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# SINGLE SIDEBAND RECEPTION

## AN ADAPTER TO CONVERT A SUPERHET INTO A TRUE SINGLE SIDEBAND RECEIVER

### Materially Reduces QRM When Receiving AM, PM, CW or SSB Signals

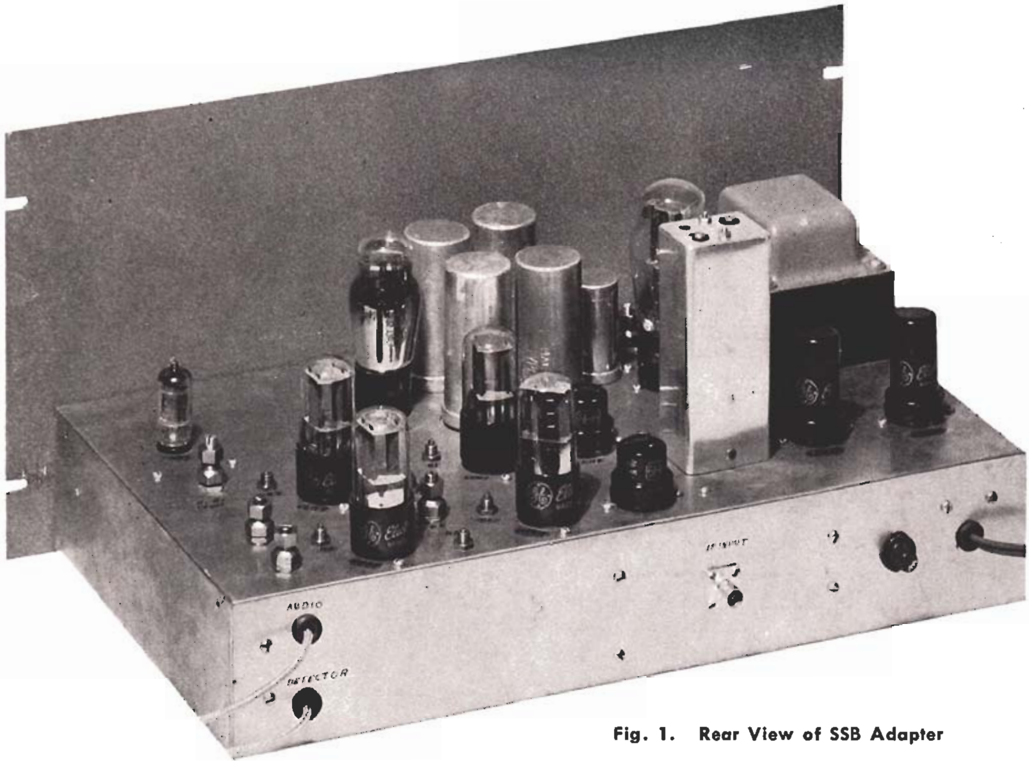


**Fig. 1. Rear View of SSB Adapter**

The single-sideband adapter, shown in Fig. 1 from a rear view, when attached to a superhet receiver will permit reception of single-sideband signals. Further, this combination will receive amplitude modulated phone signals, phase modulated signals, and c-w signals in a fashion which will enable the user to reduce the qrm on any frequency by at least fifty per cent.

In the case of reception of true single sideband signals with attenuated or suppressed carrier, the adapter furnishes a carrier against which the sidebands may be demodulated. By selecting the proper sideband with a switch, the modulation may be read. For reception of AM phone signals, this SSB receiver (adapter plus superhet) exalts the carrier component of the phone signal, making it effectively stronger than it would otherwise have been, and then allows reception of both sidebands, or either sideband singly. If qrm exists on one sideband, it can be avoided by receiving only the sideband on which the qrm does not exist. Where qrm exists on both sidebands, one is selected which is qrm'ed the least.

Phase modulated or NBFM signals may be received in the same manner as AM signals. No special detection equipment need be added to the SSB receiver. For the reception of c-w signals, the SSB receiver furnishes the hetrodyning signal so that the BFO in the superhet is not needed. True single-signal reception of c-w signals is achieved.

#### GENERAL PERFORMANCE

A single sideband receiver is not necessarily a "sharp" receiver, although the results obtained are usually superior to those obtainable with a receiver with steep-sloped IF curves. This means that if a signal has modulation with good audio fidelity, the SSB receiver will receive the full audio band, limited principally by the bandpass of the IF transformers in the superhet itself. Of course it is desirable to limit the audio range, both in transmission and reception,

