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ham radio

magazine

DECEMBER, 1970

this month

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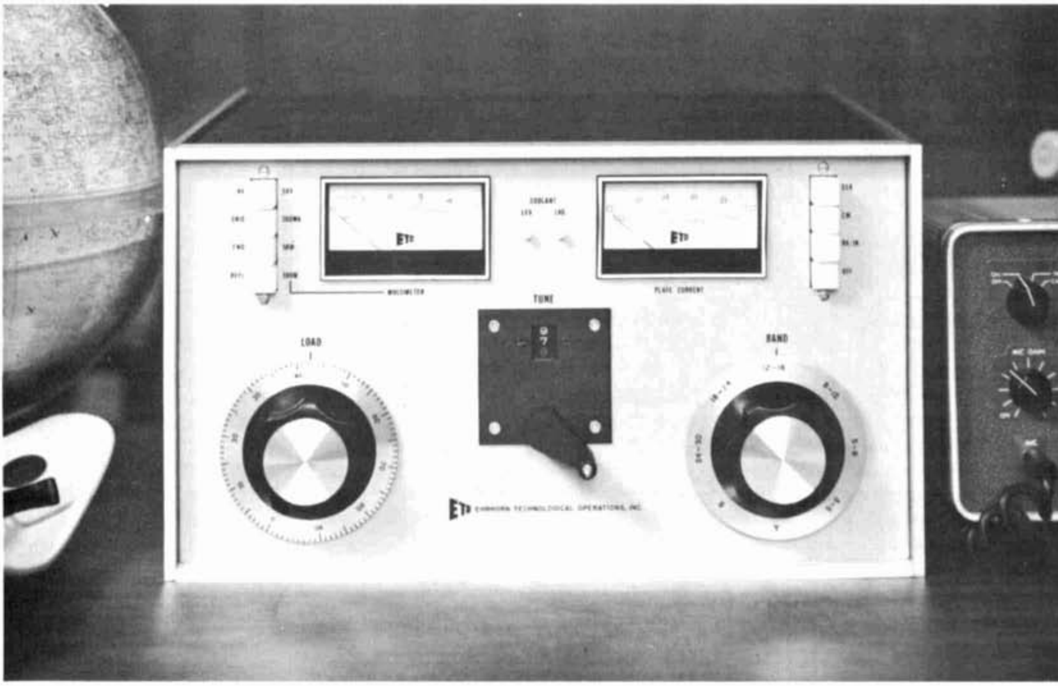

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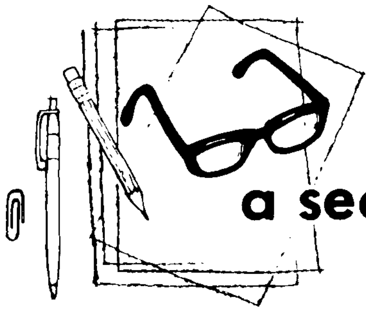


a second look

by jim fisk

Regular readers of this page may recall an editorial in the April 1970 issue by Skip Tenney, W1NLB, publisher of *ham radio.* The central theme of Skip's message concerned the growth of amateur radio and the attitude of hams in contributing to this growth – not only in quantity of numbers, but in quality of technical achievement. Such balanced growth is clearly essential if ham radio is to survive the challenge of the technology explosion in electronics.

One subject Skip touched upon was the novice ham and his problems in becoming established as a permanent member of the amateur radio community. It was mentioned that about 50% of those passing the novice test never get on the air. Carrying this thought a little further, of those who do get on the air perhaps less than 30% develop the skills and knowledge necessary to progress to higher license grades.

There are many reasons, of course, for this poor success ratio. One is plain discouragement. Novices need the help and mature direction from those who have been through the mill. Many novices build or buy equipment but have only a vague idea of how the equipment really operates beyond basic tuning adjustments. Experienced hams, who are sincerely concerned about the development of amateur radio, can help these novices over the rough spots of their transition period. Each novice who does manage to progress to general-class status is a potential contributor to the common cause of ham radio.

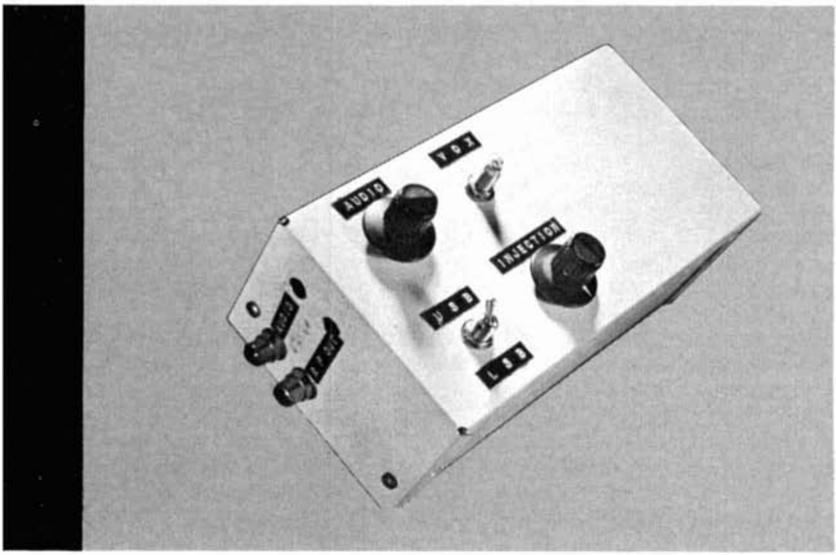
Tune across the novice frequencies on any band during the evening hours, and you'll hear hundreds of novices endlessly calling CQ with negative results. It is any wonder so many become discouraged?

One way the experienced ham can help the situation is to make contact with a few novice stations and offer technical aid if it seems appropriate. Some novices object to general and higher-class hams invading novice territory on the grounds that these bands are already overcrowded. However, it certainly seems logical that any aid given a novice by a more experienced operator would compensate for the additional band occupancy.

One example recently brought to my attention bears this out. An extra-class ham contacted a novice who was having trouble with his antenna, which in turn was causing transmitter loading problems. Actually, the novice solved the problem himself after a few friendly words of advice. All their activity consumed the better part of two hours at 12 wpm. In addition to the technical help, the contact provided some needed code practice for the novice ham, and the extra-class ham obtained some practice in forbearance.

If you've become bored with the ordinary ham operating activities, why not tune across the novice frequencies and see what's happening? A few hours a week exploring the world of the novice and his problems can be rewarding if you enjoy helping people. Who knows? Maybe your efforts might provide the amount of impetus necessary to make the difference between a dropout and a winner.

Jim Fisk, W1DTY
editor



a filter-type ssb generator

This construction project features a basic ssb generator circuit that can be used in hf or vhf exciters

R. Bain, W9KIT, 4915 Ridgedale Drive, Fort Wayne, Indiana

The state of the art being what it is today, the homebrewer seems to be a vanishing breed. For those who cut their teeth on tubes, solid state is somewhat perplexing. But then, even the ham-equipment manufacturers, with a few exceptions, have been somewhat reluctant to plunge into wholesale change-over from tubes. Single sideband also has popped up to further complicate the homebrewer's life. Though a delight to use, it's another matter when it comes to generating ssb signals. There are still those hardy few who hold that building is half the fun of getting there. For these, here is a 9-MHz selectable-sideband filter-type ssb generator.

description

Referring to **fig. 1,** two stages of audio amplification increase the microphone output to the proper level to drive the balanced modulator. A switchable 9-MHz oscillator drives an emitter-follower isolation stage, which in turn provides both drive to the balanced modulator and a variable-level carrier for injection into the output amplifier. An additional audio stage and a rectifier/filter network provide a dc vox voltage.

audio stages

A schematic of the complete ssb generator appears in **fig. 2.** The first audio stage, Q1, is a 3N128. It provides the high input impedance suitable for a ceramic microphone. The rf choke and bypass capacitor in the input help prevent any rf feedback. The first stage provides about 20 dB gain.

The second stage, Q2, provides about 30 dB gain or more and has a low-pass network in its output to restrict the high-frequency audio response. This network has the dual purpose of improving the supression of the audio components above 3 kHz and eliminating any rf at this point. There is also some low-frequency rolloff below 300 Hz, which is provided by small values of coupling and bypass capacitors in the first stage. This low-frequency rolloff helps suppress the opposite sideband components near the carrier frequency and eliminates the non-essential low-frequency components in the wanted sideband.

The third audio stage provides a low-impedance output to the balanced modulator. This circuit has a pair of diodes connected as a limiter, which allows about 8 dB compression without objectionable distortion. The level at this point is 0.7 Vrms maximum.

An additional output with variable level is provided from Q3 to drive Q4, the vox amplifier. The two diodes and filter network driven by Q4 provide a maximum of about 6 Vdc to drive an external vox-control relay. This voltage can be made poistive by reversing the diodes.

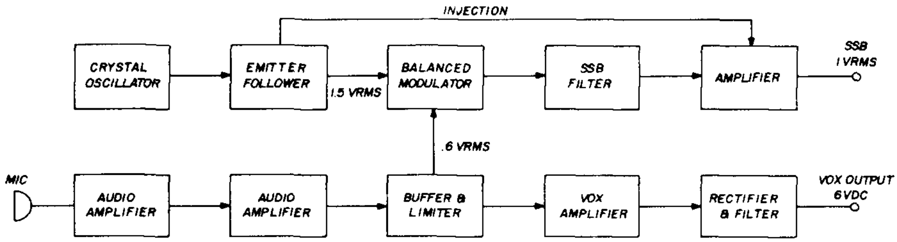


fig. 1. Block diagram of the 9-MHz selectable-sideband ssb generator.

carrier oscillator

The carrier oscillator, Q5, provides a carrier on either the upper or lower slope of the filter bandpass to produce lower and upper sidebands. The carriers ideally should be at the -6 dB points or lower. The capacitors across the crystals locate the carriers on the skirts.

The emitter-follower stage, Q6, provides isolation between oscillator and balanced modulator. The pot in the emitter of Q6 provides a variable-level carrier for tune-up, cw, and a-m operation. The input coupling network to the follower provides both bias and the proper drive level. If a 1-pF capacitor isn't available, use a capacitive divider to keep the drive level down.

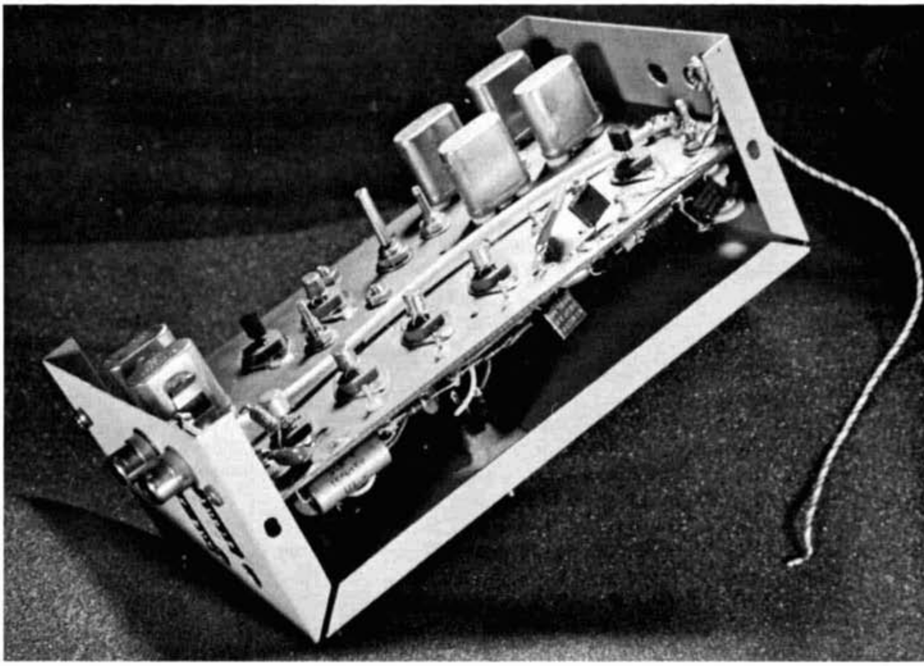
balanced modulator

The balanced modulator is of the two-diode variety, with unbalanced inputs for the audio and rf, and balanced output. The two diodes should be reasonably matched for forward resistance. The rf level should be about 1.5 Vrms into the arm of the balance pot. The ratio of rf to audio should be greater than 2 to 1. Since the limiter in the audio circuitry holds the audio to about 0.6 Vrms, this condition is met. The diodes couple into a balanced bifilar winding (the primary of T1). A bifilar winding is shown in **fig. 3.**

crystal filter

Crystal-filter design may seem difficult, but I have built two of this type with satisfactory results. The input to the filter is stepped down in impedance by a capacitive divider across the balanced modulator output transformer. The crystals used in filter were ordered in HC6 holders, series resonant, 2 kHz apart. Filter bandwidth is about 2.2 kHz at the 3-dB points. Transformer T2 is not tuned; the core is centered in the bifilar winding. The output of the filter is stepped up in impedance by T3 to provide drive to the gate of the output stage. You might think about buying a commercial filter if you don't want to bother with the alignment problems, although a filter can be built for less than half the price of a commercial model.

The output amplifier, Q7, increases the filter output to 1.0 Vrms through a capacitive divider into a 1k load. The 510-ohm resistor in series with the gate was needed to stabilize this stage. Lower impedance loads can be fed by changing the ratio of the capacitors in the divider.

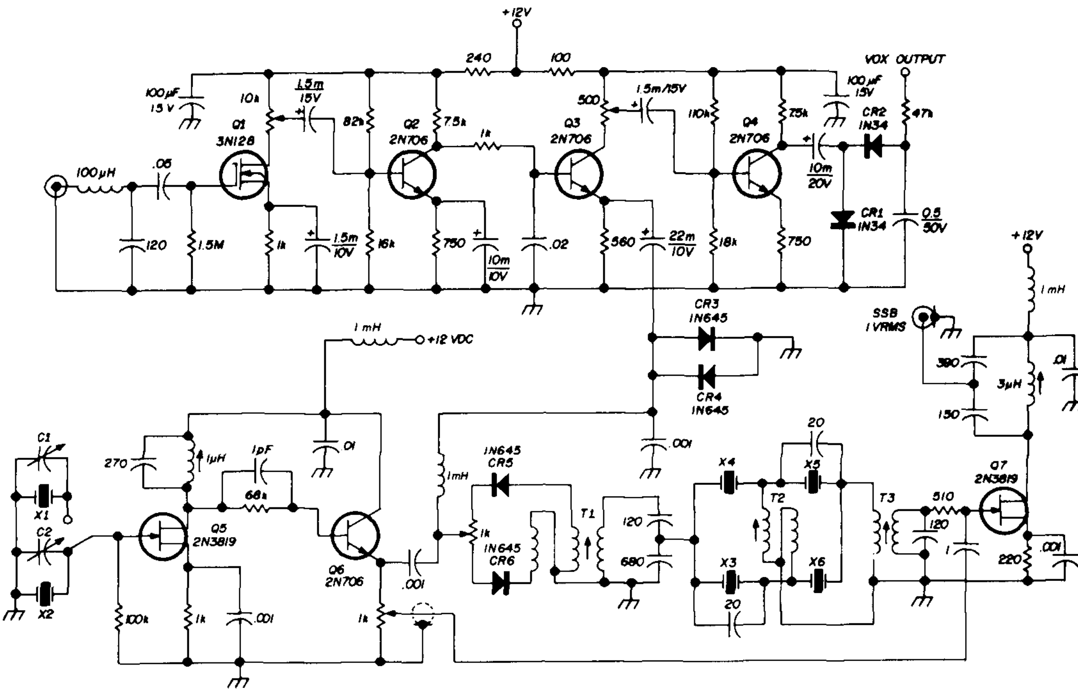


General arrangement of parts. Chassis is 0.032-inch double-clad board; unit is housed in a box fashioned from aluminum siding.

construction

The ssb generator is constructed on .032-inch double-clad board, using transistor sockets and standoff terminals as required. It would be easy to use an etched-circuit board. Having a copper layer on the transistor side of the board shield separates the oscillator from the balanced modulator.

The component side of the board faces the front panel of the unit. Short wires are run from the board to the controls on the front panel. The control location and board layout were coordinated to place



C1, C2 2 — 20 pF (variable or selected)

CR5, CR6 matched for forward resistance

T1 4 turns bifilar primary, 3 uH secondary*

T2 6 turns bifilar wound on ¼" form

T3 5:1 ratio, 3 uH secondary*

X1 8.9995 MHz (parallel resonant with 32 pF)

X2 9.0015 MHz (parallel resonant with 32 pF)

X3, X5 9.0020 MHz (series resonant)

X4, X6 9.0000 MHz (series resonant)

*3 uH coils are J. W. Miller 40A336CBI

fig. 2. Ssb generator schematic. The circuit includes provisions for af-component conditioning and speech compression. A voltage is also available for an external vox relay.

provides good shielding and a good ground plane to prevent ground loops. An inch-high shield is installed between the audio and output amplifier stages on one side of the board and the rf circuitry on the other side of the board. Another

the controls over the circuits to which they connect. A ground was necessary between the top of the balanced modulator shield and the front panel to prevent rf leakage from the oscillator to the balanced modulator. The oscillator crystal cans are grounded by clips on top of the crystal sockets.

The generator is housed in a 6-1/8 x 3-1/4 x 2-1/2-inch homebrew minibox made from a piece of aluminum siding. The board is held in place by no. 4 screws through brass tabs soldered to the corners of the board. In my application, the box is mounted behind the front panel of a homebrew exciter, with the controls projecting through the panel. The controls are fastened to the front panel of the box with silastic so the controls will stay in place when the nuts are removed.

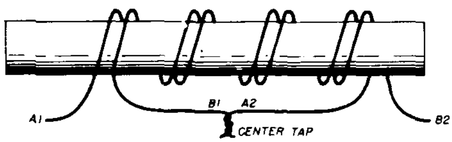


fig. 3. Bifilar winding used on transformers in the balanced modulator and filter sections. A1 indicates the beginning of one wire; A2 is its other end. Wire B is wound next to wire A. Wires should be twisted for best balance.

alignment

The tuned circuit in the oscillator output should be set far enough above the operating frequency to ensure starting and equal outputs with either crystal. The capacitors across the crystals should be adjusted so the carriers fall on the -6 dB points on either side of the crystal filter bandpass. See **fig. 4** for carrier placement. The crystals in the oscillator should be a bit low in frequency to operate with the standard 32-pF capacitance in the parallel-resonant mode. Frequencies of 8.999 and 9.001 MHz will do. The lower-frequency crystals may be easily pulled up in frequency by reducing the capacity across them.

When properly aligned, the filter bandpass should be as in **fig. 4.** Several methods can be used to align the filter. The most desirable method is to inject an fm signal into the filter and display the output on a scope synced to the fm sweep. In the absence of this test equipment, an audio signal can be injected into the rf choke feeding the balanced modulator pot. If the amplifier output is observed on a receiver S meter, the filter bandpass can be plotted as the frequency of the injected audio is swept from 100 Hz to 4 kHz. The filter bandpass char-

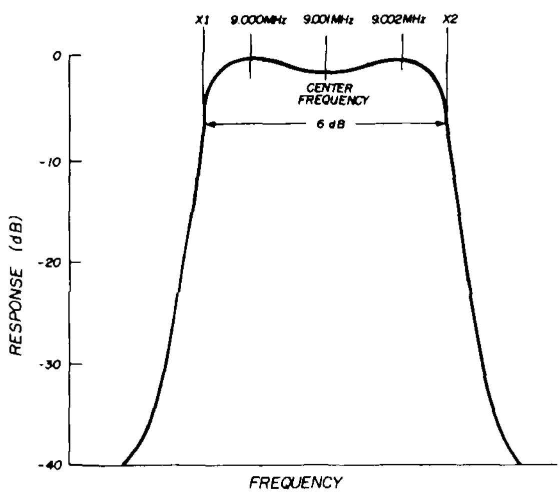
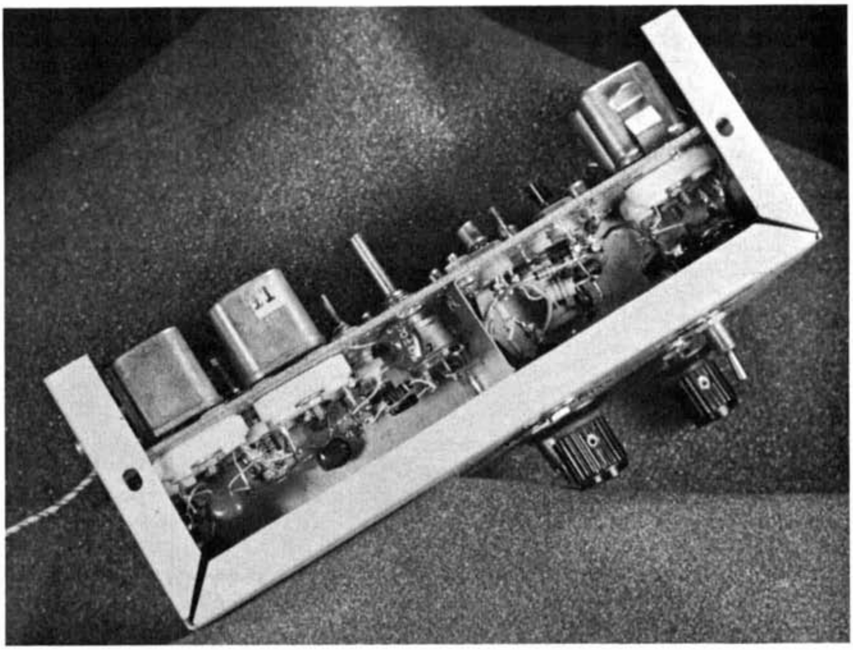


fig. 4. Crystal-filter characteristic. X1, X2 show carrier placement; 9.000 and 9.002 MHz represent filter bandpass.

acteristic is affected by the tuning of T1 and should be adjusted for equal level of the two peaks. Capacitor C1 can then be adjusted by setting it for minimum capacitance, watching the level on the s-meter, and increasing C1 until about 6 dB (or one S unit) decrease is noted. Capacitor C2 is set to maximum capacity, then backed out for the same results as with C1.

(together with a crystal oscillator), and this mixer drives a second mixer together with a 5.0 to 5.5-MHz vfo for 80 – 10 meter output. The first mixer can be omitted, and output can be obtained on 80 and 20 meters only (9 MHz plus or minus the vfo frequency). For 6-meter operation, a vxo could be multiplied to 41 MHz and mixed with the 9-MHz ssb signal to obtain 50-MHz output.



Another view of the ssb generator. Shielding between compartments is important to eliminate crosstalk between rf and audio stages.

The balance pot should null the carrier to –35 or –40 dB. The additional –6 dB from the filter will make the carrier rejection a minimum of –40 dB. If this can't be achieved, the carrier may be leaking around the balanced modulator, or a small balance capacitor may be needed on one side of the balance pot.

applications

Numerous combinations can be used for vhf or hf ssb transmitters. In my transmitter the generator drives a mixer

The bandwidth of the ssb filter may be a bit narrow for some voices, but it can be easily increased by using 2.5 or 3.0 kHz spacing on the filter crystals. I've had no complaints about the intelligibility, and I am able to compete for the dx with those who use exciters with similar power levels.

Why not try a little construction? There's nothing to compare with the satisfaction gained in creating something worthwhile.

ham radio

radio-frequency interference

Man-made interference can raise havoc with radio communications. Here's how to locate and cure troublesome noise sources.

