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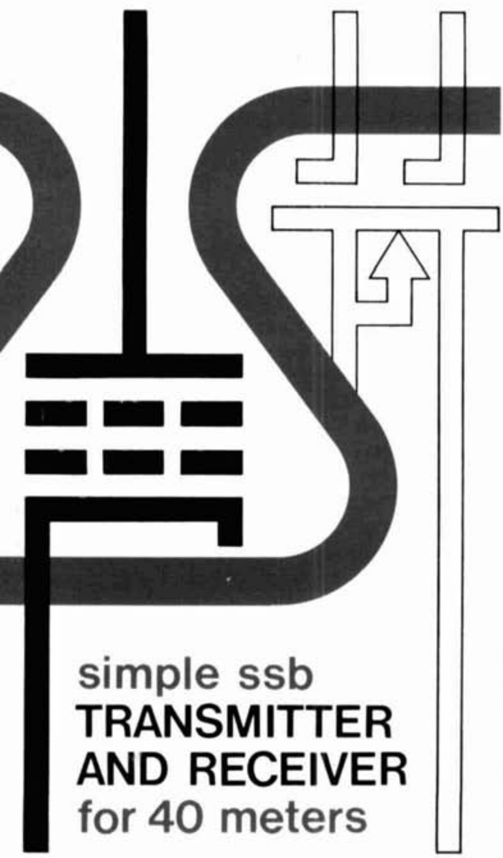
ham radio magazine

MARCH 1974

this month

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



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More Details? CHECK—OFF Page 94

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contents

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

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

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

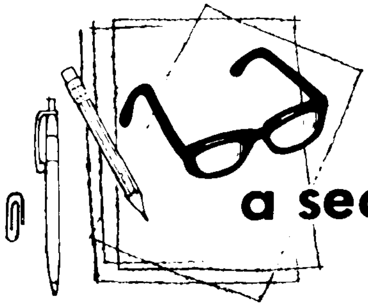
34 **vertical antenna characteristics**
Robert E. Leo, W7LR

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

42 **simplified digital readout system**
Harold W. Thompson, W6OIS

50 **how to bias fets**
Courtney Hall, WA5SNZ

4 **a second look**
94 **advertisers index**
54 **comments**
83 **flea market**
56 **ham notebook**
58 **new products**
94 **reader service**
64 **short circuits**



a second look by jim fisk

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

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

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

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

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

Jim Fisk, W1DTY
editor-in-chief

simple ssb transmitter and receiver for 40 meters

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

W.J. Weiser, M.D., VE3GSD, 98 Banstock Drive, Willowdale, Ontario, Canada

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

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

the receiver

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

The 6.545- to 6.845-MHz vfo signal is injected at gate 2 of the mixer. The 455-kHz difference frequency is selected by the i-f transformer, T1. The very stable vfo circuit features incremental tuning and output buffering, and is a modification of an earlier design **(fig. 3)**.[1] Output buffering is provided by the emitter-follower stages Q6 and Q7. Transistor Q7 also serves as a power amplifier, allowing the vfo to drive a 7360 balanced mixer tube used in the companion exciter.

The incremental tuning circuit uses a Motorola MV1654 varactor diode, CR3. This circuit permits an approximately 10-kHz offset to either side of the vfo frequency. The control voltage on the varactor is set by R3, the offset tuning control. Resistor R4 compensates for differences in varactors and allows the vfo to be adjusted to zero offset.

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

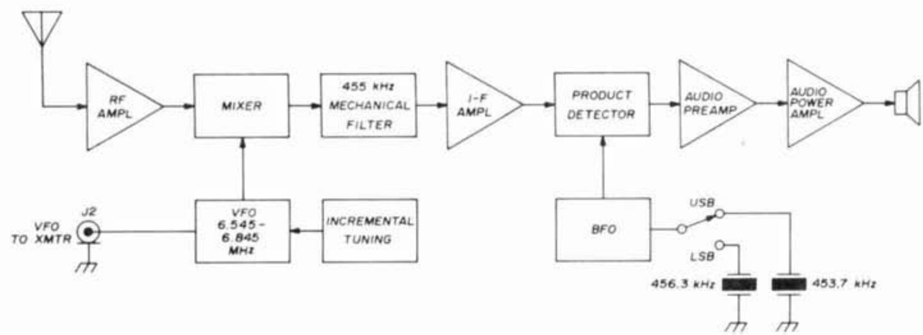


fig. 1. Block diagram of the single-conversion 40-meter receiver ssb and CW receiver.

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

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

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

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

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

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

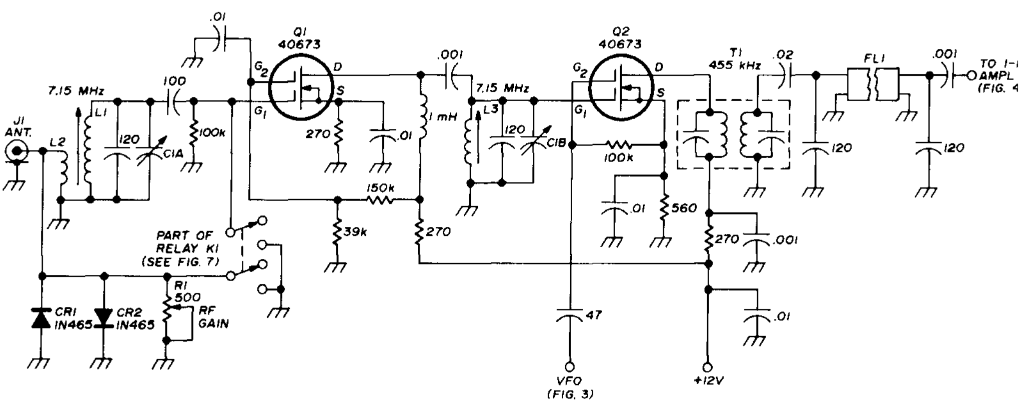
Homebrew 40-meter receiver uses all solid-state circuits.

regulation is required to ensure maximum vfo stability because the MV1654 varactor used in the incremental tuning system will significantly shift the vfo output frequency with the slightest dc voltage variation. For additional vfo stability it might be a good idea to insert a three-terminal voltage regulator IC, such as the Fairchild μA7812, in the vfo supply line.[4]

receiver construction

The mechanical layout of the receiver is shown in the photographs. The rf amplifier, mixer and mechanical filter are constructed on a 2¼x2¼-inch section of Vector board, copper clad on one side. The i-f amplifier is built on another, similar sized board, and the vfo and incremental tuning are built on another 2¼-inch square board. These three boards are mounted on 3/4-inch spacers under the chassis.

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



C1	modified dual-section 365-pF broad-cast variable (see text)	L1,L3	30 turns no. 26 wound on ¼" slug-tuned ceramic form, resonated to 7.15 MHz
FL1	455-kHz mechanical filter, 2.1-kHz bandpass (Collins FA21-7102)	L2	4 turns no. 26 on cold end of L1
		T1	455-kHz input i-f transformer

fig. 2. Schematic diagram of the rf amplifier, mixer and mechanical filter.

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

receiver alignment

Before starting the alignment procedure, all slug-tuned coils must be roughly adjusted to the proper frequencies with the help of a grid-dip meter. Also, each stage is initially tested and aligned before being mounted on the chassis. This points up any difficulties that might be more difficult to pinpoint when the receiver is completely assembled. Inductor L4 in the vfo is adjusted for an output of 6.695 MHz with C4 set at mid-excursion.

Although a signal generator is best for initial alignment of the rf and mixer stages, it is possible to use an on-the-air signal. Apply a 7.15-MHz signal to L1 and peak C1 for maximum rf voltage on gate 1 of the rf amplifier stage. Next apply a 455-kHz signal to the primary of T1 and tune the transformer for maximum signal at the output of the mechanical filter. Since a reading of 0.1 volt is typical here, a sensitive rf probe and voltmeter is required.

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

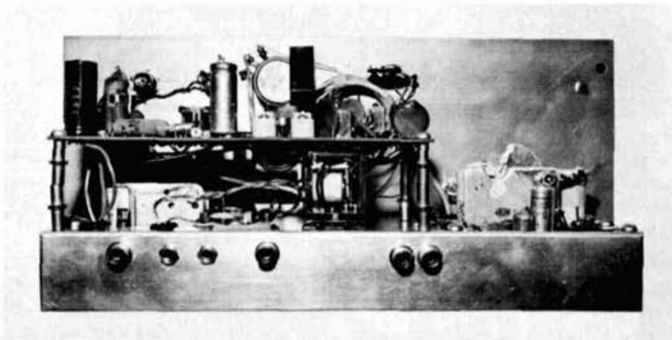
After each of the individual boards has been tested and aligned, and the receiver has been assembled, final peaking can be accomplished with an on-the-air signal. The rf amplifier, mixer and i-f stages are tuned for maximum receiver gain. To obtain good tracking with C1 it is necessary to alternately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

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

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

receiver performance

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



Rear view of the 40-meter receiver. The product detector and audio board is mounted on 1-3/4" spacers. Relay K1 is underneath the board while the vfo tuning capacitor is on the right.

the transmitter

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

A block diagram of the transmitter is

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

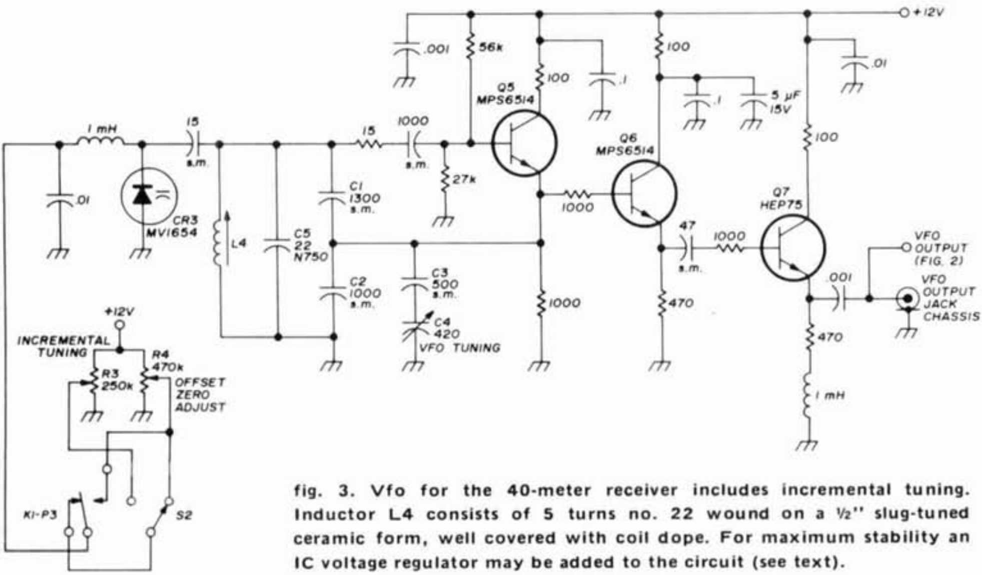
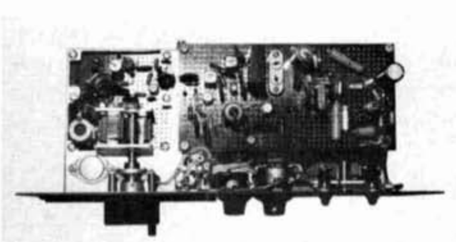


fig. 3. Vfo for the 40-meter receiver includes incremental tuning. Inductor L4 consists of 5 turns no. 22 wound on a ½" slug-tuned ceramic form, well covered with coil dope. For maximum stability an IC voltage regulator may be added to the circuit (see text).

double-sideband output signal is coupled into a Collins mechanical filter.

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

The triode section of V120 (cathode,



Top view of the receiver chassis. The vfo board is to the left, the product detector and audio board to the right.

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

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

The ssb signal from the output of the 6BA6 i-f amplifier is coupled through transformer T101 to V104, the 7360 balanced mixer. The triode section of V104 is used in a Colpitts-type internal vfo. Capacitor C102 is the main tuning capacitor and C103 and C104 serve both as frequency-trimming and temperature-compensating capacitors. For transceive

short as possible and the input and output must be sufficiently isolated; the 33-ohm non-inductive resistor in series with the grid serves as a parasitic suppressor.

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

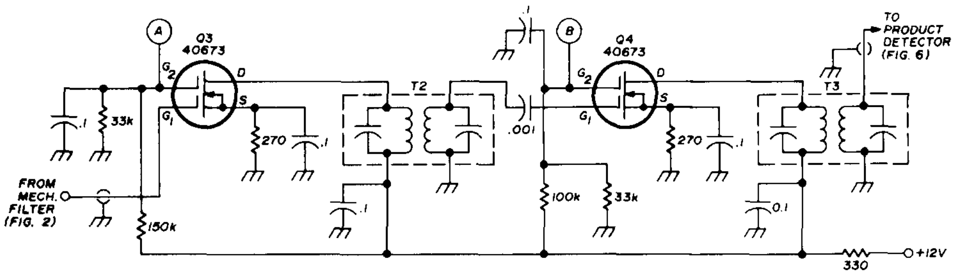


fig. 4. Two-stage 455-kHz i-f amplifier. Transformers T2 and T3 are miniature 455-kHz input i-f transformers.

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

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

The 7.0- to 7.3-MHz ssb output from V104 is coupled through L102-L103 to the 6GK6 driver stage, V105, **fig. 11.** A 6GK6 was selected as the driver because it offers considerable gain and can safely handle a 300-volt plate supply. However, because of its high gain, care must be taken to prevent instability and self-oscillation. All leads must be kept as

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

socket between the input and output pins and the ground end is also soldered to the central pin of the socket. This technique provides an effective grounded shield between the input and output circuits of the driver stage.

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

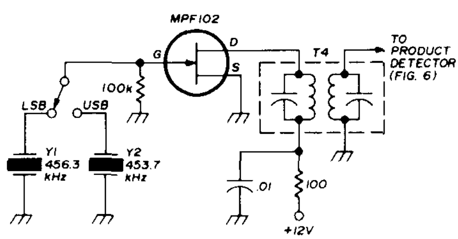


fig. 5. The 455-kHz bfo stage. T4 is a miniature 455-kHz i-f input transformer.

driver stage. Resistor R105, a 5000-ohm, 5-watt wirewound potentiometer, serves as the driver gain control.

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

the cathode keying line to prevent self-oscillation. Parasitic suppressors Z101 and Z102 help minimize any high-frequency instability. With these techniques, I did not find it necessary to neutralize either the driver or PA stages. Both are extremely stable.

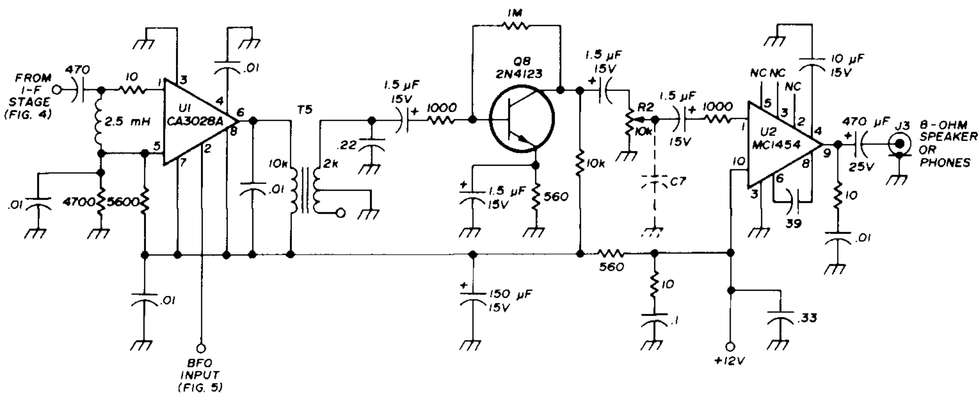


fig. 6. Product detector, audio preamplifier and audio output stage. Capacitor C7 (0.1 μF) may be required to suppress an oscillating output stage (see text).

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

As with the driver stage, considerable care must be taken in keeping leads short around the PA stage sockets, separating input and output circuits, and shielding

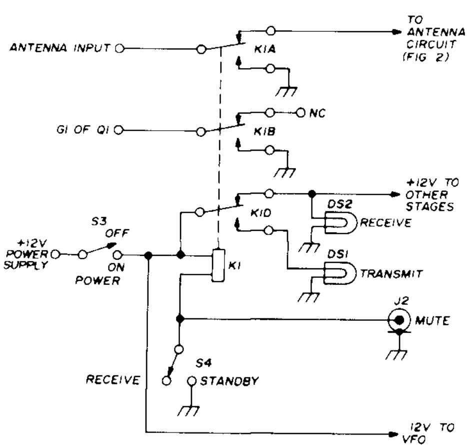


fig. 7. Switching and control circuits for the 40-meter receiver. Relay K1 is a miniature 4-pole relay with a 12-volt coil.

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

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

transmitter control circuits

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

ternal vfo, to talk himself on frequency using the companion receiver as a monitor.

power supply

The 350-0-350-volt center-tapped winding of transformer T102 is used in a

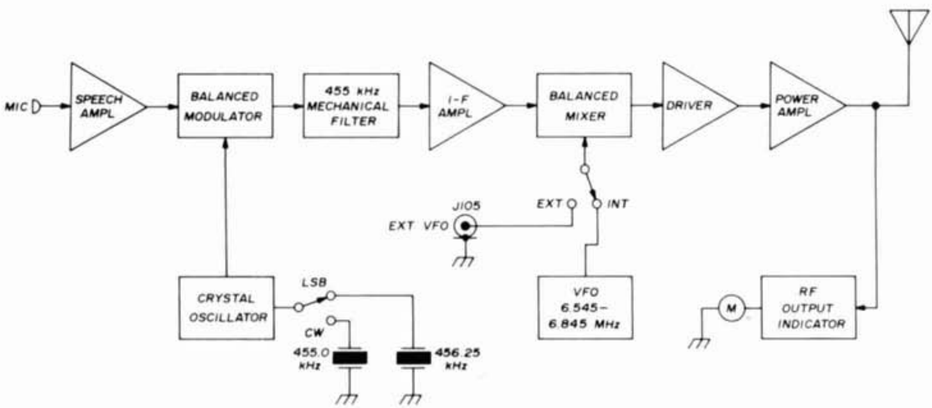


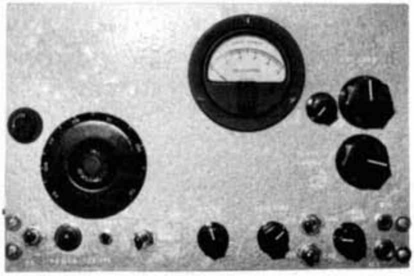
fig. 8. Block diagram of the 40-meter ssb and CW transmitter. Power input is about 180-watts PEP.

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

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

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

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



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

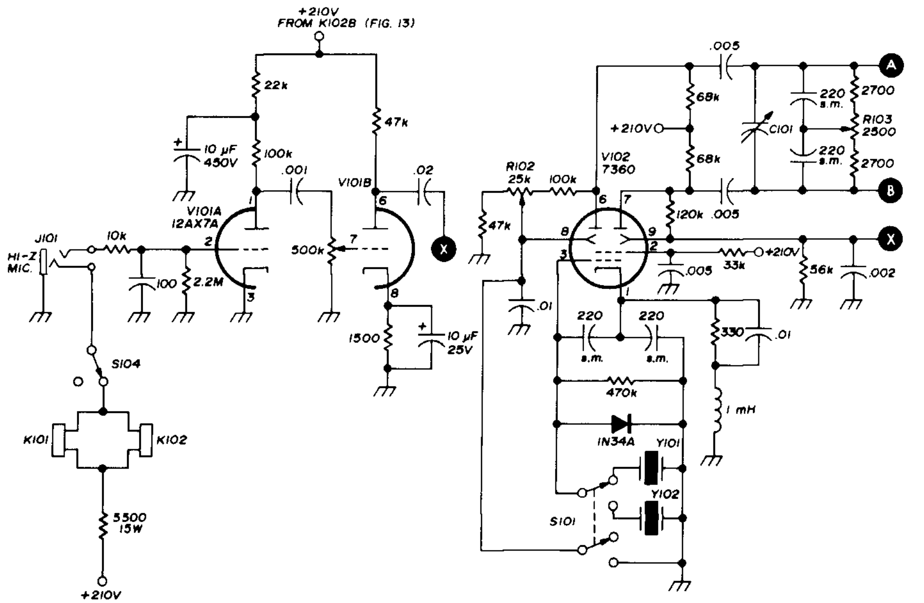
transmitter construction

The eternal frustration of any ardent home-constructor today is finding the needed parts. Most of the values given in this design can be varied; all the tuned-circuit inductors and capacitors of the tuned circuits, with the exception of the vfo, can be changed, of course, if required resonant frequencies are maintained. The seasoned builder may have his own scheme of chassis layout and wiring, and neither is particularly critical.

