

KACHINA 1 SSB TRANSCEIVER

THEORY OF OPERATION

The Kachina 1 Amateur Band Transceiver is a highly sophisticated, state of the art, piece of communication equipment, housed in the smallest of packages. Yet, the transceiver is simple to an extreme when it is considered that not only does it transmit and receive upper and lower SSB; but it also receives AM, using a special AM detector, and transmits double sideband AM. The transceiver contains a noise blanker and squelch. It covers from 26 - 30 MHz and 50 - 54 MHz in 1 MHz bands without accessory equipment.

To make the explanation of the circuit as simple as possible, two block diagrams have been presented, one shows the operation in the receive condition and the other shows the operation in the transmit condition. Asterisks denote components common to both the receive and transmit modes.

RECEIVE CONDITION:

Signal from the antenna is fed to the mixer through a hi pass filter, L27, L28, L29, C127, C128, set of band switched bandpass couplers, L1 through L4. (Shown as a single block in the block diagram.) Here the signal is mixed with local oscillator voltage provided by the oscillator IF amplifier chain, the output frequency of which covers the range 38 - 42 MHz. When the signal frequencies, 26 - 30 MHz are subtracted from the local oscillator output at 12 MHz IF frequency results. Conversely, when the local oscillator frequencies are subtracted from the signal frequency, 50 - 54 MHz, a 12 MHz IF frequency also results. Thus by either adding or subtracting the one set of local oscillator signals, both the 6 and the 10 meter bands are covered.

Because a VFO running at 38 - 42 MHz would be highly unstable, a heterodyne system is used, in which; a VFO operating from approximately 5 - 6 MHz is beat with one of four crystals, 33MHz, 34 MHz, 35 MHz and 36 MHz, to produce the sum frequencies of 38 - 42 MHz. A band pass amplifier system, Q19 and Q20 selects only the wanted signals. The 5 - 6 MHz VFO Q17, is amplified and isolated by amplifier Q18 and mixed with the output of crystal oscillator Q16 in the balanced diode ring mixer D25 through D28.

In order to keep cross modulation products as low as possible, IF amplifier Q1 provides only sufficient amplification to overcome the losses in the balanced mixer and the crystal filter. (Filter insertion Loss = 4 db Maximum)

The crystal filter is internally diode switched from the AM to the SSB condition when the mode switch is activated.

Integrated circuit amplifier IC1 provides most of the gain in the IF system and in addition provides approximately 90 db of AGC control. The output of the integrated circuit is coupled through an IF transformer to the product detector Q3 (used only to detect SSB), and also through resistance coupled amplifiers Q5 and Q6. The output from these amplifiers is then coupled to the AGC detectors, the AM detectors and the squelch/S meter detectors. DC amplifier Q7 amplifies the output of the AGC detector and applies the control voltage to pin 5 of IF amplifier IC1.

DC amplifiers Q8 and Q9 amplify the DC voltage output from the squelch detector and squelches first audio simplifier Q4.

DC amplifier Q14 amplifies the output from the squelch/S meter detector and actuates the S meter.

The output from the AM detector directly feeds the first audio amplifier Q4.

Audio amplifier Q4 drives integrated amplifier IC2. The volume control is connected between the two amplifiers.

Note that the audio output IC is directly coupled to the speaker and no transformer is used.

In the SSB condition beat frequency oscillator Q12 provides BFO voltage to the product detector through the emitter follow Q13. The BFO selects one of two crystals, a 12MHz crystal (nominal) for the upper sideband operation and an 11.997 MHz crystals are switched, the received frequency is also moved and it is thus necessary to diode switch a small capacitor across the VFO coil (not shown in the block diagram) to compensate.

A noise blanker amplifier (IC, Q501) samples signal from the antenna, detects the noise pulses, amplifies the pulses (Q502 and Q503), then applies the pulses to the transistor switch Q15 (used as two diodes) to short the input to the crystal filter during the pulse. Note that the noise blanker, to be effective, must not be preceded by highly selective circuits and thus are often prone to cross modulation in the presence of strong signals. TRANSMIT CONDITION:

Refer to the transmitter block diagram. There are two microphone amplifiers, Q10 and Q11 which drive the double balanced diode modulator D20 through D23. Carrier is supplied to the modulator from the carrier generator Q12 and amplifier Q13 (BFO in the receive condition). One of two crystals, 12 MHz (nominal) or 11.997 MHz (nominal) are selected for either upper or lower sidebands.

