low-cost
electronic keyer
with
random-access memory

this month

- AFSK keyer 10
- touch-tone decoder 14
- antenna matching 18
- rf power meter 26
- vhf pre-scaler 30
NOW!!

an exciting addition to the
magnificent Kenwood line...

The New TS-520 Transceiver

The new TS-520 is the transceiver you have wanted, but could not buy until now. A no-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 top of the line TS-900 and the superb R-599A Receiver and T-599A Transmitter are already well known to all amateurs. Now the TS-520 fills out the line offering the famous Kenwood quality and reliability at a price most amateurs can afford.

Here are 30 special reasons you will want to own a TS-520. After you have operated one, you will doubtless give us 30 more why you're glad you own one.

1. Built-in AC power supply
2. Built-in 12 volt DC power supply
3. Built-in VOX with adjustable gain, delay and anti VOX
4. 1 KHz dial readout
5. Ultra stable FET linear VFO
6. Built-in noise blanker
7. Built-in RIT circuit and RIT indicator light
8. 8 pole crystal filter
9. Built-in 25 KHz crystal oscillator
10. Provisions for optional CW filter
11. Break-in CW with sidetone
12. Completely solid state except final section. Compact, low current, reliable, with heater switch for mobile receive-only operation
13. Built-in cooling fan
14. Accessory external VFO & accessory external speaker
15. Built-in speaker
17. Amplified ALC
18. TUNE position increases tube life
19. Maximum TVI protection
20. Built-in fixed channel operation (4 channels) with indicator light
21. Provisions for use with a VHF transverter
22. Full metering
23. Selectable SSB
24. Selectable AGC operation for different modes
25. VFO indicator light
26. Built-in selectable ALC action for speech processing
27. Carrying handle
28. Rugged 6146 type final tubes
29. Internal cross-channel operation
30. Push button WWV reception

Proven Kenwood quality and reliability

The Price: $599.00
subject to change without notice.

Accessories: External VFO-(VFO-520), External speaker - (SP-520), CW Filter - (CW-520)

Available from 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 816/679-3177
WE TRY TO BUILD THE ALPHA 77 TO LAST FOREVER
NO MATTER WHAT YOUR OPERATING INTERESTS ARE.

THIS MAXIMUM-LEGAL-POWER DELUXE LINEAR AMPLIFIER WILL HANDLE ANYTHING YOUR AMATEUR LICENSE ALLOWS — ALL THE WAY FROM 10 THRU 160 METERS — AND DO IT EFFICIENTLY, QUIETLY, AND RELIABLY

DX AND CONTEST TIME IS HERE — Long stretches of heavy operating really put equipment to the test. The rugged ALPHA 77 is built to run maximum legal power in any mode, for any length of time, with a healthy margin of safety. Even if you goof changing bands at 3 a.m., the 77's protective circuits and husky components will vigorously resist damage.

BITTEN BY THE SSTV BUG? Unlike sideband, SSTV transmission is "key down" all the way — there's no duty cycle relief for marginal components. The ALPHA 77 takes it with ease.

ALPHA 77 — A great investment in performance and pleasure . . . $1995. Phone or write for brochure and an outstanding trade on your old gear.

EHRHORN TECHNOLOGICAL OPERATIONS, INC.
BROOKSVILLE, FLORIDA 33512
(904) 596-3711
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
TTP-1K, 2K, 3K & 4K, Sh. wt. 1 lb. ................. $34.50

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 110
October, 1973
volume 6, number 10

contents

6 electronic keyer with memory
   Michael J. Gordon, Jr., WB9FHC

10 audio-shift RTTY keyer
   Eric J. Kirchner, VE3CTP

14 touch-tone decoder
   Robert C. Heptig, K0PHF
   Robert D. Shriner, WA0UZO

18 two-band antenna matching
   R. W. Johnson, W6MUR

26 rf power meter
   Adrian B. Weiss, K8EEG

30 advanced vhf pre-scaler
   F. Everett Emerson, W6PBC

34 half-wave rectifiers
   John T. Bailey

38 frequency measurement
   of received signals
   J. H. Walker, Jr., W4AAD

58 electronic bandpass tuning
   D. H. Horner

4 a second look

110 advertisers index

62 ham notebook

68 new products

64 comments

99 flea market

110 reader service
The editor of a technically oriented magazine such as *ham radio* must wear several different and diverse hats. In fact, I could use up this entire page describing all the details that need attention to keep the magazine running smoothly. However, I’d like to talk for a moment about one very important editorial task that instills confidence in the reader, and one that doesn’t. This task, which I share with the rest of the editorial staff, is that of researcher and seeker of truth.

Most of the articles published in *ham radio* are contributed by readers who want to share an idea or the details of a particularly successful project. Authors range from enthusiastic hams who have never written anything more than a short story for their English professor to fellows with engineering backgrounds who make their livings in front of a typewriter. All want to share an idea and I welcome the output of anyone who is interested in contributing something that will benefit all hams.

Budding authors often ask, “What kind of articles are you looking for?” That’s a difficult question to answer because many new manuscripts come across my desk every day, but generally speaking, I am looking for simple construction projects that the average reader can complete in one or two weekends. Larger projects are also welcome, but most *ham radio* readers must split their spare time between amateur radio and other interests, so they don’t have time to build Chinese copies of complex electronics equipment.

Once a month I set one or two days aside to go over all manuscripts that have come in during the previous month. Since I seldom use more than a dozen articles in any issue, I don’t accept more than that during any one-month period. This is sometimes a nearly hopeless task since there may be three-dozen or more manuscripts to be considered. The first things I look for are originality and interest value. If the contribution passes this test, the next thing I look for is technical accuracy and attention to detail.

The contributed article doesn’t have to be a literary masterpiece to be accepted. If you have a good idea and it’s well documented, if the illustrations and technical discussion are clear and accurate — you may have a winner! On the other hand, if the article rambles from one topic to another, covers ground that has been over thousands of times before, or presents inaccurate or misleading information, you will receive a rejection slip.

If your article has been accepted for publication, don’t expect to see it published in the very next issue. The production times for a monthly magazine are probably much longer than you ever imagined. The articles for this issue, for example, were being prepared for publication during the month of June. As you are reading this we are putting together the material for the February, 1974, issue of *ham radio*.

Incidentally, my staff and I are fairly adept at ferreting out technical inaccuracies, but despite research and keeping the mailman busy between our editorial office and the author, errors do occasionally creep into the magazine. Contributing authors can help by carefully checking out their facts before submitting the article. Errors can cause considerable misery to the builder, and as publishers we are taken to task for the error. So, before you send in that next article, spend some extra time going over the text and illustrations — it might save some later embarrassment.

Jim Fisk, W1DTY editor
A NEW MEDIUM POWER HF TRANSCEIVER
COMPLETELY SOLID STATE

"Nothing can withstand the
force of a new idea whose time
has come"

We'll be happy to send you full information.
low-cost
electronic keyer
with
random-access
memory

Although many circuits for electronic keyers with a memory have appeared in the literature, recent developments in the IC industry have rendered these designs obsolete. These developments include the introduction of MOS random-access memories which are compatible with TTL ICs. It is now possible to build an electronic keyer with 512 bits of storage for a total parts cost of $40.00.* Thanks to the miniature MSI and LSI devices, there are only eight ICs in the unit, which fits on a 2-1/2- by 4-inch circuit board, power supply included!

circuit

The circuit is not very complex and can be divided into two parts: the keyer, which automatically produces dots and dashes, and the memory section and its associated logic.

The keyer circuit is fairly standard and is designed for use with a standard paddle. Speed is variable from roughly 6 to 60 words per minute; the characters are

*A complete kit of parts, including circuit board, is available for $40.00 from Psynexus Systems, P.O. Box 277, Glencoe, Illinois 60022. The drilled glass-epoxy circuit board is available for $4.00. All items post-paid.
self-completing. Details of how this portion of the circuit operates are best understood by looking at the timing diagram, fig. 1, and by examining the logic diagram, fig. 2. Output from the keyer circuit is taken at two points, labeled DATA and DATA on the logic diagram. The DATA line goes directly to the output gate, where it is inverted and fed to the output keying transistor, a pnp device with a breakdown voltage of 150 volts. The DATA line is fed to the memory inputs.

**memory**

The two memory ICs used in this design are Signetics 25L01B 256-bit random-access memories. Each is an MOS LSI circuit containing thousands of transistors on a single chip. The particular memory cell that is being readout at a given time is determined by the status of the eight address lines. A chip-select control is provided; when a chip is not selected the input buffers are disabled and the output buffers are cut off, effectively taking the device out of the circuit. This allows the two ICs to be connected in parallel, simplifying both circuit board design and the logic requirements. It is this chip-select feature that makes the random-access memory more

---

**fig. 1. Timing diagram for the electronic keyer.** Note that closing the dash contacts puts a logic 1 on the J pins of both flip-flops A and B (fig. 2). Characters are self-completing.

---

**fig. 3. Power supply for the electronic keyer.** The negative 12-volt line powers the MOS memory circuits.
fig. 2. Logic diagram of
the low-cost electronic
keyer with 512 bits of
memory. Memory is
provided by two Signetics
25LO18 read-
only memory ICs.

Breakdown voltage of the 2N4888
keying transistor is 150 volts.

cost-effective than the shift register usu-
ally used in this type of circuit.

The MSI circuits, both four-bit binary
counters, are used to cycle the memory
through its 256 bits during the read and
write cycle. Normally, the Q output of
flip-flop C is in the logic 1 state, and the
output of gate D is held low. However,
when S1 is closed flip-flop C is reset, Q
goes to zero and clock pulses are fed to
the memory address counters which cause
each of the 256 locations in the selected
memory to be accessed.

On the 256th clock pulse, the last
stage in the counter triggers flip-flop C —
Q once again is returned to the logic 1
state and a memory cycle is complete.
During the cycle, Q is in the logic 1 state
and the LED is lighted, indicating a
memory cycle in progress. If the read/
write switch, S2, is in the read position
during a cycle, the data in the memory is
sent to the output gate and thus keys the
transmitter. If this switch is in the write
mode, whatever is sent by the paddle is
recorded by the selected memory as well
as sent to the output gate. Switch S3
selects one memory of the two available.

Clock pulses for the entire circuit are
generated by a Signetics NE555V timer
IC. The speed is variable over an extreme-
ly wide range by a single 50k pot. The
NE555 is an excellent choice for this
application because of its TTL compat-
ible output, small size and low power
consumption.

power supply

The power supply is simple, efficient
and effective (see fig. 3). It consists of a
full-wave bridge feeding a discrete regula-
tor. The voltages necessary for the proper
operation of this circuit are +5 volts and
-12 volts. The most positive point in the
Construction of the electronic keyer with memory. Timing and memory components are mounted on circuit board. Power supply components are mounted on rear wall of the enclosure.

circuit is called +5, and the regulator keeps ground five volts negative with respect to this point. The most negative point, the other side of the filter capacitor, is roughly 12 volts below ground. Since the 12-volt supply is not really critical, it is not regulated. As long as it provides between -10 and -13 volts, the circuit should operate properly. Four 0.1-μF ceramic bypass capacitors are placed at various points on the circuit board between V_{cc} and ground to absorb current spikes generated by the TTL output logic.

operation

Completely assembled, this electronic keyer is a joy to operate. Programming is simply a matter of pressing the start button and sending the desired message. Readout is even simpler, requiring only the push of a button. There is no need to switch between the manual and automatic mode of operation, since this is done automatically by the logic. Now, you can have your own keyer with 512 bits of storage, at a cost that is a far cry from the $200 and up that commercial units command.

ham radio

"Look, 'Mr. Ham Operator,' if you want more coffee just ask for it, and stop tapping out ---- --- --- - on your cup."

October 1973
The desirability for the absence of phase discontinuities in the output signal of audio frequency-shift RTTY keyers has been stressed in previous articles. These phase discontinuities appear at that point in time when the AFSK generator frequency is shifted from mark to space, or vice versa. The switch-over from one frequency to the other appears as a disruption along the sinusoidal waveform, as shown in fig. 1A.

A phase disruption such as this causes over- and under-shoots which manifest themselves as fast amplitude changes of the transmitted rf envelope. This leads to

![Phase Disruption](image1.png)  
![No Phase Disruption](image2.png)

fig. 1. In many AFSK generators severe phase discontinuities are introduced when switching from mark to space, or vice versa, as shown in A. This results in undesirable clicks, similar to CW key clicks. With the AFSK generator circuit described here there is no phase discontinuity when shifting frequencies, B.
clicks, similar to CW clicks, which can be heard on either side of the RTTY signal. Needless to say, these clicks interfere with stations operating on adjacent frequencies.

Although AFSK generator circuits which eliminate these phase discontinuities have been described in the past, they were complex and expensive, and used toroid inductors. The circuit described here was designed with simplicity and state-of-the-art in mind, and uses no toroid inductors.

circuit

The circuit for the continuous-phase AFSK generator is shown in fig. 2. Integrated circuits U1 and U2 constitute the audio-frequency oscillator. The output of U2, a National Semiconductor LM311H, is a square wave which is fed through R4 to the input of U1, a National Semiconductor LM301AN. U1 operates as an active filter whose frequency is determined by C1, C2, R1 and R2. The output of the active filter is capacitively coupled to the input of U2. The loop is closed and oscillation occurs.

The sine-wave output is available at pin 6 of U1. This sine wave crosses the zero voltage point at precisely the same time the square wave at pin 7 of U2 changes polarity as shown in fig. 3. This square-wave transition can therefore be used to command the switchover from one audio frequency to the other to occur only at the zero-voltage crossover of the sine wave. This will provide a phase-continuous output.

The switchover command is accomplished in the following way. The square-wave output from U2 is fed to transistor Q2 which operates as a voltage-level changer. The output swing from U2 is about ±10 volts, while the maximum input requirement for U3, a TTL master-slave J-K flip-flop, is from zero to +5 volts. The square-wave signal at the collector of Q2 toggles the input of U3. When the keyboard contacts connected to the input of gate U4 are opened, the polarity of the voltage at pins 6 and 8 of U4 invert, and the Q output of U3 will change its state then, and only then. This

fig. 3. In the circuit of fig. 2 the zero-voltage crossover of the sine-wave output coincides with the zero-voltage crossover of the square wave. The square-wave transition is used to control the precise moment mark-space switching occurs.

fig. 4. Suggested power supply for the AFSK generator uses a three-terminal IC voltage regulator, the Fairchild 7812.

October 1973
only happens when U3 is toggled by the negative-going transition of the square wave at Q2, which occurs at the zero-voltage crossover of the sine wave. At that instant the Q output of pin 8 of U3 goes low and brings transistor Q1 into conduction.

Transistor Q1 operates as a switch, effectively paralleling the resistance net-excitier. The lowest audio frequency of this keyer is at 1450 Hz, high enough to place the second harmonic at 2900 Hz, out of the passband of most modern amateur ssb transmitters. The highest audio frequency, at 2300 Hz, lies within the passband of this same equipment.

The AFSK generator requires +12 volts at 70 mA and -12 volts at 15 mA. A suitable power supply circuit is shown in fig. 4.

alignment

The best way to adjust the frequency and amplitude equalization of this AFSK generator is by using a digital frequency counter and an oscilloscope. These instruments are now owned by many amateurs so you should be able to enlist some help, if you don’t personally own this test equipment. Once the alignment is completed it should hold for a long time.

First, connect the frequency counter

work R1 and R6 with an additional resistor, increasing the frequency of the audio-frequency generator. When the keyboard contacts are closed again, the same sequence occurs in reverse, switching back to the lower frequency at precisely the zero-voltage crossover point of the sine wave. In this way phase discontinuities are avoided and the AFSK sine wave is sufficiently pure for use with ssb transmitters.

The audio frequencies I chose were dictated by a desire to eliminate the need for a special carrier crystal in my ssb transmitters. Capacitors C1 and C2 are polystyrene types. All ICs are manufactured by National Semiconductor.

fig. 2. Circuit for the continuous-phase AFSK generator. Capacitors C1 and C2 are polystyrene types. All ICs are manufactured by National Semiconductor.
to the output jack, J1. Short the keyboard input terminals and adjust R1 for 1450 Hz on the counter. Set the switch to 850-Hz shift and adjust R2 for 2300 Hz. Set the switch to 170-Hz shift and adjust R3 for 1620 Hz. For easier adjustment you may want to install more expensive multi-turn trimming potentiometers at R1, R2 and R3.

Optional circuit shown within the dashed lines in fig. 3. Simply connect point A of the optional CW identification circuit to point A in the main AFSK generator circuit.

Although the input terminals could be connected directly to the keyboard contacts, in most RTTY station setups they are not. Since it is desirable to copy the outgoing transmission on the printer, I have a mercury-wetted relay in series with the printer solenoid — the relay contacts are used to key the AFSK generator. A suitable relay for this purpose is the Potter and Brumfield JML-1061-81 with a 33-ohm resistor connected in parallel with the relay coil.

Additional Notes

The CW identification circuit, as shown, results in the same frequency shift as the selected RTTY shift, 170 or 850 Hz. If you want to use a different CW identification shift, you can add the

References

multi-function touch-tone decoder

Complete construction details for a solid-state, multi-function Touch-Tone decoder using latching relays

With the advent of FCC Docket 18803, all repeaters are faced with the problem of shutdown control that is now defined by the FCC. The decoding system described here was designed to give absolute security in repeater control — it cannot be activated by anything other than a true Touch-Tone signal.

Two functions are utilized with latching-type relays. In the event of power failure the relays will remain in the position in which they were placed by the control operator. A time-out timer is also available in the circuit so that one of the functions will time out if desired.

For those readers who do not understand how Touch-Tone works, a short explanation seems to be in order. The Touch-Tone system was originally designed for dialing telephone services. It uses two tones for each digit, zero through 9 as well as * and #. These tones are generated by an oscillator in the decoder.

The lead photo shows a complete Touch-Tone decoder built by a Pueblo Ham, Jim Warner WBØ BTA, for use in muting his speaker when his wife is asleep. He’s figuring on hooking up the second function to the coffee pot.
Touch-Tone pads. Fig. 1 lists the frequencies of these tones. Note that only 7 tones are used. The digit 1 is composed of 1209 HZ and 697 Hz, while the digit 2 is composed of 1336 Hz and 697 Hz, and so on, throughout the twelve digits which make up the Touch-Tone pad. These tones are combined within the pad itself by various switch points. It is the job of the decoder to separate the various tone frequencies on receipt of the signal. If you don’t thoroughly understand this go back and read it again, as you must understand how the ten Touch-Tone digits are made up of combinations of 7 tones. Also note that for explanation purposes, each tone is assigned a letter from A thru G. These letters that I have assigned to the various tones will be used for the balance of this discussion.

To use the Touch-Tone system, these tones must be decoded, changed into a dc voltage and combined in an AND gate which will form digits. Then, two of the digits are combined and used to close a relay. What you do with this relay closure is up to you. It may be used to shut down your repeater, disconnect the speaker of your base station, turn on your porch lights, start the coffee perking or whatever your imagination can conjure up.

There are many circuits that can be used to decode tones and cause a relay to open or close. One of the newest circuits is the phase-locked loop (PLL). This circuit was tried in many different configurations but its primary fault is that it will accept tones that are not on the exact tone frequency. Of course, this is an asset in some applications other than Touch-Tone decoders. The broad frequency response of the PLL can also cause problems if the repeater users use a Touch-Tone autopatch system — can you think of a better way to make the telephone company unhappy than to send a batch of off-frequency tones over their lines?

Other circuits using transistor decoders don’t work too well as Touch-Tone decoders because of the inherent low impedance of a transistor, necessitating quite tight coupling of the tuned circuit which lowers the Q of the circuit.

The circuit shown in fig. 2 uses the high impedance of the field-effect transistor. This permits the use of very small coupling capacitors (.01 μF). The resulting Q of the circuit is sufficiently high to assure that the tones are on frequency. The high circuit Q also prevents accidental functions from occurring due to noise or excessive audio on the repeater.

![fig. 1. Twelve-button Touch-Tone pad showing tone frequencies and letter designations used for the purpose of this article.](image-url)
fig. 2. Schematic of the Touch-Tone decoder. Relays K1 and K2 are latching relays such as the Potter & Brumfield FL11D or those available from Circuit Board Specialists.* Capacitors marked with an asterisk are selected for the exact frequency of the desired Touch-Tone tones.

The fet is merely an ac amplifier which boosts the signal up to levels that are easier to work with. The amplified ac signal is rectified by CR1 and CR2, filtered by C22 and is seen on the gate of Q2 as a negative dc voltage. Fet Q2 is connected as a dc amplifier. Therefore, any small change of voltage on the gate will pinch-off the fet which normally conducts the voltage on the drain to ground through dropping resistor R16.

When pinch-off occurs, Q2 ceases conduction and the drain immediately goes positive. This meets one of the requirements of the AND gate made up of CR5 and CR8. Now, go back a little and assume that at the same time tone A was being decoded, tone G was being decoded in the same manner by Q2 and Q4. In this case there would be an immediate rise in

*Etched, drilled, silver-plated printed-circuit boards are available from Circuit Board Specialists, P.O. Box 969, Pueblo, Colorado 81002, $8.50. Relays, latching type, surplus and guaranteed are $2.00.
voltage at the cathode of CR8. This meets the second requirement of the AND gate, allowing the voltage at the junction of R17 and CR23 to go to a positive level. This positive voltage passes through CR23 and is impressed upon the base of Q14.

This passes all the current in the relay coil to ground, closing the contacts and performing the function. Since relay K1 is a latching relay, it is not necessary to hold it closed. Once latched, the relay stays closed until another signal releases it.

fig. 4. Power supply for the Touch-Tone decoder. Transformer T1 is an Archer 273-1386 (Radio Shack) or equivalent.

and is stored there by capacitor C34 just long enough to keep transistor Q14 turned on.

Although this all happens when you depress one digit on the Touch-Tone pad, the relay still has not been picked up. To do this you must depress another button and decode two more tones. Let’s assume that you depressed the digit 7 (tone A and tone F). Tone A would meet one of the requirements of the gate at diode CR4 while tone F would meet the other requirement at diode CR20, providing a positive voltage at the junction of R21 and R47 which is fed to the base of transistor Q12.

Transistor Q12 will turn on heavily and, in effect, ground the emitter of Q14.

is done in much the same manner as the initial closure. Through different decoding tones a voltage is imposed on the base of Q13 and stored in capacitor C33. This voltage turns on transistor Q12 again, thereby energizing the off coil or relay K1, restoring the relay and the function back to normal.

**time-out timer**

Suppose that the function which you wanted to perform with your decoder required a time-out timer, such as 3 minutes for an autopatch hookup. This is done very easily and inexpensively by unijunction transistor Q10 in fig. 3. When relay K1 closes a voltage on one set of the contacts it turns on PL1, letting you know that it all worked. This voltage is also fed through point T of the relay to point T of Q10. This voltage is dropped through resistor R31 and allowed to gradually build up across capacitor C30. At a certain predetermined level or time lapse transistor Q10 goes into conduction, turning on Q11 for a split second and energizing the off coil of relay K1 thereby timing out the function. Diode CR21 is used for a fast bleed off of C30 so that the timer will be ready for the next time function.
two-band antenna matching with stubs

Complete design details for an antenna stub matching system for two harmonically-related amateur bands

With the sun spot cycle going down there will be greater interest in 40, 80 and 160 meters for DX work in the next few years, bands where rotary beams are difficult if not impracticable. Wire antennas still have their place, and it is desirable, if possible, to build antennas that will have reasonable directional characteristics on at least two bands. For example, the familiar dipole fed with open-wire line operates as two half-waves in phase on the second harmonic and exhibits slight gain in the broadside direction. The popular W8JK array can also be operated on two harmonically-related bands.

The principal problem with the standard arrangement is that the center impedance of such an antenna at the harmonic becomes quite high, on the order of several thousand ohms, and the bandwidth also narrows; that is, the reactance and resistance change is quite large around resonance. Thus, there is a very high vswr on the open-wire line. While high vswr does not result in appreciable loss on a good open-wire line, it does lead to problems in maintaining good balance to ground and in minimizing radiation from the transmission line itself.

High vswr also complicates the antenna tuner in going from one band to another; depending on the length of feeder, it may be necessary to switch
from series tuning on one band to parallel tuning on the other, and band changing becomes complicated. Then, there is the matter of the high voltages and currents along the mismatched line. Even a 600-ohm flat line at maximum power will have about 600 to 700 volts rms of rf across it; when the vswr is high this voltage will be appropriately higher. High

voltages and currents along a transmission line can cause problems in coupling into other lines (such as telephone lines and tv lead-ins) and in arcing to nearby objects. In short, a low vswr is very desirable, even on an open-wire transmission line.

**stub matching**

It is possible, using stubs and matching sections, to design an antenna that can be operated on two bands, say 80 and 40 or 160 and 80, so that a reasonable match will be achieved to a specified open-wire line without switching. This particular problem hasn't been treated in the various antenna handbooks where stub matching for only one frequency is discussed.¹

The analytical approach to this problem can get pretty complicated, and in fact, intractable unless it is done in the right way. The solution lies in using the familiar transmission-line equations in ad-

\[
G_{in} = \frac{1 + (\tan \theta)^2}{\rho^2 + (\tan \theta)^2}
\]

(1)

\[
B_{in} = \tan \theta \frac{\rho^2 - 1}{\rho^2 + (\tan \theta)^2}
\]

(2)

at \( f \)

\[
G_{in1} = \frac{2\rho_1}{\cos \theta (\rho_1^2 - 1) + (\rho_1^2 + 1)}
\]

(3)

at \( 2f \)

\[
G_{in2} = \frac{\rho_2}{(\cos \theta)^2 (\rho_2^2 - 1) + 1}
\]

(5)

\[
B_{in1} = \frac{\sin \theta (\rho_1^2 - 1)}{\cos \theta (\rho_1^2 - 1) + (\rho_1^2 + 1)}
\]

(4)

\[
B_{in2} = \frac{(\sin \theta)(\cos \theta)(\rho_2^2 - 1)}{(\cos \theta)^2 (\rho_2^2 - 1) + 1}
\]

(6)

where \( \rho_1 = \frac{R_1}{Z_{om}} \) and \( \rho_2 = \frac{R_2}{Z_{om}} \)

Fig. 1 gives the basic relationships, the input admittance of a lossless transmission line having characteristic impedance \( Z_0 \) and length \( \theta \). In stub matching, the stub (whether shorted or open) is com-

```plaintext
\[
\]

fig. 1. Basic relationships of open-stub impedance matching at two frequencies, \( f \) and \( 2f \).
```
nected a distance, $\theta$, back from the load or from a known minimum or maximum in the standing wave of the unmatched line. The reactance of the stub is made equal and opposite to the input reactance of the matching section at that point.

For two-band matching the problem is depicted in fig. 2. The problem is to find a matching section and stub such that the input impedance with the stub connected, at the point of connection, is resistive and equal to $Z_0 = R$ of the main transmission line on each of the two bands. To do this, you must also know the antenna impedance at both frequencies. This is assumed to be resistive, justified on the basis that the antenna will be pruned to resonant length or at least carefully calculated.

Resistance $R_1$ is defined as the antenna resistance at frequency $f$, and $R_2$ as the antenna resistance at frequency $2f$. Using the appropriate trigonometric identities, eq. 3 through eq. 6 in fig. 1 may be derived from eq. 1 and eq. 2. These are the basic relationships for two-band matching. There are four unknowns, $Z_{om}$, the characteristic impedance of the matching section, $Z_{os}$, the characteristic impedance of the stub, $\theta_m$, the electrical length of the matching section ($\theta = \theta_m$), and $\theta_s$, the electrical length of the stub.

Resistance $R_1$ has previously been specified as the antenna resistance at frequency $f$. $R_2$ is the antenna resistance at $2f$. When the reactance has been tuned out by the stub, the resistance $R$ is equal to

\[ R = \frac{Z_{om}}{G_{in1}} = \frac{Z_{om}}{G_{in2}} \]

Where $R$ is the desired match to the main transmission line impedance, $Z_0$, as shown in fig. 2.

