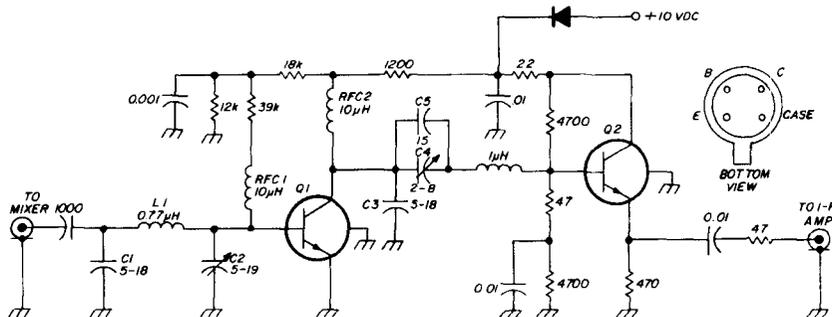


fig. 1. Low-noise preamplifier has a noise figure of 1.1 dB at 30 MHz and 3 dB bandwidth of 10 MHz. Gain is 19 dB. Total current drain with a +10 volt supply is 13 mA. All resistors are 1/4 watt carbon; bypass capacitors are 50-volt ceramics.

### bias circuit design

One factor which is often overlooked in vhf circuit design is the dc bias network. At low frequencies an emitter resistor is often used to provide negative current feedback for dc stability. In low-noise vhf applications, however (and this includes 28 MHz), the emitter bypass capacitor which is an efficient rf bypass at the design frequency often introduces low frequency instability. Furthermore, any series emitter impedance, no matter how small, results in a degradation of noise figure and gain. Therefore, vhf circuits which are designed for lowest noise or maximum gain require that the emitter lead be grounded as close as possible to the transistor package to keep emitter series feedback to an absolute minimum.

The transistor variable which has the most effect on dc stability is collector current. If you study the transistor's parameters, you'll find that gain and noise figure are the most sensitive to changes in bias, and both are stronger functions of collector current than of collector-emitter voltage,  $V_{CE}$ . There-

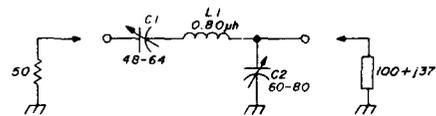


fig. 3. Suggested circuit for matching the low-noise preamplifier stage to 50 ohms.

fore, the ultimate goal in dc bias design is to stabilize collector current. The temperature-sensitive parameters which affect collector current are the internal base-emitter voltage,  $V_{BE}$ ; the dc current gain,  $h_{FE}$ ; and the reverse collector current,  $I_{CBO}$ . Normally  $I_{CBO}$  is expected to double for each  $10^\circ\text{C}$  temperature rise, but because of surface currents in uhf and microwave transistors,  $I_{CBO}$  increases at a rate much less than this and can usually be neglected in vhf bias design.

Fig. 2 shows a dc bias circuit which stabilizes  $V_{BE}$  and  $h_{FE}$  by using voltage feedback through  $R_B$

and a constant base current source from resistors  $R_{B1}$  and  $R_{B2}$ .<sup>2</sup> Not shown are the rf chokes which must be placed in series with the base and collector (RFC1 and RFC2 in fig. 1).

The design equations for this bias circuit are given in fig. 2. First determine the available supply voltage  $V_{CC}$ , select the desired transistor operating point ( $V_{CE}$  and  $I_C$ ), and check the transistor data sheet for dc forward gain  $h_{FE}$ . If  $h_{FE}$  data is unavailable, assume  $h_{FE} = 50$ ; this is a fair assumption for many vhf/uhf transistors. To ensure a constant base current source, the voltage  $V_{BB}$  is set at approximately three times the base-emitter voltage,  $V_{BE}$ , or about 2 volts for silicon transistors ( $V_{BE} = 0.7$  volt). The current through  $R_{B2}$  is set at five times the base current  $I_B$ . Since  $I_B = I_C/h_{FE}$ , the current through  $R_{B2}$  is  $5I_C/h_{FE}$ . The current flowing through  $R_{B1}$  is the

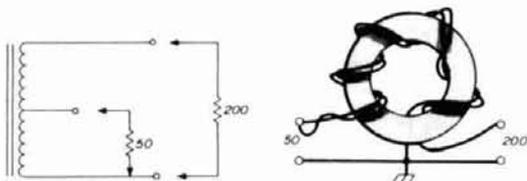


fig. 4. Schematic and construction of a 4:1 rf transformer for matching 200 ohms to 50 ohms. The transformer consists of 18 turns slightly twisted pair number 28 (0.3 mm) enamelled wire on a T-50-6 toroid form.

sum of the current through  $R_{B2}$  plus base current or  $6I_C/h_{FE}$ .

The noise-figure curve at 30 MHz for the Microwave Associates 42001-509 transistor shows a rather broad minimum centered around  $I_C = 3$  mA;  $h_{FE}$  is about 90. With a 10-volt dc power supply,  $V_{CE}$  is selected to be 6 volts. Using the design equations of fig. 2 yields the following bias resistor values:  $R_B = 39k$ ,  $R_{B2} = 12k$ ;  $R_{B1} = 20k$ ; and  $R_C = 1250$  ohms. The

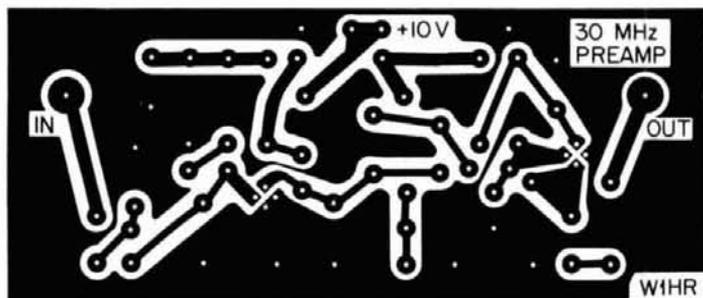


fig. 5. Full-size printed circuit layout for the low-noise pre-amplifier.

30-MHz preamplifier in fig. 1 uses the nearest standard resistance values.

In the output emitter follower stage dc stabilization is provided by current feedback produced by the 470-ohm emitter resistor; the input impedance of this stage is approximately 50 ohms. The emitter follower is used to drive a 50-ohm coaxial cable to the first i-f stage or front end rf amplifier. If the preamplifier is located very close to the 28-30 MHz rf stage, the emitter follower may be omitted.

### input matching

Another important consideration in low-noise amplifier circuits is the design of the input matching circuit. For the 42001-509 transistor the input impedance for optimum noise figure is  $100 + j37$  ohms at 30 MHz. The input pi network (C1, L1, C2 in fig. 1) transforms this to the 200-ohm source impedance of the Gunnplexer mixer diode. The output of the first stage is matched to the approximately 50-ohm input of Q2 with C3, C4, C5, and L2.

If you wish to use this preamplifier in a 50-ohm system you can either modify the input matching circuit or use a 4:1 rf transformer. A suggested 50-ohm

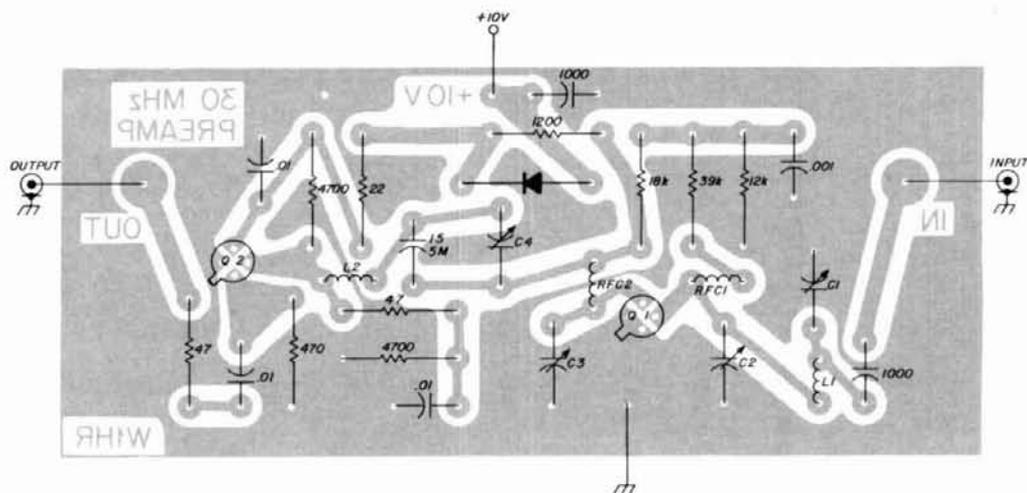


fig. 6. Component layout of the preamp circuit board. Note that RFC1 is mounted on the foil side of the board to prevent coupling to RFC2.

input circuit is illustrated in fig. 3. Construction of a simple 4:1 rf transformer which will match 200 ohms to 50 ohms is shown in fig. 4.

### construction and test

Fig. 5 shows a full-size, printed-circuit layout for the low-noise 30-MHz preamplifier; the component placement is shown in fig. 6. Note that the rf choke in the base circuit of Q1 (RFC1) is mounted on the foil side of the board; this is to prevent unwanted coupling to RFC2, which is located nearby. When winding the toroid coils, be sure to spread the windings evenly over the circumference of the form.

With slight modification the circuit board will accommodate the 50-ohm matching circuit of fig. 3. L1 and C2 are soldered to the same circuit pads as L1 and C2 in the 200-ohm matching circuit. C1 replaces the 1000-pF blocking capacitor; however, it may be necessary to drill new holes because of the wider spacing of the tabs on the variable capacitor.

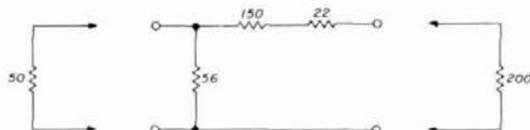


fig. 7. Minimum loss pad which may be used to match 200 ohms to 50 ohms. Pad loss of 11.5 dB must be considered when making noise or gain measurements.

Since most rf signal generators and noise-figure meters are designed for a 50-ohm system, and the preamplifier is designed to match 200 ohms, you must take a 4:1 impedance transformation at the input when tuning the preamp. You can use the 4:1 rf transformer if you wish, or the minimum loss pad\* shown in fig. 7. This pad has approximately 11.5 dB loss, which must be considered when making gain or noise measurements.

For best operation the preamplifier should be adjusted for minimum noise figure, but this is not possible if you don't have access to noise-measuring equipment. Tuning the preamplifier for maximum gain will degrade noise figure slightly, but noise performance will still be better than that available with most 28-MHz receivers or 30-MHz i-f strips.

\*A minimum loss pad is a resistance pad which will provide an impedance match between unequal terminations with the smallest possible attenuation.

### references

1. James Fisk, W1DTY, "Receiver Noise Figure, Sensitivity, and Dynamic Range — What the Numbers Mean," *ham radio*, October, 1975, page 8.
2. Kenneth Richter, "Design DC Stability Into Your Transistor Circuits," *Microwaves*, December, 1973, page 40.

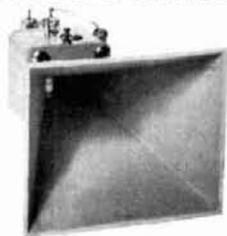
ham radio

# GUNNPLEXER™ TRANSCEIVER

## "FRONT END" BY MICROWAVE ASSOCIATES

### Features

- Low Cost
- High Sensitivity
- Integrated Assembly
- Electronically Tunable
- High Reliability
- Low Operating Voltage



**THE GUNNPLEXER SYSTEM** The fascination of amateur microwave is unique. Microwave systems have an 'exotic' ring to them. Until the appearance of the Gunnplexer, getting into microwaves required either a six foot rack of surplus gear or a friend on the inside of a microwave hardware supply company. The Gunnplexer has changed all of that; now you don't need any friends in the microwave business (in fact it may be better if you don't have any prior microwave knowledge because the Gunnplexer pretty much throws away the book on standard microwave design practices!).

Equally fascinating is the wide band capability of the microwave region. The 10 GHz assignment has spectrum-space for 111 simultaneous video (4.5 MHz wide) channels. Try that even using SSTV in the 20 meter assignment.

The bottom line on microwaves is simply that it will do much more communicating than you might first suspect.

### TWO-WAY COMMUNICATIONS

The primary application of the Gunnplexer "front end" is for 2-way communications. Two units, one a transmitter and the other a receiver down converter, are used with their carrier frequencies off-set to provide a reasonable IF (30 MHz or higher). Applications range from linking remote receivers to VHF repeaters, transmitting color video, linking homemade computers, full duplex mountain top DXing or over water duct DXing. A separate power supply and simple FM modulator must be provided; the MA-86551 (17 dB) horn antenna (shown here) is suggested.

**WHY A GUNNPLEXER?** Amateur microwave communication is fascinating and challenging. Now with the revolutionary MICROWAVE ASSOCIATES Gunnplexer front end this exotic form of communication is available to virtually anyone. And at an unbelievably low cost!

**MA-87141-1 2 Complete Gunnplexer Transceivers (MA-87127-1, 15mW typical and 2 horn antennas MA-86551, 17dB) just \$199.95 plus \$2.00 shipping and handling.**

Send for our complete Gunnplexer Introductory Package.  
VISA and MasterCharge Orders Welcomed.

**RUSH ORDER? (603) 673-7724**

Exclusive distributor for MICROWAVE ASSOCIATES products in the United States and Canada.

**G.R. WHITEHOUSE & CO.**  
10 Newbury Drive, Amherst, N. H. 03031

# clean local-oscillator chain

## for 1296 MHz

An easy-to-build  
LO for 1296 MHz  
which can be optimized  
without a spectrum analyzer.

Outputs are  
also available  
for 220 and 432 MHz

**Development of a local-oscillator chain for 1296 MHz** which can be tuned up without a spectrum analyzer, yet has an acceptably clean spectrum, has been a long-time goal. I have built several LO chains which required the use of a spectrum analyzer and several hours of trimming to tune; when they quit in the midst of a contest, there was no recourse. This article describes a 1296-MHz LO chain which can be tuned up in a few minutes with minimal test equipment, including a tripler which needs no tuning. The spectrum analyzer photographs were taken after tuning was completed; it was not used during the tuneup procedure.

What is an "acceptably clean spectrum?" Very simply, it is one which produces no birdies in the operating band. More quantitatively, the following criteria are arbitrarily defined:

1. No spurious (not harmonically related) outputs
2. Undesired harmonics of oscillator suppressed more than 40 dB
3. Undesired harmonics of oscillator well separated (spacing more than 5% of output frequency)
4. No harmonics near the i-f band
5. Low noise content

Now examine **fig. 1A**, the local-oscillator spectrum of a typical 432-MHz converter with a fairly low frequency oscillator, followed by two single-tuned transistor triplers. This converter has enough birdies so the band never sounds dead!

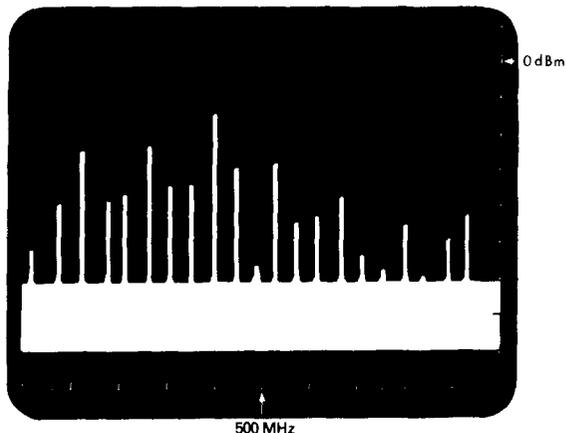
The causes of the poor spectrum of **fig. 1A** are insufficient selectivity, excessive multiplication factor, and inefficient multipliers. Increasing the oscillator frequency spaces the harmonics and eases the selectivity, or filtering, problem. However, a single transistor is still an inefficient multiplier; it would much rather amplify than multiply, so the output always has a strong fundamental component. (A tripler also has a strong second harmonic component). One solution is the use of idlers, but they make tuning very critical and usually add a tendency to parametric oscillations. Diode multipliers have the same problems, but with added loss (transistor multipliers often have gain).

A more effective solution is the use of natural multiplying circuits. A push-push doubler was described several years ago.<sup>1,2</sup> This basic circuit was incorporated into both doubler stages of a 432-MHz local-oscillator chain; the resultant spectrum shown in **fig. 1B**. This system has worked beautifully for more than two years.

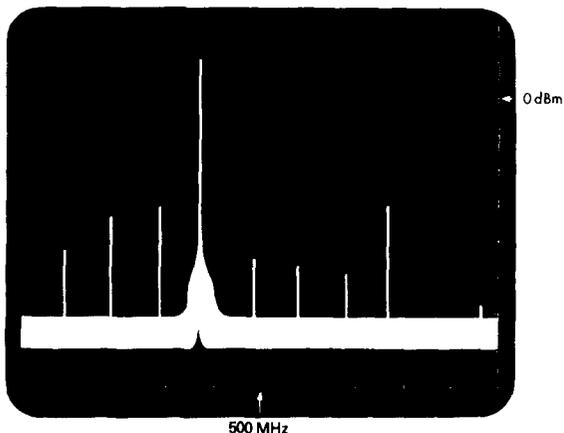
Recently, a push-pull tripler was added to the out-

**By Paul C. Wade, WA2ZZF, 153 Woods Road, Somerville, New Jersey 08876**

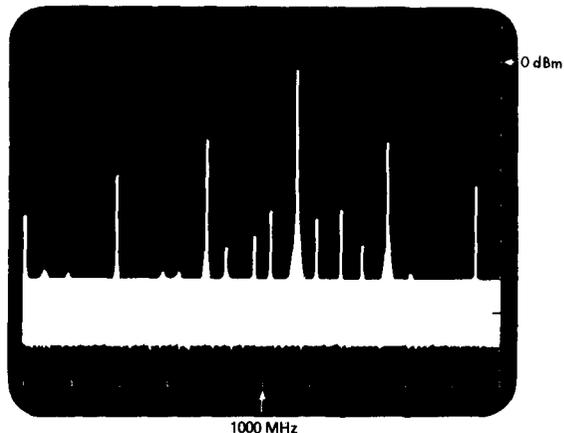
fig. 1. Spectrum analyzer display of the local oscillator chain for a typical 432-MHz converter, A, showing the large number of undesired spurs. Other displays show the output spectrum of the local-oscillator chain described in this article. (Measurements made with Ailtech 727 spectrum analyzer at 10 dB per division.)



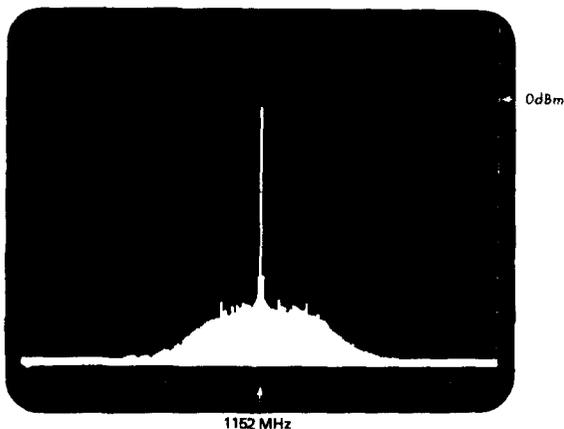
A. Local-oscillator spectrum of a typical 432-MHz converter, after tuning for cleanest output with a spectrum analyzer. Horizontal scale: 100 MHz per division.



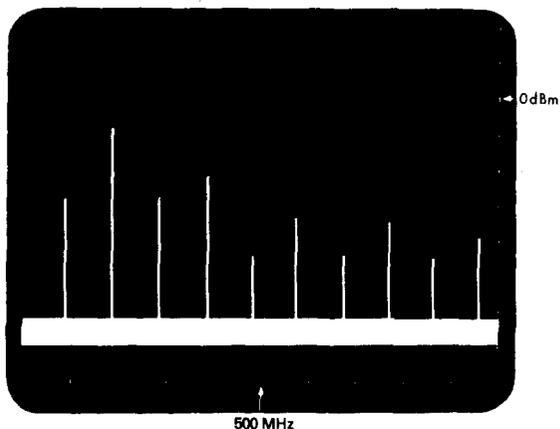
B. Output from the low-frequency multiplier chain described in this article. Output at 384 MHz is approximately 20 mW. Horizontal scale: 100 MHz per division.



C. 1152-MHz output from the frequency tripler for use as a local oscillator on 1296 MHz. Output is approximately 0.5 mW. Horizontal scale: 200 MHz per division.



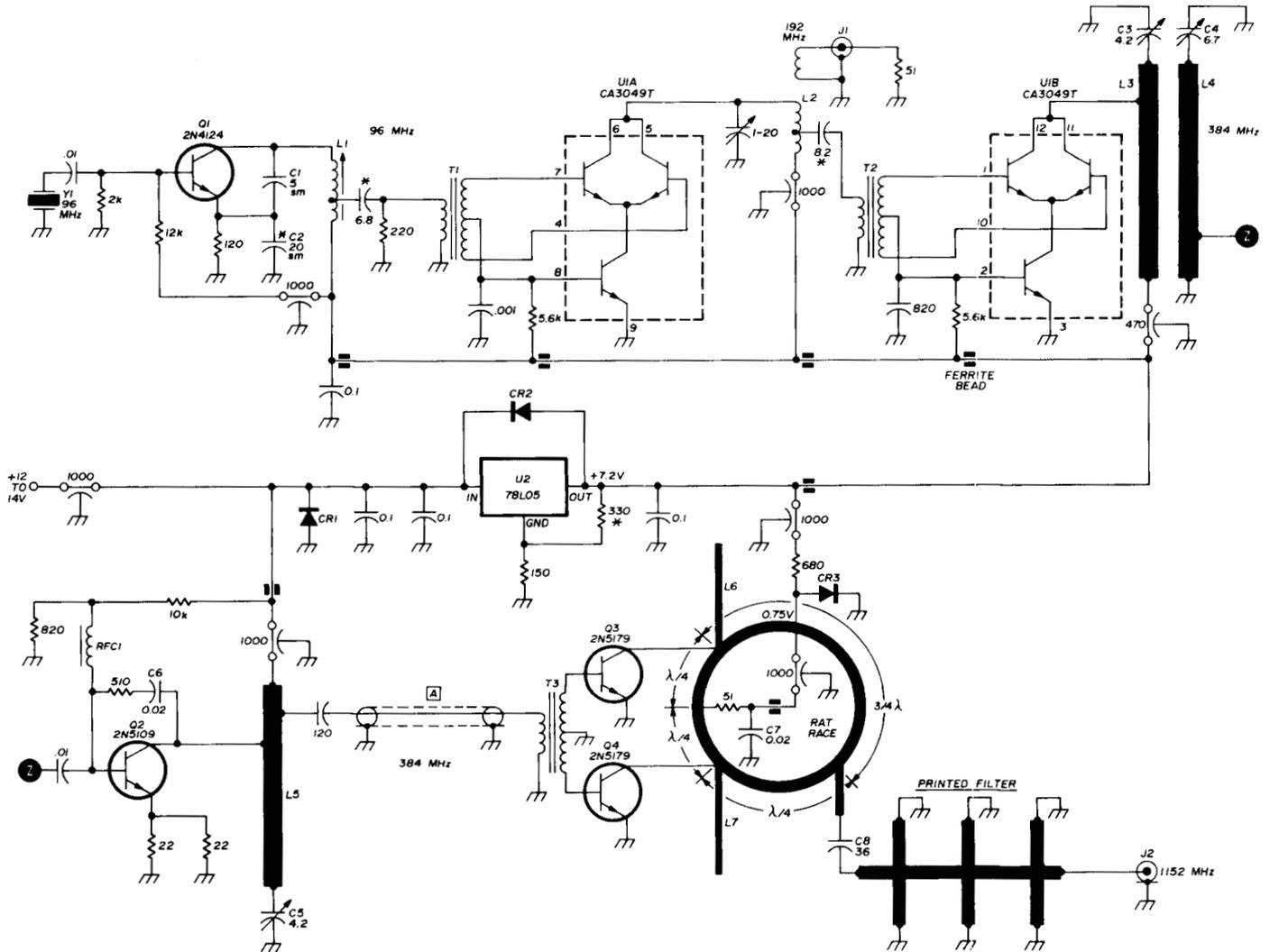
D. Display of the 1152-MHz output showing the noise spectrum. Horizontal scale: 1 MHz per division. Contribution from spectrum analyzer is probably significant.



E. Spectrum of output available from J1 is easily filtered for use as a local oscillator for 220-MHz equipment. Horizontal scale: 100 MHz per division.

put to build a 1296-MHz local oscillator. The push-pull tripler had been a stumbling block because of the requirement that the outputs, as well as the inputs, be 180° out of phase; the push-push doubler

requires phase reversal only at the input, which is easily provided by a trifilar wound transformer or a balun. If an untuned transformer was used at the output, it would be a broadband amplifier rather than



C3, C5	1.2-4.2 pF air variable (E. F. Johnson 189-501-5)	L6, L7	printed transmission lines, $\lambda/4$ long at 768 MHz, $Z_0$ chosen to provide correct tuning inductance at 1152 MHz
C4	1.3-6.7 pF air variable (E. F. Johnson 189-502-5)	Q1	2N4124
C6, C7	0.02 $\mu$ F (chip capacitor or very short leads)	Q2	2N5109, MSC 80099, or equivalent (2N3866 usable with lower gain)
C8	36 pF (chip capacitor or very short leads)	Q3, Q4	2N5179 (case floating — case cut off flush with base)
CR1, CR2,	1N4148 or 1N914 silicon diode	RFC	ferrite bead with 2 turns no. 30 (0.25mm) Formvar
CR3		T1, T2	4 turns no. 30 (0.25mm) trifilar wound on large ferrite bead, $\mu = 900$ (Ferronics 11-090-J; suggested replacements: Amidon FT-25, mix 43 or Amidon 801 ferrite bead, mix 43)
L1	6 turns no. 24 (0.5mm) Formvar close spaced on 3/16" (5mm) coil form with green slug; tap at 1 1/2 turns	T3	3 turns no. 30 (0.25mm) trifilar wound on ferrite bead, $\mu = 125$ (Ferronics 21-030-K; suggested replacements: Amidon FT-25, mix 61 or Amidon 101 ferrite bead)
L2	4 turns no. 18 (1mm) tinned wire, 3/16" (5mm) ID, 5/8" (16mm) long; tap at 1 1/4 turns (optional link: 1 1/4 turns no. 22 (0.6mm) insulated wire, 3/16" (5mm), installed near hot end of L2)	U1	RCA CA3049T
L3	40 nH printed inductance	U2	78L05
L4	43 nH printed inductance	Y1	96 MHz third-overtone crystal
L5	60 nH printed inductance		

fig. 2. Schematic diagram of the 1152-MHz local-oscillator chain. Outputs are available for use on 432 MHz (cable A) and 220 MHz (J1). Cable A is short piece of semi-rigid coax. Components marked with an asterisk may be critical or may need adjustment for optimum performance. Printed-circuit boards are shown in figs. 3 and 4.

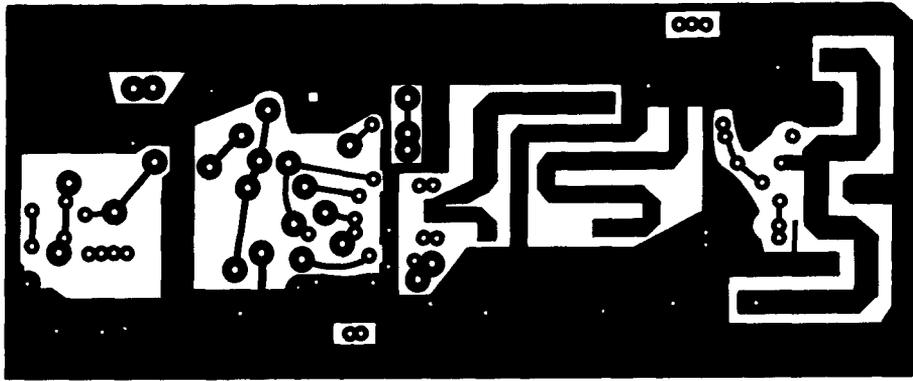


fig. 3. Printed-circuit layout for the single-sided low frequency board (output at 384 MHz). Component placement is shown in fig. 6. Material is single-clad 1.5 mm (1/16") G10 circuit board.

a tripler. The brainstorm which made this work was to use a *rat-race* coupler at the output. As used in this circuit, two input signals which are 180° out-of-phase at the resonant frequency combine at the output port, while other phases and frequencies combine in the terminating resistor. The rat-race is not critical so *no* tuning is required.

The frequency tripler is followed by a printed-circuit filter made up of quarter-wavelength stubs; the output spectrum is shown in fig. 1C. For detailed descriptions of the rat-race and printed-circuit filter, see Howe's excellent book, *Stripline Circuit Design*.<sup>3</sup> Fig. 1D shows the noise spectrum of the 1152-MHz output — none is evident down to the noise floor of the analyzer (on this non-optimum range for this measurement); fig. 1E is the output of the first

doubler, at J1, for use as a 220 MHz local oscillator, or for connection to a frequency counter.

The major objection to push-push doublers and push-pull triplers is that two transistors are required. However, prices for usable vhf/uhf transistors have dropped to the point that they are available in the 15 cents to \$1 range. As an alternative, several matched transistors on the same chips can be bought as an integrated circuit. The single CA3049T used for both doublers costs \$1.13 from a local dealer. While the prices of semiconductors have been steadily decreasing, prices for capacitors and coil forms, needed for idlers and filters in conventional multipliers, have increased.

Construction is straightforward and requires no machining; all frequency-determining elements

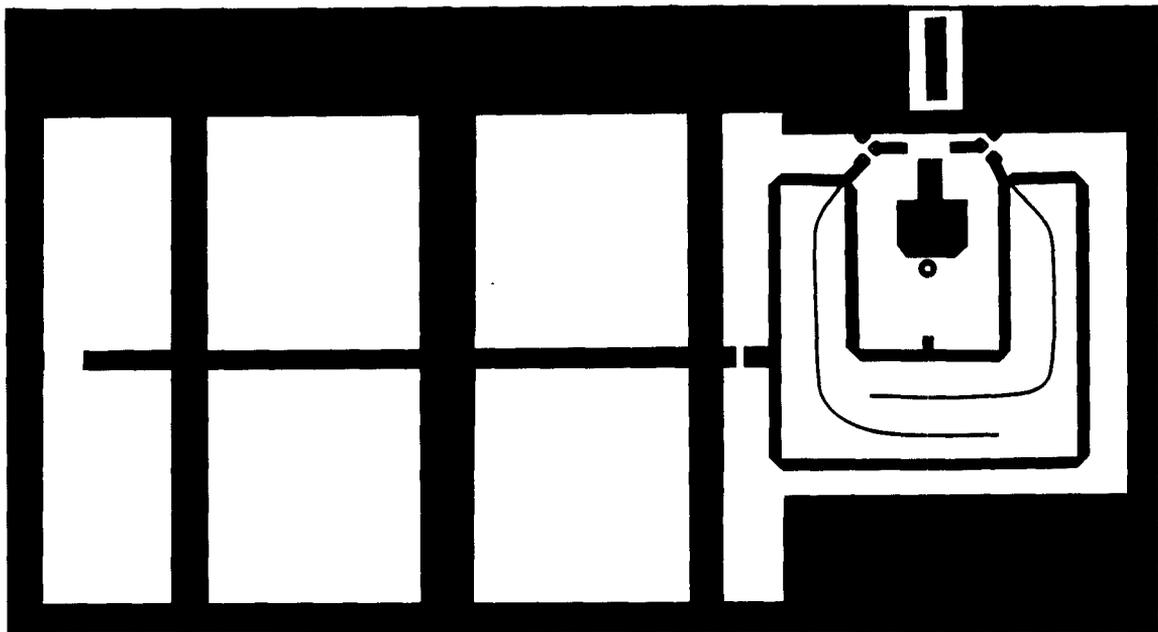


fig. 4. Active side of the double-sided 1152-MHz tripler/filter circuit board. Unetched reverse side serves as the ground plane. Material is 1.5 mm (1/16") double-clad G10 circuit board.

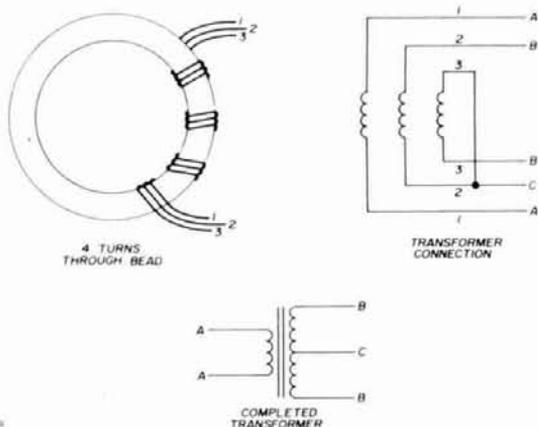


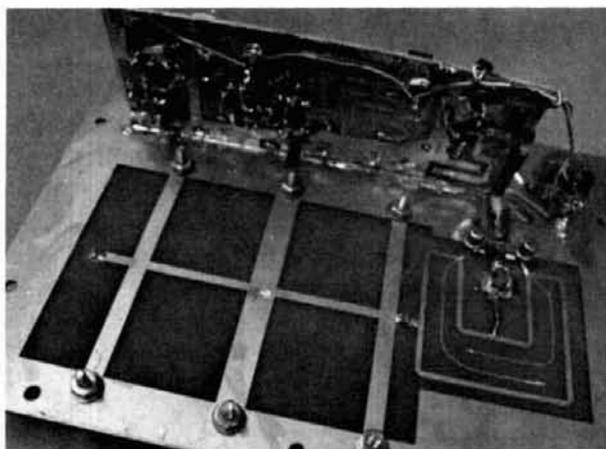
fig. 5. Construction of transformers T1 and T2. Turns are counted by the number of times the wire passes through the center. Wire is no. 30 to no. 34 (0.25-0.16mm) Formvar coated. T3 is similar except it consists of three turns.

above grid-dipper range are printed. Printed-circuit layouts are shown in fig. 3 and 4. Component placement may be seen in the photographs. Transistors Q3 and Q4 have their leads bent outward along the printed lines about 0.1 inch (2.5mm) below the case (the fourth lead, case, is cut off flush so the case is not connected) as shown in the close-up photograph.

The trickiest part in building the LO chain is winding transformers T1, T2, and T3. T1 and T2 consist of four trifilar turns on a large ferrite bead such as a Ferronics 11-090-J ( $\mu = 900$ ) as shown in fig. 5. All windings are wound at the same time for a total of 12 turns. The four turns are counted from the inside — not the outside. Also shown in fig. 5 are the transformer connections and how they are installed in the circuit. Construction of transformer T3 is similar except it consists of 3 trifilar turns on a Ferronics

21-030-K ferrite bead ( $\mu = 125$ ). Transformer T2 is installed on the copper foil side of the board to minimize lead length. Cable A in fig. 2 is not installed yet; a temporary jack is installed instead.

Tuneup is also straightforward. Monitoring the power at J1, tune L1 and the trimmer capacitor across L2 for maximum output. Check the frequency with a frequency counter, wavemeter, or grid-dipper. It may be necessary to reduce the value of C2 for maximum output with different crystals. Roughly 0.1 milliwatt is available from J1 with the small link.



Stripline filter for the low-noise amplifier. The bolts through the board ensure an adequate ground connection at the end of the quarter-wavelength filters.

Next, terminate J1 with 50 ohms and monitor the output at L5 through the 120 pF capacitor (cable A not yet installed). Adjust C3, C4, C5, and L2 trimmer for maximum output (approximately 20 mW). If convenient, check frequency — if not, note capacitor

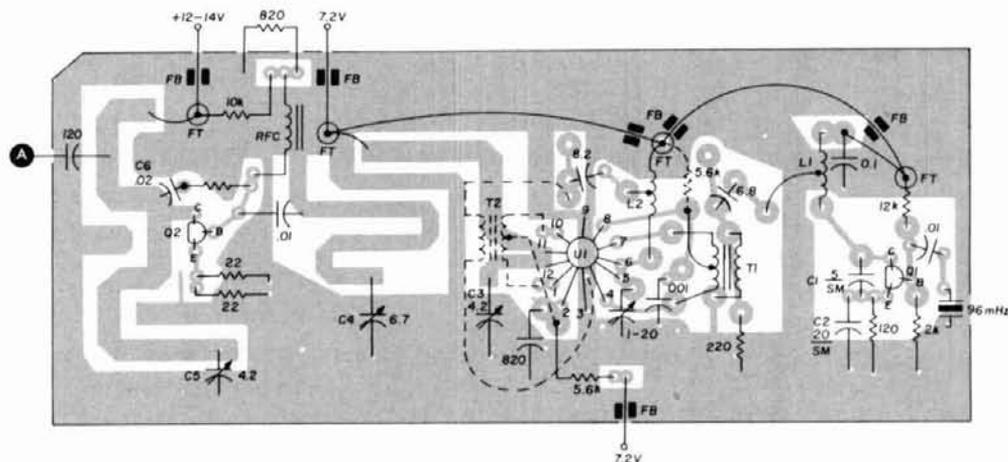


fig. 6. Component placement for the low-frequency multiplier board. Foil side is shown in fig. 3.

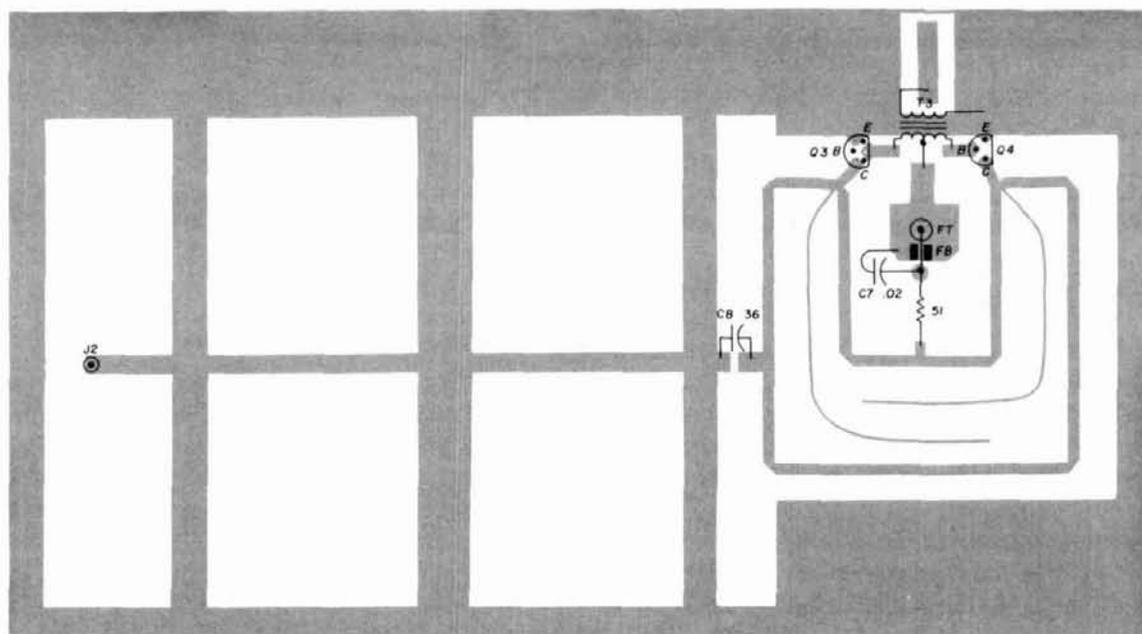


fig. 7. Component placement on the 1152-MHz tripler/filter board. Foil layout is shown in fig. 4. Contrary to other component placement diagrams, this diagram is shown from the etched side of the board.

rotor settings in the photographs. Of the three units I have built, the only one which did not proceed smoothly to this point had a defective IC section.

Now either proceed to the tripler or (optional) go back and fine tune the doublers. Small adjustments to the coupling capacitors tapped off L1 and L2, to the output of the voltage regulator (vary the 330-ohm resistor), and to all previous tuning points may help.

Finally, install cable **A**. Approximately 0.5 mW ( $-3$  dBm) should be available at J2. If the output is low, varying the voltage on Q3 and Q4 (set by CR3) may help. If the output is still low, wrap a small square of aluminum foil over the bare end of a *Q-tip* and poke around the stripline circuitry while monitoring the output; if it is working normally, nothing should produce a significant *increase* in output. However, if a balanced mixer<sup>4</sup> with variable dc bias is used, local oscillator powers as low as  $-10$  dBm will probably not significantly degrade the noise figure, if the mixer bias is set at the LO level to be used. This combination was the lowest noise-figure 1296-MHz converter measured at the 1977 Eastern VHF/UHF Conference.

The printed stripline (technically *microstrip*) elements, the rat-race and filter, were chosen partly for their non-critical nature. They have moderate inherent bandwidth, so the output frequency could be shifted  $\pm 5\%$  with no changes. Conversely, the dimensions are not too critical. For example, the

characteristic impedance of the rat-race is approximately 66 ohms vs the design value of 70 ohms because it was laid out using standard printed-circuit tape. For greater frequency changes, it is primarily the length of the lines, rather than the width, which changes. If major changes are contemplated, further research<sup>3,5</sup> is suggested.

This local-oscillator chain, together with a simple balanced mixer, provides a relatively easy way to listen on 1296 MHz; a varactor tripler would complete a basic station. Since there are no critical adjustments, it can be confidently built with moderate test equipment and skill, yet it has the stability and spectral purity required for an advanced station. Portions of the chain are usable for 220 and 432 MHz as they stand; the addition of a doubler to 2304 MHz is contemplated.

## references

1. C. Andren, "Low-Cost 100- to 200-MHz Doubler has 5 dB Gain, 1% Distortion," *Electronic Design*, 1 September, 1970, page 84.
2. D. E. Schmitzer, DJ4BG, "Frequency Multiplication With High Spurious Signal Rejection," *VHF Communications*, November, 1971, page 248.
3. H. Howe, *Stripline Circuit Design*, Artech House, Dedham, Massachusetts, 1974.
4. P. Wade, WA2ZZF, "A High-Performance Balanced Mixer for 1296 MHz," *QST*, September, 1973, page 15.
5. H. S. Keen, W2CTK, "Microwave Hybrids and Couplers for Amateur Use," *ham radio*, July, 1970, page 57.

ham radio

# HAMTRONICS, INC.

WHERE THE HAM IS KING

FOR OVER 30 YEARS



## LET US QUOTE YOUR SPECIFIC NEEDS FROM OUR \$2,000,000.00 AMATEUR GEAR INVENTORY.

**AEA** List  
AD-1 Autodialer 129.95

**ATLAS** List  
350 XL 1195.00  
350 P.S. 229.00  
305 VFO 155.00  
DD6-XL Digital 229.00  
DMK-Deluxe Mobile Mt. 65.00  
210X 765.00  
215X 765.00  
Also All Accessories

**B&W**

**COLLINS** List  
KWM2A 3533.00  
32S3A 3250.00  
75S3C 3000.00  
516F2 440.00  
Also All Accessories

**DENTRON** List  
MLA 2500B 899.50  
180-10AT 129.50  
MT2000A 199.50  
MT3000A 349.50  
Jr. Monitor 79.50  
Also All Accessories

**ICOM** List  
IC245 SSB 689.95  
IC380 480.00  
IC211 850.00  
IC701AC 1650.00  
Also All Accessories

**NPC**

**WM NYE**

**KENWOOD** List  
TS820S 1098.00  
TS820 919.00  
TS520S 739.00  
TS700SP 729.00  
TR7400A 399.00  
VFO820 155.00  
VFO520 139.00  
SM220 329.00  
Also All Accessories

**MIDLAND** List  
13-510 399.00  
13-513 499.00  
Also All Accessories

**R. L. DRAKE** List  
T4XC 699.00  
R4C 699.00  
TR7/DR7 1295.00  
MN4C 165.00  
MN2000 250.00  
Also All Accessories

**STANDARD** List  
SRC146A 259.00  
C-6500 379.00  
Also All Accessories

**SWAN** List  
350B 649.95  
350D 749.95  
750CW 679.95  
Also All Accessories

**TEMPO**

**TEN-TEC** List  
Tritan IV 699.00  
Tritan IV Dig 869.00  
Century 21 299.00  
Century 21 Dig 399.00  
Also All Accessories

**VIBROPLEX**

**WILSON** List  
Mark II 229.95  
Mark IV 259.95  
1402SM 254.95  
1405SM 329.95  
1407SM 384.95  
Also All Accessories

**YAESU** List  
FT-101F 799.00  
FT-101FE 759.00  
FT-101FX 699.00  
FL-2100B 529.00  
FT-301 769.00  
FT-301D 935.00  
FT-901DM 1459.00  
FT-901D 1259.00  
FT-901DE 1259.00  
FL-101 649.00  
FR-101D 749.00  
FR-101S 599.00  
FRG-7000 655.00  
FT-227R 349.00  
FT-225R 840.00  
FT-625RD 895.00  
Also All Accessories

### ANTENNAS • ROTORS • TOWERS

**CUSHCRAFT**  
**HY-GAIN**  
**HUSTLER**  
**MORGAIN**  
**MOSLEY**  
**ROHN TOWERS**  
**WILSON**  
**ALLIANCE**  
**CDE**

**ALLIANCE** List  
HD73 179.95  
U-100 69.95

**HY-GAIN** List  
TH6DXX 296.95  
TH3MK III 219.95  
TH3JR 144.50  
HY QUAD 229.95  
18 AVT/WB 97.00  
18HT 299.95

**CDE** List  
HAM III 194.93  
T2TX 349.95  
CD44 154.95  
BT-1 114.95

**WILSON** List  
SY-1 274.95  
SY-2 219.95  
WV-1 79.95  
WR1000 ROTOR 469.00  
WR500 ROTOR 149.95

**ROHN TOWERS**

**MOSLEY** List  
TA33 264.50  
TA33JR 197.85  
TA36 392.75  
CL33 304.75  
CL36 392.75

**MORGAIN** List  
75-10HD 74.50

**Give us a try before you buy • Call Jim Titus Toll Free and ask him to quote your requirements from this ad**

a Division of TREVOSE ELECTRONICS, INC/ 4033 Brownsville Road, Trevoese, PA 19047

FREE UPS SHIPPING ON PREPAID ORDERS



TOLL FREE QUOTES

# 800-523-8998

# HAMTRONICS, INC.

WHERE THE HAM IS KING

FOR OVER 30 YEARS



## • PICK YOUR OWN PACKAGE •

**KENWOOD**



TS-520S  
160-10M TRANSCEIVER  
**\$739.00**

**KENWOOD**



TS-820S  
160-10M TRANSCEIVER  
**\$1098.00**

**YAESU**



FT-101E  
160-10M TRANSCEIVER  
**\$799.00**

**BUY ANY ONE OF THE ABOVE RIGS AT PRICE SHOWN  
AND SELECT ANY ONE OF THE FOLLOWING FOR \$5.00**



**ALLIANCE**

HD-73 ROTOR  
HEAVY DUTY, DUAL SPEED  
**Value \$154.95**

**DENTRON**



160-10AT Tuner  
**Value \$129.50**

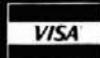
**BIRD**



Model  
43 Meter  
**Value \$125.00**

a Division of TREVOSE ELECTRONICS, INC/ 4033 Brownsville Road, Trevose, PA 19047

FREE UPS SHIPPING  
ON PREPAID ORDERS



TOLL FREE  
QUOTES

# 800-523-8998

# HAMTRONICS, INC.

WHERE THE HAM IS KING

FOR OVER 30 YEARS



## • PICK YOUR OWN PACKAGE •

### MIDLAND



13-510 FM TRANSCEIVER  
25 WATTS / 800 CHANNELS

**\$399**

### KENWOOD



TR-7400A FM TRANSCEIVER  
25 WATTS / 800 CHANNELS

**\$399**

### ICOM



IC-245 FM TRANSCEIVER  
WITH SINGLE SIDEBAND

**\$689.95**

**BUY ANY ONE OF THE ABOVE RIGS AT PRICE SHOWN  
AND SELECT ANY ONE OF THE FOLLOWING FOR \$5.00**

### DRAKE



1525 EM  
TOUCH TONE® ENCODER  
MICROPHONE

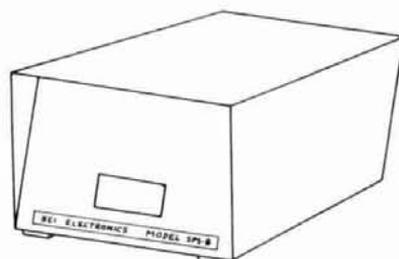
Value **\$49.95**

### CES



MODEL 300  
ACOUSTICAL PAD  
Value **\$49.95**

### SEI



SPS-8  
POWER SUPPLY  
Value **\$79.95**

a Division of TREVOSE ELECTRONICS, INC/ 4033 Brownsville Road, Trevose, PA 19047

FREE UPS SHIPPING  
ON PREPAID ORDERS



TOLL FREE  
QUOTES

**800-523-8998**



## evaluating noise sideband performance in oscillators

Receiver local oscillators produce noise sidebands which degrade receiver performance — how good is the oscillator in your receiver? Here are some ways to find out

All oscillators produce noise sidebands which can degrade the performance of the equipment in which the oscillator is used. In receivers, noisy local-oscillator stages produce reciprocal mixing products which cause blocking.<sup>1,2</sup> For oscillators used in high-frequency or vhf/uhf equipment, it's sufficient to measure the noise sideband performance in dB/Hz between 500 Hz and 100 kHz from the carrier; a way of doing this is described in this article. Also discussed is a method for determining local-oscillator noise sideband levels by measuring the receiver's blocking performance.

Fig. 1 shows the test setup recommended by the National Bureau of Standards for measuring noise sideband performance between 500 Hz and 100 kHz from the oscillator carrier.\* A signal generator with extremely high spectral purity such as a crystal oscillator is used as a reference oscillator for a high-level, double-balanced mixer. The output of the oscillator under test is fed into the rf port of the mixer through a variable attenuator. The output of the double-balanced mixer is then connected to a waveform analyzer.

A simplified block diagram of a waveform analyzer is shown in fig. 2. The signal to be analyzed is mixed

\*For a small modulation index, as in a hard-limiting oscillator there is no difference between fm and a-m noise.

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

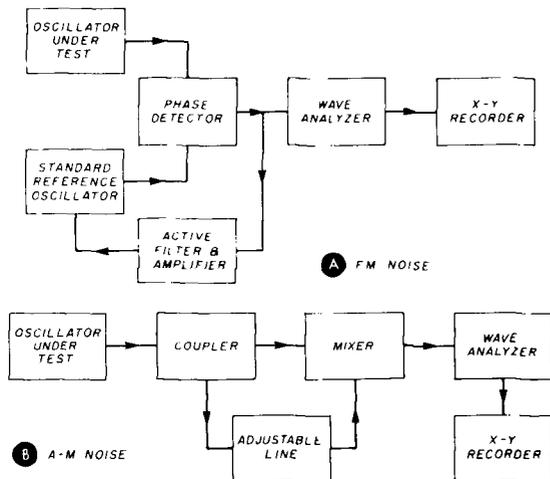


fig. 1. Test setups recommended by NBS for measuring fm noise (phase fluctuations), and a-m noise (amplitude fluctuations). For a low modulation index, as is the case of a hard-limiting oscillator, there is no difference between a-m and fm noise.

with a tunable local oscillator and the i-f output is applied to a narrow bandpass filter. In operation the frequency of the VFO is adjusted so the desired component of the input waveform is equal to the center frequency of the selective filter. Thus the component to be measured is fixed to a predetermined frequency, is amplified, and measured at this fixed frequency; other frequency components in the input waveform are rejected by the narrow bandpass filter. Fig. 3 shows the filter response curve of the Rohde & Schwartz FAT3 waveform analyzer which has an i-f at 80 kHz; the bandwidth is 4 Hz at the 3 dB points.

To calibrate the test setup, the wave analyzer is set to full sensitivity, where zero equals 10 mV and  $-80$  dB equals  $1 \mu\text{V}$ . The oscillator to be analyzed is then set to a frequency 30 kHz from the crystal oscillator, and the variable attenuator is adjusted so that the double-balanced mixer output gives a full-scale reading equivalent to 10 mV.

If an instrument with high dynamic range and a linear dB scale is used, the attenuator can remain in the same position during the entire test procedure. Where limited dynamic range is available, the attenuator is set so at full sensitivity the instrument will indi-

cate  $1 \mu\text{V}$  on a quasi-linear meter, and the logarithmic display will be simulated later by taking readings from the attenuator.

Now connect a frequency counter to the oscillator, and change the frequency either 1 kHz up or down from the original setting, which was offset 30 kHz from the crystal oscillator. Then reconnect the signal generator to the double-balanced mixer. The waveform analyzer, which typically has three or four bandwidths available, is set at 100-Hz bandwidth. Assume that the logarithmic display on the analyzer indicated  $-60$  dB when the original frequency was selected. This means that, in a 100-Hz bandwidth, the noise sideband voltage is 60 dB below the carrier. Since the noise sidebands are expressed in dB per 1 Hz (dB/Hz), a 20 dB correction factor must be added to the measured 60 dB because of the 100-Hz bandwidth; in this case the noise sideband performance is 80 dB/Hz.

Practical experience indicates that an oscillator which exhibits 80 dB/Hz noise performance is not very good, so the crystal oscillator can be considered much better and its noise contribution may be neglected.

### sideband noise evaluator

Commercial waveform analyzers with a built-in, double-balanced mixer, linear logarithmic displays, and wide choice of bandwidths are extremely expensive — as much as \$30,000, — so few are in amateur hands. However, you can build an instrument with similar performance for less than \$300 if you're willing to give up certain features:

1. Choice of multiple bandwidth
2. Extremely linear logarithmic scale
3. Small i-f bandwidth

The resulting instrument, which I call the Sideband Noise Evaluator, is no longer in the class of the waveform analyzer which permits measurements from a few Hz to 60 kHz or more, but it's ideal for measuring the noise sideband performance of oscillators.

A block diagram of the device is shown in fig. 4. The local oscillator must deliver +17 dBm drive and

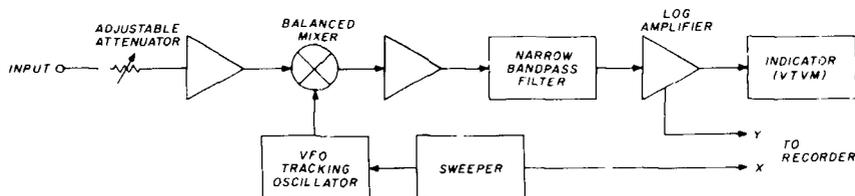


fig. 2. Simplified block diagram of a waveform analyzer. The frequency of the VFO is adjusted so the desired component of the input signal is mixed to the center frequency of the narrow bandwidth filter where it is amplified and measured.

the mixer must accept any frequency combination between 70 kHz and 200 MHz. This frequency range is sufficient to evaluate most oscillators used in radio communications systems.

### circuit description

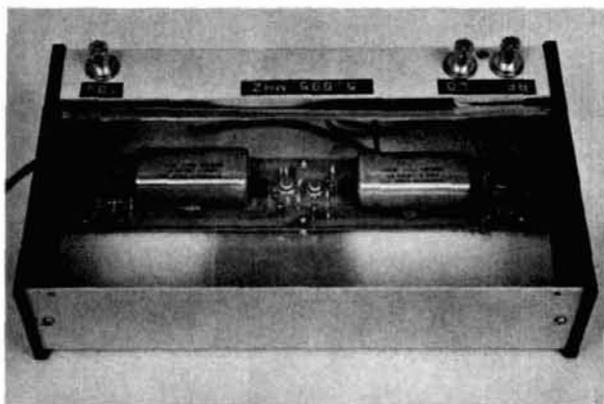
A feedback amplifier is used as a wideband termination for the mixer and as a low-noise preamplifier. It also compensates for losses of the following crystal filter. While any i-f between 1 MHz and 10 MHz can be used for which suitably selective filters can be purchased, the chosen frequency of 5.695 MHz was based on the use of 125-Hz wide filters built by Sherwood Engineering.\*

Two high-gain wideband amplifiers boost the signal by about 80 dB and feed a second crystal filter. A post-amplifier is used to compensate for the second filter losses; a detection circuit drives an operational amplifier which in turn drives a meter and the agc input for the wideband amplifiers.

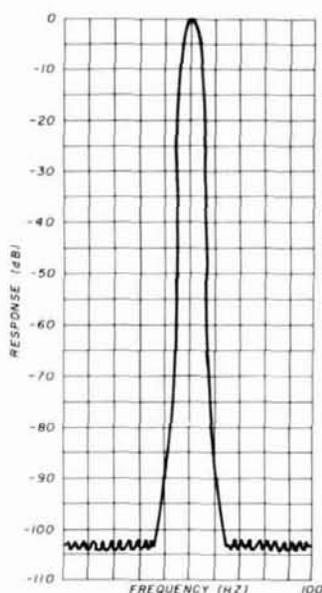
Two wideband amplifiers are used in the circuit, so there is more than 120 dB of agc range available. Thus, the instrument should provide at least 100 dB dynamic range with the 125-Hz bandwidth filters. If you consider a sensitivity of 5  $\mu$ V relative to 1 volt emf, this results in 120 dB/Hz resolution.

Resolution could be increased 10 dB by using an i-f filter 1 kHz to 2 kHz wide, but it would not be possible to make noise measurements closer than 4 kHz from the carrier. Therefore, the user must decide whether more than 120 dB dynamic range is required, or if it's more important to measure noise close to the carrier. In my opinion, close-in noise is very important because of the number of CW stations which can be heard when receiver selectivity is set to 500 Hz; that's why I used the narrow 125-Hz filters.

A complete schematic for the Sideband Noise



**Construction of the Sideband Noise Evaluator showing the location of the printed-circuit board in the Ten-Tec enclosure. The meter is connected to the circuit with two lengths of miniature coaxial cable.**



**fig. 3. Response curve for the 4-Hz wide bandpass filter used in the Rohde & Schwarz FAT3 waveform analyzer. The center frequency is at 80 kHz.**

Evaluator is shown in **fig. 5**. The Mini-Circuit Laboratories† SRA3H was found to be the ideal choice for the input mixer; a 2N5109 CATV transistor with voltage and current feedback both amplifies and provides proper termination to the mixer's i-f port. The 5.695-MHz filters from Sherwood Engineering are designed for 50-ohm input and output impedance; the Mini-Circuits 4:1 and 16:1 transformers provide correct circuit matching.

The Motorola MC1590s which are used in the wideband amplifier are the perfect choice for this application.<sup>3</sup> The gain of the stages is set by resistors R7 and R10, as discussed in the Motorola data sheet.

The Texas Instruments 733 wideband amplifier IC compensates for the losses of the second narrow-band filter. The three diodes at the output of the 733 act as a voltage doubler and provide suitable time constants and thresholds to feed an LM301 operational amplifier. The 50- $\mu$ A meter is shunted with 470 ohms to limit the reading to 45  $\mu$ A; for a full-scale reading this resistance value must be increased slightly. The two 10k resistors equalize agc distribution to the MC1590 ICs.

After this circuit was built, I found two problems with the Sherwood filters. First, the center frequency was off by 47 Hz; relative to a 6-dB bandwidth of 125 Hz, the discrepancy expressed in per cent is unrea-

\*Sherwood Engineering, Inc., Dept. A, 1268 South Ogden Street, Denver, Colorado 80210.

†Mini-Circuits Laboratory, 2625 East 14th Street, Brooklyn, New York 11235.

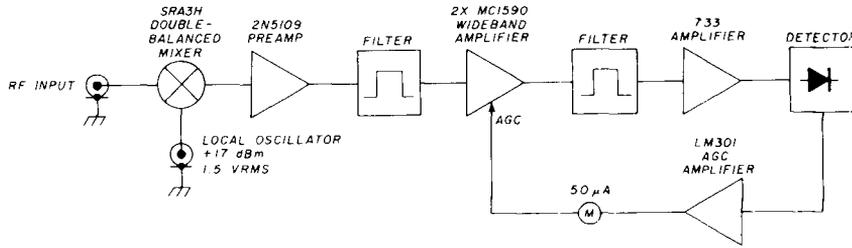


fig. 4. Block diagram of the Sideband Noise Evaluator which may be used to measure oscillator sideband noise. A schematic diagram for the instrument is shown in fig. 5.

onably high. Second, the insertion loss of the Sherwood filters was substantially higher than expected. When this was discovered, the 2N5109 preamplifier circuit between the double-balanced mixer and the first filter was redesigned. The circuit of the new amplifier is somewhat more complex (see fig. 6) and costs an additional \$5, but has nearly 20 dB gain. The gain of the circuit can be adjusted by changing the value of the unbypassed 50-ohm resistor in the emitter circuit of the first 2N5109.

