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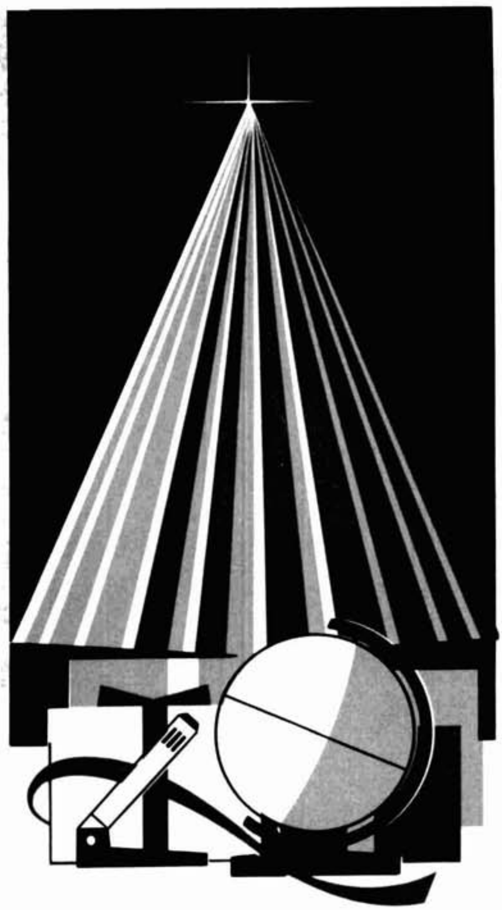

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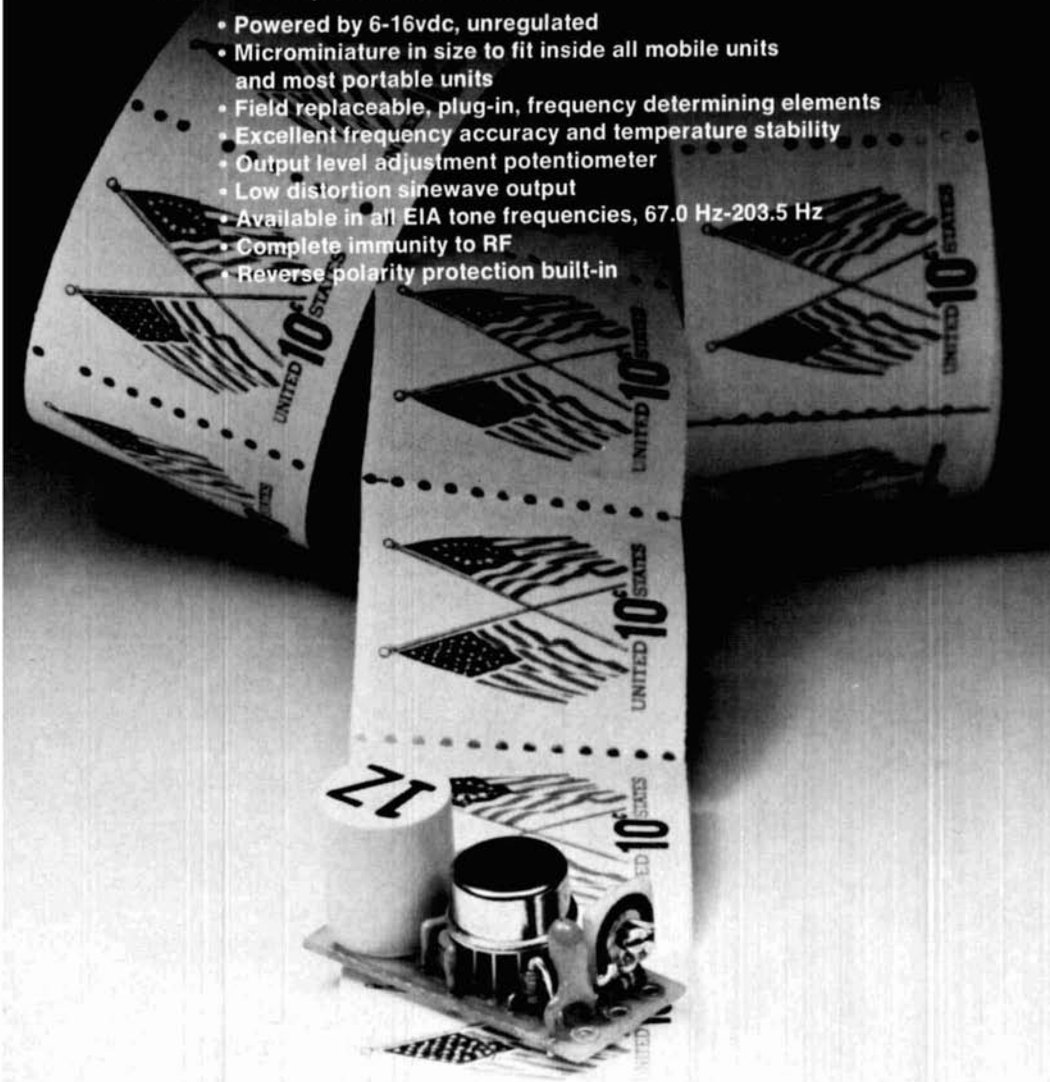

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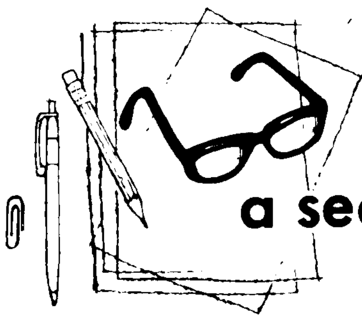


a second look by jim fisk

Beginning this month we are presenting a series of articles on microprocessors by Dave Larsen, WB4HYJ, Peter Rony and Jonathan Titus, authors of the popular series of *Bugbooks.** Not since the development of the transistor in 1948 has any product or technology offered such an exciting promise of things to come as the microprocessor – literally a computer on a chip.

Computers in the 1960s are credited with revolutionizing the engineering and accounting fields by replacing people power with instantaneous electronic computation and retrieval. Microcomputers in the 1970s are expected to extend these benefits into areas where existing computer technology has never before penetrated, including amateur radio. Several groups are now working on microprocessor controlled vhf-fm repeaters, future OSCAR satellites will carry an on-board microprocessor for systems maintenance and control, and VE3SAT and others are already using microprocessors for ASCII communications through OSCARs 6 and 7.

Other amateur applications such as RTTY speed control, RTTY-ASCII or RTTY-Morse conversion, and automatic Morse code copiers are a natural for microprocessors. Automatic satellite tracking systems, log keeping, transmitter tuneup and control, and antenna pointing systems are other straight forward microprocessor-based systems which will see widespread use in the future. If, for example, you're a DXer and hear a rare VP8 on 20 meters, you would just punch VP8 into your keyboard and your beam would automatically come around to the correct heading. If you were operating on CW you would only have to tap out VP8 in Morse code – the microprocessor would convert the Morse characters into machine language, translate that into a beam heading, and turn on your antenna rotator.

Until recently the cost of microprocessor chips put them out of reach for most amateur applications, but as more and more manufacturers have gotten into the act the prices have dropped dramatically. The popular 8-bit 8080 microprocessor which was originally developed by Intel, for example, was selling for $300 to $400 a little more than a year ago, dropped to about $150 this past summer, and is now available from one source for under $30. Although these prices are still a bit high for the amateur experimenter, industry sources predict that microprocessors will sell for $5 or less within a couple of years, perhaps as early as 1977.

In addition to the microprocessor series in the magazine which is designed to familiarize amateurs with this important new technology, during 1976 *ham radio* will be presenting a series of one-day microprocessor seminars at various hamfests across the country including SAROC in Las Vegas (January 9th), Miami (January 24th) and Dayton (April 23rd and 24th). The fee for the seminar is $50 and includes $35 worth of books. Since seating is limited, early registration is recommended – write to *ham radio* for details.

Jim Fisk, W1DTY
editor-in-chief

**Bugbook I and II, Logic and Memory Circuits Using TTL Integrated Circuits; Bugbook III, Microcomputer Interfacing Experiments using the Mark 80, an 8080 system*, $35 the set from Ham Radio Books, Greenville, New Hampshire, 03048.

More Details? CHECK—OFF Page 142

presstop

ANY HOPE THAT DOCKET 20282 — Restructuring — would be out by the end of this year has been much too optimistic. FCC Safety and Special Services Chief, Charles Higginbotham, W3CAH, feels that sometime next spring is a much more realistic target, and even then some aspects may require reexamination as additional dockets or oral proceedings such as the ARRL has requested. A tremendous amount of work has already gone into analyzing the mountain of Comments with the task far from done, and problems associated with CB's explosion aren't helping the effort.

SECRECY PROVISIONS of the Communications Act of 1934, Section 605, deserve a lot more attention by Amateurs than they've been getting. A strict interpretation of Section 605 forbids the disclosure of anything heard on the air except broadcast and Amateur transmissions — and that includes mentions of frequencies or any other information regarding the overheard signals!

Since This Ban applies to CB as well as other services, it could put a severe crimp in some of the recently publicized CB clean-up efforts conducted by Amateur groups.

The Intent Of Section 605 is quite clear — how likely an Amateur is to be cited for violating it is not.

REQUIREMENT FOR MULTIPLE COPIES for submissions to the FCC was upheld by Commissioners after consideration of a petition for its elimination submitted by W6NJU. Additional copies are necessary to insure the submission reaches all who should see it, but in their review of the requirement reductions were found possible.

Effective October 14 the number of copies required for comments on a Notice of Proposed Rule Making was reduced from 15 to 12 (original plus 11 copies) — other requirements not likely to affect Amateurs were also reduced. In their rejection of W6NJU's petition the Commissioners also noted that single copy submissions are now and have been accepted although they do not receive as wide circulation as those that meet the requirement.

Ham Radio/HR Report readers should not forget our long standing public service offer. Send your FCC submission directly to us and we'll make all the necessary copies and mail them to the Commission for just $1.00 per page of original document.

REPEATER FUNDING may become an issue with the FCC if some flagrant abuses aren't corrected. Though use of a club's dues to pay for repeater maintenance is well within the Amateur rules, the solicitation of money for the use of a given repeater or its facilities (such as autopatch) is almost certainly a violation of Part 97.112, "No remuneration for use of station."

OSCAR ORBITAL PREDICTION BOOKLET produced by W6PAJ will replace HR Report's monthly prediction sheets for HR Report subscribers in 1976. W6PAJ's handy booklet will be sent without charge to any subscriber who asks for it — dropping the monthly sheets was done in recognition that a vast number of subscribers did not use them and HR Report sheets were a duplication of effort.

6000 MILE OSCAR QSO was completed between G3IOR and W6CG! Using meteor scatter techniques on selected orbits as the Satellite was over the horizon between them, successful two-way communications were finally exchanged between the two over a period of two weeks. Congratulations to both!

CIVIL SERVICE ADMINISTERED Amateur Radio exams have not been as popular in the test areas as expected. At the mid-point of the two-year program (which runs until next July) no specific conclusions have been drawn and FCC Field Operations people are watching it carefully.

BARRY ELECTRONICS WILL CONTINUE as a major Amateur Radio supplier despite Barry's tragic loss in a boating accident on Long Island Sound. Barry's wife Kitty vows she and the crew will keep the business going just as before.

LA1SH/BY QSLs received by several west coasters are pretty exciting wallpaper but little else. It's now considered certain that he operated only from shipboard.

frequency synthesizer

for the Collins 75S receiver

Complete description of a frequency synthesizer that converts the Collins 75S-series of communications receivers to general-coverage use from 3.4 to 30 MHz

Robert S. Stein, W6NBI*

During the past few years, the use and application of frequency synthesis in both receivers and transmitters has increased tremendously. A quick perusal of the ads for vhf transceivers is all the evidence needed to verify this fact, although there are also many high-frequency military and commercial (non-amateur) transmitters and receivers which employ frequency synthesizers to generate specific frequencies required within those units.

The advantages of having a general-coverage receiver in the ham shack are manifold and were discussed in a previous article describing a synthesizer for use with the Drake R-4 series receivers[1]. This article will describe a frequency synthesizer to supplement or replace the high-frequency oscillator crystals in a Collins 75S-1, 75S-2 or 75S-3, resulting in a receiver which covers 3.4 through

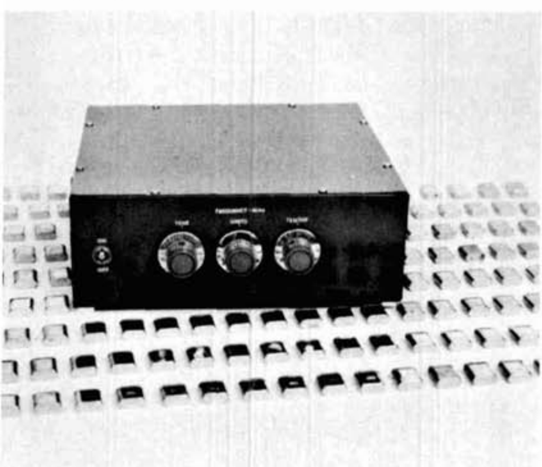
*1849 Middleton Avenue, Los Altos, California 94022.

30 MHz. Only minor electrical changes are required in the receiver; no holes need be drilled nor other mechanical modifications made.

Before proceeding with the description of the frequency synthesizer which makes this possible, a review of the receiver conversion process is in order. The 75S-1, 75S-2 and 75S-3 receivers all utilize identical crystal-oscillator and first-mixer circuits, so that the discussion is applicable to any one of the receivers.

The local-oscillator (LO) frequency injected into the first mixer is 3.155 MHz higher than the low-frequency end of the desired 200-kHz tuning range. Since the high-frequency oscillator is crystal controlled, this requirement is translated to a crystal which will generate the proper frequency. For example, the 3.8- to 4.0-MHz band requires a 6.955-MHz crystal (3.8 plus 3.155 MHz), which is supplied with the receiver. Collins specifies that the receiver

S-line frequency synthesizer with some of the 128 crystals from the Collins CP-1 crystal pack, which it replaces.



will tune from 3.4 to 30 MHz with the proper crystal. It should be noted that for receiver frequencies above 12 MHz, frequency doubling takes place in the plate circuit of the crystal oscillator; therefore the *crystal* frequency is one-half the frequency injected into the first mixer. Nevertheless, the *injection* frequency is always 3.155 MHz above the lower band edge.

In order to cover the entire range of 3.4 to 30 MHz in 200-kHz increments, 133 crystals would be required, starting with a 6.555-MHz crystal for the 3.4- to 3.6-MHz band, a 6.755 MHz crystal for the 3.6- to 3.8-MHz band, and so on. Even with the 28 crystal positions available in the 75S-3A, it is obvious that a complete set of crystals would not only be impractical to use, but prohibitively expensive. However, if we can generate frequencies of 6.155 through 32.955 MHz every 200 kHz, and substitute them for the crystals in the hf crystal oscillator, we can achieve all-band coverage within the specified tuning range of the receiver. The frequency synthesizer to be described does exactly that.

basic phase-locked loop frequency synthesizer

Although the basic phase-locked loop frequency synthesizer has been explained in previous articles, a brief review at this time will simplify the detailed explanation of this specific synthesizer. **Fig. 1** shows the basic phase-locked frequency synthesizer. A stable reference frequency is applied to one input of a phase comparator. The output of the phase comparator is a dc voltage which passes through a lowpass filter and controls the frequency of a voltage-controlled oscillator (vco). The oscillator generates the desired frequency, which may be any multiple of the reference frequency. The vco output is also applied to a frequency divider whose function is to divide the vco output frequency to the same frequency as that of the reference oscillator.

Let's assume that the reference oscillator frequency is exactly 5 kHz and that an output frequency of 6555 kHz is required. If we have a divider or programmable counter which will divide by 1311, the signal input to the phase comparator will also be 5 kHz when the vco output is exactly 6555 kHz. This is accomplished by the phase comparator producing a dc output which "tunes" the vco until it is exactly 6555 kHz. The divided vco frequency is then exactly 5 kHz, the same as the reference frequency. Thereafter, the vco output will stay at 6555 kHz; any variation from this frequency changes the signal input to the phase comparator, which in turn produces a dc output change and brings the vco back to 6555 kHz. Thus, the output frequency is locked to the reference frequency, and has essentially the same stability as the reference oscillator.

By using a frequency divider which can be programmed, it is possible to obtain virtually any number of discrete frequencies which are integral multiples of the reference frequency, all of which are phase locked to the reference oscillator. The lowpass filter keeps the reference frequency from modulating the vco and establishes the lock-up time of the loop.

75S synthesizer

A block diagram of the 75S hfo frequency synthesizer is shown in **fig. 2.** The loop reference is a 100-kHz crystal-controlled oscillator, which is divided by ten and then by two, resulting in a 5-kHz reference signal which is applied to one input of the phase comparator. The other input to the comparator is the divided vco frequency, which will be discussed presently. The output from the comparator is a function of the difference between the two input frequencies and is applied to the loop filter, consisting of an active and a passive lowpass filter. The resultant dc controls the vco frequency by changing the capacitance of a varactor diode. The vco output, 6.555 to 32.955 MHz in 200-kHz steps, is amplified to a suitable level and routed to the receiver.

The vco output is also applied, via an isolating source follower, to a Schmitt trigger, which converts the amplitude and waveform of the vco output to one that is compatible with the TTL integrated circuits in the frequency divider.

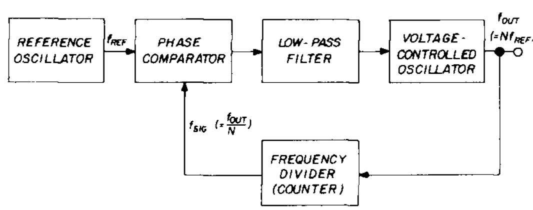


fig. 1. Basic phase-locked frequency synthesizer. The frequency divider is a variable-modulus, or programmable, counter.

The vco frequency divider is a variable-modulus counter which can be programmed to divide by any factor between 1311 and 6591 in steps of 40 (i.e. 1311, 1351, 1391, 1431, etc.). An examination of the discrete vco frequencies to be synthesized will reveal that the largest common factor is 5 kHz, thereby establishing the reference frequency. Steps of 200 kHz in the vco output are obtained by changing the counter modulus in steps of 40 (40 x 5 kHz = 200 kHz). Since each vco frequency ends in 5, the least significant digit in the number by which the vco frequency must be divided to yield 5 kHz will always be 1. Therefore the first counter always provides a 1-count. The three remaining counters are programmed by the front-panel frequency-control switches and establish the first three digits of the frequency divisor.

Preselected binary-coded-decimal (BCD) outputs from each counter, plus the output from the Schmitt trigger, are fed to a decoder circuit, which produces the divided-down vco signal applied to the phase comparator. The decoder also resets the counters (actually this is its primary function), but that signal path has been omitted from **fig. 2** because it is not pertinent to overall signal flow. Details of the counter and decoder functions will be explained in greater detail under their circuit descriptions.

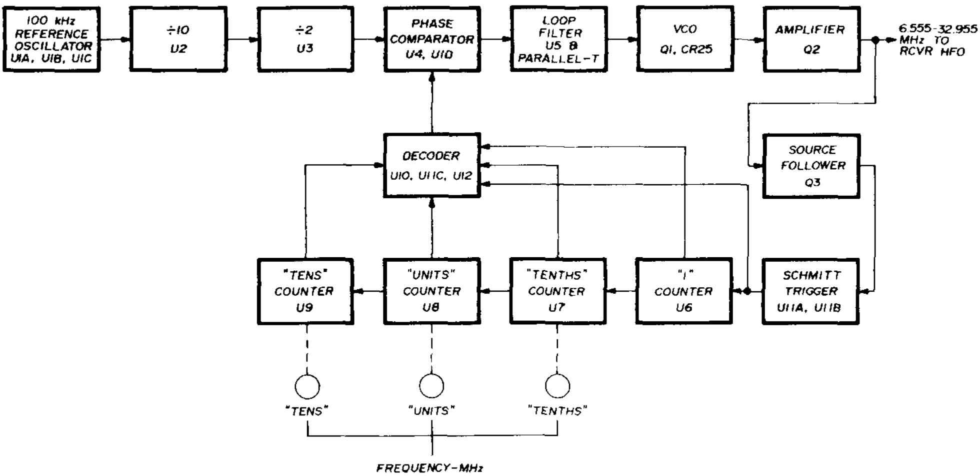


fig. 2. Block diagram of the Collins 75S hfo frequency synthesizer. The only tuning controls are the front-panel TENS, UNITS, and TENTHS rotary switches.

reference oscillator and phase comparator

The 100-kHz reference oscillator and its frequency dividers, the phase comparator, and the loop filter are shown in **fig. 3**. The reference oscillator consists of gates U1A and U1B, two sections of an MC846P quad 2-input NAND gate. The gates are configured as a multivibrator and the 100-kHz signal is developed by connecting crystal Y1 as part of the signal path between the gates. Trimmer capacitor C3, in series with the crystal, permits adjustment of the crystal frequency. The output of the oscillator is shaped and buffered by a third gate, U1C.

The 100-kHz signal is divided down to 10 kHz by U2, a 7490 decade counter. The output of the 7490 is then divided by two by one flip-flop in U3, a 7474 dual D-type flip-flop, resulting in the 5-kHz reference which is applied to pin 3 of phase comparator U4.

The phase comparator comprises U4, another 7474 dual D-type flip-flop, and the remaining gate section of U1. It compares the phase difference between the 5-kHz reference and the vco frequency divided by the counter modulus (f_{vco}/N), and produces a digital pulse output whose duty cycle is a function of the phase difference. This digital output is partially filtered by R3 and C6 to a sawtooth which is applied to the inverting input of U5.

U5 is an LM3900 quad op amp, one amplifier section of which is used as the active element in the loop filter. It attenuates the ac components of the signal from the phase comparator and thereby produces a dc output which varies in accordance with the phase difference between the inputs to the comparator. The gain of the loop filter, its frequency response, and the loop lock-up time are determined by the values of R3, R4, R5 and C7[2,3].

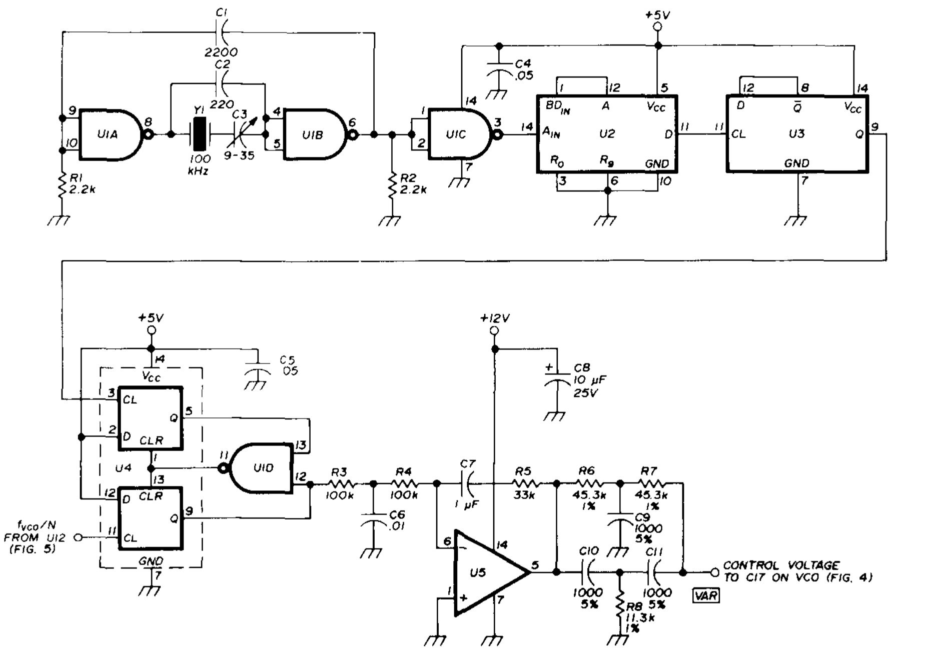


fig. 3. Schematic of the crystal oscillator and its frequency dividers, the phase comparator, and the loop filter, Integrated circuits are listed in table 1 (page 20). C7 must be a polycarbonate- or polyester-film type capacitor.