**special case**

Before proceeding to the general case, a most interesting special case is where

\[ \rho_1 = \frac{1}{\rho_2} = \rho \quad \text{or} \quad Z_{om} = \sqrt{R_1 R_2} \]

For this case eq. 3 is set equal to eq. 5 to provide the following simple quadratic expression

\[ \text{fig. 2. The matching problem.} \]

\[ \text{fig. 3. Simplified Johnson match for two-frequency antenna impedance matching.} \]

\[ \text{fig. 4. Generalized Johnson match for two bands where $R_2$, the antenna impedance on the higher frequency band, is much greater than $R_1$, the antenna impedance on the lower band, the usual case.} \]
fig. 5. Electrical length of the matching section, $\theta_m$, and the stub, $\theta_s$, at frequency $2f$ where $R_2$ is much greater than $R_1$.

$$2C^2 + C - 1 = (2C - 1) (C + 1)$$

$C = \frac{1}{2}$ or $C = -1$

where $C = \cos \theta$

For this special case $\theta = 60^\circ$ or $180^\circ$ at $2f$. The latter case is the familiar quarter-wave section at $f$, half-wave section at $2f$. The input impedance at points A-A in fig. 1 is simply $R_2$ at both frequencies. The problem here is that $R_2$ is usually high, so the main line impedance to match it is unreasonably high. The other case, $\theta =$

fig. 6. Characteristic impedance of the matching section, $Z_{om}$, where $R_2$ is much greater than $R_1$. 

October 1973
60° at 2f, is much more useful. For this case the result is

\[ R = \frac{3R_1 + R_2}{4} \]  \hspace{1cm} (7)

To tune out the reactance in this \( \theta = 60° \) case requires an open stub exactly 120° long at 2f with a characteristic impedance of

\[ Z_{os} = 400\left(\frac{3 \times 80 + 2000}{2000 - 80}\right) = 467 \text{ ohms} \]

\( \theta_m = 60° \) at 2f (1/6 wavelength)

\( \theta_s = 120° \) at 2f (1/3 wavelength)

You would have a perfect match for a 560-ohm line on both frequencies f and 2f by connecting the two 400-ohm and 467-ohm lines as shown in fig. 3.

**general case**

In the special case just considered, you do not have an arbitrary choice of main line characteristic impedance, at least if you want a perfect match. R2 may be considerably higher than the 2000 ohms assumed in the above example, and thus, R may still be unreasonably high. In the general case you first use eq. 3 and 5 to find \( Z_{om} \) and \( \cos \theta \) (\( \theta \) and \( \theta_m \) are used interchangeably here). Then, eq. 4 and 6 are used together with the stub reactance formula to find \( \theta_s \) and \( Z_{os} \). The result,
when R2 is much larger than R1, the usual case, is given in fig. 4 as the generalized Johnson Match.

To simplify finding the required lengths and characteristic impedances of the line sections, figs. 5, 6 and 7 have been prepared using the approximate formulas given in fig. 4 which are valid when R2 is much larger than R1. In fig. 5 are given the electrical lengths of the matching section and stub in degrees at the harmonic frequency 2f. In fig. 6 is the Z_{om} family giving the required characteristic impedance of the matching section, and in fig. 7 is the Z_{os} family giving the required characteristic impedance of the open stub.

As an example in using these curves, assume an antenna where R2 = 4000 ohms at 2f and R1 = 60 ohms at f. Also assume you want matching on both frequencies to a 600-ohm line, R = 600. Then, compute R/R2 = 0.15 and R/R1 = 10 and enter the curves to find

from fig. 5, at R/R2 = 0.15 and R/R1 = 10, \( \theta_m = 67.2^\circ, \theta_s = 111^\circ \) at 2f;

from fig. 6 find Z_{om}/R = 0.55 and compute Z_{om} as 600 x 0.55 = 330 ohms; and

from fig. 7 find Z_{os}/R = 0.59 and compute Z_{os} as 600 x 0.59 = 355 ohms.

antenna input resistance

An excellent, if somewhat obscure, source for accurate information on the center reactance and resistance of antennas in the vicinity of resonance is given in reference 2. This excellent book, by the way, also has sufficient information in graphical form to enable you to design a very good three-element parasitic beam for either best front-to-back ratio or for maximum forward gain (the two do not coincide) without guesswork as to the lengths of driven element, reflector and director. On pages 20 through 25 of this reference will be found some curves giving the center impedance of “nearly half-wave” and “nearly full-wave” center-fed antennas for various conductor thickness. Additionally, the effects of spaced multiple wires are also given.

The effect of ground must also be considered in estimating antenna resistance. With city-lot installations and low heights, this can get pretty indefinite, but if the antenna is reasonably in the clear, curves such as those given by Kraus\(^3\) can be used. It is noted, for example, that the half-wave antenna, when 0.34 wavelength high, has a resistance not of 73 ohms as in free space, but close to 100 ohms. When the half-wave antenna is low, say 0.1 wavelength high, the resistance drops to something like 23 ohms.

test results

The antenna shown in fig. 8 and 9 has been installed and tested at W6MUR for over two months with excellent results when this article was written. The antenna resistances were estimated for the multiple-wire arrangement at 88 ohms at 3.5 MHz and 2440 ohms at 7.0 MHz, and
the matching section and stub were proportioned accordingly. The antenna tuner is a simple parallel-resonant circuit having an edge-wound ribbon coil (surplus) of 20 turns, 4½ inches in diameter, 8-inches long (about 18 microhenries), tuned by a 250 pF vacuum-variable capacitor driven through an insulated coupling by a reversible gear motor turning a few rpm. The antenna proved itself in the pile-ups for ZD3Z, 9L1GG and 5T5CJ, all worked through eastern-U.S. QRM on 3.5 MHz. Both VU and UL7 have been worked with this antenna on 7-MHz CW, via the long path around sundown.

The main objective of achieving a good match on both bands to the open-wire feedline without excessive switching has been realized. It is hoped that the approach presented here will be useful to others wanting two-band antennas, even if they don't happen to have 135-foot redwood trees to tie them to!

references
**New Heathkit 2-meter Transceiver**

**ONLY $179.95**

It's an all solid-state design that you can build and completely align without special instruments. And this compact little beauty gives you 36 channel capability with independent push-button selection of 6 transmit and 6 receive crystals. 10 watts minimum output into an infinite VSWR without failure. And for the ultimate in convenience there's the optional tone burst encoder for front panel selection of four pre-settable tones. The HW-202 kit includes two crystals for set-up and alignment and simplex operation on 146.94; push-to-talk mike; 12-volt hook-up cable; heavy duty clips for use with temporary battery; antenna coax jack; gimbal bracket; and mobile mounting plate.

**HW-202 SPECIFICATIONS - RECEIVER**
- Sensitivity: 2 db SINAD* (or 15 db of quieting) at 5μV or less. Squelch threshold: 3μV or less. Audio output: 2 W net less than 10% total harmonic distortion (THD).

**... and here's 40 watts out for your 10 watts in**

The Heathkit HA-202 2-Meter Amplifier works with any 2-meter exciter delivering 5-15 watts while pulling a meager 7 amps from any 12 VDC system. No additional power supplies are required. All solid-state components mount on a single circuit board for easy two-evening assembly. Manual shows exact alignment procedures using a VOM or VTVM. Connecting cable and antenna cable are included.

**Kit HA-202, 4 lbs. $69.95**

**... then there's this perfect 2-meter tune-up tool**

The Heathkit VHF/SWR Bridge tests transmitter output in power ranges of 1 to 25 watts and 10 to 250 watts ±10% of full scale. 50 ohm nominal impedance permits placement in transmission line permanently with little or no loss. Built-in SWR bridge for tuning 2-meter antenna for proper match, has less than 10-watt sensitivity.

**Kit HM-2102, 4 lbs. $29.95**

**See them at your Heathkit Electronic Center – HEATHKIT ELECTRONIC CENTERS – ARIZ.: Phoenix; CALIF.: Anaheim, El Cerrito, Los Angeles, Pomona, Redwood City, San Diego (La Mesa), Woodland Hills; COLO.: Denver; CONN.: Hartford (Avon); FLA.: Miami (Hialeah); GA.: Atlanta; ILL.: Chicago, Downers Grove; IND.: Indianapolis; KANSAS: Kansas City (Mission); MD.: Baltimore, Rockville; MASS.: Boston (Wayne); MI.: Detroit; MINN.: Minneapolis (Hopkins); MO.: St Louis; N.J.: Fair Lawn; N.Y.: Buffalo (Amherst), New York City, Jericho; L.I.: Rochester; OHIO: Cincinnati (Woodlawn), Cleveland, PA.: Philadelphia, Pittsburgh; R.I.: Providence (Warwick); TEXAS: Dallas, Houston; WASH.: Seattle; WIS.: Milwaukee.
The increasing popularity of QRP operation has had one beneficial effect on amateur radio — an increased awareness of the importance of output power versus input power as a measure of performance. It has been generally accepted practice to state the performance of a given circuit in terms of input power capability, but we have long known that input power is no criteria for judging the important aspect of performance; i.e., what the circuit can deliver to the antenna. Our continued use of this archaic approach is perhaps due to the odd FCC practice of defining amateur service power limits in terms of input, while most other services are defined in terms of effective radiated power.

**efficiency**

Whatever the cause, a rather unscientific practice has occurred, namely the rule of thumb assumption that a given circuit will put out roughly 50% of the input power. But such an assumption is in defiance of all known principles of scientific methodology. One simply cannot assume that the efficiency of a given circuit is 50%. In fact, the theoretical ideal of a 60% efficiency factor may be
achieved in practice in some circuits, but more likely the efficiency achieved will be considerably below that level. Measurements I have made over the years have revealed that some commercially produced “novice” kit transmitters hardly came out above 25% efficiency, and some were as low as 10%! These results have been corroborated by other experimenters. The lesson here, then, is that input power is no index of what really matters — power delivered to the antenna.

**power output meter**

Numerous devices for measuring power output have appeared in the literature. The circuit of fig. 1 consists of two parts. First, a dummy load constructed of non-inductive, carbon composition resistors is designed for a certain level of power dissipation. Secondly, a sensitive metering circuit samples the peak rf voltage developed across the dummy load through CR1. That voltage is measured through a series dropping resistor on a 200-μA meter. The data is plotted to show μA versus watts. The formula of fig. 1 is used to convert the voltage developed to average power. Accuracy of a high order can be achieved by close attention to accurate measurements of the calibrating voltage, the actual resistance of the dummy load, and the use of a high-quality microammeter.

**construction**

The photos illustrate the final constructional approach used in this output meter, which is designed for about 60 watts continuous, and perhaps double that for intermittent service. During experimentation, it was discovered that with power levels above a few hundred milliwatts, a sufficiently intense rf field was generated, which upset the meter indication accuracy. Hence, a shield was inserted between the meter and the dummy load compartments. Next, it was found that the lead from the rectifying diode provided an rf path to the meter. A small, low-resistance 22 μH rf choke was installed in the lead and positioned halfway through the shield. This eliminated the last traces of rf feedthrough.

If the spirit of this approach is followed — shielding and filtering for rf — an accurate indicating meter will result.

**dummy load**

The dummy load should be designed for the power levels to be measured. In the meter shown, the dummy load is constructed from 21 two-watt, 1000-ohm resistors in parallel. This load will allow
for about 60 watts continuous duty, provided that at least 1/8-inch clearance around each resistor is allowed, and ventilating holes are drilled above and below the load. For power levels under 4 watts, three 180-ohm, two-watt resistors may be paralleled. Whatever setup is devised for the dummy load, an accurate measurement of the resulting actual resistance is necessary to determine the quantity $R$

drawn in the formula. The dummy load resistors are sandwiched between two sheets of PC board. The lead from one resistor at the center of the board is left about 1/2-inch long, so that it may be inserted directly into the center conductor of the coax receptacle. The ground side of the load is connected to the receptacle outer shield by two no. 18 wires, which pass through both PC boards and go directly to the receptacle.

Even though the dummy load shown in the photo is approximately 3 x 2-5/8 inches, reactance is negligible. When fed through an odd length piece of coax, the swr is not above 1.05:1.

calibration

As noted above, meter accuracy depends upon care in calibration and using a high-quality meter. The best method of calibration is at dc using a variable-voltage power supply. If no such power supply is available, a suitable substitute is shown in fig. 2, and consists of four 9-volt transistor batteries in series to provide approximately 37.5 volts. This supply will calibrate up to about 14 watts. In calibrating, the voltage drop across CR1, the rf choke, and the dropping resistor is automatically accounted for by connecting the calibrating voltage source to the dummy-load side of CR1 — disconnect CR1 from the load first, of course!

Our objective in calibration is to plot the reading in microamps against the voltage at the calibration point (fig. 1). The series dropping resistor value can be determined by experimentation. With the meter used here, a 100k resistor provided just over full-scale meter deflection at 10 watts; a 150k resistor at 5 watts. Table 1 lists the calibration points in the meter shown, and the formula used to calculate the voltage versus watts at chosen power levels. Once the complete number of power levels has been calibrated against microamp readings, the accuracy can be cross checked by attempting to reset the calibrating voltage to given levels by using the newly calibrated microammeter. Results will give you a practical idea of what to expect in the way of accuracy. With care, at least ±5% should be easily achieved. Remember we are ultimately dealing in terms of signal levels, where 1 dB is the lowest possible noticeable difference in signal strength. Accuracy of ±15% is acceptable in these terms.

other applications

The instrument is quite simple and is a valuable addition to any station. Its uses go beyond simple power output measure-
ment. It can be used to calibrate the popular Breune type in-line power output meter, such as was described by DeMaw. Also, it can be used to measure the output of an exciter to determine exactly how much attenuation is needed to provide proper excitation to a linear. For the QRPP operator, such a device is absolutely essential. For the QRO gang, it can provide a much needed moment of truth when connected to the pride and joy that’s supposed to be putting out (assuming 50% efficiency, that is) 90 watts. The device requires such little time and effort to construct and calibrate, there is little reason why any station should be without it. It provides an indication of the only significant performance factor in the transmitting system — the amount of power the transmitter can deliver to the antenna.

**Table 1. Calibration points calculated from formula of fig. 1 transposed to solve for \( V^2 \), i.e. \( V = \sqrt{P_o \times 2R} \) (102 ohms)**

<table>
<thead>
<tr>
<th>( P_o ) (watts)</th>
<th>( V ) (volts)</th>
<th>( \mu A ) (my meter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>31.93</td>
<td>203</td>
</tr>
<tr>
<td>9</td>
<td>30.02</td>
<td>194</td>
</tr>
<tr>
<td>8</td>
<td>28.50</td>
<td>185</td>
</tr>
<tr>
<td>7</td>
<td>26.74</td>
<td>169</td>
</tr>
<tr>
<td>6</td>
<td>24.7</td>
<td>158</td>
</tr>
<tr>
<td>5</td>
<td>22.5</td>
<td>145</td>
</tr>
<tr>
<td>4</td>
<td>20.17</td>
<td>129</td>
</tr>
<tr>
<td>3</td>
<td>17.56</td>
<td>113</td>
</tr>
<tr>
<td>2</td>
<td>14.28</td>
<td>93</td>
</tr>
<tr>
<td>1</td>
<td>10.99</td>
<td>67</td>
</tr>
<tr>
<td>0.9</td>
<td>9.58</td>
<td>63</td>
</tr>
<tr>
<td>0.8</td>
<td>9.03</td>
<td>59</td>
</tr>
<tr>
<td>0.7</td>
<td>8.44</td>
<td>55</td>
</tr>
<tr>
<td>0.6</td>
<td>7.82</td>
<td>51</td>
</tr>
<tr>
<td>0.5</td>
<td>7.14</td>
<td>48</td>
</tr>
<tr>
<td>0.4</td>
<td>6.38</td>
<td>43</td>
</tr>
<tr>
<td>0.3</td>
<td>5.53</td>
<td>38</td>
</tr>
<tr>
<td>0.2</td>
<td>4.51</td>
<td>30</td>
</tr>
<tr>
<td>0.1</td>
<td>3.19</td>
<td>22</td>
</tr>
<tr>
<td>0.075</td>
<td>2.76</td>
<td>17</td>
</tr>
<tr>
<td>0.05</td>
<td>2.25</td>
<td>14</td>
</tr>
<tr>
<td>0.025</td>
<td>1.59</td>
<td>10</td>
</tr>
<tr>
<td>0.01</td>
<td>1.01</td>
<td>5</td>
</tr>
</tbody>
</table>

**Reference**

Several advanced circuit improvements for the vhf divide-by-ten frequency scaler previously described in *ham radio*.

This is a follow-up to the divide-by-ten frequency scaler described in the September, 1972, issue of *ham radio*.¹ That article was originally prepared in late 1971 when the Fairchild 95H90 IC was relatively new, and experience with it, ham-wise, was quite new indeed. More than a year’s experience with the 95H90 is now behind us, so a later look seems appropriate.

To the serious experimenter, the original article presented no real problems and many letters I received indicated that the device was a worthwhile project and performed as described. Others, being perhaps less knowledgeable, have had some difficulties. Drawing upon the experience of *Belmont Spectrum Research* in its commercial manufacture of scalers, and its experience with a great many ICs, as well as letters from users, indicates that attention to the following points should greatly assist in smoothing out difficulties and in making your scaler a truly useful device.

**power supply**

Experience has shown that most 95H90s have optimized at between 4.75 and 4.85 volts. This means that the power supply should provide this voltage to the IC. Accordingly, and this is done in the
commercial version, a different power supply is now recommended for new construction (see fig. 1). This circuit is much more simple than the original and can easily be optimized. The circuit used Fairchild's 7805 voltage regulator IC (National's LM309 is equally suitable) which is rated at 5.0 volts output. These regulators may vary slightly from the "typical" 5.0-volt rating specified on the data sheets, so measure their output voltage. When using them, shoot for 4.85 volts at pins 4 and 5 of the 95H90 by inserting, if necessary, a 2.7- to 3.9-ohm resistor in series (R1 in fig. 1).

frequency limit

Experience with many manufactured scalers has shown that all 95H90s are far from being identical as far as their upper frequency limits are concerned. Some will go to 325 MHz, many will go to 300 MHz, but some will not go above 260 MHz. They are specified to 220 MHz as a minimum and to 270 MHz as "typical" by Fairchild.

The reason for the wide upper frequency range found in practice is that this IC is heat sensitive. That is, a large temperature rise lowers the upper frequency limit. Hence, the 95H90 should have a good heat sink if its maximum possibilities are to be exploited. The grounding of all unused pins (except pin 14, more on this later) will help. A good commercially made heat sink is made by IERC (their part numbers DC000080B and LIC 214A2WCB). You can make your own heat sink, however, by using a two-inch square piece of aluminum in contact with the top of the IC and bolted to the circuit board.

circuit-board design

A good ground plane is essential in the frequency scaler. This is why, in the original article, lines were removed from a "ground plane" copper board rather than using interconnecting traces. Don't forget you are dealing with very high frequencies where miscellaneous circuit paths may lead to feedback or ground loops and cause instability. Those builders who have used "traces" have had real problems and have ended up remaking their circuit boards.

preamp

If a preamp is used, and one is very worthwhile (the commercial version uses two stages), the 95H90 must be adequately decoupled from the preamp. This is rather simply accomplished by the 22-ohm resistor between the 5-volt supply and the junction of the 180-ohm resistor and the peaking coil shown in fig. 5 of the original article. Do not omit this precaution against feedback or you will end up with an oscillator, not a preamplifier.

low-impedance input

Experience has shown that most 95H90s respond best to a low-impedance input. This was not so with the prototype ICs I used for the original article. Thus, it is now recommended that a 68- and

fig. 1. Recommended power supply for the 95H90 frequency-scaler IC. The supply voltage is connected to pins 4 and 5 of the 95H90. If the voltage is greater than 4.75 to 4.85 volts, install resistor R1 (2.7 to 3.9 ohms) and adjust value, as required.
200-ohm bias divider be used for the 95H90. Also, if you would like a further refinement (the original was somewhat of a compromise in order to make it work for the vast majority of cases) the use of a threshold control, as shown in fig. 2, may be more acceptable for your applications. Try it, you may like it.

![fig. 2. Improved low-impedance input circuit for the 95H90 IC. The 250-ohm threshold control is optional but should prove useful for most applications (see text).](image)

bypassing

Bypassing pins 4 and 5 of the 95H90 (assuming you followed fig. 3B of the original article) is very important. The by-pass capacitor should be connected as close as possible to pins 4 and 5. In other words, zero lead length!

ground unused pins

Experience has shown that all unused pins of the 95H90 with the exception of pin 14, should be grounded. Thus, if you use a negative grounded board as in fig. 3B of the original article and use pin 1 as the input, pins 2 and 16 should be grounded. Pin 14 should be left floating (ungrounded). The first few ICs I tried did not require this. However, subsequent experience has proved the efficacy of the grounding of pins 2 and 16. Ground them!

heat dissipation

The 95H90, which dissipates approximately one-half watt continuously, should feel only slightly warm to the touch if operating properly. If it runs hot you have something wrong. Check the voltage at pins 4 and 5. It should not be over 5.0 volts and preferably, only 4.75 to 4.85 volts. Also, check your output resistance (with the unit turned off). It should not be much less than 800 ohms at pin 8. If it is less, you undoubtedly have a circuit error.

base diagrams

Be sure you have not somehow confused top and bottom views of the 95H90 and the 2N5179. A number of builders have interchanged them, much to their sorrow. Always check a data sheet which shows the basing diagram. In fact, double check it.

TTL interface

Unless you are sure that you need a TTL interface (as shown in fig. 6 of the original article) omit it. There are presently no known counters which require it. If you do use it, however, pay no attention to the $V_{cc}$ and $V_{ee}$ markings on fig. 6. The proper voltage is already taken care of in the 95H90.

cable termination

In using a scaler with a highly sensitive high-impedance frequency counter, false counting can be experienced if the interconnecting cable between the scaler and the counter is not properly terminated at the counter end of the line. A line termination consisting of a carbon resistor, equal to the characteristic impedance of the line, should be connected across the line at the counter end. This precaution is often overlooked by hams but is standard practice in industry. Tektronix makes a fine termination adaptor for use with 50-ohm coax (their part no. 001-0049-01).

reference

The most powerful signals under the sun!

The Total Communication System

The Hy-Gain 550A is the complete amateur system. Designed from the ground up to work together for total performance. Each element is matched to the system, for simple, plug-in expansion of your capabilities.

GT-550A Transceiver - The matchless heart of the 550A System. No other transceiver can give you this performance for the price. Operating fixed station or mobile, the GT-550A is guaranteed to have top frequency stability after warm-up. A graph showing stability during final check-out is included with each unit. 25 KHz calibrator and VOX, optional.

- Frequency Coverage - 3.5-4.0, 7.0-7.5, 14.0-14.5, 21.0-21.5, 26.0-29.0 MHz crystals supplied. Other 10 meter coverage optional. Power Output - 300 watts PEP (nominal) on SSB, 180 watts on CW and RTTY, into 50 ohm resistive load.
- Harmonic and Spurious Radiation - Carrier suppression in excess of 45 db down, unwanted side bands minus 55 db oscillator feed through and mixer spurious products down 50 db. Second harmonic minus 40 db and third order distortion in excess of minus 45 db.
- Noise Level - In excess of 40 db below single tone carrier.
- Audio Frequency Response - Up to 10 db RF compression without distortion.
- Receiver Sensitivity - Better than .5w for 10 db S+N/n ratio.
- Receiver Selectivity - 2.1 KHz with 1.8 shape factor for SSB or 300 Hz sharp selectivity with optional CW filter.
- Receiver Spurious Response - Image rejection better than 40 db down. Internal spurious below 1 uv equivalent input.
- Frequency Calibration - Interpolation to 1 KHz in 5 KHz increments.
- Frequency Stability - Within 10 Hz during any 30 minute warm-up period. less than 100 Hz in any 15 minute warm-up period, not more than 100 Hz with a plus or minus 10% line voltage variation.
- Calibration Accuracy - Interpolation to 1 KHz after calibration.
- Back Lash - Not more than 50 Hz.
- Output Impedance - Variable 50 ohms nominal capable of matching up to 2-1 SWR (30-100 Ohms).
- Automatic Volume Control - Fast attack, slow release on all receiver modes.

Order No. 855 Ham Net $59.50

RF550A contains high accuracy watt meter, calibrated in 400 and 4.000 watt scales; switch for forward or selected power; switch to select 5 antennas or dummy load. Order No. 857 Ham Net $75.00

RV550A is a solid state VFO. Function switch selects the remote unit to control Receive-Transceive-Transmit frequency independently. Order No. 856 Ham Net $95.00

SC550A Speaker Console with headphone jack. AC400 power supply will mount inside. Order No. 858 Ham Net $29.95

AC400 Power Supply is heavy duty solid state to operate GT-550A at full power, on SSB or CW, and with switch selection of 115/230 VAC. 50/60 Hz input voltages. Order No. 801 Ham Net $99.95

G-1000 12V D C Mobile power supply with cables. Order No. 802 Ham Net $129.95

HY-GAIN ELECTRONICS CORPORATION
Dept. BK, 8601 Northeast Highway Six, Lincoln, NE 68507
402/434-9151
Telex 48-6424

More Details? CHECK-OFF Page 110

October 1973
improved
half-wave rectifier

Circuit details
of an improved
half-wave, choke-input
power supply circuit
that offers
several advantages
over conventional
circuits

Suppose you needed a simple power supply in a hurry that would give you 50 volts dc at, say, 100 mA, well filtered, with load regulation at least equal to that of a choke-input filter, and without excessive peak rectifier currents. You might say, “That’s not difficult.” A conventional full-wave center-tap circuit feeding a choke-input filter would meet these requirements and the parts should be available in the junk box.

You start looking for a transformer with a 120-volt center-tapped secondary in order to get 50 volts dc at the input to the filter choke. Or, if you used a bridge rectifier, you would need a 60-volt untapped secondary. My guess is that you won’t find either transformer in your junk box.

half-wave circuit

That being a dead end, let’s make it more difficult. How would you design for the same requirements without using any transformer? I’ll give you a hint. Try a half-wave rectifier feeding a choke-input filter. But, you say, “This is never done. The regulation would be horrible and the output voltage would be practically unpredictable.”

One simple diode added in the right place can fix all that. Simply wire a diode, reversed polarity connection, from the choke input to the common line. That’s all. The load regulation will be...
equal to that of a full-wave, choke-input circuit. The output voltage will be one-half that of a full-wave, choke-input circuit or 45% of the rms ac input.

What about disadvantages? There must be some. A minor one is that when the dc output current must be varied from full load to a much lower output current the minimum load current must be greater than that for a full-wave choke-input circuit to prevent the circuit from reaching criticality.

Ripple in the output voltage will be the same frequency as the supply. Its magnitude will be more than for the full-wave, choke-input circuit but much less than for the conventional half-wave, capacitor-input circuit. The ripple voltage waveform will resemble the "full sine wave" ripple of the full-wave, choke-
input circuit rather than the "triangular" waveform of the conventional half-wave circuit.

**Tests**

To delineate the performance of the measured values on circuits whose components are not the ideal components frequently assumed in textbook analyses.

In these circuits the \( I_{\text{rms}} \) line currents were measured with a thermocouple milliammeter. The peak line currents were measured with an oscilloscope across a 1-ohm resistor in the line. The ripple waveforms were observed on a scope across the load resistor and the rms values were calculated.

Note particularly that the slopes of the curves for the improved half-wave circuit and the full-wave, choke-input circuit are straight and parallel over their useful spans indicating the internal resistance of each is constant and equal to the other.

**Summary**

Of course, this improved half-wave circuit is not limited to line operation without a transformer. It is a handy circuit to keep in mind whenever an available secondary transformer voltage is about twice as high as you need to get a certain dc voltage when using conventional circuitry. For instance, a 24-volt filament transformer feeding this circuit will give you a handy 10 volts for those transistor projects where better regulation isn’t justified.

