



JOHNSON

Viking

AVENGER



80-10 METER
AMATEUR BAND TRANSCEIVER
MODEL NO. 240-312

O W N E R ' S M A N U A L

Viking

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80-10 METER
AMATEUR BAND TRANSCEIVER
MODEL NO. 240-312

Warranty

The **E. F. JOHNSON COMPANY** warrants each new radio product manufactured by it to be free from defective material and workmanship and agrees to remedy any such defect or to furnish a new part, in exchange for any part of any unit of its manufacture which under normal installation, use and service disclosed such defect, provided the unit is delivered by the owner to us or to our authorized radio distributor or dealer from whom purchased, or authorized service station, intact, for examination, with all transportation charges prepaid, within ninety days from the date of sale to original user and provided that such examination discloses, in our judgment, that it is thus defective.

This warranty does not extend to any of our radio products which have been subjected to misuse, neglect, accident, incorrect wiring not our own, improper installation, unauthorized modifications, or to use in violation of instructions furnished by us, nor to cases where the serial number thereof has been removed, defaced or changed, to accessories used therewith not of our own manufacture, nor to merchandise manufactured more than two years prior to current production. Performance can not be guaranteed if other than JOHNSON approved crystals are used.

Radio receivers may be adversely affected by ignition noise from the vehicle in which they are installed or from passing vehicles. No warranty as to the performance of these equipments is expressed or implied when operating under conditions of external ignition or other electrical interference.

This warranty is in lieu of all other warranties expressed or implied and no representative or person is authorized to assume for us any other liability in connection with the sale of our radio products.

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E. F. JOHNSON COMPANY

The E. F. Johnson Company has been one of the leading manufacturers of electronic components for nearly fifty years. The company has more recently earned an international reputation for the manufacture of two-way radio communications systems and accessories. The name "Johnson" and tradename "Messenger" have come to symbolize quality in the field of communications. Modern "Viking" Amateur Radio equipment offers unsurpassed quality which will add even more lustre to this respected tradename.



INTRODUCTION

The Viking AVENGER heralds the large scale return of the E. F. Johnson Company to the field of Amateur Radio equipment manufacturing.

The product of more than three years of engineering design effort and extensive field testing, the Avenger offers all that is most desirable in Amateur Radio equipment. It offers built-in features which are either extra-cost add-ons or unavailable with other units. Its quality is unsurpassed in commercial gear.

Some of the Avenger features include:

- Complete coverage of the 80 through 10 meter bands, switchable upper or lower sideband on all bands.
- Commercially unique AGC system which utilizes techniques used in military SSB receivers to minimize receiver inter-modulation distortion.
- Two VFO's:
Transceive on either VFO, or transmit on one and receive on the other.
VFO dial calibration to 1 kHz.
VFO electrical calibration to 300 Hz.
VFO readability to 200 Hz.
VFO's are individually calibrated with varactors.
Each VFO power source double-regulated for maximum stability.
Coarse and fine tuning of VFO's. Fine tuning 15 kHz per revolution (approximate).
- Total receiver and transmitter drift 150 Hz maximum from turn-on.
- VLX - voice latched transmit - uses a monostable vibrator for the transmit - receive switch for the fastest and most positive voice operation available.
- Syllabic rate speech compressor with over 30 dB dynamic range, actually changes the peak-to-valley

ratio of the operator's voice for more average power at any given PEP.

- Two special six-crystal lattice filters for sideband selection.
- Built-in noise blanker, 100 kHz calibrator and coaxial antenna relay.
- Coarse and fine PA loading on one knob, concentric with PA tuning control for convenient tune-up.
- Printed circuit construction with swing-out boards for easier servicing.
- Solid state switching.
- Active device complement:
52 transistors
3 vacuum tubes
57 diodes (including 5 zener diodes and 2 varactor diodes)
- CW Operation
Full break-in up to about 13 words per minute (WPM).
Semibreak-in above about 13WPM.
Manual transmit-receive switching capability using FUNCTION switch.
Built-in 1kHz sidetone oscillator.
CW signal offset 1kHz from the SSB carrier frequency.

As you become familiar with your Avenger through study of the circuit description, operating instructions and on the air operation you will appreciate more and more the thoughtfully designed features and the quality built into your Avenger.

This instruction manual has been prepared to help you get the maximum benefits your Avenger offers. Study it carefully, especially the installation, operation and circuit description sections, before installing and operating the unit. Frequent reference to the instruction manual during use of the Avenger will further increase your familiarity with the unit.

SECTION 1

SPECIFICATIONS

1.1 GENERAL

Frequency Coverage 3.5 - 4.1 MHz
 7.0 - 7.6 MHz
 13.9 - 14.5 MHz
 20.9 - 21.5 MHz
 28.0 - 28.6 MHz
 28.5 - 29.1 MHz
 29.1 - 29.7 MHz

Dimensions of Enclosure 14 inches deep x 11 inches wide
 x 5 3/16 inches high.

Unit Weight 22 1/2 lb.

Circuitry 52 transistors
 3 vacuum tubes
 57 diodes (includes 5 zener and 2
 varactor diodes)

Stability 150 Hz maximum total drift, trans-
 mitter and receiver, from turn-
 on.

Type of emission Selectable upper, lower sideband
 and CW on all bands.

VFO's:

Number Two, independent, electrically
 identical.

Switching A transceive
 A transmit, B receive
 B transceive

Dial Cali- 1 kHz increments
 bration

Electrical Better than 300 Hz after calibra-
 Dial Accu- tion at nearest 100 kHz point.
 racy

Visual Dial 200 Hz or better.
 Accuracy

Backlash Unmeasurable

100 kHz Accurate to within ± 1 Hz, factory
 Calibrator set.
 Accuracy

Audio Processing

VLX (Voice Latched Transmit)
 Digital Circuitry

Time for Trans- 15 milliseconds maximum
 mit

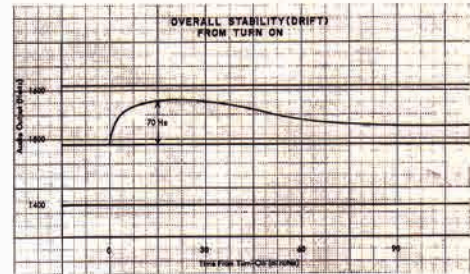
Time Delay 40 milliseconds minimum
 Dropout 2 seconds maximum
 (variable)

Audio Compressor:

Output Level 10 dB maximum for 3mV to 300mV
 Change input from microphone.

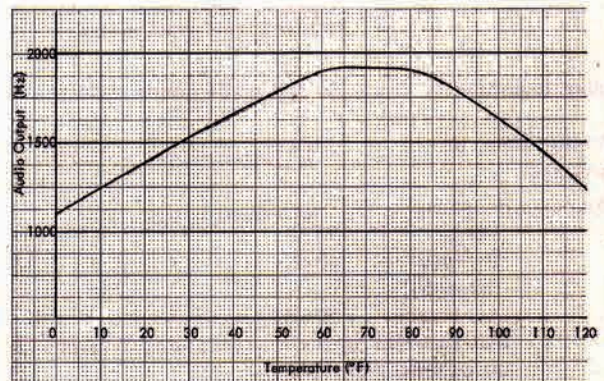
Maximum 300 mV
 output level

Nominal Com- 12 dB typical compression at 3 mV
 pression microphone input.



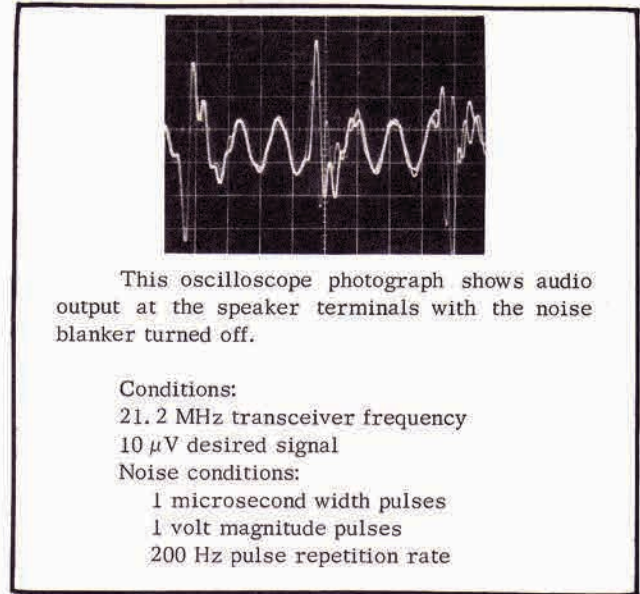
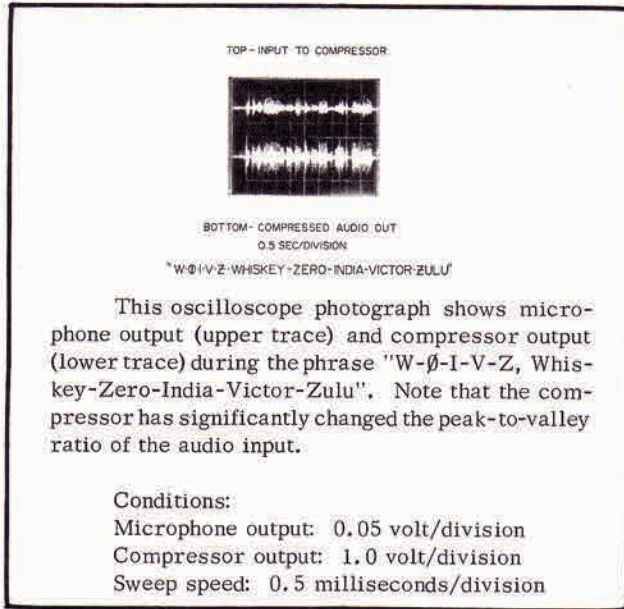
This graph shows typical total transceiver drift from turn-on. Audio output was counted from turn-on over a period of several hours. The resulting curve shown is representative. Room temperature when the curve was taken was 70-72° F. 7.200000 MHz input signal, phase locked.

OVERALL STABILITY
WITH TEMPERATURE VARIATION



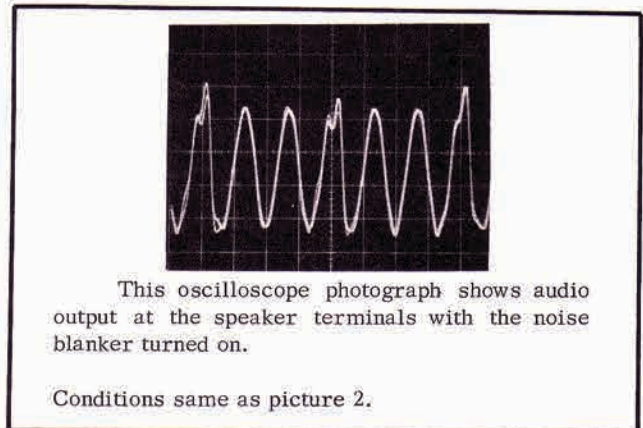
This graph shows typical overall stability of the Avenger at 7.2 MHz over an ambient temperature range of 0° F to 120° F. 7.200000 MHz input, phase locked. Note that total drift is about 800 Hz. From 60°-80° F, nominal room temperatures, the radio does not drift appreciably.

SPECIFICATIONS (cont'd)



1.2 RECEIVER

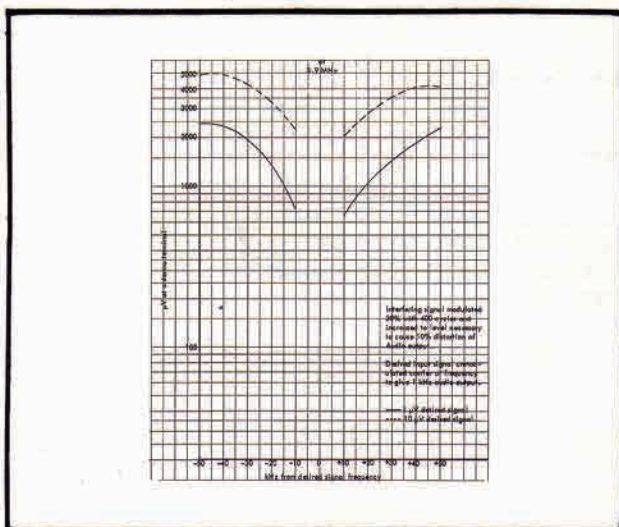
Sensitivity	0.5 μ V at the antenna terminal for 10 dB minimum signal +noise to noise ratio.
IF Selectivity	2.6 kHz bandwidth at -6 dB. Two six-crystal lattice filters.
AGC	Fast attack (10ms maximum), slow decay (0.5sec nominal). Typically a 110 dB change in input voltage at the antenna produces an 8 dB maximum change in audio output. AC gain of amplifier stages controlled without DC bias change. Variable attenuator ahead of 1st RF amplifier to minimize cross-modulation at high signal levels.
Input Impedance	50 ohms at antenna terminal.
Audio Output Impedance	4 ohms
Spurious Response:	
Image	50 dB
IF Feed-through	40 dB
All others	50 dB
	All receiver spurs less than an equivalent 0.1 μ V at antenna terminals.
Noise Blanker	During high impulse noise interference, improves signal +noise to noise ratio 10 dB minimum at 1 μ V received signal strength. (Test noise is one volt pulse, 1 microsecond wide with 50 to 500 Hz repetition rate).



1.3 TRANSMITTER

DC Power Input to Final	250 watts PEP or CW, 80 through 15 meter bands. 200 watts PEP or CW, 10 meter band. continuous duty cycle, normal voice 50 % duty cycle, CW
Intermodulation Distortion	28 dB below PEP at rated output
Harmonic Radiation	25 dB maximum below PEP
Microphone	High impedance (50,000 ohms), rated 45 to 55 dB below one milliwatt.
Carrier Suppression	55 dB minimum
Unwanted Sideband Suppression	60 dB minimum

SPECIFICATIONS (cont'd)



This graph shows typical Avenger cross-modulation characteristics. The solid line indicates the interfering signal level and distance from desired signal frequency necessary to produce 10% audio distortion with a 1 μ V desired signal. The dashed line indicates interfering signal level and frequency with a 10 μ V desired signal. With a 1 μ V desired signal at the antenna terminal (S-0 S Meter reading) the interfering signal must be 680 μ V (the equivalent of 15 dB over S-9) 10 kHz away from the desired signal to produce 10% distortion. This is about 56 dB above the desired signal level. As the interfering signal moves farther away from the desired signal its strength must increase as shown to produce 10% distortion.

TABLE 1-1 ELECTRON TUBE COMPLEMENT

SYMBOL	TYPE	FUNCTION	E. F. J. PART NUMBER
V101	6HF5	PA OUTPUT	595-2002-001
V102	6HF5	PA OUTPUT	595-2002-001
V103	6HB6	PA DRIVER	595-2007-001

TABLE 1-2 CRYSTAL COMPLEMENT

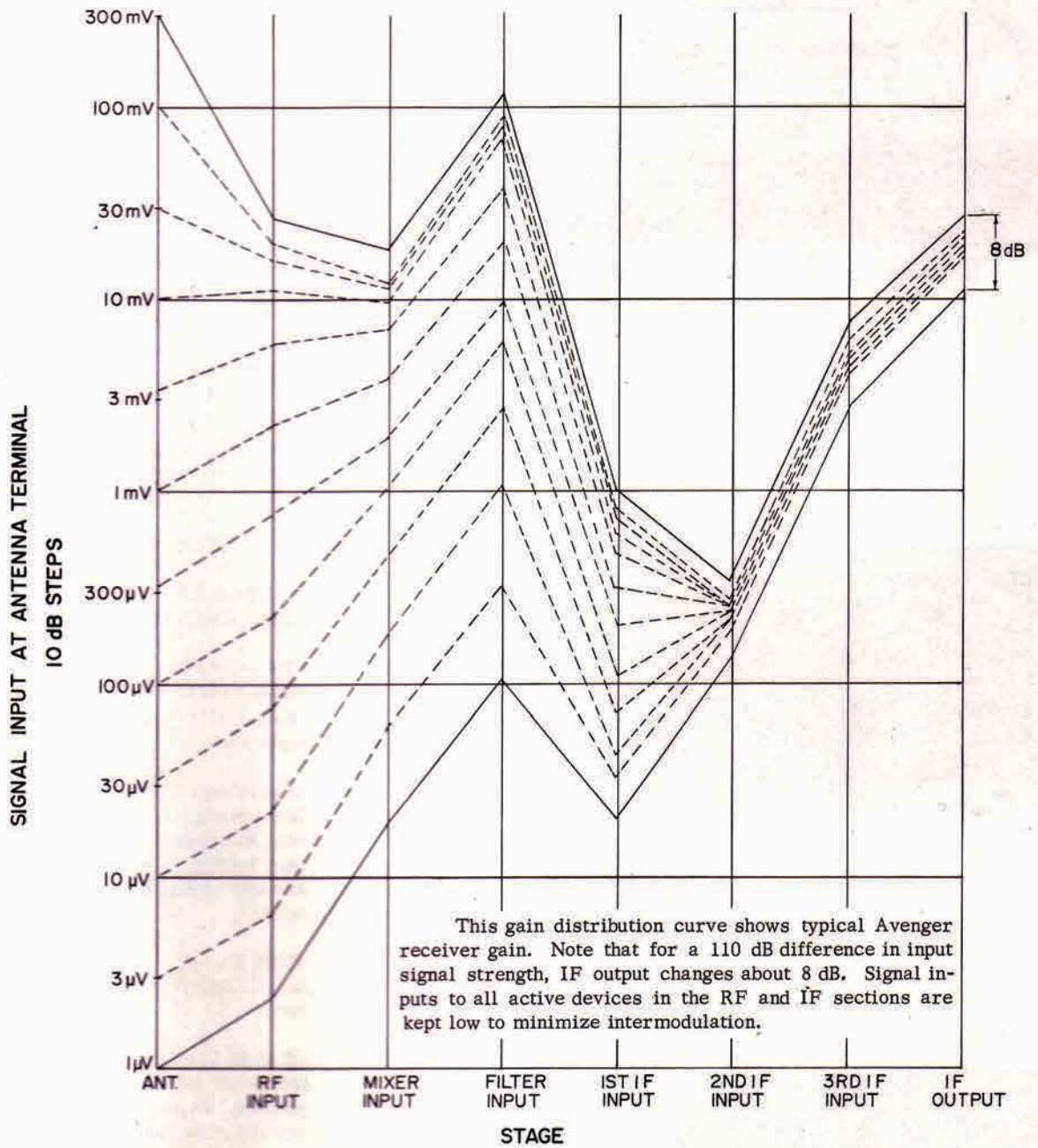
SYMBOL	FREQUENCY	FUNCTION	E. F. J. PART NUMBER
Y01	100 kHz	100 kHz CAL	519-0013-002
Y501	9 MHz	CARRIER OSC	519-0014-001
Y801	21.5 MHz	CRYSTAL OSC 15 METERS	519-0015-001
Y802	35.4 MHz	CRYSTAL OSC 40 METERS	519-0015-002
Y803	42.5 MHz	CRYSTAL OSC 10 METERS	519-0015-003
Y804	43.0 MHz	CRYSTAL OSC 10 METERS	519-0015-004
Y805	43.6 MHz	CRYSTAL OSC 10 METERS	519-0015-005

TABLE 1-3
TRANSISTOR COMPLEMENT

SYMBOL	TYPE	FUNCTION	E. F. J. PART NUMBER
Q01	SI, NPN, 3003	100 kHz Cal. Multivibrator	576-0003-003
Q02	SI, NPN, 3003	100 kHz Cal. Multivibrator	576-0003-003
Q101	SI, PNP, 1011	PA GRID BIAS SWITCH	576-0001-011
Q102	SI, PNP, 2011	AUDIO OUTPUT	576-0002-011
Q201	SI, NPN, 3011	SERIES ATTENUATOR	576-0003-011
Q202	SI, NPN, 3011	RF AMP	576-0003-011
Q203	SI, NPN, 3011	RF AGC	576-0003-011
Q204	SI, NPN, 4010	TRANSMIT MIXER	576-0004-006
Q205	SI, NPN, 3005	RECEIVE MIXER	576-0003-005
Q206	SI, NPN, 3011	NOISE BLANKER AMP	576-0003-011
Q207	SI, NPN, 3011	SHUNT ATTENUATOR	576-0003-011
Q208	SI, NPN, 2006	DRIVER CATHODE SW	576-0002-006
Q301	SI, NPN, 3007	IF AGC AMP	576-0003-007
Q302	SI, NPN, 3007	1ST IF AMP	576-0003-007
Q303	SI, NPN, 3007	2ND IF AMP	576-0003-007
Q304	SI, NPN, 3007	3RD IF AMP	576-0003-007
Q305	SI, NPN, 3003	AGC CONTROL AMP	576-0003-003
Q306	SI, NPN, 1004	AGC DRIVER AMP	576-0001-004
Q307	SI, NPN, 1004	AGC DC AMP	576-0001-004
Q308	SI, NPN, 1004	AGC TIME AMP	576-0001-004
Q309	SI, NPN, 1004	AGC DETECTOR	576-0001-004
Q310	SI, NPN, 1004	2ND AGC AUDIO AMP	576-0001-004
Q311	SI, NPN, 1004	1ST AGC AUDIO AMP	576-0001-004
Q401	SI, NPN, 1004	2ND REC AUDIO AMP	576-0001-004
Q402	SI, NPN, 1004	1ST REC AUDIO AMP	576-0001-004
Q403	SI, NPN, 3011	1 kHz OSC	576-0003-011
Q404	SI, NPN, 1004	1 kHz OSC BUFFER	576-0001-004
Q405	SI, NPN, 1004	BAL MOD DRIVER	576-0001-004
Q406	SI, NPN, 1005	1ST MIC AMP	576-0001-005
Q407	SI, NPN, 1005	2ND MIC AMP	576-0001-005
Q408	SI, NPN, 1005	3RD MIC AMP	576-0001-005
Q409	SI, NPN, 1004	COMPRESSOR	576-0001-004
Q410	SI, NPN, 1004	COMPRESSOR DET	576-0001-004
Q411	SI, NPN, 1004	COMPRESSOR AMP	576-0001-004
Q412	SI, NPN, 3011	ANTI-TRIP AMP	576-0003-011
Q413	SI, NPN, 3011	VLX AMP	576-0003-011
Q414	SI, NPN, 3011	SSB/CW SWITCH	576-0003-011
Q415	SI, PNP, 1001	VLX LATCH	576-0001-001
Q416	SI, PNP, 1001	VLX LATCH	576-0001-001
Q417	SI, NPN, 3011	RELAY PRE-AMP	576-0003-001
Q418	SI, PNP, 1001	RELAY AMP	576-0001-001
Q419	SI, NPN, 2006	RELAY DRIVER	576-0002-006
Q501	SI, NPN, 3006	CARRIER OSC	576-0003-006
Q701 A	SI, PNP, 3019	VFO A OSC	576-0003-019
Q702 A	SI, NPN, 3011	VFO A BUFFER	576-0003-011
Q701 B	SI, PNP, 3019	VFO B OSC	576-0003-019
Q702 B	SI, NPN, 3011	VFO B BUFFER	576-0003-011
Q801	SI, NPN, 3006	CRYSTAL OSC	576-0003-006
Q802	SI, NPN, 3007	BUFFER	576-0003-007
Q901	SI, NPN, 3005	HETERODYNE MIXER	576-0003-005
Q902	SI, NPN, 3003	EMITTER FOLLOWER	576-0003-003
Q903	SI, NPN, 3003	XMIT MIXER DRIVER	576-0003-003

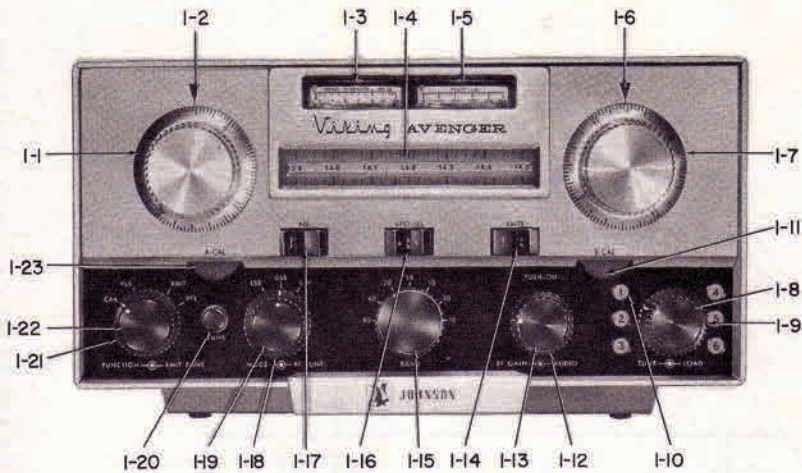
TABLE 1-4 DIODE COMPLEMENT

SYMBOL	TYPE	FUNCTION	E. F. J. PART NUMBER
D101	WG-316	RF rectifier for power meter	523-0006-002
DZ101	91 ZENER	PROTECTS Q101	
D102	SI, WG-316	RF rectifier for power meter	523-0006-002
D103	SI, WG-316	PROTECTS Q419	523-0006-002
D104	SI, WG-316	Z101 SW	523-0006-002
D105	SI, WG-316	Z101 SW IN CW	523-0006-002
D203	SI, WG-316	TRANS MIXER SW	523-0006-002
D204	SI, WG-316	REC MIXER SW	523-0006-002
D205	SI, WG-316	REC MIXER SW	523-0006-002
D206	SI, WG-316	TRANS IF SW	523-0006-002
D207	SI, WG-316	REC IF SW	523-0006-002
D208	SI, WG-316	Z102 SW	523-0006-002
D209	SI, WG-316	Z101 SW	523-0006-002
D210	SI, WG-316	Z102 SHORTING SW	523-0006-002
D211	SI, WG-316	Z101 SHORTING SW	523-0006-002
D212	SI, FD-777	NOISE BLANKING DIODE	523-0007-001
D213	GE, IN295	RF rectifier for noise blanker	523-1000-295
D214	GE, IN295	RF rectifier for noise blanker	523-1000-295
D301	SI, WG-316	Z101 SW	523-0006-002
D302	SI, WG-316	Z102 SW	523-0006-002
D303	SI, WG-316	TRANS IF SW	523-0006-002
D304	SI, WG-316	REC IF SW	523-0006-002
D305	SI, WG-316	REC IF SW	523-0006-002
D306	SI, WG-316	TRANS IF SW	523-0006-002
D307	SI, WG-316	REC IF SW	523-0006-002
D308	SI, WG-316	REC AGC SW	523-0006-002
D309	SI, GD584	CW SWITCH	523-0005-001
D310	SI, WG-316	AGC TIMING DIODE	523-0006-002
D311	SI, WG-316	AGC TIMING SW	523-0006-002
D312	SI, WG-316	AGC DETECTOR SET	523-0006-002
D313	SI, WG-316	TRANS IF SW	523-0006-002
D314	SI, 2.7V forward drop	AGC AC LIMITER	523-0012-001
D315	SI, WG-316	AGC TIMING DIODE	523-0006-002
D316	GE, GD-584	TRANS AGC SW	523-0005-001
D317	GE, GD-584	CW SWITCH	523-0005-001
D401	SI, WG-316	B+ ISOLATION SW	523-0006-002
D402	SI, WG-316	CW B+ ISOLATION SW	523-0006-002
D403	SI, WG-316	CW KEYING SW	523-0006-002
D404	SI, WG-316	CW KEYING SW	523-0006-002
DZ401	6.8 V ZENER	VFOA REG	523-2003-689
DZ402	6.8 V ZENER	VFOB REG	523-2003-689
DZ403	9.1 V ZENER	VROA REG	523-2003-919
DZ404	9.1 V ZENER	VFOB REG	523-2003-919
D405	GE, GD-584	SIDETONE LEVEL SET	523-0005-001
D406	SI, WG-316	AUDIO CLIPPING	523-0006-002
D407	SI, WG-316	AUDIO CLIPPING	523-0006-002
D408	GE, IN-295	COMPRESSOR RECTIFIER	523-1000-295
D409	GE, GD-584	CW VLX SWITCH	523-0005-001
D410	GE, GD-584	VLX Operate	523-0005-001
D411	SI, WG-316	ISOLATES +9 REG LINE	523-0006-002
D412	SI, WG-316	ISOLATES +9 REG LINE	523-0006-002
D601	SI, FD-777	BAL MOD	523-0007-001
D602	SI, FD-777	BAL MOD	523-0007-001
D603	SI, FD-777	BAL MOD	523-0007-001
D604	SI, FD-777	BAL MOD	523-0007-001
D701 A	SI, IN-881	VFOA CALIBRATION	523-1000-881
D701 B	SI, IN-881	VFOB CALIBRATION	



TYPICAL GAIN DISTRIBUTION
VIKING AVENGER
FIGURE I-1

SECTION 2 CONTROLS



1-1 VFO A (RED)
Tunes VFO A. Each dial skirt mark indicates 1 kHz. 15 kHz per rotation of the inner knob.

1-2 VFO A (RED) INDICATOR
Lights when VFO A is in use.

1-3 S Meter
Indicates received signal strength; S-9 = 100 μ V at the antenna terminal. Indicates relative power output when the TUNE button (1-20) is pushed.

1-4 DIAL DRUM
Indicates frequency in use. Illuminated white when transceiver power is on and receiving, red when transmitting.

1-5 PLATE CURRENT Meter

1-6 VFO B (GREEN)
Lights when VFO B is in use.

1-7 VFO B (GREEN) INDICATOR
Tunes VFO B. Each dial skirt mark indicates 1 kHz. 15 kHz per rotation of the inner knob.

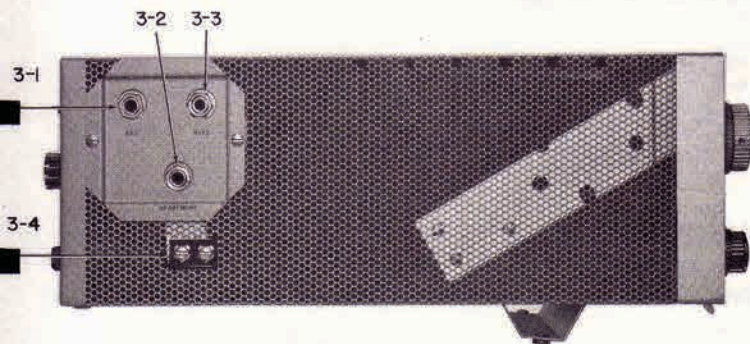
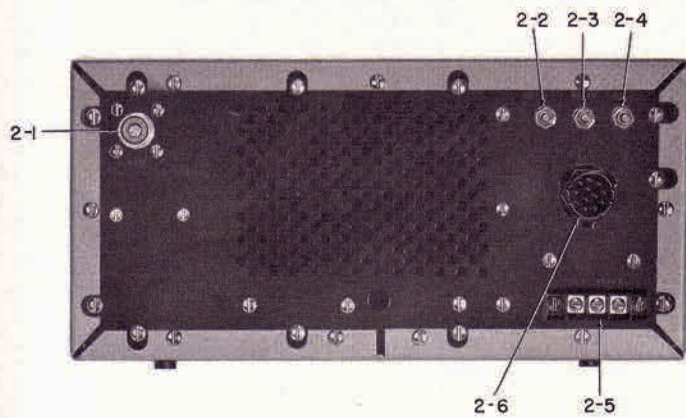
1-8 LOAD Control
Sets coarse load switch and fine load variable differential capacitor for transmitter final loading. Six switch positions add fixed amounts of capacitance to the variable capacitor.

1-9 TUNE Control
Sets C126, transmitter final tuning capacitor.

1-10 COARSE LOAD Indicator - 1, 2, 3, 4, 5, 6
Indicators 1-6 show COARSE LOAD switch position. (Approximate capacity switched into the plate circuit.)

1-11 B-CALibrator
Calibrates VFO-B by adjusting the voltage across a varactor diode.

1-12 RF GAIN Control
Sets AGC level manually to control receiver front end sensitivity.