Carrier is balanced out in the balanced modulator (SSB mode) and the resultant double sideband signal is fed into the crystal filter where, in the case of SSB, the undesired sideband is removed.

In the AM condition, the balanced modulator is unbalanced by feeding into the modulator a DC voltage, via R63), thus allowing carrier output. At the same time, the crystal filter is internally diode switched to a 6 KHz wide (nominal) band width, allowing both sidebands and the carrier through.

Following the crystal filter is the IF amplifier IC1, followed by diode gate D5 and diode mixer D1 through D4, which mixes the IF signal with the VFO amplifier output to produce a signal frequency in the 10 meter band or the 6 meter band dependent upon which tuned circuits are selected, L1 through L4. Output from the tuned circuits is then fed through diode gate D30 to the transmitter linear amplifiers Q201 through Q205.

The linear amplifier section is located on the large black heatsink at the rear of the transceiver. Because transistors at these frequencies fall off at approximately 6 db per octave, their gain is considerable at the lower frequencies. A high pass filter (not shown on the block diagram) is incorporated to attenuate all signals below the 10 meter band. This filter is situated between the tuned circuits and amplifier Q201. Transistors Q201, Q202 and Q203 are standard class A amplifiers followed by two push-pull class B amplifiers Q204 and Q205. Output from the final amplifiers is then fed to low pass filters (switched) through the antenna relay to the antenna. L30, connected across the antenna co-axial socket is part of the filter system.

RF is sampled from the output of the transmitter amplifier, rectified and amplified by transistor Q14 to activate the meter.

Referring back to the VFO section, this part of the circuit is identical with that described in the receiver section (Q17, Q18, Q16, Q19 and Q20).

Bias to the various transmitter amplifiers is provided, using silicon, silver lead diodes which sample the heatsink temperature and adjust the bias accordingly. In the case of the push-pull finals a bias amplifier Q206, provides a stiffer source than can be provided by the diodes alone.

II. DETAILED THEORY OF OPERATION

RECEIVE CONDITION

1. Signal from the antenna is applied to the antenna relay through one of two pi networks. (See transmit section). When the antenna relay is not energized the relay is in the receive condition and the signal is applied through the high pass filter, then through diode gate D29 to the wiper arm of the bandswitch SW3. Transmit diode gate D30 is in the OFF position. SW3 selects one of two band pass couplers, L1 and L2 in the 10 meter band section and L3 and L4 in the 6 meter band section. SW2 connects the output to the diode mixer circuit at L5.
2. The mixer circuit, diodes D1 through D4, mixes the local oscillator voltage, injected into potentiometer P1, with the signal, to obtain an IF frequency of 12 MHz. This signal is then fed through IF transformer L7, to amplifier Q1. Diode D5, used in the transmit condition, is OFF.
3. Output from Q1 is connected to the crystal filter FL1.
4. Transistor gate Q2, used in the transmit condition, is OFF.
5. The crystal filter is internally diode switched. When an external voltage from the AM/USB/LSB selector switch is applied to the filter through R12, the filter switches to the SSB position. The same filter is used on both sidebands. Sideband selection takes place by changing the BFO crystal. (Described later).
6. Output from the filter is connected to the integrated circuit ICI where most of the IF amplification takes place. The IF transformer L9 then feeds signal to the product detector Q3 for SSB operation, and to the amplifier Q5 and Q6 for AM operation.
7. Dealing first of all with the SSB operation, BFO . voltage from the BFO generator Q12 and amplifier Q13 is injected into gate 2 of Q3 and mixing with the SSB signal takes place.
8. The audio output from the product detector is fed into the first audio amplifier Q4.
9. In order to prevent simultaneous operation of the AM detectors D13 and D15, D13 is back biased with a voltage from the AM/SSB selector switch, preventing its operation. In AM operation the product detector Q3 is rendered inoperative simply by switching the BFO voltage off.
10. AM IF amplifiers Q5 and Q6 also supply signal voltage to the squelch detectors D14 and D15. (D15 also used to detect AM). The DC output from D14 also feeds the S meter amplifier Q14.
11. In addition, output from Q6 supplies signal voltage to the AGC detectors D10 and D11. Note that D11 is connected to a voltage divider which applies approximately 3.5 volts to the anode of D11, effectively preventing rectification until the signal level is sufficient to overcome the bias. This gives a very necessary "knee" to the AGC characteristics, preventing "pumping" of the SSB signal.
12. output from the AGC detector D10 is applied to the base of AGC DC amplifier Q7 and the AGC capacitor C44.
13. Transistor Q7 is an emitter follower which drives pin 5 of integrated circuit IC1 giving more than 90 db of AGC control.
14. Capacitor C44 and resistor R42 determine the AGC time constant. Transistor QS is a DC amplifier of the rectified squelch voltage. Potentiometer P302, on the front panel, reduces the positive voltage derived from R51, so that the collector swings positive. This positive voltage is then used to increase the

