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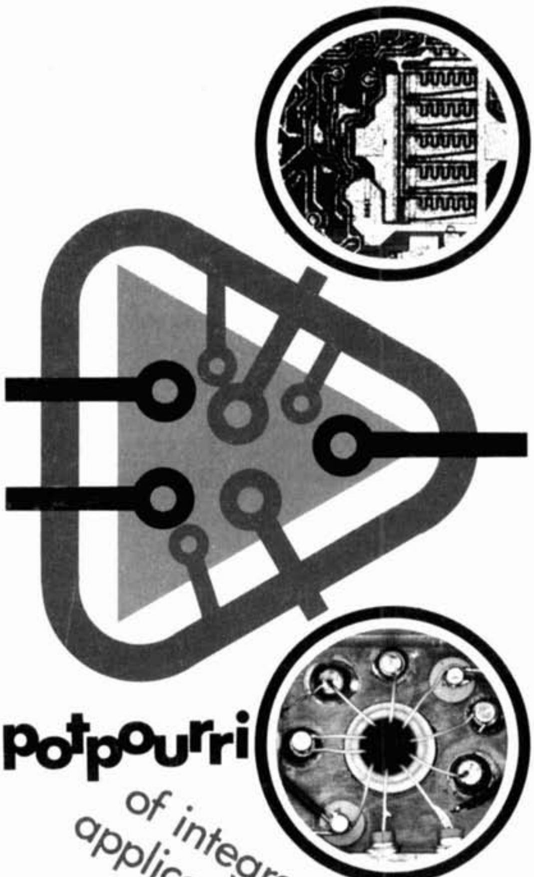
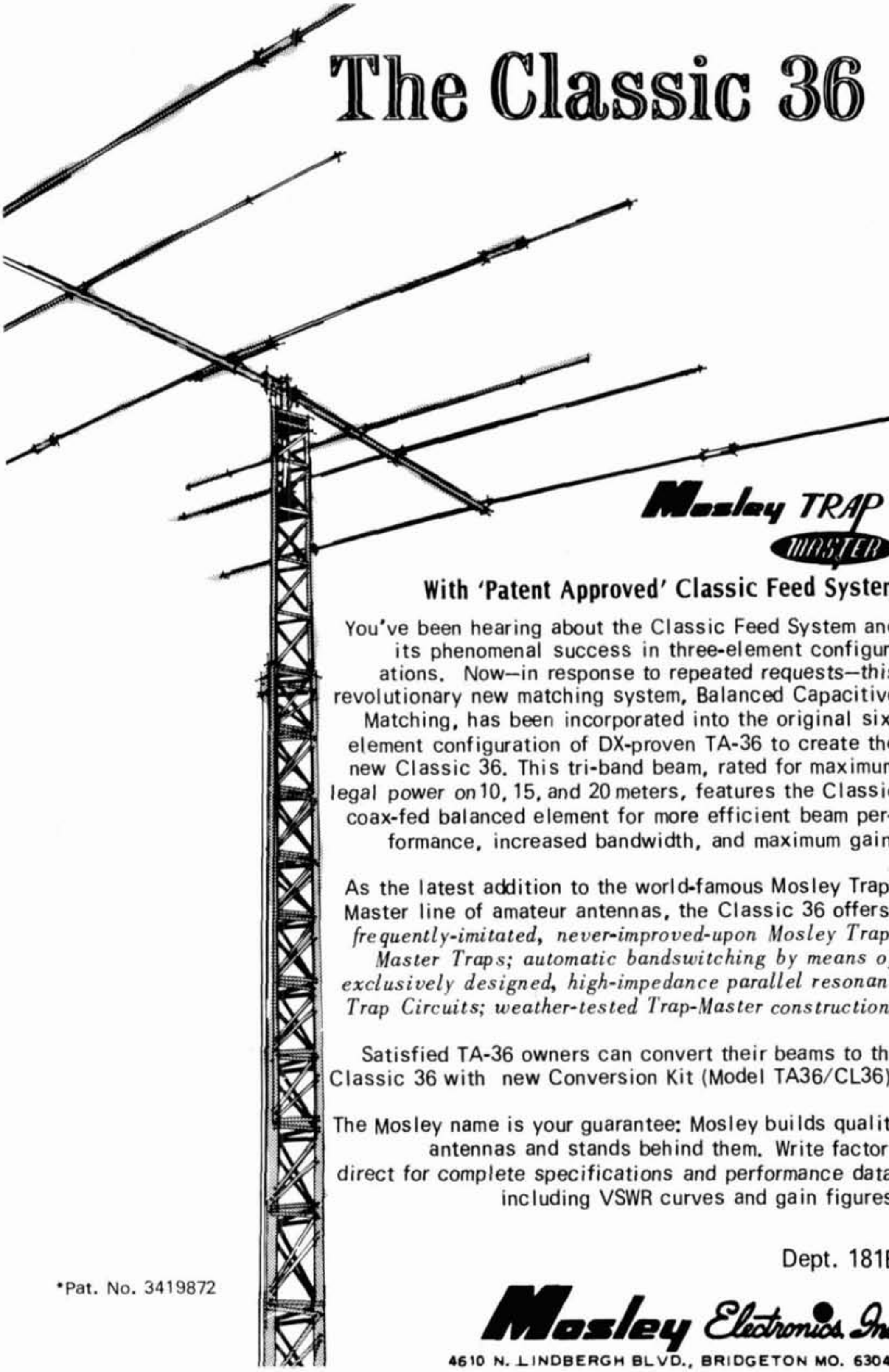
MAY 1969



potpourri of integrated-circuit applications • page 8

this month



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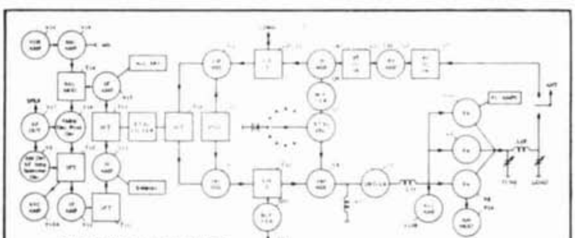

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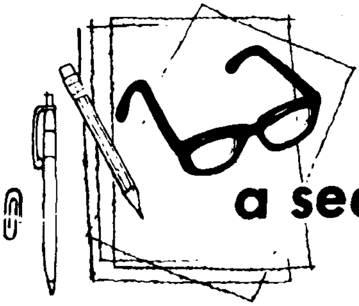

a second look

by jim fisk

Although the serious DX'ers make up a small percentage of all the licensed amateurs, they are probably more active and make more noise than all the rest of us put together. You may be able to work the world with an S-40A receiver and a DX-20, but you'll never crack a Gus pileup with that gear, even when conditions are right. The big-gun DX'er takes country chasing very seriously and has the QSL's and DXCC to prove it; but what do you do when you've worked them all? Hang up your mike and key and go back to 75-meter phone? Not by a long shot, Charlie! You generate a new award and send everybody back to the starting grid.

Amateur radio covers the world, but there is only one international award, "Worked All Continents," and that was created in 1925 by the International Amateur Radio Union. The number of amateurs who could put "WAC" on their QSL card in the 1920's was pretty slim—WAC was real attainment. Today, if conditions are right, a well-equipped station can work all continents simultaneously in a single roundtable.

In 1966 a group of European amateurs—lead by Gérard de Buren, HB9AW/WA6QAU—got together to set up a new international award that would require activity on all bands. Gérard is station manager of 4U1ITU, the International Amateur Radio Club station in Geneva. Gérard thought it was time to put together an award on an international basis with emphasis on multiband operation; he talked up the idea and was encouraged by interested amateurs all over the world.

He prepared the first draft of rules and presented them to a small working group in London in late 1968. From there on it was up to the 27 board members of the International DX Organization. The rules for the new award, the International Call Areas Award (ICAA), have two very important points: ITU regulations will be followed to the letter and no credit is given for normally uninhabited rocks or reefs. This means that a contact with a station in San Marino using an M1 call will not count for ICAA because it is in the call-sign block allocated to Great Britain. AC4, PX1 and 7G1 fall in the same category. Examples of uninhabited islands that are not on the ICAA list are Bajo Nuevo, Malpelo, Clipperton and Heard Island.

The current ICAA list has a total of 444 call areas: the large number is generated by certain countries that are expanded because of a large amateur population or wide-spaced geographical area. The United States, for example, is broken into the 48 continental states for the purpose of the award. Australia, Canada, Germany, and Japan, as well as several others are "expanded" in a similar way.

The ICAA is issued in four classes: class I for 400 call areas and 1500 points, class II for 300 call areas and 1300 points, class III for 200 call areas and 900 points, and Class IV for 100 call areas and 500 points. Intercontinental contacts on 1.8 MHz count 10 points (5 points if within the same continent). Contacts on 3.5 MHz count 3 points, contacts on 7 MHz count 2 points and contacts on ten, fifteen and twenty meters count one point per band. All contacts must date after January 1, 1969.

Two official ICAA record books are necessary for each award; one is used for the application and the other for your files. Tentative price for the two record books is $3. In addition, a registration fee of $2 is required from each applicant. If you're interested in chasing a new DX award that is in tune with today's technology, write to the International DX Organization, Post Office Box 543, 1211 Geneva 3, Switzerland.

Jim Fisk, W1DTY
Editor

Great things from NRCI

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NCX-500

Here's the potent 5-bander with a 500-Watt punch. Check the terrific features on this low-priced performer:

☐ 500-Watt PEP input on SSB, grid-block keying on CW and compatible AM operation. ☐ Sidetone monitor, plus built-in code practice oscillator. ☐ Receive vernier, with tuning range greater than ±3 kHz. ☐ Separate AM and product detection. ☐ Fast-attack/slow-release AGC in all modes. ☐ Crystal-controlled pre-mixing with single VFO for effective frequency stability, plus identical calibration rate on all bands. ☐ Crystal lattice filter for high sideband suppression on transmit, and rejection of adjacent-channel QRM on receive . . . plus solid-state balanced modulator for "Set-and-Forget" carrier suppression.

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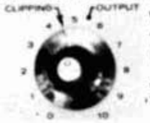
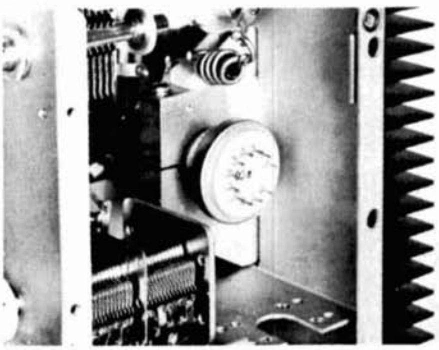


POST-CLIPPER PEAK OUTPUT CONTROL allows instant level adjustment for proper drive to any linear, and preserves signal quality right down to a watt or less!

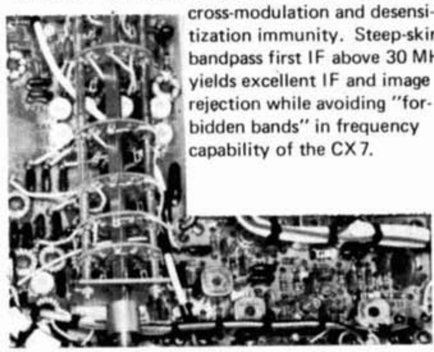
HIGH EFFECTIVE POWER OUTPUT . . . 300 watts PEP input combined with the high **average** power content of RF-clipped SSB makes the CX7 sound more like a KW . . . or several, when it's followed by a linear.

RUGGED CONDUCTION-COOLED FINAL AMPLIFIER has ample reserve power dissipation capability to run all day at full rated input . . . even on FSK. No more "key down" time limits. And its linearity is excellent.



The beryllia coupler block provides excellent electrical insulation, yet transfers anode heat to the extruded heat sink as efficiently as would a metallic aluminum block. The tube just loafs along, **cool** and **linear.**

DUAL-GATE MOSFET FRONT END provides outstanding sensitivity plus exceptional resistance to overload. Toroidal preselector helps achieve superb cross-modulation and desensitization immunity. Steep-skirted bandpass first IF above 30 MHz yields excellent IF and image rejection while avoiding "forbidden bands" in frequency capability of the CX7.



SPECTACULAR SELECTIVITY from **two cascaded** crystal filters is located **ahead of** most receiver gain, further enhancing dynamic range. Optional filters for CW or FSK are cascaded with one SSB filter, insuring unprecedented skirt selectivity and ultimate rejection in **all** modes.

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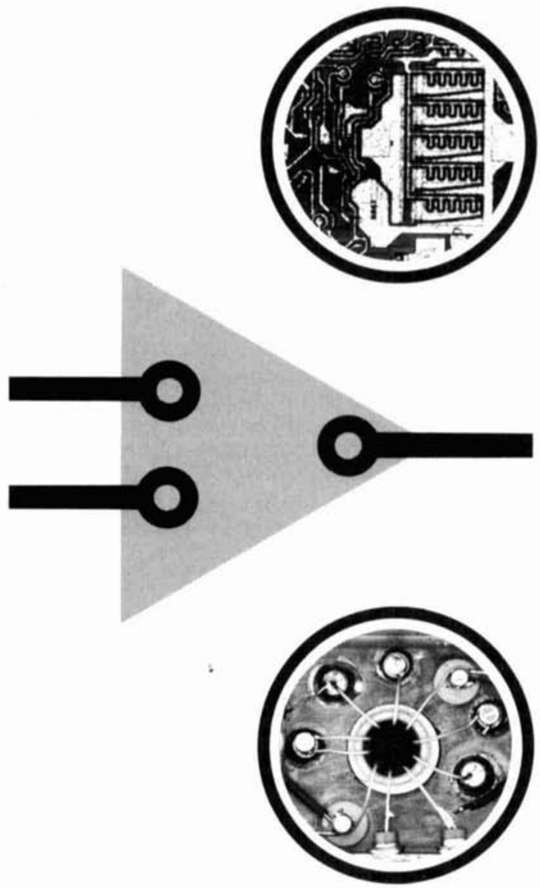
a potpourri of integrated circuit applications

Here is a collection of more than fifty linear integrated-circuit applications for audio, i-f and rf, oscillators, voltage regulators and radio communications

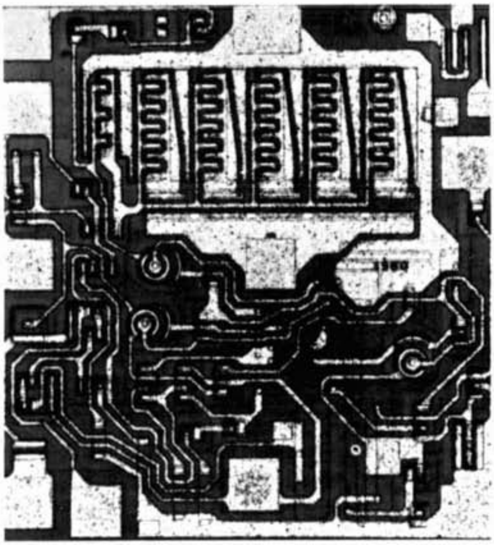


Darrell Thorpe, 3110 N. 83 Street, Scottsdale, Arizona 85251
Jim Fisk, W1DTY, RFD 1, Box 138, Rindge, New Hampshire 03461

Integrated circuits offer many unique possibilities in amateur equipment that are impractical (and often impossible) with conventional solid-state techniques. They simplify many circuits and let you do the same job at less cost—although the innards of one IC may be many times more complex than anything you would be willing to build on your bench.

This article brings together a variety of circuits to give you an idea of what can be done with today's linear IC's. The circuits were collected from a number of different sources including manufacturer's literature, engineering magazines, correspondence with other amateurs and our own basement experiments. The intention is to provide a quick-reference source to integrated circuit applications that are especially suitable for radio communications. With all the integrated circuits that are currently on the market, it is impossible to cover every type; however, we have tried to include a variety of low-cost readily available devices.

If you have never used integrated circuits before, there are several things to keep in mind. First of all, you can't use the same casual haywire breadboard layouts that work ok with transistors and vacuum tubes; if you do, you'll have nothing but trouble. Remember that the IC has a great deal of gain in a very small package. Also, the transistors used in an IC are typically rated to 400 MHz even if the IC is being used as an audio power amplifier. Keep all the leads short, use good **rf** construction practices in all IC projects and use the bypass capacitors and decoupling resistors recommended by the manufacturer.



Although it is less than 1/8" square, this integrated-circuit die contains 22 transistors (including one power type), 10 diodes and 17 resistors.

Use particular care when making input, output and power supply connections to the IC. Always think in terms of low-resistance and low-inductance grounds and power supply leads. Bypass and frequency-rolloff capacitors should be connected directly at the device socket if possible. Make sure all power supply leads are properly bypassed (at the device), keep input and output leads short and shielded if necessary, and use one common tie point for all grounds. If you follow these simple precautions, you should have a minimum of trouble with integrated circuits "taking off" at some unwanted frequency.

Sockets aren't absolutely necessary, but they are recommended. If you don't use them in your first integrated circuit project, you probably will on later ones! Several manufacturers make sockets, including Cinch-Jones, Elco and Augat; about the most inexpensive sockets are marketed by Motorola with the HEP line; they have sockets for 8- and 10-lead TO-5 cans plus sockets for the 14-lead dual-inline plastic package.

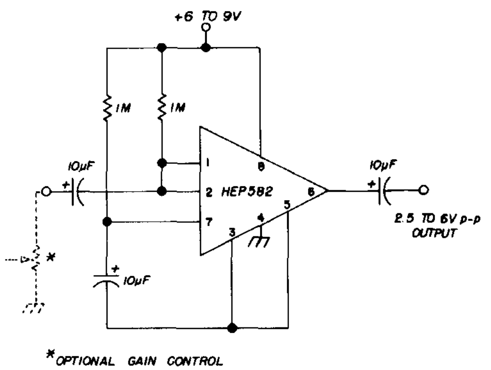


fig. 1. This high-gain audio preamplifier uses a low-cost digital IC—an RTL dual buffer.

audio preamplifiers

One of the simplest audio amplifiers that can be built with an integrated circuit is shown in **fig. 1**. This circuit uses both sections of a digital IC—a dual RTL buffer—to provide gains in the range of 5000 to 10,000 with output voltage swings between 2.5 and 6 volts. The HEP582 dual buffer has the collector load resistors built into the circuit so it's only necessary to add base bias and coupling capacitors to build an audio preamp. This IC really simplifies building a two-stage audio amplifier and is useful right after the detector in a receiver, as a mike preamp or as an oscilloscope preamp to increase scope sensitivity. The HEP582 can also be used as a broadband rf amplifier up to several MHz.

The high-gain low-level preamplifier shown in **fig. 2** uses an HEP592 dual preamplifier that is designed for stereo preamps. This IC is actually a dual operational amplifier, so the operational characteristics of any circuit that it is used in are a function of the external feedback components. The frequency response of the HEP592 can be tailored to your specific application by careful selection of the feedback resistors and capacitors shown in **fig. 2**. The bandwidth parameters of the complete preamp are defined as shown in **fig. 3**; the three "corner" frequencies are set by the external components as indicated by the three formulas.

fig. 2. High-gain preamplifier using one-half of an HEP 592; frequency response is set by the external feedback components as shown in fig. 3.

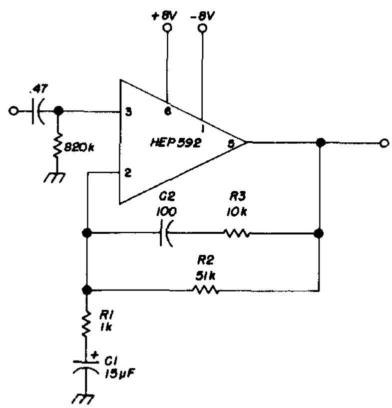
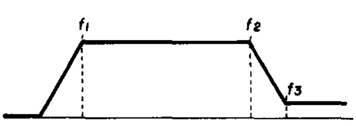


fig. 3. Frequency response and voltage gain of operational amplifiers are set by the external feedback components as shown here.



$$f_1 = \frac{1}{2\pi R1\ C1}$$

$$f_2 = \frac{1}{2\pi R3\ C2}$$

$$f_3 = \frac{1}{2\pi R2\ C2}$$

With the feedback components shown in **fig. 2**, the response is essentially flat from 10 Hz to 100 kHz. Voltage gain at 1 kHz is approximately 40 dB and the maximum fig. 4. High gain audio preamplifier using a PA230. Frequency response characteristics are determined by the feedback components shown in fig. 3. Table 1 shows typical values and performance characteristics.

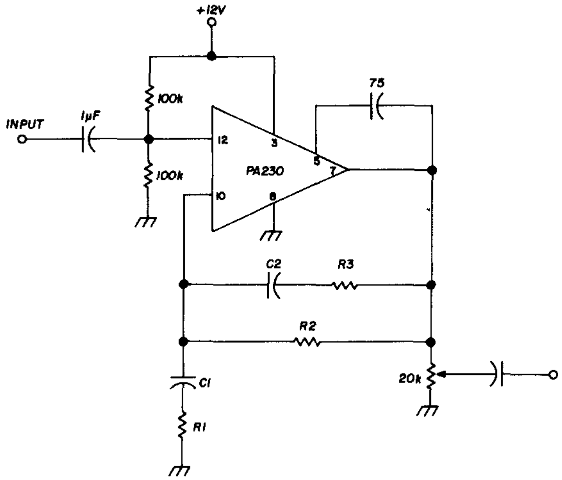
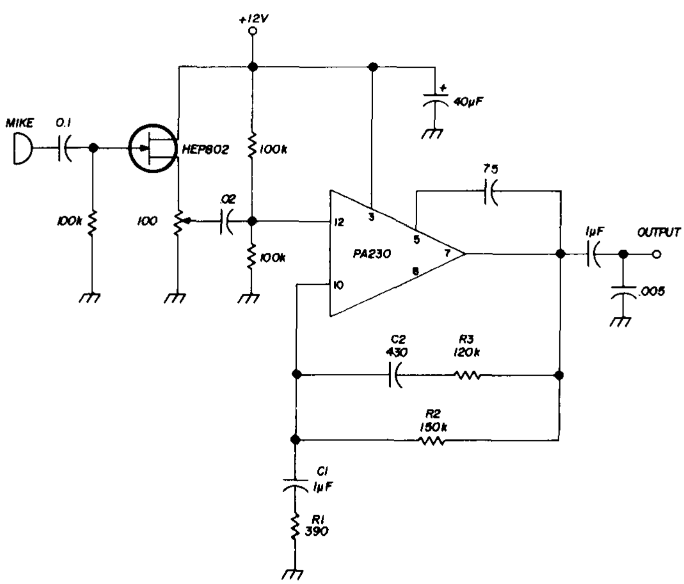


table 1. Frequency response and voltage gain characteristics of the amplifiers shown in figs. 4 and 5.

Bandwidth	Voltage Gain	C1	C2	R1	R2	R3
28 Hz—270 kHz	27 dB	10 μF	10 pF	470	10k	10k
28 Hz—230 kHz	36 dB	10 μF	10 pF	470	27k	10k
28 Hz—80 kHz	36 dB	10 μF	51 pF	470	27k	10k
28 Hz—25 kHz	41 dB	10 μF	100 pF	470	56k	10k
310 Hz—2700 Hz	40 dB	1 μF	430 pF	390	150k	120k

The high-gain audio preamplifier shown in **fig. 4** uses a General Electric integrated circuit, the PA230. This IC features expanded operating temperature range, output short-circuit protection, high voltage gain and low noise. The frequency characteristics of the preamp circuit may be set using the criteria shown in **fig. 3**. **Table 1** shows the frequency response and voltage gain characteristics with various combinations of feedback resistors and

fig. 5. High input impedance microphone preamplifier with frequency response suitable for ssb.



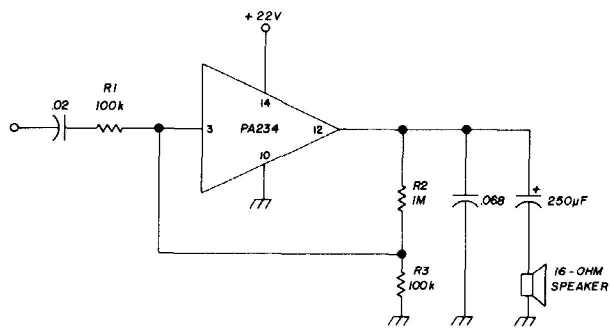
output voltage swing is 5 volts rms. Since only one-half the HEP592 is used in **fig. 2** the other half (which is identical) may be used for additional amplification or for another amplifier channel. Channel separation is typically 58 dB.

capacitors. The circuit in **fig. 5** uses a PA230 and an inexpensive fet to provide a high input impedance high-gain microphone preamp for communications work; the frequency response of this circuit is approximately 300 to 2700 Hz.

audio power amplifiers

If you need a miniature half-watt audio power stage, the circuit in **fig. 6** should be of interest. This circuit uses a single IC—the RCA CA3020 or CA3020A—to provide 545 mW output with 45 mV input. The output from a solid-state product detector or a-m detector usually provides enough drive for full output. In this circuit the idling current is 22 mA, input resistance is 50k ohms and total harmonic distortion at 135 mW output is 3.3%. For more information on uses of the CA3020, see reference 18.

fig. 7. One-watt audio power stage using a PA234. Heat sink tab must be soldered to heat sink area not less than 2 square inches.



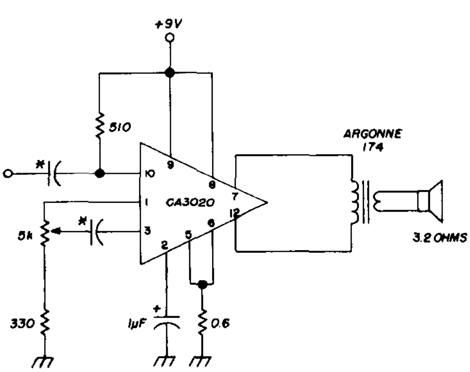
The 1-watt audio power amplifier shown in **fig. 7** is about the most simple integrated-circuit power amplifier you're apt to see. The PA234 is designed to operate with 9- to 25-volt power supplies into 8-, 16- or 22-ohm loads. The voltage gain of the circuit depends upon the ratio of R2/R1; biasing is set by the ratio R2/R3. In addition to the resistors, three capacitors are required for input and output coupling and high-frequency stabilization.

The ratio of R2/R3 must equal 10 for proper bias with a 22-V supply and to maintain good stabilization, R3 should not be greater than 100k. With the values shown in the circuit diagram, voltage gain is approximately 8 and a 600 mV input signal is required for 1 watt output. Distortion at 1 watt output is 3%; at 0.05 watt output distortion is 0.5%.

When using the PA234, the power supply output filter should be as close to pin 10 as possible with **all** other ground returns run separately to this point because common ground impedances can cause hum and distortion. Since the frequency response of the amplifier extends from 30 Hz to 100 kHz, the 0.068-µF capacitor across the output is required for protection against oscillation.

The Amperex TAA300 integrated-circuit audio power amplifier circuit shown in **fig. 8** can deliver one watt into an 8-ohm load when powered from a 9-volt power supply. In this circuit the total harmonic distortion at 1 watt output is 10%; total harmonic distortion at 0.5 watt is 3% maximum. Input impedance is greater

fig. 6. Half-watt audio power stage. For most amateur applications the capacitors marked with an asterisk should be 0.25 µF; for better low frequency response, use 1-µF nonpolarized capacitors.



than 10k ohms, and a 10 mV input signal will provide 0.7 watt output. A finned heat sink must be used when the TAA300 delivers one watt into an 8-ohm load; no heat sink is required if the load impedance is 16 ohms or greater.

Although this circuit is designed for a +9-volt supply, the IC will operate satisfactorily with power supplies down to +4.5 V. The variable resistor, R1, is adjusted for 8 mA total current drain with no

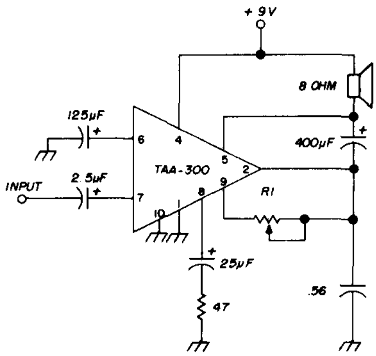


fig. 8. Amperex TAA300 1-watt audio amplifier. R1 is adjusted for 8 mA total current drain with no input signal.

input signal. When the circuit is fed from an ac power source, typical value for this resistor is 330 ohms; when a battery supply is used, it is preferable to use a smaller value because of the resistor's affect on operating current stabilization at low battery voltages.

Do not short or use too low a resistance value for R1 when **setting** the no-signal operating current. Start with a large resistance—approximately 25k—and reduce the value in small steps to arrive at the correct operating point. A 2.2k ohm resistor should be connected in series with R1 initially to protect the circuit in case the adjusting potentiometer is rotated to the zero resistance position.

The audio power amplifier shown in **fig. 9** uses an integrated circuit that was designed to amplify signals to 300 kHz with 1.8 watt delivered into a direct or capacitively coupled load. The HEP593 IC features low harmonic distortion—0.4% typical at 1 watt—plus low output impedance and excellent gain-temperature stability. The voltage gain of this power amplifier stage is determined by the connections to the "gain-option" pins. For a voltage gain of 10, pins 2 and 4 are open and pin 5 is connected to **signal** ground; for a voltage gain of 18, pins 2 and 5 are open and pin 4 is connected to signal ground; for a voltage gain of 36, pin 2 is connected to pin 5 and pin 4 is connected to signal ground.