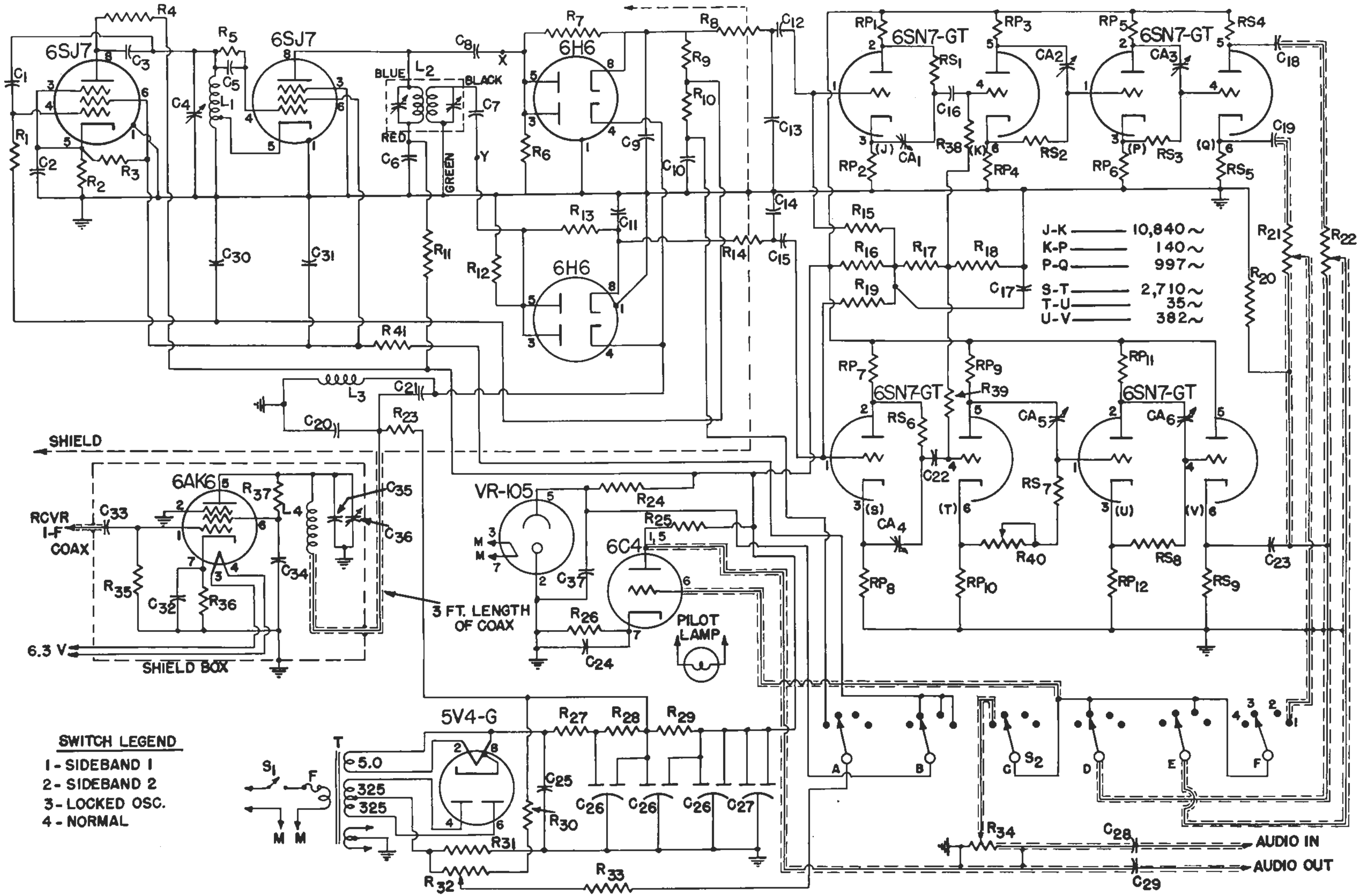


Fig. 2. Circuit Diagram of SSB Adapter

## CIRCUIT CONSTANTS

$C_1$ = 5 mmf mica or ceramic
$C_2$, $C_{30}$, $C_{31}$, $C_{32}$ = 0.1 mf 200 V paper
$C_3$ = 0.001 mf 600 V mica or paper
$C_4$ = 25 mmf variable
$C_5$ = 100 mmf mica
$C_6$, $C_{28}$, $C_{29}$ = 0.01 mf 600 V paper
$C_7$, $C_8$, $C_{13}$, $C_{14}$, $C_{33}$ = 50 mmf mica (±5%)
$C_9$, $C_{11}$ = 500 mmf mica (±5%)
$C_{10}$, $C_{17}$ = 1.0 mf 200 V
$C_{12}$, $C_{15}$ = 0.05 mf 200 V
$C_{16}$, $C_{21}$, $C_{22}$, $C_{34}$ = 0.05 mf 400 V
$C_{18}$ = 0.5 mf 400 V
$C_{19}$, $C_{23}$, $C_{37}$ = 0.5 mf 200 V
$C_{20}$ = 0.006 mf mica
$C_{24}$ = 20 mf 25 V (part of $C_{27}$)
$C_{25}$ = 20 mf 450 V electrolytic
$C_{26}$ = 40-40 mf 450 V electrolytic
$C_{27}$ = 40-40-20 mf 450-450-25 V electrolytic
$C_{35}$ = 750 mmf mica
$C_{36}$ = 150-500 mmf mica trimmer

$CA_1$ = 300 mmf adjustable (see text)
$CA_2$ = 2200 mmf adjustable (see text)
$CA_3$ = 1600 mmf adjustable (see text)
$CA_4$ = 600 mmf adjustable (see text)
$CA_5$ = 9000 mmf adjustable (see text)
$CA_6$ = 800 mmf adjustable (see text)

F = 3 amp. fuse

$L_1$ = 2.5 mH RF choke tapped at one pie
$L_2$ = 456 KC IF Transformer (Millen No. 60456) (see text)
$L_3$ = 1 pie of 2.5 mH RF choke
$L_4$ = 1 pie of 2.5 mH RF choke with 100 turns removed (see text)