**Table 1. Data applicable to the four rectifier circuits shown in fig. 1.**

<table>
<thead>
<tr>
<th>Circuit Type</th>
<th>Ripple Voltage, Rms</th>
<th>Internal Resistance, Ohms</th>
<th>( I_{\text{rms/Idc}} )</th>
<th>( I_{\text{pk/Idc}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half-wave</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacitor Input</td>
<td>9.6</td>
<td>250</td>
<td>2.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Full-wave</td>
<td>.33</td>
<td>66</td>
<td>1.00</td>
<td>1.10</td>
</tr>
<tr>
<td>Choke-input</td>
<td>5.5</td>
<td>300</td>
<td>2.3</td>
<td>6.3</td>
</tr>
<tr>
<td>Improved</td>
<td>2.7</td>
<td>500</td>
<td>2.6</td>
<td>9.2</td>
</tr>
<tr>
<td>Half-wave</td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choke-input</td>
<td>1.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 2. Voltage regulation curves of the rectifier circuits shown in fig. 1.**

Note the superior regulation of the improved half-wave circuit relative to the other half-wave circuits.
OLD
Or...
the IC-22

22 channels
of pure pleasure
for only $289

- TEN crystals... (now that alone is going to save you about $40.00)... easy to hold noise canceling dynamic mike... a quick disconnect mobile mount... battery saving HI (10 watts)/Lo (1 watt) power option. • Your IC-22 will have a receiver that just won't quit with a super hot mosfet front end, 5 helical resonators (you can forget about inter-mod), and a large speaker that will punch out plenty of audio for the car. • You'll also be on frequency with trimmer caps on both trans. and rec. on all 22 channels... with a discriminator output jack in the back to let you get on and stay on freq. • PLUS the '22' is one good lookin' compact rig that you will be proud to put in your car—(the XYL won't mind it either)—with soft green back lighting on the front panel and a light to silently let you know you are getting out... and a second light to let you know there is an incoming signal (even though you may have the volume down). • There is much, much more to tell you about the IC-22, but suffice it to say, the IC-22, with all of its unique features and performance record at $289.00, has got to be one of the best all-around values available on two meters today!

SEE THE IC-22 AT YOUR LOCAL DEALER

Distributed by:

ICOM WEST
1251 - 170th St. N.E.
Bellevue, Wash. 98008
(206) 641-0554

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

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

Dealer inquiries invited.
accurate frequency measurement of received signals

How to use an offset frequency measurement system that does not impair the performance of your receiver

Several articles dealing with frequency measurement of received signals have appeared in the amateur publications.\textsuperscript{1-6} The techniques described have been essentially of four types, manual analog comparisons, receiver dial readouts, received signal synthesis and multiplexed up/down counting. Each of these techniques has advantages and disadvantages.

Manual analog comparisons (zero beating and interpolation) are easy and inexpensive to implement but require considerable operator skill and are subject to human error at best. Receiver dial readouts are fine except that they read the frequency to which the receiver is tuned and not that of the received signal. Also, most dial readout systems described to date have a resolution of only 100 Hertz.

Received signal synthesis is good except that the synthesized signal tends to re-enter the receiver front end and cause oscillation problems. The multiplexed
up/down counter approach works well but requires some moderately complex digital design and pretty well eliminates the use of a general-purpose frequency counter.

My goals when designing this measurement system were to obtain precise readout of the received signal carrier frequency (within counter resolution) with complete independence from receiver tuning. The system would offer easy calibration and require no operator-performed analog comparisons, such as zero beating. It would provide stable, non-oscillatory operation and use an existing general-purpose frequency counter. Also, it would have high sensitivity and be capable of operating on all the hf and vhf amateur bands within the limitations of the counter.

To meet all the requirements, I decided to use a modified form of received signal synthesis. Henceforth, I will refer to this technique as offset counting. Signal synthesis satisfies most of the design goals, however, it does not satisfy the requirement for stable, non-oscillatory operation. This problem is worsened when a general-purpose counter is used because the synthesized signal must be fed into the counter with coaxial cable, thus allowing some signal leakage. Furthermore, most counters generate at least 1 volt, peak-to-peak, of counted signal and radiate some portion of that. The net result is anything but a stable, non-oscillatory system. The only way to make such a system work is to desensitize it. This compromises the goal of high sensitivity.

However, if the counted signal is on some frequency other than the received frequency, high sensitivity is not compro-

---

**fig. 1.** Block diagram of a system to synthesize a received signal for frequency counting.

**fig. 2.** Block diagram of a circuit to phase lock an offset oscillator to an "odd-ball" reference frequency.
mised, and the system provides stable, non-oscillatory operation. The problem here is that you must know exactly how the counted signal relates to the received frequency. I accomplish this in the offset counting system by introducing an offset which is derived from the time base used to control the counter gate.

This system was initially designed and used for the high-frequency bands. With the addition of just one mixer and a filter, the technique is expandable to vhf.

theory of operation

To generate a synthesized received signal for counting, the system shown in fig. 1 would be used. Such a system, typically, would be prone to oscillation. I might point out that this system can be made to work by enclosing the mixers, filters and counter section in the same small, well shielded and filtered enclosure. For this to work, after the signal has been synthesized, absolutely no rf can be allowed to escape from the enclosure.

This is not an easy task to accomplish; shielding and filtering well in excess of usual amateur practice would be required to build a truly stable, high sensitivity system. In fig. 1, the first mixer combines the filtered i-f output with the variable-frequency oscillator to produce sum, difference and spurious products.

Depending on the mixing scheme of the receiver, filter A is designed to pass only the desired product and attenuate all others. The output of filter A is then fed to the second mixer where it is combined with the output of the high-frequency oscillator. Either the sum or difference component is selected by filter B (depending on the receiver mixing scheme) and fed to the counter. This diagram is somewhat simplified in that buffer amplifiers may be required between the receiver oscillators and external mixers as well as between the first and second external mixers.

For example, when designing a synthesis system around a Collins 755-3 receiver, the hfo operates 3.155 MHz above the low end of the band in use, the first i-f is a passband from 2.955 to 3.155 MHz, the vfo tunes from 2.7 to 2.5 MHz, and the second i-f is 455 kHz. The first mixer uses difference mixing and the second mixer uses summation mixing.

Thus, in fig. 1, the first mixer sums 455 kHz and 2.7-2.5 MHz. The desired output of this mixer is 3.155-2.955 MHz (3.155 MHz is at the low end of the band being tuned). This range is selected by filter A which may be either a bandpass or highpass type.

The second mixer takes the difference between 3.155-2.955 MHz and (F₁ + 3.155 MHz) (F₁ is the frequency of the
low end of the band being used, for the 7.0-7.2-MHz band \[ F_1 + 3.155 \text{ MHz} \] is 10.155 MHz. The difference output of the second mixer is then exactly the same frequency as the received signal. Filter B selects this product.

To modify the synthesis system to offset counting, an offset frequency must be inserted which will displace the counted frequency sufficiently from the received frequency that the receiver will not respond to it. This offset can be any value large enough to get the counted frequency out of the i-f passband, or preferably, out of the i-f and rf passbands. The two absolute conditions which must be placed on the offset frequency are that it be stable (preferably locked to the counter time base) and that it be known to an accuracy at least as good as the highest resolution expected from the counter.

For example, if some multiple of the counter time base is 6.1875 MHz, this would be a perfectly acceptable offset frequency. However, it would be inconvenient to have to add or subtract this number from every frequency you measure. A much more convenient number would be 1.000 or 5.000 MHz. If a nice, round offset frequency is not directly available, it may be possible to phase lock a lower stability signal.

In the case of the 6.1875-MHz signal mentioned above, it is possible to use the circuit block diagrammed in fig. 2 to phase lock a 1-MHz oscillator to the 6.1875-MHz signal. The phase locked 1.000-MHz signal may then be used for the offset frequency. The reference frequency may be any value that has a common denominator with the offset frequency with which you desire to phase lock.7

To see how the offset frequency would be added to the basic synthesis system, refer to fig. 3. The offset counting system requires one additional mixer, another filter and an offset frequency source. The signal flow is the same as in fig. 1 up to the second mixer. At this point the offset frequency is combined with i-f/vfo sum. Either the sum or difference product of the second mixer may be selected by filter B.

In general, the sum product would be preferred as this will ease the design requirements on filter C (in the case of the 75S-3 mixing scheme, it also allows 10-MHz counters to operate up through 20 and 15 meters). The output of filter B is combined with the receiver hfo in the third mixer. Either the sum or difference product may be selected by filter C; the difference product would be preferred as it will result in a lower frequency to be counted and, thus, be within the range of more general-purpose counters.

Note that I did not combine the receiver i-f, vfo and hfo in sequence; to have done so would have resulted in the generation of the undesired received signal. Instead, the offset was entered before the hfo signal.

The offset counting system may be extended to include the vhf bands by adding an additional mixer, filter and source of vhf local-oscillator signal. Refer to the block diagram in fig. 4 to see how this is accomplished. The output from filter C in fig. 3 is fed to the fourth mixer along with a portion of the vhf converter local oscillator signal. Depending on whether the local oscillator is above or below the received vhf signal, filter D should be designed to select the difference or sum output, respectively, of the fourth mixer.

It is likely that the output from filter D will be inadequate to drive your vhf
counter so a stage of amplification will probably be required to raise the signal level. Don’t forget that the offset frequency is still in the system and the vhf counter reading will include this factor.

At this point the advantage of using 5.000 MHz or 1.000 MHz for the offset frequency should be realized. Not only will the counter correction be easy to manipulate mentally, filtering out the image from the fourth mixer will be much easier if it is 10 or 20 MHz from the desired signal, rather than some considerably smaller value.

construction

As can be seen in the photographs, I used a modular format in building this system. Each block of figs. 3 and 4 is a separate module with the exception of the offset frequency source which is a part of my counter time base. This modular approach allowed me to mount the entire frequency measuring system in a convenient, long, narrow space on my operating table, behind the transmitter and receiver.

This is desirable since the cables feeding the oscillator signals from the receiver and vhf converter can be kept to a minimum length. However, there is no reason why the system can’t be built into one large enclosure. If your operating table will permit the inclusion of an additional moderately sized unit you may wish to follow this approach. Just be sure to provide good shielding between the various mixers; otherwise, undesired signal leakage around the mixers will occur.

The modular approach also allows the builder to tackle construction of one distinct portion of the system at a time. Each module can be built, tested and set aside for later inclusion in the system. A good compromise between the modular and single unit approaches would be to build the separate modules and then assemble them in a mainframe or chassis; that way adequate inter-module shielding will be assured.

system description

My frequency measuring system was designed around a Collins 755-3 receiver,
for hf reception, plus a Collins 62S-1 transverter for six and two meters. This system can be easily adapted for use with most hf communications receivers, irrespective of mixing schemes or number of conversions. Single-conversion receivers will require one less mixer, and triple conversion units, one more.

Assuming the modular construction approach is to be used, it is obvious that there is no provision for bandswitching, at least in the classic sense. To change bands requires changing one or more of the filter modules. This is no handicap unless you are an ardent band-hopper or want to measure the exact frequency of every station you work during a DX contest! Even then, you are in luck, providing you hop around the right bands; more on this later.

Complete block diagrams of the frequency measuring system implemented around the 755-3/62S-1 combination are shown in figs. 5 and 6. In fig. 5, the 755-3 i-f and vfo signals are combined in the first mixer. The desired output from this mixer is 2.955-3.155 MHz. This is selected by filter A which is a nine-section highpass filter with a cutoff frequency of 2.9 MHz. The output of this filter is fed to a tuned rf amplifier providing approximately 25-dB gain over the

fig. 6. Block diagram of the frequency-counter time base and offset frequency source.

Figure 7. Double-balanced mixer circuit for use in the offset frequency measuring system. Transformers T1 and T2 are Vari-L wideband transformers, model HYB-1. Diodes CR1-CR4 are matched hot-carrier diodes, Hewlett Packard 5082-2805.
fig. 8. Filters for the offset frequency-measuring system. The filter in (A) is a highpass unit with a 2.9-MHz cutoff (filter A). The highpass filter in (B) has a cutoff frequency of 10 MHz (filter B1). The filter circuit in (C) is a lowpass unit with a 14.2-MHz cutoff frequency (filter B2). The lowpass filter in (C) has a cutoff frequency of 15 MHz (filter C). All capacitors are dipped mica; inductors are Nytronics Wee-ductors.

2.955-3.155-MHz range. The amplifier output is combined in the second mixer with the attenuated 10-MHz output from the time base — the offset frequency.

I elected to take the sum product of the second mixer (12.955-13.155 MHz) for further processing. This frequency range is filtered through filters B1 and B2 in tandem. Filter B1 is a 10-MHz highpass filter and B2 is a 14.2-MHz lowpass design. These two filters may be combined into a single bandpass unit. My junk box dictated the construction of the two filters in tandem. The output of filter B2 is combined in the third mixer with the 75S-3 hfo signal. The difference product is selected by filter C which is a 15-MHz lowpass design.

As indicated, the output of filter C may be fed directly to a counter for hf measurements or on to the vhf portion of the system. Assuming vhf operation, the offset hf signal is fed to the fourth mixer where it is combined with the 62S-1
local-oscillator signal (36-40 MHz for six meters or 130-134 MHz for two meters). Since the 62S-1 local oscillator is on the low side of the received signal, the sum product of the fourth mixer is selected by filter D and subsequently amplified in the vhf amplifier.

Fig. 6 is a block diagram of the 100-kHz counter time base and offset frequency source. It is not anticipated that many people will be interested in duplicating this unit exactly because it includes a surplus 2.5-MHz oven-controlled oscillator. The method and remainder of the circuitry are applicable, however, no matter what oscillator you use.

If you have a good 1-MHz oscillator, you could add a times-five multiplier and pick up fig. 6 at point A. If you have a 2.5-MHz oscillator, use the entire block diagram. If you have a 5-MHz oscillator, again enter the diagram at point A. If you have a 10-MHz oscillator, enter the diagram at point B and delete the high-impedance 5-MHz output. If you don't have an existing oscillator available, I recommend a 5-MHz version of the oscillator described by Irv Hoff.8

**Bandswitching**

Earlier, I mentioned that bandswitching essentially consisted of changing filters. With the proper selection of filters, more than one band can be covered with the same units. Refer to table 1 for a list of offset frequency ranges for each band using the 75S-3 receiver and a 10-MHz offset frequency source. It will be recalled that filter C selects the difference product of the third mixer; this is the offset range column in table 1.

If the sum product were selected instead, the lowest frequency of interest would be 19.510 MHz (80 meters), filter C would have to be a highpass type and the hf counter would have to have a much greater operating range. Since 19.510 MHz is the lowest sum product which can cause trouble, filter C should have a cutoff frequency slightly below this value. It can be seen from the offset range column of table 1 (or counted frequency) that if a 15-MHz cutoff lowpass filter is selected for filter C, then all hf bands except 10 meters can be measured with no filter changes.

To measure 10 meters, a 25-MHz cutoff lowpass filter should be substituted at filter C. If you often operate on (and want to measure) 10 meters, you may place both filters in the circuit with a coax

---

**Table 1. Offset frequency ranges for each amateur band when using a Collins 75S-3 receiver and a 10-MHz offset frequency source (all frequencies in MHz).**

<table>
<thead>
<tr>
<th>band</th>
<th>hfo</th>
<th>vhf LO</th>
<th>offset range</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5-4.0</td>
<td>6.555-6.955</td>
<td>-</td>
<td>6.0-6.5</td>
</tr>
<tr>
<td>7.0-7.3</td>
<td>10.155-10.355</td>
<td>-</td>
<td>2.7-3.0</td>
</tr>
<tr>
<td>14.0-14.4</td>
<td>17.155-17.355</td>
<td>-</td>
<td>4.0-4.4</td>
</tr>
<tr>
<td>50.0-54.0</td>
<td>17.155</td>
<td>36-40</td>
<td>40.0-44.0</td>
</tr>
<tr>
<td>144-148</td>
<td>17.155</td>
<td>130-134</td>
<td>134.0-138.0</td>
</tr>
<tr>
<td>220-225</td>
<td>17.155</td>
<td>206-211</td>
<td>210.0-215.0</td>
</tr>
</tbody>
</table>
It should be noted that if a 7-, 14- or 21-MHz i-f range is chosen for your vhf converter, then filter C may remain unchanged from hf band operation. Just drive the fourth mixer directly with the output of filter C. Filter D, of course, is selected for the vhf band to be used according to the offset range column of table 1.

**circuit description**

The module circuits will be described in the following order; mixers, filter A, filter B1, filter B2, filter C, filter D, 2.955-3.155 MHz amplifier and power supply, vhf amplifier and time base.

All mixers are passive double-balanced mixers using hot-carrier diodes. Double-balanced mixers were chosen because they provide excellent suppression of mixer input signals at the output port. Passive mixers were chosen over active circuits because of their superior performance at vhf. Also, it is easier to provide the higher LO injection levels required by passive mixers than to put together the additional circuitry required by active devices (power supply, input/output coupling, etc.).

Several approaches may be taken to acquire the four mixers required for the system. Double-balanced mixers enclosed in shielded containers with female BNC connectors are commercially available from sources such as Hewlett-Packard, Relcom and Vari-L; prices start at around $40. Mixers with similar specifications but designed for PC board mounting are available from Vari-L, Mini-Circuits Laboratory, Merrimack Industries and others. Prices start at under $10 for quantities greater than five.

If you prefer to build your own mixers, one method has been described by Ress. This unit will cost about $10 plus the PC board. If you can fabricate your own board, this is the most economical approach. I also built a double-balanced mixer using commercial wideband transformers and hot-carrier diodes mounted
on perf-board with adhesive copper foil used as the ground plane. The schematic for this unit is shown in fig. 7.

Filter A selects the 2.955-3.155 MHz output of the first mixer. This filter must have a sharp cutoff characteristic to attenuate the undesired 2.045-2.245 MHz image. I decided to use a nine section Chebyshev highpass filter with 1-dB pass-band ripple (fig. 8A). This type filter has a sharper cutoff characteristic, for a given number of sections, than either the Butterworth or older image parameter designs. It provides a minimum of 16-dB rejection to the image. If your receiver has different i-f or vfo frequencies, this and subsequent filters may be designed using references 10 and 11.

Filter B1 is a 10-MHz highpass design. It is similar to filter A except it has only five sections (fig. 8B). Filter B2 is a nine-section Chebyshev lowpass design with a 14.2-MHz cutoff frequency (fig. 8C). Filter C is a five-section Chebyshev low-pass design with a cutoff frequency of 15 MHz (fig. 8D). Filter D is a lumped-constant bandpass design which yields 3-dB bandwidths in the vicinity of 5% of \( F_0 \) and ultimate rejection of at least 40 dB (fig. 9).

**wideband amplifier**

The 2.955-3.155 MHz amplifier is built into a small Minibox (Bud CU-2100-A). The power supply was built in a separate enclosure for more convenient placement. The amplifier is a single-stage common-emitter design (fig. 10), only the collector circuit is tuned. The output is tapped from the collector tank capacitor rather than the inductor. This was done so I could use a miniature molded inductor in the circuit. Gain is approximately 25 dB.

The combination of filter D and the vhf amplifier, in fig. 5, provides approximately 20-dB gain at the selected vhf offset frequency. The most versatile way to achieve this is to follow filter D with a wideband 20- to 25-dB gain amplifier having a high-frequency cutoff at least as high as the maximum frequency to be counted. An alternative is to replace filter D and the wideband amplifier with a...
multi-stage tuned vhf amplifier. I have used both approaches successfully.

A disadvantage of using the alternative is that every time you go to a different position of a vhf band, you must retune the amplifier or replace it with another pretuned amplifier. If your interest lies in only one portion of one vhf band, then this approach is the most economical. As a matter of fact, if you have a preamplifier for the band(s) of interest, and it will wideband amplifier, see references 13 and 14 for ideas. Also, the International BAX-1 amplifier module should be useful in this application.

time-base module

The time base is the largest module in the system. Indeed, it could be considered a sub-system (fig. 11). The schematic does not include an oscillator, which may be considered as a separate module. A recommended circuit is given in fig. 12.

Referring to fig. 11, the input stage, Q1, is an emitter follower which establishes a resistive 50-ohm input impedance. This stage drives an SN7413N Schmitt trigger which will give a 2.5 or 5.0-MHz, TTL compatible, output (J3) depending on the oscillator you use. Transistor Q1 also drives a class-C doubler/amplifier stage (Q2) which operates as a doubler when driven at 2.5 MHz and as an amplifier when driven at 5 MHz.
The doubler/amplifier drives the second half of U1 (SN7413N), a Schmitt trigger, which has a TTL compatible 10-MHz output (J4). Transistor Q2 also drives Q3 which is a class-C, 10-MHz output amplifier; Q3 provides +25 dBm (315 mW) output at 10 MHz (J5). A portion of this signal is fed to the external second mixer for the offset frequency.

The 10-MHz output of U1 drives U2, which is a class-C, 10-MHz output amplifier; Q3 provides +25 dBm (315 mW) output at 10 MHz (J5). A portion of this signal is fed to the external second mixer for the offset frequency.

For oscillator power from an external battery/trickle charger to supply standby power during power outages or short term transportation (J8).

When driving Q1 with an external oscillator (J7), you will need to provide plus 20 dBm (100 mW) of 2.5-MHz signal or plus 15 dBm (30 mW) of 5-MHz signal. No tests have been made to determine how much 10-MHz signal is required to drive Q3/U1 directly but gain data indicates that zero to 10 dBm (1-10 mW) should be adequate.

**Oscillator**

The recommended oscillator circuit is shown in fig. 12. It is based on the original circuit of reference 8. The output of the original is not useful for this application. The output of fig. 12 will drive Q1 of fig. 11 directly. This oscillator circuit may be built on a separate PC or perf board and included on the chassis with the circuitry of fig. 11.

Mount the oscillator on top of the chassis, not inside with other heat producing components. Provide as much thermal isolation as possible.

I have not built this oscillator, but the original circuit is well documented and the output stage is similar to the 2.955-3.155 MHz amplifier described earlier. Tuneup procedures for both amplifiers are identical.

![fig. 12. Recommended time-base oscillator circuit.](image-url)
It is possible to duplicate the double-balanced mixer shown schematically in fig. 7 using easy-to-acquire parts. The mechanical details may be seen in the photograph of fig. 13. The enclosure is a Bud CU-2100-A Minibox. The connectors are BNC types (UG-625A/U). The circuitry is built on a piece of perf-board with holes on 0.1-inch centers. The board is cut just over the width of the transformers (0.75 inches) and approximately 1-3/4 inches long. Adhesive copper foil is applied to one side of the board; the two transformers are mounted from the other side.

The two sets of transformer terminals labeled 2, 3 and 6 are placed adjacent to each other on the board and the four diodes are used to interconnect these two windings. The copper foil can be cut away from non-grounded transformer terminals with a razor blade or X-acto knife. Grounded terminals are soldered to the foil with a small 25-watt iron.

The assembled perf-board is mounted diagonally in the Minibox. This allows each of the transformer pin-1 connections to be soldered directly to the center pin of a UG-625A/U connector. Be sure to drill the connector mounting holes on the correct centers for direct insertion of transformer pin-1 terminals. A short piece of bare tinned wire is required to connect the center tap of transformer T2 to the center coaxial jack.

Construction of the double-balanced mixer shown in fig. 7.

Construction of filters A through C is very similar. A photograph of filter C is shown in fig. 14. The enclosure is a small Minibox; the size depends upon the number of filter sections. The connectors are female BNC chassis-mounting types (UG-625A/U). The filter components are mounted between the connector center pins, small standoff insulators (about 1/2-inch high) and strategically located ground lugs. Use dipped mica capacitors and Nytronics Wee-Ductors or equivalent for the inductors. Keep individual component leads short and the total circuit path as direct as possible. Where possible, arrange the inductors at right angles to one another for minimum mutual coupling.

Filter D is constructed using the same type of enclosure and connectors as the previous filters although the circuit elements are arranged differently. The general layout is shown in the photograph of fig. 15. This is the 134-MHz filter. Half-inch standoff insulators are used to support the inductors and are mounted as close to right angles to one another as possible.

The 2.955-3.155 MHz amplifier is also built into a Bud CU-2100-A Minibox. The circuitry is built on a small piece of perf-board with holes on 0.2 inch centers. The components are inserted from one side and the leads soldered together on the other side. The layout is shown in fig. 16. The board is mounted on 1/2-inch spacers. The input, output and power connectors are UG-625A/U. The power supply for the amplifier is built in a separate Minibox which is large enough to contain the components. No particular construction technique is required in this unit — just keep it small and neat.
The time base is built on a 5x7x2-inch aluminum chassis. The switches, connectors, pilot lights and voltage regulators are mounted on the front, rear and side panels of the chassis. The oscillator is mounted on the top surface and the circuit boards are mounted inside. Fig. 17 is a photograph of the unit.

The rf and digital circuitry of fig. 11 is built on the main board plus a small piggy-back board. The power supply and control wiring is accomplished in a point to point manner within the chassis. The main board contains the analog circuitry (Q1, Q2, Q3 and associated components) lengthwise on one side and the digital circuitry on the other. Q4 and its associated components are on the small board.

Outputs from the boards are via push-in terminals and attached sections of miniature RG-174/U coaxial cable. All board-mounted components are inserted from one side and leads soldered on the opposite side. The large board is mounted on the chassis top surface using two half inch spacers. The small board is mounted on a one-inch spacer screwed to the main board. Keep the coaxial cables carrying the output signals as short as possible. This is particularly true of the 5- and 10-MHz high impedance outputs.

If the oscillator is mounted on the chassis top surface, the terminals should protrude into the chassis interior for power and rf output connections. When wiring the power supply portion, use point-to-point wiring. It is important that all component leads be kept to a minimum length. This is particularly true of the MC1461 which has the larger number of external components and contains active devices capable of sustaining high-frequency oscillations. Use the same wiring precautions with both voltage regulators that you would use with any high-frequency rf circuit. The parts location and wiring of the remainder of the power supply is not critical.

adjustment

The i-f vfo and hfo signals must be tapped and brought out to the measurement system. I used the technique suggested in reference 1 but component values were revised slightly as shown in fig. 18. It may be necessary to vary the value of the 45-pF capacitor across L1 to maximize the i-f output level. With this
method of obtaining signals for the frequency measurement system I have observed no degradation to normal 75S-3 performance. If you desire further isolation for your receiver, you may use mosfet amplifiers such as used in the Heath SB-650.

The vhf local-oscillator injection voltage is obtained from the 62S-1 by using a homebrew tee adaptor at the input to the 148-MHz trap (J31 of FL2 in the 62S-1). The tee adaptor is made from two standard phono pin connectors. The male portion is a phono plug to miniature phone jack adaptor (Lafayette 99R63455 or Switchcraft 365). To gain access to the center pin terminal, remove and discard the shell. The female portion of the adaptor is a single hole mounting phono jack (Lafayette 99R62341). The center pins of the two connectors are soldered together. The ground lug of the female connector is then connected to the remaining portion of the shell of the male connector.

The coaxial cable running to the frequency measuring system is then soldered (center conductor and shield) to the adaptor at the junction of the two component connectors. The male end is then inserted in J31 of FL2 and the cable which originally plugged into J31 now plugs into the female portion of the adaptor. The RG-174/U coaxial cable from the tee adaptor is then run through the center hole of unused phono jack (J13) on the rear apron of the 62S-1. Thus, no permanent change to the transverter is necessary.

Some experimentation with the length of the vhf local-oscillator cable and how it is terminated may be required. My cable is 41 inches long; if I leave the cable unterminated, a fairly low impedance is reflected back to the tee adaptor. Receiver and transmitter LO injection is thus reduced and vhf receiver performance and transmitter output power are affected.

If the cable is terminated in 50 ohms or lengthened about 12 inches and left unterminated, 62S-1 receiver and transmitter performance are normal. This effect could be completely eliminated by using a broadband 36 to 134-MHz amplifier with a high input impedance at the tee adaptor. Such an amplifier would have to be tailor fitted to the 62S-1. However, it is reasonably easy to obtain normal 62S-1 operation without resorting to a buffer amplifier.
Using the circuit connections described here, you should get the power levels shown in table 2 at the output end to the respective cables.