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

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

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

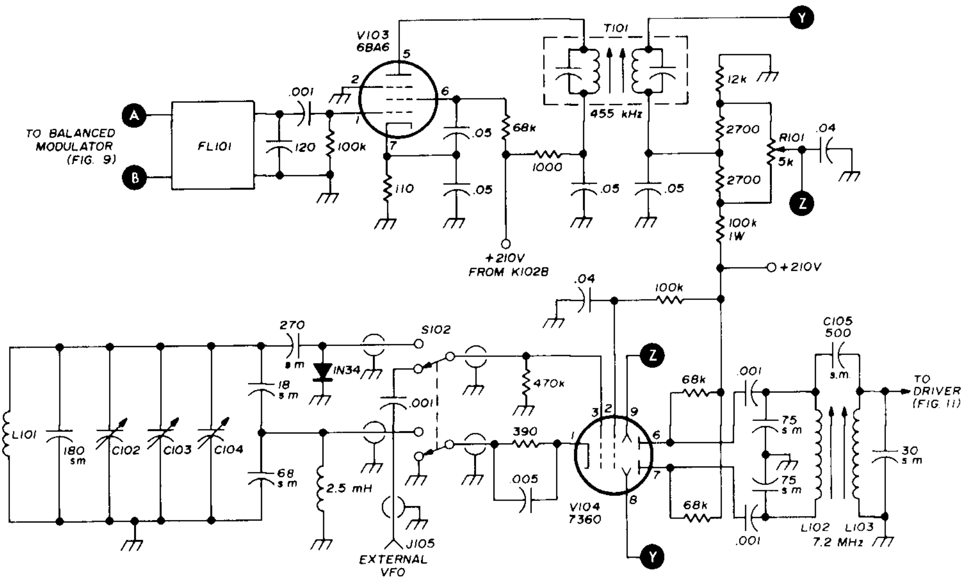


C101	5-25 pF NPO ceramic trimmer (phase balance control)
K101,K102	surplus 4-pole relays, 55-volt, 6800-ohm coil
R102	25k potentiometer (carrier amplitude control)
R103	2500-ohm potentiometer
S101	dpdt toggle switch (lower-sideband, carrier)
S104	dpdt toggle switch (spotting switch)
Y101	455.0-kHz crystal (carrier)
Y102	456.25-kHz crystal (lower sideband)

fig. 9. Speech amplifier and balanced modulator circuits. Complete relay switching system is shown in fig. 12.

to 7.3 MHz for one complete rotation. A small L-shaped bracket is used to mount C106 underneath the chassis.

The vfo main-tuning capacitor, C102, is a modified variable from a surplus ARC-5 receiver. The gear train and gear reduction ratio used on these capacitors make them ideal for amateur vfo applica- switch S102. The vfo tank coil was closewound on a 1/2-inch diameter ceramic form and Q-doped several times. Finally, the entire vfo was enclosed by an aluminum shield. The mechanical precautions were justified by the excellent vfo frequency stability characteristics I obtained.



C102	modified ARC-5 receiver tuning capacitor (see text)
C103	4-25 pF NPO ceramic trimmer
C104	4-25 pF N500 ceramic trimmer
C105	500-pF silver mica (see text for other values)
FL101	455-kHz mechanical filter (collins 455 FA21 7102)
L101	12 turns no. 22 enamelled on ½" diameter ceramic form
L102,L103	29 turns no. 22 enamelled on ½" diameter, slug-tuned form
S102	dpdt toggle switch (internal/external vfo)
T101	455-kHz i-f input transformer

fig. 10. Transmitter vfo, i-f and balanced mixer circuits. Colpitts-type vfo circuit tunes from 6.545 to 6.845 MHz.

tions. Only one capacitor section is used in the vfo. Each capacitor section had about 100-pF capacitance, and plates were removed until the entire excursion of C102 yielded a vfo range of 6.545 to 6.845 MHz with C103 and C104 set to midrange.

All the vfo components were securely soldered with short leads to firm tie points. Miniature shielded cable, soldered to frequent ground lugs, was liberally used in the switching circuitry around

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

transmitter alignment

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

maximum carrier suppression. With a typical rf probe virtually no rf voltage should be recorded at the plate of V103 when the balanced modulator is properly adjusted.

Final adjustment of the i-f amplifier is now accomplished with switch S101 in the *carrier* position. Move the rf probe to the secondary of T101 and alternately

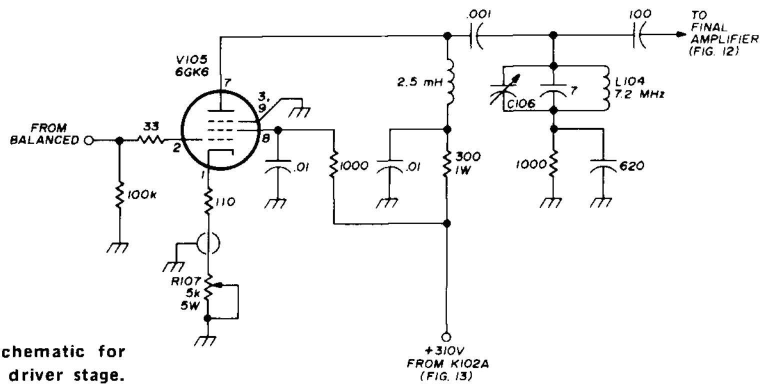


fig. 11. Schematic for the 6GK6 driver stage.

C106	approximately 5 pF (25-pF air variable with all plates removed except one
L104	28 turns no. 26 enamelled on 1/4" slug-tuned form
R107	5000-ohm, 5-watt wirewound potentiometer

Since the mechanical filter has noticeable insertion loss, adjusting the balanced modulator is best done by monitoring the signal at the output of the 6BA6 i-f amplifier, V103. A vtvm with an rf probe is coupled to the plate of V103, and switch S101 is placed in the *carrier* position. This unbalances the modulator and allows the 455-kHz carrier oscillator signal to pass through the mechanical filter. About 5- to 10-volts rf should be recorded by the probe. Next, tune the primary of transformer T101 for maximum rf voltage.

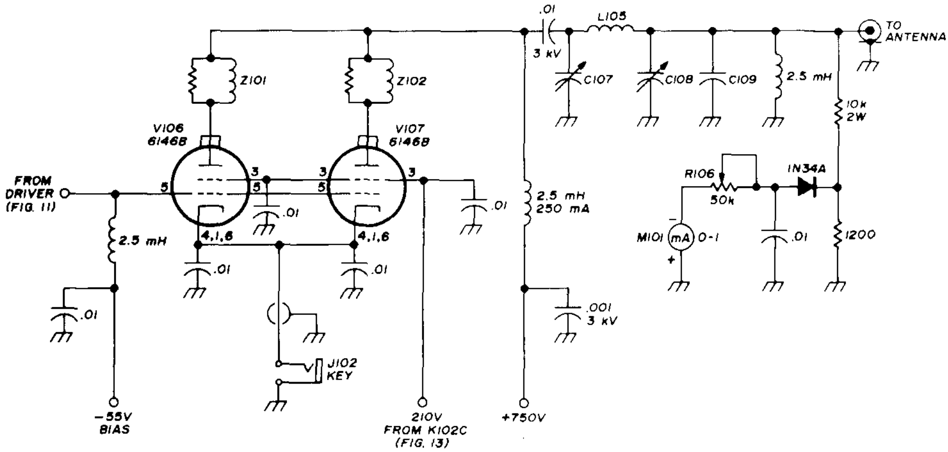
To adjust the balanced modulator for optimum carrier suppression, switch S101 is switched to the *lower-sideband* position. This switches in the 456.25-kHz carrier oscillator crystal, Y102, and any rf voltage measured at the plate of V103 is due to carrier. Alternately adjusting R102 and C101, the amplitude and phase balance controls, for minimum rf voltage sets the balanced modulator, V102 for

adjust the primary and secondaries of the i-f transformer for maximum rf voltage indication (typically 10 to 15 volts).

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

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

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



C107,C108	400-pF, 1000-volt air variable (see text)	M101	0-1 mA meter
C109	see text	R106	5000-ohm, 5-watt potentiometer (rf sensitivity control)
L105	23 turns no. 22 enamelled, closewound on 1" ceramic form	Z101,Z102	parasitic suppressors, 8 turns no. 16 enamelled, wound around 10-ohm, 1-watt carbon resistors

fig. 12. Power amplifier and rf output meter. Grid and plate current metering may be added if desired.

to reduce the value of C103 to keep the vfo within the proper operating range.

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

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

Before aligning the 6GK6 driver stage, be sure the final amplifier tubes, V106 and V107, are removed from their sockets. Place the rf probe on pin 5 of V106 (or V107) and set the driver control, R107, at midrange. Now place the exciter in the tune mode by switching S101 to the *tune* or *carrier* position and S104 to the *transmit* position. Move S103, the manual tune/transmit switch to the *tune* position, and with C106, the grid-tuning capacitor, at midrotation, adjust L104 for maximum rf voltage. Turning the driver output control, R107, should increase the measured output to a maximum of about 60 volts rf. Tuning C106 should further peak the driver output rf voltage.

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

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

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

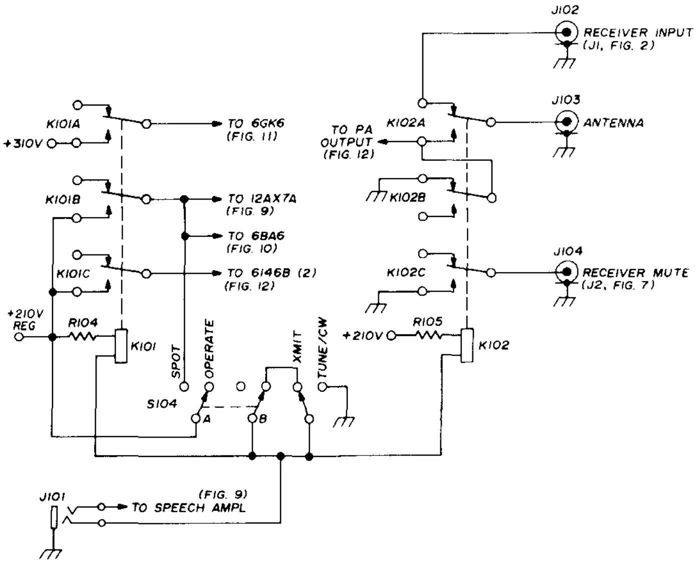
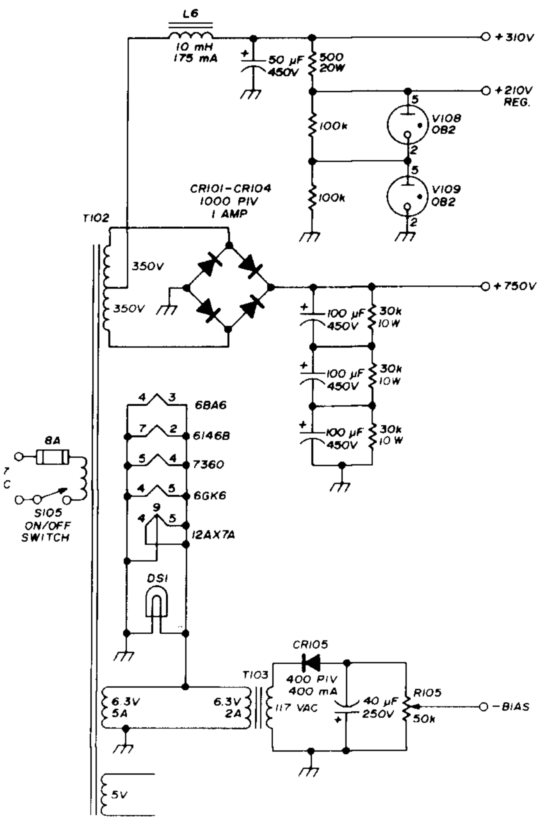


fig. 13. Voltage switching and transmitter and receiver control circuitry. Relays are shown in the standby (receive) position. Resistors R104 and R105 are voltage-dropping resistors, value chosen to reduce 210-volts dc to proper relay operating voltage.

When adjusting the PA stage remember that more than 750 volts exists there, and if touched inadvertently, that's more than enough to prematurely end a promising career. Place the 6146B power tubes in their sockets and connect a high-wattage 50-ohm dummy load to J104. Adjust R105 to supply about -55 volts bias to the grids of V106 and V107. Set the drive control, R107, to about midrange and the relative power output sensitivity control, R106, to about one-third. All the other operating controls should be set as previously described when monitoring the exciter's signal, except that switch S101 should be in the *carrier/tune* position. With the PTT switch or S103 closed, adjust C107 and C108, the plate-tuning and antenna-loading capacitors, for maximum deflection of the relative power output meter, M101. Resistor R106, the output meter sensitivity control, should be adjusted to keep the meter at about two-thirds deflection at maximum power output.

Finally, insert a dc milliameter in the 750-volt line, and with S101 in the *lower-sideband* position and the PTT switch closed, adjust R107, if necessary, to bring the final amplifier idling current to about 60 mA. As an alternative, a



I101	6-volt lamp (power on)
L106	10-mH, 175-mA filter choke (Hammond 193J or similar)
R105	50k, 10-watt potentiometer (bias control)
T102	117-Vac power transformer, 350-0-350, 6.3 Vac secondary (Hammond 273BX or similar)
T103	117-Vac filament transformer, 6.3-Vac secondary (Hammond 166L6 or similar)

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

50-ohm dummy load wattmeter or an in-line monitoring oscilloscope can be used to tune the PA stage and adjust the rf output meter. Capacitors C107 and C108 are then simply adjusted for maximum rf output as read on the wattmeter, or as seen by maximum deflection of the carrier envelope on the scope. R106 is then adjusted for two-thirds meter deflection at maximum power output.

operating

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

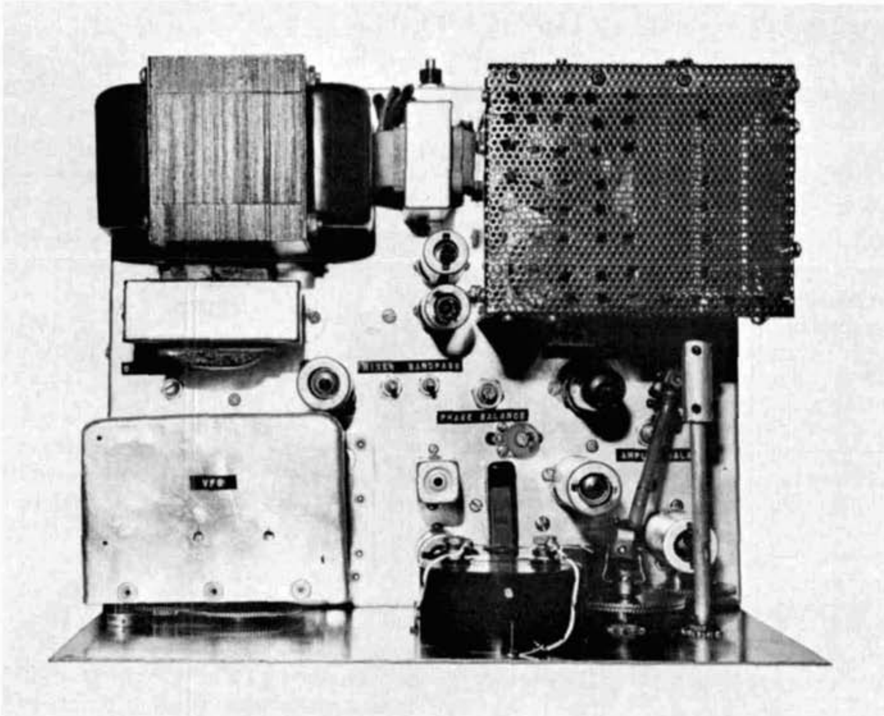
To operate in the transceive mode, connect the receiver vfo output to J105 using a shielded cable and switch S101 to the external vfo position. The exciter and receiver are now slaved to the receiver's vfo frequency, and ssb operation is the same as in the split function.

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

circuit improvements

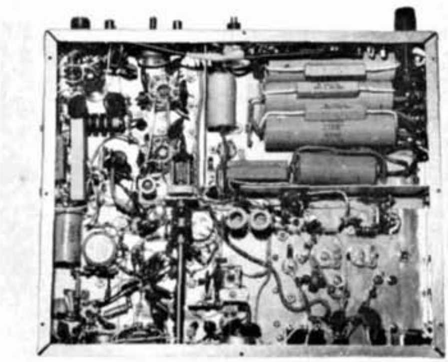
You may be surprised by the omission of some operating luxuries in this exciter. This was intentional – to keep design and alignment as simple as possible and to keep cost at a minimum. However, vox and sidetone circuitry could be easily added for voice-operated ssb operation and semi-break-in CW operation.

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



Top view of the transmitter chassis. Power amplifier cage is upper right, next to the power supply. Vfo enclosure is lower left, next to the front panel. Speech amplifier tube is underneath the antenna-loading capacitor shaft to the extreme right.

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



Underneath the transmitter chassis. Front of chassis is at bottom. Power supply components are in upper right-hand corner.

references

1. Doug DeMaw, W1CER, "Building a Simple Two-Band VFO," *QST,* June, 1970, page 20.
2. Doug DeMaw, W1CER, "A 40-Meter CW Receiver," *QST,* January, 1973, page 11.
3. *The Radio Amateur's Handbook,* 50th edition, 1973, ARRL, Newington, Connecticut, page 258.
4. James Trulove, WB5EMI, "Three-Terminal Voltage-Regulator ICs," *ham radio*, December, 1973, page 26.

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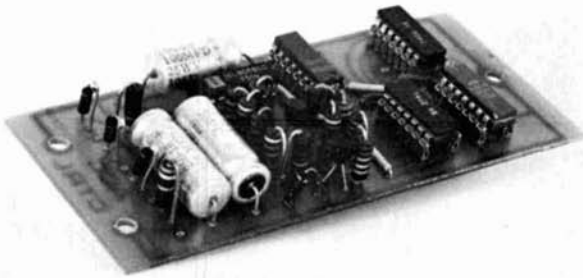
More Details? CHECK—OFF Page 94



automatically controlled access to open repeaters

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

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

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

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

the problem

The group that operates WR8ABC has consistently voted to keep the repeater as open as possible. When conditions made it necessary to guard the 146.16-MHz input, provision was made for access with private-line (110.9 Hz), tone burst (2000 Hz) and the 1336-Hz tone generated by a Touch-Tone pad. In addition, once the guard was opened by one of these means, the repeater remained open to access by any on-frequency carrier for the duration of each transmission and five seconds thereafter.

Permitting "tail-ending" in this way effectively opened the machine to use by any number of stations, with or without private-line or tone generators, as long as one of them could whistle the machine up in the first place. Unfortunately it also made it possible for a fringe area station to picket-fence the repeater indefinitely as long as his signal was strong enough to open the receiver squelch once every five seconds, which was hard on the equipment and even harder on the control operator. More than once the repeater has been out of service for several hours because a control operator switched it off and forgot to turn it on again when the interfering signal disappeared.