$R_1$ = 470 ohm ½ watt
$R_2$ = 820 ohm ½ watt
$R_3$ = 33,000 ohm 1 watt
$R_4$, $R_5$, $R_{33}$ = 0.1 megohm ½ watt
$R_6$, $R_7$, $R_{12}$, $R_{13}$, $R_{35}$ = 0.22 megohm ½ watt (±5%)
$R_8$, $R_{14}$ = 47,000 ohm ½ watt (±5%)
$R_9$ = 3.3 megohm ½ watt
$R_{10}$, $R_{17}$ = 10,000 ohm ½ watt
$R_{11}$ = 4700 ohm ½ watt
$R_{15}$, $R_{19}$, $R_{20}$, $R_{38}$, $R_{39}$ = 2.2 megohm ½ watt
$R_{16}$, $R_{30}$ = 0.33 megohm 1 watt
$R_{18}$, $R_{25}$, $R_{37}$ = 20,000 ohm ½ watt
$R_{21}$, $R_{22}$ = 200,000 ohm pot (linear taper)
$R_{23}$ = 7500 ohm 2 watt
$R_{24}$ = 10,000 ohm 10 watt
$R_{26}$ = 1800 ohm ½ watt
$R_{27}$, $R_{31}$ = 50 ohm 2 watt
$R_{28}$, $R_{29}$ = 300 ohm 5 watt
$R_{32}$ = 10,000 ohm pot
$R_{34}$ = 250,000 ohm pot
$R_{36}$ = 680 ohm 1 watt
$R_{40}$ = 100,000 ohm pot
$R_{41}$ = 500 ohm 1 watt
$RP_1$, $RP_2$ = 4000 ohm ½ watt precision (±1%)
$RP_3$, $RP_4$ = 3000 ohm ½ watt precision (±1%)
$RP_5$—$RP_8$ = 4000 ohm ½ watt precision (±1%)
$RP_9$, $RP_{10}$ = 3000 ohm ½ watt precision (±1%)
$RP_{11}$, $RP_{12}$ = 4000 ohm ½ watt precision (±1%)

$RS_1$ = 50,000 ohm ½ watt (±5%) (not wire wound)
$RS_2$, $RS_7$, $RS_8$ = 0.5 megohm ½ watt (±5%) (not wire wound)
$RS_3$, $RS_6$ = 0.1 megohm ½ watt (±5%) (not wire wound)
$RS_4$, $RS_5$ = 5000 ohm ½ watt (±5%)
$RS_9$ = 5000 ohm 1 watt (±5%)

$S_1$ = SPST toggle
$S_2$ = six pole four position shorting type rotary switch (see text)
T = Power Transformer, 325-0-325 V. at 150 ma, 5 V. at 3A, 6.3 V. at 5A (Thordarson T-22R06)

to as narrow a range as possible, consistent with intelligibility. However, signals characterized by excessive frequency-modulated hum, carrier frequency drift, or overmodulated NFM will be immediately apparent. The amateur using a SSB receiver is thus able to spot difficulties of these sorts on any signal.

This SSB receiver does not cut out one sideband completely, but it attenuates it by approximately 40 db. This is the same as about 7 "S" points on the average receiver. Attenuation is such that signals which are no closer than 70 *cycles* and as far away as 5400 cycles from the carrier are attenuated at least 40 db. However, sufficient attenuation takes place between zero and 70 cycles so that unless an interfering signal is practically zero beat it can be eliminated in most cases sufficiently well to allow the desired signal to be copied.

The SSB receiver thus allows reception of all of the usual types of signals found on the ham bands, including single sideband signals. The principal advantage is that it allows the user to receive only one sideband at a time so that qrm is reduced by at least 50%.

### ELECTRICAL DETAILS

The SSB adapter described here may be switched to any one of four types of reception by switch $S_2$ (see Fig. 2). Position 1 allows reception of one sideband of any type of signal described above. This will be either the upper or lower sideband, depending on which side of the received frequency the superhet oscillator operates. Position 2 permits reception of the other sideband. Position 3 is a locked-oscillator position. This means that the adapter is furnishing an artificial carrier (as it does also on positions 1 and 2) which augments (exalts) the carrier being received. This has the advantage of providing a strong non-fading carrier. The result is to reduce distortion on fading signals.

Position 4 of switch $S_2$ allows the receiver to function normally. The SSB adapter is not completely out of the circuit, since audio connections with the receiver require that audio be fed through the adapter. Experience has shown that position 4 is seldom used once the operator is familiar with the operation of a SSB receiver.

The circuit diagram (Fig. 2) follows the principles set forth by D. E. Norgaard in his article "Practical Single-sideband Reception" in the July 1948 *QST*.

With reference to Fig. 2, the second 6SJ7 is the oscillator which generates the artificial carrier. Its frequency is the same as that of the receiver IF. Coil $L_1$ and condenser $C_4$, along with the first 6SJ7 (reactance tube), are the frequency determining elements. Transformer $L_2$ is a 90 degree r-f phase shift circuit. The 6H6 tubes act as demodulators. The IF signal from the receiver is coupled through the 6AK6 tube (which functions as an impedance matching device) to both 6H6 tubes. The output of the 6SJ7 oscillator is also coupled to these 6H6 tubes. A portion of the output of the upper 6H6 is fed back through a low-pass RC filter ($R_9$, $R_{10}$, $C_{10}$, $C_{30}$) and acts on the 6SJ7 reactance tube so that automatic carrier synchronization is achieved.

