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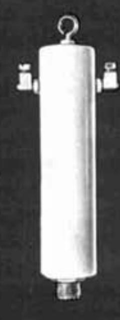

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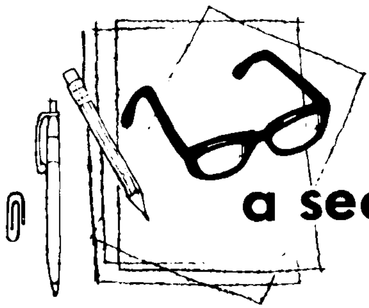


a second look

by jim fisk

The first two issues of *HR Report* are now off the presses and in the hands of subscribers around the country. If you want to know what's happening behind the scenes in amateur radio, and rapidly, as the news breaks, *HR Report* is the only way to do it. For example, did you know that we will probably lose the upper 2 MHz of the 420-MHz band (448 to 450 MHz) to the Emergency Medical Service? Did you know that the ARRL's first ten-meter contest was a partial success, with openings to Africa and South Pacific? Did you know that more than 500 two-meter repeater licenses have been issued by the FCC, nearly clearing up the backlog? Did you know that a large variety of quality-made coils, chokes and terminal boards, packaged for the amateur, are now available from Cambridge Thermionics Corporation (CTC)? These are just some of the items covered in detail in recent issues of *HR Report.* For subscription details for this new bi-weekly amateur newsletter, look on page 72.

This month we will kick off the latest project of our *more for 74* program, an Automatic License Renewal Service for *all* FCC-licensed amateurs (except Novices), subscribers to *ham radio* or not. The cost to you? Absolutely nothing, except for the effort to open an envelope. It will work like this: 60 to 90 days before your amateur license is due to expire you will receive in the mail a copy of FCC Form 610 plus a supplementary instruction sheet prepared by our staff which will include some info on such things as renewal fees, operating after your license expires *if* you filed a timely renewal application, etc. All you have to do is fill out the Form 610, enclose your check or money order, and mail it back to the FCC.

No last-minute scurrying around to find the proper form, or discovering that your license expired a month ago. However, for the Automatic License Renewal Service to operate successfully, your correct address must be on file with the FCC as required by the regulations. If you have moved since you last renewed your amateur license and the FCC does not have your current address you will not receive your License Renewal packet. It's as simple as that.

Early this month the first Automatic License Renewal packets will be in the mail to amateurs whose licenses expire in March and April, 1974. In early March License Renewal packets will be mailed to amateurs whose licenses expire in May. From then on mailings will be made the first of every month so you should receive yours at least 60 days before your license expires.

Jim Fisk, W1DTY
editor-in-chief

hr *Automatic License Renewal Service*

More Details? CHECK—OFF Page 94

solid-state transmitting converter for 144-MHz ssb

Complete construction details for a solid-state transmitting converter that provides more than 30-watts output on two meters

Bob Stein, W6NBI, 1849 Middleton Avenue, Los Altos, California 94022

In the past few years numerous articles have been published describing transistorized fm and CW transmitters and class-C power amplifiers for use in the 144- to 148-MHz band. However, there has been a noticeable lack of information covering single-sideband applications or *linear* transistor amplifiers, due primarily to the problem of generating reasonable amounts of power in linear amplifiers operating in the vhf region.

When my faithful but venerable tube-type two-meter ssb transmitter started to show its age, I began to investigate the possibilities of replacing it with a solid-state unit. A review of the published literature and manufacturers' data indicated that there should be no major obstacles up to the 1-watt level, but I found little encouragement to attempt the 30- to 35-watt output I was seeking. Fortunately, I had available a substantial quantity of vhf power transistors, designed for class-C service, with which to experiment. This article will show that it is entirely feasible to operate vhf power transistors as linear amplifiers, using techniques which are well within the capabilities of the serious vhf experimenter.

prerequisites

My needs were to generate a minimum of 30 watts PEP between 144 and 146 MHz, using my high-frequency ssb transmitter as the basic exciter. This dictated using the 28- to 30-MHz output from the transmitter in order to cover a 2-MHz range without changing the local-oscillator frequency in the transmitting converter. However, a close examination of the mixing scheme revealed one dismaying problem—operation at 145 MHz requires the ssb input to be at 29 MHz, and the fifth harmonic of 29 MHz is also 145 MHz, which is most undesirable. Since most mixers are excellent harmonic generators, I had to find one that was not. Luckily, the double-balanced mixer has excellent characteristics in this respect, thus eliminating one stumbling block.

I also decided that if I were going to have major problems (more than just the expected ones), there was no point in constructing the entire unit, and that if a problem was to prove insurmountable, it would show up before the final stage. Therefore the logical approach would be to build up the circuit to the driver stage, and then cover the final amplifier as a separate subproject. As it turned out, this was a fortunate decision, since it allowed me considerable flexibility in designing the final stage.

driver unit

A complete block diagram of the transmitting converter appears in **fig. 1**, showing the *approximate* stage gains and power levels throughout the circuit. The schematic of the driver unit is shown in **fig. 2**. The 28- to 30-MHz ssb input is applied to the RF (*R*) input port of double-balanced mixer Z1, and should not exceed -3 dBm (0.5 mW) to keep distortion products to a minimum. The 50-ohm pad formed by resistors R1 through R3 has been included to insure proper termination of the transmission line from the SSB exciter and to provide the mixer with a 50-ohm source. Values have not been specified for the pad resistors, since the required attenuation will depend on the output power of the exciter and the amount of attenuation present in your external power attenuator. The total loss in the two attenuators must be sufficient to limit the input to the mixer to the specified 0.5 mW. Design equations for calculating the resistance values may be found in reference 1 or any standard reference text.

I used a double-balanced mixer board which had been given to me because of a broken wiring trace. Its characteristics are identical to several inexpensive mixers now available, such as the Anzac MD108, Mini-Circuits SRA1, and Vari-L DBM166. Any one of these will be suitable, as would be the more expensive Hewlett-Packard or Relcom models. I have recommended the Anzac mixer in the parts list for **fig. 2**, since it is the least costly and is directly available from the manufacturer in single-lot orders.

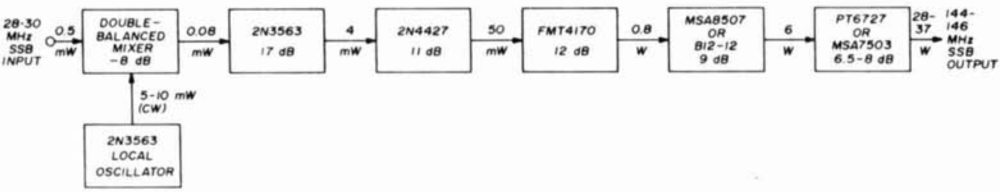
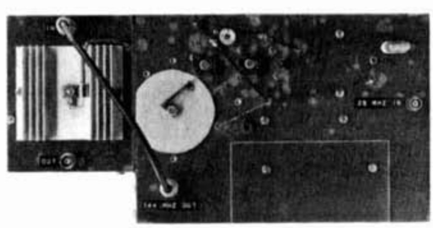


fig. 1. Block diagram showing approximate stage gains and peak-envelope-power levels throughout the converter. Output power and gain of the final stage depend on the type of transistor used and the collector supply voltage.

In order to achieve minimum loss through the mixer, a local-oscillator signal of at least 7 dBm (5 mW) is required. This is easily obtained from a 2N3563 operating in a Miller oscillator circuit which uses a 116-MHz overtone crystal. The oscillator output is taken from a tap on the collector coil, chosen to provide maximum power transfer to the mixer.

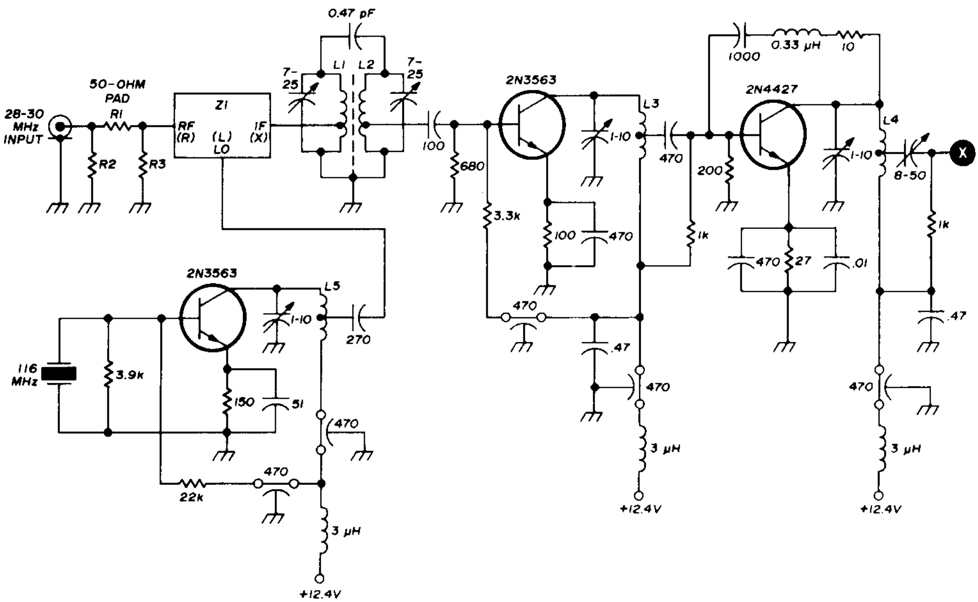
The output of the mixer is obtained at



Top view of the driver unit and MSA7503 final amplifier. The metal disc is the heat sink for the driver transistor; top-hat heat sinks are used on the 2N4427 and FMT4170 transistors. The 1N4001 and 1N4719 diodes are inside the clamps on the driver and amplifier mounting studs, respectively.

the i-f (*X*) port and is applied to a double-tuned top-coupled filter, resonant at 145 MHz. The Q of each tuned circuit and the coupling coefficient have been selected for a bandwidth of approximately 4 MHz. The input and output taps on L1 and L2 provide impedance matching

additional .01-µF emitter bypass capacitor were included to suppress a tendency of this stage to oscillate. The output of the 2N4427 is matched to the base of transistor Q1 by means of a trimmer capacitor tapped down on the collector coil.



C1,C3	1.5-20 pF compression trimmer (Arco/El Menco 402)
C2,C4	7-100 pF compression trimmer (Arco/El Menco 423)
L1,L2	4 turns no. 20, ¼" ID, ½" long, tapped ½ turn from ground end
L3	5 turns no. 20, ¼" ID, 3/8" long, tapped ½ turn from supply end
L4	6 turns no. 20, ¼" ID, ½" long, tapped 1 turn from supply end
L5	6 turns no. 20, ¼" ID, ½" long, tapped ½ turn from supply end
L6	copper strap, 1¼" long x 3/16" wide
L7	3 turns no. 16, ¼" ID, 5/8" long
L8	*25 turns no. 26E wound on Micrometals T37-3 core
Q1	*Fairchild FMT4170, RCA 2N5913, or Motorola HEP-S3001
Q2	*Fairchild MSA8507 or CTC B12-12
R1,R2,R3	see text
Z1	*double-balanced mixer (Anzac MD108 or equal)

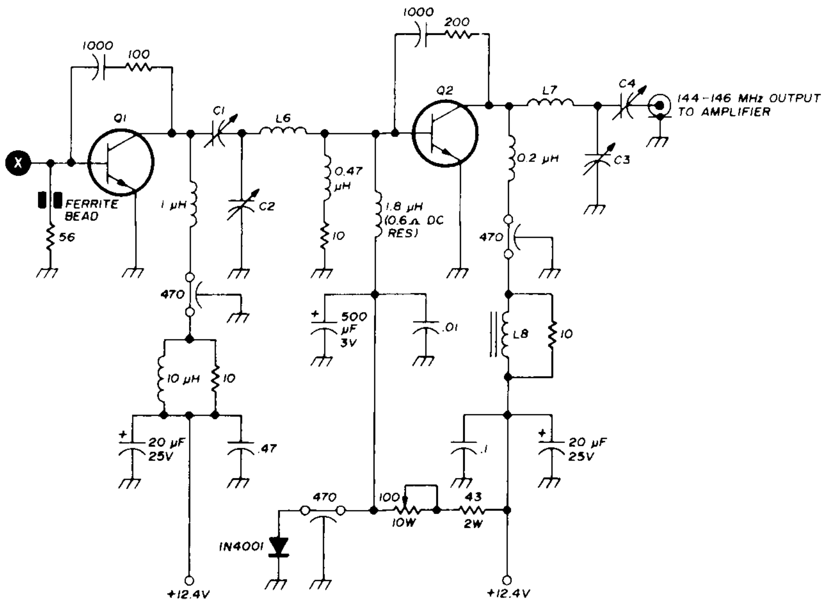
fig. 2. Schematic diagram of the driver unit. Sources of asterisked items are listed in the appendix. All 1-10 pF capacitors are piston type.

into and out of the filter. Total loss through the mixer and filter is about 8 dB.

Another 2N3563 follows the mixer, configured as a conventional class-A amplifier. The output of the 2N3563 drives a 2N4427 amplifier, which also operates class A. The RLC network between the collector and base of the 2N4427 and the

Several types of transistors were tried at Q1, all with some degree of success. The best of these was found to be the Fairchild FMT4170, although the lower-priced 2N5913 or HEP-S3001 (in that order of preference) should also be satisfactory. This stage operates closer to class-AB than class-A to keep the transistor power dissipation within acceptable limits. The RC network between the collector and base improves the linearity of the stage. Parasitic oscillations in the hf region are suppressed by the 10-μH rf choke in parallel with a 10-ohm resistor, plus the large bypass capacitors in the collector supply circuit.

To prevent thermal runaway of the transistor, the base current is controlled by a 1N4001 diode which is thermally coupled to the transistor case. This is physically accomplished by mounting the diode on the stud of the transistor so that it follows the temperature of the device.



The driver stage was designed around a Fairchild MSA8507 vhf power transistor which is characterized only for class-C operation. The transistor is forward biased into class AB operation by means of a bias circuit described by Roy Hejhall, K7QWR.[2] Quiescent collector current is set by adjusting the base bias by means of the 100-ohm adjustable resistor.

It is essential that there be approximately one-half ohm dc resistance between the base and bias source for the bias circuit to operate properly. I used a 1.8-μH rf choke from my junk box because it had a resistance of 0.6 ohm. Any choke having an inductance between 0.47 and 2 μH will be satisfactory, provided that it has the required resistance. Otherwise a resistor may be inserted between the rf choke and the bias source to make the total resistance about 0.5 ohm.

Therefore, as an increase in transistor temperature tends to increase the base and collector currents, the increase in diode temperature causes the base bias to decrease, thereby reducing the base and collector currents to the equilibrium values set by the bias-adjust resistor.

The collector-to-base RC linearizing network and the collector-supply hf

table 1. Characteristics of the Fairchild MSA8507 transistor at 175 MHz with 12-volt collector supply.

P_{out}	12 watts minimum
P_{in}	3.5 watts maximum (at rated P_{out})
Z_{in}	1.5 + j1.3 ohms
Z_{out}	3 − j2.7 ohms
C_{cb}	35 pF (at 1 MHz)
BV_{CES}	36 volts
V_{CEO}	18 volts
I_c	2.0 amperes maximum
P_D	22 watts

parasitic-suppression network are both similar to those used in the preceding stage. Power is coupled into and out of the transistor by means of conventional T-networks, resulting in an output from this stage of approximately 6 watts PEP when fed into a 50-ohm load.

lizing resistors. The circuit is shown in **fig. 3.** The first obvious question is why a nominal 28-volt transistor was used when the rest of the converter uses 12-volt devices. The answer is equally obvious when you look at the typical characteristics of 12-volt, 50-watt transistors—they

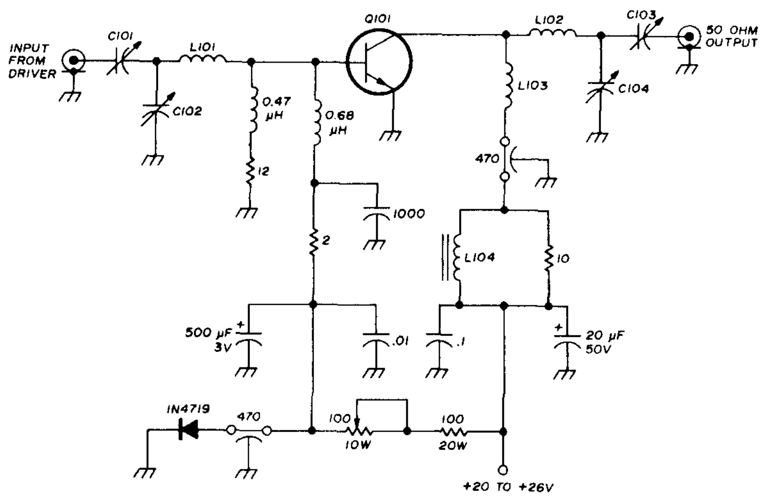


fig. 3. Schematic diagram of the final amplifier which uses a high-conductance diode to control base biasing. Details of the parts identified by reference designators appear in table 2.

Unfortunately, the Fairchild MSA8507 is no longer in production, although there may be some to be found as old stock or at surplus outlets. However the B12-12, manufactured by Communications Transistor Corporation, has similar characteristics and should be as good, if not better. For those interested in trying other transistors, the pertinent characteristics of the MSA8507 are listed in **table 1.** Reference 3 contains the design equations for the input and output networks, which must be redesigned if you use a transistor having input and output impedances substantially different from the MSA8507 or B12-12.

final amplifier

Two different amplifiers were designed, built, and operated on the air. The first uses a transistor characterized for class-C service in the 100- to 175-MHz region and having internal emitter stabi-

do not have the necessary power gain. And as will be seen later, the dual voltage requirement is not a major problem.

The circuit configuration is similar to that used in the driver stage, and uses a Fairchild MSA7503 transistor. The input and output networks are designed to match a 50-ohm source and load, respectively. As with the MSA8507, the MSA7503 is also out of production. However, the technique of placing a 50-watt transistor in linear service, when it was designed for class-C operation, may be of interest. The bias circuit is the same as previously described for the driver stage, except for one minor difference. Because of the relatively large value of base current, an rf choke having less inductance but using larger wire was used in the base circuit. Therefore a 2-ohm resistor was added between the choke and bias source to provide an empirically determined optimum value of resistance.

The transistor operates as close to true class B as possible. That is, the base is just barely forward biased, so that the quiescent collector current is 2 or 3 mA. Considering that the peak dc collector current is about 2 *amperes,* that is truly class B. All attempts to increase the static collector current resulted in catastrophic failure of the device when excitation was applied, probably caused by secondary breakdown. (See reference 4 for a discussion of this phenomenon.) However, as long as the static collector current is limited to 3 mA or less, the amplifier is stable, reliable, and entirely satisfactory. The output powers obtained at collector voltages between 20 and 26 volts are shown in **fig. 4.**

A second amplifier was then designed and built, using a commercially available transistor and a different biasing scheme. A TRW PT6727 is used in the circuit shown in **fig. 5.** This transistor is emitter-ballasted and is designed not only for CW operation at 150 MHz, but for a-m service as well.

The heart of the bias network in this circuit is a device called a *byistor,* which is manufactured by Communications Transistor Corporation, and shown in **fig. 5** as a Y-shaped symbol (originated by CTC) with its type designation BY1. The byistor acts as a low-impedance dc bias source and consists of a diode and silicon resistor; **fig. 6** shows the internal arrangement. The device is packaged in a ceramic stripline configuration, identical to that used for rf power transistors, and is meant to be mounted on the same heat sink as the transistor for temperature tracking. The diode is fabricated using the same material, geometry, and diffusion as an rf power transistor, so that it will thermally track the transistor. Tracking is further improved by the temperature characteristics of the silicon resistor.

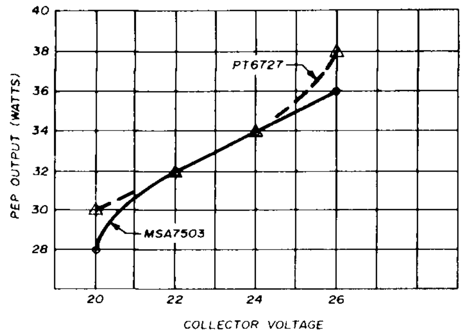


fig. 4. Outputs obtained from the Fairchild MSA7503 and TRW PT6727 transistors, plotted against collector supply voltage. These curves are not to be construed as indicating relative gains, since the drive power and tuning were optimized for each transistor at each value of collector voltage.

A constant current of approximately 350 mA is applied to injector terminal *I*, causing the diode to act as a voltage source having about 0.3 ohm impedance. The silicon resistor adds approximately 0.7 ohm and increases the apparent source impedance to approximately 1 ohm at supplier terminal *S*. The voltage at the supplier terminal will be between 0.45 and 0.85 volt, depending on the current being drawn from *S* and the temperature of the device. Thus, if a variable resistor is connected between the supplier (*S*) and reference (*R*) terminals, the supplier voltage can be adjusted. This is accomplished by the 4.7- and 100-ohm resistors shown in **fig. 5**; a single 5-ohm adjustable resistor could be used, but a 4.7-ohm, half-watt resistor in parallel with a printed-circuit type trimmer potentiometer provides finer control.

As the temperature of the byistor increases, the resistance of the silicon

table 2. Inductors and capacitors used in the amplifier circuits of figs. 3 and 5. Numbers in parentheses following the capacitance values are Arco/El Menco part numbers.

Q101	MSA7503	PT6727
C101	1.5-20 pF (402)	7-100 pF (423)
C102	7-100 pF (423)	24-200 pF (425)
C103	same as C102	3-35 pF (403)
C104	same as C102	2-25 pF (421)
L101	½ turn no. 18, 3/8" ID, 1¼" lead length	copper strap, 1" long, 3/8" wide
L102	1 turn no. 14, 3/8" ID, 1¼" lead length	3 turns no. 14, ¼" ID, ½" long
L103	7 turns no. 20, 3/16" ID, 3/8" long	7 turns no. 20, 3/16" ID, 3/8" long
L104	35 turns no. 20E wound on Micrometals T80-2 core	

resistor increases and the diode voltage decreases. This results in an increase in the apparent source impedance and lowers the bias voltage at the supplier terminal. Consequently, the base current of the associated transistor is reduced, preventing thermal runaway and providing improved dc stability of the amplifier. A more rigorous explanation of the byistor, with temperature-characteristic curves, appears in reference 5.

Aside from the biasing arrangement, the amplifier circuits of **figs. 3** and **5** are identical. Different values of inductance and capacitance in the input and output networks are required for each type of transistor, but either transistor can be used in either circuit. However, the improved construction of the PT6727 permits class-AB operation, which reduces the intermodulation distortion products to some extent. **Table 2** contains inductance and capacitance data applicable to either circuit, for each type of transistor.

The PT6727 appears to be somewhat better than the MSA7503 in terms of power gain, output, and distortion products, which is to be expected in view of its intended application. The power outputs obtained from the PT6727 appear in **fig. 4,** plotted against collector supply voltage.

power supplies

The low-power stages require a 12- to 12.6-volt dc source which is capable of supplying approximately 1.5 amperes at peak power output. The MSA7503 final amplifier draws about 2 amperes, while the PT6727 requires a 2.5-ampere supply, both values being the peak current. Both of the supplies must be reasonably well regulated because of the varying load inherent in ssb operation.

