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OF HF - VHF -- UHF
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Miami, Florida 33155
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100MX

SERVICE MANUAL

VENECOM, INC.
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OF HF - VHF -- UHF - CB

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SWAN ELECTRONICS
A Subsidiary of Cubic Corporation

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To the service technician:

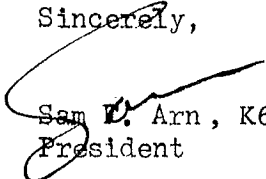
The Swan 100MX is a modern, sophisticated Amateur Band transceiver utilizing state-of-the art techniques and design. The "most wanted" features, such as noise blanker, VOX, CW sidetone, and RIT, are built in, rather than being offered as "add on" accessories.

Whenever performance measured up to required standards, integrated circuit technology was used in the design; where special functions were required, or desired performance could not otherwise be obtained, carefully designed discrete component circuits were included, rather than accept compromised performance.

Every care has been taken to provide long, troublefree life, but the requirements of extra operating features, high performance design, and compact packaging demanded by today's Amateurs results in a unit necessitating a high degree of skill on the part of you, the service technician. To assist you, this manual has been painstakingly prepared. Take the time to thumb through it; read and study the Theory of Operation section and the Servicing Hints section; it will be time well spent, even for the most highly qualified and experienced personnel.

It is you, the service technician, that will ultimately determine how well or how poorly the radio will work, and therefore how satisfied or dissatisfied our customers will be. If you have a suggestion or a problem, write or call our service department. We'll listen, and help you all we can.

Sincerely,


Sam D. Arn, K6TSD
President

VENECOM, INC!
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SECTION ONE

GENERAL

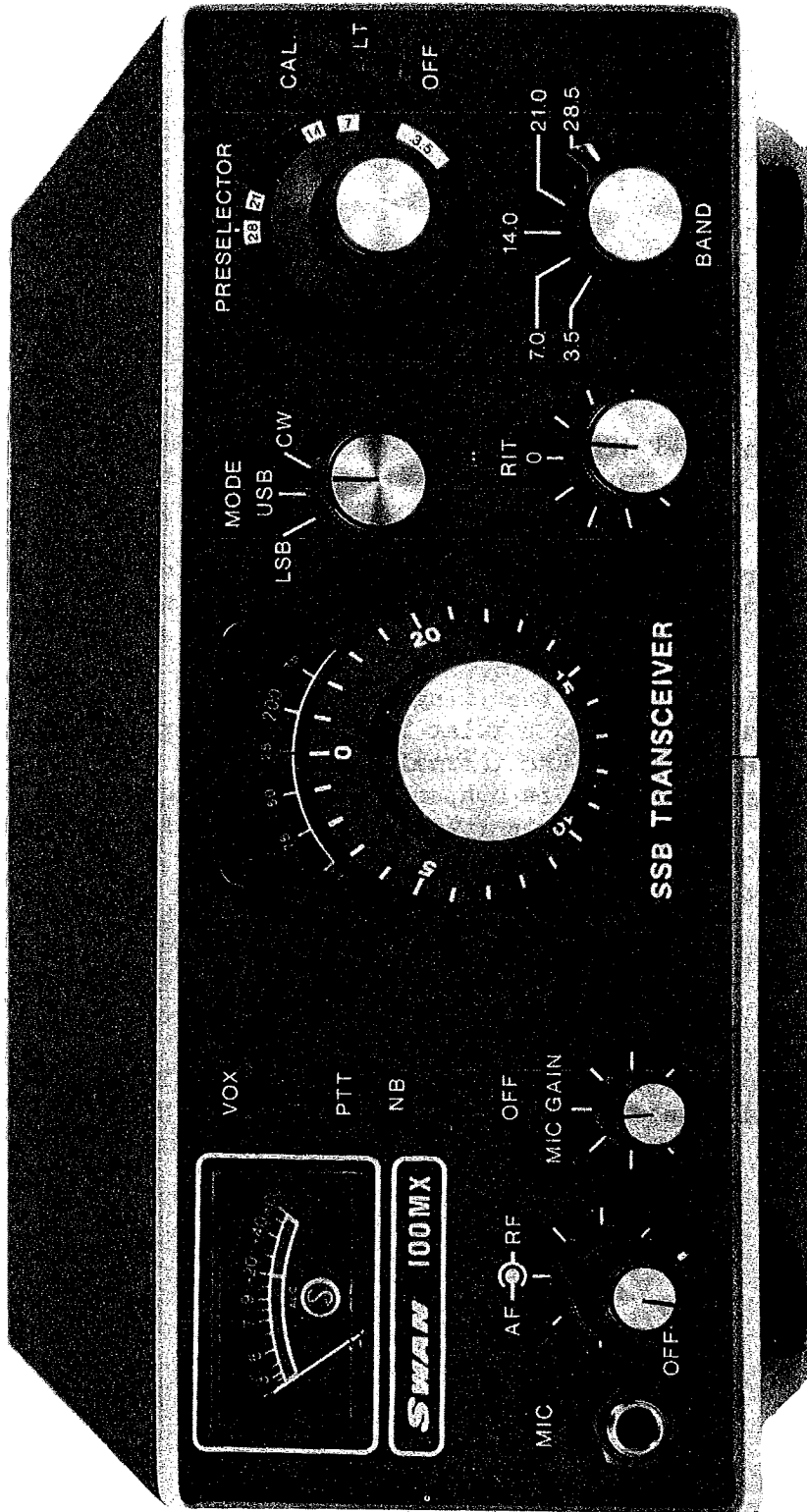


GENERAL

The Swan Model 100MX, together with its accessories and optional equipment, is designed to be used in either CW or SSB modes on all portions of the 80, 40, 20 and 15 meter amateur radio bands, plus any 500 kHz segment of the 10 meter band. The Model 100MX generates a single sideband signal by means of a crystal bandpass filter, and the transceive operation automatically tunes the transmitter and receiver to the same frequency. Provisions are included for operation on either upper or lower sideband.

Basic circuitry of the single conversion design has been proven in several thousands of the popular Swan transceivers produced over the years. Mechanical, electrical and thermal stability is exceptionally high. All oscillators are temperature compensated and voltage regulated. Push-to-talk operation is standard, as is VOX, which provides for automatic voice control and CW semi-breakin.

The unit is designed, primarily, for mobile operation. However, it is also ideally suited for fixed and portable operation. An auxiliary power supply, Model PSU-5, provides 13.8V DC from 115/230V AC sources to power the Model 100MX. Transmitter output power is 100 watts PEP on all bands during SSB operation and 100 watts on CW. Continuous operation on TTY or Slow Scan TV modes requires additional forced air cooling. See the Operator's Manual for precautions to be observed when operating in these modes. The Model 100MX includes automatic gain control (AGC) in the receive mode, and automatic level control (ALC) in the transmit mode. CW sidetone is also provided.



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100



SWAN
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SECTION TWO

SPECIFICATIONS

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SPECIFICATIONS

Frequency Coverage: 80M.....3.5-4.0 MHz
40M.....7.0-7.5 MHz
20M.....14.0-14.5 MHz
15M.....21.0-21.5 MHz
10M.....28.5-29.0 MHz

Extended Frequency Coverage: Any 500 kHz segment of the 10M band by changing the band crystal frequency.

Frequency Control: Stable permeability tuned oscillator (PTO), operating over the 5.0 to 5.5 MHz range.

Modes of Operation: SSB with selectable sideband. CW with automatic 800 Hz offset in transmit. RTTY or SSTV under conditions listed in the Operator's Manual.

Power Input: 12-14V DC negative ground only. No damage will occur over the range of 10 to 15V DC, although power output will be limited accordingly. 20 Amperes peak current required.

Electromagnetic Interference Reduction:

Five element low pass filter included for each band.

Tuned input, tuned output RF preselector for additional selectivity.

Dimensions: H 3.75" (9.53cm)
W 9.75" (24.8cm)
D 11.60" (29.5cm)
Wt. 13 lb (5.9kg)

Power Connector: Pin 1 13.6V DC (in)
Pin 2 Ground (in)
Pin 3 Ground (used for accessories)
Pin 4 13.6V DC (in)
Pin 5 Ground (in)
Pin 6 13.6V DC (for accessories, fused 2A)

Note: Due to the heavy current requirements of the 100MX, pins 1 and 4 are paralleled, as are pins 2 and 5, to reduce connector voltage drop.

Antenna Connector: UHF type, SO-239.

External Speaker/Phones: Phone jack; 4-8 ohms.

External Relay: RCA jack; grounded when keyed.



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External Counter: RCA jack; pre-mixer output, level approx. 35 mV RMS, frequency equals operating frequency plus 9 MHz (LSB) or 9.0033 MHz (USB).

Fuse: 2 Ampere fast blow; protects some internal circuitry and accessory power; external 20 ampere fast blow fuse required for full current and reverse voltage protection.

RECEIVER

Circuit: Single conversion to 9.00165 MHz IF using double balanced mixer. Exceptional immunity to overload and cross modulation.

Sensitivity: 0.35 uV for 10 dB S+N/N ratio.

Selectivity: 8-pole crystal band-pass filter. Bandwidth of 2.7 kHz at 6 dB points, 4.3 kHz at 60 dB points; 1.6 shape factor.

Internally Generated Spurious Responses: ≤ 1.0 uV equivalent input signal.

AGC: 6 dB change in audio level over input range of 1.0 uV to 0.1 V (100 dB)

Audio Output: 4 Watts available at less than 10% distortion; 300-3,000 Hz; 4 ohms output impedance.

Meter: 5 Units from 1-9; 20, 40, and 60 dB over S-9.

TRANSMITTER

Circuit: Full transceiver, solid state, with excellent harmonic and TVI suppression. ALC limits SSB peak power and CW power to 100 watts. ALC reduces output on severe antenna mismatch to protect final devices.

Power Input: 235 Watts PEP at 13.8V DC supply.

Power Output: 100 Watts PEP into 50 ohm non-reactive load at 13.8 V DC supply voltage.

Unwanted Sideband Rejection: >60 dB down at 1,000 Hz audio frequency.

Harmonic Output: >50 dB below peak power level.

Carrier Suppression: >50 dB below peak power level.

Transmit Control for SSB: Push-to-talk and VOX standard.

Transmit Control for CW: Semi-breakin with sidetone standard. Automatic 800 Hz offset on transmit frequency.

Microphone Input: 25 k ohms input impedance.

Audio Response: 300 to 3,000 Hz, ± 6 dB.

Meter: Reads ALC voltage on transmit.

Cooling: Large capacity finned heat sink utilized for convection cooling. For SSTV, RTTY, and semi-continuous transmitting, forced air cooling supplied by a "muffin" type fan on heat sink fins is required.



SECTION THREE

THEORY OF OPERATION

RECEIVE

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RECEIVE THEORY

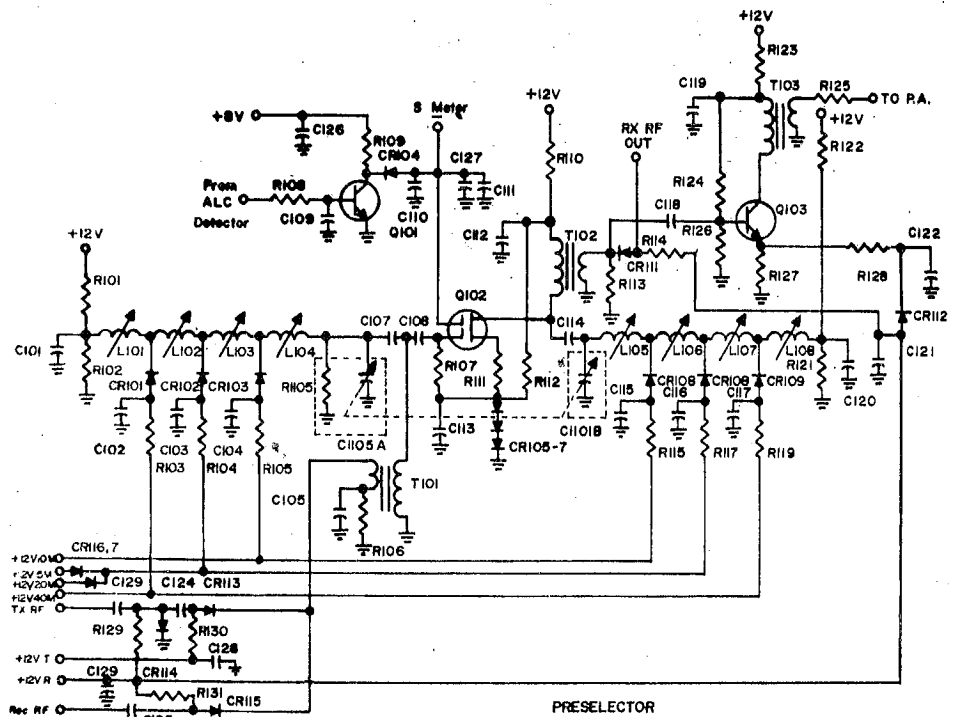
Preselector

The received RF signal from the antenna circuit is coupled through C125 and CR115 to the primary of the untuned preselector input transformer T101. Diode switch CR115 is turned on by the application of the +12V R voltage through R131.

The gate circuit of the FET, Q102, is tuned by a parallel resonant circuit composed of inductance selected by means of diode switches controlled by the band switch. Details of this switching arrangement will be covered later. R1105, in parallel with C1105 A, is included to lower the "Q" of the tuned circuit to broaden its response, so that the tuning will not be too critical.

The signal is then coupled through C108 to the first gate of the FET. Bias for gate one is developed across R111, and coupled by DC return resistor R107. R112 and the CR105-106-107 string form a voltage regulation circuit with an output (at the junction of the resistor and diode string) equal to the sum of the voltage drops of the forward biased diodes, or about 2.1 volts. Since this voltage is applied to both R107 and R111, and bypassed by C113, it has no effect on the bias as seen by gate 1; however this voltage is the fixed bias for gate two of Q102.

The signal is coupled out of the drain circuit via untuned transformer T102, through diode switch CR111, to the output terminal, although the drain circuit itself is tuned by the C1101B-L105 to L108 combination. Diode switch CR111 is turned "on" by the +12V R line through R114, while the same line, through CR112, applies a voltage across R127 sufficient to reverse bias the base-emitter junction of Q103, disabling it.





Since in the receive condition, there is no ALC voltage applied to R108 from the ALC detector, the collector of Q101 remains high, reverse biasing CR104, effectively removing the ALC amplifier from the circuit, and leaving a fixed bias on gate 2 of Q102.

Selection of the proper inductance to tune gate one of Q102 is accomplished in the following manner. When the 80M band is selected, the +12V 40M, +12V 20M, +12V 15M and +12V 10M lines are open; thus, no forward bias is applied to diode switches CR101, CR102, or CR103. A voltage developed by the R101 and R102 voltage divider is applied, through the inductors, to reverse bias these diode switches. Thus, the inductance seen by the tuned circuit is a series combination of L101, L102, L103 and L104. The left (cold) end of L101 is grounded for RF through bypass capacitor C101.

If, for instance, the 40M band was selected, the +12V 40M line would go positive, forward biasing CR101 "on". Thus, bypass capacitor C102 would be effectively connected to the junction of L101 and L102, shorting out L101 for AC through itself and C101. In this manner, only L102, L103 and L104 would be used in the tuned circuit, raising its frequency to the 40M band vice the 80M band. Similarly, application of either the +12V 20M or +12V 15M voltage would turn CR102 on, leaving only L103 and L104 in the tuned circuit (both the 20M and 15M bands use this inductance combination). For 10M operation, only CR103 is turned on, and only L104 is used in the tuned circuit. The selection of inductance in the output tuned circuit is accomplished in an identical manner.

First Mixer

The L.O. output is supplied via the analog switch to the input of the first mixer, Z101, through R176 and C160 to the base of Q112 in the receive condition. Bias for Q112 is derived via the R172 and R175 divider network. C156 is a bypass capacitor. Temperature stability for Q112 is achieved by emitter resistor R174, bypassed by C159.

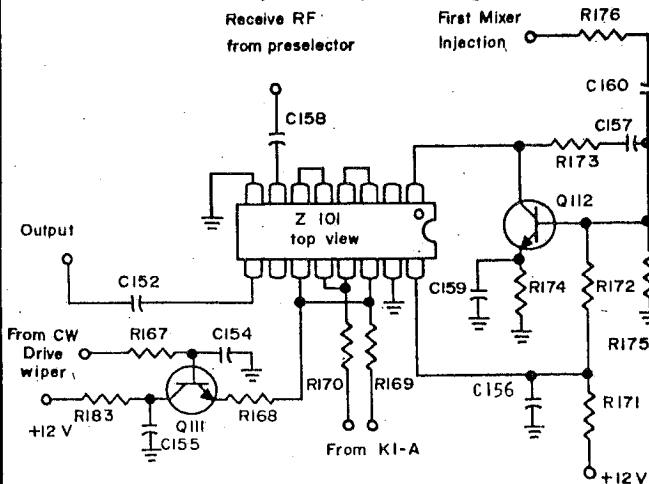
Power for Q112 is supplied through the mixer winding. R171 is a decoupling resistor. Feedback from the collector to the emitter of Q112 is supplied via the R173-C157 combination to level out the frequency response.

Z101 is a doubly balanced mixer, passive in nature, using four matched silicon diodes in a ring configuration. Both the incoming signals (RF from the preselector and VFO) are balanced out,

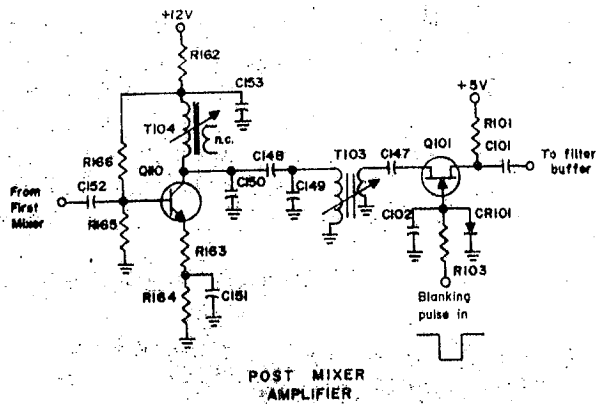
while their sum and difference products are passed on to the post mixer amplifier. Internal details of the Z101 assembly are provided later in the Transmit Theory portion of this manual.

Post Mixer Amplifier

Output of the mixer is coupled to Q110 via blocking capacitor C152. Q110 is biased by the R165-R166 combination. The R163-R164-C151 network in the emitter circuit controls both temperature stability and gain of Q110.



FIRST MIXER

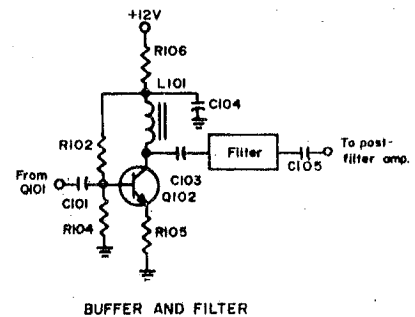


Collector loading is provided by resonant circuit T104 and C150, with decoupling provided by R162. Note that these two components form a parallel, not series, resonant circuit by virtue of having C153 bypass the upper end of T104 to ground. The signal is then applied to a second tuned circuit via C148. This tuned circuit consists of the primary of T103 and C149. Output from the secondary of T103 is coupled through C147 to blanking switch Q101, which remains on; i.e., conducting from source to drain, unless a signal is supplied to its gate

from the noise blanker circuit, in which case it acts as an open circuit, cutting off the signal for the duration of the noise pulse. In later versions of the 100MX, Q101 is moved between T103 and T104 for improved switching action.

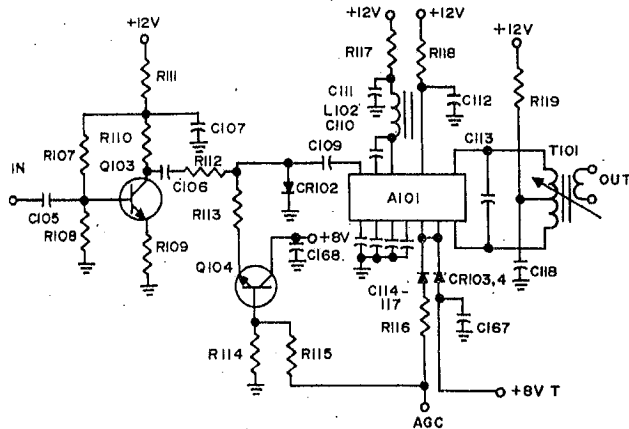
Filter Buffer Amplifier and Filter

The signal from the blanker switch is coupled through C101 to filter buffer amplifier Q102. Bias for this stage is conventional, supplied by R102 and R104, while emitter degeneration for enhanced linearity is provided by unbypassed R105. Collector loading is provided by L101, and the R106-C104 network provides decoupling from the power supply line. Output of Q102 is coupled via C103 to the crystal filter, where the bulk of the receiver's selectivity is obtained. The filter has a 6 dB bandwidth of 2,700Hz and a shape factor of 1.6.



Post Filter Amplifier

The signal from the filter is then coupled via C105 to the base of post filter amplifier Q103 for further amplification. Again, bias is conventional, with R107 and R108 forming the divider. R109 provides emitter degeneration (negative feedback) to enhance the linearity of the stage. R110 is the collector load, and R111-C107 decouple the supply.



Q103's output is coupled through C106, R112 and C109 to the integrated circuit IF amplifier A101. Q104, R113 and CR102 are part of the receiver AGC circuit. When an AGC voltage is applied to Q104 by the AGC detector (covered later), it forces a current to flow through CR102, a PIN diode. This diode acts as a shunt resistor, passing the signal to ground to a degree dependent upon the amount of current flowing through it. In this manner, the signal strength is controlled by the AGC signal from the detector.



I.F. Amplifier

The circuitry of the I. F. amplifier is shown in the previous diagram. IF amplifier A101 is an integrated circuit containing two amplifier sections which are connected in cascade in this application. C109 brings the signal to one input of the first section, while C117 bypasses the other to ground. Output of the first section is coupled to the input of the second section through C110, while L102, C111 and R117 decouple the supply lead. C114, C115 and C116 decouple other internal circuitry of the IC.

R118 and C112 decouple a second supply lead. AGC is applied to both sections through CR103, while +8V is applied through CR104 to override this AGC in the transmit condition.

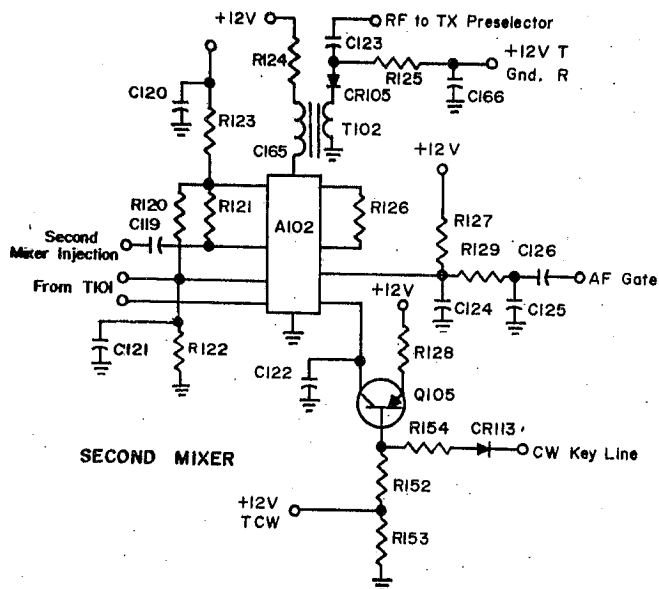
Output is push-pull, and coupled to T101, whose primary is resonated by C113 and decoupled from the supply by R119 and C118.

Second Mixer

Both sides of the secondary of T101 are connected to inputs of the integrated circuit second mixer, A102. Neither side is grounded, for these inputs must be raised above ground potential for proper operation of the IC. This is accomplished by the voltage divider R120 and R122, C120 and C121 are bypasses. Similarly, the carrier oscillator (BFO) input is raised above ground by R121 and R123.

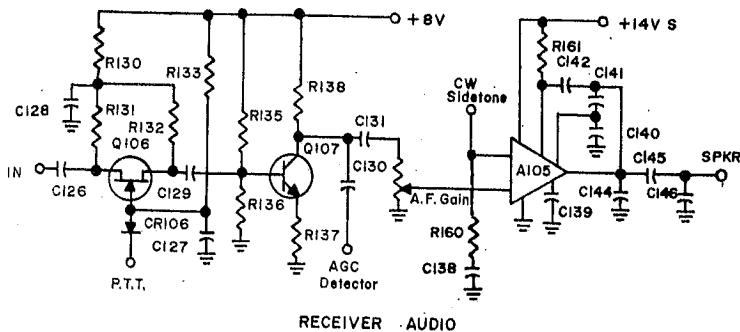
Output of the mixer is taken via low-pass RC filter C124-R129-C125 through blocking capacitor C126 to the AF gate. DC is applied to the mixer to make it function as a detector through R127.

The +12V T line is grounded in the receive condition, opening diode switch CR105, which disconnects the preselector input from the mixer.



Receiver Audio

Receiver AF from detector A102, through filter network C124-R129-C125, is coupled through DC blocking capacitor C126 to the audio muting gate Q106. In normal receive condition, the gate of Q106 is biased, through R133, to the same voltage as the source and drain through R131 and R132. Therefore, audio is coupled through Q106 to the audio preamp. When the PTT line is keyed





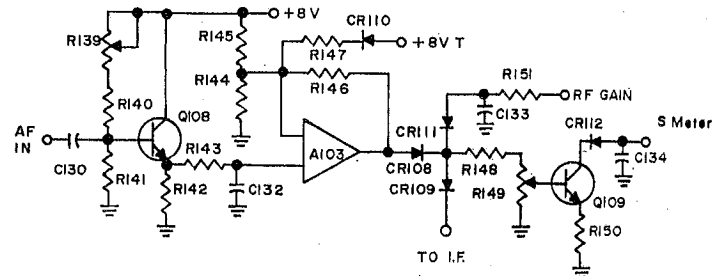
(grounded), diode switch CR106 conducts, lowering the gate potential of Q106 sufficiently to stop conduction between the source and gate, and thus opening the audio path and muting the receiver.

The audio preamplifier, immediately following the mute gate, consists of Q107 and its associated circuitry. Bias is conventional, and the emitter resistor is left unbypassed for better fidelity. The output is coupled to the high end of the AF Gain control on the front panel. The arm of the gain control is coupled to one input of audio power amplifier IC A105. The CW sidetone is coupled to the other input when operating in that mode. Output of A105 is coupled to the speaker via C145. C140, C141, C142, C144 and C146 help to shape the frequency response of the amplifier for more pleasing pitch. R160 is used to set the gain of A105, while C138 blocks the DC path.

AGC Circuit

Audio frequency signal is coupled from the audio preamplifier, as shown on the previous diagram, via C130, to the base of AGC detector Q108. The signal is rectified in the base-emitter junction of Q108, and charges C132 through a low value of resistance (R143). When the signal fades, C132 discharges through R142, which has a higher value, and thus determines the decay time of the AGC.

The signal from Q108 is further amplified by IC A103 which is an operational amplifier. The inverting input is biased between the +8V supply and ground by R145 and R144, to place the resting output voltage at the desired point. CR111 allows the RF Gain control signal to override the AGC signal.



AGC CIRCUIT

When in the transmit condition, it is necessary to disable the AGC circuit; this is accomplished by connecting +8 V through CR110 and R147 to the inverting input of the amplifier, causing its output to go to ground and remain there.

The DC signal at the junction of CR111 and CR108 also drives S meter amplifier Q109 through R148 and calibration control R149.

RF Gain control is achieved by means of injecting a voltage, determined by the setting of the RF Gain control, through R151 and CR111.

RIT Control

Control voltage for the RIT varactor in the PTO is derived from the network shown on the following page. In the receive condition, +8V is divided via the R101-R107-R108 and (assuming RIT is turned on), CR101 to the +12V T line, which is grounded unless the transmitter is keyed. R107 sets the DC level for the varactor (located in the PTO). R101 and R108 limit the range of adjustment, while R103 provides bias for the diodes.

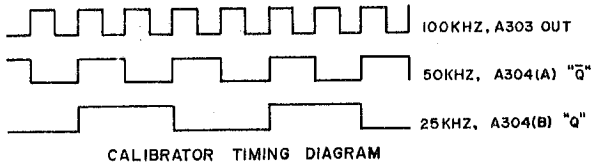
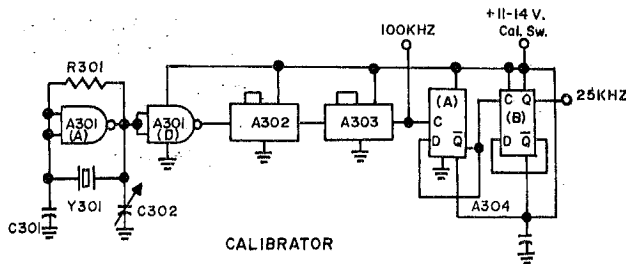
When in the transmit condition, or when the RIT switch, S102, is off, a fixed bias must be set for the varactor. This is accomplished by R102, R104 and R105, to ground through the +12V T or +12 V R lines, as appropriate. CR101 and CR102 prevent shorting these two lines under this condition. Diodes CR103 and CR104 are "steering" diodes, while DS101 is the front panel "RIT" indicator LED.



Calibrator

The frequency calibrator uses a high-stability 10 MHz crystal oscillator in a conventional CMOS oscillator circuit. Gate A301A is biased into linear operation by feedback resistor R301. The crystal used is a parallel resonant AC feedback path, and is tuned to precise frequency by the C301-C302 combination. Gate A301D is used to increase the drive level available and to square the waveform for compatibility with the digital IC's to follow.

A302 is a divide-by-ten counter, as is A303. Thus the 10 MHz oscillator signal is divided first to 1 MHz, and then to 100 kHz. This signal is further divided by A304, connected in a divide-by-four configuration, to 25 kHz. The timing diagram for A304 is included for reference.

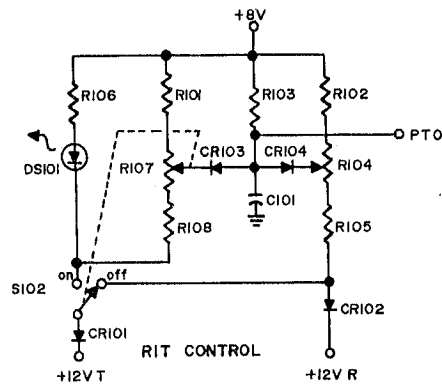


the primary power supply, via the "Cal-Light-Off" switch on the front panel. Power for CMOS may range from 3 to 18 volts, generally, and need not be regulated.