current flow through. DC amplifier Q9 causing its collector to swing negative, allowing diode gate D12 to conduct. As the base voltage of Q4 is normally about 1.2 volts above ground (due to the drop across D32 and the Q4 base emitter barrier potential) the saturated state of Q9 virtually grounds the base of Q4 and shuts off the audio.

However, when a positive DC voltage developed across the squelch rectifier, D14 is applied to the base of Q8, its collector goes negative. This in turn, causes the collector of Q9 to go positive and diode gate D12 is reversed or OFF.

15. The signal voltage which created DC output from D14 is also applied to S meter amplifier, Q14, which stage operates as an emitter follower and drives the S meter.

16. Transistor Q12 is a Colpitts type crystal oscillator supplying BFO voltage to the product detector Q3 in the receive condition, and carrier voltage to the balanced modulator in the transmit condition. In the upper sideband condition, 12 MHz BFO voltage is developed and in the lower sideband condition 11.997 MHz voltage is developed. In the receive AM condition the BFO supply voltage is turned off. In the transmit AM condition only the 12 MHz crystal is activated. Note that the two quoted frequencies are approximate only, in actual fact the BFO crystal frequencies may be adjusted to be approximately 15 db down the filter slopes.

17. Because moving the BFO frequency causes a simultaneous shift in incoming frequency (and transmit frequency), a compensating network consisting of diode switch D33, capacitor C107 and resistor R82, moves the VFO frequency an approximate equivalent and compensating amount when in the LSB position. The voltage for this action is supplied by the sideband selector switch (in the LSB position only).

18. The local oscillator frequencies are developed in a heterodyning process by mixing the VFO output frequency (approximately 5 MHz to 6 MHz), with one of four crystals, 33 MHz, 34 MHz, 35 MHz and 36 MHz, to obtain output frequencies of 38 MHz to 42 MHz in 1 MHz steps. This latter frequency is then mixed in D1 through D4, with signals from either the 10 meter band or the 6 meter band according to which tuned circuits are selected by the band switch, (See II, 1.) and a 12 MHz IF frequency results.

19. Q17 is an FET, Colpitts, VFO, direct coupled to emitter follower and isolating amplifier, Q18, which drives diode balanced mixer D25 through D28, through low pass filter L20 and C103.

20. Q16 is an overtone oscillator which supplies the 33MHz through 36 MHz crystal frequencies to the mixer. Note that this oscillator does not use inductors to obtain third overtone operation, and that its capacitor/resistor values are critical to correct operation.

21. Both oscillator frequencies are added together in the mixer and then fed to the band pass coupler L15 and L16, which removes unwanted signals before amplification by amplifiers Q19 and Q20. output from Q20 drives the receiver mixer through IF transformer L17.

22. Because Q19 and Q20 are wideband amplifiers, they generate considerable white noise. Balance control P1 is adjusted for balance so that the noise component is minimized.

23. Audio output amplifier IC2 delivers more than 3 watts of audio to the speaker. Note that the IC is a transformerless amplifier. The extension speaker should have an impedance of 3 ohms.