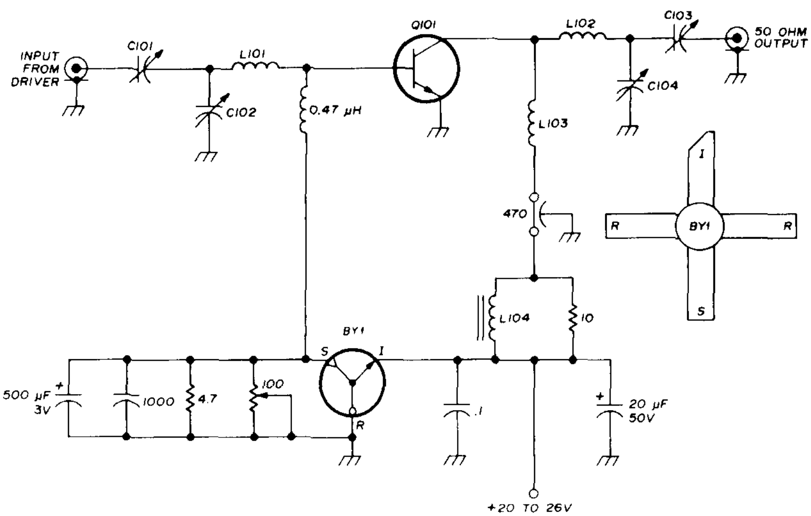


fig. 5. Schematic diagram of the final amplifier which has its base bias controlled by the CTC byistor. Details of parts identified by reference designators appear in table 2.

A convenient way to obtain the two supply voltages is to use a 20- to 26-volt supply capable of providing the total load current, and incorporate a simple regulator circuit to drop the voltage to the nominal 12 volts required for the driver unit. Such a regulator is shown in **fig. 7.** The value of dropping resistor R will depend on the input supply voltage, and may be calculated from the equation shown on the diagram.

If the 20- to 26-volt supply is regulated with a circuit similar to or better than that shown in **fig. 7,** the 12-volt regulator is more than adequate for local-oscillator stability. Purists may want to add a 10- or 11-volt zener diode at the local oscillator for additional regulation, but it was found to be unnecessary.

construction

Construction of the driver unit and the final amplifiers is shown in the various photographs. I started out using a piece of single-sided copper-clad board approximately 6-1/2 by 9-1/4 inches, since the circuits were developed stage by stage. I ultimately ran out of board, so for that reason the driver stage runs at a right angle to the low-level circuits. This is no problem except for the fact that it leaves a large portion of the board unused. To run all of the stages in the driver unit in a conventional straight line, I suggest using a piece of board approximately 12-inches long by 4-inches wide.

The normal techniques used for vhf construction should be followed—short leads and small, high-quality components. The low-level stages are each enclosed within shielded partitions which are made of pieces of copper-clad board soldered to the main board. The partitions should be placed across the transistor sockets to isolate the input and output circuits, thus minimizing any tendency of the high-gain stages to oscillate on their own. Liberal use of feedthrough capacitors and rf chokes for the supply voltages, with the dc wiring run on the top side of the board, prevents stray coupling through the power leads.

L1 and L2 in the mixer output circuit are shielded from one another by placing L1 and its associated capacitor on the mixer side of a shield partition, and L2 and its capacitor on the other side. The 0.47-pF coupling capacitor is then connected to the top end of each coil via a feedthrough terminal in the partition.

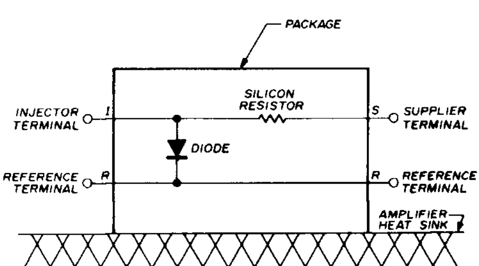


fig. 6. Schematic diagram of the bylstor (courtesy CTC).

The MSA8507 (or B12-12) and PT6727 transistors are in stripline-opposed-emitter packages, which require some care in mounting. Virtually all of the published articles employ this package configuration in circuits which use printed-wiring inductances or transmission-line sections. Since my design uses only discrete components, the mounting and connection techniques are slightly different.

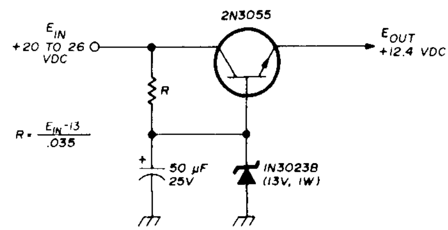


fig. 7. Regulator circuit for use in dropping the 20- to 26-volt dc supply to 12.4 volts.

There are two major conditions which must be met when mounting stripline transistors: the emitter leads must be grounded as closely as possible to the case, in order to minimize emitter lead inductance, and the case must be mounted on a heatsink without putting undue strain on any of the transistor leads. Considering the latter condition first, it can be satisfied by mounting the transistor to the heatsink, through a hole in the copper-clad board, *before* soldering to any of the leads. A sparse application of silicone thermal compound should be used between the body of the transistor and the heatsink.

Reducing the emitter lead inductance, as accomplished by soldering the leads close to the case, creates the annoying problem of what to do with the collector and base leads. Fortunately, operation at 144 MHz is not so critical as to preclude using one of the arrangements shown in **fig. 8**. In **fig. 8A**, the base and collector leads are soldered to lands which are insulated from the ground plane. These lands may be formed in one of two ways.

The copper can be routed out around the transistor leads, creating areas that are isolated from ground, and the leads then soldered to these lands. An alternate method is to cut small pieces of copper-clad board and cement them to the ground plane to form small insulated

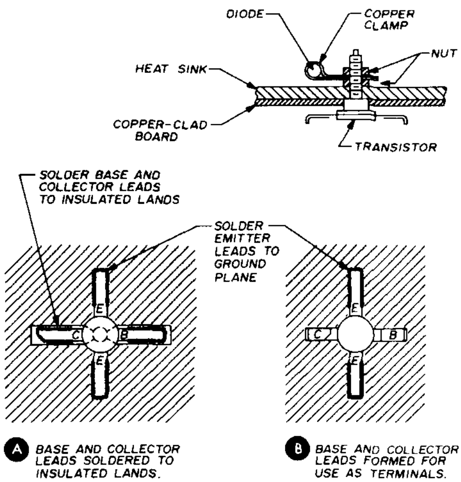


fig. 8. Methods of mounting stripline-opposed-emitter packaged transistors. Also shown is a base-bias control diode clamped to the transistor mounting stud for thermal tracking.

platforms to which the transistor base and collector leads can be soldered. In both cases, the heatsink must be spaced away from the main board so that the emitter leads are level with the ground plane or close enough to the ground plane so that they can be bent down slightly without too much strain.

Fig. 8B shows a third method which allows the heatsink to be mounted directly to the board without spacers. The base and collector leads are folded back on themselves, by means of long-nose pliers, and the folded ends carefully bent up away from the stud. This provides a relatively rigid terminal for connections to the transistor. The emitter leads are carefully bent down to the ground plane and soldered.

The heat sink for the driver transistor was made from a scrap piece of aluminum and has an area of about 6-1/2 square inches. This is enough radiating surface to keep the transistor from getting any more than barely warm to the touch. Of course, any one of the many commercial heat sinks having equivalent radiating surface could be used.

The 1N4001 diode is thermally coupled to the driver transistor by means of a clamp mounted on the transistor stud, as shown in **fig. 8B.** The clamp is made of a small piece of sheet copper which is formed around the diode to fit snugly. The diode and clamp surfaces should be coated with a thin film of thermal compound before being secured to the transistor stud. The diode cathode is soldered to the clamp, which is grounded via the heatsink, while the anode lead is connected to the bias-adjust resistor through a feedthrough capacitor.

The final amplifier is built on another piece of single-sided copper-clad board which measures 4 by 5 inches. The heat sink, which has a radiation surface of 33.4 square inches, is an Archer 276-1360, available at Radio Shack stores. The PT6727 stripline-packaged transistor is mounted to the board and heat sink in one of the ways previously described.

The MSA7503 is packaged in a TO-60 stud-mount case, which poses an additional problem in securing a low-impedance emitter-to-ground path. The emitter is connected internally to both the case and a terminal pin on the body, but using the pin is not practical because of the high internal lead inductance. The scheme shown in **fig. 9** was finally reached, and should be a useful method for mounting any similar transistor. First mount the heatsink to the board and, using a number-9 drill, drill a 0.196-inch hole through the heat sink and board for the transistor mounting stud. Then disassemble the heat sink from the board and enlarge the hole in the board to a diameter of 1/2 inch. Remount the heat sink on the board.

Obtain a small piece of copper *foil* (the kind used for electrostatic shields between power-transformer windings) and cut out a disc 1 to 1-1/4 inch in diameter. Carefully cut a hole in the center of the disc just large enough to clear the transistor stud. Apply thermal compound to that part of the heatsink which is accessible through the enlarged hole in the board. Place the copper foil on the stud and mount the transistor to the heatsink. (Note that thermal compound is not used between the copper foil and the transistor, in order to maintain a good rf path between emitter and ground.) Slit the edges of the copper foil, now protruding from the hole in the board, so that the foil can be pressed flat against the copper board, and solder it down. This results in a continuous ground plane from the board to the transistor emitter.

If a 1N4719 diode is to be used to control the bias, mount it to the transistor stud in the same manner as described for mounting the 1N4001 on the driver transistor. If you use the BY1 byistor, mount it in one of the ways described for stripline packages, except that there is no need for concern about lead inductance. I located the byistor stud 1 inch from the transistor stud, on a line with the base lead. This places it under the input inductor, which hides it in the photograph of the PT6727 amplifier.

adjusting and tuning the driver

One of the advantages of having the final amplifier separate from the driver unit is being able to tune up the low-power stages independently of the final. And since two relatively high-power transistors are involved, having to worry about just one at a time makes the process much easier.

Before making any power connections, set the 100-ohm adjustable resistor in the driver bias network for maximum resistance. Then temporarily break the collector supply circuit in the driver stage and insert a 0-50 or 0-100 mA meter between L8 and the supply. Be sure the meter will indicate only the collector current and not the current drawn by the 1N4001 diode. Connect a good 50-ohm load and power meter to the driver output connector.

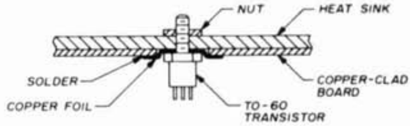
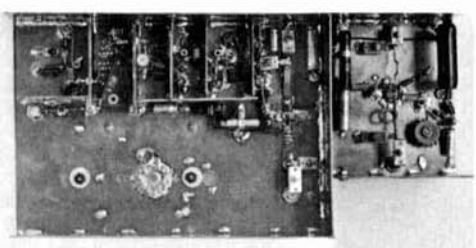


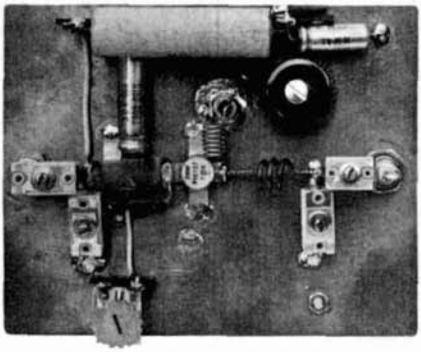
fig. 9. Method of mounting TO-60 stud-mount transistors to minimize emitter-to-ground lead inductance.



Bottom of the driver unit and MSA7503 amplifier. The local oscillator is at the left side, followed by the mixer and low-level stages to the right. The driver stage runs along the right side of the larger driver-unit board. The amplifier input circuit is at the top of the smaller board, and the collector circuit is at the bottom. Note the use of shield partitions to prevent feedback.

Connect the 12-volt supply and apply power. The meter should read zero or close to it. Adjust the 100-ohm resistor until the collector current is approximately 20 mA; this sets the operating bias on the driver transistor. Next check the operation of the 2N3563 oscillator, using an electronic voltmeter and rf probe at the output, or a sensitive detector coupled to the collector tank circuit. Tune the oscillator for maximum output. If the circuit fails to oscillate, it may be necessary to experiment with the value of the emitter bypass capacitor.

Turn off the power supply and replace the milliammeter with a 0-1 ammeter. Now connect the hf single-sideband transmitter, tuned to 29 MHz, to the input connector of the driver unit. Be sure that you have enough attenuation between the transmitter and converter to limit the power at the mixer input to 0.5 mW. Reapply power to the driver unit and slowly insert carrier at the transmitter while watching the driver-stage collector current. If the collector current starts to increase, immediately adjust the tuning capacitors in the driver output network for maximum output power. Actually, there is little likelihood of this occurring before the low-level stages have been tuned, so reduce the 29-MHz excitation



Component side of the PT6727 final amplifier. The copper-strap inductor in the input circuits hides the byistor. The transistor and byistor are mounted on the same type of heat sink as shown in the photograph of the MSA7503 amplifier.

and tune up the converter by means of the following technique.

Tune each stage for maximum power output. An electronic voltmeter with an rf probe, connected at a point which follows the circuit or stage being adjusted, makes a good tuning indicator without loading down the circuit (e.g., connect the probe to the collector of the stage *following* the one being tuned). As each stage is tuned, gradually increase the 29-MHz carrier and monitor the driver collector current so that the driver output circuit can be tuned for maximum output as soon as the collector current starts to increase. As excitation to the driver stage is increased, the collector current will rise to a maximum of 0.75 to 1 ampere. Tune the driver output circuit for maximum output consistent with minimum collector current. Since the Q of the output circuit is low, tuning is relatively broad, making it easy to pick the point of best efficiency.

As the 29-MHz drive is increased and as each stage is tuned, the output should gradually rise to at least 6 watts. However, if the output goes to 9 watts or so, it is an indication that one or more of the low-level stages are saturated. If this happens, reduce the excitation to the point where the output power drops sharply. This is the limit of linear operation, and all tuning adjustments should be repeaked at this level. Vary the frequency of the ssb transmitter from 28 to 30 MHz and retune it for constant output at several points within the frequency range, but do not retune the transmitting converter. The output from the converter should vary less than 10 percent.

Deenergize the power supply, remove the ammeter, and restore the driver collector circuit to its original state. You now have a 6-watt ssb signal, ready to put on the air or to drive the final stage. If you want to get it on two meters at this point, be sure to read the section headed *operation* before connecting the antenna.

adjusting and tuning the final amplifier

If you are using the amplifier circuit shown in **fig. 3**, set the 100-ohm adjustable resistor for *maximum* resistance. If you are using the circuit of **fig. 5**, set the 100-ohm pot for *minimum* resistance between the byistor supplier terminal and ground. Temporarily open the collector circuit, as was done for the driver, and insert a milliammeter between L104 and the power supply so that it will measure only the collector current. A 0-50 or 0-100 mA meter can be used for the PT6727; a 0-10 mA meter is preferable if an MSA7503 or equivalent is used.

Using the lowest supply voltage which will provide you with the output power that you need, turn on the power supply and adjust the bias resistor on the amplifier for a collector current of 25 mA if the PT6727 is being used. If you are using an MSA7503 or an equivalent transistor, adjust the bias resistor to the point where the collector just starts to draw current—about 2 or 3 mA. Remove power and replace the milliammeter with an ammeter having at least a 2.5 ampere range.

Connect the driver unit to the amplifier by means of a short length of 50-ohm coax cable, and terminate the amplifier with a power meter and good 50-ohm load. Energize the driver unit and amplifier power supplies, and *gradually* apply rf excitation. Tune the amplifier input and output capacitors for maximum output each time the drive is increased. The output should rise smoothly until it reaches the approximate value indicated in **fig. 4** for the supply voltage being used. As with the driver stage, the final tuning should provide maximum efficiency (maximum output consistent with minimum collector current). The collector efficiency of the PT6727, operating class AB, should be approximately 60 percent. The efficiency of the MSA7503 or any other transistor operating virtually at cut-off may be as high as 75 percent. Tuning the exciter over a 2-MHz range should not affect the output of the transmitting converter by more than 10 percent.

Driver-stage tuning may be refined during the amplifier tuning procedure by peaking the capacitors in the driver collector circuit for maximum amplifier output, but this must not be done until after the amplifier input tuning capacitors have been adjusted for maximum output. Then remove all power, disconnect the ammeter, and restore the final collector circuit to its original condition.

operation

The transmitting converter is now ready to feed an antenna or to drive a high-power linear amplifier. In the latter case, connect the converter to the amplifier through a 50-ohm coax cable (assuming that the amplifier being driven has a 50-ohm input impedance) and retune the converter amplifier collector circuit for maximum drive. It is advantageous to monitor the transistor amplifier collector current to achieve maximum efficiency, which can be done simply by inserting an ammeter in the lead from the dc supply. Remember, however, that you will now be measuring the collector current plus the current drawn by the bias-control diode or byistor, so that the total current through the meter will be 200 to 350 mA greater than the collector current alone.

If the transmitting converter is fed directly to an antenna, a lowpass filter must be inserted between the output

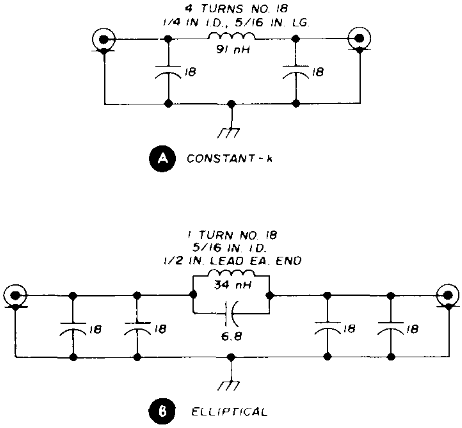


fig. 10. Schematic diagrams of two lowpass filters for suppressing harmonic radiation. The coil in the elliptical filter (B) should be adjusted so that it resonates with the 6.8-pF capacitor at 327 MHz. Capacitors are silver mica, 5 percent or better.

connector and the transmission line to attenuate harmonics which will be passed by the low-Q output network of the driver or amplifier. (The higher-Q tuned circuits in a vacuum-tube amplifier following the converter will provide sufficient filtering, and eliminate the need for a lowpass filter.) Two such filters are shown in **fig. 10**. The constant-k pi-section in **fig. 10A** is slightly simpler than the elliptical pi-section of **fig. 10B,** but the latter will provide at least 6-dB, and as much as 16-dB, more attenuation to the second harmonic than will the constant-k configuration.

After making the necessary connections and applying power, retune the output collector circuit for maximum output power. Again, it is wise to monitor the collector current, as described above. Once the preceding tuning procedures have been completed, it will not be necessary to retune any of the circuits

appendix

Most of the parts used in the transmitting converter are available through regular distributors. The following list is provided for those items which must be ordered from other sources, and includes prices (as of July 1973) for those of major importance.

item	unit price	source
CTC B12-12 BY1	$ 9.50 6.00	Communications Transistor Corporation, 301 Industrial Way, San Carlos, California 94070
Anzac MD108	7.00	Anzac Electronics, 39 Green Street, Waltham, Massachusetts 02154
TRW PT6727	35.00	Request name and address of closest distributor from Marketing Department, TRW Semiconductor Division, 14520 Aviation Boulevard, Lawndale, California 90260
Fairchild FMT4170	5.50	Request name and address of closest distributor from Marketing Department, Fairchild MOD, 4001 Miranda Avenue, Palo Alto, California 94304
Micrometals cores		Amidon Associates, 12033 Otsego Street, North Hollywood, California 91607

over long periods of time, provided that you do not change the load or supply voltages. The low-Q tuned circuits are relatively insensitive to other changes.

conclusions

Operation on two meters during the past several months, using both amplifiers, has shown that the transmitting converter is stable and trouble-free. A spectrum analyzer was not available for distortion measurements, but rough measurements using a receiver and calibrated step attenuator indicate that the third-order products are down approximately 24 dB when using the MSA7503 amplifier, and approximately 27 dB for the PT6727. The limitation in the latter case is probably due to the distortion products generated in the MSA8507 driver stage.

acknowledgements

I would like to acknowledge the technical and material assistance received from the following: Joe Reisert, W6FZJ, of Fairchild Microwave and Optoelectronics Division; Jack Manon, W6FIG, of TRW Semiconductors; and Bob Artigo, W6GFS, Lee Max, and Mike Mallinger of Communications transistor Corporation. Thanks are also due to Alan Stein for the photography.

references

1. F. Langford-Smith, "Radiotron Designer's Handbook," Radio Corporation of America, Harrison, New Jersey, Fourth Edition, 1952, page 795.
2. Roy C. Hejhall, K7QWR, "Broadband Solid-State Power Amplifiers for SSB Service," *QST*, March 1972, page 36.
3. Paul Franson, WA7KRE, "How to Use RF Power Transistors," *ham radio*, January, 1970, page 8.
4. Z. F. Chang and J. F. Locke, "Use of the RCA-2N6093 HF Power Transistor in Linear Applications," Application Note AN-4591, RCA Solid State Division, Somerville, New Jersey.
5. Lee B. Max, "Byistor—A New Device for Linear Amplifier Bias Networks," Application Note 2.0.8.1D, Communications Transistor Corporation, San Carlos, California, 1973.

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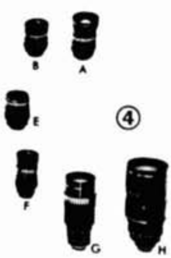

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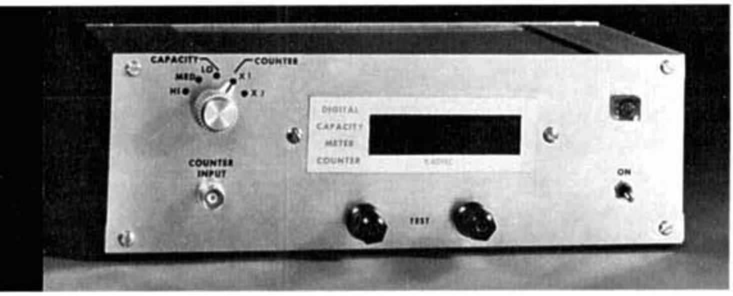


digital capacitance meter

Construction details for a wide-range digital capacitance meter that doubles as a 20-MHz frequency counter

Ray Megirian, K4DHC, Box 580, Deerfield Beach, Florida 33441

Depending on your point of view, this instrument may be called a capacitance meter which will also function as a frequency counter or it can be called a frequency counter which will also measure capacitance. To me it's a capacitance meter since that was my need at the time I designed it. However, to provide one function without the other would be foolish since circuitry for both is practically identical and requires only the switching of a few points in the control logic to implement either mode of operation.

theory of operation

The capacitor to be tested is placed in a timing circuit whose output gates a train of fixed-frequency pulses into a standard counter. The output pulse length from the timer circuit is proportional to the size of the capacitor, thus varying the gate time. The resultant count is indicated by the digital readouts. A large capacitor would result in a long gate time and a high pulse count.

If the resistance factor in the RC time constant is used as a calibrating device, it could be adjusted in conjunction with a known value of capacitance to give a known gate time and, therefore, a known count. For example, if R were adjusted to provide a 1.0-millisecond output pulse in conjunction with a 1000-pF capacitor and the pulse rate was 1.0 MHz, during the 1.0-ms opening of the gate 1000 pulses would get through to the counter and register on the readouts. A 900-pF capacitor would shorten the gate time sufficiently to allow only 900 pulses through. Larger capacitors permit proportionately longer count times with resulting higher counts.