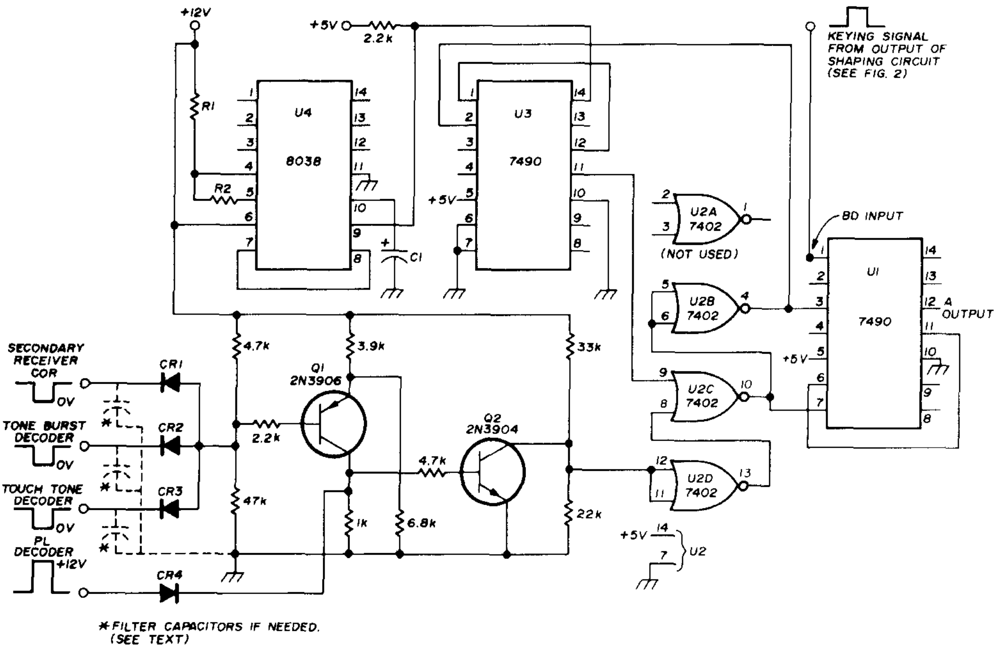


fig. 1. Timing circuit and counter for the repeater control system. For values of R1, R2 and C1, see text. All diodes are general-purpose silicon types such as the 1N914.

the solution

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

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

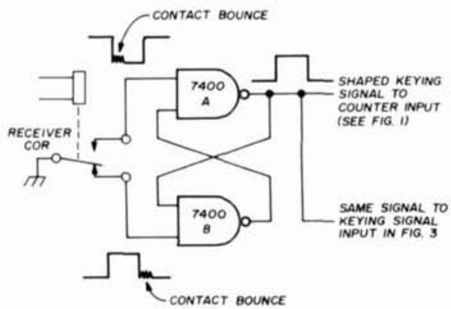


fig. 2. Shaping circuit for the keying signal.

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

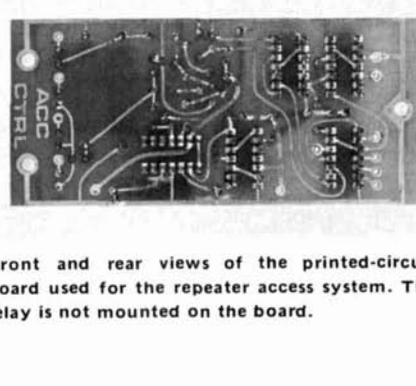
To make the counter operate in this manner the D output, pin 11, is wired to one of the R_9 reset inputs, and the other R_9 input and one $R_{\emptyset}$ input are controlled by an SN7402 NOR gate, U2. So long as one $R_{\emptyset}$ and one R_9 input are low, U1 counts the receiver COR cycles. On the fourth count the D output at pin 11 carries the R_9 input at pin 6 high. If pin 7 is also high, the counter latches with both A and D outputs in the high state. It will remain in this condition until the second R_9 input, pin 7, is switched to the low state by gate U2C. The same signal that does this switches the output of gate U2B high and U1 resets to zero.

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

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

construction

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



Front and rear views of the printed-circuit board used for the repeater access system. The relay is not mounted on the board.

tone inputs that reset the unit should be filtered to suppress response to transients, and so should the signal from the secondary receiver COR. A small electrolytic capacitor or a resistor and capacitor should suffice.

The keying signal to the counter input is more critical. COR relay contact bounce can cause erratic counting. The best way I have found to shape the COR signal is shown in **fig. 2**. This system uses two sections of an SN7400 NAND gate and a double-throw COR relay on the receiver.

The unit was designed to work with the solid-state control logic described in an earlier article,[1] but the output can be used to drive any TTL-compatible logic, or to operate a transmitter keying relay with a transistor driver. A circuit to do this using the other two sections of the SN7400 is shown in **fig. 3**. Transistor Q3 is a pnp silicon switching transistor capable of handling the keying relay current and voltage. Resistor R3 should be selected to limit the current through it to approximately 10 mA when the junction of R3 and R4 is at ground potential.

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

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

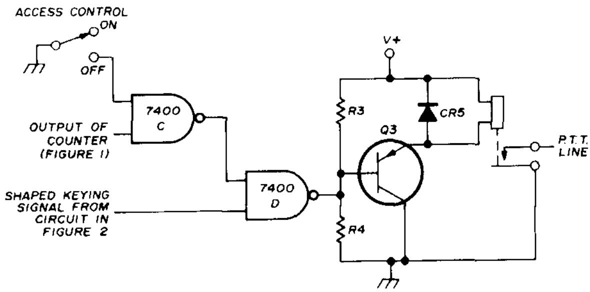


fig. 3. Transmitter control relay circuit. Values of R3 and R4 are selected as described in text. Transistor Q3 is a pnp silicon transistor capable of switching the relay current and voltage. Diode CR5 must have a PIV rating higher than the positive voltage supply.

conclusion

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

reference

1. R.B. Shreve, W8GRG, "Integrated-Circuit Sequential Switching for Touchtone Repeater Control," *ham radio*, June, 1972, page 22.

ham radio

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

six-meter frequency synthesizer

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

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

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

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

design

Following a modest literature search, a 6-meter IC frequency synthesizer was blocked out that tuned from 50.000 to 54.000 MHz in 1.0-kHz steps. Consideration was given to minimum steps of 5 or 10 kHz, knowing it would ease the task of phase-locking and reduction of spurious outputs, but this less desirable trade-off was finally overcome by intensive debugging. To be useful as an 8-MHz crystal replacement, output frequency runs from 8,333,333 to 9,000,000 Hz. An electronic calculator made quick work enameled wire, a handy enameled hookup wire with insulation which melts back from hot solder to leave a nicely tinned end ready for connection. Feeding in clock pulses having a configuration called for by the chip manufacturer at a 8,333,330 Hz rate resulted in an output that closely resembled a pseudo-random bit stream! "Oh well!" said I, "probably

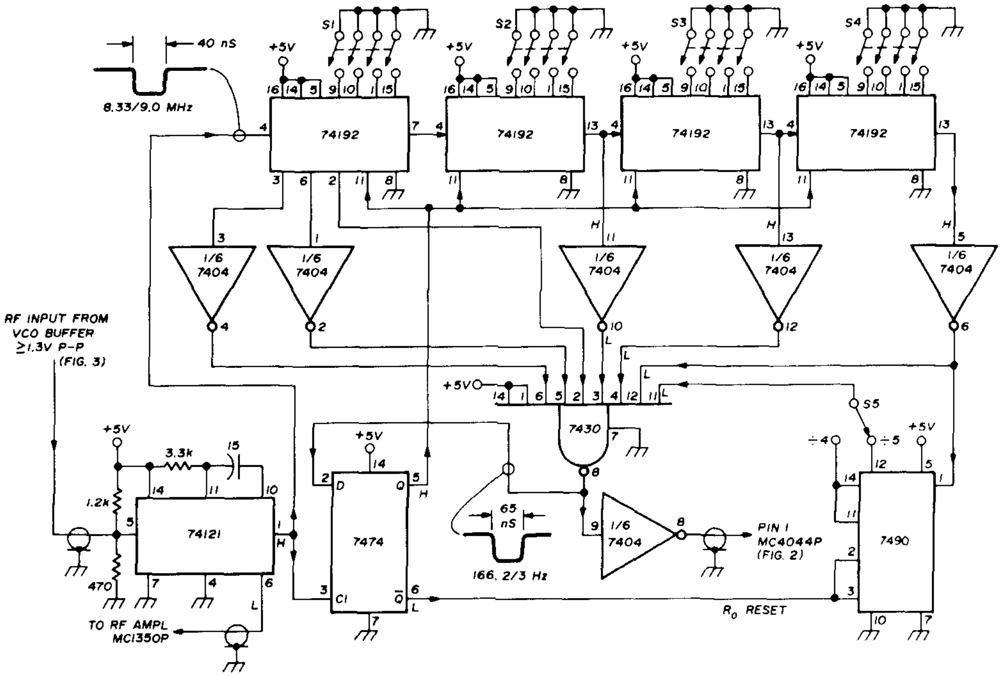


fig. 1. Programmable divider divides from 50,000 to 54,000 in steps of 1. The thumbwheel switch assembly (S1, S2, S3 and S4) is an EccoSwitch type 4R177612G. Switch S5 provides divide-by-4 for MARS netting (see text).

of the math. Frequency increments of 166.2/3 Hz, when multiplied by 6, yield 1.0-kHz steps on 6 meters; the required division is 50,000 to 54,000. A 1.0-MHz reference crystal divided by 6000 produced the necessary 166.2/3 Hz comparison signal for phase detection.

First off, a string of five 74192 programmable divider ICs were plugged into sockets Duco cemented to perfboard and wired to divide by 50,000 as shown in **fig. 1.** This wiring consisted of no. 28 Beldsol just a wiring error, maybe a stray oscillation or a bit more B+ bypassing."

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

About this time K2OAW described his programmable divider.[1] After some reading, the operating principles of K2OAW's circuit became clear. Since I only had transmitter frequency control in mind, his circuitry for receiver LO use could be deleted. Also, since the most significant extra counts. My skinny little magnet wire must have looked like kilohms!

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

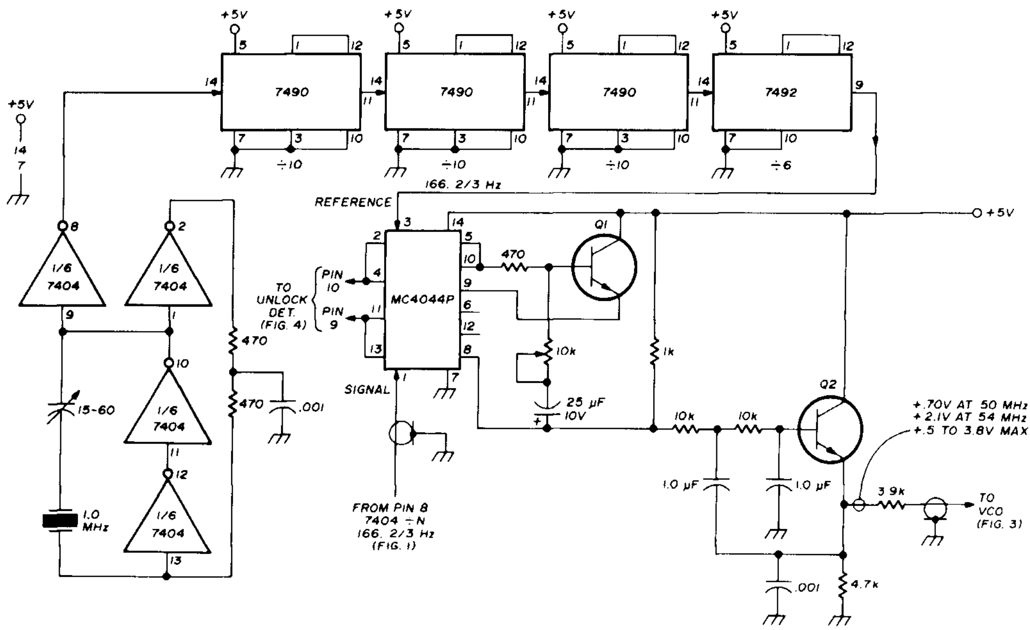


fig. 2. Circuit for the 1-MHz reference oscillator, divide-by-6000 and MC4044P phase detector. Transistors Q1 and Q2 may be any small npn transistors with current gain of at least 100 such as the 2N4124 or 2N5130.

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

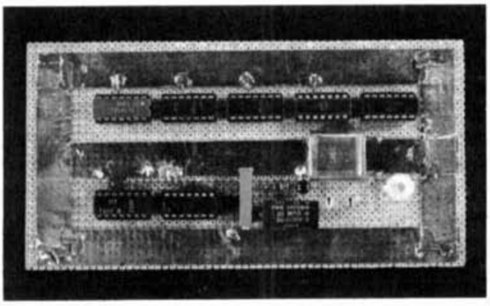
This new circuit replaced the first version and at least got me into the ballpark, meaning division was off by only scores of numbers instead of hundreds! Many troubleshooting tricks were tried and failed. Finally, a fruitful discussion with WA1CTS yielded a nugget generally known to computer builders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

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

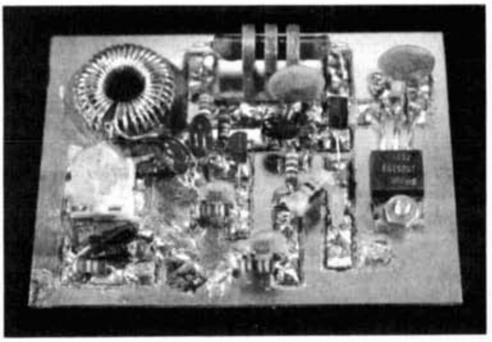
With an idealized clock pulse obtained from a lab pulse generator the next item of business was to simulate it inexpensively. A 74121 one-shot, timed to deliver 40-ns negative-going pulses, was found to be perfectly adequate. Proceeding next to the reference circuit and again using copper foil for power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

vco

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



Layout of the reference divider, showing the use of 3M adhesive-backed copper tape to achieve the low-impedance B+ and ground leads required for proper operation of the TTL logic. Circuit board for the programmable divider (fig. 1) uses the same technique.



Small size of the circuit boards used in this synthesizer results in a very compact package.

graphed tuning curve shown in **fig. 4.** This check should always be made to get an idea of linearity and voltage swing required for a given configuration.

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

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

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

phase detector

Next on the agenda was selecting and optimizing a phase detector circuit. Perhaps it would be helpful to set up an idealized specification and then see what can be done to meet it in the real world. This black box would detect the slightest difference in phase of incoming 166-Hz pulses, change this information into a precise step of dc control voltage and instantly slew the vfo back into exact synchronism with its reference. In truth, since nothing works in zero time, there would have to be *some* phase difference to produce a correction voltage, and steps of dc voltage generate wideband transients. Therefore, a real world circuit will necessarily have time delays, small error signals and low pass filtering as minimum requirements.

The first circuit I tried[2] was totally unsuited for low-frequency use; the vco put out a spectrum of hash many hundreds of kHz wide and optimization only reduced this to about 90 kHz. For audio-frequency phase detectors, many designers have gone to sample-and-hold circuits as a means of reducing pulse feedthrough, but since I didn't have any enhancement-mode fets on hand, a pair of MPSA12 Darlington transistors were substituted during a second effort. After considerable playing around with component values, sidebands were down to about 20 kHz. One bad feature was the lack of drive toward sync if the vco happened to get outside one end of lock range. For all its faults, a MC4044 IC always drove towards lock, no matter where the vco was initially.

Since W1UYK's circuit[3] worked on 41-Hz pulses I decided to give it a try. It was wired in per his schematic and showed promise right away; sidebands came down to about 10 kHz. Another period of testing commenced in an attempt to modify the circuit for this particular synthesizer. The final result is similar with one interesting exception — the use of a 10k variable for adjusting loop lock-up rate.

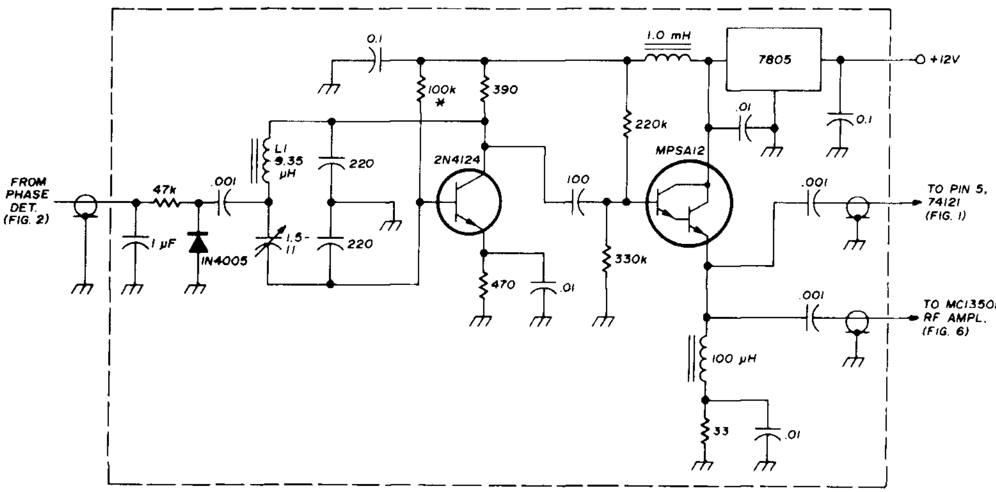


fig. 3. Circuit for the vco used in the 6-meter frequency synthesizer. The 9.35 μH inductor, L1, consists of 37 turns no. 22 enamelled on a T-68-2 Amidon toroid core.

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

Settling time is a little longer at 9 MHz due to slightly lower voltage sensitivity and is a tradeoff made for non-linear varicap pull range. A low leakage electrolytic must be used for the 25-μF capacitor (20 megohms on a Simpson 260) because it connects between a possible maximum 4 volts and a dc amplifier having a current gain of about 50,000. *Only* ac coupling is wanted. An RC filter follows the active filter to reduce sidebands to essentially zero and at 40 dB over S9, the carrier sounds perfectly quiet.

In a lab check using a special oscilloscope, varicap control voltage showed 10 microvolts pulse and about 30 microvolts random dc on a plus 1.0-volt pedestal at 8.5 MHz. This equates to an average carrier uncertainty of ±7 Hz or six times that on 6 meters, an acceptable figure for most transmission modes. These small error voltages remain unchanged, but the major dc voltage will lie between 0.5 and 3.8 volts, depending on frequency and trimmer capacitor adjustment (0.7 at 50 MHz and 2.1 at 54 MHz used here).

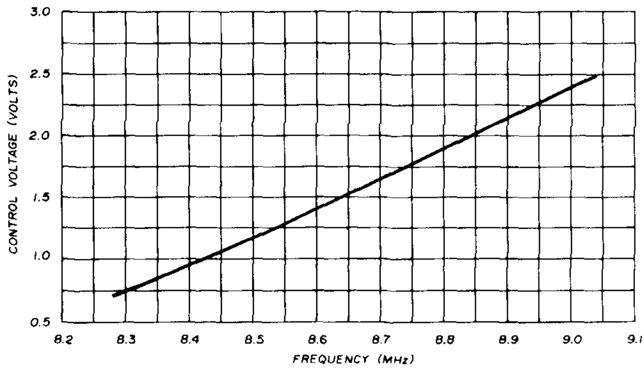


fig. 4. Frequency of vco vs control voltage, using a Sylvania 1N4005 rectifier as a varactor.

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

unlock detector

If the synthesizer becomes unlocked for any reason, transmission of off-frequency signals could take place. To prevent this, a simple pulse-width comparator, timer and relay deactivate the transmitter and hold it off until sync is regained (see **fig. 5**). Two NAND gates make up a one-shot whose timing capacitor produces one microsecond for every 770 pF, so .01 μF gives about 12 microseconds. This is longer than the normal up-to-5 microseconds out of the first gate. These two signals take turns keeping inputs low on a third gate and its output stays high. Should the vco suddenly shift frequency more than 10 kHz at 6 meters, the 5-microsecond pulse briefly becomes longer than the 12, gate output drops, firing the timer and energizing the relay for 4 seconds. Consequently, a frequency change of several kHz is possible without initiating action.

