focus on communications technology...

simple ssb TRANSMITTER AND RECEIVER for 40 meters

this month

- repeater access system 22
- six-meter frequency synthesizer 26
- vertical antenna characteristics 34
- digital readout system 42

MARCH 1974
BASSETT VACUUM TRAP ANTENNA SYSTEM

Complete packaged multi-band antenna systems employing the famous Bassett Sealed Resonators and Balun from which air has been removed and replaced with pure helium at one atmosphere. Operating bands are indicated by model designation.

MODEL DGA-4075 $59.50
MODEL DGA-204075 $79.50
MODEL DGA-2040 $59.50
MODEL DGA-152040 $79.50

The famous sealed helium filled Balun . . . employed with the DGA Series Antenna Systems. Soldierless center insulator easily handles more than full legal power while reducing unwanted coax radiation. Equipped with a special SG-238 type connector and available either 1:1 or 4:1. MODEL DGA-2000-B . . . $12.95 Postpaid in U.S.A.

BASSETT VACUUM BALUN

MODEL DGA-2M $29.50 postpaid in U.S.A.
Venus' SLO-SCAN CAMERA
has arrived!
SEE IT AND US AT THE DAYTON HAMVENTION
IN APRIL

Venus Scientific Inc.
The company that put high voltage on the moon, now brings you expanding amateur radio technology.

399 Smith Street
Farmingdale, N.Y. 11735
Phone 516-293-4100
TWX 510-224-6492

march 1974
NEW DRAKE TR-72 2-Meter FM Transceiver

GENERAL:
- Frequency coverage: 144-148 MHz
- 23 channels, 2 supplied (.52/.52 and .34/.94)
- Completely solid state
- Current drain: Rcv 0.4 A, Xmit 2.7 A (Hi power) or 1.2 A (Lo power)
- Voltage required: 13.8 VDC
- Antenna impedance: 50 ohms
- Frequency adjusting trimmers on every crystal
- Size: 7 1/16"W x 2 1/16"H x 9 3/16"D (18 x 6 x 24 cm)
- Weight: 5 1/2 lbs. (2.5 kg)

TRANSMITTER:
- RF output power: 10 W min. (Hi power) or 1 W (Lo power) at 13.8 VDC
- Frequency deviation: adjustable to ±15 kHz max., factory set to ±8.5 kHz
- Automatic VSWR protection

RECEIVER:
- Crystal-controlled, double conversion superhet
- Sensitivity: Less than .35 μV for 20 dB quieting
- Selectivity: 20 kHz at -6 dB (±30 kHz and adjacent channel rejection at least 80 dB down)
- Audio output: 1 W
- Audio output impedance: 8 ohms
- Modulation acceptance: ±7 kHz
- Image rejection: -65 dB
- Intermodulation and other spurious responses: at least 70 dB down

$320.00

Including dynamic microphone, DC power cord, mobile mount and desk mount brackets, microphone hanger, auxiliary connector, and external speaker plug

For complete details contact:

R. L. DRAKE COMPANY

540 Richard St., Miamisburg, Ohio 45342
Phone: (513) 866-2421 Telex: 288-017

AC-10 POWER SUPPLY for 115 VAC operation $39.95
March, 1974
volume 7, number 3

staff
James R. Fisk, W1DTY
editor-in-chief
Joseph Schroeder, W8JUV
editor
Patricia A. Hawes, WN1QJN
assistant editor
J. Jay O’Brien, W6GDO
tm editor
Alfred Wilson, W6NIF
James A. Harvey, WA6IAK
associate editors
Wayne T. Pierce, K35UK
cover
T. H. Tenney, Jr. W1NLB
publisher
Hilda M. Wetherbee
assistant publisher
advertising manager

offices
Greenv~l~le, New Hampshire 03048
Telephone: 603-878-1441

ham radio magazine is
published monthly by
Communications Technology, Inc
Greenv~l~le, New Hampshire 03048

Subscription rates, world wide
one year, $7.00, three years, $14.00
Second class postage
paid at Greenville, N. H. 03048
and at additional mailing offices

Foreign subscription agents
United Kingdom
Radio Society of Great Britain
35 Doughty Street, London WC1, England

All European countries
Eskil Persson, SMSCJP, Frotnunagrand 1
19400 Upplands Vadiy, Sweden

African continent
Holland Radio, 143 Greenway
Greenside, Johannesburg
Republic of South Africa

Copyright 1974 by
Communications Technology, Inc
Title registered at U.S. Patent Office
Printed by Wellesley Press, Inc
Framingham, Massachusetts 01701, USA

ham radio is available to the blind
and physically handicapped on magnetic tape
from Science for the Blind
221 Rock Hill Road, Baia Cynwyd
Pennsylvania 19440
Microf~lm copies of current
and back issues are available
from University Microfilms
Ann Arbor, Michigan 48103

6 ssb and CW transceiver
W. J. Weiser, M. D., VE3GSD

22 open repeater access system
R. B. Shreve, W8GRG

26 six-meter frequency synthesizer
Kenneth W. Robbins, W1KNI

34 vertical antenna characteristics
Robert E. Leo, W7LR

38 lowpass filters for solid-state linears
G. Kent Shubert, WA0JYK

42 simplified digital readout system
Harold W. Thompson, W6OIS

50 how to bias fets
Courtney Hall, WA5SNZ

4 a second look
94 advertisers index
54 comments
83 flea market
56 ham notebook
58 new products
94 reader service
64 short circuits
A few months ago, down in Oklahoma, several old-time radio amateurs, each now retired, attended an auction of the electronics equipment and junk collection of a prominent local amateur. From all reports, it was quite a collection, filling four large warehouses. Except for the huge volume (and original cost) the collection resembled the typical “hell box” of every amateur who lived through the halcyon days when building your own transmitter was conventional practice and everyone eagerly added to his junk collection at every possible opportunity. The same is still true to a somewhat lesser extent, with amateurs maintaining large collections of old and new electronic goodies for some, yet unplanned, project. Talk to any amateur who has been around for a few years and you’re sure to find a garage, an attic or a basement full!

However, there was one big difference in the Oklahoma collection. Where most radio amateurs painfully part with dollars, this amateur had painlessly parted with thousands of dollars. The contents of the four warehouses vividly reflected this difference. Think back a few years — what was the most delectable piece of radio gear you could imagine? It was probably in the Oklahoma collection. And not just one, but several. Parts, radio sets, test equipment, you name it, it was all there in unimaginable profusion. One whole warehouse floor was crammed full of big transmitters, spark coils and rotary gaps for 1920-style transmitters, spider-web coils and thousands of variable capacitors of every possible make and description. The list could go on for pages.

Now here’s the tragedy: These price-less articles, which belong in a museum, were grouped in huge lots with utter junk and sold to the only people who can handle large lots of junk — junk dealers! The probability that these dealers have the background to differentiate between the valuable antique and the valueless junk is frighteningly small. Antiques that can never be replaced, items not preserved in any collection, are going to be bulldozed under at a county landfill dump, and that’s a bloody shame.

This scene, on a much more modest scale, is probably repeated many times a year. Without getting morbid, each one of us should realize that we are not immortal. Each of us has a collection of electronic gear that we’ve acquired over the years that will, if someone doesn’t know any better, be bulldozed under with the trash at the city dump when we join the list of Silent Keys. Each item, when you acquired it, represented a jewel to be treasured and was carefully put away. If you were ever so careless as to toss out one of these treasures, you could be sure you would have an almost immediate pressing need for an identical article. I know, because it’s happened to me everytime I’ve cleaned house!

The point is this: Talk to your heirs. Clue them in as to what items belong in a museum. Better yet, make arrangements with the executor of your estate to donate certain prized items to the museum of your choice. This applies not only to equipment, but to your library of old electronics books. The same sort of foresight applies to your newer equipment as well. Give your executor the names of several trusted amateur friends who will help dispose of modern radio gear and test equipment. They will know the fair market value — the executor may not. There have been more than a few cases where an amateur’s survivors have been ripped off to the tune of thousands of dollars. Don’t let it happen to your family.

Jim Fisk, W1DTY
editor-in-chief
A YEAR OLD...
and
ALREADY A WORLD TRAVELER

The Raytheon 1230A is in daily use at locations throughout the world. We think it's significant that the 1230A has been chosen for use in places where day-in and day-out reliability are a must — from mid-Pacific to central Africa. Reliability and performance are two important reasons for choosing the Raytheon 1230A — our data sheet lists many more. Send for it.

$3930

RAYTHEON COMPANY
MARKETING DEPT. (SP)
P. O. BOX 1542
GOLETA. CALIFORNIA. 93017
AREA CODE 805. 967-5511
simple ssb transmitter and receiver for 40 meters

Complete construction information for a no-frills ssb and CW transceiver system that offers high performance at low cost.

This article describes a simple, high-performance 40-meter ssb and CW receiver and transmitter. The receiver incorporates a very stable vfo and incremental tuning while the transmitter features 180-watt PEP input. Although the receiver was designed to operate in conjunction with a companion 40-meter exciter, it can also be used with any number of separate exciters.

Furthermore, the basic design can be used on any of the amateur bands from 80 through 10 meters by simply using the appropriate tuned circuits in the rf and mixer stages, and by changing the frequency of the vfo so it tunes 455 kHz below the desired band. For maximum stability vfo pre-mixing should be considered for the two higher-frequency bands, 10 and 15 meters.

the receiver

A look at the block diagram in fig. 1 shows that the basic receiver circuit is a rather conventional single-conversion super-heterodyne. The incoming 7-MHz signal is coupled to the first rf amplifier, Q1, amplified, and applied to gate 1 of the mixer, Q2 (fig. 2). The dual-gate mosfets used in the rf amplifier and mixer stages provide high gain, low noise and a minimum of cross-modulation problems. These particular devices are also internally gate protected, a significant bonus when the receiver is used in strong rf fields. Diodes CR1 and CR2 are included in the input circuit as additional protection to the first rf stage.

The 6.545- to 6.845-MHz vfo signal is injected at gate 2 of the mixer. The 455-kHz difference frequency is selected by the i-f transformer, T1. The very stable vfo circuit features incremental tuning and output buffering, and is a modification of an earlier design (fig. 3). Output buffering is provided by the emitter-follower stages Q6 and Q7. Transistor Q7 also serves as a power amplifier, allowing the vfo to drive a 7360 balanced mixer tube used in the companion exciter.

The incremental tuning circuit uses a Motorola MV1654 varactor diode, CR3. This circuit permits an approximately 10-kHz offset to either side of the vfo frequency. The control voltage on the varactor is set by R3, the offset tuning control. Resistor R4 compensates for differences in varactors and allows the vfo to be adjusted to zero offset.
Switch S2 allows the receive offset to be activated manually; receiver offset is automatically turned off by relay K1 when the receiver is placed in the transmit or standby mode. This particular type of switching is necessary because a 1.5-kHz frequency difference between the transmitted and received signal exists at my station. This frequency difference resulted from the use of a 455-kHz mechanical filter in the exciter and a 453.5 kHz filter in the receiver. If you are building from scratch, I recommend that described receiver (fig. 6).2 The use of a CA3028A as the product detector allows significant conversion gain in this stage. The high-impedance output of the CA3028A is matched to the base of the audio preamplifier transistor, Q8, through transformer T5. Although the Motorola MC1454 provides more than sufficient audio output, an MC1554 or HEP593 may be substituted for even more audio. Alternately, a Motorola MFC9010 can be used to replace both Q8 and U2 and deliver about 2-watts of audio.3

fig. 1. Block diagram of the single-conversion 40-meter receiver ssb and CW receiver.

you use a 455-kHz filter in the receiver, such as the Collins FA21-7102.

The two-stage i-f amplifier, Q3 and Q4, is relatively straightforward and provides more than enough i-f gain (fig. 4). For the sake of simplicity I did not include an agc system in the receiver — if you want to include agc, it should be connected to gate 2 of the rf and i-f amplifier stages, Q1, Q3 and Q4.

An MPF102 fet is used in a simple bfo circuit which is based on the old tuned-grid, tuned-plate vacuum-tube circuit (fig. 5). Bfo output is taken from the secondary of transformer T4. For optimum performance of the CA3028A product detector, U1, the amplitude of the bfo injection voltage should be 2 to 3 volts rms. The sideband crystals are selected by switch S1. The crystal frequencies shown in the diagram are for use with a Collins 455-kHz mechanical filter.

The product detector and audio stages used here were adapted from a recently

In my receiver with the audio gain control, R2, adjusted for maximum gain, the MC1454 was driven into oscillation by transistor Q8. This was corrected by bypassing a small amount of the input audio signal to ground through C7 (0.1 µF). Because of component differences, and differences in circuit layout, you may not require this bypass capacitor.

Any well-regulated power supply with an output of 12 to 13.5 volts may be used with this receiver. Excellent voltage

Homebrew 40-meter receiver uses all solid-state circuits.
regulation is required to ensure maximum vfo stability because the MV1654 varactor used in the incremental tuning system will significantly shift the vfo output frequency with the slightest dc voltage variation. For additional vfo stability it might be a good idea to insert a threeterminal voltage regulator IC, such as the Fairchild µA7812, in the vfo supply line.4

receiver construction
The mechanical layout of the receiver is shown in the photographs. The rf amplifier, mixer and mechanical filter are constructed on a 2½x2½-inch section of Vector board, copper clad on one side. The i-f amplifier is built on another, similar sized board, and the vfo and incremental tuning are built on another 2¼-inch square board. These three boards are mounted on 3/4-inch spacers under the chassis.

The bfo, product detector, and audio stages are built on a 2½x5-inch board which is mounted on top of the chassis on 1-3/4-inch spacers. Relay K1 is installed under this board. Each board is built and tested individually, and connected to the others with miniature shielded cable.

The 1-inch-deep aluminum chassis, 10-inches long and 5½-inches deep, is installed in a commercial enclosure. The rf amplifier and mixer tuning capacitor, C1, is a modified dual-section 365-pF broadcast variable with all but two rotor plates removed from each section. With the values given for C8 and C9, the modified variable will cover the frequency range from 7.0 to 7.3 MHz.

receiver alignment
Before starting the alignment procedure, all slug-tuned coils must be rough-

C1 modified dual-section 365-pF broadcast variable (see text)
FL1 455-kHz mechanical filter, 2.1-kHz bandpass (Collins FA21-7102)

fig. 2. Schematic diagram of the rf amplifier, mixer and mechanical filter.
at the output of the mechanical filter. Since a reading of 0.1 volt is typical here, a sensitive rf probe and voltmeter is required.

To align the i-f amplifier a 455-kHz signal is applied to gate 1 of transistor Q3 and transformers T2 and T3 are tuned for maximum signal at the output of T3. The bfo should require no adjustment although T4 may be tuned, as required, if the bfo fails to oscillate.

After each of the individual boards has been tested and aligned, and the receiver has been assembled, final peaking can be accomplished with an on-the-air signal. The rf amplifier, mixer and i-f stages are tuned for maximum receiver gain. To obtain good tracking with C1 it is necessary to alternately re-tune the mixer and rf amplifier coils, L1 and L3, several times. The vfo inductor, L4, is accurately adjusted and the tuning dial calibrated with the aid of a communications receiver equipped with a crystal calibrator.

To align the incremental tuning system, monitor the received frequency, adjust resistor R3 and note the amount of frequency change. A 40% change in the resistance of R3 should result in an approximate 20-kHz shift in the vfo frequency. The dc voltage range coinciding with this frequency shift is measured at the wiper of R3 and should be in the range from zero to about 2.5 volts.

When the dc voltage required for a 20-kHz frequency shift has been determined, the wiper of resistor R4 is set to the midpoint of this dc voltage swing. With the incremental tuning turned off, vfo output is centered at its mid-frequency point with R4, and resistor R3 will move the vfo about 10 kHz to either side of this center point.

**receiver performance**

The performance of the receiver is most rewarding. It appears to be as sensitive as my FTDX-401, and its frequency stability is excellent. No significant vfo warmup drift has been noted, the audio is apparently distortion free, and the set provides more than enough gain. One very pleasing feature of the mosfet stages is their very low noise figure. The ambient noise level in this receiver is the lowest of any comparable receiver I have ever used.

**the transmitter**

The 180-watt PEP ssb transmitter may be used as a separate unit, or with the receiver. The unit is completely self-contained and incorporates a stable vfo, power supply and all the necessary control functions for antenna switching and receiver muting. The use of an RCA 7360 beam-deflection tube for the balanced modulator and balanced mixer stages provides excellent carrier suppression and local-oscillator rejection, two requirements that are difficult to achieve in single-conversion ssb exciters which use a 455-kHz i-f.

A block diagram of the transmitter is
shown in fig. 8. The output of the high-impedance microphone is amplified by V101, and applied to one of the deflection electrodes of V102, the 7360 balanced modulator. The crystal-controlled carrier signal is injected at the cathode (see fig. 9). The 455-kHz grid 1 and grid 2) serves as a self-oscillatory carrier generator, with switch S101A selecting either Y101, a 455-kHz crystal for tuneup or CW, or Y102, 456.25-kHz crystal for lower-sideband operation. For tuneup or CW one of the deflection plates of V102 is grounded by double-sideband output signal is coupled into a Collins mechanical filter.

One of the absolute requirements of a modern single-sideband exciter is adequate carrier suppression. By using a 7360 beam-deflection tube up to 60-dB of carrier suppression can be achieved if careful construction and layout have been followed, and the circuit has been properly adjusted.

The triode section of V120 (cathode, switch S101B, effectively unbalancing the modulator so that a 455-kHz carrier signal appears across the output network. In ssb service the audio signal applied to one of the deflection plates unbalances the modulator.

Another requirement for effective and courteous single-sideband operation is adequate suppression of the unwanted sideband. The Collins mechanical filter can provide up to 60-dB of sideband attenuation if careful attention is given to mechanical layout, and stray coupling is prevented between the input and output of the filter. The filter also attenuates the 455-kHz carrier signal by an additional 20 dB. The 120-pF capacitor across the output of the filter helps match the output impedance of the filter to the input impedance of the 6BA6 i-f amplifier, V103 (see fig. 10).

The ssb signal from the output of the 6BA6 i-f amplifier is coupled through
transformer T101 to V104, the 7360 balanced mixer. The triode section of V104 is used in a Colpitts-type internal vfo. Capacitor C102 is the main tuning capacitor and C103 and C104 serve both as frequency-trimming and temperature-compensating capacitors. For transceive short as possible and the input and output must be sufficiently isolated; the 33-ohm non-inductive resistor in series with the grid serves as a parasitic suppressor.

The screen bypass capacitor is soldered directly across the base of the 6GK6

fig. 4. Two-stage 455-kHz i-f amplifier. Transformers T2 and T3 are miniature 455-kHz input i-f transformers.

operation the internal vfo is bypassed and an external vfo coupled into grid 1 through switch S102.

One problem when designing a 40-meter ssb exciter using a 6.545-MHz vfo and a 455-kHz i-f in a single-conversion system is inadequate vfo suppression. Since the vfo frequency is only separated from the desired output frequency by 455 kHz, a single-tuned resonant circuit in the output of a conventional mixer stage would probably not be inadequate to sufficiently attenuate the vfo signal. However, by using a 7360 beam-deflection tube as a balanced mixer, up to 40-dB of vfo rejection is possible.

The 7.0- to 7.3-MHz ssb output from V104 is coupled through L102-L103 to the 6GK6 driver stage, V105, fig. 11. A 6GK6 was selected as the driver because it offers considerable gain and can safely handle a 300-volt plate supply. However, because of its high gain, care must be taken to prevent instability and self-oscillation. All leads must be kept as socket between the input and output pins and the ground end is also soldered to the central pin of the socket. This technique provides an effective grounded shield between the input and output circuits of the driver stage.

The output of the 6GK6 driver is coupled into the grids of V106 and V107, the 6146B power-amplifier tubes through C106 and L104. Capacitor C106 should be pruned by removing plates from a miniature variable capacitor until the tuned circuit resonates from 7.0 to 7.3 MHz with one full revolution of the shaft. Fix-tuning the power amplifier's grid circuit to the desired band makes tuneup simple and prevents the operator from inadvertently tuning the final amplifier to some unwanted spurious signal that may appear at the output of the high-gain

*Both single- and double-tuned bandpass circuits were tried by the author. The double-tuned bandpass arrangement was workable with a conventional 6BA7 mixer stage, but it allowed an unacceptably high level of vfo signal to feedthrough to the driver stage.

fig. 5. The 455-kHz bfo stage. T4 is a miniature 455-kHz i-f input transformer.
driver stage. Resistor R105, a 5000-ohm, 5-watt wirewound potentiometer, serves as the driver gain control.

A pair of 6146Bs in parallel are used as a power amplifier (fig. 12). These tubes are still among the best power amplifier tubes for ssb service, offering good linear-

ity, excellent IMD characteristics and good power sensitivity. They can also withstand considerable abuse during groggy-eyed, early morning DX chasing tune ups.

As with the driver stage, considerable care must be taken in keeping leads short around the PA stage sockets, separating input and output circuits, and shielding the cathode keying line to prevent self-oscillation. Parasitic suppressors Z101 and Z102 help minimize any high-frequency instability. With these techniques, I did not find it necessary to neutralize either the driver or PA stages. Both are extremely stable.

The final-amplifier tank circuit is a standard pi network. Capacitor C108 is a surplus, high-voltage 400-pF variable. With the values specified for C107 and L105, the stage loads nicely into a 50-ohm resistive load. You may wish to change the value of L105. In that case an additional capacitance (C109, 100-400 pF) may be needed in parallel with C108 to load properly. Or, if you wish, a triple-section 365-pF broadcast variable, with all sections in parallel, may be substituted for C108.

In the interest of simplicity and thriftiness, a grid and plate current metering system was excluded in favor of a simple rf output indicator. A sample of the output rf is applied to a 1N34A diode through a voltage-dividing network; the rectified dc is filtered and read on a 0-1 milliammeter. Resistor R106 serves as a sensitivity control.

**transmitter control circuits**

Since this exciter was intended to work in conjunction with the matching receiver, antenna switching and receiver muting functions were included in the
design. All control functions are provided by two surplus, 6800-ohm, 55 Vdc relays. One relay, K101, switches antennas and functions in receiver muting while the other, K102, is used for B+ switching between transmit and standby (see fig. 13).

One relay section, K101A, switches the antenna between the receiver and exciter while K101B grounds the exciter output during standby. A third section, K101C, activates the receiver’s muting relay during transmission.

The second relay switches the 210- and 310-volt B+ supplies to the final-amplifier tubes and the driver, respectively, via K102C and K102A. Another section, K102B, switches 210-volts to the speech amplifier, V101, and i-f amplifier, V103, during transmit. This B+ switching is paralleled by a second manual switching network, S104, which is used as a spotting switch.

With S104 in the transmit position, activating the PTT switch through S101 or the manual transmit/tune switch, S103 picks up the relays and switches the exciter from standby to transmit. With S104 in the spot position the PTT switch and S103 are interrupted and no relay switching can occur, but B+ is applied to the speech amplifier and i-f amplifier through S104B. This spotting function allows the operator, when using the in-ternal vfo, to talk himself on frequency using the companion receiver as a monitor.

**power supply**

The 350-0-350-volt center-tapped winding of transformer T102 is used in a conventional full-wave bridge circuit to provide 750-volts dc for the final amplifier (see fig. 14). The 310-volt supply for the driver is obtained from the center tap after choke-input filtering. The regulated 210-volt supply is provided by a pair of OB2 regulators in series. Bias voltage for the 6146Bs was acquired by reversing a 6.3-volt filament transformer and rectifying the 117-volt winding. A 50k, 10-watt wirewound potentiometer, R5, is used as the bias voltage adjust control (see fig. 14).

Front panel of the 40-meter ssb and CW transmitter. Power input is approximately 180 watts.
transmitter construction

The eternal frustration of any ardent home-constructor today is finding the needed parts. Most of the values given in this design can be varied; all the tuned-circuit inductors and capacitors of the tuned circuits, with the exception of the vfo, can be changed, of course, if required.

closes the final-amplifier tubes and the pi network and is made of 1/16-inch-thick aluminum siding with a ventilated top cover. The plate-tuning and antenna-loading capacitor shafts are brought out to the front panel with 1/4-inch couplers and shaft-extenders. For the sake of neatness and compactness I used a rather elaborate system of universal joints and gears to angle the shaft of capacitor C107 away from the speech amplifier tube, V101. This system can be avoided if you use a larger chassis or disrupt the straight-line layout by moving V101’s socket closer to the edge of the chassis.

Two variable capacitors, C106 and C102, were modified for use in this design. The grid-tuning capacitor, C106, was originally a 25-pF miniature variable; all but one rotor plate was removed to achieve the desired resonance range of 7.0

resonant frequencies are maintained. The seasoned builder may have his own scheme of chassis layout and wiring, and neither is particularly critical.

My transmitter was built into a 12x10x2-inch aluminum chassis. The photographs show the layout. In any chassis layout a straight-line approach is usually best and that is what I used, with the speech amplifier followed by the balanced modulator, the mechanical filter, the i-f amplifier and so on.

The power amplifier cage entirely en...
to 7.3 MHz for one complete rotation. A small L-shaped bracket is used to mount C106 underneath the chassis.

The vfo main-tuning capacitor, C102, is a modified variable from a surplus ARC-5 receiver. The gear train and gear reduction ratio used on these capacitors make them ideal for amateur vfo applications. The vfo tank coil was closewound on a 1/2-inch diameter ceramic form and Q-doped several times. Finally, the entire vfo was enclosed by an aluminum shield. The mechanical precautions were justified by the excellent vfo frequency stability characteristics I obtained.

As mentioned previously, great care should be taken to isolate the input and output circuits of all rf stages. Particular attention should be paid to circuit isolation around the mechanical filter as stray capacitative coupling between the input and output circuits here can significantly reduce sideband and carrier suppression.

transmitter alignment

Aligning the exciter is simple and should be done in stages, with each stage...
being built and aligned before the next one is started. The speech amplifier needs no adjustment and can be checked by connecting an ac voltmeter between the plate of V101 and ground through a series blocking capacitor. Speaking into a high-impedance microphone should produce a swing of several volts on the meter.

The speech amplifier needs no adjustment and can be checked by connecting an ac voltmeter between the plate of V101 and ground through a series blocking capacitor. Speaking into a high-impedance microphone should produce a swing of several volts on the meter.

Final adjustment of the i-f amplifier is now accomplished with switch S101 in the carrier position. Move the rf probe to the secondary of T101 and alternately adjust the primary and secondaries of the i-f transformer for maximum rf voltage indication (typically 10 to 15 volts).