Jim Fisk, W1DTY

As the number of sunspots goes down, and solar activity declines, more and more amateurs will be emigrating from 10 and 15 meters and lining up for clear spots on 80 and 40. This year there should still be a few good openings on the upper h-f bands, but good DX propagation during the evening hours will probably be limited to 80 and 40, and occasionally, 20 meters.

If you haven't had your receiver tuned up on 80 or 40 recently, you've probably forgotten the man-made interference you run into on our lower bands — hash from 15 kHz horizontal oscillators in local television sets, noise from vacuum cleaners, washing machines, refrigerators and other electric-motor appliances, as well as interference from furnace ignitors, fluorescent lights, and thermostats.

If you live in the country the problem is not as severe as in the city, but the ambient noise level on a cold winter night can still cover up a weak signal on the low end of 80. If you live in the city, you're apt to turn on the receiver, scan the band, note the S8 noise level, and opt for a quiet evening of television.

Unfortunately, most of the man-made noise that interferes with amateur communications must be cured at the source. If you put a brute-force line filter (see **fig. 1**) in the ac power line to your receiver, install a noise blanker, and make sure everything is well grounded you've taken steps in the right direction, but you can still look forward to a few quiet evenings in front of the one-eyed monster; noise blankers simply aren't effective against all forms of noise, and some of the noise is picked up by the antenna, not the line cord.

tracking the noise

The first problem is to find the source. After you find the culprit you can take the necessary steps to suppress the noise. If you have a mobile setup, you can cruise around the neighborhood looking for the area where the noise is the loudest. However, this approach works best in the country where the houses aren't too close together. If the noise source comes from a densely populated residential area or a high-rise apartment building, your mobile receiver isn't portable enough to track down the source.

The best bet for tracking down noise is a small lightweight battery-powered receiver that is easily carried about. The late Davco DR-30 is ideal, but not too many of us are lucky enough to have one in the shack. A simple direct-conversion receiver such as the one described by K1BQT[1] is perfectly suitable, as are any number of other simple receivers. The other alternative is to build an inexpensive receiver expressly for the purpose of locating troublesome noise sources. An excellent low-cost unit that tunes from the broadcast band to 225 MHz was described by W1CER in *QST.*[2]

finding the source

Tune your noise-seeking receiver to the highest frequency where you can hear the interference, back down on the gain until you can just hear the noise, and start driving. If the noise drops out, turn around and go in the opposite direction. The noise level will build up as you approach the source. Back off on the rf gain and keep driving until the noise disappears again. Turn around then go back, carefully checking the noise level. After two or three tries you should be able to pinpoint the source within two or three houses. Now get out of the car and walk up and down the street until you can determine which house is creating the interference.

Once you have located the noise source, you can't go any further until you talk to the householder and get his aid in tracking down the exact source. Be diplomatic. Don't accuse him of interfering with your receiver; ask him if he is having interference to his television or a-m broadcast set. If the noise source is in his house the interference will be more severe and he will probably ask you where it's coming from.

Turn up the gain on your receiver so he can hear the interference and show him that it's the same on his tv set or broadcast receiver. Then explain that you'll have to go through a process of

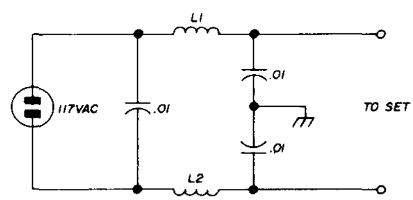


fig. 1. Brute-force power-line filter. L1 and L2 are 28 turns no. 14 enameled, ½" diameter, spaced to a length of 3½" (use a ½" wooden dowel for a form). The two coils should be wound in opposite directions.

elimination to locate the problem. Ask him to turn off his circuit breakers one at a time to make sure his house is *not* the source. *If* the noise disappears with the click of one of the circuit breakers, check out all the appliances in that circuit until you find the offending device. Then ask him to have it corrected — there are filters on the market for practically every type of electrical noisemaker.

On the other hand, if the interference isn't coming from his house, you have more detective work to do. When you have found the source and had it corrected, let him know the problem has been found, and thank him for his assistance. He'll be grateful for your help in getting rid of the interference and will probably tell his neighbors — score one for amateur radio.

For more information on identifying and tracking down radio interference, read the excellent articles by WA6FQG.[3]

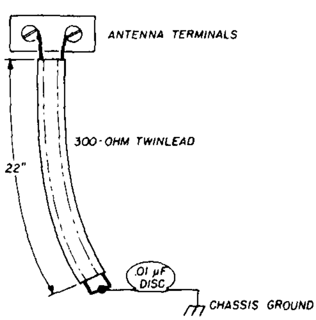
tv sync interference

One of the more troublesome sources of radio interference is the 15,750 Hz horizontal sweep oscillator found in every television set. The fast rise time of the output waveshape results in harmonics that can often be heard on the 28-MHz band. The FCC has radiation-suppression requirements for new sets, but these can still cause interference on 80 and 160 meters. Older sets have no suppression and have been known to cause interference as high as 28 MHz! Tv sync interference is easily identified because it takes the form of rather unstable ac-modulated signals spaced at intervals of 15.75 kHz.

Tv sync interference is usually radiated by the line cord, the antenna feedline or the sweep circuit wiring. In many cases it can be cured by installing a highpass filter at the antenna terminals and bypassing each side of the ac line where it enters the tv chassis with .01 μF disc capacitors.

If these two steps don't stop the interference, cut a piece of 300-ohm twinlead 25 inches long and strip 1½ inches of insulation from each end as shown in **fig. 2.** Twist the leads of one end together and connect a .01 capacitor from the twisted leads to chassis ground. Connect the other leads to the antenna terminals of the television set. This shorted stub presents a high impedance across the antenna terminals at the television frequencies, so it doesn't degrade the performance of the set, but at the 15.75 kHz sweep-oscillator frequency it looks like a dead short to ground.

fig. 2. Shorted 300-ohm stub across antenna terminals prevents radiation of tv sync pulses.



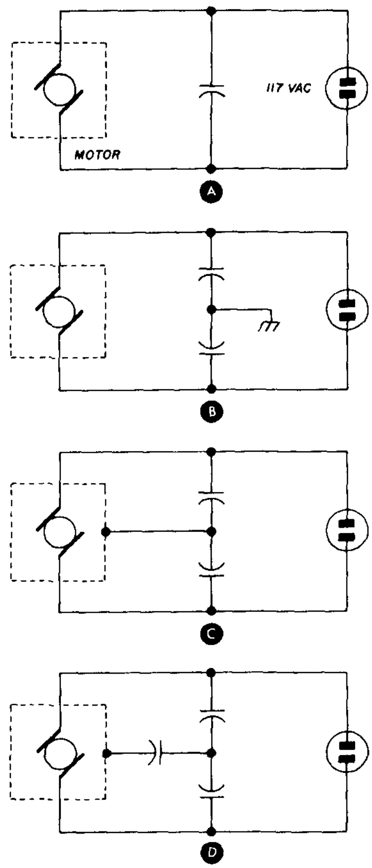


fig. 3. Methods for installing filter capacitors across noisy electric motors. Capacitors may be from .002 to 2 μF, see text.

Tv sync interference is sometimes radiated by the wires that run to the base of the picture tube. This can be cured by wrapping the wires with aluminum foil and grounding the foil to the tv chassis. (Don't wrap the high-voltage lead going to the side of the tube.)

Severe cases may require shielding the B+ wiring and additional bypassing in the sweep-oscillator stage, or lining the inside of the cabinet with screening, but at this point it would probably be worthwhile to consider a newer television set.

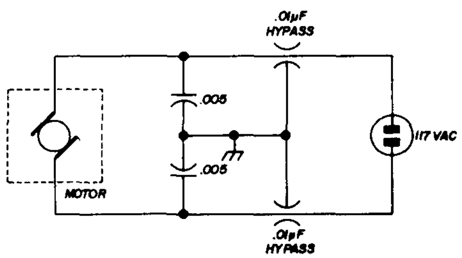


fig. 4. When the simple filter circuits shown in fig. 3 don't suppress the noise sufficiently, .01 μF Sprague Hypass capacitors should be added in each side of the line.

electric-motor interference

Most of the newer motor-powered appliances have built-in noise suppression devices but many older units do not. Series or universal motors are usually used in small household appliances such as electric razors, vacuum cleaners and food mixers. Induction motors are used in larger equipment: refrigerators, washing machines, ventilating fans, etc. Induction motors with split-phase starting have no commutators and are not noise makers unless they are exceptionally dirty. However, many motors use a commutator for starting only, so radio interference is only caused for a few seconds.

To eliminate radio noise from a commutator-type motor, have the commutator turned down on a lathe, re-seat the brushes, install a well-grounded filter as close to the motor as possible, and keep the commutator scrupulously clean. However, it's usually difficult to keep commutators in series motors in good condition because of their small size, so some sparking will inevitably result.

The most effective radio-interference filter is a large capacitor installed as close as possible to the noise source. Capacitors may be used in any of the ways shown in **fig. 3** – values will vary from 0.002 to 2 μF. For portable appliances the filter capacitors are limited in size by the requirement that possible current to ground through the capacitor may not exceed 0.3 mA. This protects the user from appreciable electrical shocks. The capacitors used in **fig. 3C**, for example, should not be larger than 0.005 μF: those used in **fig. 3D** should not exceed 0.01 μF.

In fixed installations which are permanently grounded the capacitors can be much larger, with a value of 2 μF as the practical upper limit. An excellent capacitor for this purpose is the 2-μF mylar capacitor sold by J. W. Miller. This capacitor, the Miller type 7804, is rated at 220 volts ac/dc and is designed to withstand transient surges up to 1000 volts.

If the simple capacitor filters shown in **fig. 3** do not reduce radio interference to an acceptable level, add a 0.01 μF Sprague Hypass capacitor in each of the power leads as shown in **fig. 4.** These coaxially-constructed capacitors are effective radio-interference suppressors up to 150 MHz.

Most cases of motor-generated radio interference can be suppressed with the circuits of **figs. 3** or **4** but occasionally you may run into a stubborn machine that requires the added suppression of an LC circuit. The best circuit for this purpose is the one recommended for your receiver (see **fig. 1**), although there are a number of compact commercial units available. A summary of commercial line filters and their wattage ratings is shown in **table 1.**

fluorescent-light interference

Fluorescent lights, especially fluorescent desk lamps, are about the worst offenders found in any house. They are difficult to cure because they radiate radio interference through the ac power lines as well as through space. To solve ac line radiation build the circuit of **fig. 5** into the base of the lamp and use an effective ground.

Direct radiation at distances closer than about 10 feet from the lamp is practically impossible to eliminate, although an rf shield of ¼" mesh screen may be placed across the opening of the reflector hood.

One type of fluorescent fixture that is particularly difficult to cure is the two-bulb lamp that uses pushbutton switches rather than a starter. One suppression method that is effective in these lamps is shown in **fig. 6.** Disregard B1, C1 and RFC1 if only one bulb is used: the start switch will be an spst type.

table 1. Commercial interference filters for installation in the ac line.

wattage	V	manufacturer	type	model	application
50	115	Miller	LC	7817	electric shavers
60	120	Miller	LC	7812	teletype motors
80	220	Miller	L	7878	fluorescent lights
220	115	Miller	LC	7818	small appliances
310	125	CDE	LC	NF10280	small appliances
325	125	Aerovox	LC	IN-106	fluorescent lights
550	115	Miller	LC	7815	large appliances
660	115	Miller	C	7816	household appliances
660	120	Aerovox	LC	IN-42	household appliances
980	280	CDE	LC	NF10431	household appliances
1100	220	Miller	LC	7880	uncased, heavy duty
1150	230	Miller	LC	7814	business machines
2200	220	Miller	LC	7881	uncased, heavy duty
—	120	Aerovox	C	IN-105	fluorescent lights
—	120	Aerovox	C	IN-27	small appliances
—	15 kV	Miller	L	7875	neon signs

other interference

Although electric motors, tv horizontal oscillators and fluorescent lights are the primary causes of rf interference, other devices can cause problems too — neon signs, diathermy, furnace ignitors and tv boosters — any device that is electric powered is a potential source of interference. Don't overlook that baby-bottle warmer, electric iron or electric blanket; they all contain a thermostat that generates a small arc each time it closes.

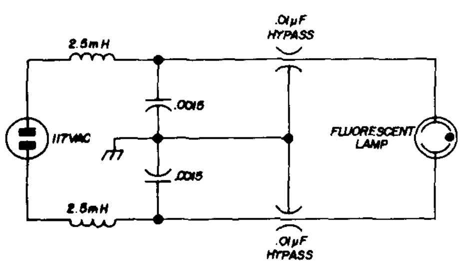


fig. 5. Circuit for suppressing interference from fluorescent lamps.

To eliminate interference from neon signs, replace any defective tubes, bond together all the conductive pieces in the field of the sign and check the insulation. High-tension filter chokes are available to eliminate neon-sign hash from the power line. One example is the J. W. Miller model 7875 insulated for 15,000 volts and designed for continuous operation up to 100 mA.

Thermostatic-arc interference is best suppressed with a filter capacitor as close to the contacts as possible. This type of interference is usually not too troublesome unless the contacts are especially dirty.

Rf heating units are another problem area. These units are found in diathermy machines and many industrial heating units. Since these units generate rf they must be licensed by the FCC, and must meet FCC standards regarding spurious emissions. However, if the unit is tuned incorrectly, or operated improperly, severe rf interference can result. To cure interference, make sure the rf heating unit is grounded and shielded. Check frequency and harmonics; reduce drive to the final amplifier to reduce harmonic output, and if necessary, install traps and filters.

apply graphite-type belt dressing to the belt and bond the machines together and to ground.

One other type of interference that can give you fits is power-line noise — noise generated by arcing at dirty or broken insulators, tree limbs touching the wires or faulty transformers. However, unless you live near the ocean or in an area of heavy air pollution, the in-

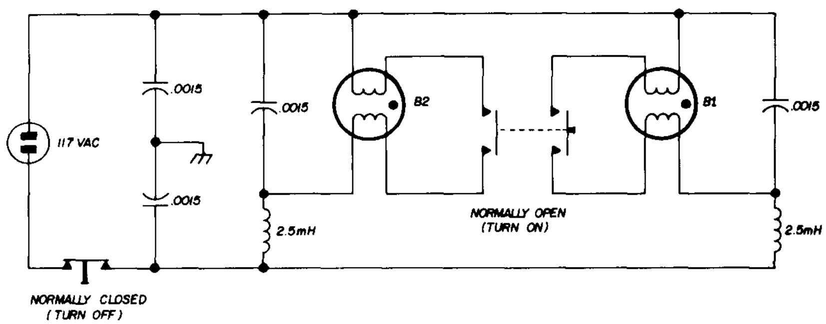


fig. 6. Noise from fluorescent desk lamps is particularly hard to cure — this circuit usually does the job.

Oscillating tv boosters are another source of interference, but not on the lower amateur bands. The first step here is to check the neutralization of the oscillating stage, check the dress on the input and output leads and provide more adequate shielding.

Remotely-controlled garage-door openers, if they use a superregenerative receiver, generate a lot of unnecessary rf interference that is best cured by replacing the culprit receiver with a non-radiating type.

Furnace ignitors, such as those used in oil burners, can generate an unbelieveable amount of hash that covers the lower amateur bands. Heavy-duty spark-plug suppressors and a line filter will usually quiet them down, but make sure that the burner unit, furnace and blower motor are all bonded together and grounded.

If your interference is emanating from a highly industrialized area, belt static may be part of the problem. To cure this,

sulators are usually cleaned by the rain. Crews from the power company try to keep branches trimmed back away from the lines, so that isn't often a problem, and modern oil-filled power transformers are designed for extremely long service. The result is that modern power distribution systems are *not* prominent noise makers, although they may act as a huge antenna for other noise sources. When they are found to be responsible for rf interference the power companies are usually helpful in finding and fixing the cause.

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ham radio

the rf bridge

Don Nelson, WB2EGZ, 9 Green Ridge Road, Ashland, New Jersey 08034

Sometimes an important idea goes unnoticed or is not sufficiently developed to gain wide acceptance. Such, I believe, is the case of the radio-frequency bridge. The rf bridge has been marketed for many years by the General Radio Company;[1] however, this precision instrument is probably too expensive for most amateurs. A moderately priced rf bridge, manufactured by Omega-t Systems,[2] has been available for several years. Oliver Swan, W6KZK, described the basic circuit of the rf bridge in an earlier issue of *ham radio.*[3]

Few hams seem to have recognized the advantages of the rf bridge over the simple vswr bridge. The rf bridge, for example, will allow you to optimize your antenna, thus reducing the dependency on a matching network. The rf bridge has other uses as well, some of which I'll discuss in the following paragraphs.

the circuit

The instrument consists basically of a broadband noise generator coupled to a bridge network by a wideband 1:1 balun transformer. By carefully compensating for circuit strays, the bridge upper frequency limit can be extended to 450 MHz.

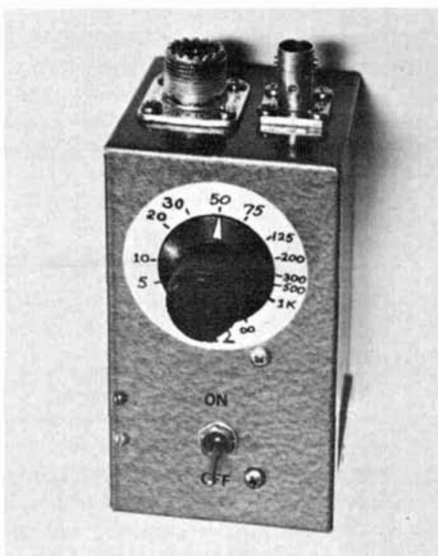
The circuit of **fig. 1** was developed not without some difficulty, mainly in reducing circuit strays and constructing the balun transformer. In its present state of development, this circuit is useful to 220 MHz.

The noise generator uses a zener in an unstable (thus noisy) mode by operating it at low current. It will pay to experiment with the value of R1 for the highest noise level of your zener. When the noise-generator output is amplified by a two-stage broadband amplifier, the instrument is useful from about 1 to 450 MHz; again, the upper frequency limit is determined by how well wiring strays are compensated.

construction

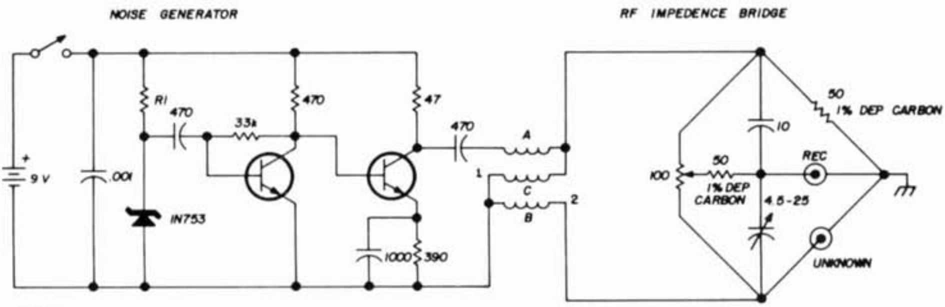
Simple construction was used, with parts mounted on a perforated board. Battery power was used for maximum utility. Wiring the bridge circuit is tricky, as might be expected with broadband equipment. If the layout shown is followed, you can expect good results. I feel there may be better layouts, and I'm sure

Recommended replacement for the common vswr bridge — the radio-frequency bridge and noise generator.



that every unit built will be slightly different with regard to compensation for circuit strays.

By far the most difficult part of the tennas, receivers, quartz crystals, and other series-resonant circuits. You will, of course, need a receiver for null detecting at the frequency of interest.



NOTES:
1. R1 - CHOOSE SUITABLE VALUE FOR BEST NOISE OUTPUT (APPROX 2200 OHMS)
2. TRANSISTORS - 2N918, 2N3563, OR HEP 56.
3. 0.375 OD TOROID FORM, INDIANA GENERAL CF 102, CORE MATERIAL Q3

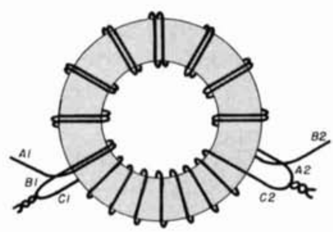


fig. 1. Schematic of the rf bridge and noise generator, A. Windings A and B of the balun are no. 26 Formvar twisted 3 turns/inch before wrapping on core. Nine turns of the twisted pair are wound on the core. Winding C is also 9 turns of no. 26 Formvar, continuing the A and B winding direction and connecting A2 to B1.

construction is the toroidal balun. The resultant transformer,[4] shown in **fig. 1** has broadband characteristics that exceed those of the more common trifilar-wound units. Pay strict attention to details!

The bridge section was laid out with regard to uhf performance, keeping wires on one side of the bridge equal to those on the other. Wiring strays are compensated by balancing them with the exact capacitor combination that gives the best null. Because I have found the trimmer adjusts slightly differently on 6 meters and higher, I assume there are a few sneaky rf paths. One suspect component is the large carbon potentiometer. Our sophisticated doubts about the layout are unfounded below 30 MHz, however. (Solid relief for the unsophisticated worrier.)

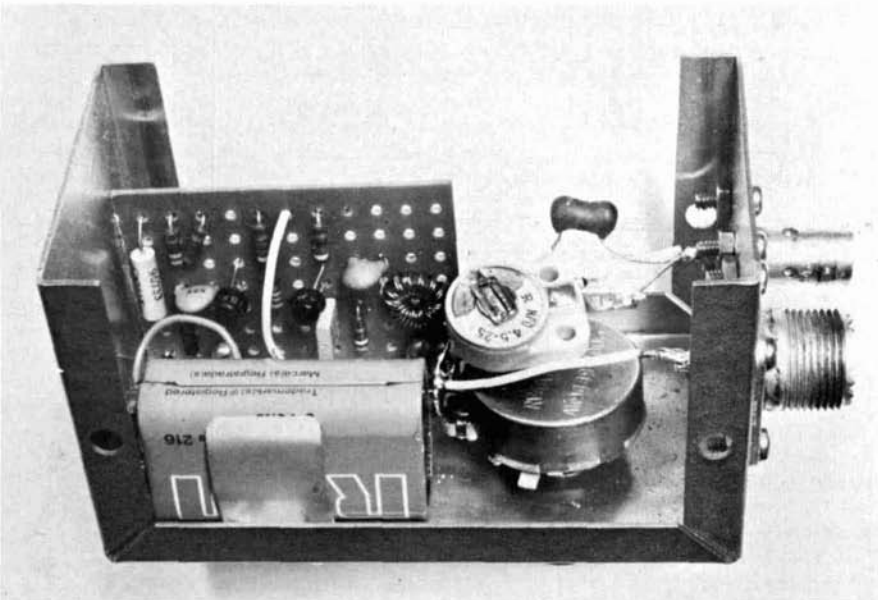
This gem is self-contained in a Bud CU2103-A Minibox, ready to check an-

calibration and use

In theory, if not in practice, the 100-ohm pot will balance any resistance placed in the "unknown" arm of the bridge. At one end of the scale is zero; at the other is infinity. Fifty ohms is midrotation with a linear pot. At 50 MHz and higher, I've found a rotational shift of the 50-ohm (rf) point. This means a special calibration check will be necessary at very high frequencies (vhf). Normally, for the hf range, the dial calibration will hold. The best null is at midrotational scale. Because the null deteriorates at the extremes of rotation, it is not worthwhile to use the instrument beyond a 20-to 300-ohm range.