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

construction

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

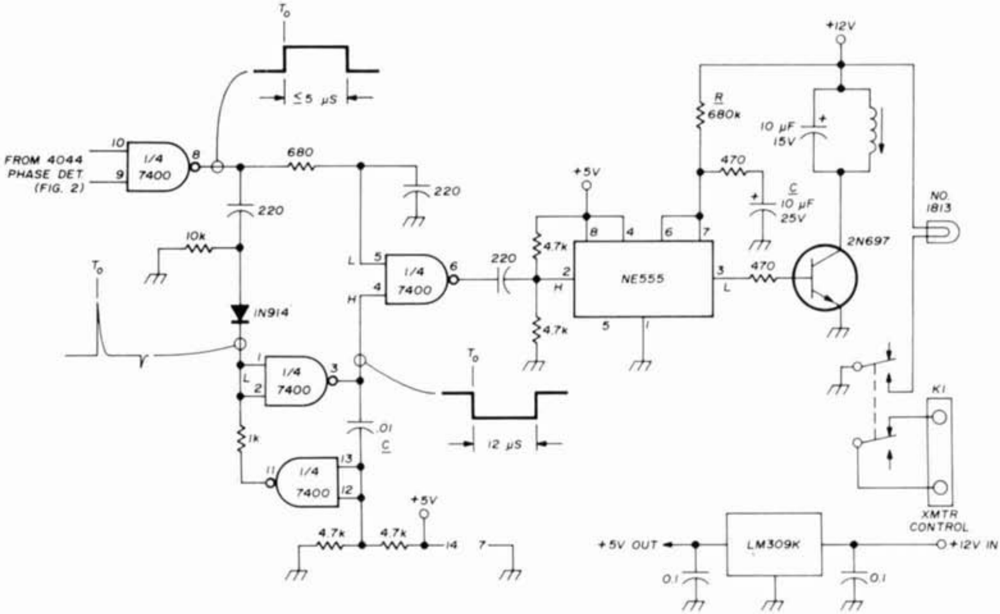


fig. 5. Circuit of the unlock detector and timer. Relay K1 is a Sigma 62R2-12DC. Simple three-terminal five-volt voltage regulator for the entire synthesizer is shown at right, below.

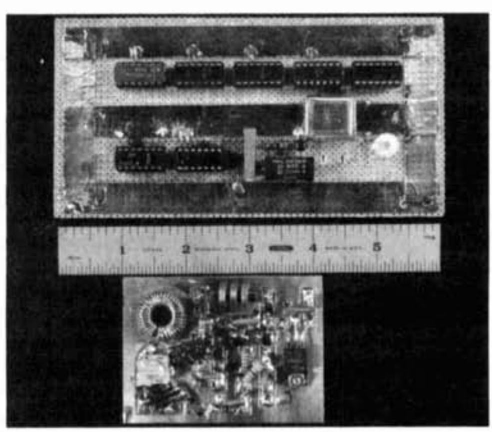
two voltage regulators: One for logic, one for the vco. Zener diodes have too high impedance and unregulated B+ is out of the question.

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

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

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

For a real eye-opener, try placing a battery-powered broadcast radio next to the programmable divider board to pick up its amazing spectrum of signals. Then,



Construction of the vco. The 9.35-µH inductor is in the upper left-hand corner of the board.

"finger test" the vco – the result is hard to believe!

summary

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

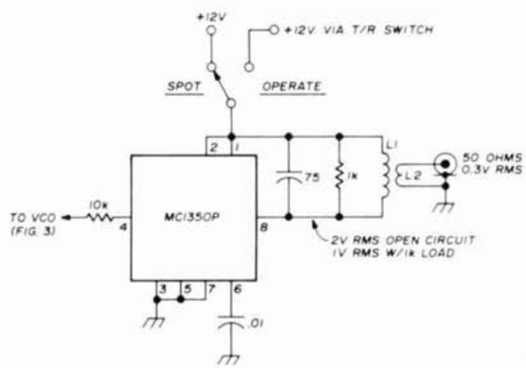


fig. 6. MC1350P rf amplifier provides 0.3-volt rms output into 50 ohms. L1 is 19 turns no. 28 on 3/6" diameter iron-core form, 3/4" long. L2 is 6 turns no. 28 over center of L1.

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ham radio

performance characteristics of vertical antennas

A discussion of matching networks, network losses and bandwidth of vertical antennas of various heights

Robert E. Leo, W7LR, Electronics Research Laboratory, Montana State University

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

The first question was, "What vertical height should be used?" A recent article[1] shows that short verticals do a pretty good job, which I agree with. Although some antenna articles have indicated that tall verticals have much better low angle radiation than short ones, reference to antenna books such as those written by Kraus[2] or Jordon[3] show that the low-angle radiation pattern is essentially the same for a wide range of vertical heights. More on this later.

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

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

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

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

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

Rather than try to answer all of the questions at once, several articles are planned, with only a few topics in each. The data and examples will cover a range

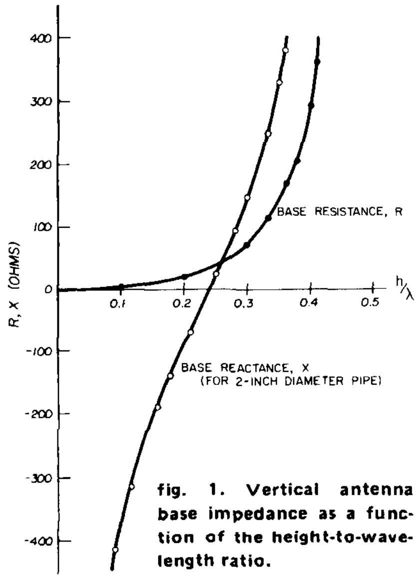

fig. 1. Vertical antenna base impedance as a function of the height-to-wavelength ratio.

of values which are practical for average amateur situations. The graphs will be large enough to serve as useful reference data for amateurs who wish to work out other examples.

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

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

antenna self impedance

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

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

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

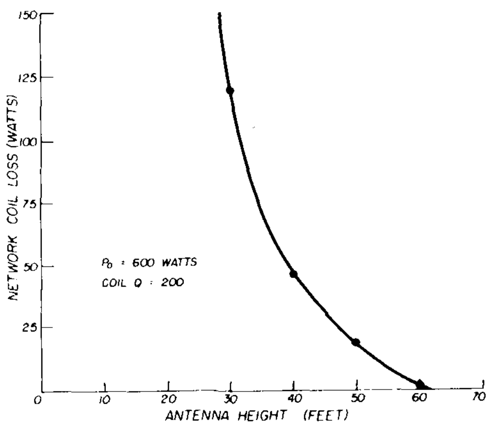

fig. 2. Network coil loss vs antenna height (see text).

base of a vertical antenna. Loop values result from considering the current loop up on the antenna. It is easy to convert from one set of values to another, as for example

$$R_{base} = R_{loop}/\sin^2(\beta h)$$

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

$$\beta = \frac{2\pi}{\lambda}$$

where λ is the wavelength, and h is the electrical length of the antenna in wavelengths.

antenna height

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

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

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

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

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

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

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

HA (feet)	h/λ	R	X	coax	vswr
80.0	0.325	90.6	+230.0	RG-11/U	8:1
76.0	0.31	75.0	+180.0	RG-11/U	8:1
60.0	0.243	33.8	+ 5.7	RG-11/U	2.2:1
70.0	0.285	55.0	+108.0	RG-8/U	6:1
69.0	0.28	52.0	+ 95.0	RG-8/U	5:1
61.5	0.25	36.6	+ 21.3	RG-8/U	1.8:1
60.0	0.243	33.8	+ 5.7	RG-8/U	1.5:1
59.3	0.241	32.0	0	RG-8/U	1.6:1

2. Series capacitor, C, between coaxial transmission line and antenna base.

HA (feet)	h/λ	R	X	coax	C,pF	vswr
80.0	0.325	90.6	+230	RG-11/U	182	1.2:
76.0	0.31	75.0	+180	RG-11/U	233	1.0:
70.0	0.285	55.0	+108	RG-8/U	388	1.06:
69.0	0.28	52.0	+95	RG-8/U	441	1.0:
61.5	0.25	36.6	+21.3	RG-8/U	1966	1.4:

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

HA (feet)	h/λ	R	X	L, μH	C,pF
60.0	0.2433	33.8	5.7	0.80	591
50.0	0.2028	20.7	−86.5	4.69	991
40.0	0.1622	12.1	−183.8	8.62	1467
30.0	0.1216	6.3	−303.0	13.41	2164

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

HA (feet)	h/λ	R	X	L, μH	C,pF
70.0	0.285	55	+105	4.33	637

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

For antennas of other heights the vswr is 1.0:1 if the proper L-networks are used. The L-networks were calculated using the methods outlined in my *QST* article,[4] or from the methods detailed in *ham radio.*[5]

network losses

The next topic to explore is that of matching network losses. Of course, there

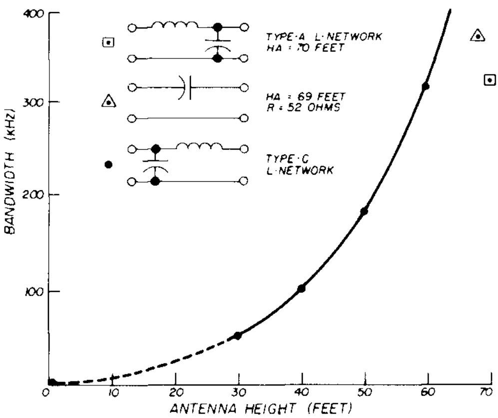

fig. 3. Bandwidth of vertical antennas vs height. Bandwidth edges defined by frequencies at which vswr increases to 2.0:1.

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

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

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

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

antenna bandwidth

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

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G. Kent Shubert, WAØJYK, 1308 Leeview Drive, Olathe, Kansas 66061

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

Semiconductors have finally found their way into high-frequency linear amplifiers. Broadband, untuned amplifiers that were seldom practical with vacuum tubes have become the best approach with semiconductors. Along with the advantages of rapid QSY and circuit simplicity comes the problem of unwanted harmonics. It is a recognized fact that a lowpass filter is a necessity with this type of amplifier.[1] Many of the broadband amplifier designs use push-pull circuitry, which may supress the second harmonic by 50 dB, but the third harmonic is suppressed only 12 dB.[2]

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

Several listings of normalized filter data have been printed and are quite simple to use.[3,4] Unfortunately, these publications are seldom in the average amateur's library. The theoretical design has been compromised only slightly to allow use of standard mica capacitors (either compression molded or dipped) that can be purchased from Allied, Newark or other suppliers. Five-hundred-volt capacitors will handle several hundred watts if the vswr of the antenna is near unity and are a wise choice unless low power and miniaturization is contemplated. The Micrometals toroidal cores listed are readily available from Amidon Associates.

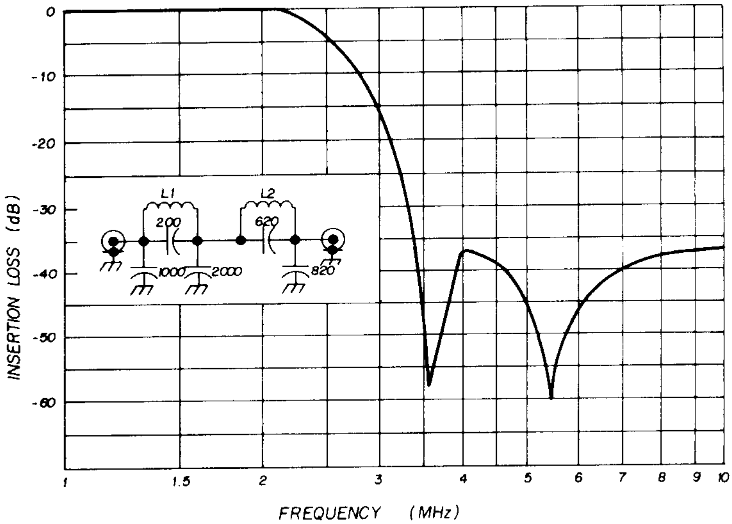

fig. 1. 160-meter lowpass filter. L1 is 26 turns number-18 on Amidon T80-2 toroid (4.2 μH). L2 is 23 turns number-18 on Amidon T80-2 toroid (3.13 μH). Insertion loss is 0.1 dB over the 160-meter band.

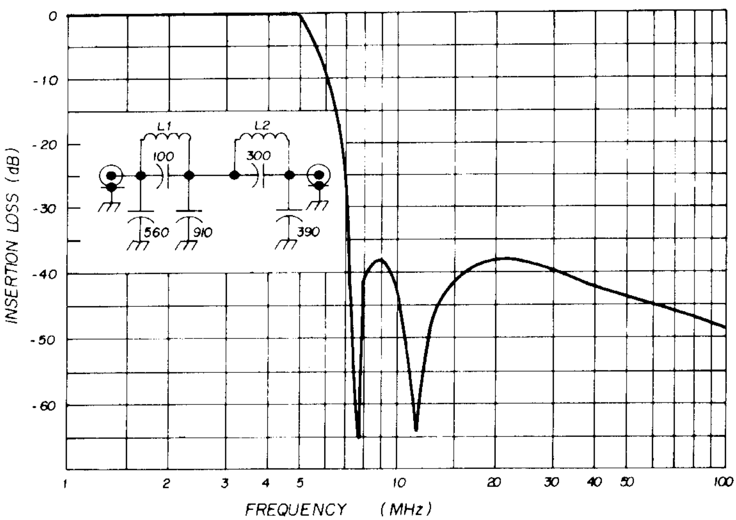

fig. 2. 80-meter lowpass filter. L1 is 18 turns number-16 on an Amidon T80-2 toroid (1.9 μH). L2 is 16 turns number-16 on an Amidon T80-2 toroid (1.46 μH). Insertion loss is 0.12 dB over the 80-meter band.

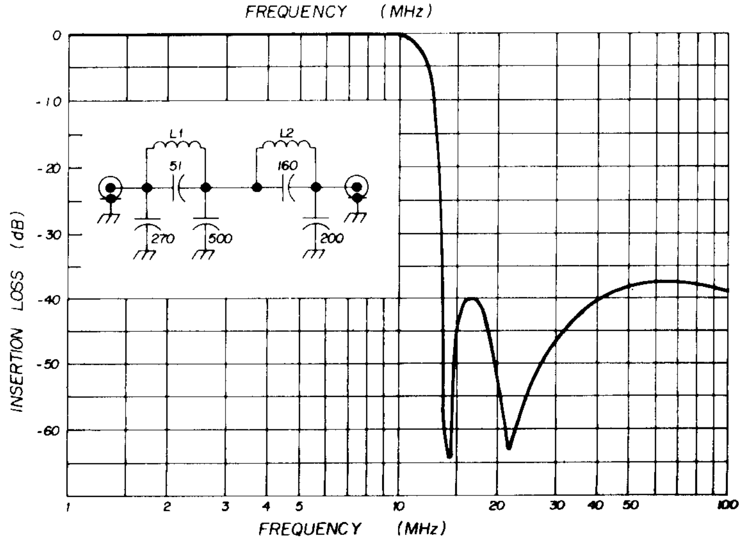

fig. 3. 40-meter lowpass filter. L1 is 10 turns number-16 on an Amidon T80-6 toroid (0.57 μH). L2 is 9 turns number-16 on an Amidon T80-6 toroid (0.41 μH). Insertion loss below 18 MHz is 0.17 dB.

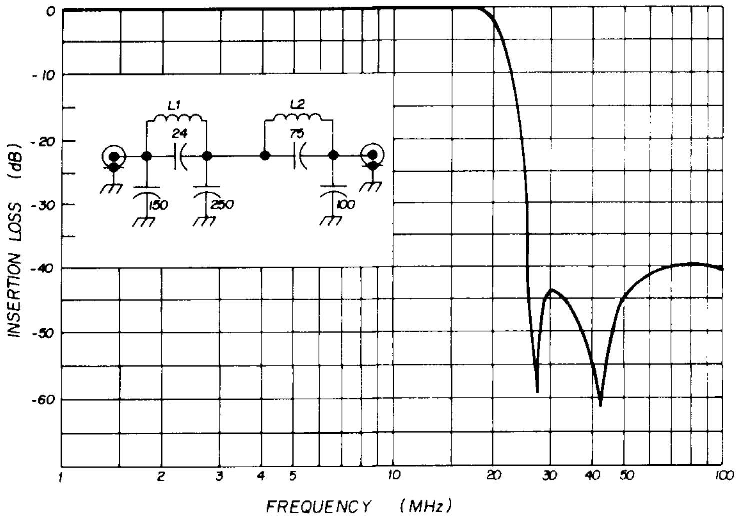

fig. 4. 20-meter lowpass filter. L1 is 10 turns number-16 on an Amidon T80-6 toroid (0.57 μH). L2 is 9 turns number-16 on an Amidon T80-6 toroid (0.41 μH). insertion loss below 18 MHz is 0.17 dB.

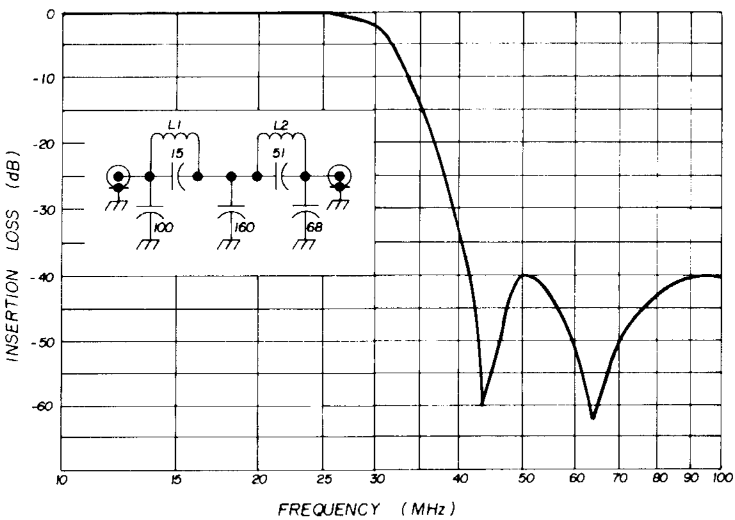

fig. 5. 15-meter lowpass filter. L1 is 9 turns number-16 on an Amidon T80-6 toroid (0.41 μH). L2 is 8 turns number-16 on an Amidon T80-6 toroid (0.27 μH). Insertion loss below 24 MHz is 0.25 dB.

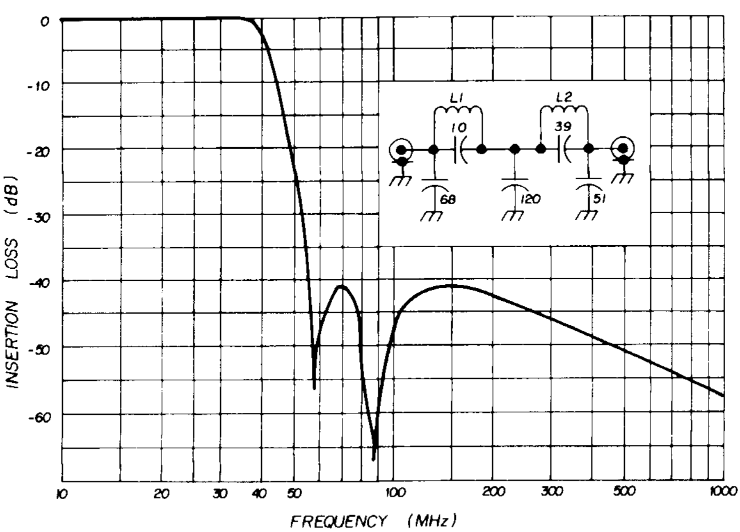

fig. 6. 10-meter lowpass filter. L1 is 8 turns number-16 on an Amidon T80-6 toroid (0.33 μH). L2 is 7 turns number-16 on an Amidon T80-6 toroid (0.19 μH). Insertion loss below 35 MHz is 0.3 dB.

Bathtub cans from old oil-filled capacitors make good cases with BNC or RCA Phono connectors soldered in the ends. If you are going solid state those old 1000-volt, oil-filled capacitors won't be needed anymore, so salvage the cases.

Designs and winding information are given for the top six amateur bands. The response curves were obtained by computer analysis with actual testbench verification of the 80- and 40-meter filters (those are the two bands I'm now working). The filters perform well without tuning, but a little adjustment of the resonant frequency will help assure 60-dB suppression of the second and third harmonics. There are several ways to tune the toroidal resonators.[5] In all six filters inductor L1 will resonate at the third harmonic and L2 will be resonated at the second harmonic.

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

references

1. Timothy P. Hulick, W9MIJ, "A Medium-Power HF SSB CW Transmitter, Part II," *QST,* June, 1973, page 37.
2. "TRW Application Note CT-113-71," TRW Semiconductors, 14520 Aviation Blvd., Lawndale, California 90260.
3. Von R. Saal, *Der Entwurf Von Filtern Mit Hilfe Des Kataloges Normierter Tiefpasse,* Telefunken, GMBH, West Germany.
4. Anatol I. Zverev, *Handbook of Filter Synthesis,* John Wiley & Sons, New York, 1970.
5. G. Kent Shubert, WAØJYK, "Tuning Toroidal Inductors," *ham radio,* April, 1972, page 24.