24. The noise blanker is located on the small "outrigger" printed circuit board fitted to the "mother" board/ ., underside. Input from the antenna is fed into the integrated circuit Q501 through step up transformer L501 and high pass filter L27, L29. The amplified signal is then fed to diode rectifier D501 through transformer L502. The time constant of the rectifier output circuitry is very short, (C506, 8505) efficiently rectifying only pulses which are then amplified by FET Q502 and bipolar transistor Q503.

The resultant pulse is fed to transistor Q15 on the main printed circuit board. The function of Q15 is unusual in that it operates as two diodes, formed by the base emitter junction and the base collector junction. Whenever a noise pulse arrives, the two diodes conduct and short out the input signal to the crystal filter for the duration of the pulse.

It should be noted that noise blanker circuits, because they must be preceded by little selectivity, are prone to cross modulation, in the presence of very strong signals.

TRANSMIT CONDITION

25. Microphone input is applied to audio amplifiers Q10 and Q11. Q11 operates as an emitter follower supplying low impedance audio to the balanced modulator (D20 through D23.)

26. Carrier voltage generated by transistors Q12 and Q13, (See Sec. II, No. 16) is supplied to the balanced modulator through the potentiometer P3. The balanced modulator mixes the audio signal with the carrier frequency and at the same time allows the carrier to be suppressed. Controls P3 and C70 allow a fine adjustment of the carrier balance. The output of the balanced modulator is double sideband suppressed carrier.

27. When the front panel SSB/AM selector switch is in the AM position, an adjustable positive DC voltage is applied to the diodes through resistor R66 and causes a carrier unbalance allowing carrier output. The size of the carrier is adjusted by pre-set potentiometer P2.

28. The double sideband output from L12 is fed to the crystal filter FL1 through diode gate D24 and transistor gate Q2.

29. In the transmit condition a positive voltage from the control line (See Sec. II, No. 44) is applied to the base of Q2 via R15, causing the stage to saturate and conduct. The resultant DC voltage developed across R14 forward biases the normally open diode gate D24 and the double sideband signal from the balanced modulator is applied to the crystal filter through resistor R9.

30. In the transmit mode, transistor Q1 is turned off by applying a positive voltage from the control line through D7 and R10 to the emitter. A positive voltage at the emitter is the same as applying a negative voltage to the base and the stage is effectively shut down.

31. For a discussion on the crystal filter see Sec. II, No. 5. In the SSB mode the filter removes one sideband of the double sideband signal, but allows both sidebands to pass in the AM mode.

32. Output from the filter is amplified by integrated circuit IC2 and fed into IF transformer L9. The IF transformer feeds the product detector Q3 but as the following audio transistor Q4 is shut down in the transmit condition, no audio output results. At the same time, output from L9 is conducted through R19, C29, C15, D5 and C11 to balanced mixer toroid input winding on L6. Although there is also signal voltage on L7, Q1 has been shut down. (See Sec. II, No. 30)

33. The balanced mixer circuit D1 through D4 mixes the signal with the local oscillator voltage and produces a signal output in both the 6 and the 10 meter bands. For a discussion of the local oscillator system see Sec. II, No. 18 through No. 22.

34. As both 6 meter and 10 meter signals are available at the output of the mixer a means must be used to select the particular band required and this is done by band pass couplers L1 and L2 in the 10 meter bandswitch position, and L3 and L4 in the 6 meter position. These couplers are also used in the receive condition and are discussed in Sec. II, No. 1.

