

one dollar

# ham radio

magazine

hr 

## OCTOBER 1976

- high-frequency receiver design 10
- multiband hf converter 32
- microwave amplifier design 40
- two-channel vhf-fm receiver 48
- four-band vhf converter 64
- and much more . . .

second annual  
receiver  
issue



# henry radio

a name that says it all

For over 40 years...dedicated to amateur radio...to offering the finest products...to dependable service.

## Henry Radio's TEMPO VHF/ONE



An advanced design synthesized 2-meter transceiver

Full phase lock synthesized (PLL) so no channel crystals are required • Solid-state • 5 digit LED receive frequency display • Full 2-meter band coverage (144 to 148MHz) for transmit and receive • Automatic repeater split (selectable up or down) • 2 built-in programmable channels • \$495.00.

TEMPO SSB/ONE (SSB adapter for the VHF/ONE) • Selectable upper or lower sideband • Plugs directly into the VHF/ONE • Noise blanker built-in • VXO for full frequency coverage • \$225.00.

## KENWOOD TS-700A



The promise of 2 meter operation...the Kenwood way. The TS-700A operates all modes: SSB (upper & lower) /FM/AM/CW and provides the dependability of solid state circuitry. Has tunable VFO and 4 MHz band coverage (144 to 148 MHz). Automatically switches transmit frequency 600 KHz for repeater operation. AC and DC capability through its built-in power supply. Outstanding frequency stability Complete with microphone and built-in speaker. .... \$700.00

## YAESU FT-221



A compact, versatile transceiver designed for the active 2 meter enthusiast. Features all mode operation — SSB/FM/CW/AM — with repeater offset capability. Advanced phase lock loop circuitry, computer-type modular construction. Preset pass band tuning provides the optimum selectivity and performance needed on today's active 2 meter band. Complete 144-148 MHz coverage. Built-in AC and DC power supplies and speaker. .... \$679.00

## Henry Radio's

### TEMPO CL 146A



... a VHF/FM mobile transceiver for the 2 meter amateur band. Compact, rugged and all solid state. One channel supplied plus two of your choice. 144 to 148 MHz. Multifrequency spread of 2 MHz. 12 channel possible. Internal speaker, dynamic mike, mounting bracket and power cord supplied. A Tempo "best buy" at \$239.00.

### TEMPO VHF/UHF AMPLIFIERS



Solid state power amplifiers for use in most land mobile applications. Increase the range, clarity, reliability and speed of two way communications.

Now,  
meet  
Henry  
Radio ...



Walt Henry  
W6ZN  
ANAHEIM



Ted Henry  
W6UOU  
LOS ANGELES



Bob Henry  
WØARA  
BUTLER

Plus a large staff of highly qualified sales and service personnel pledged to serve you. Henry Radio carries large stocks of all major brands. We take trade-ins, sell used equipment and offer better terms because we carry our own financing. Our reconditioned equipment carries a 15 day trial, 90 day warranty and may be traded back within 90 days for full credit toward the purchase of new equipment. Export inquiries solicited. Also, military, commercial, industrial, and scientific users...please write for information on our custom line of high power linear amplifiers and RF power generators.

We stock the Bird Model 43 Wattmeter and accessories.

Prices subject to change without notice.

# Henry Radio

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



# Sends code so smooth you'll think it's part of your hand...

The Heathkit HD-1410 Solid-State Electronic Code Keyer makes operating CW a real pleasure! Separate dot and dash paddles are fully adjustable so you get the exact "feel" you like. The dots and dashes are self-completing and always in the proper proportion, so your CW signal is accurate and precise. Iambic operation



lets you form characters with minimal wrist movement for comfortable, fatigue-free sending. And the HD-1410's solid-state output eliminates the bouncing and sticking

problems found in many relay-type keyers.

You can build the HD-1410 to send 10-35 wpm while you're a Novice, and a simple adjustment will increase its capability to 10-60 wpm when you advance. The HD-1410 is just one of the many superb Amateur Radio kits in the new Heathkit catalog. Get your FREE copy now!

# FREE!

## HEATHKIT CATALOG

Send for your copy today!

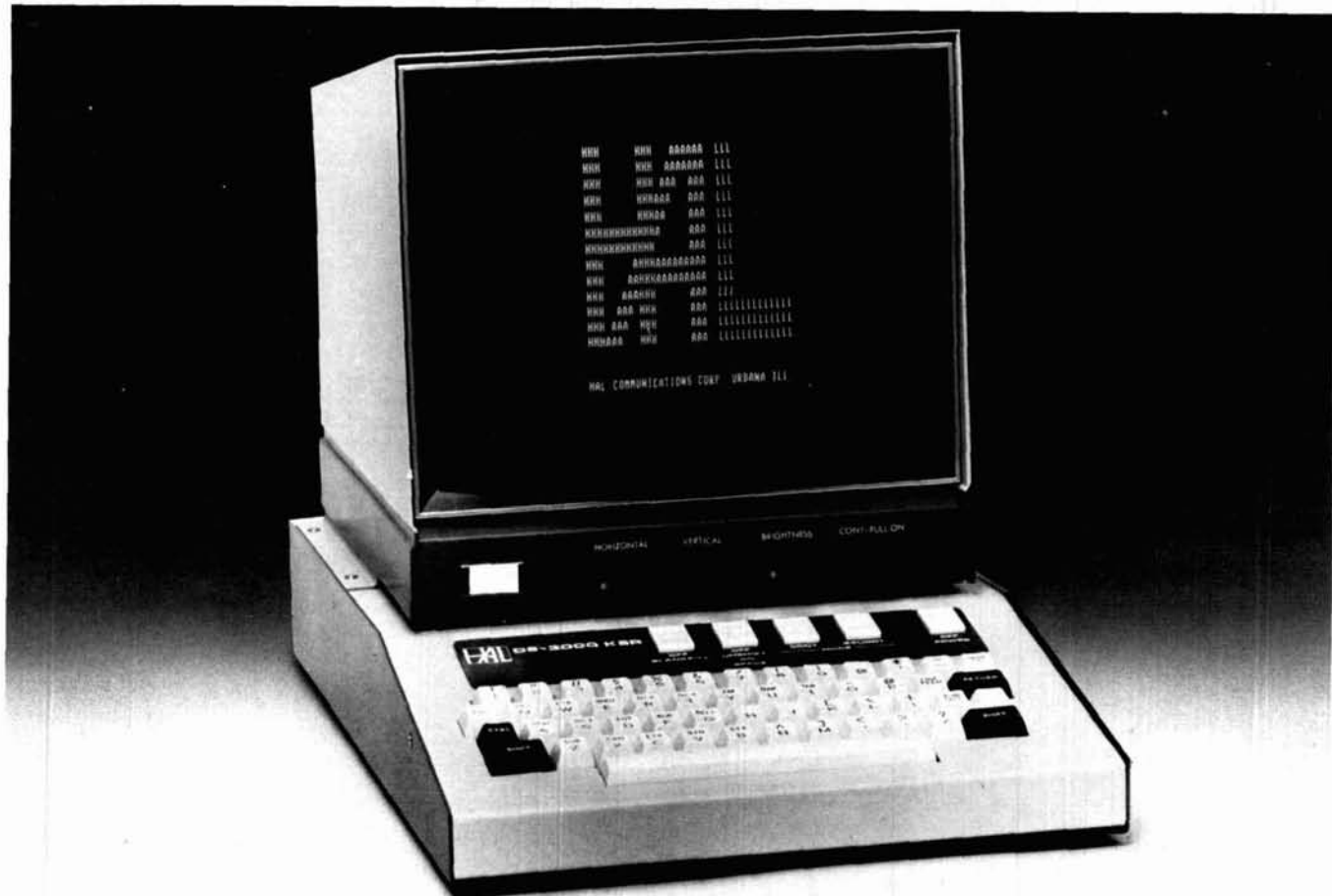
Heath Company, Dept. 122-22  
Benton Harbor, Michigan 49022



*"There's more for the Ham at Heath"*

Heath Company, Dept. 122-22 Benton Harbor, Michigan 49022		HEATH <b>Schlumberger</b>
Please send me my FREE Heathkit Catalog. I am not on your mailing list.		
Name _____		
Address _____		
City _____		State _____
AM-337		Zip _____

# Stay tuned for future programs.



The HAL ST-6000 demodulator/keyer and the DS-3000 and DS-4000 KSR/RO series of communications terminals are designed to give you superlative TTY performance today—and in the future. DS series terminals, for example, are re-programmable, assuring you freedom from obsolescence. Sophisticated systems all, these HAL products are attractively priced—for industry, government and serious amateur radio operators.

The HAL ST-6000 operates at standard shifts of 850, 425, and 170 Hz. The tone keyer is crystal-controlled. Loop supply is internal. Active filters allow flexibility in estab-

lishing different tone pairs. You can select AM or hard-limiting FM modes of operation to accommodate different operating conditions. An internal monitor scope (shown on model above) allows fast, accurate tuning. The ST-6000 has an outstandingly high dynamic range of operation. Data I/O can be RS-232C, MIL-188C or current loop.

The DS-3000 and DS-4000 series of KSR and RO terminals provide silent, reliable, all-electronic TTY transmission and reception, or read-only (RO) operation of different combinations

of codes, including Baudot, ASCII and Morse. The powerful, programmable 8080A microprocessor is included in the circuitry to assure maximum flexibility for your present needs—and for the future. The KSR models offer you full editing capability. The video display is a convenient 16-line format, of 72 characters per line.

These are some of the highlights. The full range of features and specifications for the ST-6000 and the DS series of KSR and RO terminals is covered in comprehensive data sheets available on request. Write for them now—and tune in to the most sophisticated TTY operation you can have today...or in the future.



HAL Communications Corp., Box 365, 807 E. Green Street  
Urbana, Illinois 61801 • Telephone: (217) 367-7373

# ham radio

magazine

OCTOBER 1976

volume 9, number 10

**editorial staff**

James R. Fisk, W1DTY  
editor-in-chief  
James H. Gray, W2EUQ  
Patricia A. Hawes, WN1WPM  
Alfred Wilson, W6NIF  
assistant editors  
J. Jay O'Brien, W6GO  
fm editor  
Joseph J. Schroeder, W9JUV  
associate editor  
Wayne T. Pierce, K3SUK  
cover

**publishing staff**

T. H. Tenney, Jr., W1NLB  
publisher  
Harold P. Kent, WN1WPP  
assistant publisher  
Fred D. Moller, Jr., WN1USO  
advertising manager  
Cynthia M. Schlosser  
assistant advertising manager  
Therese R. Bourgault  
circulation manager

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

**subscription rates**

U.S. and Canada: one year, \$10.00  
three years, \$20.00  
Worldwide: one year, \$12.00  
three years, \$24.00

**foreign subscription agents**

Ham Radio Canada  
Box 114, Goderich  
Ontario, Canada, N7A 3Y5  
Ham Radio Europe  
Box 444  
194 04 Upplands Vasby, Sweden  
Ham Radio France  
20 bis, Avenue des Clarions  
89000 Auxerre, France  
Ham Radio Holland  
Postbus 3051  
Delft 2200, Holland  
Ham Radio Italy  
STE, Via Maniago 15  
I-20134 Milano, Italy  
Ham Radio UK  
Post Office Box 64, Harrow  
Middlesex HA3 6HS, England  
Holland Radio, 143 Greenway  
Greenside, Johannesburg  
Republic of South Africa

Copyright 1976 by  
Communications Technology, Inc  
Title registered at U.S. Patent Office

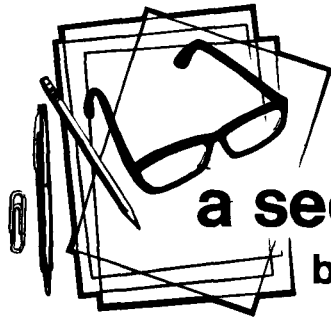
Microfilm copies  
are available from  
University Microfilms  
Ann Arbor, Michigan 48103

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



## contents

- 10 high-frequency receiver design  
Ulrich L. Rohde, DJ2LR
- 26 double-conversion high-frequency receiver  
Jack Perolo, PY2PE1C
- 32 multiband high-frequency converter  
M.A. Chapman, K6SDX
- 40 solid-state microwave amplifier design  
H. Paul Shuch, WA6UAM
- 48 two-channel receiver for repeater monitoring  
R.B. Shreve, W8GRG
- 52 updating tube-type fm receivers  
H.M. Meyer, Jr., W6GGV
- 54 RC active filters  
Fred M. Griffee, W4IYB
- 60 wideband receiver preamp  
Edward A. Pacyna, Jr., W1AAZ
- 64 four-band vhf receiving converter  
S.A. Smith, W3TQM
- 71 phasing-type signal detector  
Donald B. Lawson, WB9CYY
- 4 a second look  
134 advertisers index  
111 flea market  
120 ham mart  
78 ham notebook
- 82 new products  
134 reader service  
85 short circuits  
6 stop press



## a second look

by Jim Fisk

In their quest for new sources of needed energy, researchers at the Lawrence Livermore Laboratory in California are putting together the world's largest laser in an effort to exploit the ultimate energy source — the same fusion energy as that used by the stars. The 200-foot (60m) long laser, which is scheduled to be completed by early 1977, is expected to produce 25-million watts of electricity. Initially, it will take more energy than this to make it work, so the system will operate at a net energy loss, but scientists expect to upgrade the mammoth to 100- to 300-trillion watts, and by 1980 it should make world history by generating more energy than it actually consumes. When that happens, it will signal the birth of the fusion age and the beginning of civilization's independence from scarce oil, gas, coal and atomic fuels.

Water, the fuel for fusion, has a fantastic amount of energy locked inside: the heavy hydrogen (an isotope called deuterium) in just 75 gallons of water could light New York City for nearly 10 minutes! Although scientists have known about this cheap and inexhaustible energy source for more than thirty years, harnessing it is no easy trick. Stars solve the problem by compressing the hydrogen and heating it to extreme temperatures, and then use their immense gravitational pull to confine the plasma so it can't escape. This works just fine if you're as large as a star (our sun is 864,000 miles in diameter), but here on earth the job will be done with a powerful laser which is carefully focused on a pinhead-sized pellet of heavy hydrogen fuel, instantly heating it to a tremendous temperature. Part of the pellet's outer shell is blasted outward; the inner part, however, implodes and compresses the fuel to 10,000 times its normal density. At the instant this happens the fuel fuses into lithium and emits a shower of heat and light. A thin layer of liquid lithium, which covers the spherical implosion chamber, carries away the heat which is used to drive turbines.

The huge laser, called *Shiva* after the Hindu god of destruction and reproduction, actually consists of twenty 1000-joule lasers, each about 150 feet (46m) long, arranged somewhat like a Gatling gun. Each of the individual lasers consists of a chain of seven elements: a master laser oscillator followed by six laser amplifiers which pumps out an intense pulse of light — equivalent to 10-million megawatts — lasting about a billionth of a second. Each of the 20 beams of carefully shaped and timed laser light simultaneously enter the ports of the implosion chamber and blast the fuel pellet into oblivion. The next pellet is then inserted into the center of the chamber and, once again, implodes after being blasted.

Although there are still a number of problems to be resolved, scientists are confident they will have the first successful fusion reactor in operation by early next year. It will take four or five more years to bring the system on line, but even at that, *Shiva* looks like the most promising new energy source to come down the pike in a good many years.

Jim Fisk, W1DTY  
editor-in-chief



# Now It's Crystal Clear

Yes, now ICOM helps you steer clear of all the hassles of channel crystals. The new **IC-22S** is the same surprising radio you've come to know and love as the **IC-22A**, except that it is totally crystal independent. **Zero crystals.** Solid state engineering enables you to program 23 channels of your choice without waiting. Now the ICOM performance you've demanded comes with the convenience you've wanted, with your new **IC-22S**.

VHF/UHF AMATEUR AND MARINE COMMUNICATION EQUIPMENT

Distributed by:



# 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**  
3891 Oak Street  
Vancouver B.C. V6H 2M6  
Canada  
(604) 733-9819



FIRST TWO METER WORKED ALL STATES was achieved by KØMQS when he worked K6YNB/KL7 via moonbounce August 17th. The Alaska contact was particularly timely for KØMQS as he'd just nailed his 49th state - Idaho - when he contacted W7UBI on August 2. The QSO with KØMQS was, coincidentally, K6YNB/KL7's first EME contact though the DXpedition station had made some Perseids contacts.

VHF/UHF Bands Continued to offer "DX" treats with long-haul contacts almost a daily happening on two meters during early August. W2BOC has asked for log data from any stations that participated in the June 26-28 openings on two and six meters to aid in sporadic E propagation studies he's making.

SALE OF GENERAL CLASS AMATEUR LICENSES is being checked by FBI in Indianapolis and possibly other cities. An article in the Indianapolis Star describes a supposed ring of Amateurs who were telling prospective Amateurs that "they can bypass rigorous testing procedures by purchasing a General Class ham license for \$200" from the gang.

A "Mr. Big" in the operation is described in the article as "a government employee in Pennsylvania" who has access to the FCC's computers and, for a price, is "willing to feed the data into the computers to make sure a license will be issued."

The FBI's Agent In Charge in Indianapolis confirmed that an investigation is in progress but had no further details. Contacts at the FCC in Washington were not aware of either the story or the newspaper's report of it. Apparently a number of Indianapolis area Amateurs have been visited by the FBI investigators, and one of them said that an agent told him the Indianapolis investigation is "just the tip of the iceberg!"

FCC IS COMING DOWN HARD on bootleggers operating between the 27-MHz CB band and 10 meters. FCC agents and U.S. Marshalls nailed a dozen of the outlaw operators in a July raid in northern New Jersey, and seized an estimated \$10,000 in radio gear.

Amateur Input On Unlicensed and/or out-of-band operators played a big part in the investigation, and FCC/Justice Department people in other parts of the country are also using reports from Amateur radio monitors.

Most Valuable Data is that providing general operating patterns of illegal operation in a given area. Recent discussions with key FCC enforcement people cited reports of specific frequencies, operating times and general location of operators as being of prime importance, with detailed dossiers on one or two violator's activities of lesser interest. Reporters should also specify what they use for monitoring and their location - information can go to any FCC Field Office or Monitoring Station.

"WN" NOVICE PREFIXES will no longer be issued after October 1, and Novice licensees will receive the same prefixes as higher class license holders. In its announcement of the change August 19th, the Commission cited processing problems as the prime reason for the change - its computer has had some difficulty in translating a WN into a WA, WB, or (recently) WD, resulting in the issuance of some duplicate calls.

Present Novice Licensees whose licenses expire after October 1 will also be changing prefixes - the Commission plans to issue them new licenses with the appropriate new prefix - until a new license is actually received, however, a presently-licensed Novice should continue using "WN."

WD Callsigns are being issued or are on the verge of being issued in the 2nd, 4th, 6th and 8th call areas, according to the Commission's release on the Novice change, and WDs are imminent in the 5th, 9th and Ø districts.

TWO LETTER CALL REQUESTS have totaled about 400 since July 1st with 75 or so of those from two-letter-call holders wishing to change. A few requests continue to trickle in, and the fourth district has very few 1x2 calls left. Though the next group of eligible Amateurs will use up some of those remaining, the next big influx of requests is expected in January. Don't be surprised to hear N prefixes and "X" calls such as W9XA by then.

PACKRATS' SOUTH AMERICAN MOONBOUNCE DXpedition in August was a resounding success with 16 stations in 8 countries worked off the moon on 432 MHz. First contact was with K2UYH, providing him with the first E-M-E WAC, followed by W3CCX, F9FT, I5MSH, PAØSSB, LX1DB, K3PCP, VE7BBG, W1JAA, J1VDV, K8UQA, W4ZXI, W1SL, WØYZS, KØTLH and SM5LE. In addition to E-M-E operation, over 40 OSCAR 7 Mode B contacts were also logged before the group shut down to return to the States.

AMSAT'S ASCII STA has been granted and is good through February 6. More experimental use of ASCII through the satellites is being encouraged.

TOM McMULLEN, W1SL, has joined Ham Radio as managing editor. Tom, a well-known VHF/UHF experimenter, has been QST's Assistant Technical Editor.

Charlie Carroll, W1GQO, until recently a member of the ARRL technical staff, has also joined Ham Radio as an assistant editor. Welcome aboard!



# Does Your Transmitter Love Your Antenna?



If you're fighting the constant battle of limited band width, high SWR ratios, inefficient low-pass TVI filter operation due to high SWR you're not alone.

## DenTron makes the Problem Solvers.

The DenTron tuners give you maximum power transfer from your transmitter to your antenna, and isn't that where it really counts?

Our Super Tuners (A. B. & E.) are the only tuners on the market that match everything between 160 and 10 meters. Whether you have balanced line, coax cable, random or long wire the DenTron Super Tuners will match the antenna impedance to your transmitter.

**NEW:** The Monitor Tuner (E.) was designed because of overwhelming demand. Hams told us they wanted a 3 kiliowatt tuner with a built-in wattmeter, a front panel antenna selector for coax, balanced line and random wire. So we engineered the 160-10m Monitor Tuner. It's a life time investment at \$299.50

The DenTron 80-10 AT (D.) is a random wire, 80-10 meter tuner which is ideal for portable operation or apartment dwellers.

Every serious ham knows he must read both forward and reverse wattage simultaneously for that perfect match. So upgrade with the DenTron W-2 Dual in line Wattmeter. (C.)

The flexibility we build into our Tuners make any previous tuner you might have owned obsolete.

A. Super Tuner 1KW PEP . . . . .	\$129.50
B. Super Super Tuner 3 KW PEP . . . . .	\$229.50
C. W-2 Wattmeter . . . . .	\$ 99.50
D. 80-10 AT 500 W PEP . . . . .	\$ 59.50
E. Monitor Tuner 3 KW PEP . . . . .	\$299.50

All DenTron products are made in U.S.A.

**DenTron**  
Radio Co., Inc.

2100 Enterprise Parkway  
Twinsburg, Ohio 44087  
(216)425-3173

*Dedicated to Making Amateur Radio MORE FUN!*

# If you haven't tried the TS-700A ...you haven't experienced the excitement of 2-meters



Experience the excitement  
of 2 meters. There's more than  
just FM repeaters, you know. SSB DX,  
OSCAR Satellite, CW...and do it all with a tunable  
VFO. Do it all with the Kenwood TS-700A.

- Operates all modes: SSB (upper & lower), FM, AM, and CW
- Completely solid state circuitry provides stable, long lasting, trouble-free operation
- AC and DC capability. Can operate from your car, boat, or as a base station through its built-in power supply
- 4 MHz band coverage (144 to 148 MHz) instead of the usual 2
- Automatically switches transmit frequency 600 KHz for repeater

- operation... reverses, too
- Outstanding frequency stability provided through the use of FET-VFO
- Zero center discriminator meter
- Transmit/Receive capability on 44 channels with 11 crystals
- Complete with microphone and built-in speaker

The TS-700A is available at select Kenwood dealers throughout the U.S. For the name of your nearest dealer, please write.

## TS-700A Specifications

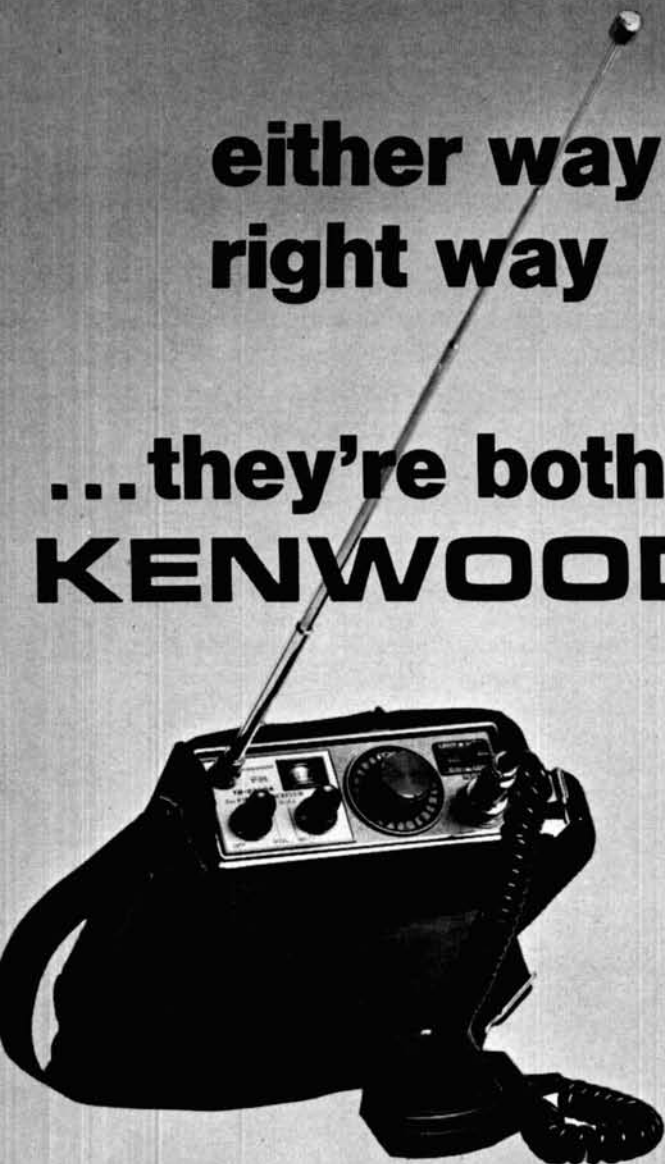
TRANSMIT/RECEIVE FREQUENCY RANGE:  
144-148 MHz  
MODE: SSB, FM, CW, AM  
RF OUTPUT: CW, FM: more than 10W output.  
AM: more than 3W output. SSB: more  
than 20W DC input.  
ANTENNA IMPEDANCE: 50Ω (unbalanced)  
CARRIER SUPPRESSION: Better than 40 dB  
SIDE-BAND SUPPRESSION: Better than 40 dB  
SPURIOUS RADIATION: Less than -60 db

MAX. FREQUENCY DEVIATION (FM):  $\pm 5$  kHz  
REPEATER FREQUENCY SHIFT WIDTH:  
600 kHz  
TONE BURST TIME: 0.5-1.0 sec.  
MODULATION: Balanced modulation for SSB.  
Variable reactance frequency shift for FM.  
Low power modulation for AM.  
MICROPHONE: Dynamic microphone, 500Ω  
AUDIO FREQUENCY RESPONSE: 400-2600 Hz,  
within -9 db  
RECEIVING SYSTEM: SSB, CW, AM: Single-  
superheterodyne; FM: Double  
superheterodyne  
INTERMEDIATE FREQUENCY: SSB, CW, AM:  
10.7 MHz; FM: 1st IF: 10.7 MHz; 2nd IF:  
455 kHz  
RECEIVING SENSITIVITY: SSB, CW: S/N = 10  
dB or better at 0.25μV, 20 dB noise  
quieting = Less than 0.4μV; AM: S/N =  
10 dB or better at 1μV  
IMAGE RATIO: Better than 60dB  
IF REJECTION: Better than 60dB  
PASS-BANDWIDTH: SSB, CW, AM: More than  
2.4 kHz at -6 dB; FM: More than 12 kHz at  
-6 dB  
RECEIVER SELECTIVITY: SSB, CW, AM: Less  
than 4.8 kHz at -60 dB; FM: Less than  
24 kHz at -60 dB  
SQUELCH SENSITIVITY: 0.25μV  
AUDIO OUTPUT: More than 2W at 8Ω load  
(10% distortion)  
RECEIVER LOAD IMPEDANCE: 8Ω  
FREQUENCY STABILITY: Within  $\pm 2$  kHz during  
one hour after one minute of warm-up,  
and within 150 Hz during any 30 minute  
period thereafter.  
POWER CONSUMPTION: Transmit mode: 95W  
(AC 120/220V), 4A (DC 13.8V), max.  
Receive mode (no signal): 45W (AC 120/  
220V), 0.8A (DC 13.8V)  
POWER REQUIREMENTS: AC 120/220V,  
50/60 Hz; DC 12-16V (13.8V as reference)  
DIMENSIONS: 278 (W) x 124 (H) x 320 (D) mm  
WEIGHT: 11 kg  
SUGGESTED PRICE: \$700.00

Prices subject to change without notice

either way is the  
right way

...they're both  
**KENWOOD**



## the TR-2200A

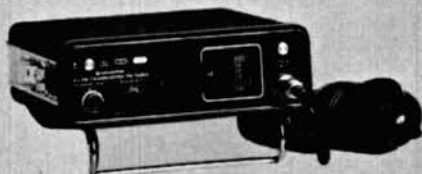
*Kenwood's high performance portable 2-meter FM transceiver... completely transistorized, rugged and compact.*

12 channel capacity. Built in telescoping antenna can be easily replaced, or stored in carrying case. Connector for external antenna also. External 12 VDC or internal ni-cad batteries, complete with 120 VAC battery charger. 146-148 MHz frequency coverage. 12 channels, 6 supplied. Battery saving "light off" position. Hi-Lo power switch (2 watts - 400 mW). Sensitivity: 0.5 uV or less/26 dB S+N/N. Built-in speaker. Size: 5-3/8" x 2-5/16" x 7-1/8", 3-3/4 lbs. Complete with Dynamic mike, O-T-S carrying case, all cables, speaker/headphone plug and 10 Ni-Cad batteries. Amateur net... \$229.00.



## the TR-7200A

*Kenwood's superb 2-meter FM mobile transceiver. Designed to withstand the most severe punishment while providing consistently excellent performance.*



Packed with features like the PRIORITY function... Put your favorite crystals in channel 7, and the

7200A switches there with the push of a button... no matter what channel you are on. 146-148 MHz coverage, 22 channels, 6 supplied. Completely solid state. Voltage required: 13.8 VDC. Antenna impedance: 50 ohms. Frequency adjusting trimmers on every crystal. RF output power: 10 watts (or 1 watt at low power). Adjustable frequency deviation (factory set at  $\pm 5$  kHz). Automatic VSWR protection. Receiver sensitivity less than .5 uV for 27 dB. Selectivity: 12 kHz/-6 dB and 24 kHz/-70 dB. Size: 7-1/16" W x 2-3/8" H x 9-7/16" D, 5-1/2 lbs.

Complete with dynamic mike, DC power cord, mobile mount, mike hanger, auxiliary connector and external speaker plug. Amateur net... \$249.00.

The perfect companion to the TR-7200A is the PS-5 AC/DC power supply. Together they provide an efficient and handsome base station. The PS-5 is complete with a digital clock and automatic time control feature built in. Amateur net... \$79.00.

# optimum design for high-frequency communications receivers

High-performance circuits  
are described  
for communications receivers  
operating in the  
10-kHz to 30-MHz range

The design of shortwave receivers has changed significantly in past years. Early receivers used double- or even triple frequency conversion, and selectivity was achieved at a fairly low frequency; for example, 455 kHz. Fig. 1 is a block diagram of this type receiver. Since the i-f had to be higher or lower than the frequency bands of these receivers, the i-f was usually set below 2 MHz, which resulted in image problems. To overcome this, many tuned circuits were required in the rf stages, and oscillator tracking became quite another problem.

Present-day design avoids these expensive mechanical arrangements thanks to the availability of crystal filters in the 30- to 120-MHz range. If an intermediate frequency higher than the highest frequency of reception is used, three advantages occur:

1. To achieve constant image and i-f suppression, a simple lowpass filter with a cutoff frequency of 31 MHz can be used, guaranteeing at least 80 dB suppression. Such a filter will also substantially reduce local-oscillator power radiation.
2. With both the oscillator and intermediate frequencies higher than the highest frequency of reception, gaps in receiver coverage are eliminated (a receiver with an i-f at 5.5 MHz, for example, precludes tuning between approximately 5 and 6 MHz).
3. The ratio of the oscillator frequency range (maximum/minimum) is, by definition, less than 2:1.

Additional input selectivity can be obtained by using fairly wide cross-modulation and intermodulation filters which operate in fixed-frequency bands. Thus the receiver can use bands of constant width; that is, in 1-MHz intervals.

If we talk about a good shortwave receiver, we must define "good" in terms of receiver electrical characteristics. Table 1 provides these characteristics for a shortwave receiver that is required for today's operation.

Many amateurs equate "good" with noise figure or signal-to-noise ratio. It has been recently agreed that a noise figure less than 10 dB is not essential for high-frequency amateur receivers. In some military and systems-oriented applications a noise figure of 6 dB or less is required for example, in systems using low-efficiency antennas such as whips. Unfortunately, sometimes some of this equipment is used with large antennas, so a large dynamic range in the receiver is needed despite the low noise figure.

What about oscillator radiation? The technique used by Southcom and being adapted by Atlas requires highly efficient shielding and filtering to avoid oscillator power feedthrough to the antenna input terminal. Commercially designed receivers for the military market must have a maximum of 15 microvolts reradiation of the oscillator signal — a requirement that practically none of the amateur receivers on today's market can fulfill.

## new receiver design

Fig. 2 is a block diagram of a receiver with a first i-f of 40.525 MHz. This receiver covers 10 kHz to 30 MHz. The reason for choosing this i-f is that one of the standard i-fs in Europe is 525 kHz (455 kHz in the U.S.). By using a 40-MHz signal derived from an internal frequency standard, conversion from the first to the second i-f can be accomplished easily.

The signal at the antenna passes through a 30-MHz lowpass filter and, depending on the selection of the reception frequency, through either a high- or lowpass filter with a 2-MHz cutoff and one of eight automatically selected bandpass filters in the range of 2 to 30 MHz. The signal is then applied to a balanced power amplifier through an automatic attenuator circuit consisting of negative temperature coefficient and positive temperature coefficient resistors. The 30-MHz filter rejects image frequencies. The 2-MHz highpass filter separates the broadcast range with its often very high field strength from the high-frequency region and prevents BC signals from arriving at the mixer. An independent agc circuit (not a limiter) is used in addition to the normal agc system. This independent agc circuit

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

responds when signals equal to or above 100 mV are fed to the receiver input. This circuit acts as an automatic attenuator and protects all following stages from being overdriven without introducing any measurable distortion of its own. A push-pull power amplifier stage following the input filters uses heavy feedback to keep second- and third-order intermodulation distortion products as low as possible.

tween  $\pm 75$  Hz to  $\pm 6$  kHz, which permits optimum matching to the bandwidths required in the various modes of operation (slow CW, frequency-shift telegraphy or broadband telephony). Since individually switchable filters would hardly prove practical for such a large number of different bandwidths, a new double mixer with fixed-tuned filters has been designed (fig. 3).

The 525-kHz intermediate frequency with its side-

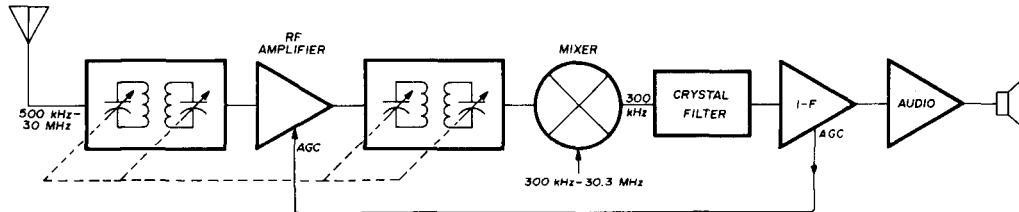


fig. 1. Block diagram of a single-conversion, low i-f, general coverage communications receiver typical of that used by many radio amateurs. The intermediate frequency is usually set below the tuning range of the receiver, as shown here, but this results in image problems on the higher frequencies.

The signal is converted to the first i-f in a high-level  $+17$  dBm or higher double-balanced mixer and applied to a cross-modulation filter. This filter is a low-ripple, 6-pole crystal filter with a bandwidth of  $\pm 6$  kHz or less, depending on its purpose. This filter suppresses adjacent signals, which might otherwise produce cross modulation in subsequent stages. A high-level double-balanced mixer is also used for converting the first i-f to the second i-f (525 kHz), where main selectivity occurs. The bandwidth of the second i-f stage is selectable in steps be-

band of  $\pm 6$  kHz maximum is first converted into the range 52 to 64 kHz. It is then applied to a bandpass filter with a steep-edged selectivity characteristic at 64 kHz and converted to the original i-f. If the oscillator frequency is varied in the proper direction, the shift of the reduced i-f toward the steep filter edge clips or completely suppresses one sideband. Using the same oscillator frequency for mixing and remixing prevents any frequency errors from occurring between input and output, which might affect receiver setting accuracy. The position of the sidebands with respect to the carrier also remains unchanged. This arrangement is followed by a similarly designed selective circuit that can limit the other sideband. Similar selective filters are used in both circuits so that the oscillator frequency is symmetrical about the 525-kHz i-f. Thus, a frequency variation by the same amount but in the reverse direction results in a symmetrical bandwidth change. The selectivity at a 500-Hz spacing from the adjusted bandwidth is at least 60 dB, and the ripple within the i-f passband is about  $\pm 1.5$  dB.

If filters with the same selectivity are used, double mixing ensures an identical, symmetrical skirt selectivity of the i-f passband characteristic, constant skirt selectivity for each bandwidth, and a phase delay characteristic symmetrical with the center frequency. With a-m reception, therefore, no distortion occurs due to delay time. With commonly used crystal or mechanical filters this high phase and gain linearity can't be achieved under any circumstances.

This method also provides a simple means of suppressing the upper or lower sideband during ssb reception. By setting the oscillator of the first and second selective circuits to a fixed frequency, variable limiting of the remaining sideband is possible.

Both conversion oscillators are synchronized with an internal reference oscillator to increase circuit stability. This avoids an impermissible variation or shift of the center frequency, especially in narrow bandwidths.

Advertised crystal filters, which are 8- to 10-pole

table 1. Electrical characteristics for a modern shortwave receiver.

Frequency range	10 kHz to 30 MHz
Antenna connection	50 ohms, unbalanced
Preselection:	lowpass filter
10 kHz-2 MHz	Bandpass filters for
2 - 30 MHz	2 - 3 MHz, 3 - 5 MHz, 5 - 7 MHz
	7 - 10 MHz, 10 - 13 MHz, 13 - 17 MHz
	17 - 22 MHz, 22 - 30 MHz
Setting accuracy	Better than 50 Hz; counter display
	10 Hz, 1 Hz preferred
Noise figure	about 10 dB
Modes of operation	CW, MCW, a-m, dsb, ssb, afsk
I-f bandwidth	$\pm 75$ Hz to $\pm 6$ Hz in steps
Shape factor	At least 1:1.45 (6/60 dB down)
I-f and image rejection	Greater than 80 dB
Crossmodulation	Less than 2% demodulation with 100 mV emf interfering signal and less than 10% with 5 V emf interfering signal
Blocking through second signal	3 dB with an unmodulated unwanted signal spaced 30 kHz from, and 100 dB above, desired signal of 1 $\mu$ V
Intermodulation distortion	
In band	>50 dB with two 50 mV emf tones
Second order	>90 dB with two 5 mV emf tones
Third order	>80 dB with two 5 mV emf tones
S meter	Should be calibrated in $\mu$ V. Input voltage range <1 $\mu$ V to >100 mV.
Outputs for accessories	Audio output 0 dBm
	Agc voltage for diversity reception
	I-f outputs
	Oscillator output for counter and digital programmer

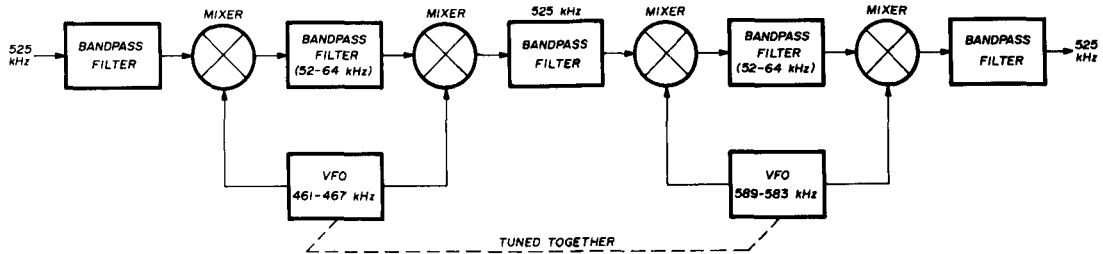


fig. 3. A system for obtaining variable i-f bandwidth through the use of a double mixing scheme. This system is used in the receiver of fig. 2 to provide selectable bandwidths from 6 kHz to 75 kHz without the expense of a large number of separate i-f bandpass filters.

designs with shape factors between 1.4:1 and 1.2:1, have two unpleasant effects:

1. The extremely steep skirt selectivity presents a problem for the agc circuit because of the high group delay and phase shift, which cannot be compensated. In almost all cases strong interfering signals at the edges of the filter response band will make the agc pump. This instability introduces distortion and overshoot.

2. Because of their high Q, and despite their fairly wide bandwidth, these filters produce appreciable ringing.

In addition, it's important to remember that, under the circumstances in which radio amateurs use their receivers, the i-f bandwidth for ssb reception should be between 1.9 and 2.4 kHz to avoid psychological fatigue

caused by unpleasant hissing noises. More than ten years ago the bandwidth of the famous Collins KWM2 was restricted to 2.1 kHz for this reason.

**I-f amplifier and gain control.** The i-f amplifier boosts the incoming signal to an amplitude sufficient for distortion-free demodulation and ensures a constant output voltage by means of gain control. Its amplifying action is such that the inherent noise from the rf section is adequate to drive the succeeding agc amplifier to full output. If you analyze practically any amateur transceiver now on the market, you will discover that these receivers don't have enough i-f gain. The reason for this is obvious: most manufacturers want to avoid the expense of careful shielding, which is required if the gain is more than 80 dB. However, to obtain enough audio

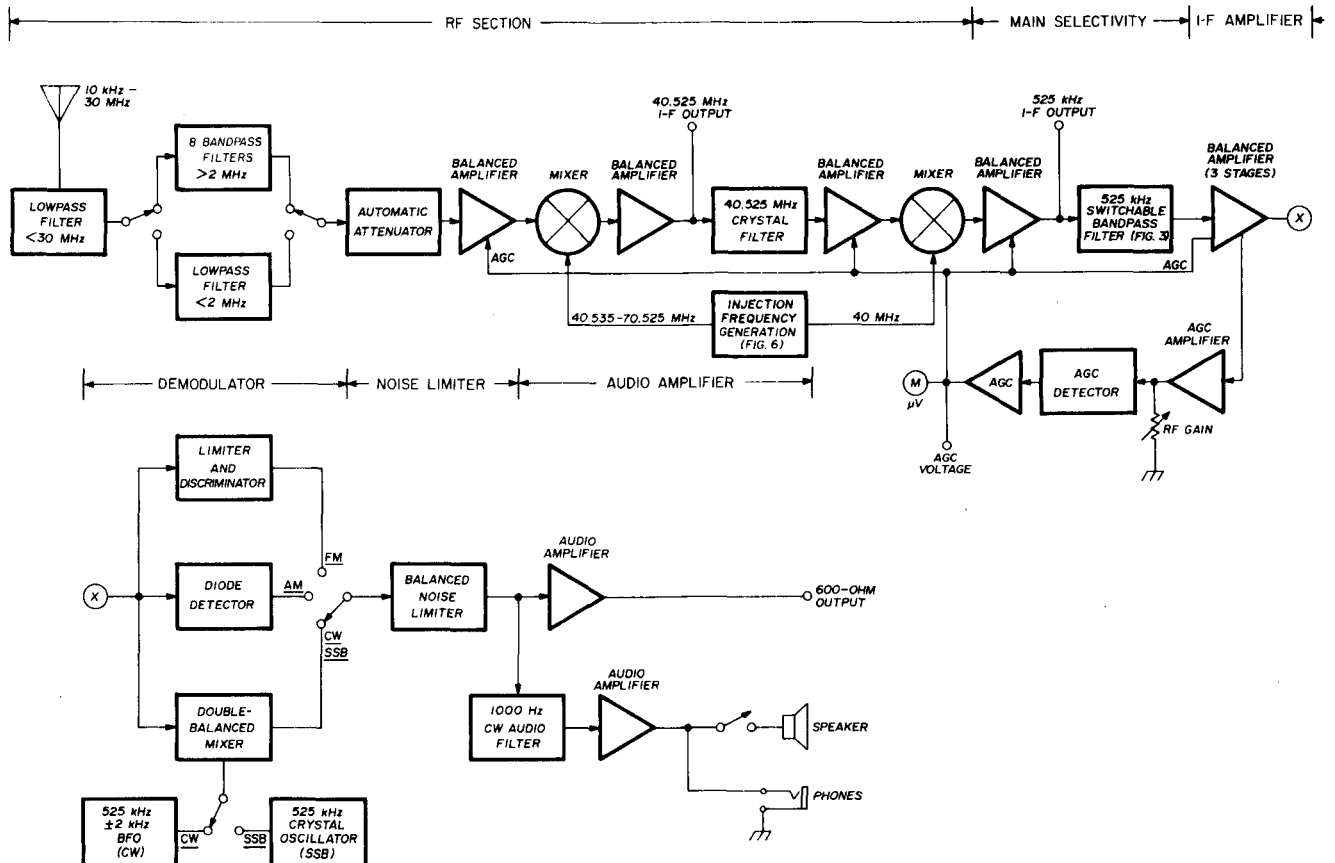


fig. 2. Block diagram of a high-performance, modern design communications receiver with an i-f at 40.525 MHz which overcomes many of the problems of previous designs. The noise figure of this receiver is about 10 dB, more than adequate for home-station use on any of the amateur high-frequency bands. Cross modulation, intermodulation distortion, and other operating characteristics of this receiver are listed in table 1.

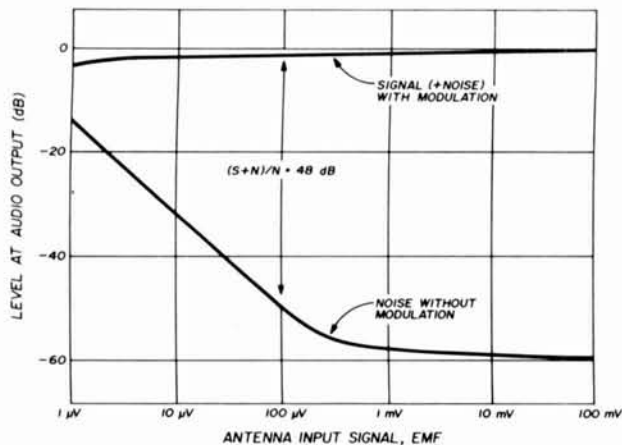
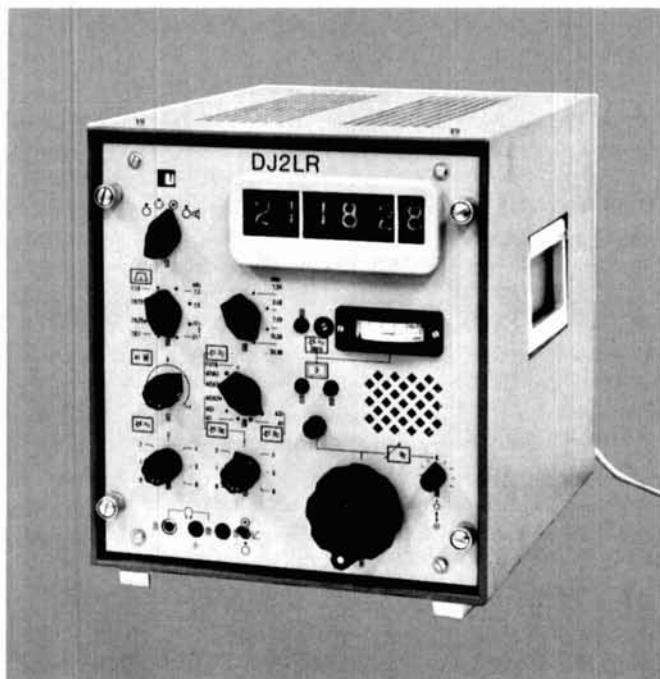


fig. 4. Optimum selection of agc action for perfect signal-to-noise performance.

output, a total gain of about 90 dB from the antenna input to the i-f output into the demodulator is required to obtain distortion-free demodulation. Unfortunately many designers use high-gain rf amplifiers and high-gain first mixers, both of which overdrive the second mixer. A sufficiently low overall noise figure can be achieved with little rf gain, as explained below.

Modern integrated circuits, such as the Plessey SL600 series or the Motorola MC1349 and MC1590, offer a good choice for a low-distortion, stable i-f amplifier with a minimum of shielding. Such a design permits sufficient agc to reduce unpleasant audio level changes. In addition,

Partially home-built receiver which tunes from 1.5 to 30 MHz. The PC boards were removed from a lab model Telefunken receiver, and the circuitry was redesigned using the techniques described in this article. The third-order intercept is +30 dBm, dynamic range is 120 dB or more, and the noise figure is 8 dB. Tuning accuracy is 1 part in 10 million.



tion, appropriate distribution of the agc voltage must be applied to the various stages to ensure a linear increase in the signal-to-noise ratio at small input voltages. Fig. 4 shows the agc response provided by the design discussed above. The agc circuit must have high gain; through pure control action input voltages up to 100 mV emf can be reduced to a residual error of  $\pm 1$  dB without additional driving (forward-acting regulation). Furthermore, the agc voltage must be applied in appropriate levels to the various stages to ensure a linear increase in the signal-to-noise ratio at small input voltages. The result is a signal-to-noise characteristic much better than previously known.

The agc response time and the type of rectification must be different for each mode of operation. Peak

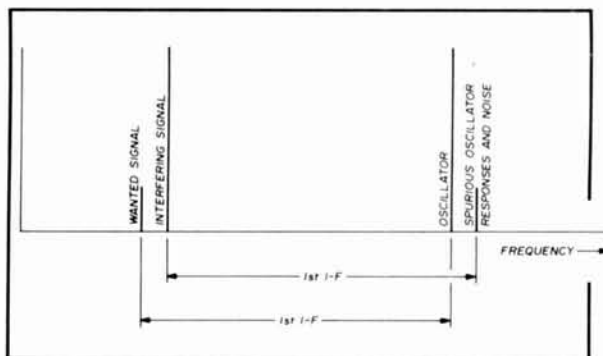


fig. 5. The noise sideband characteristics of the high-frequency injection oscillator affects receiver sensitivity because strong interfering signals at the mixer may convert the noise sidebands into the center of the i-f passband.

rectification with a short response rise time of about 20 dB per 10 mS should be used for rapid leveling of the gain to the nominal value when receiving CW or ssb signals; a too-short response time does, however, lead to blocking by interference pulses. Average-reading rectification is recommended in the a-m mode to maintain receiver dynamic characteristics.

The agc voltage fall time should be selectable to obtain a gain variation between 5 and 50 dB per second. The slow response fall time maintains the dynamic characteristics and prevents any amplification of unwanted noise during CW pulse intervals. It also takes effect with a-m signals suffering selective carrier fading; it does not eliminate the distortion but prevents audio volume from increasing.

The modulation frequency of the incoming signal, which is present in the control lines during agc operation, must be filtered – without affecting the dynamic control characteristics – to such an extent that no additional distortion arises in a-m reception due to inverse modulation. In ssb reception, with intermodulation and little difference between the sideband frequencies ( $f = 100 \text{ Hz}$ ), intermodulation products ( $2f_1 - f_2$ ) because of inverse modulation must be suppressed at least 50 dB.

**Demodulator and af amplifier.** The demodulators for the various operation modes are connected to the output of the i-f amplifier. A-m signals are rectified in a diode

fig. 6. The frequency synthesizer with linear master oscillator which is used in the high-performance communications receiver. A complete description of this circuit, which uses four separate oscillators, is contained in the text.

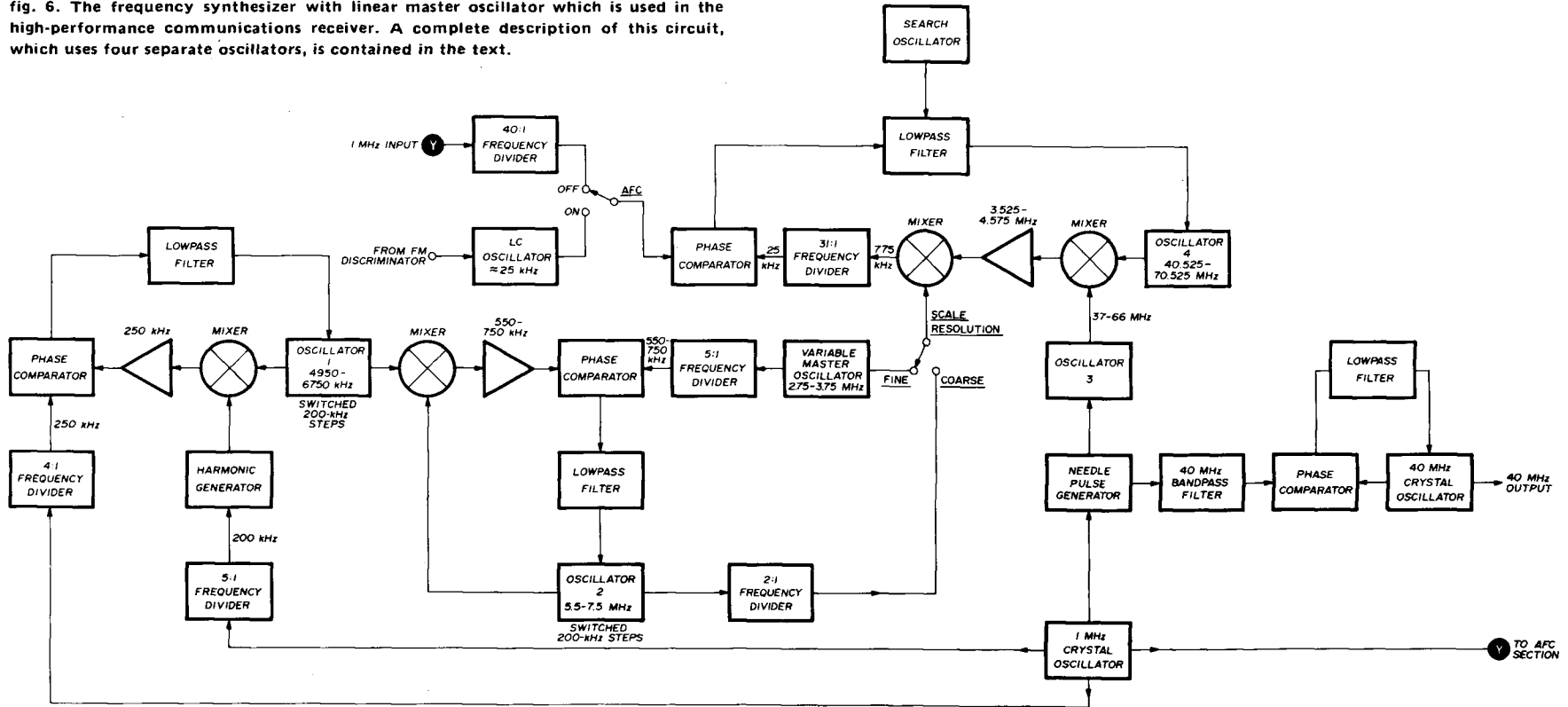
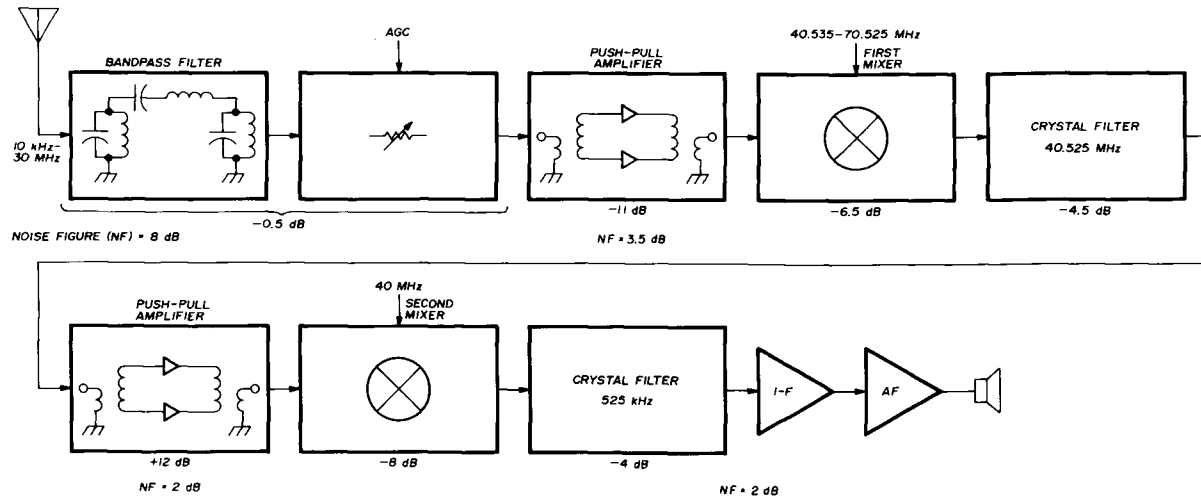


fig. 7. Gain distribution of a high-performance, high-frequency receiver. High dynamic range, as shown in fig. 8, is obtained by using as little gain as possible while keeping the overall noise figure below 10 dB.





circuit. The i-f, CW, and ssb signals are converted into audio signals in a double-balanced mixer which is driven by a vfo for CW signals, and by a high-precision crystal oscillator for ssb signals. Frequency-modulated waves (maximum bandwidth 6 kHz) are demodulated in a discriminator preceded by a limiter.

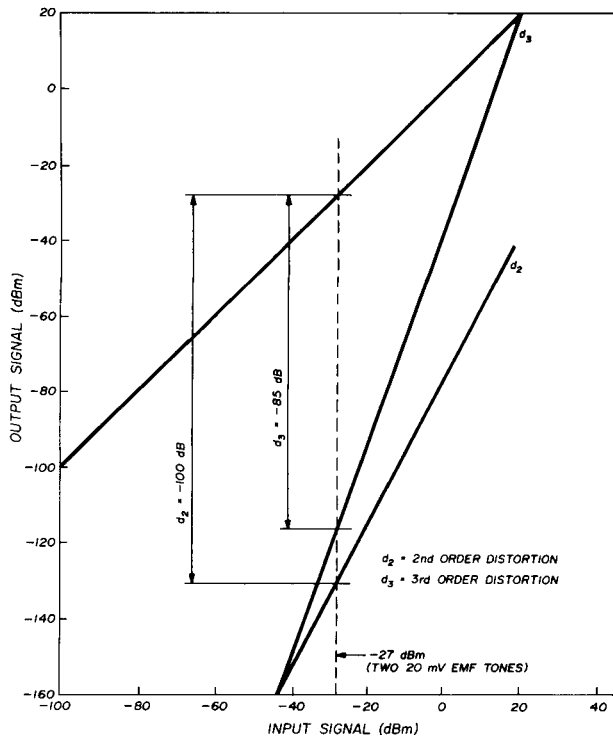


fig. 8. Dynamic performance of the receiver shown in fig. 7. The third-order intercept point is at +20 dBm. At -27 dBm input (two 20 mV emf signals), third-order products ( $d_3$ ) are down -85 dB and second-order distortion ( $d_2$ ) is down -100 dB.

The audio-frequency signal is applied through the function selector from the demodulators to an adjustable, balanced noise limiter, then to audio amplifiers. The amplifier with an output impedance of 600 ohms is associated with a balanced-line output. Starting from 0 dBm (1 mW into 600 ohms with 100% modulation), its output level is adjustable by  $\pm 10$  dB. The second amplifier feeds a built-in speaker. It also contains a switch-selected 1000-Hz filter (bandwidth 200 Hz), which improves CW audio quality.

### oscillator

The receiver frequency stability and setting accuracy depends on oscillator accuracy. The oscillator characteristics also affect receiver sensitivity, since strong interfering signals arriving at the mixer as a result of the receiver input broadband characteristic can convert noise sidebands and spurious oscillator responses into intermediate frequencies (fig. 5).

The oscillator frequency of the synthesizer (fig. 6), whose output is 40.525 to 70.525 MHz (oscillator 4), is

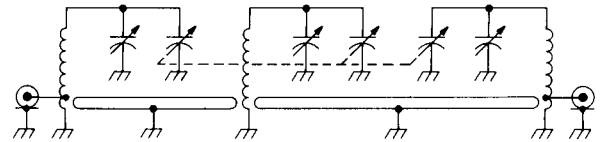


fig. 9. Tunable preselector which may be used to suppress local, high-level signals. Bandpass curve for this preselector is plotted in fig. 10.

derived in several phase-controlled circuits from selected harmonics of a 1-MHz crystal oscillator and the frequency of the variable-frequency master oscillator. The crystal in the 1-MHz oscillator is housed in a proportionally-controlled oven for stability. The frequencies derived from this 1-MHz oscillator are more accurate than those of the variable-frequency master oscillator, which determines receiver setting accuracy and stability.

While some receiver designs use frequency synthesizers which are switchable in steps down to 1 Hz, this much resolution is somewhat prohibitive for a search receiver. The lock time of such a frequency synthesizer would not permit easy tuning and, therefore, this type of receiver should only be used for channelized point-to-point communications. The method used here, derived from the Rohde & Schwarz EK07 shortwave receiver, was designed in 1957. A similar method has been used in receivers such as the National HRO500 and HRO600.

Basically, the 40.525 to 70.525 MHz frequency range is converted to an auxiliary i-f of 2.75 - 3.75 MHz. A frequency- and phase-sensitive double-balanced modulator is used as a comparator together with the master oscillator to determine oscillator 4 output frequency. The master oscillator, which can be tuned over a 1-MHz range (2.75 - 3.75 MHz) capacitor, exhibits a linear frequency characteristic. This linearity permits the use

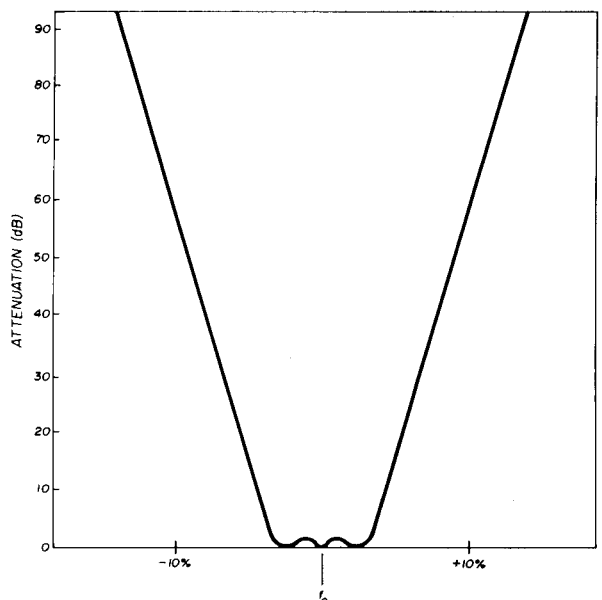


fig. 10. Selectivity curve for the preselector circuit of fig. 9.

of a directly calibrated scale with an ultimate resolution of 50 Hz.

To increase the variable master-oscillator frequency stability, all frequency-determining parts are housed in an oven and maintained at 60°C (140°F). Short needle pulses are derived from the 1-MHz oscillator output and are used to lock in oscillator 3 in 1-MHz steps. This frequency is required in a down-converter system to

to 775 kHz. This frequency is then applied to a 31:1 frequency divider. A phase comparator operating on the scanning principle compares the 25-kHz frequency difference with the output from the 1-MHz crystal oscillator. This output voltage adjusts oscillator 4 (residual superimposed ac voltages have been suppressed by the lowpass filter). If this circuit is not controlled, as for instance when the MHz range is changed, a search oscilla-

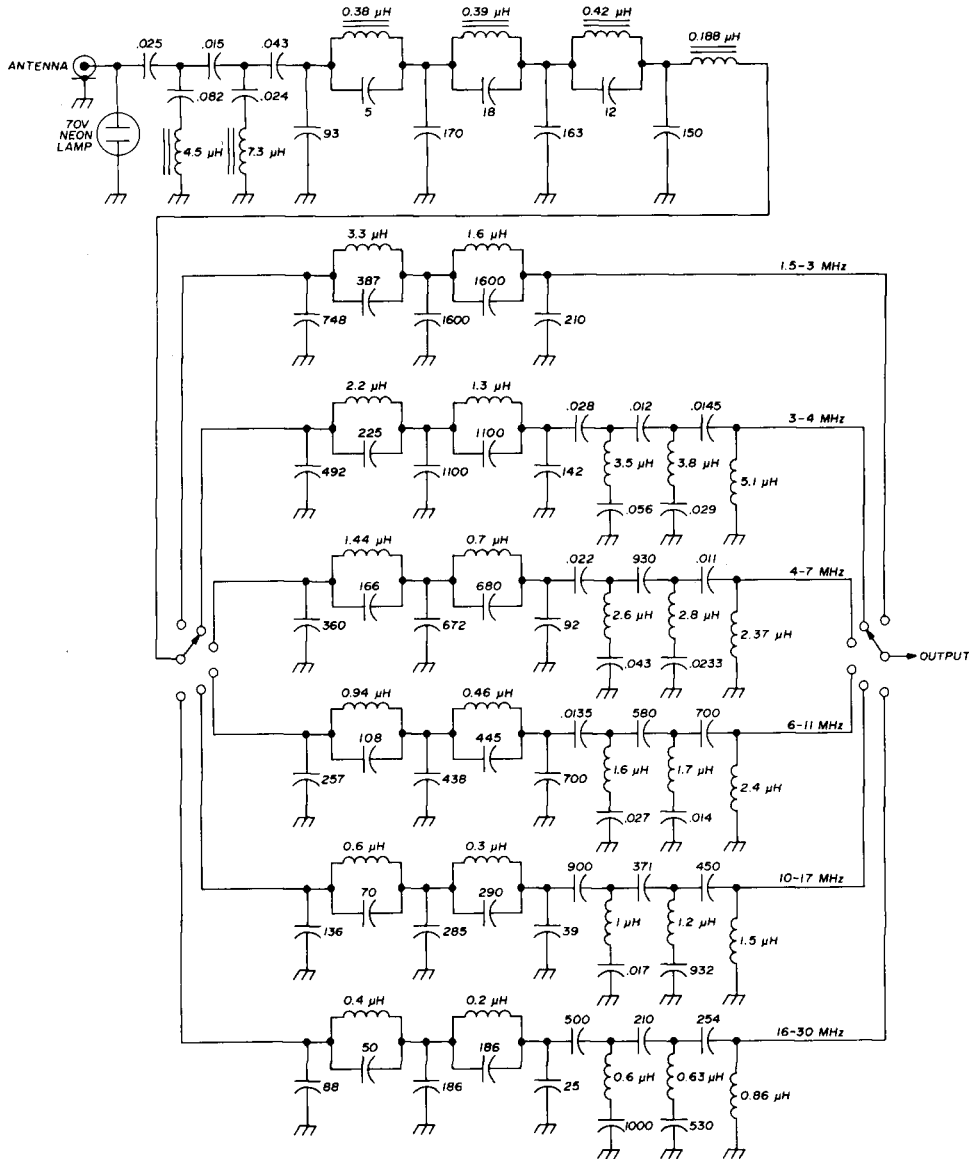


fig. 11. Highpass-lowpass elliptic filter (1.45 MHz to 32 MHz) for use at the front end of a high-frequency communications receiver.

obtain 2.75 to 3.75 MHz for the master oscillator. The same needle pulses are used in a phase-locked loop system to synchronize the frequency of the 40-MHz crystal oscillator, which converts the first i-f (40.525 MHz) to the second i-f (525 kHz) with the 40th harmonic of the 1-MHz crystal oscillator. Oscillator 4 consists of six single oscillators, each of which is tuned over a range of about 5 MHz by tuning diodes.

The frequencies of oscillators 3 and 4 are converted

to generate a sawtooth voltage that sweeps the oscillator range until its frequency is in the lock-in range of the control circuit. The frequency divider reduces the control circuit gain to the 31st part, thus increasing stability.

When the afc circuit is switched on, the 25-kHz reference frequency is not derived from the 1-MHz crystal oscillator but from an LC oscillator, whose frequency can be varied by a varactor. If the receiver is not

exactly tuned to the carrier, the output voltage of a narrowband fm discriminator at the output of the i-f section changes the LC oscillator frequency and hence that of oscillator 4, so that the carrier lies at midband except for a residual control error of about 5% of the original deviation. The afc circuit permits adjustment to within  $\pm 1.5$  kHz.

Free-running oscillator 4 has a high signal-to-noise ratio; for example, more than 140 dB per hertz of bandwidth at a 30-kHz spacing from the carrier. The control circuit has a narrow bandwidth to minimize its effect on the signal-to-noise ratio (circuit gain of 1 at about 5 kHz). Low-frequency disturbances, such as shock or noise caused by operating the switches or by the built-in monitoring loudspeaker, are avoided by mounting parts of the oscillator on shockmounts.

The mode of operation described is ideal for rapidly scanning wide frequency ranges, since a range of 1 MHz is covered in ten rotations of the tuning knob. The mode with high-scale resolution provides the full setting accuracy of the receiver. For this purpose, the tuning knob for the 100-kHz ranges is turned from its end position to the required 100-kHz step. The signal fed to the control circuit of oscillator 4 is a mixture of the tenth part of the master-oscillator frequency and a frequency derived from the 1-MHz oscillator. This signal is switch-selected in 100-kHz steps.

A frequency divider and a harmonic generator produce a 200-kHz spectrum from the 1-MHz frequency of the oscillator. Oscillator 1, like oscillator 2, is switched in 200-kHz steps by the 100-kHz tuning knob and converts one of the spectral lines in the mixer to 250 kHz. The subsequent phase bridge compares this frequency with a 250-kHz frequency derived from the 1-MHz oscillator by a 4:1 frequency divider, thereby producing the control voltage for oscillator 1. Oscillator

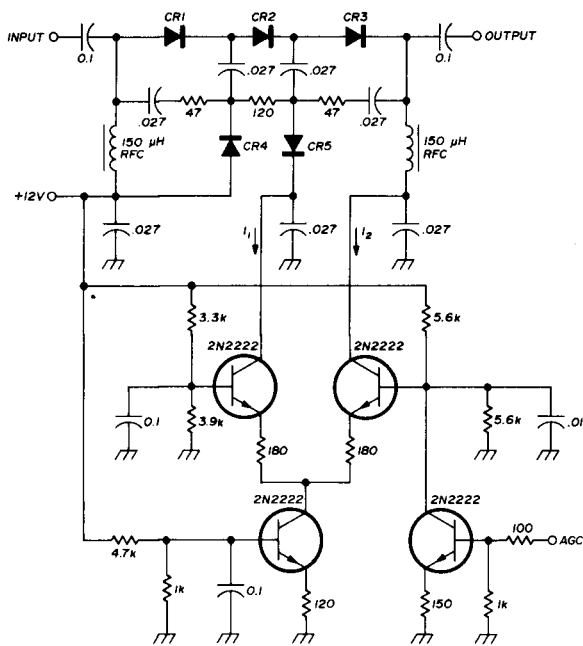


fig. 12. PIN diode attenuator with dc amplifier for use in a high-performance communications receiver. All diodes are Hewlett-Packard PIN diodes, type HP5082-3081.

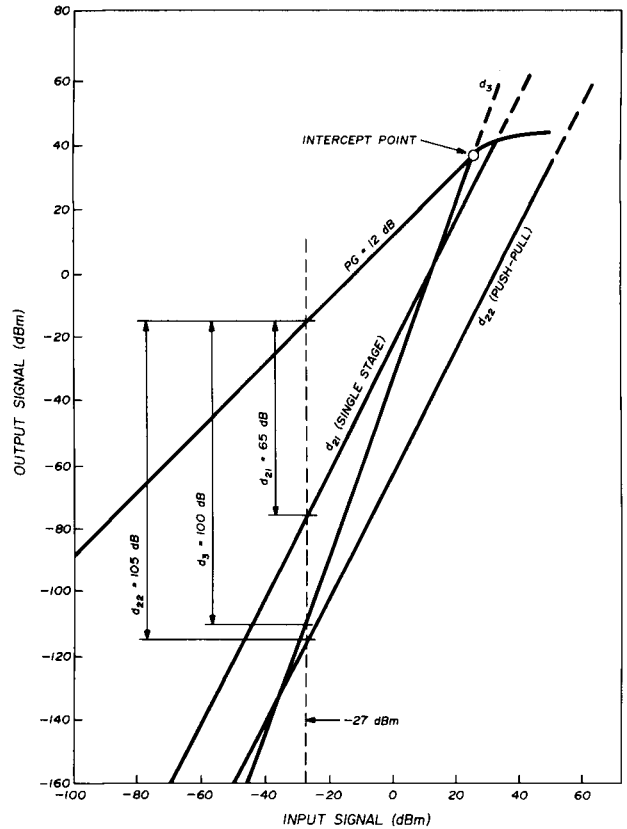


fig. 13. Dynamic performance of a new type of push-pull rf amplifier stage (figs. 14A, 14B, and 14C). Power gain is about 12 dB. With an input of  $-27$  dBm (two signals), third-order distortion products are down 100 dB and second-order distortion is down 105 dB. Third-order intercept point occurs at an input of about  $+32$  dBm

1 thus operates with the high accuracy of the 1-MHz crystal oscillator on one of the frequencies divided into 200-kHz steps between 4950 and 6750 kHz.

In a further phase-control circuit, the frequencies of oscillators 1 and 2 are converted to the 500 - 700 kHz range and compared in the phase bridge with the master oscillator frequency, which is divided in a ratio of 5:1. After separating the ac voltage components in the low-pass filter, the output voltage of the phase bridge controls the frequency of oscillator 2. By dividing the oscillator frequency in half, the frequency of the master oscillator, 2750 - 3750 kHz, is again obtained, but this time in a switch-selected, 100-kHz range. Because of the frequency divisions (5:1 and 2:1), the master oscillator covers only a tenth of the range so that receiver scale resolution and accuracy are increased by ten times. With a counter, the scale resolution may be 10 Hz or better and the BCD outputs may be used to program a direction finder through a remote-control system.

This type of synthesizer permits continuous tuning for many purposes. However, quasi-continuous tuning in steps of 10 Hz is admissible, which simplifies the whole synthesizer dramatically. This synthesizer has been described in detail to show what must be considered when building a practically spurious-free, low-sideband-noise local oscillator.



The receiver described above is the result of combining various optimized stages and careful planning. To predetermine the overall technical performance, it's required to start with a block diagram containing vital information, such as gain, dynamic range expressed in second, third, and higher-order intermodulation distortion, and noise figures.

Fig. 7 is a block diagram of a receiver with a first high i-f and shows the amplification or losses of each stage. As shown, the input bandpass filter and the automatic attenuator have a 0.5-dB loss. The push-pull rf amplifier provides approximately 11 dB gain, which will compensate for the losses of the passive, high-level, double-balanced mixer and the losses of the 40.525-kHz crystal filter. The overall gain from the rf input to the 40.525-MHz push-pull amplifier is 0 dB. The stages from 40.525 to 525 kHz are almost identical; however, the second-order intermodulation of the second rf amplifier does not exceed the high values of the first. This is not necessary because of the cross-modulation crystal filter. The second high-level double-balanced mixer has somewhat higher losses but provides the same or even better intermodulation distortion suppression. The first 525-kHz filter is about  $\pm 6$  kHz wide, and the overall gain up to this point is 0 dB.

The overall noise figure, which can be calculated from the block diagram, is 8 dB. The second and third intermodulation distortion performance of the rf input is shown in fig. 8. The main idea of obtaining a high dynamic range lies in the concept of having as little gain as possible while keeping the overall noise figure below 10 dB. This is achieved by carefully selecting the characteristics of each of the individual stages, as will be described later.

For a few rare applications it may be necessary to suppress frequencies in the immediate vicinity of a desired signal, for example, where a transmitter and a receiver are used simultaneously. Under these rare circumstances an rf preselector, as shown in fig. 9, is an absolute necessity. Because of the preselector's high selectivity, a 10-volt emf signal,  $\pm 10\%$  away from the frequency of reception should not create intermodulation distortion more than -9 dB down. However, for these purposes special transceivers with duplex capabilities are used. These preselective filters have about -4 to -5 dB insertion loss. A typical response is shown in fig. 10.

### circuit analysis

Because of the new approach in the design of this receiver, the circuits of a number of stages will differ substantially from those commonly used. To give a better understanding of the overall system, the most important stages are shown and explained here.