Unfortunately, the circuit board in fig. 7 was designed for the single 2N5109 preamplifier (fig. 5), but it shouldn't be too difficult to lay out a new PC board if you wish to use the improved preamplifier. This may be worthwhile because the improved pre-

amp expands the instrument's dynamic range by almost 20 dB due to a substantial decrease in noise figure.

### calibration

The Sideband Noise Evaluator requires *no* adjustments! It should be possible for amateurs who build this test setup to use it immediately without difficulty. Fig. 8 is a graph of output readings as a function of the rf input voltage (measured with a +12.0 volt power supply). While the scale is not as linear as that available with a commercial waveform analyzer, the curve permits adequate resolution for most noise sideband measurements.

If the two-stage preamplifier is used, however,

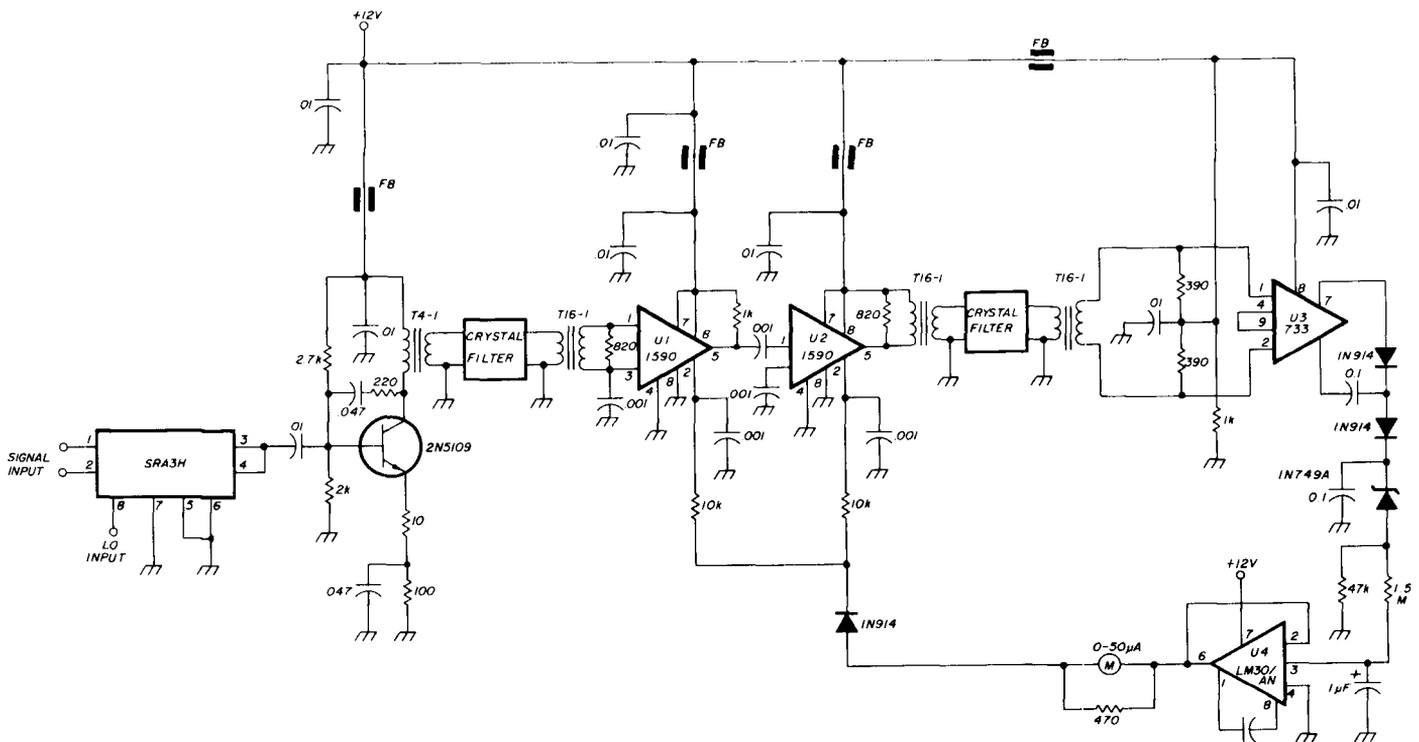


fig. 5. Schematic diagram of the Sideband Noise Evaluator. Circuit operation is discussed in the text. The filters are Sherwood Engineering 5.695-MHz crystal filters with 125-Hz bandwidth. The 4:1 and 16:1 transformers are from Mini-Circuits Labs.

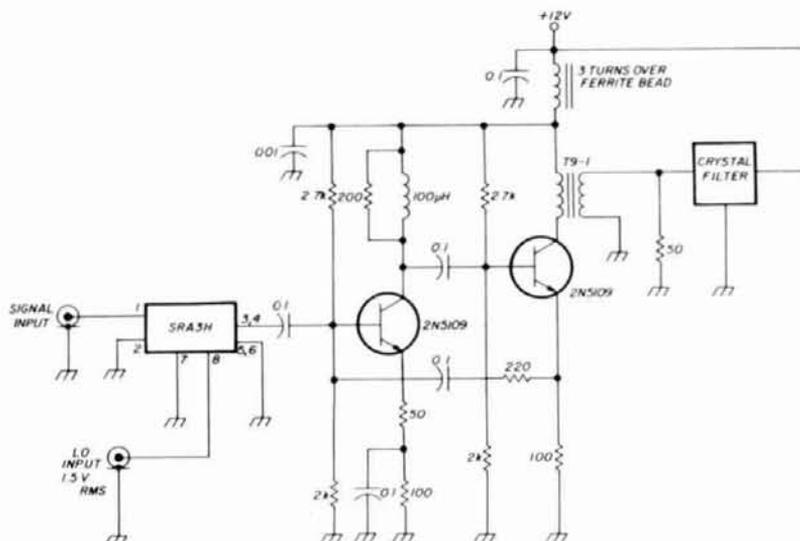


fig. 6. Improved input preamplifier for the Sideband Noise Evaluator which has nearly 20 dB gain. Gain can be adjusted by changing the unbypassed 50-ohm resistor in the emitter of the first 2N5109.

recalibration is necessary because of the higher gain. I recommend changing resistor R15 across the meter (fig. 5) to compensate for the increased sensitivity of the instrument with the improved preamp.

### crystal oscillators

To obtain full use of the Sideband Noise Evaluator, I suggest you build a set of crystal oscillators. Fundamental-frequency crystals can be purchased that operate between 400 kHz and 30 MHz in what is frequently called the parallel-resonant mode (which

should more accurately be called the inductive mode). Fig. 9 shows a suitable low-noise crystal oscillator circuit with a wideband postamplifier that delivers the required +17 dBm output level or slightly more. Any inductive-mode crystal between 400 kHz and 30 MHz can be plugged into this circuit and give useful output without any adjustments.

The frequency range between 30 MHz and 100 MHz can be covered by a crystal oscillator which uses either a third- or fifth-overtone crystal. However, the oscillators must be tuned. Various overtone

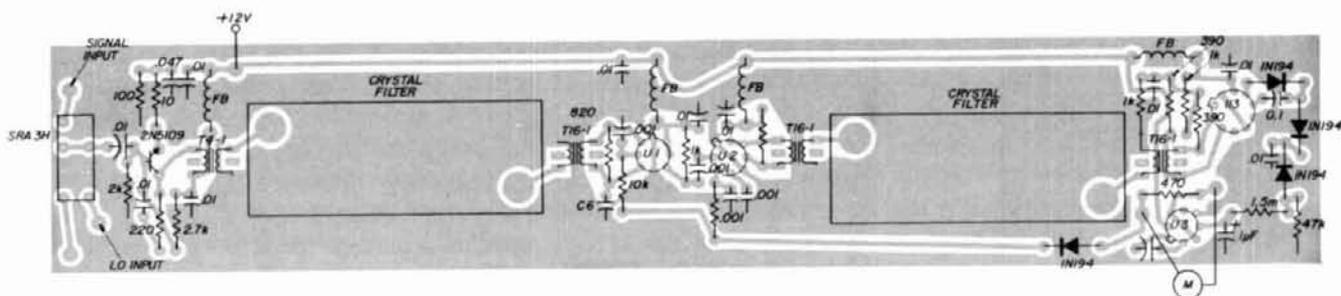
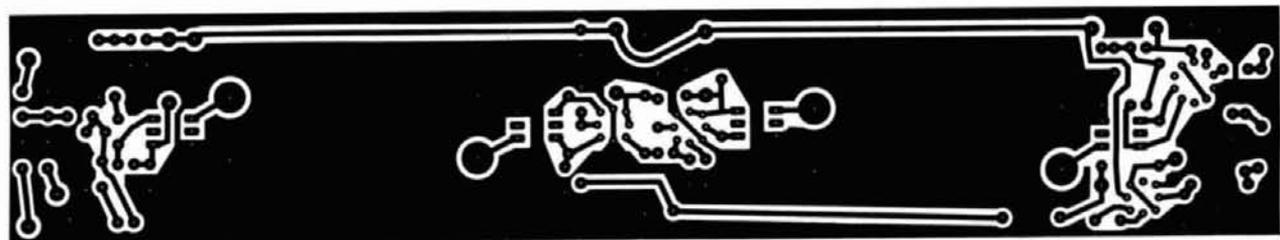


fig. 7. Printed-circuit layout (above) and component placement diagram (below) for the Sideband Noise Evaluator. Note that this artwork is approximately 67% of full size — a full-size PC layout is available from *ham radio* upon receipt of a self-addressed, stamped envelope.

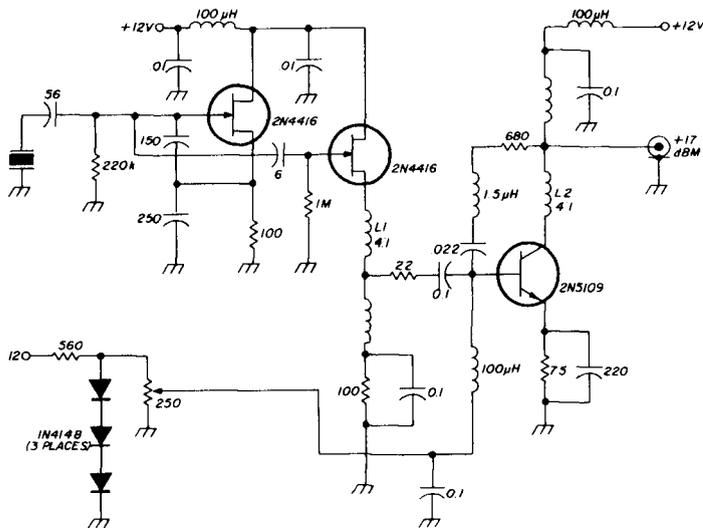


fig. 9. Low-noise crystal oscillator for operation from 400 kHz to 30 MHz; output is +17 dBm. No adjustments are required. Inductors L1 and L2 are 6 turns, center tapped, on 1/4-inch (6-mm) TC9 core.

oscillator circuits have been described in the literature, but the authors have not discussed either short-term stability or sideband noise performance. Probably the worst and noisiest of all oscillator circuits places the crystal between the transistor base and ground (fig. 10). The reason for the high noise contribution is that this circuit severely degrades the *Q* of the crystal. The noise sideband performance is partially dependent on the circuit but is determined primarily by the *Q* of the resonator: an LC circuit, a high-*Q* cavity, or a quartz crystal, and the latter has the highest *Q* of all known resonators.

Fig. 11 shows a crystal oscillator circuit that can be used for third- and fifth-overtone crystals in the frequency range from 30 to 100 MHz, and delivers +17

dBm to the double-balanced mixer. This circuit combines the best possible noise performance with high output power and excellent stability.<sup>4</sup>

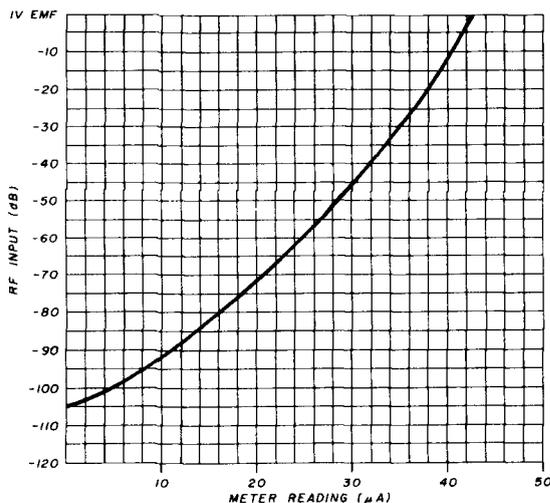
The noise performance of the crystal oscillator circuits of figs. 9 and 11 is better than 120 dB/Hz at 1 kHz from the carrier, and 150 dB/Hz or more at 20 kHz from the carrier. Because of their excellent noise performance, these circuits can be used as local oscillators without degrading receiver performance; very few oscillators and practically no frequency synthesizers achieve their low-noise sideband levels.

## measuring your receiver's oscillator sideband noise

The easiest way to measure the noise sideband performance of the local oscillator in your receiver is to measure the "blocking" or reciprocal mixing. First, accurately calibrate the receiver's S-meter between S1 and S9 + 40 dB using a signal generator and an accurate attenuator (a suitable band is 14 MHz). For the signal generator I recommend a crystal oscillator which uses a 14-MHz crystal.

Tune the receiver to the frequency of the signal generator and increase the input to the receiver so the S-meter reads S9 + 40 dB. Move the tuning dial 10 kHz and note the S-meter reading; more than likely it will be S6. Assuming S9 is 100 µV emf (50 µV terminated), and each S-unit is exactly 6 dB, then S6 is approximately 6 µV. S9 + 40 dB is 5 mV, so the difference between the two signals, for all practical purposes, is 60 dB. Since the measurement will probably be made with a 2.7 to 3 kHz ssb filter in the receiver, the conversion factor from 3 kHz to 1 Hz is about 35 dB (10 log BW<sub>Hz</sub>). Therefore, the noise sideband performance of the internal oscillator is 95 dB/Hz

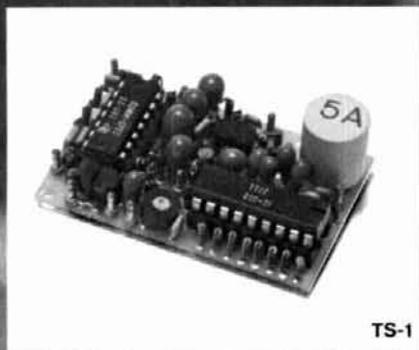
To fully utilize the low intermodulation capabilities available with high-level, double-balanced mixers in



rf input	current reading	volts emf (unterminated)
1 volt	42 µA	1 volt
-10 dB	40 µA	316 mV
-20 dB	38 µA	100 mV
-30 dB	34 µA	32 mV
-40 dB	31 µA	10 mV
-50 dB	28 µA	3.2 mV
-60 dB	24 µA	1 mV
-70 dB	21 µA	316 µV
-80 dB	16 µA	100 µV
-90 dB	11 µA	32 µV
-100 dB	5 µA	10 µV
-106 dB	1 µA	5 µV

fig. 8. Calibration curve for the Sideband Noise Evaluator shows rf input in dB relative to 1 volt emf vs indicated output current. To convert to dB/Hz add 20 dB (because of 100 Hz filter bandwidth).

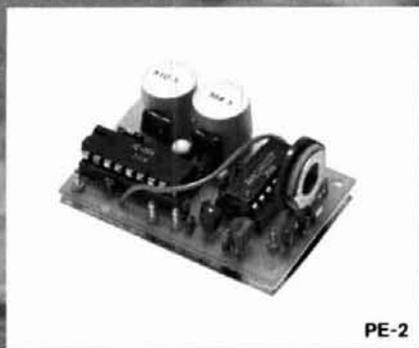




TS-1



TS-1JR



PE-2

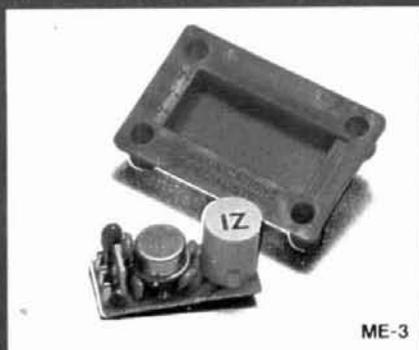


SD-1

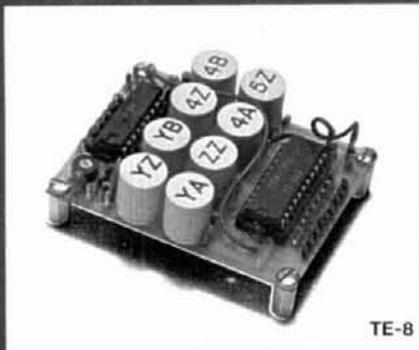
# THE DAWNING

The age of tone control has come to Amateur Radio. What better way to utilize our ever diminishing resource of frequency spectrum? Sub-audible tone control allows several repeaters to share the same channel with minimal geographic separation. It allows protection from intermod and interference for repeaters, remote base stations, and autopatches. It even allows silent monitoring of our crowded simplex channels.

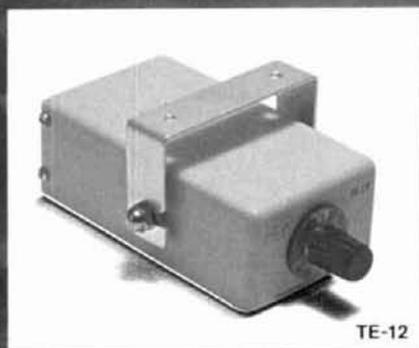
We make the most reliable and complete line of tone products available. All are totally immune to RF, use plug-in, field replaceable, frequency determining elements for low cost and the most accurate and stable frequency control possible. Our impeccable 1 day delivery is unmatched in the industry and you are protected by a full 1 year warranty when our products are returned to the factory for repair. Isn't it time for you to get into the New Age of tone control?



ME-3



TE-8



TE-12



ST-1

# OF A NEW AGE.

**TS-1** Sub-Audible Encoder-Decoder • Microminiature in size, 1.25" x 2.0" x .65" • Encodes and decodes simultaneously • **\$59.95** complete with K-1 element.

**TS-1JR** Sub-Audible Encoder-Decoder • Microminiature version of the TS-1 measuring just 1.0" x 1.25" x .65", for hand-held units • **\$79.95** complete with K-1 element.

**ME-3** Sub-Audible Encoder • Microminiature in size, measures .45" x 1.1" x .6" • Instant start-up • **\$29.95** complete with K-1 element.

**TE-8** Eight-Tone Sub-Audible Encoder • Measures 2.6" x 2.0" x .7" • Frequency selection made by either a pull to ground or to supply • **\$69.95** with 8 K-1 elements.

**PE-2** Two-Tone Sequential Encoder for paging • Two call unit • Measures 1.25" x 2.0" x .65" • **\$49.95** with 2K-2 elements.

**SD-1** Two-Tone Sequential Decoder • Frequency range is 268.5 - 2109.4 Hz • Measures 1.2" x 1.67" x .65" • Momentary output for horn relay, latched output for call light and receiver muting built-in • **\$59.95** with 2 K-2 elements.

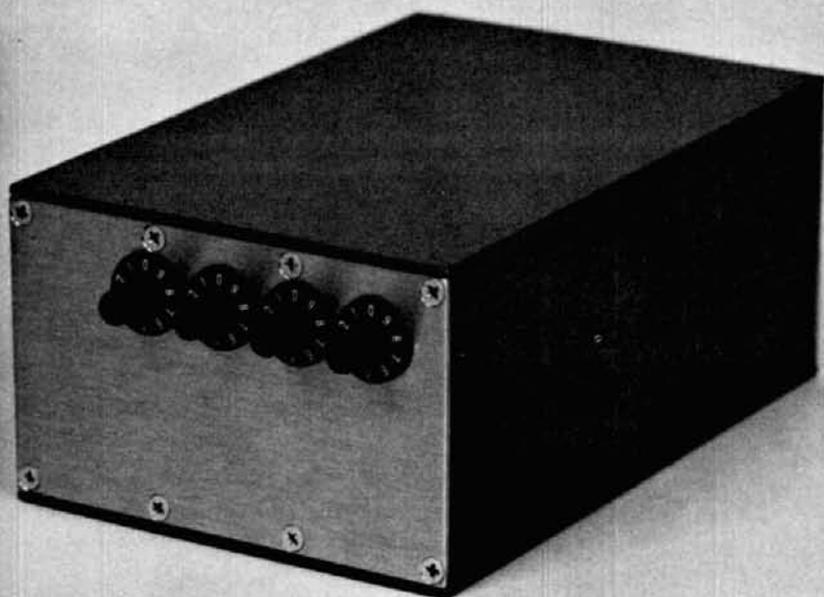
**TE-12** Twelve-Tone Sub-Audible or Burst-Tone Encoder • Frequency range is 67.0 - 263.0 Hz sub-audible or 1650 - 4200 Hz burst-tone • Measures 4.25" x 2.5" x 1.5" • **\$79.95** with 12 K-1 elements.

**ST-1** Burst-Tone Encoder • Measures .95" x .5" x .5" plus K-1 measurements • Frequency range is 1650 - 4200 Hz • **\$29.95** with K-1 element.



**COMMUNICATIONS  
SPECIALISTS**

426 W. Taft Ave., Orange, CA 92667  
(714) 998-3021



## frequency synthesized local-oscillator system

### for the high-frequency amateur bands

Design of a versatile  
frequency synthesizer system  
for high-frequency use  
which features  
exceptional spectral purity,  
10-Hz resolution,  
and low power-consumption

This article is the first of a series which will describe a complete phase-locked local-oscillator system for amateur equipment with a single-conversion, 9-MHz i-f. The system offers performance which will meet the requirements of the advanced communication techniques of the 1980s — techniques which require frequency accuracy, stability, and calibration typically 100 times better than the best commercial equipment being sold today in the amateur market. This article describes the basic VFO synthesizer. Future articles will describe the phase-locked, 9-MHz BFO system, a universal phase-locked up-converter permitting operation on all bands, 160 through 10 meters, and a variety of "acrobatic" tuning methods possible only with frequency synthesizers.

#### frequency synthesizer accuracy

With routine care, a home builder can put together a frequency standard which will hold to 1 part in  $10^7$  under room-temperature conditions. I believe that

By **Raymond C. Petit, W7GHM**, Post Office  
Box 51, Oak Harbor, Washington 98277

every amateur station should have such a standard. Our rigs today usually have several free-tuning oscillators, each one subject to calibration errors, drift, and other inaccuracies, and the usual use of the standard is to ensure that these inaccuracies are held within acceptable limits.

Most operators are satisfied if they are within a few hundred hertz. The typical digital readout which is used in place of a VFO dial resolves the frequency only to the nearest 100 Hz. Thus, even if the counter timebase and all the oscillators not being measured are perfectly on frequency, a  $\pm 50$  Hz uncertainty remains. To gain the very real 20-dB signal-to-noise level improvement possible with coherent CW and similar methods of radio communications now in development, the total frequency error must be held within 1 or 2 Hz.

The only workable method of achieving this precision in a variable-frequency system is to phase-lock every oscillator to the frequency standard. With this arrangement, proper setting of the standard automatically imparts the same accuracy to every other oscillator.

The phase-locked frequency synthesizer is well established in the vhf-fm business, where its agility saves buying hundreds of crystals. When the channel spacing is 10 kHz and the width of the output frequency band is only a few per cent of its center frequency, the synthesizer is easy to build. The requirements for a high-frequency synthesizer, however, are an entirely different story. Outputs must cover a wide range and 10 or 100 Hz "channel spacing" is required, but switching speed must still be very fast. Spurious outputs must be exceptionally low to prevent degrading the performance of wide-dynamic-range receiver designs. In addition, the synthesizer must be, like a VFO, easy to tune. Before going into the details of a practical circuit which meets these requirements, I'd like to discuss one problem which plagues most synthesizer designs.

### synthesizer noise

All oscillators generate noise in addition to the desired signal. Such noise is usually classified into three categories: harmonics, nonharmonic discrete spurs, and phase noise. Harmonics are the easiest to eliminate. In applications where good harmonic suppression is required, a bandpass or lowpass filter at the output is usually sufficient.

Nonharmonic spurs (parasitics) in oscillators are extraneous, unstable outputs at unpredictable frequencies. These are stopped by proper bypassing, shielding, and filtering in the design and construction

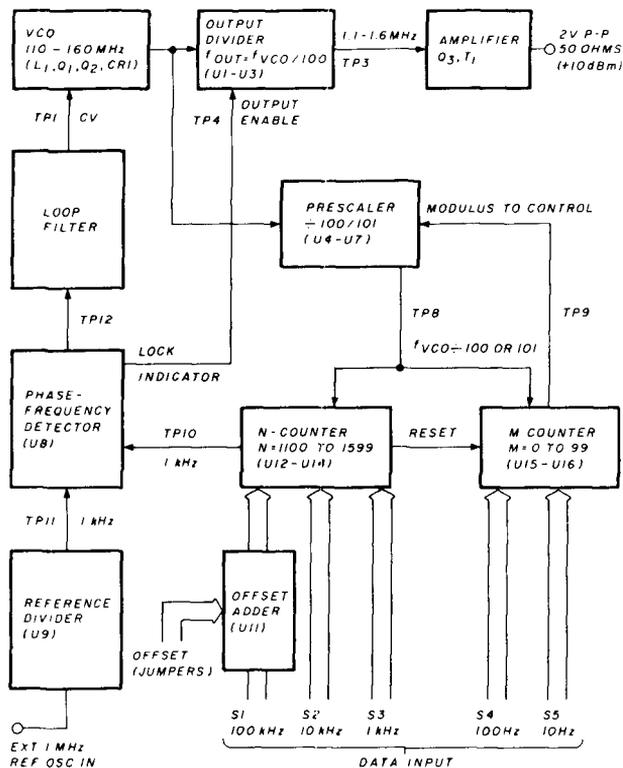
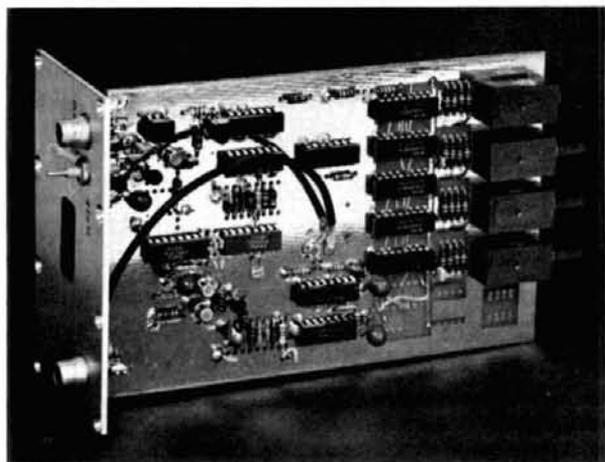


fig. 1. Block diagram of the basic synthesizer for high-frequency use. The VCO operates from 110 to 160 MHz; this same basic scheme may be used for a number of applications in the range from 500 kHz to 16 MHz. Specifications for two hf synthesizers based on this system are given in table 1.

of the circuit. In synthesizers there are several additional sources of spurs: digital counter noise, mixer intermodulation products, feedthrough of an intermediate oscillator's signal to the output, modulation of a VCO by tiny amounts of the loop reference signal from the phase detector -- these all serve to tremendously complicate designs. The presence of spurs in a receiver synthesizer's output produces birdies and the appearance of phantom signals in the i-f pass-band; the effect is very similar to that of inadequate image suppression.

An ideal oscillator would concentrate all its output energy at just one frequency, the desired carrier frequency. Real oscillators behave as if they were modulated by a broadband hissing noise. The result is that the oscillator's output energy is not perfectly concentrated at the carrier, but is smeared out above and below the carrier for many tens of kilohertz. The power level of this sideband noise typically diminishes in direct proportion to its frequency offset from the carrier.

If you had a super-selective bandpass filter with a



Construction of the frequency synthesizer showing the data input switches (right) and output (top left). The 1 MHz TTL reference signal is connected to the circuitry through the coaxial cable.

1-Hz passband and used this filter to measure the levels of this noise compared to the carrier, you would find that a well-designed vhf oscillator would produce sideband noise about 80 dB below the carrier for a frequency 100 Hz separated from the carrier, 100 dB below at 1 kHz, and 120 dB at 10 kHz. The total power level of uniformly distributed noise which reaches the detector of a receiver is directly proportional to the i-f bandwidth. Thus, if instead of a 1-Hz filter you used a 2-kHz filter, the noise reading would be two thousand times, or 33 dB, worse: only 88 dB down at 10 kHz offset.

It has been known for many years that oscillators produce this phase noise, but until recently oscillator noise was among the least of the designer's worries. The bad effects of this noise were nothing compared to the effects of mixer intermodulation and front-end overload! But today the situation has reversed. During the past few years we have seen spectacular improvements in the design of receiver front ends combined with an increasing interest in frequency synthesizers. But a phase-locked synthesizer requires a voltage-tuned oscillator, and to replace a variable capacitor with a varactor diode instantly increases the oscillator noise level by as much as 20 dB. So now instead of a -88 dB noise level 10 kHz from the carrier, you have only -68 dB.

What does this mean in terms of performance? Assume you have a state-of-the-art i-f filter for ssb which guarantees suppression of at least 120 dB for signals 10 kHz away from the center. Theoretically you could listen to a 1 microvolt DX station without interference from a carrier 10 kHz away which was 100 dB stronger, or 100 millivolts. But instead, the 68 dB noise from the oscillator can mix with a carrier

only 70 dB stronger 10 kHz away and produce a hissing noise which would mask the weak DX signal. This effect is called reciprocal mixing, and if a synthesizer signal is not free of noise, it can negate all the high-performance features of the high-intercept mixer and super i-f filters.

Fortunately, there is a way to improve the noise performance of a wide-tuning range VCO, and this method also gives us a synthesizer which can switch fast between frequencies while having very fine narrow channel spacing.

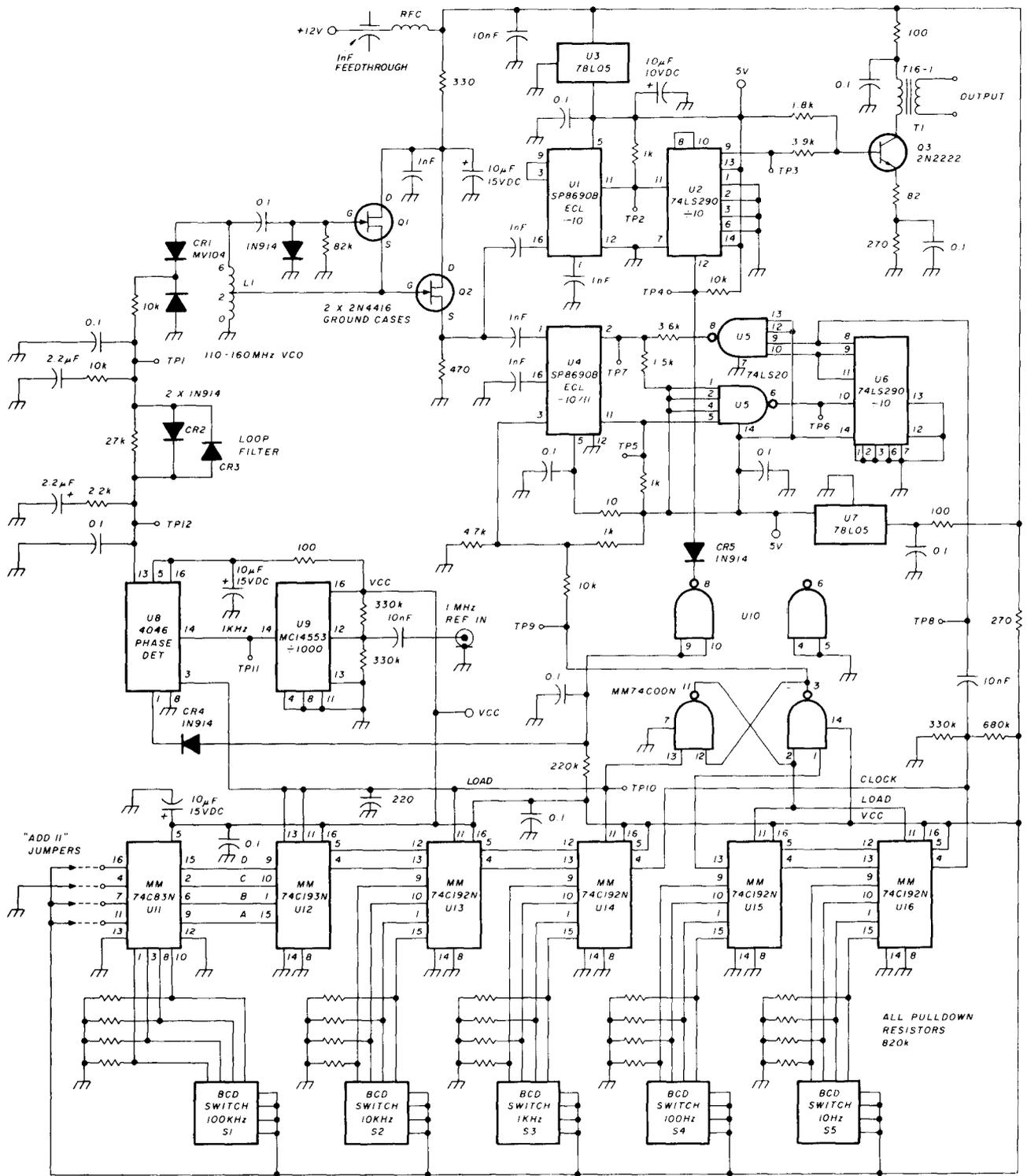
## VFO synthesizer

Two versions of the synthesizer can be built on the same circuit board. The first, or A version, covers 5 to 6 MHz in 100-Hz steps. It provides coverage of the 80 and 20 meter bands when used with a single-conversion i-f at 9 MHz. Version B covers a 500-kHz range in 10 Hz steps. It forms the basis for a three-loop local-oscillator system which covers all bands, 160 through 10 meters, with the same 9-MHz i-f. You can build an A-version synthesizer and convert it later to version B simply by adding 3 components and changing the VCO coil. **Table 1** gives specifications for the two versions.

**Fig. 1** is a block diagram of the version B synthesizer. The design features low power consumption, very high spectral purity, fast switching, and rf output suitable for driving a diode double-balanced mixer. The VCO covers 110-160 MHz in 1-kHz steps, operating in a loop having a 1-kHz reference frequency. The VCO signal is divided by 100 to yield an output from 1100 to 1600 kHz in 10 Hz steps; phase noise performance is 40 dB better than the VCO, and frequency switching seems instantaneous to the ear. A novel feature is the use of the divide-by-100/101

**table 1. Specifications for the hf frequency synthesizers. Figures for phase noise are minimums; typical measured values are approximately 10 dB better.**

	version A	version B
Output frequency range	5.0-6.0 MHz	1.1-1.6 MHz
Resolution	100 Hz steps	10 Hz steps
Output level	+10 dBm	+10 dBm
Suppression of nonharmonic discrete spurs	70 dB	80 dB
Phase noise, below carrier in 1-Hz bandwidth, for stated offsets from carrier	80 dB, 100 Hz 100 dB, 1 kHz 120 dB, 10 kHz	90 dB, 100 Hz 110 dB, 1 kHz 130 dB, 10 kHz
Switching speed	30 ms	30 ms
Data input requirement	Parallel BCD, 10 volt CMOS levels, 4 digits for version A, 5 digits for version B.	
Reference requirements	1-MHz sine or square wave, at least 1 volts p-p; input impedance of reference input approximately 50 pF to ground.	
Power	12 volts dc, approximately 75 mA.	



CR1 Dual varactor diode (Motorola MV104)

L1 6 turns no. 22 (0.6 mm), 3 mm (1/8) ID, tapped at 2 turns

RFC 6 turns no. 28 (0.3 mm) on F754-1-06 ferrite bead

S1-S5 Miniature BCD 10-position rotary switches

T1 Broadband rf transformer (Mini-Circuits Lab T16-1)

\*A complete kit of parts for this synthesizer including the double-sided PC board, data input switches, and enclosure is available for \$210 from Petit Logic Systems, Post Office Box 51, Oak Harbor, Washington 98277.

fig. 2. Schematic diagram of a frequency synthesizer that provides outputs from 1.1 to 1.6 MHz in 10 Hz steps. Total power consumption is only 75 mA. All resistors are 1/4 watt carbon film or composition; all polarized capacitors are dipped tantalum; non-polarized capacitors are ceramics. A kit of parts is available from the author.\*

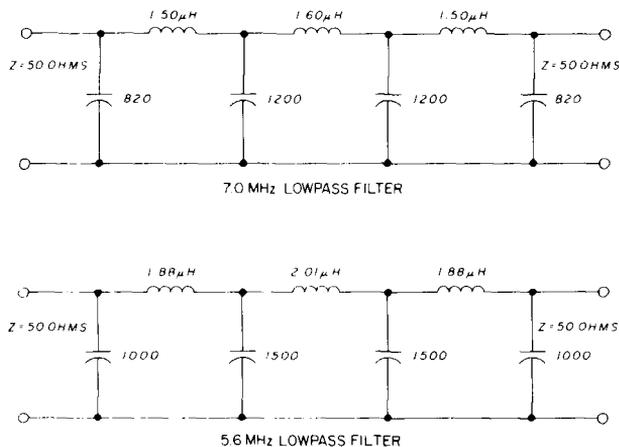


fig. 3. Seven-pole Chebyshev lowpass filters for use with the version A synthesizers. Both provide about 60 dB attenuation at twice the cutoff frequency.

prescaler in the programmable counter system. With this prescaler, comparatively slow and low power-consuming CMOS programmable counters operating at frequencies below 2 MHz can control a VCO operating at 160 MHz without sacrificing the 1-kHz spacing between adjacent steps.

The 100/101 prescaler works as follows. Suppose the  $N$  counter is set to 1500 and the  $M$  counter to zero. The VCO locks at 150 MHz so the output of the prescaler is  $150 \div 100$  or 1.500 MHz. Since  $N$  is 1500, the  $N$  counter output is 1 kHz as intended. Thus the  $N$  counter output represents 100 times 1500 or 150,000 cycles of the VCO signal. At the end of each complete cycle of the  $N$  counter, both the  $N$  and the  $M$  counter are preset to the values given by switches S1 through S5.

Suppose the  $M$  counter is now set to 01. The prescaler goes through 1500 complete divides as before, except that the first divide is by 101 instead of 100. The result is that the  $N$  counter output to the phase detector represents not 150,000 cycles of the VCO output, but 150,001 cycles. Thus for any setting  $S$  given to the  $M$  counter, the first  $S$  prescaler divides are by 101, and the remainder are by 100.

The most significant digit of the  $N$  counter is a 4-bit binary counter instead of a decimal counter. Thus, the maximum count available is 1599 instead of 999. The offset adder, U11, is programmed by jumpers to cause the synthesizer to deliver output frequencies which correspond in an appropriate way to the settings of S1.

To build a version-A synthesizer, the inductance of the VCO coil is increased to resonate with the varactor at 55 MHz; U2 is omitted, and the base of Q3 is connected directly to pin 8 of U1; U11 is omitted;

U12 preset is set to binary 5, and S1 is omitted. S2 then becomes the 100 kHz digit, S3 the 10 kHz digit, and so on.

## assembly and checkout

If a fault develops in a PLL system, it is often difficult to locate because many faults all exhibit one symptom, the loop goes out of lock. By assembling the system one section at a time and then checking that section before continuing assembly, trouble spots can be quickly located. Here is the procedure I use:

**1. VCO and divide-by-100.** Assemble the circuits starting at TP1, going through Q1, Q2, Q3, U1, U2, and U3. Take a potentiometer of any convenient value from 1k to 500k and connect the slider to TP1, one end to ground, and the other end to the 12-volt supply. With this you will be able to manually set the VCO control voltage to any value over its entire range. Apply power and check for at least 9 volts dc at the drain of Q1 and 5 volts at pin 5 of U1 and pin 14 of U2. Check for a TTL-level signal at a frequency below 20 MHz at TP2. Check for a TTL signal below 2 MHz at TP3, holding TP4 at ground. Connect a 51-ohm resistor across the output terminals and check for an approximately 2-volt p-p squarewave across this resistor. Leave TP4 grounded.

The following discussion assumes that the synthesizer under construction is the 1.1 to 1.6 MHz version. Set the control voltage to 2 volts and adjust L1 by slightly compressing or stretching the coil until the output frequency is 1.1 MHz. Then bring up the control voltage to 10 volts and check that the output frequency is approximately 1.6 MHz. (If you don't have a frequency counter, a standard a-m broadcast radio will work.) If the frequency isn't quite 1.6 MHz, stretch the coil slightly.

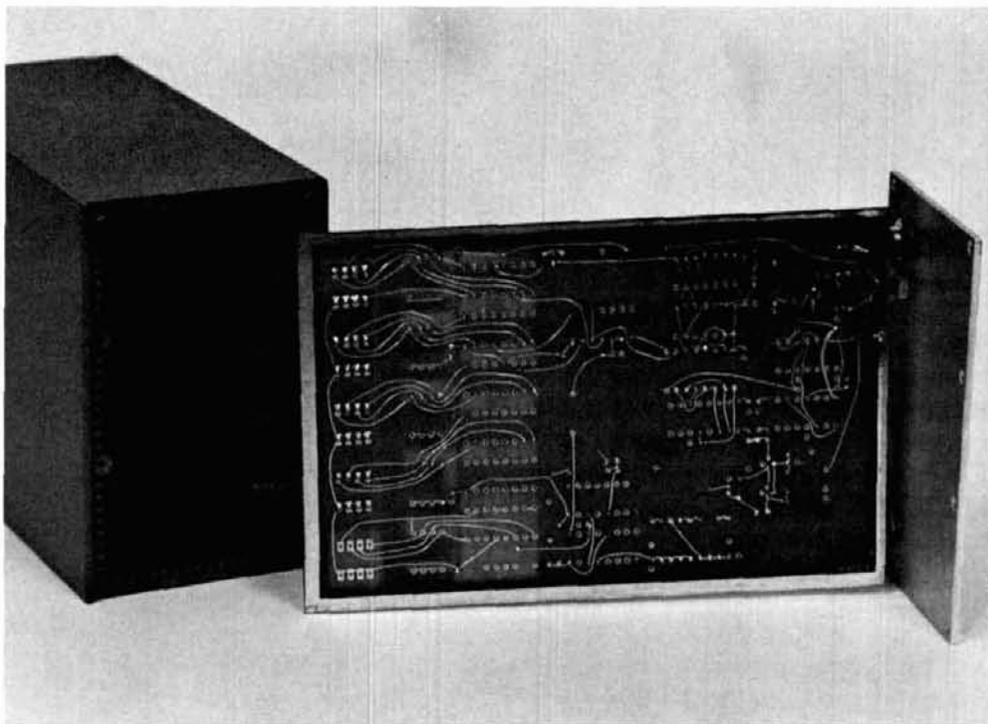
If you are building the 5-6 MHz version, set the control voltage to about 6 volts and adjust the coil L1 until the output frequency is 5.5 MHz.

**2. 100/101.** Assemble the circuits U4 through U7, including the resistor network leading to TP9. Apply power and check for 5 volts at pin 5 of U4 and pin 14 of U5 and U6. Connect TP9 to 12 volts. Observe a signal at TP5 which is identical to that at TP2. Check for the same signal inverted at TP6. Observe an ECL-level signal at TP7 which has the same frequency as the signal at TP3 except that it is at the lower logic level for one-tenth of the time and at the higher for nine-tenths of the time. Measure the signal at TP8. Then remove the connection from the power supply to TP9 and ground TP9; this should cause the frequency at TP8 to go down by 1 per cent.

**3. Programmable counter.** Assemble all the circuits of U10 through U16, the BCD switches, and the jumper-wire programming for U11. Apply power and check for at least 10 volts on pin 14 of U10, pin 5 of U11, and pins 16 of U12 through U16. Set the control voltage for 6 volts and set the data input switches to values representing the center of the synthesizer frequency range. TP10 should show an extremely narrow negative pulse at a frequency of approximately 1

critical value, the TP12 voltage should be near zero, and vice versa. As you move the potentiometer back and forth over this critical value, the TP12 signal should abruptly jump from near zero volts to near the positive supply voltage and back.

**5. Closing the loop.** Remove the potentiometer from TP1. Solder in the 27k resistor and the diodes CR2 and CR3. Apply power and observe the voltage at TP12 with a VTVM or scope using a 10-megohm



Bottom view of the double-sided PC board used for the high-frequency synthesizer.

kHz. Adjust the control voltage over its entire range and check that this pulse signal frequency rises and drops smoothly with your adjustments, not making sudden jumps or disappearing. With a scope connected to TP9, change the settings of S4 and S5 and observe a 1-kHz negative pulse, the width of which is proportional to the settings from 00 to 99.

**4. Reference divider and phase detector.** Assemble the circuits of U8 and U9, including the loop filter except for the 27k resistor and the two diodes CR2 and CR3. Apply power and check for at least 10 volts at pins 16 of U8 and U9. Connect the output of a 1-MHz frequency standard to the *reference input* terminal. Observe a 1-kHz pulse waveform at TP11. With S1 through S5 at the mid-frequency setting, observe the voltage at TP12 while varying the control voltage. When the control voltage is above some

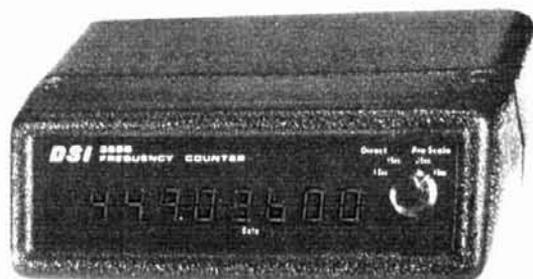
probe. The voltage should be at an intermediate value. Touch the VCO components with your finger and observe the voltage rise slightly. The output frequency of the synthesizer should now correspond exactly to the settings of S1 through S5, allowing for possible inaccuracies between the counter timebase and the reference oscillator used for the synthesizer.

Remove the ground from TP4. When making large frequency changes, the output of the synthesizer will be interrupted for perhaps 0.1 second. Remove the signal from the reference oscillator and the synthesizer output should disappear and remain off until the *reference oscillator is reconnected*. When making frequency changes of 1 kHz or less, the output is not interrupted at all. The disable function insures that, if, for any reason, the synthesizer is not locked and stable, it will have no output.

ham radio

# DSI Instruments Inc.

## Performance You Can Count On



MODEL 3550W  
\$149.95  
INCLUDES TCXO ± 1 PPM



MODEL 3600A  
\$199.95  
INCLUDES OVEN TIMEBASE ± .5 PPM



MODEL 3240HH  
\$119.95  
BATT. OPERATED

The 3600A, 3550W and 3240HH Frequency Counters represent a significant new advancement, utilizing the latest LSI Design ... which reflects DSI's ongoing dedication to excellence in instrumentation, for the professional service technician and amateur radio operator. Before you buy a DSI instrument you know that the specification is. We publish complete and meaningful specifications which state accuracy over temperature and sensitivity at frequencies you need. And we guarantee those specifications in writing. **JOIN THE RANKS OF THOUSANDS OF SATISFIED CUSTOMERS. PLACE YOUR ORDER TODAY AND BE THE ONE ON FREQUENCY.**

### DSI — GUARANTEED SPECIFICATIONS — MADE IN U.S.A.

Model	Frequency Range	Accuracy Over Temperature	@150MHZ	@250MHZ	@500MHZ	Number Of Readouts	Size Of Readouts	Power Requirements	Size
3600A	50HZ-600MHZ	OVEN 5PPM 50° to 100°F	10MV	10MV	50MV	8	.5 inch	115VAC or 8.2-14.5VDC	2 1/2"H x 8"W x 5"D
3550W	50HZ-550MHZ	TCXO 1PPM 65° to 85°F	25MV	25MV	75MV	8	.5 inch	115VAC or 8.2-14.5VDC	2 1/2"H x 8"W x 5"D
3240HH	2MHZ-250MHZ	3PPM 65° to 85°F	100MV	100MV	NA	7	.4 inch	4AA Batt.	5"H x 3"W x 2"D

ALL UNITS ARE FACTORY ASSEMBLED,  
TESTED AND CARRY A FULL 1 YEAR WARRANTY.

See Your Dealer  
OR

Call Toll Free (800) 854-2049 DSI Instruments, Inc.  
California Residents, Call Collect (714) 565-8402

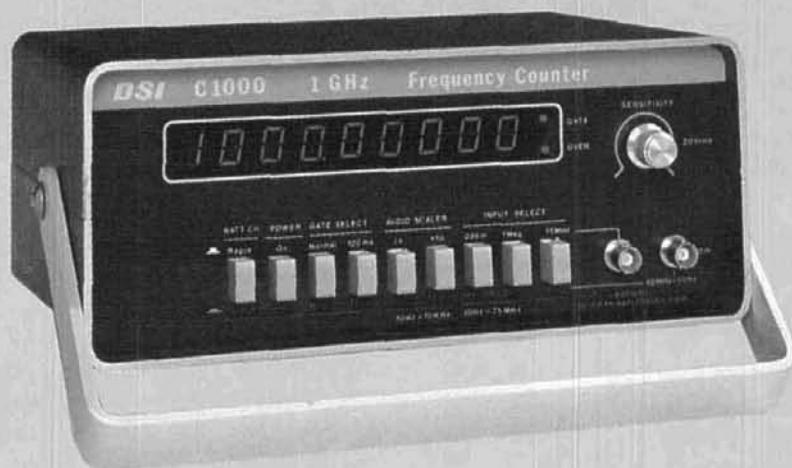
VISA • MC • AMERICAN EXPRESS • CHECK • MONEY ORDER • COD  
7914 Ronson Road, No. G, San Diego, CA 92111

• NO EXTRA COSTS •

FREE Shipping anywhere in U.S.A.  
& Canada. All other countries, Add \$10.00  
Strongest warranty in the counter field.  
ONE YEAR Parts and Labor  
Satisfaction Guaranteed.

# DSI COMMUNICATIONS SERIES

1.3GHz — 1GHz — 700MHz



## MODEL C1000 10Hz to 1GHz

**\$399<sup>95</sup>**

- AUTO ZERO BLANKING
- AUTO DECIMAL POINT

Accuracy . . . that's the operational key to this rugged advanced design Model C1000 1GHz frequency counter . . . a significant achievement from DSI. That's because you get . . . **.1 PPM** 0° to 40°C proportional oven time base . . . Built in 25DB preamplifier with a 60DB adjustable attenuator . . . x10 & x100 audio scaler which yields .01 Hz resolution from 10Hz to 10KHz equivalent to 10 sec. & 100 sec. Gate Time . . . Selectable .1 & 1 sec. time base and 50 ohms or 1 meg ohm input impedance . . . Built-in battery charging circuit with a Rapid or Trickle Charge Selector . . . Color keyed high quality push button operation . . . All combined in a rugged black anodized (.125" thick) aluminum cabinet. The model C-1000 reflects DSI's on going dedication to excellence in instrumentation for the professional service technician, engineer, or the communication industry.

## MODEL C700 50Hz to 700MHz

**\$299<sup>95</sup>**

- AUTO ZERO BLANKING
- AUTO DECIMAL POINT

ALL NEW! All UNPARALLELED DSI QUALITY! The model C 700 700 MHz frequency counter features . . . **.2 PPM** 0° to 40° C proportional oven time base . . . 25db preamplifier with a 60db adjustable attenuator. Built in battery charger with a rapid or trickle charge selector . . . Combined in a rugged (.125" thick) aluminum cabinet makes the C700 ideal for the communication industry and professional service technician.

3600A OWNERS: Up date your 3600A frequency counter to a C 700 includes, new back board, **.2PPM** proportional oven, 25db preamplifier, rugged .125" thick aluminum cabinet, order 3600A-700. Unit must be returned to DSI factory for modification.

### DSI — GUARANTEED SPECIFICATIONS — FACTORY ASSEMBLED — MADE IN USA

Model	Frequency Range	Proportional Oven Accuracy Over Temperature	50Hz To 75MHz	75MHz To 500MHz	500MHz To 1GHz	Number Of Digits	Size Of Digits	Power Requirements	Size
C700	50Hz to 700MHz	.2PPM 0° to 40°C	50MV	10MV	NA	8	.5 Inch	115 VAC-BATT 8 to 15VDC	3"H x 8"W x 6"D
C1000	10Hz to 1GHz	.1PPM 0° to 40°C	20MV	1MV	>50MV	9	.5 Inch	115VAC-BATT 8 to 15VDC	4"H x 10"W x 7½"D

— All Units Are Factory Assembled, Tested And Carry A Full 5 Year Limited Warranty —

- NO EXTRA COSTS •

FREE Shipping anywhere in U.S.A. & Canada. All other countries, Add 10%.

Strongest warranty in the counter field.  
Satisfaction Guaranteed.

See Your Dealer

OR

Call Toll Free (800) 854-2049 DSI Instruments, Inc.

California Residents, Call Collect (714) 565-8402

VISA • MC • AMERICAN EXPRESS • CHECK • MONEY ORDER • COD

7914 Ronson Road, No. G, San Diego, CA 92111

Model C 700 **\$299.95**

3600A-700 Factory update (3600A only)

Includes Labor & Re-Calibration **\$124.95**

Model C 1000 **\$399.95**

Opt. 01 1.3 GHz (C1000 only) **\$ 99.95**

Opt. 02 .05 PPM 10MHz Double Oven  
0° to 50°C Time Base (C1000 only) **\$129.95**

Opt. 03 20 Hr. rechargeable  
Battery Pack **\$ 29.95**

Ant. 210 Telescopic Ant./BNC Adapter **\$ 9.95**

# second generation reciprocating detector

An updated version  
of the reciprocating detector,  
which can be used  
in solid-state receivers  
with high-frequency  
i-f strips

During the past three years I've had many requests for revisions to the reciprocating detector circuit<sup>1</sup> so that it can be used directly at high frequencies. Here's an updated IC design that can be used at frequencies up to 20 MHz.

## background

Early attempts to directly use the RD above 5 MHz required very careful circuit layout to reduce or eliminate inter-circuit coupling, and in particular to maintain the correct phase relationship required in the feedback loop. Also, the detector portion operated as a half-wave rectifier. A current-regulating source had to be adjusted to cause the signal diode to operate at a level just below conduction, so that at fre-

The "reciprocating detector" was designed by R.S. Badessa at M.I.T. The RD features a carrier-synthesized reference signal and requires no external bfo. The circuit offers advantages over conventional detectors in that it adjusts its bfo level automatically in proportion to the average signal level received. First introduced in *ham radio* in March, 1972, the RD has gone through several metamorphoses. The version presented here uses ICs and can be used in modern receivers using semiconductors. Also included is a design for a 10.7-MHz ssb filter for single-passband receivers. Editor.

quencies above 5 MHz the diode and its circuitry ceased to perform uniformly. Result — a badly distorted detected signal.

Despite the distortion, in some cases the circuit performed well enough for signal identification. But much was to be desired. A cure for individual cases was to adjust the bias level for the current-source diode until it just conducted on noise. In most cases, with a tube receiver that produced i-f signals to the RD input exceeding the saturation level of the complete circuit, a clipped response occurred. Single sideband signals then became unmanageable because of widely varying signal levels that couldn't be controlled by the agc systems in older tube receivers.

The original circuit was designed to be used in receivers such as the Collins 51S1 and Drake R4A, which have highly selective dual or adjustable filters in the receiver i-f passband. In the 51S1 receiver the i-f output was fed to the RD through a cathode follower; the maximum output level could not exceed 3 volts. The application using the Drake R4A employed enough attenuation through the coupling to the original product detector output transformer to preclude saturation.

An updated design, which uses ICs, allows the RD to be incorporated into more modern receivers. Models of the new circuit have been made for 10.7, 16, and 20 MHz. Test models were constructed using point-to-point wiring. Later models used PC boards.

## circuit description

The circuit consists of two amplifier chips, IC1, and IC2 (fig. 1). These are monolithic wideband amplifiers with frequency response between 10 kHz and 20 MHz. These chips are 10-lead devices in TO-5 cans. A third rf amplifier, IC3 is a balanced differential amplifier using an internal constant-current source, which eliminates the original problem caused

By Stirling Olberg, W1SNN, 19 Loretta Road,  
Waltham, Massachusetts 02154

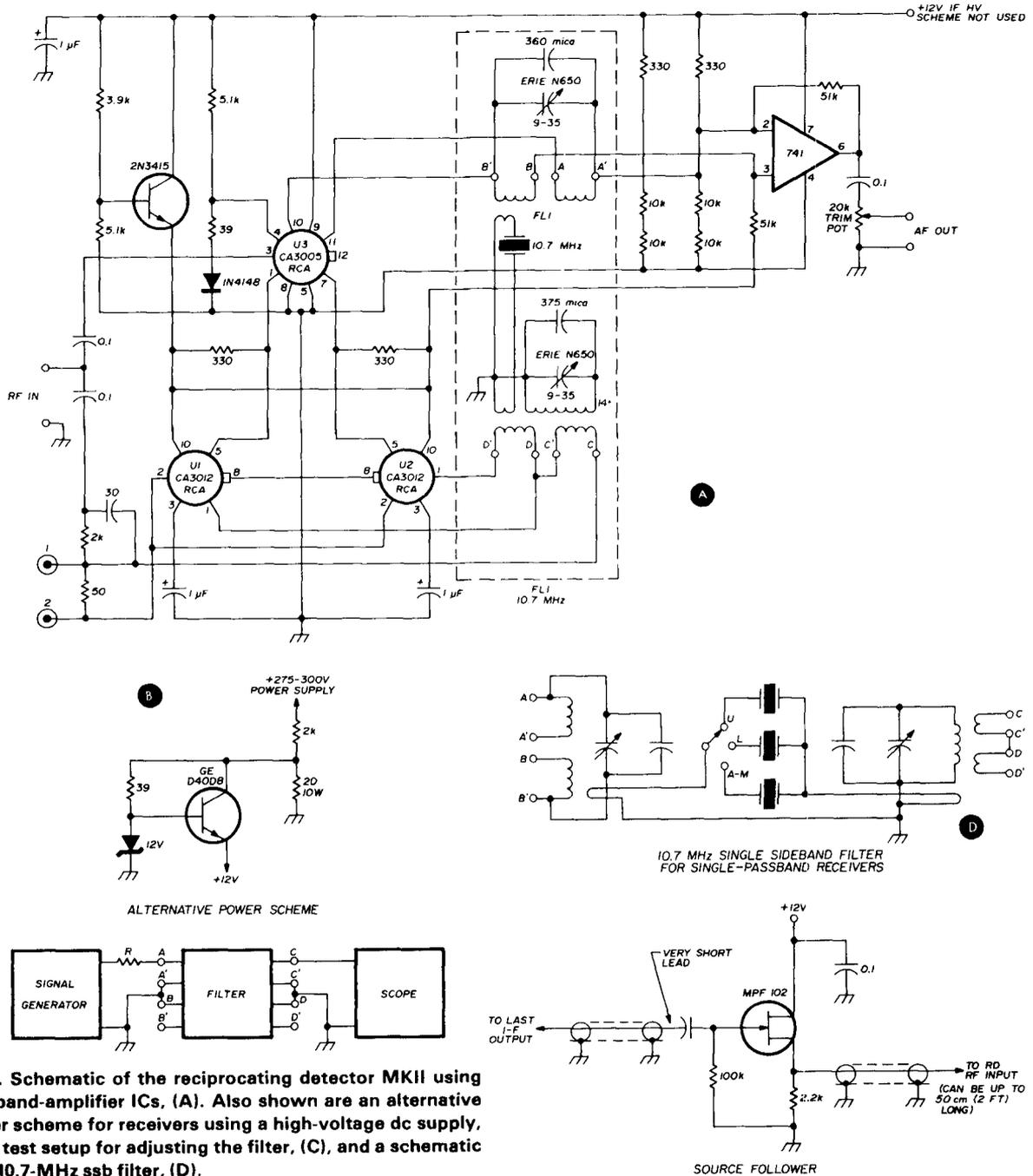


fig. 1. Schematic of the reciprocating detector MKII using wideband-amplifier ICs. (A). Also shown are an alternative power scheme for receivers using a high-voltage dc supply, (B), a test setup for adjusting the filter, (C), and a schematic for a 10.7-MHz ssb filter. (D).

by the biased half-wave rectifier. This amplifier operates from 0-100 MHz. This wideband response allows the circuit to work in the same manner as the original current source for the detector and as the reciprocating switch. These two functions are improvements over the old circuit. The dynamic range improvement alone is worth the effort.

