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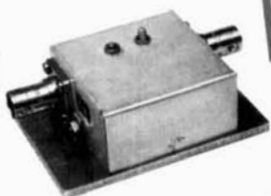
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JULY 1974

narrow-band solid-state 2304-MHz preamplifiers



this month

- miniature 40-meter transceiver 16
- sstv converter 22
- autopatch design 32
- solar power supplies 54

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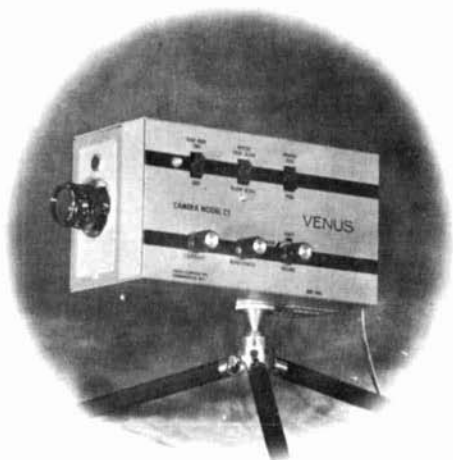
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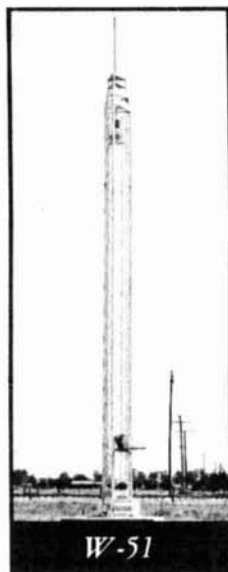
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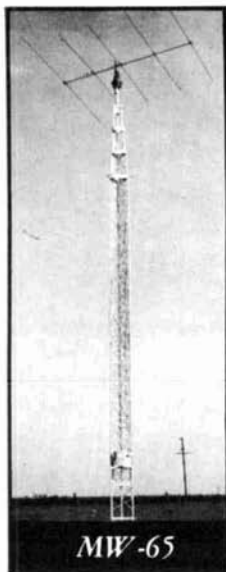
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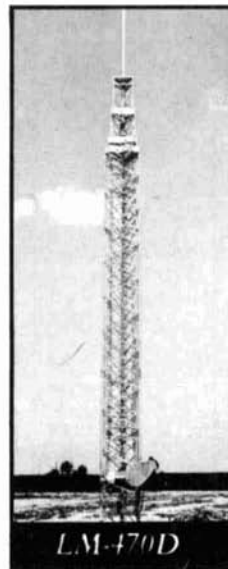
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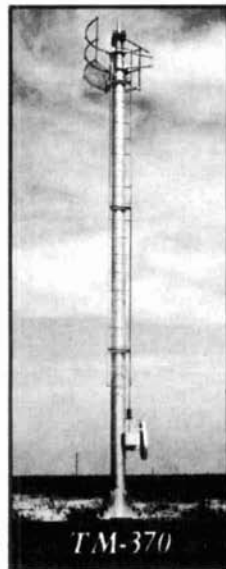
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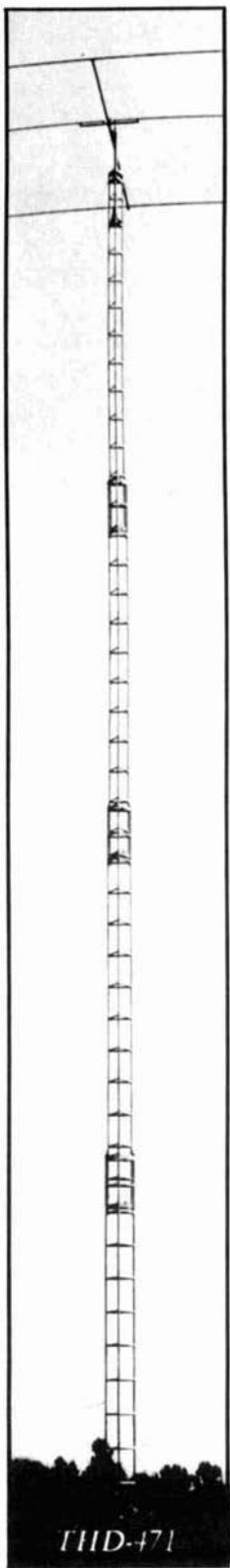
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contents

**6 narrow-band solid-state
2304-MHz preamplifiers**

Norman J. Foot, WA9HUV

12 R390A product detector

Eugene A. Hubbell, W7DI

16 miniature 7-MHz transceiver

Howard F. Batie, W7BBX

22 camera converter

Gordon P. Howlett, WA9UHV

32 autopatch design

R. B. Shreve, W8GRG

40 5/8-wavelength antennas for two meters

F. D. Sargent, K6KLO

44 vhf radio observatory

R. A. Ham

50 custom enclosures

D. A. Contini, W4YUU

54 solar power supplies

Edward M. Noll, W3FQJ

4 a second look

94 advertisers index

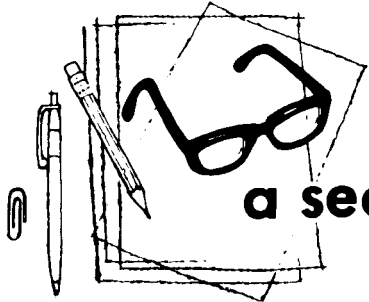
54 circuits and techniques

83 flea market

60 ham notebook

62 new products

94 reader service



a second look

by jim
fisk

Widespread rumors that restructuring of the amateur service was being studied by the FCC were confirmed on May 10th at a joint meeting between FCC officials and ARRL Directors and officers.* In as much as the specific details of the proposed restructuring are still being studied by the FCC staff, and must be presented to the Commissioners before a formal proposal can be issued, the discussion was only in very general terms.

The goal of the proposed plan is apparently to both broaden and upgrade the amateur service, encouraging potential amateurs to join the ranks while at the same time encouraging individual amateurs to improve their operating and technical skills. This means that there will probably be more classes of amateur licenses in the future, including a no-code version to stimulate newcomers, as well as extensive modifications to the amateur licenses themselves.

The proposed restructuring was only one of several topics discussed at the lengthy, all-day meeting. Also included on the agenda was a discussion of the World Administrative Radio Conference scheduled for 1979, and the formation of a National Amateur Radio Advisory Committee. Since other radio services already have such advisory committees, and have for some time, the idea is new only as it applies to amateur radio. Pending approval by the Commission, the first meeting could take place as early as September.

The proposed Committee, which would give the amateur community a much-needed opportunity to work more closely with the Commission, would be

chaired by an FCC official and would consist of 12 to 15 appointed members. The members, selected to represent various segments of amateur radio, would meet periodically to advise or make recommendations to the FCC.

With the specter of a World Administrative Radio Conference looming on the horizon only five years from now, this Advisory Committee could be particularly important. A Spectrum Planning Subcommittee Working Group on the Amateur Services (designated SPS WG/A, for short) has been meeting in Washington since early this year, and they have proposed adding 200 kHz to the 40-meter band, 150 kHz on 20 and 50 kHz on 15. They have also proposed *new* amateur bands at 10.1 - 10.6 MHz, 18.1 - 18.6 MHz and 24.0 - 24.5 MHz. With communications satellites assuming more and more of the burden of long-distance commercial and government traffic, these enlarged high-frequency amateur allocations are a distinct possibility.

However, at the 1979 conference the United States will have only one vote, as will each of the smaller, emerging nations, so it will take a lot of work to muster the necessary support to make even part of this become reality. Also, any pressure that satellites relieve on our high-frequency allocations will probably be forcefully reasserted on our vhf and uhf bands. French amateurs have already lost the exclusive use of 144-146 MHz (which must now be shared with the military), and other nations are known to be eyeing the vhf amateur bands. To meet these challenges, and be successful, will require a great deal of preparation — preparation that must begin *now*.

*A complete report on this meeting is available from *ham radio* and will be sent upon receipt of a self-addressed, stamped envelope.

Jim Fisk, W1DTY
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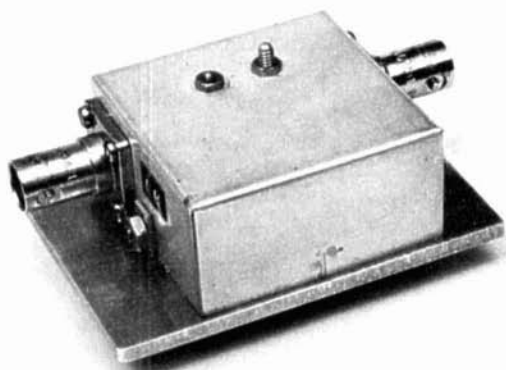


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and 2.5- to 4.5-dB
noise figures

Norman J. Foot, WA9HUV, Elmhurst, Illinois 60126

Since the publication of several simple solid-state 2304-MHz converters in the amateur radio magazines,^{1,2,3} interest in the 2300-MHz amateur band has grown by leaps and bounds. Recent solid-state devices include bipolar transistors which work effectively at S-band (1550-4000 MHz). It is now possible for the amateur uhf enthusiast to build a 2304-MHz preamplifier using any one of a number of available devices. The virtues of adding a preamplifier ahead of the mixer are well known and will not be repeated here.

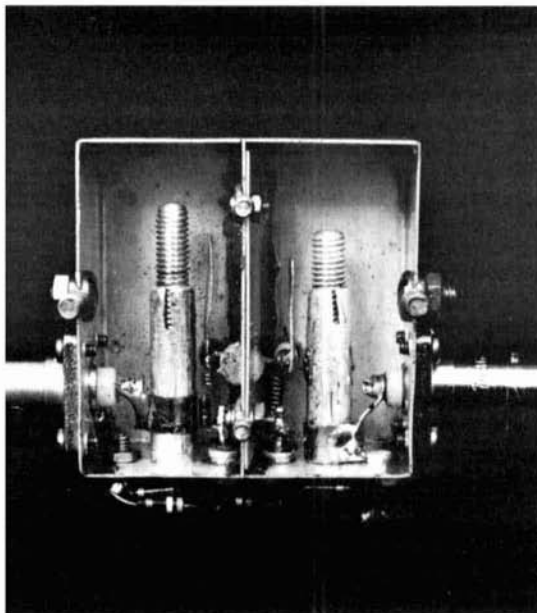
Most 2300-MHz preamplifiers which have been described in recent years feature the well known broadband strip-line circuit.⁵ It is also possible to use these transistors in narrow-band circuits which include input and output tuned circuits of the kind normally associated with the lower-frequency bands. One can present a good case for choosing the narrow-band approach where strong signals from nearby TV or fm stations cause receiver desensitization.

The narrow-band 2304-MHz preamplifier described here has excellent frequency selectivity because it uses cavity resonators at both the input and output. It provides 6- to 9-dB of gain and exhibits a noise figure between 2.5 and 4.5 dB, depending on the particular transistor. Four of these 2304-MHz preamplifiers have been built, each using a different type of transistor, including the Fairchild MT-2500 and MT-4500,* and the Hewlett-Packard HP-35821E and HP-35862E. The Nippon Electric V912 also works well in the narrow-band circuit. The performance of these devices is compared in **table 1**. When compared to a parametric amplifier, these devices give a good accounting of themselves.

preamp design

The electrical design of each amplifier was based on the published scattering parameters of the bipolar transistor used in the circuit.^{6,7,8} Fixed values of complementary input and output reactances were used to achieve the desired impe-

Top view of the 2304-MHz preamp using a Fairchild MT-2500 transistor. For more details see fig. 1.



dance matching. It is not necessary for you to become involved with these details, so long as the circuit presented here is faithfully copied. This is particularly important in view of the fragile nature of these microwave transistors—they are not very forgiving when circuit changes are attempted.

construction

The photograph shows the completed amplifier. It is built in a silver-plated brass box 7/8-inch (22-mm) high, 1-3/4-inch (44-mm) wide and 1-3/4-inch (44-mm) deep. Details of the construction are shown in the mechanical drawing, **figs. 3** and **4**. The bottom of the box is sanded flat after fabrication so that the cover will make good electrical contact all around. Before the transistor is mounted in the enclosure its emitter lead (or leads) are soldered to a brass plate; then the plate is screwed to the partition so that the base and collector leads project into their respective cavities. These leads in turn are soldered to small Teflon stand-off insulators to prevent the leads from being damaged when working down inside the close quarters of the box with the soldering iron.

The Fairchild MT-2500 used in the preamplifier shown in the photographs is a stripline-type device with three leads (see **fig. 1**). The TI-line package, also used in an otherwise identical amplifier, has a pair of emitter leads diagonally opposite one another which allow somewhat better mechanical attachment.

Type BNC connectors (UG-290A/U) are used for the rf input and output connectors. The input is tightly coupled to achieve a low noise figure while the output coupling is adjusted for maximum gain.

The center cavity conductors are made

*Although both the MT-2500 and MT-4500 have been discontinued by Fairchild Semiconductor, often these devices can still be obtained. A somewhat similar, although improved, device in a small 100-mil-square package that should work in the same narrow-band 2304-MHz circuit is the currently available Fairchild FTM-4005. Editor

of 1/4-inch (6-mm) OD brass tubing, 1-1/8-inch (29-mm) long, with 10-32 threads on the inside. Tuning is accomplished by running 1-inch (25-mm) long 10-32 brass screws in and out of the open end of the center conductors with a screwdriver. Each screw is slotted on one end for this purpose. The open ends of the center-conductor tubing are slotted with a fine hacksaw blade and then pinched together slightly like a collet so the tuning screws fit tightly.

The base lead of the MT-2500 (or MT-4500) transistor is coupled to the input cavity by means of a brass strip mounted parallel to the center conductor, one end of which is soldered to the base. This circuit resonates at approximately 2304 MHz. For the HP-35821E, a very small 5-pF dipped-mica capacitor is used instead, soldered between the base lead and the midpoint of the center conductor (see fig. 2). In both designs tuning of the input cavity is rather broad.

The dc return from the transistor base is through a 1/8-watt, 1000-ohm resistor

table 1. Typical performance, at 2000 MHz, of microwave transistors suitable for use in the narrow-band 2304-MHz preamplifier. Note that recommended collector current for minimum noise figure does not coincide with maximum gain, or vice versa.

transistor type	collector current	noise figure	gain	price
MT-2500	2 mA	4.3 dB	6.5 dB	NA
MT-2500	3 mA	4.7 dB	7.2 dB	NA
MT-2500	6 mA	5.5 dB	7.7 dB	NA
MT-4500	3 mA	5.4 dB	—	NA
MT-4500	5 mA	5.5 dB	7.5 dB	NA
MT-4500	9 mA	6.0 dB	8.3 dB	NA
FMT-4215	5 mA	4.2 dB	10.0 dB	\$17.50
FMT-4575	5 mA	2.5 dB	12.0 dB	\$44.00
FMT-4005	3 mA	2.0 dB	12.0 dB	\$70.00
FMT-4005	5 mA	2.2 dB	13.0 dB	\$70.00
H-P 35821E	3 mA	4.2 dB	6.5 dB	\$20.00
H-P 35862E	5 mA	3.3 dB	11.0 dB	\$55.00
NEC V912	3 mA	3.5 dB	9.0 dB	\$25.00
NEC V912	10 mA	4.0 dB	11.0 dB	\$25.00

to a 470-pF Allen Bradley FA-5C 471W feedthrough capacitor. The pigtail of the 1/8-watt resistor is wound into an rf choke of two or three turns before it is soldered to the base. This also provides strain relief to the transistor.

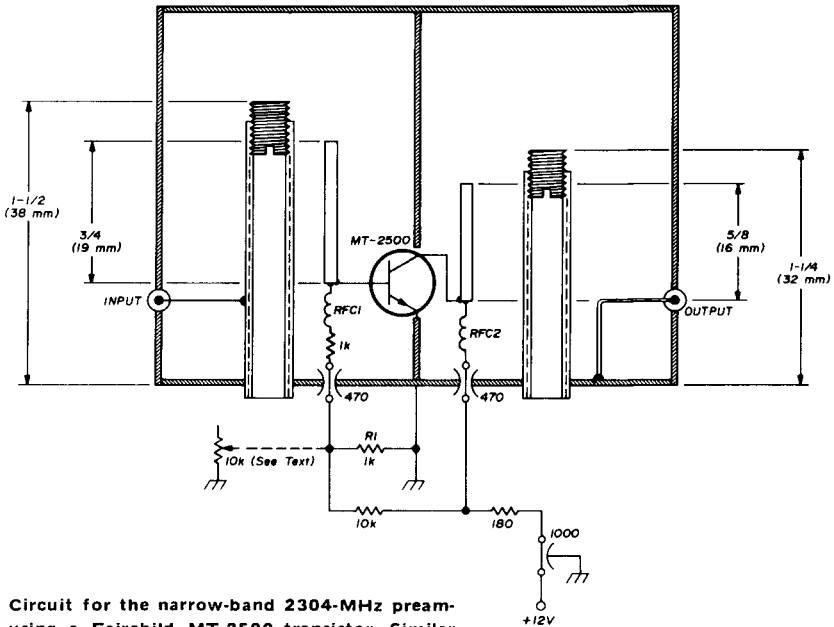
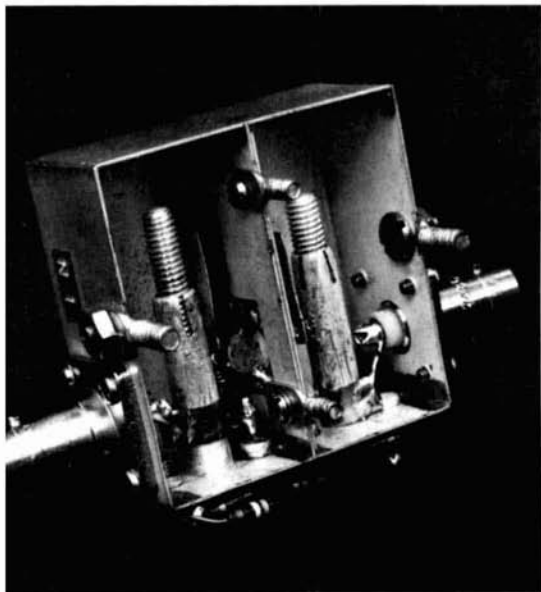


fig. 1. Circuit for the narrow-band 2304-MHz preamplifier using a Fairchild MT-2500 transistor. Similar circuit can be used with the Fairchild MT-4500 or FMT-4005. The 470-pF feedthrough capacitors are Allen Bradley type FA-5C 471W. RFC1 is 3 turns, RFC2 is 5 turns, both no. 26 enamelled wire, airwound using a no. 52 drill as a mandrel (0.0635" or 1.6-mm diameter). Coupling strips on base and collector of transistor are 0.010" (0.25-mm) brass shim stock.



The 2304-MHz preamps are built into small 1-3/4" square chassis made from 0.020" thick brass. Full-size sheet-metal layout is shown in fig. 3.

The collector lead of the Fairchild MT-2500 is coupled to the output cavity by means of a 0.010-inch (0.25-mm)

brass strip which is parallel to the center conductor. One end of the strip is soldered to the collector and resonates at a frequency lower than 2304 MHz. The dc return is through an rf choke and another Allen Bradley 470-pF feedthrough capacitor. The HP-35821E preamplifier works better with a tiny loop coupled to the center conductor as shown in fig. 2.

The 2304-MHz amplifier is fitted with four 6-32 spade screws mounted on the bottom of the enclosure for attaching a bottom cover. As an alternative the preamplifier can be mounted on the top of a flat surface such as an aluminum chassis with the use of the spade screws.

tuneup

Before connecting the preamplifier to the 12-volt supply, tack-solder a 10k potentiometer across the 1000-ohm resistor, R1. Set the potentiometer resistance to zero (shorted out). Monitor the supply current with a 0-10 mA meter in series with the 12-volt supply. Initially, the meter should register about a half milli-ampere. Now, slowly increase the potentiometer resistance (current reading

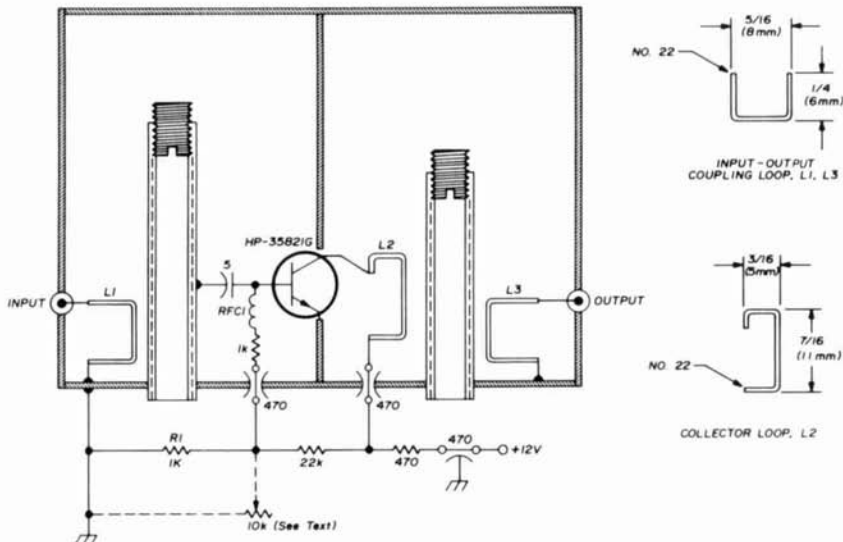


fig. 2. Narrow-band 2304-MHz preamplifier design for the HP-35821E and HP-35862E using coupling loops. The 470-pF feedthrough capacitors are Allen Bradley type FA-5C 471W. RFC1 is 2 turns of resistor lead, airwound using a no. 52 drill as a mandrel (0.0635" or 1.6-mm diameter). All cavity dimensions are as in fig. 1.