Additional filtering of the 5-kHz loop reference frequency is needed to prevent modulation of the vco, which would produce spurious sidebands on both sides of the desired frequency. A parallel-T filter, consisting of R6 through R8 and C9 through C11, provides a minimum of 35 dB attenuation at 5 kHz. (This figure is based on worst-case conditions using five-percent capacitors. If two- or one-percent capacitors are used, or the capacitors are selected by bridge measurement, the attenuation will be improved.) Additional attenuation of harmonics of the reference frequency is accomplished by R22, R34, C18 and C38 in the vco (**fig. 4**).

voltage-controlled oscillator

The vco is built as a separate, shielded unit to eliminate stray pick-up from the digital circuits and from ac fields. The oscillator consists of Q1, an E300 (or equivalent) n-channel fet, in a Colpitts circuit with varactor CR25 connected in series with C38 across the tank circuit. The varactor is a Motorola MV1401 and has a ratio of maximum-to-minimum capacitance of approximately ten, as compared to usual ratios of two to four for conventional varactors. (It also happens to be the most expensive single component in the entire synthesizer.) Despite the large capacitance ratio, the oscillator cannot cover the entire range of 6.555 to 32.955 MHz without switching. This is accomplished by diode switching, using switch section S3-D of the *tens* divider switch (**fig. 5**).

In the zero position of the *tens* switch, diodes CR26 and CR27 do not conduct, so coils L1 and L2 are each effectively in series with a 33-μH choke (L4 and L5) to ground. The high value of this inductance has only stray effect on the circuit; thus the oscillator frequency is essentially determined by coil L3 and the tank-circuit capacitance. When the *tens* switch is set to position 1 or 2, one of the diodes is biased into forward conduction and brings the low end of the associated coil close to rf ground, shunting L3 and thereby lowering the tank-circuit inductance. Resistor R21 in series with the switch arm limits diode current to a safe value.

The oscillator output is taken from the source of Q1 and coupled to the base of amplifier Q2. The amplifier, a type 2N2219 npn transistor, is a broadband stage which feeds the hf oscillator circuit in the receiver through an isolating 5-dB L-pad, R27 and R28. Also applied to the output circuit is the +12-volt power supply, which is decoupled from the vco signal by rf choke L8 in series with current-limiting resistor R32. This dc source is used to actuate a sensitive relay in the receiver, as will be explained later.

The output of Q2 is also coupled to Q3, an n-channel fet configured as a source follower. The source load is made up of two resistors, R30 and R31, which form a 6-dB L-pad in the output. The source follower drives the Schmitt trigger in the digital portion of the synthesizer and, with the L-pad, keeps

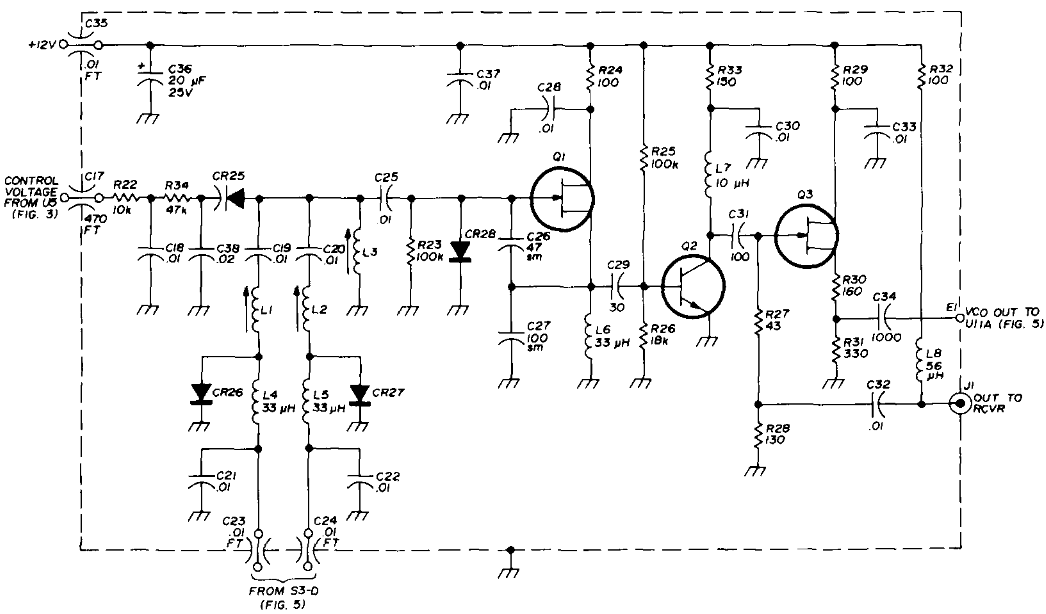


fig. 4. Schematic of the vco. See table 1 for coil-winding data and descriptions of parts not identified on the schematic.

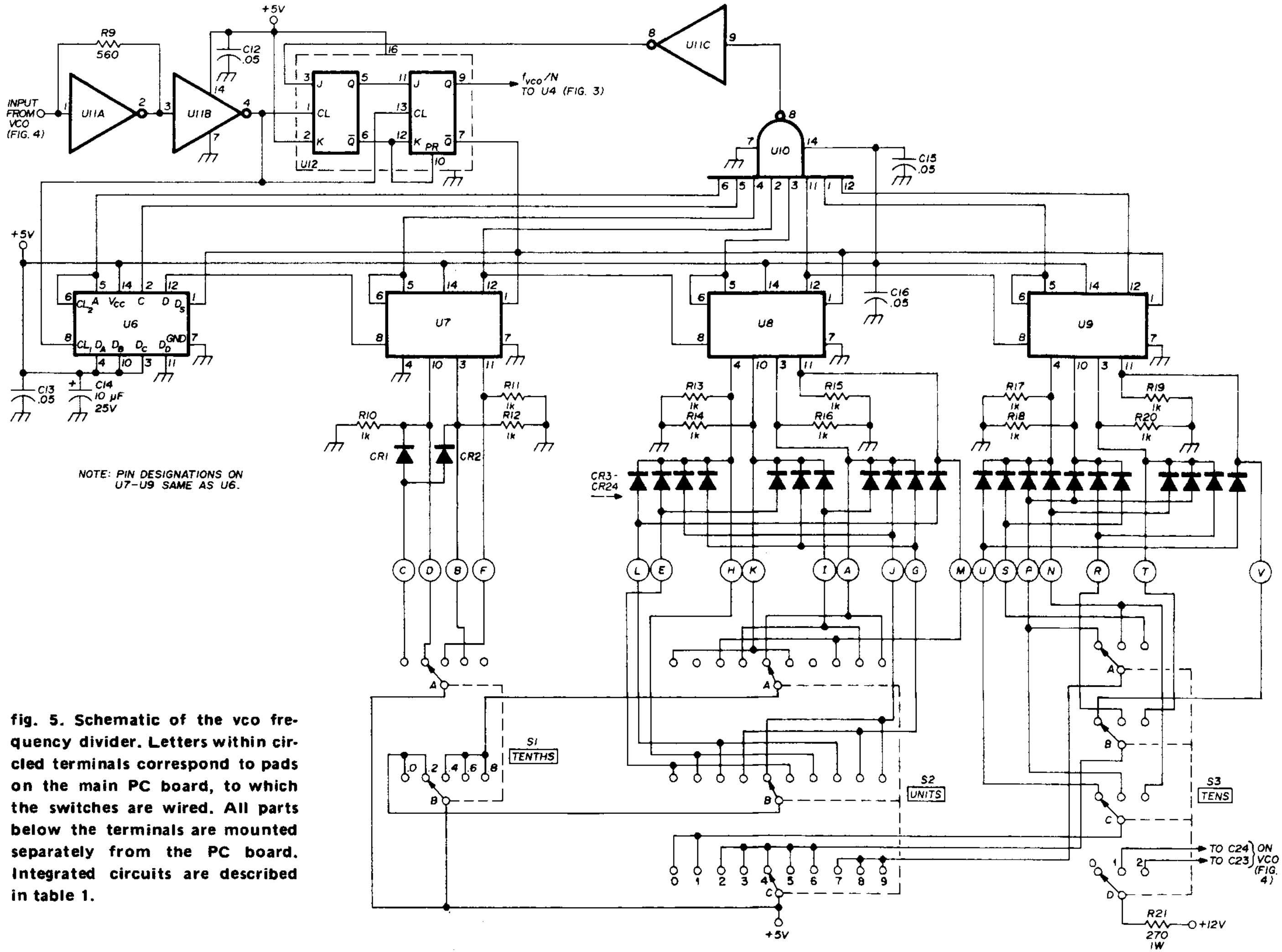


fig. 5. Schematic of the vco frequency divider. Letters within circled terminals correspond to pads on the main PC board, to which the switches are wired. All parts below the terminals are mounted separately from the PC board. Integrated circuits are described in table 1.

any digital signals from feeding back into the vco.

frequency divider

Fig. 5 shows the vco frequency divider and its associated front-panel switches. Note the use of the word *divider* in its singular form; the counters used in the divider circuit function as an integral circuit (no pun intended), rather than as separate divider stages such as are used to divide the 100-kHz crystal frequency down to 5 kHz. Because this is quite different from the usual frequency multiplier or divider stages familiar to most amateurs, as evidenced by the many inquiries received following publication of the R-4 synthesizer article[1], it seems appropriate at this point to explain the operation of a typical variable-modulus, or programmable, counter.

Let us consider a basic two-stage frequency divider, as shown in **fig. 6**. Each of the counters is a decade counter, that is, a counter which produces one output pulse for every ten input clock pulses. However, each counter is presettable, which means that its count may be programmed or modified by setting its data inputs (D_A, D_B D_C, and D_D) either high or low. The data-input subscripts indicate the binary weighting assigned to each input: A=1, B=2, C=4, and D=8. There is also a fifth data terminal, D_S; this is the data-enable input, which must be set *prior to and during* the interval that the data inputs are applied. In the simplified circuit shown, we will assume that D_S must be set high to enable the data inputs.

Conventional digital terminology designates the first pulse in a pulse train as 0, so that the tenth pulse, which produces an output from a decade counter, is therefore designated number 9. The total number of clock pulses, N_{max}, which can be counted before an output is produced from a ripple-through counter (another name for the circuit shown in **fig. 6**) is

$$N_{max} = N_1 \times N_2 \times \ldots N_n$$

where N_1 is the modulus of the first counter, N_2 is the modulus of the second counter, and so on. Since each counter in **fig. 6** has a modulus of 10, N_{max} = 100. But remember that this will be clock pulse 99, since we start with pulse 0.

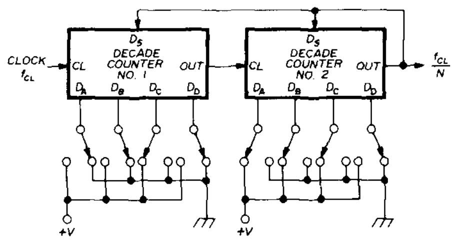


fig. 6. Basic variable-modulus counter.

Now let's assume that we want the circuit of **fig. 6** to divide the clock frequency by 25. If the counters are up-counters (as are all those used in this synthesizer), their data inputs must be preset with the nines' complement of the desired divisor. (Nines' complement simply means the difference between nine and the desired count.) The preset data to be entered, N_D, is determined by the equation

$$N_D = (N_{max} - 1) - D$$

where D is the frequency divisor. Since N_{max} is 100 for our circuit,

$$N_D = (100 - 1) - 25 = 74.$$

The least significant, or units, digit corresponds to the count of the first counter, since it is counting unit clock pulses; the most significant, or tens, digit corresponds to the count of the second counter because it is counting tens of clock pulses. Therefore counter number 1 must be preset with a 4, and counter number 2 must be preset with a 7. To do this, D_C (having a binary weight of 4) of counter number 1 is set high and all other data inputs are set low. On counter number 2, D_A, D_B and D_C are set high (binary weighting: 1 + 2 + 4 = 7) and D_D is set low. What we have done is to preset the counters so that each is in the state which would exist following the clock pulse having the same number as the preset data. Since counter number 1 has been preset with a 4, it will produce an output after five clock pulses have occurred (corresponding to the 5 in the desired divisor of 25). *Thereafter*, the first counter will count by *ten* until D_S is set high by the output of counter number 2. Similarly, because counter number 2 has been preset with a 7, it will produce an output after it has counted two pulses from the first counter, completing the count of 25. This output is applied to the D_S inputs of both counters and re-enables the data inputs, starting the count over.

If we analyze the operation of the counters, we can see that by presetting the first counter with a 4, the elapsed time between clock pulse 0 and clock pulse 9 was shortened by four clock-pulse intervals. In the same way, by presetting counter number 2 with a 7, the elapsed time between clock pulse 9 (the first output pulse from the first counter) and clock pulse 99 (N_{max}) was shortened by 7 times 10 clock-pulse intervals.. Assuming a clock frequency f_c, with a period t_c,

$$t_{out} = 99t_c - 4t_c - 7(10t_c) = 25t_c$$

and

$$f_{out} = \frac{1}{t_{out}} = \frac{1}{25t_c} = \frac{f_c}{25}$$

The preceding analysis may be extended to any number of cascaded counters and to hexadecimal as well as decade counters. However, actual operation will be limited by the propagation delays through the counters and the setup times required for the data inputs. As previously stated, the D_S inputs must be enabled *before* and during the time period that the preset data are entered. Since the preset data are dc levels, it follows conversely that they are entered shortly after the generation of the output pulse, which is applied to the D_S inputs. If the clock frequency is too high, the counters may toggle but too much time may elapse, because of propagation delays, between the output pulse following the terminal clock pulse (equivalent to pulse 99 in our basic circuit) and the arrival of the next clock pulse (pulse 0). This will prevent the data inputs from being enabled prior to the arrival of clock pulse 0, and will result in an erroneous count.

Another problem which often arises when using a circuit similar to that of **fig. 6** is caused by the short duration of the output pulse. The output pulse from counters which are used in these circuits has the same width as the clock pulse. Thus the output pulse of counter number 1 is the same as the clock pulse (although with greater time intervals between pulses), and since counter number 2 is toggled by the output of counter number 1, its output pulse width will also be the same as the clock-pulse width. Furthermore, as soon as the output pulse resets the data-enable inputs, both counters resume their preset state and the output pulse disappears. This condition, along with the narrow pulse width, may not permit the data inputs to be enabled for the minimum time which is required by the counter.

The propagation delay may be minimized by decoding the BCD outputs of the counters. These outputs have the same binary weighting as the corresponding data inputs. Thus when the terminal condition of 99 is reached in **fig. 7**, outputs A and D of each counter will go high, causing the output of the AND gate to go high and enable the data inputs. The advantage of this circuit lies in the reduction in the delay time between clock pulse 99 and the D_S enabling pulse. In **fig. 6**, the delay is equal to the propagation delay through the two counters, or through a total of eight flip-flops. In **fig. 7**, the delay is equal to the propagation delay through only one flip-flop (flip-flop A in counter number 1) plus that of the gate. This occurs because at clock pulse 98, outputs A and D of counter number 2 are high, as is the D output of counter number 1. Clock pulse 99 needs to propagate only through the first flip-flop in counter number 1 to cause output A to go high, resulting in the required enabling output from the gate.

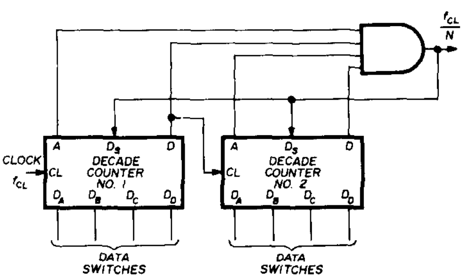


fig. 7. Basic variable-modulus counter with decoded outputs.

This technique of decoding may be used in various circuit configurations. In many cases, it may be necessary to decode outputs which are other than those of the terminal count in order to enable the data inputs before the arrival of clock pulse 0. It may also be necessary to utilize flip-flops in addition to the decoding gate in order to enable the D_S inputs with a pulse whose width is greater than the clock-pulse width. This may result in some preset factors being unusuable, but rarely are all moduli of a variable-modulus counter utilized.

Returning now to **fig. 5**, we see that the vco frequency divider is a four-stage variable-modulus counter comprising U6, a 74S196 or 82S90 presettable decade counter, and U7 through U9, each a 74196 or 8290 presettable decade counter. The signal from source follower Q3 in the vco is converted to TTL level by U11A, one section of a 7404 hex inverter. The inverter functions as a Schmitt trigger by virtue of the connection of R9 between the input and output. Additional shaping is provided by U11B, and the resultant output clocks counter U6 and both flip-flops in U12.

As stated previously, only the counts of the last three counters in the chain need be varied, since U6 provides a fixed count. The counts are controlled by *tenths* switch S1, *units* switch S2, and *tens* switch S3. **Fig. 5** shows the switches set for a receiver frequency of 4.2 MHz; the corresponding vco frequency is therefore 7.355 MHz. Since the reference frequency is 5 kHz, the vco frequency must be divided by 1471. U6 provides the least significant count of 1. The next significant count of 7 results from setting the data inputs of U7 to the nines' complement of 7, or 2. It can be seen that +5 volts are applied to pin 10 (input D_B) through S1-A, while the remaining data inputs are either grounded directly or are pulled low by resistors R11 and R12. Similarly, it can be seen that U8 provides a count of 4, and U9 a count of 1 for the most significant digit.

The complexity of the switching circuits is the result of labelling the switches so that they indicate the low end of the receiver's 200-kHz tuning range, rather than the dividing count or the vco frequency. Steering diodes CR1 through CR24, in conjunction with the switches, route the 5-volt supply to the appropriate data inputs.

The BCD outputs of the counters are decoded in U10, a 7430 8-input NAND gate, the output of which is inverted by

U11C and applied to pin 3 of U12, a 74S112 dual J-K flip-flop. Both flip-flops are used to re-enable the counters and require three clock pulses after pin 3 is set high by U11C. This means that instead of decoding when the BCD outputs of the counters total 9999, decoding should take place when the BCD outputs total 9996, so that the data inputs of the counters are enabled three clock pulses later, immediately following the terminal BCD state of 9999. However, I found it necessary to shorten the propagation time between the terminal clock pulse and the last-occurring input to U10, and therefore chose to decode a count of 9995. (Note that the A and C outputs from U6 provide the least significant digit of 5.) Since this re-enables the data inputs one clock pulse early, the extra clock pulse is accounted for by presetting U6 for a count of 2, which keeps the least significant digit in the frequency divisor at 1.

Because the preset enabling pulse for the counters must be low, the $\overline{Q}$ output from pin 7 of the second flip-flop in U12 is used. The complementary Q output from pin 9 is applied to the phase comparator for comparison with the reference frequency.

power supply

The synthesizer draws approximately 425 mA from its power supply, which is shown in **fig. 8** along with the interconnections of the main pc board and the vco unit.

Full-wave bridge rectifier CR29 through CR32 is supplied from T1, a 16-volt, 0.5-ampere transformer. The 12-volt supply for op amp U5 on the main board and for the vco is obtained from the output of U13, a fixed 12-volt regulator. The drop to regulated 5 volts for the logic circuitry takes place in U14, a similar 5-volt regulator. LED CR33, connected to the 5-volt supply through current-limiting resistor R35, serves as a pilot light.

construction

Most of the parts comprising the synthesizer are mounted on two printed-circuit boards, the main board and the vco board. The large main board contains all of the digital circuits and the phase detector, while the entire vco, except for the feedthroughs and output connector, is built on the separate vco board. **Figs. 9** through **12** show the foil patterns and parts locations for the two boards*.

The interior photograph shows the construction of the prototype unit, which is enclosed in a *steel* utility box measuring 10x10x3-1/2 inches (25.4x25.4x8.9 cm). It is imperative that a steel enclosure be used because of the strong magnetic field around the receiver caused by the power transformer. The phase-detector circuit and the vco in the synthesizer are extremely sensitive to ac fields, and when the unit was first enclosed in an aluminum box, it was impossible to eliminate a 60-Hz hum on received signals except when the synthesizer was placed directly in front of the receiver. Since this is hardly consistent with good "human engineering" practice, the aluminum housing was discarded and a steel box was substituted.

An enclosure was intentionally selected which was larger than might be expected, because of the sensitivity of the synthesizer to stray fields. This proved to be a wise choice (sometimes you luck out!), since the physical placement of the power transformer within the box became the next problem. Rather than fool around with compartment shielding, I mounted the transformer, rectifiers, and filter capacitor on a small piece of sheet steel. The steel shields the rest of the unit from the transformer

*A set of two drilled and plated boards is available from the author for $14.50, postpaid in the U.S.A. Questions will be answered if accompanied by a self-addressed, stamped envelope.

field when the power supply assembly is positioned so that the steel plate is vertical and the transformer is on the side away from the main board.

Even with the arrangement described, the placement of the power supply assembly is critical. I suggest that the assembly be mounted temporarily, with long leads, when the unit is constructed. Then after all adjustments have been made and the synthesizer is functioning, the final location can be determined by moving the assembly around until any hum on a received signal disappears. You may find that moving it one way or the other by as little as a half-inch (1 cm) may make a big difference.

On the other hand, this problem can be eliminated, and a smaller cabinet used, if the power supply is made a separate unit and connected to the synthesizer proper by means of a cable. The choice is yours.

The two voltage regulators (U13 and U14) are mounted on the outside of the left-hand wall of the enclosure, with their pins extending into the interior. Apply a thin layer of silicone heat-transfer compound between the regulators and the housing to aid in dissipating heat.

The three rotary switches, the power switch, and the LED pilot light are mounted on the front panel. On the rear is the coax output connector. Four rubber bumpers are mounted on the bottom to prevent scratches from the hardware which fastens the parts to the enclosure.

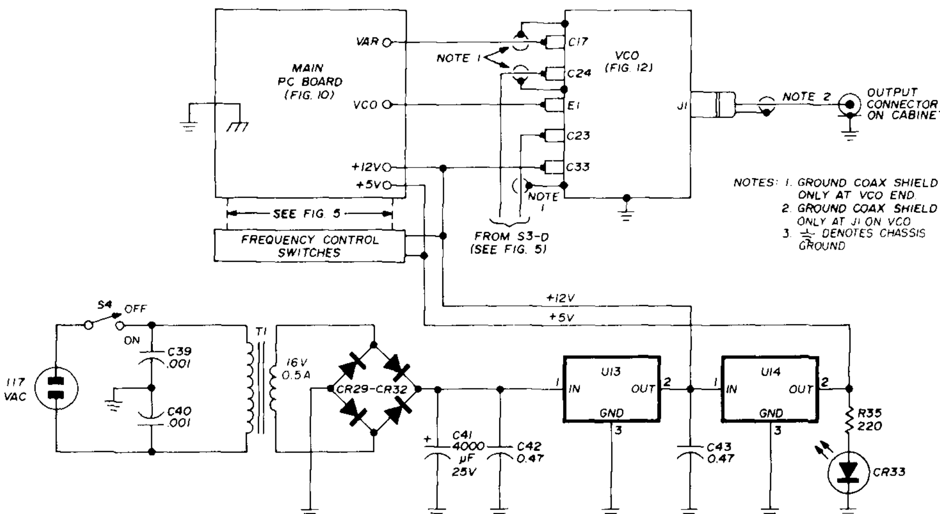


fig. 8. Schematic of the power supply and interconnections of the assemblies comprising the synthesizer. Diodes and integrated circuits are described in table 1.

When assembling the parts on the main PC board, a socket or Molex pins should be installed at U11 for the integrated circuit. It may be necessary to select a 7404, since its upper frequency limit is being pushed. But at the current price of 25 to 35 cents each, it is much more economical to buy three or four than to buy the devices which would be required for a more sophisticated Schmitt trigger. More about this later.

The main board is connected to the

frequency-control switches from 20 pads, designated A through V, along the front of the board, as shown in **fig. 5**. The remainder of the connections appear in **fig. 8**. All connecting leads to and from the board should be soldered in place on the board before connecting the other ends. Leave plenty of wire on each lead to make the connections to the parts which are not on the board so that if any troubleshooting must be done it will not be necessary to unsolder the wires. Shielded wiring is made with RG-174/U coax. All wiring, except for that between the "VCO" pad and E1 on the vco, carries dc only, making lead length noncritical. The board is mounted on four standoff posts; in order to prevent ground loops, three of the four should be non-metallic or should be insulated from the ground plane on the board, so that only a single metallic post grounds the main board to the cabinet.