Calibration is performed using non-inductive resistors of known values placed, then nulled, across the UNK terminal, with a receiver connected to the

REC *terminal.* Carbon composition resistors are fine if values are known to 5%. Above 100 MHz, deposited carbon resistors are preferable because of their low inductance. The dial plate should be vswr bridge; but without a tedious procedure, the lowest vswr will probably occur at a frequency different than that of optimum transmission. The rf bridge technique eliminates the tuning error, and



Parts layout, which should be followed closely for trouble-free results.

calibrated in the hf range, say 10 MHz. Trim the bridge capacitance for best null with a 50-ohm resistor and correct setting of the pot. Don't be too surprised if a 50-ohm resistor changes value through the vhf range.

antenna matching

Tuning an antenna with a vswr bridge is a hit or miss proposition, because the vswr bridge confuses resistive and reactive impedances. I don't mean to imply that accurate tuning is impossible with the allows an accurate measurement of vswr once the antenna is correctly tuned.

1. First connect the rf bridge directly to the antenna or at an electrical half wavelength away from the antenna. An electrical half wavelength is different from the physical length of the wire. You can determine the electrical half wavelength with this bridge by *setting the bridge to zero and placing a* short across the end of the transmission line. Now cut small lengths from the line until a null is obtained at

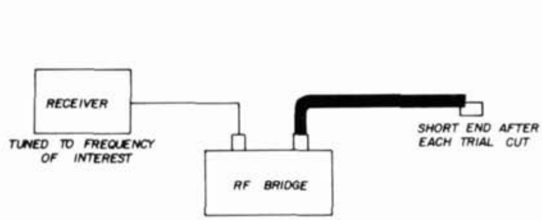


fig. 2. Determining one-half wavelength of transmission line when using the rf bridge for antenna measurements.

the frequency of interest (fig. 2). Using a half wavelength or multiple thereof effectively places the bridge at the antenna, thereby reducing transmission-line errors.

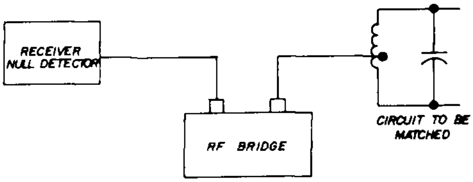


fig. 3. Arrangement for matching input circuits.

2. Tuning the antenna to a frequency is the next step. You will find its resonant frequency by a null on the receiver. A sharper null will be seen with the bridge adjusted to the impedance of the antenna system. Adjust antenna length until the null occurs at the desired frequency.

3. By adjusting the matching section, tune your antenna to the desired impedance as shown by the rf bridge.

other uses

Any series-resonant circuit can be checked with the rf bridge. This, you will recall, is the combination that cannot be dipped easily on a grid-dip oscillator. Place the LC combination across the UNK terminal with the bridge dial set to zero. Tune receiver for null. See **fig. 4**.

If a resistance is in series with L and C, the bridge will show its value. An interesting example of an R, L, C combination is the quartz crystal. While this bridge has limitations in crystal measurements, it is utilitarian. Set the dial to infinity (minimum noise for open circuit). Tune the receiver for an increase in noise at the resonant frequency of the crystal. Adjust the bridge for null. This value is the resistance of the crystal's RLC arm. In general, the lower this value, the higher will be the activity of the crystal.

The rf bridge takes over where the vswr bridge leaves off. To my embarrassment, the rf bridge singled out several mistakes in my station, as it may in yours. I feel certain that building this bridge will be the most rewarding project the experimenting amateur will undertake this year.

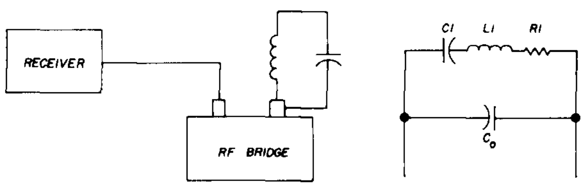


fig. 4. Connections for checking series-resonant circuits. Network at right is the equivalent circuit of a quartz crystal.

receiver input matching

Provided you already have a receiver to act as a null detector, you will find the rf bridge invaluable for determining the optimum tap position for inputs to converters, preamplifiers, and receivers. The procedure is the same as before, except that the UNK terminal is now connected to a receiver input. With the bridge dial preset to the desired impedance, adjust the tap on the antenna coil for best null (fig. 3).

Grateful acknowledgement is made to Mike Ward, WB2YJK, for his efforts in the design of this project.

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ham radio

avalanche-transistor circuits

Common transistors operated in the avalanche mode make excellent pulse generators — here's a simplified theoretical discussion and some application ideas

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This article describes avalanche transistors *in a simplified manner.* Basically, the avalanche circuit is a way to generate very high peak-power pulses from very small transistors. For example, a common 50-mW transistor can easily generate pulses with 100-W peak power. Such pulses not only have high power, but possess extremely fast rise times, which means they can generate harmonics into the lower microwave region.

Avalanche circuits are very simple and are useful in applications that require generation of harmonics, such as in frequency standards and in some types of low-level power generators at high multiplication ratios. When understood by the ham, more and more uses will be found for these circuits.

The "avalanche transistor" is a method of operating most any transistor rather than any special kind of transistor. This mode of operation is so simple as to be disbelieved until you build a circuit and see for yourself what magnificent pulses it will generate. **Fig. 1** is a schematic of a typical circuit. Most transistors will work in this circuit, and the rise time of the pulse is comparable to the highest frequency of oscillation for the transistor chosen. For example, a 2N918, 2N706, or the transistors in the μL914 integrated circuit generate harmonics to about 1000 MHz.

how it works

The transistor in **fig. 1** operates similarly to a zener diode. For many small transistors, the breakdown (zener) voltage from the collector-to-emitter junction is about 70-90 volts. This voltage depends on the base connection, which can have several configurations, ranging from V_{ceo} (base floating) to V_{cev} (base reverse biased). The collector-base junction breakdown voltage is shown in the device specification sheet as V_{cbo}. This parameter specifies the breakdown voltage with the collector-base junction reverse-biased, and with emitter open-circuited. All of these breakdown-voltage parameters are given at a specific ambient temperature, usually 25° C.

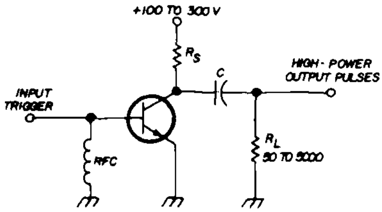

fig. 1. Basic circuit of an ordinary transistor operating in the avalanche mode.

When the transistor base is connected to the emitter, the transistor remains off, and only about 0.5 mA of collector current flows. This low current is due to the zener action and the current-limiting resistor, R_S.

When the base voltage increases to more than about 0.5 V above the emitter voltage, avalanche breakdown occurs. The transistor is then virtually a short circuit, and it will pass a high current. The voltage across the collector-base junction collapses in about 1 nsec for many vhf transistors.

charging circuit

When avalanche breakdown occurs, the current flow due to the charged capacitor, C, is limited only by the load resistor, R_L, and the small internal resistance of the transistor. If C were very large, the transistor would literally explode. Capacitor C is small in value to keep the current flowing just a little longer than its rise time, since nothing is usually gained by keeping the current flowing longer.

Capacitor C charges to the zener voltage at which the transistor operates; and during discharge, the current pulse in R_L is that voltage (70 V for example) divided by R_L, or about 1.4 A. The peak-pulse power is 70 V times 1.4 A, or about 100 W. The current flows for about two R_LC time-constant periods. In this example, R_L is 50 ohms and C is 20 pF; so the time constant is about 1 nsec. The pulse across R_L will therefore look somewhat like that shown in **fig. 2**.

This powerful pulse is about equal to a single half wave of a 250-MHz 100-watt cw transmitter. Due to the high power, harmonics will be heard above 500 MHz.

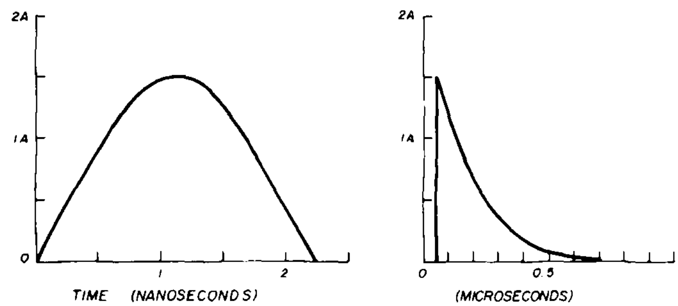

fig. 2. Approximate current pulses when load resistor R_L = 50 ohms. Time constant, R_LC, is approximately 1 nsec in A; 100 nsec in B.

Avalanche is controlled by a synchronizing signal introduced into the base-to-emitter circuit. Avalanche action occurs each time the input voltage rises above the 0.5-V trip point. Shown in **fig. 3** is a typical firing sequence when a sine-wave signal triggers the circuit.

If the input signal were 10 MHz, for example, this circuit using a 2N918 could generate harmonics to 1000 MHz. Zero beating the 10-MHz source with WWV would yield a signal at 1000 MHz accurate to better than 200 Hz. Not bad for a one-transistor circuit!

design details

Reviewing **fig. 1**, let's look at the input circuit from base to emitter. A coil was used, and rf was impressed across the coil. A low-value resistor could have been used. So long as the total resistance in the base circuit is less than a few-hundred ohms, the circuit will remain off until fired by the input signal. Remember that the zener current comes out the base.

If 0.4 mA flows, for example, the total resistance in the base must be low enough so that 0.4 mA won't cause more than about 0.2-volt drop across the base-emitter junction. More resistance will bias the circuit so that erratic firing will occur from noise or stray pickup. Obviously if the base resistance (or impedance, if it's a coil) is too low, it will be difficult to drive a 0.5-volt signal across the base-emitter junction; so don't go overboard on the low side either.

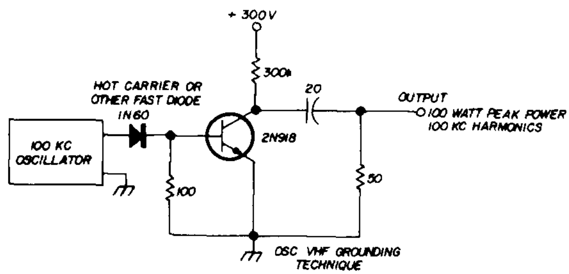

fig. 4. Example of a diode used to protect drive circuit.

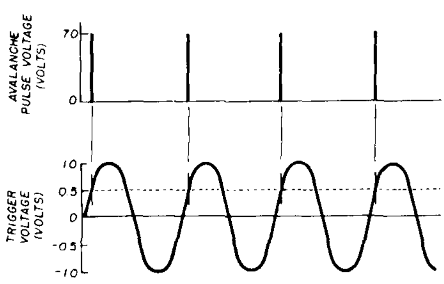

fig. 3. Relationship between avalanche-pulse voltage across the load resistor and a sine-wave trigger voltage.

erratic triggering

If a tricky application causes erratic firing due to pulse pickup, which you can't suppress, a bias of 1.5 V from a battery in series with the base resistor will restore stability. The input trigger voltage must overcome the added bias in this case, and a 2-volt trigger will be needed; but immunity from false-firing signals will be greatly enhanced.

If you don't use good uhf grounding technique, the pulse can feed back into the drive circuits. For example, the pulse can easily cause a 10-20-volt drop across a 1-inch emitter-lead length. That voltage will couple back into the trigger circuit and possibly upset it. A shorter emitter lead is obviously the answer; but if the shortest lead you can get still fouls up, use a diode to block the spike, as is shown in **fig. 4**. The ground should be within about 1/8 inch of where the lead exits from the transistor can for best results.

collector circuit

Now, let's look at the collector circuit to complete our design comments. The power dissipation of the circuit must be kept below the rating of the transistor. The zener voltage (70 V) times the current (0.4 mA) gives the dissipation (28 mW). The current in the transistor need only be large enough to recharge capacitor C between firing times. The recharge time constant is R_SC.

Allow two time-constant periods between firings for peak output. The circuit will fire at much less, however; it will fire even if C doesn't fully recharge, but reduced pulse amplitude will result, and stability will be a bit more fussy.

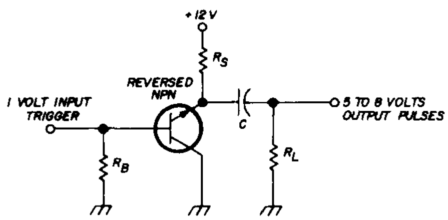

fig. 5. Typical circuit to permit use of low-voltage power supply. Transistor emitter and collector are reversed for this application.

power dissipation

Resistor R_S must be chosen to yield low current to stay within power-dissipation ratings as well as high firing by using a regulated voltage just larger than the zener level, and a low value for R_S to give high recharge current but low idling current. Power loss during discharge plus idling dissipation must remain within transistor ratings.

If you make C too large the junction can melt during a pulse or after a few pulses. The maximum C value must be found experimentally. More than .001 μF gets risky, but up to .01 μF can be used with some transistors. Expect to melt a few semiconductors when playing with a large C value.

low-voltage applications

A common problem with these circuits is the requirement for a high-voltage source. Very high pulse power is obtainable when high voltage is used, but many solid-state circuits use much less powerful pulses. By merely reversing the transistor (inverting it), we can get zener action at low voltage.

Fig. 5 shows a transistor with emitter and collector transposed. The zener voltage will be about 5-10 V, and the circuit may be operated from a 12-V dc supply.

avalanche oscillator

If resistor R_S is made adjustable, the circuit in **fig. 6** can be made to fire at a submultiple of the input signal, and you'll have what is known as an avalanche oscillator. Synchronization is a bit tricky, especially if the 12-volt supply isn't well regulated, but this one-transistor circuit can divide just like flip-flops or neon-bulb RC oscillators.

Because of their narrow width, the pulses generated by these circuits are hard to see on regular oscilloscopes, but usually something will show up on a 4-MHz scope in a darkened room.

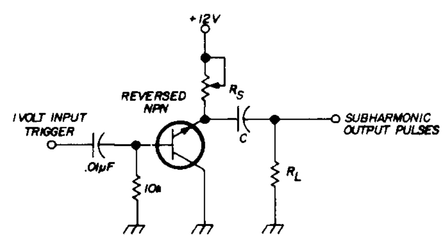

fig. 6. A free-running avalanche oscillator synchronized to a subharmonic of the input signal.

conclusion

Well, there you have it — brief, but with all the basics. These little gems will allow you to generate everything from a controlled, hefty, 1000-MHz calibration signal to one of the dangdest noise makers going.

Considerable circuitry can be eliminated in some applications. An avalanche circuit on the output of my 5-kHz calibrator produces S-9 signals up to 10 meters. This makes it mighty easy to find my own signal when calibrating.

ham radio

low-power transmitter

and indicating wavemeter

These ultrasimple circuits will introduce you to micropower communications — and a lot of operating fun

Alf Wilson, W6NIF, 3928 Alameda Drive, San Diego, California 92103

An interesting and challenging part of amateur radio that deserves more attention is communications using very low-power equipment. This is known as "QRP" operating. The name is derived from the international list of radio Q signals and means, literally, "reduce your power."

A most informative article on this operating mode is by Art Child, W6TYP (reference 1). Among other accomplishments using very low power, Art has made a 354-mile, two-way radio contact using a power input of 354 microwatts. This figures out to be *one-million* miles per watt. Undoubtedly this record has since been shattered, but it typifies one of the objectives of the QRP Club, which has several thousand members throughout the world.*

One of the problems when working with extremely low power is adjusting the transmitter for maximum output. With power of the order of microwatts, a pick-up loop and flashlight-bulb arrangement just doesn't have sufficient sensitivity to give a good indication of maximum transmitter performance. A receiver with an S-meter could be used for peaking the output of a micropower transmitter, but many hams don't have receivers with this refinement.

In QRP work, every bit of available rf energy is important. The slightest misadjustment of the transmitter can mean the difference between success and failure in making a contact. This article describes a simple indicating device that will aid the QRP enthusiast in adjusting the transmitter for maximum output. Also included is a schematic of a typical QRP transmitter for those who might wish to try their luck in the gnat-power regime.

*The QRP Club recording secretary is F. Behrman, K7LNS, 3425 S. E. King Road, Milwaukie, Oregon.

field-strength indicator

The circuit of **fig. 1** is simplicity itself. The arrangement to the left of the transistor is nothing more than a wideband diode detector and an rf-pick-up wire. This circuit has appeared in various forms in many amateur publications. The transistor circuit improves things by allowing a milliammeter, rather than a more expensive microammeter, to be used as an indicating device. The transistor operates as a current amplifier. With an input of 100 microamps applied to the emitter, a range of 0-100 microamps (approximately) can be measured with a 0-1 dc milliammeter. The circuit could be made more sophisticated to improve measurement accuracy, but all we're interested in is adjusting a QRP transmitter for full output power. Thus a relative indication is adequate for this purpose.

construction

I built my QRP field-strength indicator on a 2-inch-square piece of perf board, which fits nicely inside a universal meter case. I used an aluminum case, which costs a little more than the steel variety, but the aluminum is nonmagnetic and much easier to work with.* The finished unit has many other uses around a ham station. It's a great help when neutralizing rf amplifiers, or for making antenna adjustments. It can also be used as a detector for a-m phone signals.

A short length of vertical wire as a pickup antenna is adequate for use with transmitters of a few milliwatts or so. Sensitivity can be improved by using a 2-turn loop about 2 inches in diameter in place of the vertical antenna. Each pickup antenna (rod and loop) may be soldered to a phono plug for easy substitution. The loop works best when using the unit for neutralization.

Thus the indicating device is really nothing more than an improved version of the loop and flashlight bulb we used for tuning up our tnt oscillators in the olden days. Those who have tried to peak the power output of a QRP rig while trying to discern the barely perceptible glow of a flashlight bulb in a darkened room will appreciate this little gadget.

*Available from Allied Electronics, 100 N. Western Ave., Chicago, Illinois 60680. Stock no. 42F8542; $1.80 each.

qrp transmitter

Most serious QRP hams try to build the simplest possible transmitter using a bare minimum of components. Although the oscillator shown in **fig. 2** could be simpler, I've found this circuit to be the best compromise between reliability and simplicity. For example, many QRP rigs feed the antenna through a fixed capacitor tapped directly onto the tank coil, thus eliminating the coupling link and its mounting hardware. The direct-feed method, while certainly not the best example of good engineering practice, is okay for some situations. However, it's probably one of the most efficient harmonic radiators one could come up with. It seems improbable that a transmitter running such low power could cause interference to other services, but it can and has happened. In my case this little rig, running about 50 mW input on 21 MHz and using the direct antenna-coupling method, put a healthy 5th harmonic signal into the middle of the fm broadcast band on a neighbor's receiver. The problem was remedied by changing to the inductive-coupling method shown in the drawing.

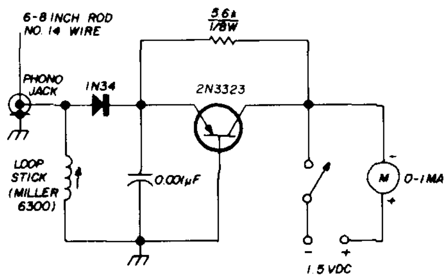

fig. 1. Rf indicating device for QRP transmitter tuneup. Current amplifier increases sensitivity of the milliammeter by a factor of ten.

construction

This little oscillator was built on a piece of perf board, which was trimmed to press fit inside a small metal box such as throat lozenges come in. The box measures 1 x 2 x 3½ inches and has a hinged lid. I mounted the crystal holder, tuning capacitor, and antenna output jack on the lid. When closed, the box makes a tidy package that fits in a shirt pocket. A coat of aluminum spray lacquer completes the job.

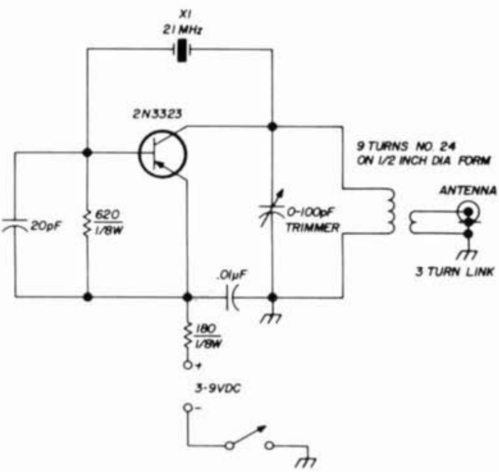

fig. 2. Typical QRP transmitter for 15 meters. It might be necessary to experiment with the feedback component values to obtain oscillation consistent with transmitter loading and good keying.

With small-signal transistors now available by the sackful for very little money, you could probably substitute a less-expensive device for the Motorola 2N3323s used in these circuits. However, at 60 cents each I felt that the 2N3323 was more than worth the price. It exhibits good power gain well into the vhf region and works well in both applications shown.

final comments

It seems that there are two camps among QRP operators, the purists and those not so pure (I happen to be one of the latter). The purists strive to limit their equipment to the barest of essentials, including receiver and antenna. While this is a very noble attitude, it requires the patience of a monk and unlimited time for operating. I tried the purist approach for awhile and managed to work one station. This fellow was operating mobile and heard my minibeeper when driving past the house. The QRP rig was loading a bedspring for an antenna. The contact lasted all of three blocks, so I finally gave up and connected the rig to the regular station antenna.

Working stations in the QRP mode under austere conditions is certainly an admirable achievement. If that's your bag – fine. But I've found that a good antenna and selective receiver make QRP operating less nerve wracking and much more fun.

reference

1. Arthur Child, W6TYP, "QRP – A New World to Conquer," *73*, May, 1969, p. 46.

ham radio

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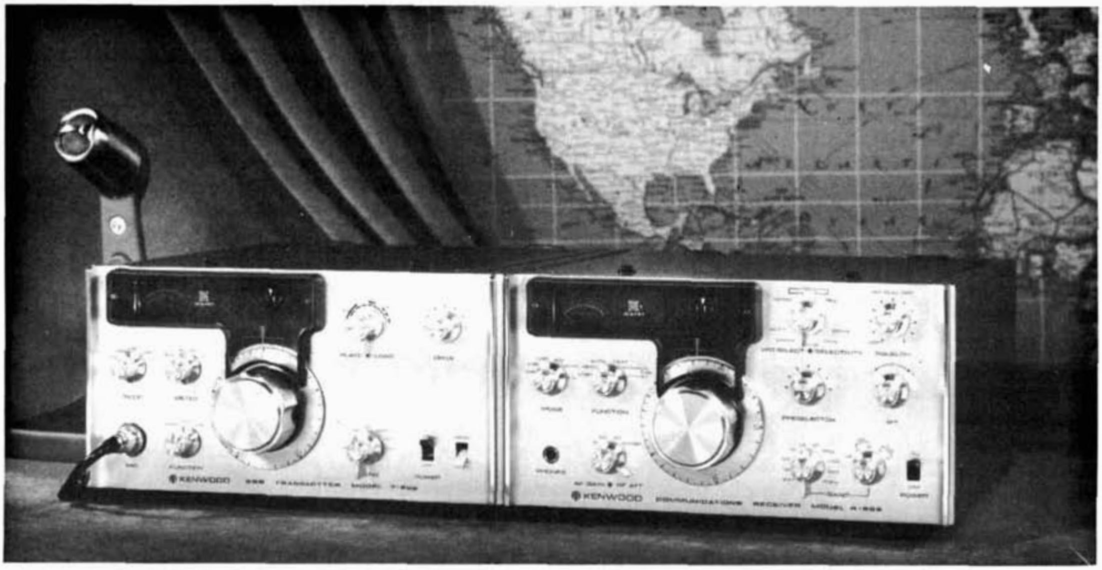

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a synchronous-phase afsk oscillator for RTTY

This circuit meets all requirements for generating the high-quality tone sinusoids necessary when using ssb transceivers in the RTTY mode

D. H. Phillips, W6FOO, 215 Carlisle NE, Albuquerque, New Mexico 87106

Audio frequency shift oscillators used to encode RTTY signals must operate in conformance with good design practice to avoid adjacent-channel interference. When an afsk oscillator is used with an ssb exciter to transmit carrier-shift fsk on the hf bands, the afsko must generate stable, sinusoidal tones. The ratio of space-tone to mark-tone amplitude must be variable to allow compensation for the combined frequency response of the microphone audio amplifiers and the crystal filter. This capability is required for adjusting the afsko so that the carrier power will be constant for both space and mark transmission. Finally, the most important afsko requirement for minimizing spurious signal generation on hf RTTY is that the transition from one tone to the other be accomplished without a phase discontinuity. The synchronous-phase afsko described here has all the required capabilities for generating the high-quality afsk waveforms required for transmitting carrier-shift fsk using an ssb exciter or transceiver.