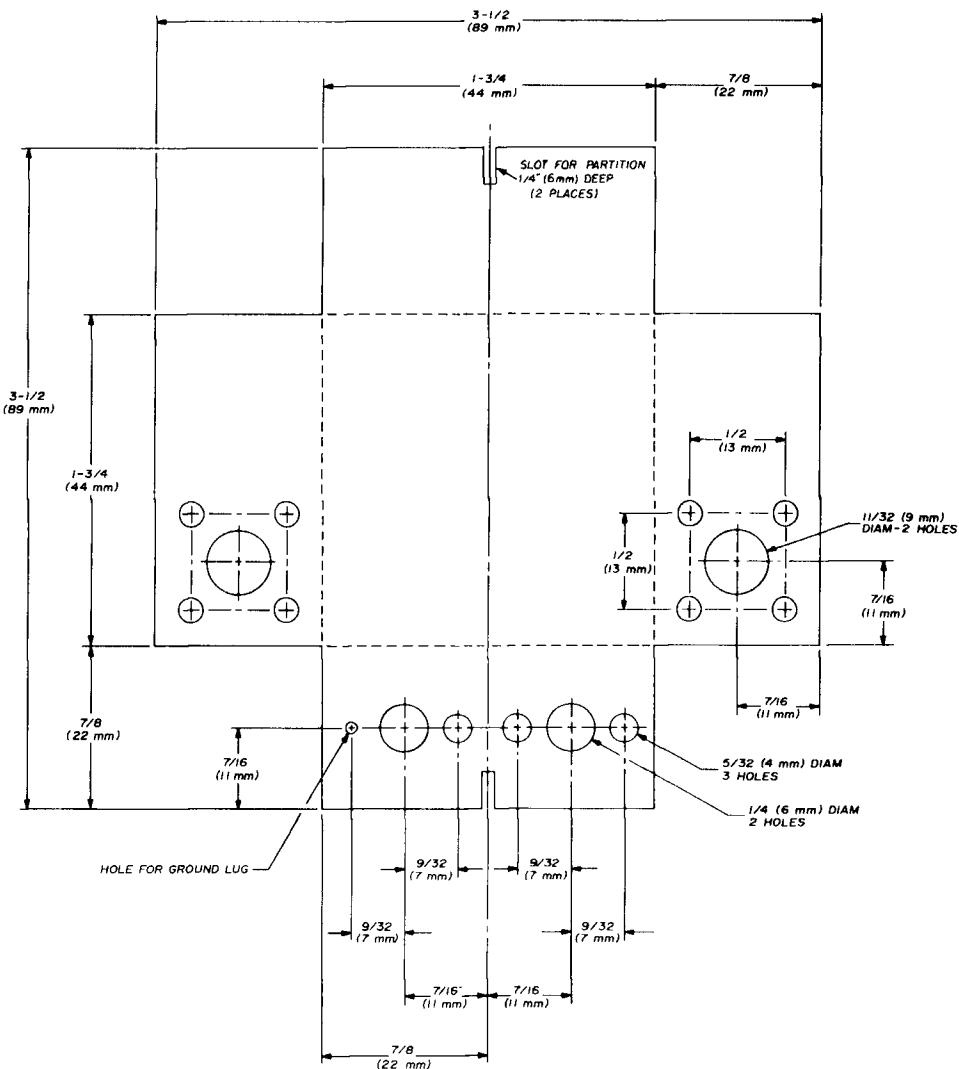
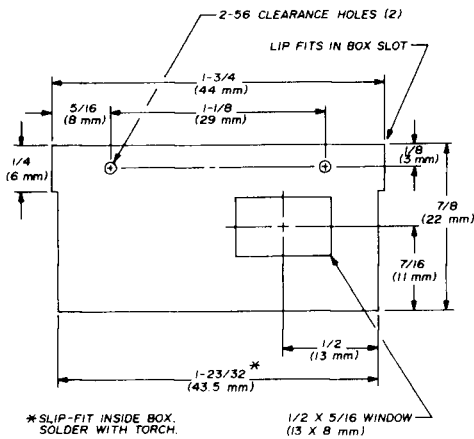


fig. 3. Layout for the enclosure for the 2304-MHz preamplifier. Material is 0.020-inch (0.5-mm) brass or copper, bent along dotted lines. Use a small torch for small solder fillets along all seams. Holes for the spade lugs are not shown (see text).

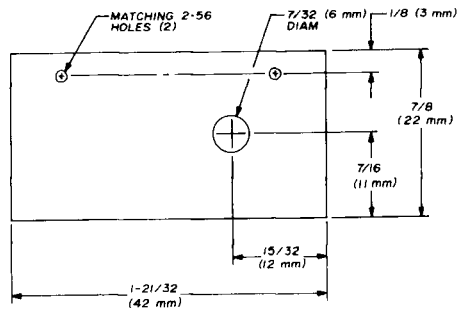
should increase). If the current exceeds 4 mA before the 10k potentiometer is full-on, back off the current to 4 mA. Disconnect the 12-volt supply and the potentiometer (in that order) and measure the resistance of the potentiometer. Solder a fixed resistor of approximately the same value in shunt with the 1000-ohm resistor.

On the other hand, if the current reading does not reach 4 mA with the

potentiometer full on, disconnect the supply and remove the potentiometer. Also remove the 1000-ohm resistor and substitute the 10k potentiometer in its place. Starting with the potentiometer *shorted out*, reconnect the 12-volt supply and slowly increase potentiometer resistance until the meter indicates 4.0 mA. Disconnect the supply and the potentiometer, and permanently solder in a fixed resistor with a value as close as possible to



A PARTITION



B TRANSISTOR PLATE

fig. 4. Layout of the center partition and transistor mounting plate. The two pieces are sandwiched together with 2-56 machine screws as shown in the photographs. Material is 0.020" (0.5-mm) brass or copper.

the measured value. Now the preamplifier is ready to go.

At this point there is no substitute for a signal source. With the preamplifier connected to the mixer, adjust both tuning screws for maximum received signal. Adjust the spacing between the collector strip from the center conductor (fig. 1) or adjust the collector coupling

loop for maximum gain (fig. 2). Check the signal-to-noise ratio with and without the preamplifier—you should be pleasantly surprised.

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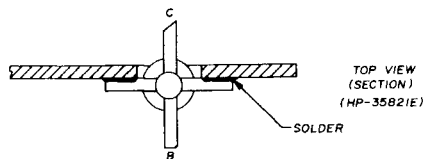
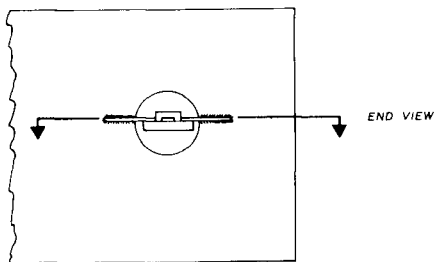


fig. 5. Mounting the transistor on the transistor-mounting plate. After the transistor is installed the mounting plate is attached to the center partition (see fig. 4).

improving the R390A product detector

Most improvements in ham gear construction or design are built on a foundation of work done by others. The modification of the military surplus R390A receiver described here owes a lot to articles^{1,2} by Captain Paul H. Lee, W3JHR. Some comments by Harry Hyder, W7IV, were also helpful.

Captain Lee's conversion of the R390A to a product detector was tried, and worked satisfactorily except for two details. One of these was a regenerative effect that occurred at the frequency of the bfo, resulting in a peak in the audio response. The other was the loss of the noise limiter for the ssb and CW modes.

Disconnecting the shielded wiring suggested in that conversion and using short direct leads under the chassis to transfer the audio from the a-m detector to the product detector removed the regenerative effect. Restoration of the noise limiter action was not so easy.

When using the noise limiter with the a-m detector a negative bias voltage appears across the combination of R526 and R527 in series and thus, across R120, the limiter control. This voltage results, of course, from signal rectification through the a-m detector, V506B. Captain Lee's circuit omits the limiter entirely in the ssb/CW position as signals will not pass this stage without some negative bias on the cathodes of V507. A check of the similar noise limiter circuit in the Collins 75A4 receiver shows such a voltage switched into the limiter control circuit from the receiver bias supply.

Trying to operate both a-m and product detectors simultaneously without switching outputs did not work out. The product detector bfo is switched on and off from the front panel, but the a-m detector is not so easily disabled. Examination of the a-m detector circuit showed an i-f filter in the transformer T503 lead to R526 and R527. Part of this filter was a 12-mH rf choke. If one end of this choke could be switched from the a-m detector to the product detector it would provide the desired audio transfer, and by introducing a bias voltage in parallel with the product detector signal, the noise limiter problem would be solved.

circuit modification

To control a circuit at a distance, I think of relays. In the R390A, 225 volts is switched on and off from the front panel by the bfo *on-off* switch, and this switched voltage appears at a tie point near the socket for the bfo. Checking a junk-box relay with a 10k-ohm coil, it was found that a 51k resistor in series with the coil would provide reliable operation at sufficiently low current drain to avoid overloading the 225-volt supply.

A negative dc supply for limiter bias in the *ssb/CW* position was provided easily by rectifying the 25.2 volts ac found on the current-regulator ballast tube adjacent to the bfo socket. The last problem had been solved, and here's the step-by-step procedure by which the complete conver-

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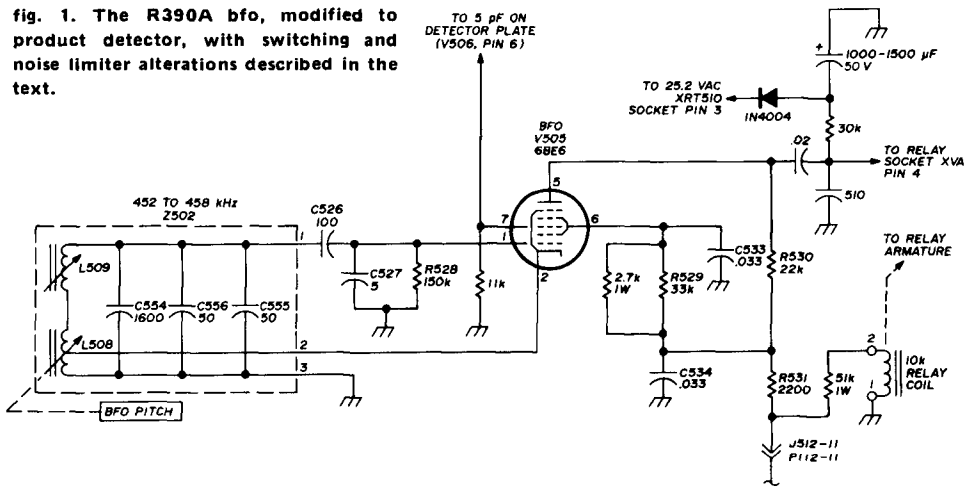
sion was done. Tech Manual TM 11-856A is almost a positive must!

1. Remove power plug P112 from the i-f chassis along with the three rf plugs P114, P213 and P218. Disconnect the *selectivity* and *bfo* tuning shafts, loosen the mounting screws and remove the i-f chassis from the receiver.
2. Loosen the set screws on the flexible-bellows shaft coupler to the bfo transformer, remove the front shaft and bearing and remove the shaft coupler. Socket XV505 is now more accessible.
3. Between sockets XV502 and XV506 are three tie points in a triangle. The two

This requires a 5/8-inch (16-mm) hole for the socket and two number-33 holes for mounting bolts. On the chassis below XV503 there should be a dual ground lug holding leads from capacitors C528, 0.1 μ F, and C529, 0.033 μ F. Remove the nut holding this ground lug and mount the tie point saved from step 3 above.

5. Clear socket terminal 2 of XV505 of all leads. If other leads go to pin 2 for grounding, re-route them to other ground points.
6. Change the cathode tap from the bfo can from pin 7 to pin 2 of XV505. This is lead number 2 on the bfo can.

fig. 1. The R390A bfo, modified to product detector, with switching and noise limiter alterations described in the text.



nearest socket XV502 will not be disturbed. Unsolder resistor R518, 100 ohms, and the connecting wire from the third tie point and remove the tie point from the chassis. Save it. Connect the wire lead back to R518, providing insulating tubing over the joint, and leaving as much slack as possible. Train the resistor close to socket XV503 and the wire between the two remaining tie points and socket XV502. A clear space about 3/4 x 1 inch (19 x 25 mm) should be left between sockets XV502, XV503, XV506 and the bfo transformer can.

4. In the cleared space drill suitable holes and mount a 7-pin miniature tube socket, which we will call XVA, for the relay.

7. Connect a 11K, 1/2-watt resistor from pin 7 to ground.
8. Remove C535, 12 pF, and discard.
9. Connect 2.7k, 1-watt resistor in parallel with R529, the 33k, 1/2-watt screen-dropping resistor.
10. Connect a 5-pF mica capacitor from pin 7 on XV505 to pin 6 on XV506. This couples the i-f signal into the product detector.
11. Solder one end of a 510-pF mica capacitor to a ground lug near XV505 and one end of a physically small 0.02 μ F capacitor to pin terminal 5 of XV505. Join the two remaining capacitor terminals and attach a wire lead. The other

end of this wire lead connects to pin 4 of the new 7 pin socket, XVA. In doing these last operations near socket XV505, be sure to leave room for the bellows shaft coupling so nothing will be shorted out when the coupling is reinstalled.

12. Ground pin 1 on the new socket XVA. Connect a 51k, 1-watt resistor from pin 7 on this socket to the tie point nearest pins 3 and 4 on socket XV505. This tie point already has a lead and one end of R531, 2200 ohms, 1/2 watt, fastened to it. Insulate the leads on the 51k resistor and dress it next to the chassis to facilitate heat transfer.

regulator tube RT510, and has 25.2 volts ac on pins 2 and 3. Install a 1N4004 diode between pin 2 (cathode end) and pin 6, which also has a wire lead attached at this time. Use an ohmmeter to check that pin six is not connected inside the regulator tube, and is merely used as a tie point here. Connect the other end of the wire lead from pin 6 to the tie point you moved and reinstalled in **step 4** above.

15. Connect a 30k, 1/2-watt resistor from this same tie point to terminal 4 on socket XVA, which already has a wire lead from the output of the product detector. Connect a 1000- to 1500- μ F,

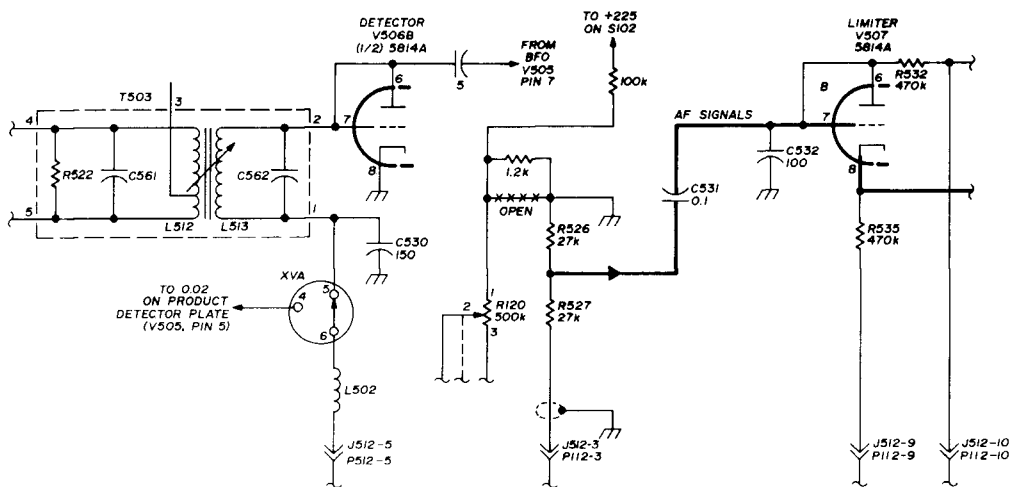


fig. 2. The R390A a-m detector and noise limiter circuits showing changes necessary to use the noise limiter with the product detector.

13. At the front of the chassis, between the *bfo tune* and the *selectivity* switch shafts, there is a molded 12-mH rf choke mounted on a spade bolt. One terminal of this rf choke connects to terminal 1 of transformer T503, which also has a capacitor C530, 150 pF, to ground. Disconnect the rf choke from the transformer, and run a wire lead from the rf choke to pin 6 of socket XVA. From pin 5 of XVA, run a lead to terminal 1 of T503.

14. Socket XRT510 is located in the corner of the chassis below the bfo tuning shaft. This is the socket for current

50-volt electrolytic capacitor from chassis ground (positive terminal) to the tie point just used for the wire lead from the diode. I found a lug under the spade bolt holding the 12-mH rf choke worked out fine for the positive (grounded) terminal.

16. Replace V505, a 6BA6, with a 6BE6. The new socket XVA is for a 7-pin plug-in relay with a 10k-ohm coil. The present Potter and Brumfield number for this unit is PW5LS, I believe, although SM5LS and XSM-1135-2 seem to be the same. About 35 volts of the 225-volt dc supply will appear across this relay coil when the bfo is turned on, switching the

audio input to the noise limiter from the a-m detector to the product detector. The output of the product detector is across the 30k resistor connected between pin 4 of socket XVA and the negative end of the electrolytic capacitor. About 20 volts dc will appear across this resistor. Audio output level should be just about equal for either detector system.

17. To provide a positive cutoff of audio feeding through the noise limiter tube, V507, when the limiter control, R120, is advanced, it is necessary to supply a small positive voltage to the normally grounded end of R120. To do this a small voltage divider must be installed, and it will help if the front panel is partially removed, or at least pulled forward a couple of inches on the tuning and bandswitching shafts. See instructions for panel removal in the Tech Manual. This is to provide access to the back of the *function* switch, S102, and to R120, the limiter control.

18. Remove the ground lead from the grounded end of R120 and the switch on the back of R120. Replace the lead with a 1.2k, 1/2-watt resistor. From the same terminal on R120 connect one end of a 100k, 1/2-watt resistor. The other end of this resistor must connect, either by its own lead or an extension wire, to the terminal on S102, the *function* switch, which turns on 225 volts dc when this switch is in *agc*, *mgc* or *cal* positions. This switch terminal is just below the ac line switch, a microswitch type with heavy terminals and two white and orange wires considerably larger in diameter than anything else nearby. A check with a voltmeter should confirm that you have found the right terminal.

check out

To check to see that things are going to work, you can reinstall the bellows coupler to the bfo can and the panel shaft bearing and shaft so the bfo can be tuned. Connect the rf input and output couplers, P114, P213 and P218, and plug in the power plug, P112. By placing a box or other support under the i-f chassis, it will be possible to turn it approximately 180

degrees from its normal operating position. This is best done by turning the receiver on end, the i-f end down. Now it should be possible to reach terminals inside the i-f chassis for voltage checks while the receiver is working.

Operating the receiver in this position is a bit awkward, especially turning the selectivity switch and tuning the bfo, but the selectivity positions may be counted from the stop at either end of rotation. With the receiver operating, rf and audio gains turned well up, but with no antenna, a considerable hiss should be heard. Set the selectivity switch to 1 kHz and adjust the bfo tuning for the lowest pitched hiss. This should be equivalent to setting the bfo to *zero* on the front panel.

A check of the voltages on the limiter pot should be made with the vom; one end should register about 16 to 20 volts negative, and the other end about two volts positive. With an antenna connected and any normal noise level, it should be possible to observe the limiting action as the limiter control is advanced in a clockwise direction. If everything checks out ok, shut off the power and put the receiver back together.

summary

I believe this modification is very worthwhile. The product detector action is good, the noise limiter is very good on CW, and the changes have a neat appearance. The diagrams show the changes in the schematic, and the step-by-step conversion is not difficult to make. One warning comment: Make sure your limiter pot does not have an open in it. I had one that was bad, and it really caused me a headache for a while.

The R390A makes a very good second receiver for the shack, is invaluable in the shop, and is really well built. If only it weren't so heavy!

references

1. Paul H. Lee, W3JHR, "The Single Tube Product Detector," *CQ*, April, 1961, page 50.
2. Paul H. Lee, W3JHR, "Modifying the R390A Receiver for SSB," *CQ*, January, 1968, page 55.

ham radio



miniature 7-MHz transceiver

Project shrink —
a Quality
Recipe for a
Pocket
Portable

Howard F. Batie, W7BBX, 2912 Johnson Road, Falls Church, Virginia

How small can a complete transceiver be made and yet retain enough features to permit consistently reliable operation? Dick Tracy notwithstanding, it seems to come down to the size of the front panel required to mount the controls for the functions desired, and not the space required for the electronic circuitry itself.

To verify this point, "Project Shrink" was undertaken to construct a complete, yet consistently useful, transceiver in as small a case as possible using commonly available parts. By useful, it is meant that the receiver should have a sensitivity on the order of a microvolt and the transmitter be in the 2- to 3-watt input class. Additionally, a vfo or vxo is considered mandatory.

By eliminating all frills, careful attention in the PC-board layout phase, and the selection of a multi-element IC, a very credibly performing transceiver can be constructed using only four solid-state devices; however, the characteristics shown in **table 1** attest to the fact that this is a very useful portable or emergency transceiver. The functional block diagram is shown in **fig. 1**.

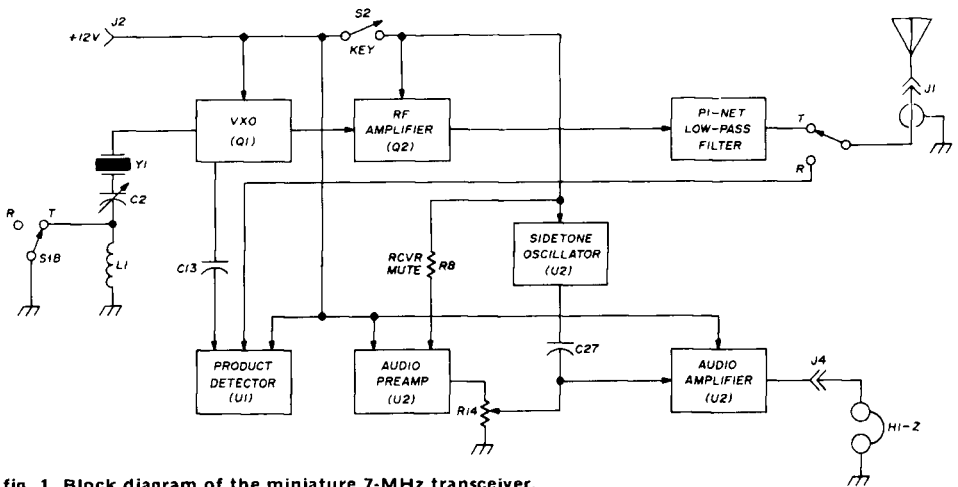


fig. 1. Block diagram of the miniature 7-MHz transceiver.

transmitter

High-beta transistors were used at both Q1 and Q2. The vxo feature was attained by placing a miniature variable capacitor from a transistor radio in series with the crystal, permitting up to about a 4-kHz excursion of the crystal frequency, depending upon the activity of the crystal. A 7-microhenry coil in series with the crystal and variable capacitor was

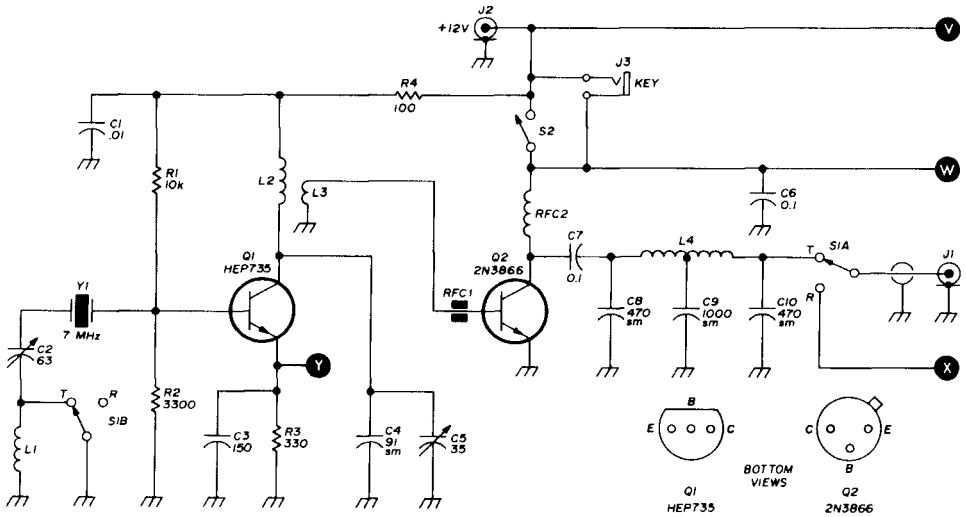
A simple class-C rf amplifier followed by a fixed pi-net low pass filter designed for 52 ohms completes the transmitter. Transistor Q2 collector current is 170 mA at 12.0 volts dc input. A pushbutton key is included in a convenient (and operable) position on the top of the cabinet. Left-handed operators may want to reverse the entire layout in mirror-image fashion. The key should not be depressed during "receive" since no load for Q2 is

table 1. Operating characteristics of the miniature transceiver.