Tracing the signal through the circuit, we see that a capacitive input circuit couples the rf signal into IC3 input. The capacitive coupling isolates any direct cur-

rent that might be superimposed on the rf signal from the i-f output circuit. The input signal is then applied to a phase-shift network, then to one set of inputs of IC1 and IC2. These three inputs are then provided with a signal path that's essentially in series with the reference signal, or beat frequency similar to a conventional product detector.

The reference frequency is generated by filtering a portion of the received signal through a narrowband crystal filter, FL1. The push-pull output of this filter

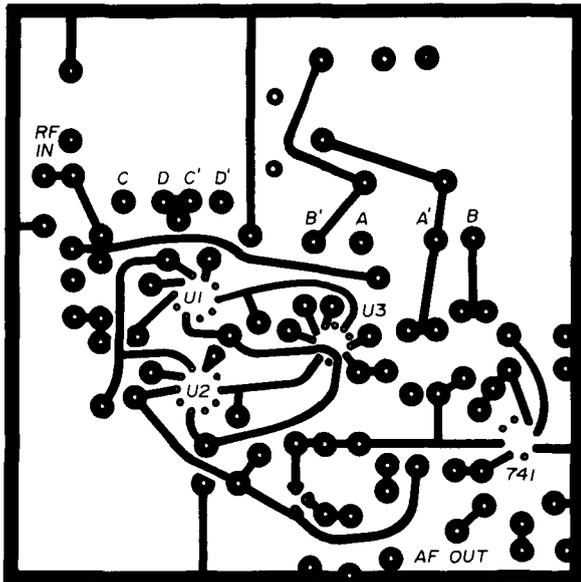


fig. 2. PC-board layout for the updated reciprocating detector.

feeds this signal into the balanced inputs of IC2 and IC3. We now have the circuit reference by virtue of a carrier-controlled feedback loop. The feedback loop response time is determined by the slow recovery time of the narrowband filter; therefore, noise pulses are reduced or eliminated.

IC4, an op amp, is an audio amplifier. The received-signal audio envelope is taken from the input filter, FL1, then applied through two lowpass filters to the 741 IC. This amplifier audio gain is established by the feedback resistor (51k). This value may be changed for a higher or lower level; however the gain will overdrive the first audio inputs of most communications receivers. A 20k trimpot at the audio amplifier output allows gain control.

The RD will work in any receiver if its i-f matches that of the RD reference filter. For best results, narrowband i-f filters offering high selectivity are a major requirement. Many receivers use dual filters offset by the correct dispersion to allow either sideband to be selected by switching in the appropriate filter section. Others use adjustable filters to obtain the same effect. I-f passband circuits using single filters, as in many of the older tube receivers, also perform nicely. With 1.8-kHz filters, however, only one side can be used unless the reference or beat frequency is displaced to center the signal in the filter. The older reciprocating detector circuits didn't provide for this problem.

Circuitry to show how a filter can be constructed for upper/lower sideband selection for use in receivers with single passband filters, incorporating three crystals, is shown in the filter circuit. If your

receiver uses filters to select sidebands, then only one crystal, set in the i-f passband center, will be required.

### construction of a 10.7-MHz RD filter

The filter used in an RD is not a complicated device. It has a shape factor similar to that of the old variable crystal filters. It's not a wide passband filter because it's used to select the beat-frequency signal.

On a Micro Metals T50-2 toroid core wind 14 turns of 0.2 mm (no. 32) enameled wire. Secure the wire so it won't become loose. Use tape or nylon string. Make sure the coil leads are at least 30 mm (1-1/2 inches) long and are scraped clean of insulation. Next, fold a 30-cm (12-inch) length of the same type wire in half. Twist this pair of wires until you have at least eight twists per 25 mm, or 8 twists per inch. (This is called a bifilar pair.)

Now, using the bifilar pair, wind on the same form a three-turn winding and secure it. This coil should be wound in the area not used by the previous winding, but it isn't important that it be exactly placed or spaced in this area. Next clean off each of the wire ends; then, with an ohmmeter, identify each coil separately. They will be used to complete the connections identified in the filter drawings as C, C', D, and D'.

After each winding has been identified, the ends opposite each other can be connected to provide the center-tapped winding signified as C' and D in fig. 1. This toroid will contain three coils. Now, on a second core of the same type, wind two eight-turn windings of the bifilar pair and scrape the four ends. Again, with an ohmmeter, identify each coil. These ends can be designated A, A', B, and B'.

Mount each coil on the PC board as shown (fig. 2). If you're not using the board, mount the coils about 30 mm (1-1/2 inches) apart. Don't tighten the coils yet. Next, mount the crystal between each toroid, then wind a single turn of 0.2 mm (no. 32) enameled wire on each toroid, terminating one end of each coil on a crystal terminal or the switch, whichever the case may be. The other two coil ends should be connected together.

If your receiver has selectable sideband filters, a single crystal will be required. If not, then wire it as shown in the filter diagram (fig. 1) and include all three crystals. In this case, a selector switch must be used at the filter location. If this is the case, connect the link ends from the two coils to the appropriate switch contacts. Reed switches can be used and provide excellent low-loss control.

The filter components are for 10.7 MHz but will work at 9 MHz with different crystals. The compo-

nents can be juggled to work around that frequency range. Lower frequencies will, of course, have a higher inductance value.

The crystals can be purchased from any of the manufacturers currently advertising in most of the amateur magazines. It's best to use fundamental-frequency crystals mounted in an HC6/U holder, with wire leads to make soldering easy. This doesn't preclude other types of holders or pin-mounted crystals; however, some of the alignment procedures will be a little more difficult, particularly if pressure-type holders are used.

### checkout and test

Connect a signal generator and scope or rf voltmeter through terminating resistor R as shown in the test setup. Set the indicator to a high sensitivity and the signal generator to a high output level. Carefully tune the signal generator across 10.7 MHz. An indication with a very sharp upswing in level will occur when passing through crystal resonance. Carefully adjust the signal generator to the peak of the upswing. Then, with an insulated screwdriver, adjust the 9-35 pF capacitors for future increase. The scope sensitivity and the signal-generator output level will have to be reduced as the resonance of each coil is reached. Frequent readjustment of the signal generator will be required to keep it centered at crystal resonance. As the adjustments proceed you'll notice that the sharp increase at the crystal frequency will become easier to adjust.

If a three-crystal unit is to be constructed, make these adjustments at the passband center or with the a-m crystal in the circuit. The other two crystal frequencies are as sharp as that of the a-m resonant frequency and will be within the inductor resonant frequency.

To use the RD in the ssb mode with a single i-f passband filter, it won't be necessary to offset tune the receiver. Simply use it as you normally would. It's like having a crystal controlled bfo — simply switch in the appropriate crystal.

### RD construction

The reciprocating detector is simplicity itself to construct. Attention to component placement is similar to that of any high-frequency device. The filter leads can be connected, after filter adjustment, to those points shown (fig. 1) that are alphabetically marked. Use leads as short as possible.

A slight tweaking of the filter might be required after it's installed in the receiver. Use care as to the length of the lead to the RD rf input. This is a two-way street: if the lead is too long, external pickup can cause interference to the hf i-f stages; if the lead is

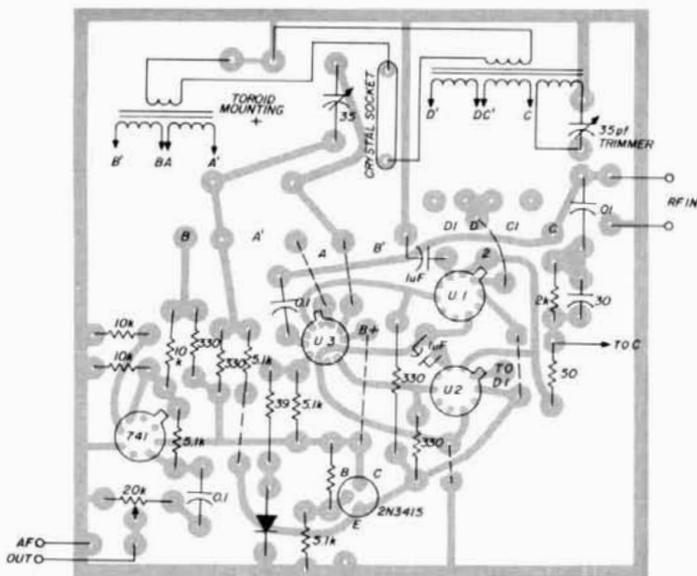


fig. 3. Component placements for the reciprocating detector circuit board.

shielded and too long, it can detune the i-f stage to which it is connected. So a short signal path is required, or an emitter or source follower will be required to reduce these effects.

The choice of how the audio is routed is up to you. It can be connected as shown in the references or used with an external amplifier. Since the output level is in the 100-millivolt level, it can easily drive an external amplifier.

### power supply

Power requirements for the new RD are further simplified. The older unit required a dual balanced supply source, but this unit requires a single 12-volt supply at 40 milliamperes. The RD supply can be taken from the receiver supply filter output if it's 12 volts. Or you can use a higher-voltage supply, such as found in a tube receiver, if you use the alternative supply scheme shown in fig. 1.

I will be pleased to hear from anyone who has used the RD and will communicate with all who write. Please include a self-addressed, stamped envelope with your letter.

### reference

1. Stirling Olberg, W1SNN, "Reciprocating Detector," *ham radio*, March, 1972, pages 32-35.

### bibliography

- Olberg, Stirling, W1SNN, "5-MHz WWV Receiver," *ham radio*, November, 1972, pages 44-49.  
 Olberg, Stirling, W1SNN, "Reciprocating Detector Converter," *ham radio*, September, 1974, pages 58-63.

ham radio

The TS-520S,  
the most popular  
Amateur Radio transceiver  
in the world

... provides a foundation  
for an expanding series of acces-  
sories designed to please any ham ... from  
Novice to Amateur Extra.

# TS-520S

The TS-520S transceiver provides full transmit and receive coverage of all Amateur bands from 160 through 10 meters. It also receives 15.0 (WWV) to 15.5 MHz and another 500-kHz range of your choice in the auxiliary band position. With the optional DG-5, you have a large digital frequency readout when transmitting and receiving, and the DG-5 also doubles as a 40-MHz frequency counter. The TS-520S includes a built-in AC power supply, and, with the addition of the optional DS-1A DC-DC converter, it can function as a mobile rig. It features a very effective noise blander, RIT, eight-pole crystal filter, 25-kHz calibrator, front-panel carrier level control, semi-break-in CW with side-tone, built-in speaker, heater switch, 20-dB RF attenuator and easy phone-patch connection. RF input power is 200 W PEP on SSB and 160 W DC on CW. Carrier suppression is better than -40 dB and sideband suppression is better than -50 dB. Spurious radiation is less than -40 dB. Receiver sensitivity is 0.25  $\mu$ V for 10 dB (S+N)/N. Selectivity is 2.4 kHz at -6 dB/4.4 kHz at -60 dB and, with the optional CW-520 CW filter, is 0.5 kHz at -6dB/1.5 kHz at -60 dB.

See your local Authorized Kenwood Dealer for more information, and a super deal!



A great station ... at an affordable price! The TS-520S with its companion accessories ... including two new units. The AT-200 antenna tuner provides a versatile tool in any station. The other is the TV-502S, Kenwood's 2 meter transverter for SSB and CW operation from 144 to 146 MHz.

*Kenwood's finest 2-meter rig...  
all modes for all occasions*

**STILL THE SAME FINE, TIME PROVEN RIG. BUT NOW WITH THE SIMPLE ADDITION OF A PLUG-IN CRYSTAL, THE TS-700SP WILL BE ABLE TO UTILIZE THE NEW REPEATER SUB-BAND (144.5 to 145.5 MHz) STILL FEATURES ALL OF THE FINE ATTRIBUTES OF THE TS-700S: A DIGITAL FREQUENCY DISPLAY, RECEIVER PRE-AMP, VOX, SEMI-BREAK IN, AND CW SIDETONE. OF COURSE, IT'S ALL MODE, 144-148 MHZ, VFO CONTROLLED... AND KENWOOD QUALITY THROUGHOUT.**

# TS-700SP

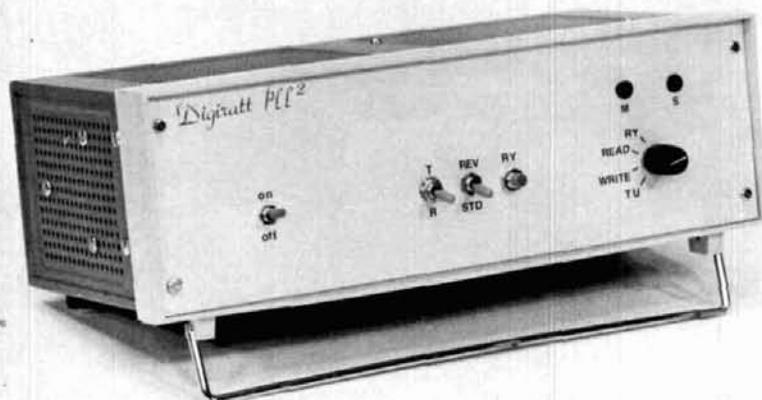
Features: 4 MHz band coverage (144 to 148 MHz) • Automatic repeater offset capability on all FCC authorized repeater subbands including 144.5 - 145.5 MHz • Simply dial receive frequency and radio does the rest... simplex, repeater, or reverse. Same features on any of 11 crystal positions • Transmit/Receive capability on 44 channels with 11 crystals • Operates all modes: SSB (upper and lower), FM, AM and CW • Digital readout with "Kenwood Blue" digits • Receiver pre-amp • Built-in VOX • Semi break-in on CW • CW sidetone • All solid-state • AC and DC capability. 10 watts RF output on SSB, FM, CW • 3 watts on AM • 1 watt FM low-power switch • 0.25  $\mu$ V for 10 dB (S+N)/N SSB/CW sensitivity • 0.4  $\mu$ V for 20 dB quieting FM sensitivity.

10 watts RF output on SSB, FM, CW • 3 watts on AM • 1 watt FM low-power switch • 0.25  $\mu$ V for 10 dB (S+N)/N SSB/CW sensitivity • 0.4  $\mu$ V for 20 dB quieting FM sensitivity.



The TS-700SP shown with the matching VFO-700S and SP-70. Also shown is Kenwood's new MC-30 noise cancelling hand held microphone, HS-4 headphone set and the MC-50 dynamic microphone.

**TRIO-KENWOOD COMMUNICATIONS INC.**  
1111 WEST WALNUT/COMPTON, CA 90220



## digiratt PLL<sup>2</sup>

### — dual demodulator terminal unit

Continuing in the digiratt series, the PLL<sup>2</sup> demodulator uses dual phase-locked loops to help eliminate loss of signal due to fading

**Phase-lock loop terminal** units have been around in various forms for several years. As a means of receiving RTTY signals inexpensively, they are certainly worth considering. The one common drawback to PLL terminal units is that they decode only half the available information present in the RTTY signal. Many comments have been made by amateurs over the years that this fact really isn't a drawback at all, because there are only two possible states that the RTTY signals can be in at any one time and the absence of one condition indicates the existence of the other.

There is, however, an occurrence known as selective fading which can completely eliminate one half of the RTTY signal while leaving the other intact. If you happen to be tuned to the particular tone which fades out, you'll find your printer ceasing to operate until the tone returns.

PLL terminal units have several good points. Among these are:

1. They will follow a drifting signal until it leaves their passband.
2. Since they are inherently frequency selective, they do not require passive input filters.
3. They are not expensive.

It follows then that if a means could be found to use PLL circuits to decode both RTTY signals (mark and space), the overall usefulness of the terminal unit would be improved.

The original Digiratt PLL terminal was an attempt to design a low-cost vhf terminal unit and AFSK generator.<sup>1</sup> I received letters from all over the world which led me to believe that there is a large amount of interest in a simple means of decoding RTTY signals. The Digiratt PLL<sup>2</sup> is the direct result of those letters and is presented here as one possible approach to the need for such a unit.

The Digiratt PLL<sup>2</sup> is composed of two identical tone demodulators, using the 567 phased-lock loop.

By **John Loughmiller, KB9AT**, Route 1, Box 480C, Borden, Indiana 47106

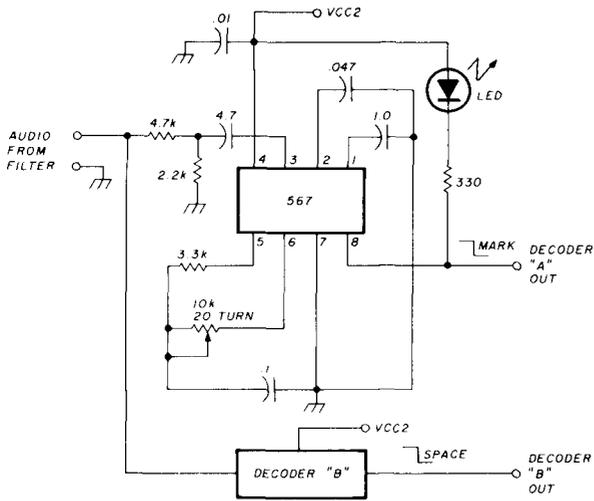


fig. 1. Schematic diagram of the 567 phase-locked loop used as a demodulator. In this case, two 567s are used; the first will demodulate the space signals while the second is for the mark frequency.

A two-stage active filter is included, and may be switched into the circuit ahead of the PLL inputs in order to detect low-level signals. Additionally, a very novel logic circuit, which has the capability to regenerate missing information during selective fading, follows the PLL portion of the terminal unit.

### circuit description

The description of the PLL circuits themselves can be found in the original Digiratt article; this unit uses the same decoder circuitry. Decoder A (see fig. 1) is tuned to the mark frequency of 2125 Hz, with decoder B tuned to the space frequency (2295 Hz). The A decoder capture frequency is slewed low and the B decoder slewed high so that there exists an area from approximately 2190 Hz to 2220 Hz where neither PLL will conduct. The exact procedure for accomplishing this operation will be covered in the alignment section.

SELCOMP is a name the author has given to the logic responsible for the *SEL*ective fading *COMP*ensation which is part of the Digiratt PLL.<sup>2</sup> The schematic diagram is shown in fig. 2. In order to understand its operation, two separate conditions will be

explained, normal full-signal operation and operation under "no space" conditions.

**Normal.** A low-going mark signal is buffered by U5A and then sets the RS latch, U6. The output from the latch causes the multiplexer, U8, to select its pin 5 input. The mark signal then appears at the base of Q1, the selector magnet driver circuit. A subsequent low-going space signal will reset the RS latch, causing the multiplexer to select the pin 6 input. Since the space input from the decoder is a low true signal, it is inverted by U4. Therefore, the output from the

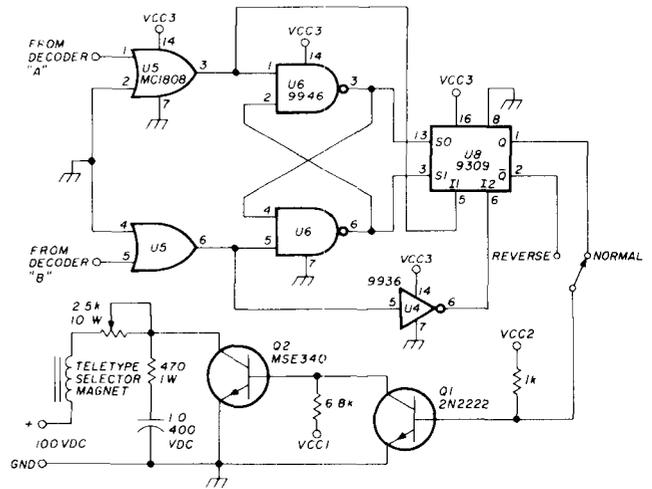


fig. 2. Under normal conditions, the multiplexer switches between the mark and space signals. If either signal is lost, the logic will continue to use the remaining signal as the drive for the selector magnets. The Q and Q outputs from U8 allow you to use either normal or inverted data. The 100 Vdc for the selector magnets comes from the power supply shown in fig. 5.

multiplexer will be low for mark and high for space. Also, the complement signal from the multiplexer can be used to provide for normal and inverted signals.

**No Space.** Now, assume that space data is lost. When this occurs, the RS latch will never reset and the magnet driver will receive only mark data. If mark data is lost, the selector magnet is driven by space data because the RS latch is never set and therefore

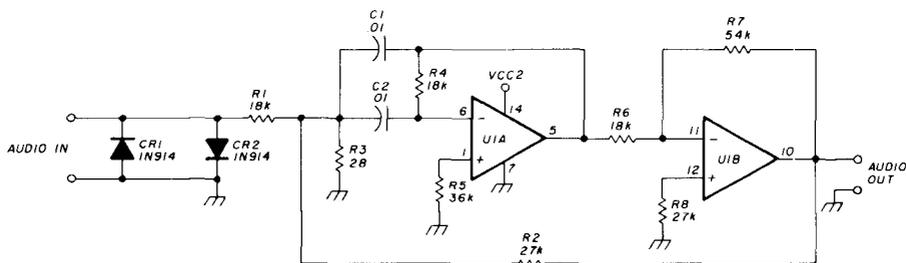


fig. 3. Schematic diagram of the 2-stage active filter. Using an LM3900, this filter provides 23-dB gain, with a designed center frequency of 2210 Hz. All resistors are 1/4 watt, 1 per cent tolerance. C1 and C2 are polystyrene capacitors.

the multiplexer always looks at the incoming inverted space data.

Because of this logic scheme, selective fading is greatly minimized. There is one condition which the logic will not correct, and that is a selective fade during a 22 ms character element. In other words, if a single bit is lost there is very little any simple system such as SELCOMP will do for the problem.

Fortunately, such rapid selective fading is relatively rare. A much more common occurrence is printer noise or external impulse type noise, which your receiver's noise blanker will generally handle.

The active filter, as shown in **fig. 3**, is a two-stage device with a gain of approximately 23 dB and a  $Q$

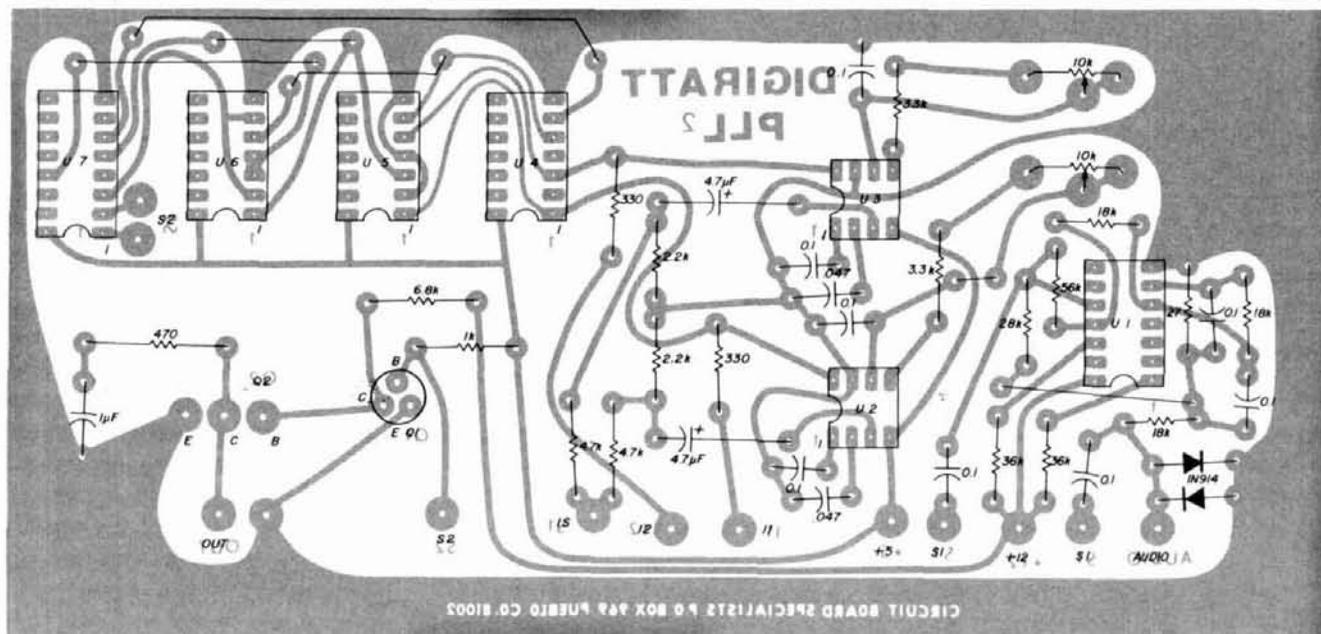
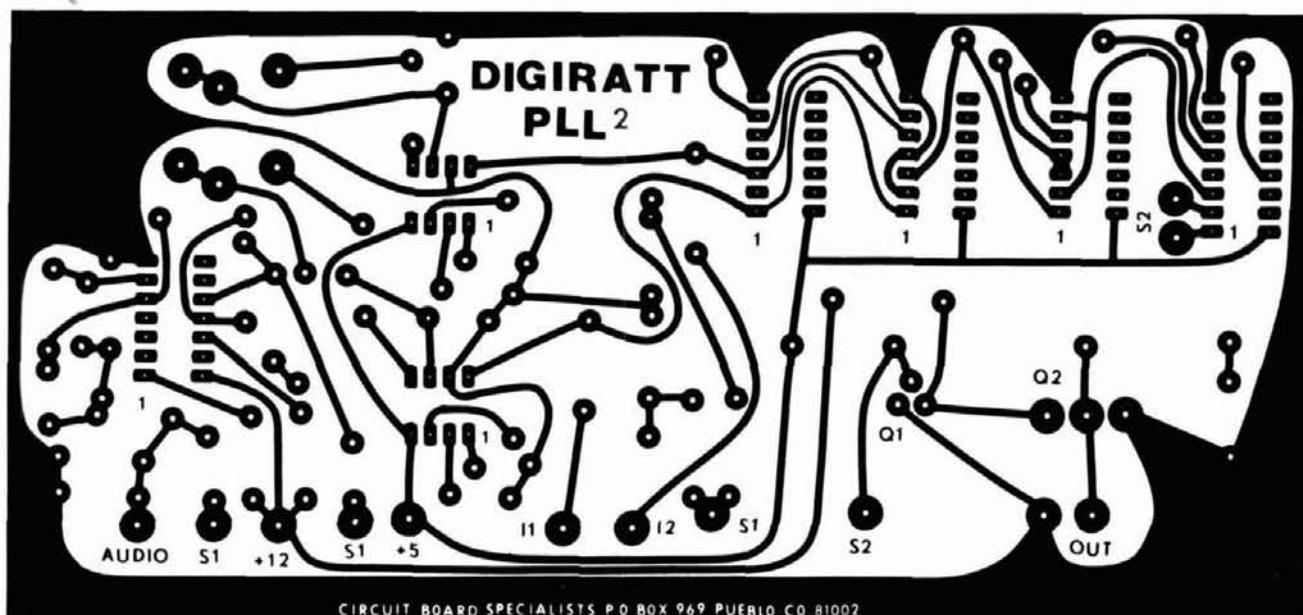
of 25. The center frequency is 2210 Hz. For the reader who wishes to design his own filter, the formulas are included in the **appendix**.

Unfortunately, the use of an active filter, and its added performance, is offset due to the rather large additional cost of 1 per cent resistors.

The back-to-back diodes, across the audio input, are required to prevent front-end overloads. These diodes should be used if the active filter is not built. In that case, the diodes are connected across the common feed point.

### construction

Construction of the PLL<sup>2</sup> is straightforward, with



**fig. 4.** The circuit board for the PLL<sup>2</sup> is shown in A, with the parts placement diagram shown in B.

the entire circuit mounted on a single printed circuit board.\* A copy of the printed circuit board and its parts placement are shown in **fig. 4**. The cabinet, which housed the prototype, measured 15 × 29 × 9 cm (5-7/8 × 11-3/8 × 3-1/2 inches).† Use shielded audio cable from the input connectors to the circuit board. For difficult RFI problems, you can apply 0.01-μF capacitors at the V<sub>CC</sub> pin of each IC.

## alignment

The Digiratt PLL<sup>2</sup> should be aligned as follows:

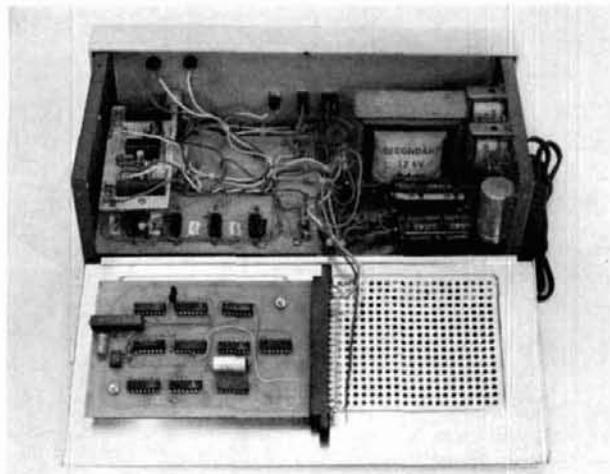
1. Apply a 2125 Hz, 1-volt, p-p sine wave into the audio input of the unit.
2. Adjust the decoder A until the mark-indicating LED illuminates.
3. Change the audio input to 2295 Hz and repeat the procedure for decoder B.
4. Reset the audio source for 2190 Hz and adjust decoder A until the mark LED goes out.
5. Reset the source for 2125 Hz and verify that the mark LED illuminates.
6. Again reset the source to 2190 Hz and verify that the mark LED goes out.

When the above conditions can be met, the mark portion of the circuit is aligned.

Decoder B is adjusted in the same manner, using 2220 and 2295 Hz. If you now sweep the frequency

\*A complete kit of parts is available from Circuit Board Specialists, Box 969, Pueblo, Colorado 81002 for \$31.10. The circuit board alone costs \$7.50.

†Available from Radio Shack — RS270-282.



In the foreground is the RY generator board (*ham radio*, January, 1978). From left to right, Prototype PLL twin decoders and Sel-comp logic, low voltage supply, 100 VDC, 100 mA loop supply is on the extreme right.

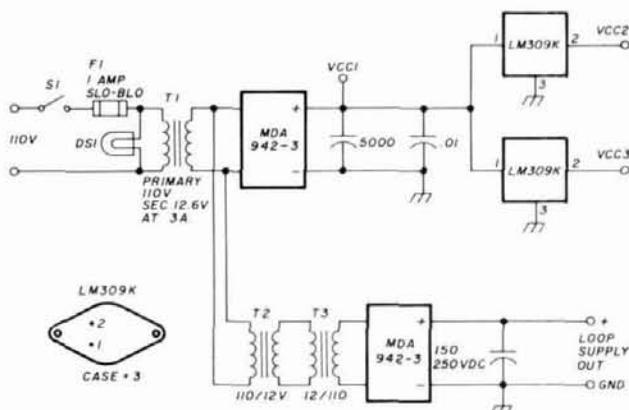


fig. 5. Power supply for the Digiratt PLL.<sup>2</sup> When mounting the LM309Ks, ensure that an adequate heat sink is provided.

from 2050 to 2350 Hz, the mark LED should illuminate at 2125 Hz, remaining on until 2190 Hz. At 2220 Hz the space LED should light until you reach 2295 Hz. Between 2190 and 2220 Hz, neither LED should be on.

## summary

The Digiratt PLL<sup>2</sup> is not the ultimate terminal unit, however the builder can expect very satisfactory results from it in all but the most adverse conditions.

The following persons have been most helpful to me over the past year or so during which I have been designing the various Digiratt projects: Don Smith, W9EPT; Bernie Holtman, W4GO; and Gus Bezy, K9FUI.

## appendix

Design equations for a two-stage, bandpass filter using an LM3900 Norton amplifier.<sup>2</sup>

$$R1, R4, \text{ and } R6 = \frac{25}{6.283 \times F_0 \times C_1}$$

where  $F_0$  = center frequency in Hertz

$C_1$  = chosen value in Farads

$$R2 = R1 \times 1.5306$$

$$R3 = \frac{R1}{623.34}$$

$$R5 = 2R1$$

$$R7 = 3R1$$

$$R8 = \frac{R1 \times R7}{R1 + R7}$$

$C1, C2$  = Any convenient value

These equations will yield a two-stage filter with a gain of 23 dB and a Q of 25. Use 1 per cent resistors.

## references

1. John Loughmiller, WB9ATW, "Digiratt — RTTY AFSK Generator and Demodulator," *ham radio*, September, 1977, page 26.
2. "The LM3900," *Linear Applications*, Volume 1, National Semiconductor Corporation, Santa Clara, California, 1976.

ham radio

there's a world of difference  
in TEN-TEC's *all-new*  
hf transceiver—

 OMNI



**OMNI—THE ALL-INCLUSIVE.** Because OMNI has it all. Designed to give you every advantage, every capability, whatever your operating specialty. Designed to give you new conveniences and new levels of performance. Designed to give you the world of Amateur Radio with a world of difference—the OMNI world of unique features. An unusual combination not found in any other.

**FUNCTIONAL STYLING.** The "look" you requested. "Clamshell" aluminum case clad in textured black vinyl. Complementary nonreflective warm dark metal front panel. Extruded satin aluminum trim bezel and tilt bail. Convenient controls. Fully shielded. And everything in a larger, easier-to-use size: 5¼" h × 14¼" w × 14" d.

**TOTALLY SOLID-STATE.** Sharing the TEN-TEC heritage of solid-state design leadership with its companion transceivers, the highly successful 540/544, OMNI has all the advantages of proven solid-state technology—reliability, long life, cool performance, better stability.

**8-BANDS.** The world now and in the future. OMNI covers 160, 80, 40, 20, 15, and 10 meters now (crystals included for all present Amateur bands, 1.8-30 MHz). And it has convertible 10 MHz and "AUX" band positions for the future.

**BROADBAND DESIGN.** Permits changing bands without tune-up, without danger of out-of-resonance damage to the final stage.

**ANALOG OR DIGITAL READOUTS.** OMNI-A features an analog dial with 1 kHz dial markings. OMNI-D has 0.43" LED readouts with the 5 most significant in red and the 6th in green to show 100 Hz increments.

**BUILT-IN VOX AND PTT.** Smooth VOX action with 3 easy-to-adjust front panel controls. PTT control is available at both front and rear panel jacks; an external microphone switch may be used.

**BUILT-IN SQUELCH.** Unusual in an hf rig, but handy for tuning or monitoring for a net or sked.

**BUILT-IN 4-POSITION CW/SSB FILTER.** 150 Hz bandwidth with 3 selectable skirt contours for optimum CW reception.

**8-POLE CRYSTAL FILTER.** 2.4 kHz bandwidth, 1.8 shape factor.

**SEPARATE MODE SWITCH.** Permits using all filters in any mode.

**2-SPEED BREAK-IN.** Switch to "fast" or "slow" receiver muting to accommodate any band condition or mobile operating.

**2-RANGE OFFSET TUNING.** Switch-select the ±5 kHz range for off-frequency DX work or the ±0.5 kHz range for fine tuning.

**OPTIMIZED RECEIVER SENSITIVITY.** Ranges from 2 uV on 160 m to 0.3 uV on 10 m (10 dB S+N/N) to achieve ideal balance between dynamic range and sensitivity.

**GREATER DYNAMIC RANGE.** Typically exceeds 90 dB to reduce possible overload from nearby stations. Also includes switchable 18 dB PIN diode attenuator for additional overload prevention.

**WWV RECEPTION.** On the 10 MHz band switch position.

**FRONT PANEL CONTROL OF LINEAR/ANTENNA BAND-SWITCHING.** Auxiliary bandswitch terminals on back panel for simultaneous control of external relays or circuits with the OMNI bandswitch.

**BUILT-IN PHONE PATCH JACKS.** Provide interface to speaker and microphone audio signals for phone patch connection.

**BUILT-IN "TIMED" CRYSTAL CALIBRATOR.** In the OMNI-A a pulsed 25 kHz calibrator desensitizes the receiver and provides an automatic 5 to 10 second "on" time for easy two-hand dial skirt adjustment.

**BUILT-IN ZERO BEAT SWITCH.** Permits placing your transmitted signal exactly on the listening frequencies of CW stations.

**BUILT-IN SWR BRIDGE.** The "S" meter electronically switches to read SWR every time you transmit to provide a continuous antenna check.

**FRONT PANEL MICROPHONE AND PHONE JACKS.**

**ADJUSTABLE AUTOMATIC LEVEL CONTROL.** For setting output power level from low power to full output, for retaining low distortion at desired drive power to linear amplifier.

**SEPARATE RECEIVING ANTENNA CAPABILITY.** Rear panel switch and jack connect receiving section to common antenna or separate receiving antenna. Also acts as receiving antenna by-pass when used with instant break-in linear amplifiers.

**BUILT-IN ADJUSTABLE SIDETONE.** Variable pitch and volume.  
**DUAL COMPRESSION-LOADED SPEAKERS.** Larger sound output, lower distortion, no external speaker needed.

**POWER INPUT.** 200 watts when used with 50 ohm load. Proven, conservatively-rated, solid-state final amplifier design with full warranty for first year and pro-rata warranty for 5 additional years.

**100% DUTY CYCLE.** Ideal for RTTY, SSTV, or sustained hard usage.

**PLUG-IN CIRCUIT BOARDS.** For fast, easy field service.

**POWER.** Basic 12 VDC operation for convenient mobile use; external supply required for 117 VAC operation.

**OPTIONAL ACCESSORIES.** As all-inclusive as OMNI is, there are a few options: Model 645 Keyer, 243 Remote VFO, 248 Noise Blanker, 252M Power Supply.

**Model 545 OMNI-A \$899    Model 546 OMNI-D \$1069**

*Experience the world of difference of OMNI, see your TEN-TEC dealer or write for details.*



**TEN-TEC, INC.**  
SEVIERVILLE, TENNESSEE 37862  
EXPORT 1715 LINCOLN AVE. CHICAGO, ILL. 60646



- 1 Receiver RESONATE control for peak sensitivity.
- 2 Receiver Dual Range OFFSET TUNING control for off-frequency work.
- 3 ZERO BEAT switch: spring-loaded, momentary contact.
- 4 6-Digit LED FREQUENCY READOUT for 100 Hz accuracy.
- 5 OFFSET TUNING LED indicates DT switch is "on".
- 6 MAIN TUNING KNOB: big, easy-to-grip with integral spinner.
- 7 AUTOMATIC LEVEL CONTROL LED indicates ALC-region operation.
- 8 Combination "S" and SWR METER, switches automatically.

- 9 Combination ALC control and NOISE BLANKER on/off switch.
- 10 DRIVE control for final stage.
- 11 SQUELCH combination on/off switch and control.
- 12 4-Position SELECTIVITY switch for SSB and CW.
- 13 4-Position MODE switch: automatic SSB Normal, Reverse, CW, and Lock (key down).
- 14 Combination push-pull POWER switch and AUDIO LEVEL control.
- 15 Combination RF ATTENUATOR on/off switch and control.
- 16 VOX GAIN control.

- 17 VOX DELAY control.
- 18 VOX ANTI-TRIP control.
- 19 11-Position BAND SWITCH.
- 20 MICROPHONE jack: hi-z input.
- 21 HEADPHONE jack.
- 22 RECEIVER OFF-SET TUNING SWITCH: 3-position: Max-Min-Off.
- 23 VOX-PTT SWITCH.
- 24 QSK (full break-in) SWITCH: 2-position: Fast-Slow.

# high-sensitivity preamplifier for frequency counters

Discussion of the  
design requirements  
for a counter preamplifier,  
which in addition to  
high sensitivity  
and input impedance  
also exhibits frontend  
overload protection

**Frequency counter design** has been greatly simplified since the introduction of the Intersil 7207/7208 and the recent 7216/26 integrated circuits. Several designs have appeared in *ham radio*<sup>1,2</sup> which make use of the 7207/7208 chip set with simple preamplifiers. Since a frequency counter's performance is largely limited by the preamplifier used to condition its input signal, this stage should receive significant attention during the design phase.

Such a preamplifier should have high input impedance, much like that of an oscilloscope vertical amplifier. It should also have enough sensitivity to permit the use of a X10 oscilloscope probe for minimum circuit loading, even at high frequencies. The preamplifier should be able to handle large input signals without overload, necessitating some form of input attenuator. Since the 7208 is a 5-MHz counter, the preamplifier should have a 50-MHz bandwidth for use with a prescaler. For proper counting of low-frequency signals with slow rise and fall times, the preamplifier should make use of a Schmitt trigger with hysteresis to prevent multiple triggering. A lowpass filter is also useful for counting noisy low-frequency signals.

## **preamplifier design**

One method of achieving the high input impedance is to use an fet input stage followed by a broadband integrated circuit amplifier for high sensitivity.

**By Paul Kranz, W1CFI, Mettacomett Path,  
Harvard, Massachusetts 01451**

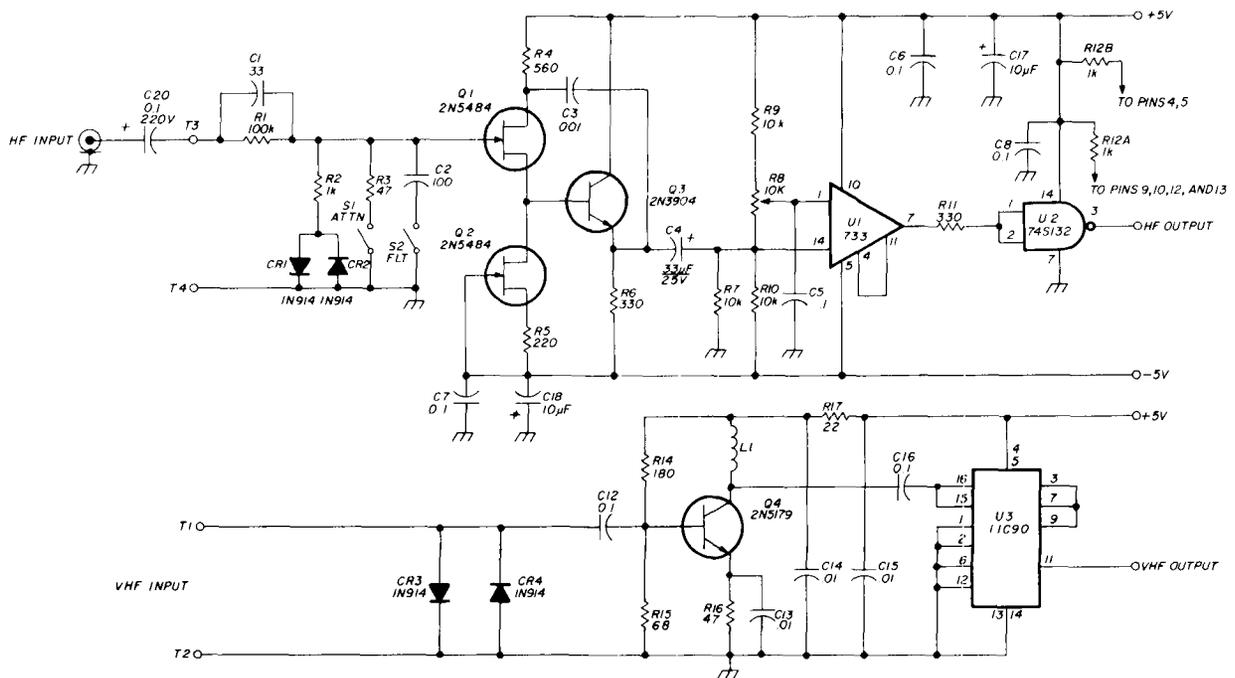


fig. 1. Schematic diagram of the high-sensitivity 0-50 MHz preamp and vhf prescaler. Input sensitivity ranges from less than 5 mV at 1 MHz to about 21 mV rms at 50 MHz. Note that the 733 uses the 14-pin DIP package. The filter (S2) is used to ensure accurate counting while measuring noisy low-frequency signals.

Overloading of the fet input stage can be prevented by a diode limiter and an attenuator. Since there are a variety of TTL integrated circuits available with Schmitt trigger inputs, one of these devices can provide the hysteresis and also the TTL signal conditioning. With the Schmitt trigger operating correctly, enough gain can be added ahead of it to provide sensitivity into the low-millivolt region.

The circuit that resulted from this approach appears in fig. 1. I've also included the vhf preamplifier and prescaler discussed by K4JIU.

The hysteresis and TTL signal conditioning are provided by a 74S132, which has a worst-case hysteresis of 0.8 volts. Therefore, I needed a preceding voltage gain of at least 100 to attain a sensitivity of a few millivolts. A 733 broadband amplifier seemed to be just

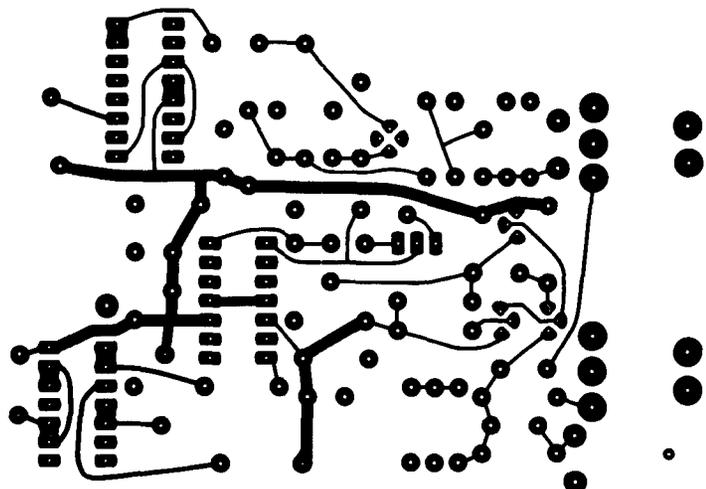
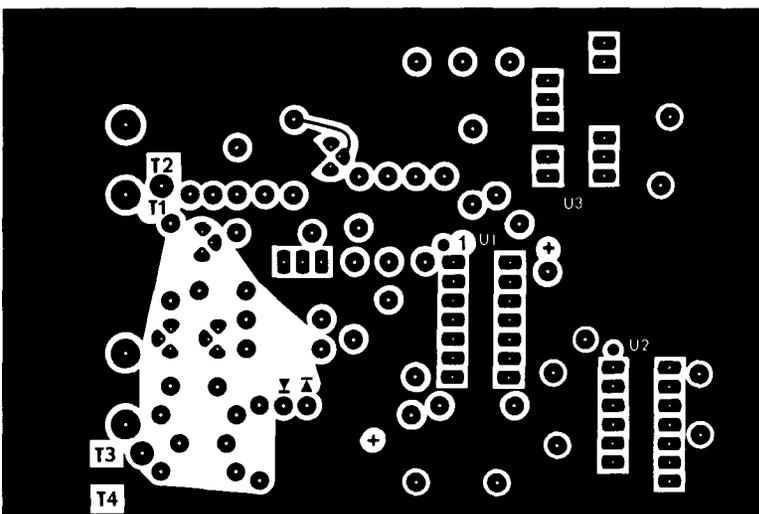


fig. 2. Circuit board layout for the preamp: bottom of board, right; component side, left.

the device, since it will provide a voltage gain of 400 to approximately 40 MHz.

During the breadboard testing, I found that the 733 would break into oscillation whenever I connected a X10 oscilloscope probe to its output. I was able to eliminate the problem by connecting a small resistor in series with the probe, thus reducing the capacitive probe loading on the 733 output. For this same reason, it seemed like a good precautionary measure to include some resistance between the 733 output and the 74S132 input. I chose R11 to be as large as possible and yet provide for proper sinking of the 74S132 input current by the 733 output under worst-case conditions.

The fet buffer amplifier, composed of Q1, Q2, and Q3, has the high-input resistance and low-input capacitance necessary for an oscilloscope-type input. In this stage, Q2 is a current source which offers several important benefits. First, it provides a high-source impedance for Q1 so that its voltage gain is nearly unity. Second, it serves as an active current sink to pull down the base of Q3 on negative-going

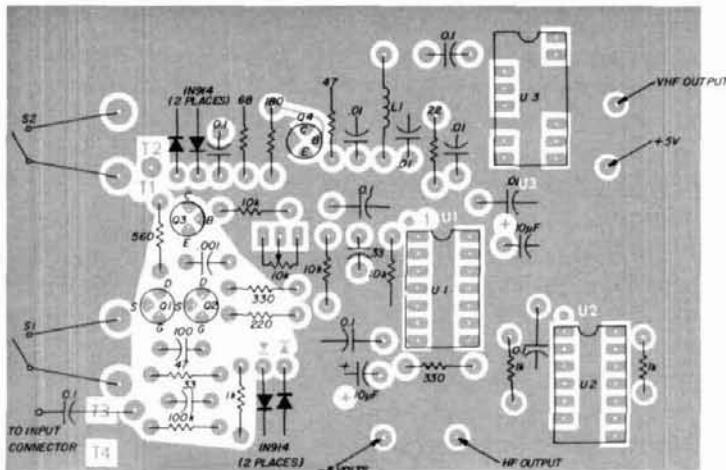


fig. 3. Parts placement diagram for the high-sensitivity preamplifier.

half cycles of the input signal. Lastly, it provides a measure of temperature compensation so that the maximum signal swing is available over a wide range of operating temperatures.

A significant reduction in the input capacitance of an fet preamplifier can be obtained by driving the input transistor's drain in phase with the input signal. This technique, implemented by C3 and R4, virtually eliminates the drain to gate capacitance of Q1, thus reducing its input capacitance by as much as 5 pF.

I spent most of my design time on the components

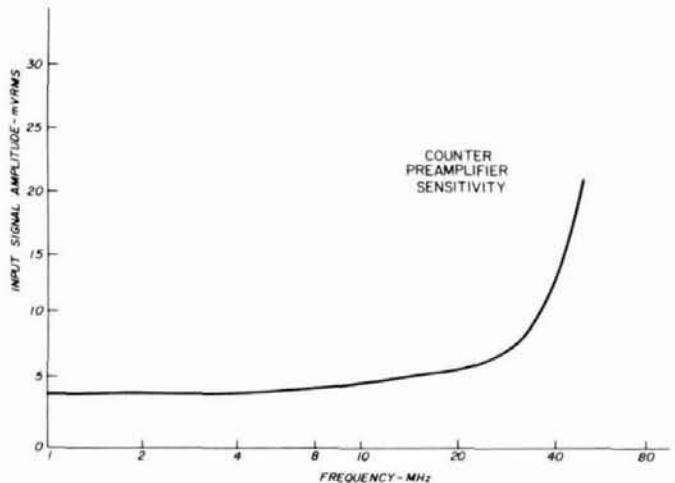


fig. 4. Input sensitivity curve for the counter preamplifier.

in the gate circuit of Q1. These components control input capacitance, input resistance, overload characteristics, and lowpass filtering. At low frequencies, and for small signal amplitudes, the input circuit consists of only R1. The gate bias current is supplied by CR1, CR2, and R2. As the low-frequency input signal increases in amplitude, CR1 and CR2 begin to conduct and form a 100-to-1 voltage divider between R1 and R2, thus limiting the Q1 gate voltage. Lowpass filtering is provided by R1 and C2, which have a 16-kHz corner frequency. With high-frequency input signals, C1 compensates for the input capacitance of the Q1 gate components and keeps the voltage gain of the stage roughly constant. The price paid for this is the unavoidable lowering of the input impedance of the preamplifier as frequency increases. The R1-R2 attenuator rapidly loses effectiveness as the input frequency increases above 1 MHz. Again, this is due to the shunting effect of C1. An input attenuator, R3 and S1, solves this problem so that it is possible to connect as much as 60 volts rms directly to the counter input at 5 MHz and still obtain correct counting of the input signal. Without this attenuator, the preamplifier would saturate at 3 volts rms input at frequencies above 10 MHz.

## construction

A printed circuit layout and component assembly appear in figs. 2 and 3. The two-sided printed circuit board contains the high-frequency preamplifier as well as the 500-MHz prescaler. Short conductor lengths and liberal use of bypass capacitors have kept the circuit stable and free of oscillations in the four preamplifiers which have been assembled.

The attenuator switch and filter switch are designed for printed circuit board mounting and may be diffi-

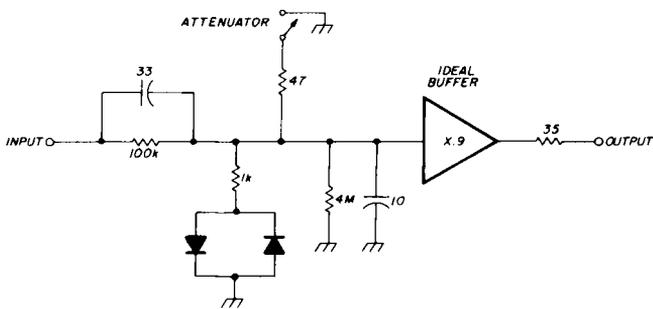


fig. 5. Equivalent circuit for the input of the preamplifier. At signal levels up to 50 mV rms, the amplifier has an equivalent input impedance of 4 megohms shunted by 10 pF.

cult to procure. However, there is no requirement that they be mounted this way. Actually, a decrease in input capacitance may be obtained by mounting them off the printed circuit board.

In order to reduce the input capacitance, C20 was mounted between T3 and the input BNC connector. A 1.5-megohm resistor may be connected between T3 and T4 to standardize the input to one megohm shunted by 10 pF.

The preamplifier will require approximately 70 mA from the +5 volt supply and 40 mA from the -5 volt supply.

### performance

The only adjustment needed to get the preamplifier operating properly is the setting of the sensitivity potentiometer, R8. The adjustment is easily accomplished by applying a 30 to 50 MHz signal to the preamplifier input and adjusting R8 for a steady pulse train out of the 74S132. The signal can then be reduced and R8 readjusted. This process should be repeated until the adjustment of R8 produces maximum sensitivity.

A plot of the input sensitivity of the preamplifier appears in fig. 4. The sensitivity remains constant from a few Hz to 5 MHz and then begins to increase to 21 mV rms at 50 MHz.

I measured the input impedance from these threshold levels up to 50 mV rms and found it to be equivalent to 4 megohms shunted by 10 pF. An equivalent circuit of this input is shown in fig. 5.

As the input amplitude increases above 50 mV rms, the diode attenuator begins to lower the input impedance so that at amplitudes greater than 300 mV rms the input impedance is determined by R1, C1, and R2. It is possible to design an input network such that the input impedance at higher frequencies is still very high, but it would suffer from the lack of protection afforded by this design. Fig. 6 is a plot of the

maximum input signal for proper counting (attenuator off) as a function of frequency. The maximum low-frequency input of 140 volts rms is limited by the 1/4-watt dissipation of R1. At high frequencies, the input buffer will overload when the Q1 gate voltage reaches 10 to 15 volts pk-to-pk. Counting errors will occur when this level is exceeded. The input attenuator, to a point, helps relieve the overloading. However, as 50 MHz is approached, the input impedance due to C1 is only slightly greater than 100 ohms. The maximum input at 50 MHz would therefore be approximately 9 volts rms.

### conclusions

This preamplifier, in conjunction with the K4JIU counter, performs admirably as an inexpensive laboratory frequency counter. The input impedance and sensitivity of the preamplifier worked out in practice to be as the design predicted and certainly adequate for most measurements. However, one thing did sur-

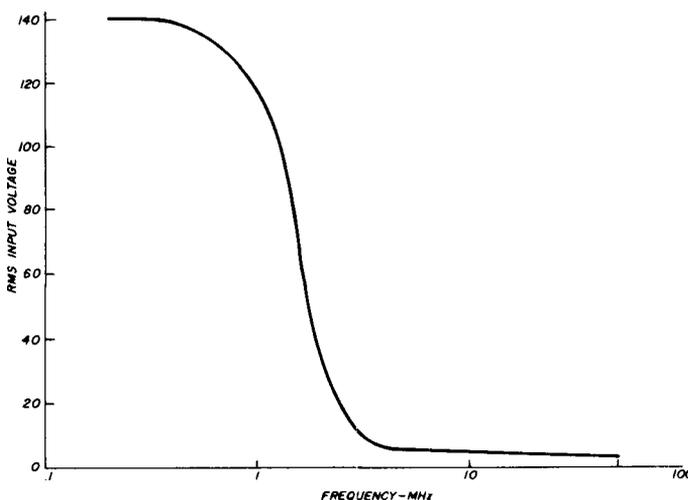


fig. 6. Maximum signal levels for an input impedance of 100k ohms and 33 pF.

prise me, the effect of input capacitance in lowering the input impedance at high frequencies. Although the preamplifier's input impedance is no worse than the typical input impedance of an oscilloscope, it still presents a very low impedance at 50 MHz.

### references

1. John H. Bordelon, K4JIU, "Simple Front Ends for a 500-MHz Frequency Counter," *ham radio*, February 1978, page 30.
2. Holton E. Harris, W1WP, "Simplifying the Digital Frequency Counter," *ham radio*, February 1978, page 22.

ham radio

# twin-diode mixer —

## a new microwave mixer

A new microwave mixer  
using two diodes  
and half-wavelength lines  
yields an approximately  
6 dB noise figure

**This article describes** a new microwave mixer, unique in that it has few parts and does not require boards or complicated metalwork. You can build it in a minimum of time, and with confidence of having a good mixer when you're done. The 1296-MHz model to be described has a 6.4 dB noise figure including a 1.2 dB i-f noise figure. Other features include the following:

1. A very low local-oscillator power requirement of  $-3$  dBm
2. The local oscillator frequency is half that normally used
3. No dc return is necessary

4. There is no tuning

5. There is high isolation between all ports

### mixer theory

A diagram of the ideal mixer is shown in **fig. 1**. The ideal filters pass currents only at the rf or i-f frequency, with the switch toggled at the normal LO frequency,  $f_{rf} - f_{if}$ . Thus, energy from an rf source is converted to the i-f and delivered to a load at the i-f port. There is no energy lost in the mixer, and the receiver's noise figure is that of the i-f.

In a real mixer, the switch takes the form of a diode which is turned on and off by the local oscillator. However, the diode is never a perfect open or short circuit, and as such will absorb some energy. Losses also occur in the circuitry surrounding the diode; the total loss depends in a complicated way upon the mixer circuit, the pump level, and, to a lesser extent, the diode itself. All high-performance mixers attempt to achieve the conditions of the ideal case shown in **fig. 1**.

Mixer performance can be characterized by the following equations:

$$T_{ssb} = (L_c - 1) T_0 \quad (1)$$

$$T_{dsb} = (L_c - 2) T_0 \quad (2)$$

$$L_c = \frac{i-f P_{in}}{rf P_{out}} \quad (3)$$

By Jim Dietrich, WA0RDX, Post Office Box 208, Mulvane, Kansas 67110

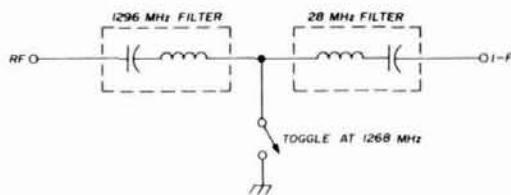


fig. 1. Diagram of the ideal mixer operating at 1296 MHz. The switch will toggle at a 1268-MHz rate, causing the 1296-MHz input to be converted to 28 MHz.

where

$T_{ssb}$  is the ssb mixer noise temperature

$T_0$  is the physical temperature of the mixer in degrees Kelvin.

$T_{dsb}$  is the double sideband mixer noise temperature.

Note that eq. 3 requires an input signal at the i-f frequency to directly measure conversion loss. The loss going the other direction is generally different. The loss of a dsb mixer is never less than 2, since i-f energy is equally converted to signal and image frequencies. However, as shown by eq. 2, the noise figure is not limited to 3 dB.

Eq. 2 is complicated by the problem of measuring the dsb mixer noise figure. The equivalent ssb noise performance in terms of the indicated noise figure is

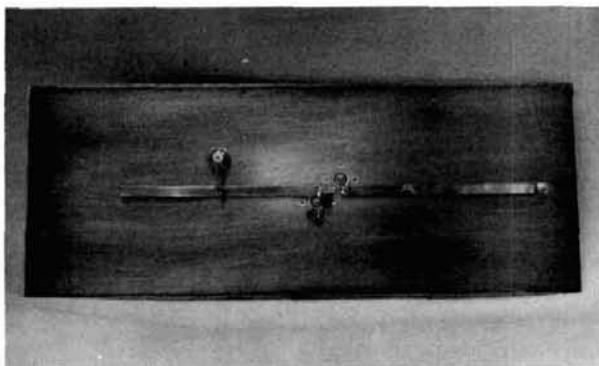
$$F_{ssb} = 2F_m - 1 \quad (4)$$

where

$F_m$  is the measured noise figure.