To avoid vhf instability with this circuit the RC stabilizing network—0.1 µF in series with 10 ohms—must be placed directly from pin 9 to ground with **short** leads. Excessive lead inductance from the positive supply to pin 10 can cause high-frequency instability. The B+ bypass capacitor should be connected directly from pin 10 to ground if possible; if not, the series RC network shown in **fig. 9** should be used

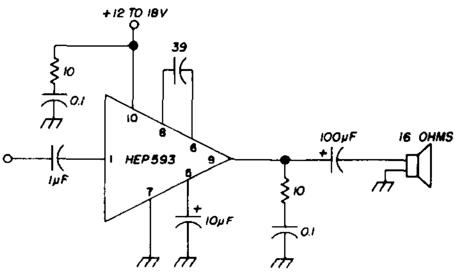


fig. 9. This audio power amplifier will provide up to 1.8 watts output. Voltage gain is determined by connections to pins 2, 4 and 5 as discussed in the text.

directly from pin 10 to ground. In addition, lead lengths from the external components to pins 7, 9 and 10 should be as short as possible to insure good vhf grounding at these points.

Because of the large bandwidth of the HEP593, coupling must be avoided between the input and output leads. This can be accomplished by using short leads which are well isolated, narrow-banding the over-all amplifier by putting a .001

table 2. Effect of feedback resistance (Rf in fig. 10) on sensitivity, distortion and input impedance.

Rf	Sensitivity at 2 W	THD	Input Impedance
0	8 mV	5.2%	20k
1k	22 mV	2.9%	35k
5k	86 mV	1.7%	40k
6.8k	120 mV	1.6%	40k
10k	150 mV	1.5%	40k

capacitor from pin 1 to ground, and by using shielded input cable.

The audio power circuit shown in **fig. 10** can deliver 2 watts into a 16-ohm load. The PA237 may be operated with supply voltages from 9 to 27 volts and is capable of 1 ampere peak output. In the circuit of **fig. 10** the integrated circuit is biased into class AB. The voltage gain of the circuit as shown here is greater than 45; a 120 mV input signal will produce two watts output. The input impedance is 40k ohms, output impedance is 0.85 ohm and noise output is 75 dB below 2 watts.

By setting the 6.8 kilohm feedback resistor (Rf) to other values, the sensitivity, distortion and input impedance will vary as shown in **table 2**. Since distortion decreases when the output level is decreased by increasing the negative ac feedback, it might be a good idea to use this feedback resistor as the volume control. This is particularly desirable for lowering crossover distortion at low levels where it becomes a significant part of over-all amplifier distortion.

In **fig. 11** the PA237 is used in an audio power amplifier that will provide 2 watts into a 16-ohm load with 5 mV drive; this is a voltage gain greater than 1100. With this amount of sensitivity, the amplifier can be driven directly with a microphone or low-level detector. The same circuit can be used with other combinations of voltage and load impedance by changing the values of the bias resistors; **fig. 12** shows the same basic circuit with an 8-ohm load and 12-volt power supply. The voltage gain of this circuit is 350, and 7 mV input drives the amplifier to 0.75 watt output. The input impedance of the circuits shown in **fig. 11** and **12** is approximately 15k.

If you need more than the two-watt

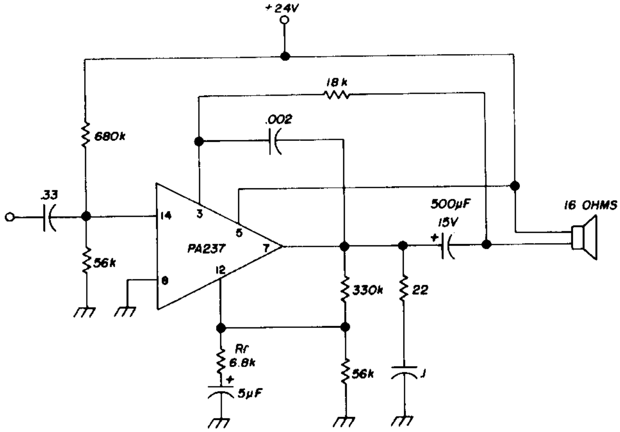


fig. 10. Two-watt audio power amplifier. Circuit sensitivity is determined by feedback resistor (Rf) as shown in table 2.

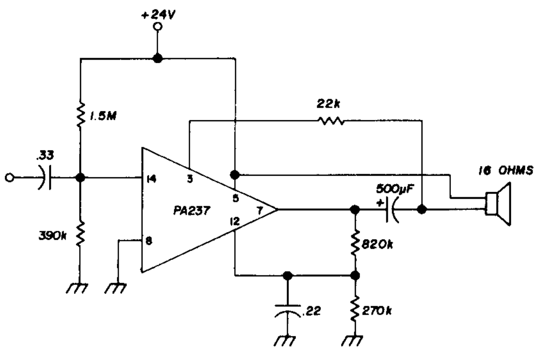


fig. 11. This power amplifier provides 2 watts output with 5 mV drive.

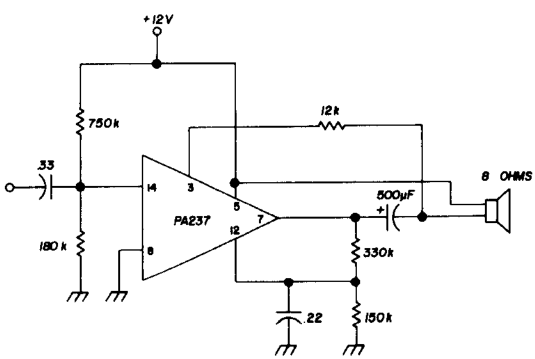


fig. 12. This circuit is the same as fig. 11 except that it is set up for a 12-V supply and 8-ohm speaker; 7 mV input drives it to 0.75 watt output.

capability of one PA237 integrated circuit, two of the devices may be connected in the bridge configuration shown in **fig. 13.** This circuit effectively doubles power output. Since each circuit is the same as **fig. 10** the feedback resistances given in **table 2** may be used to set amplifier input sensitivity and input impedance.

The highest power audio amplifier IC currently available is the new General Electric PA246 with a capability of 5 watts continuous into a 16-ohm load with less than 1% total harmonic distortion. In the circuit shown in **fig. 14,** 180 mV input will provide 5 watts output at 0.7% total harmonic distortion. When the feedback resistor (Rf) is shorted out, sensitivity increases; 12 mV input provides 5 watts output. Frequency response extends from 30 Hz to 100 kHz, and noise output is typically 70 dB below 5 watts.

The increased power dissipation capability of the PA246 is a result of a higher permissible supply voltage—up to 37 volts—and increased heat dissipation with two large heat-sink tabs. The higher voltage rating allows more power without increased heat-generating current and may eventually lead to audio power IC's with ratings up to 10 watts.

Another way to gain increased power output is to use the approach of **fig. 15.** In this circuit a low-level IC preamp is used to drive a discrete complimentary output stage: a Fairchild μA716C is used as a driver for an output stage that will put 2 watts into a 16-ohm load. The fre-

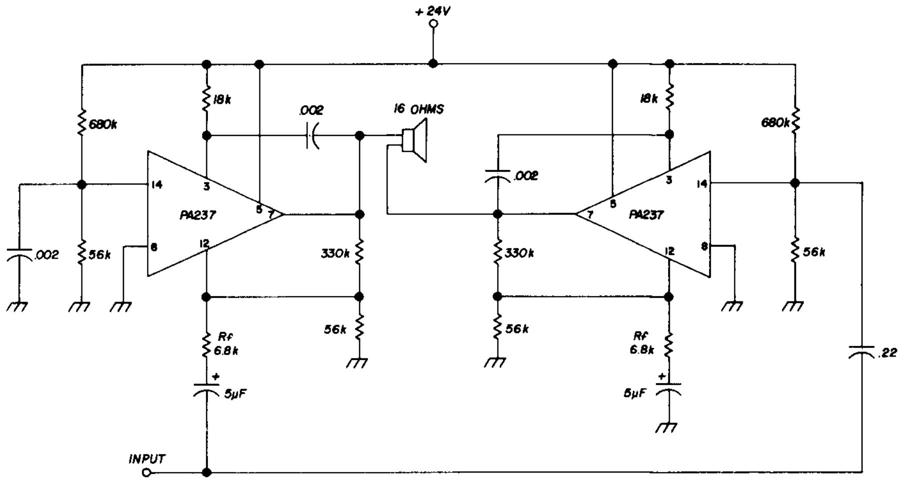


fig. 13. Two PA237's in a bridge double power output to 4 watts.

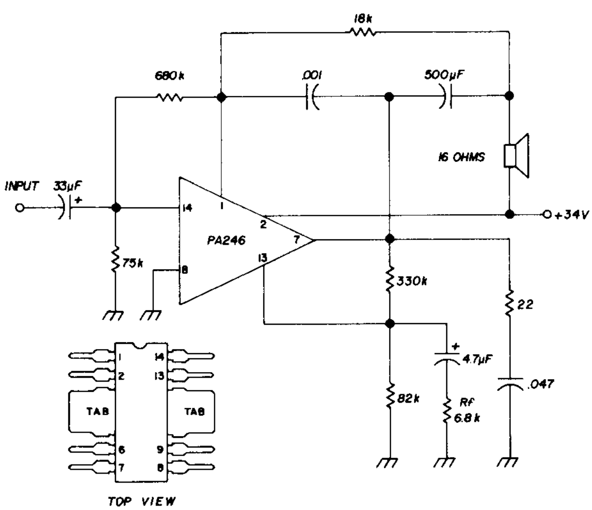


fig. 14. Five-watt audio power amplifier. The speaker should be a permanent-magnet type so resistive load is close to 16 ohms. Heat-sink tab should be connected to pin 8, circuit ground.

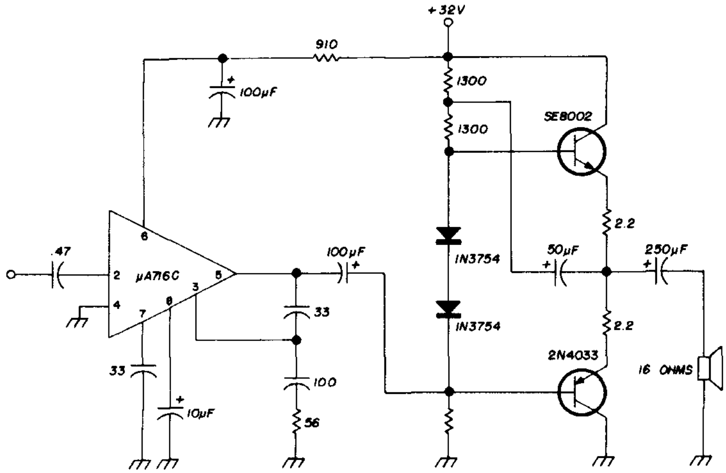


fig. 15. Two watt audio power amplifier with complimentary transistor output stage.

quency response of **fig. 15**—in reference to 1000 Hz—is −1.5 dB at 100 Hz and −4 dB at 20 kHz. Although Fairchild transistors are shown here, RCA devices such as the 40053 npn and 40319 pnp may be substituted. Dc current gain (h_{FE}) should be in the range of 60 to 100 and nearly the same in both transistors to prevent waveform clipping.

Although the highest power audio amplifier IC currently on the market is General Electric's 5-watt PA246, Bendix Semiconductor has recently announced a 15-watt audio amplifier IC that uses thick-film construction. It is not nearly as small as the other audio power IC's mentioned here, 1 x 2 x 5/16 inch, but it is still useful for many amateur applications. The 15-watt amplifier, the BHA0002, has a frequency response of 25 Hz to 20 kHz, power gain of 55 dB, total harmonic distortion less than 1%, supply voltage range of 14 to 40 volts and sensitivity of 350 mV for 15 watts output.

audio mixer

The four-input audio mixer shown in **fig. 16** may be used for mixing low-level audio signals up to 50 kHz. With a 6-volt power supply the input will handle up to 300 mV peak-to-peak; maximum output is 3 volts p-p. The 5000-ohm potentiometer should be adjusted for minimum distortion.

audio limiter

The low-distortion audio limiter shown in **fig. 17** begins to limit at 0.4 millivolt, is not affected by input signals up to 6 volts p-p and operates linearly below the clipping point without oscillation or other instability. A good limiter should limit on millivolt signals but not distort at higher levels; it should be able to reproduce a square wave with very little even-harmonic content while providing clean sine waves below the limiting threshold. By using a high-gain operational amplifier with an external clipper and feedback circuit, second harmonic generation is less than 0.3% over a dynamic range of 54 dB and less than 2% over a 78 dB range.

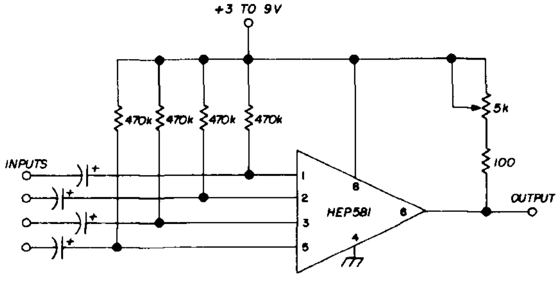
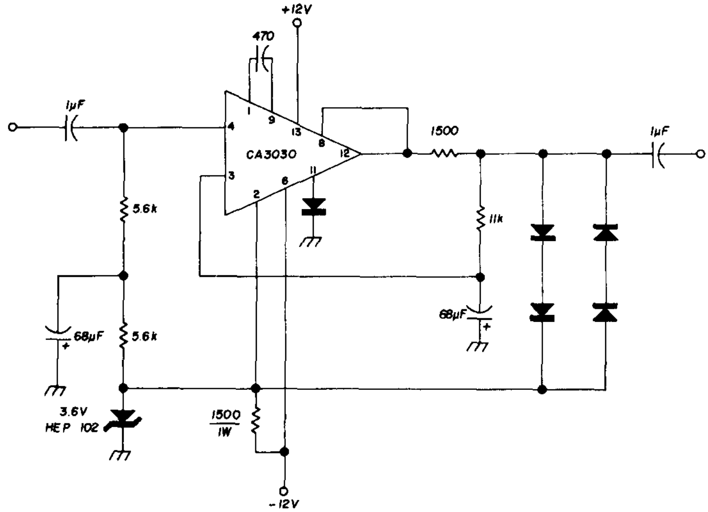


fig. 16. Four-input audio mixer using a digital 4-input gate. The 5k pot is adjusted for minimum output distortion.

fig. 17. Low-distortion high dynamic range audio limiter.



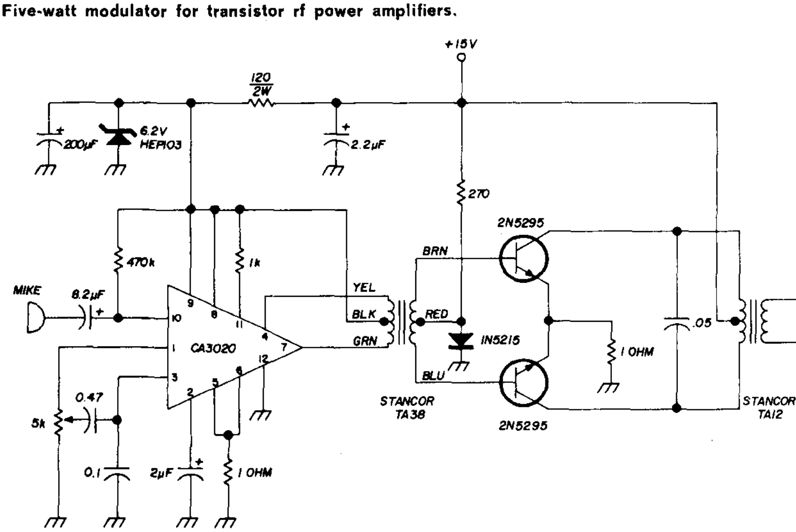
modulator

The modulator circuit shown in **fig. 18** will produce up to 5 watts of undistorted audio. The modulation transformer—a Stancor TA12—is an audio output transformer designed to work into an 8-ohm load so it is most suitable for a transistor rf power stage. The 0.05-μF capacitor between the collectors of the push-pull 2N5295 power stage should be adjusted for minimum distortion and best speech quality with your particular microphone. This circuit is designed for a high output crystal or ceramic microphone; for low-level dynamic microphones, another stage of amplification may be required at the input. If another modulation transformer is used, keep in mind that the 2N5295's should work into approximately a 20-ohm load.

i-f and rf amplifiers

Integrated circuits that are suitable for rf and i-f applications are not actually that much different from the audio-frequency variety. These IC's usually have two or more transistors on a single semi-

fig. 18. Five-watt modulator for transistor rf power amplifiers.



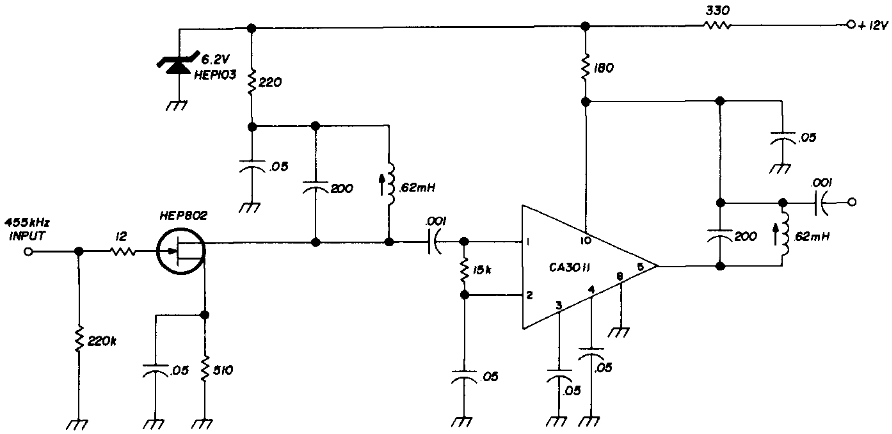


fig. 19. This 455-kHz i-f amplifier uses an fet to provide a high impedance input.

conductor chip along with the necessary biasing network. In some cases several stages of amplification are built on a single chip to provide very high gains in a tiny package. It wasn't too long ago that IC's suitable for high-frequency work were priced beyond the average amateur, but today there are a number of inexpensive devices available that do an excellent job up to 60 MHz or so.

There are both advantages and disadvantages to using IC's in rf and i-f amplifiers; and the direction in which the scale tips is generally related to the frequency of the application. On the plus side, IC's provide high gain figures, are temperature compensated and are easy to use with agc; in addition, they usually do not require external biasing networks. However, current rf-rated integrated circuits that are on the market, are frequency limited—most go to pot if you try to use them much above 100 MHz. There are IC's available that work well into the uhf range, but most of these are engineering prototypes that haven't reached production. As the manufacturing processes are perfected and designs are improved, uhf-rated integrated circuits should become commonplace.

The 455-kHz i-f amplifier shown in **fig. 19** costs less to build than an equivalent circuit built with individual components. The tuned coils are from small i-f transformers used in minature transistor broadcast radios; the low-impedance output windings are not used. The integrated circuits have only a moderately high input impedance so a field-effect transistor is used to keep loading on the input circuitry to a minimum. To modify this circuit to a limiting amplifier for fm use, connect an identical CA3011 amplifier stage to the stage shown here.

Another 455-kHz amplifier circuit is shown in **fig. 20**. Each of the stages represents one-half of a single IC package, so this high-gain amplifier is extremely compact. Over-all gain of this circuit is 67 dB, the 3-dB bandwidth is 3 kHz and the input impedance is approximately 30 kilohms. With the output transformer shown here, the output impedance is approximately 800 ohms; for a 5-kilohm output impedance, use a Miller 2063 transformer. For maximum gain, the agc input should be grounded.

The 10.7-MHz amplifier shown in **fig. 21** provides from 60 to 65 dB gain. The main disadvantage of this circuit is the low number of tuned circuits—it may be difficult to get the amount of selectivity you need. However, this may be solved by using a crystal filter or cascaded tuned circuits. Because of the high gain, this circuit may be unstable unless you are very care-

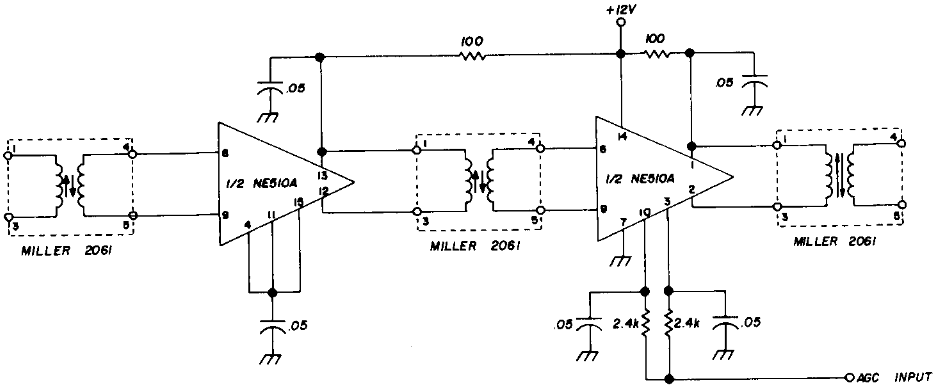
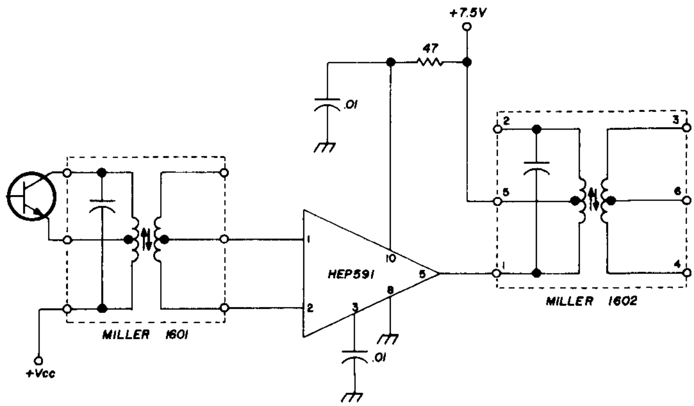


fig. 20. Two-stage 455-kHz i-f amplifier uses one integrated circuit.

fig. 21. This 10.7 MHz amplifier provides gain in the neighborhood of 60 dB. The RCA CA3012 will also work in this circuit.



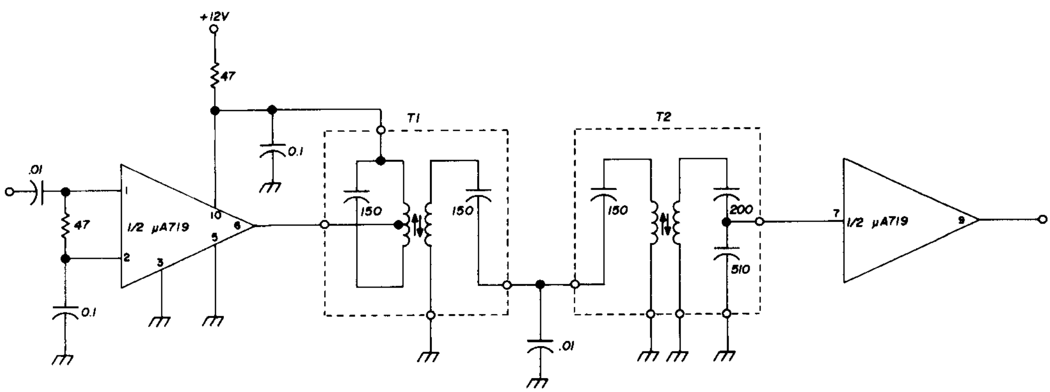
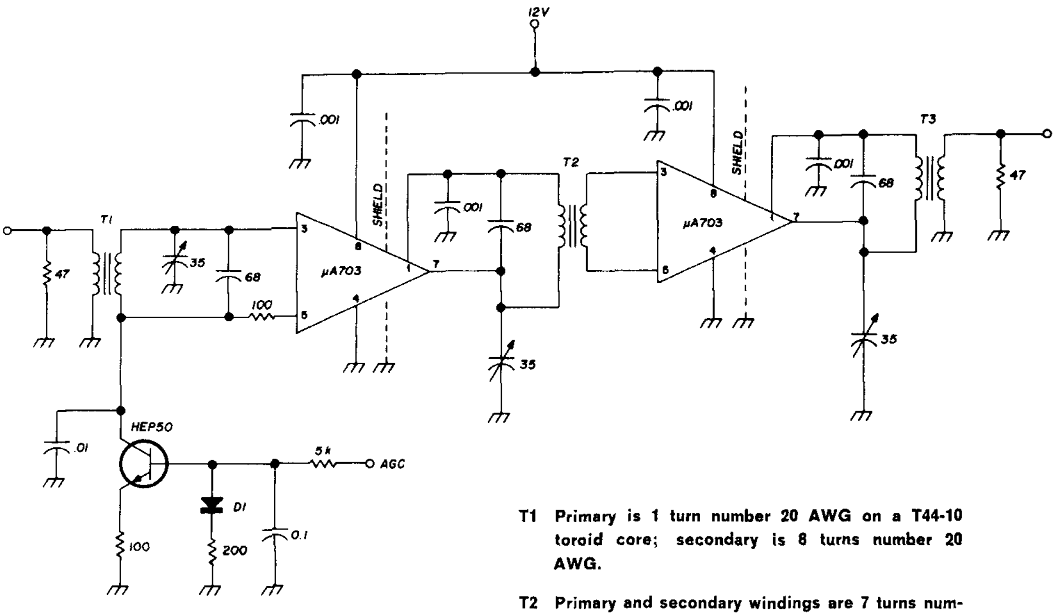


fig. 22. This 10.7-MHz i-f amplifier uses cascaded tuned circuits for improved selectivity.



T1 Primary is 1 turn number 20 AWG on a T44-10 toroid core; secondary is 8 turns number 20 AWG.

T2 Primary and secondary windings are 7 turns number 22 AWG bifilar wound on a T44-10 toroid.

T3 Primary is 8 turns number 20 AWG on a T44-10 toroid core; secondary is 1 turn number 20 AWG.

fig. 24. High-gain i-f strip has agc input. Diode D1 may be any silicon diode.

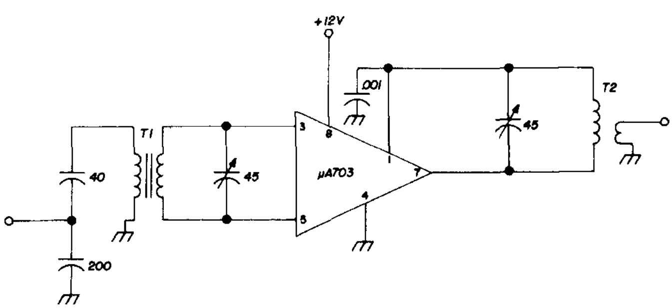
ful when laying it out. Make all the leads as short as possible. Note that the bypass capacitors are somewhat smaller than those usually recommended for this frequency; this reduces gain and helps overall stability.

The 10.7 MHz i-f amplifier circuit shown in **fig. 22** uses cascaded tuned circuits to provide selectivity. The output from the four-pole filter feeds into the second half of the Fairchild µA719. The insertion loss of the filter is such that the second stage of amplification is not driven into limiting.

The primary of T1 consists of 16 turns number 34 enamelled, close wound on a 1/4-inch form, centertapped; secondary is 16 turns number 34 enamelled, close wound on the same form with 0.225 inch between windings. The primary of transformer T2 consists of 16 turns number 34 enamelled close wound on a 1/4-inch slug-tuned form; secondary is 16 turns number 34 enamelled close wound on the same form, tapped 4 turns from cold end; spacing between windings is 0.225 inch. Transformer cans are Miller S-34.

The simple 30-MHz amplifier stage shown in **fig. 23** provides approximately 30

fig. 23. Simple high-gain 30-MHz i-f strip provides 30 dB gain.



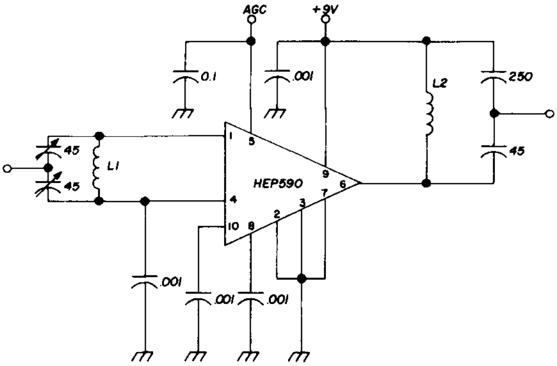


fig. 25. 50-MHz amplifier provides 30 dB gain.

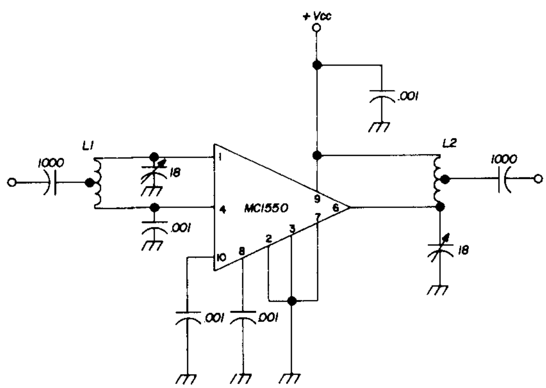


fig. 26. Two meter rf stage exhibits 13 dB gain and 6.8 dB noise figure. The HEP590 will also work in this circuit.