- 1-13 **AUDIO GAIN Control**
Push-ON, push-OFF switch controls 12 volt power supply for all but transmitter driver and final stages.
- 1-14 **XMTR Switch - ON, OFF**
Controls filament and high voltage supplies for transmitter driver and final.
- 1-15 **BAND Switch - 80, 40, 20, 15, 10, 10, 10**
Switches 13 wafers.
- 1-16 **VFO SElector Switch - A, A-B, B.**
Pushing the "A" side selects VFO A (RED) transceiver. Pushing the "B" side selects VFO B (GREEN) transceiver. The Center, A-B, position selects VFO A transmit and VFO B receive.
- 1-17 **NB Switch - ON, OFF.**
For Noise Blanker.
- 1-18 **MODE Switch - LSB, USB, CW.**
Selects the crystal filter necessary for each SSB mode and enables the +12 CW line when in the CW mode.
- 1-19 **RF TUNE**
Tunes transmit driver grid and plate in transmit, and the receiver front end in receive.
- 1-20 **TUNE Switch - Push to tune.**
Keys the transmitter and switches the S Meter (1-3) to a relative power indicator. When MODE Switch is in USB or LSB, switches the S meter to relative power indicator only.
- 1-21 **FUNCTION Switch - CAL, VLX, XMIT, PTT**
CAL position enables the 100 kHz calibrator. VLX position enables the VLX circuitry. XMIT position keys the transmitter. PTT position disables the VLX circuitry.
- 1-22 **XMIT DRIVE Control -**
Controls the level of the amplified and compressed audio to the balanced modulator.
- 1-23 **A CALibrator**
Calibrates VFO A by adjusting the voltage across a varactor diode.
- 2-1 **ANTENNA Jack -**
For PL-259 antenna connector. Connect a resonated 50 ohm antenna.
- 2-2 **VLX ANTI-TRIP -**
Desensitizes the VLX circuit to receiver audio to prevent accidental VLX tripping by receiver audio.
- 2-3 **VLX DELAY Control -**
Determines the drop-out time of the VLX latch and coaxial relay control circuitry.
- 2-4 **VLX Sensitivity Control -**
Determines the operating threshold of the VLX circuitry.
- 2-5 **Linear Amplifier Connections -**
Allows automatic linear transmit-receive switching from the Avenger.
- 2-6 **POWER Jack -**
For E. F. Johnson Part No. 515-9012-022 plug with 515-9012-061 pins (12).
- 3-1 **KEY Jack -**
Uses 0.250 inch phone plug.
- 3-2 **HEADPHONE Jack -**
For temporary speaker or headphone connection. Uses 0.250 inch phone plug.
- 3-3 **Microphone Jack -**
Uses 0.203 three circuit plug.
- 3-4 **Speaker Terminals -**
For permanent speaker or headphone connection.

SECTION 3 INSTALLATION

3.1 UNPACKING

Carefully remove your Viking Avenger from its packing material. Examine the Avenger carefully for any sign of shipping damage. Report any damage immediately to your distributor or to the shipping company and to the E. F. Johnson Company. Retain all shipping labels if damage is apparent. Retain all packing material for any future storage or shipment of the Avenger.

Check the Avenger shipping carton for any shortages. It should include an accessory package in addition to the Avenger and this instruction manual. The accessory package should include the following items:

<u>QUANTITY</u>	<u>ITEM</u>	<u>E. F. JOHNSON PART NO.</u>
One	Power plug, less pins	515-9012-022
15	Power plug pins	515-9012-061
Two	1/4 inch right angle 2 conductor phone plugs (Switchcraft 220 series Flat plug)	515-0024-001
One	0.203 inch right angle 3 conductor phone plug (Switchcraft S230 Flat plug)	515-0024-002
One	1/16 inch hex wrench (allen)	022-0600-004
One	0.050 inch hex wrench (allen)	022-0600-012

3.2 COMMUNICATIONS WITH THE COMPANY

A warranty registration card is inserted in this instruction manual. Please fill it out and return it to the E. F. Johnson Company as soon as possible to validate your warranty. Please fill out the questionnaire inserted in this manual and return it to the company. Feel free to write the E. F. Johnson Company Customer Service Department, 299 10th Ave. S.W., Waseca, Minnesota 56093, with any problems or comments you might have regarding your Avenger.

3.3 PRE-INSTALLATION

Read all of the Installation section before beginning

Avenger installation. This Pre-Installation section is intended to help you assemble the components necessary for Avenger installation before you begin the actual installation of the unit.

To operate the Avenger you will need a suitable power supply, speaker or headphone, microphone or key and an antenna.

3.3.1 POWER SUPPLIES

The E. F. Johnson Company manufactures two power supplies intended for use with the Avenger. Model No. 239-251 is the 117 VAC supply and Model No. 239-252 is the 13.4 VDC supply. The DC supply includes the Avenger Mobile Mounting Kit, Model No. 251-837. Both supplies include all hardware and interconnecting cables necessary for installation.

We recommend use of these power supplies with the Avenger. However, if you prefer to build or modify your own supply, the Avenger requires the following potentials at the indicated power plug pin numbers:

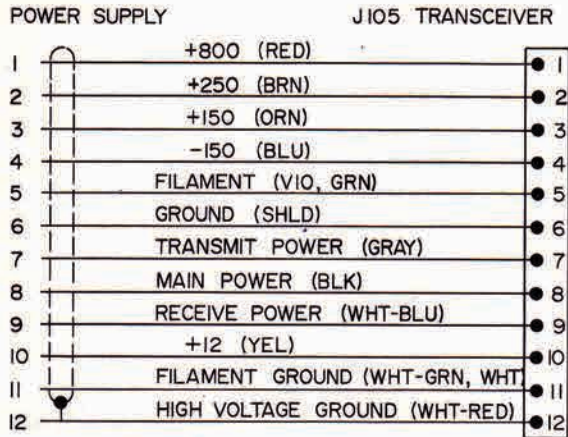
<u>VOLTAGE</u>	<u>CURRENT CAPABILITY</u>	<u>PIN NUMBER</u>
+800 V	400 mA	1
+250 V	75 mA	2
+150 V (well regulated)	50 mA	3
-150 V	30 mA	4
+12	2 A	10
12.6 VAC (or DC)	3 A	5

For 13.8 VDC mobile operation, the +12 V and 12.6 VAC (or DC) can be supplied by the vehicle electrical system and are not then required from the power supply. Any supply used should be well filtered and regulated.

Switch S2, the main power switch (1-8), connects pin 8 to pin 9. S6, the transmitter power switch (1-14), connects pin 7 to pin 8 only when S2 is closed.

Figure 3-1 is a power plug wiring diagram.

INSTALLATION (cont'd)



TRANSCEIVER POWER PLUG
WIRING DIAGRAM
FIGURE 3-1

3.3.2 SPEAKERS

There are two speakers available for use with the Avenger. Model No. 250-55-1 is intended to match the Avenger in base station use. Model No. 250-55-2 is more compact and is intended for mobile use only.

You can use any good 3.2 ohm speaker having wide range voice response and capable of handling 10 watts of peak power. Speakers with a voice coil impedance different from 3.2 ohms require more audio gain from the Avenger for a given listening level and signal level, and can damage the Avenger audio output transistor if used at high audio gain levels without proper loading for long periods of time.

3.3.3 HEADPHONE

Any good quality set of headphones can be used with the Avenger. The Avenger headphone jack is paralleled with a 10 ohm resistor making headphone impedance relatively unimportant at the low Audio Gain levels usual with headphone use. You might find that a set of headphones which is resonant at 1 kHz makes CW work easier, as it emphasizes one CW signal in a pile-up.

3.3.4 MICROPHONE

We recommend any high impedance (50,000 ohms) microphone with a flat frequency response throughout the voice spectrum. The microphone you select should have an output of at least -55dB at 1 kHz and a cardioid response characteristic for best VLX operation.

The E. F. Johnson Company has available a matching mobile PTT microphone, Model No. 250-882. A microphone holder is included with Model No. 250-882 which

fastens directly to the AVENGER enclosure.

3.3.5 KEYS

The Avenger can be operated with any good key. Because of the VLX controlled grid-block keying, (see the Circuit Description, Section 4.5), the Avenger should not be used with a key which has any contact bounce. The Avenger operates especially well with an electronic keyer.

The E. F. Johnson Company is known for its smooth acting and rugged keys. Consult your distributor or the E. F. Johnson Company for information on the keys available.

3.4 BASE STATION INSTALLATION

3.4.1 LOCATION

The Avenger and its power supply are solid state units (with the exception of the Avenger driver and final power amplifiers) and consequently produce less heat than conventional tube-type units. But heat remains the most important factor in component life. The Avenger and its power supply should be located where air can circulate freely through both units. Do not place objects on top of the Avenger or power supply which might block air circulation.

3.4.2 INTERCONNECTIONS

The Viking Avenger power supply, Model No. 239-251, is intended for use with the Avenger on a 117 VAC line.

Required power supply specifications are outlined in Section 3.3.1. The Avenger accessory package includes a power plug and fifteen power plugpins (three are spares) for use with home brew or modified power supplies. Refer to Figure 3-1 for power plug wiring details.

After you have selected a location for your Avenger and its power supply, interconnect the two units using the power cable. Refer to Figure 3-2. Ground all units.

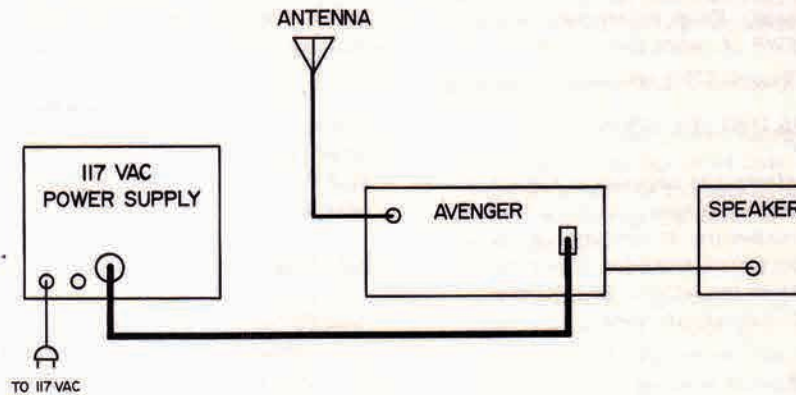
CAUTION:

Always depress the lock tabs fully on the power plug before connecting or removing the plug. Careless handling can break the lock tabs.

Connect a 3.2 ohm speaker, if one is to be used, to the Avenger speaker terminals (3-4). Remember that undistorted Avenger audio output will be reduced and the output stage can possibly be damaged if a speaker with a voice coil other than 3.2 ohms is used. The 3.2 ohm speaker can also be connected to the Avenger HEADPHONE jack (3-2) using the 1/4 inch right angle plug supplied if this is more convenient.

Connect a pair of high impedance headphones to the

INSTALLATION (cont'd)



AVENGER BASE STATION INTERCONNECTIONS

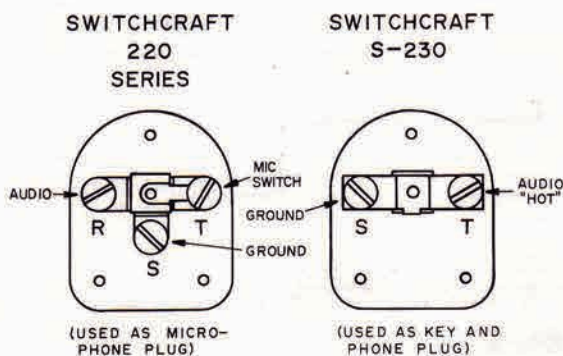
FIGURE 3-2

1/4 inch HEADPHONE jack. Use the 1/4 inch right angle plug supplied. See Figure 3-3 for plug wiring details. The HEADPHONE jack is in parallel with the speaker terminals and a 10 ohm resistor. The resistor limits the total impedance the audio output transformer works into to 10 ohms or less regardless of load. The transformer should work into 3.2 ohms for the best impedance match. The AUDIO Gain control should be kept at a reasonably low level (2 o'clock or less) when using earphones. The likelihood of Avenger audio output stage damage because of excessive output during conditions of impedance mismatch is low but it does exist.

Select a key and microphone and plug them into their respective jacks, using the 1/4 inch right angle plug for the key and the 0.203 inch right angle plug for the microphone. Refer to Figure 3-3 for plug wiring details.

3.4.3 ANTENNAS

The importance of a good antenna installation cannot be over-emphasized. Refer to ARRL publications for relatively detailed antenna information.



"FLATPLUG" CONNECTION DETAILS
FIGURE 3-3

The Avenger is designed to terminate in a 50 ohm unbalanced transmission line. Tune the antenna system for a low VSWR (Voltage Standing Wave Ratio) and maximum field strength. The lower the VSWR the better, but the Avenger can safely work into a 1.5:1 VSWR.

An antenna tower can be considered an asset to a community. One way to make it a desirable feature of a neighborhood is to stress its lightning protection values. A 60 foot well-grounded tower can act as a lightning rod giving nearly complete protection for a few hundred feet in all directions. Bonding your home's water system or other good ground to the antenna tower will help prevent splatter from the tower to the house in case the tower is hit by lightning. Lightning arrestors can provide some protection against static discharge during an electrical storm. It is a good idea to disconnect any receiver or transmitter from its antenna during an electrical storm to protect it from possible damage from atmospheric electricity.

After you have selected your antenna site, lead in your antenna cable(s). Use RG-8/U whenever possible; RG-58A/U for runs of less than 40 feet, when necessary. Install PL-259 connectors following the instructions in Figure 3-7. Connect the antenna cable to the Avenger ANTENNA jack.

Check system VSWR using a Johnson Directional Coupler and Indicator, Model No. 250-37 and 250-38 respectively, or other good VSWR bridge and indicator. To check system VSWR, follow the Simplified Operating Instructions, Section 5, exactly to tune up the transceiver except tune to about 150 mA. Key the transmitter for short periods of time only. If the VSWR is 1.5 to 1 or worse, retune the antenna to resonance if possible or use a Johnson 275 watt or Kilowatt Matchbox, Model No. 250-23-3 and 250-30-3 respectively. Retune the transmitter after each antenna adjustment. Then follow the manufacturer's instructions for the VSWR bridge and indicator and match-

INSTALLATION (cont'd)

box. When VSWR reaches 2 to 1 or better, load the Avenger fully after each adjustment. Keep keyed periods short when fully loaded into a VSWR of more than 1.5 to 1.

Check idling current (Section 7.3.6) before operation.

3.4.4 LINEAR AMPLIFIER INSTALLATION

No special considerations are necessary for linear amplifier installations with the Avenger. Be sure that the linear used has adequate exposure to cooling air on all sides. Be sure to follow the instructions for linear amplifier operation (Section 6.4) to the letter. See Figure 3-4 for Avenger-Thunderbolt II interconnections.

3.5 MOBILE INSTALLATION

3.5.1 GENERAL

A mobile communications station is a series of compromises. A vehicle of any sort is simply not a good place for a radio. A vehicular HF antenna installation is necessarily not as good as a fixed station antenna system can be. A mobile station carries a highly efficient noise generator (the engine) around with it. A mobile station is cramped, making installation, operation and modification of the equipment more difficult. A mobile station faces extreme ambient noise conditions, extremes in temperature and a great deal of vibration. Since the mobile station is primarily a conveyance rather than a radio station, only a certain amount of comfort, appearance and safety can be sacrificed for the good of the radio, depending upon the priorities of the operator and perhaps his (X)YL.

Installing and operating a satisfactory mobile station under these limitations is something of a challenge, but can be most rewarding. A traffic jam straightens itself

out too soon when you are working a CE9 during one. Interstate miles slip away quickly when you are working stations enroute or hometown stations.

This section will consider the problems involved in mobile installations one by one. If you systematically attack mobile installation deficiencies, your Avenger will give you the most satisfying mobile station you have ever operated.

3.5.2 PRE-INSTALLATION

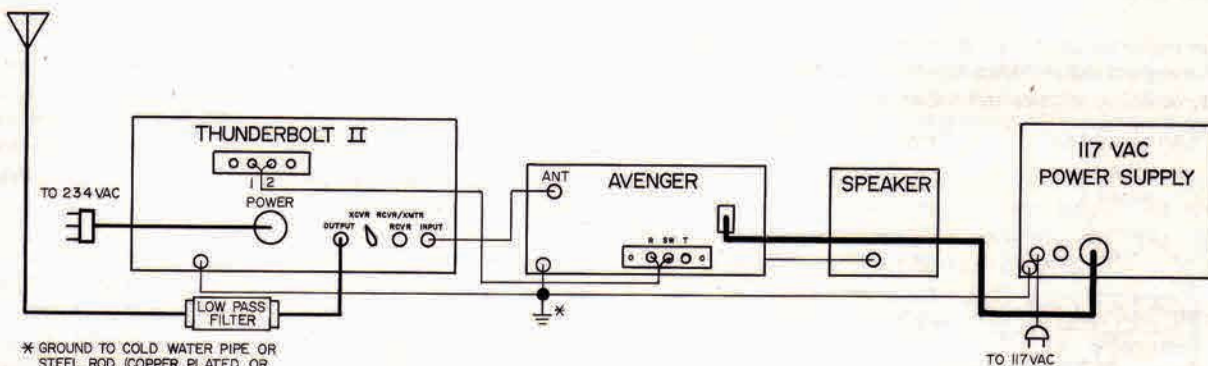
CAUTION:

The Avenger can be installed in vehicles having negative ground electrical systems only, when using the E. F. Johnson Model No. 239-252 power supply.

Before starting to drill holes and install components, look your vehicle over carefully. A few minutes spent planning can save time later (time typically spent with the installer in an inverted configuration under the dashboard with several years' accumulation of dust falling in his eyes).

The Avenger DC power supply comes equipped with 8 foot battery cable leads and an 8-1/2 foot transceiver power cable. The power supply can be mounted wherever most convenient and lead lengths allow. If you can find room on the passenger side of the firewall the power supply can be mounted there. If you mount the power supply in the engine compartment, protect it from heat and water. There are no adjustments within the DC power supply, but you may want to mount it where it is easily accessible regardless. Mount the power supply in a location which allows ventilation by relatively cool air on all sides.

Examine the interior of the vehicle carefully before



* GROUND TO COLD WATER PIPE OR STEEL ROD (COPPER PLATED OR GALVANIZED) DRIVEN SIX FEET DEEP INTO MOIST EARTH; USE AVENGER ENCLOSURE SCREW, TBII GROUND STUD.

AVENGER-THUNDERBOLT II INTERCONNECTIONS

FIGURE 3-4

INSTALLATION (cont'd)

deciding upon a location for the Avenger. Ash trays, glove compartment doors, floor mounted shift levers, passengers and the like all require clearance. You may have to move the power supply from its original intended location in order to best mount the Avenger.

Do not install the Avenger in the direct air stream from the vehicle's heater - temperatures in this area can measure up to 150 degrees fahrenheit and cause component failure.

After choosing a location for the Avenger and power supply, choose a place to drill the necessary holes in the firewall for the cables used. Drill two 5/16 inch holes if the power supply is mounted inside the passenger compartment, one 7/16 inch hole if the supply is mounted in the engine compartment. Check both sides of the intended area carefully for obstructions or anything which might be damaged by the drill. Select the hole location for the most direct route from the supply to the Avenger and battery. Cut the battery leads to length. Dress all leads to avoid anything which might damage the cables either with heat or abrasion. Install the necessary grommets to prevent cable abrasion.

Check idling current (Section 7.3.6) before operation.

Determine the antenna location and route the antenna lead (preferably RG-8/U but RG-58A/U may be used if space is a problem) before mounting the Avenger. Wire the PL-259 coaxial connectors following Figure 3-7.

The Avenger dash mounting bracket, Model No. 251-837, and DC Power Supply, Model No. 239-252-1, both include detailed illustrated mounting instructions. Consult these instructions to mount the units. Tighten all mechanical and electrical connections securely.

Locate a desirable microphone hanger position. There are often screws in the dashboard which you can use as microphone hanger mounting hardware. The center hole in the microphone hanger allows use of most large headed screws. If no available screws are satisfactory mark a

location, center punch and drill (#43 drill) two holes for the 4-40 x 3/16 in. screws included with the microphone hanger.

3.5.3 ANTENNA INSTALLATION

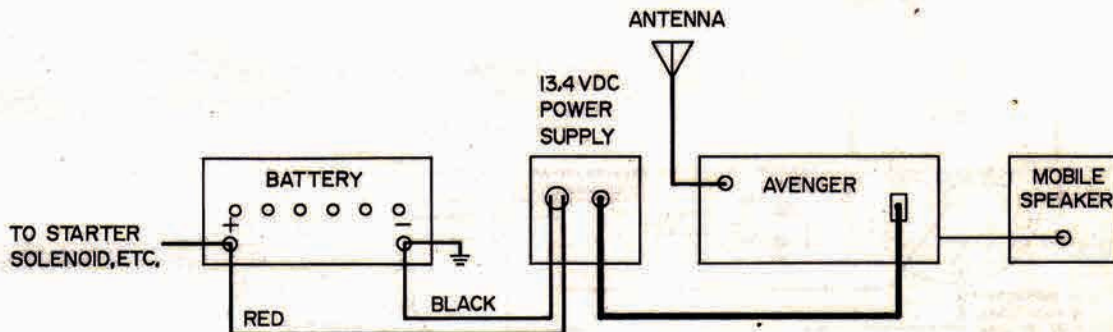
Select your mobile antenna carefully. A high Q center loaded antenna is usually best for mobile work. The antenna should be capable of at least 250 watts continuous duty. Install the antenna following the manufacturer's instructions.

The most convenient method of tuning the antenna is with the use of a VSWR directional coupler and indicator, such as the E. F. Johnson Model No. 250-37 and 250-38, respectively. Since a directional coupler and indicator can sometimes give misleading readings with antennas which do not terminate in 50 ohms, you might find a field strength indicator useful. Tune for minimum VSWR at maximum field strength.

Load the Avenger lightly, to approximately 150 mA, and keep keyed periods short; except for this reduced plate current, follow the simplified transmit instructions, Section 5.4, to the letter.

With the antenna whip at the center of its adjustment range, set the VFO in use to the desired frequency. Push the TUNE switch (1-20); quickly dip the plate current (1-5) with the TUNE control (1-8); rotate the LOAD control (1-8) for 20 mA more plate current, then repeat to obtain about 140 mA at the dip. Peak the RF TUNE control (1-8). Check VSWR and field strength.

Move the antenna whip in or out 1/2 inch or so. Re-tune, load and peak the transmitter and recheck VSWR and field strength. Continue as necessary until VSWR is at a minimum when the field strength is greatest. When VSWR reaches 2 to 1 or better, load the Avenger fully after each adjustment. Keep keyed periods short when fully loaded into a VSWR of more than 1.5 to 1. The antenna resonant peak is sharpest on 75 meters, broadest on 10 meters.



AVENGER MOBILE INTERCONNECTIONS

FIGURE 3-5

INSTALLATION (cont'd)

Whenever you change loading coils, retune the antenna carefully. Check antenna tuning periodically as corrosion and vibration can affect tuning.

3.5.4 NOISE SUPPRESSION

Vehicle electrical noise of some sort is a problem in almost all new mobile radio installations. The Avenger noise blander is capable of eliminating most vehicular noise, but sometimes at the cost of reduced selectivity.

Before beginning any special noise suppression steps, be sure that the vehicle is well tuned. Clean and tighten all electrical connections, including alternator, battery, regulator and coil connections. Perform the following maintenance steps as necessary: solder crimped spark plug and distributor leads; clean and regap or replace spark plugs and adjust ignition timing; check and clean alternator rings and brushes. Retune the engine every 10,000 miles or twice a year, whichever occurs first.

Ordinarily several sources of noise are present in any vehicle, with the strongest covering the others. Drive to a relatively quiet location (free of man-made electrical interference such as noisy power lines, industrial noise or other vehicles).

Accelerate the vehicle to about 60 miles an hour. Then turn the ignition switch off. Leave the Avenger turned on and the vehicle coasting in gear. If most electrical noise ceases, it is primarily in the ignition system. This type of noise is characterized by a loud "popping" at low engine speeds.

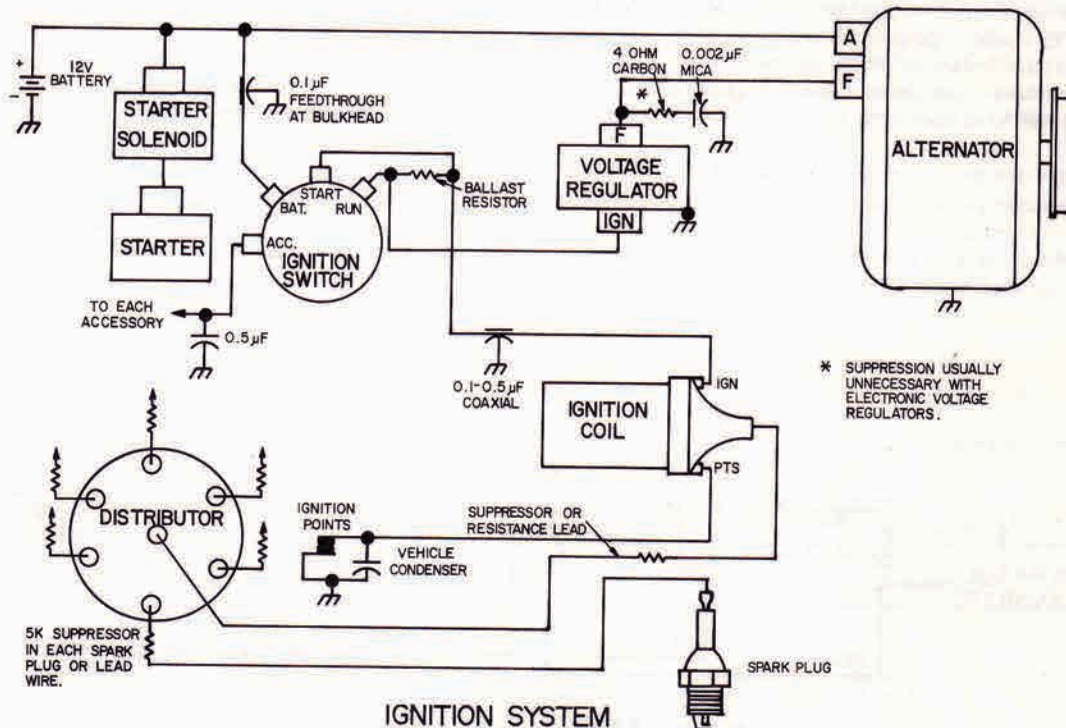
To reduce ignition noise, install resistor type spark plugs if these are not already installed and if non-resistance ignition wiring is used. Add a 10,000 ohm suppressor resistor in the center tower of the distributor and 5000 ohm suppressor resistors at each spark plug tower of the distributor. Install a coaxial capacitor at the ignition coil primary as close to the coil primary as possible.

A "whining" noise which varies with engine speed and continues with the ignition turned off with the vehicle coasting in gear is characteristic of the alternator. Check and clean the alternator rings and brushes.

An irregular "clicking" sound which disappears at a slow idle characterizes the voltage regulator. Install a 4 ohm carbon resistor as close to the field terminal of the regulator as possible, then a 0.002 μF mica capacitor in series with and as close to the resistor as possible; connect the capacitor to ground.

Irregular popping noises which vary with road surfaces indicate static discharge at any of several locations in the vehicle. Tighten loose nuts and bolts and bond large areas such as the fenders, exhaust pipe, firewall, etc. to the frame with lengths of heavy braid. Figure 3-6 illustrates these and a few other suggested noise suppression steps.

For additional noise suppression information, refer to ARRL publications or other mobile radio handbooks.



**IGNITION SYSTEM
NOISE SUPPRESSION
SCHEMATIC DIAGRAM
FIGURE 3-6**

RG-8/U



Cut end of cable even. Remove vinyl jacket 1-1/8", except 83-1SP plug remove vinyl jacket 1-1/4".



Bare 5/8" of center conductor. Trim braided shield. Slide coupling ring on cable. Tin exposed center conductor and braid.



Screw the plug sub-assembly on cable. Solder assembly to braid through solder holes, making a good bond between braid and shell. Solder conductor to contact. Do not use excessive heat.



For final assembly, screw coupling ring on plug sub-assembly.

RG-58A/U



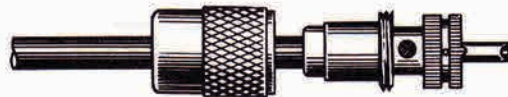
Cut end of cable even. Remove vinyl jacket 3/4". Slide coupling ring and adapter on cable.



Fan braid slightly and fold back as shown.



Position adapter to dimension shown. Press braid down over body of adapter and trim to 3/8". Bare 5/8" of conductor. Tin exposed center conductor.



Screw plug sub-assembly on adapter. Solder braid to shell through solder holes. Use enough heat to create bond of braid to shell. Solder conductor to contact.



For final assembly, screw coupling ring on plug sub-assembly.

UHF COAXIAL CONNECTORS ASSEMBLY INSTRUCTIONS FIGURE 3-7

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SECTION 4 CIRCUIT DESCRIPTION

4.1 GENERAL

Refer to the foldout block diagram and foldout schematic while following the circuit description. Schematics of individual circuits and sections are included along with the descriptions to help make each description easier to follow.

The following is a list of number designators for the assemblies that are included in the Avenger.