For example, if the meter indicates 4 dB for a dsb mixer, the ssb noise figure is actually 6 dB, not the 7 dB obtained by simply adding 3 dB to the indicated noise figure.\* This common mistake introduces substantial error for low noise figures. For each type mixer, ssb system noise temperature is given by the following:

#### Component mounting configuration at the rf and LO ports.



ssb mixer

$$T_{SYS} = (L_c - 1) T_0 + L_c T_{i-f} + T_{ant} \quad (5)$$

dsb mixer

$$T_{SYS} = (L_c - 2) T_0 + L_c T_{i-f} + 2T_{ant} \quad (6)$$

#### twin-diode mixer

An alternative to using a single diode is to use a pair of parallel-connected diodes, of opposite polarity, and pumped by a local oscillator at one-half the normal frequency. Each diode is turned on once during the LO cycle, 180 degrees apart, and both are off when the LO voltage is zero. Thus, a pair of diodes

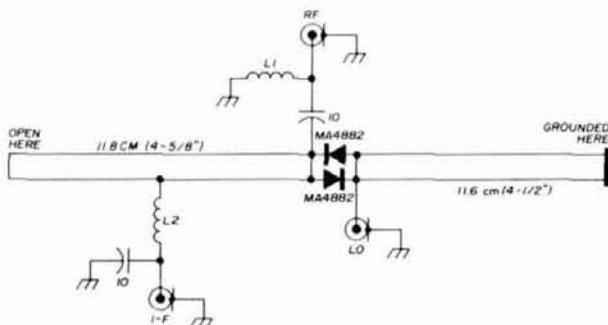


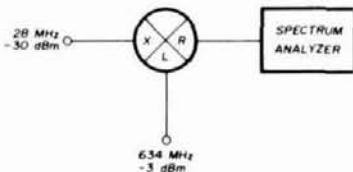
fig. 2. Schematic diagram of the twin-diode mixer. The half-wavelength lines are 5 mm (3/16 inch) wide and mounted 1.5 mm (1/16 inch) above the ground plane. Ensure that the line on the right is connected to the ground plane, while the one on the left remains open. Since the local-oscillator frequency is approximately one-half that of the input rf, the grounded half-wavelength line will look like an open circuit to the LO port and also like a low impedance to the rf port. L1 is 3 cm (1 inch) no. 28 AWG (0.3 mm) wire; L2 is 15 turns no. 32 AWG (0.2 mm) wire wound to a diameter of 1.5 mm (1/16 inch).

pumped at 634 MHz performs identically to a single diode pumped at 1268 MHz.

Fig. 2 shows a full-size mixer circuit for 1296 MHz which takes advantage of the frequency relation in the twin-diode scheme. On each side of the diode pair is a half-wavelength line at the rf frequency, and thus a quarter wavelength at the local oscillator frequency. At each frequency, an open circuit exists at the respective port, with a short on the opposite side of the diode pair. This ideally gives total isolation between the ports. The i-f and local oscillator ports may be dc or ac coupled, but the rf port must be capacitively coupled so that it presents an open circuit to the i-f. The bandwidth of the mixer is about 20 per

\*With  $F_m$  equal to 4 dB, converting to a ratio will yield 2.5 ( $\text{antilog}_{10} 4/10 = 2.5$ ). Using this number in eq. 4 produces a noise figure of 6 dB [ $10 \log_{10} (2 \cdot 2.5 - 1)$ ].

fig. 3. Test setup for the mixer conversion loss and isolation measurements. All ports are terminated in 50 ohms.



cent, so line lengths as well as component values are not critical.

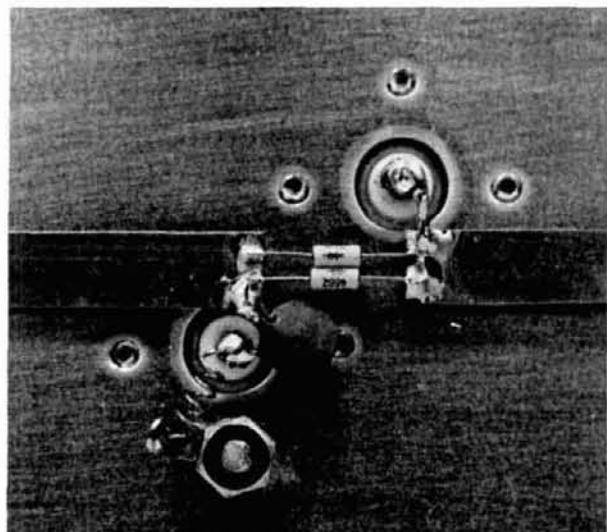
### mixer evaluation

The mixer was tested by measuring the noise figure and also by measuring the actual conversion loss. The results were in good agreement. The conversion loss test setup is shown in fig. 3. The input level was  $-30 \text{ dBm} \pm 0.1 \text{ dB}$  at 28 MHz. This level was used because more signal causes undesired higher-order products in the output, and less signal is difficult to accurately measure. The LO level is  $-3 \text{ dBm}$ , which was found to be optimum both in the conversion loss and noise figure measurements. The spectrum analyzer was calibrated for absolute level at 1296 MHz so that the overall accuracy of the conversion loss measurement is  $\pm 0.5 \text{ dB}$ .

Fig. 4 shows the output as observed on the analyzer. All LO harmonics are 37 dB down ( $-40 \text{ dBm}$ ) from the input at 634 MHz. The desired signal and its primary image are both 6 dB ( $-36 \text{ dBm}$ ) below the 28-MHz input level. Other responses are down enough that they can be neglected.

As can be seen, the device is indeed a double-sideband mixer, so that ssb receiver noise temperature is found from the following:

$$\begin{aligned} T_e &= (L_c - 2) T_0 + L_c T_{i,f} \\ &= 2(297\text{K}) + 4(92\text{K}) \\ &= 962\text{K} \end{aligned}$$



View of the microwave mixer showing overall layout. Built on 3 mm (1/8 inch) aluminum this mixer used brass shim stock for the lines. BNC connectors were used at all ports.

where

$$L_c = \text{the conversion loss } 6 \text{ dB} = 4$$

$$T_0 = \text{the mixer operating temperature } 297\text{K}$$

$$T_{i,f} = \text{a } 1.2 \text{ dB i-f noise figure } 92\text{K}$$

The single sideband noise figure is

$$F_{ssb} = 1 + T_e/290 = 6.4 \text{ dB}$$

Addition of a good input filter should lower the conversion loss to 3 to 4 dB and thus give an overall noise figure of 5 dB or less. However, care must be taken to keep filter losses low or else this improve-

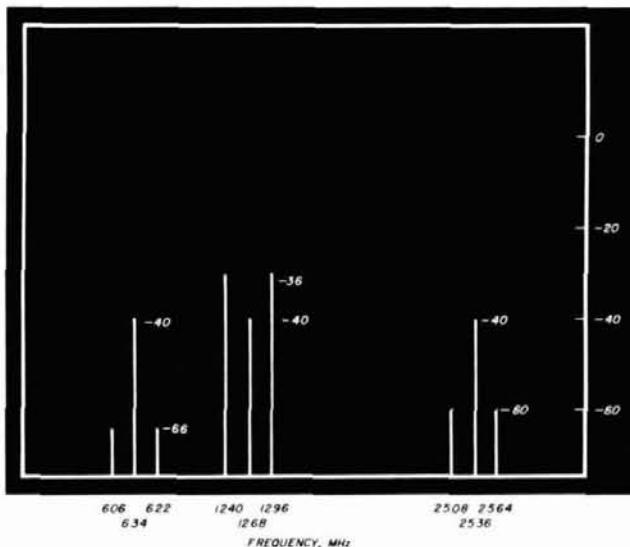


fig. 4. Mixer output as observed on the spectrum analyzer. The local oscillator was 634 MHz at  $-3 \text{ dBm}$ . The 28-MHz i-f input was at  $-30 \text{ dBm}$ . The output levels are read directly in dBm.

ment will not be obtained. In view of the fact that the mixer, as described, is probably better than most in use today, I haven't taken time to build a filter.

### summary

In this article I have presented a new mixer configuration for use at 1296 MHz. The circuit can be used at higher microwave frequencies by simply scaling the half-wavelength lines. The device exceeds the performance of most available doubly balanced mixers by producing a 6.4 dB noise figure, nearly 40 dB isolation between all ports, and an LO requirement of only  $-3 \text{ dBm}$ . In addition, the LO frequency is one-half that normally required, a most attractive feature.

A brief review of mixer theory, including noise performance, was presented to give a better understanding of twin-diode mixer operation. The noise relationships can be used to properly characterize receiver system performance using the twin-diode mixer or any other ssb or dsb mixer.

ham radio

# WHERE RELIABILITY & ACCURACY COUNT

## INTERNATIONAL CRYSTALS

70 KHz to 160 MHz

### HOLDER TYPES



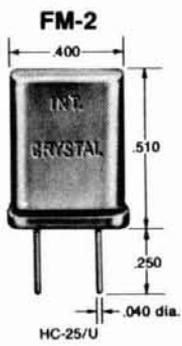
**International  
Crystal Manufacturing Co., Inc.**  
**guarantees**  
**every crystal against defective**  
**materials and workmanship for**  
**an unlimited time, when used in**  
**equipment for which they were**  
**specifically made.**

### CRYSTAL TYPES

(GP) for "General Purpose" applications  
 (CS) for "Commercial" equipment  
 (HA) for "High Accuracy" close temperature tolerance requirements

International Crystals are available from 70 KHz to 160 MHz in a wide variety of holders.

WRITE FOR INFORMATION



**INTERNATIONAL CRYSTAL MFG. CO., INC.**  
 10 North Lee, Oklahoma City, Oklahoma 73102  
 405/236-3741

# YOU ASKED FOR IT YOU GOT IT DSI QUIK-KIT®

## 550 MHZ COUNTER KIT *Performance You Can Count On*



### OPERATES ON

- Batt 6-C Size
- DC 8.2 To 14.5 VDC
- AC Batt. Eliminator

**\$99.95**  
MODEL 3550 KIT

### DSI OFFERS THE BEST OF TWO WORLDS . . .

An unprecedented DSI VALUE . . . in a high quality, LSI Design, 550 MHZ frequency counter kit. And, because it's a DSI innovation, you know it obsoletes any competitive makes, both in price & performance. The basic 550 MHZ counter & time base are factory assembled, tested and burned-in. The problems of bad LEDs, IC's, capacitors, are a thing of the past with DSI QUIK-KIT®. But you can take pride in assembling the power supply, PC mounted selector switch, input connectors, and the final mechanical assembly of your 550 MHZ counter, into its' handsome cabinet. **GO WITH THE LEADER . . . BUY A DSI FREQUENCY COUNTER KIT. SAVE TIME & MONEY AND BE ASSURED IT WILL WORK THE FIRST TIME.**

### SPECIFICATIONS

**Time Base** TCXO 1PPM 65° to 85°F  
**Frequency Range** 50HZ to 550MHZ  
**Resolution** 1HZ to 55MHZ, 10HZ to 550MHZ  
**Gate Time** 1 second - 1/10 second  
**Sensitivity** 25MV 150 & 250MHZ 75MV 550MHZ  
**Display** Eight 1/2-inch LEDs  
**Input** Two SO239 Connectors  
**Power** 6C-Size Batt., 15HR, or 8.2VDC to 14.5VDC  
**Current** 150 Ma standby 300 Ma operational

### 3550 KIT INCLUDES

- Pre-assembled, tested counter board
- Case, power supply, connectors, hardware
- Built-in prescaler & preamp
- Gate Light - Automatic Zero Blanking
- Automatic Decimal Point
- One to two hours assembly time
- One Year Warranty on all parts
- All new parts - not factory seconds or surplus

3550 Kit . . . . .	\$99.95
T-101 Telescopic Antenna . . . . .	3.95
AC-9 Battery Eliminator . . . . .	7.95
Cigarette Lighter DC Adapter . . . . .	2.95

**TERMS:** Orders to U.S. and Canada, add 5% to maximum of \$10.00 per order for shipping, handling and insurance. To all other countries, add 15% of total order. California Residents add 6% State Sales Tax.

SEE YOUR LOCAL DEALER

OR

CALL TOLL FREE (800) 854-2049

California Residents, Call Collect (714) 565-8402

**DSI INSTRUMENTS, INC.**

7914 Ronson Road No. G, San Diego, CA 92111

VISA • MC  
AMERICAN EXPRESS  
CK • MONEY ORDER  
COD

# two-meter preamplifier for handtalkies

A simple, two-meter,  
one-transistor preamp  
is used to overcome  
the lack of  
receiver sensitivity

Does your 2-meter HT suffer from the lack of receiver sensitivity? A simple single transistor preamp can do wonders, especially if you use an external power amplifier while operating near the repeater fringes. One problem that frequently arises is that they can hear you, but you can't hear them!

I have a Regency HRT-2 hand-held, which I also use mobile with a Heath HA-201 10-watt amplifier located in the trunk. After a few months of operation, I became annoyed at the received signal drop-out and static near the fringe of the repeater coverage. My friends all told me my transmitted signal was excellent — full quieting into the repeaters; I tried a 1/4-wavelength whip in the center of my car roof, and finally a 5/8-wavelength whip, but to no avail. The noise and breakup persisted.

The HRT-2 has a receiver sensitivity of  $0.7 \mu\text{V}$  for 20 dB of quieting, quite adequate in the city and compatible with the 2-watt output of the transmitter. However, as a mobile unit with 10 watts of output

capability, the  $0.7 \mu\text{V}$  sensitivity leaves much to be desired. A preamplifier seemed to be the solution.

## simple preamplifier

There are a variety of circuits available for two meter-preamplifiers, but I wanted to keep it simple, low cost, and fairly compact, so it would fit inside the case if possible. Also, I felt it would be desirable to increase the receiver sensitivity from  $0.7 \mu\text{V}$  to about

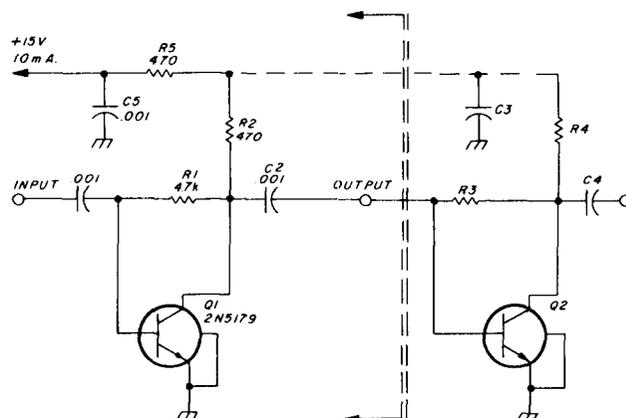


fig. 1. Schematic diagram of the wideband rf amplifier. Only the portion to the left of the dotted line is used. All resistors are 1/4 watt, and all capacitors are disc ceramics.

$0.1$  or  $0.2 \mu\text{V}$ , typical of most high-quality mobile radios; this meant a gain of about 17 dB. Another requirement was that it be broadband, so that tuning for each repeater would not be necessary. The last requirement was that it have the capability of being switched into the circuit during receive and switched out during transmit without the need for relays.

By Herbert L. Bresnick, WB2IFV, 16 Creekside Drive, Honeoye Falls, New York 14472

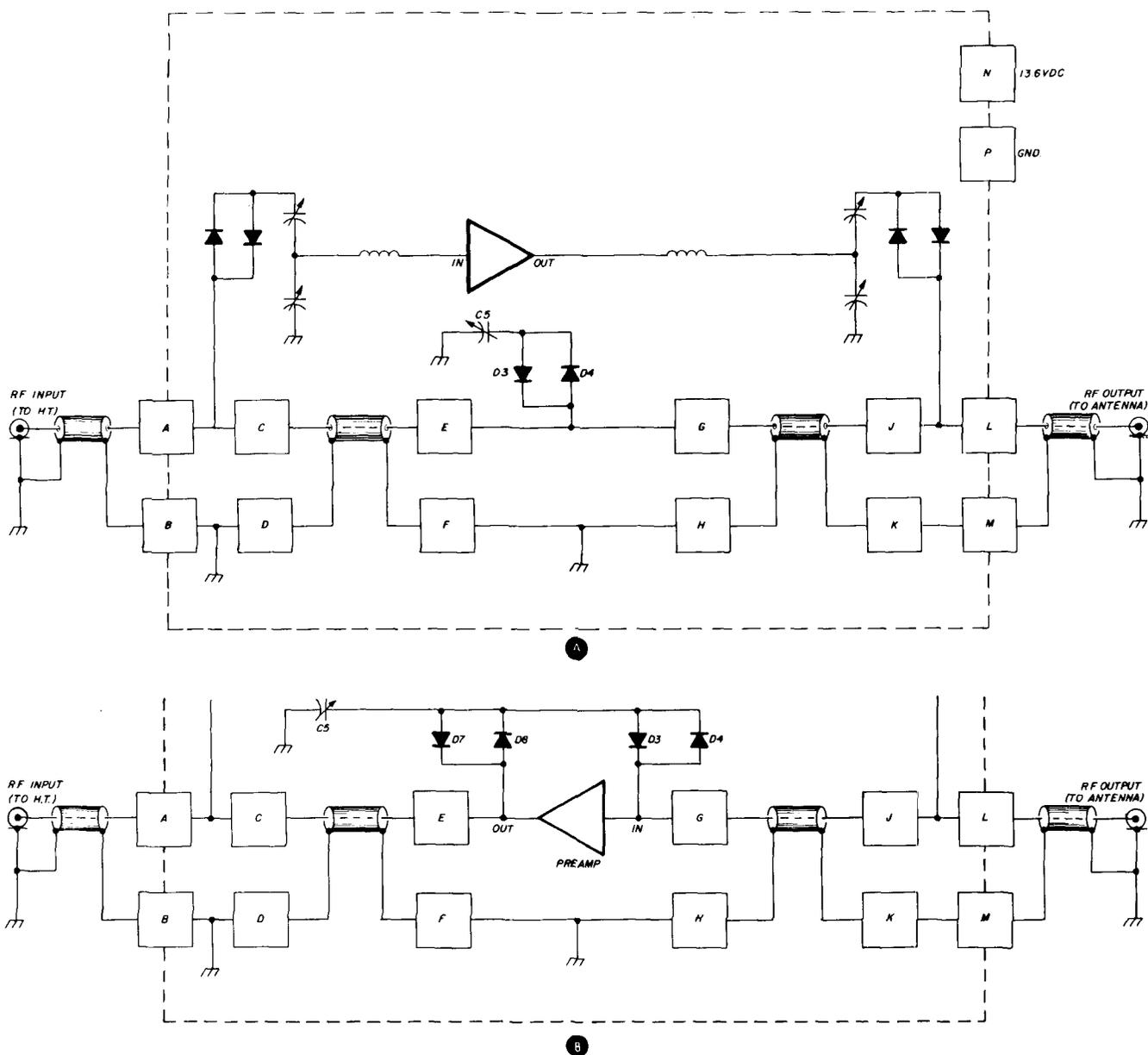


fig. 2. Schematic diagram of the Heath 2-meter amplifier (A) and the changes made to incorporate the receiving preamplifier (B). Power for the preamp can be obtained from the 13.6 volt line. D7 and D8 are also added to the existing circuitry.

A search through the literature revealed that all of these requirements would be tough to meet in one circuit. However, a simple and inexpensive wideband rf amplifier was found<sup>1</sup> which met most of the original objectives (fig. 1). Two transistors were used in the original circuit, but in my case only one was used with a gain of 14 dB. Although tuned circuits are recommended for improved selectivity, the amplifier was built up as a broadband unit to see how it would work. When externally connected to the HT the results were excellent. Clean reception was now possible with all the local repeaters, including two that

previously were extremely noisy, and there was no evidence of overloading from undesired signals.

### construction

The next problem was how to wire it into the HT. After a quick look inside the case, it appeared to be a major task to dismantle the entire set. And the thought of upsetting the rf circuits or breaking other connections was disgruntling.

A search for solid-state switching circuits did not reveal any that would be compact enough to fit inside the case. Suddenly, it occurred to me that the

answer was inside the Heath power amplifier. It already contained a solid-state TR switching network, a quite clever one at that. I decided to place the preamp *within* the power amplifier, since all the required connections were right there.

The Heath 10-watt power amplifier is a single, rf-switched transistor. The amplifier is automatically coupled to the circuit as soon as one watt of signal appears at the input. A pair of switching diodes then conduct, routing the signal to the transistor. When the HT is switched to *receive*, the diodes no longer conduct, and the received signal is passed through two 1/4-wave transformers to the receiver. A pair of switching diodes at the junction of the two transformers provide a short circuit to ground during transmission, preventing any rf feedback.

To connect the preamplifier, it was merely necessary to break the center connection between the two 1/4-wave transmission lines, insert the preamp, and add another pair of switching diodes to the input of the preamp, leaving the existing pair at the output. The revised circuit is shown in **fig. 2**. The additional diodes were obtained from Heath, and are 1N4149 or equivalent. The 12-volt supply for the preamplifier was obtained from a convenient tie point in the HA-201. The preamp was mounted by its own leads, as close as possible to the coiled transmission cables, with connecting leads kept as short as possible. Mounting did not seem to be critical. However, I would recommend using plastic tape or other insulating material between the preamp and the case to prevent accidental shorting.

## results

The results have been gratifying. Received signals are now clear and free from static and breakup at distances over 40 kilometers (25 miles) from the repeater sites. A slight readjustment of the HA-201 power amplifier was necessary to compensate for the capacitance effects of the added circuit, but there is no evidence of power loss with a wattmeter connected before and after the modification.

This solution may not work everywhere, particularly if there are strong nearby signals. If this should be a problem on some repeater frequencies, it may be possible to add a switch to short out the preamp when it is not needed. A little experimentation before modification of the HA-201 will probably determine the best arrangement for your own location.

## references

1. Randall Rhea, WB4KSS, "General Purpose Wideband RF Amplifier," *ham radio*, April, 1975, page 58.

ham radio

# new FROM ALLIANCE!



## HD-73 HEAVY-DUTY ROTATOR

### with exclusive Dual-Speed Control!

For antennas up to 10.7 sq. ft. of wind load area. Mast support bracket design permits easy centering and offers a positive drive no-slip option. Automatic brake action cushions stops to reduce inertia stresses. Unique control unit features DUAL-SPEED rotation with one five-position switch. SPECIFICATIONS: Max. wind load bending moment—10,000 in.-lbs. (side-thrust overturning); Starting torque — 400 in.-lbs.; Hardened steel drive gears; Bearings — 100-3/8" diameter (hardened); Meter — D'Arsonval, taut band (back-lighted). There's much, much more — so get the whole story!

### Mail this coupon for complete details!

**YES!**  Send me complete details on the new HD-73!  
 Give me the name of my nearest dealer!

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_

STATE \_\_\_\_\_

ZIP \_\_\_\_\_



The **ALLIANCE** Manufacturing Co., Inc., Alliance, Ohio 44601  
A NORTH AMERICAN PHILIPS COMPANY

Maker of the famous Antenna Rotator ... Alliance Tenna-Rotor® ... "TV's Better Color Getter!"

© 1978 The Alliance Mfg. Co., Inc.

# Incredible...



Incredible, that's the word people are using to describe the CT-50 frequency counter. Why? Simple, the CT-50 is an achievement in design; exceptionally low in cost, compact, easy to use and unmatched in performance and reliability.

Features of the CT-50 include; easy pushbutton operation, fully automatic decimal point positioning, quality shielded metal case, and dependable LSI circuitry. Full eight digit readout allows resolution to 1 Hz at 65 mHz, 10 Hz at 650 mHz, and the decimal point is always correct. Input protection to 50 volts insures against accidental burnout or overload. And, the best feature of all is the easy assembly. Clear, step by step instructions guide you to a finished unit you can rely on.

Use the order blank below or call us direct and order yours today!

<b>CT-50, 60 mHz Counter Kit</b>	<b>\$89.95</b>
<b>CT-50 WT, 60 mHz counter, wired, tested</b>	<b>159.95</b>
<b>CT-600, 600 mHz prescaler option</b>	
<b>for CT-50, add</b>	<b>29.95</b>

## ACCESSORIES

DC probe, direct input, general purpose type	\$12.95
High impedance probe, does not load circuit	15.95
Low pass probe, used when measuring audio	15.95
High pass probe, reduces low freq pickup	15.95
VHF flexible rubber antenna, BNC connector	12.95
Color burst adapter, for calibration, high accuracy typically 0.001 ppm accuracy, stability	14.95

# ramsey electronics

P.O. Box 4072 Rochester NY 14610

(716) 271-6487

## SPECIFICATIONS

Frequency range: 5 Hz to 65 mHz, 600 mHz with CT-600  
 Resolution: 10 Hz @ 0.1 sec gate, 1 Hz @ 1 sec gate  
 Readout: 8 digit, 0.4" high LED, direct readout in mHz  
 Accuracy: adjustable to 0.5 ppm  
 Stability: 2.0 ppm over 10° to 40° C, temperature compensated  
 Input: BNC, 1 megohm/20 pf direct, 50 ohm with CT-600  
 Overload: 50VAC maximum, all modes  
 Sensitivity: less than 25 mv to 65 mHz, 50-150 mv to 600 mHz  
 Power: 110 VAC 5 Watts or 12 VDC @ 400 ma  
 Size: 6" x 4" x 2", high quality aluminum case, 2 lbs  
 ICS: 13 units, all socketed  
 CT-600: 600 mHz prescaler option, fits inside CT-50  
 CB-1: Color burst adapter, use with color TV for extreme accuracy and stability, typically 0.001 ppm

**Ramsey Electronics**  
 Box 4072 716-271-6487  
 Rochester, NY 14610



Quantity	Description	Price
	Shipping, handling, insurance	\$5.00
	N.Y. state residents, add tax	
	Total	
Name _____		
Address _____		
City _____ State _____ Zip _____		

# NEW

## Frequency Counter

### \$89.95 kit



UTILIZES NEW MOS-LSI CIRCUITRY

You've requested it, and now it's here! The CT-50 frequency counter kit has more features than counters selling for twice the price. Measuring frequency is now as easy as pushing a button, the CT-50 will automatically place the decimal point in all modes, giving you quick, reliable readings. Want to use the CT-50 mobile? No problem, it runs equally as well on 12 V dc as it does on 110 V ac. Want super accuracy? The CT-50 uses the popular TV color burst freq. of 3.579545 MHz for time base. Tap off a color TV with our adapter and get ultra accuracy — .001 ppm! The CT-50 offers professional quality at the unheard of price of \$89.95. Order yours today!

- CT-50, 60 MHz counter kit ..... \$89.95
- CT-50 WT, 60 MHz counter, wired and tested ..... 159.95
- CT-600, 600 MHz prescaler option for CT-50, add. .... 29.95

#### SPECIFICATIONS

- Sensitivity: less than 25 mv.
- Frequency range: 5 Hz to 60 MHz, typically 65 MHz
- Gatetime: 1 second, 1/10 second, with automatic decimal point positioning on both direct and prescale
- Display: 8 digit red LED .4" height
- Accuracy: 2 ppm, .001 ppm with TV time base!
- Input: BNC, 1 megohm direct, 50 Ohm with prescale option
- Power: 110 V ac 5 Watts or 12 V dc @ 0.4 Amp
- Size: Approx. 6" x 4" x 2", high quality aluminum case

Color burst adapter for .001 ppm accuracy

CB-1 kit ..... \$14.95



### CLOCK KIT 6 digit 12/24 hour

Want a clock that looks good enough for your living room? Forget the competitor's kludges and try one of ours! Features: jumbo .4" digits, Polaroid lens filter, extruded aluminum case available in 5 colors, quality PC boards and super instructions. All parts are included, no extras to buy. Fully guaranteed. One to two hour assembly time. Colors: silver, gold, black, bronze, blue (specify).

- Clock kit, DC-5 ..... \$22.95
- Alarm clock, DC-8, 12 hr only ..... 24.95
- Mobile clock, DC-7 ..... 25.95
- Clock kit with 10 min ID timer, DC-10 ..... 25.95

Assembled and tested clocks available, add \$10.00

### VIDEO TERMINAL KIT \$149.95

A compact 5 x 10 inch PC card that requires only an ASCII keyboard and a TV set to become a complete interactive terminal for connection to your microprocessor synchronous interface. Its many features are: single 5 volt supply, crystal controlled sync and baud rate, up to 9600 baud; 2 rows of 32 characters by 16 lines; read to and from memory, computer and keyboard operated cursor and page control, parity error display and control, power on initialization, full 68 character ASCII display, block type see thru cursor, keyboard/computer control backspace, forward space, line feeds, rollover feeds, home, tabular cursor. Also clears page, clears to end of line, selects page 1 or 2, reads from or to memory. The card requires 5 volts at approx. 900 ma and outputs standard 75 ohm composite video.

- TH210 Kit ..... \$149.95
- TH210, Assembled and Tested ..... 239.95
- VD 1, Video to RF Modulator Kit ..... 6.95

### CAR CLOCK KIT \$27.95



- 12/24 Hour 12 Volt AC or DC ..... \$27.95
- High Accuracy (11 minute/month) ..... \$27.95
- 6 jumbo .4" LED readouts ..... \$27.95
- Easy, no polarity hook up ..... \$27.95
- Display flashes with ignition ..... \$27.95
- Color mounting brackets included ..... \$27.95
- Super instructions ..... \$27.95
- Complete Kit, DC 11 ..... \$27.95

#### AUTO-DIMMER \$2.50

Automatically adjusts display brightness according to ambient light level for DC 11 Car Clock

### CHEAP CLOCK KIT \$8.95

- DC-4 Features: ..... \$8.95
- 6 digit .4" LED ..... \$8.95
- 12 or 24 format ..... \$8.95
- Does not include board or transformer ..... \$8.95
- PC Board Transformer ..... \$1.49

### 600 MHz PRESCALER



Extend the range of your counter to 600 MHz. Works with all counters. Less than 150 mv sensitivity. Specify  $\pm 10$  or  $\pm 100$  Wired, tested, PS-1B ..... \$59.95  
Kit, PS-1B ..... \$44.95

### 30 watt 2 meter Power Amp

The famous RE class C power amp now available mail order! Four Watts in for 30 Watts out, 2 in for 15 out, 1 in for 8 out, incredible value, complete with all parts, instructions and details on T R relay. Case not included.  
Complete Kit, PA 1 ..... \$22.95

### CALENDAR ALARM CLOCK

Has every feature one could ever ask for. Kit includes everything except case, build it into wall, station or even car!

- FEATURES:
- 6 Digits, 5" High LED ..... \$34.95
  - Calendar shows month, day, date button ..... \$34.95
  - True 24 Hour Alarm ..... \$34.95
  - Battery back up with built in chip time base ..... \$34.95
  - 12/24 Hour Format ..... \$34.95
  - 2001 chip does all! ..... \$34.95
- Complete Kit, less case, DC-9 ..... \$34.95

LINEAR		REGULATOR		TRANSISTORS			
5314 Clock	\$2.95	555	\$.50	78MG	\$1.49		
74500	.35	556	.75	309k	.89		
74S112	.75	566	1.49	309H	.89		
7447	.79	567	1.49	340K-12	.99		
7473	.35	1458	.50	7805	.89		
7475	.50	LED DRIVER	.7812	.89	FET MPF 102 type	3/\$2.00	
7490A	.55	75491	.50	7815	.89	UJT 2N2646 type	3/\$2.00
74143	3.50	75492	.50	7818	.89	2N3055 NPN Power	.75

DIODES: 1KV.25A ..... 5/\$1.00    100V.1A ..... 10/\$1.00    1N914A type ..... 50/\$2.00

#### LED DISPLAYS

- FND 359 ..... .75
- FND 510 ..... 1.25
- DL 707 ..... 1.25
- HP 7730 ..... 1.25
- Red Polaroid Filter ..... 4.25" X 1.125" ..... .59

#### 741 OP-AMP SPECIAL

Factory prime mini dip with both Xerox and 741 part numbers  
10 for \$2.00

#### SOCKETS

- 14 PIN 5/\$1.00
- 16 PIN 5/\$1.00
- 24 PIN 2/\$1.00
- 40 PIN 3/\$2.00

#### FERRITE BEADS

- with info and specs 15/\$1.00
- 6 hole Balun Beads 5/\$1.00

# ramsey electronics

P.O. Box 4072 Rochester NY 14610

(716) 271-6487

TELEPHONE ORDERS  
WELCOME



Minimum Order \$6.00

Satisfaction guaranteed or money returned. Add 5% for shipping and handling. COD add \$1. Orders under \$10 add \$1.75. New York residents add 7% sales tax. Minimum order \$6.

## MINI-KITS

### STONE DECODER KIT

A complete tone decoder on a single PC Board. Features: 400-5000 Hz adjustable frequency range, voltage regulation, 567 IC. Useful for touch-tone decoding, tone burst detection, FSK demod, signaling, and many other uses. Use 7 for 12 button touch-tone decoding. Runs on 5 to 12 volts.  
Complete Kit, TD-1 ..... \$4.95



### SUPER SLEUTH AMPLIFIER

A super-sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as a general purpose test amplifier. Full 2 watts of output, runs on 6 to 12 volts, uses any type of mike. Requires 8-45 ohm speaker.  
Complete Kit, BN-9 ..... \$4.95

### FM WIRELESS MIKE KIT

Transmit up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9 V. Type FM-2 has added super sensitive mike preamp.  
FM-1 ..... \$2.95    FM-2 ..... \$4.95

### COLOR ORGAN/MUSIC LIGHTS

See music come alive! 3 different lights flicker with music or voice. One light for lows, one for the mid-range and one for the highs. Each channel individually adjustable, and drives up to 300 watts. Great for parties, band music, nite clubs and more.  
Complete Kit, ML-1 ..... \$7.95

### LED BLINKY KIT

A great attention getter which alternately flashes 2 Jumbo LEDs. Use for name badges, buttons, or warning type panel lights. Runs on 3 to 9 volts.  
Complete Kit ..... \$2.95

### POWER SUPPLY KIT

Complete triple regulated power supply provides variable 715 volts at 200 mA and 5 volts at 1 Amp. 50 mV load regulation good filtering and small size. Kit less transformers. Requires 6.5 V at 1 Amp and 18 to 30 VCT  
Complete Kit, PS-3LT ..... \$6.95

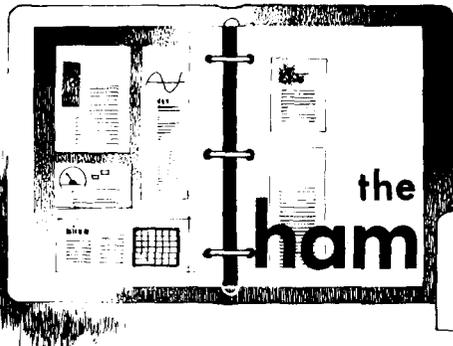


### SIREN KIT

Produces upward and downward wail characteristic of police siren. 5 watts audio output, runs on 3-9 volts, uses 8-45 ohm speaker.  
Complete Kit, SM-3 ..... \$2.95

### DECADE COUNTER PARTS

Includes: 7490A, 7475, 7447, LED readout, current limit resistors, and instructions on an easy to build low cost frequency counter.  
Kit of parts, DCU-1 ..... \$3.50



# the ham notebook

## general coverage using the Collins 75S receiver

A recent article in *QST*<sup>1</sup> detailed a relatively simple and inexpensive method for extending the frequency coverage of the 75S-1. However, this particular method did not allow for proper operation of the receiver, especially with regard to transceive operation, since the correct tuned circuits for the preselector, rf, amplifier, and crystal oscillator circuitry are not necessarily selected. The method I've employed for some

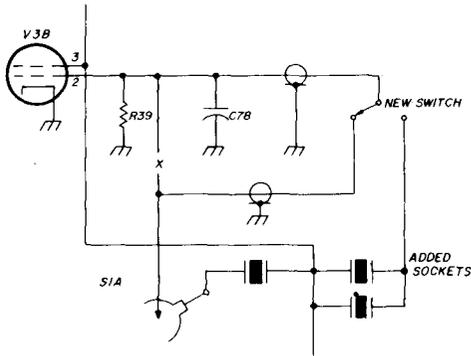


fig. 1. Schematic diagram of the change to the 75S-series receivers to permit general coverage while still maintaining transceiver capabilities. The two additional sockets are mounted on a small metal bracket above the present crystal bank.

months does allow for split or transceive operation, is somewhat more flexible, and requires only a slight modification to the receiver.

An aluminum bracket is drilled to accept two crystal sockets and a miniature spdt switch. One socket accepts HC-17/U, and the other, HC-6/U crystals. The bracket is secured to the left side rail over the

existing crystal sockets. The dimensions of the bracket allow its right side to rest on the tops of the crystals in sockets 1, 2, and 3E, providing more rigidity.

The switch is mounted with the handle pointing left/right for instant recognition of NORMAL or GENERAL COVERAGE. Two solder lugs are attached under the socket nearest the switch for coax braid connections. The coax lead that normally goes from V3B, pin 2, to the arm of S1A, was broken at the V3 side and passed through the hole near the front panel to the new switch. A new piece of coax is run from the switch to V3B. The rest of the wiring is done with hookup wire. Attachment to the common point of the sockets may be made at crystal socket 3E.

With the switch in the NORMAL position, the 75S-1 operates with the standard compliment of crystals. In the GENERAL COVERAGE position, a properly chosen crystal may be inserted and with the band switch selecting the proper frequency range, operation outside the amateur bands (or extended 10-meter coverage, for instance) is accomplished. The band-switch position is especially important when operating the receiver in transceive with the 32S series transmitters. A similar modification could be made to the transmitter, although this has not as yet been attempted.

Paul Pagel, N1FB

## reference

1. Vernon L. Gibbs, W4JTL, "An extended Frequency Range for the Collins 75S-1," *QST*, October, 1977.

## new product detector for the R-4C

As mentioned in a previous article,<sup>1</sup> the product detector in the Drake R-4B and R-4C leaves room for improvement. The present design allows the audio to leak back into the last i-f stage, from where it is detected, causing the AGC to vary at an audio rate. To correct this error we developed a reasonably simple product detector which eliminated the problems. Unfortunately, as stated in the article, the main disadvantage

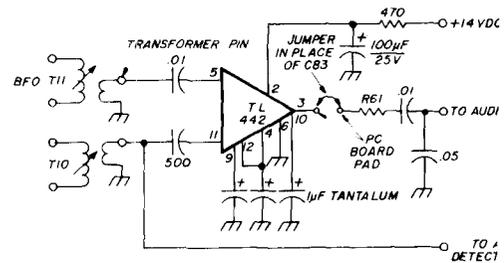


fig. 2. Schematic diagram of the TL442 product detector. All components are mounted on a 4.5 x 4.5 cm (1-3/4 x 1-3/4 inches) piece of 100-mil Vector board. The resistor and capacitor in the 14-volt line provide some additional filtering and also drop the voltage down to approximately 11.8 Vdc.

of the MC1496 was the high number of external components.

In recent correspondence with Howard Sartori, W5DA, he suggested another device which has also proved suitable as a product detector, the TL442 from Texas Instruments. As seen in fig. 1, the

\*A parts package for this product detector is available from G. R. Whitehouse, Newbury Drive, Amherst, New Hampshire 03031.

circuit is extremely simple, yet provides essentially the same performance as the MC1496.\*

To begin installation, it is first necessary to remove Drake parts CR2, CR3, C83, C84, and R60. Next, the wires connecting the output of T11 and the printed circuit board are removed. The 0.01  $\mu$ F coupling capacitor to be installed should connect between the transformer pins and the IC socket. There shouldn't be any connections on the circuit board for either the BFO of i-f inputs. Completing the installation only requires that the IC, socket, and associated components be mounted on a small piece of 100-mil Vector board and mounted in the same location as the MC1496 version. All other connections can be made according to fig. 1.

Audio output is slightly higher than a stock R-4C. The combination of R61 and the original 0.05  $\mu$ F bypass capacitor provide the proper high-frequency rolloff. In this configuration, and also in the original, the product detector will accept a 20 dB increase in signal level before it overloads.

As an addendum, several people have reported an audio oscillation problem after incorporating the 0.0015  $\mu$ F capacitor referred to in the original article. We've found that this can be cured by inserting a 4700-ohm resistor in series with the added capacitor and also connecting a 0.01  $\mu$ F capacitor across the headphone jack.

### reference

1. J. Robert Sherwood, WB0JGP and George B. Heidelman, K8RRH, "Present-Day Receivers — Some Problems and Cures," *ham radio*, December, 1977, page 10.

**Rob Sherwood, WB0JGP**  
**George Heidelman, K8RRH**  
**Sherwood Engineering**

## preprogramming the Kenwood TR7500

A Kenwood TR7500 was recently obtained for mobile usage, and has proven excellent for that purpose. It

**Table 1. Diode programming information for the TR7500.**

frequency	P1	P2	P3	P4	P5	P6
146.16	0	0	0	0	0	0
146.19	1	0	0	0	0	0
146.22	0	1	0	0	0	0
146.25	1	1	0	0	0	0
146.28	0	0	1	0	0	0
146.31	1	0	1	0	0	0
146.34	0	1	1	0	0	0
146.37	1	1	1	0	0	0
146.40	0	0	0	1	0	0
146.43	1	0	0	1	0	0
146.46	0	1	0	1	0	0
146.49	1	1	0	1	0	0
146.52	0	0	1	1	0	0
146.55	1	0	1	1	0	0
146.58	0	1	1	1	0	0
146.61	1	1	1	1	0	0
146.64	0	0	0	0	1	0
146.67	1	0	0	0	1	0
146.70	0	1	0	0	1	0
146.73	1	1	0	0	1	0
146.76	0	0	1	0	1	0
146.79	1	0	1	0	1	0
146.82	0	1	1	0	1	0
146.85	1	1	1	0	1	0
146.88	0	0	0	1	1	0
146.91	1	0	0	1	1	0
146.94	0	1	0	1	1	0
146.97	1	1	0	1	1	0
147.00	0	0	1	1	1	0
147.03	1	0	1	1	1	0
147.06	0	1	1	1	1	0
147.09	1	1	1	1	1	0
147.12	0	0	0	0	0	1
147.15	1	0	0	0	0	1
147.18	0	1	0	0	0	1
147.21	1	1	0	0	0	1
147.24	0	0	1	0	0	1
147.27	1	0	1	0	0	1
147.30	0	1	1	0	0	1
147.33	1	1	1	0	0	1
147.36	0	0	0	1	0	1
147.39	1	0	0	1	0	1
147.42	0	1	0	1	0	1
147.45	1	1	0	1	0	1
147.48	0	0	1	1	0	1
147.51	1	0	1	1	0	1
147.54	0	1	1	1	0	1
147.57	1	1	1	1	0	1
147.60	0	0	0	0	1	1
147.63	1	0	0	0	1	1
147.66	0	1	0	0	1	1
147.69	1	1	0	0	1	1
147.72	0	0	1	0	1	1
147.75	1	0	1	0	1	1
147.78	0	1	1	0	1	1
147.81	1	1	1	0	1	1
147.84	0	0	0	1	1	1
147.87	1	0	0	1	1	1
147.90	0	1	0	1	1	1
147.93	1	1	0	1	1	1
147.96	0	0	1	1	1	1
147.99	1	0	1	1	1	1

became apparent, however, that dialing up the commonly used frequencies could be, for this operator at least, hazardous while driving because of the need to watch the frequency read-out dial while changing channels.

Users of the TR7500 should be aware that the transceiver has forty-four preprogrammed channels — all ARRL band-plan frequencies between 146 and 148 MHz, including all repeaters, and simplex frequencies. However, the transceiver also offers six blank channels, which are designed to be user programmed, by use of a diode matrix, for frequencies not included in the preprogrammed sequence. These frequencies must be on standard 30 kHz centers. Complete instructions for programming these additional channels, are in the transceiver operating manual.

The thought occurred to me that regular channels could also be programmed into the blank channels, rather than having to dial them out in the regular sequence. A review of the circuit and the programming instructions lead to a simple exercise in binary numbering, and a *complete* programming table was worked out. With this information, the six blank channels were quickly programmed.

The plan has worked out very nicely. The six channels are programmed for three repeaters, and three simplex frequencies, which completely handles local driving requirements. While driving, a quick glance identifies which of the six channels the radio is set on, with subsequent changes made by feel. Of course, any of the other regular channels is immediately available, simply by dialing up the appropriate channel in the normal manner.

**Table 1** shows the complete diode programming instruction for all channels from 146.16 MHz to 147.99 MHz. Note that the columns are headed by designators P1 through P6, as used in the diode programming instructions of the operating manual.

**Bob Locher, W9KNI**

# WE KNOW YOU WANT THE VERY BEST!



In a market already over crowded by others, all making claim to being "THE BEST", we knew we had to be better. \***COMMUNICATOR I** our 6 channel, 3 watt handheld, and **COMMUNICATOR II** our 800 channel synthesized 25 watt mobile offer all the

features of the "BEST" — and a few extra, including our one year warranty and a toll free 800 number answered by other hams who speak your language.

**PACE COMMUNICATOR — THE VERY BEST!**



## pace COMMUNICATOR

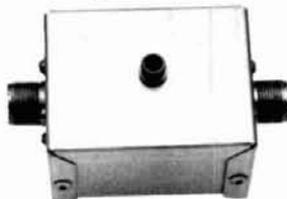
AMATEUR PRODUCTS GROUP **PATHCOM INC.** 24105 SOUTH FRAMPTON • HARBOR CITY, CA 90710

\* Communicator I will be available in the fall, Communicator II is in stock for immediate shipment.

## NEW ..... CoaxProbe\* ..... NEW

### Coaxial RF Probe for Frequency Counters and Oscilloscopes That Lets You Monitor Your Transmitted Signal Directly From the Coax Line.

Only **\$9.95**  
plus .50 postage



**FINALLY!** A RF PROBE that lets you connect into your coax cable for frequency measurements and modulation waveform checks directly from the transmitter.

**JUST CONNECT THE CoaxProbe\*** into your transmission line and plug the output into the frequency counter or oscilloscope. Insertion loss is less than .2db so you can leave it in while you operate.

**A NECESSITY IN ANY WELL-ORGANIZED HAM SHACK,** the CoaxProbe\* eliminates "jerry-rigging" and hassles when tapping into the coax line is desired.

**A SPECIAL METHOD OF SAMPLING** keeps output relatively constant with a wide variation of power. Power output of 8 watts gives .31v out, while 800 watts will give 1.8v out. (rms 3-30 mhz.) 2000 watts PEP rating too!

\*Trademark of CoaxProbe Co. for rf sampling device.

© 1978 by CoaxProbe Co.

**USE IT ON 2 METER RIGS TO ADJUST FREQUENCY.** The CoaxProbe\* has a range of 1.8 to 150 mhz.

**MONITOR YOUR MODULATION WAVEFORM.** With an oscilloscope of proper bandwidth, you can check your modulation for flat-topping, etc. Ideal for adjusting the speech processor.

**NOW YOU CAN MONITOR SIGNALS** when connected to the dummy load, eliminating unnecessary on-the-air radiation.

**AVAILABLE FOR THE FIRST TIME TO AMATEURS.** Try it for 10 days. If not satisfied, send it back for refund (minus shipping charges).

Order today from:

**CoaxProbe Co.**  
P.O. Box 426, Portage, MI 49081  
Dealer Inquiries Invited



### Radio Amateurs Reference Library of Maps and Atlas

**WORLD PREFIX MAP** — Full color, 40" x 28", shows prefixes on each country . . . DX zones, time zones, cities, cross referenced tables

**\$1.25**

**RADIO AMATEURS GREAT CIRCLE CHART OF THE WORLD** — from the center of the United States! Full color, 30" x 25", listing Great Circle bearings in degrees for six major U.S. cities: Boston, Washington, D.C., Miami, Seattle, San Francisco & Los Angeles.

**\$1.25**

**RADIO AMATEURS MAP OF NORTH AMERICA!** Full color, 30" x 25" — includes Central America and the Caribbean to the equator, showing call areas, zone boundaries, prefixes and time zones, FCC frequency chart, plus useful information on each of the 50 United States and other Countries

**\$1.25**

**WORLD ATLAS** — Only atlas compiled for radio amateurs. Packed with world-wide information — includes 11 maps, in 4 colors with zone boundaries and country prefixes on each map. Also includes a polar projection map of the world plus a map of the Antarctica — a complete set of maps of the world. 20 pages. Size 8 1/4" x 12"

**\$2.50**

Complete reference library of maps — set of 4 as listed above

**\$3.75**

See your favorite dealer or order direct.

Mail orders please include \$1.25 per order for shipping and handling.

RADIO AMATEUR **callbook INC.**

**WRITE FOR FREE BROCHURE!**



Dept. E 925 Sherwood Drive  
Lake Bluff, Ill. 60044

# MADISON ELECTRONICS SUPPLY, INC.

1508 MCKINNEY

HOUSTON, TEXAS 77002

713/858-0268

Nites 713/497-5883

**NEW! EXCITING! BREAKTHROUGH!**

**YAESU FT 901DM  
Transceiver & Accessories**



<b>FT 901DM</b>	<b>\$1,459.00</b>
<b>Speaker/Patch</b>	<b>74.00</b>
<b>CW Filter</b>	<b>45.00</b>
<b>FV-901 VFO</b>	<b>415.00</b>

**CALL FOR QUOTES ON:**

<b>YAESU</b>	<b>KENWOOD</b>
FT901 DM	TS820S
FT625	TS520S
FT225	TR7400A

**ALDA, AMCOMM, ETO ALPHA  
TEMPO VHF ONE PLUS**



**ETO — ALPHA**

*Buy The Best First!*  
Full Power + C.C.S. Ratings.

76A	\$1,395.00
76PA	1,695.00
374A	1,795.00
78	2,395.00

**CALL FOR FAST QUOTES  
SPECIAL ORDERS WELCOME**

**TERMS:** All prices FOB Houston. Prices subject to change without notice. All Items Guaranteed. Some items subject to prior sale. Send letterhead for Amateur dealers price list. Texas residents add 5% tax. Please add postage estimate.

## MADISON FABULOUS FALL BUYS

KLM: Antennas, Linears, Accessories All In Stock. Free balun w/2 meter base antenna.

**FINCO AMATEUR BEAMS** in Stock — Call! 6N2 and 2 Meter. **\$61.00**

**2 + 2 Horiz/vertical** ..... **\$37.50**

**BIRD 43 Wattmeter** plus slugs, in stock, prepaid freight.

**BENCHER keyer paddles** in stock **\$39.95**; chrome **\$49.95**

**YAESU**

FT-301D + Free FP301 ..... **\$935**

FT-301 + Free FP301 ..... **\$769**

YAESU FT-901D series. .... **Call for Quote**

**MICROWAVE MODULES MMT 432-28S** ..... **\$259**

UPS Paid.

**F9FT TONNA antennas:** 144/16 el. .... **\$65.95**

9/19 OSCAR ..... **\$63.95**

**JANEL Preamps QSA-5** ..... **\$41.95**

**TECHNICAL BOOKS:** AMECO, ARRL, Sams, TAB, TI, Rider, Radio Pub., Callbook, Cowan, TEPABCO, many others ... **call**

**HAM X ROTOR** (New Model) Turns 28 sq. ft. of antenna. List \$325. In stock. .... **Your Price \$249**

**CDE HAM-III** ..... **\$129.00**

**SWAN METERS:** WM 6200 VHF Wattmeter ..... **\$49.95**

SWR 3 Mobile ..... **\$9.95**

**TELEX HEADSETS:** ..... **in stock**

**CETRON 572B** ..... **\$27.95 ea.**

**RAYTHEON 572B** ..... **\$24.95**

**ADEL** nibbling tool, **\$6.45**; punch **\$3.50**

**CABLE 5/32"**, 6-strand, soft-drawn guy cable. For mast or light tower, **3¢ foot.**

**BELDEN COAX CABLE:** 9888 double shield RG8 foam coax, 100% braid, suitable for direct bury **39¢ ft.**, 8237 RG8 **21¢ ft.**, 8214 RG8 foam **25¢/ft.**, 8448 8-wire rotor cable **16¢ ft.**, 8210 72 ohm kw twinlead **\$19/100 ft.**, 8235 300 ohm kw twinlead **\$12/100 ft.**, Amphenol PL-259, silverplated **59¢**, UG175 adapter **19¢**, PL-258 dbi female **\$1.00**. BNC female chassis mount **59¢ ea.**

**BELDEN** 14 gauge cop. stranded antenna wire. .... **\$5/100 ft.**

**TIMES 1/2" foam hardline 60¢/ft.** ..... **Connectors \$15.00 ea.**

**7/8" Foam Hardline 1.50 ft.** ..... **Connectors \$25.00 ea.**

**KESTER SOLDER** 1 lb. 60/40, .062 ..... **\$6.50**

**LEADER GDM LDM815** ..... **\$89.95**

**MALLORY 2.5A/1000 PIV epoxy diode** ..... **19¢ ea.**

**.001 MFD 20KV CAP.** ..... **\$1.95**

**GE receiving tubes.** ..... **50% off list**

**GE6146B, 8950** ..... **\$7.95 ea.**

**SWAN 750CW + Free PSU-3** ..... **\$675**

## THIS MONTH'S SPECIAL

**KENWOOD TR7500A** ..... **\$249**

**16 ELEMENTS — F9FT — 144 MHz**



*The 'Tonna' You've been hearing about*

17.8 dBi	SWR 1.2:1
144/146 MHz	Wt. 4.4 kg.
50 ohms	Horiz./Vert.
length 6.4 m.	F/B ratio 22 dB
Horizontal aperture	2 x 16° (-3 dB)
Vertical aperture	2 x 17° (-3 dB)
Side lobe attenuation	60 dB

**\$65.95**

## MADISON ELECTRONICS SUPPLY, INC.

1508 MCKINNEY

HOUSTON, TEXAS 77002

713/858-0268

Nites 713/497-5883



# NEW products

## Drake R-7 receiver



The new Drake R-7 receiver is presently in the design and prototype stage, with first shipments scheduled for early 1979. Preliminary specifications are listed in **table 1**. The receiver is 100 per cent solid state, fully synthesized with a permeability tuned oscillator (PTO) for smooth tuning. It has continuous tuning from 0-30 MHz, and offers both a digital readout and an analog dial.

As with the Drake TR-7 transceiver, the R-7 receiver features up-conversion to a first i-f at 48 MHz; a special high-level, double-balanced mixer provides a high intercept point and strong signal handling characteristics. The receiver uses a full set of bandpass "window filters" that operate from 30 MHz, through VLF, to zero MHz. This permits performance in the MF/LF/VLF range that is very similar to that in the high-frequency range. As a result, external VLF preselectors or converters are not required.

The bandswitch selects various groups of window filters and determines the frequency limits of each range. Any 500-kHz segment within these limits is selected by simply

depressing the UP or DOWN push-buttons until the desired segment is reached. Tuning within the segment is accomplished by the PTO, which is connected to the main tuning knob.

A 10-dB, pushbutton-selected preamp can be activated on all ranges above 1.5 MHz. This preamp improves the overall sensitivity from approximately 0.5  $\mu$ V to approximately 0.2  $\mu$ V. As with any rf amplifier, however, its use lowers the intercept point by approximately the same amount as its gain. Therefore, preamp use should be limited to weak signal environments for best overall front-end performance.

The second i-f of the R-7 operates at 5645 kHz, and the selectable 8-pole crystal filters operate in this range. A choice of 300 Hz, 500 Hz, 1800 Hz, and 4.0 kHz filters are available, in addition to the 2.3-kHz ssb filter. Any of these filters may be selected from the front panel with a 5-position switch. It should be noted that the MODE

switch operates independently of these filters, and can select either a special new synchro-phase a-m detector, or the product detector. Excellent international a-m shortwave and broadcast band reception can be realized with the low-distortion synchro-phase a-m detector.

The third i-f operates at 50-kHz and features a tunable i-f notch filter for heterodyne rejection. The notch depth is approximately 40 dB.

Extremely flexible selectivity combinations may be realized by the proper choice of an 8-pole crystal filter, notch adjustment, and positioning of the passband tuner, which is also employed in the R-7 receiver. The passband tuner is full range and enables the operator to properly set the passband position, in relation to the selectivity filter, for any mode continuously from RTTY to CW or any sideband. Various positions of agc, from OFF to SLOW, are also available from the front panel.

**table 1. Preliminary specifications for the new Drake R-7 communications receiver.**

<b>Frequency coverage</b>	0-30 MHz with DR-7 digital readout general coverage board; 0.5 MHz 0.5-2.0, 2.5-3.0, 3.5-4.0, 4.5-5.0, 7.0-7.5, 14.0-14.5, 21.0-21.5, 28.5-29.0 MHz without Aux-7 (Aux-7 adds any eight 500-kHz segments from 0 to 30 MHz)
<b>Frequency stability</b>	Less than 100 Hz drift after warmup
<b>Readout accuracy</b>	Analog dial: better than $\pm 1$ kHz when calibrated to nearest marker Digital: 15 ppm $\pm 100$ Hz
<b>Sensitivity (500 kHz - 30 MHz)</b>	0.5 $\mu$ V or less for 10 dB (S + N)/N on ssb and CW; 0.2 $\mu$ V or less with preamp turned on 2.0 $\mu$ V or less for 10 dB (S + N)/N on a-m (30% modulation); 1.0 $\mu$ V or less with preamp turned on (Preamp not operational below 1.5 MHz)
<b>(0-500 kHz)</b>	2.0 $\mu$ V or less for 10 dB (S + N)/N on ssb and CW; 1.0 $\mu$ V or less for 10 dB (S + N)/N on a-m
<b>Selectivity</b>	Same as TR-7 (ultimate selectivity greater than 90 dB)
<b>Agc</b>	Same as TR-7
<b>Intermodulation</b>	Intercept point at +20 dBm, minimum; two-tone dynamic range, 95 dB
<b>Image and i-f rejection</b>	Greater than 80 dB
<b>Audio output</b>	2.5 watt with less than 10% TGD into 4-ohm load
<b>Power supply</b>	110/220 Vac 50/60 Hz or 11-16 Vdc
<b>Dimensions</b>	Same as TR-7

# Antenna Baluns

The R-7 will transceive with the Drake TR-7, and these functions are pushbutton controlled. The R-7 also has a unique antenna switch/toroidal splitter so that both the R-7 and the TR-7 may be used on the same antenna for simultaneous dual receive. This will be a boon to DXers who wish to monitor an out-of-band DXpedition and the in-band pile-up at the same time. The antenna selector also permits alternate antennas to be used on the receiver and a main antenna on the transceiver, or vice versa. The alternate antenna may also be split between the two units.

The receiver features receiver incremental tuning (RIT), so that the receiver frequency may be varied independently of the transmit frequency when operated in transceive with the TR-7. As with the TR-7, the digital readout in the R-7 may be used as an external counter to 150 MHz.

The receiver's built-in power supply operates from either 12 Vdc or 120/240 Vac. The styling, color, and size of the R-7 matches that of the TR-7, and either the internal speaker or an external MS-7 speaker may be used. Further information and prices will be available from the R.L. Drake Co. by the end of 1978.

## Racal RA6700 receiver



The Racal RA6700 is a fully synthesized, tunable, solid-state communications receiver designed for all modes of reception over the frequency range of 15 kHz to 30 MHz. The internal synthesizer provides single-knob frequency control that allows rapid tuning across the complete frequency range with the feel and smoothness of a VFO, while retaining the accuracy and stability of the in-

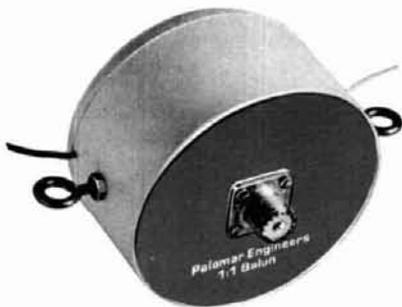
All Palomar Engineers products are made in U.S.A. Since 1965, manufacturers of Amateur Radio equipment only.



1 Kw CW, 3 Kw PEP input. For dipoles, inverted Vees, beams, quads. Dependable. Takes temporary overloads in stride.

Specify 1:1 or 4:1 ratio.

**Model 1K \$22.50**



2 Kw CW, 6 Kw PEP input. Far more rugged than any other balun made for amateur use.

Specify 1:1 or 4:1 ratio.

**Model 2K \$42.50**



2 Kw CW, 6 Kw PEP input. Our heavy duty balun with mounting bracket for 2" mast or boom.

Specify 1:1 or 4:1 ratio.