Putting the vfo on frequency can be most easily done by using a well-calibrated general-coverage receiver. If one is unavailable, a reasonably accurate grid-dip meter can be used to place the vfo within the proper general operating range. With capacitors C102, C103 and C104 set approximately at midexcursion, identify the vfo signal using a general-coverage receiver. Inductor L101 may have to be decreased or increased in value (by changing the number of turns) if the vfo signal is far from the desired range of 6.545 to 6.845 MHz. Now, with C102 at midrange, adjust C103 (and C104, if necessary) to bring the vfo frequency to 6.695 MHz. Temperature compensation was found to be unnecessary in my exciter as vfo warmup drift was quite acceptable and the frequency stability is excellent.

If you experience any excessive fre-
quency drift during warmup, this may be minimized by experimentally adjusting C104 to an increased value while checking on the frequency stability. Generally speaking, an uncompensated vfo will drift to a lower frequency as the temperature rises; adding a negative coefficient capacitance will minimize this. If it is necessary to increase the value of C104, be certain required, values of 10 to 100 pF can be used for C105, while still maintaining adequate mixer output.

Once the vfo has been set on the desired frequency, the balanced mixer can be easily aligned. During these adjustments, be certain that the internal vfo has been switched into the circuit. Place an rf probe on pin 2 of the empty driver socket to reduce the value of C103 to keep the vfo within the proper operating range.

Tuned circuits L102 and L103 were not adjusted in the conventional bandpass manner as there was more than enough drive from the mixer when its output circuit was peaked at 7.2 MHz to fully power the 6GK6 driver across the entire 7.0- to 7.3-MHz range of the exciter. The coupling capacitor, C105, connected across L102 and L103 is 500 pF. The 7360 balanced mixer offered so much carrier oscillator rejection that I opted for maximum mixer output at the expense of decreased selectivity of these tuned circuits. However, if more vfo rejection is and, with S101 in the tune position and S104 in the spot position, alternately adjust L102 and L103 for maximum rf voltage. I measured more than 5 volts rf on the grid of V105 in my unit.

Maximum vfo carrier oscillator rejection is achieved in a similar fashion. Leaving the rf probe on pin 2 of V105, place S101 in the lower-sideband operating position, adjust R101, the rejection control, for minimum rf voltage. The 7360 balanced mixer is capable of about 40-dB carrier rejection and the measured voltage should be 0.05 volts or less with the proper adjustment of R101.

Before aligning the 6GK6 driver stage, be sure the final amplifier tubes, V106

---

**C107,C108** 400-pF, 1000-volt air variable (see text)

**C109** see text

**L105** 23 turns no. 22 enameled, close-wound on 1" ceramic form

**M101** 0-1 mA meter

**R106** 5000-ohm, 5-watt potentiometer (rf sensitivity control)

**Z101,Z102** parasitic suppressors, 8 turns no. 16 enameled, wound around 10-ohm, 1-watt carbon resistors

---

**fig. 12. Power amplifier and rf output meter.** Grid and plate current metering may be added if desired.
and V107, are removed from their sockets. Place the rf probe on pin 5 of V106 (or V107) and set the driver control, R107, at midrange. Now place the exciter in the tune mode by switching S101 to the **tune or carrier** position and S104 to the **transmit** position. Move S103, the manual tune/transmit switch to the **tune** position, and with C106, the grid-tuning capacitor, at midrotation, adjust L104 for maximum rf voltage. Turning the driver output control, R107, should increase the measured output to a maximum of about 60 volts rf. Tuning C106 should further peak the driver output rf voltage.

As a final check of proper alignment, the exciter’s single-sideband signal should be monitored with an amateur-band receiver. Keep the 6146Bs out of their sockets during this testing. Place S101 in the **lower sideband** position, S104 in the **transmit** positions and switch S102 to **internal vfo**.

Keep the rf probe on the grids of V106 and V107 and loosely couple the receiver to L104. With the PTT switch closed and without modulation, virtually no rf voltage should register, indicating good carrier and vfo oscillator suppression. Speaking into the microphone should give readings of about 35 to 40 volts rf on voice peaks. The monitored, detected audio should be clear and crisp and without distortion.

Finally, switch the monitoring receiver to the upper sideband mode and check sideband suppression. No intelligible upper-sideband signal should be heard. With the sideband suppression check completed, all the low-level stages of the transmitter have been aligned and only the power amplifier and relative power output metering stages need be adjusted.

*Fig. 13. Voltage switching and transmitter and receiver control circuitry. Relays are shown in the standby (receive) position. Resistors R104 and R105 are voltage-dropping resistors, value chosen to reduce 210-volts dc to proper relay operating voltage.*

When adjusting the PA stage remember that more than 750 volts exists there, and if touched inadvertently, that’s more than enough to prematurely end a promising career. Place the 6146B power tubes in their sockets and connect a high-wattage 50-ohm dummy load to J104. Adjust R105 to supply about -55 volts bias to the grids of V106 and V107. Set the drive control, R107, to about midrange and the relative power output sensitivity control, R106, to about one-third. All the other operating controls should be set as previously described when monitoring the exciter’s signal, except that switch S101 should be in the **carrier/tune** position.

With the PTT switch or S103 closed, adjust C107 and C108, the plate-tuning and antenna-loading capacitors, for maxi-
mum deflection of the relative power output meter, M101. Resistor R106, the output meter sensitivity control, should be adjusted to keep the meter at about two-thirds deflection at maximum power output.

Finally, insert a dc milliammeter in the 750-volt line, and with S101 in the lower-sideband position and the PTT switch closed, adjust R107, if necessary, to bring the final amplifier idling current to about 60 mA. As an alternative, a 50-ohm dummy load wattmeter or an in-line monitoring oscilloscope can be used to tune the PA stage and adjust the rf output meter. Capacitors C107 and C108 are then simply adjusted for maximum rf output as read on the wattmeter, or as seen by maximum deflection of the carrier envelope on the scope. R106 is then adjusted for two-thirds meter deflection at maximum power output.

operating

Operating in either the ssb or CW modes is extremely simple. For both ssb and CW transmission the transmitter is initially tuned up as previously described for full carrier output. To use the exciter independently, S102 is switched to the internal vfo. With S101 in the lower-sideband position, placing S104 in the spot position will allow you to “talk” yourself on frequency while monitoring your signal with the station receiver. Once on frequency, simply switch S104 to transmit and all operating functions are controlled by the PTT switch.

To operate in the transceive mode, connect the receiver vfo output to J105 using a shielded cable and switch S101 to the external vfo position. The exciter and receiver are now slaved to the receiver’s vfo frequency, and ssb operation is the same as in the split function.

Although this exciter is primarily designed as an ssb unit, it puts out an excellent CW signal. To operate CW, simply tune up for maximum carrier output, then insert a key into J102. Switch S102 is left in the carrier position and S103 is used as a manual CW/standby switch.

circuit improvements

You may be surprised by the omission of some operating luxuries in this exciter. This was intentional — to keep design and alignment as simple as possible and to keep cost at a minimum. However, vox and sidetone circuitry could be easily added for voice-operated ssb operation and semi-break-in CW operation.

For those of you who may want to use upper sideband on 40 meters, switch

![power supply schematic](image)

fig. 14. Power supply for the 40-meter ssb and cw transmitter.

L105 50k, 10-watt potentiometer (bias control)
T102 117-Vac power transformer, 350-0-350, 6.3 Vac secondary (Hammond 273BX or similar)
T103 117-Vac filament transformer, 6.3-Vac secondary (Hammond 166L6 or similar)

<table>
<thead>
<tr>
<th>Part</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T101</td>
<td>6-volt lamp (power on)</td>
</tr>
<tr>
<td>L106</td>
<td>10-mH, 175-mA filter choke (Hammond 193J or similar)</td>
</tr>
<tr>
<td>R105</td>
<td>50k, 10-watt potentiometer (bias control)</td>
</tr>
<tr>
<td>T102</td>
<td>117-Vac power transformer, 350-0-350, 6.3 Vac secondary (Hammond 273BX or similar)</td>
</tr>
<tr>
<td>T103</td>
<td>117-Vac filament transformer, 6.3-Vac secondary (Hammond 166L6 or similar)</td>
</tr>
</tbody>
</table>
Top view of the transmitter chassis. Power amplifier cage is upper right, next to the power supply. Vfo enclosure is lower left, next to the front panel. Speech amplifier tube is underneath the antenna-loading capacitor shaft to the extreme right.

S101 could be changed to a 3-pole unit to switch in the required 453.75-kHz crystal. If you thrive on the sight of swinging meter needles, appropriate switching and metering could easily be added to monitor final plate current, plate voltage and grid current. And, for the few courageous builders who seek still more, multibanding this exciter might even be considered. Changing vfo frequencies and switching in separate mixer and driver coils would be the most simple means of adding 80- and 20-meter operation. For the higher frequencies, a second frequency conversion scheme would probably offer the best results.

references

ham radio
There are five transmitters available to amateur radio operators today providing 5-band coverage in SSB, CW and AM modes. Of these five, only SWAN's 600T supplies 600 watts P.E.P. input. Among the others, one has 240 watts P.E.P.; two have 200 watts P.E.P. (one of these requiring an accessory power supply); and one is a kit capable of a mere 180 watts P.E.P. input.

Compare the cost per watt, then judge for yourself as to which is the best value: The kit retails at $1.67 per watt; the 240 watt unit is $1.41 per watt; the 200 watt rig with the power supply built-in runs $2.30 per watt, while the other 200 watt transmitter costs $2.05 per watt by itself or $3.15 per watt if you buy the power supply recommended.

Now consider the economical SWAN 600T — it gives you a full 600 watts P.E.P. input, about three times the power of the others, for JUST 98¢ PER WATT!

The brand YOU should buy is obvious. Visit your authorized SWAN dealer and order your 600T.

WHEREEVER THERE'S VALUE IN AMATEUR RADIO, YOU'LL FIND SWAN ELECTRONICS

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>600T Transmitter</td>
<td>$589.95</td>
</tr>
<tr>
<td>600R Custom Receiver</td>
<td>$549.95</td>
</tr>
<tr>
<td>600R Custom Receiver with SS-166 filter</td>
<td>$599.95</td>
</tr>
<tr>
<td>600S Speaker</td>
<td>$21.95</td>
</tr>
<tr>
<td>600SP Deluxe Speaker with FP-1 phone patch</td>
<td>$64.50</td>
</tr>
<tr>
<td>510X Crystal Oscillator</td>
<td>$53.95</td>
</tr>
<tr>
<td>VX-2 Automatic Voice Control</td>
<td>$35.95</td>
</tr>
<tr>
<td>MARK II Linear Amplifier (2000 watts P.E.P.)</td>
<td>$679.95</td>
</tr>
</tbody>
</table>

DEALERS THROUGHOUT THE WORLD or order direct from

SWAN ELECTRONICS

Home Office: 305 Airport Road - Oceanside, CA 92054
Telephone: (714) 757-7525

THE BEST PRACTICAL DEVELOPMENTS IN AMATEUR RADIO

More Details? CHECK-OFF Page 94
automatically controlled access to open repeaters

A control system that automatically guards against interference while allowing open repeater operation

Anyone trying to operate an open repeater on one of the popular frequency pairs such as 146.16/76 in an area like northern Ohio is increasingly faced with a difficult choice: guard the input, and shut out the visitor or occasional user who lacks the required means of access, or leave it unguarded and expose the repeater to a lot of plucking and other unwanted transmissions. Even if the input frequency is less popular, the growing availability of synthesizers puts an unguarded repeater at the mercy of the operator who can't resist seeing how many squelch tails he can generate and how many identifiers he can trigger each time he pushes the button on his microphone.

WR8ABC, the 146.16/76 repeater serving the Cleveland area, is located on the crest of a ridge southeast of the city. There are 16/76 repeaters to the east, at Ashtabula, to the south at Newcomerstown and Columbus, and across Lake Erie in Detroit. Even without a band opening, mobiles in the fringe areas between repeaters often key more than the machine — with only a slight propagation enhancement the situation can become chaotic.

The Detroit repeaters, Great Lakes on 146.16/76, and DART on 146.04/64, have adopted sub-audible tone access, or full-time private-line. The Ohio 16/76 repeaters have established secondary inputs on discrete tertiary frequencies (for
example, 146.355 in Cleveland) to permit base stations and high-powered mobiles in the fringe areas to select the repeater they want to access.

the problem

The group that operates WR8ABC has consistently voted to keep the repeater as open as possible. When conditions made it necessary to guard the 146.16-MHz input, provision was made for access with made it possible for a fringe area station to picket-fence the repeater indefinitely as long as his signal was strong enough to open the receiver squelch once every five seconds, which was hard on the equipment and even harder on the control operator. More than once the repeater has been out of service for several hours because a control operator switched it off and forgot to turn it on again when the interfering signal disappeared.

private-line (110.9 Hz), tone burst (2000 Hz) and the 1336-Hz tone generated by a Touch-Tone pad. In addition, once the guard was opened by one of these means, the repeater remained open to access by any on-frequency carrier for the duration of each transmission and five seconds thereafter.

Permitting “tail-ending” in this way effectively opened the machine to use by any number of stations, with or without private-line or tone generators, as long as one of them could whistle the machine up in the first place. Unfortunately it also the solution

In an attempt to overcome some of the disadvantages of the previous method, a new system to control access to the 146.16-MHz input has been installed which leaves the input open until it is repeatedly keyed by a signal which is not modulated by any of the access tones recognized by the decoder. When the receiver squelch is operated three times in succession by such a signal the input is automatically guarded. The guard is opened, also automatically, by a timer in approximately 15 minutes; it opens

fig. 1. Timing circuit and counter for the repeater control system. For values of R1, R2 and C1, see text. All diodes are general-purpose silicon types such as the 1N914.
sooner if the repeater is keyed by a station using an accepted access tone, or by one using the unguarded secondary input.

The circuit is shown in fig. 1. The BD input of an SN7490 decade counter, U1, is toggled by a signal source that goes high each time the guarded receiver COR

[Image of circuit diagram]

fig. 2. Shaping circuit for the keying signal.

is triggered by a signal. It counts the pulses generated by a signal with no access tone, and latches in the “binary 9” condition on the fourth count. This generates a logic 1 at the A output, pin 12, until the counter is reset to zero.

To make the counter operate in this manner the D output, pin 11, is wired to one of the Rg reset inputs, and the other Rg input and one Rq input are controlled by an SN7402 NOR gate, U2. So long as one Rq and one Rg input are low, U1 counts the receiver COR cycles. On the fourth count the D output at pin 11 carries the Rg input at pin 6 high. If pin 7 is also high, the counter latches with both A and D outputs in the high state. It will remain in this condition until the second Rg input, pin 7, is switched to the low state by gate U2C. The same signal that does this switches the output of gate U2B high and U1 resets to zero.

The impulse to reset the counter to zero can come from any one of the four sources connected to the resistor-transistor network through diodes CR1 through CR4. The private-line (PL) output from the WR8ABC PL decoder is low when the receiver is squelched and high when the squelch is opened by a private-line tone. The inputs to the other three diodes are normally high, and are switched to ground potential when an activating signal is received.

If no signal is received from any of the four sources connected to the diodes for a predetermined interval, the timer connected to the second input of gate U2C will reset the output counter. The timer is another decade counter, U3, driven by the square-wave output of an Intersil 8038 precision waveform generator, U4. The rate at which the 8038 cycles is controlled by the values of C1, R1 and R2. As installed at WR8ABC, C1 = 100 µF, R1 = 47k, and R2 = 100 ohms. The generator cycle is just under two minutes, and U3 reaches the count of 8 in 15 minutes, at which time it resets itself and U1.

construction

Note that the 2.2k load resistor connected to pin 9 of the 8038 is returned to +5 volts rather than to +12 volts to make the square-wave output TTL compatible. Some precautions in construction are advisable. Rf shielding is essential if the unit is to be installed near a transmitter, although there should be no problem with a split-site repeater. The count and reset inputs are all sensitive to short pulses. Signals connected to the PL and

Front and rear views of the printed-circuit board used for the repeater access system. The relay is not mounted on the board.
tone inputs that reset the unit should be filtered to suppress response to transients, and so should the signal from the secondary receiver COR. A small electrolytic capacitor or a resistor and capacitor should suffice.

The keying signal to the counter input is more critical. COR relay contact bounce can cause erratic counting. The

fig. 3. Transmitter control relay circuit. Values of R3 and R4 are selected as described in text. Transistor Q3 is a pnp silicon transistor capable of switching the relay current and voltage. Diode CR5 must have a PIV rating higher than the positive voltage supply.

best way I have found to shape the COR signal is shown in fig. 2. This system uses two sections of an SN7400 NAND gate and a double-throw COR relay on the receiver.

The unit was designed to work with the solid-state control logic described in an earlier article, but the output can be used to drive any TTL-compatible logic, or to operate a transmitter keying relay with a transistor driver. A circuit to do this using the other two sections of the SN7400 is shown in fig. 3. Transistor Q3 is a pnp silicon switching transistor capable of handling the keying relay current and voltage. Resistor R3 should be selected to limit the current through it to approximately 10 mA when the junction of R3 and R4 is at ground potential.

Resistor R4 should limit the voltage at this junction to between 3.5 and 5 volts when the junction is ungrounded. Diode CR5 protects Q3 against surges when the relay opens. The access control on/off switch, which can be a remotely controlled flip-flop or relay, permits the operator to inactivate the guard circuit if a completely open operation is desired at any time.

The original unit in service at the WR8ABC repeater is built on a homemade PC board approximately 2x4 inches, which provides for all the components in figs. 1 and 2 except the COR relay. Boards for the later model shown in the photographs, which includes the optional input filters, and/or complete assembled units are available from the author.*

fig. 3. Transmitter control relay circuit. Values of R3 and R4 are selected as described in text. Transistor Q3 is a pnp silicon transistor capable of switching the relay current and voltage. Diode CR5 must have a PIV rating higher than the positive voltage supply.

conclusion

To summarize operation of a repeater with this system of access control, so long as no more than three successive signals without access tones key the transmitter through the guarded receiver in any 15-minute period, the guard will remain open indefinitely. It will close immediately, however, when the guarded input is plucked three times, accidentally or on purpose. A visitor to the area, without tone access, never has to wait more than 15 minutes for the repeater to open up, and since he is usually answered by a station using PL, tone, or the secondary receiver, can carry on a conversation indefinitely in most instances as though the repeater was ungarded.

reference


*Epoxy printed-circuit boards can be purchased from the author for $5.00, postpaid. Prices on complete units, with any reset time interval up to 30 minutes, and designed to interconnect with the user's equipment, will be quoted on request."
six-meter frequency synthesizer

Complete construction details for a frequency synthesizer that covers the entire 50-MHz band in 1-kHz steps.

Although I have been relatively inactive on 6 meters in recent years, this band has always been a favorite. This is no doubt due to an austere but exciting ham beginning on 5 meters during the 1930s when modulated oscillators, superregen receivers and Pickard antennas were common. After World War II modulated oscillators were phased out by stability regulations, and crystal control became mandatory.

Rock-bound transmitters forced development of improved vacuum-tube vfos over the years, and these gradually gave way to solid-state circuits. Heterodyne versions improved on them in turn and now, with the “galloping IC Technology,” synthesizer frequency control is coming on strong. Widely used in military and commercial equipment for many years, until recently frequency synthesis has been too costly for general ham use. However, two-meter units are now on the market and a number of construction articles have appeared in print for the do-it-yourselfers.

Recently, I had a go at working up one of these exotic channelizing vfos for a 50-MHz a-m rig. New and unusual circuit problems had to be solved before success was attained. For the unwary homebuilder who is or will be building an indirect synthesizer, this article will endeavor to point out some constructional pitfalls, offer a few guidelines and, hopefully, aid in maximizing proper operation on your first try.

design

Following a modest literature search, a 6-meter IC frequency synthesizer was blocked out that tuned from 50.000 to 54.000 MHz in 1.0-kHz steps. Considera-
tion was given to minimum steps of 5 or 10 kHz, knowing it would ease the task of phase-locking and reduction of spurious outputs, but this less desirable trade-off was finally overcome by intensive debugging. To be useful as an 8-MHz crystal replacement, output frequency runs from 8,333,333 to 9,000,000 Hz. An electronic calculator made quick work of the math. Frequency increments of 166.2/3 Hz, when multiplied by 6, yield 1.0-kHz steps on 6 meters; the required division is 50,000 to 54,000. A 1.0-MHz reference crystal divided by 6000 produced the necessary 166.2/3 Hz comparison signal for phase detection.

First off, a string of five 74192 programmable divider ICs were plugged into sockets Duco cemented to perfboard and wired to divide by 50,000 as shown in fig. 1. This wiring consisted of no. 28 Beldsol enameled wire, a handy enameled hookup wire with insulation which melts back from hot solder to leave a nicely tinned end ready for connection. Feeding in clock pulses having a configuration called for by the chip manufacturer at a 8,333,330 Hz rate resulted in an output that closely resembled a pseudo-random bit stream! “Oh well!” said I, “probably just a wiring error, maybe a stray oscillation or a bit more B+ bypassing.”

Three weeks later, the output wasn’t quite so random but counting down to zero from a given input frequency never agreed with the divider truth table. Even getting close to 166 Hz required a higher input frequency than theory said was necessary. The B+ supply from a three-terminal IC regulator had to exhibit very low impedance. Miniature axial-lead tantalum capacitors added for supply voltage

---

**fig. 1.** Programmable divider divides from 50,000 to 54,000 in steps of 1. The thumbwheel switch assembly (S1, S2, S3 and S4) is an EccoSwitch type 4R177612G. Switch S5 provides divide-by-4 for MARS netting (see text).
bypassing helped a little, but it was just impossible to obtain a stable, fixed division ratio.

About this time K2OAW described his programmable divider. After some reading, the operating principles of K2OAW's circuit became clear. Since I only had transmitter frequency control in mind, his circuitry for receiver LO use could be deleted. Also, since the most significant extra counts. My skinny little magnet wire must have looked like kilohms!

Not wishing to process double-clad printed-circuit board, and with low cost always in mind, the socket/perfboard layout was modified to accomodate 3M's 1181 half-inch wide, copper-foil adhesive tape, one pattern stuck down for ground and the same pattern directly opposite for B+. This formed a low dc resistance,

digit never changed, a 7490 wired binary could divide by five.

This new circuit replaced the first version and at least got me into the ballpark, meaning division was off by only scores of numbers instead of hundreds! Many troubleshooting tricks were tried and failed. Finally, a fruitful discussion with WA1CTS yielded a nugget generally known to computer builders but seemingly little known among amateurs: B+ and ground for TTL logic should use ground-plane techniques with a 100-ohm transmission line built in for power distribution. Neglect of this basic design requirement was manifested in low inductance and distributed bypass capacitance power feed system that also made socket wiring easier. When fired up once again, the long sought after magic numbers appeared!

Dividing 8,333,330 by 50,000 gave 166.6 Hz, and dividing 9,000,000 by 54,000 also gave 166.6 Hz. Various in-between divisions were tried; all came out correctly. This without any B+ bypassing to ground, too. Success was so sweet, the foil transmission line impedance never did get measured. However, 4.2 pF per half square inch of foil was measured and with 20 inches per board this is 168 pF. As a rule of thumb,
pulse rise time can be related to one cycle of rf in the same period, so the 5-nanosecond transitions correspond to 200 MHz where 168 pF has a reactance just under 5 ohms. Obviously, this is quite effective in shunting pulses whose source impedance is 10 to 20 times higher.

With an idealized clock pulse obtained from a lab pulse generator the next item of business was to simulate it inexpensively. A 74121 one-shot, timed to deliver 40-ns negative-going pulses, was found to be perfectly adequate. Proceeding next to the reference circuit and again using copper foil for power distribution, a 1.0-MHz crystal oscillator divided by 6000 was constructed (fig. 2) and never failed to operate properly from first turn-on.

VCO

As other writers have indicated, the vco must be inherently stable by itself before electronic frequency control is fed back. A Vackar oscillator circuit was chosen for three reasons: it is frequency and amplitude stable, and, like the Clapp, has one connection where small capacitance variations result in large frequency shifts. The circuit, fig. 3, was built on a bit of double-clad printed-circuit stock to insure mechanical integrity and simplify shielding. It was then tested by feeding in varactor bias from a 10-turn 10k pot tied across 5 volts of B+. Tuned-circuit component values were juggled to obtain the graphed tuning curve shown in fig. 4. This check should always be made to get an idea of linearity and voltage swing required for a given configuration.

When tuned in on a CW receiver, the carrier jumped in discrete steps as the pot wiper moved along individual turns of winding resistance which is understandable when it is realized that slew sensitivity is about 500 Hz per millivolt. Slow frequency drift is not important during this test but any audio rate burble must be eliminated. Some rectifier diodes work well as tuning devices but be careful of ambient light effects; one diode I tried had a translucent plastic case which caused 60 Hz fm from an overhead light until the device was wrapped in black plastic tape.

Oscillator B+ must be essentially battery-pure and stable, and a separate 7805 IC voltage regulator is recommended. No doubt a µA723 regulator could be used, but these new three-terminal voltage regulators are so easy to wire in, they spoil you for anything else.

Unilateral amplification is necessary to prevent spurious vco pulling by logic pulses sneaking back through the gain chain. The resultant pulsed fm generates a wide spectrum of hash that is impossible to cure without redesign. A Darlington emitter follower has worked well in this regard and is able to properly fire the one-shot. Additional isolation and gain is provided by a MC1350P which drives the transmitter multiplier.
phase detector

Next on the agenda was selecting and optimizing a phase detector circuit. Perhaps it would be helpful to set up an idealized specification and then see what can be done to meet it in the real world. This black box would detect the slightest difference in phase of incoming 166-Hz pulses, change this information into a precise step of dc control voltage and instantly slew the vfo back into exact synchronism with its reference. In truth, since nothing works in zero time, there during a second effort. After considerable playing around with component values, sidebands were down to about 20 kHz. One bad feature was the lack of drive toward sync if the vco happened to get outside one end of lock range. For all its faults, a MC4044 IC always drove towards lock, no matter where the vco was initially.

Since W1UYK's circuit worked on 41-Hz pulses I decided to give it a try. It was wired in per his schematic and showed promise right away; sidebands would have to be some phase difference to produce a correction voltage, and steps of dc voltage generate wideband transients. Therefore, a real world circuit will necessarily have time delays, small error signals and low pass filtering as minimum requirements.

The first circuit I tried was totally unsuited for low-frequency use; the vco put out a spectrum of hash many hundreds of kHz wide and optimization only reduced this to about 90 kHz. For audio-frequency phase detectors, many designers have gone to sample-and-hold circuits as a means of reducing pulse feedthrough, but since I didn’t have any enhancement-mode fets on hand, a pair of MPSA12 Darlington transistors were substituted came down to about 10 kHz. Another period of testing commenced in an attempt to modify the circuit for this particular synthesizer. The final result is similar with one interesting exception – the use of a 10k variable for adjusting loop lock-up rate.