The outputs from the two 6H6 demodulators are fed independently to two audio-frequency phase-shift networks. The upper two 6SN7-GT tubes with their associated components act as one network and the lower pair of 6SN7-GT tubes with their circuit components act as the other phase-shift network.

The audio outputs of these two networks are mixed by resistors $R_{21}$ and $R_{22}$ so that response from sideband 1, sideband 2 or both sidebands can be selected. The 6C4 is an audio amplifier tube.

The power supply circuit and the voltage regulator tube circuit are conventional. A large amount of capacitance is required because the two audio phase-shift networks must be supplied from a low impedance source of voltage.

### CONSTRUCTIONAL DETAILS

Before starting the constructional work, it is wise to have all the necessary components on hand. Some of these need explanation at this point. Resistors $RP_1$ through $RP_{12}$ are specified as ½ watt precision resistors, with a resistance tolerance of ±1%. These are an important part of the SSB adapter. Quantities

**Fig. 3. Detail View of Probe with Cover Removed**

**Fig. 4. Detail View of Probe Shield Can**

of this type are available at low prices. Naturally, one watt resistors may be used if ½ watt ones are not available. It is possible to measure regular tolerance resistors until suitable values are found. This is not advisable unless the resistors chosen are certain to hold their measured values. A better alternative is to use stable resistors and pair them. For example, $RP_1$ and $RP_2$ need not be exactly 4000 ohms so long as they are the *same* value (within 40 or 50 ohms). Similarly, other pairs are $RP_3$, $RP_4$; $RP_5$, $RP_6$; $RP_7$, $RP_8$; $RP_9$, $RP_{10}$; and $RP_{11}$, $RP_{12}$.

Resistors $RS_1$ through $RS_9$ are listed separately because it is desirable for them to be very stable although their exact value is not important as long as they hold that value. Precision resistors are usually stable types, and for this reason they are recommended although not required. Ordinary resistors are suitable, although the performance of the unit may suffer if these resistors change value with time.

Condensers $CA_1$ through $CA_6$ are shown as single condensers, but except for $CA_1$, they are all multiple units. For example, $CA_2$ is listed as a 2200 mmf adjustable condenser. This made up by paralleling a 0.002 mf mica and a 150 to 500 mmf *mica* trimmer. Each of these specified condensers consist of a 150-500 mmf trimmer in parallel with mica condensers. $CA_1$ is simply a 100-500 mmf trimmer. The objective sought here is to permit adjustment of the RC products ($RS_1$ times $CA_1$, $RS_2$ times $CA_2$, etc.) to the proper value. This will be covered more thoroughly under "Tune-up Adjustments."

A Millen IF transformer is specified for $L_2$. Other types will undoubtedly work, although difficulty may be experienced in obtaining the correct coupling between the primary and the secondary windings. Generally speaking, high stability air tuned IF transformers of the proper frequency are suitable. Switch $S_2$ is specified as a shorting type switch in order to provide smooth switching action.

Inductance $L_4$ should be approximately 0.15 millihenrys, for use with receivers having 450-470 kc IF amplifiers. This value of inductance was obtained from a 4 pie 2.5 mh choke, by removing 3 of the pies, then taking 100 turns off the remaining pie. The particular choke used was a Millen No. 34100.

The SSB adapter is built on a 17 by 10 by 3 inch chassis and uses a 8¾ inch relay rack panel. The 6AK6 probe (Figs. 3 and 4) is built into a 2⅛ inch diameter by 4 inch long shield can (Millen No. 80006). It is desirable to follow the layout as shown. Fig. 1 indicates the general placement of parts, and Fig. 7 will serve as a drilling and layout guide. The rear of the chassis, referring to Fig. 1, is drilled for the two audio leads on the left, the coaxial connector on the right of center, and the fuse and a-c cord on the right. The front panel (Fig. 5) is drilled with four holes for the on-off switch, oscillator tuning control, control switch ($S_2$) and the pilot light. All holes are in a center line 1½ inches up from the bottom of the panel, and the side dimensions are three inches and five inches, respectively, in from either side of the panel.

The under-chassis view (Fig. 6) clearly shows the layout of parts. Note the shield which encloses the wiring for the two 6SJ7 and two 6H6 tubes. In order to better balance the layout in this shield compartment, the IF transformer could be moved toward the 6SJ7 oscillator tube.

It is necessary to make a small change in the IF transformer, assuming that the Millen No. 60456 is used. The blue lead should be unsoldered from the terminal point on the end of the coil form (which is a tap on the coil) and soldered instead to the stator of the primary tuning condenser. Also, the 24 mmf padding condenser across the primary coil should be removed.

The tune-up process will be simplified if a small piece of wire is soldered to the eight cathode connections of the four 6SN7-GT tubes. This wire should be about one inch long and arranged so that a clip lead may be attached to it.

The filaments of all the 6.3 volt tubes except the 6AK6 are wired to the 6.3 volt winding on the power transformer.

The 6AK6 tube is mounted in the probe chassis. The mounting piece is made of aluminum to fit the shield can. See Figs. 3 and 4. The coaxial lead which comes out the rear of this can connects to the receiver by means of a coaxial connector. The two filament leads and the coaxial line to the receiver are brought out the side of the can.