Noise Blanker

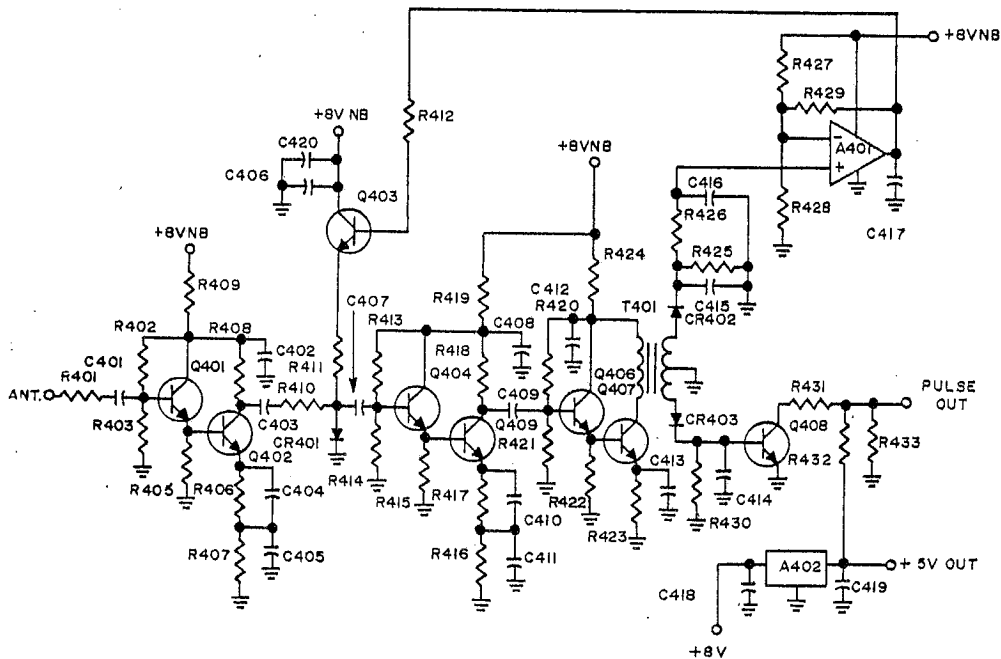
The noise blanker signal input is taken directly from the receiver antenna input, and is coupled through isolation resistor-capacitor combination R401-C401 to the base of Darlington pair Q401-Q402. Bias for the pair is derived from R402 and R403, with supply decoupling provided by R409 and C402.

Frequency compensation is accomplished by the R406-C404 and R407-C405 networks. Output is taken through C403, R410 and C407 to the base of the second Darlington pair, Q404 and Q405, which operate in the same manner as the first pair. In turn, this output is taken to yet a third Darlington pair, Q406 and Q407. This pair utilizes a conventional emitter network and untuned transformer T401 for its output. Note that the entire circuit is broad banded---no selectivity is built in, so that the noise pulses, no matter what frequency, will be accepted. The use of three Darlington pairs of transistors in cascade realizes a very high gain, for good sensitivity to the noise pulses.





The upper half of the secondary of T401 drives detector CR402, and after filtering by the C415-R425-C416 network, the resultant DC signal is applied to operational amplifier A401. The gain of this device is set by the ratio of R429 to R426, and its quiescent output point is determined by voltage divider R427 and R428 on the non-inverting input. The DC output of A401 is filtered by C417 and applied through current limiting resistor R412 to



NOISE BLANKER.

the base of Q403. Q403 supplies a current to PIN diode CR401 which serves as a variable attenuator, thus supplying AGC to the noise blanker receiver. The R425, R426, C415 and C416 network integrates all incoming signals to drive A401 and generate AGC to prevent strong signals (SSB, AM, or CW) from generating cross-modulation in the blanking gate.

The bottom half of T401 drives a detector, CR403, which supplies a DC bias to the base of Q408 when a noise pulse is received. When Q408 is thus turned on, the output of five volt regulator IC A402, as coupled through R432, is brought to a low level, thus providing the necessary blanking pulse. The duration of the pulse is equal to the duration of the noise pulse, plus a small time duration caused by RC network C414-R430 in the base circuit of Q408.



SECTION FOUR

THEORY OF OPERATION

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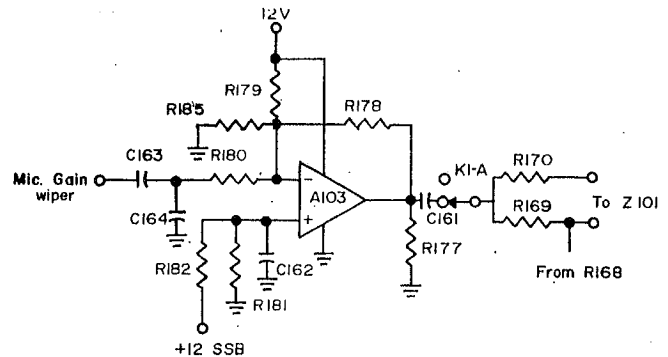


TRANSMIT THEORY

Microphone Amplifier

Audio from the mic. gain control is coupled via blocking capacitor C163 and resistor R180 to the inverting input of one half of A103, an LM358 dual operational amplifier. C164 provides RF bypassing and high frequency roll-off for the audio input. The gain of the amplifier is set by the ratio of R178 to R180. Bias is applied to the non-inverting input via R179. Output is taken via C161, through relay contact K1-A and applied to the first mixer, Z101, through isolating resistors R169 and R170.

When the mode switch is in either "USB" or "LSB" position, +12V bias is applied to the non-inverting input through voltage divider R181 and R182. C162 is a decoupling capacitor. In the "CW" mode, this bias is removed, disabling the microphone amplifier.



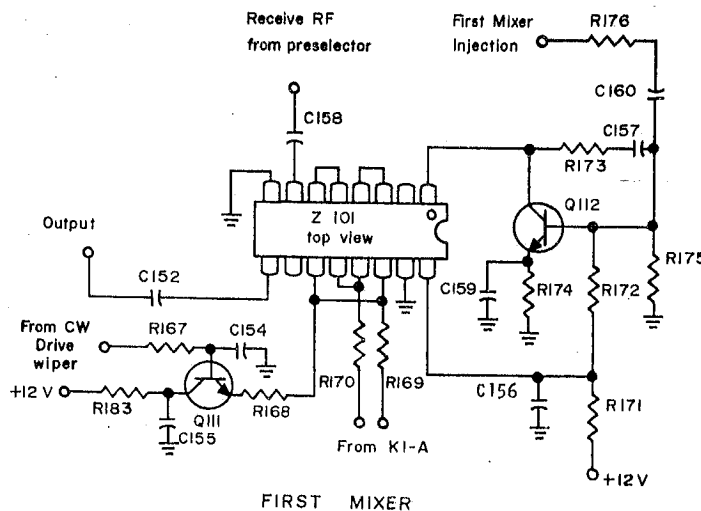
MICROPHONE AMPLIFIER

First Mixer

Carrier energy is supplied to the mixer, Z101, through R176 and C160 to the base of Q112 in the transmit condition. Bias for Q112 is derived via the R172 and R175 divider network. C156 is a bypass capacitor. Temperature stability for Q112 is achieved by emitter resistor R174, bypassed by C159.

Power for Q112 is supplied through the mixer winding. R171 is a decoupling resistor. Feedback from the collector to the emitter of Q112 is supplied via the R173-C157 combination.

In the "CW" mode, voltage from the wiper arm of the CW drive control is applied through R167 to the base of Q111 causing the mixer to become unbalanced, allowing the carrier energy to pass. C154 is an RF bypass, as is C155. R183



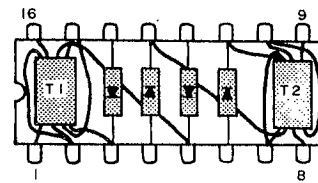
FIRST MIXER

is a decoupling resistor. Emitter current is coupled to the mixer to accomplish this unbalance, via R168.

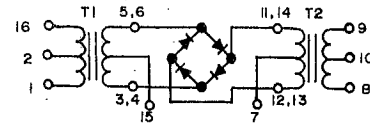


Z101 is a doubly-balanced mixer, passive in nature, using four matched silicon diodes in a ring configuration. Both the carrier and the audio signals are balanced out, minimizing their presence in the output. Hence, the output, in "USB" or "LSB" mode of operation, is a double-sideband, suppressed carrier (DSBSC) signal. As mentioned before, injection of current from Q111 unbalances the mixer, allowing the normally suppressed carrier energy to be passed with little loss when operating in the "CW" mode.

Z101 is a small subassembly, wired on a 16-pin DIP header. The diagram and pictorial representations are to the right. This assembly is also used in the Premixer section of the VFO.

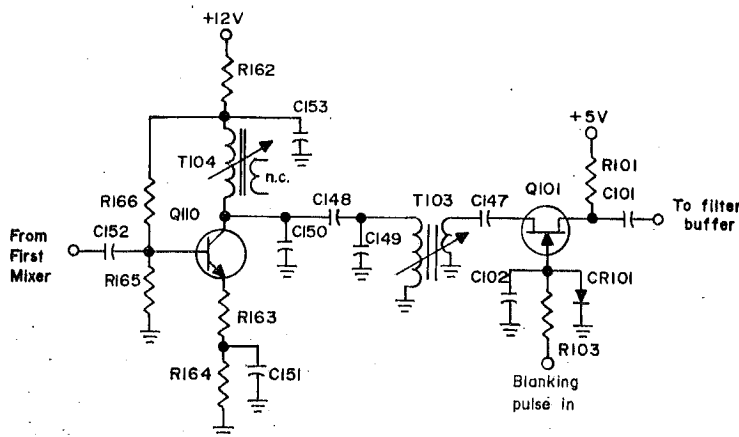


MIXER Z101



Post Mixer Amplifier

Output from the mixer is coupled to Q110 via blocking capacitor C152. Q110 is biased by the R165-R166 combination. The R163-R164-C151 network in the emitter circuit provides both temperature stability and to control the gain of Q110.

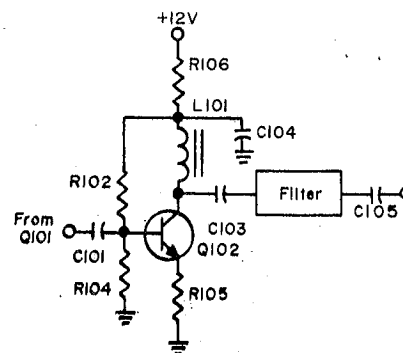


Collector loading is provided by resonant circuit T104 and C150, with decoupling provided by R162. The DSBSC or CW energy is then coupled to a second tuned circuit via C148. This tuned circuit consists of the primary of T103 and C149. Output from the secondary

of T103 is coupled through C147 to blanking switch Q101, which remains biased on, i.e., conducting from drain to source, in the transmit condition. (Operation of the blanking switch, Q101, is covered in detail in the "Noise Blanker" portion of the Receiver Theory of Operation section.)

Filter Buffer Amplifier and Filter

The signal from the blanker switch is coupled through C101 to filter buffer amplifier Q102. Bias for this stage is conventional, supplied by R102 and R104, while emitter degeneration for enhanced linearity is provided by unbypassed R105. Collector load is provided by L101, and the R106-C104 network provides decoupling from the power supply line. Output of Q102 is coupled via C103 to the eight-pole crystal filter, where the unwanted sideband is removed and the carrier is further suppressed, except in the case of operation in the "CW" mode, where the frequency used falls within the pass band of the filter.

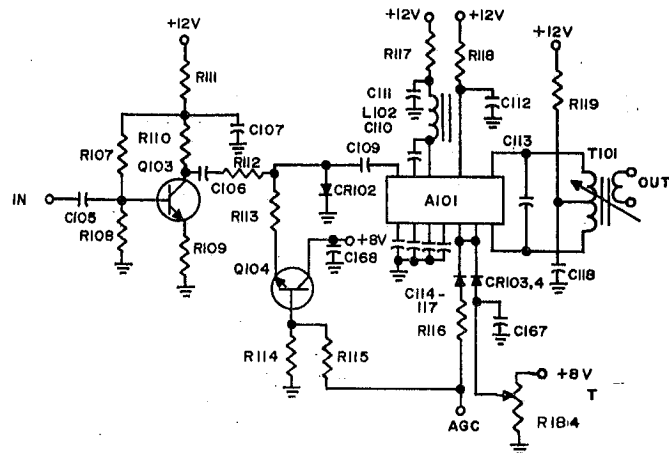


BUFFER AND FILTER

Post Filter Amplifier

The signal from the filter is then coupled via C105 to the base of post filter amplifier Q103 for further amplification. Again, bias is conventional, with R107 and R108 forming the divider. R109 provides emitter degeneration (negative feedback) to enhance linearity of the stage. R110 is the collector load, and R111-C105 decouple the supply.

Q103's output is coupled through C106, R112 and C109 to the integrated circuit IF amplifier A101. Q104, R113 and CR102 are part of the receiver AGC circuit, and are disabled in the transmit condition. Their operation is covered in detail in the Receiver Theory of Operation section.



POST-FILTER AND I.F. AMPLIFIERS

I.F. Amplifier

The circuitry of the I.F. amplifier is shown in the previous diagram. Amplifier A101 is an integrated circuit containing two amplifier sections which are connected in series in this application. C109 brings the signal to one input of the first section, while C117 bypasses the other to ground. Output of the first section is coupled to the input of the second section through C110 with L102 acting as load, and C111 and R117 decouple the supply. C114, C115, and C116 decouple other internal circuitry of the I.C.

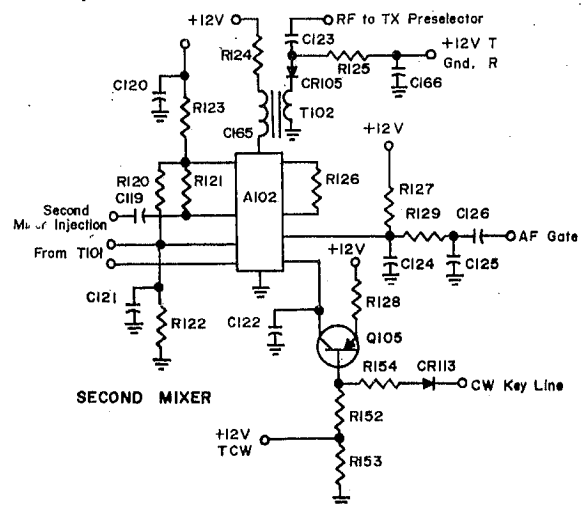
R118 and C112 decouple a second supply lead. AGC input to the chip, normally through CR103, is defeated in the transmit condition through the +8V T applied through CR104. R184 adjusts the gain of A101.

Output is push-pull, and coupled to T101, whose primary is resonated by C113 and decoupled from the supply by R119 and C118.

Second Mixer

Both sides of the secondary of T101 are connected to inputs of the integrated circuit second mixer, A102. Neither side is grounded, for these inputs must be raised above ground potential for the device to operate correctly. This is accomplished by the voltage divider R120 and R122. C120 is a bypass. Similarly, the oscillator input is also biased above ground by R121 and R123.

Output from the mixer is taken via T102, which is untuned, through CR105, which is biased "on" during transmit, and through C123 to the pre-selector. Bias for CR105 is supplied



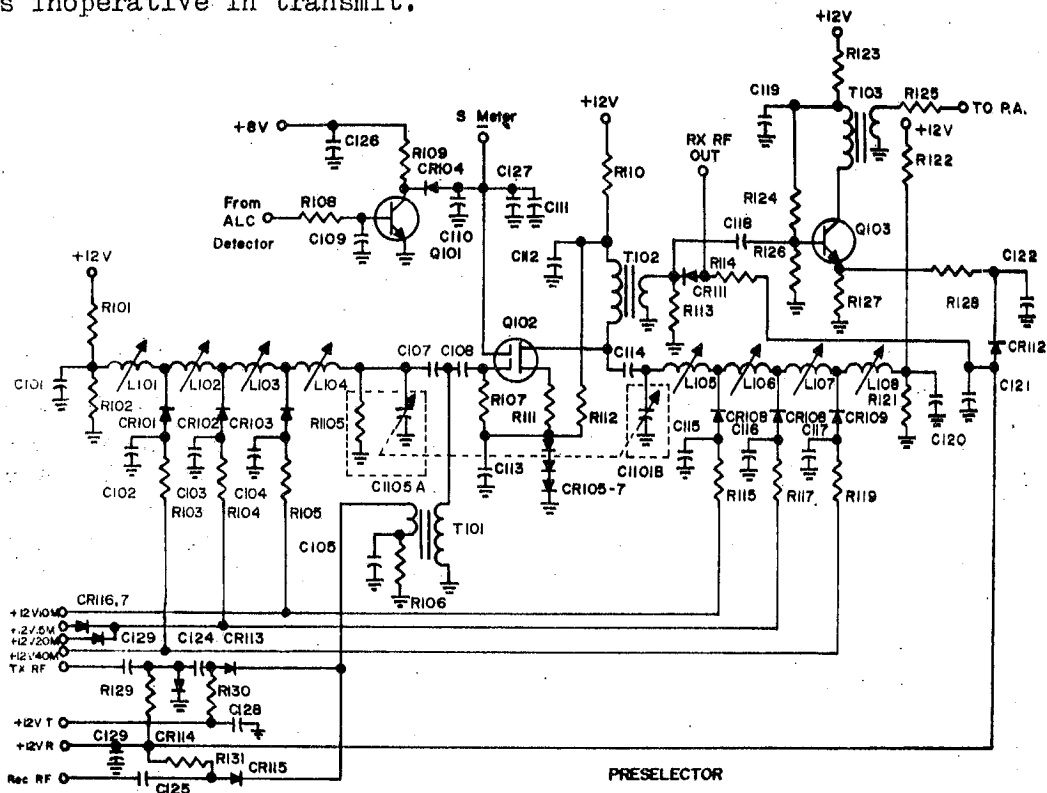


through R125 and bypassed by C166.

For CW operation, the mixer is keyed via Q105. +12V is supplied in this mode to the junction of R152 and R153, the same potential as the emitter of Q105, so it cannot conduct. When the key is depressed (key line grounded), the base of Q105 is made less positive than the emitter, and it saturates, keying the mixer IC.

Preselector

The SSB or CW signal from the second mixer is coupled through C129 and C124 to diode switch CR113. When in the transmit mode, +12V is applied through R130 to CR113 and thence to ground through the primary of T101 and R106, turning the diode switch "on". C128 and C105 are bypasses. CR114 serves as a switch to short out any transmit signal when in the receive mode but is inoperative in transmit.



From the secondary of T101, the signal is applied to gate one of Q102, a dual gate MOSFET amplifier. C107 and C108 serves as DC blocking capacitors. Gate one is resonated by the parallel tuned circuit made up of L101/102/103/104, as selected by diode switching arrangement CR101, 102 or 103, and preselector tuning capacitor C1105A. Resistors R101 and R102 form a voltage divider, reverse biasing the three diode switches, unless a positive voltage of greater magnitude is applied to one of the band select lines, thus forward biasing the appropriate diode. In that event, the bypass capacitor connected near the anode of the diode is effectively connected to the tap between the inductors, bringing that point to AC ground. The resonant frequency of the tuned circuit, then, is determined by the sum of the inductances to the right of the selected diode switch, in parallel with C1105A.



For example, when the 80M band is selected, none of the band select lines is high, so all diode switches are reverse biased, and all four inductances are used in series, with the left end grounded for signal frequencies through C101. For 40M operation, diode CR101 is switched on, bypassing L101 and leaving L102, L103 and L104 in series; for 20M and 15M operation, only L103 and L104 are used; and similarly, for 10M operation, only L104 is effectively in the circuit.

Bias for gate one of Q102 is derived from the current flow through R111 and applied to the gate via DC return resistor R107. Additional bias, required for gate two, is developed across CR105, CR106 and CR107, supplied by R112. The three diodes, which are conducting, will each develop the standard forward-bias drop across their junctions (about 0.7V), so the total drop is about 2.1V. Since it is applied to both the source and gate one, it is not effective for that gate; but it is effective for gate two, and is the fixed bias required there.

The DC voltage from the ALC detector is amplified and inverted by Q101, and applied through CR104 to both the S meter and gate 2 of Q102; thus, the S meter will read the ALC level during transmit, and the gain for Q102 will be automatically adjusted to limit drive to the power amplifiers in the event of high SWR or misadjustment of the microphone level control. C110, C127 and C111 are low, medium, and high frequency bypass capacitors.

Output of Q102 is taken via T102, which is untuned, through C118 to the base of amplifier Q103. R110 and C112 decouple the +12V supply for Q102. The output of Q102 is tuned by parallel resonant circuit C1101B and the appropriate combination of L105, L106, L107 and L108, selected via diode switches in the same manner as the input inductances.

Bias for Q103 is from R124 and R126. R127 is the emitter resistor for Q103, unbypassed in early versions and bypassed in later versions for additional gain. Output is taken via T103 through R125 to the power amplifier predrivers. R123 and C119 are, of course, decoupling components.

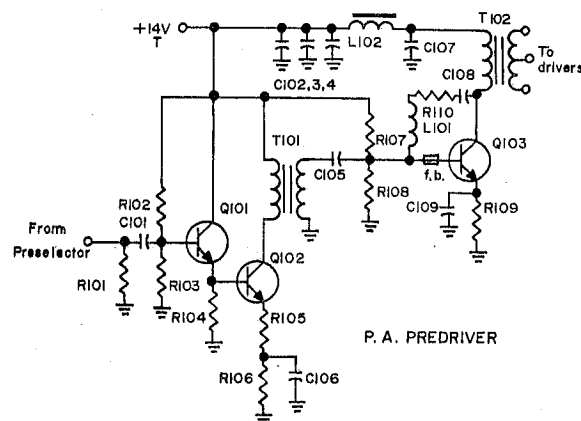
CR111, R114, R128, CR112, C121 and C122 are utilized only in the receive condition and are discussed in that section of this manual.

Predrivers (Early version)

The preselector output is applied to the base of Q101 on the PA board through C101, while R101 terminates the interconnecting cable in its characteristic impedance. Bias for Q101 is derived conventionally by R102 and R103.

Q101 and Q102 are connected in the Darlington configuration for higher gain. Bias and drive for Q102 come from the emitter of Q101, as developed across R104. Q102 is compensated for high frequency roll off by emitter network R105, R106, and C106. Output is through T101.

The signal then travels through C105 to the base of Q103, with a ferrite bead which suppresses any VHF oscillation tendency. Bias is derived by R107 and R108. Feedback from the collector of Q103 to its base is accomplished by the L101, R110, C108 network to level its gain vs. frequency characteristic. Output is





taken from T102.

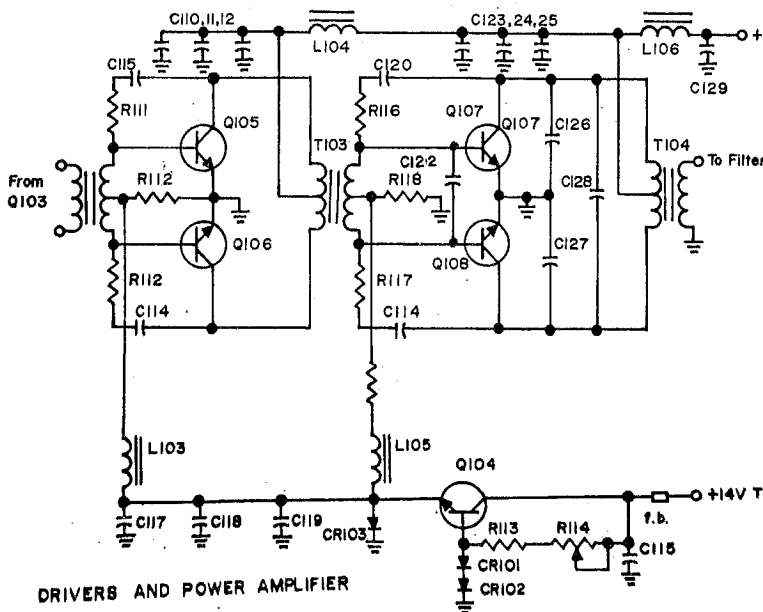
C107, L102, C102, C103 and C104 decouple the supply line. Again, good practice requires that this line be bypassed for low, medium and high frequencies. No one capacitor can do it all (high value electrolytics, for instance, have substantial internal inductance at high frequencies, and so are not effective bypasses; yet low value disc ceramic capacitors are not, of course, effective at the audio rate of variation of the signal envelope.)

Driver/Power Amplifier (Early version)

Signal from the transmitter predriver is applied to the driver transistors Q105 and Q106 through T102. Frequency compensation is accomplished for each by the R111-C115 and R112-C114 gain-levelling networks. Output is taken through broad band transformer T103 to the power amplifiers, Q107 and Q108, which are similarly frequency compensated. Their output is taken via

broad band transformer T104. Capacitors C126, C127 and C128 maintain balance while tuning out the reactance of T104.

Bias for the drivers and PA devices is supplied by bias regulator Q104. Base current for Q104 is set by R114 in series with R113, while the base voltage is maintained at about 1.4 volts by CR101 and CR102, serving as forward biased regulating diodes. Thus a fixed amount of current is allowed to flow



DRIVERS AND POWER AMPLIFIER

in the emitter-collector circuit of Q104. This current is the bias supply for the drivers and power amplifier.

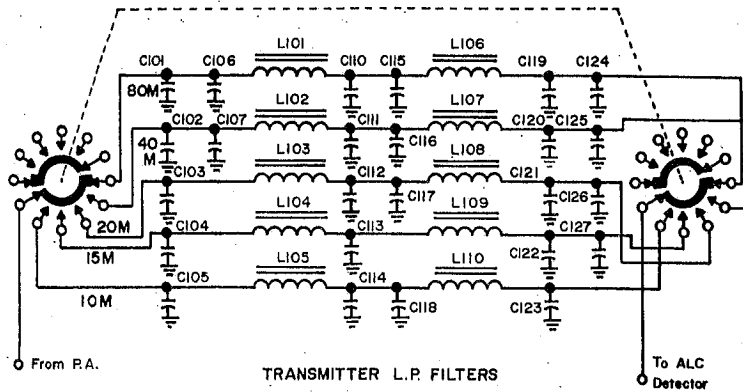
A portion of this bias current is bypassed to ground through CR103, which is mounted near the heat sink. It is selected so that, as the heat sink temperature increases, its effective forward resistance drops and it shunts more of the available bias current from Q104 to ground, thus reducing the amount available for bias of the power devices. The drivers and PA devices are therefore protected from thermal runaway. C117, C118 and C119 provide the usual tri-frequency bypassing. L103 and L105 isolate the bias line, preventing feedthrough of the signal via that path from the drivers to the PA or vice-versa. R112 and R118 are selected so that the available bias current is divided between the driver devices and PA devices in the required proportion.

Low Pass Filters and ALC Detector (Early version)

After the transmitter power amplifiers, a bandswitch-selected series of five-pole low pass filters, of conventional design, are used to reduce harmonic radiation from the antenna.



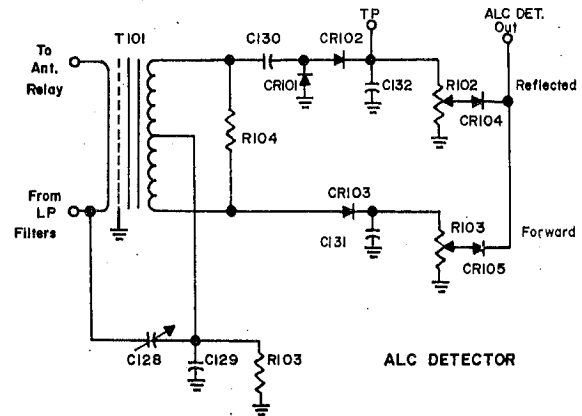
The output of the selected filter passes through the single turn primary of the ALC detector transformer T101. The signal appearing in the secondary is proportional to the current in the primary. Capacitive voltage divider C128-C129 supplies a signal proportional to the voltage appearing on the transmission line, and is connected to the center tap of the secondary of T-101. The phase relationship between these two signals is such that a new signal is produced at the upper end of the secondary that is proportional to any reflected power present in



the transmission line. This signal is coupled through C130 to a voltage doubler rectifier, CR101 and CR102.

Similarly, the phasing at the lower end of the secondary of T101 is such that its signal is proportional to the power in the forward direction. Since this power is greater, normally, than any reflected power, a single rectifier, CR103, is required. C131 and C132 smooth the DC produced by the respective circuits, and R103 serves as the DC return. R102 and R103 set the DC output levels of each section as required, and CR104 and CR105 prevent either signal from being loaded down by the setting of the other potentiometer.

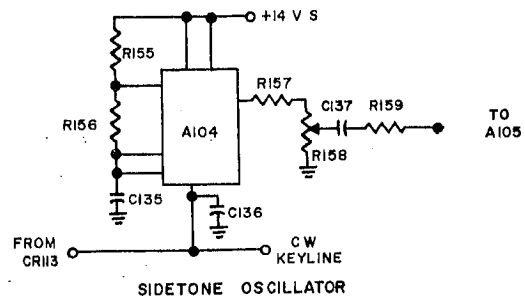
The ALC detector provides a proportional shut-down signal for the preselector whenever (1) the voltage or current in the transmission line is equal to or greater than that produced by a 100 watt peak signal, or the VSWR is 2:1 or greater, or (2) output of the transmitter exceeds a safe 100 watts peak. The ALC signal is also used to drive the S meter when in the transmit condition, giving an indication of the power level.



Sidetone Oscillator

The sidetone oscillator consists simply of a 555 timer integrated circuit as a free-running (astable) multivibrator, which produces a square wave output whose frequency depends upon the R155-R156-C135 combination. This output is coupled through R157 to the sidetone level control, R158.