Frequency	7.0-7.3 MHz, vxo controlled			
Vxo excursion	4 kHz nominal			
Transmitter output impedance	52 ohms, unbalanced			
Receiver input impedance	52 ohms, unbalanced			
Size	1¼ x 4¼ x 2¼ inches, 12 cubic inches (3.2 x 10.8 x 5.7 cm, 197 cc)			
Weight	7 ounces (198 grams), including key and five crystals			
Number of active devices	2 transistors, 2 ICs			
Current drain, 52-ohm resistive load:				
	9-volts	12-volts	15-volts	18-volts
Receive	15 mA	21 mA	28 mA	34 mA
Transmit	185 mA	220 mA	240 mA	250 mA
Transmitter input power	1.35 W	2.3 W	3.2 W	3.9 W

experimentally determined to offset the frequency shift of the oscillator by the correct amount when transmitting. This allows the transmitter during transmit to be zero-beat with the receiver during receive, and yet retain the vxo function.

present; however, Q2 was purposely keyed for 10 seconds with no load and no damage resulted. It should be noted that since the +V_{CC} to Q2 is keyed, any external key must be capable of handling the full Q2 collector current.



- | | | | |
|-------|---|------|---|
| C2 | BC variable, 63 pF per section (see text). | L3 | 6 turns no. 28 enamelled wound around L2 |
| C5 | 3-35 pF trimmer (Arco 403) | L4 | 20 turns no. 24 enamelled, center-tapped, on Amidon T-50-2 toroid core. |
| J1,J2 | phono jacks (Calectro F2-806) | RFC1 | Amidon ferrite bead mounted close to base of Q2 |
| J3 | 3.5-mm phone jack, insulate from chassis. | RFC2 | 50- μ H rf choke |
| L1 | 50 turns no. 32 enamelled on Amidon T-37-10 toroid core | S1 | miniature dpdt slide switch |
| L2 | 38 turns no. 28 enamelled on Amidon T-37-10 toroid core | S2 | miniature spst pushbutton switch |
| | | Y1 | 7 MHz crystal |

fig. 2. Schematic diagram of the transmitter used in the miniature transmitter. Transistor Q2 must be provided with a heatsink. In some cases a 75-pF silver-mica capacitor may be required from the base of Q1 to the emitter to sustain oscillation.

receiver

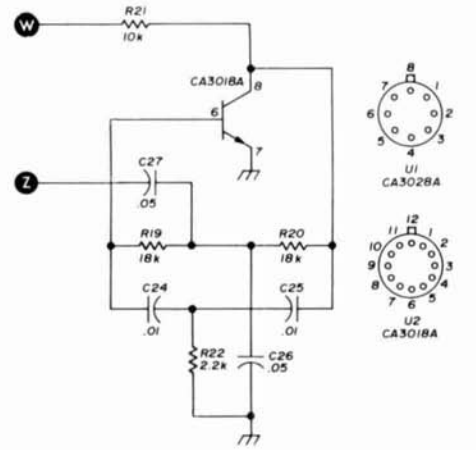
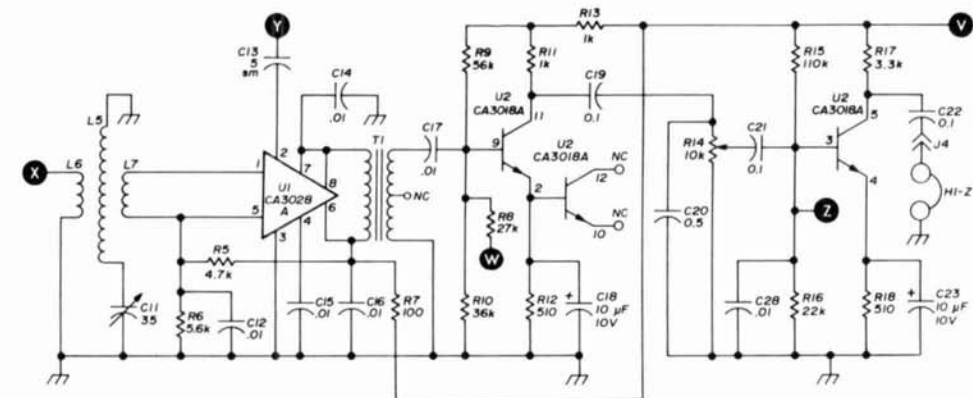
The conventional direct-conversion receiver of fig. 3 uses an RCA CA3028A as the product detector and Q1 as the oscillator. Inclusion of L7 on the L6 core eliminates the need for the rf choke normally found between pins 1 and 5 of U1. The entire audio section is contained in a single RCA CA3018A linear IC. The audio preamplifier uses one of the two Darlington-connected transistors; the audio amplifier uses a separate transistor on the same IC chip. Recovered audio is more than sufficient to drive high-impedance headphones. The 0.5- μ F capacitor from the top of the audio gain control serves to attenuate some of the higher audio frequencies. Although this capacitor also reduces the overall audio output available, sufficient margin is left

to run the audio gain control about one-third open for most operations.

The remaining transistor on the chip of U2 is connected in a twin-tee configuration and acts as the sidetone oscillator. Power is derived from the keyed +12 volts to Q2. The tone can be adjusted by varying R22. The volume may be more than required; if so, decrease the value of the sidetone oscillator output coupling capacitor C27 until a comfortable level is reached. To ensure that the audio preamp is firmly "off" during transmission, R8 upsets the base bias enough to saturate the transistor, thus preventing any signal other than the sidetone oscillator to be introduced into the audio amplifier.

cabinet layout

An LMB 101 Minibox (12 cubic inches



- C11 3-35 pF trimmer (Arco 403)
- J4 3.5-mm phone jack
- L5 60 turns no. 28 enamelled on Amidon T-50-2 toroid core
- L6 5 turns no. 22 enamelled wound around L5
- L7 10 turns no. 22 enamelled wound around L5
- R14 miniature 10k pot, audio taper
- T1 miniature transformer, 10k primary, 2k center-tapped secondary (Calrad CR-75 or Calctro D1-722)

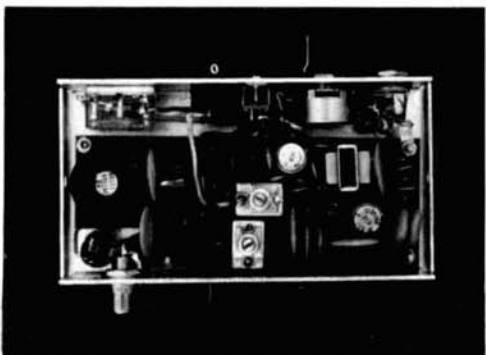
fig. 3. Schematic diagram of the receiver circuit.

or 197 cc) was selected as about the smallest available enclosure which provides enough panel space for the necessary controls. Elimination of the vx0 feature would have permitted a smaller enclosure, but it was felt that the flexi-

bility provided by the vx0 was essential. An internal key, a simple pushbutton switch, was included on the cabinet top. This made upside-down mounting of the PC board necessary. The external key jack may be eliminated if desired.

printed-circuit board

As can be seen from the photographs, more than enough space for the board is available; component density is fairly compact, but not unmanageably so.* The layout of components on the board was determined after considering the location of PC board inputs and outputs which give minimum interconnection lengths to the panel controls. By using an elevated



Miniature 7-MHz transceiver is built into small, 12-cubic-inch LMB 101 Minibox.

*Printed-circuit boards for the miniature 7-MHz transceiver are available from MFJ Enterprises, Post Office Box 494A, Mississippi State, Mississippi 39762 for \$3.75, post-paid.

heatsink on Q2, it is possible to locate some components under the heatsink near the body of Q2. Toroid coils are mounted vertically to conserve space, and held in place with Q-dope after soldering. The ¼-watt resistors are also vertically mounted throughout. U1 and U2 are

wire the PC board and install it. Four small bolts serve as corner mounting posts with washers and nuts providing the appropriate spacing between the board and chassis. Dry transfer labels were applied and then given a light coating of acrylic spray to prevent rubbing off.

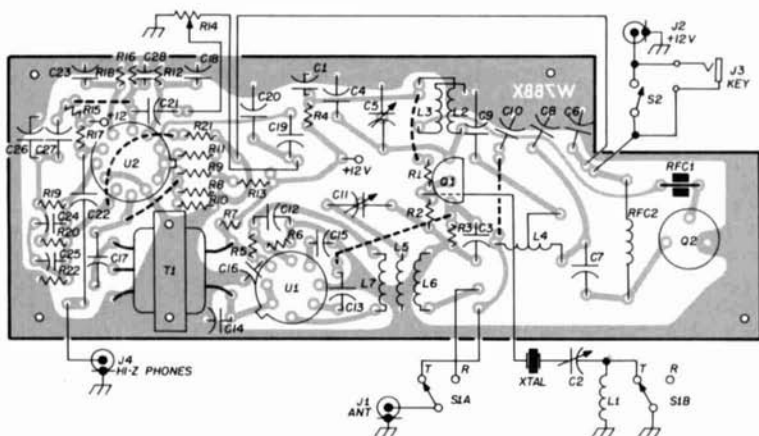


fig. 4. Component layout for the miniature 7-MHz transceiver. Printed circuit is shown in fig. 5.

mounted in IC sockets which are press-fit into appropriate-sized holes, and held in place by epoxy on the underside and the component leads soldered to the socket pins. Check the value of each of the ¼-watt resistors used with a reliable ohmmeter; the tolerances indicated are often exceeded.

construction

It is helpful to first mount all chassis controls. Size and layout of the PC board paper template can then be verified before actual construction and etching of the board. After the board is etched and drilled, drill the four corner post-mounting holes in the chassis top. Then

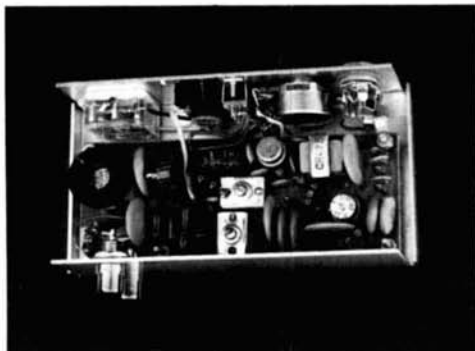
Alignment requires only a separate 7-MHz receiver and a dc milliammeter or vom capable of reading 250 mA. With the antenna connected and S1 in the *receive* position, peak C11 for maximum received signal; this completes the receiver alignment.

Connect a 51-ohm, 1-watt resistor to J1 and place a milliammeter in series with the +12-volt supply to J2. Place S1 to *transmit* and depress the key. Adjust C5 for maximum meter reading and good keying characteristics in the monitor receiver. Approximately 200 mA should be indicated; remember that receiver current drain and oscillator current are included in the metered current.

fig. 5. Full-size printed circuit board for the 7-MHz transceiver. Component layout is shown in fig. 4.



To adjust the frequency offset required during transmit, monitor the oscillator frequency in the *receive* position and transmitter output frequency in the transmit position when keyed. Adjust the number of turns on L1 to make the two coincide. Although $7 \mu\text{H}$



Component layout for the 7-MHz transceiver. In this photograph the transmitter output transistor is to the left, the receiver input circuit to the right.

was required in my version to provide the necessary 1-kHz offset, this value may vary. L1 can then be cemented to the rear of the crystal socket with Q-dope.

Reconnect the antenna to J1 and try not to appear surprised when you consistently get 569-599 reports from single-hop contacts. Experience has shown, however, that double-hop QSOs from 2000 to 3000 miles are generally in the 339-559 range with a well-matched dipole up 18 feet (5.5 meters).

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4. *RCA Linear Integrated Circuits*, Technical Series IC-42, 1970, page 312.
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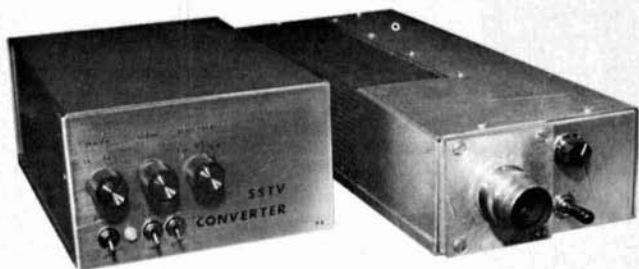
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fast-scan camera converter for sstv

Complete
construction details
for an economical
approach to sstv
picture generation
using a surplus
FS camera

Gordon P. Howlett, WA9UHV, Kokomo, Indiana 46901

Conversion of surplus fast-scan (FS) closed-circuit TV cameras to slow-scan television (sstv) standards has attracted many hams to the exciting field of picture transmission on the hf bands. W9NTP¹ and others have pioneered the sampling conversion approach to sstv picture generation. W3EFG² introduced an sstv sampling converter, using discrete components, that produces high-quality pictures via camera conversion.

This article presents an sstv converter using some of the low-cost, high-performance integrated circuits that have become readily available. Also included are several FS camera conversion techniques that may be helpful to interested experimenters.

The project began with the following objectives:

1. High-quality sstv pictures with minimum cost.
2. Use of simple, proven circuits and

readily available ICs were feasible and advantageous.

3. Derivation of all timing signals from the 60-Hz power line.
4. Features such as video reversal and fractional scan.
5. Stability with temperature.
6. Simplified FS camera conversion.

preliminary steps

1. After studying the FS camera schematic, locate and identify the various circuits in the camera, including polarities and absolute levels of signals; this information will speed the camera/converter interface task.
2. Using an oscilloscope, determine the high and low sides of the vertical deflec-

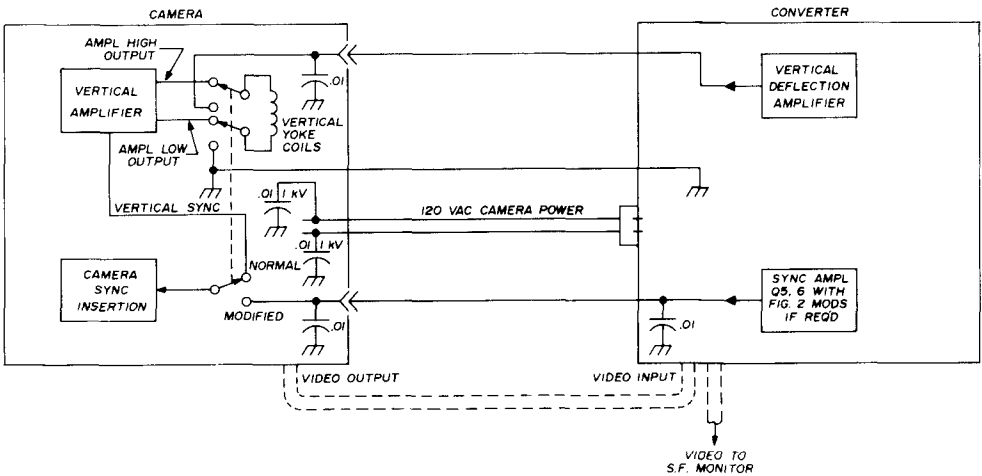


fig. 1. Typical camera-to-converter connections. All leads out of the camera (except video output) should be bypassed. Shielded cable will help with RFI reduction.

camera modifications

The frame rate of the camera must be reduced from 60 to 15 Hz. In order to overcome the difficulties in obtaining a linear 15-Hz sweep voltage from the camera's 60-Hz vertical deflection amplifier, I included a simple deflection amplifier with the converter. This amplifier is similar to one used by W3EFG. Also, to ensure that the vertical size of the FS picture is identical in both the FS and SS modes, I decided to switch size controls rather than vertical ramp capacitors. This method eliminates ramp capacitor selection for the SS mode.

tion yoke coils and record the amplitude of the 60-Hz ramp at the yoke.

3. Locate the sync insertion circuit; this will usually be a single transistor whose base is driven with signals from both the vertical and horizontal deflection amplifiers. Generally this transistor will be located at or near the output of the video amplifier.
4. Observe and record the polarity and level of the vertical sync pulse; this information will be helpful in determining the type of interface (if any) required between the converter sync amplifier and camera.

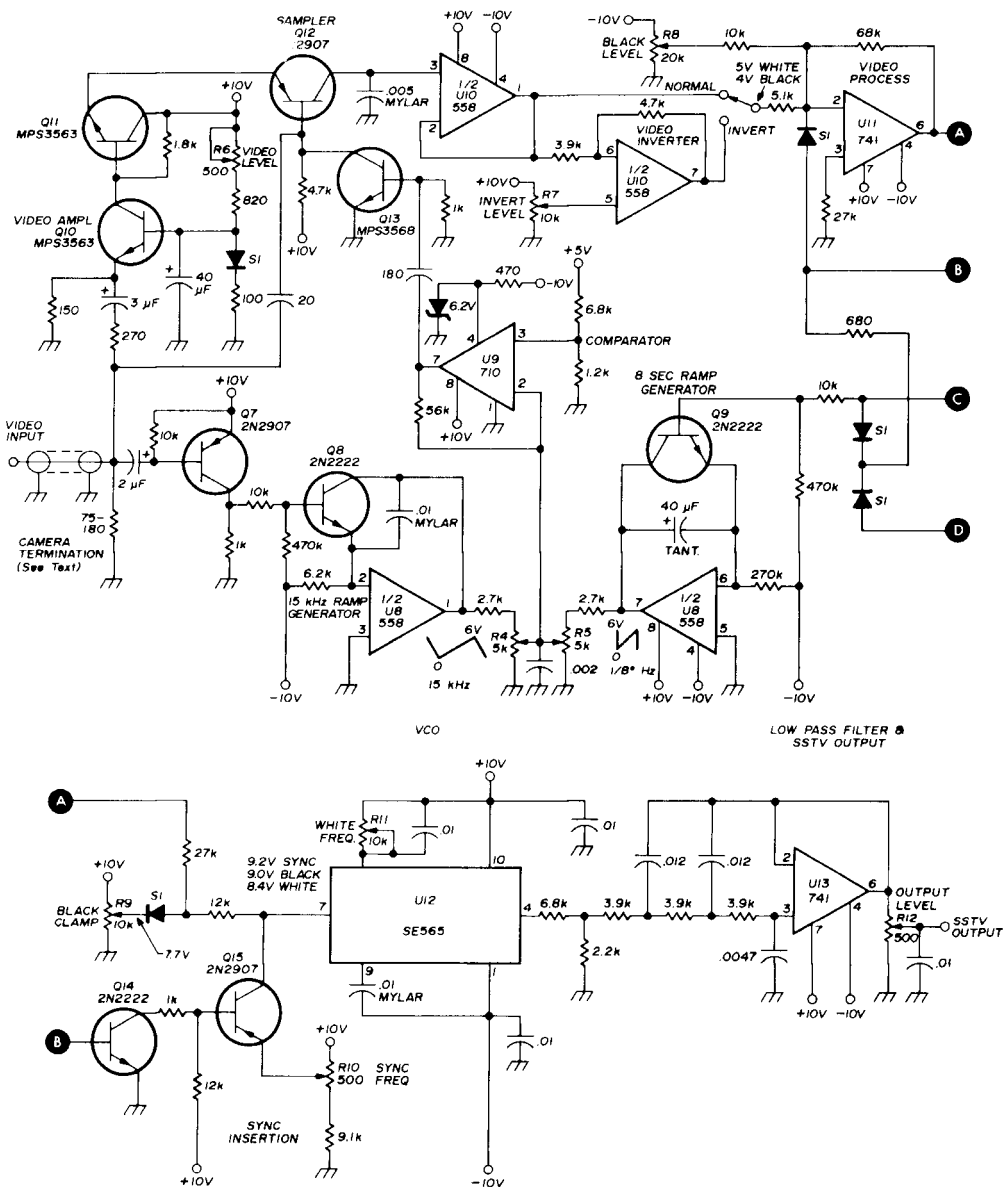


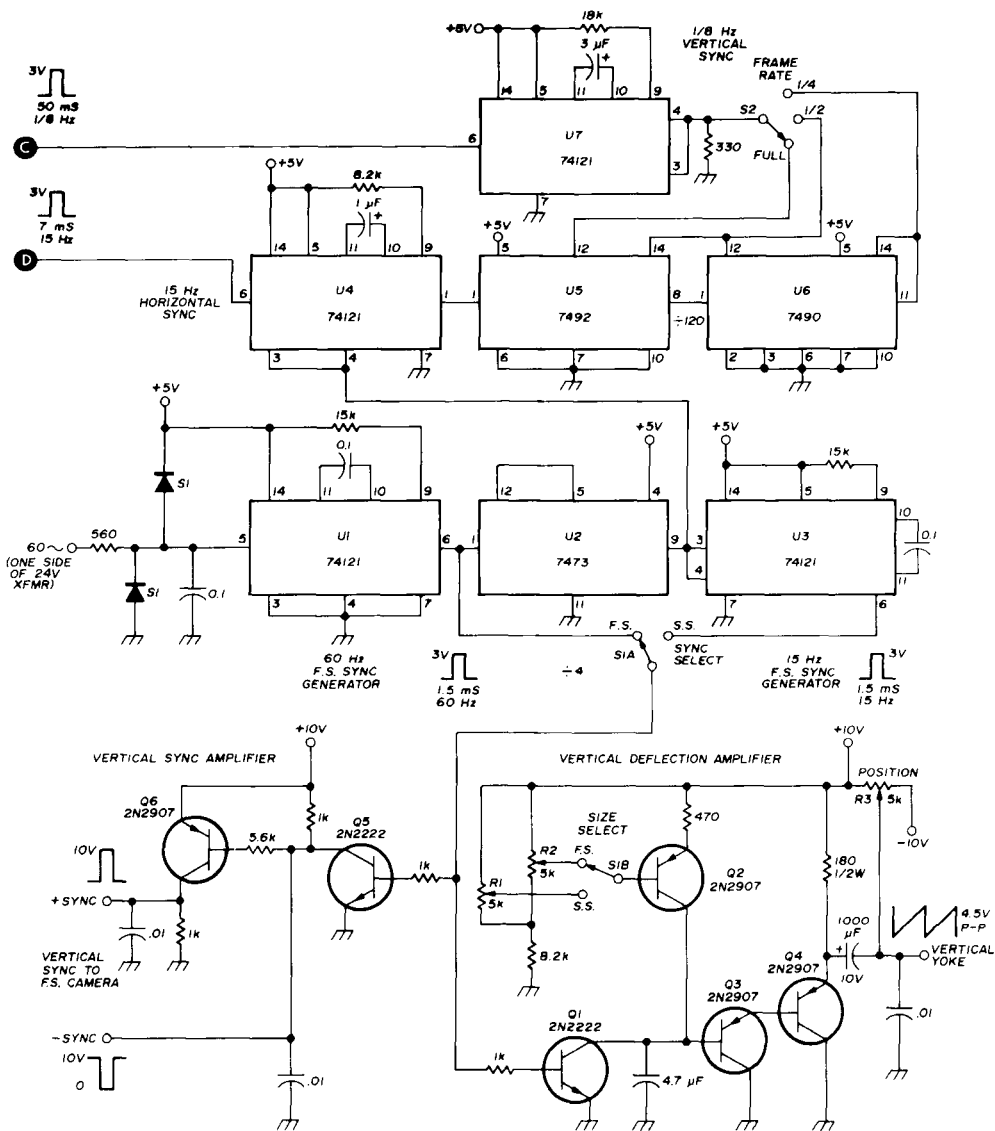
fig. 2. Converter schematic. Voltages and waveforms are for reference only; see text.