- 35.** Output from the couplers are fed through diode switch D30, the transmitter linear amplifier module on the large heat sink at the rear of the transceiver.
- 36.** Diode switch D29, normally closed in the receive condition is now open or OFF.
- 37.** Due to the fact that the transistors used in the linear amplifier module have a considerably higher gain at the lower frequencies, especially around 14 MHz, than they have at 28 MHz and 50 MHz, it was necessary to fit a high pass filter at the input to the amplifier module. This filter consists of the components C205, C206 and L207.
- 38.** Signal from the filter is amplified by wideband Class A amplifiers Q201, Q202, Q203 and Class B push pull amplifiers Q204 and Q205.
- 39.** The outputs of Q204 and Q205 is combined in the output transformer L206.
- 40.** Bias to the various amplifiers stages is set by silver lead diodes, which diodes sense the temperature of the environment and the heatsink and adjust the bias accordingly. Similarly, if the supply voltage is varied, the diodes maintain a constant bias voltage.
- 41.** The Class A stage bias is controlled by diodes D201 and D204, and the Class B stage bias is controlled by diodes D203 and D204 together with follower amplifier Q206. Bias to the final stages is controlled by potentiometer P201, normally a factory adjustment.
- 42.** Output from the linear amplifier is fed by twisted, pair cable to either the 6 meter or the 10 meter network sections, which effectively remove harmonics generated in the amplifiers. As 2nd harmonics are already considerably reduced by the push pull operation of the final output transistors, a simple single section pi network is sufficient. L30 is part of the network system.
- 43.** Output at the antenna socket is sampled by capacitor C114 and rectified by diode D31 and the output then fed to the "S" meter amplifier Q14, which in turn causes the meter to show a relative power output condition. Note that the reading can only be relative and will vary somewhat according to the SWR of the antenna.

CONTROL CIRCUITS

- 44.** When the microphone push to talk switch is actuated, one end of the relay coil of K1 is grounded. As the other end of the coil is connected to the positive supply voltage through polarity protect Diode D17, the relay closes. The moving arm of a parallel set of relay contacts, normally grounded in the receive condition, is connected to the positive supply voltage; and a positive control voltage is supplied to the following, turning them ON: a. Entire linear amplifier module. b. D30, D5, D24, Q2, Q4 through D9, IC2 through R94, Q12, Q13 and D13 via SW1 (only when in the 'AM mode), Q6 through D6.
- 45.** The following devices are turned OFF when the control line is made positive: D29, D8, D19, Q1 via D7
- 46.** The following devices are turned ON when the control line is grounded (receive condition): Q1, Q4, Q6, D13, D29 D8
- 47.** In order to prevent a certain amount of audio output from the speaker due to leakage across the chasses, IC2 is turned off when in the Transmit condition.

48. Due to heterodyning principle used in the Kachina 1, the transceiver would be capable of operation on both the 26 MHz and 27 MHz bands. However, in order to comply with the law, transmission on these two bands has been prevented.

SUPPLY VOLTAGES

49. The nominal voltage which should be supplied to the Kachina 1 is 13.6 volts. However, the transceiver will not be damaged if voltages as high as 16 are applied.

Most of the stages in the transceiver are supplied from a regulated 8.2 volts provided by the Regulator Circuit D16 and R30. Because of voltage drop across the resistance of the RF Choke L10, the voltage on the output side of the choke will be a little lower than 8 volts. The figure of 8.2 volts is nominal and may, in fact, vary as much as 10% from this figure.

SECTION III

ALIGNMENT, ADJUSTMENTS AND TEST PROCEDURES

1. The Kachina 1 transceiver contains a lot of functions in a small package. Yet the alignment and adjustment processes are relatively simple. However, these adjustments must be conducted with considerable care; and good test equipment should be available. In particular, a high-frequency oscilloscope should be available and a VTVM for reading voltage across the dummy load in the transmit condition. UNDER VOICE CONDITIONS, A WATTMETER IS QUITE USELESS TO READ SSB POWER OUTPUT. Alignment should be conducted in the following manner and in the order given:

BFO

2. Connect a frequency counter to the emitter of Q13. With the Mode Switch on LSB, adjust the Trimmer Capacitor C75 (nearest the rear) until the frequency reads 11997.00 kHz. Switch to USB, and adjust C74 (nearest front) until the frequency reads 12000.00 kHz. VFO Connect the counter to the emitter of Q18. Turn the band switch to 27 MHz and the tuning capacitor fully meshed. Adjust the coil slug L18 until the counter read 4950 kHz. THIS IS A TEMPORARY ADJUSTMENT until the VFO IF is aligned. Final adjustment is given in Paragraph 4.