Filters A through C should not require any adjustment after construction. However, to insure that there are no faulty components, it would be wise to check the cutoff frequency and ultimate rejection of each filter. This will require a signal generator (with frequency calibration) and a volt-meter (or powermeter) with a frequency response higher than the highest filter cutoff frequency (15 MHz).

Filter D must be tuned-up. This will require a calibrated signal generator and voltmeter or powermeter with adequate frequency range (220 MHz). A swept-frequency generator plus detector would be better. In any event, C1 sets the filter center frequency and the tap points on L1 and L2 determine bandwidth and insertion loss. The taps given in fig. 9 should be satisfactory. Capacitor C1 should be tuned to the offset frequency region of interest. If you want to measure frequencies more than a few hundred kilohertz apart, you should re-peak C1 for each different region.

Although the mixers have no adjustment provisions you should insert a known rf and LO signal and check for proper mixing action and suppression of undesired feedthrough products. Feedthrough from rf and LO ports to the i-f port should be more than 20-dB down, referenced to the input levels at the rf and LO ports, respectively. Performance less than this may indicate a bad or mismatched set of diodes.

<table>
<thead>
<tr>
<th>Signal</th>
<th>Condition</th>
<th>Level (into 50 ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-F</td>
<td>S9 signal</td>
<td>-5 dBm</td>
</tr>
<tr>
<td>VFO</td>
<td></td>
<td>-7 dBm</td>
</tr>
<tr>
<td>HFO</td>
<td>80 and 40 meters</td>
<td>+3 dBm</td>
</tr>
<tr>
<td>HFO</td>
<td>20 and 15 meters</td>
<td>-7 dBm</td>
</tr>
<tr>
<td>HFO</td>
<td>10 meters</td>
<td>-10 dBm</td>
</tr>
<tr>
<td>VHF LO</td>
<td></td>
<td>+5 dBm</td>
</tr>
</tbody>
</table>

To properly tuneup the 2.955-3.155 MHz amplifier, a calibrated signal generator and voltmeter or rf powermeter operating to beyond 3 MHz are required. Set the signal generator to 3.055 MHz and adjust C1 for maximum gain (about 25 dB). To optimize the combination of filter A and the 2.955-3.155 MHz amplifier, connect the two in tandem and run response measurements at 2.955, 3.055 and 3.155 MHz. It should be possible to skew the response curve of the amplifier down in frequency to make the overall gain at 2.955 MHz more nearly equal to that at 3.155 MHz (on the low side you have filter and amplifier rolloff, while on the high side you have only amplifier rolloff).

Your vhf or broadband amplifier plus filter D should be initially adjusted for 20-25 dB overall gain at the offset frequency to be measured. For example, if you are measuring frequencies near the low end of two meters, the vhf amplifier or filter should be tuned to 134 MHz. Ultimate gain adjustment will depend on counter sensitivity.

The only adjustments necessary to the time-base module will be to the analog section. The tank circuits for Q2 and Q3 may be optimized by starting with slightly lower value capacitors and increasing the value with small padders until the respective outputs peak. Varying the value of the 62-pF capacitor from pin 12 of U3 to ground may result in a cleaner 100-kHz output waveform.

The value of the resistor from pins 8 to 9 of the MC1461 voltage regulator IC determines the high output voltage. A value of 24k ohms results in about 15 volts out. This value is not sacred; if you want to change the voltage for your oscillator, it may be done. Lowering the voltage will result in less 10-MHz (low impedance) signal output.

If you increase the value be careful not to exceed transistor breakdown voltage. To increase the voltage substantially, you will need a different power transformer. The maximum current drain for the MC1461 regulator is 500 mA; be sure...
your oscillator load does not exceed this value. If you use a non-oven oscillator there should be no problem.

**operation**

Typical offset counter readings for specific received frequencies on each band are shown in table 3. It should be evident from this table that on all bands except 80 and 40 meters you simply add 10.000 MHz to the counted frequency to arrive at the actual received frequency. On 80 and 40 meters you subtract the counted frequency from 10.000 MHz to obtain the received frequency.

80 and 40 meters can be offset in a manner so that to obtain the received frequency you simply subtract 10.000 MHz from the counted frequency. This is accomplished by making the second mixer (fig. 5) a difference mixer and the third mixer a summing mixer. However, there are two disadvantages to this scheme. First, you have to change or bandswitch new filters at B1, B2 and C; second, you cannot count 80 and 40 meters on a 10-MHz counter. For these reasons, I did not use this arrangement.

If a spectrum analyzer or frequency-sensitive voltmeter is available when you are initially assembling the modules into the system, it may be enlightening to observe the output spectrum of each mixer/filter combination. The undesired mixer products should all be down approximately 20 dB. If they are not, the individual mixers and/or filters should be checked for proper operation.

When installing the mixers, be aware that there is an rf port (R), LO port (L) and an i-f port (I). I have achieved best conversion loss and isolation performance in this up-conversion application by applying the lowest frequency to be mixed to the i-f port and taking the up-converted output from the rf port.

In fig. 5 no amplification is shown following filter C for HF operation. If your counter doesn’t have a built-in preamplifier, you may need to include one or more stages of gain at this point. The amount of gain and whether it be provided by tuned or wideband stages will be determined by things such as counter sensitivity, amplifiers presently available to you and the state of your junk box and/or pocketbook.

System calibration may be achieved by setting your time-base oscillator against a laboratory standard of known frequency or by using WWV. To use WWV with the 755-3, tune the receiver to 15 MHz and during a period of no tone modulation, place the receiver in the CW mode (narrowest bandwidth) and center the WWV carrier in the passband. Your counter should now read 5.000 MHz plus/minus 1 count offset frequency. If it does not, adjust your time base oscillator until it does. If the counted frequency is not even remotely close to 5.000 MHz, do not adjust the oscillator, something else is wrong and this must be corrected first.

**table 3. Typical offset frequencies for each band (all in MHz).**

<table>
<thead>
<tr>
<th>band</th>
<th>received frequency</th>
<th>offset frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>3.774368</td>
<td>6.225632</td>
</tr>
<tr>
<td>7.0</td>
<td>7.024732</td>
<td>2.975268</td>
</tr>
<tr>
<td>14.0</td>
<td>14.251051</td>
<td>4.251051</td>
</tr>
<tr>
<td>21.0</td>
<td>21.246188</td>
<td>11.246188</td>
</tr>
<tr>
<td>28.0</td>
<td>29.499987</td>
<td>19.499987</td>
</tr>
<tr>
<td>50.0</td>
<td>50.101687</td>
<td>40.101687</td>
</tr>
<tr>
<td>144</td>
<td>146.160752</td>
<td>136.160752</td>
</tr>
<tr>
<td>220</td>
<td>222.561357</td>
<td>212.561357</td>
</tr>
</tbody>
</table>
Be sure that you make this adjustment when propagation conditions between WWV and your location are quiet. Typically, this will be during a daylight period at both WWV and your location. If the WWV signal is varying widely in strength or is of marginal strength, postpone the adjustment.

System stability on all bands should be excellent. No whistles, howls or low-frequency motorboating should be heard with the receiver operating normally and the measuring system activated. The ultimate test is to have the normal station antenna connected to the receiver and the counter on and counting. If your system is stable under these conditions on all bands, you are in business. If not, suspect mixer leakage as the primary culprit.

Leakage of 2.955-3.155 MHz energy through the second mixer, filters B1 and B2 and the third mixer is the main sneak path. Another possibility is radiation from the 2.955-3.155 MHz amplifier to the third mixer. If you have one mixer with particularly good rfli-f port isolation, use it for the second mixer.

summary

Results at my station have been most rewarding. Previous systems based on signal synthesis proved to be oscillatory, very difficult to tune up and always in need of tweaking. The present offset system provides the capability of making frequency measurements on incoming hf signals at least 20 dB weaker than with my best performing signal-synthesis scheme. On two meters, system sensitivity has been increased by more than 40 dB using the offset technique.

Accuracy in the ARRL Frequency Measuring Tests (relative to umpire measurements) has averaged better than 0.2 parts per million for ten measurements submitted during the last 20 months. Most of these measurements have been on the lower amateur frequencies (80 meters) which results in the average absolute error being less than 1 Hz. A histogram of my system error relative to ARRL FMT umpire measurements is shown in fig. 19.

references
NEW!

Your finest discount antenna and equipment supplier.

Beat inflation.

Save time and money with mail order.

- NAME BRANDS -

- GIGANTIC SAVINGS -

WRITE FOR CATALOG

ANTENNAS ACCESSORIES

TOWERS ROTORS

Phone (213) 534-“KING”

48 HOUR SHIPMENT WITH CASHIERS CHECK OR MONEY ORDER

ANTENNA KING

Box A

Lomita, Calif. 90717

56 october 1973
GTX-10 by Genave
10 watts output power norm.; accommodates 10 channels; rotatable frequency selector; adaptable for portable operation (with HamPak, below).

$199.95
(Includes 146.94 MHz)

GTX-2 by Genave
30 watts output power norm.; accommodates 10 channels; pushbutton frequency selection; back-lit for night operation.

30 Watts R.F. Output for Only
$249.95
(Includes 146.94 MHz)

GTX-200 by Genave
30 watts output power norm.; accommodates 100 channel combinations; features independent selection of transmit and receive frequencies, and switch for pre-selected pairing.

30 Watts R.F. Output for Only
$259.95
(Includes 146.94 MHz)

$30.00 BONUS COUPON
DC Converter — 117 volts to 12 volts
4 amps continuous — 5 amp search
Free with any Genave Transceiver
Include this coupon with order
FREE SHIPPING IN THE U.S.A.
48 hour shipping w/cashiers check

Electronix Sales
23044 Crenshaw Blvd., Torrance, Calif. 90505
Phone (213) 534-4456 or 534-4402
ALSO AMERICAN EXPRESS
CLOSED SUNDAYS & MONDAYS
Many amateur operators believe bandpass tuning is an invaluable adjunct to the main communications receiver in their station. It enables one to adjust the exact bandpass of the receiver in relationship to the bfo frequency so that interference from other stations can be dodged, another operator's voice characteristics can be made more pleasant, or a pleasing pitch can be obtained from CW. Also, the proper bandpass can be set for RTTY reception.

Many years ago the Collins Radio Company incorporated bandpass tuning in their 75A-4 receiver by rotating the PTO assembly at the same time as the bfo capacitor was tuned. This gave the advantage of bandpass tuning along with the flat-topped and steep skirt selectivity afforded by the Collins mechanical filter. This was accomplished mechanically, of course, and worked well because Collins maintained extremely close manufacturing tolerances; zero-beat moved no more than 50 Hz during the adjusting process.

The R.L. Drake Company has featured bandpass tuning in many of its amateur communications receivers by tuning the resonant frequency of a four-pole LC
filter operating at 50 kHz. The bfo frequency remains fixed, and the actual i-f is tuned to one side or the other by an amount selected by the operator. This system has proved to be very successful, and is readily attested to by the continued popularity of the Drake receivers.

There is a small drawback, however. With the advent of mechanical and crystal filters, 6-dB to 60-dB skirt ratios in the order of 2:1 or even 1.7:1 are now expected by the amateur fraternity, with in the BC-312 was turned into an injection oscillator, a mixer stage was added, and the i-f was mixed down to some lower frequency.

Some builders made their own 50 kHz i-f amplifiers; others cannibalized 85-kHz i-f transformers from the ubiquitous BC-453 command set. Then — and this is the crux of the system — the same bfo was used to mix back to 915 kHz where an added oscillator and detector operated. By varying the frequency of the vfo, which now operated at a frequency removed far enough from 915 kHz to mix to the new i-f frequency, the signal could be made to sweep across the low frequency i-f, and bandpass tuning was the result.

To the extent of my knowledge this technique remained in limbo until the R.L. Drake Company announced the new R-4C Amateur Receiver in March, 1973. This receiver uses electronic bandpass tuning coupled with the selectivity afforded by 8-pole crystal bandpass filters. However, the mixing scheme is different from that used with the BC-312 (see fig. 1).

The rf signal is first converted to 5645

---

**fig. 1. Basic block diagram of the new Drake R-4C communications receiver which features electronic bandpass tuning.**
SUPER-QUAD FIBERGLASS ANTENNAS

* COMPLETE KITS INCLUDE HARDWARE, WIRE, ALL MOUNTS, BOOM.
* STRONGER AND LIGHTER THAN ALUMINUM.
* MAXIMUM GAIN.

AVAILABLE IN A COMPLETE RANGE OF KITS

Special Instruction Manual on Kirk’s “Super Quads” – $2.00

- 2 - 3 ELEMENT TRI BAND
  10 - 15 - 20 METER ......... AMATEUR NET FROM $129.95
- 2 - 3 ELEMENT DUAL BAND
  10 - 15 OR 10 - 6 METER AMATEUR NET FROM $77.95
- 2 ELEMENT 40 METER AMATEUR NET $386.95
- UHF 4 ELEMENT 2 OR 6 METER AMATEUR NET FROM $54.95

ANTENNA MOUNT KITS

COMPLETE PACKAGED KITS INCLUDING SPIDERS OR V-SUPPORTS • BOOM TO MAST MOUNT
• ALL NECESSARY ASSEMBLY HARDWARE
• INSTRUCTION MANUAL

HEAVY DUTY CAST ALUMINUM

DELTA LOOP MOUNT KIT

DL-1 (2) 1 1/4" Hub V-Supports
(1) 1 1/4" Boom to 1 1/4" Mast T-Mount .......... Net $14.65
DL-2 (2) 2" Hub V-Supports
(1) 2" Boom to 1 1/2" Mast T Mount ........... Net $22.45
DL-3 (2) 3" Hub V-Supports
(1) 3" Boom to 2" Mast T-Mount ........... Net $36.95

QUAD MOUNT KIT

QM-1 (2) 1 1/2" Hub Spiders (Small Spider for VHF)
(1) 1 1/2" Boom to 1 1/4" Mast T-Mount .......... Net $10.85
QM-2 (2) 1 1/4" Hub Spiders
(Heavy Spider for EM & 10M)
(1) 1 1/4" Boom to 1 1/4" Mast T-Mount .......... Net $13.75
QM-3 (2) 1 1/2" Hub Spiders
(1) 1 1/2" Boom to 1 1/2" Mast T-Mount .......... Net $14.65
QM-4 (2) 2" Hub Spiders
(1) 2" Boom to 1 1/2" Mast T-Mount .......... Net $22.45
QM-5 (2) 3" Hub Spiders
(1) 3" Boom to 2" Mast T-Mount .......... Net $36.95

KIRK ELECTRONICS
73 FERRY ROAD
CHESTER, CONNECTICUT 06412
(203) 526-5324

kHz where a 4-pole crystal-lattice filter does much to ward off the degrading effects of strong stations near the operating frequency. Converting all bands into the high i-f is accomplished by mixing the output of the vfo with various crystal-controlled frequencies so the i-f is the same for all bands. Then, a tunable oscillator at 50 kHz is used to up-convert to 5695 kHz. The standard 2.4-kHz ssb filter as well as the accessory filters for CW and RTTY operate at this frequency. Then, the 5695-kHz signal is mixed with a 5645-kHz crystal oscillator to obtain a 50-kHz output. Two tuned LC circuits at 50-kHz help establish “distributed selectivity.”

The same tunable oscillator that is used to mix from 5645 kHz to 5695 kHz also serves as the bfo. Because it both up-converts and down-converts (i-f to audio) at the same time and by a similar amount, zero-beat does not vary during adjustment of the bandpass tuning control.

The Drake R-4C Communications Receiver also has provision for a-m. However, as bandpass tuning is not needed in this mode, the additional conversion process is not used. Filters with 4.0- and 6.0-kHz selectivity are stocked by the Drake Company, but these are at 5645 kHz, rather than at 5695 kHz where the ssb and CW filters operate. In the a-m mode a different crystal frequency (5595 kHz) is used to convert to the 50 kHz i-f.

This dual-conversion electronic bandpass tuning technique is simple and relatively inexpensive for the manufacturer to build, and it makes operating much more pleasurable than with receivers which have fixed bfo/filter frequency relationships. One benefit of this particular bandpass tuning technique is less noise in the audio output — receivers that lump all the selectivity in the filters and then use broadband i-f amplifiers following them tend to have “broadband hiss” or white noise appear at the output. The Drake R-4C is pleasantly free from this effect.

ham radio
NEW
DRAKE
TR-22C

2 Meter FM
Transceiver

New Features
- 12 Channels
- Monolithic crystal filter in IF for superior adjacent-channel selectivity
- Improved microphone

Amateur Net... $229.95

Including Mike, Over-the-Shoulder Carrying Case, 120 VAC and 12 VDC Cords, 10 Ni-cad Batteries, and Speaker/Headphone Plug

SPECIFICATIONS

GENERAL: • Frequency Coverage: 144 through 148 MHz, 12 Channels, 2 supplied: (1) Receive: 146.52 MHz, Transmit: 146.52 MHz; (2) Receive: 146.94 MHz, Transmit: 146.34 MHz • Power Requirements: 13.0 Volts DC ±15% • Current Drain: Transmit: 450 mA, Receive: 45 mA • Antenna Impedance: 50 Ohms • Dimensions: 5½” x 2¾” x 7½” (13.6 x 5.8 x 19.1 cm) • Weight: 3.75 lbs (1.7 kg)

RECEIVER: • Sensitivity: Typically 0.5 microvolt for 20 dB quieting • IF Selectivity: 20 kHz at 6 dB down; ±30 kHz channel rejection greater than 75 dB down. • First IF: 10.7 MHz with 2-pole monolithic crystal filter. • Second IF: 455 kHz with ceramic filter. • Intermodulation Response: At least 60 dB down. • Modulation Acceptance: ±7 kHz. • Audio Output: At least 1 Watt at less than 10% distortion. • Audio Output Impedance: 8 Ohms

TRANSMITTER: • RF Output Power: 1 Watt minimum • Frequency Deviation: Adjustable to ±10 kHz maximum, factory set to ±6.0 kHz. • Multiplication: 12 Times

ACCESSORIES
- Model AA-10 Power Amplifier: Use with TR-22C or any transceiver up to 1.8 watts output. 10 db power increase. At least 10 watts output at 13.8 VDC. Automatic transmit/receive switching.................. $49.95
- Accessory Crystals ................................ each $7.50
- Model MMK-22 Mobile Mount ........................................ $9.95

At your dealer’s

R. L. DRAKE COMPANY 540 Richard St., Miamisburg, Ohio 45342 Phone: (513) 866-2421 • Telex: 288-017

Drake manufactures a complete line of Amateur, Commercial, and Marine Communications Equipment. Write for prices and details.
portable fluorescent light

Have you ever wanted one of those portable fluorescent lights to use during field day or on camping trips? They are quite expensive and are not used too often, but they're handy to have around. If you have a well supplied junkbox and a little ingenuity, you can build your own.

Most amateurs have some old portable vacuum-tube equipment or CB rigs laying around that can provide most of the parts you need. Try to find a Triad TY74S transistor power transformer or something similar. This will provide the high-voltage supply for your portable fluorescent light.

Remove the power transformer and the power transistors from the old rig, but discard the rectifier diodes and the filter network. You won't need them. Build a metal or wooden framework similar to that found on commercial portable fluorescent lights so you can mount the fluorescent lamp with sockets.

The switch, transformer and power transistors can be mounted on the back or in the base.

When you're putting the unit together be sure to use a heatsink. If the light is used continuously there will be a fair amount of heat generated. However, the heat sink doesn't have to be anything fancy, a small aluminum chassis will work.

Wire up the unit as shown in fig. 1 using the original transistor oscillator circuit. Connect the center tap of the power transformer to one end of the fluorescent lamp and one of the transformer end windings to the other end of the lamp. If you want to include a dimmer control place a 10-ohm, 50-watt rheostat in the primary lead as shown in the schematic. My unit required from 0.5 to 1.6 amps, depending upon the setting of the dimmer control.

If you can't find an old high-voltage transistor power supply, you can accomplish the same thing with an old vibrator power supply. These are plentiful — just get an old car radio from your local junk yard. Disconnect the filter network and bring out the center tap from the vibrator transformer to one side of the fluorescent tube. Run the other lead to the other end of the tube as shown in fig. 1.

Ken Gray, K8BYO

great circle charts

A number of Great Circle Distance and Azimuth Charts are available from United States Government sources. These may be obtained from numerous local sales agents and distribution centers, or by
mail from the U.S. Naval Oceanographic Office, Washington, D.C. 20390.

Such charts are available at $1.50 centered as follows: 5180, Fairbanks, Alaska; 5181, Seattle; 5182, Honolulu; 5183, Guam; 5184, San Francisco; 5185, Washington, D.C.; 5186, Moscow; 5187, Adak, Alaska; 5188, Kodiak, Alaska; 5189, Eniwetok Atoll; 5190, San Diego, Calif.; 5191, Cutler, Maine; 5192, Balboa, Canal Zone; 5193, Yosami, Japan; 5194, Australia-N.W. Cape; and 5195, Keflavik, Iceland.

For those purchasing a computer readout, possibly they can plot the results conveniently on a 5142 Azimuthal Equidistant Projection of a Hemisphere, priced at 50 cents.

Bill Conklin, K6KA

using the HW-101 transceiver with a separate receiver

Modifications to transceivers such as the Heath HW 100/101 or Swan 350 for split frequency operation have been described as has incremental tuning by means of a variable capacitance diode¹ or operation in conjunction with a separate vfo.² In both cases some limitations remain; cross-band operation is not possible and the separation between receive and transmit frequency must remain small because the driver and receiver preselector circuits cannot be independently peaked.

Conversion for use with a separate receiver, using the built-in TR relay, is simple and eliminates these limitations. It is described here for the case of the HW-101.

Two rf-quality phono jacks are installed on the rear chassis apron into the compartment containing the antenna connector, located just below the rf cage. The coax lead from the rf driver circuit board (the receiver input) is disconnected from lug 4 of the relay and from the adjacent ground lug. If sufficient in length, this coax is connected directly to the nearer of the two jacks just installed. Otherwise, it is first extended or replaced by a longer section. Another 50-ohm coax lead is connected to the more distant of the two jacks at one end and to lug 4 of the relay (inside conductor) and to the adjacent ground at the other end. The trap coil (L905) is not disturbed.

In the transceive mode an external coax connector (50-ohm with two rf-quality phono plugs) is jumpered between the two new jacks; the transceiver then functions as before the modification. For separate receive operation a 50-ohm coax lead is connected between the receiver antenna input and the jack, which is fed from lug 4 of the relay. The other jack remains unconnected. To spot the transmit frequency on the receiver the mike/CW level control is turned counterclockwise below the point where the relative power meter indicates any measurable output; the transmitter is then keyed. This provides sufficient signal for spotting without radiating an appreciable amount of power. All that is needed to transmit is to advance the mike/CW level control to the point of full rf output.

This simple modification leaves the transceiver circuitry essentially undisturbed and permits semi break-in operation, cross-band or in-band operation with any desired frequency separation between receiver and transmitter, with both tuned for peak performance.

Incidentally, the modification permits the insertion of an rf-preamplifier, tuned or broadband, between the output coming from the TR relay and the internal or external receiver. A low-noise preamplifier improves the signal-to-noise ratio, especially on 10 and 15 meters.

references

Max Blumer, WA1MKP
ic speech clipper

Dear HR:

Although K6HTM seems satisfied with the performance of his speech clipper, his conclusion that it's "not much better than a typical agc-type compressor" caused me to take a critical look at the schematic. The main reason for what I would regard as poor performance is fairly obvious. The output impedance of pin 9 of the IC, to which the clipping diodes are connected, is that of an emitter follower and given as 85 ohms on the data sheet.

If author Bird uses IN75 diodes for the clipper he would obtain virtually no clipping since their ac resistance is likely to be several hundreds of ohms. Even with hot-carrier diodes, clipping will not exceed 4 dB or so. This would definitely make the device perform comparable to alc or agc schemes! A resistor (2000 ohms for hot-carrier diodes, 20k for 1N75s) in series with the 0.01-µF coupling capacitor will improve matters.

I am distressed at the author's lack of concern for carrier rejection. Unless the peak carrier level, at pin 9 of the LM373, is appreciably lower (at least 10 dB), than the voltage at which clipping starts, the advantages of rf clipping will be lost. K6HTM probably forgot to mention the need for precise frequency adjustment of the crystal oscillator, so that the proper low frequency response is achieved, as well as some additional carrier rejection.

Some builders may experience difficulty, and possibly instability, due to undesired coupling via the two oscillator injection points, which are, in fact, connected together. Fortunately, the level at pin 6 of the LM373 is much higher than needed (by a factor of 100), so the desired isolation can be obtained by means of a resistive attenuator.

The second mechanical filter, FL2, is quite superfluous. Filtering after the clipper is needed to prevent rf harmonics from reaching the final mixer. A moderate Q pi network is quite adequate for this purpose and obviously much less costly. As the available post clipper gain is much larger than needed, two 10,000-ohm resistors, one in series with "high" side of the output level control, the other in series with the FL2 input, will give desirable isolation of the filter from the clipping diodes.

If Mr. Bird will modify his device in accordance with this letter, he will obtain results similar to the ones I get with the Comdel unit.

Walter Schreuer, K1YZW
Ipswich, Massachusetts

I am pleased that Walter Schreuer read my article, "IC Speech Clipper" in the February, 1973, issue of ham radio. What follows is a reevaluation encouraged by his suggestions and some additional information.

The 1N75 diodes first used in this project were abandoned early in favor of hot-carrier diodes in both the balanced modulator and clipper sections. Carrier balancing with these devices far exceeds the 10-dB figure referred to by Mr. Schreuer, and the total suppression after the first filter, FL1, is further enhanced by placing the carrier frequency 20-dB down the filter slope as recommended by Collins.

The surplus crystal referred to may
not necessarily meet this requirement. Two or three could be tried, but ultimately the builder may wish to warp the crystal frequency, or he may wish to modify the crystal itself. I have found that regardless of the carrier position, greater roll-off of high frequency audio is desirable at the output of the device. Adding a simple series RC network ($R = 10k$ pot, $C = 1\, \mu F$) from pin 7 of the LM373 to ground allows more latitude in tonal balance.

I do not find that adding any of the suggested resistors really improves matters. There is an overall loss of system gain necessitating compensation with the transmitter gain control. Instability is not a factor in my device, but the suggested isolation may be helpful, especially at high frequencies. Concerning resistors, one which could be left out of the circuit diagram is incorrectly shown at the input to FL1 as going to ground. If retained, it should be connected to the other filter terminal.

The real problem in comparing the clipper to the compressor, it seems to me, has more to do with the limiting action of the transmitter alc than with any defects in the clipper. With or without the 2k ohm resistor suggested by Mr. Schreuer, severe clipping is possible (my data sheet indicates 70 ohms at pin 9). Heavy driving of the device will produce a solid carrier-like bar on an oscilloscope trace at the clipper diodes.

Power gain measured on a wattmeter appears to be about 4 dB with the compressor and 7 dB with the clipper when the input levels to the transmitter are equal. I note that Comdel claims 10 dB for their device, Magnum-Six, 6-dB, and DX Engineering, 5-dB power gain. But it is possible to drive the transmitter harder with the compressor and achieve 5 to 6 dB gain without flattopping. This observation is the basis of my conclusion, which has not changed.

With this condition I made the following table showing how the compressor and clipper treat pure vowel sounds and two voiceless consonants. English vowels are diphthongized and, therefore, unsustainable. So I have used the French vocalic system.