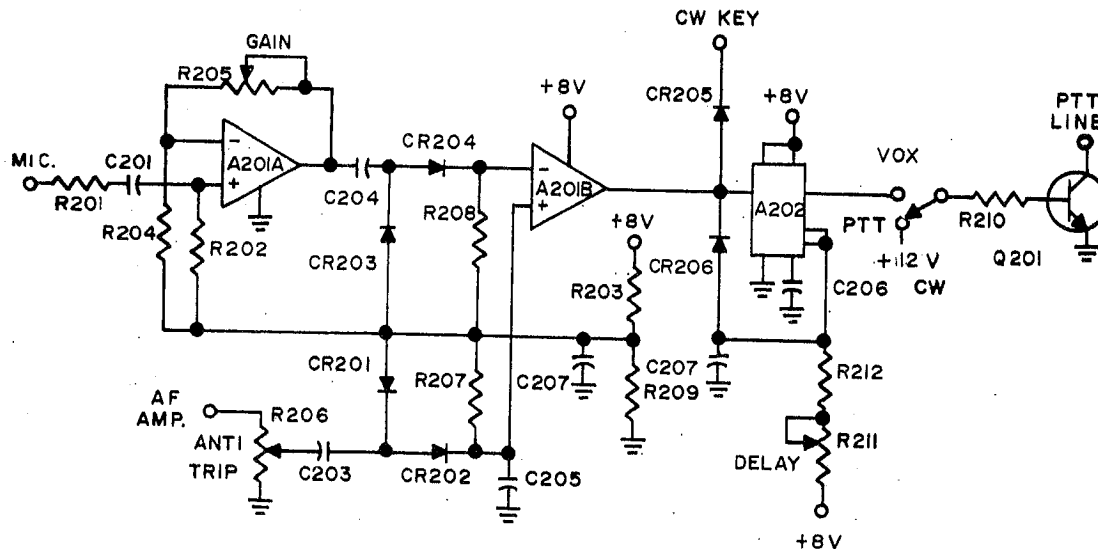
Output is coupled to audio power amplifier A105 through C137 and R159. Keying is accomplished by grounding the DC supply return pin of A104 through the CW keyline. C136 is a bypass capacitor.





VOX/PTT

Microphone audio is coupled to amplifier IC A201A via RC network R201-C201. The gain of A201A is set by R205 (VOX Gain), the feedback resistor, while R202 acts as a DC return resistor to the bias bus (phantom ground).



VOX / PTT

Bias for A201A and A201B is set by the R203-R209 voltage divider, bypassed by C207. This provides a "phantom ground", i.e., a DC reference level, bypassed to ground for the signal frequencies. This DC level is applied to the non-inverting inputs of the two amplifier stages through R202 and R208 respectively, causing their output terminals to assume a quiescent point between the supply voltage and ground, thus allowing them to swing both positive and negative with respect to this quiescent point as the signal dictates.

Output of A201A is rectified by voltage doubler CR203 and CR204, and the resultant DC is applied to the inverting input of A201B.

Receiver audio level (anti-VOX) is set by R206 and coupled through DC blocking capacitor C203, then rectified by voltage doubler CR201-CR202, and applied to the non-inverting input of A201B. C205 is a filter/bypass capacitor.

A201B, connected without a feedback resistor, operates as a comparator with very high gain. Thus, if a positive signal is applied to the inverting input due to microphone audio being rectified, the output of the amplifier is driven low, all the way to ground potential. Conversely, if a positive voltage is applied to the non inverting input from the rectified anti-VOX signal, the output of A201B is driven high, to the supply voltage value. The transitions will take place very rapidly.

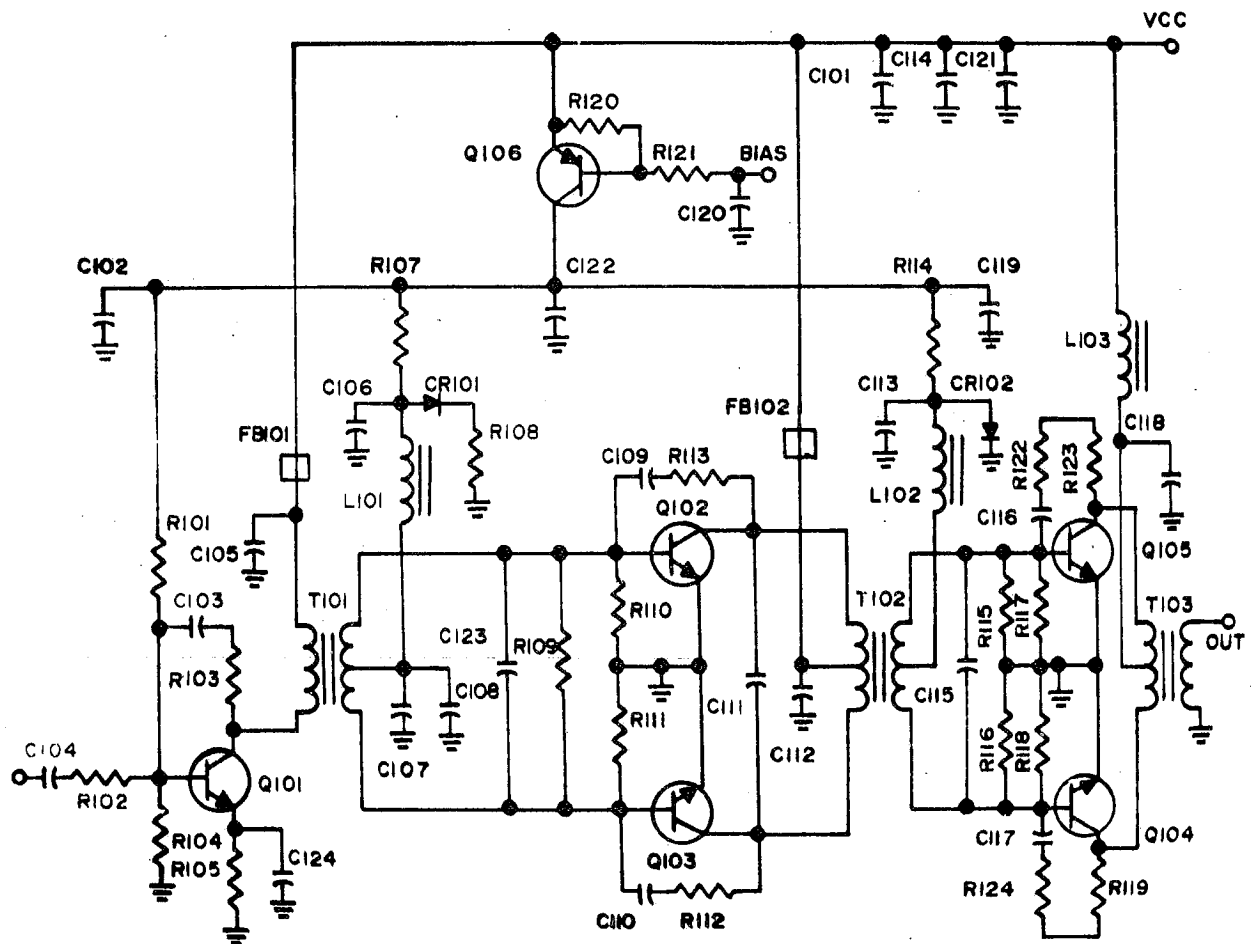


The VOX keyer, A202, is a 555 timer IC, connected as an astable. When triggered by a low level from A201B or the CW key line, its output goes high and, through R210, turns Q201 on, thus grounding the PTT line, provided the "VOX/PTT" switch is in the VOX position. When the triggering signal is removed, the RC network consisting of the R211-R212-C207 combination holds the output of A202 high for a period of time determined by that RC time constant and adjusted by R211, thus providing the necessary delay.

Since this delay must begin at the end of the triggering signal and not at its beginning, diode CR206 is provided to hold the charge on the timing capacitor low until the end of the triggering signal.

Predriver (later version)

Predriver Q101 amplifies the level of the incoming signal (supplied from the preselector board via C104 and R102) to a level sufficient for the drivers. Bias is supplied via R101 and R104 from the keyed bias bus, while collector to base feedback for gain levelling is provided by the C103-R103 combination. Output is taken from the collector of Q101 via T101, and the collector supply is decoupled by ferrite bead FB101 and C105. The gain of predriver Q101 is determined by the ratio of R103 to R102.



**POWER AMPLIFIER
(LATER VERSION)**

Driver/PA (later version)

Signal from the predriver Q101 via T101 is coupled to the bases of the drivers, Q102 and Q103, in push-pull. The R109-R110-R111 combination of resistors properly terminate T101 and swamp the variation in the transistor's input impedance, thus providing greater stability. Bias is supplied via the bias line through decoupling network L101-C106-C107 and C108, and the regulation network R107-CR101-R108. Feedback is provided by the C109-R113 and C110-R112 networks for gain levelling. Output is taken from T102, and the collector supply line is decoupled by FB102 and C112.

Power amplifier stages Q104 and Q105 are driven in push-pull by the secondary of T102. R115, R116, R117 and R118 provide termination for the transformer, as with the driver stage input. The parallel combination of resistors lessens the effect of stray reactance. Feedback is provided by R122-R123-C116 and R119-R124-C117 combinations, while output is taken via broad band transformer T103. Collector supply voltage is decoupled by L103 and C118.

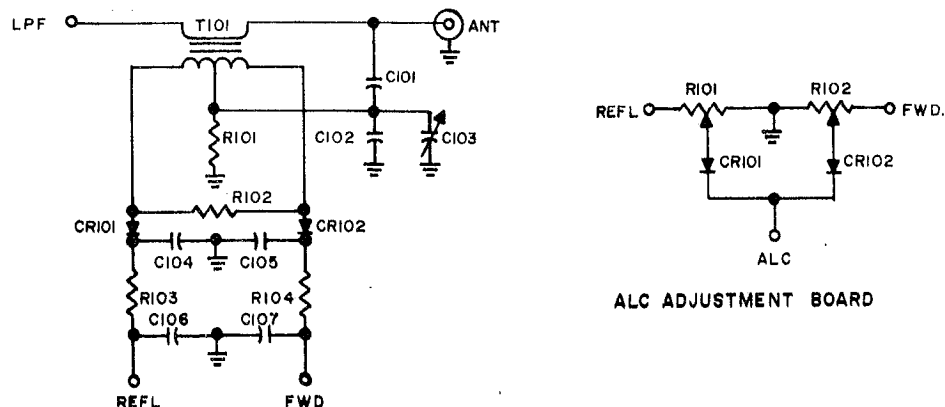
Bias is supplied via decoupling network L102-C113, and regulating network R114-CR102 from the bias bus. C102, C122, and C119 are tri-frequency bypasses for the bias bus. This bus is switched to the supply voltage by Q106, when its base is grounded through R121 by the "Bias" connection. The base of Q106 is normally kept at the same potential as its emitter by R120, thus turning it off during receive conditions. C101, C114, and C121 provide tri-frequency bypassing for the power supply line.

Low Pass Filter (later version)

The low pass filters, five in all, are provided to suppress harmonic radiation and receiver spurious responses, and are selected by the band switch, and require no operator adjustment. The selected filter is used in both the transmit and receive conditions. Each filter is a five-pole type. The diagram is on the following page.

ALC Detector (later version)

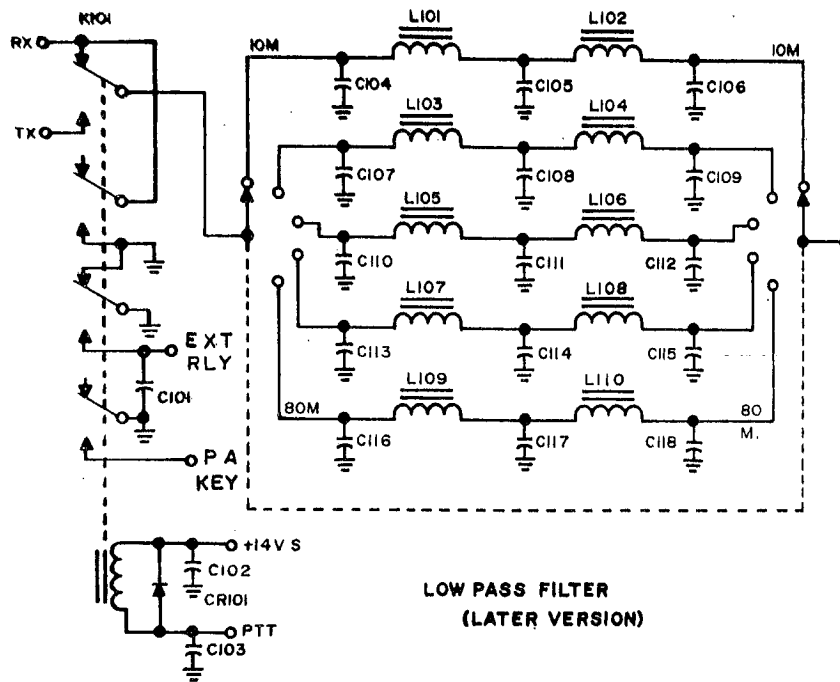
The ALC detector of the later version is much the same as that of the earlier version, but is contained on two separate PC boards rather than being incorporated with the LPF board. For the theory of operation, one is referred to the earlier version as described in this manual. The schematic diagrams of the new version are included here.





SWAN

ELECTRONICS





SECTION FIVE

THEORY OF OPERATION

OSCILLATORS

Permiability Tuned Oscillator (PTO).....	5-1
Band Crystal Oscillators (Early version).	5-1
Premixer.....	5-2
Premixer Filters.....	5-2
Carrier Oscillator.....	5-3
Analog Switch (early version).....	5-4
Analog Switch (later version).....	5-4

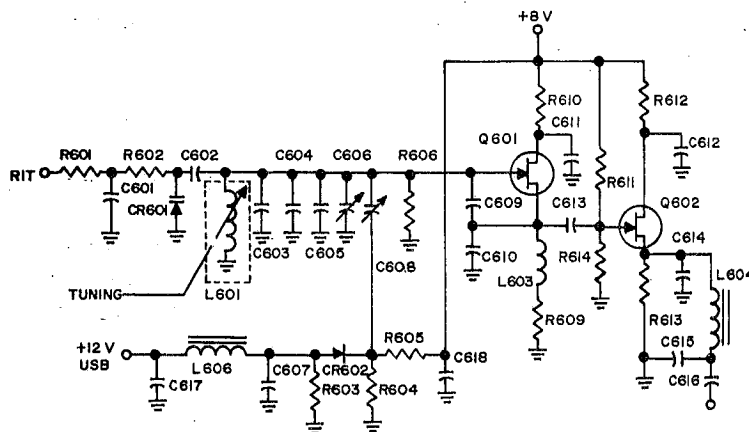


OSCILLATOR THEORY

Permiability Tuned Oscillator (PTO)

The permability tuned oscillator is the primary means of varying the frequency of the transceiver. It is a Colpitts circuit, and the tuned frequency is determined by L601 in parallel with the appropriate capacitors, CR601, C603, C604, C605 and C606. The frequency tuned is 5.0 to 5.5 MHz, and this combination of capacitors is chosen to provide temperature compensation for low drift, and must be replaced with exactly the same types to maintain this low drift, if replacement is necessary.

R606 provides a DC return for the gate bias of Q601, which is developed by R609. Feedback to sustain oscillation is achieved by the C609-C610 di-



PERMIABILITY TUNED OSCILLATOR

vider combination. The drain is decoupled to ground by R610 and C611, while the output is taken from the source to drive FET buffer Q602.

The bias generated by source resistor R613 of Q602, whose value is set by the desired output impedance, is greater than is desirable for this FET; hence, a positive voltage to offset this is developed by the R611-R614 combination. Output is taken via

low pass filter C614-L604-C615 to assure good spectral purity.

When operating in the USB mode, the required frequency shift is set by C608, which is switched in parallel with the tuned circuit by CR602.

When RIT is used, the required shift is obtained by varactor diode CR601, connected in parallel with the tuned circuit by blocking capacitor C602. The DC tuning voltage for the varactor is applied through the R601-R602 combination, and is decoupled by C601. C606 is a calibration control.

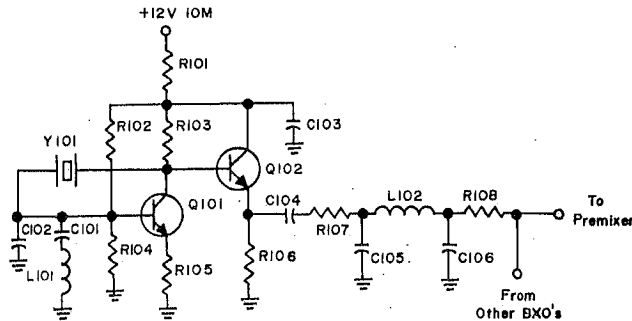
Band Crystal Oscillators (BXO)

Since the PTO operates on a fixed range of 5.0 to 5.5 MHz, it is necessary to move its output frequency to that required for the desired band of operation. This is accomplished by means of the Band Crystal Oscillators, or BXOs. There are five nearly identical BXOs, one for each band covered by the transceiver. The oscillators are of the modified Pierce type. Only one oscillator will be described in detail, that of the 10M band; the others function in a similar manner, with only the reactive components scaled to the new frequencies. All crystals are third overtone types.

Bias for Q101 is obtained conventionally via R102 and R104 from the band switched +12V supply, decoupled by R101 and C103. Emitter degeneration



provided by unbypassed R105 helps to provide a more pure oscillator waveform. The collector of Q101 has as its load R103, and is DC coupled to the base of Q102 in a modified Darlington configuration. Q102 serves as a buffer, with an emitter follower low impedance output developed across R106.



BAND CRYSTAL OSCILLATOR (BXO)

DC is blocked by C104, while R107 and R108 sets the gain of Q111 for the 10M band. See the Servicing Hints section for a discussion of the operation of summing type amplifiers.

C105, L102 and C106 form a low pass filter to ensure spectral purity of the output of the oscillator.

C101 and L101 are included in the 10M BXO (and equivalent components in the 15M circuit) to

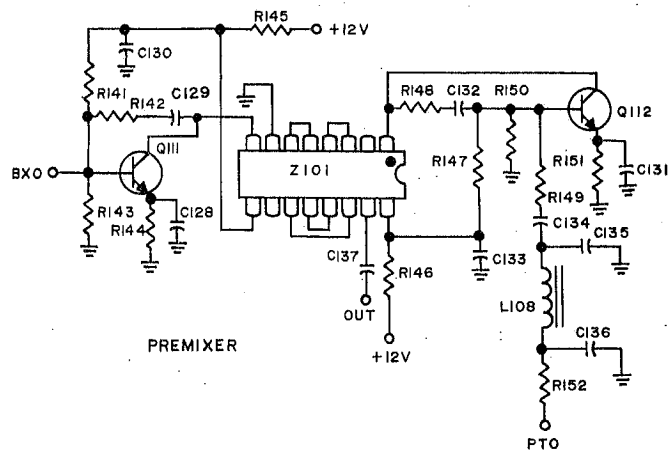
suppress any possibility of the overtone crystals oscillating on the wrong frequency. They are unnecessary on the lower bands, and are omitted.

Premixer

The BXO output is mixed with the PTO output in the premixer to provide the proper injection frequency for the transceiver.

The signal from the selected BXO is amplified by Q111 and coupled to doubly balanced mixer Z101 (the same mixer circuit used as the first mixer in the transceiver). Bias and emitter circuits of Q111 are conventional. C129 and R142 make Q111 act as a summing amplifier with different gains for different bands of the radio.

PTO signal, after passing through the low pass filter, is applied to the base of amplifier Q112. R151 and R152 maintain a high impedance load for the output of the PTO to prevent "pulling". Bias for Q112 is via the R147-R150 voltage divider, while the emitter circuit is conventional. R148, C132, and R149 make Q112 into a summing amplifier also.



Output from Q112 is also applied to Z101, which mixes the two signals, producing sum and difference products. The two original signals are both suppressed in the output of the mixer.

Premixer Filters

There are five premixer filters, one for each band, just as there are five BXOs. All are identical, except for reactive component values, which are scaled for the appropriate band. Only one of these filter stages will be discussed, the one for the 10M band, as operation of all are the same.

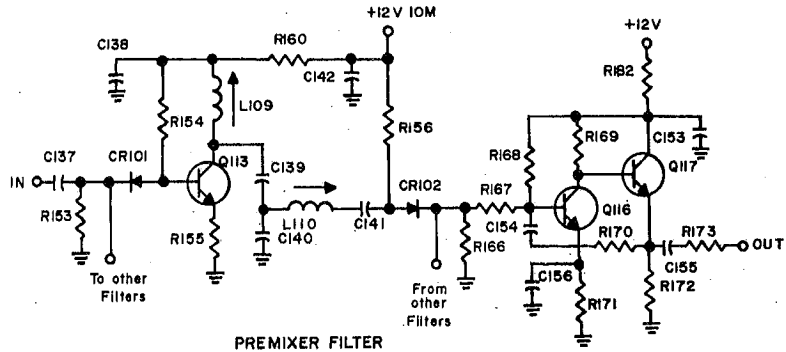
Both sum and difference products are produced in Z101, yet only the difference signal is desired---9 MHz above the incoming received frequency.



The sum frequency must then be removed. This is the function of the pre-mixer filters.

Simple bias is applied to Q113 by R154. Unbypassed emitter resistor R155 provides degeneration. The collector circuit is loaded by a parallel tuned circuit, L109 and series capacitor combination C139 and C140. Note that this is a parallel tuned circuit, not a series tuned one, as it may at first glance appear, for the top (+ voltage side) of the inductor is grounded via the decoupling capacitor, placing it in parallel with the capacitor combination so far as the AC signal is concerned.

C139 and C140 also serve to transform the impedance to a lower value, to match a second, series tuned circuit comprised of L110 and C141. The +12V band switched supply, decoupled by C138, R160 and C142, besides supplying the collector of Q113, is applied to diode switch CR102 via R156, turning it "on" and



PREMIXER FILTER

passing the signal. The voltage drop across R166 reverse biases the other filter stage's diode switches, assuring that they remain "off".

The signal is then passed through R167 to the base of the Q116-Q117 modified Darlington amplifier. Bias for Q116 is supplied via R166, R167 and R168 from the +12V supply, and is decoupled by R182 and C153.

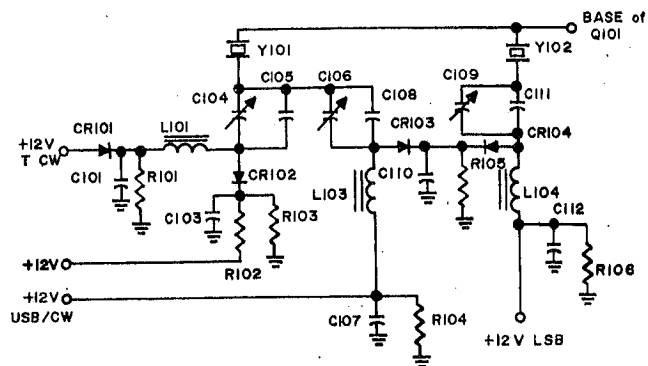
The collector of Q116 is connected directly to the base of Q117, which is an emitter follower stage and supplies a signal output through C155 and R173. Feedback from the emitter of Q117 to the base of Q116 controls the gain of the combination.

Carrier Oscillator

Since the 100MX utilizes only one crystal filter, the carrier oscillator frequency must be shifted appropriately when selecting USB, LSB or CW modes so that the signal will fall within the pass band of the filter. Only one oscillator is used, with a crystal switching scheme used to select the proper crystal, depending on the mode desired.

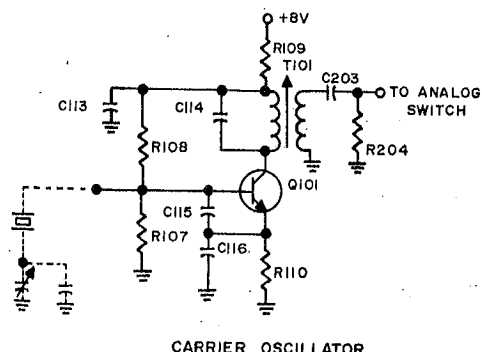
In CW, the +12V TCW line is energized, forward biasing CR101 and CR102, effectively grounding one side of crystal Y101 through tuning capacitors C104 and C105. L101 and C101 decouple the RF from the line, and R101 provides a DC return.

USB operation also uses Y101, but this time it is tuned to a slightly different frequency, one appropriate for USB operation, by a different set of capacitors, C106 and C108, grounded for RF through CR103, which is turned on by the +12V USB line. Both USB trimmer C106 and CW trimmer C104 are on in the "CW" mode.



CARRIER OSCILLATOR
CRYSTAL SWITCHING

The LSB crystal, Y102, is similarly selected by the +12V LSB line. The oscillator itself, of the Colpitts variety, is shown in simplified form in the accompanying diagram. Q101 is biased by R107 and R108. Feedback to sustain oscillation is provided by the capacitive divider across the crystal, C115 and C116. Output is taken through tuned transformer T101, and coupled via C203 to A201, the analog switch.

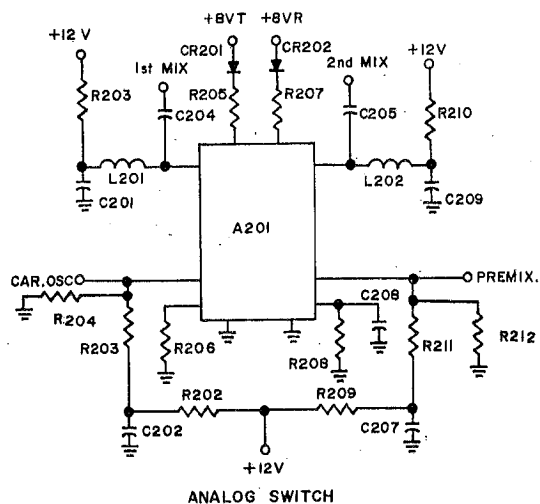


CARRIER OSCILLATOR

Analog Switch (Early version)

In a true transceiver such as the 100MX, the first and second mixers and IF components are shared by both transmitter and receiver. In the transmit mode, the carrier oscillator (fixed frequency) is used in the first mixer in conjunction with the microphone signal to produce the sidebands, while the LO signal is used in the second mixer to heterodyne the IF sideband signal to the desired operating frequency.

In the receive condition, the oscillators must be reversed, with the LO connected to the first mixer to transform incoming signals to the IF, and the carrier oscillator to the second mixer to serve as a BFO for detection. In the 100MX, this is accomplished by the Analog Switch, A201.

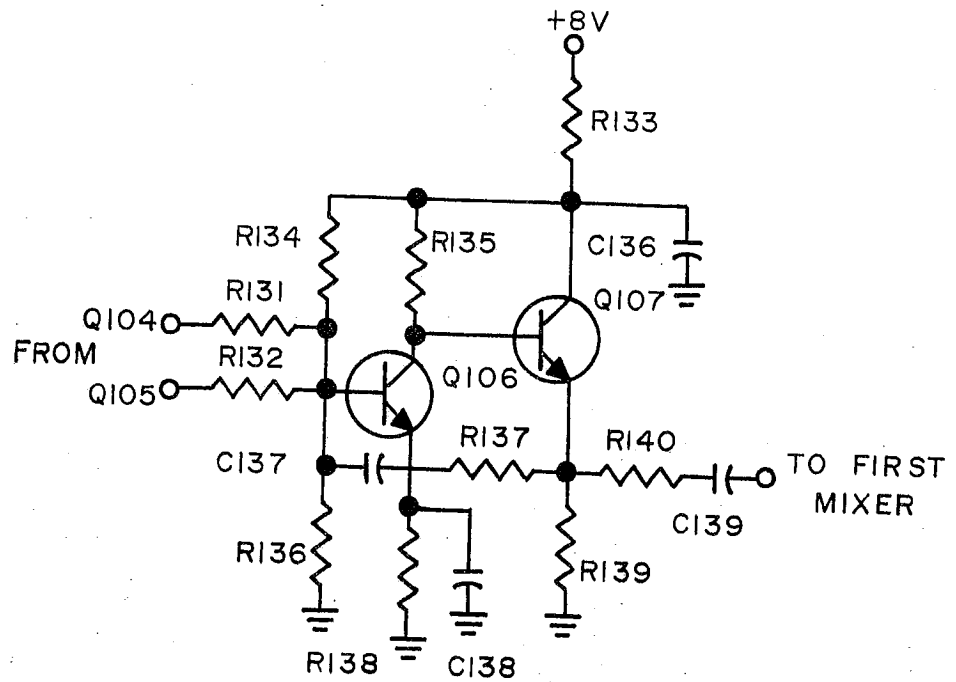


When the +8V T is applied to the indicated terminal, the carrier oscillator is connected through the IC to the first mixer output terminal of A201, and the LO (premixer output) is connected to the second mixer injection output. When the +8V R line is energized, the two oscillator signals are switched to the opposite output ports, as with a DPDT switch.

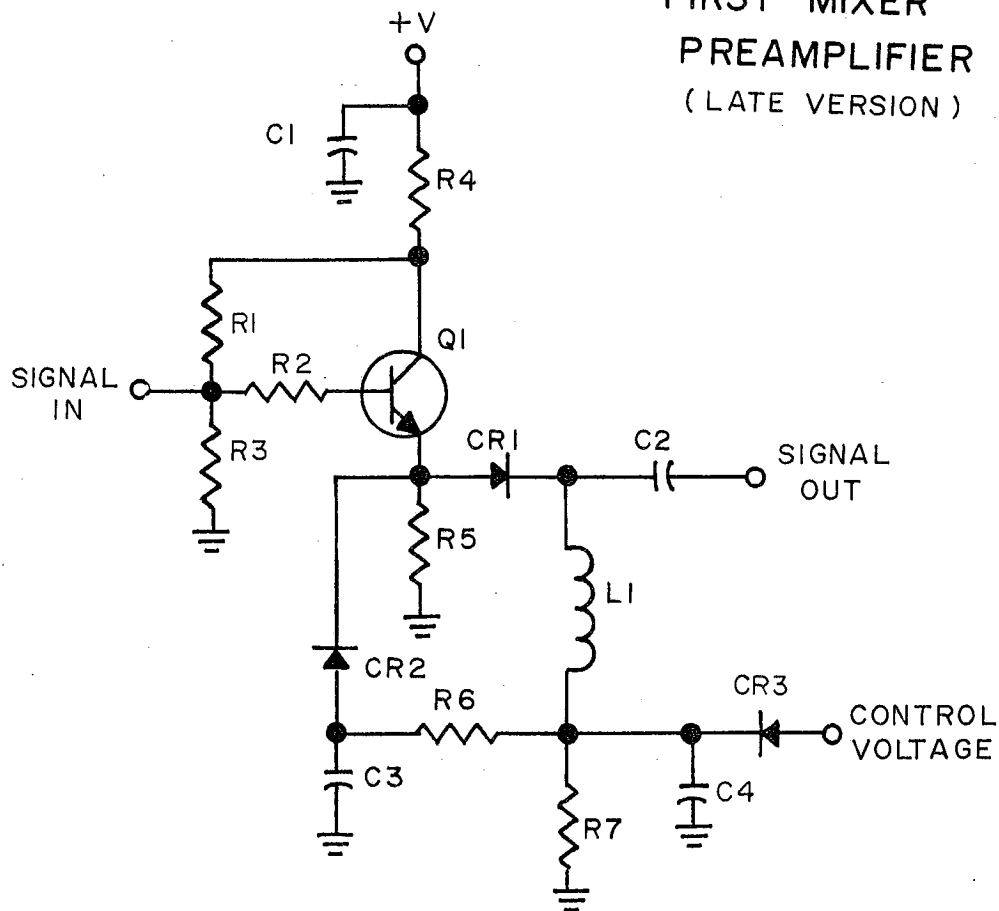
Analog Switch (Later version)

The later version of the analog switch uses discrete components rather than the integrated circuit used in the early version. It consists of Q102, Q103, Q104 and Q105. In Rx mode, Q102 and Q105 are turned on, passing the carrier oscillator signal through Q102 to the second mixer and the local oscillator signal through Q105 to the first mixer preamplifier (Q106 and Q107) to the first mixer, and Q103 and Q104 are turned off. In the Tx mode, Q102 and Q105 are turned off, and the carrier oscillator signal is passed through Q104 to the first mixer via the preamplifier, and the local oscillator signal passed to the second mixer via Q103.