The vco printed-circuit board is enclosed in a 2-1/8x2-5/8x2-3/4 inch (5.4x6.7x7 cm) mini-box. Feedthrough terminal E1 and feedthrough capacitors C17, C23, C24 and C33 are mounted on one side of the box, and J1 is placed on one end, corresponding to the leads designated in **fig. 12**. Use solder lugs under the outsides of the feedthrough capacitors which are to have shielded leads attached. The PC board is fastened to the side of the box on which the feedthroughs are mounted by means of small right-angle brackets which are soldered to the ground plane of the board. The feedthroughs and J1 are then connected to the appropriate pads on the board, using short lengths of bare wire.

The vco mini-box must be mounted so that there is only a single return to common ground, in order to prevent ground loops. When mounting the vco,

table 1. Semiconductor and miscellaneous parts list.

CR1-CR24	1N34A, 1N100, 1N270 or equivalent germanium diode
CR25	Motorola MV1401 varactor
CR26,CR27	1N658
CR28	1N914 or 1N4148
CR29-CR32	1N4001 or equivalent 50 PIV, 1 amp silicon rectifier
CR33	Hewlett-Packard 5082-4882, Motorola MLED655, Radio Shack 276-041 or equivalent light-emitting diode
E1	insulated feedthrough terminal
L1	5-3/4 turns no. 28, closewound on 0.211" (5.5mm) diameter slug-tuned form (Miller 25A014-4)
L2	10-3/4 turns no. 28, closewound on 0.211" (5.5mm) diameter slug-tuned form (Miller 25A014-3)
L3	20 turns no. 30, closewound on 0.211" (5.5mm) diameter slug-tuned form (Miller 25A014-3)
Q1	Siliconix E300, 2N5397 or 2N5398
Q2	2N2219
Q3	2N5458, 2N5459 or Motorola MPF103
S1	2-pole, 5-position, non-shorting rotary switch
S2	3-pole, 10-position, non-shorting rotary switch
S3	4-pole, 3-position, non-shorting rotary switch
U1	Motorola MC846P quad 2-input NAND gate
U2	7490 decade counter
U3,U4	7474 dual D-type flip-flop
U5	National LM3900 quad op amp
U6	74S196 or Signetics 82S90 presettable decade counter
U7,U8,U9	74196 or Signetics 8290 presettable decade counter
U10	7430 8-input NAND gate
U11	7404 hex inverter (see text)
U12	74S112 dual J-K flip-flop
U13	7812 or National LM340-12 12-volt regulator
U14	7805, National LM340-5 or LM309K 5-volt regulator

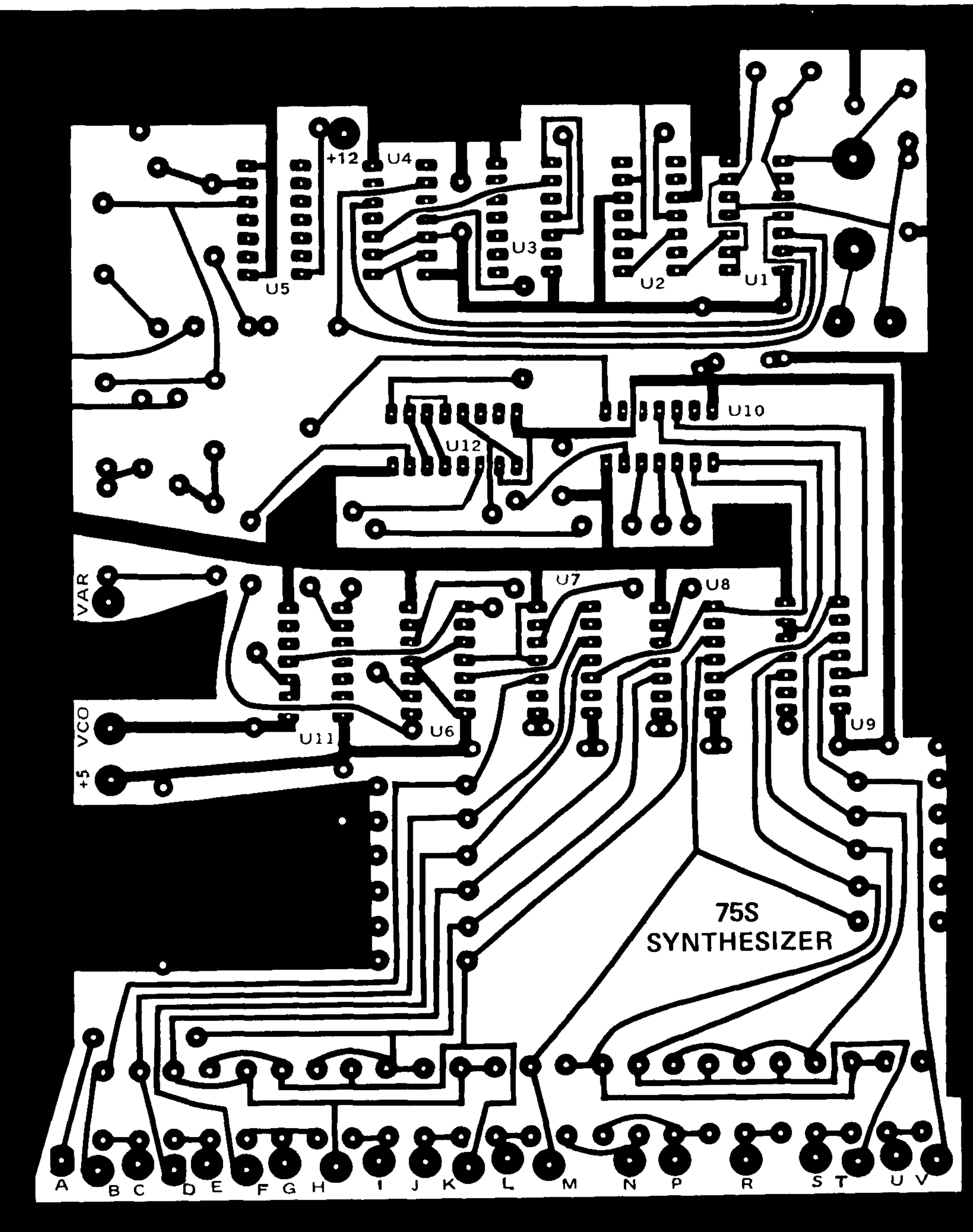
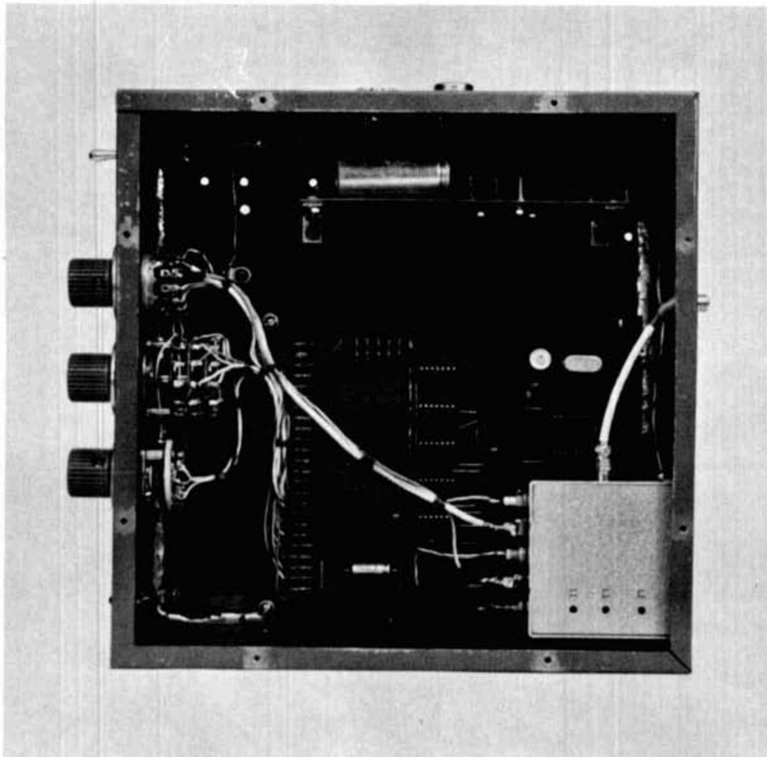


fig. 9. Foil pattern of the main printed-circuit board.

be sure to position it so that the feedthroughs are close to the side of the main PC board on which are located the pads designated "VAR" and "VCO." The lead between E1 on the vco and the



Interior of the assembled synthesizer. The power supply components are located to the left of the main PC board (top). The vco is mounted on the rear wall just above the main board (bottom right). Note the holes in the vco enclosure which provide access to the tuning slugs of the coils mounted on the vco board inside.

"VCO" pad on the main board should not be more than 3 or 4 inches (7.5 or 10 cm) long. The shields of the leads going to capacitors C17, C23 and C24 are grounded to the solder lugs under those capacitors.

The coax between J1 and the output connector on the rear of the cabinet should be 95-ohm type, such as RG-180/U or RG-195/U (although using a very short piece of 50-ohm RG-174/U will probably have little detrimental affect). The cable between the synthesizer and the receiver *must* be the 95-ohm type or 93-ohm RG-62/U.

The power transformer should supply 16 to 17 volts ac at approximately 0.5 ampere. Any higher voltage only results in greater heat dissipation in regulator U13. The method by which this voltage can be obtained by modifying an inexpensive 24-volt transformer is described in reference 1.

The numbered positions on the rotary switch knobs were made by using number transfers on the skirts of the knobs. Several heavy coats of Krylon

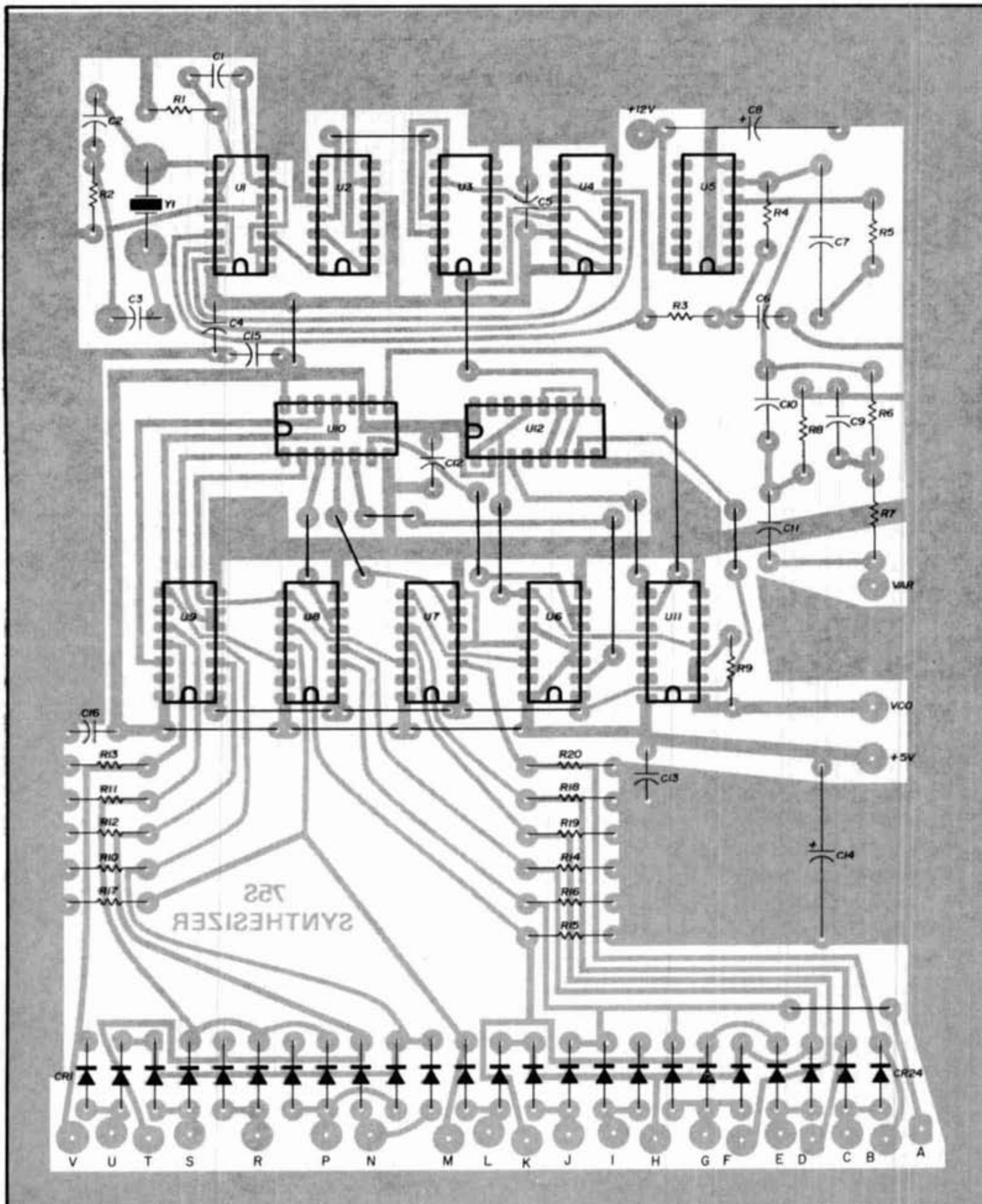


fig. 10. Location of parts on the main printed-circuit board.

fixative were sprayed on to keep the numbers from peeling off. The panel markings can be applied in the same manner. If you are fortunate enough to have access to a Selectric Composer, or even a good electric typewriter, the panel labeling can be typed on frisket, which is an adhesive-backed translucent acetate. The material is virtually invisible when applied to a grey panel, against which the black type effectively contrasts. Frisket is available at art-supply dealers.

receiver modifications

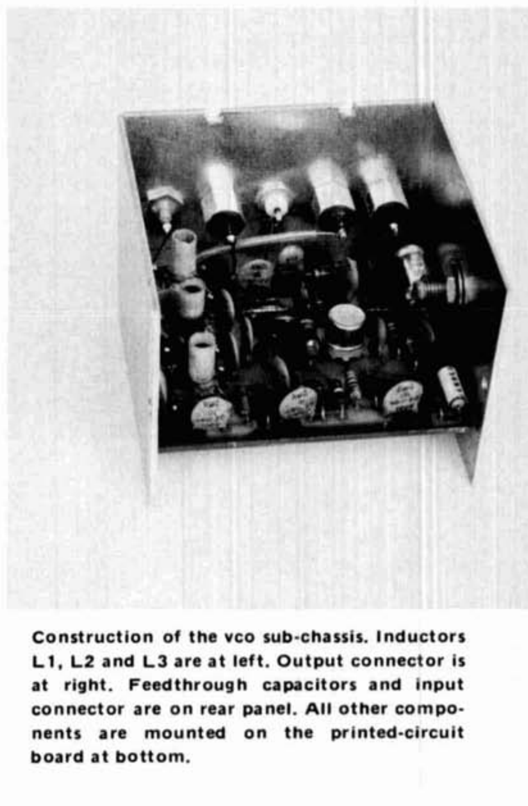
At the beginning of the article, I indicated that only minor modifications had to be made to the receiver; these are shown in **fig. 13**. The synthesized crystal frequency is introduced into the receiver via the *spare* jack on the rear apron. The added components must be placed close to the oscillator-mixer (V3) tube socket, and the shielded connection to the *spare* jack made with 93- or 95- ohm coax, e.g. RG-62/U, RG-180/U or RG-195/U.

The existing coax lead in the receiver between *bandswitch* S1 and pin 2 of V3 is disconnected from V3 and rewired to the added relay. This relay may be a reed or "crystal can" type; its coil resistance must be at least 500 ohms in order to minimize the voltage drop across R32 in the vco.

When the synthesizer is off or is disconnected from the receiver, the normally-closed relay contacts complete the circuit between S1 and V3, allowing the receiver to function as if no changes had been made. When the synthesizer is turned on, the relay is energized by the 12-volt supply in the vco through R32 and L8 (see **fig. 4**), disconnecting the crystals and applying the synthesized crystal signal to the control grid (pin 2) of the oscillator section of V3. The 56-μH choke at the relay coil isolates it from the rf signal path.

A new *preselector* scale may be added to the receiver so that you don't have to consult or memorize the preselector chart in the manual. **Fig. 14** is a full-scale reproduction of the new *preselector* scale and may be cut out, or photocopied if you prefer not to mutilate the magazine.

Remove the *preselector* knob and pointer and attach the scale to the front panel of the receiver, using either a spot of rubber cement or a small piece of double-sided sticky-back tape in each corner. The scale shows the approximate settings of the *preselector* control; the letter at the end of each scale segment indicates the *bandswitch* position to be used.



Construction of the vco sub-chassis. Inductors L1, L2 and L3 are at left. Output connector is at right. Feedthrough capacitors and input connector are on rear panel. All other components are mounted on the printed-circuit board at bottom.

alignment and test

After all wiring and connections have been checked and rechecked, the synthesizer is ready for the few adjustments necessary to set the vco on frequency. The only test equipment absolutely necessary is an electronic voltmeter, although a frequency counter and oscilloscope can be helpful.

Apply power to the synthesizer and

check the supply voltages to make sure that they are within five percent of the nominal values. Then make sure the reference oscillator is working by bringing a lead from the receiver antenna jack close to the crystal. Harmonics of the 100-kHz oscillator should be heard in the receiver. The oscillator may also be checked with a scope; 100-kHz square waves should be observed at pin 3 of U1, and 5-kHz square waves should be present at pin 9 of U3. If the oscillator is not working, adjust trimmer capacitor C3, although it is not necessary for the crystal to be oscillating at exactly 100 kHz at this time.

Connect an electronic voltmeter between ground and feedthrough capacitor C17 on the vco. Set the rotary switches to 9.8 MHz and adjust the tuning slug of L3 until a meter reading of 10 volts is obtained. Rotate the *units* switch toward zero, noting that the voltmeter reading drops with each change in the switch setting until position 3 is reached. Then rotate the *tenths* switch to zero, noting that the voltage continues to drop. (Actually, any switch setting below 3.4 MHz is invalid, since it is below the tuning range of the receiver preselector.) A frequency counter connected to the output of the synthesizer should indicate approximately 12.955 MHz with the frequency switches set to 9.8 MHz, and 6.155 MHz with the switches set to 3.0 MHz. The exact frequencies will be obtained only if the crystal is set to exactly 100 kHz, which adjustment is not made until the vco is aligned.

Next, set the rotary switches for a frequency of 19.8 MHz, and adjust the slug in L2 for a voltmeter reading of approximately 10 volts. *Do not touch the slug in L3*. Again turn the *units* switch toward zero and note that the voltage drops at each switch position, including position 0. Turn the *tenths* switch to 0 and make sure that the voltage also decreases with each step. A counter should indicate about 13.155 MHz and 22.955 MHz respectively for the minimum and maximum *units* and *tenths* switch settings.

Finally, set the rotary switches for a frequency of 29.8 MHz and adjust L1 as described in the preceding adjustment. The frequency range of the vco with the *tens* switch in position 2 is 23.155 to 32.955 MHz. If you find that it is not possible to obtain a 10-volt reading on the voltmeter at switch settings of 29.8 MHz, but that at some lower frequency the loop starts to lock up (as indicated by incremental changes in the voltage as the *tenths* or *units* switch positions are changed), you must change U11. I tried four 7404 hex inverters in the circuit; two worked at the highest frequency and two quit at about the 26-MHz switch settings. Thus there is every probability of getting at least one better-than-average IC out of three or four.

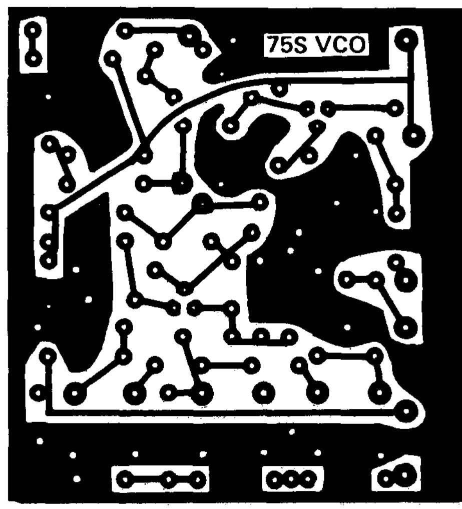


fig. 11. Foil pattern of the vco printed-circuit board.

Connect the synthesizer output to the *spare* jack on the receiver, using a cable made from 93- or 95-ohm coax, Turn on the receiver and synthesizer and set the synthesizer switches to one of the WWV frequencies suitable for good reception. Set the receiver *bandswitch* and *preselector* control to the settings specified for the frequency selected. WWV should be heard when the receiver is tuned to zero. Then allow the synthesizer and receiver to warm up for about a half-hour.

Wrap a few turns of one end of an insulated wire around V2 in the receiver and bring the other end close to the 100-kHz crystal in the synthesizer. Carefully adjust the crystal trimmer capacitor in the synthesizer to zero-beat with WWV. It may be necessary to retune the receiver slightly when doing this because changing the frequency of the crystal changes the synthesizer output frequency, which is now the receiver hfo frequency.

That completes the alignment – you now have a general-coverage receiver.

Operating the receiver with the synthesizer involves no more than turning on the synthesizer and setting its switches to the desired frequency. Then set the receiver *bandswitch* and *preselector* control to the appropriate positions and tune.

One minor difference will be noted when using the synthesizer. On the 10-meter band, the 200-kHz segments start at 28.0 MHz and progress in 200-kHz increments so that you tune from 28.4 MHz, 28.6 MHz, etc. In other words, while each segment throughout the synthesizer range will start with an even *tenths* digit, the crystals supplied with the receiver set the 10-meter segments at 28.5, 28.7, and 28.9 MHz.

There is one precaution which *may* be necessary. Even with the prototype unit enclosed in a steel box, there was still a very small amount of 60-Hz pickup from the receiver transformer when the synthesizer was placed next to either side of the receiver. (The condition also exists with the synthesizer on top of the receiver, but this arrangement would block the heat convection flow

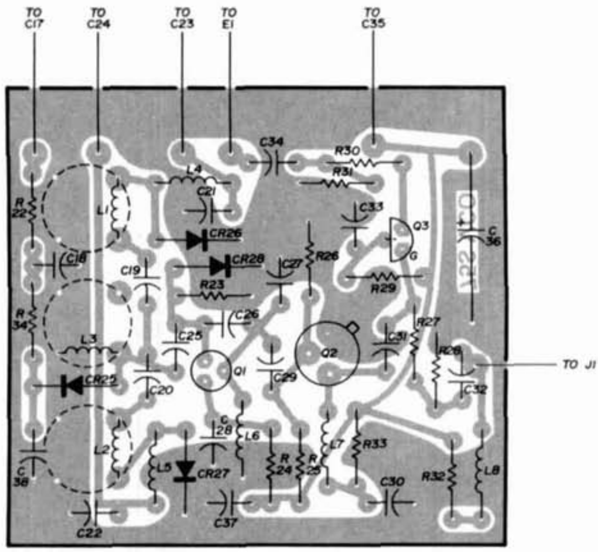


fig. 12. Location of parts on the vco printed-circuit board.

from the receiver and should not be used anyway.) Simply moving the synthesizer 3 to 4 inches (7.5 to 10 cm) away from either side eliminated the stray pick-up. It is entirely possible that this condition may not manifest itself with all receivers, and it will undoubtedly depend on the physical locations of the assemblies within the synthesizer cabinet. In any event, the synthesizer is still close enough to the receiver for convenient operation.

conclusions

The synthesizer satisfies all the requirements necessary to make any Collins 75S a general-coverage receiver. Spurious signals are down a minimum of 80 dB on all frequencies, and are down better than 90 dB on most. The major spurs appear 10 kHz either side of the incoming signal, and are caused by the second harmonic of the 5-kHz reference frequency. The reference frequency itself is weaker than the harmonic because of the attenuation provided by the parallel-T filter. Although the suppression of the spurious sidebands was achieved at the expense of fast lock-up time, a one- or two-second lock-up is of little consequence, since it takes that long to move your hand from the synthesizer switches and tune the receiver.

The synthesizer has not been used with a 75S receiver operating in transceive mode with a 32S transmitter, although there is little reason to doubt that it will work. There should be sufficient sideband attenuation to keep spurious outputs from the transmitter at least 60 dB down. The only possibility of trouble might be rf getting back into the synthesizer from the transmitter, which would be simply a shielding problem. However, until and if new amateur bands are forthcoming, there is no reason to use the synthesizer for transmitting except possibly on part of the 10-meter band.