### TUNE-UP ADJUSTMENTS

When the SSB adapter has been completed it is necessary to check the alignment carefully. In particular, the amount of attenuation obtainable on either sideband depends upon how well these adjustments are made.

Connect the adapter to the receiver in the following manner: The small can with the 6AK6 tube should be placed as close as possible to the last IF transformer in the receiver. The lead marked "receiver IF" should be soldered to the "hot" end of the secondary of the last IF transformer. Do not disconnect the lead from this point going to the second detector. The shielding braid on the coaxial cable should be stripped back only as far as necessary and then soldered to ground (receiver chassis). The 6.3 volt filament leads should be wired into a 6.3 volt a-c source in the receiver.

If the IF alignment of the receiver is questionable, it should be carefully realigned, following the manufacturer's directions. In any event, it is necessary to check the tuning of the secondary of the last IF transformer to compensate for the addition of the 6AK6 stage.

The other two connections are those marked "audio in" and "audio out." The audio connection to the input of the first audio amplifier must be opened. If the receiver has a phono input jack which accomplishes this, the two leads may be connected at this point. The "audio in" lead should be connected to the receiver connection which carries audio voltage from the second detector tube, and the "audio out" lead should be connected so that the audio signal on this lead is fed to the remainder of the audio system of the receiver. It is difficult to be specific about this because the adapter may be connected to a wide variety of receivers.

Turn on the receiver and the adapter. Allow both units to reach operating temperature. Turn off the avc on the receiver and set the adapter switch $S_2$ to position 4 (normal). Tune in a stable signal, such as a broadcast station. Adjust $R_{34}$ and the receiver volume control until an adequate volume level is obtained. Change $S_2$ to position 3. Adjust condenser $C_4$, which tunes the oscillator, until a beat note is heard. Adjust for zero beat. If no beat is heard, the oscillator is either not oscillating or is not able to reach the correct frequency. With the constants shown, the oscillator will operate in the 450 KC to 465 KC IF range. For higher or lower frequencies it may be necessary to change $L_1$ and $C_4$.

Next, detune the receiver slightly so that a beat note is audible. Set the r-f gain on the receiver to ensure that no overloading is taking place. Adjust condenser $C_{36}$ until this beat note is as loud as possible. If the receiver does not use a 450-465 KC IF, it may be necessary to change $L_4$, $C_{20}$, $C_{35}$, and $C_{36}$ in order to achieve resonance.

Tune the receiver to a low frequency beat note. Inability to hold a low-frequency beat note indicates that the r-f gain control should be reduced. Insert a 0-1 mil d-c meter between resistor $R_6$ and ground. The positive connection on the meter should connect to ground. A 0-5 mil d-c meter may also be used if a 0-1 mil meter is not available. The 0-1 milliammeter becomes, in effect, a 0-200 volt voltmeter (approximately). Adjust the tuning condenser in the primary of $L_2$ for a maximum reading of this meter. This adjustment probably will cause the oscillator to change frequency slightly and the beat note will change frequency. If so, adjust $C_4$ to get the original low-frequency beat note. Recheck for maximum meter reading and repeat if necessary. Remove the meter and connect $R_6$ to ground again. Place the meter between $R_{12}$ and ground in the same way. Adjust the tuning of the secondary of $L_2$ for maximum meter reading. If the beat note changes, adjust $C_4$ as before.

The IF transformer $L_2$ is now tuned approximately to the receiver IF. It is next necessary to adjust the coupling of $L_2$ so that approximately equal voltages are fed to the two 6H6 tubes. This condition is satisfied when the voltages from "x" to ground and "y" to ground are equal. (These voltages are those that were measured with the 0-1 milmeter.)

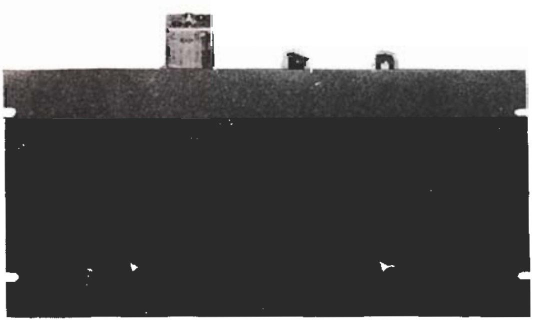

Fig. 5. Front View of SSB Adapter

It may be desirable to connect a closed circuit jack between $R_6$ and ground and $R_{12}$ and ground. Inserting a 0-1 mil d-c meter in the jack between $R_6$ and ground reads voltage "x" and between $R_{12}$ and ground reads voltage "y".

Therefore, measure voltage "x" and "y." Normally "x" will be greater than "y," indicating that there is not sufficient coupling between the primary and the secondary of $L_2$. Carefully heat the coil form of the Millen IF transformer with a soldering iron, through the large hole in the chassis, until the wax melts and the bottom coil can be pushed slightly toward the top coil. After this adjustment, retune $C_4$ to obtain the low-frequency beat note if this note changes frequency. Now measure voltages "x" and "y" by plugging the 0-1 mil meter into the two temporary jacks. Voltage "y" should increase as the coupling is increased. Several adjustments should be required as this process should be taken in easy steps to avoid too much coupling. Each time the coupling is adjusted the oscillator frequency should be adjusted to the low frequency beat with the signal in the receiver. Also the primary and secondary tuning condensers should be checked for proper tuning as indicated by a peak reading of the 0-1 mil d-c meter. (Peak the primary and read current in $R_6$ and peak the secondary by reading current in $R_{12}$.)