To see how this is accomplished, see the simplified diagram of one of the four identical switching transistors on the following page. If the terminal marked control voltage is grounded, the voltage drop developed by the emitter current of Q1 across R5 is coupled through CR1 and L1, and reverse



FIRST MIXER
PREAMPLIFIER
(LATE VERSION)



SIMPLIFIED DIAGRAM,
ANALOG SWITCH
(LATE VERSION)



biases CR3, as it does CR2. The transistor is allowed to operate as a normal emitter follower, and the input signal appears at the output, since CR1 is forward biased and therefore "on".

However, a positive voltage applied to the control voltage terminal forward biases CR3, passing that voltage on, through L1, to CR1, reverse biasing it, and thus, it acts as an open circuit for the signal. Further, this same control voltage (reduced in magnetude by the voltage divider action of R6 and R5, forward biases CR2. This applies a reverse bias to the base-emitter junction of Q1, cutting it off, too; the combination of cutting off Q1 and reverse biasing CR1 provides the high input-to-output isolation necessary to this application.

The control voltages used are the +8VT and +8VR lines; they are at ground potential when not energized, due to conduction through other circuitry connected to them. Note that the +8VT line drives the transistors that are "on" in the receive condition and the +8VR line drives the transistors that are "on" in the transmit condition.

The first mixer preamplifier, Q106 and Q107, merely bring the level of the signal up sufficiently to drive the mixer. They are connected in one of the Darlington configurations, with bias derived from R134 and R136. Gain is controlled by R137 and the appropriate input resistor, R131 or R132 (see the section on feedback amplifiers in the "Servicing Hints" section of this manual for a discussion of this type of amplifier).



SWAN
ELECTRONICS

SECTION SIX

SERVICING HINTS

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SERVICING HINTS

Transistor Troubleshooting

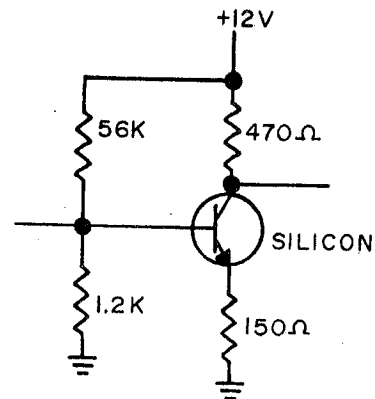
Many techniques for troubleshooting transistor circuits have been evolved, of varying degrees of complexity and reliability. One system, perhaps the simplest and most reliable, is outlined here for your information. With it, you can determine, with only a few minutes thought and basic arithmetic calculations, what the normal operating voltages on any given transistor stage should be, and by comparing them with those actually measured, locate the fault in the circuit.

The key to the scheme is to remember that, for normal operation, the base-emitter junction of a transistor must be biased into conduction--and that when this is so, the voltage drop across that junction will be approximately 0.7 volts for silicon devices and about 0.25 volts for germanium.

To illustrate how the system works, let's take a simple amplifier stage (at the right). To start with, we know that the base current is very small, on the order of microamperes. For our purposes, then, we can ignore it, for it would be masked by circuit tolerances sufficiently that we couldn't measure a voltage drop caused by it with our usual methods. We therefore treat the bias network (the 56 k Ω and 1.2 k Ω resistors) as a simple voltage divider, and can compute the voltage that would appear at their junction (the base of the transistor). In this case, it works out to about 2.1 volts. Since we know that this silicon transistor has a base-emitter drop of about 0.7 volts, it follows that the emitter voltage is that amount less than the base voltage, or about 1.4 volts. The emitter current can then be calculated by Ohm's Law, and comes out to about 9.3 mA.

We know that both the base current and the emitter current flow through the emitter resistor, but the base current is so small that we can say for practical purposes, the emitter current is the same as the collector current; therefore, the current through the 470 Ω collector resistor is also about 9.3 mA, and the voltage drop across it is about 4.4 volts. This means that the collector voltage would be 12-4.4 or 7.6 volts.

Actual measured values on a normally operating circuit would be close to these values, while a malfunctioning transistor would result in greatly different values being found. Remember, transistors do not get "weak", as do vacuum tubes (with the exception of some emitter-ballasted power devices) so when they fail, they do so catastrophically--they open or short, or both. Thus, the voltages found on their terminals will be greatly different than if it were operating normally. For example, a shorted base-emitter junction would result in no 0.7 volt drop between those terminals; an open base-emitter junction would leave the emitter at ground potential (no base current





flowing, so no collector current, so no drop across the emitter resistor). And so on. It isn't hard to figure out just what is wrong with the device, although this isn't really necessary---if the voltages are not close to what you calculated, the device is probably bad.

Integrated Circuit Troubleshooting

Very little can be written concerning the finding of internal faults in integrated circuits. Often, the exact internal circuitry is both complex and unknown to the service technician, for manufacturer's data sheets generally show only an equivalent circuit at best, and at worst, only the pinout.

The data sheets often do, however, give a truth table or timing (waveform) diagram for digital circuits, or some other description, not of what the internal circuitry is, but rather what it does. This, then, is the approach we must use in troubleshooting them, also.

In short, we troubleshoot IC's by the process of elimination; Are the voltages at each of the pins about what they should be? Is the proper signal going into it? Then, if the proper signal isn't coming out of it, it is bad and must be replaced. Never mind what is wrong inside--you can't get inside to fix it anyway, and time spent figuring it out is wasted. Just replace it.

A good voltmeter, a high impedance VTVM or better yet one of the newer digital voltmeters that will read to tenths of a volt or less, and a good oscilloscope are then necessary pieces of test equipment, and no shop should be without them. If you don't have them, you'll have to spend your time in speculation, and for the most part, the results will depend on guesswork. Either you'll use more time than necessary (and have to charge the customer for it) or you'll wind up missing the cause of intermittent problems, replacing perfectly good parts, or the like. In either case, the increased cost to the customer (or decreased profit to the shop) is something that you can hardly justify.

Measuring Signal to Noise Ratio

The procedure for measuring the signal to noise ratio of a receiver is really quite simple, and it is a check that should be made on every receiver before it leaves your shop---finding a weak receiver and fixing the problem while it's in the shop is one of the best ways to keep a customer happy, and it will pay dividends on repeat business.

Connect an unmodulated signal generator that has a 50Ω output impedance to the antenna terminals, and tune it for about a 1 kHz beat note audible in the speaker. Adjust the generator's output for about 0.25 μV at the antenna terminals, so that the AGC circuit isn't activated. (Note that some generators are calibrated in terms of their open circuit output voltage, not what is present when connected to a load---check yours out, so you can get the right setting).

Connect an AC voltmeter across the speaker terminals, and adjust the volume control for a convenient reading on the meter. Note that reading. Now remove the signal generator connection and short out the antenna terminals without changing anything else on the receiver. Note that reading.

The first is the reading for the signal-plus-noise; the latter is the signal for noise only. The S/N ratio is 20 times the common log of the ratio between the first and second values. Some AC meters have log (or dB) scales and can be used directly.



Solid State Switching

One of the more useful innovations in recent years is the application of solid state switching to signals within receivers and transmitters. It allows switching to be accomplished at the site, without the need for routing long signal leads to a bulky, complex, and often troublesome multi-pole mechanical switch. Instead, a simple switch controls a DC voltage which in turn is applied to all of the points where switching of the signal is to take place.

The simplest form of a solid state switch is the diode. We know that when it is reverse biased, it presents a very high resistance---high enough to be considered an open circuit when used in low or medium impedance circuits. Modern manufacturing techniques have reduced the junction capacitance of switching diodes so low that they can also be effectively used in most high impedance circuits, too. Thus, a diode which has a reverse bias voltage greater than the peak value of any AC signal applied to it, so that it does not conduct during any part of the signal cycle, will act as an open circuit.

Conversely, modern diodes have a very low "on" resistance, so if forward biased with a current greater than the peak signal current, so that it conducts during all parts of the signal cycle, it passes the signal with little or no attenuation.

All that is needed, then, is a circuit arrangement of capacitors to block the DC but pass the signal, (and perhaps bypasses, if high-level RF is near) and resistors to apply the bias and switching voltages.

Field Effect Transistors (FET's) can be used as even better solid state switches. Remembering that the source to drain path of the FET is a pure resistance, normally conducting, we can see that, as with any other resistance, current can flow in either direction (bilateral), from source to drain or from drain to source, depending on the polarity of the applied voltage. Therefore, AC signals will pass.

Now, if we apply a voltage to the gate that is sufficient to "pinch off" the source-drain path, the effective resistance of that path increases greatly, effectively opening the circuit, and thence the signal path.

Normally, N-channel, depletion mode devices, with good bilateral characteristics in the source-drain path and low "on" resistance are selected for service in switching applications.

All, then, that is needed for a FET switching circuit is the FET, suitable blocking capacitors and load and biasing resistors, just as in the case of the diode switch.

Two-Tone Testing.

Probably the most useful and yet least often performed test of a single sideband transmitter's performance a technician can make is the two-tone test, and yet it is easily performed. The two-tone test will disclose quickly and easily most of the major faults that are to be found in an operating transmitter by showing nonlinearities, improperly adjusted bias, overdriving, and many other problems.

While a full discussion of the two-tone test and its results is beyond the scope of this manual, a brief discussion is in order. More thorough treatment is available in many competent references for those who wish to pursue the matter further.

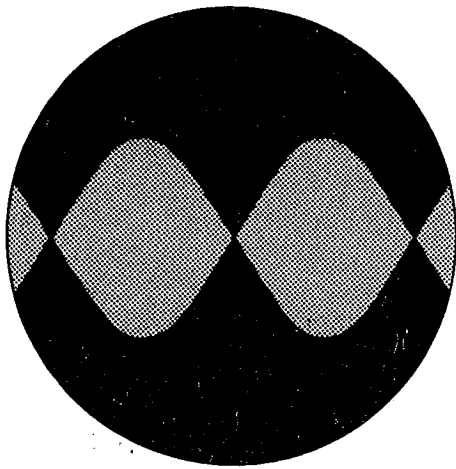


Basically, this test is performed by applying two non-harmonically related audio tones, of equal amplitude and within the pass band of the radio, to the microphone input and observing the output across a dummy load on an oscilloscope. In this manner, the entire transmitter, from microphone jack to antenna terminal, is tested in one simple operation.

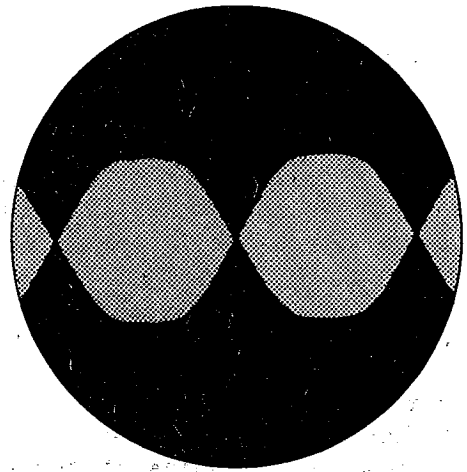
These tones can come from two audio signal generators, or better yet, from a two-tone test set specifically designed for the purpose. Several such designs of adequate quality are included in amateur handbooks and other readily available literature. The tones must be very pure sine waves, and of equal amplitude and not harmonically related to each other as mentioned earlier.

The oscilloscope used to view the transmitter's output must be capable of displaying frequencies at least as high as those in use, and preferably higher. A 30 MHz bandwidth instrument is adequate for all HF amateur bands, while the more common 15 MHz bandwidth instrument would serve for the 80, 40, and 20 meter bands. Since any problem of nonlinearity, bias, etc., could be expected to show up on all bands, testing on one band only is usually considered adequate.

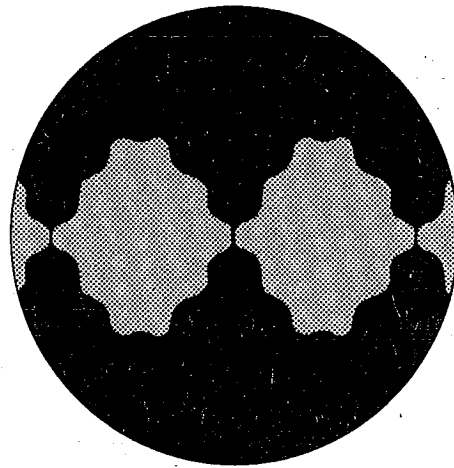
Several waveforms and their common causes are included for reference, and others are available in current literature.



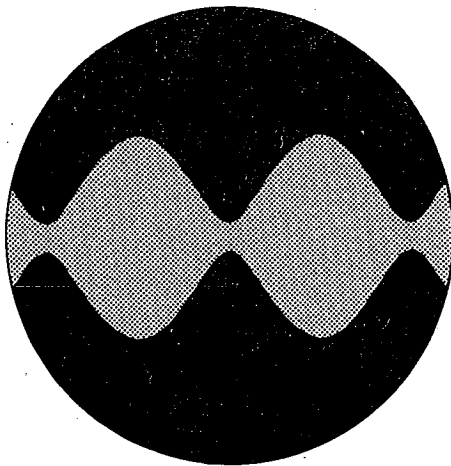
Two-Tone Pattern, Correctly
Adjusted



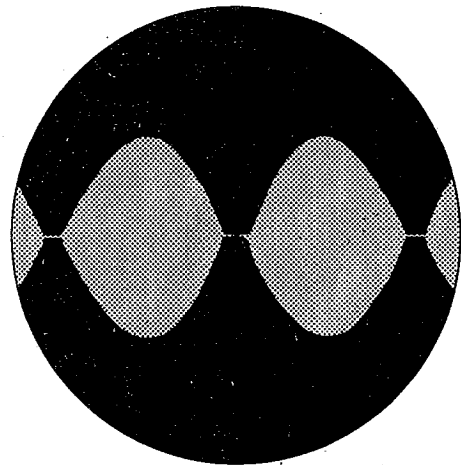
Two-Tone Pattern,
Overdriven



Two-Tone Pattern, Carrier
Present



Two-Tone Pattern, Unequal
Tones



Two-Tone Pattern, Improper
P.A. Bias

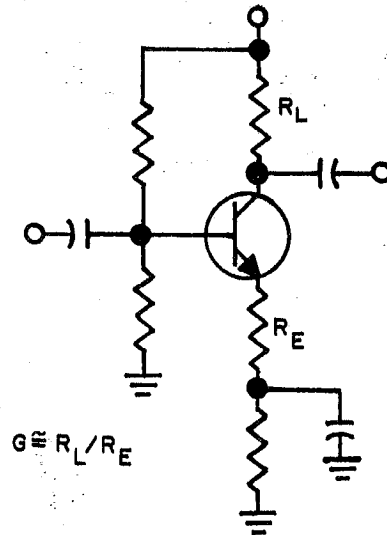
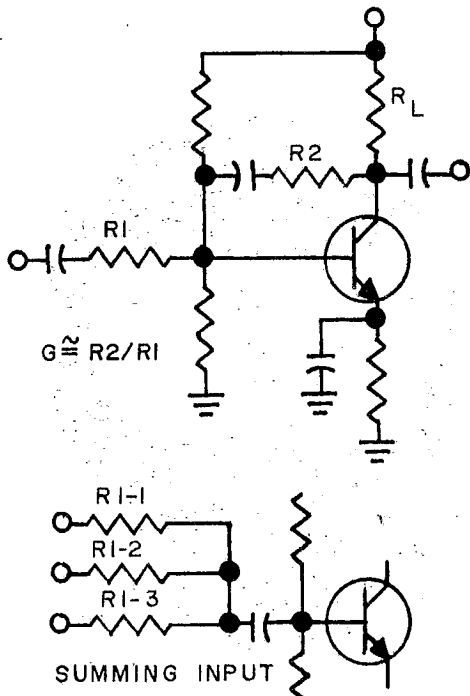


FEEDBACK AMPLIFIERS

The gain of individual transistors, within a given type number, unfortunately varies over a wide range. Often, this is satisfactory for the designer's purpose, but occasionally there arises a situation where the gain of the stage must be controlled more precisely. In that case, it is often advantageous to use an amplifier stage employing emitter degeneration (feedback) to set the gain of the stage. The accompanying diagram shows one such typical stage. The gain of the stage is approximately equal to the ratio of the collector load to the unbypassed portion of the emitter resistance. In the case of choke or tuned circuit loads, the value used in this calculation is the absolute value of the collector load impedance.

Utilizing this technique also raises the input and output impedances to higher values than would otherwise be the case, a condition that is often desirable. The bandwidth of the circuit can also be increased, under the right circumstances, although, under other conditions, it might be decreased.

Another type of feedback amplifier is shown in the second diagram. In this instance, the gain is approximately equal to R_2 divided by R_1 , provided the load resistance is much much greater than R_2 , and the impedance of the source feeding the circuit is much much less than R_1 . The input impedance of this stage is equal to R_1 's value, and the output impedance is low. Since both input and output impedances can be quite low, the bandwidth may be very wide---100 MHz or greater.



Since the feedback path of the circuit (R_2) allows just enough signal from the output to be fed back to the base to cancel out that coming in through R_1 (and the feedback signal is out of phase with the incoming signal), little or no signal will be seen at the base. It is a virtual ground!

This characteristic can be used to sum two or more signals, setting different gain values for each signal, if desired. The gain for each signal is proportional to the ratio of the feedback resistor (R_2) to it's own input resistor only; the other input resistors do not affect the gain of that particular signal. It is interesting to note that this is a summing, not mixing amplifier, another useful property.

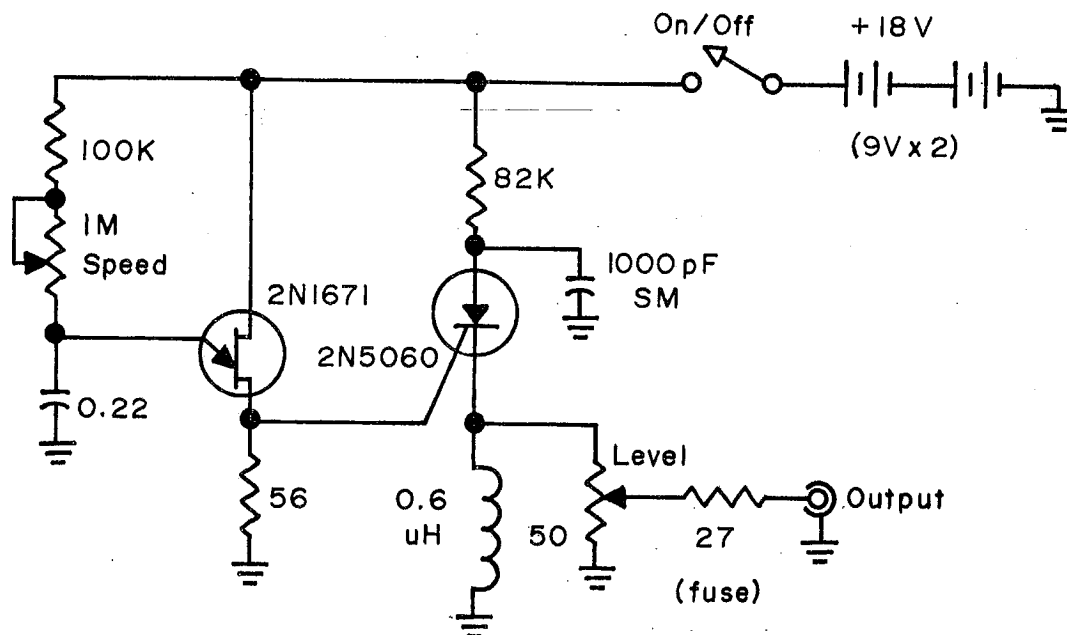


A SIMPLE IMPULSE NOISE GENERATOR

The noise blanker circuit utilized in the 100MX, like all effective noise blankers, is designed to detect the presence of impulse noise above a certain threshold, and to mute, or blank, the output of the receiver for the duration of the pulse. (There is no circuit or scheme that can eliminate static or background hiss types of noise. Since operation of the blanker circuit depends upon the presence of this high level impulse type of noise, it is difficult if not impossible to service the circuit unless a source of such impulses is available. Efforts to service it using the commonly available test equipment lineup are ineffective, and may well lead to misadjustments--most often, this section of the receiver is never checked out, but merely accepted on faith.

It follows then, that a simple, inexpensive instrument that generates this type of signal would be most useful in the service shop, yet commercial instruments are prohibitively expensive. For that reason, the circuit of such an instrument is included here, so that it may be built up locally and added to the shop equipment inventory for such service.

Referring to the accompanying diagram, we see that the 2N1671 is a unijunction transistor, connected in an oscillator circuit. The 0.22 mfd capacitor is charged through the 100K and 1M resistors, with the latter made adjustable to control the charging rate. When the charge reaches a certain level, the UJT fires, discharging the capacitor, and generating a sharp pulse of current through the 56 ohm resistor. This in turn fires the



Noise Generator

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2N5060, delivering a relatively large current pulse through the inductor. This pulse is used to simulate the impulse noise. Level is adjusted by the 50 ohm potentiometer, and the small wattage 27 ohm series resistor acts as an output fuse, for protection of the circuit to which it is connected. Power is shown as two 9-volt batteries in series, although a suitable AC power supply delivering approximately 18 volts at a few milliamperes would also be suitable.



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SERVICING DATA

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TEST EQUIPMENT

A certain amount of quality test equipment is necessary to service today's sophisticated communications equipment. Below is a list of that required for the 100MX:

- Wattmeter, 0-200W scale.
- Dummy load, non-reactive, 50 ohms Capable of $\geq 200W$ dissipation.
- Light bulb load, 100W, 10 ohms cold.
- Oscilloscope, 30 MHz minimum bandwidth, with x10 attenuator probe to be used for all measurements.
- Frequency counter, at least 100 mV sensitivity, high impedance input, counts to 30 MHz or higher.
- VTVM or DVM with high input impedance.
- Two-tone generator (See the "Servicing Hints" section of this manual).
- Noise generator (See the "Servicing Hints" section of this manual).
- Signal generator, 3-30 MHz, calibrated output.
- Power supply, 11-14V DC adjustable, 22 amperes or greater regulated output.

OPERATIONAL CHECKS

Initial Check

Check for physical damage--broken components, knobs, switches, meter, bent shafts, damage to case and heatsink, etc. Check the interior for damaged boards, including burns and broken foils; check for torn or pinched wires, loose boards or hardware, PTO, etc.

Performance Check (Transmitter)

General:

Connect the unit to a power supply (see list of test equipment for requirements). Turn the power switch (AF Gain) on, and check the dial lights to see that they are operable and controlled by the light switch; check the



8V regulator to see that the output is $8V \pm 0.8V$ at A101 (orange wire). Turn the AF Gain control clockwise---there should be an increase in the background noise.

Power Output:

Connect the wattmeter, the 50 ohm dummy load, and oscilloscope to the antenna connector on the rear apron of the set. Connect a microphone to the microphone jack. Check the CW power output on each band by setting the mode switch to CW and the VOX/PTT switch to PTT. It should be in the range of 100 to 130 watts. Note the current drawn by the set. It should be less than 17 amperes at 100W output for the later versions and approximately 3 amps higher on the 20 and 15 meter bands with earlier versions.

The preselector should peak at the center marking for the appropriate band when the main tuning dial is set at 250.

There should be no output in the CW-PTT mode of operation until the microphone button is depressed. The Microphone gain control should vary the power output. The meter should vary with the output and read over S 9 with the Microphone gain fully clockwise.

ALC;

Disconnect the 50 ohm dummy load and substitute a standard 100W light bulb (10 ohms cold) as the load. Check the power output with the Microphone gain control fully clockwise on all bands. Power output should be 40-70 watts if the ALC circuit is operating properly.

With the antenna connector open (i.e., no load), the total set current in transmit should not exceed 12 amperes. If so, the ALC circuit is not working properly.

Note: The purpose of the ALC is to limit power output and therefore PA device dissipation to safe limits, by limiting collector current. If there is too much ALC control, it will not be possible to obtain full output into loads with SWRs less than 1.5:1. If there is too little ALC control, then the PA transistors can draw excessive current, especially when the load is poorly matched, and possibly go into oscillation, causing them to overheat and fail. The temptation to increase the power output of the transmitter by reducing ALC control must be resisted---to do so will almost guarantee the failure of expensive components in the PA.

Modulation:

Check the two-tone signal on each band and in both USB and LSB for crossover distortion, carrier leakage, and spurious outputs. None of the above should be detectable in the output (see the "Servicing Hints" section of this manual for examples and procedures for making the two-tone test). Output should go to 100W PEP without distortion being introduced into the two-tone pattern.

Note: If a two-tone source is not available, a close examination of a modulated output display using a high quality microphone and/or monitoring the signal on another radio should show up any major discrepancy, although not so accurately as does the two-tone test.

Reconnect the microphone and check the transmitter for sufficient microphone gain; output should go to 100W PEP without distortion (i.e. no flat-



topping.

VOX:

Set the VOX/PTT switch to VOX. Anti-trip and VOX Gain controls should be adjusted so that talking into the Microphone keys the set, but audio from the loudspeaker does not. The Delay control should vary the unkeying delay over the range of no delay to approximately 2 seconds delay. In the CW mode the VOX should hold the set in receive until the CW key is closed, which should then put the set into the transmit condition. The delay control should operate the same as in USB.

Note: There should be no loud popping noises when going from receive to transmit with the power output at any level. Should any be noted, refer to the alignment section.

Sidetone/External Relay:

In the CW mode, when the key is closed, there should be a sidetone present at the loudspeaker. There should not be a sidetone at any other time. The center contact of the External Relay jack on the rear apron of the radio should show a short to chassis ground when the transmitter is keyed, and should be an open circuit at all other times.

Performance Check (Receiver)

General:

Disconnect the microphone, wattmeter, oscilloscope and dummy load. Set the VOX/PTT switch to PTT and the Mode switch to USB. Turn the Microphone gain control fully counterclockwise. Connect an RF signal generator with a calibrated output to the antenna connector and an audio voltmeter across the speaker leads.

Sensitivity:

Check for 0.3 uV sensitivity at 10 dB S+N/N on all bands. See the "Servicing Hints" section for procedure.

Check that sensitivity is better than 1.0 uV at 10 dB S+N/N with the input voltage set at 11V DC on all bands.

S Meter/AF Output:

Check that the S meter reads S9 for 50 uV input signal at a supply voltage of 13.8V DC. The S meter reading should vary with the input signal. Changing the input signal from 1 uV to 0.1V should result in 6 dB or less increase in audio output. (6 dB is a voltage ratio of about 2). Audio output should be 4 watts (approximately 5.5 volts AC across the speaker) before clipping occurs.

Turning the RF Gain control fully counterclockwise should increase the S meter reading to about +20 dB over S 9, and decrease the input sensitivity of the receiver.

Spurious:

Set the generator output to 1 uV output and note the S meter reading. Tune the set to each internally generated spurious signal and note that they each should be less than the S meter reading noted above.



Noise Blanker:

To check the noise blanker circuit, connect a pulse type noise generator to the antenna connection along with the signal generator using a "T" connector. If a noise generator is not available, see the "Servicing Hints" section of this manual for the schematic diagram of a simple inexpensive set that may be constructed and kept for future use.

Tune in a 0.5 μ V signal from the generator; turn on the noise generator and set the noise level to S 3 to S 8 with the Noise Blanker switch off. Turn the Noise Blanker switch on; the signal should now be audible above the residual noise. Check on all bands.

Tune the signal generator to another frequency at least 1 MHz away from the set frequency and modulate the signal generator at 100% modulation. Increase the generator output to about 100,000 μ V and at this point the noise level should come back up to S 4 to S 8; switching the Noise Blanker switch from on to off should have no effect.

RIT:

Switch RIT on (indicator lighted) with the index of the knob set at 0. Tune in a signal, and switch the RIT to off. The signal should not shift frequency. With the RIT off, vary the RIT control; the signal should not vary. With the RIT on, varying the RIT control should make the signal pitch shift about ± 1 kHz. With the RIT switched off, tune in a signal for zero beat in the LSB mode. Changing the Mode switch to USB should not change the tuning from zero beat.

Calibrator & Dial Tracking:

Turn the calibrator on and check output with a frequency counter at pin 9 of A304 on the calibrator board. It should read 25,000 Hz ± 1 Hz. Adjust C302 if necessary to make it so.

Check the dial accuracy and tracking using the calibrator. It should be within ± 2 kHz from 0 to 500 on the dial without moving the dial skirt.

External Counter:

There should be approximately 100 mV p-p of signal at a frequency equal to the dial frequency + 9 MHz present at the external counter jack.

ALIGNMENT:

Alignment should be performed only after making a complete performance check of the unit. It is advisable to align only those portions necessary to meet the performance specifications. This procedure will save time and help to avoid the possibility of accidentally misaligning some sections.

Initial Setup:

Remove top and bottom covers. Remove both PA module covers. Connect the radio to a power supply capable of delivering 13.8 V DC at 22 amperes, with a current meter. Connect the antenna terminal to a 200-watt non-reactive dummy load. Connect a 30 MHz bandwidth oscilloscope to the output through a 10:1 attenuator probe.

Set the controls of the radio as follows: Power off; RF Gain, full clockwise; Microphone Gain, full counterclockwise; PTT/VOX switch to PTT; Noise blanker switch off; Mode to LSB; Light off; Band to 28.5 MHz band; dial to 250; and Preselector to "28" range.



Carrier Oscillator Adjustment:

1. Connect the oscilloscope through a 10:1 attenuator probe to pin 8 of A102 on the exciter board. Adjust T101 on the carrier oscillator board for maximum signal. Disconnect the oscilloscope.
2. Connect a frequency counter having a high impedance input to pin 8 of A102 on the exciter board. Adjust C109 on the carrier oscillator board for a reading of 9.00000 MHz on the counter, ± 10 Hz.
3. Switch the Mode switch to USB. Adjust C106 on the carrier oscillator board for a reading of 9.00330 MHz on the counter, ± 10 Hz.
4. Switch the Mode switch to CW. Move the frequency counter connection to pin 1 of Z101 on the exciter board and adjust C104 on the carrier oscillator board for a reading of 9.00250 MHz on the counter, ± 10 Hz. Disconnect the counter.