The oscillogram of **fig. 1** shows the input-output characteristics of the synchronous-phase afsk oscillator. A positive input voltage greater than 0.7 volt constitutes a space command. The mark tone is generated for an input voltage less than 0.7 volt.

control circuit logic

The afsko uses a Signetics SP620A flip-flop IC.* The 620A is a dc-triggered, master-slave flip-flop that can be switched synchronously by using the J and K inputs together with a clock. The rising clock pulse cuts the slave off from the master. As the clock pulse rises still higher, it allows the logic at the J and K inputs to be set into the master. Then when the clock pulse returns to its low level, the state of the master is transferred to that of the slave which, in turn, sets the output levels. Transfer gate and master flip-flop gate thresholds are separated by sufficient voltage to guarantee that input and transfer cannot occur simultaneously.

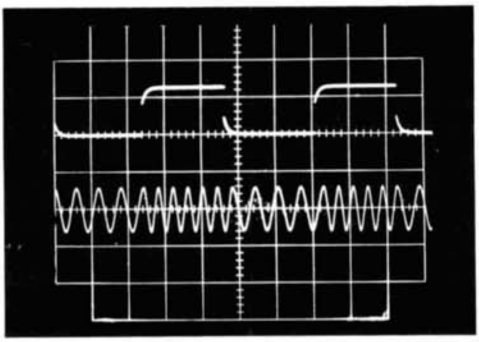


fig. 1. Input-output characteristics of the synchronous-phase afsk oscillator. Top is the input signal, 5 volts/division. Bottom is output signal 1 volt/divison, 1650 Hz mark, 2500 Hz space. Horizontal scale is 1 millisecond/division.

The flip-flop logic diagram, composed of AND and NOR gates, is shown in **fig. 2. Fig. 3** shows the input, clock, and output waveforms for synchronous operation. The inputs can be switched at any time, but the outputs switch to obey the input command *only* on the trailing edge of a positive clock pulse. The flip-flop functions as an electronic delay line. When a change in the input signal occurs, the new signal is delayed by the flip-flop until the next clock pulse trailing edge, at which time the new signal appears at the Q and $\overline{Q}$ output terminals. The delay time

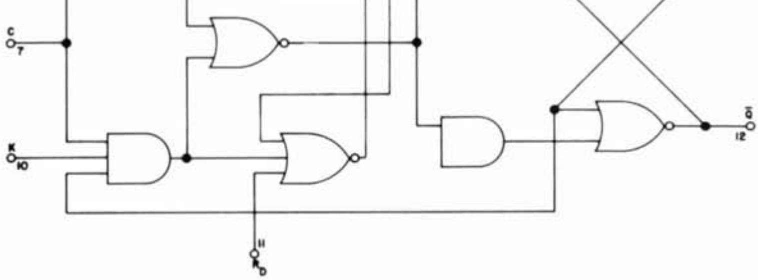


fig. 2. Logic diagram for the Signetics SP620A flip-flop IC used in the afsko control circuit.

*The SP620A (price $3.50) is available from Compar Corporation in Huntsville, Alabama; Glendale, California; Hamden, Connecticut; Seattle, Washington; and other locations.

is variable and can range from 65 nsec to infinity, depending upon the clock pulse-to-pulse interval.

the afsko circuit

Figs. 4 and **5** are the functional block diagram and schematic of the synchronous-phase afsko. The input signal to the afsko is processed by Q5-Q6, which provide complementary inputs to the flip-flop. Q5 is a threshold detector that conducts for any input voltage greater than 0.7 volt. Q5 is off for any input voltage less than the 0.7-volt threshold. D8 protects Q5 by preventing excessive reverse bias being applied to the Q5 emitter-base junction. D8 also allows the afsko to be driven by a source having an ac-coupled output, since D8 provides a discharge path for the driving-source output capacitor. S1 is a reversing switch that allows the space and mark signals to be inverted; thus the afsko can be used on either lower or upper sideband.

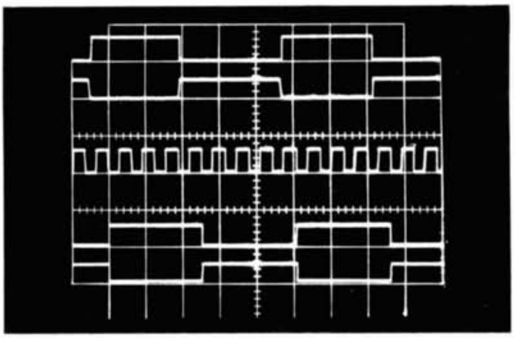


fig. 3. Switching characteristics of the SP620A IC. Vertical scale, all traces, 0 to + 6 volts, 10 volts/division. Horizontal scale is 1 millisecond/division.

sine-wave oscillator and buffer

The basic sine-wave oscillator[1] consists of the complementary amplifier (Q3 and Q11) and a tuned LC circuit. The tuned circuit, composed of L1 and one of three capacitors (C_{sn}, C_{sw}, or C_m), is switched in parallel with L1. Only one of the three capacitors is in parallel with L1 at any given time. Q1 switches the mark-tone capacitor, C_m, into and out of the oscillator circuit. S2B selects the desired space-tone capacitor; C_{sn} for narrow-shift

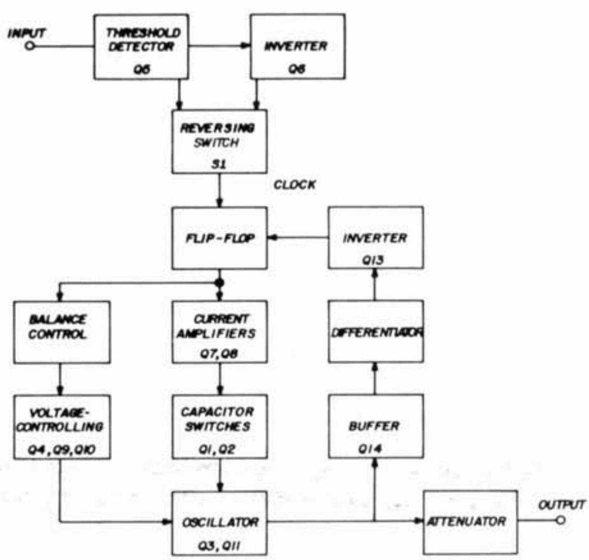
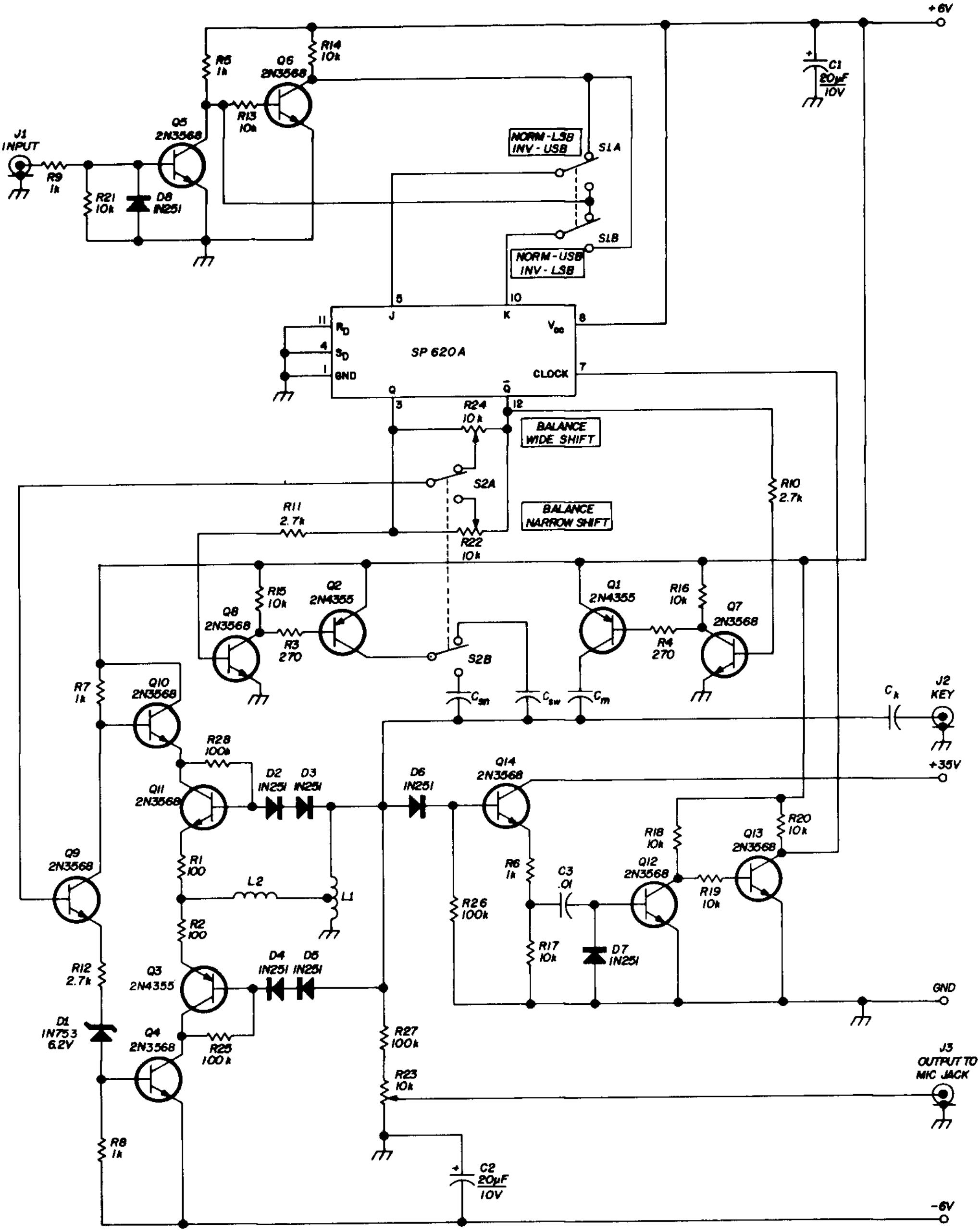


fig. 4. Block diagram of the synchronous-phase afsko.

fig. 5. (right) Synchronous-phase afsko schematic. Capacitors Csn, Csw, Cm must be selected for space and mark tone frequencies. See text.



C_{sn}, C_{sw}, C_m select for desired narrow-shift space, wide-shift space, and mark tone frequencies. See fig. 11 and table 1 for capacitance values. Use capacitors having a voltage rating of > 20 v

C_k select for the desired cw identification frequency shift

J_1-J_3 type C-11, ¼-in. phone-jack, or equivalent

L_1 88 mH

L_2 22 mH. Use only one winding of an 88-mH toroid

D_1 1N753, 6.2 V zener (price $1.05) or equivalent

D_2 - D_8 1N251 (30 Volts PIV. Price 32¢) or equivalent

Q_1 - Q_3 2N4355 (price 55¢) or equivalent

Q_4 - Q_{14} 2N3568 (price 32¢) or equivalent

SP620A Signetics flip-flop (see Text)

operation, or C_{SW} for wide-shift operation. Q2 switches the selected space-tone capacitor in parallel with L1 only during space intervals. Actually, these capacitors are switched to the +6 volt power supply, but C1 provides an ac short circuit from the power supply to the grounded side of L1.

The oscillator drives a buffer stage, Q14, which prevents oscillator loading.

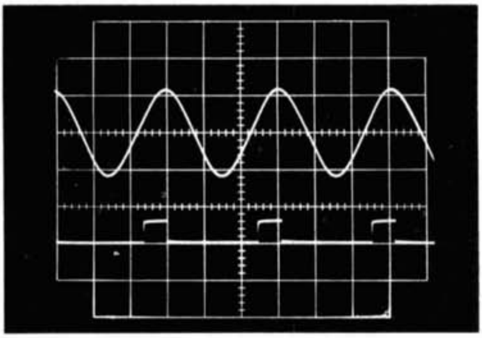
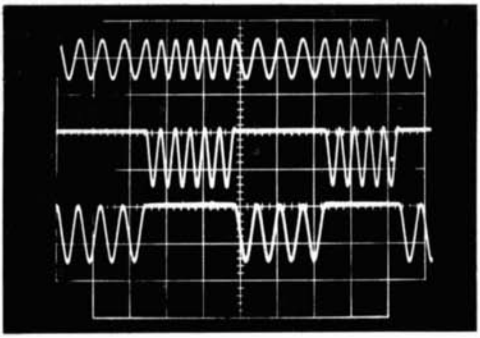


fig. 6. Time relationship between clock pulse and afsk oscillator output-signal waveform. Clock trailing edge occurs at positive peak of output waveform. Top is output signal, 0.5 volt/division. Bottom is clock signal, 10 volts/division. Horizontal scale is 0.2 milliseconds/division.

The buffer drives a differentiator, Q12. The function of this differentiating circuit is to generate a signal when the output sine wave reaches its positive peak. At this point in time, Q12 is turned off and the inverter, Q13, is turned on, thereby providing a +6-to-OV transition signal to the clock terminal of the flip-flop. This high-to-low transition is the trailing edge of the positive clock pulse.

fig. 7. Time relationship between output signal and collector voltage on mark-space capacitor switches, Q1 and Q2. Top is output signal, 1 volt/division. Center is Q2 collector, 10 volts/division. Bottom is Q1 collector, 10 volts/division. Horizontal scale is 1 millisecond/division.



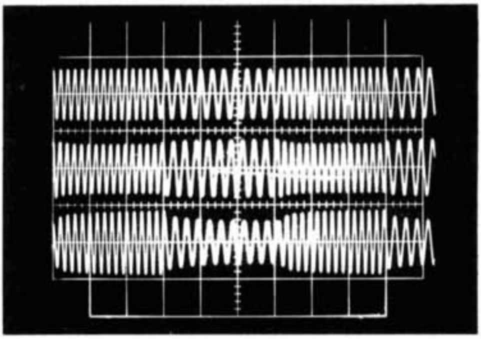


fig. 8. Effect of balance control setting afsk oscillator output waveform. Mark, space, and switching frequencies are respectively 1650, 2500, and 100 Hz. Top is output waveform of properly balanced afsk oscillator. Center is balance control set fully counterclockwise. Bottom is balance control set fully clockwise. Vertical scale is 0.5 volts/division; horizontal scale is 2 milliseconds/divison.

timing

Fig. 6 shows the time relationship between the output sine wave and the clock pulse. The afsko is allowed to switch frequencies, from mark to space or vice versa, only at the time when the output sine wave reaches its peak; and only if the afsko input signal was changed during the previous period of the output waveform.

The Q and $\overline{Q}$ flip-flop outputs drive the current amplifiers Q8 and Q7. These current amplifiers provide the high base current required by the capacitor switches, Q1 and Q2. These switching transistors must support the circulating L1-C tank circuit currents.

At any given time, one of the capacitor-switching transistors (Q1 or Q2) will be on, while the other is off. Because the capacitor switching occurs at the positive peaks of the periodic output waveform, the collector-to-emitter voltage on Q1

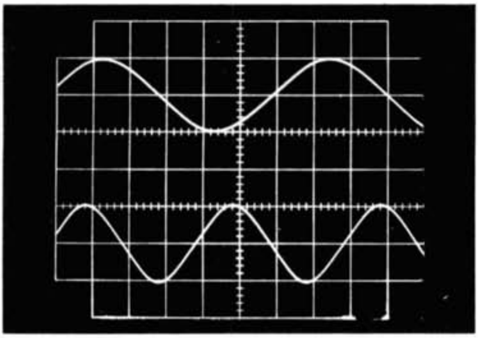


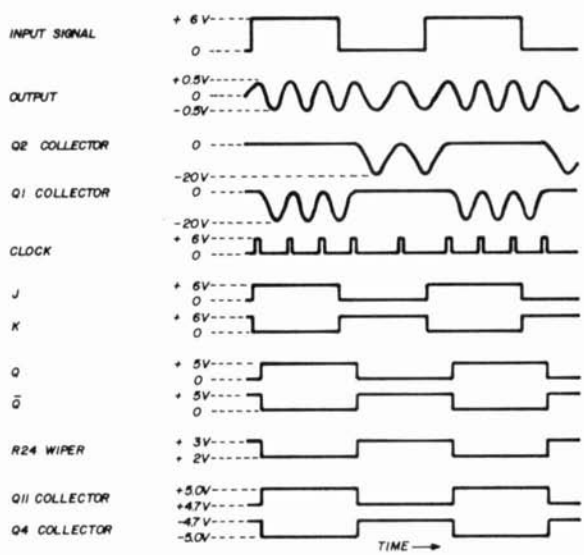
fig. 9. Output waveforms of the afsk oscillator showing quality of mark and space tones. Top is mark tone, 1650 Hz. Bottom is space tone, 2500 Hz. Vertical scale is 0.5 volt/division; horizontal scale is 0.1 milliseconds/division.

and Q2 is always zero or some negative value. **Fig. 7** shows how the collector voltages of both Q1 and Q2 vary with respect to time as the afsko is electrically commanded to switch from space to mark and vice versa.

narrow and wide shift

Switch S2A selects one of two balance potentiometers; R22 for narrow shift and R24 for wide-shift operation. The selected balance potentiometer provides a voltage to the voltage-controlling circuit composed of Q4, Q9, and Q10. This circuit controls the voltage that provides power to the sine-wave oscillator, so that the mark-to-space tone amplitude ratio can be varied. When the afsko is used to drive an ssb exciter, this ratio should be adjusted for equal space and mark carrier power. **Fig. 8** shows the high-quality afsk modulation waveform generated when the balance control is adjusted properly. Also shown are conditions of unbalance that can be used to compensate for a nonuniform combined frequency response of the microphone amplifiers and the sideband filter. When unbalanced, the output waveform reaches its equilibrium amplitude within 2 ms (less than 10% of the bit time for 60-wpm teletype) after a change in tone frequency. R23 controls the afsko output amplitude, which can be varied from zero to 1 volt p-p. The output waveform is a high-quality sinusoid.

Fig. 9 shows the waveform quality for a mark tone of 1650 Hz and a space tone



,fig. 10. Timing diagram of the afsk oscillator.

table 1. Recommended tone frequencies and capacitor values.*

	upper sideband		lower sideband
mark tone	2500 Hz	mark tone	1650 Hz
key-down tone	2000 Hz	key-down tone	1450 Hz
space tones	2330 Hz (narrow shift)	space tones	1820 Hz (narrow shift)
	1650 Hz (wide shift)		2500 Hz (wide shift)
	C_m = 0.045 μF 20V		C_m = 0.11 μF 20V
	C_k = 0.036 μF 20V		C_k = 0.036 μF 20V
	C_{sn} = 0.055 μF 20V		C_{sn} = 0.094 μF 20V
	C_{sw} = 0.11 μF 20V		C_{sw} = 0.045 μF 20V

*Note: Most capacitors have 20% tolerance, requiring hand selection for best frequency accuracy.

of 2500 Hz. The results of distortion-analyzer measurements made on the output signal from the afsko show a waveform distortion of less than 4% for any tone frequency below 3.5 kHz. The frequency stability is better than 0.2%, including the effects of balance control setting.

The waveforms at various points in the afsko when S1 is in the "normal (lsb)" position and S2 is set for wide-shift operation are shown in **fig. 10.**

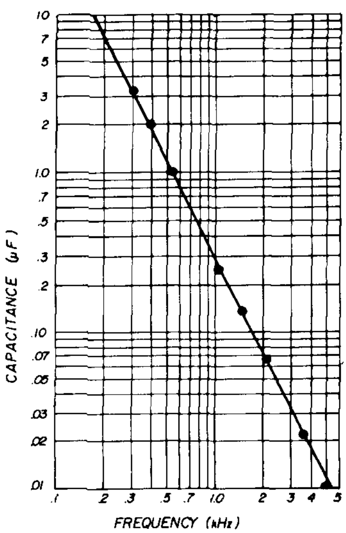


fig. 11. Curve for determining capacitance for the three tone frequencies.

conclusion

The afsko can be operated with either lsb or usb ssb transceivers. The selection of tone frequencies should be made so that, in normal operation, the mark frequency doesn't change when switching from wide to narrow-shift. The three tone frequencies can be independently controlled by selecting the proper values for C_{sn}, C_{sw}, and C_m. **Fig. 11** can be used to select the proper capacitance value for the three selected tone frequencies. **Table 1** gives recommended capacitance values for usb and lsb operation. The recommended capacitor values aren't standard, so parallel combinations of two or more capacitors may be used, including very small capacitors for fine frequency adjustments.

The choice of semiconductors isn't critical, except that *silicon* transistors and diodes must be used. Bias conditions are designed to make use of the forward voltage drop (0.7 V) across a silicon diode, and capacitor switching must be done with low-leakage silicon transistors. The physical layout of the components isn't critical, and special construction techniques aren't required.

reference

1. D. H. Phillips, "An Audio Sinusoid Generator," *73*, September, 1969, pp. 88-89 and October, 1969, p. 131.

ham radio

identifying unknown transistors

Simple methods you can use to classify bargain devices obtained from surplus sources

George R. Allen, W2FPP, 4059 Bay Park Drive, Liverpool, New York 13088

Surplus transistors are readily and inexpensively available from many sources. However, a large number of these transistors are either unmarked or marked with some undecipherable number. This is especially true of transistors on surplus computer boards.

An attempt to obtain data on these transistors by writing to manufacturers will result in a great deal of frustration, as manufacturers will not usually release specifications on specially marked devices. So if the transistors are to be of any value, the only solution is to identify and grade them. This article describes several such techniques that you can apply in your own workshop. Using simple circuits, you will be able to identify polarity (pnp or npn) and grade the devices into three general categories:

1. Audio (low beta).
2. Audio (high beta).
3. Rf types.

The techniques described here apply only to small-signal transistors and won't work for large-signal or power devices. The culls from the grading process will, in most cases, be of the latter type. These can be saved and used with other techniques for grading.

circuit applications

For most practical purposes, transistors of the same polarity within a given group (small-signal devices) can be used interchangeably. These general categories provide a starting point when building transistor circuits. The desired circuit is built, and the category of the required transistor is determined. Graded transistors of the proper category are then substituted into the circuit until optimum performance is obtained. In most cases, you'll find that just about all transistors in a given category will work equally well. The exception will be in circuits considered by the designer to the critical.