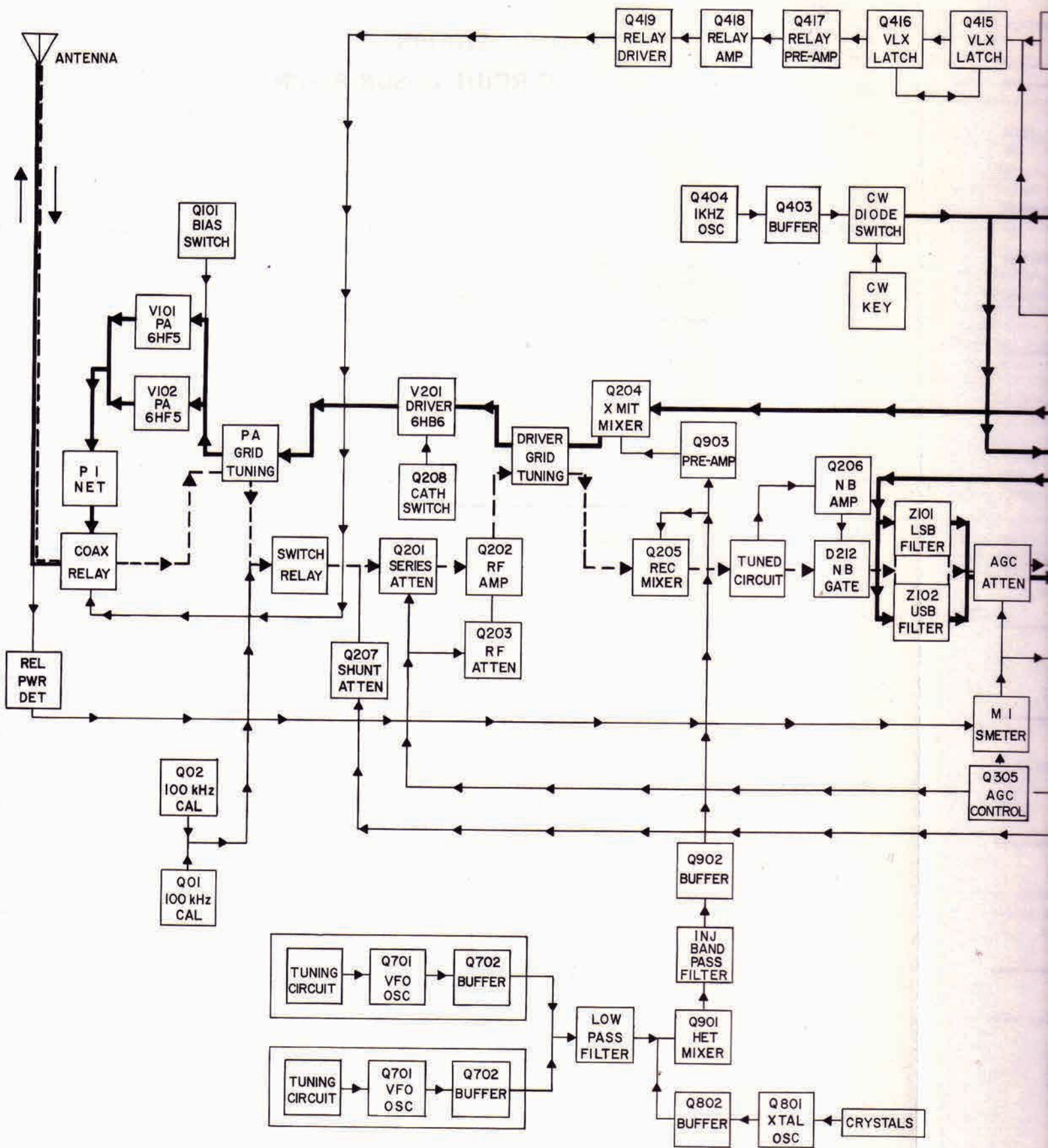
00 - 99	100 kHz Calibrator
100 - 199	Chassis
200 - 299	RF Board
300 - 399	IF Board
400 - 499	Audio Board
500 - 599	Carrier Oscillator Board
600 - 699	Balanced Modulator and Product Detector Board
700 - 799	VFO Assemblies
800 - 899	Crystal Oscillator Board
900 - 999	Heterodyne Mixer Board

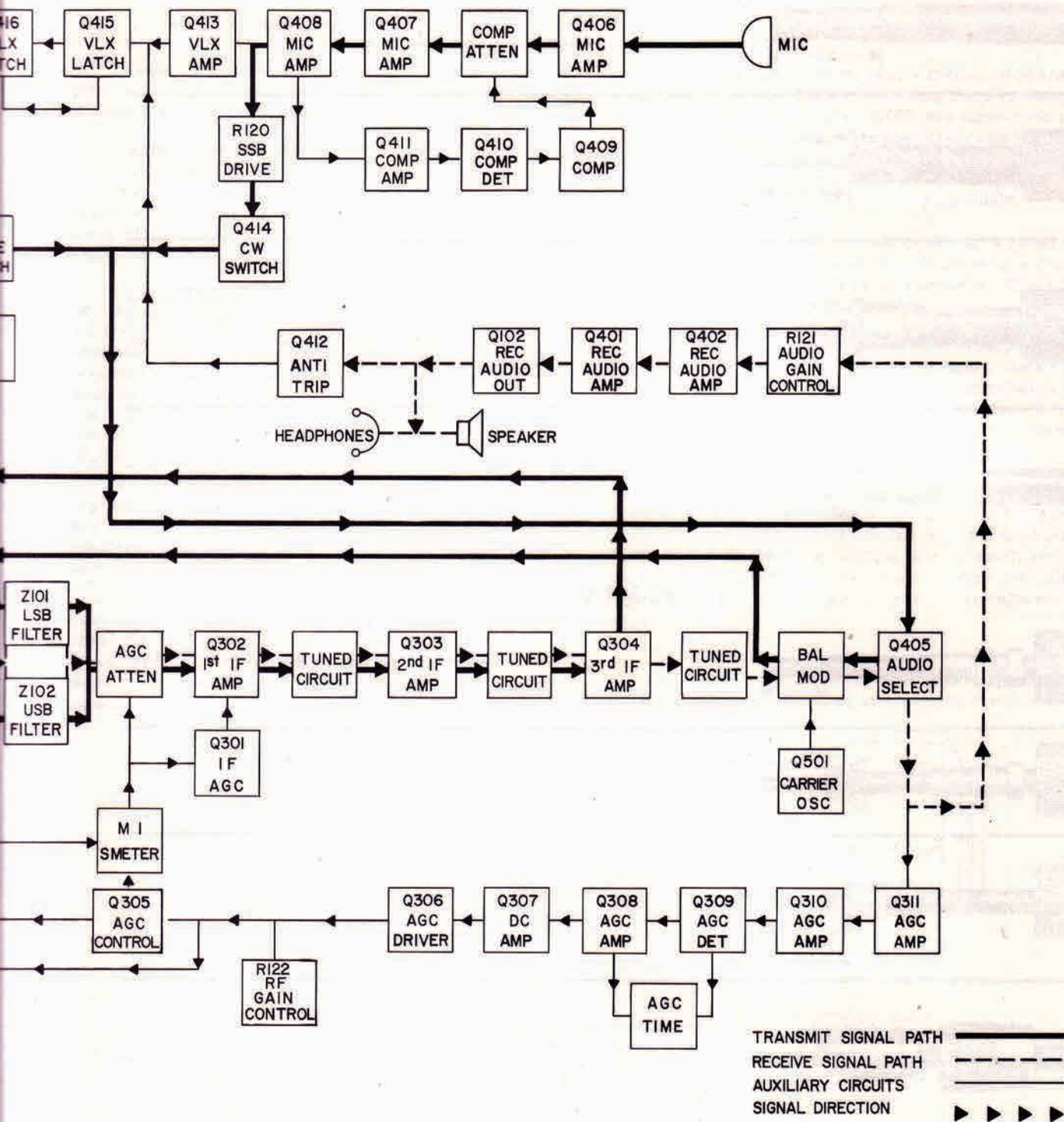
4.2 FREQUENCY SYNTHESIS SCHEME (All Frequencies in MHz)

4.2.1 TRANSMIT FREQUENCY SYNTHESIS TABLE

BAND (#1)	CRYSTAL OSC. (#2)	VFO OUTPUT (#3)	HET. MIXER OUTPUT (#4)	IF OUTPUT (#5)	TRANSMIT MIXER OUTPUT (#6)
80 Meters	Not Used	4.9 to 5.5	4.9 to 5.5	9.0	3.5 to 4.1 (#5 - #4)
40 Meters	21.5	4.9 to 5.5	16.0 to 16.6 (#2 - #3)	9.0	7.0 to 7.6 (#4 - #5)
20 Meters	Not Used	4.9 to 5.5	4.9 to 5.5	9.0	13.9 to 14.5 (#4 + #5)
15 Meters	35.4	4.9 to 5.5	29.9 to 30.5 (#2 - #3)	9.0	20.9 to 21.5 (#4 - #5)
10 Meters	42.5	4.9 to 5.5	37 to 37.6 (#2 - #3)	9.0	28 to 28.6 (#4 - #5)
10 Meters	43.0	4.9 to 5.5	37.5 to 38.1 (#2 - #3)	9.0	28.5 to 29.1 (#4 - #5)
10 Meters	43.6	4.9 to 5.5	38.1 to 38.7 (#2 - #3)	9.0	29.1 to 29.7 (#4 - #5)

FOLDOUT →





BLOCK DIAGRAM
 VIKING AVENGER TRANSCEIVER
 FIGURE 4-1

CIRCUIT DESCRIPTION (cont'd)

4.2.2 RECEIVE FREQUENCY SYNTHESIS TABLE

BAND (#1)	CRYSTAL OSC. (#2)	VFO OUTPUT (#3)	HET. MIXER OUTPUT (#4)	ANTENNA FREQUENCY (#5)	RECEIVE MIXER OUTPUT (#6)	IF OUTPUT (#7)	PRODUCT DETECTOR OUTPUT (#8)
80 Meters	Not Used	4.9 to 5.5	4.9 to 5.5	3.5 to 4.1	9.0 (#4+#5)	9.0 ± Audio	Audio
40 Meters	21.5	4.9 to 5.5	16.0 to 16.6	7.0 to 7.6	9.0 (#4 - #5)	9.0 ± Audio	Audio
20 Meters	Not Used	4.9 to 5.5	4.9 to 5.5	13.9 to 14.5	9.0 (#5 - #4)	9.0 ± Audio	Audio
15 Meters	35.4	4.9 to 5.5	29.9 to 30.5	20.9 to 21.5	9.0 (#5 - #4)	9.0 ± Audio	Audio
10 Meters	42.5	4.9 to 5.5	37 to 37.6	28 to 28.6	9.0 (#4 - #5)	9.0 ± Audio	Audio
10 Meters	43.0	4.9 to 5.5	37.5 to 38.1	28.5 to 29.1	9.0 (#4 - #5)	9.0 ± Audio	Audio
10 Meters	43.6	4.9 to 5.5	38.1 to 38.7	29.1 to 29.7	9.0 (#4 - #5)	9.0 ± Audio	Audio

4.3 RECEIVE SIGNAL PATH (Figure 4-1)

The signal from the antenna passes through the de-energized coaxial relay, RY101, to the 50 ohm tap on toroid T201. The signal is capacitively coupled from T201 through a series AGC stage (Q201) to the base of the receiver RF amplifier, Q202. The signal is amplified by Q202 and applied to the receiver mixer, Q205. Here the RF signal is mixed with the output from the heterodyne mixer. The receiver mixer output is applied to either the upper or lower sideband crystal filter. The crystal filters have a very narrow bandpass allowing only 0.3 to 3.0 kHz signals above or below 9 MHz to pass. This signal is amplified by three stages of IF amplification and coupled to the product detector. The 9 MHz signal from the carrier oscillator is also injected into the product detector and the difference between these two signals is audio. Thus $9000 + (0.3 \text{ to } 3.0) \text{ kHz} - 9000 \text{ kHz}$, or $9000 \text{ kHz} - (9000 - 0.3 \text{ to } 3.0 \text{ kHz}) = 0.3 \text{ to } 3 \text{ kHz}$ or the audio frequencies. This audio is amplified by four stages and applied to T102.

4.3.1 +12 RECEIVE LINE (See Complete Schematic)

In receive operation, the +12 R line is applied to the following stages:

- * Q205 - (receiver mixer)
- * Q305, Q306, Q307, Q308 and Q309 - (AGC amplifiers)
- * I113, I114 and I115
- ** Q414 - (SSB/CW audio switch)
- * Q401 and Q402 (receive audio)

NOTE:

- * indicates enabling voltages.
- ** indicates disabling voltages.
- ** Q101 - (PA bias switch)
- * Q202 & Q207 - (RF amplifier)

4.4 TRANSMIT SIGNAL PATH (Figure 4-1)

The audio signal generated either by the microphone or by the 1 kHz oscillator in CW and tune operation is applied to the balanced modulator through Q405. In voice operation the microphone audio is amplified by three stages. The output of the third stage, Q408, passes through SSB drive control R120. From the drive control the microphone audio passes through the SSB-CW switch, Q414, to the base of Q405. The low impedance audio output from Q405 is applied to the balanced modulator. In CW operation the output from the 1 kHz oscillator buffer is applied directly to Q405 with no interstage amplification. In addition to the audio from the emitter of Q405, the balanced modulator also receives an input from the 9 MHz carrier oscillator. The output of the balanced modulator is applied, depending upon the position of the mode switch, to either the upper or lower sideband filter. The output of the selected sideband filter is amplified by three stages of IF amplification and coupled to the transmit mixer. The transmit mixer receives an additional input from the transmit preamp. The output level of the transmit mixer is raised to a suitable level for driving the class AB1 stage by the driver, V201. The class AB1 power amplifier stage consists of V101 and V102 (6HF5's). Its output is applied to the antenna through a Pi network and the energized contacts of antenna switching relay RY101.

CIRCUIT DESCRIPTION (cont'd)

4.4.1 +12 TRANSMIT LINE (See Complete Schematic)

1. The transmitter is keyed by PTT, VLX or manual operation.
2. Relay RY102 energizes. The coil of RY101 is connected in parallel with RY102; RY101 also energizes.
3. The +12 line (contact 12) is switched by RY102 from +12 R (contact 4) to +12 T (contact 8).
4. The +12 T line is applied to the following stages:

- * Q101 - turns power amplifiers on.
- * Q208 - turns driver on.
- * Q204 - (transmit mixer)
- ** Q205 - (receive mixer)
- ** Q310 - (2nd AGC amp.)
- * Q304 - (3rd IF amp.)
- * I109, I110, I111 and I112
- * D403
- * D405 - (CW sidetone level control)

NOTE:

- * indicates enabling voltage.
- ** indicates disabling voltage.

4.4.2 TRANSMIT SWITCHING (See Complete Schematic)

When the transmitter is keyed by the microphone PTT, VLX or manual transmit, the following switching sequence occurs:

1. Relay RY102 energizes. The coil on RY101 is connected in parallel with RY102; RY101 also energizes.
2. +12T and or +12CW, depending upon the mode of operation, is applied to the various diode switching networks and changes their state from receive to transmit.
3. +12T is applied to the base of the driver cathode switch, Q208. This stage is biased into conduction and provides a cathode ground path for driver V201.
4. +12T is applied to the PA bias switch, Q101. This biases Q101 into conduction. Q101 in the conducting state drops the -150 volts to approximately 50 volts. This biases the power output amplifiers on, ready to be driven in class AB1.

4.5 CW SIGNAL PATH (Figure 4-1)

In CW operation +12 volts CW is applied to the 1 kHz phase shift oscillator, audio amplifiers Q401 and Q402, and the anode of diode D404 through D426. Depressing the CW key or the push-to-tune switch shorts the DC voltage at the junction of D403 and D404 anodes to ground. D403 and D404 become forward biased. Audio from the operating 1 kHz oscillator passes through this diode switch to

emitter follower Q405 and on to the balanced modulator. Simultaneously the grounded key line causes D317 to conduct and allows IF signal to drive the transmit mixer. The CW shaping during operation when not using break-in (RY102 is not dropping out with key up) is done by D317, R412 and C451. R412 and C451 cause the IF signal path switch to come on and off slowly, creating soft leading and trailing edges. The CW shaping on the leading edge when working break-in is done by capacitor C242 and R203 in the cathode switch of the driver. This allows the driver ground to have a time constant, removing the hard leading edge which would be caused by the relay.

With the mode switch in CW and the function switch in VLX the radio is ready for CW operation. Grounding the key line causes D409 to conduct which in turn allows Q416 to conduct, turning on Q417, Q418, and Q419. Q419 drives relay RY102 to the energized position and the transceiver goes to the transmit state.

To operate CW switching manually from receive to transmit, use the function switch in PTT for receive and XMIT for transmit. Then, pushing the key only turns on the diode switches having to do with the signal path.

Because of the frequency mixing scheme on the various bands and the fact that the lower sideband filter in the IF is always on in CW, the 1 kHz sidestepped CW is 1 kHz above the frequency indicated on the VFO dial on 40, 15 and 10 meters. It is 1 kHz below the indicated frequency on 80 and 20 meters.

4.5.1 +12 CW LINE (See Complete Schematic)

1. CW function is selected on the mode switch. The +12 line is connected to the +12 CW line.
2. The +12 CW line is applied to the following stages:
 - * Z101
 - ** Z102
 - * D104 (turns on the lower sideband, 9.000 MHz, filter for CW)
 - * D404 and D403 (CW audio switch; this circuit is completed by the CW key)
 - * D409 (manually causes VLX amplifier to go to transmit state)
 - ** Q310 (2nd AGC amp)
 - * Q304 (3rd IF amp)
 - ** D309 (back bias causes D317 to be only path for keying switch in IF)
 - ** Q414 (SSB-CW switch to CW)
 - * Q409 (compressor, shorts out mike audio)
 - * Q403 and Q404 (1 kHz oscillator)
 - * Q401 and Q402 (receive audio, used as sidetone amp in CW)

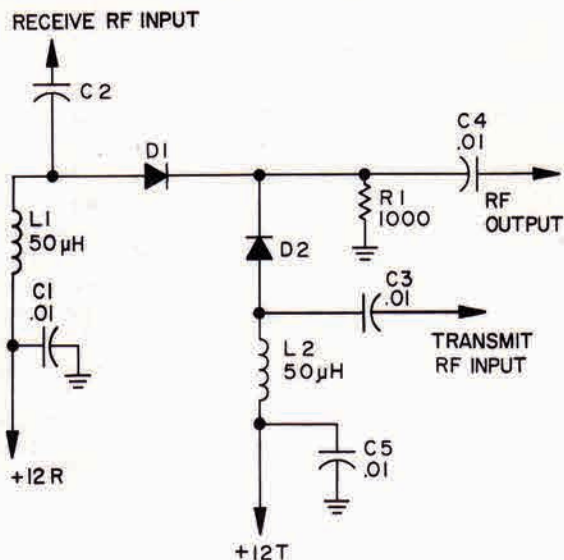
NOTE:

- * indicates enabling voltage.
- ** indicates disabling voltage.

CIRCUIT DESCRIPTION (cont'd)

4.6 TYPICAL DIODE SWITCH (Figure 4-2)

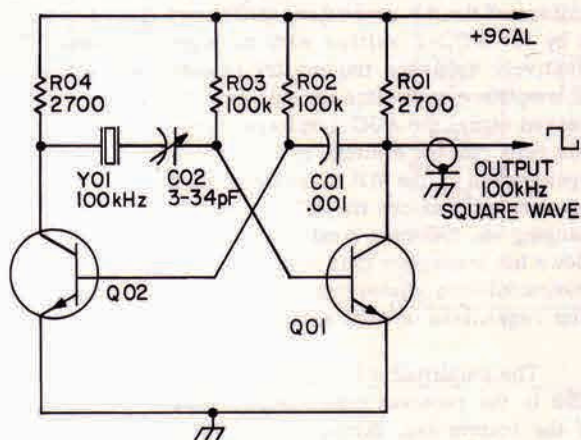
In the receive condition +12 R line voltage is applied through RF choke L1 to the anode of D1. D1 is forward biased and conducts. With D1 conducting to ground through R1, there is approximately a 0.7 V drop across D1 and the rest of the +12 volts is dropped across R1. The +12 T



TYPICAL DIODE SWITCH
FIGURE 4-2

line is ground potential in receive, so D2 is reverse biased by approximately 11 volts. This provides good isolation of any signal being passed on the RF output line from the transmit RF input. C1 keeps RF out of the power supply by bypassing to ground any residual RF getting through L1. The receive RF input is coupled through the RF switch by C2, D1 and C4.

In the transmit condition the +12 T line is applied through RF choke L2 to the anode of D2. D2 is forward biased, conducts, and +12 T minus the junction drop across D2 is applied to D1. D1 is reverse biased in the same manner as before and blocks the receive RF. The transmit RF input is coupled through the diode switch by C3, D2 and R4.



100 kHz CALIBRATOR
FIGURE 4-3

4.7 100 kHz CALIBRATOR (Figure 4-3)

An astable (free running) multivibrator functions as a 100 kHz square wave generator. The active elements are Q02 and Q01. A 100 kHz crystal, Y01, and variable capacitor C02 determine the frequency. The variable capacitor C02 provides precision adjustment of the 100 kHz frequency and can be used to adjust for any aging that may take place in the crystal over a long period of time. The frequency is factory set for 100,000 \pm 0 Hz using a frequency counter. The calibrator is turned on when the calibrate position is selected on the function switch. In calibrate position, +9 volts regulated is switched to the calibrator. With +9 volts applied, positive feedback from one of the transistors is greater than the other. The switching action starts. Cross coupling feedback is from collector to base.

One stage is switched on while the other stage switches off. This action is continuous (free running). The result is a 100 kHz square wave that is coupled from the collector of Q01 to the receiver RF section by C159. Theoretically,

a square wave contains an infinite number of harmonics. These harmonics appear every 100 kHz on every band in calibrate.

4.8 RF AMPLIFIER (Figure 4-4)

The receive signal from the antenna passes through the de-energized contacts of the antenna relay (RY101). C202 couples the signal from the antenna relay to the primary center tap of the input transformer (T201). S1J, S1K, S1G, and S1H provide for switching the front end, or pre-selector, coils. These are actually the input and output tuning coils of the RF amplifier, Q202. Bands switch wafer S1J switches coils in parallel with T201 on bands other than 80 meters. The S1K switch places small capacitors in series with the tuning capacitor, C149A, providing the smooth tuning necessary to tune the higher frequency bands easily. S1G and S1H switch the necessary parallel coils and series capacitors into the collector circuit of Q202 with L205 and C165A, and perform the same function between the RF amplifier and receive mixer.

CIRCUIT DESCRIPTION (cont'd)

The signal path from the tap on T201 is through C230, de-energized contacts 9 and 1 of RY102, C204 and C201 to the collector of Q201. Q207 is a shunt attenuator and Q201 is a series attenuator. These transistors act from voltages on the AGC-2 and AGC-1 lines, respectively. Increased signal level causes the AGC-2 voltage to increase and turn on Q207. Simultaneously AGC-1 is decreasing, turning Q201 off. This action provides a very effective attenuator ahead of the first stage of gain in the receiver, the RF amplifier. Refer to the Gain Distribution Chart in the Specifications Section for an indication of the effectiveness of the shunt attenuator. It prevents signals of more than 10 mV from hitting the first RF amplifier stage. The receive RF signal passes through Q201 and is coupled by C205 to the base of the RF amplifier, Q202. Q203, connected between the emitter bypass capacitors of the RF amplifier, Q202, and ground is turned on by the AGC-1 voltage with no signal present. This effectively bypasses the emitter resistor and allows the RF amplifier to realize its full gain potential. With increased signal the AGC-1 voltage drops, turning off Q203. This removes the emitter bypass resistance and causes degeneration of the RF amplifier transistor, Q202. The degeneration reduces the AC RF gain of the stage without changing the DC bias conditions of the transistor. This allows the transistor bias to be optimized for noise figure, intermodulation distortion and gain and remain at this point regardless of AGC action.

The amplified RF signal path from the collector of Q202 to the receiver mixer is as follows: through L205, off the bottom tap, through C236, D205 and C213 to the base of Q205.

4.9 RECEIVE AND TRANSMIT MIXERS

4.9.1 RECEIVE MIXER (Figure 4-6)

The receive mixer (Q205) receives two input signals. The receive antenna frequency is applied to the base of Q205 through C236, forward biased diode D205 and C213. Diode D205 is in the circuit to provide transmit isolation. Since L205 is shared by the RF amplifier in receive and the driver tube in transmit, considerable signal appears on the coil in transmit. To keep this signal level from driving the receive mixer transistor into a class C condition, D205 is reverse biased in transmit. The other input is applied to the emitter of Q208 from the emitter of the heterodyne mixer emitter follower. The signal path is through C189, forward biased diode D204 and C212 to the emitter of Q205. Diodes D204 and D203 provide the switching necessary for the injection frequency to drive either the receive or transmit mixers. The output of Q205 is one of the sidebands of 9 MHz and some undesired products that are filtered by one sideband filter, Z101 or Z102.

4.9.2 TRANSMIT MIXER (Figure 4-5)

The inputs to the transmit mixer are from the 3rd IF amplifier and transmit mixer driver. In transmit condition the 3rd IF amplifier, Q304, functions as an emitter follower. Its output is coupled through C322, D303, C209 and R214 to the base of Q204. The other input to the base of Q204 is from the collector of Q903 through C909 and L903. With the diode switch, D204 and D203, in the transmit condition, D203 is conducting and allows the injection frequency signal to drive the transmit mixer driver, Q903. This stage amplifies the injection signal to a level consistent with the needs of the transmit mixer transistor, Q204. The coil, L903, and C910 are a parallel tuned circuit at 9.000MHz. This provides a high impedance at 9 MHz and provides isolation of Q903 from the 9 MHz signal at the base of the transmit mixer, Q204. The transmit mixer output is taken off its collector and coupled to the control grid of the driver, V103, through L205. The tap on L205 provides an impedance match for maximum power transfer to V103. The bandswitch wafers, S1G and S1H, switch the coils for grid tuning of the drive tube. These are the same coils that are used by the RF amplifier in the receiver for collector tuning. This circuit is normally tuned in transmit for maximum drive with the capacitor, C165A, which is adjusted with the RF tune control.

4.10 NOISE BLANKER (Figure 4-7)

The noise blanker consists of noise spike rectifiers, D213 and D214, noise blanker amplifier, Q206, and blanking diode D212.

Placing the noise blanker rocker switch on the front panel (S5) to the ON position grounds the emitter of Q206 through R223 and enables the noise blanker. When a noise spike appears at the collector of receiver mixer Q205 it is coupled by C254 to the spike rectifier. The spike rectifier is a voltage doubler (D213 and D214) which provides a DC pulse that is coupled by C218 to the base of Q206. The pulse switches Q206 to conduction for the duration of the noise spike. In the conducting state Q206 drops the forward bias of noise blanker diode D212. The diode becomes reverse biased and blocks the input of the crystal filter for the duration of the noise spike. Diode D212 conducts when the noise blanker is turned off. When the noise blanker is turned on diode D212 is also turned on but at a lower conduction current. This is to allow good blanking by transistor Q206. The length of time taken to turn the diode off and on again at the end of the pulse is critical to good blanking action. Therefore, the diode must not be turned on too hard before being pulsed off. An extremely fast nanosecond diode is used for this purpose (D212). Because of the lower current through the diode in the on condition some cross modulation may be noticed in extremely

CIRCUIT DESCRIPTION (cont'd)

strong adjacent signal conditions. The noise blanker is not necessary under strong received signal conditions since the signal-plus-noise to noise ratio is high enough to make it unnecessary. You will probably find that in a base station with a good antenna system, desired signals are usually strong enough to make the noise blanker unnecessary.

4.11 SIDEBAND FILTER (Figure 4-8)

In receive condition the input to the sideband filters is from the receiver mixer. In transmit condition the input is from the balanced modulator. Diode switching is used to switch both input and output signals.

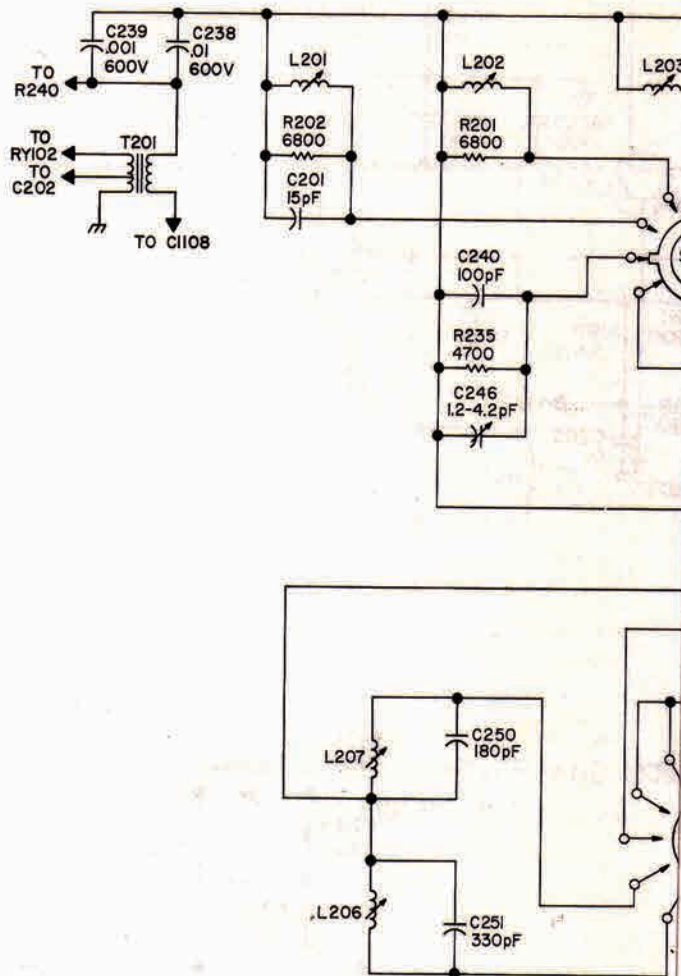
The lower sideband filter is not always the filter in use in the LSB mode. To illustrate this let us consider using lower sideband on 7.3 MHz. We obviously want an output frequency that is below 7.3 MHz. Referring to the transmit frequency synthesis chart, table 4.2.1, we see that the requirement for 7.3 MHz output is 16.3 MHz - 9.000 MHz = 7.3 MHz. To obtain lower sideband on 7.3 MHz we must have 7.299 MHz. Subtracting 7.299 MHz from 16.3 MHz gives 9.001 MHz. So in order to have lower sideband on 7.3 MHz we must use the upper sideband filter on 9 MHz. If you refer to the frequency synthesis scheme in Section 4.2 and follow this procedure you will find that any time you have to subtract the frequency that has the modulation (i.e., audio in the form of SSB) on it from another frequency to obtain the desired frequency, regardless of whether considering transmit or receive, the sideband changes. Thus, from the synthesis tables in 4.2.1 and 4.2.2, we see that to work lower sideband requires the lower sideband filter on 80 and 20 meters, and the upper sideband filter on 40, 15 and 10 meters. Conversely, to work upper sideband on 80 and 20 meters requires the upper sideband filter; and on 40, 15 and 10 meters the lower sideband filter is required. The switch wafers S8A, S8B, S1B and S1A grouped near the upper center of the schematic provide the combination of switching necessary to perform the above described function. +12SB2 turns on the lower sideband filter when needed and +12SB1 turns on the upper sideband filter when needed. The unused diode switches must be reverse biased to isolate the unwanted filter and the switch wafers also include this function.

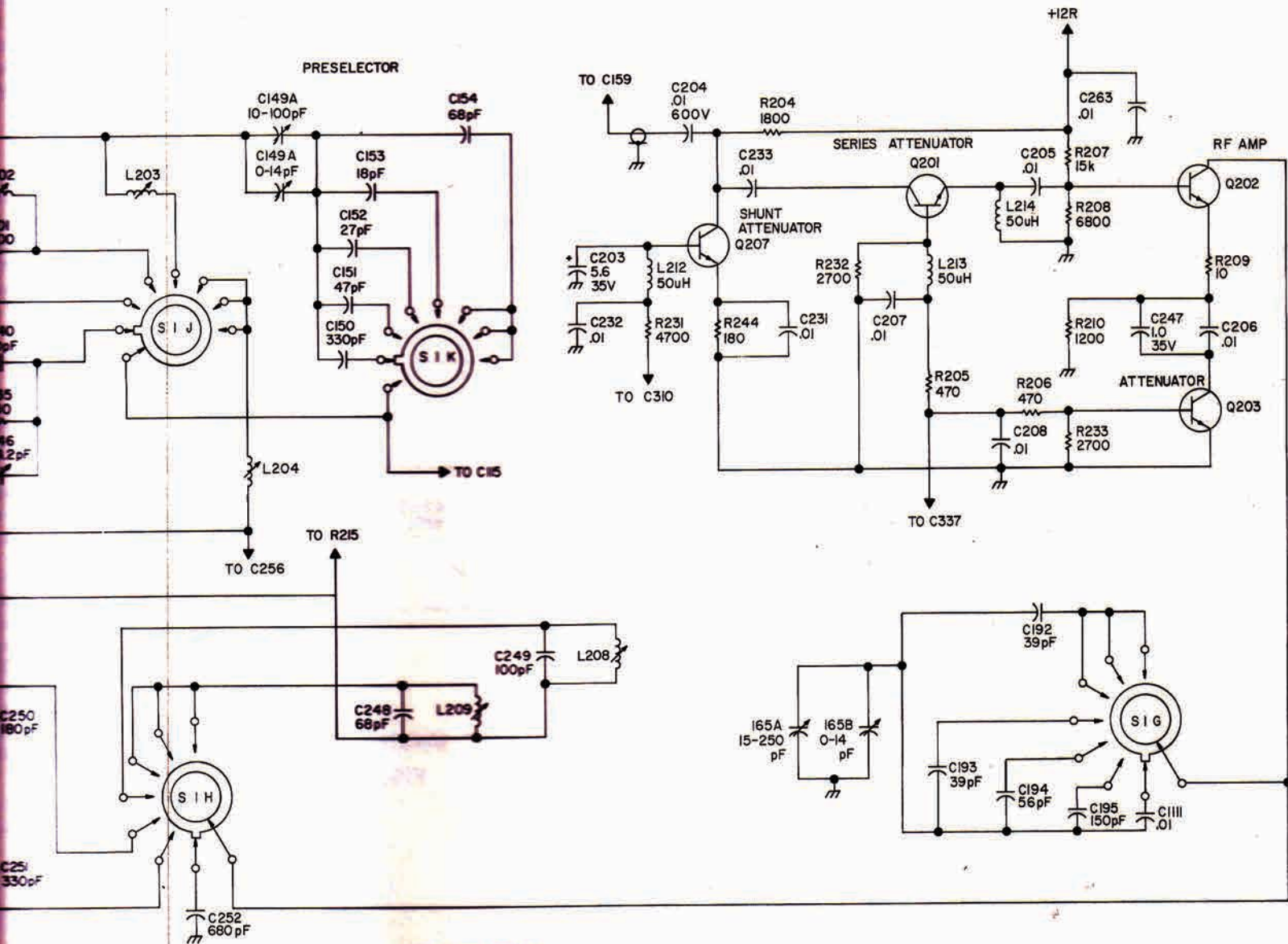
D211 and D210 are forward biased when the respective filter they are associated with is turned off. These diodes help provide a low AC impedance at the input of the filters or output of the reverse biased switch at the input of the filters to isolate the unwanted filter from the circuit. This allows the filter response to realize its full potential and keep the unwanted sideband to a minimum.