As resistance is progressively reduced, vco slew response changes from over to critical to under damping and eventually into sustained hunting. It’s quite easy to hear this effect on a CW receiver and adjust for a rapid settling time (about 2 seconds) by placing a finger momentarily on the vco tank coil to force it far out of lock. Do this at 8.33 MHz where loop gain is highest.

Settling time is a little longer at 9 MHz.

fig. 3. Circuit for the vco used in the 6-meter frequency synthesizer. The 9.35 µH inductor, L1, consists of 37 turns no. 22 enamelled on a T-68-2 Amidon toroid core.
due to slightly lower voltage sensitivity and is a tradeoff made for non-linear varicap pull range. A low leakage electrolytic must be used for the 25-μF capacitor (20 megohms on a Simpson 260) because it connects between a possible maximum 4 volts and a dc amplifier having a current gain of about 50,000. Only ac coupling is wanted. An RC filter follows the active filter to reduce sidebands to essentially zero and at 40 dB over S9, the carrier sounds perfectly quiet.

In a lab check using a special oscilloscope, varicap control voltage showed 10 microvolts pulse and about 30 microvolts random dc on a plus 1.0-volt pedestal at 8.5 MHz.

This equates to an average carrier uncertainty of ±7 Hz or six times that on 6 meters, an acceptable figure for most transmission modes. These small error voltages remain unchanged, but the major dc voltage will lie between 0.5 and 3.8 volts, depending on frequency and trimmer capacitor adjustment (0.7 at 50 MHz and 2.1 at 54 MHz used here).

A simple but revealing test can be made by tuning in the reference crystal’s 9th harmonic at 9.0 MHz, then setting in a division of 53,999 to produce a 166-Hz heterodyne. Servo loop limitations will be evidenced by a small burble or beat note instability. Any circuit modifications should be aimed at minimizing this randomness without degrading sideband levels or lock-up action.

**unlock detector**

If the synthesizer becomes unlocked for any reason, transmission of off-frequency more than 10 kHz at 6 meters, the 5-microsecond pulse briefly becomes longer than the 12, gate output drops, firing the timer and energizing the relay for 4 seconds. Consequently, a frequency change of several kHz is possible without initiating action.

A desired frequency shift tolerance may be set in by variation of the one-shot capacitor while off time is changed by appropriate shift of R or C in the NE555 timer. Start-up, long settling times or hunting will keep the relay on; it will not reset until phase lock is effected.

**construction**

If you decide to build this six-meter frequency synthesizer, there are several important points to keep in mind. First of all, use a ground plane or copper strip for logic B+ and ground power distribution. Strive for battery-pure dc supplies for the oscillator and buffer. Use at least

---

*fig. 4. Frequency of vco vs control voltage, using a Sylvania 1N4005 rectifier as a varactor.*
fig. 5. Circuit of the unlock detector and timer. Relay K1 is a Sigma 62R2-12DC. Simple three-terminal five-volt voltage regulator for the entire synthesizer is shown at right, below.

two voltage regulators: One for logic, one for the vco. Zener diodes have too high impedance and unregulated B+ is out of the question.

Keep the dialed logic wiring short and direct to its respective IC terminal. Optimize the base-bias resistor in the vco using the 9-MHz burble test (use a 22k isolating resistor and 250k pot in series to determine the proper value). Follow the vco with one-way rf amplification.

Shield the entire synthesizer. Shield the oscillator separately, and use feed-through capacitors and shielded cable. Beware of ground loops — non-reducible sidebands usually result. All construction must be mechanically secure. Anything that moves will cause phase shifts that the detector tries to correct for. Think of phase as a change of less than one-half Hz at 8 MHz!

Stray capacitance at the varicap connection will have considerable affect on the capacitor values required to bracket 8.33/9.00 MHz with a given tuning diode and bias voltage swing. A frequency counter is convenient, but a well-calibrated communications receiver will do fine. If only the first MHz on six meters is of interest, adjustment is that much easier. Experiment with different voltage-variable capacitors. A Sylvania 1N4005 rectifier diode produced less frequency jitter than a Motorola Epicap MV2209.

For a real eye-opener, try placing a battery-powered broadcast radio next to the programmable divider board to pick up its amazing spectrum of signals. Then,
"finger test" the vco — the result is hard to believe!

summary

Troubleshooting this synthesizer was a real challenge but definitely worthwhile once it began to operate correctly. There is tremendous satisfaction in having a 6-meter crystal-stable rf generator with 4000 discrete frequencies. Great for nets, receiver calibration and avoiding interference. When asked to move "up a couple," you'll shift exactly two kHz. Schedules on a prearranged frequency will be right on. Other vfos can be calibrated by your dialing in spot frequencies to zero in on. MARS netting is possible by adding a toggle switch on the 7490 bi-quinary to divide by four; see the schematic in fig. 4. Narrow-band fm is possible by adding modulation to the vco control voltage, but hum will be a problem as only tens of microvolts can be tolerated.

references


NEW RANGER RANGER
for Amateur FM

Get extended range with this exciting new antenna. A one eighth wave phasing stub and three half waves in phase combine to concentrate your signal at the horizon where it can do you the most good.

6.3 dB Gain over ¼ wave whip
4.5 dB Gain over ½ wave dipole

ARX-2 146-148 MHz
$22.50
ARX-450 435-450 MHz
$22.50
ARX-220 220-225 MHz
$22.50

Extend your present AR-2 Ringo with this RANGER KIT. Simple installation.

ARX-2K .............. $8.95

IN STOCK AT
YOUR LOCAL DISTRIBUTOR

621 HAYWARD STREET
MANCHESTER, N.H. 03103

ham radio

march 1974
I've been interested in antennas for 80-meter DX that were simple, inexpensive and effective, so I've been reading a lot of the vertical antenna literature prior to putting up a vertical or a phased vertical array. I chose verticals early in this effort since antenna books show that the low angle radiation from vertical monopole antennas is considerably better than from horizontal dipoles unless the dipoles are unreasonably high, at least for 80 meters.

The first question was, "What vertical height should be used?" A recent article shows that short verticals do a pretty good job, which I agree with. Although some antenna articles have indicated that tall verticals have much better low angle radiation than short ones, reference to antenna books such as those written by Kraus or Jordon show that the low-angle radiation pattern is essentially the same for a wide range of vertical heights. More on this later.

My studies show that earth and network losses are the most important factors. These losses are greater for short verticals than they are for tall verticals.

I've indicated a few considerations, but there are still a number of questions to consider and answer, and in more detail. How high should the vertical be? Is a tall vertical better than a short one? If so, how much better? What does better mean, or what factors or tradeoffs are important, and what is their relative importance?

You will find that there is quite a bit of choice in the height that may be used for a single vertical. If two or more verticals are to be part of a phased array, then there is less choice as to which antenna height may be used.

Some of the factors that must be considered are self-impedance; mutual impedance in arrays; earth, radial, and network losses; bandwidth and vswr versus height; vertical radiation pattern; type of tuning network required; type of transmission line used; physical or mechanical factors; and the radial ground system.

How can you make sense out of so many interrelated factors? You don't want to reinvent the wheel, so I will make use of material such as that from early
issues (1930s) of the *Proceedings of the IRE*, and from standard antenna textbooks. Today there are a number of new tools at our disposal such as digital computers, pocket electronic calculators, etc., and these were used to develop answers to some of the questions.

Rather than try to answer all of the questions at once, several articles are planned, with only a few topics in each. The data and examples will cover a range of values which are practical for average amateur situations. The graphs will be large enough to serve as useful reference data for amateurs who wish to work out other examples.

This first article will deal with the self impedance of a single vertical, and indicate what networks (if any) are required for various heights of verticals, what losses occur in these networks, and what bandwidths result.

The second article will compare the vertical radiation patterns of various height verticals. The third article will discuss ground losses, and answer the remaining questions posed here. The last article will present mutual impedance data, and will analyze a particular phased array.

antenna self impedance

The electromagnetic field produced by an antenna results from certain current distributions on the antenna which vary with time. Many cases are analyzed in the literature, from the elementary current element, to the elementary dipole, to a full-length dipole with sinusoidal current distribution. Various steps in the analysis show that induction, radiation and electrostatic fields result, all of which fall off differently with distance. All of these fields (the near field) must be considered to determine either the reactance of a single antenna, or the mutual impedance between two or more antennas.

The radiation field is sufficient when considering the radiation patterns. These theories were used by authors of antenna books and articles to develop equations used to make calculations here. I used the appropriate formula from Jordan\(^2\) for antenna self impedance (one for resistance and one for reactance). Each formula is a long complex expression consisting of many sine and cosine integral terms, and they are also functions of antenna height.

Antenna self impedance, as used here, consists of the antenna base resistance, \(R\), and the antenna base reactance, \(X\). You must be careful when using such formulae to be sure that loop or base values are used consistently and properly. The base impedance values are those seen at the antenna self impedance

The electromagnetic field produced by an antenna results from certain current distributions on the antenna which vary with time. Many cases are analyzed in the literature, from the elementary current element, to the elementary dipole, to a full-length dipole with sinusoidal current distribution. Various steps in the analysis show that induction, radiation and electrostatic fields result, all of which fall off differently with distance. All of these fields (the near field) must be considered to determine either the reactance of a single antenna, or the mutual impedance between two or more antennas.

The radiation field is sufficient when considering the radiation patterns. These theories were used by authors of antenna books and articles to develop equations used to make calculations here. I used the appropriate formula from Jordan\(^2\) for antenna self impedance (one for resistance and one for reactance). Each formula is a long complex expression consisting of many sine and cosine integral terms, and they are also functions of antenna height.

Antenna self impedance, as used here, consists of the antenna base resistance, \(R\), and the antenna base reactance, \(X\). You must be careful when using such formulae to be sure that loop or base values are used consistently and properly. The base impedance values are those seen at the

The radiation field is sufficient when considering the radiation patterns. These theories were used by authors of antenna books and articles to develop equations used to make calculations here. I used the appropriate formula from Jordan\(^2\) for antenna self impedance (one for resistance and one for reactance). Each formula is a long complex expression consisting of many sine and cosine integral terms, and they are also functions of antenna height.

Antenna self impedance, as used here, consists of the antenna base resistance, \(R\), and the antenna base reactance, \(X\). You must be careful when using such formulae to be sure that loop or base values are used consistently and properly. The base impedance values are those seen at the
base of a vertical antenna. Loop values result from considering the current loop up on the antenna. It is easy to convert from one set of values to another, as for example

\[ R_{\text{base}} = R_{\text{loop}}/\sin^2(\beta h) \]

Antenna textbook data is sometimes given for loop values, and sometimes for base values. Base values are used here.

\[ \beta = \frac{2\pi}{\lambda} \]

where \( \lambda \) is the wavelength, and \( h \) is the electrical length of the antenna in wavelengths.

**antenna height**

Another time you must be careful is when you calculate the physical length of the antenna. For antennas of the diameter of interest (2-inch diameter conduit was used here), the physical length should be 5% less than the electrical length. The computer calculations were made using the electrical length in order to compare my results with standard antenna textbook data, but the physical lengths given here will have the 5% shortening included. A handy formula for this is

\[ HA = \frac{984 \times h/\lambda}{F_{\text{MHz}} \times 1.05} \text{ feet} \]

where \( HA \) is the physical antenna length in feet, and \( h/\lambda \) is the electrical length in fractions of a wavelength. For example, if \( F_{\text{MHz}} = 3.8 \), then \( HA = 246 h/\lambda \). Then, if \( h/\lambda = 0.25 \), \( HA = 61.5 \) feet.

The results of the first computer program I wrote gave values of \( R \) and \( X \) vs \( h/\lambda \). This standard data is reproduced in fig. 1 for use in selecting some examples of practical heights of verticals.

The antenna lengths selected for consideration were even multiples of 10-foot pieces of conduit, and specifically were 30-, 40-, 50-, 60- and 70-feet long. Some special lengths were also selected, and these were lengths which were easily matched to RG-8/U or RG-11/U coaxial cable.

**Table 1. Calculated vertical antenna characteristics vs height, and vswr performance with three different types of matching systems.**

<table>
<thead>
<tr>
<th>HA (feet)</th>
<th>( h/\lambda )</th>
<th>( R )</th>
<th>( X )</th>
<th>Coax</th>
<th>VSWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>80.0</td>
<td>0.325</td>
<td>90.6</td>
<td>+230.0</td>
<td>RG-11/U</td>
<td>8:1</td>
</tr>
<tr>
<td>76.0</td>
<td>0.31</td>
<td>75.0</td>
<td>+180.0</td>
<td>RG-11/U</td>
<td>8:1</td>
</tr>
<tr>
<td>60.0</td>
<td>0.243</td>
<td>33.8</td>
<td>+5.7</td>
<td>RG-11/U</td>
<td>2.2:1</td>
</tr>
<tr>
<td>70.0</td>
<td>0.285</td>
<td>55.0</td>
<td>+108.0</td>
<td>RG-8/U</td>
<td>6:1</td>
</tr>
<tr>
<td>69.0</td>
<td>0.28</td>
<td>52.0</td>
<td>+95.0</td>
<td>RG-8/U</td>
<td>5:1</td>
</tr>
<tr>
<td>61.5</td>
<td>0.25</td>
<td>36.6</td>
<td>+21.3</td>
<td>RG-8/U</td>
<td>1.8:1</td>
</tr>
<tr>
<td>60.0</td>
<td>0.243</td>
<td>33.8</td>
<td>+5.7</td>
<td>RG-8/U</td>
<td>1.5:1</td>
</tr>
<tr>
<td>59.3</td>
<td>0.241</td>
<td>32.0</td>
<td>0</td>
<td>RG-8/U</td>
<td>1.6:1</td>
</tr>
</tbody>
</table>

1. No matching network (center of coax connected directly to antenna base).

2. Series capacitor, \( C \), between coaxial transmission line and antenna base. VSWR 1.0:1.

3. Type-C L-network (see fig. 3) used with RG-8/U coaxial cable. VSWR 1.0:1.

4. Type-A L-network (see fig. 3) used with RG-8/U coaxial cable. VSWR 1.0:1.

Table 1 lists these choices, the network used (if any) and the resulting vswr calculations made at 3.8 MHz. This data shows that with no network and RG-11/U transmission line, the lowest vswr is 2.2:1 with \( HA = 60 \) feet. With no network and RG-8/U coax, the lowest vswr is 1.5:1 with \( HA = 60 \) feet. If the proper series capacitor is used, the vswr is 1.0:1 for RG-8/U at \( HA = 69 \) feet, and for RG-11/U at \( HA = 76 \) feet.

For antennas of other heights the vswr is 1.0:1 if the proper L-networks are used. The L-networks were calculated using the methods outlined in my QST
network losses

The next topic to explore is that of matching network losses. Of course, there is no network loss for cases not using a matching network, and I will also assume that there are no losses in any of the network capacitors. However, there are coil losses, and these can be significant for matching networks for short vertical antennas. Assuming that the power output to the matching network is 600 watts, and that the Q of the network coil is 200, coil losses are as shown in fig. 2. On the basis of this graph you can select a height of vertical depending upon the amount of network loss that you are willing to accept.

As an example of these calculations, consider a 30-foot vertical, where HA = 30 feet, R = 6.3 ohms, and \( X_L = 320 \) ohms. If there are no capacitor losses, the 600 watts delivered by the coax feedline to the network must be divided between the network coil and the antenna. There are earth losses too, but I will consider these in a later article, and assume that they are zero now in order to examine network losses. The coil loss resistance, \( r \), is \( X_L/Q \), or \( 320/200 = 1.6 \) ohms. The current in the coil and antenna is then

\[
I = \sqrt{\frac{P}{R + r}} = \sqrt{\frac{600}{6.3 + 1.6}} = 8.71 \text{ amps}
\]

Thus, the coil loss is \( I^2R = 121.5 \) watts, and \( I^2R = 478.5 \) watts delivered to the antenna.

antenna bandwidth

The last topic for this article is that of the bandwidth for the antenna examples given. For each of these examples the network was designed to make the input impedance seen by the coax feedline to be 52 ohms for a vswr of 1.0:1 at an arbitrary frequency of 3.8 MHz. Another computer program was written which calculated the input impedance versus frequency for the same network and same height vertical. The previous program furnished the changing antenna self impedance versus frequency. The changing input impedance versus frequency was plotted on a Smith chart for 30-, 40-, 50- and 60-foot verticals using one type of L-network; the 69-foot vertical using a series C network; and the 70-foot vertical using a different type of L-network. Bandwidth was arbitrarily defined as being the difference between those frequencies having a vswr of 2.0:1. These bandwidths are shown in fig. 3. As expected, the shorter antennas have a smaller bandwidth. Use of this graph will help you to select an antenna height depending upon what bandwidth is acceptable to you.

references

lowpass filters

for solid-state linear amplifiers

Complete low-power, lowpass filter designs for 160, 80, 40, 20, 15 and 10 meters

Semiconductors have finally found their way into high-frequency linear amplifiers. Broadband, untuned amplifiers that were seldom practical with vacuum tubes have become the best approach with semiconductors. Along with the advantages of rapid QSY and circuit simplicity comes the problem of unwanted harmonics. It is a recognized fact that a lowpass filter is a necessity with this type of amplifier. Many of the broadband amplifier designs use push-pull circuitry, which may suppress the second harmonic by 50 dB, but the third harmonic is suppressed only 12 dB.

I have selected an elliptic function filter design that provides low insertion loss, low VSWR and attenuation peaks at the second and third harmonics. It is assumed that a linear amplifier will be used in the phone portion of the bands but adequate suppression is obtained for CW operation too.

Several listings of normalized filter data have been printed and are quite simple to use. Unfortunately, these publications are seldom in the average amateur's library. The theoretical design has been compromised only slightly to allow use of standard mica capacitors (either compression molded or dipped) that can be purchased from Allied, Newark or other suppliers. Five-hundred-volt capacitors will handle several hundred watts if the VSWR of the antenna is near unity and are a wise choice unless low power and miniaturization is contemplated. The Micrometals toroidal cores listed are readily available from Amidon Associates.

G. Kent Shubert, WAOYJYK, 1308 Leevue Drive, Olathe, Kansas 66061
fig. 1. 160-meter lowpass filter. L1 is 26 turns number-18 on Amidon T80-2 toroid (4.2 μH). L2 is 23 turns number-18 on Amidon T80-2 toroid (3.13 μH). Insertion loss is 0.1 dB over the 160-meter band.

fig. 2. 80-meter lowpass filter. L1 is 18 turns number-16 on an Amidon T80-2 toroid (1.9 μH). L2 is 16 turns number-16 on an Amidon T80-2 toroid (1.46 μH). Insertion loss is 0.12 dB over the 80-meter band.

fig. 3. 40-meter lowpass filter. L1 is 10 turns number-16 on an Amidon T80-6 toroid (0.57 μH). L2 is 9 turns number-16 on an Amidon T80-6 toroid (0.41 μH). Insertion loss below 18 MHz is 0.17 dB.
fig. 4. 20-meter lowpass filter. L1 is 10 turns number-16 on an Amidon T80-6 toroid (0.57 μH). L2 is 9 turns number-16 on an Amidon T80-6 toroid (0.47 μH). Insertion loss below 18 MHz is 0.17 dB.

fig. 5. 15-meter lowpass filter. L1 is 9 turns number-16 on an Amidon T80-6 toroid (0.41 μH). L2 is 8 turns number-16 on an Amidon T80-6 toroid (0.27 μH). Insertion loss below 24 MHz is 0.25 dB.

fig. 6. 10-meter lowpass filter. L1 is 8 turns number-16 on an Amidon T80-6 toroid (0.33 μH). L2 is 7 turns number-16 on an Amidon T80-6 toroid (0.19 μH). Insertion loss below 35 MHz is 0.3 dB.
Bathtub cans from old oil-filled capacitors make good cases with BNC or RCA Phono connectors soldered in the ends. If you are going solid state those old 1000-volt, oil-filled capacitors won't be needed anymore, so salvage the cases.

Designs and winding information are given for the top six amateur bands. The response curves were obtained by computer analysis with actual testbench verification of the 80- and 40-meter filters (those are the two bands I'm now working). The filters perform well without tuning, but a little adjustment of the resonant frequency will help assure 60-dB suppression of the second and third harmonics. There are several ways to tune the toroidal resonators. In all six filters inductor L1 will resonate at the third harmonic and L2 will be resonated at the second harmonic.

Please join me in fighting air pollution. Keep the bands upstairs clean for the other operators!

references
3. Von R. Saal, Der Entwurf Von Filtern Mit Hilfe Des Kataloges Normierter Tiefpasse, Telefunken, GMBH, West Germany.

NEW YAESU FT-101-B
still $649

includes new 8-pole filter, LED indicators on the clarifier and external vfo switch.

The selling dealer is responsible for warranty and service on Yaesu equipment. We have a factory trained Japanese service technician for expert service and quick return.

FTDX-401 transceiver $599
FL-2100 linear $339
FL-dx-400 transmitter $339
FR-dx-400SD receiver $399

Most items in stock

FT-101 and FTDX-401 shipping will be prepaid in continental U.S.A. on cash orders

No sales tax (except in Nevada)
Trade-Ins wanted

WILSON ELECTRONICS
BOX 794 HENDERSON, NEVADA, 89015
702-451-5791

march 1974
Discussion of a new and unique system of glyphs which are ideally suited for use with IC logic.

The word instrumentation has a magic ring and is something every true amateur desires, but usually cost tempers that desire. Some years ago, while fighting to read a Potter counter which used four columns of four lamps each, displaying a BCD format, I was sure there must be a better way. As transistors mutated to integrated circuits and costs plummeted, a number glyph was developed that could revolutionize numeral concepts. As not everyone is interested in the historical development of numerals, suffice it to say that man has spent several thousand years developing and changing his numeric glyphs. Now the age of the computer will require another change if man and machine are ever to communicate directly.

invention

Accepting the fact that digital equipment will never be anything more than
off and on switches relegates them to binary operation. Man must learn to use these bits of information in an efficient manner. My own approach to this binary age is to reform the old Potter readout lamps by arranging them in illuminated bars as follows:

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Why? These bars are a direct output from the decade counter. What has been gained? A readily readable symbol, reduced cost, simplified circuitry and more reliability.*

**logic**

To answer in more detail, some discussion of logic, counters and circuitry is necessary. It helps to remember that any digital device is just a mass of electrical switches. It depends on your own insight and knowledge to parallel or series them to produce your desired result. For instance, the door and screen door are AND gates. Both must be open for the fly to come in. The results can be negative, NAND, if somebody is waiting with the fly swatter. The same analogy can be applied to a door and window forming the OR and NOR gates.

Master these concepts and their ramifications, and you will be able to follow any logic design. One ingredient you must apply to all logic is that in the real world a finite time must be allowed for signals to pass through each logic block. Believe me, this is important. Usually, logic circuits end up in a counter, probably for display, or register, a group of binary bits which will be processed further.

The device of most interest to the amateur is the ripple counter. Fig. 1 is the logic diagram for a ripple counter decade unit. This unit should go through the binary sequence shown in the accompanying table and repeat.

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>C</td>
<td>B</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>10 = Reset signal</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

*U.S. Patent No. 3,671,943. A copy may be obtained from the Commissioner of Patents, Washington, D.C. 20231 (50 cents money order).
can’t happen (see fig. 2, a commercial decade counter). Now that your counter is designed, you will need an indicator to communicate the binary number it holds.

About 30 years ago Potter built one of the first counters which, with four neon lamps per decade, displayed the state of each flip-flop. Each lamp was weighted 1, 2, 4 or 8 and you simply added the values, or, to be more precise, you learned binary equivalents for Hindu-Arabic numbers.

Engineers soon mastered the art of using gates. From then on it didn’t take too much time to build decoding logic which could combine the counter outputs and light individual one-of-ten lamps such as the Nixie tube. Finally, the ten outputs were combined into a diode matrix to illuminate a 7-segment numeral (see fig. 3).

Rad-Ex began a search for a readout display which could be connected directly to a counter and would convey a feeling of quantity. The Rad-Ex numerals fit this concept perfectly and in surprising ways open up several interesting possibilities such as handwritten machine readable characters, and a new way to teach arithmetic.

**technical**

Electronically, the basic counter is different and more simple than present decade counters, has no critical race

---

**fig. 2. Commercial decade counter.**

---

**fig. 4. Rad-Ex System, decade counter to readout.**
paths, while almost doubling the counting rate and automatically suppressing leading zeros. Fig. 4 shows the circuit; its truth table is below:

<table>
<thead>
<tr>
<th>D</th>
<th>C</th>
<th>B</th>
<th>A</th>
<th>State Before Count Begins</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>AND to Reset</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

At first the truth table seems to indicate two zeros, but the fact is that binary 0000 is a true starting point where no count exists. It is also a unique way of suppressing leading zeros. Once the counter starts, binary 1010 becomes the systems designated zero. (For many reasons it is handy to have a binary designation for zero; for instance, on a punch tape a blank space is ambiguous.) Electronically, good things happen too. Circuitwise, the first flip-flop is independent and needs no clear signal when counting. Thus critical races are eliminated, allowing the use of a simple 3-input NAND gate to reset the counter for each decade count.

For readout purposes, with one exception, the lamps are tied through lamp drivers directly to the flip-flops. The one exception is the case where binary 1000 also illuminates the lamp associated with flip-flop C.
The use of the Rad-Ex system can best be illustrated in a 24-hour clock where mixed counting is necessary. Fig. 5 is the logic diagram for the clock and should be used as reference in the following sequence of operation: 60 Hz is fed to a one-shot multivibrator, U1, simply to eliminate false triggering. The output from U1 triggers a chain of 7493 flip-flops U2, U6, U7, which are used as a ripple counter to divide incoming pulses by 3600 (1110, 0001, 0000).

All that is required for this operation is to detect the four binary ones and use a 4-input gate, U5, to reset U6 and U7 (U2 is already at 0000). The resulting one-minute pulses are fed to the first decade counter which displays zero to 9 minutes. As the transition from binary 1001 to 1010 occurs, a pulse passes to a divide-by-6 counter. Again, the non-conventional system works to the advantage of simplicity. The truth table shows how the Rad-Ex numbers zero through 5 are energized.

<table>
<thead>
<tr>
<th>B</th>
<th>C</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1 AND to Resets B &amp; C</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

The 24-hour portion of the clock uses the standard Rad-Ex decade counter plus a counter to keep track of the hours.
Essentially, the decade counter acts the same as the minute decade with the exception that the suppressed leading zero feature may be observed. The binary numbers 10 (2) and 0100 (4) are combined in a NAND gate, U8, to reset both decade and modulo-4 counters to binary (00) (0000). Thus, until the first hour is reached only the minute display is illuminated.