3. Local Oscillator IF Amp.

Connect the oscilloscope to the output of 117, where it connects to the 47 ohm Resistor R1. Set the VFO Tuning Capacitor to full mesh. Set the Band switch to 26 MHz, and adjust IFT L15 for full output. (Rear IFT) Set the Band switch to 29 MHz, and adjust L16 for maximum output. (Center IFT) Work back and forth (as there is interaction) until no further increase in output can be obtained. Set the band switch to 28 MHz, and adjust L17 for maximum (IFT nearest the front).

4. VFO Calibration

Remove the oscilloscope from the output of L17, above, and connect the counter in its place. Set the dial to Half Mesh and the Band switch to LSB. Set the Tuning Capacitor to Full Mesh, and adjust the coil slug L18 to read 39950.00 kHz. Turn the Tuning Capacitor fully out of mesh, and adjust the Trimming Capacitor C105 until the frequency reads 41010.00 kHz. It will now be found that this latter adjustment upsets the first adjustment, so the slug is again set to 39950.00 kHz with the Tuning Capacitor Plates in full mesh. Repeat the high frequency end adjustment, and continue back and forth until both ends read correctly. This is a somewhat tedious operation and must be carefully performed if a linear dial reading is to be obtained.

Set the Tuning Dial to a frequency of 40200.00 kHz, then fit the dial drum so that the scale reads 200. The Mode Switch should be in the LSB position for this operation. When the drum is secured, check the dial calibration against the Cursor Line. The reading should be within 3 kHz. If the error is greater

than 3 kHz-but not excessively so--the drum may be turned a little, to give, say, a smaller error over a greater part of the scale. Remember that a 2kHz error is about the width of the window line.

Note: that the plastic dial drum rides on 4 wires. The drum must just touch these wires so that vibration of the drum cannot take place in mobile operation or a "warble" on the SSB signal will take place. The vibration is actually causing frequency modulation by moving the VFO capacitor shaft. The wires must not be bent up too high or they will cause drag of the tuning mechanism.

5. Crystal Oscillator

The Crystal Oscillator Q16 needs no adjustment. However, a check on proper operation may be made by reading frequency of the local oscillator output at the output of L17 and observing that the output changes in 1 MHz increments as the Band switch is rotated. The 50 MHz to 53 MHz positions will be a repeat of the 26 to 29 MHz positions.

6. VFO Sidestepping

As outlined in Section 17, the VFO is sidestepped when the LSB Sideband Crystal is activated. This may be checked as follows. Connect the frequency counter to the output of L17 and the junction of RI. Turn the Tuning Dial to approximately midrange. Set the Band switch to any convenient position, and read the frequency with the mode switch in the AM position. Now switch to the LSB position. The frequency should read approximately 3 kHz lower in frequency. Switch to the USB position. The frequency should be the same as that obtained on AM.

7. IF Alignment .

Connect the Signal Generator to the Antenna Terminal and a meter across the speaker. Set the Mode Switch to LSB. Set the Bandswitch and Dial to 28600 kHz. Advance the Signal Generator until the signal can just be heard. Adjust the IF Transformers L7 and L9 for maximum output. Detune the Signal Generator, and adjust the Potentiometer P1 (located at the front edge of the printed circuit board for minimum white noise output as read on the Output Meter. Note that the minimum point may shift a db or so from band to band, so other bands should be checked; and, if need be, a compromise setting made. In any case, a S+N/N of at least 10 db for 1uv should be obtained.

8. Front-End Alignment

This process is best done in the transmit condition because the tuned circuits L1, L2 and L3 and L4 are connected between the exciter proper and the linear amplifier when in the Transmit mode. The adjustment will then be correct for the receiver mode. However, a preliminary adjustment should be made by setting the dial to approximately 28200 kHz and aligning L1 and L2. Then set the dial to 50200 kHz and align L3 and L4 for maximum output. See Section 15.

9. Checking the AGC

There are no adjustments to be made to the automatic gain control system. However, proper operation of the AGC System is dependent upon proper operation of other parts of the circuit. A quick check may readily be made by measuring the DC voltage at the Emitter of Q7. This point is labeled AGC on the bottom of the printed circuit board, on the left hand edge near the 1000mfd 10 volt electrolytic capacitor. With no signal, the voltage should read around 4 volts DC. As the signal level is increased, the voltage will also increase. As a further check, the Audio Meter should be connected across the speaker and the Generator set to 5 uv. The audio gain control should be set to a level well below audio amplifier overload. Advance the Signal Generator output and read the audio increase. The increase should not be more than 12 db from 5 uv to 0.1 volts.