The sideband filters, Z101 and Z102, have a very narrow bandpass. They pass the sidebands and attenuate all other signals a minimum of 60 dB.

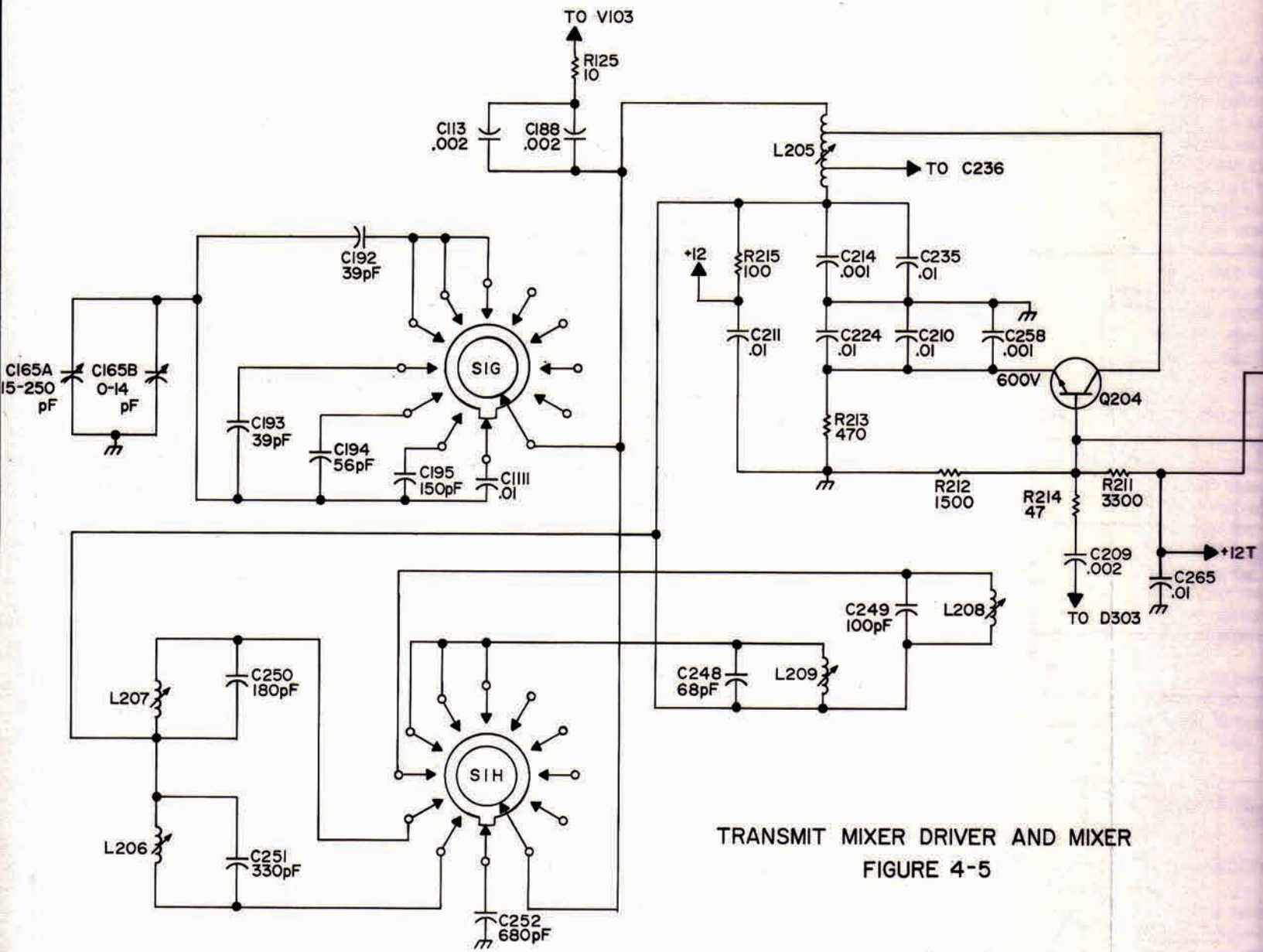
4.11.1 LSB FILTER

Assume that LSB (lower sideband) is selected when

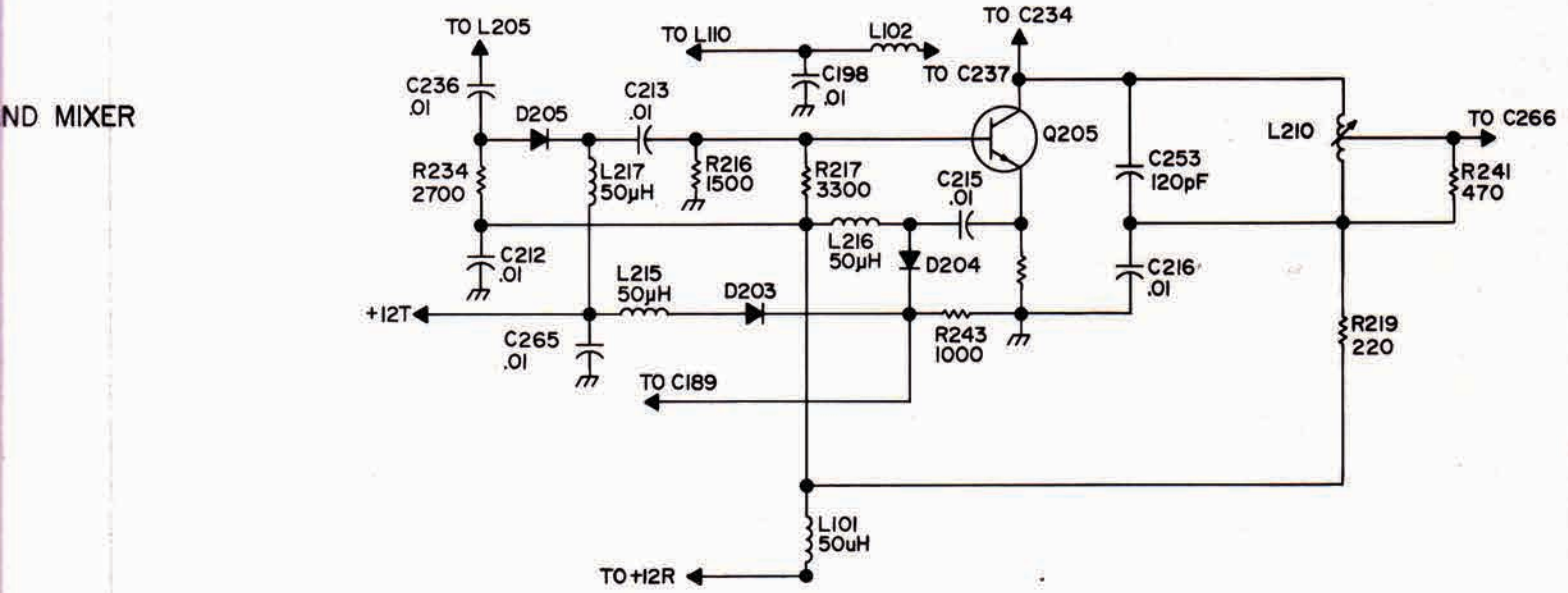
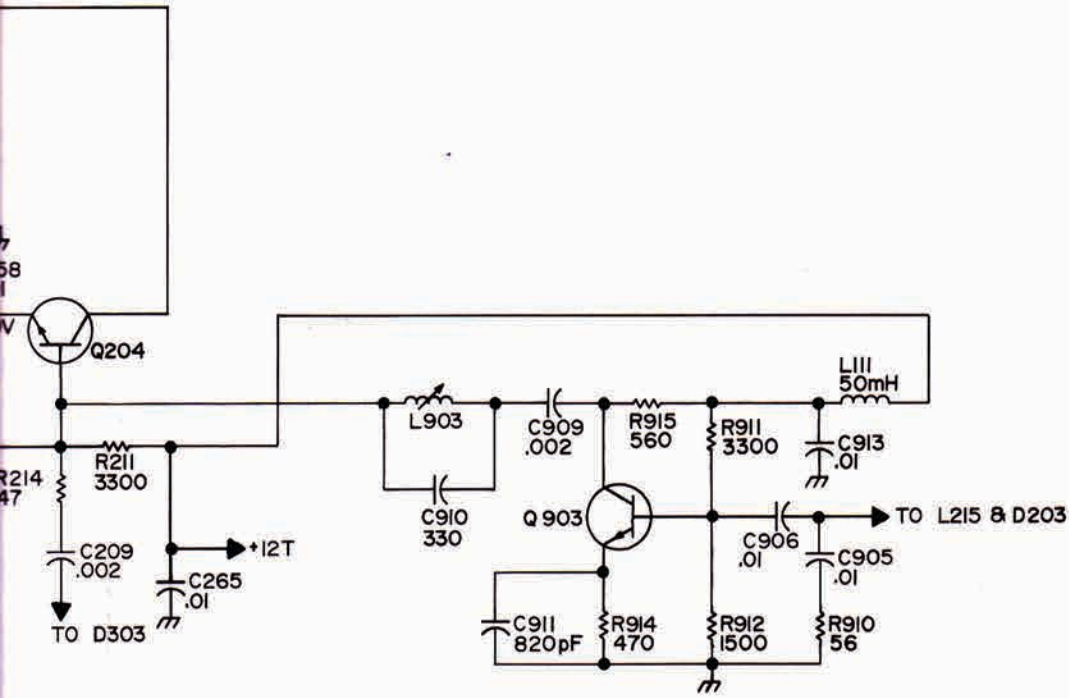




**RF AMPLIFIER
FIGURE 4-4**



TRANSMIT MIXER DRIVER AND MIXER
FIGURE 4-5



RECEIVE MIXER
FIGURE 4-6

CIRCUIT DESCRIPTION (cont'd)

on the 80 meter band. In this condition, +12SB2 is applied to the sideband filter diode switches. The following switching action takes place: D105, D209, D210 and D301 become forward biased. D208 and D302 become reverse biased. The signal path in and out of the lower sideband filter is completed. The signal path through the upper sideband filter is blocked. The signal path through the lower sideband filter is through D209, C222, C223, Z101, C306, D301, R321 and C310.

4.11.2 USB FILTER

Assume that USB is selected on the mode switch when on the 80 meter band. In this condition, +12SB1 is applied to the sideband filter diode switches. The following switching action takes place: D208, D302 and D211 become forward biased. D209 and D301 become reverse biased. The signal path in and out of the upper sideband filter is completed. The signal path through the lower sideband filter is blocked. The signal path through the upper sideband filter is through D208, C226, C227, Z102, C309, D302, R321 and C310.

4.12 IF AMPLIFIERS (Figure 4-9)

4.12.1 RECEIVE

In receive condition the output of the sideband filter is coupled to the base of Q302 by C310 and C311. Q302 functions as the 1st IF amplifier. Q301 is connected between C313, the emitter bypass capacitor for Q302, and ground. Q301 controls the gain of Q302 by changing the impedance of C313, thus providing variable degeneration. The conduction of Q301 is controlled by the AGC. Q301 operates in exactly the same manner as Q203. This oper-

ation is discussed in detail in Section 4.8. The output of Q302 passes through tuned circuit L301. From L301 the output is coupled by C315 to the base of the second IF amplifier, Q303. C319 couples the output of Q303 from L302 to the base of the 3rd IF amplifier, Q304. The output of Q304 is coupled from L303 to the anode of D307. D307 is forward biased by the +12R line. The signal passes through it and is coupled to the product detector by C329.

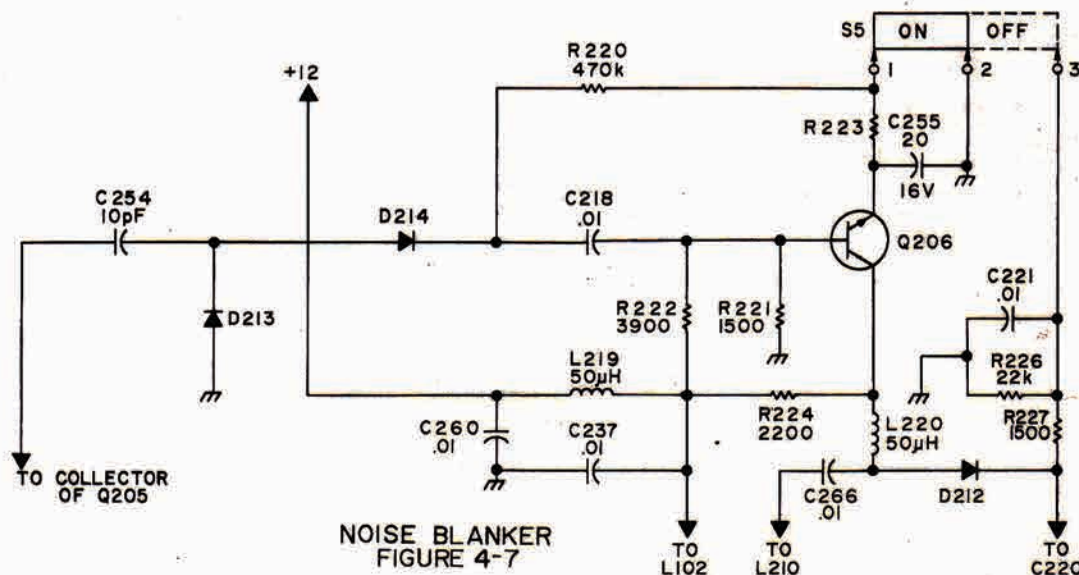
4.12.2 TRANSMIT

In transmit condition the output of the sideband filter is also amplified by Q302, Q303 and Q304. But the output of the 3rd IF amplifier, Q304, is at the emitter. The output is coupled to diode switch D303 by C322. D303 is forward biased by the +12 T line. The output voltage passes through D303 and is coupled to the base of the transmit mixer.

4.13 AGC (Figure 4-10)

A sophisticated AGC system, commercially unique, is used in the Avenger. The DC operating point is not changed in any of the receiver stages. Instead, electronic attenuators, operated from two AGC lines, control the gain of the receiver. Audio voltage from the collector of Q405 is used to operate the AGC system and is applied to audio amplifier Q311.

Q311 is the first stage of the eleven stage AGC network. This network consists of two audio amplifiers, Q311 and Q310; AGC detector, Q309; AGC timer, Q308; two emitter followers, Q307 and Q306, and an AGC control transistor, Q305. Also included are RF attenuator Q207 and Q201 and emitter impedance level changers, Q203 and Q301. The output of Q311 is coupled by C332 to the base of the second amplifier, Q310. Gain

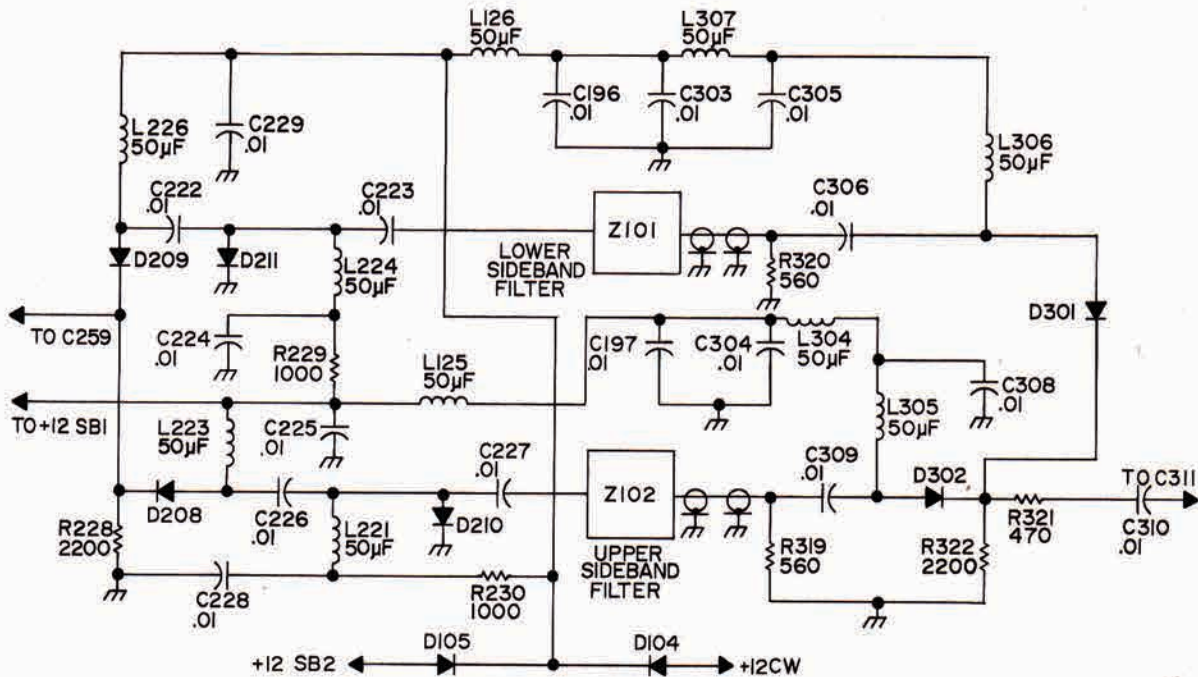


CIRCUIT DESCRIPTION (cont'd)

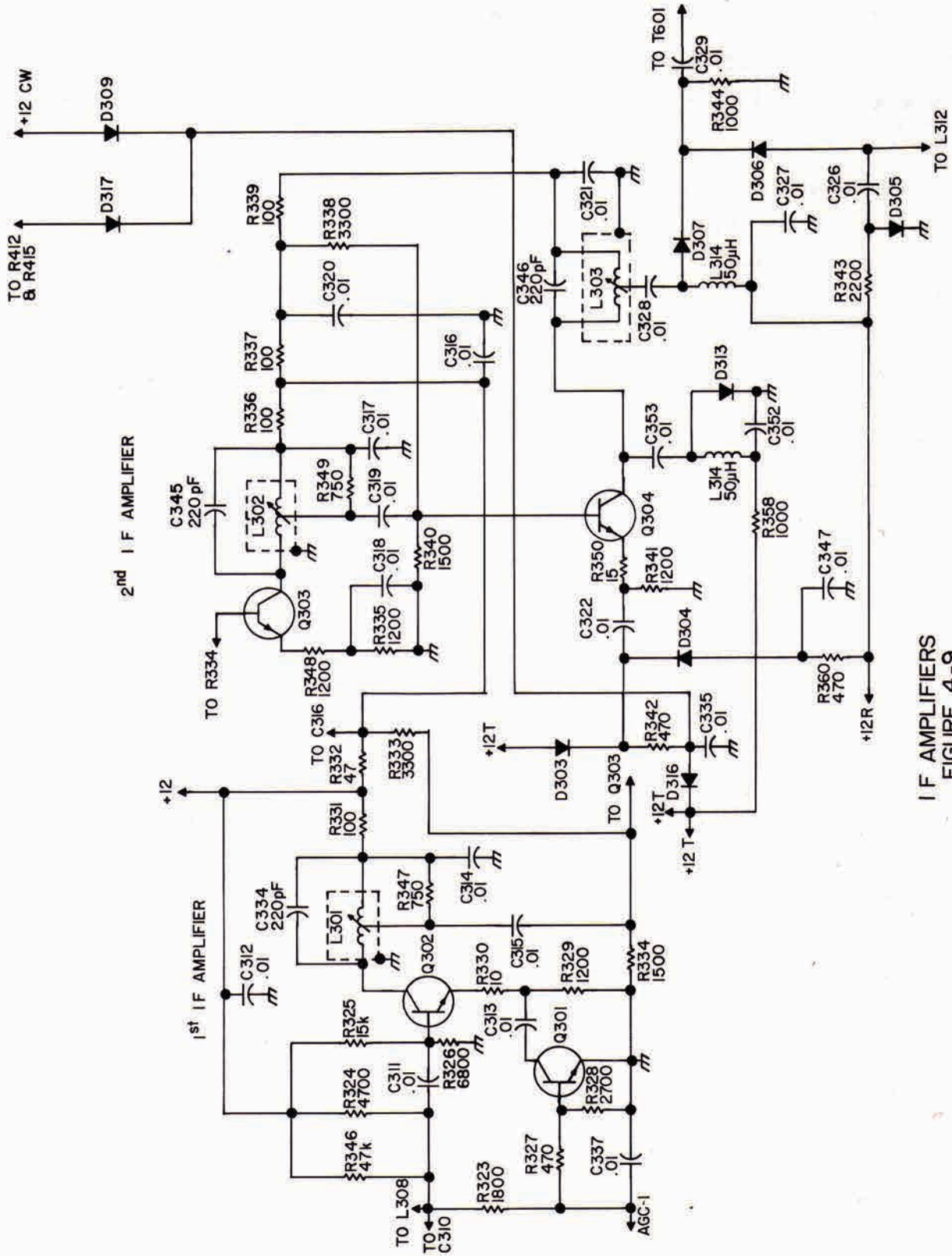
stabilization of Q311 and Q310 is provided by degenerative feedback. This is obtained by leaving part of the emitter resistance to ground unbypassed. The output of Q310 is coupled by C351 and C349 to the base of the AGC detector, Q309. D314, connected between C351, C349 and ground, is a special diode with a forward voltage drop of 2.7 volts. D314 prevents the AGC line from overshooting by conducting on any positive level above 2.7 volts. Q309 acts as an audio detector and drives the AGC timing circuit. D312 rectifies the audio negative half-cycles. The base-emitter junction of Q309 and D311 rectify the positive half-cycles, C342 and C343, connected in series between the emitter of Q309 and ground, provide filtering. C342 also acts as a speedup capacitor. C342 charges during fast pulses at the emitter of Q309 and shorts R311 with respect to AC, increasing the AGC attack time. C341, an AGC timing capacitor, charges through D311. C340, the other AGC timing capacitor, is charged by the rising emitter voltage of Q308. These two capacitors with their respective resistors, R313 and R309, give the AGC its fast attack and

slow decay characteristics. When the amplitude of the audio signal decreases, C341 discharges through R313. C340 has a very long discharge time rate when D310 and D315 are reverse biased by C341. When C341 discharges to a level forward biasing D310 and D315, C340 discharges through R309, D310, D315 and R313. Silicon diodes D310 and D315 have a forward voltage drop of 0.6 volts each. They are connected in series and conduct only on levels higher than +1.2 volts. C340 controls Q307 and thus controls the voltage present on the AGC lines 1 and 2.

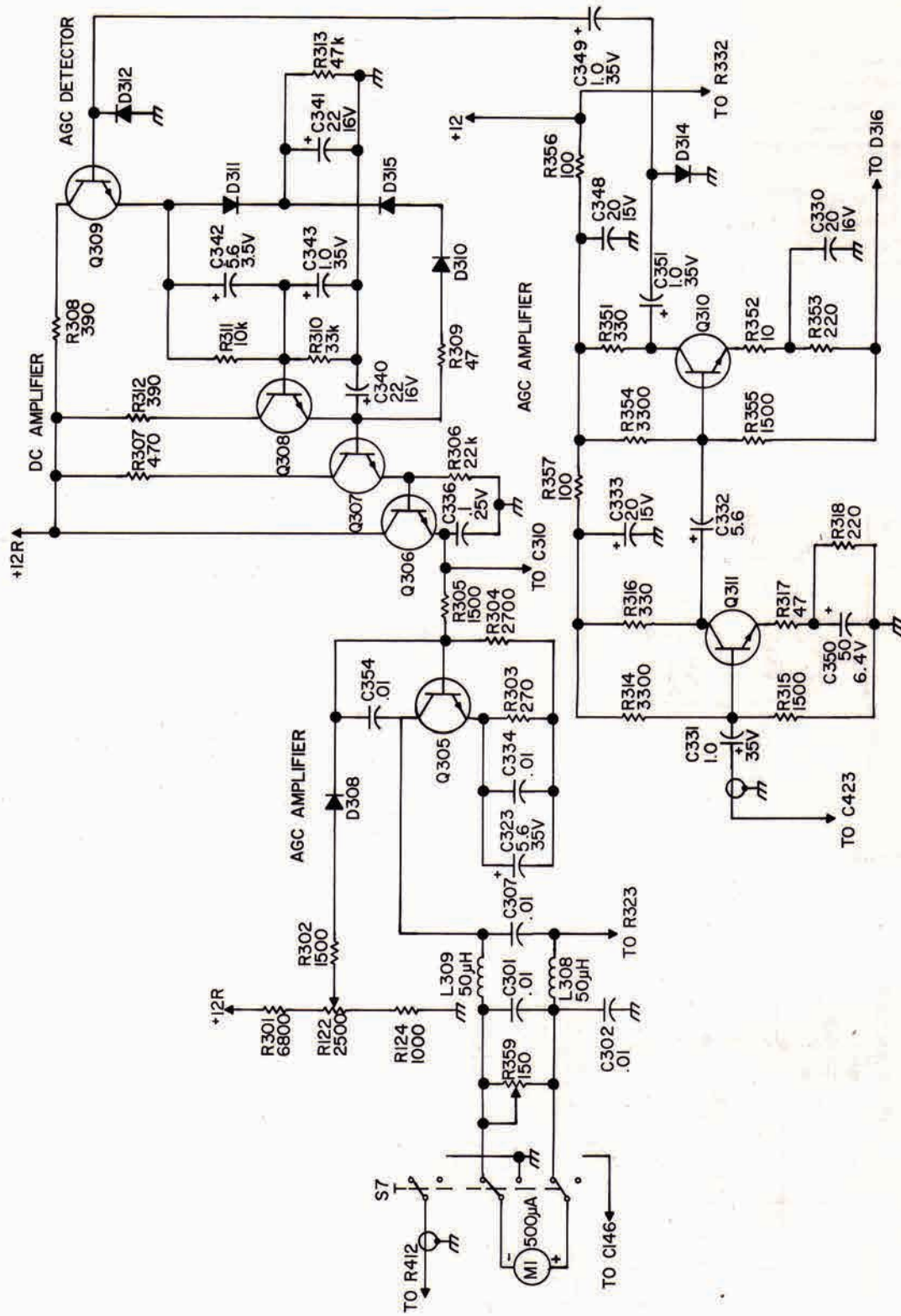
Two emitter follower output stages provide positive DC drive for AGC line 1 and AGC line 2 which are driven by driver and S-Meter amplifier, Q305. AGC line 1 controls the gain of series attenuator Q201 and emitter impedance changers Q203 and Q301. AGC line 2 controls the gain of shunt attenuator Q207.



SIDEBAND FILTERS
FIGURE 4-8



IF AMPLIFIERS
FIGURE 4-9



AGC AMPLIFIERS
FIGURE 4-10

CIRCUIT DESCRIPTION (cont'd)

4.14 BALANCED MODULATOR/PRODUCT DETECTOR

(Figure 4-11)

4.14.1 BALANCED MODULATOR (TRANSMIT)

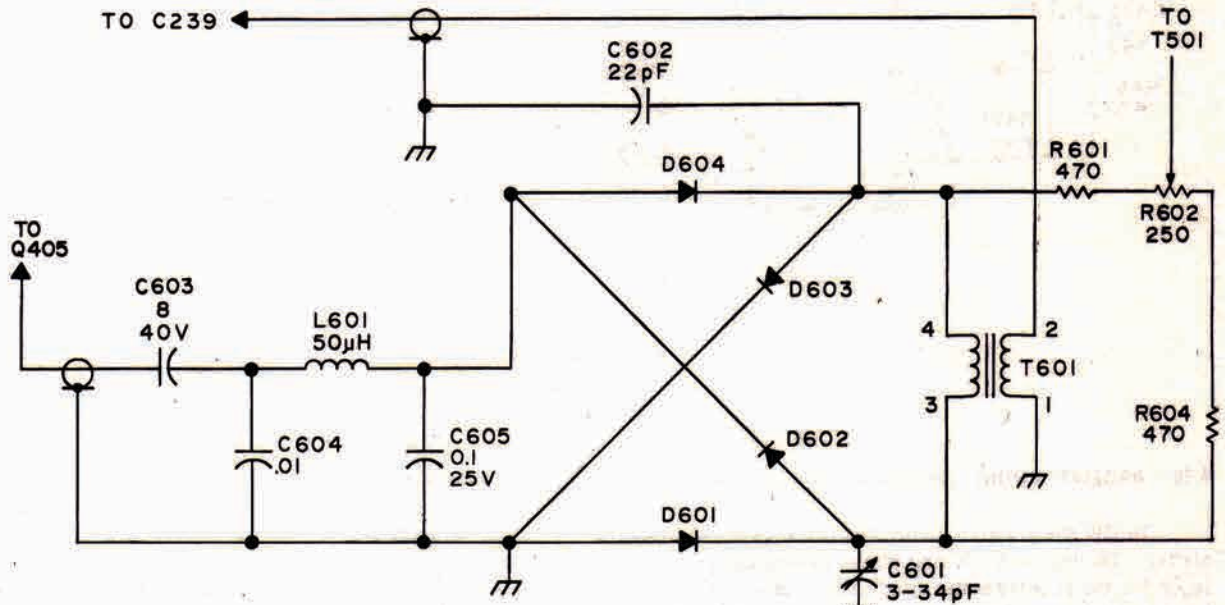
The balanced modulator consists of D601, D602, D603, D604, R601, R602, R604, C602 and C601. The carrier balance controls are C601 and R602. They compensate for the resistance and capacitance variations of the diodes. In the balanced condition the bridge does not provide an output with an input from the carrier oscillator. An additional input must be available. This input is the transmit audio from the emitter of Q405. The audio is coupled by C603 through an RF filter consisting of C604, L601 and C605 to the diode bridge. The audio input unbalances the bridge and causes it to conduct. The resulting output is double sideband suppressed carrier, or the 9 MHz from the carrier oscillator plus the audio frequency and the 9 MHz carrier minus the audio frequency. The output is coupled to the crystal filters.

4.14.2 PRODUCT DETECTOR (RECEIVE)

The balanced modulator acts as a product detector in receive. In receive condition the product detector's additional input is from the 3rd IF amplifier. Remember that the carrier oscillator is operating continuously. These two signals are mixed together. The resulting audio is the difference frequency. An RF filter network consisting of C604, L601 and C605 allows audio through, but L601 blocks RF and C604 and C605 bypass it to ground. C603 couples the audio to Q405, where it is amplified and applied to the receiver audio circuits.

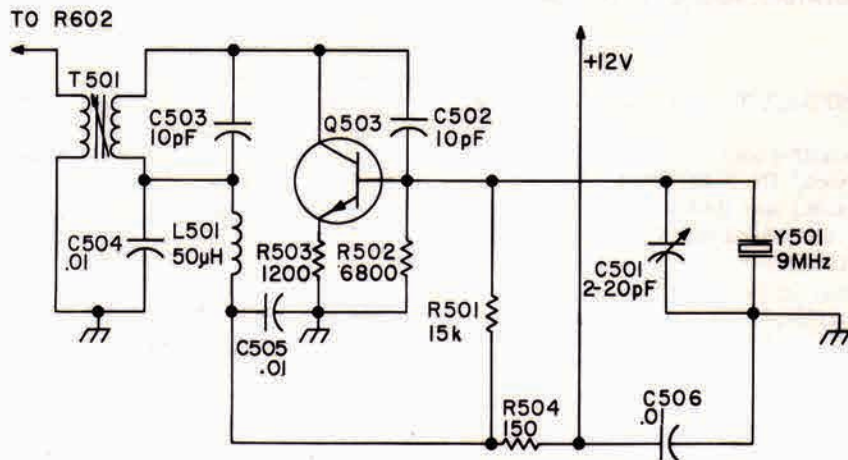
4.15 CARRIER OSCILLATOR (See Figure 4-12)

The carrier oscillator is a crystal oscillator using a parallel resonant crystal, Y501, in its base circuit. The collector is loaded with a parallel tuned resonant circuit consisting of T501 and C503. C501 sets the crystal frequency precisely on 9.000000 MHz. C502 provides feedback between the base and collector. The unbypassed emitter provides some degeneration for stability and minimum distortion. The output of the carrier oscillator is coupled by T501 to the balanced modulator.