The sharp eye may spot two NAND gates, part of U3A and U8B, which don’t seem quite right. Here you must juggle your logic thinking for in the case of the NAND gate, I say, “If both inputs A and B (A⋅B) are high, Y is low (Y).”

You may look at this in a different way and say, “If A or B (A+B) is low, (A+B), Y is high.

These two NAND gates are used in a NOR sense, U8B is used to clear the decade counter whenever the count of ten or 24 is present. Gate U3A is used to allow a fast or semi-fast setting of the clock.

A check of the cost of ICs for this unit amounts to $9.85. ICs for a comparable clock designed to use 7-segment readouts cost about $14.00. A set of Rad-Ex readouts costs $4.75; the 7-segment readouts and four decode units cost about $15.00.

**future**

As mentioned earlier, this is a symbol that can be handwritten and machine read. Fig. 6 is a block diagram showing a method of scanning the numeral to set up a BCD character. The number is scanned horizontally to pick up ones and vertically to pick up fours. These outputs are combined in a shift register which on command transmits the BCD word.

Hopefully, this article will inspire experimenters, hobbyists, and professionals to become involved in the man-machine communication problem. At present, there is a growing need for man to communicate through handwritten glyphs directly to computers, with bank drafts and zip codes being prime examples. There is also need to simplify instrumentation so that digital voltmeters, frequency counters, etc. can talk more directly and less expensively to you. Rad-Ex Syntactics feels we have brought these goals closer to realization.

*ham radio*

**fig. 6.** Rad-Ex optical reader device.
TELEPRINTER HANDBOOK

The largest and most complete handbook on RTTY ever published.

Thirteen detailed chapters include page printers, auxiliary equipment, demodulators, power supplies, filters, test equipment and much, much more.

Contributors include a number of the world's leading RTTY amateurs. Truly a must book for any RTTY amateur.

360 pages, hardbound $14.95 ppd

HAM NOTEBOOK

by the Editors of HAM RADIO Magazine

The very best from the popular Ham Notebook Section in HAM RADIO Magazine. Hundreds of short ideas, simple circuits and useful hints on virtually every subject. Ten chapters including such subjects as Antennas, FM and Repeaters, and Test Equipment. No amateur's technical library is complete without this vital book.

Just $3.95 postpaid

HR REPORT

Completely new — Completely different. An airmail, twice monthly newsletter with all the news of amateur radio as it happens, not weeks later.

Covers everything, FCC, ARRL, Contests, DX, Hamfests, Industry news and much, much more.

The story behind the story plus the integrity of HAM RADIO'S editorial staff equal a publication you must have.

One Year (24 or more issues)

All copies sent airmail (except to New England states)

$12.00 U.S. and Canada $15.00 Worldwide
NOW.

Top-of-the-Line

Tri-Ex Towers

for HAM operators

at basic prices!

Now you can afford the best! Free-standing or guyed. Tri-Ex Towers stress quality. All towers are hot dipped galvanized after fabrication for longer life. Each series is specifically engineered to HAM operator requirements.

W Series

An aerodynamic tower designed to hold 9 square feet in a 50 mph wind. Six models at different heights.

MW Series

Self-supporting when attached at first section — will hold normal Tri-Band beam. Six models.

LM Series

A 'W' brace motorized tower. Holds large antenna loads up to 70 feet high. Super buy.

TM Series

Features tubular construction for really big antenna loads. Up to 100 feet. Free-standing, with motors to raise and lower.

THD Series


Start with Top-of-the-Line Tri-Ex Towers. At basic prices. Write today, for your best buy.

TOWER CORPORATION

7182 Rasmussen Ave

Visalia, Calif. 93277

march 1974

More Details? CHECK-OFF Page 94
new fets
simplify bias problems

The operating characteristics of several new field-effect transistor families simplify proper biasing

Many circuits in the amateur literature specify the Motorola MPF102 fet. The Texas Instruments 2N3819 and the Siliconix U183 have essentially identical data sheets to that of the MPF102. The trouble with all three of these devices is the 10-to-1 spread of $I_{DSS}$ (2-20 mA) which makes bias point and performance somewhat unpredictable. $I_{DSS}$ is the drain current when zero bias is applied between the gate and source terminals of the fet.

bias problem

The circuit shown in fig. 1 is a typical fet biasing arrangement. The gate of the fet is held at ground potential (zero volts) by resistor, $R_g$, and the voltage drop across the source resistor, $R_s$, biases the source terminal to some voltage above ground. Thus, the gate is biased negative with respect to the source. The value of the gate-to-source bias is equal to the product of the drain current, $I_D$, in mA, and the source resistor, $R_s$, in kilohms. If $R_s$ is 2000 ohms and $I_D$ is 1.5 mA, the voltage across $R_s$ is 3 volts. The gate is thus biased 3 volts more negative than the source.

Fig. 2 shows how drain current varies versus gate-to-source voltage for an fet whose $I_{DSS}$ is 20 mA. This fet could be an MPF102, a 2N3819 or a U183. A straight line is drawn through the origin which represents a source resistor, $R_s$, having a resistance of 1000 ohms. Notice that a change of one volt along this line
results in a change in current of 1 mA, indicating a resistance of 1000 ohms.

The point where the straight line intersects the curve gives the values of drain current and gate-to-source voltage. In this case the drain current is about 3.7 mA, and the gate-to-source voltage (drop across \( R_g \)) is about 3.7 volts. Fig. 3 shows how the situation is changed if the fet is replaced by one having a value of \( I_{DSS} \) equal to 2 mA. The drain current is now 0.48 mA, and the gate-to-source voltage is 0.48 volt. This shows that the drain current of an MPF102, 2N3819 or U183 may be anywhere from 0.48 mA to 3.7 mA when a 1000-ohm source bias resistor is used.

With such a wide range of possible drain current, it is impossible to choose an efficient drain load that would be suitable for all fets of these types. As an example, suppose a 2N3819 is to be used in a resistance-coupled audio amplifier stage such as shown in fig. 4. Under no-signal conditions, it is desired that the dc drain voltage be 10 volts. This means there must be a 5-volt drop across the drain resistor, \( R_D \). If a 2N3819 is used which has an \( I_{DSS} \) of 2 mA, the drain current will be 0.48 mA, and the value of \( R_D \) should be

\[
R_D = \frac{5 \text{ volts}}{0.48 \text{ mA}} = 10.4k \text{ ohms}
\]

But if a 10k resistor is used for \( R_D \), and a 2N3819 with \( I_{DSS} \) equal to 20 mA is plugged into the circuit, the drain current will try to be 3.7 mA, which would produce a 37 volt drop across \( R_D \). Obviously this is impossible with a 15-volt supply, so the fet simply saturates, and linear amplification is not possible. If, on the other hand, \( R_D \) is chosen so that it has a 5-volt drop when the current through it is 3.7 mA ( \( I_{DSS} \) equal to 20 mA), its value would be

\[
R_D = \frac{5 \text{ volts}}{3.7 \text{ mA}} = 1.35k \text{ ohms}
\]

If this value of resistor is used with an fet
having an $I_{DSS}$ of 2 mA, the drop across it will be only

$$0.48 \text{ mA} \times 1.35\text{k} = 0.65 \text{ volt}$$

The problems involved in biasing fets with large $I_{DSS}$ spreads should now be quite apparent.

**new fets give relief**

One way to get around this biasing problem is to take a large number of fets and sort them into groups, each group having a relatively narrow $I_{DSS}$ range. Fortunately, manufacturers are now doing this. Texas Instruments has taken the 2N3819 and broken it into five fet types, each of which has an $I_{DSS}$ spread of 2 to 1 or less. These fets, which have a different pin configuration than the 2N3819 are listed in **Table 1**. All of these fets are priced under a dollar in small quantities, and they should be available from any of the larger electronic wholesalers which stock TI semiconductors.

**Table 1. List of 2N3819-type fets with small $I_{DSS}$ spreads.**

<table>
<thead>
<tr>
<th>Fet type</th>
<th>$I_{DSS}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2N5949</td>
<td>12-18 mA</td>
</tr>
<tr>
<td>2N5950</td>
<td>10-15 mA</td>
</tr>
<tr>
<td>2N5951</td>
<td>7-13 mA</td>
</tr>
<tr>
<td>2N5952</td>
<td>4-8 mA</td>
</tr>
<tr>
<td>2N5953</td>
<td>2.5-5 mA</td>
</tr>
</tbody>
</table>

Fig. 5 shows how the drain current of a 2N5953 would be in the range of 0.7 to 1.1 mA if its source bias resistor is 1000 ohms. The drain current could be said to be 0.9 mA, ± 0.2 mA for all 2N5953 fets used with a 1000-ohm source bias resistor. **Fig. 6** shows a practical fet audio amplifier circuit using the 2N5953. Voltage gain is typically around 10, and any 2N5953 used in this circuit will be reasonably well biased.

The Motorola 2N5484 series, priced at about a dollar each, have $I_{DSS}$ spreads of 5 to 1 and 2.5 to 1.

**Fet type | $I_{DSS}$**

| 2N5484   | 1-5 mA |
| 2N5485   | 4-10 mA|
| 2N5486   | 8-20 mA|

This isn’t as good as the TI 2N5949 series, but is considerably better than the MPF102 types.

**Conclusion**

The newer fets, having lower $I_{DSS}$ spreads, allow the use of simple bias arrangements to arrive at reproducible circuits. The cost of these devices is not much higher than the older types having wide $I_{DSS}$ spreads. Thus, fets may be applied with greater ease to a wide variety of circuit applications, and the high input impedance of fets may be taken advantage of without the penalty of unpredictable bias conditions.
When you want FM equipment, you shouldn't have to wait for special sales to get the most value for your dollar. At the FM Supermarket every day is a special day for value. Whether you want the ruggedness and reliability of used commercial radios or the convenience of such radios as Clegg, ICOM, Genave, SBE, or our own synthesized SPEC II, you get the most in value from "The FM People".

Here is just a small listing of the low every-day prices on used Motorola radios. Compare for yourself and see what we mean.

<table>
<thead>
<tr>
<th>LOW BAND</th>
<th>HIGH BAND</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>12 volt-trunkmount</strong></td>
<td><strong>12 volt-trunkmount</strong></td>
</tr>
<tr>
<td><strong>MODEL</strong></td>
<td><strong>DESCRIPTION</strong></td>
</tr>
<tr>
<td>FMTR80D</td>
<td>30w, dynamotor</td>
</tr>
<tr>
<td>FMTR140D</td>
<td>60w, dynamotor</td>
</tr>
<tr>
<td>FMTR41V</td>
<td>12w, vibrator</td>
</tr>
<tr>
<td>U41GGT</td>
<td>30w, transistor</td>
</tr>
<tr>
<td>U51GGT</td>
<td>50w, transistor</td>
</tr>
<tr>
<td>U41HHT</td>
<td>30w, motrac ps</td>
</tr>
<tr>
<td>U51HHT</td>
<td>50w, motrac ps</td>
</tr>
<tr>
<td>U71HHT</td>
<td>100w, motrac ps</td>
</tr>
<tr>
<td>T71GJT</td>
<td>100w, transistor</td>
</tr>
<tr>
<td><strong>6/12 volt-trunkmount</strong></td>
<td><strong>6/12 volt-trunkmount</strong></td>
</tr>
<tr>
<td>T41GGV</td>
<td>30w, vibrator ps</td>
</tr>
<tr>
<td>T51GGD</td>
<td>60w, dynamotor</td>
</tr>
<tr>
<td>T51GGV</td>
<td>60w, vibrator ps</td>
</tr>
<tr>
<td>T51AGD</td>
<td>60w, dynamotor</td>
</tr>
</tbody>
</table>

Motrac subject to availability.

**TERMS OF SALE:** Sales to licensed Radio Amateurs for use on Amateur freqs only. All prices FOB Oak Park, IL. Check with order, COD or you can charge to your BankAmericard or Master Charge.

**STORE HOURS:** Mon.-Thurs. 9:30-6:00, Fri. 9:30-8:00, Sat. 9:30-3:00. Closed Sun. & Holidays.

INQUIRIES WITHOUT ZIP CODE OR CALL . . . NO ANSWER.

**SPECTRONICS**
1009 GARFIELD STREET
OAK PARK, ILL. 60304
(312) 848-6778
log-periodic antennas

Dear HR:

Last December the Cyprus Government issued me a ham ticket. Then I began a mad scramble, looking for a source of commercial beam antennas. I quickly found that all antennas cost at least double the retail prices in the United States. Considering the cost of a beam, tower and rotator, it was very discouraging. Next, I searched for material for building my own beam. Aluminum is practically unobtainable here, and PVC tubing was out because the available material is too thin and flexible.

The log-periodic antenna article by W4AEO in the September, 1972, issue of *Ham Radio* provided the answer. It was the only antenna I could find parts for and the design had sufficient gain to consider working the United States (as noted by myself and others, most of the signals from the States on 20 meters average 20-dB less here than reported by stations located in continental Europe).

Putting the log periodic together was much faster than I imagined, but a vswr of 4:1 when fed with 50-ohm coax was a puzzle until a check with a noise bridge indicated the input impedance was 200 ohms. I wound a 4:1 balun and maximum vswr on 15 and 20 meters is now 1.2:1. On-the-air reports indicate at least 8-dB gain. I’m running a Collins KWM-2 bare-foot, but many old timers accuse me of using at least a kilowatt.

It goes without saying that W4AEO’s log periodic, while requiring some acreage, provides considerable gain and solves the parts and money problem. Due to W4AEO’s article, a number of us in Nicosia are building other log periodics. We are discovering that the surface has only been barely scratched, and amateurs still have plenty of elbow room to incorporate their own innovations.

Stan Whiteman, 5B4AO/W1MDZ
Nicosia, Cyprus

reciprocating detector

Dear HR:

I have received several letters regarding my “reciprocating detector” article which appeared in the March, 1972, issue of *Ham Radio*. Transistor Q5 is part of the reciprocating detector switch, but the questions are understandable due to the lack of a dot to show a connection in the schematic; resistors R4 and R5 should be joined with a dot where these two resistors form a junction point at the input to the diode and the base of Q5. The diode is a 1N252.

Several readers have also asked where the selectivity curve is 500-Hz wide and what is its slope. The filter I used was designed to have its 500-kHz passband at the 3-dB points on a slope which is not particularly steep for an inductive filter. Indeed, at 500 Hz, the L3 inductance is very loosely coupled to the other two sections of the transformer. The bandpass formula \( f_c / Q_0 \) indicates that the bandpass of the filter is actually narrower than
500 Hz – in fact, bandpass is closer to 250 Hz. The 390-ohm resistor used in series with one of the differential inputs loads the thing down so it is broader. If the bandpass is too narrow, poor lock-in range is experienced on a-m, and there is very poor “presence” in the quality of sb signals. If the bandpass is too wide, poor impulse rejection will result.

Stirling M. Oberg, W1SNN
Waltham, Massachusetts

vhf fm in the United Kingdom

Dear HR:

Fm channel operation in the United Kingdom is now going strong, thanks to the imported black boxes and new regulations permitting 12.5-kHz deviation (there are lots of 25-kHz mobile equipment around, made by Pye and Storno). We now have one repeater working north of London in Hertfordshire. The callsign is GB3PI with input at 145.15 MHz and output at 145.75 MHz (600-kHz spacing). This repeater just covers outer N. London.

Our Radio Society of Great Britain now has at least five applications for repeaters, and our group, the UK FM Group (Southern), hopes to be able to put a repeater in Hampshire (one of five). Coverage of this repeater should be from Southampton to the edge of southwest London.

John Akam, G8BIH
Wooteys, Alton, Hants

finding square roots

Dear HR:

The technique for computing square roots described in the ham notebook by K9DHD in the September, 1973, issue of ham radio can be extended to increased accuracy by carrying out further iterations. For example, if one uses the first approximation of the square root of 54 obtained as the next estimate and recomputes, an answer of 7.348469 is obtained; this closely approximates the 7.348692 provided by the square root key on my calculator.

As another example, my calculator gives the square root of 75 as 8.660254. Using the Mechanic’s Rule, first iteration results in an answer of 8.6875, the second then becomes 8.6602965, and the third the desired 8.660254 whose square is 74.999999. These answers were obtained using the very crude first estimate of 8.

Fred R. Scaff, Jr., K4E1D
Springfield, Virginia

Dear HR:

I would like to add a note to the short article on finding square roots which appeared in the September, 1973, issue of ham radio.

In that article K9DHD gave a procedure for estimating the square root of any number. By a simple extension, arbitrary roots of any number can be determined with a little work and a hand-held digital calculator. To find the nth root of any number P, estimate the root, $X_o$, and use the following formula

$$ X_1 = \frac{1}{n} \left[ \left( n - 1 \right) X_0 + \frac{P}{X_0^{n-1}} \right] $$

where $X_1$ is the desired root. For the case of a square root, $n = 2$, this formula is the same as that presented by K9DHD. For a cube root, $n = 3$, and the formula is

$$ X_1 = \frac{1}{3} \left( 2X_0 + \frac{P}{X_0^2} \right) $$

For example, to find the cube root of 30, first estimate the cube root (about 3.1). Then

$$ X_1 = \frac{1}{3} \left[ (2 \times 3.1) + \left( \frac{30}{3.1^2} \right) \right] = 3.107 $$

This is very close to the accepted, approximate, cube root of 30, 3.1072. Of course, the closer your initial estimate, the closer the answer will be to the exact value. With a little patience, this formula will do great service to anyone making use of it.

Stephen R. Alpert, W1GGN
Auburn, Massachusetts
surplus thumbwheel switch modification

At this year's Rochester Hamfest I picked up at a bargain price an assembly of thumbwheel switches made for Fairchild consisting of 20 Digiswitch C units. I needed these to complete my frequency synthesizer. I took a chance on these switches in spite of the fact that the connector terminals plainly showed they were coded 1 2 4 2' (the last number is read, "two prime") and not the 1 2 4 8 BCD called for in most synthesizers. I took this calculated risk since, first, I am a cheapskate and the price was too good to resist, and second, I hoped to convert the switching to the required coding.

I am happy to say that I was successful in converting the switches to the desired coding, and I offer the following for other bargain hunters since these switches appear to be in plentiful supply and will probably be showing up on the surplus market. Since the old 1242' code is passe' now, these switches can be purchased for one-tenth of their original cost. The time required to rework each switch amounts to 7 to 10 minutes, so one evening's work can yield all the switches necessary for a two-frequency synthesizer.

These switches can be identified by placing a single unit so the thumbwheel number is right side up and facing to the right. The edge connector coming out the back then indicates, from bottom to top, 335-1, which I presume is the model number, C (common), and 1 2 4 2'. To modify the switch, remove the PC board from the case and set it on the bench so the inside is facing upwards, and the gap is oriented at 9 or 10 o'clock. Using an Xacto knife, remove a thin sliver of the conducting material from the second and third contacts from the center as shown in fig. 1. The cut edges should be bevelled so the moving contact can slide up and over easily.

At the same time, remove the 2' designation and scratch in an 8 in its place. Turn the PC board over and, referring to fig. 2, cut away all the conducting material indicated by the crosshatch. From a small length of approximately no. 22 stranded wire use a single strand to solder in the three jumpers.
ers where shown. Be sure the solder doesn’t lump up since these switches have minimal clearance between units when stacked. For best results use a small soldering iron.

Table 1. With an ohmmeter connected between the common and pins 1, 2, 4 and 8, respectively, of the modified Digiswitch, you should obtain the following readings:

<table>
<thead>
<tr>
<th>number</th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>open</td>
<td>open</td>
<td>open</td>
<td>open</td>
</tr>
<tr>
<td>1</td>
<td>short</td>
<td>open</td>
<td>open</td>
<td>open</td>
</tr>
<tr>
<td>2</td>
<td>open</td>
<td>short</td>
<td>open</td>
<td>open</td>
</tr>
<tr>
<td>3</td>
<td>short</td>
<td>short</td>
<td>open</td>
<td>open</td>
</tr>
<tr>
<td>4</td>
<td>open</td>
<td>open</td>
<td>short</td>
<td>open</td>
</tr>
<tr>
<td>5</td>
<td>short</td>
<td>open</td>
<td>short</td>
<td>open</td>
</tr>
<tr>
<td>6</td>
<td>open</td>
<td>short</td>
<td>short</td>
<td>open</td>
</tr>
<tr>
<td>7</td>
<td>short</td>
<td>short</td>
<td>short</td>
<td>open</td>
</tr>
<tr>
<td>8</td>
<td>open</td>
<td>open</td>
<td>open</td>
<td>short</td>
</tr>
<tr>
<td>9</td>
<td>short</td>
<td>open</td>
<td>open</td>
<td>short</td>
</tr>
</tbody>
</table>

When you are finished, put the two parts together and check out the switching sequence to make sure it agrees with Table 1. Use an ohmmeter, one lead on C and the other lead on 1 2 4 and 8, respectively, to make sure the BCD sequence is correct.

Geo. Hrischenko, VE3DGX

Reference

Cutting a Minibox Down to Size

Although several sizes of metal boxes and chassis are available to experimenters, sometimes the nearest size for your project is a little too large. It is not difficult to reduce the height of a two-piece metal box. One-half of the box is the top and two ends; the other half is the bottom and two sides.

From the first piece cut down the ends to the desired height. On the other piece cut down the sides to the same height. The result is a Minibox that fits and looks as good as the original, but which has less height.

1. Queen, W2OUX

Finding the Focal Length of Surplus Microwave Dish Antennas

The focal length of most parabolic dish antennas can be determined with two simple measurements, the diameter and the depth as shown in Fig. 3. The antenna's surface can be described by

\[ Y^2 = 4Px \]

where \( P \) represents the distance from the vertex to the focal point. The equation is that of a parabola with its vertex at \( x = 0, \ Y = 0 \). The curve is symmetric about the x-axis and opens to the plus-x direction. The coordinates of one point other than the vertex are needed to determine the curve. The edge of the antenna is a convenient point. The diameter is equal to \( 2Y \) and the depth is equal to \( x \). Solving for the focal length \( P \)

\[ P = \frac{Y^2}{4x} = \frac{(\text{diameter})^2}{4(\text{depth})} \]

or

\[ P = \frac{1}{16} \frac{(\text{diameter})^2}{\text{depth}} \]

The units of \( P \) are the same as those used to measure the depth and diameter. This method also works for orange-peel or segment dishes, but cannot be applied directly to off-center-feed dish antennas.

John M. Franke, WA4WDL
Linear Systems has announced the introduction of a new amateur transceiver for use on the 6-meter band. The transceiver, known as the SB-50, is completely solid-state and weighs only 7 pounds. The SB-50 is synthesized with variable frequency control of both receiver and transmitter with separate receiver incremental tuning control. It covers the band from 50.05 to 50.28 MHz. The new transceiver should be especially useful for mobile installations since it contains a very effective noise limiter.

The SB-50 is rated at 20-watts PEP input and 8-watts a-m. Receiver sensitivity is less than 0.5 microvolt for 10-dB $S + N/N$ and selectivity of 20 dB at 3 kHz and 60 dB at 6 kHz. Additional features include a lighted S-meter which indicates receive signal strength as well as power output in both the ssb and a-m mode, separately adjustable receiver incremental tuning and an external speaker connection. The transceiver comes equipped with push-to-talk dynamic microphone and mobile mounting bracket.

For further information regarding the new SBE SB-50 6-meter transceiver, write to Linear Systems, Inc., 220 Airport Boulevard, Watsonville, California 95076, or use check-off on page 94.

two-meter converter

Janel Labs has announced a new crystal-controlled two-meter converter that combines an impressive list of performance features with a low selling price. This new converter, the 144CC, rounds out the Janel line that already includes the deluxe 144CA high performance two-meter converter. Other products include converters for 50, 220 and 432 MHz as well as a complete line of receiving preamps.

The new 144-MHz converter uses gate-protected dual-gate mosfets to provide high sensitivity while avoiding serious overload effects. The carefully designed circuit allows full utilization of the mosfet sensitivity with one rf amplifier. This is of great help in preventing cross-modulation overload by keeping the signal level low at the mixer. It allows reception of signals with 15 to 20 dB greater strength than is possible for converters with two rf stages.

The converter is virtually free from birdies due to the use of a seventh overtone crystal oscillator. This high overtone oscillator eliminates the need for frequency multipliers. This feature, standard in all Janel converters, is very effective in reducing suprious responses. Three tuned circuits between the rf amplifier and the mixer complete the defense against spurious responses.
An attractive, metallic green, die-cast cabinet is used with this compact converter. BNC connectors are provided on the back panel for input and output. A power connector for 12 Vdc is also provided. Gain is 20 dB and noise figure is 3 to 5 dB. Converters are available for i-f frequencies of 26-30 MHz or 28-32 MHz. The units, completely guaranteed, are priced at an economical $49.95, postpaid. Order from Janel Laboratories, Box 112, Succasunna, New Jersey 07876. For more information, use check-off on page 94.

general-purpose op-amps

Teledyne Semiconductor has introduced a low cost, general purpose operational amplifier series, LM 141/142, which fills the performance gap between the 741 and 108 type op amps. Improved electrical characteristics of the new series include an increased slew rate of 2V/µs providing full output voltage swing through the audio frequency range and reduced input bias current of 30 mA maximum and 5 mA input offset current maximum.

The LM 141 series is fully compensated internally and is compatible with existing circuit designs of the popular 741, 107 and 1556. The uncompensated LM 142 series is a replacement for 101A, 748 and 777 applications and approaches the input performance of the 108 series amplifiers at a significant price reduction. The LM 141/142 is expected to fit applications where the 741 falls short on speed and impedance performance. They have excellent characteristics for sample

Mobile Antennas should be judged on the basis of ruggedness, ease of installation and performance... mostly performance. Larsen Kälrod Antennas are "solid" on all scores. They have a low, low silhouette for best appearance and minimum wind drag. Hi-impact epoxy base construction assures rugged long life. The Larsen mount gives you metal to metal contact, has only 3 simple parts and goes on fast and easily.

And performance! Larsen Antennas for the 144-148 MHz range deliver a full 3 db gain over a 1/4 wave whip. V.S.W.R. is less than 1.3 to 1. The exclusive Larsen Kälrod assures you no loss of RF through heat. Handles full 150 watts.

It all adds up to superior performance... just one of many reasons why Larsen Antennas are the fastest growing line in the commercial field in both the U.S. and Canada. Available as antennas only or complete with mounting hardware coax and plug. Write today for fact sheet and prices.

Need a BETTER 450 MHz Antenna?
Get the Larsen 5 db gain Phased Collinear. Same rugged construction and reliability as the 2 meter Larsen Antennas including exclusive Kälrod. Write for full fact sheet.

Larsen Antennas
1161 N.E. 50th Ave. • Vancouver, WA 98665
Phone: 206/695-5383
For fastest mail service address:
P.O. Box 1686 – Vancouver, WA 98663

©Kälrod... a trademark of Larsen Electronics

All Mobile Antennas are NOT alike.