A typical camera/converter interface is shown in fig. 1. Vertical yoke drive and vertical sync information is supplied to the camera from the converter. A switch may be mounted on the camera case to select between converter-supplied signals or normal camera operation. If the camera will not be used in other non-sstv

applications, the switch may be omitted and direct connections made to the camera.

interface circuits

The sync amplifier, Q5 and Q6 (fig. 2), produces positive and negative pulses between zero and 10 volts. Many



cameras use a negative power supply voltage. In this case, you may need to incorporate one of the interface circuits in **fig. 3**, since quite likely the sync pulses in the camera will swing between zero volt and some negative potential. As mentioned earlier, careful study with an oscilloscope before beginning camera modification will show you which combination of sync amplifiers in **fig. 2** and interface circuits in **fig. 3** are required.

As with the W3EFG converter, the camera (or yoke assembly) is rotated 90 degrees to lie on its left side so that the top of the picture will be at the viewer's right side on the FS monitor.

camera power supply

The camera's primary power is supplied from a connector on the converter. This connector is wired so that the camera cannot be operated without the

converter turned on and the deflection amplifier active. Connections in this manner help prevent serious vidicon target burn resulting from loss of scan.

Stray magnetic fields may occur from a camera-mounted power supply. These fields can cause distortion on the FS picture, which appears as wavy kinks or vertical bars on the sstv picture. Quite possibly mu-metal shielding around the power transformer and/or vidicon, or a piece of thin copper strap formed around one leg of the power transformer core as a shorted turn, will suppress the distor-

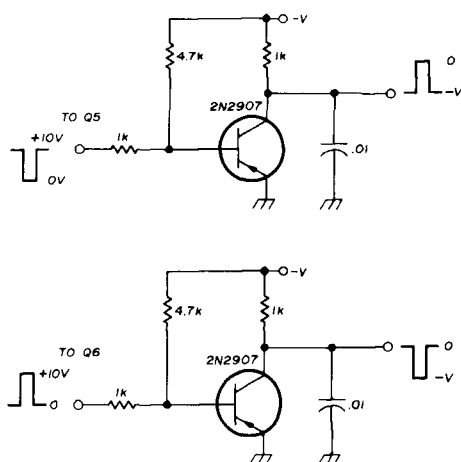


fig. 3. Special interface circuits for cameras with negative sync signal requirements.

tion. If these measures don't succeed, the power transformer may be remotely mounted in the converter package as mentioned later in the construction section.

picture contrast

Some experimentation with the camera video termination may yield higher contrast on sstv. With my converted FS cameras, I found that terminations higher than the standard 75-ohm value will yield usable pictures at lower light levels. Fig. 2 indicates that the termination may be between 75 and 180 ohms. Once the complete system is operating, the termination should be optimized.

video monitor

I made a simple modification to my old TV set so it could serve as a video monitor. As shown in fig. 4, a 30- μ F capacitor is connected to the output of the video filter. A short piece of coax (less than 1-foot [30.5 cm] long) is run to a connector on the chassis. Plug the camera video output into this coax, through an additional length of cable, add a camera termination, and you have a picture. The termination is not required if the converter (with its own termination) is in the circuit.

circuit description

Explanation of the sampling principle of scan conversion has been well covered elsewhere.¹ It is recommended that W9NTP's excellent articles be studied by those not familiar with the sampling technique.

The converter schematic and block diagram are shown in figs. 2 and 5 respectively. Line frequency (60 Hz) is applied to U1, producing 1.5 ms, 60-Hz pulses. These pulses are divided by 4 in U2 and shaped into 1.5 ms, 15-Hz pulses by U3. Switch S1A selects either 60- or 15-Hz pulses for the vertical deflection and sync amplifiers. Transistors Q1 through Q4 comprise a direct-coupled yoke driver similar to the one used by W3EFG.² Switch S1B selects the vertical ramp size for the FS and SS modes. A variable dc bias on the yoke centers the scan on the vidicon target. Transistors Q5 and Q6 interface the sync generators with the FS camera. Transistor Q6 may be omitted if negative sync is required by the FS camera, as mentioned earlier.

The sstv horizontal sync pulse width is determined by U4. A separate monostable multivibrator is used, since it's desirable for the 15-Hz FS vertical sync pulse (determined by U3) to be considerably shorter than the sstv horizontal sync pulse, thereby eliminating shading on the left side of the sstv picture.

The 15-Hz sstv horizontal sync pulses are used by ICs U5 and U6 to produce

the sstv vertical sync pulse. These ICs are connected so that switch S2 can select divide-by-30, divide-by-60 and divide-by-120 to produce $\frac{1}{4}$, $\frac{1}{2}$, and full sstv frame rates respectively. The sstv vertical sync pulse width is determined by U7.

Sync stripper Q7 removes the 15,750-Hz FS horizontal sync pulses from the composite video. These pulses are used to produce a 15,750-Hz ramp by Q8 and one-half of U8. One-eighth Hz ramps are produced by Q9 and one-half of U8. The amplitudes of these ramps are adjusted by controls R4 and R5 to set the start (R4) and finish (R5) of the FS frame sampling. The summation of these two ramps is compared with the reference voltage on pin 3 of comparator U9, producing a sliding pulse at its output, pin 7.

Video amplifier Q10 and emitter follower Q11 amplify and shift the FS video to a dc level determined by the setting of the video level control, R6. The diode in the base bias circuit of Q10 is used for temperature compensation.

The sliding pulse from U9 is differentiated by the 1k, 180-pF RC combination, producing a voltage spike that switches Q13 and Q12 to sample the FS video. The 0.005- μ F capacitor holds the sampled voltage until the next sample.

One-half of U10 provides an impedance transformation between the holding capacitor and succeeding circuits. The other half of U10 provides the video inversion feature. Control R7 sets a reference level such that the average video voltage selected by S3 is the same for either the normal or inversion function.

Video-processor IC U11 amplifies the sstv video and establishes a reference level, controlled by R8, which sets the range of the panel-mounted video-level control. Composite sstv sync is applied to U11 to blank the video during sync insertion. The black clumper, R9, prevents video excursion below 1500 Hz.

Composite sstv sync, applied to transistors Q14 and Q15, clamps the vco volt-

age to the level set by the sync frequency control R10.

The vco, in an SE-565 phase-locked loop, is used because of its excellent linearity. Potentiometer R11 sets the white frequency. The square-wave vco output is filtered by a simple active low-pass filter, providing a low source

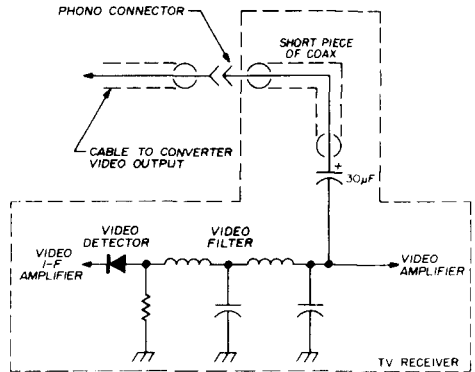


fig. 4. Tv receiver modification for use as a video monitor.

impedance, through the output level control. R12, for driving external equipment.

The power supplies use integrated circuits to control series-pass transistors. The negative supply tracks the positive supply, resulting in a single adjustment. Five volts are obtained from a single IC. All supplies are current limited.

construction

Lead length and component placement are not critical in the sstv converter. My breadboard model has long leads and haphazard stage and component placement. The second model, shown in the photographs, was built using the technique I've found convenient for camera and monitor construction.

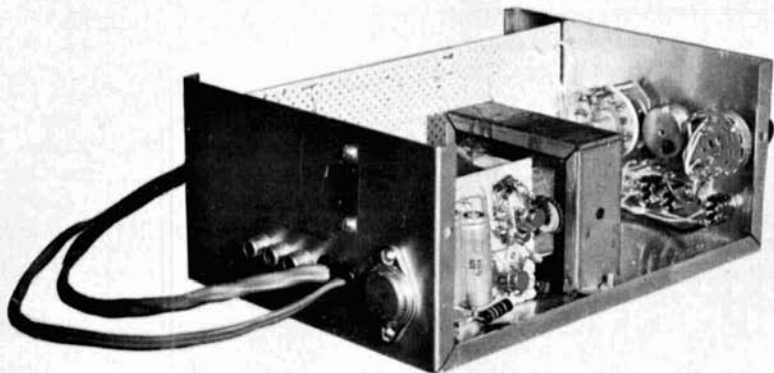
After board layout and approximate stage placement has been selected, B+ and ground busses are run on the vector board. Components are then mounted between the busses using short, direct connections. The result is a reasonably

neat, one-sided layout that's easy to troubleshoot and later modify. Sockets are not used for the active devices because of the extra space and cost required, although they may be included if desired. Vector board pins are used only at board/wire interfaces. Teflon wire is recommended for board jumpers to prevent insulation burning during soldering.

Board size of the converter is 7½ inches by 3¼ inches (19.1 x 8.25 cm), which also includes a gray-scale generator not described here. The power supplies

setup procedures

Disconnect the power supplies from the converter and set the ± 10 -volt adjustment. Check for 5 volts at U16. Reconnect the supplies and use an oscilloscope to trace the waveforms, shown on the schematic, through U1, U2, U3 and the vertical deflection amplifier. With the scope at the vertical yoke connection, set S1 to FS mode and adjust R2 for a maximum, linear ramp signal without positive peak clipping. Switch S1 to SS



Left-rear of converter. The power transformer is mounted in the center for balance.

are located on a separate board near the rear. The cabinet is a 8 x 6 x 3½ inch (20.3 x 15.2 x 8.9 cm) Minibox.

If it's desired to build the camera and converter as a single unit, removal of the camera's power transformer should provide adequate room for the converter. Since layout is not critical, the converter can be packaged on two or three small boards to suit the available space. Camera and converter power transformers may be mounted on a separate chassis and connected to the camera through a multi-conductor cable. Radio-frequency interference difficulties may be reduced by single-unit packaging.

mode and adjust R1 as above. Set R3 to center rotation.

Turn the converter off and connect the camera to the converter as shown in **fig. 1**. If any of the special interface circuits are required, they should also be in the circuit. With power applied, a locked raster should appear on the FS monitor. Be sure S1 is in the FS position. With the aid of a test pattern or a circle on a sheet of paper, adjust R2 and R3 for a centered, symmetrical picture. Note the amplitude of the 60-Hz ramp on the vertical yoke with the scope, switch S1 to SS, and adjust R1 to the same amplitude. If difficulty is experienced in locking the

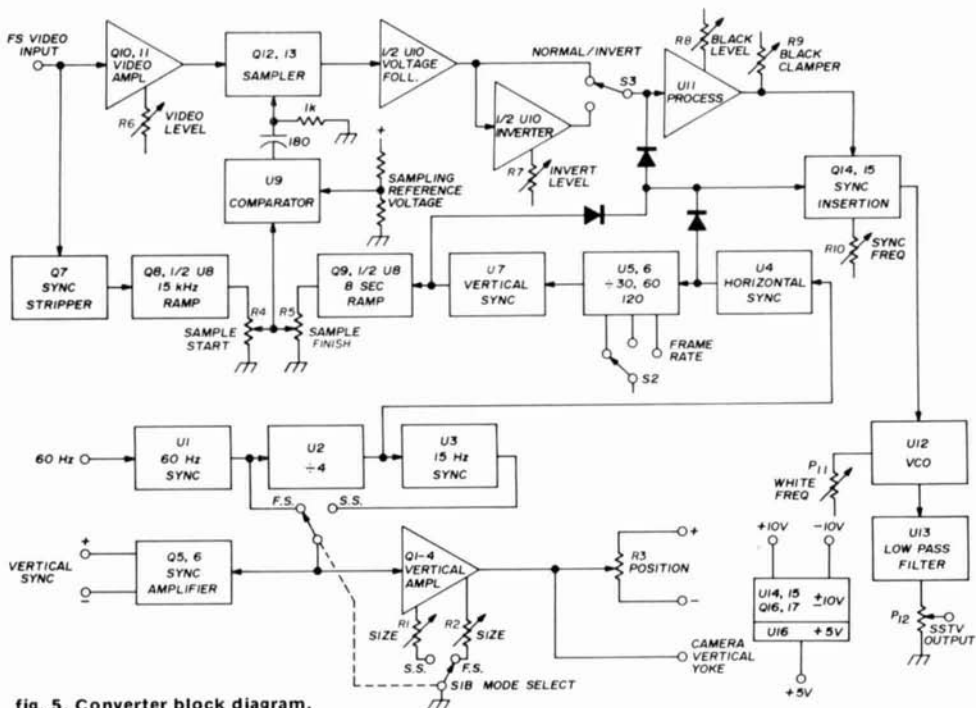


fig. 5. Converter block diagram.

raster on the monitor, experimentation with the sync insertion connection may be required.

Using the scope, check the following points for the waveforms shown on the schematic:

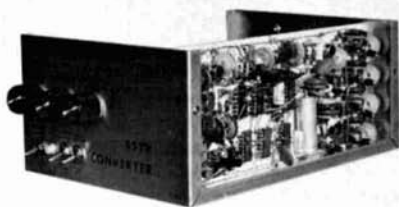
1. U4, pin 6: 15-Hz pulses.
2. U7, pin 6: 1/8-, 1/4-, and 1/2-Hz ramps, depending on S2 position.
3. U8, pin 7: 1/8-, 1/4-, and 1/2-Hz ramps, depending on S2 position.
4. U8, pin 1: 15,750-Hz ramps.

The output of the comparator, U9, pin 7, is a sliding pulse that changes width during picture scan. Adjustment of R4, scan start, and R5, scan end, will produce a continuous sliding pulse that changes width smoothly and without hesitation. The differentiated spike will be visible as a thin black line on the FS monitor, moving from right to left. Its position on the screen indicates the part of the FS picture being sampled.

Sstv has a 1:1 aspect ratio (FS is 3

high to 4 wide), so a narrow portion of the left- and right-hand sides of the FS picture will be lost. Controls R4 and R5 have some interaction, so patience is required to center the sampled portion of the FS picture.

The setup of the vco and clamer should be made in a step-by-step procedure initially. The FS camera (with its lens capped) must be connected to the converter. Preadjust the following controls as indicated:



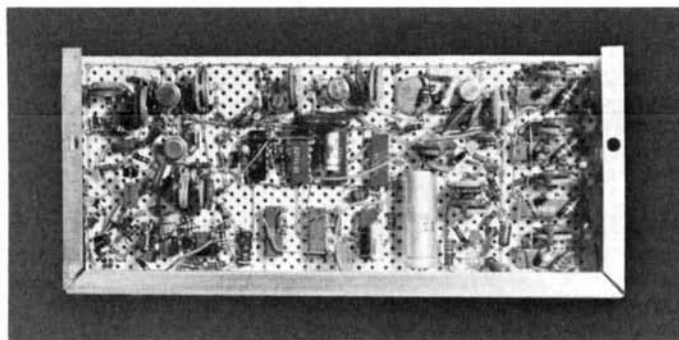
All circuitry (excluding power supply) is mounted on Vector board along one side of the box.

1. R9 to 10 volt end.
2. R6 to maximum resistance.
3. R11 to midrange.

Proceed with final adjustment as follows:

1. Adjust R8 from ground until the vco frequency (as monitored at the sstv output jack) begins to decrease.
2. Set R11 to 2300 Hz.

Main converter board. Circuits in the left quarter are the video amp, ramp generators, comparator, sampler, and video processor. Lower center contains the counters and sync pulse generators. Upper center is the vco and output filter. Immediately to the right of the large cap is the yoke driver and sync amp. Circuitry in the right quarter is the grey-scale generator.



3. Set R6 to minimum resistance.
4. Adjust R9 for 1500 Hz.

If it is not possible to adjust the vco frequency over the full 1500- to 2300-Hz sstv video range with the video level control, readjust the black level control, R8, and repeat steps 2 through 4. With a 1k resistor connected between the base of Q14 and 5 volts, set the sync frequency control, R10, to 1200 Hz. Set R6 to 1900 Hz, switch S3 to invert, and adjust R7 to 1900 Hz. Set S3 to normal.

The voltages and waveforms were measured in one of my converters; they are for reference only and may vary considerably between units.

With the lens uncapped, adjustment of the video level control and lens opening will produce a sstv picture.

component substitutions

I've built two converters using identical component values and observed identical results. It's possible, however, to change some component values to suit

personal preference. The 68k resistor at U11 may be revised to change the sstv contrast, or a control may be mounted on the panel if desired. Likewise, the contrast in the invert mode may be adjusted by changing the 4.7k resistor at U10. Sstv sync pulse width may be changed by adjusting the timing resistors in U4 and U7.

With the component values shown, the video circuits will operate at high gain. It is then possible to obtain useful sstv

pictures using less light and/or lower lens openings. In either case, camera setup is simplified.

device selection

Transistors Q10, Q11 and Q13 are high-frequency devices; Q12 is a low-leakage, high-frequency unit. All other transistors except Q16 and Q17 are small-signal devices. You may substitute providing you use silicon types. ICs U8 and U10 are dual op amps, which may be single 741s if desired. Diodes, except those in the power supply, are small-signal devices of the 1N914 variety.

operation

Only two adjustments (assuming the lens is focused) are required to set up the camera/converter for pictures. I use the lens opening, or amount of light, to control the contrast and set the video level control so the video swings from full black to full white with plenty of gray scale in between. Be sure your monitor's brightness and contrast controls have

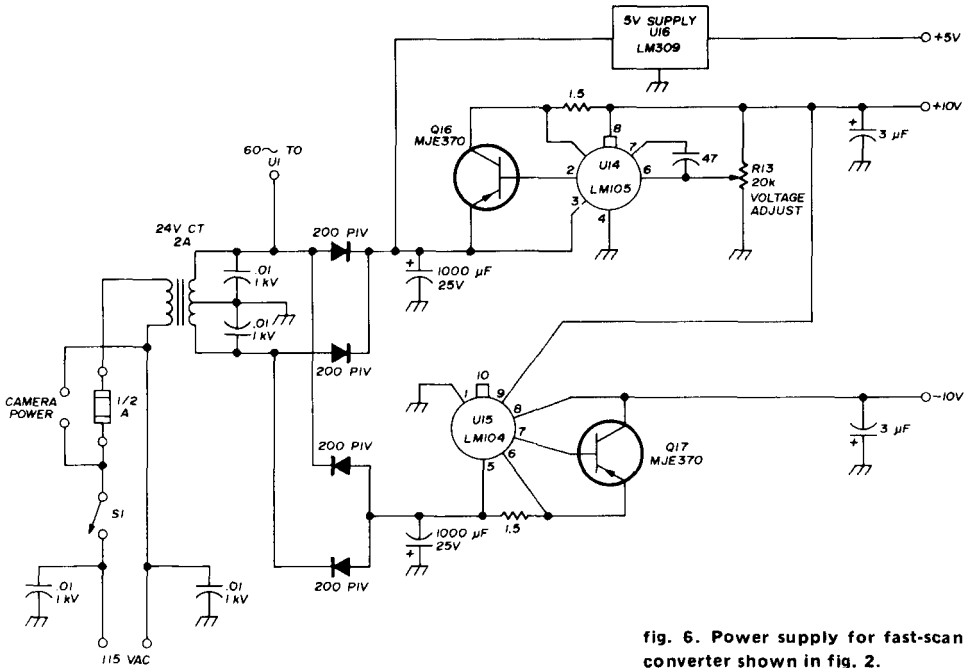


fig. 6. Power supply for fast-scan converter shown in fig. 2.

been set using a gray-scale tape or generator, as the monitor is your reference for camera adjustment.

I use a 100-watt bulb in a gooseneck lamp and a f/16 lens opening for photographs. For lettering, I open the lens to f/11 so the video will swing from full white to full black with no gray scale. Live pictures are taken with normal room lighting and a f/4 or f/5.6 lens setting.

summary

The conversion of a used, closed-circuit FS camera to slow-scan provides an economical approach to sstv picture generation. Furthermore, an old black and white TV may be pressed into service to allow fast, accurate focus and lighting adjustments.

The scan converter described here produces high-quality sstv pictures using inexpensive integrated circuits to reduce complexity and simplify construction. With the addition of only a few components, fractional frame rate and video reversal features are included.

I've attempted to use proven circuitry where possible and not try to reinvent the

wheel. Several circuits, created by others, have been used since they provided the best performance with the least complexity and cost, which was one of my goals. I would be interested in hearing from readers who build this converter. Those interested in using this basic converter with a FS camera previously modified for use with the W3EFG converter (divide-by-4 and sync/deflection amplifiers not required) are invited to write for interface details. Please include a self-addressed, stamped envelope.

acknowledgements

I would like to thank James Mathews, W9KYS, for assistance with the photographs and K.O. Learner, K9PVW, for stimulating discussions during the course of the work.

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ham radio

a versatile autopatch system for vhf fm repeaters

Complete design
information for an
autopatch system
that includes
access control and
protective features

An autopatch for fm repeater use is not just an automated phone patch. A good autopatch should have protective features not necessary on a phone patch at an attended station. On the other hand, certain features that I consider desirable in a phone patch add nothing to an autopatch installation.

Both phone patch and autopatch should provide undistorted audio coupling from the telephone line to the transmitter and from the receiver to the telephone line. Freedom from distortion between the receiver and telephone line is

particularly important in an autopatch working into a Touch-Tone central office. Provision should be made on both phone patch and autopatch to set the audio gain at levels acceptable to the telephone system, and to provide a desirable amount of modulation to the transmitter.

phone-patch requirements

Beyond acceptable audio, the two systems have little in common. Features desirable in a phone patch to be used at an ssb station have been described in another article¹ and include facilities for three-way conversation, enabling the operator to talk to both parties—the person on the telephone as well as the one on the radio—using the station microphone and monitoring with the station speaker or headphones. Vox operation of the transmitter by the party on the telephone is also an advantage. Successful accomplishment of these objectives can involve fairly sophisticated hybrid circuitry and incorporation of a number of amplifiers for level control and circuit isolation.

autopatch features

An autopatch system does not require vox operation or isolation of the transmitter audio input from the receiver output. Monitoring is the responsibility of the control operator, usually at a remote control point. The autopatch circuit is essentially one for two-way communication, with switching between transmit and receive controlled by the party originating the radio contact.

R. B. Shreve, W8GRG, 2842 Winthrop Road, Cleveland, Ohio 44120

However, the autopatch system does need a control system which will permit the caller to gain access to the telephone line and originate and terminate a call. It should also have reasonable protection against accidental activation, and automatic time-out if the calling party neglects or is unable to terminate the call. It should also be possible for the control operator to interrupt a call if necessary, without turning off the repeater.

Optional control features include protection against toll calls, and a provision

working successfully on a busy 146.16/76 repeater.

simple autopatch

The audio circuit for the simple autopatch is shown in **fig. 1**. This patch was constructed from a Heathkit HD-15 Hybrid Phone Patch, and uses most of the kit components and circuitry. Except for the Touch-Tone decoder and power supply the unit is completely contained in the 9¼ x 3½ x 2½-inch (23.5 x 8.9 x 6.4-cm) cabinet supplied with the kit.