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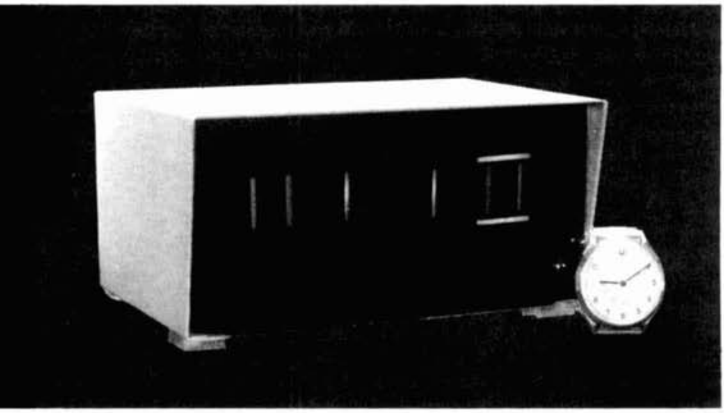
"That's Dave's bad habit!"



a simplified digital readout system

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

Harold W. Thompson, W6OIS, President, Rad-Ex Syntactics*

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

invention

Accepting the fact that digital equipment will never be anything more than

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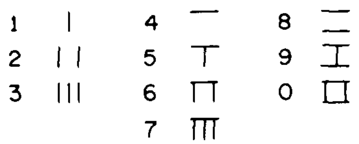
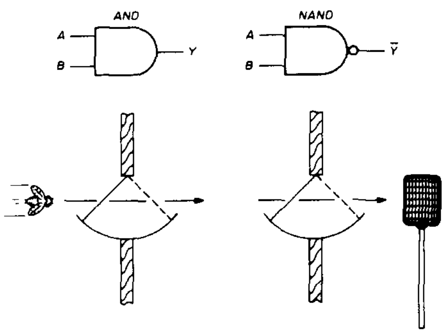
off and on switches relegates them to *binary* operation. Man must learn to use these bits of information in an efficient manner. My own approach to this binary age is to reform the old Potter readout lamps by arranging them in illuminated bars as follows:



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

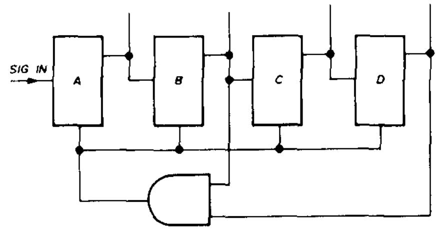
logic

To answer in more detail, some discussion of logic, counters and circuitry is necessary. It helps to remember that any digital device is just a mass of electrical switches. It depends on your own insight and knowledge to parallel or series them



to produce your desired result. For instance, the door and screen door are AND gates. Both must be open for the fly to come in. The results can be negative, NAND, if somebody is waiting with the fly swatter. The same analogy can be applied to a door and window forming the OR and NOR gates.

Master these concepts and their ramifications, and you will be able to follow any logic design. One ingredient you must apply to all logic is that in the real world a finite time must be allowed for signals



D	C	B	A	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10 = Reset signal
0	0	0	0	

fig. 1. Theoretical divide-by-10 ripple counter.

to pass through each logic block. Believe me, this is important. Usually, logic circuits end up in a counter, probably for display, or register, a group of binary bits which will be processed further.

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

The old problems of finite time and reality interfere and develop into a condition called *critical race.* Beware of these problems. It's been the downfall of many designs.

What happens is that the reset pulse has set all flip-flops to zero but in so doing, flip-flop B passes a trigger signal to flip-flop C and you find yourself with *binary* 0100. Thus, you spend a few more hours devising lockout circuitry so this

*U.S. Patent No. 3,671,943. A copy may be obtained from the Commissioner of Patents, Washington, D.C. 20231 (50 cents money order).

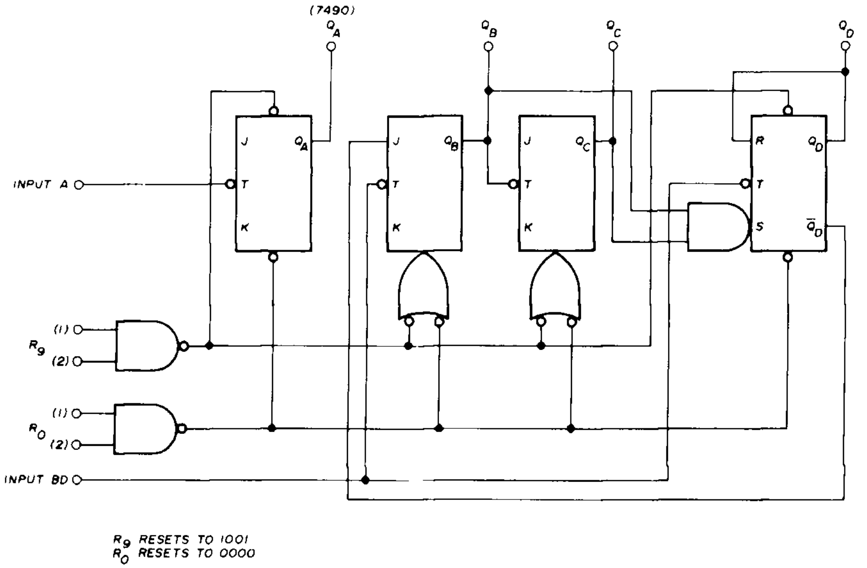


fig. 2. Commercial decade counter.

can't happen (see **fig. 2,** a commercial decade counter). Now that your counter is designed, you will need an indicator to communicate the binary number it holds.

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

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

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

technical

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

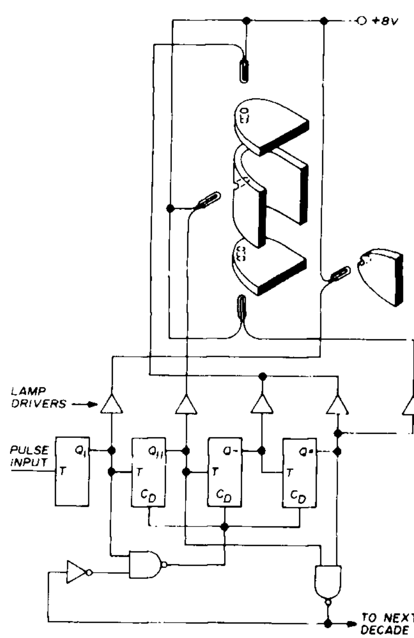


fig. 4. Rad-Ex System, decade counter to readout.

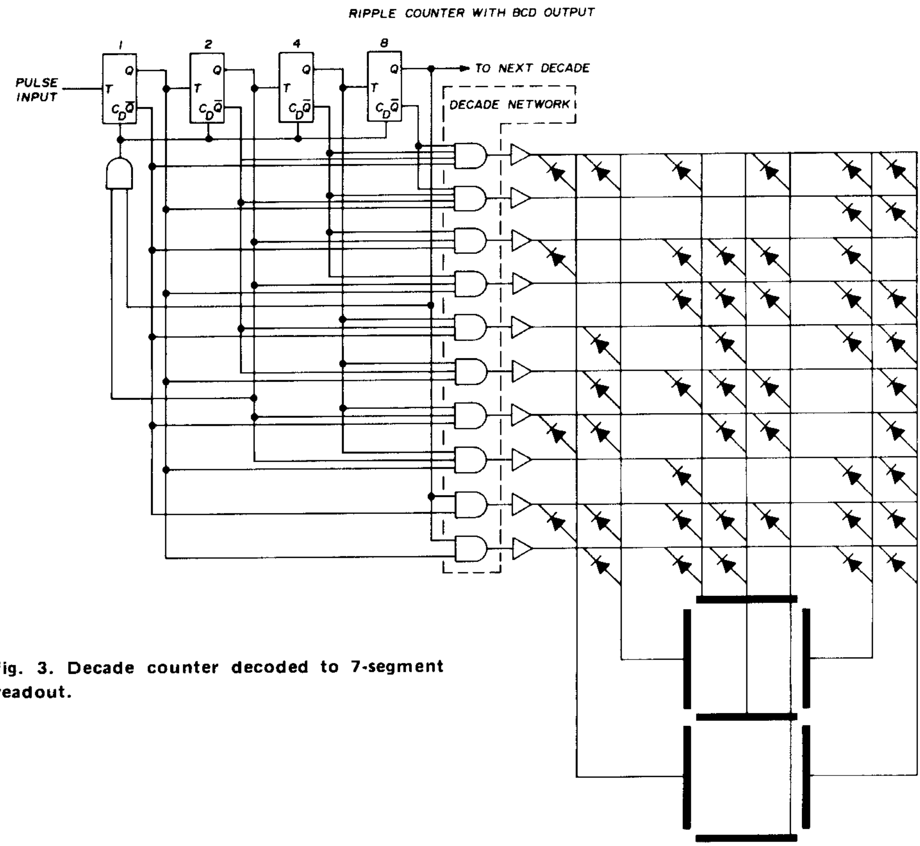


fig. 3. Decade counter decoded to 7-segment readout.

paths, while almost doubling the counting rate and automatically suppressing leading zeros. **Fig. 4** shows the circuit; its truth table is below:

D	C	B	A	
0	0	0	0	State Before Count Begins
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	AND to Reset
0	0	0	1	

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

For readout purposes, with one exception, the lamps are tied through lamp drivers directly to the flip-flops. The one exception is the case where binary 1000 also illuminates the lamp associated with flip-flop C.

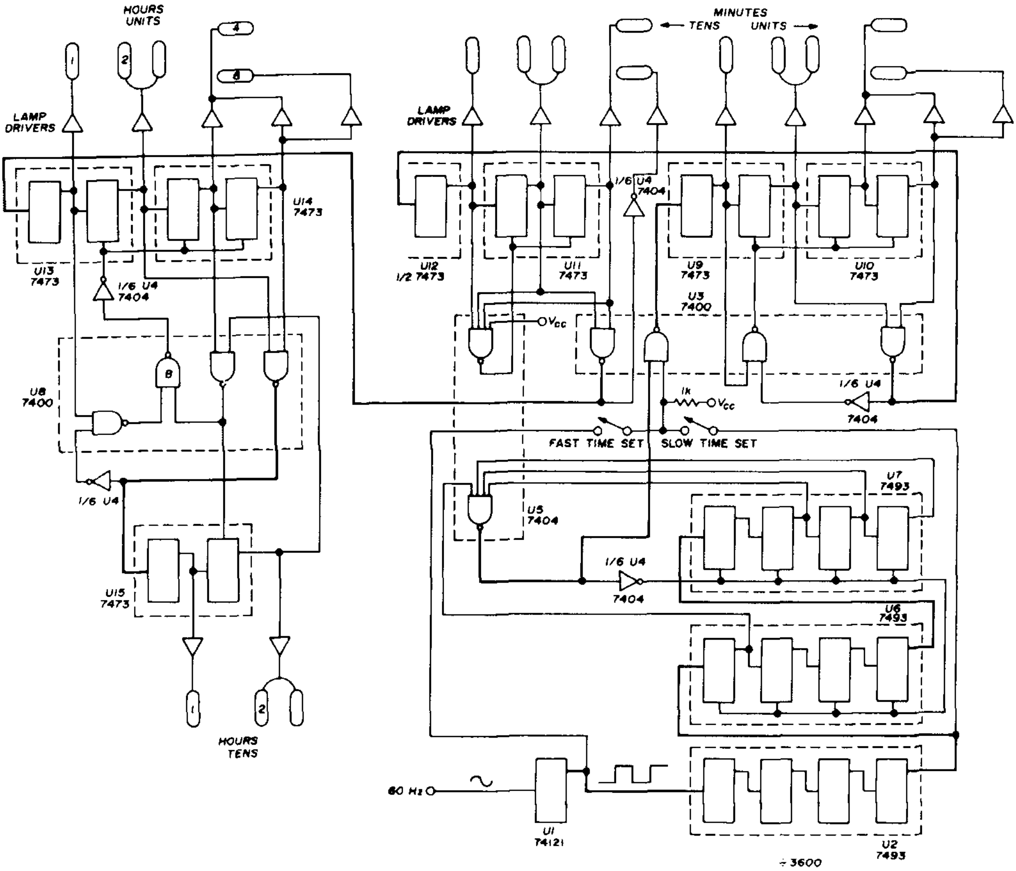


fig. 5. Twenty-four hour clock using Rad-Ex readouts.

application

The use of the Rad-Ex system can best be illustrated in a 24-hour clock where mixed counting is necessary. **Fig. 5** is the logic diagram for the clock and should be used as reference in the following sequence of operation: 60 Hz is fed to a one-shot multivibrator, U1, simply to eliminate false triggering. The output from U1 triggers a chain of 7493 flip-flops U2, U6, U7, which are used as a ripple counter to divide incoming pulses by 3600 (1110, 0001, 0000).

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

C	B	A	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	AND to Resets B & C
0	0	1	

The 24-hour portion of the clock uses the standard Rad-Ex decade counter plus a counter to keep track of the hours.

Essentially, the decade counter acts the same as the minute decade with the exception that the suppressed leading zero feature may be observed. The binary numbers 10 (2) and 0100 (4) are combined in a NAND gate, U8, to reset both decade and modulo-4 counters to binary

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

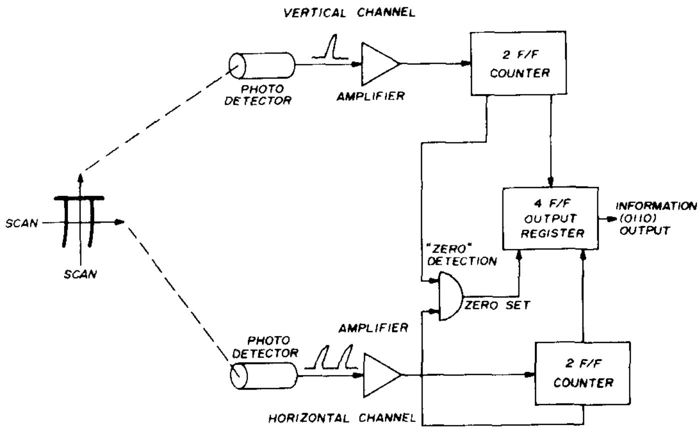
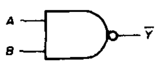


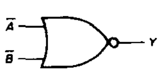
fig. 6. Rad-Ex optical reader device.

(00) (0000). Thus, until the first hour is reached only the minute display is illuminated.

The sharp eye may spot two NAND gates, part of U3A and U8B, which don't seem quite right. Here you must juggle your logic thinking for in the case of the NAND gate, I say, "If both inputs A and B ($A \cdot B$) are high, Y is low ($\overline{Y}$)."



You may look at this in a different way and say, "If A or B (A+B) is low, ($\overline{A+B}$), Y is high.



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

future

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

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

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More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94

new fets

simplify bias problems

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

Courtney Hall, WA5SNZ, 7716 La Verdura Drive, Dallas, Texas 75240

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

bias problem

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

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

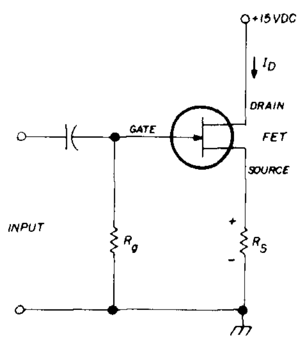

fig. 1. Typical field-effect transistor biasing arrangement.

results in a change in current of 1 mA, indicating a resistance of 1000 ohms.

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

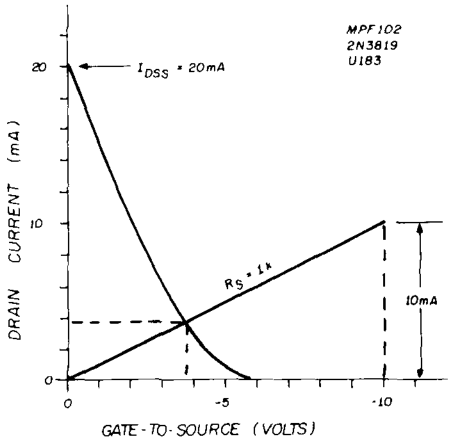

fig. 2. Typical fet drain current vs gate bias characteristic for I_{DSS} = 20 mA.

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

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

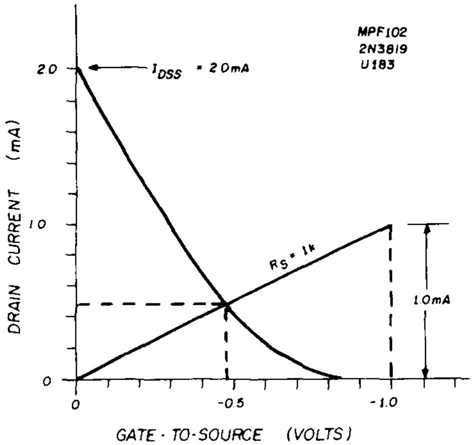

fig. 3. Typical fet drain current vs gate bias characteristic for I_{DSS} = 2 mA.

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

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

If this value of resistor is used with an fet

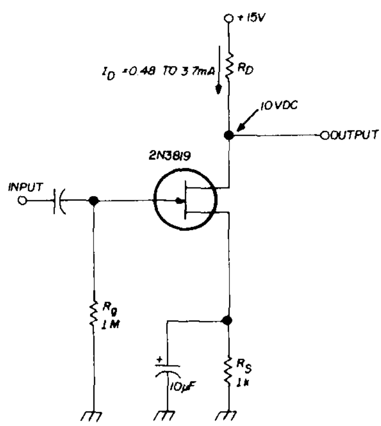

fig. 4. Simple audio amplifier circuit using a 2N3819 fet.

having an I_{DSS} of 2 mA, the drop across it will be only

(0.48 mA) (1.35k) = 0.65 volt

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

new fets give relief

One way to get around this biasing problem is to take a large number of fets and sort them into groups, each group having a relatively narrow I_{DSS} range. Fortunately, manufacturers are now doing this. Texas Instruments has taken the 2N3819 and broken it into five fet types, each of which has an I_{DSS} spread of 2 to 1 or less. These fets, which have a different pin configuration than the 2N3819 are listed in **table 1**. All of these

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

fet type	I_{DSS}
2N5949	12-18 mA
2N5950	10-15 mA
2N5951	7-13 mA
2N5952	4-8 mA
2N5953	2.5-5 mA

fets are priced under a dollar in small quantities, and they should be available from any of the larger electronic wholesalers which stock TI semiconductors.

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

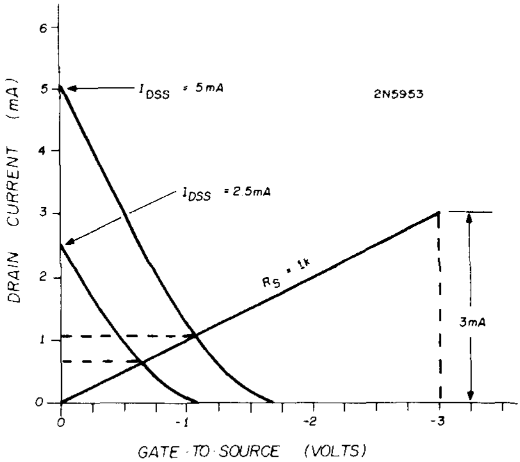

fig. 5. Typical drain current vs gate bias characteristic for Texas Instruments 2N5953 fet.

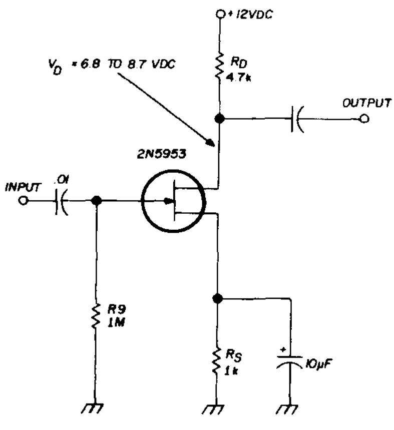

fig. 6. Audio amplifier circuit using a 2N5953 fet.