**Beam Balun \$47.50**

### Only Palomar Baluns Have All These Features

- RF toroidal core for highest efficiency.
- Teflon insulated wire.
- Stainless steel hardware. Won't rust.
- Epoxy filled case. Waterproof.
- Wideband 1.7 to 30 MHz.
- White case to reflect the sun.
- Lightning protection built in.

Free brochure sent on request

How many lightweight baluns have you burned out already? Install the balun that will stay up there working year after year.

**To order, add \$2 shipping/handling. California residents add sales tax.**

# Palomar Engineers

Box 455, Escondido, CA. 92025 • Phone: [714] 747-3343

# PUNCH UP

## your MOST CALLED NUMBERS

at your favorite  
*Amateur Radio Dealer*

Look for This Display at  
the Finest Radio Dealers  
everywhere and dis-  
cover why present  
AD-1 owners are  
so proud of  
their new  
Auto Dialers.



- **UP TO 18 TELEPHONE** or control numbers retrieved with a one or two key punch.
- **AUTOMATIC RE-DIAL** of last number manually dialed.
- **SAFE AUTOPATCH CALLS** even in heavy traffic.
- **10 NUMBER RAM** easily programmed in moments from the keypad.
- **OPTIONAL PLUG-IN 8 NUMBER PROM** custom-programmed by factory is available for \$4.95. A Prom Order Card is packed with each AD-1.
- **PROGRAMMABLE TONE-LENGTH AND DURATION** ensures accessing virtually any repeater having strict timing requirements. Ask any veteran autopatch user and he will tell you that this feature is an absolute must!
- **EASY INTERFACING** with virtually any amateur transceiver using the coil cord provided.
- **CRYSTAL CONTROLLED TIMEBASE** assures high stability over a wide temperature range.
- **MADE IN U.S.A.**  
All these features and more are possible thanks to the exclusive AEA 197701 MOS Microcomputer Chip. (OEM inquiries invited).



ADVANCED ELECTRONIC APPLICATIONS, INC.  
P.O. BOX 2160, LYNNWOOD, WA. 98036

ternal frequency standard. In addition, the operator can select either a 100- or 10-Hz tuning rate, with the separate MHz control knob, permitting rapid changes from one end of the frequency range to the other.

The RA6772 incorporates the very latest techniques in mixer and signal path refinements to produce improved dynamic range and to reduce intermodulation products, reciprocal mixing, cross modulation, blocking, and spurious responses to a degree that exceeds the capabilities of any other general-purpose receiver currently in production. The basic receiver will accommodate six i-f filters; two may be asymmetrical ssb filters with either 3- or 6-kHz nominal bandwidths. Provisions are also available for additional filters if the standard 300-Hz, 3-kHz, and 8-kHz filters are not adequate. During CW reception, the internal BFO provides  $\pm 3$  kHz tuning range.

The receiver is ruggedly constructed to permit operation under extreme conditions. Yet the internal layout permits easy access for servicing, all components being accessible without the use of extension leads or adapters. The rear panel contains all input and output connectors, with many internal connections making possible the use of the receiver as the basis for a more sophisticated receiver system.

To enhance receiver versatility and flexibility for communications, surveillance, and direction-finding applications, a number of options and variations are available. In addition to the normal modes of reception provided in the basic RA6772, additional units can be added within the receiver to permit reception of ISB and FSK signals, along with AFC operation. When configured for teletype, one or two machines may be directly connected to the receiver without the need for external power supplies.

The RA6700 receiver series is well suited for single- or multiple-receiver systems, with numerous options and configurations possible. As an ex-

ample, the RA6774 can be controlled by a computer, or, as in the case of the RA6780, by either local or remote manual control. For additional information, contact RACAL Communications, Inc., 5 Research Place, Rockville, Maryland 20850.

## Sherwood Engineering crystal filters

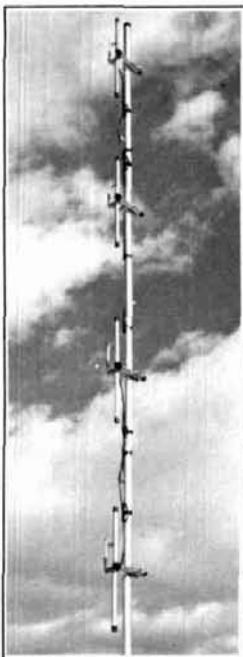
Sherwood Engineering has recently expanded still further its already extensive line of high-performance crystal filters. To complement their filters for the Drake R4C, they've now added a 2.1-kHz a-m filter (CF-2.1K/8AM) which plugs directly into a normal a-m filter socket. This 8-pole ladder filter, which can be used to replace the normal 4- or 6-kHz filters, exhibits a -6dB bandwidth of 2.1 kHz and is 3.6 kHz wide at the -60 dB point.

To help you take advantage of the extensive filter capability that can be obtained by using the full line of Drake-type filters, Sherwood Engineering is now offering a custom-made, dual function switch for the front panel of the R4C. This switch, which replaces the present AGC switch, makes it possible to switch each filter from the front panel. In addition, the new concentrically mounted AGC switch provides five AGC positions, instead of the original four (off, fast, medium, and slow). This offers the operator the option of incorporating an additional AGC speed for greater time-constant flexibility. The switch itself does not replace the Sherwood Engineering relay kits, but is offered as an alternative to the normal toggle switches.

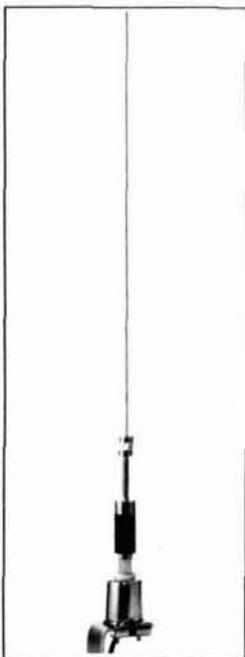
In addition to filters for the Drake R4C, Sherwood Engineering is also manufacturing the CF-350/8, a 350-Hz CW filter for use with the TR4, TR4C, or the TR4Cw. This 8-pole filter has a shape factor of 2.43:1 (as compared with the 4:1 factor for the normal 500-Hz filter supplied in the TR4Cw), yet it is easily installed in many TR4s in less than two hours.

# CUSHCRAFT IS THE FM ANTENNA COMPANY.

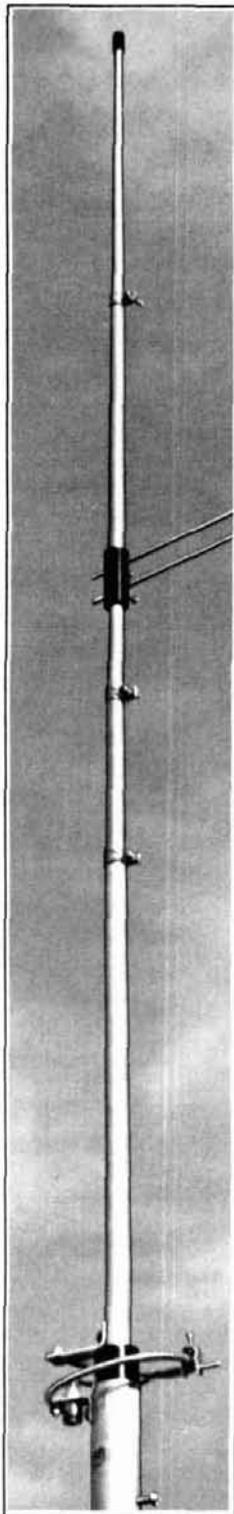
Cushcraft manufactures the world's most complete line of quality antennas for amateur VHF-FM repeater service including high-gain multi-element vertical beams, stacked collinear arrays, 5/8-wavelength mobile whips, half-wavelength Ringo® verticals, and the world-famous Ringo Ranger®, which features stacked vertical half-wavelength elements for 4.5 dBd omnidirectional gain. Whether your favorite repeater is next door or across the state, Cushcraft has a VHF-FM antenna which is exactly engineered to your needs.



Four Pole Collinear



5/8 wave Mobile



Ringo Ranger®



**cushcraft**  
CORPORATION

UPS SHIPPABLE

In Stock With Dealers World Wide P.O. Box 4680, Manchester, N. H. 03108

## NEW - IMPROVED\*



Model 1500 - Binaural Synthesizer-Filter with Tone-Tag  
Uses 8 "D" Cells - Less Batteries \$86.00 ppd, U.S.

Model 1501 - Requires your 12 to 15 volt DC input, 100 ma.  
nom. (internal regulation) \$89.00 ppd, U.S.

Wall Transformer 115V AC supply rated at 12 volts, 350 ma.  
for use with Model 1501 or . . . \$4.95

\*A new balanced bipolar Tone-Tag modulator system replaces diode modulators of Models 1100 and 700

GET BETTER THAN 100 HZ EFFECTIVE SELECTIVITY ON CW, A SELECTABLE NOISE BANDWIDTH OF LESS THAN 150 HZ PLUS PERIPHERAL HEARING IN BINAURAL SOUND . . . ALL WITHOUT LISTENING THROUGH THE TINKLING ROAR OF A NARROW-BAND FILTER OR FUSSING WITH SELECTIVE SQUELCH SYSTEMS. . . EXPERIENCE THE BINAURAL FUNCTION ON SIDE BAND VOICE . . . Just connect to your receiver's headphone or speaker jack and plug in two 8 Ohm speakers arranged stereo fashion . . . additional jack provided at lower power to protect your stereo headset.

See HR magazine articles on Nov. '75 and Nov. '76 . . . Ask for our note on listening with binaural and Tone-Tag systems

HILDRETH ENGINEERING BOX 60003 SUNNYVALE CA 94088

## HAND HOLDING? . . . LET

**DATA SIGNAL** *put rings on your fingers . . .*

with our **SUB-MINIATURE ENCODERS**



The world's smallest hand-held goes hand-in-hand with the world's smallest, lightest and least expensive T-T Pads.

**MODEL SME** — Smallest available Touch Tone Encoder. Thin, only .05" thick, keyboard mounts directly to front of hand-held portable, while sub-miniature tone module fits inside. This keyboard allows use of battery chargers. Price \$29.00, with your choice of keyboards. **SME** (less keyboard) \$24.00



**DTM**

or,

**SME**

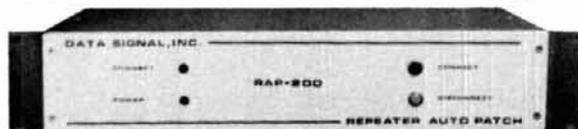


**MODEL DTM** — Completely self-contained miniature encoder for hand-held portables. Only 5/16" thick. Three wire connection. Automatic PTT keying optional. With your choice of keyboards. Price **DTM** - \$39.00, **DTM-PTT** - \$49.00.

\*Touch-Tone is a registered trade name of AT&T.

*. . . And Bells on Your Toes*

with our **AUTOPATCH** — Ready to go!



A Complete Autopatch facility that requires only a repeater and a telephone line. Features include single-digit access/disconnect, direct dialing from mobile or hand-held radios, adjustable amplifiers for transmitter and telephone audio, and tone-burst transponder for acknowledgement of patch disconnect.

**RAP-200 P. C. Card** \$199.50  
**RAP-200R Rack Mount** \$249.50



Be sure to ask about  
our new keyers and CW  
memory for CW buffs.



**ds**

**DATA SIGNAL, INC.**

2403 COMMERCE LANE ALBANY, GEORGIA 31707

912-883-4703

For the TR4Cw, installation can be accomplished in less than five minutes.

Other new products include 350-Hz CW filters for both the Kenwood TS-820 (CK-350/8) and the Signal One (CS-350/8). Each is a custom-made, 8-pole ladder filter which exhibits a 6/60-dB shape factor of 2.43:1. Both are direct replacement filters which can be installed in minutes. The CS-350/8 has a lower insertion loss, in many cases, than the hard-to-find deluxe factory CW filter.

For the CW operator who wants the best, Sherwood Engineering has developed a 125-Hz CW filter for the new Drake TR-7. This filter is excellent for the high selectivity demanded during DX and contest work. The new filter will mount directly on the TR-7 filter board. Or, for the person with both Drake CW filters already installed, a plug-in filter board can be obtained to add the additional flexibility afforded by incorporating all filters.

For complete details and price information on all products, contact Sherwood Engineering, 1268 South Ogden Street, Denver, Colorado 80210.

## Alliance heavy-duty rotator

The HD-73 Heavy-Duty rotator, combining wind- and ice-resistant features plus two-speed rotational control never before incorporated into a unit of its size and performance, is offered by the Alliance Manufacturing Company Inc., of Alliance, Ohio.

Designed especially for the serious amateur who wishes to increase his capability with in-tower or mast-mounting option, the HD-73 features a unique dual-speed control with one five-position switch. It provides a one-minute-per-revolution speed for

rotating over an extended arc, and a slower speed permitting pinpoint adjustments for the best signal on receive and transmit.

Improved automatic brake action not only simplifies positioning, but also reduces risk of antenna damage by sudden stops that impose high inertial stress on antenna, tower, and rotator.

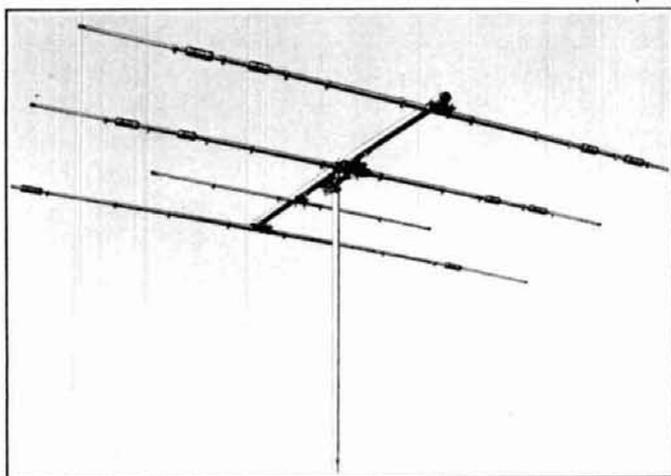
Designed to move antennas with a maximum of 1 square meter (10.7 square feet) of load capacity, the HD-73 develops a wind-load bending moment capable of withstanding the most severe prevailing wind conditions. Icing, another weather hazard for rotators, is overcome by the heaviest hardened-steel pitch-gear teeth of any rotator in its size and price range. The consistently high performance of the unit in all weather conditions is enhanced by a factory-installed lubricant that withstands temperature ranges of +49 to -29°C (+120 to -20°F).

The HD-73's 20-volt ac, capacitor-operated, split-phase, reversible motor and its transformer are doubly protected by fuse and thermal protectors against shorts, possible connection error, and prolonged operation. No voltage on the motor or leads exceeds Underwriters Laboratory safety limits.

The meter, a dc, D'Arsonval, taut-band type, is calibrated in bold S-W-N-E-S lettering as well as with a degree-graduated scale for full 360° position recording. The voltage supply for meter indication is solid-state regulated to assure accuracy regardless of wide line-voltage or load variation. The bar switch permits dual-speed rotor control with utmost accuracy and fingertip ease.

The power required is 117 volts ac, 60 hertz. The mast mounting size range is 35 mm (1-3/8 inch) to 63 mm (2-1/2 inch) O.D.; it requires a six-conductor cable. Total shipping weight of the rotator with two pairs of brackets and control box is 7.7 kg (17 lbs).

# CUSHCRAFT IS THE HF MULTIBAND ANTENNA COMPANY.

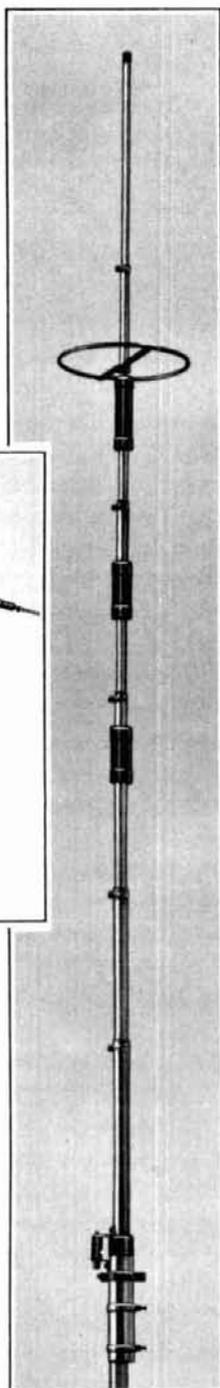


ATB-34, Three Band

Cushcraft manufactures a full range of high-frequency antennas which are performance engineered for the most discriminating amateur. For the amateur who demands top performance in a multiband Yagi beam there's the incomparable ATB-34 three-band beam for broadband, high-gain coverage on 10, 15 and 20 meters.

And for the Amateur with limited antenna space and budget who wants reliable, multiband radio communications there are three Cushcraft multiband verticals to choose from: the three-band ATV-3 for 10, 15 and 20; the four-band ATV-4 for 10, 15, 20 and 40 meters; and the ATV-5 for low VSWR five-band performance from 80 through 10 meters.

Cushcraft high-frequency antennas are quality engineered for top performance; they are often imitated, but never duplicated.



ATV-4, Four Band



**cushcraft**  
CORPORATION

UPS SHIPPABLE

In Stock With Dealers World Wide P.O. Box 4680, Manchester, N. H. 03108



# Radio World



CENTRAL NEW YORK'S FASTEST GROWING HAM DEALER



Yaesu  
MJ A 2901



IC 201E



Ten-Tec  
FT 227R

IC 2A5



Denon  
2020



Atlas  
150XL



Featuring Yaesu, Icom, Atlas, Dentron, Ten-Tec, Swan, Regency, Standard, Tempo, KLM, Hy-Gain, Mosley, Larsen, Midland, Wilson, Southwest Technical Products, Tristao Towers, MFJ, KDK, and Microwave Module. We service everything we sell! Write or call for a quote. YOU WON'T BE DISAPPOINTED.

We are just a few minutes off the NYS Thruway (I-90) Exit 32

Warren  
K2IXN

ONEIDA COUNTY AIRPORT TERMINAL BUILDING  
ORISKANY, NEW YORK 13424

Bob  
WA2MSH

315-337-2622

# LINEARIZED AMPS by LUNAR



## BI-LINEAR VHF MODELS

- Covers entire Amateur Band w/o Tuning
- Built-in Receive Preamp
- Automatic T-R Switching
- Exceeds FCC R&O 20777 Requirements of -60 dB
- Variable T-R Delay for SSB/CW use
- Preamp & Power Amp Independently Controllable
- Preamp nom 10 dB gain, 2 dB Overall NF
- Functionally Designed Package

MODEL	FREQUENCY (MHz)	POWER IN	POWER OUT	CURRENT	H	X	W	X	L	WT.	PRICE
2M10-80P	144-148	10W	80W	12A	7.0	14.9	20.3	cm	1.0kg	\$189.95	
VHF 10-80P	148-174.15 MHz	10W	80W	12A	7.0	14.9	20.3	cm	1.0kg	\$229.95	
1.3M10-70P	220-225	10W	70W	11A	7.0	14.9	20.3	cm	1.0kg	\$199.95	
2M30-160P	144-148	25W	160W	25A	7.0	14.9	32.5	cm	1.6kg	\$249.95	
VHF30-160P	128-174.15 MHz	30W	160W	25A	7.0	14.9	32.5	cm	1.6kg	\$289.95	
1.3M30-140P	220-225	25W	140W	23A	7.0	14.9	32.5	cm	1.8kg	\$269.95	
2M25-150P	144-178	25W	150W	25A	7.0	14.9	32.5	cm	1.6kg	\$299.95	

Models available for the 148-174 MHz bands, 5 MHz segments. Other models 50 thru 432 MHz bands plus higher power units out in near future.



Louis Anclaux  
WB 6NMT



## INTRODUCING OUR NEW AMP MODEL 2M25-150P

- 10 watts in, 100 watts output.
- 25 watts in, 150 watts output.
- Very linear operating amplifier compatible with all SSB rigs up to 25 watts.

## LUNAR'S RECEIVING PRE-AMPS

These ultra performance receiving preamplifiers are suitable to the most demanding needs where low noise figure is important! Construction is of the highest quality with PC boards double solid plated holes to ensure maximum performance.

PRICES ON ALL LUNAR AMPS AND PRE-AMPS WILL BE INCREASED NOV. 15TH. ORDER NOW!

See your nearest Alliance Distributor, or write to Alliance Manufacturing Company, Inc., Alliance, Ohio 44601.

## compact amateur handheld from Standard Communications



A compact new 1-watt, 2-meter handheld amateur fm transceiver is now available from Standard Communications Corp. of Carson, California. This transceiver, designated C-118, is approximately the height and width of a dollar bill, and permits the user to transmit up 600 kHz, down 600 kHz, or receive and transmit on the same frequency with just one crystal. This provides 18-channel capability with only six crystals.

The C-118 also incorporates a built-in capacitor microphone and LED status lights for CHANNEL BUSY and TRANSMIT. Also included at no additional charge is a BNC connector with flexible antenna, provisions for an external dc power supply, and earphone. It has a frequency range of 144-148 MHz and comes equipped with one crystal for operation on 146.94 simplex and 146.34/94 MHz.

To obtain a free copy of the C-118 data sheet, write Standard Communications Corp., P. O. Box 92151, Los Angeles, California 90009.

## 500-watt rf transformer



Palomar Engineers has a new broadband rf transformer. It matches vertical and mobile antennas to 50-ohm coaxial cable. Impedance values of 8, 12.5, 16, 22, 32, and 50 ohms can be selected by a convenient switch.

The transformer is mounted in a die-cast aluminum case 10 × 12 × 5 mm (4 × 5 × 2 inches) fitted with UHF (SO-239) connectors. The rf ferrite toroid core is wound with teflon-insulated wire and is rated at 500 watts in continuous commercial service. Operating frequency range is 1-30 MHz (1-10 MHz below 20 ohms).

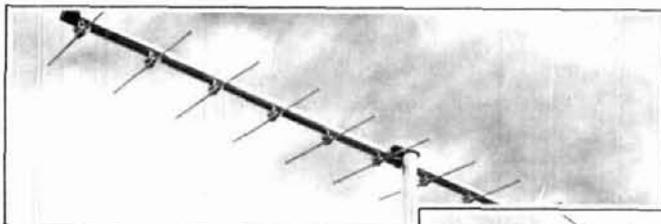
Price is \$35 plus \$2 for shipping in the United States and Canada. For a free descriptive brochure, write to Palomar Engineers, Post Office Box 455, Escondido, California 92025.

## Stolen Equipment

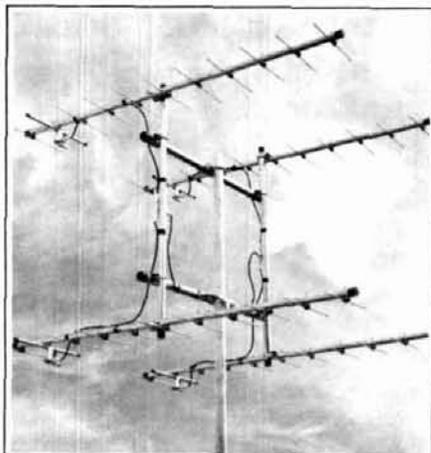
**STOLEN:** June 30, 1978, Rochester, NY from K2DHA. 2-meter transceiver, KDK model FM144-10SXRII Serial #5670. Scanner adapter attached to above. Amateur Wholesale Electronics, FMSC-1, no serial #. Amateur Wholesale Electronics Touch Tone Pad, Model FMTP-1. If tendered for trade, sale, or service, please notify: K2DHA, A. C. Peed, L66 Monterey Road, Rochester 14618 or: Brighton Police Dept., 2300 Elmwood Ave., Rochester, N.Y. 14618.

# CUSHCRAFT IS THE VHF-UHF ANTENNA COMPANY.

Cushcraft precision engineered VHF/UHF Yagi beams have become the standard of comparison the world over for SSB and CW operation on 6 meters through 432 MHz. Built by skilled craftsmen from the best available materials, these beams represent that rare combination of high electrical performance, rugged construction, and durability.

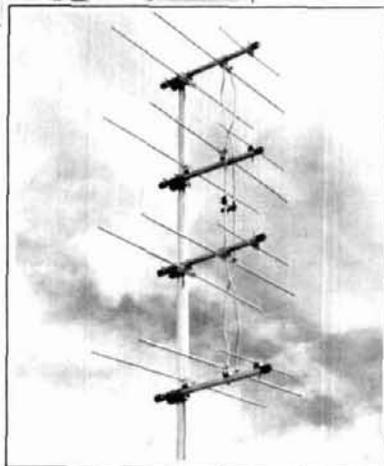


1/2-1-2 Meter Yagi



Quad Array

Cushcraft's Quad Arrays for 144, 220, and 432 MHz use four matched 11-element Cushcraft Yagis and are the ultimate in a high-performance Yagi array. These arrays have been carefully engineered for maximum forward gain, high front-to-back ratio, and broad frequency response. All antennas provide a low VSWR match to 50-ohm coaxial feedline.



20 Element DX Array

Cushcraft's wide variety of VHF/UHF Beams includes an antenna for every amateur activity above 50 MHz, whether local ragchewing or long-haul over-the-horizon DX. All models have been carefully optimized for maximum forward gain with high front-to-back ratio. The heavy-wall bright hard-drawn aluminum booms and elements are combined with heavy formed aluminum brackets and plated mounting hardware for long operating life and survival in severe weather.



UPS SHIPPABLE

In Stock With Dealers World Wide P.O. Box 4680, Manchester, N. H. 03108

# WE CARRY OCEANS OF MANUFACTURERS

Call the Communications Leader in the Northwest for Price Quotes on your Amateur and other Communications Needs.

Weller

Standard Bearfinder

TOLL FREE

Duracell Jensen  
EMI  
Vaco Panasonic



YAESU  
FT-901 DM

From Alaska in the Northwest to Florida in the Southeast  
From Maine in the Northeast to Hawaii in the Southwest  
Call TOLL FREE on . . .

800-426-6937

Residents of the State of Washington call TOLL FREE on 800-562-7625



KENWOOD  
TS-820S

ICC Alliance Mosley

Fuzzbuster MFJ Cushcraft

Vector Motorola ICOM Hayden

Yaesu CDE Howard Sams Pioneer

Antenna Specialists Jim-Pak Fairchild

GC Electronics The Manufacturers  
shown are only a  
few we stock.

Callbook

Hitachi Valor

Pipo

17550 15th AVE. N.E.



ABC  
COMMUNICATIONS

SEATTLE, WASH. 98155

Orders are  
normally shipped  
in 48 hours.

Kenwood  
Whistler

G.E. Larsen SBE

206-364-8300



## DRAKE OWNERS

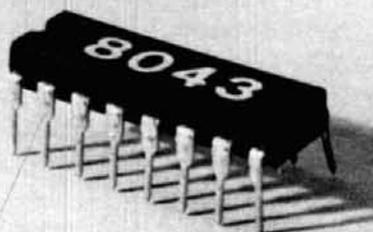
Please note that our Las Vegas Repair facility is being closed in early September to allow staff personnel to return to our main plant in Ohio to help meet the fantastic demand for the TR-7 and other exciting new Drake products.

The need for a western factory service center has been reduced in recent months as our western dealers have expanded their service capabilities.

### R. L. Drake Co.

540 Richard Street  
Miamisburg, Ohio 45342  
Phone 513-866-2421  
Telex 288-017

## CURTIS 8043 retires with honors



## but look at our NEW STARS!

- \* 8044; Keyer-On-A-Chip\* (Replaces 8043) . . . \$14.95  
Apr '75 HR, Feb '76 DST, Radio Hdbk '75, ARRL Hdbk '77-78
- \* 8044-3; IC, PCB, Socket, Manual . . . . . 24.95
- \* 8044-4; Semi-Kit . . . . . 54.95
- \* 8045; Morse Keyboard-On-A-Chip IC . . . . . 59.95
- \* 8045-1; IC, PCB, FIFO, Sockets, Manual . . . . . 89.95
- \* 8047; Message Memory-On-A-Chip IC . . . . . 39.95
- \* 8047-1; IC, PCB, RAM, Sockets, Manual . . . . . 69.95  
(add \$1.75 on above for postage and handling)

EK-430; CMOS Keyer\* (Feb '76 DST) . . . . . 124.95

IK-440A; Instructokeyer\* (Mar '76 DST) . . . . . 224.95

\*now with dash memory as standard

System 4000 Ham Computer (see Jan '78 DST). (write)

Curtis Electro Devices, Inc.

(415) 964-3136

Box 4090, Mountain View, CA 94040



## TEST EQUIPMENT

All equipment listed is operational and unconditionally guaranteed. Money back if not satisfied. Prices listed are FOB Monroe.

- HP120B 450kHz gen pur scope . . . . . \$215
- HP170A (USM140) 30MHz scope with reg horiz, dual trace vert plugs . . . . . 475
- Meas Mod 80 Stand sig gen 2-400MHz with calib atfn . . . . . 225
- Quantech 303 Wave Anal . . . . . 445
- Tek565 Dual beam 10MHz scope less plug-ins (3 series) . . . . . 625
- Tek585 80MHz gen pur scope less plugin . . . . . 645
- URM25 Stand Sig Gen 10kHz-50MHz calib atfn . . . . . 225

For complete list of all test equipment send stamped, self-addressed envelope.

### GRAY Electronics

P.O. Box 941, Monroe, Mich. 48161

Specializing in used test equipment.

## SUB-AUDIBLE GENERATOR for FM

- Inexpensive multi tone encoder
- Compatible with PL-CG-QC
- Low distortion sinewave
- Input 8-18 VDC unregulated
- Rugged, plastic encased with leads
- Adjustable frequency (98-250 Hz), Lower available
- Excellent stability

THE CUBE



5x.6 x .8 in.

Price \$19.95

Freq. set at factory \$5.00 extra

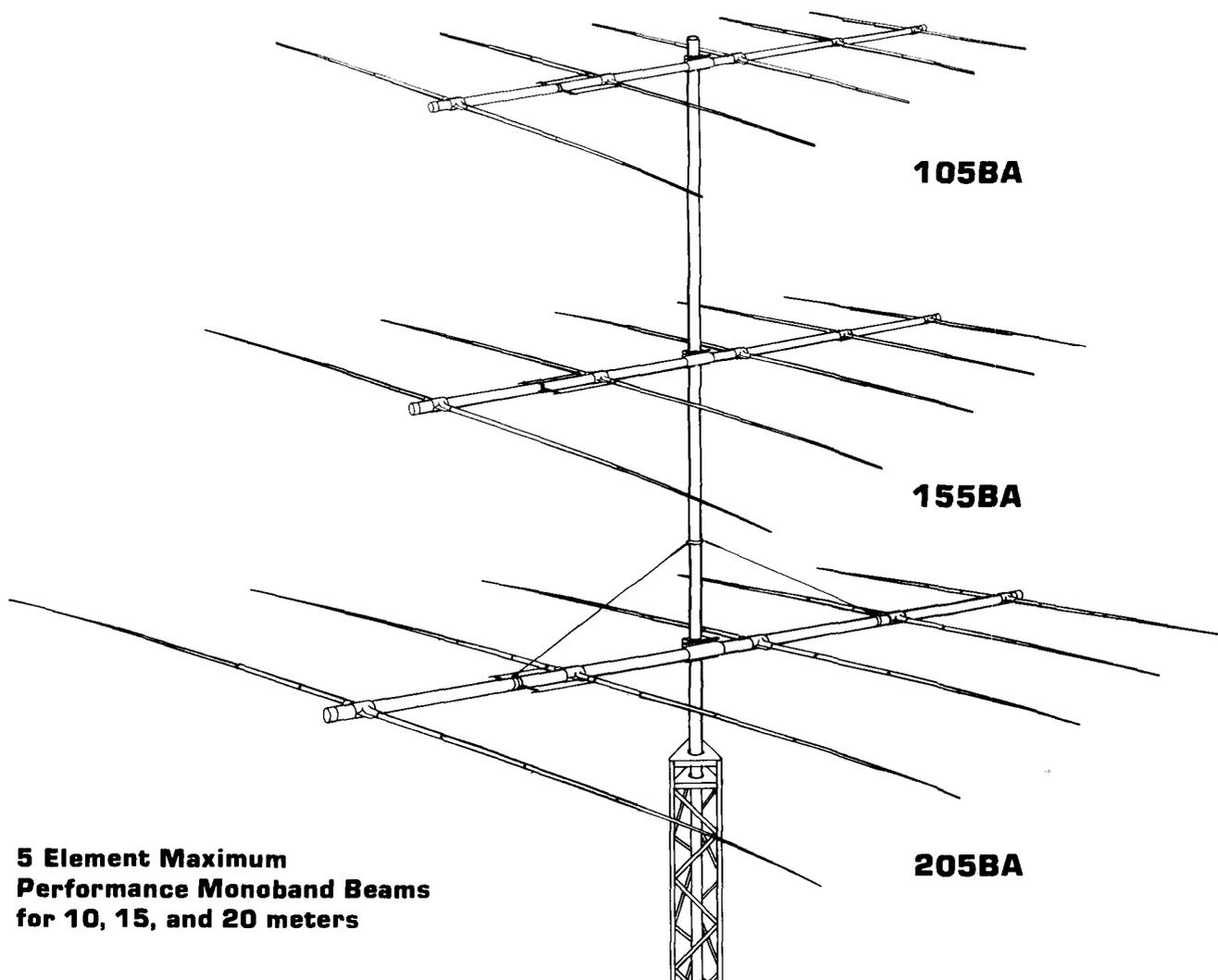
Calif. res. add 6%

Send for more info

lyle Products

Dept. hr P.O. Box 2083 Santa Clara, CA. 95051

# BE PREPARED FOR CYCLE 21 GET HY-GAIN'S NEW LONG-JOHNS "THE STACKABLES"



**5 Element Maximum  
Performance Monoband Beams  
for 10, 15, and 20 meters**

With sunspot cycle 21 now in the upswing, you should be prepared for the DX available on the 3 top HF bands, if not, our new "Long-Johns" are for you. The new 5 element "Long-John" monobanders are ideal for the serious DX'er. Each utilizes Hy-Gain's unique Beta-match for optimum power transfer. Also each antenna uses taper-swaged tubing for minimum wind load and maximum strength. For maximum durability each "Long-John" uses Hy-Gain's rugged boom-to-mast clamp.

## Specifications:

Order Number	377	376	375
Model Number	205BA	115BA	105BA
Gain	11.6 dB	12.0 dB	12.0 dB
Front-to-back ratio	20 dB minimum	20 dB minimum	20 dB minimum
SWR (at resonance)	Less than 1.5:1	Less than 1.5:1	Less than 1.5:1
Impedance	50 ohms	50 ohms	50 ohms
Power rating	Maximum Legal	Maximum Legal	Maximum Legal
2:1 VSWR Bandwidth	400 KHz	500 KHz	1.5 MHz
Longest Element	36½"	24½"	18½"
Boom Length	34'	26'	24'
Boom Diameter	2"	2"	2"
Turning Radius	25'	17½"	15'
Surface Area	9.0 sq. ft.	5.2 sq. ft.	3.9 sq. ft.
Wind Load at 80 mph	230 lbs.	133 lbs.	100 lbs.
Maximum Wind Survival	80 mph	100 mph	100 mph
Mast DIA Accepted	1¼" to 2½"	1¼" to 2½"	1¼" to 2½"



**HY-GAIN ELECTRONICS**  
8601 Northeast Hwy 6  
Lincoln, Nebraska 68505  
(402) 467-5321 telex: 48-4324

**Clegg  
is**



QTR-24



FT-901



FT-301

**Yaesu  
Headquarters**

Dozens of Distributors offer you a selection of YAESU products. Some might even quote you a slightly lower price. But—no one can serve you better than Clegg when you choose any item from YAESU's extensive product line. Because:

1. We have YAESU products in stock.
2. We know YAESU products inside and out.
3. We service all YAESU products.

If you are considering upgrading your station with a new YAESU FT901—or an FT-225RD—or an FT301—or merely a YAESU clock—call us TOLL FREE today. YAESU and Clegg guarantee your satisfaction with the product and with the service.

Call Clegg TOLL FREE 1-(800)-233-0250, for YAESU or any other requirement for your station.

**Clegg**  
Communications Corp.  
1911 Old Homestead Lane  
Lancaster, PA 17601

Toss 80 and 40 meters  
in your briefcase.



only  
**\$79.95**

**Kantronics 8040-B Receiver**

**It weighs about as much as a loaf of bread!**

The **Kantronics 8040-B CW receiver** measures 3"x5"x7"(HWD) and runs on two 9 volt transistor batteries. **It's small enough to fit in your briefcase**, light enough to take on a hiking trip and sensitive enough to pick up signals at a microvolt.

Now you can copy code from 3.650 to 3.750 MHz on 80 meters and 7.050 to 7.150 MHz on 40 meters **almost anywhere you have room for a pad and pencil!** A simple dipole brings in armchair copy on both bands.

Check with your dealer about the **8040-B**, or order direct from our address below.

**KANTRONICS**

*The Lightweight Champs.*

1202 East 23rd Street  
Lawrence, Kansas 66044

We accept Visa, Master Charge, check, and money orders.

Phone 913-842-7745

**If you expect  
to invest in  
a new ham  
antenna in the  
next 90 days,  
invest 15¢**



**postage to get Antenna  
Specialists' brand  
new, complete ham  
catalog today.**

**Amateur  
Radio  
spoken  
here!**

**FREE decal  
just for fun!**

Name \_\_\_\_\_

Address \_\_\_\_\_

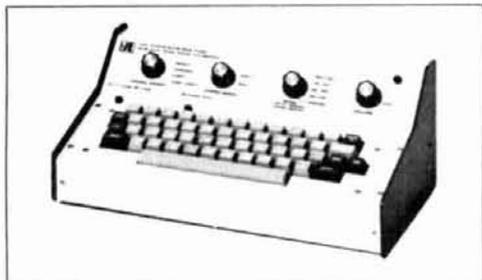
City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_



**the antenna  
specialists co.**  
a member of The Allen Group Inc.  
12435 Euclid Ave. Cleveland, Ohio 44106  
Export: 2200 Shames Drive, Westbury, L.I., New York 11580  
Canada: A. C. Simmonds & Sons Ltd.

# RTTY Can Be Easy!

Have You Wondered . . .  
What Owning a RTTY Station Would be Like?  
Have You Thought . . .  
About Finding Out but Didn't Know Who to Ask?



## ASK THE GUYS AT HAL!

Our sales and service staff will be happy to assist you in your choice of RTTY equipment, answer questions about RTTY, and provide assistance if problems do arise. In addition, all HAL amateur RTTY equipment manuals can be purchased for \$10.00 each for an advance look (applicable to future purchase of that unit).

Answers to common RTTY questions are featured in the center-fold of our new amateur radio catalog. Such questions as "What do I need?", "How do I hook it up?", and "What frequencies do I use?" are discussed. Technical points concerning RTTY pulses, FSK and AFSK, and high-tones vs low-tones are covered.

Write today for HAL'S new catalog and RTTY guide and discover how much fun RTTY can be.



HAL COMMUNICATIONS CORP.  
Box 365  
Urbana, Illinois 61801  
217-367-7373

For our European customers  
see HAL equipment at:  
Richter & Co., Hannover  
I.E.C. Interelec, Bessone  
Primetek Systems, Handen, Sweden  
Radio Shack of London

State  
of the art



by  
**K.V.G.**

**CRYSTAL FILTERS and DISCRIMINATORS**

**9.0 MHz FILTERS**

XF9-A	2.5 kHz	SSB TX	\$35.20
XF9-B	2.4 kHz	SSB RX/TX	\$47.75
XF9-C	3.75 kHz	AM	\$51.40
XF9-D	5.0 kHz	AM	\$51.40
XF9-E	12.0 kHz	NBFM	\$51.40
XF9-M	0.5 kHz	CW (4 pole)	\$35.95
XF9-NB	0.5 kHz	CW (8 pole)	\$63.95

Export  
Inquiries  
Invited

**9.0 MHz CRYSTALS (Hc25/u)**

XF900	9000.0 kHz	Carrier	\$4.15
XF901	8998.5 kHz	USB	\$4.15
XF902	9001.5 kHz	LSB	\$4.15
XF903	8999.0 kHz	BFO	\$4.15
F-05	Hc25/u	Socket Chassis	.50
F-06	Hc25/u	Socket P.C. Board	.50

Shipping  
\$1.50  
per filter

**VHF and UHF FILTERS**

ELIMINATE IMD "BIRDIES"	432 MHz PSF432	\$39.95
FROM YOUR RECEIVER.	1236 MHz PSF1296	\$39.95
CLEAN UP YOUR TRANS-	1691 MHz PSF1691	\$52.45
MITTER OUTPUT.	Shipping	\$3.50

**OSCAR - J FILTER**

Suppress 2m Tx Third Harmonics. Low 2m loss (0.5 dB typ.). High loss at 435 (35 dB typ.).

**MMf 200 \$29.95**

**432 MHz SSB TRANSVERTERS**

Use your HF Transceiver on the 432 MHz band with the addition of the MMt432 linear Transverter. The MMt432 operates on all modes; SSB, CW, AM, FM. It contains BOTH the linear transmit up-converter and the receive down-converter. An internal PIN diode T/R connects to your Transceiver T/R line. The MMt432 is FT101 and similar HF rig compatible. Add the 70/MBM48 MULTIBEAM and operate direct into OSCARS 7 & 8. Write for application note.

**Specifications:**

Output Power	10 W PEP
Drive, 10 Meters	1/2 W max
Receiver N.F.	3.0 dB typ
Receiver gain	30 dB typ
Prime Power	12 V D.C.

Shipping: \$3.50

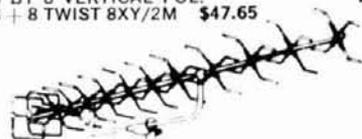


<b>MMt432-28</b>	<b>\$257.50</b>	<b>MMt144-28</b>	<b>\$197.50</b>
<b>MMt432-50</b>	<b>\$265.00</b>	<b>Also Available:</b>	
<b>MMt438-ATV</b>	<b>\$275.00</b>	<b>FMt440-146</b>	<b>\$154.95</b>
<b>MMt432-144</b>	<b>\$319.95</b>	<b>QMt432-144</b>	<b>\$154.95</b>

**ANTENNAS (FOB CONCORD, VIA UPS)**

**144-148 MHz J-SLOTS**

8 OVER 8 HORIZONTAL POL.	+12.3 dBd	D8/2M	\$45.95
8 BY 8 VERTICAL POL.		D8/2M-VERT.	\$53.95
8 + 8 TWIST 8XY/2M	\$47.65		



**420-450 MHz  
MULTIBEAMS**

48 EL.	GAIN +15.7 dBd	70/MBM48	\$49.95
88 EL.	GAIN +18.5 dBd	70/MBM88	\$73.50

**UHF LOOP YAGIS**

26 LOOPS	GAIN +20 dBi		
1250-1340 MHz	1296-LY		\$56.95
1650-1750 MHz	1691-LY		\$63.95

Send 30¢ (2 stamps) for full details of KVG crystal products and all your VHF & UHF equipment requirements.

Pre-Selector Filters	Amplifiers	SSB Transverters
Varactor Triplers	Crystal Filters	FM Transverters
Decade Pre-Scalers	Frequency Meters	VHF Converters
Antennas	Oscillator Crystals	UHF Converters



**Spectrum  
International, Inc.**  
Post Office Box 1084  
Concord, Mass. 01742, USA



**GREGORY ELECTRONICS**  
The FM Used  
Equipment People.

**New Low Price!**

**2 Meter Portable  
G.E. MASTR PR 36**  
132-150 MHz - 5 Watts  
**ALL SOLID STATE  
with Ni-Cad Battery**



Reg.  
~~\$228~~ **\$188.**  
NOW

- Vehicular Charger 4EP63A** (sold only with unit) **\$25.**
- A.C. Charger** (subject to availability)..... **\$25.**
- Speaker/Mike Type EM36** ..... **\$15.**



**GREGORY ELECTRONICS CORP.**

245 Rt. 46, Saddle Brook, N.J. 07662  
Phone: (201) 489-9000

WHERE THE HAM  
IS KING



SERVICE FOR  
OVER 30 YEARS

**DEALERS WANTED**

Hamtronics, Inc. is a stocking distributor for all major lines of Radio Communications Equipment, parts and accessories.

If you are presently in the electronics sales and service business, and have experienced difficulty in maintaining proper inventory to serve your customers or if you are contemplating going into your own business, we may be able to solve your problem with our large inventory.

For more information fill in coupon below and mail today with your letterhead or Tax Exempt Number.

A DIVISION OF TREVOSSE ELECTRONICS

**HAMTRONICS, INC.**

4033 BROWNSVILLE ROAD, TREVOSSE, PA. 19047

Business Name \_\_\_\_\_  
Street \_\_\_\_\_  
City, State \_\_\_\_\_ Zip \_\_\_\_\_  
Telephone No. \_\_\_\_\_  
Tax Exempt No. \_\_\_\_\_  
Name, Title \_\_\_\_\_

# GIANT KILLER!

## ATLAS 210x/215x

5 BAND - 200 WATT - ALL SOLID STATE HF SSB CW TRANSCEIVER

Don't let its small size, and light weight fool you . . . the Atlas 210x/215x is a top notch performer, with all the power and performance that you find in rigs twice as big, and costing twice as much. And none of the others have as many superior features as our little Giant Killer, regardless of their size.

- ALL SOLID STATE DESIGN.
- 200 WATTS PEP.
- NO TRANSMITTER TUNING.
- 5 BAND COVERAGE ,  
(210x covers 10-80 meters,  
215x covers 15-160  
meters).

- PLUG-IN CIRCUIT BOARDS .
- SUPERIOR SELECTIVITY, with exclusive 8 pole crystal ladder filter.
- EXCEPTIONAL IMMUNITY TO STRONG SIGNAL OVERLOAD AND CROSS MODULATION.
- SLIPS IN AND OUT OF SPECIAL MOBILE MOUNTING BRACKET OR AC CONSOLE IN SECONDS, with connections for DC power input, antenna jack, and mic jack made automatically.

*For complete details on the Giant Killer see your Atlas dealer or drop us a card and we'll mail you a brochure with dealer list.*



 **ATLAS  
RADIO INC.**

417 Via Del Monte Oceanside, CA 92054  
Phone (714) 433-1983  
Special Customer Service Direct Line  
(714) 433-9591

MADE IN U.S.A.

# ALL-MODE VHF amplifiers

115V/230VAC OPERATION  
FOR BASE STATION & REPEATER USE



FAN KIT



- ☆ No Power Supply Needed
- ☆ AM-FM-CW-SSB-RTTY
- ☆ 60dB Harmonics
- ☆ 60dB Spurious
- ☆ Heavy Duty Design
- ☆ Illuminated Panel Meter
- ☆ Internal T/R Switch
- ☆ Fully Protected
- ☆ + 13V/3A Accessory Socket
- ☆ U.S. Manufactured

FCC Type Accepted Models also available, Parts 89,91,93.

MODEL	FREQUENCY	INPUT	OUTPUT	SIZE WxDxH	WEIGHT	FAN KIT Required	PRICE
V70	144-148MHz	10-15W	75-90W	216x330x178mm	11.7 kg (26 lbs)	NO	\$315.00
V71	144-148MHz	1-3W	75-90W	216x330x178mm	11.7 kg (26 lbs)	NO	\$349.00
V180	144-148MHz	8-15W	170-200W	216x330x178mm	13.5 kg (30 lbs)	CW & FM	\$539.00
V350	144-148MHz	10-20W	350-400W	432x330x178mm	20.2 kg (45 lbs)	YES	\$875.00
V130B	220-225MHz	10-15W	70-85W	216x330x178mm	11.7 kg (26 lbs)	NO	\$329.00
V135B	220-225MHz	25-35W	140-160W	216x330x178mm	11.7 kg (26 lbs)	CW & FM	\$469.00
F110	FAN KIT, 115VAC			135x135x50mm	1 kg (2.2 lbs)	—	\$ 33.00
F220	FAN KIT, 230VAC			135x135x50mm	1 kg (2.2 lbs)	—	\$ 33.00
RM-1	19 INCH RACK ADAPTOR			483x3x178mm	1 kg (2.2 lbs)	—	\$ 25.00

\*Available after September 1, 1978

OTHER FREQUENCIES AVAILABLE ON REQUEST.  
CALL FRANK KALMUS — WA7SPR



**RF POWER LABS, INC.**

11013-118th Place N.E. • Kirkland, Washington 98033 • Telephone: (206) 822-1251 • TELEX No. 32-1042



## SWR Power Meters



**COMBINATION SWR/FIELD STRENGTH METER**  
Measures SWR up to 3:1, or higher. Meter has sensitive movement and easy-reading two-color scale. 5% accuracy. 52 ohms impedance. SO-239 female coaxial connectors. 6" high x 2" wide x 2 3/4" deep. Model SWR-A \$14.95

### MINI SWR METER

Small size makes this the perfect mobile or portable meter. Sensitive meter with easy-to-read two-color scale. Metal case 1-5/8" x 2-1/8" x 2-1/8". Model SWR-B \$12.95



### POWER/SWR/F.S. METER

Measures SWR and power on 0-10 and 0-100 watt ranges. Good up to 225 MHz for SWR function, up to 148 MHz for power functions. Accuracy: 5% on SWR, 10% on power functions. 2" x 4 3/4" x 2 1/4". Model SWR-C \$26.95



### DUAL METER SWR BRIDGE

Shows output power and reflected power simultaneously. Can be used as reference power meter, too. Wide scale, easy-to-read meter faces. Dual meters make antenna tuner adjustments a snap. Good through 175 MHz. May be left in-line up to 2,000 watts. Model SWR-D \$29.95

### DIPOLE ANTENNA CONNECTOR



**HYE-QUE (HQ-1) dipole connector** has coax SO-239 socket molded into glass filled plastic body to accept coax PL-259 plug on feedline. Drop cap keeps coax fittings dry. Instructions included. Guaranteed. At your dealers or \$4.95 postpaid. Companion insulators 2/\$9.95.

**BUDWIG MFG. Co.** PO Box 97H, Ramona, CA 92065

### K-ENTERPRISES

Frequency Counters  
Prescalers  
Marker & Peaking  
Generators

Power Supplies  
Amplifiers  
Frequency  
Standards

Write for Free Catalog

Box 410 (Pump Sta. Rd.) Fairland, OK 74343  
Phone: 918-676-3752

# Barry Electronics . . .

Your One Source for Amateur Radio Gear

FEATURING: ANTENNA SPECIALISTS

Yes, we have  
EIMAC Tubes  
& Chimneys,  
and YAESU  
Replacement Tubes  
in stock!

Repair lab  
on premises.

ATLAS  
BIRD  
COLLINS  
CUSHCRAFT  
DENTRON  
DRAKE  
EIMAC

E-Z WAY  
HY-GAIN  
ICOM  
KDK  
KLM  
MOSLEY  
NEWTRONICS

ROHN  
STANDARD  
SWAN  
TRI-EX  
WILSON  
YAESU

**BARRY ELECTRONICS** 512 BROADWAY  
(212) 925-7000 NEW YORK, N. Y. 10012

Call (213) 376-5887 to order  
COD or with VISA or M.C.

Card # \_\_\_\_\_  
Exp. date \_\_\_\_\_  
Name \_\_\_\_\_  
Street \_\_\_\_\_  
City \_\_\_\_\_  
State \_\_\_\_\_ Zip \_\_\_\_\_

Models desired: \_\_\_\_\_  
\$2 shipping per order Calif. res. add tax  
Check or M.O. enclosed \$

**SSS ELECTRONICS**

# SST T-1 RANDOM WIRE ANTENNA TUNER



All band operation (160-10 meters) with any random length of wire. 200 watt output power capability—will work with virtually any transceiver. Ideal for portable or home operation. Great for apartments and hotel rooms—simply run a wire inside, out a window, or anyplace available. Efficient toroid inductor for small size: 4-1/4" x 2-3/8" x 3", and negligible loss. Built-in neon tune-up indicator. SO-239 connector. Attractive bronze finished enclosure.

only **\$29.95**

THE ORIGINAL Random Wire Antenna Tuner... in use by amateurs for 6 years.

## SST T-2 ULTRA TUNER

Tunes out SWR on any coax fed antenna as well as random wires. Works great on all bands (80-10 meters) with any transceiver running up to 200 watts power output.

Increases usable bandwidth of any antenna. Tunes out SWR on mobile whips from inside your car.

Uses efficient toroid inductor and specially made capacitors for small size: 5-1/4" x 2-1/4" x 2-1/2". Rugged, yet compact. Negligible line loss. Attractive bronze finished enclosure. SO-239 coax connectors are used for transmitter input and coax fed antennas. Convenient binding posts are provided for random wire and ground connections.



only **\$39.95**

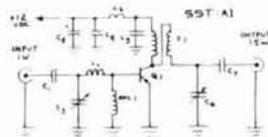


only **\$19.95**

## SST T-3

### Mobile Impedance Transformer

Matches 52 ohm coax to the lower impedance of a mobile whip or vertical. 12-position switch with taps spread between 3 and 52 ohms. Broadband from 1-30 Mhz. Will work with virtually any transceiver—300 watt output power capability. SO-239 connectors. Toroid inductor for small size: 2-3/4" x 2" x 2-1/4". Attractive bronze finish.



only **\$29.95**

\$49.95 wire and tested

## SST A-1 VHF Amplifier Kit

1 watt input gives you 15 watts output across the entire 2 meter band without re-tuning. This easy-to-build kit (approx. 1/2 hr. assembly) includes everything you need for a complete amplifier. All top quality components. Compatible with all 1-3 watt 2-meter transceivers. Short and open protected—not damaged by high SWR.

Kit includes:

- Etched and drilled G-10 epoxy solder plated board.
- Heat sink and mounting hardware. All components—including pre-wound coils.
- Top quality TRW RF power transistor.
- Complete assembly instruction with details on a carrier operated T/R switch.



**GUARANTEE**



All SST products are guaranteed for 1 year. In addition, they may be returned within 10 days for a full refund (less shipping) if you are not satisfied for any reason. Please add \$2 for shipping and handling. Calif. residents, please add sales tax. COD orders OK by phone.



**ELECTRONICS**

P.O. BOX 1 LAWDALE, CALIF.  
90260 (213) 376-5887

# ATTENTION KENWOOD & YAESU OWNERS!!!

## the W6TOG\* RECEIVER MODIFICATION KIT

- INCREASES SELECTIVITY
- IMPROVES SENSITIVITY
- LOWERS INTERNAL NOISE
- COMBATS BLOCKING FROM LOCAL SIGNAL
- IMPROVES NOISE BLANKER OPERATION

TS-520 KIT	.....	\$27.50
TS-520S KIT	.....	32.50
TS-820 & 820S KIT	..	34.50
FT-101 SERIES KIT	..	32.50
FR-101 SERIES KIT	..	34.50

EXPLICIT INSTRUCTIONS MAKE MODIFICATION A CINCH

\*WELL KNOWN DXer WITH OVER 300 COUNTRIES CONFIRMED.

Order from  
**S-F AMATEUR RADIO SERVICES**  
4384 KEYSTONE AVE., CULVER CITY, CA. 90230  
(213) 837-4870

## IT'S MAGIC—IT'S "MAGICOM" PROCESSOR MODIFICATION KIT

IMPROVES AUDIO PUNCH • IMPROVES PROCESSED SPEECH QUALITY

Converts **TS-820** speech processor from RF compressor to RF clipper

The "MAGICOM" RF processor module provides up to 6db increase in output with smooth, clean, non-distorted audio and more penetration for those pile-ups. Price \$27.50

ENDORSED BY W6TOG AND BIG GUN DXers WORLD WIDE

SATISFACTION GUARANTEED OR MONEY REFUNDED  
All prices postpaid - in Calif. add 6% sales tax - Mastercharge & Visa accepted

## ALUMA TOWERS

60 Ft.  
Ham Crank-Up  
Model T-60-H

40 Ft.  
Crank-Up  
Ham Model T-140

HIGHEST QUALITY

MADE IN ALUMINUM

★ TELESCOPING  
(CRANK UP)

★ GUYED

★ TILT OVER MODELS

QUALITY MADE

Excellent for

### HAM COMMUNICATIONS

MANY MODELS MFG.

Towers to 100 feet. Specials designed & made. See dealer or send for free catalog.

ALUMA TOWER CO.  
BOX 2806HR  
VERO BEACH, FLA. 32960  
PHONE (305) 567-3423

NEW! VIP-100 Option provides  $\pm 10$  kHz from dialed frequency.  
146 - 148 MHz Only \$9.95

## ALL 2-METER FM CHANNELS

with your  
IC-22S

- SINGLE KNOB CHANNEL SELECTION
- DIRECT FREQUENCY READOUT
- SIMPLE, EASY INSTALLATION
- LOW COST
- INSTALLS IN PLACE OF ORIGINAL SWITCH

These repeater pairs are programmed in the switch:

146.01-61	146.22-82	147.60-00	147.81-21
146.04-64	146.25-85	147.63-03	147.84-24
146.07-67	146.28-88	147.66-06	147.87-27
146.10-70	146.31-91	147.69-09	147.90-30
146.13-73	146.34-94	147.72-12	147.93-33
146.16-76	146.37-97	147.75-15	147.96-36
146.19-79	146.40-00	147.78-18	147.99-39

PLUS: The following simplex channels are also programmed in the switch:

146.43	146.55	147.48
146.46	146.58	147.51
146.49	147.42	147.54
146.52	147.45	147.57

PLUS: Two user programmed channels

NOW! Only \$24.95

VIP-42 kit

~~\$29.95~~

VIP-600 option - \$3.50  
VIP-15 option - \$3.50



COMING! New 220 MHz Synthesizer for Midland 13-509

Now you can have all the 2-meter FM frequencies from 146.01 thru 147.99 on your IC-22S. The basic VIP-42 conversion provides 42 channels, including all the repeater pairs, all of the standard simplex frequencies, and any two other desired user programmed channels. The VIP-600 option adds simplex capability on channels 600kHz above the indicated channel, while the VIP-15 option provides the capability of moving the IC-22S 15kHz up from the indicated frequency for split operation.

Order yours today! Make your fine transceiver even better!

**Vip Valley Instrument Products**

(312) 741-8820 — P.O. BOX 339 BARTLETT, ILLINOIS 60103

**Vip Valley Instrument Products**  
P.O. Box 339  
Bartlett, IL 60103

PLEASE SHIP \_\_\_\_\_ VIP-42 conversion kit(s) at ~~\$29.95~~ each, \$24.95

ALSO INCLUDE \_\_\_\_\_ VIP600 option(s) at \$3.50 each.

and \_\_\_\_\_ VIP15 option(s) at \$3.50 each.

BANK AMERICARD

VISA

Name \_\_\_\_\_ Call \_\_\_\_\_  I enclose \$ \_\_\_\_\_ check or money order.