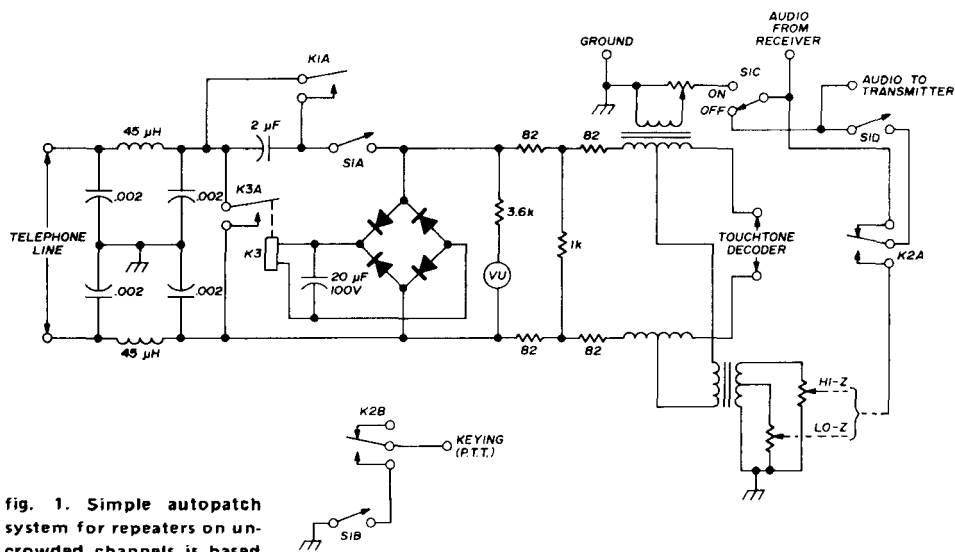


fig. 1. Simple autopatch system for repeaters on uncrowded channels is based on a Heathkit HD-15 hybrid phone patch kit. Control logic and timing circuits are shown in fig. 2.

whereby persons knowing what number to call can dial the autopatch line, monitor the repeater input frequency, and if the control system permits, send control signals over the telephone line. Some groups have gone further, and made it possible to originate calls through the repeater from a telephone—sort of a “reverse autopatch.” Restricting this capability to licensed operators is a problem those choosing to install such a system must solve for themselves.

This article describes two autopatch systems that I have built. One is comparatively simple, suitable for use on a repeater on an uncrowded channel. The other, with more protective features, is

The Heathkit HD-15 phone patch includes a hybrid circuit which isolates the receiver audio output from the transmitter. As previously noted, this isolation is unnecessary in an autopatch. However, the hybrid transformer provides excellent quality audio coupling between receiver and telephone line, and from line to transmitter. The null adjustment balancing network is replaced by the Touch-Tone decoder which operates the phone patch control circuits. The control circuits combine solid-state logic with relay switching.

Operation of the patch is as follows. Switch S1 is a manual on/off switch, which in the off position disconnects the

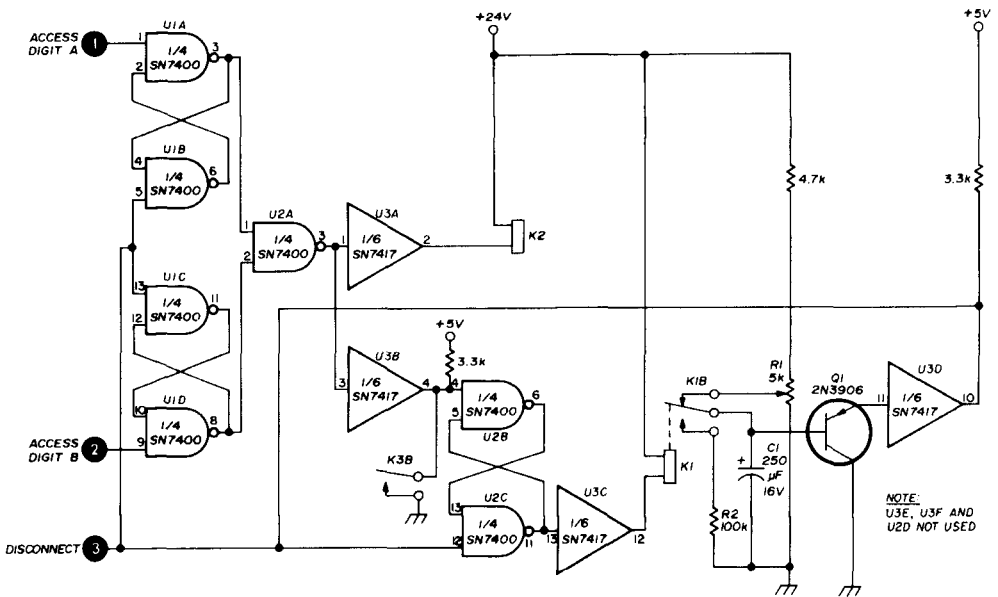


fig. 2. Simple control logic and timing circuit for the autopatch system shown in fig. 1.

phone patch from the repeater and telephone line, and bypasses the repeater audio signal from receiver to transmitter. This switch is normally left *on* to permit autopatch operation.

When a call is to be made, relays K1 and K2 are operated by the Touch-Tone-controlled logic. Contact K2A opens the direct audio path between receiver and transmitter and connects the phone patch output to the transmitter input. Relay contact K2B keys the repeater transmitter. Contact K1A establishes a dc path for the telephone circuit, signalling the central office and bringing up the dial tone. Both these relays stay closed until the call is terminated. Everything said on the telephone and radio is transmitted over the repeater.

Relay K3 and the bridge rectifier compose an automatic telephone answering circuit. If the autopatch telephone is called by another party when manual switch S1 is *on*, rectified ringing current closes K3 momentarily, "answering" the telephone and stopping the ringing. Relay K1 closes, K2 does not. The calling party can monitor the repeater receiver over the

telephone line, and transmit Touch-Tone commands to the Touch-Tone decoder to operate the patch or other repeater control functions. The connection should be terminated by the calling party by transmitting the disconnect signal before he hangs up his telephone.

The control logic shown in fig. 2 recognizes a two-digit access code and a single-digit disconnect signal. When the two access digits are received by the decoder it generates a logic zero, or ground, at inputs 1 and 2, operating relays K1 and K2 and activating the phone patch as described earlier. The disconnect signal is decoded as a logic zero at terminal 3, releasing both relays. While the disconnect signal will usually be transmitted by the calling party on completion of the call, it can be used by the control operator if necessary.

Automatic time limiting is provided with the circuit controlled by relay contact K1B. In the standby condition, capacitor C1 is charged to a level determined by the setting of potentiometer R1. When K1 is picked up, the capacitor is discharged through resistor R2. When

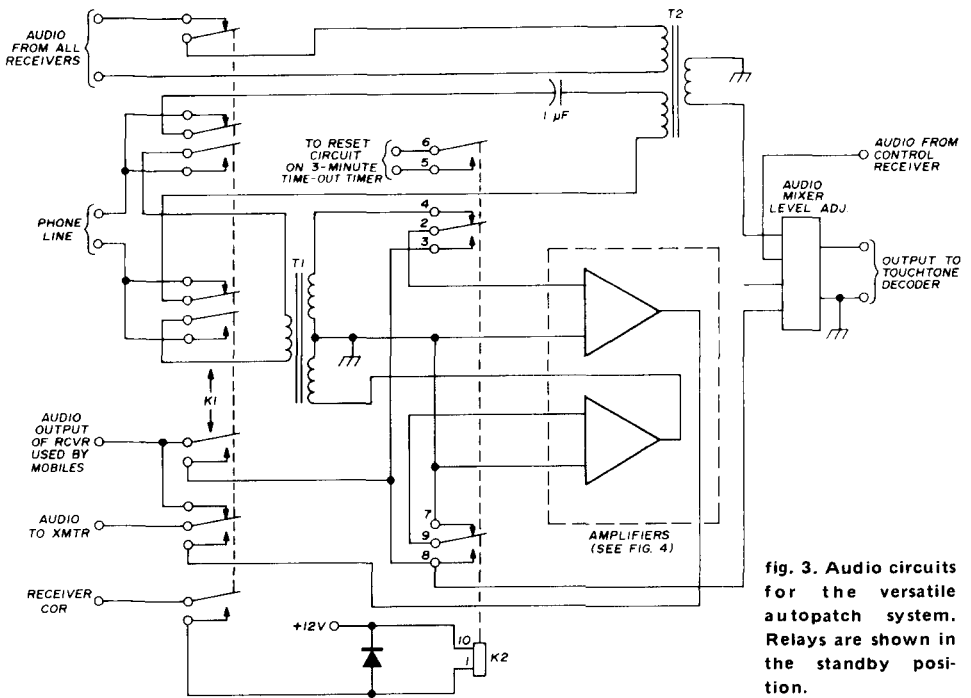


fig. 3. Audio circuits for the versatile autopatch system. Relays are shown in the standby position.

its charge falls to the level at which Q1 conducts, an automatic disconnect signal is generated at terminal 3. The timing cycle is also started by relay contact K3B, when relay K3 answers an incoming call. Of course, no one calling in on the telephone line to monitor the receiver would normally forget to transmit the disconnect signal—but K3B is still a good precaution, let's say, against someone calling a wrong number!

Performance of this simple autopatch is excellent as far as audio quality and circuit reliability are concerned. Its big disadvantage is lack of security—it can be activated by the two access tones in either AB or BA order, and there is no protection against long-distance calls. A lesser disadvantage is the lack of any way to boost the audio level from the telephone line to the repeater transmitter; it is sometimes hard for a mobile operator in heavy traffic to hear a soft-voiced woman when she answers the telephone. A more versatile autopatch system which overcomes these limitations is described below.

versatile autopatch

Although the autopatch system described previously provides excellent, reliable operation, it lacks some desirable security and operational refinements that enhance autopatch operation. The unit described here is more versatile, better protected, and incorporates audio amplifiers which permit adjustment of audio levels to the telephone line and transmitter. Construction is modular, so you can select the features you want and program the logic to fit your own requirements.

audio circuits

The audio circuits for the versatile autopatch system are shown in fig. 3. Component selection is not critical. Relay K1 is a multi-contact telephone type relay, and K2 is a 12-volt relay with one single-throw and two double-throw sets of contacts. Transformers T1 and T2 are audio transformers with three windings; any good-quality transformer with impedance of 400 to 1200 ohms and a 1:1 or 2:1 ratio should work. Surplus 400-cycle

power transformers with 117-volt primaries and 300-volt center-tapped secondaries have been used successfully.

The circuit diagram shows the relays in standby position. Audio from the receiver used by mobile stations goes directly to the transmitter. The telephone line is connected, through a blocking capacitor, to transformer T2. Another winding of T2 is connected to an input of the mixer which drives the Touch-Tone decoder. The third winding is connected to an audio source that monitors all the repeater inputs except the control receiver. This arrangement permits control operators to call the autopatch number on the

set of contacts on relay K1, but keying it from the control logic permits more versatile operation, as explained later. Relay K2 is connected by a set of contacts on K1 to the mobile receiver COR which enables the mobile operator to switch the amplifier inputs, controlling what goes out on the telephone line and on the air. Note that this gives the mobile operator the ability to cut off any potentially objectionable remarks that might be made over the telephone by simply pressing his microphone button; he does not have to deactivate the phone patch.

The phone patch may be wired so that the repeater will repeat both sides of a

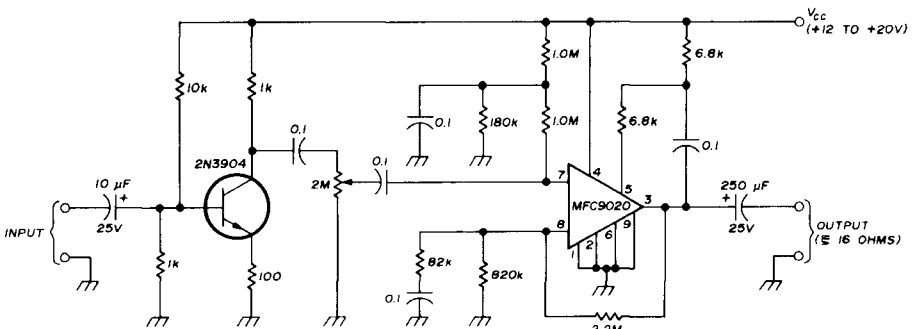


fig. 4. Audio amplifier circuit for the versatile autopatch system uses a Motorola MFC9020 audio power IC. Maximum power output is approximately two watts.

telephone, listen to the repeater inputs, and send instructions to the decoder over the telephone line. It also permits Touch-Tone signals from all receivers, such as those used to open a guarded input, to reach the decoder.

When the patch is activated audio from the mobile receiver is disconnected from the transmitter and connected to a phone patch amplifier and the Touch-Tone decoder. The telephone line is disconnected from T2 and connected to T1; the dc path through the transformer brings up the dial tone. The audio output that monitors all receivers is disconnected from the Touch-Tone decoder so only the mobile and control receivers can transmit instructions while the phone patch is activated.

The transmitter could be keyed by a

conversation by interconnecting contacts 3 and 8 on relay K2 as shown in fig. 3. To have only the telephone party's side of the conversation repeated, omit the jumper between contacts 3 and 8, and connect 3 to ground. Details of the amplifier circuits are shown in fig. 4. They have tremendous gain and are capable of two watts output, which is what makes the impedance match of T1 relatively unimportant.

patch control circuits

The autopatch control logic, shown in fig. 5, is designed to operate with the solid-state repeater control logic described in an earlier article.² Activation of the phone patch requires two Touch-Tone digits in the proper sequence to set flip-flops U1 and U2. When U2 is set by

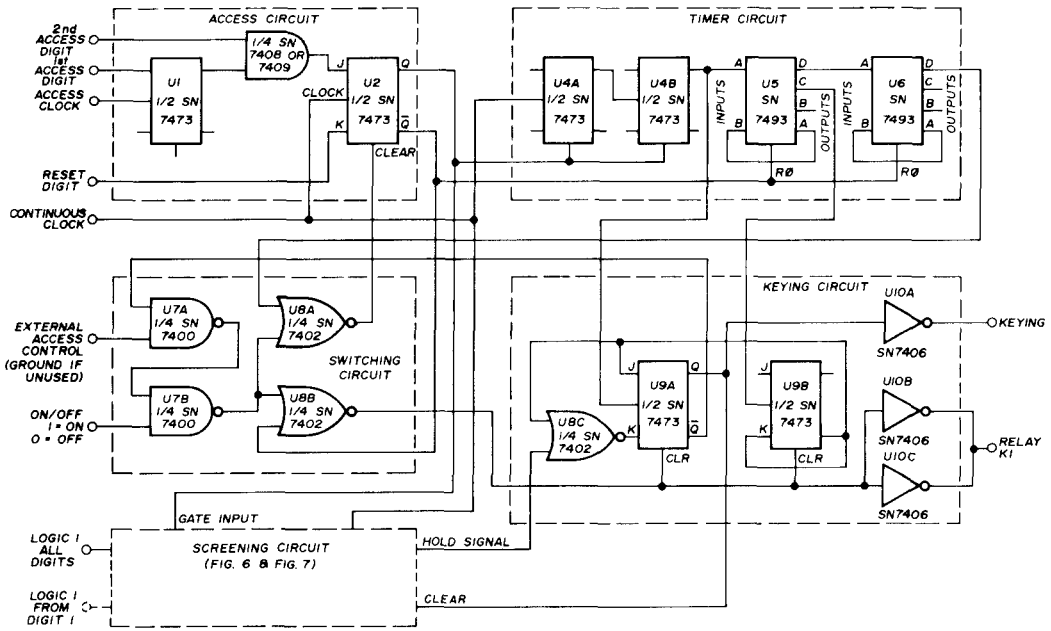


fig. 5. Control logic for the versatile autopatch system. Screening circuits are shown in figs. 6 and 7.

the final digit of the code, several things happen. The logic 1 at U2's Q output permits the timer to start counting clock pulses, and opens the gate to the digit screening module. At the same time, the logic zero at the \bar{Q} output actuates the main patch relay K1 through the NOR gate U8B and the two inverter drivers, U10B and U10C, connected in parallel to handle the heavy relay current.

At the end of four clock pulses, the counter sets flip-flop U9A, keying the transmitter so that the dial tone is heard on the air. The caller then dials the desired number. The first digit of the number is checked by the screening circuit, and if it is acceptable a logic 1 is generated at the hold terminal, latching flip-flop U9A.

If no telephone number is dialed, or if the first digit is unacceptable to the screening circuit, no hold signal is generated and U9A is not latched. When flip-flop U9B toggles at the end of 32 clock pulses (approximately 20 seconds) flip-flop U9A is reset, and U9B latches it

in the off position. Transmitter keying is released, and all patch logic is reset to the standby condition. This sequence effectively prevents anyone from activating the patch and leaving a dial tone on the air for more than 20 seconds. The interval can be made shorter by changing the output of U5 which is connected to the clock input of flip-flop U9B.

If an acceptable telephone number is dialed within the time allowed the patch will remain activated until released by the *reset* digit or a logic 1 from the last stage of the timer. With the circuit shown this signal is generated after 512 clock pulses, or approximately 5 minutes. The 3-minute timer on the repeater is reset each time the caller keys his transmitter by contacts 5 and 6 of relay K2 so it will not time-out the repeater as long as he doesn't let the party on the other end of the telephone talk too long.

The degree and type of protection provided can be varied to suit the user and the requirements of the situation in which the autopatch system is to be used.

Security of access can be increased over that provided by the integral two-digit code by adding an external access module. This module can be used to control the *access clock* input to flip-flop U1, or provide a logic zero at the *external access control* terminal (this terminal should be grounded if no external access control is used). The external access module can also be wired to disable the transmitter while the two digits that activate the patch are received and decoded, helping to preserve their secrecy.

Another protective feature that can be varied to suit the user is the screening circuit. The simple circuit shown in fig. 6 will only insure that some number is dialed—in other words, that a dial tone is not left on the air until the repeater times out. As explained earlier, failure to dial at least one digit will deactivate the patch in 20 seconds.

Adding another AND gate and dual flip-flop as shown in fig. 7 provides protection against long-distance calls. As in fig. 6, flip-flop U1A will be set by the first digit dialed after the access code. However, if this digit is a 1 (long distance) flip-flop U1B will also be set, and both U1A and U1B will latch. Flip-flop U2 will not be set, no *hold signal* will be generated, and the patch will deactivate itself as though no number had been dialed. Any digit except a 1 will set U1A without setting U1B; U2 will be set when U1A is reset by the next clock pulse and will generate the *hold signal*.

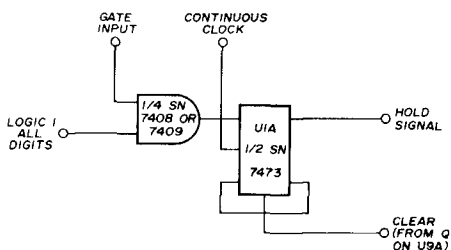


fig. 6. Simple screening circuit for the autopatch control logic. Dialing any number will hold the patch in the active condition (see text).

conclusion

Many other control variations are possible. A counter can be incorporated in the screening circuit to count the digits and deactivate the patch if too many or too few are dialed. External switching

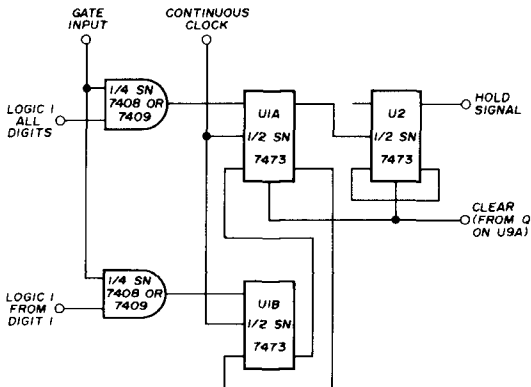


fig. 7. This screening circuit for the autopatch logic control system includes provision for locking out long-distance calls.

modules can be used to screen out the three-digit prefixes for weather reports, time signals and exchanges that are toll calls. The timer can also be connected to key the transmitter long enough for the dial tone to be heard, and then silence the repeater while the telephone number is being dialed. An external circuit can be added to override the five minute time limit and provision can be made to put the repeater in a standby mode at night—silent until the patch is activated by an emergency code. What you do with this circuit is truly limited only by your own imagination. I will welcome correspondence from readers interested in going beyond the capabilities of the circuit described here.

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ham radio



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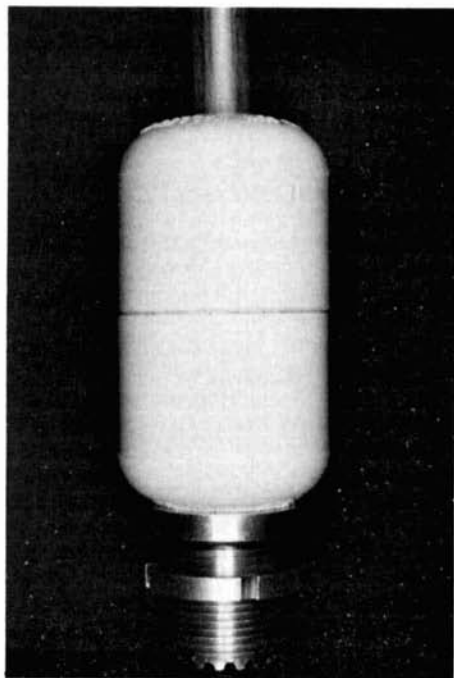
5/8-wavelength two-meter antenna

How to build
a low-cost
gain antenna
for your two-meter
mobile or base-station

The simplest way to match a 5/8-wavelength end-fed radiator to a 50-ohm feed system is to lengthen it by 1/8 wavelength with loading to make the antenna electrically 3/4-wavelength long.¹ The antenna will then present the same 50-ohm load as the familiar 1/4-wave whip. Radiation from the small loading coil will be almost nil, and the low angle radiation of a 5/8-wavelength radiator will be realized. Two-meter antennas of this type are available from several antenna manufacturers, but at rather dear prices. Described here is a 5/8-wavelength two-meter antenna which can be assembled for less than five dollars. The necessary materials are available from any hardware store, and standard hand tools are all that is needed for its construction. An electric drill is the only power tool required.

The 5/8-wavelength radiator is a replacement-type adjustable automobile antenna. The one I used was purchased from Allied Radio Shack for \$1.39 (catalog number 12-1309). Many auto supply stores also carry these antennas, and any of them that will extend to 48 inches (1.22 meters) should be satisfactory.

fig. 1. Completed loading coil for 5/8-wave two-meter antenna. The type-uhf fitting at the base lends itself to a variety of mounting methods, and a replacement-type automobile broadcast antenna slips handily over the 5/16-inch brass rod on the top.



Dave Sargent, K6KLO, 5343 Clovercrest Drive, San Jose, California 95118

With the radiator portion of the antenna taken care of, all that is needed is a loading coil with a good mechanical base. Many approaches were considered, but none were going to be easy to construct. I finally tried the design shown in fig. 4, which went together successfully on the first try. All parts are labeled in the drawing. The 1/2-inch (12.7-mm) PVC plastic pipe caps cost about a quarter. Half-inch (12.7-mm) PVC pipe is usually available in ten-foot (3-meter) lengths for about fifty cents. Only two inches (5.1 cm) of pipe is needed, but the remainder may prove handy for some other project. Some number-16 copper bus wire for the coil, some epoxy, about two inches (3 cm) of 5/16 inch (7.9 mm) diameter brass rod, and a uhf coax connector (UG-266/U) or a piece of 3/8-24 (standard U.S. mobile mount) threaded brass stock round out the bill of materials. Although other coax connectors may be used the UG-266/U is best. A special PVC cement is available which is better than epoxy for gluing the plastic parts together.

fig. 2. PVC pipe cap with the UG-266/U coax connector installed.