When the positive lead of the ohmeter is placed on either collector or emitter, the ohmeter should show a low resistance if the transistor is pnp. Now reverse the ohmeter leads; a high resistance should be indicated between base and collector and between base and emitter.

With the ohmeter negative lead on the base, a high resistance should be found between base and both emitter and collector if the transistor is npn. Reversing the leads should produce a low-resistance reading.

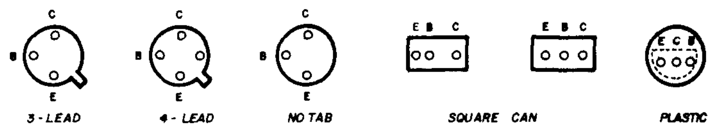


fig. 1. Base connections for many small-signal transistors. Metal-case and plastic-encapsulated-device bases are shown.

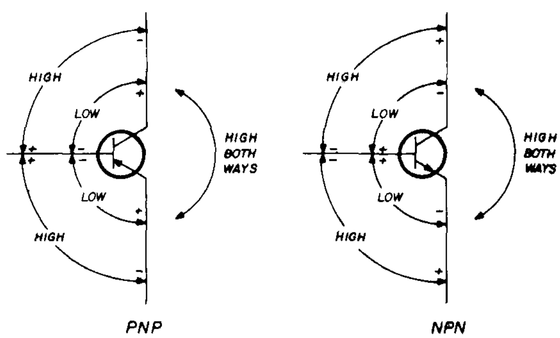


fig. 2. Ohmeter connections for finding transistor polarity. Resistance readings de termine whether unknown device is pnp or npn.

pnp or npn?

Transistor polarity must be determined before the devices can be graded into their general categories. To separate them into pnp or npn types, use an ohmeter and refer to the base diagrams in **fig. 1**. Place the ohmeter negative lead on the base lead of the transistor to be tested (see **fig. 2**).

It's always wise to reverse the ohmeter leads during this test to ensure the transistor isn't shorted. If a low resistance is measured between base and either collector or emitter, with the ohmeter in both normal and reversed positions, the transistor is shorted.

If, when testing a transistor, a low-resistance is found between base and one lead; and a high resistance is found between the base and the other lead, the transistor is bad or you don't have the base identified correctly.

determining lead connections

In cases where you're uncertain of lead connections, the following procedure may be used to determine the proper connections.

Looking at **fig. 3**, label the three unknown leads so you won't become confused during the test. Since you have three leads, there is a possibility of three arbitrary pairs. In the example shown, the pairs would be xy, xz, and zy. Select a pair at random, then connect the ohmeter so that the ohmeter reading is lowest. Now, short the third lead to each of the other two leads. If the resistance increases when shorting this lead to one of the others, the unpaired third lead is the transistor base. The lead to which the base is shorted to cause an increase in resistance is the emitter.

With the ohmeter connected as above, shorting the third lead to one of the other two should produce an increase in resistance if the third lead is the base. If not, it will be necessary to repeat the procedure with the other pairs until the right combination is found. This method isn't foolproof and may not work for some transistors. In such cases the base still can be identified, but you may not be able to identify the emitter and collector.

If, when using the preceding technique, the base can't be identified; and if you notice a high resistance in both directions for a given pair of leads, then most likely the third lead is the base. This can be checked by assuming this lead is the base and connecting the ohmeter between it and the other two leads to determine if the transistor is pnp or npn. If you can successfully determine transistor polarity, then you have correctly identified the base lead. The collector and emitter can be identified by reversing the two unknown leads during one of the grading tests.

The rough grading of transistors is accomplished using three simple circuits that will separate the transistors into four general categories:

1. Audio transistors with a beta (dc current gain) of less than 120.

2. Audio transistors with a beta of 120 or greater.

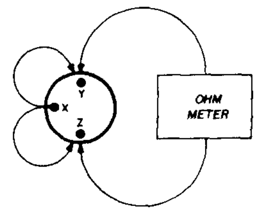


fig. 3. Identifying transistor leads. Leads are labeled as shown; ohmeter leads are alternated to obtain lowest reading. The third lead, x, is shorted to one of the other transistor leads. If resistance increases, x is the base lead. The lead to which the base is shorted to obtain a resistance increase is the emitter; remaining lead is the collector.

3. Transistors usable at radio frequencies.

4. Transistors not gradeable by these methods.

Be sure in all tests to observe proper battery polarity for pnp and npn, or erroneous results will be obtained.

checking transistor beta

The first step in grading transistors is to determine their approximate beta. The circuits of **figs. 4** and **5** are used. Connect the circuits together; then place two known transistors, such as the HEP251, into the circuits. Note that transistor sockets must be used.

Connect the battery and either a pair of headphones or a scope, as shown in **fig. 5**. Adjust R1 until oscillation occurs, indicated by a tone in the headphones or a trace on the scope. Now substitute the transistors to be tested, one at a time, into the circuit of **fig. 4** and note whether oscillation occurs. If such is the case, the transistor has a beta of 120 or more and can be placed in the high-beta category. The twin-tee oscillator in this circuit will not oscillate with transistors having a beta less than 120. If the circuit won't oscillate, save the transistors for use in the remaining two tests.

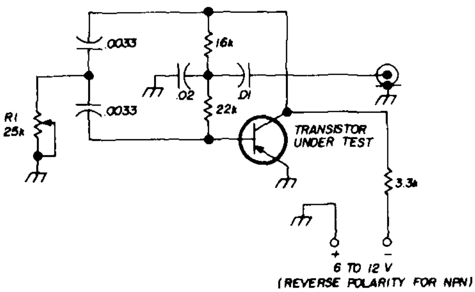


fig. 4. A twin-tee oscillator used to determine beta of unknown transistors.

identifying emitter and collector

Suppose you were able to identify only the base lead during the polarity tests described earlier. The unknown leads should now be reversed, while keeping the base connection unchanged, until the circuit oscillates. If oscillation still does not occur, then again save the transistor for the remaining two tests and reverse the leads in these tests until results are obtained.

Don't hesitate to reverse the leads, as it's unlikely that you'll zap the transistor. Even if you should burn out an occasional transistor, you've lost nothing because an unidentifiable transistor is of no value anyway. Note that in some cases during this test it may be necessary to vary R1 until the circuit oscillates.

The transistors in this category are to be considered as having a high beta and may be used in circuits requiring such a device.

amplification test

Transistors that fail during the high-beta test should be tested to see if they will amplify. To perform this test, set up the circuits in **figs. 4** and **5.** If possible, use a scope instead of headphones, as additional information can be obtained.

Replace the known transistor in the circuit of **fig. 5** with the transistor to be tested, observing the correct battery polarity. Note whether amplification occurs, as indicated by an increase in the tone in the headphones or a change on the scope trace. If amplification occurs, the transistor is good and is in the low-beta category.

oscilloscope clues

When using a scope for these tests, note whether part of the waveform is distorted or clipped. If this is the case, then most likely the transistor is in the large-signal class or in a class that can't be properly graded by these techniques.

If the scope reveals no amplification whatever, even badly distorted amplification, the transistor is probably bad or is in the category "ungradeable by these methods." Transistors in this low-beta

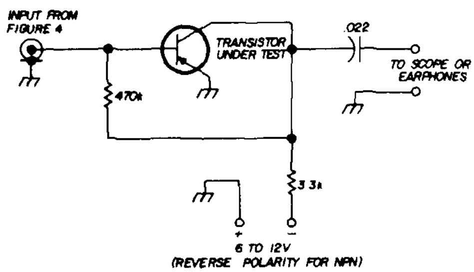


fig. 5. Circuit used with that of fig. 4 in the amplification test.

class can be used for most general applications in which a low-beta device is acceptable.

rf test

Any of the transistors in the previous cases can be given the rf test, regardless of whether they passed or failed any of the earlier tests.

For the rf test, use the circuit shown

in **fig. 6**. Choose a crystal within the range of your receiver. Choose the constants of C1, L1 to resonate within the appropriate range. Use a 2N706 or equivalent for Q. Note that battery polarity is important for the device chosen.

Adjust C1 until oscillation occurs. Set C1 midrange between the two points where oscillation ceases. If a receiver isn't available, a grid-dip oscillator set to the diode position can be coupled to L1. I've shown circuit constants in **fig. 6** for the ranges in which I separate my transistors: up to 30 MHz and up to 50 MHz. By using the proper crystal and circuit constants, transistors can be graded into any desired radio-frequency range.

Once the circuit is oscillating with the 2N706, simply plug in the transistors to be tested, one at a time, and note whether oscillation occurs. If the circuit oscillates, you know the transistor is good up to the frequency of the crystal. It shouldn't be necessary to reset C1 for different transistors. If no oscillation occurs, the transistor is not an rf type.

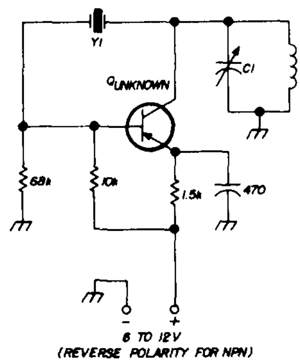
power, voltage, and current

It's very difficult without manufacturers' specifications to determine power, voltage, and current ratings of unknown transistors. The assumption I make is that *all* the transistors *will* operate at 12 volts minimum and will dissipate at least 60 mW. So far, this has been a safe assumption, because by keeping within these ratings I haven't burned out any devices. As for the current rating, I usually assume that if the device is kept within its power rating, the current rating will take care of itself.

If you need transistors with a higher power rating, and you have several devices of the same type, then by all means try out a sample in your circuit to determine if it gets too warm. I don't know of any other approach to this problem.

using graded transistors

At this point you may question the logic of separating the transistors into only three groups. The general feeling among most experimenters is that transistors with different numbers can't be readily interchanged. This is not usually the case. I've found from experimentation that, if a circuit calls for a transistor with high beta, in about 90 percent of the cases one of the transistors I've graded as high beta will work well. In the majority of cases, the first transistor I choose from the group will work well.



L1 6 turns no. 18, ½" diameter, 3/8" long

Y1 25 to 30 MHz overtone crystal (C1 = two 7-45 pF trimmers in parallel)

50 to 60 MHz overtone crystal (C1 = 3-12 pF trimmer)

fig. 6. Circuit for determining if unknown transistor will work at radio frequencies.

applications

Once your transistors have been graded into the general categories, they're ready for use in new projects. When building a new circuit, be sure that transistor sockets are used so substitution can be made easily.

To use your graded transistors, first look at the original transistor in the circuit. From its specifications, determine if the transistor is high beta, low beta, or general rf. Keep in mind we're talking about small-signal devices — those of less than 150 mW dissipation.

Once the category of the transistor has

been determined, select samples from your graded stock and substitute them into the circuit, one at a time, until optimum performance is obtained. In most cases, the first or second transistor will work.

As an example, suppose your circuit calls for a 2N217, which has a high beta, pnp polarity, and a dissipation of about 150 mW. This fits into our category of high-beta devices, but we previously made the assumption that all our units would dissipate about 60 mW. In this case, choose a transistor that's duplicated several times in the high-beta category. Substitute one of the high-beta graded units into the circuit and see if it works. If such is the case, leave the transistor in the circuit for five or ten minutes. (Make certain your power supply is fused.) If the device burns out or gets hot quickly, then try another variety.

While this method of determining transistor dissipation may not seem very scientific, I'm at a loss for a better method. I've tried to guess transistor dissipation from the case size, but I've found that some devices with large cases will dissipate little power, while others with small cases will dissipate quite a bit.

rf transistors

The rf test described above is not a complete and thorough test. It will only test whether a transistor will oscillate at a specific frequency or below. In practice, transistors in this class will work well as oscillators, multipliers, and amplifiers in noncritical applications such as transmitters. In receivers, this class of transistor may be too noisy. This criteria may be easily determined by substitution.

conclusion

The techniques described in this article are by no means intended for precise determination of transistor parameters. Rather, the techniques are presented so you can classify unidentified devices into several general categories. These categories can then be used as a starting point for building many transistor projects.

ham radio

harmonics, distortion and splatter

A brief review of the reasons behind nonlinear amplifier operation

A. E. McGee, Jr., K5LLI, 2815 Materhorn Drive, Dallas, Texas 75228

Judging by what I hear, and even occasionally by what I read, there seems to be a lack of understanding concerning harmonics and other associated phenomena. Every ham knows the definition of a harmonic; that is, a harmonic is an exact whole-number multiple (2 times, 3 times, etc.) of a given fundamental frequency. Some think, however, that harmonics are a part of the natural order of things and that all signals will have harmonics. Others consider harmonics to be quite unnatural and that their presence is a sure sign of improper design or operation of a circuit. Neither of these assumptions is entirely true, as you will see later on.

harmonic-free signals

There is one, and only one, type of signal completely free of harmonics, and that is the perfect sinusoid or sine wave. A sine wave is the wave shape formed by rotating a loop of wire at a constant speed in a uniform magnetic field. It's called a sine wave, because the instantaneous output voltage is proportional to the sine (a value found in a set of trigonometry tables) of the angle of rotation. The sine wave and how it is derived is shown in **fig. 1.**

A sine wave can be generated electronically at audio and radio frequencies by specially designed circuits. Just any oscillator circuit won't necessarily produce a sine-wave output, although many will approximate it closely. No matter how you produce it, a signal with a true sine-wave shape will have only one frequency, and harmonics will be nonexistent.

distortion produces harmonics

Any variation from a true sine-wave shape causes other frequencies to appear along with the fundamental or lowest frequency. These extra frequencies will be harmonics of the original frequency, and their number and strength is determined by the shape of the wave. You could also say that the shape of the wave is determined by the number, strength, and phase of the harmonics present. The result is the same in either case.

The harmonics of a distorted sine wave are all perfect sine waves. The fundamental frequency is also a perfect sine wave. This fact is rather confusing and hard to grasp at first, but it can be more easily understood if you will realize that the wave shape you see on an oscilloscope is a composite of all the frequencies present in the wave. The instantaneous voltages of the harmonics add to and subtract from the instantaneous voltage of the fundamental sine wave to give the resultant wave shape. See **fig. 2.**

The total number of harmonics present in a wave can range from one, as in a sine wave with some second- or third-harmonic distortion, to thousands, as in a good square wave.

Many wave shapes also have a dc component. This is caused by the part of the wave on one side of zero being larger than that on the other side. As a general rule, it can be said that only even harmonics will produce a dc component.

mathematical proof

I have made a number of statements without giving proof that any are true. It can be proved mathematically, by means of a Fourier analysis, that a distorted or nonsinusoidal electrical wave is the sum of a fundamental sine wave, a series of sinusoidal harmonics, and a dc or average value. I'll leave this to the mathematicians, and take their word for its truth.

causes of distortion

If you generate a pure sine-wave signal, then feed it through an amplifier to increase its strength, chances are you will no longer have a pure sine wave at the output of the amplifier. This is because no vacuum tube or transistor is a perfectly linear device. That is, the output current doesn't increase and decrease exactly in proportion to an increase or decrease in input voltage or current. Many amplifiers, however, will be very nearly linear over a certain range of input voltges; and by using negative feedback or other special techniques, an extremely good amplifier can be built. I just wish to emphasize that unless care is taken, there will be harmonic frequencies present in the output of an amplifier that were not present at the input.

Distortion in an amplifier isn't always a bad thing, and may be purposely introduced, as in the case of a frequency-multiplier circuit. A frequency multiplier is usually biased so that output current flows during only a small portion of the input cycle. This distorts the output signal greatly and causes the generation of strong harmonics.

All class-C amplifiers produce a great deal of distortion and many harmonics. Class-C amplifiers are used only to amplify cw or fm signals, however, and the tuned-output circuits attenuate the harmonics to a reasonable level.

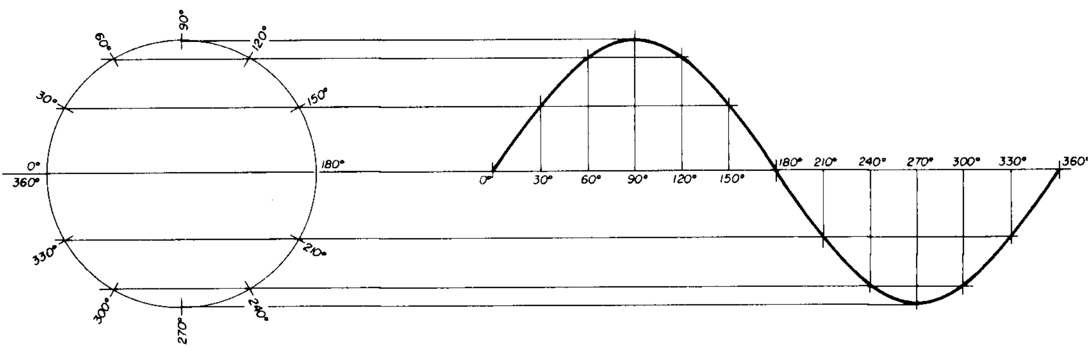


fig. 1. The sine wave; the only wave that has no harmonic content.

harmonics and splatter

When more than one signal is present in a nonlinear circuit, the situation becomes more complicated. Not only will harmonics of the signals be present, but the nonlinear amplifier will also act as a mixer, and the sum and difference frequencies of the fundamental and the various harmonics will be present in the output. For example, let's see what

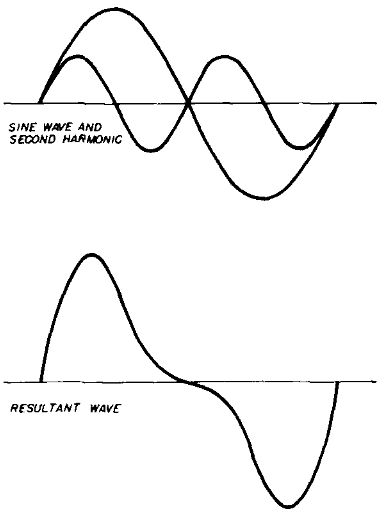


fig. 2. A distorted wave consisting of a fundamental sine wave and a large second harmonic.

would happen if two sine-wave signals were fed into an amplifier where considerable distortion is present. For convenient numbers I'll use 1000 and 1001 kHz as the two frequencies. This would be the equivalent of a two-tone single-sideband suppressed-carrier signal.

The harmonics and the sum frequencies generated by the amplifier would be greatly reduced in strength by the selectivity of the tuned-output circuit. However, some of the difference frequencies would fall within the passband of the tuned circuit. The second harmonic of 1001 kHz (2002 kHz) will mix with the 1000-kHz signal to get an output of 1002 kHz; the second harmonic of 1000 kHz (2000 kHz) will mix with the 1001-kHz signal to get an output of 999 kHz; the third harmonic of 1001 kHz (3003 kHz) will mix with the second harmonic of 1000 kHz (2000 kHz) to get an output of 1003 kHz; the third harmonic of 1000 kHz (3000 kHz) will mix with the second harmonic of 1001 kHz (2002 kHz) to get an output of 998 kHz; and so forth, depending on the amount of distortion in the amplifier and the number of harmonics present.

You can see that although we started out with only two signals, at 1000 and 1001 kHz, we now have six signals; at 998, 999, 1000, 1001, 1002, and 1003 kHz. These extra signals are caused by distorting the wave shapes of the original signals by amplifying them with a nonlinear amplifier. With a properly designed and operated amplifier, these extra signals will be so much weaker than the desired signals that they will be of no consequence.

However, even the best amplifier, when over-driven, badly loaded, or otherwise improperly operated, will put out a great many strong undesired signals. This is why it's important that linear amplifiers be correctly operated, or else they may suddenly become nonlinear amplifiers, and can easily put out spurious signals (known as splatter) covering an entire amateur band.

In conclusion, the sine wave is the only wave form that has no harmonic content, any distortion of a sine wave means that harmonic frequencies are present, and when two or more signals are amplified by a nonlinear amplifier, a great many unwanted signals may appear in the output.

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2. Nelson M. Cooke, "Mathematics for Electricians and Radiomen," McGraw-Hill Book Co., Inc., 1942.
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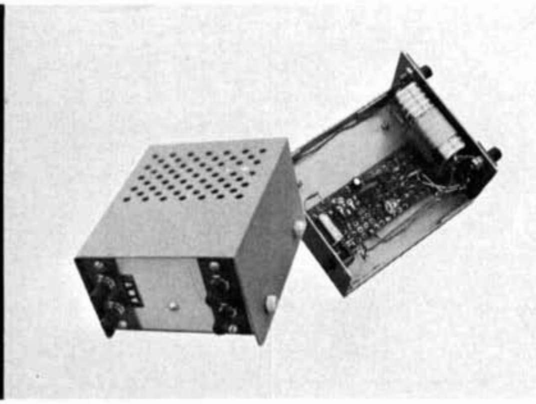
ham radio



improved superregenerative receiver

Atuyuki Iwakami, JA1BHG, 2-203, 1-3 Kasumigaoka, Fukuoka, Iruma, Saitama, Japan

The superregenerative receiver is a simple low-cost system often used in portable equipment operating on the amateur vhf and uhf bands. Although this circuit offers high sensitivity, it suffers from poor selectivity, high noise level, oscillator radiation and hangover. Hangover results in blocking that limits sensitivity because the receiver is swamped by its own residual signal.

The high sensitivity of the superregenerative detector is due to the use of an alternating quench voltage, usually between 20 and 300 kHz. The regeneration control is set so the detector goes into oscillation on each positive peak of the quench voltage: on each negative swing the oscillator is cut off.

The superregeneration principle can be applied to any oscillator circuit; a grounded base Hartley circuit is shown in **fig. 1.** If the bias is gradually increased with the "regeneration" control the circuit will break into oscillation. When the amplitude of oscillations overcomes the base bias voltage on the negative portion of the swing, rectified current through the base-emitter diode charges capacitor C_b, putting a negative bias on the base that runs off the transistor. When C_b has discharged through resistor R_b the circuit begins to oscillate again. Hence, the quenching frequency is determined by the base-bias voltage and the time constant of C_bR_b. In **fig. 1** R_b is the effective resistance from base to ground and consists of R1 in parallel with R2 and part of R3.

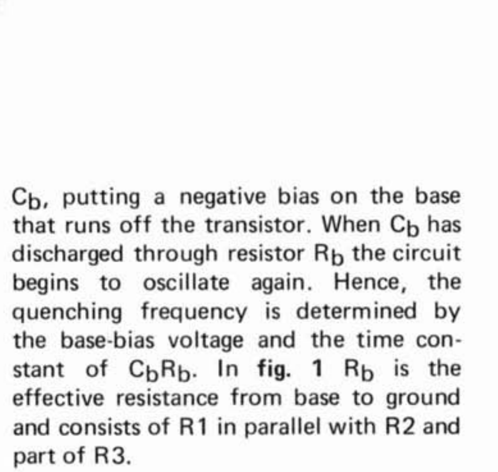


fig. 1. Simple superregenerative circuit using the grounded-base Hartley circuit.

An analysis of one cycle of quenching is shown in **fig. 2.** The oscillation is triggered by the incoming signal and builds until it overcomes the bias potential, then is quenched. When there is no input signal, internal circuit noise acts as

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the trigger with a resultant "hiss" in the audio output. Hangover is due to the fly-wheel effect of the tank circuit, and the higher the Q, the more troublesome the hangover.