Address \_\_\_\_\_  Please charge my VISA/Bank Americard \$ \_\_\_\_\_

City \_\_\_\_\_ Card number \_\_\_\_\_ Expiration date \_\_\_\_\_

State \_\_\_\_\_ ZIP \_\_\_\_\_ Signature \_\_\_\_\_

ILLINOIS RESIDENTS ADD 5% SALES TAX

## JAN CRYSTALS HOLD THE FREQUENCY



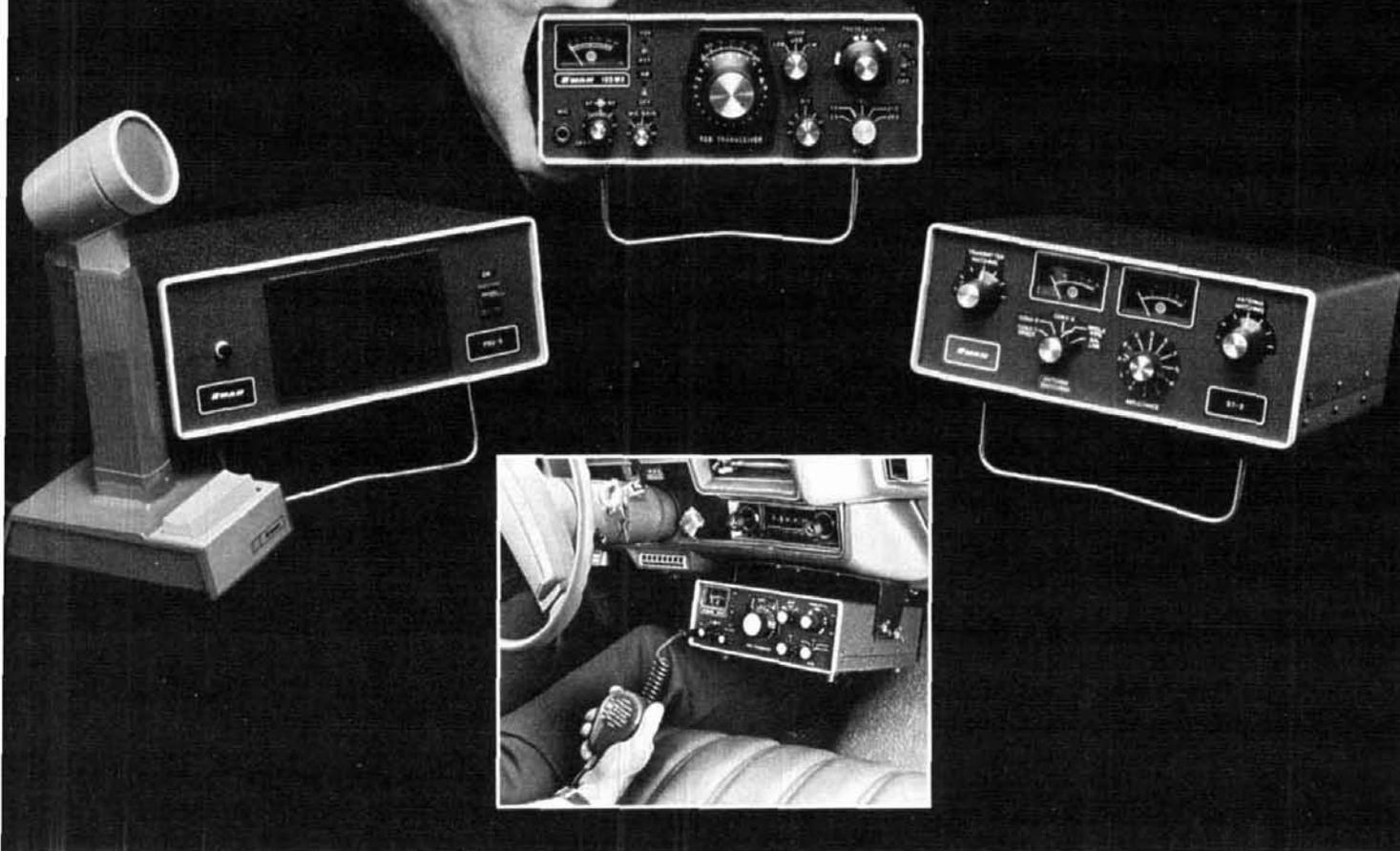
- CB
- CB standard
- 2 meter
- Scanners
- Amateur Bands
- General Communication
- Industry
- Marine VHF
- Micro processor crystals

easy to charge



Send 10¢ for our latest catalog  
Write or phone for more details  
2400 Crystal Drive  
Ft. Myers, Florida 33901  
all phones (813) 936-2397

# BREAKS THROUGH EVERY HF SOUND BARRIER --INSIDE AND OUT!



**The revolutionary Swan 100 MX: 100% new, 100% solid state,  
100% portable from home station to mobile!**

Introducing a superb "get up and go" transceiver, superbly designed for 100% mobility and control, as only new Swan space-age technology could do it!

**100% solid state 100 MX:** the compact HF unit you can take seriously — anywhere you choose to operate.

At home, set into Swan's unique new style-coordinated station, with *matching* antenna tuner and power supply.

Or on the road — it's easy to relocate 100 MX. Instantly. Just two simple connections on the back panel: snap out, snap in... and run!

**100% improved audio quality:** home or mobile, transmit or receive. 100 MX electronics cut through SSB sound barriers —

producing a natural clarity reported comparable to AM!

**Your most-wanted extras, 100% built-in:** like noise blanker and VOX. Like a preselector to optimize signals. Like a real RF GAIN control, and CW sidetone.

Swan includes the RIT control ( $\pm 1.5$  kHz) you'd like too. Plus, for stability, a permability tuned oscillator with 1Kc readout.

A powerful package, delivering a minimum 100 watts PEP output on all bands, 10-80 meters.

**Setting a 100% new state of art:** 100 MX and our matched-station units. Ready for check out today at your Swan dealer, the first major breakthrough in Swan's new program dedicated to changing the face — and performance — of ham equipment 100%... inside and out!

**Swan 100 MX: \$849.95**

Matching Power Supply PSU-5:  
\$179.95

Matching Antenna Tuner ST-3:  
\$169.95

Available only through authorized Swan dealers.

Please rush full specs on Swan's all-new 100 MX home/mobile transceiver.

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_

State \_\_\_\_\_ Zip \_\_\_\_\_

HAM 10/78

**SWAN**  
ELECTRONICS

a member of the Cubic Corporation family of companies

305 Airport Road, Oceanside, CA 92054  
(714) 757-7525

Swan's continuing commitment to product improvement may affect specifications and prices without notice.

# BULLET ELECTRONICS

P.O. Box 19442 Dallas, TX. 75219 (214)823-3240



### MC3301P HOUSE #

4 OP AMPS IN ONE PACKAGE USES SINGLE SUPPLY. (4 to 28VDC). INTERNALLY COMPENSATED. SIMILAR TO MC3401, BUT HIGHER GAIN. **49¢**

### MC1437P DUAL 709 OP AMP

HIGH OPEN LOOP GAIN, LOW NOISE. 14 PIN DIP **3/1.00**

### MC1351P FM-IF AMP AND DISCRIMINATOR

USED IN FM & TV SOUND CIRCUITS. REQUIRES MINIMUM EXTERNAL COMPONENTS. 14 PIN DIP. DIRECT REPLACEMENT FOR HEPC 6060, ECG 748 and MANY OTHERS. HOUSE # **50¢** WITH SPECS

### HOUSE #

### LM3900 QUAD NORTON AMP

WE BOUGHT A LARGE QUANTITY OF THESE HOUSE NUMBERED PARTS AT A BARGAIN PRICE THAT ALLOWS US TO SELL THEM AT A LOW, LOW **39¢**

### TIL312 COMMON ANODE READOUT



3" CHARACTER SIZE WITH PINOUT **.65 6/3.00**

### MPF131 N-CHANNEL DUAL GATE MOSFET



**50¢**

DESIGNED FOR AMPLIFIER AND MIXER APPLICATIONS TO 200 MHZ. PLASTIC CASE. UNITS ARE HOUSE NUMBERED WITH SPECS.

### IL-1 OPTO ISOLATORS

BY LITRONIX 6 PIN DIP STANDARD PINOUT LED-TRANSISTOR COMBINATION. **50¢** WHILE THEY LAST!



### SMALL SKIRTED BLACK INSTRUMENT KNOB.

FITS 1/4" SHAFT WITH SET SCREW.



**5/1.00**

### MJ900 - MJ1000

COMPLIMENTARY PNP, NPN DARLINGTON POWER TRANSISTORS. 8 AMPS. WE SUPPLY A SCHEMATIC TO BUILD A HIGH POWER (35W) LOW DISTORTION AUDIO AMP WITH ONLY ONE ADDITIONAL TRANSISTOR AND A DOZEN INEXPENSIVE COMPONENTS! TO-3 CASE STYLE **BUY A PAIR FOR \$3.00!**

### 1N4148 DIODES

LEADS ARE TARNISHED BUT CLEAN UP EASILY. THE BOSS SAYS "DUMP 'EM"...SO CHECK THIS PRICE! **50/1.00**



### HOUSE # PNP POWER

TO-3

150 WATTS  
80 VCEO  
10 AMPS



IDENTICAL TO 2N3790 **1.00**

### MC1469R POSITIVE VOLTAGE REGULATOR

1/2 AMP COMPLETE SPECS AND APPLICATIONS SHOW HOW TO BUILD FIXED OR VARIABLE POWER SUPPLIES FROM 3 TO 30VDC. DRIVE EXTERNAL SERIES PASS FOR CURRENT TO 20 AMPS! **1.25 EA. 10/10.00** HOUSE #



### FANTASTIC SOUND EFFECTS CHIP

AVAILABLE ONLY FROM BULLET!

THIS 28 PIN MARVEL CONTAINS A LOW FREQUENCY OSCILLATOR, VCO, NOISE OSCILLATOR, ONE SHOT, MIXER AND ENVELOPE CONTROL WITH 8 PAGE MANUAL. 5 to 9VDC **3.95**

### ALL COMPONENTS 100% GUARANTEED



- CA3011 WIDEBAND IF AMP w/specs **50¢**
- 2N3569 NPN EPOXY 1W **6/1.00**
- 741 OP AMP 8 PIN DIP **5/1.00**
- 723 VOLTAGE REG. 14 PIN DIP **50¢**
- MPS6530 NPN HOUSE # **8/1.00**
- 725 OP AMP LOW NOISE HOUSE # **99¢**
- 7815 15V 1A REGULATOR HOUSE # **69¢**
- LM340T-12 12V 1A VOLT. REG. w/specs **75¢**
- TCA430 QUAD OSCILLATOR 1/specs **69¢**
- 2N4343 P CHANNEL J FET **4/1.00**
- 2N6111 PNP MED PWR 40W TO-220 **3/1.00**
- 2N6028 PROGRAMMABLE UNIJUNCTION w/specs **50¢**
- TRIAC 200V 8A UNMARKED **3/1.00**



### INCANDESCENT PANEL LAMP

WITH TINNEMAN NUT YOUR CHOICE OF RED, GREEN, YELLOW, WHITE 12-24VDC **15¢**



### CAPACITORS

SMALL SIZE!



- 2200 MFD @ 16 VDC RADIAL **3/1.00**
- 500 MFD @ 35VDC **5/1.00** AXIAL
- 220 MFD @ 25VDC **7/1.00** AXIAL
- .1 MFD @ 20VDC DISC CERAMIC **15/1.00**

### POWER SUPPLY METERS

Quality 3 1/2" meters for the P-S14, 0-15VDC & 0-25A. Matched set, individually packaged. **12.95/set** NOT SURPLUS!

### FND510 69¢

COMMON ANODE READOUT 1/2" CHARACTER **LIMIT 24 PER CUSTOMER!**



Miniature 7K Pot w/water PC Mount or panel mount 1/8" shaft 49 Black plastic knob for above **FREE**

LIMITED QTY Computer Grade FILTER CAP Screw Terminals 2" x 5/8" 9500 mfd@25V 2.95 or 4/9.95

### ULTRASONIC SENDER RECEIVER KIT US-02

TOTAL SECURITY! Completely invisible ultrasonic (23KHZ) sound beam works like a photoelectric beam but is unaffected by light, heat or noise. Separate Transmitter and Receiver can be used from 6 inches to 25 feet! A solid object breaking the beam causes an output to go low that will sink up to 150 MA to Drive a Relay, TRIAC, etc. Complete electronics are provided. Works on 12VDC (unregulated) and draws less than 100 MA. Use it for burglar alarms, subject counters, automatic door openers, automatic door bells, electronic rat trap? and more. **COMPLETE KIT LESS CASES 21.50**

Optional entry delay and Alarm Timeout Circuit will source or sink up to 200 MA DC. **3.95**

### LED'S JUMBO: RED 5/.89 GREEN 4/.89



MEDIUM: RED .15 MINI: GREEN .16 RED .10 YELLOW .16

1.5V 10-30 ma

### POWER SUPPLY KIT PS-14

- Better than 200mV load and line regulation
- Foldback Current Limiting
- Short Circuit Protected
- Thermal Shutdown
- Adjustable Current Limiting
- Less than 1% ripple.
- 15 amps 11.5 to 14.5V
- All parts supplied including heavy duty transformer.
- Quality plated fiberglass PC board.

Less Case, meters & jacks

**42.95** UPS SHIPPING PAID!

### OVERVOLTAGE PROTECTION KIT 6.95

Provides cheap insurance for your expensive equipment. Trip voltage is adjustable from 3 to 30 volts. Overvoltage instantly fires a 25A SCR and shorts the output to protect equipment. Should be used on units that are fused. Directly compatible with the PS-12 and PS-14. All electronics supplied. Drilled and plated PC board. (Order OVP-1)

### WATCH FOR IT! Coming next month, a special kit for HAMS!

### MINI GRANDFATHER CLOCK KIT

- Complete Electronics!
  - Chimes the hour (ie: 3 times for 3 O'clock)
  - Unique "swinging" LED pendulum
  - Tick tick sound matches pendulum swing.
  - Large 4 digit .5" LED readout
  - All CMOS construction
  - Complete electronics including transformer & speaker; drilled and plated PC boards measure 4.5" x 6.5"
- BEAUTIFUL SOLID WALNUT**  
Custom case for above kit. Over 9 1/4" tall **39.95 19.95**

### MK-03A CLOCK/TIMER KIT

Features 24 hour Zulu time and up to 24 hours of elapsed time on the same set of six digit LED readouts. Totally independent operation of both functions. Clock has presettable alarm with 10 minute snooze. Timer has reset, hold, and count functions. Full noise and overvoltage protection, 24 hour only. Readouts has dimmer feature or they can be turned off without disturbing the clock or timer. Timebase included (.01% accuracy). Because of the many options and mounting considerations the case and switches are not included. Switches are standard types. Will fit inside standard aircraft instrument case. **9-14VDC 28.95**

### WARBLE ALARM Kit

A fun EASY kit to assemble that emits an ear piercing 10 watt dual tone scream. Resembles European siren sound. Great for alarms or toys. Operates from 5-12VDC at up to 1 amp (using 12VDC 8 ohm speaker). Over five thousand have been sold. All parts including PC board, less speaker. **2.50** ORDER WB-02

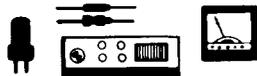
**2.50**



- \* NO C.O.D.'S
- \* SEND CHECK M.O. OR CHARGE CARD NO.
- \* PHONE ORDERS ACCEPTED ON VISA AND MASTERCARD ONLY.

- \* ADD 5% FOR SHIPPING
- \* TX. RES. ADD 5% STATE SALES TAX
- \* ORDERS OF \$50. & OVER TAKE 10% DISCOUNT
- \* FOREIGN ORDERS ADD 10% (20% AIRMAIL) U.S. FUNDS ONLY.

# flea market



**RATES** Non-commercial ads 10¢ per word; commercial ads 60¢ per word both payable in advance. No cash discounts or agency commissions allowed.

**HAMFESTS** Sponsored by non-profit organizations receive one free Flea Market ad (subject to our editing). Repeat insertions of hamfest ads pay the non-commercial rate.

**COPY** No special layout or arrangements available. Material should be typewritten or clearly printed (not all capitals) and must include full name and address. We reserve the right to reject unsuitable copy. **Ham Radio** cannot check each advertiser and thus cannot be held responsible for claims made. Liability for correctness of material limited to corrected ad in next available issue

**DEADLINE** 15th of second preceding month.

**SEND MATERIAL TO:** Flea Market, Ham Radio, Greenville, N.H. 03048.

**MOBILE IGNITION SHIELDING** provides more range with no noise. Available most engines. Many other suppression accessories. Literature, Estes Engineering, 930 Marine Dr., Port Angeles, WA 93862.

**HAPPY BIRTHDAY!** Now ten years fighting TVI. The RSO low pass filter. For brochure write: Taylor Communications Manufacturing Company, Box 126, Agincourt, Ontario, Canada M1S 3B4.

**UNLIMITED VHF/UHF EQUIPMENT** is at Radios Unlimited. From transverters to specialized transceivers, from mobile whips to E-M-E arrays. Plus all accessories. Authorized dealer for top manufacturers. (Also all your needs from 160 to 10) RUN in, write or phone — Radios Unlimited, 1760 Easton Avenue, Somerset, New Jersey 08873, 201-469-4599 — Hours 1 to 8 Mon-Fri; 10 to 8 Sat.

**ELECTRONIC EQUIPMENT HOTLINE** is a new classified advertising newsletter for buying and selling professional, industrial, and surplus electronic equipment. Subscriptions \$6/year, ads 50¢/word. Prepublication offer: \$1 off subscriptions and 20% off all ads postmarked by October 1, 1978. Electronic Equipment Hotline, P.O. Box 4768, Panorama City, CA 91402.

## Foreign Subscription Agents for Ham Radio Magazine

Ham Radio Austria  
Karin Ueber  
Postfach 2454  
D-7850 Loerrach  
West Germany

Ham Radio Belgium  
Stereohouse  
Brusselsesteenweg 416  
B-9218 Gent  
Belgium

Ham Radio Canada  
Box 114, Goderich  
Ontario, Canada N7A 3Y5

Ham Radio Europe  
Box 444,  
S-194 04 Upplands Vasby  
Sweden

Ham Radio France  
Christiane Michel  
F-89117 Parly  
France

Ham Radio Germany  
Karin Ueber  
Postfach 2454  
D-7850 Loerrach  
West Germany

Ham Radio Holland  
MRL Electronics  
Postbus 88  
NL-2204 Deift  
Holland

Ham Radio Italy  
S.T.E. Via Maniago 15  
I-20134 Milano  
Italy

Ham Radio Switzerland  
Karin Ueber  
Postfach 2454  
D-7850 Loerrach  
West Germany

Ham Radio UK  
P.O. Box 63, Harrow  
Middlesex HA3 6HS,  
England

Holland Radio  
143 Greenway  
Greenside, Johannesburg  
Republic of South Africa

**CANADIANS:** 1,000,000 surplus electronic parts. Hundreds of fantastic bargains! Good deals on Yaesu & Icom. Free catalog. ETCO-HR, 183G Hymus Blvd., Pointe Claire, Quebec H9R 1E9.

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

**PORTA PAK** the accessory that makes your mobile really portable. \$67.50 and \$88.00. Dealer inquiries invited. P.O. Box 67, Somers, Wisc. 53171.

**FREE CATALOG** of new merchandise. Resistors, capacitors, IC's, semiconductors, and more. Send to: Key Electronics, Box 3506H, Schenectady, New York 12303.

**MOTOROLA HT220, HT200,** and Pageboy service and modifications performed at reasonable rates. WA4FRV (804) 320-4439, evenings.

**AUTHORIZED DEALER** for DenTron, KLM, Larsen, Bearcat, etc., Big Catalog 201-967-4695 Narwid Electronics, 61 Bellot Road, Ringwood, N.J. 07456.

**RECONDITIONED TEST EQUIPMENT** for sale. Catalog \$5.50. Walter, 2697 Nickel, San Pablo, Ca. 94806.

**TELETYPEWRITER PARTS WANTED:** for all machines manufactured by: Klienschmidt Corp., Teletype Corp. and Mite. Any quantity, top prices paid send list for my quote. Phil Rickson, W4LNU, Rt. 6, Box 1103G2, Brooksville, Fl. 33512.

**VERY In-ter-est-Ing!** Next 3 issues \$1. "The Ham Trader", Sycamore, IL 60178.

**QSL CARDS** 500/\$10. 400 illustrations, sample. Bowman Printing, Dept. HR, 743 Harvard, St. Louis, MO 63130.

**HOMEBREWERS:** Stamp brings component list. CPO Surplus, Box 189, Braintree, Mass. 02184.

**ELECTRONIC BARGAINS, CLOSEOUTS, SURPLUS!** Parts, equipment, stereo, industrial, educational. Amazing values! Fascinating items unavailable in stores or catalogs anywhere. Unusual FREE catalog. ETCO-012, Box 762, Plattsburgh, N.Y. 12901. SURPLUS WANTED.

**TELETYPE EQUIPMENT** for beginners and experienced operators. RTTY machines, parts, supplies. Beginner's special: Model 15 Printer and demodulator \$139.00. Dozen black ribbons \$6.50; case 40 rolls 11/16 perf. tape \$17.50 FOB. Atlantic Surplus Sales, 3730 Nautilus Ave., Brooklyn, N. Y. 11224. Tel: (212) 372-0349.

**THE "CADILLAC"** of QSL's! Samples: \$1.00 (Refundable) — W5YI, Box #1171-D; Garland, Texas 75040.

**TELETYPEWRITER PARTS,** gears, manuals, supplies, tools, toroids. SASE list. Typetronics, Box 8873, Ft. Lauderdale, FL. 33310. N4TT Buy parts, late machines.

**EXCLUSIVELY HAM TELETYPE** 24th year, RTTY Journal, articles, news, DX, VHF, classified ads. Sample 35¢. \$3.50 per year. 1155 Arden Drive, Encinitas, Calif. 92024.

**MANUALS** for most ham gear made 1937/1970. Send only 25¢ coin for list of manuals, postpaid. HI, Inc., Box H864, Council Bluffs, Iowa 51501.

**QSL FORWARDING SERVICE** — 30 cards per dollar. Write: QSL Express, 30 Lockwood Lane, West Chester, PA. 19380.

**RECEIVE PARTS LISTS** regularly for \$4/yr. Surplus Parts, P.O. Box 7057, Norfolk, VA 23509.

**WANT UP-TO-DATE INFORMATION?** Radio-Hobbyist Newsletter issued every 2 weeks. Only \$5.00 year. W5YI, Box 1171-D, Garland, Texas 75040.

**EZ deals** are the best! Try me and see for Yaesu, Drake, KLM, Swan, Cushcraft, DenTron, VHF Ege, ICOM, CDE, Hustler, Wilson and more. Call, see or write W0EZ. Bob Smith Electronics, RFD 3, Hwy 169 & 7, Fort Dodge, IA 50501. (515) 576-3886.

**THE MEASUREMENT SHOP** has used/reconditioned test equipment at sensible prices; catalog. 2 West 22nd St., Baltimore, MD 21218.

**WANTED: COLLINS 51S-1 CABINET.** W9JUV, Box 406, Glenview, IL 60025.

**AMATEUR MICROPROCESSOR EXPERIMENTERS:** 10 MHz ± 20 ppm Coldweld crystals. 1 ppm/yr. 32 pF. C<sub>0</sub> 6 pF. \$4.25 ea. postpaid. Savoy Electronics, Inc., P.O. Box 5727, Ft. Lauderdale, FL 33310. 305-563-1333.

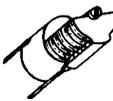
**AUTHORIZED DISTRIBUTOR** F9FT Antennas, Microwave Modules, RIW Products' new tandem reflector, 19 element, 432 MHz Yagi — Radio Clinic — N2MB (formerly WA2BIT) 212-327-4952.

## 430-450 MHz

### UHF POWER MODULE

 **430-450 MHz — Factory New, leading manufacturer. 200 Milliwatts input at 430-450 MHz will get 12 Watts output. Input Voltage is 13.6 Volts DC. No tuned circuits required. Hook-up supplied and all units tested before shipment.**  
\$10.00 ea. ppd.

**Highest Quality E. F. Johnson Trimmer Caps. Hard-to-find P.C. board mount. .5-11 mfd. No junk. 90¢ each; 10 for \$7.50 ppd.**



**In-Line Fuseholder — Complete with 5 Amp fuse. 50¢ ea. ppd.**



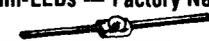
**XTAL Socket — Standard HC-6 style 10¢ ea. ppd.**

**Vertical Mount Trimmer Pots — All highest quality. No junk. 100 - 1000 - 2000 - 5000 - 10K - 20K - 25K - 50K - 250K - 500K Ohms. All have thumbscrew adjust. Your choice 5 for \$1.00 ppd.**



**Transformer — 115 VAC Primary. 12 Volt AC 200 mA Secondary. PC board type. \$1.00 ea. ppd.**

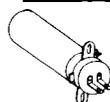
**Mini-LEDs — Factory New — Color red. 15¢ ea. ppd.**



**Germanium Diodes — 1N34A. Factory New — full leads. 12¢ ea. ppd.**

**1N914-1N4148 Type diodes — full leads. 10¢ ea. or 100 for \$8.00**

**6 foot AC Line Cords. 2 conductor heavy duty. Color white. 40¢ ea. ppd.**



**SUPER-BUY — 5000 mfd. @ 40 volt electrolytic cap. factory new and complete w/all hardware. \$1.35 ea. ppd.**

**1000 volt PIV 2 amp diodes .10 ea.**

**88 mHy unpotted toroids 5 for \$3.50**

**S0239 Coax Fittings . . . . . 50¢ ea.**

**PL259 Coax Fittings . . . . . 50¢ ea.**

**Transformer: 115V AC Primary, Secondary 17-0-17V @ 7 Amps. We tested and find good for 10 Amps intermittent duty. Ideal for 2M rigs! \$8.00 ea. ppd.**

**ALL ITEMS PPD USA  
SEND STAMP FOR LIST OF BARGAINS  
PA RESIDENTS ADD 6% SALES TAX  
FONE 412-863-7006**



**Full Electronics**  
12690 ROUTE 30  
NORTH HUNTINGDON, PA. 15462

## SLEP SPECIALS

### RADIO RECEIVERS, TRANSCEIVERS

R-390/URR Receiver, tunes 500 kHz thru 30.5 MHz, digital tuning, dual RF, audio filters, 19" rack mount, 115V/60 Hz \$495.00  
 R-390A/URR Receiver, tunes 500 kHz thru 30.5 MHz, digital tuning, mechanical filters, 19" rack mount, 115V/60 Hz \$595.00  
 R-389/URR VLF Receiver, tunes 15 kHz thru 1500 kHz, 19" rack mount, digital tuning, 115V/60 Hz \$550.00  
 HAMMARLUND SP-600JX Receiver, tunes 500 kHz thru 54 MHz, 19" rack mount, 115V/60 Hz \$375.00  
 R-388/URR Receiver, military version of the 51J-3, tunes 500 Hz to 30.5 MHz, 19" rack mount, 115V/60 Hz \$375.00  
 R-392/URR Receiver, tunes 500 kHz thru 32 MHz, digital tuning, mechanical filters, in cabinet size 11 1/2" H x 14" D x 11" L, takes 28 volts DC - 5 amps to operate. \$275.00  
 URR-13 Receiver, tuneable UHF, 225-400 MHz. Used to monitor military and satellite frequencies. In Cabinet, 115V/60 Hz \$175.00  
 COLLINS KWM-2 Xcvt w/516F-2 pwr sup. \$900.00  
 NEMS-CLARKE 1432 Telemetry Receiver, 215 to 260 MHz, FM, phase lock loop decter. By removing stops, can operate 15 to 260 MHz or further by using a converter. A fine lab rcvr. \$165.00  
 COLLINS RT-594/ARC-38A Aircraft Transceiver. 2.0 thru 25 MHz, synthesized channels 35, 250 (20 preset), 100 watts PEP, SSB, FSK, AM, CW, size 24" L x 15 1/2" W x 7 3/4" H, weight 65 lbs., requires 28 volt DC power supply. \$145.00  
 MODEL VOX-2 Technical Material Corp. Variable Frequency Oscillator. Tuneable 2 thru 64 MHz, oven controlled, 115V/60 Hz \$85.00

### TEST EQUIPMENT

COLLINS 479T-2 VOR/ILS Signal Generator. 108-135.9 MHz and 329.3 - 335 MHz, output sigs. include VOR, LOC, glide slope & 1000 CPS. Operated 28 VDC port. or bench pwr source. \$225.00  
 TS-510A Signal Generator, military version of HP608D, 10-420 MHz, AM, CW, pulse, built-in calibrator. \$425.00  
 TS-497/URR Signal Generator, 2-400 MHz, 0-100,000 microvolts, calibrated output, 400, 1000 Hz modulation. \$225.00  
 AN/URM-25 Signal Generator, 10 kHz thru 50 MHz, AM/CW, MOD 400 & 1 kHz, RF output 0-2V, DR 0-.1V from precision 50 ohm stop attenuator. \$285.00  
 AN/URM-26 Signal Generator, 4-405 MHz in 6 bands, 400 & 1 kHz MOD, attenuator variable .1 UV to .1V \$350.00  
 SG-12 FM Signal Generator, 20-100 MHz in 5 bands, RF output .5UV to .5V, deviation 0-100 kHz in 3 ranges, internal modulations \$185.00  
 SG-3 FM Signal Generator, 50-400 MHz in 3 bands, RF output .1 to .1V, variable 50 ohm attenuator, deviation 0-150 kHz in 3 ranges, internal modulation. \$385.00  
 HEWLETT PACKARD 612A UHF Signal Generator, 450-1230 MHz, output .1UV to .5V, modulation 0-90%, internal 400 and 1 kHz. \$650.00  
 MEASUREMENTS MODEL 65B Signal Generator, 75 kHz thru 30 MHz, calibrated output, fully metered, 19" rack mount, 115V/60 Hz \$175.00  
 HP410B VTVM, measure AC/RF voltages 0-300V RF to 700 MHz, resistance to 500 MEG ohms DC 0-1 KV \$95.00  
 HP416A Ratio Meter, measures reflection coefficient of a load, SWR and response of an RF system forward & reverse sigs. automatically. \$145.00  
 HP205AG Audio Oscillator, range 20 Hz to 20 kHz, input 50, 200, 500, 600 ohms, two meters with attenuators. \$165.00  
 HP400D AC VTVM, measures AC voltages from 1 MV to 300V in 12 ranges, frequency response 10 Hz to 4 MHz \$85.00  
 HP430C, measures power .1 MW to 10 MW in 5 ranges to 10 GHz \$60.00  
 HP415BR VSWR Indicator and Amplifier, used for precise VSWR measurements and a null amplifier in bridge applications. \$85.00  
 GENERAL RADIO 916AL Impedance Bridge, range 50 kHz to 5 MHz, measures resistance 0-1000 ohms and reactance 5000 ohms at 1 MHz \$285.00  
 BOONTON 250A RX Meter, measures R-C-L, a self contained bridge, range 500 kHz to 250 MHz in 8 ranges. \$375.00  
 TEKTRONIX 545A Oscilloscope, DC to 33 MHz with dual trace CA plug-in. \$550.00  
 TEKTRONIX 535 Oscilloscope, DC to 15 MHz with type "L" fast rise, high gain plug-in. \$350.00  
 TEKTRONIX 525 Television Waveform Monitor 5" CRT. Used to monitor broadcast video waveforms. \$185.00  
 TS-1379A SPECTRUM ANALYZER, range 0-30 MHz in 6 bands, 5" CRT display, 8 sweep widths from .15 to 30 kHz, sweep rate 1 sec to 10 sec, has fast sweep mode for rapid tuning. Dynamic range 60 dB, solid state. \$385.00  
 KAY ELECTRONIC 154C Solid State Wide Band Sweep Oscillator, 50 kHz to 110 MHz with PM 7650 pulse marker plug-in. \$375.00  
 All equipment shop tested. Satisfaction Guaranteed or money refunded. Send check, Master Charge or VISA, FOB Otto, N. C. N. C. residents add 4% sales tax. Phone (704) 524-7519.

**SLEP ELECTRONICS CO**

P. O. Box 100, Highway 441, Dept. HR-10  
 Otto, North Carolina 28763

**RADIO MUSEUM NOW OPEN.** Free admission, 15,000 pieces of equipment from 1850 telegraph instruments to amateur and commercial transmitters of the 1920s. Amateur station W2AN. Write for information: Antique Wireless Assn., Main St., Holcomb, NY 14469.

**TEST EQUIPMENT CATALOG** listing used Tektronix, HP and GR equipment at bargain prices. PT1, Box 8699, White Bear Lake, MN 55110. Price \$1.00 refundable with first order.

**STOP LOOKING** for a good deal on amateur radio equipment — you've found it here — at your amateur radio headquarters in the heart of the Midwest. We may not have a toll free number but we'll save you more in the long run! We are factory-authorized dealers for Kenwood, Drake, Yaesu, Collins, Wilson, Ten-Tec, Atlas, ICOM, DenTron, MFJ, Tempo, Regency, Hy-Gain, Mosley, Alpha, CushCraft, Swan, and many more. Write or call us today for low quote and try our personal and friendly Hoosier service. HOOSIER ELECTRONICS, P.O. Box 2001, Terre Haute, Indiana 47802. (812) 238-1456.

**NEW CONCEPT** — Novice instructional package, theory tale & study material. Complete license study package, \$17.95. General study package, \$19.95. MARI, 1320 Canary Drive, West Columbia, SC 29169.

**COMMUNICATIONS ENGINEERS — SENIOR TECHNICIANS** 23-36K after six month apprenticeship. We have openings for highly competent self motivated professionals with in depth knowledge of analogue and digital circuits and proven "hands on" troubleshooting ability. You will have full responsibility for maintenance of complex shipboard communications, electronics navigation, and computer systems and handle all ships communications. A second class FCC radiotelegraph license is required. If you lack the FCC license but are otherwise qualified we can train you. Outstanding vacation and fringe benefits. Submit resume in confidence to: Radio Officers Union, Attn: IME, 70 Hudson Street, Rm. 710, Hoboken, New Jersey 07030 or telephone (201)659-7370.

**TR-7, IC-701, Ten-Tec 544, IC-211, Midland 510, Mark II, KDK, WE-800, MLA-2500, VHF One-Plus, IC-280...** and on, and on. Shopping price? Better drop us a card or call us for our low, low cash quote. The Comm Center, Inc., Laurel Plaza — Rte. 198, Laurel, Maryland 20810. Telephone (301)792-0600.

**WANTED** — Radio transcription discs. Any size or speed. Larry, W7FIZ, Box 724, Redmond, Washington 98052.

**SIGNAL ONE:** CX-7B mint condition \$995. Have matching speaker, CW filter, spare finals, documentation plus many extras. W3JW, 4513 Mountain Road, Pasadena, MD 21122. (301)437-0171.

**SELLING OUT COMPLETE STATION.** Brand new HW-101, all accessories, much more. SASE for list. R. Broomfield, Route 289, Lebanon, Conn. 06249.

**COLLINS R392 USERS GROUP** now forming. Contact Ian H. Grant, 49 Silverstone Drive, #905, Rexdale, Ontario, Canada M9V 3G2.

**WILL PAY \$25.00 TO ANYONE** who can give me a demonstration of Hal, Info-Tech, or Microlog in Morse mode. W2OQK, Tracy Diers, 58-14-84th Street, Elmhurst, N.Y. 11373, Tel. (212)651-2798.

**TI PROGRAMMABLE 58 CALCULATOR.** Mint. \$65. See HR, May, p. 45. WD4GRI, 1907 Lodgepole Ave., N. Augusta, S.C. 29841.

**FOR SALE:** 16 Digit Touch Tone Converter Regenerator. Factory built Data Signal DCR-71. NEVER USED. Tested on bench and works perfectly. Like New. Cost \$325. Sell for \$210 including shipping. Leo Wilson, Rt. 4, Box 1851, Huntsville, AL 35803; Phone (205)881-2028.

**SLOW SCAN ROBOT MODEL 70** monitor, Model 61 viewfinder, Model 80 Camera. Drake T4XC, R4c, L4 Linear, TC-2, TC-6, SC-2, SC-6, CC-1, Power Supply, Calibrator, WV-4, ZEA W-4, AC-4, MS-4. Sell as complete station. Will not ship. Prefer you examine and pick up only if your bid is accepted. R. Leaf, P.O. Box 202, Dabel Branch, Dayton, Ohio 45420. No telephone calls. Letters only.

**SHACK CLEANOUT! NOVICES:** Heath HR-1680 receiver, HS-1661 speaker, SBA-104-1 noise blanker, \$200. HW-100 with CW filter, AC power supply, \$150. HG-10B VFO, \$40. George Ritter, WBBEPE. (216)368-3738 (days); (216)368-4923 (nights); (216)725-4394 (weekends).

**PC BOARDS FROM YOUR 1:1 ARTWORK.** 40¢ per square inch plus \$1.00 for postage and handling. If drilled 1¢ per hole. Please specify. Screen printing and screened component layouts available. Send for quote. Reserve right to refuse any non acceptable artwork. SP Enterprises, RT. #5, Mt. Sterling, KY. 40353.

**LABORATORY GRADE 12V POWER SUPPLIES** at ham prices. SST antenna tuners. Catalog: SST Electronics, P.O. Box 1, Lawndale, CA 90260. (213)376-5887.

# NEW FROM GLB

A complete line of **QUALITY 50 thru 450 MHz TRANSMITTER AND RECEIVER KITS.** Only two boards for a complete receiver. 4 pole crystal filter is standard. Use with our **CHANNELIZER** or your crystals. Priced from \$69.95. Matching transmitter strips. Easy construction, clean spectrum, **TWO WATTS** output, unsurpassed audio quality and built in **TONE PAD INTERFACE.** Priced from \$29.95.

**SYNTHESIZER KITS** from 50 to 450 MHz. Prices start at \$119.95.

Now available in **KIT FORM — GLB Model 200 MINI-SIZER.**

Fits any HT. Only 3.5 mA current drain. Kit price \$159.95 Wired and tested. \$239.95

Send for **FREE 16 page catalog.**

We welcome Mastercharge or VISA

## GLB ELECTRONICS

1952 Clinton St., Buffalo, N. Y. 14206

## THIS IS IT

**bird**



MODEL 4431 THRULINE®

**RF DIRECTIONAL WATTMETER** with **VARIABLE RF SIGNAL SAMPLER — BUILT IN** IN STOCK FOR PROMPT DELIVERY

AUTHORIZED DISTRIBUTOR

**Webster**  
 associates

115 BELLARMINE  
 ROCHESTER, MI 48063

CALL TOLL FREE

800 - 521-2333

IN MICHIGAN 313 - 375-0420

# The world's most popular 2 meter amateur hand-helds now are even better!!!

with the miniature-sized

## Wilson

### 2.5 watt MARK II and 4.0 watt MARK IV amateur hand-helds

Wilson hand-helds have been known world-wide for exceptional quality and durable performance. That's why they have been the best selling units for years.

Now the American made Mark Series of miniature sized 2 meter hand-helds offers the same dependability and operation, but in an easier to use, more comfortable to carry size . . . fits conveniently in the palm of your hand. Like its size, the price is also the smallest on the market.

To obtain complete specifications on the Mark II and Mark IV, along with Wilson's other fine products, see your local dealer or write for our Free Amateur Buyer's Guide.



*Illustrated with  
optional Chomaries  
or Digitran Touch Pad.*

#### SPECIFICATIONS

- Range: 144-148 MHz
- 6 Channel Operation
- Individual Trimmers on TX and RX Xtals
- Rugged Lexan® outer case
- Current Drain: RX 15 mA  
TX - Mark II: 500 mA  
TX - Mark IV: 900 mA
- 12 KHz Ceramic Filter and 10.7 Monolithic Filter incl.
- 10.7 MHz and 455 KHz IF
- Spurious and Harmonics: more than 50 dB below carrier
- BNC Antenna Connector
- .3 Microvolt Sensitivity for 20 dB Quieting
- Uses special rechargeable Ni-Cad Battery Pack
- Rubber Duck and one pair Xtals 52/52 included
- Weight: 19 oz. including batteries
- Size: 6" x 1.770" x 2.440"
- Popular accessories available



Illustrated is Wilson's  
BC-2 Desk Top  
Battery Charger  
shown charging the  
Mark Series Unit or the  
BC-4 Battery Pack only.



Consumer Products Division



## Wilson Electronics Corp.

4288 South Polaris Avenue • P. O. Box 19000 • Las Vegas, Nevada 89119  
Telephone (702) 739-1931 • TELEX 684-522

Prices and specifications subject to change without notice.

**8080 SOFTWARE** — Learn and practice copying CW and transmit using your microcomputer. Full program documentation plus source and object listings for \$6.00. TRANSCRIBIT, P.O. Box 194, Northfield, N.J. 08225.

**QRQ QRQ QRQ** for the greatest thrill in ham radio, join the 40 to 60 WPM code operators. Learn to use that high speed read-out you already have in your head: High Speed Code Receiving and Keyboard Touch Typing Course, \$3.95 postpaid USA. Introductory offer. Com-Viz Publications, Box 215, Sherman, IL 62864.

**TELETYPE EQUIPMENT AND PARTS** Model 33 KSR and many parts for sale cheap. Lee Zanteson WA6FPO, (213)792-8909.

**COLLIN'S FILTERS, \$45.00 EACH.** F455D-31 and F455H-60. Latter easily adapted to 75-A-4 receiver. Certified check or money order. Ken Hager W7KQ, Rt. 1, Box 186, Burton, WA 98013.

**CERTIFICATE** for proven two-way radio contacts with Amateurs in all ten USA call areas. Award suitable to frame and proven achievements added on request. SASE brings TAD data sheet from W6LS, 2814 Empire, Burbank, CA 91504.

**OLD TELEPHONE WANTED.** Handed upright with or without dial. Also Old spring suspended mike & Old Key. DelPopwell, W. Peiper, P.O. Box 326, D-7880 Sackingen 11.

**RTTY — NS-1A PLL Demodulator** W/AT \$26.95 ppd. Parts kit including board \$19.95 ppd. SASE for info. Nat Stinnette Electronics, Tavares, FL 32778.

**\$100 FINDER'S FEE FOR YOU** (even if finder is seller) for lead to item made by J. J. Duck Co. If I buy, \$50 for lead to crossfoot glass telegraph battery if I buy. Dr. A. E. Richmond, 7809 SW 4th Ave., Portland, OR 97219.

**FOR SALE: MAKE OFFER** Sony Betamax sl7000 K-60 Tapes ICOM IC-211; Drake FS-4, R-4C, T-4XC, AC-4, MS-4, 7075 Filters. Noise blanker. Atronics Code Reader, Heathkit phone patch/Weather station. Conar 400 trans. 500 receiver. Jerry Bayless, 316 S. Delmar, Decatur, IL (217)428-8218.

**\$100 EACH OR BEST OFFER?** New Atlas 220CS (210X power supply), National HRO 50, coil sets, TEK 561A, Dumont 303-A, Want 2M FM, Hustler RM20S, 40S, MO2. Reid W6MTF, 2701 Durant, Apt. 9, Berkeley, CA 94704.

**CALL PINS 3 lines 1-1/4 x 3-1/4 \$1.55 each.** Call — First Name and Club. Colors black, red or blue with white letters. (Catalog) Arnold Linzner, 2041 Linden Street, Ridgewood, N.Y. 11227.

**I WOULD LIKE TO TRADE** my Western Data Systems 6502 based computer for an SSB xmt, SSB xcvr, or 2-meter FM xcvr. WB6WDI, P.O. Box 234, Mt. Shasta, CA 96067.

**HAM RADIO MAGAZINES** — Vol 1 No. 1 through today (complete set) in HR binders — Mint! \$225 or trade for model railroad base. Steve Hyett, 1440 Royal St. George, Naperville, IL 60540.

## Coming Events

**OCTOBER 1** — Talk-in WR4ADH — 146.34/146.94. North West Georgia ARC Hamfest Fairgrounds, Rome, GA WA4IBI Scott Lomax, (404)278-2581.

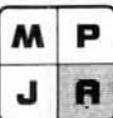
**MICHIGAN:** R.A.D.A.R. The Repeater Association of Downriver Amateur Radio is holding its 2nd annual swap & shop on Sunday, Oct. 22, 1978 at Kennedy High School in Taylor, Michigan. Located on Northline Rd. East of Telegraph Rd. (U.S. 24). Admission \$2.00. For info write R.A.D.A.R. Inc., P.O. Box 1023, Southgate, Michigan 48195.

**MASSACHUSETTS:** Hampden County Radio Association's annual Ham and Electronic Equipment auction, Friday, October 6, Feeding Hills Congregational Church, Feeding Hills. Doors open — 7PM — Auction 8PM. For info Larry Soltz, WB1CJH, (413)567-6707.

**MARYLAND:** The Foundation for Amateur Radio's annual Hamfest, Gaithersburg Fairgrounds, Gaithersburg, Sunday, October 8. Flea market, food, exhibits, ladies and children's programs. Picnic grounds and free parking. Fee: \$2.00, flea market space \$5.00 each, commercial \$15.00 each. Pre-registration required prior to October 4. Talk-in provided. For info Ron Levin, W3GBU, 802 Greenview Court, Reistertown, MD 21136. (301)833-1818.

**NEW YORK:** LIMARC Hamfest, Islip Speedway, Islip Avenue (Rt. 111), Islip, Long Island, October 15. Gate opens 9:30 AM. Admission: \$1.50. Ladies and children under 12 free. Sellers and exhibitor's spaces \$3.00 each. Limarc tune-up clinic (bring your own power cord). Talk-in 146.25/85 or 52. For info, Hank Wener, WB2ALW, 53 Sherrard St., East Hills, NY 11577 — (516)484-4322 evenings or Ken Denston, WB2RYC (516)379-6463 evenings.


**MARLIN P JONES & ASSOCIATES**  
PO BOX 9023  
RIVIERA BEACH, FLORIDA 33404  
(305) 848-8236



\*FLA. RESIDENTS ADD 4% SALES TAX  
\*N.C. & VISA ACCEPTED  
\*ADD \$1.00 FOR ORDERS UNDER \$10.00  
\*USA ORDERS ADD 5% FOR SHIPPING  
\*FOREIGN ORDERS PLEASE ALLOW SUFFICIENT POSTAGE

## DIPOLE HEADQUARTERS

Famous "W2AU" Balun



MODEL 1:1 OF MODEL 4:1 \$14.95

HANDLES FULL 2 KW PEP AND THEN SOME (Broad Banded 3 to 40 Mc HELPS TVI PROBLEMS BY Reducing Coax Line Radiation NOW ALL STAINLESS STEEL HARDWARE. 50/20 Double Silver Plated IMPROVES F.R.B. RATIO BY Reducing Coax Line Pick Up. REPLACES CENTER INSULATOR. Withstands Antenna Pull of Over 600 Lbs. BUILT-IN LIGHTNING ARRESTER. Helps Protect Balun — Could Also Save Your Variable Cap. BUILT-IN HANG UP HOOD. Ideal for Inverted Yees. Multi-Band Antennas. Dipoles, Beam and Quads.

MINIMUM ORDER \$10.00

<b>CABLE</b>	
SU FOAM, hi density braided, 50'	\$11.95
SU FOAM, hi density braided, 100'	22.00
ROSBAR, stranded center, 100'	3.95
RG58, 2 ft. w/PL259 on each end.	3.05
RG58, 5 ft. w/PL259 on each end.	3.35
RG58, 5 ft. w/PL259 on each end.	3.65
RG58, 12 ft. w/PL259 on each end.	4.45
RG58, 50 ft. w/PL259 on each end.	7.84
GUY WIRE, steel/plastic, 100 ft.	4.95
<b>COPPER WIRE</b>	
#14 STRANDED, 100' spool.	\$5.95
#14 SOLID, enameled, 100' spool.	5.95
<b>INSULATORS</b>	
AIRPLANE style, porcelain ins., wt. 2 lb.	2/3 .99
DOG BONE style, porcelain ins., wt. 2 lb.	3/ 1.25
NAIL KNOB style, stand off ins., wt. 3 lb.	4/ 1.20
HY GAIN #155 center insulator, wt. 1.5 lb.	5.95
HY GAIN Cycotec and ins. pair, wt. 1 lb.	3.95
MOSLEY dipole center insulator, wt. 1 lb.	4.25
<b>CONNECTORS and ADAPTORS</b>	
PL259, UHF male conn. .... 2 for \$1.59	
SO239, UHF female, chas. mtg. .... .80	
UG175, Adapts RG58 to PL259 .... 2 for .50	
UG176, Adapts RG58 to PL259 .... 2 for .50	
PL259, UHF double female .... .99	
DM-SP, UHF double male conn. .... 1.99	
M389, 90 deg. UHF elbow conn. .... 2.10	
UG284, BNC male for RG58 .... 2.00	
IO94, BNC female chassis mtg. .... .99	
M358, UHF "T" connector .... 2.10	
UG255, Adapts UHF female to PL259 .... 2.00	
UG273, Adapts BNC female to UHF male .... 1.59	



**SPECTRONICS, INC.**

1009 Garfield St. Oak Park, Illinois 60304

(312) 848-6777

## COLLINS & MORE Ham Gear

Collins 312B4, Sta. Cntl., rd., exc.	\$250
Collins 312B5, Vfo Console, exc.	\$550
Collins 32S3, Transmitter, rnd., exc.	\$850
Collins 75S3B, Ham receiver, vy gd	\$695
Collins 75A4, Ham receiver, vy gd	\$425
Collins 51S1, 2-30MHz rcvr	Special
Collins R-388/51J3 receiver, vy gd	\$425
Hammarlund SP-600JX, rcvr	\$395
Collins CP-1 Crystal Pack	\$195
Racal 6217E, .5-30MHz receiver	Special
New R390A rcvr avail. Call for quote.	
Collins 312B4 Console, rnd., new, orig. box	\$325
Collins 30S1 Linear, wing, excellent	\$1695
National NCL 2000, 2kW Linear, exc.	\$550
Johnson 2kW Matchbox w/swr meter	\$225
Collins 302C3 wattmeter, vy gd	\$125
Collins 75S2 ham receiver, vy gd	\$450
Collins 32S3 ham transmitter, vy gd	\$450
Yaesu FTDX-570 transceiver, vy gd	\$475

## Test Gear

Boonton Radio 225A 10-500MHz sig. gen., like new	\$475
HP-200CD wide-range oscillator	\$175
HP-202H 54-216MHz AM/FM sig. gen.	\$695
HP-608D 10-420MHz sig. gen.	\$550
<b>Power Designs</b>	
#605, 6VDC, 500mA, lab. p/s	\$60
#1210, 12VDC, 10A, lab. p/s	\$95
Measurements Mod. 65B, LF sig. gen.	\$325
260A Q-meter, exc.	\$450
Model 80, 2-400 MHz sig. gen.	\$350
Tek 465 portable scope, excellent	\$1650

We stock good, used equipment from Collins, Drake, Heath and other manufacturers. Hundreds of test items also available. Call for specific requirements, or write for free catalog.

## DAMES COMMUNICATION SYSTEMS

201-998-4256  
10 SCHUYLER AVENUE  
NORTH ARLINGTON, N. J. 07032

All equipment sold checked and realigned

# SOME DRY INFORMATION ABOUT OUR ALL WEATHER ANTENNAS

Sooner or later almost all ordinary ham antennas are going to become victims of bad weather.

But Shakespeare's brand new line of two meter and HF antennas is anything but ordinary.

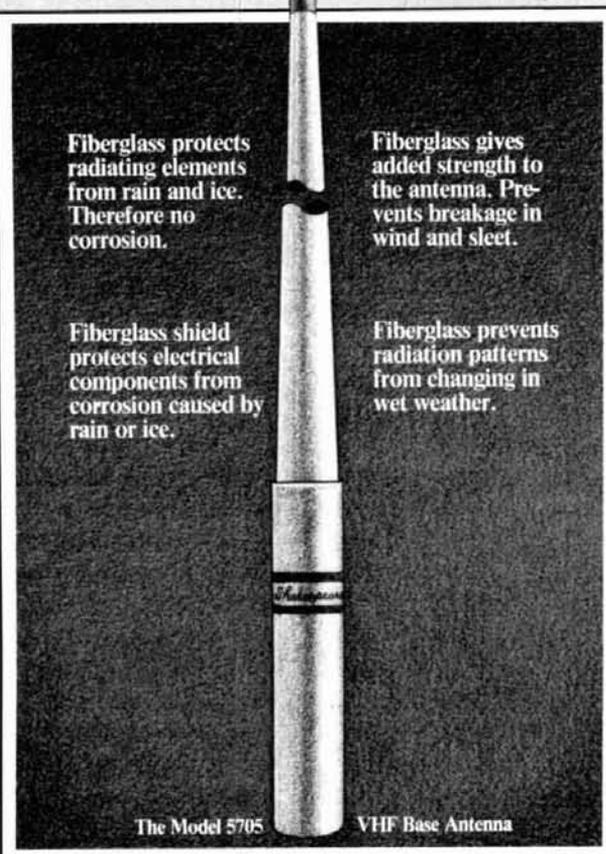
We're new to the ham market, but we've been making marine and military antennas for 26 years.

And those 26 years have taught us how to make a ham antenna that'll take just about anything Mother Nature can dish out.

Look at our 5705 omnidirectional VHF base antenna, for example.

Its radiating elements are non-ferrous brass and copper, the finest practical material available for conductivity and corrosion resistance. Surrounding the radiating elements and electrical components is a tough, flexible fiberglass shield. A shield that gives the antenna the strength to withstand winds in excess of 120 miles-per-hour.

The fiberglass keeps out rain, sleet and snow too. So the antenna's radiation pattern won't change, no matter how bad the weather.



And you don't have to worry about radials breaking off, because the 5705 doesn't have any.

But it does have seven vertically polarized and phased 1/2 wave elements, stacked in colinear array.

And you can get optional style 5709 reflector that blocks out unwanted coverage in one direction and gives you an additional gain in the opposite direction.

And here's another important piece of information: the 5705 is pre-tuned at our factory to operate in all environments. So you will never have to have it re-tuned.

Our full ham antenna line is featured in our new catalog: *The Complete Works of Shakespeare*. And

the catalog is yours. For free. All you have to do is ask for it.

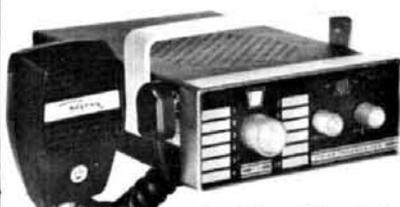
Just drop us a line at Shakespeare, Electronics and Fiberglass Division, Department C, Post Office Box 246, Columbia, South Carolina 29202.

Or call National Sales Manager John Hughes, WA4EAU or (803) 779-5800.

*Shakespeare*<sup>®</sup>

# BIG REGENCY FM CLOSEOUT

Don't pass up the Savings!



HR-2B 2m Fm Xcvt. 15w, 12ch w/94 crystals, mic & mt. (Reg. \$229) ... **CLOSEOUT \$139.00**



HR-312 2m FM Xcvt. 30w, 12ch T/R w/94, mic & mt. (Reg. \$269) ... **CLOSEOUT \$169.00**

HR-6 6m FM Xcvt. 25w, 12 ch T/R w/52.525, mic & mt. (Reg. \$239) ... **CLOSEOUT \$149.00**

HR-220 220 MHz FM Xcvt. 12 ch T/R w/223.5, mic & mt. (Reg. \$239) ... **CLOSEOUT \$149.00**

HR-440 440 MHz FM Xcvt. 10w, 12 ch w/ 446.0, mic & mt. (Reg. \$349) ... **CLOSEOUT \$249.00**

AR-2 2m FM Power Amplifier. 13.8vdc - 9 A. max. 5db power gain. 10 to 25w input for 32 to 80w output. (Reg. \$119) ... **CLOSEOUT \$99.00**

HRT-2 Basic 2m FM Hand-Held Xcvt. 2 or 1w, 5 ch w/94 crystals. Whip antenna. No other accessories. (Reg. \$179) ... **CLOSEOUT \$99.00**

HRT-2 Deluxe. As above, but includes Nicad Battery. Charger, Flexible Antenna, External Microphone, Earphone, Case and DC Cord with plug (Reg. \$295) ... **CLOSEOUT \$195.00**

All NEW - Full Warranty!

Extra crystals for 2/6m - \$5.00 each, 220/440 MHz - \$10.00 each. Quantities Limited - Order direct from this ad. Send Check, Money Order or use your Mastercharge or BankAmericard (VISA). Allow \$5.00 for UPS shipping charges.

Write for FREE  
1978 CATALOG



## AMATEUR ELECTRONIC SUPPLY®

4828 West Fond du Lac Avenue  
Milwaukee, Wisconsin 53216  
Phone (414) 442-4200

### BRANCH STORES:

28940 Euclid Avenue; Wickliffe, Ohio 44092  
Phone: (216) 585-7388  
621 Commonwealth Ave.; Orlando, Fla. 32803  
Phone: (305) 894-3238

Note: Branch Stores are set-up to handle Walk-in business or telephone orders only. They do not have facilities to respond to written inquiries.

**NEW JERSEY:** Knight Raiders VHF Club Auction & Flea Market, St. Joseph's Church, East Rutherford, Saturday, October 14. Doors open 10:00 AM. Free admission/parking. Flea market tables - \$6.00/full or \$3.50/half. Talk-in 146.52 and 144.65/145.25. For info: Bob Kovaleski, (201)473-7113 or Bob Czerwinski (201)791-5651. Evenings only.

**INDIANA:** Marshall County ARC's 3rd annual Swap and Shop Hamfest, the Armory, 11th and West Madison Sts., Plymouth, October 29, 7:00 to 4:00. Donation \$2.00. Free tables. For info and res. tables: Melvin Mahler, P.O. Box 151, Plymouth, IN 46563.

**MISSISSIPPI:** Gulf Coast Ham/Swap Fest, Sunday, October 22, International Plaza, west end of Biloxi/Ocean Springs bridge, Highway 90, Biloxi. Donation: \$1.00. Tables \$2.00. Talk-in 146.13/73 and 146.52. For info, advance tickets and tables: Irvin L. Kelly, K5YIN, 116 Wiltshire Blvd., Biloxi, MS 39531. (601)374-3340.

**MISSOURI:** Mo-Kan Council of ARC's ARRL Convention, Hilton Airport Plaza Inn, Kansas City. October 13, 14, and 15. Exhibits, Ladies' program, luncheon, fashion show, Saturday night banquet (\$12.00/person). Pre-registration \$3.00. Checks to Mo-Kan Council of ARCs, P.O. Box 704, Kansas City, MO 64141.

**NEW YORK:** Radio Amateurs of Greater Syracuse 14th annual Hamfest, New York State Fairgrounds, Arts and Home Center, Syracuse, Saturday, October 7. 9AM to 6PM. Talk-in 90/30 - 31/91. Exhibits, indoor/outdoor flea market, ladies programs. Tickets before October 1 - \$1.50. \$2.00 gate. Under 12 free. Overnight and trailer parking available. For info R.A.G.S., P.O. Box 88, Liverpool, N.Y. 13088.

**ONTARIO:** London Amateur Radio Club will hold its 10th annual RSO Convention October 13th, 14th and 15th at the Downtown Holiday Inn City Center Tower, London, Ontario. A Friday night Oktoberfest-type Eyeball is FREE to all registrants and their spouses. Events and programs for the weekend include contesting, antennas, DXing, CW-FM-RTTY-ATV-SSB discussions, technical topics, computers and AMSAT, R.S.O. - CARF - CRRL forums, and DoC discussion. Saturday night banquet, prizes, and dancing to the big band sounds. Sunday flea market, and much, much more. Talk-in (VE3RSO) 75 sb, 3775 kHz; 2-meter FM 146.46/147.06 (VE3LAC). For more information write London Amateur Radio Club, Inc. Attention: Convention Tickets, P.O. Box 82, Station B, London, Ontario N6A 4V3.

**NEW YORK:** The annual United States Air Force Military Affiliate Radio System (USAF MARS) Region One Convention will be held in Albany, New York on October 13-15, 1978. For more information write Convention Committee, P.O. Box 1978, Boiceville, N.Y. 12412.

**NEW JERSEY:** Livingston ARC Annual Fleamarket, Saturday, October 14, 1978 from 10AM until 4PM at the Fairfield United Methodist Church, corner of Plymouth and Horseneck Road, near Route 80 and only one block from Route 46. Registration \$4 per car space; buyers and lookers free. Refreshments. For more information, write LARC, 116 Orton Road, W. Caldwell, N.J. or call (201)226-7943.

**ISLAND DX AWARD:** Sponsored by Radio Amateurs residing on Whidbey Island, the IDX Award is available to all Radio Amateurs and SWLs of the world who can meet some simple requirements: QSL confirmations from 50, 100, 150, or 162 (max possible) islands including Whidbey Island. Special band and mode endorsements are added features of this attractive award certificate. Since not all islands are qualified contacts, each Amateur should have the IDX special Island Listing and a copy of the rules. As an added incentive, a special IDX wall plaque will be awarded to the first Radio Amateur who confirms the maximum possible number of recognized islands. Please send large business-size SASE to Bill Gosney, WB7BFFK, 2665 North, 1250 East, Whidbey Island, Oak Harbor, Washington 98227. Foreign amateurs please include 5 IRCs.

**JAMBOREE ON THE AIR:** annual gathering of Scouts, former Scouts and interested hams on the Amateur Radio bands reaches a milestone in October - It's twenty-first birthday! The jamboree-on-the-air will be held over the weekend of 21st and 22nd October starting at 0001 LOCAL time on Saturday, October 21, 1978 and terminating 2359 LOCAL time on Sunday, October 22, 1978. However, each station is permitted to select its own operating schedule, including Friday evening, if desired. Frequencies suggested: Phone: 3940, 7190, 14290, 21360, 28990 and 52500 kHz. CW: 3590, 7030, 14070, 21140, 28090 kHz. SSTV: normal SSTV frequencies. The World Scout Bureau plans to operate from a special camp about 15 km. from Geneva, Switzerland, and will use the callign HB9S/portable. They plan to be on all bands simultaneously and all modes including SSTV, RTTY, and OSCAR. For more information, write: Harry A. Harchar, W2GND/K2BSA, Boy Scouts of America, North Brunswick, N.J. 08902; telephone (201)249-6000.

Practical experience with  
Superior Quality Materials  
and Construction that's...