In the capacitance meter frequency is fixed and gate time is variable, while in the counter gate time is fixed and frequency is variable.

circuit details

About the time I first started thinking about this idea, Signetics introduced their NE555 IC timer. This little item requires only two external components, a resistor and a capacitor, and is just the thing for

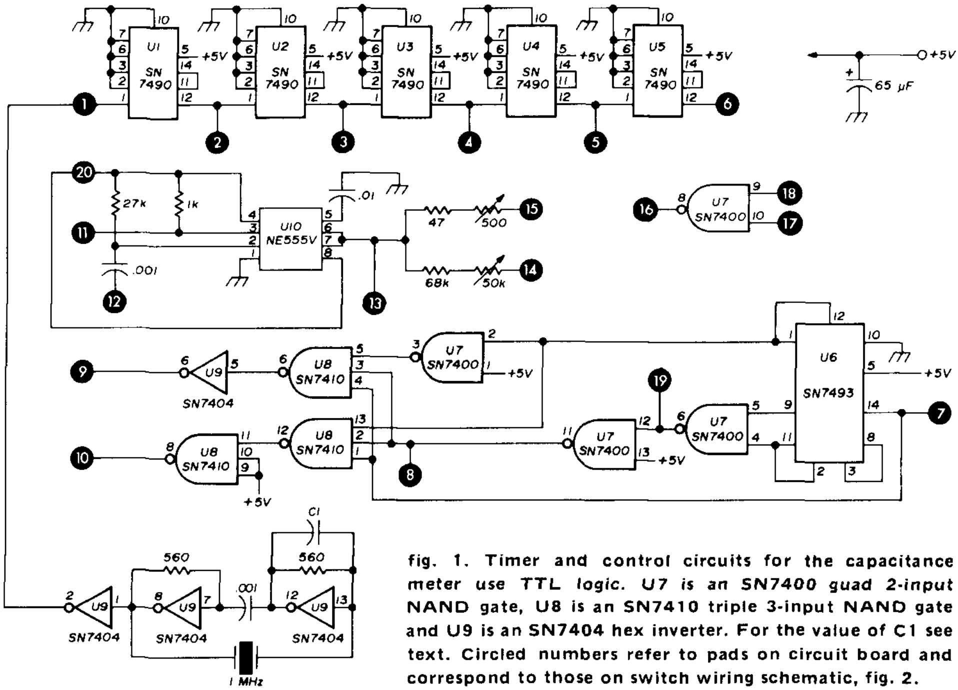


fig. 1. Timer and control circuits for the capacitance meter use TTL logic. U7 is an SN7400 quad 2-input NAND gate, U8 is an SN7410 triple 3-input NAND gate and U9 is an SN7404 hex inverter. For the value of C1 see text. Circled numbers refer to pads on circuit board and correspond to those on switch wiring schematic, fig. 2.

generating the timing pulses. In this case the resistor would be a calibrating pot and the capacitor would be the unit under test.

Inside the NE555 are two comparators, a flip-flop, an output stage and a discharge transistor. Initially, the capacitor is held discharged by the transistor connected across it. When a negative-going pulse is applied to pin 2 of the IC, the flip-flop is set, releasing the short across the capacitor and charging commences.

A circuit operating in this mode is the old familiar one-shot or monostable. The NE555 may also be wired as an astable if free-running operation is desired. For interested readers, the data sheets show many other interesting applications for this IC.

The control logic circuit used in this instrument was borrowed from an article by W1EO in *QST.*[1] A 1-MHz crystal oscillator and SN7404 hex inverter IC were added to provide the clock input (see **fig. 1**). Five SN7490 decade counters

table 1. Capacitance ranges used in the instrument built by the author.

range	calibration	clock frequency	readout format
1000 μF	1.0 μF = 0.1 ms	100 kHz	1000.0
1.0 μF	.001 μF = 0.1 ms	100 kHz	1.0000
0.1 μF	.001 μF = 0.1 ms	1.0 MHz	0.1000

The reference voltage for the comparator is internally set at two-thirds of the operating voltage. When the voltage ramp across the capacitor reaches this level, the circuit fires, resetting the flip-flop and discharging the capacitor. Upon receipt of another trigger pulse, the cycle repeats.

divide the crystal frequency down to 10 Hz — this results in a string of pulses spaced exactly one-tenth second apart. An SN7493 is used as a divide-by-twelve counter to provide a period of 1.2 seconds or 12 clock pulses for a complete timing cycle.

The initial 1-second portion is the count period during which the count gate is open. During the 0.2-second interval between counting periods, a transfer pulse is generated which allows the in-

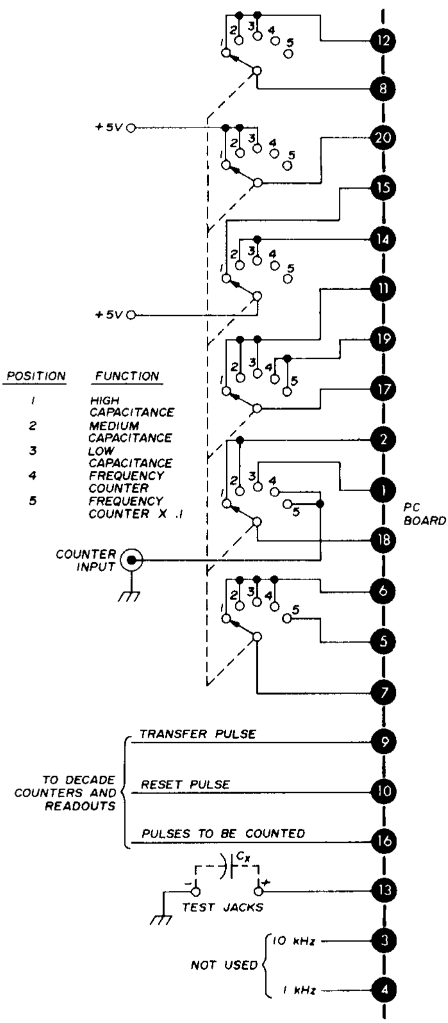


fig. 2. Wiring diagram for the function switch. Circled numbers refer to pads on the circuit board (see fig. 4).

formation stored in the latches (if used) to be shifted to the decoder/drivers for readout of the latest count.

A subsequent reset pulse is also generated during this interval which returns all counters to zero in preparation for the next 1-second counting period. These latter two pulses are formed by interconnecting various gates contained in an SN7400 and an SN7410 IC. The pulse appearing at pin 11 of U7 is negative-going at the start of the timing period and is used to trigger the NE555 for capacitance measuring.

When the instrument is operating as a capacitance meter, the control pulse for the count gate comes from the timer circuit and the pulse train to be counted is generated by the internal clock. When functioning as a straightforward counter, the count gate reverts to internal control and the signal to be counted comes from an external source. These and other points require switching and are combined into a single multi-pole switch. In my unit this switch provides three capacitance ranges and two for counter operation. Sections of the function switch are also used to apply power and trigger pulses to the timer when operating in the capacitance-measuring mode (see **fig. 2**).

Table 1 shows the relationships between the various parameters when applied to a 5-digit counter such as that used here. Obviously this scheme is not a mandatory one and can be altered to suit other situations. If you are planning to place decimal points at appropriate points in the display, don't forget to reserve a pole on the function switch for that purpose.

construction

The heart of the capacitance meter is the control logic and timer circuitry. A two-sided PC board was laid out to accommodate all of the circuitry in an uncrowded area 2.5 by 4.6 inches. Since the TTL logic ICs come in dual-inline packages, a similar version of the Signetics NE555 timer was used. This is their 8-pin mini-DIP known as the V package (NE555V).

The 1-MHz crystal is in an HC6-U holder with wire leads. The calibrating trimmers are the common 1-inch type which have pin spacings of 0.2 and 0.3 inch with a 0.2-inch stradle. The decoupling filter capacitor is a 65-μF dipped tantalum but any substitute unit of 50-μF or so may be used if it fits on the board.

Circuit pads are provided at all points being switched as well as at inputs and outputs. A pad is provided at the crystal output as well as at each decade although not all frequencies will be used in this particular application.

The most practical scheme I've been able to devise for making double-sided PC boards is to cut out a cardboard frame for the blank board so that it just fits in the opening without moving around. Position one of the negatives over the opening with the proper side up and tape the edges to the cardboard frame. Turn the frame over and place the second negative so that the two are back-to-back and in perfect registration. Tape this one along one edge so that it may be lifted to allow insertion of the blank PC board. After both sides have been exposed, develop

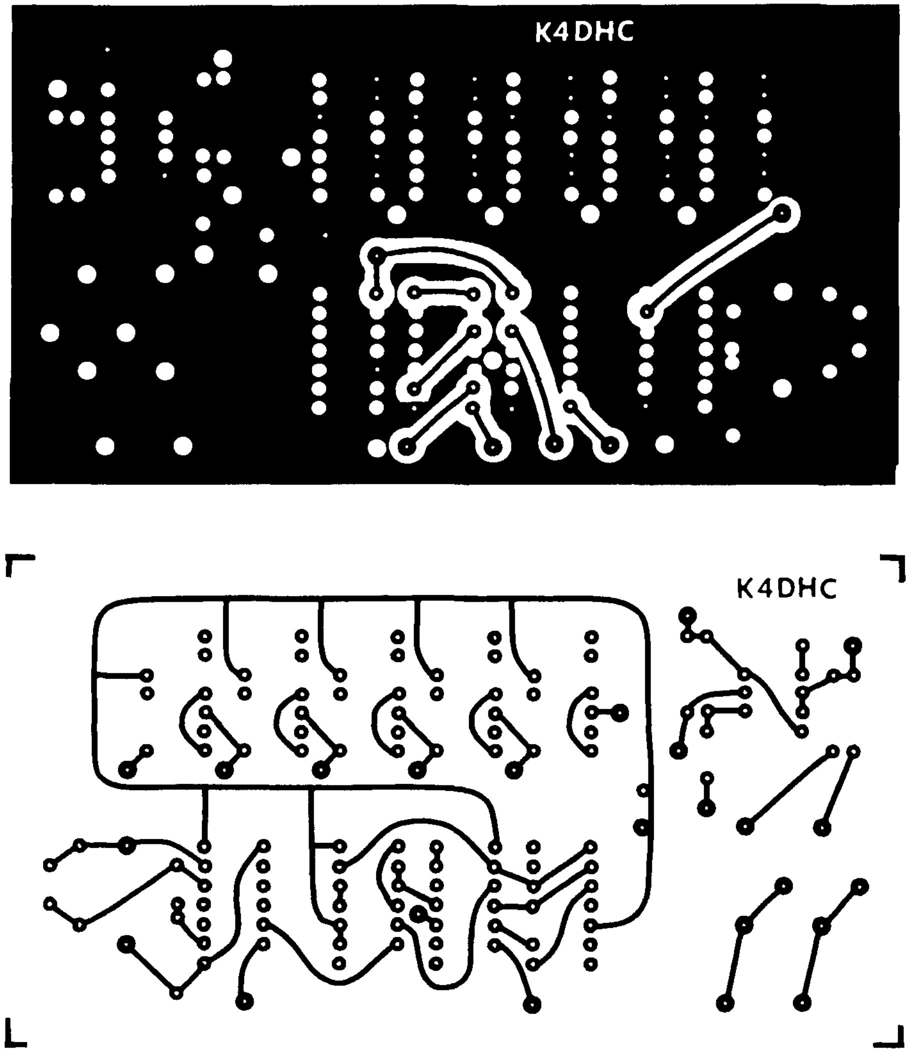
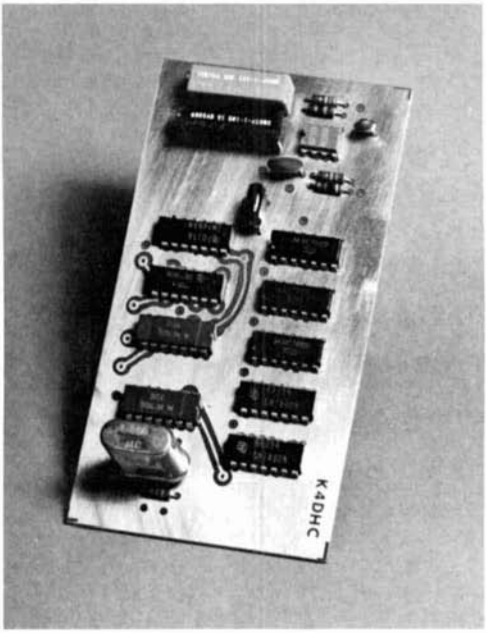


fig. 3. Full-size layout for both sides of the double-sided circuit board.

and etch in the normal manner. The board in the photograph was homemade in this way (see **fig. 3** for the layout).

If you are planning to build one of these instruments from scratch, you'll need several decades of counting and readout circuitry. Many of the advertisers in *ham radio* sell kits consisting of a counter, a latch, a decoder/driver and a readout device, along with a PC board for easy assembly. Four decades would be the minimum required. Anything over that would be at the builder's discretion.



Component side of the printed-circuit board containing the timer and control circuits for the digital capacitance meter.

I used five stages because I happened to have five hybrid assemblies on hand which were suitable for this application. Each of these dual-inline packages contained a counter, a latch and a decoder/driver. I mated these with five homemade readouts and ended up with a neat 5-digit counter section.

I would have used one or two more stages if I'd had more of the hybrids since it would have made the frequency counter a little more useful. For capacitance measurements, however, the five digits are adequate since the accuracy of the system doesn't really warrant any greater resolution.

If you already own a counter and don't mind tearing into it, you could do a little rearranging along the lines described here to add the capacitance measurement feature. In counters that provide for external gate control the output from the timer could be fed into this connection. In addition, a suitable trigger pulse must be brought out to fire the timer at the start of the cycle. Suitable clock pulses could also be brought out for the various operating ranges.

It is by no means mandatory that a PC board be used for assembly. The circuit described here was at one time made up on a piece of perforated board and wired from point-to-point. It worked just fine.

calibration

All you need for calibration are a couple of fairly close tolerance capacitors of suitable values. With a capacitor connected to the test jacks and the instrument switched to the high range, adjust the 500-ohm trimmer for proper display of the value. Adjust the 50k trimmer for either of the two remaining ranges.

A capacitor of around 1.0 μF could be used for setting both trimmers since there is an overlap between ranges. The more points you can check, of course, the more accurate the instrument. From my experience it seems reasonable to expect at least 10% accuracy across the operating range of 1000 pF to 1000 μF.

Since this unit was intended primarily to measure large capacitors, readings should be close enough for most experimental work. They will also bear out the fact that most electrolytics have values a lot higher than marked.

It should be pointed out that the unit will read well over 1000 μF but accuracy falls off rapidly above 1500 μF. This is apparently due to shortening of the output pulse from the timer as the duty cycle increases. At the opposite end, reading values below 1000 pF seems to be impractical due to bad jitter on the timer output pulse. The comparator input which the capacitor is connected across is a high impedance point and consequently picks up all kinds of noise and hum. Looking at the trailing edge of the output pulse on a scope will verify this. The end result is that the count gate sees a constantly varying count time which makes valid readings impossible.

All circuitry is powered from a single 5-volt supply capable of supplying the required current. In my instrument maximum current is about 1.5 amperes. Close regulation is not essential as voltage variations will not affect the timer output. When you are measuring electrolytic capacitors, remember that they should have a minimum rating of 6 volts just to be safe.

summary

Parts of this circuit may be of interest to some readers even if not all of it is. The control logic may be suitable for a counter you've been thinking of building or the timer circuitry may be extracted for use with an existing counter. The crystal oscillator could be modified for 10-MHz operation by adding another decade divider. A calibrating trimmer capacitor could also be added in series with the crystal for precise adjustment of the clock. This would be primarily for *improving frequency measuring accuracy..*

Incidentally, you may find that some 1-MHz crystals won't oscillate at their fundamental frequency. A scope should be used to check this. Holes have been provided on the circuit board to install a capacitor across one of the feedback resistors if this problem is encountered. Try about 100 pF as a starting value and substitute values until you're sure the oscillator will start properly every time you fire up.

A preamplifier and conditioning circuit for the counter was not included on the board. There have been numerous examples of such circuits in all the amateur publications so finding what you want should not be too difficult.

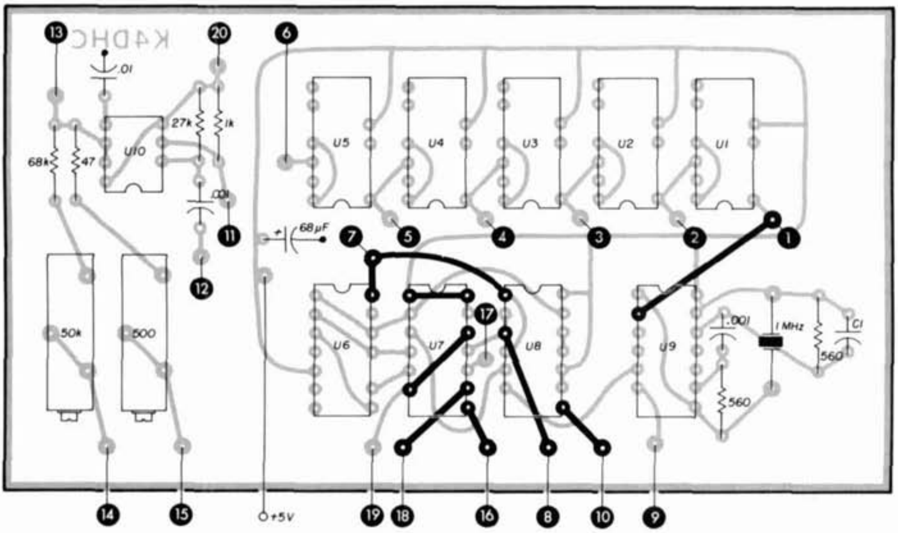


fig. 4. Component layout for the capacitance meter circuit board. Circled numbers correspond to connections on the function switch (see fig. 2). Bold traces are on component side of the printed-circuit board.

reference

1. Kenneth Macleish, W1EO, "A Frequency Counter for the Amateur Station," *QST,* October, 1970, page 15.

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how to design L-networks

How to choose the proper L-network for your particular impedance-matching problem, and how to calculate the required component values

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Graphical methods of designing L-networks have been presented several times in the past.[1,2,3] As shown in reference 1, there are eight possible L-networks for matching a pure resistance to *any* impedance. In most amateur cases the pure resistance is the 52-ohm coaxial transmission line, and the impedance is that at the base of a vertical antenna.

It is important to note that only certain networks can be used to match certain ranges of impedance. Also, because of possible mutual coupling, networks using two inductors are less desireable than the others. The lowpass filter network is the most desireable, but can be used only for some load conditions. One criteria which affects the choice of network is whether or not the antenna resistance is greater or less than 52 ohms. A more definite way of selecting the correct network is shown in the graphs that follow.

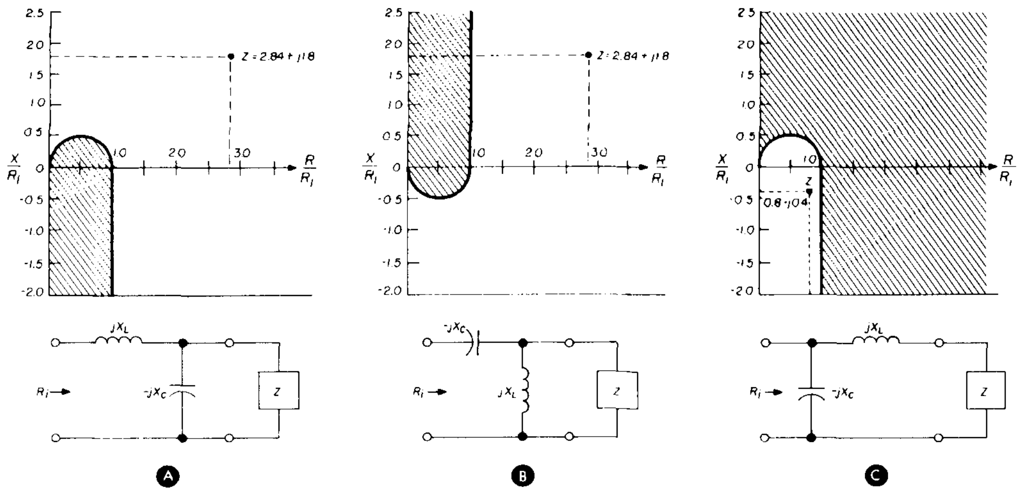
One of my former graduate students, John Lewis, studied the L-network situation and found that there are three different networks that will match any conceivable load impedance. He developed equations for these three networks and wrote a computer program that would, for a given problem, select the proper network and calculate the two necessary L-network element values. This article will give those equations, and describe them so that you can design your own L-networks, using simple equations and elementary arithmetic.

He developed the equations by writing the network equations for a given network, calling the input impedance R_i (50 ohms in our case). He then solved the equations for the network element values. For example, for the case of the network in **fig. 1C**

$$R_i = \frac{-jX_c\,(R + j(X_L + X))}{R + j\,(X + X_L - X_C)}$$

tions for X_L and X_C. John called these networks **A, B,** and **C** as shown in **fig. 1.**

The best way to show which load impedances each network can match is by means of a graph, first presented by Smith in *Electronics.*[4] The shaded part of each graph shows those load values which that



Network A $\quad X_C = \dfrac{-2\,R_i\,X + k}{2(R - R_i)}$ (1) $\qquad X_L = \dfrac{R_i\,X + X_C\,(R - R_i)}{R}$ (2)

Network B $\quad X_L = \dfrac{2\,R_i\,X + k}{2(R - R_i)}$ (3) $\qquad X_C = \dfrac{X_L\,(R - R_i) - R_i\,X}{R}$ (4)

Network C $\quad X_L = \left(\sqrt{R_i\,R - R^2}\right) - X$ (5) $\qquad X_C = \dfrac{(X_L + X)^2 + R^2}{X_L + X}$ (6)

$$\text{constant } k = \sqrt{4\,R_i^2\,X^2 + 4\,R_i\,(R - R_i)\,(X^2 + R^2)} \qquad (7)$$

fig. 1. Three types of L-networks which may be used for impedance matching. The accompanying graphs show the range of impedances which may be matched by each of the networks. Point Z in (A) and (B) is the normalized impedance used in the first example in the text. Point Z in (C) is the normalized load impedance used in the second example.

solving, $X_L = (R_i\,R - R^2)^{1/2} - X$

$$X_C = \frac{(X_L + X)^2 + R^2}{X_L + X}$$

The steps in the solution are not shown here. To do that the first equation was expanded and the real and imaginary terms properly equated, resulting in solu-

particular network cannot match. The network can provide a match for any impedance in the non-shaded area. The graphs are normalized, which means that all graph values are divided by the impedance value of transmission line used (50 ohms). Thus, a load resistance of 50 ohms shows up on the graph as 1 unit horizontally.

When using the graphs and formulae presented in **fig. 1,** solve first for the network element given in the left-hand column. For example, assume you have a vertical antenna with an input impedance of 142 + j90 ohms and want to feed it with 50-ohm coaxial cable. Therefore, R = 142 ohms, X = 90 ohms and R_i = 50 ohms. Normalizing, R/R_i = 2.84 and X/R_i = 1.8. In this case either network A or B must be used because the normalized impedance (Z = 2.84 + j1.8) falls into the forbidden region in the graph for network C.

To use network A, first calculate the constant, k, from **eq. 7**. Then find X_C and X_L, respectively, using **eqs. 1** and **2**.

$$k = \sqrt{(4 \cdot 50^2 \cdot 90^2) + (4 \cdot 50)\,(142 - 50)\,(90^2 + 142^2)} = 24516.48$$

$$X_C = \frac{-(2 \cdot 50 \cdot 90) + (24516.48)}{2(142 - 50)}$$

$$= 84.33 \text{ ohms}$$

$$X_L = \frac{(50 \cdot 90) + 84.33(142 - 50)}{142}$$

$$= 86.33 \text{ ohms}$$

To determine the component values for network B calculate X_L and X_C from **eqs. 3** and **4**, respectively. The constant, k, is the same as before.

$$X_L = \frac{(2 \cdot 50 \cdot 90) + 24516.48}{2(142 - 50)} = 182.15 \text{ ohms}$$

$$X_C = \frac{182.15\,(142 - 50) - (50 \cdot 90)}{142}$$

$$= 86.32 \text{ ohms}$$

These values check with the graphical solutions shown in **figs. 2** and **3** (see reference 3 for application with a 7-MHz vertical antenna).

As another example, assume that you want to match a 50-ohm transmission line to an antenna with an input impedance of 40 - j20 ohms. Therefore, R = 40 ohms, X = -20 ohms and R_i = 50 ohms; R/R_i = 0.8 and X/R_i = -0.4. The normalized input impedance is 0.8 - j0.4 ohms. This value can be matched by network C but

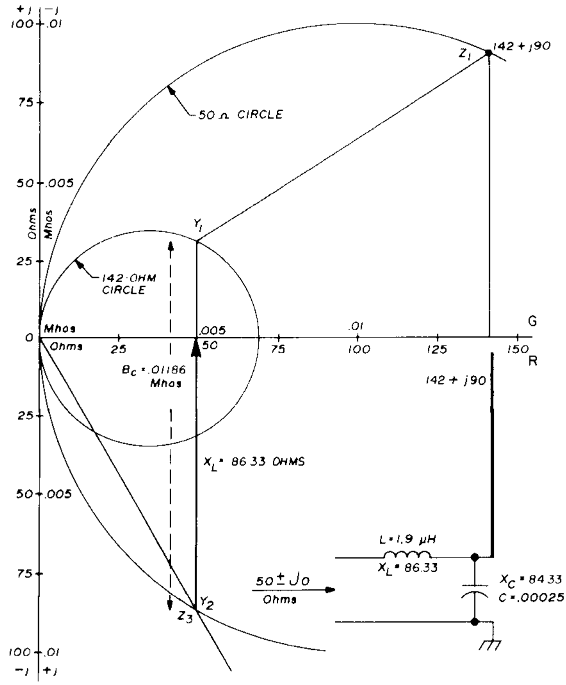


fig. 2. Graphical solution using the L-network of fig. 1A to match a load impedance of 142 + j90 ohms.