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

fet type	I_{DSS}
2N5484	1-5 mA
2N5485	4-10 mA
2N5486	8-20 mA

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

conclusion

The newer fets, having lower I_{DSS} spreads, allow the use of simple bias arrangements to arrive at reproducible circuits. The cost of these devices is not much higher than the older types having wide I_{DSS} spreads. Thus, fets may be applied with greater ease to a wide variety of circuit applications, and the high input impedance of fets may be taken advantage of without the penalty of unpredictable bias conditions.

ham radio

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LOW BAND

12 volt-trunkmount

MODEL	DESCRIPTION	PRICE
FMTR80D	30w, dynamotor	$ 30.00
FMTR140D	60w, dynamotor	40.00
FMTR41V	12w, vibrator	25.00
U41GGT	30w, transistor	100.00
U51GGT	50w, transistor	110.00
U41HHT	30w, motrac ps	200.00
U51HHT	50w, motrac ps	225.00
U71HHT	100w, motrac ps	250.00
T71GJT	100w, transistor	125.00

6/12 volt-trunkmount

MODEL	DESCRIPTION	PRICE
T41GGV	30w, vibrator ps	70.00
T51GGD	60w, dynamotor	40.00
T51GGV	60w, vibrator ps	75.00
T51AGD	60w, dynamotor	40.00

HIGH BAND

12 volt-trunkmount

MODEL	DESCRIPTION	PRICE
FMTRU80D	30w, dynamotor	$ 35.00
FMTRU140D	50w, dynamotor	45.00
U43GGT	30w, transistor	100.00
U43HHT	30w, motrac	200.00
U53HHT	50w, motrac	225.00
U63HHT	80w, motrac	250.00
U73MHT	110w, motrac	300.00

6/12 volt-trunkmount

MODEL	DESCRIPTION	PRICE
T33GGV	10w, vibrator ps	50.00
T43GGV	25w, vibrator ps	75.00
T43GAD	30w, dynamotor	35.00
U53GKT	60w, transistor ps	125.00
T53GKD	60w, dynamotor ps	65.00
FMTRU41V	10w, vibrator ps	25.00

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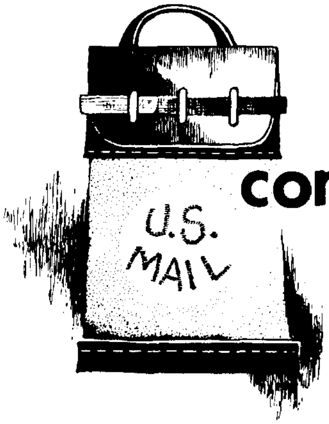


comments

log-periodic antennas

Dear HR:

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

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

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

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

Stan Whiteman, 5B4AO/W1MDZ
Nicosia, Cyprus

reciprocating detector

Dear HR:

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

Several readers have also asked where the selectivity curve is 500-Hz wide and what is its slope. The filter I used was designed to have its 500-kHz passband at the 3-dB points on a slope which is not particularly steep for an inductive filter. Indeed, at 500 Hz, the L3 inductance is very loosely coupled to the other two sections of the transformer. The bandpass formula (f_r/Q_o) indicates that the bandpass of the filter is actually narrower than

500 Hz – in fact, bandpass is closer to 250 Hz. The 390-ohm resistor used in series with one of the differential inputs loads the thing down so it is broader. If the bandpass is too narrow, poor lock-in range is experienced on a-m, and there is very poor "presence" in the quality of ssb signals. If the bandpass is too wide, poor impulse rejection will result.

Stirling M. Olberg, W1SNN
Waltham, Massachusetts

vhf fm in the United Kingdom

Dear HR:

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

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

John Akam, G8BIH
Wooteys, Alton, Hants

finding square roots

Dear HR:

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

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

Fred R. Scalf, Jr., K4EID
Springfield, Virginia

Dear HR:

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

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

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

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

$$X_1 = \frac{1}{3}(2X_o + \frac{P}{X_o^2})$$

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

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

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

Stephen R. Alpert, W1GGN
Auburn, Massachusetts

the ham notebook

surplus thumbwheel switch modification

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

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

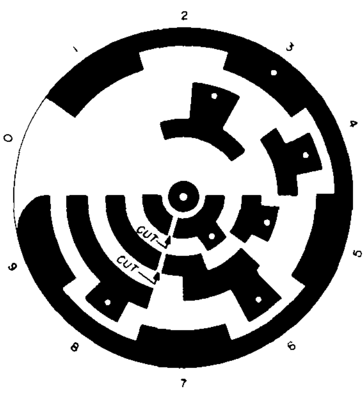


fig. 1. First step in the modification is removal of two thin sections of conducting material on the wiper side of the switch.

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

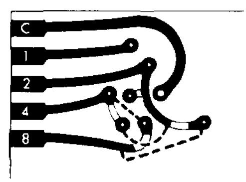


fig. 2. On the reverse side of the switch remove the sections indicated and install the three jumpers.

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

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

number	1	2	4	8
0	open	open	open	open
1	short	open	open	open
2	open	short	open	open
3	short	short	open	open
4	open	open	short	open
5	short	open	short	open
6	open	short	short	open
7	short	short	short	open
8	open	open	open	short
9	short	open	open	short

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

Geo. Hrischenko, VE3DGX

reference

1. A.D. Helfrick, K2BLA, "High-Frequency Frequency Synthesizer," *ham radio,* October, 1972, page 16.

cutting a minibox down to size

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

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

I. Queen, W2OUX

finding the focal length of surplus microwave dish antennas

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

$$Y^2 = 4Px$$

where P represents the distance from the vertex to the focal point. The equation is that of a parabola with its vertex at x = 0, Y = 0. The curve is symmetric about the x-axis and opens to the plus-x direction. The coordinates of one point other than the vertex are needed to determine the

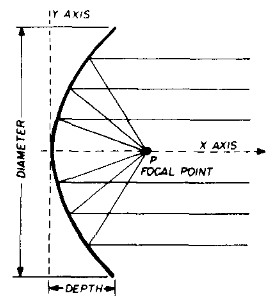


fig. 3. Cross-section of a typical microwave dish antenna. Equation for finding the focal point is given in the text.

curve. The edge of the antenna is a convenient point. The diameter is equal to 2Y and the depth is equal to x. Solving for the focal length P

$$P = \frac{Y^2}{4x} = \frac{\left(\frac{\text{diameter}}{2}\right)^2}{4\,(\text{depth})}$$

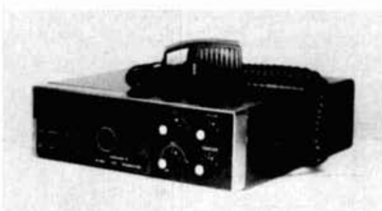
or $$P = \frac{1}{16}\,\frac{(\text{diameter})^2}{\text{depth}}$$

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

John M. Franke, WA4WDL

new products

six-meter transceiver



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

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

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

two-meter converter

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

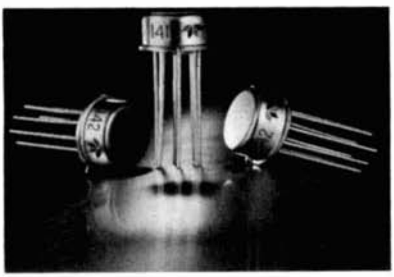
The new 144-MHz converter uses gate-protected dual-gate mosfets to provide high sensitivity while avoiding serious overload effects. The carefully designed circuit allows full utilization of the mosfet sensitivity with one rf amplifier. This is of great help in preventing cross-modulation overload by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

The converter is virtually free from birdies due to the use of a seventh overtone crystal oscillator. This high overtone oscillator eliminates the need for frequency multipliers. This feature, standard in all Janel converters, is very effective in reducing suprious responses. Three tuned circuits between the rf amplifier and the mixer complete the defense against spurious responses.

More Details? CHECK—OFF Page 94

An attractive, metallic green, die-cast cabinet is used with this compact converter. BNC connectors are provided on the back panel for input and output. A power connector for 12 Vdc is also provided. Gain is 20 dB and noise figure is 3 to 5 dB. Converters are available for i-f frequencies of 26-30 MHz or 28-32 MHz. The units, completely guaranteed, are priced at an economical $49.95, postpaid. Order from Janel Laboratories, Box 112, Succasunna, New Jersey 07876. For more information, use *check-off* on page 94.

general-purpose op-amps



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

The LM 141 series is fully compensated internally and is compatible with existing circuit designs using the popular 741, 107 and 1556. The uncompensated LM 142 series is a replacement for 101A, 748 and 777 applications and approaches the input performance of the 108 series amplifiers at a significant price reduction. The LM 141/142 is expected to fit applications where the 741 falls short on speed and impedance performance. They have excellent characteristics for sample and hold circuits, long interval integraters, timers and active filter through the audio frequency range. Each amplifier meets all of the standard electrical characteristics and also includes the convenience features of short circuits and latch up protection found in other general-purpose amplifiers.

Teledyne Semiconductor will provide a free sample of the LM 141/142 to qualified engineers who respond on company letterhead with information on intended application. For more information, write to Teledyne Semiconductor, 1300 Terra Bella Avenue, Mountain View, California 94040, or use *check-off* on page 94.

base-station power supply

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

More Details? CHECK–OFF Page 94

PW-4 features a modern cabinet design, current limiting and reliable heavy-duty components.

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

programmable voltage regulator

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

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

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

slinky dipole antenna

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

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

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

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

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

More Details? CHECK–OFF Page 94

variable rf attenuator

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

eliminating engine interference

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

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

short circuits

capacitance meter

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

motorola dispatcher conversion

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

vhf superregen receiver

In the July, 1973, issue, on page 23, the schematic for the vhf regenerative receiver should include a 0.01-μF capacitor between the wiper of the 5000-ohm gain control and the base terminal of the first TIS97 transistor.

continuous-phase audio-shift keyer

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

two-meter cavity filter

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

	frequency (MHz)			
	50	144	220	432
A	41.0"	17.0"	7.30"	5.00"
B	38.0"	15.0"	5.20"	4.80"
C	35.0"	12.9"	4.00"	3.80"
D	3.0"	3.0"	3.00"	3.00"
E	4.5"	1.5"	3.00"	3.00"
F	1.4"	0.375"	1.00"	0.75"
G	3.0"	2.1"	1.20"	1.00"
H	3.0"	1.063"	2.75"	2.75"
J	0.75"	0.75"	0.75"	1.00"
K	see text			

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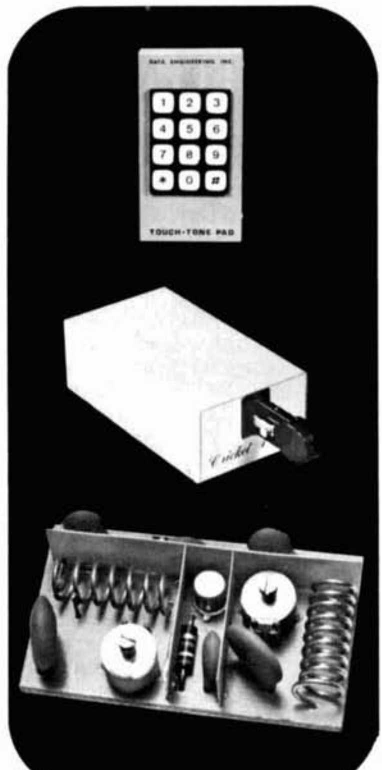

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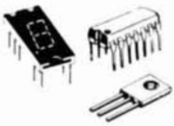

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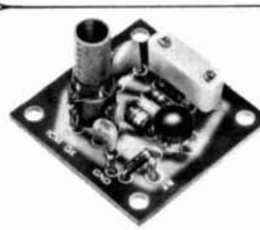

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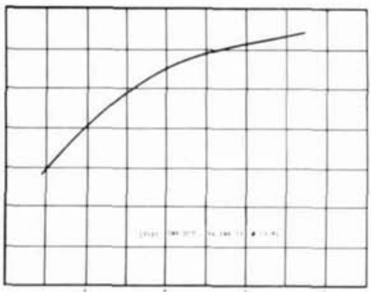

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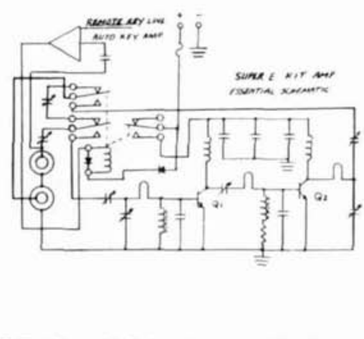

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SG24/TRM3 Sweep Gen. 15-400 MHz, CW, AM, FM Xtal markers, scope-Dev. to 20%	245
TS-403A-Sig. Gen. (HP616) 1.8-4gHz	385
URM 7 RI-FI mtr (sim. NF-105) 20-400MHz	750

(Send SASE for complete list)

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

More Details? CHECK—OFF Page 94

Lowest Prices

Largest Selection TTL IC's

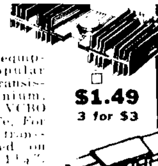
Buy 3 or more. 10% discount

Brand New * "DIP" Packages Order by type number! Spec sheets on request "ONLY"

Type	Sale	Type	Sale	Type	Sale	Type	Sale	Type	Sale
SN7400	$0.30	SN7437	.55	SN7472	.50	SN74112	.95	SN74163	1.95
SN7401	.30	SN7438	.55	SN7473	.55	SN74113	.95	SN74164	2.95
SN7402	.30	SN7440	.30	SN7474	.55	SN74114	.95	SN74165	2.10
SN7403	.30	SN7441	1.40	SN7475	1.00	SN74121	.60	SN74166	2.05
SN7404	.35	SN7442	1.50	SN7476	.65	SN74122	.95	SN74173	2.50
SN7405	.35	SN7443	1.50	SN7478	.95	SN74123	1.20	SN74174	3.20
SN7406	.45	SN7444	1.50	SN7480	.65	SN74125	.71	SN74175	3.20
SN7407	.55	SN7445	1.50	SN7481	1.25	SN74126	.71	SN74176	2.10
SN7408	.35	SN7446	1.65	SN7482	.99	SN74139	1.25	SN74177	2.10
SN7410	.30	SN7447	1.45	SN7483	1.25	SN74140	1.25	SN74179	2.10
SN7411	.35	SN7448	1.50	SN7485	1.41	SN74145	1.55	SN74180	1.20
SN7413	.95	SN7450	.30	SN7486	.55	SN74148	4.50	SN74181	4.90
SN7415	.55	SN7451	.30	SN7489	4.50	SN74150	1.61	SN74182	1.20
SN7416	.55	SN7453	.30	SN7490	1.49	SN74151	1.25	SN74185	2.50
SN7417	.55	SN7454	.30	SN7491	1.35	SN74152	4.95	SN74192	1.95
SN7420	.30	SN7455	.55	SN7492	1.35	SN74153	1.60	SN74193	1.95
SN7421	.55	SN7460	.30	SN7493	1.35	SN74154	2.10	SN74194	1.95
SN7422	.35	SN7461	.35	SN7494	1.35	SN74155	1.55	SN74195	1.25
SN7425	.50	SN7462	.35	SN7495	1.35	SN74156	1.45	SN74196	2.50
SN7426	.36	SN7464	.30	SN7496	1.35	SN74157	1.55	SN74197	2.50
SN7430	.30	SN7465	.50	SN74106	.95	SN74158	1.55	SN74198	2.65
SN7432	.35	SN7470	.50	SN74107	.70	SN74160	1.95		
		SN7471	.55	SN74108	.95	SN74161	1.95		

• Factory Marked   * Money Back Guarantee   Buy 100 — Take 20%

HIGH POWER TRANSISTOR WITH HEAT SINK



Removed from new equipment! Includes popular 2N174 'doorknob' transistor TO-36, germanium, PNP, 150 watts, VCBO 80V, 15 amps, 40 hfe. For ignition, high power transmitters, etc. Mounted on heat sink 5 x 2½ x 1¼".

☐ **$1.49** 3 for $3

"MEMORY LANE" Buy Any 3 Take 10%

☐ 1101	256 Bit RAM MOS	$2.50
☐ 1103	1024 Bit RAM MOS	7.50
☐ 2516	Character Gen. ROM	12.50
☐ 7489	64 Bit RAM TTL	3.25
☐ 8223	Programmable ROM	6.50
☐ MM5260	1024 Bit RAM	7.95
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Op Amps FACTORY TESTED

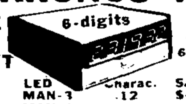
Buy Any 3 Take 10% Discount!

☐ 531	Hi slew rate op-amp (TO-5)	$2.50
☐ 532	Micro power 741 (TO-5)	2.50
☐ 533	Micro power 709 (TO-5)	2.50
☐ 536	FET input op amp (TO-5)	2.95
☐ 556	5 Times faster than 741C	2.10
☐ 558	Dual 741 (TO-5)	1.00
☐ 560	Phase lock loops (DIP)	2.95
☐ 561	Phase lock loops (DIP)	2.95
☐ 562	Phase lock loops (DIP)	2.95
☐ 565	Phase lock loops (A)	2.95
☐ 566	Function generator (TO-5)	2.95
☐ 567	Tone decoder (A)	2.95
☐ 702C	Hi-grain, DC amp (TO-5)	.49
☐ 703C	RF-IF, amp, 14 ckts (TO-5)	.69
☐ 704	TV sound IF system	1.50
☐ 709C	Operational amp (A)	.47
☐ 709CV	Op amp (mini DIP)	.47
☐ 710C	Differential amp (A)	.47
☐ 711C	Dual diff. comp (A)	.47
☐ 723C	Voltage regulator (A)	.75
☐ 733	Diff. Video Amp	1.75
☐ 741C	Frequency compensator 709 (A)	.49
☐ 741CV	Freq. comp 709 (Mini DIP)	.49
☐ 747C	Dual 741C (A)	.95
☐ 748C	Freq. adj. 741C (A)	.49
☐ 753	Gain Block	1.75
☐ 709-709	Dual 709C (DIP)	1.00
☐ 739-739	Dual stereo preamp	1.98
☐ 741-741	Dual 741C (A)	1.00
☐ PA265	5-Watt voltage regulator	1.95
☐ ULN2300M	Op amp with SCR	1.50
☐ CA3065	Video Audio system	1.05
☐ 75451	Dual peripheral driver	.88
☐ 75491	Quad seg driver for LED readouts	1.65
☐ 75492	Hex driver w/col. out 250 ma. For LED readouts	1.85

(A) TO-5 or DIP dual in line pak

KRONOS WITH "TIME BASE"*

CHOOSE YOUR READOUT



6-digits

Cabinet is 6" x 5½" x 6"

$47. Any Type Clock less time-base

NEW FOR 1974!

• With TIME BASE $64.95

Type	LED	Charac.	Sale
☐ KR-101	MAN-3	.12	$47.
☐ KR-103	MAN-4	.19	47.
☐ KR-104	Nixie*	.45	47.
☐ KR-105	707†	.33	47.
☐ KR-106	704†	.33	47.
☐ KR-107	SLA-1†	.33	47.
☐ KR-108	Same as SLA-1 but GREEN, add $12.		

† "MAN" LED readouts are "all LEDs" but the Litronix 707 and Opcoa SLA-1, like the MAN-1, are of the reflective bar segment technique, the 704 is the reflective bar version of the MAN-4. *The Nixie tube is a 7-segment device as others.

- Now two clocks in one!
- For 12VDC* 110VAC!
- Now adaptable to boats, planes & cars too!
- *One price for any LED!*
- The only clock of its kind in USA today!
- Compare and see!
- 12 or 24-hr clock

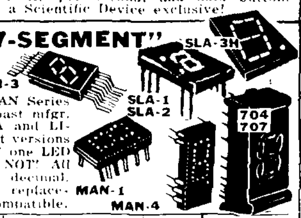
Scientific Devices introduces the new any LED Kronos digital clock. That's right, you can choose the "ALL-LED" Man-1, Man-3, and Man-4, and the new reflective bar types with the larger digits, at only one price, $47. This is a Scientific Device first! We even hav the GREEN LED readouts at a slightly extra cost. We have more . . . for $19.95 we have available as an (*) extra option to Naval Observatory your clock, or making it an all-purpose all-duty unit. For indoor and outdoor activity. This **"TIME BASE"** is the simplest on the market today with the help of one of the largest time base manufacturers for the famous digital wrist watches. Therefore, current drain is negligible, not like other cumbersome types. It's easy to construct, easy to slip into the Kronos of your choice and connect with easy instructions. Its overall design is simple and easy to construct. The kit is complete with famous black-and-white TEN-TEC cabinet, plus all accessories with booklets. Features include 3 setting controls, 1-hour per second, 1-minute per second, and hold button. KR100 series is a Scientific Device exclusive!