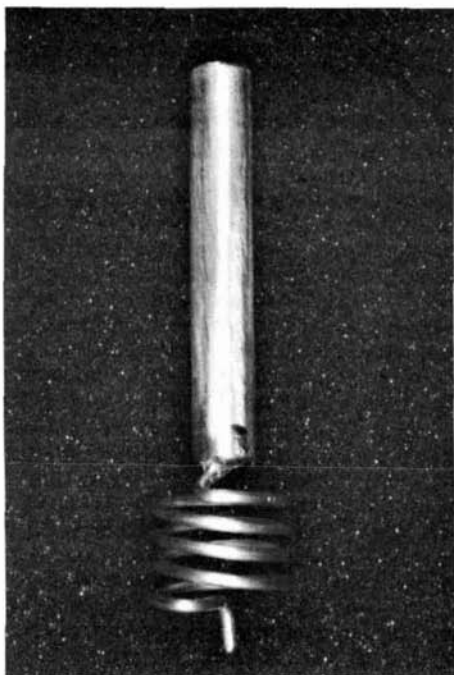


fig. 3. The loading coil is soldered to a hole drilled in the end of the brass rod, which then slips through a hole drilled in the top PVC cap.

coil assembly

To start the assembly, glue a two-inch (5.1-cm) piece of PVC pipe into one of the caps. The cap and pipe are then filled with about 3/4 inch (19 mm) of epoxy. This filling provides support for the 5/16-inch (7.9-mm) diameter rod used to mount the whip. With this assembly set aside for the epoxy to cure, a 9/16-inch (14.3-mm) diameter hole is drilled into the center of the other cap for the connector. A tapered hand reamer is satisfactory for making this hole if a large enough drill is not available. Screw the connector a short way into this hole, being careful to maintain alignment. Now heat the connector with a large iron or solder gun. When it is too hot to touch, grasp it with a pair of pliers and screw it into the cap. The heat will soften the PVC enough to allow this to be done and, after cooling, the connector will be molded into the PVC as shown in fig. 2.

After the epoxy has set, drill a 5/16-

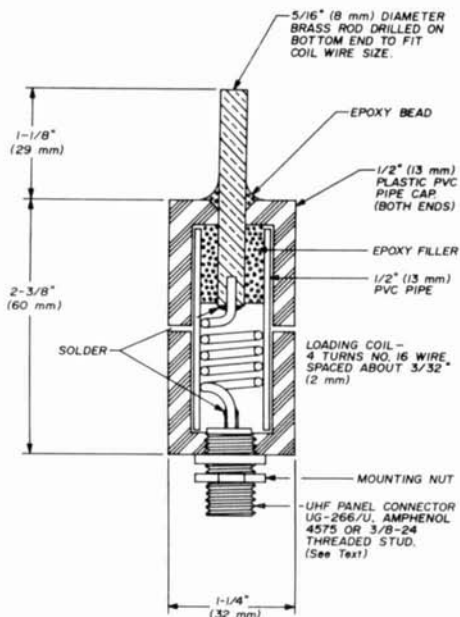
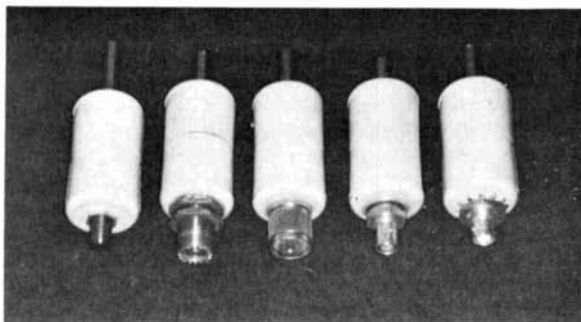


fig. 4. Cross-sectional drawing of completed loading coil assembly.

inch (7.9-mm) diameter hole in the center of the other cap. File this hole out slightly to allow easy insertion of the brass rod, bevel the top of the hole with a countersink or drill. Trim the PVC pipe to a length which will allow the caps to just come together when the halves are

Other connectors which have been used successfully are (left to right): 3/8-24 screw, UG-363/U UHF bulkhead feedthrough, UG-273/U UHF/BNC adapter, UG-492A/U BNC bulkhead feedthrough, and UG-911A/U panel jack (mounted from inside).



assembled. Wind four turns of number-16 wire on a form which will allow the finished coil to just fill the inside of the PVC pipe (about 9/16-inch (14.3-mm) diameter), and bend the ends of the coil to protrude radially from its center line.

Drill a small hole about 1/2-inch (12.7-mm) deep into one end of the 5/16-inch (7.9-mm) diameter brass rod and solder one end of the coil into it as shown in fig. 3. Solder the other end to the center terminal of the coax connector. Slip the top cap and PVC pipe assembly over the coil and rod to check the fit of the entire unit.

alternate mounting

In many mobile installations it is desirable to have the antenna screw into a standard mobile mount. In this case, the bottom cap should be drilled out with a size Q (about 21/64 inch or 8.4 mm) drill. A 3/8-24 threaded stud can then be heated and inserted in the same way that the connector was. A hole in the inside end of the stud should be drilled and tapped to provide a place for a solder lug for soldering the coil. Finally, a 3/8-24 nut should be run up the stud and tightened against the plastic cap. About 1/8 inch (3.2 mm) of the stud should protrude inside the cap, and some epoxy filler should be put around it to increase the strength of the base. This is necessary because the stud has 1/4 inch (6.4 mm) less diameter than the connector and might break out of the plastic if sufficient stress were placed on it.

Before the assembly is sealed, its operation should be checked. For mobile installations, mount the antenna on an appropriate mobile mount. For a good match the base should be close to the car body, so do not use a large base spring.

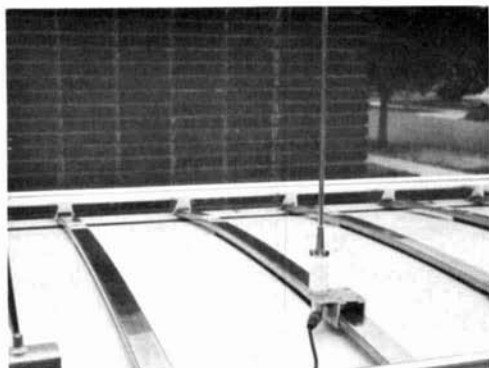


fig. 5. The 5/8-wave two-meter antenna installed on the roof of the author's station wagon. The set screws for mounting the whip have been replaced by thumb screws to permit quick removal for entering the garage.

For most installations, the connector is mounted to an angle bracket through a hole, and four or more 20-inch (51-cm) radials must be added. In either case, adjust the whip to 48 inches (1.22 meters) and check the vswr. If it is not close to 1:1, adjust the whip length for minimum reflected power. If the whip needs to be lengthened the loading coil inductance needs to be increased; a shorter whip length means the coil requires less inductance. A whip adjusted to slightly shorter than 48 inches (1.22 meters) is acceptable, but whips of longer lengths should be avoided since undesirable high angle lobes will increase, and the low angle lobe will be weakened.

After any needed coil adjustments are made, coat the lower 3/4 inch (19 mm) of the brass rod with epoxy. The bottom cap may now be glued in place and a bead of epoxy placed in the beveled edge around the top cap as shown in the cross-section drawing, fig. 4. The final assembly is now a rugged, air-tight unit equal in performance to expensive commercial gain antennas. It is well-suited to a variety of mountings such as the one used on the K6KLO station wagon in fig. 5.

reference

1. R. L. Crawshaw, "5/8 Wavelength Verticals," 73, May, 1970, page 36.

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a vhf radio observatory

An interesting report
on the relationship
between the sun
and the
earth's weather,
using data
obtained at vhf

Ron Ham, Faraday, Greyfriars, Storrington, Sussex RH204HE, England

For many years prior to 1968 I had frequently heard solar radio noise whilst using vhf communications receivers for atmospheric studies. I realised these bursts of metre-wave radio noise were telling me that a solar event had taken place, and that a stream of complex particles may be heading toward earth. If the timing were right, these solar particles would enter earth's atmosphere and cause an aurora or disturb the natural state of the ionosphere, which would cause the normal propagation of a variety of radio signals to be upset.

With this in mind, I decided to build a radio telescope to give me prior knowledge of solar activity and to include this information in my propagation reports to the radio organizations.

the radio telescope

The aerial consists of four Yagis, each having four elements, mounted on a 10 x 6-foot (3 x 1.8-meters) wood frame, which is covered with a ½-inch (13-mm) wire mesh for the reflector. The whole reflector framework is hinged on its bottom rail so that its altitude can be adjusted periodically to keep the sun within its vertical beamwidth. The aerial faces south, and the earth drift principle is used for the azimuth adjustment.

The working frequency selected for the radio telescope is 135.95 MHz,

because at my location this frequency is free from terrestrial interference and the radio noise associated with sunspots can be very strong at this frequency.

The solar radio waves are fed to a crystal-controlled transistor converter mounted behind the aerial reflector. The intermediate frequency of 26 MHz, produced at the converter, is fed on underground coaxial cables to an i-f amplifier and detector. The dc voltage at the detector is amplified by a type 709 integrated circuit to drive a pen recorder.

The completed instrument was put into operation on June 1, 1968, and was soon producing results. Daily observations, which are controlled by a time switch, start when the sun enters the antenna beam at 1130 gmt and terminate at 1330 gmt; during this period, five feet (1.5 meters) of paper chart are produced from the recorder.

solar activity

As time passed, two features of solar activity emerged from the daily recordings. First was the burst of radio noise (fig. 1) and second was the noise storm (fig. 2). The individual solar burst may last only a few minutes, whilst the noise storm may continue for several days. The radio noise from a solar event is received 8.3 minutes after it has taken place, but the streams of nuclear waste, which are ejected by the sun at the same time, may take up to 40 hours before reaching the earth's orbital path.

The author is an amateur radio astronomer and a Fellow of the Royal Astronomical Society. For many years he has operated a radio observatory from his home in Sussex, England. Data from author Ham's observations have been supplied to the Radio Society of Great Britain, the International Amateur Radio Union (Region 1), and the British Astronomical Association. His equipment operates on 135.95 MHz, which favors the "active" sun noise. Although no technical data on the author's receiver are supplied with his article, it would appear that any good vhf converter could be used to duplicate the author's set for those who wish to expand their knowledge in this area. **Editor.**

The first "prize" observation came on November 1, 1968, when an Aurora Borealis was evident at the climax of a noise storm, which my telescope had been recording for several days. The great Auroras of March 8, 1970; August 5, 1972; and April 1, 1973, followed prolonged periods of solar activity, which had been recorded by my instrument. Throughout the five-year life of my radio telescope, many atmospheric disturbances

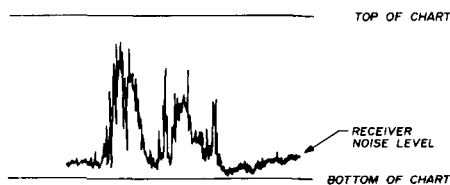


fig. 1. Four-minute burst of solar data recorded at 1308 gmt, June 29, 1973.

have been associated with solar activity. From the time I built this instrument, my friends in the radio world have been interested in its results and frequently have asked me for information to complement their studies.

objectives

The daily routine at my observatory consists of checking several vhf radio frequencies looking for the effects of Aurora, sporadic E, or tropospheric disturbances and then attempting to associate these effects with the results from the solar observations. In addition to the radio work, I record rainfall, humidity, temperature, wind speed and atmospheric pressure data for correlation with tropospheric openings. When possible I also log the "freak" weather disturbances that are large enough to justify the attention of the national news media.

solar activity and the earth's weather

Through keeping records of solar and atmospheric events I noticed that during or soon after I had recorded a noise storm

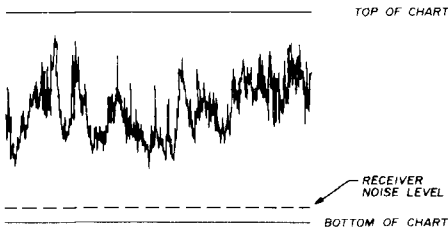


fig. 2. Eight-minute sample of solar activity recorded on August 7, 1972 during a storm that occurred August 1-9.

the news media were likely to report (somewhere on earth) a freak, or violent weather event, often with tragic loss of life and/or extensive damage to property. The following examples illustrate the typical weather news reports coinciding with recorded solar storms that set me

date of solar storm	date of news report	date of solar storm	date of news report
1970 - Nov. 11 to 22	20th. East Pakistan flood disaster.	1972 - Feb. 12 to 23	14th. 100-mph (161-kmh) gales in southern France. 18th. Freak storms in Australia. 20th. Flooding in New York.
1970 - Dec. 17 to 23	The unpredicted "White Christmas" in Europe with severe blizzards. (Some countries had snow for the first time.)	1972 - March 3 to 12	13th. Flooding in Peru.
1971 - Jan. 28 to 31	30th & 31st. Floods in Poland and Mozambique. Nine inches (22.9 cm) of rain in one day was reported from Australia. Heavy rain and snow in parts of U.K. The Thames river was at risk of flooding because of severe gales in the North Sea.	1972 - June 15 to 22	22nd. Worst floods in American history; whole towns evacuated near New York; some parts declared disaster areas.
1971 - April 9 to 18	16th/17th. Worst weather in 72 years experienced by Mount Everest climbers. 13th. BBC news report that monsoons in E. Pakistan had started a month early.	1972 - Aug. 1 to 9	2nd. Flooding in London.
1971 - July 13 to 19	18th. Freak rain storm in Seoul, Korea. 20th. Hong Kong hit by worst typhoon for many years.	1972 - Aug. 11 to 14	11th. Freak tornado reported in Holland.
1971 - Aug. 18 to 27	26th. (Stop press). Storm havoc in Spain.	1972 - Oct. 19 to 31	24th. Serious flooding in Australia. 28th. Severe gales in Icelandic waters. 20th. Severe flooding in Costa de Sol. 31st. Gales in Somalia; many dead.
		1973 - April 1 to 11	2nd. Hurricane—force winds in Holland. 10th. Some parts of USA had snow for first time. 14th. Storms in E. Pakistan; many dead.

thinking about a possible connection between these two natural events.

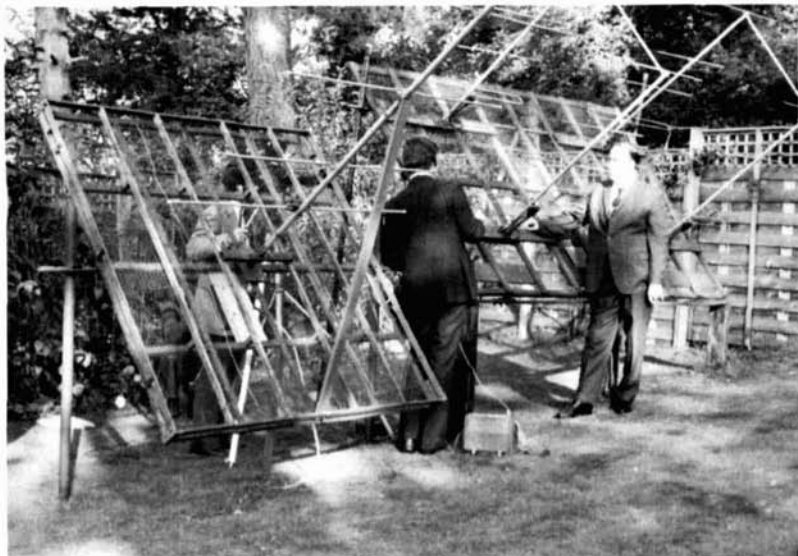
These are just a few of the reports I have gathered from newspaper items and radio news broadcasts; there may well be many more, or more detailed information in subsequent reports.

Scientific literature tells us that a connection between the active sun and the earth's weather has been known for many years, but the precise link has not yet been identified. Briefly, certain changes in climate, and in plant life, have already been associated with the eleven-year sunspot cycle. For approximately 400 years astronomers have systematically recorded the number of visible sunspots; and throughout these years, scientists have related many natural events to the existence of a large sunspot.

solar radio waves

The association of radio waves with an active sunspot has been recognized only for about 40 years; prior to this, solar observations relied on what the eye could see. Could it be that a simple amateur radio telescope has identified the particu-

talked about this matter until Jim Fisk raised the subject of geomagnetic effects on weather in his editorial of a recent issue of *ham radio*.¹ Like a shot from a gun an old friend, Brian Oddy, read this editorial and promptly contacted me to see if I had seen my copy of *ham radio*. Brian quickly pointed out that a solar



Author's radio telescope aerials. At left is a BBC cameraman behind a 90-MHz aerial. A BBC interviewer and author (extreme right) stand in front of the 136-MHz aerial.

lar sunspot activity responsible for stirring up the existing weather systems on earth? After all, we know that solar particles, which are heralded by radio noise, can upset the ionosphere; so why, by some indirect means, can't they upset the troposphere?

This sun/weather relationship phenomena caught the imagination of several friends, and it was suggested that my observations be placed on record. In August, 1971, an article containing some of these observations was published in the RSGB journal, *Radio Communication*. Since this article was published people have kindly sent me a variety of press cuttings about freak weather conditions for me to correlate with my solar recordings.

Amongst my friends, little more was

storm could upset the geomagnetic field and in turn upset the weather.

Perhaps the editorial in *ham radio* has joined together two independent observations which, as Brian suggests, have provided another vital link in the chain of events between the sun and the earth's weather.

reference

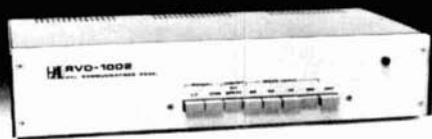
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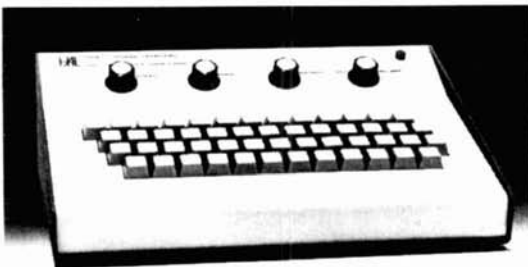
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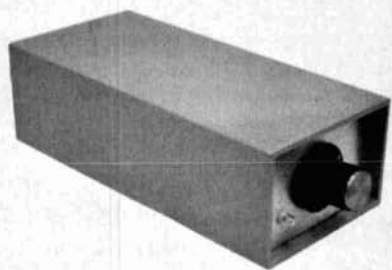
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How many times has one of your elegantly conceived projects turned into a "kluge" because the only housing you could find for it was an uninspiring standard Minibox? The satisfaction gained from building your own ham gear is determined by both performance and appearance, and it is the latter that suffers most severely from the limitations of the home workshop. As if Miniboxes weren't ugly enough, everything from office file-card boxes to a *Sucrets* can have also been used to house small electronic gadgets. Presented here, however, is a technique for fabricating your own attractive housing for that next project—one that requires only simple hand tools and is quite inexpensive.

materials

The key to this technique is rectangular cross-section extruded aluminum tubing. A shopping visit to an industrial aluminum supply house is your first step. You are looking for a stock of scrap pieces of 2 x 2-, 2 x 3-, 2 x 4- and 2 x 6-inch (approximately 5 x 5- through 5 x 15-cm) tubing. A wall thickness of 1/8

inch (3 mm) is best. Assorted lengths from 6 inches (15 cm) up are usually available from the scrap bin for a nominal price. At worst you should expect to pay \$1.50 to \$2.50 per foot (30 cm) if they have to cut it from stock. If they are very stuffy and will only talk in terms of 12-foot (3.6 meter) lengths you are at the wrong place. Besides the tubing, you will need some 0.032-inch (0.8-mm) to 0.062-inch (1.6-mm) sheet aluminum for the chassis and panels. Get a soft alloy like 6061-T4 so it won't crack when you bend it.

For finishing the metal, you will need a can of spray enamel. Sears and Roebuck epoxy enamel (catalog number 30F66258), made for painting appliances,

this determination. As shown in fig. 1, a front and rear panel are cut from sheet aluminum to fit inside the tubing and a U-shaped chassis of the required length is formed from the same material. These parts are fastened together by the controls and connectors that are mounted on the front and rear panels. This assembly is then slid into a piece of aluminum tubing which is 1/2-inch (1.27-cm) longer than it. A 6-32 x 1/4-inch (6.35-mm) flat-head screw that goes through the bottom of the case and screws into a 6-32 clinch nut located at an appropriate point on the chassis holds the chassis assembly in place.

To recap, select a tubing size and length which is adequate to house the required components, making sure to allow room for all the controls and connectors to be mounted on the front and rear panels. Cut the front and rear panels to the inside dimensions of the selected tubing. Cut the chassis material 1/4 inch (6.4 mm) narrower than the inside width of the tubing to provide a 1/8-inch (3.2-mm) clearance inside the case. Form the chassis from a sheet

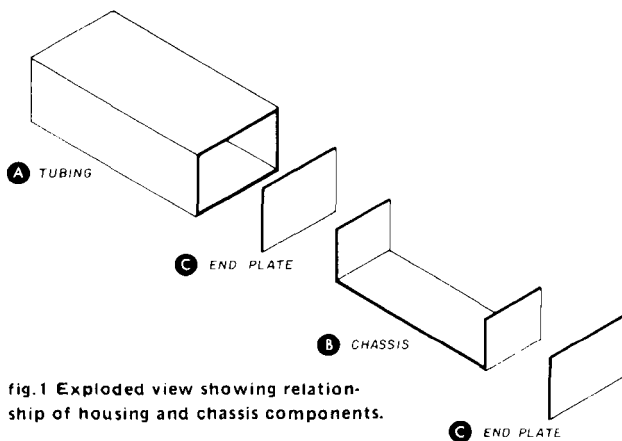


fig.1 Exploded view showing relationship of housing and chassis components.

works very nicely. Finally, you will need some 6-32 x 1/4-inch (6.35-mm) and 4-40 x 1/4-inch (6.35-mm) flat-head machine screws, and some 6-32 self-clinching nuts.*

layout

The first step is to determine what length and size of tubing will be required for your project. A little "chess game" with the components will help you make

which is as long as the required chassis plus twice the inside height of the tubing, minus 1/4 inch (6.4 mm). Cut the tubing 1/2 inch (1.3 cm) longer than the finished chassis and panel assembly. Fig. 2 is a completely dimensioned layout for a 2 x 3 x 7-inch (5.1 x 7.6 x 17.8-cm) case.

fabrication

If you can arrange access to a sheet metal shear you can cut up a supply of panels and chassis stock for the sizes of tubing you have on hand. In the absence of a shear, cut the parts a little oversize with a hacksaw or saber saw and trim them to size with a file. Delay cutting the

*Available from Small Parts, Inc., 6901 N.E. Third Avenue, Miami, Florida 33138. Part number ON632-56, 10 for \$1.15 or 25 for \$2.50. \$1.00 handling charge on orders under \$5.00; postage is included. Catalog available.

tubing until the chassis and panels are assembled. Measure the panel height minus 1/8 inch (3.2 mm) from each end of the chassis material and bend these ends up 90 degrees. Clamp the front panel to one vertical end of the chassis so that the bottom edge of the panel is flush

intended component layout, and insert the chassis assembly into the finished length of tubing so that both panels are recessed equally.