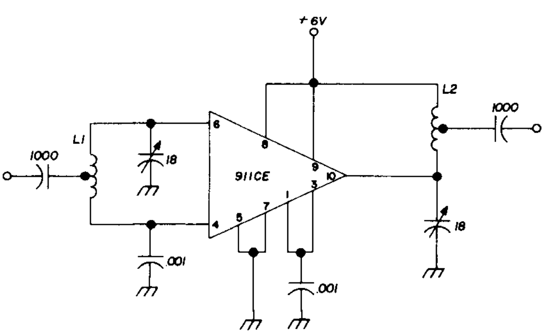


fig. 27. This 144-MHz amplifier will provide up to 17.7 dB gain with a 4 dB noise figure.

dB gain. The noise figure of this stage is 6 dB and the bandwidth is 1 MHz. The primary and secondary of transformer T1 are each 10 turns number 22 enamelled bifilar wound on a T44-10* toroid core. The primary of transformer T2 is 12 turns number 22 enamelled on a T44-10 core; secondary is one turn to work into a 50-ohm load. This stage can also be used as a limiting amplifier for fm work—simply change the turns ratio of the output transformer by making the secondary of T2 two turns (to work into a 50-ohm load). This increases the load impedance the integrated circuit works into and turns the stage into a limiting amplifier.

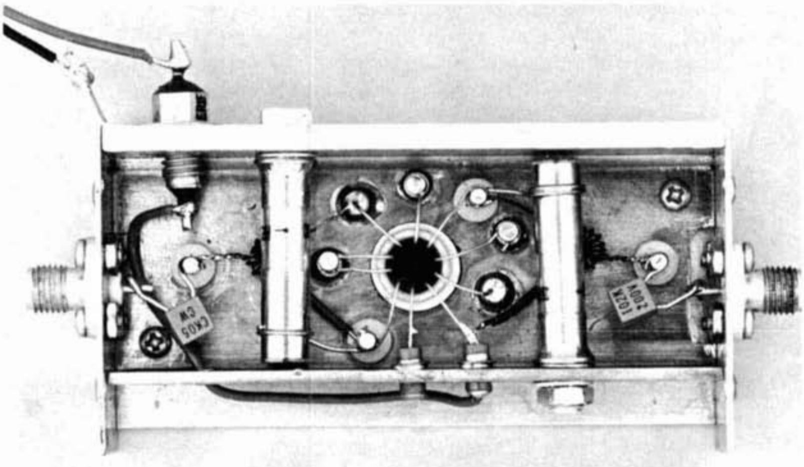
The 30-MHz i-f strip shown in **fig. 24** is an extension of the circuit of **fig. 23** with provision for agc. The agc range is approximately 40 dB with agc voltage variation from zero to 4 volts. Gain of the i-f strip is approximately 60 dB, bandwidth is 900 kHz and noise figure is about 6 dB. For an additional 30 dB gain, another μA703 stage may be added between transformer T2 and the second μA703; the interstage transformer for the additional stage would be the same as T2.

vhf amplifiers

For high-frequency applications of modern integrated circuits, you might consider the vhf amplifier circuits shown in **fig. 25, 26** and **27**. The 50-MHz rf stage in **fig. 25** uses a readily available IC to provide up to 30 dB gain with 18 dB agc range. When the agc voltage is zero, gain is 30 dB; when the agc voltage is 4 volts, gain is 12 dB. Both input and output coils L1 and L2 are 9 turns number 20 AWG on a T44-10 toroid core.

The two-meter amplifier in **fig. 26** exhibits about 24 dB gain with a 25 volt supply; gain drops to 13 dB when the supply voltage is lowered to 6 volts. The best noise figure can be obtained with the 6-volt power supply—6.8 dB. Input coil L1 is

* Toroid cores listed in this article are available from Circuit Specialists Company, Post Office Box 3047, Scottsdale, Arizona 85251; price, two cores $1, postpaid in the U.S.A.



Layout for the amplifiers shown in figs. 26 and 27.

13 turns number 28 AWG on a T20-10 toroid, tapped 6 turns from the cold end; output coil L2 is 13 turns number 28 AWG on a T20-10 toroid, tapped 9 turns from the cold end.

The two-meter amplifier shown in **fig. 27** provides somewhat more gain than **fig. 26**—19.8 dB with a 12-volt supply and 17.7 dB with a 6-volt supply. Best noise figure is again coincident with the 6-volt supply and is about 4 dB. Input coil L1 is 12 turns number 28 on a T20-10 toroid, tapped 5 turns from the cold end; output coil L2 is 11 turns number 28 AWG, tapped 6 turns from the cold end.

The novel integrated-circuit amplifier shown in **fig. 28** may be used as an rf or i-f amplifier at frequencies up to about 200 MHz with 60-dB gain; the IC is a Sylvania SA-20. The circuit is unusual because of the placement of the tuned circuit—as a frequency selective feedback loop between two of the transistors within the integrated circuit. L1 and C2 should resonate at the desired operating frequency, and C1, which is a dc blocking capacitor, is made large enough to prevent series resonance with L1 (at least in the rf range). A notch amplifier results if L1 and C1 are resonated and C2 is removed. Replacing the LC circuit with piezoelectric crystals or ceramic filters results in sharper selectivity.

mixers

Most of the integrated circuits that are designed for rf and i-f applications may also be used as frequency mixers. Most amateurs are not aware of one of the advantages of using a differential amplifier as a frequency mixer—the local-oscillator frequency may be one-half the required injection frequency. At the higher frequencies this is particularly helpful since the ease of building stable oscillators declines rapidly as frequency is increased above 60 MHz or so.

A mixer circuit for the μA703 is shown in **fig. 29.** L1-C1 are tuned to the signal

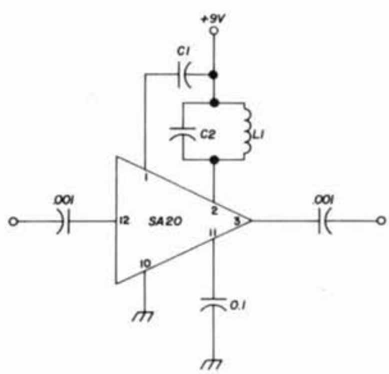


fig. 28. Multipurpose rf/i-f amplifier has good gain and bandpass characteristics up to 100 MHz.

frequency, L2-C2 are tuned to the local oscillator frequency and L3-C3 are tuned to the intermediate frequency. Other rf-rated integrated circuits can be used in this manner as long as you use the differential inputs to the IC. This mixer circuit can theoretically be operated at any **even** harmonic of the local oscillator, although efficiency drops drastically at more than the fourth harmonic.

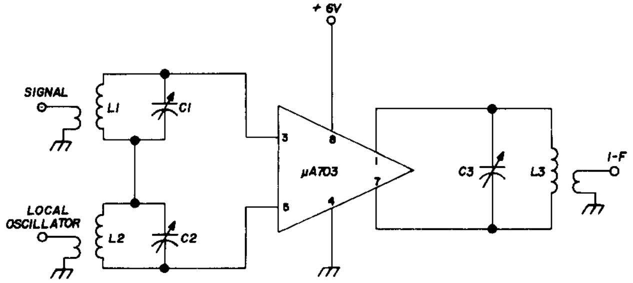


fig. 29. With this harmonic mixer circuit, the local oscillator can operate at one-half the required injection frequency.

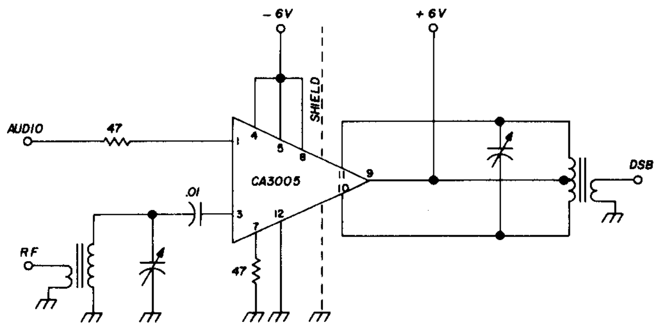


fig. 30. Balanced modulator circuit provides up to 25 dB carrier suppression.

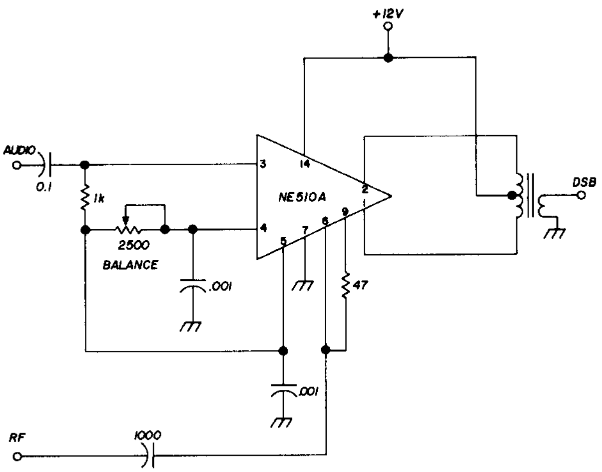


fig. 31. Balanced modulator circuit using a Signetics NE510A.

The balanced mixer (or balanced modulator) shown in **fig. 30** is useful for generating a double-sideband signal. Carrier suppression with this circuit is a function of circuit symmetry and the modulation-to-carrier drive ratio. If external component symmetry is watched carefully, carrier suppression is about 25 dB with 10 mV audio and 32 mV carrier signals. For best results, the output transformer should be bifilar wound.

Another balanced modulator circuit is shown in **fig. 31**. This circuit uses a Signetics NE510A. When the 2500-ohm balance potentiometer is properly adjusted, there will be no rf output without an audio signal. When an audio signal is applied, the differential transistors are unbalanced and a double-sideband suppressed-carrier signal appears at the output.

product detector

The product detector circuit shown in **fig. 32** is another application of the balanced mixer. Ssb drive and bfo injection can be altered for minimum harmonic distortion; overdrive from either source results in third-harmonic distortion of the detected signal. In typical operation, the bfo voltage is 0.5 volts rms, signal voltage is 4 mV rms, third-harmonic distortion is 54 dB down and second, fourth and fifth harmonics are more than 60 dB down.

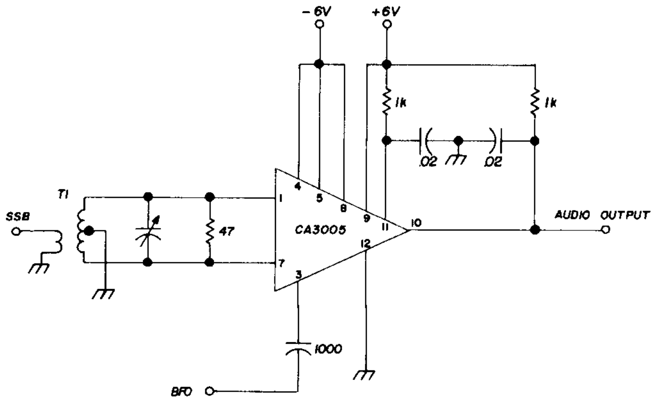


fig. 32. This product detector circuit provides excellent linearity with minimum distortion.

low-level modulator

The fine agc characteristics of devices like the HEP590 make them excellent choices for low-level a-m modulators (see **fig. 33**). The modulated rf signal can be followed by linear amplifier stages to build the signal up to several watts. The 3.5 volts bias sets operation of the modulator at its most linear point with 90% modulation along with good up-and-down modulation characteristics and very low distortion. For operation on 50 MHz, primary of transformer T1 is 6 turns number 22 AWG on a T12-2 toroid; secondary is 19 turns number 22. Primary of transformer T2 is 30 turns number 22 AWG on a T12-2 toroid core; secondary is 3 turns number 22.

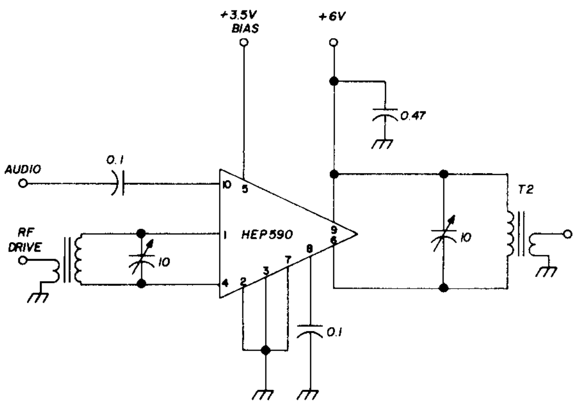


fig. 33. Low-level a-m modulator may be used in signal generators or with linear amplifier stages for communications.

oscillators

If you will remember from your basic theory, two things are necessary for oscillation: unity circuit gain and zero (or 360°) phase shift from input to output. Most linear integrated circuits (as well as many digital types) fulfill both these requirements. In fact, as you use integrated circuits in various projects, you'll find that many times you will have problems with unwanted oscillations—particularly vhf parasitics.

The oscillator circuits that are presented here are only a sample of the many circuits that can be used. However, some of them are rather unique and probably have never been used in amateur gear before so they warrant further investigation.

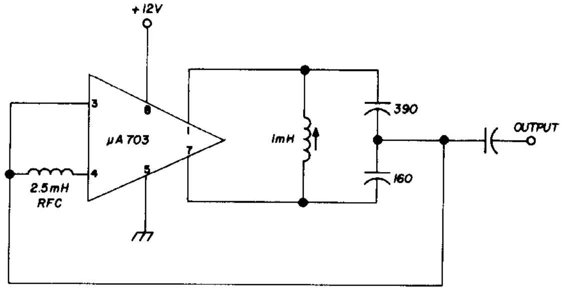


fig. 34. This 455-kHz beat-frequency oscillator may be used up to 150 MHz by changing the tuned-circuit values.

The oscillator shown in **fig. 34** is designed for use as a bfo and is very similar to the Colpitts oscillator used in vacuum-tube and transistor circuitry. Although the tuned-circuit values shown are for 455 kHz, the basic circuit may be used up to 150 MHz by simply changing the inductor and up to about 2 MHz. Most drift in this circuit is due to crystal changes with temperature; supply voltage variations up to ±20% have a negligible effect on frequency.

Digital integrated-circuit gates that use emitter-coupled logic (ECL) provide excel-

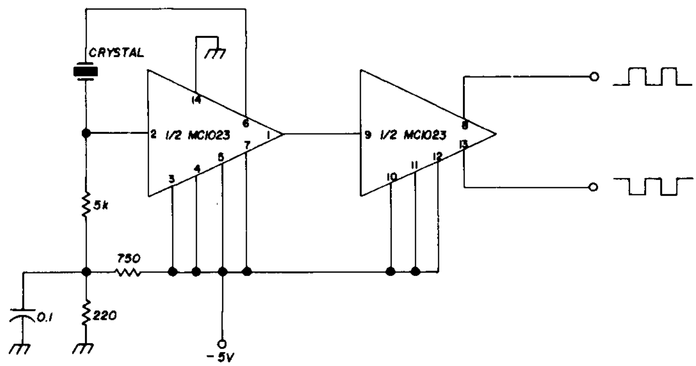


fig. 36. This crystal oscillator uses emitter-coupled logic IC's and will work up to about 20 MHz.

two capacitors. The rf choke between pins 3 and 4 is between the bases of the differential transistors at the input of the IC; it provides the proper bias voltage and current for symmetrical limiting.

If you look at the internal circuit of an RTL digital gate, you'll find most of the load and bias resistors for a conventional amplifier stage. If you use the correct pins, these low-cost IC's can be used for amplifiers or oscillators. The circuit shown in **fig. 35** can be used as a crystal oscillator

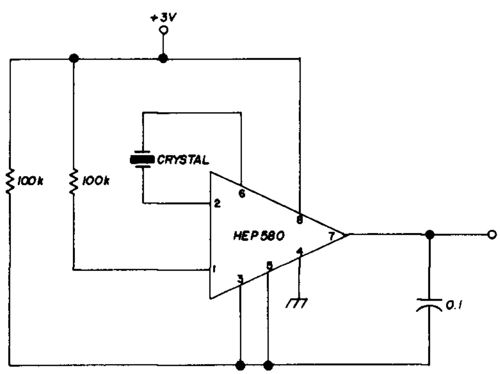


fig. 35. Simple crystal oscillator circuit is useful up to about 2 MHz.

lent high-frequency (and vhf) response and can be used to advantage in crystal-controlled oscillator circuits. A second gate can be used as a buffer and waveshaper.

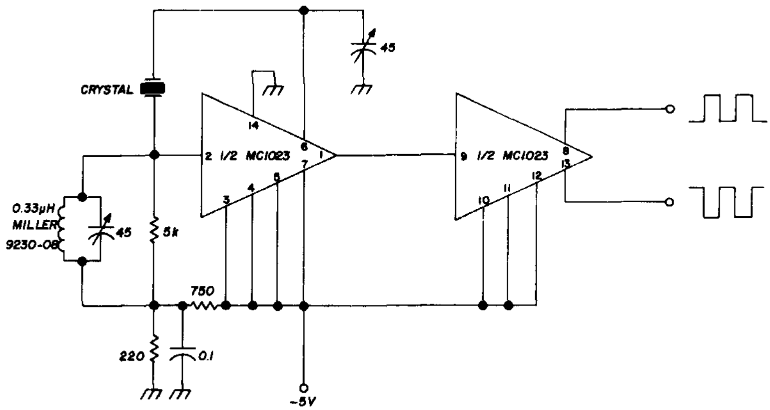
The circuit shown in **fig. 36** is designed for crystals in the series resonant mode from 1 to 20 MHz. The differential-connected transistors in the first half of the IC operate linearly and provide loop gain while the emitter-follower outputs drive the crystal and buffer stage. In addition to acting as a buffer, the output stage works as a waveshaper; rise and fall times of the output square wave are on the order of 2 nanoseconds.

At frequencies above about 10 MHz overtone crystals are usually used. Overtone oscillator circuits are somewhat more complex than circuits designed for the fundamental because the circuit must operate at the desired harmonic. The circuit shown in **fig. 37** is designed for overtone crystals from about 50 to 150 MHz and is a modification of the circuit in **fig. 36.**

This circuit uses a tank circuit at the input to the ECL gate to insure operation at the desired overtone. At other frequencies it acts as a low impedance shunt. The variable capacitor from pin 6 to ground may be necessary to provide the proper phase relationship in the feedback loop. The second gate again serves as a buffer and waveshaper.

The oscillator circuits shown in **fig. 36** and **37** are very stable, and temperature drift characteristics are determined by the crystals that are used; voltage changes of 20% produce no frequency drift. Be particularly careful when laying these circuits out—emitter-coupled logic has extremely good vhf response so keep all the leads as short as possible and run all the unused inputs to the minus voltage supply.

fig. 37. This crystal oscillator will work with overtone crystals up to about 150 MHz. The tank circuit is resonated to the desired output frequency.



The circuit in **fig. 38** uses a low-cost dc-amplifier IC—the RCA CA3000—as a crystal-controlled oscillator stage that will work up to about 2 MHz. The output waveform of this circuit has high harmonic content; to provide a sinusoidal output, put a 10K potentiometer and 0.01-μF capacitor in series with the crystal. With this "feedback adjust" control, the output waveform can be made into a pure sine wave. The frequency response of the circuit can be increased to about 10 MHz by adding a tuned circuit resonant at the output frequency; this is shown by the dotted lines.

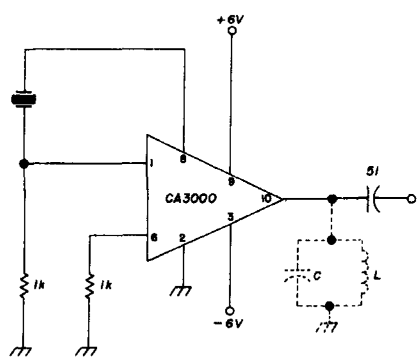


fig. 38. Simple crystal oscillator will work up to 2 MHz with no tuned circuits; tuned circuit extends range to about 10 MHz.

The circuit shown in **fig. 39** uses two low-cost RTL digital integrated circuits in a crystal-controlled frequency standard with outputs at both 100 kHz and 50 kHz. The oscillator itself is the same as the one shown in **fig. 35** and uses the two gates of a HEP580. The HEP583 JK flip-flop divides the output of the crystal oscillator by two to provide 50-kHz markers. Other markers can be generated by using different divider arrangements—two flip-flops can be wired to divide-by-4 for 25 kHz markers (or another HEP583 added to the one shown in **fig. 39**). A divide-by-5 circuit for 10-kHz markers requires three JK flip-flops while a divide-by-10 circuit for 5-kHz markers requires four.

vfo's

The variable frequency oscillator shown in **fig. 40** may be used at any frequency between 2.5 and 13 MHz by choosing the value of the capacitor C1. The HEP590 acts as a common-emitter, common-base amplifier when the input signal is connected to pin 1 and the output taken from pin 6; it has high gain and 180° phase shift. Therefore, to operate as an oscillator, the external circuitry must provide quencies in the range from 1 MHz to 150 MHz. The output level is 0.5 volts peak-to-peak, and the waveform is relatively free of harmonics. Inductors L1 and L2 are each 10 turns number 24, bifilar wound on a T44-10 toroid core; L3 is 5 turns number 24 wound over L1 and L2.

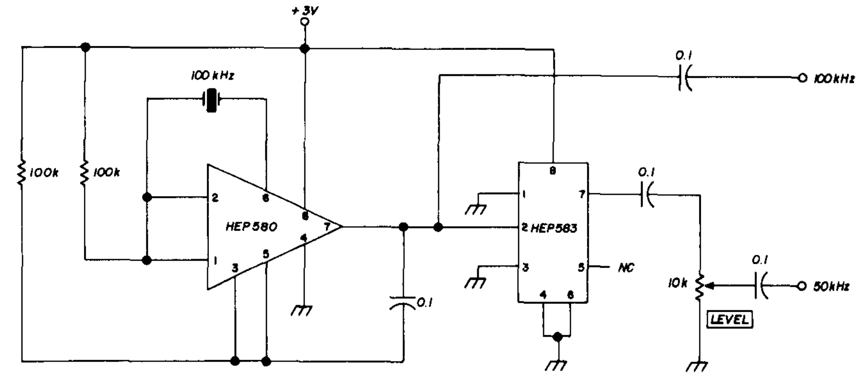
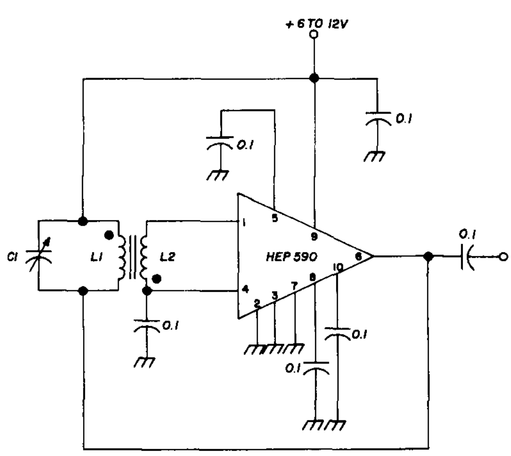


fig. 39. Frequency standard circuit provides 50-kHz markers. Output level potentiometer may not be required for some applications.

180° phase shift. This can be accomplished in several ways, but perhaps the easiest way is used in **fig. 40**—the coupling transformer is inverted.

This circuit can be used anywhere in the range from about 2500 kHz to 13 MHz by simply changing the value of the tuning capacitor, C1, as shown in **fig. 40.** To decrease the range, the total capacitance may be made up with a fixed mica capacitor in parallel with a variable. To tune from 5.0 to 5.5 MHz for example, capacitor C1 would consist of a 100-pF variable, a 80-pF trimmer and a 560-pF silver mica; the trimmer is used to set the frequency range covered by the variable. The output of this oscillator has very little harmonic content; output level depends on the load that it works into. With a 12-volt power supply and a 10k load, the output is 12 volts peak-to-peak. Frequency stability is consistent with other solid-state designs.

A vfo that tunes the range from 9 to 10 MHz is shown in **fig. 41**; the tuned-circuit values can be changed to cover other fre-



Frequency	C1 (pF)	Elmenco part. no.
2.5 - 5	780 - 2110	311
5 - 10	170 - 780	469
8 - 13	80 - 480	466

fig. 40. Wide range vfo. L1 is 21 turns number 36 on a T12-2 toroid core; L2 is 7 turns number 36 on the same core. Elmenco trimmer capacitors are available from Allied Radio.

voltage-controlled oscillator

The unusual oscillator circuit shown in **fig. 42** deserves further amateur experimentation. This circuit uses two cross-coupled transistor-transistor logic (TTL or T^2L) gates to form a voltage-controlled oscillator. The oscillation frequency is determined by the cross-coupling capacitance and the supply voltage; the cross-coupling capacitance consists of the two capacitors plus wiring capacitance and internal device capacitance. With the component values shown in **fig. 42** the circuit will cover both the 40- and 80-meter amateur bands as the control voltage is varied from 4 to 6 volts. The frequency change with voltage is linear.

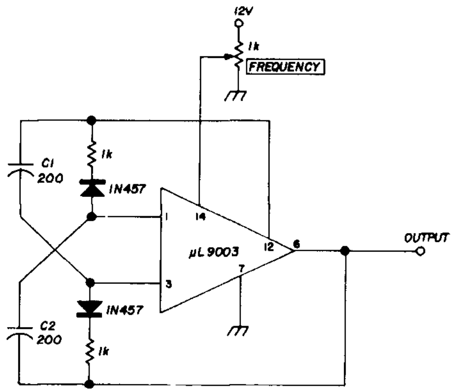


fig. 42. Voltage-controlled oscillator uses two transistor-transistor logic gates. With the components shown, the circuit covers the 80- and 40-meter bands as the voltage is varied from 4 to 6 volts.

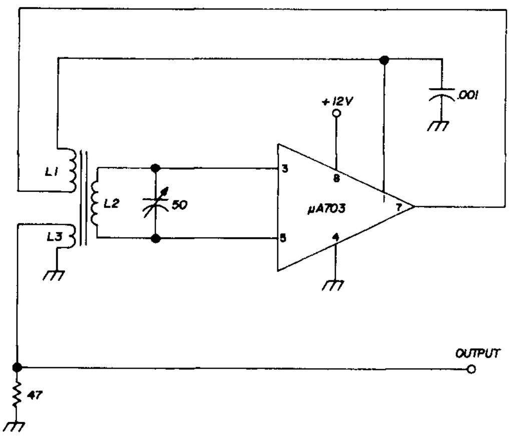


fig. 41. This 10-MHz vfo provides a clean sine wave at about 500 mV p-p.

With a stable, well filtered voltage supply this circuit can be used as a vfo with the frequency controlled by a multiturn potentiometer. The timing capacitors (C1 and C2) can be changed to cover other frequencies, although the maximum oscillation frequency is in the neighborhood of 25 to 30 MHz.

Maximum oscillation frequency is obtained with 18 to 22 pF cross-coupling capacitors although this depends upon how much stray capacitance you have in the circuit. The output waveform is a square wave but a buffer amplifier with a tuned tank circuit can be used to convert it to a sine wave.

audio oscillator

Oscillator applications of integrated circuits aren't necessarily limited to the radio frequencies. The IC Wein-bridge oscillator in **fig. 43** is designed to cover the audio frequencies although it may be used into the video frequency range. This circuit uses the μA716, an integrated circuit that provides gain options of 10, 20, 100 or 200, depending on the pin connections; for this application, a gain of ten is sufficient. The output frequency is determined by the resistors and capacitors in the positive feedback loop, and good waveform is maintained by the transistor agc circuit.

Diode D1 rectifies a portion of the output waveform and feeds it to the base of the transistor. Collector current is picked off the resistive divider, changing the voltage across diode D2. This changes the current through the diode, alters its dynamic resistance, and establishes stable operation of the IC by setting the gain at a point just sufficient to allow oscillation —this results in low distortion. The zener diode keeps the transistor from going into saturation and destroying its agc performance.

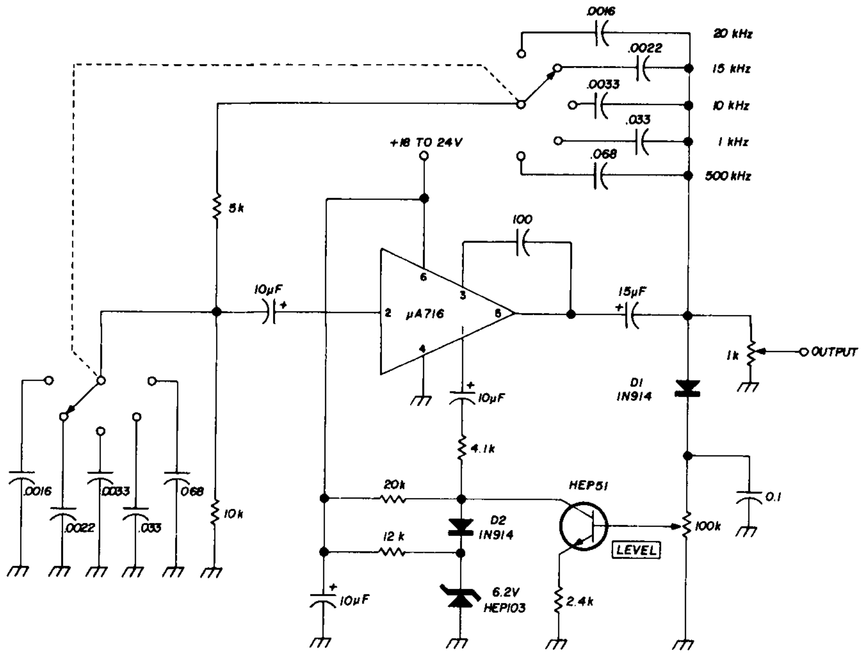


fig. 43. Audio oscillator circuit uses Wein bridge circuit to provide exceptionally pure waveform.

voltage regulators

Now that low-cost voltage regulator IC's are available, it's difficult to justify the design of regulators using discrete components. The nature of integrated-circuit construction is such that it costs very little for the manufacturer to add extra gain for improved regulation, overload and current-limiting circuits or capability for working with negative supplies. With discrete components each of these features increases cost and size.