**Input filter.** In most cases the highly selective preselector of fig. 9 is not required, so a combination of elliptical filters selected for the frequency ranges is adequate. Third- and higher-order, odd-number intermodulation distortion products cannot be overcome by selectivity unless filters are 10 kHz wide or less. Second-order

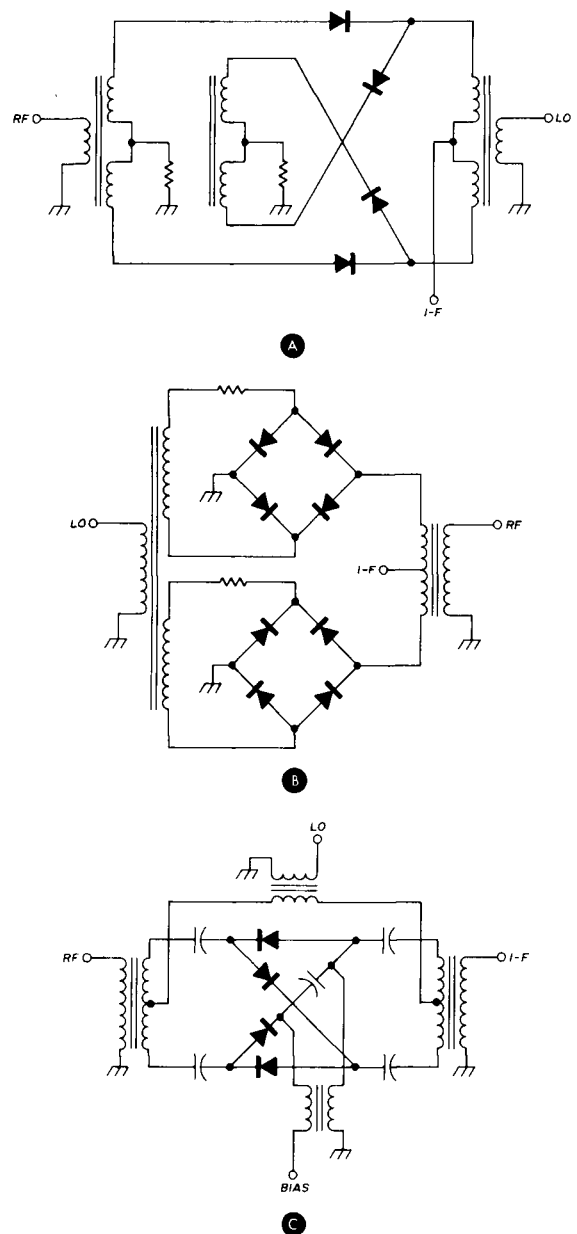


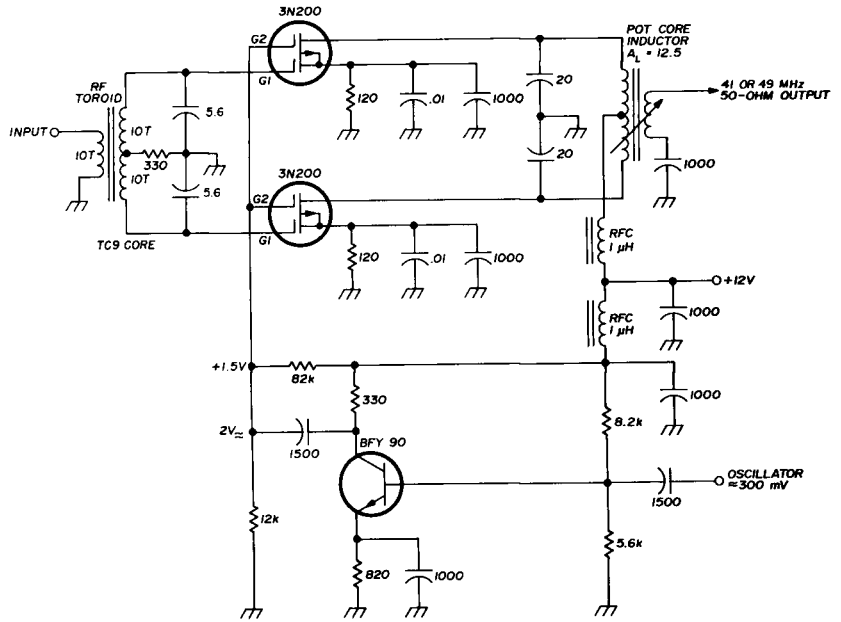
fig. 15. Double-balanced mixers. A and B are medium- and high-power configurations; C is a double-balanced mixer for uhf/shf with adjustable bias.

intermodulation distortion products can be improved by about 40 dB with these switchable filters.

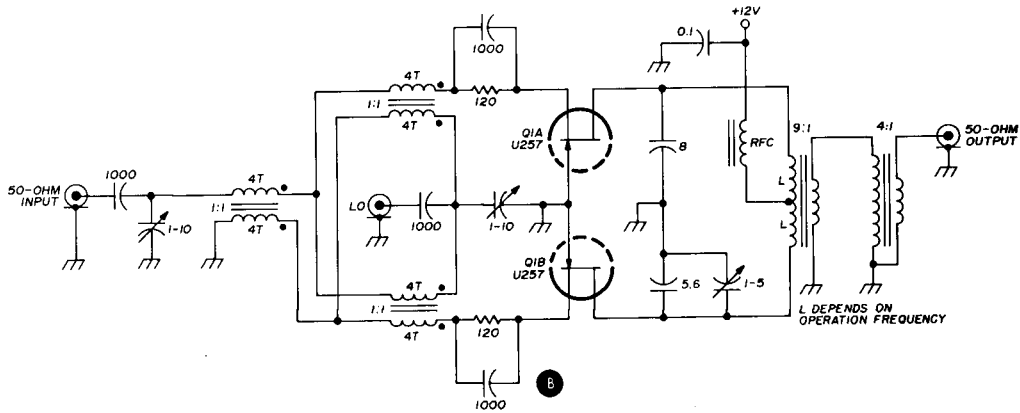
Special Bessel-Cauer elliptical filters are used with a given Chebishev response in the passband. This is absolutely necessary, because 50-ohm impedance matching is required in the stopband and passband so that filters can be cascaded. Fig. 11 shows a modern input filter covering the range 1.5 to 30 MHz in six steps.

A highpass-lowpass input bandpass filter suppresses unwanted broadcast signals, and the lowpass filter section, together with the following lowpass section of the individual bandpass filter, guarantees more than 90 dB image suppression. The advantage of this technique is that these filters can be aligned very easily with the help

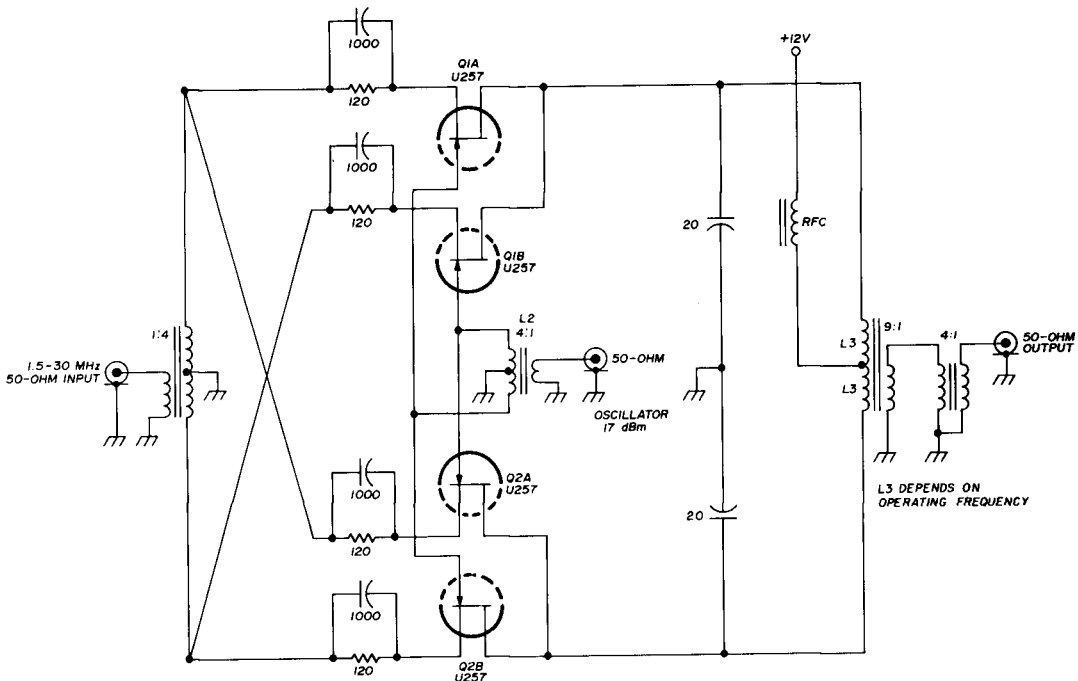
fig. 16. Examples of fet mixers. A balanced mixer with high input impedance (1 kilohm) is shown in A. A two-tone, 176 mV emf signal produces third-order IMD 68 dB down. A balanced fet mixer with 50-ohm input is shown in B (same performance as the circuit in A). C is a double-balanced mixer suggested by Ed Oxner of Siliconix. Its performance is 3 dB better than that of the circuit in B. An improved version of this mixer is shown in D (on facing page), also by Mr. Oxner.



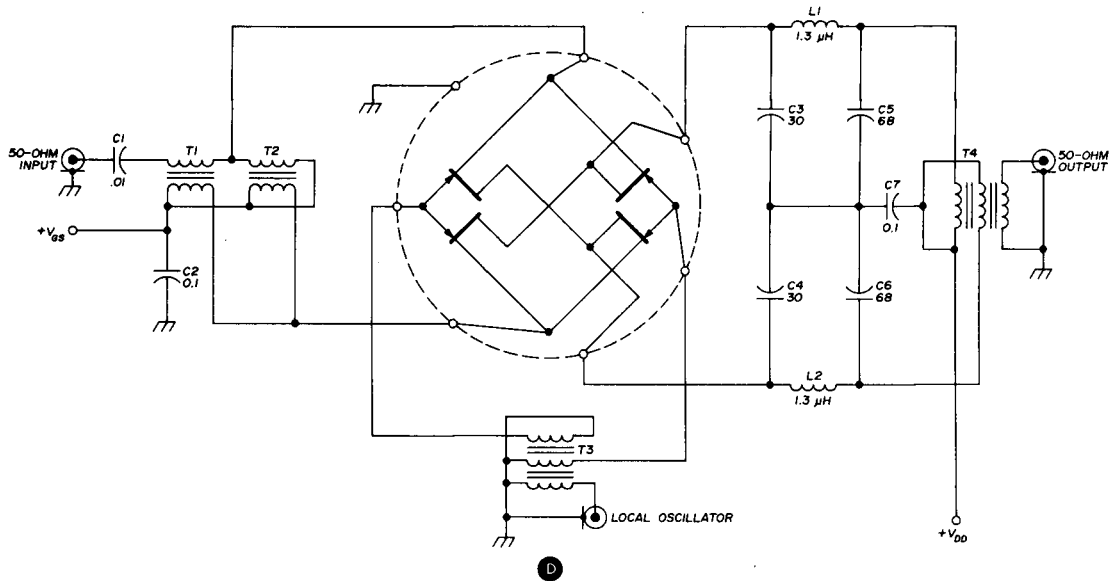
A



B



C



of a sweeper generator and an oscilloscope, and are much less complex than a mechanical tracking arrangement.

**Input attenuator.** Modern communications receivers should have low-distortion, automatic input attenuators that are activated at input signal levels above 100  $\mu$ V emf. For the frequency range from 1 MHz to 30 MHz, pin diodes such as the HP5082-3081 are highly recommended in a double-T configuration (fig. 12), where the line impedance must remain fairly constant because of filter matching. The intermodulation distortion products of an attenuator such as this are about 85 dB down for two 1-volt emf signals. This means that the attenuator does not add any serious distortion to the system.

**Rf input stage.** In the past only certain vacuum tubes were considered to be sufficiently linear for rf front ends. However, recently it has been found out that if both voltage and current feedback are used in a transistorized rf stage, much better linearity can be obtained than with any receiving-type tube. The second-order intermodulation distortion products can be suppressed by almost another 40 dB over a single stage when using a push-pull arrangement. Fig. 13 shows the intermodulation distortion performance of a single stage and a push-pull stage, using the highly linear 2N5109 uhf power transistors made by RCA. The input and output impedances are stabilized with a third feedback network using a wideband transformer.

Fig. 14 shows three push-pull arrangements suitable for this purpose. Fig. 14A, which was published earlier,<sup>2,3</sup> uses voltage and current feedback to minimize intermodulation distortion, while the transformers act as impedance stabilizing devices. The cores recommended are F625-0-TC9 for 1.5-30 MHz or F625-9-Q1 for the higher frequencies (made by Indiana General).

Fig. 14B shows an improved version of the circuit in fig. 14A. While the latter produces a 50-ohm output impedance, the circuits of figs. 14B and 14C are

basically constant-current devices. Because of this, a push-pull pin diode attenuator using only two diodes can be used (5082-3081 made by Hewlett-Packard). With the constant-impedance attenuator, fig. 12, second-order intermodulation distortion products are also further suppressed. However, because of the unbypassed emitter resistors, the additional noise contribution will not permit noise figures below 3 to 4 dB.

Fig. 14C show a low-noise arrangement in which

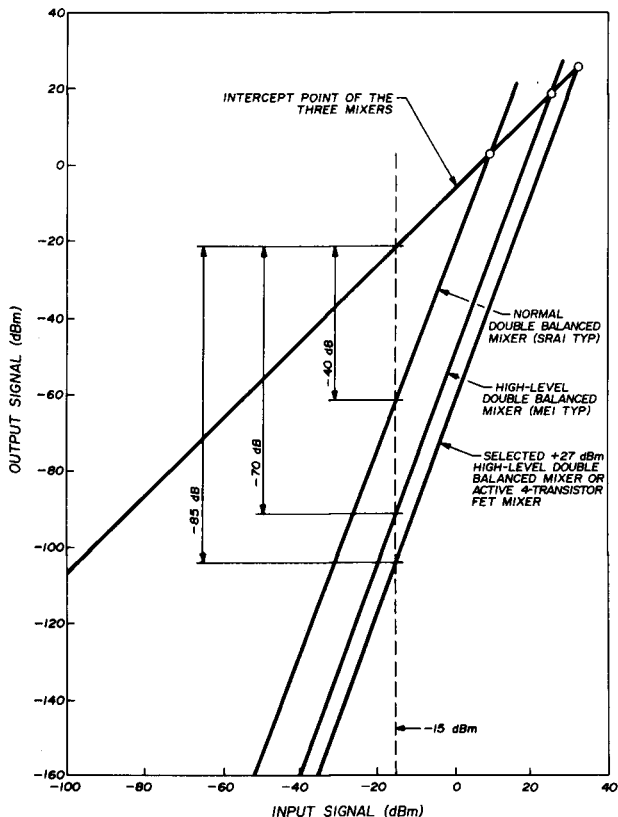


fig. 17. Comparison of three hot-carrier, double-balanced mixers showing third-order IMD performance.

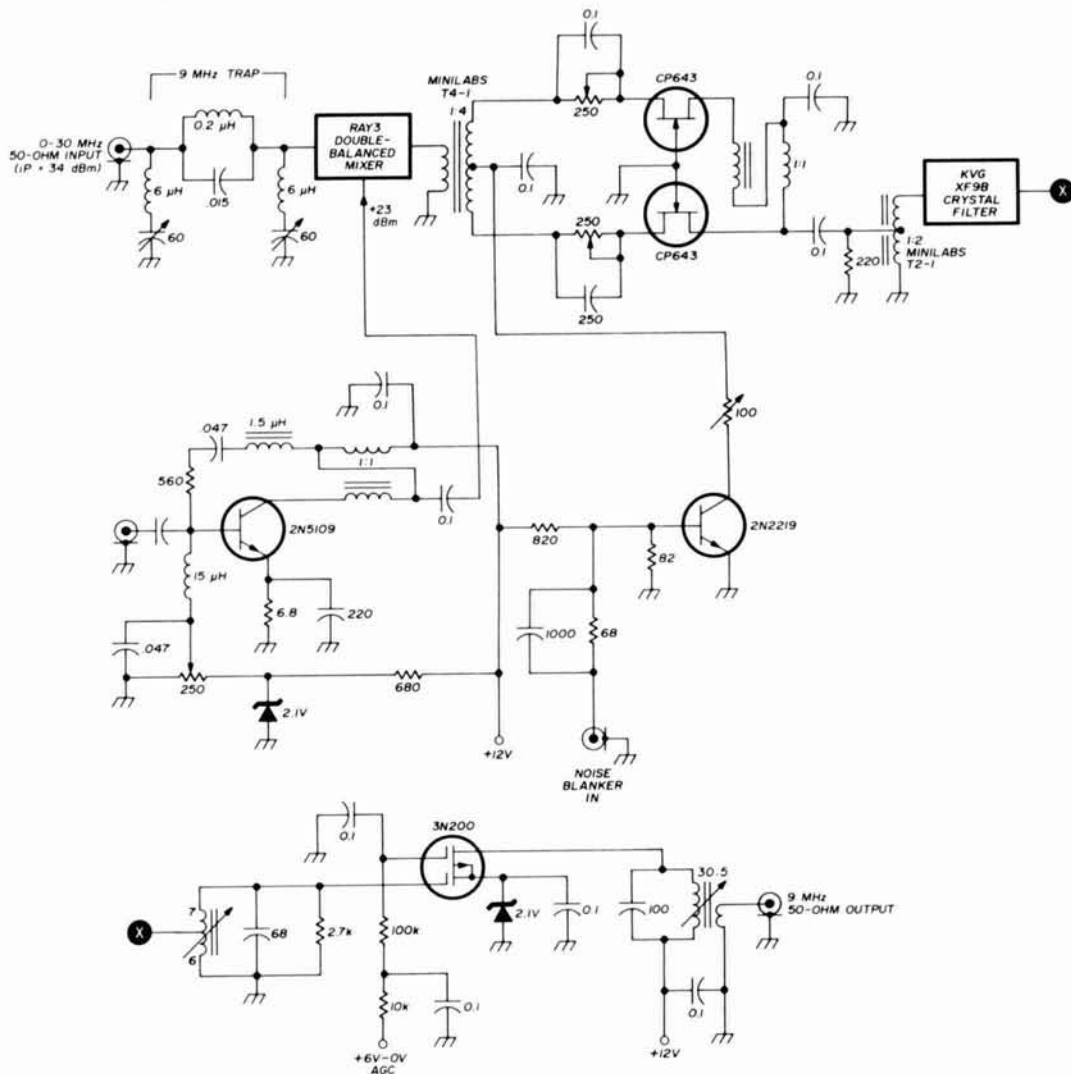
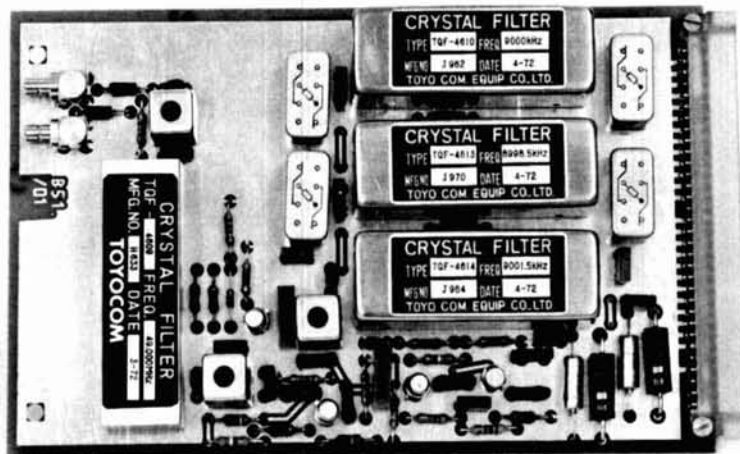


fig. 18. Improved version of Martin's rf input stage. The 9-MHz trap suppresses i-f feedthrough, and the push-pull fets increase dynamic range by 4 dB relative to the original design. In addition, a noise blanker can be used with 1- $\mu$ s switching time because of the push-pull arrangement.



i-f section of the high frequency receiver built by DJ2LR. Crystal filters are switched into the circuit with small relays. The i-f amplifiers are located along the bottom portion of the board.



emitter feedback through a transformer is accomplished. As a result, the input and output impedances are extremely high, and the voltage feedback permits choosing suitable values. However, this push-pull stage will provide noise figures of 2 dB or less, while still having the same basic dynamic range.

In some cases it's possible to build a receiver without an rf input stage. Especially for fixed operation, the antenna system will have a noise temperature much higher than  $300 KT_0$ , which means that the various noise sources being picked up by the antenna system will provide a noise floor significantly higher than the receiver-input noise. Under these circumstances, receiver sensitivities up to 20 dB do not degrade overall performance. For applications like mobile radios, however, such sensitivity is not good enough. Since mobile antenna efficiency is between 10 and 30%, the noise pickup is reduced by the same amount and, therefore, noise figures less than 10 dB are vital. In cases of fixed stations new circuitry can be used, which is discussed in the next section.

**Double-balanced wideband mixers.** It has been found that push-pull arrangements have advantages over single-stage mixers; however, because of the high input impedance of tubes, few attempts have been made to use push-pull or double-balanced mixers with vacuum tubes in high-frequency communications receivers. Because of some other disadvantages the use of beam-deflection tubes was not a breakthrough. Since the introduction of low noise hot-carrier diodes, double-balanced mixers for high-level operation have been constructed and various configurations have been used, as shown in fig. 15.

Only recently double-balanced mixers with field-effect transistors have been used which exhibit excellent third-order intermodulation distortion suppression. Fig. 16 shows four tested configurations with fets. Figs. 16B and 16C use matched pairs.

Fig. 17 shows the third-order intermodulation distortion suppression of low-level double-balanced diode mixers, medium-level double-balanced mixers, and high-level double-balanced mixers, including double-balanced, field-effect transistor mixers. As can be seen, the fet mixer shows significantly higher signal-handling capability. Most circuits using field-effect transistors in double-balanced mixers were originated by Ed Oxner (ex W9PRZ) of Siliconix Incorporated.

Because of the inherent gain capability, fet double-balanced mixers offer advantages in test instruments but their application in shortwave receivers remains debatable. These circuits are very sensitive to load termination, and the input impedance of most crystal filters found on the market changes significantly over frequencies outside the passband. To reduce this effect, a resistive termination is required at the input (valid for all mixers, independent of configuration). However, the remaining impedance jump of 1 to 2 for out-of-passband operation reduces performance greatly.

Field-effect transistors are high-input-impedance

devices. Fet mixers require about 2 volts rms across 50 ohms, which is equivalent to the injection required by a high-level double-balanced mixer. Because of the difficulty in providing wideband impedance matching in fets at high impedances, in my opinion medium- to high-level double-balanced mixers offer an advantage over fet mixers.

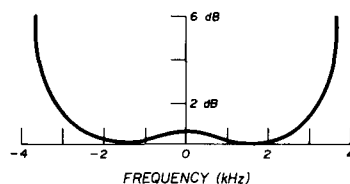
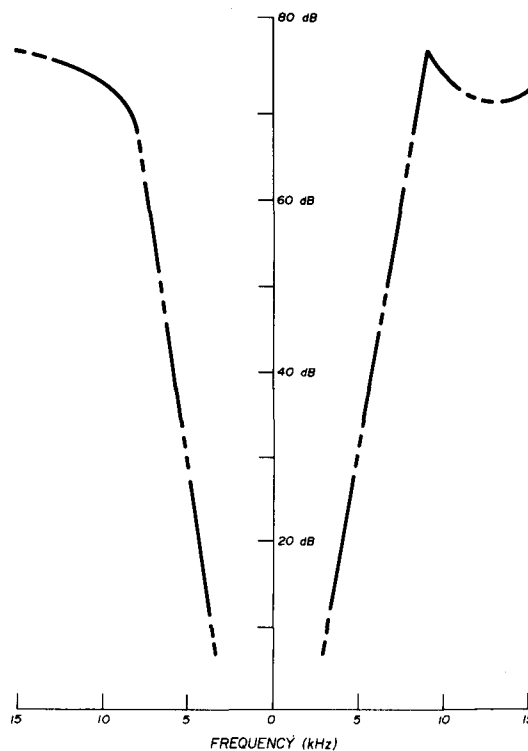


fig. 19. Selectivity curve of a 41-MHz crystal filter manufactured by Toyocom in Japan (Toyocom TQF4633, about \$80).

A typical application for an input stage using a double-balanced mixer and no rf stage is shown in fig. 18. This is an improved version of a circuit designed by Mr. Martin, based upon an article I published in 1972.<sup>4</sup> The 9-MHz trap in the input suppresses image feed-through. The grounded-gate operation of the CP643 transistors (Crystalonics) provides a wideband resistive input termination for the mixer. The magnitude of the input impedance to the CP643s can be set by adjusting the 250-ohm potentiometers.

The 2N5109 transistor amplifier provides about 20 dBm injection for the RAY3 high-level double-balanced mixer (Mini-Circuits Laboratory). This circuit, which is

similar to that found in the Atlas transceiver, has a distinct advantage: because of proper termination of the double-balanced mixer, unwanted intermodulation distortion products are at least 15 dB below those found in the Atlas circuit. The reason for this is that the Atlas circuit uses a tuned circuit between the crystal filter and the first i-f transistor (2N3866), and this tuned circuit does not provide proper matching to attenuate spurious products. All manufacturers of double-balanced mixers

this push-pull amplifier is 220 ohms and a crystal filter requires 500 ohms, a 2:1 transformer, model T2-1 (made by Mini-Circuits Lab), must be used.

The 220-ohm resistor reduces the high-impedance characteristic effect of the filter as described in reference 3. The output termination of the crystal filter is provided by the tuned circuit, which is heavily damped by the 2.7 kilohm resistor. This is necessary to provide stable operation.

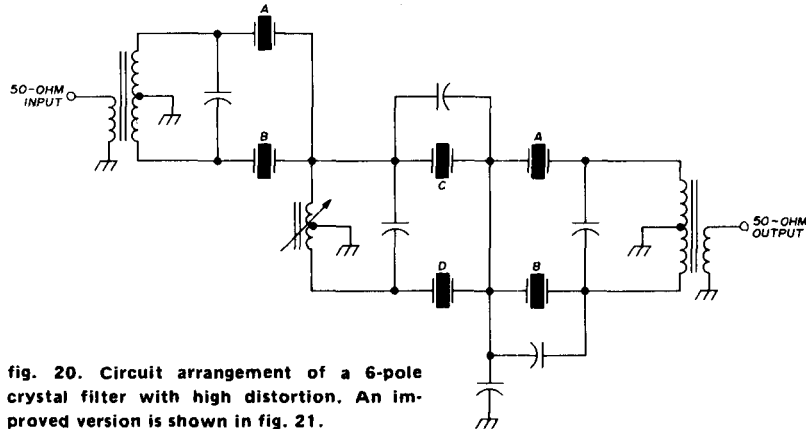


fig. 20. Circuit arrangement of a 6-pole crystal filter with high distortion. An improved version is shown in fig. 21.

specifically require proper resistive termination for optimum performance.

The KVG XF9B crystal filter is a popular ssb filter familiar to most amateurs. The first i-f stage after the crystal filter shown here provides enough gain and agc action for most applications.

The RAY3 double-balanced mixer requires a 50-ohm termination, which is obtained by an rf transformer, model T4-1.\* Using a push-pull arrangement not only increases total dynamic performance by 3 dB but also provides the possibility of using the transistors as a switch for noise blanking. For high-efficiency noise blanking a switch time of 10 microseconds is essential. A

The field-effect transistor provides 60 dB gain variation, and the overall gain from input to output at 50 ohms is 28 dB. In cases where a tuned circuit is used as a first i-f amplifier between the double-balanced mixer and an input stage, the dynamic range of the mixer will be heavily degraded. This is one of the reasons why the Atlas circuit does not provide the dynamic range that would be expected from the mixer alone. I believe this circuit is a good suggestion for experimenters who are still willing to build their own communications receivers.

**Vhf crystal filters.** Until recently low-loss 6-pole crystal filters were not available. The most significant feature

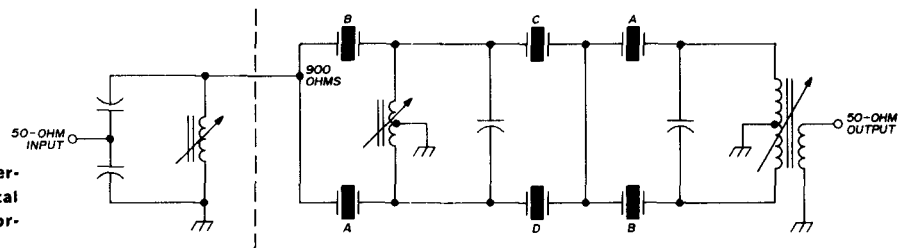


fig. 21. Improved version of a 6-pole crystal filter with low distortion.

similar circuit, which is extremely efficient, is found in the Swan 200 series of amateur equipment.

To reduce costs, or if the CP643 is difficult to obtain, two BF246C transistors, made by Texas Instruments, may be substituted. These are high-current vhf fets with an  $I_{DSS}$  of about 100 mA. Since the optimum load for

other than the shape factor of these vhf filters is the internal loss, which must be held below 5 dB (typical 4.5 dB) for narrow-band applications, i.e.,  $\pm 3.5$  kHz. Fig. 19 shows the typical response of a 41- or 49-MHz crystal filter.

When it was discovered that mechanical filters with magnetostrictive transducers create heavy intermodulation distortion at high input voltages, these filters were updated and now use piezo-electric transducers, which avoid this distortion. A similar effect can be observed at

\*The RAY3 mixer and T4-1 transformer are made by Mini-Circuits Laboratory, 837-843 Utica Avenue, Brooklyn, New York 11203.

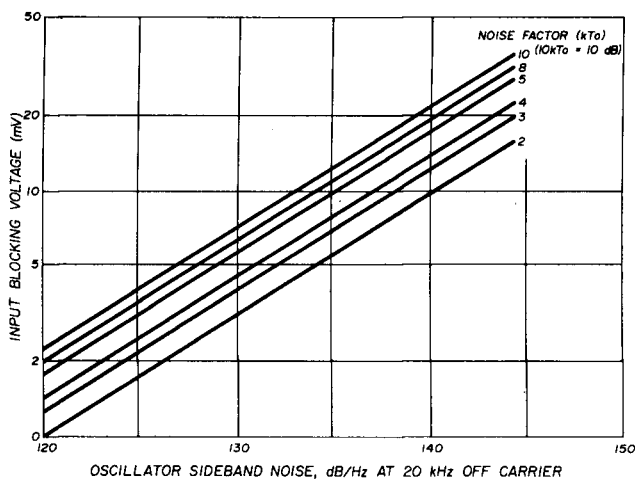


fig. 22. Receiver blocking effect caused by oscillator sideband noise. Blocking can be improved dramatically by ensuring that oscillator sideband noise is suppressed by careful circuit design.

the input transformer of crystal filters using toroids. Two 1-volt input emf signals at 50 ohms must not produce third- and second-order intermodulation distortion products of 85 dB or less. Fig. 20 shows a typical configuration of a 6-pole vhf crystal filter with high distortion because of the input toroidal transformer, while fig. 21 shows an improved version using a tuned input transformer with almost no measurable distortion.

**Oscillator sideband noise.** As explained earlier, oscillator sideband noise contributes significantly to the large-signal-handling capability of a receiver. Blocking and 3-dB compression are often confused in the literature. Compression is the effect caused by sideband noise, i.e., 20 kHz off the vfo carrier frequency, which causes blocking. This blocking effect can be expressed in terms of the sideband noise as it affects receiver sensitivity:

Assume sideband noise of 145 dB per hertz located 20 kHz from the vfo carrier frequency and a receiver noise figure of 10 dB. An input signal of 50 mV will cause 3-dB blocking or desensitization of the receiver, while 3-dB compression may occur at a point as high as 1 volt on the input signal. This relationship is shown in fig. 22.

When designing oscillators with very low sideband noise, either selected fets operating in a saturated mode or medium-power 2N3866 transistors should be used.

### references

1. James R. Fisk, W1DTY, "Receiver Noise Figure, Sensitivity and Dynamic Range — What the Numbers Mean," *ham radio*, October, 1975, page 8.
2. Ulrich L. Rohde, "Eight Ways to Better Radio Receiver Design," *Electronics*, February 20, 1975, page 87.
3. Ulrich L. Rohde, DJ2LR, "High Dynamic Range Receiver Input Stages," *ham radio*, October, 1975, page 26.
4. M. Martin, "Extrem lineares Empfaengereingangsmoedel mit gressem Dynamikbereich und sehr geringen Intermodulationsverzerrungen," *Internationale Elektronische Rundschau*, April, 1975, page 73.

### bibliography

1. U. Rohde and K. Eichel, "Stand der Technik bei Amateurfunkgeraeten im Kurzwellengebiet," *Funkschau*, December, 1972, January and February, 1973.
2. U. Rohde, "Zur optimalen Dimensionierung von Kurzwellen Eingangsteilen," *Internationale Elektronische Rundschau*, November, 1973, page 244; December, 1973, page 244.
3. K. Eichel and U. Rohde, "Stand der Technik bei UKW Amateurfunkgeraeten," *Funkschau*, July and August, 1972, page 205.
4. U. Rohde, "Zur optimalen Dimensionierung von UKW-Eingangsteilen," *Internationale Elektronische Rundschau*, May, 1972, page 103.
5. H.P. Lier and H. Oberbeck, "Oktavbreite, digitale Frequenzeinstellung von Mikrowellenoszillatoren," *Wiss. Berichte AEG-Telefunken*, January, 1970.
6. R.P. Rafuse, "Symetric Mosfet Mixer of High Dynamic Range," *1968 International Solid State Circuits Conference*, February, 1968, page 122.
7. E. Oxner, "Fets in Balanced Mixers," *Siliconix Applications Note*, July, 1972.
8. S.P. Kwok, "A Unified Approach to Optimum FET Mixer Design," *Application Note, Motorola AN 410*.
9. Peter Will, "Reactive Loads — The Big Mixer Menace," *Microwaves*, April, 1974, page 38.
10. James S. Sherwin, "Distortion in FET Amplifiers," *Electronics*, December 12, 1966, page 99.
11. E.F. McKeon, "Cross-Modulation Effects in Single-Gate and Dual gate MOSFETS," *RCA AN 3435*, Application Note.
12. H. Lotsch, "Nichtlineare Verzerrungen in Transistorstufen," *Archiv der Elektronischen Uebertragung*, May, 1960, page 204.
13. J.M. Gerstlauer, "Kreuzmodulation in Fets," *Internationale Elektronische Rundschau*, August, 1970, page 199.
14. Thomas Moliere, "Kreuzmodulation bei geregelten Empfaen-

- ger-Vorstufen mit Feldeffekttransistoren," *Funk-Technik*, February, 1971, page 60.
15. K.H. Eichel, "Einfache Methode zur Erzielung eines konstanten Eingangswiderstandes bei Breitbandverstaerkern," *Internationale Elektronische Rundschau*, March, 1973, page 45.
16. Franz C. McVay, "Don't Guess the Spurious Level," *Electronic Design*, February 1, 1967, page 70.
17. L.S. Baar, "RF Applications of the Dual Gate Mosfet Up To 500 MHz," *RCA Application Note AN4431*.
18. Richard Brubaker, "Semiconductor Noise Figure Considerations," *Motorola Application Note AN421*.
19. Ramundt, Neues von Rohde & Schwarz, "Blocking Messung an Sprechfunkgeraeten," December, 1970; January, 1971.
20. K. Zirwick, Neues von Rohde & Schwarz, "Analysatoren fuer Sender und Empfaengermessungen," January, 1974, page 23.
21. *Phase-Locked Loop Systems*, Motorola Data Book, 2nd Edition, August, 1973.
22. B. Priestly, "Oscillator Noise and its Effect on Receiver Performance," *Radio Communication*, July, 1970.
23. W.A. Edson, "Noise in Oscillators," *Proceedings of the IRE*, August, 1960.
24. Erich Hafner, "The Effects of Noise in Oscillators," *Proceedings of the IRE*, February, 1966.
25. E.J. Baghdady, R.N. Lincoln, and B.D. Nelin, "Short Term Frequency Stability. Characterization, Theory and Measurement," *IEEE-NASA Symposium on Short Term Frequency Stability*, U.S. Government Printing Office, Washington, D.C., 1964, NASA SP-80.
26. R.H. Holman and L.J. Paciorek, "Short Term Stability Measurement Techniques and Results," Syracuse University Research Corporation.

ham radio



## double-conversion hf receiver with mechanical frequency readout

Although designed  
for shortwave broadcast,  
this receiver  
is easily modified  
to provide coverage  
between 3.2 and 30 MHz

Previous articles have described my ideas on monoband versus multiband receivers.<sup>1,2</sup> The concepts developed in these articles are still true, but response to another article<sup>3</sup> indicates many experimenters aren't interested in building a one-band receiver and are willing to accept spurious responses in a multiband unit. This is particularly true for amateur-band operation where it's a simple

matter to change frequency if a contact is made where a spurious response exists in the receiver. My operation is largely confined to listening to shortwave broadcast. Tuning a signal on these bands is a different situation. Shortwave broadcast stations emit signals on one frequency. If one of these signals happens to fall on a spurious response in the receiver, reception is difficult and a rare DX station may be lost.

This article presents the results of my experiments to produce a miniaturized, solid-state receiver with a mechanical counter digital frequency readout. The receiver covers 4.2 - 5.2 MHz in five bands, but with modification to front-end inductances and suitable crystal selection, it can provide general coverage between 3.2 and 30 MHz.

### conversion method

An extensive search was made of commercial and military communications gear. Some mixing combinations, excellent as they are, were discarded because of their complexity. This was particularly true of the Collins 51J4, whose mechanical complexity is high and for the Racal 217 whose electrical complexity is high. Other combinations were also discarded. The Collins 75A4, for instance, would be difficult to duplicate because of the complexity required to build a linear vfo over 1 MHz in the 2-MHz region.

The Collins 75S3 series was screened in depth. I operated a 75S3 inside and outside the amateur bands for several years and found only one spurious response

By Jack Perolo, PY2EIC, P.O. Box 2390, San Paulo, Brazil

at 5000 MHz caused by the second harmonic of the vfo when tuned to 2500 MHz. This occurred when 5 MHz was tuned in the 4.8-5.0 MHz band; by switching to the 5.0-5.2 MHz band, 5000 MHz was received with no problem.

Among the advantages a duplication of the Collins 75S3 would offer is its straightforward construction. And, even more important by amateur standards, the vfo tunes only 200 kHz making it easy to linearize. The price you have to pay for these advantages, however, is that if the vfo frequency excursion is only 200 kHz, each high-frequency crystal provides coverage for a band 200-kHz wide. In other words, if you wish to use the receiver over a wide frequency range, the quantity of crystals required is somewhat high. The model GP48

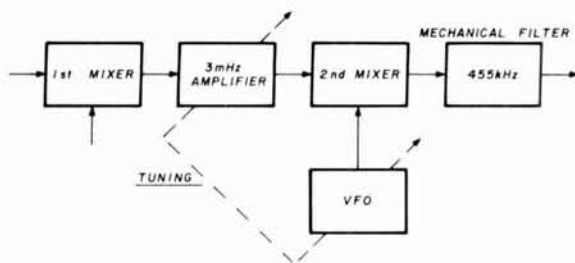


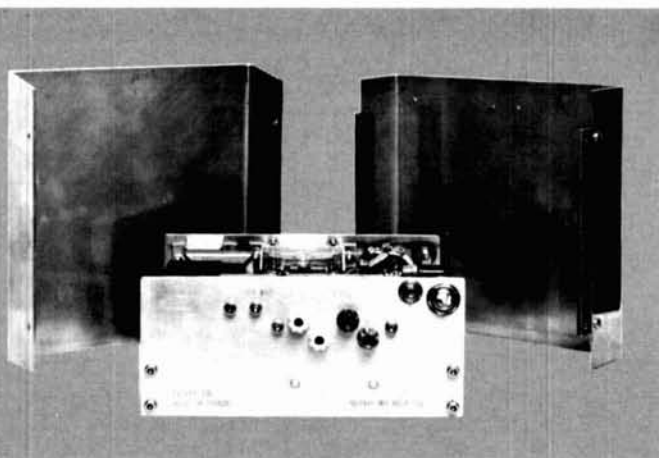
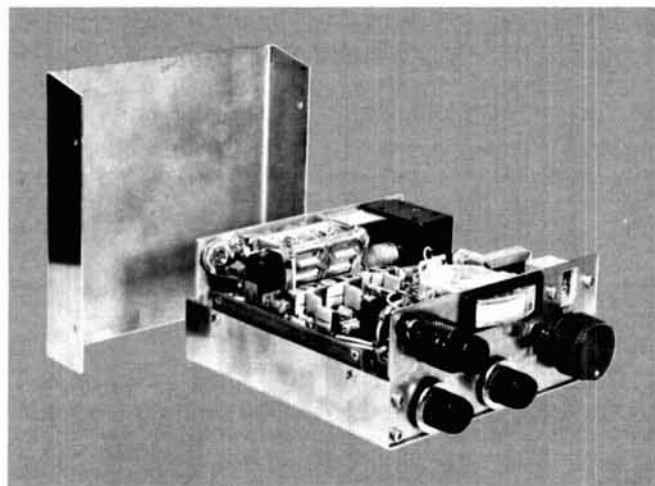
fig. 1. Block diagram of receiver 3-MHz i-f strip showing tuning method.

cover the low-frequency bands. While I've built similar units, I preferred the usual variable capacitor combination for this project, as most builders would probably not be able to homebrew a backlash-free multicore mechanism. For those who prefer the permeability tuned version, some surplus outlets offer powdered-iron cores with high length-to-diameter ratios and with a spring (rather than the usual threaded pin) termination. The permeability,  $\mu$ , of the cores is unknown, but it could be found with a grid dip meter or by breadboarding the front end before final assembly.

The Collins 3-MHz i-f is fixed tuned with a remarkably flat response over the 2955-3155 kHz range. I didn't wish to compromise on sensitivity and, after some experimenting, I decided to make the 3-MHz i-f partially tunable (fig. 1). The vfo capacitor is a two-gang affair that tunes the vfo and the input to the 3-MHz i-f amplifier, whereas the second mixer is fixed tuned. This improves the bandpass flatness and, by having a fixed-tuned mixer, buffer stages aren't needed between the vfo and the mixer. In fact, since the mixer is fixed tuned and operates over a narrow frequency range (200 kHz), it offers a reasonably constant load to the vfo.

This brings up another difference between my design and that of the Collins 75S3 line; the vfo is capacitance-tuned in my case. I have already published an article on

View with upper half of cabinet removed. Front panel controls are (from left) antenna input jack, af/rf gain control, preselector tuning control, band switch, zero-frequency set control, and main-tuning control.



Rear view showing stainless-steel cabinet construction details together with the back-panel 110-Vac input (white jacks) and 6-Vdc input (dark jacks). Two phone jacks in parallel allow headphone operation with standard and miniature plugs. This receiver required about \$150 worth of parts and 150-200 hours construction time.

receiver described here has only five bands and therefore five crystals; earlier models had wider coverage: the GP45 had ten bands and the GP46 36 bands. At about \$4 per crystal, the GP46 had about \$150 worth of crystals.

I built some solid-state receivers around the Collins 75S3 mixer combination. I was quite pleased with these experimental efforts; then I made another unit (dubbed GP42). The GP48 is the sixth of a series. Its schematic appears in fig. 2. This receiver covers 4.2-5.2 MHz or, generally speaking, the 60-meter shortwave broadcast band. With suitable crystal selection and front-end coil inductances, any frequency between 3.2 and 30 MHz can be covered with the exception of 5.2-6.5 MHz.

### circuit considerations

The basic circuit is closely related to the receivers in references 1 and 3, whereas the basic mixing scheme is derived from the Collins 75S3 line. There are, however, some differences worthy of mention. The Collins front end is slug tuned, with parallel capacitors switched in to

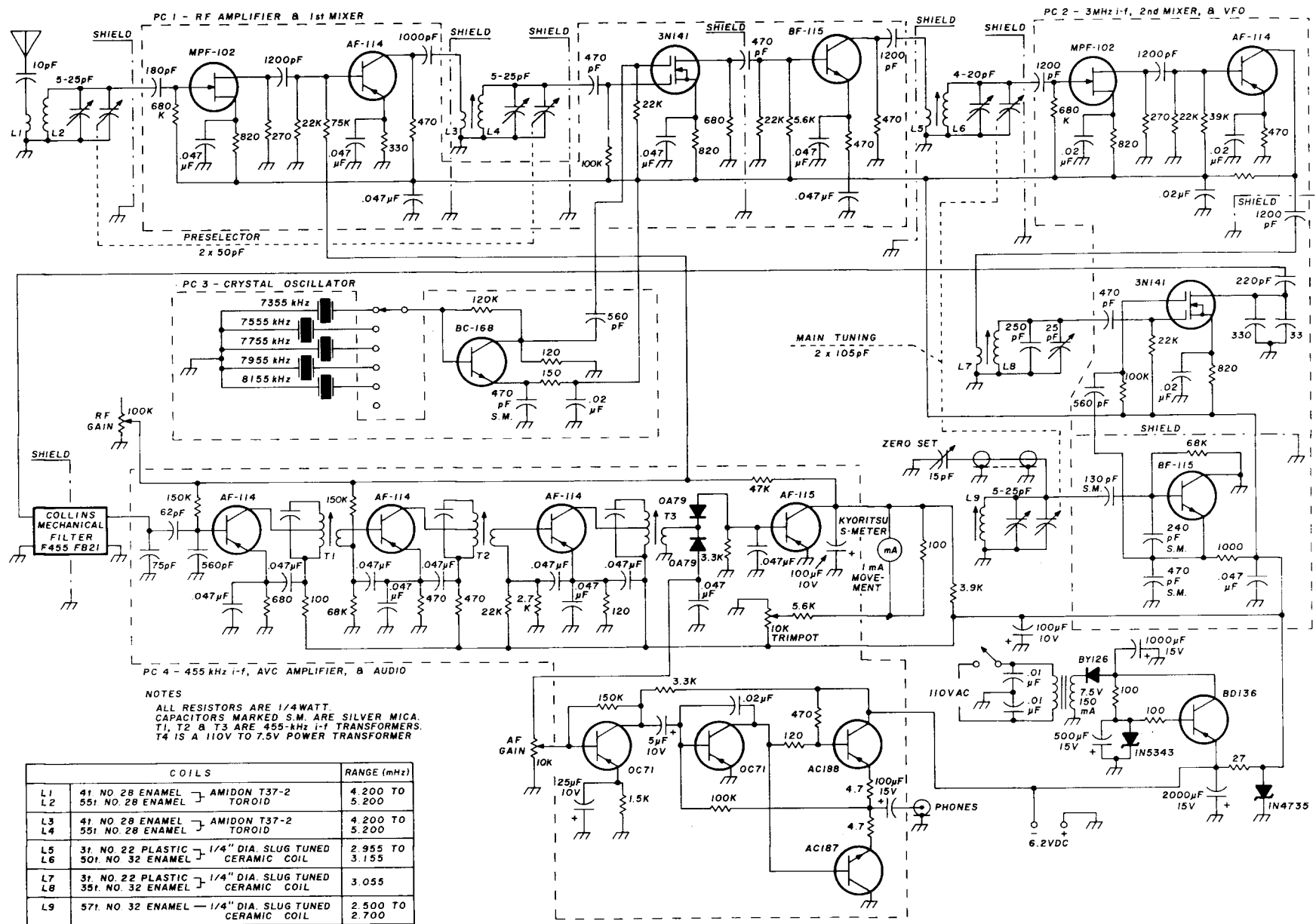
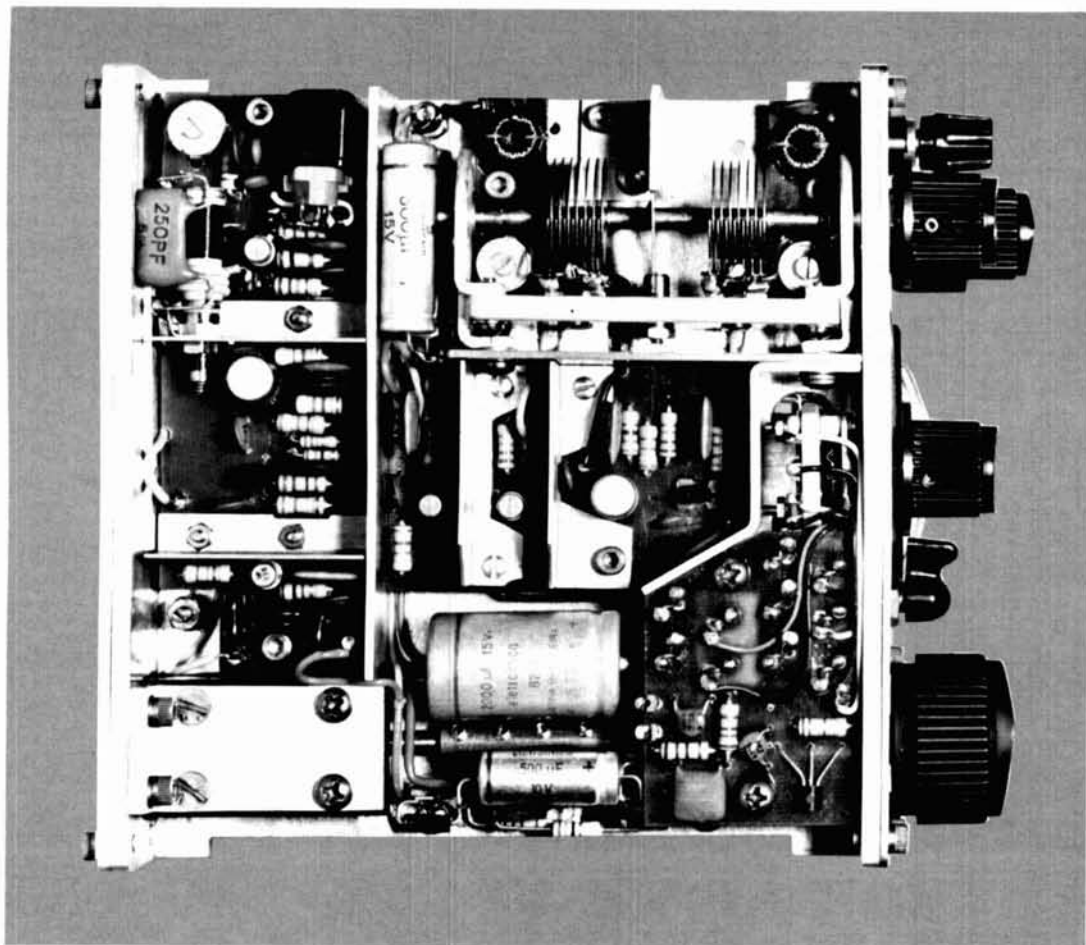


fig. 2. Receiver schematic. Crystal frequencies shown are for receiver coverage between 4.2-5.2 MHz. Receiver range may be changed to include 3.2-30 MHz by substitution of suitable crystals and front-end inductances.



Bottom view. Mechanical filter is at top left next to the mixer coil and its circuit. The 3-MHz two-stage i-f amplifier is at left center; the vfo circuit is at the bottom next to the gear reducer. At top right is the two-gang front-end variable capacitor with its toroids and trimmers. The rf and mixer circuits are at center; the band switch and crystal oscillator are at right (crystals are under the PC board). At bottom center is the regulated power supply.

a permeability tuned vfo<sup>4</sup> as well as some generalized considerations on linear vfos.<sup>5</sup> Again, the average amateur will find it difficult to come up with a backlash-free permeability-tuned vfo and even more difficult, as in this case, to gang two slugs together.

### construction details

The photos show different views of the GP48; most of the construction details can be seen in these pictures. The receiver dimensions are 6 inches wide by 2.5 inches high by 6 inches deep (15 by 6 by 15 cm). All front and back panel lettering was made with a pantograph; knob skirts were made from 16-gauge stainless steel and were similarly engraved. Aluminum shields are 1/32 inch (0.8mm) for PC-board mounting and 1/16 inch (1.6mm) for chassis mounting. Extensive shielding and capacitive decoupling assure stable operation at high gain. High-quality components are used throughout.

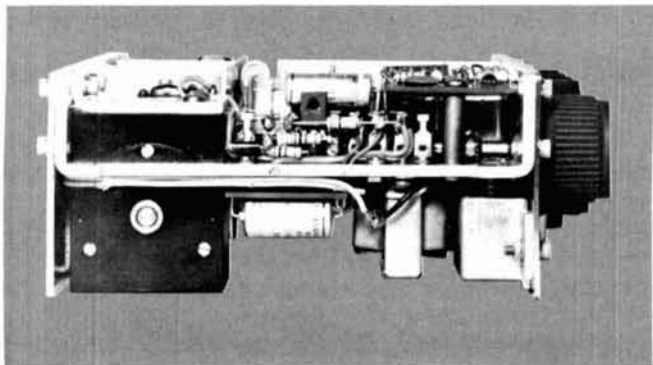
The gear-reduction unit, which has a 100:1 ratio, is permanently lubricated in a sealed container. It's a British import made by Muffett, Ltd. The counter, made by Veeder Root, has three vertical digits. A vertical

counter eliminates parallax problems when the receiver is tilted upward. The receiver tuning rate is 10 kHz per knob revolution, which makes for exceptionally smooth action. The brass bevel gears for the counter, made by Boston Gears, have a 1:1 ratio.

The vfo double-gang variable capacitor is also a British import, available in the U.S. from the J.W. Miller Company. The capacitor has very low torque, with ball bearings at both ends. It is coupled by a flexible (bellows) joint to the worm gear reducer. The S-meter is a Japanese import with a 1-mA movement. The meter face was replaced with one reading in S-units.

The receiver cabinet, which is in two halves, is made of 18-gauge stainless steel, secured by 1/8 by 3/4 by 4 1/2 inch (3 by 19 by 114 mm) spacer bars and four 4-40 (M3) binder-head screws. Four glass-epoxy PC boards are used. The i-f/af board is mounted on top of the chassis, while the vfo/3-MHz i-f/second-mixer, together with the front-end rf amplifier/first mixer and crystal oscillator/crystal holder, are mounted below chassis.

The vfo circuit was derived from previous receivers and its circuit adapted to cover the 2500-2700 kHz



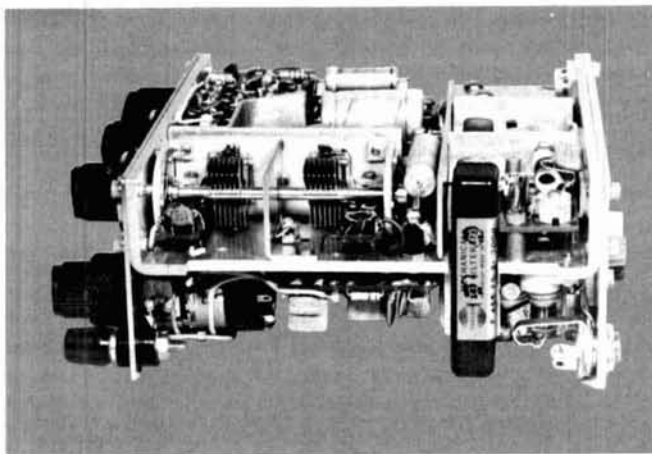
Right side. Gear reducer is at left; regulated power supply at center top. At top right is the crystal oscillator PC board with the crystals barely visible below. The power transformer is at the bottom right next to the mechanical counter. Both front and back panels are fastened with 6-32 (M 3/5) Allen-head stainless steel screws.

range; the variable capacitor (105 pF) is correct for the frequency excursion in question. The audio strip ends with a complementary pair wired to avoid transformers. Output power exceeds 0.5 W — more than enough for headphones. The power supply is electronically regulated providing, through back panel jacks, the dc power to run other gear, or conversely, to be used to feed the receiver from a dc source.

### circuit details

Because of the extremely high gain of this set, proper shielding and bypassing must be used to achieve stability. All tuned circuits are shielded from the circuits of the corresponding active devices. Heavy filtering is used on all power lines. The vfo coil is shielded to minimize proximity effect. The vfo capacitor is not shielded because it must be accessible to allow for easy filing of its plates during the linearization procedure (described below). It must be remembered, however, that during the filing process, a small temporary shield must be fastened to the top of the vfo variable capacitor to

Left side. Front-end double-gang variable capacitor, toroids, and trimmers are at upper left, installed on small printed circuit boards.



simulate the effect of the metal receiver cabinet. Failure to do so will result in degrading vfo linearity because of the proximity of the cabinet when set in place.

It is important to understand that when a vfo is coupled to a counter, a simple change such as moving a wiring harness can degrade the calibration by more than one kHz at the band edge. Therefore, before starting to linearize the vfo capacitor all screws, nuts and components in general must be securely tightened in place and no circuit changes should be made during or after linearization. The easiest way to achieve perfect linearity is to file down the capacitor plates to within 1 kHz or so of the nominal frequency desired; from then on, the fine part of the linearization procedure is to slightly bend and adjust the side plates of the capacitor rotor. This procedure has the advantage of being reversible whereas filing is not.

### selectivity improvements

A major difference between amateur-band operation and shortwave broadcast listening is in selectivity. In the

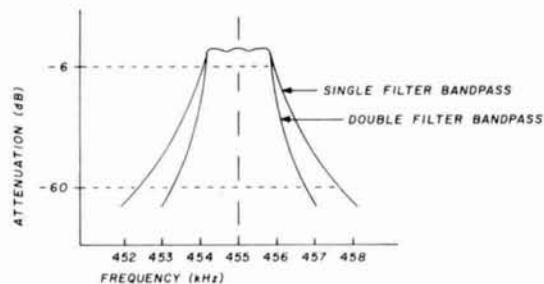


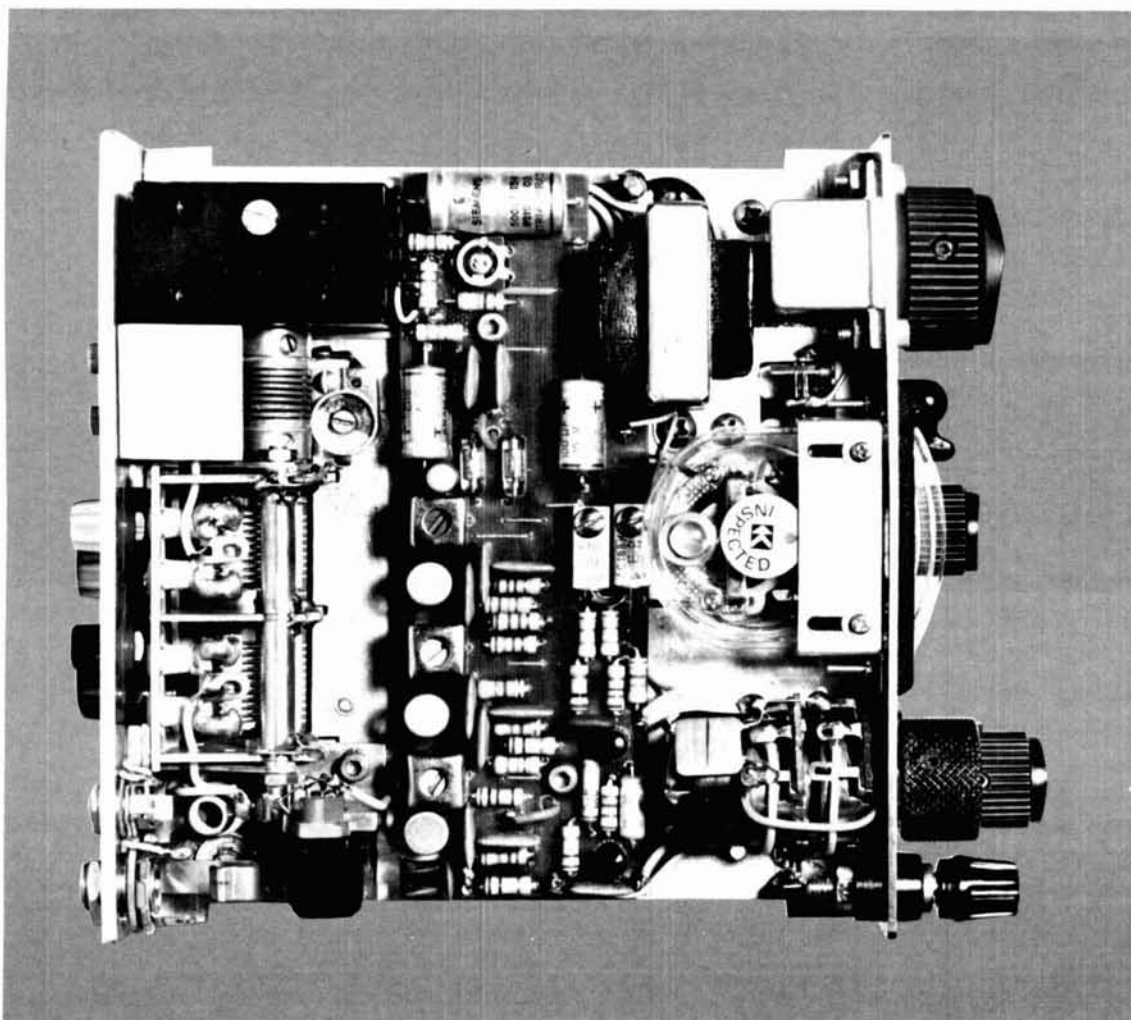
fig. 3. Skirt response of single and double filter arrangements. When cascaded, each filter must have an identical midband frequency for best results.

first case interference may be generally avoided by changing frequency; obviously this isn't possible when receiving shortwave broadcast stations. The minimum bandwidth for a-m reception is stated in the literature as 3 kHz or thereabouts. Any serious listener knows this number is way too high. I've used a 2.1-kHz bandwidth (through a mechanical filter) for many years but have changed to narrower bandwidths as conditions demand. For serious shortwave broadcast listening, I'd say the ideal receiver bandwidth is 1.8 kHz.

While mechanical filters are available with a skirt ratio of 2:1 (-60 to -6 dB), a nearby station can still cause interference because of the bell-shaped response of these filters. A remarkable improvement can be achieved by cascading two identical filters, but some words of caution are in order. Using this method, the skirt response at -60 dB can be improved by a factor of  $\sqrt{2}$ , or about 1.4 times, while maintaining the response constant at -6 dB (see fig. 3). A definite improvement is obtained; so much in fact that comparing two receivers tuned to the same station, one with a 1.4-kHz mechanical filter and the other with two cascaded 2.1-kHz mechanical filters (both bandpass figures at -6 dB), one's reaction is that the second receiver is more selective than the first.

To realize the full potential of this combination it's





Top view. Gear reducer is at top left. One of the 3-MHz i-f coils is visible below the variable capacitor. PC board in center includes the three i-f amplifiers, avc amplifier, and audio strip. At top right are the power transformer, mechanical counter, S-meter, rf/af control, and antenna input jack. Aluminum bracket, top left, shields the vfo coil to minimize proximity effect when the steel cabinet is installed.

imperative to use two filters of identical midband frequency to avoid stagger tuning with consequent skirt degradation. Each filter must be individually shielded to avoid ground loops and to ensure the signal travels through the filters and not around them. You can't take excessive precautions in this respect, because such arrangements are critical beyond imagination. The GP46 receiver (mentioned earlier) was based on this concept with entirely satisfactory results. Another i-f stage should be added to compensate for the insertion loss of the second filter.

### frequency readout

While an electronic frequency readout could be used, a mechanical counter is less expensive and physically smaller. For portable work, the mechanical counter is also better since it requires no power. I believe that the vfo linearization work, however tedious and delicate, is still more advantageous than building an electronic counter. Such a counter, however, could always be added to the receiver as an external unit. The advantage in this

case is that the counter can be used for other projects. I've found that an external counter offers less interference than built-in units, as their 100-kHz clocks tend to show some leakage into the receiver circuits.

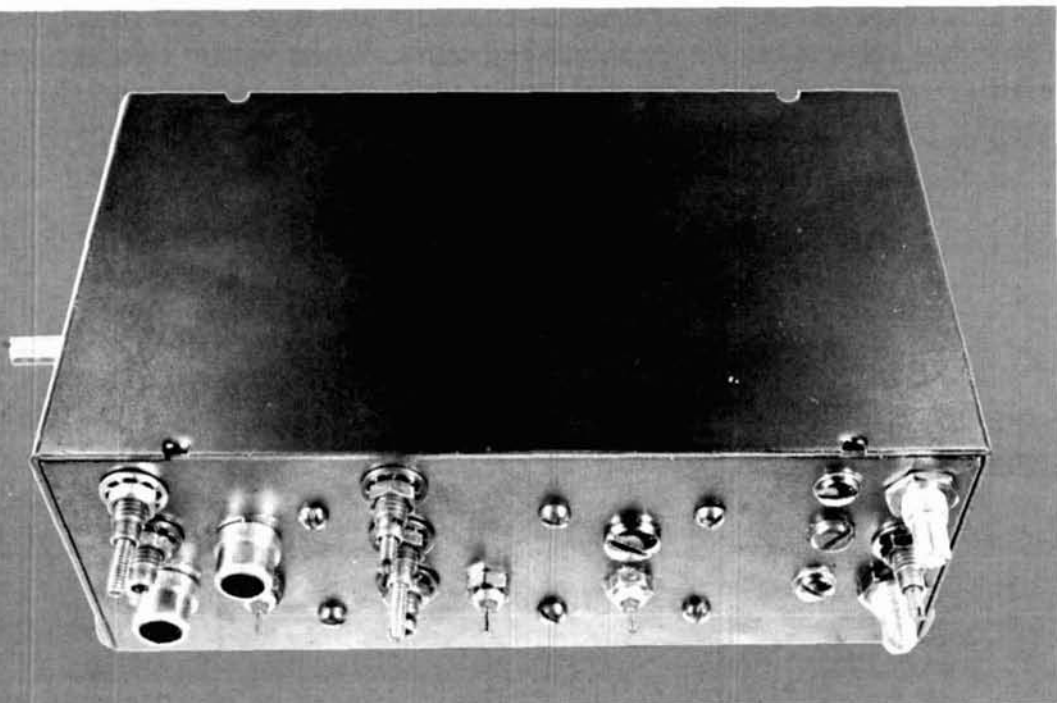
### acknowledgement

I'd like to thank PY2GP for his continued support in the realization of this and other projects.

### references

1. J. Perolo, "A Transistorized Communications Receiver with Digital Frequency Read-Out," *CQ*, July/August, 1970.
2. J. Perolo, "A Universal Solid State Preselector/Converter for the Short-Wave Bands," *CQ*, June, 1971, page 49.
3. J. Perolo, "A General Coverage Solid-State Communications Receiver with Direct Digital Frequency Read-Out," *CQ*, August, 1973, page 28.
4. J. Perolo, "A Solid-State Permeability-Tuned VFO with Digital Frequency Read-Out," *CQ*, October, 1970, page 18.
5. J. Perolo, "Considerations for Solid-State Linear VFOs," *CQ*, September, 1972, page 62.

ham radio



## multiband high-frequency converter

A VVC-tuned converter  
that extends  
your 80-meter receiver  
tuning range  
to include 40-10 meters  
plus WWV

Many receiver designs have been published for the 80-meter band. This article provides complete design and construction details for a multiple-band converter to extend the range of this type of receiver. This design provides conversion of the hf bands and 10-MHz WWV signals to 3.4-4.0 MHz for i-f amplification and detection.

Fig. 1 illustrates the converter design in which mos field-effect transistors are used in the rf amplifier and mixer stages because of their superior spurious-response rejection and signal-handling capability. The dual-gate protected mosfet features rf gain or agc control in the rf-amplifier (Q1) stage and outstanding mixing characteristics for conversion to the i-f output (Q2).

Overall gain of the converter is shown in table 1. Coil Q for each stage is fairly high; as a result bandwidths are narrow, so some method of tuning is necessary to cover each band. Tuning is by variable capacitance (VVC) diodes in each of the rf and mixer tuned circuits.

### circuit description

Fig. 2 is a schematic of the rf and mixer stages. Selection of each band is by band switching the appro-

By M.A. Chapman, K6SDX, 935 Elmview Drive, Encinitas, California 92024

appropriate tuned circuit in the rf and mixer input stages. The mixer output uses a VVC that tunes a full MHz. The individual tuned circuit design centers are for the middle of each amateur band. The VVC will allow the coils to cover each band with a margin of several hundred kHz at

end. Both the rf and mixer stages depend on source resistance for gate bias. The source bias in Q2 is extremely important since it establishes the transfer curve linearity that provides an optimum combination of mixing and spurious response rejection (more informa-

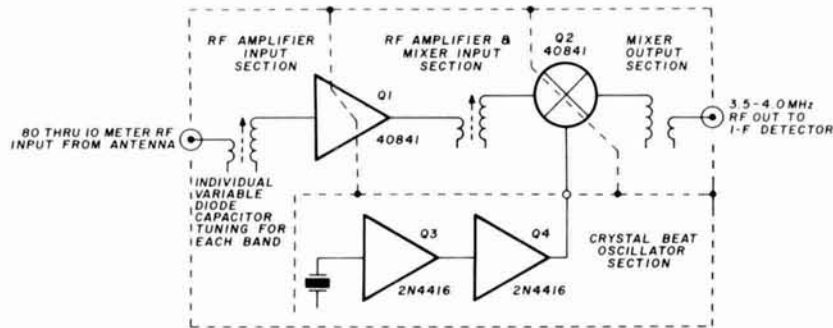
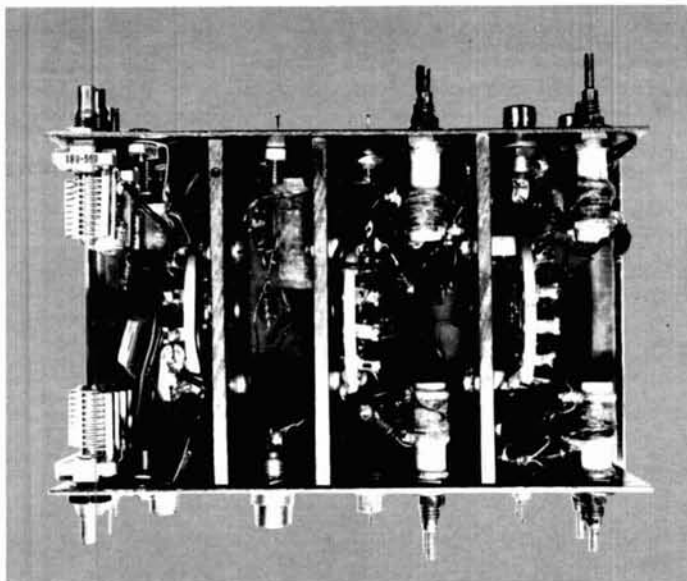


fig. 1. Converter block diagram. Design covers 80-10 meters and 10 MHz for WWV.

the band edges. The unloaded Q of the mixer output is approximately 150; the bandwidth is quite sharp and will require simultaneous tuning with the rf stages.

The total converter bandwidth is difficult to specify because of the variety of interpretations. The half-power bandwidth — that is, the width for 50% decrease in converted signal amplitude — was measured at less than 200 kHz on all bands. This sharp selectivity also indicates that for a typical 500-kHz band-segment width, several peaking adjustments are required from end to

**Converter interior.** Shielded partitions contain (l to r) oscillator, mixer output, rf amplifier output, and rf amplifier input sections.



tion about this source bias and mixer linearity is given in the mixer discussion that follows).

Fig. 3 is the high frequency beat oscillator schematic. This circuit is an adaptation of those in references 1 and 2. A conventional LC network is illustrated for 10-meter

table 1. Performance summary

band	tuning range (MHz)	i-f output (MHz)	converter gain (dB)
80M	3.5-4.0	3.5-4.0	0
40M	7-7.3	3.7-4.0	37
20M	14-14.25	3.625-3.875	41.7
15M	21-21.45	3.5-3.95	36.5
10M	28.5-30	3.5-4.0	34.5
	(any 500 kHz segment)		
WWV	9.9-10.1	3.65-3.85	28.9

Sensitivity: <.15V rms using the i-f system described in reference 3 on all bands.

Bandwidth: ±100 kHz for 50% decrease in signal amplitude without peaking adjustment.

Spurious signal rejection: ≥50 dB attenuation at ±1 MHz.

beat-oscillator conversion. This signal could have been generated by a crystal as for the other bands; however, fundamental crystals above 20 MHz are expensive and restrict the circuit to some fixed segment of the 10-meter band. Down conversion is accomplished for all bands using a beat oscillator signal approximately 3.5 MHz less than the lower edge of the receiving frequency. For 7.0-7.3 MHz conversion we use the top end of the 80-meter band, 3.7-4.0 MHz, as the i-f output to minimize beat-oscillator feedthrough in the mixer output stage. The 20-meter band (14.0-14.25 MHz) is down converted to the middle of the 80-meter i-f range to maximize circuit selectivity in subsequent stages.

Regular 32-40 pF, parallel-tuned, fundamental-

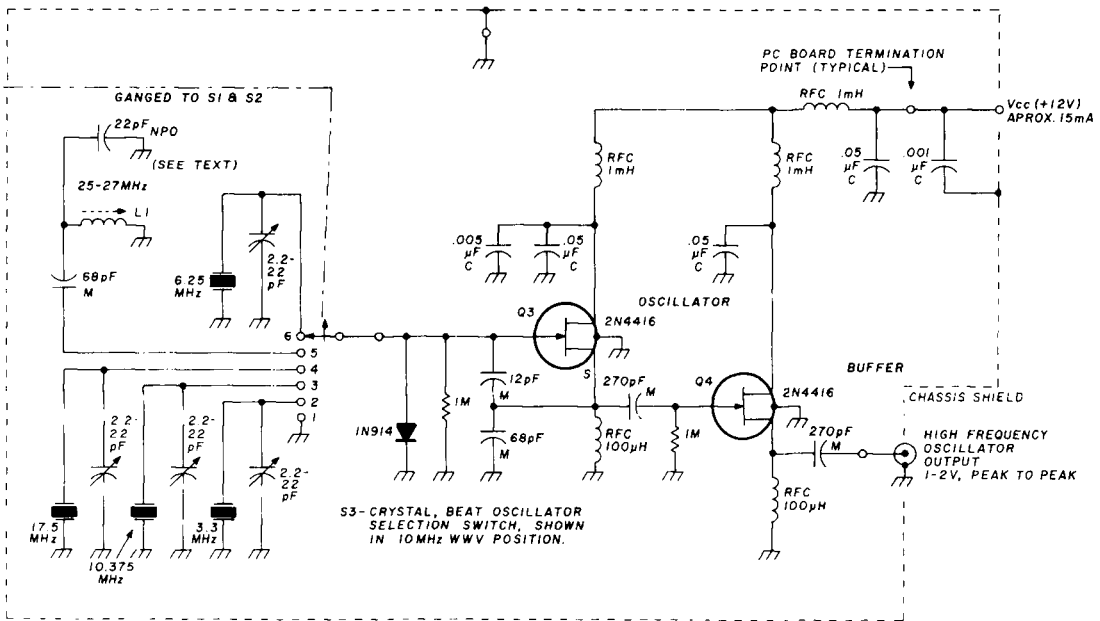


fig. 3. Oscillator schematic. L1 consists of 11 turns of AWG 26 (0.3mm) enameled wire on J.W. Miller 4500-2 form.

frequency crystals should be used. The 2.2-22 pF parallel trimmer capacitors across the crystals may be deleted if you're willing to accept some error in the converted signal output. This error in most cases will be less than  $\pm 5$  kHz if the capacitors are not used. The total capacitance across the crystal is the sum of the parallel compo-

nent capacitance and the gate source capacitance. Since all of these components contain variations in capacitance tolerance, some compensation or trimming is required for exact beat-oscillator frequency generation.

Where digital readout schemes are used for frequency display and consideration has been given for band-edge

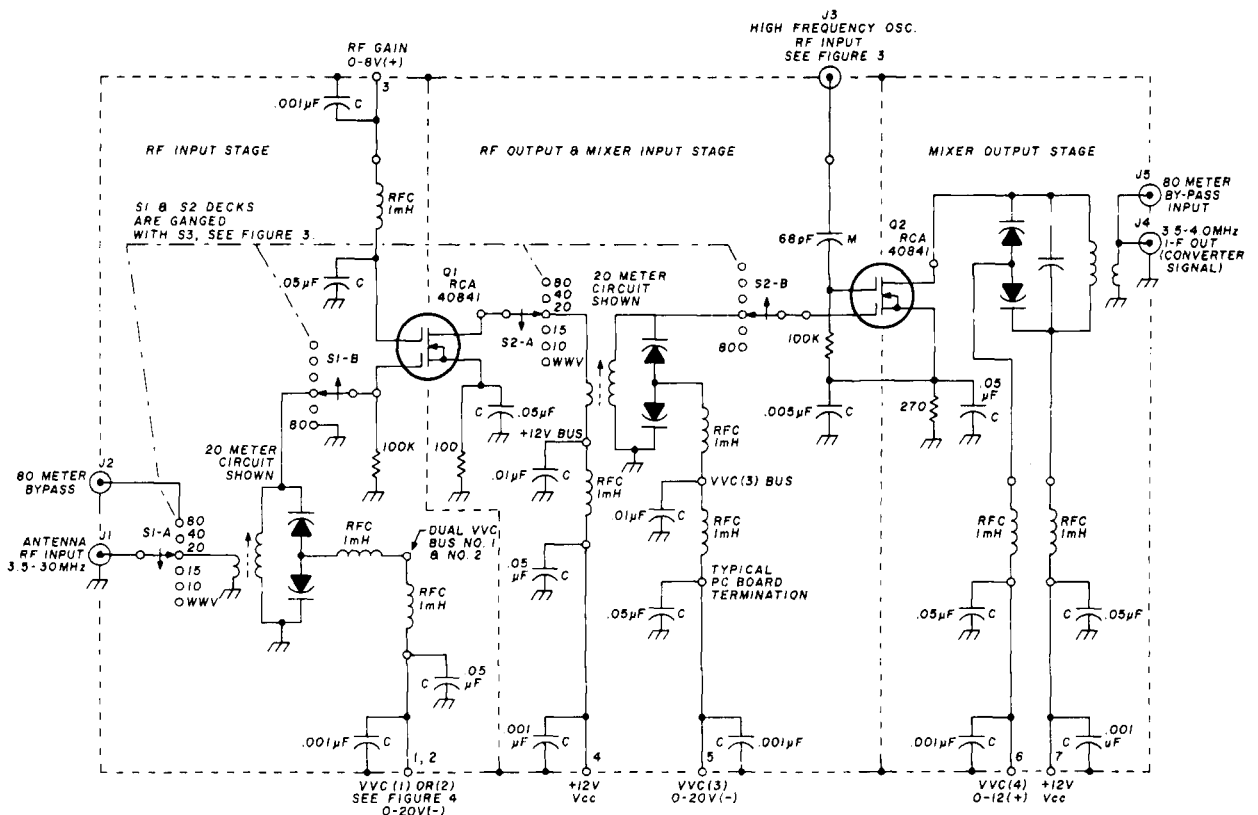


fig. 2. Rf amplifier and mixer schematic. Variable capacitance diode tuning is used in each stage.