<table>
<thead>
<tr>
<th></th>
<th>compressor</th>
<th>clipper</th>
</tr>
</thead>
<tbody>
<tr>
<td>a a</td>
<td>5.18 dB</td>
<td>6.02 dB</td>
</tr>
<tr>
<td>e e</td>
<td>3.97 dB</td>
<td>6.02 dB</td>
</tr>
<tr>
<td>i i</td>
<td>7.78 dB</td>
<td>10.00 dB</td>
</tr>
<tr>
<td>o o</td>
<td>2.55 dB</td>
<td>3.80 dB</td>
</tr>
<tr>
<td>u y</td>
<td>7.78 dB</td>
<td>9.03 dB</td>
</tr>
<tr>
<td>s s</td>
<td>11.76 dB</td>
<td>11.76 dB</td>
</tr>
<tr>
<td>t t</td>
<td>6.99 dB</td>
<td>6.99 dB</td>
</tr>
<tr>
<td>average</td>
<td>6.57 dB</td>
<td>7.66 dB</td>
</tr>
</tbody>
</table>

I have long felt, as does Mr. Schreuer, that the second filter is superfluous and could be replaced by a tuned circuit. The statement in the ARRL Radio Amateur’s Handbook, 1970, page 258, “. . . a filter as good or better than the filter used to form the original ssb signal,” in my opinion, only serves to confuse the issue.

I used two filters because I had them. Two identical filters might actually have the disadvantage of reinforcing certain peaks and valleys in the passband.

Regardless of the refinements suggested, this device will add considerable authority to an otherwise unmodified signal.

Charles G. Bird, K6HTM

vertical antenna

Dear HR:

The article by VQ9N in the December, 1972, issue of ham radio on a single-element vertical antenna caught my eye immediately as it is similar to the antenna I have been using for about ten years.

When I moved to my present location I was unhappy with the antenna prospects. There is a 12,000-volt Edison line across the back of the lot about 60 feet from the shack with a maple tree in between. Putting up an antenna was a problem. After much head scratching, I finally took three sections of aluminum tv mast (about 30 feet), set it on a soft-drink bottle alongside the house with an insulator extended from under

---

*Charles G. Bird, K6HTM*
the eaves of my two-story house. A single wire was run through a basement window about three feet to a tuner which is coax fed to the transmitter. I used the hot-water heating system for ground.

While reports are not spectacular, I get into the East Coast with good reports. My operating time is very limited so I have not calculated the engineering parameters of the system, but it is about as simple as you can get. I have used the antenna on 80, 40 and 6 meters but never on 20 where it would be most efficient. There are no guy wires. I would be the first to agree that it is makeshift, but it works. If you need an antenna in a hurry, or have a limited area, try it. My only problem is the tv service men who try to sell me a new tv antenna for the mast!

Paul R. Smith, W8FHB
Toledo, Ohio

Dear HR:
I was very interested to read the article by VQ9N on the use of a half-wave vertical antenna. For many years as VS4RS I used a 14-MHz version of the J-vertex described in the vhf section of the ARRL Antenna Handbook.

This antenna is essentially a half-wave vertical situated a quarter-wave above ground. My arrangement was a 50-foot guyed steel pipe with a 17-foot matching section at ground level, fed with 600-ohm open-wire feeder. No ground system is required.

Deducting two S-units for the rarity of the VS4 prefix, I am still convinced it was a very effective DX antenna.

Ron Shelton, 6Y5SR
Kingston, Jamaica

fetrons

Dear HR:
After reading your comments in the August, 1972, issue of ham radio regarding Fetrons, plus hearing some scuttlebutt from a ham in Seattle, I decided to give them a try.

I work for Pacific Northwest Bell in the Portland, Oregon, mobile telephone and two-way radio shop. We have some GE Progress line 150-MHz base-station receivers, and I thought we could upgrade them with the Fetrons. To make a long story short, Fetrons are very good attenuators at 150 MHz.

After going around in circles a few times I called Teledyne. Their first question was, “at what frequency are you using them?” When I indicated it was 150 MHz, they told me that was the problem. Contrary to the specification sheets, which call for a 500-MHz upper frequency limit, the upper usable frequency for current production Fetrons is 10 MHz.

The TS6AK5 and TS12AT7 Fetrons are being manufactured for telephone carrier systems, which have a top frequency of about 4.5 MHz. Teledyne indicated that Fetrons could be made to work at 150 MHz, but they do not at the present time.

As you pointed out in your editorial, most fetrons are designed for the lower frequencies. Before amateurs spend some of their hard-earned money on the current TS6AK5 and TS12AT7 Fetrons, they should realize that they are not usable much above 10 MHz.

Walter J. Loomis, K7BQE
Portland, Oregon

current limiting

Dear HR:
The December, 1972, issue of ham radio carried an article on adding current limiting to existing solid-state power supplies. I have used the circuit in the article, roughly as shown.

I tried other versions of current limiting and for simplicity’s sake, I settled on one similar to the one in the article. As shown in the schematic, there is still one hangup that needs to be overcome. There is no protection against short circuits for the current-limiting transistor. Several deceased transistors attest to this fact. There are two causes for this. First, the instantaneous output voltage of the power supply appears across $R_1$, the current-sensing resistor, at the onset of a short.
This places 15 volts, in this instance, across the base-emitter junction of Q1. This is several times the voltage rating of most transistors. To overcome this problem, placing a 1000-ohm resistor (ballpark figure) in series with the base lead to Q1 effectively gives it some current-limiting protection without unduly adversely affecting performance.

A second, and less likely to happen, transistor failure is due to the fact that Q1 is called upon to instantly discharge the electrolytic capacitor that is usually placed across the reference zener. This involves high peak currents with higher voltages and large value electrolytics. A 10- or 15-ohm resistor in series with the collector lead of Q1 limits this current. It is recommended that a fairly high beta transistor with at least 600 mW of dissipation be used at Q1.

The addition of these two resistors is a simple and inexpensive way to make the supply truly current limiting with very little adverse effect on operation.

Donald G. Cheshier, K5MKO
Garland, Texas

cooling fan error

Dear HR:

In the November, 1972, issue of ham radio the ham notebook section contains an erroneous concept of the nature of reactance. Author WB8IUF, in an attempt to lower the voltage supplied to a cooling fan, placed a capacitor in series with it. This is legitimate in itself, but he has fooled himself.

A capacitor is not equivalent to a resistance value equal to its reactance. The impedance also has a phase angle of 90 degrees. This means that the total impedance of the fan-capacitor combination is not the simple sum of the two impedances, but is the vector sum. This can be found from

\[ Z_T^2 = R_F^2 + X_C^2 = 1200^2 + 442^2 \]
\[ Z_T = 1280 \text{ ohms} \]

where \( Z_T \) is the total impedance, \( R_F \) is the resistance of the fan and \( X_C \) is the reactance of the capacitor. In this case, where the total impedance is 1280 ohms, the current is 93.8 mA and the voltage across the fan, \( V_F \), is 112.5 volts. Thus, \( V_F \) is considerably higher than that given by WB8IUF.

To find the correct value capacitor for this application use the following equations:

\[ Z_T = \frac{V_T}{I} = \frac{120 \text{ V}}{75 \text{ mA}} = 1600 \text{ ohms} \]
\[ X_C^2 = Z_T^2 - R_F^2 = 1600^2 - 1200^2 \]
\[ X_C = 1060 \text{ ohms} \]

At the line frequency of 60 Hz, 1060 ohms capacitive reactance is provided by a 2.5-\( \mu \)F capacitor. That gives the desired 90 volts across the fan.

Terry Conboy, WB6GRZ
Redwood City, California

yaesu spurious signals

Dear HR:

Reference, "Spurious Signals with the Yaesu," December, 1972, issue of ham radio, page 69. Unfortunately, the article by K6KA was incomplete with regard to which units of the FTdx560 can be affected by the spurious radiation problem.

Starting with serial number 30001, the vfo frequency range in the FTdx560 was changed from 8400-8900 kHz to 8700-9200 kHz. The resulting change in local-oscillator frequencies produced a heterodyne with the second harmonic of the 3180 kHz i-f in some units to produce the spurious output. This was eliminated by addition of the 6358.6-kHz crystal.

All FTdx560s manufactured after introduction of the FTdx570, and all FTdx570s, have this circuit modification incorporated during production.

James Young
Spectronics
Signal Hill, California

October 1973
Topeka FM Engineering has announced their new line of dual-gate mosfet preamplifiers. Their new model HF450 is designed for use in the range of 406 to 470 MHz, and is available in three models: 406 to 430 MHz, 430 to 450 MHz and 450 to 470 MHz. The rf voltage gain of these amplifiers is typically 15 dB with a 10-to 15-volt dc power supply. Noise figure is typically 4.5 dB. Superior cross-modulation performance and the greater dynamic range of the mosfet greatly reduces spurious responses. Each mosfet gate is protected by back-to-back diodes.

These new preamplifiers feature rf shielding of input and output circuits on both sides of the printed-circuit board and silver-plated G11 epoxy-glass boards for high performance. The preamplifier comes complete with all mounting hardware, rf jumper and detailed instructions.

The HF450 is priced at $29.95 shipping prepaid. Also available is the model HF450 MO for Motrac radios. For more information, write to Topeka FM Communications and Electronics, 1313 East 18th Terrace, Topeka, Kansas 66607, or use check-off on page 110.

free electronics catalog

One of the biggest problems for the amateur home builder is obtaining the necessary electronic components for his projects. This problem is particularly bad if you don’t live in or near a large metropolitan area. The new 1974 Olson Electronics catalog will solve many of these problems. This new, illustrated catalog, which features over 8000 quality-tested items, is free for the asking. In addition to a complete line of electronic components, transistors, ICs, etc., Olson carries the best of name brands in amateur radio equipment, antennas, test equipment, kits, electronic calculators and stereo and four-channel sound systems. For your free copy, write to Olson Electronics, Dept. HH, 260 S. Forge Street, Akron, Ohio 44327, or use check-off on page 110.

tube substitution handbook

Since 1960, there has been a tremendous increase in the number of American and foreign models of home-entertainment equipment. Consequently, an expansion of more than 600 percent has taken place in the number of available tube substitutions. This new and up-to-date edition of the Howard Sams Tube Substitution Handbook has kept pace with this rapid expansion by listing over 12000 direct replacements for all types of receiving tubes.

For convenience, this handy guide is divided into seven informative sections. Section 1 presents a cross-reference of all American receiving tubes, and section 2 lists picture tubes and their recommended
substitutes. Section 3 contains a cross-reference of subminiature tubes, while the fourth section consists of industrial substitutes for receiving tubes. The fifth section is a substitute listing for communications and special-purpose tubes. The final two sections feature cross-references of American and foreign tubes.

There are easy-to-follow instructions accompanying each section that help you make proper tube substitutions and that explain how to cross-reference between sections for other substitutes. This guide fills the need of electronic experimenters, radio amateurs and service technicians who desire quick and accurate information for making suitable vacuum-tube substitutions. 96 pages, softbound. $1.75. A companion pocket-size volume which will fit into your pocket or your tube caddy is also available in a twin-pack which includes the regular sized volume, $2.25. Order from Comtec Books, Greenville, New Hampshire 03048.

digital chronometer kit

The Kronos KR100 chronometer kit features an LSI National clock chip, and a 32-page brochure with pictorials and easy-to-understand, step-by-step instructions. The chronometer includes 3 setting controls, 1-hour per second, 1-minute per second, and hold button. Easy-to-change from 12 to 24 hours, 4 to 6 digits, 50/60 Hz operation.

There are 3 models to choose from: 7-segment MAN-3 type LEDs, 6-digit kit, $47.00; 7-segment MAN-1 type LEDs, 6-digit kit, $69.95; and 7-segment Nimix type tube kit for $47.00. Available from Poly Paks, P.O. Box 942H, Lynnfield, Massachusetts 01940. For more information use check-off on page 110.
Seconds To Bond... Years To Undo!

Literally thousands of uses; Repair printed circuit boards, cabinets, install knobs, controls, all types of hardware... metal, ceramic, porcelain, glass, etc. One Drop should be in every workshop. It's ideal for repairing jewelry, appliances, sporting goods, tools and countless other items.

If unavailable in your area order direct with 30 Day Money-Back Guarantee

- 132 Drop Dispenser (2 grams) $3.00 postpaid
- SAVE... Order two for only $5.00
- Send check or money order - No C.O.D.'s.

Name
Address
City
State Zip

Note: This One-Drop formula is not recommended for use on porous materials unless it is properly filled. Request Instant-Weld 240 for use on porous materials. No. 240 sets in about 3 minutes on most materials.

Tangent Template, Inc. has published a short-form catalog that gives quick reference to a comprehensive line of user-designed drafting templates for printed-circuit design work. A total of fourteen different templates are described and illustrated, including templates for 1:1, 2:1 and 4:1 reproduction ratios. If you design PC boards, these templates should prove to be very useful. For a copy of the catalog, write to Tangent Template, Inc., Post Box 20704, San Diego, California 92120, or use check-off on page 110.

phone patch

New from Radio Shack is the Realistic Phone Patch at a price which the company says brings this useful accessory within the reach of any amateur's budget.

A phone patch provides an interconnection between your station's equipment and the telephone system, making it possible to place or receive telephone calls through a base station and relay them to another station which does not have access to a telephone. Phone patches
have been of great use during civil emergencies, in providing communications in disaster areas, and often as a means for servicemen overseas to talk with relatives at home.

The Realistic Phone Patch is priced at $19.95 and comes complete with 15-foot telephone leads, three-foot transmitter lead and installation instructions. It features a built-in VU meter, gain control and locking push-to-talk bar. Not for use with transceivers employing electronic switching.

Realistic products are available at more than 1650 Radio Shack and Allied Radio Stores in all 50 states and Canada, and through Radio Shack Authorized Sales Centers, nationwide. For more information, use check-off on page 110.

**rotary log-periodic antenna**

Recently, KLM Electronics began manufacturing and marketing a line of antennas designed by Oliver Swan. This line includes a variety of high-performance vhf antennas that cover the spectrum from 50 to 520 MHz. The most recent addition to this line is a rotary log-periodic antenna that covers from 13 through 30 MHz. This antenna covers not only the 10-, 15- and 20-meter amateur bands, but MARS frequencies, the short-wave broadcast band and CB. Performance is equivalent to a three-element Yagi on any frequency between 13 and 30 MHz.

The KLM 13-30 log periodic uses seven elements and provides 9.2 dB over an isotropic. Front to back ratio is 12 dB. The input impedance is 50 ohms (a 4-kW balun is supplied), and maximum vswr at any point between 13 and 30 MHz is 2.0:1. The antenna weighs 76 pounds and has a boom length of 29.5 feet. The antenna is priced at $289.00, FOB San Jose, California. For more information, write to KLM Electronics, 1600 Decker Avenue, San Martin, California 95046, or use check-off on page 110.

**THE $39.95 2 METER FM TRANSMITTER**

It's here . . . a single channel, crystal controlled solid state FM transmitter with built-in speech processing. A complete circuit board assembly (11/2 oz., 3.75 cu. in.) NOT a Kit that doesn't have it all together. Includes miniature crystal microphone, complete technical data. Fully tested. Just connect battery, antenna and microphone, and you're in the 2 meter world.

**TYPICAL PERFORMANCE SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmitter output</td>
<td>200 MW typical</td>
</tr>
<tr>
<td>into 50 ohms:</td>
<td>@ 8.1 kHz</td>
</tr>
<tr>
<td>Frequency Stability:</td>
<td>±0.0025% (-35°C to +55°C), nom. freq. ref.</td>
</tr>
<tr>
<td>Current Drain:</td>
<td>70 ma. @ 8.1v</td>
</tr>
<tr>
<td>FM Noise:</td>
<td>45 dB below 3.3 KHz, deviation @ 1000 Hz</td>
</tr>
<tr>
<td>Modulation:</td>
<td>Phase Modulation</td>
</tr>
<tr>
<td>Audio Response:</td>
<td>±3 dB of 6dB/octave pre-emphasis over 300-3000 Hz</td>
</tr>
<tr>
<td>Deviation:</td>
<td>±5 KHz (adjustable)</td>
</tr>
</tbody>
</table>

Available for limited time only. Fill out the order form below NOW and mail with check or money order payable to ComData Division, International Signal & Control Corp.

1-4 units $39.95
5 or more $34.90

INCLUDING MICROPHONE
- [ ] 146.94 or [ ] 146.34 or [ ] 146.16

Extra Crystals $2.95 each, available only with order for transmitter. List Frequencies Below:

(Pennsylvania residents, please add 6% sales tax.)

Name ..........................................................
Address ..................................................
City ............................................. State ....... Zip ........

International Signal & Control Corp.
3050 Hampland Road
Lancaster, Pa. 17601 Tel. (717) 299-3671

More Details? CHECK-OFF Page 110
Save on Holiday

For a limited time only, SWAN ELECTRONICS and participating dealers are offering the best-buys-of-the-year in amateur radio...complete mobile or home stations...at very low "special package" prices. Act now. Be sure orders are placed early to assure early delivery—these special offers will expire December 25, 1973.

A LUXURY SWAN TWINS HOME STATION WITH MATCHING DELUXE SPEAKER AND QUALITY DESK MICROPHONE COVERS ALL 5 AMATEUR BANDS - SSB/AM/CW

It's all here—the most envied and sought after amateur radio system—at a special reduced price that may never be repeated again. You'll save more than $125 if you take advantage of this offer, now!

You get: The SWAN 600R/Custom Receiver including the ICAF 500 audio notcher-peak and NB-500 noise blanker; the 600 watt P.E.P. input SWAN 600T Transmitter with self-contained heavy-duty AC power supply; a deluxe SWAN 600SP Speaker and cabinet with FP-1 phone patch, headphone jack and tone control; plus, the SWAN 444 desk microphone...a $1,228.90 retail value!

Among many features included are: Mode selectors, Band selectors, Plate and antenna load matching controls, Selectivity and sensitivity controls, Hi-Lo power switch, Full break-in or semi-break-in CW with sidetone, VOX or PTT switch, Dual-ratio planetary tuning, Tuning eye and S-meters, Controlled AGC, VFO selector, and much more...practically every condition you'll ever want is at the control of your finger tips.

THIS COMPLETE DELUXE PACKAGE IS YOURS FOR $1,099.95 or just $110 down and no monthly payments until next year when ordered on an approved SWAN Revolving Credit Service account.

NEW 700CX CHAMPION SSB TRANSCEIVER

Less than 82¢ per watt! Punch through QRM for more contacts with 700 watts P.E.P. without an expensive accessory amplifier. The most power for the money available today...compare any others, you'll see it's a fact!

- SSB/CW/AM
- Dual-ratio planetary tuning
- 5.5 MHz crystal I.F. filter
- 5-Bands, 3 to 30 MHz
- ALC and AGC
- 2.7 kHz bandwidth

Choose a winner—SWAN's 700CX CHAMPION—it's gotta lotta punch!

NEW FM-1210A 2 Meter FM

Independent switching of 12 transmit and 12 receive channels gives you up to 144 possible channel combinations for your communications pleasure. Now you can move off the crowded frequencies, effectively eliminating unwanted QRM. Eight crystals are included for the most popular frequencies.

The FM-1210A is the only 2 meter transceiver providing a crystal oven for superior stability in the coldest of weather conditions. Transmitter is fully solid-state. DC power cord is included for mobile operation and the heavy-duty pedestal type AC power supply is perfect for home station applications. Mobile mounting bracket and dynamic microphone is supplied. The FM-1210A transceiver may be purchased without the AC power supply at just $319 for mobile installation or any standard 12V DC system.

$569.95

SWAN CHAMPION FM-1210A and Power Supply $359.95

2 Meter
144 Channels

More Details? CHECK-OFF Page 110
Compact Quarters? Need Space?
Try the 300B Cygnet de novo with built-in speaker and AC power supply.

Yes! A complete amateur radio station expertly engineered into this newest generation of portable Cygnet SSB/CW transceivers. It's lightweight, less than 25 pounds. An ideal traveling companion for Hams on the move. Take it on vacation — operate from motel room, hunting cabin, boat or car. Connect an AC power source, plug in your microphone and antenna — you're on the air!

With 5 bands and 300 watts P.E.P. input, the Cygnet de novo has all the control and power necessary to work the world. A CW sidetone monitor is provided along with capability for CW semi-break-in with an optional VOX unit. Requires plug-in DC converter for 12V DC mobile operation.

300B Cygnet de novo ... $499.95
VX-2, VOX unit ... $35.95
SWAN 14-A, converter ... $44.95

Economical—Superior Quality—Amazing Clarity—Easy to use! That's the reaction to this installation. Specifically designed for the mobile ham, here is 50 watts P.E.P. input radiated through the most efficient heavy-duty single-band mobile antenna we know of. No tune-up time required. Just flip on the power switch and you're in operation. An easy to see light emitting diode, on the S-meter face, is activated to let you know when you're transmitting. The built-in speaker reproduces the most natural sounding voices we've ever heard in a mobile rig.

Like its big brother, the SS-200, this monobander needs no transmitter tuning and is infinitely protected from VSWR damage. Front-end overload, distortion and cross-modulation is virtually eliminated. Select the MB-40 for 7.0 to 7.3 MHz use, or the MB-80 if you prefer to work 3.5 to 4.0 MHz. Whichever monobander you select, we'll include the correct single-band coil and whip antenna together with a bumper mount and microphone. A total value of $374.00 offered during this special holiday season for only $320. SAVE $54.00.

Includes: SWAN MB-40 or MB-80 transceiver, appropriate antenna coil, 6 foot whip and 36 inch antenna base section, SWAN BMT mount, SWAN 404 microphone, and all necessary mounting brackets, coax and connectors.
JOIN THE NEW AGE OF AMATEUR RADIO ELECTRONICS!
THRILL TO THE SWAN SS-200 EXPERIENCE

- Completely solid-state
- 200 watts P.E.P. input
- Operates directly from any 12V DC supply
- 3 to 30 MHz
- Broadband transmitter eliminates operator tuning adjustments
- Full power maintained on all 5 bands
- Selectable SSB/CW
- Semi-CW break-in and monitor
- Infinite VSWR protection
- Crystal I.F. filter with 1.7 shape factor
- 2.7 MHz audio bandwidth
- Noise blanker with variable threshold control
- and more!

Also available in 15 watt P.E.P. input version.
Home station power supplies may be purchased for 115V AC or 220V AC installations.

SS-15 (15 watts P.E.P.) ....................... $579.00
SS-200 (200 watts P.E.P.) ..................... $779.00

SWAN MARK 6B — Linear Amplifier.
2,000 watts P.E.P. input. Compatible with SWAN 250C. 50 to 54 MHz.
Complete with power supply ................ $679.95

SWAN VHF-150 — 2-Meter Amplifier.
150 watts P.E.P. input. Will operate class "B" or "C". Rugged
self-contained power supply ................ $299.95

SWAN 117-XC — 117V AC power supply with speaker, phone jack and indicator light.
Ready to plug in and use ....................... $109.95

SWAN SS-16B — Super Selective I.F. Filter.
Exclusive 16 pole filter has a 1.28 shape factor with an ultimate rejection in excess of 140 dB.
In easy-to-install kit form ..................... $79.95

2-METER MOBILE FM STATION
FEATURING THE NEW FM-2XA TRANSCEIVER

#3 PACKAGE
Transmit 10 watts of RF power over 12 channels from 144 to 148 MHz.
Operates directly from any 12V DC battery system.
MOS FET front-end substantially eliminates cross modulation and overloading.
Infinite VSWR protection.
Dynamic microphone and all necessary cables and connectors are included.
The 3 dB gain whip is stainless steel with tapped transformer moulded at the base.
Your choice of roof or deck mounting.
A real value, worth up to $288.70.
You save up to $23.75 at this low bargain price of $264.95 for this complete package deal.

PS-10 (115V AC power supply) ................ $89.00
PS-20 (115V AC power supply) ............... $139.00

SWAN FP-1 — Hybrid Phone Patch.
Separate receiver and transmitter gain controls.
Exact voice reproduction ............... $48.95

SWAN 55C — 5-Band Remote Control Mobile Antenna. Power rated at 1000 watts P.E.P. A SWAN exclusive ...... $129.00

SWAN 45 — 5-Band manual switching version of the 55C ........ $79.00

SWAN TB-2A — 2-Element Beam Antenna
Power rated at 2000 watts ............... $89.95

SWAN TB-3A — 3-Element Beam Antenna
Power rated at 2000 watts ............... $108.00

GOLDEN SWAN 1040V — Trap Vertical Antenna.
10, 15, 20 and 40 meters.
PR @ 2000 W. ............................ $69.95
75 Meter add-on kit ..................... $36.95

2000 WATT P.E.P. INPUT MARK
II LINEAR AMPLIFIER
Full frequency coverage from 10 to 80 meters plus MARIS.
Requires 100 watts of drive — compatible with SWAN 270B, 300B, 500CX, 700CX and 600T. All controls are easily accessible on the front panel.
Provides full legal power limit on SSB, CW, AM and RTTY.
Meter switch allows you to read Plate Voltage, Plate Current, Grid Current and Relative Output.
Separate matching AC power supply included with 4½ foot connecting cable.

$679.95

more Details? CHECK-OFF Page 110
Holiday Offers!

You may use this Special Holiday Purchase Form to place your order or you may want to use it as a HINT CHECK-LIST for your XYL or YL! Don’t forget to point out the unique amateur radio gift counseling service available especially for her:

ATTENTION ALL XYL’s and YL’s — If you’re in doubt about what to get the OM or YM, or if you have any question at all about SWAN equipment or services — call SWAN’s Gift Information Service... collect! Call area code 714, 757-7525 (between 8 AM and 4 PM Pacific Time) and ask for our Gift Information Service. You’ll receive our most courteous and confidential assistance.

---

CUT ALONG DOTTED LINE

---

I I AND MAIL TO SWAN OR BRING TO YOUR LOCAL SWAN DEALER I I

### PACKAGE #1 — $1099.95

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUXURY 600 HOME STATION</td>
<td>$569.95</td>
</tr>
<tr>
<td>700CX Champion</td>
<td>$569.95</td>
</tr>
<tr>
<td>FM-1210A &amp; AC Power Supply</td>
<td>$359.95</td>
</tr>
<tr>
<td>FM-1210A Mobile Unit</td>
<td>$319.00</td>
</tr>
<tr>
<td>300B Cygnet <em>de novo</em></td>
<td>$499.95</td>
</tr>
<tr>
<td>VX-2, VOX Unit</td>
<td>$35.95</td>
</tr>
<tr>
<td>14-A, DC Converter</td>
<td>$44.95</td>
</tr>
<tr>
<td>SS-15 Solid-State Transceiver</td>
<td>$579.00</td>
</tr>
<tr>
<td>SS-200 Solid-State Transceiver</td>
<td>$799.00</td>
</tr>
<tr>
<td>PS-10, AC Power Supply</td>
<td>$89.00</td>
</tr>
<tr>
<td>PS-20, AC Power Supply</td>
<td>$139.00</td>
</tr>
<tr>
<td>Mark 6B, Linear Amplifier</td>
<td>$679.95</td>
</tr>
<tr>
<td>VHF-150, 2 Meter Amplifier</td>
<td>$299.95</td>
</tr>
<tr>
<td>Mark II, Linear Amplifier</td>
<td>$679.95</td>
</tr>
</tbody>
</table>

### PACKAGE #2 — $320.00

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB-40</td>
<td>$117-XC, AC Power Supply</td>
</tr>
<tr>
<td>Roof Mount</td>
<td>$79.95</td>
</tr>
<tr>
<td>Deck Mount</td>
<td>$510X, Crystal Oscillator</td>
</tr>
<tr>
<td>SS-16B, Super Filter</td>
<td>$48.95</td>
</tr>
<tr>
<td>WM-1500, Wattmeter</td>
<td>$49.95</td>
</tr>
<tr>
<td>55C, Mobile Antenna</td>
<td>$129.00</td>
</tr>
<tr>
<td>45, Mobile Antenna</td>
<td>$79.00</td>
</tr>
<tr>
<td>TB-2A, Beam Antenna</td>
<td>$89.95</td>
</tr>
<tr>
<td>TB-3A, Beam Antenna</td>
<td>$108.00</td>
</tr>
<tr>
<td>TB-3HA, Beam Antenna</td>
<td>$125.00</td>
</tr>
<tr>
<td>TB 4HA, Beam Antenna</td>
<td>$148.00</td>
</tr>
<tr>
<td>1040 V, Trap Antenna</td>
<td>$69.95</td>
</tr>
<tr>
<td>75 Meter Add-On Kit</td>
<td>$36.95</td>
</tr>
</tbody>
</table>

### PACKAGE #3 — $264.95

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWAN Account #</td>
<td>$499.95</td>
</tr>
</tbody>
</table>

This check list can be used as an order form. Check the items you want, fill in all necessary data, and mail to SWAN or your favorite dealer. All shipping charges will be collect. Sales tax will be added where appropriate.