When voltages "x" and "y" are within ten per cent of one another the coupling adjustment may be considered complete. These voltages should normally be about 100 volts—half-scale on the 0-1 milliammeter.

The next step is to determine that transformer, $L_2$ is acting as a 90 degree phase-shift device. An oscilloscope is required for this and the following adjustments. The horizontal and vertical amplifiers in the scope may have differential phase shift, so first it is necessary to check for this condition.

Connect the "high" input leads of the horizontal and vertical amplifiers of the scope to pin 3 of the first 6SN7-GT tube (point J). The ground connections of the scope should be tied to the chassis of the SSB adapter. Detune the receiver so that a beat note of approximately 6000 cycles is obtained as heard in the speaker. Adjust the gain of the receiver (RF gain) until a relatively small signal is available. Adjust the horizontal and vertical amplifier gain controls on the scope until a straight line at a 45 degree angle is obtained. If the scope has no detrimental phase shift this line will be a thin straight line. If phase shift occurs, the line will be opened up, or split, so that it is in the form of a flat ellipse.

In order to correct this phase shift insert a 50,000 ohm potentiometer in the "high" lead of either the horizontal or vertical input at the scope. Adjust this potentiometer until the line becomes a solid line. If this is not possible, transfer the potentiometer to the other "high" lead. It should now be possible to adjust the resistance to give a straight line on the scope.

Next, remove one scope lead from point J and connect it to point S on the cathode of the first 6SN7-GT tube in the lower network. Do not remove the potentiometer and do not change the gain controls on the scope.

Change the receiver tuning to get a beat note of approximately 200 cycles. A circle should now appear on the scope tube. It may be lopsided, but it should resemble a circle. Adjust the condenser in the secondary of transformer $L_2$ until a perfect circle appears. If the best adjustment does not give a perfect circle then either the horizontal or vertical gain control should be adjusted to give equal horizontal and vertical deflections. This may upset the phase-shift compensation so check as before and readjust the 50,000 ohm potentiometer if necessary. Now repeat

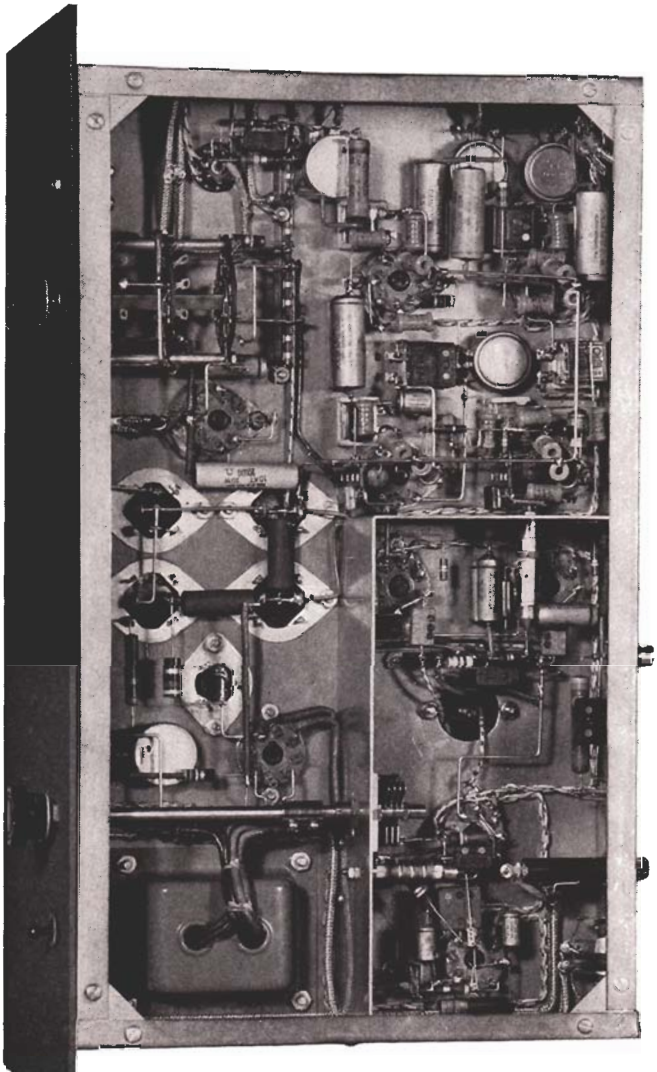

**Fig. 6. Under-chassis View of SSB Adapter. Note the Shield Around the Four Tubes on the lower Right Side**

the check for the circle by adjustment of the secondary tuning of $L_2$. Detune the receiver to provide a 6000 cycle beat note. The circle may change size but it should hold its shape reasonably well. If not, the fault will probably lie in condensers $C_7$, $C_8$, $C_9$, $C_{11}$, $C_{13}$, $C_{14}$ or resistors $R_6$, $R_7$, $R_8$, $R_{12}$, $R_{13}$, $R_{14}$. Ideally $C_7$ and $C_8$ should be the same value, that is, equal in capacitance. Also, $C_9$ and $C_{11}$ should be equal, and $C_{13}$ and $C_{14}$ should be equal. Further, $R_6$ and $R_{12}$ should be equal, $R_7$ and $R_{13}$ equal, and $R_8$ and $R_{14}$ should be equal. It may be necessary to measure them in order to pair them in the way which makes them as close to equal values as possible.