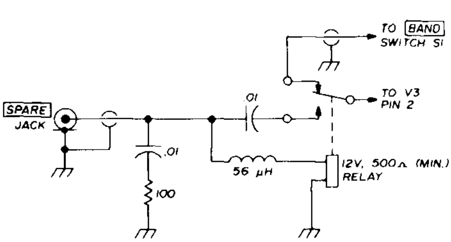


fig. 13. Wiring changes to be made to the Collins 75S receiver. Make sure that the relay will pull in when it is connected in series with a 110-ohm resistor to a 12-volt dc supply.

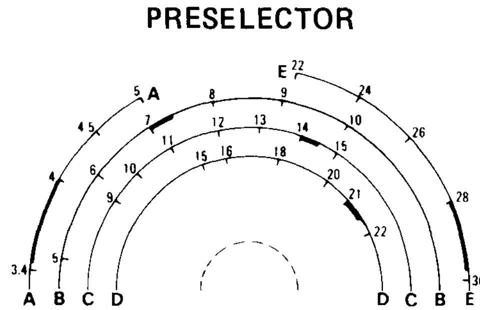


fig. 14. New receiver preselector scale for the Collins 75S receiver.

acknowledgements

The following were instrumental in enabling me to complete this project; without their assistance this article would never have been written: Cliff Buttschardt, W6HDO, for the use of his 75S-3 receiver; Duke Moran, W6SPB, who etched the prototype PC boards; Paul Zander, WB6GNM, for his invaluable help in the design of the phase-locked loop; and Bob Melvin, W6VSV, who listened to my problems and even made a suggestion or two.

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2. F. M. Gardner, *Phase Lock Techniques*, John Wiley and Sons, New York, 1967.
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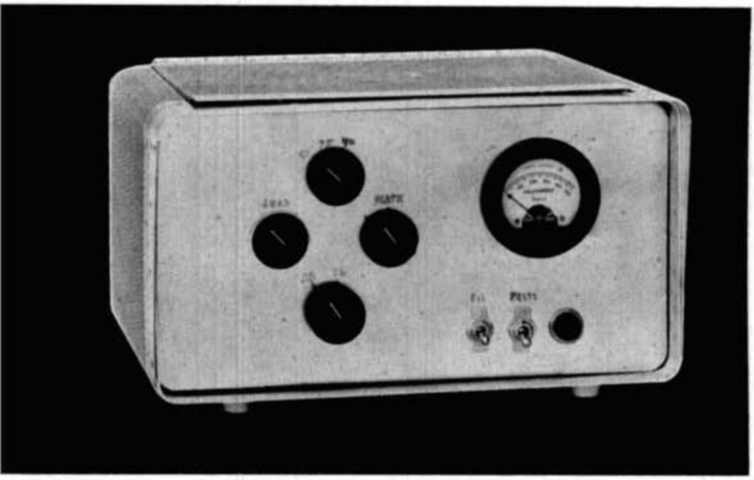

100-watt linear amplifier for QRP rigs

A compact rf amplifier for ultra low power amateur transmitters

W. S. Skeen, W6WR*

To dispose of the first question apt to be asked – "Why add a linear amplifier to a QRP rig since it defeats the whole idea of QRP operation?" – I'd like to say that while 2 to 5 watts can do wonders during the day, night operation is a different story. The prevailing sunspot activity precludes the predictable propagation conditions of 10 or 15 years ago, even on the 40- and 80-meter bands. A little boost to the output of a QRP rig means the difference between fun and drudgery during nighttime operation. When good conditions return, a linear amplifier probably won't be needed for low-power work.

I built this amplifier to augment a homebrew rig that didn't live up to my expectations – the rig had only about 5 watts output on ssb. The linear amplifier described here should prove to be a useful adjunct to low-power transmitters in the 2 to 10 watt range.

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circuit

The schematic (**fig. 1**) is simple, effective, and uncluttered. A grounded-grid, grounded screen circuit is used without the usual blower for tube cooling. Any of the Eimac 4X or 4CX tubes will perform equally well.

In the late 1950s, I witnessed some tests at Eimac that were run to see what these tubes would do without forced air cooling. The tests indicated that the tubes would dissipate 60 to 70 watts under key down operation – however, the tubes were mounted *in the open*, with no restriction to ambient air flow. Under intermittent operation, it appears that a tube of this family could safely dissipate at least 50 watts; perhaps a little more if cooling fins are provided. Again, the qualifier is: unrestricted air flow around the tube. A further advantage is that the heater-cathode isolation in these tubes is excellent; no filament chokes are required at this power level.

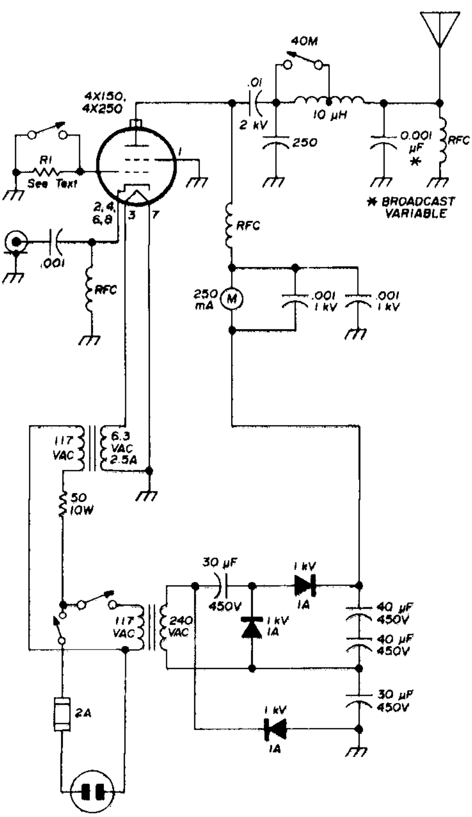


fig. 1. QRP linear schematic. Any of the 4X or 4CX series of tubes may be used. Up to 50 watts dissipation is possible without a blower providing tube is mounted in the clear.

One other precaution should be observed. Although the heater is rated at 6.0 volts ±5%, it is recommended that 6.0 volts be considered the upper limit. A 50-ohm, 10-watt resistor in series with the primary of a 6.3 Vac, 2.5 amp filament transformer should do the trick. The heater contributes a large part of the heat to be dissipated, and tube life is prolonged by keeping the heater voltage on the low side.

A noninductive, 1-watt carbon resistor (R1) of a few hundred ohms is provided for situations where excitation is excessive with no provision for reducing it. The resistor should be selected to obtain recommended operating conditions. While this amplifier is a two-band affair for 80 and 40 meters, additional taps can, of course, be provided for other bands on the pi-net output coil.

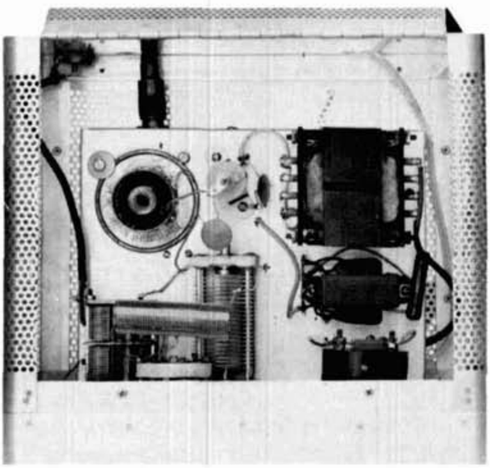
operating conditions

The amplifier has a power gain of about ten with both grids grounded, so 5 watts input should yield about 50 watts output, with a plate current of 100 mA and E_b at 1 kV. This current is 100 mA as read on the meter in the CW mode. Although up to 150 mA can be obtained with 7 watts input on CW, it is recommended that the series grid resistor be switched in to hold the plate current to 100 mA on ssb or 150 mA on CW. As with any low duty cycle amplifier, don't hold the key down longer than necessary.

Static plate current (no drive) is about 10 mA. Linearity could be improved by a higher idling current, but observations with a spectrum analyzer indicate that, with 10 mA static plate current, the bandwidth is entirely acceptable, and reports have been universally good.

construction

An aluminum chassis, 2x6x9 inches (5x15x23cm) in an LMB cabinet constructed with perforated aluminum for sides top and bottom, easily contains the amplifier with power supply. The



Chassis layout. Power transformer (upper right) is a 50VA isolation transformer. Note air space around tube.

LMB cabinet (model CO-2) measures 6½ inches high by 10 inches deep by 13 inches wide (16.5x25x33cm) excluding hood. The chassis was purposely selected to improve air circulation. The tube socket is mounted as close as possible to one rear corner, both for short leads from coax connectors and again to improve cooling by air circulation over the chassis edge (see photo).

While the built-in screen bypass capacitor of the SK-600 socket is superfluous, open space around the tube pins permits air flow around the header (tube base). Old timers will remember that these tubes also fit in a loctal socket. A 4-inch (10.2cm) square piece of perforated aluminum with chassis cutout should also be suitable.

The grid resistor shorting switch, if used, should be mounted close to the tube, which means a shaft extension. The rf chokes are ordinary garden-variety 2 mH, 100 mA chokes with the exception of the plate choke; but even here, tests indicated that the smaller chokes should hold up.

The 10-μH pi-net coil (46 turns, 7/8 inch [2.2cm] OD, 3 inches [7.6cm] long, air wound) is barely large enough to cover the low end of 80 meters and is tapped at slightly less than one-half for 40 meters. The coil is mounted on the switch. A paralleled BC tuning capacitor suffices for the output. Additional fixed capacitance to total 1000 pF can be used, if necessary, for 80 meters.

power supply

A 50-VA isolation transformer is used with 120 Vac input and 240 Vac output to a voltage tripler arrangement that provides the 1-kV plate supply. Inspection of recent catalogs indicates that 115/230 V primary, 115 V secondary transformers are about all that are available now (about $10). In this case, the secondary may be used for the primary with a slight loss in output voltage and regulation. The filter capacitors and diodes mount under the chassis, and since there isn't much else there, no under chassis photograph is provided. A separate heater transformer and switch are provided. The tube heater should be allowed to warm up at least a half minute before applying plate voltage. Static plate current provides "bleeder" protection.

summary

This small linear compares favorably, both in size and performance, with commercially built units of the same power class. It has held its own with other 200-watt-plus units and has provided many solid contacts during the worst interference hours of the evening.

ham radio

an introduction to microprocessors

David Larsen, WB4HYJ, Peter Rony and Jonathan Titus*

Microprocessors are probably the single, most exciting development in the entire field of electronics, and in this article, the first of a series on microprocessors, we would like briefly to compare them to programmable calculators for typical laboratory applications.

The best description of what a microprocessor is, and isn't, was given by Laurence Altman in a recent issue of *Electronics*:[1] "A microprocessor is not a computer but only part of one. To make a computer out of a microprocessor requires the addition of memory for its control program, plus input and output circuits to operate peripheral equipment . . . What a microprocessor is, then, is the control and processing portion of a small computer or microcomputer. Moreover, it has come to mean the kind of processor that can be built with LSI mos or, more recently, bipolar circuitry, usually on one chip. Like all computer processors, microprocessors can handle both arithmetic and logic data in bit-parallel fashion under control of a program. But they are distinguished both from a minicomputer processor by their use of LSI with its lower power and costs, and from other LSI devices (except calculator chips) by their programmable behavior."

Thus, a microprocessor is not a totally self-contained computer-on-a-chip, nor is it able to complete with and replace the central processing unit (CPU) within a computer. Existing microprocessor chips are simply much too slow for such applications. The niche that microprocessors will soon fill is in the creation of "smart" input/output devices to a computer that relieve the computer of the drudgery associated with the data acquisition from and the control of such devices. In other words, microprocessors will shortly become very important tools in computer interfacing, a trend that will accelerate as the price of microprocessor chips declines, as more individuals develop the capability to handle such chips, and as more manufacturers incorporate such chips in laboratory instruments and other types of devices that communicate with computers.

The advantages of interfacing with microprocessors are at least fourfold:

1. Microprocessor communications are simple. The communications capability of a microprocessor system is a big point in its favor. Most such systems come with a built-in asynchronous serial port, and thus can communicate with teleprinters or with any device that also has an asynchronous serial port. The microprocessor is not inherently limited to only a single asynchronous port; it is

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very easy to add more such ports and thus permit the microprocessor system to communicate serially with other external devices such as laboratory instruments that are interfaced with Analog Devices' *Serdex* modules.

Microprocessor systems have parallel input ports for inputs from various digital sensor instruments, including voltmeters, panel meters, frequency meters, and counters. Any type of digital circuit that can supply parallel digital data can be used in conjunction with a microprocessor system.

2. Microprocessor systems are inexpensive. Such systems currently range in price from several hundred dollars to several thousand dollars, depending upon the capability of the system. They are available from Intel, Prolog Corporation, E & L Instruments, Control Logic, and other companies. The number of manufacturers that offer microprocessor systems is increasing rapidly.

3. Microprocessor systems are flexible and powerful. Microprocessors have the ability to make decisions. (Is an input value from a digital sensor too high or too low? If it is too high, then open a valve and release pressure on the system. If it is too low, then open another valve and add gas to the system.)

Microprocessors use software to replace hardware; i.e., microprocessor programs replace complicated hard-wired random logic digital electronic circuits that perform a variety of functions, including sequential logic, non-sequential logic, simple arithmetic calculations,

This the first of a new series of articles on the subject of microprocessors which we will be presenting in future months. Material presented here is reprinted with permission from *American Laboratory*, June, 1975, copyright © International Scientific Communications, Inc., Fairfield, Connecticut, 1975.

and comparison of digital signals. Manufacturers of microprocessor systems provide you with both read/write memory, for temporary data and program storage, and with read-only memory, which is easily programmed with the aid of a PROM programmer. Once you have written and tested a program using read/write memory that can acquire data and perform desired control operations, you can "burn" it into a programmable read-only memory (PROM) IC and then use that chip day after day to operate the microprocessor system.

You never have to worry about a power failure causing your program to be erased. The program can remain in the PROM for up to twenty years; it is always available for reloading into a read/write memory. The program can be easily modified to accommodate changed data acquisition or control requirements. You can develop a whole repertoire of PROM chips to accomplish different functions.

4. Microprocessor systems are capable of handling most laboratory data acquisition requirements. Current microprocessor systems can acquire digital data at the rate of five hundred 16-bit words per second. Higher data acquisition rates are occasionally claimed by manufacturers, but they frequently overlook the real software overhead that is needed, for example, to input the data, check if the data are ready, and compare the data to make sure that they are within the right range of values.

In the area of mathematical computations, microprocessors can perform integer multiplications and divisions, i.e., 3 times 4 or 5 divided by 7, with reasonable accuracy. A floating-point package available with the 8-bit Intel microprocessor allows you to perform additions, subtractions, multiplications, and divisions over the range of $\pm 10^{32}$ to $\pm 10^{-32}$. This package requires four read-only memories, which means that 1000 words of your microprocessor are dedicated to the floating-point package. Execution times are slow, so you must worry about the following types of questions: Do you acquire a data point and then operate upon it and still have sufficient time to acquire the next data point? Or must you store a complete block of data and then operate upon the block as a whole? If you store a block of data, how much additional memory is required for the microprocessor? Finally, is the system sufficiently complex and expensive that it can be replaced by a minicomputer or programmable calculator?

The strong point of the microprocessor is that it can perform control functions quickly, easily, and inexpensively. The microprocessor can turn devices on and off. It can regulate physical parameters such as temperature, pressure, velocity, and flow. Since it lacks special functions such as log, χ^y, sine, cosine, square root, hyperbolic sine, and hyperbolic cosine, it cannot perform sophisticated mathematical computations. This is one reason why many individuals are looking very seriously at programmable calculators, which start in the vicinity of $3000; are available from Wang, Tektronix, and Hewlett-Packard; and allow the user to program with complex functions such as sine, cosine, log, and χ^y. The programmable calculators, however, are not nearly as convenient to use as microprocessors in the control of equipment and processes.

As a final point, we would like to caution you about making any long-term decisions concerning both microprocessors and programmable calculators. The comments above apply to today's technology, which is precisely what you can do today. The price/performance ratio changes from day to day so that a decision that is valid today may not be the same one that would be proper in a month or a year from now; e.g., 8-bit bipolar microprocessors now available from Intel have cycle times of 50 nanoseconds. This speed is a little bit difficult to precisely define for the user, but it represents probably a decade of improvement in overall microprocessor speed when compared to any microprocessor available a year ago.

If you can postpone your problem, you may find that you can solve it differently and/or less expensively a year from now. Digital electronics is without doubt the fastest changing technological field today. You, as an amateur, engineer or scientist, will be a major beneficiary of the changes that are occurring. However, to take proper advantage of the new technology, you will have to spend some time learning the jargon and understanding the tradeoffs that can be made.

Microprocessor equipment, if cared for properly, has an operational life of at least ten years but a functional life that may only be several years. A reasonable strategy would be to postpone the purchase of a microprocessor until the price/performance ratio justifies a purchase, and then to go ahead and purchase a system with the knowledge that the same system will probably cost at least 20% less for the same performance a year later. We believe that not too much time will pass before all of us who are involved in research or manufacturing and depend upon instrumentation will have to take advantage of the power of microprocessors if we are to continue to have viable products or research programs.

We recommend that you give careful consideration to the ability to interface newly acquired digital instruments to future ones that will come on the market within the next several years. We emphasize again that the existence of asynchronous serial ports on your digital instruments will allow you to hedge your bets for the future.

reference

1. L. Altman, "Single-chip microprocessors open up a new world of applications," *Electronics*, April 18, 1974, page 81.

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squelch circuits

for transistor radios

Agc-activated squelch can easily be added to portable transistor radios

Robert Harris, Jr., WB4WSU, 801 Tucson Road, Virginia Beach, Virginia 23462

Inexpensive transistorized portable radios can become excellent monitor receivers for vhf operators (a-m and fm) with the addition of one of the simple squelch circuits presented in this article. The squelch will get rid of the constant and fatiguing hash and noise usually put out under no-signal conditions, making the portable a much more useful and enjoyable radio to listen to. I have had much success in adding the circuits shown here to several portables. It should be possible to adapt this same basic approach to just about any existing portable receiver.

A brief explanation of squelch circuitry seems appropriate at this point. During no-signal conditions, the audio output of a receiver is random and unpleasant noise. When a signal is received, the gain of the receiver is reduced or limited by agc action, and the level of noise output is reduced. The greater the signal strength, the lower the noise output, and hence the term "receiver quieting," By adding circuitry which detects the degree to which the receiver has been quieted, and by using this circuitry to mute or un-mute the audio output, squelch may be added to the receiver.

Note, that with the squelch I have just described the operator may adjust the sensitivity of his receiver in terms of a minimum signal-to-noise ratio needed to produce an audio output signal. By making this signal-to-noise ratio sufficiently high, the operator can be sure that whenever the receiver produces an audio output it will contain a signal of a

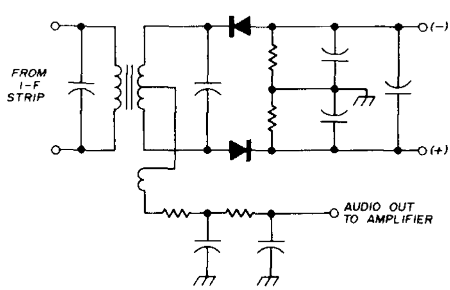


fig. 1. A typical ratio detector found in many transistor radios. Agc voltage may be taken from the (+) or (−) terminals.

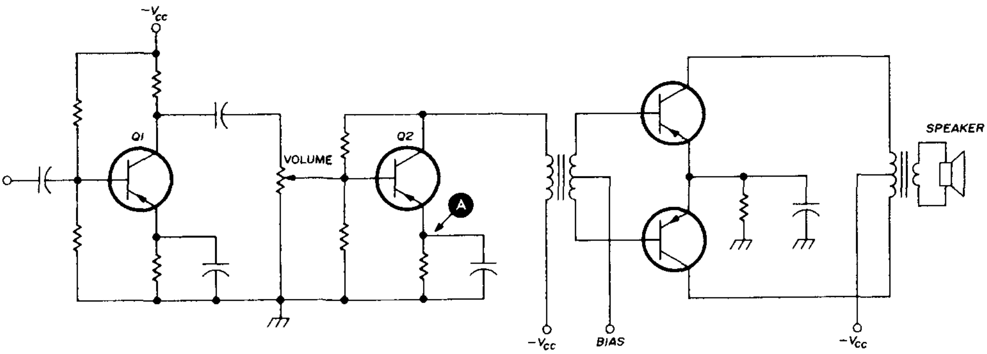


fig. 2. The audio section of most portables will closely resemble the circuit shown here. Point A in Q2's emitter is a control point for muting the audio output.

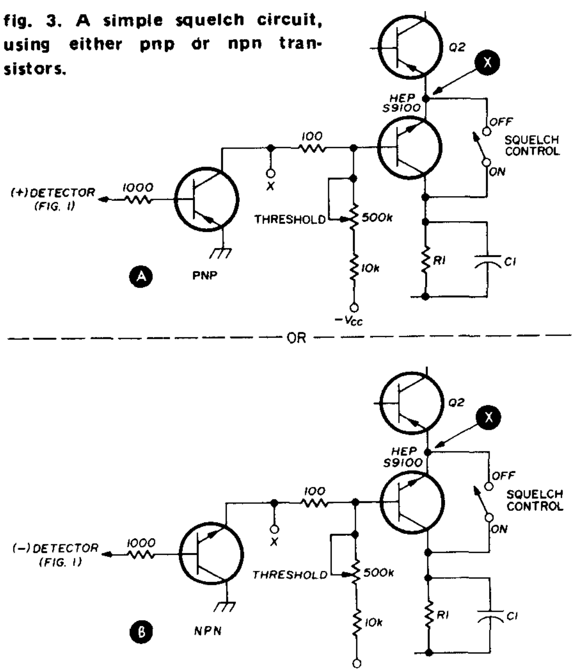
certain minimum readability. At first this might sound like intentionally reducing the sensitivity of your receiver, but this is not so. With sophisticated circuits, the opening of the receiver squelch alerts the operator to the presence of marginal level signals that might otherwise have gone unnoticed in the noise. Unfortunately, these noise-operated squelch circuits are somewhat complex, and they are beyond the scope of this article.