Exciter Board I.F. Adjustments:

1. Adjusting the AF Gain control as necessary, peak T101, T103 and T104 on the exciter board for maximum background noise in the receive condition.
2. Switch between USB and LSB modes several times and listen for any changes in pitch of the background noise. If there is a noticeable change, T101 and T103 can be slightly detuned (approximately 1/8 turn) to balance the noise pitch. This change in pitch is due to regeneration encountered because of the high gain of the IF amplifier and results in a "hollow" sound in the audio. Reducing the IF gain by the slight detuning mentioned does not degrade the receiving sensitivity.
3. If the exciter board has a transmit gain adjustment trimpot (R184) (later versions only), adjust it so that the voltage on pin 3 of A101 is 6V DC $\pm 0.5V$ in the transmit mode, as read on a high impedance VTVM or DVM.

Preselector Alignment:

1. Connect a microphone to the radio. Set the Mode switch to CW and the VOX/PTT switch to PTT. Connect the oscilloscope probe to the dummy load. Set the Band switch and preselector to 28.
2. Depress the microphone button and adjust the Microphone Gain control for approximately 10 watts output. Adjust the oscilloscope controls for a convenient display of the waveform.
3. Adjust L104 and L105 on the preselector board for maximum output as observed on the oscilloscope, readjusting the Microphone Gain control as necessary to hold the output to 10 watts or less.
4. Set the Band switch to 14.0, and the Preselector to the center of the "14" range. Repeat step 3, this time adjusting L103 and L106 for maximum output.



SWAN ELECTRONICS

5. Set the Band switch to 7 and the Preselector to the center of the "7" range. Repeat step 3, this time adjusting L102 and L107 for maximum output.
6. Set the Band switch to 3.5 and the Preselector to the center of the "3.5" range. Repeat step 3, this time adjusting L101 and L108 for maximum output.
7. Set the Band switch to 21. Key the radio and adjust the Preselector for maximum output. The Preselector should be peaked within the "21" range.

ALC Adjustment:

1. Set Band switch to 14, Mode switch to CW, and VOX/PTT switch to PTT. Connect oscilloscope probe to center leg of the "Reflected" ALC trimpot.

Note: During this and subsequent CW tests, limit the "key down" time to 30 seconds or less to prevent overheating and resultant damage to the power amplifier devices. Allow time between keyings to permit them to cool.

2. Key the transmitter, and adjust the Microphone Gain control for an output of approximately 50 watts. Adjust the ALC null trimmer capacitor (C103) for minimum DC voltage on the oscilloscope.
3. Turn the Microphone gain control fully clockwise, key the transmitter and quickly adjust the "Forward" ALC trimpot for 100W output.
4. Remove the dummy load and replace it with a 100-watt (10 ohms cold) light bulb. Key the set with the Microphone Gain fully clockwise and quickly adjust the "Reflected" ALC trimpot for 50W of output.
5. Check the output on all bands for 40 to 70 watts output using the light bulb as a load.
6. Replace the light bulb load with the 50 ohm dummy load. Check all bands for 100 to 130 watts of output.
7. Disconnect the test equipment from the radio. Key the transmitter and check that the total supply current is less than 12 amperes on all bands with the Preselector properly peaked.

Note: It may be necessary to slightly readjust the ALC null trimmer capacitor and ALC Reflected and Forward trimpots to meet the requirements of steps 6 and 7 above. On early versions, the ALC controls are all on the Low Pass Filter board; on later versions, they are on two separate boards.



Bias Adjustment: (Early version only)

1. Adjust the PA bias trimpot on the PA board for a total supply current of one ampere with the set keyed, no output, and the dial lights turned off.
2. Bias should be adjusted for minimum PA idling current with no crossover distortion on the two-tone test. (See Servicing Hints section for discussion of the two-tone test.)

Transmit I.F. Gain: (Later version only)

1. Connect the 50 ohm dummy load to the antenna terminals. Set the VOX/PTT switch to the VOX position. Key the transmitter and adjust the Microphone Gain control for approximately 10 watts of output power in CW.
2. Adjust the transmit IF gain control until output increases to about 15 watts.
3. Increase the power output to 100 watts. Key and unkey the transmitter, listening for "popping" sounds in the receiver speaker. If the IF gain is set too high, the IF amplifier becomes regenerative, causing the "popping" noise or causing the output to go to full when keyed, regardless of the Microphone Gain control setting. It may be necessary to readjust the IF gain control to prevent this regeneration.

Receiver AGC and S Meter:

1. Connect a signal generator with a calibrated output to the antenna terminal. Set the Mode switch to the LSB position, the VOX/PTT switch to the PTT position, the Band switch to 3.5, and the Microphone gain control fully counterclockwise.

Note: Unplug the microphone, if it is connected, to prevent accidentally keying the transmitter and the resultant damage to the signal generator.

2. Set the signal generator to a frequency of 3.750 MHz, with an output of 50 μ V. Tune the receiver dial for a beat note of about 800 Hz. Adjust the Preselector for maximum S Meter indication.
3. Connect the oscilloscope probe to the collector of Q107 on the exciter board.
4. Adjust the AGC threshold trimpot (R139) on the exciter board for an indication of 0.6V peak-to-peak on the oscilloscope. Disconnect the oscilloscope.
5. Adjust the S Meter calibration trimpot (R149) on the exciter board for an indication of S 9 on the meter.



Calibrator:

1. Connect the frequency counter to pin 1 of A302 on the calibrator board. Adjust trimmer C302 for a counter reading of 10.00000 MHz ± 10 Hz.
2. Move the counter connection to pin 9 of A304 and check that the frequency is 25,000 kHz ± 1 Hz.

PTO and RIT:

1. Connect the frequency counter to the output of the PTO (J103). Turn the RIT control on (indicator lighted). Set the index mark on the RIT control to "0". Set the Mode switch to LSB.
2. Check to see that the main tuning dial is set at 250. Adjust the rear trimmer on the PTO assembly (C606) for a reading on the counter of 5.25330 MHz ± 10 Hz.
3. Turn the RIT control off (indicator extinguished). Adjust the TX set trimpot (R104) on the RIT board for a reading of 5.25330 MHz ± 10 Hz on the counter.
4. Change the Mode switch to USB mode. Adjust the front trimmer on the PTO assembly (C608) for a reading on the counter of 5.25000 MHz, ± 10 Hz.
5. Change the Mode switch to LSB mode. Turn the main tuning dial for a reading of 5.25330 MHz ± 10 Hz on the frequency counter.
6. Repeat steps 4 and 5 above until no further adjustment of C608 is necessary.
7. Repeat step 2 above.

Premixer Filters:

The premixer bandpass filters on the bandswitch board are adjusted for flat output, ± 1 dB, across their respective bandpasses, as listed below:

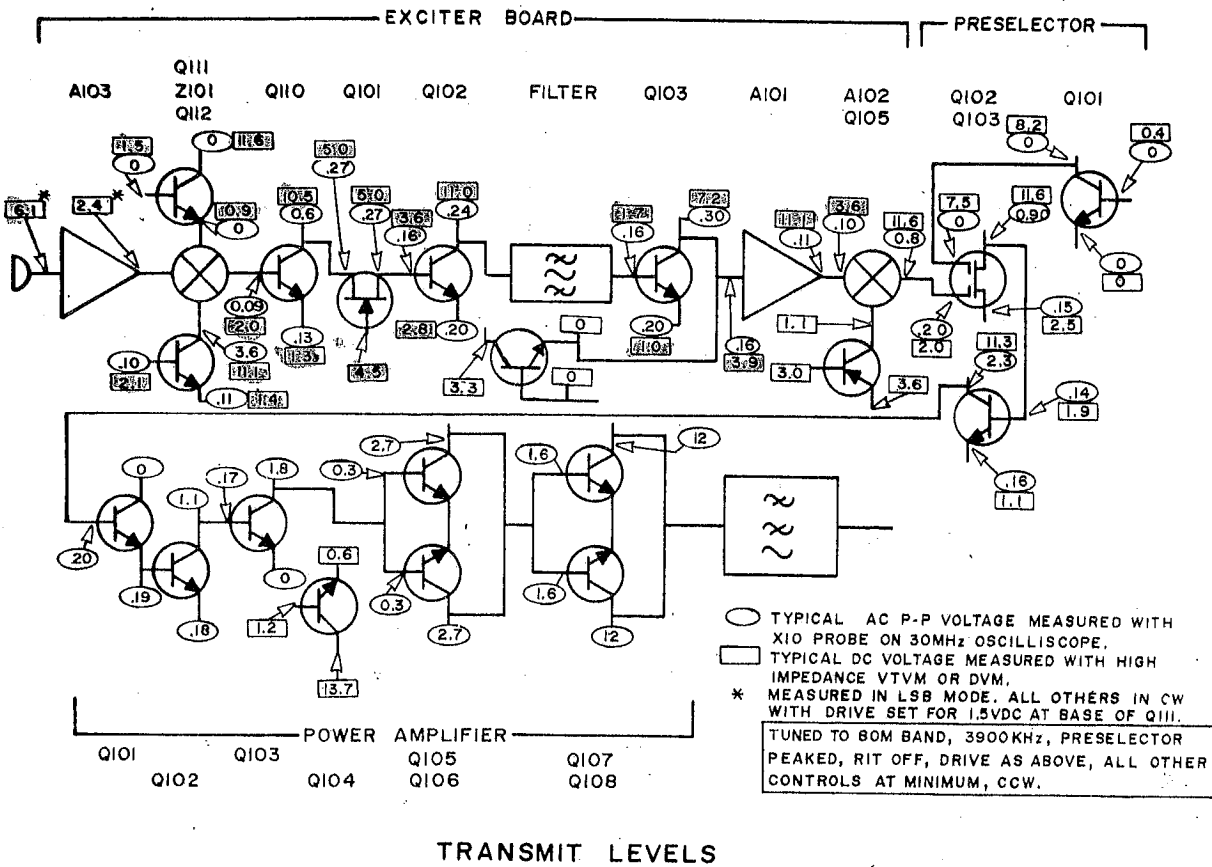
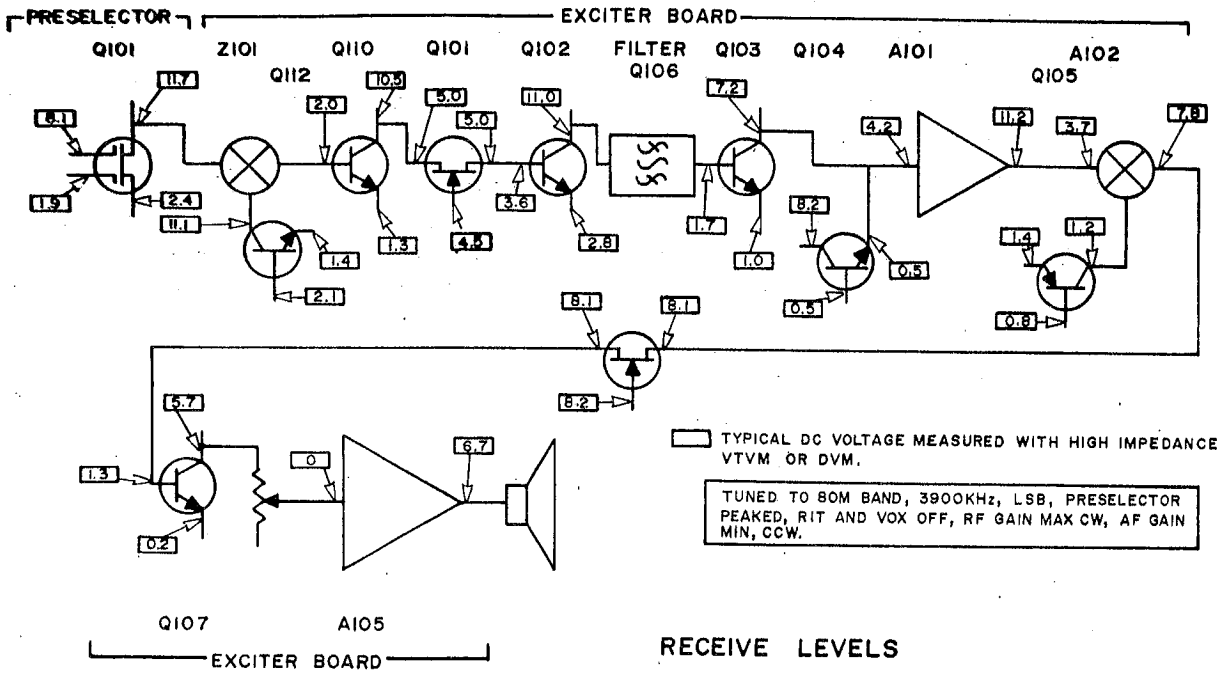
<u>Band</u>	<u>Coils</u>	<u>Bandpass (MHz)</u>
80M	L117, L118	12.5-13.0
40M	L115, L116	16.0-16.5
20M	L113, L114	23.0-23.5
15M	L111, L112	30.0-30.5
10M	L109, L110	37.0-39.0

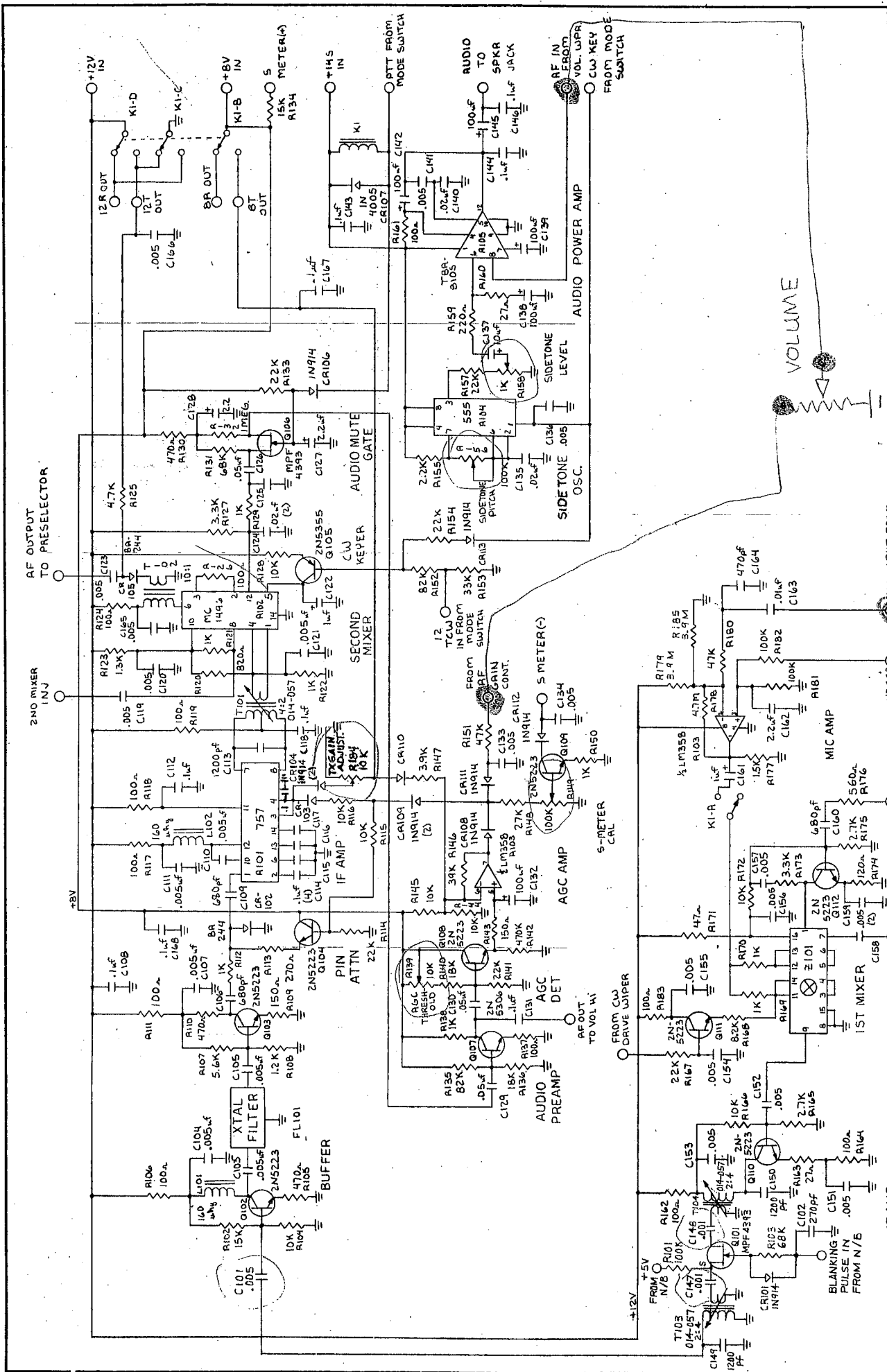
Should it become necessary to realign one or more of the filters because of component replacement, the following procedure can be used; however, alignment of these filters is challenging; it should not be attempted unless it is certain that it is required.

1. Connect the oscilloscope probe to the output coaxial cable on the bandswitch board--output is generally in the range of 100 to 200 mV p-p.



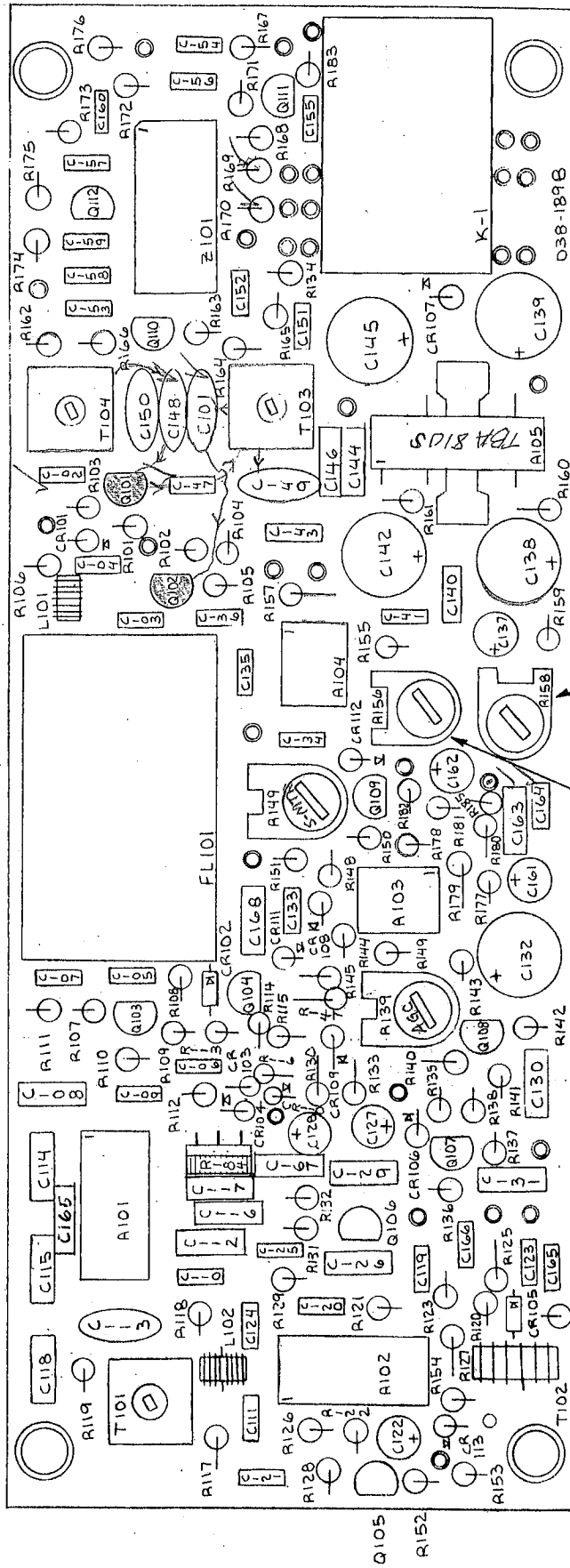
2. Set the Band switch to the band needing alignment and set the main tuning dial to 250.
3. Peak the two coils for that band for maximum output indication on the oscilloscope.
4. While observing output on the oscilloscope, change the dial reading from 250 to 0 to 500 and note any change in output on the oscilloscope screen. If there is more than a ± 1 dB change in the output, readjust one or the other of the coils slightly and check the output across the band again. (1 dB equals a voltage ratio of about 1.1).
5. Repeat steps 2 through 4 for all bands needing alignment.





SWAN ELECTRONICS	
SCALE NONE	APPROVED BY: <i>gjm</i>
DATE: 9-21-78	DESIGN REC. 038-1898
EXCITER BRD SCHEMATIC 038-1898	
REV: <i>WA</i>	DATE: 9-21-78

1. COMPONENT DESIGNATORS 2000 SERIES
 NOTES:



Q105
R152

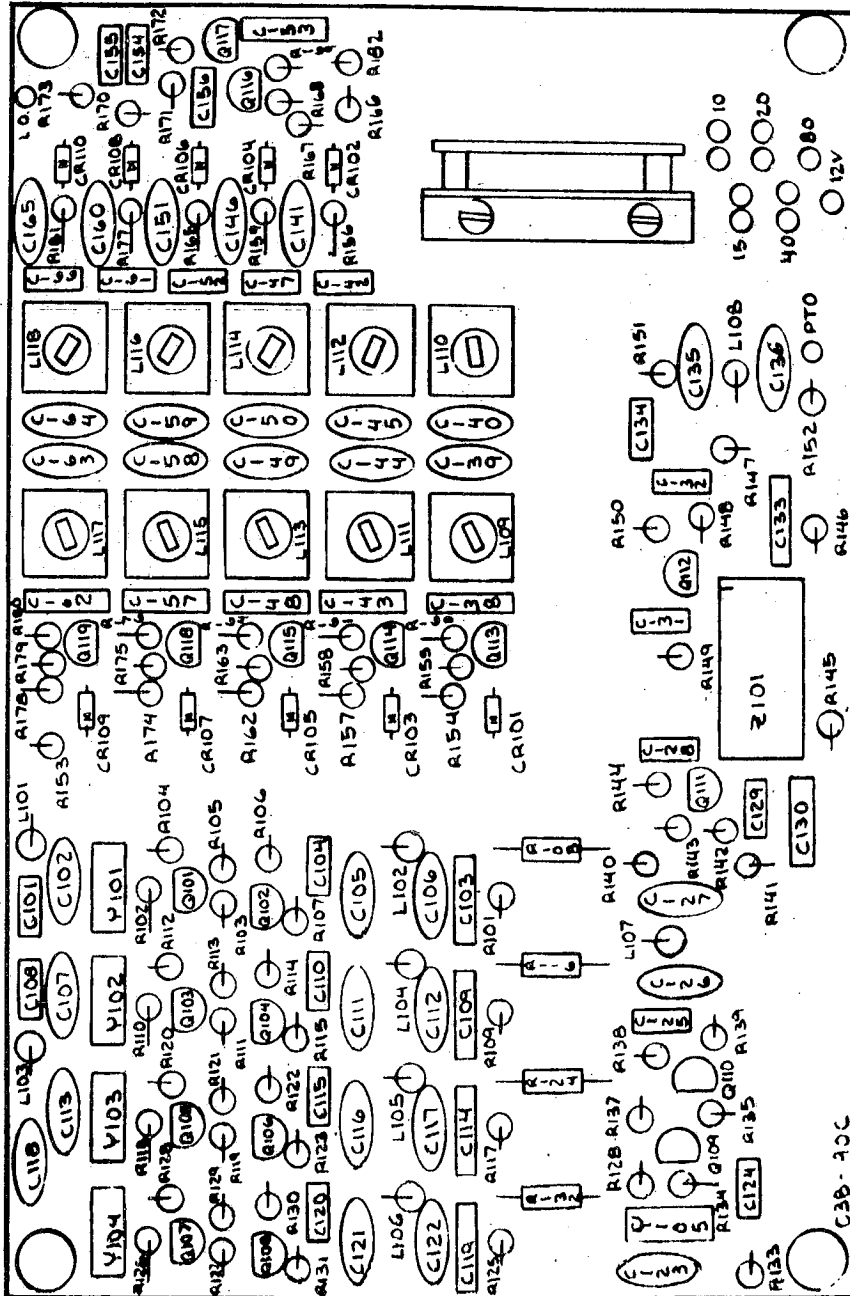
R124

SWANELECTRONICS

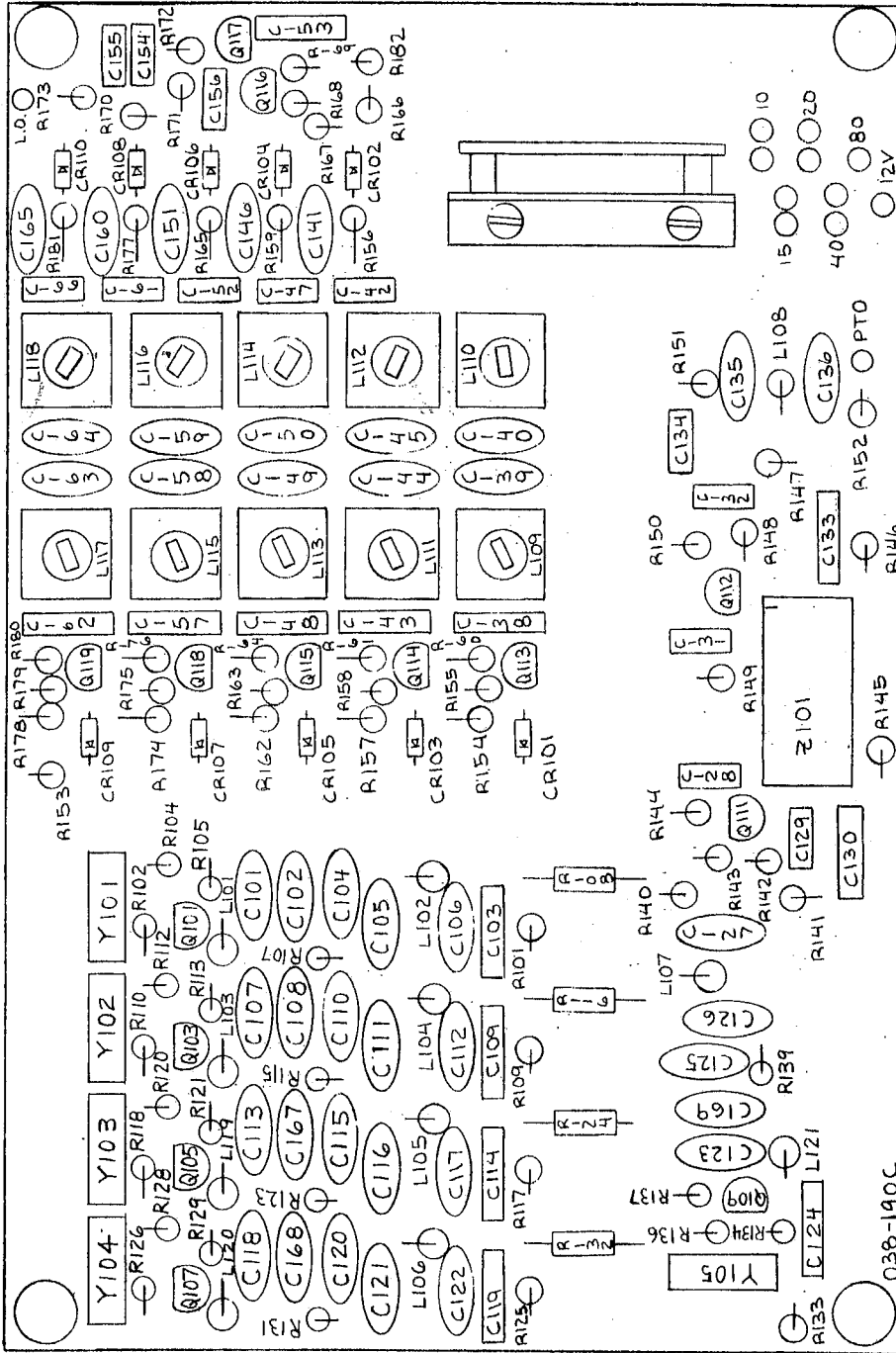
SCALE: NONE	APPROVED BY: <i>JM</i>	DRAWN BY: C.R.V/DSDM
DATE: 9-18-78		REVISED
PRD. D143	EXCITER BRD LAYOUT	
	REV. A	DRAWING NUMBER 3

1. COMPONENT DESIGNATORS 2000 SERIES

NOTES:
1117 PRINTED ON NO. 1000K CLEARPRINT



BANDSWITCH BOARD
(EARLY VERSION)

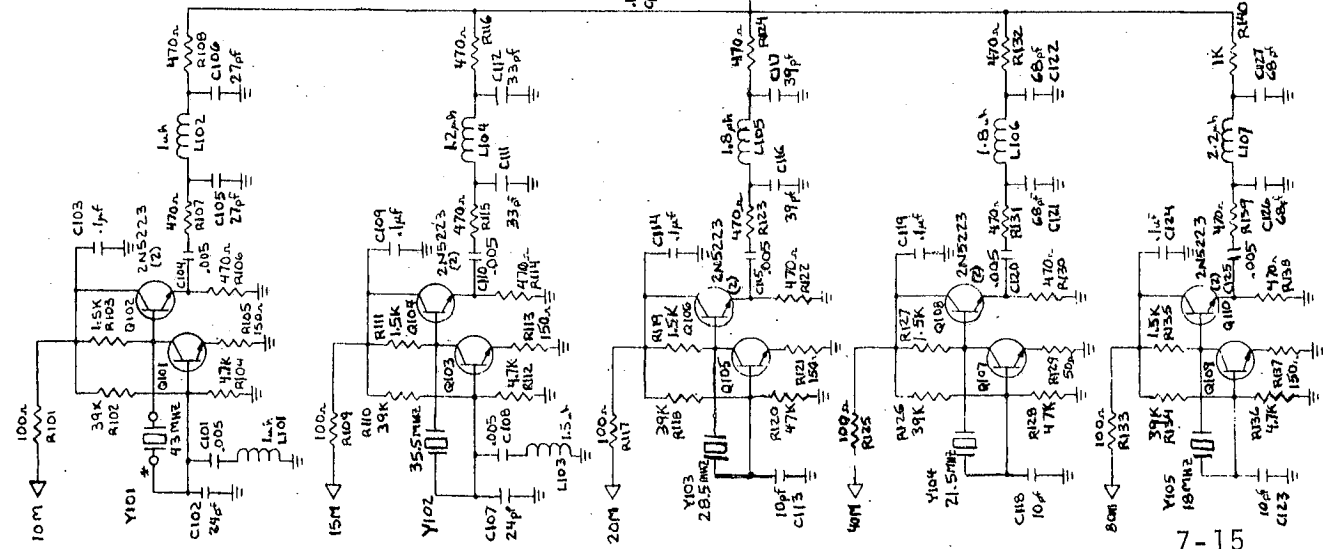


SWAN ELECTRONICS

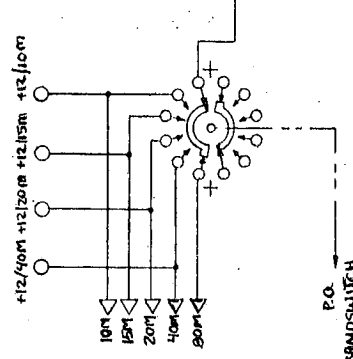
SCALE: NONE	APPROVED BY: <i>gw</i>	DRAWN BY: C. DAVIDSON
DATE: 10-17-78	REVISED	
BANDSWITCH BRD LAYOUT		REV A
		DRAWING NUMBER 5