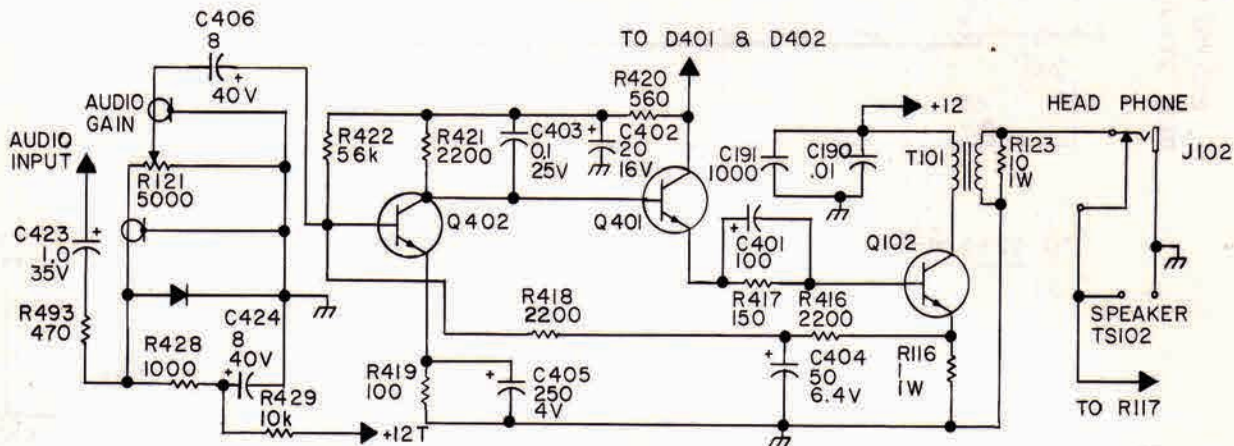


BALANCED MODULATOR AND PRODUCT DETECTOR
FIGURE 4-11

CIRCUIT DESCRIPTION (cont'd)



CARRIER OSCILLATOR
FIGURE 4-12

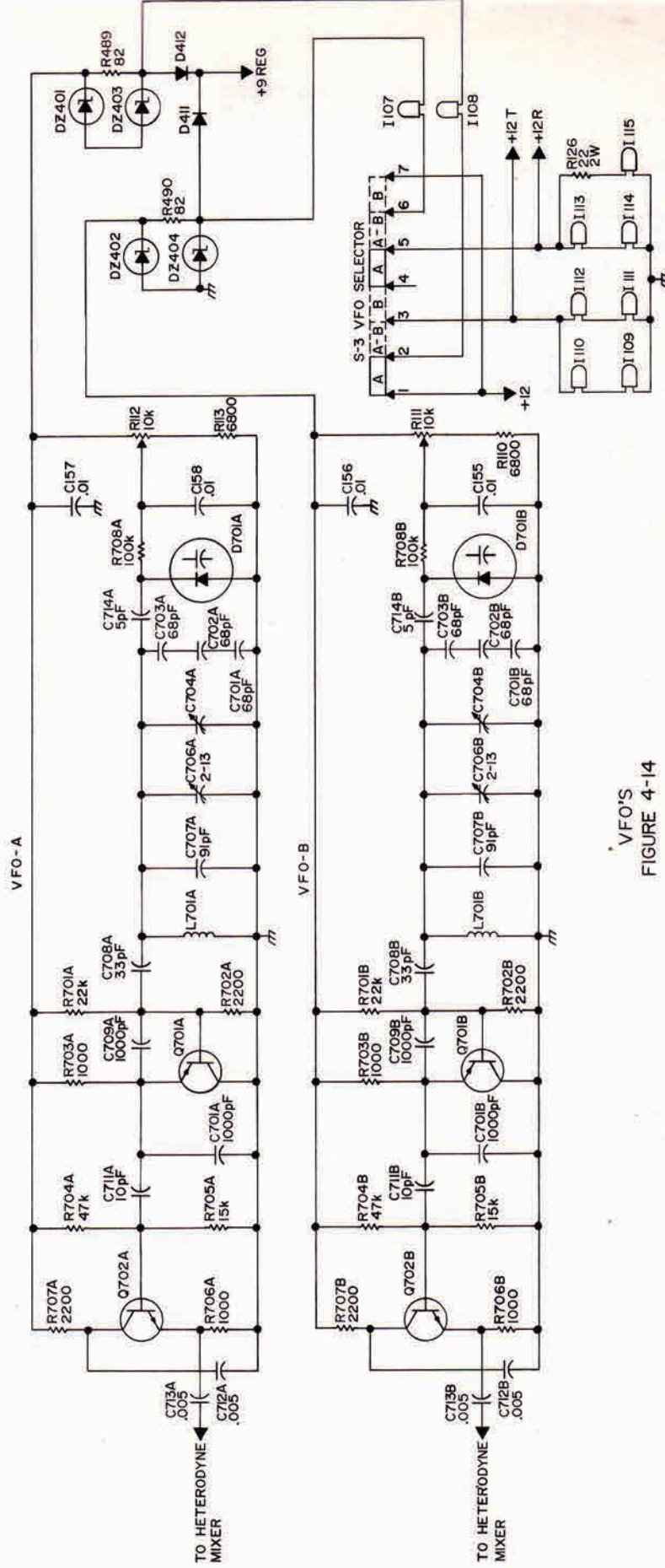


RECEIVE AUDIO
FIGURE 4-13

4.16 RECEIVE AUDIO (Figure 4-13)

In CW the receive audio functions as a sidetone amplifier. During both CW and phone modes of operation the input for the receive audio section is coupled from the collector of Q405 by C423 to the audio gain control, R121. In CW the +12 T line is applied across R428 and D405 in the forward direction. D405 is the audio level set control. Its conduction is controlled by the audio gain potentiometer, R121. The audio from the gain control is coupled by C406 to the base of Q402, the audio preamplifier. The output from the collector of Q402 is direct coupled to the base of

the driver stage, Q401. Q401 provides the power and current gain necessary to drive audio output stage Q102. The series network (C401 and R417) connected between the emitter of Q401 and the base of Q102 provides two functions: R417 limits and C401 improves low frequency response. Negative DC feedback is used between the emitter of Q102 and the base of Q402. The feedback loop path is through isolating resistors, R416 and R418. C404 provides audio filtering. This feedback linearizes the output and improves temperature stability. The output of Q102 is transformed by T101 and applied to the audio load (speaker or head-phone).



VFO'S
FIGURE 4-14

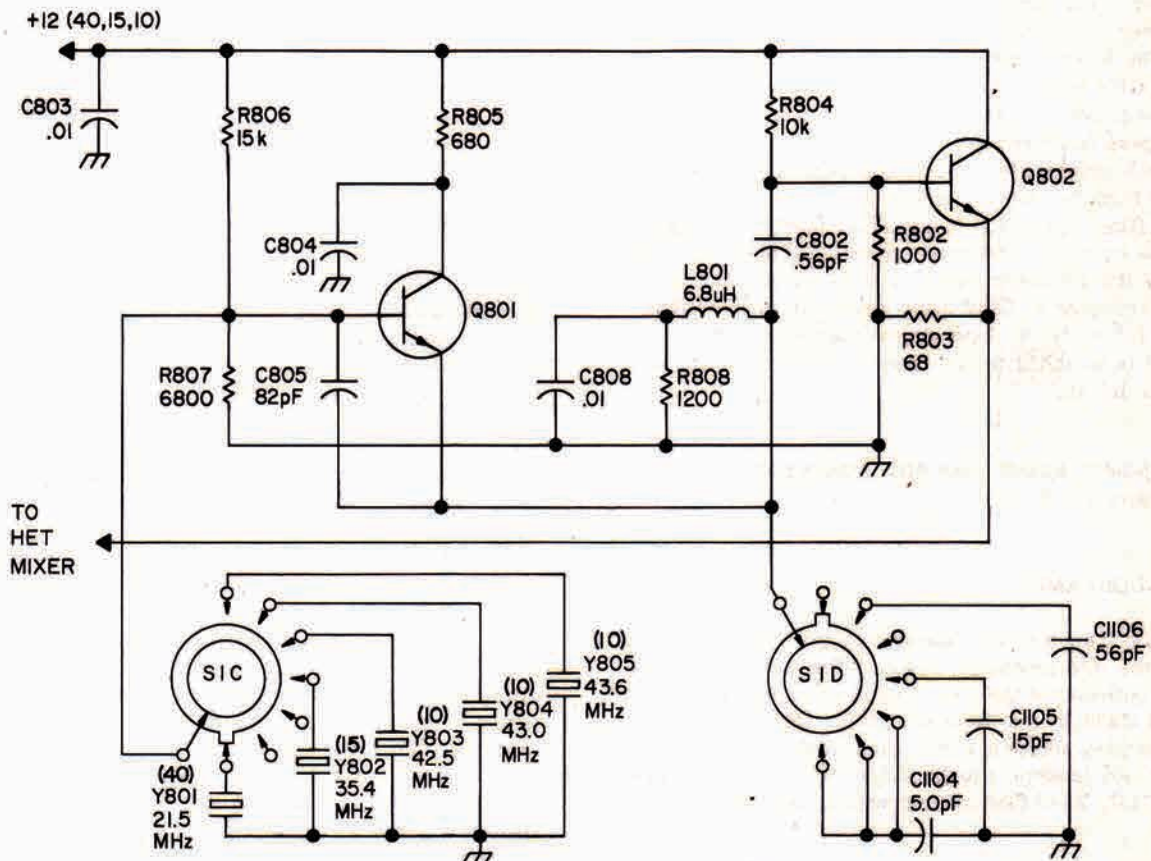
CIRCUIT DESCRIPTION (cont'd)

4.17 VFO's (Figure 4-14)

Two VFO's (variable frequency oscillators) are used in the Avenger. Each VFO covers a frequency range of 4.9 to 5.5 MHz. A rocker switch on the front panel is the VFO selector. VFO power is regulated by a zener diode network. DZ401, DZ403, I108 and R489 provide +6.8 volts double regulated for VFO A. DZ402, DZ404, I107 and R490 provide +6.8 volts double regulated power for VFO B.

The VFO selector, S3, depending upon its positions, switches +12 volts to either regulator, and thus 6.8 volts to the desired VFO. DZ403 and DZ404 are 9.1 volt diodes using I108 and I107 for variable dropping resistors, respectively. This 9 volts is used for the +9 volt regulated line. D412 and D411 provide isolation to prevent voltage from appearing on the VFO not in use while continuously providing the +9 volts to the regulated line. In position A and in position B of the VFO selector switch, the +12 volt line provides the power for the regulator circuit in use and, subsequently, to the desired VFO. In position A-B, however, the +12 receive line provides the power for VFO B and the +12 transmit line provides the power for

VFO A. This automatically switches VFO A in transmit and VFO B in receive. The VFO's exhibit excellent frequency stability. Frequency stability is better than ± 150 Hz total drift from turn on. Diodes D701 A (VFO A) and D701 B (VFO B) are conventional small signal silicon diodes. But both diodes are reverse biased and provide the same function as varactors. Potentiometers R112 (VFO A) and R111 (VFO B) control the bias applied to the diodes and are used as the calibrate tuning controls. The calibrate tuning controls have a range of approximately ± 1.5 kHz. The VFO oscillator stages are Q701A (VFO A) and Q701B (VFO B). Q702A and Q702B are emitter follower buffers. They present a high impedance to the oscillators and reduce loading. VFO output is coupled to the base of the heterodyne mixer, Q901. The capacitors in parallel with coil L701, complete the tuned circuit. C707 is a precision 1% padder capacitor. C706 is the trimmer capacitor for final calibration and bandspread. C704 is the main tuning capacitor. C701, C702 and C703 are temperature compensation (TC) capacitors. The three TC capacitors in series virtually eliminate TC tolerances commonly realized in temperature compensating capacitors, for excellent VFO stability over wide temperature changes.



CRYSTAL OSCILLATOR
FIGURE 4-16

CIRCUIT DESCRIPTION (cont'd)

4.18 CRYSTAL OSCILLATOR (Figure 4-16)

The crystal oscillator consists of an oscillator, five crystals, and an emitter follower buffer output stage. Crystal selection is made by the bandswitch knob on the front panel. The oscillator operates on the 40, 15 and 10 meter bands. Only the VFO output is used on the 80 and 20 meter bands. The oscillator stage, Q801, is a grounded collector type with feedback between base and emitter. The amount of feedback is determined by a capacitor selected by bandswitch wafer S1D and switched from the emitter to ground. This provides a capacitance divider from the base to ground with the emitter connected to the variable tap. The crystals are selected by bandswitch wafer S1C. The output of the oscillator is coupled from the buffer emitter by C1103 to the heterodyne mixer. Here it is mixed with the output of the VFO.

4.19 HETERODYNE MIXER AND EMITTER FOLLOWER (Figure 4-15)

The outputs from the VFO and the crystal oscillator (on 40, 15 and 10 meter bands) are applied to the heterodyne mixer. The output from the crystal oscillator emitter follower is coupled by C1103 and C166 to the base of Q901. The VFO output is coupled through L901, L902, R902 and C166 to the base of the heterodyne mixer, Q901. The output of Q901 is taken from the collector and applied to a bandpass filter selected by bandswitch wafers S1E and S1F. The bandpass filters attenuate spurious and harmonic outputs from the heterodyne mixer. The output from the bandpass filter is coupled from S1F by C167 to the base of Q902. The emitter follower configuration of Q902 prevents loading of the bandpass filter tuned circuits. The output of Q902 is coupled by C189 to the junction of diode switches D203 and D204. Here, depending on the mode of operation, the signal is switched to the receiver mixer or the transmit mixer driver.

4.20 TRANSMIT AUDIO AMP AND COMPRESSOR (Figure 4-17)

4.20.1 AUDIO AMP

Audio from the microphone is coupled by C450 to the base of the mic amplifier, Q406. The amplified audio from the collector of Q406 is coupled through C429, R450, R451 and C430 to the base of Q407. Q407, along with Q408, provides additional mic audio amplification. The output of Q408 is coupled to the SSB/CW switch stage, Q414, through C437, R120 (SSB drive control), and C425.

4.20.2 SYLLABIC COMPRESSOR

Audio from the microphone is maintained at a nearly constant amplified level by a compression loop between the

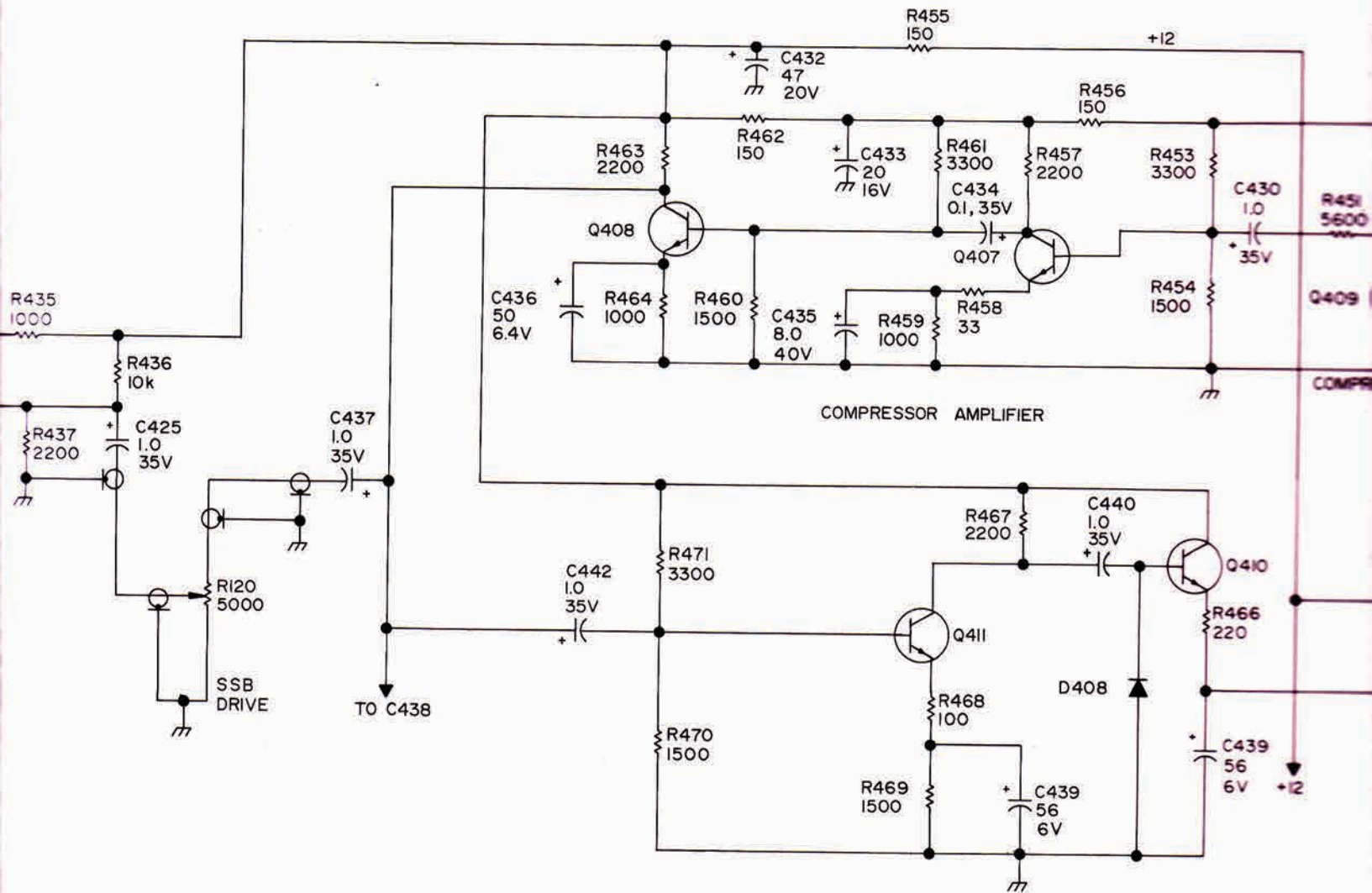
collector of Q408 and the junction of R450 and R451. Output from the collector of Q408 is coupled to the base of the compression amp, Q411, by C442. Q411 drives the compressor detector, D408, connected between the base of Q410 and ground. D408 provides a low resistance DC path for the base current of Q410 without loading Q411 on low level signals. With Q410 turned on current flow occurs between its collector and emitter and C439 charges quickly through R446. C439 charging turns on the compressor transistor, Q409. Q409 functions as a shunt audio attenuator. The rising emitter voltage of Q410 increases the conduction of Q409. This lowers the impedance between the collector of Q409 and ground, reducing the microphone audio amplitude at the junction of R450 and R451. This decreases the overall microphone amp loop gain. C439 discharges rapidly through the base-emitter diode of Q409. The time constants are such that the circuit responds quickly both in attack and decay at a rate that is in accordance with the syllabic rate of speech. Thus the actual peak to valley ratio of the audio envelope of speech is changed. This causes speech compression without appreciable audio distortion. The result is truly more average power in the speech envelope for the same peak power.

4.21 DRIVER AND POWER AMPLIFIER (Figure 4-18)

4.21.1 DRIVER

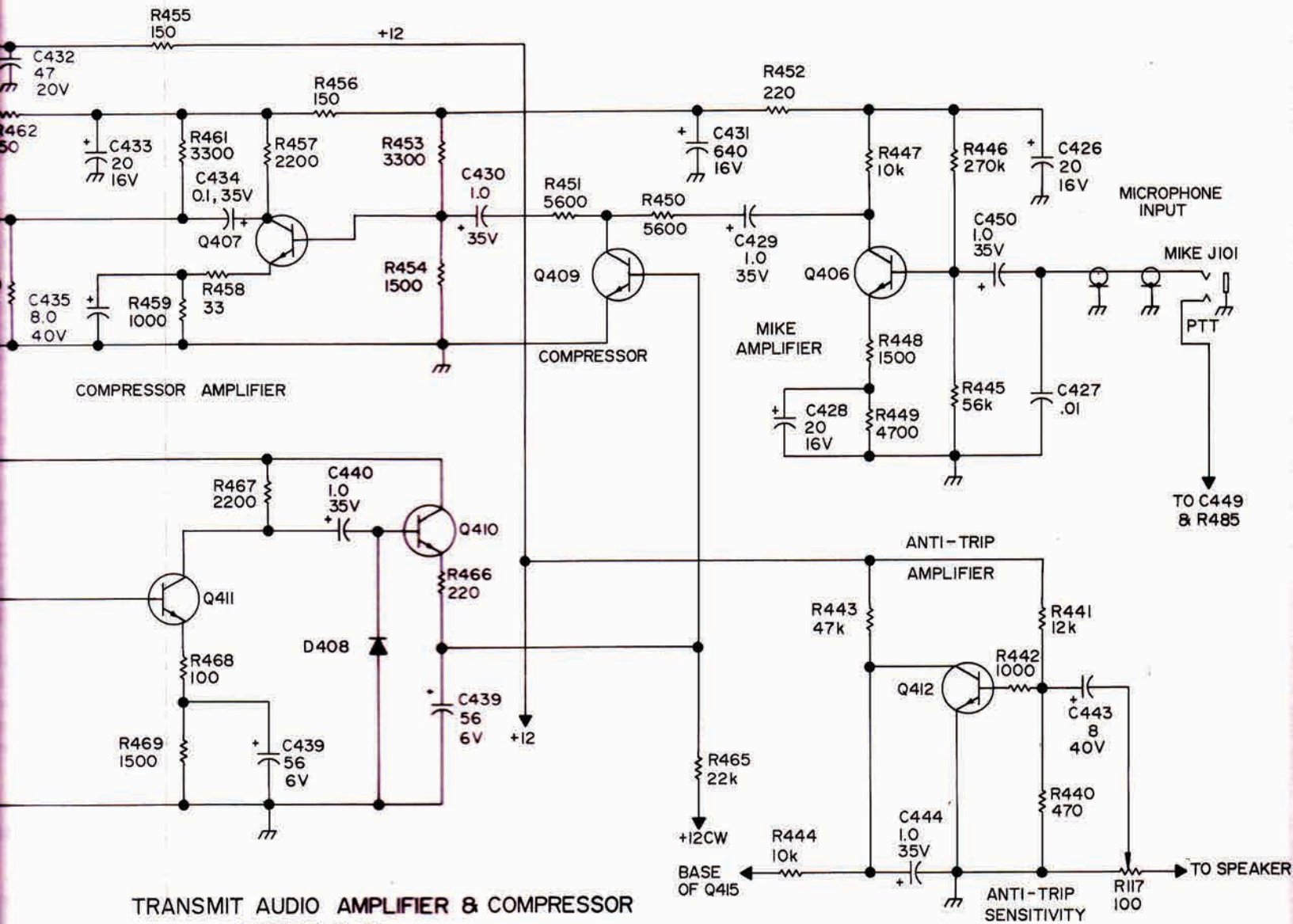
In receive condition the cathode of V103 is lifted off ground by the nonconducting (off) state of Q208. The base of Q208 is connected to the +12 T line. In transmit operation, RY102 energizes and switches the +12 line from +12 R to +12 T. This applies +12 T to the base of Q208 through R203. Q208 switches into saturation. In this condition, Q208 provides a ground path for the cathode of V103. The input to the control grid of V103 is furnished by the transmit mixer, Q204. Figure 4-18 shows that the tuned circuit that acts as a collector load for the transmit mixer, Q204, and grid tuning for the driver tube, V103, is also used in receive for the collector load of the RF amplifier, Q202, and the base tuning of the receive mixer, Q205. This is important because the driver grid tuning affects the receiver front end tuning. The most critical tune condition is transmit. A slight mistuning of the receiver might only make one S unit difference in the ultimate sensitivity of the receiver. However, one S unit mistuning of the transmitter might well make a 120 watt difference in output. So peak the RF tune in transmit. The output of the driver is coupled to the power amplifiers' grids by C1108 and C115. Tuned circuits for the driver plate circuit are selected by bandswitch wafers S1J and S1K. These tuned circuits perform the transmit driver - final grid tuning as well as the antenna - RF amplifier input tuning in receive. They are tracked with the coils previously mentioned and all are tuned with the RF tune control concentric with the mode switch. The explanation above of the receive-transmit sharing applies to both groups of coils.

TRANSMIT AUDIO AMPLIFIER

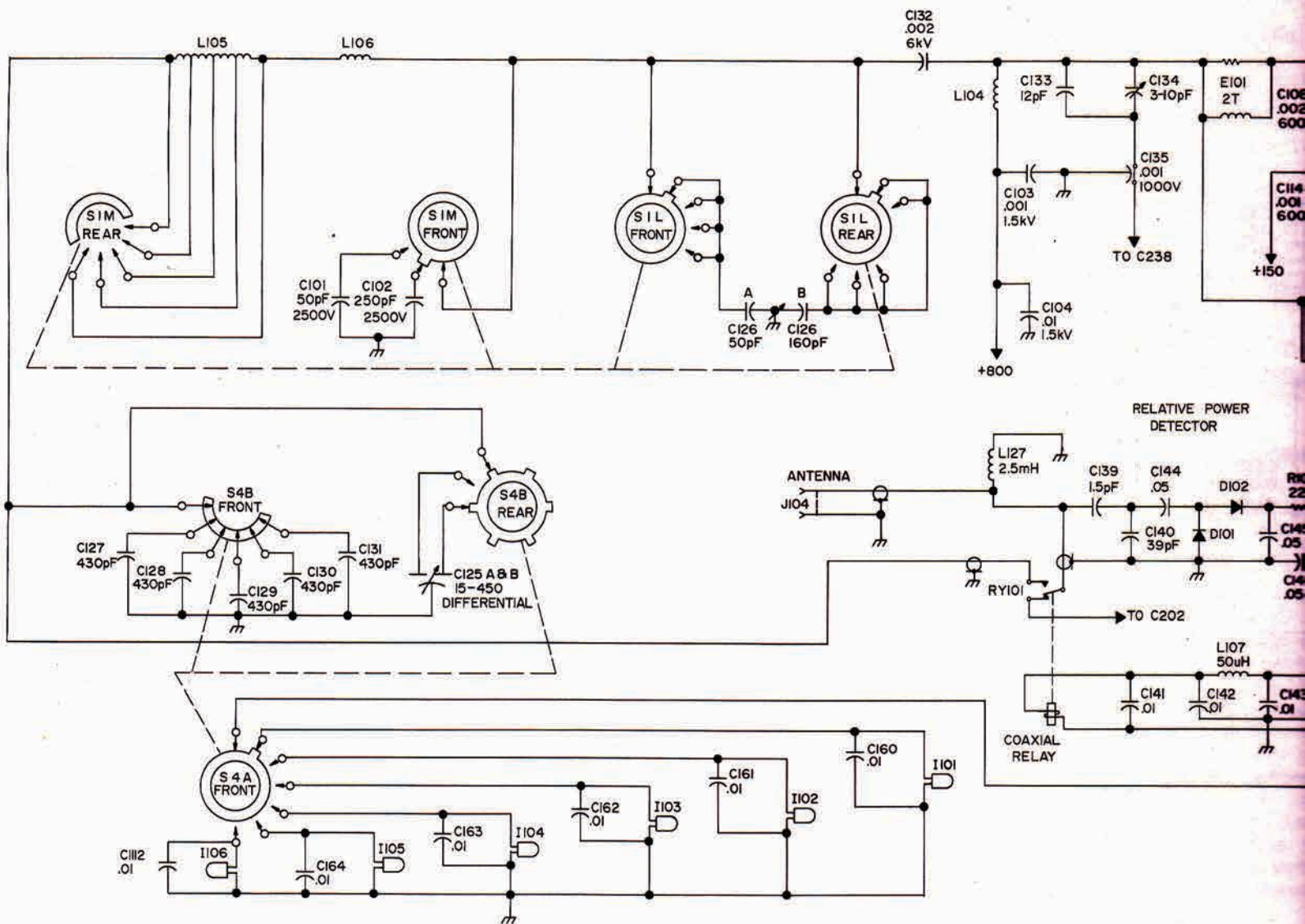


TRANSMIT AUDIO AMPLIFIER & COMPRESSOR
FIGURE 4-17

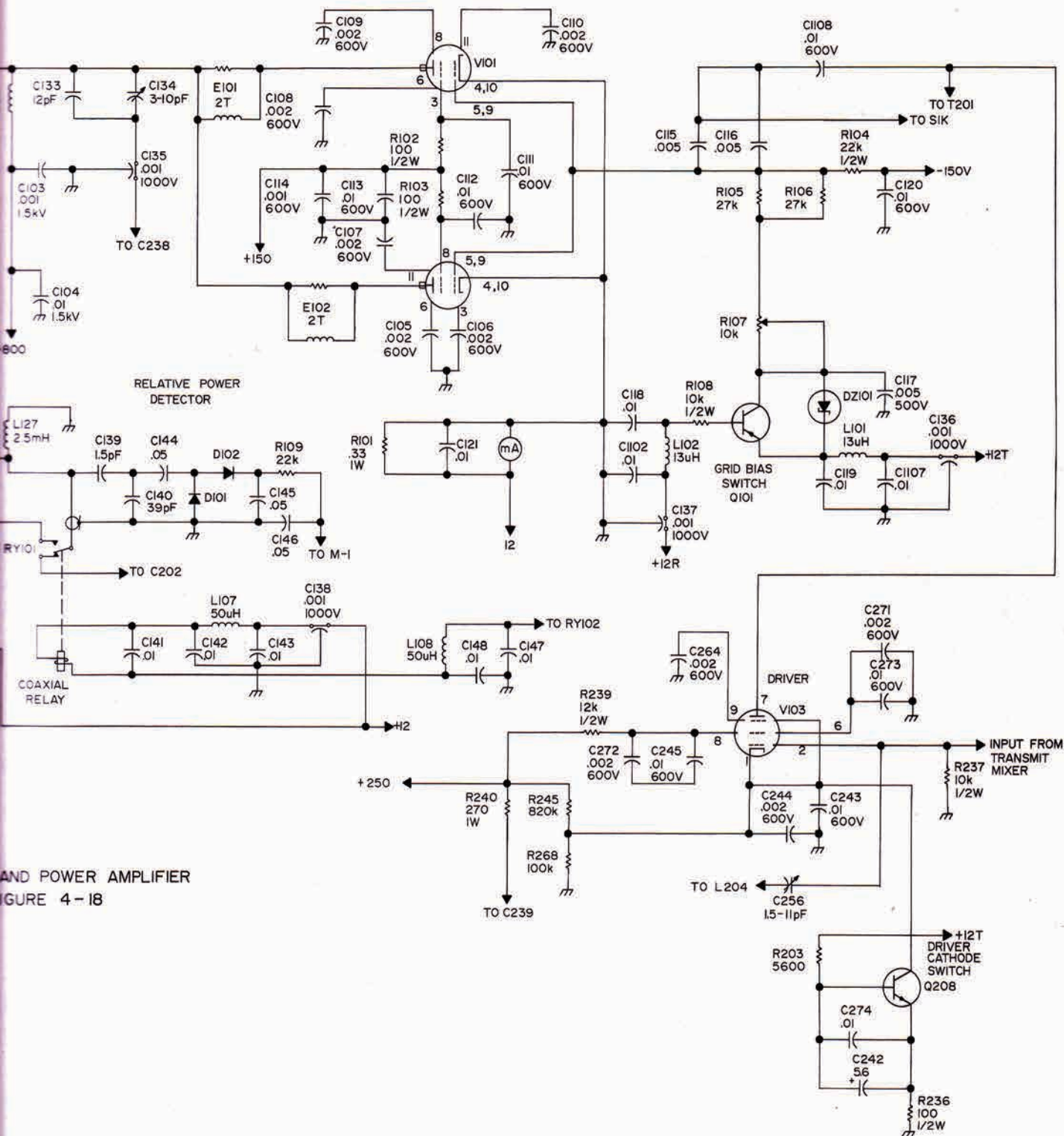
TRANSMIT AUDIO AMPLIFIER



TRANSMIT AUDIO AMPLIFIER & COMPRESSOR
FIGURE 4-17



DRIVER AND POWER AMPLIFIER
FIGURE 4-18



AND POWER AMPLIFIER
FIGURE 4-18

CIRCUIT DESCRIPTION (cont'd)

There may be a slight difference in tuning on the higher frequency bands between receive and transmit. The front end, or preselector, tuning is done by peaking the drive to the final in transmit and any slight degradation in the ultimate receiver sensitivity will not usually be of any consequence. The receiver sensitivity of 10 dB minimum S+N/N at 0.5 μ V will still be realized.