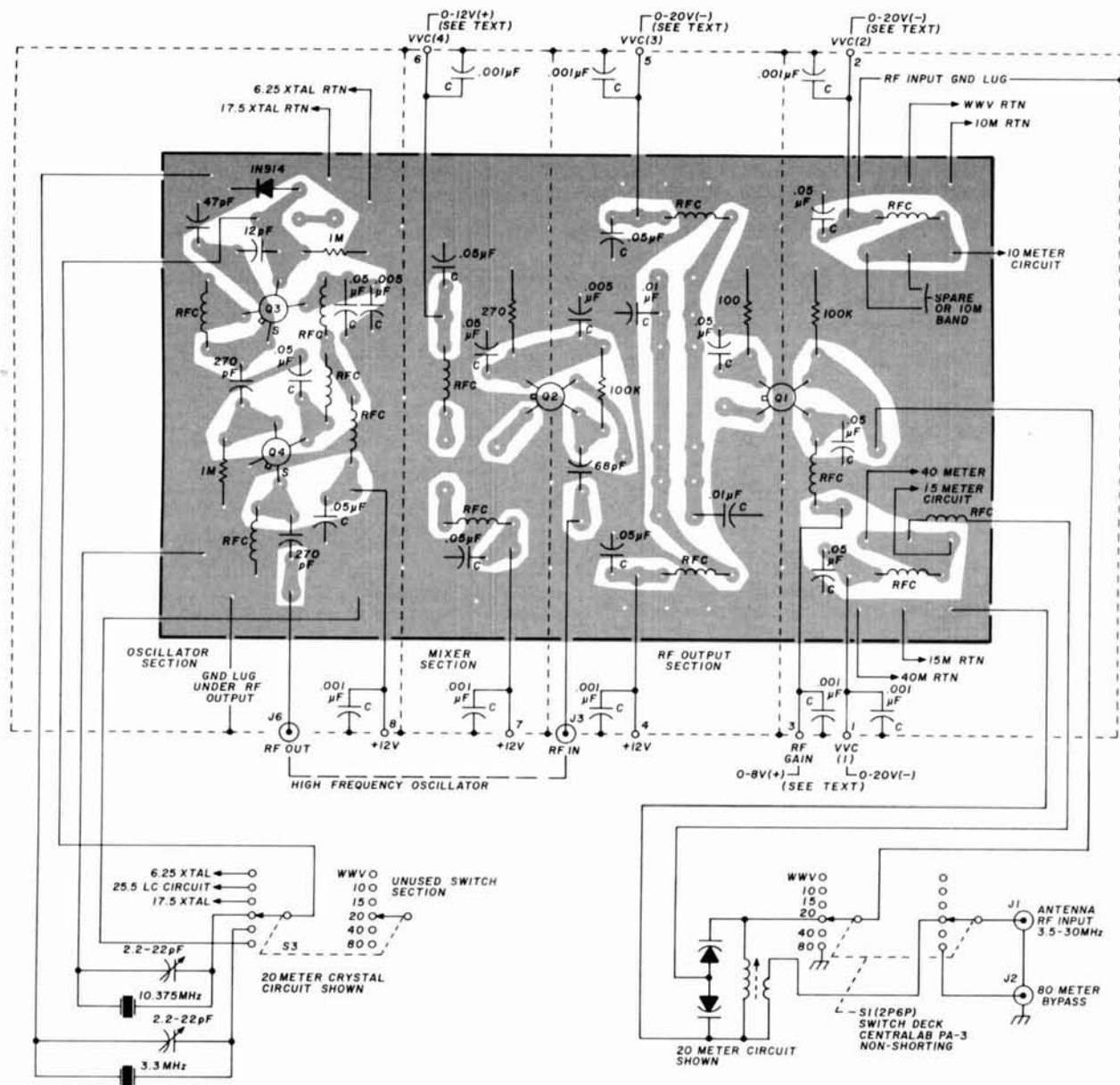


fig. 4. PC-board component layout for rf amplifier and oscillator.

determination, this frequency error is continuously known. If you depend on a slide rule dial visual display of the tuned frequency, then the oscillator crystal frequencies should be set precisely using some type of capacitor trimming similar to that indicated in the diagram. Both oscillator and buffer use a source inductive load. Considering the wide range of oscillator frequencies, this method of buffering the oscillator produces a stable, moderately uniform output level and minimizes spurious frequencies, which could fall within the tuned frequency range. In combination, the rf mixer and oscillator stages are joined to provide a comfortable 300-500 kHz segment from each of the hf bands to be converted to the 3.5-4.0 MHz 80-meter band. Because of the wide tuning capability in the rf and mixer stages, MARS and

general-purpose tuning can also be added if sufficient i-f tuning range is available.

### construction

From the photos it's seen that the converter is built around a simple PC board\* with attached aluminum plates acting as interstage shields and a convenient mount for the switch decks. This PC board with the attached shield plates is mounted in a standard LMB 136 aluminum chassis box. The shield plates are aligned by drilling the switch shaft clearance hole through all three plates at the same time, then centering one plate on the

\*Undrilled PC boards are available from the author for \$3.00 including postage.

end of the box to locate and align the box and shaft clearance hole. The PC board is attached to the bottom edge of the plates using self-tapping screws. The shield plates are fastened to the sides of the box in the same manner. This construction follows the same general approach described in reference 3.

To reduce spurious noise and birdies in other portions of the receiver, generous use is made of bypass capacitors and rf chokes both at the PC board and at the point on the chassis side where control and supply voltages are applied. Each stage is individually separated and control lines decoupled from each other to minimize feedback. An examination of figs. 4 and 5 shows potential band-switching of six individual bands; however, only five are used in this design because of physical limitations of the

The PC layout of fig. 4 also indicates an unused pad next to Q3 gate. The purpose of this pad is for the installation of a coupling capacitor between the oscillator switch deck common and Q3 gate to allow for conventional LC networks to be used for all oscillator frequencies instead of crystals, similar to the method for generating high-frequency oscillator signals for 10 meters as in fig. 3.

### oscillator

Construction should be accomplished one stage at a time. The easiest place to start is with the crystal oscillator. It's not necessary to have the shields or switch decks in place to verify crystal-oscillator operation. Mount the oscillator components to the PC board as indicated in

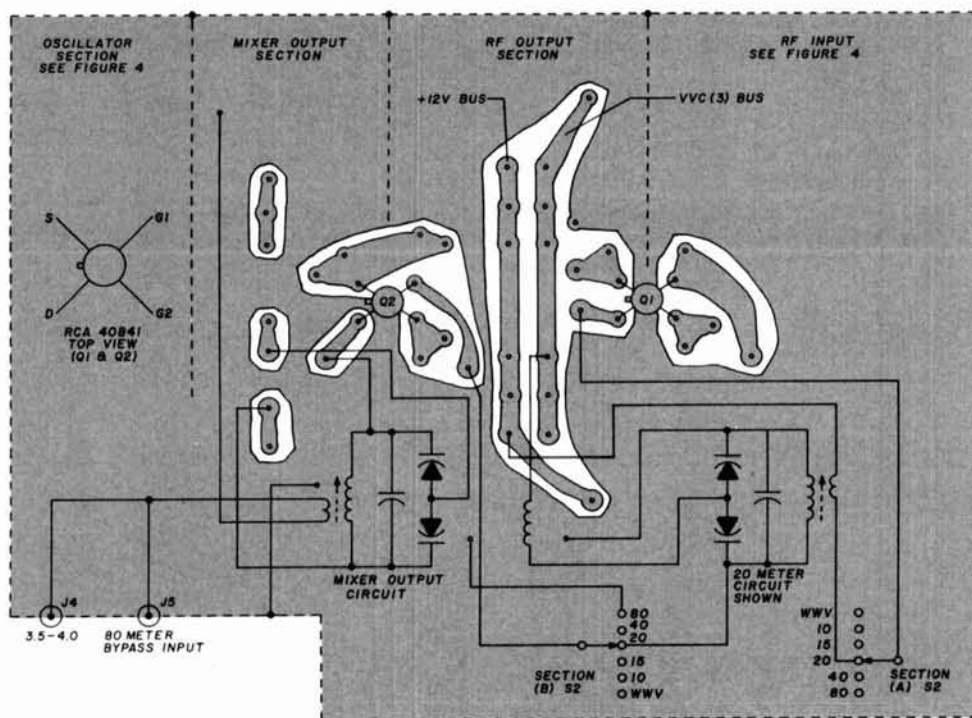


fig. 5. Rf and mixer tuned-circuit interconnections.

box and coils. By using a slightly larger box, an additional portion of the 10-meter band could be included or perhaps a 6-meter segment.

Not everyone will be interested in the conversion of all the bands shown. For instance, if only two or three bands are desired, considerably more room would be available for access. If only one band conversion is desired, adequate room is available to mount the coil components directly to the PC-board groundplane areas. For those who may wish to experiment with a less complex and expensive system of fixed-band conversion, the capacitor resonant values of fig. 6 may be used. Padding the coils with a 10k, 1/2-watt resistor will decrease coil Q sufficiently so that no rf tuning would be required over most of the 500-kHz band segment. The VVC control wouldn't be required, resulting in a further reduction in power-supply voltages.

fig. 4. Temporarily install any fundamental frequency crystal between 3-30 MHz between the PC pad from Q3 gate and the ground plane where holes are provided. Install a 100 ohm current-limiting resistor from the +12V PC pad and apply power. The crystal signal should appear at the source of both Q3 and at the output coupling capacitor (270 pF) from the Q4 source.

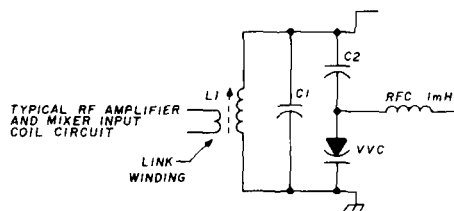
### mixer

The mixer output stage should be wired next. Estimate the service lead length required from the output coil to the board, and allow the coil to hang free from its leads. The bandswitch and shield between the input and output aren't required for initial testing. Install 100-ohm current-limiting resistors to the +12V mixer coil PC pad and the VVC (4) control PC bus (0-12V). By applying a low-level 3.5-4.0 MHz signal to Q2 gate 1 and varying

the VVC voltage on the output coil, signal gain and selection should be apparent. The network will be detuned because of oscilloscope internal shunt capacitance if a scope probe is not placed on the coil link output. In this mode we're using Q2 as a simple single-channel fet amplifier, tuning the drain circuit and monitoring the link. Additional verification can be obtained by tempo-

between 200 and 300 ohms. This resistor establishes the gate 1-to-source bias on Q2 for linearity of the fet transfer characteristics. For ideal mixing the transconductance curve should approach a straight line when the drain current is plotted against the gate 1 voltage. Since the zero gate voltage versus drain current varies over a wide margin, selection of this source resistor will optimize the device operation.

table 2. Rf tuned-circuit component complement



### rf amplifier

The rf amplifier PC components should be installed next. As in the previous steps, no interstage shield is necessary for initial testing. From the pad on the PC board for Q1 drain circuit, temporarily install a 0.01μF capacitor to the gate 1 pad of Q2 and add a 100-ohm

band/ freq	rf amplifier coils						nominal cap (pF)	C1 (pF)	C2 <sup>(3)</sup> (pF)	VVC type
	L1 form <sup>(4)</sup>	Q <sup>(2)</sup>	winding <sup>(1)</sup>		link <sup>(1)</sup>					
			turns	AWG (mm)	turns	AWG (mm)				
40m <sup>(3)</sup>	4500-2	65	25	28 (0.3)	5	30 (0.25)	175	22	—	MV1666(2)
20m <sup>(3)</sup>	4500-3	80	20	28 (0.3)	5	30 (0.25)	65	—	—	MV1652(2)
15m	4500-3	65	13	26 (0.3)	4	28 (0.3)	58	—	68	MV1660
10m	4500-6	60	10	26 (0.3)	3.5	28 (0.3)	45	—	43	MV1660
10MHz	4500-2	60	23	28 (0.3)	4	30 (0.25)	82	82	—	—

- Notes:
1. Turns are close wound, slightly loose over form.
  2. Unloaded value.
  3. C2 is a VVC, mounted anode-to-anode. Q dope all components after soldering.
  4. D.W. Miller part numbers.

freq (MHz)	mixer coil						nominal cap (pF)	C1 (pF)	C2 (pF)
	L1 form	Q <sup>(2)</sup>	winding <sup>(1)</sup>		link <sup>(1)</sup>				
			turns	AWG (mm)	turns	AWG (mm)			
3.5/4.0	plex rod 3/8 in. (9.5mm) dia	90	48	28 (0.3)	10	30 (0.25)	185- 245	150	MV1403(2) VVC mounted anode- to-anode

- Notes:
1. Winding is 3/4 in. (2cm) long located along center of rod. Link is on bottom end near chassis.
  2. Unloaded value.

rarily grounding Q2 gate 2; the output signal should fall off immediately. To simplify these observations the signal applied to gate 1 should be modulated so that a low-frequency audio envelope can be monitored by an oscilloscope. To verify Q2 mixing characteristics and to optimize the circuit, substitute a 500-ohm potentiometer in place of Q2 source resistor. Add a jumper wire from the oscillator output PC pad (Q4 source capacitor) to the input coupling capacitor on Q2 gate 2.

Any of the indicated crystals may be used in the oscillator; however, let's assume that the 10.375-MHz crystal is used and temporarily mounted in the PC board oscillator section as previously discussed. By applying a low-level modulated 14-MHz signal to Q2 gate 1 with the beat oscillator signal applied to gate 2, and by adjusting the VVC (4) control voltage on the mixer coil, a signal envelope similar to that shown in fig. 7 should be seen while monitoring the mixer output coil link. Mixing linearity may be optimized by adjusting the temporarily installed 500-ohm potentiometer for both mixer gain and peak signal-to-local oscillator feedthrough ratios. Next, remove the potentiometer and measure its resistance. Select a fixed resistor of this value, which will be

resistor between the Q1 drain PC pad and the +12V bus. Apply power to the rf and mixer drain circuits and oscillator, and apply a low-level modulated 14-MHz signal to Q1 gate 1. The mixer output should be similar to the previously described mixer test signal, with some high-frequency feedthrough apparent. Q1 gain control can be verified by temporarily grounding Q1 gate 2; the output signal should fall off immediately then slowly increase when gate 2 is left open. The rf and agc gain control features of a dual-gate mosfet can be observed if a variable positive voltage is applied to Q1 gate 2. The output signal should be nearly zero when gate 2 is at or near ground potential; then the output signal will rise in amplitude as the gate 2 voltage is increased to about 8 Vdc. Maximum gain is achieved when the gate 2-to-source voltage is about 6 Vdc.

You may want to adjust the Q1 source resistor. Because Q1 is a depletion device, the source could be operated at ground potential with maximum gain from the stage; however, some biasing of gate 1 is desirable for device stability, and 100 ohms is a common value for a mosfet in this type of rf application. For higher frequencies, such as 144 or 220 MHz, a 220-ohm resistor would

provide some improvement in the noise figure with a sacrifice in gain. If you need the extra gain, the source resistor could be reduced to 47 ohms. If plenty of selectivity and gain are available in the i-f amplifier, my suggestion would be to increase Q1 source bias to several hundred ohms.

### final adjustment

At this point we're confident of our component operation, and all temporary connections should be removed. Figs. 4 and 5 illustrate the inductor and switch deck interconnection. The switches select the crystal beat oscillator frequency and appropriate tuning network for the desired band. In the 80-meter position the signal bypasses the rf mixer stages and is presented directly to the output connector. Using 24 AWG (0.5mm) solid hookup wire, adequate strength is available to support the coil components until you're ready to install the PC board into the box and fasten the coil to the chassis sides.

Before installing the PC board and coil assemblies into the box, the interface connections should be temporarily installed as in fig. 7 and a low-level signal applied to each band. This will allow you to de-bug any wiring errors and initially adjust the coil slugs. A signal level of one or two millivolts may be required, depending on your oscilloscope sensitivity, for alignment. A typical modulated 14-MHz signal is shown in fig. 6 and indicates the envelope response with proper tuning and normal gain settings. The signal amplitudes and features may differ considerably if the mixer output is left unloaded. During my initial testing, a 51-ohm, 1-watt resistor was used across the oscilloscope input terminals, and the normal input capacitance was 40 pF.

### additional suggestions

VVC selection was based on what was readily available. Nominal resonance capacitance for middle of the band tuning of each coil is shown in table 2. An infinite number of VVC and capacitor values will tune the circuits. The total tuning capacitance of these VVC devices is not fully used for the bands indicated. The tuning ratio for the rf and mixer input VVC devices is approxi-

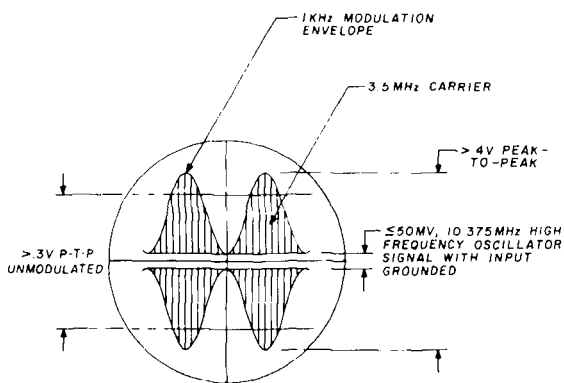


fig. 6. Typical oscilloscope patterns from mixer output with a 1000-microvolt input signal at 14 MHz and 50-ohm resistive load across the scope terminals. Gain is about 40 dB.

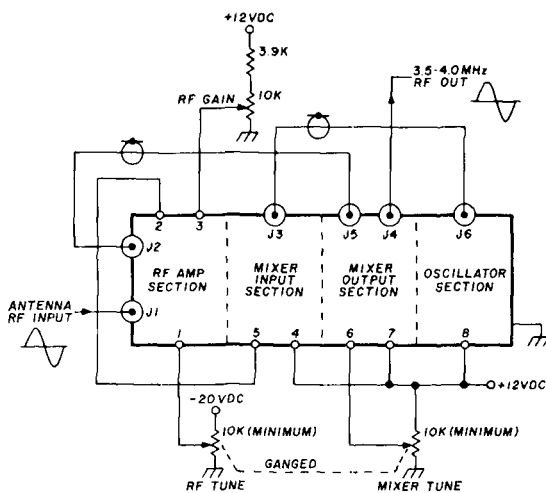


fig. 7. Application diagram. Agc control may be applied to pin 3 of the rf amplifier instead of the rf gain control (see reference 3).

mately 3, and the mixer output VVC device has a tuning ratio of 10. The reader is referred to Motorola's application note<sup>4</sup> for design options.

Resistors for the oscillator are 1/4-watt; those for the rf and mixer are 1/2-watt. Low-voltage ceramic or mica capacitors are used. You might experiment using 100-ohm resistors in place of rf chokes for cost reduction; however, the tradeoff here is added spurious noise.

### application

Fig. 7 shows the typical interface for VVC control and power bus lines. The rf and mixer tuning controls may be ganged as indicated by adjusting the mixer tuning control for maximum signal output at 3.75 MHz then readjusting the coil slug to the center positions. Tracking between rf and mixer stages is not perfect because of device nonlinearity and frequency tuning ranges; however, for nominal 500 kHz bandwidths, these variations are minimal.

Reference 3 includes an agc circuit that may be used instead of the rf-amplifier gain control. Because of the high input impedance of Q1 control gate, several agc stages may be ganged in parallel; however, the device types in the rf and i-f stages should be similar because of variations in gate 2 voltage and gain between device types. For optimum receiver performance, the VVC controls should remain independent so that signal peaking will be maximum.

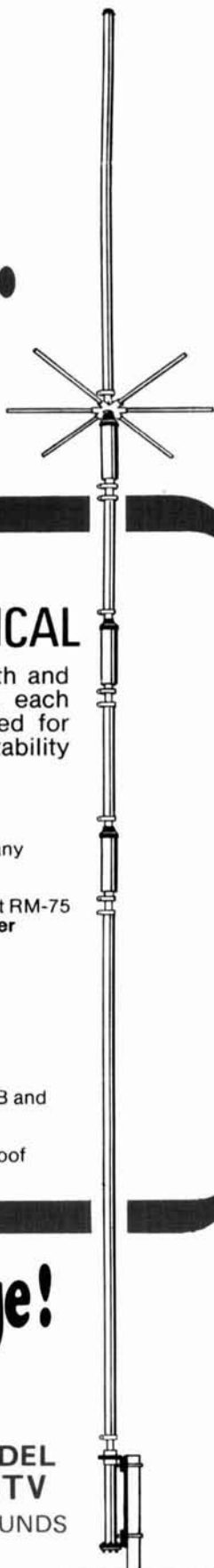
### references

1. M.A. Chapman, K6SDX, "A Master Frequency Oscillator," *ham radio*, November, 1975, page 50.
2. D.L. Stoner, W6TNS, "High-Stability Crystal Oscillator," *ham radio*, October, 1974, page 36.
3. M.A. Chapman, K6SDX, "High Performance i-f Detector Receiver Module," *ham radio*, August, 1976, page 34.
4. Technical Application Note AN-178A, "EPICAP Tuning Diode Theory and Applications," Motorola Semiconductor Products, Inc., Phoenix, Arizona.

ham radio



# if the 4-BTV weighs 39% more... what do others leave out?



## **HUSTLER** FIXED STATION FOUR BAND VERTICAL

The 4-BTV is longer for greater aperture, larger in diameter for strength and bandwidth, heavier traps for precision and safety factor. Individually, each subassembly weighs more to collectively give you an antenna designed for convenience of assembly and installation, a wide margin in mechanical stability and far superior electrical performance.

- **Lowest SWR—PLUS!**
- Bandwidth at its **broadest!** SWR 1.6 to 1 or better at band edges.
- Hustler exclusive trap covers "**Spritz**" extruded to otherwise unattainable close tolerances assuring accurate and permanent trap resonance.
- Solid one inch **fiberglass trap forms** for optimum electrical and mechanical stability.
- Extra heavy duty aluminum mounting bracket with **low loss—high strength** insulators.
- All sections **1 1/4" heavy wall**, high strength aluminum. Length 21'5".
- **Stainless steel clamps** permitting adjustment
- without damage to the aluminum tubing.
- Guaranteed to be **easiest assembly** of any multi-band vertical.
- Antenna has **3/8"-24 stud** at top to accept RM-75 or RM-75-S Hustler resonator for **75 meter operation** when desired.
- Top loading on 75 meters for broader bandwidth and **higher radiation efficiency!**
- Feed with **any length** 50 ohm coax.
- Power capability—**full legal limit** on SSB and CW.
- Ground mount with or without radials; roof mount with radials.

## one setting for total band coverage! 40 THROUGH 10 METERS

HUSTLER ANTENNA PRODUCTS—for sixteen years—original designs—created and manufactured by American ingenuity, labor and materials—used by communicators throughout the world.

Hustler designs are patented under one or more of the following assigned to New-Tronics Corporation: 3287732, 3513472, 3419869, 3873985, 3327311, 3599214, 3582951

# **HUSTLER**

Available from all distributors  
who recognize the best!

**MODEL  
4-BTV  
15 POUNDS**

## new-tronics corporation

15800 commerce park drive,  
brook park, ohio 44142  
Exporter: Roburn Agencies, Inc., New York, N. Y.

# solid-state microwave amplifier design

A complete  
design approach  
for uhf and  
microwave amplifiers,  
and the performance  
tradeoffs which result  
with simplified  
design methods

In two recent articles I introduced a rather simplistic design method for matching microwave transistors in microstripline preamplifiers for 1296 MHz.<sup>1,2</sup> The designs proved entirely acceptable for amateur applications, exhibiting input and output vswr well below 2:1, and yielding gains within 0.5 dB of those theoretically obtainable from the transistors used in the circuits. In fact, these designs were so successful that they ultimately formed the basis for a commercial product line for the 1296 MHz band. There is, however, no reason why full maximum available gain, and true 1:1 vswr, should not be achievable in microstripline amplifiers if simplistic design methods are abandoned in favor of a more complex, rigorous approach. In military and aero-

space electronics, where the ultimate in performance is essential, such perfectionism has become a watchword. Small wonder, then, that a few discerning radio amateurs are attempting to achieve state-of-the-art performance in their microwave transistor designs.

This article is an exposition of state-of-the-art design techniques and is intended to be instructional, rather than constructional. By briefly reviewing the design approach applied in my previous articles, I shall attempt to identify the omissions which cause the resulting amplifier performance to depart from optimum. Following a brief discussion of transistor parameter characterization, I will show the mathematical procedures necessary to overcome the performance shortcomings of my previous designs. This is followed by a design example based on the MRF-901 transistor. The final section of the article outlines the minor performance differences between the rigorous design approach and more casual matching computations. For those readers who are interested, an appendix is provided which outlines some of the rules of vector arithmetic that are required for proper manipulation of semiconductor scattering parameters.

## simple matching scheme

For any two-port device, optimum power transfer occurs when both input and output are terminated in their complex conjugate impedances. That is, for any port impedance consisting of a resistance and a series reactive component, the termination should appear as a like value of resistance in series with the *opposite* reactive component. For example, a port with an impedance of  $35 + j100$  ohms (35 ohms of resistance, 100 ohms of series *inductive* reactance), should be terminated in  $35 - j100$  ohms (35 ohms of resistance, 100 ohms of series *capacitive* reactance).

Recognizing the above, amplifier design consists of causing the ports (transistor input and output imped-

By H. Paul Shuch, WA6UAM, Microcomm, 14908 Sandy Lane, San Jose, California 95124

ances) to be terminated in their complex conjugates. The problem is to identify the actual transistor input and output impedances occurring at a given frequency, and under a given set of bias conditions.

It is convenient to assume that the impedances related to the transistor's input and output reflection coefficients ( $s_{11}$  and  $s_{22}$ ) approximate the device's input and output impedances. This is the approach I used in my previous articles. The fallacy (and one source of minor errors) is the fact that  $s_{11}$ , the *input reflection coefficient*, directly relates to input impedance *only* when the output is terminated in a pure resistance of 50 ohms. Similarly,  $s_{22}$ , *output reflection coefficient*, is directly related to the output impedance *only* when the input is terminated in a pure resistance of 50 ohms. In other words, varying the impedance match at one port will affect the impedance seen at the other port.

To understand the reason for this interaction, it's important to realize that no transistor is strictly a unilateral device. Any time a signal is injected into the output of a transistor amplifier, some signal will be discernible at the input. The physics of semiconductor construction allow for a feedback path which, though it may appear minimal, nonetheless allows output matching to have an impact on input impedance, and vice versa.

If the input and output reflection coefficients of a transistor were both zero, this feedback path would have no effect on transistor matching. A reflection coefficient of zero indicates a corresponding port impedance of 50 ohms, nonreactive. Since  $s_{11}$  is measured with the output terminated in 50 ohms, and  $s_{22}$  is measured with the input similarly loaded, this is the only case in which terminating one port will not disrupt matching to the other. Of course, if both the input and output impedances of a transistor were 50 ohms, pure resistive, matching to a 50-ohm source and load would be considerably simplified. Unfortunately, we are not blessed with such transistors. Hence, to properly determine input and output impedances, the device's *transfer coefficients* must be considered.

### S-parameters

In addition to  $s_{11}$  and  $s_{22}$ , the reflection coefficients discussed previously, a microwave transistor is characterized by a *forward transfer coefficient*,  $s_{21}$  (mathematically related to gain), and a *reverse transfer coefficient*,  $s_{12}$  (which describes the internal feedback path). Together, these four scattering parameters fully characterize the operation of the device. From them can be calculated the transistor's stability factor (tendency to oscillate under various conditions of source and load termination), maximum available gain, maximum stable gain, and equivalent input and output impedances. The s-parameters can be further manipulated to determine the device's maximum linear power output capability<sup>3</sup> although such an analysis is beyond the scope of this article.

It should be remembered that each of the four s-parameters varies with frequency, as well as with varying conditions of bias current and operating potential. The term "scattering" is derived from the fact that the para-

meters describe a set of variables, based on traveling waves incident on a port and reflected (or scattered) from it, which are evaluated with a mathematical tool called a scattering matrix.<sup>4</sup>

It should be further pointed out that s-parameters are *vectors*. That is, they appear as points on a Smith chart or polar plot which can be defined by both *magnitude* and *angle*. For example, at a frequency of 1.3 GHz, with

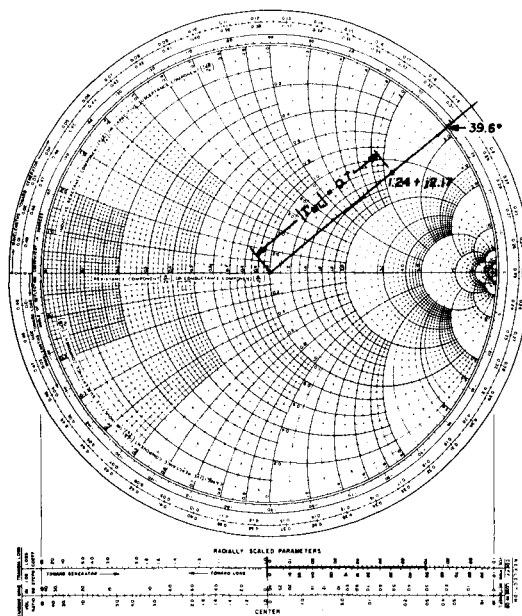


fig. 1. Using a Smith chart to plot the load impedance which exhibits the specified load reflection coefficient,  $0.7 \angle 39.6^\circ$ . On this normalized Smith chart this yields  $1.24 + j2.17$ . In a 50-ohm system the required load impedance is  $62 + j108.5$ . To plot this point first locate the angle of the reflection coefficient on the peripheral scale and draw a line from  $39.6^\circ$  on this scale through the center of the chart. Referring to the radially scaled voltage reflection coefficient below the chart, measure the distance to 0.7, and transfer this length to the previously plotted line on the Smith chart. The crossover point marks the required complex load impedance.

a collector current of 10 mA and a collector-to-emitter potential of 10 volts, the common-emitter s-parameters for a Motorola MRF-901 microwave transistor are:

$$\begin{aligned} s_{11} &= 0.47 \angle +161^\circ \\ s_{22} &= 0.43 \angle -41^\circ \\ s_{12} &= 0.08 \angle +64^\circ \\ s_{21} &= 3.1 \angle +63^\circ \end{aligned}$$

A complete discussion of the derivation and usefulness of the four s-parameters is available in an application note published by Hewlett-Packard.<sup>5</sup> Tabulations of s-parameters corresponding to various frequencies and bias conditions are available from the manufacturers of most microwave transistors.

### gain and stability analysis

Before attempting to determine input and output impedances and design matching networks, it is desirable to approximate the gain capabilities of the transistor

under the chosen operating conditions, and to determine whether the resulting amplifier will be stable. Three parameters which aid in such analysis are Maximum Available Gain (*MAG*), Maximum Stable Gain (*MSG*), and Rollett's stability factor (*K*). *K* indicates the amplifier's tendency to oscillate. If *K* is greater than 1, the amplifier will be stable under any combination of input and output impedances or phase angles. Such an amplifier is said to be *unconditionally* stable. Conservative

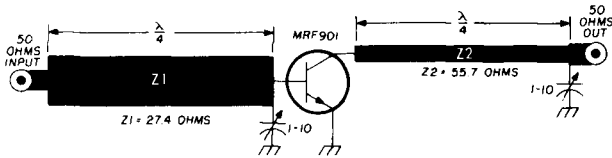


fig. 2. Basic circuit for a 1296-MHz amplifier which uses a Motorola MRF-901 transistor. Input and output matching is provided by microstriplines and 10 pF trimmer capacitors. This amplifier is unconditionally stable and gain is about 13 dB (bias networks are not shown).

design philosophy suggests that if *K* calculates to less than unity a different transistor or bias condition should be selected.

Maximum stable gain is, to quote WA6RDZ, "... the most important figure of merit. Transistors with high *MSG* are easy to match, easy to tune, and give high performance, trouble-free amplifiers."<sup>6</sup> Maximum available gain, also easily calculated, is a fairly accurate approximation of the gain you will observe in the actual circuit if it is carefully designed and built. If *MAG* is on the order of 2 or 3 dB less than *MSG*, the amplifier is likely to be both stable and reliable.

Of the above parameters, *MSG* is the most readily computed because it involves only the absolute values (magnitudes) of  $s_{21}$  and  $s_{12}$ :

$$MSG (dB) = 10 \log \frac{|s_{21}|}{|s_{12}|} \quad (1)$$

In order to perform the remaining calculations, the vector quantity  $\Delta$  and the scalar values  $B_2$  are required:

$$\Delta = s_{11} s_{22} - s_{12} s_{21} \quad (2)$$

$$B_2 = 1 + |s_{22}|^2 - |s_{11}|^2 - |\Delta|^2 \quad (3)$$

It is now possible to calculate Rollett's stability factor, *K*

$$K = \frac{1 + |\Delta|^2 - |s_{11}|^2 - |s_{22}|^2}{2 \cdot |s_{21}| \cdot |s_{12}|} \quad (4)$$

If *K* proves greater than unity, go ahead and calculate maximum available gain:

$$MAG (dB) = MSG + 10 \log |K \pm \sqrt{K^2 - 1}| \quad (5)$$

where if  $B_2$  is greater than zero (i.e., positive), the sign preceding  $\sqrt{K^2 - 1}$  is negative, and if  $B_2$  is less than zero (i.e., negative), the sign is positive. At this point in

the circuit design, it is possible to determine whether the performance of the amplifier is acceptable for the intended application. If the amplifier proves only conditionally stable ( $K \leq 1$ ), or if *MAG* is insufficient, select another transistor or bias point, and go through the calculations again with the new *s*-parameters.

## output conjugate matching

Assuming that the gain and stability analysis indicate that the amplifier design is workable, the output circuit is designed to terminate the transistor in the complex conjugate of its *actual* output impedance. To determine the true output impedance requires a manipulation involving not only  $s_{22}$ , but also  $\Delta$  and  $B_2$  (eqs. 2 and 3) as well as  $s_{11}$ . To find the desired load reflection coefficient, first compute the intermediate vector quantity  $C_2$ :

$$C_2 = s_{22} - (\Delta \cdot s_{11}^*) \quad (6)$$

where the asterisk indicates that the complex conjugate of the immediately preceding vector is used (that is, same magnitude, angle has opposite sign).

The angle of the desired load reflection coefficient,  $\Gamma_{ML\theta}$ , is simply  $C_{2\theta}^*$ . The desired magnitude is found from:

$$|\Gamma_{ML}| = \frac{B_2 \pm \sqrt{B_2^2 - 4|C_2|^2}}{2|C_2|} \quad (7)$$

The sign preceding the radical sign is, once again, opposite to the sign on  $B_2$ . The desired load reflection coefficient may now be converted on a Smith chart into a complex impedance value, then matched to 50 ohms, as discussed in my previous articles.

## input conjugate matching

Once the output load has been specified, the source reflection coefficient which will properly terminate the transistor's input is found from

$$\Gamma_{MS} = \left[ s_{11} + \left( \frac{s_{12} \cdot s_{21} \cdot \Gamma_{ML}}{1 - (\Gamma_{ML} \cdot s_{22})} \right) \right]^* \quad (8)$$

where the asterisk indicates the complex conjugate (same magnitude, angle has opposite sign). This reflection coefficient may be plotted on a Smith chart to determine equivalent impedance, and the result transformed to 50 ohms.

To those readers who have Hewlett-Packard HP-45 engineering calculators, I highly recommend an article by Martin<sup>7</sup> which reduces formulas similar to the above to straightforward keystroke sequences. I have also published a HP-35 algorithm for series-to-parallel complex impedance conversion which may prove useful in designing matching networks.<sup>8</sup> Additionally, I recently derived a family of programs for the new HP-25 programmable calculator which greatly simplify all of the above calculations.\*

\*A complete set of HP-25 amplifier design programs is available from the author for \$2.00 plus a stamped, self-addressed envelope.

## design example

As noted previously, the common-emitter  $s$ -parameters for the Motorola MRF-901 transistor at 1.3 GHz, when biased at 10 volts and 10 mA, are as follows:

$$\begin{aligned}s_{11} &= 0.47 \angle +161^\circ \\ s_{22} &= 0.43 \angle -41^\circ \\ s_{12} &= 0.08 \angle +64^\circ \\ s_{21} &= 3.10 \angle +63^\circ\end{aligned}$$

Using these parameters, the maximum stable gain,  $MSG$ , is calculated from eq. 1:

$$\begin{aligned}MSG \text{ (dB)} &= 10 \log \frac{s_{21}}{s_{12}} \\ &= 10 \log (3.1/0.08) = 15.9 \text{ dB}\end{aligned}$$

Before performing the remaining calculations, it's necessary to compute the vector quantity  $\Delta$  (eq. 2) and the scalar quantity  $B_2$  (eq. 3).

$$\begin{aligned}\Delta &= (s_{11} \cdot s_{22}) - (s_{12} \cdot s_{21}) \\ &= [s_{11} \cdot |s_{22}| \angle (s_{11\theta} + s_{22\theta})] - [s_{12} \cdot |s_{21}| \angle (s_{12\theta} + s_{21\theta})] \\ &= [0.47 \cdot 0.43 \angle 161^\circ + (-41^\circ)] - [0.08 \cdot 3.1 \angle (63^\circ + 64^\circ)] \\ &= (0.202 \angle 120^\circ) - (0.25 \angle 127^\circ)\end{aligned}$$

Converting to rectangular notation and subtracting the  $x$  and  $y$  components,

$$\Delta_x = 0.049 \quad \Delta_y = -0.025$$

Returning to polar notation

$$\begin{aligned}\Delta_{tR} &= \sqrt{\Delta_x^2 + \Delta_y^2} = \sqrt{0.00306} = 0.055 \\ \Delta_{t\theta} &= \arctan \Delta_y/\Delta_x = \arctan -0.500 \\ &= -26.56^\circ \\ \Delta &= 0.055 \angle -26.56^\circ\end{aligned}$$

The scalar quantity  $B_2$  is calculated from the relationship

$$\begin{aligned}B_2 &= 1 + |s_{22}|^2 - |s_{11}|^2 - |\Delta|^2 \\ &= 1 + (0.43)^2 - (0.47)^2 - (0.055)^2 = 0.96\end{aligned}$$

With the vector quantity  $\Delta$  and scalar quantity  $B_2$  now known, it's possible to calculate Rollett's stability factor,  $K$ , from eq. 4.

$$\begin{aligned}K &= \frac{1 + |\Delta|^2 - |s_{11}|^2 - |s_{22}|^2}{2 |s_{21}| \cdot |s_{12}|} \\ &= \frac{1 + (0.055)^2 - (0.47)^2 - (0.43)^2}{2(3.1)(0.08)} = 1.20\end{aligned}$$

Since the stability factor is greater than 1, the amplifier will be unconditionally stable.

The maximum available gain,  $MAG$ , of the amplifier is calculated with eq. 5.

$$MAG \text{ (dB)} = MSG \text{ (dB)} + 10 \log |K \pm \sqrt{K^2 - 1}|$$

Since  $B_2$  is greater than zero (i.e., positive) the sign of the radical is minus.

$$\begin{aligned}MAG \text{ (dB)} &= 15.9 \text{ dB} + 10 \log |1.20 - \sqrt{1.20^2 - 1}| \\ &= 15.9 \text{ dB} + 10 \log 0.54 \\ &= 15.9 + (-2.7) = 13.2 \text{ dB}\end{aligned}$$

Since  $MAG$  is approximately 3 dB lower than  $MSG$ , the amplifier can be expected to tune easily.

**output matching.** To terminate the transistor in the complex conjugate of its output impedance, first compute the intermediate vector quantity  $C_2$  from eq. 6.

$$C_2 = s_{22} - (\Delta \cdot s_{11}^*)$$

remembering that the angle of  $s_{11}^*$  has a sign opposite to that of  $s_{11}$  (in this case,  $s_{11}^* = 0.47 \angle -161^\circ$ )

$$\begin{aligned}C_2 &= (0.43 \angle -41^\circ) - [(0.054 \angle -25.61^\circ) \cdot (0.47 \angle -161^\circ)] \\ &= (0.43 \angle -41^\circ) - (0.025 \angle 173.4^\circ)\end{aligned}$$

Converting to rectangular notation and subtracting the  $x$  and  $y$  components,

$$C_{2x} = 0.344 \quad C_{2y} = -0.284$$

Returning to polar notation

$$\begin{aligned}C_{2R} &= \sqrt{C_{2x}^2 + C_{2y}^2} = \sqrt{0.199} = 0.45 \\ C_{2\theta} &= \arctan C_{2y}/C_{2x} = \arctan -0.826 \\ &= -39.6^\circ\end{aligned}$$

$$C_2 = 0.45 \angle -39.6^\circ$$

The angle of the load reflection coefficient,  $\Gamma_{ML\theta}$  is  $C_{2\theta}^*$  where the asterisk indicates that the sign of the angle is changed. In this case,  $C_{2\theta}^* = +39.6^\circ$ . The magnitude of the load reflection coefficient is found from eq. 7:

$$|\Gamma_{ML}| = \frac{B_2 \pm \sqrt{B_2^2 - 4|C_2|^2}}{2|C_2|}$$

where the sign ahead of the radical is opposite to the sign on  $B_2$ .

$$\begin{aligned}|\Gamma_{ML}| &= \frac{0.96 - \sqrt{(0.96)^2 - 4(0.45)^2}}{2(0.45)} \\ &= 0.70\end{aligned}$$

$$\Gamma_{ML} = 0.70 \angle 39.6^\circ$$

This quantity may be plotted on a Smith chart to determine the desired load impedance as shown in fig. 1.\* This yields

$$Z_L = 62.0 + j108.5$$

\*The load impedance can also be calculated from the relationship

$$Z_L = Z_o \frac{1 + \Gamma_{ML}}{1 - \Gamma_{ML}}$$

where  $Z_L$  is the complex load impedance ( $R \pm jX$ ),  $Z_o = 50 + j0$ , and  $\Gamma_{ML}$  is the complex load reflection coefficient. Since all quantities are complex numbers, vector arithmetic is required.

**Input matching.** Now that the output load impedance has been specified, the source reflection coefficient which will properly terminate the input to the transistor can be calculated from eq. 8:

$$\begin{aligned}\Gamma_{MS} &= \left[ s_{11} + \left( \frac{s_{12} \cdot s_{21} \cdot \Gamma_{ML}}{1 - (\Gamma_{ML} \cdot s_{22})} \right) \right]^* \\ &= (0.47 \angle 161^\circ) + \left( \frac{(0.08 \angle 64^\circ)(3.1 \angle 63^\circ)(0.7 \angle 39.6^\circ)}{1 - [(0.7 \angle 39.6^\circ)(0.43 \angle -41^\circ)]} \right)^* \\ &= (0.47 \angle 161^\circ) + \left( \frac{(0.08 \cdot 3.1 \cdot 0.7) \angle 64^\circ + 63^\circ + 39.6^\circ}{1 - [(0.7 \cdot 0.43) \angle (39.6^\circ - 41^\circ)]} \right)^* \\ &= (0.47 \angle 161^\circ) + \left( \frac{0.17 \angle 166.6^\circ}{0.70 \angle 0.60^\circ} \right)^* \\ &= [(0.47 \angle 161^\circ) + (0.24 \angle 166^\circ)]^*\end{aligned}$$

Converting to rectangular notation and adding the  $x$  and  $y$  components,

$$\Gamma_{MSx} = -0.68 \quad I_{MSy} = 0.21$$

Returning to polar notation

$$\begin{aligned}\Gamma_{MSR} &= \sqrt{\Gamma_{MSx}^2 + \Gamma_{MSy}^2} = \sqrt{0.51} = 0.71 \\ \Gamma_{MS\theta} &= \arctan \Gamma_{MSy} / \Gamma_{MSx} = \arctan -0.31 \\ &= 162.7^\circ \\ \Gamma_{MS} &= 0.71 \angle 162.7^\circ = 0.71 \angle -162.7^\circ\end{aligned}$$

The source reflection coefficient for a complex conjugate input match may be plotted on a Smith chart to determine the corresponding source impedance. This yields the series complex impedance,  $Z_s = 8.7 - j7.4$  ohms (parallel complex impedance,  $Z_p = 15 \parallel -j17.6$  ohms).

**Matching networks.** An input conjugate match can be obtained by shunting the transistor base with a capacitive reactance equal to the desired parallel equivalent reactance value ( $-j17.6$  ohms) and transforming the source impedance to the required parallel resistance value (15 ohms) through a quarter-wavelength transmission line. The required capacitance value is found from the familiar reactance equation

$$C = \frac{1}{2\pi f X_c}$$

At 1296 MHz:

$$C = \frac{1}{2\pi(1296 \cdot 10^6) 17.6} = 6.98 \text{ pF}$$

A 10 pF trimmer capacitor will assure a proper reactive termination.

Transformation of the resistive component (to a 50-ohm source in this case) is accomplished with a quarter-wavelength transmission line which has a characteristic impedance  $Z_o$ , equal to the geometric mean of

the source impedance  $Z_f$ , and the parallel input resistance,  $R_p$ .

$$Z_o = \sqrt{R_p \cdot Z_f}$$

With a 50-ohm source and a parallel input resistance of 15 ohms

$$Z_o = \sqrt{15 \cdot 50} = 27.4 \text{ ohms}$$

At 1296 MHz this is easily provided by a microstrip transmission line 0.26 inches (6.5mm) wide and 1.16 inches (29.5mm) long on a 1/16-inch (1.5mm) double-clad, fiberglass printed-circuit board.

A similar quarter-wavelength transformer can be designed to match the resistive component,  $R_s$ , of the complex series output impedance (62 ohms) to a 50-ohm termination,  $Z_t$ . As before, the characteristic impedance of the transmission line is given by

$$Z_o = \sqrt{R_s \cdot Z_t} = \sqrt{62 \cdot 50} = 55.7 \text{ ohms}$$

At 1296 MHz this is provided by a microstrip transmission line 0.09 inches (2.3mm) wide and 1.21 inches (30.7mm) long on 1/16-inch (1.5mm) double-clad, fiberglass printed-circuit board.

The required inductive reactance in series with the collector (+j108.5 ohms) is provided by shunting a capacitive reactance across the output end of the quarter-wavelength transformer. The required capacitive reactance is given by

$$X_c = \frac{Z_o^2}{X_s} = \frac{55.7^2}{108.5} = 28.6 \text{ ohms}$$

At 1296 MHz:

$$C = \frac{1}{2\pi(1296 \cdot 10^6) 28.6} = 4.3 \text{ pF}$$

Again, a 10 pF trimmer capacitor will suffice. The circuit in fig. 2 shows the complete matching layout.

### performance comparison

A simplified amplifier design, in which source and load impedances appear as the complex conjugate of the impedances related to  $s_{11}$  and  $s_{22}$ , yields the circuit shown in fig. 3. This circuit was derived by matching to the following assumed shunt-equivalent impedances:

$$\begin{aligned}\text{Parallel: } Z_{in} &(\text{derived from } s_{11}) \\ &= 21 \parallel j56.5 \text{ ohms} \\ \text{Series: } Z_{out} &(\text{derived from } s_{22}) \\ &= 75 - j52.5 \text{ ohms}\end{aligned}$$

A more rigorous analysis shows the actual device impedances to be:

$$\begin{aligned}\text{Parallel: } Z_{in} &(\text{actual}) = 15 \parallel +j17.6 \text{ ohms} \\ \text{Series: } Z_{out} &(\text{actual}) = 62.0 - j108.5 \text{ ohms}\end{aligned}$$

Note that the reactive components of the shunt input impedance and the series output impedance differ significantly. Thus some degree of mismatch can be anticipated.

ted if the circuit of fig. 3 is built as shown. Since the actual device impedances are now known, this mismatch can be accurately predicted.

As it happens, only the resistive component of the transistor's input or output complex impedance sees a mismatch. This is because the tuning range of the trimmer capacitors in fig. 3 is sufficiently wide to properly terminate the reactive components. The input and out-

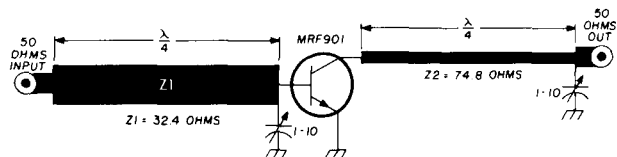


fig. 3. 1296-MHz amplifier which was designed with a simplified method. Input and output matching is provided by microstriplines and 10 pF trimmer capacitors. This amplifier is unconditionally stable and has about 0.5 dB less gain than the circuit shown in fig. 2 (bias networks are not shown).

put mismatches are determined by transforming the actual resistive components through the existing quarter-wave length transformers and comparing the resulting impedance to 50 ohms. Referring to fig. 3,

$$Z_{in}(\text{amplifier}) = \frac{Z_1^2}{R_{p\text{ in}}} = \frac{32.4^2}{15.0} = 70.0 \text{ ohms}$$

$$Z_{out}(\text{amplifier}) = \frac{Z_2^2}{R_{s\text{ out}}} = \frac{74.8^2}{62.0} = 90.2 \text{ ohms}$$

Thus, the input vswr is 1.4:1 and the output vswr is 1.8:1, calculated values which correlate quite closely with those values observed in the actual amplifiers.

These input and output mismatches will result in somewhat lower stage gain than available from a properly terminated device. Actual stage gain is found from

$$A_p(\text{dB}) = \text{MAG} + G_1 + G_2$$

where  $G_1$  and  $G_2$  are both negative and represent the mismatch losses at the input and output, respectively. Since  $G_1$  (for a 1.4:1 vswr) is about -0.1 dB, and  $G_2$  (for a 1.8:1 vswr) is about -0.4 dB,

$$\begin{aligned} A_p &= 13.2 + (-0.1) + (-0.4) \\ &= 12.7 \text{ dB} \end{aligned}$$

This closely represents the measured gain of the amplifier shown in fig. 3.

### summary

A method has been outlined for using device s-parameters to analyze the gain and stability of a microwave amplifier, and to determine appropriate source and load impedances for a complex conjugate match. It has been shown that designing around the reflection coefficients of a particular transistor (while ignoring the transfer coefficients) resulted in input and output mismatches of 1.4:1 and 1.8:1, respectively, while degrading overall amplifier gain by approximately 0.5 dB.

This is a modest penalty for enjoying the convenience of a simplistic design approach. Whether the additional performance available from the more rigorous design method is justified depends largely upon the goals of the designer, and the intended application of the amplifier.

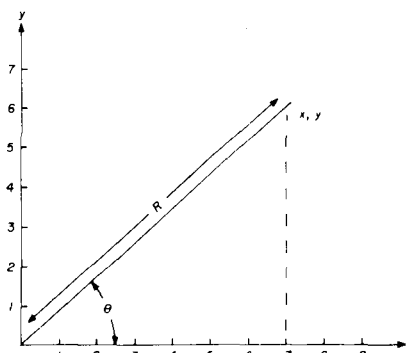
### references

1. H. Paul Shuch, WA6UAM, "Microstripline Preamplifiers for 1296 MHz," *ham radio*, April, 1975, page 12.
2. H. Paul Shuch, WA6UAM, "Low Cost 1296 MHz Preamplifiers," *ham radio*, October, 1975, page 42.
3. Kenneth Richter, "Predicting Linear Power Amplifier Performance," *Microwaves*, February, 1974, page 56.
4. K. Kurokawa, "Power Waves and the Scattering Matrix," *IEEE Transactions on Microwave Theory and Techniques*, volume MTT-13, March, 1965.
5. S-Parameter Design, Application Note 154, April, 1972. Hewlett-Packard, Palo Alto, California 94304.
6. Will Alexander, "Feed Back Strays," *Fairchild Journal of Semiconductor Progress*, May/June, 1975, page 13.
7. William J. Martin, "HP-45 Calculator Speeds RF Amplifier Design," *Electronics*, March 20, 1975, page 134.
8. H. Paul Shuch, "Series/Parallel Conversion in Reverse Polish Notation," *Microwaves*, July, 1975, page 62.

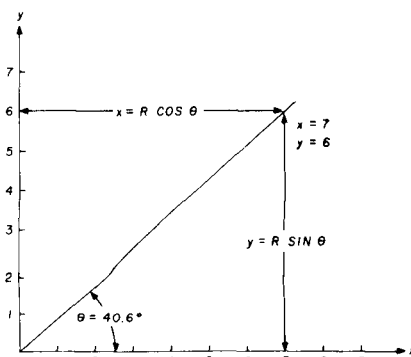
### appendix 1

#### vector arithmetic

In the application of s-parameter design equations, it's necessary to perform numerous computations involving vector quantities. Vectors may be expressed either in conventional polar notation (magnitude  $R$  and associated angle  $\theta$ ) or may be resolved into their rectangular



components ( $x$  and  $y$  displacement on Cartesian coordinates) as shown below. Since the vector is part of a right triangle, manipulation between the two forms of notation involves the application of trigonometric functions. These manipulations may be accomplished on a slide rule, manually with the aid of trig tables, or on a hand-held digital calculator.



Readers who have advanced scientific calculators which include polar-rectangular conversion and summation keys will find the process considerably simplified. The following review is for the benefit of those not so fortunate.

**1. Resolving vectors.** Vector arithmetic often requires that the  $x$  and  $y$  components of the vector be known. Any vector,  $V$ , described by magnitude,  $R$ , and angle  $\theta$ , can be resolved into its  $x$  and  $y$  components with the following formulas

$$\begin{aligned}x &= R \cos \theta \\y &= R \sin \theta\end{aligned}$$

**Example:** What are the  $x$  and  $y$  components of the vector  $9.22 \angle 40.6^\circ$  ( $R = 9.22$ ,  $\theta = 40.6^\circ$ )?

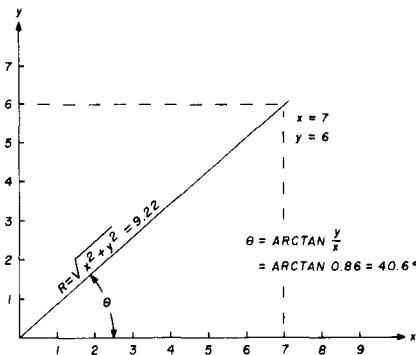
$$\begin{aligned}x &= R \cos \theta = 9.22 \cos 40.6^\circ \\&= 9.22 \cdot 0.76 = 7.00 \\y &= R \sin \theta = 9.22 \sin 40.6^\circ \\&= 9.22 \cdot 0.65 = 6.00\end{aligned}$$

**2. Constructing vectors.** The results of vector addition and subtraction (reviewed later) generally appear as  $x$  and  $y$  components of the resultant vector. These coordinates can be converted to a polar vector of magnitude,  $R$ , and angle,  $\theta$ , with measurements on a graphical plot, or by using a trigonometric solution. Since the vector is represented by the hypotenuse of a right triangle formed by dimensions  $x$  and  $y$ , the Pythagorean theorem may be used to find the magnitude  $R$ :

$$R = \sqrt{x^2 + y^2}$$

Trigonometry is used to calculate the angle  $\theta$

$$\theta = \arctan y/x$$



**Example:** What is the magnitude,  $R$ , and angle  $\theta$ , of the vector described by the Cartesian coordinates,  $x = 7$ ,  $y = 6$ ?

$$\begin{aligned}R &= \sqrt{x^2 + y^2} = \sqrt{49 + 36} \\&= \sqrt{85} = 9.22 \\ \theta &= \arctan y/x = \arctan 6/7 \\&= \arctan 0.86 = 40.6^\circ\end{aligned}$$

**3. Vector addition.** Any two vectors  $V_1$  and  $V_2$ , which have been resolved into  $x$  and  $y$  components  $V_{1x}$ ,  $V_{1y}$ ,  $V_{2x}$ , and  $V_{2y}$ , may be added by summing the respective  $x$  and  $y$  components. The summed components may then be constructed into a resultant vector  $V_t$ , of magnitude  $V_{tR}$  and angle  $V_{t\theta}$ .

**Example:** What is the sum of vectors  $V_1$  and  $V_2$  when

$$\begin{aligned}V_1 &= 1.5 \angle 40^\circ \\V_2 &= 2.0 \angle -60^\circ \\V_{1x} &= V_{1R} \cos V_{1\theta} = 1.5 \cos 40^\circ = 1.15 \\V_{1y} &= V_{1R} \sin V_{1\theta} = 1.5 \sin 40^\circ = 0.96 \\V_{2x} &= V_{2R} \cos V_{2\theta} = 2.0 \cos -60^\circ = 1.00 \\V_{2y} &= V_{2R} \sin V_{2\theta} = 2.0 \sin -60^\circ = -1.73 \\ \Sigma_x &= V_{1x} + V_{2x} = 1.15 + 1.00 = 2.15\end{aligned}$$

$$\begin{aligned}\Sigma_y &= V_{1y} + V_{2y} = 0.96 + (-1.73) = -0.77 \\V_{tR} &= \sqrt{\Sigma_x^2 + \Sigma_y^2} = \sqrt{2.15^2 + (-0.77)^2} \\&= \sqrt{5.22} = 2.28\end{aligned}$$

$$\begin{aligned}V_{t\theta} &= \arctan (\Sigma_y/\Sigma_x) = \arctan (-0.77/2.15) \\&= -19.70^\circ\end{aligned}$$

$$V_{t\theta} = V_1 + V_2 = 2.28 \angle -19.70^\circ$$

**4. Vector subtraction.** Any two vectors  $V_1$  and  $V_2$ , which have been resolved into  $x$  and  $y$  components  $V_{1x}$ ,  $V_{1y}$ ,  $V_{2x}$ , and  $V_{2y}$ , may be subtracted one from the other by subtracting their respective  $x$  and  $y$  components. The results of such subtraction comprise the  $x$  and  $y$  components of the resulting vector  $V_t$ , which may be constructed to yield magnitude  $V_{tR}$  and angle  $V_{t\theta}$ .

**Example:** What is the difference when vector  $V_2$  is subtracted from vector  $V_1$ ?

$$\begin{aligned}V_1 &= 0.8 \angle -40^\circ \\V_2 &= 0.4 \angle 120^\circ\end{aligned}$$

$$\begin{aligned}V_{1x} &= V_{1R} \cos V_{1\theta} = 0.8 \cos -40^\circ = +0.61 \\V_{1y} &= V_{1R} \sin V_{1\theta} = 0.8 \sin -40^\circ = -0.51 \\V_{2x} &= V_{2R} \cos V_{2\theta} = 0.4 \cos 120^\circ = -0.20 \\V_{2y} &= V_{2R} \sin V_{2\theta} = 0.4 \sin 120^\circ = +0.35 \\(\Sigma_x) &= V_{1x} - V_{2x} = +0.61 - (-0.20) = +0.81 \\(\Sigma_y) &= V_{1y} - V_{2y} = -0.51 - (+0.35) = -0.86\end{aligned}$$

$$\begin{aligned}V_{tR} &= \sqrt{(\Sigma_x)^2 + (\Sigma_y)^2} = \sqrt{(0.81)^2 + (-0.86)^2} \\&= \sqrt{1.40} = 1.18\end{aligned}$$

$$\begin{aligned}V_{t\theta} &= \arctan (\Sigma_y)/(\Sigma_x) = \arctan (-0.86/+0.81) \\&= -46.7^\circ\end{aligned}$$

$$V_t = V_1 - V_2 = 1.18 \angle -46.7^\circ$$

**5. Vector multiplication.** For any two vectors,  $V_1$  and  $V_2$ , each described by a magnitude,  $R$ , and an angle,  $\theta$ , the vector product is found by multiplying the the magnitudes and adding the angles:

$$\begin{aligned}V_{tR} &= V_{1R} \times V_{2R} \\V_{t\theta} &= V_{1\theta} + V_{2\theta}\end{aligned}$$

**Example:** What is the vector product of  $V_1$  and  $V_2$  when

$$\begin{aligned}V_1 &= 0.8 \angle 45^\circ \\V_2 &= 0.65 \angle -118^\circ \\V_{tR} &= V_{1R} \times V_{2R} = 0.8 \times 0.65 = 0.52 \\V_{t\theta} &= V_{1\theta} + V_{2\theta} = +45^\circ + (-118^\circ) = -73^\circ \\V_t &= V_1 \cdot V_2 = 0.52 \angle -73^\circ\end{aligned}$$

**6. Vector division.** For any two vectors,  $V_1$  and  $V_2$ , each described by a magnitude,  $R$ , and an angle,  $\theta$ , the vector quotient is found by dividing the magnitudes and subtracting the angles:

$$\begin{aligned}V_{tR} &= V_{1R} \div V_{2R} \\V_{t\theta} &= V_{1\theta} - V_{2\theta}\end{aligned}$$

**Example:** What is the vector quotient when  $V_1$  is divided by vector  $V_2$ ?

$$\begin{aligned}V_1 &= 0.96 \angle 64^\circ \\V_2 &= 0.42 \angle -102^\circ \\V_{tR} &= V_{1R} \div V_{2R} = 0.96 \div 0.42 = 2.29 \\V_{t\theta} &= V_{1\theta} - V_{2\theta} = +64^\circ - (-102^\circ) = +166^\circ \\V_t &= 2.29 \angle 166^\circ\end{aligned}$$

**7. Maximum angle.** Whenever a vector manipulation yields an expression whose angle exceeds  $\pm 180^\circ$ , subtract the absolute value of the angle from  $360^\circ$ , and assign to the resulting angle a sign opposite to that of the original angle.



Examples:  $-196^\circ = +360 - |-196|$   
 $= +360 - 196 = +164^\circ$   
 $265^\circ = -360 - |+265|$   
 $= -360 - 265 = -625^\circ$

8. **Compound expressions.** In expressions involving both vector and scalar quantities, treat the scalar quantity as though it were a vector of angle  $0^\circ$ .

**Example:** In the expression for the source reflection coefficient which will properly terminate the transistor's input (eq. 8), the product of the load reflection coefficient,  $\Gamma_{ML}$ , and  $s_{22}$  are subtracted from one. If  $(\Gamma_{ML} \cdot s_{22}) = 0.65 \angle -118^\circ$ , what is the value of the expression,  $1 - (\Gamma_{ML} \cdot s_{22})$ ?

$$V_1 = 1 \angle 0^\circ$$

$$V_2 = 0.65 \angle -118^\circ$$

$$V_{1x} = V_{1R} \cos V_{1\theta} = 1 \cos 0^\circ = 1.00$$

$$V_{1y} = V_{1R} \sin V_{1\theta} = 1 \sin 0^\circ = 0$$

$$V_{2x} = V_{2R} \cos V_{2\theta} = 0.65 \cos -118^\circ = -0.31$$

$$V_{2y} = V_{2R} \sin V_{2\theta} = 0.65 \sin -118^\circ = -0.57$$

$$\Sigma_{-x} = V_{1x} - V_{2x} = 1.00 - (-0.31) = 1.31$$

$$\Sigma_{-y} = V_{1y} - V_{2y} = 0 - (-0.57) = 0.57$$

$$V_{IR} = \sqrt{(\Sigma_{-x})^2 + (\Sigma_{-y})^2} = \sqrt{1.31^2 + 0.57^2}$$

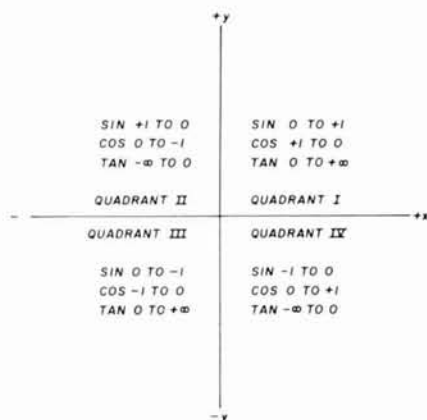
$$= \sqrt{2.04} = 1.43$$

$$V_{\theta} = \arctan(\Sigma_{-y} / \Sigma_{-x}) = \arctan(0.57 / 1.31)$$

$$= 23.51^\circ$$

$$1 - (\Gamma_{ML} \cdot s_{22}) = 1.43 \angle 23.51^\circ$$

9. **Angular functions.** Since most trigonometry tables show only the functions to  $+90^\circ$ , when working with vectors which may fall in any of the four quadrants below (0 through 360 degrees) this can lead to ambiguities in specifying the angle  $\theta$  of a resultant vector. Note that the



tangent function varies from zero to  $+\infty$ , from zero to 90 degrees, from  $-\infty$  to zero in the second quadrant (90 to 180 degrees), from zero to  $+\infty$  in the third quadrant (180 to 270 degrees), and from  $-\infty$  to zero in the fourth quadrant (270 through 360 degrees). The sine and cosine functions are also ambiguous, as shown, but this doesn't create a problem in vector arithmetic.

In the expression for the angle of the source reflection coefficient,  $\Gamma_{MS\theta}$ , in the design example  $\Gamma_{MSx} = -0.68$  and  $\Gamma_{MSy} = 0.21$ . Therefore,

$$\Gamma_{MS\theta} = \arctan -0.68 / 0.21 = \arctan 0.31$$

$$= -17.3^\circ$$

This is in the fourth quadrant whereas the x and y values place the vector in the second quadrant. Therefore, the correct value for the angle is  $180^\circ + (-17.3^\circ) = 162.7^\circ$ . The same sort of ambiguity exists for the first and third quadrants, and can only be resolved by inspection.

ham radio

State  
of  
the  
art



by  
K.V.G.

## CRYSTAL FILTERS and DISCRIMINATORS

### 9.0 MHz FILTERS

XF9-A	2.5 kHz	SSB TX	\$31.95
XF9-B	2.4 kHz	SSB RX	\$45.45
XF9-C	3.75 kHz	AM	\$48.95
XF9-D	5.0 kHz	AM	\$48.95
XF9-E	12.0 kHz	NBFM	\$48.95
XF9-M	0.5 kHz	CW	\$34.25
XF9-NB	0.5 kHz	CW	\$63.95

Export  
Inquiries  
Invited

### 9.0 MHz CRYSTALS (Hc25/u)

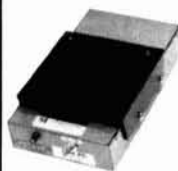
XF900	9000.0 kHz	Carrier	\$3.80
XF901	8998.5 kHz	USB	\$3.80
XF902	9001.5 kHz	LSB	\$3.80
XF903	8999.0 kHz	BFO	\$3.80
F-05	Hc25/u	Socket	.50

Shipping  
\$1.25  
per filter

### 9.0 MHz DISCRIMINATORS

XD9-01	$\pm 5$ kHz	RTTY	\$24.10
XD9-02	$\pm 10$ kHz	NBFM	\$24.10
XD9-03	$\pm 12$ kHz	NBFM	\$24.10

## 146 MHz ↔ 440 MHz FM TRANSVERTER



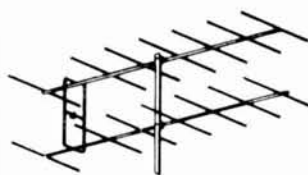
Use your 2 meter Transceiver on the 440 MHz band with addition of the FMt440 TRANSVERTER. No changes needed to your 2 meter transceiver. Connect FMt440 in place of regular 2 meter antenna. Switch selected band changeover. Write for application note.

FMt440 Specifications:	
2 meter Drive Power	25 W max
440 MHz Sensitivity	0.5 $\mu$ Volt
Frequency Ranges	144 - 150 MHz 430 - 450 MHz

Price: \$179.95 Repeater Groups write for terms  
Shipping \$3.50 Application Note available free

## ANTENNAS

### 144-148 MHz



8 over 8 J-Beam, Horizontal polar.  
Gain +12.6 dBd. Feed 50 coaxial.  
Model DB/2M \$39.95  
Vertical polar mounting kit (for  
long range repeater access) \$9.80



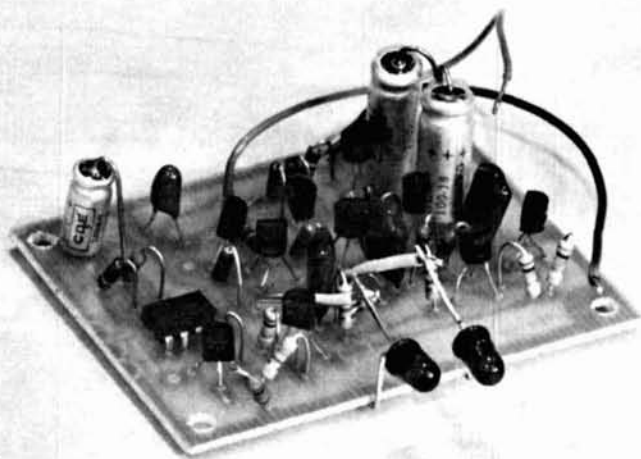
### 420-450 MHz

48 element J-Beam MULTIBEAM  
Gain +15.7 dBd. Feed 50 coaxial.  
Model 70/MBM48 \$49.95

Shipping: Antennas FOB Concord, Mass. via UPS.  
Write direct for Polar plots, Gain & VSWR curves.

si

Spectrum  
International, Inc.  
Post Office Box 1084  
Concord, Mass. 01742, USA



# two-channel scanner for repeater monitoring

Simple modifications to  
WA2GCF's  
popular channel scanner  
for use with the  
Icom IC-2F and  
other vhf-fm transceivers

The two-channel scanner described in this article was never really designed — it evolved. I wanted a simple scanner to monitor two repeaters, using a small solid-state transceiver. The simplest circuit I found was one described by WA2GCF in an article in *ham radio*.<sup>1</sup> The unit proved to have all the advantages the author claimed; it was inexpensive, small, easy to assemble, and operates directly from the 13-volt transceiver power supply or an auto battery. Only minor modifications

were necessary to monitor the two club repeaters with my Icom IC-2F.

The first problem was how to use diode switching with the IC-2F receiver oscillator. WA2GCF described circuitry for switching crystals in oscillators requiring +5 volts to turn on, and oscillators requiring a ground for turn-on. Both are designed for circuits where one side of the crystal is grounded. The IC-2F, however, like many other Japanese receivers, has a receiver oscillator in which the crystal is connected between the collector and base of the oscillator transistor (fig. 1A). Neither side of the crystal can be grounded. At first it appeared it would be necessary to redesign the oscillator circuit, but the switching circuit modification shown in fig. 1B, which required rewiring only the switch, proved useable.

## squelch recognition

Scanning action is stopped when a carrier opens the receiver squelch. The original scanner could be stopped by a squelch circuit that goes to ground when an incoming signal is received, or with alternate wiring by a squelch circuit that is at ground potential when the squelch is closed and goes high when it is opened. Unfortunately, the IC-2F does neither. Its squelch circuit is high when the squelch is closed, and goes to a lower voltage when it opens, but not all the way to ground. The scanner stopped for strong signals but not for ones that were weak but still quite readable.

The original circuit used to stop the scanner multi-vibrator is modified by changing Q1 to a pnp transistor with its emitter connected to the positive supply voltage, and adding an npn transistor, Q1A, to control it as

By Pat Shreve, W8GRG, 2842 Winthrop Road, Shaker Heights, Ohio 44120

shown in fig. 2. The base of Q1A is biased so that it will be turned off when the squelch circuit connected to its emitter is high; it is turned on by a voltage less than the bias but still above ground potential, which occurs when

many club members want to do. If the repeater carrier does not drop between users' transmissions, the scanner locks on that repeater and will stay there for the entire conversation. Without a periodic search-back feature

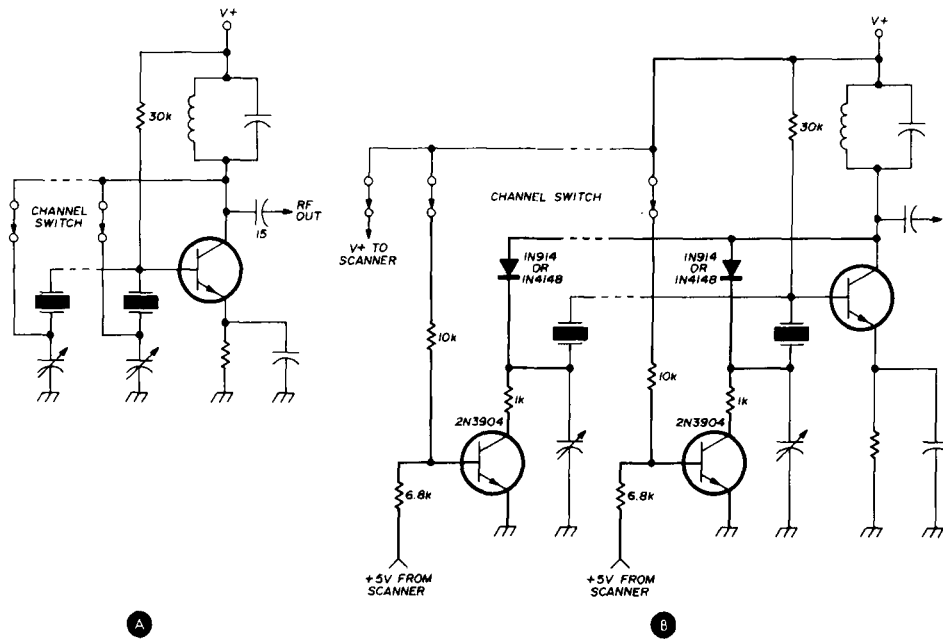


fig. 1. IC-2F receiver oscillator circuit. (A). As originally wired. (B). Modified for diode switching. Heavy lines show wiring changes.

the squelch opens. When Q1A is off, Q1 and Q2 are also off, and the multivibrator can oscillate. When the three transistors turn on, the multivibrator is locked and scanning action stops.

The scanner still had one disadvantage for monitoring our two repeaters, which all our control operators and

there is no way for the listener to know what may be happening on the other repeater.

To prevent lock-up on any channel for long periods a lock release, rather than a priority channel circuit, is needed. This can be done by adding a timer to the squelch recognition circuit described above. Instead of

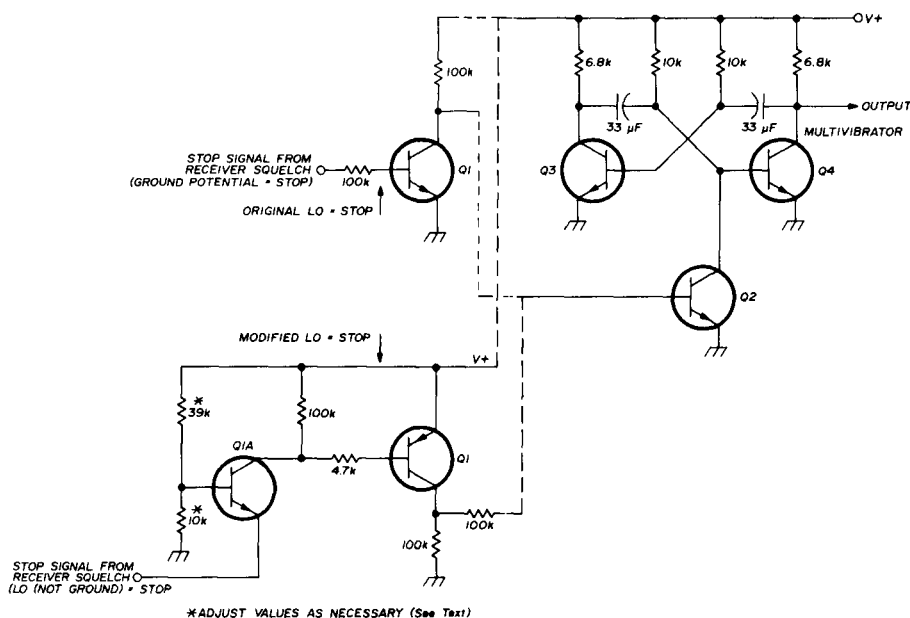


fig. 2. Multivibrator circuit modification to stop scanning action with low but above-ground stop signal.



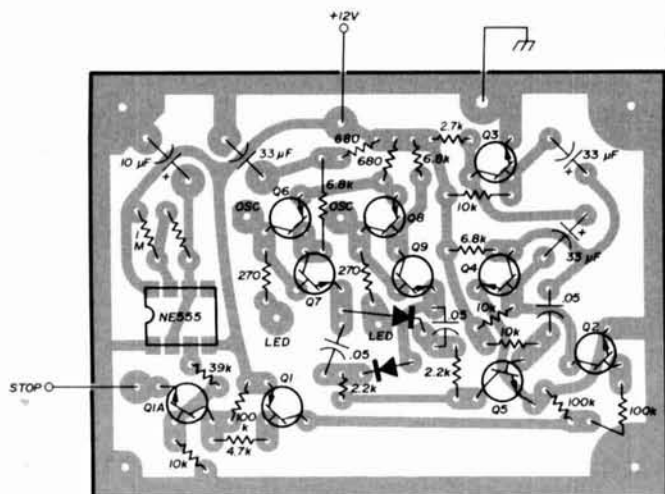


fig. 5. Printed-circuit component layout for the scanner viewed from the component side of board. Circles indicate external connections.

the start of scanning action. With the scan rate provided by the multivibrator circuit components shown in fig. 3, and the NE555 timing values, the scanner should stop every time it senses an active frequency.

#### adjustment

The scan rate can be varied by changing the values of the multivibrator capacitors. The length of time the scanner will stay locked on a single frequency can be

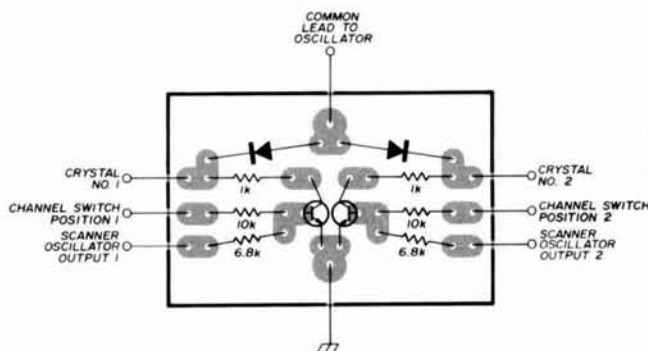


fig. 6. Printed-circuit component layout for oscillator switching circuit shown in fig. 1B.

changed by replacing the 1-megohm NE555 charging resistor with a different value. If these timing components are changed, it may be necessary to change the value of the 47k discharge resistor, also, to limit the multivibrator to only one cycle each time the NE555 output goes low. Excessive low time will cause the scanner to miss a signal on the next channel.

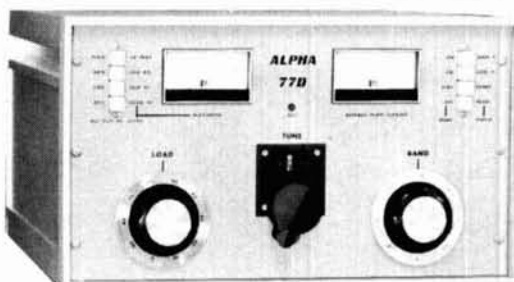
#### reference

1. Jerry Vogt, WA2GCF, "Improved Channel Scanner for VHF FM," *ham radio*, November, 1974, page 26.

ham radio

# GREAT PUNCH LINE

Any ALPHA Linear Will Give Your Signal Maximum Legal Power "Punch" . . .