1. COMPONENT DESIGNATORS 3000 SERIES
 NOTES:

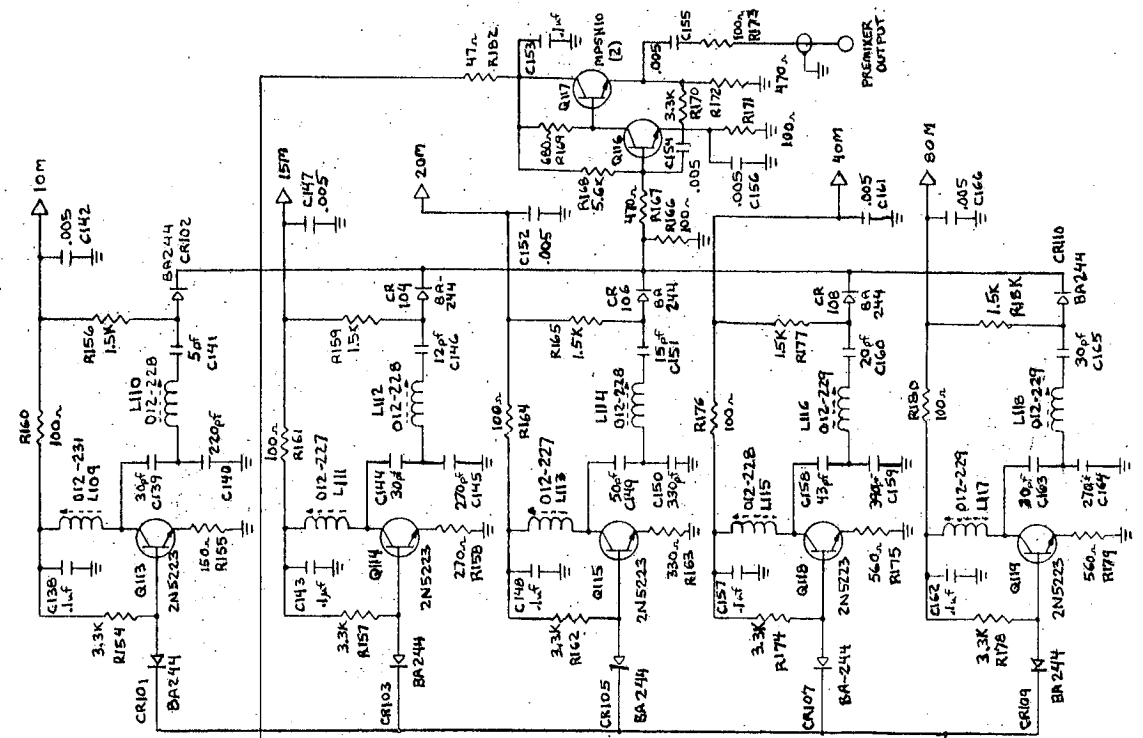
BAND XTAL OSCILLATORS



TO PRESELECTOR BOARD

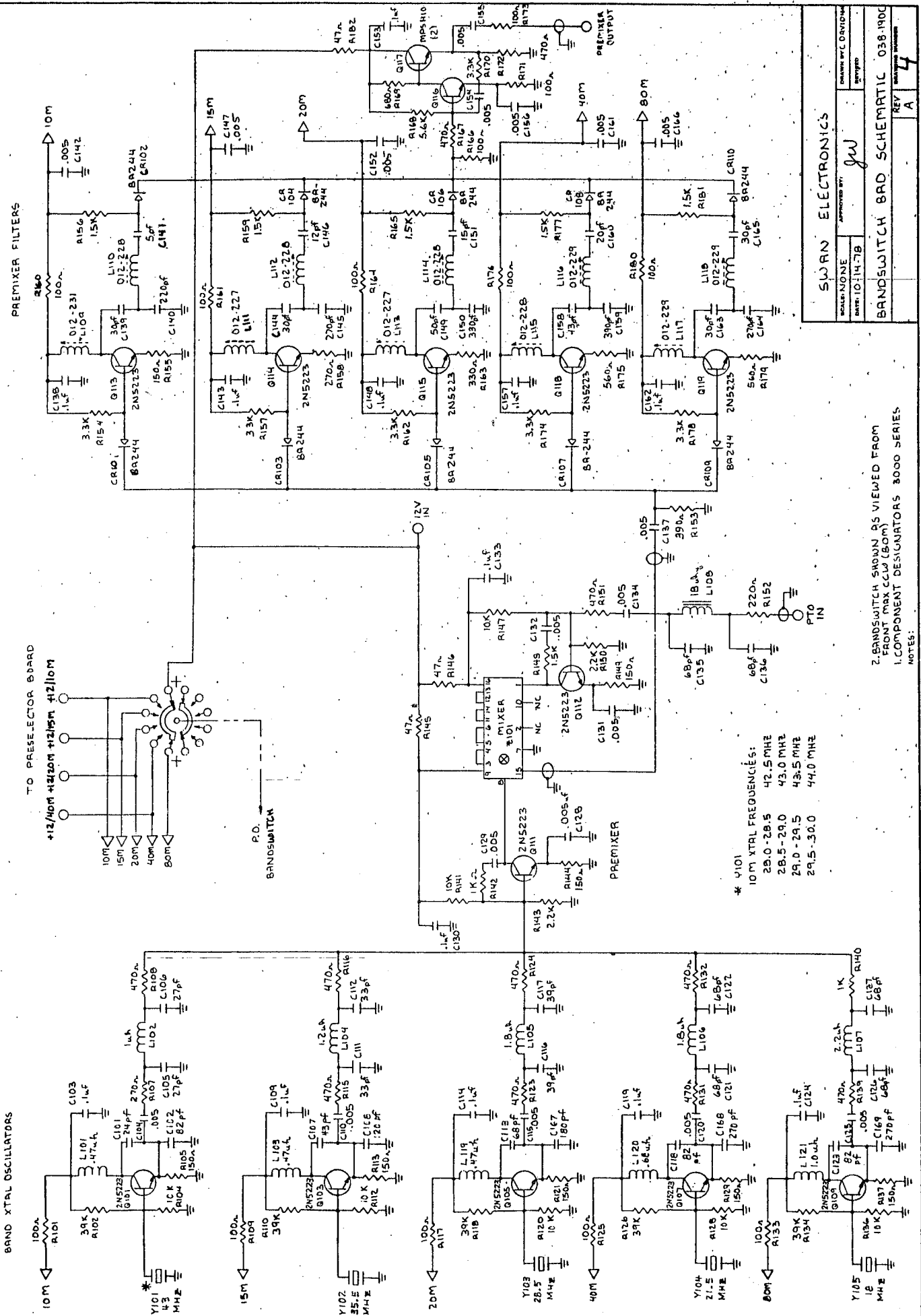


PREMIXER FILTERS



BANDSWITCH BOARD (EARLY VERSION)

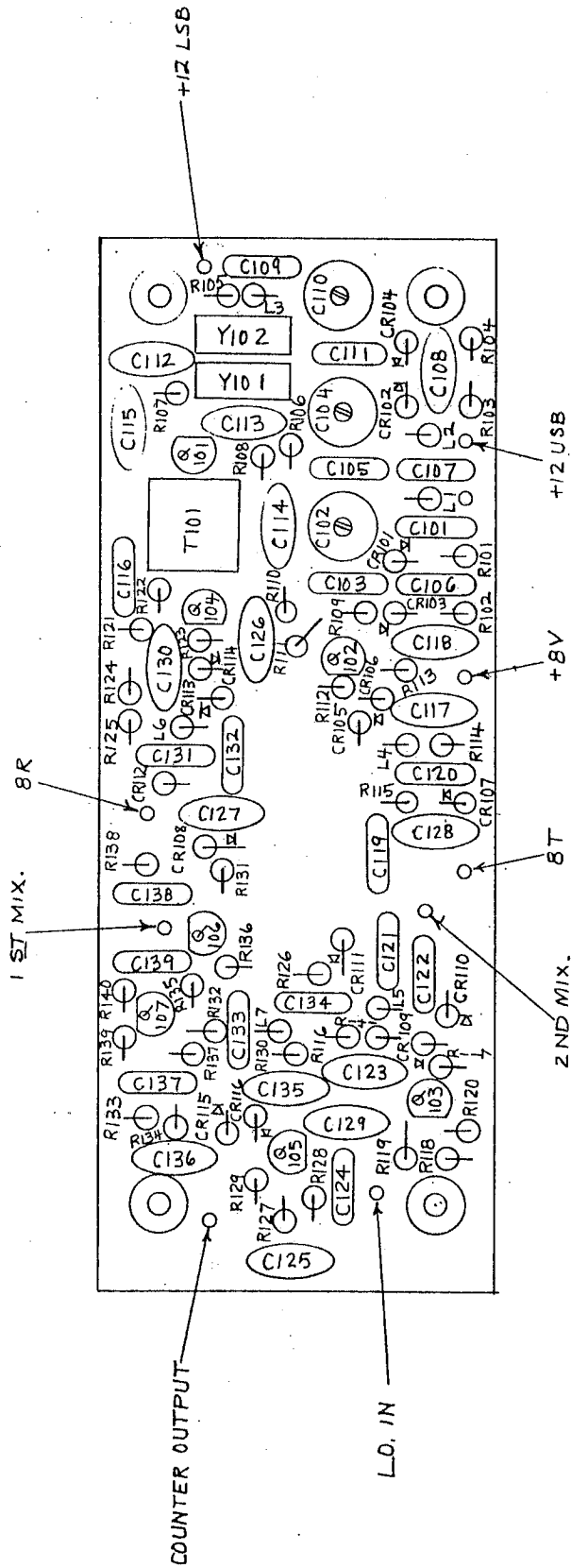
- * Y101
10 M XTAL FREQUENCIES:
- 28.0 - 28.5
 - 42.5 MHz
 - 28.5 - 29.0
 - 43.0 MHz
 - 29.0 - 29.5
 - 43.5 MHz
 - 29.5 - 30.0
 - 44.0 MHz



2 BANDSWITCH SHOWN AS VIEWED FROM FRONT MAX CLOW (BOM)
 1 COMPONENT DESIGNATORS 8000 SERIES

- * Y101
 10M XTAL FREQUENCIES:
 28.0-28.5 42.5 MHz
 28.5-29.0 43.0 MHz
 29.0-29.5 43.5 MHz
 29.5-30.0 44.0 MHz

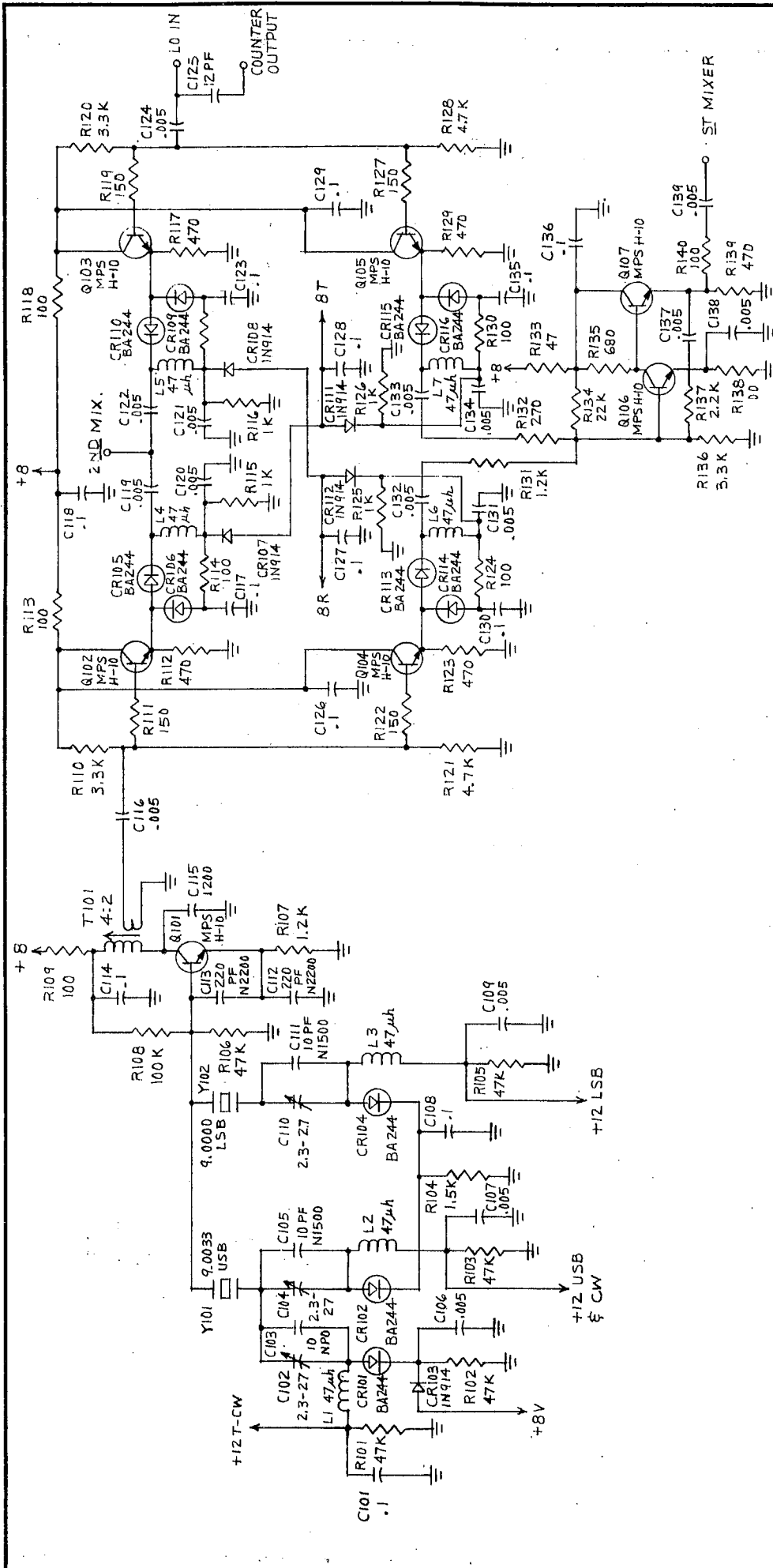
SWAN ELECTRONICS	
DESIGNED BY: J.W.	APPROVED BY: J.W.
DATE: 10/14/78	REVISION: 4
BANDSWITCH BAD SCHEMATIC 038-190C	



SWAN ELECTRONICS	
SCALE: NONE	APPROVED BY: AJG
DATE: 3-13-79	REVISED
ANALOG SWITCH BD LAYOUT	
REV	DRAWING NUMBER
A	7

2. REF. PCB NO. 038-191
 1. COMPONENT DESIGNATORS 4000 SERIES
 NOTES:

15517 PRINTED ON NO. 10694 CLEARPRINT

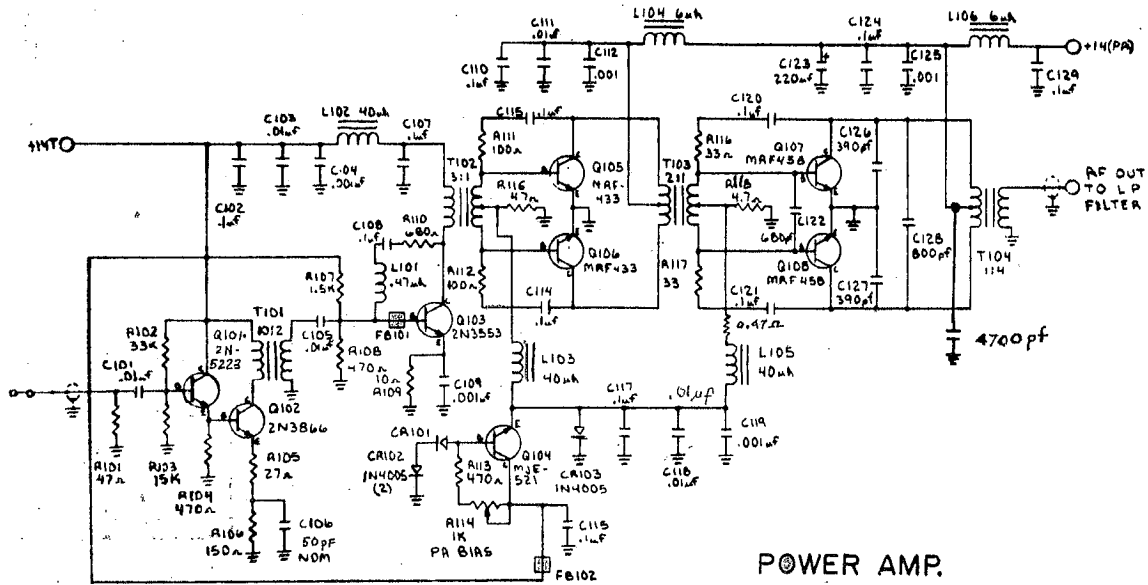


SWAN ELECTRONICS	
SCALE: NONE	APPROVED BY: ALG
DATE: 3-8-79	REVISED:
PROJ. ANALOG SWITCH SCHEMATIC	DRAWING NUMBER
0143	038-191
REV A	6

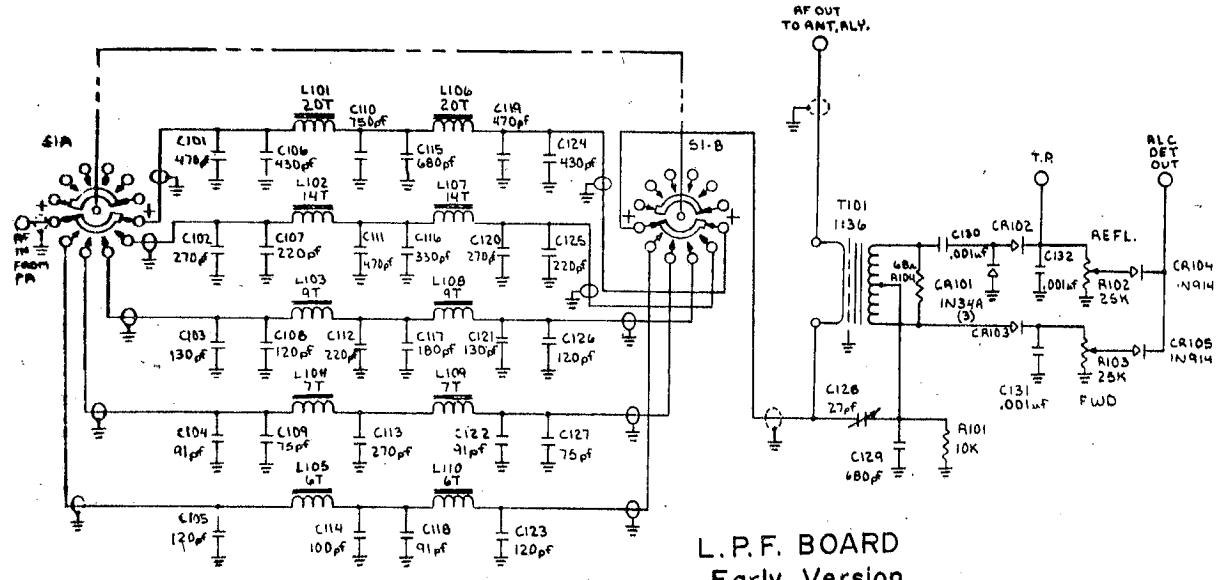
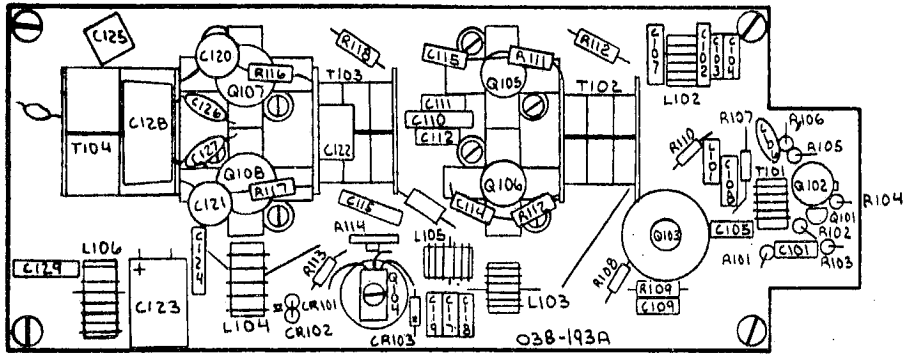
3. COMPONENT DESIGNATORS 4000 SERIES.
 2. CAPACITANCE IN MICROFARADS.
 1. RESISTOR VALUES IN OHMS, 1/4 W, 5%
 NOTES: UNLESS OTHERWISE SPECIFIED



SWAN ELECTRONICS



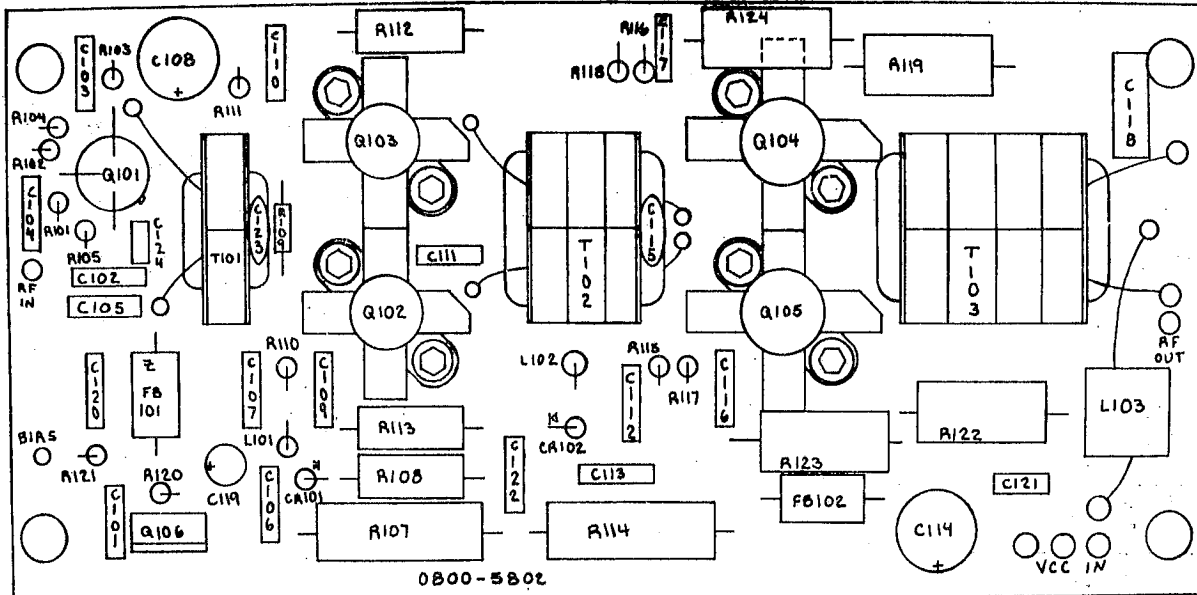
POWER AMP.
Early Version



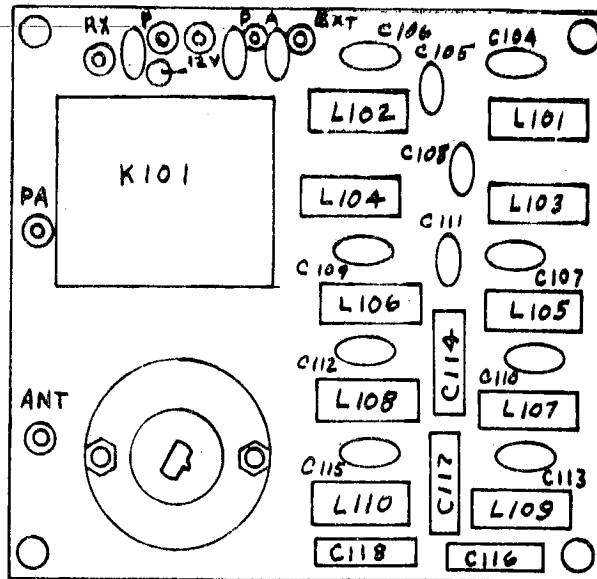
L.P.F. BOARD
Early Version



SWAN
ELECTRONICS



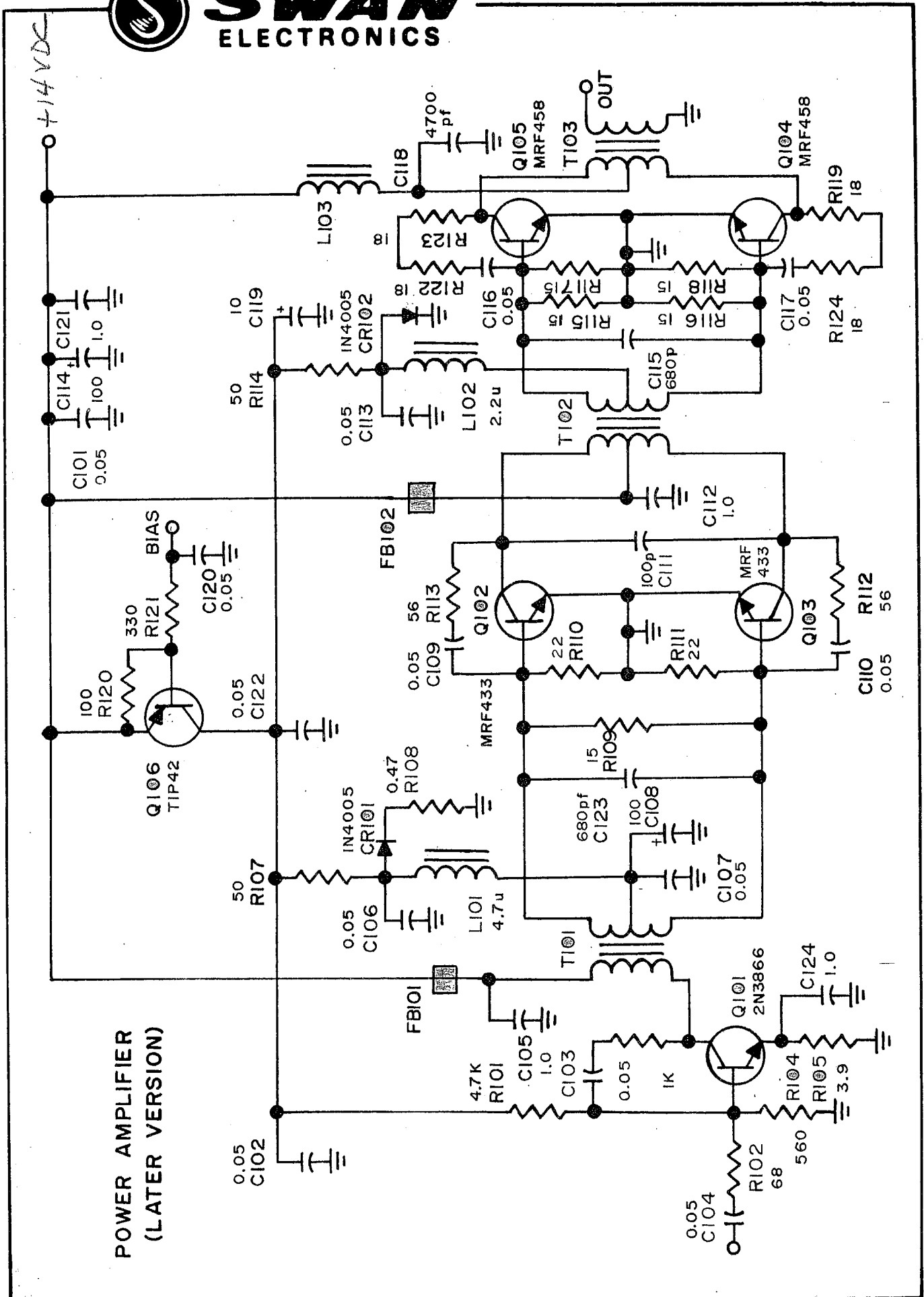
POWER AMP
Later Version



L.P.F. BOARD
Later Version



SWAN
ELECTRONICS

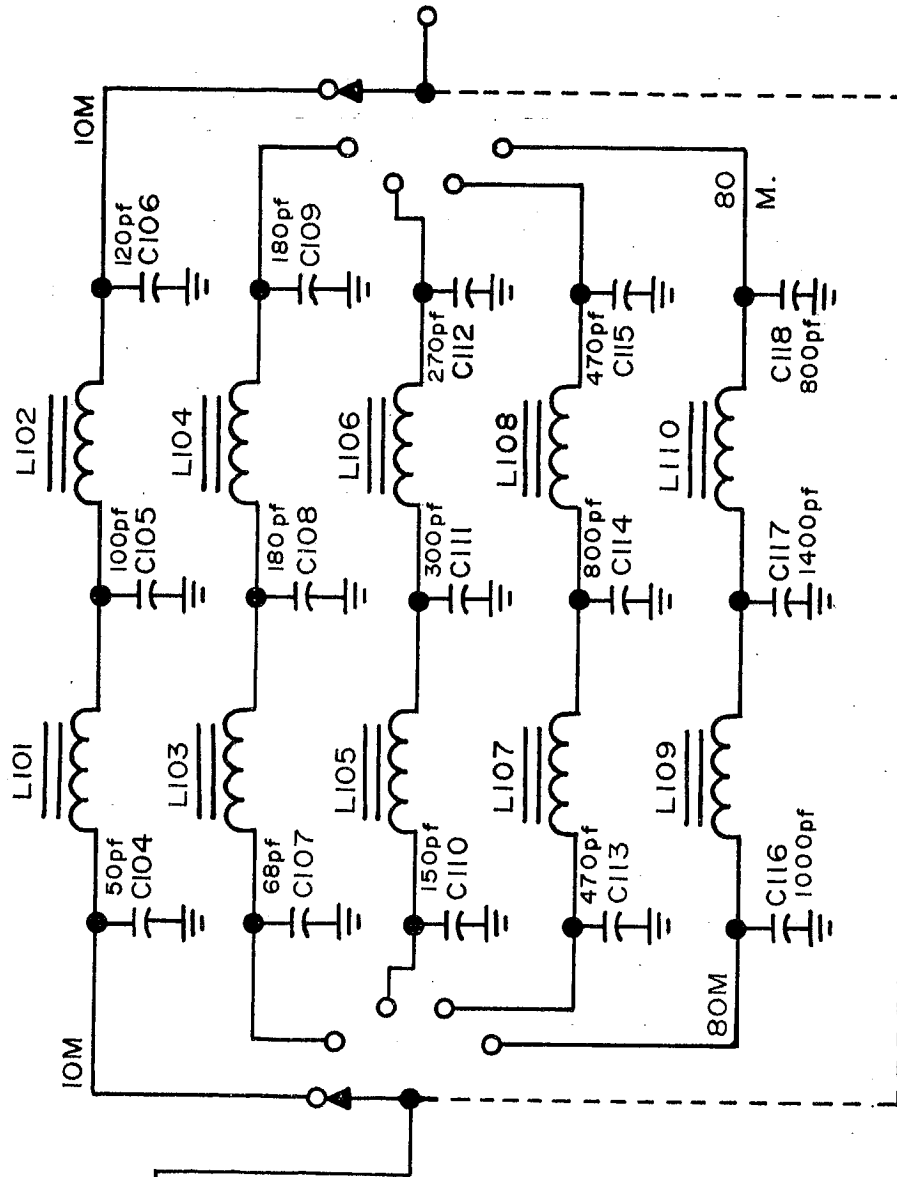


POWER AMPLIFIER
(LATER VERSION)