# TOWER POWER by TRISTAO

Tristao isn't just a trade name... it's a man called Lou, and he's been designing towers for hams all his life...the pioneer. That's why Tristao towers above all. And because he knows hams, he engineers quality at prices you can afford. From Mini-Masts to the giants, it's TOWER POWER all the way with Tristao.

WRITE RIGHT NOW FOR FULL SPECS and dealer nearest you. PROMPT DELIVERY.

## TRISTAO TOWER

Division of Palmer Industries, Inc.

415 E. 5th St. - P.O. Box 115

Hanford, CA 93230 / Ph. (209)582-9016

### ALDELCO ELECTRONICS COMPANY

RF DEVICES			
2N3375 3W 400 MHz	5.50	2N6080 4W 175 MHz	5.40
2N3866 1W 400 MHz	.99	2N6081 15W 175 MHz	8.45
2N5589 3W 175 MHz	4.75	2N6082 25W 175 MHz	10.95
2N5590 10W 175 MHz	7.80	2N6083 30W 175 MHz	12.30
2N5591 25W 175 MHz	10.95	2N6084 40W 175 MHz	16.30

ALD-1158 12 Watts. 200 MHz, T0117. Has 8/32 Heat Sink Stud. Similar to 25C1177. Fits Standards. **Only \$12.30**

OVERVOLTAGE PROTECTION. OV-12 Provides protection from runaway Power Supply Voltage. Triggers @ 16V. 25 Amp rated. 1 piece moulded unit for 12 Volt DC fused Power Supply \$7.95 OV-5 for 5 Volt PS triggers at 7V \$7.95. Other Voltages \$9.95

ACCUCKEYER KIT. Similar to Handbook version. Includes PC Board, IC's, Sockets & all parts. **\$19.95**

ACCUCKEYER MEMORY KIT. Matches our Accucyker and many other keyers. Two memories of 30 Characters each. (2 1101 Memory Chips). Includes PC Board, IC's, Sockets and all parts. **\$19.95**

Dual digital 12 or 24 HOUR CLOCK KIT. NOW WITH A NEW WALNUT WOOD GRAIN CABINET. Model ALD 5-W. Six Big 0.5 Displays. **Only \$49.95** 12 or 24 Hour Operation - Each Clock controlled separately. Freeze Feature for Time Set - Easy assembly for clock and Cabinet.



ALD 1158 Replaces SD1177 12 Watts **\$12.30**  
2N5590 RF Transistor 10 Watts 175 MHz **\$5.95**

ALARM CLOCK KIT. Six 0.5 LED Display Readouts. Elapsed Time indicator. 12 Hour Format with 24 Hour Alarm Snooze feature. AM/PM indicator. Power Supply power failure indicator. **Only \$19.95**  
12 or 24 Hour Clock Kit. 0.5 Display LED's **\$18.95**  
Wood Grain Cabinet **\$4.95**

TUNABLE AMATEUR TV CONVERTER. Receive Fast Scan ATV in the 420 MHz Band with any TV Set. Low noise high gain Amplifier stage with Varactor Tuned input and output. Built-in 110 VAC Supply. Two Tone Walnut & Beige Cabinet measuring 1-7/8" x 4-1/4" x 4-1/8". Factory Wired & Tested. 2 Year Warranty **Only \$49.95**

Adjustable Power Supply Kits. 500 mA 5 to 15 Volts **\$6.95**  
12 to 20 Volts **\$6.95**  
Power Supply Kit of Parts, 5 Volt 6 Amp (add \$1.00 per Power Supply shipping) **\$17.95**

Add 6% for Shipping. Min. Order \$10.00 out of USA send Certified Check or Money Order. Include Postage.

# ALDELCO

2281H Babylon Turnpike, Merrick, N. Y. 11566

(516) 378-4555

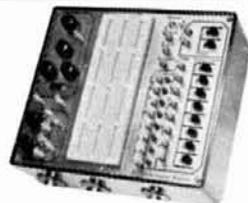
Send 1st class stamp for our catalog.

# YOUR BEST BUY IN KITS

# FREQUENCY COUNTERS

## 6 GOOD REASONS FOR BUYING A HAL-TRONIX FREQUENCY COUNTER

(1) 100% COMPLETE KIT, (2) EASY ASSEMBLY, (3) COMPLETELY ENCLOSED IN METAL CABINET, (4) IC SOCKETS USED THROUGHOUT FOR EASY TTL REPLACEMENT (5) EASY ON YOUR POCKET BOOK, AND (6) NO EXPENSIVE CHIPS TO REPLACE (EXAMPLE — IF YOU LOSE A DECODER, LATCH OR DRIVER IN A HAL-TRONIX COUNTER, THE AVERAGE COST OF REPLACEMENT OF THE LOW-COST TTLS IS LESS THAN \$1.00 EXCLUDING THE PRE-SCALE CHIP. IN SOME OF THE NEWER COUNTERS NOW BEING MARKETED BY MY COMPETITION, THEY ARE USING THE EXOTIC SINGLE CHIP AND WOULD COST YOU CLOSE TO \$30.00 TO REPLACE). THIS IS SOMETHING YOU SHOULD CONSIDER.



### ANALOG-DIGILAB KIT \$139.50

DESIGNED BY HAL-TRONIX AND MIKE GOLDEN OF R.E.T.S. ELECTRONICS SCHOOL OF DETROIT. FOR RUGGED CLASSROOM USE.

FOR THE RADIO AMATEUR, STUDENT, EXPERIMENTER OR DESIGNER  
 SPECIFICATIONS: OUTPUT VOLTAGES: +5V, +12V, -12V; USABLE CURRENT: 750mA; % Regulation at 500mA: 0.2%; Short-circuit limited at 1.0 amp; Thermal overload protected. Power requirements: 117VAC, 60HZ, 40 Watts.  
 Function Generator: Frequency range: 1HZ to 100 HZ in 5 bands. Amplitude adjustable from 0 to 10 VPP. DC offset adjustable from 0 to  $\pm 10V$ . Waveforms: Sine, square, triangular and TTL Clock. TTL Clock 0 to +5V level, 200 ns rise and fall time. Frequency determined by Function Generator. Output impedance 1.2K ohm.

Most of all, it's easy to construct and service. PC boards are predrilled, plated thru and solder flowed. Over 1000 units sold to schools.

## NEW FROM HAL-TRONIX FIRST TIME OFFER

**6-DIGIT ALARM CLOCK KIT** for home, camper, RV, or field-day use. Operates on 12-volt AC or DC, and has its own 60-Hz time base on the board. Complete with all electronic components and two-piece, pre-drilled PC boards. Board size 4" x 3". Complete with speaker and switches. If operated on DC, there is nothing more to buy.

PRICED AT **\$16.95**  
 Twelve-volt AC line cord for those who wish to operate the clock from 110-volt AC. **\$2.50**

\*Fits clock case advertised below.

### 6-DIGIT CLOCK 12/24 HOUR

COMPLETE KIT CONSISTING OF 2 PC G10 PRE-DRILLED PC BOARDS, 1 CLOCK CHIP, 6 FND 359 READ-OUTS, 13 TRANSISTORS, 3 CAPS, 9 RESISTORS, 5 DIODES, 3 PUSH-BUTTON SWITCHES, POWER TRANSFORMER AND INSTRUCTIONS INCLUDED. DON'T BE FOOLED BY PARTIAL KITS WHERE YOU HAVE TO BUY EVERYTHING EXTRA.

PRICED AT **\$12.95**

**CLOCK CASE** Available and will fit any one of the above clocks  
 Regular Price... \$6.50 But Only **\$4.50** when bought with clock

### 60-HZ TIME BASE

CRYSTAL TIME BASE KIT. WILL ENABLE MOST ALL DIGITAL CLOCKS TO OPERATE FROM 12 VDC. LOW PROFILE UNIT. EASY 3-WIRE HOOKUP. ACC 2PPM. ADJUSTABLE.  
 COST ONLY \$4.95 EACH OR 2 FOR \$9.00 — OR ONLY \$4.50 WITH CLOCK PURCHASE.

### ATTENTION RADIO CLUBS

For club or group projects, request FREE information about our DISCOUNTS on any of the HAL-TRONIX kits. Discounts range from 10-25%, depending upon the quantity needed.

We are experienced in supplying kits in volume quantities to schools, laboratories, clubs, and common-interest groups. Nobody beats HAL-TRONIX quality and price. Just try us and see for yourself.

### 10-MHz CRYSTALS

HI-QUALITY CRYSTALS, DESIGNED FOR FREQUENCY CONTROL AND ELECTRONIC TIME PIECES; AGING FACTOR 5PPM. MEETS OR EXCEEDS MIL-C-3098 SPECS. MADE ESPECIALLY FOR HAL-TRONIX BY SENTRY.  
 PRICE \$5.95 OR 2 FOR \$10.00

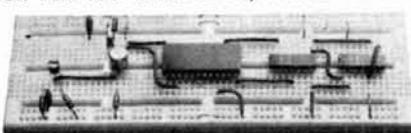
## WATCH FOR FUTURE ANNOUNCEMENTS OF NEW HAL-TRONIX KITS — ON THE WAY:

- POCKET-SIZE FREQUENCY COUNTERS
- CAPACITANCE METERS
- FUNCTION GENERATOR

DISTRIBUTOR FOR **A P PRODUCTS, INCORPORATED**



**SUPER STRIP SS-2 #923252 PRICE \$17.00**



**BY POPULAR DEMAND** — we are continuing to offer with any purchase of \$99 or more from ad or flyer, a Fairchild clock module FCS-8100A (suggested retail price \$20).



## Look at these Summer Specials

**COMPLETE KITS:** CONSISTING OF EVERY ESSENTIAL PART NEEDED TO MAKE YOUR COUNTER COMPLETE. **HAL-600A** 7-DIGIT COUNTER WITH FREQUENCY RANGE OF ZERO TO 600 MHz. FEATURES TWO INPUTS: ONE FOR LOW FREQUENCY AND ONE FOR HIGH FREQUENCY; AUTOMATIC ZERO SUPPRESSION. TIME BASE IS 1.0 SEC OR .1 SEC GATE WITH OPTIONAL 10 SEC GATE AVAILABLE. ACCURACY  $\pm .001\%$ . UTILIZES 10-MHz CRYSTAL 5 PPM.

COMPLETE KIT... ~~\$149~~... **\$129**

**HAL-300A** 7-DIGIT COUNTER WITH FREQUENCY RANGE OF ZERO TO 300 MHz. FEATURES TWO INPUTS: ONE FOR LOW FREQUENCY AND ONE FOR HIGH FREQUENCY; AUTOMATIC ZERO SUPPRESSION. TIME BASE IS 1.0 SEC OR .1 SEC GATE WITH OPTIONAL 10 SEC GATE AVAILABLE. ACCURACY  $\pm .001\%$ . UTILIZES 10-MHz CRYSTAL 5 PPM.

COMPLETE KIT... ~~\$124~~... **\$109**

**HAL-50A** 8-DIGIT COUNTER WITH FREQUENCY RANGE OF ZERO TO 50 MHz OR BETTER. AUTOMATIC DECIMAL POINT, ZERO SUPPRESSION UPON DEMAND. FEATURES TWO INPUTS: ONE FOR LOW FREQUENCY INPUT, AND ONE ON PANEL FOR USE WITH ANY INTERNALLY MOUNTED HALTRONIX PRE-SCALER FOR WHICH PROVISIONS HAVE ALREADY BEEN MADE. 1.0 SEC AND .1 SEC TIME GATES. ACCURACY  $\pm .001\%$ . UTILIZES 10-MHz CRYSTAL 5 PPM.

COMPLETE KIT... ~~\$124~~... **\$109**

### ATTENTION RADIO CLUBS

For club or group projects, request FREE information about our DISCOUNTS on any of the HAL-TRONIX kits. Discounts range from 10-25%, depending upon the quantity needed. We are experienced in supplying kits in volume quantities to schools, laboratories, clubs, and common-interest groups. Nobody beats HAL-TRONIX quality and price. Just try us and see for yourself.



## FROM HAL-TRONIX

**DELUXE 12-BUTTON TOUCH-TONE ENCODER KIT** utilizing the new ICM 7206 chip. Provides both VISUAL AND AUDIO indicators! Comes with its own two-tone anodized aluminum cabinet. Measures only 2 3/4" x 3 3/4". Complete with Touch-Tone pad, board, crystal, chip and all necessary components to finish the kit.

PRICED AT... **\$29.95**

For those who wish to mount the encoder in a hand-held unit, the PC board measures only 9/16" x 1 1/4". This partial kit with PC board, crystal, chip and components.

PRICED AT... **\$14.95**

### PRE-SCALER KITS

**HAL 300 PRE** ..... **\$19.95**  
 (Pre-drilled G10 board and all components)

**HAL 300 A/PRE** ..... **\$24.95**  
 (Same as above but with preamp)

**HAL 600 PRE** ..... **\$34.95**  
 (Pre-drilled G10 board and all components)

**HAL 600 A/PRE** ..... **\$39.95**  
 (Same as above but with preamp)

### SPECIAL — due to OVERSTOCK (while they last!) FAIRCHILD FND-70

common cathode readouts (can replace FND-359... same pin-out)

Qty.	Price each	Amount
10	40c	\$4.00
100	35c	35.00
500	30c	150.00
1000	25c	250.00



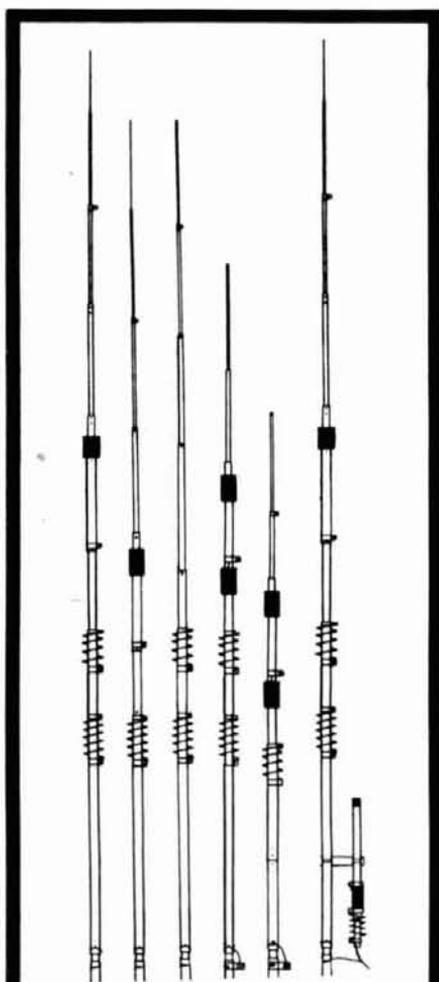
"HAL" HAROLD C. NOWLAND WBZHX

## HAL-TRONIX

PO BOX 1101, SOUTHGATE, MI 48195  
 PHONE (313) 285-1782

### SHIPPING INFORMATION:

ORDERS OVER \$15.00 WILL BE SHIPPED POSTPAID EXCEPT ON ITEMS WHERE ADDITIONAL CHARGES ARE REQUESTED ON ORDERS LESS THAN \$15.00 PLEASE INCLUDE ADDITIONAL \$1.00 FOR HANDLING AND MAILING CHARGES. SEND SASE FOR FREE FLYER.



## PILE-UP TESTED!

- Model HF5V-II -- Automatic bandswitching 80-10 meters.
- Model HF4V-II -- Automatic bandswitching 40-10 meters.
- Model HF3V -- Automatic bandswitching 80-20 meters.
- Model HF5V-S -- Automatic bandswitching 80-10 meters.
- Model HF4V-S -- Automatic bandswitching 40-10 meters.
- MODEL TBR -- 160 Meter base resonator unit.

The most choice  
in vertical antennas from



ROUTE 1; LK. CRYSTAL, MN. 56055

Phone: (507) 947-3126

AT YOUR DEALER OR FACTORY DIRECT...  
FREE INFO!

8-POLE 350-Hz FILTER FOR SIGNAL/ONE TRANSCEIVERS \$120.00

### Finally! Superior 8-Pole CW Selectivity for Drake TR-4, TR-4C, TR-4 Cw

350 Hz at -60db, 500 Hz at -60db, Cuts QRM. More selective than 6-pole CW filter in new TR-4Cw which is 500 Hz at -60db, and 2000 Hz at -60db. CF-350/B \$100.00. Switch and mounting kit \$10.00

### At Last! Superior 8-Pole CW Selectivity for Kenwood TS-820

MINIMAL LOSS IN SET. GOOD SIGNAL TO NOISE. 350 Hz at 60db, 500 Hz at 60db. Cuts QRM. More selective than standard YG-68C 6-pole CW filter which is 500 Hz at 60db, and 1800 Hz at 60db. CK-350/B \$100.00

### 600 Hz 6-Pole First-IF Filter for Drake R-4C

Improve the early-stage selectivity. Eliminate those high-pitched beeps from signals that leak around the switchable second-IF filter. Minimize the chance of strong signals overloading the second mixer, causing intermodulation and desensitization. Both the existing filter and our CF-600/B can be mounted in the receiver and relay switched to retain phone capabilities. CF-600/B \$80.00. Relay switch kit \$33.00

### 125 Hz 8-Pole Second-IF Filter for Drake R-4C

Still sharpest available! 300 Hz at -60db! Cuts QRM. Ideal for DX and contest work. Unexcelled under crowded band conditions. Does what no audio filter can do. More selective than audio filters. Pure selectivity in AGC loop. Unlike with audio filters, receiver gain not reduced by QRM outside passband. Yet works well with an audio filter to improve receiver performance. Plug directly into an accessory filter socket of the R-4C. CF-125/B \$130.00

**CW Operators!**  
**Attention:**  
**These crystal filters**  
**are for you!**

All filters contain specially-treated high-Q crystals.

**Sherwood Engineering Inc.**

1268 South Ogden St.

Denver, Colo. 80210

(303) 722-2257

Money back if not satisfied

Add \$3 per order shipping;

\$6 overseas air

Dealer Inquiries Welcome

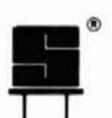


The **only** thing you need to know about Quartz Crystals is:

# 1-405-224-6780

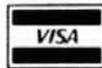
- ★ Best Delivery *plus* Emergency Service with Guaranteed Delivery
- ★ Highest Quality with gold MIL-C-3098 Process
- ★ Ask for *Sentry Technology Manual*

And, order Toll Free 1-800-654-8850



## Sentry®

CRYSTAL PARK  
CHICKASHA, OKLAHOMA 73018



**COMPLAINTS?**  
... SEE FOR YOURSELF!

**NATIONWIDE SPECTRUM-ANALYSIS SERVICE**

FOR ALL LEGAL AMATEUR TRANSMITTERS.

Now you can get written proof of your unit's transmit non-purity with spectrum analysis done on HF lab equipment. All units carefully re-packed, insured and shipped within 24 hrs. Send 20¢ or SASE for full details and authorization form.

PHOTOGRAPH OPTIONAL

MOST 8M UP **\$17.95**

MOST HF **\$25.00**

**SPECTRONICS, INC.**  
(312)848-6777 1009 GARFIELD ST. OAK PARK, ILL. 60304

### TRANSFORMERS

American made, 115V Pri. All ppd.

12V 1.2 amp	\$2.84 ea.
12V 3 amp	\$4.48 ea.
12V, ¼ amp for P.C.	\$1.66 ea.
36VCT, 1A; 14VCT, 400Ma	\$4.20 ea.
44VCT, 1A; 6.3V ¼ amp tap	\$3.47 ea.
48VCT, 1A, 6.3V, ¼ amp tap	\$3.46 ea.

6.3V, 1 amp shielded \$1.80 ea.

UNPOTTED TOROIDS — Center tapped

88 MHY - 5 oz. 5/\$2.95; 9 oz. - 5/\$3.49

44 MHY - 5/\$3.95

3000 MFD Capacitors. @ 30 Volts

1" Dia. x 3" — 90¢ ea. or 3/\$2.25

NEW — LINE CORDS — US — 7 AMP

6' — Blk — 50¢ ea. 4/\$1.50 ppd.

8' — Gray — 60¢ ea. 4/\$1.90 ppd.

EDGEVIEW METERS 250 µA 'S' METERS

NEW — \$2.65 ea. 3/\$7.25 ppd.

**m. weinschenker**

electronic specialties-BOX 353, IRWIN, PA 15642

**NEW!**

**DAVIS ELECTRONICS**

600 MHz Mini Counter

7208 COUNTER

600.70483

NOW...  
• Completely PORTABLE with Ni-Cad Batteries  
• Crystal Oven Available

General Purpose Low Cost Counter Without the Sacrifice of Basic Performance  
"Check the features we have that some other low cost counters don't have."

- All Metal Cabinet
- 8 Digit 4" LED Display
- Input Cable Included
- 12V Input Jack
- Sensitivity 10 MV at 60 MHz
- 115V or 12V Operation
- Push Button Controls
- Gate Light
- Completely Auto Decimal Point
- Selectable Gate Times (1 sec & .1 sec)
- Built-in Preamp (optional)
- Crystal Time Base (1 ppm after cal.)

7208K 600 MHz Kit ... \$149.95 7208A Assembled ... \$199.95

OPTIONS ...  
01) Portable w/Ni-Cad. Battery (Built-in Charger) ... \$39.95  
02) Crystal Oven (1 ppm 0 to 60°C) \$39.95 03) Handle ... \$5.00  
04) Built-in Preamp 10 MV @ 150 MHz ... \$10.00

**DAVIS ELECTRONICS** 636 Sheridan Dr., Tonawanda, NY 14150 716/874-5848

Pre-Amp PROBE  
10-500 MHz  
Only \$49.95

# Sunspot Cycle Madness

WE'RE CELEBRATING - WITH SUPER DEALS FOR YOU!

## THOMAS COMMUNICATIONS



YAESU  
FT-7



YAESU  
FT-901



ICOM  
IC-701



DRAKE  
TR-7



KENWOOD  
TS-820S



YAESU  
FT-227R



TEN TEC  
544



PANASONIC RECEIVER  
RF 4800



KENWOOD  
TS-700SP



KDK  
2015R



DENTRON  
MLA-2500B



WILSON  
MARK IV

"OVER 50 BRANDS IN STOCK"

- KENWOOD • YAESU • KDK • DENTRON • WILSON • MFJ • SWAN • DRAKE • LARSEN •
- TEMPO • KLM • BEARCAT • B & W • ARRL PUBLICATIONS • MOSLEY • REGENCY • ASTATIC •
- CUSHCRAFT • MICROLOG • HAM KEY • CDE • PIPO • ICOM • TEN TEC • PANASONIC •
- DAYBURN INSULATORS • BIRD • AMECO • HUSTLER • CALL BOOK • SAXTON • ALLIANCE •

### ★ COMPLETE RADIO SERVICE SHOP ★

— FAST EFFICIENT SERVICE — WE REPAIR ALL BRANDS —

— ALL WORK GUARANTEED — AMATEUR EXTRA / FIRST CLASS LICENSES —

— SEND US YOUR DEFECTIVE EQUIPMENT U.P.S. COLLECT —

— FREE SHIPPING BOTH WAYS IF WORK IS DONE —

— MOST REPAIRS DONE AND SHIPPED WITHIN 7 DAYS —

★ OUR FINE REPUTATION SPEAKS FOR ITSELF ★

"YOU SHIP IT — WE FIX IT"

- ★ NEW AND USED EQUIPMENT — "Get on our used equipment mailing list" —
- ★ TRADES WELCOME — "The best allowances anywhere" — "We buy good used SSB gear" —
- ★ FREE CATALOG — "Prices of all major manufacturers" —
- ★ SAME DAY U.P.S. SHIPPING — "Just a phone call away" —



Telephone Orders  
203-667-0811  
Call Today!

Call or write for  
your super quote today!



**THOMAS COMMUNICATIONS** - "Near ARRL Headquarters"

95 KITTS LANE, NEWINGTON, CONNECTICUT 06111

OPEN MON.-FRI. 10-6 • THURS. 10-8 P.M. • SAT. 10-4

EASY DIRECTIONS: Rt. 15 South — 2 blocks past McDonald's (Berlin Turnpike)

# Ham it up for \$4.50.



Amateur crystals 143.99 - 148.01 only for this trim price (and it's postpaid).

Florida residents add 4% sales tax.

Send frequencies, make and model when ordering. Our price includes most gear on our free Parts List.

For equipment not listed, we'll provide prices on request and slice up something special.

Master Charge & BankAmericard telephone orders accepted.

No C.O.D.'s.

## Savoy Electronics Inc.

P.O. Box 5727, Fort Lauderdale, Florida 33310  
305/563-1333

Manufacturers of Quality Quartz Crystals Since 1937

WHERE THE HAM  
IS KING



SERVICE FOR  
OVER 30 YEARS

## OCTOBER'S SPECIAL OF THE MONTH

**KENWOOD**



**Kenwood's TS-700SP  
Deluxe All-Mode Two-  
Meter Solid-State Trans-  
ceiver now covers the  
new repeater sub-band.**

### SPECIFICATIONS:

FREQUENCY RANGE: 144-148 MHz  
MODES: USB/LSB, FM, AM, CW  
INPUT POWER: 13 VDC or 115 VAC  
FUNCTIONS: PTT, VOX, Semi-Breakin CW with Sidetone  
POWER OUT: 10 Watts RF on SSB, FM, CW  
3 Watts AM  
1 Watt FM — Low Power Switch  
RECEIVER: 0.25 MV for 10 dB (S&N)/N SSB/CW  
0.4MV for 20dB Quieting FM

**LIST PRICE: \$729.00**

**YOUR SPECIAL DEAL . . .  
BUY A TS-700SP AND GET A BIRD  
MODEL 43 WATTMETER FREE**

A DIVISION OF TREVOSE ELECTRONICS

# HAMTRONICS, INC.

4033 BROWNSVILLE ROAD, TREVOSE, PA. 19047

CALL TOLL FREE  
FOR QUOTES

## 800-523-8998

## FT-227 "MEMORIZER" OWNERS: SCANNER KIT

- Selectable sweep width (up to full band)
- Scans **only** the portion of band you select
- Scans at the rate of 200 kHz per second
- Switch modification on mike allows you to scan past, or lock on, any occupied frequency
- Complete kit with detailed instructions
- Installs **inside** rig; no obtrusive external connections
- Rig can easily be returned to original condition whenever desired
- Scans to preset limits and reverses
- Automatic bypass of locked frequency in 3-1/2 seconds unless you press lock-on switch

Kit **\$34.95** preassembled and tested **\$54.00**  
add \$1.50 postage and handling

Also available: Scanners for your IC-22S;  
\$29.95 kit; \$39.95 assembled

**DEALER INQUIRIES INVITED**



**AED  
ELECTRONICS**  
750 LUCERNE RD., SUITE 120  
MONTREAL, QUEBEC, CANADA H3R 2H6  
TEL. 514-737-7293





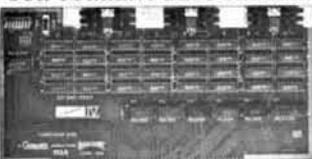
# At Your Service . . .

**IF YOU'RE INTO COMPUTERS,  
THIS IS THE BEST PART**

Econoram™ memories are known throughout the industry for reliability and the ability to mate with all S-100 buss mainframes . . . and they're the boards to use in your computer. We offer fully static design, full buffering, high speed/low power parts, intelligent mechanical design, and an enviable reputation for quality.

These boards are available in 3 forms: unkit (with sockets and bypass caps pre-soldered in place), assembled and tested, and qualified under the Certified Systems Components program. CSC boards are assembled, tested, guaranteed to run at 4 MHz, burned in for 200 hours, and serial numbered. We exchange (not repair) the board if failure occurs within one year of invoice date.

## OUR CURRENT BEST SELLER:



**16K ECONORAM IV™**  
**\$279 unkit** Assembled \$314, CSC \$414.

Current under 2000 mA; manual write protect for 4K blocks; use with or without phantom line. Excellent where you need a big chunk of cost-effective memory.

## OUR TOP OF THE LINE:

**24K ECONORAM VII™**  
**\$445 unkit** Assembled \$485, CSC \$605.

A full feature dense memory with current under 2000 mA. Configuration as two 4K and two 8K blocks, with independent write protect for each block; use with or without phantom lines; and provision for two unused qualifiers.

## TRS-80 CONVERSION KIT \$190 (3/\$ )

Upgrade your 4K TRS-80 mainframe with our Conversion Kit; chips are also compatible with Memory Expansion Module. Includes eight uPD16 16K RAMs, DIP shunts, and instructions for mainframe conversion. (Many dealers additionally report using these chips to expand memory in APPLes). We back up these parts with a 1 year warranty.

## MA1003 CLOCK MODULE **\$16.50!**

Needs only 12V DC and 3 time-setting switches for operation in boat, truck, van, car, or home. 4 digit, 0.3" green fluorescent display with blinking colon. When wired in car, display turns off when ignition is off. Accurate to ± 1/2 second a day thanks to built-in crystal timebase.

Finally . . . here is a clock that is simple to build, good looking, and at our price, inexpensive.

## RF TRANSISTORS

#2NRF1 2GHz power transistor. Pd max 3.5W, Pout minimum 1.0W, Pin 310 mW, efficiency 30%. Similar to RCA 2N5470. **\$4.95**

#2NRF2 2 GHz power transistor, Pd max 8.7W, Pout min 2.5W, Pin 300 mW, efficiency 33%. Similar to RCA TA8407. **\$5.95**

#2NRF3 2 GHz power transistor. Pd max 21W, Pout min 5.5W, Pin 1.25W, efficiency 33%. Similar to RCA 2N6269. **\$6.95**

#2NRF4 2 GHz power transistor. Pd max 29W, Pout 7.5W, Pin 1.5W, efficiency 33%. Factory selected prime 2N6269. **\$7.95**

# GODBOUT

BILL GODBOUT ELECTRONICS  
BOX 2355, OAKLAND AIRPORT, CA 94614

TERMS: Add \$1 to orders under \$15. COD orders OK with street address for UPS. Cal res add sales tax. VISA® /Mastercharge® orders call our 24 hour answering service at (415) 562-0636. Thank you for your business.

## YOUR MARK II & MARK IV HEADQUARTERS!

**MARK II** 2.5-WATT  
**\$229<sup>95</sup>** Plus Shipping

**MARK IV** 4-WATT  
**\$259<sup>95</sup>** Plus Shipping



**IN STOCK**

THEY WORK  
AS GOOD AS  
THEY LOOK!

SHOWN WITH OPTIONAL TT PAD



**SPECTRONICS, INC.**

**(312)848-6777** 1009 GARFIELD ST.  
OAK PARK, ILL. 60304

## BENCH POWER SUPPLY 5 to 30 VDC ADJUSTABLE



Newest, state-of-the-art IC regulator chip provides outstanding features at low cost.

- Adjustable 5 to 30 VDC
- Regulation 1% at 100 mA Load to Full Load
- Deluxe Panel Meter
- 1 Amp Output Current
- Thermal Overload Protection
- Short Circuit Protection
- Metal Cabinet

An honest value at \$48.50  
Prepaid UPS anywhere in USA  
(Please Include Street Address)



Harper-Stanley Co.  
305 University Tower Bldg.  
Little Rock, Ark. 72204



## RTTY for ALL Systems



**ELECTROCOM® "SERIES 400"  
FREQUENCY SHIFT CONVERTERS**

Professionally engineered for outstanding performance, stability, and reliability, the Electrocom® Models 400 and 402 add new dimensions of compatibility between radio and teletypewriter systems. Manufactured to highest quality standards—an Electrocom tradition for nearly two decades—these units are ideal for military, government, commercial, civil defense and amateur applications. The Model 400 front panel digital knob accurately selects shifts up to 1000 Hz, while two such knobs on the Model 402 independently set the mark and space frequencies. Both models may also be preset with any tone pair between 1000 and 3200 Hz.

Optimum performance with FSK or AFSK

systems is assured by matched filters, precision linear detectors, baud rate selector, bias compensation, and semi-diversity circuitry. Operation is enhanced by a CRT monitor, autostart with solid-state motor switching, antispaces, markhold, EIA/MIL output voltages, and a constant current loop supply. In addition, various options are available including rack mounting and polar current output.

Write or call us for complete product details and specifications. Learn why Electrocom® "400" Converters are designed not only for today's communication environment, but ultimately to fulfill RTTY requirements for years to come.

## FACSIMILE

**COPY SATELLITE, PHOTOS,  
WEATHER MAPS, PRESS!**

The Fax Are Clear — on our full size (18-1/2" wide) recorders. These commercial-military units now available at surplus prices. Learn how to copy with our FREE Fax Guide. **Tel.: (212) 372-0349**

**ATLANTIC SURPLUS SALES**  
3730 NAUTILUS BROOKLYN, N.Y. 11224

## MILITARY SURPLUS WANTED

Space buys more and pays more. Highest prices ever on U.S. Military surplus, especially on Collins equipment or parts. We pay freight. Call collect now for our high offer 201 440-8787.  
**SPACE ELECTRONICS CO.**  
div. of Military Electronics Corp.  
35 Ruta Court, S. Hackensack, N.J. 07606

## SYNTHESIZERS

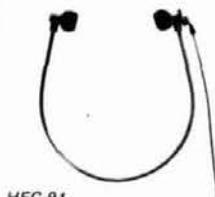
We have the worlds largest selection of synthesizers for receivers, transmitters and transceivers. For complete details see our 1/3 page ad in the April 1976 issue of this magazine or call or write for additional information. Phone orders accepted between 9 AM and 4 PM EDT. (212) 468-2720

## VANGUARD LABS

196-23 JAMAICA AVENUE  
HOLLIS, N. Y. 11423

**Electrocom® INDUSTRIES**  
1105 N. IRONWOOD DRIVE, SOUTH BEND, INDIANA 46615  
Telephone: (219) 232-2743

## Lightweight Headphones



**HFC-91**  
Ultra-light undercush. Acoustic delay of 1 millisecond enhances intelligibility on CW or SSB. Low impedance: 8-20 ohms. Shaped response - 100 - 3,000 Hz. 1.5 ounces.  
Order by Catalog No. 18135-013 \$8.95



**HMC-2**  
Featherweight - Undercush - rugged aluminum tone arms direct signals into the ear - ideal for contests. 1.2 ounces. 100 - 3,000 Hz. Low impedance: 8-20 ohms.  
Order by Catalog No. 18183-002 \$13.85



**HTC-2**  
Lightest Dual-driver headset. Choice of the pros. also must wear them for hours. 1.6 ounces. 100 - 3,000 Hz. Low impedance: 8-20 ohms.  
Order by Catalog No. 3775-002 \$22.00

## Mobile Microphones



### ProCom I & II Electret

Broadcast quality - clarity and crispness. Describe the auto of the electret. 1.4 V battery provides bias to the electret in the ProCom I in the ProCom II the 1.4 volt battery also powers the 10dB amplifier.

ProCom I low impedance  
Order by Catalog No. 63540-000

ProCom II  
Usable in low or high impedance  
Order by Catalog No. 63550-000



### CB-73

Flight Line - auto quality and performance for that FM transmitter. Rugged electret mic - canceling 43 dB sensitivity variable gain shaping amplifier. Use on high or low Z applications. Available in grey, silver, or clear. Tests clear.

Clear - Order by Catalog No. 63373-003  
Grey - Order by Catalog No. 63373-002  
\$42.95

## Special Headsets



### Lightweight Headset

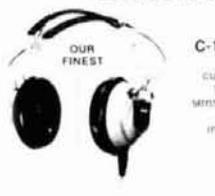
VHF operation will never be the same. Noise canceling magnetic microphone. 8-ohm earphone. on-line PTT and variable gain shaping amplifier deliver performance. Hams have been waiting for - 43 dB maximum microphone sensitivity at 600 ohms - complete with eyeglass adapter.  
Order by Catalog No. 63388-002  
\$69.95

### Mobile "FM"

VHF Mobile or Mobile - high performance audio on transmit and receive - Fat amplifier - low Z microphone. Earphone. 8 ohms - on-line PTT.  
Order by Catalog No. 63380-002  
\$59.95



## Dual Muff Headphones/Headsets



### C-1320 Headphone

Top of the line - fully cushioned audiometric type drivers are ultra-sensitive - DX or SSB - 20 - 20,000 Hz. Low impedance: 8-20 ohms.  
Order by Catalog No. 61320-012  
\$39.80



### CM-1320S Headset

Top of the line - with a built-in microphone - ceramic high impedance. The choice of DX operators.  
\$71.70  
Order by Catalog No. 61320-013



### C-1210 Headphone

Ultimate comfort and performance - mylar diaphragms assure continued sensitivity for digging out the weak ones. 20 - 20,000 Hz - low impedance: 8-20 ohms.  
Order by Catalog No. 61210-031  
\$28.30



### CM-1210 Headset with microphone

Ceramic - 50,000 ohms. Ideal for traffic nets.  
Order by Catalog No. 61200-058  
\$59.75



### C-610 Headphone

Lightweight. 8 ounces. An ideal headphone for code courses, code practice or actual operating. Low impedance: 50 - 12,000 Hz.  
Order by Catalog No. 61630-063  
\$9.95



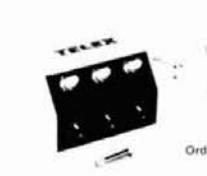
### CM-610 Headset

with high impedance ceramic microphone - 50,000 ohms. Economical price - professional construction.  
Order by Catalog No. 61630-064  
\$44.95



### PC-100 Headphone

Full cushion comfort - performance and long life make these dynamic phones ideal for novice or extra. 50 - 12,000 Hz. Low impedance: 8 - 200 ohms. weight 12 ounces.  
Order by Catalog No. 63510-010  
\$16.95



### Headphone Jack Box

Ham Clubs - hell day contest operation. No more - pure rigs. For multiple headphones. 7.4 phone jacks with individual volume controls. 4 foot cord with 1.4 phone plug.  
Order by Catalog No. 62753-000  
\$16.25

## the indispensable BIRD 43



### THRULINE WATTMETER

Power Range	Frequency Bands (MHz)			
	2-25	100-1000	200-2000	400-4000
10-watts	1.4	1.4	1.4	1.4
20-watts	1.4	1.4	1.4	1.4
50-watts	2.5	2.5	2.5	2.5
100-watts	5.0	5.0	5.0	5.0
200-watts	10.0	10.0	10.0	10.0
500-watts	25.0	25.0	25.0	25.0
1000-watts	50.0	50.0	50.0	50.0
2000-watts	100.0	100.0	100.0	100.0
5000-watts	250.0	250.0	250.0	250.0
10000-watts	500.0	500.0	500.0	500.0

### MODEL 43

Elements (Table 1) 2-30 MHz 125.00  
Elements (Table 1) 25-1000 MHz 45.00  
Carrying case for Model 43 & 6 elements 38.00  
Carrying case for 12 elements 27.50  
17.00

READ RF WATTS DIRECTLY! (Specify Type N or SO239 connectors) 0.45 - 2300 MHz, 1-10,000 Watts  $\pm 5\%$ , low insertion VSWR - 1.05. Unequaled economy and flexibility. Buy only the element(s) covering your present frequency and power needs, add extra ranges later if your requirements expand.



## BOMAR Crystal Company

### TWO METER CRYSTALS

Standard / Icom / Heathkit / Ken / Clegg / Regency / Wilson / VHF Eng. / Drake / Motorola HT 220 - and others!

### LIFETIME GUARANTEE!

Now Only \$7.00 Per Pair!

Make/Model	Xmit Freq.	Rec. Freq.

Don't Miss The N.E. ARRL CONVENTION  
At the Beautiful Sheraton Boxborough  
Boxborough, Mass. Oct 14-15th.  
GIANT FLEA MARKET!

Name \_\_\_\_\_ Call \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_  
State \_\_\_\_\_ Zip \_\_\_\_\_  
Order: \_\_\_\_\_  
 Check enclosed  Visa  Master Charge  
 American Express  
Credit card # \_\_\_\_\_  
Card expiration date \_\_\_\_\_  
Signature \_\_\_\_\_

SEND FOR FREE CATALOG!



Radio Electronics  
209-H Mystic Avenue  
Medford, Mass. 02155  
(617) 395-8280

Master Charge • Visa • American Express  
Minimum \$3.00 shipping & handling for ALL orders.



Prices FOB Medford Mass. (Mass. residents add 5% sales tax)



**NEW**

# 1800 Hz 8 pole xtal FILTER

YAESU AND KENWOOD FT-7, FT-101, FR-101, FT-301, TS-520, R-599

**\$50**



AIRMAIL Postpaid Overseas add \$3.

## SSB OPS! Win the Battle against QRM!

What can you do when two single sideband signals overlap? At present, not much in most older sets. If you are correctly tuned to one signal, and an adjacent one comes on, his high- or low-frequency components will be within your passband, and while you are not able to "read" him you will surely know he is there.

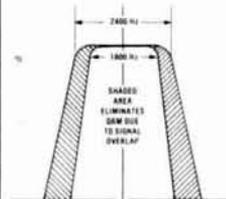
Many of the newer receivers seek to solve this overlap problem by providing continuously variable i-f bandwidth or passband shifting — both difficult to adapt to existing designs. So, you can solve your problem by buying a new set! Not a pleasant prospect at today's prices.

A simple, less expensive, but effective alternative is to supplement the existing SSB filter in your tried-and-tested present rig with our high-quality, 1800-Hz, 8-pole unit. Installation using our dual diode switch board is easy and permits the addition (now or in the future) of a second, sharp CW filter. Selection of the standard or sharp filters (SSB or CW) is achieved by flipping a single miniature toggle switch which can usually be mounted in an existing hole.

Our complete line of filters is listed below. All units are \$50 except as indicated. Prices are likely to rise. Better buy now.

VISA & MASTER CHARGE ACCEPTED

Rig	Filter No. YF	Used for	Center Freq. kHz.	No. of Poles	Band Width	Notes
YAESU SERIES FT-101 FR-101	31H250	CW	3179.3	8	250 Hz	Sharp unit for DX and contest work. Use instead of standard 600 Hz unit. Same as standard XF-30C unit, \$40. For narrow SSB. Substitute for XF-30A (6 pole) in early units. Same as standard XF-30B unit, \$40.
	31H500	CW	3179.3	8	500 Hz	
	31F600	CW	3179.3	6	600 Hz	
	31H1.8	SSB	3180	8	1.8 kHz	
	31H2.4	SSB	3180	8	2.4 kHz	
YAESU SERIES FT-7 FT-301	89H250	CW	8999.3	8	250 Hz	Sharp unit for DX and contest work. Use instead of standard 600 Hz unit. For narrow SSB. For use in speech processor.
	89H500	CW	8999.3	8	500 Hz	
	90H1.8	SSB	9000	8	1.8 kHz	
YAESU SERIES TS-520 R-599	33H250	CW	3395	8	250 Hz	Sharp unit for DX and contest work. Use instead of standard 500 Hz unit. For narrow SSB.
	33H400	CW	3395	8	400 Hz	
	33H1.8	SSB	3395	8	1.8 kHz	
KENWOOD SERIES TS-820	88H250	CW	8830.7	8	250 Hz	Sharp unit for DX and contest work. Use instead of standard 500 Hz unit.
	88H400	CW	8830.7	8	400 Hz	



### DIODE SWITCHING BOARDS permit easy mounting

(without drilling) of up to two crystal filters of any type in addition to those for which the manufacturer provides space. These boards will accommodate any of the filters listed and other types planned for the future. To avoid error when ordering, specify filter number desired as well as rig with which it is to be used. Complete instructions, SPECIFY Set with which board is to be used. \$15 with purchase of any filter. \$20 without filter. Airmail Ppd. US & Canada. Overseas add \$1.



**FOX-TANGO CORP.**  
Box 15944, W. Palm Beach, FL 33406

## QUARTZ CRYSTALS



"IN A HURRY"  
SINCE 1970

CRYSTALS AVAILABLE FOR:

- CB — Synthesizers
- Amateur - HF, VHF, UHF
- Industrial
- Scanner
- Marine — LB & VHF
- Conversion Crystals
- Special Attention to R & D.
- Micro-processor Types.

DISCOUNTS AVAILABLE TO DEALERS & MANUFACTURERS

CALL "BONNIE" FOR PRICES & DELIVERY

VISA & MASTER CHARGE



credit cards accepted.



**CAL CRYSTAL LAB, INC.**  
1142 N. Gilbert Street  
Anaheim, CA 92801  
(714) 991-1580

# "THE PROFESSIONALS"

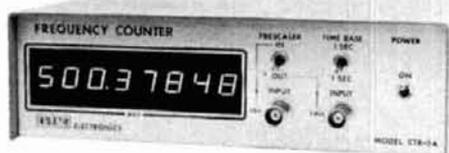
**NEW**

MODEL CTR-2A • 500 MHz & 1 GHz

**COUNTERS**

**NEW**  
Period Measurement

1 us to 1 sec.



**NEW**  
Built-in Pre-Amp

10 mv @ 150 MHz

The New Model CTR-2A Series Counters are designed and built to the highest standards to fulfill the needs of commercial communications, engineering labs and serious experimenters. With an accuracy of +.00005% (oven option) the CTR-2A can handle the most critical measurements and is about half the cost of other commercial counters.

If you need a reliable counter at an affordable price, the CTR-2A is the answer.

- Built-in Pre-Amp 10 mv @ 150 MHz
- 8 Digit .3" LED Display
- High Stability TCXO Time Base
- Built-in VHF-UHF Prescaler
- Automatic Dp Placement
- TCXO Std. ± 2 ppm
- Period Measurement (Optional)
- Input Diode Protected
- 12V-DC Operation (Optional)
- Oven Controlled Crystal (Optional) ± .5 ppm
- Selectable Gate Times - .1 & 1 sec.

500 MHz Kit CTR-2A-500K	.....	\$249.95
500 MHz Assembled CTR-2A-500A	.....	349.95
1GHz Kit CTR-2A-1000K	.....	399.95
1GHz Assembled CTR-2A-1000A	.....	549.95

#### OPTIONS . . . .

02) Oven Crystal	\$49.95	05) 10 sec. Time Base	\$ 5.00
03) .43" LED	10.00	06) Period	15.00
04) 12 V-DC	10.00	07) Handle	10.00

**PROBES**

Hi-Z  
\$15.00

•  
Low Pass  
\$15.00



DAVIS ELECTRONICS 636 Sheridan Dr., Tona., N.Y. 14150 716/874-5848



## ALIGNMENT

Alignment and check out of your transmitter or receiver by our FCC licensed technician. Xmitters checked for harmonics, chirp, etc. Fast service and professional work. Only \$15 plus shipping. Send radio with check in reusable carton (insured) or \$1 extra for new carton to:

**Wolverine Radio**  
P.O. Box 426  
Portage, Michigan 49081

## DON'T KEEP A GOOD ANTENNA DOWN

pull it up instead. Install the World-Record Breaking antenna that won W5TYP the QRP ARC 1,000,000 miles/watt award

### THE JOYSTICK VFA

(Variable freq. ant) gives low angle, omni-directional, harmonic free radiation on all bands 160 thru 10 (+MARS and receive on all BC & SW). 1000's of glowing reports in our files of the VFA in use, often in poor QTH and/or under QRP, contests, etc.

**SYSTEM 'A' \$84.00**

250W P.E.P. &/or Receiving only

**SYSTEM 'J' \$110.00**

500W P.E.P. &/or Improved Q Factor Receive

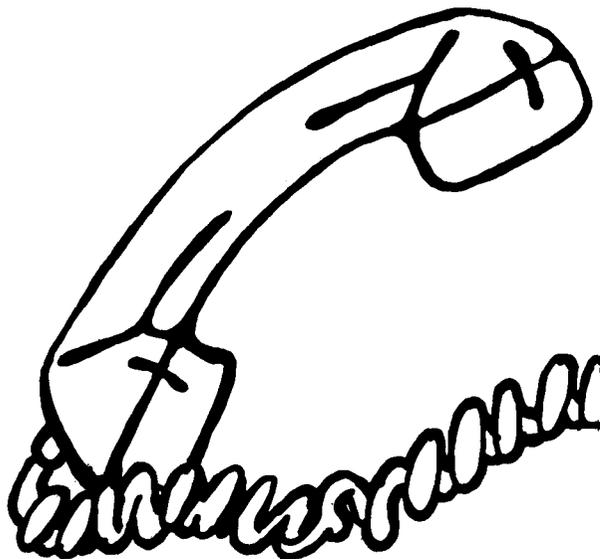
Air mail cost included. (Each system 3 sections easily assembled to make unit 7' 6" long. Matching ATU). Not only will you save space but you get better values per \$ if buying direct IRL mail. Rush your order -Mastercharge, Visa, BankAmericard, or check, or ask for brochure.

**PARTRIDGE (HR) ELECTRONICS LTD**  
Broadstairs, Kent, England  
Tel: 0843 62535

G3CED

G3VFA

# You're just a few digits away from name brand radio equipment - AT DISCOUNT PRICES!



CALL TOLL FREE

**1-800-228-4097**  
**Communications Center**  
 443 N 48th Street  
 Lincoln, Nebraska 68504  
 In Nebraska Call (402) 466-8402

**1-800-634-6227**  
**Communications Center**  
**West**  
 1072 N. Rancho Drive  
 Las Vegas, Nevada 89106  
 In Nevada Call (702) 647-3114

YAESU  
 KENWOOD  
 DRAKE  
 ICOM  
 STANDARD  
 EDGECOM  
 KDK

DENTRON  
 HY-GAIN  
 MOSLEY  
 CUSHCRAFT  
 WILSON  
 HUSTLER  
 LARSEN

TAYLOR  
 SWAN  
 TEMPO  
 TEN-TEC  
 MIDLAND  
 CDE  
 AUTEK

E.T.O. ALPHA  
 VHF ENGINEERING  
 BERK-TEK CABLE  
 CONSOLIDATED TOWER  
 SAY  
 SHURE  
 TELEX

plus many more

## **1-800-228-4097** CALL TOLL FREE FOR **1-800-634-6227** **ANTENNAS**

HY-GAIN  
 TH6 DXX  
 TH3MK III  
 18 AVT/WB

MOSLEY  
 CLASSIC 33  
 CLASSIC 36  
 TA-33

CUSHCRAFT  
 ATB-34  
 ARX-2  
 A-147-20T

HUSTLER  
 4BTV  
 66-144A  
 RM-75s

WILSON  
 SYSTEM 1  
 SYSTEM 2

**Specials on CDE Rotors**  
 Ham III - \$125.00  
 Tailtwister - \$225.00

■ ■ ■ ■ ■ LOOK! ■ ■ ■ ■ ■  
 HOURS: Monday - Friday 8 a.m. - Midnight  
 Saturday 8 a.m. - 8 p.m.  
 Sunday Noon - 8 p.m.

SAME DAY SHIPPING ON MOST ITEMS

**We carry all major lines of antennas  
 at DISCOUNT PRICES  
 call for quotes: 1-800-228-4097**





Ham Radio's guide to help you find your local

**Alabama**

**LONG'S ELECTRONICS**  
2808 7TH AVENUE SOUTH  
BIRMINGHAM, AL 35202  
800-633-3410  
Call us Toll Free to place your order

**Alaska**

**RELIABLE ELECTRONICS**  
3306 COPE STREET  
ANCHORAGE, AK 99503  
907-279-5100  
Kenwood, Yaesu, DenTron, Wilson,  
Atlas, ICOM, Rohn, Tri-Ex.

**Arizona**

**HAM SHACK**  
4506 A NORTH 16TH STREET  
PHOENIX, AZ 85016  
602-279-HAMS  
Serving all amateurs from  
beginner to expert.

**KRYDER ELECTRONICS**  
5520 NORTH 7TH AVENUE  
NORTH 7TH AVE. SHOPPING CTR.  
PHOENIX, AZ 85013  
602-249-3739  
We service what we sell.

**POWER COMMUNICATIONS**  
6012 NORTH 27th AVE.  
PHOENIX, AZ 85017  
602-242-6030  
Arizona's #1 Ham Store.  
Kenwood, Drake, ICOM & more.

**QSA 599 AMATEUR RADIO CENTER**  
11 SOUTH MORRIS STREET  
MESA, AZ 85202  
602-833-8051  
Eimac Distributor. New & Used  
Equipment, Parts - Surplus too!

**California**

**C & A ELECTRONIC ENTERPRISES**  
22010 S. WILMINGTON AVE.  
SUITE 105  
P. O. BOX 5232  
CARSON, CA 90745  
213-834-5868  
Not the Biggest, but the Best —  
since 1962.

**HAM RADIO OUTLET**  
999 HOWARD AVENUE  
BURLINGAME, CA 94010  
415-342-5757  
Visit our stores in Van Nuys  
and Anaheim.

**QUEMENT ELECTRONICS**  
1000 SO. BASCOM AVENUE  
SAN JOSE, CA 95128  
408-998-5900  
Serving the world's Radio Amateurs  
since 1933.

**TOWER ELECTRONICS CORP.**  
24001 ALICIA PARKWAY  
MISSION VIEJO, CA 92675  
714-768-8900  
Authorized Yaesu Sales & Service.  
Mail orders welcome.

**Colorado**

**MILE-HI COMMUNICATIONS, INC.**  
1970 SOUTH NAVAJO  
DENVER, CO 80223  
303-936-7108  
Rocky Mountain's newest  
ham store. Lee Tingle KØLT.

**Connecticut**

**AUDIOTRONICS INC.**  
18 ISAAC STREET  
NORWALK, CT 06850  
203-838-4877  
The Northeast's fastest growing  
Ham Dept. dedicated to service.

**Florida**

**AGL ELECTRONICS, INC.**  
1800-B DREW ST.  
CLEARWATER, FL 33515  
813-461-HAMS  
West Coast's only full service  
Amateur Radio Store.

**AMATEUR RADIO CENTER, INC.**  
2805 N.E. 2ND AVENUE  
MIAMI, FL 33137  
305-573-8383  
The place for great dependable  
names in Ham Radio.

**MARC'S  
CENTRAL EQUIPMENT CO., INC.**  
18451 W. DIXIE HIGHWAY  
NORTH MIAMI BEACH, FL 33160  
305-932-1818  
See Marc, WD4AAS, for complete  
Amateur Sales & Service.

**RAY'S AMATEUR RADIO**  
1590 US HIGHWAY 19 SO.  
CLEARWATER, FL 33516  
813-535-1416  
West coast's only dealer:  
Drake, Icom, Cushcraft, Hustler.

**Illinois**

**AUREUS ELECTRONICS, INC.**  
1415 N. EAGLE STREET  
NAPERVILLE, IL 60540  
312-420-8629  
"Amateur Excellence"

**ERICKSON COMMUNICATIONS, INC.**  
5935 NORTH MILWAUKEE AVE.  
CHICAGO, IL 60646  
312-631-5181  
Hours: 9:30-5:30 Mon, Tues, Wed,  
Fri; 9:30-9:00 Thurs; 9:00-3:00 Sat.

**SPECTRONICS, INC.**  
1009 GARFIELD STREET  
OAK PARK, IL 60304  
312-848-6777  
Chicagoland's Amateur Radio  
leader.

**Indiana**

**HOOSIER ELECTRONICS, INC.**  
P. O. BOX 2001  
TERRE HAUTE, IN 47802  
812-238-1456  
Ham Headquarters of the Midwest.  
Store in Meadows Shopping Center.

**KRYDER ELECTRONICS**  
GEORGETOWN NORTH  
SHOPPING CENTER  
2810 MAPLECREST RD.  
FORT WAYNE, IN 46815  
219-484-4946  
We service what we sell. 10-9 T,  
TH, F; 10-5 W, SAT.

**Iowa**

**BOB SMITH ELECTRONICS**  
RFD #3, HIGHWAY 169 and 7  
FT. DODGE, IA 50501  
515-576-3886  
For an EZ deal.

**Kansas**

**ASSOCIATED RADIO**  
8012 CONSER P. O. B. 4327  
OVERLAND PARK, KS 66204  
913-381-5901  
Amateur Radio's Top Dealer.  
Buy — Sell — Trade

*Dealers - You should be here too! Contact Ham Radio today for complete details.*

# Amateur Radio Dealer

## Kentucky

**COHOON AMATEUR SUPPLY**  
HIGHWAY 475  
TRENTON, KY 42286  
502-886-4535  
Yaesu, Ten-Tec, Tempo, DenTron.  
Our service is the BEST.

## Maryland

**THE COMM CENTER, INC.**  
9624 FT. MEADE ROAD  
LAUREL PLAZA RT. 198  
LAUREL, MD 20810  
301-792-0600  
R.L. Drake, Ten-Tec, Icom, Wilson,  
Tempo, DenTron, Mosley, Cushcraft

**PROFESSIONAL  
ELECTRONICS CO., INC.**  
1710 JOAN AVENUE  
BALTIMORE, MD 21234  
301-661-2123  
A professional place for amateurs.  
Service-sales-design.

## Massachusetts

**TEL-COM, INC.**  
675 GREAT RD. RT. 119  
LITTLETON, MA 01460  
617-486-3040  
The Ham Store of New England  
you can rely on.

**TUFTS RADIO ELECTRONICS**  
209 MYSTIC AVENUE  
MEDFORD, MA 02155  
617-395-8280  
New England's friendliest  
ham store.

## Michigan

**ELECTRONIC DISTRIBUTORS**  
1960 PECK STREET  
MUSKEGON, MI 49441  
616-726-3196  
Dealer for all major amateur  
radio product lines.

**RADIO SUPPLY & ENGINEERING**  
1207 WEST 14 MILE ROAD  
CLAWSON, MI 48017  
313-435-5660  
10001 Chalmers, Detroit, MI  
48213, 313-371-9050.

## Minnesota

**PAL ELECTRONICS INC.**  
3452 FREMONT AVE. NORTH  
MINNEAPOLIS, MN 55412  
612-521-4662  
The Midwest's Fastest Growing  
Ham Dealer.

## Missouri

**HAM RADIO CENTER, INC.**  
8340-42 OLIVE BLVD.  
ST. LOUIS, MO 63132  
800-325-3636  
For Best Price and Fast Delivery  
Call toll free 1-800-325-3636

**MIDCOM ELECTRONICS, INC.**  
2506 SO. BRENTWOOD BLVD.  
ST. LOUIS, MO 63144  
314-961-9990  
At Midcom you can try before you  
buy!

## Nebraska

**COMMUNICATIONS CENTER, INC.**  
443 NORTH 48 ST.  
LINCOLN, NE 68504  
800-228-4097  
Kenwood, Yaesu, Drake and more  
at discount prices.

## Nevada

**COMMUNICATIONS CENTER WEST**  
1072 RANCHO DRIVE  
LAS VEGAS, NV 89106  
800-634-6227  
Kenwood, Yaesu, Drake and more  
at discount prices.

## New Hampshire

**EVANS RADIO, INC.**  
BOX 893, RT. 3A BOW JUNCTION  
CONCORD, NH 03301  
603-224-9961  
Icom, DenTron & Yaesu dealer.  
We service what we sell.

## New Jersey

**ATKINSON & SMITH, INC.**  
17 LEWIS ST.  
EATONTOWN, NJ 07724  
201-542-2447  
Ham supplies since "55".

**METUCHEN RADIO**  
216 MAIN STREET  
METUCHEN, NJ 08840  
201-494-8350  
New and Used Ham Equipment  
WA2AET "T" Bruno

**RADIO UNLIMITED**  
1760 EASTON AVENUE  
SOMERSET, NJ 08873  
201-469-4599  
New Jersey's newest  
complete Amateur Radio center

**THE BARGAIN BROTHERS**  
216 SCOTCH ROAD  
GLEN ROC SHOPPING CTR.  
WEST TRENTON, NJ 06828  
609-883-2050  
A million parts - lowest prices  
anywhere. Call us!

## New Mexico

**ELECTRONIC MODULE**  
601 N. TURNER  
HOBBS, NM 88240  
505-397-3012  
Yaesu, Kenwood, Swan, DenTron,  
Tempo, Atlas, Wilson, Cushcraft

## New York

**ADIRONDACK RADIO SUPPLY, INC.**  
185 W. MAIN STREET  
AMSTERDAM, NY 12010  
518-842-8350  
Yaesu dealer for the Northeast.

**GRAND CENTRAL RADIO**  
124 EAST 44 STREET  
NEW YORK, NY 10017  
212-682-3869  
Drake, Atlas, Ten-Tec, Midland,  
Hy-Gain, Mosley in stock

**HAM-BONE RADIO**  
3206 ERIE BLVD. EAST  
SYRACUSE, NY 13214  
315-446-2266  
We deal, we trade, all major brands!

**RADIO WORLD**  
ONEIDA COUNTY AIRPORT  
TERMINAL BLDG.  
ORISKANY, NY 13424  
315-337-2622  
New & Used ham equipment.  
See Warren K2IXN or Bob WA2MSH.