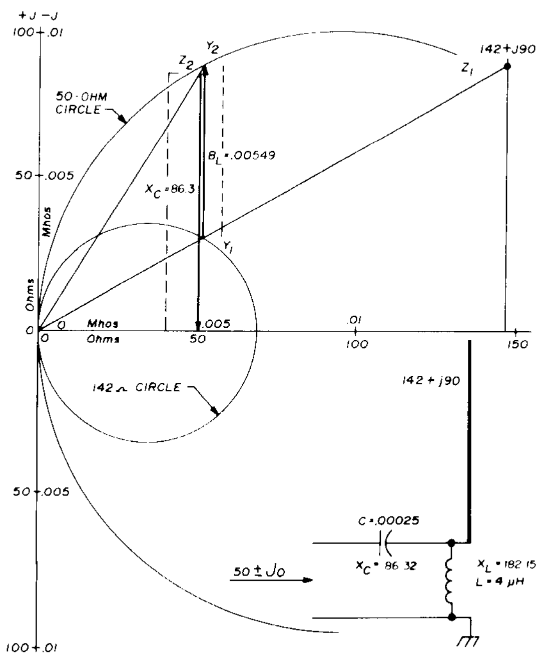


fig. 3. Graphical solution of the L-network of fig. 1B to match a load impedance of 142 + j90 ohms.

falls into the forbidden region in networks A and B.

To determine the proper values for network C first calculate X_L, using **eq. 5.** Then find X_C using **eq. 6.**

$$X_L = [(50 \cdot 40) - 1600]^{1/2} + 20 = 40 \text{ ohms}$$

$$X_C = \frac{(40 - 20)^2 + 1600}{40 - 20} = 100 \text{ ohms}$$

To check the correctness of these values it is necessary to calculate the impedance seen at the input terminals. From inspection, it can be seen that Z_C is in parallel with the series combination of Z_L and the complex load impedance Z. Using the formula for parallel impedances:

$$R_i = \frac{(Z_C)(Z + Z_L)}{Z_C + (Z + Z_L)}$$

$$= \frac{(-j100)(40 - j20 + j40)}{(-j100)(40 - j20 + j40)}$$

$$= \frac{(-j100)(40 + j20)}{(-j100) + (40 + j20)}$$

$$= \frac{-j4000 + 2000}{40 - j80}$$

Multiplying by the conjugate:

$$\left(\frac{-j4000 + 2000}{40 - j80}\right)\left(\frac{40 + j80}{40 + j80}\right)$$

$$= \frac{400 \times 10^3}{8 \times 10^3} = 50 + j0$$

This network provides a perfect match to 50-ohm transmission line.

references

1. Robert Leo, W7LR, "An Impedance-Matching Method," *QST,* December, 1968, page 24.
2. I. L. McNally, W1NCK, Henry S. Keen, W3CTK, "Graphical Design of Matching Networks," *ham radio,* December, 1969, page 26.
3. Robert Baird, W7CSD, "Designing Impedance-Matching Systems," *ham radio,* July, 1973, page 58.
4. Phillip H. Smith, "L-Type Impedance Transforming Circuits," *Electronics,* March, 1942, page 48.

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RTTY message generator

Complete construction details for an RTTY message generator that uses TTL digital logic

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For a number of years, the users of teletypewriter services have relied on an automatic response from an interrogated RTTY terminal unit to confirm completion of a desired traffic circuit. The interrogated terminal, upon command, generates a station identification code or message such as, DE KX6IT. This message is usually generated by an electromechanical device consisting of a number of coded bars on a rotating drum, momentarily closing electrical contacts.

With the advent of low-cost, multifunction integrated circuits, it is feasible to generate the message using digital logic. This increases reliability and makes maintenance easier as well as lowering the cost. Moreover, some electro-mechanical message generators are mechanically peculiar to a specific type or family of teleprinters. The digital logic method is directly applicable to any machine or circuit of any family of teleprinters using compatible signaling codes.

RTTY signaling code

The presently used Baudot (Murray) RTTY code is a binary code, a two-state condition, such as the presence or absence of current. As applied to most teletypewriter circuits, it is a condition of current flowing in a loop (*mark*) or no current flowing in the loop (*space*). Each printed character or machine function is determined by the sequence of mark and space pulses received by the machine.

The format of the signaling code depends on the maximum number of different characters to be printed or functions to be performed by the machine. The two most common arrangements used are the 5-level and 8-level formats. The term *level* refers to the number of unit intervals or pulses in the intelligence-determining portion of the code. Each unit interval is either a *mark* or *space* as determined by the code for the desired character. The 5-level code has 2^5 (32) character permutations available and the 8-level code has 2^8 (256) available permutations.

To keep the transmitting and receiving machines in synchronization a start pulse is placed in front of the group of intelligence pulses. A stop pulse is placed at the end of the group of intelligence pulses to complete the synchronization function. The start pulse is always a *space* condition and has the same pulse width or unit interval as an intelligence pulse. The stop pulse is always a *mark* condition and its minimum duration may be up to two unit intervals.

The 5-level code may be divided into three subcode types, depending on the width of the stop pulse. For example, a 60 word-per-minute 5-level code character includes the start pulse and five intelligence pulses, each of which has a pulse width of 22 milliseconds. Each 22-ms pulse or bit may be referred to as a *unit.* If the stop pulse in this group is also 22-ms wide then the group is called a 7-unit code. If the stop pulse is 31-ms wide then it is a 7.42-unit code. The 7.42-unit code is the most common 5-level code.

Another code in use is the 7.5-unit code where the stop pulse is 33-ms wide. The intended effect of the longer stop pulse is to decrease the amount of message garble under marginal operating conditions. However, the longer stop pulse has the undesirable effect of slightly decreasing the circuit speed capability.

functional description

The design objective was a simple, semi-programmable, all-electronic message generator using low-cost TTL IC logic packages and meeting the following requirements:

1. The required serial message format is: letters (LTRS), space, DE, space, K, X, figures (FIGS), 6, letters (LTRS), I, T, space, carriage return (CR), and line feed (LF).

2. The message generation cycle is initiated by an external momentary contact closure and/or a TTL compatible negative-going pulse.

3. The device must be self-stopping at the end of the message generation cycle.

4. The device keyer output must be compatible with any normal RTTY loop without regard to loop polarity or voltage level.

5. The device's message must be field programmable, either by means of plug-in boards or minor hardware changes, or both.

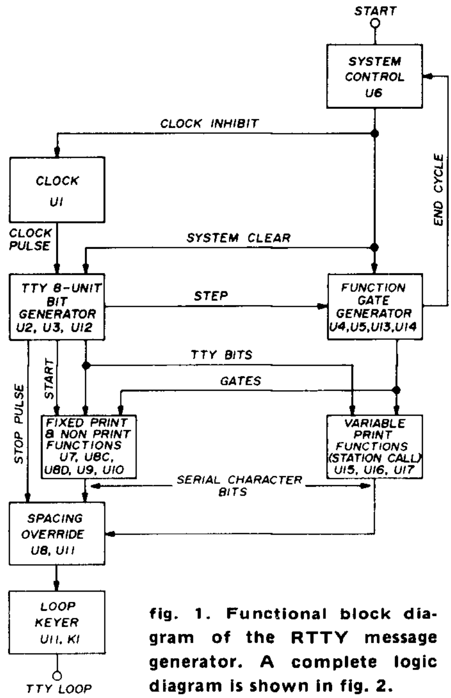
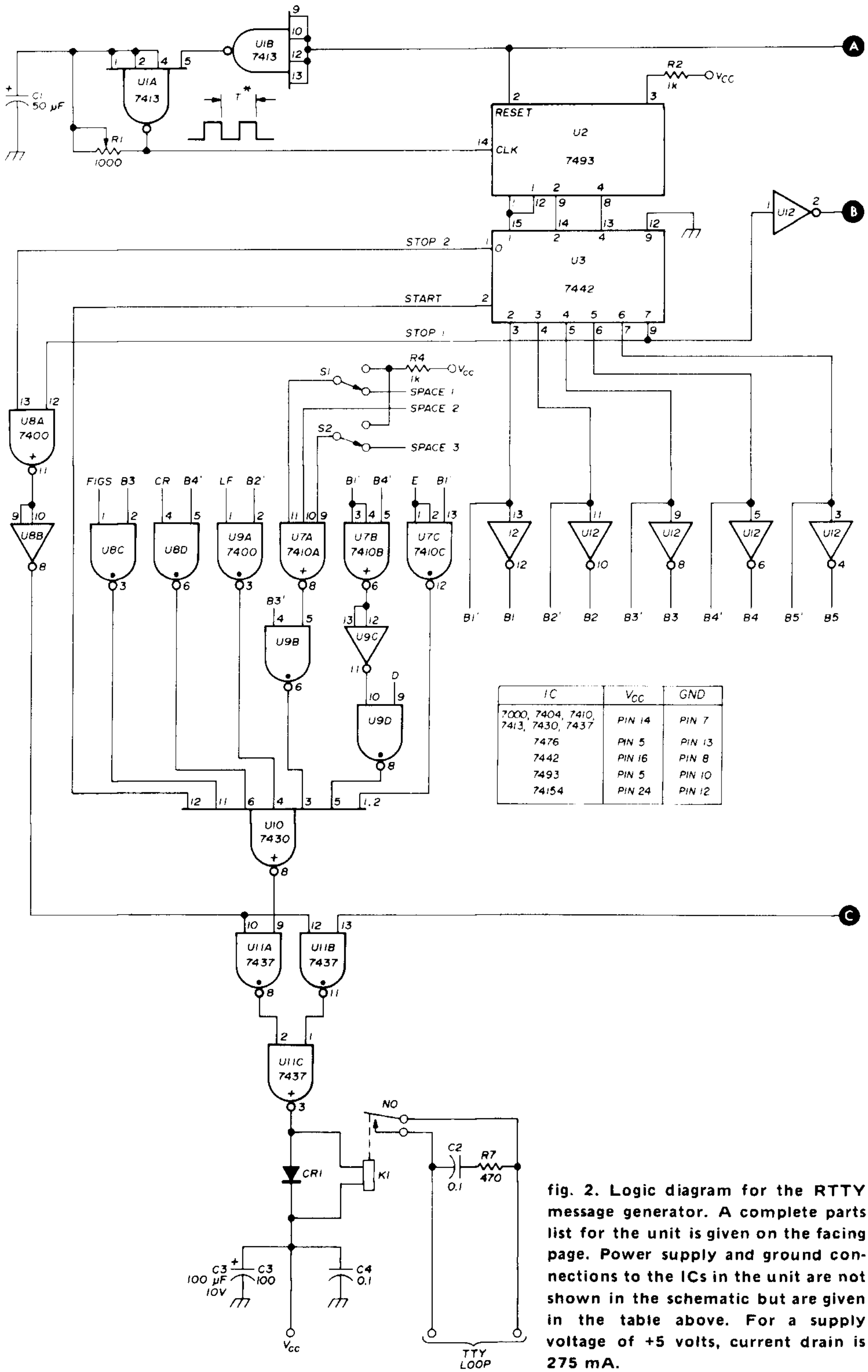


fig. 1. Functional block diagram of the RTTY message generator. A complete logic diagram is shown in fig. 2.

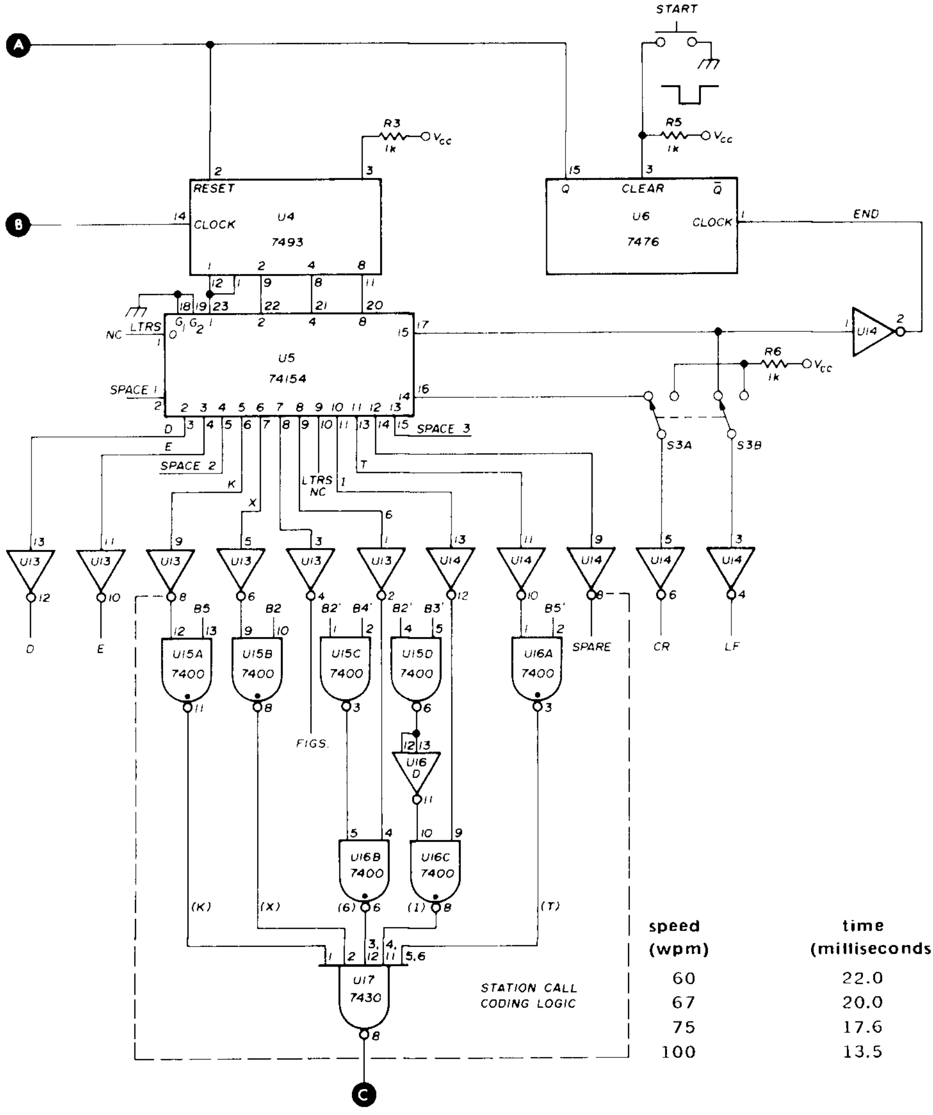
Fig. 1 illustrates the operation of the device at a basic functional block diagram level. A detailed logic diagram is shown in **fig. 2.**

System control. When the circuit is in an idle state, U6 generates a signal that inhibits 2 clock pulse generation (U1) and sets the 8-unit big generator and function gate generators to a cleared condition. On receipt of an external start signal, system control removes the clock inhibit and system clear signal. The device now begins the message generation cycle. At the end of the message, the function gate generator provides an end-of-cycle signal which returns system control to idle



IC	V_{CC}	GND
7000, 7404, 7410, 7413, 7430, 7437	PIN 14	PIN 7
7476	PIN 5	PIN 13
7442	PIN 16	PIN 8
7493	PIN 5	PIN 10
74154	PIN 24	PIN 12

fig. 2. Logic diagram for the RTTY message generator. A complete parts list for the unit is given on the facing page. Power supply and ground connections to the ICs in the unit are not shown in the schematic but are given in the table above. For a supply voltage of +5 volts, current drain is 275 mA.



speed (wpm)	time (milliseconds)
60	22.0
67	20.0
75	17.6
100	13.5

K1	spst printed-circuit relay (Clare LA-005, 5-volts, 380 ohms, DIP package)
K2	spst normally closed reed relay (Grisby-Barton GB821B-2)
S1,S2	spdt toggle switch
S3	dpdt toggle switch
U1	dual NAND Schmitt trigger (SN7413)
U2,U4	4-bit binary counter (SN7493)
U3	BCD-to-decimal decoder (SN7442)
U5	4-line to 16-line decoder/demultiplexer (SN74154)
U6	dual J-K master-slave flip-flop (SN7476)
U7	triple 3-input positive NAND gate (SN7410)
U8,U9 U15,U16	quadruple 2-input positive NAND gate (SN7400)
U10,U17	8-input positive NAND gate (SN7430)
U11	quadruple 2-input positive NAND buffer (SN7437)
U12,U13 U14	hex inverter (SN7404)

status, thereby terminating the message cycle.

Clock. IC U1 is connected as a gate-controlled pulse generator. The time between the negative-going edges of two adjacent pulses is set to equal the desired unit or bit width, i.e., 22 ms for a 5-level, 60-wpm machine.

RTTY 8-unit bit generator. The clock pulse from U1 is fed to the 4-bit binary counter, U2. The output of the binary counter is decoded by 1-of-10 decoder U3. This decoder sequentially produces eight unit bits each character generation cycle. In order of generation they are start, five intelligence bits and stop, which is 2 units in length. At the end of the 7th unit bit (halfway through the stop pulse) a step pulse is applied to the function gate generator. Complements of the bits are available through hex inverter U12. An 8-unit code is used instead of the standard 7 or 7.42-unit codes in the interest of circuit simplicity and minimum package count.

Function gate generator. The function gate generator is functionally similar to the 8-unit bit generator described above. The decoder section is a 1-of-16 decoder. The active function gate is advanced to the next decoded line each character generation cycle of the 8-unit bit generator. The last (16th) function gate pulse is inverted and applied to system control, U6, to terminate the message generation cycle. ICs U13 and U14 invert all function gates to match the character coding logic.

Fixed character. The 2-input and 3-input gate ICs in this block combine the active function gate and selected intelligence bits from the 8-unit bit generator to form the desired fixed print and non-print RTTY functions.

Variable character. This block is functionally similar to the fixed character block, combining function gates and selected bits to form the desired printing functions. It is labeled variable as this is the area of the circuit that can be programmed for different station call signs by use of plug-in circuit boards.

Spacing override. To realize gate and interconnection economy in the fixed and variable character circuits during the generation of certain characters, it was convenient to allow a spacing condition to exist at the outputs of these blocks during the stop-pulse generation period. The logic gates in the spacing override block ensure that the stop pulse is always fed to loop keyer, even if a spacing condition from the fixed or variable character blocks happens to be present simultaneously with the stop pulse.

Loop keyer. ICs U11C and U11D drive the loop keying relay, K1. Only one gate is used when driving a normally-open contact relay. The second gate is used as an inverter if a normally-closed contact relay is used. A high-voltage transistor could replace the relay if loop polarity is observed.

character coding logic

The idle condition of a teleprinter is the marking (loop current flowing) state. Moreover, examination of a coding chart reveals a slight preponderance of *mark* over *space* in the code as a whole if you disregard the seldom used *blank* character. Thus, it is logical to set up a condition at the loop keyer where it is only necessary to create a spacing condition at the proper intervals to generate the desired message.

The first space pulse in any character or machine function is the start pulse. In the letters (LTRS) function, where all five information pulses are marking, the start pulse is the only spacing pulse in the entire code group. Therefore, to generate a LTRS function, it is only necessary to apply the start pulse to the loop keyer – and the machine performs the LTRS function.

Refer to the logic diagram in **fig. 2** to follow the formation of the LTRS function. Initially, the circuit is in the standby state. Clock U1 is inhibited. Binary counters U2 and U4 are set to zero count.

One-of-ten decoder U3 is low on output zero and is high on the remaining 7 outputs (outputs 8 and 9 are not used for 5-level codes).

Output zero of U3 (pin 1) is labeled stop 2. This is the last half of the 2-unit stop pulse and is applied to U8A as a low level. The remaining input to U8A is a high level from output 7 (stop 1). The output of U8A is a high, inverted by U8B, and applied to both U11A and U11B as a low. Therefore, with one input of both U11A and U11B at a low level, the output of these AND gates will always be high, regardless of whether highs or lows appear at the remaining gate inputs.

For example, in the case of generating characters with only one or two information bits marking, it is convenient to set up the character coding logic so that a spacing condition (a high level at the output of U17) is applied to the remaining input of U11B during the last half of the stop pulse. Thus, a low on one input of U11B overrides the spacing condition, keeping the output of U11B high. This, in turn, keeps the loop in the marking state during the entire stop-pulse period.

To initiate generation of the message and the first character (LTRS), momentarily depress the start switch, S4. This sets the Q output of flip-flop U6 to low, removing the inhibit from the clock, U1, and removing reset from U2 and U4. The first negative-going edge of the clock pulse toggles binary counter U2, causing output zero (stop 2) of U3 to go high and output 1 (start) of U3 to go low.

At this time both inputs of U8A are high, its output is low, and the output of U8B is now high and applied to one input of both U11A and U11B. Simultaneously, output 1 (start) of U3 is low and is applied to one input of U10, causing the output of U10 to go high. This high is applied to the remaining input of U11A. Both inputs of U11A are now high, causing the output to go low, creating a spacing condition at the loop keyer.

Thus, it may be seen that the loop is in a spacing condition immediately following arrival of the first negative-going edge of the clock waveform. It remains in this condition until the next negative-going edge of the clock again toggles binary counter U2; then output 1 (start) of U3 goes high and output 2 (intelligence bit 1) goes low. As soon as output 1 goes high, the output of U10 goes low, and the resulting high output of U11A causes the loop keyer to return to the marking condition. This sequence completes the generation of the start pulse, which is always a spacing condition.

Successive clock pulses applied to binary counter U2 move the low output of U3 through outputs 2 through 6 (intelligence bits 1 through 5). Since the function gate generator, U4 and U5, is still set

Classification of characters according to number of marking pulses.

1	2	3	4	5
E (M1)	A (M1,2)	B (S2,3)	K (S5)	LTRS
T (M5)	D (M1,4)	C (S1,5)	Q (S4)	
SPACE (M3)	H (M3,5)	F (S2,5)	V (S1)	
CR (M4)	I (M2,3)	G (S1,3)	X (S2)	
LF (M2)	L (M2,5)	J (S3,5)	FIGS (S3)	
	N (M3,4)	M (S1,2)		
	O (M4,5)	P (S1,4)		
	R (M2,4)	U (S4,5)		
	S (M1,3)	W (S3,4)		
	Z (M1,5)	Y (S2,4)		

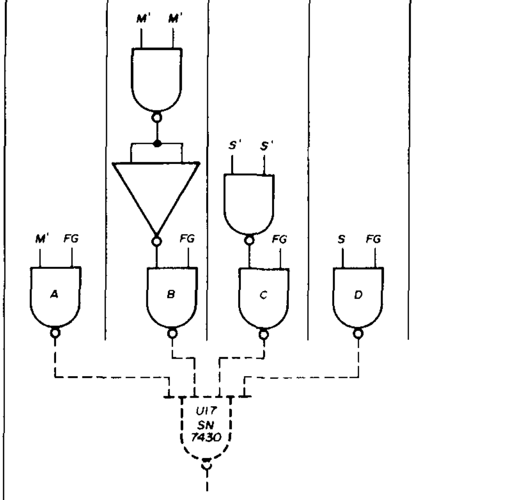


fig. 3. Callsign programming chart.

to zero, and because output zero of U5 (labeled LTRS) is not connected, no space pulses are generated during the periods of the five intelligence bits and the loop keyer remains in the marking state. Clock pulses continue to move the counter and decoder through 7 (stop 1)

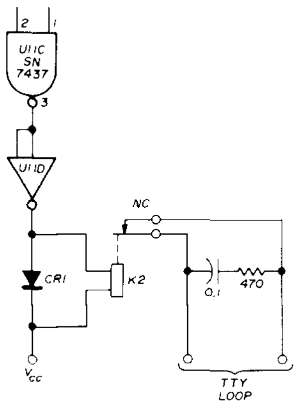


fig. 4. Alternate loop keyer circuit using a normally-closed relay. Relay K2 is a Grigsby-Barton 5-volt, 80-ohm spst relay in a DIP package. Diode CR1 is a silicon diode.

and returns it to output zero (stop 2). These two units of stop pulse complete the formation of the LTRS function.

space function

The machine space function character code has only bit 3 of the five intelligence bits in the *mark* state. Examination of 1-of-16 decoder U5 in **fig. 2** shows that output zero (pin 1, labeled LTRS) is low during the idle condition and during the first character generation cycle of U3. At the time output 7 (stop 1) goes high, a pulse is applied to the clock input to U4. This changes the count from zero to 1 and moves the active low from output zero to output 1 in U5.