Drill a 0.187-inch (4.8-mm) hole from the bottom of the tubing through both it and the chassis at this point. Remove the

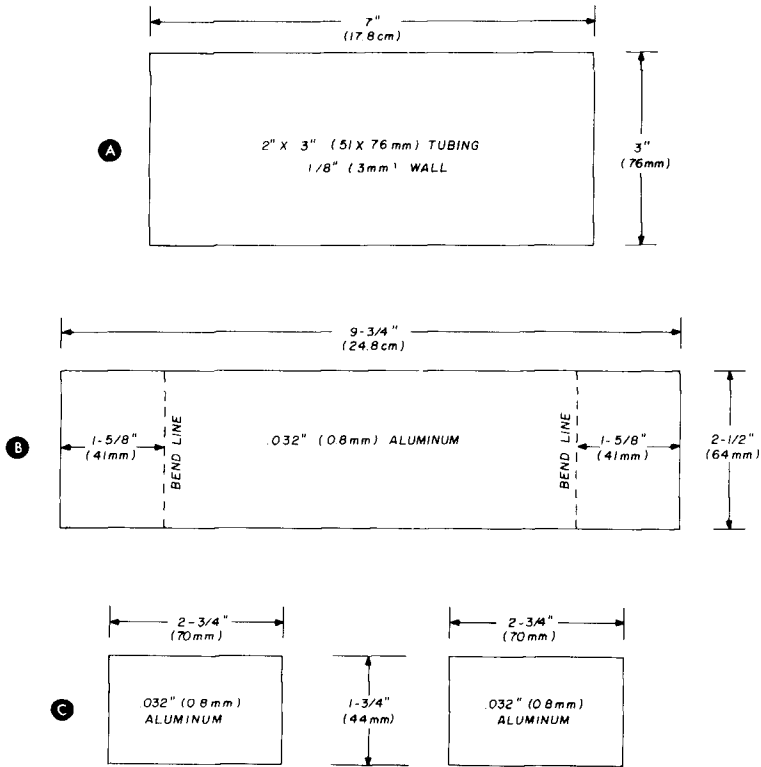


fig. 2. Dimensioned layout for components of an enclosure having a usable area of 2 1/2 x 7 x 2 inches (6.4 x 17.8 x 5.1 cm).

with the underside of the chassis, and drill the mounting holes for controls and terminals through both pieces at the same time. Repeat this process for the rear panel. Temporarily assemble the panels to the chassis using one or two of the controls to hold each end. Check to see that the assembled chassis slides smoothly into the tubing. Measure the length of the assembled chassis, and then cut the tubing 1/2 inch (1.3 cm) longer. Dress any rough edges with a file.

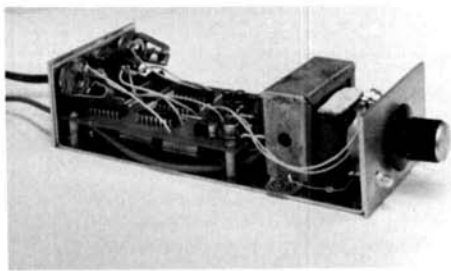
Select a point on the chassis where the clinch nut will not interfere with the

chassis assembly from the tubing and swage a clinch nut into the drilled hole in the chassis from the top. Countersink the matching hole in the tubing to accept a flat-head screw. Run a 6-32 x 1/4-inch (6.4-mm) flat-head screw through the bottom of the case into the clinch nut to lock the chassis into the tubing.

This completes the fabrication of the case. To mount circuit components to the chassis, use 4-40 x 1/4-inch (6.4-mm) flat-head screws inserted from the chassis underside, countersinking each hole to provide a smooth bottom.

finishing

Prepare the tubing for painting by giving it a light sanding. This removes surface scratches and provides a slightly roughened surface to improve paint adhesion. Next, wash the metal with hot water and detergent. To provide a completely



The Accu-Keyer removed from the case, showing how panel components hold the chassis assembly together and the technique for mounting the internal components.

grease-free surface do not touch the metal with your fingers. After rinsing with hot water, spray the case with two light coats of enamel, waiting about a half hour between coats. Carefully sanding the outside of the panels in a single direction will provide an attractive brushed-metal finish; alternatively, they too may be painted as the case was. The photographs show the popular WB4VVF Accu-Keyer packaged in this manner.

variations

As an alternative to the configuration described above, the tubing may be cut at an angle to give a "shadow" overhang at the top. The enclosure may be oriented with the short side of the tubing vertical, as in **fig. 1**, or with the short side horizontal when a tall narrow enclosure is preferred. Instead of enamel, you may wish to try a color anodizing if the facilities are available. Whichever way you go, you'll be pleased at the result.

reference

1. J.M. Garrett, WB4VVF, "The WB4VVF Accu-Keyer," *QST*, August, 1973, page 91.

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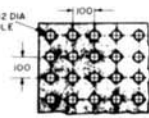


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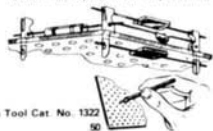
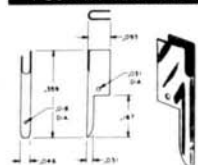
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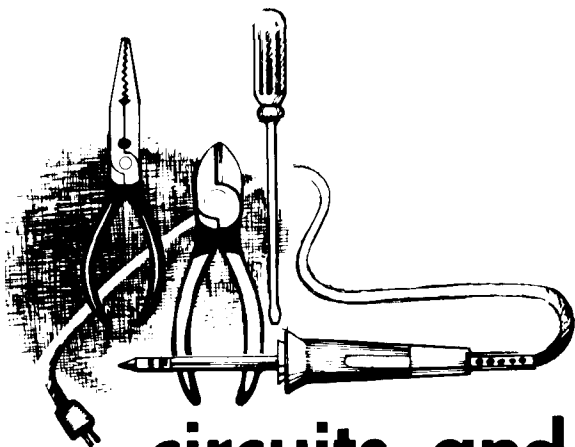
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amateurs and solar power

How would you like to operate a solar-powered ham station? You can start at the QRPP level and work up—right up to the 1-kilowatt input limit. Today the initial installation is costly at high-power

levels, but a solar power supply for low-powered equipment is reasonable and certainly will become more so as more and more amateurs go in this direction. Solar power activities are under way at W3FQJ and you will be kept informed.

some basics

First, let's put aside the notion that solar cells are only effective in bright sunlight and that only in the Southwest, with its endless clear days and bright sun, are solar-powered devices feasible. Actually, solar cells work quite efficiently even in considerable overcast. The secret is to match the installation with local average climatic conditions. The number of cells required for a specific application depends directly on the average weather conditions at the site. This simply tells us that in the East and Northeast, with their more generous portion of cloudy days, more solar cells are needed per given power demand than would be required in the sunny Southwest.

However, for each part of the country average solar energy levels have been measured for many years. Using this data you can select the proper number of cells required and add a few additional ones for good measure to accommodate a long sequence of cloudy winter days.

To make efficient use of solar light, the cell bed, **fig. 1**, must be tilted in a southerly direction. The average tilt angle corresponds with the latitude of the site (number of degrees that you are north of the equator). If your solar bed is mounted where it is readily accessible, you can make minor adjustments in this

angle in spring and fall to compensate for the somewhat different path taken by the sun across the heavens between dawn and dusk. (More exactly, in an astronomical sense, compensation is made for the changing tilt angle of the rotating earth, the sun being in a fixed position.)

A solar cell system or, more precisely, a solar energy or light energy converter, can be designed to deliver a certain amount of power in daylight. However, any solar energy system, to be worthy, should also be capable of taking care of

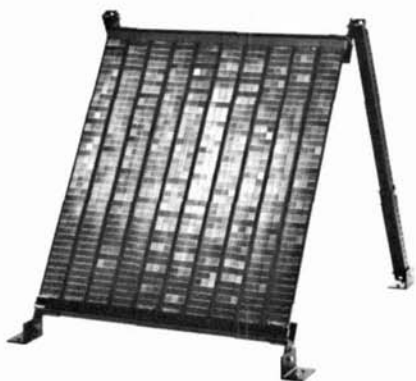


fig. 1. Light-energy converter which could be used for a solar-powered amateur radio station. (Photo courtesy Spectrolab.)

nighttime needs. In terms of electrical power energy this can be handled by chargeable batteries. Thus a 24-hour, all-year system requires a light energy converter and a battery pack. Such a system can be combined into a completely self-sustaining and unattended installation.

An alternative manual system would be one that would permit daytime operation from the solar converter; nighttime operation would be by battery. However, the battery's capacity would have to be such that it could handle the nighttime operating hours and power demand. This battery would be charged to desired

capacity sometime during the day using the light energy converter.

The two big factors in planning a successful solar power system involve the power requirements and how these demands can be met by a solar converter. The criteria for the latter were mentioned previously. Next consider how the average power demand can be estimated. A voltage requirement must be met. This is accommodated by the number of individual solar cells that are connected in series for the solar converter. Load current must be averaged on the basis of day-night operations and then over a long-term solar-year basis.

A practical approach is to determine the ampere-hours required per day. This figure can be averaged for the solar year. Current demand evaluation should also be established for nighttime operation as an aid in choosing a battery source with the required ampere-hour capability. Peak power is also a consideration in determining the peak current demand at any time to make certain the solar converter and battery pack are capable of delivering this current level. After the power requirement evaluations are made, the solar energy converter is designed to deliver at least this amount of voltage, current and power based on the solar conditions at the mounting site.

A small safety factor may be advisable although initial cost can be kept down by not exaggerating possible power requirements. It is no great problem to add additional solar beds later if an increase in power demand is anticipated.

A functional diagram of a complete, unattended system is shown in fig. 2. Only a few basic components are needed in addition to the light energy converter and batteries. A charging diode is needed to present a conducting path between the converter and the batteries to be charged. This diode acts as a one-way path, preventing the batteries from discharging into the converter when they have been fully charged. This completes the power source when using lead-acid storage

batteries. An additional voltage regulator may be advisable to prevent overcharge of nickel-cadmium batteries. Conductors, of course, should have adequate size to minimize IR losses. Too great an IR drop between converter and battery results in inadequate charging current.

like batteries, to obtain a desired converter voltage. Likewise, the current capability is increased by connecting the cells in parallel. This series-parallel grouping of cells into an array permits the construction of a bed of solar cells that will supply the voltage and current needs

table 1. Standard 12-volt LECTM solar-power arrays manufactured by Spectrolab.

array model number	approximate dimensions (inches)	current output	amp-hours generated under various per day solar conditions ²			approximate weight (lb)
			poor	average	good	
12V 300 mA	37 x 3 x 3	300 mA	1.1	1.3	1.6	3.8
12V 600 mA	37 x 6 x 3	600 mA	2.2	2.6	3.1	9.3
12V 900 mA	37 x 9 x 3	900 mA	3.3	3.9	4.7	14.0
12V 1.2 A	37 x 12 x 3	1.2 A	4.4	5.2	6.3	18.6
12V 1.5 A	37 x 15 x 3	1.5 A	5.5	6.5	7.9	23.3
12V 1.8 A	37 x 18 x 3	1.8 A	6.6	7.8	9.4	28.0
12V 2.1 A	37 x 21 x 3	2.1 A	7.7	9.0	11.0	32.6
12V 2.4 A	37 x 24 x 3	2.4 A	8.9	10.4	12.6	37.3
12V 2.7 A	37 x 27 x 3	2.7 A	10.0	11.7	14.1	41.9
12V 3.0 A	37 x 30 x 3	3.0 A	11.1	13.0	15.7	46.6
12V 3.6 A	37 x 37 x 3	3.6 A	13.3	15.6	18.9	55.9
12V 4.2 A	37 x 43 x 3	4.2 A	15.5	18.2	22.0	65.2
12V 4.8 A	37 x 49 x 3	4.8 A	17.7	20.8	25.2	74.5
12V 5.4 A	37 x 55 x 3	5.4 A	20.0	23.4	28.3	83.8
12V 6.0 A	37 x 61 x 3	6.0 A	22.2	26.0	31.5	93.1
12V 6.6 A	37 x 67 x 3	6.6 A	24.4	28.6	34.7	102.4
12V 7.2 A	37 x 73 x 3	7.2 A	26.6	31.2	37.8	111.7

1. Minimum current output under Standard Test Conditions (STC) Intensity = 100 mw/cm²; Temperature = 0° C to + 60° C.
2. Usable energy generated for use in a solar power supply system with lead-acid storage batteries under typical conditions and based on annual mean solar radiation data for various locations in the contiguous United States.

Silicon solar cells are light-sensitive semiconductor devices. P- and N-type impurities are added to a basic silicon crystal. For example, the basic wafer can be a P-type semiconductor. An N-type layer can then be diffused a certain depth into the wafer, fig. 3. A P-N junction is formed between the two layers. When light is directed onto the junction, electron and hole carriers are formed by the impacting light photons. The hole carriers move to the N-type region; electron carriers, to the P-type region. This motion of charges across the junction constitutes an electric current. The path is completed through the external circuit.

A single solar cell has only a small voltage drop and a limited current capability. Cells are connected in series, just

of the light-energy converter. All of these must then be assembled in a durable frame and support structure, fig. 1, including output terminals.

The assembly must be made as impervious as possible to weather and other environmental extremes. A bracket arrangement is needed for obtaining the proper tilt of the array at the mounting site. The solar cells themselves are not exposed to the elements because they are protected by an efficient transparent coating that provides proper diffusing and channeling of the arriving light energy. Even with considerable icing the conversion efficiency remains high.

The directional diode is usually a silicon type, selected with proper voltage rating and adequate current-carrying

capability. Keep the diode voltage drop as low as possible.

The chart of **table 1** shows the standard 12-volt light energy converter array made by Spectrolab.* The first unit, about three-feet (92-cm) long and three-inches (75-mm) wide, supplies 12-volts at

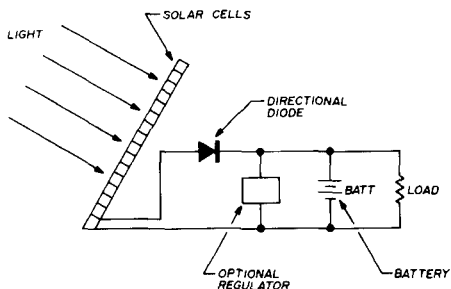


fig. 2. Circuit for a basic solar energy converter and battery system. Battery is recharged during the day, provides power at night.

300 milliamperes. This is the minimum current under standard test conditions. This standard test condition corresponds to the solar intensity at noon on a clear day when the temperature is 77°F (25°C). In designing the system it is necessary to derate current values on the basis of higher operating temperatures. This is done in the design of the particular array module to be used at a given site. The three-column, ampere-hours specifications are interesting since they represent the useful ampere-hours that can be supplied by a solar power supply system using lead-acid storage batteries. These typical conditions are based on annual mean solar radiation data for various locations in the continental United States.

batteries

Battery quality is an important consideration. Low-cost lead-acid cells can be charged by solar converters of adequate size. However, for all-day, all-year, uninterrupted service, batteries should be

*Spectrolab, 12500 Gladstone Avenue, Sylmar, California 91342.

selected more carefully if initial cost and efficient operating conditions are to be achieved. Inexpensive types have a high cell-discharge rate and perhaps a two-to-four year potential life. However, high-quality lead-acid storage batteries are made by various manufacturers. Some of these have a self-discharge rate as low as 10 to 15 percent per year, and have a lasting capability of 10 to 15 years in a properly designed solar power supply. Nickel-cadmium batteries do very well.

The storage capacity of the battery should be based on peak daily use, considering also the number of days such a system may need to operate at reduced solar intensity. In an optimum system it is customary to incorporate approximately seven days of reserve battery capacity so as to preclude system failure under several days of very low light levels.

Some quality lead-acid batteries have a charging efficiency of 95%. This means that 95% of the power delivered to the battery ends up as charge. Thus, considerably less power must be delivered from the solar energy converter for a given level of battery charge.

amateur requirements

Radio amateur applications in general would not be nearly so stringent. There is

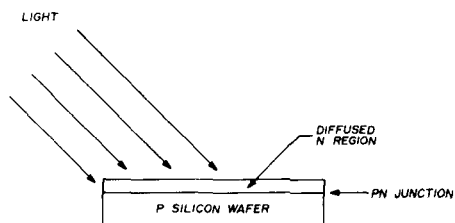


fig. 3. Construction of the basic silicon solar cell.

no need for all-day, all-night and all-year uninterrupted capability. Perhaps the only exception would be for the operation of a solar-powered fm repeater. Consider how many hours per day you operate your station. What is the longest span of continuous operation, on the

average? Do you operate every day? When you are on the air what is the ratio of your transmit time (when power is drawn) compared to your receive and listening time? All of the above factors mean that the power requirements of any solar energy converter for the usual amateur radio application can be much more modest than the restrictions of commercial use.

Is the average amateur on the air more than 2 to 3 hours per day? Even though a station may be on the air each day, the total hours may actually be less than 12 per week. No doubt the actual transmit time is less than half of the total amount. It would be interesting to go through your log and determine just how many operating hours you have per month. When your total operating hours are this modest, solar power could be quite feasible, even for a 200-watt PEP sideband transceiver.

Some sample figures will help to clarify power demand. Assume a solid-state transmitter that would draw 8 amperes from a 12-volt source. If the transmitter were on continuously drawing maximum power, a 60-ampere-hour storage battery would operate the unit for 5-6 hours on one charge. However, the actual transmit time is perhaps less than 50% of total operating time. Hence the battery would not discharge completely in six hours (complete discharge is to be avoided). Furthermore, using sideband transmission, the heavy demand is only made on those occasional modulation peaks. It is apparent that a good number of operating hours are feasible with a single charge of a good quality 12-volt battery.

If the battery has a 120-ampere-hour capability, a single charge might be adequate for a good number of operating hours per week. A trickle charge from a solar converter could readily maintain battery charge. In fact, you would probably not even require continuous connection to the solar converter. Charge time during two or three clear days of the week would be adequate in most cases.

Admittedly, at present production the cost of such a solar converter would be substantially higher than a conventional mains-powered battery charger. However, with proper care the life of such a converter would be 15 years or more for the present state of the art. It offers a practical means for conserving precious electrical energy and would be especially useful for those locations where no electrical power is available for a battery charger. Here is an answer for those amateurs in countries plagued by electrical black-outs and brown-outs.

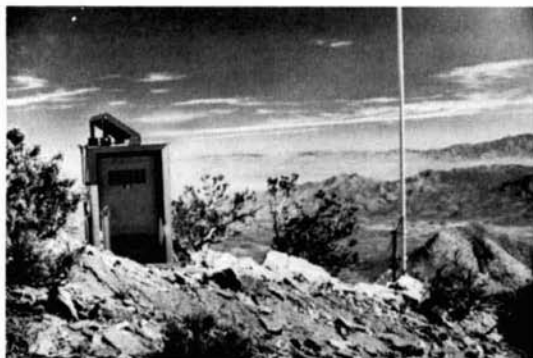


fig. 4. Solar power site installed by the Bureau of Land Management at Clark Mountain, California. (Photo courtesy Spectrolab.)

low-power transmitters

At the QRP and QRPP levels it costs very little to get involved with solar energy conversion and gain a knowledge of the technique. Off-the-shelf photocells and associated components can get you started at the 100-milliwatt level. Daylight operating power is no problem at all. The addition of a nickel-cadmium battery (very low-powered in terms of ampere/hour charge and therefore inexpensive) will give you nighttime operation as well.

Going up to 1 or 2 watts involves very little additional cost. An upgrade to 5 to 10 watts requires a few bucks but adds fun, satisfaction and versatility, even to powering a low-powered sideband transceiver.

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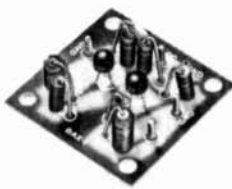
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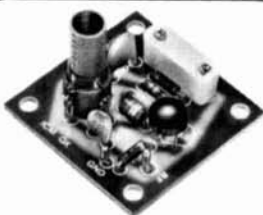
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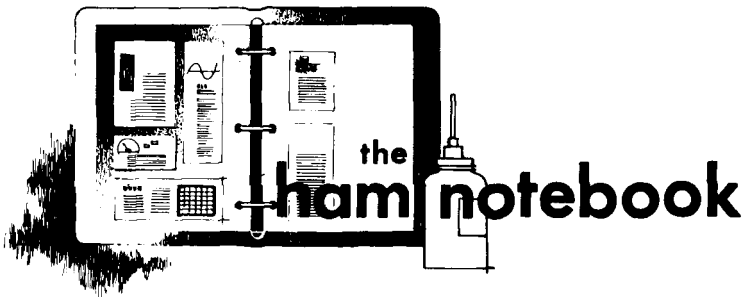
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precision voltage supply for phase-locked terminal unit

A previous article in *ham radio* described a phase-locked loop RTTY tuning unit which requires a stable, well regulated source of +12 volts.¹ Author W4FQM suggested using a commercially available power supply and described it as, "quite a buy for only \$38.00." Well, hold on to your money fellows, and read on.

Fig. 1 shows the schematic of the precision supply. A full-wave bridge rectifier feeds the regulator. The value of C1 provides sufficient filtering with the regulator rejecting any remaining ripple. Resistors R1 and R2 determine the output voltage based on the following manufacture data sheet equations:

$$R1 \approx (2V_{out} - 7) \text{ kilohms}$$

$$R2 = 6.8k$$

Resistor R_{sc} and transistor Q1 provide short-circuit protection for the regulator. When the output short-circuit current

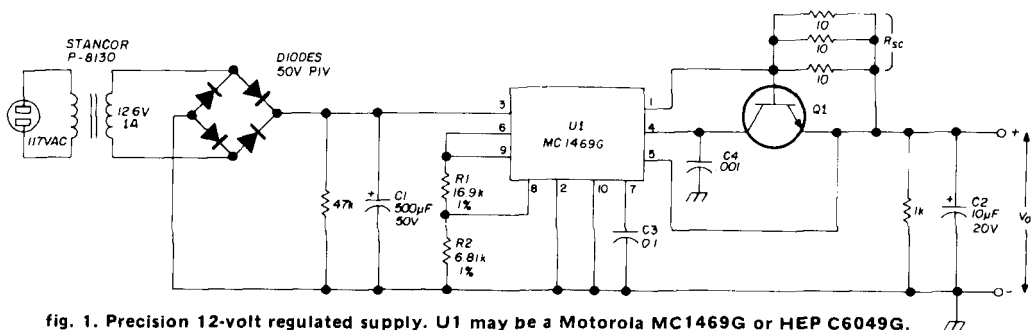


fig. 1. Precision 12-volt regulated supply. U1 may be a Motorola MC1469G or HEP C6049G.

The power supply described here uses an IC voltage regulator, Motorola MC1469G, and two precision 1% resistors as special parts. Everything else should be available in the average RTTY enthusiast's junk box. Except for these specific parts, other values and part types are not critical.