Larsen Antennas
with exclusive Kälrod
let you
HEAR the difference!
HERE IS A FIST FULL of 2 METER POWER

Model HRT-2
5 Channel, Narrow Band
2.2 watt FM Transceiver

This light weight, "take anywhere" transceiver has the "Regency-type" interior componentry to give you what others are looking for in portable communications. You get a heavyweight 2.2 watt signal . . . or if you want, flip the HI/LO switch to 1 watt and the receiver gives you 0.7 uv sensitivity and 0.5 watts audio. Both transmitter and receiver employ band-pass circuitry so that power and sensitivity are maintained across the entire band. Get one to go . . . only $179.00

Amateur Net

E&L Instruments has developed a new power supply designed primarily for ham radio enthusiasts. The unit, called the PW-4, produces enough power to operate both an FM transceiver and an amplifier simultaneously. The new PW-4 uses 110-120 volt ac input power, and produces a rated output of 13 volts dc at 10 amps, IC regulated to ±3%. This increased power capability means that amateurs with mobile units in their cars may take them into homes for use at night. The
PW-4 features a modern cabinet design, current limiting and reliable heavy-duty components.

It can be used with most 12 to 13-volt dc transceivers, together with 50 to 60-watt amplifiers. The PW-4 is available direct from the factory, or from local distributors, at $84.95. For more information contact E&L Instruments, Inc., 61 First Street, Derby, Connecticut 06418, or use check-off on page 94.

**programmable voltage regulator**

A 100-watt hybrid silicon voltage regulator capable of line regulation of 0.10 percent and load regulation of 0.15 percent has been introduced by Motorola. The new MPC1000 is a 10-ampere positive or negative series voltage regulator capable of operating with input voltages as high as 60-volts. Output voltage can be adjusted from 2 to 35-volts.

Output currents of 10-amperes are easily obtained from the MPC1000 without external pass transistors; however, circuits using external pass transistors can expand the capability of the regulator to handle currents in excess of 50-amperes. Current limiting protection also has been built-in to protect the regulator from excessive surge currents.

The price for the MPC1000 in a 9-pin, metal TO-3 package is $14.95 in single unit quantities. For more information contact the Technical Information Center, Motorola Inc., Semiconductor Products Division, P.O. Box 20924, Phoenix, Arizona 85036, or use check-off on page 94.

---

**Regency HR-2B gives a lot to talk over**

**Full 12 Channel, 15 Watts with HI/LO power switch**

Here is everything you need, at a price you like, for excellent 2 meter FM performance. The 12 transmit channels have individual trimmer capacitors for optimum workability in point-to-point repeater applications. Operate on 15 watts (minimum) or switch to 1 watt. 0.35 uv sensitivity and 3 watts of audio output make for pleasant, reliable listening. And the compact package is matched by its price. $229.00

Amateur Net

---

**Regency ELECTRONICS, INC.**

7707 Records Street

Indianapolis, Indiana 46226

**An FM Model For Every Purpose . . . Every Purse**

---

More Details? CHECK-OFF Page 94
slinky dipole antenna

The Slinky Dipole is a new Amateur antenna which combines good performance with practical size and the ability to erect or disassemble in a minimum time. It requires no matching network for low vswr operation in 50-ohm systems, and can be installed indoors in an attic or crawl space with 25- and 70-feet of available length.

The Slinky Dipole operates at 80, 40 and 20 meters and comes in kit form, including a balun, center insulator, 50-feet of RG-58/U coaxial feedline, a PL259 connector and a pair of specially made Slinky helical spring conductors. Assembly of the antenna from the kit components takes about one-half hour, and the initial setup from the completed kit to an operating antenna can be accomplished in another 30 to 60 minutes, depending on the particular installation.

The performance of the antenna is as good as that of a full-size dipole. The power capacity of the antenna is 1000 watts CW (2000 watts PEP on ssb), and the vswr is typically less than 2.5:1 over the full 80/75-meter band and less than 1.8:1 over the full 40- and 20-meter bands.

The antenna is very versatile. As opposed to normal dipole antennas which only operate at discrete lengths, the Slinky Dipole will perform for any available length between 24' and 70' on 80/75 meters, between 12' and 35' on 40 meters, and between 18' and 6' on 20 meters. The antenna will also work in an apartment house, provided that the steel supports used in the construction are more than 150-feet apart for 75-meter operation (75-feet apart for 40-meter operation), and that the walls are essentially non-conducting.

The price for the complete antenna kit is $24.95, including all accessories, or $14.95 for the special Slinky coils alone. Include $1.00 for shipping. For more information, write to Teletron Data Corporation, 2950 Veterans Memorial Highway, Bohemia, L.I., New York 11716, or use check-off on page 94.
variable rf attenuator

Singer Instrumentation's new variable rf attenuator operates from dc to 500 MHz with an attenuator range of 10 to 60 dB. It is particularly suitable for coupling between instruments, checking transmitter output and receiver system degradation. Power dissipation is 100 mW. Input and output impedances are 50 ohms. Typical accuracy curves for each 10 dB of attenuation over the full frequency range are provided. The unit is priced at $130 and is available from Singer Instrumentation, 3211 South LaCienega Boulevard, Los Angeles, California 90016. For more information, use check-off on page 94.

eliminating engine interference

Engine interference has long been a major problem to amateur mobile operators. This new book is concerned with solving this problem in a practical manner. It explains why modern engines create interference and discusses the parts of the engine that contribute to the problem. Instructions are included on how to identify and isolate the specific components that generate noise.

Commercial noise-suppression and shielding techniques are discussed, and instructions are given for their installation. Diagrams covering the most common types of automobile ignition wiring have been included. Automatic noise limiters are also covered as are such other interference problems as instruments, wheels and tires, turn and stop signals, power-supply vibrators and antennas. 128 pages, softbound, $4.50 from HR Books, Greenville, New Hampshire 03048.
short circuits

capacitance meter

In the circuit for the capacitance meter on page 50, of the August, 1972, issue there should be a 2200-ohm resistor connected between the base of transistor Q1 and the -6 volt bus.

motorola dispatcher conversion

Inquiries and parts orders for this popular Motorola conversion should now be sent to the author at his new address: John Darjany, WB6HXU, 622 Pacific Avenue, Long Beach, California 90802.

vhf superregen receiver

In the July, 1973, issue, on page 23, the schematic for the vhf regenerative receiver should include a 0.01-μF capacitor between the wiper of the 5000-ohm gain control and the base terminal of the first T1S97 transistor.

continuous-phase audio-shift keyer

In the continuous-phase audio-shift keyer published in the October, 1973, issue the 2N5033 field-effect transistors used at Q1 and Q3 must be Fairchild's. It has been found that 2N5033s from other manufacturers have a different "on" resistance and are not usable in this application.

two-meter cavity filter

The dimensions for the two-stage, vhf cavity filter shown in fig. 3 on page 25 of the December, 1973, issue are incorrect. Use the following corrected dimensions when building this filter.
LIKE FM OR CW?

Then you'll love Data Engineering's new catalog

Write for your free copy today!

TOUCH TONE PADS
More features than any other pad including built-in monitor speaker and latest Phase-Lock loop circuitry.

TTP-1 Standard pad for portable transceiver mounting.
TTP-2 Standard pad in attractive case for home or mobile use.
TTP-3 Mini-pad in attractive case for home or mobile use.
TTP-4 Mini-pad for portable transceiver mounting.

TTP-1, 2, 3 & 4, Sh. wt. 1 lb. $44.50

CRICKET 1
A popularly priced IC keyer with more features for your dollar. Cricket 1 is a small size, solid state keyer designed for the beginner as well as the most advanced operator. It provides the user with fatigue-free sending and its clean, crisp CW allows for easy copying at all speeds. Turned on its side, the Cricket can be used as a straight key for manual keying.

CRICKET 1 Sh. Wt. 3 lbs. $49.95

2-METER PREAMP
Specially made for both OLD and NEW receivers. The smallest and most powerful preamp available. Provides 20dB gain at 2.5 N.F. to bring in the weakest signals.

Sh. wt. 4 oz. $9.50 kit
$12.50 wired

Please include sufficient postage for shipping.

DATA ENGINEERING INC.
Ravenswood Industrial Park, Springfield, Va. 22151
5554 Port Royal Road • 703-321-7171

More Details? CHECK-OFF Page 94 March 1974
LEARN RADIO CODE!

THE EASY WAY!

- No Books To Read
- No Visual Gimmicks To Distract You
- Just Listen And Learn

Based on modern psychological techniques - This course will take you beyond 13 w.p.m. in less than half the time! Available on magnetic tape $9.95 - Cassette $10.95

EPSILON RECORDS
508 East Washington St., Arcola, Illinois 61910

NEW FOR 74

ECM 5A FM modulation Meter

Only $55.00

WHY FIGHT QRM & QRN?

Are your CW contacts lost because of QRM or QRN? The NEW DE-101 family of Signal Discriminators is designed to fight QRM and QRN for you without rig modifications. Each discriminator unit consists of two 3 pole operational amplifier filters stagger tuned for a flat 100 hertz bandwidth at 1000 Hz. A buffer amplifier is included for driving earphones, or a 3 watt power amplifier for driving an 8 ohm speaker. No adjustments, factory tuned, plug in installation, 1 year warranty, and 15 day return privilege.

DE-101 For earphones only. 115 Vac $29.95 + $2.00 ship.
DE-101A For spkr & phones. 115 Vac $39.95 + $2.00 ship.
DE-101B For spkr & phones. 12 VDC $29.95 + $1.00 ship.
DE-101C For earphones only. 12 VDC $19.95 + $1.00 ship.
CB-1 Wired & tested DE-101C circuit board $14.95 ppd.
CB-2 3 Watt Audio PWR AMP for 8 ohm spkr. 12 VDC Kit $7.95 ppd. Wired & tested $10.95 ppd.

For Al. residents add 5% sales tax.

ECM CORPORATION
412 N. Wenchach Ave.
Evansville, Indiana 47711

DYNAMIC ELECTRONICS INC.
BOX 1131
DECATUR, AL. 35601

NEW AND SURPLUS ELECTRONIC COMPONENTS FOR THE PRO AND SERIOUS AMATEUR. AN ORDER OR 8c STAMP PUTS YOU NEW FOR 58.

ECM 5A FM Modulation Meter

Only $55.00

NEW AND SURPLUS ELECTRONIC COMPONENTS FOR THE PRO AND SERIOUS AMATEUR. AN ORDER OR 8c STAMP PUTS YOU NEW FOR 58.

ECM 5A FM Modulation Meter

Only $55.00

NEW AND SURPLUS ELECTRONIC COMPONENTS FOR THE PRO AND SERIOUS AMATEUR. AN ORDER OR 8c STAMP PUTS YOU NEW FOR 58.

ECM 5A FM Modulation Meter

Only $55.00

NEW AND SURPLUS ELECTRONIC COMPONENTS FOR THE PRO AND SERIOUS AMATEUR. AN ORDER OR 8c STAMP PUTS YOU NEW FOR 58.

ECM 5A FM Modulation Meter

Only $55.00

NEW AND SURPLUS ELECTRONIC COMPONENTS FOR THE PRO AND SERIOUS AMATEUR. AN ORDER OR 8c STAMP PUTS YOU NEW FOR 58.

ECM 5A FM Modulation Meter

Only $55.00

NEW AND SURPLUS ELECTRONIC COMPONENTS FOR THE PRO AND SERIOUS AMATEUR. AN ORDER OR 8c STAMP PUTS YOU NEW FOR 58.

ECM 5A FM Modulation Meter

Only $55.00

NEW AND SURPLUS ELECTRONIC COMPONENTS FOR THE PRO AND SERIOUS AMATEUR. AN ORDER OR 8c STAMP PUTS YOU NEW FOR 58.
**FT-2 Auto**

A High Performance AUTO SCAN 2 Meter Mobile or Fixed Station Transceiver with Built-in AC Supply.

**TRANSMITTER**

**RF Output:**
- 10 watts (HI) or 1 watt (LOW) into 50-ohm load at 13.5 volts DC.

**Frequency Stability:**
- ±0.001%

**Crystal Multiplication:**
- 8 times

**Modulation:**
- F3 (phase modulation)

**Deviation:**
- Up to ±15 kHz (factory adjusted at ±7.5 kHz)

**Audio Response:**
- +1, -3 dB of 6 dB/octave pre-emphasis characteristic from 300 to 2500 Hz

**Spurious Emissions:**
- 60 dB below carrier minimum

**Tone Burst:**
- Normally one second at 1800 Hz (adjustable between 1300 and 3000 Hz)

---

**RECEIVER**

**Type:**
- Double conversion superhet (crystal controlled)

**Intermediate Frequency:**
- 10.7 MHz first IF; 455 kHz second IF

**Sensitivity:**
- 0.3 uV for 20 dB S/N/N ratio

**Selectivity:**
- ±15 kHz at 6 dB; ±25 kHz at 60 dB

**Audio Output:**
- 2 watts at 10% distortion

---

**Price - $379.00**

Price Subject To Change Without Notice

Frequency coverage 146-148 MHz, 8 channels, 3 simplex channels furnished — 146.76, 146.82, 146.94 MHz. Scan speed: 20/sec. Priority channel at 2 sec. intervals, even when locked on another channel. AC power supply built-in. DC current receive: 53 amps. Transmit .92 amps. Low power: 2.1 amps High power. Signal strength and relative output meter on front panel. Discriminator metering available at accessory plug. Size: 8¼ x 4¼ x 11¾. Weight: 9 lbs. All plugs and cables furnished.

---

More Details? CHECK-OFF Page 94
When you want an authoritative, up to date directory of licensed radio amateurs
It's the CALLBOOK

Over 210,000 QTH's in the DX edition
DX CALLBOOK for 1974
$8.95

Over 285,000 QTH's in the U.S. edition
U.S. CALLBOOK for 1974
$9.95

See your favorite dealer or Send today to
(Mail orders add 50c per CALLBOOK for postage and handling)

WRITE FOR FREE BROCHURE

GATEWAY ELECTRONICS
8123 PAGE AVENUE
ST. LOUIS, MISSOURI 63130
314-427-6116

COLLINS MECHANICAL FILTER — Round case
- from R-390A — 2kHz, 4 kHz, 8 kHz or 16 kHz, 445 kHz center freq. $15.00
VACUUM VAR. COND. — JENNINGS UXC 500
- 500 mmf. — 15 KV $35.00
TEKTRONIX 527 WAVEFORM MONITOR — Ex
Cond. — less case $295.00
GEL-CELL RECHARGEABLE BATTERY — 6 volt-
1 Amp 1 1/4 x 2 x 2 $3.50
0.1" PUNCHED BOARD — Standard spacing
for IC's
Phenolic — 4.5 x 5.125 - $1.49, 4.5 x 17 - $3.19,
6 x 17 - $4.19
Epoxy — 4.5 x 6.5 - $1.69, 4.5 x 8.5 - $2.10
4.5 x 17 - $3.83
Push in Terminals for above boards — Package
of 100 terminals — $1.80
8 x 8 1/2" SINGLE SIDED PHENOLIC PC BOARD
50c-
TRANSISTORS — 2N2219 NPN Sil - 50c, 2N2222
NPN Sil - 50c, 2N2905 PNP - 50c, 2N2646 Uni-
junct - 70c, 2N3394 NPN Sil - 20c, 2N3569 NPN
Sil - 45c, 2N3567 NPN Sil - 40c, 2N3905 PNP
Sil - 30c, 2N4072 NPN Sil RF - 75c 2N4852
Uni-junct - 70c, MJE1093 Pwr Darlington - $2.25

$5 Minimum Order.
Visit us when in St. Louis.
Please include sufficient postage.

the latest...
FROM
• FCC
• ARRL
• INDUSTRY
• PROPAGATION
• CONTESTS
• DX

ISSUE
AFTER ISSUE
AFTER ISSUE!

*24 issues per year
for more when things get busy

A four page instant
newsletter in the mail
when it happens: not weeks later.

1 year $12.00 US, Canada & Mexico — $15.00 Worldwide

More Details? CHECK-OFF Page 94
CW or RTTY, whichever way you go,

HAL HAS TOP QUALITY YOU CAN AFFORD!

TOP QUALITY RTTY... WITH THE HAL MAINLINE ST-6 TU. Only 7 HAL circuit boards (drilled G10 glass) for all features, plug-in IC sockets, and custom Thordarson transformer for both supplies, 115/230 V, 50-60 Hz. Kit without cabinet, only $135.00; screened, punched cabinet with pre-drilled connector rails, $35.00; boards and complete manual, $19.50; wired and tested units, only $280.00 (with AK-1, $320.00).*

OTHER HAL PRODUCTS INCLUDE:
ID-1 Repeater Identifier (wired circuit board)... $75.00*
ID-1 (completely assembled in 1½" rack cabinet) $115.00*
HAL ARRL FM Transmitter Kit $50.00*
W3FFG SSTV Converter Kit $55.00*
Mainline ST-5 TU Kit $50.00*
Mainline AK-1 AFSK Kit $27.50*

TOP QUALITY... WITH THE HAL 1550 ELECTRONIC KEYER. Designed for easy operation; perfectly timed CW with optional automatic ID for sending call letters, great for DX and RTTY; TTL circuitry, transistor switching for grid block, cathode keying. Handsome rugged crackle cabinet with brushed aluminum panel. With ID, only $90.00; without ID, $65.00.*

TOP QUALITY... WITH THE HAL MKB-1 MORSE KEYBOARD. As easy as typing a letter—you get automatic CW with variable speed and weight, internal audio oscillator with volume and tone controls, internal speaker, and audio output jack. Smooth operation: completely solid-state, TTL circuitry using G10 glass boards, regulated power supplies, and high voltage transistor switch. Optional automatic ID available. Assembled MKB-1, $275.00. In kit form, $175.00.*

NEW FROM HAL—TOP QUALITY RVD-1002 RTTY VIDEO DISPLAY UNIT. Revolutionary approach to amateur RTTY... provides visual display of received RTTY signal from any TU, at four speeds (60, 66, 75, and 100 WPM), using a TV receiver modified for video monitoring. Panasonic solid-state TV receiver/monitor, or monitor only, available. RVD-1002, $525.00; Panasonic TV receiver/monitor, $160.00; monitor only, $140.00.*

HAL provides a complete line of components, semi-conductors, and IC's to fill practically any construction need. Send 24¢ to cover postage for catalog with info and photos on all HAL products. Above prices do not include shipping costs. Please add 7½¢ on parts orders, $2.00 on larger kits. Shipping via UPS whenever possible; therefore, street address required.

HAL COMMUNICATIONS CORP.
Box 365 L, Urbana, Ill. 61801 • 217-359-7373

More Details? CHECK-OFF Page 94
VHF POWER AMPLIFIERS

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Model</th>
<th>Input Range</th>
<th>Nominal Po.</th>
<th>Nominal Amps</th>
<th>Price ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 144</td>
<td>PA10-128B</td>
<td>1 - 3</td>
<td>12</td>
<td>1.8</td>
<td>164.95</td>
</tr>
<tr>
<td>1 160</td>
<td>PA10-40B</td>
<td>5 - 15</td>
<td>40</td>
<td>5.0</td>
<td>79.95</td>
</tr>
<tr>
<td>1 180</td>
<td>PA10-70B</td>
<td>1 - 4</td>
<td>70</td>
<td>8.0</td>
<td>149.95</td>
</tr>
<tr>
<td>1 200</td>
<td>PA10-100B</td>
<td>5 - 15</td>
<td>100</td>
<td>15.0</td>
<td>179.95</td>
</tr>
<tr>
<td>1 220</td>
<td>PA10-140B</td>
<td>15 - 40</td>
<td>140</td>
<td>20.0</td>
<td>169.95</td>
</tr>
<tr>
<td>1 240</td>
<td>PA10-240</td>
<td>1 - 4</td>
<td>40</td>
<td>7.0</td>
<td>139.95</td>
</tr>
<tr>
<td>1 260</td>
<td>PA10-320C</td>
<td>1 - 4</td>
<td>320</td>
<td>6.0</td>
<td>149.95</td>
</tr>
</tbody>
</table>

*Availability to be announced*

SEND FOR FULL CATALOG ON VHF AMPLIFIERS AND HF-VHF-UHF ANTENNAS.

DEALER INQUIRIES INVITED

AK-1 BOARD ONLY $3.25
AK-1 KIT OF ELECTRONIC PARTS $20.00
ST-5 BOARDS ONLY $5.25
ST-5 KIT OF ELECTRONIC PARTS $47.50
ST-5A BOARDS ONLY $5.25
ST-5A KIT OF ELECTRONIC PARTS $54.00
ST-6 BOARDS ONLY (These are the 8 original by W6FFC) $18.00
ST-6 KIT OF ELECTRONIC PARTS $128.50
MOD. KIT FOR UPDATING THE ST-5 TO THE ST5A $9.00
PEMCO 250 EIGHT DIGIT COUNTER WITH BUILT-IN PRE-SCALER AND POWER SUPPLY SEMI-KIT $165.00
PEMCO MODEL 50A FREQUENCY COUNTER SEMI-KIT $125.00

These are fully assembled and tested boards only, you add your own cabinet, etc. Write for details.

You must supply the cabinet, A.C. cord, meter, switches, etc. on all kits except where noted otherwise. (All prices are postage paid (we pay shipping). We will do most any printed circuit board for individuals or prototypes. If required we will also do the layout of the boards. All our boards are 6×10 glass-epoxy solder-plated and come drilled only. At present we can do only single sided. All component parts used in our kits are new manufacturers stock. We Do Not Use Any Used or Surplus Parts. All inquiries are answered promptly.

PEMCO ELECTRONICS MANUFACTURING
422 18th St., N.E., Salem, Ore. 97301, (503) 585-1262

KITS

<table>
<thead>
<tr>
<th>Encoder</th>
<th>Sub-Audible Tone Decoder</th>
<th>Wired</th>
</tr>
</thead>
<tbody>
<tr>
<td>$8.95</td>
<td>$13.95</td>
<td></td>
</tr>
</tbody>
</table>

- Compatible with all sub-audible tone systems such as Private Line, Channel Guard, Quiet Channel, etc.
- Glass epoxy PCB's & Silicon xtrs throughout
- Any reeds, except special dual coil types may be used: Motorola, G.E., RCA, S.D.L., Branco, etc.
- All are powered by 12 vdc
- Use on any tone frequency 67 Hz to 250 Hz
- Small size 1.5 x 4 x .75"n
- All parts included except Reed and Reed socket
Postpaid — Calif. residents add 5% sales tax

COMMUNICATIONS SPECIALISTS
P. O. Box 153, Brea, CA 92621

LOW PRICES ON POPULAR COMPONENTS

IF FILTERS
- Monolithic crystal filters at 10.7 and 16.9 MHz
- Ceramic filters at 455 kHz

SEMI CONDUCTORS
- VHF power transistors by CTC-Varian
- J and MOS FETS
- Linear ICs — AM/FM IF, Audio PA
- Bipolar — RF and AF popular types

INDUCTORS
- Molded chokes
- Coil forms — with adjustable cores

CAPACITORS
- Popular variable types

QUALITY COMPONENTS
- No seconds or surplus
- Name brands — fully guaranteed
- Spec sheets on request

GREAT PRICES
- Price breaks at low quantities
- Prices below large mail-order houses

WRITE FOR CATALOG 173

AMTECH
P. O. BOX 624, MARION, IOWA 52302
(319) 377-7927 or (319) 377-2638
TOMORROW'S RIG ...available TODAY!

The exciting all new INOUE IC-230!

TAKE A SLICE OUT OF THE FUTURE...

...and put 67+ CHANNELS* of 2-meter FM pleasure in the palms of your hands... with the SUPER COMPACT (2.3" x 6.1" x 9.7") IC-230.

Feature-wise... the IC-230 is fully synthesized (with the new exclusive “Phase Lock Loop System”)... all modular construction (servicing is a snap—in and out) ...
...a receiver that is very sensitive and selective as to what it hears (better than 0.4UV/20db), with unique Inoue helical filters to eliminate intermod ...plus a super E filter mosfet front end, making copy a pleasure.

* And not a crystal to buy with the exclusive "Phase Lock Loop System".
(That's close to $650.00 worth of xtals!)

-- GRAB HOLD OF THE IC-230 AT YOUR LOCAL DEALER TODAY --

Distributed by:

ICOM WEST, INC.
Suite 232 — Bldg. II
300 - 120th Ave. N.E.
Bellevue, Wash. 98005
(206) 454-2470

ADIRONDACK
RADIO SUPPLY
185 West Main Street
Amsterdam, N.Y. 12010

ICOM EAST
Div ACS, Inc.
Box 331
Richardson, Tex. 75080
(214) 235-0479

march 1974
SB-36 — personalized station and — with half-a-thousand watts p.e.p. input, a table-top powerhouse. But much more! Picture the precision, 6-digit counter that reads out your frequency as fast as you can spin the free-turning, counter-weighted tuning knob. And see how RIT (Receiver Incremental Tuning) obsoletes older, zero-beat-only transceiver operation — prevents leapfrogging. Push the RIT button — zero-in received sigs ±7kHz — without effecting transmit frequency! Also, change sidebands without beat note shift or retuning. It takes two 9MHz crystal lattice filters to do this job. SB-36 has 'em.

WRITE FOR COMPLETE BROCHURE.

LINEAR SYSTEMS, INC.
220 Airport Blvd., Watsonville, CA 95076
for the EXPERIMENTER!

INTERNATIONAL EX CRYSTAL & EX KITS
OSCILLATOR • RF MIXER • RF AMPLIFIER • POWER AMPLIFIER

1. MXX-1 TRANSISTOR
RF MIXER
A single tuned circuit intended for signal conversion in the 3 to 170 MHz range. Harmonics of the OX oscillator are used for injection in the 60 to 170 MHz range. Lo Kit 3 to 20 MHz, Hi Kit 20 to 170 MHz (Specify when ordering) $3.50

2. SAX-1 TRANSISTOR
RF AMP
A small signal amplifier to drive MXX-1 mixer. Single tuned input and link output. Lo Kit 3 to 20 MHz, Hi Kit 20 to 170 MHz (Specify when ordering) $3.50

3. PAX-1 TRANSISTOR
RF POWER AMP
A single tuned output amplifier designed to follow the OX oscillator. Outputs up to 200 mw, depending on the frequency and voltage. Amplifier can be amplitude modulated. Frequency 3,000 to 30,000 KHz $3.75

4. BAX-1 BROADBAND
AMP
General purpose unit which may be used as a tuned or untuned amplifier in RF and audio applications 20 Hz to 150 MHz. Provides 6 to 30 db gain. Ideal for SWL. Experimenter or Amateur $3.75

5. OX OSCILLATOR
Crystal controlled transistor type. Lo Kit 3,000 to 19.999 KHz, Hi Kit 20,000 to 60,000 KHz. (Specify when ordering) $2.95

6. TYPE EX CRYSTAL
Available from 3,000 to 60,000 KHz. Supplied only in HC 6/U holder. Calibration is ± .02% when operated in International OX circuit or its equivalent. (Specify frequency) $3.95

for the COMMERCIAL user...