Output 1 from U5 (labeled *space 1*) is connected to one input of U7A through switch S1. This input goes low (all three inputs were high), the output goes high and is applied to U9B. At this time the B3 input to U9B is still high so the output goes low, causing the U10 output applied to U11A to go high. However, since the stop 2 bit applied to U8A is now low, the remaining input to IC-U11A, is also low, and, the loop keyer, U11C, continues to hold relay K1 in the marking state.

The next clock pulse applied to U2 moves the active low output of U3 to *start.* This low is applied to pin 12 of U10, but because of the low already on pin 3 of U10, the output and input to pin 9 of U11A remain high. At the same moment the active low in U3 moves from *stop 2* to *start,* the output of U8B goes high and the U11A output goes low, creating a spacing condition at K1 for the duration of the *start* pulse. Successive clock pulses continue to move the active low through the outputs of U3.

Because input to pin 3 of U10 remains in the high state, the loop keyer remains spacing throughout the periods of information bits 1 and 2. At the instant bit 3 goes low, the signal at pin 4 of U9B goes from high to low and U10 has all inputs high. This causes the loop keyer relay K1 to go to the marking condition for the duration of intelligence bit 3. Relay K1 returns to a spacing condition during the periods of bits 4 and 5 and then goes to marking during *stop 1* and *stop 2* periods. The *space* machine function character is now complete.

message characters

Completion of the *space* machine function character described above has advanced the count in U4 to three. Decoder U5 is now low on pin 3, labeled D. This low is inverted by one section of U13 and applied as a high level to pin 9 of U9D. The character D has intelligence bits 1 and 4 marking. These two bits are applied to the inputs of U7B. Both inputs are high at all times except during the periods of bits 1 and 4. Thus, a spacing condition exists at the output of U9D during the formation of the letter D except during the periods of bits 1 and 4, which are marking.

It is now apparent that as each character is completed, the gate function generator, U4 and U5, is advanced one count, and the associated active output is applied to a logic gate or group of logic gates, enabling the appropriate selection of marking or spacing intelligence bits from the bit generator, U2 and U3, to form the desired characters.

Character generation continues until the beginning of the 17th pulse input to U4 which sets output 15 (pin 17) of U5 from low to high, and applies a negative-going level to the clock input (pin 1) of flip-flop U6. This causes the U6 Q output to go low, resetting both binary counters to zero and inhibiting the clock, U1, returning the message generator to idle. Should the clear input (pin 3 of U6) be held low continuously, it will override the end-of-cycle signal on pin 1 and the message generator will repeat itself until the low on pin 3 is removed.

programming

Switch S1 is provided to inhibit the *space 1* machine function if a space is not desired before the first printed character in the message. When *space 1* is inhibited, the message generator forms the non-printing machine function LTRS. Switch S2 inhibits a space after the last printed character in the message. Switch S3 inhibits the carriage return (CR) and line feed (LF) machine functions when a continuous line of print across the page is desired.

As many as four different character gating configurations are required for programming the generator. The gating configuration selected for a specific character is dependent upon the number of marking pulses in the character. **Fig. 3** tabulates characters according to their marking pulse content and illustrates the appropriate gating configuration. The notation FG at a gate input in **fig. 3** indicates connection to the inverted function gate originating at U5. The notation M′ indicates connection to the appropriate marking bit from the bit generator. Note that marking bits are selected only when the character contains one or two marking pulses.

The notation S′ indicates connection to the appropriate spacing bit from U3. Spacing bits are selected when the desired character contains three or four marking pulses. The numerals to the right of each character in columns one and two refer to the location of marking pulses in the 5-bit pattern. The numerals in columns three and four refer to the location of spacing pulses in the bit pattern.

In gate D (**fig. 3**) note the absence of a prime mark after the S input reference. This means that the spacing bit for characters in column four must be inverted instead of coming directly from the outputs of U3. Refer to connections in U8C and U12, pin 8 in **fig. 2** for an example.

As previously covered in the text, no gating or connections are required for the LTRS function.

construction

The physical configuration of the prototype message generator consists of two printed-circuit boards (main and station call) with edge connectors, a regulated power supply and a fully enclosed aluminum cabinet to provide radio frequency interference shielding as well as control mounting facilities. The main printed-circuit board is a universal dual in-line package (DIP) type breadboard with 15 sets of DIP IC pads for the 14 ICs and one DIP reed relay. Each IC pin pad has up to three solder pads for interconnection. The station call board is about half the size of the main circuit board and contains the three ICs indicated within the station call coding logic box in **fig. 2.**

Total cost of the IC packages for this unit is less than ten dollars. The cost of all components including ICs, power supply and transformer, but not including the printed-circuit boards, connectors and cabinet, amounts to less than $35.00. These costs are based on single unit prices.

Although not indicated in the logic diagram or in the parts list, the prototype unit uses a 4-position, single-pole rotary switch to select one of four 1000-ohm trimpots (R1) in the clock circuit. Each trimpot is adjusted for one of the four operating speeds listed in the speed-time chart in **fig. 2.** Also not shown on the logic diagram are V_{cc}-to-ground bypass capacitors for ICs U1 through U6. These are 0.1-μF disc ceramic capacitors mounted as closely as possible to the V_{cc} and ground pins of each of the indicated ICs. These capacitors are required for suppressing noise generated by internal IC switching transients.

The spark suppression network (C2, R7) across the contacts of the keying relay is mandatory. Operation of the device without this network will result in premature failure of relay contacts, and in erratic operation of the circuit due to noise. Diode CR1 suppresses the voltage transient caused by back-emf generated in the coil of the relay at de-energization.

The normally open, spst reed relay, K1, is the type actually used in the prototype. It is less costly and easier to obtain from supply sources than the normally-closed, spdt reed relay, K2, shown in the alternate loop keyer configuration in **fig. 2.** Actually, the alternate configuration is preferred for most applications because loop continuity is maintained when power is removed from the unit.

The power supply consists of a 6.3 volt, one ampere power transformer and a rectifier-regulator circuit with 1% line-load regulation of the 5-volt dc V_{cc} output. The V_{cc} supply should be maintained within the limits of 5 volts, ± 5%.

troubleshooting

Troubleshooting improper operation is simplified if a typing reperforator is available as this permits recording of all normally non-printing machine functions on paper tape. Should a character not be the same as programmed, correlation of the tape readout with the appropriate area of the logic diagram should assist in isolating the problem. Experience has shown that almost all initial checkout problems in a handwired prototype result from improper or missing connections.

Rf interference can cause problems, although the prototype has functioned without error in the immediate vicinity of gain radiators with power inputs of 100 watts rms at 14 MHz. Most rfi problems can be cured with proper application of shielding and installation of bypass capacitors on all the input and output lines.

summary

A simple, reliable, low-cost method of generating short RTTY messages has been described. An operational prototype message generator using state-of-the-art integrated circuits has been constructed and tested under field operation conditions. This unit was built with components costing less than thirty-five dollars at unit quantity prices.

bibliography

1. *Principles of Telegraphy (Teletypewriter)*, NAVSHIPS 0967-255-0010, Department of the Navy, Electronic Systems Command, June, 1967.
2. *Designing with TTL Integrated Circuits*, Texas Instruments Electronics Series, McGraw Hill Book Co., New York, 1971.
3. *The Integrated Circuits Catalog for Design Engineers*, Texas Instruments Incorporated, 1972.

ham radio

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universal frequency standard

A precision frequency standard featuring a high-accuracy crystal, stable transistor oscillator and TTL logic

Bert Kelley, K4EEU, 2307 South Clark Avenue, Tampa, Florida 33609

This frequency standard has been designed to supply precision frequencies for several purposes. Its main use is with my station receiver as a precise and reliable frequency calibrator. It may also be used as a digital counter time base, a scope calibrator or to drive a digital clock. With all integrated circuit packages installed on the board there are no less than eighteen frequencies available extending from 2 MHz down to 1 Hz. Ten of these, of your choice, are connected to a rotary switch for calibrator use while the lower frequencies below 1 kHz that would not normally be used with the station receiver, are picked off terminals on the circuit board by a small clip lead when needed.

The design is flexible. If you do not need the versatility of the complete unit, the photo shows a frequency standard that will provide markers at 1 and 2 MHz, and at 500, 250, 100, 50, 25 and 12.5 kHz with the installation of only three digital IC packages. Provision is made on the circuit board for as many or as few output frequencies as are likely to be needed.

circuit features

Features include excellent frequency stability, front panel calibration and a precise, self-contained, regulated power supply. An adjustable level control is included so the calibrator output can be matched to incoming signals such as WWV for really accurate zeroing or advanced full on for strong, clear markers.

With proper temperature compensation, the frequency standard will stay within 1 Hz of WWV at 10 MHz over an extended period of time with no adjustment.

This precision is not needed if the unit is used only to find band edges or set the receiver graticule. However, for frequency measurement or use as a time base for a move, capacitors change value. Solid-state circuitry has substantial advantages over vacuum-tube circuits; much heat is eliminated, components run cooler and the crystal is driven at the low levels recommended by the manufacturer. However, a substantial amount of drift can come from the semiconductor alone.

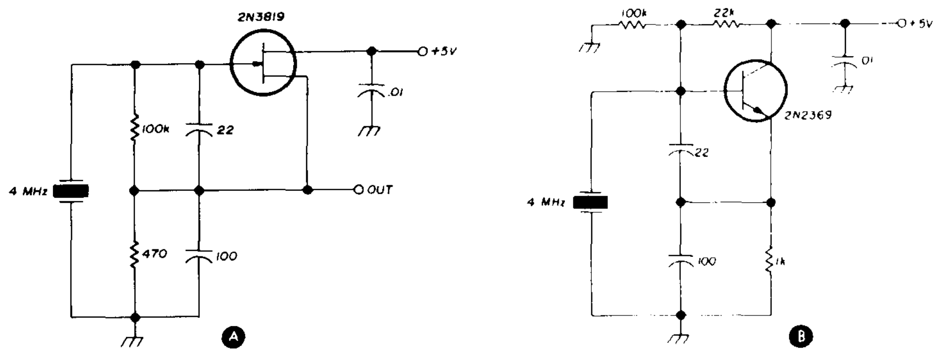


fig. 1. Solid-state crystal oscillator circuits. Fet circuit in (A) is considerably more stable than the bipolar circuit shown in (B). For a more stable bipolar oscillator circuit, see fig. 2.

counter or digital clock, you need all the accuracy you can get. The best reason for going first class is that it costs little more, and probably less, in this do-it-yourself project. The required stability can be obtained with inexpensive construction.

The oscillator circuit in this calibrator was first used as a stable time base for a digital clock and later in a receiver.[1] Several circuits evaluated in drift tests showed the Clapp-Colpitts to be most stable — not a new circuit, but seldom used in recent designs. While both the circuit used and the TTL logic is familiar, it is the combination of circuit, crystal and construction that makes this calibrator better. Stability comes when a few hertz drift is removed or greatly reduced from each of several sources. A 10-Hz drift caused by a trimmer might be tolerated, but when the drift from other sources is combined, the total becomes excessive.

Most oscillator circuits would cause even a perfect crystal to drift. Voltage and temperature changes cause changes in the semiconductor's internal impedance. Trimmers don't stay where set, wires

How much? Two circuits are shown. **Fig. 1A** shows a fet oscillator circuit using crystals in the 1- to 9-MHz range. The crystal ground for 32-pF load is sometimes brought on frequency with a small trimmer. If this circuit is built so the semiconductor is isolated, it can be heat cycled without affecting other components and the drift can be measured on a

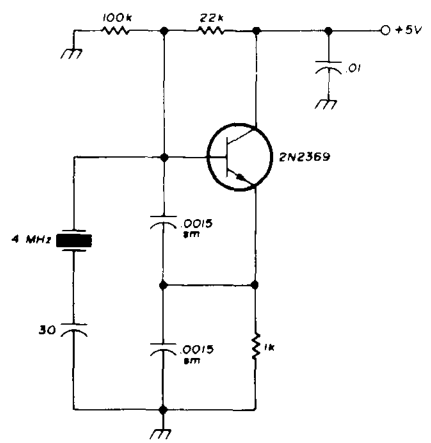
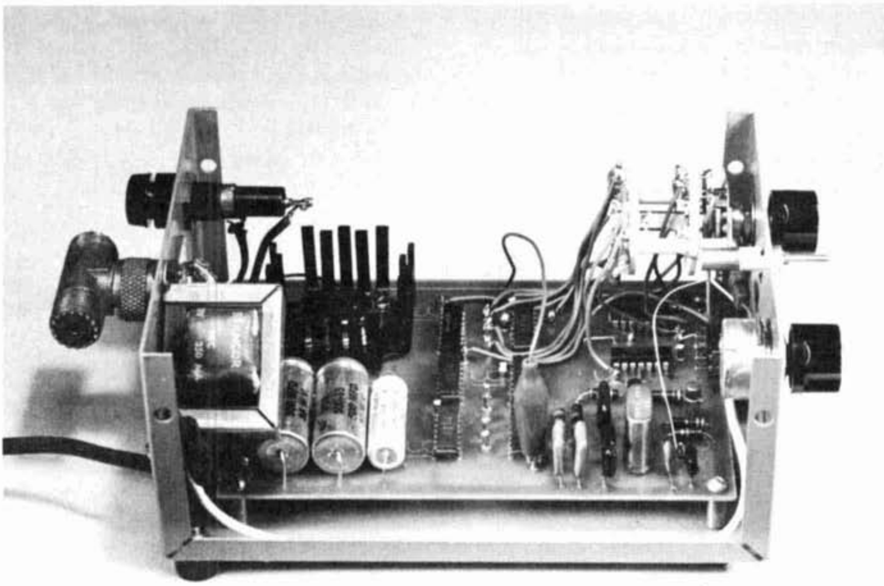


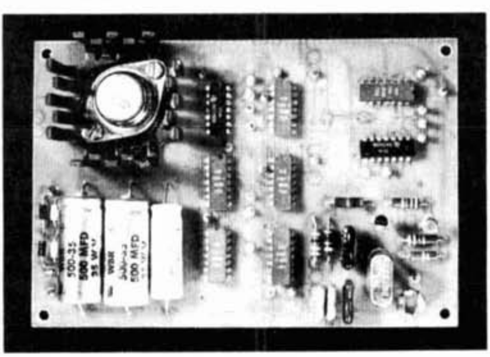
fig. 2. This transistor crystal oscillator circuit is stable because impedance changes are swamped out by the 1500-pF silver-mica capacitors.



Frequency standard and power supply are installed in a 3x5x7-inch (7.6x12.7x17.8-cm) Minibox.

digital counter. The best of several fets caused a change of 12 Hz at 4 MHz with a 5-degree ambient temperature variation.

Fig. 1B shows a transistor in a similar oscillator circuit, not recommended, but sometimes used. Although not as sensitive as the fet to temperature, a change of only one volt caused a 70-Hz frequency shift. If this circuit is modified as shown in **fig. 2,** there is a substantial improvement. Changes of ten degrees and one volt did not cause a frequency change readable on the counter. The transistor case could be heated with a soldering iron to the point where it burned the fingers with a 2 Hz change registered at 4 MHz.



Printed-circuit board with all logic packages installed, as would be required for driving a digital clock or a frequency counter. One jumper is used.

These experiments show both the extent of drift that can be contributed by the semiconductor and indicates the solution. The more stable the capacitance used across the transistor, the better the stability. The 1500-pF capacitors have a very low reactance at 4 MHz, swamping out any other impedance changes in the circuit. This circuit will not oscillate with some transistors because there must be enough gain to sustain oscillation. This requirement is met by the Motorola HEP715, a pnp device with a typical beta of 120. Other transistors with similar current gain can be substituted.

the crystal

Some time ago while working with digital counter time bases[2] I noticed that the ordinary 100-kHz crystal was not as stable as it might be. A time base derived from the power line was nearly as accurate. Although used in amateur calibrators for many years, the 100-kHz rock is

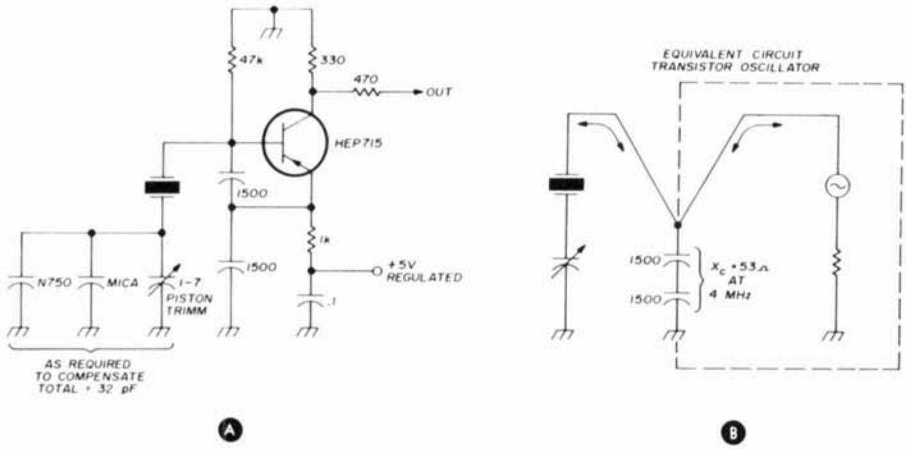


fig. 3. Stable transistor crystal oscillator circuit. Equivalent circuit in (B) shows how 1500-pF capacitors swamp out any internal impedance changes which would cause the output frequency to drift.

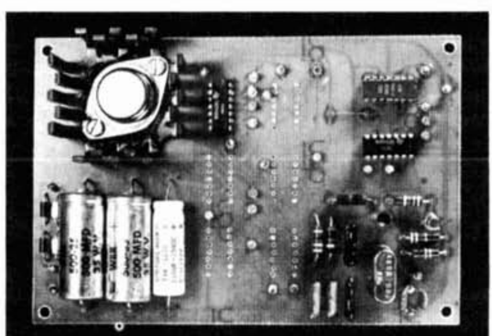
not a good choice as it must be stabilized by use of an oven; this adds bulk, expense and a heater supply.

A better crystal for a frequency standard is the high-accuracy 4-MHz crystal recommended by W6FFC.[3] High accuracy as used here means the crystal drifts less, and at a predictable rate. Although cheaper crystals in the 1- to 5-MHz range are better than those at 100 kHz, they are subject to random drift which is difficult to compensate. Therefore, it is important to obtain the better quality crystal. They are manufactured by both Sentry and International and cost less than $10.*

Note the drift characteristic curves for a typical AT-cut crystal in **fig. 4.** As the temperature increases, the crystal frequency decreases. Drift can be almost entirely eliminated at room-temperature operation which most amateurs are interested in by selecting the proper value of negative coefficient compensation capacitor. Curve A requires the most compensation while curve B requires little if any. A crystal cut for a 32-pF load allows about 30 pF for compensation with the piston trimmer adding the 2 or 3 pF needed to pull the crystal to the exact frequency.

*Write for their catalogs. Sentry Manufacturing Company, Crystal Park, Chickasha, Oklahoma 73018; International Crystal Manufacturing Company, 10 North Lee, Oklahoma City, Oklahoma 73102.

A new crystal might require anything from a maximum of 30-pF (N1500) to a 30-pF silver mica (NPO), depending on its temperature vs frequency characteristic. Since there is no way to know what will be needed, it is advisable to have a supply of different values of N750 and N1500 coefficient capacitors on hand, with small silver micas to pad the total to 30 pF, before starting any temperature compensation work. A piston trimmer is recommended because of the smoother adjustment and lack of drift. It is also easier to determine if capacitance is being added or removed, useful information when temperature compensating the calibrator.



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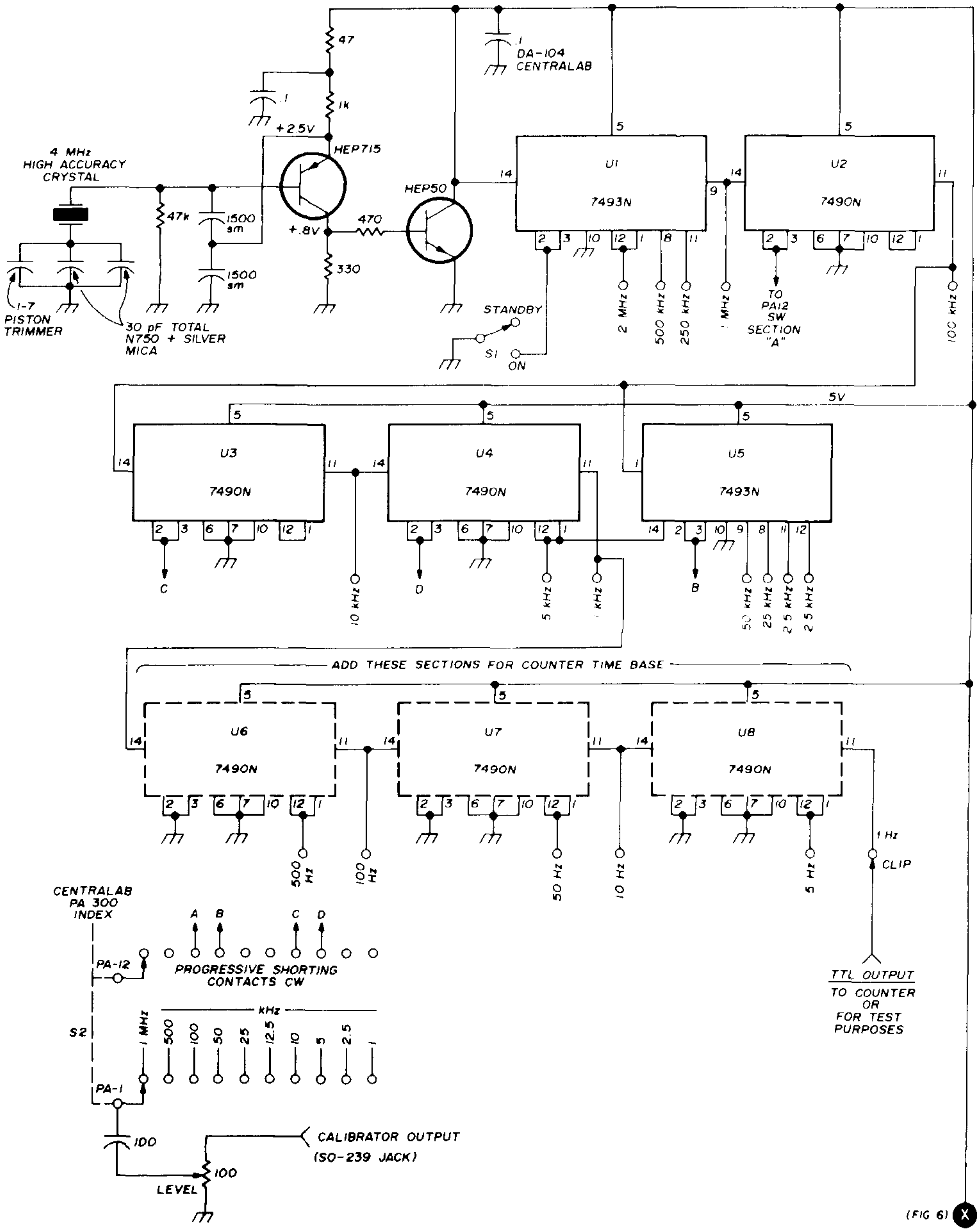


fig. 5. Complete schematic diagram for the universal secondary frequency standard. Unit uses high performance TTL logic ICs. A printed-circuit layout is shown in fig. 6.

the circuit

In **fig. 5** the pnp oscillator transistor, Q1, is coupled to the TTL logic by transistor Q2. The 7493 binary dividers U1 and U5 are used to divide by factors of 2, with 7490 decade packages making up the remainder of the logic. IC U5 has two inputs for 5 kHz and 100 kHz. Reset pins 2 and 3 control operation of the logic, either by switch S1, the standby switch, or by progressively shorting contacts on the rotary switch.