10. Checking the Squelch

There are no internal squelch adjustments. However, proper operation is dependent upon the proper operation of other parts of the circuit. A check may be made as follows: Set the Mode Switch to LSB and, with the Signal Generator Output fully attenuated, adjust the Squelch until muting just occurs. It will be found that there is a little backlash in the squelch point, and the control should be advanced carefully back until the audio is just beginning to unsquelch. This is a most sensitive point. Now advance

the Signal Generator output. The Squelch should open on less than 1.5uv of signal. Note that if there is any BFO voltage getting into the front end of the receiver this will open the Squelch, and a larger, opposing Squelch voltage will be required, and thus a larger signal to overcome to voltage. This may be simply checked by operating the Squelch in the AM position when the BFO is turned off. Note that if the balanced modulator is badly out of balance, BFO voltage may be sufficient to overcome the normally shut off Q2 and enter the IF amplifier system. In all but early models of the Kachina 1, a diode-D24--has been placed in series with the emitter of Q2 giving increased isolation from the BFO when in the Receive position.

11. S Meter, Receive Condition

There are no adjustments to be made to the S Meter system. However, proper operation of the S Meter is dependent upon other parts of the circuit. As the S Meter circuit shares components common to the AM and Squelch Detection systems, a defect in any one part of the system may well affect the S Meter system- For example, BFO voltage leaking into the IF system will not only affect the Squelch operation but will also affect the AGC system and cause the S Meter to read when no signal is being received. It is normal, however, to have the S Meter show up to an S1 signal when in the SSB modes.

12. Sensitivity

A simple check on receiver sensitivity may be performed as follows: Set the Band switch to 28 MHz and the dial to approximately 600. Connect the audio voltmeter across the speaker and the signal generator output to the antenna socket. Set the generator output to 1uV and measure the voltage developed across the speaker when the Audio Gain Control is fully advanced and the Mode Switch is set to LSB. The voltage across the speaker should measure between 0.5 and 1 volt. Note that this measurement--alone--is quite meaningless and could well be a measure of how good the receiver operates as a noise generator. However, if the signal to noise reading is satisfactory, then the reading is a good measure of satin factory operation. Note if the receiver will not make the sensitivity measurement, then it is highly unlikely it will make the AGC test. , Switch the Signal Generator to 308 modulation and the Kachina 1 to AM. Output across the speaker should be better than 0.5 volts, typically 1 volt.

13. Signal to Noise Ratio (S+N/N)

Connect the Signal Generator and set the Receiver Mode Switch to LSB. Set the Generator to 28200 kHz-no modulation-and tune in the signal until a beat not* of about 1 kHz is obtained. Set the Receiver Audio Gain Control until an audio output meter connected across the speaker shows no more than 1 volt. Detune the receiver until no beat note is heard, and note the drop in meter reading. The meter should have dropped at least 10 db, typically 15 db.

Turn the Kachina 1 to AM and the Generator Modulation to 30% at 3 u volts output, and note the reading on the Audio Output Meter. Turn off the modulation. The output should drop at least 10 db, typically 14 db. This measurement measures the signal and the noise against the noise. Note that this reading may drop slightly after the front end tuned circuits are broad banded.

TRANSMITTER

14. Band Pass Coupler Alignment

Connect the dummy load and set the Mode Switch to AM. A VTVM such as the Hewlett Packard 410B should be connected across the dummy load and set to the 100 volt scale. A high frequency oscilloscope should also be connected across the dummy load. Turn down the microphone gain control, and press the microphone Push-To-Talk Switch. Note the carrier output on the VTVM. On the 10-meter band, this should be approximately 30 volts. Now check the output on 28, 29 and 30 MHz. If the voltage is very uneven, align L1 and L2 as follows: Set the Band switch to 28 MHz and the Dial to 0. Adjust L2 (the rear metal cased coil under the Band switch) for maximum output. Set the Band switch to 29, and set the dial to 500. Adjust L1 (the metal-cased coil nearest the front under the Band switch) for maximum. As there is some interaction between the settings, work back and forth until the output is as even as

possible. It is normal to have as much as 4 volts difference between the ends. Repeat the operation on 50 and 53 MHz, this time adjusting the uncased coils L3 and L4. Note that in one particular part of the band is favored, the coils may be aligned at that frequency. It is assumed that the Carrier Balance Controls and the AM Carrier Controls had previously been adjusted.