4.21.2 POWER AMPLIFIER

In receive condition the power amplifiers are biased off by the -150 volt PA bias line. Approximately 100 volts is dropped across Q101. DZ101 is a 91 volt zener diode. It protects Q101 by conducting at any level of voltage above 91 volts. In transmit condition, RY102 energizes and connects the emitter of PA grid bias switch, Q101, to the +12 T line. Simultaneously, +12 R is grounded, connecting the base of Q101 to ground. Q101 switches to the conducting state. When the grid bias of the class AB1 power amplifiers (V101 and V102) drops to approximately 55 volts, the amplifiers conduct. +800 volts B+ is applied to the power amplifiers through RF choke L104 and parasitic suppressor E101. L104 prevents RF from getting into the +800 volt supply. C103 provides bypassing for any residual RF on the supply side of L104. E101 is a parasitic suppressor in the plate circuit.

C133 is the bridge neutralization control. It adjusts the required amount of negative feedback. This type of final amplifier neutralization is called grid neutralization. This means the grid is neutralized. Any signal that is fed back to the grid from the plate circuit through the inter-electrode capacitance in the tube is cancelled out by feeding back an identical voltage to the other end of the tuned circuit in the grid. This causes the two voltages to be cancelled in the grid circuit and negates any affect they could have. The driver tube neutralization is called plate neutralization. Here the voltage that may be fed back to the grid from the plate circuit through the inter-electrode capacitance is cancelled out by sampling a voltage that is 180° out of phase in the plate circuit and feeding it back to the actual grid. Thus the out of phase voltage is in the plate circuit. Since the driver tube plate circuit and the final amplifier grid circuit use the same coil and the final is grid neutralized and the driver is plate neutralized the capacitive bridge circuits for the respective tubes are common in C135. This is the bypass capacitor for the ground end of the final amplifier grid circuit (and of the driver plate circuit). C135 is also the ground end bypass for the RF amplifier input circuits in the receiver. C134 and C256 are the final amplifier and driver amplifier neutralizing capacitors, respectively. They adjust the amount of feedback voltage in each case. Bandswitch wafer S1L, front and rear, selects the sections of tuning capacitor C126 used. Wafer S1M selects the necessary parallel capacitance for C126. S1M selects the taps of output coil L105. S4B rear selects the loading capacitor, C125. S4A selects the parallel capacitance for C125. The output of the power amplifiers passes through the pi network, the energized contacts of RY101, and to the antenna.

An RF detector consisting of L127, C139, C140, D101, D102, C145, R109 and C146 provides DC voltages for the relative power output meter.

4.22 VLX-VOICE LATCHED TRANSMIT (Figure 4-19)

The voice operate circuit in the Viking AVENGER is called VLX because of the "Latch" affect of the multivibrator, or flip flop, in triggering the transceiver to the transmit state. The effect is to provide a much faster triggering into transmit than is realized with the commonly used "rectified audio" circuitry. Latch speed is not affected by voice volume. When the preset "threshold" level is exceeded the radio trips into transmit at the same speed regardless of microphone output level.

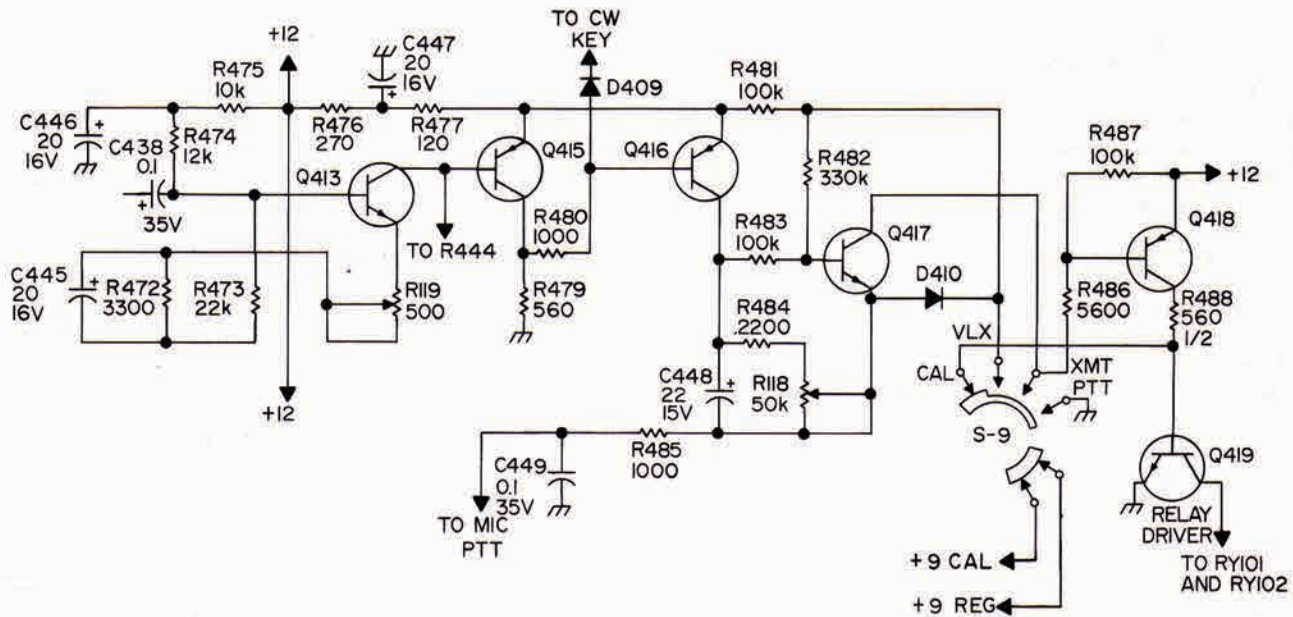
The amplified audio from microphone amp, Q408, is coupled to Voice Latched Transmit (VLX) amplifier, Q413, by C438. Q413 functions as the triggering element for a monostable multivibrator circuit consisting of Q415 and Q416. The conduction of Q413 turns Q415 off. Q415 is coupled to Q416, collector to base, through R480. The non-conducting state of Q415 quickly switches Q416 on. The conducting state of Q416 allows the base bias of Q417 to go positive. Q417 starts to conduct and drives relay amplifier Q418 into conduction. The conducting state of Q418 provides forward bias for Q419, the relay driver. Q419 conducts and provides a DC ground path for relays RY101 and RY102. Both relays energize and activate the transmitter circuitry.

VLX adjustments are provided for anti-trip, delay and sensitivity. Anti-trip adjustment R117 sets the input level to anti-trip amplifier Q412. The input to Q412 is the output from the speaker. R117 is set so that the receiver audio will not trip the VLX circuit. Q412 conduction determines the turn-off level of Q415. R118 is the VLX delay adjustment. It sets the turn-off time of Q417. R119 is the VLX sensitivity adjustment. It adjusts the operating point of Q413. All three VLX adjustments are located at the rear of the Avenger.

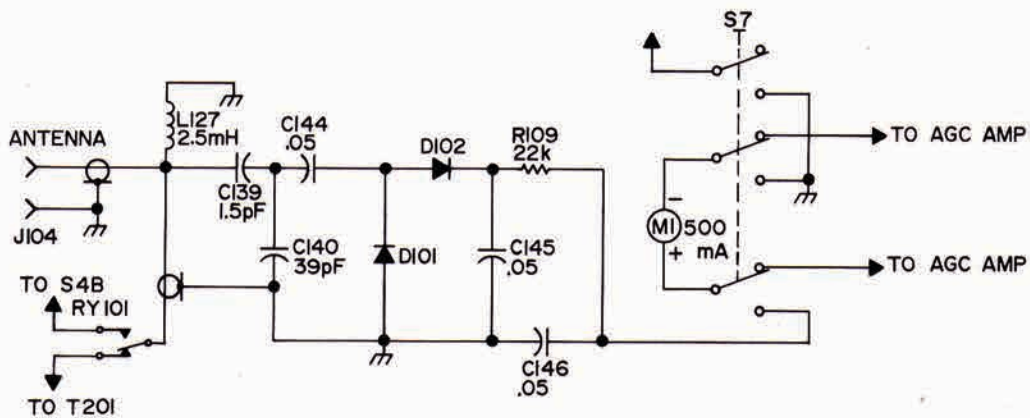
4.23 S-METER AND RELATIVE POWER INDICATOR (Figure 4-20)

During receive, the S-Meter is operated by the DC AGC voltage. An increase in received signal causes an increase in the AGC voltage which causes an increase in the S-Meter reading. The S-Meter is calibrated to read S-9 at 100 μ V at the antenna terminal. Whenever the TUNE button is depressed the S-Meter indicates relative power output. If the radio is in VLX and CW the TUNE button keys the transmitter. This ordinarily occurs during transmitter tuneup. Whenever the transmitter is on the air in either SSB or CW modes the TUNE button may be depressed to check transmitter output. A rectifier filter network connected to the antenna terminals converts a small portion of the transmitted signal to operate the S-Meter.

CIRCUIT DESCRIPTION (cont'd)



VLX AMPLIFIER
FIGURE 4-19



S-METER AND RELATIVE POWER INDICATOR
FIGURE 4-20

4.24 1 kHz OSCILLATOR AND CW KEYING SWITCH
(Figure 4-21)

The 1 kHz oscillator is a three section phase-shift type with feedback from collector to emitter. Each of the RC sections shifts the phase 60° . The total phase shift is the sum of the three RC sections, or 180° . The frequency is adjusted by phase-shift controls R404, R405, and R406. The 1 kHz output is applied to buffer stage, Q404. The output of the buffer is coupled to the CW drive control by

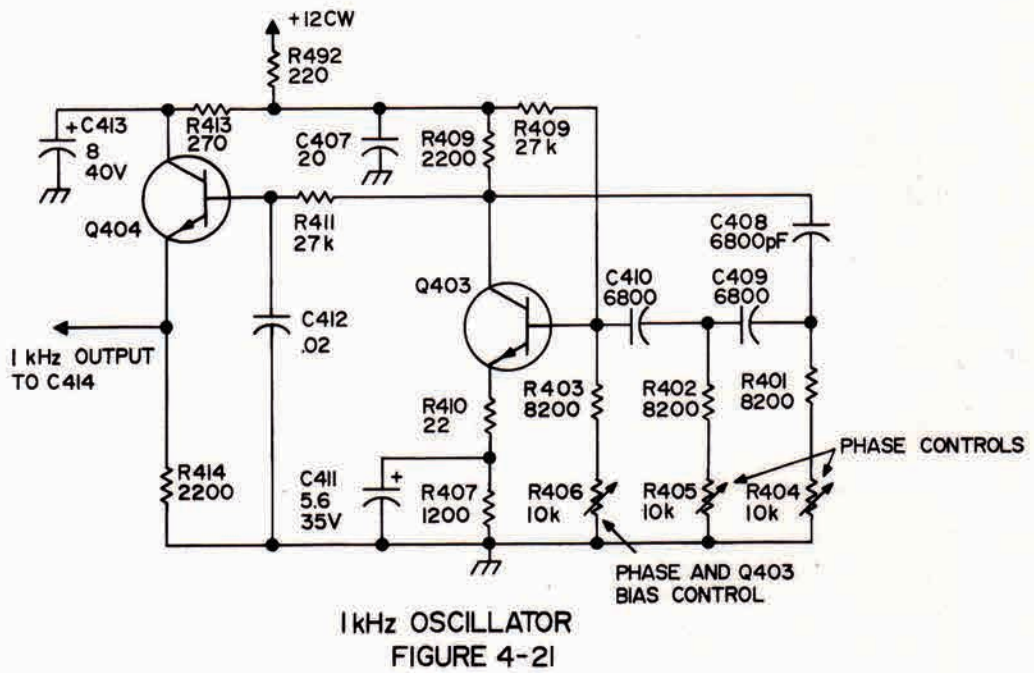
C414. The CW drive control, R491, is set for a 1 kHz audio level of 70 mV at the emitter of Q405 with the key line connected to ground. The audio is coupled by C415 through the CW audip switch, D403 and D404. C416 couples the audio from D404 to the base of the balanced modulator driver, Q405. Here the CW audio is amplified and applied to the balanced modulator.

The CW switch operates in the following manner: selecting the CW function with the mode switch applies

CIRCUIT DESCRIPTION (cont'd)

+12 CW to the switching diodes, D404 and D403. D404 and D403 are reverse biased with the CW key open. Closing the key shorts the DC at the diode cathodes to ground

through R415 and R412. Both diodes are forward biased and the CW audio passes through to the balanced modulator driver.

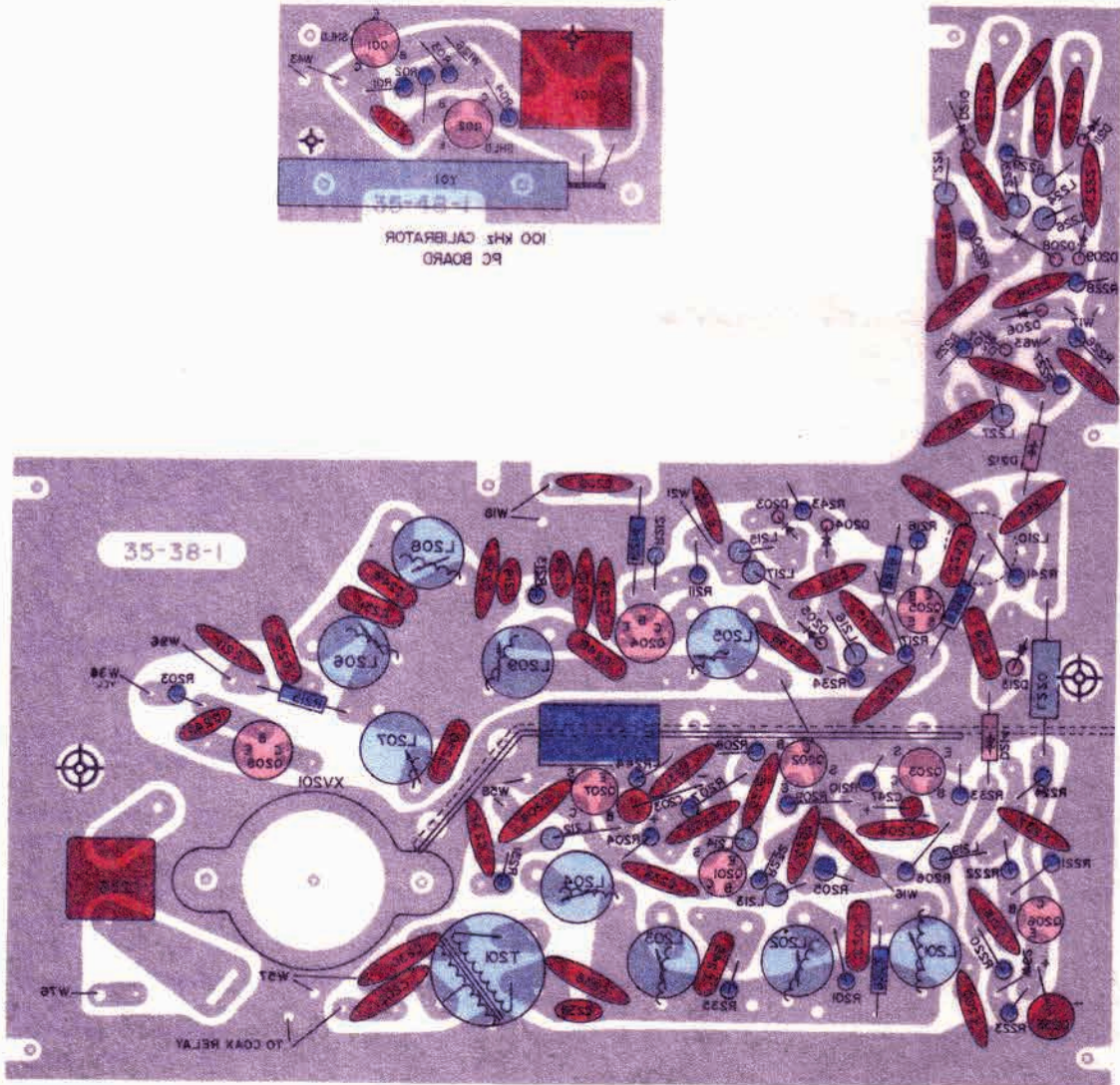
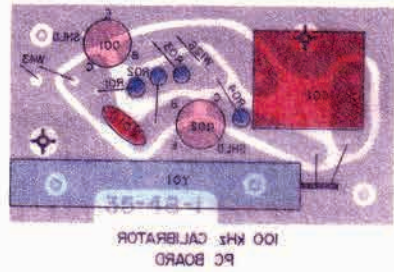


TRANSPARENCIES

Facing this page and on two pages preceeding the Maintenance Section are printed circuit transparencies. These indicate parts layouts as viewed from either side.

To use the transparencies, first turn the transparency page so that it is on the facing page labeled "COMPONENT SIDE". The transparency nomenclature now reads correctly. Locate the component. If servicing is to be done on the solder side of the board, mark the component's location, then turn the transparency page to the "SOLDER SIDE" facing page to view the component as seen through the solder side of the board.

- TRANSISTORS AND DIODES
- RESISTORS
- RELAYS, TRANSFORMERS AND COILS, CRYSTALS
- CAPACITORS



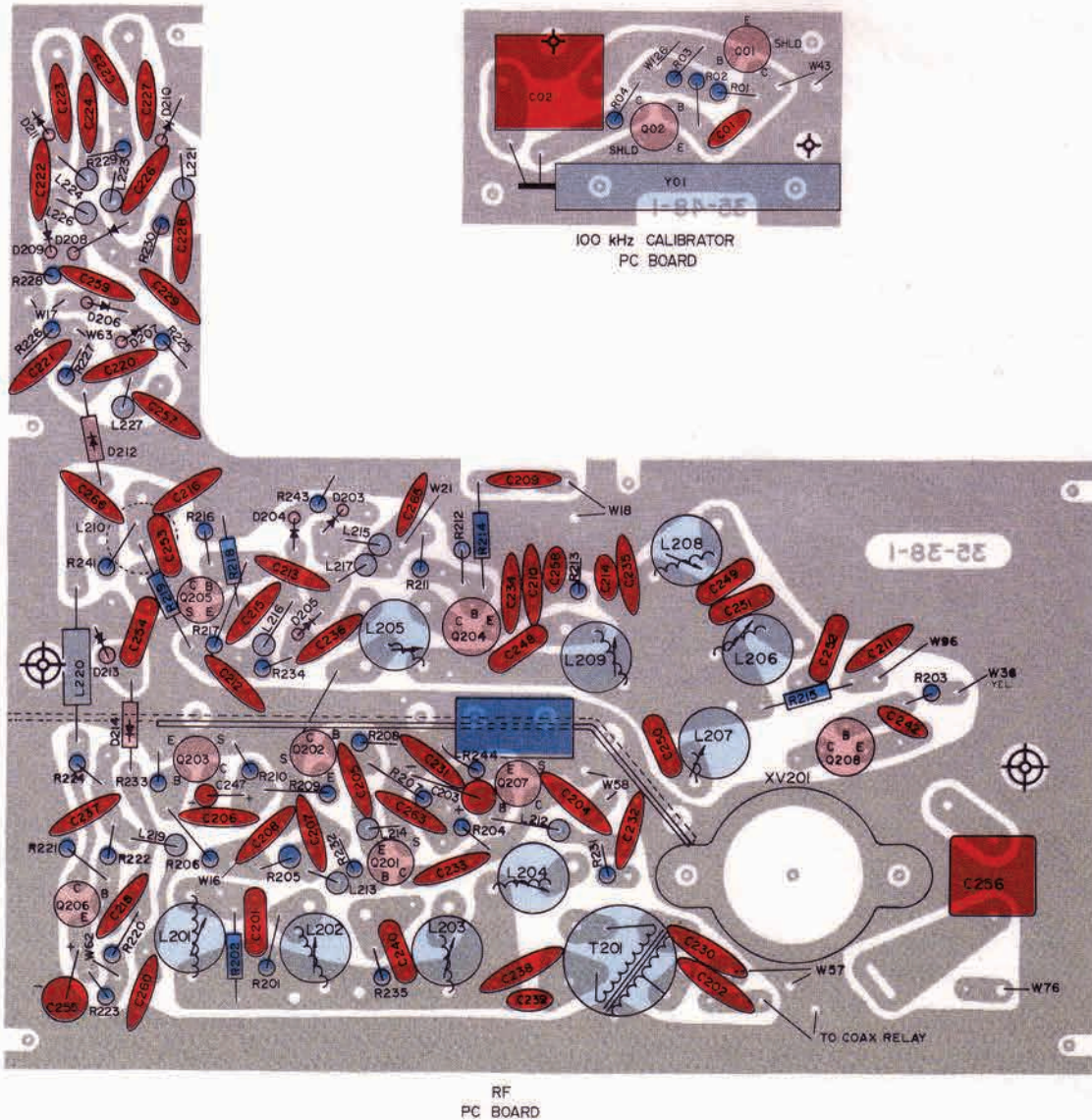
PC BOARD RF

TRANSPARENCIES

Facing this page and on two pages preceding the Maintenance Section are printed circuit transparencies. These indicate parts layouts as viewed from either side.

To use the transparencies, first turn the transparency page so that it is on the facing page labeled "COMPONENT SIDE". The transparency nomenclature now reads correctly. Locate the component. If servicing is to be done on the solder side of the board, mark the component's location, then turn the transparency page to the "SOLDER SIDE" facing page to view the component as seen through the solder side of the board.

- CAPACITORS
- COILS, CRYSTALS, TRANSFORMERS AND RELAYS
- RESISTORS
- TRANSISTORS AND DIODES



SECTION 1

1. The first part of the document discusses the general principles of the project and the objectives to be achieved. It also outlines the scope of the work and the resources available.

SECTION 2

2.1. Description of the Project

The project is aimed at developing a new system for data processing. The main objectives are to increase the efficiency of the existing system and to reduce the risk of data loss. The project will be carried out in three phases: analysis, design, and implementation.

The first phase, analysis, involves a detailed study of the current system and the requirements for the new system. This will include a review of the existing hardware and software, and a consultation with the users of the system.

The second phase, design, will involve the development of a detailed design for the new system. This will include the selection of the hardware and software to be used, and the development of a data flow diagram and a user interface design.

The third phase, implementation, will involve the installation and testing of the new system. This will include the migration of data from the old system to the new system, and the training of the users of the new system.

The project is expected to be completed by the end of the year. It is hoped that the new system will provide a significant improvement in the efficiency of the data processing system and will reduce the risk of data loss.

SECTION 5

SIMPLIFIED OPERATION

5.1 GENERAL

These simplified operating instructions are intended to help the operator who is familiar with the Avenger put it on the air in as short a time as possible. A thorough understanding of the unit is necessary for most satisfying operation. Consult the Operating Procedures, Section 6, for full operating instructions. Consult the Circuit Description, Section 4, for a complete description of Avenger circuitry.

5.2 PRELIMINARY CHECKS AND CONNECTIONS

5.2.1 CHECKS

- The Avenger AC power supply must be connected to a 110-120 VAC, 50-60 Hz line.
- The Avenger DC power supply must be connected to a 12-14.6 VDC negative ground source capable of delivering 40 amperes.
- Be sure that a properly resonated 50 ohm antenna is connected to the Avenger antenna jack (2-1). VSWR must be 1.5:1 or less.

5.2.2 PHONE OPERATION

- Connect a 3.2 ohm (nominal) speaker to the Avenger speaker terminals (3-4) or to the HEADPHONE jack (3-2).
- Connect a 50,000 ohm microphone to the Avenger MIKE jack (3-3).

5.2.3 CW OPERATION

- Connect a 600 ohm nominal headphone to the Avenger HEADPHONE jack (3-2).
- Connect a key to the Avenger KEY jack (3-1).

5.3 TO RECEIVE

- AUDIO GAIN (1-13) - Push ON.
- RF GAIN (1-12) - Set to maximum.

- AUDIO GAIN (1-13) - Set to pleasant listening level.
- BAND Switch (1-15) - Set to desired band.
- MODE Switch (1-18) - Set to desired mode.
- VFO SElector Switch (1-16)
 - Set to A.
- RF TUNE (1-19) - Tune for maximum received signal strength.
- FUNCTION Switch (1-21) - Set to Calibrate.
- VFO A (1-1) - Set to 100 kHz mark (0).
- A-CAL (1-23) - Set to null calibrator tone.
- VFO SElector Switch (1-16)
 - Set to B.
- VFO B (1-7) - Set to 100 kHz mark (0).
- B-CAL (1-11) - Set to null calibrator tone.
- FUNCTION Switch (1-21) - Set to desired transmit select function. To receive only, set to PTT.
- NB Switch (1-17) - Noise Blańker -
 - Set to OFF unless noise is a problem.
- VFO SElector Switch (1-16)
 - Set to VFO A.
- XMTR Switch (1-14) - Set to OFF if you do not plan to transmit for some time.
- VFO-A (1-1) - Set to desired frequency. Tune for most natural sounding signal. Check calibration if the desired frequency is more than 50 kHz from the calibrate point.

SIMPLIFIED OPERATION (cont'd)

- RF GAIN (1-12)
- Back off for maximum selectivity.

- Load for 350 mA with maximum power output at the dip on 80 through 15 Meters.

5.4 TO TRANSMIT (80-15 meters)

- Perform "To Receive" operations. See Section 5.5 for 10 meter instructions.

- XMTR Switch (1-14) - Push ON. Allow two minute warm up before proceeding.

- Plate Current (1-5) - Check for 50-65 mA; refer to section 7.3.6 for adjustment instructions.

- Transmitter tuning:

- MODE Switch (1-18) - Switch to CW.

- FUNCTION Switch (1-21) - VLX

- LOAD (1-9) - Preset coarse LOAD switch for the band to be tuned (fine LOAD full counterclockwise in each case). Pilot lights (1-10) should light as follows:

80 Meters - #1 lighted
40 Meters - #3 lighted
20 Meters - #4 lighted
15 Meters - #5 lighted
10 Meters - #6 lighted

These are starting points only; when loaded fully a higher number light may be on. Push TUNE switch (1-20). Quickly adjust the TUNE control (1-8) for a dip in plate current. (At this point the Avenger is transmitting in CW while untuned; its final tubes can be damaged by too long a tuning period).

- RF TUNE (1-18) - Tune for peak plate current. This peaks the drive to the final.

- LOAD (1-9) - Turn LOAD control clockwise for increased plate current (1-5) in small steps.
- Tune for dip in plate current after each loading step.

- Load for 200 to 250 mA with maximum power output on 10 Meters.

Phone Operation

- Adjust the transmit drive so that the plate current on voice peaks is not more than 63.6% of the CW plate current you loaded to. See Figure 6-1.

5.5 TO TRANSMIT (10 Meters)

- Follow instructions in Section 5.4, TO TRANSMIT (80-15 Meters), except: Peak plate current with RF TUNE control (1-18) after dipping plate current with each 20 mA of increase in plate current.

- Tune and load for 200-250 mA plate current maximum with maximum power output.

5.6 VLX OPERATION

- Adjust the VLX sensitivity control (2-4) as necessary.
- Adjust the VLX ANTI-TRIP control (2-2) to prevent undesired tripping by receiver audio.
- Adjust the VLX DELAY control (2-3) for the drop-out time you prefer.

5.7 DUAL VFO OPERATION

- Use the red VFO A (1-1) for normal single VFO transceive operation.
- Use the red VFO A to transmit and the green VFO B (1-7) to receive when using two VFO's.
- Always keep the red VFO A in the United States amateur band.
- Following rules such as these at all times will help prevent out of band transmission through selection of the wrong VFO.

NOTE: Number in parentheses reference illustrations which fold out from page 8.

SECTION 6

OPERATING PROCEDURES

6.1 GENERAL

Refer to the Front, Side and Rear Views, which fold out from page 8, for the location of all controls. Section 5 presents an extremely simplified operating procedure which can be followed by an operator who is familiar with the transceiver. You should familiarize yourself completely with the unit and study the following operating procedures, and the Circuit Description, Section 4, carefully before attempting to place the unit on the air.

If you follow these instructions carefully, and if you study the circuit description, you will appreciate more fully the unique qualities of the instrument you are using. With knowledge comes understanding. With understanding comes respect and operating craftsmanship.

6.2 RECEIVE

6.2.1 TURN-ON

Momentarily press the PUSH-ON switch (part of the AUDIO GAIN control (1-13). This applies power to all stages of the Avenger. If you do not intend to transmit, switch the transmitter XMTR switch (1-14) to OFF. This turns off the high voltage power supply, reducing current drain sharply and lengthening the life of the power amplifier and power supply components.

Set the RF GAIN control (1-12) to maximum. This is the most sensitive setting of the control. Reducing the RF GAIN sometimes reduces received QRM. To reduce received QRM observe the S meter (1-3) reading of the desired signal alone. Reduce the RF GAIN control to this reading or slightly less with the QRM present. Adjust the AUDIO GAIN control for a comfortable listening level.

Rotate the BAND switch (1-15) to the desired band. Select the desired mode with the MODE switch (1-18).

6.2.2 RF-TUNE CONTROL

Adjust the RF-TUNE control (1-19) for maximum received signal strength. The RF-TUNE control acts as a receiver pre-selector. In transmit, it tunes the grid circuit of the driver and final amplifier tubes. When re-

ceiving only, tune for maximum signal strength; when transceiving, see Section 6.4.6.

6.2.3 VFO CALIBRATOR

Whenever you change bands or move more than about 200 kHz within the same band, you should check the VFO calibration. Set the FUNCTION switch (1-21) to CAL, then rotate the VFO in use to a 100 kHz point ("0" on the VFO dial skirt). Null the calibrator tone with the A-CAL or B-CAL control (1-23 or 1-11). The A-CAL and B-CAL thumbwheels operate potentiometers that control the voltage across a varactor diode. A varactor's capacitance varies with applied voltage. The change in varactor capacitance varies the circuit capacitance sufficiently to calibrate the VFO's. As the heterodyne approaches the zero point, its level decreases because of the receiver crystal filter selectivity.

Do not operate the Avenger with the FUNCTION switch in the CAL position during normal listening. The 100 kHz signal from the calibrator causes receiver spurs.

6.2.4 FUNCTION SWITCH, T-R SWITCHING

The FUNCTION switch (1-21) selects three means of switching the Avenger from transmit to receive as well as the calibrate function. In PTT, the transmitter is turned on whenever the microphone push-to-talk (PTT) switch is depressed. In XMTR, the transceiver is manually switched to transmit. In VLX (Voice Latched Transmit) the transceiver automatically switches from receive to transmit when the operator speaks into the microphone.

6.2.5 NOISE BLANKER

The NB (Noise Blanker) switch (1-17) turns the noise blanker on and off. The noise blanker consists primarily of a noise detector, a noise amplifier and a diode gate in the receive signal path. The noise detector detects pulses at the collector of the receiver mixer. These pulses are amplified and reverse bias the gate which blocks the signal path, effectively turning the receiver off, for the duration of the pulse. The receiver might be turned off hundreds of times a second for microseconds each time. The noise blanker is located electrically ahead of the main receiver selectivity. Strong off-frequency signals can mix with desired signals in the noise blanker detector resulting in intermodulation distortion. If strong signals are near the

OPERATING PROCEDURES (cont'd)

frequency of the desired frequency, the noise blanker should be turned off. The noise blanker is intended to reduce or eliminate pulse type interference found in mobile and some base station applications. It reduces receiver gain by up to six to 10 dB, which is noticeable in S meter readings. Refer to the Circuit Description, Section 4.10, for a more complete explanation of the noise blanker operation.

6.2.6 DUAL VFO USE

The Avenger is equipped with dual VFO's. The operator can transceive using either VFO or transmit on VFO A (red) (1-1) and receive on VFO B (green) (1-7). The two VFO's are electrically identical.