The simple voltage regulator shown in **fig. 44** uses an integrated circuit that is designed as an audio power amplifier. However, it performs well as a voltage

Nominal Regulated Voltage	R1 ohms
10	100k
12	68k
15	51k
17	39k
20	30k
22	20k

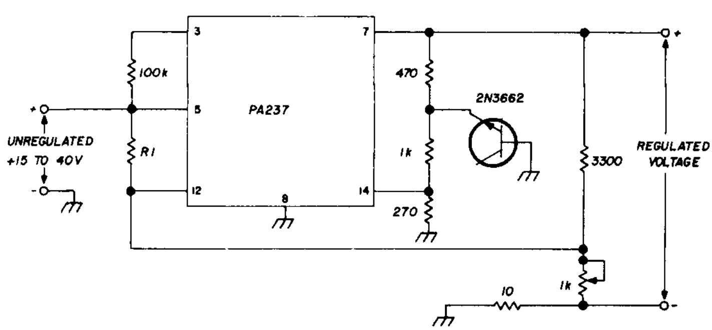


fig. 44. Simple voltage regulator using an audio power IC. Value of R1 is determined by desired output voltage as shown above. Unregulated input must be as least 3.5 volts higher than the desired output. The base-emitter junction of the 2N3662 is used as a zener diode.

regulator. Keep in mind that the PA237 is limited to 2 watts dissipation; the input current and voltage **difference** between unregulated input and regulated output must not exceed 2 watts. The unregulated input voltage can be between 15 and 40 volts; the size of R1 is determined by the desired output voltage. Short-circuit protection is provided by the 10-ohm resistor in the ground return path.

The voltage-regulator circuit shown in **fig. 45** uses an IC that was designed specifically for this purpose—National Semiconductor's LM300. The dissipation of this device is limited to about 300 mW, but an external pass transistor can be added as shown in the schematic. With the values shown here, the output can be adjusted over the range from 2 to 20 volts —depending also on the level of the unregulated input voltage. This circuit is limited to about 200 mA output with the pass transistor shown, but may be increased to 2 amperes with the circuit shown in **fig. 46.**

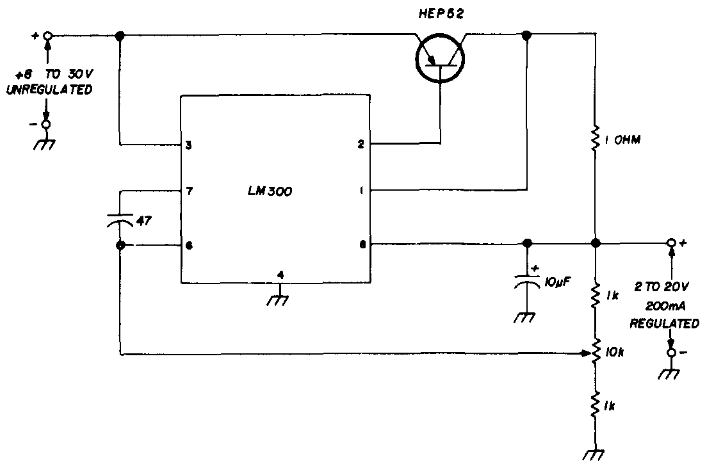


fig. 45. Voltage regulator provides adjustable 2 to 20 volts at 200 mA.

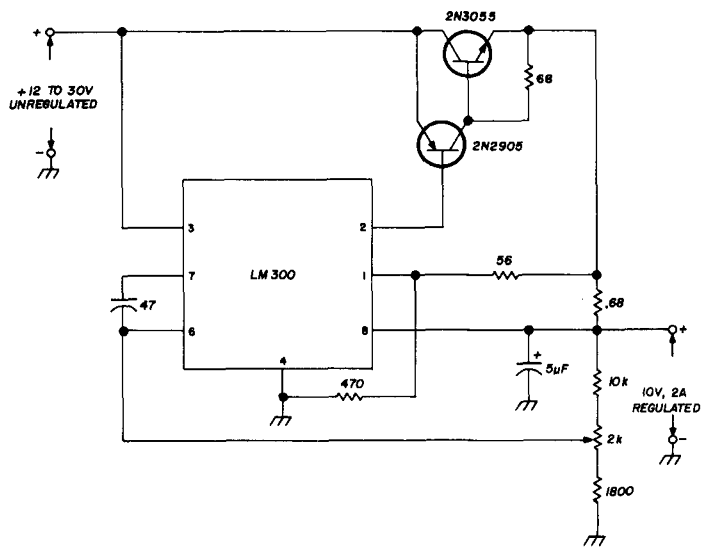


fig. 46. Current capability can be extended to 2 amperes with this circuit; nominal output voltage is 10 volts.

This circuit is designed for a nominal 10-volt output.

The voltage regulator shown in **fig. 47** will provide 9 volts output with 12 to 20 volts input. Although the CA3018 wasn't designed specifically for voltage-regulator duty, it serves admirably. The reference voltage necessary to regulator action is generated by a reverse-biased emitter-base junction. If you don't need the 1-ampere capability of this circuit, simply connect pin 1 to the output terminal, change R1 to 470 ohms and R2 to 1500 ohms—this will provide 9 volts output up to 50 mA. However, keep the input voltage low enough so device dissipation doesn't exceed 300 mW.

fig. 47. Low-cost voltage regulator uses external pass transistor to provide up to 1 ampere current capability. IC itself will handle up to 50 mA.

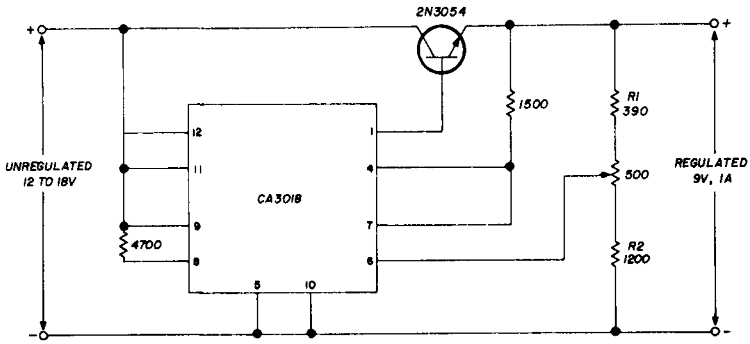
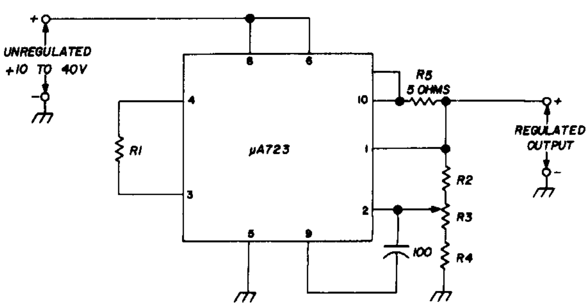


fig. 48. Voltage regulator provides up to 150 mA output current over a wide operating range.

Output Voltage	R1	R2	R3	R4
9	1500	750	1000	2700
12	3000	2000	1000	3000
15	3900	3300	1000	3000
28	5100	5600	1000	2000



The voltage regulator circuit shown in **fig. 48** uses an integrated circuit designed for the job, the μA723. This device will handle up to 150 mA output currents by itself, or it may be used to drive higher powered pass transistors. The circuit in **fig. 48** can be tailored to your particular requirement by choosing resistors R1, R2, R3 and R4 as shown in the table. Current limiting of this regulator is determined by resistor R5, in this case in the neighborhood of 120 mA.

Typical operation of this circuit is very good. With a regulated output voltage of 15 volts, a change in input of ±3 volts results in a 1.5 mV change in output. Load changes of 50 mA result in about 4.5 mV change. The μA723 is a very versatile device and may be used to regulate negative as well as positive voltages over a very wide range. Only one application is shown in **fig. 48;** others are included on the manufacturer's data sheet.

The regulator circuit shown in **fig. 49** uses an integrated circuit that will provide up to 500 mA current into the load. Actually, the Motorola MC1460 voltage-regulator IC is available in two packages—the MC1460R in a T0-5 case that will handle 200 mA and the MC1460G in a T0-66 case that will handle up to 500 mA. The piece of silicon that constitutes the active circuit is exactly the same; package design determines dissipation. When the 500-mA version is used to drive an external pass transistor, output currents up to 10 amperes are available.

In the circuit of **fig. 49,** resistor R1 determines the output voltage level—representative values are listed in **table 3**. For output voltages other than those listed in **table 3**, the value of resistor R1 can be calculated from the following formula:

table 3. Resistors R1 and R2 (fig. 49) as a function of regulated output voltage and short-circuit current. These resistors are independent.

Nominal Regulated Voltage	R1 (ohms)	Short-circuit Current (mA)	R2 (ohms)
4.5	2k	50	13
6	4.7k	100	5.6
9	12k	150	3.9
12	18k	200	2.7
15	22k	300	1.5

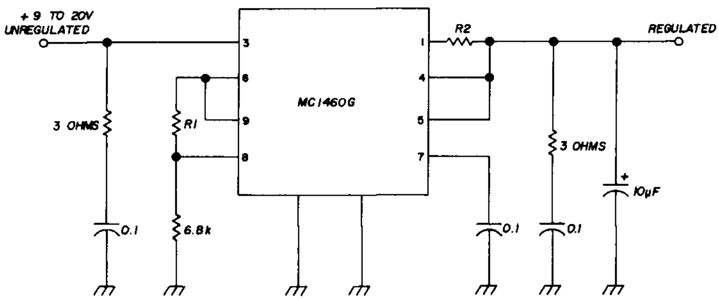


fig. 49. This excellent regulated power supply will serve most receiver needs since it will provide up to 500 mA output current. Resistor values for various output voltages are listed in table 3.

$$R1\ (\text{kilohms}) = 2(V_{out} - 3.5)$$

For an adjustable output, of course, a potentiometer could be used for R1. R2 is a current-limiting resistor; its value for various levels of short-circuit current is listed in **table 3.**

Most of the currently available voltage-regulator IC's are limited to voltages below about 40 volts, but the μA723 can be operated as a "floating" regulator at much higher voltages as shown in **fig. 50.** All that is required is that the voltage across the IC must not exceed 40 volts; in this case it is limited by the 36-volt zener diode to a safe operating point. The maximum voltage and current levels are determined by the pass transistor.

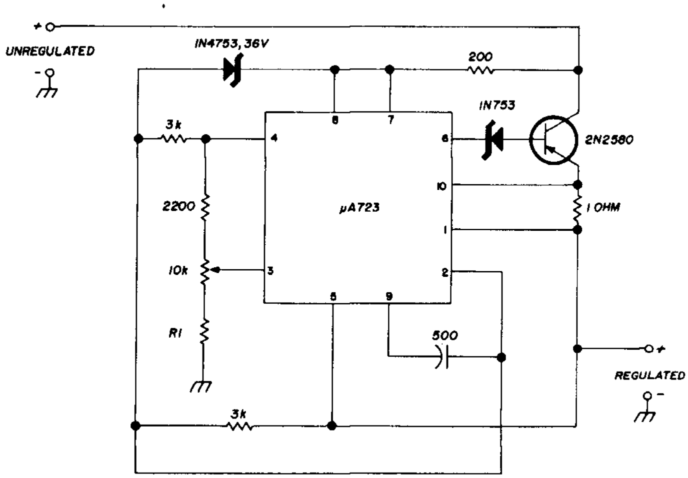


fig. 50. This circuit can be used to regulate high dc voltages. The regulated output voltage is determined by R1: R1 = 39k, E = 45 V; R1 = 68k, E = 75 V; R1 = 91k, E = 100 V; R1 = 240k, E = 250 V.

The regulation of the circuit of **fig. 50** is excellent: input voltage changes of ±20 volts result in 15 mV change in the output voltage, and 50 mA variations in load current result in 20 mV change. This device may also be used in a slightly different "floating" circuit to regulate high negative voltages; see the manufacturer's data sheet for complete details.

Many circuits—including voltage regulators—require a precise reference voltage. The circuit shown in **fig. 51** provides an adjustable reference voltage over the range of −5 to +5 volts. This circuit is particularly useful where low-level reference voltages are required. The integrated circuit isolates the zener so diode current doesn't change with the load. Since the output voltage is controlled by the potentiometer it can be set to the desired level.

fig. 52. Alc circuit provides gain control proportional to the rf envelope of the transmitter.

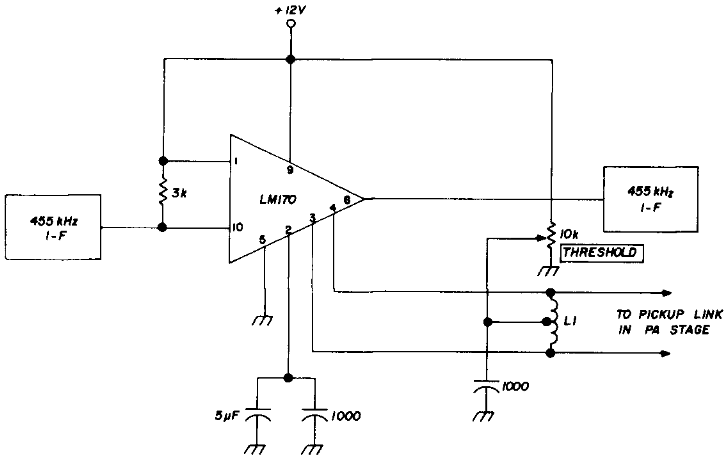
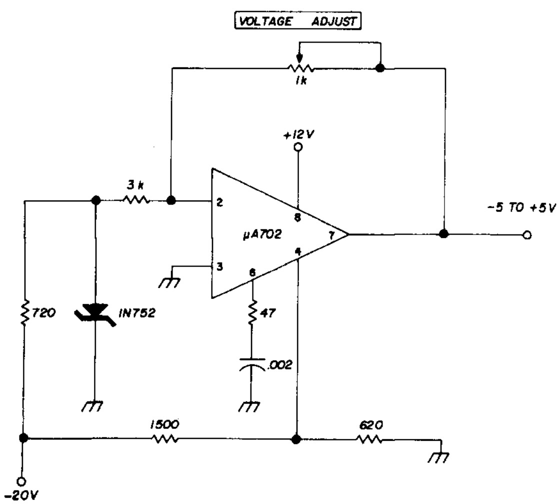


fig. 51. IC amplifier circuit isolates the zener from the load and provides an adjustable reference voltage.



other applications

In addition to the many circuits for audio, rf, i-f and voltage regulation, there are several communications-oriented applications that don't fit neatly into one category or another. One of these circuits is the alc circuit for ssb transmitters shown in **fig. 52.** This circuit compensates for variations in load impedance, tuning and supply voltage. The amplifier responds to the rf output envelope and provides control proportional to rf output. The push-pull coupling link responds to both positive and negative peaks; the threshold control can be used as a carrier level control in the absence of modulation.

The dc voltmeter shown in **fig. 53** is another handy application for integrated circuits. Most high quality commercial voltmeters use a balanced circuit but it's difficult to design a direct-coupled unit that works well. By properly selecting an integrated circuit, you will have a well balanced circuit with high gain that does an excellent job in a voltmeter circuit. The circuit shown in **fig. 53** for example has an input resistance of 200,000 ohms per volt and is very stable. It requires no zero adjustment and has four ranges up to 1000 volts that may be read on a 1-mA meter.

To calibrate the unit, set the range switch on the 10-volt range, connect 10 volts across the input terminals and set the 1000-ohm calibration control so the meter reads full scale. The calibration control can be located out of the way since it requires very infrequent attention.

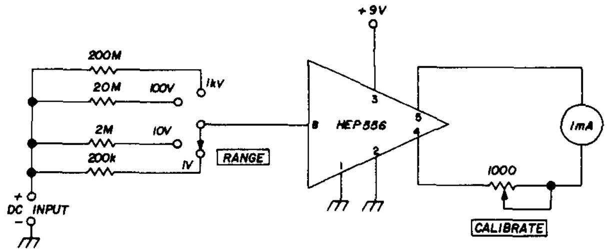


fig. 53. This dc voltmeter is very stable and linear; input resistance is 200,000 ohms per volt. The 200-megohm resistor consists of ten 20-meg resistors connected in series.

The internal circuitry of most integrated circuits is quite complex, and they will work in many more applications than those shown here. If you're interested in a particular IC, write to the manufacturer for a data sheet and a list of stocking distributors or sales representatives. Allied Radio stocks integrated circuits made by General Electric, Motorola, RCA and Sylvania. However, many major cities have distributors so it doesn't hurt to find the one nearest you. In most cases you can determine the manufacturer of a particular IC by the letter prefix on the part number: CA, RCA; LM, National Semiconductor; MC, Motorola; PA, General Electric; μA and μL, Fairchild. Here are the manufacturers' addresses:

Amelco Semiconductor, 1300 Terra Bella Avenue, Mountain View, California 94040

Amperex Electronic Corporation, Slattersville, Rhode Island 02876

Fairchild Semiconductor, 313 Fairchild Drive, Mountain View, California 94040

General Electric Company, Semiconductor Products Department, 7 Electronic Park, Syracuse, New York 13201

Motorola Semiconductor Products, Inc., 5005 East McDowell Road, Phoenix, Arizona 85008

National Semiconductor, 2975 San Ysidro Way, Santa Clara, California 95051

RCA, 415 South 5th Street, Harrison, New Jersey 07029

Signetics Corporation, 811 East Arques Avenue, Sunnyvale, California 94086

Sylvania Electric Products, Inc., Semiconductor Division, 1100 Main Steet, Buffalo, New York 14209

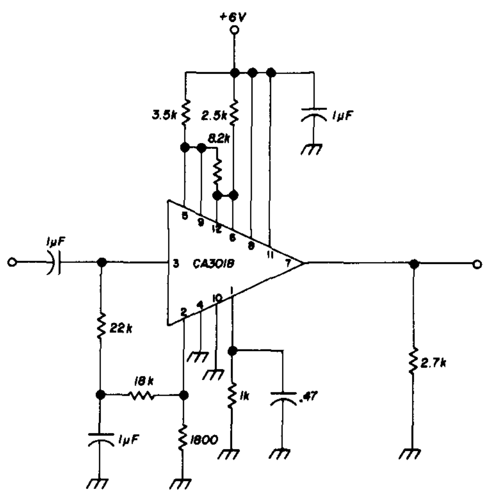


fig. 54. Broadband video amplifier covers all of the amateur bands up to 30 MHz. Mid-frequency gain is nearly 50 dB.

In addition to integrated circuits that are designed for a particular job (or set of jobs), some manufacturers are offering arrays of transistors that are on a single chip of silicon. Since the devices are physically close, their electrical characteristics are very similar; drift characteristics are nearly identical because of the high thermal conductivity of the silicon. These arrays can be used to advantage in a number of circuits where large resistors, capacitors or inductors must be used externally.

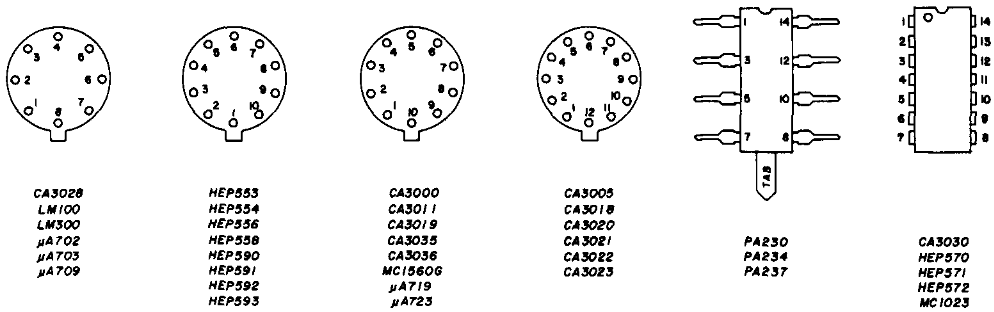


fig. 55. Basing diagrams of the integrated circuits used in this article. The circular pin layouts are bottom views; the 14-pin dual-inline packages are top views.

The RCA CA3018 transistor array contains two isolated transistors and two transistors with a common base-emitter terminal that may be used in rf amplifier service up to 100 MHz as well as video amplifiers, i-f amplifiers, class-B service or voltage regulation (see **fig. 47**). A broadband video amplifier using this device is shown in **fig. 54.**

In addition to the transistor array, RCA also offers a diode array, the CA3019, that contains one diode quad plus two isolated diodes on a single silicon chip, a dual-Darlington array, the CA3036, that contains two Darlington-connected transistor pairs and a wideband amplifier array, the CA3035, that contains three high-gain amplifier stages which may be operated individually or in cascade.

The broadband video amplifier shown in **fig. 54** is a typical application for the CA3018 transistor array. This circuit covers all of the amateur bands up to 30 MHz and provides almost 50 dB gain. With the components shown, frequency response is from 800 kHz to 32 MHz. The dynamic range is extremely good—20 μV p-p to 4 mV rms at the input.

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ham radio

receiving system degradation in fm repeaters

How to improve talk-in range using shielding and tuned-cavity filters

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The popularity of vhf fm repeaters is steadily increasing in the ranks of amateur radio despite several problems inherent in the design and operation of such stations. Perhaps the most serious and least understood is receiver blocking, or more properly, receiver desensitization.

This problem appears in two ways. First, it can severely limit the effective talk-in range of the repeater system. It can also show up as repeater chatter which is a cyclic keying of the station. First a signal breaks the receiver squelch and keys the transmitter. With the transmitter on, receiver sensitivity falls off, and the squelch closes. When the squelch closes, the transmitter shuts off, and the receiver sensitivity returns to normal; if the signal is still present, the squelch opens and the cycle repeats.

This article explores the causes and cures of receiver degradation, describes some measurement techniques, and offers some good methods to lick the problem.

noise

A transmitter will affect a nearby receiver's sensitivity in two ways. First, it can significantly reduce the receiver's front-end gain. This occurs when the transmitter carrier is present at the front end at a sufficient level to cause rectification in the amplifier or mixer input circuit. The resultant change in bias reduces the stage gain, which in turn reduces the noise input to the limiters and the limiter current. The effect of all this is ultimately to reduce the receiver's sensitivity.

The second effect is produced by the transmitter's noise spectrum. It is a sad but true fact that all transmitters produce not only a carrier and modulation sidebands, but noise sidebands as well. These sidebands may extend several hundred kilohertz on either side of the carrier. If the transmitter and receiver frequencies are only a few hundred kilohertz apart, which is usually the case in ham repeaters, the transmitter noise output that lands on the receiver frequency can be many times greater than front-end or antenna noise. This increased noise input to the limiters produces an increase in limiter current, which in turn reduces receiver sensitivity.

While rectification decreases limiter current, transmitter noise increases it. Thus, since both effects can occur simultaneously, it's not uncommon to find them cancelling each other in regard to changing limiter current. Therefore, there may be severe receiver degradation with no apparent change in limiter current readings.

Before proceeding to a description of techniques for curing the problem, I'll develop a method for measuring the effects so corrective steps can be properly evaluated. The problem is basically how to measure receiver sensitivity, or to be more precise, the change in sensitivity. The term sensitivity refers not only to the receiver itself, but to the entire receiving system including antenna and feedline.

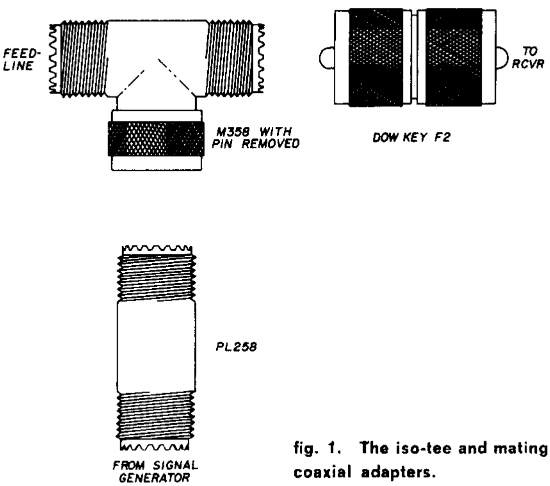

fig. 1. The iso-tee and mating coaxial adapters.

measurements

The basic piece of test gear required is a controlled signal source. A calibrated signal generator is ideal; however, most of us don't have one. Since we are primarily interested in changes of sensitity, rather than the actual measurement of it to a hundredth microvolt, simple equipment can be used with great success. You'll require a well-shielded signal source, preferably crystal controlled, and a step attenuator. Both are within the pocketbook range of most hams, supplemented by home-brewing.

Also required is an "iso-tee." This is simply a coaxial tee adapter, such as the M-358, with the center pin of the male termination removed (**fig. 1**). The female terminations are connected to the receiver and the antenna feedline. The output of the signal source is connected through the step attenuator to the male termination of the tee. The tee provides very loose coupling of the signal source to the receiving system.

receiver degradation

To measure the receiver degradation produced by the transmitter, connect an ac voltmeter across the receiver speaker terminals (see **fig. 2**). Open the receiver squelch and increase the output of the signal source until the receiver output decreases by 20 dB, just as when making a standard 20-dB quieting sensitivity check. It will probably require several hundred microvolts of rf output from the attenuator to produce this quieting, as the isolation of the tee fitting is substantial.

The next step is to key the transmitter and repeat the measurement. Ideally, it should take the same amount of signal to quiet the receiver with the transmitter on as with it off. More likely, it will require considerably more signal. If, for instance, you must inject 30 dB more signal to produce 20 dB quieting with the transmitter on, the transmitter is degrading the receiver sensitivity by 30 dB! Now the question is, what to do about it?

the cure

If the transmitter and receiver are located at the same site, the first step is to shield the two units. This includes filtering all power, control and audio leads entering or leaving the shielded enclosure. Shield kits for this purpose are available from the manufacturers, or you can brew your own. The effectiveness of the shielding can be tested by the same technique previously outlined. To test the transmitter shielding, replace the transmitter antenna with a dummy load and make the quieting measurement. To test the receiver shielding, replace the receiving antenna with a dummy load and perform the measurements.

If the shielding is effective, no degradation will be apparent during either test. Of course, this presumes no radiation from the dummy load, so forget that light bulb nonsense. Once the units are properly shielded, reconnect the antennas and check for degradation. If it is still severe or objectionable, the next step is antenna spacing.

The transmit and receive antennas should be as far apart as possible. If they are mounted on the same tower, they should be at least 100 or more feet apart. Unfortunately, few hams can realize the benefits of 200-foot towers or separate transmitter and receiver sites, so a more practical solution is the use of tuned cavities.

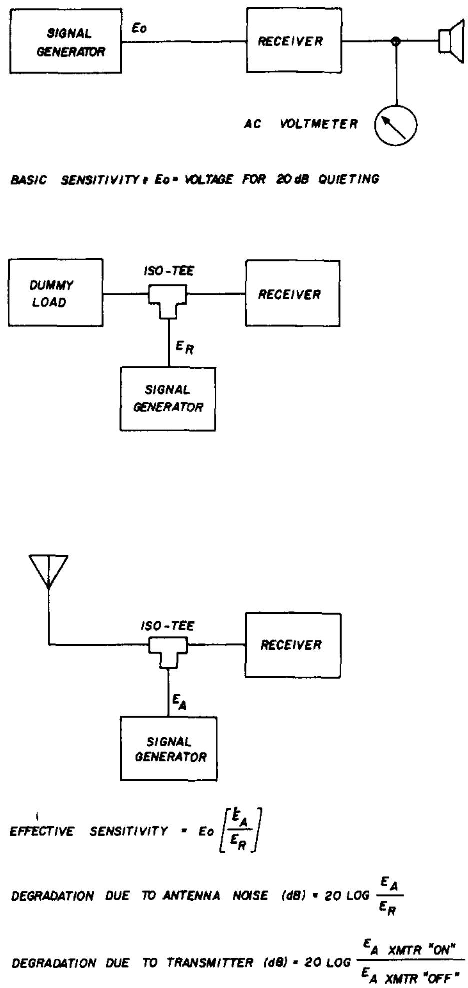

fig. 2. Test equipment setup for measuring receiving system degradation.

tuned cavities

A tuned cavity is essentially a very high-Q tuned circuit. A cavity placed in the receiver feedline and tuned to the receiver frequency will pass signals on the receive frequency, while rejecting all other frequencies. A cavity placed in the transmitter feedline and tuned to the transmitter frequency will pass the transmitter signal, while rejecting noise on the receiver frequency.

The criteria for selecting a cavity, either commercial or homebrew, are physical size and power rating. As a rule of thumb, the bigger they are, the better. Many commercial units are available with a choice of coupling loops, thus providing a selection of different amounts of selectivity. There is a tradeoff involved here as the higher the selectivity, the greater the insertion loss and the lower the power rating.

cavity location

To determine the appropriate location for the cavity, watch the limiter current as the transmitter is keyed. An increase indicates degradation due to transmitter noise, and the cavity should be placed in the transmitter feedline. A decrease indicates desensitization due to rectification, and the cavity should be placed in the receiver feedline.