NAME ______________________ AMATEUR CALL _______________________

ADDRESS __________________________________________ PHONE _______

CITY ______________________ STATE ______ ZIP ______

Payment by: [ ] Check/Money Order [ ] C.O.D. [ ] SWAN Finance (10% or more down payment enclosed) [ ] BankAmericard # _______________ Expires _______________

[ ] Master Charge # _______________ Expires _______________ Interbank # _______________

[ ] SWAN Account # _______________ — Check here if this is an add-on order [ ] HAM

(All prices contained herein are subject to change after December 25, 1973)

---

**BONUS SCOPON**

If your total purchase of SWAN equipment ordered from this advertisement exceeds $500, present this coupon for an additional 2% discount off the total list price of your purchases. This coupon is not valid unless signed by an authorized purchaser. Date of

Name ______________________ Purchase ______________________

Signature ______________________

Expires December 25, 1973

clipped from HAM magazine

More Details? CHECK—OFF Page 110

305 AIRPORT ROAD
OCEANSIDE, CA 92054
TELEPHONE (714) 757-7525

October 1973
**GLOBALMAN™ QUALITY PRODUCTS**

Phone: 714/533-4400  Telex 678496

10 day return privilege for cash refund

---

**TRANSKEY™ Since 1966 Is On The Move!**

**TWO NEW IC KEYERS!!**
PORTABLE! USES FLASHLIGHT BATTERIES!

**EK-105D with monitor**

$51.95 POSTPAID

- Keys built in, finger tip adjustments
- Wired, ready to operate
- Output, heavy duty TR switch: 160 v. 700 ma.
- Jam proof IC circuitry, 5-50 wpm self completing precise keying any speed
- Variable tone control on monitor; volume on EK-105D
- Power; 2 inexpensive flashlight batteries 3 v; or external 6 v source
- Tune push switch on EK-105D
- Microlight pilot lamps, both keyens

**EK-108D monitor built in**

$64.95 POSTPAID

- Main differences — EK-108D uses more transistors and diodes; has external key adjustments and built in monitor. Both covers easily removable with fingertip screws on each side.
- 1 year unconditional guarantee.
- DEALERS WANTED: We intend to sell through dealers wherever possible and will not knowingly sell direct in a dealers area. Identify and send for dealer info.
- Write for specs, photos, front, back & inside.
- Fellow hams invited to visit dealers and try keyers or send check or M.O. please to:

**W6PHA - GLOBAL IMPORT CO.**
P. O. Box 246, El Toro, Calif. 92630

---

GATEWAY ELECTRONICS

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

GIANT 7 SEGMENT L. E. D. READOUT — 6/10 inch character height — NEW $3.95
L. E. D. 7 SEGMENT READOUT — MAN 1 TYPE — NEW $2.75
L. E. D. INDICATOR — STANDARD SIZE — RED — NEW 35¢ 3/$1.00
DIGITAL CLOCK CHIP — NATIONAL 5314 — 6 DIGIT — 12/24 hour — NEW $12.95
STEREO AMPLIFIER "IC" 14 Pin, 2 watts per channel — NEW $2.00

THUMBWHEEL SWITCHES
- 0.5 x 2.125 x 1.78 — 10 position decimal $3.00
- 10 position BCD & Compliment $4.00
- End Plates (per pair) $1.45

MINIATURE SIZE
- 0.312 x 1.3 x 1.3 10 position decimal $2.50
- 10 position BCD & Compliment $3.75
- End Plates (per pair) $1.00

$5 Minimum Order.
Visit us when in St. Louis.
Please include sufficient postage.
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 110 October 1973
A COMPLETELY PORTABLE FREQUENCY COUNTER WITH . . .

- 10 HZ to 65 MHZ range
- Full six digit readout (L.E.D.)
- Sensitive front end (LESS THAN 10 MV.)
- Only $199

FEATURES

- High capacity rechargeable Ni Cd batteries
- Crystal controlled time base (can be field calibrated)
- Convenient 3-position range select switch allows:
  1. Readout always in MHz.
  2. Eight digit resolution by range selection
  3. Direct reading pre-scalar operation to 999.999 MHz.
- "Battery save" switch for spot checks
- Less than 5 watts power consumption (5 volts @ 0.9 AMPs)
- Dimension 6" x 3.5" x 2.3"
- TTL input for use with pre scalar
- Can be operated on internal or external power, with trickle charge and full charge positions
- Sample control lets operator determine how often the readout is updated. Can "hold" present count without being updated

Mail orders directly to:
Great American Miniatures, Inc.
P. O. Box 10990
Midwest City, Okla. 73110

Model C-65 Freq. counter $199.00
Battery charger 8.00
Battery charger & eliminator 18.00

REEDLESS ENCODER

- SUB-AUDIBLE
- -30 TO 65°C OPERATION
- FAST STARTING TIME
- R F SHIELDED
- OPERATES ON 9 TO 18VDC
- SMALL SIZE ONLY
  1.3 "SQ X 1/2" HIGH

$ 28.50
AVAILABLE FOR ANY EIA CODE 67.0 THRU 192.8 Hz
WRITE FOR COMPLETE SPECS AND DATA SHEET

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

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

SIX METER TRANSMITTER

- MOBILE
- FIXED STATION
- EMERGENCY
- AVIATION

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

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

Price 4995
Net to Amateurs Complete with Tubes Power Supply $9.95
INTEGRATED CIRCUIT SOCKETS

- 16-Pin, Dual .54
- 16-Pin, Side Mount .50
- 10-Pin, Wire Wrap .50
- 12-Pin, 5- & 10-Pin .50

HAM’UHF 400 MC HIGH POWER TRANSISTORS

- 12A $1.95
- 10A $1.95
- 8A $1.95
- 6A $1.95

By RCA or equal values. NPN. 23 watts, 10,000-conversion factor, withudio mix. DCQ max 65.

AEROSPACE

BASCOCK & LEACH CRYSTAL CAN RELAYS

- $1.50
- $3.50

All hermetically sealed, Submini, 1/8”, half, and full crystal can, types in 12-24, in most contacts up to 400A 1 amp up to 12 volts, various types and styles. 11, 16, 18, 24, 25, etc. Sorry, no mail orders or type of orders. From factory most direct. No cash limits, if you are ample-designed, at low prices.

GLASS AMP II

SPACE AGE CRYSTALS

Meets critical JAN specs. A place “half of silicon strength” that meets JAN specs, high reliability, with stand and variable power supplies to 1k watts. ONE and two amplifiers, with capabilities. Ask leads.

PACER 75V

- $1.95
- $5.95
- $10.95

SILICON TUBES

- $50.00
- $100.00

VOLTA LIQuID ELECTROLYTE

- $1.50
- $2.00
- $3.50

More Details? CHECK-OFF Page 110.
two calculating ideas

Texas Instruments TI-2500

Fast-figuring. Adds, subtracts, multiplies, divides... does true credit balances, mixed and chain calculations.

8-Digit Display with a floating decimal, no need to ever set it. Constant switch allows shortcut multiplication and division. Everything Included. AC adapter/charger, rechargeable batteries and handy carrying case. Only 12 oz. Measures 5½" x 3" x 1-7/10".

Model TI-2500 Only $84.95 postpaid USA

Texas Instruments SR-10

The electronic slide rule

Made to order for technicians, engineers and scientists, this amazing little machine not only adds, subtracts, multiplies and divides, but also figures reciprocals, squares and square roots. It also incorporates capability for sign change and scientific notation.

Display includes 8 digits plus 2 digit exponent and 2 signs for 12 total characters.

Compact size 6.3" x 3.1" x 1.5". Includes AC adapter/charger, nicad batteries, carrying case and owners manual.

Model SR-10 Just $119.95 postpaid USA

Here are the wonder products of the 70's — two exciting Texas Instruments' handheld portable calculators all ready to go to work for you at any time and any place. Two models to fit virtually every need, both made in the USA by Texas Instruments and backed with their warranty and service organization.

Order today. Send either a check or money order or all of the information from your MasterCharge or BankAmericard and we'll send your new calculator by return mail.

comtec

 Greenville, New Hampshire 03048

80 october 1973 More Details? CHECK—OFF Page 110
HAVE A COPY OF OUR NEW CATALOG YET?

IF NOT, WRITE OR CIRCLE READER SERVICE CARD FOR YOUR COPY NOW!

SOLID STATE SYSTEMS, INC.
P.O. BOX 773
COLUMBIA, MISSOURI 65201

(CALL TOLL FREE) 800-325-2981
THE ULTRA-BAL 2000

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

ONLY $8.95/pd. (state ratio)
At your dealer or order direct
Box 1270, Tustin Calif. 92680

THE ULTRA-BAL 80-40 DUAL DIPOLE ANTENNA

Full length Copperweld elements for the 80 and 40 meter bands, feed with the famous Ultra-Bal 2000 Antenna Balun. With drop-proof spacer insulators for parallel dipole use. May also be used as a dual-band "fan" dipole. A complete antenna, ready to connect to your coax feed line.

Model UB-80-40-DDA $24.50 pd. Calif add 6%
K. E. ELECTRONICS Box 1279, Tustin, Calif. 92680
F-LINE MODEL 400D/400SD

FR DX 400 $299.00
FR DX 400 SD $399.00
SP-400P $59.00
SP-400S $19.00
FLDX 400 Exciter $339.00
FL 2000B 1200 Watt Linear Amp. $339.00

Includes 6 & 2 Meters

FR-DX-400 RECEIVER
SP400-P

Mode of Operation: SSB, CW and AM (FM)
Frequency Range: 1.7-2.3Mc, 3.5-4.1Mc, 8.9-
7.4Mc, 13.9-14.4Mc, 20.9-
21.4Mc (26.9-27.5Mc), 27-
9.29-28.5Mc, 28.5-29.1Mc, 28-
9.29-28.5Mc, (28.9-29.5Mc),
9.91-9.9Mc, (9.95-10.0Mc),
(9.92-9.95Mc), (52.5-54Mc), (144-146Mc or
covers 146-148Mc).

Spurious Response: Better than 60 db at 14Mc.
Frequency Stability: After warm up less than
100 cps. per any 15 min.
or 10% line voltage fluctu-
ation.

T-notch Attenu-
ation: 50db
Antenna Impedance: 50-75 ohms
Audio Output Impedance: 4 or 600 ohms
Output: 1 watts @ 5% distortion
Power Requirement: 100/110/117/200/220, or
234 volts AC, 50 or 60 cps.,
approx. 50 watts

Calibration: 50 kc main dial division, 1
kc reading
Calibration: 100kc or 25kc
Dimensions: 14 1/2" W, 6 1/4" H, 11
Weight: Approx. 24 lbs.

Here is the opportunity you have been waiting for:
- Split frequency operation for working that choice DX and Net Operation.
- This is the ultimate for complete coverage with control from either the transmitter or the receiver.
- 2 Mechanical Filters for excellent selectivity plus T-notch rejection tuning.
- Solid State VFO for excellent stability.
- Clarifier for Net operation.
- Built in Monitor for listening to transmitted signal.
- 100KC and 25KC Kalibrator...3 step AOC.
- Pick up a brochure at your Dealers and ask for Demonstration.

FACTORY SERVICE IS AVAILABLE WHERE WARRANTY HAS EXPIRED. MODIFICATION KIT MK 160 (160M)
$16.00 WITH XTAL PLUS LABOR. MODERNIZATION KIT MK-1 FOR OLDER MODEL FT101 $40.00 PLUS LABOR. BROCHURES WITH SPECIFICATIONS ARE AVAILABLE AT YOUR DEALERS LISTED BELOW:

HENRY RADIO STORES/213-477-6307
Los Angeles, Anaheim, CAI.: Butler, Md.
HAM RADIO OUTLET/435-342-5757
Burlington, C.
RACOM ELECTRONICS/206-255-6656
Renton, Wash.

WILSON ELECTRONICS/703-457-3596
Princeton, N.J.
ED JUKE ELECTRONICS/814-926-5211
Fort Worth, Tex.
AMATEUR ELECTRONICS SUPPLY/414-442-4200
Milwaukee, Wl.
FRECK RADIO & SUPPLY/704-254-9551
Asheville, N.C.
HARRISON RADIO/516-292-7990
Farmdale, L.I. Valley Stream, L.I. New York City, N.Y.

YAESU MUSEN USA INC.
7625 E. ROSECRANS AVE. UNIT 29 PARAMOUNT, CAL. 90723
TWX 910 346 7624
TEL 213 633 4007

More Details? CHECK-OFF Page 110

October 1973 83
To most people this is a symbol from Greek mythology. But to hundreds of thousands of active amateurs, Pegasus is the symbol of the Radio Amateur CALLBOOK the single most useful operating reference for active amateur stations. The U.S. Edition lists over 285,000 Calls, Names and Addresses in the 50 States and U.S. possessions while nearly 200,000 amateur stations in the rest of the World are listed in the DX edition.

Both editions contain much other invaluable data such as World Maps, Great Circle Maps, QSL Managers around the World, ARRL Countries list and Amateur Prefixes around the World, Time information, Postal Information and much, much more. You can’t contest efficiently, you can’t DX efficiently, you can’t even operate efficiently without an up to date CALLBOOK.

To make the CALLBOOK even more valuable, three supplements are issued each year which bring your copy completely up to date every three months. These are available at a modest extra cost. Full details in every CALLBOOK.

Get your copies of the big new 1973 CALLBOOKs today.

US CALLBOOK (less service editions) $8.95
US CALLBOOK (with service editions) $14.95

DX CALLBOOK (less service editions) $6.95
DX CALLBOOK (with service editions) $11.45

Mail orders add 50¢ per CALLBOOK postage and handling.

See your favorite dealer or send today to:

RADIO AMATEUR CALLBOOK INC.
Dept. E 925 Sherwood Drive
Lake Bluff, Ill. 60044

PHONE ORDERS
NOW ACCEPTED FOR
1 DAY C.O.D. SHIPMENT
ON ALL OUR
P R E - A M P S
AND SOME OF OUR
CONVERTERS
AND FREQUENCY SYNTHESIZERS

If you need a low noise pre-amp in a hurry for communications or instrumentation, we can fill your order custom tuned to any frequency from 5 MHz. to 475 MHz. within 24 hours by air mail or special delivery. All you pay is our regular low price plus C.O.D. shipping charges. This rush service is also available on some of our stock converters and frequency synthesizers. To place an order or for information on any of our products call us between 9 A.M. and 4 P.M., Monday thru Thursday except holidays (no collect calls please). If line is busy keep trying.

PHONE: 212-468-2720

PEMCO ELECTRONICS MANUFACTURING
422 18th St., N.E., Salem, Ore. 97301, (503) 585-1641

PRINTED CIRCUIT BOARDS
Available for any amateur project appearing with artwork in any amateur periodical.

Write for complete details and prices
D. L. "Mac" McClaren, W8URX
Printed Circuit Service for the Amateur
19721 Maplewood Ave. Cleveland, Ohio 44135
216-267-3263
Midland, for years one of the top names in communications equipment, proudly introduces this sensational new 15-watt Amateur mobile. More power than most sets, it drives linear amplifiers to full output. And there's a low-power position switch for short-range 1-watt output. Instantaneous final protection circuit prevents damage from excessive VSWR. Receiver has multiple F.E.T. front end with high "Q" resonator filter, ceramic filters in I.F.—superb selectivity, sensitivity, and bandpass characteristics. King-size illuminated S/RF meter, channel selector. Variable squelch, volume controls. ADL circuit maintains deviation level without distortion. Crystals supplied for .16-.76, .34-.94, and .94 simplex. Each receive-and-transmit crystal has individual frequency trimmers. Equipped with connector for attaching tone burst and discriminator meter accessories. Includes dynamic mike and mounting hardware.

Model 13-500

For information on Midland Amateur radio, write for our full-line brochure:
P.O. Box 19032, Kansas City, Missouri 64141
THE MOST COMPLETE
2 METER REPEATER AVAILABLE

DYNAMIC COMMUNICATIONS, INC.
948 Ave. "E" P.O. Box 10116
Riviera Beach, Fla. 33404 (305) 844-1323

SPACE SAVER
TOWERS & MASTS

CZ series towers, cranks up, installs without guy wires. New lacing design creates greater strength. Mini and Magna rotating masts... high strength galvanized tubing, self-supporting crank-up.

For complete details and prices please check your local dealer or write
Certified Welders L.A. City License #634
TRISTAO TOWER CO.
P.O. Box 115, Hanford, California 93230

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.

$9.95 - Cassette, $10.95

Epsilon [Records]
508 East Washington St., Arcola, Illinois 61910

Model 50 SPEECH PROCESSOR — OCR the average-to-peak ratio of the speech waveform as much as 8 db. using a logarithmic principle. Operates with FM, SSB and AM transmitters and transceivers. Low/High impedance Mic input. Two 9Vdc batteries provide a self-contained unit.

Model 60W (Processor + Amplifier) $26.50
Model 60K (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 trim base. Customize your fixed or mobile transmitter, receiver or transceiver 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 rig.

Model 20 5.5 MHz VFO range... $169.95
Model 20C (Collins).............. $169.95
Model 20D (Drake)............. $169.95
Options: 4 Digit Readout... $29.95
(Crystal Trim Base)........... $29.95

MODEL 11A PADDLE — Designed with reliability in mind. No mechanical switches or bearings to fail. Peddle contact spacing adjusted easily.

Model 11A (Assembled)......... $9.95

MODEL 10A ELECTRONIC KEYER — Has NEW features at no extra cost! Linear Speed Control and Operate/Tone Switch. Plus internal penlight cells and reset relay output provide a compact, portable, versatile unit.

Model 10A (Assembled)........ $33.95
Model 10AW (Keyer Assembled) $26.50
Model 10AK (Keyer Kit)........ $21.95
200-2K (Keyer Board Kit)..... $12.95
200-3K (Sidetone Board Kit) $4.95

REPUBLIC 40 SERIES TOWERS

THE MOST COMPLETE
EVERYTHING INCLUDED!

ANTENNA KIT

- Complete antenna system for the 2 meter band.
- Fully adjustable for maximum performance.
- Includes everything you need to get up and running.
- Designed to comply with new FCC requirements.
- Ask for flyer sheet.

DYNAMIC COMMUNICATIONS, INC.
948 Ave. "E" P.O. Box 10116
Riviera Beach, Fla. 33404 (305) 844-1323
What has feathers, a lot of class, and loves hams?

Why, the FLAMINGO of course.

SAROC
The Fun Convention
hosted by SOUTHERN NEVADA AMATEUR RADIO CLUB, INC. at
FLAMINGO HOTEL CONVENTION CENTER, LAS VEGAS, NEV. 89109 — JANUARY 3-6, 1974

ADVANCE REGISTRATION — $10.50 per person includes:
1. Special room rate of $15.00 plus room tax per night single or double occupancy, effective January 3 through 10, 1974 while 500 rooms last at the Flamingo Hotel.
2. Advance Registration drawing ticket for Saturday.
3. Regular Registration drawing ticket for Saturday.
4. Complimentary cocktail at the Flamingo Hotel.
5. Complimentary KENO ticket at the Flamingo Hotel.
6. Admission to technical seminars, meetings and exhibit area, Friday and Saturday.
7. Ticket for admission to cocktail party hosted by SAROC and HAM RADIO MAGAZINE, Friday.
8. Ladies who register will receive admission ticket for their program on Saturday.
9. Ticket for admission to cocktail party hosted by SAROC and SWAN ELECTRONICS, Saturday.
10. Ticket for Flamingo Hotel Buffet Hunt Breakfast with Champagne, Sunday.
11. Tax and Gratuity on all items 1 through 10 except hotel accommodations.

ADVANCE REGISTRATION with midnight show — $17.50 per person:
Includes all items 1 through 11, plus Flamingo Hotel Midnight Show and two drinks, Sandler and Young are scheduled in the Flamingo Hotel Main Show Room.

ADVANCE REGISTRATION with dinner show — $21.50 per person:
Includes all items 1 through 11, plus Flamingo Hotel Dinner Show (Entree: Brisket of Beef) no cocktails, Sandler and Young are scheduled in the main show room.

Advance registration must be received in SAROC, P. O. Box 73, Boulder City, NV 89005 on or before December 15, 1973. Refunds will be made if request in writing received in P. O. Box 73 on or before January 3, 1974.

SEVENTH NATIONAL FM conference Friday and Saturday, FM Hospitality Room 16/76, 28/88 and 34/94 repeaters. WCARS-7255 and WPSS 3952 special events stations to assist mobile operators.

Mail accommodations request to Flamingo Hotel, Las Vegas, Nevada 89109 — Do it now!
Mail Advance Registration fee to, SAROC, P. O. Box 73, Boulder City, NV 89005 — Before December 15
13-500 MOBILE 2-METER FM TRANSCEIVER. 15-watt, 12-channel with crystals for .16/.76, .34/.94, and .94/.94. Includes microphone and mounting hardware. 219.95

13-509 220 MHz FM MOBILE TRANSCEIVER. 10-watt, 12-channel with crystals for 223.00 MHz simplex. Includes microphone and mounting hardware. 209.95

13-520 2-METER FM HAND-HELD TRANSCEIVER. 2-watt, 6-channel with crystals for .16/.76, .34/.94, and .94/.94. Includes case with carrying strap. 209.95

MADISON ELECTRONICS SUPPLY, INC.
1508 McKinney Ave. — Houston, TX, 77002
713/224-2668
Nite/Weekend 713/497-5683

PROXIMITY SWITCH
MAGNETIC REED SWITCH. Normally open contacts. Magnet operates switch within 1⁄8 inch. (3 in. x 5⁄16 in. x 5⁄16 in.) Ideally suited alarm systems, doors, windows, etc. Prized at only 7 pair for $10.95.

8509-1 MEMORY DRIVER with B-7971 jumbo ALPHA-NUMERIC nixie tube $15.00 ea.
8910-1 4 Line 8-4-2-1 BCD IC DRIVER for B-5750 NIXIE less tube $5.50 ea.
8054-B 110 KHz BI DIRECTIONAL COUNTER for B-5991 NIXIE. Less tube. $5.50 ea.
8006 POLARITY DETECTOR MODULE for 8054 Counter. Drives B-5992 (+, −) NIXIE. Less tube. $5.50 ea.

ALL ABOVE PREPAID CONTINENTAL U.S.A.

WHY FIGHT QRM?
Win the battle against CW QRM with the new DE-101 using advanced integrated circuit design. Connect it between your receiver and high impedance earphones for a guaranteed superior CW reception. Operate your receiver the same way as before except now you discriminate against QRM. No adjustments, the DE-101 is factory tuned and complete with built in ac supply. One year warranty. 4" x 2½" x 6" $29.95 plus $2.00 shipping.

ATTENTION EXPERIMENTERS
Raise your printed circuits and breadboards with inexpensive 1⁄4 inch long plain metal spacers for a #4 screw. 30 for $1.00 postpaid.
Ala. residents add 5% sales tax.

DYNAMIC ELECTRONICS INC.
BOX 1131 DECATUR, AL 35601
ARRL

SOUTHWEST DIVISION

CONVENTION

OCTOBER 19-21, 1973

SHERATON-UNIVERSAL HOTEL,
NORTH HOLLYWOOD, CALIF.

• Shuttle Service To LA International and Hollywood-Burbank Airports
• Free Parking for 750 Cars
• Easy Access by Freeway
• Four Restaurants In Hotel
• Reduced Daily Room Rates
  One Person @ $19, $21, $24 or $26
  Two People @ $24, $26, $29 or $31
  Suites @ $50 And Up
• Universal Studio Tour Saturday @ 1:30 p.m.
• 3 Meeting Rooms Booked Solid with Technical Presentations
• ARRL Open Forum Saturday @ 3-5 p.m. with W2TUK, WLRW, WL1CP, etc. on Hand

PRE-REGISTRATION CLOSES OCTOBER 15, 1973

PRIZES GALORE

GRAND PRIZE: KENWOOD TS-900 WITH AC SUPPLY/SPEAKER
PRE-REGISTRATION PRIZE: TEN-TEC ARGONAUT WITH AC SUPPLY
BANQUET PRIZE

HOURLY DRAWING PRIZES
PROGRAM DRAWING PRIZES

Served BEEF BANQUET SATURDAY 7-10 P.M.

TICKET PRICES (Each):

<table>
<thead>
<tr>
<th></th>
<th>Pre-Reg.</th>
<th>Regular</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXHIBITS &amp; PRESENTATIONS ONLY</td>
<td>$4.50</td>
<td>$5.00</td>
</tr>
<tr>
<td>BANQUET ONLY</td>
<td>$8.50</td>
<td>$9.00</td>
</tr>
<tr>
<td>EXHIBITS, PRESENTATIONS &amp; BANQUET</td>
<td>$12.00</td>
<td>$13.00</td>
</tr>
</tbody>
</table>

Breakfasts and Luncheons for several special interest groups

More Details? CHECK—OFF Page 110
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.

2N1512 45 volt 170 watt PNP-G $1.00
2N3713 80 150 NPN-S 1.00
2N3773 160 150 NPN-S .75
2N3789 60 150 NPN-S .75
2N5301 40 200 NPN-S 1.25
2N5301 40 200 NPN-S 1.00

*Removed from used equipment

TRANSFORMERS
BRAND NEW, 115 volt AC input. OP-AMP XFMR, output: 16 VCT ½ amp, 17 VCT ¼ amp. $3.50

FILAMENT or BTRY CHARGER XFMR
output of 18 volts at 4.5 amp $3.50

Postage Extra on all Items

JOHN MESHNA JR. ELECTRONICS

IC SALE YOUR CHOICE 3 for $1.00
µ1 900 BUFFER TO-5
µ1 914 DUAL 2 INPUT GATE TO-5
µ1 923 JK FLIP FLOP TO-5
µ1 926 Hi speed JK FLIP FLOP TO-5
µ1 931 JK/RS FLIP FLOP (DIP)
10 pin socket for TO-5 IC $3.10

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

COMPUTER TAPE DECK $75.00

LASER DIODES, new listing just arrived, send SAE.

P. O. Box 62 E. Lynn, Mass. 01904

WE PAY HIGHEST PRICES FOR ELECTRON TUBES AND SEMICONDUCTORS

H & L ASSOCIATES
ELIZABETHPORT INDUSTRIAL PARK
ELIZABETH, NEW JERSEY 07206
(201) 351-4200

(1) 6600 66 Ft 75 Thru 10 Meters, Model 75.10HD $60.00
(2) 6600 66 Ft 75 Thru 20 Meters, Model 75.20HD $50.00
(3) 6600 66 Ft 75 Thru 40 Meters, Model 40.20HD $43.00
Model 80-40HD $42.00

ORDER DIRECT OR WRITE FOR FULL INFORMATION
300H Shawnee
Leavenworth, Kansas 66048

More Details? CHECK-OFF Page 110
NEW

- 1-2 WATTS IN
  15 WATTS PLUS OUT
- SOLID STATE
  SWITCHING
- 12-14 VOLTS
  NEGATIVE GROUND
- LESS THAN 1dB
  LOSS ON RECEIVE

PA-1501 H
Wired and Tested
$49.95 $39.95 complete kit

NEW — 10 CHANNEL SCANNER  $14.95
works on any receiver — less crystal deck

NEW — 10 CHANNEL CRYSTAL DECK  $6.95
with diode switching

NEW — COR  $19.95
with 3 min, 3 sec timer

NEW — 6 METER FM RECEIVER  $59.95
with crystal filter

Also available:
- RX 144/220 A  $59.95
- RX 144/220 F w/Ceramic filter  $65.95
- RX 144/220 C w/Crystal filter  $69.95
- TX-144  1 Watt Exciter $29.95
- TX-220  1 Watt Exciter $29.95
- PA 144/220 15 Watt Amp less cabinet connectors & switching $29.95
- PA-8005 H 60—90 Watt Amp 5 Watts in $159.95
- PA-8020 H 60—90 Watt Amp 25 Watts in $129.95

Add $1.00 shipping per kit ordered. New York Residents add sales tax.
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: ±0.005% accuracy
- Stable Low Drift Outputs: 20 Hz per degree C typical
- Full 2 Meter Band Coverage: 144.00 to 147.99 MHz, in 10KC steps
- Fast Acting Circuit: 0.15 second typical settling time
- Low Impedance (50 ohm) Outputs: Allow long cable runs for mobiles
- Low Spurious Output Level: Similar to crystal output

SEND FOR FREE DETAILS

Rp Electronics

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

RADIO TRANSMITTER
PRINCIPALS & PROJECTS
BY ED NOLL, WJFQJ
This new volume by a popular HAM RADIO author covers both the basics and the advanced side of radio transmitters. CW, AM, SSB & FM — Transistors and Tubes. They're all in this useful new book:

320 pages $6.95

RCA RF POWER TRANSISTOR MANUAL
Covers the use of power transistors in a variety of power-circuit applications from the VHF range to well within the microwave region. Includes design examples and performance data for power amplifiers, oscillators, and frequency multipliers designed for use in a wide range of applications.