CRYSTAL TIME BASE FOR ANY KRONOS

☐ **$19.95**

Includes precision crystal, time-base IC, pc board & accessories with info.

LITRONIX-OPCOA-MAN "7-SEGMENT" LED Readouts



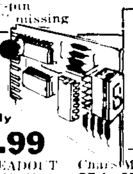
All fit 14-pin IC sockets. All 7-segments. MAN Series "all LED" and made by well-known West Coast mfgr. Others Reflective Bar type made by OPCOA and LITRONIX. The Reflective Bar types are low-cost versions of the MAN's except .33 character height! If one LED blows you lose a segment. MAN's you DO NOT! All readouts 0-to-9 numerals, plus letters and decimal. **Opcoa and Litronix products pin-for-pin replacements for MAN-1 MAN-4. All 5V TTL compatible.

ALL LED READOUTS — TYPE	character Size	Color Display	Decimal	Mils	Driver	Each	Special
☐ MAN-3 equal	.115	Red	Yes	10	SN7448	1.69	3 for 4.50
☐ MAN-3 equal	.115	Red	***	10	SN7448	1.50	3 for $4.
☐ MAN-3M equal*	.127	Red	Yes***	10	SN7448	1.50	3 for $4.
☐ MAN-4 equal*	.190	Red	Yes	15	SN7448	2.50	3 for $6.
☐ MAN-4 equal*	.190	Red	Yes***	15	SN7448	2.25	3 for $5.
"REFLECTIVE LITE BAR" (Segment LED Readouts)							
☐ 707** (MAN-1)	.33	Red	Yes	20	SN7447	2.75	3 for $6.
☐ 704** (MAN-4)	.33	Red	Yes	20	SN7448	2.75	3 for $6.
☐ SLA-1** (MAN-1)	.33	Red	Yes	20	SN7447	2.75	3 for $6.
☐ SLA-1** (MAN-1)	.33	Red	No	20	SN7447	2.25	3 for $5.
☐ SLA-3H Giant	.70	Red	Yes	20	SN7447	6.50	3 for $18.
☐ SLA-11C** (MAN-5	.33	Green	Yes	40	SN7447	4.95	3 for $13.

* Red epoxy case, others clear. ** Litronix and Opcoa's pin-for-pin equals and electrical specs as MAN-1 or MAN-4. *** LED "dot" missing

LED MITY DIGIT "DCM'S"

Buy 3 — Take 10%



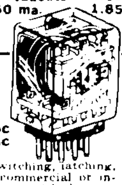
Scientific Devices "Digital Counting Modules" outperform any other DCM on the market today. More features than ever before! Not gaseous, not incandescents, not nixie but the modern LED. Choose from such famous manufacturers as Monsanto's MAN-1, MAN-4, Litronics 707 and 704, Opcoa's SLA-1 (the last 4 having character heights of 0.33 at no extra charge). Each kit includes *3x2" p.c board with fingers for a FREE edge* connector, side-mounting dip socket, LED readout of your choice, resistors, 3 IC's, and Molex connectors (this ELIMINATES SOLDERING YOUR IC's) and booklet. **INCLUDES P.C. EDGE CONNECTOR — FREE!**

Only **$9.99**

READOUT	Chars	Maker
☐ MAN-1	.27 h.	Monsanto
☐ MAN-4	.19 h.	Monsanto
☐ 707*	.33 h.	Litronics
☐ 704**	.33 h.	Litronics
☐ SLA-1*	.33 h.	Opcoa

* Pin-for-pin MAN-1, ** Pin-for-pin MAN-4, elec. char. same

Potter & Brumfield KAP RELAYS



Your choice 3 for $7.80 **$2.98**

3PDT 12 VDC 115 VAC

Excellent for "HAM" use as antenna switching, latching, transmit, receive, etc., and 100's of commercial or industrial uses. Includes plastic dust-cover with diagram and hookup info, 11-pin plug-in base. Contacts movable gold flashed silver, stationary overlay, with silver cadmium oxide movables. *All contacts 10 amp 3PDT. Coil* data.115VAC 2250 ohms, 17.5 ma. 12 VDC 21 mils 168 ohms. Size: 2¼" x 1 5/16". Wt. 4 ozs. Center pin missing. Comar Mfg. type equal too.

Any "Chip" $8.88 ☐ *With Spec Sheet

NATIONAL EQUALS ON "DIGITAL CLOCK on a CHIP"

Mfrs #	Description	Sale
☐ 5311	28-pin, ceramic, any readout, 6-digits: A-B-D	$8.88
☐ 5312	24-pin, ceramic, any readout, 4-digits: C-D	$8.88
☐ 5313	28-pin, ceramic, any readout, 6-digits: A-C	$8.88
☐ 5314	24-pin, plastic, LED and incandescent readouts. 6-digits: A-B	$8.88
☐ 5316	40-pin, normal alarm, snooze alarm, sleep timer, 4-digits:	$14.95

Code: A—Hold Count. C—1 PPS Output.
B—Output Strobe. D—BCD

☐ **1-MM5316, DIGITAL ALARM CLOCK FACTORY FALLOUT — $1.49 EACH**

Terms: add postage **Rated:** net 30
Phone Orders: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield, Mass. (off Water Street) C.O.D.'S MAY BE PHONED

☐ **15¢ CATALOG** on Fiber Optics, 'ICs', Semi's, Parts

POLY PAKS

P.O. BOX 942H LYNNFIELD, MASS. 01940

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More Details? CHECK—OFF Page 94

COMPUTER KEYBOARD
$7.00 (as is)

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

2N2152	45 volt	170 watt	PNP-G	$1.00
*2N3713	80	170	NPN-S	1.00
*2N3789	60	150	PNP-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, out puts: 16 VCT ½ amp, 17 VCT ⅓ amp. $3.50

FILAMENT or BTRY CHARGER XFMR

output of 18 volts at 4.5 amp $3.50

CALCULATOR KEYBOARD

Brand new keyboards for hand held calculators. Two styles available.
One for use with calculator chip CAL TEX 5001-5002-5012 or MOSTEK 5010-5012.
Another for use with Gen. Inst. chip C500.
Priced at $8.00 each or two for $15.00.

CT 5005
CALCULATOR CHIP

Single MOS chip with all logic required for 12 digit 4 function desk top calculator with extra storage register for memory or constant. Multiplexed 7 segment outputs for LED, Incandescent, Fluorescent, or Gas Discharge displays. Brand new, bargain priced, with specs.
$8.00 each, 2 for $15.00

HP LED DISPLAYS

Brand new 4-on-a-strip LED readouts. End-butt two strips and come up with 8 digit readout. An unheard of Super Value . . . $8.00 per strip, 2 strips $15.00
Another strip . . . this one a Clock Chip readout. 2 digits . . . a space . . . and 2 more digits. Just right for a clock reading hours and minutes. This one only $8.00

313,344 CORE MEMORY $125.00

From SPECTRA computer, visually OK. 64 x 68 x 4 x 18 core stack. Figures out to 35K Byte.

LED 7 SEGMENT READOUT

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

IC SALE YOUR CHOICE 3 for $1.00

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

GIANT NIXIE B7971

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

COMPUTER TAPE DECK $75.00

Takes ½ inch tape, made by Computer Entry Systems. Visually ok, with electronics, no data available.

PHONE PATCH KIT

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

CMOS 4814 HEX INVERTER

CMOS HEX INVERTER, dual inline package. 3-18 volt range, dual diode protection against static charge. Dielectrically isolated complimentary MOS. $1.00 each 12 for $10.00

DUAL 16 BIT MEMORY

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

2048 BIT MOS MEMORY

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

RCA INJECTION LASER DIODES

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

6 WATT $10.00
10 WATT $15.00

Postage Extra on all Items

JOHN MESHNA JR. ELECTRONICS P. O. Box 62 E. Lynn, Mass. 01904

flea market

RATES Commercial Ads 35¢ per word; non-commercial ads 10¢ per word payable in advance. No cash discounts or agency commissions allowed.

COPY No special layout or arrangements available. Material should be typewritten or clearly printed and must include full name and address. We reserve the right to reject unsuitable copy. **Ham Radio** can not check out each advertiser and thus cannot be held responsible for claims made. Liability for correctness of material limited to corrected ad in next available issue. Deadline is 15th of second preceding month.

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

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

RESISTORS: Carbon composition brand new. All standard values stocked. ½W 10% 40/$1.00; ¼W 10% 30/$1.00 — 10 resistors per value, please. Minimum order $5.00. 15W RMS 1C Audio Amplifier — Panasonic. Frequency response 20Hz-100 kHz. ½% distortion. Price $6.95 Postpaid. Pace Electronic Products, Box 161-H, Ontario Center, New York 14520.

OUTSTANDING RTTY MANUAL. *Teleprinter handbook.* Covers everything. Beautiful hardbound volume. $14.95 ppd. from HR Books, Greenville, NH 03048.

THE KNIGHT RAIDERS VHF CLUB'S auction and flea market is Sunday, March 24 at the YM-YWHA of North Jersey, 152 Van Houten St., Paterson. Free admission, free parking, refreshments available. Talk-in 146.94 MHz. Flea market tables $5 for 8 ft. or $2.50 for ½ table. Reserve tables in advance: Knight Raiders VHF Club, Inc., K2DEL, P. O. Box 1054, Passaic, N. J. 07055.

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

WE'VE BEEN RIPPED OFF! Dec. 11th in Madison, Wisconsin. Collins, Model KWM-2, Transceiver, Serial #13551 with noise blanker, Waters filter, WØBNF modifications, and a Turner ceramic mike. Has many identifying features — I will be able to identify even if serial is removed. Call W9JS collect at area code 312-665-0071, or report to the Madison Police Department.

TEFLON WIRE #22 gauge stranded, silver plated. $1.75/100 ft. Rich Shyer, 625-4 S. Palomares, Pomona, Ca. 91766.

QSL'S — BROWNIE W3CJI — 3035B Lehigh, Allentown, Pa. 18103. Samples with cut catalog 35¢.

WORLD QSL — See ad page 84.

HAMFEST! Indiana's friendliest and largest spring hamfest. Wabash County ARC's 6th Annual Hamfest, May 19, 1974, 4-H fairgrounds, rain or shine. Admission still only $1.00 for advanced tickets ($1.50 at gate). Large flea market, technical sessions, bingo for XYL's, free overnight camping, plenty of parking. Bonus for car-pools (4 or more adults per car). For more information or advanced tickets write: Jerry Clevenger, WA9ZHU, Route 4, Wabash, Indiana 46992.

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

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

CANTON AMATEUR RADIO CLUB annual auction & flea market, Friday, March 8, 1974, at the Imperial House Motel in Canton, Ohio, at 7:30 p.m. Doors open for set-up at 5:00 p.m., mobile check-ins on 147.06 & 146.94 Simplex, Stark County repeater 146.19/79. Grand Prize, mobile check-in prize, other prizes awarded each half-hour. Free coffee and donuts. All companies are invited to attend and set up displays and exhibitions, free space will be provided. For reservations or information contact Mark Schontz, WB8NUA, 601 Perry Dr. N.W., Canton, Ohio.

DO-IT-URSELF DXPEDITION — 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.

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

NEED PARTS? We carry parts for R-388-390-390A-391-392-1051-51SI - Nems Clark-Racal-Pack sets - PRC-25-41-47-62-70-71-73-74-77. If you need a part no matter what you have. If its U.S. government we have it or can get it. Also we want to buy or trade *all aircraft communications. All ground radio* communications. All plug-in modules control heads. No matter what cond. they are in - bent or busted ok. We will buy or trade. We have R-390-388-390A-392-1051-51SI Nems Clark - Racal - and new ham gear for trade. D & R Electronics, R. D. #1, Box 56, Milton, Pa. 17847. Phone 1-717-742-4604 after 6:00 P.M.

NORTH FLORIDA SWAPFEST, March 31, 1974, Community Center, Hwy 98. Write: PARC, Box 873, Fort Walton Beach, Fla. 32548.

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

QRP STATION. Ten-Tec PM3A transceiver 210 PS AC5 tuner, used 2 hours, $75.00 postpaid. Cal Cornils, 1293 West L, Benicia, Calif. 94510.

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

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

JOHNSON VALIANT — $125.00, and SBE-33, $175.00. Both good condition. W7ISJ, 8822 Driftwood, Tucson, Ariz. 85715.

CANADIAN JUMBO SURPLUS and Parts Catalogs. Bargains Galore. Send $1. ETCO-HR, Box 741, Montreal "A" H3c 2V2.

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

TELL YOUR FRIENDS about Ham Radio Magazine.

More Details? CHECK-OFF Page 94

QSLs CATALOG SAMPLES 35¢. Ritz Print Shop, 5810 Detroit Avenue, Cleveland, Ohio 44102.

GOOD NEWS — SRRC Hamfest June 2, 1974 at fabulous new site in Princeton Illinois Fairgrounds. SRRC-W9MKS, R.F.D. #1, Box 171, Oglesby, Illinois 61348.

TELETYPE MODEL 19 with 14TD — $65.00; Siemens ASR teleprinter (equal to 32 ASR) — $95.00; Model 28 stock ticker (strip printer) — $20.00; two desk fax — both for $15.00. Plus shipping charges. Koppelmeier, 8025 Kolmar, Skokie, Illinois 60076.

MOBILE IGNITION SHIELDING provides more range with no noise. Available most engines in assembled or kit forms, plus many other suppression accessories. Free literature. Estes Engineering, 543-H West 184th, Gardena, California 90248.

BUY-SELL-TRADE. Write for monthly mailer, give name, address, call letters. Complete stock of major brands new and reconditioned equipment. Call us for best deals. We buy Collins, Drake, Swan, etc. SSB & FM. Associated Radio, 8012 Conser, Overland Park, Kansas 66204. 913-381-5901.

SIGNAL ONE OWNERS, expert and prompt service by ex-Signal/One engineer. Also will purchase your functioning or not functioning unit or spare parts. Write or call for details. Larry Pace, K2IXP/7, 1071 W. Roller Coaster, Tucson, AZ. 85704 (602-888-5234).

STEEL RELAY CABINET RACK. 76″ high x 17″ deep x 22″ wide. Excellent condition. Has ground buss, outlet strip, switch fuse box and screened back door for RFI. $100.00 or best offer. Must be picked up. Harry Kundrat, 29 Walton Avenue, New Providence, New Jersey 07974, (201) 665-1873.

QSL's, Sample catalog 20¢. N & S Print, P. O. Box 11184, Phoenix, Ariz. 85061.

NEW! Solid state speech processor kit, 26 dB + compression. $19.95 ppd. Speech Products Co., K. A. Teague, P. O. Box 65, Alma, Arkansas 72921.

LEDS, sample pack of 10, includes green and yellow, $3.25 postpaid U.S.A. East Coast Electronics, 50 Scott St., Hamburg, N. Y. 14075.

WANTED, APRIL 1970 issue of Ham Radio. Larry D. Van Duyn, K8JBL/5, 1802 Crescent Drive, Alamogordo, N. M. 88310.

432 MHz TRANSMITTER CONVERTER, 5 watts out, 6939 mixer, 6939 amplifier and solid state LO chain. 4½ x 7½ cast aluminum box. Send for more information. Carmichael Communications, P. O. Box 256, Carmichael, CA 95608.

PARTS BARGAINS: Motorola HEP 170 Epoxy Diode 2.5A/1000PIV 29¢, 25.00/100; #15 copper antenna wire 1.95/C; 6x9 copper clad boards 69¢; 3/16″ cable clamps 18¢; Belden, Consolidated RG8 foam coax 17¢/ft; CDE .001/10KV doorknob capacitor 1.95; Sigma 12VDC 4PDT/15A relay 3.95; Amidon toroid cores; RG63/U 15¢/ft; RG22B/U 15¢/ft; Motorola semiconductor data series 7.50; many old tubes, write needs. Monarch code oscillator module 1.50; Hammarlund variable HF50 PF 1.95; Sorensen ACR-2000VA AC regulator 150.00; Madison Electronics, 1508 McKinney, Houston, Texas 77002.

MOTOROLA PORTABLES — Expert repairs, reasonable prices, fast turn-around time. More details and flat rate catalog FREE. Ideal Services, 6663 Industrial Loop, Greendale, Wi. 53129.

FREE: 18 crystals of your choice with the purchase of a new Genave GTX-200 at $269.95. Send cashier's check or money order for same-day shipment. For equally good deals on Drake, Swan, Standard, Clegg, Regency, Hallicrafters, Tempo, Kenwood, Midland, Ten-Tec, Galaxy, Hy-Gain, CushCraft, Mosley, Sony, and Hustler, write to Hoosier Electronics, your ham headquarters in the heart of the Midwest. Become one of our many happy and satisfied customers. Write or call today for our low quote and try our individual, personal service. Hoosier Electronics, R. R. 25, Box 403, Terre Haute, Indiana 47802. (812)-894-2397.

FT101 LATE MODEL, mint condx, w/CW filter, fan and 160 xtal. Telex boom mike - $30. D. Sachnoff, 9429 Ohio, Omaha, Nebr. 68134.

Sold

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More Details? CHECK–OFF Page 94

DISCOUNT PRICES PLUS FULL WARRANTY, call or write for fast quote and delivery. All items new, guaranteed. 2M: Midland 13500 15W/12CH 219.95; SB144 199.95; SB450TRC converts 2M-3/4M 149.00; Standard 826MA 299.95; Ham-M 99.00; TR44 69.95; Belden 8-wire rotor cable 10¢/ft; AR22R 31.95; CDE parts; 20% plus off Hygain, Mosley: Hygain TH6DXX 143.00; TH3MK3 124.00; 204BA 129.00; 402BA 144.00; DB10/15A 96.00; Mosley Classic 33, CL36, MCQ3B Quad; MP33. Belden, Consolidated RG8 foam coax 17¢/ft; Amphenol PL259 49¢; Guaranteed gear: Collins 75S1 345.00; SB303, filters (Mint) 350.00; Tentec 315 receiver 199.95; Cush-Craft A147-22 49.00; Dowkey 110VAC antenna relay 60 series 39.95; Johnson KW Matchbox 219.95; Triex W51 437.00; MW50 283.00; MW65 374.00; MW35 175.00; Write: Swan, Tentec, Drake, Kenwood, Electra Bearcat 2-band scanner 129.95; 1972 Radio Masters 3.50; Callbooks; free flyer. Prices collect freight. Madison Electronics, 1508 McKinney, Houston, Texas 77002. 713/224-2668; Nite: 713/497-5683.

MANUALS for most ham gear made 45/65, some earlier. Send SASE for specific quote. Hobby Industry, WØJJK, Box H-864, Council Bluffs, Iowa 51501.

LIGHTNING ARRESTORS, Joslyn DMA969 feed thru rated 10 amps, 9 kVp, 2-32 MHz. $50.00 Vacuum capacitors: MMC1500, $150.00; MMC3000, $200.00; MMC 5000, $350.00. All unused. H. G. Husbands, 6626 Talmadge, Dallas 75230.

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

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

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

TECH MANUALS for Govt. surplus gear, $6.50 each: R-220/URR, R-274/FRR, R-390/URR, URM-25D, URM-32, TT-63A/FGC, TS-382D/U, USM-16, BC-779B, TS-497B/URR, LM-21, TS-34A/AP, PRC-10, GRR-5, ALR-5, TS-413A/U, ARR-7, GRC-19, TS-175/U, TS-173/UR. Thousands more available. Send 50¢ (coin) for list. W3IHD, 7218 Roanne Drive, Washington, D. C. 20021.

SEND PERFECT MORSE WITH YOUR RTTY and save over $150 on price of a comparable Morse keyboard. TMC-1 RTTY to Morse converter connects right into your loop trouble-free and accepts input from keyboard or paper tape reader. Entire circuit including 64-letter buffer memory on one 4 x 6 inch board for $310. Write for information. Petit Logic Systems, Box 51, Oak Harbor, Wa. 98277

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

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

SELL: Drake R-4B RCVR and MS-4 SPKR $350; T-4XB XMTR and AC-4 power supply $450. Excellent condition. Frans Liem-WB8EPJ, 5732 Rosebury Dr., Dayton, Ohio 45424. Phone (513)-236-2050.