To illustrate the usefulness of two independent VFO's, think of their advantages during net operations. One VFO can be left on the net frequency while the other is tuned off frequency to pass traffic. Switching back to the VFO on the net frequency puts your whole station back exactly on frequency immediately. If you are net manager, you can look for off-frequency stations with your second VFO without changing your net frequency VFO.

The tendency for round tables to chase one another across the band while "rag chewing" can be reduced if some stations use the Avenger's dual VFO's to follow drifting stations.

The indicator light above each VFO indicates which VFO is in use. With the VFO selector switch (1-16) to the left, that is with A depressed, VFO A (red) is on. With the VFO selector switch to the right so B is depressed VFO B (green) is on. If the switch is in the center of its three positions, VFO B (green) is on in receive and VFO A (red) is on in transmit. This allows you to use your Avenger as a receiver and transmitter. You must receive and transmit on the same band. The frequency for which you are tuned can be observed from the dial pointer. The long heavy lines are 100 kHz markers. The shorter lines are at 25 kHz increments. You can determine the precise frequency from the dial skirt. The 25 kHz markers on the dial skirt have nomenclature depicting the frequency which they represent. The next smaller size markers are at 5 kHz increments. The smallest lines are at 1 kHz increments. A little experience in tuning will develop your ability to estimate the frequency between 1 kHz markers with surprising accuracy, to 300 Hz or less. The VFO's should be calibrated at the 100 kHz point nearest the frequency of operation. After changing bands you should calibrate the VFO's before relying completely on their accuracy.

Always tune for most natural sounding signals. The extreme stability and good audio quality of the Avenger permit excellent sounding received audio. While off-frequency signals are understandable and some operators even prefer them, the transmitted signal will also be off-frequency. If the station you are working is operating transceive with

a single VFO, his attempt to tune you in will result in leap-frogging across the band. If you find this happening with your tuning technique, either change the technique or operate in VFO position A-B and tune VFO A for the most natural sounding received audio. If other stations drift or tune off frequency you can prevent leap-frogging by following the drifting station with your receive VFO while transmitting on frequency with your transmit VFO.

6.2.7 CW

It is not necessary to be in the CW position on the MODE switch to receive CW. Either sideband position works equally well. Best operating practice requires use of a good set of earphones.

The Avenger transmitted CW signal is offset 1 kHz from its receive frequency; 1 kHz above the receive frequency on 40, 15, 10 meters, offset lower on 80 and 20 meters. Zero beat the received CW signal, then tune 1 kHz away to bring the received signal back into the passband.

6.2.8 SPEAKER

Connect a good 3.4 to 4.0 ohm communications speaker, such as the Johnson Model No. 250-55, to the speaker terminals (3-4) for the best audio quality from your Avenger. The headphone jack (3-2) is in parallel with the speaker terminals and may be used for speaker connection if this is more convenient. Both outputs are connected in parallel with a 10 ohm resistor, which keeps the Avenger audio output loaded into 10 ohms or less regardless of external load.

6.2.9 HEADPHONES

Connect a good pair of headphones into the headphone jack (3-2). A headphone set with good wide range audio response is best for phone operation. For best CW operation, the operator might find that he prefers a headphone set with a 1000 hertz peak to emphasize one CW signal in a pile-up.

Keep the Avenger audio gain at a reasonably low level during headphone use, since the headphones paralleled with the 10 ohm resistor present a mismatch to the Avenger audio output. See Section 3.3.2 for explanation for this procedure.

6.3 TRANSMIT

6.3.1 RECEIVING

Good conversationalists are first of all good listeners. Since most amateur radio operating is simply long distance conversation, most of a good operator's time is spent listening. To get the most benefit from the Avenger's transmit capabilities, always spend some time tuning around the band before calling CQ or keeping your schedule. Follow the instructions in Section 6.2, Receive.

6.3.2 MICROPHONES

The Avenger sounds best when used with a high im-

OPERATING PROCEDURES (cont'd)

pedance (50,000 ohm) microphone which has a flat frequency response. The microphone should be rated at 55 dB below one milliwatt. The Johnson Mobile Microphone, Model No. 250-882-1, performs excellently with the Avenger.

6.3.3 COMPRESSOR

The voice compressor is a part of the microphone amplifier. There is no operating control for the compressor. The compressor is factory set to give 12 dB of compression to normal voice levels at nominal input levels. With higher input levels the compressor can provide more than 30 dB compression. It boosts low level voice inputs and reduces levels which would overdrive the transmitter into "splatter" without introducing the distortion associated with simple clipping. The Avenger compressor actually improves the peak-to-valley ratio of the transmitted audio envelope for more effective transmitted power. The higher the microphone output the more helpful the compressor will be.

With practice you can develop the ability to keep the plate current between 106 to 225 mA (assuming 350 mA CW tune current) for extended periods.

6.3.4 TRANSMIT DRIVE

The TRANSMIT DRIVE control (1-22) must be adjusted to drive the transmitter properly for each operator, and whenever the transmitter is retuned. The graph, Figure 6-1, indicates the correct SSB plate current on voice peaks which the operator should observe after the transmitter is properly tuned.

To use the "Peak Single Sideband Plate Current Graph", first locate the CW plate current to which you have tuned the Avenger on the horizontal scale of the graph. Read up from that plate current value to the intersecting curve. Read across from the point of intersection. The value on the vertical scale is the maximum value the plate current can hit on voice peaks without flat-topping. Adjust the TRANSMIT DRIVE for this peak value with your voice and microphone.

6.3.5 VLX OPERATION

The three controls on the Avenger rear panel provide complete control of the Voice Latched Transmit (VLX) system. The VLX sensitivity control (2-4) sets the amount of microphone input to the audio stages required to switch from receive to transmit. The VLX DELAY control (2-3) sets the amount of time the Avenger is held in transmit after the operator stops talking. The ANTI-TRIP control (2-2) desensitizes the VLX circuit to sound from the Avenger speaker so that loud received signals do not trip the VLX.

The following are starting points for VLX control adjustments. The operator will quickly find his own fa-

vorite settings for each control.

Rotate the FUNCTION switch (1-21) to VLX. Speak into the microphone in a normal voice with the TRANSMIT DRIVE control set to its usual operating point. Set the VLX sensitivity control maximum counterclockwise. Slowly rotate the VLX sensitivity control clockwise until the transmitter keys. Rotate the VLX sensitivity control 1/4 turn beyond the keying point.

Adjust the VLX DELAY to unkey the transmitter a reasonable length of time after you have finished speaking. Some operators prefer to drop back into receive immediately after they stop talking while others are distracted by a VLX which drops in and out too often.

The ANTI-TRIP sensitivity control setting determines the VLX sensitivity to Avenger receiver audio. Adjust the ANTI-TRIP sensitivity control maximum clockwise. Set the RF GAIN (1-12) and AUDIO GAIN (1-13) to your usual operating level. Slowly rotate the ANTI-TRIP control counterclockwise to the point where the transmitter keys. Back off from this point 1/4 turn.

6.3.6 RF TUNE (Driver Tune)

The RF TUNE control tunes the receiver front end (preselector tuning) in receive and the grid and plate of the driver tube in transmit. Tune this control for maximum received signal strength. When tuning and loading the transmitter Pi network, repeak the RF TUNE as necessary. Repeak frequently when tuning up on 10 meters.

6.3.7 TUNING AND LOADING

The PA TUNE and LOAD controls tune the Pi network in the final amplifier. The PA TUNE control (1-8) dips the plate current when tuned to resonance. The LOAD control (1-9) controls both fine and coarse loading of the power amplifier. The LOAD control has six coarse load switch positions. The light indicators, numbered one through six, indicate which coarse load position is switched in. There is 160 degrees of relatively free movement between detents. This is the fine load 15-450 pF differential capacitor. Continuing past each detent trips the coarse load switch in the PA, switching in or out one of five 430 pF dipped mica capacitors. Full counterclockwise rotation of the LOAD control lights indicator #1. Full clockwise lights indicator #6. Do not try to go past either of these positions; this will damage the coarse loading drive. Tripping the coarse load switch returns the fine load capacitor to full capacity (with clockwise rotation) or minimum capacity (with counterclockwise rotation). The fine load control is a differential capacitor that increases capacity on one side as it decreases on the other. Rotating clockwise past the detent switches from a minimum capacity condition (15 pF) on one side to maximum capacity (450 pF) on the other. Rotating clockwise simultaneously switches out a 430 pF capacitor. The result is smooth loading from 2600 pF to an approximate load capacitor value of 15 pF.

OPERATING PROCEDURES (cont'd)

There is a position of the coarse load switch, or value of rough loading capacitance, that is the best starting point to tune any particular band. The antenna being used, the feed line, etc., can greatly modify this value. High VSWR's cause loading complications. Recommended starting points are as follows:

<u>Band</u>	<u>Coarse Load</u>
80 meters	#1
40 meters	#3
20 meters	#4
15 meters	#5
10 meters	#6

Fine load is full counterclockwise in each case.

When starting to tune and load each band from the recommended settings, follow this procedure:

FUNCTION switch - VLX

MODE switch - CW

VFO SEL - To VFO desired - be sure you are in the amateur band with the VFO selected.

XMIT PWR-ON - wait 2 minutes before keying.

BAND switch - To band desired.

Push the TUNE button (1-20) and quickly dip the plate current (1-5) with the PA TUNE control (1-8). Peak the RF TUNE (1-19) for maximum plate current. Turn the LOAD control (1-9) clockwise to increase the plate current in small steps (10-20 mA) and dip the plate current again with the PA TUNE control. Peak the drive with the RF TUNE control. Continue this process until the Avenger is loaded to the full recommended input of 350 mA plate current on 80 thru 15 meters; 200 to 250 mA plate current on 10 meters. On 10 meters peak the RF TUNE control often; peaking it after each 20 mA of additional loading is a good practice.

Check the grid tuning again with the RF TUNE control.

The relative power output meter (1-3) should read approximately S-6 to S-7 when fully loaded on 80 thru 15 meters or S-3 to S-4 on 10 meters. This reading will vary because of the particular impedance and VSWR of a given antenna system.

Observe the relative power output indicator when reading plate current levels. If the peak power output and the plate current do not occur simultaneously, and this can happen with some loads, especially on 10 meters, obtain the best output power while keeping the plate current within the recommended limits. With some load impedances the relative power output will indicate outside of the stated levels.

Switch to the desired sideband with the MODE switch (1-17) and to either VLX, PTT or XMIT with the FUNCTION switch (1-21).

To check transmitter output while transmitting in SSB push the TUNE button while talking. This switches the S meter to relative power indication. The S meter does not normally indicate power output except when in CW and tuning with the TUNE button. In SSB the only function of the TUNE switch is to switch the S meter to relative power output.

After connecting your microphone talk into it and adjust the XMIT DRIVE so that the audio peaks drive the plate current to the value designated on the chart in Figure 6-1 for the particular value of plate current you loaded to in CW.

Always check idling current after replacing tubes or making new installations and frequently thereafter. Idling current should be 50-65 mA. Refer to Section 7.3.6. in adjustment instructions.

6.3.8 TUNING ON 10 METERS

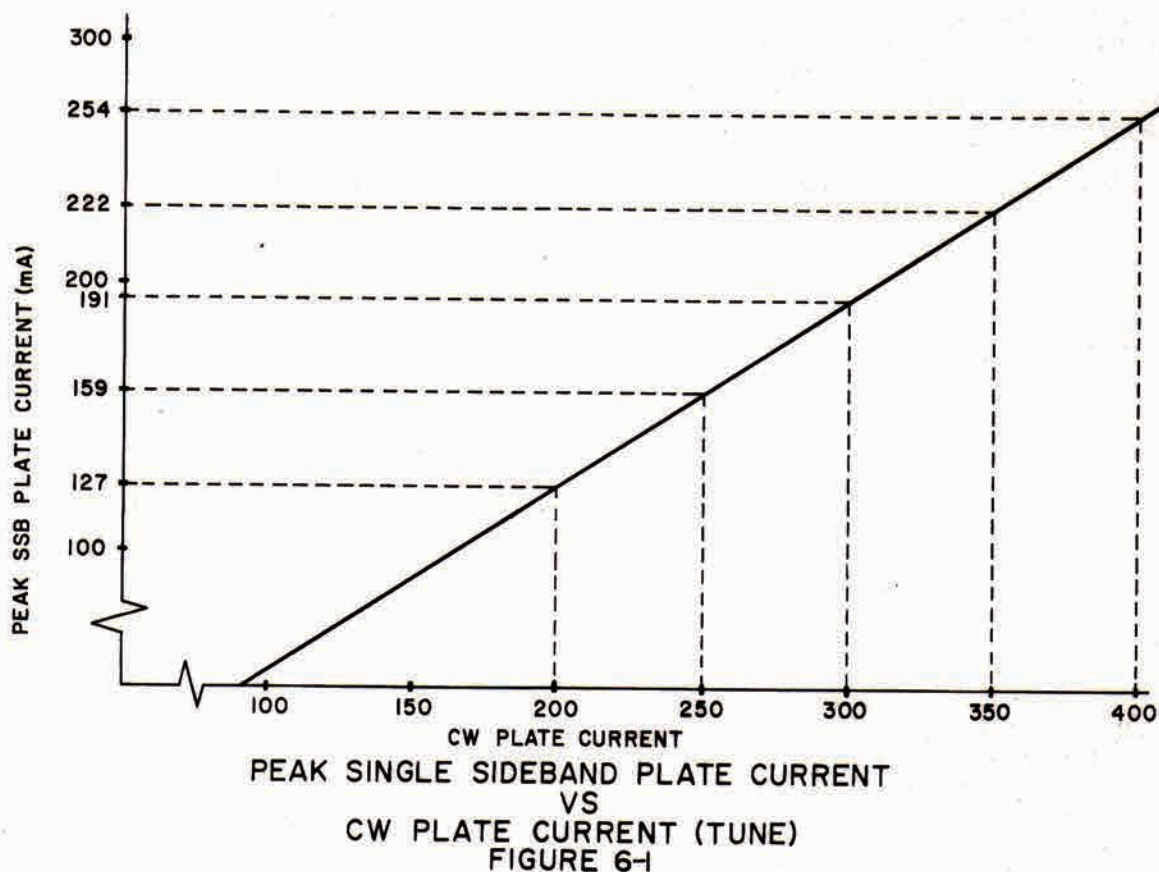
Viking Avenger minimum sensitivity across all bands except 10 meters is 20 dB signal + noise to noise ratio (S+N/N) at 1 μ V input to the antenna terminals. The unit specifications require only 10 dB (S+N/N) minimum at 0.5 μ V to the antenna terminal. 10 meter sensitivity is better than 10 dB (signal + noise) /noise ratio at 0.5 μ V input to the antenna terminal. 10 meter sensitivity is lower than the sensitivity on other bands because receiver and transmitter tuning in the Avenger differ significantly on this band. Receiver and transmitter tuning differ somewhat throughout the 80-10 meter transceiver range, but this difference becomes significant only on 10 meters. On most bands receiver and transmitter tuning differences are unmeasurable.

The operator should not attempt to "split the difference" between transmit and receive tuning on 10 meters because transmitter tuning is critical. Under normal operating conditions, this reduced receiver sensitivity is not important, but is noticeable when receiving extremely weak stations.

6.3.9 How to use the "Peak Single Sideband Plate Current" Graph, Figure 6-1.

- Tune and load the transmitter as described in the Operation Section.
- Observe the plate current value when properly tuned. This value is "CW PLATE CURRENT (mA)" on the graph.
- Read up the graph on that line to where it intersects the curve.
- Read to the left from the point of intersection to find the corresponding "PEAK SSB PLATE CURRENT (mA)".
- This value is the maximum peak the plate current

OPERATING PROCEDURES (cont'd)



should be allowed to hit on voice peaks to prevent "flat topping".

- f. Adjust the XMIT DRIVE control for this peak value with your voice and microphone.

6.3.10 TRANSMIT SPURIOUS RESPONSES

A transistor is inherently a non-linear device. This means that it tends to produce harmonics of any frequency applied to it. If allowed to, a transistor can in theory produce an infinite number of harmonic frequencies. This is the principle behind the Avenger 100 kHz crystal calibrator. (See Section 4.7 for the 100 kHz calibrator circuit description.)

A transistor mixer is particularly prone to spurious harmonic production since it is designed to manufacture new frequencies. The result is a stage which is non-linear and which tends to produce harmonics of both of the two applied signals as well as of their sum and difference mix products. For example, if a mixer is used to produce 4 MHz from applied signals at 5 MHz and 9 MHz it will produce harmonics of all three of these frequencies as well as harmonics of their sum mix product (14 MHz). So

this single stage might produce signals at 4 MHz, 8 MHz, 12 MHz, 5 MHz, 10 MHz, 15 MHz, 9 MHz, 18 MHz, 27 MHz, 14 MHz, 28 MHz, 42 MHz, etc.

The Avenger circuitry has been carefully designed at each stage to minimize spurious ("spur") production. Additionally, receiver mixing occurs before the crystal filter in the receiver signal path. This careful stage-by-stage harmonic reduction plus the highly selective band-pass crystal filters and mixer tuned circuit reduce receiver spurs to insignificant levels. Transmitter design also minimizes spur production at each stage, but transmit mixing occurs after the crystal filters. (Refer to the Block Diagram, Figure 4-1.) Transmit mixer spurs are reduced by two tuned circuits and the pi network, but not to such a dramatic degree as the receive spurs by the crystal filters.

The strongest transmit spur occurs at 3.6 MHz. It is caused by mixing action between the third harmonic of the VFO frequency and the second harmonic of the IF frequency: $(3 \times 5.4) - (2 \times 9.0) = 3.6$ MHz. This is a cross over spurious which moves through the operating frequency three times as fast as VFO rotation, in the opposite direction. This spur is typically 25 dB below PEP.

OPERATING PROCEDURES (cont'd)

To produce a 14.0 MHz transmit frequency 5.0 MHz and 9 MHz are added in the transmit mixer. The third harmonic of 5 MHz, 15 MHz, is an output of the mixer. The level of the 15 MHz signal is approximately 35 dB down at the output of the radio. However, this is enough to change the idling current by approximately 10 mA. This may cause 0.1 watt output maximum on 15 MHz. IF the RF TUNE control is tuned to the high end of the 20 meter band (RF TUNE control to the right of 12 o'clock) with the VFO in use at 14.0 MHz substantial drive to the final can be obtained which is out of the Amateur Band. Always make sure that the RF TUNE is properly tuned to the left of 12 o'clock, to peak the drive when the frequency in use on the 20 meter band is below 14.050 MHz.

Other spurs, which occur at 3.842 and 7.125, are a minimum of 35-40 dB below PEP. The Avenger transmitter typically has six to eight other spurs which are less significant, being 40-60 dB below PEP.

6.3.11 LINEAR AMPLIFIER OPERATION

The Avenger compressor, properly used, enables it to receive on the air signal reports when running barefoot, which are comparable to other transmitters using a high powered linear amplifier and simple automatic level control. When the Avenger is teamed with a linear amplifier and a good antenna system it can deliver a devastating signal.

The Viking Thunderbolt II (TB II) includes a built-in 50 ohm pad for exciter tuning. When switched off the TB II is electrically removed from the circuit. To tune the Avenger into the dummy load switch the TB II to DRIVER TUNE. To tune the Avenger into the antenna, switch the TB II to OFF. Refer to the Thunderbolt II operators manual for specific tuning instructions.

The following tuning instructions include blanks to be filled in with values pertinent to your linear.

To operate the Avenger with any linear amplifier, perform the following operations:

1. Tune the Avenger up fully on the frequency to be used, either into a good 50 ohm antenna or into a 50 ohm, 250 watt DC continuous, dummy load.
2. Switch the Avenger into the linear amplifier input.
3. Reduce Avenger output to a level sufficient to drive the linear fully. _____ mA plate current for _____ watts input. Push the TUNE switch (1-20). Adjust the LOAD control (1-9) for reduced output; adjust the TUNE control (1-8) for the desired plate current at the dip.
4. Push the Avenger TUNE switch.

5. Tune and load the linear to its proper input. (_____ mA plate current).
6. Check Avenger drive to the linear for proper level.
7. Switch the Avenger to a good 50 ohm antenna or 50 ohm dummy load.
8. Retune the Avenger for full output. This step must be performed in the single sideband mode to ensure proper linear operation.
9. Switch both units to the SSB mode.
10. Rotate the XMIT DRIVE control (1-22) full CCW.
11. Adjust the XMIT DRIVE control clockwise while speaking into the microphone to drive the linear to 1 kW DC input on voice peaks. (_____ mA plate current.)

6.4 MOBILE OPERATION

The Avenger's compactness and low receiver current drain make it an ideal mobile transceiver. Mobile operation does require some special considerations. These follow.

6.4.1 INSTALLATION

Use a good antenna system with your Avenger. Some antennas allow a VSWR of less than 1.5 to 1 on any band. The antenna used can be one of the most important factors in the satisfaction you derive from your mobile station.

Never allow the transceiver to vibrate in its mount. Check all mechanical and electrical connections whenever you notice excessive vibration. Vibrations are annoying, and can shorten the life of any component.

Do not install the transceiver in the direct hot air stream from the vehicle heater.

Be sure that there is adequate ventilation on all sides of the power supply. Do not install it in a "dead air" section, such as between the spare tire and fender well in the trunk. If the power supply is mounted under the vehicle hood, install it where it can be cooled by outside air, if possible. It is often feasible to mount the power supply next to the vehicle radiator behind the grille, where it will receive plenty of cool air.

6.4.2 OPERATION

Set the idling current when the vehicle is idling normally. With higher battery voltage (normal at higher engine speeds) the idling current will drop, since the final grid bias voltage increases as supply voltage increases.

OPERATING PROCEDURES (cont'd)

You will find that the Avenger drifts slightly during warmup from turn on during cold weather. This warmup drift should be negligible during more typical operating conditions. Refer to the Avenger frequency stability vs. temperature graph, page 3.

It is not a good practice to operate with transmitter power on for long periods without transmitting, while at high vehicle speeds. If you do not intend to transmit for some time, turn the transmitter switch off. This helps prolong the life of your power supply and transmitter, as well as the battery and alternator.

Turn the Avenger off before turning your vehicle engine off when operating at high speeds or warm temperatures. Underhood temperatures increase significantly soon after the engine is turned off, and can conceivably damage the power supply.

You may find it convenient to operate mobile using a set of headphones combined with a boom microphone, with the Avenger in the VLX mode. This leaves you free to devote more attention to driving.

The Avenger noise blanker effectively eliminates most distracting electrical interference, but does so at the cost of some selectivity and sensitivity. Do not use the

noise blanker as a substitute for adequate noise suppression or vehicle engine tuneup. You will find that the noise blanker is invaluable in heavy traffic as a substitute for other vehicles' lack of noise suppression.

It is a good idea to clean any electronic device, especially a transmitter, periodically. A mobile unit is especially subject to dust accumulation. A mobile Avenger should be removed from its enclosure and cleaned with a vacuum cleaner every few weeks.

6.4.3 TUNEUP

Always keep keyed periods short when off resonance. The Avenger can draw up to 500 mA plate current when off resonance; this corresponds to 60 A drawn from a 12 volt line. The power supply is protected by an automatically resetting circuit breaker. If the circuit breaker functions during tuneup, you might be keeping the Avenger keyed too long when off resonance.

We recommend stopping the vehicle before trying to tune the Avenger final. The Avenger is easy to tune, but it should be done with two hands. Any attempt to tune one-handed will result in too little attention given to both driving and tuning to do a good job of either.

OPERATING PROCEDURES (cont'd)

6.5 OPERATING HINTS

6.5.1 WORKING DX WITH YOUR AVENGER

The Avenger is a transceiver that gives you true DX operating capability without an external VFO. The Avenger's two internal VFO's make it possible for you to operate transceive on two different frequencies or to operate as if you had a separate transmitter and receiver.

In explaining how you can work DX with the Avenger let us look first at the most obvious advantage of the Avenger, i. e. , operating the Avenger as a separate transmitter-receiver combination. This type of operation is best suited for working DX stations that are transmitting outside the American phone bands. The right-hand (Green) VFO is used for receiving and the left-hand (Red) VFO is used to control your transmitting frequency. For this type of operation the VFO Selector switch is placed in the middle of its three positions. The Avenger now switches automatically from the receive VFO (Green) to the transmit VFO (Red) when it is keyed. The DX station transmitting outside the American phone band will usually specify a frequency that he is listening on. If he does, the specified frequency can be checked by switching the Avenger to Transceiver Red operation. This switches the Avenger receiver to the Red VFO frequency (your transmitting frequency) so you can check to see if the frequency is clear or see how many stations are calling. This procedure can also be used to locate a clear frequency to transmit on if a transmitting frequency isn't specified by the DX station.

CAUTION - DO NOT SWITCH TO GREEN VFO TRANSCEIVE OPERATION WHILE OPERATING CROSSBAND. ALWAYS BE SURE THAT THE RED VFO IS CONTROLLING THE TRANSMIT FREQUENCY.

When working DX stations that are transmitting in the American phone bands the separate transmit and receive type of operation can be utilized two different ways. If the DX station is hard to copy because he is a little off your transmitting frequency or if he drifts you can use the Green VFO to tune in the DX station as you like while leaving your transmit frequency constant. Also, this type of operation is very advantageous in pile-ups. The green VFO can be left on the DX station's frequency for receiving and the red VFO transmitting frequency can be moved to either side of the DX station's frequency. Usually it is advantageous to move so that the pile-up signals sound lower pitched. This causes your voice to be the highest pitched in the pile-ups and "out of the mud".

You will find yet another advantage of having two VFO's in working DX in contests. If the DX station is working U. S. stations by call areas and if your turn doesn't come for awhile you can leave one VFO on that frequency and use the other to work other stations, checking back at intervals by simply switching back to the other VFO. This type of operation allows you to work that rare DX station without wasting all of the time you spend awaiting your turn.

Of course the Avenger can't work DX by itself even with two VFO's. It needs a good antenna system, a linear (sometimes) and a good operator. Of these three the last is the most important. Your operating procedures can mean the difference between a QSO or no QSO with that rare DX station. Use your Avenger's complete DX operating capabilities and "work the world".

Best DX

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6.5.2 WINNING CONTESTS WITH YOUR AVENGER

Antennas are by far the most important factor in winning any contest. A national winner always, without exception, has an excellent antenna system. His antennas are tuned for low SWR, and carefully selected to provide the best pattern for his part of the country. On the 10-20 meter bands, some rotatable directive gain is a must. On 40 meters it is desirable, but not always feasible. On both 40 and 80, the type and height of the antenna should be selected to provide an optimum vertical angle of radiation.

For national contests, limited to the United States, Canada, and U.S. possessions, an operator must be aware of his own location relative to that of the bulk of the other contestants. Since skip is longer on the higher bands, a coastal station operator should tend to spend much of his time about one band higher in frequency than a centrally located station, and vice versa. However, most winners spend some time on every band, in order to work the most multipliers. For example, an operator in a distant area such as the Yukon (VE8) will most likely work the higher bands a large part of the time in order to maximize his contact rate. A Kansas operator who stayed on 20 meters and below in order to maximize his own contact rate would miss a VE8 (perhaps the only one) on 15 meters.

In DX contests it is quite important to be aware of the times of day and the bands on which various parts of the world

OPERATING PROCEDURES (cont'd)

can be heard. The best way to do this is to operate frequently on the DX bands previous to the contests, especially the preceding day or two. In addition, propagation prediction charts can be a big help in knowing what openings may be expected during a particular time of day.

Most DX contests multiply contacts times some kind of area multiplier. The contest winners do not just try to maximize their contact rate, but actually spend quite a bit of time hunting multipliers. For example, if a DXer knows that there have been long-path openings to the Far East at about 7 a. m. on 20 meters for the past couple of days, in addition to many strong signals from Europe, he will work the Europeans as rapidly as possible, but will occasionally turn his beam southeast to get the multipliers.

In any contest, a primary objective is to be understood by other operators. This requires good speech habits, including very clear enunciation. It is actually best to carry this to a point of exaggeration, enunciating more distinctly and clearly than in normal conversation. On CW, a good "fist" is an absolute must. On either mode, impatient contest operators will tune right on by a sloppily sent CQ. If called by two stations of about equal strength, they will naturally answer the one which is the most easily understood.

Good phonetics are an absolute necessity on SSB. Although it is desirable to use either the ARRL or the ICAO list of standard phonetic words, on-the-air experience may show that other words are still better in specific instances. This can be especially true in DX contests, where the DX operator may not be used to either standard word list. In general, names of places and countries are very easily understood. For example, you may find that the word "JAPAN" gets through better than "JOHN" or "JULIET", or that "UNITED" is more often understood the first time than "UNION" or "UNIFORM". "Clever" phonetics, making use of a play on words, seldom work well at all.

There are a few hints which apply specifically to an Avenger. For example, some contests give a multiplier for operation at 150 watts or below. An Avenger can easily be run at this power level on both CW and SSB. With the plate voltage of 800 volts, this comes to 188 milliamps plate current. On CW, just load to this value. On SSB maximum efficiency may be obtained by first loading, on CW, to slightly less than the normal 350 mA. A value of around 280 mA is best. However, when the Avenger is operated at this reduced loading, it is important not to talk the plate current above 188 mA on SSB or the voice signal will flat-top and "splatter". Use the XMIT DRIVE control to set the voice level properly.

Efficient use of the two VFO's is quite important in contests. In general, use the RED VFO for tuning, either when looking for a hole to call CQ or for another contact. When you hear what you are looking for you can transmit immediately, without thinking about the VFO selector switch, since you are in transceive. If you want to tune the receiver slightly, bring the GREEN VFO to the same dial reading as the RED VFO and put the VFO selector switch in the middle position. You will now be receiving on the GREEN, but still transmitting on the RED VFO. The VFO's must be properly calibrated for the above procedure to put you on the right receive frequency. Even then, there can be a few hundred cycles disparity between VFO's. If this is objectionable, just tweak the GREEN VFO calibrate control slightly to bring the VFO's into exact agreement for the portion of the band on which you are working.

SSB DX contests provide an important exception to the general rule of tuning with the RED VFO. When listening for stations outside of your allowed phone segment it is best to set the VFO selector switch in the center position, with the RED (transmit) VFO in the allowed phone band, and tune with the GREEN (receive) VFO. It is very, very easy to accidentally transmit out of the band when one has two VFO's with one tuned to out-of-band DX. However, if the RED VFO is always left within the allowed segment and the VFO selector switch is never set on XCVE B (Green), this mistake will never occur.

When using the Avenger on SSB, it is important to take advantage of its built-in syllabic-rate voice compressor. With most microphones, this requires that you speak directly into the mike, holding it very near your mouth. (The louder you talk the more compression occurs). You may have to reduce the XMIT DRIVE control.

Proper use of accessories can also help in a contest. For example, a good set of headphones can be a definite advantage over a speaker. The headset eliminates sound reflections, so you only have to listen to the QRM once, and at the same time keeps extraneous noises out. However, it is important that the headphones be good ones. A poor set will seriously degrade your copying ability, and you may not even be able to tell that this is happening. If you doubt your phones, try comparing them with a few other sets.

One last hint concerns use of the VOX and PTT circuits. Some operators find that the handiest system of all is a foot switch. This can be used on both SSB and CW, and it enables an operator to switch the transmitter on and off at ex-

OPERATING PROCEDURES (cont'd)

actly the right time, while leaving both hands completely free for operating. On the Avenger, the foot switch can be wired into the PTT circuit in the microphone plug.

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6.5.3 USING YOUR AVENGER ON CW

CW operation is very easy and straightforward on an Avenger. With the function switch in PTT, you can switch between transmit and receive with your microphone switch, or with a foot switch. If you wish, you can receive in either the PTT or the VLX position, simply switching to XMIT in order to transmit. However, the simplest method of all is to leave the function switch in VLX and use break-in keying.

The break-in keying on an Avenger has a very short attack time and a variable release time. For most operators, the release time may be set at minimum, providing the best break-in. At this setting, the Avenger will switch back to receive each time the key is up at speeds up to about 13 words per minute (WPM). At higher speeds the Avenger will only switch to receive between letters. At still higher speeds, above 30 WPM or so, the Avenger will stay in transmit for entire words.