If the transmitter noise is the culprit and a separate exciter and final are used, try placing the cavity between the exciter and the final. Since most of the transmitter noise is generated in multiplication stages, a cavity at the output of the exciter will reduce the noise output of the amplifier. An added benefit of this location is the fact that, since you are dealing with a low-level signal, you can use a cavity with a higher selectivity (remember the tradeoff) thus improving the noise reduction. Also, due to the reserve gain of the final amplifier, insertion at this point will result in less loss of radiated power than if the same filter were placed after the final.

After the first cavity is installed, a noticeable improvement should be observed. If some degradation still exists, it may be necessary to resort to additional cavities. Complete elimination of the problem may require several cavities in both the transmitter and receiver feedlines.

insertion loss

Many hams will object to the use of cavities because of their insertion loss. However, from a system viewpoint, they are the least of several ills. A repeater is useful only to stations who can both hear and be heard by it. If your repeater can be heard across the state, but it can only hear across town, then the repeater's effective range is just across town. Stations outside the talk-in range can't use the repeater and so are probably not very interested in hearing it. As far as they are concerned, it just ties up the frequency.

If you install a cavity or two on the transmitter, you may reduce your talk-out range to halfway across the state, but you may have reduced receiver desensitization to the point where you can hear halfway across the state. Thus, you've increased your effective range to halfway across the state, insertion loss and all.

Similarly, in the case of the receiver, what really counts is not just receiver sensitivity, but effective sensitivity when the transmitter is keyed. If adding cavities to the receiver feedline reduces the degradation produced by the transmitter, then you are improving performance and increasing operational range even at the expense of additional insertion losses.

receiver sensitivity

An interesting point regarding receivers arises at this point. If a receiver is capable of hearing external noise from the antenna, this noise is the limiting factor in weak signal detection. Low noise preamps and high gain antennas won't help matters, and they may produce additional problems. With an **a-m** receiver, the simplest test for sensitivity is to replace the antenna with a dummy load and see if the noise output of the speaker decreases. If it does, the receiver is hearing external noise. This test won't work with fm receivers; and if it does, you'd better start replacing tubes.

An equivalent test for fm receivers can be made by watching limiter current, but a much more accurate method is to perform the same test as used for measuring degradation due to transmitter noise. First, make the quieting check with a dummy load on the receiver. Then replace the normal antenna, and again check the quieting level. The difference in levels required to produce 20 dB of quieting is the amount of external degradation.

If the receiver sensitivity is being degraded by, say, 8 dB of antenna noise, then up to 8 dB of additional loss, either in the form of cavity insertion loss or attenuators, can be inserted in the feedline without affecting the effective sensitivity by more than 2 or 3 dB. The attenuator, by the way, will provide some improvement in desensing characteristics and considerable improvement in intermodulation protection.

If the receiver is not being degraded at all by antenna noise, then the limiting factor is the receiver front-end noise, and you may want to add a low-noise preamp or switch to a higher-gain antenna. If you decide on a preamp, be careful. Many preamps, especially those using bipolar transistors, are extremely susceptible to desensing problems. The same unit that works wonders in a mobile or base station may prove disastrous in a repeater.

in conclusion

The steps toward elimination of receiving system degradation in repeater applications are transmitter and receiver shielding, spacing between antennas and the proper use of tuned cavities. With enough cavities, it's even practical to use the same antenna simultaneously for transmitting and receiving.

ham radio

mini rtty converter

Presenting an adaptation of a standard circuit using an IC

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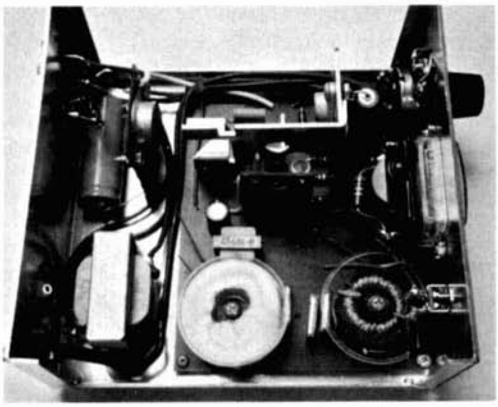
With the present trend toward compactness and space saving equipment, this converter should appeal to most RTTY fans.

The circuit (**fig. 1**) is not new except for the IC and has appeared in other RTTY publications. The unit is self-contained even to the power supply, and is housed in a 6x5³/₄x2¹/₂-inch box, which in this case was custom made.

Converter layout.



Printed circuit boards were used, and careful placement of parts is necessary to get all the components in the small package. A vertical printed circuit board was used for the IC circuit and its associated parts.

cuit. Any well-filtered, regulated circuit capable of handling the current can be used.

The integrated circuit and Q2 share a common heat sink. It is very important that heat sinks are used for long life and

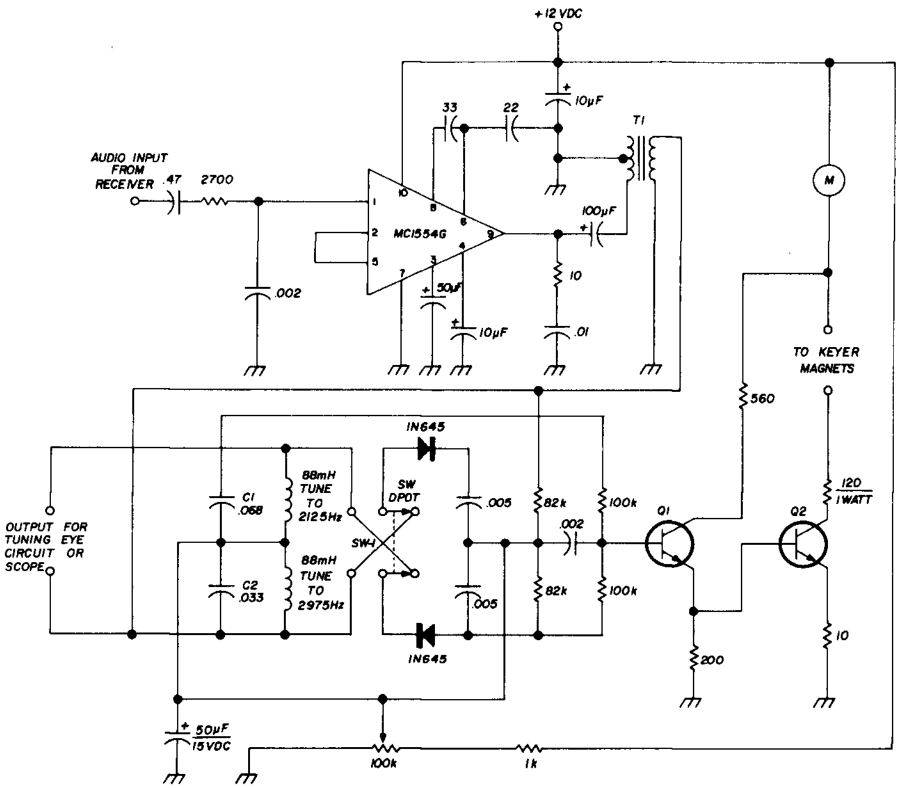


fig. 1. Schematic of the integrated-circuit RTTY converter. Transistor Q1 is a Motorola MPS6515; Q2 is a Motorola MJ3202 or RCA 40264. Transformer T1 is a 10k-to-2k interstage such as the Stancor TA35, Thordarson TR7 or Argonne AR-109. All electrolytic capacitors are rated at 15 Vdc.

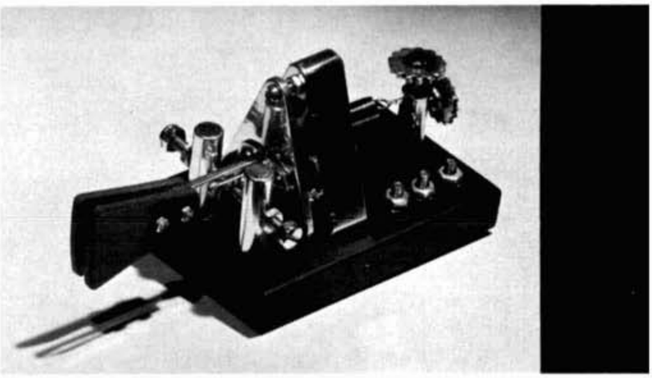
Careful tuning of the toroids is important and can be accomplished in the usual manner, using a vtvm and an audio oscillator of known accuracy. The space filter is tuned to 2975 Hz and takes approximately 0.33 μF; the mark filter is tuned to 2125 Hz and takes approximately 0.068 μF.

A regulated power supply is built into the unit, although not shown in the circuit.

trouble-free operation. This unit has been used for some time with great success. It will give lots of trouble-free service.

The receiver input is matched to 10k as the impedance of the transformer I used was from 10k to 3.2 ohms, but in several cases the converter has been used without a transformer.

ham radio



a homebrew keyer paddle

If you love craftsmanship, here's a project to challenge your ability and patience

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This paddle is a sort of dare item. I was aching for a paddle to go with my newly made "TO" keyer, which I built about five years ago. So I modified my bug to a three-terminal job and began practicing on the keyer. It was rough going, because the old bug was just that—old. I acquired it second-hand from a commercial operator about 1927 or thereabouts. It wasn't new even then. I certainly can't complain about its service, but after about 40 years it was getting pretty sloppy, especially where no compensation could be made for wear and tear.

I'd visited some hams who used different types of paddles. This gave me an opportunity to try the different types. Well, you have to pay for what you get. If the price was reasonable, the thing either didn't feel right or just didn't **look** right. If it had the good qualities, then the price was out of range. So the idea of a homebrew design came into being.

the mount

The three-point rocker mount used by W8FYO seemed to be the best choice, because no sloppy bearings could develop, and any mechanical wear that did develop would

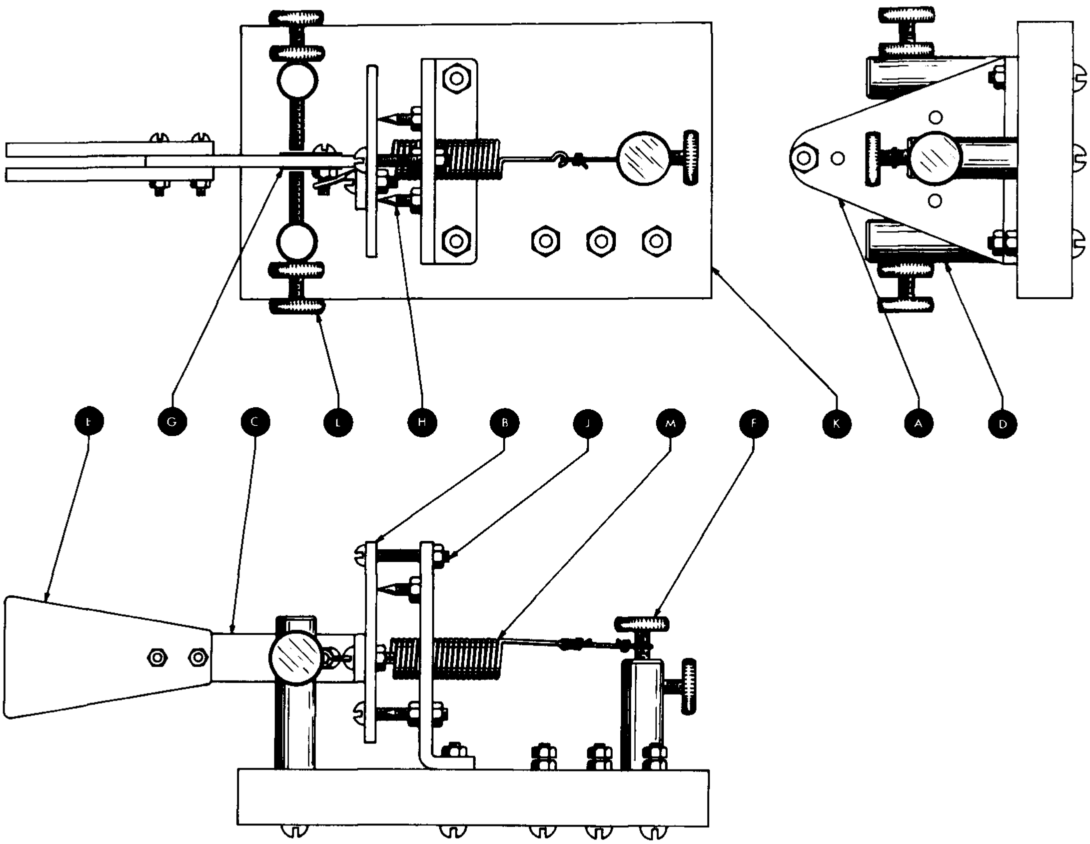


fig. 1. The assembled paddle.

be automatically taken up. It's not a copy of the W8FYO paddle, but I do wish to thank Joe for the idea of the three-point mounting.

Money aside for the moment, the main reason for the homebrew was the fun of making something with ordinary hand tools. If this design worked as anticipated, I would have a unique paddle.

performance

When completed it worked beautifully—I could do about 40 words per minute without undue strain, something that I couldn't do with the old bug for very long. But the surprise bonus was that it looked pretty good too. I took it to the office and showed it to some of my colleagues, nonham engineers. Their reaction was real joy to me. They offered lots of suggestions as to what I should do with it. The most common one was to write an article for **ham radio** magazine, so here it is. You can either make it as is, or modify it as you wish. It may even generate a bug of an idea for a design of your own.

construction

This paddle was made from scraps available in my workshop. The base is two pieces of quarter-inch Lucite cemented together with epoxy. The Lucite used to be one of those sheets that people put on their desks with notes, charts, and pictures of the family looking up from underneath. It was thrown out because it was rough and scratched so

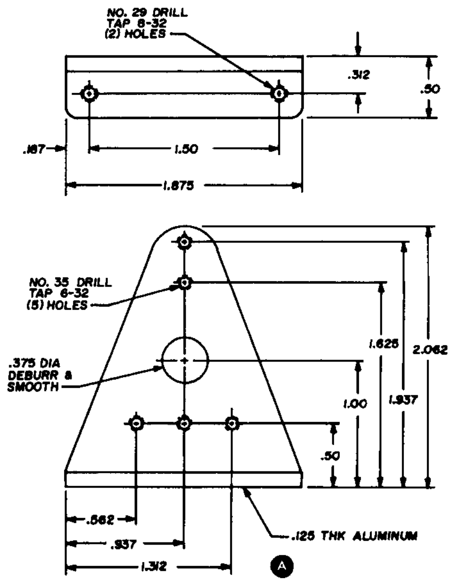


fig. 2. Main support A.

badly it lost its usefulness—except to me. However, almost any insulating material can be used such as hard rubber or bakelite.

I could have made a lead base to keep the paddle from sliding around. I decided not to, though, because heavy as my old bug was, I still had to screw it down to the desk top. So I settled for an insulating material that didn't complicate the design by having to insulate the contact posts and binding posts. One screw holds it to the desk, no matter how heavy handed you might be.

Does the paddle (**fig. 1**) look like a big undertaking? Actually it should be easier for you than for me, because I made the piece parts first, depending only on an image of what I wanted. The drawings were made after I decided to write it as a construction article. And believe me, it took much less time to build the paddle than to produce the drawings.

Except for one area, there's nothing critical despite the formidable fractional dimensions which are in inches. They're for the purists. Reasonable errors can be tolerated, because the final adjustments will compensate for any small misalignments.

the rocker panel

The critical area that requires care is marking the rocker panel to match the three points of the main support (**fig. 2**) against which the rocker panel and paddle assembly will be held by the tension spring. Precision measurements can be avoided by using the main support points as a template. But care is required. (That's the way I did it.)

After the three points have been made on the main support (A) and filed flush, carefully place the main support over the rocker panel (B) and align it so that the upper inverted-V section is matched flush. With the main support resting lightly on the rocker panel, gently tap the top screw to make a mark on the rocker panel. With the top pin

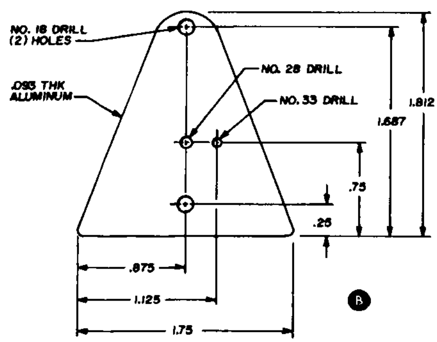


fig. 3. Rocker panel B.

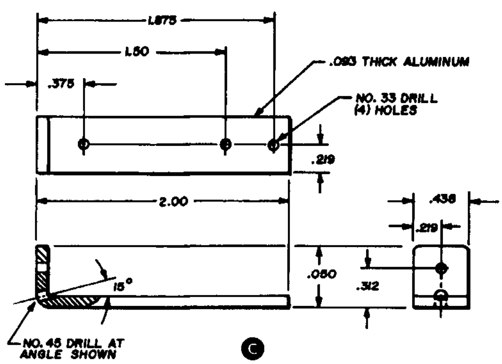


fig. 4. Paddle arm C. The wire spring feeds through the hole drilled on a 15° angle.

snugly in the mark, recheck the alignment, then tap one of the other screws. With the two screws snugly in place, tap the third screw.

the pressure points

Now that the three points have been located, they can be enlarged with a center punch. A depth of 1/32 inch is sufficient. To get the feel of how much of a wallop you'll have to apply to the center punch, try practicing on scrap aluminum.

Now that the pressure point seats have been made, a word of caution: these seats match the points on the main support. Don't change the screws on the main frame. If you have any reason to turn them after marking the rocker, chances are you won't be able to re-align the pointed screws to match the seat exactly. So be sure that the pointed screws are **set** and **tightened,** then leave them alone.

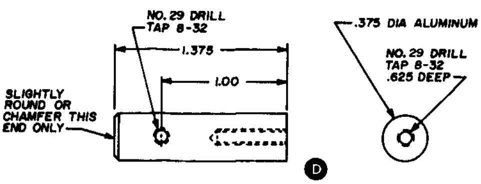


fig. 5. Terminal contact post D (two required).

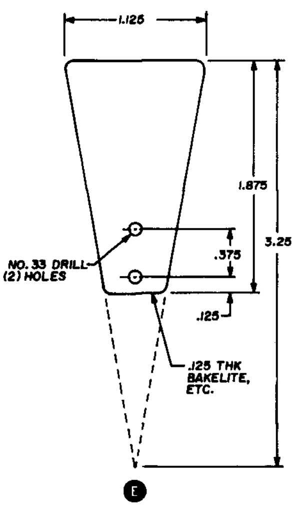


fig. 6. Paddle E (two required).

If you've been wondering why the assembly drawing looks a little different from the photograph, it's because I built two paddles. The only difference is that for the first I used a heavy chunk of aluminum for the main support, and for the second I used a piece of

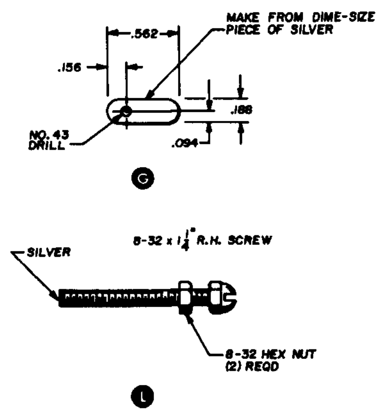


fig. 7. Silver contact G (two required) and contact screw L. Sufficient scrap should be left after making the silver contacts to make a silver contact for the contact screw. Cut a piece to size, solder to the end of the screw, and trim to size with a fine file.

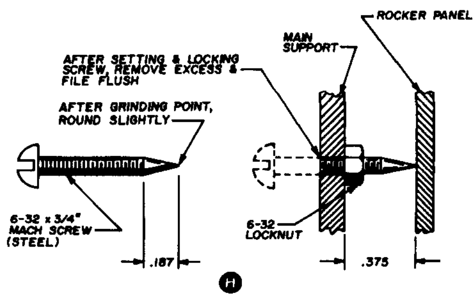


fig. 8. Support point H (three required).

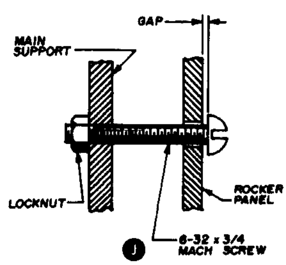


fig. 9. Retainer screw J (two required). After the rocker panel subassembly is in place, insert the retainer screws and lock with nut, permitting just enough gap to allow freedom of paddle motion.

bent, 1/8-inch stock. I made a photo of the first one and drawings of the second.

Fig. 1 shows knurled instrument-type screws and lock nuts. This was wishful thinking on my part. Actually, only ordinary round-head screws were used as can be seen in the picture. If you wish to use fancy screws, be sure that the tap matches the screw threads.

detail parts

Now to pick up the odds and ends. A 2-56 x 1/2 inch screw holds the silver contacts to the paddle arm. The screws that hold the bakelite paddle to the paddle arm are 4-40 x 1/2 inch. The terminal screws, those that hold the main support to the base, and the screws that hold the contact posts are all 8-32 x 7/8 inch. The screw that holds the paddle arm to the rocker panel is 6-32 x 3/8 inch. Before final assembly, I polished each piece part, including screws, on a buffing wheel. If you'd like to silver plate the parts, a good article on this appears in **ham radio,** December, 1968, page 62.

The second version of the paddle is presently in use at W3NK. The first version (photograph) was given to K3SFT as a memento of his visit to my station.

ham radio

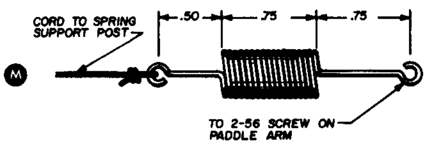


fig. 11. Tension spring M. The one I used is 3/8" diameter and about 1" long—from the junk box. Just about any small spring will work since final adjustment is made on the spring-support post (fig. 12).

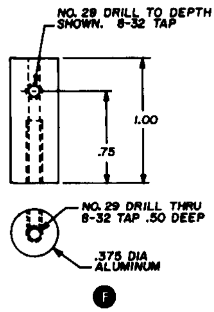


fig. 12.

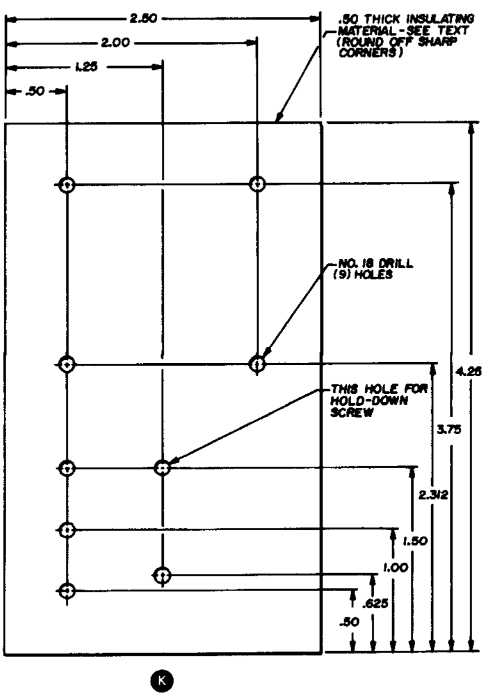


fig. 10. Keyer base K.

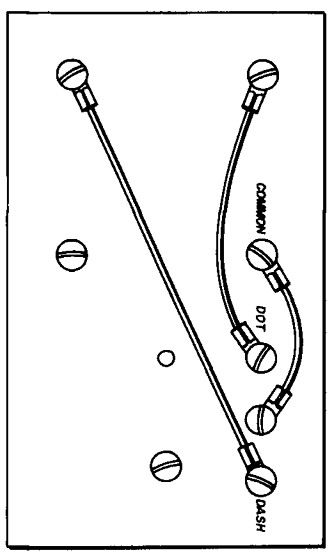


fig. 13. Base terminal wiring.

solid-state

antenna switch

for

two meters

Adapted from a commercial design, this rf-activated switch has many features that will appeal to vhf enthusiasts

Robert M. Brown, K2ZSQ, 5611 Middaugh Avenue, Downers Grove, Illinois 60515

The subject of antenna switching without relays was discussed in fairly down-to-earth terms in a 1968 issue of **ham radio.**[1] Much is being done in this area on a more sophisticated level, however, which should be of interest to amateurs. I refer to the "mystery" band above two meters. This is known as the business radio service (BRS) band and occupies 150 to 174 MHz. Design engineers have been producing for this service some interesting circuits that are adaptable to amateur use, especially since the BRS frequencies are so close to the two-meter band.

Many manufacturers are now turning out fixed-frequency versions of their two-meter lines for use in the BRS band, which until recently has been an fm band. While single sideband has been designated for marine radio, the BRS equipment designers are just beginning to use a-m. All this has spurred new interest in equipment design, because a-m versus fm is a controversial subject in these communications circles, especially from a performance and reliability standpoint.

Let's take a look at a solid-state rf-activated antenna switch designed by Mr. K. W. Angel, applications engineer for RCA at Meadow Lands, Pennsylvania. This switch has several features that will appeal to amateurs: low insertion loss, fast response, reliability and low-cost components.

The switch exhibits about 0.2 dB loss during transmission and provides about 25 dB isolation of the receiver. As reported by Mr. Angel,[2] "Receiver sensitivity is not measurably degraded by resistive losses within the . . . diode." Furthermore, the simple device (see **fig. 4** for the circuit RCA finally adopted) has had an "excellent record of service in the field. Severe customer acceptance testing has not produced a failure."

foolproof, fail-safe

At a Canadian IEEE annual meeting on vehicular communications an RCA representative stated, "Coupled with simplicity,

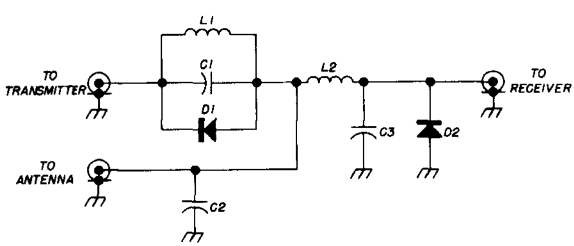


fig. 1. Essential elements of the rf-activated antenna switch. C1 and L1 are parallel resonant at the receiving frequency.

we have developed (switching) circuitry that is foolproof and fail-safe." It was further pointed out that no adjustments are possible that could damage the receiver, certainly a feature most two-meter men can readily appreciate.

Gas discharge tubes have not been used in the past for one basic reason: poor reliability. Only with the advent of accelerated semiconductor technology has an acceptable design been possible.

RCA's design considerations included simplicity, convenience and low-power consumption—similar to conventional t-r switches. Only three external terminals would be needed: antenna, transmitter and receiver coaxial inputs (50-ohm lines). The switch could then be used with nearly all existing transceivers.

the circuit

The basic elements of the rf-activated antenna switch are shown in **fig. 1.** As the transmitter is turned off, rf signals from the antenna are applied to the receiver through the pi filter consisting of L2, C2, and C3. C1 and L1 are parallel resonant at the receiving frequency. As the transmitter is activated, the first rf-voltage cycle exceeds the diodes' breakdown voltages. This forces D1 to conduct, which shorts C1 and L1; then D2 shorts C3. What happens is shown in the equivalent circuit, **fig. 2**. Rf output is switched to the antenna, and the voltage divider, L2 and R2, isolates the receiver. C2 and L2 are selected to resonate near the transmitting frequency to avoid what the designer refers to as "reactive transmitter loading."

Damage to the receiver's first rf-amplifier transistor could occur if the circuit were left as it now stands. The reason is that the time duration, before D2 breaks down after D1 starts to conduct, could be significant. To circumvent this, further isolation of the receiver is recommended.

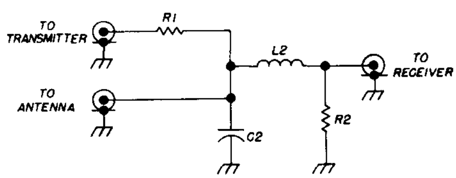
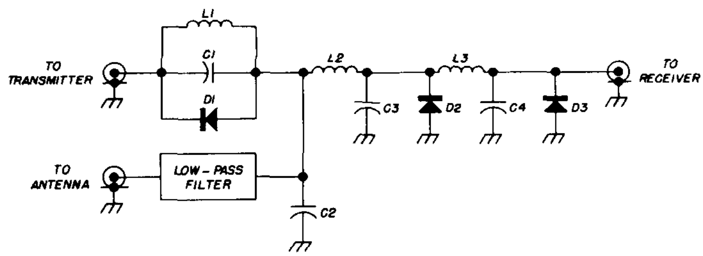


fig. 2. How the circuit appears when the transmitter has been activated. Note that C1, C3, D1, D2 and L1 have been effectively shorted out of the circuit. R1 and R2 (R2 as a voltage divider with L2) isolate the receiver from what's happening.

The designer added a second filter section between D2 and the receiver (see **fig. 3**). D3 is a low-power switching diode that isolates the receiver just before D2 conducts. Interestingly, it was found that D3 turned on when it shouldn't have. The problem was resolved by placing the receiver at some multiple of one-half wavelength from the diode. In this manner, undesired signals rejected by the receiver's fig. 3. A second filter section has been added to prevent possible receiver damage caused by time lag between breakdown of D1 and D2. D3 doubles effectiveness of low-pass filter.



low impedance selectivity characteristics are not sufficient to cause D3 to conduct.

operation and tests

Fig. 4 represents the final circuit. Various varactors, p-n junction diodes or other switching types could be used with different forward and reverse biasing techniques. In operation, the circuit acts as a continuation of a low-pass filter inserted between receiver and antenna. On transmit, inductance L2 approaches parallel resonance with C2 and a second capacitance value on the transmit side of D1. This effectively reduces C2's value, resulting in an increase in the low-pass filter's high-end *cutoff frequency. In tuneup,* C2 is adjusted for minimum receiver-frequency feedthrough.