15. SSB Carrier Balance

Connect the dummy load, the VTVM and the oscilloscope as indicated in the last paragraph. Turn the Mode Switch to SSB. Turn the Microphone Gain Control completely down.

Press the Push-To-Talk Switch. Turn up the VTVM and Scope Gain. If the carrier is greater than 0.1 volts peak-to-peak, adjust the Carrier Balance Controls C70 and P3. The controls are located right at the rear of the main printed circuit board and are screened CAR BAL on the board. Turn first the Potentiometer for a minimum output. Then turn the Capacitor for minimum. Return to the Potentiometer. If the control will not reduce the output further, turn the shaft slightly so as to double the output and go back to the Capacitor. The output should decrease. If not, return to the Potentiometer and set it on the other side of minimum and null the Capacitor again. Work back and forth until the absolute minimum is obtained. Check the USB position; and if the carrier increases, go through the operation once more. **IMPORTANT NOTE:** If the carrier balance is not complete, some distortion of the AM signal may become apparent when using AM. See next paragraph.

16. AM Carrier Level

The AM Carrier Reinsertion Potentiometer is right alongside the SSB/AM Mode Switch and is screened AM CAR on the board. This control sets the amount of carrier when in the AM mode. **IMPORTANT NOTE:** The Kachina 1 uses low-level modulation, therefore only 1/2 of the SSB power should be transmitted in the form of carrier, or distortion will result. Increasing the carrier level beyond the correct amount will actually decrease the intelligibility of the signal for the modulation will be all negative and have no positive excursions. The Carrier Level is normally set to 30 volts on the VTVM, which is 18 watts on the dummy load. Advance the microphone gain to about 9 o'clock, and whistle while observing the oscilloscope. The RF voltage should double in amplitude on the peaks and drop to Zero in the valleys. If the Carrier Level is too high, the amplitude will not double on peaks; and it will be necessary to reduce the Carrier Level. If the Microphone Gain is advanced too far, note that the valley in the waveform will begin to fill in and "double hump." This indicates too much audio gain. To an AM listener, too much microphone will turn the signal into Sideband, and he will claim it is distorted. However, were he to switch his receiver to SSB, he would find that it was 100% copy.

IMPORTANT: IF THE CARRIER BALANCE CONTROLS ARE ADJUSTED AFTER THE AM CARRIER LEVEL IS SET, DISTORTION OF THE SIGNAL WILL RESULT, AND IT WILL BE FOUND IMPOSSIBLE TO OBTAIN NEGATIVE MODULATION on the OSCILLOSCOPE.

Imbalance due to maladjustment of the Carrier Balance Controls AND the deliberate unbalance in order to create carrier will cause a phase shift of the carrier and consequent distortion of the signal. In addition, adjustment of the Carrier Level Controls AFTER the Carrier Level has been set will cause a change in the Carrier Level. Therefore, adjust the Carrier Balance before setting the AM Carrier Level, and then do not touch the Carrier Balance Controls afterward.

17. Final Amplifier Bias

To make this adjustment, it is necessary to remove the linear amplifier section from the rear of the radio. Open the supply to the RF Choke L211, which supplies voltage to the collector of the amplifiers, and insert a milliamperere set to the 500ma scale. Make certain that the Mode Switch is on SSB and that the Microphone Gain Control is down. There must be no signal coming through the amplifier. It is a good idea to remove the voltage from Q201--the first amplifier stage--to be sure that there is no signal coming through the amplifier. Then adjust the Bias Potentiometer, located at the front end of the linear amplifier module, for a Collector Current of 75ma. It will be necessary to adjust the Push-To-Talk Switch.