This way, the oscillator runs continuously for best stability, and unused packages are disabled. It prevents some markers from leaking across the selector switch and being heard in the receiver. If this feature is not wanted, pins 2 and 3 should be jumpered to ground.

Board outputs and compensating ca-

easily supplied by a LM309K voltage regulator IC mounted on a heatsink (**fig. 6**). All power supply components except the power transformer are mounted on the circuit board. High temperature shut-down and overcurrent protection are provided by the regulator.

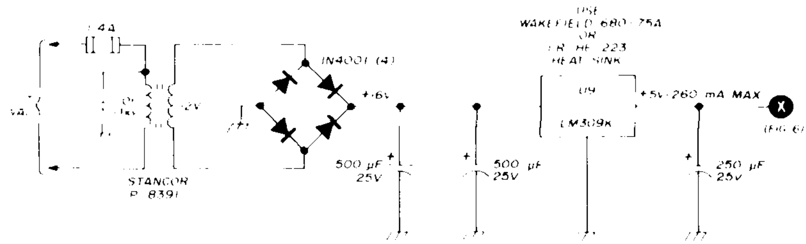


fig. 6. Power supply for the universal frequency standard.

pacitor terminals appear at convenient terminals at the top of the board made by forcing short lengths of bare number-12 wire into 5/64-inch holes. This facilitates exchange of compensating capacitors, or selection of a different logic output at some future time. After completion, it is difficult to work on the underside of the board without removing several wires.

The fast switching TTL logic has active transistor pull-up circuitry which is well suited to driving external loads. The 2900th harmonic of the 10-kHz marker is over S9 in the ten-meter band. In the unlikely event that a logic package fails, repair would be facilitated if Molex sockets are used.

The full current drain with all IC packages installed is 5 volts at 260 mA,

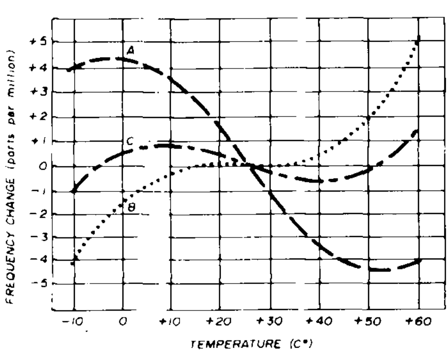


fig. 4. Frequency vs temperature chart for typical high-accuracy AT-cut crystals.

construction

This frequency calibrator is simple to build. The circuit board may be hand duplicated following the layout given in **fig. 7**, or an etched, plated epoxy board is available which speeds construction and minimizes errors.* Parts locations and identifications are screened on the board. It is only necessary to drill the IC holes with a number-60 drill, insert parts, and solder. The assembly is mounted in a compact 3x5x7-inch Minibox.

temperature compensation

Crystals should be ordered for 0.0005% tolerance, F-700 or SP7-P holder (depending on manufacturer), 32-pF load, 4 MHz at room temperature. New crystals should be operated for a time before starting any compensation work. You will need the previously mentioned supply of N750 and N1500 capacitors, and a receiver with an S-meter that will tune WWV.

Start with 15 pF in parallel with a 15-pF N750, allow an hour for the unit to stabilize, and adjust to frequency using the S-meter on the receiver as an aid to exact zeroing. Select a time when WWV is

*An epoxy, plated 4x6-inch printed-circuit board for this frequency standard is available from the author. $8.00, postpaid, in the United States.

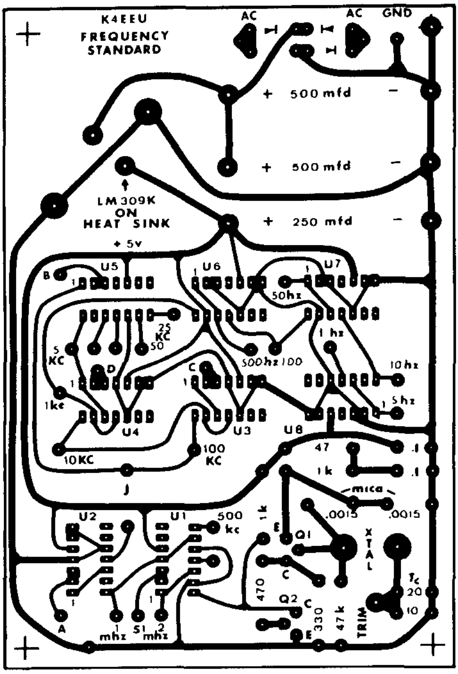


fig. 7. Printed circuit layout for the secondary frequency standard. Boards are available from the author for $8.00, postpaid.

moderately strong, with little fading, so the meter remains reasonably steady.

The standby switch, S1, is turned on and the calibrator *level* control advanced about halfway so both signals are heard. At first, the calibrator will probably be so far off frequency that an audible beat note will be noted, mixed with the WWV tone. As it is zeroed, the warble in the WWV tone will decrease in pitch until it is no longer heard and the S-meter will swing, rapidly at first, then slower, as tuning becomes more exact.

The amplitude of this swing will maximize when the calibrator level is equal to WWV's strength. It should be easy to set the calibrator exactly in zero beat with WWV at 10 or 15 MHz. When this is finished, note the temperature of the room on a thermometer, and record it for reference. Recheck the frequency with WWV periodically, and if there is any drift note the temperature and the direction the trimmer must be adjusted – to add or remove capacitance. If this trimmer capacitance must be reduced for a temperature increase, more N750 or even N1500 capacitance is needed, always padding the combination to a total of 30 pF. after a few tries the exact value of compensation will be found.

Take your time during this work and be sure a trend is established before changing capacitors, possibly making two or more observations before proceeding. The temperature compensation is easier to accomplish than it appears and makes the difference between an ordinary and a precision instrument.

some uses

The photos show a frequency standard supplying pulses for a digital clock. This clock controls nineteen slave clocks in a broadcast installation, so reliability and accuracy are important. The clock is made immune to momentary power-line failures by floating the dc supply across a nicad battery large enough to operate the logic until emergency power can be started or service is restored, whichever comes first.

Fig. 8 shows diodes used to drop the battery voltage to TTL requirements. The one-second pulses from this standard are so accurate that this clock stays on the tick with WWV for weeks with no correction.

In this circuit the 4-MHz crystal frequency is divided by a factor of 4 X 10^6 to obtain the one-second pulses. If this crystal drifted an extreme 1 Hz away from nominal, it would require four million seconds (or 46.3 days) for the clock to accumulate an error of one

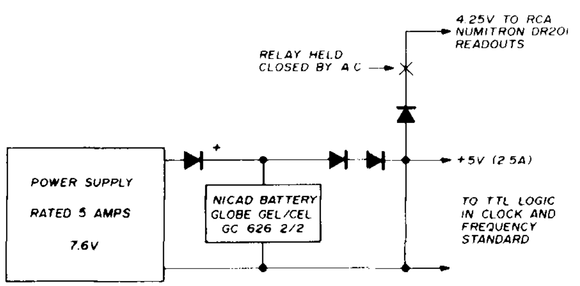
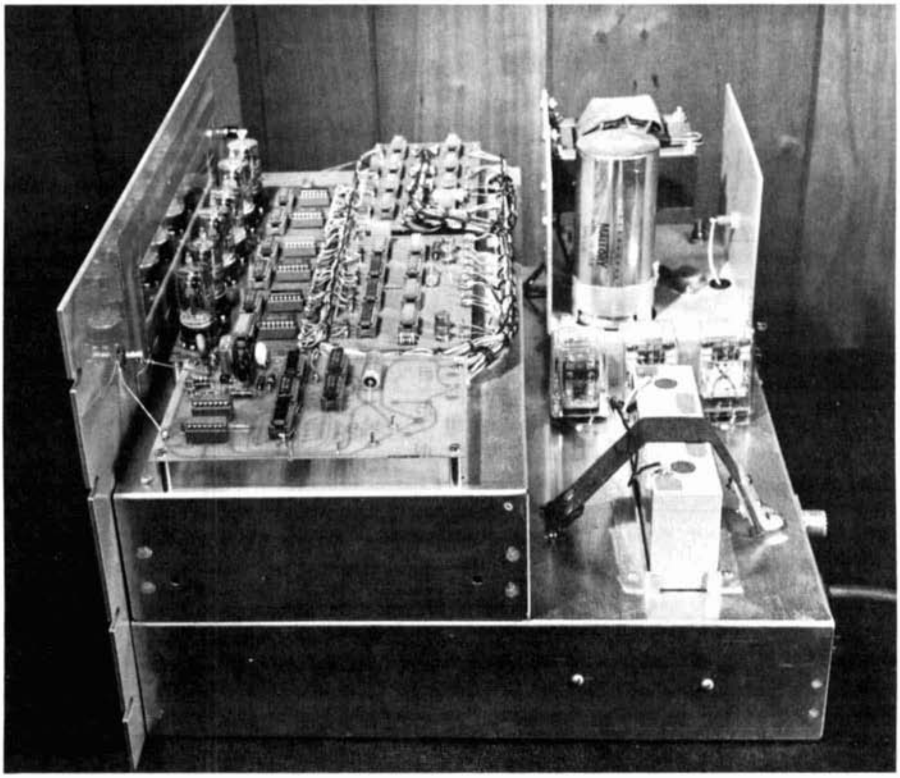


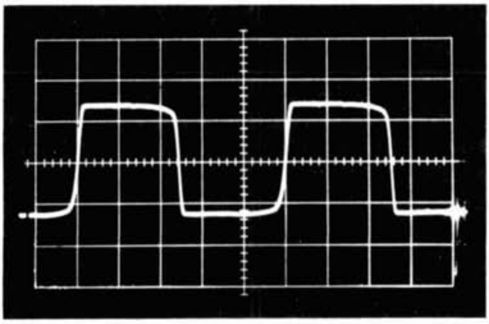
fig. 8. Failsafe power supply used with the digital clock described in the text.



Precision digital clock discussed in the text. The frequency standard board used to provide the 1-second driving pulses is located in the foreground on the upper deck. Nicad battery to the right is part of the failsafe power supply (see fig. 7).

second. But, since the crystal is compensated closer than this, and any minor drift is above and below the frequency, the average error is very small.

The secondary frequency standard would also make a good time base for a digital or Rec-Counter.[5] Readout kits with the tubes, storage latches and counter ICs are advertised in this magazine, so only the gating circuitry would have to be hand wired. Other applications for the standard include audio oscillator or signal generator calibration, or calibration of the sweep time base in oscilloscopes.



1-MHz output of the frequency standard as observed on a 10-MHz oscilloscope. Rounded waveform shows bandpass limitation of the scope. Horizontal scale is 0.2 microsecond per cm.

references

1. A.A. Kelley, K4EEU, "RTTY Monitoring Receiver," *ham radio,* December, 1972, page 27.
2. A.A. Kelley, K4EEU, "15-MHz Digital Frequency Counter," *ham radio,* December, 1968, page 8.
3. Irvin M. Hoff, W6FFC, "The Mainline FS-1 Secondary Frequency Standard," *QST,* November, 1968, page 34.
4. A.A. Kelley, K4EEU, "How to Make your Own Printed-Circuit Boards," *ham radio,* April, 1973, page 58.
5. Kenneth Macleish, W1EO, "A Frequency Counter for the Amateur Station," *QST,* October, 1970, page 15.

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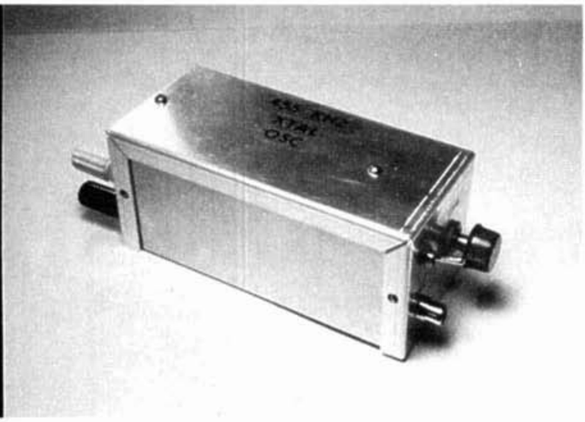
More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94



455-kHz i-f alignment signal generator

Simple, crystal-controlled signal generator for aligning i-f strips — modulation is built in

Courtney Hall, WA5SNZ, Dallas, Texas 75240

I recently completed a homebrew receiver project which included a 455-kHz i-f strip, and I needed a signal source to align it. My home workshop doesn't boast a signal generator, and even if I had one, I would have no way of precisely setting its output frequency to 455 kHz. A little thought and investigation provided a fairly cheap and easy solution.

circuit

A schematic of the resulting generator is shown in **fig. 1.** It consists of an fet crystal oscillator and an amplitude modulator. I decided on crystal frequency control because it would set the frequency accurately and because 455-kHz crystals are available from JAN Crystals for $1.75 plus 10 cents postage.* These crystals are supplied in an FT-241 holder;

*JAN Crystals, 2400 Crystal Drive, Ft. Myers, Florida 33901.

the pins are 0.093 in diameter with 0.486 spacing. JAN sells the mating SSO-1 socket for 15 cents.

Transformer T1, the drain load for the fet oscillator, is a 455-kHz i-f transformer salvaged from a junked a-m transistor radio. This provides a simple way to tune

A Colpitts audio oscillator is used to provide amplitude modulation, and a switch allows the modulation to be turned on or off. A surplus 88-mH toroid is used in the audio oscillator. These can be found listed in surplus and classified ham ads for about 50 cents each or less.

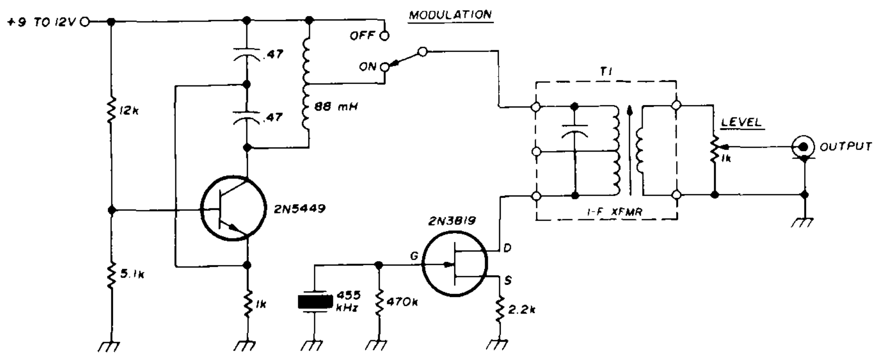


fig. 1. Schematic for the 455-kHz signal generator. Transformer T1 was salvaged from a junked transistor broadcast radio.

the drain circuit and obtain a low output impedance. Removing these transformers from the radio PC board is tricky because you have to simultaneously melt the solder at several different points. A large soldering iron is an advantage.

The junked radio had three i-f transformers, and I tried all three. I couldn't get the first one (mixer output) to oscillate at all, but it may have been damaged in removing it from the PC board. The last i-f transformer (which feeds the detector) had the highest output, but oscillations stopped if it was loaded with less than 200 ohms. I used the middle transformer because it would still oscillate when loaded with 50 ohms.

Another source of i-f transformers is Radio Shack. They sell a kit of four transformers for $1.39 (catalog number 273-1383). I believe the one in this kit which would correspond to the one I used is color-coded white.

The one I used has four leads, and two adjacent leads must be tied together to provide the center-tap. The audio frequency is about 1-kHz, but this may be altered by changing the value of the 0.47-μF tank capacitors.

I used a 2N3819 fet, but a Motorola MPF102 or Siliconix U183 should perform identically. The 2N5449 modulator should be available at local Radio Shack stores for 79 cents (catalog number 276-2014).

construction

As shown in the photographs, the generator is housed in a 2¼x2¼x5-inch Minibox. A piece of perfboard holds most

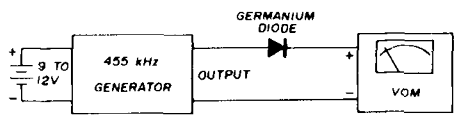
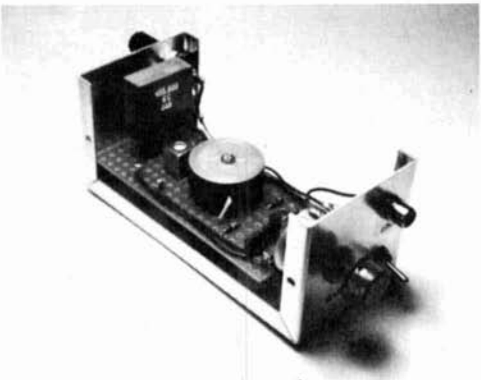


fig. 2. Arrangement used to adjust transformer T1 for maximum rf output.



Layout of the 455-kHz i-f signal generator. All components are wired on a section of perfboard which is mounted in a small Minibox.

of the circuit components. It is mounted in the Minibox by two screws with ½-inch spacers. The 88-mH toroid is held to the perfboard by a screw and two discs (one metal, one plastic) which were furnished with the toroid. I detected nothing critical in the layout.

One end of the Minibox holds the modulation switch, output phono jack and level control. Two 5-way binding posts are mounted on the other end for connecting the generator to a dc power source.

operation

The fet may not oscillate until T1 is adjusted. Connect a sensitive vom to the output through a germanium diode detector as shown in **fig. 2**. Set the level control at maximum and the vom to its most sensitive dc volts scale. Now adjust the tuning slug in T1 for a maximum reading on the vom. This will only be a fraction of a volt, but this is more than enough for i-f amplifier alignment. The level control pot will not set the output voltage low enough for sensitive i-f circuits, and I found it necessary to use the

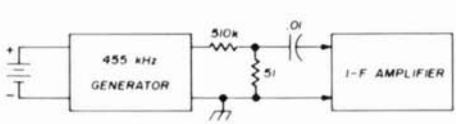


fig. 3. External attenuator which may be used to decrease generator output.

external attenuator shown in **fig. 3** to prevent overdriving the i-f strip.

Although the circuit was originally designed to operate from a 12-volt dc supply, it appears to perform well using only a 9-volt transistor radio battery for a power source. Current drain is about 7 mA with a 12-volt supply and 5 mA using the 9-volt battery.

conclusion

This little gadget is intended only for 455-kHz i-f alignment which is a rather limited use. However, it has a limited cost too – only a few dollars. A well stocked junk box can cut the dollar outlay to a very nominal amount. I haven't had an opportunity to check its frequency on a counter or observe its output waveform on an oscilloscope, but it performed its intended function to my satisfaction. If amplitude modulation is not required, the unit could be simplified to a single fet circuit. This would reduce battery drain substantially. A worthwhile addition would be a built-in step attenuator which would permit setting the output voltage to micro-volt levels.

ham radio

"The wife just gave me a hint of something I need to do!"

multichannel fm receiver for six and two

How to use commercial fm receiver strips in a multichannel, two-band vhf fm receiver

Stirling Olberg, W1SNN, 19 Loretta Road, Waltham, Massachusetts 02154

Surplus public-service vhf-fm equipment, which is sold in *strip* form, can be used as the basis for a low-cost, multichannel, two-band fm receiver. This is accomplished simply by adding a two-meter converter and a logic crystal oscillator[1] to a single-channel 30-50 MHz Motorola Sensicon receiver strip as shown in block form in **fig. 1.** If the output of the two-meter converter is fed into the strip receiver's first-conversion i-f input, and a logic oscillator is provided as the local oscillator (17.775 to 17.830 MHz) the strip will cover the fm channels for 146.34/94 MHz. By adding a multiple crystal oscillator operating at approximately 16 MHz and appropriate switching controls, two-band control and channel selection is possible.

These modifications are not limited to Motorola receivers, as there are a number of commercial fm receiver strips sold in the same way. Any of these strips can be adapted to perform the same task. However, before modifying one of these units it's a good idea to put it into operating condition before adding to the confusion. A circuit diagram and receiver tuneup data, if you can find them, are a great help in this respect. Information on many of these units is included in *The FM Schematic Digest.*[2]

two-meter converter

If you already have a good two-meter converter, all you have to do is convert its output frequency to the same frequency as the receiver strip you are going to use (4.3 MHz in the Motorola Sensicon receiver strip). This may be as simple as plugging in the two-meter logic oscillator and realigning the converter, or it may require more extensive circuit modifications. If considerable modification is required, it might be easier to build a two-meter converter specifically for use with the fm receiver strip.

My two-meter converter consists of a single mosfet rf stage using an RCA 40822 mosfet. Another mosfet, an RCA 40823, is used as the mixer (see **fig. 2**). Both of these devices were designed for vhf work and provide good performance on two meters. The rf amplifier has excellent gain as an unneutralized rf amplifier, a low noise figure, and wide dynamic range which results in low cross modulation. The dual-gate mosfet used in the mixer stage isolates the input from the output and allows low-level local-oscillator injection.

The tuned input network to the rf amplifier is designed to match a 50-ohm antenna. The small trimmers, C1 and C2, the inductor, L1, and the rf amplifier transistor, Q1, are located in a shielded compartment made from 1-inch-wide strips of copper-clad PC material. The drain lead of Q1 passes through a small hole in the shield wall and is connected to inductor L2. Gate 2 and the source lead of the mosfet are connected directly to 1000-pF standoff capacitors. The 275-ohm source resistor is grounded next to the source bypass capacitor with as short leads as possible. A ferrite bead is installed on the drain lead.