Several tests were performed that are well worth examining. To ensure that the circuit could withstand equipment faults, for example, conditions of open or short-circuited antenna were simulated. According to the designer, the most severe fault condition was run at 75° C ambient on a continuous basis for over 72 hours with no apparent change in diode performance characteristics.

From a two-meter enthusiast's viewpoint (especially mine, with my limited pocketbook), the next test was even more *significant.* A life test conducted at 60°C revealed that small and inexpensive glass-package diodes are fully capable of continuous operation through 174 MHz with output powers to 80 watts. At 80 watts, according to the designer, "The level of power was sufficient to darken the paint on the *diode package." But no operation*al deterioration could be detected. Later, a larger-stud package was put into the rcuit. Power was increased from 90 through 350 watts (output). After operat-

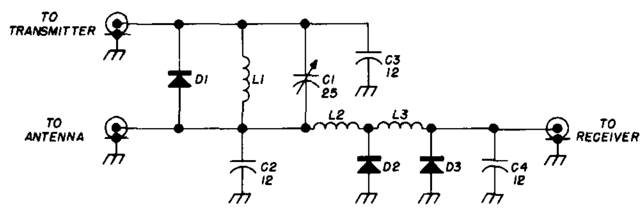


fig. 4. Final vhf antenna switch now being used extensively by communications equipment manufacturers. C1 is tuned for minimum feedthrough of the receiver frequency; it is a preset adjustment (conventional 5-25 pF trimmer) that almost never requires retuning.

ing for two days at the 350-watt level, no deterioration was measured.

Incidentally, for those of you scrambling for the soldering gun and junkbox Mr. Angel's version as adopted for use in this years line of solid-state vhf communications equipment measures a scant 1-inch high by 1-inch wide by 2¼-inches deep. *And that includes the physical dimensions* of the three coaxial connectors!

references

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3. K. W. Angel, "An Rf Activated Antenna Switch," *Communications Marketing,* August, 1966.

ham radio

TOP OF THE YAESU F LINE

THE FT DX 400 TRANSCEIVER

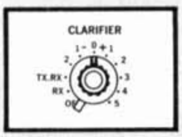
Conservatively rated at 500 watts PEP on all bands 80 through 10 the FT dx 400 combines high power with the hottest receiving section of any transceiver available today. In a few short months the Yaesu FT dx 400 has become the pace setter in the amateur field.

FEATURES: Built-in power supply • Built-in VOX • Built-in dual calibrators (25 and 100 KHz) • Built-in Clarifier (off-set tuning) • All crystals furnished 80 through the complete 10 meter band • Provision for 4 crystal-controlled channels within the amateur bands • Provision for 3 additional receive bands • Break-in CW with sidetone • Automatic dual acting noise limiter • and a sharp 2.3 KHz Crystal lattice filter with an optimum SSB shape factor of 1.66 to 1.

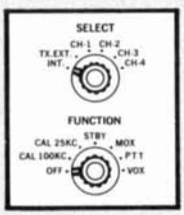
Design features include double conversion system for both transmit and receive functions resulting in, drift free operation, high sensitivity and image rejection • Switch selected metering • The FT dx 400 utilizes 18 tubes and 42 silicon semi-conductors in hybrid circuits designed to optimize the natural advantages of both tubes and transistors • Planetary gear tuning dial cover 500 KHz in 1 KHz increments • Glass-epoxy circuit boards • Final amplifier uses the popular 6KD6 tubes.

This imported desk top transceiver is beautifully styled with non-specular chrome front panel, back lighted dials, and heavy steel cabinet finished in functional blue-gray. The low cost, matching SP-400 Speaker is all that is needed to complete that professional station look.

SPECIFICATIONS: **Maximum input:** 500 W PEP SSB, 440 W CW, 125 W AM. **Sensitivity:** 0.5 uv, S/N 20 db. **Selectivity:** 2.3 KHz (6 db down), 3.7 KHz (55 db down). **Carrier suppression:** more than 40 db down. **Sideband suppression:** more than 50 db down at 1 KHz. **Frequency range:** 3.5 to 4, 7 to 7.5, 14 to 14.5, 21 to 21.5, 28 to 30 (megahertz). **Frequency stability:** Less than 100 Hz drift in any 30 minute period after warm up.

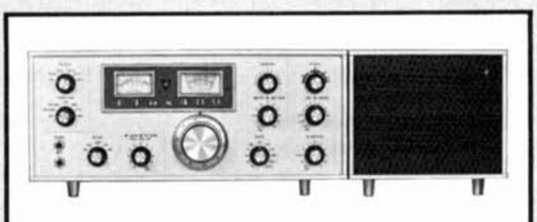


CLARIFIER CONTROL — Does the work of an external VFO — allows operator to vary receive frequency 10KHZ from transmit frequency, or may be used as an extra VFO combining transmit and receive functions.



SELECT CONTROL — Offers option of internal or outboard VFO and crystal positions for convenient preset channel operation.

FUNCTION CONTROL—Selects crystal calibration marker frequency and desired transmit mode of operation.



FT DX 400 $599.95 — SP-400 $14.95

SPECTRONICS BOX 356, LOS ALAMITOS, CALIFORNIA 90720

— PROFESSIONAL EQUIPMENT FOR THE AMATEUR —

integrated circuit noise blanker

John J. Schultz, W2EEY, 40 Rossie Street, Mystic, Connecticut 06355

As long as we have radio receivers, noise in one form or another will probably always be with us. This unwelcome but necessary evil depends on atmospheric and ionospheric conditions, station location and the frequency covered by the receiver. In general, receiver noise is of two types: (A) short duration, high-impulse amplitude, and low repetition rate, or (B) long duration, moderate impulse amplitude, and high repetition rate. Examples of type A are ignition and click-type noise; atmospherics are typical of type B.

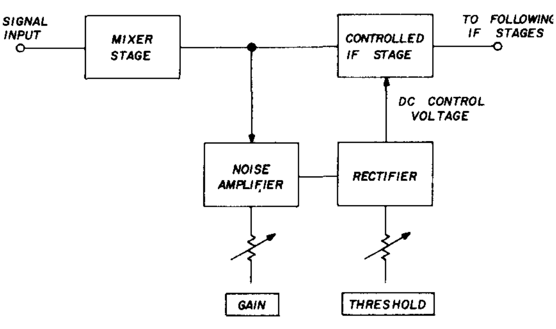
Atmospheric noise is by far the most difficult to overcome, because its characteristics are similar to those of the desired signal. Special signal processing circuits that distinguish between this type of noise and the desired signal can be designed, but they are complex and generally involve a process that compares the received signal with an "expected model" of the desired signal. Such a process is generally only possible with a digital type of transmitted signal.

There is really no need to compromise your operating by living with the racket and clatter caused by impulse noise, especially with all the technology available today using solid-state circuits that can be put together by the average amateur using low-cost devices. The following paragraphs describe a really effective noise blanker using IC's. All you need do is follow my suggestions with regard to layout and lead dress, and you can build a noise silencer that will provide many hours of operating pleasure. It could mean the difference between working that rare station and not hearing him at all.

noise suppression circuits

Many circuits have been developed to suppress the effects of high-impulse, low-repetition rate noise. Such circuits fall into either of two categories—the first type limits the absolute value of a received signal, thus ensuring that the noise impulses don't exceed the level of the desired signal and hence aren't unduly irritating. This allows the receiving operator to perform a type of filtering wherein he distinguishes between the noise signal and the real information signal. The

fig. 1. Basic stages of the Lamb noise blanker.

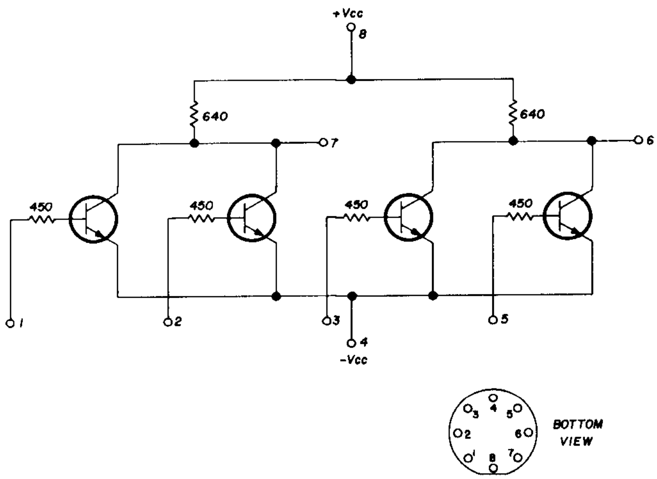


second type makes the receiver instantaneously inoperative during a noise impulse, so that the operator never hears the noise impulse and has only to integrate mentally the portions of the received signal conducted before and after the presence of the noise impulse.

a built-in example

This integrating process may sound rather complex, but actually it isn't. The simplest example occurs in everyday speech. Under somewhat noisy conditions, we may not distinguish every word a person says, but because we understand the language and generally the subject matter, we fill in mentally any missing portions. In fact, studies show that, for the expression of simple ideas, 30 or 40 percent of the actual expression of these ideas can be absent, and a person familiar with the language and background of the speaker will receive clear communication.

fig. 2. Internal circuit of the Fairchild μL914 dual two-input gate integrated circuit used in the noise blanker.



Circuits that make the receiver inoperative during a noise impulse are called noise silencers or blankers. One of the classic methods of accomplishing this action was developed by Lamb. The basic circuit (**fig. 1**) is referred to as a Lamb-type noise blanker or silencer.

blanker circuit operation

Fig. 1 shows that the signal at the output of the first mixer of the receiver to which the noise silencer is added is in two parts. The main portion flows, as usual, directly into the first i-f amplifier. However, a small portion of the signal flows into a so-called noise amplifier. This amplifier doesn't really distinguish between the desired signal and noise, but amplifies both noise and signal much the same as the usual i-f amplifier.

The output of the noise amplifier is rectified, and the resultant dc control voltage regulates the action of a cutoff device or circuit that makes the normal i-f amplifier inoperative. The rectifier threshold control is set so only signals of a definite amplitude from the noise amplifier will activate the cutoff circuit. Thus, the circuit can be set (by the threshold and noise amplifier gain controls) so that noise from the first mixer exceeding a given value will activate the cutoff device and control the first i-f stage output.

The basic idea of producing an instantaneous interruption in the signal output, when a noise impulse is present, can be applied to any stage in a receiver right up to the audio output stage. However, it has value only when applied as early as possible to the receiver signal-processing chain. This is because every tuned circuit a noise impulse encounters, as it passes through the receiver, tends to elongate the noise impulse due to the Q, or ringing, effect of the tuned circuits. The exact elongation a noise impulse receives depends on the receiver characteristics. However, it's not impossible for a noise impulse with a real-time duration of microseconds to be apparent as a milisecond impulse by the time it reaches the audio output stages.

Disabling the receiver for the duration of a microsecond pulse will never be noticed, but disabling it for many milliseconds may produce a noticeable decrease in received signal intelligibility. The high Q of the i-f circuits also accounts for the fact that many conventional noise limiters produce no real benefit for ssb or cw reception.

By the time a sharp noise impulse reaches the detector, so much circuit ringing and

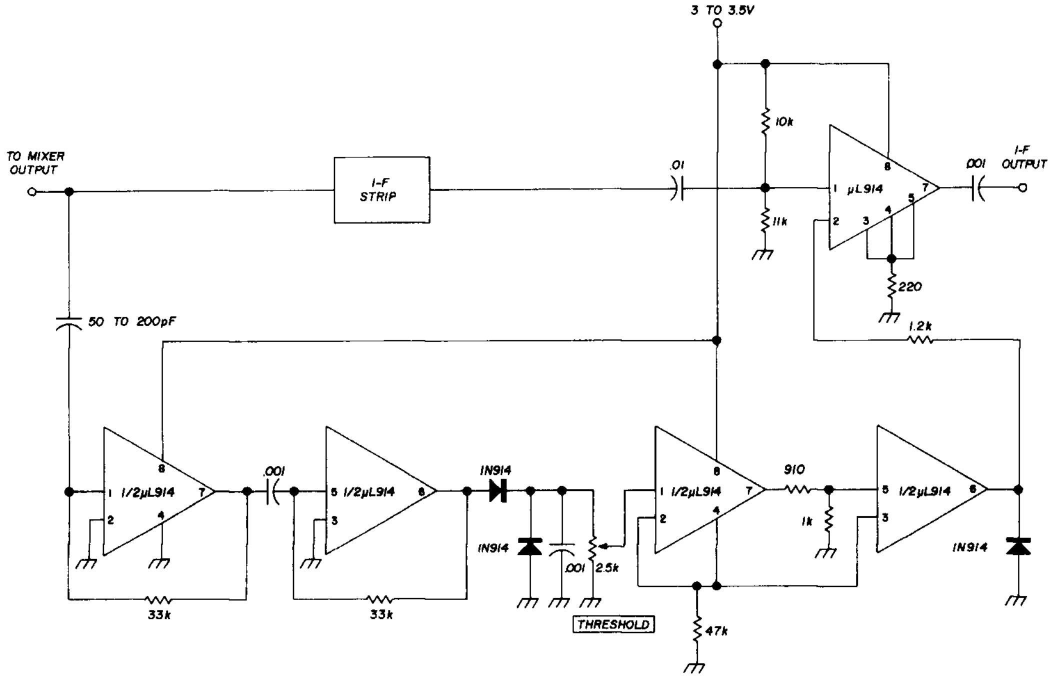


fig. 3. Schematic of the integrated-circuit noise blanker. All IC's are Fairchild μL914's or equivalent.

impulse elongation have occurred that severe signal distortion is present, which no limiter can change. So, with modern receivers, some variation of the Lamb circuit offers the only practical solution to eliminate the effects of impulse noise.

the ic lamb unit

The integrated-circuit version of the Lamb silencer uses three inexpensive Fairchild μL914 units. **Fig. 2** shows the circuit of each μL914 unit, which contains four transistor functions.

The tube-type Lamb unit used a loosely coupled i-f transformer at the input to the noise amplifier to gain some degree of signal/noise discrimination **and** a diode switch or double-grid tube such as a 6BE6 either to act upon or replace the first i-f stage to achieve cutoff. The IC uses a slightly different approach, although the over-all operation is the same as the tube unit.

Fig. 3 shows the wiring of the IC. The first μL914 on the left is a common emitter amplifier. It provides a degree of noise discrimination due to the time constants in the coupling circuits. The second IC is a Schmidt trigger. This is the main area in which the IC circuit differs from the tube circuit. The output of the trigger goes positive when the input voltage exceeds a certain value. Then the trigger switches to zero output when its input voltage falls below another set value.

The input voltage required to make the trigger switch is adjusted by a triggering level control, which is the equivalent of the threshold control in the usual Lamb circuit. The level control is also used to control simultaneously the gain of the noise amplifier.

The last μL914 unit is a simple diode switch. Positive pulses from the Schmidt trigger cause the switch to disable the i-f signal path. The fact that no rectification takes place, as in the usual Lamb circuit, means that switching is extremely fast, and no compromise is necessary between rectifier output filtering and a short time constant.

construction and adjustment

It's almost impossible to describe a unit that will universally fit any receiver. Therefore, the IC unit should be breadboarded before installation. The unit shown will work nicely with many receivers, but others may require that the signal from the detector stage be further amplified. This can be done by connecting another IC amplifier circuit similar to the first μL914 shown in **fig. 3** in series with the first amplifier.

Also, an i-f transformer can be used between the detector stage and noise amplifier to provide increased voltage gain. The circuit should be usable at i-f's to about 2 MHz. At higher frequencies some signal leakage through the last μL914 switch will be noticeable. Other dual-input gate IC's may be used in place of the μL914's if information on their biasing is available.

Construction can be accomplished by grouping the circuit components on a piece of Vector board, which is then mounted by the detector/first-i-f stage. I recommend that the unit not be used externally, because the effect of long signal cables can easily degrade performance. Care should be taken that the leads to terminals 1 and 7 of the last μL914 switch are well separated to prevent signal leakage. Also note that the μL914 switch breaks the dc line between the first i-f transformer and the base of the first i-f amplifier.

If bias for the stage is fed through the secondary of the i-f transformer, it must be rerouted to go after the coupling capacitor from terminal 7 of the last μL914. Connection of the unit will also generally require simple repeaking of the first i-f transformer primary and secondary.

The triggering level control carries only dc and may be located wherever desired; it can be an external panel control, or it can be set and left alone if continuous noise silencer action is desired.

For the reasons previously stated, the noise silencer should be placed well ahead of the receiver selective circuits. For receivers having broad selectivity, typical of some vhf types, the silencer may still prove reasonably effective if placed later in the i-f strip, or possibly even in the audio circuit.

ham radio

the integrated station

A quick look at some of the design highlights of the new Signal/One amateur transceiver

Skip Tenney, W1NLB, Publisher, ham radio magazine

Nearly all of us have had our curiosity aroused by a recent series of advertisements by a new name in the amateur field, Signal/One in St. Petersburg, Florida. While I was in the Sunshine State to attend the Tropical Hamboree in Miami I decided to take an extra day and see just what was going on on the other side of the state.

I found Signal/One in a small modern plant in the shadow of their parent company, the ECI Division of NCR. A quick tour of ECI disclosed approximately 2000 people producing all types of military equipment from sophisticated satellite terminals to small man-pack sets for use in underdeveloped parts of the world.

But the visit became really interesting when Don Fowler, W4YET, project engineer for the CX7 of Signal/One and Dick Ehrhorn, W4ETO, the general manager, introduced me to their new integrated station.

It is a transceiver, whether or not their ads are willing to accept the fact, but the title "integrated station" is also a very appropriate description. Not only do they offer an excellent transceiver, they have included in the same box a 115/230-volt, 60-Hz power supply, an extra vfo, an IC keyer, an rf clipper plus a noise blanker. The complete transceiver is solid state with the exception of the final power-amplifier stage.

The standard unit covers all amateur bands between 1.8 and 29.7 MHz. A $5 crystal permits operation in one 1-MHz segment in any one of the bands from 2 to 3, 4 to 7, or 8 to 14 MHz; three spare bandswitch positions are included for this purpose. As an extra feature the CX7 offers a four-digit frequency counter with Nixie® tube readout that gives you tuning accuracy down to 100 Hz.

You have your choice of broadband or tunable transmitter output at the change of a switch; if your antenna has an swr below 1.5:1 it is absolutely unnecessary to tune the transmitter in any way—the receiver preselector needs peaking, of course—just dial the frequency at which you wish to operate, and start talking. The transmitter features an RCA 8072 operating at a conservative 300 watts PEP under steady-state conditions. It is conduction cooled and has more than ample heat dissipation. The alc circuitry offers both grid and screen protection assuring the longest possible tube life.

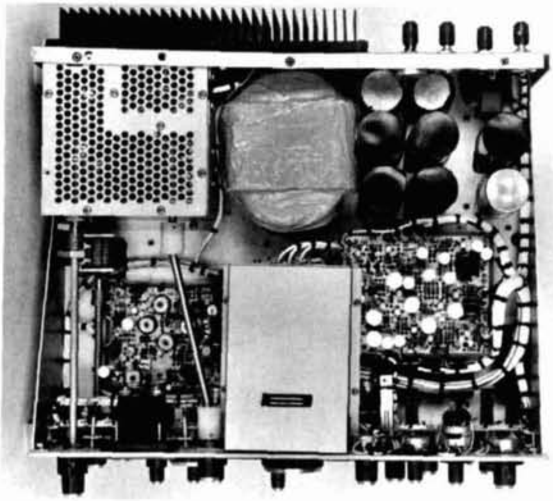
Probably the most interesting part of the CX7 is the receiver. The designers have incorporated two extremely steep-sloped filters, with a combined bandpass of 2.0 kHz at 6 dB down and 3.0 kHz at 60 dB down, together with the niftiest new passband tuning arrangement (Electronic i-f shift*) that anyone has yet to come up with. Signal/One is also promising an outstanding CW filter, but it was not in the unit which I used.

By tuning the bfo crystal oscillator (**fig. 1**) both second mixer injection and bfo injection into the product detector are varied by an equal amount. Thus, as you vary this tuning control, the signal you are listening to remains unchanged but its relationship to the i-f passband can be completely altered. With the very sharp filter skirts you can listen to a CW signal and drop an interfering signal in and out almost as though it was being switched on and off. Even a 1000 microvolt signal from a signal generator was easily eliminated —whether just above or just below the desired signal. When listening to the 40-meter phone band I found no signal that could not be comfortably copied through the European broadcast QRM that is so prevalent on the East Coast in the late afternoon.

* patent applied for

Don Fowler, W4YET, project engineer at Signal/One, left, and Skip Tenney, W1NLB, right, with the engineering prototype of the Signal/One integrated station.

Compact but uncrowded layout of the CX7.



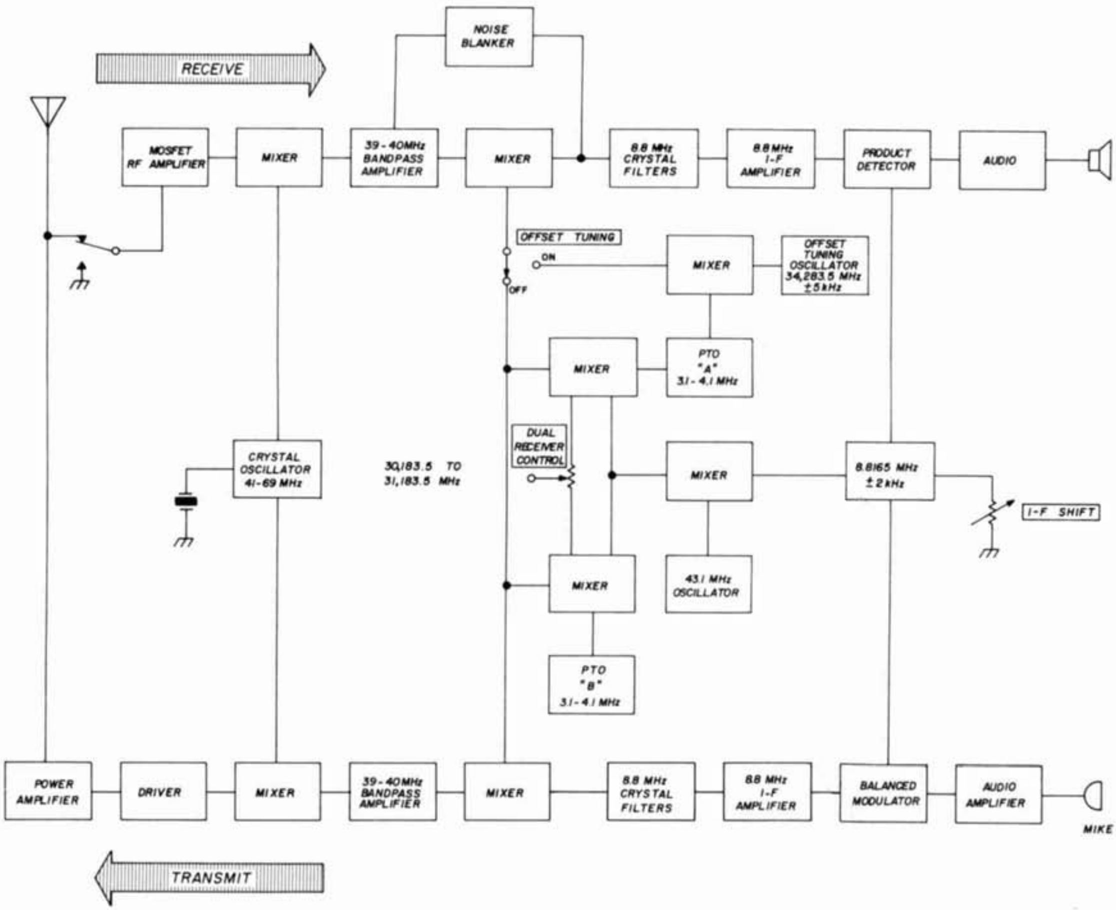
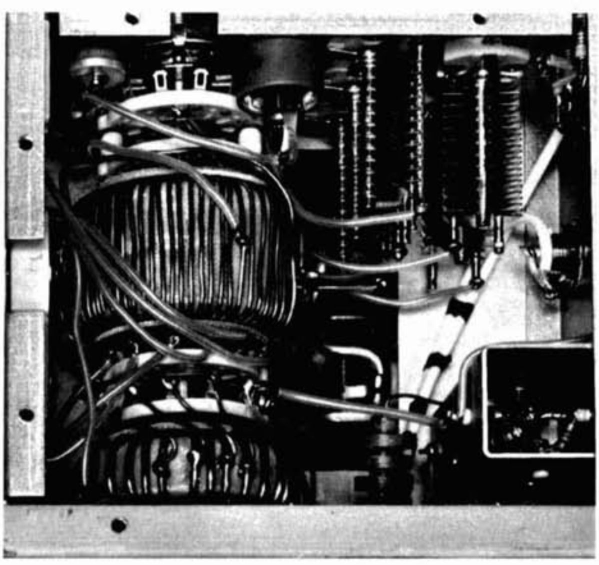


fig. 1. Block diagram of the Signal/One CX7.

Not only does this rig offer outstanding selectivity, it scores very high in the versatility department too. It can be operated as a straight transceiver offering several kHz of offset tuning, or you may listen to two channels simultaneously and transmit on either channel at the push of a button. Receiver preselector tuning is independent of the transmitter so split-frequency operation can literally be from one end of the band to the other; the broadband transmitter circuits completely eliminate any form of transmitter tuneup.

In the block diagram you can see many of the interesting features. The diagram has been simplified to eliminate much of the special switching, but all of the basic functions are shown. Special functions such as vox have been left out for clarity al-



though they add much to the usefulness of the entire unit.

This design has made extensive use of the latest devices. For instance, dual-gate mosfets are used in the front end, in most mixers and in the high-frequency i-f stages. IC's are incorporated into the audio output, the electronic keyer, the frequency counter, the low-frequency i-f strip and the final broadband mixer in the transmitter.

Another interesting design innovation is the use of ground-plane circuit boards. This refers to the use of printed-circuit boards with copper foil on both sides. On the side on which the components are mounted the foil is grounded and acts in much the same manner as a chassis in conventional construction. The foil on the other side of the board is used for circuit wiring in the normal manner. Signal/One claims this offers much better stage isolation and stability.

Although there is much more that is new in this unit and well worthy of comment, I have only tried to hit the high spots of this new design. There should be a number of complete technical reviews published as the CX-7 becomes more available.

The final-amplifier tube is clamped to a block of Beryllium oxide that provides a thermal path to the heat sink as well as high-voltage insulation. The final tank circuit (left) uses a low-Q toroid design.

specifications

general

frequency coverage:	1.8 to 29.7 MHz transceive,
vfo's:	dual permeability-tuned oscillators, resetability to 100 Hz
frequency readout:	built-in frequency counter with digital readout to 100 Hz
stability:	less than 100 Hz in first half hour; less than 50 Hz in any hour thereafter at fixed ambient
CW keyer:	built-in, 5 to 50 wpm
power supply:	built-in, 115/230 volts, 60 Hz
sensitivity:	better than 10 dB signal-plus-noise-to-noise ratio with .33 μV at 10 meters (2-kHz bandwidth)
selectivity:	2 kHz at —6 dB, 3 kHz at —60 dB provided by two cascaded crystal filters; optional CW filter available
image rejection:	80 dB
i-f rejection:	60 dB
agc:	less than 6 dB audio output change for signal level from 1 μV to 100 mV; selectable hang time
i-f shift:	variable up to 2 kHz above and below normal
noise blanker:	active blanker with adjustable threshold
power:	300 watts PEP input, 150 watts minimum PEP output on all modes and bands
carrier suppression:	60 dB
unwanted sideband:	60 dB down
distortion:	third-order intermodulation 30 dB below each of two equal tones at full-rated output
tuning controls:	none for amateur bands when load swr does not exceed 1.5:1
power amplifier:	conduction-cooled 8072 ceramic-metal tetrode
duty cycle:	continuous at full-rated input, all modes
speech processing:	rf envelope clipper built-in

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You're really operating 'First Class' with our 500C. It combines all the features you require to have a complete SSB-AM-CW transceiver with performance, quality, and reliability second to none.

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The Swan 500C is a deluxe transceiver with proven reliability and performance, yet is priced substantially less than competitive gear. See it at your Swan dealer soon.

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The Swan Cygnet has been an instant success since we first introduced it in February. Experienced hams find it ideal for taking along on business trips or vacations since it can be operated from a motel room, boat, car, or practically anywhere. Newly licensed hams find that the Cygnet provides a complete amateur radio station at a minimum investment.

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propagation predictions for may

A discussion of the ionospheric E-layer, sporadic E and vhf and h-f propagation for the month

Vivtor R. Frank, WB6KAP, 12450 Skyline Boulevard, Woodside, California 94062

The ionosphere is divided into three main regions: the D region that extends from approximately 30 to 55 miles above the earth's surface, the E region from 55 to 80 miles and the F region from 80 miles to 250 miles or more above the earth's surface. This month's column will primarily be concerned with processes that occur in the E region.

The earth's atmosphere is well mixed and chemically homogeneous below the E region. At greater heights the atmospheric constituents are separated according to their atomic weight. The most important change in the neutral atmosphere in the ionosphere is the dissociation or breaking apart of diatomic oxygen (O_2) to monatomic oxygen. From heights greater than 80 miles to the peak of the ionosphere, monatomic oxygen makes up the largest part of the atmosphere; at greater heights lighter gases dominate.