### The Ultimate – ALPHA 77D

- Ultra-conservative, super-rugged design
  - 1.8 through 30 MHz
  - 8877 Eimac Triode
  - Full QSK break-in
  - Vacuum tuning and T/R
  - Whisper quiet
  - Full year warranty
- \$2995 amateur net.

So Just Choose The Model Best Suited . . .



### No-Tune-Up – ALPHA 374

- Bandpass or manual tuning 10-80 meters
  - Maximum legal power continuous duty all modes
  - Three Eimac 8874's
  - Proven dependability
  - Full year warranty
- Immediate delivery at \$1395.

To YOUR Operating Interests And Budget!



### Practically Perfect – ALPHA 76

- 2+ Kilowatts SSB PEP
  - Full KW CW/FSK/SSTV
  - 10-160M Standard
  - Two EIMAC 8874's
  - Fully self-contained
  - Full year warranty
- Now available for prompt factory delivery at a practical \$895.00



EHRHORN TECHNOLOGICAL  
OPERATIONS, INC.  
BROOKSVILLE, FLORIDA 33512  
(904) 796-1428

# how to improve receiver performance of vacuum-tube vhf-fm equipment

Simple circuit modification  
for replacing 6AK5 receiver  
rf amplifier stages  
with a low noise,  
dual-gate, mosfet

Vhf fm operation is becoming increasingly popular with radio amateurs, with tens of thousands of fm transmitters and receivers now in use, and more being put into service daily. Not an insignificant number of these rigs are converted from commercial service — equipment that was originally manufactured by firms such as Motorola, RCA, and GE. However, most of the older receivers use vacuum-tube front ends so they don't provide the sensitivity that is possible with modern solid-state devices. This article describes a simple, proven mosfet circuit that can be easily substituted for those noisy tube-type front ends.

The most popular receiver rf amplifier used by communications equipment designers back in the late 1950s and early 1960s was based on the 6AK5 pentode — a workhorse used heavily during the war in vhf radar and communications systems. Typical receiver sensitivities provided by this tube are on the order of 1.5 to 3.0 microvolts for 20 dB quieting. Considering the state of the art for those days, that was not shabby performance.

In recent years the communications designer has been provided with a proliferation of very reasonably priced, high performance, dual-gate mosfet devices from several different manufacturers. One example is the 3N204 by Texas Instruments which has optimum spot noise figures of 2 dB at 200 MHz, 3 dB at 400 MHz, degrading to 7 dB at 900 MHz, all for \$1.25 in small quantities. Anyone who has worked with a 417A/5842 vacuum-tube converter from the 1950s can certainly appreciate how rapidly technology has marched forward during the past two decades.

By **Hank Meyer, W6GGV**, 29330 Whitley Collins Drive, Rancho Palos Verdes, California 90274

It's a relatively simple task to replace the 6AK5 rf amplifier in your present rig with a 3N204 or other dual-gate device. Fig. 1 shows the circuit of a typical 6AK5 rf amplifier stage found in many commercial rigs, while fig. 2 shows the base diagram of the 6AK5. The following steps describe the circuit modification, which can be accomplished in less than an hour.

1. Remove the center pin from the 6AK5 tube socket by bending it over and breaking it with a pair of pliers. Cut any wires which are soldered to the center grounding pin.

2. Install a 33k, 1/2-watt resistor from pin 6 to ground. If there is already another resistor from pin 6 to ground,

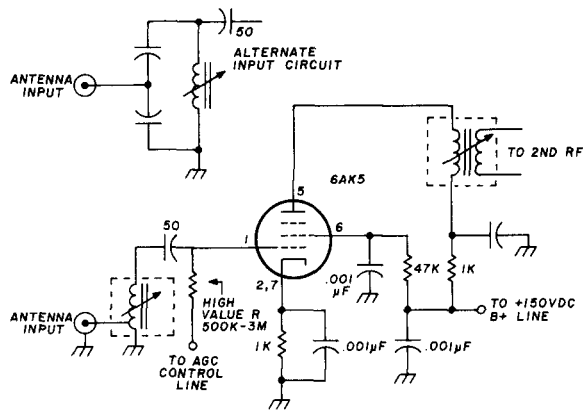


fig. 1. Typical 6AK5 receiver rf amplifier stage found in many older commercial vhf-fm rigs. Performance of this circuit is typically 1.5 to 3.0 microvolts for 20 dB quieting. Replacing the 6AK5 with a vhf dual-gate mosfet, as described here, increases sensitivity to 0.25 to 0.30 microvolt for 20 dB quieting.

remove it. Make sure that there is a 0.001  $\mu\text{F}$  disc bypass capacitor between pin 6 and ground.

3. Remove the original resistor from the B+ line to pin 6 and replace it with a 120k, 1/2-watt resistor.

4. Remove the voltage-dropping resistor(s) from the B+ line to the B+ point on the 6AK5 rf amplifier plate output coil and replace it with a 300-ohm, 1/2-watt resistor.

5. Break the B+ line from the high-voltage feedpoint to the 6AK5. Now install a 3-lug terminal strip (two insulated lugs, one grounded lug) by soldering the ground lug to a convenient point on the chassis. Install a 6.8k, 2-watt resistor between the two insulated tie points and connect one end of the resistor to the previously removed B+ line. Connect an 18-volt zener diode (400 mW to 1 watt rating) from the other end of the 6.8k resistor to ground. From this same point connect a wire to the former B+ feedpoint for the 6AK5.

6. Insert the 3N204 mosfet into the center hole of the 6AK5 tube socket.

7. Using the 3N204 basing diagram in fig. 3, make the

following connections to the 6AK5 tube socket:

- Drain to pin 5
- Source to ground (pin 3 or 4)
- Gate 1 to pin 1
- Gate 2 to pin 6

8. Disconnect the antenna input lead and reconnect it to the top of the rf input coil as shown in fig. 3.

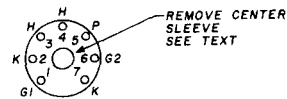


fig. 2. Base diagram (bottom view) of the 6AK5 tube socket.

9. Using a signal generator or on-the-air signal, repeat the tuned input and output circuits for maximum output.

10. Remove the 6-volt filament wiring from the socket, but before you do, check to see if two or more tubes are wired in series. If they are, install a 36-ohm, 2-watt resistor in series with the filament line to compensate for the current drain of the 6AK5 filament. This completes the conversion.

I have converted several 6AK5 rf amplifier stages to dual-gate mosfets using this simple procedure, and all have provided outstanding results. Sensitivity measurements using a Hewlett-Packard 608D signal generator indicate a sensitivity of about 0.25 to 0.30 microvolts for 20 dB quieting — a marked improvement in performance.

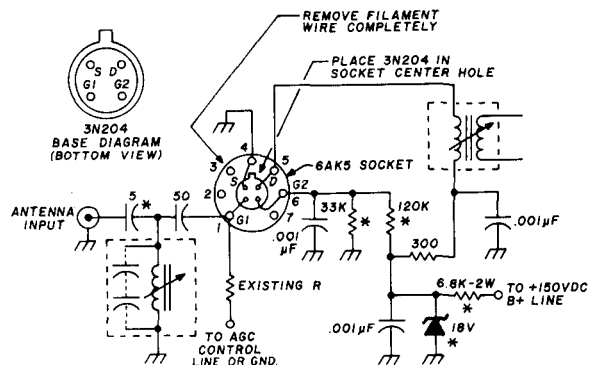


fig. 3. Modified receiver rf amplifier using a 3N204 dual-gate mosfet. Components marked with an asterisk are new.

In addition to the 3N204 I have tried several other, similar dual-gate devices, including the 3N201 and 3N200, all with good success. All of these devices are in the same price class, although the 3N204 has a bit better performance. If you're using an older tube-type commercial rig, this simple modification can significantly extend your receiving range and operating pleasure.

ham radio

# RC active filters

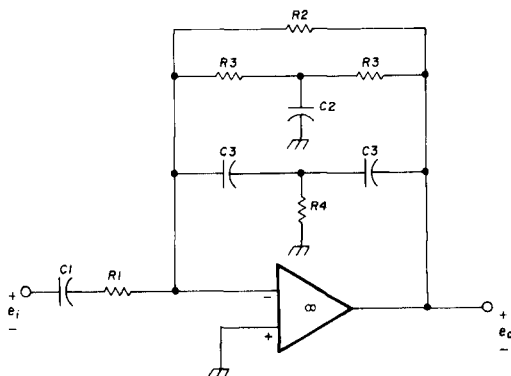
## using op amps

An overview of three of the most popular filter circuits,

A narrow bandpass filter of small size and low power consumption is often needed for increased receiver selectivity or other communications applications, such as RTTY. Active filters are also presently found in IC form for applications in modems, function generators, and level detectors.<sup>1</sup> This article presents information that has been omitted from the many articles on the subject in the amateur literature. Three of the most popular RC active filters are described together with their design equations and response characteristics. Also included is a discussion of breadboard testing and results of filter performance both singly and in cascaded form.

### choice of circuit

The parallel-T network is a popular narrowband filter, which is used in the feedback loop of an op amp in various ways. In this case the network was inserted between the inverting input and op-amp output: In this



arrangement R1, C1 form part of the network, allowing a symmetrical response about center frequency. This added input network increases the lower-frequency skirt selectivity, which otherwise would not fall off as fast as the upper-frequency skirt characteristic. The frequency-response equation including phase relationships is:

$$\frac{e_o}{e_i}(\omega) = \left\{ \frac{1}{R1 + \frac{1}{j\omega C1}} \right\} \left\{ \frac{R2[2 + j\omega C2R3]}{\left[1 - \omega^2 \left(\frac{C2R3}{2}\right)^2\right] \frac{R2}{R3} + [2 + j\omega C2R3]} \right\}$$

The response equation remains in this form since it becomes rather cumbersome to deal with if expanded further. The design equations for the filter are:

$$f_o = \frac{1}{\pi C2R3} \sqrt{1 + \frac{2R3}{R2}} \approx \frac{1}{\pi C2R3} \quad (2)$$

$$C1 = \frac{\alpha}{2\pi f_o R1} \quad (3)$$

where  $\alpha = \sqrt{2}$

$$R2 = R1 = \frac{1}{2R3(\pi f_o C2)^2} \quad (4)$$

for  $\frac{e_o}{e_i} = 1$

$$R3 = 2R4 \quad (5)$$

Typical values chosen for this filter were:

R1 39,000 ohms	R4 1727 ohms	C3 0.05 $\mu$ F
R2 39,000 ohms	C1 0.006 $\mu$ F	$f_o$ 1000 Hz
R3 3454 ohms	C2 0.1 $\mu$ F	3-dB BW,
Q 14 (four stages); shape factor 13		(four Stages
		71 Hz)

The Q can be made very high if desired, but the skirt

By Fred M. Griffiee, W4IYB, 8809 Stark Road, Annandale, Virginia 22003



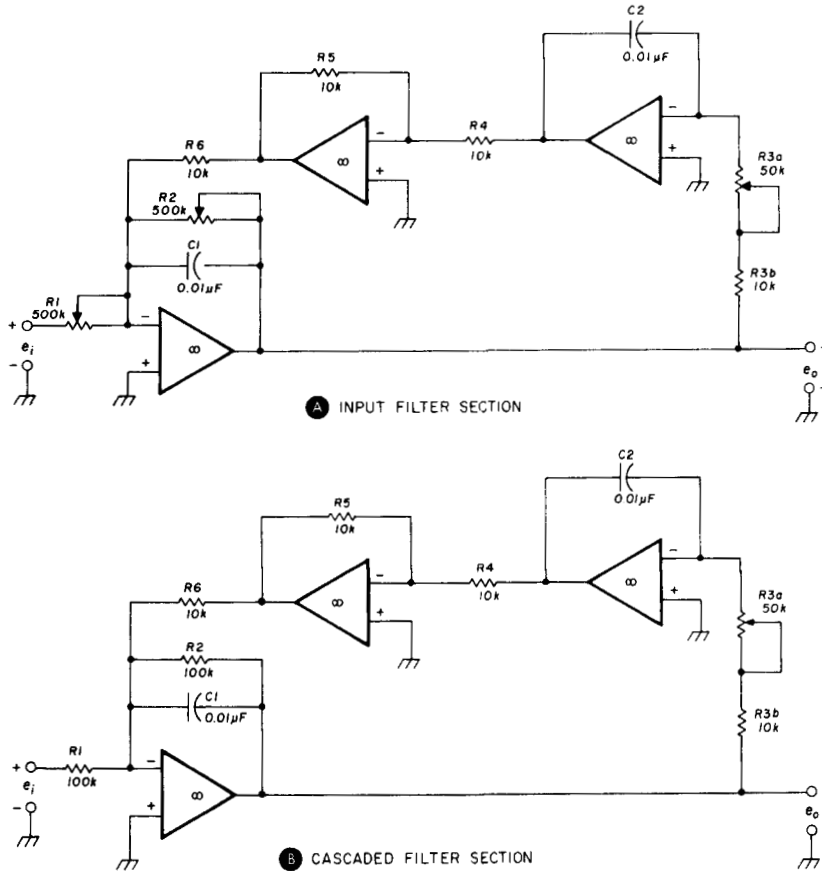
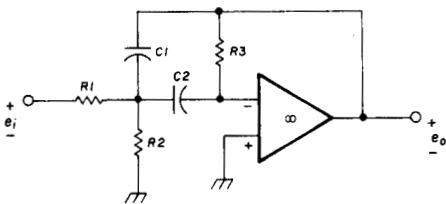


fig. 1. Input bandpass filter section, A, and cascaded sections, B, used for analysis. The rationale for component values is discussed in the text.

selectivity or bandpass-filter shape factor with only one stage remains poor. With three or four stages, the skirt selectivity and shape factor become fairly good for a narrow-bandpass audio filter; however, the component tolerance sensitivity is high.

Another circuit employing feedback in a slightly different manner (the same approach used by the popular MFJ-CWF2 filter<sup>2</sup>) to acquire the bandpass characteristic is given below (for one stage):



The response and design equations can be derived in the usual manner as in the previous case using flow-graph analysis. They are given below for reference:

$$\frac{e_o}{e_i}(\omega) = -\frac{j\omega[1/R1C1]}{\left[\frac{R1+R2}{R1R2R3C1C2} - \omega^2\right] + j\omega\left[\frac{C1/C2+1}{R3C1}\right]} \quad (6)$$

R1 975,000 ohms  
R2 13,165 ohms  
R3 1.95 megohms  
Shape factor 13

C1 0.001 µF  
C2 0.001 µF

$f_o$  1000 Hz  
3-dB BW 71 Hz  
Q = 14

$$f_o = \frac{1}{2\pi \sqrt{\frac{R1+R2}{R1R2R3C1C2}}} \quad (7)$$

$$\frac{e_o}{e_i}(\omega_o) = -\frac{R3}{2R1} \quad (8)$$

$$R1 = \frac{1}{2}f_o C, \text{ where } C = C1 = C2$$

$$R3 = \alpha f_o C$$

$$R2 = 1/(2\pi)^2 f_o C \alpha$$

$$Q \approx \pi \alpha, \text{ letting } \alpha = \sqrt{2}$$

Again, this filter will not have good skirt selectivity and cascaded stages must be used to obtain a good shape factor. Otherwise, regardless of Q, signals will still be heard with respect to sideband frequencies far removed from the center frequency,  $f_o$ . Values chosen from the design equations for this filter are given below for four stages:

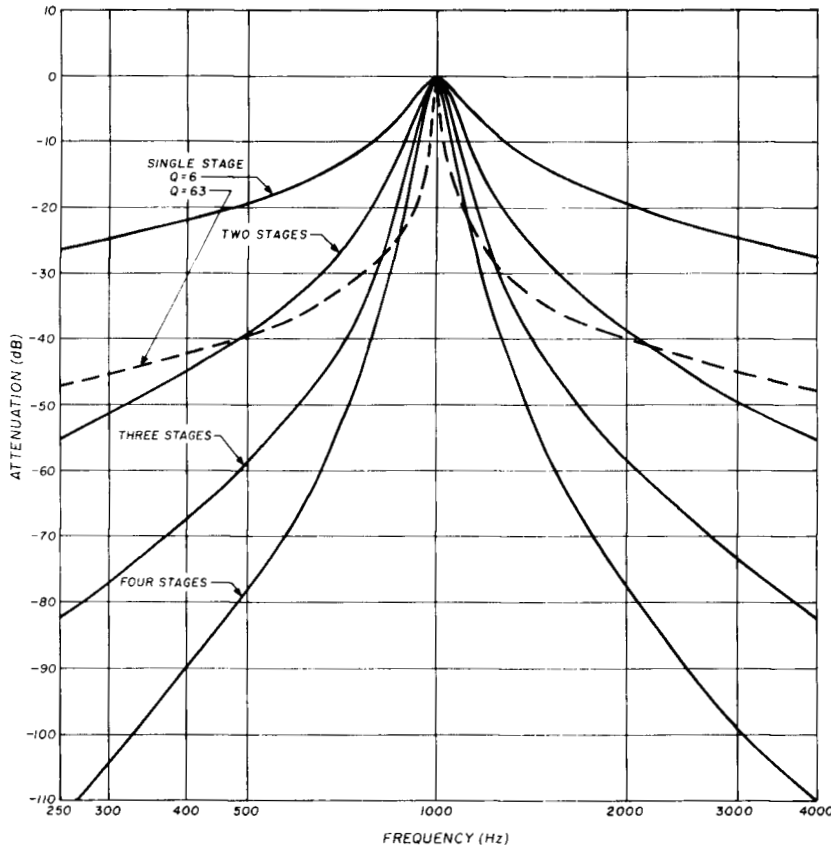


fig. 2. Response characteristics of single and cascaded filter sections. Cascading offers a more practical approach for R1 and R2 values, which are used to vary filter gain and Q (see fig. 1).

Still another circuit that is probably a little more complex is shown in fig. 1. The response and design equations for this filter are:

$$\frac{e_o}{e_i}(\omega) = - \frac{j\omega[1/R1C1]}{\left[ \frac{1}{R3R6C1C2} \left( \frac{R5}{R4} \right) - \omega^2 \right] + j\omega[1/R2C1]}$$

$$f_o = \frac{1}{2\pi} \sqrt{\left( \frac{1}{R3R6C1C2} \right) \cdot \left( \frac{R5}{R4} \right)}$$

$$\frac{e_o}{e_i}(\omega_o) = - \frac{R2}{R1} \quad (9)$$

Choose  $C1 = C2$   
 $R4 = R5$   
 $R3 = R6$

$$Q = 2\pi f_o C1 R2$$

Typical component values chosen for this circuit were:

R1 98,000 ohms	R4 10,000 ohms	C1 0.01 $\mu$ F
R2 98,000 ohms	R5 10,000 ohms	C2 0.01 $\mu$ F
R3 15,915 ohms	R6 15,915 ohms	$f_o$ 01000 Hz

3-dB BW 71 Hz (four stages); shape factor 13  
 (See fig. 1 for final values).

The values for R1, R2, R3 were made variable for the first stage, while a potentiometer was used in the follow-

ing stages for R3. (See fig. 1.) R1 varies the overall filter gain, R2 the Q, and R3 tunes each stage to the same desired center frequency. A value of 50k was more than adequate to cover the tolerance variations and range of interest. The variable pots, R1 and R2, were 500k maximum for the input stage. The remaining stages included the values given above except for R3, which was chosen to be 50k in series with a 10k resistor.

This approach shows no improvement in skirt selectivity over the others and, in the same manner, requires cascaded stages or building blocks as they are sometimes called.<sup>3</sup> However, this circuit has the advantage of not being so component-tolerance sensitive. In fact, the Q can be varied without affecting the gain or center frequency by varying R2; the gain can be varied independently by varying R1; and the center frequency can be varied independently by varying R6 or R3. The filter can be easily tuned using components with 10-percent tolerance. Also, you can adjust the tone or output level without varying other filter parameters, such as frequency or Q.

This completes the basic description of the three more popular bandpass filter circuits. The following discussion addresses the breadboard testing of each circuit, with a final filter design using the circuit having independent characteristic control.

### filter-circuit breadboards

The parallel-T network was evaluated first. The feed-

back network using a parallel-T network was very sensitive to component variation. The measured filter characteristics agreed with theoretical results, using a programmable hand calculator, almost to the point where one would be satisfied without evaluating a breadboard circuit (if 1-percent or better component tolerances were used).

The second circuit evaluated was that used in the popular MWJ-CWF2, which uses matched components for each section — difficult to implement unless you have an impedance bridge. The measured results again agreed with theoretically derived results when 1-percent component tolerances were used.

When reviewing the references on this subject, I found that all attained the same success between theoretical and measured results at audio frequencies when using close tolerance values.<sup>4</sup> As in the parallel-T circuit, the second circuit was sensitive to component-value variation and only slight improvement was obtained regarding characteristic control.

The third circuit was by far the most superior in terms of varying filter characteristics independently of each other. Again, theoretical results agreed with measured results after tuning each stage to the desired center frequency. In all cases, the measured results departed from those of the theoretical case only when the operational amplifier characteristics no longer were allowed to assume a very high input impedance, a near-zero output impedance (power limited of course), and a very high open-loop gain (with respect to the  $Q$  and skirt selectivity plus stage-to-stage isolation).

### construction and cost

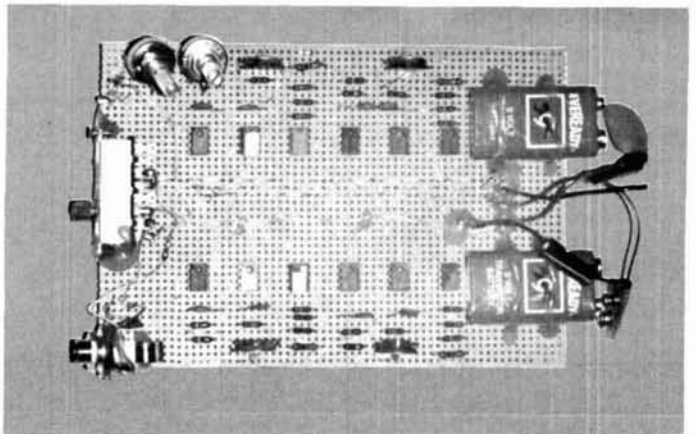
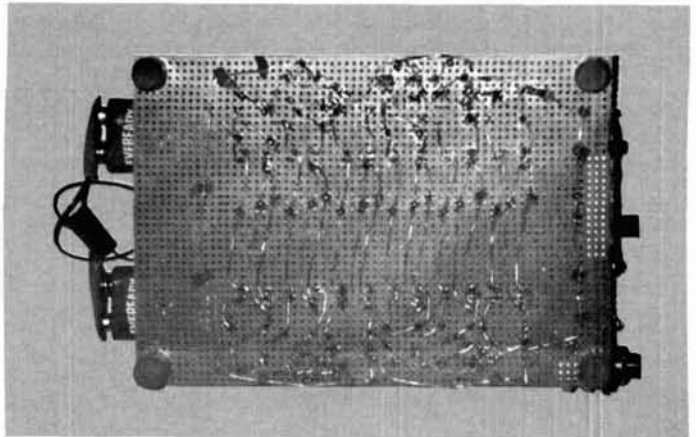
Cost was kept to a minimum by using available barrel-kit components. In this case, 14 good  $\mu 741$  ICs were found among fifty purchased, for a little less than two dollars. The quad operational amplifier, LM324, although a little more expensive, provided a much neater layout and also showed a slightly higher open-loop gain at 1000 Hz, where the  $\mu 741$  drops of quite a bit.

Construction and layout were arranged so that either the quad operational amplifier chips or the single  $\mu 741$  could be evaluated. The photos show top and bottom component layout. Printed circuit boards could have been used, but construction time and cost would have increased. Batteries were used; however, a separate power supply might be more desirable. The filter draws only about 17 mA.

### concluding remarks

Fig. 2 illustrates the response characteristics as the stages are cascaded. At first I thought that one stage with a higher  $Q$  would suffice (the dashed curve shows the response characteristic of a single stage with a  $Q$  of 63). This arrangement didn't provide the desired skirt attenuation for rejecting strong signals close to center frequency, so additional stages were cascaded to improve the shape factor (60-dB bandwidth divided by the 3-dB bandwidth).

Cascading stages offered more practical and less component-sensitive values for  $R1$  and  $R2$ . An im-



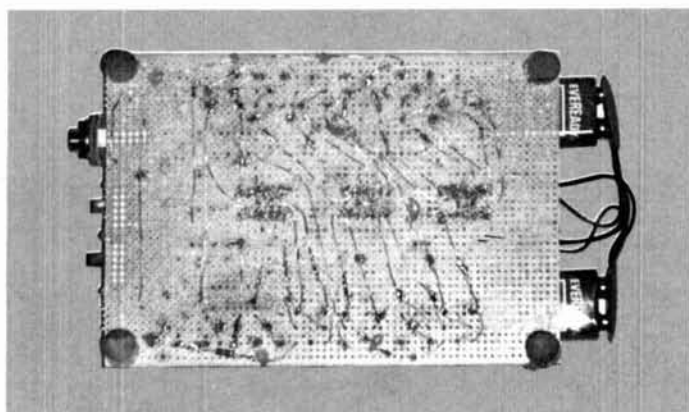
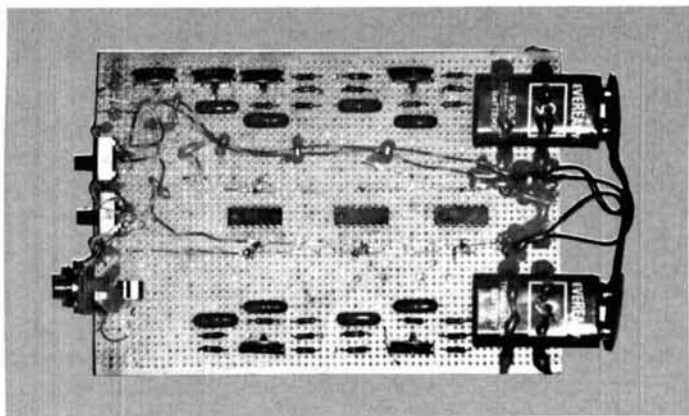
Top and bottom (above and below) of the Vector board construction used for the experimental active bandpass filter using a single  $\mu 741$  op amp.

portant observation noted from the response curves is that only one stage needs a variable pot for varying  $Q$ , at least within the ranges normally desired. If a greater  $Q$  range is desired, pots can be used in all four sections.

The more practical approach for wide  $Q$  variation is to use a four-stage pot with a common shaft coupling. Similarly, the frequency adjustment requires only one pot per stage unless a wide frequency range is desired. Normally  $R5$  is chosen to equal  $R4$ ;  $C1$  to equal  $C2$ ; and  $R3$  to equal  $R6$  for maximum dynamic range. However, varying only one of the resistors,  $R3$  or  $R6$ , seems to allow ample dynamic range, especially if the filter is installed immediately after the detector in a receiver. A center frequency between 700 and 1500 Hz is usually chosen.

It will also be noted from fig. 2 that the response is not affected nearly as much near the center frequency when cascading stages as it is far removed from the center frequency. This further illustrates the need for cascading stages to obtain the desired skirt selectivity.

The two circuits shown in fig. 1 illustrate the input stage, A, which includes the pots for  $Q$  and gain adjustment and the following additional cascaded stages, B, each of which uses a pot for tuning to center frequency. The op amps, with their near-infinite input impedance



The experimental quad op amp active bandpass filter showing component layout, above, and wiring, below, using Vector board construction for flexibility and low cost.

## ten commandments for technicians

**I** Beware the lightning that lurketh in the undischarged capacitor, lest it cause thee to bounce upon thy buttocks in a most untechnician-like manner.

**II** Cause thou the switch that supplieth large quantities of juice to be opened and thusly tagged, that thy days in this earthly veil of tears may be long.

**III** Prove to thyself that all circuits that radiateth and upon which thou worketh are grounded and thusly tagged lest they lift thee to radio frequency potential and causeth thee also to make like a radiator.

**IV** Tarry not amongst those fools who engageth in intentional shocks for they are surely nonbelievers and are not long for this world.

**V** Take care that thou useth the proper method when thou takest the measure of a high-voltage circuit lest thou incinerate both thyself and thy meter, for verily, though thou hast no account number and can easily be surveyed, the test meter doth have one and, as a consequence, bringeth much woe unto the supply department.

and near-zero output impedance, provided excellent isolation between filter stages in the feedback loop. In this case, the noninverting inputs were connected to ground along with the center common point of the two bias sources of plus and minus 9 volts.

Very weak signals could be pulled out of the noise by increasing the first-stage filter gain and  $Q$ . The filter exhibits an increase in weak-signal level when the gain and  $Q$  are adjusted carefully by presenting energy near the center frequency of the filter, which causes it to ring slightly. Filter ringing increases the desired signal output level and provides an apparent signal-processing gain, which strengthens the lower signal voltage levels. This does not mean that energy is created, but that energy is added to the amount detected.

It was not the intent of this article to describe each filter in great detail but rather to present an introduction and the supporting design equations. Many other configurations are possible, but I feel that those discussed here are of primary interest. At any rate, you can use the design equations for your own audio bandpass filter and tailor it to your requirements.

### references

1. G.S. Moschytz, *Linear Integrated Networks Design*, Bell Laboratories Series, Van Nostrand Reinhold, New York, 1975.
2. J.G. Graeme, G.E. Tobey, and L.P. Huelsman, *Operational Amplifier Design and Applications*, 1973 Burr-Brown Electronic Series, McGraw-Hill, New York.
3. P.E. Fleischer and J. Tow, "Design Formulas for Biquad Active Filters Using Three Operational Amplifiers," *Proceedings of the IEEE* (letter), May, 1973, page 662.
4. S.K. Mitra, *Active Inductorless Filters*, IEEE Press, New York, 1971, page 105.

ham radio

**VI** Take care that thou tampereth not with safety devices and interlocks, for this incurreth the wrath of thy supervisor and bringeth the fury of thy safety inspector down upon thy head.

**VII** Work thou not on energized equipment, for if thou dost, thy fellow workers will surely buy beers for thy widow and console her in other ways.

**VIII** Service thou not equipment for electrical cooking. It is a slothful process and thou might sizzle in thine own fat for hours upon a hot circuit before thy Maker sees fit to end thy misery.

**IX** Trifle thou not with radioactive tubes and substances lest thou commence to glow in the dark like a lightning bug and thy wife have no further use for thee except thy wages.

**X** Thou shalt not make unauthorized modifications to equipment, but causeth thou to record all field changes and authorized modifications made by thee, lest thy successor tear his hair out and go slowly mad in his attempt to decide what manner of creature hath made a nest in the wiring of such equipment.

Reprinted with permission from *Newcastle*, publication of the U.S. Army Engineer District, Los Angeles Corps of Engineers.

# The Drake SSR-1

provides real

# PORTABILITY and VERSATILITY

in a  
general coverage  
SW receiver ...

**Compare these features  
with any other general  
coverage SW receiver:**

- Complete general coverage operation from 500 kHz to 30 MHz with synthesizer circuitry. No range crystals to buy. Dial calibration accuracy within 5 kHz at all frequencies
- Built-in telescoping antenna with provision for external antenna.
- Built-in ac power supply. Provision for internal "D" cell batteries in built-in battery holder. Receiver automatically switches to batteries if ac power fails.
- Product detector for ssb/cw reception.
- Clarifier for extra fine ssb/cw tuning.
- 100% solid state. Dc power cord available for external 12V dc operation from auto or boat.



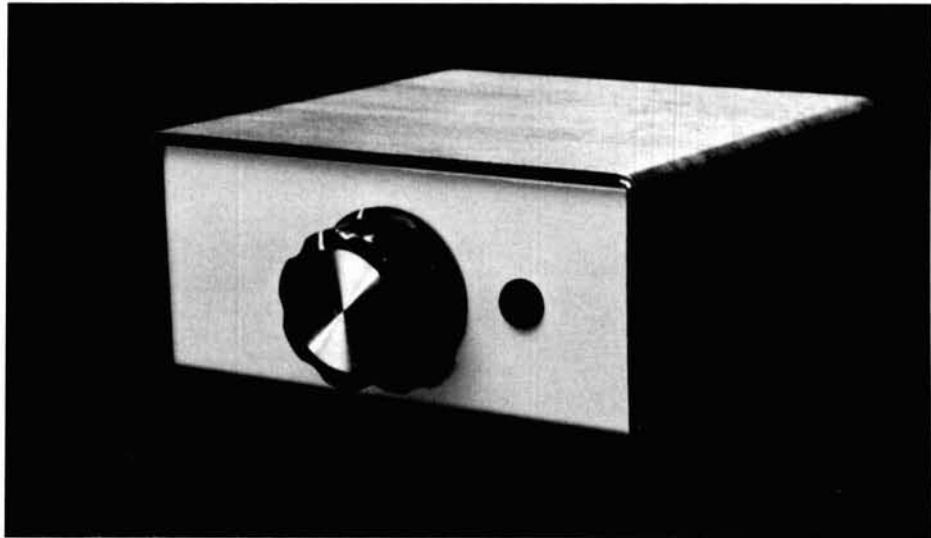
*For more information on this and other  
fine Drake products, please contact:*

**R. L. DRAKE COMPANY**



540 Richard Street, Miamisburg, Ohio 45342 • Phone (513) 866-2421 • Telex 288-017

- Built-in loud speaker. Drake HS-1 cushioned, impedance-matched headphones also now available for SSR-1
- Small size: 13" wide, 11" deep, 5.5" high (33 x 28 x 14 cm). Weight 14 lbs (6.4 kg).



## wideband preamp

Construction details  
for a low noise,  
wideband receiver preamp  
that covers the  
frequency range from  
1000 kHz to 50 MHz

Here's an effective yet inexpensive wideband preamp that covers the amateur high-frequency bands. Use it to soup up old receivers of the pre-1970 era or improve performance of more modern equipment. The circuit is easy to build, requires no exotic parts, and should go together in one or two evenings. Total parts cost is less than ten dollars.

The circuit (fig. 1) features a 2N5109 npn silicon high-frequency transistor, which is used in CATV amplifiers requiring low cross-modulation distortion and low-noise input. The 2N5109 has a 3-dB noise figure at 200 MHz, current gain-bandwidth product of 1200 MHz, cross-modulation distortion of -70dB, and collector-emitter amplifier voltage gain of 11 dB (50-216 MHz). It sells for about \$3.00 in small quantities. A PC-board layout is shown in fig. 2.

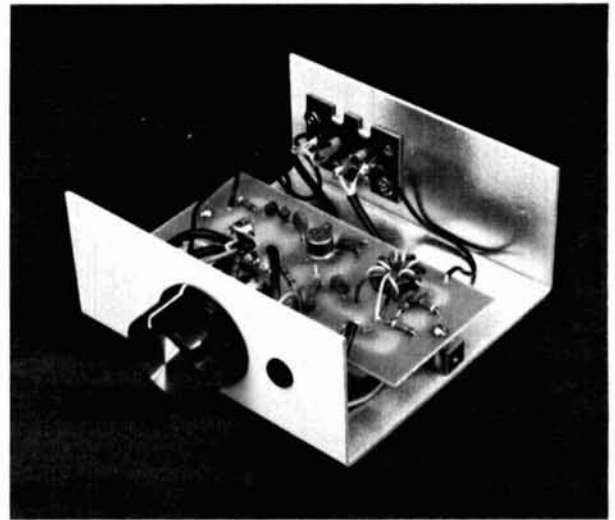
While the circuit was intended to be used in the frequency range from 1 to 50 MHz, the 2N5109 is a hot

By Ed Pacyna, W1AAZ, Danbury Circle, Amherst, New Hampshire 03031

performer well into the vhf range. However, the coupling and bypass capacitors, balun transformer, and circuit layout may need to be changed to reach the higher frequencies. In certain cases, as when using a wideband antenna or equipment with poor intermodulation or spurious-response characteristics, it may be necessary to use bandpass filters<sup>1</sup> on the amplifier input or output.

### acknowledgement

I would like to acknowledge the contributions of Jim Jenkins, K1JXK, who's early ideas led to my writing this article.



The printed-circuit board for the wideband rf preamplifier is built into a 4x4x1½ inch (10x10x3.8cm) aluminum enclosure. LED is mounted inside rubber grommet to the right of the in/out switch knob.

### reference

1. Wes Hayward, W7ZOI, "Bandpass Filters for Receiver Preselectors," *ham radio*, February, 1975, page 18.

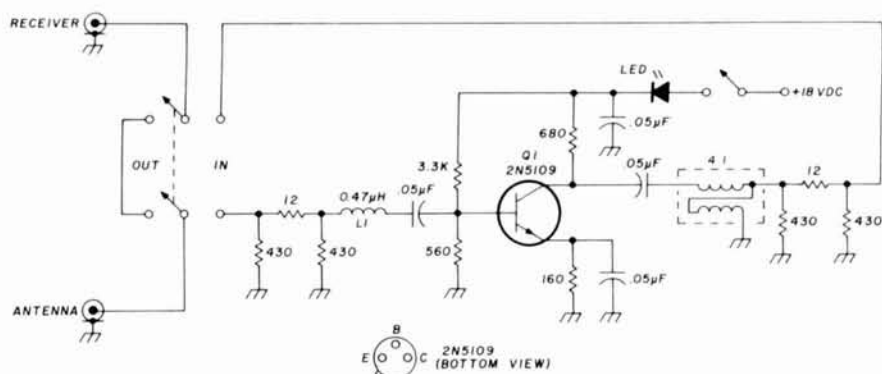


fig. 1. Wideband preamp schematic. The .47 µH inductor can be a couple of ferrite beads placed over a short loop of no. 20 to no. 30 AWG (0.8-0.25mm) insulated wire. The 4:1 wideband transformer in the transistor collector circuit is made by twisting together two pieces of insulated 20 to 30 AWG (0.8-0.25mm) wire, then winding 8 to 10 bifilar turns on a ¼ to ½ inch (6-13mm) toroid core.



fig. 2. Foil side of the printed-circuit layout for the wideband amplifier.

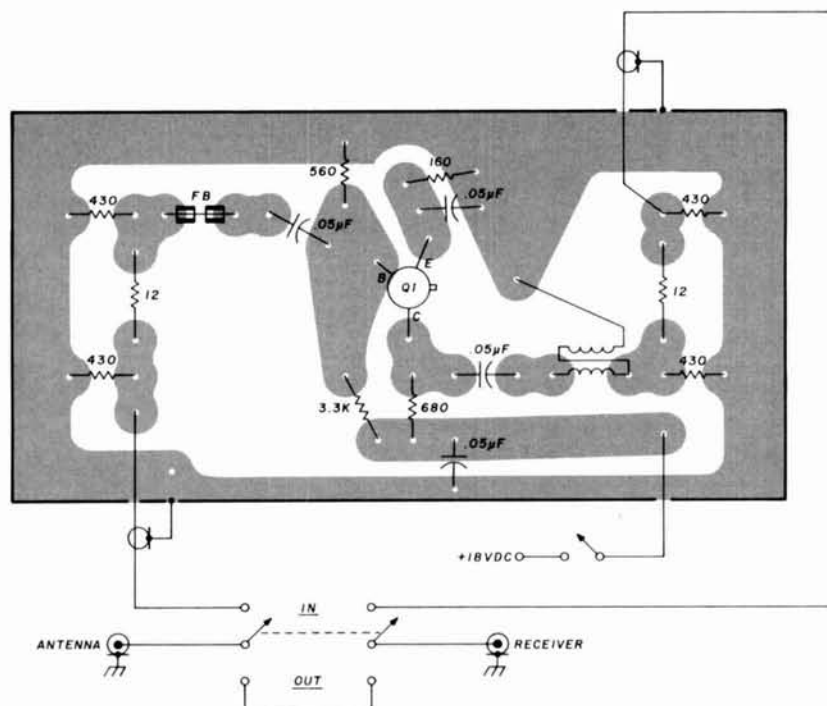
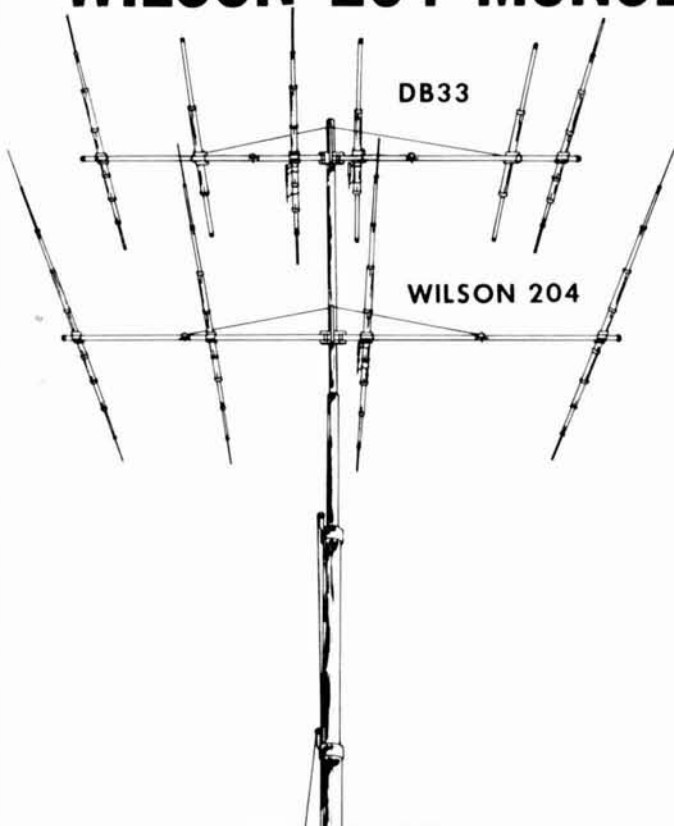


fig. 3. Component layout for the wideband high-frequency preamplifier.



# WILSON 204 MONOBANDER PLUS DB33



The Wilson 204 is the best and most economical antenna of its type on the market. Four elements on a 26' boom plus a Gamma Match (no balun required) make for high performance on CW & phone across the entire 20 meter band. The 204 Monobander is built rugged at the high stress points. Using taper swaged slotted tubing permits larger diameter tubing where it counts, for maximum strength with minimum wind loading.

The DB33 is the newest addition to the Wilson line of antennas. Designed for the amateur who wants a lightweight economical antenna package, the DB33 complements the M204 for an excellent DXers combination.

### WILSON AMATEUR ANTENNA SPECIFICATIONS

	Boom Length (ft)	Number Elements	Turning Radius (ft)	Surface Area (sq ft)	Wind load at 80 MPH (lbs)	Assembled Weight (lbs)	Shipping Weight (lbs)	Price
M520	40	5	27'0"	5.0	125	90	96	269.00
M204	26	4	22'6"	3.9	100	46	49	139.00
M155	26	5	18'0"	3.7	93	41	44	139.00
M154	20	4	15'9"	3.0	75	30	32	89.00
M106	31	6	16'1"	2.9	73	34	36	99.00
DB54(20)	40	5	27'0"	7.9	198	105	119	299.00
(15)	4							
DB43(15)	19	4	15'8"	4.3	108	36	38	119.00
(10)	3							
DB33(15)	17	3	12'2"	3.8	95	31	33	89.00
(10)	3							

All Wilson Monoband and Duoband beams have the following common features:

- Taper Swaged Tubing
- Full Compression Clamps
- No Holes Drilled in Elements
- 2" or 3" Aluminum Booms
- Adjustable 52 Ω Gamma Match
- Quality Aluminum
- Handle 4kw
- Heavy Extruded Element to Boom Mounts

All Wilson Antennas are **FACTORY DIRECT ONLY!** The low prices are possible by eliminating the dealer's discount. Most antennas in stock. If you order any antenna, you may purchase a CDR Ham II for \$129.95 or a CDR CD44 for \$109.95. Send check or money order, or phone in BankAmericard or Master Charge. All 2" Boom antennas shipped UPS, 3" by truck.

## 220 and 450 HAND HELDS

- SWITCHABLE 1 - 2.5 WATT (1 & 1.8W ON 450)
- 6 CHANNEL - ALL PLUG-IN XTALS WITH TRIMMERS ON BOTH TX & RX CRYSTALS
- 12 kHz CERAMIC FILTERS • BATTERY INDICATOR
- HAS .3 μV SENSITIVITY FOR 20 dB QUIETING
- 10.7 & 455 kHz IF ON 220 (21.4 & 455 kHz ON 450)
- CURRENT: 14 mA RX, 500 mA TX ON BOTH MODELS @ 12.0 VDC
- MICROSWITCH PTT BUTTON
- WEIGHT IS LESS THAN 22 OUNCES (w/o NI-CADS)
- SIZE IS 8.9" x 1.7" x 2.9"
- UNBREAKABLE LEXAN® CASE
- BOTH UNITS USE THE SAME ACCESSORIES AS THE 2-METER 1402 & 1405 HAND HELDS
- OPTIONAL 12 BUTTON TOUCH-TONE PAD AVAILABLE
- COMES COMPLETE w/RUBBER DUCKIE, NI-CAD CASE, (\$223.50 INSTALLED OR 446.00 ON THE 450)

### SPECIAL @

- ★ 220 mHz MODEL 2202SM - \$219.95
- ★ 450 mHz MODEL 4502SM - \$269.95



90 DAY WARRANTY

10 DAY MONEY BACK GUARANTEE

### ACCESSORIES AVAILABLE

DESCRIPTION	SPECIAL PRICE
BC1 BATTERY CHARGER	\$34.95
BP1 10 EA. AA GOULD NIKAD BATTERIES	14.95
BT1 EXTRA BATTERY TRAY	6.00
LC1 LEATHER CASE 1402	12.95
LC2 LEATHER CASE 1405, 2202, 4502	12.95
SM1 SPEAKER MIKE FOR EARLY MODEL 1402 9 PIN CONNECTOR	24.95
SM2 SPEAKER MIKE FOR ALL NEW HAND HELDS WITH ROUND 6 PIN CONNECTOR	24.95
TE-1 SUB-AUDIBLE TONE ENCODER	34.95
TTP TOUCH-TONE PAD	49.95
INSTALLATION AT TIME OF RADIO PURCHASE	FREE
INSTALLATION AT LATER DATE, ADD	15.00
XF-1 10.7 KC MONOLITHIC XTAL FILTER	9.95
CRYSTALS TX or RX (Common Frequency Only)	3.75

BC-1 BATTERY CHARGER



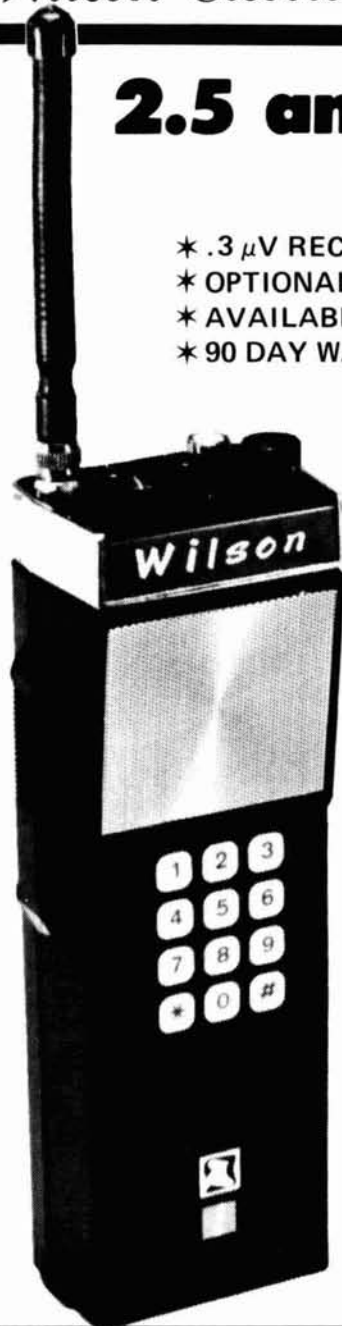




## 2.5 and 5 WATT 2 METER

6 CHANNEL HAND HELD TRANSCEIVERS

- \* .3  $\mu$ V RECEIVERS - 12 kHz CERAMIC FILTERS
- \* OPTIONAL 12 BUTTON PAD AVAILABLE FOR ANY HAND HELD FACTORY INSTALLED
- \* AVAILABLE FOR MARS OR CAP • 10 DAY MONEY BACK GUARANTEE
- \* 90 DAY WARRANTY • INCLUDES 52 SIMPLEX and "DUCKIE" ANTENNA



- TRIMMER CAPS ON RX & TX
- ALL PLUG-IN CRYSTALS (Same as WE-224 Mobile)
- 10.7 and 455 kHz IF
- .3  $\mu$ V SENSITIVITY FOR 20dB QUIETING

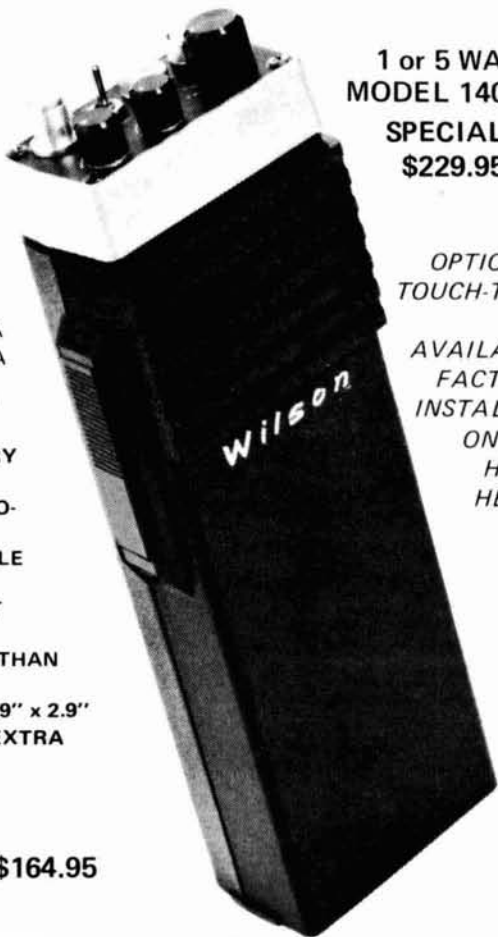
CURRENT DRAIN @ 12 VDC

**MODEL 1402SM:**  
RCVR: 14 mA - XMTR: 500 mA

**MODEL 1405SM:**  
RCVR: 14 mA - TX @ 1W: 400 mA  
TX @ 5W: 900 mA

- 1402 HAS S METER & BATTERY INDICATOR
- 1405 HAS A SENSITIVE BATTERY INDICATOR
- BOTH MODELS FEATURE MICRO-SWITCH PTT
- THE 1405 CASE IS UNBREAKABLE LEXAN®
- THE 1402 CASE IS HIGH IMPACT ABS PLASTIC
- WEIGHT (w/o NI-CADS) IS LESS THAN 22 OUNCES
- OVERALL MEASURE IS 8.9" x 1.9" x 2.9"
- 10 NI-CADS (ORDER BP-1) ARE EXTRA @ \$14.95
- OVER 2000 UNITS IN STOCK

2.5 WATT MODEL 1402SM SPECIAL @ \$164.95



1 or 5 WATT MODEL 1405SM SPECIAL @ \$229.95

OPTIONAL TOUCH-TONE PAD AVAILABLE FACTORY INSTALLED ON ALL HAND HELDS

TO: WILSON ELECTRONICS CORP., 4288 S. Polaris Ave., Las Vegas, Nevada 89103, (702) 739-1931, Telex 684-522

### FALL SPECIAL DIRECT SALE ORDER BLANK

PLEASE PRINT CLEARLY

- \_\_\_ 1402SM @ \$164.95
- \_\_\_ 1405SM @ \$229.95
- \_\_\_ 2202SM @ \$219.95
- \_\_\_ 4502SM @ \$269.95
- \_\_\_ BC1 @ \$34.95
- \_\_\_ BP1 @ \$14.95
- \_\_\_ BT1 @ \$6.00
- \_\_\_ LC1 @ \$12.95
- \_\_\_ LC2 @ \$12.95
- \_\_\_ SM1 @ \$24.95
- \_\_\_ SM2 @ \$24.95
- \_\_\_ TE1 @ \$34.95

- \_\_\_ TTP @ \$49.95
- \_\_\_ XF1 @ \$9.95
- \_\_\_ EXTRA CRYSTALS @ \$3.75 ea.
- \_\_\_ PLEASE PUT ALL INSTALLED XTALS ON FREQ. (\$7.50 Extra per Radio)
- \_\_\_ INSTALL THESE CRYSTALS

	TX	RX	TX	RX
	52	52		
A.			G.	
B.			H.	
C.			I.	
D.			J.	
E.			K.	
F.			L.	

Specify Freq. on Tone Encoder TE-1 \_\_\_\_\_ Hz

ENCLOSED IS \_\_\_\_\_  CHECK  MONEY ORDER  MC  BAC

CARD # \_\_\_\_\_

EXPIRATION DATE \_\_\_\_\_

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_

STATE \_\_\_\_\_ ZIP \_\_\_\_\_ PHONE ( ) \_\_\_\_\_

SIGNATURE \_\_\_\_\_

SHIPPING & HANDLING PREPAID FOR FALL SPECIAL  
NEVADA RESIDENTS ADD SALES TAX  
SPECIAL PRICES GOOD THRU NOV. 30, 1976

# four-band vhf receiving converter

One 46-MHz crystal  
and an ingenious  
mixing scheme  
provide coverage between  
six meters and 420 MHz

How would you like an inexpensive way to monitor your local two-meter repeater? Or how about a 220-MHz receiver? In fact, how about a receiver covering 6 meters through 420 MHz? These are a few of the questions that were buzzing around in my head, so I decided to build a general-purpose receiver capable of covering all vhf bands. The result is the front end of an all-band vhf converter.

## design

At a recent test-equipment seminar, a nifty but little-used fact concerning mixers surfaced once again: Not only is the local oscillator's fundamental frequency available; but the mixer itself, being a nonlinear device, produces harmonics of the oscillator frequency that can be used in the mixing action.

Example: Use a 46-MHz local oscillator and an input of 51 MHz to generate an i-f at 5 MHz. The local oscillator's 138-MHz third harmonic can produce the same i-f from an input at 143 MHz. In fact, this i-f will be produced from any of the following input frequencies: 87 MHz, 97 MHz ( $2 \times 46 = 92$ ); 133 MHz, 143

MHz ( $3 \times 46 = 138$ ); 179 MHz ( $4 \times 46 = 184$ ); 179 MHz, 189 MHz ( $4 \times 46 = 184$ ); and so on.

Now, 46 MHz is not just a number plucked out of thin air for this example. It was developed after weeks of doodling, and is a key ingredient in the design. To understand why, consider this:

$1 \times 46 = 46$	(used on 6 meters)
$3 \times 46 = 138$	(used on 2 meters)
$5 \times 46 = 230$	(used for 220 MHz)
$7 \times 46 = 322$	(not used)
$9 \times 46 = 414$	(used for 420 MHz)

Therefore, it should be possible to use only one crystal and some sort of odd-harmonic generator to meet the design objective of all-vhf-band coverage. 420 MHz is picked up as a bonus (vhf ends at 300 MHz).

## circuit description

Fig. 1 is the complete converter schematic with parts list. Ignoring the broadband rf preamplifier (Q1 through Q3) for the moment, let us continue our study of the harmonic mixer. Crystal Y1, a plated, overtone unit, oscillates at 46 MHz in a series-resonant mode. Transistors Q5 and Q6 form the differential amplifier oscillator: rf voltage at Q5's collector is fed back to Q6's base by capacitor C5 and the crystal.

Harmonic emphasis is supplied by tuned line L1 connected from Q6's base to rf ground. L1 is a shorted, quarter-wave transmission line cut to resonance at the crystal frequency. It is  $3/4$  wavelength long at the third harmonic,  $5/4$  wavelength long at the fifth harmonic, etc., and acts as a parallel-tuned circuit at all odd harmonics. Therefore, the fundamental and odd harmonics of the crystal are present at the base of mixer transistor Q6, as desired. Construction details for a miniaturized quarter-wave line suitable for PC-board mounting are given in fig. 2, which is self-explanatory.

The remainder of the converter consists of a broad-

By S. Smith, W3TQM, Laurel, Maryland 20810

band, cascode preamplifier (transistors Q1, Q2, and Q3) that is R-C coupled to mixer driver Q4. No tuning is incorporated purposely so that the converter may be conveniently used on any of the four bands. Of course, external tuning is required, or the device will work on all

to figs. 2 and 3, you should have no difficulty building one of these converters.

The six transistors, in two differential amplifier configurations, are packaged as RCA's CA3049T integrated circuit. This IC was reportedly designed for low-noise

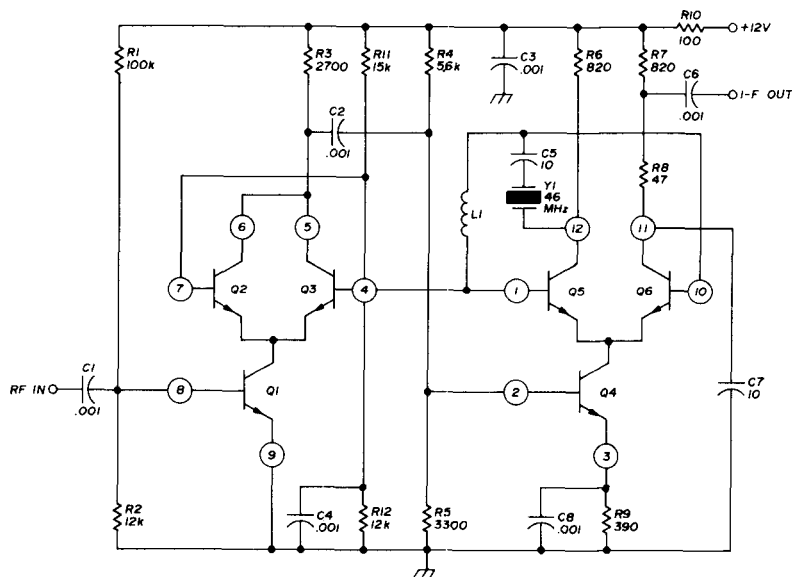


fig. 1. Schematic of the four-band vhf receiving converter. Resistors are 1/2 watt, 10% composition. All transistors are part of RCA CA3049T integrated circuit. Circled numbers are IC pin numbers. Capacitor voltage rating is 25 volts working or greater. Construction of transmission line resonator, L1, is shown in fig. 2.

bands at once! It also converts local TV and fm frequencies, because even harmonics of the crystal are not eliminated in the design.

**construction**

Fig. 3A is the foil pattern I used. A glass/epoxy board, 2 by 2 inches (51x51mm) is used. Fig. 3B is a parts layout diagram. Note that all components mount on top of the board; the foil is the bottom. By reference

vhf amplifier service and was chosen for its small size and cost.

**performance**

Several converters I built had sensitivities below 1 μV on 50, 144, and 220 MHz, and sensitivities of about 2 μV on 420 MHz. Image rejection and i-f feedthrough, being functions of the input tuning, are not meaningfully measured on such a broadband device. These parameters vary according to the tuning scheme used. Fig. 4 is a simple tuner that serves the purpose and matches the converter input to a 50-ohm antenna. Note that, with a bit of care, this input tuner could be bandswitched.

Conversion gain is a function of the band in use. The output level obtained during sensitivity checks, at 10 dB s/n ratio, is 10 μV. Power required is 12 Vdc at approximately 15 mA; the circuit works well on a 9-volt supply with slightly reduced sensitivity.

**applications**

I use one converter to monitor 146.76 and 146.94 MHz on a broadcast-band transistor radio. To do this, the crystal was changed to 48.5 MHz, achieving an injection frequency of 3 x 48.5 = 145.5 MHz. The resulting i-f is in the broadcast band, and the segment of two meters between 146 and 147 MHz can be tuned by tuning the broadcast receiver through the i-f range of 0.5 to 1.5 MHz. For 146.76 MHz, the i-f converts to 1260 kHz, while 146.94 MHz converts to 1440 kHz. Another common vhf fm frequency, 146.52, converts to 1020 kHz.

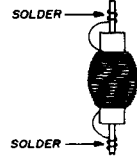
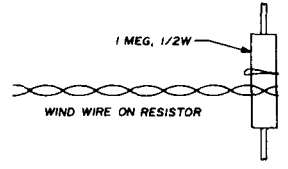
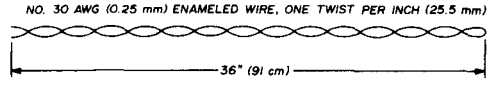
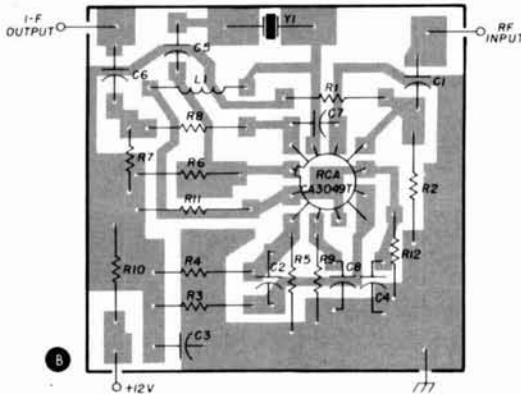
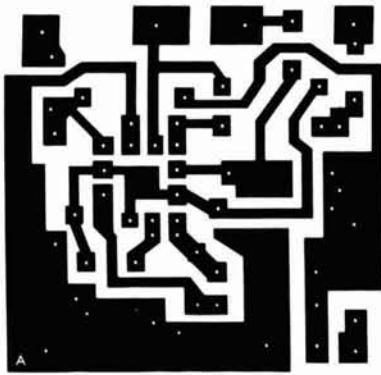


fig. 2. Construction details for a miniaturized 1/4-wave transmission line suitable for PC-board mounting.

fig. 3. Foil side of the PC board, A, and parts layout, B. Note that all components are mounted on top of the board; foil is the bottom.



The i-f output can be inductively coupled to a pocket transistor radio or directly coupled to an auto broadcast receiver. See fig. 5 for suggested coupling methods. In either case, fm can be recovered quite successfully by slope detection. When using a pocket transistor set, interference from broadcast stations can be removed by wrapping the radio in aluminum foil. Be sure to put the rf choke of fig. 5 inside the foil and as close as possible to the radio's Loop-Stick antenna.

Another of the converters is used to monitor the local repeater output at 146.76 MHz on my Drake R-4A receiver. Again, a crystal other than 46 MHz is used, so that the i-f can be tuned with the receiver. In this case, a 46.5-MHz crystal yields an i-f of 7.460 MHz, which is in range of the Drake's 40 meter band. Once again, slope

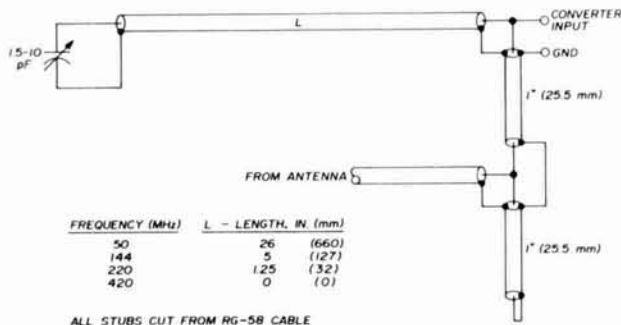


fig. 4. Simple tuner for reducing feedthrough and images.

detection is used to recover fm; some distortion is experienced because of the receiver's selectivity, but no trouble is experienced copying traffic.

Yet another unit is in use converting both 15- and 10-meter signals to an i-f in the range of a surplus BC-348 receiver. A crystal frequency of 25 MHz was chosen. It was necessary to replace the tuned line, L1, with a parallel-resonant circuit at the crystal frequency.

The converter may also be used as a general-coverage vhf/uhf receiver. Any i-f up to 35 MHz may be used without modification of the original circuit, and other intermediate frequencies could be adapted by modification of the output stage.

As all crystal harmonics are present in the mixer, a frequency in the 25 to 1000 MHz range can be converted to an i-f of less than 35 MHz. As an example, using

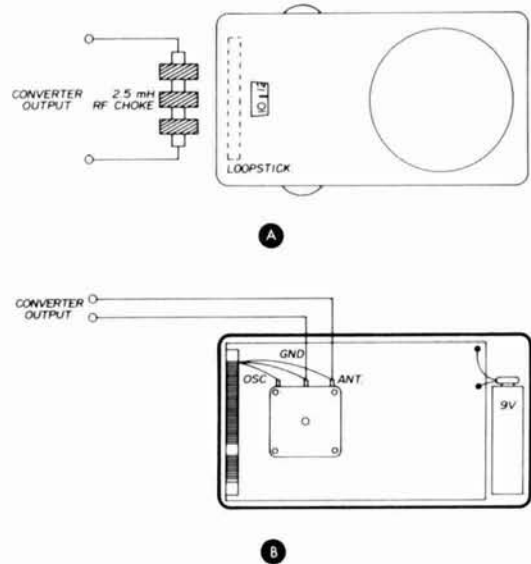


fig. 5. Methods for coupling the vhf converter to a pocket transistor broadcast-band radio, A, or an automobile broadcast-band set, B. Transistor radio and rf choke should be wrapped in aluminum foil to eliminate BC-band interference.

the second harmonic of 46 MHz (92 MHz), 121.5 MHz would be converted to 29.5 MHz. Using the third harmonic (138 MHz), this same signal would be found at 16.5 MHz. Thus, the converter can be used to monitor aviation, police, business, and other frequencies. Again, the tuned input circuit should be resonated to the desired frequency. Problems experienced when the signal frequency falls close to or on a crystal harmonic can be circumvented by using a second crystal differing in frequency from the 46-MHz standard, so that low i-fs are avoided.

Now there's little excuse for not monitoring the higher-frequency amateur bands. This project can be built in a few evenings, and for less than \$20.00. It's inexpensive, simple, and it works. See you on vhf.

ham radio

## **Ham Radio Magazine**

**October 1976**

**Page numbers 67, 68, 69 and 70  
were skipped in this issue.  
There were no articles on these pages.**

**Ham Radio Magazine**

**October 1976**

**Page numbers 67, 68, 69 and 70  
were skipped in this issue.  
There were no articles on these pages.**

## **Ham Radio Magazine**

**October 1976**

**Page numbers 67, 68, 69 and 70  
were skipped in this issue.  
There were no articles on these pages.**

**Ham Radio Magazine**

**October 1976**

**Page numbers 67, 68, 69 and 70  
were skipped in this issue.  
There were no articles on these pages.**



# phasing-type single-signal detector

Phase-shift  
network design  
and construction data  
for improving receivers  
with marginal selectivity

**Phasing-type detectors**, despite their superficial complexity, are the only means of avoiding audio images in a direct-conversion receiver. Likewise if a superheterodyne receiver has inadequate selectivity or is plagued by broad-band i-f noise,<sup>1,2</sup> the cure lies in either additional i-f filters or in a phasing detector.

Although the circuits described here would make a good direct-conversion receiver, they were designed for use in a superhet with lots of i-f noise and inadequate stop-band rejection. While this system can't offer all the advantages of a second crystal filter, it does give substantial improvement at moderate cost. (Phase-shift net-

works are described in the appendix for unwanted side-band suppressions of at least 30, 37, and 60 dB, depending on the audio bandwidth and circuit complexity. A simple network for CW reception offering 50 dB rejection is also described).

The circuits were chosen for their ease of construction and adjustment. No special LCR precision bridges are needed to set the audio phase network capacitors. If

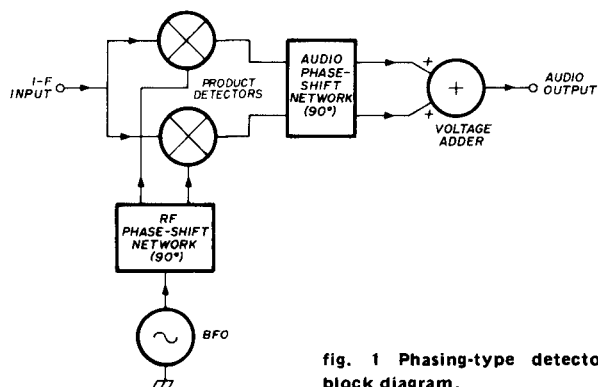


fig. 1 Phasing-type detector block diagram.

you can tune a musical instrument the only test equipment needed is a grid-dip oscillator and a vtm. A frequency counter and oscilloscope are useful but not absolutely required. The system costs between \$5 and \$25 more than a simple bfo-product detector combination depending on how good a scrounger you are. (Compare this price with the cost of crystal filters!) The phasing detector block diagram is shown in fig. 1.

By Don Lawson, WB9CYY, 4601 Jay Drive, Madison, Wisconsin 53704

The audio phase-shift networks described here are also suitable for use in ssb phasing-type transmitters. For such applications wire the two inputs (C and D of fig. 3) together and run the outputs (TP1 and TP2) to the balanced modulators.

### bfo and product detector

The bfo and product detector schematic is given in fig. 2. L2 and C2 resonate at the bfo frequency; R1 is

should be chosen so that the combined drain current of both mosfets is equal to the average of their individual values of  $I_{D55}$  so that about 9 volts are between the source and drain of each transistor (whichever condition gives the larger value of R4).

R2 and R3 can have values anywhere between 470 ohms and 1k and should be closely matched. C4 and C5 should also be matched to 5% or so (using the method described later). L3, L4, C6, and C7 form a lowpass

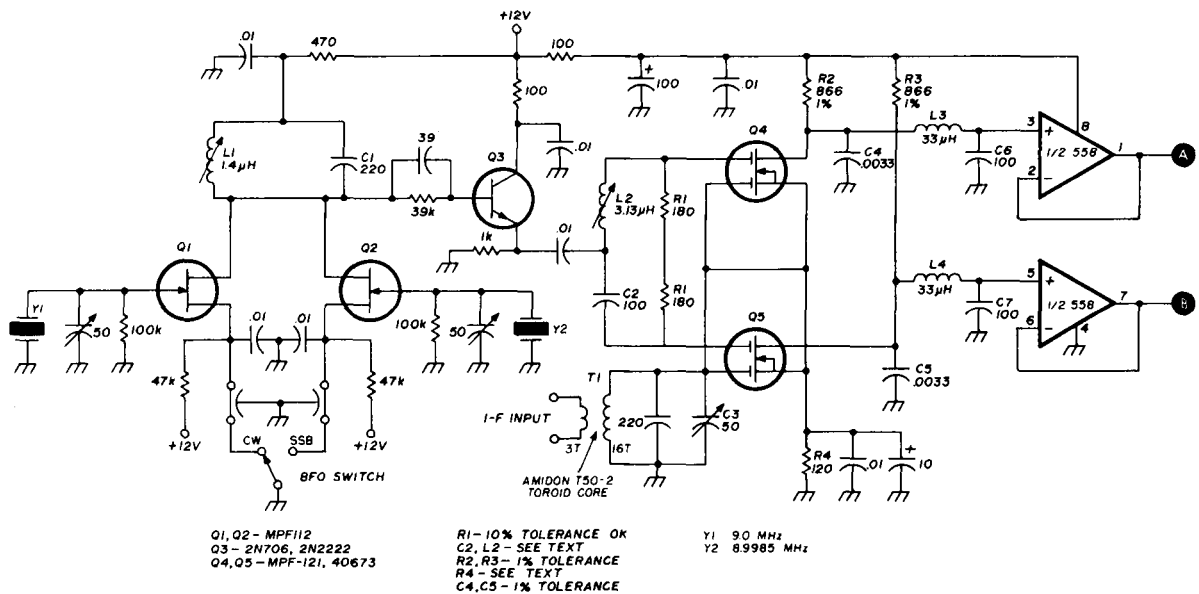


fig. 2. Bfo-product detector schematic. Components that must be closely matched are discussed in the text.

equal to the reactance of the capacitor or inductor at resonance. For an i-f of 9 MHz, representative values are R1 = 180, C2 = 100 pF, and L2 = 3.13 μH.

The bfo uses about the simplest method I know for switching parallel-resonant crystals, and with MPF-112s at 35 cents apiece, it's fairly inexpensive. The product detector's dual gate mosfets, Q4 and Q5, can be MPF-121s or 40673s. If you buy three or four mosfets (instead of just two), you can be fairly sure of finding two that have similar values of  $V_{gs0ff}$  and  $I_{D55}$ . R4

filter to prevent the bfo signal from getting into the op-amps. The bfo-product detector assembly should be built into a shielded enclosure to keep the bfo signal out of the i-f strip.

### audio circuits

The audio phase-shift network is shown in fig. 3. There are simpler circuits in the literature but this one is by far the easiest to build. C1, C2, C3, and C4 should be set to equal values by padding with small capacitors in

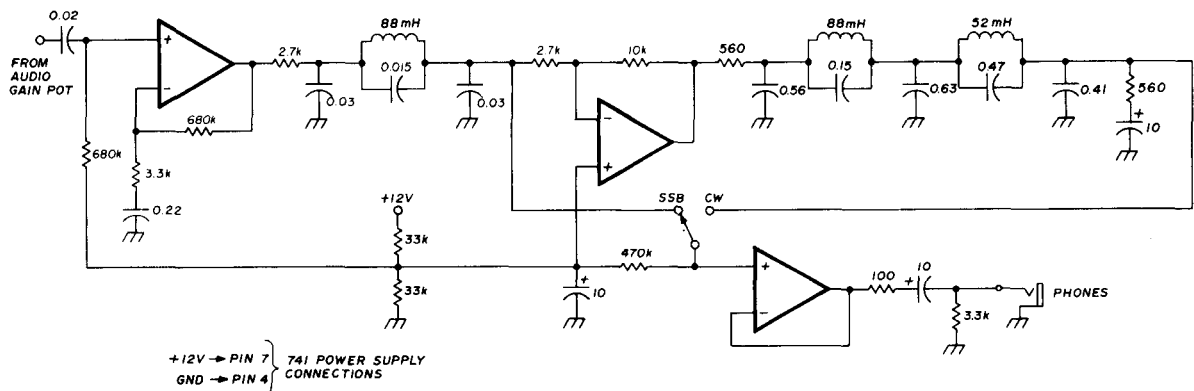


fig. 4. Audio amplifier and filter schematic. Cutoff frequencies are respectively 3 kHz and 800 Hz for the single- and double-section filters.

parallel. Several 50, 100, and 200 pF capacitors are handy for this. If you want to use some other value for the capacitors, multiply R1 through R4 by your capacitor value divided by 0.022; i.e., for 0.1  $\mu$ F, R1 would be  $23.03k \times 0.1/0.022$  or 104.7k. The phase-shift network is designed to work from 300 to 4000 Hz and theoretically provides at least 31 dB suppression. For this circuit, R5 through R8 form voltage dividers. In the circuit of fig. 3 they have a ratio of resistances of 14.94 to 1.

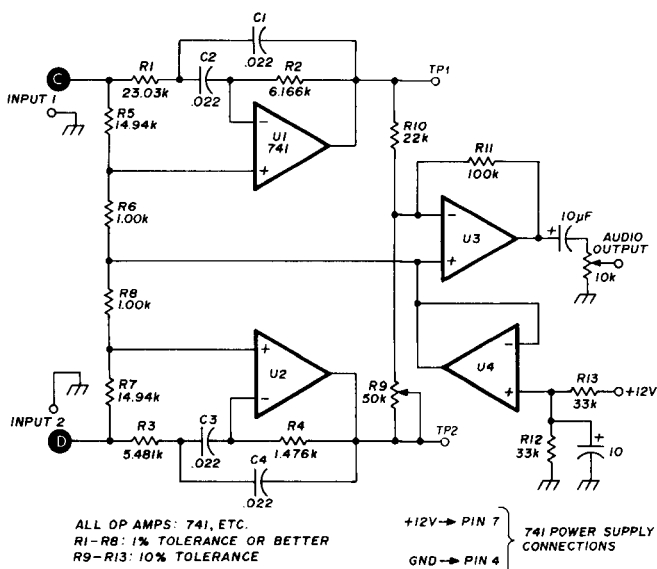


fig. 3. Audio phase-shift network schematic. C1-C4 should be matched by adding small capacitors in parallel.

R9, R10, R11, and U3 form the voltage adder of fig. 1. U4 gives a good ac ground for the networks. Trying to substitute a large bypass capacitor for U4 isn't good enough. To eliminate U4 you'd need dual power supplies for U1 through U3, so that dc ground is also a suitable ac ground. The audio output can be applied to an amplifier with sharp filters; a typical circuit is shown in fig. 4. The single-section filter is a 3-kHz elliptical low-pass; the two-section filter has a cutoff frequency of 800 Hz for CW reception.

### construction and alignment

A grid-dip oscillator is all that's necessary for building and checking the bfo and product detector. If an oscilloscope is available, it might be a good idea at this point to set L2 initially for the point where the signals at A and B (fig. 2) are 90 degrees apart in phase. (Use the circuit of fig. 5A if a scope with a triggered sweep is available; use fig. 5B if one is not).

All capacitors in the audio phase-shift network should be matched as closely as possible and R1-R4 should be proportional to their calculated values. The ratios of R5/R6; R7/R8 should also be as close as possible to their computed ratios. For example, if all your capacitors were equal to 0.019  $\mu$ F and R1-R4 were 0.9 times their computed values, the only bad effect would be that

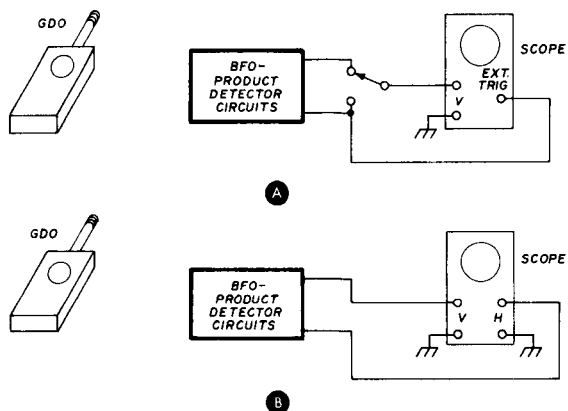


fig. 5. Setups for checking and presetting the rf phase-shift network. Methods (A) and (B) are for oscilloscopes with and without triggered sweep.

the network frequency range would be shifted slightly. The resistors can be made up from parts on hand, using an accurate volt-ohmmeter, or 1% wirewound resistors may be used.