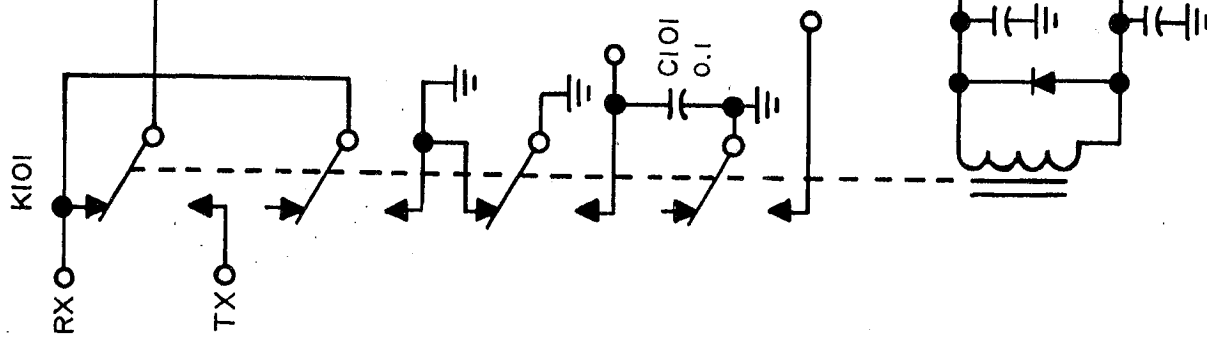
7-22

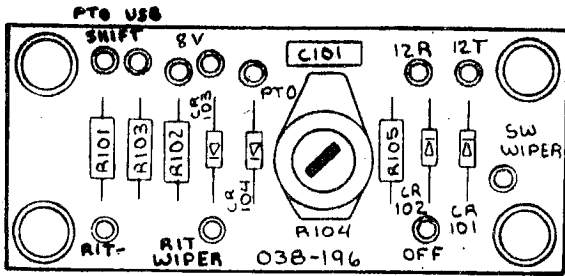


SWAN
ELECTRONICS

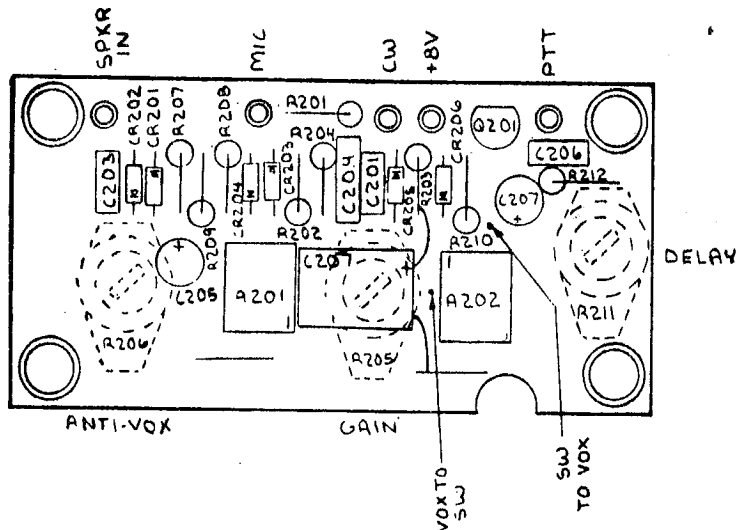
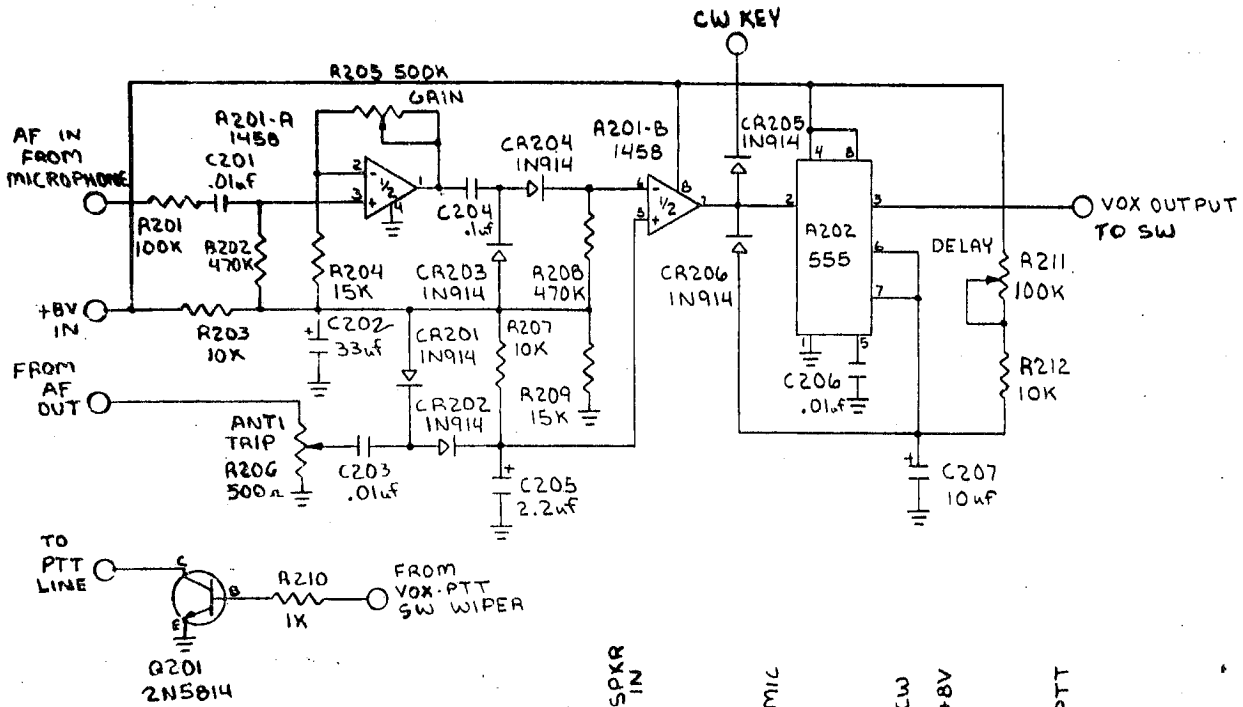
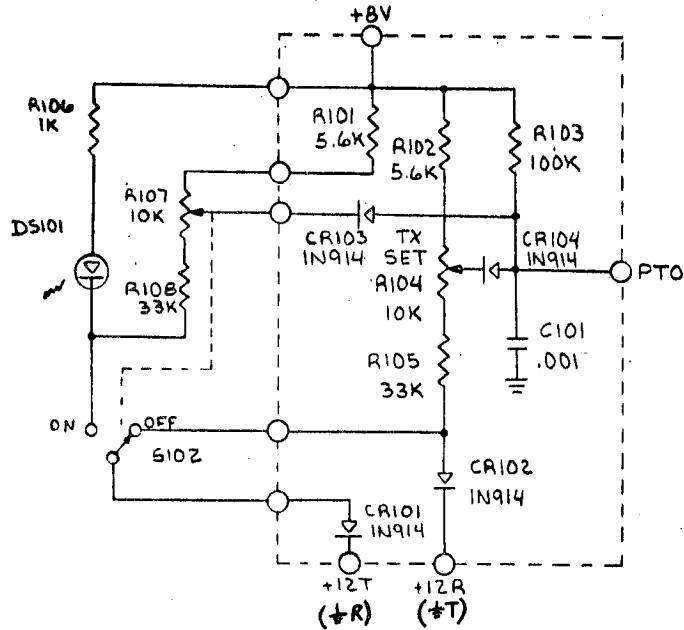


**LOW PASS FILTER
(LATER VERSION)**



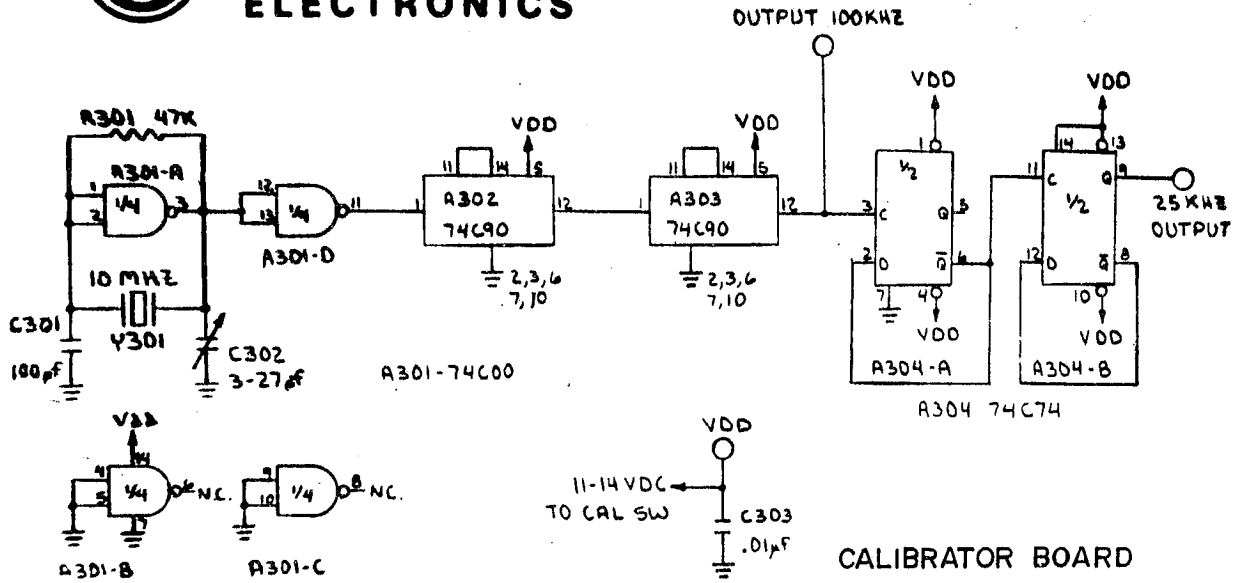


RIT BOARD

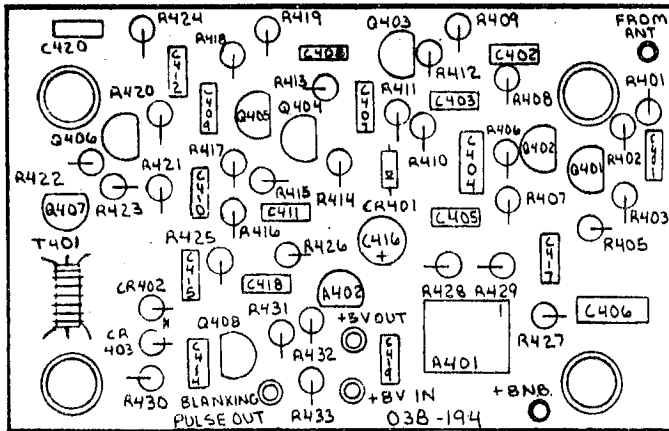




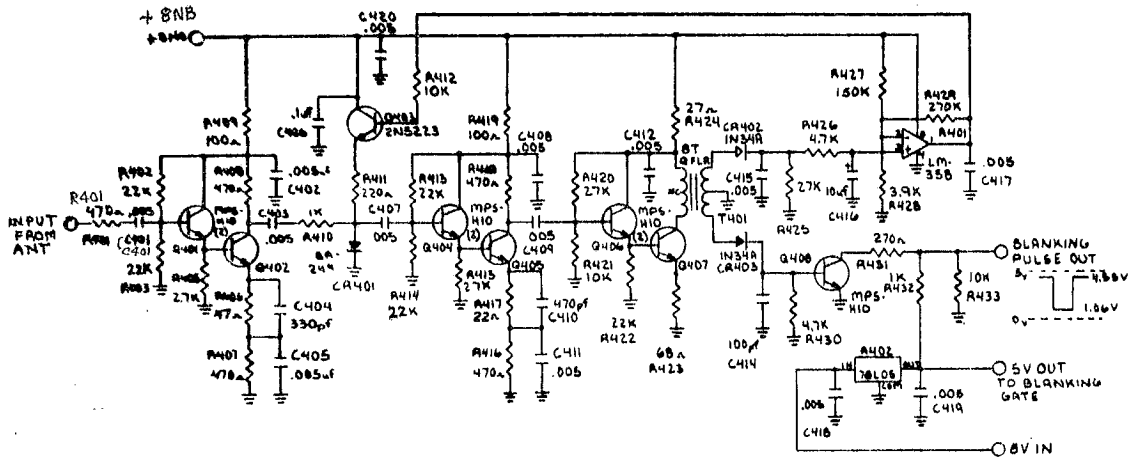
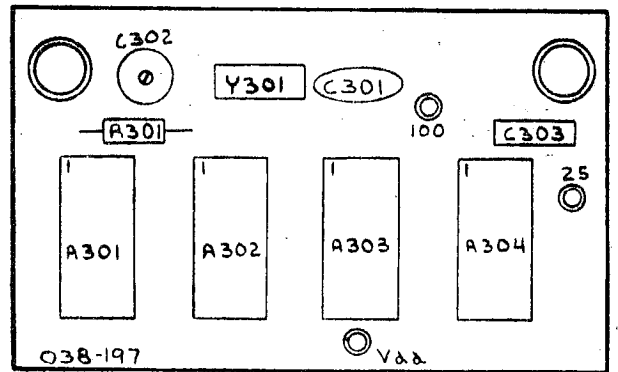
SWAN
ELECTRONICS



CALIBRATOR BOARD

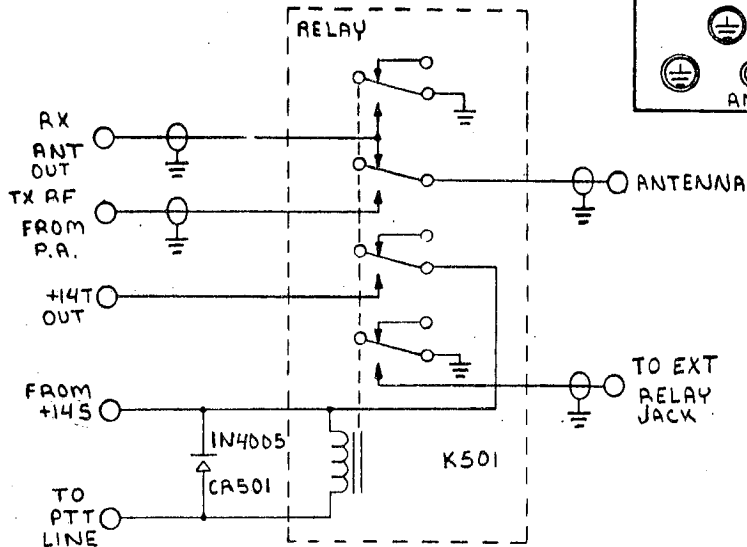
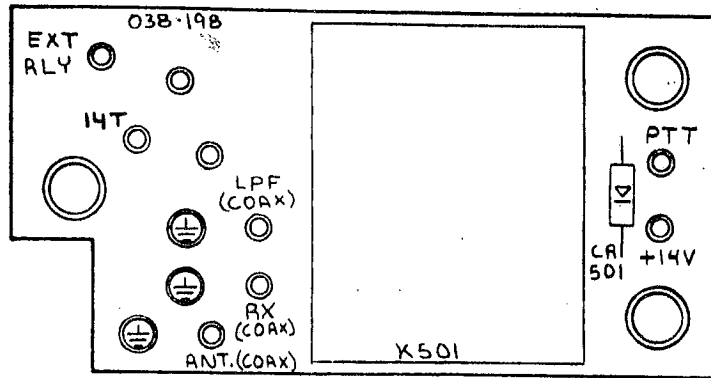


NOISE BLANKER BOARD

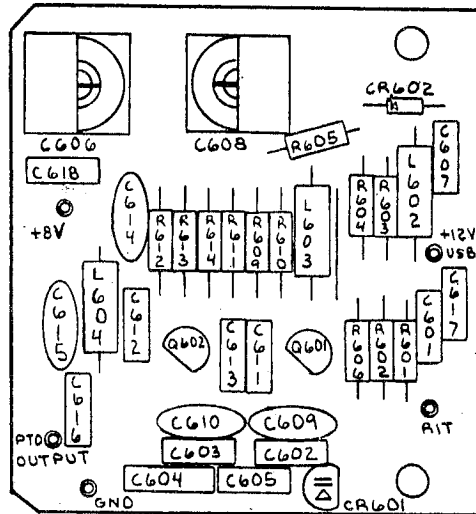




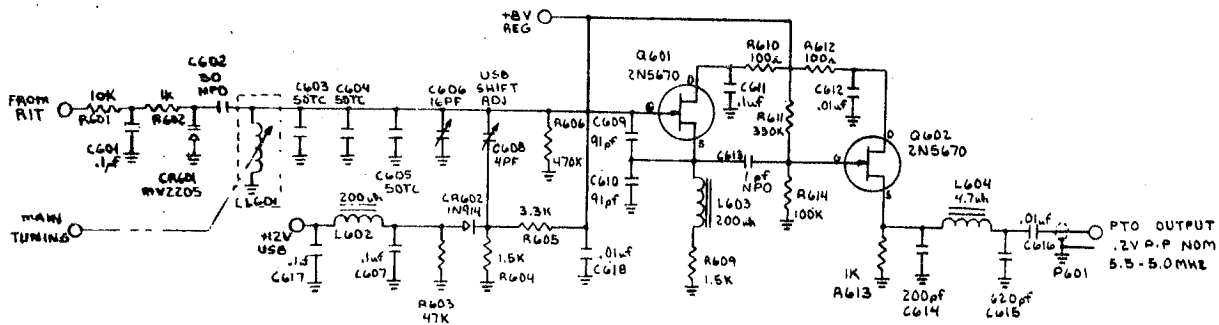
SWAN ELECTRONICS

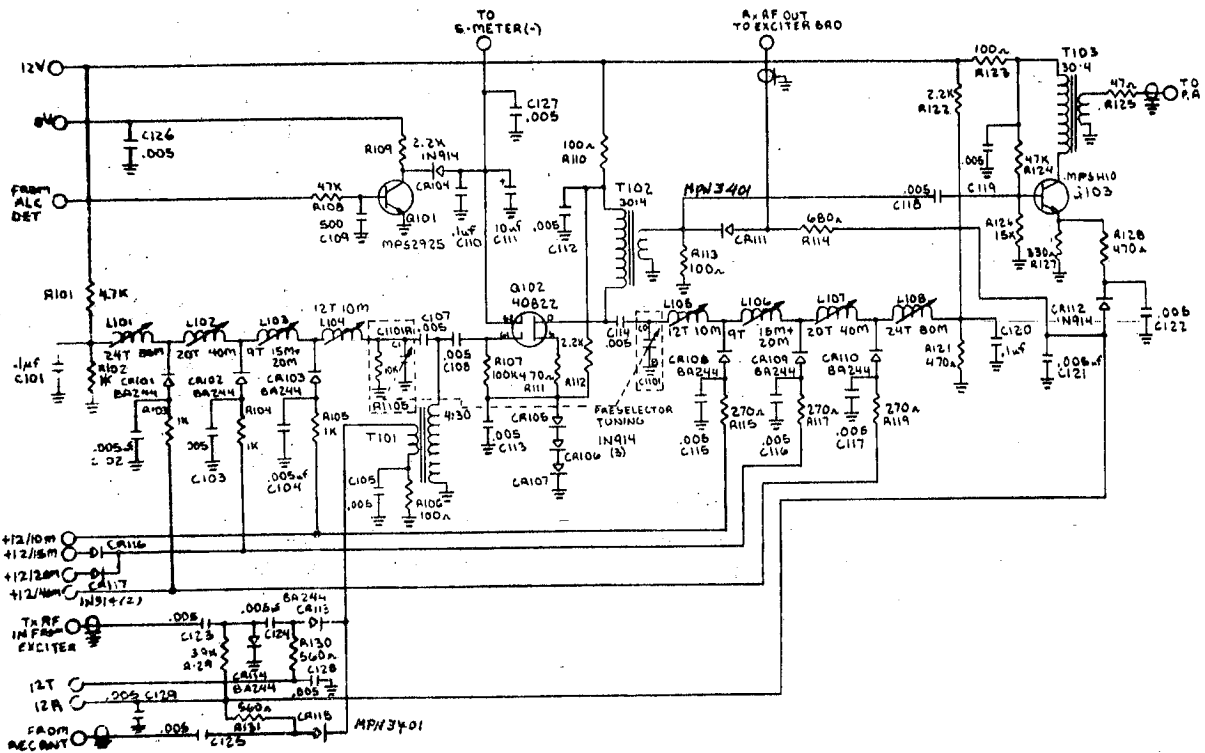


RELAY BOARD

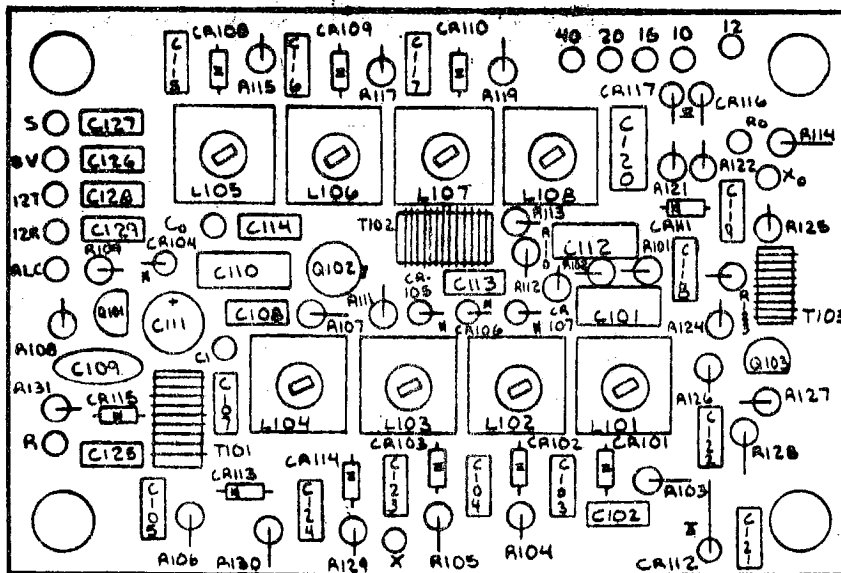


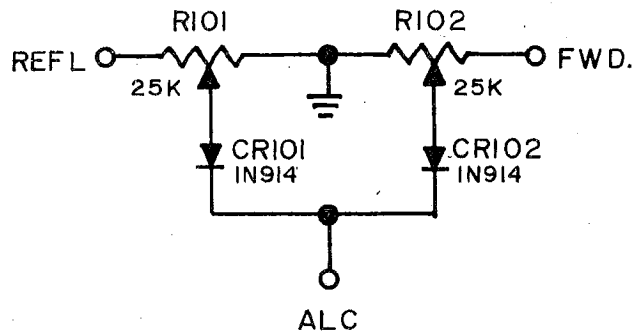
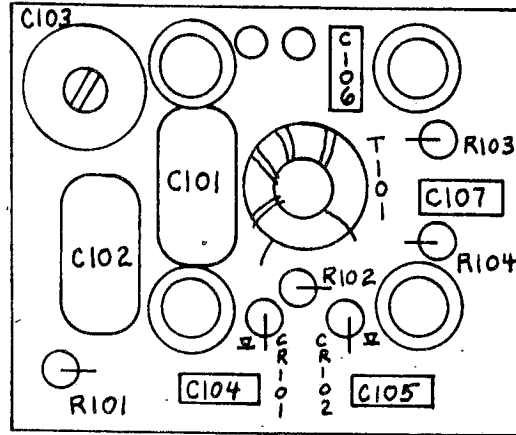
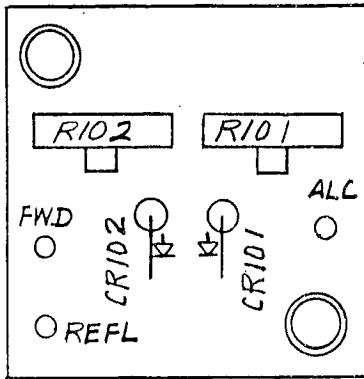
PTO



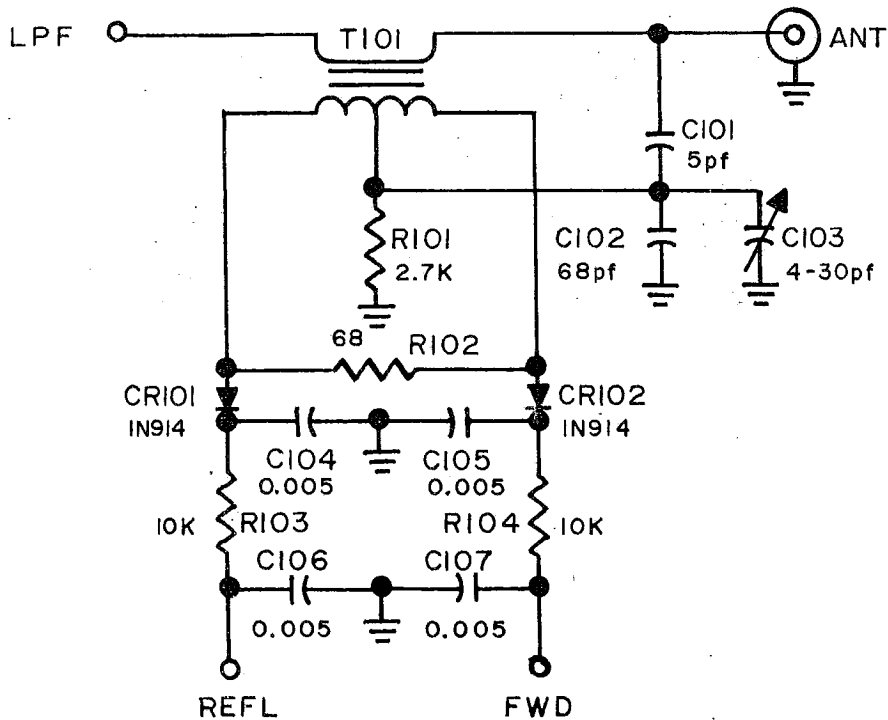


PRESELECTOR

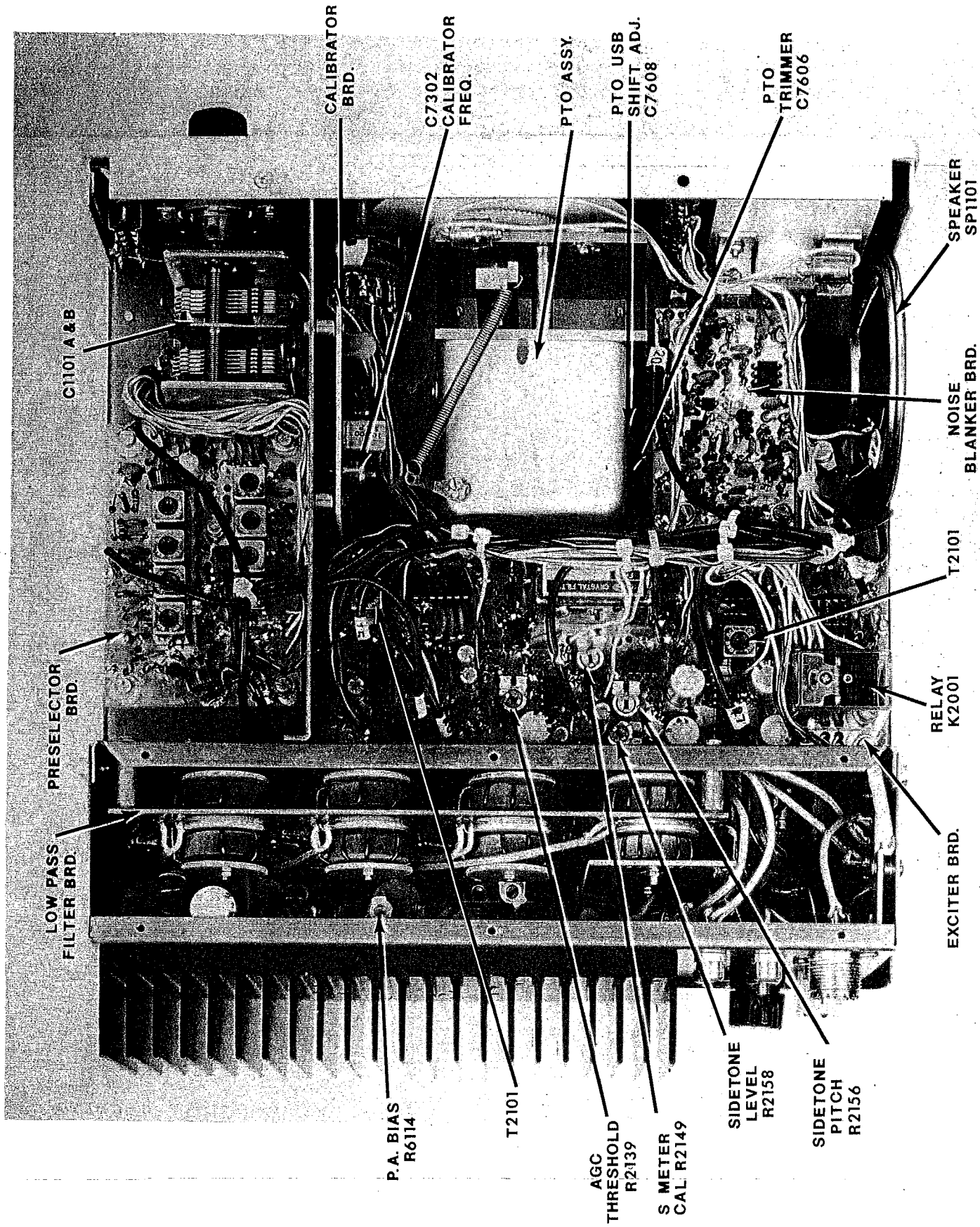




ALC ADJUSTMENT BOARD



SWR / WATTMETER BOARD



LOW PASS
FILTER BRD.