176 pages $2.50

RCA LINEAR INTEGRATED CIRCUITS
Explains the basic principles involved in the fabrication, design and application of linear integrated circuits. Covers the operation and application of RCA linear integrated circuits and detailed ratings and characteristics data.

416 pages $2.50

comtec BOOKS
Greenville, New Hampshire 03048
YAESU FT-101
now with 160 meters
SEE WILSON
for your Yaesu products
FTDX 401 Transceiver
FL2100 Linear Amplifier
FL2000B Linear Amplifier
Interested in trading Tempo One's
and other Yaesu equipment.

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

NEW - 440 MHz PREAMPS
$54.95

POSTPAID
432PA-1
Two stage preamps use KMC Bipolar and Mos- 
fet Transistors. 20db gain, 20 MHz bandwidth. 
These are high quality preamps suitable for the 
most demanding applications. AC models have 
the case case, others have metal enclosure.
432PA 3.5db NF 12VDC $29.95
432PA-1 3.5db NF 117VAC $45.95
432PC 1.5 to 2.0db NF 12VDC $45.95
432PC-1 1.5 to 2.0db NF 117VAC $49.95
Write for our new catalog.
JANEL
P. O. BOX 112
SUCCASUNNA, N. J. 07876
201-584-6521

GROTH - Type
COUNTS & DISPLAYS YOUR TURNS
- 99.99 Turns
- One Hole Panel Mount
- Handy Logging Area
- Spinner Handle Available

CASE: 2x4"; shaft 1/4"x3" MODEL TC2: Skirt 2 1/4"; Knob 1 1/2"
MODEL TC3: Skirt 3"; Knob 2 1/4"

R. H. BAUMAN SALES
P.O. Box 122, Itasca, Ill. 60143

NATIONAL MOS
CT500S
7400 TTL
DIP
7400 - 1.35
7403 - 1.35
7405 - 1.35
7407 - 1.35
7409 - 1.35
7411 - 1.35
7413 - 1.75
7414 - 1.75
7415 - 1.75
7418 - 1.75
7419 - 1.75
7423 - 1.75
7424 - 1.75
7425 - 1.75
7427 - 1.75
7435 - 1.75
7440 - 1.75
7464 - 1.75
7470 - 1.75
7474 - 1.75
7481 - 1.75
7485 - 1.75
7490 - 1.75

7400 TTL DIP
7400 - 1.35
7403 - 1.35
7405 - 1.35
7407 - 1.35
7409 - 1.35
7411 - 1.35
7413 - 1.75
7414 - 1.75
7415 - 1.75
7418 - 1.75
7419 - 1.75
7423 - 1.75
7424 - 1.75
7425 - 1.75
7427 - 1.75
7435 - 1.75
7440 - 1.75
7464 - 1.75
7470 - 1.75
7474 - 1.75
7481 - 1.75
7485 - 1.75
7490 - 1.75

Interested in trading Tempo One's
and other Yaesu equipment.

NEW - 440 MHz PREAMPS
$54.95

POSTPAID
432PA-1
Two stage preamps use KMC Bipolar and Mos- 
fet Transistors. 20db gain, 20 MHz bandwidth. 
These are high quality preamps suitable for the 
most demanding applications. AC models have 
the case case, others have metal enclosure.
432PA 3.5db NF 12VDC $29.95
432PA-1 3.5db NF 117VAC $45.95
432PC 1.5 to 2.0db NF 12VDC $45.95
432PC-1 1.5 to 2.0db NF 117VAC $49.95
Write for our new catalog.
JANEL
P. O. BOX 112
SUCCASUNNA, N. J. 07876
201-584-6521

GROTH - Type
COUNTS & DISPLAYS YOUR TURNS
- 99.99 Turns
- One Hole Panel Mount
- Handy Logging Area
- Spinner Handle Available

CASE: 2x4"; shaft 1/4"x3" MODEL TC2: Skirt 2 1/4"; Knob 1 1/2"
MODEL TC3: Skirt 3"; Knob 2 1/4"

R. H. BAUMAN SALES
P.O. Box 122, Itasca, Ill. 60143

Many thousands of you have become 
very familiar with the various 
Radio Society of Great Britain 
books and handbooks, but very 
few of you are familiar with their 
excellent magazine, Radio Com- 
unication.

It includes numerous technical 
and construction articles in addi 
tion to a complete rundown on 
the month's events in amateur 
radio. Surely a most interesting 
addition to your amateur radio 
activities.

We can now offer this fine maga 
zine to you along with the other 
advantages of membership in the 
RSGB (such as use of their out 
going QSL Bureau) for $12.95 a 
year.

comtec
Greenville, New Hampshire 03048

More Details? CHECK—OFF Page 110
the most powerful antennas under the sun!

The Best Vertical There IS!
80 through 10 meters

# hy-gain 18AVT/WB

New, from the inventors of wideband verticals.
Pack some punch! All the omnidirectional performance of Hy-Gain’s famous 14AVQ/WB...plus 80 meter capability! Unrivaled performance, rugged extra heavy duty construction, and the price you want...all in one powerful package!

- Automatic switching on all five bands through the use of three beefed-up Hy-Q traps...featuring extra large diameter coils for exceptional L/C ratio and extremely high Q.
- Recessed coax connector furnished.
- Top loading coil and four element static hat.
- Constructed of extra heavy wall high tensile aluminum.
- Hot performance all the way across the band with just one setting (10 through 40).
- Hy-Q traps effectively isolate antenna sections for full 1/4 wave resonance on all bands.
- No dissimilar metals to cause noise.
- SWR 2:1 or less at band edges.
- Maximum legal power with low frequency drift.
- Exceedingly low radiation angle makes DX and long haul contacts a cinch...whether roof or ground mounted.
- Very low RF absorption from insulating materials.

The 18AVT/WB is constructed of extra heavy duty, taper swaged, seamless aircraft aluminum with full circumference, corrosion resistant compression clamps at all tubing joints. This antenna is so rigid, so rugged...that its full 25' height may be mounted using only a 12" double grip mast bracket...no guy wires, no extra support...the 18AVT/WB just stands up and dishes it out!

Order No. 386 $79.95

Get the strength, the performance and the price you want...from the man who sells the complete line of quality Hy-Gain equipment.

HY-GAIN ELECTRONICS CORPORATION
Dept. BK, 8601 Northeast Highway Six Lincoln, NE 68507
402/434-9151 Telex 48-6424

More Details? CHECK—OFF Page 110
You're about to pass up bargains on Northwest Florida's newest and fastest growing dealer.

REGENCY HR-2MS ............................................. $319.00
REGENCY HR-212 ............................................. $259.00
REGENCY HR-220 ............................................. $239.00
HYGAIN TH6DXX ............................................. $179.95
HYGAIN 204BA ................................................ $149.95
GALAXY GT-550A ............................................. $595.00
HALLICRAFTERS SR400A ..................................... $995.00
HALLICRAFTERS FPM300 ..................................... $955.00
ICOM IC-20 ..................................................... $299.00
ICOM IC-21 ..................................................... $399.00
ICOM IC-22 ..................................................... $279.00
GLADDING 25 ................................................. $249.95
GENAVE GTX-10 .............................................. $199.95
GENAVE GTX-200 ............................................. $259.95
STANDARD 146A .............................................. $289.00

Drop me a line for those unadvertised extras

GOLDSTEIN'S
P. O. BOX 3561
PENSACOLA, FLA. 32506
Phone 904-455-2533

SB-144 2 meter FM TRANSCEIVER

12 CHANNEL 10 WATT 2 METER FM TRANSCEIVER COMPLETE
WITH 3 SETS CRYSTALS
MICROPHONE, MTG. BRACKET
List 259.95 Your Cost 199.95 FOB Houston

MADISON ELECTRONICS SUPPLY
1508 McKinney Ave. • HOUSTON, TEXAS
713/224-2668
If you like 2 METER...

YOU'LL LOVE OUR

ALL NEW

HR-2B

NARROW BAND FM TRANSCEIVER

15 OR 1 WATT POWER OUT/SWITCH SELECTABLE / FULL 12 CHANNEL TRANSMIT AND RECEIVE CAPABILITY

You'll like the crystal clear transmit and receive performance of this compact, 2 meter unit and so will those listening. The 12 transmit channels are provided with individual trimmer capacitors for the optimum in point-to-point and repeater applications. A HI/LO power switch provides 1 watt output or full rated output. The receiver has an audio output of 3 watts at excellent sensitivity. Solid state, American made quality at a low price.

$229.00 AMATEUR NET

includes plug-in ceramic mike, mounting bracket and transmit and receive crystals for 146.94 MHz.

THE FM LEADER IN 2 METER AND 6 METER... AND NOW 220 MHz
MISC.
Scanacmat High Band 8 channel scanner Write Kenwood Trng. R-599 & T-599. Receiver and transmitter. Regular net $818 for both. Excellent, guaranteed good as new $618.00
Henry 2K-4 Floor Model. mint. Write U.S. Callbooks $8.95
DX Callbooks $6.95
Radio Handbooks latest 19th edition $14.95
Radio Handbook 18th Edition $8.95
Lafayette Telsat-SSB 25, Sideband CB Rig Write Gonet 503A 2 meter amplifier. 5 watts input, 50 watts output. New cond. $375.00
HQ-180 with clock. Mint condition, professionally calibrated. Write
Mullen magnetic shields for 3" C.R. scope tubes with brackets Brand new $6.95 TP-9 similar to EE-8 field telephone with built-in amplifier. Up to 50 mi. Less easily obtained $99.00
115 Volt AC Power Supply for BC-221, slips into battery compartment. Also can be used with LM FEQ, meters $29.50
ALUMINUM DIE CAST BOXES in many different sizes. Doxy boxes. Details in New Green Sheet No. 23. Write for latest prices.
2 METER VHF DUMMY LOAD/WATTMETER Good up to 15 watts w/SO-239 CONNECTOR and 30 METER $15.95
Jackson G80 brass 50:1 anti-backlash dial drive 1/4" to 1/4", $19.00 value $5.50

INOUIC IC-22
2 Meter Transceiver
10 WATTS OUTPUT PLUS TREMENDOUS RECEIVER
22 CHANNELS
Ready to go with crystals for 5 frequencies at no extra charge $289.00
Extra Crystals $6.95 each
IC-3PA Power Supply $99.00
$89.00 when purchased with IC-22

BARKER & WILLIAMSON
Little Dipper, GDO Dummy Load/Wattmeters - 520 $94.50
333 DC-300 MHz, 5, 50, 125 or 250 watts int. $79.95
334A DC-300 MHz, 1000 watts $139.95
374 DC-300 MHz, 1500 watts int. $169.95
850A, 852 Inductors $39.95
851 Inductor 29.95
425 Low Pass Filter, 10-80 watts $24.95
210 Audio Osc., ideal for lab & broadcast $329.95
410 Distortion Meter, ideal for lab & broadcast $369.95
AM-141 Amplifier, 2000 watts RF output, continuous 21-18 MHz, complete with coils and 833-A's. Built-in 115 VAC Supply, unused. $950.00

STANDARD
SRC-146A 2 meter handheld transceiver $289.00
SBE SBE-450 TRC, use with 10 watt, 2 meter transceiver to operate on 450 $195.00

LITTLE LULU
6 Meter AM Transmitter with VFO
12 VDC/115 VAC Power Supply
Available factory wired or as parts
Write for details

INVERTER/CONVERTER:
INVERTER, 12 volt DC input, 115 volt AC output. Model 12-115 solid state power supply, 200 watts continuous. New $59.95

TELEX
610-2 Deluxe Economy 2000 ohm headset with cushions $9.95
EN-9 Stereo Headphones $9.95

572B Tube Headquarters. Diversified Stock.
Heavy inventory of Elmac tubes, chimes, sockets, etc. $17.50

BARRY HAS ANTENNAS
C.D. HAM "M" ROTATORS, new complete $99.95
CD Ham-M for 220 VAC in stock $175.00
C.D. TELEPHONE ROTATORS, new (complete) $63.95
CABLE for Ham-M & TR-44 @ 14c/ft.
CD AR-22R complete rotator for small beams $33.95
BNB6 Balun by HyGain $14.95
RG-8A/U 100 ft. rolls. VHF connector PL-239 $259.00
one end Type "N" (UG-21E/U) other end $12.50
RG8A/U 65 feet with PL-239 connectors on each end $9.50
Wire & Cable T-4-50 (FM-8) 50 ohm lowest loss type RG-8 cable $25.00/ft.
Columbia Superflex, RG-8A/U 50 ohm high quality foam $17.00/ft.
Coaxial adapter for VHF to RG-17 (Amphenol 83-86) RG-17 plug to VHF female connector $6.95

BNC to RG-17 adapter UG-167C/U $7.95
B & W Vacationer apartment house antenna, 2, 6, 10, 15 & 20 meters. Hang out your window. Take along on your vacation $24.95
Authorized factory dealers for Antenna Specialists, CushCraft, Gam, Heights Towers, Hy Gain, Mor-Gain Antenna, Mosley, Newtonics, Tri-Ex, Rohn, C & W, Times Wire, Telrex.
Cush-Craft Trick Stick, universal dipole, 10-2 meters, 1.5 dB gain at 146 MHz $8.95
English Ultra Balun, low dielectric $9.95
RINGO AR-2 3.75 dB gain, 135-175 MHz $12.50
BBLT-144 Trunk Lip, 3.75 dB gain $34.95
Newtonics CG-144 mobile 5.2 dB gain $37.95
Quick Disconnect by Newtonics for CTC, etc. $10.95
CG-1 Gutter Clip by Newtonics $1.25
2M MAGNETIC MOUNT w/RG-58 & PL-259 $10.95
with 10 ft. RG 58 ready to go $9.95
14AVQ/WB VERTICAL $47.95
18AV/WB VERTICAL $69.95
HY GAIN 2 METER, 15 element beam demo, $35.00

CASH PAID . . . FAST! For your unused TUBES, Semiconductors, RECEIVERS, VAC. VARIABLES, Test Equipment, ETC. Write or call Now! Barry, W2LN1. We Buy! We ship all over the World.

Send for Green Sheet Supplement 23.
Send 50¢ postage & handling (refund 1st order).
TELETYPEWRITERS - Active Hams - Monthly mailer of reconditioned and Repeater Association, is having its annual.

WESTERN UNION DESK-FAX Telefax Transceivers: and new equipment specials. Sell - Buy - Trade.

STILL HAVE A FEW LEFT! We have a few of the invited to attend. Gates than $49.95. Also low noise receiver.

WE BUY ELECTRON TUBES, diodes, transistors. Simply brush on. 6 liquid ounces plates 1800 square inches copper - brass. Durable. $6.50, Abear Research, 11118 Parker, Mokena, Illinois 60448.


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


THE NORTHWEST GEORGIA Amateur Radio Club and Repeater Association, is having its annual hamfest on Sunday, October 7, 1973 at the Coosa Valley Fair Grounds in Rome, Georgia. Everyone is invited to attend. Gates open at 9:00 a.m.


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

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

STILL HAVE A FEW LEFT! We have a few of the

HAVE A FEW LEFT! We have a few of the

BRAND NEW deluxe equipment enclosures left. See our ad on Page 89 of the July 1973 Ham Radio.

DX'ers — New Logarithmic Speech Processor. Nominal 8 dB increase in average power. Less than 5% distortion @ 1kHz, L/C filter, Hi-Z Meter. $49.95. Also, low noise dual gate MOSFET receiver preamplifier. Nominal 20 dB gain, 10-30 MHz. $39.95. With cabinets, Dynamomm, 1183 Wall Road, Webster, N. Y. 14580.

WE BUY ELECTRON TUBES, diodes, transistors, integrated circuits, Semiconductors. Astral Electronics, 150 Miller Street, Elizabeth, New Jersey 07207, (201) 354-2420.

WESTERN UNION DESK-FAX Telefax Transceivers: Several extra machines (checked out), $14 each, shipping collect. Bill Johnston, 1808 Pomona Drive, Las Cruces, New Mexico 88001.

WORLD QSL — See ad page 105.

EMBROIDERED EMBLEMS AND PATCHES. Custom made from your design. 10 to 1000's. Write Russell, 1109 Turner St., Augusta, Maine 04821.

MULTI ELMAC PKG. (HF68, PMR88, PS1070). $150.00; Heath 6M SSB pkg. (SB110A, PS123A, PS134A, SB150), $325.00; Heath Spectrum Analyzer S2590, Hy-Gain HM-801, Hy-Gain 6M 6 el. beam, $30.00. All equipment even the beam, absolutely mint, with manuals and cables, you will despine with 150 miles. Prices not firm, make offer. Dan Roe, W8JSR, 24644 Madison Ct., Apt. #227, Farmington, MI., 48024. Phone 1-313-477-4846.

WANTED, RD 92/UX; fax recorder. Need several mechanical drum subassemblies. Don W1GGO, Box 803, North Fairdale, Mass. 02556.


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

AUCTIONEER — KBCOT. Bring Action By Auction.

CANADA'S MOST UNUSUAL Surplus and Parts Catalog. Jam packed with bargains and unusual items. Send $1. ETCO-HR, Box 741, Montreal, Canada.

MFJ-235QS or lethal chemicals. Simply brush on. 6 liquid ounces plates 1800 square inches copper - brass. Durable. $6.50, Abear Research, 11118 Parker, Mokena, Illinois 60448.


FREDAN can't stand it without you! You can use my transceiver! Meet me at the Memphis Hamfest on October 7th and we'll go home together. Herb

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

"DON AND BOB" NEW GUARANTEED BUIYS. Discount prices plus full warranty. Write for few prices of following: Micronat TH6DXX, TH3MK3, 204BA, DB1015A, 402BA; Mosley CL33, CL36, S402; Triex tower MW50, MW65, W51 (FOBCal); Clegg FM7; Hustler HR12, HR150, HR12 2W 150W HR2A, HR2B, SBE144 199.95; SBE450 TRC converts 2CM/3-4M (179.95) 149.00. Standard 826MA, 146A; Ham-M 99.00; TR44 59.95; AR22 31.95; Belden 14488 rotor cable 10/ct; 8214 RGB foam 17/ct; 8237 RGB/U 15/ct; Amphenol PL259 499; Hallicrafters FPP300 demos, need factory warranty repair 4500 ea; Used guaranteed — Collins 754A 345.00; Kenwood R599 300.00; T599 350.00 Hammarlund HQ180 250.00; Heath SB300 250.00; write quote, Swan, Eimac, Rohm power: 3/16" cable clamps; Motorola HEP170 epoxy dioxide 2.5/1000PV 29e, 25.00/100 jolt; hardbound technical magazines from Petrochemical library; 3.00 yr write: remembers; 1972 Radio Masters 3.50; Motorola semiconductor data series 7.50; Calrad KW du=wave power rectifier 1000W 50.00; MOT MC1709C OPAMP (709) T05 39; write quote items not listed.

Shipping charges collect. Madison Electronics, 1508 McKinney, Houston, Texas 77002.

FOR SALE CIE First Class ,Course with answers, $22.82. IQ/2400 MHz. Warranty perfect. [CANADA'S MOST UNUSUAL Surplus and Parts Catalog. Jam packed with bargains and unusual items. Send $1. ETCO-HR, Box 741, Montreal, Canada.]
DIGITUALLY-TUNED RECEIVERS:

R-389/URR: 15-1500 kHz, OK gridd, w/book ........................................... 375.00
R-390: 0.2-32 MHz, OK gridd, w/oper. book ........................................... 495.00
R-390A adds mech. filters, w/oper. book ........................................... 525.00
AN/WRR-2: 2-32 MHz, OK gridd, w/book ........................................... 750.00

CV-591A SSB Conv., 455 kHz, OK, w/book ........................................... 137.50
Nems-Clarke #1670 FM rcvr 55-260 MHz w/book ........................................... 195.00
OCT-3 TTY FSK deviat. meter/rcvr, new ........................................... 49.50
WWVB 60 kHz rcvr/comparator OK, w/book ........................................... 295.00
Mot. 3 MHz osc., 5 parts in 10 to eleventh ........................................... 199.50
AIL 30 MHz cvr/ampl/atten. calibrator ........................................... 99.50

HIGH-SENSITIVITY WIDE-BAND RECEIVER

COMMUNICATIONS • BUG DETECTION

SPECTRUM STUDIES

38-1000 MHz AN/ALR-5: Consists of brand new tuner/ converter CV-253/ALR in original factory pack and an exc. used, checked OK & gridd main receiver R-444 modified for 120 v. 50/60 Hz. The tuner covers the range in 4 bands: each band has its own Type N Ant. input. Packed with each used, checked OK

38.1000 MHz tuner is the factory inspector's checkout sheet. The one we used, checked OK.

AVC position; Pan., Video & AF outputs; switch select pass of ±200kHz or ±2 MHz and SELECT AM or FM! With Handbook & w/oper. input plug, all only ........................................... 375.00

30 MHz PANADAPTOR OK gridd ........................................... 295.00

Attention!

Buyers, Engineers, advanced Technicians: We have the best test-equipment & oscilloscope inventory in the country for sale. Ask for our needs ... 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

MODEL “A” Frequency Counter Price $299.00

10Hz to 80 MHz (±1 Hz) Direct Count guaranteed (1Hz to over 100MHz) typical
RI Out: 5 digits
LED Range Sensitivity: Less than 100 millivolts over entire range.
Power Req.: Either 120 VAC or 12 VDC 15 watts approx.
Small Size: 2.34” x 5.68” x 8.18”
Overload protected input and DC power input.

MODEL “A” Frequency Counter Price $375.00

Exactly as above plus an internal 250MHz Scaler (±10Hz to well over the guaranteed frequency of 250MHz.) No external power is required.
Shifting DECIMAL POINT gives a DIRECT READOUT of VHF Frequencies.
One BNC INPUTS for both ranges. No cable changing from HF to VHF.
(CA residents add State Sales Tax)
Dealer inquiries invited

ELECTRONICS
P. O. BOX 1672
VISTA, CA. 92083
714-726-1313

Special Purchase Sale
$1895*

Last chance to buy
latest series CX7A.

90 day warranty by dealer.

complete parts inventory available

*5% discount for no-trade in sale

Phone/write Don Payne, K4ID
for a King-Size trade on your gear

PAYNE RADIO
BOX 525
SPRINGFIELD, TENN. 37172
Days
(615) 384-5573
Nites
(619) 384-5643

BARGAINS!

KLEINSCHMIDT TELETYPE EQUIPMENT

(1) TT-100 PAGE PRINTER, AS IS 60 OR 100 WPM ........................................... 599.95
(2) TT-117 PAGE PR OR (B) TT-179 REPERF & TD, AS IS ........................................... 599.95
(3) ABOVE CHECKED OUT, OILED & ADJUSTED EA ........................................... 895.00
(4) TABLE $199.95 (C) TABLE $349.95 (D) COPYHOLDER $39.95
(5) PAPERWINDERS $149.95 (6) TT-107 REPERF ONLY ........................................... 499.95
TH-5 CONVERTER TRANS/REC 100 CYCLES ADJUST TO 170 SHIFT $49.95

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

MINIATURE SUB-AUDIBLE TONE $14.95
ENCODER Tested

- Compatible with all sub-audible tone systems such as
  Private Line, Channel Guard, Quiet Channel, etc.
- Glass Epoxy PCB, silicon transistors, and tantalum
  electrolytics used throughout
- Any miniature dual coil contactless reed may be used
  (Motorola TL-N6824A, TL-N6709-B — Branco RF-20)
- Powered by 10vcc @ 3ma
- Use on any tone frequency 6kHz to 250Hz
- Miniature in size 2.5 x 75 x 1.5” high
- Complete with Reed $28.45 (Specify Freq.)
- Output 3v RMS sine wave, low distortion
- Postpaid — Calif. residents add sales tax

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

More Details? CHECK—OFF Page 110
TREASURE COAST HAMFEST — Vero Beach, Florida, March 9 & 10, 1974. Details from WADDP.


ROCHESTER NY 1974 WNY hamfest dates are May 17 and 18. Exhibitors: space reservations now being accepted. WNY Hamfest, Box 1388, Rochester, N. Y. 14603. 

MANUALS for most ham gear made 45/65, some earlier. Send SASE or copy quota for info. WOJJK, Box 864, Council Bluffs, Iowa 51501.

DO-IT-YOURSELF EXPEDITION — Stay at ZF1SB — Cayman Is. Vertical antenna and Caribbean at your doorstep. Diving/fishing if band folds. We arrange license. Write Spanish Bay Reef Resort, Box 800K, Grand Cayman, B. W. I.

TELETYPewriter PARTS, gears, manuals, supplies, tape, toroids, SASE list. Typtronics, Box 8873, Ft. Lauderdale, Fl. 33310. Buy parts, late machines.

PRECISION HAND TOOLS, special ham-experimenter discount. Letter brings mailings, Artisan Tool Company, Box 36, Glenmont, New York 12077.


THE AMATEUR TELEVISION ASSOCIATION promotes interest and experiments in amateur video communication. The association is non-profit, organized by amateur engineers and based on voluntary cooperation. It publishes a quarterly, mainly technical magazine in English, "ATA International". Membership fee is five dollars a year, payable to: Kreidtbank No. 4464-51520 GHENT ATA vzw, Hullenkensstraat 7, 9831 Deurle, Belgium.

WANT TO BUY ship's chronometer or navigational watch for shack. Ted Denton, 3279 Ledgewood Drive, Los Angeles, California 90068.

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

QSLS, SECOND TO NONE. Same day service. Samples 25¢ Ray, KTHLR, Box 331, Clearfield, Utah 84015.


STANDARD 146-A still in factory carton with warranty card, $238.70. W4AOQ, Box 17222, Nashville, Tenn. 37217, (615-834-8899).

PT 300 with 4 channel factory deck & new nicad including charger, tuned to 34/94, 22/82, 34/94, 76/36, $350. We have new warranty. $295. Cliff Fleury, Lewis, N. Y. 12590, 518-873-2054.

FOR SALE, COLLINS CRYSTAL FILTERS 5 MHz, BW9 kHz. $5.00 each. Wanted new 4CX250B. Henry Ingwersen, 33 Jewett Street, Georgetown, Mass. 01833.

WANTED: tubes, transistors, equipment, what have you! Bernard Goldstein, W2MNP, Box 257, Canal Station, New York, N. Y. 10013.


SIGNAL ONE OWNERS, expert and prompt service by ex-Signal/One engineer. Write or call for details. Larry Pace, K21XP, 7071 W. Roller Coaster, Tucson, Ariz. 85704 (602-888-5234).

TONE-LOGIC Educational Systems for WWV, SSTV, RTX. Eight 21°C x 3" PCB's, plans, $3. Hornung, Box 24614, San Jose, Ca. 95154.

More Details? CHECK-OFF Page 110
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 (wire 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 clicker 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; volume, 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.*

TOP QUALITY...WITH THE HAL RKB-1 RTTY KEYBOARD. Gives you typewriter-easy operation with automatic letter/number shift at four speeds (60, 66, 75, and 100 WPM). Use with RVD-1002 video display system, or insert in loop of any teleprinter, for fast and easy RTTY. Completely solid state, TTL circuitry using G10 glass boards, regulated power supplies, and transistor loop switch. RKB-1 assembled, only $275.00.*

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 available.