In a recent article K2ZSQ suggested a simple circuit addition to limit the affects of radiation and hangover.[1] The circuit change consists of adding a germanium diode across the tank circuit as shown in **fig. 3.** With this diode undesired energy is immediately dissipated after the oscillation burst. This eliminates hangover effects during the remaining period of the burst. Radiation is also lessened because the damping action of the diode lowers amplitude and shortens the duration of radiated pulse.

practical receiver

The modified superregenerative receiver shown in **fig. 3** has been used on 50 and 144 MHz with similar results. The added diode is not critical, and any germanium point-contact seems to work well. The transistor should be a vhf type for best operation, but this isn't too critical either. I used Japanese types 2SC372 (f_T = 150 MHz) and 2SC387 (f_T = 900 MHz), but Motorola equivalent types HEP55 and HEP56 will perform as well.

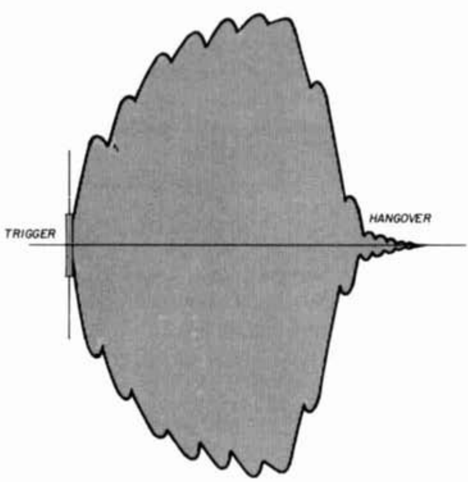
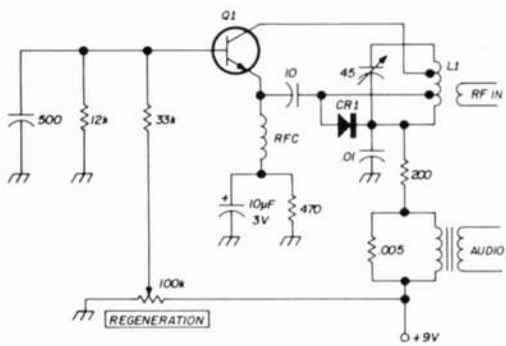


fig. 2. One cycle of superregenerative operation shows the input trigger, oscillation, quenching and hangover.

Smoother operation is obtained by tapping the collector down on the final tank coil as shown in **fig. 3.** Oscillation can also be improved by moving the emitter tap down, but effective damping action requires the emitter to be tapped as high as possible on the coil.



50 MHz

L1 7 turns no. 20, 9/16" diameter, ¾" long. Collector tap at 2½ turns, emitter tap ½ turn from ground

Q1 HEP 55

RFC 10 µH

144 MHz

L1 4 turns no. 16, 3/8" diameter, 9/16" long. Collector tap at 1½ turns, emitter tap at ½ turn from ground

Q1 HEP 56

RFC 20 turns no. 26, closewound on ¼" form

fig. 3. Practical vhf receiver for 6 and 2 meters using the modified superregenerative circuit.

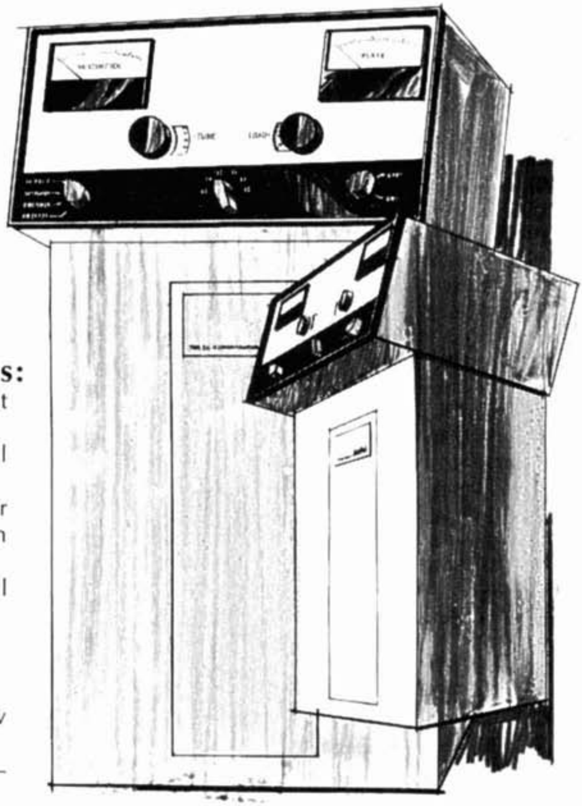
results

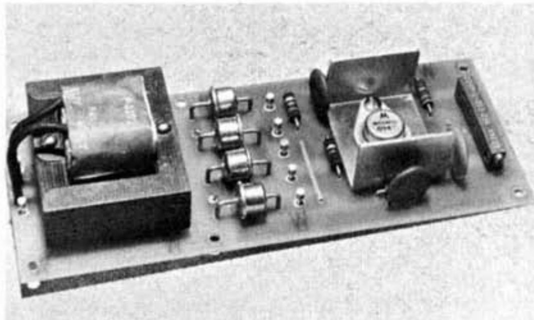
Since this circuit is basically an oscillator, radiation was decreased very little by the addition of the germanium diode. However, the hangover effect was considerably improved. No noticeable decrease in sensitivity was found.

reference

1. Robert M. Brown, K2ZSQ, "No-Radiation, No-hangover 28-MHz Superregen Receiver," *ham radio,* November, 1968, p. 70.

ham radio





a flexible voltage-regulated power supply

Putting the Motorola MC1460R regulator IC to work in a useful circuit for the experimenter

Ron Vaceluke, W9SEK 17 W. 540 Hillcrest, Wood Dale, Illinois 60191

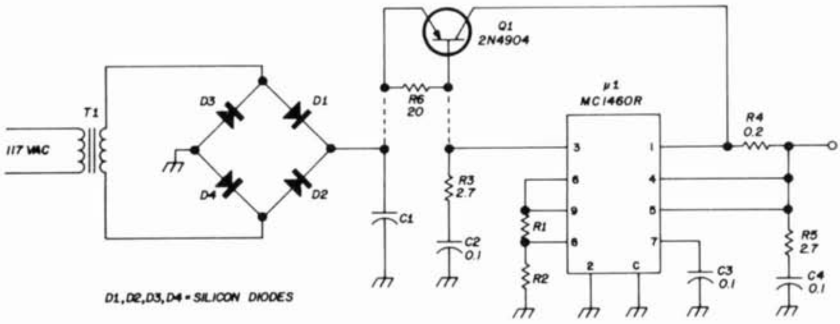
The power supply described here was originally designed for a 2-meter fm receiver.[1] However, it can be used for any equipment requiring a regulated low-voltage power supply.

The integrated circuit is a Motorola MC146OR, which can handle up to 20 volts input at 600 mA maximum. For higher voltages, the MC1461R (35 V), or the MC1561R (40 V) can be used. The case is a small diamond shape, which can be mounted in a heat sink.

the circuit

The power supply requires a minimum of parts **(fig. 1).** Resistors R1, R2 constitute a voltage divider that determines output voltage. With R2 = 6.8k, R1 will be $(2V_O\text{-}7)$k ohms, where V_O is the output voltage. R1 can be fixed or variable. Resistor R4 is the current-limiting resistor, which determines the short-circuit load current. If an external pass transistor is not used, values for R4 may be obtained from **fig. 2** for various short-circuit load currents.

Since the IC transistors have high frequency capabilities, there's a chance of oscillation with this device; therefore, some means must be used to suppress this tendency. Networks composed of R3, C2 and R5, C4 form suppressors for input and output respectively.



C1 filter capacitor (value depends on current drawn from supply)

R1, R2 see text

R4 0.2 ohms (for use with Q1 at 2A maximum output)

T1 12 VAC, .45A (Stancor P-8392)

fig. 1. Schematic of the regulated supply. If an external pass transistor isn't used, terminals E and C are jumpered. Components outside the dashed line are mounted externally.

construction

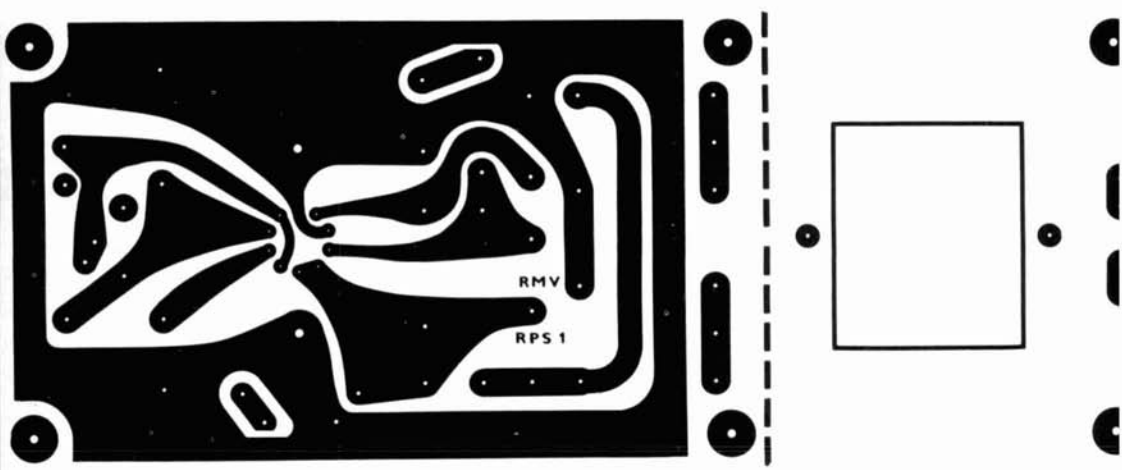
Because of the vhf transistors in the IC, care must be used in wiring the circuit. Hand wiring can be used, but it's not recommended unless vhf-type construction techniques are used. This means extremely short leads and vhf grounding methods. A printed-circuit board is the best solution. A PC board can be made from the template shown, or it can be purchased.*

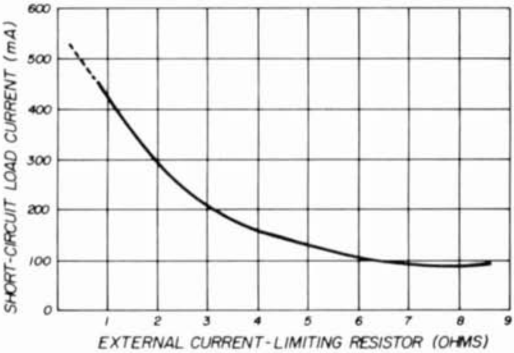
The PC-board layout has a certain amount of built-in flexibility. A small power transformer can be included on the board or the board can be cut on the dashed line if a larger transformer is desired.

Space is provided for four separate rectifier diodes rather than a diode assembly, so junk-box components can be used. The circuit board is arranged so that three

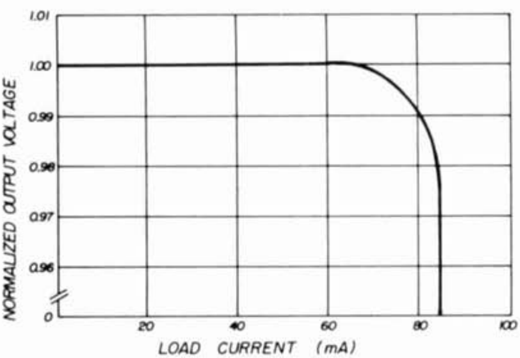
*A G-10 epoxy board, drilled and tinned with staked terminals, is available from RMV Electronics, P. O. Box 283, Wood Dale, Illinois 60191. $3.25 each postpaid.

fig. 3. Full-size PC board template. Board can be cut on dashed line if the transformer is mounted externally.





A



B

fig. 2. Curve A is used to determine the value of R4 if a pass transistor isn't used; curve B shows voltage and current when R4 is 6.8 ohms.

different styles of potentiometer can be used for R1. A fixed rather than a variable resistor may be used if desired.

The heat sink can be made from a piece of aluminum with a ½-inch hole to pass the IC leads. Make sure the leads don't touch the heat sink. The size of the heat sink will depend on the power to be dissipated.

Examination of the photo shows a jumper, which should replace R6 if an external pass transistor is not used. The only other external component is the filter capacitor, C1.

reference

1. R. M. Vaceluke, W9SEK, and J. C. Price, WA9CGZ, "Vhf Fm Receiver," *ham radio,* September, 1970, p. 22.

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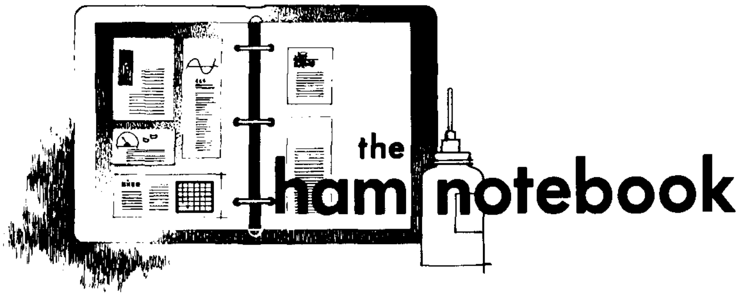


frequency-sensitive resistors

Deposited-film resistors operating in circuits at hf aren't always to be trusted if precise resistance values are needed.

While at work, I needed a fairly husky precision resistor for a phase-sensitive network in a 100-kW transmitter. When I learned that the resistor order would be delivered in the distant future, I decided to check our stock of deposited-film resistors to see if I could use an acceptable substitute. Much to my surprise, I found that at frequencies as low as 14 MHz most values were completely inadequate.

The resistors were checked on an rf bridge. I found that the "r" component generally tended to run quite low – at least 10% low in a 1% resistor – except that values in the 25k and higher ranges showed violently reversed characteristics. Resistors from some manufacturers were fairly accurate in this frequency range, but many showed bulk resistance effects. For example, a 25k unit would shoot up to 100k or more!

I haven't completely checked out the results of these tests, but it appears that values of about 300 ohms or so tended to be capacitive at these frequencies, which is opposite to what I would have suspected. Units of 200 ohms or less tended to be slightly inductive. So you might bear this in mind the next time you need precision resistors in a frequency-sensitive application.

Bill Wildenhein, W8YFB

fm repeater receiver isolation

If you are interested in obtaining channel isolation in your fm-repeater receiver, the Motrac units made by Motorola are worth considering. These units have a five-cavity front end and are readily available from surplus sources dealing in fm gear.

continuous tuning for fm converters

The Collins 75A-3 and 75A-4 receivers, with their calibrated-tuning capability, can be used with most crystal-controlled converters to provide continuous coverage of the two-meter fm band.

The appropriate converter is one having an output between 26-30 MHz. The 75A-3 receiver will tune this range directly; the 75A-4 will cover most of this range, and an appropriate crystal can be selected to cover the frequency portion desired.

On all later production models of the 75A-3 (and on all 75A-4 receivers) a broadband i-f output jack is provided, which was originally intended for use with a panadapter. This output can be coupled via 52-ohm coax to the i-f strip of any of the surplus Motorola receivers, most of which use the same 455-kHz i-f.

For early 75A-3 receivers that don't have the panadapter output, the instruction manual gives complete details for installing the output jack, which is a very simple job.

If you have a 75A receiver, this is an excellent way to become acquainted with the two-meter band and discover which spot frequencies are active. Then you can decide which crystals to purchase for the fixed-tuned equipment you would eventually use. You can't beat fm for communications reliability and noise-free operation.

inexpensive WWV converter

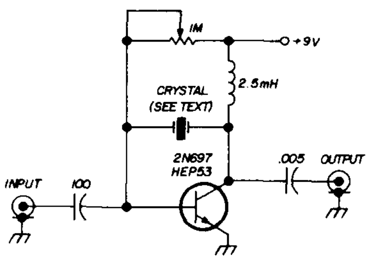


fig. 1. Simple mixer circuit for converting WWV signals to amateur bands.

Here's a simple circuit that will convert WWV signals above 5 MHz to amateur bands between 80 and 15 meters. The converter consists of a simple crystal mixer using a single npn transistor **(fig. 1)**.

A variety of crystal frequencies can be used, depending on which WWV signal is desired. See **table 1.** The exact output frequency may be determined by finding the difference or sum of the desired WWV frequency and the crystal frequency.

No tuned circuits are used, so other

table 1. Crystal frequencies that can be used to convert WWV to the various amateur bands.

ham band	WWV frequency (MHz) 10	15	20	25
80	6-6.5	—	—	—
40	2.7-3.0	8-7.70	—	—
20	4-4.35	—	6-6.65	—
15	—	6-6.45	—	3.55-4.00

signals will be received in additon to WWV. For example, if a 6.5-MHz crystal were used to convert WWV at 10 MHz to 3.5 MHz, all signals on 3.5, 3.0, and 10 MHz would be picked up. However, WWV is usually strong enough to be picked out easily. If necessary, tuned circuits could easily be installed between the antenna and the converter.

WWV transmits much interesting data in addition to time ticks. Schedules and types of information are published in the ARRL handbook.

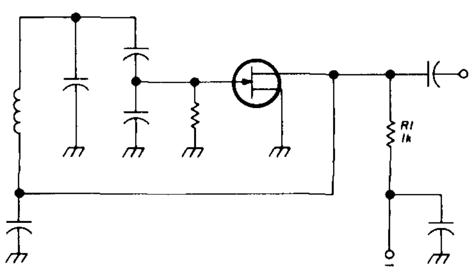
Doug Pongrance, WA3JBN

cure for cranky oscillators

In all the Vackar oscillators I've built using a Motorola MPF102 jfet, I've found that the usual circuit **(fig. 2)** is reluctant to oscillate with low drain voltage. A quick and sure fix is to replace the usual 1k-ohm drain load resistor, R1, with a small rf choke. I found that video peaking coils pulled from an old TV set are adequate. With such a modification, the circuit will oscillate vigorously in the 8-12 V power-supply range.

Bill Wildenhein, W8YFB

fig. 2. Typical Vackar oscillator using the MPF102 fet. Replacing R1 with a small rf choke ensures oscillation with low drain voltage.



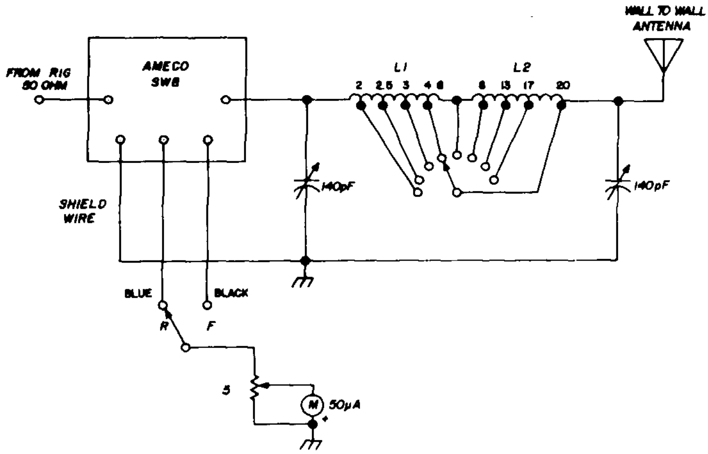


fig. 3. Bridge and tuner for random length antennas. Variable capacitors are Hammarlund type MC140. L1 is 8 turns per inch; L2 is 16 turns per inch. Both coils are 1½-inch diameter. L1 is tapped at 2, 2½, 3 and 4 turns; L2 at 8, 13 and 17 turns.

wall-to-wall antenna tuner

Although a well-elevated outdoor antenna is best for radio communications, such an antenna is often impractical or impossible to erect (due, for example, to space restrictions or a grouchy landlord). Fortunately, communications on the ham bands can be effective with only a simple short-wire antenna installed indoors.

I have contacted many stations on the West Coast and in the Midwest using only a horizontal wire strung between two walls. However, the antenna must be properly terminated to be effective. The terminating impedance for most rigs is 50 ohms.

All the equipment needed to terminate the antenna properly is shown in **fig. 3.** In addition to the rf input and output terminals, the Ameco Model SWB bridge has three leads, which should be connected as shown. The switch selects either forward or reverse power. We want as high a reading as possible in the forward position and as low a reading as possible in the reverse direction. The antenna tuner is adjusted for optimum impedance match between transmitter and antenna.

construction

For convenience, I mounted my bridge in a 4 x 4 x 2-inch aluminum box. The Ameco bridge, which comes with Amphenol SO-329 connectors, is 4½ inches long. It won't fit into a 4-inch-long box, so here's what to do.

Remove the front and rear panels of the box. Then saw one edge of the box so you can spread it apart to accommodate the bridge. Drill holes to allow the Amphenol connectors to protrude. Use a ¾-inch circle cutter.

Mount the bridge on the bottom of the box with screws. Close the box, using a small angle bracket and pk screws to keep it closed tightly.

The 4-inch box also includes the meter (1½-inch square), a miniature toggle switch, and a miniature potentiometer. There's plenty of space for these components if they're mounted on the front panel.

the tuner

The tuner is housed in a metal box, 8 x3 x 2-3/4 inches. The variable capacitors are Hammarlund type MC140. The inductance consists of two separate coils in series, each 1½ inches in diameter. The coils are mounted side-by-side, about one half inch apart.

tune-up

If you have a 50-ohm dummy load, adjust your rig for optimum output. Position the switch to R, and select a tap on the tuner that gives minimum reading on the meter. Adjust the variable capacitors for a minimum meter indication.

I use this system with an indoor antenna on 15 and 20 meters, my favorite bands. The tuner and bridge will probably match any random-length antenna. I've used the circuit of **fig. 3** with a vertical whip, 6 feet high, and with an outdoor long-wire antenna 50 feet long. Results have been very good.

I. Queen, W2OUX

plastic protective material

A self-adhesive plastic sheet product is on the market that is of interest to amateurs. The material I use is called "PLAIN-VU" manufactured by Carr Adhesive Products, Inc., Somerville, Massachusetts.

PLAIN-VU is a clear plastic contact material, which is good for covering homemade dials, panels, I. D. cards, licenses, QSL cards, and the like. It's available in stationery stores in sheets 9 x 11-5/8 inches, two sheets for about a dollar.

Paul White, W6BKX

fm deviation meter

With fm becoming more and more popular, a deviation meter is a nice piece of equipment to have in your station. The method described can be used for most frequencies, and on 2 meters it works fine.

features

The deviation meter allows you to check deviation of on-the-air signals as well as your own. The use of an oscilloscope is ideal, and peak deviation can be monitored.

A two-channel fm receiver is used, with channel A tuned to the desired frequency and channel B tuned either 15 kHz above or below channel A. The setup is shown in **fig. 4**. Discriminator output is fed to the vertical input of a scope. Internal sweep is used for the horizontal plates.

With no signal, noise will be displayed on the scope. When an unmodulated

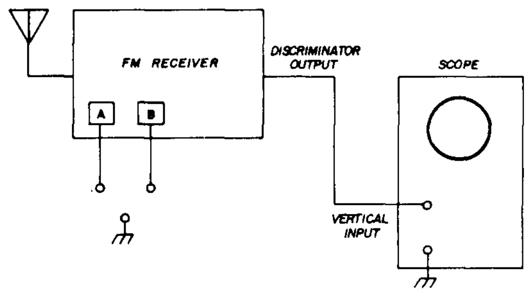


fig. 4. Fm deviation meter using 2-channel receiver and oscilloscope. Method allows monitoring of peak deviation of received signal or your own.

signal is received, a straight line will appear, possibly with some noise, depending on signal strength.

operation

Switch the receiver to the desired signal.