Another method of producing squelch action is to make use of the agc or other signal level dependent voltages to control audio muting. The only drawback with this approach is that sufficiently strong noise or interference will also open the squelch. However, for the purpose intended here they work quite acceptably.

detector

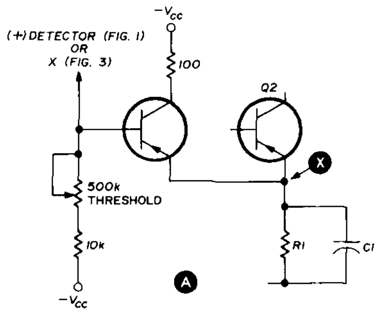
Most inexpensive portable receivers use the common ratio detector similar to the one shown in **fig. 1**. This detector develops significant positive and negative voltages during signal conditions, either of which may be used for control of the audio muting. Generally, the audio section of a portable receiver will closely resemble the circuit of **fig. 2**. Audio from the detector is coupled to Q1, a preamplifier, (which is sometimes omitted in inexpensive sets). The output is coupled through the volume control

fig. 3. A simple squelch circuit, using either pnp or npn transistors.



to the driver stage, Q2, which in turn drives the output stage. These sections are easily located by finding the audio transformers associated with them, and it is seldom necessary to resort to a schematic to find the desired stages.

plete muting are shown in **fig. 4.** In these circuits, the emitter signal path of the driving transistor is not broken, but the biasing of the driver is upset when no signal is present. But with even a small signal present, the bias is sharply



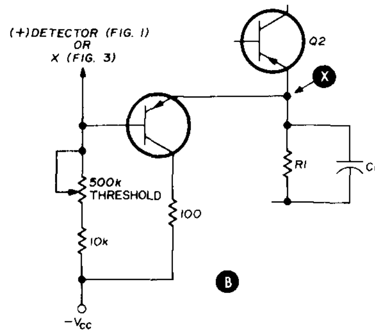
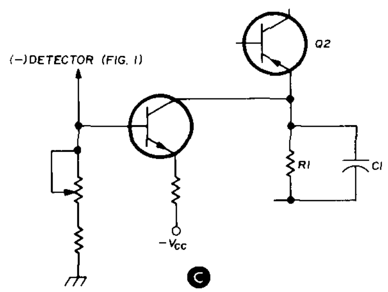


fig. 4. A "brute force" squelch circuit is shown at (A); variations of the circuit are shown in (B) and (C). A spst switch may be placed in the control line for on/off control of the squelch.



simple squelch

The point marked X in the emitter of Q2 is a convenient point to add squelch control to the audio stages. By breaking the circuit at this point and adding the muting circuit of **fig. 3A**, a simple squelch circuit is obtained. In some cases, small amounts of signal or noise will leak through even when this stage is supposedly squelched. Also, an increase in distortion may be noticed at high volume levels. A variation of this circuit is also shown, using an npn transistor, in **fig. 3B**.

improved design

Somewhat more positive acting squelch circuits which do not tend to cause distortion or suffer from incom-

returned to normal and audio output is restored.

conclusion

The several approaches to agc-controlled squelch shown here can be easily adapted to most portable radios. Receivers using both npn and pnp transistors may be accommodated, and junk box transistors seem to work a great percentage of the time. If you are unable to locate a source of agc voltage, do a little poking around with a vtvm until you find a voltage source that varies with signal strength. That is all that is needed to add squelch to a portable radio, making it a much more useful and enjoyable low cost monitor receiver.

ham radio

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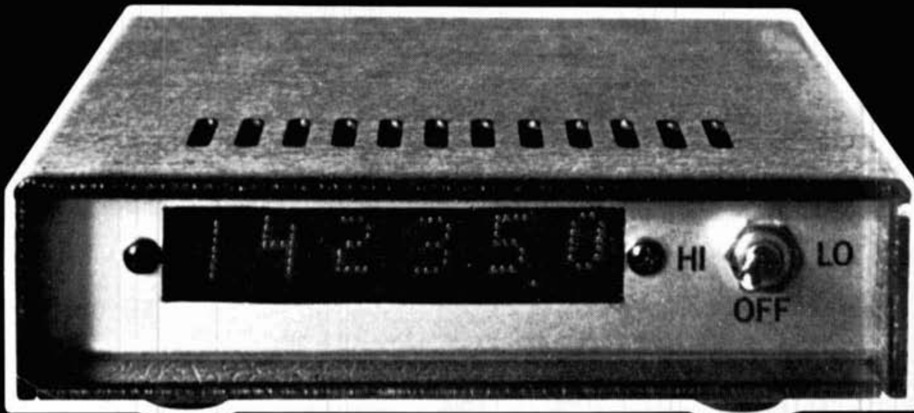

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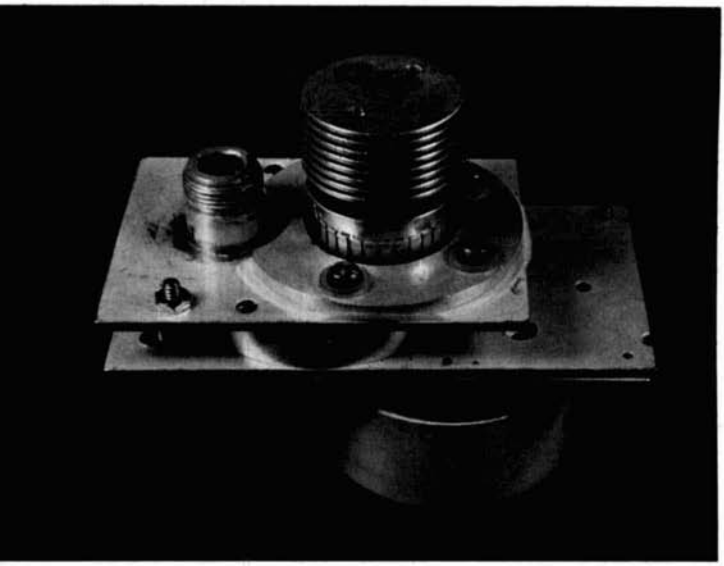

1152- to 2304-MHz power doubler

Construction of a single-tube frequency doubler for 2304 MHz that provides 5 dB power gain

Norman J. Foot, WA9HUV*

A 2C39 power amplifier capable of providing 30 watts output on 2304 MHz was described in the February, 1975, issue of *ham radio*.[1] Its design involves a combination of the best characteristics of various experimental 2.3 GHz amplifier models I have built and tested over the past three years. Each succeeding version differed from the previous one in ways which both improved performance and simplified construction.

During the same three-year period, on-the-air tests over a ten-mile path were performed between WA9HUV and both W9DCN and K9CNN, first working 432/2304 crossband, and later using 2304 MHz two-way. Signals were well over S9 on 2304 MHz, in spite of the 1296-MHz antenna used by W9DCN. Contacts over longer distances have

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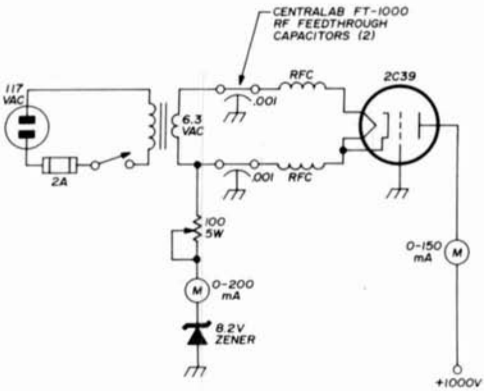


fig. 1. Circuit diagram for the 1152 to 2304 MHz power doubler using a 2C39 which provides approximately 5 dB gain. Rf chokes are 8 turns no. 18 tinned copper, airwound on 3/16" (5mm) mandrel, turns spaced slightly.

been solicited, but none have yet been tried. It is hoped that this article, together with the preceeding one which described the 30-watt power amplifier, will provide the impetus necessary to develop new interest in the 2304 MHz band.

frequency doubler

Having arrived at a reasonably good basic design, attention was focused on developing a companion doubler stage capable of driving the power amplifier to full power output with drive to spare. Rather than starting from scratch, it was decided to convert one of the earlier power amplifiers into a doubler by lengthening the cathode cavity to 1-3/8 inch (35mm). No changes were made to the amplifier plate circuit. The resulting doubler circuit is very similar to the power amplifier.

Because the doubler plate circuit is identical to that of the companion power amplifier, only the doubler cathode circuit will be described here. Details of the plate circuit can be obtained from reference 1.

Complete cathode partition assembly showing the heater/cathode line (left), piston tuner (center) and cathode coupler (right).

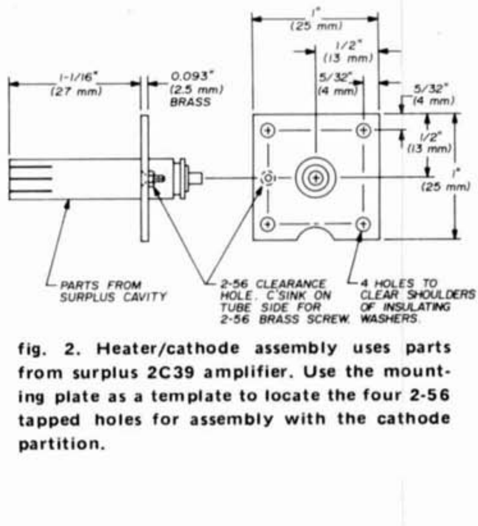


fig. 2. Heater/cathode assembly uses parts from surplus 2C39 amplifier. Use the mounting plate as a template to locate the four 2-56 tapped holes for assembly with the cathode partition.

heater-cathode assembly

The heater-cathode assembly shown in **fig. 2** is nearly identical to the one used in the amplifier except that the heater-cathode line extends into the cavity 1-1/16 inches (27mm). The 2-56 brass flat-head machine screw holds a solder lug to connect the cathode side of the heater to the appropriate circuitry (this detail was omitted from the amplifier article). Attach the screw to the plate with a 3/16 inch (4.5mm) hexagonal nut and then sand the inside surface of the plate flat to make sure the screw head does not project beyond the surface of the plate. Finally, position the plate over the finger-stock assembly and solder the two together as shown in **fig. 2**.

The completed heater-cathode assembly should be insulated from the cathode partition with insulating shoulder washers and 0.005 inch (0.1mm) Teflon sheet.

cathode piston tuner

The cathode partition is identical to the one described for use with the amplifier and is shown in **fig. 3**. Rather than using a brass bushing from an old volume control for the piston trimmer, a 3/4 inch (19mm) diameter brass cylinder 5/8 inch (16mm) long is soldered to a length of 1/4 inch (6.5mm) diameter brass rod. Then a 1-1/4 inch (32mm) length of 3/8-32 threaded brass sleeving is slipped over the 1/4 inch (6.5mm) shaft and soldered in place as shown in **fig. 4**. Soldering should be done with the aid of a propane torch, using solder sparingly. Finally, the tuner and sleeve assembly are screwed into the tuner bushing from inside the cathode partition.

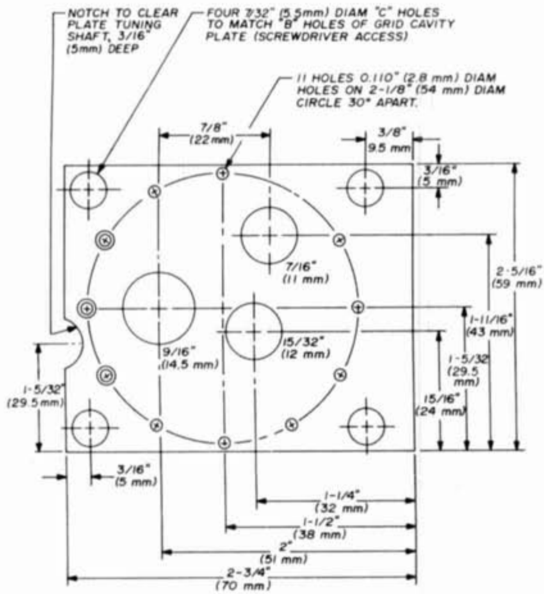


fig. 3. Cathode partition. Holes marked with the letter C are screwdriver clearance holes to facilitate assembly. Material is 0.093" (2.5mm) brass.

Exterior view of the cathode partition.

If 3/8-32 threaded brass tubing is not available, use 3/8-28 threaded lamp fixture brass tubing which is obtainable in most hardware stores. In this case, the tuning shaft should be made of 5/16 inch (8mm) diameter brass rod to fit inside the lamp hardware. Test the threaded tubing with a magnet to make sure it is not brass-plated steel. Before reassembly with the cathode cavity, the cathode input coupling circuit is assembled as described in the next section.

Helical springs are used to put pressure on the threads of the tuning piston trimmer threads. These springs, which are used on the amplifier as well as the power doubler, are 9/32 inch (7mm) inside diameter. A brass collar with set screws is used at the far end of the tuning shaft to place the spring in compression. These springs are quite important as tuning is likely to be erratic if they are omitted.

cathode coupling assembly

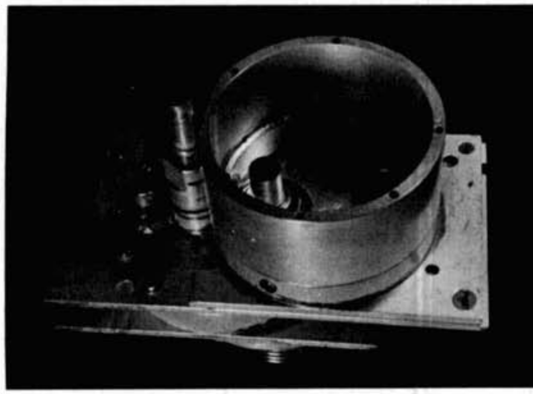
The 1/8 inch (3mm) and 5/32 inch (4mm) OD brass tubing needed to fabricate the cathode coupler (**fig. 5**) can be obtained from most hobby shops. The connector end of the assembly is soldered to the center conductor of the type-N coaxial connector. The 1/8 inch (3mm) end is slotted with a fine (32 teeth per inch) hacksaw blade. Spread the slotted end slightly to provide a tight slide fit with the cavity end of the coupler assembly.

The cavity end is screwed into the 3/16 inch (5mm) diameter hole in the grid cavity plate. Solder a flat brass washer on the cavity end as shown to provide a good rf contact on the inside of the cavity.

When assembling the cathode partition on the cathode cavity, slide the connector end of the coupler into the cavity end. If the instructions have been carefully followed, the two parts should slide together without interference.

tuning up

The circuit diagram of the frequency doubler shown in **fig. 1** is identical to the amplifier wiring diagram except for



View of cathode cavity before installation of the cathode partition. Since an earlier model of the 2304 MHz power amplifier was modified for use as a doubler, parts in this do not correspond exactly with figs. 2 through 5.

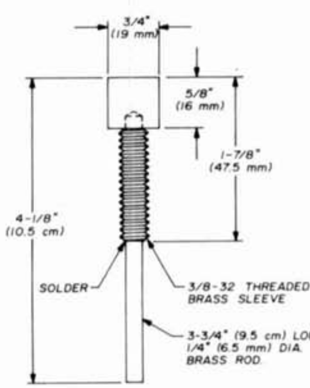


fig. 4. Cathode piston tuner assembly. Brass rod is soldered to 3/8-32 threaded sleeve.

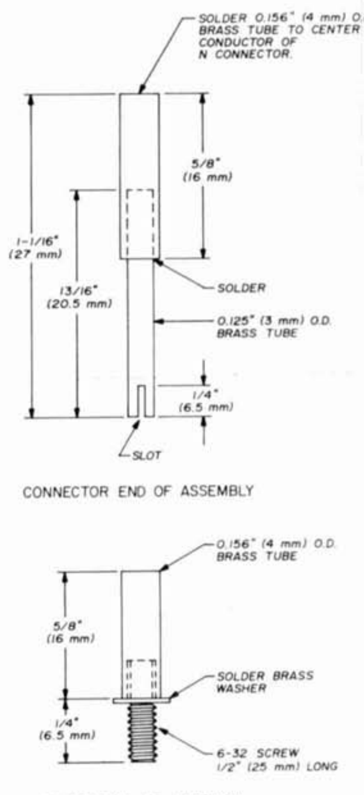
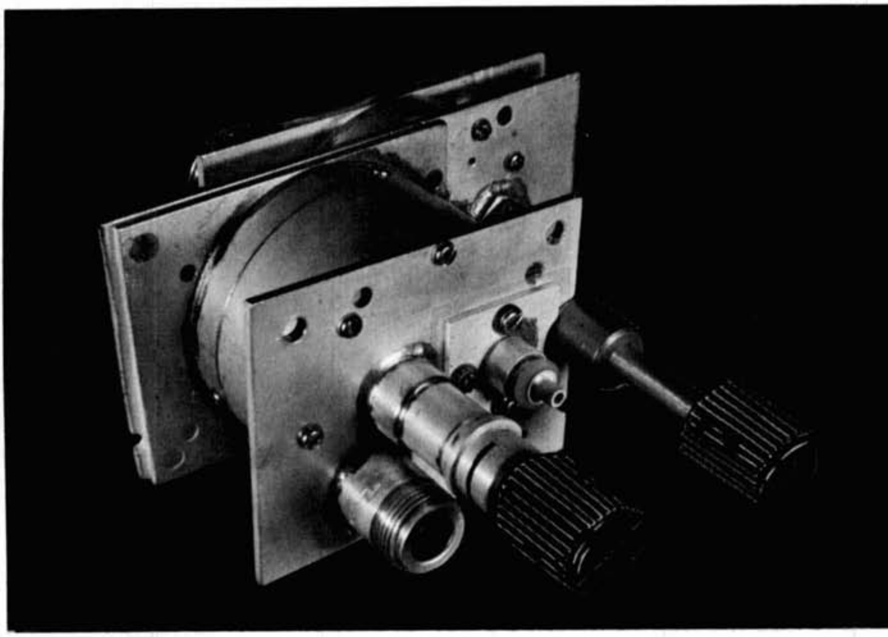


fig. 5. Cathode coupling assembly. Brass tubing can be obtained from most hobby shops.



Front view of completely assembled 1152 to 2304 MHz power doubler.

component values and the meter ranges. A 7.6-volt zener diode is used instead of the 6.3-volt unit to reduce the conduction angle of the plate current for better doubler efficiency. The quiescent (no-drive) plate current should be set to approximately 25 mA by adjusting the position of the slider on the 100 ohm variable resistor.

"Just replace capacitor C10 . . . than you'll be back on the air."

Measurements were made using a calorimeter which indicate that the doubler has a power gain of approximately 5 dB. It is interesting to note that this doubler provides about 8 dB more power output on 2304 MHz than would be expected from a varactor doubler with the same drive power. Therefore, with less than one watt of drive at 1152 MHz, more than sufficient output is obtained to drive the power amplifier stage to full output. It is recommended that the primary winding of the doubler plate supply transformer be controlled with a variable transformer so that drive to the power amplifier can be adjusted to the desired level.

reference

1. Norman J. Foot, WA9HUV, "Power Amplifier for 2304 MHz," *ham radio*, February, 1975, page 8.

ham radio

INSTRUCTIONS

Cut on Dotted Line

FILL IN ORDER FORM
LEAVE IN CONSPICUOUS PLACE
(It's not very subtle, but it may work.)

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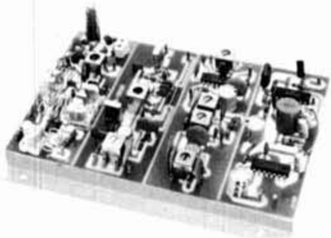

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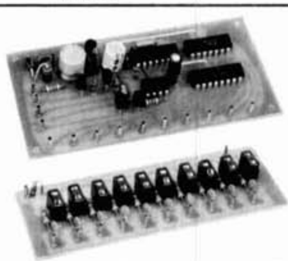

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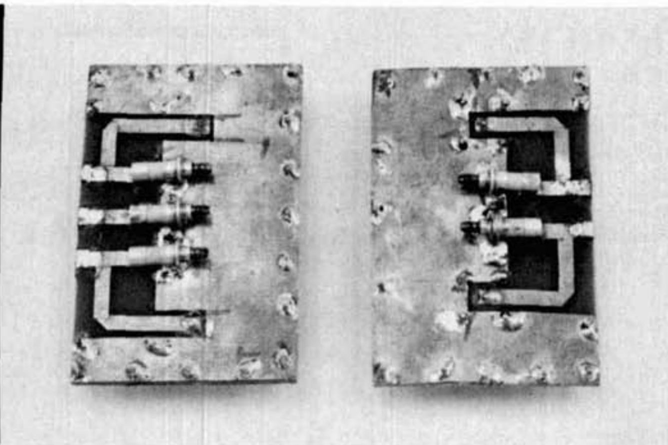


microstripline bandpass filters for 1296 MHz

Miniature bandpass filters for the amateur 1296-MHz band

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

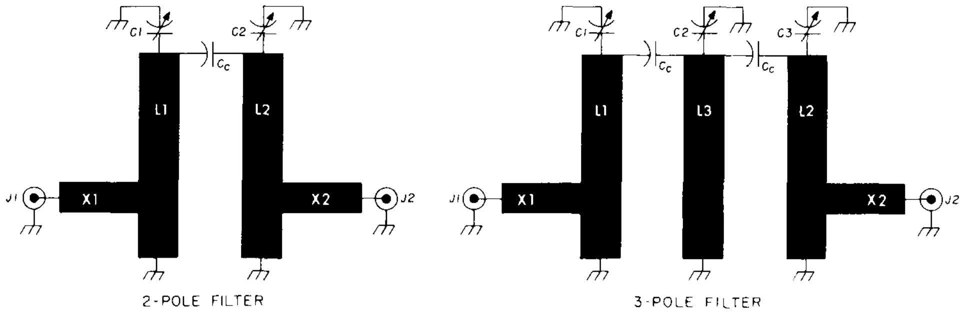
Uhf experimenters frequently need to filter out spurious or image responses, usually with coaxial or trough-line resonators.[1-5] Although properly designed coaxial and trough-line filters offer exceptional skirt selectivity and minimum insertion loss, they are large and bulky and require access to sheet-metal cutting and forming equipment. The 1296-MHz filters presented here are based on printed-circuit microstripline techniques and are easily duplicated in the home workshop.

Two- and three-pole bandpass filters for 1296 MHz are shown schematically in **fig. 1**. In each of the filters parallel-resonant sections, consisting of microstripline inductors and piston trimmer capacitors, are loosely top coupled. The input and output striplines are tapped down on the inductors to provide a match to 50 ohms. The two-pole bandpass filter is functionally equivalent to the filters used at the input of the RF and LO ports of my 1296-MHz double-balanced mixer.[6] In the design presented here, however, the coupling capacitor, C_c, formerly a 0.5 pF chip capacitor, has been replaced by the stray coupling capacitance between the stator ends of trimmers C1 and C2.

As can be seen from the swept frequency response curve in **fig. 2**, these microstripline filters are relatively low-Q devices. The steepness of the rejection skirts may be sacrificed somewhat to minimize passband insertion loss, which for this design averages around 1 dB.

construction

Full-size artwork for the printed-



C1-C3	1-5 pF ceramic piston trimmer
C_c	Stray coupling capacitance between stator ends of trimmer capacitors
J1, J2	SMA or equivalent microstripline launchers (E. F. Johnson 142-0248-001 or similar)
L1, L2, L3	Microstripline inductor, 0.5" (13mm) long, 0.1" (2.5mm) wide, spaced 0.3" (7.5mm) center to center. Bottom ends strapped to groundplane with thin copper strap
X1, X2	50 ohm microstripline, 0.1" (2.5mm) wide, any length. Centerline tapped to L1 and L2 0.2" (5mm) from grounded end

fig. 1. Two- and three-pole microstripline bandpass filters which tune the range from 1100 to 1500 MHz. Full-size printed-circuit layouts for these filters are shown in fig. 3.

circuit microstripline filters is shown in **fig. 3** and is designed for 1/16 inch (1.5mm) thick G-10 epoxy-glass printed-circuit board, double clad with 1 ounce copper.* The unetched side of the board serves as a groundplane. Board dimensions are such that the filters mount easily in a miniature die-cast aluminum box such as a Pomona 2417. The cutaway view of **fig. 4** shows the method of mounting the piston trimmer capacitors on the circuit board.

With the circuit values shown, these filters can be adjusted to resonate anywhere in the range between 1100 and 1500 MHz. The easiest method to adjust for resonance at 1296 MHz is to connect a weak-signal source through the filter into a receiver, and adjust the trimmer capacitors for maximum received signal. Since the output impedance of the signal source and the input impedance to the receiver may deviate substantially from 50 ohms, it's a good idea to temporarily install fixed attenuators at the input and output of the filter while tuning as shown in **fig. 5**. There is a certain amount of interaction between the trimmer capacitors so the adjust-

*Tuned and tested two- and three-pole bandpass filters for 1296 MHz are available from Microcomm. For complete specifications and prices, send a self-addressed, stamped envelope to Microcomm, 14908 Sandy Lane, San Jose, California 95124.

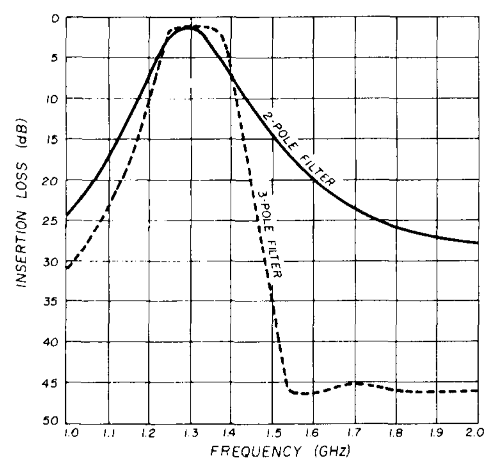


fig. 2. Swept frequency response of the two- and three-pole microstripline filters (measured with a Hewlett-Packard network analyzer and X-Y plotter). The 3 dB bandwidth is 150 MHz and passband insertion loss is about 1 dB. The 20-dB bandwidth is 320 MHz for the 3-pole filter, 570 MHz for the two-pole design.

ments should be repeated several times to insure that you have the filters tuned for minimum insertion loss.

If the filter is to be used to reduce the spurious output of a local-oscillator chain, alignment to the desired passband frequency is most easily accomplished by placing the filter in the line between the LO and the mixer and adjusting the filter for maximum indicated mixer current (**fig. 6**).