*Above prices do not include shipping costs. Please add 75¢ on parts orders, $2.00 on larger kits. Shipping via UPS whenever possible; therefore, street address required.

HAL COMMUNICATIONS CORP., Box 365 H, Urbana, Illinois 61801
International Electronics Unlimited

MOVING SALE

10% OFF - ANY ITEM - ANY QUANTITY

TTL
4700 .25 7443 1.25 7493 1.05
4701 .25 7444 1.30 7494 1.10
4702 .25 7445 1.25 7495 1.05
4703 .25 7446 1.45 7496 1.05
4704 .26 7447 1.45 7497 1.05
4705 .27 7448 1.50 7492 1.15
4706 .55 7450 2.90 7491 1.25
4707 .27 7451 3.22 7498 1.25
4708 .27 7452 3.29 7499 1.25
4709 .29 7453 3.42 7493 1.45
4710 .25 7454 3.61 7494 1.50
4711 .35 7455 3.75 7491 1.50
4713 .35 7457 3.85 7493 1.50
4720 .25 7458 4.50 7497 1.55
4723 .34 7459 4.62 7496 1.60
4725 .39 7467 4.95 7494 1.65
4730 .25 7483 1.25 7475 2.95
4732 .30 7485 1.40 7471 4.50
4739 .50 7486 1.69 7492 1.65
4740 .25 7489 3.25 7493 1.65
4741 .25 7490 3.25 7494 1.65
4742 .15 7492 1.05 7495 1.15

LOW POWER TTL

L74L0 1.40 74L42 .80 74L85 1.25
L74L2 1.40 74L51 1.50 74L86 1.95
L74L7 1.50 74L60 1.65 74L84 1.35
L74L10 1.40 74L72 .60 74L93 1.75
L74L16 1.40 74L73 .80 74L93 1.75
L74L16 1.40 74L74 .80 74L93 1.75
L74L30 1.40 74L78 .80 74L164 2.95

8000 SERIES

8006 .60 8123 1.75 8810 9.95
8092 .80 8214 1.95 8810 9.95
8093 .80 8280 1.95 8831 9.95
8094 .60 8520 1.45 8836 1.25
8095 .60 8551 1.95

LINEAR

LM301 T05 .45 LM311 T05 1.25
LM302 T05 .95 LM380 Dip 1.75
LM304 T05 1.25 LM709 T05-Dip .95
LM308 T05 1.75 LM723 Dip .75
LM309K T03 1.95 LM741 Dip .45
LM309H T05 1.25 LM747 Dip .95

PHASE-LOCKED LOOP

MEMORIES with data
NE565 2.45 8213 1.95
NE566 2.95 1103 7.95
NE567 2.95 7489 3.25
NE568 2.25 8223 5.95

CALCULATOR CHIPS

5001 LSI (40 pin) Data supplied with chip 6.95 ea.
Data only-Refundable w/purchase 1.00 ea.
5002 LSI (40 pin) for battery power Data supplied with chip 8.95 ea.
Data only-Refundable w/purchase 1.00 ea.
5005 LSI (28 pin) four function memory Data supplied with chip 10.95 ea.
Data only-Refundable w/purchase 1.00 ea.

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 3 days after receipt. Please add $0.50 per spec sheet for items priced at less than $1.00 ea.

INTERNATIONAL ELECTRONICS UNLIMITED
P. O. BOX 1708H
MONTEREY, CA 93940

MOTION CITY HAMFEST — October 21 — Lock Park, near Opryland USA in Nashville, Tennessee. Many activities planned with drawing for prizes at 3 p.m.

WANTED: Tube testers. Also, used or reconditioned equipment. For more information call (800) 222-2575.

More Details? CHECK—OFF Page 110

October 1973 103
THE KW2000B transceiver
with speaker and power supply
-60-100 meters
-80 watts PEP
-MAUX VO
-available
-built-in VOX
-cw side tone
-Variable pitch filter
-Crystal controlled first mixer
-velvet-smooth two-speed VOX tuning

KW Electronics $699
55 Bridge St., Pittsburg NY 2901
in Canada 220 Dolomite Dr
Downview Ont. M3J 2P8

BEST SELLERS - STOCKS REPLENISHED
FANS and BLOWERS, ABSOLUTELY NOISELESS.
100 CFM ROTRON Muffin Fan Motor 14w. 2" dia. x 1 1/4" deep. 3 plastic rubber fan blades. 4 thin, plastic mounting strips, 2" long, 5/16" mounting holes. Metal shroud removed. NO HOUSING. UNUSED. 2 lbs. $18.50; ea. $5.00
50 CFM FAN. Howard 4 shaded pole, PM brushless motor: 12w.; 2 3/4" x 2 3/4" x 2 3/4", including 4 nyl blades 4" dia. 3 lbs. $8.50; ea. $2.25
50 CFM BLOWERS. Motor, as above but 16w. 2 1/4" sq. x 1 1/2" x 1 1/2" for impeller. Housing 3 1/2" dia. input hole 1 1/2" dia. output hole 1 1/4" x 1 1/4". 4 lbs. USED. tested good.
$13.50; ea. $3.50
JOHNSON #152-804, dual section, variable. 37-305 pf/sec. 7 KV (.185" spacing); split stator. 5 1/4" x 5 1/2" x 16 1/4" + 2" for dual 1/4" shafts. Has 401 r. angle size. 15 lbs.
$431.00; ea. $8.50
PI-NET output, variable. 5 gang. 402 pf/sec. total 2010 pf. Will load 1 KW, to 160 meter, without inductance. Shaft 3/4" x 1 1/2". 3 lbs. Take-outs, excellent.
$411.50; ea. $3.00

PLEASE - include sufficient to cover postage.
Any excess remittance will be returned.
1973 FLYER, included free with all orders. All others - SELF ADDRESSED STAMPED ENVELOPE required.

BC ELECTRONICS - c/o BEN COHN
Store at 6696 N. Ridge Ave, Chicago, Illinois 60660.
Hours - Wed. 11:30 a.m. to 2:30 p.m.; Sat. 10:00 a.m. to 2:30 p.m. Other times by appointment only.

MAILING ADDRESS
1249 W. Rosedale Ave., Chicago, Illinois 60660
Phones - 312-334-4463 & 784-4426

FM Schematic Digest
A COLLECTION OF MOTOROLA SCHEMATICS:
Alignment, Crystal, and Technical Notes covering 1947-1960
136 pages 11 1/2" x 17" ppd $6.50
S. Wolf
P. O. Box 535
Lexington, Massachusetts 02173

GROUNDED GRID AMPLIFIER FILAMENT CHOICE
MODEL FC-30US: A dual choke for 20-30 Ampere filaments in 3-30 MHz amplifiers. A classic design proven and used by thousands. Wound on a 7" ferrite rod with No. 10 AWG wire. Ready to install. With instructions.
MODEL FC-30US $4.50 ppd. U.S.A.
MODEL FC-305 $6.95 ppd. U.S.A.

K.E. Electronics
Box 1279, Tustin Calif. 92680

F.C.C. EXAM MANUAI
PASS FCC EXAMS! Memory study "1973 Test Answer" for FCC First and Second class Radio-telephone licenses. Newly revised multiple-choice questions and diagrams. Cover all areas tested in FCC exams. plus "Self-Study Ability Test" $9.95 Postpaid.

COMMAND INSTRUCTIONS
P. O. BOX 26346 K
S A N FRANCISCO, CALIF. 94126

Radio Amateurs Reference Library of Maps and Atlas

WORLD PREFIX MAP - Full color, 40" x 28", shows prefixes on each country. DX zones, time zones, cities, cross referenced tables $1.25


RADIO AMATEURS MAP OF NORTH AMERICA! Full color. 30" x 25" - includes Central America and the Caribbean to the equator, showing call areas, zone boundaries, prefixes and time zones, FCC frequency chart, plus useful information on each of the 50 United States and other Countries. $1.25

WORLD ATLAS - Only atlas compiled for radio amateurs. Packed with worldwide information - includes 11 maps, in 4 colors with zone boundaries and country prefixes on each map. Also includes a polar projection map of the world plus a map of the Antarctica - a complete set of maps of the world. 20 maps size 8 1/4" x 12", $2.50

Complete reference library of maps - set of 4 as listed above $3.75

See your favorite dealer or order direct.
Mail orders please include $50 per order for postage and handling.
CRISTAL BARGAINS

We supply crystals from 16kHz to 100MHz. Over 6 million crystals in stock.

SPECIAL
Crystals for most amateur 2-Meter F.M. Transceivers:

$3.75 Each
Inquire about quantity discounts. Order direct. Check or Money Order. For first class mail add 15¢ per crystal...for airmail add 20¢ ea.

SPECIAL! CRYSTALS FOR:
Frequency Standards
100 KH (HC6/U) $4.50
1000 KH (HC6/U) 4.50
Almost All CB Sets, Trans. or Rec. 2.50
(CB Synthesizer Crystal on request) 1.50
Any Amateur Band in FT-243 (Except 80 meters) 4 for 5.00
80 Meter Range in FT-243 2.50
Color TV 359.645 KH; (wire leads) 4 for 5.00

DIVISION OF BOB WHAN & SONS ELECTRONICS, INC.
2400 Crystal Dr.
Fort Myers
Florida 33901
(813) 936-2397

Send 10¢ for new catalog with oscillator circuits and listings of thousands of frequencies in stock.

READOUTS $3.00
7-SEGMENT 5 VDC
Long life incandescent tube 1/2 inch high character. Drive with 4447 IC. Write for complete list including wavering filters, complete counter modules, many more items.
Display Electronics
P.O. BOX 1044
LITTLETON, CO 80120

WORLD QSL BUREAU
THE ONLY QSL BUREAU to handle all of your QSL's to anywhere: next state, the next country, the whole world. Just bundle them up (please arrange alphabetically) and send them to us with payment of 5¢ each.
5200 Panama Ave., Richmond, CA 94804

THE ULTIMATE MORSE KEYBOARD
- 64 character buffer
- Standard typewriter format with space
- Compatible with KM-420 memory
Available 1 November Model #KB-4200
Write for specifications
$499.95

NO ETCH CIRCUIT BOARDS
FROM FULL SCALE TEMPLATES
Hardened chrome alloy steel, with #60 drill
ISOLATED - PAD - DRILL - MILL
Simple - Fast - Accurate - Safe
Sizes: 0.025", 0.125" Slits, $6.95 ea.
A F STAHLER Co
PO BOX 354
CUPERTINO, CALIF 95014
Calif. Residents add 6%

140 WATTS
PA10-140B

Calif. residents add 6%, add $2.00 per unit for ppd.
U.S.A. Prices subject to change without notice — Send for full amplifier and antenna catalog.

SEE YOUR LOCAL KLM ELECTRONICS DEALERS NOW

DEALER LIST

ARIZ. Apache Auto Sales — Tucson/Phoenix
CALIF. JYO Enterprises — Fullerton
Ham Radio Outlet — Burlingame
Quemet Electronics — San Jose
L. A. Electronics Sales — Torrance
Research Unlimited — Clovis/Fresno
Harold Munzer K6IAH/Roger Bailey K6GHM — San Diego

CANADA Dollard Electronics — Vancouver, B. C.
CONN. Marcus Communications — Manchester

KLM ELECTRONICS
1600 DECKER AVE.
SOUTHват MARTIN, CALIFORNIA 95046

"THE COMMUNICATIONS EQUIPMENT INNOVATORS"

(408) 683-4240
(408) 842-7349

More Details? CHECK-OFF Page 110

october 1973
EL CHEAPO
Describes the price not the quality.

Announcing the New Line of Miniature power supply kits Zener or electronic integrated circuit regulated. Floating pos & neg output.

250MA and 1 amp types from $7.95

1.5, 3, 4.5, 6, 7.5, 9, 12, 15, 18, 20, 22, 24 volts

Use one to power your next project. Use for battery charges or battery eliminators also. Call or write today for data on:

THE POWER LINE
E.M.C. ASSOCIATES, INC.
9 Shields Lane • Ridgefield, Ct. 06877
203-438-0116

FULL FIVE YEAR GUARANTEE
SHIIPMENT FROM STOCK
LOW PRICES
ON POPULAR COMPONENTS
IF FILTERS
- Monolithic crystal filters at 10.7 and 16.9 MHz
- Ceramic filters at 455 kHz

SEMICONDUCTORS
- 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

Want To Meet Some Old-Timers?
NEW VINTAGE RADIO BOOK
Re-live the early days of wireless and radio. Over 1,000 pictures. 1887-1929.

RADIO COLLECTOR'S GUIDE
Over 50,000 useful facts. 1921-1932

ORDER NOW! Send check to McMahon's Vintage Radio, Box 2045, Palos Verdes Peninsula, Calif., 90274
Vintage Radio, hard cover $6.95
Radio Collector's Guide 4.95
California residents add 6% State Sales Tax

Name ___________________________________________ Street ____________________________
City _____ State ______ Zip _______________________

Ten Day Money-Back Guarantee
A new book from HR...worth looking into!

Here it is! HAM RADIO'S first book, a compilation of the best of our popular Ham Notebook section during our first years of publication.

Just loaded with clever ideas and nifty little circuits to make your time in the ham shack more productive and enjoyable.

The many chapter headings include:
- Antennas and Transmission Lines
- FM and Repeaters
- Keying and Control
- Measurements and Test Equipment
- Oscillators
- Power Supplies
- Receivers and Converters
- Transmitters
- VHF and UHF
- Station and Workshop

Just $3.95 postpaid

comtec BOOKS

Greenville, New Hampshire 03048
**PCB KITS**

- **RTTY SPEED CONVERTER** Drilled PCB $40.00
- **DRILLED PCB ONLY** $6.00
- **RTTY AFSK Gen. All Shifts & CW I.C. 9 VDC @ 2ma** $6.60
- **100 kHz XTAL CALIBRATOR** Less XTAL 9 VDC @ 2ma $4.75
- **POWER SUPPLY** — 28 VDC @ 650 ma output $8.95
- **PREAMP MICROPHONE** 26 DB Gain 9 VDC @ 1ma $3.50
- **LIMITER PREAMP For High Z Mike** 9 VDC @ 1ma $4.80
- **PRODUCT DETECTOR** For Your Receiver 9 VDC @ 1ma $3.60
- "S" METER KIT Less 1ma Meter 6.3VAC $4.75
- **SWR METER** Stripline, Less 200 ma Meter $2.95
- **WWV CONVERTER** 3.5-4.0 MHz Output 9 VDC @ 5ma $5.25
- Requires 6-6.5 MHz Crystal.
- **6 METER CONVERTER FET** Front End 9 VDC @ 5ma $5.95
- **CW KEYING MONITOR, RF Keyed** Less Spkr. 9 VDC $9.60
- **POWER SUPPLY** - 9 VDC @ 50ma Output 115VAC $4.85
- **6 OR 2 METER CASCODE PREAMP** 80 VDC @ 4.5ma $4.95
- Wired & Tested Less 2 ea 6CW4
- Nuvisitior. Specify 6 or 2 Meter Model
- **DRILLS** #54, 56, 58 or 60 (each) $0.40
- **Satisfaction Guaranteed. Return in 30 Days for Refund. All Kits Postpaid. Include 25c Handling Charge. Washington Residents Add 5.3% Sales Tax.**

**FREQUENCY STANDARD**

Only $32.50 (less batteries) POSTPAID USA

- **Precision crystal**
- **Fully guaranteed**

- **Markers at 100, 50, 25, 10 or 5 kHz selected by front panel switch.**
- **Zero adjust sets to WWV. Exclusive circuit suppresses unwanted markers.**
- **Compact rugged design. Attractive, completely self contained.**
- **Send for free brochure.**

**P. M. ELECTRONICS INC.**

519 SOUTH AUSTIN, SEATTLE, WASH. 98108

---

**Meet the family.**

**$75**

**Automatic Station Identifiers**

Let one of Control Signal's solid-state CWID's provide CW identification in precise Morse code. The heart of a CWID is a plug-in memory, factory programmed with call (or message). All CWID's arrive ready to install; guaranteed for 1 year.

- **CWID-50** (or rack-mounted 50R) automatically transmits station ID at precisely timed (adjustable) intervals. For repeaters (or AM, FM, SSB, or AFSK rigs). Power: 7.5 to 30vdc.
- **CWID-51** has all features of CWID-50, plus a 117vac power supply, monitor speaker, switch complement, and automatic switching to a DC source if AC power is lost.
- **CWID-49** is an automatic message generator. For CW, RTTY, or any audio modulated rig. Push-button (or remote contact closure) initiates pre-programmed message.

Delivery: 7 days. To order, state call sign or message, and enclose full amount; we pay postage. Or, remit $10 part payment for COD shipment. Write for brochure or call.

**csc control signal company**

5964 W. Columbia Place, Denver (303)794-7234
... for literature, in a hurry — we’ll rush your name to the companies whose names you “check-off”

INDEX

ARRL Convention ........................ 89
Amidon Associates ......................... 88
Amtech .................................... 107
Andy Electronics, Inc. ..................... 100
Antenna King ................................ 56
Antenna Mart ................................ 78
BC Electronics .............................. 104
Babylon Electronics ........................ 94
Barry ....................................... 98, 113
Bauman ..................................... 94
CFP Enterprises ............................. 82
Carvill International Corp. ................. 88
Comdata, Division of ISC ................. 71
Command Productions ...................... 104
Communications Specialists .............. 108
Comtec .................................... 108
Control Signal Electronics ................ 109
Curtis ...................................... 109
Data Engineering, Inc. ................. 102
Display Electronics ....................... 105
Drake, Co. R. L. ........................... 61
DX'er Magazine ............................ 106
Dycomm ................................... 86
Dynamic Electronics, Inc. ................. 88
E & L Associates, Inc. ................. 106
Ehrhorn Technological Operations, Inc. 1
Emac, Div. of Varian Assoc. .............. Cover IV
Epsilon Records ............................ 85
Erickson Electronics ...................... 76
Exceltronics Research Labs ............... 76
G & G Radio Supply Co. ................... 108
Gateway Electronics ...................... 76
Global Import Co. .......................... 76
Goldstein's ................................ 96
Goodheart Co., Inc. R. E. ................. 100
Gray Electronics ........................... 78
Heath Company ............................. 105
Henry Radio Stores ........................ Cover III
Hy-Gain Electronics Corp. ............... 33, 95
dicom ...................................... 106
Illinois Repeater Club ...................... 106
INX Sales .................................. 107
International Crystal Mfg. Co. Inc. .... 77
International Electronics Unlimited .... 103
Jan Crystals ................................ 103
Janel Labs .................................. 94
K Enterprises ............................... 82
K. E. Electronics ......................... 82, 84, 104, 106
KLM Electronics ........................... 105
KRP Electronic Supermart, Inc. .......... 82
KW Electronics ............................. 104
Kirk Electronics ............................ 56
L. A. Sales ................................... 57
Leeds Radio ................................ 88
Logic Newsletter .......................... 96
MFA Enterprises ........................... 96
Matric ..................................... 86
McClaren .................................. 84
Meshra, John, Jr. .......................... 91
Midland Electronics Co. ................. 85
Mor-Gain, Inc. ............................. 90
Mor-Mini Electronics Supply ............... 104
Oneida Electronic Manufacturing Co. Inc. 70
PM Electronics, Inc. .................... 109
Palomar Engineers ......................... 107
Payne Radio ............................... 100
Pemco, Inc. ............................... 79, 93
Poly Paks .................................. 94
Professional Electronics Co. Inc. ....... 82
QRP Electronics ............................ 82
Racor Electronics, Inc. ................... 90
Radio Amateur Callbook ................... 84, 104
Regency Electronics, Inc. ............... 97
SAROC ..................................... 87
Seymore Electronics ....................... Cover IV
Signal Systems ............................. 96
Solid State Systems, Inc. ............... 81
Space-Military Electronics ............... 82
Spectrum International ................... 29
Stahler Co. A. F. ......................... 138
Standard Communications Corp. ......... 111
Sewan Electronics ........................ 72, 73, 74, 75
Ten-Tec, Inc. .............................. 109
Tobel Electronics ......................... 78
Tri-Tek, Inc. .............................. 107
Tristao Towr Co. .......................... 86
VHF Engineering, Div. of Brownian Elec. Corp. 91
Vanguard Labs ............................ 101
Vintage Radio ............................. 107
Weinschener, M. ........................... 69
Wilson Electronic ........................ 94
Wolf, S. .................................. 104
World QSL Bureau ........................ 105
Y & C Electronics .......................... 100
Yaesu Musen USA, Inc. ................. 83

Limit 15 inquiries per request.

October 1973

Tear off and mail to

HAM RADIO MAGAZINE — “check off”

Greenville, N. H. 03048

NAME ........................................

CALL ........................................

STREET ......................................

CITY .........................................

STATE ........................................

ZIP ..........................................
MAXIMIZE
YOUR AMATEUR RADIO

What new 2M FM gives me most for my money, performance vs. price? The answer's as clear as the superb reception you'll get on the new Standard 826MA, 10 watt, 2 meter FM transceiver. You'll find such outstanding features as 12 channels — with the four most popular ones included — and a RF output meter with selection of 10 watts or 0.8 watt for battery conservation. And of course, our "Astropoint" system that assures: top selectivity, great sensitivity, and rejection of unwanted signals on today's active 2M band.

Helical Resonators & FET front end provide the performance needed for tomorrows crowded channels. Provision for tone coded squelch to activate modern repeaters. A radio that won't become obsolete. Occupies less than 200 cu. in. Weighs less than 5 lbs. It has all the same "Astropoints" as entire Amateur line.

NEW 22 CHANNEL BASE STATION
SRC-14U
Ultimate in a 2M FM Transceiver features:

- 22 channels
- AC & DC supplies Built In
- 10W (1, 3 & 10 selectable)
- Receiver offset tuning
- VOX
- Three Front Panel Meters
- Plus many more exciting features.

For detailed information on these, the complete Standard line and the name of your nearest dealer write: Standard Communications Corp.
213 / 775-6284 · 639 North Marine Avenue, Wilmington, California 90744

More Details? CHECK-OFF Page 110

october 1973

111
BARRY presents
CLEGG FM-27B

Total 146-148 MHz coverage without buying a crystal. 25w. out, fully synthesized. $479.95
Clegg FM-27B Regulated AC power supply $79.95

BIRD 43 WATTMETER $100.00
Bird 43 Slugs specify frequency and power
HF $35.00 each
VHF $32.00 each
Also 4350 80-10M dual scale 200w/2kw HamMate $79.00

DRAKE
MS-4 Speaker $22.00
AC-10 AC Supply for AA-10, TR-22, TR-72, 13.8 VDC @ 3 amps $39.95
TR-22, in stock $219.95
AA-10 Amplifier for TR-22 $49.95
TR-72 2 meter FM transceiver, 23 channel, 1 & 10 watts, 13.8 VDC $320.00
TR/4/C new, $599.95 T-4XC Trans. $530.00
RAC Rec. $499.95
AC-4 Drake A.C. Power Supply $99.95

MARINE
Barry stocks and has fast availability Sonar, Pearce-Simpson, Andrea, SBE and Antenna Specialists VHF Transceivers, Antennas, Depth Finders and compasses by Andrea.

HALLCRAFTERS
SR-150 Transceiver 10-80 meters AC or DC power supplies write
SR-160 Transceiver 80, 40, 20 meters write
PS-150-R DC power supply for SR-150 or SR-160 reg. 109.50, sale unused $75.00
FPM-300 new $595.00

TEMPO
2 Meter Linear Amplifiers, 502, 5-12 watts input. 35-55 watts output $105.00
802-B 1-1/2 watts input, 80-90 watts output $195.00

SWR BRIDGE COUPLER, DC-800 MHZ
TNC Connectors (no indicator) full amateur power $90.00 Value $10.95

DX ENGINEERING
SPEECH COMPRESSORS
DIRECT PLUG-IN FOR COLLINS 32S $79.50 ppd. U.S.A.
DIRECT PLUG-IN FOR KWM $79.50 ppd. U.S.A.
Pay us a visit when you are in New York
Thousands of unadvertised specials.
Separate expert department to expedite overseas orders.

E. F. JOHNSON
Matchbox complete with direction coupler and indicator, 10-80 meters $229.00
2KW PEP, 1 KW AM — new, $154.50
275 watts — new, $94.95
151-14 Variable Capacitor, 250 pF, medium Xmitting type $9.95 ea.

VIBROPLEX
Vibro Keyer Standard $24.95
Deluxe $32.95
Original Standard Vibroplex Bug $29.95

INSTRUMENTS
Millen 90652 Solid State Dipper in stock. New $110.00
Pan Adapter BC-1031A ± 100 kc unused with spare parts & book useful with any short wave receiver $75.00

SWAN
SS-200 Solid State SSB Transceiver with power supply & 16 pole filter $2500.00
Brand new, Write Swan 350 with 117XC power supply $89.95

DYCOMM
DYCOMM BRICK, 2w in 35w out $79.95
DYCOMM BLOCK, 10 in 50w out $99.95

ETO
ALPHA-77. The finest amplifier ever offered for amateur, commercial or military service. 3000 watts PEP continuous duty. Write

1 CX7A brand new, latest version, write or call

GE INDUSTRIAL SILICON RECTIFIER
1400 PIV
250 amp., GE #41A281049-11. Quantities in stock. $90.00 value, brand new $15.00

BARRY 512 Broadway NY, NY 10012 ELECTRONICS
See Page 98 for MORE from Barry
BASSETT

High efficiency mobile and portable antennas for all amateur bands, CAP, MARS, CB, SECURITY, PUBLIC SERVICE, MARINE, AND GOVERNMENT USE.

- 2-6-10-15-20-40-75
- Identical size, cost, and appearance
- FULLY ADJUSTABLE TO FREQUENCY IN FIELD
- Low weight, low drag, high strength fiberglass
- Polished chrome brass standard %24 thread
- High gain collinear on 2 meters

MODEL DGA-2M
$29.50 postpaid in U.S.A.

HIGH ACCURACY CRYSTALS FOR OVER 30 YEARS

Either type for amateur VHF in Regency, Swan, Standard, Drake, Varitronics, Tempo, Yaesu, Galaxy, Trio, Sonar, Clegg, SBE, Genave. Quotes on request for amateur or commercial crystals for use in all other equipment.

Specify crystal type, frequency, make of equipment and whether transmit or receive when ordering.

BASSETT VACUUM BALUN

The famous sealed helium filled Balun employed with the DGA Series Antenna Systems. Solderless center insulator and easily handles more than full legal power while reducing unwanted coax radiation. Equipped with a special SO-239 type coax connector and available either 1:1 or 4:1.

MODEL DGA-2000-B $12.95
Postpaid in U.S.A.

Savoy Electronics, Inc.
P.O. Box 5727 - Fort Lauderdale, Florida - 33310
Tel: 305-566-8416 or 305-947-1191
When Henry Radio set out to design a sophisticated linear amplifier for high reliability communications in the high frequency range, they chose EIMAC's high-mu 8877 power triode.

The result is the new 4K Ultra, which operates with 4000 watts input in heavy-duty commercial service. The 4K employs continuous variable capacitive and inductive elements tunable over the 3.0 to 30 MHz range. Optimum input and load conditions are provided for a wide variation in antenna systems. EIMAC's 8877 enables the 4K to deliver over 2500 watts of continuous SSB or CW output with only 50 to 75 watts of drive. For RTTY the 4K will provide about 2000 watts of continuous duty output.

The 8877 is a ceramic-metal triode that delivers a lot of power and linearity in a package only three and one-half inches high. At 30 MHz, typical power gain is 15 dB. This impressive gain is achieved with 3rd order intermodulation products -38 dB below one tone of a two equal-tone drive signal.

With Henry Radio, you know quality counts. And they know you can't do better than EIMAC. For full specifications on the 8877, write to EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070. Or contact one of the more than 30 Varian/EIMAC Electron Tube and Device Group Sales Offices throughout the world.