INTERNATIONAL PRECISION RADIO CRYSTALS

International Crystals are available from 70 KHz to 160 MHz in a wide variety of holders. Crystals for use in military equipment can be supplied to meet specifications MIL-C-3098E.

CRYSTAL TYPES:
(GP) for “General Purpose” applications
(CS) for “Commercial Standard”
(HA) for “High Accuracy” close temperature tolerance requirements.

write for CATALOG

INTERNATIONAL CRYSTAL MFG. CO., INC.
10 NO. LEE • OKLA. CITY. OKLA. 73102

More Details? CHECK-OFF Page 94

march 1974
"SOUND-OFF" with the
SHURE 444 mike at $29.95
The best dynamic avail-
able for the ham. Tailored
for SSB & CW operation
(-53db to 100K) to
give big audio "punch".
PTT & VOX switching, 3Lb.

COAX CABLE WITH PLUGS
50ft. RG58/U & PL259s
each end, 3Lb. .... $4.49
Add $1 ea. for packing
and shipping. OR, order BOTH & incl-
ude $34.95 payment
with orders for pre-
paid shipment USA.

SUIT CASE
DIPOLES
#16 stranded copper wire
Insulated for cleaner, easy handling
Pretuned and tested guaranteed resonance
Available 80 thru 10 meters amateur radio bands
Clips included for portable use allowing same coax to be used
for different antennas (small coax only)
C110 - $6.95 C115 - $7.95 C120 - $9.95
C140 - $12.95 C180 - $17.95
RG-58/U & RG-59/U available at $12.95 per 100 feet.

EXCELTRONICS RESEARCH LABS
MANUFACTURERS OF ELECTRONIC DEVICES
224-15 Linden Blvd. Cambria Heights, N.Y. 11411

For Digital-Theory, Design, Construction
LOGIC NEWSLETTER
SAMPLE COPY $1.00
LOGIC NEWSLETTER
POB 252
WALDWRCK, N.J. 07463

8MC. XTALS--8333--9000.
Silk Screened Panel.
18 Watts Output.

SIX METER TRANSMITTER
for
MOBILE
FIXED STATION
EMERGENCY
AVIATION

TUBE COMPLIMENT
6U8 Oscillator Multiplier
12AX7 Speech Amplifier
2E26 Final Amplifier
6BQ5 Modulator

Price 49.95
Net to Amateurs
Complete with Tubes
Power Supply $9.95

EXCELTRONICS RESEARCH LABS
MANUFACTURERS OF ELECTRONIC DEVICES
224-15 Linden Blvd. Cambria Heights, N.Y. 11411

More Details? CHECK-OFF Page 94
We use a 2N6084 final Transistor (each one rated 40 W Infinite VSWR) featuring EMITTER BALLASTED construction and of first Quality, so you can't burn them out in tuning or under any load mis-match; each Transistor has been individually Hand tested at DYCOMM before shipment.

Typical assembly time is 5 hours. Kit is complete with full assembly procedure, including lay-out Photos, and Manual.

Tune-up and alignment is easy and straightforward using a watt-meter, dummy load and VOM.

Kit includes: 6' control wire, 6' power cables (fused), 4' RG174 to make interconnect cable, 2 PL 259 connectors.

SPECIFICATIONS:

Prices: KIT $49.95; Wired and Tested $99.95. Residents of Florida add 4% sales tax, shipping (UPS where possible) included. For Airmail add $2.00. Foreign-add postage extra.

All parts are guaranteed and if a defective part should be found it will be replaced free within 30 days of shipment. Quantities Limited. First come — First served: this offer ends May 10, 1974.

Send check or money order to
DYCOMM 948 Ave. E., P. O. Box 10116, Riviera Beach, Florida, 33404. (305-844-1323)
NYE VIKING PHONE PATCH

Be a GOOD GUY! Complete a phone patch for a fellow ham. (First, install a Nye Viking phone patch.) It's great for your ego, and you really can provide a useful service!

The Nye Viking Hybrid phone patch has separate controls for receive and transmit audio. The adjustable null control allows normal VOX operation with most connections.

Installation is EASY! Mount it vertically, or install it in any associated enclosure using the removable front panel as a face plate. Measures 2" x 6" x 2-1/2" deep (plus mounting feet and knobs.)

From an original design by E. F. Johnson, manufactured by the Wm. M. Nye Company.

Suggested list price, $34.50 at leading dealers throughout the U.S.A. and Europe.

WM. M. NYE COMPANY, INC.
1519 - 130th N.E., Bellevue, Washington 98005

SUPER CRYSTAL
THE NEW DELUXE DIGITAL SYNTHESIZER!! FROM RP

MFA-22 DUAL VERSION

Also Available MFA-2 SINGLE VERSION

- Transmit and Receive Operation: All units have both Simplex and Repeater Modes
- Accurate Frequency Control: 0.0005% accuracy
- Stable Low Drift Outputs: 20 Hz per degree C typical
- Full 2 Meter Band Coverage: 144.00 to 147.99 MHz, in 10KHz steps
- Fast Acting Circuit: 0.15 second typical setting time
- Low Impedance (50 ohm) Outputs: Allow long cable runs for mobiles
- Low Spurious Output Level: similar to crystal output

SEND FOR FREE DETAILS

Prices MFA-2 $210.00 BOX 1201H
MFA-22 $275.00 CHAMPAIGN, ILL.
Shipping $3.00 extra 61820

GRAY Electronics
P. O. Box 941, Monroe, MI 48161
Specializing in used test equipment

USED TEST EQUIPMENT

All checked and operating unless otherwise noted. FOB Monroe. Money back if not satisfied.

Boonton 190A Q-mtr 20-260 MHz Q5-1200 375
Boonton 202B Sig Gen AM-FM 54-216 MHz 325
Boonton 202E - Later version of above 585
Boonton 260A Q-mtr 0.5-50 MHz Q10-625 375
HP1000F-Q, freq. w/scope-Acc. 1ppm 85
HP185A Scope w/186A samp. 1GHz 335
HP330C Dist anal 20 Hz-20kHz, 1% 225
HP5240-Freq Counter. Basic unit 10kHz-10MHz 185
HP5408 Trans. osc for 524 to 12.4GHz 185
HP600D (TS10SU) Sig. gen. 10-420 MHz 450
Nemis Clark 1651 FM rcvr 175-260MHz 125
Polarad MSG34-Sig. Gen 4.2-11GHz calib. attn. AM-FM-Pulse mod. 495
Polarad R uwave rcvr 4.84GHz with plug-in AM, FM, CW, Pulse — less plug-in 225
Polarad TSA Spec. Anal .01-.44GHz with plug-in — less plug-in 125
HP803A Imp Bridge 50-500MHz, 2-200 ohm 195
Solitron 200A SCR tester-checks anode, gate volts current, leakage and holding 165
Stoddart NM10A (URM-6) RF inten 10-250 kHz, complete with acc. 630
Stoddart NM20A (PRM-1) RF inten 15-25MHz, complete with acc. 655
Stoddart NM52A-RFI mtr .375-1GHz, w/ acc. 985
Tek RM 15 DC-15MHz GP scope 265
Tek 181 Time mark generator 95
Tek 190A Const. Ampl. Sig. Gen .35-50MHz 125
Tek 531 DC-15MHz scope-takes letter plug-in 175
Tek 565 dual beam 10 MHz scope, less plug-ins 525
SG24/TRM3 Sweep Gen. 15-400 MHz, CW, AM, FM Xtal markers, scope-Dev. to 20% 245
TS-403A-Sig. Gen. (HP616) 1.8-4GHz 385
URM 7 RF-Fi mtr (sim. NF-101) 20-400MHz 750

(Send SASE for complete list)
KRONOS WITH "TIME BASE"**

<table>
<thead>
<tr>
<th>Type</th>
<th>LED</th>
<th>Price (per LED)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR-90</td>
<td>270M</td>
<td>$4.50</td>
</tr>
<tr>
<td>CR-90</td>
<td>271M</td>
<td>$4.75</td>
</tr>
<tr>
<td>CR-90</td>
<td>272M</td>
<td>$4.90</td>
</tr>
<tr>
<td>CR-90</td>
<td>273M</td>
<td>$5.05</td>
</tr>
<tr>
<td>CR-90</td>
<td>274M</td>
<td>$5.20</td>
</tr>
<tr>
<td>CR-90</td>
<td>275M</td>
<td>$5.35</td>
</tr>
<tr>
<td>CR-90</td>
<td>276M</td>
<td>$5.50</td>
</tr>
<tr>
<td>CR-90</td>
<td>277M</td>
<td>$5.65</td>
</tr>
<tr>
<td>CR-90</td>
<td>278M</td>
<td>$5.80</td>
</tr>
<tr>
<td>CR-90</td>
<td>279M</td>
<td>$5.95</td>
</tr>
<tr>
<td>CR-90</td>
<td>280M</td>
<td>$6.10</td>
</tr>
</tbody>
</table>

NEW: Crystal oscillator designed for this "TIME BASE" has 1.0ppm in 10 days; 1.5ppm at 20°C.

**With TIME BASE $64.95

**NEW, ANY MODEL $37.95

*New models 1.25ppm at 20°C; 1.75ppm in 10 days.

One of the latest developments in the field of electronic circuits is the "TIME BASE". This circuit is used in conjunction with a crystal oscillator to provide a stable reference for timing and synchronization purposes. It is particularly useful in applications where precision timing is required, such as in oscilloscopes, digital clocks, and control systems.

CRystal oscillator designed for this "TIME BASE" has 1.0ppm in 10 days; 1.5ppm at 20°C.

LITRONIX-OPOCA-MAN "7-SEGMENT" LED READOUTS

All 10 11-pin IC sockets. All 7-segment, MAN Series all-LCD and made by well-known West Coast edge. Others reflective type made by HPOCA and POT. MAN: The Reflective Bar Type is non-contact, low-cost, low-power consumption, and easy to use. OPOCA: The Reflective Bar Type is non-contact, low-cost, low-power consumption, and easy to use. LITRONIX: The Reflective Bar Type is non-contact, low-cost, low-power consumption, and easy to use.

POTTER & BRUMFIELD KAP RELAYS

 deterioration on "DIGITAL CLOCK on a CHIP"

NATIONAL EQUALS ON "DIGITAL CLOCK on a CHIP"

Mfrs.  

S 5378 28-pin, ceramic, any readout, $8.88 6-digits: $8.88
S 5377 28-pin, ceramic, any readout, $8.88 6-digits: $8.88
S 5376 28-pin, ceramic, any readout, $8.88 6-digits: $8.88
S 5375 28-pin, ceramic, any readout, $8.88 6-digits: $8.88
S 5374 28-pin, plastic, LED and 6-digits: $8.88
S 5373 40-pin, normal alarm, snooze alarm, sleep timer, 4-digits: $14.95

S 5372 40-pin, normal alarm, snooze alarm, sleep timer, 4-digits: $14.95

Code:  

A: Digital Control, output, D: Digital Control

A: Digital Control, output, D: Digital Control

I-MSM316, DIGITAL ALARM CLOCK MARKET FALLOUT — $1.49 EACH

Postmark: Sold at: 130 West 35th Street, New York, N.Y. 10018

P.O. BOX 242, LYNFIELD, MASS. 01940
MODEL 60 SPEECH PROCESSOR — QRO
the average-to-peak ratio of the speech wave-
form to much an 8 db, using a logarithmic
principle. Operates with FM, SSB and AM
transmitters and receivers. Low/High
impedance Mic input Two 9Vdc batteries
provide a self-contained unit
Model 60W (Processor Assembled) $26.50
Model 60R (Processor Kit) $21.90
200-15 (Processor Board Kit) $12.95

MODEL 20 DIGITAL DIAL — Available for
Collins and Drake gear. Optional four digit
readout and crystal time base QSY your
fixed or mobile receiver, transmitter or trans-
ceiver with 100 Hz accuracy and no last digit
jitter. Simple one wire connects dial to rig
and you're ready to go. Specify your type of
dial. Model 20 (5.65 MHz VFO range) $169.95
Model 20C (Collins) $169.95
Model 20D (Drake) $169.95
Options: 4 Digit Readout! (Crystal Time Base) $29.95

MODEL 11A PADDLE — Designed with re-
liability in mind. No mechanical switches or
contacts to fail. Paddle contact space ad-
justs easily
Model 11A (Assembled) $9.95

MODEL 10A ELECTRONIC KEYER — Has
NEW features at no extra cost: Linear Speed
Control and Operate/Tune Switch Plus in-
ternal LED light cells and read-out output
provide a compact portable versatile unit
Model 10AW (Keyer & Side-tone Assembled) $33.95
Model 10AK (Keyer Kit) $29.95
Model 202K (Keyer Board Kit) $12.95
Model 203K (Side-tone Board Kit) $4.95

FREE Catalog
OF THE WORLD'S FINEST
GOVERNMENT SURPLUS
ELECTRONIC EQUIPMENT
And BETTER Than Ever!

Mail Coupon for Your FREE Copy, Dept. HR
FAIR RADIO SALES
1016 E. EUREKA • Box 1105 • LIMA, OHIO • 45802

TV-FM-CLASS E CB ANTENNA
NEW ROLLABLE (with perfect color band-width). Just
unroll and stick on wall. Uses no mast, no
rabbit ears, no dangerous plugging to AC lines,
and NO SIGNAL SPLITTERS since the VHF-UHF-
FM terminals (VHF usable for CB with high
power handling) available at the same time.
(NEW 1971 slotted design with U.S. Patent
S/N 3577196). Made of decorative foil/plastic
yet rugged for use in yatch or RV. Antenna
size: 18" x 48" unrolled, works behind picture,
against metal! Price is only $15 for model with
following gain: (VHF - 9 dB), (UHF - 12 dB),
(FM - 6 dB); gains above dipole.

Order postpaid AIRMAIL, insured, from
ANTENNA DESIGN CO.
11621 HUGHES AVE., N.E.
ALBUQUERQUE, N. M. 87112

STOP

GLADE VALLEY SCHOOL RADIO SESSION
13th year - July 27 - Aug. 9, 1974

Courses Taught: General Theory and Code
Advanced Theory and Code
Amateur Extra Theory and Code
Golf privileges at New River Country Club: also fishing

TRULY A VACATION WITH A PURPOSE!!!

People attended from the following states:
North Carolina, South Carolina, Missouri, Tennessee,
Utah, Florida, Ohio, West Virginia, Alabama,
New Hampshire, Iowa, District of Columbia,
Vermont, Arizona, Indiana, Ohio, New Jersey,
New York, Massachusetts, Maryland, Virginia, Illinois,
Michigan, Georgia, Kansas, Mississippi,
Nebraska, Maine, Kentucky, California, New Mexico,
Arkansas, Tennessee, Wisconsin, Louisiana, Oregon,
Connecticut, Minnesota, Pennsylvania.

We've changed our name and location. We have just moved four miles from our previous site. We are now in the campus of a beautiful small board-
ing school. Excellent accommodations, same good
food and the same excellent instructors.

C. L. Peters, K4DNJ, Director
P. O. Box 770, Elkin, North Carolina 28621

Please send me the Booklet and Application Blank
for the Glade Valley School Radio Session.

Name
Address
City/State/Zip

More Details? CHECK-OFF Page 94
MARCH SPECIALS

18 PIN CALCULATOR KIT
MCT 2 Translator .99 ea.

TTL dip pak
7400 10 2-input gate $1.95 ea.
7402 4-bit binary full adder 1.00 ea.
7404 4-bit binary multiplier 1.95 ea.
74123 Timing, mono, multivolt/wider 1.05 ea.
8123 Tri-state 8272, multiplexer 1.00 ea.

Linear Circuits
301 (7546) Dual parallel driver 3.10 ea.
723 Voltage regulator 3 for $1.00

$11.95/kit

Calculator Chips
5001 LE (160 pin) Add, subtract, multiply & divide 12 digit
Data input/output multiplexer 99.95 ea.
Data output multiplexer 1.00 ea.
Data input/output multiplexer 1.00 ea.
5006 LE (28 pin) Full four function memory 12 digit display & unit 7 segment
multiplexer 99.95 ea.
Data input/output multiplexer 1.00 ea.

Digital clock . . . on a Chip
MM 3217 28 pin Any number 8 digit
BDC 28 pin with 4 digit 99.95 ea.
BDC 28 with 3 digit 99.95 ea.
BDC 28 with 2 digit 99.95 ea.
MCM 28 8 digit display 10.95 ea.
2 MCM 28 11.95 ea.

LED
MM 108 8- LED Rock Super Special .00 ea.
MM 109 10-LED Rock Super Special 26.00 ea.
MM 2116 16-LED Rock Super Special 89.95 ea.
MM 1171 7-LED Rock Super Special 120.00 ea.
MM 108 8- LED Rock Super Special 26.00 ea.
MM 2116 16-LED Rock Super Special 89.95 ea.

Opto Isolators
MCA 200 Orlando 8 99.95 ea.
MCA 200 8 99.95 ea.
MCT 2 Translator 1.45 ea.

Unrested IC's
MM1463 1028-10K trimmer input 88 ea.
MM1464 100K passive input 88 ea.
MM1468 20K passive input 88 ea.
MM1469 1K passive input 88 ea.
MM1470 1K inward input 88 ea.
MM1471 100K inward input 88 ea.
MM1472 10K inward input 88 ea.
MM1473 1K inward input 88 ea.
MM1474 100K inward input 88 ea.
MM1475 1K inward input 88 ea.
MM1476 100K inward input 88 ea.

ON ORDERS OVER $25.00 DEDUCT 10%
Satisfaction guaranteed. All items except as noted are fully tested. Minimum order $5.00 prepaid in U.S. and Canada. Calif. residents add sales tax. Orders filled within three days from receipt.

INTERNATIONAL ELECTRONICS UNLIMITED
P.O. BOX 1708R
Monterey, Calif. 93940

ON SALE!!
10% DEDUCT
Call (408) 373-7727
24 HOURS A DAY
PUNCH TAPE PERFORATOR
Burrows A522 or A560 Tape Perforator, 8-unit code on 1-inch tape. Used, exc. cond. Shpg. wt. 35 lbs. $75.00
Friden Model BA or BC tape perforator and reader in one unit, 8-unit code on 1 1/2" tape. Used, exc. cond. Shpg. wt. 100 lbs. $150.00
Teletype Model 28 tape unit; Tape reader LBXD, 3-speeds, 60-75-100 WPM; High-speed perforator BRPE, 700 WPM, on LTHS Tape Handling unit. Exc. cond., as removed from service. Shpg. wt. 100 lbs. $75.00 each
LED READOUTS: Opcoa SLA-1. Electrically equal to MAN-1. 33" high, 20 ma. per segment. With decimal point. Red. $2.65 each. 6/$15.00
BIG LED READOUTS: Opcoa SLA-3. 7" high, 40 ma. per segment. With decimal point. Red. $5.55 each. 4/$19.75
ETCHANT FOR P.C. BOARDS, Ammonium Persulfate, 1 pound of crystals, just dissolve in water. Enough for 100 sq. in. of 2 oz. copper. $1.25
Wheatstone bridges, portable, Industrial Instruments RN-1. 4 dials and ratio. Very good cond. $50.00
Marion model M-2 Meter Tester. Measures voltage to 100 v., current to 2 ma., and resistance. Good cond. $65.00
Digital 2400-B digital millivoltmeter, 0-100 millivolts. Reads to 0.2 mv. Very good cond. $60.00
Please add shipping charges. Wheatstone bridges, portable, Industrial Instruments RN-1. 4 dials and ratio. Very good cond. $50.00
Marion model M-2 Meter Tester. Measures voltage to 100 v., current to 2 ma., and resistance. Good cond. $65.00
DIGITAL CHARGE: Master charge

JEFF-TRONICS
1916 Clark Ave. Cleveland, OH. 44109
(216) 621-1004

DUAL BAND ANTENNAS
These ready to mount antennas consist of full 1/2 wavelength elements of No. 12 copperweld wire and can be used as either dipoles or inverted yees. No traps, coils, gimmicks, etc. are used to shorten the elements. 2KV rating. Single coax feedline required. Individually mounted dipoles with common center insulator:

HOUSE OF DIPLOES
P. O. BOX 8484
ORLANDO, FLORIDA 32806

YAESU
Racom has the following Yaesu models in stock for immediate delivery:
FT-101B, FTDX401, FRDX400/FLDX400
External VFO's, Speaker-Patches
Frequency Counters.
Also 2 Meter FM Mobile Transceivers
FT-2FB and FT-2 Auto
IC-20, IC-21, IC-22 CRYSTALS $3.00 each
Write to Woody, W7RC
Racom Electronics, Inc.
15051 S.E. 128 ST., RENTON, WA. 98055
Telephone 206-ALS-6656
COMPLETE REPAIR SERVICE
HOLD IT!

TWO WATTS 4 CHANNELS

.5 uv for 20 dB quieting
aluminum case 2½ x 1½ x 9
prewound coils dual conversion
ceramic 455 filter predrilled PC boards
silk screened parts layout for easy construction

ORDER YOURS NOW
Please send me.____ HT-144  © $99.95 each.
Name ___________________________ ________
Address ___________________________ ________
City ___________________________ ZIP ________
State ___________________________ ________

Shipping ($1.00/kit).
NYS res. sales tax
TOTAL ENCLOSED.

VHF ENGINEERING
— DIV. OF BROWNIAN ELECT. CORP. —
320 WATER ST. POB 1921 BINGHAMTON, N.Y. 13902 607-723-9574

More Details? CHECK-OFF Page 94
COMPUTER KEYBOARD $7.00 (as is)

Several styles on hand in poor condition, broken key/keys, broken case or no case, etc. Still a good value at $7.00 for parts, switches, and each has encoder board in base.

2N2152 45 volt 170 watt PNP-G $1.00
*2N3713 80 170 NPN-S 1.00
*2N3789 60 150 NPN-S .75
2N3501 40 200 NPN-S 1.25
*2N3501 40 200 NPN-S 1.00
*Removed from used equipment

LEAD 7 SEGMENT READOUT
Similar to MAN-1. Factory seconds, but functionally OK. Fit 14 pin DIP socket. 7 segment w/ left decimal #LED-A-L $3.00
7 segment w/ right decimal #LED-A-R 3.25
7 segment no decimal #LED-A 2.75
Above LEDS 2 for the price of 1 Socket for above, gold plated leads 3/1.00

313,344 CORE MEMORY $125.00
From SPECTRA computer, visually OK. 64 x 68 x 4 x 16 core stack. Figures out to 35K Byte.

LED 7 SEGMENT READOUT
Similar to MAN-1. Factory seconds, but functionally OK. Fit 14 pin DIP socket. 7 segment w/ left decimal #LED-A-L $3.00
7 segment w/ right decimal #LED-A-R 3.25
7 segment no decimal #LED-A 2.75
Above LEDS 2 for the price of 1 Socket for above, gold plated leads 3/1.00

IC SALE YOUR CHOICE 3 for $1.00
µ900 BUFFER TO-5
µ914 DUAL 2 INPUT GATE TO-5
µ923 JK FLIP FLOP TO-5
µ926 Hi speed JK FLIP FLOP TO-5
µ931 JK/RS FLIP FLOP (DIP) 10 pin socket for TO-5 IC 3.100

GIANT NIXIE B7971
Used $1.00 Brand New $2.00
With schematic for GIANT clock.

COMPUTER TAPE DECK $75.00
Takes 1/2 inch tape, made by Computer Entry Systems. Visually ok, with electronics, no data available.

IC SALE YOUR CHOICE 3 for $1.00
µ900 BUFFER TO-5
µ914 DUAL 2 INPUT GATE TO-5
µ923 JK FLIP FLOP TO-5
µ926 Hi speed JK FLIP FLOP TO-5
µ931 JK/RS FLIP FLOP (DIP) 10 pin socket for TO-5 IC 3.100

PHONE PATCH KIT
Includes all parts, instructions, cabinet.
AM PATCH — $5.00 SSB PATCH — $9.00

CMOS 4814 HEX INVERTER
CMOS HEX INVERTER, dual inline package. 3.18 volt range, dual diode protection against static charge. Electrially isolated complimentary MOS.
$1.00 each 12 for $10.00

DUAL 16 BIT MEMORY
Dual 16 bit memory, serial MOS by Philco TO-5 case, brand new with 2 page specs.
#PLR 532 $1.00 each 10/12

2048 BIT MOS MEMORY
2048 bit MOS LSI random access memory NEC 6003. All inputs except clock are TTL compatible. 2048 word by 1 bit. 22 pin ceramic dual-in-line. With specs.
$9.00 each 2 for $17.00

RCA INJECTION LASER DIODES
Another SUPER SCOOP by Meshna. Brand new RCA packaged, considered obsolete by RCA but what an exotic opto-electronic device for the sophisticated experimenter. Only several hundred on hand. Values shown are approx. as each diode characteristic varies. Each is marked with correct value.
6 WATT $10.00
10 WATT $15.00

Postage Extra on all Items

JOHN MESHNA JR. ELECTRONICS P. O. Box 62 E. Lynn, Mass. 01904
RATES Commercial Ads 35¢ per word; non-commercial ads 10¢ per word payable in advance. No cash discounts or agency commissions allowed.

COPY No special layout or arrangements allowed. Material should be typewritten or clearly printed and must include full name and address. We reserve the right to reject unsuitable copy. Ham Radio cannot check out 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 is 15th of second preceding month.

SEND MATERIAL TO: Flea Market, Ham Radio, Greenville, N. H. 03048.

WORLD QSL — See ad page 84.

HAMFEST! Indiana's friendliest and largest spring hamfest. Wabash County ARC's 6th Annual Hamfest, May 19. Call for details - 4-H fairgrounds. Admission still only $1.00 for advanced tickets ($1.50 at gate). Large flea market, technical sessions, bingo for XYL's, free overnight camping, plenty of parking. Bonus for car-pools (4 or more adults per car). For more information or advanced tickets write Larry Chengler, WA5ZHU, Route 4, Wabash, Indiana 46992.

FRAME & DISPLAY your QSL's with 20 pocket plastic holders. Two for $1.00, seven for $3.00 from your dealer or direct, prepaid. Free sample to dealers upon request. TEPSABCO, Box 198H, Gallatin, Tennessee 37077.

SURPLUS TEST EQUIPMENT, VHF and microwave gear; write for bulletins. David Edsall, 2843 St. Paul, Baltimore, Md. 21218.