At a height of about 67 miles, diatomic nitrogen (N_2) comprises 69 percent of the atmosphere (compared with 78 percent at the earth's surface). Monatomic oxygen comprises 25 percent and diatomic oxygen 6 percent of the atmosphere (compared to 21 percent at the surface of the earth).[1] In addition there are traces of argon, monatomic nitrogen, monatomic hydrogen, neon, helium, krypton, xenon, ozone and water in descending order of occurrence. There are about 2.4 x 10^{12} molecules per cubic centimeter at these heights, but less than one in ten million is ionized at any one time. But it is the coherent minute motions of trillions of free electrons under the influence of radio-frequency electric fields that makes ionospheric radio propagation possible.

Solar flux of ultraviolet and x-rays is primarily responsible for photo-ionization in the ionosphere. Photo-ionization is the dissociation of a molecule into a positive ion and a free electron by the absorption of radiation. The ultraviolet flux primarily responsible for the ionization of the E region has wavelengths between 900 and 1216 angstroms. This radiation is produced primarily by emission from excited hydrogen and carbon atoms in the solar atmosphere. The x-ray flux occurs in the wavelengths between 10 and 100 angstroms.[1]

Although diatomic oxygen comprises only 6 percent of the atmosphere at E-region heights, it furnishes about half of the free electrons. The other half of the free electrons are furnished by ions of nitric oxide ($NO+$)[2]. In addition, significant quantities of magnesium, sodium, iron and calcium ions have been found at E-region heights. The total electron density, N, in the daytime E-region has been found to vary as

$$N = 10^4 (180 + 1.44R)\chi$$

Where χ is the solar zenith angle and R is the smoothed sunspot number.

The intensity of solar radiation responsible for the E-region varies by a factor of about 2 between the years of low and high solar activity. The maximum electron density of the normal E-region is about 100,000 per cubic centimeter. The electron density of the nighttime E-region reaches a minimum of about 1000 per cubic centimeter which is comparable with the density of monatomic metallic ions. Since the characteristic time required for the recombination of the normal ions ($NO+$ and O_2+) is on the order of 17 seconds and for monatomic ions is many weeks, it appears probable that the ionization of the nighttime E-region and nighttime sporadic-E is due to presence of meteoric metallic ions.[3, 4]

Fig. 1 is a time chart of E-layer muf for May 1969. This chart gives the maximum frequency usable for regular E-layer communications over 2000-km paths (1200 miles) and may be used in the same way as the F2 layer chart except the control point is only 600 miles away. Practically, however, the E-layer muf will frequently be much higher during summer due to the presence of sporadic-E (E_s).

sporadic-E

Sporadic-E is an ionospheric layer and propagation mode that involves reflection or scattering from the E-region of the ionosphere. Sporadic-E propagation is distinguished from regular refraction processes in the daytime E-layer in that higher than normal frequencies are reflected (often only partially) from regions localized in time and place. Sporadic-E is distinguished from meteor reflections in that it is prolonged over a period of several minutes to several hours.

Sporadic-E is observed both by vertical incidence ionosondes and by oblique sounders and communications circuits. Observations with an oblique sounder lead to a classification of nine different types of sporadic-E, eight of which can be found in the United States. The seasonal and diurnal characteristics of sporadic-E vary widely with latitude and even with longitude. In the auroral zone, sporadic-E is least likely during the hours of 0600 and 1500 local time; in temperate and equatorial zones Sporadic-E is most likely during those hours.[5] The boundary between the auroral and temperate zones, as far as Sporadic-E is concerned, is not well delineated.

My personal experience of over 15 years on 50 MHz suggests that the northern United States may have some characteristic of both zones. It is fairly well established that strong and widespread sporadic-E openings occur more frequently when the path midpoint is at southerly latitudes. In fact, sporadic-E occurs less frequently at north temperate latitudes than anywhere else. Texas, Florida, Southern California, and the Caribbean, the Gulf states and south-western states have an advantage over the northern states for multiple-hop 50-MHz and single-hop 144 MHz sporadic E.[6] However, for widespread occurrence of temperate-zone sporadic-E, the Far East is hard to beat. A very persistent type of sporadic-E also occurs over the geomagnetic equator.

A sporadic-E "cloud" is seldom a perfect reflector at frequencies of 50 MHz and above. Propagation losses of 20 to 60 dB over free space are common at vhf. One contributing factor is that the cloud may be small, i.e., less than a Fresnel zone* in extent. The primary factor, however, is that sporadic-E is frequently a poor reflector—most of the signal is transmitted through the "layer".

Present-day theories suggest that most temperate-zone sporadic E takes the form of a thin reflecting stratum, perhaps less than a mile or so thick, found most frequently at heights between 60 and 75 miles. The horizontal extent of a sporadic-E cloud may range from tens of miles to hundreds, and it may or may not move. It it does, it is generally from east to west at velocities of around 100 mph.[7]

Our prime interest in sporadic E is its ability to reflect signals at much higher frequencies than are reflected by normal ionospheric layers. Although sporadic E occurs at frequencies below 21 MHz, it is frequently not recognized as such. At 21 and 28 MHz, propagation frequently occurs by mixed sporadic-E and F2-layer modes. At 50 MHz there is little difficulty in recognizing sporadic E since it is usually the only mode propagating at the time.

May, June and July are the months of peak occurrence of sporadic E in temperate latitudes in the northern hemisphere. A minor peak frequently occurs in December and January.

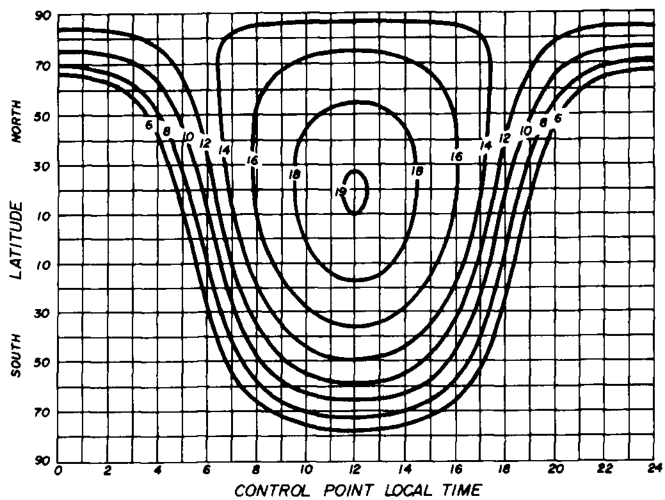

fig. 1. Time chart of median E-layer for May 1969 predicted for the regular daytime E-layer.

A large patch of sporadic E as viewed by a vertical incidence sounder may evolve from a small bulge in the virtual-height-vs-frequency trace at the top of the E-region, descending and strengthening to form a thin layer near a height of 67 miles. Occasionally sporadic E is seen at heights as low as 55 miles, and more than one layer may be present at one time.

Only recently with the advent of sounding rockets and guns has appreciable progress been made in direct measurement of the conditions surrounding a sporadic-E cloud. Ionospheric winds are measured by observation of the drift of chemi-luminescent trails;[8] chemical composition of the positive ions is measured with a mass spectrometer.[9] The results of these measurements suggest that temperate-zone sporadic E results from an accumulation of ions at a preferred height of convergence of the vertical component of the neutral wind.[3]

sporadic-E last year

The year of 1968 was exceptional for the reported occurrence of sporadic E in the 144-MHz band. Openings were reported on May 29 and June 10, but the most widely observed were the openings of June 20 and 21, starting about 2230 gmt both nights.[10] The number of observations was sufficient for me to run a crude statistical analysis of the data. All contacts and "heard" reports listed in QST where both station's locations could be ascertained were computer analyzed to determine the path length and the coordinates of the path center.

Most of the reports were for paths between 900 and 1400 miles long (see **fig. 2**). A scatter plot of longitude and latitude of the path centers is shown in **fig. 3** with a rough outline of the state boundaries. Most of the path midpoints are clustered about the probable location of the sporadic-E cloud at the time of reception. Notable deviations are the contacts between K1FKW and K5GKR, and W3TFA and W4IID. Reports over 1400 miles and under 800 miles were:

W1AZK-W5MCC	1415 miles
K2BWR-W5GVE	1454 miles
W5MCC-W2YQI	1410 miles
W5MCC-W1YDF	1403 miles
W1AZK-W4LSU	749 miles
K2BWR-K4TAG	754 miles
W3TFA-K4TAG	633 miles
W4ISS-K2CBA	793 miles

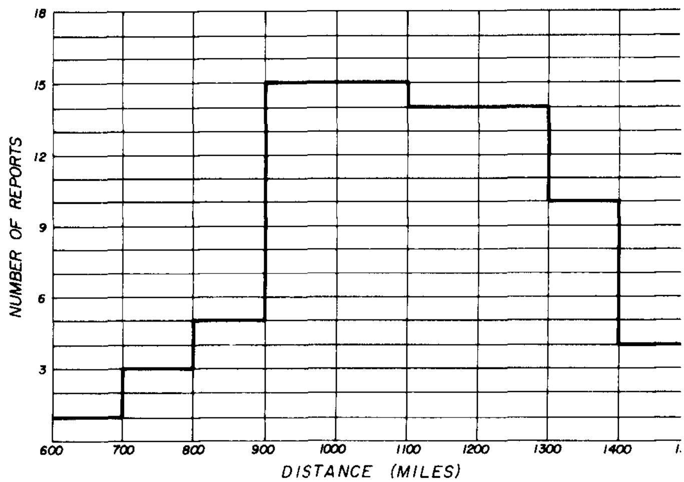

fig. 2. Distribution of two-meter reports according to distance for the sporadic-E openings of June 20 and 21, 1968.

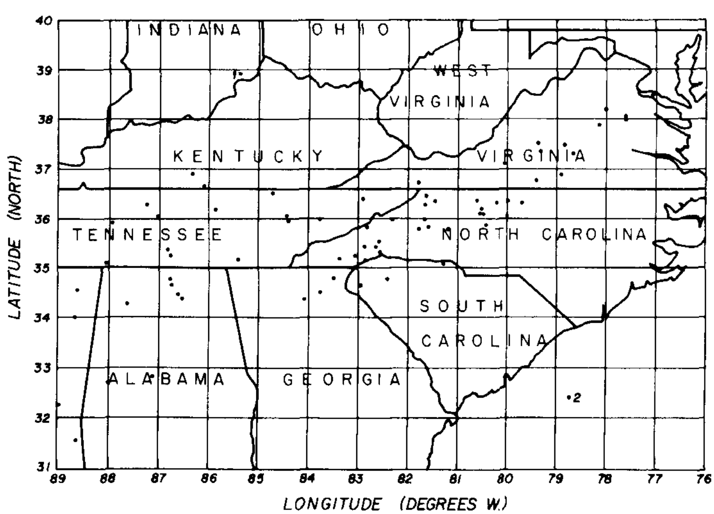

fig. 3. Midpoints of the two-meter paths for the June 20-21 openings. It is thought that the sporadic-E clouds originated somewhere east of Washington, D. C., and drifted to the Southwest. The points marked 1 and 2 indicate off-path and off-center reflections and are identified in the text.

Some of the exceptional distances or path midpoints may be due to errors in callbook addresses. Although I do not have the times of these reports, I would guess that the sporadic-E cloud was first detected just south and west of Washington, D.C., and that it spread and moved westward with time. Some of the spreading to the west may be due to different tracks on the two days.

of these charts have been covered in the column in the March issue.

80 meters: Daytime maximum ranges of 300 miles and nighttime maximum ranges of about 2000 miles may be realized in areas with low noise levels; but about half these distances will be more likely. May is a good month for local nets. Some DX may be

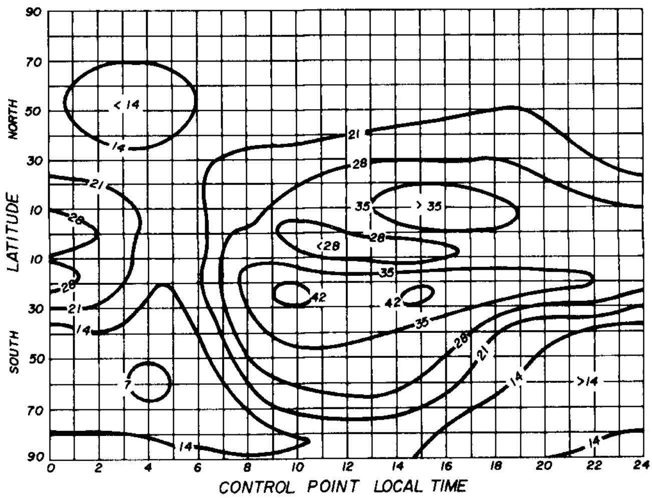

fig. 4. Time chart of median muf for May 1969 from ITS predictions centered on a longitude of 90° W.

It is very tempting to speculate that these two openings were more than a natural occurrence. Artificial electron clouds have been produced at Holloman Air Force Base, New Mexico,[11, 12, 13] Egland Air Force Base, Florida and Wallops Island, Virginia. However, a thorough check of operations at Wallops Island indicates no activity on these dates; thus sporadic-E events were most likely of natural origin.

propagation summary for may

Summer has arrived in the northern-hemisphere ionosphere, resulting in decreased daytime muf's, increased nighttime muf's and increased noise levels. The F2-layer muf's vs time of day and latitude are shown in **fig. 4.** May is one month where the differences between northern and southern states on 15 and 10 meters is quite evident. The maximum range charts are shown in **figs. 5** to **9.** The use

worked on quiet nights into the southern hemisphere, where wintertime conditions prevail, but frequent static crashes are likely to dampen your enthusiasm.

40 meters: Continuous daylight over the North Pole may attenuate the European and Asian broadcasters somewhat. Good nighttime propagation is expected to the Southern Hemisphere (Africa, South America and Australia). Midday maximum ranges may be as short as 600 miles.

20 meters: Twenty should remain open all night. Best DX will occur near sunrise (NW) and during the evening hours (NE). Remember that twenty may be closed to southern temperate latitudes during hours of darkness (theirs). During midday, however, you may have trouble working across the continent.

15 meters: Fifteen will be the optimum band

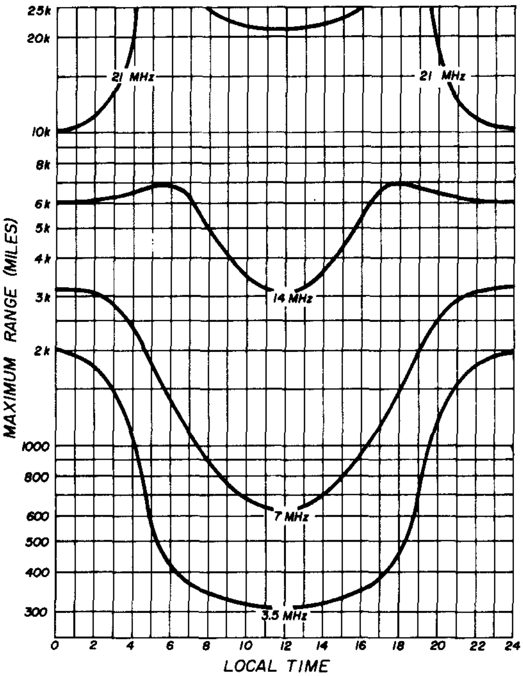

fig. 5. Maximum range to the north from 38° N. latitude as limited by absorption, atmospheric noise and system parameters (100 watts cw to typical antennas).

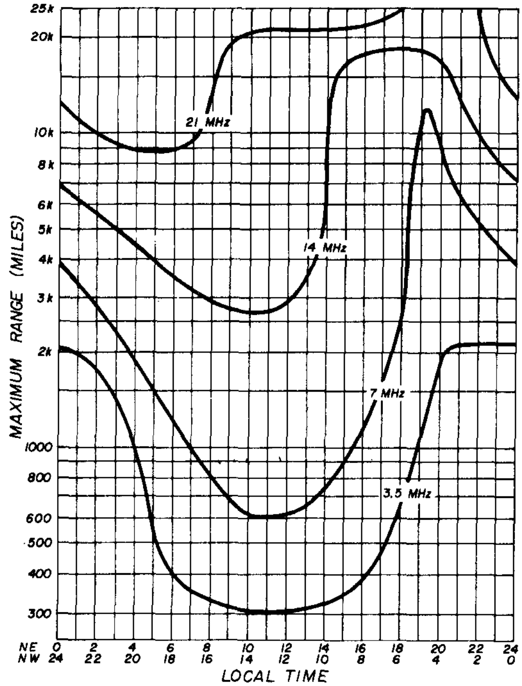

fig. 6. Maximum range to the northeast (top time scale) and to the northwest (bottom time scale) from 38° N. latitude.

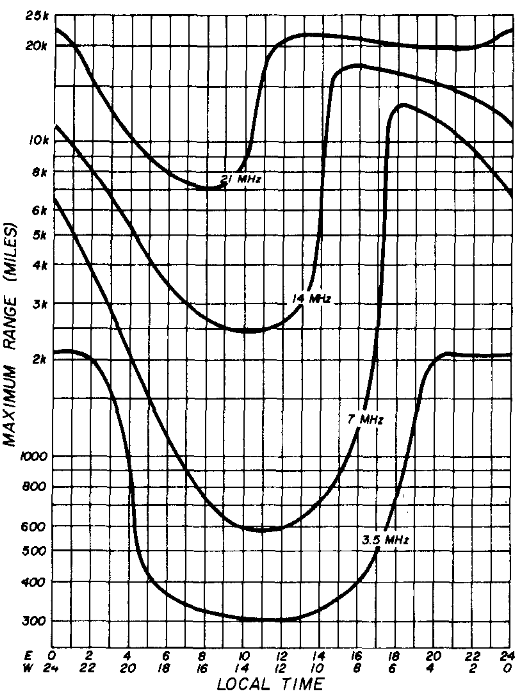

fig. 7. Maximum range to the east (top time scale) and to the west (bottom time scale) from 38° latitude.

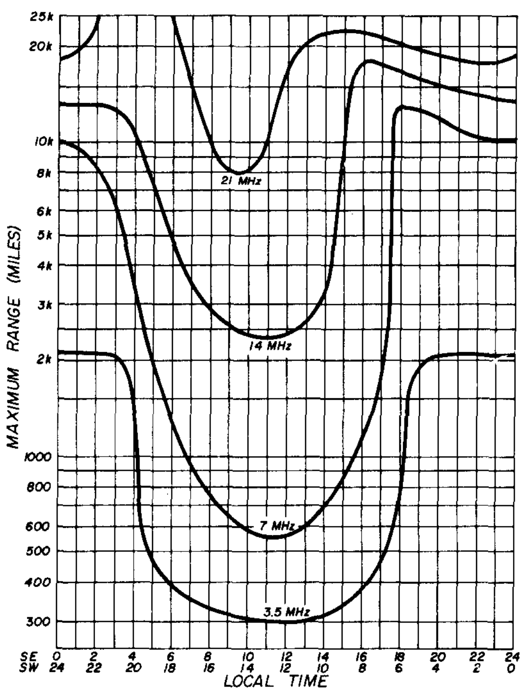

fig. 8. Maximum range to the southeast (top time scale) and to the southwest (bottom time scale) from 38° N. latitude.

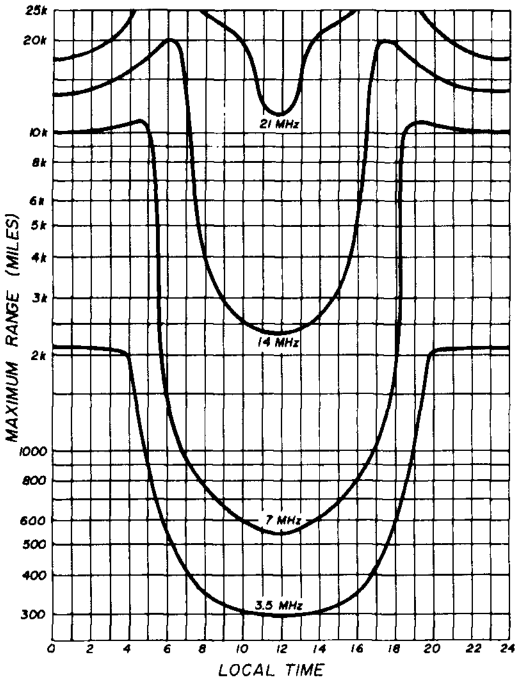

fig. 9. Maximum range to the south from 38° N. latitude.

for daytime DX, but may not open to other than southerly directions until midmorning. The time of the highest muf's to the northeast may be as late as 2 pm and to the northwest may be as late as 8 pm. Fifteen may be open to the southwest as late as midnight.

10 meters: Many will have given up ten meters since openings between east and west coasts may have become much less reliable than during the Spring. However, muf's are way up in the daylit southern hemisphere and if you want to work Antarctica on ten, this is a good month. Sporadic E will be in evidence by one or more hops.

6 meters: May marks the end of the trans-equatorial (TE) season although ZK1AA reports TE reception of Hawaiian tv signals throughout the summer months. May also marks the beginning of the sporadic-E season, which will likely start at southerly latitudes early in the month and work north as the month progresses.

2 meters: Two meter operators should again be on the lookout for sporadic E, especially during the daylight and early evening hours, at southerly latitudes, and towards the end of the month. Tropospheric openings will be occurring farther north, and by the time this appears in print, KH6EEM and I should be running regular schedules trying to rebreak the California-Hawaii tropo path.

meteor showers: Include the Aquarids, May 1 to 6 (0300-1200); the Cetids, May 19 to 21 (0530-1430); the Herculids, May 11 to 24 (1800-0630); and the Pegasids, May 30 (2300-1200).

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ham radio

the ham notebook

bandswitching fet converter postscript

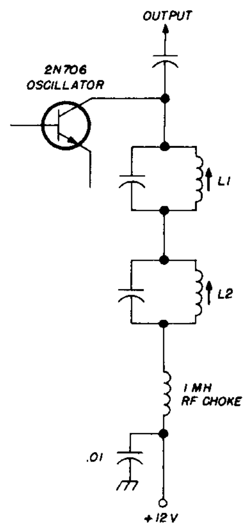
Since I recently completed the development of the "second generation" bandswitching fet converter,[1] I felt that several design changes included in it would be of interest to those who built the initial version or are working along similar lines.

Being rather elated at the time when Motorola solved my instability problems with a new super mosfet, it was only natural when contemplating a new design to give them a call on the off chance that they had come up with bigger and better things since my first attempts—and they had. The rf amplifier in the new version sports a mosfet with feedback capacity rated at less than 0.03 pF while retaining the high gain and low noise figure of the device I used in the previous converter.

In addition, the new fet is a dual-gate affair, allowing agc voltage to be applied to the second gate. The specs state that —3 volts will cut off the device. These new transistors can be used in the original converter but if you don't want to apply agc, the second gate should be connected to the positive supply (not greater than 24 volts).

The second design change occurred in the output circuit of the oscillator and was initiated after a discussion with the crystal manufacturer. He informed me that most high-frequency crystals above 20 MHz were overtone types and a selective circuit in the oscillator was necessary to pick out the correct overtones. It's possible that images could appear if this is not done, and if anybody experienced images on ten meters with the previous circuit, a tuned circuit will probably cure the problem.

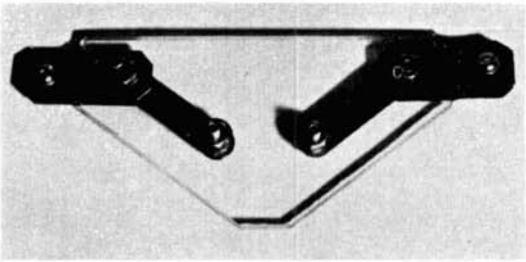
I had trouble with twenty-meter images in the new converter when listening on fifteen, although mathematically they should have been outside the range of the i-f strip being used to test the converter. I added a similar filter in the oscillator circuit for fifteen meters and cured the problem.



As seen in **fig. 1** the oscillator output circuit now appears as two parallel-tuned circuits in series with an rf choke. The parallel circuits have a very high impedance at their respective resonant frequencies, but a minimal impedance at frequencies removed from resonance. They are adjusted for resonance at the crystal frequencies used on the ten- and fifteen-meter bands. Except for these changes, the second generation converter is identical in all aspects except for size and the inclusion of a power supply.

Mike Goldstein, VE3GFN

dipole center insulator



If you need a dipole center insulator in a pinch and can't get down to your local electronics emporium, try the gadget shown in the photo. Just cut out a triangle from 1/4-inch plexiglass or other strong plastic, install some copper or brass strips with brass nuts and bolts, hook up your antenna wire and feedline and you're in business.

Ted Woolner, WA1ABP

using integrated circuits

There are many amateur projects showing up with integrated circuits, but IC's in the dual-inline package (DIP) have two rows of pins spaced 0.1 inch apart. This tight spacing makes casual breadboarding difficult at best, even if you use printed circuits. Here are two simple methods you can use to make the most out of IC's.

Use standard Vector number 169P59/032 perforated board. This board uses a hole arrangement that will fit either the fourteen- or sixteen-lead dual-inline package. Although it is fairly expensive, you can plug your IC in, solder wires to each pin and bring these out to flea-clip. This approach is a natural for casual experiments.

The second method is to turn the IC upside down and secure it to the board with a small dab of glue (be sure to note the alignment dot on top of the IC before turning it over). This method lends itself to circuits that are going to be used for awhile. When soldering to the IC pins, use a small well tinned iron and gingerly solder your connections. Normally no heat sink is required if you are careful and treat the device as you would a silicon transistor.

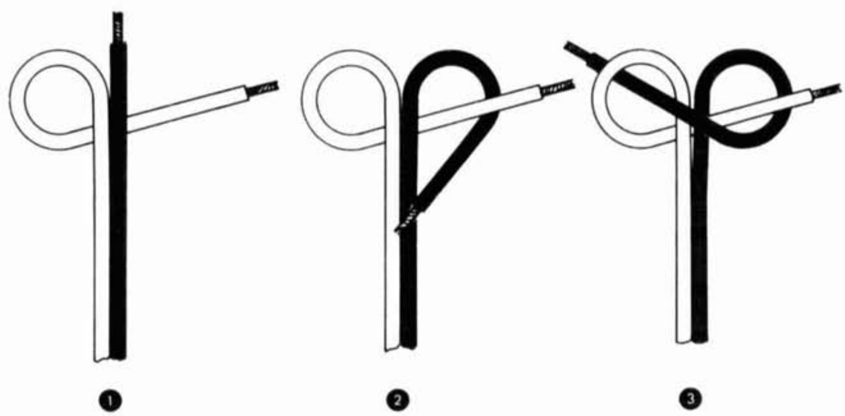
Elliott Kanter, W9KXJ

underwriter's knot

I'd bet most hams are pretty adept at replacing ac power plugs and installing new line cords, but how many know how to tie the underwriter's knot? Most hams use a simple over-hand knot when terminating a line cord in a plug or lamp socket, but this is not only incorrect, it's unsafe. As you can see from the three steps shown in **fig. 1,** the underwriter's knot is easy to tie when you know how. Use **it** next time instead of that half-knot you've been using all these years—it's a lot safer.

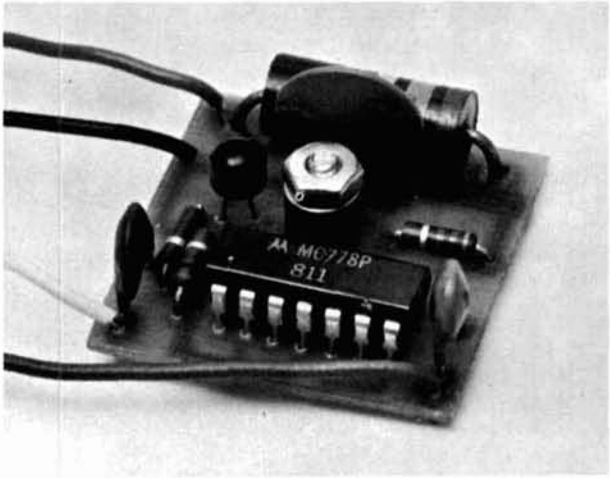
Jim Fisk, W1DTY

fig. 2. Underwriter's knot.



paxitronix frequency calibrator

Since the new frequency regulations went into effect, a number of magazine articles have described ways of getting 25 kHz check points from a 100 kHz calibrator. Although tubes or transistors could be used for this task, integrated circuits can do the job with more accuracy and at less cost. The Paxitronix IC-3 uses a dual JK flip-flop IC in a divide-by-four circuit that will convert a 1.5 volt rms sine wave into a square wave at one quarter the input frequency. The maximum toggle frequency of the MC778 flip-flop is in the neighborhood of 8 MHz so it works well with the 100-kHz crystal calibrators that are found in most modern communications receivers.



The Paxitronix IC-3 frequency divider consists of a transistor amplifier stage and integrated circuit, all on a miniature printed-circuit board about 1.3 inches square. Also mounted on the board is a 2-watt dropping resistor—its value depending on the dc voltage that is available to run the IC-3. Total current drain is very low so it's no problem to tack the unit on to the existing dc supply in your receiver. Although the IC-3 can be used with dc power supplies up to 300 volts, lower voltages are recommended by the manufacturer—down to about 3 volts dc. Most units will work satisfactorily down to about 1.5 Vdc.