The capacitors can be matched quite well by using the oscillator circuit of fig. 6. Be sure to use an uncompensated

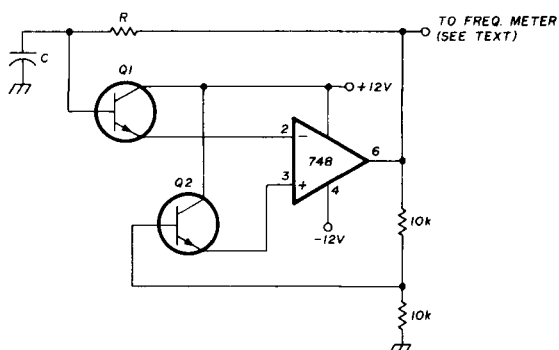


fig. 6. Oscillator circuit for measuring capacitance. An uncompensated op-amp should be used. Q1, Q2 are general-purpose audio transistors.

compensated op-amp, such as a 741 or a 709. The internal compensation in a 741 will slow down the oscillator and measurements will be unreliable. Try to keep the frequency between 1 and 10 kHz for best accuracy. If you're going for readings of four significant digits, power the oscillator from either batteries or a regulated supply to eliminate effects of line-voltage variations.

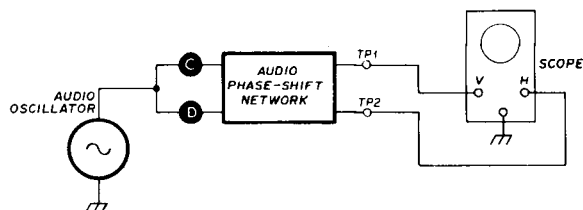


fig. 7. Test circuit for checking the audio frequency phase-shift network.

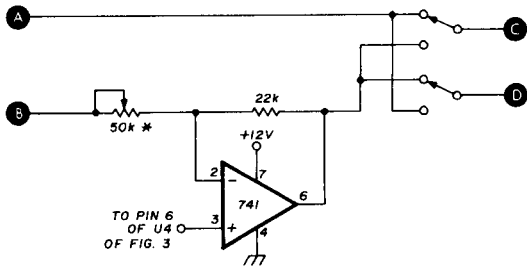


fig. 8. Method for sideband selection through a panel switch. Adjust the 50k pot so that the signal amplitude at pin 6 of the 741 is the same as at point A.

The "frequency meter" should be either a digital frequency counter or a tape recorder. A meter-movement type instrument won't allow sufficient precision. If you use a tape recorder, find which capacitor gives the lowest-pitch tone then pad the other capacitors to give this same frequency. By taping the lowest pitch, you'll save having to switch constantly between capacitors for comparison. If you use a counter, choose one capacitor as a reference and note its frequency. Assuming it equals its marked value exactly, the relative capacitance of the other capacitor is:

$$C_x = \frac{f_{req}}{f_x} \times C_{ref}$$

Unless you're using a very good ohmmeter to measure the resistors, there's little point in matching the capacitors to better than 0.25%. If possible, use high-stability capacitors (polystyrene is best). \* If you're using carbon-composition resistors, coat them with epoxy to reduce

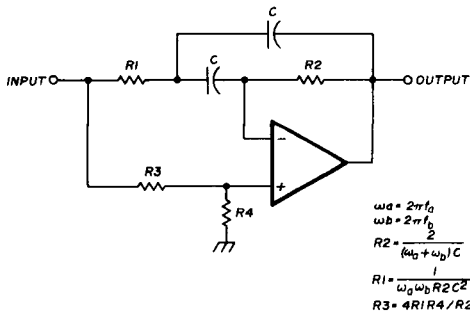


fig. 9. Portion of a phase-shift network with singular frequencies,  $f_a$  and  $f_b$ . Formulas are used with table 1 to compute component values.

variations of their values with humidity. Use fig. 7 to check the operation of the phase-shift network. With the scope setup shown you should be able to see a circle on the scope screen.

Referring to figs. 2 and 3, in final adjustment first wire A to C and B to D. Sweep the grid-dip oscillator or

\*Polystyrene capacitors can be obtained from Weinschenker, Box 353, Irwin, Pennsylvania 15642.

signal generator past the bfo frequency and decide which sideband (upper or lower) is being rejected. If it's not the sideband you want, try wiring A to D and B to C. (If you want to select sidebands by a panel switch, try using the circuit of fig. 8). Now, alternatively adjust L2 of the bfo and R9 of the audio phase-shift network for the best unwanted sideband rejection.

## results

If you use the circuit in fig. 3, you should be able to easily get about 30 dB of unwanted sideband rejection between 300-4000 Hz. For better rejection, use one of the other circuits in the appendix.

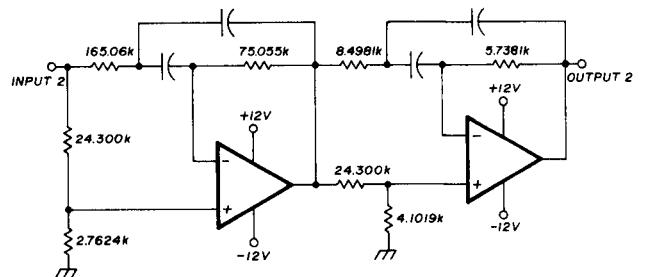
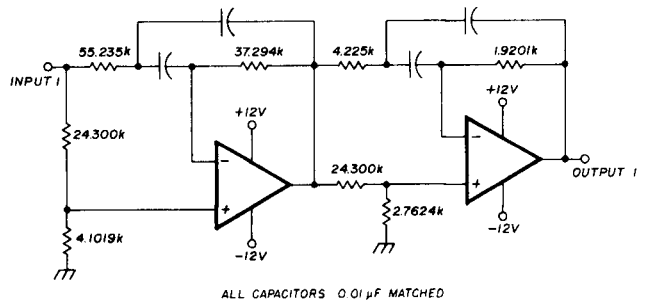


fig. 10. Cascaded filters to obtain an 8-pole network. Circuit provides at least 60 dB unwanted sideband rejection between 200-4000 Hz using 741 op-amps.

I hope this article provides some ideas for those who build or modify receivers. When it comes to improving the selectivity of a marginal receiver, this system is the best for the money.

## references

1. W.H. Sabin, W01YH, "The Solid-State Receiver," *QST*, July, 1970, page 35.
2. W. Hayward, W7ZO1, "A Competition-Grade CW Receiver," *QST*, March, 1974, page 16; April, 1974, page 34.
3. Shirley, "Optimum Design of Phase Shift Networks," *IEEE Transactions on Circuit Theory*, May, 1969.
4. Shirley, "Shift Phase Independent of Frequency," *Electronics Design*, September 1, 1970.
5. Budak, *Passive and Active Network Analysis and Synthesis*, Houghton, Mifflin and Company, 1974, page 451.

## bibliography

1. G. Kent Shubert, WA0JYK, "Solid-State Phasing-Type SSB Communications Receiver," *ham radio*, August, 1973, page 6.
2. D. Norgaard, W2KUJ, "Practical Single-Sideband Reception," *QST*, July, 1948, page 11.

## appendix

The design of any phase-shift network is a trade between complexity, bandwidth, and phase accuracy. Phase-shift networks are a special category of "all-pass filters," meaning that the network gain is constant regardless of frequency. Phase-shift networks are characterized by a set of "singular frequencies." The calculation of these frequencies is too involved to be covered here, but an algorithm is in the literature that requires nothing more than a calculator with a square-root key.<sup>3,4</sup> For those who don't like lots of arithmetic, I've compiled the results of several design computations in table 1. Network 1 is the general-purpose network shown in fig. 3, while network 2 is for more narrow-band ssb use. Network 3 is for use in direct-conversion CW receivers. These networks are all of the four-pole variety since each has four singular frequencies.

table 1. Phase-shift network design data.

network	freq range (Hz)	minimum unwanted sideband rejection (dB)	singular frequencies			
			f <sub>1</sub>	f <sub>2</sub>	f <sub>3</sub>	f <sub>4</sub>
1	300-4000	31	148.9	625.8	1916.	8049.
2	300-2500	37	136.2	525.2	1428.	5507.
3	225-950	49	88.7	298.6	672.0	2265

As noted before, the circuit used here was chosen for its simplicity of construction as compared to other circuits.<sup>5</sup> (Unless you have a frequency counter or precision LCR bridge, it's much easier to set capacitors equal than it is to set them to arbitrary ratios). To compute component values from table 1, we take either odd- or even-numbered singular frequencies and plug them into the formulas of fig. 9.

As an example, let's try designing the network shown in fig. 3. As a start, we take odd frequencies of 148.9 and 1916 Hz. Converting to radians/sec, we get  $\omega_1 = 935.6$  and  $\omega_3 = 12,038$ . Assuming  $C = 0.025 \mu F$  ( $2.5 \times 10^{-8} F$ ), we compute

$$R2 = \frac{2}{(935.6 + 12,038) \times 2.5 \times 10^{-8}} = 6166 \text{ ohms}$$

Likewise,

$$R1 = \frac{1}{935.6 \times 12,038 \times (2.5 \times 10^{-8})^2 \times 6166} = 23,040 \text{ ohms} = 23.04k$$

Finally, since we have a couple of 1k 1% resistors on hand, we choose  $R4 = 1k$  and

$$R3 = \frac{4 \times R1 \times R4}{R2} = \frac{4 \times 23,040 \times 1000}{6166} = 14,946 \text{ ohms} = 14.95k$$

We now have half of our network designed. For the other half we follow the same procedure except that we work with  $f_2$  and  $f_4$ .

Note that at dc the circuit gain is  $R4/(R3 + R4)$ . Since this is an all-pass network, all audio frequencies are attenuated by this same amount. Hence, this network attenuates the signal by 24 dB. Because the 741 op amps have internal noise it may be desirable, especially in direct-conversion receivers, to put low-noise amplifiers (such as an LM381) between the product detector and the phase-shift network.

A final note: It's possible to cascade phase-shift network sections to get an 8-pole network. A practical 8-pole network is shown in fig. 10. According to a computer simulation, this circuit provides at least 60 dB of unwanted sideband rejection between 200-4000 Hz. This simulation was with 741s. It may be possible to get an additional 5 dB suppression by using 556 op-amps since their input impedance is much higher than that of a 741. Of course, the components would have to be set very accurately to realize this theoretical figure and a preamplifier would be necessary to overcome the network signal attenuation. This circuit would be ideal for a high-quality, phasing-type ssb direct-conversion receiver.

ham radio

## KENWOOD HEADQUARTERS



TS-820  
160-10M TRANSCEIVER



TS-700A  
2M TRANSCEIVER



TS-520  
80-10M TRANSCEIVER



TR-7200A  
2M MOBILE TRANSCVR

TR-2200A  
2M PORTABLE TRANSCVR

PS-5  
AC/DC POWER SUPPLY



R-599D  
160-10M RECEIVER

T-599D  
160-10M TRANSMITTER

Request EDI Wholesale Catalog Today!

All Models of Kenwood Gear and Accessories  
Always Available at:

**ELECTRONIC DISTRIBUTORS, Inc.**

Communication Specialists for over 37 years  
1960 PECK ST., MUSKEGON, MICH. 49441  
TEL. (616) 726-3196 TELEX 22-8411

### 7400N TTL

SN7400N	16	SN7450A	25	SN74150N	1.00
SN7401N	16	SN7460N	35	SN74155N	.99
SN7402N	21	SN7470N	45	SN74156N	.99
SN7403N	16	SN7472N	39	SN74157N	.99
SN7404N	18	SN7473N	37	SN74158N	.99
SN7405N	24	SN7474N	32	SN74160N	.99
SN7406N	20	SN7475N	50	SN74161N	.99
SN7407N	29	SN7476N	32	SN74163N	.99
SN7408N	25	SN7479N	5.00	SN74164N	1.10
SN7409N	25	SN7480N	50	SN74165N	1.10
SN7410N	18	SN7481N	96	SN74166N	.99
SN7411N	30	SN7483N	70	SN74167N	5.50
SN7412N	33	SN7485N	89	SN74170N	2.10
SN7413N	45	SN7486N	39	SN74172N	8.95
SN7414N	70	SN7487N	39	SN74173N	1.50
SN7416N	35	SN7489N	2.25	SN74174N	.99
SN7417N	35	SN7490N	.45	SN74175N	.99
SN7420N	21	SN7491N	75	SN74176N	.90
SN7421N	33	SN7492N	49	SN74177N	.90
SN7422N	49	SN7493N	49	SN74180N	.99
SN7423N	29	SN7494N	79	SN74181N	2.49
SN7425N	39	SN7495N	79	SN74182N	.99
SN7426N	29	SN7496N	89	SN74184N	1.95
SN7427N	37	SN7497N	4.00	SN74185N	2.20
SN7429N	45	SN74100N	1.00	SN74186N	1.25
SN7430N	26	SN74107N	39	SN74187N	6.00
SN7432N	31	SN74121N	39	SN74188N	3.95
SN7437N	27	SN74122N	79	SN74190N	1.19
SN7438N	27	SN74123N	70	SN74191N	1.25
SN7439N	25	SN74125N	60	SN74192N	.99
SN7440N	15	SN74126N	60	SN74193N	.89
SN7441N	89	SN74132N	1.09	SN74194N	1.25
SN7442N	59	SN74136N	.95	SN74195N	.75
SN7443N	35	SN74141N	1.15	SN74196N	1.25
SN7444N	75	SN74142N	4.00	SN74197N	.75
SN7445N	75	SN74143N	.40	SN74198N	1.75
SN7447N	81	SN74144N	4.50	SN74199N	1.75
SN7447N	69	SN74145N	1.15	SN74200N	5.59
SN7448N	79	SN74147N	2.35	SN74210N	1.99
SN7450N	26	SN74148N	2.00	SN74251N	.79
SN7451N	27	SN74150N	1.00	SN74284N	6.00
SN7451N	27	SN74151N	.79	SN74285N	6.00
SN7454N	20	SN74152N	.89	SN74367N	.75

### CMOS

CD4000	25	74C04N	.75
CD4001	25	74C01N	.65
CD4002	25	74C02N	.65
CD4006	2.50	74C03N	.65
CD4007	25	74C04N	2.15
CD4009	59	74C29N	1.50
CD4010	59	74C046	2.74
CD4011	25	74C047	2.75
CD4012	25	74C049	2.90
CD4013	47	74C050	1.25
CD4016	64	74C051	2.95
CD4017	1.35	74C053	2.95
CD4019	55	74C060	3.25
CD4020	1.49	74C066	1.75
CD4021	1.49	74C069	1.75
CD4022	1.50	74C071	2.50
CD4023	1.50	74C071	2.50
CD4024	1.50	74C081	4.50
CD4025	25	74C173	2.60
CD4027	69	74C193	2.75
CD4028	1.65	74C200	2.95
CD4029	2.90	74C202N	5.50
CD4030	6.00	MC4044*	4.50
CD4031	6.00	MC4047*	5.50

### LINEAR

LM1300H	80	LM1310N	2.95
LM301H	35	LM1351N	1.65
LM301CN	35	LM1414N	1.75
LM302H	75	LM1486C	.65
LM304H	1.00	LM1496N	.65
LM305H	95	LM1529V	1.85
LM307CN	35	LM2111N	1.95
LM308H	1.00	LM2901N	2.95
LM309CN	1.00	LM3052N	.65
LM309H	1.10	LM3811N	1.39
LM309K	95	LM3829N	1.79
LM310CN	1.15	NE501K	8.00
LM311H	90	NE502H	6.00
LM311N	90	NE511H	6.00
LM318CN	1.50	NE536T	6.00
LM319N	1.30	NE540L	6.00
LM320K-5	1.35	NE550N	79
LM320K-5.2	1.35	NE555D	45
LM320K-12	1.35	NE560B*	5.00
LM320K-15	1.35	NE562B*	5.00
LM320T-5	1.75	NE562B*	5.00
LM320T-5.2	1.75	NE565H	1.25
LM320T-8	1.75	NE581CN	.79
LM320T-12	1.75	NE586G*	1.25
LM320T-15	1.75	NE567H*	1.95
LM320T-18	1.75	NE567V*	1.50
LM323T-24	1.75	LM703CN	.45
LM323N-5	9.95	CA3012	2.15
LM324N	1.80	LM709N	.29
LM339N	1.70	LM710N	.79
LM340K-5	1.95	LM711N	.39
LM340K-6	1.95	LM723N	.55
LM340K-8	1.95	LM730N	.55
LM340K-12	1.95	LM733N	1.00
LM340K-15	1.95	LM739N	1.00
LM340K-18	1.95	LM741CN	.35
LM340K-24	1.95	LM743N	.35
LM340L-5	1.75	LM74114N	.39
LM340L-6	1.75	LM747H	.79
LM340L-8	1.75	LM747H	.79
LM340L-12	1.75	LM748H	.99
LM340L-15	1.75	LM748H	.99
LM340L-18	1.75	LM748H	.99
LM340L-24	1.75	LM748H	.99
LM350N	1.00	LM1305N	1.19
LM351CN	65	LM1307N	.85

### 74LS00 TTL

74LS00	39	74LS55	39	74LS151	1.55
74LS02	39	74LS73	65	74LS175	1.89
74LS03	39	74LS74	65	74LS187	1.55
74LS04	45	74LS75	79	74LS162	2.25
74LS05	45	74LS76	65	74LS163	2.25
74LS10	39	74LS83	2.19	74LS164	2.25
74LS11	39	74LS86	65	74LS181	3.69
74LS13	79	74LS90	1.29	74LS190	2.85
74LS14	2.19	74LS92	1.25	74LS192	2.85
74LS15	39	74LS93	1.25	74LS192	2.85
74LS16	49	74LS95	2.19	74LS193	2.85
74LS17	49	74LS96	1.89	74LS194	2.25
74LS18	49	74LS107	65	74LS195	2.25
74LS19	49	74LS107	65	74LS251	1.89
74LS20	49	74LS132	1.55	74LS260	5.5
74LS21	49	74LS136	65	74LS279	.79
74LS22	49	74LS137	1.89	74LS279	.79

### DATA HANDBOOKS

7400	Pin-out & Description of 5400/7400 ICs	\$2.95
CMOS	Pin-out & Description of 4000 Series ICs	\$2.95
Linear	Pin-out & Function Description	\$2.95

ALL THREE HANDBOOKS \$6.95

### 100 PER STRIP MOLEX PINS

Intended for use as an inexpensive substitute for IC sockets. Also perfect for use as board connectors and in subassemblies.

SPECIAL — 100/1.49 — 1000/12.00

## CONSUMER ELECTRONICS

### PONG SUPER PONG PONG

GAMES INCLUDED IN SUPER PONG ARE:

- PONG
- CATCH
- SUPER PONG
- HANDBALL

FEATURES OF PONG AND SUPER PONG

- Incremental speed on volleys increases excitement
- Playing field adjusts to any screen size
- Game appears in color or in black & white, depending on television set.
- Unmistakable "PONG" sound accompanies each volley.
- Digital scoring flashes on the screen between each point.
- 2 player challenge or Solitaire
- Hooks up simply to any model television set, the screen actually becomes the playing field
- English and other languages can be used to make any member of the family a Pong champion
- Battery operated by 4 size D flashlight batteries included with the Unit

AC Adaptor (Eliminates Batteries) \$9.95



### DISCRETE LEADS SPECIAL SALE!

XC209 Red	10/\$1				
XC209 Green	4/\$1				
XC209 Yellow	7/\$1				
XC209 Orange	4/\$1				
XC22 Red	5/\$1				
XC22 Green	4/\$1				
XC22 Yellow	7/\$1				
XC22 Orange	4/\$1				
SSL 22RT	8/\$1				
XC526 Red	10/\$1				
XC526 Green	7/\$1				
XC526 Yellow	4/\$1				
XC526 Orange	4/\$1				
XC526 Clear	7/\$1				
XC556 Red	10/\$1				
XC556 Green	7/\$1				
XC556 Yellow	7/\$1				
XC556 Orange	7/\$1				
XC556 Clear	7/\$1				

### MAN 7 DISPLAY LEADS SUPER SAVINGS!

### DL33B

MAN 1	Common Anode	2.75	2.49	MAN 3620	Common Anode orange	3.00	.99
MAN 2	5 x 7 Dot Matrix	3.00	4.95	MAN 3640	Common Cathode orange	3.00	.99
MAN 3	Common Cathode	1.25	3.71	MAN 4710	Common Anode red	4.00	.99
MAN 4	Common Cathode	1.87	1.95	DL 701	Common Cathode red	3.00	1.99
MAN 5	Common Anode	3.00	.99	DL 707	Common Anode	3.00	1.50
MAN 6	Common Anode green	3.00	1.95	DL 728	Common Cathode	6.00	2.50
MAN 7	Common Anode yellow	3.00	1.95	DL 747	Common Anode	6.00	2.50
MAN 8	Common Anode green	3.00	.99	DL 760	Common Cathode	2.50	4.49
MAN 9	Common Anode red	4.00	.99	DL 33B	Common Cathode	1.10	.99
MAN 10	Common Anode yellow	3.00	1.15	FND303	Common Cathode	2.50	1.29
MAN 11	Common Anode yellow	3.00	1.15	FND507	Common Cathode	5.00	1.29
MAN 12	Common Cathode	3.00	.99				

### IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

8 pin	1.24	25-49	50-100	24 pin	1.24	25-49	50-100
14 pin	\$0.17	16	15	36 pin	\$3.38	37	36
16 pin	\$0.22	21	20	38 pin	\$0.60	59	58
18 pin	\$0.29	28	27	40 pin	\$0.63	62	61
22 pin	\$0.37	36	35				

### SOLDERTAIL STANDARD (TIN)

14 pin	\$0.27	25	24	28 pin	\$0.99	90	81
16 pin	\$0.30	27	25	36 pin	1.59	1.26	1.15
18 pin	\$0.35	32	30	40 pin	1.59	1.45	1.30
24 pin	\$0.49	45	42				

### SOLDERTAIL STANDARD (GOLD)

8 pin	\$0.30	27	24	24 pin	\$0.70	60	57
14 pin	\$0.35	32	29	28 pin	1.10	1.00	.93
16 pin	\$0.38	35	32	36 pin	1.75	1.40	1.26
18 pin	\$0.42	41	38	40 pin	1.75	1.59	1.45

### WIRE WRAP SOCKETS (GOLD) LEVEL #3

10 pin	\$0.45	41	37	24 pin	\$1.05	95	85
14 pin	\$0.39	38	37	28 pin	1.40	1.25	1.10
16 pin	\$0.43	42	41	36 pin	1.59	1.45	1.30
18 pin	\$0.45	42	41	40 pin	1.75	1.55	1.40

### 50 PCS. RESISTOR ASSORTMENTS \$1.75 PER ASS'T.

ASS'T. 1	5 ea.	10 OHM	12 OHM	15 OHM	18 OHM	22 OHM	27 OHM	33 OHM	39 OHM	47 OHM	56 OHM	1/4 WATT 5% — 50 PCS.
ASS'T. 2	5 ea.	68 OHM	82 OHM	100 OHM	120 OHM	150 OHM	180 OHM	220 OHM	270 OHM	330 OHM	390 OHM	1/4 WATT 5% — 50 PCS.
ASS'T. 3	5 ea.	470 OHM	560 OHM	680 OHM	820 OHM	1K	1.2K	1.5K	1.8K	2.2K	2.7K	1/4 WATT 5% — 50 PCS.
ASS'T. 4	5 ea.	3.3K	3.9K	4.7K	5.6K	6.8K	8.2K	10K	12K	15K	18K	1/4 WATT 5% — 50 PCS.
ASS'T. 5	5 ea.	22K	27K	33K	39K	47K	56K	68K	82K	100K	120K	1/4 WATT 5% — 50 PCS.
ASS'T. 6	5 ea.	150K	180K	220K	270K	330K	390K	470K	560K	680K	820K	1/4 WATT 5% — 50 PCS.
ASS'T. 7	5 ea.	1M	1.2M	1.5M	1.8M	2.2M	2.7M	3.3M	3.9M	4.7M	5.6M	1/4 WATT 5% — 50 PCS.

5 EACH MINIMUM PER VALUE ON ANY RESISTORS FROM 2.2 OHM TO 5.6M

5-25 PCS .05 ea. 30-95 PCS .04 ea. 100-495 PCS .03 ea. 500-995 .0275 ea.

SINGLE TURN 1/4" CERMET POTENTIOMETER

- Resistance Tolerance ± 20%
- High Power — 0.5 Watt at 70°C
- Wide Operating Temp. Range — 55°C to +125°C

\$0.89

STANDARD RESISTANCE VALUES

50Ω 100Ω 500Ω 1K 2K 5K 10K 20K 50K 100K 200K 500K 1 MEG

\*Astrisk Denotes Items On Special For This Month\*

Satisfaction Guaranteed. \$5.00 Min. Order. U.S. Funds.  
California Residents — Add 6% Sales Tax — Data Sheets 25c each  
Send a 13c Stamp (postage) for a FREE 1976 Catalog

### MINIATURE TOGGLE

DPDT	ON OFF ON	221	2.95	2.55	1.87	1.70
	ON NONE ON	223	2.95	2.15	1.58	1.43
	ON OFF ON	121	2.15	1.95	1.43	1.30
	ON NONE ON	123	2.05	1.85	1.21	1.10

### PB-123 \$1.75

Miniature Toggle Switch

### PB-126 \$1.75

Miniature Toggle Switch

### THUMBWHEEL SWITCHES

SP 17</
---------

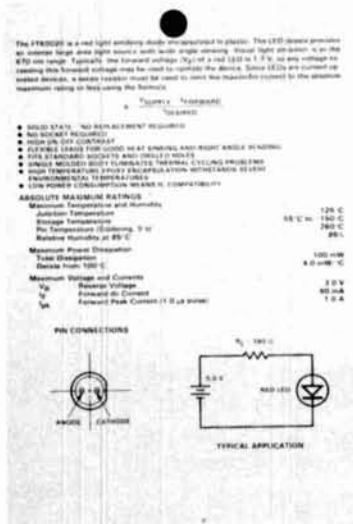
# SOLID STATE TECHNOLOGY KIT

- FOR THE EXPERIMENTER WITH TASTE FOR "STATE OF THE ART" PRODUCTS
- COMPLETE SPECIFICATIONS ARE PRINTED ON THE BACK OF EACH TECHNOLOGY KIT

FTK0020

FTK0020

FTK0011



CARD FRONT

CARD BACK

CARD FRONT

**DIGITS**

FTK0001	0.5" High Common Cathode Digit	\$1.00
FTK0002	0.5" High Common Anode Digit	1.00
FTK0003	.357" High Common Cathode Digit	.75
FTK0004	0.8" High Common Cathode Digit	2.00
FTK0005	0.8" High Common Anode Digit	2.00

**0.8" HIGH DISPLAY ARRAYS**

FTK0010	12 Hour, 3 1/2 Digit Clock Display	7.00
FTK0011	24 Hour, 4 Digit Clock Display	8.00

**LED LAMPS**

FTK0020	10 Red LED Lamps	1.00
FTK0021	5 Mixed Colored LED Lamps	1.00
FTK0022	10 LED Mounting Clips	1.00
FTK0023	5 Three Piece LED Mounting Adapters	1.00

**PHOTO TRANSISTORS**

FTK0030	5 Flat Lens Photo Transistors	1.00
FTK0031	5 Round Lens Photo Transistors	1.00
FTK0032	3 Flat Lens Photo Darlington	1.00
FTK0033	3 Round Lens Photo Darlington	1.00

**PHOTO ARRAYS**

FTK0040	9-Element Tape Reader Array	16.00
FTK0041	12-Element Card Reader Array	24.00
FTK0042	Reflective Opto Coupler	4.00

**COUPLERS**

FTK0050	3 General Purpose Opto Couplers	1.00
FTK0051	Darlington Opto Coupler	1.00

**MOS CLOCK CIRCUITS**

FTK0400	Digital Clock/Calendar Circuit (FCM7001)	7.00
FTK0401	Digital Clock/Calendar with BCD Outputs (FCM7002)	7.00
FTK0402	Direct Drive Digital Clock Circuit with AC Output (FCM3817A)	5.00
FTK0403	Direct Drive Digital Clock Circuit with DC Output (FCM3817D)	5.00
FTK0405	Direct Drive Digital Clock/Calendar Circuit (FCM7015)	6.00

**KITS**

FTK0106	Automobile Clock Kit	40.00
---------	----------------------	-------

• THESE PRODUCTS ARE PACKAGED FOR OUT-STANDING WALL DISPLAY APPEARANCE

• DEALER'S AND WHOLESALER'S INQUIRIES INVITED—PRICE LIST AVAILABLE.

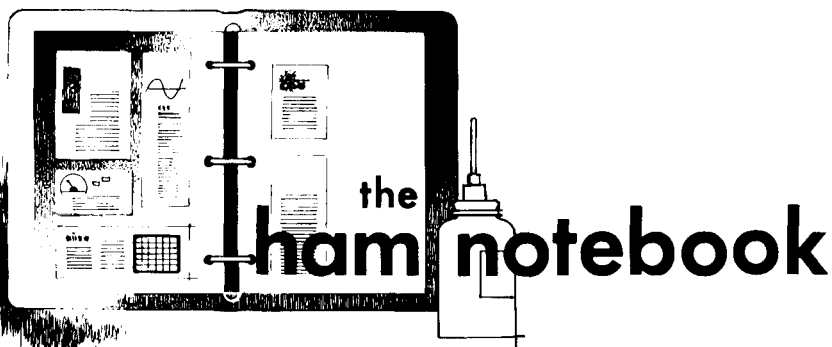
• FULL **FAIRCHILD** PRODUCT LINE TO FOLLOW

• BUY WITH PRIDE THE PRODUCTS BUILT BY THE INDUSTRY'S LEADER — **FAIRCHILD**

Satisfaction Guaranteed. \$5.00 Min. Order. U.S. Funds. California Residents — Add 6% Sales Tax. Send a 13c Stamp (postage) for a FREE 1976 Catalog.

*JAMES*

1021 HOWARD STREET  
SAN CARLOS, CA 94070  
PHONE ORDERS — (415) 592-8097



## another squelch circuit

Interest has developed in the squelch circuit appearing in the September, 1974, issue of *ham radio*, page 68, which was published before the inexpensive and popular LM380 audio amplifier IC became readily available. Fig. 1

signal conditions. A carrier activates the LM380. R6 determines the length of the squelch tail, and R5 controls the promptness to which the circuit responds to carrier signals. Increasing the value of C1 increases the noise-amplifier gain, but the smaller the value of C1, the less susceptible the circuit will be in

abrade the surface to be lettered gently with very fine (0000 or finer) sandpaper and water, and then to dry it thoroughly before lettering. Alternatively, swab the area to be lettered with acetone (most nail polish removers will do). Other solvents probably would work as well, but I have not experimented with

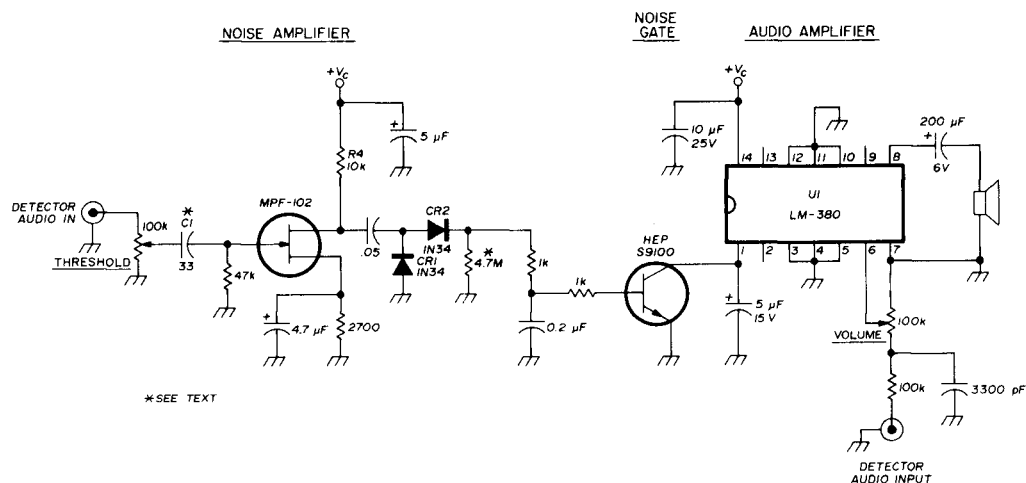


fig. 1. Squelch circuit using the M-380 audio amplifier IC.

shows a squelch circuit with excellent performance and greater simplicity.\*

Transistor Q1 amplifies random noise which is greater in frequency than the normal spectrum occupied by voice communications during no-signal conditions. Diodes CR1 and CR2 rectify the noise, which is filtered by R6, C5. Q2 conducts and clamps U1 off during no-

responding to heavy voice peaks, thus the more positive its operation. Cost of the parts at the time of this writing: Q1 \$0.45, Q2 \$0.77, U1 \$1.65. Not bad!

Robert Harris, WB4WSU

## transfer letters

In the past I have had great difficulty with dry transfer letters failing to adhere to various surfaces, especially unfinished aluminum. There are two techniques which I have found helpful in overcoming this problem. The first is to

them. Either of these methods should always be used before trying to letter a raw aluminum surface that has been handled, or etched in a sodium hydroxide bath (this process leaves a waxy film on the aluminum, and the letters will not adhere to it).

Michael Tortorella, WA2TGL

## voltage safety valve

The safety circuit in fig. 2 was developed after several accidents where a power transistor shorted in a low-



voltage power supply causing the transformer output voltage to be supplied to a solid-state transceiver. This voltage could be up to three times the rectified voltage and could cause considerable damage to the transceiver.

A high wattage zener diode could be used across the output of the power supplied, but it takes a very large zener to blow a fuse. Furthermore, the zener could burn open if used to carry currents above its rating.

What was needed was a circuit that would respond when a set limiting voltage was reached and cut off the current flow. The circuit in fig. 2 is simple and cheap, and uses a relay with contacts large enough to handle the required current (6 or 8 amperes should be ample). The relay coil should be about 200 ohms, the potentiometer 100 ohms or more, the zener diode is a 6 or 8 volt, 10 watt unit.

This circuit can be adjusted to trip at 14 to 24 volts. When the limiting volt-

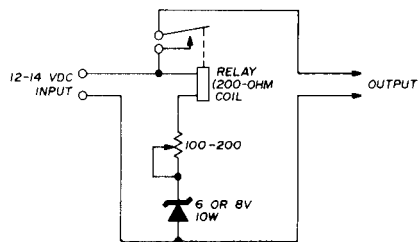


fig. 2. Over-voltage protection circuit. Potentiometer can be set so relay picks up at any preset voltage between 14 and 24 volts.

age is reached the relay opens up, breaking the circuit to the transceiver. The residual charge in the circuit will hold the relay open until the voltage drops or the power is disconnected.

Harold C. Dressel, W2UVF

## Swan 250 carrier suppression

Most Swan 250 transceivers have only about 30 to 35 dB carrier rejection. I have done some work on my unit and now have obtained more than 50 dB carrier rejection. All I did was put 1% resistors in the plate and screen circuits, remove the original 5k carrier balance pot, and install a ten-turn 2000-ohm pot with 1.5k resistors on

each side of the pot to give finer control (see circuit in fig. 3).

After doing this I can still insert enough carrier to get full power output from the Swan 250. Before the modification I had about 150 mW of output power with the carrier completely nulled; now, with the carrier completely nulled, output is only 1.5 mW. All measurements were made with a Bird Thru-line wattmeter.

Charles A. Beener, WB8LGA

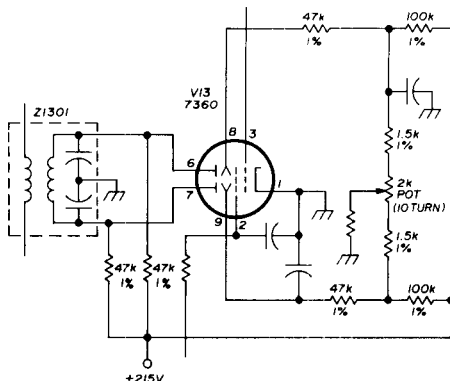


fig. 3. New carrier-balance circuit for the Swan 250 increases carrier suppression to 50 dB or more. The 2000-ohm pot is a miniature, precision 10-turn unit (Bournes 3707).

## using your signal generator for absorption measurements

An absorption meter measures the frequency of an rf circuit to which it is coupled. Like a conventional signal generator, it uses an rf tank circuit to tune over the desired band. Therefore, it is logical to combine both functions in a single instrument. I modified my RCA model WR-50A signal generator to also operate as an absorption meter. Performance of the generator is not affected in any way.

The following are added: two RCA-type phono jacks on the front panel, an rf detecting diode, and a pickup (search) coil (see fig. 4). J1 is for the coil, J2 for a 50  $\mu$ A meter. There is only a slight error in the dial calibration for absorption measurements (due to the pickup coil shunting the cathode portion of the generator tank).

The search coil does not have to be plugged in at the panel where it would be awkward to couple to anything, but

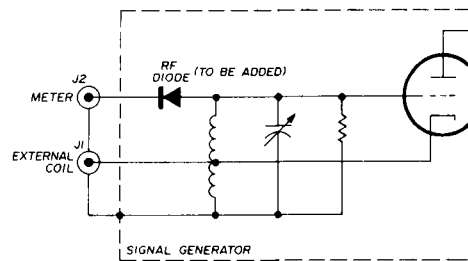


fig. 4. The rf pickup coil is rectified by the diode and indicated by the meter.

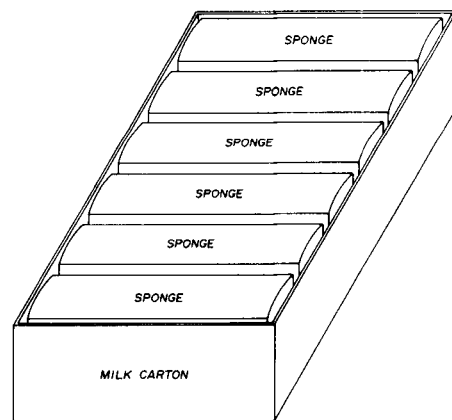
may be plugged in at the far end of an extension cable. I use 4 feet (1.2m) of ordinary shielded audio cable and find that 8 turns around a 1/4 inch (6.5mm) polystyrene coil form works well up to the frequency limit of the generator (40 MHz). An RCA phono plug is mounted on the coil form.

When you are ready to test the absorption device, couple its search coil to a grid-dip meter. At resonance, the meter will read about full-scale with the coils 1/2 inch (13mm) apart. Turn off the signal generator when making absorption measurements.

I. Queen, W2OUX

## soldering tip cleaner

A clean soldering-iron tip helps make reliable solder connections. Fig. 5 shows an inexpensive tip cleaner made from a half-pint (1/4 liter) milk container and some sponges cut to fit the container.



SOLDERING IRON TIP CLEANER

fig. 5. Soldering iron tip cleaner.

Best results are obtained when the sponges are kept moist. To clean your soldering iron, just insert the tip between the sponges.

Gary Tater, W3HUC



- Advance Registration \$12.50 per person; with Hotel Sahara Late Show and two drinks \$23.00 per person or with Hotel Sahara Congo Dinner Show (entree Cornish Hen), no drinks \$30.00 per person. Tax and Gratuity included.
- Totie Fields and Bert Convy are scheduled entertainers in Hotel Sahara's Congo Room.
- Advance Registration must be received by **SAROC** on or before January 1, 1977.

## The NATION'S TWELFTH ANNUAL LAS VEGAS PRESTIGE CONVENTION



## HOTEL SAHARA'S CONVENTION SPACE CENTER

# January 6-9, 1977

- **SAROC** Registration includes: registration tickets, admission to technical sessions, Friday cocktail party hosted by T. P. L. Communications and TRI-EX Tower Corp. with **SAROC**; Saturday cocktail party hosted by Ham Radio Magazine with **SAROC**; Hotel Sahara Buffet Brunch on Sunday, Tax and Gratuity.
- Hotel Sahara room rate for **SAROC** registered delegates \$17.00 per night plus room tax, single or double occupancy.
- Hotel Sahara room reservation request card will be sent to **SAROC** registered delegate.



Send your check or money order to **SAROC**, P. O. Box 945, Boulder City, NV 89005

# We have the perfect mobile/portable HF SSB Transceiver for you.



## The Atlas 210x/215x

The Atlas 210x or 215x measures only 9½" wide x 9½" deep x only 3½" high, yet the above photograph shows how easily the Atlas transceiver fits into a compact car. And there's plenty of room to spare for VHF gear and other accessory equipment. With the exclusive Atlas plug-in design, you can slip your Atlas in and out of your car in a matter of seconds. All connections are made automatically.

### BUT DON'T LET THE SMALL SIZE FOOL YOU!

Even though the Atlas 210x and 215x transceivers are less than half the size and weight of other HF transceivers, The Atlas is truly a giant in performance.

### 200 WATTS POWER RATING!

This power level in a seven pound transceiver is incredible but true. Atlas transceivers give you all the talk power you need to work the world barefoot. Signal reports constantly reflect great surprise at the signal strength in relation to the power rating.

### FULL 5 BAND COVERAGE

The 210x covers 10-80 meters, while the 215x covers 15-160 meters. Adding the Atlas Model 10x Crystal Oscillator provides greatly increased frequency coverage for MARS and network operation.

### NO TRANSMITTER TUNING OR LOADING CONTROLS

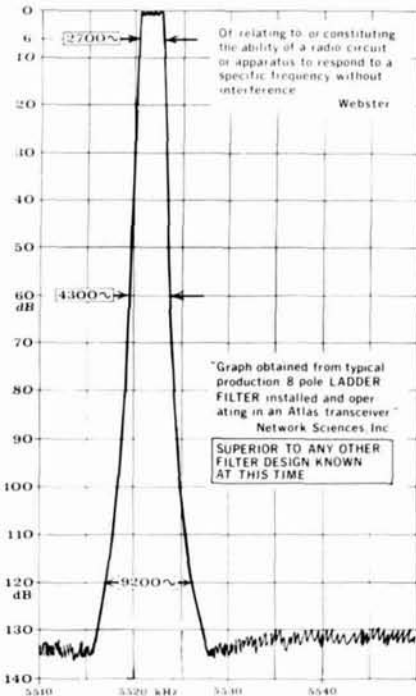
with Atlas' total broadbanding. With your Atlas you get instant QSY and band change.

### MOST ADVANCED STATE OF THE ART SOLID STATE DESIGN

not only accounts for its light weight, but assures you years of top performance and trouble free operating pleasure.

### PLUG-IN CIRCUIT BOARDS

and modular design provides for ease of servicing.



### PHENOMENAL SELECTIVITY

The exclusive 8 pole crystal ladder filter used in Atlas transceivers represents a major breakthrough in filter design, with unprecedented skirt selectivity and ultimate rejection. As the above graph shows, this filter provides a 6 db bandwidth of 2700 Hertz, 60 db down of only 4300 Hertz, and a bandwidth of only 9200 Hertz at 120 db down! Ultimate rejection is in excess of 130 db; greater than the measuring limits of most test equipment.

**EXCEPTIONAL IMMUNITY TO STRONG SIGNAL OVERLOAD AND CROSS MODULATION.** The exclusive front end design in the receiver allows you to operate closer in frequency to strong neighboring signals than you have ever experienced before. If you have not yet operated an Atlas transceiver in a crowded band and compared it with any other receiver or transceiver, you have a real thrill coming.

### ATLAS AMATEUR RADIO EQUIPMENT:

Model 210x or 215x Transceiver . . . . . \$679  
With noise blanker installed \$719

### ACCESSORIES

AC Console 110/220V . . . . . \$147  
With VOX \$194  
Portable AC Supply 110/220V . . . . . \$100  
Plug-in Mobile Kit . . . . . \$48  
Auxiliary VFO Model 206  
Includes Digital Dial . . . . . \$299  
Model DD6-B Digital Dial only . . . . . \$229  
10x Osc. less crystals . . . . . \$59  
Matching Transformer MT-1 . . . . . \$27  
Model VX-5M Self-contained VOX . . . . . \$55

### NEW FROM ATLAS

DL 200 Dummy Load  
200 watt intermittent or 60 watt continuous power rating. Housed in a compact one pint can . . . . . \$9  
(These new prices effective Oct. 1, 1976)

For complete details see your Atlas dealer, or drop us a card and we'll mail you a brochure with dealer list.



417 Via Del Monte • Oceanside, CA 92054  
Phone (714) 433-1983

## high-current regulated power supplies

VHF Engineering, Binghamton, New York, has announced two new regulated 12-volt dc power supplies for use in amateur and commercial applications. The two power supplies have current ratings of 15 amps at 10 to 12 volts dc, and 25 amps at 10 to 12 volts dc, respectively. Voltage regulation is 2% from no load to maximum rated current.

These new power supplies feature over-voltage protection and fold-back current limiting. Over-voltage protection is provided by a crowbar circuit which will shut down the supply if its output voltage exceeds 14 volts, thereby protecting the equipment being powered. The foldback current-limiting circuit limits the output current to a maximum of 1 amp if the output is shorted. This protects the power supply from damage and prevents high current from flowing into a piece of equipment that may have developed an internal short. When the short is removed, the power supply output returns to normal.

These regulated power supplies have been designed to commercial standards and use tinned, glass-filled epoxy circuit boards and high quality components. Additional information may be obtained from VHF Engineering, 320 Water Street, P.O. Box 1921, Binghamton, New York 13902 or use *check-off* on page 134.

## air-variable capacitors

Among the components which are most difficult to find these days are air-variable capacitors, especially those rated for transmitting powers. Now,

model	type	capacitance		voltage rating	price
		minimum	maximum		
D-88-120	single	53 pF	208 pF	6000	\$23.50
D-140-75	single	23 pF	140 pF	4500	16.50
D-232-45	single	23 pF	232 pF	3000	16.50
D-500-45	single	48 pF	500 pF	3000	19.50
DD-150	dual	33 pF	205 pF	3000	20.00

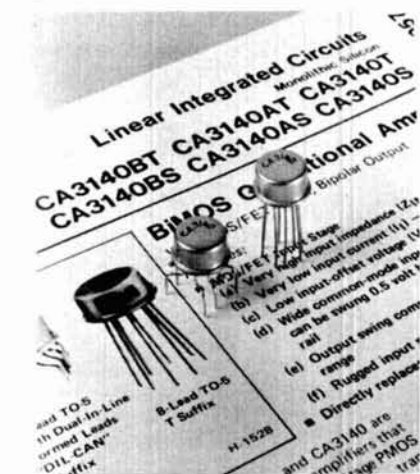
(per section)

however, the Dentron Radio Company is offering a line of air variables which are suitable for most amateur applications in transmitters and antenna tuning units. Listed in the table above are the electrical specifications for these

capacitors.

These air-variable capacitors may be ordered directly from Dentron Radio Company, 2100 Enterprise Parkway, Twinsburg, Ohio 44087. For more information use *check-off* on page 134.

## bipolar/mos op amp



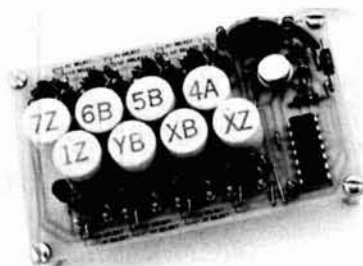
A new bipolar/mos op amp, the CA3140, featuring a pmos input stage and a bipolar output stage with a wide output voltage range, has been introduced by RCA Solid State Division. Its versatility permits it to fill virtually all 741 sockets and, at the same time, most of the premium op amp sockets currently served. The pmos input stage is similar to the one used in the RCA CA3130 op amp but with internal compensation and the ability to operate from a supply voltage between 4 and 44 volts, dual or single supply. A special feature is the addition of bipolar diodes which protect the input to such an extent that preliminary tests, under simulated electrostatic conditions up to 1000 volts, show the CA3140 to be more rugged than any other device yet

tested, including bipolar and fet input op amps.

Typical performance features for the CA3140 include: an input impedance of 1500 megohms; input current of 10 pA at  $\pm 15$  volts, low input-offset voltage of



## sub-audible tone encoder



Communications Specialists announce their new ME-8, a sub-audible tone encoder for repeater access. Measuring only 2x3x9 inches (5x7.5x22.5cm) and operating on any voltage between 6 and 16 volts dc, the unit is capable of generating any eight of the 32 EIA tone codes between 67.0 and 203.5 Hz.

Frequency selection is made by supplying ground or positive voltage to the desired control lead, and plugging in the desired K-1 element. The unit is completely immune to rf and has a start-up time of only 10 milliseconds. Frequency accuracy and stability are excellent and the output is a low-distortion sinewave at 3 volts rms.

The ME-8 is priced at \$79.95 and includes eight K-1 elements. Extra elements are available for \$3.00 each. For additional information write Communications Specialists, Post Office Box 153, La Brea, California 92621 or use *check-off* on page 134.

5 mV, wide common-mode input voltage range, -0.5V below negative bus; output swing to within 0.2 volt of negative supply; high and low operating supply voltage of 4 to 44 volts, high slew rate of 9V/ $\mu$ s; high gain bandwidth product of 4.5 MHz; and fast settling time of 1.4  $\mu$ s, to 10 mV with a 10 volt<sub>p-p</sub> signal. The new device is available in the basic TO-5 package or the dual-in-line package.

The breadth of applications permits the device to replace numerous op amp categories such as general purpose, fet-input, and wideband or high slew-rate types. The wide bandwidth feature reduces costs by permitting wideband video and audio circuits at lower cost than with current op amps, as well as lower-cost wideband TTL interfaces. The strobable output stage allows the output to be driven low, independent of the input signal. The fact that the output swings to within 0.2 volt of the negative supply permits power transistors to be driven directly, thus eliminating level shifting circuitry.

For additional information, including copies of the 20-page data sheet, File no. 957, and a descriptive applications brochure, Publication no. 2M1144, offering a free sample, write to RCA Solid State Division, Box 3200, Somerville, New Jersey 08876 or use *check-off* on page 134.

## digital pulse generator



Continental Specialties Corporation has introduced the Design Mate-4, a versatile, laboratory-quality generator which lists for \$124.95. The DM-4 may be used as a clock source, delayed pulse generator, synchronous clock source, manual system stepper, pulse stretcher, or clock burst generator.

The DM-4 is designed to fill the bill wherever a source of clean, crisp, fast output pulses compatible with virtually

# No Other 2 Meter Transceiver Provides The Features Of The

## Cleqq FM-DX



• 143.5 - 148.5 MHz.

- 5KHz STEPS
- 35-45 WATTS
- LARGE LED FREQUENCY DISPLAY
- CHOICE OF 8 POLE OR SUPER SELECTIVE 16 POLE FILTER
- 100% DUTY CYCLE
- ACCOMMODATES MARS, CAP, ETC.
- CLEANEST TRANSMIT SPECTRUM
- INTERMOD IMMUNE RECEIVER
- MADE IN THE USA
- .25 uv RECEIVER
- COMPACT, ATTRACTIVE, RUGGED.
- INTERMOD IMMUNE RECEIVER

Direct from *Cleqq* only . . . . .  
 Phone toll free for brochure  
 or to order your FM-DX!

FM-DX complete with mike and accessories - \$599.00  
 or with 16 pole super filter - \$650.00  
 MASTERCHARGE & BANKAMERICA CARDS WELCOME

(Please add 2% on credit card purchases,  
 we pay shipping on orders accompanied by check or money order.)

*Cleqq* Communications Corp.

208 Centerville Road, Lancaster, PA 17603  
 Toll free sales & services - Phone (800) 233-0250  
 In Pa. call (717) 299-7221 (collect)

# DUPAGE FM

**WILL NOT BE UNDERSOLD!**

## FALL SPECIALS FOR TWO METER MOBILEERS

### RCA SUPERCARFONES

These rigs are ideal for two meter ham or commercial uses. No conversion needed for the ham band.

Frequency range: 148 to 174 mc • Output power: 30 watts  
Receiver sensitivity: .35 microvolt for 12 dB SINAD • Standby drain: 200 mA.  
Fully transistorized receiver and exciter.  
Plug in any tone coded squelch accessory designed for 12 volts.  
While they last — ONLY \$175.00 each, with accessories.

2 to 5 units \$160.00 each      6 or more \$150.00 each

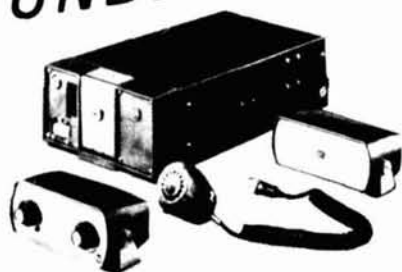
**ACT NOW, AT THESE PRICES WE WON'T HAVE THESE RIGS VERY LONG.**

**PORTABLE USERS:** We still have a few RCA TACTECS available for two meter use. Prices start at \$375.00 each. Call any evening for details.

Send check or money order to:

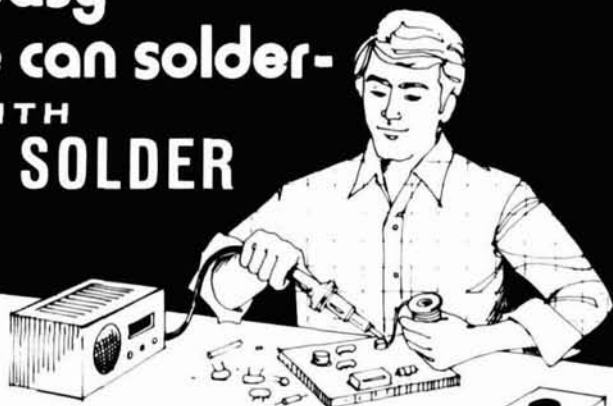
**DUPAGE FM Inc.**  
P. O. Box 1, Lombard, IL 60148 • (312) 627-3540

**TERMS:** All items subject to prior sale, sold as is. If not as represented return for exchange or refund (our option) within 5 days of receipt, freight prepaid. All items are shipped freight collect. Illinois residents add 5% sales tax. Accessories do not include antennas, relays, crystals or reeds.



## This is easy- anyone can solder- WITH KESTER SOLDER

**KESTER  
SOLDER**



## Handymen! Hobbyists! DO-IT-YOURSELFERS!

Let Kester Solder aid you in your home repairs or hobbies. For that household item that needs repairing — a radio, TV, model train, jewelry, appliances, minor electrical repairs, plumbing, etc. — Save money — repair it yourself. Soldering with Kester is a simple, inexpensive way to permanently join two metals.

When you Solder go "First Class" — use Kester Solder.

For valuable soldering information write Kester for your Free copy of "Soldering Simplified".



**KESTER SOLDER**

Litton 4201 WRIGHTWOOD AVENUE/CHICAGO, ILLINOIS 60639

all logic families and discrete circuits is required. It is capable of generating symmetrical and asymmetrical pulses from 0.5 Hz - 5 MHz and has a positive output of 100 mV to 10 V, with a rise and fall time of less than 30 nanoseconds. Additionally, the DM-4 offers an independently controlled pulse width and spacing from 100 ns to 1 second in seven overlapping ranges, as well as independent variable-amplitude CMOS, and fixed-amplitude TTL outputs. The unit operates either continuously or in manual one-shot fashion. It also features external triggering from dc to 10 MHz and synchronous output gating.

For more information contact Continental Specialties Corporation, 44 Kendall Street, Box 1942, New Haven, Connecticut 06509 or use *check-off* on page 134.

## electronic keyer



The *CW Sendin' Machine* was designed by an amateur and allows you to write in your log while it sends your routine information. Not only a fine keyer with iambic operation and dot and dash memories, it is also equipped with two random-access memories that can store short CW messages and send them at the push of a button.

The model 2048 is equipped with a cord and plug to be connected to your favorite paddle. The keyer contains no relays and can operate into open-key voltages of up to 150 volts and closed-key currents to 10 mA. Sidetone level can be controlled by a volume control; pitch can be varied by a pot on the PC board.

The *CW Sendin' Machine* model 2048 comes with two 1024-bit memories, and an automatic reset feature is available as a modification which can be added to your board. The PC board is on a connector for easy service. The board operates on 5 volts at 400 mA.

For more information write H.A. Harp, WA4SVH, 718 Magnolia Dr., Lake Park, Florida 33403 or use *check-off* on page 134.

## short circuits

### frequency synthesizers

Several errors crept into DJ2LR's excellent article on frequency synthesizers in the July, 1976, issue of *ham radio*. In fig. 13 (page 16), the wiper of the 4.7k potentiometer between the emitters of the two 2N3570 transistors should be grounded. In fig. 17 the input labeled "10 kHz from divider" should show a pulse width of 200-500 nanoseconds (not microseconds). In fig. 20 the CD4000 gate should be a 74COO, and in fig. 23 the gate with three inputs which is not identified is a 74LS30. Finally, the caption to fig. 24 on page 23 is incorrect — this circuit adds 41 MHz to the synthesizer reading.

### DT-600 RTTY demodulator

In the schematic of the DT-600 RTTY demodulator in the February, 1976, issue of *ham radio* one end of the 10k balance pot (at the input to U1, wiper connected to R9) should go to -12 Vdc. This pot should be labeled R8. In fig. 5 the horizontal axis was measured in Hz but mistakenly labeled in baud; none of the standard RTTY speeds (60, 75, and 100 wpm) are attenuated. Potentiometers to fit the circuit board are available from Data Technology Associates, Inc., Box 431912, Miami, Florida 33143. A set of four pots is priced at \$2.00.

### DT-500 RTTY demodulator

Due to an editorial oversight, the names of co-authors Gary K. Barrell, K4OAH, and Archie C. Lamb, WB4KUR, were inadvertently deleted from the cover page of the DT-500 article in the March, 1976, issue. In addition, in fig. 2 (page 26), the negative return from the +170 volt loop supply should be connected to ground through a 2500 ohm, 20 watt resistor. Printed-circuit boards for the DT-500 are priced at \$10.50 from Data Technology Associates, Inc., Box 431912, Miami, Florida 33143. A set of four PC potentiometers is available from the same source for \$2.00.

### S-line frequency synthesizer

In the S-line frequency synthesizer article published in the December, 1975, issue, in fig. 3 (page 12) R2 should be connected to pins 4 and 5 of U1B, not pin 6. The parts layout in fig. 10 is correct.

# GET TO THE TOP FAST!

**NOW YOU CAN CHANGE, ADJUST OR JUST PLAIN WORK ON YOUR ANTENNA AND NEVER LEAVE THE GROUND!**

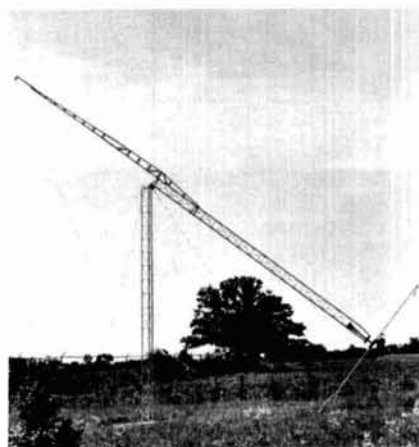
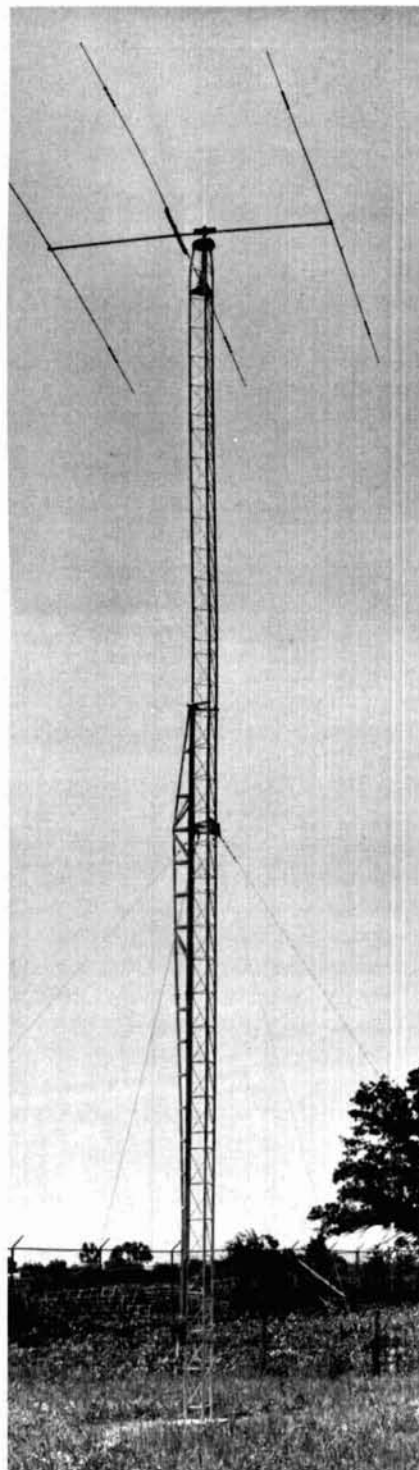
Rohn manufactures towers that are designed and engineered to do specific jobs and that is why we have the FOLD-OVER TOWER... designed for the amateur. When you need to "get at" your antenna just turn the handle and there it is. Rohn "fold-over" towers offer unbeatable safety. These towers let you work completely on the ground for antenna and rotator installation and servicing. This eliminates the hazard of climbing the tower and trying to work at heights that could mean serious injury in a fall. So use the tower that reduces the risks of physical danger to an absolute minimum... the Rohn "fold-over"!

Like other Rohn big communication towers, they're hot dip galvanized after fabrication to provide a maintenance free, long lived and attractive installation. Rohn towers are known and used throughout the world... for almost a quarter century... in most every type of operation. You'll be in good company. Why not check with your distributor today?



**Unarco-Rohn**

Division of Unarco Industries, Inc.  
P.O. Box 2000, Peoria, Illinois 61601

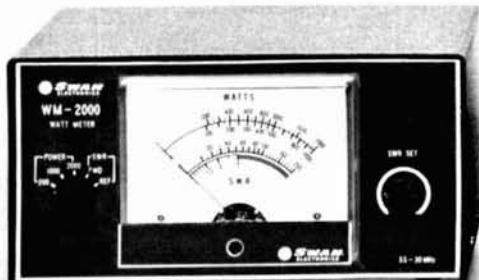


# SWAN METERS HELP YOU GET IT ALL TOGETHER

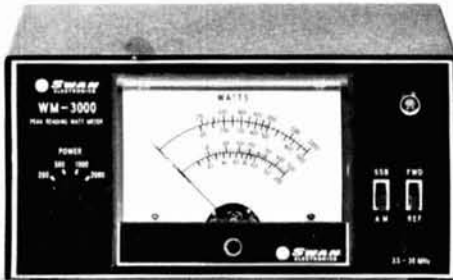
These wattmeters tell you what's going on.

With one of these in-line wattmeters you'll know if you're getting it all together all the time. Need high accuracy? High power handling? Peak

power readings? For whatever purpose we've got the wattmeter for you. Use your Swan credit card. Applications at your dealer or write to us.



**WM2000 In-Line Wattmeter With Muscle.** Scales to 2000 watts. New flat-response directional coupler for maximum accuracy. \$49.95



**WM3000 Peak-reading Wattmeter.** Reads RMS power, then with the flick of a switch, true peak power of your single-sideband signal. That's what counts on SSB. \$66.95



**WM1500 High-Accuracy In-Line Wattmeter.** 10% full scale accuracy on 5, 50, 500 and 1500 watt scales, 2 to 30 MHz. Forward and reflected power. Use it for trouble-shooting, too. \$64.95



**SWAN ELECTRONICS**  
A subsidiary of Cubic Corporation  
305 Airport Road, Oceanside, CA 92054  
(714) 757-7525

(Prices FOB Oceanside, CA)

## DON & BOB'S SUPER BUYS

### OCTOBER RECEIVER DEALS

R-4C, R599D, SSR-1, SPR4 . . . Call or Write

HY GAIN TH6DX	\$192.00
TH3MK3 3 ELEMENT BEAM, 20, 15, 10	\$160.00
MOSLEY CLASSIC 33	\$179.00
GREAT BUYS ON 204BA, 402BA	
BN86	\$15.95
CDE HAM-II ROTOR	\$129.00
KLM (KENPRO) ROTOR + 100 FT. OF CABLE	\$100.00
18HT HY TOWER	\$218.00
ROHN 25G TOWER & ACCESSORIES	Call or Write
BELDEN 8214 RG-8/U FOAM COAX	23¢/FT.
BELDEN 8237 RG-8/U	19¢/FT.
BELDEN 8 WIRE ROTOR CABLE #8448	14¢/FT.
AMPHENOL PL-259	59¢
CALL FOR QUOTES — TS-520, TS-820, TS-700A, 210X.	
TEMPO 2020 & MULTI 2700	Call or Write
BOOKS	
SWAN SWR-1	\$18.95
ELECTRA BEARCAT 101	\$319.00
RAYTHEON 811A, SEALED BOXES	\$15 per pair
PENETRATOR 200 W BASE AMPLIFIER	\$275.00

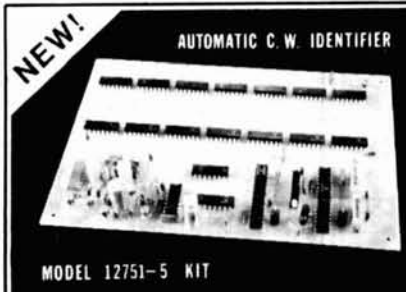
ALL PRICES FOB HOUSTON. CALL TODAY FOR ITEMS NOT LISTED

## MADISON ELECTRONICS SUPPLY, INC.

1508 MCKINNEY AVENUE, HOUSTON, TEXAS 77002

713/658-0268

Nites 713/497-5683



NEW!

AUTOMATIC C.W. IDENTIFIER

MODEL 12751-5 KIT

### Special Introductory Offer, \$4995\*

(Reg. \$59.95) Offer extended through Dec. 31, 1976

#### FEATURES:

- CONNECTS IN LINE BETWEEN MIC. AND MIC. JACK, REQUIRING NO MODIFICATION TO TRANSCEIVER.
- SOLID STATE RELIABILITY.
- AUTOMATIC TIMER CAN BE SET FROM 1 MIN. TO 10 MIN.
- ADJUSTABLE CODE SPEED FROM 5 TO 40 WPM.
- ADJUSTABLE CODE TONE AND AUDIO LEVEL.
- EASILY PROGRAMMED WITH ANY U.S. CALL SIGN.
- SPECIALLY DESIGNED CIRCUITRY ASSURES CORRECT AND FULL ID. EVERY TIME.
- OPERATES IN AUTOMATIC OR MANUAL MODES.
- IDEAL FOR BASE, MOBILE, OR REPEATER OPERATION.

#### KIT INCLUDES:

- QUALITY 5 X 7 PRINTED CIRCUIT BOARD, COMPONENTS, AND 20 PAGE INSTRUCTION AND ASSEMBLY MANUAL.
- FULL 90 DAY WARRANTY.

AVAILABLE NOW!

\*Calif. res. add 6% tax  
Include \$2 shpg./handling  
Phone (408) 263-3107

Send check or MO to:

**SECURITRON**

P. O. Box 24899  
San Jose, Ca 95154



There is no substitute for quality, performance, or the satisfaction of owning the very best.

Hence, the incomparable Hy-Gain 3750 Amateur transceiver. The 3750 covers all amateur bands 1.8-30 MHz (160-10 meters). It utilizes advanced Phase-Lock-Loop circuitry with dual gate MOS FET's at all critical RF amplifier and mixer stages. There's a rotating dial for easy band-scanning and an electronic frequency counter with digital readout and a memory display that remembers frequencies at the flip of a switch. And that's just the beginning.

Matching speaker unit (3854) and complete external VFO (3855) also available.

See the incomparable Hy-Gain 3750 at your radio dealer or write Department MM. There is no substitute.



3854

3750

3855

# There is no substitute.

**hy-gain**<sup>®</sup>  
Amateur Radio Systems.

Hy-Gain Electronics Corporation  
8601 Northeast Highway Six; Lincoln, NE 68505

© 1976 Hy-Gain

# Performance... your choice for under \$299\*

**Horizon "2" outclasses them all!** 25 watt output 2 Meter FM transceiver for HAM, CAP, and MARS • Full 12 channel capability • All solid state • Compact size: 6¼ x 2½ x 9 inches • Weighs less than 4 pounds • Dynamic microphone • Built-in speaker • External speaker jack for 3 watts of crisp audio • Unique quick release/locking bracket and key included.

Because no two transceiver applications are exactly alike, Standard also makes the rugged 146-A. An action Handheld for 2 meter FM, the 146-A, like the Horizon "2," is also available for under \$299. Both of these rugged radios offer you exceptional quality and outstanding performance at a price that's right.



**Standard Communications**

Standard Communications Corp. P.O. Box 92151 • Los Angeles • Ca • 90009

## Incredible counter! Incomparable price!

A 500mHz (6-Digit) FREQUENCY COUNTER for under 40 cents per mHz! Figure it out. It adds up to unheard-of savings! With guaranteed quality to match and exceed overpriced brands. Let us prove it to you now!

**169<sup>95</sup>**

\$199.95 assembled

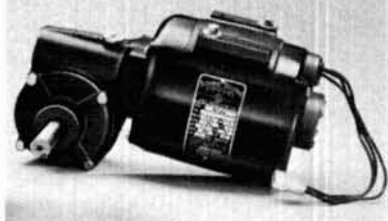
**Perfect for: CBers, Hams, Service Techs, & Experimenters!**

• HAM, CB, & COMMERCIAL BANDS • WIRED & TESTED AVAILABLE • 100HZ READOUT • 6 DIGITS  
• CRYSTAL TIME-BASE • 1HZ OPTIONAL • MASTER CHG. / B. AMERICARD OK • ADD \$2 SHIPPING

**Hufco**

Incredible counters starting at \$45.95 are also available!  
All counters can be factory wired and tested. Write or call today!  
Box 357, Dept. 61, Provo, UT 84601 (801) 375-8566

(6-DIGIT/500mHz KIT)  
FREQUENCY COUNTER



**HIGH QUALITY HEAVY DUTY GEAR-MOTORS** — made by **BODINE** as used by Xerox — surplus but guaranteed perfect.

Gear Input 1650 RPM — Output 28 RPM — Shaft 5/8" steel with 1/8" Key and Keyway — capacity 44 Inch/lbs.

115 V 60 Cycle 1/15 HP Complete with Capacitor.

**Price \$16.** F.O.B. Dallas, Shipping Weight 20#. Send Cash with order — shipped UPS or advise.

**J.P. Ashcraft Company**  
INCORPORATED

5626 DYER ST., DALLAS, 75206

# Tone Encoding - Decoding at its BEST

## DATA-TONE KEYBOARDS

- Five Styles
- Slimness — 0.050"
- Positive Tactile Feedback
- Positive Audio Feedback
- Keyboards are designed, fabricated and guaranteed by Data Signal
- Gold Plated Contacts
- Stainless Steel Domes
- Conforms to curved-surfaces
- Best keyboard for Hand Helds



Style A



Style B



Style C



Style D

### Sizes:

- 2 1/4" x 3"
- 1 1/2" x 2"
- 2" x 1 1/2"
- 2 1/8" x 2 1/8"

Any Style Keyboard ..... \$8.50

## DATA-TONE ENCODERS

- RF Proof
- Cmos IC Encoder
- Sub-Miniature HC-43 Crystal
- Easy Installation
- Choice of Five Keyboards
- Single Tone Capability
- Lowest Cost

### SELF-CONTAINED

Complete 12 or 16 digit encoders for mounting directly to hand held portables. All electronics included WITHIN keyboard, includes LED and adjustable output control. Only 1/4" thick. Select style when ordering.

DTM ..... \$49.50

## SUB-MINIATURE MODULE AND KEYBOARD

The smallest encoder, allows for mounting encoder INSIDE hand-held portable, while .050 thick keyboard mounts on portable. Assembled for quick installation. Select style keyboard when ordering.

SME ..... \$29.50

## DO-IT-YOURSELF KITS

Ala-cart encoders are here, now buy the parts and build your own DATA-TONE Encoder. Parts come with complete set of instructions and schematics.

- Keyboard, Your choice of styles ..... \$8.50
  - Digital IC Encoder with 1-MHz, HC-43 Crystal ..... \$13.50
  - P.C. Board with all resistors, capacitors, etc. .... \$2.50\*
- (\*FREE with purchase of keyboard, encoder and crystal.)

## AUTOMATIC DATA TONE DIALER

Automatic mobile telephone dialing is now available. By the push of a single button you can automatically dial up to six separate 7-digit numbers. All solid-state micro-power COS-MOS design. Automatic PTT operation. Low profile dash mount, easy installation. Available with keyboard for manual dialing of numbers. Manual operation provides automatic PTT operation with 1 1/2 second transmitter hold.



AMD-6 ..... 119.50  
Factory programming of numbers \$7.50.

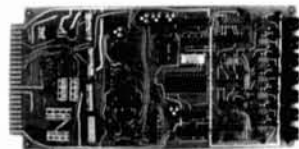
## DATA TONE PADS

Standard size 12 and 15 digit Data Tone Pads. Automatic PTT operation with 1 1/2 second transmitter hold. Self powered via internal 9V battery. Audio and PTT outputs, low volume audio monitor for acoustically coupling of tones to microphone. Zero quiescent current. R. F. proof.

TTP-1, 2 ..... 59.50

## DATA TONE TO DIAL PULSE CONVERTER

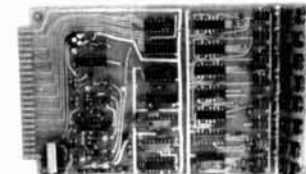
Convert standard 0-9 Data Tone digits to Bell System compatible dial pulse code. Completely solid state. Includes state-of-the-art Phased Locked Loop anti-falsing Data Tone decoder, large capacity 64-digit memory and solid state pulsing. Starts dialing on first incoming digit. Memory will not become congested due to rapid succession of incoming digits. Cancel and redial function. \* and # digits are decoded and provided for remote control purposes. Available as p.c. board or rack mounting.



DPC-121 ..... P.C. Board ..... \$195.00  
DPC-121R ..... Rack Mount ..... \$285.00

## ANTI-FALSING DATA TONE DECODER

Now, a true anti-falsing decoder/receiver. Virtually immune to high noise or audio falsing. Twelve or 16 digit capability. Completely solid state, uses latest Phased Locked Loop decoding. Single 5-volt power supply. Heavy duty transistor output. Available as p.c. board or 19" rack.



TTD-126-12 ..... 12 digit ..... P.C. \$149.95 ..... Rack \$219.95  
TTD-126-16 ..... 16 digit ..... P.C. \$169.95 ..... Rack \$239.95

## REPEATER AUTO PATCH

It's complete — a single digit access/disconnect Auto Patch facility. All you need is a repeater and the phone line. Complete with automatic disconnect, dial-in capability, two way audio monitor plus remote control. When used with a rotary dial exchange, Data Signal's DPC-121 dial converter is also required. P.C. board or Rack Mount available.



RAP-2 ..... PC \$99.50 ..... Rack \$149.50

## DELUXE C-MOS P.C. KEYS

Complete C-MOS keyer in kit form, or wired, just right for your custom enclosure. Versatile controls allow wide character weight variations, speeds from 5 to 50 w.p.m. plus volume and tone control. Solid-state output switching saves power, eliminates all those annoying relay problems and is compatible with both grid block and solid-state circuitry. With its side-tone monitor and 90 day warranty the Data Signal PC Keyer is the one for you.



C-MOS Keyer Wired \$24.95; Kit \$19.95

## DELUXE RECEIVER PREAMP

Specially made for both OLD and NEW receivers. The smallest and most powerful single and dual stage preamps available. Bring in the weakest signal with a Data Preamp.

FREQ. (MHz)	USE	STAGES	DELUXE PREAMPLIFIER			
			GAIN dB	NF dB	KIT WIRED	
144 to 148	2 METER	SINGLE	20	2.5	\$ 9.50	\$12.50
		DOUBLE	40	2.5	\$18.50	\$24.50
1 thru 30	HF BROADBAND		19-36	3	—	\$17.95

Others Available.

Order Today — Send for Free New Catalog

# DATA SIGNAL, INC.

2403 COMMERCE LANE  
ALBANY, GEORGIA 31707, 912-883-4703



# CALL TOLL FREE 800-521-4414 SAVE \$80,000.00 IN CRYSTALS

LISTEN TO 16,000 DIFFERENT FREQUENCIES WITH NO CRYSTALS



## BEARCAT 101

16 channels  
30-50 MHz  
146-174 MHz  
416-512 MHz  
CE's Price - \$296.95



## TENNELEC

MCP 1  
16 channels  
31.18-51.655  
151.18-171.655  
451.18-471.655  
CE's Price - \$399.95



## Regency

WHAMO-10  
10 channels  
30-50 MHz  
146-174  
440-512  
CE's Price - \$278.95



## SBE

OPTISCAN  
10 channels  
30-50 MHz  
150-170 or 140-160  
450-470  
490-510  
CE's Price - \$339.95



Toll free U.S.A. 24 hour order & information line 800-521-4414. Outside U.S.A. & Michigan 24 hour phone 313-994-4441. Certified check or charge card on mail orders for immediate shipment. Dealer inquiries invited. Michigan residents add tax. Foreign orders invited. Call toll free or write for your free complete catalog & specifications. Satisfaction guaranteed or your money back. For engineering advice, call after 6:00 P.M. E.S.T.