The final tune-up adjustment concerns the two audio frequency phase shift networks. In addition to the scope, an audio oscillator is required. This oscillator should be as good an instrument as can be obtained, since accurate calibration and good waveform is required in order to permit adjustment of the audio-frequency phase shift networks for optimum performance. This audio oscillator is required to generate the six audio frequencies shown in the circuit diagram (Fig. 2).

If the available oscillator is not accurately calibrated, it is not too difficult to calibrate it for the six frequencies involved. This can be done by means of a piano, if the piano is in tune. Using the proper key on the piano it is possible to produce a frequency which may be used as a calibration point, or in some cases as a sub-multiple of a required calibration. Of course, any other calibration means which is accurate may also be used.

When the oscillator is ready for use, turn on the adapter and remove both 6H6 tubes and set $S_2$ to position 4. The receiver need not be turned on. Connect the audio oscillator output to pin 8 of the upper 6H6 tube with the ground lead on the audio oscillator output going to the adapter chassis. Connect the ground connections of the horizontal and vertical amplifier inputs of the scope to adapter chassis. Connect the "high" connections of both amplifiers to point J. Set the audio oscillator at 10,840 cycles and adjust its output to approximately one volt.

The scope tube should now show a line at a 45 degree angle, or the gain controls should be adjusted so that it does. If the line is thin and not split the phase compensation is correct. If not, adjust the 50,000 ohm potentiometer which should still be in series with one scope lead, as explained before. Next, move one lead from point J to point K. A figure which resembles a circle should now appear on the scope. Adjust the variable condenser $CA_1$ until a *perfect* circle is obtained. If this is not possible, then either the correct RC product ($CA_1$ times $RS_1$) is outside the range of adjustment or the gain controls on the scope are set in the wrong position. As before, adjust the gain controls so that equal horizontal and vertical deflection is obtained. Then check phase compensation again. This must always be done whenever the gain controls are changed. If the RC product is wrong change $CA_1$, $RS_1$ or both in order to obtain the required values.

The next five steps are repetitions of the above as follows. Remove the scope lead from J and place it on K. Adjust the oscillator to 140 cycles. The phasing adjustment to get a single line, if it is required, may call for a condenser in series with one of the scope leads rather than the 50,000 ohm condenser. Try values between 0.001 and 0.1 mf. When phase compensation is correct, move one lead from K and place it on P. Adjust $CA_2$ until a perfect circle is obtained.

Next, move the lead that is on K to point P. Adjust oscillator frequency to 997 cycles. Check for phase compensation by getting a single line as before. Move one of the leads on P to point Q. Adjust $CA_3$ until a perfect circle is obtained. This completes the upper network adjustment.

Change the oscillator output so that it connects to pin 8 of the lower 6H6 in the circuit diagram. Connect both scope leads to point S and set the audio oscillator to 2710 cycles. Check for phase compensation as before, using either capacitance or resistance as required. Move one lead from S and place on point T. Adjust $CA_4$ until a perfect circle is obtained.

Change oscillator to 35 cycles and move the lead from S to T. Check for phase compensation. Move one lead from T to point U. Adjust $R_{40}$ and $CA_5$ until a perfect circle is obtained. Usually adjustment of $R_{40}$ alone is all that is required, but if a perfect circle cannot be obtained, adjust $CA_5$ slightly and try again with $R_{40}$. Repeat until you get a perfect circle.

Change oscillator to 382 cycles and move the lead from T to point U. Check for phase compensation. Move a lead from U to point V. Adjust $CA_6$ until a perfect circle is obtained.

This completes the adjustment of the networks, and the balancing adjustments of $R_{21}$ and $R_{22}$ are next. Turn on the receiver, replace the 6H6 tubes in the adapter and allow the receiver to reach operating temperature. Set $R_{21}$ and $R_{22}$ to approximate mid-position. Connect the vertical input on the scope to the "audio out" lead. Set the horizontal plates to sweep frequency so that several sine waves will be visible on the scope screen after a 1000 cycle beat is obtained as described below. Tune in a steady signal, such as a broadcast station, while the adapter is in position 3. Set the r-f gain for a low signal level and make sure that the avc is turned off.

Tune the receiver slightly until the 1000 cycle beat note is obtained. Reduce the r-f gain until this heterodyne is just nicely audible with the audio gain opened most of the way. Now change $S_2$ to either position 1 or 2. On one of the positions the heterodyne will be weaker. This heterodyne will now be shown as a sine wave on the scope. Adjust the vertical gain until the sine wave covers about one-third of the screen. If the switch is in position 1, adjust $R_{21}$, or if in position 2, adjust $R_{22}$ until the heterodyne sounds as weak as possible to the ear. At the same time the scope trace will decrease in amplitude. Next, retune the receiver through zero beat, to the opposite side of the signal until a 1000 cycle heterodyne note is obtained. Change switch $S_2$ to the other of the two sideband positions. Then adjust the other potentiometer (which was not touched before) for a minimum, checking both by the scope and by ear.