The lower voltages are recommended because of the heat generated by the large dropping resistor that is needed with typical receiver power supplies. If you don't have a source of low-voltage dc available in your receiver, you might consider rectifying the 6.3 Vac filament supply for the job—all it requires is one diode, one resistor and one small dual-section electrolytic capacitor; Paxitronix gives you a circuit on the data sheet that comes with the IC-3.

Although the Paxitronix IC-3 is only rated to 30 MHz by the manufacturer, I could detect 25 kHz markers to nearly 60 MHz, so the unit would serve well on six meters. Usable markers are available with 3 mA current drain, but much stronger markers result with 5 to 10 mA of current.

The IC-3 is simple to install. Only one mounting screw is required; four wires take care of the electronics—input, output, and two for the power supply. If you've been meaning to build a frequency divider but haven't gotten around to it, the IC-3 is a natural. $7.25 postpaid from Paxitronix, Inc., P. O. Box 1038(D), Boulder, Colorado, 80302.

Jim Fisk, W1DTY

new products

ic voltage regulators

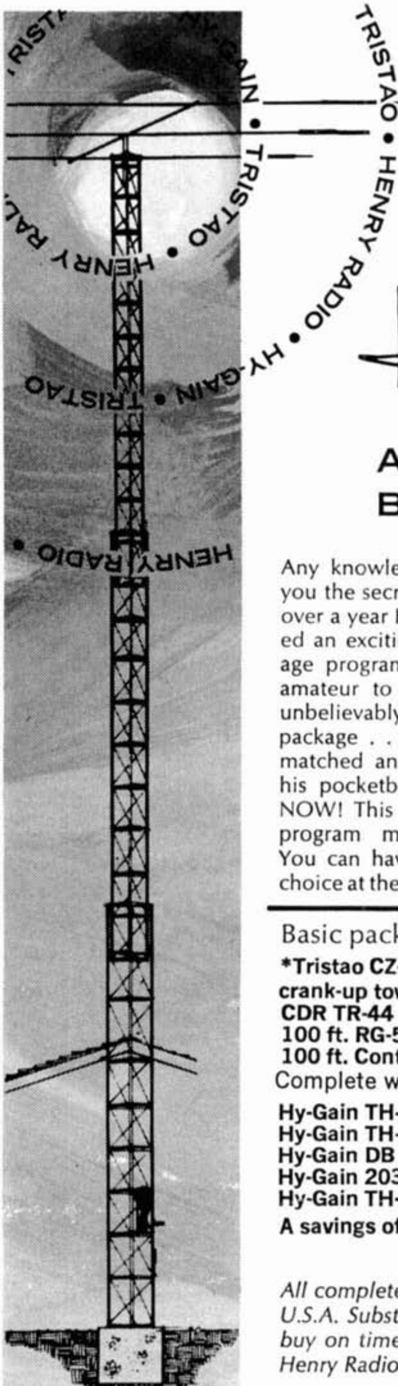
A new integrated-circuit voltage regulator from Motorola features 0.002% regulation and output current up to 500 mA in a single package. The new regulator, the MC1560, is available in full-temperature-range tight-specification versions as well as a relaxed-spec unit, the MC1460, that sells for as little as $5.25.

One of the big features of the MC1560 is its very low output impedance—typically 20 milliohms (0.020 ohm)—and this varies only a few milliohms over the output voltage range of 2.5 to 17 volts; maximum input voltage is 20 volts. Temperature compensation is provided by a resistive divider on the monolithic chip that balances the positive temperature coefficient of a zener diode against the negative temperature coefficient of forward-biased diodes.

Another feature of the MC1560 is the shut-down control. If a control voltage is applied to the shut-down terminal, both the load and regulator bias current are turned off; this can be used for remote on-off switching, for squelch control in communications equipment or to protect the regulator during sustained short circuits.

The data sheet for the MC1560/MC1460 offers complete information to the designer: it not only lists ratings and electrical characteristics with extensive notes on measurements, but also has a full page of operating data. The MC1460R is in a new 9-pin version of the TO-66 power transistor case that will dissipate 10 watts at 65°C and regulate a 500-mA load. A single external power transistor can increase this to more than 10 amperes. The MC1460G, packaged in a 10-pin TO-5 case, will dissipate 1.8 watts at 25°C and regulate a 200-mA load. The MC1460G is $5.25 and the MC1460R, $6.75 in small quantities.

The Motorola MC1461 is a voltage regulator IC with all the features of the MC1460 but with an increased maximum input voltage limit—up to 35 Vdc. Regulated output may be set from 3.5 volts to slightly over 30 volts, depending on the external components. Packaging and dissipation ratings are the same as the MC1460. The MC1461G sells for $6.75 and the MC1461R, $8.25 in small quantities. For more information on the MC1460 and MC1461 voltage-regulator IC's, write to Technical Information Center, Motorola Semiconductor Products, Inc., P. O. Box 20924, Phoenix, Arizona 85036.



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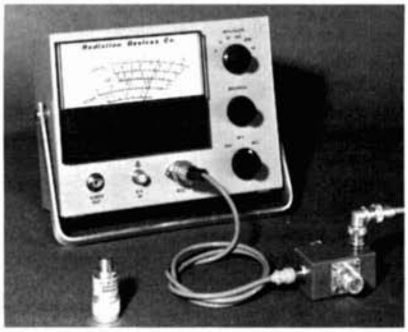

A novel new approach to radio-frequency measurements is provided by the new Radiation Devices RF Multimeter. When this instrument is used with its accessories, it can be used to make dc and rf measurements from 3 mV to 1 V, dB measurements from zero to 60 and vswr measurements in two ranges from 1.0 to 3.0. Swept frequency measurements are facilitated by an internal video amplifier with 200 kHz bandwidth and switchable gain up to 50 dB; direct access to the video amplifier is provided through connectors on the front panel. Accessories include a 100:1 dc probe that increases maximum range to 100 volts and calibrated vswr mismatches and terminations. $98.50 including swr bridge, connecting cable and 1:1 dc probe. For more information, write to Radiation Devices Company, P. O. Box 8450, Baltimore, Maryland 21234.

semiconductor power circuits handbook

Motorola has just announced the publication of a new 264-page text, the **Semiconductor Power Circuit Handbook.** This new book has all the latest information on power-semiconductor circuit design and was prepared especially for users of power transistors, thyristors, rectifiers and zener diodes. This handbook includes many designs that have never been published before as well as 150 new circuits that were designed, built and tested in the Motorola labs to ensure top performance.

The **Semiconductor Power Circuit Handbook** is divided into six chapters that cover the major areas of interest to power semiconductor users—audio and servo amplifiers, regulators, inverters and converters, static switches, motor speed controls and miscellaneous thyristor and transistor switch applications. These six categories cover virtually every type of power application. The text is liberally illustrated with circuit schematics and waveform diagrams; complete bibliographies are included with each chapter, so if you need more information on a particular subject you'll know where to look. $2 per copy; send check or money order payable to Motorola, Inc., Box 20924, Phoenix, Arizona 85036.

ic project handbook

Low-cost integrated circuits for amateurs and experimenters are relatively new, so a lot of people have shied away from using them in their construction projects. Up until now there has been relatively little information on how to use these handy devices in homebrew gear. The new **Electronic Hobbyist's IC Project Handbook,** written by Bob Brown, K2ZSQ, and Tom Kneitel, K2AES, describes 50 different integrated-circuit projects, all based on popular inexpensive IC's which are readily available.

The projects cover the whole gamut of electronics from amateur radio to stereo. Some of the more interesting amateur circuits are an 11- through 6-meter receiver, 40-meter VFO (may also be used as a QRP transmitter), 6-meter signal booster, 20-meter preamp, electronic keyer, audio amplifier and microphone preamp, crystal calibrator, voltage regulator and voice-controlled relay. In addition, there are several circuits for test equipment as well as a tachometer, simple memory tester and miniature adding machine.

If you've been holding off on IC's because you didn't know anything about them, here's a way to get your feet wet. $3.95 paperback, $6.95 hardbound from TAB Books, Blue Ridge Summit, Pennsylvania 17214.

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- **DISPLAYS and DEMONSTRATIONS** by leading manufacturers and distributors of amateur gear.

Convention Hall open Saturday and Sunday 10 to 5

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- **NET MEETINGS**
- **DX MEETINGS**
- **MARS MEETINGS** Army-Navy-Air Force
- **QSL CONTEST**
- **A.R.R.L. FORUM**
- **LAPEL BADGES** Call letter pins made while you wait.
- **REFRESHMENT BOOTH** Lunches and Snacks Both Days.

Featured Speakers

SATURDAY, MAY 24

Wayne Green — DX Trips and Pictures
Robert Knowles — Radio Propagation
Lew McCoy — (A.R.R.L.) Technical
Air Force MARS
Dr. Radnay (ex-Hungarian Communications Official)
Ed Tilton — VHF Topics
Jim Fisk — Technical
Dr. Neimann — Actual movies from Apollo 8 Moon Shot
Antenna Talk — Mosley
George Hart (A.R.R.L.)
Doug DeMaw — Editor of A.R.R.L. Handbook
Ed Perry "Setting up A Commercial Broadcast Station"

SUNDAY, MAY 25

A.R.R.L. Forum (11 a.m.)
Katashi Nose — Antenna Demonstration — Tuning & Matching
(Actual antennas "on the air" demonstration)
Henry Cross — VHF Exciters
Nathan Hallenstein (F.C.C., Boston) Retired
William Grenfell (F.C.C., Washington)
East Coast VHF Society
Jerry Jodice — RTTY Demonstration
Navy MARS — Army MARS
WRONE
Fr. Linehan "Recent Advances in Seismology"
DXCC Forum with Bob Wallace, Ellen and Bob White
Cal Hadlock — VHF FM and Repeaters

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c/o John McCormick, W1KCO
Berkley Street
Taunton, Mass. 02780

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

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.

WANTED — RECENT ISSUE USED CALL BOOK. Will trade Sam's Photofact folders or buy outright. James Fred, RR1, Cutler, Ind. 46920.

FANTASTIC — 1969 New England ARRL Convention May 24 & 25, Swampscott, Massachusetts. Save money! Early bird registration $10.50 including Saturday dinner, dance and night club entertainment. Be a winner! Every major manufacturer will exhibit plus top speakers from science and industry. Tickets: W1KCO, John McCormick, Berkeley Street, Taunton, Massachusetts.

FOR SALE: KWM-2 #12739, 516F-2, $800. Henry 2K-2, spare tube, $575. KWM2-A #15,965, 516F-2 (new), $925. 312B-5, $275. 75S3-C (latest production), $600. KWM2 Noise Blanker, $75. 32S2, 516F-2, $450. 75A-3, $225. Ranger I, Johnson LPF, $75. Gonset G-28 10-meter transceiver, $125. Heath Q-Multiplier, $5. K. W. Match-Box Model 250-30-3, new, $125. 75A-4 #3481, 0.5, 2.1, 3.1 filters, Collins speaker, vernier knob, $450. Swan 500-C, VOX, $390. GSB-201, $225. Telrex TM-30-D, $250. 20M-3E26-B, $150; 10M-309-B, $35. Hy-Gain 402-BA (40-M), matching balun, $75; 204-BA (20-M), matching balun, $75. P & H AFC-2 Speech Compressor, $25. Eldico SSB-100-F, $225; SSB-1000-F Linear, spare tubes, $235; SSB-1000-F (early), spare tubes (4X250B), coax relay, $185. P & H LA-500-M "Spitfire" linear, new, $75. Eico 320 Signal Generator, $15. James W. Craig, Jr. W1FBG, 29 Sherburne Avenue, Portsmouth, N. H. 03801. Phone: 603-436-9062.

TEST EQUIPMENT WANTED: Any equipment made by Hewlett-Packard, Tektronix, General Radio, Stoddart, Measurements, Boonton. Also military types with URM-( ), USM-( ), TS-( ), SG-( ) and similar nomenclatures. Waveguide and coaxial components also needed. Please send accurate description of what you have to sell and its condition to Tucker Electronics Company, Box 1050, Garland, TX 75040.

MAKE MONEY! Sell subscriptions to Ham Radio. Send for complete information. Ham Radio, Greenville, N. H. 03048.

BRASS SHEET, new, 0.051" thickness. Perfect for VHF chassis. Any size 6 cents per square inch. John Reddick, K6RBB, 2529 W. Alpine, Stockton, CA. 95204.

OUTSTANDING COMMERCIAL OPPORTUNITY for licensed ham. NCRI has home office opening for assistant equipment sales manager. Good salary, benefits. Call or send resume to National Radio Co., Inc., 37 Washington St., Melrose, Mass. attn: T. Clark. 617-662-7700.

TOROIDS: 44&88mhy., center-tapped, not potted, 5/$2.00 POSTPAID. Model 32KSR complete page printer, excellent operating condition $325. Model 15 page printers $85. Motorola 55 amp alternator complete, brand-new $60. Hallicrafters CSM-20 30watt hi-band mobile, like new $95. Hallicrafters SX101A receiver $160. Dow-Key relay $10. 11/16" reperferator tape $3/box/10. Page printer paper $5.50/case/12. WANTED: Back covers for rf unit of measurements Model 80 signal generator. PTO for Collins 51J3 (#70E15). RTTY and FM gear. Stamp for list. Van W2DLT, 302H Passaic Avenue, Stirling, N. J. 07980.

73 MAGAZINE — COMPLETE COLLECTION. 1st year bound volume, rest single issues. No splitting. Complete set $99.00. K1PSR, Box 132, Amherst, NH 03031.

SELLING OUT COMPLETE STATION. Many goodies. Transmitters, Receivers, Transceivers, Power Supplies, Modulators, Converters, Test Equipment, Antennas, Rotors, Relay Racks, Transformers, Inductors, Capacitors, Tubes. This is a very complete collection of equipment. Includes 3.3 Mcs RTTY transmitter, 600 watt 50 Mcs AM rig, 300 watt 14.4 Mcs CW or AM, 200 watt amplifier for 220 Mcs, SX-99 & HQ-129X receivers, BC-221AH & TS-323/UR frequency meters and much, much more. Don't miss out on this one — send S.A.S.E. for very complete list. K1PSR, Box 132, Amherst, NH 03031. 603-673-2613.

THE LERC AMATEUR RADIO CLUB is conducting its Annual Hamfest on the weekend of May 17 and 18. In addition to live displays of the newest ham equipment and accessories, experts will conduct several programs on state-of-the-art communication/electronic practices. Thousands of dollars worth of prizes for hams and prospective hams. Write to 2814 Empire Avenue, Burbank, Calif. 91504, or call (213)848-9340, for additional details.

EXCELLENT NEW HW-32A with calibrator, manuals, plus Hygain 18V; all for $125. Jim Sandberg, K6HE, 1138 Rustic Road, Escondido, Calif. 92025.

CQ de W2KUW. Buying all tubes and equipments. Ted Dames Company, 308 Hickory Street, Arlington, New Jersey 07032.

SAVE OVER 50%. 36 copies of Ham Radio cost $27.00 at your newstand, but only $12.00 with a three year subscription.

GREENE — DIPOLE CENTER INSULATOR. Write, Greene, Box 423, Wakefield, R. I. 02880.

FOR SALE: HT-41, $170.00; SX-99 and Matching Speaker, $60.00; Globe Scout (680) $30.00; Heath QF-1, Q-Mult., $7.00; RME Preselector, DB 23, $25.00; DX-20, $20.00; Globe 755 VFO, $15.00; Globe King 500A, $185.00 with spare final tubes; Johnson Valiant 1, $85.00; Globe D.S.B. 100, $40.00; Drake Phone Patch, $25.00; Heathkit Phone Patch, $25.00; SX-71, $90.00; NC-98, $65.00; 250 Watt Inverter, $25.00; KW M1-with noise blanker, $275.00; Globe Champ 300A, $40.00 (as is); Gonset GSB-6 910B and DC supply, $275.00; AX 9909 Tube (new), Amprex (6083) $20.00. **You pay shipping. Wanted to buy:** Gonset VFO for 2 and 6 meters; Gonset 100 watt 6 meter VHF Linear; 826 tubes. Tom Dittrich WB2LZD, 249 Meadow Lane, Vestral, New York 13850.

BRITISH COLUMBIA: The 1969 Okanagan International Hamfest will be held on July 26 and 27 at the Dolly Varden Auto Court, Okanagan Falls, B. C. Registration time 11 a.m. Saturday. For further information write: Clarence La Bounty, P. O. Box 551, Oliver, B. C., Canada.

WANTED: VERY LOW FREQUENCY RECEIVER (MSL-5) Write: WA7KDZ, Box 355, Kent, Washington 98031.

HAMFEST — ROANOKE, VIRGINIA — Roanoke Valley ARC May 24-25. Saturday, May 24 — 7:00 p.m. Rag chew at Embassy Motor Lodge. Sunday, May 25 — 8:00 a.m. to 4:00 p.m. contests and prizes — Vinton War Memorial, Vinton, Virginia.

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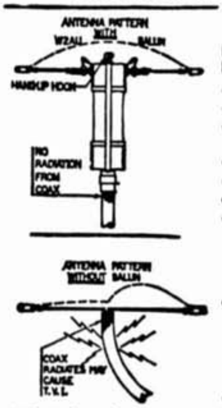

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Power input, 10 watts (5 out); receiver sensitivity, 1 μv or less at 20 db S/N; three crystal controlled positions (2 crystals each) selectable from front panel for three different repeater situations; completely solid-state, employing modular construction for very rugged durability; power requirements, 12 to 14.5 VDC. Three sets of crystals of your choice, battery pack, microphone included. Small — 2¾" H, 6⅜" W, 7¼" D.

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SOMERSET COUNTY HAMFEST — June 8, Casebeer Church Grove, Route 219, 7 miles north of Somerset, Pa. (9 a.m.-5 p.m.) Write Theodore J. Leonberger, K3RCI, Rd. 2, Rockwood, Pa. 15557.

SWAP: DAVCO DR-30 w AC/DC PS-SPKR, Factory overhauled and updated, for SBE-33 w DCPS or SBE-34 or transceiver. RANKIN, W4ZUS, NAVEODFAC, Indian Head, Md. 20640.

SELL-TRADE: Electronic Test Equipment, Stereo Items. R. Zahorcak, 29 Parker, Passaic, N. J. 07055.

INDIANAPOLIS HAM CONVENTION — ARRL-Central Division (Sat.) May 24 at Lafayette Square Mall (air conditioned). Ham and Manufacturers' Displays — 1000 seat cinema technical sessions — free or $1.00 reserved flea market — $1.00 family registration (Ham XYL-kids) $2.00 at door. 80 plus shops for XYL-kids. Banquet reservations $10.00 each/$18.00 couple — Barry Goldwater (K7UGA/K3UIV) — guest of honor with Stu Meyer (W2GHK/4) — master of ceremonies. Family fun. Write: Indianapolis Ham Association, 309 Benton Drive, Indianapolis, Indiana 46227.

MAGAZINES. QST since March 1944. CQ since 1947. Sold as individual copies. What issues do you need? Write K1PSR, Box 132, Amherst, NH 03031.

WATERS dummy load, model 384, like new, $45. 117 Vac, 26-amp variable transformer, will handle 3 kw with ease, pick it up for $20. Cushcraft 6-meter 6-element beam, $15 (pickup only). QST, nearly complete run from 1949 to 1965, missing a few issues around 1960, plus some earlier issues, over 200 magazines to read for only $30; 90 issues of CQ from the early 50's, $10; both sets CQ and QST, $35. Wanted, January and March 1961 issues of 73 magazine to complete collection. W1DTY, Box 25, Rindge, N. H. 03461.

SPACE PROBLEMS SOLVED with Joystick Variable Frequency Antennas. With Tuners for 10 thru 160 Meters. Under $45. Brochure. Shortwave Guide, 218-H Gifford, Syracuse, N. Y. 13202.

HANDICAPPERS INFORMATION NET. Mondays, Wednesdays and Fridays from 2000 to 2100 GMT on 7270 KHz. Primarily a net for handicapped, but all amateurs are invited. Goals are to aid handicapped persons in daily problems, to help handicapped amateurs advance their class of license, and to interest and assist other handicapped people in obtaining an amateur license. We need the help of many amateurs. For further information, check into the net or contact: Kathleen Wilson, WA5QQR, Net Manager.

SWAP & SHOP: Biggest in Southeastern Michigan. Sponsored by Hazel Park Amateur Radio Club. May 18, 1969, 10:00 a.m. to 4:30 p.m., Hazel Park High School, Hazel Park, Michigan.

QSL'S — BROWNIE W3CJI — 3111-B Lehigh, Allentown, Pa. 18103. Samples 10¢. Cut catalogue 25¢.

WRL's used gear has trial-terms-guarantee! KWM1 — $299.95; SR34AC — $149.95; HE45B — $79.95; Swan 240 — $179.95; Galaxy V — $229.95; B & W 5100B — $109.95; HX20 — $149.95; HX50 — $249.95; AMECO R5 — $59.95; SX146 — $189.95; HR20 — $79.95; NC303 — $199.95; SB301 — $269.95. Hundreds more. Free "blue-book" list. WRL, Box 919, Council Bluffs, Iowa 51501.

FOR SALE: KWM-2 with 516-F2 Power Supply, PM-2 SS AC Supply, CC-1 Carrying Case and Mosley TT-31 portable Antenna $700.00. Hammarlund HX-500 SSB, FSK, CW Transmitter $280.00. Hallicrafters SR-34 6 and 2 meter portable AC/12 Volt DC Transceiver $250.00. BC 221 $35.00 complete with wood case and canvas cover. All very clean and in excellent operating order. A. S. Johnson, W1UVG, 20 Woodside Road, Newtonville, Mass. 02160.

20th GRAND RAPIDS Amateur Radio Assoc. (ARRL sanctioned) State Convention May 9-10, 1969. Write GRARA Box 1333, Grand Rapids, Michigan 49501 for tickets and information.

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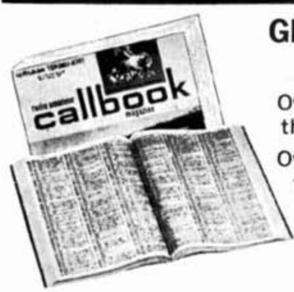

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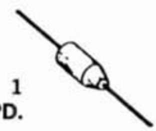

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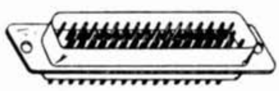
TEFLON BNC FITTING UG-1094/U REMOVED FROM EQUIPMENT. **3 FOR $1.00 PPD.**



50 PIN CANNON CONNECTORS. GOLD PLATED PINS. PART NO. DDM-50 P (A106). REMOVED FROM NEW EQUIPMENT. SOLD IN PAIRS ONLY. **4 PAIRS (8 PIECES) $1.00 PPD.**

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the permaflex key

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- **gives instant choice of automatic semi-automatic & straight hand keying.**
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- **8 amp. gold diffused silver contacts adjust from 0-.060" & 5-50 grams.**
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- **cabinet is 16 gauge polished chrome steel: 1.95" sq. x 3.75", paddles extend 1.25", weight app. 1 pound.**
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60 WATT TRANSISTORS 80 VOLTS

From computer assemblies, board with 4 each power transistors 2N1137B, 60 watt, 80 volt PNP power .... **$1.25 per board**

$10 TRANSISTOR IGNITION $10

Complete electronic 2 transistor dual ignition system for cars, boats, trucks. Fully wired harness, dual primary coil, instant changeover from transistor to conventional or back. Neg. ground, 6 or 12 volt system. Complete with instructions, ready to install. Original price $35, now only $10.00 ppd.

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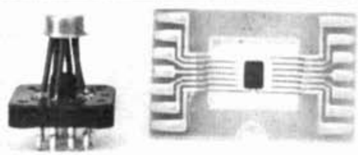

IC's are in abundance, but try and find holders for them. We have them . . . flat pack holder and TO-5 holder as shown above. The TO-5 holder plugs into any 9 pin octal tube socket. These holders yield an extra bonanza . . . they already have IC's in them. Remove the IC's and solder your own in place. So in addition to the holder, you have some Fairchild & Sylvania IC's for your grab bag. The price . . . only $2.00 the dozen . . . assort if you like. On the flat pack holder, you solder your IC in place and then have nice wide edges to work with. Also the edge will fit snugly into printed circuit sockets. We can supply PC socket which you can cut in half and the two halves will fit each end of the above flat-pack holder. The printed circuit board sockets are 25¢ each or 5 for $1.00.

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From HAWK MISSILE termination contract. Good for 5 amps, 600 volt, 10 cycles to 500 mc, insertion loss 60 DB-plus, low pass pi-network type, excellent as feed-thru filter in converters, transmitters. Hermetically sealed inside are 2 toroidal chokes and 4 low induct. caps. #41102 .... **$1.00 each, 6 for $5.00**

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Diff. Amp. 12M2 .... 1.00 ea, 12/10.00
#7M6 flat pak, w/schematic, 6NPN transistors in package, ... 3/1.00

1.00 each or $10.00 dozen

Buffer	900
Dual Input Gate	2-903
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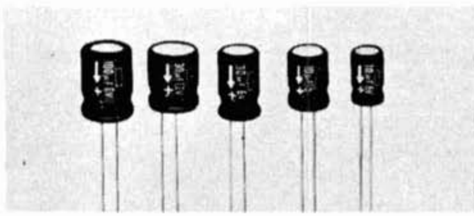

TRANSISTOR CAPS

Volts	Mfd	Each	12
25	1	$ .10	$ 1.00
15	5	.10	1.00
15	10	.12	1.20
15	500	.20	2.00
12	15	.12	1.20
12	150	.15	1.50
8	300	.20	2.00
6	10	.09	.90
6	30	.10	1.00
6	50	.12	1.20
6	200	.15	1.50

Your choice of the above as listed . . . or . . . grab-bag our choice, **10 different $1.10**

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RECEIVE: 6-7-9-11-13-15-17-18-19

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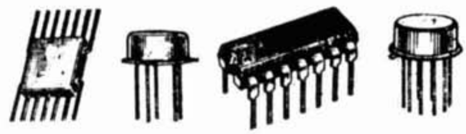
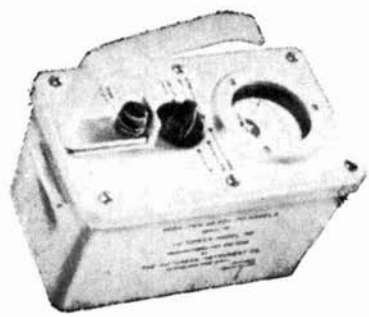


IC GRAB BAG $2.00 DOZEN

Mixture of one dozen units, some marked, untested. 10 pages of RTL & DTL specs to aid in identifying. All configurations, TO-5, TO-85, Flat-Pack, Dual Inline. At this price you can't lose. 12 for $2.00

VARACTOR SIMILAR TO MA4060A

Good for 40 watts at 432 MC, ea. tested in circuit, w/diagram for 432 MC tripler. **$5.00 ea.**



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SURPLUS SPECIAL **$10.00**

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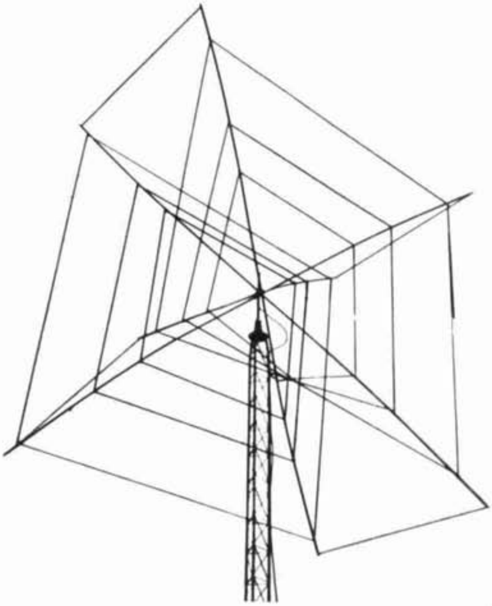

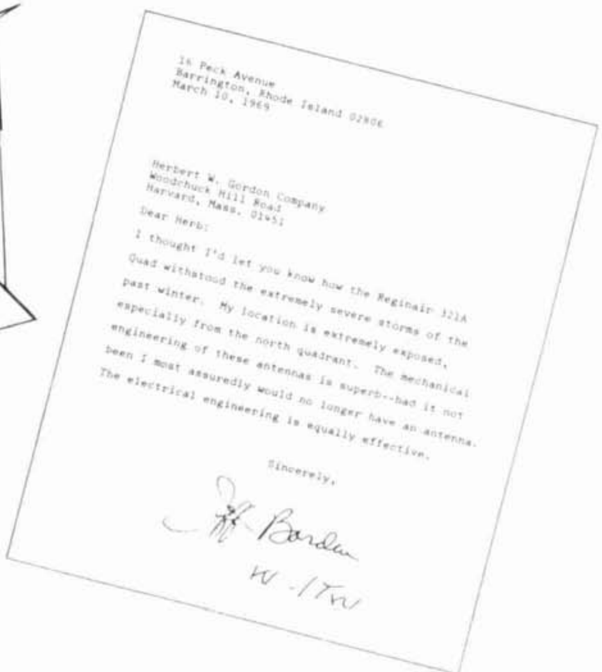

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March 10, 1969

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Sincerely,

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W-1TW

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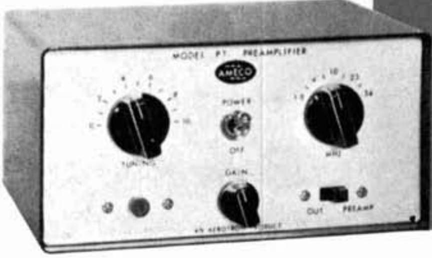

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