**COMMUNICATIONS ENGINEERING**  
P.O. BOX 1002  
ANN ARBOR MI 48106

CALL TOLL FREE  
800-521-4414  
OR  
313-994-4441

# NEW 500/50 MHz FREQUENCY COUNTER



MODEL CTR-2

### FEATURES

- 8 Digit Display
- Large .3" LED Readouts
- Automatic Dp Placement
- Resolution to 1 Hz
- High Input Sensitivity
- Automatic Input Limiting
- Input Diode Protected
- Selectable Gate Times, 1 ms and 1 sec. Provision for 10 sec.
- High Stability 10 MHz Crystal Time Base
- Plug-in Time Base
- Plug-in Prescaler

Kits include all parts, drilled and plated PC boards, cabinet, switches, hardware and a complete instruction manual including calibration instructions.

Factory assembled units are tested and calibrated to specifications.

### SPECIFICATIONS

	BASIC	WITH PRESCALER
Frequency	50 MHz	500 MHz
Input Z	1 Meg/20pf	50 ohm
Sensitivity	30 mv @ 50 MHz 10 mv @ 25 MHz	150mv @ 500 MHz
Range	10 Hz to 50 MHz	10 MHz to 500 MHz
Max. Input Voltage	120v RMS to 10 MHz	2.5V
Time Base	10 MHz XTAL ± 2 ppm 15° to 55°C	
Power	117V 50/60HZ 15W	
Size	8.8" x 8" x 2.8" (223.5 x 203.2 x 71.12 mm)	
Weight	3 lbs., 10 oz. (1.64 k.g.)	

### PRICES

	MODEL	
50 MHz Kit	CTR-2-50K	\$199.95
500 MHz Kit	CTR-2-500K	249.95
50 MHz Factory Assembled	CTR-2-50	289.95
500 MHz Factory Assembled	CTR-2-500	349.95

Please add \$2.00 shipping

**DAVIS ELECTRONICS**

636 Sheridan Drive, Tonawanda, N. Y. 14150  
(716) 874-5848



## the indispensable BIRD 43 THRULINE® WATTMETER

### Read RF Watts Directly.

0.45-2300 MHz, 1-10,000 watts ±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.

AUTHORIZED

## BIRD DISTRIBUTOR

WEBSTER COMMUNICATIONS

115 BELLARMINE

ROCHESTER, MICHIGAN 48063

(313) 375-0420

\*T.M. of BIRD ELECTRONIC CORP.

YEARS AHEAD



WITH YAESU

# THE "WOW" DESIGN!

**YAESU'S NEW FT221 — ENTIRE 2 MTR BAND!**

FM - AM - USB - LSB - CW

PHASE LOCK LOOP!

# AND WOW! ONLY \$629.

Price and Specifications subject to change without notice.

No crystals needed!

Broadbanded — no transmitter tuning!

20 watts input — FM and CW!

Phase lock loop circuit!

Full band coverage —

144-148 MHz!

Pulse noise blanker!

3-way metering, discriminator zero center!

1 kHz dial accuracy!

AC-DC power supplies built-in!

Repeater offset — up, down, (standard or special)!

Crystal calibrator!

FM - AM - USB - LSB - CW!

Clarifier offset tuning!

No-nar feel!

Auto-patch input!

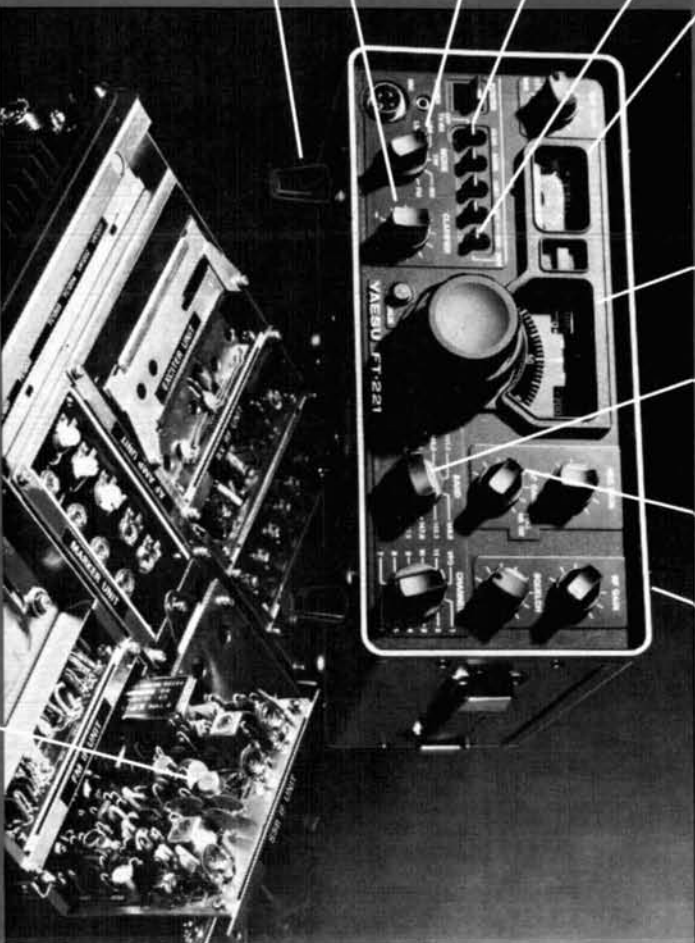
0.5 microvolt receiver sensitivity!

24 watts SSB PEP input!

PTT or VOX operation!

Mike, plugs, connectors supplied!

Plug-in computer quality circuit boards!



See your Yaesu Dealer or write:

YAESU-MUSEN USA, INC., 7625 E. Rosecrans,  
No. 29, Paramount, CA 90723

YAESU-MUSEN USA, INC., Eastern Service Center,  
613 Redna Terrace, Cincinnati, Ohio 45215



# YAESU

The radio.

# NEW... from KLAUS RADIO

## *the Pacesetter*



### KENWOOD'S TS-820

This is the PACESETTER for the industry and no small wonder when you consider these features:

IF shift, RF speech processing, digital readout (option), digital hold, monitor circuit, monoscale VFO dial, PLL circuitry, RF negative feedback, RTTY, 160-10 meter coverage, front panel VOX controls, RF attenuator, phone patch terminals, IF OUT jack, . . . Treat yourself to all these operating conveniences now.

**TS-820** ..... **\$830.00 ppd. in U.S.A.**

#### Accessories for the TS-820 are:

The plug-in digital kit (DG-1), a DC-DC converter (DS-1A), 500 cycle CW filter (CW-820), deluxe remote VFO (VFO-820), MC-50 microphone, TV-502 2 meter transverter, etc.

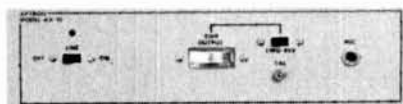
Send SASE NOW for detailed info on this system as well as on many other fine lines. Or, better still, visit our store Monday thru Friday from 8:00 a.m. thru 5:00 p.m.

## KLAUS RADIO Inc.

8400 N. Pioneer Parkway, Peoria, IL 61614  
Jim Plack WB9BGS — Phone 309-691-4840

### FAST SCAN AMATEUR TELEVISION EQUIPMENT

- SOLID STATE
- BROADCAST QUALITY PERFORMANCE
- FOR TECHNICAL DATA AND PRICING, WRITE TO:



AX-10 TRANSMITTER



AM-1A RCVR MODEM

**APTRON LABORATORIES** BOX 323, BLOOMINGTON, IN 47401

— CLEAN SIGNAL —  
— ALL CHANNELS —



ONLY RP GIVES YOU BOTH PLUS

- SUPER ACCURACY (.0005%)
- FULL 2M FM COVERAGE

144-148 MHz

WORKS WITH MOST FINE AMATEUR OR COMMERCIAL GRADE RADIOS

### MFA-22 SYNTHESIZER

### NOW SAVE 20%

MFA-22 ..... \$260.00  
with 5kHz Stops ..... \$300.00  
Shipping (UPS) ..... \$3.00  
Fully wired, tested, 1 yr. warranty

Factory direct only

**RP Electronics**

SEND FOR FULL DETAILS



BOX 1201H  
CHAMPAIGN, ILL.  
61820

### Announcing

## BIG EAR

by

**John Kraus, W8JK**

Director and Founder  
Ohio State-Ohio Wesleyan  
Radio Observatory  
Author — ANTENNAS

- **BIG EAR** is a new book by a long-time amateur and inventor of antennas, a pioneer radio astronomer and mapper of the Cosmos.
- **BIG EAR** is about the Ohio telescope, how it has probed the universe to its limits and now searches for intelligent life beyond Mars.
- Accounts of personal exploits from early amateur days to the present provide revealing behind-the-scenes glimpses.
- An authoritative book written in a warm, entertaining, non-technical style.

225 pages, illustrated  
Published July 1976

Paperbound \$3.25, hardbound \$6.25, postpaid  
Cygnum-Quasar Books, Box 85,  
Powell, Ohio 43065

# Solder is for sissies.

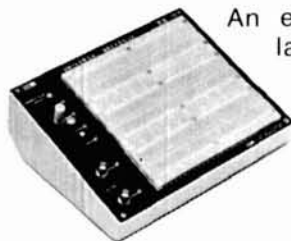
Are you still designing circuits the old fashioned way? Soldering and unsoldering? Burning up valuable IC's? If so, it's time you made a switch to solderless breadboarding. E&L Instruments offers a complete line of breadboarding products from sockets to the most complete systems for professional use. Here are five ways you can go solderless . . .

## SK-10 Socket



This precision solderless breadboarding socket will pay for itself in one afternoon. Integrated circuits and discrete components insert directly, without adapters. All interconnections are made with 20 to 26 gage solid conductor wire. \$17.75.

## Breadbox III



An economical approach to a large breadboarding area. Three SK-10 sockets, four 5-way binding posts, two BNC connectors, six BP-22 solderless breadboarding pins. \$65.00.

## Op-Amp Designer #OA-2K



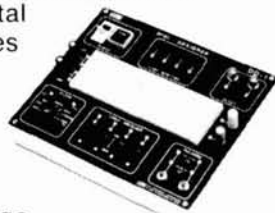
Powerful design tool for linear work and CMOS digital circuitry. SK-10 socket. Heavy current capacities on all three power supplies [ $\pm 15V$  &  $+5V$  DC]. Sensitive null detector and a full function generator with external frequency adjustment. All interconnections are solderless. \$95.00 in kit form.

## Op-Amp Designer #OA-3K



SK-10 socket. Plus and minus variable supplies (1 to 15V). This adjustable feature makes the unit exceptionally flexible, allowing it to be more useful for odd voltage requirements. The fixed 5 volt supply allows interfacing with TTL circuitry. \$80.00 in kit form.

## Digi-Designer #DD-1K



A must for every student, engineer or technician doing digital circuit design. Handles both IC and discrete components without soldering. Connections to the SK-10 socket are made using any solid 22 gage insulated wire. The DD-1K includes a clock, power supply, logic lights, pulsers, logic level switches and much more. All circuitry is now in one circuit board. \$70.00 in kit form.

### CIRCUIT DESIGN, INC.

Division of E & L Instruments, P.O. Box 24, Shelton, Conn. 06484

It's time you went solderless! Order any one of the five products above by completing and sending in this coupon. Please don't forget to sign coupon and include check, money order or charge card information.

Please send me your model # \_\_\_\_\_  
\_\_\_\_\_ pictured above for \$ \_\_\_\_\_.  
Enclosed find my Check \_\_\_\_\_ Money  
Order \_\_\_\_\_ or Charge information for  
BankAmericard \_\_\_\_\_ or Master Charge  
\_\_\_\_\_. (Make sure you sign the order  
blank.)

NAME: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

CITY: \_\_\_\_\_ STATE: \_\_\_\_\_ ZIP: \_\_\_\_\_

SIGNATURE: \_\_\_\_\_

Circuit Design will prepay shipping anywhere in the U.S.

# 2 IN 1 FREQUENCY COUNTER DIGITAL MULTIMETER \$179.95 KIT



150 MHZ  
Frequency Counter  
Only \$139.95 Kit

### FREQUENCY COUNTER —

6 Digit .33 inch 7 seg. LED Latched Display (Can be expanded to 8 digit) Crystal Oscillator Timebase .001% ± 1 count. Readout MHZ or KHZ to over 40 MHZ.

### MULTIMETER —

11 Megohm Input Impedance. 100% Overrange except 1 amp range. AC-DCV 0-1,000, 10,00, 100.0, 1000. AC-DCMA 0-1,000, 10.00, 100.0, 1000. OHMS 0-100, 0-10K, 0-1 Megohm. Input protection, auto polarity, overrange and negative sign indication.

Add \$3.00 Shipping/Handling  
Allow 5 Weeks for delivery



### FOR THE EXPERIMENTER ASSEMBLED — TESTED MODULES

1. Crystal Timebase, 1MHZ with six divide by 10 Outputs 1HZ to 1MHZ (size 3" x 5") \$21.95
2. Freq. Counter Gate Module includes 80 MHZ ÷ 10 Schottky (Size 3" x 5") \$16.95
3. Four digit 7 seg. .33 inch LED Latched Display (Size 4" x 5" x 2 1/4" high) (Above Require 5 VDC) \$34.95
4. Function Generator Module Sine, Saw, and Squarewave Outputs 1HZ - 100KHZ to 10 Volt output. Requires Switches & Pots. \$19.95
5. Function Generator Kit Includes assembled/tested module, Switches, Case, Hardware, (Requires two 9 Volt Batteries.) \$39.95

Add \$1.00 Shipping Any Above  
Allow 3 Week Delivery



### NEW

AT A PRICE  
THE HOBBYIST  
CAN AFFORD

KIT \$69.95

### DIGITAL CAPACITANCE COUNTER

4 Digit LED Display

Ranges to 1000 MFD.

± 0.5% (± 1 PFD Below 100 PFD)

Add \$2.00 Shipping/Handling  
Allow 4 Weeks Delivery

California Residents add 6% Sales Tax  
Send Check or Money Order to

**LIN CORPORATION**  
15311 S. Broadway Gardena, Ca. 90248  
(213) 532-8809

# ALUMA TOWERS

LOW PRICED

MADE IN ALUMINUM

★ TELESCOPING  
(CRANK UP)

★ GUYED

★ TILT OVER MODELS

QUALITY MADE

*Excellent for*

## HAM COMMUNICATIONS

10 MODELS MFG.

Towers to 100 feet. Specials designed & made. See dealer or send for free catalog.

ALUMA TOWER DIVISION

**FRED FRANKE, INC.**

BOX 2806HR  
VERO BEACH, FLA. 32960  
PHONE (305) 567-3415

# tone ENCODER PAD

MODEL TTP-03

- A Better Keyboard
- Output Level Set Pot
- Crystal Controlled-Digitally Synthesized Tones
- Strapping for Hi-Low Z Output
- Internal 5 V. Regulator Supply Voltage Range 7 to 24 V.
- RFI Suppression
- Velcro and Case Included
- Size 2.80 - 2.00 - 0.60 Inches



\$54.95

POSTPAID  
IN U.S.A.

TEXAS RESIDENTS  
ADD 5% SALES TAX

CHECK OR M.O.  
WRITE FOR BROCHURE ON  
AUTOMATIC UNIT ATD-30

## CLENG ELECTRONICS CO.

BOX 12171 — DALLAS, TEXAS 75225

### ANTENNA SUPERMARKET, PO Box 1682, Dept. H, Largo, Fla. 33540

DIPOLE AND WIRE ANTENNA KITS, complete with HI-Q BALUN, 100' rope, copper antenna wire and insulators.

80/40/15 parallel dipole	\$36.95	160 short, 130' length	\$36.95
40/20/15 parallel dipole	\$30.95	80 short, 63' length	\$31.95
80/40 trap dipole	\$41.95	40 short, 33' length	\$28.95
40/20 trap dipole	\$36.95	Single band models from	\$24.95

VERTICALS — complete with Universal Mounting Base, Folds to 5' for Easy Transport, Hvy. Duty Aluminum Tubing.

20/15 trap, 13' hgt.	\$29.95	160 compact 23' hgt.	\$44.95
40/20/15 trap 22' hgt.	\$44.95	80 compact 20' hgt.	\$39.95
80/40/20 trap 30' hgt.	\$69.95	40 compact 15' hgt.	\$34.95
80/40/15 trap 20' hgt.	\$59.95	20/15/10 full size vertical	\$29.95
10 meter cov. for above add	9.95		

TO ORDER — Include \$1.95 shipping (\$2.95 West Coast)  
24 hour shipment. 30 day guarantee.

For Info: SASE or 1st Class Stamp.



Include Interbank # and Expiration date on Credit Card orders.

NEW  
from  
NRI

## Home training in AMATEUR RADIO

NRI, leader in Communications, Television, Electronics and TV-Radio home training, now offers the first in Amateur Radio courses, designed to prepare you for the FCC Amateur License you want or need.

### Don't lose your favorite frequency

The FCC has said "either-or" on licensing, but to pass Advanced and Extra Class exams, you need the technical guidance as offered by NRI. NRI Advanced Amateur Radio is for the ham who already has a General, Conditional or Tech Class ticket. Basic Amateur Radio is for the beginner and includes transmitter, 3-band receiver, code practice equipment. Three training plans offered. Get all the facts. Mail coupon. No obligation. No salesman will call on you. NATIONAL RADIO INSTITUTE, Washington, D.C. 20016.



### MAIL NOW

NATIONAL RADIO INSTITUTE 46-076  
Washington, D.C. 20016  
Please send me information on Amateur Radio training.

Name \_\_\_\_\_ Age \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

ACCREDITED MEMBER NATIONAL HOME STUDY COUNCIL



**HERE'S A HOT NUMBER!**

**CALL**

**800-325-3636**

**(TOLL FREE)**

**FOR**

**NEW & USED**

**AMATEUR RADIO EQUIPMENT**

**HAM RADIO CENTER INC.**

8340-42 OLIVE BLVD., P. O. BOX 28271

ST. LOUIS, MISSOURI 63132

# the BRIMSTONE 144

## 2 METER FM TRANSCEIVER



Size 9 1/2" x 10 1/2" x 3 1/4"

- ★ 143 to 149.99 MHz in digitally dialed 5 KHZ steps without buying a single crystal! 142 MHz coverage optional.
- ★ 25 Watts RF output
- ★ .25 uV, 12 Db. SINAD sensitivity
- ★ Completely independent transmit/Receive frequency control, yet simplex with the flip of a single switch.
- Includes dynamic microphone and mobile mounting bracket

**AMATEUR NET**  
\$650.00

- ★ TWO YEAR WARRANTY!
- ★ Very low transmitter spurious output
- ★ Beryllium copper printed circuit card guides provide SOLID retention of plug in modules, as well as excellent ground connection to the modules.

All of this plus optional plug in modules for Tone Burst, Dial Tone, Sub-Audible Tone, and a Touch Tone® interface module.

Send for our six page COLOR brochure which gives you the full story, inside and out!  
Touch Tone® — trademark of the Western Electric Co.

### NEW PRODUCTS!



- ★ REPEATER AUTOPATCH AND CONTROL  
3 digit access, single digit disconnect.  
3 digit repeater ON-OFF control.  
AGC with 30 Db dynamic range on all inputs and outputs! Just connect Repeater Rcvr, TX, Idler, Touch-Tone line and power.  
Size 9 1/2" x 4 1/8" \$199.95 Assembled



- ★ REPEATER AND RTTY CW IDENTIFIER  
254 bit capacity allows you to send your call plus other desirable information.  
Easily programmed.  
Size 6" x 4 1/8" \$62.50 Assembled



- ★ 650 MHz PRESCALER KIT  
Why pay \$75.00 to \$100.00 or more for a 250 MHz prescaler when you can get one that goes all the way to 650 MHz for just  
Size 1" x 1 1/8" 12V or 5VDC \$47.50



- ★ TOUCH-TONE KEY BOARD  
Positive snap-action push-button switches!  
No need to worry about long finger nails.  
No more mis-dialing because of intermittent switch contacts.  
Standard touch-tone format.  
Size 2 1/4" x 2" x 3/4" \$8.00



**SATAN ELECTRONICS, INC.**  
BLDG. 317 AIRPORT INDUSTRIAL AREA  
SALINA, KANSAS 67401  
913/823-2235

- ★ COMING SOON . . . the P.A.D. The PROGRAMMABLE AUTOMATIC DIALER. Send for more information.

## 2 METER CRYSTALS IN STOCK

FOR THESE RADIOS ON STANDARD ARRL REPEATER FREQUENCIES

- Clegg HT-146
- Drake TR-22
- Drake TR-33 rec only
- Drake TR-72
- Genave
- Heathkit HW-202
- Heathkit HW-2021 rec only
- Icom/VHF Eng
- Ken/Wilson
- Lafayette HA-146
- Midland 13-505
- Regency HR-2A
- Regency HR-212
- Regency HR-2B
- Regency HR-312
- Regency HR-2MS
- S.B.E.
- Sonar 1802-3-4, 3601
- Standard 146/826
- Standard Horizon
- Tempo FMH
- Trio/Kenwood TR2200
- Trio/Kenwood TR7200

Send for free frequency list and order blank to:

**KENSCO COMMUNICATIONS**

Dept. 11076

Box 469  
Quincy, MA 02169  
(617) 471-6427



Aha, the SECRET of PC Board success finally revealed. A perfectly balanced lighting tool combining magnification with cool fluorescence. Excellent for fine detail, component assembly, etc. Lens is precision ground and polished.

Regularly \$70.00. Now, over 30% discount (only \$49.00) to all licensed Hams, verified in Callbook. Uses T-9 bulb (not supplied).

Include \$3.00 U.S. postage, or \$4.00 in Canada. \$5.00 elsewhere. California Residents include 6% sales tax. Or send stamped envelope for free brochure of other incandescent or fluorescent lamps suitable for all engineers, architects, students, etc.

Mastercharge and BankAmericard accepted

### D-D ENTERPRISES

Dept. A, P. O. Box 7776  
San Francisco, CA 94119

### COMPETITIVELY PRICED!

ALL PRODUCTS FULLY ASSEMBLED, TESTED AND WARRANTED. PRICES INCLUDE ALL POSTAGE FEES WITHIN THE USA. FOREIGN ORDERS, ADD \$3.00 TO COVER POSTAGE & HANDLING.

Arizona Residents Add 5% Sales Tax



\$49.95  
EPC-300  
300 MHz Prescaler

- o Built-In 117 vac 60 HZ power supply
- o Size 3 1/2" w x 2 1/2" h x 4" L
- o BNC input, output connectors
- o Input impedance = 50 ohms
- o Output TTL, Fan out of 1
- o Sensitivity 14 mv @ 150 MHz, 150 mv @ 300 MHz



\$32.95  
EPC-144-B  
2 Meter FM Transmitter

- o 2 Channels, 144-148 MHz
- o Power Output 2 watts typical, 1 watt min @ 12.5 VDC
- o 50 ohm output impedance
- o Narrow band FM ± 5 KHZ
- o Rugged balanced emitter output transistor
- o Small size 1 7/8" w x 1" h x 3 3/4" L



Input Watts	Output Watts Min.	Output Watts Typical
1	15	20
2	20	25
4	30	30

\$39.95  
LA-144  
30 Watt 2 Meter Power Amplifier

- o Frequency range 144-148 MHz
- o Maximum RF output power 30 watts
- o Maximum RF input power 5 watts
- o Supply voltage 13.6 VDC
- o Small size 1 7/8" w x 5/8" h x 3 1/2" L
- o Virtually burn-out proof balanced emitter output transistor.
- o Fully compatible with the EPC-144-B
- o 50 ohm input & output impedance
- o Sold as a fully tested & assembled circuit board less case, connectors and heat sink

Send Self-Addressed Stamped Envelope For More Information

Elprocon  
ELECTRONIC PROTOTYPE CONSULTANTS  
1907 W. Campbell / Phoenix, Arizona 85015

# DON'T BROADCAST THE FACT THAT YOU'VE GOT A HAM RIG.



Now you don't have to let everyone know that you've got a mobile ham transceiver. Our model ASPR798 gain disguise antenna looks and acts just like a normal Ford antenna, operating on AM and FM broadcast\* as well as the 2 meter band. We know the disguise is effective because we've been making them for law enforcement agencies for years. Antenna Specialists has an entire line of disguise antennas to prevent the theft of your VHF FM rig. Exact replacements for Chrysler and Ford products and universal mounts for everything else on wheels.

When it comes to choosing the right amateur antenna, don't settle for less than the best. Look for the Stripes of Quality. At your Antenna Specialists Dealer.

\*When used with corresponding antenna coupler.



© Stripes of Quality

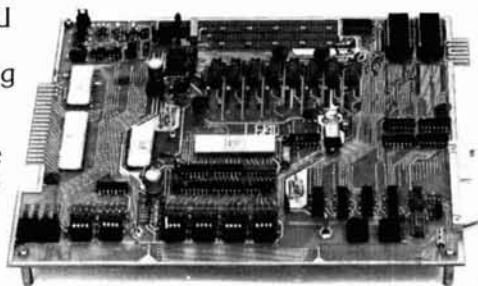
**the antenna specialists co.**

a member of **The Allen Group Inc.**  
12435 Euclid Avenue, Cleveland, Ohio 44106  
Export: 2200 Shames Drive, Westbury, L.I. New York 11590  
Canada: A. C. Simmonds & Sons, Ltd.

© 1976 by The Antenna Specialists Co.

# If you want a microcomputer with all of these standard features...

- 8080 MPU (The one with growing software support)
- 1024 Byte ROM (With maximum capacity of 4K Bytes)
- 1024 Byte RAM



- (With maximum capacity of 2K Bytes)
- TTY Serial I/O
- EIA Serial I/O
- 3 parallel I/O's
- ASCII/Baudot terminal compatibility with TTY machines or video units
- Monitor having load, dump, display, insert and go functions

- Complete with card connectors
- Comprehensive User's Manual, plus Intel 8080 User's Manual
- Complete-

factory assembled and tested —not a kit

- Optional accessories: keyboard/video display, audio cassette modem interface, power supply, ROM programmer, and attractive cabinetry... plus more options to follow.

**The HAL MCEM-8080. \$375**

## ...then let us send you our card.

HAL Communications Corp. has been a leader in digital communications for over half a decade. The MCEM-8080 microcomputer shows just how far this leadership has taken us...and how far it can take you in your applications. That's why we'd like to send you our card—one PC board that we feel is the best-valued, most complete



microcomputer you can buy. For details on the MCEM-8080, write today. We'll also include comprehensive information on the HAL DS-3000 KSR microprocessor-based terminal, the terminal that gives you multi-code compatibility, flexibility for future changes, editing, and a convenient, large video display format.

**HAL Communications Corp.**  
**Box 365, 807 E. Green Street, Urbana, Illinois 61801**  
**Telephone (217) 367-7373**

**Webster** says:  
*radio, inc.*

Everything from A to Z in quality **TRANSCIVERS!**



The TS-520 **KENWOOD** \$629.  
 Transceiver. Solid state 80 thru 10 meters.



The FT-620B **YAESU** Transceiver  
 Solid state 6 meters SSB. \$449.

CTC - UHF/VHF  
 POWER TRANSISTORS FOR AMATEUR USE  
 J101 UNDERWOOD CAPACITORS

- Order Direct 1. Check or M.O. with order.  
 3 E-Z Ways 2. BankAmericard or Mastercard.  
 3. C.O.D. (20% deposit, please)

Write for FREE brochures and particulars on all models.

**Webster**  
*radio, inc.*

2602 E. Ashlan  
 Fresno, CA 93726  
 Phone (209) 224-5111



Simple as A.B.C.

A. Stamp Components on P.C. Board B. Use Pen to Interconnect Lines C. Etch Board

SE 2 KIT CONTAINS

- CONDUCTOR PENCILS
- 16 PIN ROUND IC LINE IC SOCKET
- 12 PIN ROUND IC SOCKET
- 8 PIN ROUND IC SOCKET
- 10 PIN TRANSISTOR SOCKET
- 10 PIN TRANSISTOR SOCKET
- LARGE & SMALL SIGNAL PAI
- RESISTORS
- DIODES
- PRINTED PCB

PLUS

ONLY \$9.95

PLUS 75¢ Postage & Handling

ADDITIONAL STAMPS

- 16 PIN ROUND IC SOCKET
- 12 PIN ROUND IC SOCKET
- 8 PIN ROUND IC SOCKET
- 10 PIN TRANSISTOR SOCKET
- 10 PIN TRANSISTOR SOCKET
- LARGE & SMALL SIGNAL PAI
- RESISTORS
- DIODES
- PRINTED PCB

M-TECH ENGINEERING, INC.

BOX C

SPRINGFIELD, VIRGINIA 22151

703/354-0573

### NOW AVAILABLE IN KIT FORM

- 6:1, 4:1 and 1:1 Baluns
- Frequency Range 3-30 MHz
- 2 KW Rating
- Lightning Protection Built In



All Prices Postpaid in USA / Add Shipping outside USA  
 Shipping Wt. 1 lb.

[California Residents Add 6% Sales Tax]

6:1 Assembled — 22.95

Kit — 16.95

1:1 & 4:1 Assembled — 16.95

Kit — 11.95

Case Only — 7.95

Core Only — 3.50

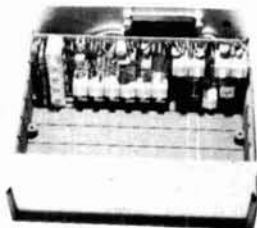
**59+**

**FIVE NINE PLUS**

3402 Campus  
 Claremont, Ca 91711  
 (714) 621-1658

*Antenna Products for the Amateur*

**FM  
 XMTR  
 KITS**



2M, 150MW EXCITER \$39.95  
 432-450 MHz TRIPLER \$19.95  
 20W PA, WIRED \$79.95

SEND SASE FOR CATALOG, INCL.  
 RCVRs, PREAMPS, CONV., ETC.

**hamtronics, inc.**

182 BELMONT RD., ROCHESTER, NY 14612

# DIGITAL DATA RECORDER

## for Computer or Teletype Use

### Up to 4800 Baud

Uses the industry standard tape saturation (NRZ) method to beat all FSK systems ten to one. No modems or FSK decoders required. Loads 8K of memory in 17 seconds. This recorder enables you to back up your computer by loading and dumping programs and data fast as you go, thus enabling you to get by with less memory. Great for small business bookkeeping. Imagine! A year's books on one cassette.

Can be software controlled. Comes complete with a software program used to test the units in production (8080). Manual includes software control hook up data and programs for 8080 and 6800.



#### SPECIFICATIONS — MODEL CC7:

- A. Recording Mode: Tape saturation binary (NRZ). This is not an FSK or Home type recorder. No voice capability. No Modem. Runs at 2400 baud or less Asynchronous and 4800 baud Synchronous. Runs at 3.1"/sec. Speed mechanically regulated  $\pm .5\%$  or better.
- B. Two channels (1) Clock, (2) Data. Or two data channels providing four (4) tracks on the cassette. Can also be used for Bi-Phase, Manchester, etc.
- C. Inputs: Two (2). Will accept TTY, TTL or RS 232 digital.
- D. Outputs: Two (2). Board changeable from TTY, RS232 or TTL digital.
- E. Erase: Erases while recording one track at a time. Record new data on one track and preserve three or record on two and preserve two.
- F. Compatibility: Will interface any computer using a UART or ACIA board. (Altair, Sphere, IMSAI, M6800, etc.)
- G. Other Data: 110-220 V - (50-60) Hz; 3 Watts total; UL listed; three wire line cord; on/off switch; audio, meter and light operation monitors. Remote control of motor optional. Four foot, seven conductor remoting cable provided.
- H. Warrantee: 90 days. All units tested at 300 and 2400 baud before shipment. Test cassette with 8080 software program included.

**Also available — MODEL CC7A** with variable motor speed which is electronically regulated. Runs 4800 baud Synchronous or Asynchronous. Recommended for quantity users who require tape interchangeability. Comes with speed calibration tape to set exact speed against 60 cycle line.

**\$169.95**

#### **NEW** — 8080 I/O BOARD with ROM

Permanent Relief from "Bootstrap Chafing"  
This is our new "turnkey" board. Turn on your Altair or Imsai and go (No Bootstrapping). Controls one terminal (CRT or TTY) and one or two cassettes with all programs in ROM. Enables you to turn on and just type in what you want done. Loads, Dumps, Examines, Modifies from the keyboard in Hex. Loads Octal. For the cassettes, it is a fully software controlled Load and Dump at the touch of a key. Even loads MITS Basic. Ends "Bootstrap Chafe" forever. Uses 512 bytes of ROM, one UART for the terminal and one USART for the Cassettes. Our orders are backing up on this one. #2SIO (R)

**Kit form \$140.00**

**Fully assembled and tested \$170.00**

Fill out form and send check or money

Mailing Label — PRINT

#### NATIONAL MULTIPLEX CORPORATION

3474 Rand Avenue, Box 288  
South Plainfield, New Jersey 07080 201-561-3600

SHIP TO: .....

.....

.....

CARD NO. .... ZIP .....

EXPIRATION DATE .....

..... Data Recorder CC-7 @ \$149.95

..... Data Recorder CC-7A @ \$169.95

Please enclose \$2.00 Shipping & Handling on each Recorder or I/O Board.

..... Operating & Technical Manual (Schematics) Includes Software & Hookups for 8080, 6800, and I/O. \$2.00

N. J. Residents add 5% Sales Tax



# INTRODUCING THE ALL MODE LINEAR AMPLIFIER FOR 2 METERS



For use with the many new all-mode 2 meter transceivers, typified by the Kenwood TS-700A.

## SPECIALTY COMMUNICATIONS SYSTEMS MODEL 2M10-70L

### SCS's AMPS ARE BUILT FOR ALL MODES OF OPERATION!

Want more power on FM? You've got it with the SM10-70L. Want more power on SSB? Just flip the switch on the 2M10-70L and you've got it.

### A TRUE 70 WATT P.E.P. OUTPUT with 10 watts input.

WITH LOWER INPUT POWER, THE 2M10-70L GIVES APPROXIMATELY A 10 dB GAIN.

### SCS's ALL MODE LINEAR AMPS ARE FULL CAPACITY PRODUCTS!

Not economy lines. The Model 2M10-70L is the finest linear amplifier for 2 meters that can be purchased. Components are of the highest quality.

If not available at your dealer, tell him to get up to date, and call the SCS factory for name of your nearest SCS dealer.

- All solid state—microstripline design.
- Broadband—requires no tuning across band.
- Variable T-R delay for SSB/CW operation.
- Full VSWR and reverse voltage protection.
- Under 1 dB insertion loss in receive or bypass mode.
- Harmonics levels typically -40 dB or better.
- Measures only 7.1 x 10.2 x 16.5 cm. Wt. 1 kg.
- One year warranty on entire unit.

**\$139.<sup>95</sup>**

## SCS SPECIALTY COMMUNICATIONS SYSTEMS, INC.

8160 Miramar Road, San Diego, CA 92126 • Louis N. Anciaux • WB6NMT



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 3/4" 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 75¢ per order for postage and handling.

RADIO AMATEUR

**callbook INC.**

Dept. E 925 Sherwood Drive  
Lake Bluff, Ill. 60044

WRITE FOR FREE BROCHURE!



Barry is Calling CQ, CQ, DE Sale on all Collins Amateur Equipment: KWM 2A 1690.00, 32S 3A 1480.00, 75S 3C 1295.00, 30L1 830.00, 312B5 600.00, 312B4 300.00, 30S1 3290.00. Also Ten to Fifteen, to Twenty Percent off on all products in the house. Complete Export Department to handle over seas orders. We ship all over the world. Bring your used gear in, we will trade on above prices. Barry Stocks Large amounts of everything in Drake, KLM, DX Engineering, Antenna Specialists, HyGain, Newtronic, Tempo 2020, Yaesu, Standard, CushCraft, Ten Tec, Savoy, Atlas Radio, Brimstone, CDE, Spectronics, Venus, Icom. Barry Has Complete Service Department at all times for all your repairs. Please write us on your amateur needs. We Have A Large line of commercial line linear amplifiers from 2-30 MHz at one to fifty thousand watts. Barry Electronics World Wide Amateur Dealer Since 1940.

### Barry Electronics

512 BROADWAY, NY, NY 10012  
212-925-7000

## YOUR BEST BUY IN KITS



### ANALOG-DIGI-LAB

Features 3 Regulated power Supplies, 3 Output wave forms, 8 digital level switches, 2 no bounce pulser switches,

8 LEDs with drivers, 1 AP Super strip, Easily constructed. Designed by RETS Electronic Schools.

1st time offer **\$139.00**

Clock Kit (complete less case) **\$12.95**  
Function Generator Kit **\$10.95**

Please add \$1.00 Shipping/Handling on any order under \$15.00  
Send SASE for flyer. Featuring Electronic components and kits available.

### HAL-TRONIX

P. O. Box 1101 • Southgate, Mich. 48195  
(313) 285-1782

### FREQUENCY COUNTER

7 Digit 0-300 MHz Freq. Counter **\$99.00**

7 Digit 0-500 MHz Freq. Counter **\$139.00**

8 Digit 0-30 MHz Counter

with Options (Special) **\$99.00**

0-300 MHz Prescaler

for 8 Digit Counter **\$19.95**

0-600 MHz Prescaler for

8 Digit Counter **\$39.95**

Cabinet accessory package available for

all of the above **\$24.95**

Anyone of the above kits available pre-

assembled for an additional \$50.00.



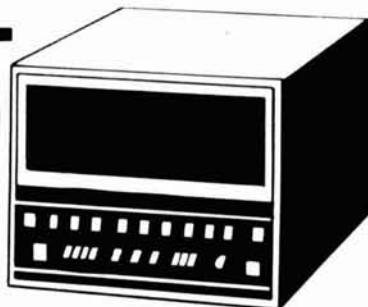
**GROTH-Type**  
**COUNTS & DISPLAYS YOUR TURNS**

- 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"	
<b>R. H. BAUMAN SALES</b>	
P.O. Box 122, Itasca, Ill. 60143	

# THINKING ABOUT YOUR OWN COMPUTER?



The last few years have seen a remarkable quantum jump in the cost effectiveness of computing power brought about by the advent of inexpensive microcomputer systems. You've been reading about these machines for some time in the technical press. You've seen stories of applications ranging from specialized numerical control systems for machine tools to intelligent traffic light controllers.

One of the most exciting possibilities which has come about as a result of the inexpensive LSI computer is the fact that a general purpose computing system is within the budget range of you, the individual with an interest in the technology and an appreciation of both the intellectual challenge and fun of building and using a personal computing system. There is now a whole micro industry of

companies which package and market microcomputer related items as kits, finished products and related items for personal use. The products range from complete system kits with hardware and software to peripherals, software and literature on the subject. But where do you go to find out about this personal involvement aspect of microcomputer technology?

Turn to **BYTE**, The Small Systems Journal for a wealth of information on the personal use of computer systems. **BYTE** is a monthly compendium of information you need for personal use applications of microcomputers:

#### Theoretical:

- Computers are Ridiculously Simple
- What is A Character?
- Total Kitchen Information System
- The Magic of Computer Languages
- Data Paths
- Processing Algebraic Expressions
- The Software Vacuum

#### Practical:

- Build a Graphics Interface
- Powerless IC Test Clip
- Let There Be Light Pens
- Golf Handicapping By Computer
- The COMPLEAT Tape Cassette Interface
- Assembling Programs By Hand
- Add A Kluge Harp to Your Computer

#### Speculations:

- Buck Rogers and the Home Computer
- Could A Computer Take Over?
- Frankenstein Emulation
- Biorhythm for the Computer

#### News and Reviews:

- Son of Motorola
- The LSI-11: A New Mini-Microcomputer System
- Microprocessor Update: CP-1600
- Microprocessor Update: TMS9900
- Assembling an Altair 8800
- The HP-65: World's Smallest Computer System
- The SR-52: Another World's Smallest
- The CT-1024 Kit
- Build a 6800 System With This Kit



**BYTE** is professionally edited and packed with the information you need on this fast growing field of personal computer applications. Don't miss a single exciting issue. Order your subscription today, using the coupon below, or phone your request directly (call 603-924-7217 and ask for the subscription department).

Please allow six weeks for processing

**If you are into computers,  
if you are planning  
a computer of your own,  
or if you're just curious,  
send this coupon today . . .  
subscribe to BYTE.**

**BYTE** PETERBOROUGH,  
DEPT. HO NH 03458

Please enter my subscription to BYTE . . .  
 \$12 One Year  \$22 Two Years  
 \$30 Three Years

Bill me.  Enclosed is my check for \$\_\_\_\_\_

Bill BAC No. \_\_\_\_\_  Bill MC No. \_\_\_\_\_

Credit Card Expiration Date \_\_\_\_\_

Name (Please Print) \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_ 89

## TS-1 MICROMINIATURE ENCODER-DECODER

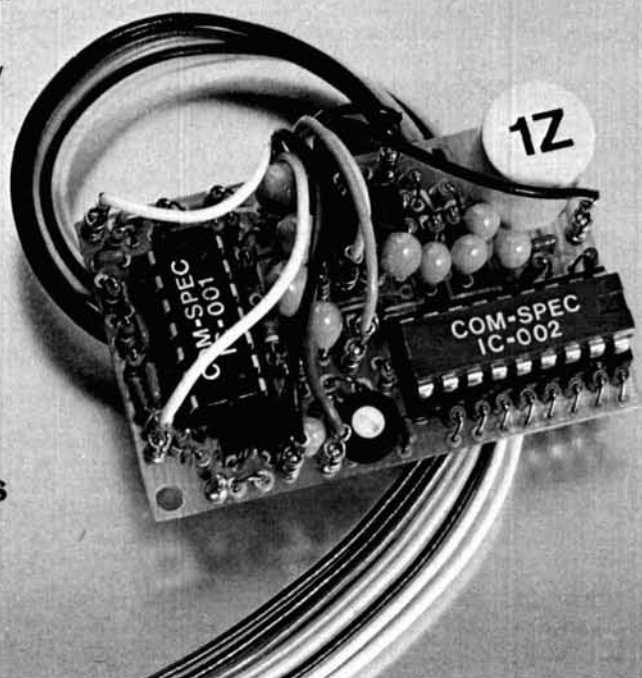
- Available in all EIA standard tones 67.0Hz-203.5Hz
- Microminiature in size, 1.25x2.0x.65" high
- Hi-pass tone rejection filter on board
- Powered by 6-16vdc, unregulated, at 3-9ma.
- Decode sensitivity better than 10mvRMS, bandwidth,  $\pm 2$ Hz max., limited
- Low distortion adjustable sinewave output
- Frequency accuracy,  $\pm 25$ Hz, frequency stability  $\pm 1$ Hz
- Encodes continuously and simultaneously during decode, independent of mike hang-up
- Totally immune to RF

Wired and tested, complete with K-1 element

**\$59.95**

K-1 field replaceable, plug-in, frequency determining elements

**\$3.00 each**



### COMMUNICATIONS SPECIALISTS

P.O. BOX 153  
BREA, CALIFORNIA 92621  
(714) 998-3021

# PRESTO!

## Your counter becomes a digital display!

Like magic, Hufco's Digi-Dial Adaptor turns any frequency counter into an absolutely accurate digital display! Inexpensively! With continual display of both transmit and receive frequencies — as fast as you turn your transceiver dial!

With the Digi-Dial Adaptor your counter easily adapts to Yaesu, Tempo, Drake C Line, Collins, Kenwood and other transceivers. (Tell us which other brand you have. We'll tell you if the adaptor fits.)

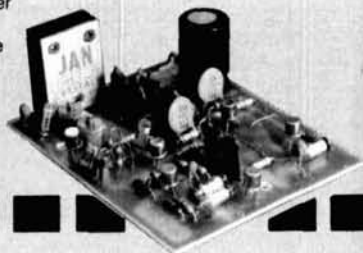
Operation requires only a connecting cable to the transceiver VFO plug. Translates VFO output to 2 through 2.5 MHz. No internal connection or modifications necessary! Complete instructions included.

No frequency counter? Get both the Digi-Dial Adaptor and a frequency counter from Hufco. We have counters starting as low as \$45.95!

### DIGI-DIAL ADAPTOR

**39.95**  
kit form

\$49.95 assembled



**Quick!**  
**Order yours today!**

Please rush me:

- Digi-Dial Adaptor \$39.95 kit form - \$49.95 assembled  
Check or money order enclosed.
- Complete data on Hufco frequency counters

Name \_\_\_\_\_

Address \_\_\_\_\_

City/State/Zip \_\_\_\_\_

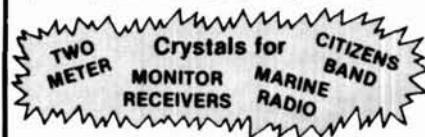
**Hufco** Box 357, Dept. 70,  
Provo, Utah 84601 801/375-8566

## We're Fighting Inflation No Price Rise for '76



### FOR FREQUENCY STABILITY

Depend on JAN Crystals. Our large stock of quartz crystal materials and components assures Fast Delivery from us!



### CRYSTAL SPECIALS

Frequency Standards  
100 KHz (HC 13/U) ..... \$4.50  
1000 KHz (HC 6/U) ..... 4.50  
Almost all CB sets, TR or Rec ..... \$2.50  
(CB Synthesizer Crystal on request)  
Amateur Band in FT-243 ..... ea. \$1.50  
80-Meter- ..... \$3.00 (160-meter not avail.)  
For 1st class mail, add 20¢ per crystal. For Airmail, add 25¢. Send check or money order. No dealers, please.



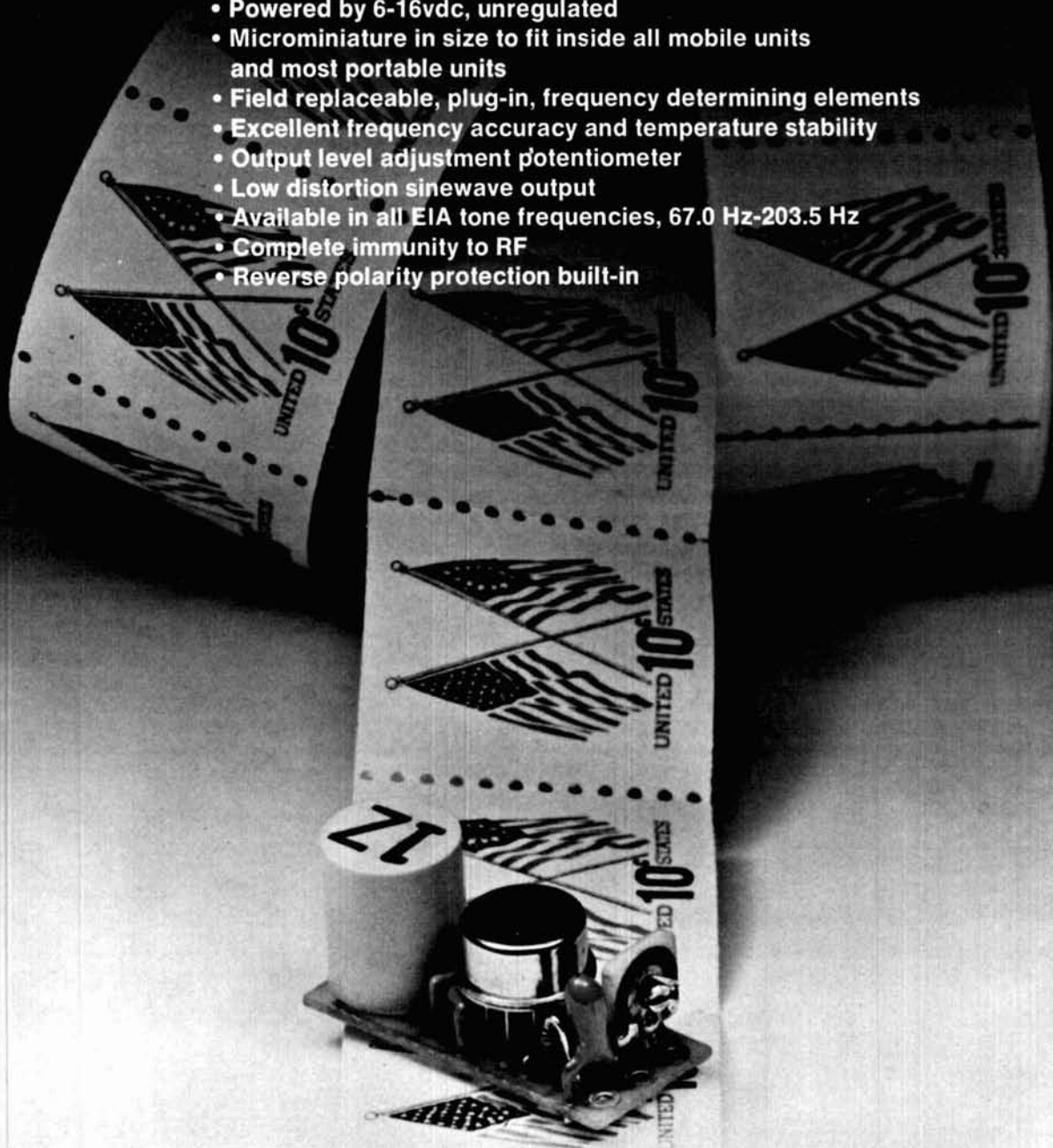
Div. of  
**Bob Whan & Son Electronics, Inc.**  
2400 Crystal Dr.,  
Ft. Myers, Fla. 33901  
All Phones: (813) 936-2397  
Send 10¢ for new catalog



# ME-3 microminiature tone encoder

Compatible with all sub-audible tone systems such as: Private Line, Channel Guard, Quiet Channel, etc.

- Powered by 6-16vdc, unregulated
- Microminiature in size to fit inside all mobile units and most portable units
- Field replaceable, plug-in, frequency determining elements
- Excellent frequency accuracy and temperature stability
- Output level adjustment potentiometer
- Low distortion sinewave output
- Available in all EIA tone frequencies, 67.0 Hz-203.5 Hz
- Complete immunity to RF
- Reverse polarity protection built-in



**\$29.95 each**

Wired and tested, complete with K-1 element

**communications specialists**

P. O. BOX 153  
BREA, CALIFORNIA 92621  
(714) 998-3021

K-1 FIELD REPLACEABLE,  
PLUG-IN, FREQUENCY  
DETERMINING ELEMENTS

**\$3.00 each**

# Your Next Purchase.



**ELECTRONIC KEYSER  
MODEL 10B**

Reed relay output (1 amp, 250V, 20VA). 10-30 WPM @ 6V-DC supply, 12 MA drain. 15-45 WPM @ 9V-DC supply, 15 MA drain. 3 MA idle current drain. Fixed spacing. Dots 1:1. Dash 1:3. Self-completing Dot/Dash. Manual dash in tune position. (Batteries not included.) Use the Model 10B Keyer with your paddle or our Model 11B matching paddle.

MODEL 10BWA KEYSER with Sidetone assembled \$39.95  
MODEL 10BWB assembled \$29.95  
MODEL 10BK (Kit) \$23.95  
200-2K PC BOARD KIT \$14.95  
200-3K SIDETONE KIT \$ 5.95  
Ship. Wt. 1 Lb., add \$ 1.00

(PA RES. ADD 6% SALES TAX)

**SEND FOR CATALOG & DEALER LIST.  
ORDER FROM DEALER OR DIRECT.  
FOR U.P.S., C.O.D SHIPMENTS—ADD 854**



**PADDLE  
MODEL 11B**

Dit/Dah travel adjustment. No mechanical switches. No bearings to fail. Paddle assembly weight is 1.5 pounds. Reversible Dit and Dah connections. Rubber feet. Damping on paddle operator lever. Feather glide paddle movement.

MODEL 11BW assembled \$11.95  
MODEL 11BK (Kit) \$ 8.95  
Ship. Wt. 2 Lb., add \$ 1.35

(PA RES. ADD 6% SALES TAX)



**CW TRANSMITTER  
MODEL 50**

15 watts input. Full break-in keying. All solid state. Crystal control. 160, 80 or 40M plug-in coil. Zener regulated chirpless keying. Has built-in 120 Vac power supply. OPTIONS: Built-in keyer and/or sidetone. Paddle Model 11B is compatible with built-in keyer option.

MODEL 50K (Kit) \$49.95  
MODEL 50W (Wired) \$69.95

Add-on options:  
SIDETONE 200-21 Kit \$ 5.95  
200-21 Wired \$ 8.95  
KEYER 200-22 Kit \$13.95  
200-22 Wired \$18.95  
Ship. Wt. 4 Lb., add \$ 2.10

(PA RES. ADD 6% SALES TAX)

(All units come with 40M plug-in coil unless otherwise specified. (Additional coil kits \$3.95 each postpaid.)



**ELECTRONIC KEYSER WITH PADDLE  
MORSE-1835  
MODEL 12**

C-MOS circuitry. Solid state output switch. (250V, 1 AMP MAX.) 8-45 WPM. Fixed spacing. Dot 1:1. Dash 1:3. Self-completing Dot/Dash. No on/off switch required. Sidetone has 2-inch speaker. Paddle travel adjustment. Rubber feet. 4 night batteries (not included).

MODEL 12 assembled \$49.95  
Ship. Wt. 2 Lb., add \$ 1.35

(PA RES. ADD 6% SALES TAX)



**SPEECH PROCESSOR  
MODEL 60A**

200K/500 OHM inputs. PTT on connector. Instantaneous attack and release. 2, 9V-DC batteries (not included). 1.5 MA drain. Frequency is  $\pm 1/2$  db., 300-3000 Hz. Process gain control has an in/out switch. The process threshold is: 1.5 MV-RMS (HI-Z). 400 micro V-RMS (LO-Z). Output voltage 100 MV-RMS nom.

MODEL 60AW assembled \$29.95  
MODEL 60AK (Kit) \$23.95  
Ship. Wt. 1 Lb., add \$ 1.00

(PA RES. ADD 6% SALES TAX)

## THE WORLD AT YOUR FINGERTIPS!



RD-1 • BOX 185A • FRANKLIN, PA. 16323  
TELEPHONE (814) 432-3647

SSB & CW Filters for Superior reception through QRM & QRN. Built in AC supply & AF Power Amp. SSB filters are for CB or Ham use.

DE-102A SSB filter \$51.95  
DE-103A CW & SSB \$59.95  
DE-104A CW filter \$49.95  
Other filters & products are available.

DYNAMIC ELECTRONICS, Box 896, Hartselle, AL 35640

**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. Drip-cap keeps coax fittings dry. Instructions included. Guaranteed. At your dealers or \$3.95 postpaid. Companion insulators 2/\$.99.

BUDWIG MFG. Co. PO Box 97H, Ramona, CA 92065

**CASH FOR 2-WAY FM RADIO**  
MOTOROLA, GE, RCA, ETC. EQUIPMENT  
MOBILES, BASES, PORTABLES, MOBILE-TELEPHONES, REPEATERS, REMOTE CONTROLS, TONE EQUIPMENT, 2-WAY TEST EQUIPMENT

Operational Units Only  
Commissions/Finders Fees

**CAL-COM SYSTEMS, INC.**  
701-51A KINGS ROW, SAN JOSE, CALIF. 95112  
Telephone 24 Hours 408/998-4444

# NEW! ATRONICS Visual Code Reader Kit \$149



Model KCR101  
Ready Made Model CR101 \$225  
**USE YOUR BANKAMERICARD**

Now you can have the famous Atronic Code Reader, that displays decoded Morse Code signals visually, in kit form. Assembly is simple, and can be completed in as little as 5 hours. Complete, step by step, illustrated instructions are included.

- The Atronic Code Reader:**
- Displays letters, numbers, and commonly used punctuation visually as Morse Code signal is received.
  - Operating speed 5 to 50 WPM at selected speed.
  - All Solid State
  - Make code learning faster and easier
  - One single connection to your speaker receiver or transceiver puts it into operation
  - Hard copy read out of CW available with TU-102 TTY Interface Module accessory.

**Buy Factory Direct & Save! Send for Free Literature Today.**  
**ATRONICS** P.O. Box 77, Escondido, CA 92025 Call (714) 745-1971

## IRON POWDER TOROIDS

CORE SIZE	MIX 2 u = 10 5-30MHz	MIX 6 u = 8.5 10-90MHz	MIX 12 u = 4 60-200MHz	SIZE OD (in.)	PRICE USA \$
T-200	120			2.00	3.25
T-106	135			1.06	1.50
T-80	55	45		.80	.80
T-68	57	47	21	.68	.85
T-50	51	40	18	.50	.55
T-25	34	27	12	.25	.40

## RF FERRITE TOROIDS

CORE SIZE	MIX Q1 u = 125 1-10MHz	MIX Q2 u = 40 1-10MHz	SIZE OD (in.)	PRICE USA \$
F-240	1300	400	2.40	6.00
F-125	900	300	1.25	3.00
F-87	600	190	.87	2.05
F-50	500	190	.50	1.25
F-37	400	140	.37	1.25
F-23	190	60	.23	1.10

Charts above show uH per 100 turns. Use iron powder toroids for tuned circuits. Use ferrite toroids for broadband transformers. Q1 for .1-70 MHz, Q2 for 10-150 MHz.

Ferrite beads 20-500 MHz (fit #18 wire) \$2.00 Doz. Wideband chokes 20-500 MHz (Z=850 ohms) 95¢ Ea. Specify core size and mix. Pack and ship 50¢ USA and Canada. Air parcel post delivery worldwide \$2.00; 6% tax in Calif.; Fast service; Cores shipped from stock via first class mail or air. Send for free brochure.

**PALOMAR ENGINEERS**  
BOX 455 ESCONDIDO CA 92025

# GET IT UP BEFORE IT GETS COLD

WINTER IS JUST AROUND THE CORNER. NOW'S THE IDEAL TIME TO PUT UP THAT ANTENNA SYSTEM OR TOWER YOU'VE BEEN THINKING ABOUT ALL SUMMER. DURING OCTOBER SAVE \$ \$ ON THE ANTENNA PACKAGE OF YOUR CHOICE . . .

**hy-gain**

**cushcraft**

**KLM ELECTRONICS**

**HUSTLER**

**CDE**

**Dentron**  
Radio Co., Inc.

**Mosley Electronics, Inc.**

**SLINKY!**

FULL SPEC SHEETS AVAILABLE ON REQUEST. A WIDE SELECTION IS AWAITING YOUR PHONE CALL OR LETTER.

## OF SPECIAL INTEREST . . .

### MOBILE CHARGERS

We have a limited supply of mobile, rapid chargers for the HT-220 Omni. These chargers are similar to the Convertacom Console, but Convertacom goodies are not installed. Chargers are checked out and print of PC board is included.

**Only \$75.00**

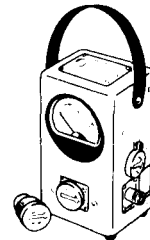
Plus Shipping

### SOLID STATE RECEIVER STRIPS

We have some Motorola "H" series hi-band receiver strips in stock. They have the cavity front end for selectivity. Ideal for repeater receiver or standby use. Limited supply.

**\$49.00 each**

Plus Shipping



**BIRD**

. . . If you have been having difficulty locating the Wattmeter or element just right for you. . . You may have been looking in the wrong places. Our large inventory of most common elements lets you get what you want when you need it. Give us a call first for your BIRD needs.

## WE WANT TO MEET YOU . . .

We'll be at the following Hamfests . . . Hope to see you there . . . Sept. 26 Louisville, Ky — Oct. 2, 3 Memphis, Tn — Oct. 8, 9 Omaha, Nebr. If not send for your FREE Buyer's Guide and shop with confidence from your own home.



### SPECTRONICS, INC.

1009 GARFIELD  
OAK PARK, IL. 60304  
312-848-6777  
TELEX 72:8310

### HOURS

#### STORE HOURS:

Mon-Thurs 9:30-6:00, Fri. 9:30-8:00  
Sat. 9:30-3:00, Closed Sun. & Holidays.



# ramsey electronics



6 DIGIT  
LED CLOCK  
KIT  
**\$22.95**

A SUPER QUALITY kit that features:

- Handsome extruded aluminum case in black, gold, silver, bronze or blue
- Large .33" bright LED display
- 12 or 24 hour readout format
- All parts included — no extras to buy
- Alarm version (12 hour only)

**\$24.95**

## 60 Hz TIME BASE KIT

Run any digital clock in your car, boat or airplane. Features zener regulation, output buffering, CMOS circuitry and small size. Kit includes all parts and instructions to hook up to any clock.

**\$3.95**  
with clock  
purchase

**\$4.95 6/\$25.00**

## FM WIRELESS MIKE KIT

Transmit up to 300' to any FM broadcast radio. Sensitive mic. input requires crystal, ceramic or dynamic mike. Runs on 3 to 9V. Small one inch square size.

**Complete Kit \$2.95**

## SIREN KIT

Produces police-type wail of siren at toy volume. Runs speaker from 3 — 45 Ohms to 200 mW output. Requires power source of 3 to 6 volts. A neat toy for the kids.

**Complete Kit \$2.95**

## 600 MHz PRESCALER

Extend the range of your counter to 600 MHz. Works with most any counter. Completely assembled and tested. Sensitivity of 100 millivolts. Choice of  $\times 10$  or  $\times 100$ , specify with order.

**\$59.95**



## FERRITE BEADS

Beads come with valuable info on uses and specs 15/\$1.00  
6 hole BALUN beads also available . . . . . 5/\$1.00

LED  
DECADE  
COUNTER  
PARTS KIT  
**\$2.95**

- INCLUDES:
- 7490A 33 MHz decade counter
  - 7475 latch
  - 7447 LED driver
  - 7 — 100 Ohm current limit resistors
  - 7 segment LED readout

Complete with hook-up instructions on how to build an easy, low-cost frequency counter.

SLIDE POT — 10k linear taper . . . SPECIAL 4/\$1.00

1000 uf 15v FILTER CAP . . . . . 5/\$1.00

# ramsey electronics

P.O. Box 4072E Rochester, NY 14610



**48 HOUR  
SERVICE**

Satisfaction guaranteed or money refunded. **NO COD.** Orders under \$10.00 add \$.75. NY residents add 7% tax.



**GREGORY ELECTRONICS**  
*The FM Used  
Equipment People.*



FE53:  
W 9",  
H 4", D 16"

# 150-170MHz MOBILE UNITS

## GENERAL ELECTRIC T.P.L.

Transistorized Progress Line, FE53JA6, Front Mount, 150-174 MHz, 12 volt, 35 watts, fully solid state receive, 4 tubes in transmitter, fully narrow band, complete with accessories, shipping weight 50 lbs.

Regular ~~\$168~~  
**NEW LOW PRICE \$118.**

(Schematic available on request)



## GREGORY ELECTRONICS CORP.

245 Rt. 46, Saddle Brook, N.J. 07662  
Phone: (201) 489-9000

## 2-METER LINEAR (KW)

DON'T MISS OUT ON OSCAR AND 2 METER DX. AM-SSB-CW-FM MODES. 16 in W X 5 in. H X 17 in. D IN A CASE THAT EVEN THE XYL WILL WANT IN THE LIVING ROOM! ALL NEW AMERICAN PARTS-FULLY ASSEMBLED AND TESTED. (requires power supply offered below or equivalent)

fob san bernardino, calif. **L-2-K \$450**

## COMMERCIAL QUALITY 2KW POWER SUPPLY

220/115 v POWER SUPPLY THAT DELIVERS: B+: 2,200 v at 500 ma. WITH METER/FILIMENTS: 0-6.3 v AC WITH METER/SCREEN: 0-250 v WITH METER/BIAS: 0-90 v WITH METER. SUPPLIES ALL REQUIRED VOLTAGES FOR THE ABOVE LINEAR. MATCHING CASE WITH THE L-2-K, 16 in. W X 8 1/2 in. H X 17 in D. (the XYL will like this one too). ALL NEW AMERICAN PARTS-WEIGHT APPROX. 100 lbs. ASSEMBLED AND TESTED.

fob san bernardino, calif. **PS-2000 \$790**

**PERCENT OF QUIETING MEASUREMENT**  
FINELY, A SYSTEM TO MEASURE THE PERCENT OF QUIETING IN FM RECEPTION. ACCURATE AND CONSISTENT PERCENT QUIETING REPORTS PLUS FINE TUNING FM RECEIVERS AND ANTENNA SYSTEMS MAKES THIS A WINNER! THIS PIECE OF GEAR IS A MUST FOR THE SERIOUS VHF'ER. ASSEMBLED AND TESTED.

shipped paid in U.S.A. **PQ-A \$ 65**

**FREQUENCY DEVIATION MEASUREMENT**  
A 2 METER FREQUENCY DEVIATION METER AT ITS BEST. STABLE, ACCURATE AND EASY TO OPERATE. MULTI-RANGE FOR WIDE OR NARROW FM DEVIATION. SUPPLIED WITH BATTERY AND 146.94 MHz XTAL (other freq avail). ASSEMBLED AND TESTED.

shipped paid in U.S.A. **FD-2 \$ 85**

**SORRY-NO COD'S CALIF. RES ADD 6% TAX**

## CHM products inc.

p.o. box 6193  
san bernardino, california 92412

# FIRST

Make this comparison:

The GTX-1 gives the high quality performance that compares with Motorola, GE, RCA or any other hand-helds that sell for \$700 or more.

# THEN

Check these features:

**Small:** only 8"x2.6"x1.28" ...  
**Appearance:** slim silhouette all black metal ...  
**Serviceable:** easy access to separate receive and transmit circuit boards ...  
**PLUS:** 6 pole xtal filter for superlative receiver operation ...  
**and:** trimmers on receive and transmit xtals: standard 10.7 MHz 1st IF.

and specs:

**Rec. Sens.:** .2 $\mu$ V for 12 db SINAD ...  
**Adjacent channel rejection:**  $\pm$ 30 kHz 55 db ...  
**Spur. Resp.:** more than 65 db ...  
**Audio Output:** 500 mw ...  
**Power output:** Hi 3 w, Lo 1 w ...  
**Audio Quality:** Distortion free, crisp, clear receive and transmit.

# NOW

Look at the Price:

**GTX-1**  
 2 Meter 6 channel Hand-Held (without encoder)  
**\$249<sup>95</sup>**  
 (Bat. Not Incl.)

**GTX-1T**  
 with Built-In Tone Encoder  
**\$299<sup>95</sup>**  
 (Bat. Not Incl.)

GENAVE stocks most common 2-M Xtals for immediate delivery



Use This Handy Order Form

4141 Kingman Dr., Indianapolis, IN 46226  
 Phone-in orders accepted (317+546-1111)

NAME \_\_\_\_\_  
 ADDRESS \_\_\_\_\_ CITY \_\_\_\_\_  
 STATE & ZIP \_\_\_\_\_ AMATEUR CALL \_\_\_\_\_

CLIP OUT AND ORDER NOW

**GTX-200-T**

2-meter FM, 100 channel combinations, 30 watts with factory installed tone encoder (Incl. 146.94 MHz)



**\$249<sup>95</sup>**

**GTX-200**

2-meter FM, 100 channel combinations, 30 watts (Incl. 146.94 MHz)



**\$199<sup>95</sup>**

**GTX-10-S**

2-meter FM, 10 channels, 10 watts (Xtals not included)



**\$149<sup>95</sup>**

**GTX-2**

2-meter FM, 10 channels, 30 watts with pushbutton frequency selector (Incl. 146.94 MHz)



**\$189<sup>95</sup>**

**GTX-1**

2-meter FM, 6-channel, 3.5 watts Hand-Held

**\$249<sup>95</sup>**  
 (Bat. not incl.)

**GTX-1T**

Same as GTX-1, plus Factory Installed Tone Encoder

Operate Auto Patch  
**\$299<sup>95</sup>**  
 (Bat. not incl.)



Ringo Ranger ARX-2 6 db 2-M Base Antenna @ \$29.95 \$ \_\_\_\_\_

Lambda/4 2-M and 6-M Trunk Antenna @ \$29.95 \$ \_\_\_\_\_

TE-I Tone Encoder Pad for plug-in installation on most amateur transceivers @ \$59.95 \$ \_\_\_\_\_

TE-II Tone Encoder Pad for installation on most Hand-Helds @ \$49.95 \$ \_\_\_\_\_

PS-1 AC Power Supply for use with all makes of transceivers 14 VDC-6 amps @ \$69.95 \$ \_\_\_\_\_

and the following standard crystals @ \$4.50 each \$ \_\_\_\_\_  
 Non-standard crystals @ \$6.50 each: \$ \_\_\_\_\_



### ACCESSORIES FOR GTX-1 and GTX-1T

PSI-18 Optional Nicad battery pack \$29.95 \$ \_\_\_\_\_

PS-2 Charger for GTX-1(T) battery pack \$39.95 \$ \_\_\_\_\_

GLC-1 Leather carrying case \$12.95 \$ \_\_\_\_\_

TE-III Tone Encoder (for use with GTX-1) \$49.95 \$ \_\_\_\_\_

Add \$4 per Radio for Shipping, Handling, and Crystal Netting.

Payment by:

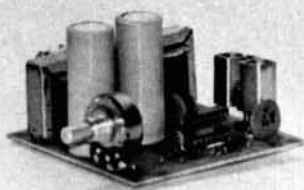
Certified Check/Money Order  Personal Check  
 C.O.D. Include 20% Down

Note: Orders accompanied by personal checks will require about two weeks to process.  
 20% Down Payment Enclosed. Charge Balance To:

BankAmericard # \_\_\_\_\_ Expires \_\_\_\_\_  
 Master Charge # \_\_\_\_\_ Expires \_\_\_\_\_  
 Interbank # \_\_\_\_\_ Expires \_\_\_\_\_

IN residents add 4% sales tax: \$ \_\_\_\_\_ 1  
 CA residents add 6% sales tax: \$ \_\_\_\_\_ 0  
 All orders shipped post-paid within continental U.S. 7  
 (allow 8 weeks delivery.) HAM 6

# ADVA



## KIT \$11<sup>95</sup>

ASSEMBLED \$17.95  
ADD \$1.25 FOR  
POSTAGE/HANDLING

# VARIABLE POWER SUPPLY

- Continuously Variable from 2V to over 15V
- Short-Circuit Proof
- Typical Regulation of 0.1%
- Electronic Current Limiting at 300mA
- Very Low Output Ripple
- Fiberglass PC Board Mounts All Components
- Assemble in about One Hour
- Makes a Great Bench or Lab Power Supply
- Includes All Components except Case and Meters

### OTHER ADVA KITS:

**LOGIC PROBE KIT** - Use with CMOS, TTL, DTL, HTL, HNL and most MOS IC's. Built in protection against polarity reversal and overvoltage. Draws only a few mA from circuit under test. Dual LED readout. Complete kit includes case and clip leads. **ONLY \$7.86**

**FIXED REGULATED POWER SUPPLY KITS** - Short-circuit proof, with thermal current limiting. Compact size and typical regulation of 0.5% make these ideal for most electronic projects. Available for 5V @ 500mA, 6V @ 500mA, 9V @ 500mA, 12V @ 400mA, 15V @ 300mA. Specify voltage when ordering. **\$9.95 ea.**

These easy-to-assemble kits include all components, complete detailed instructions and plated fiberglass PC boards. Power supply kits do not include case or meters. Add \$1.25 per kit for postage and handling.

**1MAIL NOW!** FREE DATA SHEETS supplied with many items from this ad. FREE ON REQUEST - 741 Op Amp with every order of \$5 or more - 748 Dual Op Amp or two F100 FET's with every order of \$10 or more, postmarked prior to 12/31/78. One free item per order.

**ORDER TODAY** - All items subject to prior sale and prices subject to change without notice. All items are new surplus parts - 100% functionally tested.

**WRITE FOR FREE CATALOG #76** offering over 350 semiconductors carried in stock. Send 13¢ stamp.

**TERMS:** Send check or money order (U.S. funds) with order. We pay 1st Class postage to U.S. Canada and Mexico (except on kits). \$1.00 handling charge on orders under \$10. Calif. residents add 6% sales tax. Foreign orders add postage. COD orders - add \$1.00 service charge.

### MORE SPECIALS:

**RC4195DN - 15V @ 50mA VOLTAGE REGULATOR IC.** Very easy to use. Makes a neat Highly Regulated 15V Supply for OP AMP's, etc. Requires only unregulated DC (18-30V) and 2 bypass capacitors. With Data Sheet and Schematics. 8-pin mDIP **\$1.25**

**LM741 FREE COMPENSATED OP AMP.** #A741, MC1741, etc. mDIP 5/S1 **3/S1**

**RC4558 DUAL 741 OP AMP mDIP 3/S1**

**RC4558 DUAL 741 OP AMP mDIP 3/S1**

**2N3904 NPN TRANSISTOR AMPLIFIER/SWITCH** to 50 mA, 100 6/S1

**ZENERS** - Specify Voltage 3.3, 3.9, 4.3, 5.1, 6.8, 8.2, 400mW 4/S1 00  
9.1, 10, 12, 15, 16, 18, 20, 22, 24, 27, or 33V (+10%) 1 Watt 3/S1 00

- MONEY-BACK GUARANTEE
- ALL TESTED AND GUARANTEED

# ADVA

**ELECTRONICS**  
BOX 4181 D, WOODSIDE, CA 94062  
Tel. (415) 851-0455

# FREE

IC or FET's WITH  
\$5 & \$10 ORDERS.<sup>†</sup>  
DATA SHEETS  
WITH MANY ITEMS.

DIODES	TRANSISTORS	TRANSISTORS	TRANSISTORS	LINEAR IC's
ZENERS & RECTIFIERS	2N710 50.24 2N4001 3/S1 2N4338 2/S1 LM3008 5 \$1.75	2N718 24 2N4002 50.75 2N4340 2/S1 LM3007 5 1.75	2N720 48 2N4127 3/S1 CP643 34.00 LM3007 5 1.75	1N456 6/S1 2N4130 3/S1 CP650 <sup>†</sup> 50.00 LM3007 12 1.75
1N462 6/S1 2N4133 50.28 2N4134 5/S1 CP651 50.00 LM3007 15 1.75	1N486 6/S1 2N1711 29 2N4248 5/S1 E100 4/S1 LM3007 24 1.75	1N476 4/S1 2N1890 38 2N4249 5/S1 E101 3/S1 LM378N <sup>†</sup> .55	1N4720 3/S1 2N1903 38 2N4250 4/S1 E102 3/S1 LM378N 2.50	1N4721 15/S1 2N2219 24 2N4274 5/S1 E175 3/S1 LM3008 15 1.75
1N492 14/S1 2N2222 6/S1 2N4302 50.28 MPP102 <sup>†</sup> 3/S1 NE555 <sup>†</sup> 2/S1	1N474 1N474 2N2222A <sup>†</sup> 5/S1 2N4303 29 MPP104 3/S1 NE568A 50.90	1N4936 6/S1 2N2905 50.24 2N4302 50.90 MPP112 4/S1 LM709CN 29	1N4937 6/S1 2N2906 24 2N4304 29 MPP150 3/S1 LM709CN 29	1N4901 <sup>†</sup> 12/S1 2N2909 32 2N4301 51 SE1001 4/S1 LM723H 2/S1
1N4902 12/S1 2N2905 50.24 2N4302 50.90 SE1002 4/S1 LM723N <sup>†</sup> 2/S1	1N4903 12/S1 2N2906 24 2N4316 29 SE1003 4/S1 LM723N 2.50	1N4904 12/S1 2N2907 51 2N4418A 50.88 SE2002 4/S1 LM741CN 3/S1	1N4905 10/S1 2N3552 51.50 2N4850 14 51 SE5001 3/S1 LM741CN <sup>†</sup> 4/S1	1N4906 10/S1 2N3563 6/S1 2N4801 SE5003 4/S1 LM741CN14 34
1N4907 10/S1 2N3564 4/S1 2N4802 29 SE5002 53.00 LM741CN 34	1N4148 15/S1 2N3565 14 6/S1 2N4808 29 T1573 3/S1 748CJ DIP .35	1N4154 <sup>†</sup> 25/S1 2N3568 6/S1 2N4881 \$2.50 T1575 3/S1 748CJ DIP .80	1N4370 14/S1 2N3569 6/S1 2N4888 31 DIGITAL IC's 84CF DIP .80	1N4372 14/S1 2N3583A 5/S1 2N4905 3/S1 74LS00 1.15
1N4454 15/S1 2N3641 5/S1 2N5087 4/S1 MM9728N \$2.95 LM1558N <sup>†</sup> 3/S1	1N4728 14/S1 2N3642 5/S1 2N5088 4/S1 SN7410N 16 LM2111N 31.40	1N4753 15/S1 2N3643 6/S1 2N5129 16/S1 SN7410N 16 LM2111N 31.40	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7420N 16 274602 1.95	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7420N 16 274602 1.95
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75
1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N5129 16/S1 SN7440N 16 LM2902N 1.75	1N4753 15/S1 2N3644 4/S1 2N512		

*"Experience  
is the best  
Teacher..."*

*Especially in total solid state  
HF Transceiver Technology*



made its debut, with unique and exciting operating advantages made possible by full solid-state technology.

At the moment, there are over 7,500 solid-state TEN-TEC transceivers in service in nearly every Free-world country. We are acknowledged, we think, to be the World's Most Experienced Designer of Fully Solid-State HF Transceivers. And there is no short cut to design perfection.

It is notably significant that TEN-TEC is the only manufacturer that has placed a five-year pro-rata warranty on output transistors — with an unlimited guarantee the first year against failure from any possible cause under normal operating conditions.

You can put your full trust in the integrity of design, quality, craftsmanship and performance to specifications of any TEN-TEC product. Year after year after year . . . See your local TEN-TEC Dealer, or write for full details.

Since 1969, the year in which TEN-TEC introduced the first solid-state HF transceiver, progress has been rapid. It was in this year that we produced the POWERMITE which triggered the booming QRPP activity. Two years later, the ARGONAUT followed, demonstrating that Ham Radio can be more than just push-button communication.

Then, in 1972, a break-through — the 100 watt "405" solid state linear amplifier which requires but two watts of rf drive power. And in 1973 the 200 watt TRITON



### **Argonaut**

SSB/CW 5 watts input. Fully solid-state.



### **"405" Linear**

100 watts input. Fully solid-state.



### **Triton IV**

SSB/CW 200 watts input. Fully solid-state.



**TEN-TEC**  
SEVIERVILLE, TN. 37862  
EXPORT: 5715 LINCOLN AVE.  
CHICAGO, ILLINOIS, 60646

# Poly Pak's EXCLUSIVE \$1.98

## BARREL KITS

100'S OF BARRELS PURCHASED! TEST 'EM YOURSELF 'N SAVE!