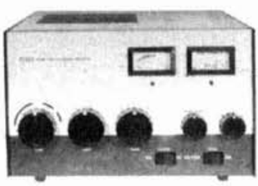
Adjust vertical centering so that the line appears in the center of the display. Now switch to channel B. The line will swing either up or down. Calibrate the scope vertical gain for a reasonable display.* Switch back to channel A, and modulate the transmitter to be tested. If voice peaks hit the calibration points, the signal is deviating ±15 kHz.

A more elaborate unit could be made using a three-channel receiver, which would allow calibration above and below the received frequency. Two channels should suffice, however, since the signal deviates equally well both ways.

Vern Epp, VE7ABK

*Or use a grease pencil to mark deviation limits on the face of the scope tube. editor.

SB-35...great new transceiver



and SB-3LA... great new linear!

The SB-3LA Linear Amplifier

- 5 bands: Phone and CW sections, 80-40-20-15-10 meter bands.
- 2 kilowatts, p.e.p. power input on SSB--1KW on CW.
- Drive power needed is approximately 100 watts, easily supplied by SB-35 transceiver.
- 3rd order distortion is down 30db or more.
- Uses 2, Type 3-500Z triodes in grounded grid.
- Adjustable solid-state ALC.
- Input is 52 ohms with built-in fixed tune pi nets for each amateur band.
- Output, 50 ohms. Adjustable pi network.
- Power supply built-in, 115/240VAC, 50-60Hz.
- Built-in relays.
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- Weight: Approximately 50 pounds.

See these great ones at your SBE dealer and also write for full line brochure.

The SB-35 Transceiver

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- 260 watts p.e.p. input.
- **Built-in,** power supply, 12VDC **and** 117VAC.
- Selectable SB's: LSB, USB CW w/zero car. shift.
- CW keying--shaped--carrier re-insertion type.
- Offset--no leapfrogging on transceive.
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- Crystal lattice filter in 2nd I-F with shape factor of 1:1.9!
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- Only 2 tubes. Type 8417 hi-fi types matched for low distortion. **Not** TV sweep types.
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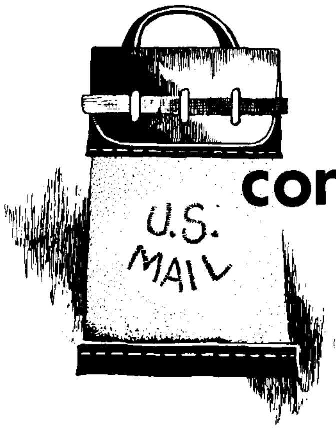


comments

antenna dimensions

Dear HR:

In the *ham notebook* section of the June, 1970 issue the antenna dimensions presented by WA9JMY seem to have a discrepancy in the "inverted-vee" column.

It has always been my experience that if I had a dipole of a certain length, resonant at a certain frequency, and then positioned it in the inverted-vee configuration, the resonant frequency *increased.* Thus, to maintain resonance at the original frequency, I had to *increase* the length such that the length of the inverted vee at the original frequency was *greater* than the length of the dipole at the same frequency.

The figures given by WA9JMY do not seem to be in line with my experimental findings. Throughout the chart, the inverted-vee lengths are *less* than those for a resonant dipole at the same frequency. Realizing that there is a multiplicity of factors involved in antenna work, I took a peek at the *ARRL Antenna Book,* 11th edition, page 204, and it seems to confirm my results.

"Sloping of the wires results in an increase in the resonant frequency and a decrease in feedpoint impedance and bandwidth as the angle between the two wires is decreased. Thus, for the same frequency, the length of the dipole (used as an inverted vee) must be increased somewhat."

Has a mistake been made in the calculation of the lengths in the inverted-vee column?

Donald R. Nesbitt, K4BGF
Gainesville, Florida

For each antenna length computed by the computer, I fed formulas that were taken out of the 1968 edition of the ARRL handbook. I did this with the assumption that they were correct and that no research into other books would be necessary. After receiving your letter questioning the correctness of the inverted-vee column I checked back into the handbook with a little more alertness. This is what I found: Quoting the last paragraph on page 350 of the 1968 edition:

> *"When its ends are near the ground, the length of the wire in an inverted V antenna is slightly shorter than when the dipole is strung in a straight line . . . "*

These are the formulas I fed to the computer:

Inverted vee: Length = 464/Freq.

Dipole: Length = 468/Freq.

These formulas indicate that the dipole will always be longer.

I did not have a chance to verify your source of information but it is evident that one of these books is wrong. If you can dig up any more info, I would appreciate you letting me know.

James Barcz, WA9JMY

inverted-vee length

Dear HR:

I have checked out both the Antenna Handbook and the Handbook and sure enough, they seem to be contradictory except for the qualifier: "When its ends are near the ground. . ." It makes me wonder just how near the ground "near" is!

As for any additional information which I can add, most of my inverted-vees have been close to a half-wave above ground with apex angles in the 140° to 120° range thereby placing the ends perhaps not "near the ground!!"

In an article by K4GSX, "Radiation Resistance of Inverted V Antennas," *QST,* October, 1968, using a ten-meter test antenna with an apex angle of 105°, the length as compared to the standard dipole varied from longer than the resonant dipole (determined by setting k = 0.95 in the formula L = 492(k)/f(MHz)) to shorter depending upon the height above ground. Experimentally, he measured values of k for an antenna with the forementioned delta and an L/D ratio of 230 (hardly typical!!) which were less than 0.95 for heights less than 0.3 wavelengths (ie: the inverted vee was shorter than the corresponding dipole) and values of k which were larger than 0.95 (ie: the inverted vee was longer than the corresponding dipole) for heights greater than 0.3 wavelengths.

Perhaps in this case the center height of about 0.3 wavelengths or less put the ends "near the ground . . ."

Lewis McCoy, W1ICP, in the July, 1968 issue of *QST* p. 42 suggested that as a starting point, the length given by L = 515/F(MHz) would be appropriate using the tried and true method of pruning from there. Antennas being the cantankerous beasts that they are this seems a wise suggestion!!!!!

I propose to run some checks on an experimental 40-meter setup which would be a typical amateur antenna. Number 14 or 16 wire used with the small glass end insulators fed with a half-wave of coax (electrical of course) and adjustable both in height and apex angle. I'm interested in checking this type of antenna since I think that it represents the way most of the inverted vees are constructed and used. Hopefully it will satisfy my curiosity about how near "near" is!

Donald R. Nesbitt, K4BGF
Gainesville, Florida

variable crystal oscillators

Dear HR:

I want to thank you for the fine article on vxo design. K6BIJ's circuit of **fig. 4** which achieves 50 kHz frequency shift is certainly most impressive. I shall have to give it a try in the near future.

For your information, the circuit shown in **fig. 1** was originally published in the February, 1965 issue of *73 Magazine* and was specifically developed for use with the OSCAR 3 satellite.

These circuits would seem to have a wide area of applicability which has been pretty much overlooked. Perhaps your article will lead to additional applications.

Even the narrow shift of circuit 1 could be of value as a simple no-holes modification of existing transceivers for net and schedule type operation. For example, in my Heath SB-300 and 400 it could be readily adapted by making the vxo for 5 to 5.5 MHz and plugging its output into the system in place of the internal LMO (variable frequency oscillator) and still have the flexibility to zero in on the exact net frequency.

Your circuit which features increased frequency swing would have even more uses. I am thinking of one particular application but I wonder if it would be acceptable to the FCC. What I have in mind is its use by Novices. This could give

them the capability of vfo operation while still meeting the specific regulation requiring that their transmitters be crystal controlled. With just a few crystals they could cover the entire band available to them. Similarly, they could modify existing commercial units by replacing the internal vfos with vxos for novice operations.

Harley C. Gabrielson, K6DS
La Mesa, California

antenna tuners

Dear HR:

The article (in your May, 1970 issue) about "compatible vs incompatible" tuners has many hams wondering about their antenna couplers. Initial investigations here have borne out the points of the article. One interesting discovery—I can match my antenna across the shorted-out section of the antenna-tuner coil and get a different set of tuning conditions—proof that what W2WLR said is true, that power *is* circulating around in all those extraneous portions of the tuner rather than getting out to the antenna!

Ade Weiss, K8EEG
Meckling, South Dakota

simple wwv receiver

Dear HR:

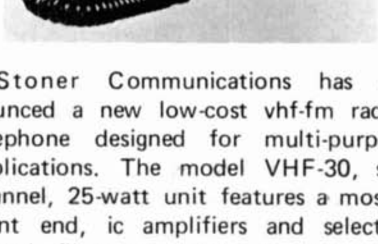
Amateurs who have ham-band-only receivers and need a converter to receive WWV should consider International Crystal's OX oscillator and MXX-1 mixer. I put these two units together, and with a 6000 kHz crystal beat the 10.000 MHz WWV signal into my receiver at 4000 kHz in the 80-meter band.

Using a double-pole double-throw switch to put the WWV signal into the mixer for zeroing my crystal calibrator, and then out again, makes for one of the easiest and economical approaches to this problem.

James W. Harrison, Jr., WB4TBX
Norfolk, Virginia

new products

vfm-fm radiotelephone



Stoner Communications has announced a new low-cost vhf-fm radiotelephone designed for multi-purpose applications. The model VHF-30, six-channel, 25-watt unit features a mosfet front end, ic amplifiers and selective crystal filter to provide low-noise reception of weak signals. The equipment incorporates tropicalized epoxy board modules and splash and corrosion-proof construction. The unit can be used as a battery-operated base station; low current drain permits operation from any 12-volt source in base or vehicle applications. The VHF-30 covers the frequency range from 148 to 174 MHz with 0.6 μV sensitivity for 20-dB quieting.

For more information on the new VHF-30, use *check-off* on page 88, or write to Donald L. Stoner, Stoner Communications, Inc., 8751 Industrial Lane, Cucamonga, California 91730.

cir-kit printed-circuit material

Cir-Kit is a revolutionary new material for the construction of experimental and prototype printed-circuit boards and consists of high-purity 0.002-inch copper foil tape – 1/8- or 1-16-inch wide – coated with a heat-resistant self adhesive and protected by lacquer. To use the material you simply remove the backing paper and place the adhesive side down in the desired position. Component leads are soldered to the Cir-Kit. If any circuit modifications are required it's a simple matter to remove the Cir-Kit material with a knife.

Cir-Kit can be bent, curved, used on both sides of a board to simplify layout or passed around the edges of a board to accomodate edge connectors.

The adhesive used on Cir-Kit actually increases its strength with age. The heat of soldering merely speeds up this process. The adhesive softens when it is heated but full adhesive strength returns as soon as the temperature drops to normal.

Rolls of Cir-Kit, 1/8 or 1/16 inch wide, 5-feet long are $.60 each; 100-foot spools are $9.95 each. Sheets of Cir-Kit, 6 x 12 inches are $2.50 each, 5 for $9.95. For more information, use *check-off* on page 88, or write to Cir-Kit, Box 592, Amherst, New Hampshire 03031.

automatic cw identifier

Curtis Electro Devices has announced an advanced integrated-circuit keyer that incorporates an automatic identification-message generator in addition to the basic *Electronic-Fist* circuitry. In this new keyer, called the *Mnemonic,* a custom integrated-circuit read-only memory (ROM) provides permanent memory to generate the repetitive calls used by amateurs in normal and contest operation.

As an example, the operator might select any one of the three sequences below from a single ROM:

1. CQ CQ DE W1DTY K
2. CQ FD CQ FD DE W1DTY K
3. DE W1DTY K

Three auto-stop selections allow continuous cycling or a choice of two stopping points. The message can be transmitted once, continuously or every ten seconds.

In the manual mode the keyer provides 8 to 50-wpm paddle or squeeze keying with dot memory, independent weight control and iambic character generation. A tap on the straight key of a Brown Brothers CTL combination key (or external push button) initiates the automatic program at the exact speed and weight used by the operator in the manual mode. At 20 wpm a full message sequence takes 15 seconds. The sequence terminates either automatically or by a tap on the dash paddle.

The *Mnemonic* keyer will operate both grid-block and cathode keyed transmitters. Power supply, cw monitor and speaker are built-in. All cables and connectors are provided.

The EK-39M Mnemonic keyer is available from dealers or directly from the manufacturer, and is priced at $179.95 less the individually tailored plug-in memory which is ordered direct from the factory per user message instructions. The memory is priced at $59.95. For more information, use *check-off* on page 88, or write to Curtis Electro Devices, Box 4090, Mountain View, California 94040.

amateur radio techniques

The new enlarged edition of this very popular book is now available, and the author, Pat Hawker, G3VA, has included many new topics. The emphasis is on solid state, with many new semiconductor circuits for amateur equipment. Chapters are included on semiconductors, components and construction, receivers, oscillators transmitters, audio and modulation, power supplies, antennas and troubleshooting and test equipment. This is an excellent book that presents many unique circuits and construction techniques, as well as solutions to old problems.

The chapter on receivers, for example, discusses modern communications receiver design, including front ends, gain distribution, mixers, oscillators, i-f stages, spurious responses, crystal filters, detectors, noise limiters, cross modulation, and direct-conversion systems. All the latest techniques are there, including many that were developed for military and commercial use, and have yet to filter down to amateur gear.

The other chapters are equally as diversified as the one on receivers, and provide a broad look at modern communications circuits and systems and how they may be used by the amateur. 208 pages. 470 diagrams. $3.50 from Comtec Book Division, Box 592, Amherst, New Hampshire 03031

new zero bias triodes

Eimac has just announced a new family of ceramic-metal zero-bias triodes that are suitable for use up to 450 MHz

or so. Three versions are featured: the 8875 transverse air cooled, the 8873 conduction cooled and the 8874 axially air cooled. The 8875 is a high-mu power triode having 300 watts plate dissipation and capable of 1200 watts peak in Intermittent Voice Service. The 8874 features 400 watts plate dissipation. In the January, 1971 issue of *ham radio* we will present application articles on the 8875 and 8873.

The big tube in the center of the photograph is a new 1500-watt zero-bias triode, the 8877. In the February issue we'll have an article describing its application in a six-meter linear amplifier. Right now, your're not even supposed to be seeing it!

For more information on these new Eimac power tubes, use *check-off* on page 88, or write to Eimac Division of Varian, 301 Industrial Way, San Carlos, California 94070.

high-power rf transistors

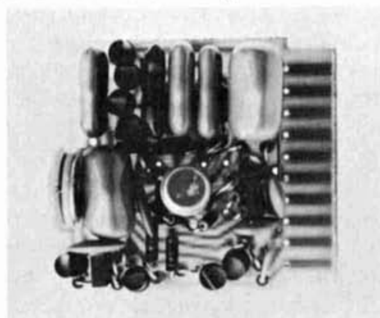
Two npn silicon rf power transistors for vhf power amplifier applications to 175 MHz are available from Motorola Semiconductor Products. The transistors, types MM1552 and MM1553, use balanced-emitter construction for extreme electrical ruggedness; load mismatch conditions of 10:1 at 75 watts output can be withstood by either device.

Intended for use as high-power class-C amplifiers in the 100-175 MHz frequency range, the MM1552 and MM1553 have the high peak power capabilities and breakdown voltages required for a-m applications. The MM1552, for example, is rated at 90 W peak power output for

18 W (maximum) input at 150 MHz (27 Vdc power supply), permitting close to 100 percent modulation with a 25 W carrier at V_{CC} = 13.5 Vdc. For the MM1553, the same figures are obtained with a 13.5 W (maximum) input. In fm or cw service, both devices are capable of a continuous 75 watts output at 150 MHz.

Much of the fine broadband performance of the transistors comes from their low lead-inductance, strip-line package – Motorola Case 145C-01. For more information use *check off* on page 88, or contact the Technical Information Center, Box 20912, Phoenix, Arizona 85036.

tone encoder/decoder



Because of the increased demand for a reliable all solid-state sub-audible continuous-tone encoder/decoder that is small enough to fit internally in small two-way radios, Alpha Electronic Services developed the SS-80H. Measuring only 1½ x 1¼ x ½ inch, it is probably the smallest unit of its kind. The SS-80H meets or exceeds all EIA specifications, and when coupled with the TN-91H frequency-determining module can be easily installed in equipment where space is a problem. The SS-80H is completely compatible with private line, channel guard or other standard frequency tone-quieting devices. It is also available with special tone frequencies, allowing greater use of congested channels. The SS-80H uses no mechanical reeds. For more information, use *check-off* on page 88, or write to Alpha Electronic Services, Inc., 8431 Monroe Avenue, Stanton, CA. 90680.

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short circuits

ST-5 demodulator

Several component values were omitted from the discriminator section of the schematic on page 14 of the September issue. These values are determined by the shift, and are shown in the following table:

shift	2125 – 2975	1275 – 2125
R1	4700	1500
R2	33k	8200
R3	5600	2200
R4	91k	68k
C1	.068	.18
C2	.033	.068

frequency counter

In **fig. 5,** page 23 of the July issue, IC2 should be shown as an MC799P. In **fig. 2,** page 19, the 20-pF capacitor in the crystal-oscillator circuit should be an N750 type for temperature compensation. In **fig. 7** the 170-volt power supply output is shorted – this should be shown as a shielded line to ground. Also in **fig. 7** one of the switch contacts is labeled *control module pin 14;* this should be *clock module pin 14.* And finally, in **fig. 5,** an electrolytic capacitor on the bottom right side of the drawing is shown with the wrong polarity.

wwv receiver

On page 68 of the July issue the schematic for the simple WWV receiver has no detector stage – a diode should be installed between the 1.2k and 20k resistors on the output of the SA21 integrated circuit, cathode end toward the 20k resistor.

microwave hybrids

On page 61 of the July issue, under **applications,** the sentence that states, "A detector-indicator, such as a receiver with an S-meter connected at port 3 . . ." should say port 1. If imbalance is measured at port 3 the input signal must be applied to port 1, in which case the signals at ports 2 and 4 will be 180 degrees out of the phase, and not suitable for balancing antenna sections. The situation is correctly described in the previous paragraphs.

. . . IF HE ALREADY OWNS GET HIM

The HT-2 Mark II, now with a new and improved transmitter, is the only 2 meter FM walkie-talkie built for the amateur. It features an extra-sensitive receiver with crystal and mechanical filters for excellent selectivity, and 1.6-2 watts out with very good audio quality. The ideal rig for repeater operation — in town or hilltopping! Comes with many extras.

Amateur Net $269.95

The IC-2F Deluxe 2 meter FM transceiver, shown here with the matching IC-3P AC power supply with built-in discriminator meter.

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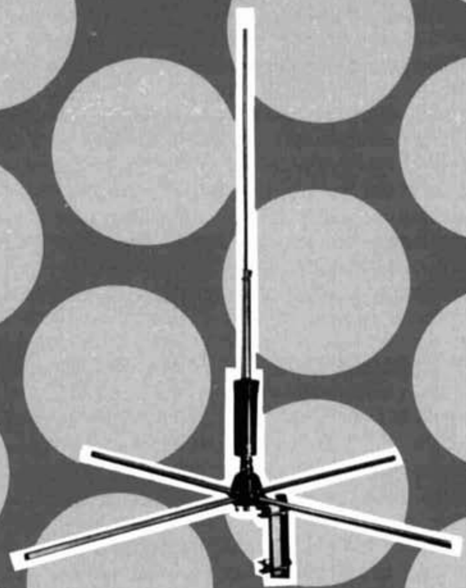

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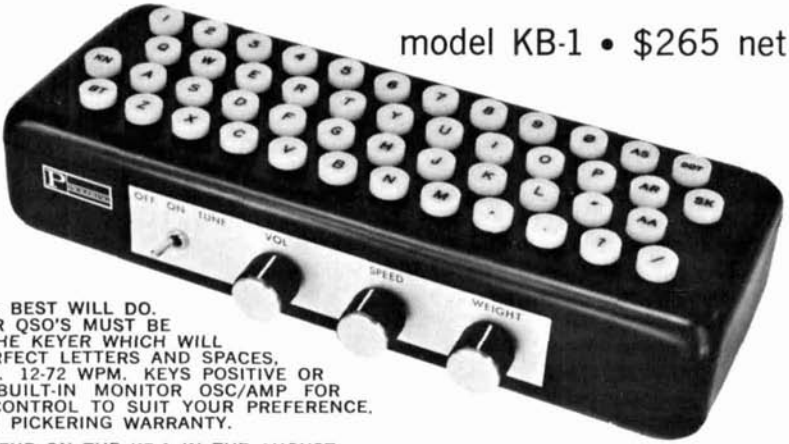

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- 40-80-160 VFO
- VFO Amp and Doubler
- Bipolar One-Watter
- 10-160 Two-Watter
- ½ Watt 10-160 CW-AM
- VFO CW-AM Tx
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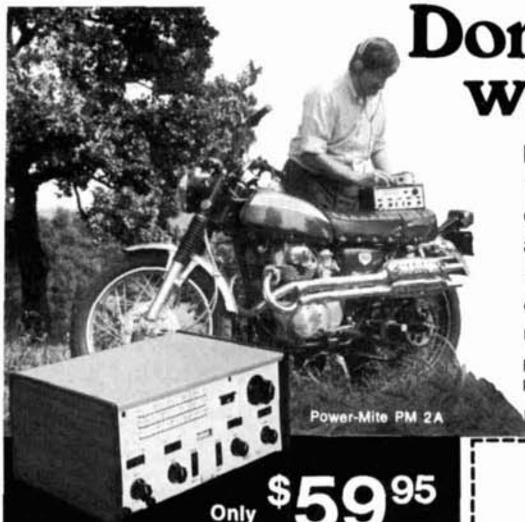

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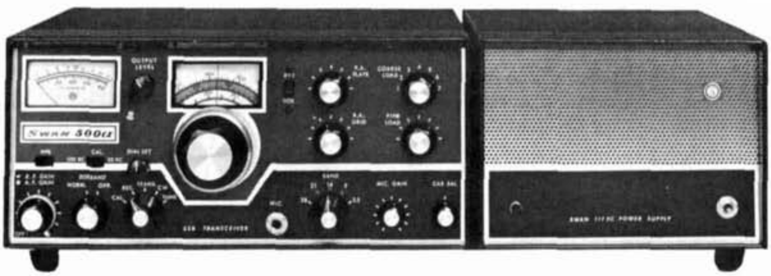

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TORRANCE, CALIF. 90505
Phone 213-534-4456
(corner of 231st Street & Crenshaw)

flea market

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

DON'T BUY QSL CARDS from anyone until you see my free samples. Fast service. Economical prices. Little Print Shop, Box 9848, Austin, Texas 78757.

CODE PRACTICE TAPES - Novice - General - Extra Class - Specify - $8.00 each. W9CJJ, 1105 Schaumburg Road, Schaumburg, Illinois.

WANTED: MODEL 15 Teletype machine in the New England Area. Joseph Fallon, WA1IWQ, 4 Lynch St., Peabody, Mass. 617 531-6725.

MECHANICAL FILTERS: 455 Khz. 2.1 Khz $18.95. 300 Hz $22.95. J. A. Fredericks, 314 South 13th Avenue, Yakima, Washington 98902.

ELECTRONICS YOUR BAG? Looking for an electronics course . . . that you can pay for by the subject AND take ONLY the subjects you NEED? . . . that you can change into ANY PHASE of electronics after completion of basics WITH NO PENALTY? For full information, write: EDCO ENTERPRISES INC., P. O. Box 432, Sparks, Nev. 89431.