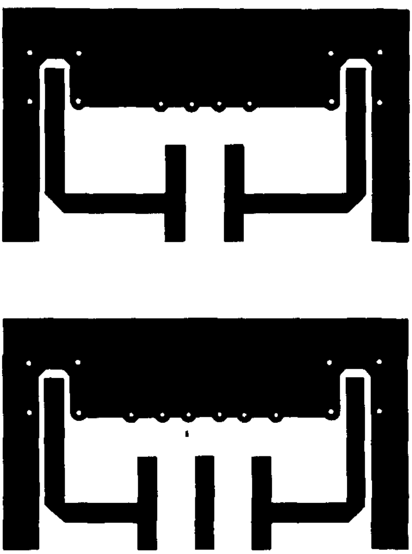


fig. 3. Full-size artwork for the two- and three-pole bandpass filters for 1296 MHz which are designed for 1/16" (1.5mm) double-clad G-10 epoxy-glass circuit board.

applications

Most amateurs who are active on 1296 MHz will probably want to have several of these bandpass filters available on their workbench. In general, accurate measurements on any two-port device are enhanced by the application of filtering at each port. Microstripline amplifiers, for example, tend to be extremely broadband; since transistors tend to have higher gain at lower frequencies, any low-frequency spurious which is applied to the amplifier will be amplified more than the desired in-band signals. It is not unlikely, in fact, for lower frequency, out-of-band signals to actually force an amplifier into gain compression. Bandpass filters at the input and output of an amplifier under test will thus aid considerably in making accurate gain and dynamic range measurements.

In operational equipment it's a good idea to place bandpass filters between each wideband stage as shown in **fig. 7.** The filter's 1 dB or so of insertion loss is more than offset by the elimination of image signals and spurious responses. For maximum image rejection it is recommended that the more selective three-pole filter be installed between all active stages. In the local-oscillator chain, where harmonically related spurious signals are separated from the passband by an octave or more, the simpler two-pole resonators are usually sufficient.

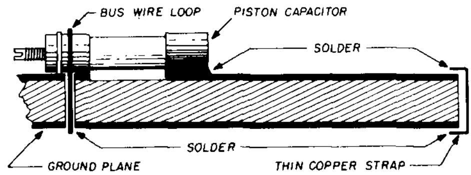


fig. 4. Method of mounting the piston trimmer capacitors on the microstriplines.

acknowledgements

I would like to thank Marvin Wahl, W6FUV, for critiquing the design of these filters, and Stu Rumley, WB6LOU, for assisting in the swept-frequency response measurements.

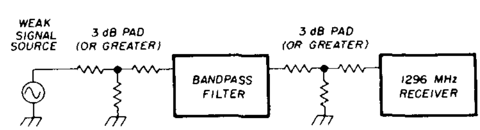


fig. 5. Using a weak-signal source to align a filter to 1296 MHz. The 3 dB attenuators swamp out any impedance mismatches.

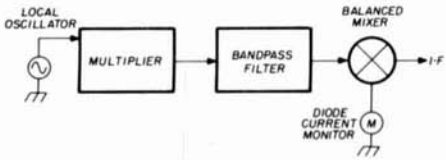


fig. 6. Bandpass filter can be adjusted to the local-oscillator output frequency by tuning the filter for maximum mixer current.

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1. Henry Meyer, Jr., W6GGV, "A Crystal-Controlled 1296-MHz Converter," *QST*, September, 1962, page 11.
2. John Specialny, Jr., W3HIX, "1296-MHz Converter," *73*, November, 1962, page 6.
3. Donald Nelson, WB2EGZ, "Modernizing a Classic 1296-MHz Converter," *QST*, December, 1969, page 21.
4. N. H. Sandford, VK4ZT, "Solid-State 1296-MHz Converter," *ham radio*, November, 1970, page 6.
5. William O. Troetschel, K6UQH, "1296 Revisited," *QST*, July, 1973, page 40.
6. H. Paul Shuch, WA6UAM, "How to Use Double-Balanced Mixers on 1296 MHz," *ham radio*, July, 1975, page 8.

ham radio

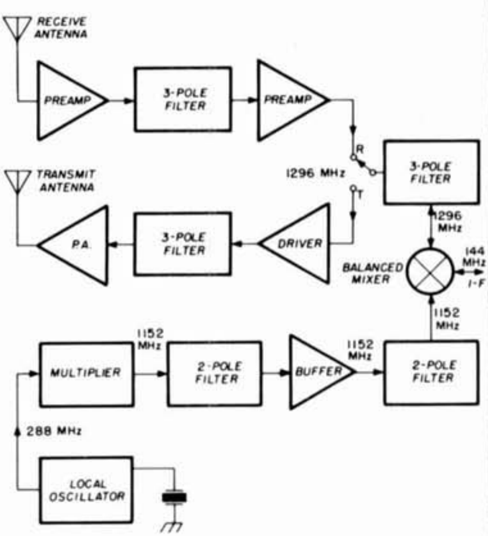


fig. 7. Installation of bandpass filters in a typical 1296-MHz transmitter and receiver. Three-pole filters are recommended between active stages, as discussed in the text.

uhf frequency scaler

New Fairchild 11C90 decade counter IC is a direct plug-in replacement for the popular 95H90 that extends operation to above 500 MHz

Doug Schmieskors, WB9KEY, 22065 McClellan Road, Cupertino, California

Fairchild Semiconductor has introduced another outstanding IC in the 11C00 series[1] which should be of *immediate* interest to amateurs — the 11C90, a pin-for-pin replacement for the popular 95H90 that has a *minimum* guaranteed toggle frequency of 520 MHz from 0°C to +75°C. At its best, the new 11C90 is a complete front end for a 700 MHz frequency counter (typical toggle frequency at 25°C).*

The 11C90 uhf divide-by-10/11 prescaler makes use of Fairchild's Isoplanar II technology for high speed with reasonable power dissipation. Pins which were unused on the 95H90 decade prescaler are used on the 11C90 to provide a reference voltage which centers the input clock voltage about the switching threshold and allows direct capacitive coupling to the signal source or test antenna. An on-chip ECL-to-TTL level converter is capable of driving ten TTL loads and eliminates the need for any external output interface circuitry.

circuit operation

To take full advantage of the 11C90's uhf counting ability, a circuit such as that shown in **fig. 1** should be built or derived from an existing 95H90 layout.[2,3] Pin 13 (TTL V_{EE}) should be tied to ground (low) if the TTL output (pin 11) is used. If only the ECL output

*The 11C90 is available now from franchised Fairchild distributors worldwide for $16.00 in small quantities.

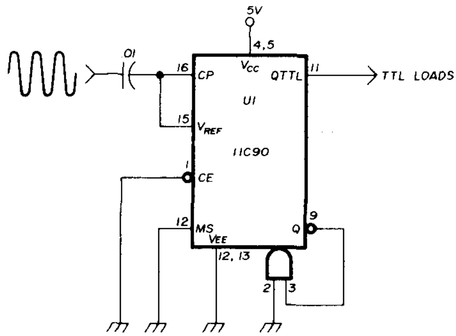


fig. 1. Divide-by-10 uhf prescaler has a minimum guaranteed toggle frequency of 520 MHz. Typical toggle frequency at 25°C is 700 MHz.

(pin 8) is used, pin 13 may be left open to reduce power consumption.

A *reference voltage* is *generated* internally across a 400-ohm resistor to the V_{BB} supply and is present at pin 15 (V_{ref}). This completely eliminates any need for an external biasing network.

Pins 6 and 7 of the 11C90 are uncommitted 2000-ohm resistors which are internally connected to the mode control inputs, $\overline{M1}$ and $\overline{M2}$. When tied high (+5 volts) these resistors allow the associated mode control input to be driven from TTL; if these inputs are left open or tied low, the mode control inputs offer, respectively, unterminated or terminated ECL loads to the drivers.

The mode control inputs are useful primarily when the 11C90 is employed in the divide by 10/11 mode to produce

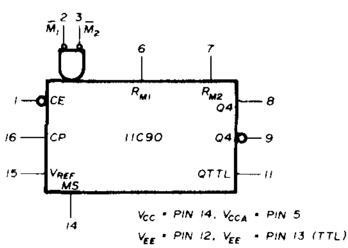


fig. 2. Logic symbol for the Fairchild 11C90. Mode control inputs $\overline{M1}$ and $\overline{M2}$, and RM1 and RM2 inputs are discussed in text. The IC includes a built-in ECL-to-TTL converter.

non-standard divide ratios such as those used in pulse swallowing for frequency synthesis. The 11C90 logic symbol (**fig. 2**) and truth table in **table 1** should aid in understanding the device.

Circuit layout, although not critical, can be used to enhance the high-frequency operation of the 11C90. Proper power supply decoupling, broad ground connections, short signal runs, and short leads (sockets are *not* recommended) will all help the user to reap the maximum performance that has been built into the device. The 11C90 typically requires only 65 mA as compared to 90 mA for the 95H90, so it runs much cooler than its predecessor.

***table 1.* Mode selection for the 11C90. Low is indicated by L, high by H.**

M1	M2	module divide by
L	L	11
H	L	10
L	H	10
H	H	10

summary

The 11C00 family of sub-nanosecond logic now consists of nine devices ranging from the 11C05 prescaler to the 11C01 gate package, and includes the 11C58, a 150-MHz voltage-controlled monostable oscillator which features a 4:1 frequency range with 2-volt dynamic range. These new devices obviously open up a whole new range of frequency synthesizer possibilities, but that's another story.

references

1. Douglas Schmieskors, WB9KEY, "1200-MHz Frequency Scalers," *ham radio*, February, 1975, page 38.
2. F. Everett Emerson, W6PBC, "300 MHz Divide-by-Ten Frequency Scaler," *ham radio*, September, 1972, page 41 (correction, December, 1972, page 90).
3. F. Everett Emerson, W6PBC, "Circuit Improvements for the Advanced Frequency Scaler," *ham radio*, October, 1973, page 30.

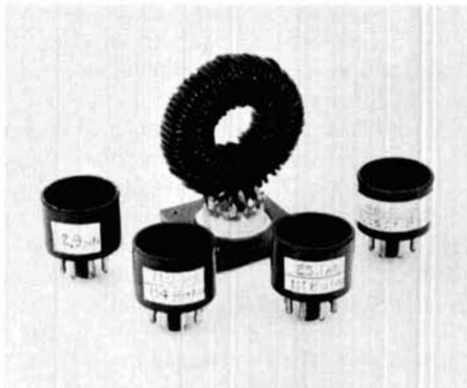
ham radio

quadrifilar toroid

The prevalence of roller inductors in transmitters and antenna couplers attests to the need for adjustability. The quadrifilar toroid limits the adjustability to discrete steps but offers the advantages of small size, internal field requiring little if any shielding, and balun applications.

The ends of the four, parallel, tightly-coupled windings are connected into the desired configuration by an octal socket and tube base. Of several octal sockets I tested those with "wrap-around" pins consistently measured 0.003 dc ohm per contact while the "edge-bite" pins varied from 0.003 ohm for a few pins to many times that value for most. Obviously only the "wrap-around" octal socket is recommended and preferably in ceramic or mica-filled bakelite. If a *low-resistance* 12-point switch or plug-socket can be found, a hexifilar toroid with inductance ratios of 1, 4, 9, 16, 25 and 36 can be built.

This example of a quadrifilar toroid consists of an Amidon T-200-6 toroidal core with four windings of 16 turns each of number 12 (2.1mm) enamelled



Construction of the quadrifilar toroid which is based on an Amidon T-200-6 powered-iron toroidal core.

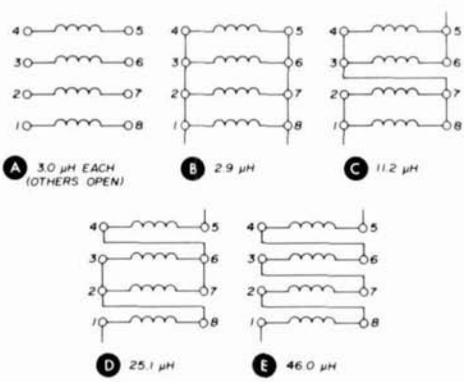


fig. 1. Five methods of interconnecting the four quadrifilar windings, and the measured inductance values of each configuration. Winding consists of 16 quadrifilar turns of no. 12 (2.1mm) on an Amidon T-200-6 toroid core.

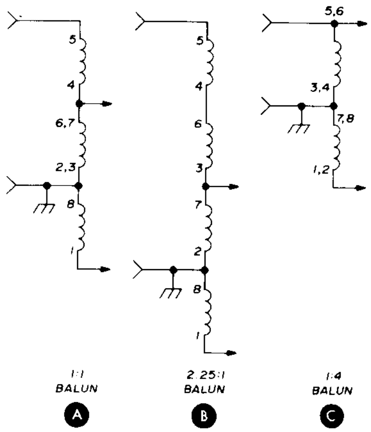


fig. 2. Quadrifilar windings may also be used to build baluns with 1:1, 2.25:1 and 1:4 transformation ratios.

wire. **Fig. 1** shows the socket connections and the measured inductance values.

In balun service the four independent windings lend themselves to several configurations; three of the simpler forms are shown in **fig. 2.** The easy access to the terminals suggests other arrangements.

The frequency response of the 1:1 balun is flat to at least 20 MHz (the limit of my sweep generator) and probably well beyond. Even at one-half and twice termination the smooth roll-off dropped only 30 and 20 per cent, respectively, at 20 MHz.

R.S. Naslund, W9LL

technique speeds antenna tuner adjustment

This article deals with a simple and accurate procedure for tuning or adjusting antenna tuners without using a transmitter *or* a standing-wave bridge. To avoid some possible confusion the term antenna tuner refers to such devices as Johnson Matchbox, Millen Transmatch, Murch Ultimate Transmatch and most similar homebuilt antenna tuners. Every ham shack should have at least one.[1]

In almost every technical article on antenna tuners that is published, you are instructed to make a written record of the dial settings and coil tap points for future use. If you've gone through this you know it's time consuming to search for coil tap points and tune two or three variable capacitors for each tap, trying to find the correct settings for each operating frequency. Furthermore, going through this procedure on the air generates a lot of unnecessary interference. I deliberately put up a four-band parallel dipole so I could avoid using (or adjusting) an antenna tuner, but because of the high swr the antenna tuner is now back in the line.

The simple technique discussed here for adjusting your antenna tuner does require an additional piece of test equipment which you may not have. However, the necessary test gear, a simple impedance bridge, can be easily built from junkbox parts. Although several RX impedance bridges have been described in the amateur literature,[2,3,4] the more simple *antennascope*[5] or antenna impedance meter[6] are suitable for

1. Ed Noll, W3FQJ, "Antenna Tuners," *ham radio*, December, 1972, page 58.
2. Henry S. Keen, W2CTK, "A Simple RX Bridge for Antenna Measurements," *ham radio*, September, 1970, page 34.
3. Bill Wildenhein, W8YFB, "A Low Cost RX Impedance Bridge," *ham radio*, May, 1973, page 6.
4. Jerry Hall, K1PLP and John Kaufmann, WA1CQW, "The Macromatcher," *QST*, January, 1972, page 14.
5. William Orr, W6SAI, *Beam Antenna Handbook*, Radio Publications, Wilton, Connecticut, page 178.
6. Robert G. Middleton, *101 Ways to Use Your Ham Test Equipment*, Howard Sams & Company, Indianapolis, page 80.

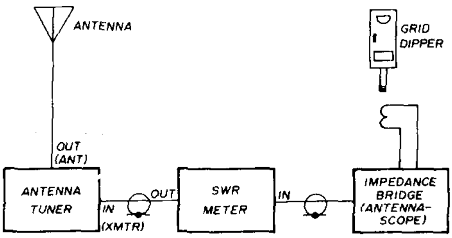


fig. 3. Simple test setup speeds initial adjustment of antenna tuning unit with minimum on-the-air interference.

this application. You will also need a grid-dip meter or low power transmitter as a source of rf for the impedance bridge. A grid-dip meter is highly recommended as it will cause less unnecessary interference.

impedance bridge. When finding the tap point it is suggested that the clip be held by its insulation and moved slowly up and down the coil until you see a downward movement of the bridge meter. That's the tap point you're looking for. This procedure is simplified somewhat if your antenna tuner uses a roller inductor, but the end result in either case is the same.

When the correct tap point has been found, fasten the clip on the inductor and tune the variable capacitor for as perfect null as possible on the bridge meter. Record the dial settings for future use. When a transmitter, tuned to the same frequency, is connected in place of the impedance bridge, only very minor touchup of the antenna

table 1. Comparison of Transmatch dial settings obtained with three different impedance bridges using the test setup of fig. 3.

bridge type	frequency (MHz)	input capacitor	inductor tap	output capacitor
RX Bridge[3]	3.95	98	59	40
	7.25	90	68	0
	14.05	55	3	40
	21.05	90	2	10
Macromatcher[4]	3.95	95	60	15
	7.25	100	68	0
	14.05	35	4	24
	21.05	90	2	15
Antennascope[5]	3.95	90	52	10
	7.25	98	68	0
	14.05	30	4	20
	21.05	95	2	15

Set up the test equipment as shown in **fig. 3**. If you use a grid-dip meter you won't get a reading on the swr meter, but at this point that's not important. Set the impedance bridge to 50 ohms (or 75 ohms if that's the impedance of your transmission line), tune the grid-dipper to the desired operating frequency and couple it to the impedance bridge. The meter on the bridge should swing upscale.

Now locate the tap on the antenna tuner inductor that causes a null on the

tuner should be required for an indicated vswr of 1:1. The data of **table 1** show the results I obtained while using this procedure to adjust a Transmatch.[7] Note the close correlation between dial settings obtained with three different types of impedance bridges. The operating swr for all cases was very nearly 1:1.

Howard Stark, WA4MTH

7. Lewis G. McCoy, W1ICP, "The Ultimate Transmatch," *QST*, July, 1970, page 24.

burglar-proof alarm

When you are setting up a burglar-proof alarm for your car, you should have an unusual alarm. The more unusual the alarm, the harder it is for a burglar to get into the car. The most important parts of the alarm are the switches used to activate it. These switches must be placed so that they are hard to find, but still allow complete protection. This means that switches should be used to prevent the car from being towed away, as well as being broken into.

After the switches have been placed, you must connect them to some sort of alarm. The alarm device must make a very noticeable sound. This requirement rules out the car's horn because people hear them constantly in a populated area. The best device for the alarm is a siren. There are two types of sirens that can be used, mechanical or electronic. Both types are suitable for the system shown in **fig. 4**.

In the schematic there is a time-delay switch which is used to eliminate outside control on the car. This is important because it gives the advantage of surprise when a burglary is being committed. The approximate one-minute time delay allows you to enter the car and shut the alarm off. This is enough time to shut the device off if you know how, but not enough if you don't. This stops the burglar from removing anything that is fastened inside the car or searching the interior. The schematic also shows that two switches are used in the driver's door. The second switch is used to activate the circuit with the time delay.

The on-off switch is a simple dpst switch placed somewhere in the middle of your ham gear. This way a burglar will never realize that it is the switch to deactivate the device. Also, the battery and siren are placed in the trunk. This makes it very hard for a burglar to disarm the system.

As noted in the schematic, there are four other switches marked "trunk," "hood" and "limit." These four switches are very important in deterring a person from stealing your car. The trunk and hood switches are simply placed in the trunk and hood, preventing anyone from opening either one and tampering with anything inside.

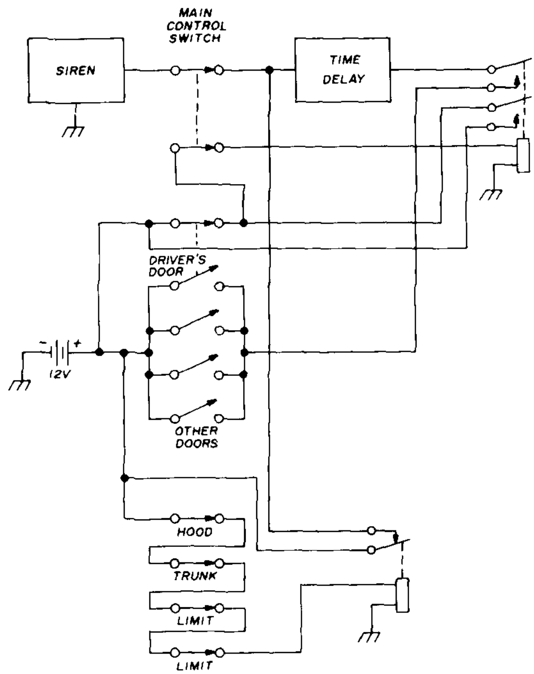


fig. 4. Simple burglar-proof auto alarm. All switches are shown as they would be when the doors, hood and trunk are closed.

The other two switches are harder to place, but they prevent the car from being moved. One of the switches is placed inside the car and is operated by the parking brake cable. Cutting the cable releases the tension on the cable and activates the alarm. The other switch is placed on one of the back shock absorbers. It is a limit switch, operating when the shock absorber is extended to its maximum. This sounds the alarm if the car is being towed away.

Installed correctly, this alarm system will keep your car well protected. It has already prevented three burglaries for me.

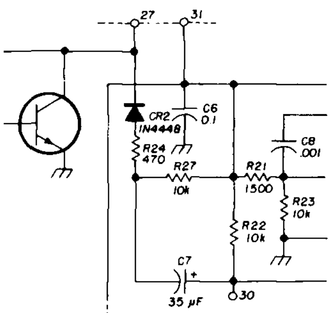
Glenn Eisenbrandt, Jr.

More Details? CHECK—OFF Page 142

short circuits

universal tone encoder

A few transceiver models using diode PTT switching will not operate correctly with the Universal Tone Encoder shown in the July, 1975, issue. The problem occurs in the tone-burst mode after the PTT button is released, and results from the charging current drawn by C7. Some transceivers are not able to supply this current and will not return fully to the receive mode.



This problem is solved by adding CR2 and R27 as shown in the schematic above; the polarity of C7 was also reversed in the original schematic. The encoder will now operate with relay- and diode-switched transceivers. The new circuit board incorporates this change. Circuit boards are available from Larry McDavid, W6FUB, 185 South Alice Way, Anaheim, California 92806.

dc latch circuit

In the CMOS dc latch circuit, **fig. 2**, on page 44 of the August, 1975 issue, the D input of U2A (pin 5) should be connected to the $\bar{Q}$ output (pin 2), *not* to the Q output (pin 1) as shown.

low-frequency loop antenna

In the article on the loop antenna receiving aid in the May, 1975 issue, no ground return is shown for the fet preamp (**fig. 3**) or Q multiplier (**fig. 4**). In both cases the 100k resistor connected to the gate of the HEP802 fet should be grounded.

automatic az/el control

Several errors appeared in the automatic azimuth/elevation rotator control system published in the January, 1975, issue of *ham radio*. In the base diagram for the 558 op amp (**fig. 3**), the inverting and non-inverting inputs to the lower op-amp are reversed (pin 5 should go to the non-inverting [+] input). In **fig. 7** the *sensed position* output should be connected to the junction of the 100- and 750-ohm resistors, *not* to the op-amp output terminal. Also, add two to all IC numbers in the second column on page 29 and the first column on page 31 (U11C, for example, should be U13C).

Some readers have found that the frequency-selective amplifier in **fig. 4** oscillates. This can be easily solved by increasing the value of the shunt resistance of the bridged-T network. In amplifier U1, for example, the resistor to change is the 7500-ohm unit connected between the two 0.05 µF capacitors.

To eliminate difficulty with rf interference, shunt each rotator motor winding lead with a 0.01 µF disc capacitor at the control unit case. Treat the leads to the rotator potentiometer as illustrated in **fig. 1**, shown here. In addition, the grounded end of the rotator potentiometer should be fastened to the circuit ground near the comparator, U11. Otherwise, unrelated ground currents may upset the sensed rotator position.

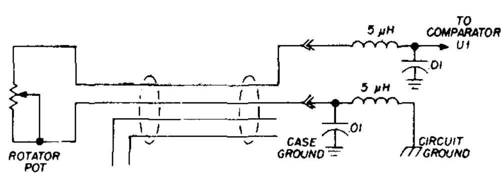


fig. 1. Use the circuit shown here with rotator potentiometer leads to eliminate difficulty with rf interference.

phase modulation techniques

In the article on phase modulation principles and techniques on page 28 of the July, 1975 issue, the value of R in **fig. 7** should be 10k. The loss formula shown in **fig. 7** should be

$$\text{loss} = 20 \log \left(\frac{X_C}{\sqrt{R^2 + X_C{}^2}} \right) \text{ dB}$$

communications receiver

In the communications receiver described in the October, 1975 issue (page 32), the KVG XF9E crystal filter has 12 kHz bandwidth, *not* 2.4 kHz. Transformers T1 (**fig. 2**) and T1, T2 and T3 (**fig. 8**) are wideband transformers which I5TDJ wound on Ferroxcube 0.25" (6.5mm) diameter toroid cores (permeability of 1000 or more). The Amidon T50-6 cores specified in the article have low permeability and low-frequency performance is poor. For those who have asked, Q6 in **fig. 8** which is specified as an HEP S0014 may be replaced with a 2N3866 or 2N4427.