For the first time anywhere, Poly Pak merchandisers introduce a new way in buying the economical way. Raw stock from the "barrel". Remember the "good ole days"? They're back again. The same way merchandisers throughout the United States buy from various factories... their overruns in barrels. Poly Pak has done the same. Therefore you are getting the same type of material as the RE-TESTERS DO!

Every kit carries a money back guarantee!

<b>BARREL KIT #1</b> SN7400 DIP IC'S 75 for \$1.98 Cat. No. 10H2415 Untested.	<b>BARREL KIT #2</b> LINEAR OP AMPS. DIPS 75 for \$1.98 Untested Cat. No. 10H2416	<b>BARREL KIT #3</b> 1N4148/94 SWITCHING DIODES 100 for \$1.98 Cat. No. 10H2418 Untested.	<b>BARREL KIT #4</b> "4000" RECTIFIERS 100 for \$1.98 Untested. Cat. No. 10H2417
<b>BARREL KIT #7</b> VOLUME CONTROL BONANZAI 40 for \$1.98 Cat. No. 10H2421	<b>BARREL KIT #11</b> POWER TAB TRANSISTORS 40 for \$1.98 Cat. No. 10H2425 Untested	<b>BARREL KIT #14</b> PRECISION RESISTORS Marked and unmarked 200 for \$1.98 No. 10H2428	<b>BARREL KIT #18</b> DIPPED MYLARS 60 for \$1.98 Cat. No. 10H2597 100% good
<b>BARREL KIT #20</b> LONG LEAD DISCS 150 for \$1.98 Cat. No. 10H2598 100% good	<b>BARREL KIT #25</b> METAL CAN TRANSISTORS 100 for \$1.98 Cat. No. 10H2603	<b>BARREL KIT #26</b> PLASTIC CAN TRANSISTORS 100 for \$1.98 Cat. No. 10H2604	<b>BARREL KIT #30</b> PREFORMED RESISTORS 250 for \$1.98 Cat. No. 10H2608 100% good
<b>BARREL KIT #31</b> METALLIC RESISTORS 100 for \$1.98 Cat. No. 10H2609	<b>BARREL KIT #37</b> 1 AMP "BULLET" RECTIFIERS 100 for \$1.98 Cat. No. 10H2615	<b>BARREL KIT #39</b> 2N3055 HOBBY TRANSISTORS 15 for \$1.98 Cat. No. 10H2617	<b>BARREL KIT #58</b> SLIDE SWITCHES 30 for \$1.98 No. 10H2726 100% good
<b>BARREL KIT #61</b> POLYSTYRENE CAPS 100 for \$1.98 Cat. No. 10H2729	<b>BARREL KIT #68</b> 2 WATTERS 100 for \$1.98 Cat. No. 10H2735	<b>BARREL KIT #71</b> CAPACITOR SPECIAL 100 pcs. \$1.98 Cat. No. 10H2738	<b>BARREL KIT #73</b> TRANSISTOR ELECTROS 50 for \$1.98 Cat. No. 10H2747
<b>BARREL KIT #76</b> 1-WATT ZENERS 100 for \$1.98 Cat. No. 10H2741	<b>BARREL KIT #86</b> HOBBY LEDS 40 for \$1.98 Cat. No. 10H2859	<b>BARREL KIT #87</b> NATIONAL IC BONANZAI MOLEX SOCKETS 100 for \$1.98 Cat. No. 10H2860 Untested	<b>BARREL KIT #115</b> MOLEX SOCKETS 200 for \$1.98 Cat. No. 10H3144

**REPEATER**  
Name take note!

**HOME**  
**OFFICE**  
**FACTORY**  
**SHOP**

**IT'S REVOLUTIONARY!**  
**TOUCH TONE ENCODER KIT\***

1.25M, 2-meter and 6-meter amateur radio operators, if your rig is mobile, convert it easily to a mobile telephone station and contact your home, shop, school, factory TTE-100 touch tone encoder kit. Kit includes: Chomerics touch tone pad, Motorola MC14410 chip, trimpot, resistors, zener, diagram, and G-10 pc board. Electrical specs: 12-16 volts, 5 mA (max), 4 volts PP output. \* Less 1-MC crystal. Cat. No. 10H3385

Cat. No.	Description	Sale	BUY 'EM SEPARATELY
10H3249	Touch Tone Pad	\$4.50	10H3383 P.C. Board 2.95
10H3382	MC14410 Chip	10.50	

**DIGITAL CLOCK**

**MODULE WITH BUILT-IN "CHIP"**

Never before offered (as far as we know) the latest in Digital Clock circuitry... 4-digit, 0.5" height... LED, built-in red filter, with MM5386 multi-function alarm chip, mounted on a 3 x 1 3/4 x 1/4" module. Has all necessary discrete components mounted on module by factory, to require only 6 function switches, 2 brightness and voltage divider control, 12-16 volt filament transformer, AC line cord and case. Makes easy-built-in alarm and radio output; switch functions: Seconds, Sleep timer up to 1 hour, fast set, Snooze alarm display (tells you when snooze alarm triggers), Alarm display (tells you when alarm triggers).

Alarm ON/OFF, Instruction and hookup diagrams. Shpg. wt. 7 ozs.

Cat. No. 10H3411

**\$14.95**

**\$8.88**

- 3-5-6 Blades
- 115 VAC
- Compact
- Lightweight
- Only 4-11/16" sq. x 1 1/2" deep!

**Rotron Fans**

Now anyone can afford these neat Muffin and Centaur Fans by Rotron. Used extensively for high-quiet because of low-cost, dependable cooling, as well as flushing computers, power supplies, office equipment, light projectors, transmitters, receivers & more! Weighs only 1-1/8 lbs. LOW NOISE LEVEL! Humidity & moisture resistant motor. REVERSIBLE AIR FLOW! Impedance protected. Suitable for -40° to +100° F. Both 115 VAC, 9200 rpm, 1/8 watts, 1.6 amps. High-impact, flame retardant polycarbonate propellers in a reinforced phenolic venturi block. Blow away high prices with our Muffin and Centaur fans! Removed from new equipment. Money back guarantee.

Cat. No. 10H3108 "Muffin" 3-blade Shpg. wt. 1 1/2 lbs.  
10H3109 "Centaur 2" 5-blade  
10H3110 "Centaur" 6-blade

**FAIRCHILD, NATIONAL VOLTAGE REGULATOR PANIC**

**YOUR CHOICE \$1**

- 1-AMP RATING
- TO-220 or TO-3 CASES
- POSITIVE OR NEGATIVE

3 for \$2.75 Cat. No. 10H3445 Positive Voltage\*\*  
Cat. No. 10H3450 Negative Voltage\*\*

\*\* State voltage and case style when ordering.

Type	Sale	2 for	Type	Sale	2 for
SN7400	.22	.23	SN7494	.82	.83
SN7401	.22	.23	SN7495	.86	.87
SN7402	.22	.23	SN7496	.86	.87
SN7403	.22	.23	SN74125	1.29	1.30
SN7404	.24	.25	SN74126	1.29	1.30
SN7406	.36	.37	SN74127	1.95	1.96
SN7407	.46	.47	SN74141	1.12	1.13
SN7408	.22	.23	SN74145	1.69	1.70
SN7409	.52	.53	SN74146	3.25	3.26
SN7410	.22	.23	SN74150	1.12	1.13
SN7411	.27	.28	SN74153	1.10	1.11
SN7417	.62	.63	SN74154	1.33	1.34
SN7418	.22	.23	SN74157	1.09	1.10
SN7421	.55	.56	SN74158	1.55	1.56
SN7423	.47	.48	SN74160	1.59	1.60
SN7425	.22	.23	SN74163	1.50	1.51
SN7444	.22	.23	SN74164	1.79	1.80
SN7432	.36	.37	SN74165	1.79	1.80
SN7440	.22	.23	SN74171	1.69	1.70
SN7442	.97	.98	SN74174	1.42	1.43
SN7444	.97	.98	SN74175	1.45	1.46
SN7446	1.10	1.11	SN74176	1.59	1.60
SN7447	1.10	1.11	SN74177	1.59	1.60
SN7448	1.12	1.13	SN74178	1.59	1.60
SN7450	.22	.23	SN74181	3.75	3.76
SN7451	.27	.28	SN74184	2.19	2.20
SN7473	.44	.45	SN74190	2.75	2.76
SN7475	1.00	1.01	SN74191	2.75	2.76
SN7483	.99	1.00	SN74193	1.29	1.30
SN7484	1.44	1.45	SN74195	.89	.90
SN7486	.47	.48	SN74196	2.19	2.20
SN7489	2.25	2.26	SN74198	2.25	2.26
SN7490	1.00	1.01	SN74199	2.25	2.26
SN7491	.91	.92			

Cat. No.	Type	Sale	2 for
10H2310	8008	\$19.95	\$19.96
10H2855	2102	2.50	2.51
10H2856	2102-1	2.95	2.96
10H2897	1103	1.50	1.51
10H1989	1103	1.50	1.51
10H2853	5262	1.95	1.96
10H2155-A	MM5203	9.95	9.96
10H2158	MM5202	6.95	6.96
10H2854	1702-A	9.95	9.96

**Terms:** Add postage Rated: net 30  
**Phone:** 1-800-245-3829  
**Retail:** 16-18 Del Carmine St., Wakefield, MA

**MINIMUM ORDER — \$6.00**

**POLY PAKS**

P.O. BOX 942 H LYNNFIELD, MASS. 01940

**MEMORIES**

**SALE**

**Send for FREE Fall-Winter CATALOG**

**C.O.D.'S MAY BE PHONED**

**2250**

3 for \$60.

**CITIZENS BAND POWER SUPPLY**

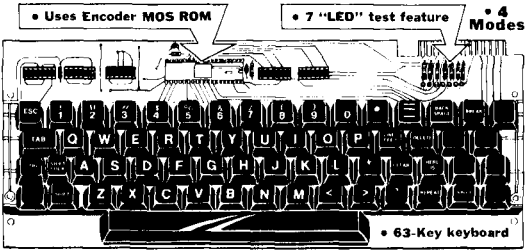
- 12 VDC @ 3 AMPS
- REGULATED, CONTINUOUS DUTY
- CONVERTS CB, HAM RIGS TO HOME
- COMPLETELY WIRED

**ECC INDUSTRIAL SPEED CONTROL**

Repeat of a sellout! A \$30 item, made by ECC famous for semiconductor, designed and built this speed control for XEROX. Controls home, shop and industrial lighting too. Rated at 1200 watts. A very elaborate circuit for controlling many electrical and electronic devices. Easily controls speeds of electric drills, brush-type motors, etc. Built with heavy duty aluminum framing. Complete with external 50K pot, for variable speed control, and series resistor. Heavy duty colored wires for 115VAC 60 cycles, and item to be controlled. 10/32 mounting stud. Outperforms our previous sell-out. With hookup diagram. Use as temperature controller too. Wt. 2 lbs. Cat. No. 10H3392

**\$4.95**

## KEYBOARD & ENCODER KIT



• Double sided PC board

Outputs — standard ASCII 7 bits plus strobe

Lowest priced Keyboard and Encoder kit we've seen. General purpose ASCII keyboard for data terminal applications. Could be used for TV, RTTY, Code Transmission, Altair and other Mini Computers, etc. Utilizes 2-key rollover MOS memory allowing encoded outputs to be strobed out as each key is depressed. Uses double side pc board. Electronic shift lock, not mechanical on keyboard. Keyswitches, one integral assembly not individual keys. Keyboard: 63 keys (49 encoded keys). 4 mode: normal, shift and control. 3 internal function keys: shift, teach side of board, shift lock and control. 3 functions: Key Break, Here Is, Repeat, 7 additional functions (can be assigned by user).

Cat. No. 10H3208 Keyboard & Encoder Kit \$59.95  
Cat. No. 10H3209 Keyboard & Encoder Wired 69.95

**\$59.95**

**WIRE**

Electrical specs: voltage requirements plus 5 volts and minus 12 volts, 200mw, negative or positive logic output, jumper selectable. Output connector. On the PC board we have A NEW KEYBOARD TEST FEATURE... 7 LEDS! These LEDs display visually the ASCII code for the depressed key. TTL compatible. Kit includes: 63 key keyboard, pc board, ROM, 7 LEDs, resistors, capacitors, TTL IC's and SOCKETS. We include diagram and wiring instructions, ROM code. Wt. 7 lbs. Size overall: 13 x 5 1/2 x 2".



# flea market



**RATES** Non-commercial ads 10¢ per word; commercial ads 40¢ 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 and must include full name and address. We reserve the right to reject unsuitable copy. Ham Radio can not 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.

**WANTED: SSB TRANSCEIVER** for mountain backpacking or design information for same. Also need 3 channel RC rig, modestly priced. W6DOM, 6017 Marjorcs Ct., San Jose, California 95120.

**STOP** don't junk that television set. ASE manufactures the world's most complete line of television picture tubes. Over 1700 types. Most types immediate delivery. Tubes for Old or New TV's, black & white and color. 2 year factory warranty. Lowest prices anywhere. Allied Sales & Engineering, Inc., Dept. 22, Pimento, IN 47866. Telephone 812-495-6555.

**WANTED:** Mint 500CX, 117XC, VX2. Indicate serial number. WB21WH.

**ETCHED CIRCUITS** glass epoxy, drilled and plated. \$.25/square inch. Send artwork to Ready Circuits, P. O. Box 34, Pinesdale, Montana 59841.

**VARIABLE CONDENSORS**, Johnson 154-3, 19-488pt, 2KV, used, excellent condition, \$12 each or 3 for \$30, postpaid. KP4DSD, Box 297, Sabana Seca, P. R. 00749.

**VERY in-ter-est-ing!** Next 4 big issues \$1. "The Ham Trader," Sycamore, IL 60178.

**SYNTHESIZER.** See Ham Radio, July 76, pg. 20-23, figures 21 to 24. Kit for \$115, assembled and tested, \$140. Power supply to run from 117 volts additional \$15.00. CTD, P. O. Box 708, Cambridge, MA 02139.

**FREQUENCY COUNTER BOARDS**, Jan. 76 Ham Radio includes 500 MHz prescaler circuitry and LED board with instructions, \$15.00. QST March 76 speech compressor, \$10.00. Both projects come with parts source listing. Double sided glass epoxy, drilled and plated. CSJ Electronics, 5201 Cameron Ct., Lincoln, NE. 68512.

**HEATHKIT BY ANDREA** — Excellent building and check-out services of most Heath equipment. We ship finished product to you. For rates / information, Tycol Communications, Route 3, Mt. Airy, Md. 21771, 301-831-7086.

**SAVE!** Bomar FM, xtals \$4.00 ppd. Dentrone, Hustler, CushCraft, W. M. Nye, Ameco. Used gear. Complete catalog - write Ferris Radio, 308 E. Harry, Hazel Park, Mich. 48030.

**TELETYPE EQUIPMENT FOR SALE** for beginners and experienced operators. RTTY machines, parts, supplies. Special beginners package consists of Model 15 page printer and TH5-TG demodulator \$125.00. Atlantic Surplus Sales, 3730 Nautilus Ave., Brooklyn, N. Y. 11224. Tel: (212) 372-0349.

**RECONDITIONED TEST EQUIPMENT** for sale. Catalog \$.50. Walter, 2697 Nickel, San Pablo, Ca. 94806.

**KLM, LARSEN, ARCOS and HENRY RADIO** — We stock popular items, KLM Echo II, Echo 70CM, Multi-7, Multi-U11; KLM antennas, 7 to 470 MHz. Larsen mobile antennas and mounts for 2 meters and 450 MHz. ARCOS 432 MHz transverter and kilowatt amplifiers. Henry Radio solid state amplifiers 50 to 500 MHz. Write/call for information. Tycol Communications, Rt. #3, Mt. Airy, Md. 21771. 301-831-7086.

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

**LOOKING FOR USED GEAR?** Buyers & Sellers radio brokerage has the equipment you want at the right prices. Call our Ham Gear Hotline 617-536-8777 Monday-Friday.

**GOVERNMENT SURPLUS** Communication Equipment, FREE catalog. Colonel Russell, 9410 Walhampton, Louisville, KY 40222.

**FREE** Electronics Surplus Catalog. Electronic Specialties, 1659 Wetmore, Tucson, AZ 85705.

**HOMEBREWERS:** Stamp brings list of high quality components. CPO Surplus, Box 189, Braintree, Mass. 02184.

**COMPLETE LINE** KLM, CushCraft, Covercraft dust covers, SCS amplifiers, Regency, Triex Towers. Call or write Radios Unlimited, 86 Balch Ave., Piscataway, N. J. 08854. 201-752-4307.

**500 MHz PRESCALER** +10 or +100 \$59.95. Free information. CBS Enterprise, P. O. Box 1356, Cocoa Beach, Fla. 32931.

**DIRECT CONVERSION RECEIVER KITS** for AM or CW. Write WB9MBH, 3132 North Lowell Avenue, Chicago, Illinois 60641.

**FERRITE BEADS:** Ferroxcube beads w/specification and application sheet — 10 @ \$1.00 postpaid. Includes latest catalog. CPO Surplus, Box 189, Braintree, Mass. 02184.

**FREE** Catalog. Calculators \$4.95 each, ultrasonics, digital thermometers, strobe light kits, UARTS, memories, photographic electronic flash units, rechargeable batteries, LEDs, transistors, IC's, piezoelectric crystals, toroidal cores, unique components. Chaney's, Box 27038, Denver, Colo. 80227.

**NEW POWERFUL THREE OUTPUT REGULATED POWER SUPPLY, PLUS 900** parts worth \$400.00 list. Solid state TV recorder electronic unit. Schematics, parts cross reference. Free brochure. \$17.95 plus \$3.50 S&H, USA. Master Charge, BankAmericard. Satisfaction guaranteed. Madison Electronics Company, Incorporated, Box 369, D77, Madison, Ala. 35758.

**YAESU EQUIPMENT OWNERS** — Present or Prospective — Join the five-year-old, 2000-member, 40-country, International Fox-Tango Club. Members receive valuable monthly Newsletter, money-saving purchasing service, technical committee consultation, free ads, FT net, more. Back issues of Newsletter available from 1972. To join, send \$5 for calendar year (includes all 1976 issues of Newsletter) or \$1 creditable towards dues, for complete information and sample Newsletter. Milton Lowens, WA2AQQ/4, 248 Lake Dora Drive, W. Palm Beach, Fl. 33411.

**RUBBER STAMP**, name/call/QTH \$2.50 ppd. (CA residents add tax). LWM Press, Box 22161, San Diego, CA 92122.

**CRYSTAL FILTER**, 8 pole, 10.7MHz, 13 kHz BW Piezo model #1433. Equivalent to K.V.G. filter model #XF107-A. \$12.00. Jim Wiggenhorn, K8DRN/4, 7791 NW 42nd Pl., Coral Springs, Fla. 33065.

**CANADIAN JUMBO SURPLUS** and Parts Catalogs. Bargains Galore. Send \$1. ETCO-HR, Box 741, Montreal "A" H3C 2V2.

**MOTOROLA HT-200 GOODIES.** Unmodified H23DEN-1110A, \$125. NLN6259B charger, \$25. NLN6316A case with NLN6320A cover and NLN6349A strap, \$7.50. NAD6219A flex antenna, \$2.50. Complete system \$150. Unmodified H23DCN-1010A, \$100. NLN6260A twelve unit charger, \$125. Bill Wood, WB6FXJ, 31094 Hemlock Ave., Barstow, California 92311 or call 714-256-9576 after 5:30 PST.

**PORTA-PAK** the accessory that makes your mobile really portable. \$59.95 and \$39.95. Dealer inquiries invited. P. O. Box 67, Somers, Wisc. 53171.

**NEW CANADIAN MAGAZINE.** "Electronics Work Shop", \$5.00 yearly, sample \$1.00. ETCOB, Box 741, Montreal, H3C 2V2.

**TELL YOUR FRIENDS** about the BIG NEW Ham Radio Magazine!

## Barlow Wadley XCR-30 Receiver



- \* Only general coverage direct frequency readout portable
- \* Original Wadley loop circuit
- \* Tunes 500 kHz to 30.99 MHz
- \* Receives AM, CW, USB and LSB
- \* Clarifier fine tunes SSB
- \* One microvolt SW sensitivity
- \* Reset or readout within ± 5 kHz
- \* Zero set adjustment on panel
- \* Average 300+ hour battery life

### Antenna "Multi-tuner"



- Matches any antenna to any shortwave receiver
- Usable from 2 to 35 MHz
- Choice of 5 matching circuits
- Coaxial or long wire input
- 10-position coil tap switch

### GILFER C-10 Calibrator



- Calibrate any type of receiver
- Strong harmonics every 10, 25, 50, 100 and 1000 kHz
- Adjustable output level
- Modern CMOS integrated circuits
- Accurate—completely drift-free
- Identifies by "Gate" circuit
- Easy to use—long battery life

See our mini-catalog for other SWL supplies including books, clocks, antennas, headphones, log sheets, receivers, QSL albums, etc.

## GILFER ASSOCIATES, INC

P.O. Box 239, Park Ridge, NJ 07656

# This Month's Specials

## NEW

### Fairchild VHF Prescaler Chips

Type	Description	Price
11C01FC	High Speed Dual 5-4 Input OR/NOR	\$15.40
11C05DC	1 GHZ Counter Divide By 4	\$74.35
11C05DM	1 GHZ Counter Divide By 4	\$110.50
11C06DC	UHF Prescaler 750 MHz D Type Flip/Flop	\$12.30
11C24DC	Dual TTL VCM	\$2.60
11C44DC	Phase Freq. Detector	\$2.60
11C58DC	ECL VCM	\$4.53
11C70DC	600 MHz Flip/Flop With Reset	\$12.30
11C83DC	1 GHZ 248/256 Prescaler	\$29.90
11C90DC	650 MHz ECL/TTL Prescaler	\$16.00
11C90DM	650 MHz ECL/TTL Prescaler	\$24.60
11C91DC	650 MHz ECL/TTL Prescaler	\$16.00
11C91DM	650 MHz ECL/TTL Prescaler	\$24.60
95H90DC	250 MHz Prescaler	\$9.50
95H90DM	250 MHz Prescaler	\$16.55
95H91DC	250 MHz Prescaler	\$9.50
95H91DM	250 MHz Prescaler	\$16.50

### RF TRANSISTORS

New			
RCA 40290	12.5v, Ft. Typ. 500MHz 2 watts min. at p. in 0.5 watts	\$2.48	
2N2857	\$1.85	2N6080	\$5.45
2N3375	\$7.00	2N6081	\$8.60
2N3866	\$1.08	2N6082	\$11.25
2N4072	\$1.50	2N6083	\$12.95
2N4427	\$1.20	2N6084	\$13.75
2N5179	\$6.68	2N6166	\$85.00
2N5589	\$4.60	MRF511	\$8.60
2N5590	\$6.30	MMCM918	\$2.50
2N5591	\$10.35	MMT2857	\$2.50
2N5637	\$20.70		

### TUBES

IP21	\$19.95	4-400	\$29.95
2E26	\$4.00	6661	\$1.00
4X150C	\$18.00	6680	\$1.00
4X150A	\$15.00	6681	\$1.00
4CX250B	\$24.00	8321	\$32.00
4X250F	\$22.00	7984	\$3.95
DX415	\$25.00	8072	\$32.00
572B/T160L	\$25.00	8106	\$1.95
811A	\$7.95	8156	\$3.95
813	\$19.00	8950	\$5.50
931A	\$9.95	6L06	\$3.95
4652/8042	\$6.95	3-500Z	\$65.00
5894	\$32.00	3-1000Z	\$120.00
6146A	\$4.75	6907	\$35.00
6146B/8298A	\$5.75		

**JUST ARRIVED!** These radios have just been pulled out of service. Set up for approx. 150 MHz. Clean. All tubes included. No accessories. Prices FOB Phoenix.

Motorola U43 GGT	\$49.95
GE TPL	\$99.95
GE MT-33	\$39.95

NICAD Batteries, AA, 1.25 volts	49¢ ea.
GEL/CELL #GC1215, 12 volts, 1.5 amp hrs	\$19.95

We have all types of test equipment. Call or write today!

# MHz electronics

2543 N. 32ND STREET  
PHOENIX, ARIZONA 85008  
PH. 602-957-0786

# flea market

**HAMMARLUND HQ180 RECEIVER** — General coverage and Ham band spread — 0.5 to 30 MHz. \$195. W6OSU, 7811 Agnew Ave., Los Angeles, CA 90045. Phone: 213/670-5486.

**NOT C.B. decals, 1 x 2 inches, black over white, plastic, weatherproof, peel and stick.** Great for load coils, radios, control heads, etc. Stop having your radio gear mistaken for C.B. radio. 10 for \$1.00, with SASE 12 for \$1.00, 100 for \$7.00. WA4SGI, Ronald P. Pitts, 2113 Lester Lane, Birmingham, AL 35226.

**SWAN, 1200X, linear amplifier, new, in sealed carton, \$250.** Russell, 19680 Mountville Dr., Maple Hts., Oh. 44137.

**QRP TRANSMATCH** for HW7, Ten-Tec, and others. Send stamp for details to Peter Meacham Associates, 19 Loretta Road, Waltham, Mass. 02154.

**FOR SALE: AR-88, RCA WW-II comm. receiver.** Top condition, with manual and complete spares. Tunes 540 kHz to 30 MHz in 5 bands. Art Fillebrown, 48 Hunton St., Warrenton, Va. 22186.

**MAXI TUNER** solves antenna problems! Matches coax, random wires, and balanced feedlines from 160 thru 10 meters. Features Johnson 229-203 rotary inductor, vernier dials, optional SWR metering, styled cabinet and color options to complement Collins, Heath, and Drake lines. Spec. sheet, pricing, and amateur RF antenna tuner comparison chart from RF Power Components, P. O. Box 11, Ladysmith, WI 54848. (715) 532-3971.

**MOTOROLA HT220, 4 freq., 2 mtr. \$275.** Motorola U43HHT-3100 vhf \$210, Mocom D34DRT-3100 UHF \$190, Mocom D33CMT-3100 vhf \$190. Daniel M. Herlihy, K6KTP, 2338 Berry St., Lemon Grove, Cal. 92045. 714-466-7558.

**SALE: Model 28 ASR's - KSR's repurfs - key-boards TD's - printers parts - all priced for hams.** All in excellent condition. A.D.M. Communications, Inc., 1322 Industrial Avenue, Escondido, Ca. 92025. (714) 747-0374.

**MANUALS NEEDED.** RCA ET-4336-H, Waterman S-14 Pocketscope and HP 524B Counter. State price first letter. W1KCR, Claremont, New Hampshire.

**TRAVEL-PAK QSL KIT** — Send call and 25¢; receive your call sample kit in return. Samco, Box 203, Wynantskill, N. Y. 12198.

**ARTS ON 7103 KHZ DAILY 1300Z to 1900Z** for emergency or routine traffic. Amateur Radio Telegraph Society, 2730 South Tabor Avenue, Silver City, New Mexico 88061.

**WANTED:** Car telephones and mobile telephone parts, heads, cables, etc. Greg Hyman, 87 Yonkers Ave., Yonkers, N. Y. 10701. 914-476-4330.

**TELEVISION SYNC GENERATOR.** Broadcast standards. Best offer or swap for VHF or UHF transceiver, CB SSB, etc. Manual, W9YLU. 6731 N. Hermitage, Chicago, IL 60626.

**MANUALS** for most ham gear, 1939/70. List \$1.00. Send SASE (or 25¢) for one specific model quote. Hobby Industry, W2JJK, Box H864, Council Bluffs, Iowa 51501.

**THE PERFECT GIFT FOR A HAM** — His/her call sign cut into solid redwood. Type one: just the call, approximately 18" x 5 1/2", \$7.50. Type two: the call plus any handle, seven letters or less, approximately 18" x 9 1/2", \$12.50. Call signs Ltd., P. O. Box 101, Hurley, N. Y. 12443. N. Y. State residents add sales tax.

**RADIO MUSEUM** now open. Free Admission. 15,000 pieces of equipment from 1850 telegraph instruments to amateur and commercial transmitters of the 1920's. Amateur station W2AN. Write for information. Antique Wireless Assn., Main St., Holcomb, N. Y. 14469.

**OSCILLOSCOPE AN/USM-140D**, dual trace, 24 MHz, \$325. HP-140A/1415A time domain reflectometer, \$600, HP-130BR oscilloscope 300 kHz, \$200. B & K 445 CRT tester, \$50. AN/URM-32A frequency meter, \$100. Boonton 207H univertor, \$150. HP-302A wave analyzer, \$550. Hickok 1600B VTVM, \$75. AN/USM-34 VTVM, \$35. Both with RF probes. All instruments in working condition with manuals. James Walter, 2697 Nickel, San Pablo, Ca. 94806.

**SIDESWIPE** only \$13. Airmailed USA. Kungsimport, Box 257, Kungsbacka, Sweden.

**MOTOROLA HT220, HT200, Pageboy, and other popular 2M FM transceiver** (Standard, Regency, etc.) service and modifications performed at reasonable rates. WA4FRV (804) 320-4439 evenings.

## SUPER CALCULATOR VALUE!



\$4<sup>95</sup> ea.

New Calculators made by one of the largest calculator manufacturers (their name has been removed so that we can offer these at this low, low price).

### Check These Quality Features

- Full 8 digit capacity
- All 4 functions plus constant (K) switch
- Floating or 2, 3, 4 decimal pt. set switch
- Clear last entry key
- Automatic display time out to conserve battery
- Indicator for input greater than 8 digits
- Indicator for answer greater than 8 digits
- Indicator for low battery condition
- Quality aluminum keyboard with tactile feedback buttons
- Size approx. 6" x 3 1/2" x 1 3/4". White case with black trim.

These were originally designed to operate from six AA size nicad batteries, however, they were removed by the manufacturer before we purchased them. It's up to you to power the calculator — there is room in the battery compartment to wire penlight batteries in or use a small transformer and rectifier to make a handy desk calculator.

Please include \$1.00 for shipping.

AA size nicads (used - excellent condition) 59¢ ea.

**CHANEY'S**  
electronics

P. O. Box 27038 • Denver, Colorado 80227

Send for our free catalog listing hundreds of bargains on nicads, IC's, transistors, digital thermometers, clocks, ultrasonics, strobe lights, kits, crystals, resistors, capacitors, etc.

### BUILD YOUR OWN TV CAMERA!

Ideal for home & business



GREAT FOR AMATEUR TV INDUSTRIAL SURVEILLANCE HOME ENTERTAINMENT & MONITORING PLUS HUNDREDS OF OTHER USES MODEL KIT SERIES D - KIT \$185 FACTORY ASSEMBLED \$285 - SOLID STATE CONNECTS TO ANY TV SET OPTIONAL SOUND KIT \$235 PHONE OR WRITE FOR FREE CATALOG DIAL 602 987 3771

1301 BROADWAY N.W. ATV Research DAKOTA CITY, NEBR. 68731

## 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

## 125 Hz Crystal Filter For Drake R-4C



Cuts QRM. Ideal for DX and Contest Work. Does what no audio filter can do. A must for CW operators who want the best. 125 Hz @ -6 db, 325 Hz @ -60 db, 8 poles.

CF-125/B \$125.00  
Return in 10 days for full refund if not satisfied.

**Sherwood Engineering, Inc.**

Dept. A  
1268 South Ogden St.  
Denver, Colo. 80210  
(303) 722-2257



# 6 Digit LED Clock Kit - 12/24 hr.

**\$9<sup>95</sup>** QTY. 12  
ea. OR MORE

**\$10<sup>95</sup>** QTY.  
ea. 6-11

**\$11<sup>95</sup>** QTY.  
ea. 1-5

## KIT INCLUDES

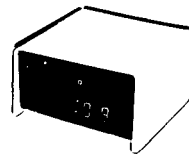
- INSTRUCTIONS
- QUALITY COMPONENTS
- 50 or 60 Hz OPERATION
- 12 or 24 HR OPERATION

- 6-LED Readouts(FND-359 Red, com. cathode)
- 1-MM5314 Clock Chip (24 pin)
- 13-Transistors
- 3-Switches
- 6-Capacitors
- 5-Diodes
- 9-Resistors
- 24-Molex pins for IC socket

**LARGE .4" DIGITS!**  
**ORDER KIT #850-4**  
**AN INCREDIBLE VALUE!**

"Kit #850-4 will furnish a complete set of clock components as listed. The only additional items required are a 7-12 VAC transformer, a circuit board and a cabinet, if desired."

Printed Circuit Board for kit # 850-4 (etched & drilled fiberglass) .....\$2.95  
Mini-Brite Red LED's (for colon in clock display) pkg. of 5 ..... 1.00  
Molded Plug Transformer 115/10 VAC (with cord) ..... 2.50  
NOTE: Entire Clock may be assembled on one PC Board or Board may be cut to remote display.  
Kit # 850-4 will fit Plexiglas Cabinet II.



## PLEXIGLAS CABINETS

Great for Clocks or any LED Digital project. Clear-Red Chassis serves as Bezel to increase contrast of digital displays.

**Black, White or Clear Cover**

**CABINET I**  
**3"H, 6 1/4"W, 5 1/2"D**

**CABINET II**  
**2 1/2"H, 5"W, 4"D**

ANY SIZE / COLOR **\$6.50** ea. **2/\*12.**

RED OR GREY PLEXIGLAS FOR DIGITAL BEZELS  
3"x6"x1/8" **95¢** ea. **4/\*3**

## 60 HZ.

### XTAL TIME BASE

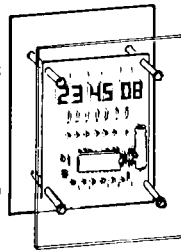
Will enable Digital Clock Kits or Clock-Calendar Kits to operate from 12V DC. 1"x2" PC Board Power Req: 5-15VDC (2.5 MA. TYP.) Easy 3 wire hookup Accuracy: ± 2PPM (Adjustable) Complete Kit

**\$4<sup>95</sup>** ea.

#TB-1

### SEE THE WORKS Clock Kit Clear Plexiglas Stand

- 6Big .4" digits
  - 12 or 24 hr. time
  - 3 set switches (back)
  - Plug transformer
  - all parts included
- Plexiglas is Pre-cut & drilled Size: 6"H, 4 1/3"W, 3"D



**A SUPER LOOKING CLOCK!**

Kit #850-4 CP **\$23<sup>50</sup>** ea. **2/\*45.**

## 6 Digit-LED Clock-Calendar-Alarm Kit

• 12/24 HR TIME • CHOICE OF DIGITS • 28-30-31 DAY CALENDAR • AC FAILURE/BATTERY BACK-UP • 24 HR ALARM - 10 MIN. SNOOZE • ALTERNATES TIME (8 SEC) AND DATE [2 SEC] OR DISPLAYS TIME ONLY AND DATE ON DEMAND • THIS KIT USES THE FANTASTIC CT-7001 CHIP. FOR THE PERSON THAT WANTS A SUPER CLOCK KIT-TOO MANY FEATURES TO LIST!

#7001 B [6-.4" Digits/Man-64] **\$39.95**  
#7001 C [4-.6" Digits/2-.3" Seconds] **\$42.95**  
#7001 D [4-.8" Digits/2-.3" Seconds] **\$45.95**

ALL KITS ARE COMPLETE INCLUDING IC SOCKET, TRANSFORMER, LINE CORD, SWITCHES, etc.

Cabinet not included (Ideal fit in Cabinet I above)

## 1/2" DIGIT CLOCK KIT

A COMPLETE KIT LESS CABINET. FEATURES: MM5314 IC, 12/24 HR, 50/60 HZ, 6-FND-503 LED'S, PLUG-TRANSFORMER, LINE CORD, etc.

[Ideal Fit in Cabinet II]

**\$19<sup>95</sup>** ea. **2/\*38.**

Kit #5314-5

## JUMBO DIGIT CONVERSION KIT

Convert small digit LED clock to large .5" displays. Kit includes 6-.5" LED's, Multiplex PC Board & easy hook-up info.

Kit #JD-1CC For common Cathode

Kit #JD-1CA For common Anode

**\$9<sup>95</sup>** ea. **2/\*19.**

## DIODES

IN4002	12/\$1.00
IN4003	12/\$1.00
IN4005	11/\$1.00
IN4007	10/\$1.00

2.5A/1000PIV	5/\$1.00
IN5400	5/\$1.00
IN914	20/\$1.00
IN4148	20/\$1.00



TRANSISTOR SOCKET GOLD PINS **5/\*1.00**

## SWITCHES

ROCKER SPDT	6/\$1.
MINI-SLIDE SPDT	5/\$1.
REG. SLIDE DPDT	6/\$1.
PUSH BUTTON N.O.	3/\$1.

### TRANSISTORS 5/\$1.00

All Prime Marked Units

2N2222A	NPN	TO-18
2N3415	NPN	TO-92
2N3704	NPN	TO-92
2N4249	PNP	TO-92
2N4400	NPN	TO-92
2N4437	NPN	TO-92
2N5089	NPN	TO-92
2N6027	PUT	TO-92

## Fairchild Super Digit FND-359



.4" Char. Ht. 7 segment LED RED Com. Cath. Direct pin replacement for popular FND-70.

**95¢** ea, **10/\$8.50**  
**100/\$79.00**

SET OF 6 FND-359 WITH MULTIPLEX PC BOARD **\$6.95**

## 25 AMP BRIDGE

**\$1.95** ea.  
**3/\$5.00**

100 PIV

## TELEPHONE FORMAT KEYBOARD

BY Chomerics

2-1/9"x3"  
5/32" thick  
**\$4.95**  
**6/\*28.**

10K 10 TURN SPECTROL POT 3/8"x3/8"x1/4" High

SPECTROL **95¢**  
#50-4-11-103 **4/\$3.00**

CT-7001.....	7.95	CT-7002.....	13.95
MM5314N...	3.95	MM5369N....	2.50
MM5316N...	4.95	MM5375AB..	3.95

IC SOCKETS		Solder Tail	
Pin	Profile	1-24	25 100
14	LP	\$.25	\$.22 \$.20
16	LP	.28	.25 .23
18	LP	.31	.28 .26
24	SP	.50	.45 .40
28	SP	.60	.55 .50
40	LP	.75	.70 .65

NYLON WIRE TIES  
8" for bundle dia. 1/4"-1-3/4" 100/\$1.95  
4" for bundle dia. 1/16"-3/4" 100/\$1.75

Form Inexpensive Sockets **MOLEX PINS**  
100 for \$1.25  
Reel of 1000 - \$8.50

## 7-SEG LED

COMMON CATHODE			
HP5082-7702	RED	.3"	1.25
FND-71	± 1	.25"	.75
FND-359	RED	.4"	.95
FND-503	RED	.5"	1.35
FND-803	RED	.8"	3.50
DL-33MMB	RED	3x.1"	.75
DL-750	RED	.6"	2.95
XAN-654	GREEN	.6"	2.95 (no D.P.)
XAN-664	RED	.6"	2.95 (no D.P.)

# OPTOELECTRONICS, inc.

BOX 219 • HOLLYWOOD, FLA. 33022 • (305) 921-2056

master charge



ORDER BY TELEPHONE  
USE BAC, MC or COD  
Orders Under \$15 Add \$1 Handling  
COD Charge - \$1.00  
Fla. Res. Add 4% Tax

WE PAY ALL SHIPPING IN CONTINENTAL USA — OTHERS ADD 5% [10% FOR AIRMAIL]

# 2 METER FM

and HF too . . .

Chicago  
Area  
Hams!

Come in or call for the

## ERICKSON COMMUNICATIONS

Cash or trade deal on:

- Ameco • ASP • Atlas
- Belden • Bird • CDE
- CES • Collins • Cushcraft
- Data Signal • Dentron
- Drake • ETO • HAL
- Hy-Gain • Icom • KLM
- Kenwood • Larsen • MFJ
- Midland • Mosley • NPC
- Newtronics • Nye
- Regency • Shure • Swan
- Standard • TPL • Tempo
- Ten-Tec • Yaesu . . .



Hours: 9:30-9 Mon. & Thurs,  
9:30-5:30 Tues, Wed. & Fri.  
9-3 Sat.



## ERICKSON COMMUNICATIONS

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

## flea market

**FIGHT TVI** with the RSO Low Pass Filter. For brochure write: Taylor Communications Manufacturing Company, Box 126, Agincourt, Ontario, Canada. MIS 3B4.

**RTTY** — NS-1A PLL TU (HR 8/76). Wired/tested \$29.95 ppd. Board \$4.75 ppd. SASE for info. Nat Stinnett Electronics, Tavares, FL 32778.

**TELETYPEWRITER PARTS**, gears, manuals, supplies, tape, toroids. SASE list. Typetronics, Box 8873, Ft. Lauderdale, Fl. 33310. Buy parts, late machines.

**TECH MANUALS** for Govt. surplus gear — \$6.50 each: SP-600JX, URM-25D, OS-8A/U, PRC-8, 9, 10. Thousands more available. Send 50¢ (coin) for 22-page list. W3IHD, 7218 Roanne Drive, Washington, D. C. 20021.

**QSL'S** — BROWNIE W3CJI — 3035B Lehigh. Allentown, Pa. 18103. Samples with cut catalog 50¢.

**GOOD CONDITION** — Conrac video monitors, model CUA17 with rack mount frame and non glare face plate. Ideal for use with slow to fast scan converters, \$100 each. Robot model 70B SSTV monitor in original packing, \$300. W5DFC, (713) 862-7875.

**EXCLUSIVELY HAM TELETYPE** 21st year, RTTY Journal, articles, news, DX, VHF, classified ads. Sample 35¢. \$3.50 per year. Box 837, Royal Oak, Michigan 48068.

**BUY — SELL — TRADE.** Write for free mailer. 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. 913-381-5901.

**OSCAR 7, SSB-CW TRANSMIT CONVERTERS.** For 28 or 50 MHz input at 20 mw. 432 MHz output at 1 watt. Solid state, for 12 volt supply. 35 watt solid state amplifier available for this converter. Units designed and built by WØENC. Write for information. UHF-VHF Communications, 53 St. Andrew, Rapid City, S. D. 57701.

**CIRCUIT BOARDS.** Artwork, negatives, etching. SASE for details. Karl Raup, WB4OXG, Box 8013, Orlando, Fla. 32806.

**FREE!** Over 100 electronics items. "Electronics Sourcebook" tells how, where to obtain free samples, manuals, publications. Write Technical Publications, 1405 Richland, Metairie, La. 70001.

**VARIABLE AND TRIMMER CAPACITORS** — Milen, Johnson, Hammarlund, Erie, Arco. In stock for immediate shipment, write for free price list "A". D & V Radio Parts, 12805 W. Sarle Rd., R#2, Freeland, Mich. 48623.

**YOU CAN INSTALL YOUR OWN SECURITY SYSTEM** at a price you never dreamed possible. Our 1976 Burglar-Fire Alarm Catalog describes our complete line of commercial security equipment. It has everything you need to produce a durable, custom installation — just as good as the professionals. Free Catalog. Emel Electronics, P. O. Box 146-D, Sheffield, Mass. 01257.

**HEATH HW-101** with CW filter, HP-23B and SB-600. With new tubes and aligned. Used less than one hour on tubes \$380. Tennenec MS-2 scanner, brand new \$240. Clegg 66er rarely used \$100. Kenwood TS-700A new \$635. Also Yaesu FR-101 digital receiver and FL-101 transmitter. Write or call. All equipment meets factory specifications and is in mint condition in performance and looks. WBØGOA, Mike Folta, Laddonia, MO 63352. 314-373-2325.

**SB-34**, mint condition, with mic and xtal calibrator, \$240. John Abdnour, WB9TQB, 806 Arcadia, Bloomington, IL 61701.

**YOUR AD** belongs here too. Why not send it in today.

## Coming Events

**MEMPHIS IS BEAUTIFUL IN OCTOBER!** The Memphis Hamfest, bigger and better than the 3,500 who attended last year, will be held at State Technical Institute, Interstate 40 at Macon Road, on Saturday and Sunday, October 2 and 3. Demonstrations, displays, MARS meetings, flea market, ladies' flea market, too! Hospitality room, informal dinners, XYL entertainment, many outstanding prizes. Dealers and distributors welcome, too! Contact Harry Simpson, W4SCF, Box 27015, Memphis, TN 38127, phone 901 358-5707.

## test for resonant resistance with an omega-t antenna noise bridge



The Omega-t Noise Bridge is an inexpensive and flexible testing device that can effectively measure antenna resonant frequency and impedance. This unique piece of test equipment does the work of more expensive devices by using an existing receiver for a bridge detector. There is no longer a need for power loss because of impedance mismatch. Get more details or order now!

Model TE7-01 for 1-100 MHz Range \$29.95  
Model TE7-02 for 1-300 MHz Range \$39.95

**ELECTROSPACE SYSTEMS, INC.**

320 TERRACE VILLAGE  
RICHARDSON, TEXAS 75080  
TELEPHONE (214) 231-9303

Sold at Amateur Radio Dealers  
or Direct from ElectroSpace Systems, Inc.

**MODSET:** precision modulation measurements for AM-SSB, 0.2 to 300 MHz, \$29.50 (Kit: \$19.50)

**D. R. CORBIN MFG. CO.**

P. O. Box 44, North Bend, Ore. 97459

## VHF/UHF CONVERTERS PREAMPS

Ten meters through 432 MHz. A post card will bring our full 1976 Catalog.



**JANEL laboratories**

3312 S.E. VAN BUREN BLVD.  
CORVALLIS, OREGON 97330  
Telephone: 503-757-1134

## L.E.D.'S

High Dome: Red 8/\$1.00  
Green 6/\$1.00  
Yellow 6/\$1.00

TIL 31 Infrared LEDs \$1.20 each  
LED panel mounts 12/\$1.00

## Capacitors

5 pf @ 15 V 20/\$1.00  
330 pf @ 15 V 20/\$1.00  
120 pf @ 5KV 10/\$1.00  
180 pf @ 5KV 10/\$1.00  
.1 mfd @ 200 V 20/\$1.00

## Electrolytics

1000 mfd. @ 6.3 V 6/\$1.00  
220 mfd @ 16 V 6/\$1.00  
Dynamic Mike Cartridge @ 40 ohm \$1.50 each

2½ amp, 1000 V PIV Diodes 6/\$1.00

Orders over \$5 will be shipped prepaid in continental USA  
Use "Check-Off" for complete product catalog.

**HOSFELT ELECTRONICS**

2610 SUNSET BLVD.  
STUEBENVILLE, OHIO 43925  
Phone 614 264-6464

# BULLET ELECTRONICS

PO BOX 19442

DALLAS TEXAS 75219

PHONE NO. (214) 823-3240

## 10.7 CERAMIC FILTER. MURATA

SFG 10.7 FOR FM APPLICATIONS (wideband) SPECIAL PRICE REDUCTION while they last **\$1.50**

## PNP POWER

TAB TRANSISTOR SIMILAR TO TIP30 IN SPECS. HOUSE NO. GUARANTEED **3/1.00**

## HARDWARE

A VERY USEABLE ASSORTMENT OF 2-56, 4-40, 6-32 and 8-32 SCREWS AND NUTS A FULL 225 gms OF NEW HARDWARE **\$1.95** 3/5.00

## TOUCHTONE ENCODER KIT

SINGLE IC GENERATES THE STANDARD 16 TONE PAIRS FOR TOUCHTONE DIALING. KIT FEATURES: Small Size (1.5 x 2.25") NO Tuning Required PTT Circuit has built-in 1 second delay Low Level output is adjustable Audio output circuit for tone monitoring or acoustic coupling Kit includes all parts Plug compatible with DIGITRAN® KEYBOARDS Complete with PC Board **TE-01 \$12.00**

Same as above but less Audio output and PTT circuit. Smaller size permits use with handtalkies. \$10.00 TE-02

## PS-01A POWER SUPPLY KIT

A COMPACT, WELL REGULATED TRIPLE OUTPUT POWER SUPPLY. GIVES +5VDC @ 1.5A and +15 @ 150MA AND -15@150MA. THE PS-01A USES THE SUPERIOR 78L SERIES OF 3 TERMINAL REGULATORS.

SPECS:  
Voltage: +5@1.5A  
±15@150MA  
Ripple: Less than 10mv  
Regulation: Load 50mv  
Line 100mv

**\$14.95**

PS-01B AS ABOVE BUT WITH ±12 OUTPUT INSTEAD OF ±15.

SAJ110  
7 STAGE FREQ. DIVIDER FOR MUSIC **.99**

9 VOLT BATTERY CLIPS **12/1.00**

50 Hz. TIMEBASE KIT **\$5.00**

## ELECTROLYTIC CAPS

WE BOUGHT A WHOLE TRUCKLOAD OF VARIOUS VALUES FROM 20 mfd to 100 mfd ALL FROM 15 to 50 VOLT RATINGS. TRUST US! 8 PIECES **\$1.00**

## 2N 3772

150W 60V NPN POWER TRANSISTORS Most popular unit for high current power supplies or audio work. NEW-GUARANTEED **\$1.75** TO-3

## HARD TO FIND!

LOW VALUE HIGH WATTAGE WIREWOUND RESISTORS **3/1.00**  
.1ohm@10W  
.032ohm@10W  
2ohm@10W

100V 60MA BRIDGE RECTIFIER HOUSE NUMBER **3/1.00**

## AIRCRAFT/MOBILE CLOCK TIMER KIT

A FULL 6 DIGIT LED READOUT CLOCK THAT GIVES 24 HOUR (ZULU) REALTIME AND ELAPSED TIME IN SECONDS, MINUTES AND HOURS UP TO 24 HOURS. READOUTS CAN BE TURNED OFF OR DIMMED. PC BOARDS ARE SMALL TO FIT INSIDE A STANDARD INSTRUMENT CASE (2 1/2" Dia.)

12V NEG GND

MK-03

**\$26.95**

KIT IS SUPPLIED WITHOUT SWITCHES OR CASE

FEATURES:  
Real Time (24 hr.)  
Elapsed Time  
2 MOS Chips  
3" LED Readouts  
Special Noise Filter  
Quality plated boards

**2N3904**  
NPN  
General Purpose Switching **12/1.00**

**2N2222**  
UNMARKED TO-18 NPN **12/1.00**

**2N4861**  
N CHANNEL FET GEN. PURPOSE FET **3/1.00**

## 6 DIGIT ALARM CLOCK CHIP

MM5375AB NEW LOW PRICE! **\$2.95** DRILLED AND PLATED PC BOARDS FOR 5375 Com Cathode - 1.50 Com Anode - 1.50

## SCREAM!

AS LOUD AS YOU WANT, BUT OUR LITTLE WARBLE KIT IS LOUDER! COMPLETE DUAL TONE WARBLE ALARM WITH 10 WATT OUTPUT. INCLUDES ALL PARTS AND BOARD. **\$2.50**

GREAT FOR BURGLER ALARMS 6-15VDC (Speaker not included)

## AUDIBLE CONTINUITY TESTER KITS

A FANTASTIC LITTLE DEVICE THAT HAS A HUNDRED AND ONE USES AROUND THE SHOP AND HOME. **\$1.95**

USES:  
Code Practice  
Continuity Test  
Transistor Test  
LED & DIODE Test  
Tone varies with resistance  
REQUIRES 3 to 6 VOLT BATTERIES (not included)

## 50 OHM COAX

SUPER QUALITY COAX SLIGHTLY LARGER IN DIAMETER THAN RG-74 BUT BETTER SPECS **100 ft. ROLL \$3.99**

## CONTEST! ELECTRONIC DESIGN

Monthly Prize Given for best circuit.  
1. All entries become property of BULLET.  
2. Entry should include schematic and circuit description.

WATCH THIS SPOT FOR WINNER'S NAME!  
**\$100. GIFT COUPON FROM BULLET**

SORRY - NO COD'S CHECK OR M.O. ADD 5% FOR POSTAGE

FOREIGN ORDERS ADD 10% (20% FOR AIRMAIL) ORDERS UNDER \$10. ADD 60c HANDLING TEXAS RESIDENTS ADD 5% SALES TAX

# NEW! IC KEYER

The World's Greatest  
Sending Device



Adjustable to Any  
Desired Speed

Now available from Palomar Engineers - the new Electronic IC KEYER. Highly prized by professional operators because it is EASIER, QUICKER, and MORE ACCURATE.

It transmits with amazing ease CLEAR, CLEAN-CUT signals at any desired speed. Saves the arm. Prevents cramp, and enables anyone to send with the skill of an expert.



**SPECIAL  
RADIO MODEL**

Equipped with large specially constructed contact points. Keys any amateur transmitter with ease. Sends Manual, Semi-Automatic, Full Automatic, Dot Memory, Squeeze, and Iambic - MORE FEATURES than any other keyer. Has built-in sidetone, speaker, speed and volume controls, BATTERY OPERATED, heavy shielded die-cast metal case. FULLY ADJUSTABLE contact spacing and paddle tension. The perfect paddle touch will AMAZE you.

Every amateur and licensed operator should know how to send with the IC KEYER. EASY TO LEARN. Sent anywhere on receipt of price. Free brochure sent on request.

Send check or money order. IC KEYER \$87.50 postpaid in U.S. and Canada. Add \$10.00 for HEAVY NON-SKID BASE. IC KEYER LESS PADDLE \$67.50. Add 6% sales tax in California.

Italy write I2VTT, P.O. Box 37, 22063 Cantu. Elsewhere send \$92.00 (U.S.) for IC KEYER or \$72.00 (U.S.) for IC KEYER LESS PADDLE for air parcel post delivery worldwide.

Fully guaranteed by the world's oldest manufacturer of electronic keys. ORDER YOURS NOW!

**PALOMAR  
ENGINEERS**

BOX 455, ESCONDIDO, CA 92025  
Phone: (714) 747-3343

# flea market

**FLEA MARKET** sponsored by LIMARC, October 10, rain date Oct. 24, N. Y. Institute of Technology, Rte. 25A & Whitney Lane, Old Westbury, L. I., N. Y. Largest flea market in the N.Y.C. area. Talk-in on 25/85 & 52. \$1.25 per buyer, \$2.50 per seller space. Hank Wener, WB2ALW, 516 484-4322.

**NOW YOU ALL COME, YOU HEAR.** Where? Why ARRL Hudson Division Convention, November 13 and 14, Playboy Resort and Country Club at Great Gorge, McAfee, New Jersey. Many exhibits, giant indoor flea market, FCC and ARRL forums, FCC exams, special YL programs, technical sessions and a Saturday night banquet with Jean Shepherd, K2ORS, world traveler, columnist and famed radio and TV personality as the speaker. For information write to Al Piddington, WA2FAK, 4 Acorn Drive, East Northport, N. Y. 11733.

**6TH ANNUAL SOUTHERN MINNESOTA SWAP-FEST** — Minnesota's largest ham gathering — Saturday, October 9th, 9:00-4:00 — Contact VARS, Box 3, Waseca, Minn. 56093 — Talk-in on 94 or call 507-835-2679.

**SAVE THIS DATE:** October 9, 1976 for the 22nd Annual VHF Conference. Western Michigan University, 1 & ET Bldg., Kalamazoo, Michigan. Registration 8 a.m. — full day of activity. Write: Dr. Glade Wilcox, Chm., W9UHF/8, Dept. of Electrical Engineering, Western Michigan University, Kalamazoo, MI 49008. Get on the mailing list for yourself and your club.

**THE NEXT CEDAR VALLEY AMATEUR RADIO CLUB HAMFEST** is Sunday, October 3, in Cedar Rapids. Manufacturers and dealers welcome. ARRL representation. Held at Hawkeye Downs Exhibition Building, ample parking, camping. Tickets \$1.50 advance; \$2.00 at gate. First table - \$3.00; others - \$5.00. Saturday afternoon setup available. Talk in frequencies 146.16/76, 146.52, 3.970 MHz. Prizes are Collins 75S-3C Receiver, Hy-Gain TH-3MK3 Beam, Wilson WE-224 Mobile XCVR, Wilson 1402SM H/T, Heathkit HW-8 QRP XCVR, plus more. Write: CVARC Hamfest, P. O. Box 994, Cedar Rapids, Iowa 52406.

**INDIANA** — Marshall County swap-n-shop. Sunday, October 31, 1976, at the Plymouth Indiana National Guard Armory located at 1220 W. Madison St. from 7:00 a.m. to 4:00 p.m. Talk-in on 146.07-67 and 146-94 simplex. Free tables, no charge for set-up! Tickets \$2.00 at the door. Food, drink and door prizes. For further information contact WA9INM, Route 3, Box 526, Plymouth, Indiana 46563.

**PASCAGOULA EXPLORER AIR SQUADRON** will hold its annual Air Show Oct. 15, 16 and 17. In conjunction, the Jackson County Amateur Radio Club will operate mobile units and a multi-band radio station. The special call of KM5BSA will be applied for. Operators are needed. KM5BSA will also operate from here in the Nineteenth (19) International Boy Scouts Jamboree on the air. We hope any Explorers with an amateur license will plan to be present and take shifts as operators. Any scout or scouter so licensed is asked to contact W5UCY as soon as possible.

**CEDAR VALLEY HAMFEST** (Cedar Rapids, IA, home of Collins Radio) Sunday, October 3. Hawkeye Downs Exhibition Bldg. Prizes. Talk-in 146.16-76, 146.52, 3.970 MHz. Advance tickets CVARC, P. O. Box 994, Cedar Rapids, IA 52401.

## Stolen Equipment

**REGENCY HR-2B;** Serial #49-02817. Stolen from automobile. Microphone cable is hard-wired to set (instead of conventional cable-jack). Kristen N. Johnson, WA1TJP, 86 Alton Rd., Quincy, Mass. 02169.

**EBC-144JR,** 2 meter transceiver. Serial number 7514359A, and "Tuna Two" home-brew antenna with magnetic mount. Unit is inscribed on bottom with: Name: J. C. Maikisch; Call: WA20FT; SS #: 089-32-6899; N. J. Dr. Lic. #: MO1814076312424; Tel. #: (201) 538-1667. Any info, contact above or Bernards Township Police (201) 766-1122.

# ! HELP !



**MIXED VALUES.  
DISC CERAMIC CAPACITORS  
\$5.00/LB. PPD. IN U.S.A.**

If you don't like the pound you get — call or write and we'll send another pound FREE. (And you keep the first pound.)

7.9pF Glass Piston Trimmer, JFD, VC-1 \$2.25 ea  
10 for \$1.75 ea  
4.7 MFD/10V Sprague 158D \$7.50/Hundred



215-265 MHz — Plug in front-end and video unit with BW 1.5 KC to 1 MC built-in deviation meter. Defense Electronics Model TMR-5A. Only 2 in stock \$315.00



RVCR 2 to 30 MHz depending on the plug-in front end. Provision for XTAL control. Makes a fine single-channel H.F. RCVR (Westcars, etc.)

\$125.00

CAVITIES . . . CU 691 antenna coupler, 200-400 MHz, contains 6 very Hi-Q silver plated cavities & 4 directional wattmeters \$100.00

SPECIAL OFFER . . . One R-390 overhauled, complete — \$590.00. Absolutely the Cadillac of HF receivers.

WE ARE BUYERS as well as sellers. What have you? We don't have a catalog, by the time we'd publish it the merchandise would be gone.

**DISC-CAP**, 19075 BRAEMORE RD.  
NORTHIDGE, CA. 91326 213-360-3387

## NEW MULTI-BAND ANTENNA

The UR "TRIPOLE"™  
Guaranteed. . . Pat. Pend.  
80 to 6 Meters plus 1601.5 Mc Bands.  
Built-in balun. . . 1 KW ICAS rating.  
80 to 120 ft inverted-V or horizontal.  
Available in kit form or assembled.  
Kit 80K \$54.95 cash PPD in USA,  
kit 80K+HF with 100 ft 8/10 foam cable  
and two PL259 \$82.95 cash PPD in USA.  
Texas residents add 5% sales tax.  
Order direct. Master Charge accepted.  
Send stamped envelope for information.

Universal Radio Co. Dept M1  
Box 26041 El Paso, TX 79926  
Telephone (915) 592-1910

## SST T-1 RANDOM WIRE ANTENNA TUNER



All band operation (160-10 meters) with most any random length wire. 200 watt power capability. Ideal for portable or home operation. A must for Field Day. Size 2 x 4 x 2 3/8. Built-in neon tune-up indicator. Guaranteed for 90 days. Compact — easy to use. Only \$29.95 postpaid. (Add Sales Tax in Calif.)

SST ELECTRONICS, P.O. BOX 1, LAWDALE, CA 90260

## PROBABLY THE BEST IN THE WORLD

An antenna system that holds a WORLD PERFORMANCE RECORD won from a cramped, low elevation hotel room.

### THE JOYSTICK VFA

is a Variable Frequency Antenna that gives you all ham bands 160 thru 10 plus MARS and BC and all the MHz in between. It comes to you with ATU, easily assembled, only 7" 6" long, direct by airmail from UK manuf. Save, too, on favourable exchange rates.

**SYSTEM 'A' \$69.90, 250 w. p.e.p.**

**SYSTEM 'J' \$91.33, 500 w. p.e.p.**

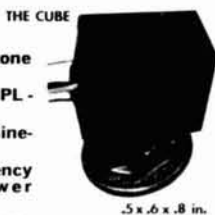
(improved Q on receive)

SEND MASTER CHARGE NUMBER OR CHECK OR ASK FOR BROCHURE

Partridge (HR) Electronics Ltd.  
Broadstairs, Kent, England  
G3CED Phone Thanet 62535 G3VFA

# SUB-AUDIBLE GENERATOR for FM

- Inexpensive multi tone system
- Compatible with PL-CG-QC
- Low distortion sine-wave
- Adjustable frequency (98-250 Hz), Lower available
- Rugged, plastic encased with leads, easy to mount
- Input 8-18 VDC unregulated
- Excellent stability



Lyle Products  
P.O. Box 2083  
Santa Clara Calif.  
95051

Price \$19.95

Calif. res. add 6%

Freq. set at factory \$5.00 extra  
Send for more information

# LOWEST PRICES

WE OFFER THE IDENTICAL PRODUCT AS THE OTHER HOUSE AT ABOUT ONE HALF THE COST



Specify desired material for toroids — All popular sizes in stock.

Packing & Shipping in USA \$2.00  
SEND FIRST CLASS STAMP FOR PARTS FLYER

Iron Powder Toroidal Cores		Ferrite Toroidal Cores	
Size	Price	Size	Price
T-200	\$1.60	FT-114	\$1.00
T-130	1.15	FT-82	.40
T-106	.75	FT-50	.35
T-94	.50	FT-37	.30
T-80	.40	FT-23	.25
T-68	.35	<b>Ferrite Shielding Beads</b>	
T-50	.30	<b>Size</b>	<b>Price</b>
T-37	.25	FB-73-101	\$1.00 Doz.
T-25	.20	FB-43-101	\$1.00 Doz.
T-12	.15	FB-73-801	\$1.50 Doz.
		FB-43-801	\$1.50 Doz.

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

## TRANSFORMERS

American made, 115V Primary:  
6.3 V, 1 Amp, Shielded \$1.75 Ea. ppd.  
12V — 250 mits — for P.C. Board. Size:  
1 1/2" x 2" x 1 1/4" x 1 1/4", 3.5 OZ.  
\$1.40 ea. ppd.  
12 volt 1/2 amp. \$1.68 ppd.  
12V 1.2 Amp \$2.57 ppd.  
12V, 3 Amp \$4.15 ppd.



## NEW NEW NEW

Dual Secondaries; 18-0-18V @ 1.2 Amp  
and 7-0-7V @ 400 MA, 1 lb. 5 oz., Shielded.  
2 1/2" x 2" x 2 1/4" (3 1/4" MTG) — \$3.85 ppd.  
22-0-22V — 1 Amp, 6.3V. Tap 1/4 Amp —  
2" x 2 1/4" x 2 3/8" (MTG 2 3/8") Leads from  
top of shield, 1 lb. 4 oz. \$3.20 ppd.  
24-0-24 @ 1 amp with tap at 6.3 volt for  
pilot light. \$3.15 ea. ppd.

TRANSISTOR OUTPUT TRANSFORMER —  
One watt rating 200 ohm Centertapped  
primary, 8 ohm secondary 85¢ Each ppd.

## NEW

Transistor and Relay Assembly — consists of (2)  
MJE3055 and (2) MJE2955  
transistors (10 amp, 90w,  
60w complementary pairs)  
mounted in "U" channel  
heat sink 2 1/2" x 1 1/4" x  
1 1/2". (2) XTAL CAN RE-  
LAYs, DPDT, 28v, 8000Ω,  
5.8 ma DC, 1 amp contacts  
mounted on PC board with  
resistors. \$2.85 ea. ppd.



## BRIDGES

400 PIV — 1.5A. Gen. Instr. P.C.  
Bd type. 60¢ ea. or 3/\$1.75 ppd.



## SEMTECH BRIDGES

Heat sink w/center hole  
mtg. 10 Amp — Tested —  
50V P.I.V. \$1.25 ea. ppd.  
100V P.I.V. \$1.50 ea. ppd.  
200V P.I.V. \$1.75 ea. ppd.  
400V P.I.V. \$1.95 ea. ppd.  
600V P.I.V. \$2.15 ea. ppd.



## 25 AMP — TESTED

50V P.I.V. \$1.75 ea. ppd.  
100V P.I.V. \$2.00 ea. ppd.  
200V P.I.V. \$2.25 ea. ppd.  
400V P.I.V. \$2.50 ea. ppd.  
600V P.I.V. \$2.85 ea. ppd.



9 Volt Batt. Clips — Dual 4"  
Leads. 10¢ ea. ppd



TUNING METERS — Blue  
tinted plastic body, 0 to  
left, graduated scale,  
200μA, 1 1/2"W x 1 1/4"H x  
3/4"D. Scale can be rear  
lighted. Sylvania #18148-1  
\$2.25 ea. or 4/\$6.95 ppd.



Red 6 foot #18-2 line cord with flanged  
safety plug — 55¢ ea. or 3/\$1.45 ppd.

Gray 6 foot, 7A, plugs into auto liter  
socket — 95¢ ea. or 3/\$2.55



## SPEAKERS



SQUARE — 3" - 4Ω - .3W, 4 mtg. holes.  
\$1.45 ea. ppd., 2/\$2.75 or 4/\$4.80 ppd.

PIONEER — Round 2 3/4" x 7/8" - 16Ω -  
.3W, 4 hole Mtg. \$1.55 ea., 2/\$2.85 or 4/\$5.20 ppd.

OVAL — 2" x 4" x 1 1/4" deep - 8Ω - .1W.  
4 Hole Mtg. \$1.75 ea. ppd., 2/\$3.15 or  
4/\$5.75 ppd.



Round #5P585A 2" x 3/4" - 8Ω  
- .1W \$1.35 ea. ppd.  
2/\$2.55 or 4/\$4.75 ppd.

NOBLE Dual Slide Potentiometer, 2 7/8" x  
3/4" x 3/4" with 1 1/2" lever.  
\$1.45 ea. or 10 for \$12.00 ppd.

## NEW — Just Arrived — NEW

1/2 WATT — Full Leads — Imported Res-  
istors. 5% Resistors — 33 - 75 - 180 -  
220 - 330 - 390 - 430 - 820 - 1.5K - 2K  
18K - 22K - 39K - 75K - 82K - 100K - 120K  
- 2.2K - 3.3K - 3.9K - 4.3K - 10K - 15K -  
150K - 220K - 270K. Resistors 10% Res-  
istors, 47 - 10K - 12K - 150K. Both  
tolerances 33 for \$1.66 ppd.  
(You choose values)  
One Value — 100/\$4.15 ppd.  
Assorted — 100/\$4.55 ppd.

QUANTITY PRICES 500 or 1000 lots. ALL  
VALUES.

## 1/2 WATT CARBON RESISTORS

With Full Leads — 33 for \$1.22 ppd. Val-  
ues may be mixed. Tol. 5%, 10%, 20%.  
No Choice of Tolerance.

6.8	270	1.3K	4.7K	47K	330K	2.2M
22	330	1.5K	5.6K	68K	390K	2.7M
27	390	1.8K	6.8K	75K	470K	5.6M
39	470	2.2K	8.2K	100K	680K	9.1M
47	620	2.4K	10K	120K	1M	10M
82	750	2.7K	22K	180K	1.5M	
100	1K	3.3K	33K	220K	1.8M	

## ZENERS

OUR TEST — Very Good Knee — No  
Hobby Types.

400 MILLIWATT UNITS — 3, 3.3, 3.6, 3.9,  
4.3, 4.7, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1, 18, 22,  
24, 27, Volts.

1 WATT UNITS — 10, 11, 12, 13, 15, 16,  
18, 20, 22, 27, 30, 33, 39, 43, 47, 51, 56,  
62, 68, 75, 82, 91, 100, 110, 120, 130,  
150, 160, 180, Volts

ALL UNITS 10% — 4 for \$1.00 ppd.  
5% — 3 for \$1.00 ppd.

SEND STAMP FOR BARGIN LIST  
PENNSYLVANIA RESIDENTS - ADD 6%  
ALL ITEMS PPD. USA

Canadian orders for less than \$5.00 add  
\$1.00 to cover additional mailing costs.  
UPS requires your street address.

**m. weinschenker**  
electronic specialties-BOX 353, IRWIN, PA 15642

## CAPACITORS

### BACK IN STOCK



3000 MFD  
@ 30 Volt  
Capacitors.

Size 1" Diameter x 3" Long. 90¢ Each  
or 3 For \$2.25 ppd.

3000 MFD @ 20V Capacitors. Same size  
as above. 80¢ ea. or 3 for \$2.00 ppd.

ALSO 3000 MFD @ 50V, 3" x 1 1/4" dia.  
95¢ ea. or 3/\$2.65 ppd.

### ELECTROLYTIC CAPACITOR — PHILCO

4" x 1 3/8" dia.

Quad section 100x150 MFD @ 400V and  
at 350V D.C. and 20x50 MFD @ 250V —  
TWISTAB MTG. A very nice unit for Trans-  
ceiver Power Supplies etc.  
Price is only \$1.10 ea. or 3/\$2.95 ppd.

DUAL Electrolytic 1000 & 500 MFD. 15V,  
long leads. 3/4" dia. x 2 1/4" long.  
55¢ each 3/\$1.50 ppd.

Dual Electrolytic 1000  
MFD @ 16V, 500 MFD @  
12V. 3/4" dia. x 2 1/4" long.  
60¢ ea. or 3/\$1.55 ppd.

CRL Disc Capacitors. .1 MFD, 10V 3/4"  
dia., long leads. 10 for \$1.00 ppd.  
100/\$8.40, 500/\$36.60 (U.P.S. Only)

UNPOTTED TOROIDS — center tapped  
88MHY Limited Qty's 44 MHY  
5/\$2.95 5/\$3.95 ppd.

General Purpose Germanium Diodes. Simi-  
lar to 1N34a etc. All Cathode banded  
Full leads. 16 for \$1.00 ppd.

Small, glass, silicon diodes. Fairchild FD-  
type. Full leads and guaranteed.  
Price: 16 for \$1.00 ppd.



### CARBON TRIMMERS

Miniature 1/4 watt units for  
limited-space applications.  
PC type terminals. Max 500  
volts. Ohm ratings are:

200, 700, 1000, 1.5K, 250K, 700K  
30¢ ea. or 5/\$1.35 ppd.

NEW MINI Imported vertical pots (1/2"H,  
3/8"W, 1/16"D) Values: 1000, 2.5K,  
5K, 50K ohms. Slot adj. Also 500Ω and  
5K Horiz. Price: 5 for \$1.20 ppd.

MINIATURE SNAP ACTION SWITCHES —  
SPDT leaf actuator, 10A, 125v AC, 1 1/4" x  
1 1/2" x 3/8" 60¢ ea. or 3 for \$1.55  
SPST N.O. Cherry "Button Type" E34,  
15A, 125v AC, 1 1/4" x 3/8" x 3/8"  
50¢ ea. or 3 for \$1.35  
SPST N.C. Acro "Button Type" (tab ac-  
cessible to make SPDT), 1 1/8" x 5/8" x  
3/8" 50¢ ea. or 3 for \$1.35

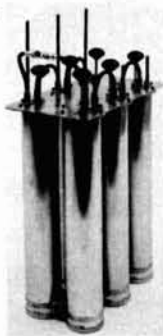
SPST SLIDE SWITCHES (Red) Made by  
Stackpole — 4A, 125V A.C. 35¢ ea. ppd.

14 MULTI-CONDUCTOR RIBBON — #22  
color coded — Qty limited.  
20¢ per ft. or \$1.25/10 ft.

I.C. — μL900 or μL914 — Fair-  
child RTL - Full Leads. 3/1.35 ppd.

# DUPLEXER & CAVITY KITS...

## Now available for you fully assembled and tuned!



- UPGRADE YOUR REPEATER WITH A RF TECHNOLOGY DUPLEXER.
- ALL DUPLEXERS AND CAVITIES ARE TEMPERATURE COMPENSATED WITH INVAR® AND MEET ALL COMMERCIAL STANDARDS
- ONLY TOP QUALITY MATERIALS GO INTO OUR PRODUCTS.
- BOTH KITS & ASSEMBLED DUPLEXERS AND CAVITIES ARE AVAILABLE TO YOU AT A SAVINGS TO YOU.

**Mod. 62-3...6 cav., 2 mtr.,** insertion loss 0.6 db with isolation 100 db typical; pwr. 350 w. Kit \$349 ea.-Assembled \$439.

**Mod. 4220-3...4 cav. 220 MHz** insertion loss 0.6 db with 80 db isolation typical; pwr. 350 w. Kit \$249 ea. - Assembled \$329.

**Mod. 4440-3...4 cav. 440 MHz,** insertion loss 0.6 db with 80 db isolation typical; pwr. 350 w. Kits \$249 ea. - Assembled \$329.

**Mod. 30 Cavity Kits:** 2 mtr. \$65 ea., 220 MHz \$65 ea., 440 MHz \$65 ea.; 6 mtr. \$115 ea. Add \$15 for Assembled Kit.

Also available: 6 mtr., 4 cav. Kit \$399-Assembled \$499, 2 mtr. 4 cav. Kit \$249-Assembled \$329, 440 MHz TV Repeater Duplexer

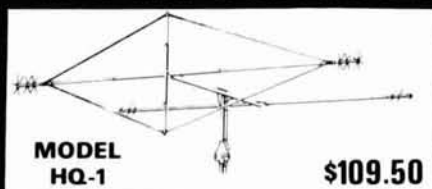
Only hand tools are necessary to assemble Kits!

Send your order to: Distributor: **TUFTS RADIO**, 386 Main St., Medford, Mass. 02155. Phone (617) 395-8280.

(Prices F.O.B. Medford, Mass. All units can be shipped U.P.S.-C.O.D. orders require \$50 deposit. —Mass. residents add 5% sales tax.)

## WANT SOMETHING REALLY SMALL AND EFFICIENT?

Then you want the antenna that's known around the world for its small size and superior performance...  
The Mini-Products Multiband HYBRID QUAD



MODEL HQ-1

\$109.50

If not stocked by your dealer order direct. We pay shipping in USA. Send for free catalog of other models and more data.

- ELEMENT LENGTH - 11 ft.
- BOOM LENGTH - 54 INCHES
- WEIGHT - 15 POUNDS
- WIND SURVIVAL - 75 MPH
- BANDS COVERED - 6, 10, 15 & 20
- 1200 WATTS P.E.P.
- FEED LINE - 50 OHMS

Mini-Products, Inc.

1001 W. 18th St. Erie, Pa. 16502

## FIRST CLASS FCC LICENSE

CIE will help you pass the government-administered First Class FCC License exam... broaden your career opportunities in electronics. In-depth electronics career training to help you add to your technical skills and knowledge, prepare for valuable First Class FCC License at the same time. Basic and advanced training. Study at home, spare time. Fully accredited career courses.

Send today for Free FCC License booklet and school catalog. G. I. Bill info on request. For your convenience, we'll try to have a school rep contact you. No obligation. Write CIE — Cleveland Institute of Electronics, Inc., Dept. WHM-03, 1776 East 17th Street, Cleveland, Ohio 44114.

**NEW!** \$24.95

**LOGIC PROBE**  
from Logic Systems Inc.  
**Look at This!**

- 2 meg input Z
- Input protection
- Automatic memory
- Use with TTL/DTL/MOS/CMOS
- Detects 16 nsec pulses
- Assembled and tested

Check or M.O.  
L.S.I., Box 7197, Univ. Sta., Provo, Utah 84602

## NEW CODE TAPE

SINGLE 60 min — ALL YOU NEED at 5, 10, 13 and 20 wpm. Coded groups, num. punc. Get your new ticket easily with this proven technique. Order now during our introductory offer. Instructions included.

Max. Chg. MSBA No.	\$2.50 cash.	M & D Electronics
Bank Amer.	ppd.	P. O. Box 3577 Dept. 10
Card No. Exp. date	\$5.00 8-tra	Boulder, Colo. 80303
Signature	ppd.	(303) 499-7818

## ALDELCO SEMI-CONDUCTOR SUPERMARKET

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

<b>HEAVY DUTY RECTIFIERS</b>	
200 Volt 100 Amp D08	8.50
200 Volt 250 Amp D09	12.50
1000 Volt 2 Amp Silicon Rectifier RCA	10 for 99
10,000 Volt Silicon Rectifier Erie, 65 mA	2.95

### ALDELCO KITS

Digital Clock Kit. Hours, Minutes & Seconds. Large Half Inch LED readouts. Elapsed time indicator. 12 hour format with 24 hour alarm. Snooze feature. AM PM indicator. Power Supply, power failure indicator. Complete with wood grain cabinet. \$23.95

2" Round 8 Ohm Speakers	.75 each
2 1/2" Round 100 Ohm Speakers	1.00 each
510 pF Silver Mica Capacitors	15 each

MOS Time Base Kit 50/60 Hz. \$5.95

### LEDs

Jumbo Reds. Long or Short bulb	6 for \$1.00
Jumbo Orange, Green, Clear Red or Green	5 for \$1.00
209 Series, Green, Orange, Yellow or Red	5 for \$1.00
RL2 or Micro Red	5 for \$1.00

### ZENERS

1N746 to 1N759 400 Mw ea.	25	1N4728 to 1N4764 1 w.	35
TC106B	\$.65	CA 3028A Di1 Amp.	\$1.50
MPSA14	.90	LM301 OP Amp.	.55
2N3055	.99	LM309K Volt. Reg.	1.10
MPF 102 FET	.45	LM3800 Audio Amp.	1.75
2N3904 or 2N3906	10/99	NE540L Power Driver	5.95
2N5496 or 2N6108	.40	NE561B PLL	4.95
FT0601 FET	.99	NE562B PLL	4.95
40673 RCA FET	\$1.55	NE565A PLL	2.50
741 or 709 14 Pin DIP	.25	LM709 Min DIP OP Amp.	.45
555 Timer	.75	LM741CE TO5 OP Amp.	.45
556 (Dual 555)	\$1.75	14 or 16 Pin IC Sockets	.30
200 Volt 25 Amp Bridge	\$1.50		
1N914 1N4148	10 for 99		
1N34 - 1N60 - 1N64	10 for 99		

We quote on any device at any quantity. All items postpaid in USA. Min. order \$6.00. Out of USA send Certified Check or Money Order. Include postage and \$1.00 money exchange fee.