(I_{sc}) creates a voltage drop across R_{sc} large enough to turn Q1 on, the regulator output is limited by the saturated collector-emitter across pins 4 and 5. The value of R_{sc} is determined by the equation $R_{sc} \cong (0.6/I_{sc})$ ohms and $C_2 \leq (250/R_{sc}) \mu F$, where I_{sc} is expressed in amperes and C_2 is 250 μF maximum.

performance

The design I tested uses the values shown in the schematic. With the three 10-ohm resistors in parallel, the value of I_{sc} measured was 200 mA. For a nominal load current of 50 mA the output voltage was 12.235 volts. Changing this load current ± 10 mA caused the output to

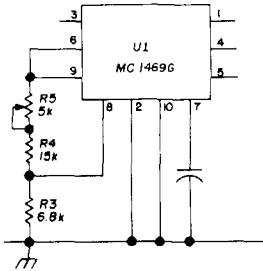


fig. 2. Alternate resistor configuration for the 12-volt regulated supply. R5 is a miniature multiturn potentiometer.

vary ± 1 millivolt. This corresponds to a load regulation of $\pm 0.008\%$. The power supply showed a 0.01% change in output voltage with a 7% change in the input ac voltage. Both of these characteristics more than satisfy the $\pm 0.1\%$ regulation requirement of the PLL.

The output voltage was designed for a nominal 12.0 volts and measured at 12.23 volts. This is explained by the approximately equals sign in the equation for resistor R1. The absolute value of the output is not critical so long as the output is stable.

construction

Layout and construction of the circuit is not critical except that the manufacturer recommends the $.001\text{-}\mu\text{F}$ capacitor on pin 4 of the MC1469G IC must have short lead lengths for regulator stability. Vector boards and point to point wiring is a lot easier than trying to design a one-time printed-circuit board. Sockets were used for the IC and Q1 but are not necessary. Just make sure when soldering the leads that a heatsink is used and all soldering is done quickly to avoid overheating.

The alternate configuration shown in fig. 2 can be used in place of the 1% metal-film resistors for R1 and R2. Resistors R3 and R4 are carbon composition resistors and R5 is a multiturn trimpot or a fixed composition resistor. Specific values of R4 and R5 are not important so long as they can be varied over the range of desired output voltage. The use of carbon composition resistors will degrade the long term stability of the supply but should not significantly effect TU performance.

Transistor Q1 is any general purpose npn silicon transistor. Rectifier diodes should be greater than 50 volts PIV. A clip-on TO-5 heatsink is used as a precaution because the regulator dissipates approximately 300 milliwatts.

Elliott Lawrence, WA6TLA

reference

1. Ed Webb, W4FQM, "Phase-Locked RTTY Terminal Unit," *ham radio*, January, 1972, page 8.

Collins S-line power supply mod

I found that I had to readjust the idling current potentiometer in my Collins 516F-2 S-line power supply quite frequently due to changes in the 117-volt ac power line. Connecting two 36-volt 400-mW, 5% zener diodes (1N974Bs) in series from the junction of R8 and R9 to ground as shown in fig. 3 takes care of the problem nicely.

Ralph Cabanillas, Jr., W6IL/CT1HO

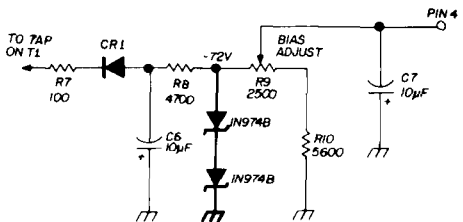


fig. 3. Negative bias portion of Collins 516F-2 power supply, showing two 36-volt zener diodes added to regulate the bias.

new products

communications receiver



Yaesu Musen has just introduced a new solid-state communications receiver, the FR-101S, with provision for all-mode reception on twenty-one 500-kHz amateur and shortwave bands from 160 through 2 meters. This new receiver is designed to be used in transceive, if desired, with the new FL-101 transmitter which is to be introduced in the near future. New solid-state technology, with features such as a doubly-balanced mixer, offer excellent rejection of cross-modulation and intermodulation interference. The FR-101S, which copies a-m, fm, ssb, CW and RTTY, has less than 100 Hz drift in any 30-minute period after warmup. Sensitivity is 0.5 μ V for 10-dB

signal-to-noise ratio on ssb and CW, 1.0- μ V for 10-dB signal-to-noise ratio on a-m and 12 dB SINAD on fm, comes complete with 2.4-kHz, 4.0-kHz and 0.6-kHz crystal filters (1.5-kHz, 12-kHz and 45-kHz filters are available as optional accessories). Image rejection is 60-dB minimum and audio output is two watts into 4 ohms.

The FR-101S, which tunes the 160-, 80-, 40-, 20-, 15- and parts of the 10-meter band in standard trim, can be used on six and two meters and other shortwave bands with optional accessories. Priced at \$499, this new receiver is available from Yaesu Musen USA Inc., 7625 East Rosecrans Avenue, Unit 29, Paramount, California 09723. For more information use *check-off* on page 94.

scanner-monitor servicing data

A new edition of Howard Sams' popular *Scanner Monitor Servicing Data* is now available. This new volume, third in a series, covers many of the popular Regency units including the MT-15S, TME-16H/L, TME-16H/LH/U, TME-16H/LL/U, TME-16H/LM/U, TMR-1H, TMR-1L, TMR-4H, TMR-4L, TMR-8H, TMR-8L, TMR-8H/LH, TMR-8H/LL and TMR-8H/LM. Included are schematics, parts lists and complete service adjustments. Other scanners covered in this new volume are the Electra Jolly Roger; Johnson Hi/Lo Duo Scan, UHF/VHF Duo-Scan, UHF Mono-Scan and VHF Mono-Scan; Midland 13-914; Pearce-Simpson Cherokee 8+8, Cheyenne 8 (PR-78) and Comanche 16 (PR-160). Available for \$5.95 postpaid from Ham Radio Books, Greenville, New Hampshire 03048; order book number SD-3. Earlier volumes SD-1 and SD-2 (\$4.95 each), which provide the same sort of complete servicing data on other scanner units, are also available.

slow-scan monitor



Venus Scientific has introduced their new SS2 Slo-Scan Monitor. This Monitor is the second generation of Slow Scan with many features not previously available on the market. These features include Accu-Sync,TM a diagnostic and tuning aid which converts the SS2 Monitor to an oscilloscope by the flip of a switch, LED sweep indicators for ease of servicing, camera adapter provision which enables you to take Polaroid photographs right off the air with the P-1 Camera Adapter and simplified independent controls.

The SS2 Monitor's picture size is 4-7/16-inch (11.3-cm) diagonal, 3-1/4 x 3-1/8 inch (8.3 x 7.9 cm) with 128 lines. It has a 15-Hz line rate and a 8-1/2-second frame rate. Video input modulation is fm, 1200 to 2300 Hz. Complete details may be obtained from Venus Scientific, Inc., 399 Smith Street, Farmingdale, New York 11735, or use *check-off* on page 94.

rf clipper



Holdings of England has introduced a unique new rf clipper for use with the Yaesu FT-101, Mark 2, that is used on both transmit *and* receive. The extra sideband filter provides a noticeable

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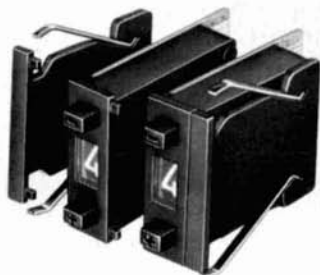
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improvement in adjacent channel selectivity on receive, and since the gain is added after the filter, this gives improved agc action with an *apparent* improvement of cross-modulation performance. The no compromise, all fet design uses a high quality input filter that matches the ssb filter supplied with the FT-101, Mk 2. A diode switch on the output control, in conjunction with a controlled fet stage, adjusts the gain independently on both receive and transmit. On receive the gain is set to give a boost of approximately two S-units.

This rf clipper, which should not be confused with normal clippers which are often no better than a good quality microphone, is wired to an octal plug which fits into the vfo socket. *No modification* of any kind is required to the FT-101, Mk 2 (device cannot be used on earlier FT-101). Normal operation without the clipper is restored in seconds by inserting a shorted octal plug. Units will be shipped from England via airmail. For more information write to Holdings Ltd., 39/41 Mincing Lane, Blackburn BB2 2AF, England, or use *check-off* on page 94.

bi-directional code switches



Alco Electronics' new SMC Series bi-directional pushbutton code switches maximize reliable performance in a small package. These modules occupy a panel area only 0.945-inch high by 0.3-inch wide, yet the position indicator numerals are an easy-to-read 0.2-inch high. The compact size is ideal for compact portable and mobile applications. Push-

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Available standard codes include conventional BCD (8-4-2-1), BCD with complement, and decimal (1-of-10) formats, all 10-position types. The numerals of the visual readout are 0 through 9, corresponding to the electrical output codes. Electrical contact surfaces are gold plated for long, trouble-free life.

Possible applications for SMC switches include control of frequency synthesized tuners, channel selectors, and preset counters and timers. For special applications, such as 2-meter fm tuners, dummy switches (nonfunctioning, but identical in appearance) are available, with fixed numeral (e.g., "1" or "4"). Switches with limit stops, restricting the range of operation, are also available. For further information use *check-off* on page 94, or write to ALCO Electronic Products, Inc., 1551 Osgood Street, North Andover, Massachusetts 01848.

world radio and tv handbook

When a specialized handbook like this has gone into its 28th edition, there's very little that's "new and exciting" that can be said. The *World Radio & TV Handbook* (popularly called the *WRH*) is the only complete and comprehensive directory on radio broadcasting throughout the entire world—from Afars to Zambia. Updated during the latter part of 1973 for use during 1974, the *WRH* tells it all: stations, call signs, frequencies, schedules, languages, power, etc. If you want the shortwave schedule for a certain country, the *WRH* is the place to find it. If you tune in a new station and wonder which one it might be, the List of All Shortwave Broadcasting Stations will give the information. No casual—and certainly no serious—shortwave listener is ever without a copy of the latest edition of the *WRH*. 408 pages, softbound, \$7.50 from Ham Radio Books, Greenville, New Hampshire 03048.

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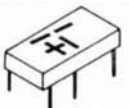
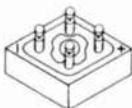
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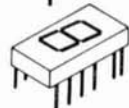
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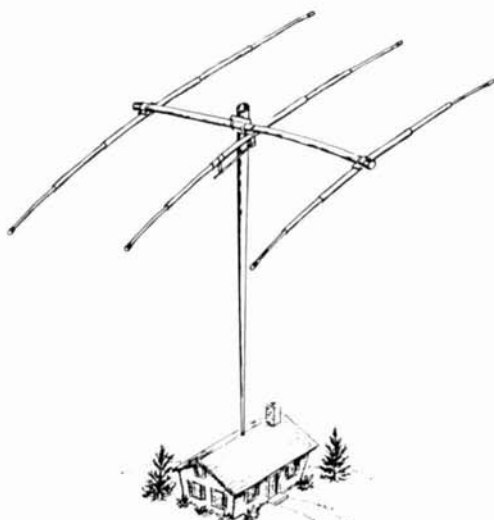
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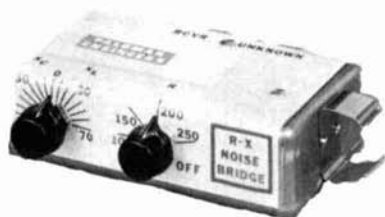
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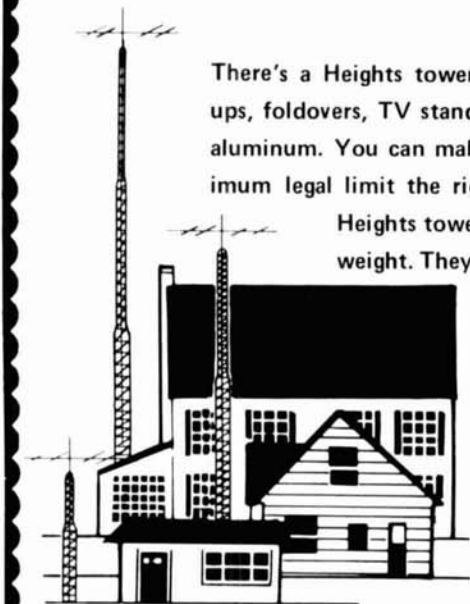
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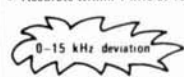
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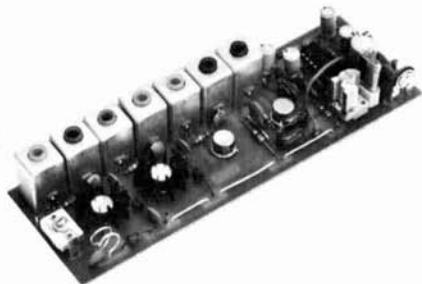
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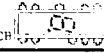
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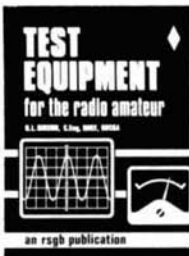


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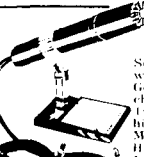
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107	Op AMP (super 741)	MINI-DIP TC-5	45 ea
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109A	S.V. Regulator	TC-3	1.95 ea
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111	Hi. perf. full 4 comp. AMP	MINI-DIP TC-5	1.75 ea
113	Hi-Speed Dual Compar.	DIP	1.65 ea
120	5 V V. Neg. Regulator	TC-1	1.75 ea
121	15 V V. Neg. Regulation	TC-1	1.95 ea
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139	Quad Comparator	DIP	2.50 ea
1407	Pos. Volt. Reg.	16V-18V 12V-15V 24V-220	2.25 ea
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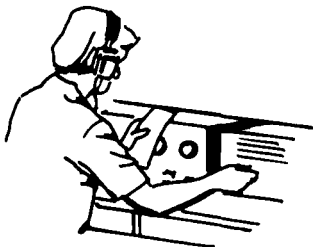
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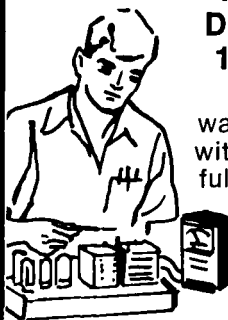
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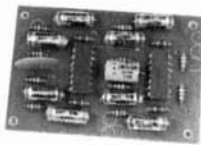
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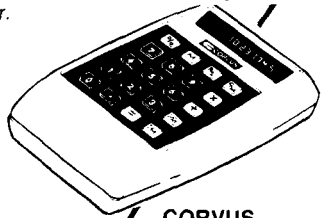
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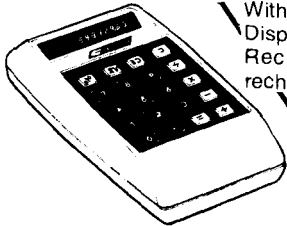
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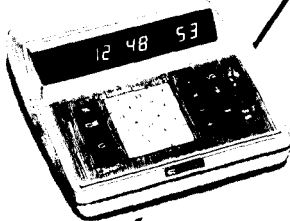
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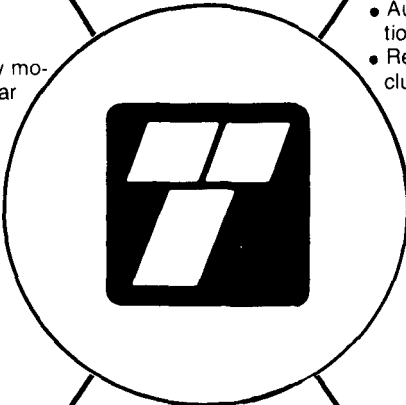


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INDEX

Alco	002	Janel	068
Amtech	006	Jeff-Tronics	069
Antenna Mart	009	K. E.	072
Atlas	198	K-Enterprises	071
Babylon	014	KLM	073
Barry	016	Larsen	078
Budwig	233	Leland	193
Caddell Coil	247	Logic	133
Columbia	212	MFJ	082
Communications		Martex	197
Unltd	248	Matric	084
Curtis	034	Motorola	160
Cush Craft	035	Nasem	249
Delavan	235	Nurmi	090
Drake	039	Pagel	092
Dycomm	040	Palomar	093
ECM	190	Poly Paks	096
Eimac	043	Prof. Elect.	140
Electronics		RMS	239
Center	236	Radiation Dev.	099
Electronic Dist.	044	Callbook	100
Epsilon	046	Regency	102
Erickson	047	Step	232
Fair	048	Space-Military	107
Gam	237	Specialty	216
Gilfer	207	Spectronics FM	191
Glade	213	Spectrum	108
Gray	055	Swan	111
HR Report	150	Technical Doc.	226
Hal	057	Tekpro	250
Ham Radio	150	Ten-Tec	114
Hamtronics	230	Topeka FM	115
Heath	060	Tri-Ex	116
Heights	061	Tri-Tek	117
Henry	062	Tucker	113
Holdings Ltd.	252	VHF Eng.	121
House of Dipoles	036	Venus	192
Icom	065	Vibratrol	251
International		Weinschenker	122
Crystal	066	Wilson	123
International		Wolf	124
Elect. Unltd	141	World QSL	125
Jan	067	Yaesu	127

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Advertisers index

ATV Research	92
Amtech	80
Antenna Mart	76
Atlas Electronics	67
Babylon Electronics	77
Barry	96
Budwig Manufacturing Co.	86
Caddell Coil Corp.	70
Columbia Electronics Sales	93
Communications Unlimited	81
Curtis Electro Devices	90
Cush Craft	21, 68
Drake Co. R. L.	76
Dycomm	65
ECM Corporation	72
Eimac, Div. of Varian Assoc.	Cover IV
Electronics Center, Inc.	64
Electronic Distributors, Inc.	85
Epsilon Records	93
Erickson Communications	71
Fair Radio Sales	85
Gam Electronics	80
Glade Valley School Radio Session	67
Goodheart Co., Inc. R. E.	72
Gray Electronics	84
Gregory Electronics	89
HR Report	74
Hal Communications Corp.	48, 49, 93
Ham Radio	78, 84
Hamtronics, Inc.	70
Heath Company	39
Heights Manufacturing Company	72
Henry Radio Stores	Cover III
House of Dipoles	90
Icom	5
International Crystal Mfg. Co. Inc.	59
International Electronics Unlimited	88
Jan Crystal	67
Janel Labs	92
Jeff-Tronics	68
K. E. Electronics	90
K-Enterprises	84
KLM Electronics	93
Larsen Electronics	63
Leland Associates	85
Logic Newsletter	72
MFJ Enterprises	90
Martex Corporation	86
Matric	74
Motorola	69
Nasem	80
Nurmi Electronic Supply	53
Pagel Electronics	74
Palomar Engineers	70
Poly Paks	82
Professional Electronics	90
RMS Corporation	85
Radiation Devices	76
Radio Amateur Callbook, Inc.	86, 68
Regency Electronics, Inc.	87
Step Electronics	74
Space-Military Electronics	86
Specialty Products	84
Spectronics FM	75, 92
Spectrum International	43
Swan Electronics	Cover II
Technical Documentation	70
Tekpro Design Systems	92
Ten-Tec, Inc.	92
Topeka FM Communications & Electronics	86
Tri-Ex Tower Corp.	2
Tri-Tek, Inc.	74
Tucker Electronics	91
VHF Engineering, Div. of Brownian Elect. Corp.	73
Venus Scientific	1
Vibratrol, Div. of E. G. I.	79
Weinschenker, M.	66
Wilson Electronics	78
Wolf, S.	76
World QSL Bureau	86
Yaesu Musen USA	95

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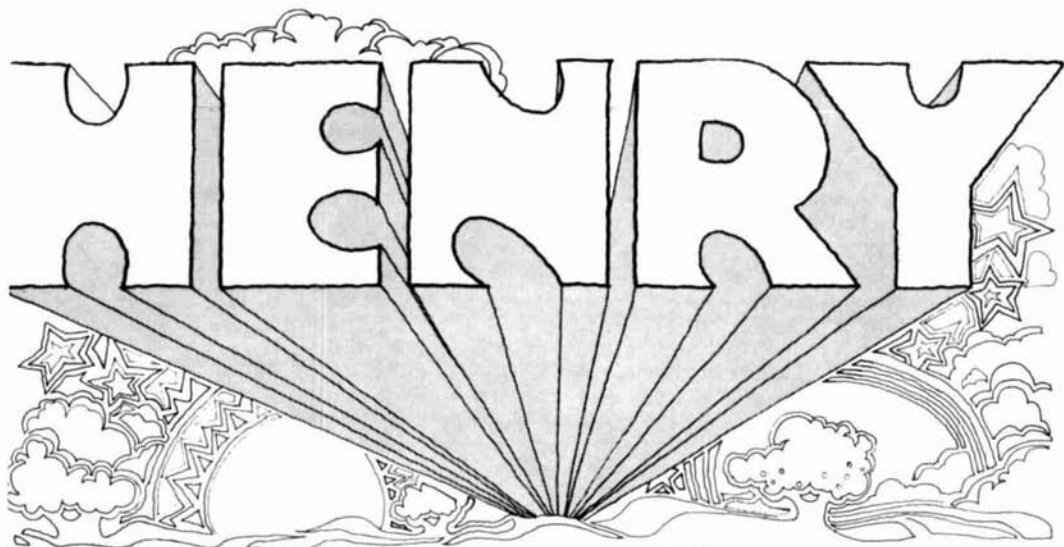
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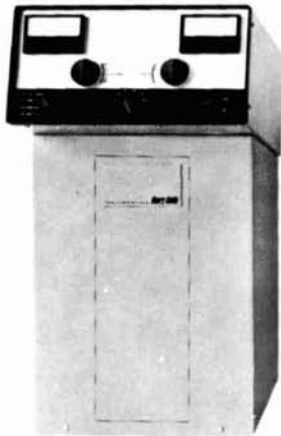
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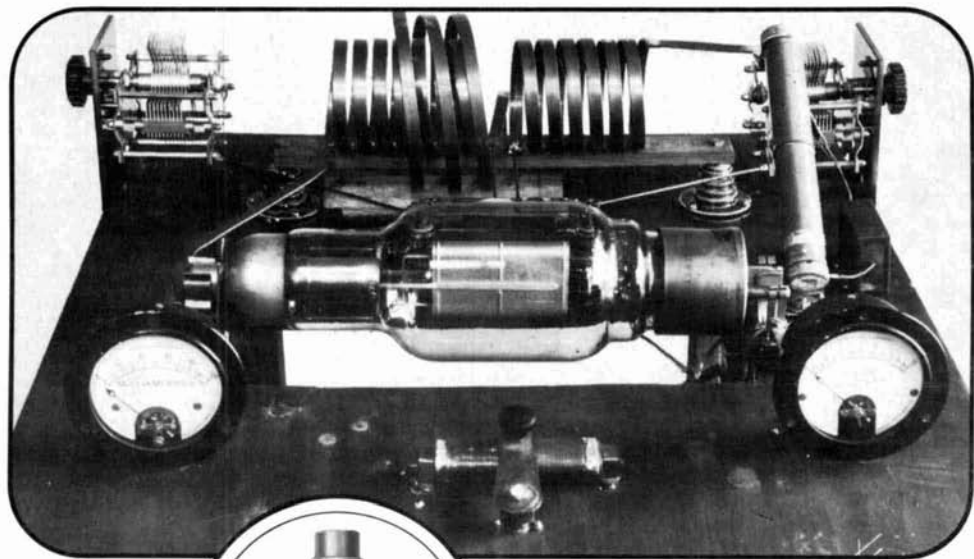
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