Designer I5TDJ has heard from several amateurs who have built duplicates of this receiver that they sometimes have trouble with the fet crystal oscillator circuits (**fig. 8**). He subsequently tested a number of fets and found that some circuits would not oscillate with fets with high I_{DSS} because of the large voltage drop across the 1000-ohm drain resistor which biased the fet into the pinch-off region. This can be solved by using low I_{DSS} fets or by reducing the value of the drain resistor to 100 ohms.

radiation hazards

In the September editorial W1DTY made an error when calculating the power density at 10 watts input to a 30-foot dish. Since the 10 watts is essentially spread over the area of the dish in the near field (within one or two dish diameters), the power density at 10 watts input is 0.061 mW/cm^2. An input of 1642 watts would be required to reach 10 mW/cm^2.

new products

logarithmic speech processor

New from MFJ Enterprises is the LSP-520BX speech processor, which provides 400% more rf power to your phone signal. The LSP-520BX adds this extra punch by means of three active filters, two of which are switch-selectable, and a low-distortion IC logarithmic amplifier with a 30-dB dynamic range, assuring constant transmitter output without clipping or appreciable distortion. Voice frequencies are tailored to put communication intelligence where it will do the most good – in your transmitted signal.

Four techniques are used to maximize the voice-to-noise power ratio. First, an rf-protected preamp is optimized for low-noise performance by using a premium, low-noise transistor. Second, putting two high-pass active filters *before* the log amplifier input ensures a clean, noise-free signal at the log amp output. Third, battery operation eliminates hum, and fourth, a filtered and shielded input circuit provides immunity from rf fields.

The low-noise preamp has a gain of about 43 dB. An emitter follower matches the preamp output to a 500-Hz two-pole active filter, which has a rolloff of 12 dB/octave (at 250 Hz the signal is attenuated 12 dB). A switch-selectable two-pole 1400-Hz highpass active filter, which also has a 12-dB/octave rolloff, follows the 500-Hz filter. When these two filters are cascaded, rolloff is 24 dB/octave below 500 Hz for maximum filtering. Following the two filters are a compression-level control and the logarithmic amplifier. A six-pole, low-pass active filter accepts the *log amp output*. This filter features steep rolloff at 36 dB/octave, with a 2100-Hz cutoff frequency. Thus, bandwidth restriction prevents a *wide* ssb signal and removes distortion products.

Installation is simple. Plug your microphone into the processor, plug the processor output into your transmitter microphone output, and you're ready for some pleasant surprises on the crowded phone bands. The LSP-520BX is priced at $49.95 or $35.95 in kit form. Write MFJ Enterprises, P.O. Box 494, Mississippi State, Mississippi 39762, or use *check-off* on page 142.

525-MHz uhf prescaler

The new Pagel model 525 uhf prescaler divides frequency by ten to extend the range of any 50 MHz or higher counter to the vhf and uhf bands. The unit also contains a 20 dB preamp for the unscaled 1 MHz to 50 MHz range to improve frequency counter sensitivity to 5 millivolts rms or better. Sensitivity is 50 mV rms at 500 MHz, and 30 mV rms below 400 MHz. A through-line feature with an internal signal sampler can be used with transmitters up to 100 watts (requires 50-ohm dummy load). This feature can be used to perform simultaneous power and frequency measurements and is a great time saver.

The model 525 operates from the 117 Vac line or battery power (8 to 15 volts) may be used for portable or mobile use. Price is $159. For more information, write to Pagel Electronics, 6742-C Tampa Avenue, Reseda, California 91335, or use *check-off* on page 142.

hamtronics catalog

Hamtronics, Inc., long known for its vhf preamplifiers and fm communications receiver kits for amateur and monitor applications, recently announced a new catalog, which is available to readers in return for a self-addressed, stamped envelope. It lists many new products, including a high performance version of its famous standard vhf preamp. This kit, which is wired in series with the coaxial antenna lead of vhf communications receivers of various operating frequencies, boosts the receive signal by 20 dB or more, depending on the frequency. It operates from +12 Vdc, and is constructed on a PC board. Cost of the kit is $9 (wired and tested, $14).

The second new product is a two-stage grounded-gate preamplifier for uhf receivers in the 400-500 MHz range, including amateur, commercial, and monitor receivers. It provides 20 dB gain, and is priced at $15 (kit) or $30 (wired and tested). A companion uhf converter kit is available for operation on various i-f frequencies, thereby converting a vhf receiver into a uhf receiver. The converter kit is priced at $20 plus crystal.

A new improved vhf receiver for fm communications has also been introduced in this catalog. It consists of a vhf converter board and a i-f/audio board. The converter is also available separately to operate with various i-f frequencies. The vhf receiver kit is $65 less crystal. A uhf version, which includes the uhf and vhf converters and i-f/audio board, is priced at $80, less crystals.

For your free copy of this new catalog, send a self-addressed, stamped envelope to Hamtronics, Inc., 182 Belmont Road, Rochester, New York 14612.

CW filter

Operators active in contest and DX work will welcome a novel CW filter offered by Palomar Engineers, The circuit combines a wideband and narrowband filter to provide simulated stereo reception. Active filters prevent annoying ringing and give sharp skirt selectivity, which removes all signals except those within an 80-Hz bandwidth. The simulated stereo technique allows off-frequency signals to be heard, but because of the action of mind and ears, the off-frequency signals do not interfere with the desired signal.

The filter connects between your receiver and a set of stereo headphones. In the simulated-stereo mode, the narrowband signal is applied to one side of the stereo headset and the wideband signal to the other. Alternatively, the narrow-

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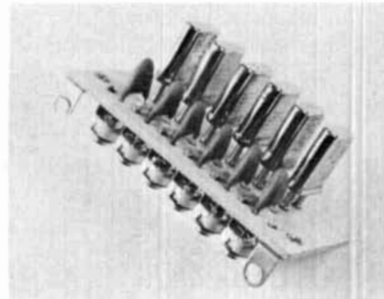
phones by panel-switch selection. The simulated stereo mode uses both filters with a dramatic improvement over either filter alone. The desired signal is heard in both phones; the off-frequency signals and noise are heard in only one phone. The mind concentrates on the desired signal and rejects the interference — yet off-frequency calls can still be heard, which otherwise might be missed.

The center frequency of the CW filter is 800 Hz. Bandwidths of the narrow- and wide-band filters are 80 and 300 Hz respectively. A 9-volt transistor battery supplies power. Input impedance is 1 megohm; the output will drive either low- or high-impedance headphones. The panel switch has four positions: *off* (receiver output direct to phones); wideband amplifier to both phones; narrowband amplifier to both phones; and simulated stereo. The CW filter is $39.95 postpaid in U.S. and Canada. More information may be obtained from Palomar Engineers, Box 455, Escondido, California 92025, or use *check-off* on page 142.

unique ic op-amp applications

A specialist in IC operational amplifiers, Walter Jung, has written this book on the uses of unique op amps. Unique op amps are those with characteristics that set them apart from previous amplifiers. Modified types of op amps are discussed along with totally unique types, such as programmable op amps, operational transconductance amplifiers, and quad current-differencing amplifiers. The material has been extracted from another Sams book, *IC Op-Amp Cookbook*. Heavily illustrated. 144 pages, softbound, $4.95 from Ham Radio Books, Greenville, New Hampshire 03048.

Regency crystal deck



Topeka FM Communications has just introduced a new improved version of their highly popular 6T-HR2 six-channel crystal deck. Mounted in a Regency HR-2 or HR2-A, the deck allows full 12-channel transmit/receive capability. Improvements include a smaller board which makes installation notably easier. Component placement has been changed to allow netting without removing the speaker from the radio.

The new version, designated the 6T-HR2-3, is now available for $15.50. Kit versions are also available for $11.50. For more information, write or call Topeka FM Communications, Inc., 125 Jackson, Topeka, Kansas, 66603.

noise in electronics

Why is noise important? What is shot noise? How can noise figure be measured using a signal generator? These and dozens of other pertinent questions are answered in this new book for the amateur, engineer and technician. They provide the reader with a basic understanding of noise characteristics and noise measurement techniques for practical applications.

The author first introduces the reader to noise with explanations on white, pink, man-made, atmospheric and galactic noise. The remainder of the book answers questions about thermal noise, shot noise, noise bandwidth, special considerations for noise, signal-

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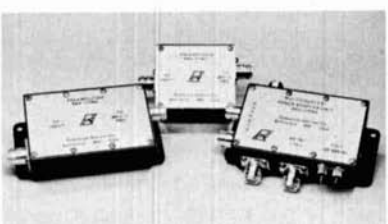
to-noise ratio, noise figure and other miscellaneous noise characteristics.

Here's an opportunity to learn about flicker noise, noise power, the effect a-m detectors have on noise and dozens of other noise-related subjects. Easy-to-understand answers are detailed without the complex mathematical manipulations usually required with noise associated calculations. Illustrations, examples, and tables of solutions are provided to further explain the answers. 96 pages, softbound, $3.95 from HR Books, Greenville, New Hampshire 03048.

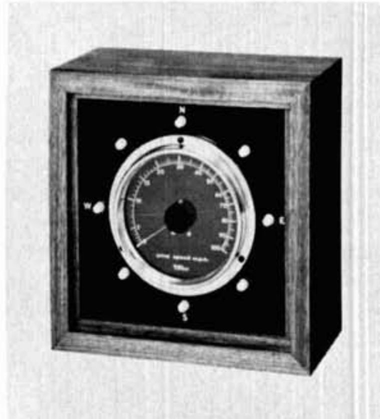
multicoupler/ preamplifier



The new multicoupler set from Radiation Devices features an antenna-located preamplifier and provides preamplification of signals at the base of a broadband high-frequency antenna to overcome coaxial cable loss. Preamplifier BBA-1/PMS-3 has greater than 9 dB gain over the band from 2 to 50 MHz. It receives power via the coaxial cable connecting it to the Multicoupler/Power Adapter Unit MPU-1. The MPU-1 provides four isolated signal ports to receivers or other equipment. Intermodulation and cross-modulation distortion products are greater than 60 dB below the desired signal at zero dBm output level. The unit operates from 115 Vac, 50 to 400 Hz.

For more information, contact Radiation Devices Company, Post Office Box 8450, Baltimore, Maryland 21234, or use *check-off* on page 142.

wind direction and velocity meter



Knowing wind speed and direction will allow you to trim that big beam antenna for minimum wind resistance when the next storm arrives. The model 75C Brunswick Wind Set by TMAC Products consists of a wind-speed transmitter, wind-direction transmitter, an indicator mounted in a handsome console, and all cables and mounting hardware. The transmitter units are low profile; the entire assembly measures only 12-3/4 inches high by 24 inches long (53 by 61cm) and may be mounted on any convenient surface.

The wind-speed transmitter consists of a dc generator coupled to a 5½-inch (14cm) diameter, spherical cup rotor assembly mounted on a 1-inch (2.5cm) diameter pvc pipe support. Wind speed is indicated by a 6-inch (15cm) diameter, 250-degree linear taut band pivot and jewel movement. Readout is in mph, with 1-mph divisions between 0 and 100 mph inscribed in white against a contrasting background.

The wind-direction transmitter uses hermetically sealed reed switches actuated by a magnet in an environment-protected, low-friction assembly. Wind direction is indicated by eight panel lamps, one at each cardinal compass point, located around the periphery of the wind-speed indicator. Intercardinal

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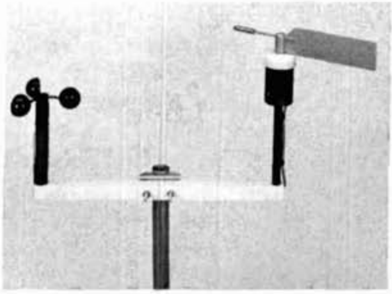

compass points are indicated by the illumination of two adjacent lamps. Thus, 16 compass points may be indicated; at least one indicator lamp will be on at all times. The instrument is powered by 110 V, 60-Hz. Price and additional information are available from TMAC Products, P.O. Box 28341 (Lincoln Village Branch), Columbus, Ohio 43228, or use *check-off* on page 142.

miniature touch-tone encoders

Data Signal has announced a new line of solid-state crystal-controlled Touch-Tone encoders which use a CMOS encoder IC. Only ¼ inch (6.5mm) thick, these self-contained units provide Touch-Tone capability to repeater stations or provide data entry. They are designed to be mounted directly on the side of hand-held portables, on the front of mobile transceivers, or on the dashboard of vehicles. The circuitry is completely rf proof, and all electronics are contained *within* the keyboard. Keyboards with 12 Touch-Tone digits are available in three sizes: 2¼x3 inches (57x76mm), 1½x2 inches (38x51mm) and 2x1½ inches (51x38mm). The 16-digit keyboard is 2 inches (51mm) square. These keyboard encoders, type DTM, require only three external connections and are priced at $49.95.

Also available from Data Signal is a sub-miniature Touch-Tone encoder and keyboard which is designed for use with hand-held fm transceivers. The encoder PC board measures a mere 0.8 by 1.2 inch (20x30.5mm) and is easily installed inside hand-held transceivers. The keyboard is available in the same four styles mentioned above and can be mounted on the side of the transceiver. The Touch-Tone encoder and keyboard, type SME, is priced at $29.95.

In addition to the DTM and SME keyboards and encoders, the major components are also available for amateurs who want to build their own. The keyboard, choice of four styles, is $8.50. The digital Touch-Tone encoder with 1-MHz HC-6/U crystal is $12.50 (encoder with *slim* 1-MHz crystal is $13.50). The miniature printed-circuit board is $2.50. If you purchase a keyboard, encoder and crystal, the PC board, and all resistors and capacitors are provided free of charge.

For more information, write to Data Signal, Inc., 2212 Palmyra Road, Albany, Georgia 31701 or use *check-off* on page 142.

dual-trace oscilloscope adapter

A new RCA dual-tracer adapter that can be attached to any triggered or recurrent-sweep oscilloscope to update it to dual trace operation is now available.

The RCA WM-541A *Dual-Tracer* Adapter provides two displays on a single-trace oscilloscope for simultaneous viewing of two signals. Applications of the new RCA instrument include comparison tests of gain, frequency, response, distortion, phase shift, and time delay. In addition, the WM-541A can also be used to add additional traces to dual-trace oscilloscopes.

Display modes included in the operation of the instrument are channel A only, channel B only, or both A and B channels simultaneously (chopped or alternate). The switching rate is continu-

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ously variable over a range designed to minimize flicker and beat interference.

The RCA WM-541A has additional features which include ac or dc coupling and vertical position controls for both channels; separate, variable sync-level control with polarity reversing switch; a zener-regulated power supply and LED power-on indicator. The inputs and outputs are terminated with BNC connectors for connection to the oscilloscope The latest cos/mos integrated circuitry is used for high performance operation. The instrument can be used from dc to 10 MHz.

The RCA WM-541A Dual-Tracer Adapter is priced at $108.00. An optional WG-400A Direct/Low Capacitance Probe and Cable is available for $15.00.

Additional information on RCA Electronic Instruments is available from RCA Distributor and Special Products Division, 2000 Clements Bridge Road, Deptford, New Jersey 08096, or use *check-off* on page 142.

corrosion-resistant vhf antenna

Most mobile antennas include a stainless-steel whip but here is one that is built entirely of stainless steel, brass, and an elastomer compound. This unit has been developed to meet and overcome two significant obstacles to antenna performance – corrosion and the necessity for a ground plane. The construction materials allow this popular model to live happily in a salt environment. The design has no need for a ground plane; this feature allows this unit to operate perfectly on a wood deck or fiberglass trunk lid.

For further details on this high gain, almost indestructible antenna, write to Gam Electronics, Inc., 191 Varney Street, Manchester, N.H. 03102, or use *check-off* on page 142.

synthesized scanning monitor

The new Bearcat 101 is a totally synthesized, five-band scanning monitor featuring a re-programmable custom integrated circuit. In addition to receiving the low (30-50 MHz), high (148-174 MHz) and uhf (450-470 MHz) bands, the unit will also receive the two-meter ham band (146-148 MHz) as well as uhf frequencies from 416 to 450 MHz.

The nerve center of the Bearcat 101 is provided by two exclusive, custom, large-scale ICs: one for *scanning* and the second for a non-volatile *memory* system. With the memory chip, the radio retains all frequencies programmed — without the need for a battery. This feature allows users to order sets fully programmed with frequencies and assures program retention, even if the unit is unplugged or if there is a power outage.

The Bearcat 101 scans 16 channels. Individual lock-out switches are provided for each channel; these are also used in programming frequencies. Channel indicators are light-emitting diodes, providing a scan rate in excess of 20 channels-per-second. Selective Scan Delay, a new feature, permits the listener to remain on a channel for one second longer, in case of a reply on a simplex channel. The Bearcat Selective Scan Delay system permits delay on just those channels desired. Sensitivity in the low and high bands is measured at 0.6 μV;

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on the uhf bands, it typically ranges from 0.6 to 0.9 μV. A six-pole crystal filter offers 70 dB of i-f selectivity.

For more information, write to the Electra Company, Cumberland, Indiana 46229, or use *check-off* on page 142.

precision low-noise op amp

It isn't often that a precision, low noise, ultra-stable, high gain operation amplifier is put into production, and when one is, the cost is usually very high. Not so with a new state-of-the-art amplifier developed by National Semiconductor. Called the LH0044, the new operational amplifier includes all of these features plus low cost.

The LH0044 precision operational amplifier is intended to replace modules and chopper-stabilized monolithic amplifiers and is particularly well-suited for differential mode, inverting, and non-inverting mode applications that require very low initial offset, low offset drift, very high gain and high power supply rejection ratio. In addition, the low initial offset and offset drift of the LH0044 eliminate costly and time-consuming null adjustments.

Specifications include an input offset voltage less than 25 microvolts, long term stability better than ±1 microvolt per month, a maximum offset drift of only 0.5 microvolts/°C, and a noise level lower than 0.7 microvolts peak-to-peak from 0.1 to 10 hertz. Other performance features include a CMRR and PSRR of 120 dB minimum, open-loop gain greater than 120 dB, and a common mode range wider than ±13 volts. The power supply range is from ±2 volts to ±20 volts.

For more information, write to National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, California 95051, or use *check-off* on page 142.

YES! There is an antenna that your neighbors will love!

We know you're not going to believe your neighbors will like your new 20 meter beam; but just wait until they CAN'T see it.

Introducing a little functional beauty. The new DenTron trim-tenna™ 20 meter beam.

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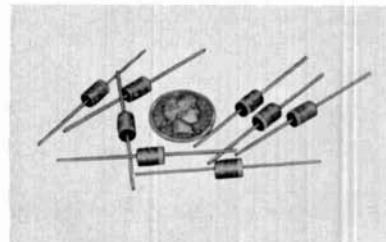
3000-volt silicon rectifiers



Electronic Devices has announced the development of a miniaturized, high voltage, high current silicon rectifier diode with a surge capacity of 300 amperes. The rectifier is an axial lead type. Electrical specifications for the series 3W3 diode are 3000 peak reverse voltage, 2 amp rating with 300 amp surge capacity. Two other similar designs are available with peak reverse voltages of 2000 and 2500 volts. Fast recovery types are also available. The exceptionally high surge capability and small size of these rectifiers results from a special diffusion process and larger junction with lower forward voltage drop.

For complete information, write to the Sales Manager, Electronic Devices, Inc., 21 Gray Oaks Avenue, Yonkers, New York 10710, or use *check-off* on page 142.

tool catalog

A free tool catalog describing over 2500 individual items is offered by Jensen Tools and Alloys. "Tools for Electronic Assembly and Precision Mechanics" is a 112-page handbook of particular interest to amateurs, electronic technicians, engineers, scientists, and instrument mechanics working on fine assemblies. Section headings include screwdrivers, wrenches, pliers, tweezers, files, shears, knives, microtools, relay tools, power tools, metalworking tools, wire strippers, soldering equipment, lighting and optical equipment, work holders, test equipment, engineering and

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drafting supplies and electronic chemicals. New sections include metric tools, books, and wire wrapping tools. A 15-page tool kit section features the world famous Jensen kits for field engineers and kit builders.

Another important feature of the catalog is the inclusion of four pages of technical data on tool selection. These pages include sections on screwdriver selection, machine screw data, tool materials, metal conducitivity, color coding, wire and insulation data, solderability of metals, temperature conversion, drill sizes, metal gauges, metric conversion and safety. Five pages of "Tool Terms" are also included.

A free copy of the Jensen catalog may be obtained by writing to Jensen Tools and Alloys, 4117 North 44th Street, Phoenix, Arizona 85018, or by using *check-off* on page 142.

contact cement

Industrial strength *Zipbond* contact cement bonds most materials almost instantly. It is easy to use, with no pre-mixing necessary, and is used directly from the squeeze applicator bottle (production-line dispenser also available). No heat or pressure treatment is needed, and *Zipbond* sets up quickly at room temperature.

Zipbond is impervious to most chemicals, weather and temperatures. Its bonding strength is not affected by most solvents. Low viscosity allows *Zipbond* to seep into tiny spaces most adhesives can't penetrate. It is very economical, as one drop covers a 1 inch square area to form a colorless transparent bond. For more information write to Instrument Division, Tescom Corporation, 2600 Niagara Lane North, Minneapolis, Minnesota 55441, or use *check-off* on page 142.

audio power amplifier

A new 40-watt (20 watt rms) B high-fidelity amplifier with total harmonic distortion of 0.2 per cent at 15 watts output is now available from Plainview Electronic Supply. This class B, quasi-complimentary amplifier is capable of delivering full output power into a standard 8-ohm speaker with a 500 mV input signal. Supply voltage can be +36 volts or ±18 volts. Frequency response is from dc to 80 kHz.

The hybrid amplifier is designed for use in communications, stereo, public address and intercom systems, and is priced at $10.65 in small quantities. For more information, write to Bernard Erde, Marketing Manager, Plainview Electronic Supply, 7 Gordon Avenue, Plainview, New York 11803, or use *check-off* on page 142.

transformer catalog

Triad's new *Catalog of Transformers, Inductors, Power Supplies and Circuit Cards*, is now available. The 52-page catalog covers more than 30 categories of transformers, including autoformers, bridging, driver, input, interstage line matching and voltage correction. The inductor section of the catalog lists audio and filter reactors, high Q reactors, tone control and toroidal inductors.

These components are available from 44 Triad-Utrad representatives and distributors worldwide. Catalog requests should be addressed to Steve Fisher, General Manager, Triad-Utrad Distributor Services, 305 N. Briant Street, Huntington, Indiana 46750, or use *check-off* on page 142.

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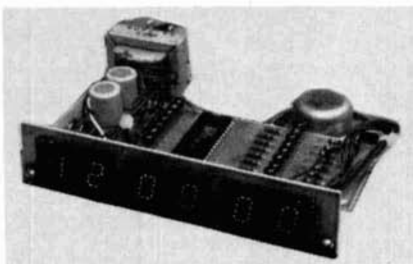
SUPER KIT II

CK-04

6 DIGIT JUMBO LED ALARM CLOCK KIT



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$5.75

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CLOCK MOUNTING INSTRUCTIONS

BULLET ELECTRONICS

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LAKE WORTH, FLORIDA 33460

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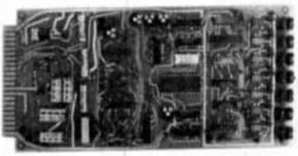


TOUCH TONE* TO DIAL PULSE CONVERTER

Convert standard 0-9 touch tone* digits to Bell system compatible dial pulse code. Completely solid state. Includes state-of-the-art Phased Locked Loop anti-falsing touch tone* decoder, large capacity 64-digit memory and solid state pulsing. Starts dialing on first incoming digit. Memory will not become congested due to rapid succession of incoming digits. Cancel and redial function. * and # digits are decoded and provided for remote control purposes. Available as p.c. board or rack mounting.