# ALDELCO

2281H Babylon TnPk., Merrick, NY 11566  
(516) 378-4555

# ANTENNA COMPONENTS

## COAX CABLE TO MIL SPEC BY

### TIMES & ESSEX

RG 8/U	\$19/C
RG 8A/U	\$20/C
RG 8/U FOAM	\$22/C
RG 11/U	\$14/C
RG 11A/U	\$17/C
RG 58A/U	\$7/C
RG 213	\$23/C
RG 331/U	\$45/C

ANTENNA WIRE \$5/C

RIBBON CABLE

24 AWG 20 COND. \$.50/ft.

RIBBON CABLE

22 AWG 20 COND. \$.75/ft.

INS. OPEN LINE BROWN \$5.50/C

## CONNECTORS

PL 259 @ .60; SO 239 @ .60; PL 258 @ 1.00; UG 175/U @ .20; 88/U @ .80; UG 1094/U @ .65

SHIPPED ANYWHERE IN U.S.A.  
VIA UPS

## WIRE CONCEPTS INC.

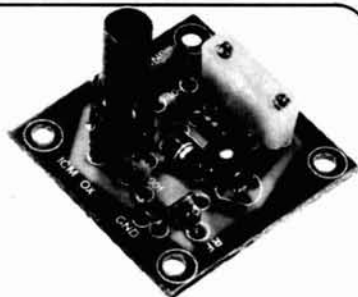
WIRE CONCEPTS INC.  
**WC** 201-227-1751  
198 Passaic Ave.,  
Fairfield, N.J. 07006



# for the experimenter!

INTERNATIONAL CRYSTALS & KITS

OSCILLATORS • RF MIXER • RF AMPLIFIER • POWER AMPLIFIER



### OX OSCILLATOR

Crystal controlled transistor type. 3 to 20 MHz, OX-Lo, Cat. No. 035100. 20 to 60 MHz, OX-Hi, Cat. No. 035101. Specify when ordering.

\$3.95 ea.



### MXX-1 TRANSISTOR RF MIXER

A single tuned circuit intended for signal conversion in the 30 to 170 MHz range. Harmonics of the OX or OF-1 oscillator are used for injection in the 60 to 179 MHz range. 3 to 20 MHz, Lo Kit, Cat. No. 035105. 20 to 170 MHz, Hi Kit, Cat. No. 035106. Specify when ordering.

\$4.50 ea.



### PAX-1 TRANSISTOR RF POWER AMP

A single tuned output amplifier designed to follow the OX or OF-1 oscillator. Outputs up to 200 mw, depending on frequency and voltage. Amplifier can be amplitude modulated. 3 to 30 MHz, Cat. No. 035104. Specify when ordering.

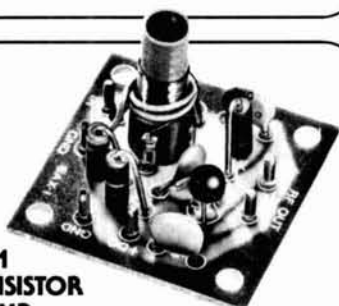
\$4.75 ea.



### OF-1 OSCILLATOR

Resistor/capacitor circuit provides osc. over a range of freq with the desired crystal. 2 to 22 MHz, OF-1 LO, Cat. No. 035108. 18 to 60 MHz, OF-1 HI, Cat. No. 035109. Specify when ordering.

\$3.25 ea.



### SAX-1 TRANSISTOR RF AMP

A small signal amplifier to drive the MXX-1 Mixer. Single tuned input and link output. 3 to 20 MHz, Lo Kit, Cat. No. 035102. 20 to 170 MHz, Hi Kit, Cat. No. 035103. Specify when ordering.

\$4.50 ea.



### BAX-1 BROADBAND AMP

General purpose amplifier which may be used as a tuned or untuned unit in RF and audio applications. 20 Hz to 150 MHz with 6 to 30 db gain. Cat. No. 035107. Specify when ordering.

\$4.75 ea.



### .02% Calibration Tolerance EXPERIMENTER CRYSTALS (HC 6/U Holder)

Cat. No.	Specifications	
031080	3 to 20 MHz — for use in OX OSC Lo	\$4.95 ea.
031081	20 to 60 MHz — For use in OX OSC Hi	\$4.95 ea.
031300	3 to 20 MHz — For use in OF-1L OSC	\$4.25 ea.
031310	20 to 60 MHz — For use in OF-1H OSC	\$4.25 ea.

Shipping and postage (inside U.S., Canada and Mexico only) will be prepaid by International. Prices quoted for U.S., Canada and Mexico orders only. Orders for shipment to other countries will be quoted on request. Address orders to:  
M/S Dept., P.O. Box 32497,  
Oklahoma City, Oklahoma 73132.



International Crystal Mfg. Co., Inc.

10 North Lee  
Oklahoma City, Oklahoma 73102



*Ham Radio's guide to help you find your local*

### *Alabama*

**LONG'S ELECTRONICS**  
3521 TENTH AVE. NORTH  
BIRMINGHAM, AL 35234  
800-633-3410  
Call us Toll Free to place your order

### *California*

**COMMTECH ENTERPRISES**  
13754 VICTORY BLVD.  
VAN NUYS, CA 91401  
213-988-2212  
Headquarters for Yaesu, Kenwood,  
Drake, Icom, Collins, Atlas.

**HAM RADIO OUTLET**  
999 HOWARD AVENUE  
BURLINGAME, CA 94010  
415-342-5757  
Northern California's largest  
new and used ham inventory.

**HENRY RADIO**  
931 N. EUCLID AVE.  
ANAHEIM, CA 92801  
714-772-9200  
The world's largest distributor of  
Amateur Radio equipment.

**HENRY RADIO CO., INC.**  
11240 W. OLYMPIC BLVD.  
LOS ANGELES, CA 90064  
213-477-6701  
The world's largest distributor of  
Amateur Radio equipment

**M-TRON**  
2811 TELEGRAPH AVENUE  
OAKLAND, CA 94609  
415-763-6262  
We service what we sell.

**QUEMENT ELECTRONICS**  
1000 SO. BASCOM AVENUE  
SAN JOSE, CA 95128  
408-998-5900  
Serving the world's Radio Amateurs  
since 1933.

### *Colorado*

**C W ELECTRONIC SALES CO.**  
1401 BLAKE ST.  
DENVER, CO 80202  
303-573-1386  
Rocky Mountain area's complete  
ham radio distributor.

### *Florida*

**GRICE ELECTRONICS**  
320 EAST GREGORY  
PENSACOLA, FL 32502  
904-434-2481  
Your Gulf Coast Drake & Kenwood  
dealer.

### *Illinois*

**ERICKSON COMMUNICATIONS, INC.**  
5935 NORTH MILWAUKEE AVE.  
CHICAGO, IL 60646  
312-631-5181  
Headquarters for all your Amateur  
Radio needs.

**KLAUS RADIO, INC.**  
8400 NORTH PIONEER PARKWAY  
PEORIA, IL 61614  
309-691-4840  
Let us quote your Amateur needs.

**SPECTRONICS, INC.**  
1009 GARFIELD STREET  
OAK PARK, IL 60304  
312-848-6777  
Chicagoland's Amateur Radio  
leader.

### *Indiana*

**HOOSIER ELECTRONICS**  
P. O. BOX 2001  
TERRE HAUTE, IN 47802  
812-238-1456  
Ham Headquarters of the Midwest.  
Store in Meadow Shopping Center.

### *Kansas*

**ASSOCIATED RADIO**  
8012 CONSER P.O.B. 4327  
OVERLAND PARK, KS 66204  
913-381-5901  
Amateur Radio's Top Dealer.  
Buy — Sell — Trade.

### *Kentucky*

**COHOON AMATEUR SUPPLY**  
HIGHWAY 475  
TRENTON, KY 42286  
502-886-4535  
Ten-Tec dealer — Call 24 hours  
for best deal

### *Maryland*

**COMM CENTER, INC.**  
9624 FT. MEADE ROAD  
LAUREL PLAZA RT. 198  
LAUREL, MD 20810  
301-792-0600  
New & Used Amateur Equipment.  
All Inquiries Invited.

### *Massachusetts*

**TUFTS RADIO ELECTRONICS**  
386 MAIN STREET  
MEDFORD, MA 02155  
617-395-8280  
New England's friendliest  
ham store.

### *Michigan*

**AUDIOLAND**  
36633 SOUTH GRATIOT  
MT. CLEMENS, MI 48043  
313-791-1400  
All major brands, new/used  
equipment & accessories.

**PURCHASE RADIO SUPPLY**  
327 E. HOOVER  
ANN ARBOR, MI 48104  
313-668-8696 or 668-8262  
We still sell Ham parts!

**RADIO SUPPLY & ENGINEERING**  
1203 WEST 14 MILE ROAD  
CLAWSON, MI 48017  
313-435-5660  
10001 Chalmers, Detroit, MI  
48213, 313-371-9050.

### *Minnesota*

**ELECTRONIC CENTER, INC.**  
127 THIRD AVENUE NORTH  
MINNEAPOLIS, MN 55401  
612-371-5240  
ECI is still your best buy.

### *Missouri*

**HAM RADIO CENTER, INC.**  
8342 OLIVE BLVD.  
P. O. BOX 28271  
ST. LOUIS, MO 63132  
800-325-3636  
Call toll free.

**MIDCOM ELECTRONICS, INC.**  
2506 SO. BRENTWOOD BLVD.  
ST. LOUIS, MO 63144  
314-961-9990  
At Midcom you can try before you  
buy!

*Dealers - You should be here too! Contact Ham Radio today for complete details.*

# Amateur Radio Dealer

## New Hampshire

**EVANS RADIO, INC.**  
BOX 893, RT. 3A BOW JUNCTION  
CONCORD, NH 03301  
603-224-9961  
Icom & 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".

## New Mexico

**JIM'S TV AND ELECTRONICS**  
805 N. FIRST  
GRANTS, NM 87020  
505-287-8148  
Stocking Icom. BAC & MC.  
Open 6 Days.

## New York

**ADIRONDACK RADIO SUPPLY, INC.**  
185 W. MAIN STREET  
AMSTERDAM, NY 12010  
518-842-8350  
Yaesu dealer for the Northeast.

**CFP COMMUNICATIONS**  
211 NORTH MAIN STREET  
HORSEHEADS, NY 14845  
607-739-0187  
Jim Beckett, WA2KTJ, Manager  
Dave Flinn, W2CFP, Owner

**GRAND CENTRAL RADIO**  
124 EAST 44 STREET  
NEW YORK, NY 10017  
212-682-3869  
Drake, Atlas, Ten-Tec, Midland,  
Hy-Gain, Mosley in stock

**HARRISON**  
"HAM HEADQUARTERS, USA"  
ROUTE 110 & SMITH STREET  
FARMINGDALE, L. I., N. Y. 11735  
516-293-7990  
Since 1925 . . . Service, Satisfaction,  
Savings. Try Us!

## Ohio

**UNIVERSAL SERVICE**  
114 N. THIRD STREET  
COLUMBUS, OH 43215  
614-221-2335  
Give U.S. a try when ready to buy.

## 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

**OREGON HAM SALES**  
409 WEST FIRST AVENUE  
ALBANY, OR 97321  
503-926-4591  
Yaesu dealer for the Northwest.

## Pennsylvania

**ARTCO ELECTRONICS**  
302 WYOMING AVE.  
KINGSTON, PA 18704  
717-288-8585  
The largest variety of crystals  
in N. E. Penn.

**ELECTRONIC EXCHANGE**  
136 N. MAIN STREET  
SOUDERTON, PA 18964  
215-723-1200  
New & Used Amateur Radio  
sales and service.

**"HAM" BUERGER, INC.**  
68 N. YORK ROAD  
WILLOW GROVE, PA 19090  
215-659-5900  
Communications specialists.  
Sales and service.

**HAMTRONICS, INC.**  
4033 BROWNSVILLE ROAD  
TREVOSE, PA 19047  
215-357-1400  
Same location for 25 years.

## South Dakota

**BURGHARDT AMATEUR CENTER**  
124 FIRST AVE. N.W. P.O. BOX 73  
WATERTOWN, SD 57201  
605-886-7314  
America's most reliable Amateur  
Radio Dealer — Nationwide!

## Texas

**ALTEC COMMUNICATIONS**  
1800 S. GREEN STREET  
LONGVIEW, TX 75601  
214-757-2831  
Specializing in ham equipment for  
the Ark-La-Tex.

**TECO ELECTRONICS SUPER STORE**  
1717 S. JUPITER ROAD  
GARLAND, TX 75040  
800-527-4642  
Call Toll Free for Service Today!

## Virginia

**ARCADE ELECTRONICS**  
7048 COLUMBIA PIKE  
ANNANDALE, VA 22003  
703-256-4610  
Serving Maryland, D.C., and Virginia  
area since 1962.

## Washington

**AMATEUR RADIO SUPPLY CO.**  
6213 13TH AVE. SO.  
SEATTLE, WA 98108  
206-767-3222  
Amateur center of the  
Northwest.

## Wisconsin

**AMATEUR  
ELECTRONIC SUPPLY, INC.**  
4828 WEST FOND du LAC AVENUE  
MILWAUKEE, WI 53216  
414-442-4200  
Open Mon & Fri 9-9, Tues, Wed,  
Thurs, 9-5:30, Sat, 9-3.

# 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

## 1/2 PRICE SALE!

Regardless of size of order

7400 Series	7439	.45	7496	.90	74173	1.70	74197	1.00	MH	0028CN	2.95	MEMORIES
	7440	.25	74100	1.50	74174	1.90	74198	2.20	0025CN	2.00		MM1101N
	7401	.17	7441	1.00	74107	.45	74175	1.90	74200	7.00	0026H	2.75
	7402	.17	7442	1.00	74122	.50	74177	.90		0026CG	4.00	1000 Series
	7403	.17	7443	1.00	74123	1.00	74180	.95	74500 Series			10102
	7404	.45	7448	1.15	74145	1.10	74182	.95	AH			10105
	7410	.17	7454	.35	74151	1.25	74184	2.25	0014D	9.00	10106	.75
	7413	.75	7460	.25	74153	1.40	74185	2.25	0014CD	4.00	10107	.75
	7417	.45	7472	.40	74155	1.25	74189	3.00	0151CD	4.50	10109	.75
	7425	.35	7473	.40	74157	1.40	74190	1.50	0126CD	4.50	10110	.75
	7426	.35	7474	.45	74161	1.55	74191	1.50	74S151	1.50	10111	.75
	7430	.25	7475	.80	74162	1.45	74192	1.25	74S157	1.95	10112	.75
	7432	.25	7476	.45	74163	2.40	74193	1.25	0008CH	3.50	10117	.75
	7437	.45	7483	1.10	74164	2.40	74195	1.00	0011H	7.00	10118	.75
	7438	.45	7492	.90	74170	2.90	74196	1.25	0016CN	2.75	10119	.75
									0017N	2.50	10121	.75

### WEIRNU

PO Box 942, Colton, CA 92324

1. Add 50¢ for postage & handling on orders under \$10.
2. All items guaranteed.
3. Send SASE for Bargain Flyer.
4. SEND YOUR ORDER ALONG WITH CHECK OR MONEY ORDER TO: WEIRNU, P. O. Box 942, Colton, CA 92324 (Calif. residents include 6% tax).

### Better Than FT.101E

Your FT.101 + G3LL's RF Clipper gives RF speech processing + extra receive gain and selectivity. Fits in minutes, send for full details or order with confidence - Hundreds sold direct from Holdings Photo Audio Centre, 39/41 Mincing Lane, Blackburn. Eng. or write WA2-AOQ for duty inclusive price.



G3LL's RF Clipper for FT.101 now only \$99 air post paid.

- 12 Button touch-tone pads calibrated and guaranteed 90 days (abuse excluded) with diagram ..... \$14.00
- Attractive plastic mounting box with brackets ..... \$4.75
- Complete working system ready to connect to your transmitter ..... \$24.95

### TELEPHONE EQUIPMENT COMPANY

Post Office Box 596, Leesburg, Florida 32748  
(904) 728-2730

## Sensational price! Superb quality!

**69<sup>95</sup> 119<sup>95</sup>**  
(30mHz Kit) (250 mHz Kit)

**6-DIGIT FREQUENCY COUNTERS**



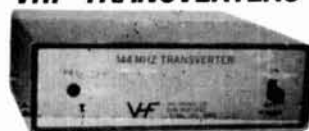
A counter-offer you can't refuse! It's rock-bottom price and sky-high quality make it your best buy! We've proved it to thousands. Let us prove it to you!

- 100mHz Readout
- Ham, CB, & Commercial Bands
- 1Hz Optional
- Master Chg./B. Americard OK
- Crystal Time-Base
- Add \$2 Shipping

All counters can be factory wired and tested.

**Hufco** Write or call today!  
P.O. Box 357, Dept. 54,  
Provo, UT 84601 (801) 375-8566

### VHF TRANSVERTERS



- 50, 144 & 220MHZ models
  - 1 watt min. output
  - Compatible with HF SSB equip
- \$129.50**

VHF Signal Co.  
2246 Beech St.  
Laurel, DE 19956 (302) 846-2691

# STOP WHISPERING

## SHOUT!

### EXPAND YOUR COVERAGE WITH THIS 150 WATT OUTPUT RF AMPLIFIER



All solid state / Strip line design  
Broad band / High efficiency  
Easily added to your present system.

Power boosters for 2 meters, Class C using balanced emitter transistors for long life and high SWR protection. For FM mobile or fixed operation.

**PA140/10** 5-15 watts in for 100-150 watts out @ 13.6 volts Typically 140 watts for 10 watts in  
**PA140/30** 15-40 watts in for 100-150 watts out @ 13.6 volts Typically 140 watts for 30 watts in

**POWER GAIN:** PA 140/10 . . . . 12DB PA 140/30 . . . . 7DB  
**INPUT POWER:** PA 140/10 . . . . 5 to 15 watts  
PA 140/30 . . . . 15 to 40 watts  
**INPUT VOLTAGE:** 12 to 14 volts DC negative ground  
**NOMINAL INPUT CURRENT:** PA 140/10 . . . . 22 Amps  
PA 140/30 . . . . 18 Amps  
**STANDBY CURRENT:** Virtually insignificant  
**INSERTION LOSS:** Less than 1 DB on receive  
**DUTY CYCLE:** 50% or less  
RF sensing relay switched  
**DIMENSIONS:** 7" x 10-1/2" x 2-7/8"  
**WEIGHT:** 4 lbs.

#### PRICES

PA 140/10 . . . . . \$179.95 wired and tested  
PA 140/30 . . . . . \$159.95 wired and tested

### NEED TO POWER YOUR 25-35 WATT TRANSCEIVER AND YOUR PA 140/30 OR PA 140/10? NOW AVAILABLE . . .

#### OUR PS 3012 . . . THE BRUTE



At last a brute of a power supply that will deliver regulated 11-14VDC at 30 amp and at a very affordable price. The PS3012 is a ruggedly built, fully protected power supply. This is the power supply that is destined to become the standard of the industry.

PS 3012 . . . . . Price \$239.95 . . . . . Wired & Tested  
Other models available.

PS 25C . . . . 25 amps at 12VDC . . . . . Wired, \$149.95 Kit, \$129.95  
PS 15C . . . . 15 amps, 12VDC . . . . . Wired, \$94.95 Kit, \$74.95

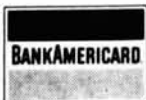
#### Just Look At These Features:

- 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.
- 115/230 volt input — 50/60 cycle.
- Units are factory wired for 115 volt AC, 50/60 cycle power. A simple jumper will reconfigure the input for 230 volt AC, 50/60 cycles.
- Temperature range — operating: 0° to 60° C.
- Black anodized aluminum finish.

THE WORLD'S MOST COMPLETE LINE  
OF  
VHF - FM KITS AND EQUIPMENT

**Vhf engineering**  
DIVISION OF BROWNIAN ELECTRONICS CORP.

320 WATER ST.  
BINGHAMTON, N.Y. 13902 • 607-723-9574



#### ORDER FORM

Item	Price Each	Quantity	Total Price

Name \_\_\_\_\_ Total \_\_\_\_\_  
Address \_\_\_\_\_ Shipping \_\_\_\_\_  
City \_\_\_\_\_ NYS Resident \_\_\_\_\_  
Sales Tax \_\_\_\_\_  
State \_\_\_\_\_ Zip \_\_\_\_\_ Total \_\_\_\_\_  
Master Charge or BankAmericard No. \_\_\_\_\_ Enclosed \_\_\_\_\_  
Bank No. \_\_\_\_\_ Expiration Date \_\_\_\_\_

**SHIPPING INFORMATION:** All shipments are F.O.B. Binghamton, N.Y. 13902. Shipments will be made by the most convenient method. Please include sufficient funds to cover shipping and handling. Figure shipping charges on a weight of 6 lbs. for PA 140/30, 30 lbs. for PS3012. Allow 3 to 4 weeks for delivery.  
**TERMS:** C.O.D., cash or check with order. We also accept BankAmericard and Master Charge.  
**CLAIMS:** Notify VHF and the carrier of damage within seven (7) days of receipt of shipment.  
**RETURNS:** Obtain authorization from VHF before returning any merchandise.  
**PRICES AND SPECIFICATIONS:** Subject to change without notice. Export prices are slightly higher.

# POWER PLUS PERFORMANCE



## depend on BLACK CAT® Linear Amplifiers

The Black Cat® JB 2000 10/80 linear amplifier delivers the power you need and rugged performance you can count on. Designed and built with the same quality craftsmanship and pride that backs every Black Cat® product, the JB 2000 10/80 lets you stay up as long as you like, whenever you like.

Containing a 120VAC — 240VAC, Solid State self contained power supply, with a power input of 2000 watts PEP SSB, the JB 2000 10/80 linear amplifier greatly increases your signal. Whether building a new station or renovating an old, the Black Cat® JB 2000 10/80 is the perfect addition to any ham operator's equipment roster.

Also included in the Black Cat® line of durable and dependable ham accessories is the test equipment to insure that you stay on the air: the JB 1000 Dummy Load, JB 1000 SM Oscilloscope/RF Wattmeter/SWR Bridge, and JB 2000 SW Power Meter/SWR Bridge.



For complete information on all Black Cat® products, contact your nearest Black Cat® dealer, or write:

# WAWASEE ELECTRONICS

"HOME OF BLACK CAT® PRODUCTS"

Wawasee Electronics Co., Inc.

P.O. Box 36 • Syracuse, Indiana 46567

Phone: (219) 457-3191



6 digit AUTOMOTIVE CLOCK KIT complete with a CRYSTAL TIMEBASE accurate to .01 percent. 12 volts d.c. operation — built in noise suppression and voltage spike protection. Readouts blank when ignition is off — draws 25 mA in standby mode. Has .3 in. readouts. Use it in your car or for all applications where a battery-operated clock is needed. Approximate size 3" x 3.5" x 1.75"



WITH BLACK PLASTIC CASE \$34.95 ppd.  
WITHOUT CASE \$29.95 ppd.  
ASSEMBLED AND TESTED \$45.95 ppd.

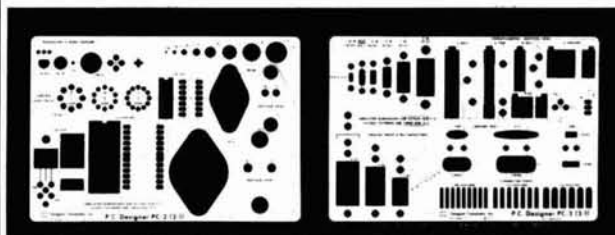
CMOS CRYSTAL TIMEBASE KITS with .01 percent accuracy. 5-15 v.d.c. operation. Draws only 3 mA at 12 volts. Single I.C. — very small size — the P.C. board is 7/8" x 1-5/8". Choose a main output of 50 or 100 Hz., 60 Hz., 500 or 1000 Hz., or 1 Hz. Several related frequencies are also available on each board, in addition to the main ones listed above. Be sure to specify the Frequency you want. All kits are \$10.95 ppd.

Flyer available —

# NEXUS TRADING CO.

Box 3357 San Leandro, Ca 94578

## pc design template



The new *PC Designer* template set has been updated to include additional, frequently used component packages and mounting patterns for printed-circuit layouts and assembly drawings. All patterns conform to guidelines established by Mil-Std 275C and The Institute of Printed Circuits bulletin CM-770. Component mounting patterns are on grid centers which enable the designer to design for automatic insertion assembly equipment.

Fixed and variable resistors, axial and radial lead capacitors, and several semi-conductor packages are included. Template use reduces circuit-board design time by eliminating constant referral to manuals and data sheets for package dimensions. The template sets are available from stock in actual, twice, and four times size layout ratios and are priced from \$12.00 to \$20.00 per set.

Write: TANGENT TEMPLATE, INC.  
Post Office Box 20704  
San Diego, California 92120

For Spare Time Income, Your Own Business or a Career...

# LEARN TO SERVICE COMMUNICATIONS/CB EQUIPMENT...THE NRI WAY

**Career opportunities are opening up fast for the man trained in communications.**

The field of communications is bursting out all over. In Citizens Band alone, class "D" licenses grew from 1 to over 2.6 million in 1975, and the FCC projects about 15 million U.S. CB'ers by 1979. That means countless careers in design, installation and



**CB Specialist Course now available**

NRI now offers a special course in CB Servicing. You get 37 lessons, 8 reference texts, your own CB Transceiver, AC power supply and multimeter . . . for hands-on training. Also included are 14 coaching units to make it easy to get your commercial radio telephone FCC license—enabling you to test, install and service communications equipment.

Commercial, and Amateur communications: a digitally-synthesized 400-channel VHF transceiver and AC power supply. This 2-meter transceiver gives you "Power-On" training. Then we help you get your FCC Amateur License with special instructions so you can go on the air.

The complete program includes 48 lessons, 9 special reference texts, and 10 training kits. Also included are: your own electronics Discovery Lab, a new Antenna Applications Lab, an Optical Transmission System, CMOS Digital Frequency Counter, and TVOM. The course covers AM and FM Transmission Systems; Radar Principles; Marine, Aircraft, and Digital Electronics; and Mobile Communications. You must earn your first class radio telephone FCC license or you get your money back.



maintenance. Start training now, the NRI way, to get your FCC license and qualify for one of these openings.

**Learn on your own 400-channel, digitally-synthesized VHF Transceiver.**

The NRI Complete Communications Course teaches you to service and adjust all types of two-way radio equipment (including CB), using the one unit that is best equipped to train you for CB,



**Over a million men have enrolled with NRI**

Send for the free NRI catalog and discover why more than a million men like yourself have chosen the NRI way the right way to get ahead. Read how you learn from bite-size lessons, progressing at your own speed to your FCC license and then into the communications field of your choice. There's no obligation and no salesman will call.

**Send coupon now for FREE NRI catalog**



If coupon is missing, write to: NRI Schools, McGraw-Hill Continuing Education Center, 3939 Wisconsin Avenue, Washington, D.C. 20016

Rush the free catalog of my choice (select only one, please). No salesman will call.

- Complete Communications Electronics with CB • FCC licenses • Aircraft, Mobile, Marine Electronics
- CB Specialists Course
- Amateur Radio Basic and Advanced
- Industrial and Business Electronics Digital Computer Electronics • Electronic Technology • Basic Electronics
- TV/Audio Servicing Choose from 5 courses
- Appliance Servicing Homeowner & Professional Repairs
- Automotive Mechanics Master Automotive Technician • Tune-Up and Basic Repairs
- Auto Air Conditioning
- Air Conditioning & Refrigeration Basic Air Conditioning Servicing • Master Course in Air Conditioning, Refrigeration & Heating

**NRI SCHOOLS**  
McGraw-Hill Continuing Education Center  
3939 Wisconsin Avenue,  
Washington, D.C. 20016

**APPROVED UNDER GI BILL** if taken for career purposes.  
 Check box for details.

Name \_\_\_\_\_ Age \_\_\_\_\_  
(Please Print)

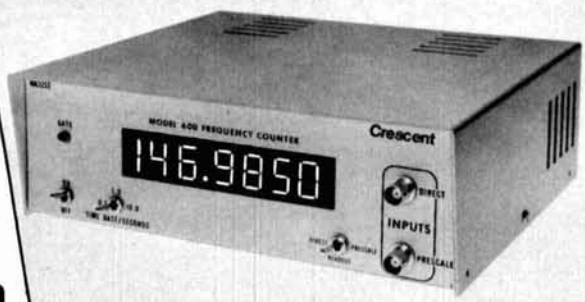
Street \_\_\_\_\_

City/State/Zip \_\_\_\_\_

Accredited Member National Home Study Council

# NEW

## a digital frequency counter you can count on



New 300/600 Mhz Digital Frequency Counters are in a class by themselves when it comes to reliability, accuracy and performance.

Quality features include full 7 digit display panel with large LED read-outs, resolution to .1HZ, high input sensitivity, automatic limit on input, controlled time base, selectable gate times .1 sec., 1 sec. and 10 sec. and high stability time base options available.

Complete Kit includes all parts, drilled and plated PC boards, cabinet, switches, hardware and a complete Instruction Manual including calibration instructions.

### SPECIFICATIONS

Input Impedence: Direct HI-Z, Pre-scaled 50  
 Sensitivity:  $\Omega$  50 mv/20MHZ 150 mv/200MHZ 200 mv/600MHZ  
 Time Base: 10 Mhz crystal oscillator  
 Stability:  
 Standard 10ppm 25 to 40 C  
 TXCO\* 2ppm 15 to 55 C  
 Frequency Range: Model 300 1HZ to 300 Mhz  
 Model 600 1HZ to 600 Mhz  
 Resolution: 0.1 second gate  
 1.0 second gate  
 10.0 second gate\*  
 Power: 120 VAC 25 Watts  
 12 VDC\*  
 Cabinet Size: 8" x 8" x 2 1/2"

\*Optional

### TO ORDER

Send check or money order  
 \$129.00 for Model 300 Kit (1 HZ to 300Mhz)  
 \$179.00 for Model 600 Kit (1 HZ to 600Mhz)  
 For preassembled and tested units  
 \$199.00 Model 300  
 \$249.00 Model 600

NAME \_\_\_\_\_  
 ADDRESS \_\_\_\_\_  
 CITY \_\_\_\_\_  
 STATE \_\_\_\_\_  
 ZIP \_\_\_\_\_  
 (CALL) - - - - -

Send check or money order to:

# Crescent Wire & Cable Inc.

... for all your wire & cable needs

Bldg. 13 Euclid Ave., Newark N.J. 07105 (201) 589-4647



## BOOKS BY PHONE CALL TOLL FREE 800-258-5353

Almost all popular Amateur Radio Books available for immediate shipment.

**HAM RADIO**  
GREENVILLE, NH 03048

## HEARD THE GOOD? WORD?



*"You can order books from HAM RADIO on their NEW*

**TOLL FREE NUMBER."**  
**800-258-5353**

## NEW

from the  
**RSGB**



## VHF-UHF MANUAL

3rd Edition

by D. S. Evans, G3RPE  
& G. R. Jessop, G6JP

Here is the most comprehensive and up-to-date book on VHF & UHF ever prepared for the Radio Amateur.

In over 400 pages it thoroughly covers such topics as receivers, transmitters, space communications, filters, antennas and FM. Included is a major new section on Microwave work.

This latest edition is a handsome hardbound book and is sure to become the standard reference for anyone involved in the world above 30 MHz.

**ONLY \$12.95**

**GIVE US A CALL  
TODAY!**

**HAM RADIO**  
GREENVILLE, N. H. 03048



MAKE  
PROFESSIONAL LOOKING  
P.C. BOARDS FAST  
AND EASY

• SENSATIONAL  
• REVOLUTIONARY  
• FANTASTIC

**STAMP-IT  
ETCH-IT**

SEE  
MAY, 1975  
OST (page 42) NEW  
PRODUCTS  
REVIEW



Reduces Printed Circuit Board Art Work From 2 Hours to 10 Min. ...

Simple as A.B.C.

A. Stamp Components on P.C. Board. B. Use Pen to Interconnect Lines. C. Etch Board.

**SE-2 KIT CONTAINS:**

- CONNECTOR FINGERS
- 16 PIN DUEL IN LINE IC SOCKET
- 10 PIN ROUND IC SOCKET
- 8 PIN ROUND IC SOCKET
- TO-5 TRANSISTOR SOCKET
- TO-18 TRANSISTOR SOCKET
- LARGE & SMALL DONUT PAD
- RESIST INK
- INK PAD
- RESIST PEN

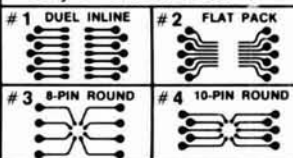
**ONLY \$9.95**

PLUS 1 LB. POSTAGE

**ADDITIONAL STAMPS:**

Bread board stamps for all integrated circuits "Great" for experimenters.

Only \$2.95 each or all four \$9.95



- RESIST INK .95c per bottle
- RESIST PEN ea. 95c
- INK PAD ea. \$1.15
- Etching Containers .10 for 95c

**RAINBOW INDUSTRIES**

P.O. BOX 2366 - DEPT. 11-3  
Indianapolis, Indiana 46206

Are you tired of the hours of small, detailed, eye-straining art work that goes into making printed circuit boards? "STAMP IT, ETCH IT" is introducing a NEW product called "STAMP IT, ETCH IT" Kit. This Kit will take the tedious art work and many tiresome hours out of printed circuit board preparation. In just a few short minutes you have a professional looking etched printed circuit board ready for drilling!

The "STAMP IT, ETCH IT" Kit is exactly as the name implies. Following the step by step simple instructions, you can have a printed circuit board and have saved hours of frustration. As easy as you use a rubber stamp to stamp messages on paper, you stamp your component connections on copper clad printed circuit boards.

In your "STAMP IT, ETCH IT" kit we supply all component stamps shown in SE-2 Kit. In the SE-2 kit we also have resist ink enough for months and months of experimenting, ink stamp pad, resist pen, and etching containers. The most revolutionary item in your "STAMP IT, ETCH IT" Kit is ... The Fool Proof System of etching your printed circuit boards.

With our kits and our etching containers, you are able to etch a printed circuit board as fast as bubble etching machinery and the results are as good or better.

**COAX CONNECTORS**

- PL 259 ..... .55
- SO 239 ..... .50
- PL 258 BARREL 1.15
- DOUBLE MALE 1.75
- M 358 'T' ADAPTER 2.95
- M 359 Right ANGLE 1.49
- UG 175/U RE-DUCER (RG58/U) .25
- UG 176/U RE-DUCER (RG59/U) .25
- PL 259 P.O. (PUSH ON TYPE) 1.25
- UHF F to MOTOROLA M 1.50
- UG 255 BNC.M to UHF.F 2.95
- UG 273/U UHF.M to BNC.F 1.95
- UG 2608/U BNC CABLE END 1.15
- UG 274C/U BNC 'T' ADAPTER 2.45
- UG 306B/U RIGHT ANGLE 1.75
- UG 4918/U DOUBLE MALE 2.45

**PRINTED CIRCUIT BOARDS G-10 FIBERGLASS**

Size	1 Side	2 Sided
2"x 4"	.25	.35
2"x 6"	.35	.45
3"x 6"	.50	.65
4"x 6"	.65	.90
6"x 6"	.90	1.35
6"x 12"	1.50	2.50
12"x 12"	2.95	3.95

**QUANTITY DISCOUNT (same size)**

10 to 24	10%
25 to 99	15%
100 up	25%

\$5.00 Minimum Order  
PLEASE ADD POSTAGE

**FAN (MUFFIN TYPE)**

Rotron Mfg. Mod. MU2A2. 4 1/4" Square, no bezel. 80 CFM, Whisper Quiet, 115 VAC. 60 cy.

BRAND NEW. \$9.95 ea.

**STEREO PREAMPS**

High Quality Module Type, wires easily into existing stereo where an equalizer pre-amp state is required, can be used in magnetic cartridges, tape decks, or heads, low impedance microphones, etc. 12 V power source. 20 to 20 KHZ Frequency response, very sensitive. 3"x4 1/4" x 1/2" BRAND NEW WITH SCHEMATIC. LIMITED QUANTITY—3 for \$2.00 — 10 for \$5.00.

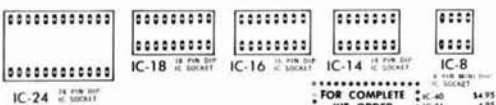
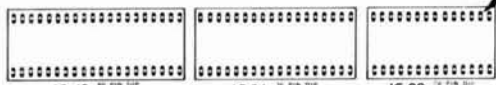
**VIDEO PREAMPS**

Originally made for CARTAVISION VIDEO TAPE SYSTEM. Has many uses. 2/\$1 — 10/\$4

**3" CRT TUBES 3EP1**  
NEW GUARANTEED  
\$3.95 ea.—4/\$10.00

**DESOLDERING IRON**

Mfgd. by leading company (in U.S.A.) in the soldering tool field. These units are NEW! Slight plating blemish prevents factory from marketing. A 40 watt unit which may be used for soldering as well as desoldering. **WE GUARANTEE!!** ORIGINALY SELLS FOR \$16.95  
PRICE \$8.95 each (Limited inventory)



FOR COMPLETE KIT ORDER SE-28 KIT \$29.95

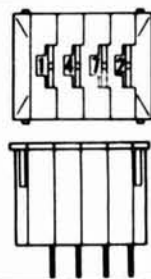
**LOW PROFILE IC SOCKETS WIRE WRAP**

FIN	EA.	10	100
8	.17	\$1.53	\$14.45
14	.20	1.80	17.00
16	.22	1.98	18.70
18	.29	2.61	24.65
24	.38	3.42	32.30
28	.45	4.05	38.25
36	---	---	---
40	.63	5.67	53.55

Send for our CATALOG...

**THUMBWHEEL SWITCHES**

**MODEL MF FRONT MOUNTING SWITCH**



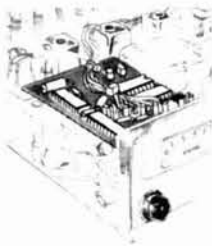
BOARD CODE & DESCRIPTION	MF
12 10 Pos. Decimal, 1 Pole	\$3.25
12A 10 Pos. Decimal, Ext. Bd.	3.85
13 10 Pos. Decimal, 2 Pole	4.35
18 10 Pos. BCD Comp. Only	2.95
18A 10 Pos. BCD Comp. Ext. Bd.	3.45
21 10 Pos. BCD Only	2.70
21A 10 Pos. BCD, Ext. Bd.	3.15
22 10 Pos. BCD, + Comp.	4.45
22A 10 Pos. BCD, + Comp., Ext. Bd.	5.30
48 11 Pos. Decimal	4.10
55 16 Pos. Decimal	N/A
57 16 Pos. BCD + Comp.	N/A
57A 16 Pos. BCD + Comp., Ext. Bd.	N/A

**ACCESSORIES**

End Plates	1.00
Divider Plate	1.50
Blank Body	.50

**HW-202 SCANNER**

- \*No holes to drill. Easy installation.
- \*Doesn't interfere with tone encoder.
- \*Mounts neatly over power board, completely inside radio.
- \*Six bright L.E.D.'s visible through semi-transparent meter panel.
- \*Stops scanning when either signal is heard or manual selection is made.
- \*Built-in squelch addition eliminates all noise when scanner is scanning.
- \*Designed especially for your HW-202.
- \*Assembled.



**NEW**

**ELECTRONIC KEYS**

LOWEST PRICE EVER

- \*3-50 WPM.
- \*Self-completing dots and dashes.
- \*Has speed control.
- \*Has automatic weight control.
- \*Built-in side tone to drive small speaker.
- \*Use directly with grid block keying or add relay (not included) as per instructions to key any transmitter.
- \*Use 3 penlight cells.
- \*Solder plated board. Instructions included.
- \*Just add your key, batteries and speaker.



Kit — \$12.97 ppd.  
Assembled — \$16.97 ppd.

Designed by WB4QDB — Georgia Residents Include 3% Sales Tax  
**SANDLIN ELECTRONICS ENGINEERING**  
P. O. Box 4909 / Martinez, Georgia 30907 / Telephone (404) 863-5852

# GO AUTO-PATCH THE EASY WAY!

**BUY AN ICOM IC-230 AT THE  
REGULAR PRICE \$489.00 AND GET THE  
TOUCH TONE HANDSET FREE!**

**PLUGS DIRECTLY INTO IC-230  
AND YOU ARE READY TO GO.**

Works with IC-22A and others by  
wiring accessory socket for handset.  
**TOUCH TONE HANDSET ONLY \$79.00**

**IMMEDIATE DELIVERY FROM STOCK**

**UTAH FM SALES**  
1365 East 5360 South  
Salt Lake City, Utah 84117

801 533-0101

24 hour message  
recorder

801 278-3156



## 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

## BOOKS BY PHONE

TOLL FREE

**800-258-5353**

HAM RADIO, Greenville, NH 03048

## NEW ELECTRONIC PARTS

Resistors Meters LED Displays Fuses  
Capacitors Switches Proto Boards IC sockets  
Diodes Dozy Boxes Mod-U-Line Test Clips  
Tripmots Transistors Hardware And much more  
SASE brings our new parts catalog.

*NuData Electronics*

104 N. EMERSON ST. MOUNT PROSPECT, ILLINOIS 60056



**CLOSE OUT  
1976!**



**ATTEND THE ARRL  
FLORIDA SECTION CONVENTION  
NOV. 6 AND 7 AT THE  
SHERATON SAND KEY HOTEL  
ON THE GULF, AT  
CLEARWATER BEACH, FLORIDA**

Complete family entertainment, with tours to the area attractions such as Disney World and Busch Gardens, plus Hotel facilities. HAMS HAVE MORE FUN also, with the best Technical Sessions yet in the Southeast. Forums abound, with John Johnson, K3BNS chairing the FCC Forum. FCC exams given at the Hotel Nov. 6! Send Form 610 and \$4 to FCC, Zack St., Tampa, Fl. 33602, to reserve your exam. ARRL President Dannels will highlight the festivities at a gala Banquet Saturday evening, with a "Special Feature" unearthed from Lew McCoy, W1ICP. A complete Drake station (TR4C, RV-4, AC4) is the main Convention prize, with a TEN-TEC Argonaut 509 as the main Banquet prize.

### Advanced Registration:

**\$3 family ticket (2 bonus tickets)**

### Banquet tickets:

**\$9 person (limit 400 persons)**

### Hotel:

**\$25 Single or Double, \$4 per person extra, under 18 free.**

**Write: Florida Gulf Coast  
Amateur Radio Council, Inc.  
P. O. Box 157  
Clearwater, FL. 33517**

## YAESU INTRODUCTORY SPECIAL



This SPECIAL OFFER is valid only during October 1976. Don't miss out!

**\$749<sup>00</sup>** will buy not only a brand new YAESU FT-101E but also two very popular accessories (valued at \$64.00). This purchase will include a CW filter and a fan. Order yours today. (N. Y. residents add sales tax.)

Jim Beckett  
WA2KTJ

Bryant Hozempa  
WB2LWV

### C F P COMMUNICATIONS

211 NORTH MAIN STREET  
HORSEHEADS, N. Y. 14845  
PHONE: 607-739-0187



Expanded Store Hours  
Tues.-Thurs. 10:00-7:00 p.m.  
Fri. 10:00-9:00 p.m.  
Sat. 10:00-7:00 p.m.  
Fri. & Sat. subject to  
Hamfest weekends  
Closed Sun. & Mon.

# UNIQUE!



## Convert Morse, RTTY and ASCII to Video

### MODEL 100 TRI-MODE CONVERTER

Based on the powerful F-8 Microprocessor system, this new product from Info-Tech advanced technology features:

- Morse reception with Automatic Speed and Wordpace
- RTTY reception with four manually selected speeds and automatic readout of incoming speed (requires T.U. for demodulation)
- ASCII reception at 100 w.p.m. (110 baud); (requires T.U. for demodulation)
- Video Display: Model 100A—32 characters x 16 lines of 5 x 7 DOT matrix with scrolling

Model 100 B (optional)—64 characters x 16 lines with scrolling

**PRICE:** Model 100 A—\$450.00 (wired & tested)  
Model 100 B— 495.00 (wired & tested)

Master Charge Welcome • Send for Data Sheets

**INFO-TECH** **INCORPORATED** *Specializing in Digital Electronic Systems*  
20 Worthington Drive, St. Louis, Missouri 63043 Phone: 314-576-5489

Vintage Radio



Vintage Radio



# Vintage Radio Has Great Books For You!

*Relax With A Time Trip To Yesterday!*

Thousands have already discovered the pleasure of owning Vintage Radio books. You too can enjoy browsing through those pioneer days of wireless and radio. You'll recapture the excitement of wireless days even though they were long before your time. You'll see fine old battery radios of the 1920's, and rediscover "cathedral" radios of the 1930's. You'll relive the dawn of radio broadcasting, visit the radio operator aboard

his ship, visit G. I. Joe in his foxhole with his handy-talkie set, and meet the radio "Ham" in his shack.

These experiences and many more await you in Vintage Radio's family of books. Young or old, you'll be fascinated by your journey through those earlier days. You'll also discover the fun and rewards of collecting old-time radio sets and memorabilia.

## 1921-1932 RADIO COLLECTOR'S GUIDE



This book makes you an "instant expert" as you go prospecting for those fine old radios. It eliminates guesswork in determining a set's age and "pedigree." There are 264 pages loaded with over 50,000 facts on 9,000 radio models made by 1,100 manufacturers.

Just \$6.95

## 1927 RADIO ENCYCLOPEDIA



Own this authentic reproduction of Gernsback's classic. Browse through radio's heroes (who's Marconi?) and hardware (what's a coherer?) of the old days. 175 fascinating pages. Our hard-cover version is a serialized limited edition, an ideal gift.

Soft Cover **Only \$10.95**

Deluxe Hard Cover **Only \$14.95**

## A FLICK OF THE SWITCH 1930-1950



Here's your time trip through the great days of radio broadcasting and the dawn of television. Re-visit the Lone Ranger, Philco "cathedral" radios, old "Ham" days and many more. You'll revel in 312 pages of story, old ads and over 1,000 pictures.

Soft Cover **Only \$8.95**

Hard Cover **Only \$10.95**

## VINTAGE RADIO 1887-1929



You'll enjoy this fascinating pictorial story of pioneer days in wireless and radio. Relive the days of Marconi, old spark transmitters, and the struggles of early radio broadcasting. It's the radio collector's reference, with over 1,000 pictures on 263 pages.

Soft Cover **Only \$8.95**

Hard Cover **Only \$10.95**

## MOST-OFTEN-NEEDED 1926-1938 DIAGRAMS

This reprint of Morris Beitman's Supreme Publications book shows circuit diagrams for 600 radio models. Its 240 pages are valuable for historical circuit information, and are great aids in restoring those old sets. Made from Supreme's original artwork, it is clear and readable.

**Only \$7.00**

Please add 25¢ per book postage and handling  
Order your Vintage Radio books from

**ham  
radio**

Greenville, NH 03048

**Call Toll Free 800-258-5353**

8 AM TO 10 PM  
Eastern Time (7 PM Pacific)

Vintage Radio



Vintage Radio



**PALMER INDUSTRIES  
INTRODUCES  
THE  
NEW  
MODEL**

**52'  
TRISTAO  
SUPER  
MINI-MAST**



Featuring an exclusive three-section, crank-up, self-supporting 52' mast with automatic brake winch. Constructed of high-strength steel tubing, designed to handle 9 to 10 sq. ft. of antenna and withstand winds of 50 to 60 MPH.

Only TRISTAO'S Mini-Mast features as an exclusive option, a rotor base assembly allowing rotor to be mounted at ground level for easy maintenance.

We offer a complete assortment of accessory bases and raising fixtures for the Mini-Mast.

**NORMALLY STOCKED  
FOR IMMEDIATE  
SHIPMENT**

40' MODEL ALSO IN STOCK

Call or write for FREE catalog covering all the other fine Tristao towers and masts.

**TRISTAO TOWER  
DIVISION**

PALMER INDUSTRIES, INC. Dept. HR  
3900 San Fernando Road Glendale, Calif. 91204  
(213) 246-8333



**THE FM LEADER**



**2 METER** 

**220 MHz** 

**6 METER** 

**440 MHz** 

FEATURING THE...

**HR-2B**



12 Channels  
15 Watts  
\$229<sup>00</sup> Amateur Net

**The Master in 2 Meter FM**

Positive performance at a practical price makes our HR-2B tops on 2 meters. Individual trimmer capacitors give bull's-eye accuracy for working repeaters or point-to-point. The .35 $\mu$ V sensitivity and Hi/Lo power switch insure your hearing and being heard... clearly and reliably... the Regency way.

...AND THE

**HR-440**



12 Channels  
10 Watts  
\$349<sup>00</sup> Amateur Net

**UHF—The Ultimate in FM**

440 is fresh... it's new... and with our HR 440 you can use UHF without using-up your budget. So, pioneer some new ground! Put a compact HR 440 under your dash or at your desk. It's the best way to usher yourself into UHF.



© 1976

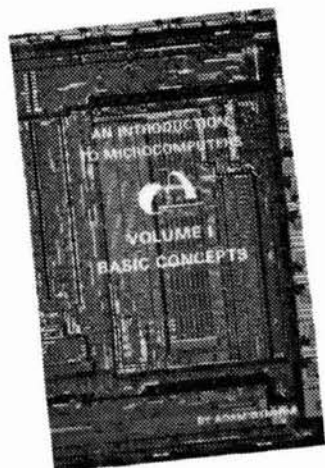
**ELECTRONICS, INC.**

7707 Records Street  
Indianapolis, Indiana 46226

# MICROPROCESSOR BOOKS

---

## FROM ADAM OSBORNE



### INTRODUCTION TO MICROCOMPUTERS – Volume I Basic Concepts by Adam Osborne

Takes you by the hand from elementary logic and simple binary arithmetic through concepts shared by all microcomputers. You learn how to take an idea that may need a microcomputer and create a product that uses one. This book is complete. Every aspect of microcomputers is covered: the logic devices that constitute a microcomputer system; communicating with the external logic via interrupts, direct memory access, and serial or parallel I/O; microprogramming and macroprogramming; assemblers and assembler directions; linking and relocation — everything you need to know to start selecting or using a microcomputer.

Order AO-2001

Just \$7.50

### INTRODUCTION TO MICROCOMPUTERS – Volume II Some Real Problems by Adam Osborne

Covers real microcomputers in considerable detail. Every major microcomputer: 4-bit, 8-bit or 16-bit is described including some soon to be announced products. Major chip slice products are also covered; more than 20 microcomputers in all.

Included is material on the following:

- 8259 Priority Interrupt Control Unit from Intel
  - 8253 Programmable Counter Timer from Intel
  - 8257 Direct Memory Access control devices from Intel
  - 6028 Priority Interrupt Controller from Motorola
  - 6875 USART from Motorola
  - M6700 single chip microcomputer from Motorola
  - 10800 family of chip slice logic from Motorola
  - Single chip F-8 from Fairchild
  - EA9002 microprocessor from Electronic Arrays
- Plus others

Order AO-3001

Only \$7.50



Call Toll Free

800-258-5353

8 AM TO 10 PM

Eastern Time (7 PM PACIFIC)

MONDAY-FRIDAY

8:30 AM - 4:30 PM Saturday

### 8080 PROGRAMMING FOR LOGIC DESIGN by Adam Osborne

A completely new book on a totally new subject: implementing digital and combinatorial logic using assembly language within an 8080 microcomputer system. What happens to fan-in and fan-out? How do you implement a one-shot? This book simulates well known digital logic devices using assembly language. Next it shows you how to simulate an entire schematic, device by device, keeping the assembly language simulation as close to the digital logic as possible. But that is the wrong way to use a microcomputer; the book explains why. Then shows you the correct way.

Order AO-4001

Just \$7.50

Order from **HAM RADIO, Greenville, NH 03048**

# ARRL HUDSON DIVISION CONVENTION

NOVEMBER 13-14, 1976

## SHANGRI-LA '76

### PLAYBOY RESORT & COUNTRY CLUB

AT GREAT GORGE

### McAFEE, NEW JERSEY

SPONSORED BY THE HUDSON AMATEUR RADIO COUNCIL, INC.

**A DYNAMITE HOTEL... A SIZZLING PROGRAM... A BLAST OF A CONVENTION...**

**BANQUET: SPEAKER—JEAN SHEPHERD, K2ORS**

**PROGRESS THRU: EDUCATION • TECHNICAL KNOWLEDGE • PUBLIC SERVICE**

#### FOR ALL

INDOOR SWIMMING—SAUNA—WORLD'S LARGEST WHIRLPOOL—TENNIS—RIDING—GOLF—FREE DAY CAMP FOR 4 YEAR OLDS & UP—BABYSITTERS AVAILABLE... EATING AT THE DELI, BUFFET IN THE LIVING ROOM, SIT UNDER A FORTY-FIVE FOOT TREE IN THE SIDEWALK CAFE, DINNER IN THE PENTHOUSE OR PLAYBOY CLUB OR THE VIP ROOM... UNBELIEVABLE BUT TRUE, PLUS LIVE BROADWAY ENTERTAINMENT AND A THREE LEVEL GAME ROOM... STAY FOR A FEW NIGHTS AND HAVE A REALLY SUPER VACATION...

#### FOR THE HAM

ANTENNAS—ARPSC & AREC—ARRL & FCC FORUMS—ATV—CONTEST—CAC—CONSUMER FORUM—DX—FAX—FM & REPEATERS—LAW—MARS—MICROPROCESSING & HAM APPLICATION—OSCAR—PUBLIC RELATIONS—QRP—RTTY—SOLID STATE—TECH. MOVIES—TRAINING—VHF-UHF—YLRL

**MANUFACTURERS EXHIBIT AREA... LATEST GEAR**

**TAKE YOUR LICENSE UPGRADE TEST AT THE CONVENTION**  
SEND FORM 610 WITH CHECK OR M.O. MADE OUT TO F.C.C.  
1 WEEK IN ADVANCE TO: PAUL MAZER, 70-29 KISSENA BLVD., FLUSHING, N.Y. 11365

#### GIANT INDOOR FLEA MARKET

**SELLERS: ONE DAY—\$8.00, TWO DAYS—\$15.00, PLUS CONVENTION REGISTRATION**

**OR FLEA MARKET TABLE RESERVATIONS: WRITE P.O. BOX 1054, PASSAIC, NEW JERSEY 07051**

**SPECIAL CONVENTION HOTEL RATES: \$36.00 PER NIGHT FOR TWO, \$8.00 EACH ADDITIONAL PERSON IN THE ROOM. \$32.00 PER NIGHT FOR A SINGLE ROOM.**



**playboy RESORT AND COUNTRY club**  
**AT GREAT GORGE**

HOTEL RESERVATIONS:  
CALL DIRECT 800-621-1116  
OR CHECK BOX ON CONVENTION  
REGISTRATION FORM...

REGISTER EARLY IN ORDER TO GET GROUP SEATING AT THE BANQUET

TO: AL PIDDINGTON, WA2FAK, 4 ACORN DRIVE  
EAST NORTHPORT, N.Y. 11731 (516-261-3285)

NAME \_\_\_\_\_  
CALL \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_

Advance Ham Registrations \_\_\_\_ @ \$3.00 (\$4.00 at door)  
Saturday Night Banquet Tickets \_\_\_\_ @ \$15.00 (\$16.00 at door)  
Please send Hotel Reservation form(s) \_\_\_\_\_

# 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

ARRL Florida *	Jan	067
ATV *	Janel	068
Adva	Kensco	394
Aidelco	Kenwood	341
Antenna Spec.	Kester Solder	492
Supermarket	Klaus	430
Apron	Lin	451
Ashcraft *	Logic Systems	493
Atlas	Lyle	373
Atronics	M & D	494
Bauman	MFJ	082
Barry *	MHz	415
Budwig	Madison	431
Bullet	Matric	084
Byte	Mini-Products	395
CFP	M-Tech	357
CHM	National Multi	396
Cal-Com	N. R. I.	397
Chaney's	New-Tronics	171
Circuit Design *	Nexus	454
Clegg	Northshore RF	296
Cleng	NuData	495
C. I. E. *	Optoelectronics	352
Comm. Eng.	Palomar	093
Comm. Spec.	Partridge	439
Cont. Spec.	Poly Paks	096
Corbin	RCA Solid State	499
Crescent Wire	RP	098
Cush Craft	Callbook	100
Cygnus-Quasar *	Rainbow	392
D-D	Ramsey	442
Data Signal	Regency	102
Davis	Rohn	410
Dentron	SST	375
Disc-Cap	Sandlin	471
Drake	SAROC *	
DuPage FM	Satan	443
Dynamic	Savoy	105
E.T.O.	Securatron	461
Elect. Dist.	Sherwood	435
Electrospace	Space	105
ELPROCON	Spec. Comm.	
Erickson	Sys.	318
59+	Spectronics	191
Franke	Spectrum	108
Genave	Standard	109
Gilfer	Swan	111
Gray	Tangent	166
Gregory	Tel. Equip.	496
Hal	Ten-Tec	
Hal-Tronix	Tristao	118
Ham Radio	Universal	444
Ham Center	Utah FM	445
Hamtronics	VHF Eng.	121
Harp	VHF Signal	497
Heath	Vanguard *	
Henry	Varian	043
Holdings *	Wawasee	498
Hosfelt	Webster Comm.	423
Hudson ARRL *	Webster Radio	255
Hufco	Weinschenker	122
Hy-Gain	Weirnu	379
Icom	Whitehouse	378
Info-Tech	Wilson	123
Int'l Xtal	Wire Concepts	476
James	Yaesu	127

\*Please contact this advertiser directly.

Limit 15 inquiries per request.

October 1976

Please use before November 30, 1976

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 nearly 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 235,000 calls, names and addresses of amateurs outside of the USA.

Order from your favorite electronics dealer or write direct for your free catalog to:

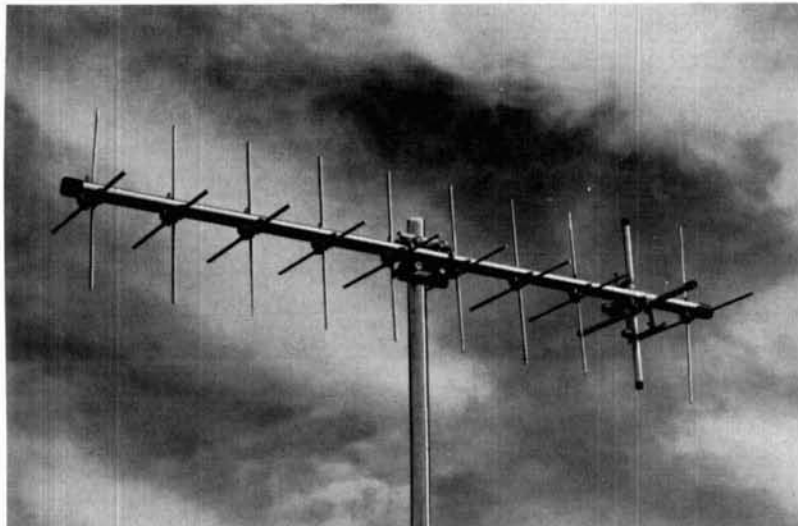
RADIO AMATEUR  
**callbook** INC.  
Dept. E 925 Sherwood Drive  
Lake Bluff, Ill. 60044

# Advertisers index

ARRL Florida Convention	128
ATV Research	112
Adva Electronics	108
Aidelco	118
Antenna Specialists Co.	97
Antenna Supermarket	94
Apron	92
J. P. Ashcraft Co.	88
Atlas Radio	81
Atronics	104
Bauman	100
Barry	100
Budwig Mfg. Co.	104
Bullet	115
Byte Publications, Inc.	101
CFP Communications	128
CHM Products, Inc.	106
Cal-Com Systems, Inc.	104
Chaney's Electronics	112
Circuit Design, Div. of E & L	93
Clegg Communications Corp.	83
Cleng Electronics	94
Cleveland Institute of Electronics	118
Communications Engineering	90
Communications Specialists	102, 103
D. R. Corbin Mfg. Co.	114
Crescent Wire & Cable, Inc.	126
Cush Craft	135
Cygnus-Quasar Books	92
D-D Enterprises	96
Data Signal, Inc.	89
Davis Electronics	90
Dentron Radio Co.	7
Disc-Cap	116
Drake Co., R. L.	59
DuPage FM	84
Dynamic Electronics	104
Echorn Technological Operations	51
Electronic Distributors	75
Electrospace	114
ELPROCON	96
Erickson Communications	114
Five Nine Plus	98
Fred Franke, Inc.	94
General Aviation	107
Gilfer Associates	111
Gray Electronics	108
Gregory Electronics	106
Hal Communications Corp.	2, 98
Hal-Tronix	100
Ham Radio	126, 130, 132
Ham Radio Center, Inc.	95
Hamtronics, Inc.	98
Heath Company	1
Henry Radio Stores	Cover II
Holdings	122
Hosfelt Electronics	133
Hudson Division ARRL Convention	133
Hufco	88, 102, 108, 122
Hy-Gain Electronics Corp.	87
Icom	5
Info-Tech	129
International Crystal	119
James Electronics	76, 77
Jan Crystals	103
Janel Labs	114
Kensco Communications, Inc.	96
Kester Solder	8, 9, 67-70
Klaus Radio	84
Lin Corporation	92
Logic Systems, Inc.	94
Lyle Products	118
M & D Electronics	117
MFJ Enterprises	118
MHz Electronics	136
Madison Electronics Supply	112
Matric	86
Mini-Products	104
M-Tech	118
National Multiplex Corp.	98
National Radio Institute	99
New-Tronics Corp.	94, 125
Nexus Trading Company	39
Northshore RF Technology	124
Northshore RF Technology	118
NuData Electronics	128
Optoelectronics	113
Palomar Engineers	104, 116
Partridge (HR) Electronics	116
Poly Paks	110
RP Electronics	92
Radio Amateur Callbook	100, 134
Rainbow Industries	127
Ramsey Electronics	106
Regency Electronics	131
Rohn	85
SST Electronics	112
Sandlin Electronics Engineering	127
SAROC	80
Satan Electronics	96
Savoy Electronics	122
Securatron	86
Sherwood Engineering	112
Space Electronics Corp.	112
Specialty Communications Systems	100
Spectronics	105
Spectrum International	47
Standard Communications	88
Swan Electronics	96
Tangent Template	124
Telephone Equipment Company	122
Ten Tec	109
Tristao, Div. of Palmer	131
Universal Radio	116
Utah FM Sales	128
VHF Engineering, Div. of Brownian	123
VHF Signal Co.	122
Vanguard Labs	128
Varian, Eimac Division	Cover IV
Wawasee Electronics	124
Webster Communications	90
Webster Radio	98
Weinschenker	117
Weirnu	122
G. R. Whitehouse & Co.	62, 63
Wilson Electronics	108, 118
Wire Concepts, Inc.	108, 118
Yaesu Musen USA	91, Cover III



# 2 METERS...



... *Alive* with activity at *both* ends of the band! Be a part of the total 2 Meter picture with the Cush Craft Twist Antenna. Actually two, easily assembled, 10 element yagis in one — the vertical elements are cut for the high end, the horizontal elements for the low end, and separate feed lines are used. The A147-20T is tailored to meet the demands of the operator who enjoys the best of both worlds

— FM and SSB/CW.

A147-20T

\$47.50

# CQ OSCAR

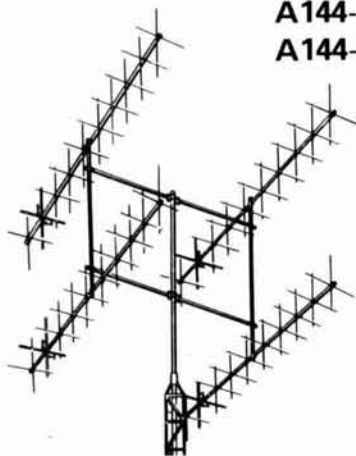
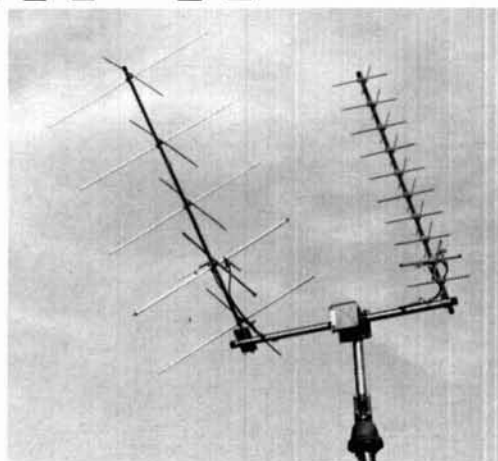
... *Extend your horizon* — Explore the exciting new world of amateur satellite communications using low power with our multi-polarized Twist Antennas. All models include phasing harness for selectable linear or right/left circular polarization. Two of these Twists may be mounted on the A14T-MB mounting boom which is complete with a pre-drilled plate for a readily available mast-through rotator. *Face this challenging frontier — Become a Specialist!*

A144-10T \$32.50

A432-20T \$45.00

A144-20T \$47.50

A14T-MB \$13.95



## PERFORMANCE ARRAYS . . .

Enjoy fade-free contacts on VHF/UHF with Twist Antennas and Arrays. Excellent for scatter and other long-haul techniques. Double your effective radiated power by stacking two Twists, or quadruple ERP by stacking four Twists. Arrays are easily assembled for your special communications requirement. Write for stacking and phasing harness details concerning amateur and commercial frequencies.

*Dependable communications — Now Yours!*

### SPECIFICATIONS

Model	A147-20T	A144-10T	A144-20T	A432-20T
Center Freq. (MHz)	144.5/146.5	145.9	145.9	432
No. Elements	10/10	10	20	20
Weight (lbs.)	6	3.5	6	3.5
Wind Surf. Area (ft. <sup>2</sup> )	1.42	.74	1.42	.37
Mounting	Center	Rear	Center	Rear
Dimensions (Inches)	40x40x140	40x40x70	40x40x140	14x14x57
Front-to-Back Ratio (dB)	22	22	22	22
Forward Gain (dBi) circular	—	10.8	13.6	13.6
linear	12.4	9.6	12.4	12.4

IN STOCK WITH  
DISTRIBUTORS WORLDWIDE

**cushcraft**  
CORPORATION

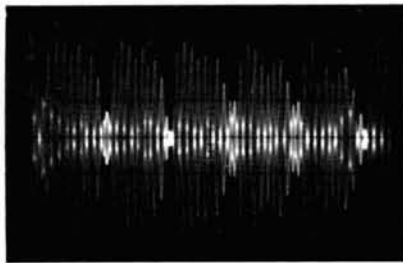
621 HAYWARD ST., MANCHESTER, N.H. 03103

# 400% MORE RF POWER

WITH THE NEW **MFJ** SUPER LOGARITHMIC SPEECH PROCESSOR



SSB Signal Before Processing. The weak valleys and high peaks give a low average power output, resulting in a real lack of punch.



SSB Signal After Processing. The once weak valleys are now strong peaks giving up to a 400% increase in average power output. The result is a signal full of punch with power to slice through QRM.

TWO MODELS TO CHOOSE FROM —  
PLUGS BETWEEN YOUR MICROPHONE AND TRANSMITTER



**\$4995**

**LSP-520BX.** 2-3/16 x 3 1/4 x 4 inches. Uses 9 volt battery. RF protected. 3 conductor, 1/4" phone jacks for input and output.



**\$5995**

**LSP-520BX II.** Same as LSP-520BX but in a beautiful 2 1/8 x 3 3/8 x 5-9/16 inch Ten-Tec enclosure with uncommitted 4 pin Mic jack, output cable, rotary function switch.

Up To 400% More RF Power is yours with this plug-in unit. Simply plug the MFJ Super Logarithmic Speech Processor between your microphone and transmitter and your voice is suddenly transformed from a whisper to a Dynamic Output.

Your signal has power to slice through QRM and you go from barely readable to "solid copy OM".

Look that happens to the RF power output on our NCX-3. It was tuned for normal SSB operation and then left untouched for these "before" and "after" oscillograms.

Three active filters concentrate power on those frequencies that yield maximum intelligence. Adds strength in weak valleys of normal speech patterns. This is accomplished through use of an IC logarithmic amplifier with a dynamic range of 30 dB for clean audio with minimum distortion.

The input to the LSP-520BX and LSP-520BX II is completely filtered for RF protection. A 9 volt transistor battery provides months of operation. These quality units are designed and manufactured entirely in the U.S.A.

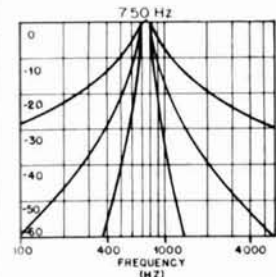


**\$2795**

## CWF-2BX SUPER CW FILTER

By far the leader. Over 5000 in use. Razor sharp selectivity. 80 Hz bandwidth, extremely steep skirts (See Response Curves).

- No ringing • Bandwidth: 80 Hz, 110 Hz, 180 Hz (selectable) • Skirt rejection: at least 60 dB down one octave from center frequency for 80 Hz bandwidth • Center frequency 750 Hz • Drastically reduces all background noise (up to 15 dB improvement in S/N ratio) • 8 pole active filter uses ICs • 9 volt transistor battery provides months of operation • 400 Hz or 1000 Hz center frequency optional. Add \$3.00 • Size: 2-3/16 x 3 1/4 x 4 inches.



**CWF-2PC**  
wired PC  
board  
**\$18.95**

**CWF-2PCK**  
kit PC  
board  
**\$15.95**



**\$4995**

## CMOS-8043 ELECTRONIC KEYS

- Uses Curtis 8043 Keyer IC • Built-in key • Dot memory • Iambic operation with external squeeze key • 8 to 50 WPM • Sidetone and speaker • Volume, tone, weight controls • Solid State Keying ±300 volts max. • Uses 4 penlight cells • 2-3/16 x 3 1/4 x 4 inches.



**\$4995**

## MFJ-1030BX RECEIVER PRESELECTOR

- Clearly copy weak unreadable signals (increase signal 3 to 5 "S" units) • More than 20 dB low noise gain • Separate input and output tuning controls give maximum gain and RF selectivity to significantly reject out-of-band signals and reduce image responses • Dual gate MOS FET for low noise and strong signal handling abilities • Completely stable • Optimized for 10 through 30 MHz • Uses 9 volt battery • Beautiful Ten-Tec enclosure • 2 1/8 x 3 3/8 x 5-9/16 in.

**NEW**  
**SHIPPING NOW**



**\$3995**

## MFJ-16010 ANTENNA TUNER

Now you can operate all bands — 160 through 10 meters — with a single random wire and run your full transceiver power output — up to 200 watts RF power OUTPUT.

- All bands 160 thru 10 meters • Matches almost any random length of wire to any Transceiver or Transmitter • Rated at 200 watts RF Output to handle virtually any transceiver running barefoot • Ultra compact 2-3/16 x 3 1/4 x 4 inches • Matches low and high impedances by interchanging input and output • SO-239 coaxial connectors • Unique wide range, high performance, 12 position tapped inductor. Uses two stacked toroid cores • High quality specially designed variable capacitor • Heavy duty construction • All aluminum cabinet.

ORDER TODAY. MONEY BACK IF NOT DELIGHTED. ONE YEAR UNCONDITIONAL GUARANTEE.

ORDER BY MAIL OR CALL 1-601-323-5869 AND CHARGE IT ON



Please add \$2.00 per item for Shipping and Handling

**MFJ ENTERPRISES** • P. O. BOX 494(H) • MISSISSIPPI STATE • MISSISSIPPI 39762

# For Flexible Station Design

and

## Total Spectrum Coverage from 160 thru 2 Meters



YC-801  
DIGITAL DISPLAY UNIT



FT-101E  
TRANSCEIVER



YO-100  
MONITOR SCOPE



FL-2100B  
LINEAR AMPLIFIER



FV-101B  
EXTERNAL VFO



SP-101PB  
PHONE PATCH SPKR.



FTV-250  
2-M TRANSVERTER

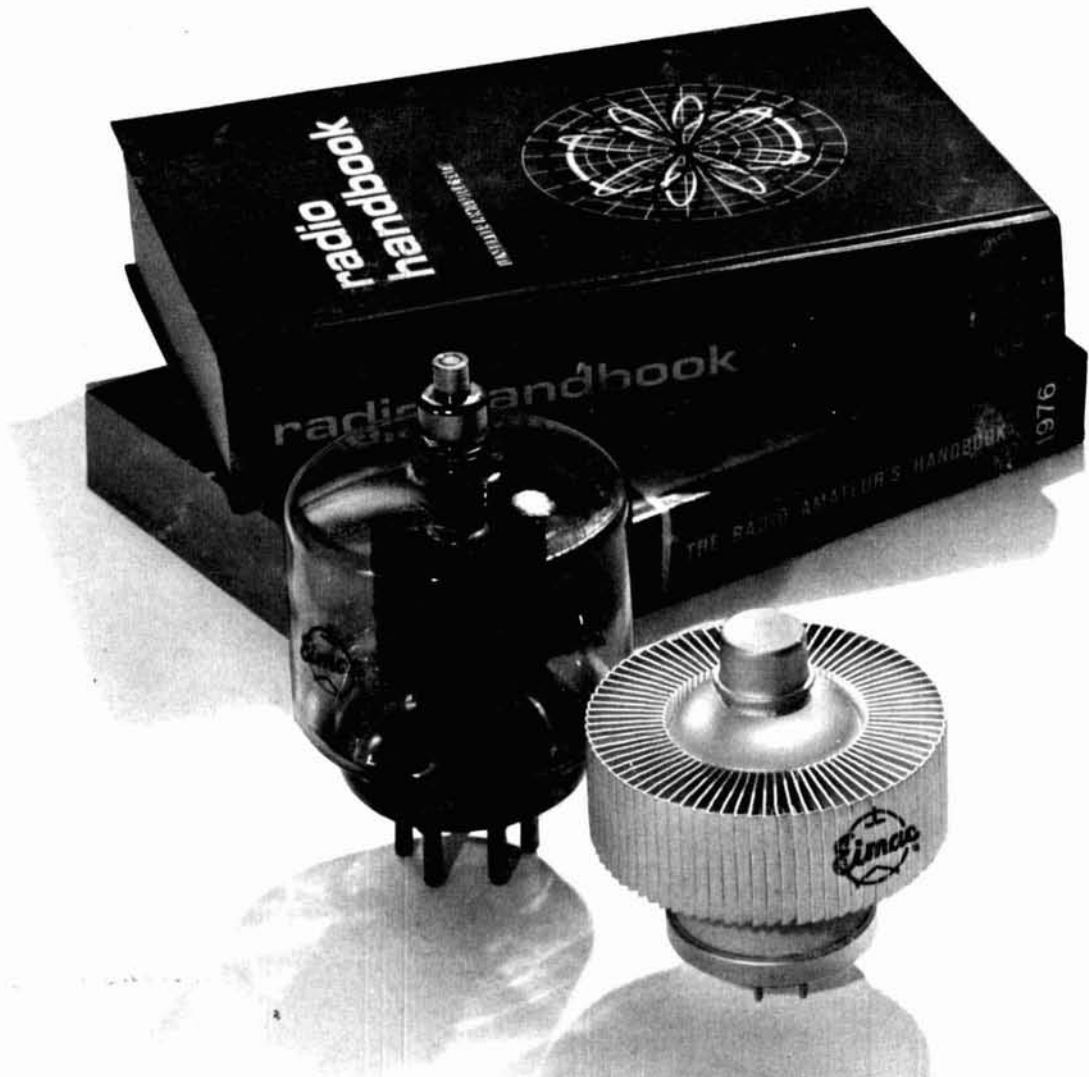


FTV-650B  
6-M TRANSVERTER

There are many reasons for you to choose Yaesu and they are best summed up as PERFORMANCE AT THE RIGHT COST. Your dealer will proudly demonstrate why the finest sounding signals heard around the world originate from YAESU.

YAESU  
***The radio.***

Yaesu Musen USA Inc., 7625 E. Rosecrans, No. 29, Paramount, California 90723  
Yaesu Musen USA Inc., Eastern Service Center • 613 Redna Terrace, Cincinnati, OH 45215



## Amateurs who build their own equipment go EIMAC.

Building HF or VHF power amplifiers? You'll find them described in detail in both the *ARRL Handbook* and the *Radio Handbook*. And you'll find that EIMAC tubes are the overwhelming choice of expert equipment designers for 1.8 to 1296 MHz service.

The *Radio Handbook* features a deluxe amplifier using the 3-1000Z for HF service plus other HF or VHF designs built around the 3-500Z, 4CX1500B, 8877 and the 8874. The *ARRL Handbook* describes a multiband HF amplifier using the 8877, plus other designs featur-

ing the 3-500Z, 8873, 4CX250B and 3CX100A5. And there's plenty of information about design and construction of transmitting equipment using EIMAC power tubes in both handbooks.

For tube information, contact Varian, EIMAC Division, 301 Industrial Way, San Carlos, California 94070. Or contact any of the more than 30 Varian Electron Device Group Sales Offices throughout the world.