CANTON AMATEUR RADIO CLUB annual auction & flea market, Friday, March 8, 1974, at the Imperial House Motel in Canton, Ohio, at 7:30 p.m. Doors open for set-up at 5:00 p.m.; mobile check-ins on 146.06 & 146.94 Simplex Stark County repeater 146.19/79. Grand Prize, mobile check-in prize, other prizes awarded each half-hour. Free coffee and donuts. All companies are invited to attend and set up displays and exhibitions, free space will be provided. For reservations or information contact Rich Shyer, W3CJ1, Canton, Ohio.

DO-IT-YOURSELF EXPEDITION — Stay at ZF1SB — Cayman Is. Vertical antenna and Caribbean at your doorstep. Diving/fishing if band holds. We arrange license. Spanish Key Resort, Box 808, Grand Cayman, B. W. I.

SECOND ANNUAL WOODWARD HAMFEST- SWAPFEST will be held on March 30-31, 1974. The event will be held at the Woodward County fairbuilding in Woodward, Okla.

NEED PARTS? We carry parts for R388-390-390A-391-392-1051-5151 Nems Clark-Racal-Pack sets, 146.25-4-7, 71-73-74-75. If you need a part no matter what you have. If its U.S. government we have it or can get it. Also we want to buy or trade all aircraft communications. All ground radio communications. All plug-in modules control heads. No matter what cond. they are in we have it or can get it. We will buy or trade. We have R-390-388-390A-392-1051-5151 Nems Clark - Racal - and new ham gear for trade. D & R Electronics, R. D. 3, Box 273, Milpa, Pa. 17847. Phone 717-742-4604 after 6:00 P.M.

NORTH FLORIDA SWAPFEST, March 1, 1974, Community Center, Hwy 98. Write: PARC, Box 873, Fort Walton Beach, Fla. 32548.

QSLs, Second to none. Same day service. Sample 25¢. Ray, K7HLR, Box 331, Clearfield, Utah 84015.

QRT STATION. Ten-Tec PM3A transceiver 210 PS AC5 tuner, used 2 hours, $70.00 prepaid. Call Cornils, 1293 West L. Benicia, Calif. 94510.


WANT OLD RADIO SHOW TRANSCRIPTION discs. Any size or speed. Send details to. Larry Kiner, W7FIZ, 7554 132nd Ave. N.E., Kirkland, Wa. 98033.

JOHNSON VALIANT — $125.00, and SBE-33, $175.00. Both good, condition. Letter brings mailings. W7TSJ, 8822 Driftwood, Tucson, Ariz. 85715.


WANTED: tubes, transistors, equipment, what have you? Bernard Goldstein, W3MNP, Box 257, Canal Station, New York, N. Y. 10013.

TELL YOUR FRIENDS about Ham Radio Magazine.

19TH ANNUAL HAMFEST AND AUCTION to be held Saturday, March 9, 1974 at the Lucas County Rec. Center, 290 Key St., Maumee, Ohio. Registration $2.00 at door. $1.50 advance. For further info write Toledo Mobile Radio, Ass'n., P. O. Box 273, Toledo, Ohio 43695.

RESISTORS: Carbon composition brand new. All standard values stocked. 1/2 W 10%, 40/100; 1/4 W 10% 30/$1.00 — 10 resistors per value, please. Minimum order $5.00. 1C MS RMS 1C Audio Amplifier — Panasonic. Frequency response 20Hz-100 kHz. 5% distortion. Price $6.95 Postpaid. Pace Electronic Products, Box 161-H, Ontario, Center, New York 14404.


THE KNIGHT RAIDERS VHF CLUB'S auction and flea market is Sunday, March 24 at the YM/YWHA of North Jersey, 152 Van Houten St., Paterson. Free admission, free parking, refreshments available. Talk-in 146.94 MHz. Flea market tables $5 for 8 ft, $2.50 for 1/2 ft. Reserve tables in advance. Knight Raiders VHF Club, Inc., K2DEL, P. O. Box 1054, Passaic, N. J. 07055.

RECIPROCATING DETECTOR, write Peter Meacham Associates, 19 Loretta Road, Waltham, Mass. 02154.

WE'VE BEEN RIPPED OFF! Dec. 11th in Madison, Wisconsin. Collins, Model KWM-2, Transceiver, Serial 13531 with noise blanker. Wafers filter WO80N modifications, and a Turner ceramic mic. Has many identifying features — I will be able to identify even if serial is removed. Call W7JS collect at area code 312-665-0071, or report to the Madison Police Department.

TEFLON WIRE #22 gauge stranded, silver plated. $1.75/100 ft. Rich Shyer, 6254 S. Palomares, Pomona, Ca. 91766.

QSL'S — BROWNIE W3CJ — 3035B Lehigh, Allentown, Pa. 18103. Samples with cut catalog 35¢.
L. I. Electronic Supermart
(Off the wall self service)

New P.C. Boards — G10, 1 oz. - 1 side copper-fiber glass
6" x 6", 80c ea. — 6 x 12, $1.50 ea. - 12 x 12, $2.85 ea.

New P.C. Boards — G10, 1 oz. - 2 side copper-fiber glass
6" x 6", $1.10 ea. - 6 x 12, $2.00 ea. - 12 x 12, $3.75 ea.

New P.C. Boards — G10, Fiber glass punch:
F Pattern 4.5 x 6.5, .062 holes, 5 per 1/" $1.30
P Pattern 6 x 6.5, .024 holes, 10 for 1/" $1.35
G Pattern, 4.5 x 6.5, .062 holes, $1.30
Pkg. 10 Bircher P.C. Board, metal 2/" slides $1.00
Package of 50 flea plugs for above punched
Boards, .062, .024 holes $1.25
30 1/4 or 1/2 W resistors, packaged $5 per value
your choice of values $1.00
25-1W resistors, packaged $5 per value
your choice of values $1.00
15-2W resistors, packaged $5 per value
your choice of values $1.00
5 1/4 or 1/2 W, 1% resistors, packaged $5 per value
your choice of values $1.00
5 cent Resistors, #7001, packaged $5 per value
your choice of values $1.00
5 mica dip caps, 1 pf-150 pf, packaged $5 per value
your choice of values $1.50
5 mica dip caps, 150 pf-60 pf, packaged $5 per value
your choice of values $1.50
5 mica dip caps, 910 pf-1500 pf, packaged $5 per value
your choice of values $1.50
Wire #22 solid PVC, 5 packages, 6 colors 50' ea.
spool $3.50
Wire Kit #22 stranded PVC, 6 spools, 6 colors 50' ea.
spool $3.50
Wire Kit #24 Solid PVC, 6 spools, 6 colors 50' ea.
spool $3.50
Wire Kit #24 stranded PVC, 6 spools, 6 colors 50' ea.
spool $3.50
10' Three cond. ribbon wire, color coded $2.22
or #24, stranded $1.50
C & K #7101 mini switch, SPDT on-on $1.05
C & K #7201 mini switch, SPDT on-off $1.20
C & K #7201 mini switch, DPDT on-on $1.35
C & K #7203 mini switch, DPDT on-off $1.55
Alco 105D MST momentary on-off-momentary $1.75

Central Lab DPDT push momentary. SPEC. 4/$1.00
Connectors, PL269, $45; PL268, $70; 175U or
176U, $20 ea.; UG 38 cu., $50; UG 201 a/u
(N to BNC adapter). $75; RCA to UHF, $90.
Encapsulated chokes 1uh to 5 Mh, choice $3/$1.00
Vario rectifiers, mini bridge rectifiers, approx. 5/" sq.
size: 2 amp. - .50 v., 1.25; 4 amp. - .50 v., $1.25;
6 amp. - .50 v., $1.25; 10 amp. - .50 v., $1.50;
15 amp. - .50 v., $1.50; 20 amp. - .50 v., $2.00;
30 amp. - .50 v., $3.00; 50 amp. - .50 v., $5.00;
100 amp. - .50 v. $10.00
RCA coaxial RF cable spools, 50': 1/4", $3.75;
3/16", $4.50; 1/2", $5.50; 9/16", $7.00;
1 1/4", $10.00
25 amp. 600 v. $7.00; 40 amp. - 600 v. $10.00;
50 amp. - 600 v., $15.00
50' spool, 60 amp. - 600 v. $25.00
50 amp., #20 solid wire $1.00
100 amp. #20 solid wire $1.25
100 amp. #14 solid wire $1.50
200 amp. #14 solid wire $2.00
1000 amp. #14 solid wire $3.00
2500 amp. #14 solid wire $5.00
1000 amp. #12 solid wire $7.50
2500 amp. #12 solid wire $10.00
1000 amp. #10 solid wire $15.00
2500 amp. #10 solid wire $25.00
1000 amp. #8 solid wire $40.00
2500 amp. #8 solid wire $60.00
1000 amp. #6 solid wire $100.00
2500 amp. #6 solid wire $150.00
10000 amp. #4 solid wire $750.00
25000 amp. #4 solid wire $1500.00

FREE BONUS WITH EACH $10.00 ORDER
50' SPOOL 600 V. #22 PVC WIRE

KRP
ELECTRONIC SUPERMART, INC.
219 WEST SUNRISE HIGHWAY
FREEPORT, L. I., N. Y. 11520
516-623-3346-9

THE ULTIMATE MORSE KEYBOARD
• 64 character buffer
• Standard typewriter format with space
• Compatible with KM-420 memory

Available 1 November
Model $50
Write for specifications $49.95

THE ONLY QSL BUREAU to handle all
of your QSLs to anywhere; next door, the
next state, the next country, the whole
world. Just bundle them up (please arrange
alphabetically) and send them to us with
payment of $6 each.

5200 Panama Ave., Richmond, CA USA 94804

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
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

WORLD ATLAS — Only atlas compiled for radio ama-
teurs. Packed with world-wide information — includes
11 maps, in 4 colors with zone boundaries and coun-
try prefixes on each map. Also includes a polar pro-
jection map of the world plus a map of the Antarc-
tica — a complete set of maps of the world. 20 pages
size 8 1/2" 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 $5.00 for postage and handling.

KRP
ELECTRONIC SUPERMART, INC.
219 WEST SUNRISE HIGHWAY
FREEPORT, L. I., N. Y. 11520
516-623-3346-9

Callbook INC.
Dept. E 925 Sherwood Drive
Lake Bluff, Ill. 60044

Looking for a new challenge? may then build a TV camera?

Only solid-state camera available in kit form
or factory assembled. Complete kit with video
tube only $115.75. Postpaid delivery anywhere in
USA. Canadian dealer, optional long-distance.
$135. Write to phone now for complete catalog of
kits, parts and plans. Dial 450-877-3711.

1100 BROADWAY, N. W.
ATV Research
Dakota City, Neb. 68731

49 march 1974

More Details? CHECK-OFF Page 94

KRP ELECTRONIC SUPERMART, INC.
219 WEST SUNRISE HIGHWAY
FREEPORT, L. I., N. Y. 11520
516-623-3346-9

219 WEST SUNRISE HIGHWAY
FREEPORT, L. I., N. Y. 11520
516-623-3346-9

219 WEST SUNRISE HIGHWAY
FREEPORT, L. I., N. Y. 11520
516-623-3346-9

Looking for a new challenge? may then build a TV camera?

Only solid-state camera available in kit form
or factory assembled. Complete kit with video
tube only $115.75. Postpaid delivery anywhere in
USA. Canadian dealer, optional long-distance.
$135. Write to phone now for complete catalog of
kits, parts and plans. Dial 450-877-3711.

1100 BROADWAY, N. W.
ATV Research
Dakota City, Neb. 68731

49 march 1974

More Details? CHECK-OFF Page 94

KRP ELECTRONIC SUPERMART, INC.
219 WEST SUNRISE HIGHWAY
FREEPORT, L. I., N. Y. 11520
516-623-3346-9

219 WEST SUNRISE HIGHWAY
FREEPORT, L. I., N. Y. 11520
516-623-3346-9

219 WEST SUNRISE HIGHWAY
FREEPORT, L. I., N. Y. 11520
516-623-3346-9

Looking for a new challenge? may then build a TV camera?

Only solid-state camera available in kit form
or factory assembled. Complete kit with video
tube only $115.75. Postpaid delivery anywhere in
USA. Canadian dealer, optional long-distance.
$135. Write to phone now for complete catalog of
kits, parts and plans. Dial 450-877-3711.

1100 BROADWAY, N. W.
ATV Research
Dakota City, Neb. 68731

49 march 1974

More Details? CHECK-OFF Page 94
6T-HR2
6 frequency crystal deck
Improved circuit board, layout and foil.

INCREASES THE REGENCY HR-2 OR HR-2A RADIOS TRANSMIT CAPABILITY TO SIX ADDITIONAL FREQUENCIES. NO MAJOR CHANGE HAS TO BE MADE TO THE RADIO WHEN INSTALLING THE 6T-HR2 DECK

KIT $9.95 WIRED $13.95

HF144U MOS FET PREAMP
OUR FAMOUS 2-METER PRE-AMP STILL OUTSTANDING IN THE HIGH BAND PRE-AMP FIELD GIVES 17DB OF AMPLIFICATION WITH ONLY 3DB OF NOISE INSERTION.

KIT $11.95 WIRED $17.95

SCAN-2
with search back
DECKS MOUNTS IN HR-2 WITH OR WITHOUT AY MAJOR MODIFICATION TO THE RADIO. GIVES USER A SCANNING TYPE RADIO AT A FRACTION OF THE COST. INCORPORATES “SEARCH BACK” A NEW AND EXCITING FEATURE TO SCANNING TYPE OPERATION.

WIRED ONLY $19.95

WE PAY HIGHEST PRICES FOR ELECTRON TUBES AND SEMICONDUCTORS
H & L ASSOCIATES
ELIZABETHPORT INDUSTRIAL PARK
ELIZABETH, NEW JERSEY 07206
(201) 351-4200

25 to 75% SAVINGS ELECTRONIC COMPONENTS
- Rectifier Diodes and Zeners - Resistors (carbon, metal film, wire wound) - Capacitors (molded electrolytic, disk, tubular, ceramic; electrolytic; tantalum; aluminum; polyester; mylar; disc ceramic; silver mica; specials) - Memory Chips - IC Sockets - Fuses - Pots - Drills for PC Boards - Rubber Feet

FREE, NEW CATALOG
Lists Many More at 25 to 75% Savings

PRASAD ELECTRONICS
P. O. Box 32, Addison, IL 60101
only STANDARD sells more STANDARDS than Erickson...and here's why!

SRC-146A ERICKSON SPECIAL
WITH
• Charger
• "Stubby" antenna
• Leather case
• Ni-Cads
• 94/94, 34/94 and one channel of your choice

$369 List
-50 Package Discount
$319 Prepaid — Cashiers

Check or M.O.
ERICKSON COMMUNICATIONS
3501 W. Jarvis
Skokie, Ill. 60076 (312) 677-2161

WESTERN N. Y. HAMFEST and VHF CONFERENCE
MAY 17, 18, 1974
Monroe County Fairgrounds
Rt. 15A Rochester, N. Y.
(Near Thruway Exit 46)

• Huge Flea Market
• Top Programs
• Award Presentations
• Friday Night Cocktails

WRITE:
WNY HAMFEST
BOX 1388
ROCHESTER, N. Y.
14603

THE ULTRA-BAL 2000
NOW — An extremely rugged weather-proof BALUN!
• Full 2Kw. 2-30 MHz, 1/2 or 1/4 ratios.
• Special Teflon insulation. May be used with tuned lines and tuners.
• With dipole insulator and hang-up hook.

ONLY $9.95ppd. (state rate)
At your dealer or order direct
K.E. Electronics
Box 1279, Tustin Calif. 92680

BAR GAINS!
KLEINSCHMIDT TELETYPewriter EQUIPMENT
(1) TT-100 PAGE PRINTER, AS IS 60 OR 100 WPM $550.95
(2) TT-117 PAGE PR. OR (B) TT-170 REPERF & TD, AS IS $594.95
ABOVE CHECKED OUT, OILED & ADJUSTED, EA $894.95
(2) TABLE $39.95 (1) TABLE $149.95 (1) COPYHOLDER $5.95
(1) PAPERWINDER $54.95 (4) TT-107 REPERF ONLY $49.95
TH-5 CONVERTER TRANS/REC 350 CYCLES ADJUST TO 170 SHIFT $49.95

Andy Electronics Co., Inc.
6431 Springer Street / Houston, Texas 77017
ALL PRICES FOB HOUSTON, TEX.

EXCLUSIVE 66 FOOT
75 THRU 10 METER DIPOLE
NO TRAPS — NO COILS — NO StubS — NO CAPACITORS
Full Air Tested — Thousands Already in Use

#16 40% Copper Weld wire annealed so it handles like soft Copper wire—Rated for better than full legal power AM/CW or SSB Coaxial or Balanced 50 to 75 ohm feed line—VSWR under 1.5 to 1 at most heights—Stainless Steel hardware—Drop Proof Insulators—Terrific Performance—No coils or traps to break down or change under weather conditions—Completely Assembled ready to put up—Guaranteed 1 year—ONE DESIGN DOES IT ALL; 75-10HD—ONLY $12.00 A BAND!

Model 75-10HD $60.00 66 Ft 75 Thru 10 Meters
Model 75-20HD $50.00 66 Ft 75 Thru 20 Meters
Model 80-40HD $42.00

ORDER DIRECT OR WRITE FOR FULL INFORMATION

300H Shawnee
Leavenworth, Kansas 66048
DISCOUNT PRICES PLUS FULL WARRANTY, call or write for fast quote and delivery. All items new, guaranteed. 2M: Midland 13500 15W/12CH 219.95; SB450TBC converts 2M/3/4M 149.00; Standard 826MA 299.95; Ham-M 99.00; TR4 69.95; Belden 8-wire rotor cable 10c/ft; AR22R 31.95; CPE J-40A/200; 20% off. J. M. Belden. Hygain. Mosley. Hygain. THG6XX 143.00; TH3MK3 124.00; 204BA 129.00; 402BA 144.00; DB10/15A 95.00; Mosley Classic 33; CL-100; MSG30B Quad; MP35; Belden, Consolidated. RGB foam coax 17c/ft; Amphenol PL259 49.00; Guaranteed gear: Collins 7551 345.00; SB303. filters (Mint) 350.00; Tencel 315. receiver 199.95; CushCraft A147-22 49.00; Dowkey 110VAC antenna relay 60 series 39.95; Johnson KW Matchbox 219.95; Trumatic W51 437.00; WM50 283.00; 374.00; WM3S 175.00; Write: Swain, Tenton, Drake, Kenwood. Electra Bearcat 2-band scanner 129.95; 1972 Radio Masters 3.50; Calibooks; free flyer. Prices collect freight. Madison Electronics, 1508 McKinney. Houston, Texas 77002. 713/224-2668; Nite: 713/497-5683.

MANUALS for most ham gear made 45/65, some earlier. Send SASE for specific quote. Hobby Industry, WoJJK. Box H-864, Council Bluffs, Iowa 51503.

LIGHTNING ARRESTORS, Jostyn DMA969 feed thru rated 10 amps. 9 kVp, 2-32 MHz, $50.00 Vacuum capacitors: MMC1500, $150.00; MMC3000, $200.00; MMC5000, $350.00. All unused. H. G. Husbands. 6626 Talmadge, Dallas 75230.

PRINTED CIRCUIT DRILL BITS. Trumbull, 833 Balta Drive, El Cerrito, California 94530.

OUTBOARD FILTERS for Drake R4B. $75.00. Collins R-390A IF strip, $30.00. Drake W4 wattmeter, $40.00. H. McDonald. 25617 Third St., Barstow, California 92311.

HIGH-PERFORMANCE H.F. SYNTHESIZER replaces VFO and delivers output 1-30 MHz continuous coverage with accuracy, stability, resolution, and calibration to one Hertz. Write for information. Petit Logic Systems, Box 51, Oak Harbor, Wa. 98277.


SEND PERFECT MORSE WITH YOUR RTTY and save over $150 on price of a comparable Morse key-board. TMC-I RTTY to Morse converter connects right into your loop trouble-free and accepts input from keyboard or paper tape reader. Entire circuit including 64-letter buffer memory on one 4.5 inch board for $310. Write for information. Petit Logic Systems, Box 51, Oak Harbor, Wa. 98277.

HAM RADIO, every issue, 1968 thru 1973, with two binders: first money order $65.00 prepaid; James W. Harrison, 1234 Little Bay Avenue, Norfolk, Va. 23503.

1000 PIV AT 2.5 AMP DIODES. New Motorola HEP-170. 10 for $2.50, 100 and up 20c each, postpaid. K. E. Electronics, Box 1279, Tustin, California 92680.

SELL: Drake R-4B RCVR and MS-4 SPKR $350; T-4XB XMT and AC-4 power supply $450. Excellent condition. Frank Liem-WB6EPJ; 5732 Rosebury Dr., Dayton, Ohio 45424. Phone (513)-236-2050.

RTTY BAUDOT LOOP TO ASCII CONVERTER accepts loop signal at any RTTY speed and delivers corresponding 6 or 8 level parallel ASCII, all on one 4-6 inch circuit board for $120. Write for information. Petit Logic Systems, Box 51, Oak Harbor, Wa. 98277.


EMBROIDERED EMBLEMS AND PATCHES. Custom made from your design, 10 to 1000's. Write Russell, 1109 Turner St., Auburn, Maine 04210.

TRAVEL-PAK QSL KIT Converts photos, post cards to QSLs! Send call and 25c for personal sample. Samco, Box 203H, Wynantskill, N. Y. 12198.

---

**Preparing for OSCAR 7?**

<table>
<thead>
<tr>
<th>TX</th>
<th>MMv432</th>
</tr>
</thead>
<tbody>
<tr>
<td>70/MBM46</td>
<td></td>
</tr>
<tr>
<td>144-432 MHz TRIPLER</td>
<td></td>
</tr>
<tr>
<td>$75.20</td>
<td></td>
</tr>
<tr>
<td>432 MHz J-BEAM</td>
<td></td>
</tr>
<tr>
<td>$47.50</td>
<td></td>
</tr>
<tr>
<td>Rx MMc 144</td>
<td></td>
</tr>
<tr>
<td>2.10 METER CONVERTER</td>
<td></td>
</tr>
<tr>
<td>$53.70</td>
<td></td>
</tr>
</tbody>
</table>

---

**IMPROVE YOUR RECEPTION WITH KVG CRYSTAL FILTERS**

- **XF9A SSB** — 5 POLE $31.95
- **XF9B SSB** — 8 POLE $45.45
- **XF9M CW** — 4 POLE $34.25

- **MATCHING OSCILLATOR CRYSTALS**
  - **XF901** 8998.5 kHz USB $3.80
  - **XF902** 9001.5 kHz LSB $3.80
  - **XF903** 8999.0 kHz CW $3.80

- **F-05 CRYSTAL SOCKET**
  - 50¢

---

**SPECTRUM INTERNATIONAL**

**BOX 1084 CONCORD**

**MASSACHUSETTS 01742**

---

March 1974
Wilson Electronics Presents The Finest 2 Meter Handie Talkie
With the Hottest Rx Front End on The Market.

2 METER FM TRANSCEIVER MODEL 1402SM

FREQUENCY .................................................. 140 - 150 MHZ
(2 MHZ SPREAD)

NUMBER OF CHANNELS .................. 6
Supplied with 146.94 Simplex
146.34/94 - 146.16/76

R.F. Output .............................................. 2 Watts minimum

Sensitivity ........................................... better than 0.3
MV/20 DB Q.S.

Audio Output ............................................. 500 mv

Meter .................................................. Monitors battery voltage
on Tx, S meter on Rx

Weight ........................................... 1 lb. 4 ounces
without batteries

Current drain ................................. 15 MA Rx
410 MA Tx

Size 8 7/8” x 1 7/8” x 2 7/8”
Includes Adjustable Whip Ant

$239.00
Amateur
Net Price

MODEL # ACCESSORIES
1410A 12 Watt Power Amplifier
Also Includes Steel Case
For 1402SM - Charges 1402 SM
When Plugged into Cigarette
Lighter 99.00

LCL LEATHER CASE .............. 12.00
14BC BATTERY CHARGER ... 29.95
SM1 SPEAKER MIKE ............... 24.00

WRITE FOR COMPLETE SPEC SHEETS.
SEE YOUR NEAREST DEALER FOR
THE FINEST AMATEUR HANDIE
TALKIE ON THE MARKET

DEALER INQUIRIES INVITED
COMMERCIAL VERSION AVAILABLE 1410A

Wilson Electronics
P.O. Box 794 Henderson, Nevada 89015
Telephone (702) 451-5791 451-6650
WE BUY ELECTRON TUBES, diodes, transistors, integrated circuits, Semiconductors. Astral Electronics, 150 Miller Street, Elizabeth, New Jersey 07207, (201) 354-2420.

WANTED — Technical manual for R-278B/GR military receiver, WB5AYZ, 1013 Indiana St., S.E., Albuquerque, N. M. 87108.

USED MYLAR TAPES — 1800 foot. Ten for $8.50 postpaid. Fremerman, 4041 Central, Kansas City, Mo. 64111.

SELL CHEAP: Eico #369 sweep-gen., panel meters, vacuum-caps, I.C.'s. S.A.E. for listing Samkofsky, 4803 Brenda Drive, Orlando, Florida 32806.


STANDARD 146-A (1.2) $238.70, (3.11) $212.30.

USED MYLAR TAPES - 1800 foot. Ten for $8.50 postpaid. Fremerman, 4041 Central, Kansas City, Mo. 64111.

SPECIAL ORDERED VISIBLE RECORDING FILM — 100 ft. $10.00. (3-11) $10.00. Standard Vacuum Caps, 1401 Market St., Phila., Pa. 19102.

NEW: Standard 4450A. 100 kHz to 200 MHz. 500 microamps. $299.00. Standard Vacuum Caps, 1401 Market St., Phila., Pa. 19102.

NEW: Standard 4450A. 100 kHz to 200 MHz. 500 microamps. $299.00. Standard Vacuum Caps, 1401 Market St., Phila., Pa. 19102.

FREE PRIORITY MAIL ORDER Forms. Write for information if you have not attended the last HAMVENTION. Waltham, Mass. 02154.

FREE PRIORITY MAIL ORDER Forms. Write for information if you have not attended the last HAMVENTION. Waltham, Mass. 02154.

FOR SALE: Drake 2NT xmtr., Heathkit VFO, one year old, perfect, $140. Write or call, Richard Newman, 2 Clinton St., Milford, Connecticut 06460. 203-877-2205.

YOUR AD belongs here too. Commercial ads 35¢ per word. Non-commercial ads 10¢ per word. Commercial advertisers write for special discounts for standing ads not changed each month.