Finally, very carefully adjust the secondary tuning condenser of $L_2$ in conjunction with the potentiometer for a further reduction in volume of the heterodyne. Now retune the receiver for a 1000 cycle note on the other side of the signal and change $S_2$ to the other sideband. Readjust the potentiometer which controls this sideband for minimum heterodyne strength. If this is not as little as before, it will be necessary to go to the other sideband again and adjust $L_2$ secondary for equal rejection. It may be necessary to go back and forth several times to accomplish this. This rejection should be in the order of 40 db., which means a voltage ratio of about 100:1 as seen on the scope screen by switching $S_2$ back and forth between positions 1 and 2 while everything else is fixed.

Two more adjustments must now be made before the SSB receiver is really ready for use. Disconnect the scope. With $S_2$ in position 3, tune in a station. Be sure the input signal is small. Return to position 4. If the audio level changed, adjust $R_{34}$ until no change in audio level is noted when going from position 3 to 4 or vice versa. (When in position 1 or 2 receiving AM signals the audio level will be lower by 6 db than the level observed in positions 3 and 4. This is normal.)

Lastly, tune in a signal zero beat in position 3 of $S_2$. Make sure the unit is at operating temperature. Reduce r-f gain as far as practical. Switch to position 4, wait five seconds and switch to position 3. If a sliding frequency change is heard as the oscillator is pulling in, $R_{32}$ needs adjustment. Make a slight adjustment, return to position 4, wait five seconds, then switch to 3. If the frequency change is less continue the adjustment process in that direction until no change of frequency is heard. If the frequency change was worse, adjust $R_{32}$ the other direction and follow the above steps until no frequency change is heard.

The SSB adapter is now completely aligned and adjusted. If it is to be used on another receiver at some future date some of the previous steps in adjustment will need to be repeated. Condenser $C_4$ will have to be set for the new IF of the receiver and transformer $L_2$ may similarly need touching up. Also, $R_{34}$ and $R_{32}$ will probably need re-adjustment. It might be desirable further to check the settings of $R_{21}$ and $R_{22}$ in the manner previously described. The two audio phase shift networks should not require any re-adjustment at any time unless the components change value. This might be a good place to mention that the adjustments which have been described may seem very complicated, but they are much easier to perform than to describe in writing.

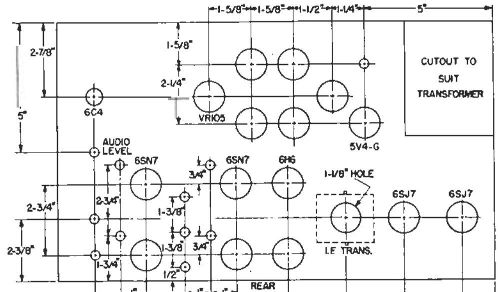


**Fig. 7. Layout Guide for SSB Adapter**

## USE OF THE SSB RECEIVER

A person using a SSB receiver for the first time will be in a position very similar to that of a young child taking his first steps. That is to say, the child does not know how to walk until he has learned, and the user of a SSB receiver will not be able to use the SSB receiver to full advantage until he has had some experience with it. (And he is due for as big a thrill as the child gets—Editor's note.) However, there are some basic rules to keep in mind. The *smaller* the r-f input, that is, the more the r-f gain can be turned down and still have a readable signal, the more certain one will be of obtaining maximum unwanted-sideband rejection. Always use the receiver with the avc off.

When the SSB receiver is used for the reception of c-w signals, it is not necessary to use the receiver BFO, as the necessary beat note is supplied by the oscillator in the adapter. Of course, when switch $S_2$ is in position 4 the BFO is used as usual with the receiver. Tuning is usually done in the locked oscillator position when the receiver is first in use, although with experience a c-w man will develop his own tuning patterns. For example, if the receiver is set to reject the high frequency sideband, and tuning is done from a low to a high frequency, then signals are not heard (unless they are very strong) until you have passed them frequency-wise.

For AM reception, the oscillator in the adapter will produce a heterodyne when tuning acrosss phone signals, when in position 1, 2, or 3. This beat note disappears when the received signal is tuned to zero beat. It thus acts as a signal locater and is a real tuning aid.

For phase-modulated signals and narrow-band f-m signals reception is carried out in positions 1 or 2, assuming that the frequency swing is not excessive. It is not necessary to tune to one side of the signal to receive it. It might be well to emphasize that reception of PM and NBFM signals requires only the SSB adapter and a regular superhet—no special limiting device or FM adapter is necessary, or desirable, on the receiver. Merely tune in the signal to zero beat in position 3, and switch to either sideband (position 1 or 2) for reception.

Reception of single-sideband signals is obviously possible, whether the signal is transmitting a carrier or not. If a carrier is transmitted the SSB receiver will lock on it provided the carrier is of sufficient amplitude. If this is not true, it is only necessary to ensure that the receiver is kept properly tuned. After tuning in the signal, make certain that you listen on the sideband being transmitted.

The user of a SSB receiver will find that he switches back and forth between positions 1 and 2 rather often, during a QSO, in order to dodge QRM which comes up. (Unless he is listening to a single-sideband signal.) In addition, he will find that whatever interference is heard may also be further reduced by means of the crystal filter, assuming that the superhet has such a device.

For best results, the receiver to which this adapter is connected and the signals which are tuned, should have reasonably good frequency stability. The more perfect the receiver, the better the results will be.

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