# HAM MART

## Ohio

**AMATEUR RADIO  
SALES & SERVICE INC.**  
2187 E. LIVINGSTON AVE.  
COLUMBUS, OH 43209  
614-236-1625  
Antennas for all services.

**UNIVERSAL AMATEUR RADIO, INC.**  
1280 AIDA DRIVE  
REYNOLDSBURG, (COLUMBUS) OH  
43068  
614-866-HAMS  
Drake, Yaesu, Ten-Tec, KDK, Wilson,  
DenTron, Tempo, Sigma.

## Oklahoma

**RADIO STORE, INC.**  
2102 SOUTHWEST 59th ST.  
(AT 59th & S. PENNSYLVANIA)  
OKLAHOMA CITY, OK 73119  
405-682-2929  
New and used equipment —  
parts and supply.

## Oregon

**PORTLAND RADIO SUPPLY CO.**  
1234 S.W. STARK STREET  
PORTLAND, OREGON 97205  
503-228-8647  
Second location, 1133 S. Riverside  
Avenue, Medford, OR 97501.

## Pennsylvania

**ARTCO ELECTRONICS**  
302 WYOMING AVENUE  
KINGSTON, PA 18704  
717-288-8585  
The largest variety of semiconduc-  
tors in Northeastern Pennsylvania

**ELECTRONIC EXCHANGE**  
136 N. MAIN STREET  
SOUDERTON, PA 18964  
215-723-1200  
Demonstrations, Sales, Service  
New/Used Amateur Radio Equip.

**"HAM" BUERGER, INC.**  
68 N. YORK ROAD  
WILLOW GROVE, PA 19090  
215-659-5900  
Delaware Valley's Fastest Growing  
Amateur Radio Store

**HAMTRONICS, DIV. OF  
TREVISE ELECTRONICS**  
4033 BROWNSVILLE ROAD  
TREVISE, PA 19047  
215-357-1400  
Same Location for 30 Years.  
Call Toll Free 800-523-8998.

## Tennessee

**GERMANTOWN AMATEUR SUPPLY**  
3203 SUMMER AVE.  
MEMPHIS, TN 38112  
800-238-6168  
No monkey business. Call  
Toll Free.

## Texas

**AGL ELECTRONICS**  
3068 FOREST LANE, SUITE 309  
DALLAS, TX 75234  
214-241-6414 (within Texas)  
Out-of-State, Call our toll-free  
number 800-527-7418.

**HARDIN ELECTRONICS**  
5635 E. ROSEDALE  
FT. WORTH, TX 76112  
817-461-9761  
Your Full Line Authorized  
Yaesu Dealer.

**TRACY'S ELECTRONIC MODULE**  
5691 WEST CREEK DRIVE  
FORT WORTH, TX 76133  
817-292-3371  
We Handle and Service  
All Major Lines.

## Wisconsin

**AMATEUR  
ELECTRONIC SUPPLY, INC.**  
4828 WEST FOND du LAC AVENUE  
MILWAUKEE, WI 53216  
414-444-4200  
Open Mon & Fri 9-9, Tues, Wed,  
Thurs, 9-5:30, Sat, 9-3.

## Washington

**AMATEUR RADIO SUPPLY CO.**  
6213 13TH AVENUE SOUTH  
SEATTLE, WA 98108  
206-767-3222  
First in Ham Radio in Washington  
Northwest Bird Distributor

FULLY AUTOMATIC C.W. IDENTIFIER



MODEL 12751 KIT

REGULAR \$59.50 VALUE, NOW ONLY **\$35.95**+

**MODEL 12751** — connects in line between mic. and transmitter requiring no modification to transceiver • automatic 1 to 10 min. timer • 5 to 40 wpm adjustable code speed • built-in squelch tail • auto or manual modes • ideal for repeaters • 5" x 7" PCB and 20-page manual.

### FACTORY PROGRAMMED MEMORY Ider KITS

**MODEL 11764** — semi-auto. MCW Ider • adjustable audio level • programmable code speed, tone and repeat interval • 1.7" x 3" PCB. \$29.95/kit\*

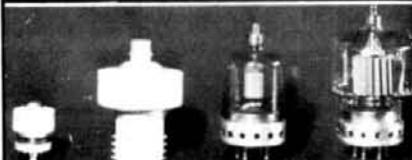
**MODEL 97710** — manual CW Ider • programmable code speed • IDs upon request • ideal for contesting or repeated messages • 1.5" x 2.2" PCB. \$24.95/kit\*

**MODEL 11765** — beacon CW Ider • programmable code speed • great for 1750-meter band • 1.3" x 2" PCB. \$19.95/kit\*  
(additional pre-programmed memory elements available)

\*Include \$3 shpg/hdlg., \$5 foreign. CA res. add 6% tax. CODs accepted. Send check or MO, allow 3 weeks on personal checks. Write for additional information  
Phone (408) 294-8383

**SECURITRON CO.**  
P. O. Box 24899  
San Jose, Ca 95154

## WANTED FOR CASH



4CX150	4CX1000	4-65	4-250
4CX250	4CX1500	4-125A	4-400
4CX300A	4CX3000		4-1000
4CX350A	4CX5000		304TL
	4CX10,000		
	5CX1500		

Other tubes and Klystrons also wanted.  
See last month for other items available.

### The Ted Dames Company

308 Hickory St. Arlington, N.J. 07032  
(201) 998-4246 Evenings (201) 998-6475

**IN STOCK FOR  
IMMEDIATE  
DELIVERY!**

**MODEL 43  
\$125  
Plus Shipping**

**BROAD LINE OF  
BIRD PRODUCTS  
STOCKED IN DEPTH**

**AUTHORIZED  
DEALER/  
DISTRIBUTOR**

**BIRD**

**SPECTRONICS, INC.**  
1009 GARFIELD ST.  
DANK PARK ILL. 60014  
**(312)848-6777**

## NEW FM/CW EXCITER KITS

BUILD UP YOUR OWN GEAR FOR MODULAR STATIONS, REPEATERS, & CONTROL LINKS  
 ● Rated for Continuous Duty ● Professional Sounding Audio ● Built-in Testing Aids



T50 Six Channel, 2W Exciter Kit for 2M, 6M, or 220 MHz ..... \$49.95

## FAMOUS HAMTRONICS PREAMPS

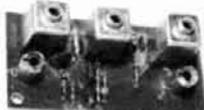
let you hear the weak ones!

Great for OSCAR, SSB, FM, ATV. Over 10,000 in use throughout the world on all types of receivers.

**P9 Kit \$12.95**

**P14 Wired \$24.95**

Deluxe vhf model for applications where space permits.



- 1-1/2 x 3" ● Covers any 4 MHz band ● 12 Vdc
- Ideal for OSCAR ● Diode protection ● 20dB gain

MODEL	RANGE
P9-LO	26-88 MHz
P9-HI	88-172 MHz
P9-220	172-230 MHz
P14 Wired	Give exact band



**P8 Kit \$10.95**

**P16 Wired \$21.95**

- Covers any 4 MHz band
- 20 dB gain ● 12 Vdc

Miniature VHF model for tight spaces - size only 1/2 x 2-3/8 inches.

MODEL	RANGE
P8-LO	20-83 MHz
P8-HI	83-190 MHz
P8-220	220-230 MHz
P16 Wired	Give exact band

**P15 Kit \$18.95**

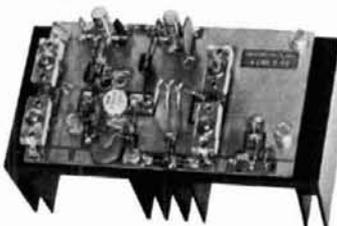
**P35 Wired \$34.95**

- Covers any 6 MHz band in UHF range of 380-520 MHz
- 20 dB gain ● Low noise



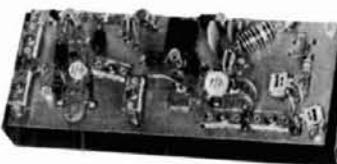
## YOU ASKED - HERE THEY ARE! VHF Linear PA's

- Use as Linear or Class C PA's ● For XV-2 Xmtg Converters, T50 Exciters, or any 2W Exciter



LPA 2-15 Kit \$59.95

- 15W out (linear) or 20W (class C) ● Solid State T/R Switching ● Models for 6M, 2M, or 220 MHz



LPA 2-45 Kit \$109.95

- 45W out (linear) or 50W (class C)

● Models for 6M or 2M

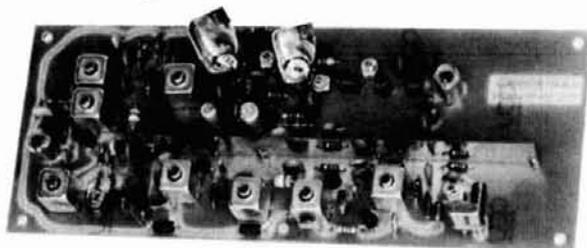
LPA 8-45 Kit \$89.95

For 2M, 8-10W in, 45W out

# AT LAST! 6M, 2M, & 1 1/4 M SSB TRANSMITTING CONVERTERS

## At a price you can afford

Use inexpensive recycled 10 or 11 meter ssb exciter on VHF bands!



### FEATURES:

- Linear Converter for SSB, CW, FM, etc.
- A fraction of the price of other units
- 2W p.e.p. output with 1 MW of drive
- Use low power tap on exciter or attenuator pad
- Easy to align with built-in test points

**XV2- ( ) TRANSVERTER KIT \$59.95**

**A25 Optional Cabinet for Xverter & PA \$20**

### Frequency Schemes Available:

XV2-1	28-30 MHz =	50 - 52 MHz
XV2-2	28-30 MHz =	220-222 MHz
XV2-4	28-30 MHz =	144-146 MHz
XV2-5	28-29 MHz =	145-146 MHz
XV2-6	26-28 MHz =	144-146 MHz

## New VHF&UHF Converter Kits

let you receive OSCAR signals and other exciting SSB, CW, & FM activity on your present HF receiver.



either one  
**- ONLY \$34.95**  
 including crystal



MODEL	RF RANGE (MHZ)	I-F RANGE
C50	50-52	28-30
C144	144-146	28-30
C145	145-147 (OSCAR)	28-30
C146	146-148	28-30
C110	Aircraft	28-30
C220	220 band	28-30
Special	Other i-f & rf ranges available	

MODEL	RF RANGE (MHZ)	I-F RANGE
C432-2	432-434	28-30
C432-5	435-437 (OSCAR)	28-30
C432-7	427.25	61.25
C432-9	439.25	61.25
Special	Other i-f & rf ranges available	
A9 Extruded Alum Case/Connectors		\$12.95

## VHF/UHF FM RCVR KITS

- ★ NEW GENERATION RECEIVERS
- ★ MORE SENSITIVE ★ MORE SELECTIVE (70 or 100 db)
- ★ COMMERCIAL GRADE DESIGN
- ★ EASY TO ALIGN WITH BUILT-IN TEST CKTS
- ★ LOWER OVERALL COST THAN EVER BEFORE



R70 6-channel VHF Receiver Kit for 2M, 6M, 10M, 220 MHz, or com'l bands..... \$69.95  
 Optional xtal filter for 100 dB adj chan 10.00



R90 UHF Receiver Kit for any 2 MHz segment of 380-520 MHz band..... \$89.95

## \* FREE 1978 CATALOG \*

NEW JUNE 1978 CAT. IS YOURS FOR THE ASKING!

### IT'S EASY TO ORDER!

● CALL OR WRITE NOW FOR FREE CATALOG OR TO PLACE ORDER!

● PHONE 716-663-9254. (Answering service evenings and weekends for your convenience. Personal service 9-5 eastern time.)

● Use credit card, c.o.d., check, m.o.

● Add \$2.00 shipping & handling.

IN CANADA, send to Comtec; 5605 Westluxe Ave; Montreal, Que H4W 2N3 or phone 514-482-2640. Add 38% to cover duty, tax, and exchange rate.

**hamtronics, inc.**

182-K Belmont Rd; Rochester, NY 14612

# We're Proud of Our Flock!



MODEL 43

## BIRD

ALL MODELS AND TABLE ELEMENTS IN STOCK.  
WE ALSO CARRY OTHER BIRD PRODUCTS... WRITE!

**NEW PRICE \$125.00**

AUTHORIZED BIRD DISTRIBUTOR — DEALER INQUIRIES INVITED.

We are also Dealers for:



YAESU

KLM electronics

Mosley



Wilson



ALL PREPAID & CREDIT CARD ORDERS SHIPPED NO CHARGE IN U.S.  
SALES TAX 4% TO VIRGINIA RESIDENTS ONLY.  
SPECIALISTS IN HANDLING FOREIGN ORDERS



**ELECTRONIC EQUIPMENT BANK, INC.**

516H MILL STREET, VIENNA, VA 22180

CALL 703-938-3511

# Regency Scanner

BRINGS YOU THE NEWS WHILE ITS HAPPENING



10 channels covering all 5 bands. AC/DC operation.

**SAVE \$40 \$89.95**  
LIST-\$129.95



**1,000's OF CRYSTALS**

- H25C Case Scanner Monitor
- 10.7 Amateur Ham
- 2 Meter, CB, Standard

1 to 9	10 to 49	50 and UP
<b>\$3.70</b>	<b>\$3.00</b>	<b>\$2.50</b>

**CRYSTAL BANKING SERVICE**  
P.O. BOX 683  
LYNNFIELD, MASS. 01940

## JOIN THE COSMIC QUEST!

• Subscribe now to **COSMIC SEARCH** and share the provocative articles and latest news about mankind's most exciting venture, the search for intelligent life in space. Get **COSMIC SEARCH** starting with its first issue, out December 1.

• **COSMIC SEARCH** is for everyone who has ever wondered about life in the universe.

• Featured in the first issues of **COSMIC SEARCH** are articles by RONALD BRACEWELL, JOCELYN BELL BURNELL, ARTHUR C. CLARKE, NORMAN COUSINS, FRANK D. DRAKE, CARL SAGAN, WALTER SULLIVAN and many other world-famous persons.

• Will communication be by radio, gravity waves or neutrino beams? Are there cosmic languages? Will long transmission times make us cosmic archeologists? These and many other questions are discussed in **COSMIC SEARCH** in a popular, authoritative manner.

• Exclusive interviews with noted researchers, book reviews and an extensive book list for further reading are regular special features of **COSMIC SEARCH**.

• **COSMIC SEARCH** award papers on SETI topics by students and others under 30 will add new talent.

• **COSMIC SEARCH** is published 6 times per year. First issue January 1979. Out Dec. 1, 1978.

**COSMIC SEARCH**, Radio Observatory, P.O. Box 293, Delaware, Ohio 43015 Tel. 614-363-1597

Single copies \$2.50 (\$15 a year). Subscription rate: \$12 for 1 year, \$22 for 2 years.

SPECIAL PRE-PUBLICATION rate \$10 for 1 year, \$18 for 2 years

SPECIAL PREPAID PRE-PUBLICATION rate \$8 for 1 year, \$15 for 2 years

Enter my subscription to **COSMIC SEARCH**, Box 293, Delaware, Ohio 43015  
At special pre-publication rate: \$10 for 1 year  \$18 for 2 years  and bill me later.  
At special PREPAID pre-publication rate: \$8 for 1 year  \$15 for 2 years   
 Check or Money Order enclosed  MASTERCHARGE  VISA (BankAmericard)

Account # \_\_\_\_\_ MC Interbank # \_\_\_\_\_ Exp. date \_\_\_\_\_

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

BARBER

# TONE ENCODER

FEATURES:

- Crystal Controlled - Digitally Synthesized Tones.
- Low Current Drain CMOS Logic.
- RFI Immune
- 16-Button Tactile Feedback Keyboard.
- Will Interface to Transceivers Using Dynamic Microphones with Only Two Wires.
- Provisions for Three Wire Interface Are Provided.
- Gold-Plated Keyboard Contacts Provided for Maximum Reliability.
- Operating Voltage Range 9-18VDC.
- Size: 2.1" x 2.1" x .250" Without Case. 2.1" x 2.1" x .312" With Case.
- 2" Square Velcro Available for Convenient Mounting - Dashboard - Sun Visor - Radio - etc.



Tone Encoder	\$46.00
Case	\$ 2.00
Velcro	\$ .50

**NEW! GOLDLINE AMP - 2M**  
1-4 Watts In, 7-25 Watts Out \$46.50

Ohio Residents Add 4.5% Sales Tax  
Send Check or Money Order To:

**WREN CO.**  
8630 WINTON RD.  
CINCINNATI, OHIO 45231

**DIODES/ZENERS**

1N914	100v	10mA	.05
1N4005	600v	1A	.08
1N4007	1000v	1A	.15
1N4148	75v	10mA	.05
1N4733	5.1v	1 W Zener	.25
1N753A	6.2v	500 mW Zener	.25
1N758A	10v	"	.25
1N759A	12v	"	.25
1N5243	13v	"	.25
1N5244B	14v	"	.25
1N5245B	15v	"	.25

**SOCKETS/BRIDGES**

8-pin	pcb	.20	ww	.35
14-pin	pcb	.20	ww	.40
16-pin	pcb	.20	ww	.40
18-pin	pcb	.25	ww	.75
22-pin	pcb	.35	ww	.95
24-pin	pcb	.35	ww	.95
28-pin	pcb	.45	ww	1.25
40-pin	pcb	.50	ww	1.25
Molex pins	.01	To-3 Sockets		.25
2 Amp Bridge		100-prv		.95
25 Amp Bridge		200-prv		1.95

**TRANSISTORS, LEDS, etc.**

2N2222	NPN (2N2222 Plastic)	.10	.15
2N2907	PNP		.15
2N3906	PNP (Plastic - Unmarked)		.10
2N3904	NPN (Plastic - Unmarked)		.10
2N3054	NPN		.35
2N3055	NPN 15A 60v		.50
T1P125	PNP Darlington		.95
LED Green, Red, Clear, Yellow			.15
D.L.747	7 seg 5/8" High com-anode		1.95
MAN72	7 seg com-anode (Red)		1.25
MAN3610	7 seg com-anode (Orange)		1.25
MAN82A	7 seg com-anode (Yellow)		1.25
MAN74A	7 seg com-cathode (Red)		1.50
FND359	7 seg com-cathode (Red)		1.25

**C MOS**

4000	.15
4001	.15
4002	.20
4004	3.95
4006	.95
4007	.20
4008	.75
4009	.35
4010	.35
4011	.20
4012	.20
4013	.40
4014	.75
4015	.75
4016	.35
4017	.75
4018	.75
4019	.35
4020	.85
4021	.75
4022	.75
4023	.20
4024	.75
4025	.20
4026	1.95
4027	.35
4028	.75
4030	.35
4033	1.50
4034	2.45
4035	.75
4040	.75
4041	.69
4042	.65
4043	.50
4044	.65
4046	1.25
4049	.45
4050	.45
4066	.55

**- T T L -**

7400	.10	7473	.25	74176	.85	74H72	.35	74S133	.40
7401	.15	7474	.30	74180	.55	74H101	.75	74S140	.55
7402	.15	7475	.35	74181	2.25	74H103	.55	74S151	.30
7403	.15	7476	.40	74182	.75	74H106	.95	74S153	.35
7404	.10	7480	.55	74190	1.25			74S157	.75
7405	.25	7481	.75	74191	.95	74L00	.25	74S158	.30
7406	.25	7483	.75	74192	.75	74L02	.20	74S194	1.05
7407	.55	7485	.55	74193	.85	74L03	.25	74S257 (8123)	1.05
7408	.15	7486	.25	74194	.95	74L04	.30		
7409	.15	7489	1.05	74195	.95	74L10	.20	74LS00	.20
7410	.15	7490	.45	74196	.95	74L20	.35	74LS01	.20
7411	.25	7491	.70	74197	.95	74L30	.45	74LS02	.20
7412	.25	7492	.45	74198	1.45	74L47	1.95	74LS04	.20
7413	.25	7493	.35	74221	1.00	74L51	.45	74LS05	.25
7414	.75	7494	.75	74367	.75	74L55	.65	74LS08	.25
7416	.25	7495	.60			74L72	.45	74LS09	.25
7417	.40	7496	.80	75108A	.35	74L73	.40	74LS10	.25
7420	.15	74100	1.15	75491	.50	74L74	.45	74LS11	.25
7426	.25	74107	.25	75492	.50	74L75	.55	74LS20	.20
7427	.25	74121	.35			74L93	.55	74LS21	.25
7430	.15	74122	.55			74L123	.85	74LS22	.25
7432	.20	74123	.35	74H00	.15			74LS32	.25
7437	.20	74125	.45	74H01	.20	74S00	.35	74LS37	.25
7438	.20	74126	.35	74H04	.20	74S02	.35	74LS38	.35
7440	.20	74132	.75	74H05	.20	74S03	.25	74LS40	.30
7441	1.15	74141	.90	74H08	.35	74S04	.25	74LS42	.65
7442	.45	74150	.85	74H10	.35	74S05	.35	74LS51	.35
7443	.45	74151	.65	74H11	.25	74S08	.35	74LS74	.35
7444	.45	74153	.75	74H15	.45	74S10	.35	74LS86	.35
7445	.65	74154	.95	74H20	.25	74S11	.35	74LS90	.55
7446	.70	74156	.70	74H21	.25	74S20	.25	74LS93	.55
7447	.70	74157	.65	74H22	.40	74S40	.20	74LS107	.40
7448	.50	74161	.55	74H30	.20	74S50	.20	74LS123	1.00
7450	.25	74163	.85	74H40	.25	74S51	.25	74LS151	.75
7451	.25	74164	.60	74H50	.25	74S64	.15	74LS153	.75
7453	.20	74165	1.10	74H51	.25	74S74	.35	74LS157	.75
7454	.25	74166	1.25	74H52	.15	74S112	.60	74LS164	1.00
7460	.40	74175	.80	74H53J	.25	74S114	.65	74LS193	.95
7470	.45			74H55	.20			74LS367	.75
7472	.40							74LS368	.65

4069/74 C04	.25
4071	.25
4081	.30
4082	.30
VC 14409	14.50
VC 14419	4.85
4511	.95
74C151	1.90

**LINEARS, REGULATORS, etc.**

MCT2	.95	LM320T5	1.65	LM340K15	1.25	LM723	.40
8038	3.95	LM320T12	1.65	LM340K18	1.25	LM725N	2.50
LM201	.75	LM320T15	1.65	LM340K24	1.25	LM739	1.50
LM301	.45	LM324N	1.25	78L05	.75	LM741 (8-14)	.25
LM308 (Mini)	.95	LM339	.75	78L12	.75	LM747	1.10
LM309H	.65	7805 (340T5)	.95	78L15	.75	LM1307	1.25
LM309K (340K-5)	.85	LM340T12	.95	78M05	.75	LM1458	.65
LM310	.85	LM340T15	.95	LM373	2.95	LM3900	.50
LM311D (Mini)	.75	LM340T18	.95	LM380 (8-14 PIN)	.95	LM75451	.65
LM318 (Mini)	1.75	LM340T24	.95	LM709 (8, 14 PIN)	.25	NE555	.35
LM320K5 (7905)	1.65	LM340K12	1.25	LM711	.45	NE556	.85
LM320K12	1.65					NE565	.95
						NE566	1.25
						NE567	.95

**9000 SERIES**

9301	.85	95H03	1.10
9309	.35	9601	.20
9322	.65	9602	.45

**MICRO'S, RAMS, CPU'S, E-PROMS**

1S188	3.00	8214	8.95
702A	4.50	8224	3.25
M5314	3.00	8228	6.00
M5316	3.50	8251	8.50
102-1	1.45	8255	8.50
102L-1	1.75	8T13	1.50
114	9.50	8T23	1.50
R1602B	3.95	8T24	2.00
MS 4044	9.95	8T97	1.00
		2107B-4	4.95
J80	8.95	2708	9.50
212	2.95	Z80 PIO	8.50

**INTEGRATED CIRCUITS UNLIMITED**

7889 Clairemont Mesa Boulevard, San Diego, California 92111  
(714) 278-4394 (Calif. Res.)

All orders shipped prepaid No minimum  
Open accounts invited COD orders accepted

Discounts available at OEM Quantities California Residents add 6% Sales Tax  
All IC's Prime/Guaranteed. All orders shipped same day received.

24 Hour Toll Free Phone 1-800-854-2211

American Express / BankAmericard / Visa / MasterCard

**SPECIAL DISCOUNTS**

Total Order	Deduct
\$35 - \$99	10%
\$100 - \$300	15%
\$301 - \$1000	20%

# One Good Turn Deserves Another...

LET US INTRODUCE YOU  
to the

## alda 103

Super Compact

250 watts  
SSB/CW

Super  
Stable



3 1/4" H x 9" W x 12 1/2" D  
8.25 lbs

All Solid-State

80-75, 40, 20

Totally  
Broadbanded

**For Only \$495** you get  
all these plus:

Receiver Sensitivity 0.5 mV for  
10 dB S + N/N and 3 watts  
*minimum* audio output — ideal  
for mobile — and a drain of  
only 5.5 watts — including  
meter and dial lamps.

### ACCESSORIES:

Microphone	\$14.95
Mobile Mount	\$3.95
Noise Blanker	\$39.95
Calibrator	\$19.95
Portable AC Supply	\$84.95
Heavy-Duty AC Supply	\$149.95

**Communications Specialists Serving Hams**  
— since 1939 —

## ELECTRONIC DISTRIBUTORS, INC.

1806 BEIDLER ST.  
TELEPHONE (616) 726-3196

MUSKEGON, MICHIGAN 49441  
TELEX 22-8411

# NEW

### THE RADIO AMATEUR ANTENNA HANDBOOK by William I. Orr, W6SAI and Stuart D. Cowan, W2LX

□ **RP-AH** Brand NEW! One of Amateur Radio's most notable authors Bill Orr, W6SAI has combined his efforts and knowledge with W2LX to provide you with a clearly written, understandable book on antennas. All types of beam, quad, horizontal and sloping wire antenna information is included in this super volume. Location decisions, height, ground loss, towers, rotors, SWR meter reading — it's all here in one great book. 148 illustrations, charts and diagrams. A new book you have just got to read!...190 pages...©1978.

Softbound \$6.95

### Z-80 MICROCOMPUTER HANDBOOK by William Barden, Jr.

□ **Z1500** Zilog Model Z-80 represents a microprocessor that has become extremely sophisticated and useful to many computer buffs. This brand new volume is organized into three sections, the first concentrates on hardware; the second on software; and the third on microcomputers built around the Z-80. This handbook will provide the current user and the prospective user with essential information on the fascinating technology of the Z-80. 304 pages...©1978.

Softbound \$8.95

### LOG BOOK New from HRCB

□ **HR-LB** Here is the finest book you've ever used. 80 big pages of clear, legibly ruled stock, all spiralbound to lie flat for easy writing. You'll find room for your entries on both sides of each page, thus giving you twice as much space and for less cost than the log book you are probably using now. This is unquestionably the best log book value anywhere. 8-1/2 x 11 size...80 pages.

Spiralbound \$1.50

### RADIO ANGELS by Paul Jerome Stack, WA6IPF

□ **HR-RA** This brand new, exciting book depicts the heroic, glorious efforts of Amateurs around the world serving their fellow man during the times of need. Daring rescues, emergency assistance and human compassion all in one super volume. This book was over two years in the making. Get your thrilling copy now!...160 pages...©1978.

Softbound \$4.50

### 303 DYNAMIC ELECTRONIC CIRCUITS by Frank Tedeschi and Raymond McIntyre

□ **T-1060** Complete circuit descriptions, detailed schematics, parts lists, modification instructions and efficient application ideas — this new book has circuits for nearly everything. Applications for automobiles, games, hobbies, electronic organs, musical instruments, audio and RF amplifiers, oscillators, detectors, electronic timers, test circuits and computers. If you need a circuit or idea this book has got it...308 pages...©1978.

Softbound \$6.95

Presenting  
THE A.R.O. UNITY RING

**Your Prestige**      **Your Pride**

The unique, one of a kind, personalized "A.R.O. UNITY RING".

Your call letters. Your identity. Made just for you. Group III, WB2LCL, WB2LCK and WB2LHC designed this beautiful 10 Karat Gold ring because of our pride in Amateur Radio. Wear this ring of distinction, personalized with your call letters and symbolizing the great and proud fraternity of Amateur Radio. We invite you to QSL for full color brochure and free reusable ring sizer.

Holiday Orders Must Be Received By October 25th.

Group III Sales Co.  
Dept. 35 - P.O. Box 259  
Little Neck, N.Y. 11362

No Obligation

2-METER FAVORITES

### RUBBER DUCKIES

Model HM-4. Has 5/16"-32 thread. Fits Motorola HT's ICOM IC215 and Standard 146A ..... \$7.00

Model HM-5. Same as above, but with PL-259 connector ..... \$7.00

Model HM-226. Same, with TNC connector for Wilson 1405 ..... \$16.00

Model HM-227. Same, but with BNC connector termination ..... \$11.00

Model HM-228. With F connector for Wilson 1402 & Tempo ..... \$10.00

ADD \$1.00 to each order for shipping.

**SPECTRONICS, INC.**  
(312)848-6777 1009 GARFIELD ST.  
OAK PARK, ILL. 60304

# ALL BAND TRAP ANTENNAS!

PRETUNED - COMPLETELY ASSEMBLED - ONLY ONE NEAT SMALL ANTENNA FOR UP TO 6 BANDS! EXCELLENT FOR CONGESTED HOUSING AREAS - APARTMENTS LIGHT - STRONG - ALMOST INVISIBLE!

COMPLETE AS SHOWN with 90 ft. RG58U-52 ohm feedline, and PL259 connector, insulators, 30 ft. 300 lb. test dacron end supports, center connector with built in lightning arrester and static discharge - molded, sealed, weatherproof, resonant traps 1" XG" - you just switch to band desired for excellent worldwide operation - transmitting and receiving! WT. LESS THAN 5 LBS.

80-40-20-15-10 bands 2 trap --- 102 ft. with 90 ft. RG58U - connector - Model 998BU ... \$49.95  
40-20-15-10 bands 4 trap --- 54ft. with 90 ft. RG58U coax - connector - Model 1001BU ... \$48.95  
20-15-10 bands 2 trap --- 26 ft. with 90 ft. RG58U coax - connector - Model 1007BU .... \$47.95

SEND FULL PRICE FOR POST PAID INSURED DEL. IN USA. (Canada is \$5.00 extra for postage - clerical - customs - etc.) or order using VISA Bank Americard - MASTER CHARGE - AMER. EXPRESS. Give number and ex. date. Ph 1-308-236-5333 9AM - 6PM week days. We ship in 2-3 days. PRICES MAY INCREASE SO - ORDER NOW AND SAVE! All antennas guaranteed for 1 year. Money back trial! Made in USA. FREE INFO. AVAILABLE ONLY FROM.

WESTERN ELECTRONICS      Dept. AR-10      Kearney, Nebraska, 68847



# values from HRCB:

## PRICES SLASHED!

**NOW \$4.95**  
REGULARLY ~~\$8.50~~

### The ARRL 1978 AMATEUR RADIO HANDBOOK

AR-HB Ham Radio's Communications Bookstore has just acquired a limited number of the current 1978 ARRL Radio Amateur Handbooks at an unbelievably low price — and we are able to pass along a **GIANT** savings to you! But, you must act now while they last at this fantastic price.

This is your chance to latch onto the most popular and complete Handbook ever printed for the Radio Amateur. In addition to extensive technical coverage, this 664-page volume offers loads of theory, construction and reference information which will be extremely valuable and practical for years to come. 664 pages . . . ©1977.

**Softbound \$4.95**

*At this low price all sales must be final.*

Contents include: Amateur Radio, Electrical Laws and Circuits, Radio Design Technique and Methods, Solid-State Fundamentals, AC-Operated Power Supplies, HF Transmitting, VHF and UHF Receiving Techniques, Mobile and Portable/Emergency Equipment and Practices, Code Transmission, Amplitude Modulation and Double-Sideband Phone, Single-Sideband Transmission, Frequency Modulation and Repeaters, Specialized Communications Systems, Interference with other Services, Test Equipment and Measurements, Construction Practices and Data Tables, Wave Propagation, Transmission Lines, Radiation and Antennas, VHF and UHF Antennas, Assembling a Station, Operating a Station, Vacuum Tubes and Semiconductors.

**LIMITED QUANTITIES • ORDER NOW**

Send to: Ham Radio's Communications Bookstore, Greenville, NH 03048

- |   |               |  |               |
|---|---------------|--|---------------|
| <input type="checkbox"/> AR-HB 1978 ARRL Handbook . . . . .               | <b>\$4.95</b> | <input type="checkbox"/> 21500 Z-80 Microcomputer Handbook . . . . . | <b>\$8.95</b> |
| <input type="checkbox"/> RP-AH Radio Amateur Antenna Handbook . . . . .   | <b>\$6.95</b> | <input type="checkbox"/> HR-RA Radio Angels . . . . .                | <b>\$4.50</b> |
| <input type="checkbox"/> T-1060 303 Dynamic Electronic Circuits . . . . . | <b>\$6.95</b> | <input type="checkbox"/> HR-LB Log Book from HRCB . . . . .          | <b>\$1.50</b> |

- Check or Money Order Enclosed  
 VISA     Master Charge

Total books checked \_\_\_\_\_, net cost \$ \_\_\_\_\_,  
plus \$1.00 for shipping = TOTAL \$ \_\_\_\_\_

Acct.

Expires  MC Bank

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

**CALL TOLL FREE  
800-258-5353**



Order RP-AH

Order 21500

Order AR-HB

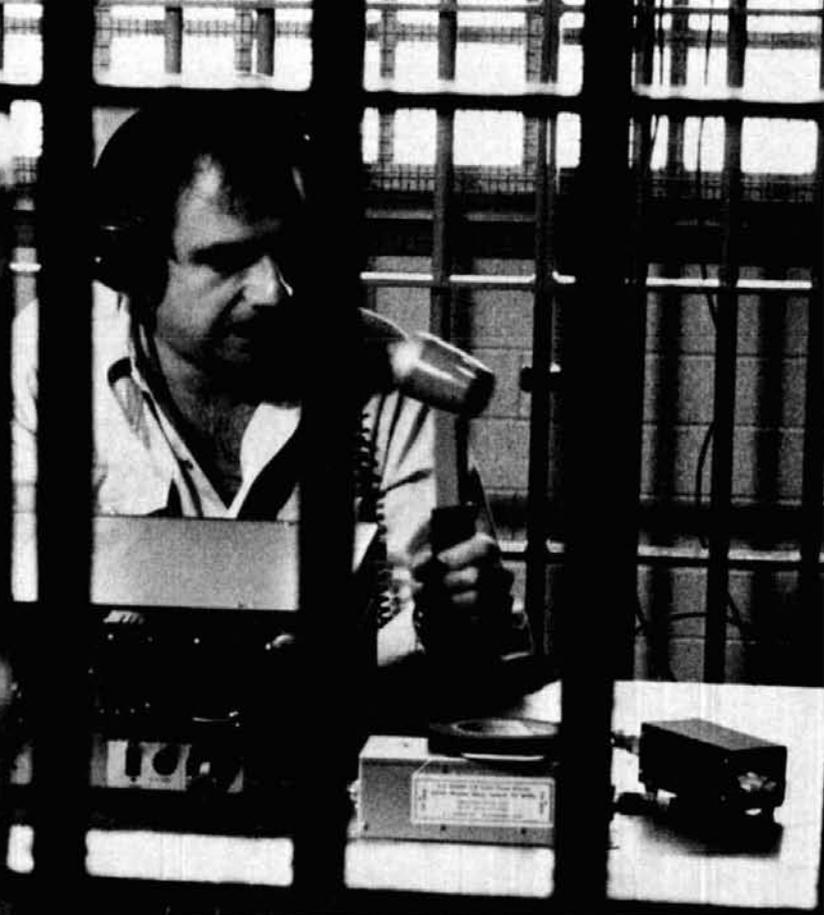
Order HR-LB

Order HR-RA

Order T-1060



## Because K6SSS loves DX, his neighbors sent him on a little expedition.



One neighbor sued him for interfering with Lawrence Welk. Another filed a complaint about that "monstrosity" in his backyard—a tribander at 40 feet.

### 7,781 tangled with the law

The K6SSS case is an example of what can happen to you these days. No matter where you live. It is hypothetical. But real lawsuits are being fought right now by people like K50VC, W2LTP, WB7NOM, W8NRM and W6UFJ/N6QQ to name a few. Last year nearly 8,000 unsuspecting hams and CB'ers ran afoul of the law. Sure, they're taking their fight to court—but they're losing! Never mind that they've got building permits for their towers. Or that the FCC says their rigs are "clean." Judges are ruling against them. The alarming part is that every suit lost makes it that much easier to nail the next guy. Prosecuting attorneys love to cite recent adverse decisions during a trial.

### Legal ammunition available

The tragedy is that suits are being lost that could have been won. But TVI/RFI and tower cases fall into a little-known area of the law. Unless your lawyer is a specialist, he could spend hundreds of hours researching court decisions. And still not be sure he's put together the strongest defense possible. It's expensive (expect to spend an average \$4,000 to \$8,000 if you're sued). And risky. Which is why we formed the non-profit Personal Communications Foundation\* To provide your lawyer with legal ammunition.

### Who we are

We're a handful of ham lawyers, professors and judges (all volunteers) who wanted to help before it's too late. We're putting together the first research library of personal communications and zoning law. And having briefs written by the best legal brains. It's all available to your lawyer. For 10¢ a page. We can't guarantee you'll win. We can't try the case for you. But if you or your lawyer contacts us, we'll sure make sure you get a fighting chance.

### Give us a fighting chance

To be even more successful in future battles, we're building an arsenal of weapons to use in court. For example, we're commissioning a study by real estate experts on the effect of a backyard tower on neighborhood property values. The pricetag is a stiff \$11,000. But without the study, more cases will be lost. And more dangerous precedents will be set.

We are winning. But it takes money to keep fighting. You can help us fight by sending a check. The ARRL did. Think of us as your insurance policy against a lawsuit. All checks are 100% tax-deductible.

Please act today. We've already got a late start.

\*Non-profit Cal. membership corp. #788-085

Kenneth S. Widelitz, WA6PPZ, President  
Personal Communications Foundation\*  
Suite 1504  
10960 Wilshire Blvd.  
Los Angeles, CA 90024 (213) 478-1749

I want to give you a fighting chance. Enclosed is my 100% tax-deductible membership application.

- Life member \$250       Contributing member \$100  
 Full member \$25       Associate member \$10

All members receive our free legal kit and newsletter

name \_\_\_\_\_ call \_\_\_\_\_

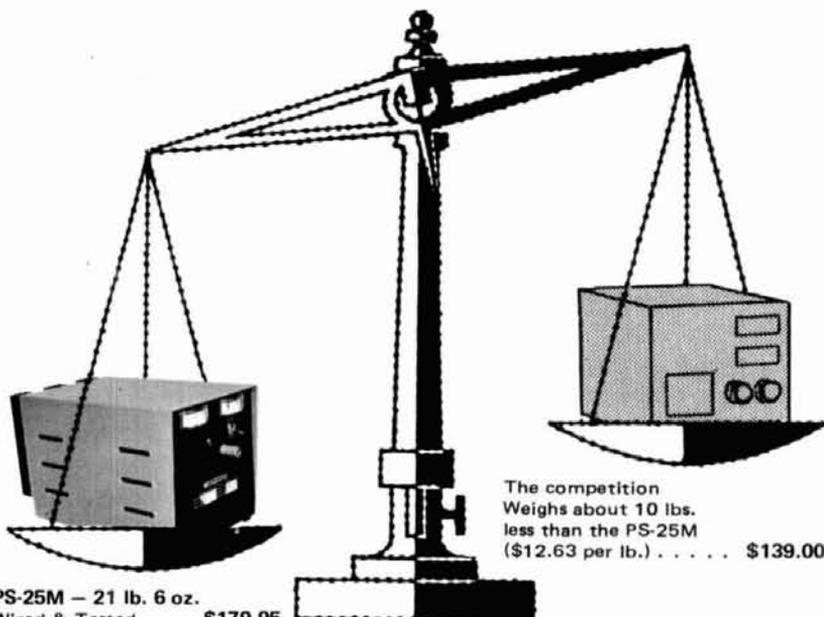
address \_\_\_\_\_

city \_\_\_\_\_ state \_\_\_\_\_ zip \_\_\_\_\_

**PCF**  Personal Communications Foundation  
**Defending the rights of hams**

# Pound for pound, there is no match for the

## Vhf engineering PS-25M Power Supply



The competition  
Weights about 10 lbs.  
less than the PS-25M  
(\$12.63 per lb.) . . . . . \$139.00

PS-25M - 21 lb. 6 oz.  
Wired & Tested . . . \$179.95  
(\$8.42 per lb.)  
Kit (\$7.25 per lb.) . . . \$154.95

**25 Amp regulated power supply with fold back current limiting, over voltage and transient protection. Also, output voltage and current meters**

You might find a cheaper power supply, but you can't find one as well built with top quality components. Other power supplies with lighter weight transformers and components are no match for the VHF engineering PS-25M. It is rated at 20 amps continuous duty (not 10 amps). This power means extra dependability and versatility when you need it.

### FEATURES

- Over-voltage protection crowbar.
- Electrostatic shield for added transient surge protection.
- A foldback output limiter operates for loads outside of the operating range.
- Isolation from ground. The circuit is isolated from the case and ground.
- 115/220 volt input - 50/60 cycle.
- Units are factory wired for 110 volt AC, 50/60 cycle power. A simple jumper will reconfigure the input for 220 volt AC, 50/60 cycles.
- Temperature range-operating 0 to +55 C.
- Black anodized aluminum heatsink.

### SPECIFICATIONS

Voltage Output:  
adjustable between 11-15V  
Load Regulation:  
2% from no load to 20 amps  
Current Output:  
25 amps intermittent  
(50% duty cycle)  
20 amps continuous  
Ripple:  
50 mV at 20 amps  
Weight:  
25 pounds  
Size:  
12 1/4" x 6 3/4" x 7 1/2"



### GROTH-Type COUNTS & DISPLAYS YOUR TURNS

- 99.99 Turns
- One Hole Panel Mount
- Handy Logging Area
- Spinner Handle Available

Case: 2x4"; shaft 1/4"x3"

**PRICES** POST PAID  
TC 2 - \$8.00  
TC 3 - \$8.75  
Spinner (S) - \$1.00  
Add \$0.75 for Air or UPS

Model TC2: Skirt 2-1/8";  
Knob 1-5/8"  
Model TC3: Skirt 3";  
Knob 2-3/8"

**R. H. BAUMAN SALES**

P.O. Box 122, Itasca, Ill. 60143

### IMPORTANT NEWS FROM YAESU

This is to advise that early Yaesu advertisements for the NEW FT-225RD were incorrect, in that they tend to indicate that the memory unit was included in the price whereas in fact it is an option. We apologize for this error, and hope this has caused our valued customers no inconvenience.

Vy 73,  
Yaesu Electronics

### MOVING? KEEP HAM RADIO COMING...

If possible let us know four to six weeks before you move and we will make sure your HAM RADIO Magazine arrives on schedule. Just remove the mailing label from this magazine and affix below. Then complete your new address (or any other corrections) in the space provided and we'll take care of the rest.

**ham  
radio**  
Magazine

Allow 4-6 weeks for correction.

Greenville, NH 03048

Thanks for helping us to serve you better.

Here's my new address:

Call \_\_\_\_\_ Zip \_\_\_\_\_  
Name \_\_\_\_\_ State \_\_\_\_\_  
Address \_\_\_\_\_ City \_\_\_\_\_

**AFFIX  
LABEL  
HERE**

**arma**  
amateur radio manufacturers' association

**Vhf engineering**

Division of Brownian Electronics Corp.

320 WATER STREET / BINGHAMTON, N.Y. 13901 / Phone 607-723-9574

Prices and specifications subject to change without notice. / Export prices slightly higher.



# Advertisers check-off

... for literature, in a hurry — we'll rush your name to the companies whose names you "check-off"

Place your check mark in the space between name and number. Ex: Ham Radio  234

## INDEX

ABC	571	Icom	065
AED	710	Integ. Circuits	518
Adv. Elect. Appl.	677	Int. Crystal	066
Aldelco	347	Jameco	333
Alliance	700	Jan	067
Aluma	589	Jones	626
Ama. Elect. Supply *		K-Enterprises	071
Antenna Spec.	010	Kantronics	605
Atlantic Surplus	644	Kenwood *	
Atlas	198	Larsen	078
Barry *		Long's	468
Bauman	017	Lunar	577
Budwig	233	Lyle	373
Bullet	328	MFJ	082
Butternut *		Madison *	
Cal Crystal	709	Palomar Eng.	093
Clegg	027	Partridge	439
CoaxProbe	726	Pathcom	705
Communications Center	534	Personal Comm. *	
Comm. Spec.	330	RF Power Labs	602
Cosmic Search *		Racal	728
Crystal Banking	573	Callbook	100
Curtis Electro	034	Radio World *	
Cushcraft	035	Ramsey	442
DSI	656	SST	375
Dames Comm.	551	S-F A. R. S.	640
Dames, Ted	324	Savoy	105
Data Signal	270	Securtron	461
Davis Elect.	332	Sentry	600
DenTron	259	Shakespeare	729
Drake *		Sherwood	435
E. T. O. *		Slep	232
Electrocom	663	Space	107
Elec. Distr.	044	Spectronics	191
Elec. Equip. Bank	288	Spectrum Int.	108
Fox-Tango	657	Standard	109
GLB	552	Swan	111
Godbout	647	TPL	240
Gray	055	Ten-Tec	
Gregory *		Thomas Comm.	730
Group III	701	Tristao	118
Gull	635	Tufts	321
Hal	057	VHF Eng.	121
Hal-Tronix	254	V.I.P.	583
H. R. C. B.	150	Vanguard Labs	716
H. R. Magazine	150	Varian	043
Hamtronics, NY	246	Webster Assoc.	423
Hamtronics, PA *		Weinschenker	122
Harper-Stanley	713	Western *	
Heath	060	Whitehouse	378
Henry	062	Wilson	123
Hildreth	283	Wolverine Radio	731
Hy-Gain	064	Wren	702
		Yaesu	127

\*Please contact this advertiser directly.  
Limit 15 inquiries per request.

October, 1978

Please use before November 30, 1978

Tear off and mail to

HAM RADIO MAGAZINE — "check off"  
Greenville, N. H. 03048

NAME.....

CALL.....

STREET.....

CITY.....

STATE..... ZIP.....



## There's nothing like it!

### RADIO AMATEUR callbook

Respected worldwide as the only complete authority for radio amateur QSL and QTH information.

The U.S. Callbook has over 300,000 W & K listings. It lists calls, license classes, names and addresses plus the many valuable back-up charts and references you come to expect from the Callbook.

Specialize in DX? Then you're looking for the **Foreign Callbook** with almost 300,000 calls, names and addresses of amateurs outside of the USA.

U.S. Callbook \$14.95

Foreign Callbook \$13.95

Order from your favorite electronics dealer or direct from the publisher. All direct orders add \$1.50 for shipping. Illinois residents add 5% Sales Tax.

RADIO AMATEUR **callbook** INC.  
Dept. E 925 Sherwood Drive  
Lake Bluff, Ill. 60044

# Advertisers index

ABC Communications	106
AED Electronics	126
Advanced Electronic Applications	100
Aldelco	122
Alliance Mfg. Company	91
Aluma Tower Co.	114
Amateur Electronic Supply	122
Antenna Specialists	108
Atlantic Surplus Sales	128
Atlas Radio	111
Barry Electronics	112
R.H. Bauman Sales Co.	141
Budwig Mfg. Co.	112
Bullet	116
Butternut Electronics	124
Cal Crystal Lab, Inc.	130
Clegg	108
CoaxProbe Co.	96
Communications Center	131
Communications Specialists	58, 59
Cosmic Search	136
Crystal Banking Service	136
Curtis Electro Devices	106
Cushcraft	101, 103, 105
DSI Instruments	66, 67, 68
Dames Communications Systems	120
Dames, Ted	134
Data Signal, Inc.	102
Davis Electronics	124, 130
DenTron Radio Company	9
Drake Co., R. L.	106
Ehrhorn Technological Operations	143
Electrocom Industries	128
Electronic Distributors	138
Electronic Equipment Bank	136
Fox-Tango Corporation	130
GLB	118
Godbout Electronics	128
Gray Electronics	106
Gregory Electronics	110
Group III Sales Company	138
Gull Electronics	117
Hal Communications Corp.	109
Hal-Tronix	123
Ham Radio's Communications Bookstore	138, 139
Ham Radio Magazine	141
Hamtronics, Inc., Rochester, NY	135
Hamtronics, Inc., Treviso, PA	48, 49, 50, 110, 126
Harper-Stanley Co.	128
Heath Company	33
Henry Radio Stores	Cover II
Hildreth Engineering	102
Hy-Gain Electronics	107
Icom	5
Integrated Circuits Unlimited	137
International Crystal	87
Jameco Electronics	127
Jan Crystals	114
Jones, Marlin P. & Assoc.	120
K-Enterprises	112
Kantronics, Inc.	108
Trio-Kenwood Communications, Inc.	7, 72, 73
Larsen Antennas	57
Long's Electronics	144
Lunar Electronics	104
Lyle Products	106
MFJ Enterprises	2
Madison Electronic Supply	97
Palomar Engineers	99
Partridge (HR) Electronics	130
Pathcom, Inc.	96
Personal Communications Foundation	140
RF Power Labs	112
Racal Communications, Inc.	1
Radio Amateur Callbook	96, 142
Radio World	104
Ramsey Electronics	92, 93
S-F Amateur Radio Service	114
SST Electronics	112, 113
Savoy Electronics	126
Securtron	134
Sentry Manufacturing	124
Shakespeare Antennas	121
Sherwood Engineering	124
Slep Electronics	118
Space Electronics	128
Spectronics	120, 124, 128, 134, 138
Spectrum International	110
Swan Electronics	115
TPL Communications	37
Ten-Tec	78, 79
Thomas Communications	125
Tristao Tower	122
Tufts Radio Electronics	129
VHF Engineering, Div. of Brownian	141
Valley Instrument Products	114
Vanguard Labs	128
Varian, Eimac Division	Cover IV
Webster Associates	118
Weinschenker	124
Western Electronics	138
Whitehouse, G. R. & Co.	41
Wilson Electronics	119
Wolverine State Radio Supply	130
Wren Company	136
Yaesu Electronics Corp.	Cover III, 141



Sopris, Colorado — In ETO's "back yard" — Photo by Douglas J. Martin

# ALPHA POWER... Rugged, Cool & Quiet

When you buy an ALPHA linear amplifier you make a long term investment in dependable power and operating pleasure.

You can take your ALPHA for granted — it will go on delivering that big, clean, maximum-legal-power signal no matter how tough the contest or how long the SSTV or RTTY QSO's.

We strive constantly to make every ALPHA even better. If we can't improve it, we don't change it.

**DURABILITY?** You get TWO YEARS of factory warranty protection with your new ALPHA . . . other manufacturers give you 90 days.

**CONVENIENCE?** Every ALPHA is self-contained, compact, and smooth-tuning. All 76A - 374A - 78 models can be shipped via economical, door-to-door UPS.

**VERSATILITY?** The new ALPHA 374A delivers full legal power (in any mode) on all amateur HF bands WITHOUT TUNE-UP and with excellent efficiency. (On 160M you peak the output manually; new FCC rules permit easy owner modification to restore full 10M capability, too.)

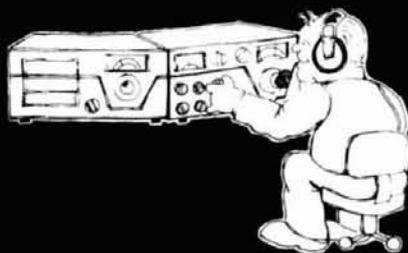
The ALPHA 78 combines the best of everything: full instant CW break-in (QSK) and NO-TUNE-UP bandchange! And of course all ALPHAs substantially exceed every applicable FCC requirement.

For detailed literature and fast delivery of your new ALPHA, contact your dealer or ETO direct. While you're at it, ask for a free copy of our brief guide, *"Everything You Always Wanted to Know About (Comparing) Linears . . . But Didn't Know Whom to Ask."*

ALPHA — Sure you can buy a cheaper linear . . . But is that really what you want?

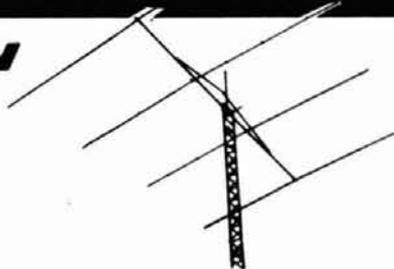
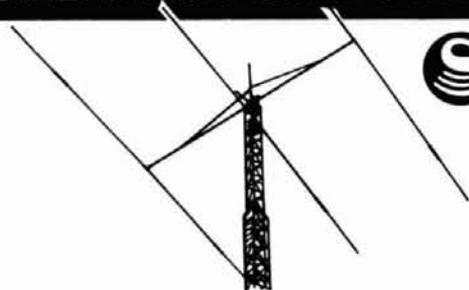
**ETO** Ehrhorn Technological Operations, Inc.  
P.O. Box 708 • Cañon City, Colorado 81212 • (303) 275-1613

# Longs Suggest You Try SWAN Call Toll Free



# 1-800-633-3410

IN ALABAMA CALL 1-800-292-8668 9:00 AM TIL 5:30 PM CST



## SWAN TB3HA 3 element tri-band beam

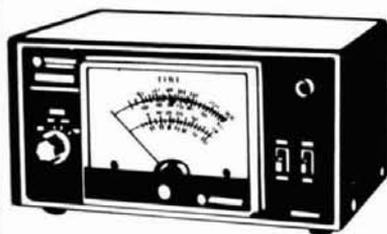
The heavy duty TB3HA features: Gain 8dB • Front to back 20-22 dB • Boom length 16' • Longest element 28'2" • Wind surface area 4 sq. ft. • 10-15-20 meters.

**199.95** list price. Call for quote.

## SWAN TB4HA 4 element tri-band beam

All four elements active on all three bands. The heavy duty TB4HA features: • Gain 9dB • Front to back 24-26 dB • Boom length 24' • Longest element 28 ft. 10 in. • Wind surface area 6 sq. ft. • 10-15-20 meters.

**259.95** list price. Call for quote.



## SWAN WM-3000 precision PEAK/RMS wattmeter

Read forward or reflected power with maximum accuracy from 3.5 to 30 MHz • RMS readings available with the flick of a switch • Four scales from 0 to 2000 watts. Requires 117V AC power source.

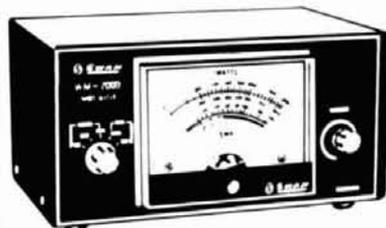
**87.95** Call for yours today.



## SWAN HFM-200 SWR & power meter

Frequency 1.8-30 MHz. Two power ranges: 0-20 and 0-200 watts. VSWR 1:1-3:1. For mobile installation, directional coupler may be located separate from main indicator. Meter is lighted for night use.

**49.95** Call for yours today.



## SWAN WM-2000 in-line wattmeter

Frequency 3.5 to 30 MHz. 3 scales: 0-200, 1000 and 2000 watts. VSWR scale permits reading from 1:1 to 3:1. Uses two SO-239 connectors.

**64.95** Call for yours today.



# Long's Electronics



MAIL ORDERS. P.O. BOX 11347 BIRMINGHAM, AL 35202 • STREET ADDRESS 2808 7TH AVENUE SOUTH BIRMINGHAM, ALABAMA 35233

Remember, you can Call Toll Free: **1-800-633-3410** in the U.S.A. or call **1-800-292-8668** in Alabama for our low price quote. Store hours: 9:00 AM til 5:30 PM, Monday thru Friday.

# FRG-7 COMMUNICATIONS RECEIVER



## SYNTHESIZED ALL SOLID STATE HI-PERFORMANCE GENERAL COVERAGE RECEIVER AND QTR-24 WORLD CLOCK

The Model FRG-7 is a precision-built communications receiver with continuous coverage (500 kHz to 29.99 MHz) featuring:

- Drift Canceling Circuit
- RF Attenuator
- Noise Suppression Circuit
- 5 kHz Direct Dial Readout
- Ceramic IF Filters
- AC-DC or Internal Battery
- Hi Sensitivity
- Excellent Stability
- USB/LSB/AM/CW
- Triple Conversion

Completely Solid State Circuitry for Stable Trouble-Free Operation ■ Built-in Front Mounted Speaker ■ RF Attenuator for Reception of Local or High Powered Stations ■ Outstanding Frequency Stability through the use of Drift Cancellation Circuit (Wadley Loop) ■ Recording Output Jack provides Constant Output Level Regardless of Audio Volume Control Settings ■ 3-Position Audio Range Selector 1. Normal (Broad) 2. Narrow (Hi & Low Cut Off) 3. Low (Hi Cut Off) ■ Excellent IF Receiver for VHF/UHF Converters.



# YAESU *The radio.*

YAESU ELECTRONICS CORP., 15954 Downey Ave., Paramount, CA 90723 ● (213) 633-4007  
YAESU ELECTRONICS Eastern Service Ctr., 9812 Princeton-Glendale Rd., Cincinnati, OH 45246

# EIMAC's new Pyrogrid can run hotter so your transmitter can run better.

No easier way to generate 50 kW  
for AM, FM, and VHF-TV service.

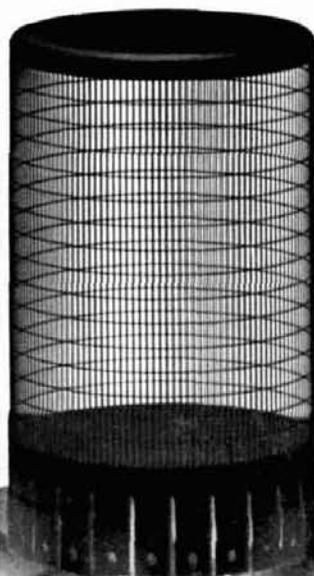
The pyrolytic graphite grid in EIMAC's  
newest tough tetrode, the 4CX40,000G,  
has triple the screen dissipation of earlier  
tetrodes. Which means:

1. A previous limiting factor in tetrode  
design, screen dissipation, is virtually  
eliminated.
2. Primary grid emission is eliminated.
3. Secondary grid emission is eliminated,  
improving linearity.
4. Hot and cold spacing  
between grids remains  
constant, allowing closer  
spacing between ele-  
ments and improved  
performance.

**High gain, better reliability.**

With over 20 dB power gain,

EIMAC's Pyro-  
grid 4CX40,000G  
tetrode can fol-  
low a solid state  
driver, allowing a  
smaller, more effi-  
cient transmitter.



The stability of  
pyrolytic graphite  
assures better tube  
reliability.

**Available today for  
tomorrow's single  
tube transmitters.**

For complete infor-  
mation about the  
tough new EIMAC  
tetrode for tomor-  
row's AM, FM  
broadcast

and  
VHF-TV  
linear am-  
plifiers, contact Varian, EIMAC Division,  
301 Industrial Way, San Carlos, CA 94070.  
Telephone (415) 592-1221. Or any of the  
more than 30 Varian Electron Device  
Group Sales Offices throughout the world.





Share the Heathkit experience with your kids!  
Send for the big new

# HEATHKIT<sup>®</sup> CATALOG

You'll find nearly 400 fun-filled kit building experiences both you and your family can enjoy. There's ham gear, color TV's, stereo components, digital clocks, test instruments, treasure finders, computers, peripherals, and MORE—all with easy, step-by-step instruction manuals. Share the Heath experience—it'll make your whole relationship...a lot more special!

It's **FUN** to build-in more quality for your electronics dollars! Send for your

## FREE HEATHKIT CATALOG

**yes**

Send me my personal copy of the newest Heathkit Catalog. I am not currently on your mailing list.

Heath Company, Dept. 122-460, Benton Harbor, MI 49022

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_

STATE \_\_\_\_\_ ZIP \_\_\_\_\_

Ham Radio

PC-129

**Start a worthwhile family hobby today!**



enjoy the world's  
leading electronic  
kit catalog...



**FREE**

**THE ALL-NEW  
HEATHKIT CATALOG**

Nearly 400 build-it-yourself  
kits that the entire family  
can enjoy

Send for your free copy today!

**HEATH COMPANY**  
Benton Harbor, MI 49022

PLACE  
STAMP HERE  
Post Office  
will not  
deliver mail  
without  
postage