DPC-121	P.C. Board	**$195.00**
DPC-121R	Rack Mount	**$285.00**

ANTI-FALSING TOUCH TONE* DECODER

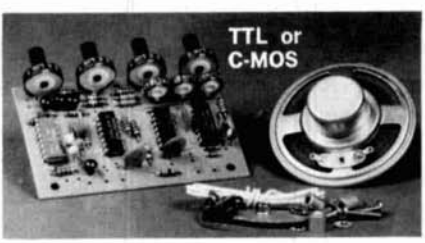
Now, a true anti-falsing decoder/receiver. Virtually immune to high noise or audio falsing. Twelve or 16 digit capability. Completely solid state, uses latest Phased Locked Loop decoding. Single 5-volt power supply. Heavy duty transistor output. Available as p.c. board or 19" rack.

TTD-126-12	12 digit	P.C. **$149.95**	Rack **$219.95**
TTD-126-16	16 digit	P.C. **$169.95**	Rack **$239.95**

REPEATER AUTO PATCH

It's complete — a single digit access/disconnect Auto Patch facility. All you need is a repeater and the phone line. Complete with automatic disconnect, dialing capability, two way audio monitor plus remote control. When used with a rotary dial exchange, Data Signal's DPC-121 dial converter is also required. P.C. board or Rack Mount available.

RAP-2	PC **$99.50** Sh. Wt. 2 lbs.	Rack **$149.50** Sh. Wt. 8 lbs.



DELUXE P.C. KEYER

In either a 5 volt TTL or a 9 volt C-MOS version this new module type IC keyer can be easily adapted to your own custom package or equipment.

Versatile controls allow wide character weight variation, speeds from 5 to 50 w.p.m. plus volume and tone control.

Solid-state output switching saves power, eliminates all those annoying relay problems and is compatible with both grid block and solid-state circuitry.

With its side-tone monitor and 90 day warranty the Data Signal PC Keyer is the one for you.

TTL Keyer Wired $19.95
Kit $14.95
C-MOS Keyer Wired $24.95
Kit $19.95

FREQ. (MHz)	USE	STAGES	DELUXE PREAMPLIFIER GAIN dB	NF dB	KIT	WIRED
14, 21 or 28	HIGH FREQ.	SINGLE DOUBLE	25 48	2 2	$10.50 $20.50	$13.50 $26.50
28 to 30	OSCAR SPECIAL	SINGLE DOUBLE	25 48	2 2	$12.50 $24.50	$15.50 $30.50
50 to 54	6 METER	SINGLE DOUBLE	25 48	2 2	$10.50 $20.50	$13.50 $26.50
108 to 144	VHF AIRCRAFT	SINGLE DOUBLE	20 40	2.5 2.5	$ 9.50 $18.50	$12.50 $24.50
135 to 139	SATELLITE	SINGLE DOUBLE	20 40	2.5 2.5	$ 9.50 $18.50	$12.50 $24.50
144 to 148	2 METER	SINGLE DOUBLE	20 40	2.5 2.5	$ 9.50 $18.50	$12.50 $24.50
146 to 174	HIGH BAND	SINGLE DOUBLE	20 40	2.5 2.5	$ 9.50 $18.50	$12.50 $24.50
220 to 225	1¼ METER	SINGLE DOUBLE	18 35	2.5 2.5	$ 9.50 $18.50	$12.50 $24.50
225 to 300	UHF AIRCRAFT	SINGLE DOUBLE	15 30	2.5 2.5	$ 9.50 $18.50	$12.50 $24.50
1 thru 30	HF BROADBAND		19-36	3	—	$17.95

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912-435-1764

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7400N TTL

SN7400N	.16	SN7451N	.27	SN74151N	1.25
SN7401N	.16	SN7453N	.27	SN74153N	1.35
SN7402N	.21	SN7454N	.41	SN74154N	1.25
SN7403N	.16	SN7459A	.25	SN74155N	1.21
SN7404N	.21	SN7460N	.22	SN74156N	1.30
SN7405N	.24	SN7470N	.45	SN74157N	1.30
SN7406N	.45	SN7472N	.39	SN74160N	1.75
SN7407N	.45	SN7473N	.45	SN74161N	1.45
SN7408N	.25	SN7474N	.45	SN74163N	1.65
SN7409N	.25	SN7475N	.80	SN74164N	1.65
SN7410N	.20	SN7476N	.47	SN74165N	1.65
SN7411N	.30	SN7480N	.50	SN74166N	1.70
SN7412N	.42	SN7482N	1.75	SN74167N	5.50
SN7413N	.85	SN7483N	1.15	SN74170N	3.00
SN7414N	.70	SN7485N	1.12	SN74172N	18.00
SN7416N	.43	SN7486N	.45	SN74173N	1.70
SN7417N	.43	SN7488N	3.50	SN74174N	1.95
SN7418N	.25	SN7489N	3.00	SN74175N	1.95
SN7420N	.21	SN7490N	.59	SN74176N	.90
SN7421N	.39	SN7491N	1.20	SN74177N	.90
SN7423N	.37	SN7492N	.82	SN74180N	1.05
SN7425N	.43	SN7493N	.82	SN74181N	3.55
SN7426N	.31	SN7494N	.91	SN74182N	.95
SN7427N	.37	SN7495N	.91	SN74184N	2.30
SN7429N	.42	SN7496N	.91	SN74185N	2.20
SN7430N	.26	SN74100N	1.25	SN74187N	6.00
SN7432N	.31	SN74107N	.49	SN74190N	1.50
SN7437N	.47	SN74121N	.55	SN74191N	1.50
SN7438N	.40	SN74122N	.49	SN74192N	1.50
SN7439A	.25	SN74123N	1.05	SN74193N	1.40
SN7440N	.21	SN74125N	.60	SN74194N	1.45
SN7441N	1.10	SN74126N	.81	SN74195N	1.00
SN7442N	1.08	SN74132N	3.00	SN74196N	1.25
SN7443N	1.05	SN74141N	1.15	SN74197N	1.00
SN7444N	1.10	SN74142N	6.50	SN74198N	2.25
SN7445N	1.10	SN74143N	7.00	SN74199N	2.25
SN7446N	1.15	SN74144N	7.00	SN74200N	7.00
SN7447N	.89	SN74145N	1.15	SN74251N	2.50
SN7448N	.99	SN74148N	2.50	SN74284N	6.00
SN7450N	.26	SN74150N	1.10	SN74285N	6.00

20% Discount for 100 Combined 7400's

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CD4000	.25			74C10N	.65
CD4001	.25			74C20N	.65
CD4002	.25	CD4030	.65	74C30N	.65
CD4006	2.50	CD4035	1.85	74C42N	2.15
CD4007	.25	CD4040	2.45	74C73N	1.50
CD4009	.59	CD4042	1.90	74C74	1.15
CD4010	.59	CD4044	1.50	74C90N	3.00
CD4011	.25	CD4046	2.51	74C95N	2.00
CD4012	.25	CD4047	2.75	74C107N	1.25
CD4013	.47	CD4049	.79	74C151	2.90
CD4016	.56	CD4050	.79	74C154	3.00
CD4017	1.35	CD4051	2.98	74C157	2.15
CD4019	.55	CD4053	2.98	74C160	3.25
CD4020	1.49	CD4060	3.25	74C161	3.25
CD4022	1.25	CD4066	1.75	74C163	3.00
CD4023	.25	CD4069	.45	74C164	3.25
CD4024	1.50	CD4071	.45	74C173	2.60
CD4025	.25	CD4081	.45	74C193	2.75
CD4027	.69	74C00N	.39	74C195	2.75
CD4028	1.65	74C02N	.55	80C97	1.50
CD4029	2.90	74C04N	.75		

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IN4001	50V @ 1 Amp	15/$1.00
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TRANSISTORS

2N2907A	PNP Switching	6/$1.00
2N2222A	NPN Switching	6/$1.00
2N3904	NPN Amp	6/$1.00
2N3906	PNP Amp	6/$1.00
2N918	NPN RF	6/$1.00
2N5951	NJ Fet	6/$1.00
C106B1	3.6 Amp SCR	2/$1.00

TTL/LINEAR

7400	Gate	7/$1.00
7447	Decoder	.79
7490	Counter	.49
74100	8 Bit Latch	.99
74154	Decoder	.99
74197	Counter	.75
LM301H - LM741H		4/$1.00
LM324N - Quad 741		1.19
LM309H	5V Reg TO-5	.79
LM309K	5V Reg TO-3	.99

MM5262 DYNAMIC 2K RAM $2.95

CLOCK & CALC. CHIPS

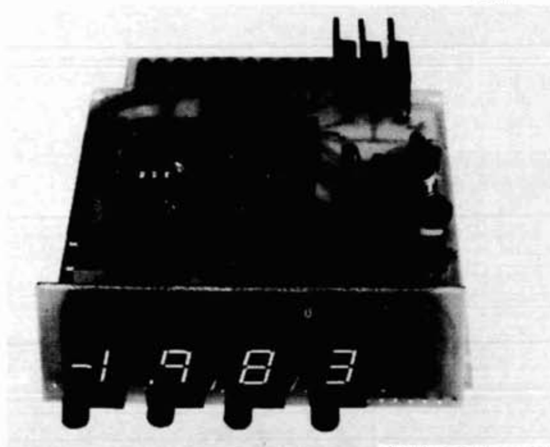
MM5311N	6 Digit	$2.95
MM5312N	4 Digit	2.95
MM5313N	6 Digit	2.95
MM5314N	6 Digit	2.95
MM5316N	6 Digit Alarm	3.95
MM5725N	8 Digit 4 Funt.	1.85
MM5736N	6 Digit 4 Funt.	1.95
MM5738N	8 Digit 5 Funt.	2.95

26 Awg RIBBON CABLE

1 Ft. Minimum	1-9 ft.	10 ft.
4 Cond.	.29 ft.	.25 ft.
8 Cond.	.59 ft.	.49 ft.
16 Cond.	.89 ft.	.79 ft.
32 Cond.	1.89 ft.	1.69 ft.

DIGITAL-VOLTMETER

JE801
DVM



$39.99 Per Kit
SINGLE UNIT

GENERAL DESCRIPTION

The JE801 is a three and one half digit, auto polarity digital voltmeter, in a kit form. It features several options not available in any commercial digital voltmeter. Its low cost is perhaps the most important feature, which is achieved by offering it in a kit form. A kit allows the unit to be used by small OEM's where cost effectivenessis an important factor, and by the hobbyist who has to be concerned with cost. The unit also features on card regulators, allowing it to be operated off a single plus and minus fifteen volt, unregulated power supply. The unit has a small size of three inches width, three and three quarters of an inch length, and one and a quarter inch height.

MICROPROCESSOR COMPONENTS

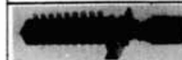
8008 – $19.95 **2102 – $2.95**

	CPU'S			RAM'S		
8008	8 bit CPU	$19.95	1101	256x1	Static	$ 2.25
8080	8 bit Super 8008	149.95	1103	1Kx1	Dynamic	2.95
4040	4 bit 8080	39.95	2102	1Kx1	Static	2.95
	UARTS		2107	4Kx1	Dynamic	19.95
AY-5-1013		6.95	7010	1Kx1	Mnmos	29.95
	PROM'S		7489	16x4	Static	2.49
8223	32x8 Prom	3.00	8101	1Kx1	Static	7.95
1702A	2K E Prom	15.95	8111	1Kx1	Static	7.95
5203Q	2K E Prom	14.95	8599	16x4	Tristate	3.49
74S287	1Kx1 Prom	7.95	91L02	1Kx1	Low Power	3.95
	SR'S		74200	256x1	Static	6.95
2401	2K DSR	9.95	74LS670	4x4	Register	3.95
2533	1K SSR	7.95	93410	256x1	Static	2.95

91L02 1K Static RAM Direct Replacement for 2102-1 with 40% Less Current Drawn **2.49**

Vector General Purpose Logic CARD Board 14.95
*Very High Noise Immunity * Holds 12 ea. 14 pin DIPS
*44 pin Edge Connection

THE KILOBYTE RAM CARD Per Kit **$49.95**
*Complete 1Kx8 Memory * High Noise Immunity Components
*Single 5v supply *500NS Access Time &Kit includes sockets, ICS & Board



4 PDT SWITCHES, HIGH QUALITY P.B. TYPES .69

KITS EXAR ICS

XR-2206KA **SPECIAL $17.95**
Includes monolithic function generator IC, PC board, and assembly instruction manual.

XR-2206KB **SPECIAL $27.95**
Same as XR-2206KA above and includes external components for PC board.

TIMERS		
XR-555CP	**SPECIAL**	$ .69
XR-320P		1.55
XR-556CP		1.85
XR-2556CP		3.20
XR-2240CP	**SPECIAL**	3.25
PHASE LOCKED LOOPS		
XR-210		5.20
XR-215		6.60
XR-567CP		1.95
XR-2567CP	**SPECIAL**	2.99

STEREO DECODERS		
XR-1310P		$3.20
XR-1310EP		3.20
XR-1800P		3.20
WAVEFORM GENERATORS		
XR-205		8.40
XR-2206CP	**SPECIAL**	4.49
XR-2207CP		3.85
MISCELLANEOUS		
XR-2211CP		6.70
XR-2261		3.79

Special Requested Items

RC4194	Dual Track V Reg	$5.95	N8T97	$3.00	2533	$7.95
RC4195	±15V Track Reg	3.25	4024P	2.25	8263	5.95
F9368	Decoder	3.95	2513	11.00	8267	2.75
LD110/111	DVM Chip Set	28.00	2518	7.00	8288	1.15
CA3130	Super CMOS Op Amp	1.49	2524	3.50	8826	3.00
MC1408L7	A/D	9.95	2525	6.00	8880	1.35
F3341	FIFO	8.95	2527	5.00	7497	5.00

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10.7 MHZ CERAMIC FILTER

$1.69

- 48 HOUR MAIL SERVICE
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- QUALITY PARTS — NO JUNK!
- COMPLETE SATISFACTION OR MONEY BACK

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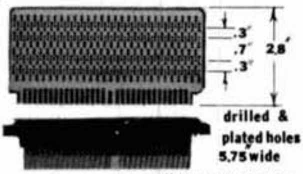
The most Versatile Breadboard we have seen!



drilled & plated holes
5.75 wide

Holds un to 12, 16 pin IC's or combinations of 8, 14, 16, 24, 28 or 40 pin chips

COMPLETE WITH MATCHING EDGE CONNECTOR
$4.89

HEATshrink TUBING
1 FOOT CUT LENGTHS
assorted sizes: 1/4, 1/8 & 1/16 49¢
PACK of 10

POWER SUPPLY SPECIAL

We brought a large quantity of parts to make a quality power supply for TTL & linear work.

+5V 1.5A
±15V 150 ma
.1% regulation
low ripple

12.95

YOU GET:
- Drilled & Plated Board
- All components including transformer
- Complete instructions

UNIVERSAL BCD UP/DOWN COUNTING MODULE WITH LATCH

Low Current
Actual size 2"x 2-3/8"

+12vdc
+24vdc required

4.95
6 for $25

- Drilled & Plated PC Board
- MOS Counting Chip
- .25 inch Character Phosphor Readout
- Presettable ÷N Counting to 1MHZ
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- Board fits standard edge connectors
- Complete Instructions
- Application & Project notes
- Units can be Cascaded

MINI POWER SUPPLY KIT

Build your own +5 volt power Module at a fraction of commercial cost!

4.95
3 for 12.50

+5 volt regulated @ 400 MA with overload protection low ripple for TTL work!

4.95
Complete

- Drilled & Plated Board
- All Components
- Complete Instructions
- Transformer

NEW! Supersedes model TB-01

50 or 60HZ TIME BASE KITS

TB-60
TB-50

Small:

either model
9.95

Use with mos clock chips

KIT INCLUDES:
drilled plated board
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Direct interface
ultra low current
1 min/week accuracy (adjustable)

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- **Full Factory Warranty**
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Scientific Notation — Enter Numbers Or Calculate Results From 10^{99} to 10^{-99}
Convert Key — Changes Between Floating Point Notation And Scientific Notation.
5 Function, Full Accumulating Memory: M+, M-, MR, MC, X M
Transcendental Functions: Sin, Cos, Tan Sin^{-1}, Cos^{-1}, Tan^{-1}, Lnx, e^x
Trig Functions Calculated In Radians Or Degrees
$\sqrt{x}$ and 1/x Functions
π Key
Capability To Calculate $\sqrt[y]{x}$ and x^y
Chain Calculations
Automatic Power On Clear
Trailing Zero Suppression
Automatic Constant
MOS/LSI Solid State Circuitry For Durability And Dependability
Size: 1" x 3" x 5-½"
Weight (With Battery): 8 ounces

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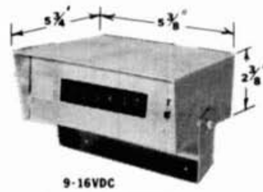
COMPLETE MOBILE LED CLOCK KIT

SPECIAL OFFER: PRICES GOOD TILL DECEMBER 18th, 1975



$28.75
COMPLETE!

9-16VDC

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12 or 24 hour MODELS
Please Specify on Order

		compare
6 DIGIT LED CLOCK KIT:	bright 1/4" readouts	$16.95
XTAL TIMEBASE KIT:	low current 60HZ .01%	9.95
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*WE GUARANTEE ALL COMPONENTS IN THE **MK-01** and WILL REPLACE OR REPAIR ANY DEFECTIVE PART WITHIN 60 Days AFTER PURCHASE THAT FAILS UNDER NORMAL USAGE. ANY KIT MAY BE RETURNED TO US FOR A FULL REFUND IF IN THE ORGINIAL PACKAGING AND INTACT. SERVICE IS AVAILABLE AT 20% of THE PURCHASE PRICE PLUS RETURN POSTAGE.

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Put your best fist forward.

To be one of the best fists on the air, all you need is a little practice and the HAL 2550 Keyer and its precision-built companion, the FYO Key.

The 2550 features a triggered clock pulse generator, sidetone monitor, iambic keying and dot memory. There's an optional tailor-made ID too.

Many amateurs remember the famous FYO Key, a key infinitely adjustable to every fist. Now it's back again, better than ever, and available only from HAL. The 2550 Keyer and the FYO Key make a great combination.

So to put your best fist forward, send today for a detailed brochure on these two great products.

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TOUCH-TONE ENCODER

FEATURES:

- Crystal Controlled - Digitally Synthesized Tones.
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- RFI *Immune.*
- 16-Button Tactile Feedback Keyboard.
- Will Interface to Transceivers Using Dynamic Microphones with Only Two Wires.
- Provisions for Three Wire Interface Are Provided.
- Gold-Plated Keyboard Contacts Provided for *Maximum* Reliability.
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- 2″ Square Velcro Available for Convenient Mounting - Dashboard - Sun Visor - Radio - Etc.

Touch-Tone Encoder	$29.50
Case	$ 2.00
Velcro	$ .50

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flea market

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R-388 RECEIVER, $200. AN/USM-159 frequency meter, solid state, battery powered, 125 kHz to 1 ghz, $150. Boonton 101 GDO, 300-1000 MHz, $45. AN/TRM-3 AM/Sweep Generator, 15-400 MHz, piston attenuator, metered output, CRT display, markers, all accessories, $250. Manuals included. Jim Walter, 2697 Nickel, San Pablo, Ca. 94806.

SOCIETY OF WIRELESS PIONEERS offers Life Membership to active and former C.W. operators on comm'l., military, gov't., etc. wireless/radio circuits. Contact: Society of Wireless Pioneers, Dept. H, P. O. Box 530, Santa Rosa, California 95402.

SELL GONSET 910A-SSB 6M transceiver - AC and DC power supplies. Original cartons, manuals. In storage last five years, W2PKZ, P. O. Box 47, Larchmont, N. Y. 10508. Best offer.

DRILLS — Carbide and high speed steel for PC work. Send SASE, Bob's Electronic Repair, Box 393, Bay City, MI 48706.

STOLEN, on October 3, 1975 a two meter transceiver (Simpson "Model A" with serial number 44475) from my car. L. Fred Towers, 2253 Poates Drive, Richmond, Virginia 23228.

PC's, Send large S.A.S.E. for list. Semtronics, Rt. #3, Box 1, Bellaire, Ohio 43906.

TUBES — Motorola Dispatcher — Hard to find types — tested — CK6397 $2 and IAD4 $1. M. J. Moss, W4UXJ, Box 28601, Atlanta, Ga. 30328.

OSCAR SLIDES, set of 5, $1.25. Launch and spacecraft. Proceeds AMSAT. K6PGX, P. O. Box 463, Pasadena, CA 91102.

WANTED. 1st, 5th, 6th and 8th editions of ARRL Radio Amateur's Handbook. Have many early Handbooks and publications for sale or trade. Send SASE for list. Jim Fisk, W1DTY, Greenville, NH 03048

RECONDITIONED TEST EQUIPMENT for sale. Catalog $.50. Walter, 2697 Nickel, San Pablo, Ca. 94806.

WANTED: Motorola HT-220 Omni or HT-200 (any model). D. W. Kelly, 100 Sylvan Court, Alexandria, Va. 22304.

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

More Details? CHECK—OFF Page 142

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ENGRAVED RADIO LICENSE. Exact reproduction in solid brass. Permanent identification. Send good Xerox copy, with $5.00, to Metal Art Graphics, 1136 Potomac Ave., Hagerstown, Md. 21740.

WANTED: R389 VLF receiver. K2GW, 100 Webb Ave., Ocean Grove, N. J. 07756.

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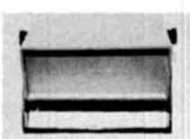
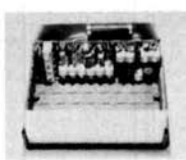
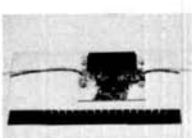
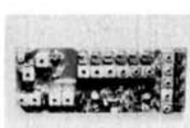

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And the angel said unto them, Fear not: for, behold, I bring you good tidings of great joy, which shall be to all people.
For unto you is born this day, in the city of David a Saviour, which is Christ the Lord.
...And the shepherds returned, glorifying and praising God for all the things that they had heard and seen, as it was told unto them.

Luke 12: 10, 11 and 20

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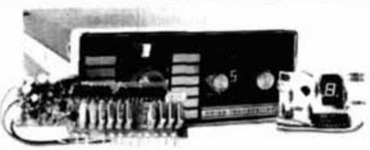

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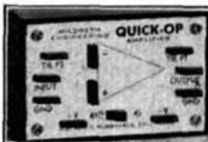

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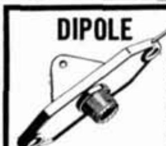

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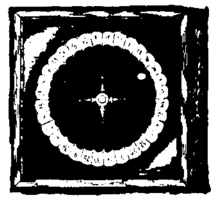

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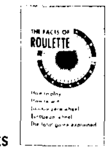

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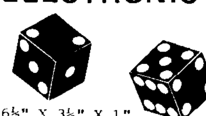

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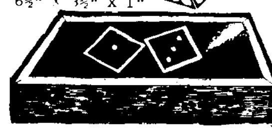

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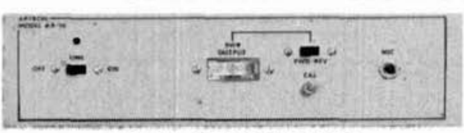

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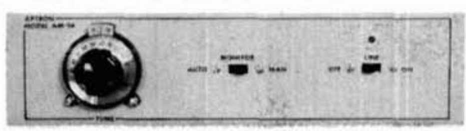

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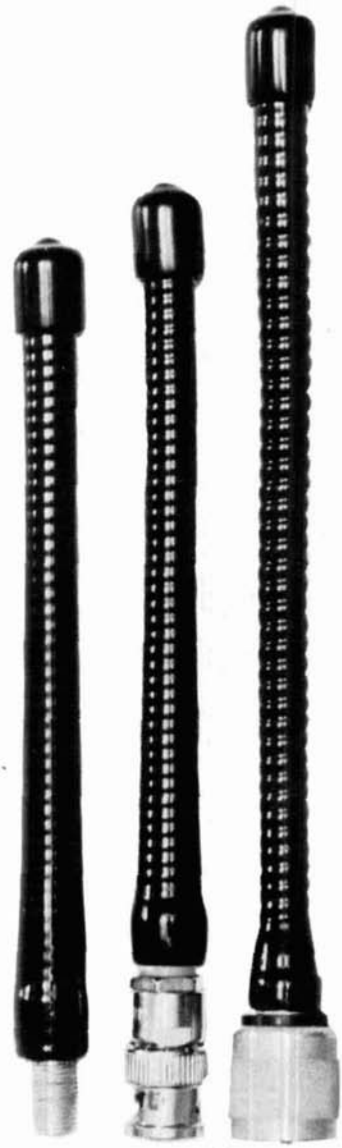

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