More Details? CHECK-OFF Page 94
FM YOUR GONSET

for your Clegg 22-er, Poly Comm 2, PC 62, Johnson
GNZ, Aerovox 500, HA 460, TX 62 or VHF 1J)

• New! Plug-in modulator puts the
Communicator transmitter on FM.
• No modification or rewiring on your
Communicator. Just plug into mike jack
and crystal socket.
• Compact self-contained modulator measures
4" x 3" x 1".
• Works with Communicator I, II, III, IV
and GC-105, and other rigs listed.
• FM at a tenth the cost of a new rig.
• Frequency adjust for netting built in.
• $34.50 prepaid U. S. $36.50 for PC-2,
PC-62, HA-460. Specify transmitter model. California residents add 5% sales tax. (HC-6/U crystal and 9 volt transistor battery not supplied.)
• Send for free descriptive brochure.

PALOMAR
ENGINEERS
BOX 455, ESCONDIDO, CA 92025

WANTS TO BUY

All types of military electronics equipment and parts. Call collect for cash offer.
SPACE ELECTRONICS division of
MILITARY ELECTRONICS CORP.
76 Brookside Drive, Upper Saddle River
New Jersey 07458 (201) 327-7640

LOWER PRICES

Two models
TIME TELLER

DX Operating Aid

AC1

A turn of knob and 2 color drum dial shows time your
QTH and corresponding local time in all zones
also GMT. Both models feature 2 color map panel of
enamel on aluminum 9" in length.

Model 1

Model A

AMATEUR NET

U-J

6605 Shoal Creek Blvd.
Industries
Austin, Texas 78757

For FREQ.
STABILITY

Depend on JAN Crystals.
Our large stock of quartz
crystal materials and components assures Fast
Delivery from us.

CRYSTAL SPECIALS

2-METER FM for most Transceivers ea. $3.75
144-148 MHz — .0025 Tol.
Frequency Standards
100 KHz (HC 13/U) 4.50
1000 KHz (HC 6/U) 4.50
Almost all CB Sets, Tr. or Rec.
(CB Synthesizer Crystal on request)

Any Amateur Band in FT-243

1.50

(80-meter, $3.00 -160-meter not available) 4 for 5.00
For 1st class mail, add 20¢ per crystal. For
Airmail, add 25¢. Send check or money order.
No dealers, please.

Division of Bob Whan
& Son Electronics, Inc.
2400 Crystal Drive
Ft. Myers, Florida
33901

All Phones
(813) 936-2397

Send 10¢ for new catalog with 12 oscillator
circuits and lists of frequencies in stock.

CW FILTER

New Model CWF-2 $19.95
Ready to use. Please include
$1.00 postage

Model CWF-2-812.95 Kit
$14.95 Wired, tested, guaranteed
Please include 50¢ postage

- Get Razor Sharp selectivity from any receiver or transceiver.
- Extremely high signal rejection.
- Dramatically reduces background noise.
- No audible ringing.
- No impedance matching.
- Ultra modern active filter design uses IC's for super high performance.

We have done all the hard work necessary to make this filter plug into your Ore and Orinco. Simply plug it into the phone jack or connect it to the speaker terminals of any receiver or transceiver and use headphones, speaker, or speaker amplifier. Better yet connect it between any audio stages for top performance of your equipment.

Build it yourself. CWF-2 PC card into your receiver and get the selectivity and sensitivity you are missing.

The 2 MHz CWF-2-12,000 Crystal filter puts your receiver to the top of the list. The selectivity is second to none. Get the best for your money back.

We will cheerfully refund it if these filters don't improve your receiver. A turn of knob and 2 color drum dial shows time your QTH and corresponding local time in all zones also GMT. Both models feature 2 color map panel of enamel on aluminum 9" in length.

CRYSTAL SPECIALS

2-METER FM for most Transceivers ea. $3.75
144-148 MHz — .0025 Tol.
Frequency Standards
100 KHz (HC 13/U) 4.50
1000 KHz (HC 6/U) 4.50
Almost all CB Sets, Tr. or Rec.
(CB Synthesizer Crystal on request)

Any Amateur Band in FT-243

1.50

(80-meter, $3.00 -160-meter not available) 4 for 5.00
For 1st class mail, add 20¢ per crystal. For
Airmail, add 25¢. Send check or money order.
No dealers, please.

Division of Bob Whan
& Son Electronics, Inc.
2400 Crystal Drive
Ft. Myers, Florida
33901

All Phones
(813) 936-2397

Send 10¢ for new catalog with 12 oscillator
circuits and lists of frequencies in stock.

CW FILTER

New Model CWF-2B $19.95
Ready to use. Please include
$1.00 postage

Model CWF-2-812.95 Kit
$14.95 Wired, tested, guaranteed
Please include 50¢ postage

- Get Razor Sharp selectivity from any receiver or transceiver.
- Extremely high signal rejection.
- Dramatically reduces background noise.
- No audible ringing.
- No impedance matching.
- Ultra modern active filter design uses IC's for super high performance.

We have done all the hard work necessary to make this filter plug into your Ore and Orinco. Simply plug it into the phone jack or connect it to the speaker terminals of any receiver or transceiver and use headphones, speaker, or speaker amplifier. Better yet connect it between any audio stages for top performance of your equipment.

Build it yourself. CWF-2 PC card into your receiver and get the selectivity and sensitivity you are missing.

The 2 MHz CWF-2-12,000 Crystal filter puts your receiver to the top of the list. The selectivity is second to none. Get the best for your money back.
3-CHIP CALCULATOR

This calculator set provides all of the electronics for an 8-digit, floating point calculator with left-hand entry. Keyboard, display, clock generator, and display driver is all that need be added to make a calculator that will add, subtract, multiply, and divide. Overflow and negative signals are also provided. Complete instructions to build a calculator included.

CHIPS AND DATA

$9.95
DATA ONLY (Refundable)

3500 CALCULATOR

This calculator chip has a full four-function memory, which is controlled by four keys, M (adds entry into memory), -M (subtracts entry from memory), R (return memory) without clearing rest of registers, RM (read memory or use as entry). 12-digit display and calculate.

Fixed decimal at 0, 1, 2, 3, 4, or 5.
Leading zero suppression
7-segment multiplexed output
True digit on display
Single 28-pin chip

CHIP AND DATA

ONLY $9.95
DATA ONLY (Refundable)

5000 CALCULATOR

40-Pin calculator chip will add, subtract, multiply, divide, 12-digit display and calculate. Chain calculations. True credit balance sign output. Automatic over-flow indication.

Fixed decimal point at 1, 2, 3, or 4.
Leading zero suppression.
Complete data supplied with chip.

CHIP AND DATA

ONLY $9.95
DATA ONLY (Refundable)

RECIPIENTS

1000 FULL-WAVE BRIDGES
V5450 2A 400V $9.90
V5674 2A 600V 1.10
MR810 Rect. 50V 1A .10

Special 811: Hex Inverter

TTL DIP hex inverters, pin interchangeable with SN7404. Parts are brand new and are branded Signetics and marked “811.”

Price:
$100 EACH
Supplied
100 FOR $10.00
200 FOR $19.00

CD-2 Counter Kit

This kit provides a highly sophisticated display section module for clocks, counters, or other numerical display needs. The unit is 4-digit and supplies a single 5-volt power source powers both the ICs and the display tube. It can attain typical count up to 30 digits (with all interconnects) and also has a least test, causing all 7 segments to light. Key includes a 2-sided (with plated thru holes) fiberglass printed circuit board, a 7495, 7475, 7474, a 3010 RCA Numtron display tube, complete instructions, and enough Nock pins for the ICs. NOTE: boards can be supplied in a bag of up to 10 digits (with all interconnects), therefore, when ordering, please specify whether you want them in single panels or in a multi-digit display board. Not specifying will result in shipping delay.

COMPLETE KIT

ONLY 5.15
FULLY-ASSEMBLED

Boards can be supplied separately $5.00 per digit.

LINEARS

NE540 70-watt power driver amp. $2.00
NE555 precision timer $1.30
NE556 phase lock loop DIP $3.25
NE557 phase lock loop TO-5 $3.25
NE558 function generator TO-5 $4.00
NE559 tone decoder $4.00
NE5588 dual 741 op amp MINI DIP $1.00
909 popular op amp DIP $0.75
711 voltage comparator DIP $0.40
733 precision voltage regulator DIP $1.00
741 op amp TO-91 MINI DIP $0.75
742 dual op amp TO-91 MINI DIP $1.50
744 op amp TO-95 $1.00
CA1018 2 isolated transistors and a Darlington connection-constant $2.00
CA1045 5 WPN transistor array $1.00
CA3024 dual differential amp $1.00
CA3052 positive regulator TO-5 $0.10
CA1051 voltage regulator DIP $0.10
LM302 op amp voltage follower TO-95 $1.75
LM309 op amp $1.00
LM308 op amp $2.00
LM311 comparator TO-95 $1.75
LM3070 AGC amplifier $2.00
LM3090 1A op amp $2.00
LM3091 2A op amp module $2.00
LM3092 9Y-1A power supply module TO-95 $2.00
LM3900 quad op amp $2.00
LM3903 4-quadrant full-wave $2.00
LD38 nine square triangle function generator $4.95
RECEIVERS, OK GRTD, WITH BOOKS:

- SP-600-JX: AM, CW, 0.54-54 MHz continuous .................................. 275.00
- R388-URR: AM, CW, 15-301/2 MHz linear dial, PTO .......................... 325.00
- R390A-URR: 1/2-32 MHz by digits, PTO tuning .................................. 595.00
- AM/FRR-59B (later version WR-2R): 2-32 MHz digital tune each 500 Hz or continuous. A1, 2, 3, 9, F1, 4, FSTTY, SS, carrier suppressed, either band or both for 2 different intelligences. Stable and accurate enough to use as freq. meter! Net wt. 276 lbs. in 2 cabinet in rack cradle 750.00
- WWVB 60 KHz rcrv/comparator .......................................................... 295.00
- WWV 60 KHz tones, use to calib. 100 KHz .................................................. 175.00
- 38-1000 MHz by Band Switching, 4 bands: Separate antenna for each band, AN/ALR-5 modified for 117 v 50/60 cyc line. AM/FM. The Tuner is a plug-in converter; the receiver is 30 MHz IF and all that follows IF. Selectivities 200 KHz or 2 MHz each side of center. Factory checkout sheet, typical for the original-pack tuner you get, says sensitivity ranges from 1.1x1/v at 28 MHz to 7 at 1 GHz. IF attenuator IS calibrated in 6 dB steps to -74 dB. Diode current meter makes this rcvr useful for relative field strength measurements and harmonic finder. Rcvr unil is exc. used and checked out OK .............................................. 375.00
- 30 MHz PANADAPTER may be useful with above ..................................... 295.00
- 30 MHz PANADAPTER may be useful with above ..................................... 295.00
- A.I.L. #132 30 MHz rcrv/amplifier/atten. calib. .................................. 99.50
- EDDYSTONE AM/CW/FM/NBFM 19-165 MHz rcvr ............................ 295.00
- CV-591A: SSB Converter either sideband ............................................... 137.50
- MOTOROLA 3 MHz OSCIL. 5 parts in 10 to 11th ................................... 199.50

Attention!

Buyers, Engineers, advanced Technicians: We have the best test-equipment & oscilloscope inventory in the country so ask for your needs . . . don't ask for an overall catalog . . . we also buy, so tell us what you have. Price it.

R. E. GOODHEART CO., INC.
Box 1220-HR, Beverly Hills, Calif. 90213
Phone: Area Code 213, Office 272-5707

NEW - 440 MHz PREAMPS

$54.95 POSTPAID
432PA-1

Two stage preamps use KMC Bipolar and Mos- tet Transistors. 20db gain, 20 MHz bandwidth. These are high quality preamps suitable for the most demanding applications. AC models have die cast cases, others have metal enclosure.

432PA 5.5db NF 12VDC................................................................. 29.95
432PA-1 5.5db NF 117VAC ............................................................. 54.95
432PC 1.5 to 2.0db NF 12VDC .................................................... 69.95
432PC-1 1.5 to 2.0db NF 117VAC ................................................. 94.95

JANEL LABORATORIES
P. O. BOX 112 SUCCASUNNA, N. J. 07876
210-584-6521

BROADBAND AMPLIFIERS, for amateur, MATV, CATV and commercial use

We offer a quality line of low noise, low IMD amplifiers covering the region from 2 MHz to 1.5 GHz. For communication use, simple filters at the input will yield coverage of the bands of your choice. Where remote location is necessary to offset line losses, coax powered versions are available with adapters or power supplies.

RADIATION DEVICES CO., P. O. Box 8450, Baltimore, Md. 21234

Please write for information on our other products including RF Multimeters, VSWR Bridges, Detectors, L-C, Crystal and Tunable Active Peak-N-Notch Filters.
THE TIME
THE DATE
AND THE ANSWER

10-DIGIT DESK
CALCULATOR WITH
DIGITAL CLOCK AND
CALENDAR

✓ Convenient keyboard switch selects
calculator or clock/calendar mode.
✓ In clock position, hours, minutes
and seconds are displayed in alter-
ning sequence with the month
and day.
✓ Automatic day update, automatic
month update.
✓ Keeps perfect time even when turned
off.
✓ Seven powerful functions including
add, subtract, divide, multiply, re-
ciprocal, square root and percent.
✓ Two, four or floating decimal, float-
ing negative sign.
✓ Automatic constant on five func-
tions, non-interfering keyboard for
speed entries.
✓ One year full warranty.

ORDER MODEL — 305

Mail to:
TUCKER ELECTRONICS CO., P.O. Box 1050, Garland, TX 75040
or CALL TOLL FREE 800-527-4642 (in Texas call 214-348-8800)

Please send me ______ 305 Calculators at $99.95 each plus $2.76 for shipping and handling.
(Residents of California, Illinois, New Jersey and Texas add 5% tax.)

☐ Bill my Master Charge ☐ BankAmericard ☐ American Express

Card No. __________________________ Name __________________________
Expiration Date __________________________ Address __________________________
Signature __________________________

☐ Check Enclosed

☐ Ship COD

City/State __________ Zip __________

Who is Corvus?

CORVUS is a wholly-owned subsidiary
of MOSTEK Corporation — the first
company in the world to introduce the
now famous single-chip calculator inte-
grated circuit. The MOSTEK innovation
has virtually revolutionized the calcu-
lator industry allowing noiseless, com-
pact design and portable operations.
TUCKER says — try the 305 for 30
days — if you don’t agree it’s the best,
return it for full credit.

$99.95

THE TIME
THE DATE
AND THE ANSWER

10-DIGIT DESK
CALCULATOR WITH
DIGITAL CLOCK AND
CALENDAR

✓ Convenient keyboard switch selects
calculator or clock/calendar mode.
✓ In clock position, hours, minutes
and seconds are displayed in alter-
ning sequence with the month
and day.
✓ Automatic day update, automatic
month update.
✓ Keeps perfect time even when turned
off.
✓ Seven powerful functions including
add, subtract, divide, multiply, re-
ciprocal, square root and percent.
✓ Two, four or floating decimal, float-
ing negative sign.
✓ Automatic constant on five func-
tions, non-interfering keyboard for
speed entries.
✓ One year full warranty.

ORDER MODEL — 305

Mail to:
TUCKER ELECTRONICS CO., P.O. Box 1050, Garland, TX 75040
or CALL TOLL FREE 800-527-4642 (in Texas call 214-348-8800)

Please send me ______ 305 Calculators at $99.95 each plus $2.76 for shipping and handling.
(Residents of California, Illinois, New Jersey and Texas add 5% tax.)

☐ Bill my Master Charge ☐ BankAmericard ☐ American Express

Card No. __________________________ Name __________________________
Expiration Date __________________________ Address __________________________
Signature __________________________

☐ Check Enclosed

☐ Ship COD

City/State __________ Zip __________

Who is Corvus?

CORVUS is a wholly-owned subsidiary
of MOSTEK Corporation — the first
company in the world to introduce the
now famous single-chip calculator inte-
grated circuit. The MOSTEK innovation
has virtually revolutionized the calcu-
lator industry allowing noiseless, com-
pact design and portable operations.
TUCKER says — try the 305 for 30
days — if you don’t agree it’s the best,
return it for full credit.

$99.95

THE TIME
THE DATE
AND THE ANSWER

10-DIGIT DESK
CALCULATOR WITH
DIGITAL CLOCK AND
CALENDAR

✓ Convenient keyboard switch selects
calculator or clock/calendar mode.
✓ In clock position, hours, minutes
and seconds are displayed in alter-
ning sequence with the month
and day.
✓ Automatic day update, automatic
month update.
✓ Keeps perfect time even when turned
off.
✓ Seven powerful functions including
add, subtract, divide, multiply, re-
ciprocal, square root and percent.
✓ Two, four or floating decimal, float-
ing negative sign.
✓ Automatic constant on five func-
tions, non-interfering keyboard for
speed entries.
✓ One year full warranty.

ORDER MODEL — 305

Mail to:
TUCKER ELECTRONICS CO., P.O. Box 1050, Garland, TX 75040
or CALL TOLL FREE 800-527-4642 (in Texas call 214-348-8800)

Please send me ______ 305 Calculators at $99.95 each plus $2.76 for shipping and handling.
(Residents of California, Illinois, New Jersey and Texas add 5% tax.)

☐ Bill my Master Charge ☐ BankAmericard ☐ American Express

Card No. __________________________ Name __________________________
Expiration Date __________________________ Address __________________________
Signature __________________________

☐ Check Enclosed

☐ Ship COD

City/State __________ Zip __________

More Details? CHECK—OFF Page 94
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

A-5 181
Antech 006
Andy 007
Antenna Design 211
Babyon 014
Barry 016
Catronics 189
Columbia 212
Communications Specialists 030
Curtis 034
Cush Craft 035
Data 037
Drake 039
Dycomm 040
Dynamic Elect. 041
ECM 190
E & L 182
Eimac 043
Electronic Dist. 044
Epsilon 046
Erickson 047
Exceltronics 139
Fair 048
G & G 051
Gateway 052
Glade School 213
Global 053
Goldstein's 130
Gray 055
Gregory 021
H & L 056
HR Books 150
HAL 057
Harry 062
Hobby 063
House of Dipoles 036
Icon 065
International Crystal 066
International Elect. Unltd. 141
Jan 067
Janel 068
Jeff-Tronics 069
K. E. 374
KLM 073
KRP 074
Larsen 078
Leland 193
Linear 081
Logic 133
MFJ 082
Marx 197
Matic 084
Mclaren 155
Meshna 085
Mor-Gain 089
Motorola 160
Nym 090
Palomar 093
Pemco 095
Prasad 215
Poly Paks 096
Prof. Elect. 140
RP 098
Racal 097
Radiation Devices 099
Callbook 100
Raytheon 101
Regency 102
Rochester 217
Saway 105
Singer 219
Space-Military 107
Specialty Prod. 216
Spectronics, FM 191
Spectrum 108
Star-Tronics 110
Swan 111
Teledyne 218
Telespot 188
Ten-Tec 114
Topeka FM 115
Tri L. 116
Tri Tek 117
Tristato 118
Tucker 113
U J 119
VHF Engineering 121
Venus 192
Weinschenker 122
Wilson 123
Wolf 124
World QSL 125
Y & C 126
Yaesu 127

Limit 15 inquiries per request.

March 1974

Please use before April 30, 1974

Tear off and mail to
HAM RADIO MAGAZINE — "check-off"
Greenville, N. H. 03048

NAME

CALL

STREET

CITY

STATE

ZIP

94 march 1974
The TRITON is a One-of-a-Kind HF transceiver, totally solid state including the final amplifier. The new generation that does more things better than ever before.

One, you can change bands instantly. Just turn the band switch—and go!

Two, there is less internal heat to prematurely age components and no high voltage to break down insulation or cause accidental shock.

Three, it has ample reserve power to run at full rating even for RTTY or SSTV without limit. Great for contests or emergency service.

Four, it is light and compact with a detachable AC power supply to work directly from 12 VDC—for mobile operation without tedious installation.

Five, the TRITON is a delight to operate. SSB is clean, crisp and articulate. Amplified ALC puts all available speech power into the antenna without splatter. CW is wave-shaped to cut through QRM and pile-ups. Instant break-in (not "semi" which really isn't break-in) lets you monitor the frequency while transmitting.

And six, a lot more goodies such as excellent dial illumination, plug-in circuit boards, offset tuning, built-in SWR bridge, speaker, crystal calibrator, snap-up anti-parallelax front feet, light indicators for offset and ALC, direct frequency readout, WWV, entire 10 meter band coverage—and a lot more.

The TRITON brings together all that is new and exciting in Solid State for your greater enjoyment of Amateur Radio.

TRITON I 100 watts input $519.00
TRITON II 200 watts input $605.00
Model 251 Supply for TRITON I $69.00
Model 252 Supply for TRITON II $89.00

We'll be happy to send you full information.

TEN-TEC, INC.
SEIIVERVILLE, TENNESSE 37862
Miscellaneous from Barry

NPC POWER SUPPLIES
115 VAC input - 12 VDC 4 amps out .................................. $24.95
Same as above but regulated .................................................. $34.95
115 VAC input - 12 VDC 10 amps out ................................... $54.95
C.D. TR-44 Rotators new, complete ....................................... $69.95
Cable for Ham-M & TR-44 ...................................................... $44.95
Collins 150-11 Phone Patch .................................................. $24.95
Erie free thru ceramic capacitors, 1500 pf with hardware ....... $70.95
Victoreen Radiological Survey Meter with 20 uA meter .......... $19.95

B & W WATERS Model 334-A
DUMMY LOAD, WATTMETER, ONE KW $139.95 PREPAID

FM from Barry
IC-22 22 channel, 2 meter transceiver. Very hot receiver, 10 watts out $289.00

IC-230 by Inoue
Completely synthesized with phase locked loop, Single Knob Control, Smart compact styling $489.00

See Barry for Receivers
Hammarlund HQ-180 with SSB ................................................ $225.00
Hallicrafters SX-100 with SSB .............................................. $100.00
Hallicrafters SX-110 gen. coverage ....................................... $99.95
Heath SB-301 with SB-620 Scanalysr and SB-600 Speaker Write
National NC-88 General Coverage with band spread for ham bands, 80 meter band needs repair fairly good, $55.00
Motorola R-220 20-220 Mcs. All Modes: Write

HF Gear from Barry
Hallicrafters FPM-300 Safari, 5 bands 80-10 meters Shipping Prepaid net $625.00
A Free Hustler 4BTV Vertical Antenna with every FPM 300 regular price $49.95
Famous Triton II by Ten-Tec. Fully solid state, 200 watt transceiver, 5 bands. Full break in on CW $606.00
Ten-Tec 252 AC Power Supply $89.00
Ten-Tec Model 315 Receiver .................................................. $229.00
CW Filter ............................................................................ $14.95
Drake TR-4C Transceiver new, $99.95 AC-4 Power Supply $99.95
Drake R4-B Super Mint, Extra Crystals Write
Collins 30L-1 Linear Amplifier good, $375.00
Collins 3126-4 Station Control good, $149.00
Collins 3129 Stationry Control Write

C.D. Ham-M Rotators
new, complete $99.95

TMC RF Master Oscillator. 2-64 Mcs. on harmonics, relay rack mount excellent, $150.00
Tube Headquarters. Diversified Stock. Heavy inventory of Eimac tubes, chimneys, sockets, etc. $572B $17.50
Dycomm Super Block. Input 2-35 watts, Output 10-80 watts $149.95

Clegg FM-27B, 146-148 Mc. coverage without buying a crystal. Fully synthesized 25 w. out $479.95
Clegg PS-011 AC power supply for FM-27B $79.95
Shipping prepaid on all FM-27B's

Tempo TPL 1002-3, 2-meter amplifier, 10 watts in, 130 watts out $220.00
Drake TR-72, 2-meter FM transceiver, 23 channels, 1 or 10 watts output, 13.8 volts $320.00
GE Model YGS-3 FM signal gen. 1-150 Mc, excellent, no manual $200.00
SBE-450 TRC Transverter, 2 meters in, 450 Mcs out $179.95

VENUS SS-2
Slow Scan Monitor $349.00

VENUS C1
Fast Scan/Slow Scan Camera & Converter
Micro focus ¼ inch to infinity Bar Generator, Reversal $469.00

Venus Now Stocks Bogen, Electrovoice & University. Call or Write.

CASH PAID FAST! For your unused TUBES, Semiconductors, RECEIVERS, VAC. VARIABLES, Test Equipment, ETC. Write or call Now! Barry, W2LNI. We Buy! We ship all over the World. Thousands of unadvertised specials. F.O.B. point of shipment.

Send for Green Sheet Supplement 23. Send 50c postage & handling (refund 1st order).

BARRY 512 Broadway NY, NY 10012 ELECTRONICS
DEPT. H-3
212-749-7000
TELEX 12-7670

96 March 1974 More Details? CHECK-OFF Page 94
WHEN YOU BUY KENWOOD  
...YOU BUY
PRIDE, PLEASURE & PERFORMANCE

Pride in knowing that you own today's ultimate in state-of-the-art technology...pleasure in operating a rig whose day in, day out performance will show you why the Kenwood name is world-famous for reliability and value.

Kenwood's superb state-of-the-art SSB transceiver

TS-900

...the ultimate transceiver. The promise of the transistor has been fulfilled. Here is the transceiver you will want to own...whatever you have now, at ready to trade up. Its important features are far too numerous to list. Its specifications are superb. The TS-900 is unquestionably the best transceiver of its kind ever offered. The price $795.00

PS-900 (AC Supply) $120.00, the DS-900 $140.00

TS-520

Kenwood's go every place...do everything transceiver

The new TS-520 is the transceiver you have wanted, but could not buy until now. It is a non-compromise, do everything, go everywhere 5 band transceiver for SSB or CW that performs equally well at home, in an automobile, airplane, boat or trailer. The TS-520 features built-in AC power supply, built-in 12 volt DC power supply, built-in VOX with adjustable gain delay and anti-VOX. The price $599.00

The R-599A is the most complete receiver ever offered. It is solid state, superbly reliable, small and lightweight, covers the full amateur band...10 thru 160 meters, CW, LSB, USB, AM, AM, N and FM.
The price $439.00

The T-599A is mostly solid state...only 3 tubes, has built-in power supply, full metering (ALC, Ip, RF output & high voltage), CW-LSB-USB-AM operation.
The price $459.00

Please call or write for complete specifications. Also available at Kenwood dealers throughout the U.S.

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

Prices subject to change without notice.
EIMAC
The DX Champion.

In contest after contest, contact after contact, you'll hear the EIMAC-equipped stations come out on top. Join the elite operators who choose EIMAC for power, dependability and quality. You'll be in good company.

For technical information on EIMAC products, contact the EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070. Or any of the more than 30 Varian/EIMAC Electron Tube and Device Group Sales Offices throughout the world.