WANTED: CUSTOMERS: No experience necessary: Write or call "HOSS TRADER ED MOORY" for the best deal on new or used equipment: DECEMBER BARGAINS: Guaranteed: 75A-4, $309.00: 75S-3, $395.00: 2B, $165.00: TR-3, $350.00: TR-4, $475.00: R4-B, $349.00: T4-XB, $369.00: GT-550, $369.00: SX-96, $99.00: SX-111, $99.00: HX-10, $165.00: Viking Valiant, $135.00: NC-183D, $129.00: NC-303, $169.00: Swan 350, $269.00: Swan 500C $379.00: Swan 270B Cygnet, $399.00: Ham-M, $85.00: CONTACT us for Special Package Deals on New Equipment in factory sealed cartons with full factory warranty: WE NOW HAVE the new Varitronics 2 meter equipment, Tymeter Clocks, and Ten-Tec Keyers in addition to all our other new equipment: Moory Electronics Co., Box 506, Dewitt, Arkansas 72042. Phone (501) 946-2820.

1916 QST'S wanted. Especially May and June. Any unreasonable price paid! Ted Dames, W2KUW, 308 Hickory Street, Arlington, N. J. 07032.

SIXTH ARKANSAS QSO PARTY from 2200 GMT January 23 to 0400 GMT January 25. Arkansas stations score 1 point per contact and multiply by number of states, Canadian provinces and foreign countries worked. Other stations score 5 points for each Arkansas station worked and multiply the total by the number of counties in Arkansas worked. Stations may be worked once each band and each mode. A certificate will be awarded the highest-scoring station in each state, province and country with 100 or more points. General Call: "CQ ARK". Arkansas c.w. stations identify themselves by signing "de (call) ARK K." Phone stations say "Arkansas Calling." Suggested frequencies (plus or minus 5) C.W. 3560, 7060, 14,060, 21,060, 28,060; S.S.B.: 3960, 7260, 14,300, 21,360, 28,560; Novice: 3735, 7175, 21,110. Arkansas send QSO number, RS(T) and county. Others send number, RS(T) and state, province or country. Logs and scores must be postmarked no later than February 9 and sent to the North Arkansas Amateur Radio Society, c/o J. K. Fancher, Jr., W5WEE, 407 Skyline Terrace, Harrison, Arkansas 72601.

ORIGINAL EZ-IN DOUBLE HOLDERS display 20 cards in plastic, 3 for $1.00, 10 for $3.00 prepaid. Guaranteed. Patented. Free sample to dealers. Tepabco, John K4NMT, Box 198R, Gallatin, Tennessee 37066.

SSB/CW RIG FOR SALE: Heath SB 300 w/all filters, SB401 w/PTT and VOX mic, SB600 matching speaker, $450 or offer — Doug Henry, WA7OHD, Box 3235, Tacoma, WA 98499.

TOLEDO MOBILE RADIO Association's 16th Annual Hamfest and Auction will be held February 21, 1971, Lucas County Recreation Center, Maumee, Ohio. $1.00 Registration, open table sales. Map and info write: TMRA W8HHF, Box 273, Toledo, Ohio 43601.

SB-300, MINT, $175. Charles Talbott, K3ICH, 8405 Old Marlboro Pike, Upper Marlboro, Maryland 20870. Tel: 301-420-5271.

READ RADIO CONSTRUCTOR for many interesting home-brew projects. Radio Constructor, Greenville, N. H. 03048.

ROCHESTER, N. Y. will again be headquarters for the huge W.N.Y. Hamfest, V.H.F. Conference and Flea Market May 15, 1971.

TOROIDS! Lowest price anywhere. 40/$10.00 **postpaid.** Center-tapped 88 or 44mhy. (5/$2.00). Fan fold page printer paper $10.00/box/920. Sync motors $7.00. Model 14TD $20.00. Model 32KSR reconditioned, perfect page printer $200. Lorenz 60 speed page printer with reperf and TD built-in $125. Reperferator tape (11/16") $10.00/case/40. Stamp for list. Van, W2DLT, 302H Passaic Avenue, Stirling, N. J. 07980.

TELETYPE #28 LRXB4 reperforator-transmitter "as is" $100; checked out $175. Includes two 3-speed gearshifts. Alltronics-Howard Co., Box 19, Boston, Mass. 02101. 617-742-0048.

SELL: GALAXY GT550, RF550, SC550, AC400, VOX35C, CAL25, Mint, in original cartons, $550 FOB. Walter Atkins, 1609 Valley Road, Champaign, IL 61820.

MANUALS for - R-390/URR, R-390A/URR, BC-639A, OS-8C/U, BC-779B, TS-186D/UP, $6.50 each. Hundreds more. S. Consalvo, 4905 Roanne Drive, Washington, DC 20021.

NOVICE CRYSTALS: 40-15M $1.38, 80M $1.83. Free flyer. Nat Stinnette Electronics, Umatilla, Florida 32784.

POLICE — FIRE — AIRCRAFT — MARINE Calls on your broadcast radio with TUNAVERTER S! Tunable — Crystal! Brochure. Salch Company, Woodsboro HMC, Texas 78393.

TELEGRAPH KEYS WANTED: Wire, wireless, Spark or CW. Related books. Ted Dames, W2KUW, 308 Hickory St., Arlington, N. J. 07032.

WANTED — APRIL 1968 Ham Radio — Advise price. W2AOM — a/c 201-384-1264.

SURPLUS MILITARY RADIOS, Electronics, Radar Parts, tons of material for the ham, free catalogue available. Sabre Industries, 1370 Sargent Ave., Winnipeg 21, Manitoba, Canada.

JACKITRONIX — New & used Electronic components — Special — 455KC IF, Iron core, air tuned, Q approx. 175, Sharpen up your Rcvr, 99¢ ea 6 for $5.00 — Special — Jennings type RA vacuum relay, DPDT, 30a, 300v (2 KV test), coil 115 vdc @ 25 ma, $7.00 ea — Special — Micro-switch, SPDT, 10a125v, 35¢ ea 4 for $1.00. Send 25¢ for catalog. JackiTroniX, 106 H Scherman Oakes, Walnut Grove, Georgia 30209.

PC BOARD. 3/32 inch, 2 oz. Copper one side, paper base. Specify size desired. 1.5¢ per square inch plus postage. HAL Devices, Box 365H, Urbana, Illinois 61801.

SAVE. On all makes of new and used equipment. Write or call Bob Grimes, 89 Aspen Road, Swampscott, Massachusetts, 617-598-2530 for the gear u want at the prices u want to pay.

DIGITONE TONE CONTROL DEVICES — decoders, encoders, logic. Compact solid-state modules. Application Notes/catalog. Write Digitone, Box 73-HR, Bellbrook, Ohio 45305.

SILICON BORON non-inductive rod resistors 200 ohms 5% 100 watts 1″x6″ $2.00 ea postpaid. Joe Gentle, 2420 1st Ave., N.E., Cedar Rapids, Iowa 52402.

THE LAKEHEAD AMATEUR RADIO CLUB has made available to all amateurs and SWL's a certificate to be known as: — The Thunder Bay Award —. The requirements are: For VE/VO — Eight (8) different Thunder Bay Ontario Stations must be worked, or heard for SWLS, since January 1, 1970. For all others — Five (5) different Thunder Bay Stations must be worked, or heard for SWLS, since January 1, 1970. All contacts must be with different stations. Contacts may be on mixed modes and bands. No QSLs are required, only the full log information on stations worked or heard. Send one (1) dollar Canadian funds, or 10 IRCs to: Lakehead Amateur Radio Club, Awards Committee, P. O. Box 571, Stn. "P", Thunder Bay, Ontario, Canada.

BUY, TRADE, SELL used receivers. Or trade for new general merchandise. Available R-4A, 51S-1, NC-190 and BC-779B. Ten day money back guarantee. 30 day warranty on parts and labor. Steven Kullmer, Evergreen Hatchery, Dysart, Iowa 52224.

FOR SALE: 62S1, $475. Heath KL1 (Chippewa), KS1, $200. Factory-sealed: 30L1, $445; 312B4, $175. 75S3 (6EH7 RF Amp per Feb 66 QST), 32S3, 516F2, 312B4, $1050. 75S1, 32S1, 516F2, 312B4, $700. Swan 500C, 117XC, $425. HW32A, HP13, $135. Lafayette HA460, $65. B & W Variable inductor, new (used as L401 in KWS1), $15. BC221, manual, charts, $40. Viking Thunderbolt, $250. 4CX1000A, sealed carton, $100. Varitronics FDFM-2S, PS1500, $250. NCL2000, factory re-worked, sealed carton, $350. 100V, $250. Ham-M, sealed carton, $110. TA33, new, $120. TR44, new, $60. SR160, PS150DC, $200. Galaxy 300, PSA300 Console/p. s., $185. Filter F455Y60 (for 75S1/2/3), $20. 312B5, $275. Lambda VR supplies (rack mounting), write for details, $25. 30L1, $350. Capacitors, 4 mfd/10KV, $25. Bowerstat Model 136, 0-140V/20 amps, $25. Simpson Model 260 VOM (factory reconditioned), $50. Telex headset, new, $5. 3-500Z, new, $28. Waters Hybrid Coupler #3002, new, $45. WANTED: Collins 351R1/RW rack panels for S-Line (need 2). 30S1, TR4, late. T4XB, R4B, AC4. 3-1000/4-1000, new. SR-150, PS150 AC, $275. James W. Craig, W1FBG, 29 Sherburne Ave., Portmouth, N. H. 03801.

TOROIDS 44 and 88 mhy. Unpotted, 5 for $1.50 ppd. W. Weinschenker, Box 353, Irwin, Pa. 15642.

AUTO BURGLAR ALARM — Save your rigs and car. Fantastic outfit $7.75 ppd. Express Traders, P. O. Box 696, Freedom, Calif. 95019.

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NEW, 3rd edition, **Amateur Radio Techniques** by J. Pat Hawker, G3VA. Latest edition of this popular book has 48 more pages and much valuable new material. New deluxe binding. Only $3.50. Order today from Comtec, Box 592, Amherst, N. H. 03031.

HAM-M ROTOR AND CONTROL $94.95. New in factory sealed carton. Ideal Christmas gift for dad. RG8U and RG11U Foam Coax 10¢ foot. F.O.B. Monte Southward, WB8GZQ, R1, Upper Sandusky, Ohio 43351.

AUTUMN HOUSECLEANING. Making room for new gear. Amphenol FET voltmeter, $75. UHF signal generator, LAE2, 500 to 1300 MHz, $75. Eico 717 electronic keyer, $40. 3-amp Variac, $8. Antenna noise bridge, $20. 8 μF, 1500 Vdc electrolytics, $1 each. All items fob. W1DTY, Ham Radio, Greenville, NH 03048.

FM TRANSCEIVER — Solid-state, 6 channel, dual conversion receiver with mechanical filter. 10 watt transmitter. Includes mike, mobile bracket & 34/94 crystals. $240.00 f.o.b. Denver. V H F Associates, Inc., P. O. Box 22135, Denver, Colorado 80222.

SQUEEZE KEY, the ultimate electronic keyer. Compact, integrated circuit board, built-in double lever paddle, sidetone speaker. Quality import. $79.50. SASE for brochure. Dave Kennedy, W9DL, Far View Road, R. F. D. #1, Elburn, Illinois 60119.

GREENE DRAGON FLY . . antenna for 20-40-75 meters . . one feed line . . SWR one to one . . and guaranteed-self construction drawings $5.00. Greene, Box 423, Wakefield, R.I. 02880.

WEST COAST HAMS buy their gear from Amrad Supply Inc. Send for flyer. 1025 Harrison St., Oakland, Ca. 94607.

FOR SALE: HAMMARLUND HQ200. General coverage receiver, $175, Knight TR106 transceiver 6 meter $100, both excellent. Heathkit GR54 receivers $50, "Heath Sixer" $25, Knight TR108 2 meter transceiver $60 fair, Dwight Sunday, 708 Langrick, Sturgis, Michigan 49091.

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

"DON AND BOB" NEW GUARANTEED GOODIES. KW all band mobile antenna coil, Icore 2408T 3"/8TPI 24.95. Write custom coil quotes. Monarch KW SWR-relative power dualmeter bridge (reg. 24.95) 15.95; Ham-M 99.00; TR-44 59.95; Hygain TH6DXX 139.00; Triex W51 tower 329.00 prepaid; Regency HR2 6 channel 20 watt 2 meter FM (reg. 229.00) 195.00. New gear cash quotes. Quotes any brand tube. Write special price R-4B, SPR4. Items full warranty, prices fob Houston. Mastercharge, BankAmericard, GECC. Madison Electronics, 1508 McKinney, Houston, Texas 77002. (713) 224-2668.

TA-33 MOSLEY Tribander antenna. Unused $120.00. Reginald C. Reindorp, 641 Hathaway Drive, Macon, Georgia 31204. Tel. 912-746-5816.

WANTED: APRIL 1968 "Ham Radio". K2DGI, 22 Ivy Drive, Jericho, N. Y. 11753.

TR-4, FACTORY BLANKER — Overhaul. New cond. AC-DC, Hustler Mobile Ant. $600. or Cash and Test Equipment. Bill Teasdale, WB2UAD, Seaford, N. Y. 11783. 516-SU5-6924.

GALAXY GT-550 transceiver with all accessories. System is practically new — less than 8 hours operation. Accessories include AC-400 ac power supply, SC-550 speaker console, RV-550 remote vfo, PR-550 phone patch, VX-35 vox unit, CAL-25 25-kHz crystal calibrator, and F-3 300-Hz cw filter. List price for this package is over $900. Must sacrifice for $600 to keep peace in the family. All units have original warranty cards. Box E, Ham Radio, Greenville, NH 03048.

WORLD QSL BUREAU — see ad page 82.

W6AG SELLING OUT. Lifetime collection goodies. Example: Immaculate 75A4, $300. SASE for fantastic steal list. 213-764-4401.

GREENE DIPOLE CENTER INSULATOR . . . see ad page 93, May 1970 Ham Radio.

CIR-KIT — The amazing new pressure sensitive tape that let's you make a "PC Board" in minutes with no chemicals or special equipment. See our ad in this issue.

REVISED REQUIREMENTS for the Okinawa Award, as follows: QSLs required: 25 — KR6 and KR8 applicants; 10 — BV, CR9, DU, HL/HM, JA/KA, KG6, VS6, W/K applicants; Rest of the World send 5. KR6 and KR8 applicants must submit cards. All others, send only a log book extract with signed confirmation that required QSL information had been received and verified by two licensed amateur radio operators, or by an official of a recognized radio club or society. Send all applications and $1.00 (U.S.) or 10 IRC's, to QSL and Awards Manager, Okinawa Amateur Radio Club, P. O. Box 465, APO, San Francisco, CA 96331.

WE WILL BE VERY GRATEFUL if some Hams could help us by sending to us some old copies of Call Books "World" and "U.S.A." Editions and other Radio Books and Magazines such as "QST", "CQ", "73", etc., as it is very difficult to obtain books and magazines on Radio in this country and will be very thankful for the gifts. Mr. Kushal Harvant Singh, Malaysian Radio Club, 31, (774), Upper Museum Road, Taiping. Perak. Malaya. Malaysia.

2nd **WORLD RTTY CHAMPIONSHIP** is announced. At the present time, the Contests which count towards this Award are as follows: 1970 B.A.R.T.G. Spring RTTY Contest; 1970 D.A.R.C. RTTY WAE Contest; 10th World-Wide RTTY DX Sweepstakes; 1970 Alex Volta RTTY Contest; 1971 Giant RTTY Flash Contest. In order to arrive at the final score the following points system will be used for each Contest: 30 points to the winner, 25 points for 2nd place, 22 points for 3rd place, 20 points for 4th place, 18 points for 5th place, 17 points for 6th place, 16 points for 7th place . . . 1 point for 22nd place and all other entrants will be credited with one point. For the final score for the year, only the best 4 scores (Out of a possible 5) will be used for each operator. In order to take part in this Award it is not necessary for entrants to send in a claim as the entries of all competitors will automatically be included. The 1970 World Champion of RTTY will receive a plaque and prizes will be awarded for the leading positions in the final score. The Italian Magazine "CQ Elettronica" will make available the Awards for each year. It will be the responsibility of the British Amateur Radio Teleprinter Group to nominate the winner for the year 1970 and this Society will notify the "CQ Elettronica" Magazine of the results in order that the Awards can be made.

The **SIXTH ANNUAL TELEPHONE PIONEER QSO PARTY** will start at 1900 hours GMT, Saturday Decmber 5, 1970, and will end at 0500 hours GMT on Monday, December 7, 1970. All telephone Pioneer ham radio operators in the United States and Canada are invited to participate. All bands may be used and the same station may be worked on more than one band. Phone User: Call "CQ Telephone Pioneers." C. W. User: Call "CQ T.P." Suggested Frequencies: Phone: HF (±5KHz) — 3,965KHz; 7,260KHz; 14,295KHz; 21,365KHz; 28,675 KHz. VHF-50.100MHz to 50.250MHz; 144.275MHz to 145.500MHz. C. W.: HF (±5KHz) — 3,565KHz; 7,065KHz; 14,065KHz; 21,065KHz. Scoring: One (1) point for signal report exchange with a Pioneer in any chapter. One (1) point for exchanging reports with each different chapter. Exchange: Signal report, contact number, chapter name and number. Reporting: Send log extract showing date, time, station worked, chapter name and number and contact number, not later than January 5, 1971 to: Frank J. Wojcik, W2SNJ, Stanley S. Holmes Chapter, Telephone Pioneers of America, 100 Central Avenue, Kearny, New Jersey 07032.

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December 1970

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Advertisers Index

ham radio

index to volume III – 1970

This index covers all articles published in **ham radio** during 1970. The articles are listed alphabetically under each category along with the author, page number and month. Categories are: antennas and transmission lines; commercial equipment; construction techniques; fm and repeaters; integrated circuits; keying; measurements and test equipment; miscellaneous technical; power supplies; propagation; receivers and converters; RTTY; semiconductors; single sideband; transmitters and power amplifiers; and vhf and microwave. Articles followed by (HN) appeared in the **ham notebook.**

antennas and transmission lines

audio

commercial equipment

construction techniques

fm and repeaters

integrated circuits

keying

measurements and test equipment

miscellaneous technical

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Details are on page 72

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That means taking the FT-101 with you. The solid-state portable rig that fits in a suitcase. 260 W PEP, 180 W CW and 80 W AM maximum input power, 0.3 microvolts receiving sensitivity for 10 db signal-to-noise ratio . . . in a thirty-pound package that even includes built-in 12 VDC and 117 VAC power supplies.

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For in-car operation, there's a built-in noise blanker — to pick out noise spikes, leaving behind only clean signal copy.

About those plug-in modules — if one of them ever should give you trouble, just send it in to us and we'll rush you a new card by return mail. The Yaesu FT-101 is guaranteed fully for one year.

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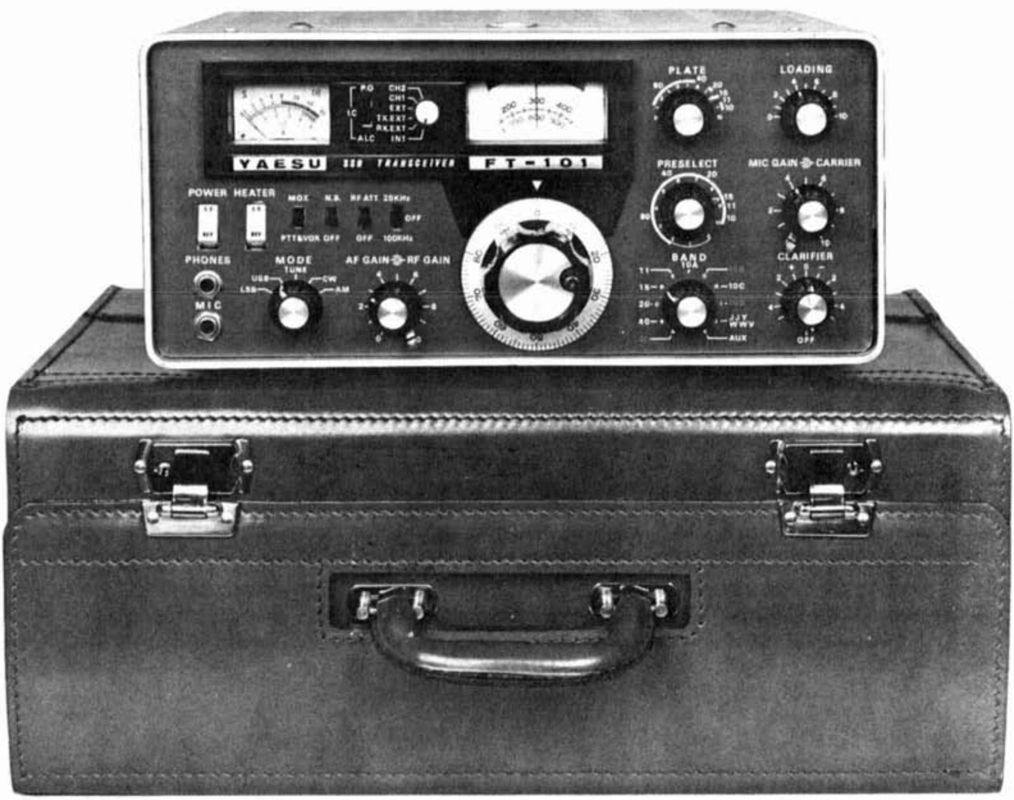

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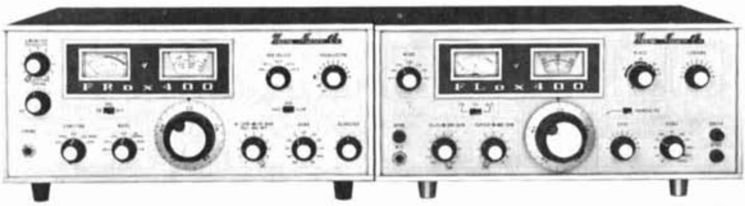

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The FRdx 400 Receiver

Get a big ear on the world with complete amateur band coverage from 160 meters through 2 meters, including WWV and CB reception. Four mechanical filters do it — they provide CW, SSB, AM and FM selectivity. Separate AM-SSB-FM detectors are included, along with squelch and transmit monitor controls. Plus a noise limiter and a variable delay AGC. And a built-in notch filter with front panel adjust for notch depth.

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The FRdx 400 sells for $359.95.

The FLdx 400 Transmitter

Here's how to set yourself up with dual receive, transceive or split VFO operation. The FLdx 400 with its companion receiver brings you the ultimate in operational flexibility. Flexibility like frequency spotting, VOX, break-in CW, SSB, AM and even an optional FSK circuit.

The completely self-contained FLdx 400 features a built-in power supply, fully adjustable VOX, a mechanical SSB filter, metered ALC, IC and PO. A completely solid-state FET VFO provides rock-solid frequency stability.

We rate the FLdx 400 very conservatively. That rating guarantees you 240 W PEP input SSB, 120 W CW and 75 W AM. The FSK option will go all day at a continuous 75 W. And you get full frequency coverage on all amateur bands — 80 meters through 10 meters — with an optional provision for certain other bands that you can personally specify. For all that, you pay just $299.95.

FL2000 B Linear Amplifier.

Ideal companion to the Series 400, this hand-crafted linear is another example of Yaesu's unbeatable combination of high quality and low cost. Designed to operate at 1500 watts PEP SSB and 1000 watts CW, this unit provides superb regulation — achieved by a filter system with 28 UF effective capacity.

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