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

CAPACITORS WANTED: Computor-Grade, Tantalums, Mylars, Discs. Write for top cash offer. National Electronic Supply, Dept. H1, 7231-B Garden Grove Blvd., Garden Grove, Calif. 92641. (714) 893-2900 or (213) 597-7010.

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

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

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

2 METER FM TRANSCEIVER MODEL 1402SM

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

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

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

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

Audio Output ....500 mv

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

Weight ....1 lb. 4 ounces without battieres

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

Size 8 7/8" x 1 7/8" x 2 7/8"

Includes Adjustable Whip Ant

$239.00 Amateur Net Price

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

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

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SEE YOUR NEAREST DEALER FOR THE FINEST AMATEUR HANDIE TALKIE ON THE MARKET

DEALER INQUIRIES INVITED
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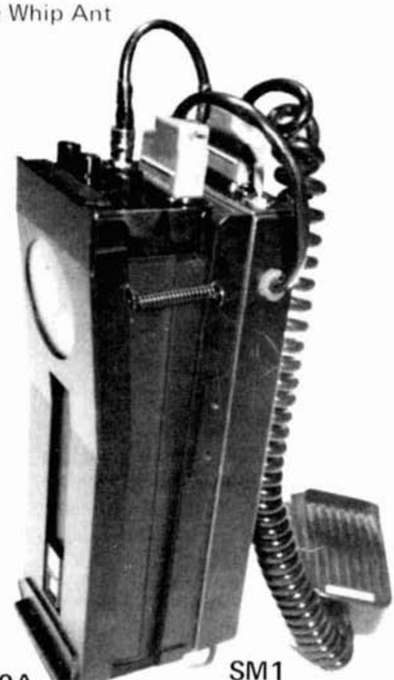

1410A SM1

Wilson Electronics

P.O. Box 794 Henderson, Nevada 89015
Telephone (702) 451-5791 451-6650

 More Details? CHECK—OFF Page 94

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

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

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

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

VERY in-ter-est-ing! Next 5 big issues $1. "The Ham Trader," Sycamore IL 60178

STANDARD 146-A (1-2) $238.70, (3-11) $212.30, Nicad batteries $1.58, Stubby antenna $5.00. Standard 826MA (1-2) $324.50, (3-11) $306.90. Standard 851T 25 watt mobile $420.20. Standard RTP-1 repeater $600.00. HM-175 antenna $16.00. Base station antenna HM-191 8.25 dB (list $169.50) net $119.95. Send check and we'll pay postage or we will ship COD. Electronics Communications Co., P. O. Box 17222, Nashville, Tenn. 37217 (24 hr.) 615-834-8999.

CALCULATOR OWNERS: Use your +—×÷ calculator to compute square roots, cube roots, sin(X), cos(X), tan(X), arcsin(X), arccos(X), arctan(X), logarithms, exponentials, and more! Quickly, Accurately, Easily! Send today for the Improved and Expanded Edition of the first and best calculator manual — now in use throughout the world . . . only $2.00 postpaid! Be sure to try this manual before buying a more expensive calculator — Absolutely Unconditional Money-back Guarantee — and Fast service! Mallman Optics and Electronics, Dept.-H, 836 South 113, West Allis, Wisconsin 53214.

QRP TRANSMATCH for the HW7 and other rigs. Write Peter Meacham Associates, 19 Loretta Road, Waltham, Mass. 02154.

DAYTON HAMVENTION expands to three days April 26, 27, 28, 1974 at HARA Arena and Exhibition Center. Brochures mailed March 15th. Write for information if you have not attended the last two years. P. O. Box 44, Dayton, Ohio 45401.

TEN TEC ARGONAUT with AC supply, $190. Two-er, $20. ARR-7, $25. 15/20/75 Hustler, $20. HP-10, $30. Terry Welch, K4IQT, 615-968-8152 weekdays.

TELETYPEWRITERS — Kleinschmidt — portable, fixed, sets, punches, parts, reconditioned, reasonable. Mark/Space Systems, 3563 Conquista, Long Beach, Calif. 90808. 213-429-5821.

DRAKE R4A, mint, late model - $245 postpaid, firm. Heath SB301 and SB401 combo in excellent condition - $395 postpaid, firm. CW and AM filters included with SB301. Sam Leslie, W4EGY, 1307 E. Esther St., Orlando, Fla. 32806, (305) 898-9413.

FIGHT TVI with the RSO Low Pass Filter. For brochure write: Taylor Communications Manufacturing Company, Box 126, Agincourt, Ontario, Canada. MIS 3B4.

REGENCY HR-2A, 2m Xcvr. Serial no. 04-05632. Stolen from my home QTH 12 December 1973. JoAnne E. Moore, W8NSU, 112 Seward #307, Detroit, Mich. 48202.

HOMEBREWERS: Stamp brings list of high quality components. CPO Surplus, Box 189, Braintree, Mass. 02184.

WANTED — TUBES, 4-1000A, 3-1000Z, 3-400Z, 4-400A, 4CX1000A, 4-250A, 4-125A, 813, 811A. All letters answered. WB2PTI, Michael D. Harrison, 431 Windsor Pl., Oceanside, L. I., N. Y. 11572. (516) 536-5320.

HAM RADIO, complete run wanted; sell complete run, 73. K8JLK.

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

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- New! Plug-in modulator puts the Communicator transmitter on FM.
- No modification or rewiring on your Communicator. Just plug into mike jack and crystal socket.
- Compact self-contained modulator measures 4" x 3" x1½".

- Works with Communicator I, II, III, IV and GC-105, and other rigs listed.
- FM at a tenth the cost of a new rig.
- Frequency adjust for netting built in.
- $34.50 postpaid U.S.A. $36.50 for PC-2, PC-62, HA-460. Specify transmitter model. California residents add 5% sales tax. (HC-6/U crystal and 9 volt transistor battery not supplied.)
- Send for free descriptive brochure.

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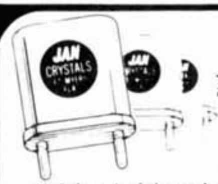
BOX 455, ESCONDIDO, CA 92025



For FREQ. STABILITY

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

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2-METER FM for most Transceivers 144-148 MHz — .0025 Tol.	ea. $3.75
Frequency Standards	
100 KHz (HC 13/U)	4.50
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Almost all CB Sets, Tr. or Rec. (CB Synthesizer Crystal on request)	2.50
Any Amateur Band in FT-243	1.50
(80-meter, $3.00 - 160-meter not avail.)	4 for 5.00

For 1st class mail, add 20¢ per crystal. For Airmail, add 25¢. Send check or money order. No dealers, please.

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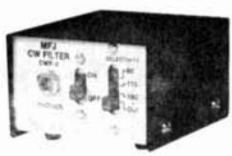
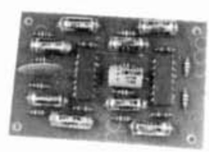
CW FILTER





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

Model CWF-2—$12.95, Kit
$14.95 Wired, tested, guaranteed. Please include 55c postage.

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

We have what we think is the finest CW filter available anywhere. The 80 Hz selectivity with its steep sided skirts will allow you to pick out one signal and eliminate all other QRM and QRN. Simply plug it into the phone jack or connect it to the speaker terminals of any receiver or transceiver and use headphones, small speaker, or speaker amplifier. Better yet, connect it between any audio stages to take advantage of the built in receiver audio amplifier.

Build the 2"x3" CWF-2 PC card into your receiver or get the self contained and ready to use CWF-2BX and plug in!

SPECIFICATIONS

BANDWIDTH: 80 Hz, 110 Hz, 180 Hz (Switch selectable)
SKIRT REJECTION: At least 60 db down 1 octave from center frequency for 80 Hz bandwidth
CENTER FREQUENCY: 750 Hz
INSERTION LOSS: None. Typical gain 1.2 at 180 Hz BW, 1.5 at 110 Hz BW, 2.4 at 80 Hz BW
INDIVIDUAL STAGE Q: 4 (minimizes ringing)
IMPEDANCE LEVELS: No impedance matching required
POWER REQUIRED: CWF-2: 6 volts (2 ma.) to 30 volts (8 ma.). CWF-2BX: standard 9 volt transistor radio battery
DIMENSIONS: CWF-2: 2"x3" PC board. CWF-2BX: 4"x3 1/4"x2 3/16" (black wrinkle steel top, white aluminum bottom, rubber feet)

TRY this fantastic CW filter. If you don't think it is the best you have ever used, ask for your money back. We will cheerfully refund it. These filters carry a full one year warranty.

Write for FREE brochures and magazine test reports. Other IC active filters available: CW mini filter (1"x2"), low pass, high pass, and wide bandpass filters. Audio amplifiers ... 1, 2 watts. Crystal calibrator.

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LOWER PRICES

Two models

AC1

TIME TELLER

DX Operating Aid

MC1

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

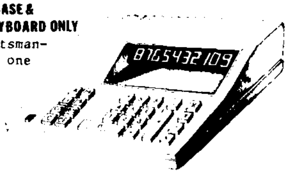
MODEL	AMATEUR NET
MC1 Unfinished mahogany cabinet	$9.90
AC1 Polished acrylic cabinet	14.75

Add $1.25 for mailing cost

U-J Industries
6605 Shoal Creek Blvd.
Austin, Texas 78757

More Details? CHECK-OFF Page 94

TABLE TOP CALCULATOR CASE & KEYBOARD ONLY



Attractively designed! Excellent craftsmanship. Case and keyboard (designed as one unit). Cabinet is made of high-impact plastic beige color with black bezel and amber window. Keyboard consists of a 3-position slide switch and 25 keys, 5 of which are used for memory function. 20 keys gray, 5 keys orange. All keys mounted on one printed circuit board. This modular unit is well suited for our calculator chips. Ideal for the CT5005. Case and Keyboard Complete: ONLY $29.95

RCA NUMITRON

EACH............$ 5.00

SPECIAL: 5 FOR $20.00

3-CHIP CALCULATOR

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

CHIPS AND DATA............$8.95
DATA ONLY (Refundable).... 1.00

CT5005 CALCULATOR

This calculator chip has a full four-function memory, which is controlled by four keys, +M (adds entry into memory), -M (subtracts entry from memory), CM (clear memory, without clearing rest of registers), RM (read memory or use as entry).

- 12-Digit display and calculate
- Fixed decimal at 0, 1, 2, 3, 4, or 5
- Leading zero suppression
- 7-Segment multiplexed output
- True credit sign display
- Single 28-pin chip

CHIP AND DATA...........ONLY $9.95
DATA ONLY (Refundable)....... 1.00

5001 CALCULATOR

40-Pin calculator chip will add, subtract, multiply, and divide. 12-Digit display and calculate. Chain calculations. *True credit balance sign output.* Automatic over-flow indication. Fixed decimal point at 1, 2, 3, or 4. Leading zero suppression. Complete data supplied with chip.

CHIP AND DATA........ONLY $9.95
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All ICs are new and fully-tested; leads are plated with gold or solder. Orders for $5 or more will be shipped prepaid. Add 35¢ for handling and postage for smaller orders; residents of California add sales tax. IC orders are shipped within 2 workdays--kits are shipped within 10 days of receipt of order. $10.00 minimum on C.O.D.s (phone in).

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MV50 red emitting 10-4 ma @ 2V — $ .25; 5 FOR 1.00

MV5024 red TO-18 high dome — $ .75; 10 FOR 6.50

MV10B visible red 5-7 ma @ 2V — $ .30; 10 FOR 2.50

SPECIAL 874

256-BIT RANDOM ACCESS MEMORY

TTL bi-polar fully-decoded 256 x 1 bit:

- Single 5V supply
- 80 NS access time
- Simple memory expansion thru 3-chip select lines

Data with chip. 16-Pin DIP.
$5.00 — 10 FOR $39.95

3-Amp Power Silicon Rectifiers Marked Epoxy Axial Package

PRV	PRICE	PRV	PRICE
100	$ .10	800	$ .30
200	.15	1000	.40
400	.18	1200	.50
600	.23	1500	.65

CMOS

CD4001	$ .75	CD4023	$ .75
CD4002	.75	74C00	.75
CD4010	1.00	74C20	.75
CD4011	.75	74C160	3.25
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7400 Series DIP

7400	$ .25	74L51	$ .30
74H00	.35	74H51	.35
7401	.25	7453	.20
7402	.35	7454	.25
74H01	.35	74L54	.35
7403	.30	74L55	.35
7404	.28	7460	.20
74H04	.35	74L71	.30
7405	.28	7472	.40
7406	.70	74L72	.50
74H05	.35	7473	.60
7408	.35	74L73	.75
74H08	.35	7474	.65
7410	.25	74L74	.80
74L10	.35	74H74	.80
74H11	.35	7475	1.40
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7420	.25	7480	.65
74L20	.35	7483	1.00
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74H22	.35	7490	1.20
7430	.25	7491	1.00
74H30	.35	7492	.90
74L30	.40	7493	1.15
7440	.25	7494	1.15
74H40	.35	7495	1.15
7441	1.25	74L95	2.00
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V5447	2A	400V	$ .90
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Special 811: Hex Inverter

TTL DIP Hex Inverter; pin interchangeable with SN 7404. Parts are brand new and are branded Signetics and marked "811."

Data Sheet Supplied

EACH.......$ .30
10 FOR..... 2.50
100 FOR.... 23.00
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MAN 3M

0-9 plus letters. Right-hand decimal point. Flat-pack type case. Long operating life. IC voltage requirements. Ideal for pocket calculators!

EACH $2.50
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MAN4

Seven-segment, 0-9 plus letters. Right-hand decimal point. Snaps in 14-pin DIP socket or Molex. IC voltage requirements. Ideal for desk or pocket calculators!

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TEN OR MORE 2.50 EACH

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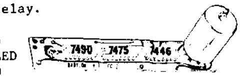
This kit provides a highly sophisticated display section module for clocks, counters, or other numerical display needs. The unit is .8" wide and 4 3/8" long. A single 5-volt power source powers both the ICs and the display tube. It can attain typical count rates of up to 30 MHz and also has a lamp test, causing all 7 segments to light. Kit includes a 2-sided (with plated thru holes) fiberglass printed circuit board, a 7490, a *7475, a 7447, a DR 2010 RCA Numitron display* tube, complete instructions, and enough Molex pins for the ICs . . NOTE: boards can be supplied in a single panel of up to 10 digits (with all interconnects); therefore, when ordering, please specify whether you want them in single panels or in one multi*ple digit board. Not specifying will result* in shipping delay.



COMPLETE KIT, ONLY $11.95
FULLY-ASSEMBLED UNIT $13.00

Boards can be supplied separately @ $2.00 per digit.

L I N E A R S

NE540	70-watt power driver amp	$2.00
NE555	precision timer	1.50
NE560	phase lock loop DIP	3.25
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NE566	function generator TO-5	4.00
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NE5558	dual 741 op amp MINI DIP	1.00
709	popular op amp DIP	.45
710	voltage comparator DIP	.75
711	dual comparator DIP	.40
723	precision voltage regulator DIP	1.00
741	op amp TO-5/MINI DIP	.55
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INDEX

A-5 ___ 181
Amtech ___ 006
Andy ___ 007
Antenna Design ___ 211
Babylon ___ 014
Barry ___ 016
Catronics ___ 189
Columbia ___ 212
Communications Specialists ___ 030
Curtis ___ 034
Cush Craft ___ 035
Data ___ 037
Drake ___ 039
Dycomm ___ 040
Dynamic Elect. ___ 041
ECM ___ 190
E & L ___ 182
Eimac ___ 043
Electronic Dist. ___ 044
Epsilon ___ 046
Erickson ___ 047
Exceltronics ___ 139
Fair ___ 048
G & G ___ 051
Gateway ___ 052
Glade School ___ 213
Global ___ 053
Goldstein's ___ 130
Gray ___ 055
Gregory ___ 201
H & L ___ 056
HR Books ___ 150
HAL ___ 057
Henry ___ 062
Hobby ___ 063
House of Dipoles ___ 036
Icom ___ 065
International Crystal ___ 066
International Elect. Unltd ___ 141
Jan ___ 067
Janel ___ 068
Jeff-Tronics ___ 069
K. E. ___ 374
KLM ___ 073
KRP ___ 074
Larsen ___ 078
Leland ___ 193
Linear ___ 081
Logic ___ 133
MFJ ___ 082
Martex ___ 197
Matric ___ 084
McClaren ___ 155
Meshna ___ 085
Mor-Gain ___ 089
Motorola ___ 160
Nurmi ___ 090
Nye ___ 214
Palomar ___ 093
Pemco ___ 095
Prasad ___ 215
Poly Paks ___ 096
Prof. Elect. ___ 140
RP ___ 098
Racom ___ 097
Radiation Devices ___ 099
Callbook ___ 100
Raytheon ___ 101
Regency ___ 102
Rochester ___ 217
Savoy ___ 105
Singer ___ 219
Space-Military ___ 107
Specialty Prod. ___ 216
Spectronics, FM ___ 191
Spectrum ___ 108
Star-Tronics ___ 110
Swan ___ 111
Teledyne ___ 218
Teletron ___ 188
Ten-Tec ___ 114
Topeka FM ___ 115
Tri-Ex ___ 116
Tri Tek ___ 117
Tristao ___ 118
Tucker ___ 113
U J ___ 119
VHF Engineering ___ 121
Venus ___ 192
Weinschenker ___ 122
Wilson ___ 123
Wolf ___ 124
World QSL ___ 125
Y & C ___ 126
Yaesu ___ 127

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Advertisers iNdex

A-5 Magazine	70
ATV Research	84
Amtech	70
Andy Electronics	86
Antenna Design Co.	78
Babylon Electronics	91
Barry	96
Catronics	74
Columbia Electronics Sales, Inc.	72
Communications Specialists	70
Curtis Electro Devices	84
Cush Craft	33
Data Engineering	65
Drake Co. R. L.	2
Dycomm	75
Dynamic Electronics	66
ECM Corporation	66
Eimac, Div. of Varian Assoc.	Cover IV
Electronic Distributors, Inc.	89
Epsilon Records	66
Erickson Communications	86
Exceltronics Research Labs	74
Fair Radio Sales	78
G & G Radio Supply Co.	89
Gateway Electronics	68
Glade Valley School Radio Session	78
Global Import Co.	80
Goldstein's	78
Goodheart Co., Inc. R. E.	92
Gray Electronics	76
Gregory Electronics	63
H & L Associates	85
HR Books	80
HR Report	68
HAL Communications Corp.	69
Ham Radio	48
Henry Radio Stores	Cover III
Hobby Industry	74
House of Dipoles	80
Icom	71
International Crystal Mfg. Co. Inc.	73
International Electronics Unlimited	79
Jan Crystals	90
Janel Labs	92
Jeff-Tronics	80
K. E. Electronics	86
KLM Electronics	70
KRP Electronic Supermart, Inc.	84
Larsen Electronics	59
Leland Associates	86
Linear Systems, Inc.	72
Logic Newsletter	74
MFJ Enterprises	90
Martex Corporation	74
Matric	78
McClaren	72
Meshna, John Jr.	82
Mor-Gain, Inc.	86
Nurmi Electronic Supply	62
Nye, William M. Co. Inc.	76
Palomar Engineers	90
Pemco	70
Prasad Electronics	85
Poly Paks	77
Professional Electronics	72
RP Electronics	76
Racom Electronics Inc.	80
Radiation Devices	92
Radio Amateur Callbook, Inc.	68, 84
Raytheon Company	5
Regency Electronics, Inc.	60, 61
Rochester Hamfest	86
Savoy Electronics	Cover II
Space-Military Electronics	90
Specialty Products	80
Spectronics, FM	53
Spectrum International	87
Star-Tronics	70
Swan Electronics	21
Ten-Tec, Inc.	95
Topeka FM Communications & Electronics	85
Tri-Ex Tower Corp.	49
Tri Tek, Inc.	66
Tristao Tower Co.	72
Tucker Electronics	93
U J Industries	90
VHF Engineering, Div. of Brownian Elect. Corp.	81
Venus Scientific	1
Weinschenker, M.	64
Wilson Electronics	41, 88
Wolf, S.	92
World QSL Bureau	84
Y & C Electronics	92
Yaesu Musen USA	67

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