PRESELECTION
BRD.

C1107 A & B

P.A. BIAS
R6114

T2101

AGC
THRESHOLD
R2139

S METER
CAL R2149

SIDETONE
LEVEL
R2158

SIDETONE
PITCH
R2156

EXCITER BRD.

RELAY
K2001

T2101

NOISE
BLANKER BRD.

SPEAKER
SP1101

CALIBRATOR
BRD.

C7302
CALIBRATOR
FREQ.

PTO ASSY.

PTO USB
SHIFT ADJ.
C7608

PTO
TRIMMER
C7606

CRYSTAL FL.

PTO

PTO

PTO

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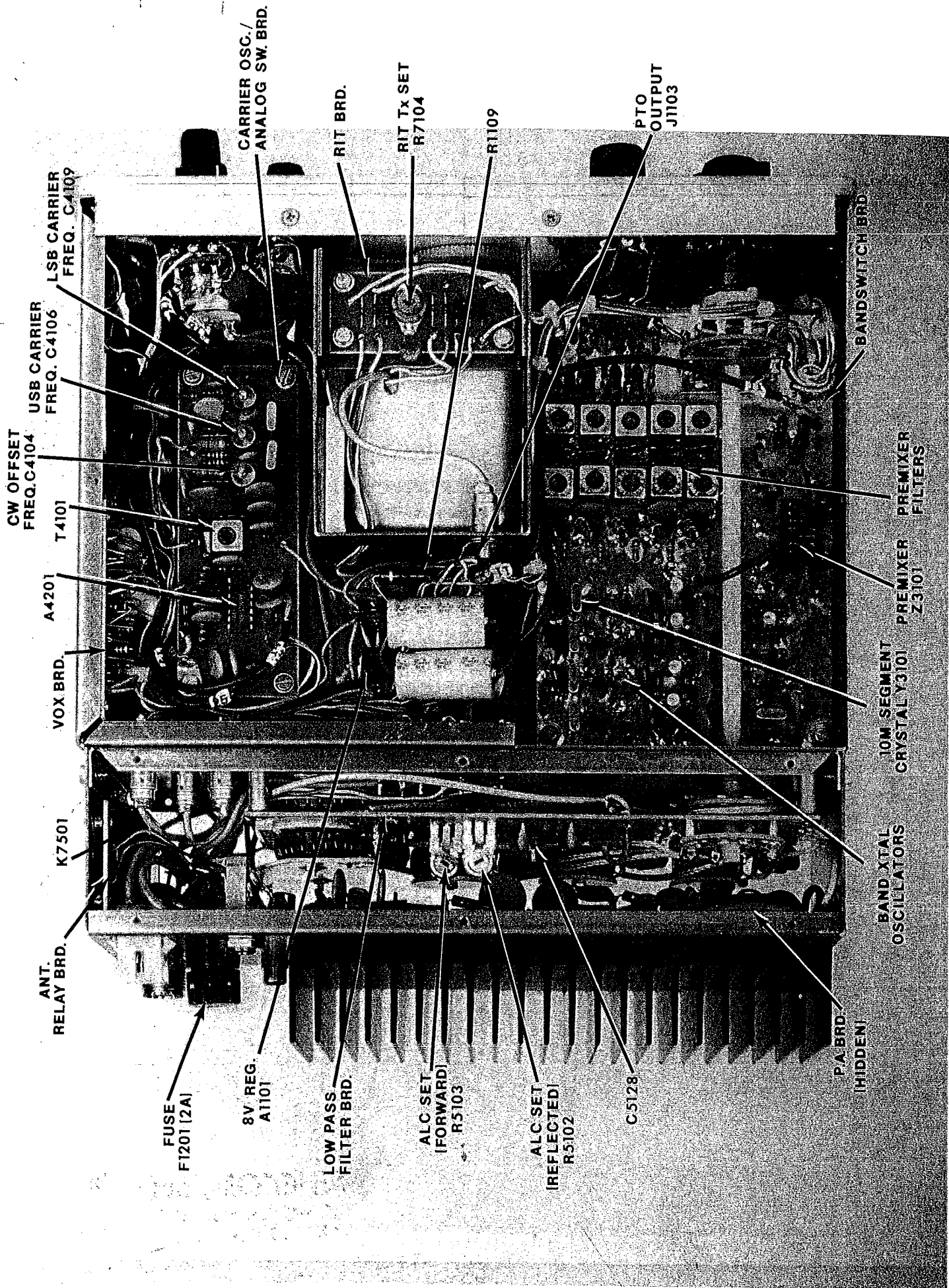
PTO

PTO

PTO

PTO

VENECOM, INC.
WE REPAIR ALL KIND
OF MF - VHF - UHF



CW OFFSET
FREQ. C4104

USB CARRIER
FREQ. C4106

LSB CARRIER
FREQ. C4109

CARRIER OSC./
ANALOG SW. BRD.

RIT BRD.

RIT Tx SET
R7104

R1109

PTO
OUTPUT
J1103

BANDSWITCH BRD

PREMIXER
FILTERS

PREMIXER
Z3101

10M SEGMENT
CRYSTAL Y3101

BAND XTAL
OSCILLATORS

PA BRD.
(HIDDEN)

ANT.
RELAY BRD.

FUSE
FI201 (2A)

8V. REG.
A1101

LOW PASS
FILTER BRD.

ALC SET
(FORWARD)
R5103

ALC SET
(REFLECTED)
R5102

C-5128

A4201

VOX BRD.

K7501

ANT.
RELAY BRD.



WIRE CODE FOR CHASSIS WIRING

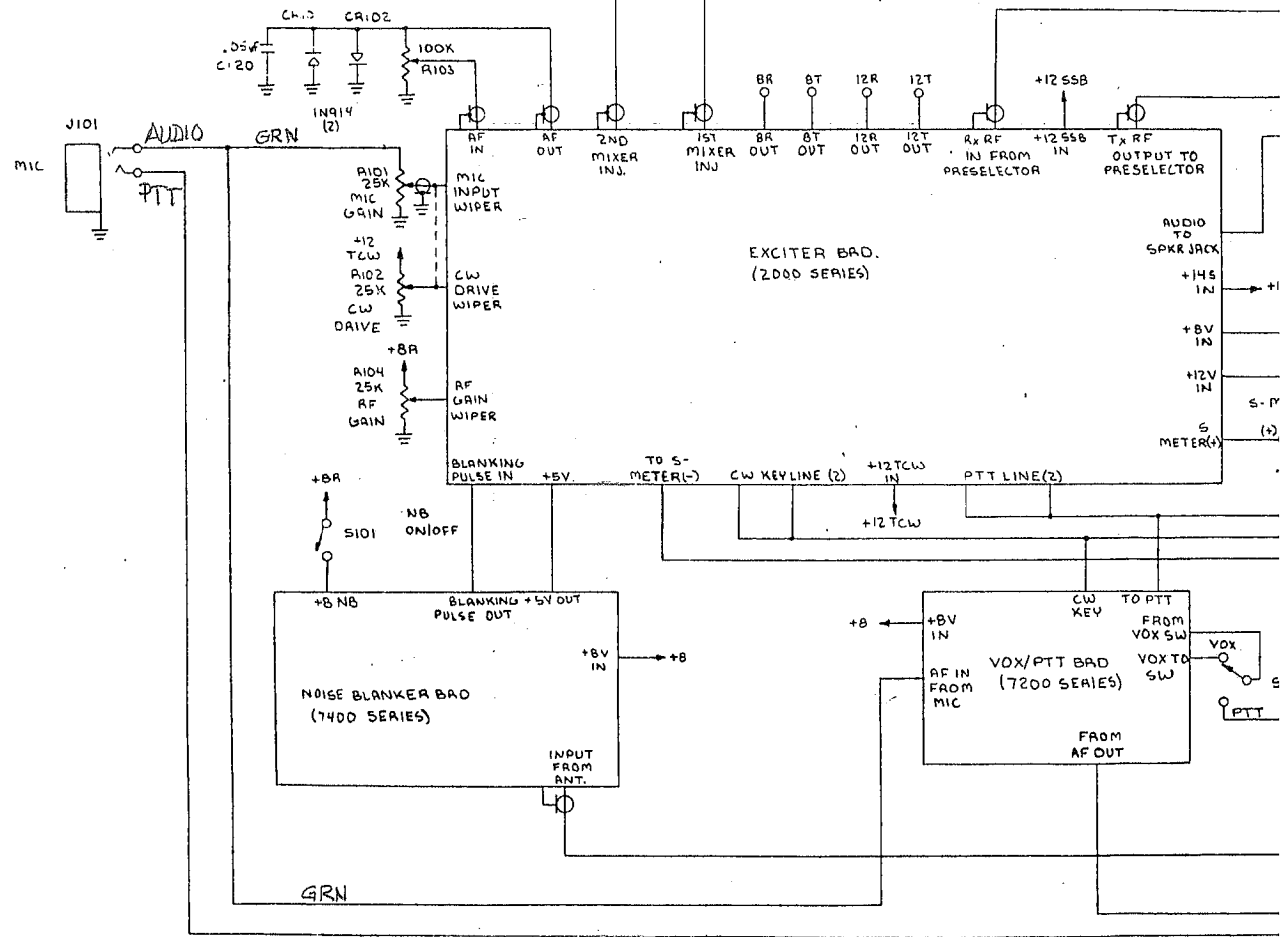
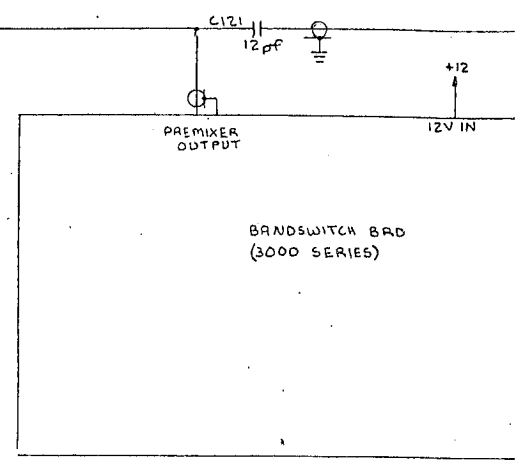
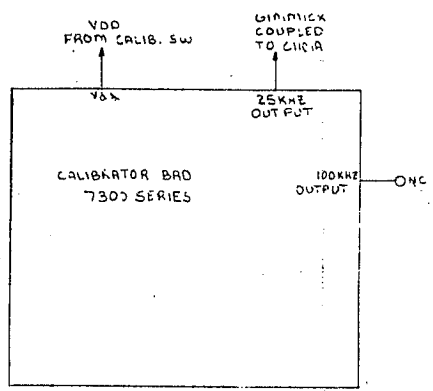
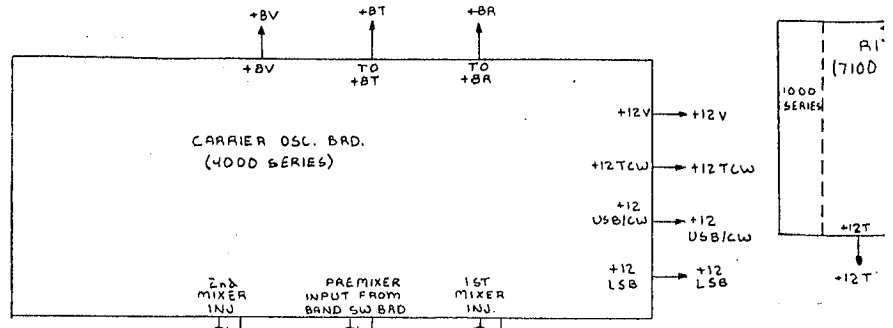
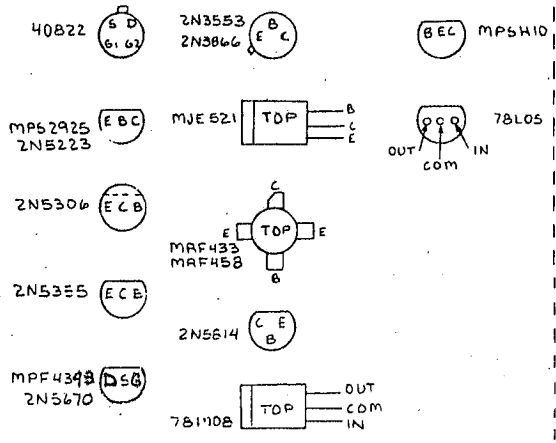
14 volts (supply).....	red
12 volts (decoupled).....	white/red/red
12 volts (receive only).....	white/red/blue
12 volts (transmit only).....	white/red/orange
12 volts (LSB only).....	violet/blue
12 volts (USB and CW).....	white/violet/violet
12 volts (PTO shift).....	white/yellow/yellow
12 volts (SSB).....	yellow/violet
12 volts (CW).....	white/yellow/green
12 volts (transmit CW).....	red/violet
8 volts.....	orange
8 volts (receive only).....	white/orange/blue
8 volts (transmit only).....	white/orange/black
Ground.....	black
PTT & CW keying.....	white/red/brown
PTT Line.....	brown
CW key line.....	brown/black/white
CW drive control wiper.....	blue
AF output to jack.....	yellow
AGC.....	blue/green
ALC rectifier output.....	violet
Meter plus.....	blue/yellow
Meter minus.....	white/blue/black
RIT control wiper.....	blue/green
RIT to PTO.....	yellow
RIT.....	white/green/green
RIT switch wiper.....	white/orange/violet
AF output jack to speaker.....	white/red/grey
VOX to switch.....	white/yellow
Switch to VOX.....	white/orange/violet
Noise blanker to exciter board.....	white/green/black
Microphone audio.....	green
RF gain control wiper.....	white
RIT switch.....	white/yellow/yellow
Panel lights.....	white/red/violet
L.E.D. cathode.....	grey

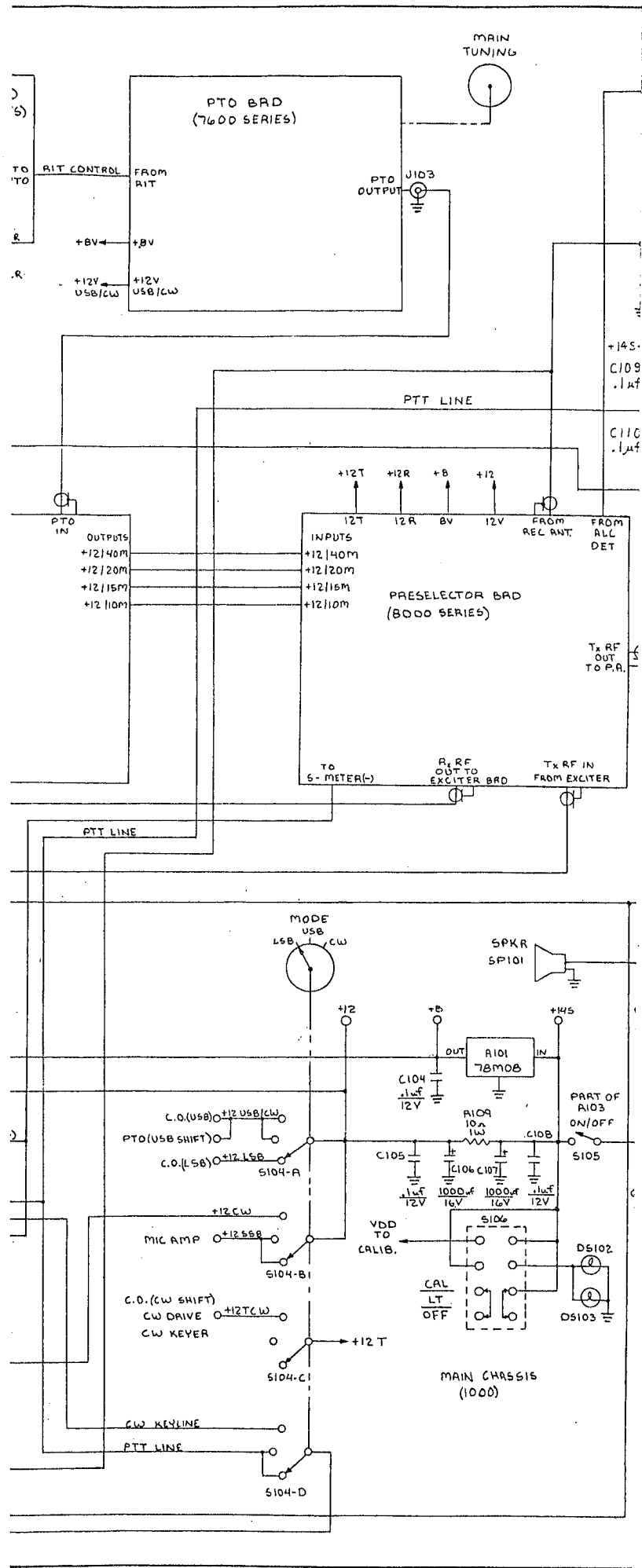
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SECTION EIGHT

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PARTS LIST

NOTE: Only "parts peculiar" are listed in this section of the manual; that is, only those parts which might otherwise be difficult for the servicing facility to obtain. Common resistors and capacitors are omitted; their value is shown on the schematic diagrams, and the type, size, wattage, etc., can be determined from the part being replaced. Since any service shop can be expected to have a stock of these common parts available, it is unlikely that they would be ordered from Swan in any event.

Circuit symbols shown on the schematics should be correlated with the 'series' number also shown on the schematic, as only the last three digits of the circuit symbol is used on the diagrams; for instance, integrated circuit R101 on the exciter board (2000 series) schematic would be shown in the parts list under circuit symbol R2101; C106 on the early version of the band switch board (3000 series) would be shown as C3106. The full circuit symbol, Swan part number, and description of the part, as well as the model and serial numbers of the radio should be supplied with any parts order to ensure that the correct part is shipped. Semiconductors are listed separately, by manufacturer's type number and Swan part number only.

BE CERTAIN THAT YOU ARE USING THE PARTS LIST FOR THE CORRECT VERSION WHERE MORE THAN ONE VERSION OF A BOARD EXISTS.

Semiconductors

Transistors

2N3866.....	476-015
2N5355.....	476-016
2N5306.....	476-024
MPS-H10.....	476-026
MJE-521.....	476-031
2N3553.....	476-054
MPF-4393.....	476-060
40822.....	476-072
MPS-2925.....	476-074
MRF-433.....	476-075
MRF-458.....	476-076
2N5223.....	476-077
TIP-42.....	476-118

Integrated Circuits

MC1458P.....	477-008
78M08.....	477-025
MC1496.....	477-046
TBA810S.....	477-047
78L05.....	477-051
74C90.....	477-061
LM555.....	477-067
uA757.....	477-069

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Integrated Circuits, continued

74C00.....477-070
 74C74.....477-071
 LM358.....477-072

Diodes

1N34A.....475-008
 1N914.....475-021
 1N4005.....475-023
 LED.....475-024
 BA244.....475-048

Exciter Board

Circuit Symbol	Swan Part Number	Description
K2001	011-028	Relay, 4PDT, 12V, PC mount
L2101	012-247	Inductor, 160 uH
L2102	012-247	Inductor, 160 uH
R2139	052-102	Potentiometer, 10 kΩ
R2149	052-076	Potentiometer, 100 kΩ
R2156	052-076	Potentiometer, 100 kΩ
R2158	052-070	Potentiometer, 1 kΩ
R2184	052-102	Potentiometer, 10 kΩ
T2101	014-057	Transformer, RF, 4:2 ratio
T2102	012-248	Transformer, RF, 10:1 ratio
T2103	014-057	Transformer, RF, 2:4 ratio
T2104	014-057	Transformer, RF, 2:4 ratio
Filter	487-024	Filter, IF, 8 pole crystal
Z2101	800-038	Mixer assembly, doubly balanced

Band Switch Board

(Both versions)

Circuit Symbol	Swan Part Number	Description
Y3101	486-076	Crystal, quartz, 43.0 MHz
Y3102	486-075	Crystal, quartz, 35.5 MHz
Y3103	486-074	Crystal, quartz, 28.5 MHz
Y3104	486-073	Crystal, quartz, 21.5 MHz
Y3105	486-072	Crystal, quartz, 18.0 MHz
Z3101	800-039	Mixer assembly, doubly balanced



SWAN ELECTRONICS

Carrier Oscillator/Analog Switch Board (Early version)

<u>Circuit Symbol</u>	<u>Swan Part Number</u>	<u>Description</u>
C4104	089-028	Capacitor, trimmer, 27pf
C4105	084-060	Capacitor, NPO, 10pf
C4106	089-028	Capacitor, trimmer, 27pf
C4108	084-006	Capacitor, N1500, 10pf
C4109	089-028	Capacitor, trimmer, 27pf
C4111	084-006	Capacitor, N1500, 10pf
C4115	084-084	Capacitor, N2200, 220pf
C4116	084-084	Capacitor, N2200, 220pf
L4101	027-040	Inductor, 47 uH
L4102	-----	Not used
L4103	027-040	Inductor, 47 uH
L4104	027-040	Inductor, 47 uH
L4201	012-246	Inductor, 100 uH
L4202	012-246	Inductor, 100 uH
T4101	014-058	Transformer, RF, 4:1 ratio
Y4101	426-081	Crystal, quartz, 9003.3 kHz
Y4102	486-080	Crystal, quartz, 9000.0 kHz

Carrier Oscillator/Analog Switch Board (Later version)

<u>Circuit Symbol</u>	<u>Swan Part Number</u>	<u>Description</u>
C4104	089-028	Capacitor, trimmer, 27pf
C4105	084-060	Capacitor, NPO, 10pf
C4106	089-028	Capacitor, trimmer, 27pf
C4108	084-006	Capacitor, N1500, 10pf
C4109	089-028	Capacitor, trimmer, 27pf
C4111	084-006	Capacitor, N1500, 10pf
C4115	084-084	Capacitor, N2200, 220pf
C4116	084-084	Capacitor, N2200, 220pf
L4101	027-040	Inductor, 47 uH
L4102	027-040	Inductor, 47 uH
L4103	027-040	Inductor, 47 uH
L4104	027-040	Inductor, 47 uH
L4105	027-040	Inductor, 47 uH
L4106	027-040	Inductor, 47 uH
L4107	027-040	Inductor, 47 uH
T4101	014-058	Transformer, RF, 4:1 ratio
Y4101	426-080	Crystal, quartz, 9003.3 kHz
Y4102	486-081	Crystal, quartz, 9000.0 kHz



SWAN ELECTRONICS

Low Pass Filter Board (Early version)

Circuit Symbol	Swan Part Number	Description
C5128	089-027	Capacitor, trimmer, 27pf
L5101	012-241	80M Inductor
L5102	012-242	40M Inductor
L5103	012-243	20M Inductor
L5104	012-244	15M Inductor
L5105	012-245	10M Inductor
L5106	012-241	80M Inductor
L5107	012-242	40M Inductor
L5108	012-243	20M Inductor
L5109	012-244	15M Inductor
L5110	012-245	10M Inductor
R5102	052-072	Potentiometer, 25 k Ω
R5103	052-072	Potentiometer, 25 k Ω
T5101	012-115	Transformer, RF, 1:36 ratio

Low Pass Filter Board (Later version)

Circuit Symbol	Swan Part Number	Description
K5101	111-025	Relay, 4PDT, 12V
L5101	027-072	10M Inductor
L5102	027-072	10M Inductor
L5103	027-073	15M Inductor
L5104	027-073	15M Inductor
L5105	027-074	20M Inductor
L5106	027-074	20M Inductor
L5107	027-075	40M Inductor
L5108	027-075	40M Inductor
L5109	027-076	80M Inductor
L5110	027-076	80M Inductor

Power Amplifier Board (Early version)

Circuit Symbol	Swan Part Number	Description
FB6101	027-054	Ferrite bead
FB6102	027-010	Ferrite bead
L6101	027-053	Inductor, .47uH
L6102	012-137	Inductor, 40uH
L6103	012-137	Inductor, 40uH



SWAN ELECTRONICS

L6104	012-166	Inductor, 6uH
L6105	012-137	Inductor, 40uH
L6106	012-166	Inductor, 6uH
R6114	052-060	Potentiometer, 1 k Ω
T6101	014-061	Transformer, RF, 10:2
T6102	800-2503	Transformer, RF, 3:1
T6103	800-2504	Transformer, RF, 2:1
R6104	800-2502	Transformer, RF, 1:4

Power Amplifier Board (Later version)

Circuit Symbol	Swan Part Number	Description
C6105	072-012	Capacitor, ceramic, 1.0uF
C6112	072-012	Capacitor, ceramic, 1.0uF
C6121	072-012	Capacitor, ceramic, 1.0uF
FB6101	027-055	Ferrite bead
FB6102	027-055	Ferrite bead
L6101	027-050	Inductor, 4.7uH
L6102	027-061	Inductor, 2.2uH
L6103	027-071	Inductor
R6107	049-060	Resistor, wire, 5 watt, 50 Ω
R6114	049-060	Resistor, wire, 5 watt, 50 Ω
T6101	273-014	Transformer, RF
T6102	273-013	Transformer, RF
T6103	273-006	Transformer, RF

RIT Board

Circuit Symbol	Swan Part Number	Description
R7104	052-108	Potentiometer, 10 k Ω
S7102	-----	on R104

VOX/PTT Board

Circuit Symbol	Swan Part Number	Description
R7205	052-109	Potentiometer, 500 k Ω
R7206	052-111	Potentiometer, 500 Ω
R7211	052-110	Potentiometer, 100 k Ω



Calibrator Board

<u>Circuit Symbol</u>	<u>Swan Part Number</u>	<u>Description</u>
C7302	089028	Capacitor, trimmer, 27pf
Y7301	486-071	Crystal, quartz, 10 MHz

Noise Blanker Board

<u>Circuit Symbol</u>	<u>Swan Part Number</u>	<u>Description</u>
C7404	072-077	Capacitor, N330, 330pf
C7410	072-068	Capacitor, N330, 470pf
C7413	072-068	Capacitor, N330, 470pf
T7401	014-062	Transformer, RF

Antenna Relay Board (early version only)

<u>Circuit Symbol</u>	<u>Swan Part Number</u>	<u>Description</u>
K7501	111-025	Relay, 4PDT, 12V

PTO

<u>Circuit Symbol</u>	<u>Swan Part Number</u>	<u>Description</u>
PTO	1125-700	Permiability Tuned Oscillator (Assembly)

SWR Board (Later version only)

<u>Circuit Symbol</u>	<u>Swan Part Number</u>	<u>Description</u>
C7703	089-028	Capacitor, trimmer, 30pf
T7701	012-256	Transformer, RF

ALC Adjustment Board (Later version only)

<u>Circuit Symbol</u>	<u>Swan Part Number</u>	<u>Description</u>
R7801	052-072	Potentiometer, 25 k Ω
R7802	052-072	Potentiometer, 25 k Ω



Preselector Board

Circuit Symbol	Swan Part Number	Description
L8101	012-235	Inductor, 80M
L8102	012-229	Inductor, 40M
L8103	012-255	Inductor, 20M & 15M
L8104	012-254	Inductor, 10M
L8105	012-254	Inductor, 10M
L8106	012-255	Inductor, 20M & 15M
L8107	012-229	Inductor, 40M
L8108	012-235	Inductor, 80M
T8101	012-240	Transformer, RF, 4:30 ratio
T8102	012-240	Transformer, RF, 30:4 ratio
T8103	012-240	Transformer, RF, 30:4 ratio

Miscellaneous Parts and Hardware

Section	Swan Part Number	Description
Power Amplifier	116-003	Heat sink, small
	116-013	Heat sink, large
	342-008	Phono (RCA) plug
	263-625	Mica washer
	337-006	Fuse holder
	342-003	Jack, closed circuit
	342-007	Phono (RCA) jack
	344-015	Coax socket
	344-082	Six-circuit receptacle
	344-083	Pin for 6-circuit receptacle
	761-063	Wing nut
	171-162	Filter switch wafer, front
	171-166	Filter switch wafer, rear
Band Switch	171-162	Switch wafer
	141-048	Crystal socket
	453-1073	Switch wafer bracket
Panel	112-027	Meter
	441-147	Panel
	455-105	Window
	455-116	Escutcheon
Chassis	052-107	RIT potentiometer with switch
	052-112	AF/RF gain potentiometer w/switch
	052-113	Mic Gain/CW Drive potentiometer
	074-065	Variable capacitor
	114-007	Planetary drive
	152-008	Speaker
	171-161	Band Switch detent
	172-039	3-position slide switch
211-043	Mode Switch/RIT knobs	



SWAN ELECTRONICS

	211-044	Band Switch knob
	211-047	RF/AF Gain knobs
	211-049	Mic Gain knob
	211-068	Preselector knob w/o skirt
	453-1038	Preselector skirt (scale)
	211-069	VFO knob w/o skirt
	455-115	VFO skirt (scale)
	243-053	Flex coupling
	243-059	Band Switch shaft
	453-1039	Meter bracket
	342-001	3 conductor open circuit jack
	454-014	Slide switch
	471-007	Lamp
	1100-017	VOX/PTT Switch bracket
	1100-019	Mode switch
Optional/replacement items	486-077	Crystal, quartz, 42.5 MHz, covers 28-28.5 MHz band
	486-078	Crystal, quartz, 43.5 MHz, covers 29-29.5 MHz band
	486-079	Crystal, quartz, 44.0 MHz, covers 29.5-30 MHz band
	150-032	Power cord assembly
	344-077	Microphone connector
	453-1042	Mobile mounting bracket
	442-004	Bezel
	223-001	Tilt stand