Similar construction is used for the mixer stage. A small coaxial cable must be used to connect gate 2 of the mixer to the output of the multiplier chain. This is because the mixer requires only a small amount of local-oscillator signal — unwanted signals can leak in and appear in the 4.3-MHz output.

local oscillator

Construction of the logic oscillator will not be discussed as that was covered in detail in the previous article.[1] Crystal

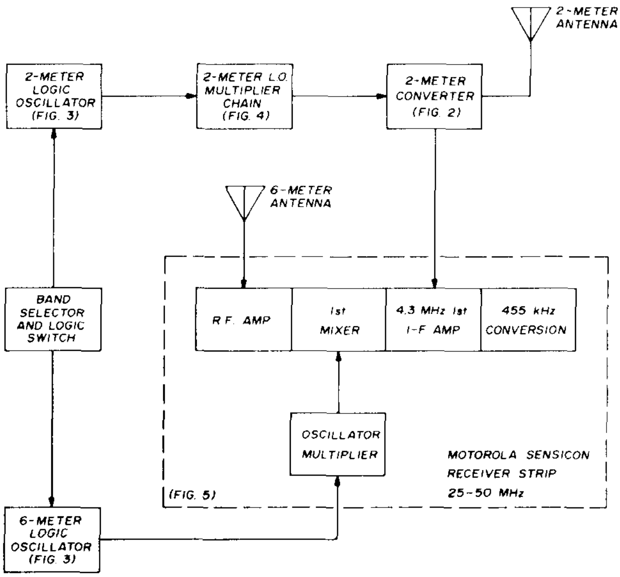


fig. 1. Block diagram of the multichannel six- and two-meter fm receiver using a Motorola Sensicon receiver strip.

frequencies for the logic oscillator may be determined from the following formula

$$f_{xtal} = \frac{f_o - f_{i\text{-}f}}{8} \qquad (144\ \text{MHz})$$

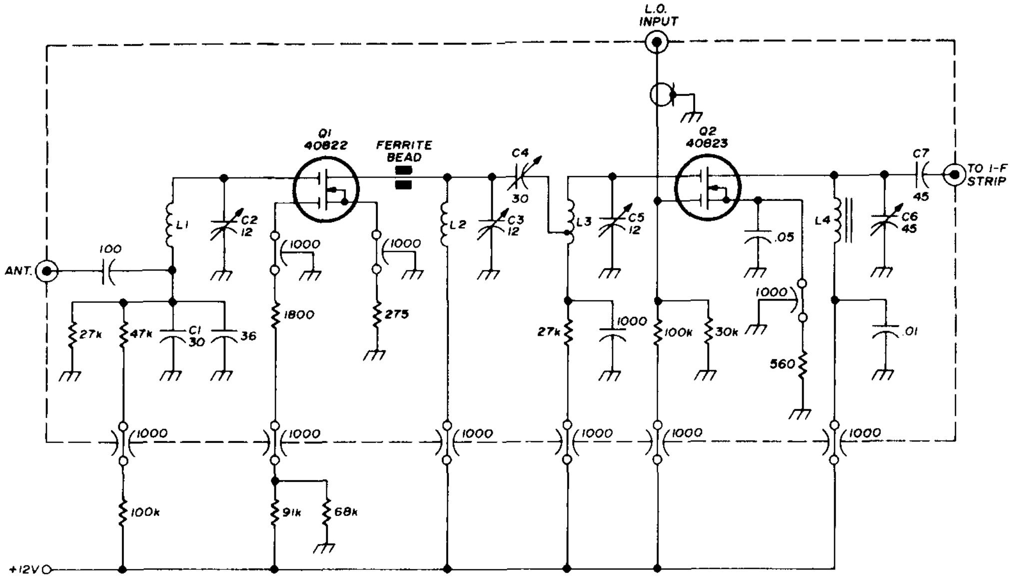
$$f_{xtal} = \frac{f_o - f_{i\text{-}f}}{3} \qquad (50\ \text{MHz})$$

where f_{xtal} is the crystal frequency, f_o is the desired operating frequency and $f_{i\text{-}f}$ is the intermediate frequency of the receiver strip (often 4.3 MHz). For example, the crystal required for a two-meter input frequency of 145.500 MHz is

$$f_{xtal} = \frac{145.500 - 4.30}{8} = 17.650\ \text{MHz}$$

For a six-meter input at 52.525 MHz, the required crystal frequency is

$$f_{xtal} = \frac{52.525 - 4.30}{3} = 16.075\ \text{MHz}$$

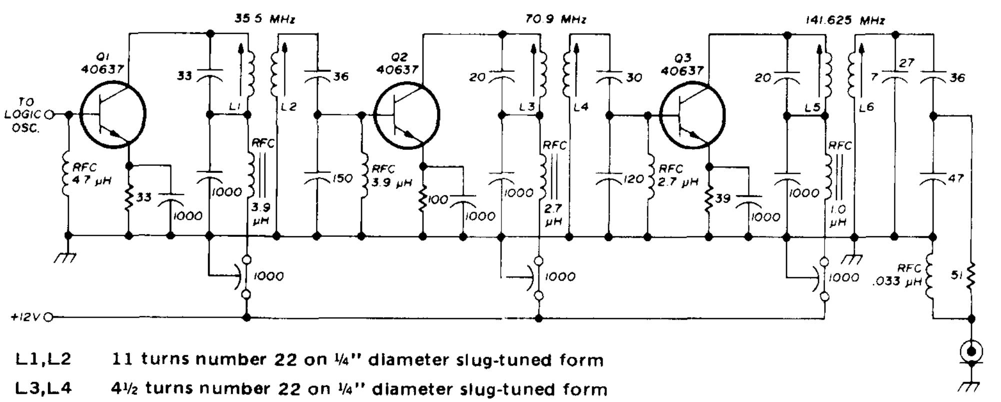


L1,L2	6 turns number 22, air wound, 1/4" diameter
L3	6 turns number 22, air wound, 1/4" diameter, center tapped
L4	37 turns number 32 on Amidon T50-2 toroid core

fig. 2. Simple two-meter converter for the two-band fm receiver. The ferrite bead on the drain lead of Q1 is an Amidon 45-101.

The frequency-selector switch is a 2-pole, 6-position rotary wafer switch wired so that +12 volts is applied to the two-meter converter when the two-meter channel crystals are switched into the circuit. More crystal frequencies can be added simply by adding additional logic oscillator stages – the only limiting factor to the number of logic-oscillator channels is the current handling ability of the voltage regulator.

The logic oscillator will operate properly with fundamental-mode crystals up to about 20 MHz. Above 20 MHz it is



L1,L2	11 turns number 22 on 1/4" diameter slug-tuned form
L3,L4	4 1/2 turns number 22 on 1/4" diameter slug-tuned form
L5,L6	1 1/2 turns number 20 on 1/4" diameter slug-tuned form

fig. 4. Local oscillator multiplier chain. Stagger-tuned circuits provide relatively flat output across the two-meter fm band. L1, L3 and L5 are peaked for the lowest frequency crystal; L2, L4 and L6 are peaked for the highest.

necessary to use higher speed gates than the TTL ICs shown in **fig. 3.** Do not use overtone crystals in this circuit as they will not oscillate at the same frequency as that marked on the crystal can.

spaced by the diameter of one coil form (¼inch). The input coil of each pair is peaked for the lowest frequency crystal while the secondary coils are peaked for the highest frequency crystal. The fre-

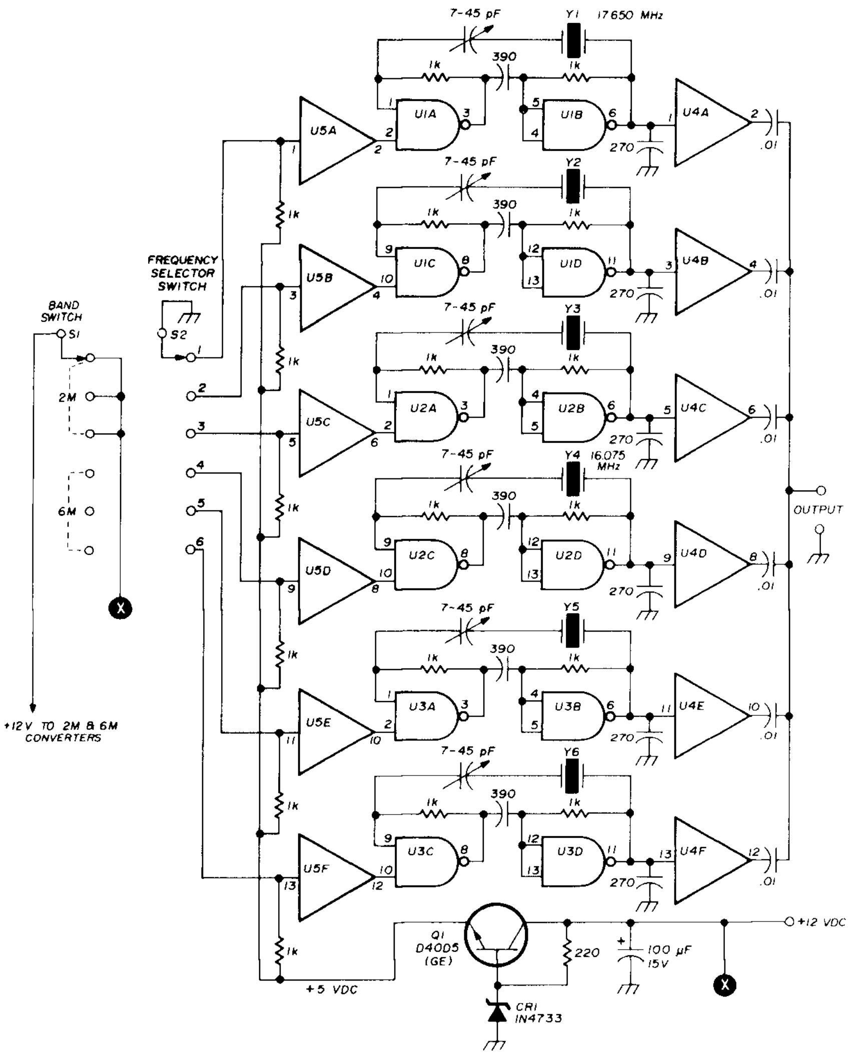


fig. 3. The logic oscillator circuit uses TTL ICs which are suitable for use with fundamental crystals up to approximately 20 MHz. Overtone crystals do not operate properly in this circuit.

Construction of the local-oscillator chain (**fig. 4**) is very straight forward and should cause no problems. The stagger-tuned stages provide the bandwidth necessary to cover the entire two-meter fm band. Each of the inductors is wound as described in **fig. 4,** and the coil pairs quencies indicated in the circuit diagram are the approximate center frequencies of the stagger-tuned stages.

The two-meter converter, logic oscillator and multiplier chain are built on a single piece of copper-clad board 3-inches wide by 8-inches long. The oscillator is

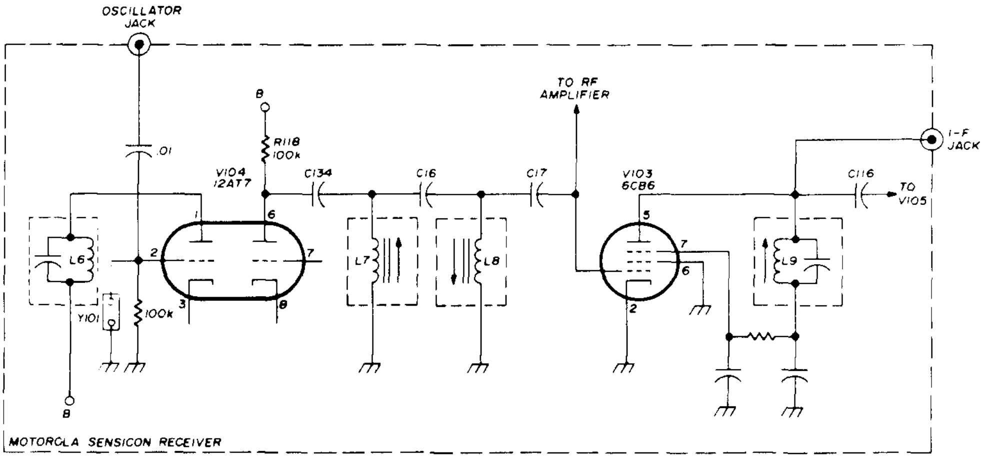


fig. 5. Partial diagram of the Motorola Sensicon receiver strip used in the two-band fm receiver built by W1SNN.

built into a separate shielded compartment as are the multiplier chain and the two-meter rf amplifier and mixer stages. Short lengths of coaxial cable are used to connect these units together and to the fm receiver strip.

receiver strip

The low-band Motorola Sensicon receiver (model PA9244-12) I modified for use in the two-band receiver is easily moved into the six meter fm band by replacing the fixed tuning capacitors in the rf amplifier, mixer and local-oscillator stages. The values for these capacitors are given in the Motorola schematic and are prefixed with the letters L, M or H, depending on the desired operating frequency. The H values (for high-band) are the values that should be installed for *six-meters*.

To use the receiver strip in the two-band fm receiver it is necessary to add an i-f input jack and an access jack to the first local oscillator. The i-f jack is located close to V103 so that the lead to pin 5 of the 6CB6 is as short as possible (see **fig. 5**). Another jack is mounted on the opposite side of the chassis and connected to pin 2 of V104, the grid of the 12AT7 oscillator multiplier. This completes the modifications to the receiver strip.

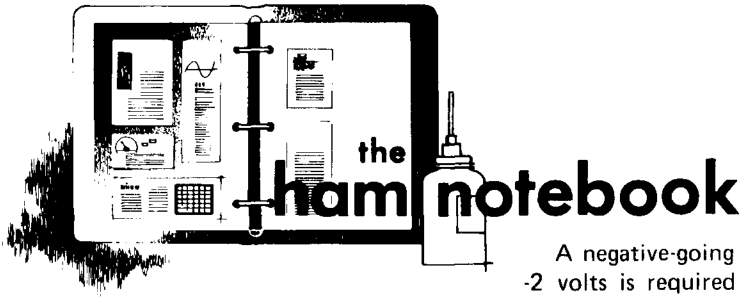
The receiver is aligned by connecting a center-scale dc vtvm to the discriminator output and adjusting the frequency control trimmer of each channel crystal until the meter reads zero with an incoming signal.

references

1. Stirling Olberg, W1SNN, "Logic Oscillator for Multi-Channel Crystal Control on VHF FM," *ham radio*, June, 1973, page 46.
2. Sherman M. Wolf, "FM Schematic Digest," P.O. Box 535, Lexingtin, Massachusetts 02173.

ham radio

"Delta . . . India . . . Sierra . . . Hotel . . . Echo . . . Sierra."



vhf fm scanner modifications

Although solid-state equipment is fast becoming the ideal equipment, at the same time there is still quite a bit of tube-type equipment in use. At the time I saw the February, 1973, edition of *ham radio* I was in the process of trying to come up with a scanner to add to my base station receiver. After looking over K2ZLG's vhf fm receiver scanner, I decided it was worth a try. However, the basic design was not completely acceptable for use with tube-type equipment. The following modifications were developed and tried. So far the unit has worked flawlessly.

Since most vacuum-tube receivers produce a negative-going voltage when the squelch is open, the original input circuit will not work. The circuit shown in **fig. 1** was finally tried and seemed to work the best of any. One of the major problems with the bipolar input was to get the input impedance high enough to prevent loading of the receiver squelch circuitry; the dual-gate fet takes care of this problem nicely.

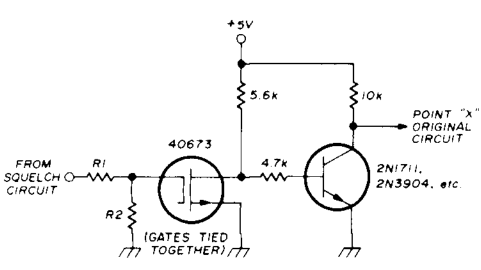


fig. 1. Input circuit for frequency scanner.

A negative-going voltage of more than -2 volts is required to stop the scanner. However, this voltage should not be more than -6 volts at the gate of the fet. For voltages in the range of -2 to -6 volts R2 can be eliminated. For voltages higher than -6 volts, R1 and R2 should limit the gate voltage to less than -6 volts. Typical values are between 1 and 10 megohms. The important thing is to try to keep the input impedance as high as possible since loading of less than about 1 megohm will interfere with normal squelch operation.

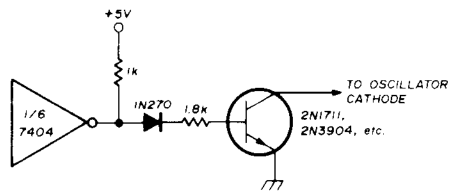


fig. 2. Output circuit. Repeat for each channel.

The next problem is that most tube-type receivers use separate oscillators for each frequency. Most circuits require that the cathode of the appropriate oscillator be grounded for operation of that particular oscillator. In addition, the ungrounded cathode produces about 30 volts. The simplest way around this seems to be to use an npn transistor to isolate the cathode from the scanner since TTL circuitry will not normally tolerate 30 volts. This is shown in **fig. 2.** The transistor used is non-critical as long as it will withstand the voltage present when the tube cathode is above ground.

In the unit at my station some MC4039 ICs were on hand instead of the 7446 decoder, so these were used. This IC happens to have an enable pin that was used with an inverting transistor off the output of the input circuit. I didn't like seeing the numbers go by as the unit scanned, and this configuration turns the readout off while the unit is scanning. The same thing could be done by putting a switching transistor in the +5-volt line to the readout.

Mike Jones, WA5WOU

10 MHz coverage for the SB-303

The utility of 15-MHz WWV reception on Heath SB-303 receivers is somewhat dubious, considering present propagation conditions in this area. I've changed mine to tune WWV-10, finding virtual 24-hour coverage on 10 MHz. Modifications are relatively simple, but refer to the manual and schematic.

The 23.895 MHz crystal, Y104, used for 15 MHz, is replaced with an 18.895 MHz, HC6-U type, third overtone crystal intended for a 32 pF load. This change is made on the *crystal switch-board* (85-348), whose Xray pictorial with other PC boards is found at the back of the SB-303 manual.

To resonate the LC circuit marked "15 MHz" on the *heterodyne oscillator switch-board*, a 33-pF dipped mica or disc capacitor is added across C131. The slug in L117 must be moved in a few turns until oscillation occurs as noted by voltage appearing at TP on the PC board. An extra half-turn provides positive crystal starting when switching bands.

Modification of the *rf amplifier switch-board* (85-346) involves isolating foil pad areas around switch-points 5 and 6. Switch-point 5 will then be jumpered back to the foil lead coming from L111, the 14-MHz tuned circuit. A new resonant circuit for 10 MHz is required. I used 22 turns of number-24 enamel wire on an Amidon T-50-2 toroid, turns spaced evenly around the core. This is approximately 2.9 μH which, with a 47-pF disc in parallel, will resonate – out of the circuit – at 14 MHz. The older vacuum tube type of grid dipper will dip this unit satisfactorily. One end of this LC combination is soldered to switch-point 6 (on 85-346) and the other to ground foil near the *rf in* phone jack. Mount it close to the board, avoiding shorts.

Operation of the receiver on 10 MHz may be checked by attaching a short antenna through a few pF to *rf in* at C106 on the *amplifier switch-board*. The *preselector* should resonate broadly at about 30 to 40 percent of its range.

The *antenna switch-board* (85-345) is modified similarly to the previous PC board. Again, switch-point 5 and 6 pad areas are isolated, 5 being jumpered back to the foil lead running to the 14-MHz tuned circuit L103-C103. Also, between and clear of switch-points 6 and 7, drill about a number-58 hole. This board has a double-section rotary switch, the section nearest the board being the secondary, and the outer, the primary. Switch-points 5 and 6 on the primary are isolated by unsoldering the blue wire and jumper between 5 and 6. Resolder the blue wire directly to switch-point 5 (14 MHz).

Primary switch-point 6 is left blank for the moment. The LC antenna circuit also uses an Amidon T-50-2 toroid with 22 turns of number-24, with the addition of 6 turns of number-26 or -28 wire forming the primary. Use an adjacent winding rather than over-winding for the primary. The tuning capacitor is again a 47-pF disc paralleled with the 22-turn secondary. The combination mounts on the foil side of the board (85-345).

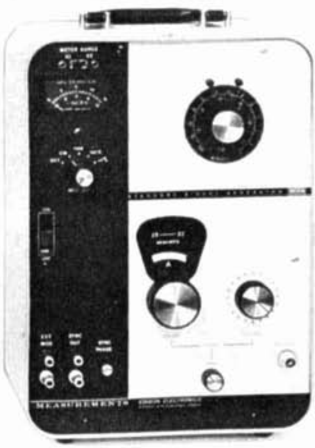
One end of the secondary goes to switch-point 6 and the other to any convenient ground-foil point. One side of the 6-turn primary also ties to this point, the other side being fed through the pre-drilled hole and soldered to outer switch-point 6. An adjustment of a turn on the secondary may be desirable for better tracking, but I found the *preselector tuning* to be adequately sharp.

This application can be used for other 500-kHz segments. The crystal frequency must be 8895 kHz above the lowest signal frequency.

Bill Fishback, W1JE

new products

fm signal generator



The Measurements Model 800A series of solid-state fm signal generators cover all mobile communication frequency bands allocated by the FCC. Any desired frequency can be quickly obtained by selecting one of the six frequency bands, tuning the coarse tuning control, and making narrowband adjustments with either the electronic fine tuning or incremental frequency controls.

The Model 800A signal generator provides accurate output voltages traceable to the National Bureau of Standards. The output is continuously variable from 0.1 microvolt to 0.1 volt by means of a mutual inductance type attenuator. Output voltages are automatically maintained at all levels by a temperature-compensated bolometer circuit. Rf leakage is negligible, and microphonics are so low that accurate receiver sensitivity measurements can be made down to 0.1 microvolt.

Internal modulators provide frequency modulation at 1000 Hz sine wave or 20 Hz sawtooth. External modulation from dc to 30 kHz may be applied through front-panel binding posts. Sync out and sync phase are available for external modulation (up to ±32 kHz peak deviation) so that dual-trace sweep alignment techniques may be used.

For complete technical data write to Edison Electronics, Division of McGraw-Edison Co., Grenier Field, Manchester, New Hampshire 03103, or use *check-off* on page 94.

WWV data folder

Complete, up-to-date information on the many services provided by The National Bureau of Standards Radio Stations WWV, WWVH and WWVB is being offered at no charge by the True Time Instrument Company, manufacturers of receivers for all of the standard time and frequency broadcasts.

The NBS transmissions provide an invaluable service to radio amateurs, laboratories and engineers throughout the world. Extremely precise audio and radio frequency standards are broadcast, as well as accurate time signals, geophysical alerts, Atlantic and Pacific area storm warnings and radio frequency propagation forecasts. This information is at the disposal of anyone having a receiver capable of tuning to one or more of the transmitting frequencies. The proper use of NBS facilities can greatly supplement the instrumentation of any laboratory.

Maximum utilization of this valuable "natural resource" depends upon a complete knowledge of the current broadcasting schedules and transmitting frequencies. The folder supplies this data, as

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well as information on suitable methods of comparison with local chronometers or instrumentation. Also included are the hourly broadcast schedules of National Bureau of Standards stations WWV, WWVH, WWVB, with supporting data.

Write to True Time Instrument Company, 225 Melbrook Way, Santa Rosa, California 95405, and request Bulletin 373-1, or use *check-off* on page 94.

swr meter

Carvill International has announced its new in-line swr and power meter, the model ME-IIN. The ME-IIN is a direct-reading swr and power meter which measures the ratio of the forward and reflected wave on a coaxial transmission line. In this instrument a printed-circuit transmission line is used to eliminate unbalanced rf pickup which is often a problem in more simple swr meters. The swr meter is usable on all bands from 3.5 to 150 MHz.

For more information, write to Carvill International Corporation, 825 Constitution Drive, Foster City, California 94404, or use *check-off* on page 94.

signal intensifier

The new SABA-5 (Symtek Automatic Broadband Amplifier) provides low-noise and high *useful* gain for amateur communications receivers. This new amplifier, which covers 80, 40, 20, 15 and 10 meters with no tuning has a typical noise figure of 2.5 dB and gain of 20 dB (minimum). Input and output impedance is 50 ohms.

The SABA-5 uses a dual-gate, diode-protected mosfet to take advantage of its low noise characteristics as well as its

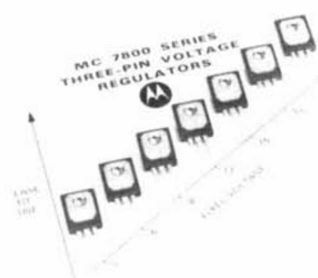
More Details? CHECK–OFF Page 94

inherent protection against strong rf fields. The Qs of the tuned circuits are engineered for high gain and adequate bandwidth to cover the entire amateur bands with MARS overlap. Insertion loss, when the amplifier is turned off, is kept to a minimum through the use of a straight-through coaxial loop and low-loss ceramic switches.

Biasing of the amplifier is optimized for best gain, cross-modulation and noise-figure characteristics. Gain may be adjusted by varying the main supply voltage ±3 volts. The amplifier is easily installed on any communications receiver in minutes by simply inserting it between the receiver and the antenna. Transceivers may be easily modified by breaking the antenna circuit from the T/R relay to the receive rf amplifier and bringing each end to an external phono jack.

The SABA-5 carries a 30-day money-back guarantee and 1-year warranty, and is priced at $79.95. Models for 160 meters, 6 meters and 2 meters are also available. For more information, write to Symtek, Inc., Box 128, Clearwater, Florida 33517, or use *check-off* on page 94.

three-pin voltage regulators



Many times the need arises for a simple, low-cost voltage regulator which can provide a moderate amount of current without complex current-boosting circuitry. Applications include on-card regulation and power supply distribution in large systems.

A new Motorola device family composed of seven fixed-voltage regulators

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housed in a popular plastic power transistor package fulfills these needs. The MC7805/24 series positive voltage regulators can supply in excess of 1 ampere at nominal voltages of 5, 6, 8, 12, 15, 18 or 24 volts (as designated by the last two digits of the device number). However, unlike most voltage-regulator ICs, these devices have only three terminals – input, output and ground – and they require no external components. The devices can be easily attached to a heatsink surface with a machine screw through the hole in the package to attain higher maximum power dissipation.

To insure a rugged device, internal current limiting, thermal shutdown, and output transistor safe operating area compensation techniques are employed. These features make the regulators essentially burn-out safe.

For further information contact the Technical Information Center, Motorola Inc., Semiconductor Products Division, Post Office Box 20912, Phoenix, Arizona 85036, or use *check-off* on page 94.

spring-type fuse holder

Oneida Electronics has recently introduced a new coil-spring fuse holder that makes it easier than ever to replace fuses. The new holder eliminates the need for using more costly type pig-tail fuses and does away with cutting and re-soldering pig-tail leads.

Regular fuses can be snapped into the coil-spring holder in seconds. Service people will find them ideal for use in those hard-to-get at places. Replaces permanently installed pig-tail fuses by merely soldering the leads of the new spring holder to stubs of removed pig-tail fuse. The spring holders have been designed to accommodate tv, radio, hi-fi and most other electronic device fuses.

The new spring-type holder is permanent – quality constructed of tempered spring steel with dip soldered leads. Available packaged 5 pair per pack on dealer cords and in bulk for OEM use. For detailed information write Oneida Electronic Manufacturing, Inc., Meadville, Pennsylvania 16335, or use *check-off* on page 94.

new allied catalog

Allied Electronics (Division of Tandy Corporation) has published their new catalog number 740. Previous catalogs have served as the electronics industry's "answer book," and the new catalog is even better. In addition to the easy-to-use tab-index format and easy-to-use 9 x 11-inch size introduced in 1973, even more useful product information is included in the book. Prime feature of the Engineering Manual and Purchasing Guide catalog is the inclusion of *Engineering Drawings* of all electrical components. All physical dimensions are given to allow efficient design of electronic packages before components are purchased. Electrical characteristics of all items are also included.

Allied has also introduced a new policy for obtaining a copy of their

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catalog: instead of the $5.00 price, or $10.00 order requirement, *anyone* can now obtain a copy for the cost of postage and handling – just $1.00. All items shown are in stock at all Allied warehouses. With Allied enjoying the best order filling record in the industry, this, as always, is the one catalog you can't do without. For your copy, send $1.00 for postage and handling to Allied Electronics, 2400 W. Washington Boulevard, Chicago, Illinois 60612.

transistor substitution handbook

The *Transistor Substitution Handbook* is updated continuously, and a new edition is published annually. This 13th edition has been published in an easy-to-read 8-1/2x11-inch format, and contains over 100,000 transistor substitutions. To guarantee the most accurate possible substitutions, the electrical and physical parameters as described in the manufacturers' published specifications for each bipolar transistor were fed into a computer; then each transistor was compared with all others. Consequently, transistors which matched within prescribed limits are listed as substitutes.

Section 1 of the handbook contains substitutions for both American and foreign-made transistors which are arranged in numerical and alphabetical order. Types recommended by the manufacturers of general-purpose replacement transistors are included at the end of each list of substitutes. Additional data on these general-purpose replacement types – manufacturer, npn or pnp, germanium or silicon, and the recommended applications – are also reviewed.

The *Transistor Substitution Handbook* is a valuable source of information for amateurs concerned with transistor replacement in communications industrial, commercial or home-entertainment equipment. 144 pages, softbound. $2.95 from Comtec Books, Greenville, New Hampshire 03048.

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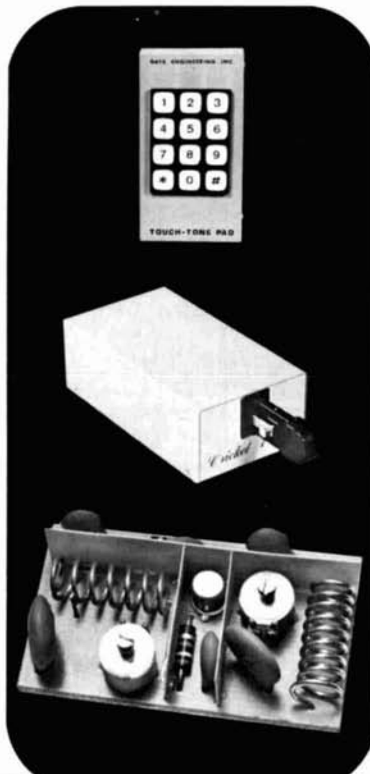

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- **Transmit and Receive Operation:** All units have both **Simplex** and **Repeater Modes**
- **Accurate Frequency Control:** .0005% accuracy
- **Stable Low Drift Outputs:** 20 Hz per degree C typical
- **Full 2 Meter Band Coverage:** 144.00 to 147.99 MHz. in 10KC steps
- **Fast Acting Circuit:** 0.15 second typical settling time
- **Low Impedance (50 ohm) Outputs:** Allow long cable runs for mobiles
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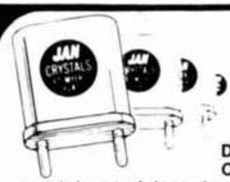
RP Electronics

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



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More Details? CHECK—OFF Page 94

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

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

OTHER HAL PRODUCTS INCLUDE:

ID-1 Repeater Identifier (wired circuit board)	$ 75.00*
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TOP QUALITY... WITH THE HAL MKB-1 MORSE KEYBOARD. As easy as typing a letter—you get automatic CW with variable speed and weight, internal audio oscillator with volume and tone controls, internal speaker, and audio output jack. Smooth operation; completely solid-state, TTL circuitry using G10 glass boards, regulated power supplies, and high voltage transistor switch. Optional automatic ID available. Assembled MKB-1, $275.00. In kit form, $175.00. *

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SN7407	.55	SN7445	1.50	SN7481	1.25	SN74126	.71	SN74176	2.10
SN7408	.35	SN7446	1.65	SN7482	.99	SN74139	1.25	SN74177	2.10
SN7410	.30	SN7447	1.45	SN7483	1.25	SN74140	1.25	SN74179	2.10
SN7411	.35	SN7448	1.50	SN7485	1.41	SN74145	1.55	SN74180	1.20
SN7413	.95	SN7450	.30	SN7486	.55	SN74148	4.50	SN74181	4.90
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SN7425	.50	SN7462	.35	SN7495	1.35	SN74156	1.45	SN74196	2.50
SN7426	.36	SN7464	.30	SN7496	1.35	SN74157	1.55	SN74197	2.50
SN7430	.30	SN7465	.50	SN74106	.95	SN74158	1.55	SN74198	2.65
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		SN7471	.55	SN74108	.95	SN74161	1.95		

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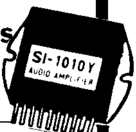
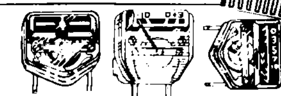
Mfgr's Type	Watts	Sale
☐ SI-1010Y	10	$ 8.88
☐ SI-1025E	25	18.88
☐ SI-1050E	50	29.95

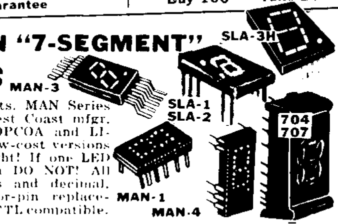




HI-FI 1" SQUARE MINI METERS $1.49 3 for $3.75

* Plastic case * Red needle indicators
- ☐ Balancing, stereo, tape, amps.
- ☐ VU, side mtg, plus 3 minus 20 db.
- ☐ VU, front mtg, plus 3 minus 20 db.

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



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

ALL LED READOUTS — TYPE	character Size	Color Display	Decimal	Mils	Driver	Each	Special
☐ MAN-1 equal	.27	Red	Yes	20	SN7447	$3.95	3 for $10.
☐ MAN-1A equal*	.27	Red	Yes	20	SN7447	3.95	3 for $10.
☐ MAN-3 equal	.115	Red	Yes	10	SN7448	1.69	3 for 4.50
☐ MAN-3A equal*	.115	Red	Yes	10	SN7448	1.69	3 for 4.50
☐ MAN-3M equal*	.127	Red	Yes	10	SN7448	1.69	3 for 4.50
☐ MAN-3 equal	.115	Red	***	10	SN7448	1.50	3 for $4.
☐ MAN-3M equal*	.127	Red	Yes***	10	SN7448	1.50	3 for $4.
☐ MAN-4 equal*	.190	Red	Yes	15	SN7448	2.50	3 for $6.
☐ MAN-4 equal*	.190	Red	Yes***	15	SN7448	2.25	3 for $5.
"REFLECTIVE LITE BAR" (Segment LED Readouts)							
☐ 707** (MAN-1)	.33	Red	Yes	20	SN7447	2.75	3 for $6.
☐ 704** (MAN-4)	.33	Red	Yes	20	SN7448	2.75	3 for $6.
☐ SLA-1** (MAN-1)	.33	Red	Yes	20	SN7447	2.75	3 for $6.
☐ SLA-1** (MAN-1)	.33	Red	No	20	SN7447	2.25	3 for $5.
☐ SLA-2 + − 1	.33	Red	No	15	SN7447	2.75	3 for $6.
☐ SLA-3H Giant	.70	Red	Yes	20	SN7447	6.50	3 for $18.
☐ SLA-11C** (MAN-5)	.33	Green	Yes	40	SN7447	4.95	3 for $13.
☐ SLA-12** ±1	.33	Green	No	40	SN7447	3.50	3 for $ 9.

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

Op Amps

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☐ 531	Hi slew rate op-amp (TO-5)	$2.50
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☐ 703C	RF-IF, amp, 14 ckts (TO-5)	.69
☐ 704	TV sound IF system	1.50
☐ 709C	Operational amp (A)	.47
☐ 709CV	Op amp (mini DIP)	.47
☐ 710C	Differential amp (A)	.47
☐ 711C	Dual diff. comp (A)	.47
☐ 723C	Voltage regulator (A)	.75
☐ 733	Diff. Video Amp	1.75
☐ 741C	Frequency compensator 709 (A)	.49
☐ 741CV	Freq. comp 709 (Mini DIP)	.49
☐ 747C	Dual 741C (A)	.95
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☐ 753	Gain Block	1.75
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☐ 739-739	Dual stereo preamp	1.98
☐ 741-741	Dual 741C (A)	1.00
☐ PA265	5-Watt voltage regulator	1.95
☐ ULN2300M	Op amp with SCR	1.50
☐ CA3065	Video Audio system	1.05
☐ 75451	Dual peripheral driver	.88
☐ 75491	Quad seg driver for LED readouts	1.65
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(A) TO-5 or DIP dual in line pak

3 for $3 HIGH POWER TRANSISTOR WITH HEAT SINK ☐ **$1.49**

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

☐ 10-pc. kit, 0-to-9 only, **3.50**

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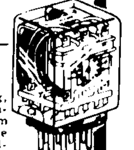
Excellent for "HAM" use as antenna switching, latching, transmit, receive, etc., and 100's of commercial or industrial uses. Includes plastic dust-cover with diagram and hookup info, 11-pin plug-in base. Contacts movable gold flashed silver, stationary overlay, with silver cadmium oxide movables. All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



3PDT ☐ 12 VDC ☐ 115 VAC

WEST COAST MAKER OF LED'S

☐ 4-MV5054	Jumbo red lens, red lite TO-18	$1.00
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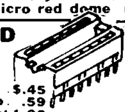
☐ 4-MV5080	Micro red dome red lite, TO-18	1.00

INTEGRATED CIRCUIT SOCKETS



14-Pin, DIP	$.45
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'HAM' UHF 400 MC HIGH POWER TRANSISTORS ☐ 3 for $10. 3.95

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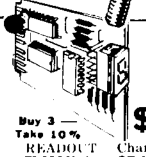

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READOUT	Char.	Maker
☐ MAN-1	.27 h.	Monsanto
☐ MAN-4	.19 h.	Monsanto
☐ 707*	.33 h.	Litronics
☐ 704**	.33 h.	Litronics
☐ SLA-1*	.33 h.	Opcoa

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MODEL 60 SPEECH PROCESSOR — QRO the average-to-peak ratio of the speech waveform as much as 8 db using a logarithmic principle. Operates with FM, SSB and AM transmitters and transceivers. Low/High impedance Mic input. Two 9Vdc batteries provide a self-contained unit.

Model 60W (Processor Assembled) **$26.50**
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MODEL 20 DIGITAL DIAL — Available for Collins and Drake gear. Optional four digit readout and crystal time base. QSY your fixed or mobile transmitter, receiver or transceiver with 100 Hz accuracy and no last digit jitter. Simple one wire connects dial to rig and you're ready to go. **Specify your type of rig.**

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Model 20D (Drake)................ **$169.95**
Options: (4 Digit Readout)....... **$ 29.95**
(Crystal Time Base)..... **$ 29.95**

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

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

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Model 10AW (Keyer Assembled).... **$26.50**
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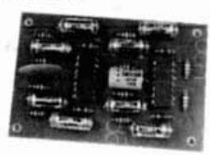
CW FILTER



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

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

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

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

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

SPECIFICATIONS

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

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

Write for FREE brochures and magazine test reports. Other IC active filters available: CW mini filter (1½"x2"), low pass, high pass, and wide bandpass filters. Audio amplifiers: ½, 1, 2 watts. Crystal calibrator.

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Wired & Tested Less 2 ea 6CW4 Nuvistors
DRILLS, #54, 56, 58 or 60 (each) $.40
Finest Quality for PCB'S, Made in USA Three For $1.00

EXCEPT AS NOTED ABOVE, ALL KITS ARE NEW, 100% SOLID STATE, AND COME COMPLETE WITH AN UNDRILLED G-10 PCB (PRINTED CIRCUIT BOARD) AND ALL PCB MOUNTED COMPONENTS. KITS ARE LESS POWER SUPPLIES, CHASSIS, AND ENCLOSURE HARDWARE. SEND SELF-ADDRESSED, STAMPED ENVELOPE FOR COMPLETE DATA SHEET AND SCHEMATIC.

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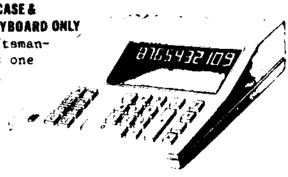
TABLE TOP CALCULATOR CASE & KEYBOARD ONLY



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

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

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

- 12-Digit display and calculate
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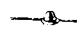
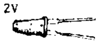


MV50 red emitting 10-4 ma @ 2V — $ .25; 5 FOR 1.00



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

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

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200	.15	1000	.40
400	.18	1200	.50
600	.23	1500	.65

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

7400	$ .25	74L51	$ .30
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7401	.25	7453	.20
7402	.35	7454	.25
74H01	.35	74L54	.35
7403	.30	74L55	.35
7404	.28	7460	.20
74H04	.35	74L71	.30
7405	.28	7472	.40
7406	.70	74L72	.50
74H05	.35	7473	.60
7408	.35	74L73	.75
74H08	.35	7474	.65
7410	.25	74L74	.80
74L10	.35	74H74	.80
74H11	.35	7475	1.40
7413	1.25	7476	.60
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7430	.25	7491	1.00
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7450	.25	74163	2.00
74H50	.35	74193	1.50
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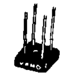

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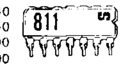
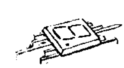


MAN 3M

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



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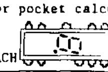

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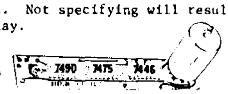
This kit provides a highly sophisticated display section module for clocks, counters, or other numerical display needs. The unit is .8" wide and 4 3/8" long. A single 5-volt power source powers both the ICs and the display tube. It can attain typical count rates of up to 30 MHz and also has a lamp test,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

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



Boards can be supplied separately @ $2.00 per digit.

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NE565	phase lock loop TO-5	3.25
NE566	function generator TO-5	4.00
NE567	tone decoder	4.00
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709	popular op amp DIP	.45
710	voltage comparator DIP	.75
711	dual comparator DIP	.40
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747	dual 741 op amp DIP	1.00
748	op amp TO-5	1.00
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LM703	RF-IF amp epoxy TO-5	.45
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LM3900	quad op amp	2.00
LM1595	4-quadrant multiplier	2.00
8038	sine square triangle function generator	4.95

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flea market

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THE ANNUAL CUYAHOGA FALLS RADIO CLUB AUCTION to be held Friday, February 22nd at the United Electronics Institute Building, 1225 Orlen Ave., Cuyahoga Falls, Ohio. Hours are 7 p.m. to 11 p.m. More details are available from WA8ZGL, Tom Carroll, Box 106, Cuyahoga Falls, Ohio 44222.

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

THE CALGARY AMATEUR RADIO ASSOCIATION will host an international meeting on Friday, Saturday, and Sunday, August 1, 2, and 3, 1975 — Calgary's Centennial Year. Canadian division ARRL meeting, a CLARA meeting, technical meetings, surprizes, exhibits and banquet, several on-the-air contests, two days program for the ladies and for all children (3 age groups). Watch for additional information in this column, or write: 75CONVEN, Box 592, Calgary, Alberta.

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B.A.R.T.G. SPRING RTTY CONTEST: 0200 GMT, March 23rd to 0200 GMT, March 25, 1974. Not more than 36 hours of operation is permitted. Listening counts as operating time. Off periods may not be less than 2 hours at a time. Times on and off the air must be summarized on the log and score sheets. Also open to short wave listeners. 3.5, 7.0, 14, 21 and 28 MHz Bands. Stations may only be contacted once on any band, but additional contacts may be made on other bands. Use ARRL countries list, except KL7, KH6 and VO are separate countries. Message exchange will consist of: Time GMT, message number and RST. All two-way RTTY contacts with one's country earn TWO points. All two-way RTTY contacts outside one's country earn TEN points. All stations receive a bonus of 200 points per country worked including their own. Any country may be counted again if worked on another band but continents are counted once. SCORING: Two way exchange points times total countries worked, plus total country points times number of continents worked. Use one log for each band and indicate any rest periods. Include date, time GMT, message and RST numbers sent and received and exchange points claimed. All logs must be received by May 31, 1974 to qualify. Send your contest logs to: Ted Double, G8CDW, 89 Linden Gardens, Enfield, Middlesex, England. EN1 4DX.

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WORLD QSL — See ad page 78.

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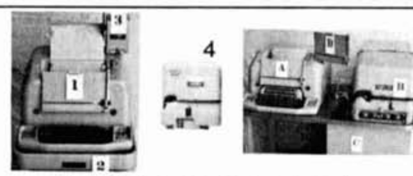

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QSL's, Sample catalog 20¢. N & S Print, P. O. Box 11184, Phoenix, Ariz. 85061.

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

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THE LaPORTE INDIANA, Amateur Radio Club will hold its annual Swapfest-Auction on the 10th of February, 1974, inside the LaPorte Civic Auditorium, beginning at 10 a.m. Auction beginning at 1 p.m. Talk-in will be on .94 Simplex and 22-82 Repeater.

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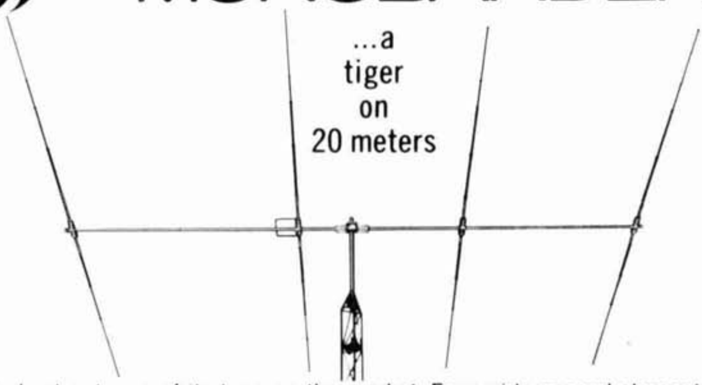

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February 1974

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CD AR-22R cmplt. rotator for small beams $33.95
BN86 Balun by HyGain .... $ 14.95
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RG8A/U — 65 feet with PL-259 connectors on each end .... $ 9.50
Times Wire & Cable, T-4-50 (FM-8) 50 ohm lowest loss type RG8/U foam cable .... 20¢/ft.
Columbia Superflex, RG-8/U 50 ohm high quality foam .... 20¢/ft.
Coaxial adapter for VHF to RG-17 (Amphenol 83-86) RG-17 plug to VHF female connector $6.95
BNC to RG-17 adapter UG-167C/U $7.95
Authorized factory dealers for Antenna Specialists, CushCraft, Gam, Heights Towers, Hy Gain, Mor-Gain Antenna, Mosley, Newtronics, Tri-Ex, Rohn, E-Z Way, Times Wire, Telrex.
RINGO AR-2 3.75 dB gain, 135-175 MHz $ 14.50
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Newtronics CGT-144 mobile 5.2 dB gain $37.95
Quick Disconnect by Newtronics for CGT, etc. $ 10.95
CG-1 Gutter Clip by Newtronics .... $ 1.25
2M MAGNETIC MOUNT w/RG58 & PL259 with 10 ft. RG 58 ready to go .... $ 9.95
14AVQ/WB VERTICAL .... $ 55.00
Roofmounting Kit: .... $ 15.95
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More Details? CHECK—OFF Page 94

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2K-ULTRA ... THE "ULTIMATE"

There has never been an amateur linear amplifier like the new 2K-ULTRA. Small and lightweight, yet rugged and reliable . . . all that the name implies. The ULTRA loafs along at full legal power without even the sound of a blower. Its anode heat is silently and efficiently conducted to a heat sink through the use of a pair of Eimac 8873 tubes. In fact, all of its components are the very best obtainable.

TEMPO/2001

Small but powerful, reliable but inexpensive, this amplifier is another top value from Henry Radio. Using two 8874 grounded grid triodes from Eimac, the Tempo 2001 offers a full kilowatt of output for SSB operation in an unbelievably compact package (total volume is .8 cu. ft.). The 2001 has a built-in solid state power supply, a built-in antenna relay, and built-in quality to match much more expensive amplifiers. This equipment is totally compatible with the Tempo One as well as most other amateur transceivers. Completely wired and ready for operation, the 2001 includes an internal blower, a relative RF power indicator, and full amateur band coverage from 80-10 meters.

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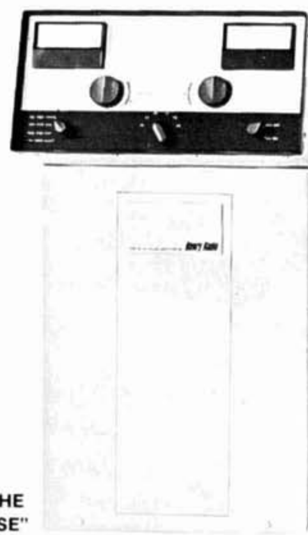
The Tempo 6N2 joins the Henry Family of fine HF amplifiers, bringing the same high standards of performance and reliability to the 6 meter and 2 meter bands. Using a pair of advanced design Eimac 8874 tubes, it provides 2,000 watts PEP input on SSB or 1,000 watts input on FM or CW. The 6N2 is complete in one compact cabinet with a self-contained solid state power supply, built-in blower and RF relative power indicator. Price . . . $695.00

3K-A COMMERCIAL/MILITARY AMPLIFIER

A high quality linear amplifier designed for commercial and military uses. The 3K-A employs two rugged Eimac 3-500Z grounded grid triodes for superior linearity and provides a conservative three kilowatts PEP input on SSB with efficiencies in the range of 60%. This results in PEP output in excess of 2000 watts. In addition, the 3K-A provides a heavy duty power supply capable of furnishing 2000 watts of continuous duty input for either RTTY or CW with 1200 watts output.

Prices subject to change without notice.



2K-4 . . . THE "WORKHORSE"

The 2K-4 linear amplifier offers engineering, construction and features second to none, and at a price that makes it the best amplifier value ever offered to the amateur. Constructed with a ruggedness guaranteed to provide a long life of reliable service, its heavy duty components allow it to loaf along even at full legal power. If you want to put that strong clear signal on the air that you've probably heard from other 2K users, now is the time. Move up to the 2K-4. Floor console or desk model.

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