For some operators it is distracting to hear the receiver come back on after each letter. If this is the case, the release time may be set to provide up to two seconds delay after the last word before the receiver comes back on. It has been found, however, that if an operator will put up with the distraction of maximum break-in for a while he soon learns to ignore it and begins to really enjoy the advantages of break-in. For example, use of maximum break-in minimizes the chances of two stations doubling.

An Avenger's transmitted CW signal is offset from zero-beat (SSB carrier frequency) by one kHz. If the same VFO is being used for both receive and transmit, a received signal producing a one kHz audio tone will be zero-beat with the Avenger's transmitted signal. Since the Avenger's sidetone oscillator produces a one kHz tone on transmit, it is possible to zero-beat a received signal simply by matching its tone with that of the sidetone oscillator. Another method, almost as accurate, is to tune the received signal to zero-beat and then move the VFO dial exactly one kHz in the direction which brings the received signal back into the passband.

Operating efficiency depends to some extent on the proper choice of VFO for each type of operation. When tuning the receiver and looking for something, it is best to use the RED VFO (VFO A). When receiving on this VFO the Avenger is in transceive and can automatically transmit on the received frequency at any time. After becoming established on a particular transmit frequency, an operator can put the VFO selector switch in the middle position and tune the receiver separately with the GREEN VFO.

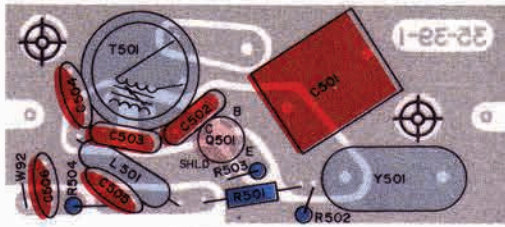
At times it may be desirable to have more receive selectivity on CW than the Avenger provides. In this case a set of headphones with a sharp response at one frequency can be used to great advantage. An L-C audio filter will provide even more audio selectivity.

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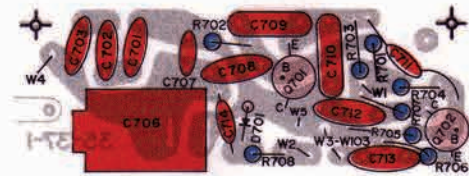
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TRANSPARENCIES

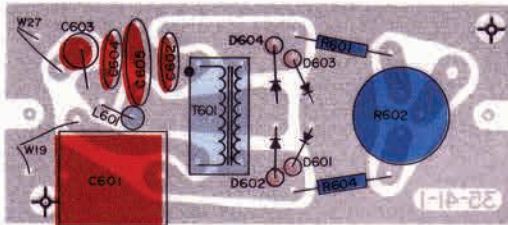
Facing this page, the page following and on the page preceding Section 5 are printed circuit transparencies. Refer to the transparency page preceding Section 5 for hints regarding use of these transparencies.



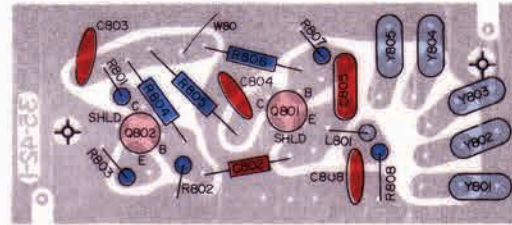
CARRIER OSCILLATOR
PC BOARD



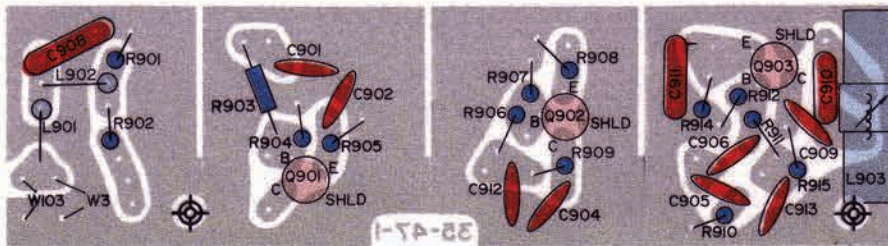
VFO
PC BOARD



BALANCE MODULATOR
PC BOARD

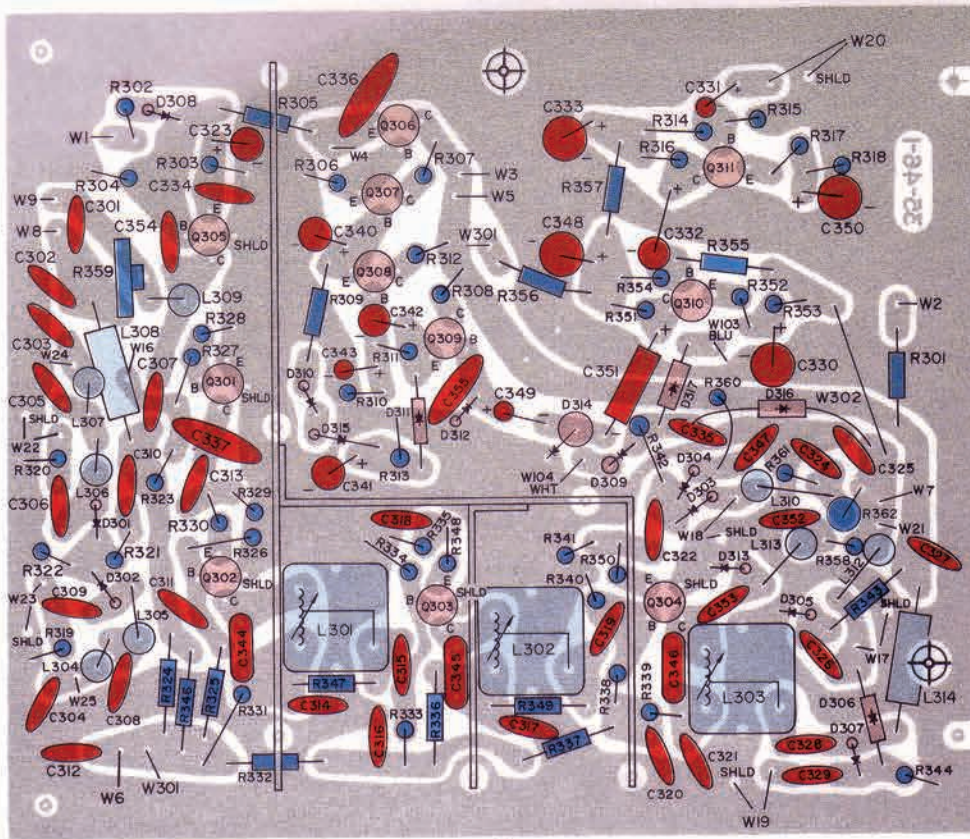


CRYSTAL OSCILLATOR
PC BOARD

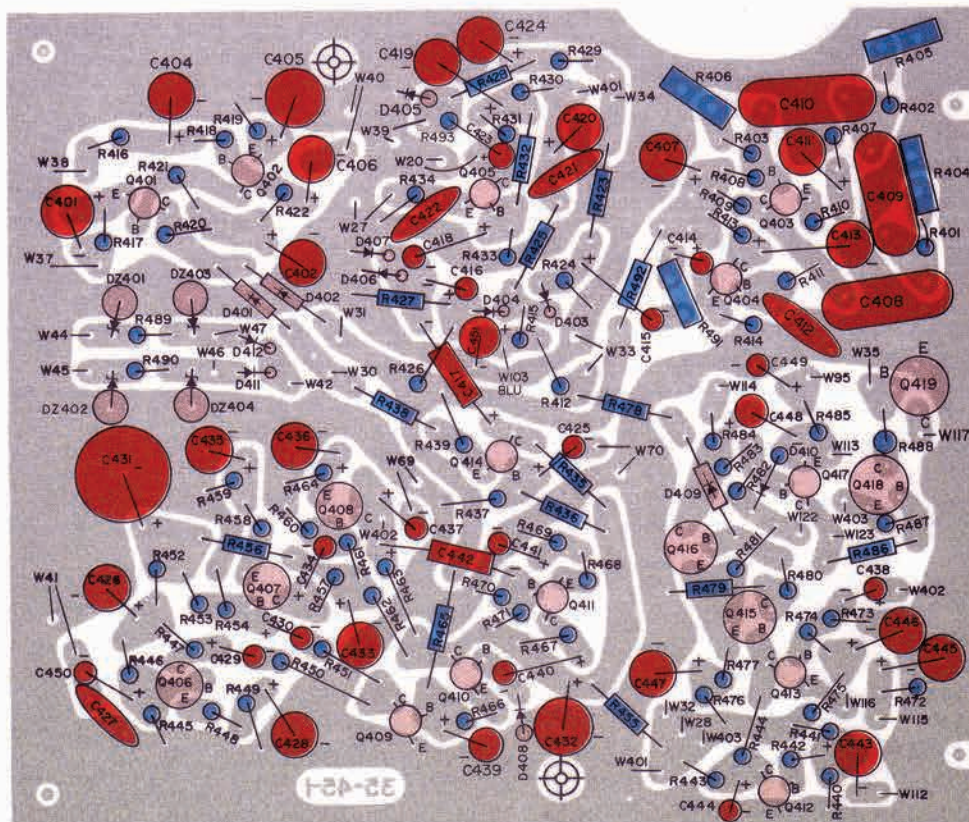


HETERODYNE MIXER
PC BOARD

- CAPACITORS
- COILS, CRYSTALS,
TRANSFORMERS AND
RELAYS
- RESISTORS
- TRANSISTORS
AND DIODES



IF
PC BOARD



AUDIO
PC BOARD

- CAPACITORS
- COILS, CRYSTALS, TRANSFORMERS AND RELAYS
- RESISTORS
- TRANSISTORS AND DIODES

SECTION 7 MAINTENANCE

7.1 TRANSISTOR TROUBLE SHOOTING

7.1.1 GENERAL

Troubleshooting transistorized equipment is not particularly difficult; many technicians find that, with experience, it is easier than troubleshooting tube type equipment. It does require knowledge of techniques peculiar to transistorized servicing. Some of these techniques are outlined in this section.

Troubleshooting any piece of electronic equipment requires a thorough background knowledge of electronics theory and servicing, a good general knowledge of the equipment and a thorough understanding of the circuits in question. Before troubleshooting any Avenger circuits, study the entire Circuit Description, especially sections dealing with the circuits involved. Many circuits are interrelated; a malfunction in one circuit can result in an apparent defect in another area. Studying the circuit description will help guard against troubleshooting the wrong circuit.

The E. F. Johnson Company Customer Service Department is equipped to handle any Avenger problems. Contact this department at 299 10th Avenue S.W., Waseca, Minnesota 56093 (telephone 507-835-2050).

Refer to the printed circuit board transparencies, pages 38, 52 and 54, for printed circuit component locations. Refer to the Avenger top and bottom views, Figures 7-2 and 7-3 respectively, for the location of maintenance items.

7.1.2 TRANSISTOR OPERATING CHARACTERISTICS

For all practical purposes the transistor base-emitter junction and the transistor base-collector junction can be considered diodes. For the transistor to conduct collector to emitter its base-emitter junction must be forward biased in the same manner as a conventional diode. In a germanium transistor the typical forward biased junction voltage is 0.2 to 0.4 volts. A typical silicon transistor has a forward biased junction voltage of 0.5 to 0.7 volts. When collector current is high the base-emitter voltage of both germanium and silicon transistors increases from 0.1 to 0.2 volts. The base-emitter bias voltage in the forward

biased condition is then 0.4 to 0.5 volts for a germanium transistor and 0.7 to 0.9 volts for a silicon transistor. High current silicon transistors may go up to 2 volts under load.

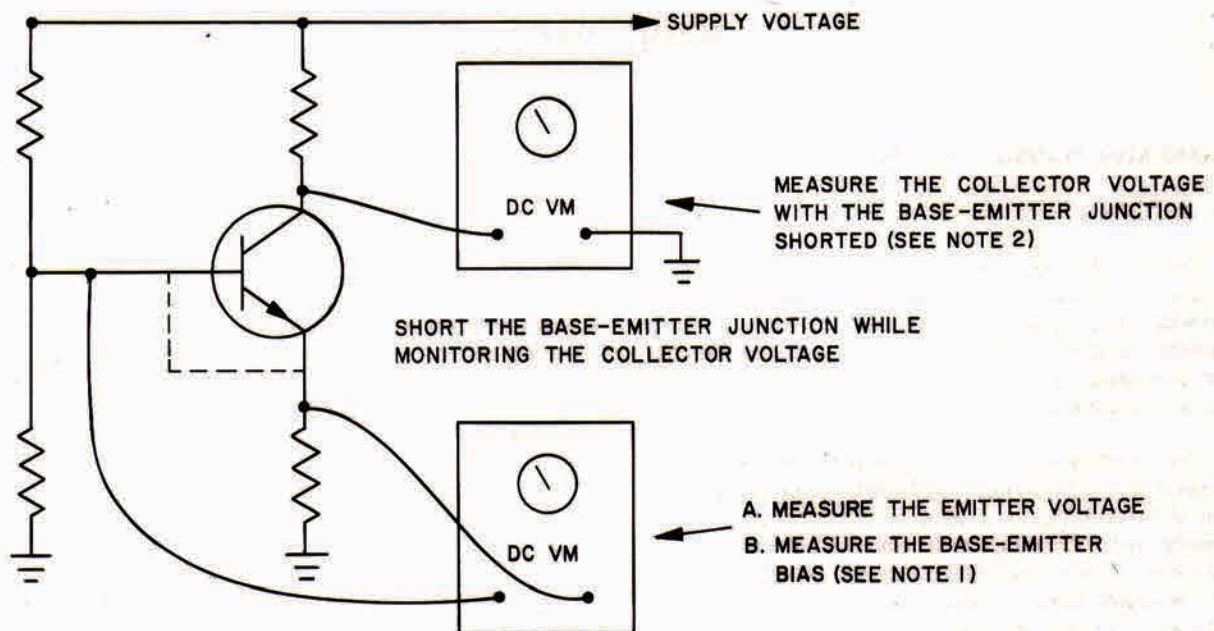
A high impedance DC voltmeter is usually the only measuring instrument required for determining the operating condition of an in-circuit transistor. The meter is used to measure the transistor bias voltages. See Figure 7-1 for the correct voltmeter connections for measuring in-circuit transistor bias.

7.1.3 IN-CIRCUIT TRANSISTOR TESTING

- a. Refer to Figure 7-1 for test connections.
- b. Measure the emitter voltage. Compare your measurement to the voltage listed on the voltage table. A correct emitter voltage reading generally indicates that the transistor is working properly. If you are in doubt as to the condition of the transistor after measuring the emitter voltage, proceed to the following tests.
- c. Measure the base-emitter junction bias. The voltage measured across a forward biased junction should be approximately 0.3 volts for a germanium transistor and 0.6 volts for a small signal silicon transistor.
- d. Check for amplifier action by shorting the base to the emitter while monitoring the collector voltage.* The transistor should cut off (not conduct emitter to collector) because the base-emitter bias is removed. The collector voltage should rise to near the supply level. Any difference is the result of leakage current through the transistor. Generally, the less the leakage current the better the transistor. If no change occurs in the collector voltage when the base-emitter junction is shorted the transistor should be removed from the circuit and checked with an ohmmeter or a transistor tester. The following section describes the technique for testing transistors out of the circuit with an ohmmeter.

* Not recommended for high level stages under driving conditions.

MAINTENANCE (cont'd)



TEST CONNECTIONS FOR
IN-CIRCUIT TRANSISTOR TESTING
FIGURE 7-1

NOTE 1:

Enough loop current is present in the leads of some electronic voltmeters to destroy transistors if measurements are made directly across transistor junctions. If an electronic voltmeter is used, perform the above measurements with respect to the circuit voltage common.

NOTE 3:

Be careful when connecting test leads to in-circuit transistors. Operating transistors can be ruined by shorting the base to the collector and, in some circuit configurations, the emitter to ground.

NOTE 2:

If the collector voltage is measured with a VOM the meter leads may be connected directly across the collector resistor. The difference between the supply voltage and the collector voltage will then be indicated directly on the VOM.

7.1.4 OUT OF CIRCUIT TRANSISTOR TESTING

Only high quality ohmmeters should be used to measure the resistance of transistors, and these only on their higher resistance ranges. Many ohmmeters of both VOM and electronic types have short circuit current capabilities in their power ranges that can destroy semiconductor

devices. A good rule of thumb is never to measure the resistance of a semiconductor on any ohmmeter range that has an open circuit battery voltage of more than 1.5 volts

The following section describes a method for determining the short circuit current capabilities of ohmmeters.

MAINTENANCE (cont'd)

7.1.5 HOW TO DETERMINE OHMMETER CURRENT

When the ohmmeter test probes are shorted together (measuring the forward resistance of a diode or the base-emitter junction of a transistor amounts to the same thing) the meter deflects full scale and the entire battery voltage appears across a resistance that we will designate as R1. The current through the probes is the battery voltage divided by the resistance of R1. An easy method is available for determining the value of R1. Look at the exact center of the ohmmeter scale. Your reading is the value of R1 on the Rx1 range.

The only other unknown required to calculate the short circuit current of an ohmmeter is the internal battery voltage. Let's take a well known meter that has a center scale reading on the ohms scale of 4.62 and a battery voltage of 1.5 volts. Its short circuit current can be calculated by using Ohm's Law. Dividing 1.5 volts by 4.62 ohms equals a short circuit current of 325 mA on the Rx1 range. Obviously, the Rx1 range of this meter cannot be used to measure the resistance of semiconductors. When the value of R1 is known for the Rx1 range it can then be determined for any range by multiplying R1 by the multiplier value of the range. The value of R1 for the Rx10 range of a meter

with an R1 value on the Rx1 range of 4.62 ohms is 4.62×10 or 46.2 ohms. The short circuit current on the Rx10 range can then be calculated: 1.5 volts divided by 46.2 ohms equals 32.5 mA. By using this method, the lowest safe range for measuring semiconductor resistance may be determined for any ohmmeter.

Remember that you should not measure any semiconductor resistance on any ohmmeter range which produces more than three milliamperes of short circuit current.

Table 7-1 indicates the results that should be obtained from operational transistors measured out of the circuit.

7.1.6 REMOVING TRANSISTORS FROM CIRCUIT BOARDS

Use a 47 watt minimum soldering iron. High temperature for a very short period of time is easier on circuit boards than inadequate heat which must be applied for a long period of time. We recommend some form of vacuum bulb desoldering device such as a "Solder Sipper". The "Solder Sipper" may be obtained at the following address:

Solder Sipper Company
1527 Faris Avenue
St. Louis, Missouri 63133

OUT OF CIRCUIT TRANSISTOR
MEASUREMENTS WITH OHMMETER
Table 7-1

Transistor Type		Ohmmeter Connections		Resistance in ohms
		+ lead	- lead	
Germanium PNP	Power	Emitter	Base	30 to 50 ohms
		Emitter	Collector	Several hundred
	Small Signal	Emitter	Base	200 to 250 ohms
		Emitter	Collector	10 k to 100 k ohms
Silicon PNP	Small Signal	Emitter	Base	10 k to 100 k ohms
		Emitter	Collector	Very high (Might read open)
Silicon NPN	Power	Base	Emitter	200 to 1000 ohms
		Collector	Emitter	High; often greater than 1 Megohm
	Small Signal	Base	Emitter	1 k to 3 k ohms
		Collector	Emitter	Very high (Might read open)

MAINTENANCE (cont'd)

TROUBLE ANALYSIS

Table 7-2

TROUBLE	POSSIBLE CAUSE
TRANSMITTER	
1. CW inoperative, phone normal.	<ul style="list-style-type: none"> a. D403, D404, D409 or D104 defective. b. 1 kHz oscillator inoperative, check Q403, Q404.
2. Relative power indicator inoperative, S-Meter normal.	<ul style="list-style-type: none"> a. D101 or D102 defective.
3. VLX (voice latched transmit) completely inoperative. Push-to-talk and CW keying normal.	<ul style="list-style-type: none"> a. Q413 or Q415 defective.
4. All keying functions inoperative.	<ul style="list-style-type: none"> a. Q416, Q417, Q418, Q419 or RY102 defective.
5. Low power output.	<ul style="list-style-type: none"> a. V103. b. V101, V102. c. Power Supply defective. d. Low primary line voltage.
6. Transmit completely inoperative on CW and phone. Receive and keying functions normal.	<ul style="list-style-type: none"> a. Q903, Q204, Q208, Q101, V101, V102 and V103. b. No high voltage. c. D206, D306 or D303 open. d. D207, D307, D305 or D304 shorted. e. R102 defective.
7. Transmitter plate current meter inoperative. Transmit operation normal.	<ul style="list-style-type: none"> a. M2.
8. Idling current too high (60 to 70 mA is normal).	<ul style="list-style-type: none"> a. Check setting of R107. Set this control for 60 to 70 mA. b. After setting R107, check the power output with the relative power indicator (push-to-tune must be depressed). If power output is low, final tubes probably need to be replaced. c. Defective power supply, (bias section).
9. Transmitter unstable.	<ul style="list-style-type: none"> a. Improper neutralization. b. V101 or V102 defective, or V103. c. Shield covers not properly fastened.
10. Insufficient carrier suppression.	<ul style="list-style-type: none"> a. Balanced modulator improperly adjusted. b. Carrier oscillator off frequency.
11. CW normal, receiver normal. Goes into transmit normally, plate current does not move from idle.	<ul style="list-style-type: none"> a. Check microphone, microphone cord and plug. b. Q406, Q407, Q408, Q409 or Q414.
12. When the function switch is in VLX position and the mode switch in USB or LSB, a chatter occurs (transceiver going from receive to transmit or vice versa, rapidly).	<ul style="list-style-type: none"> a. R118 (VLX Delay), R117 VLX Anti-trip), R119 (VLX Sensitivity) incorrectly adjusted.

MAINTENANCE (cont'd)

TROUBLE ANALYSIS Table 7-2 (cont'd)

RECEIVER

- | | |
|--|--|
| 1. Receiver inoperative. Transmit operates normally. No S-Meter indication. | a. Q201, Q202 or Q205 defective. Also D204, D205 and D212. |
| 2. Receiver inoperative, S-Meter indication but no CW sidetone. | a. D405, Q401, Q402, Q102 and D401. |
| 3. No CW sidetone. Receiver operative. | a. D402. |
| 4. 100 kHz calibrator inoperative. | a. Q01, Q02, or Y01 defective. |
| 5. Noise Blanker inoperative. Receiver otherwise seems normal. | a. Q206, D214 or D213. |
| 6. Receiver completely inoperative on one VFO, but operates normally on the other. VFO indicator light out on the VFO that does not appear to operate. | a. I107 or I108 defective depending upon which VFO is out. |
| 7. 100 kHz calibrator inoperative in one VFO position only. | a. D411 or D412 open. |
| 8. No dial lights, receiver or transmitter inoperative, tube filaments are lighted. | a. 12 volt fuse F2 in power supply open. |
| 9. Same as 7 but no filaments. | a. Main fuse F1 in power supply open.
b. Mobile supply-breaker CB1 open. Allow to cool. |

7.2 REPLACING COMPONENTS

7.2.1 REPLACING TRANSISTORS

Always use E. F. Johnson part number transistors when replacing transistors. Many Avenger circuits use transistors selected for particular parameters. Replacement with the same E. F. Johnson part number transistor insures equivalent performance.

7.2.2 REPLACING Q102

The audio output transistor, Q102, is mounted on the front of the accessory compartment. Q102 is mounted with a nylon screw (part no. 011-1014-012). The nylon screw allows Q102 to expand and contract with changes in temperature without damage. If for any reason you replace Q102 be certain to use the original hardware when mounting the new transistor.

7.2.3 REPLACING DIAL INDICATING BULBS

The following light bulbs are used for lighting the front panel:

Clear bulbs I113, I114, and I115 light during receive.

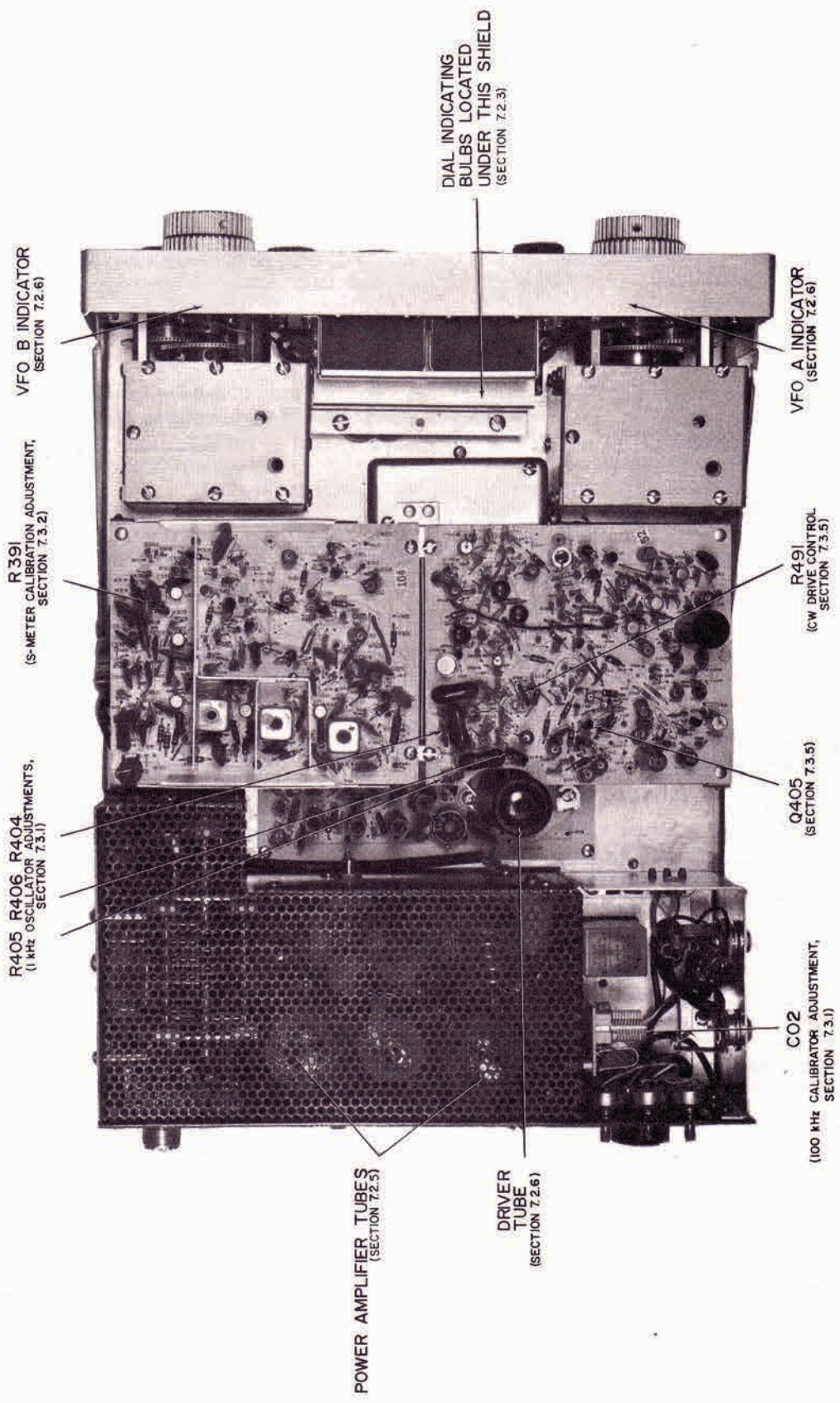
Red bulbs I109, I110, I111 and I112 light during transmit.

Burned out dial light bulbs may be replaced in the following manner:

- a. Remove the chassis enclosure.
- b. Remove the two number 6 screws holding the dial indicator cover SH1. Carefully slide the cover out and away from the bulbs.

NOTE: If either clear bulb located directly under the meters requires replacement, you must unscrew the indicator assembly. If this is necessary, proceed to the following steps.

- c. Unfasten both the audio and IF circuit boards and flip them up. Secure the boards in the up position by tightening the hinge screws.
- d. Remove the crystal oscillator shield, SH3.
- e. Unscrew the two screws holding the indicator assembly and slide the assembly away from the panel. You can now replace any of the front clear indicator bulbs.



TOP VIEW SHOWING
OWNER SERVICEABLE ITEMS
FIGURE 7-2

MAINTENANCE (cont'd)

- f. Reverse the previous steps to reassemble the disconnected parts.

7.2.4 REPLACING VFO INDICATING BULBS

Clear bulbs I107 and I108 indicate the selected VFO and provide additional VFO voltage regulation. If one of these bulbs burns out, the corresponding VFO will be inoperative.

- a. Remove the cabinet enclosure.
- b. Locate the burned out bulb.
- c. Unsolder both bulb leads from the "Rib-Loc" terminals.
- d. Slide the bulb out of its mounting clip.
- e. Insert the new bulb and solder its leads to the "Rib-Loc" terminals.

7.2.5 REPLACING POWER AMPLIFIER TUBES

- a. Remove the nine number 6 screws that fasten the transceiver enclosure to the chassis.
- b. Carefully withdraw the enclosure from the chassis.

NOTE: If a microphone holder is mounted on the enclosure, remove it before withdrawing the enclosure. This will prevent the microphone hanger mounting screws from scratching the chassis.

- c. Remove the eight number 6 screws holding the PA top shield in place.
- d. Remove the suppressor assemblies from the plate caps.

CAUTION: Do not flex the suppressor assemblies more than is necessary for removal of the PA tubes. The suppressor assemblies are soldered to the output network with very short leads. Excessive flexing can cause the leads to break off.

- e. We recommend a pair of rubber tipped tube pullers for the following operation. Remove the PA tubes. If tube pullers are not available, make sure the tube envelopes are cool before removal is attempted. When the tubes are cool, gently rock the tubes back and forth while pulling them out of their sockets.
- f. After replacing the PA tubes, align the tinnerman clips around the compartment shield carefully. Then install the compartment shield.
- g. Refer to the idling current and neutralization adjust-

ment procedures before you put the new tubes into operation.

7.2.6 REPLACING DRIVER TUBE

- a. Remove transceiver enclosure as in step a and b of Section 7.2.4.
- b. Allow the driver tube and shield to cool.
- c. Carefully remove the driver tube shield; lift up on it carefully to avoid unnecessary flexing of the RF board. If too much force seems necessary insert a thin bladed screwdriver into the tube shield slots at the base of the shield and pry it up.
- d. Remove the driver tube. Rock the tube gently out of its socket.
- e. Replace the driver tube.
- f. Replace the tube shield, aligning the raised dimples on the tube socket with the slots on the tube shield.

7.3 ADJUSTMENTS

7.3.1 100 kHz CALIBRATOR

Equipment required: Monitor Receiver tuned to WWV and a fiber or plastic flat tipped alignment tool.

NOTE: This adjustment can be made with the enclosure left on.

- a. Turn the Avenger on by depressing the on/off switch.
- b. Turn the monitor receiver on.
- c. Run a length of wire from near the Avenger accessory compartment to the monitor receiver antenna jack.
- d. Place the function switch in the CALIBRATE position.
- e. Reach through the key jack with the alignment tool to adjust the calibrator trimmer, C02.
- f. Choose a time to calibrate when the received WWV signal is not modulated. If the calibrator is adjusted when the WWV signal is modulated a 440 or 600 Hz error will be introduced in the calibrator.
- g. Carefully adjust C02 for a zero beat.

7.3.2 S-METER CALIBRATION

Test Instruments required. (Equivalent or superior test instruments may be used).

Signal Generator - With calibrated attenuator; Heath IG-42.

MAINTENANCE (cont'd)

Speaker Load - 3.2 ohms, 3 watts.

- a. Set the front panel controls in the following manner:

Bandswitch	20 meters
VFO A	14.2 MHz
VFO B	14.2 MHz
Noise Blanker	OFF
VFO Sel.	B
Xmit Pwr.	OFF
Function	PTT
Xmit Drive	Full counterclockwise
Mode Switch	USB
RF Tune	Adjust as directed
RF Gain	Full clockwise
Audio Gain	Where desired
PA Tune	N. A.
PA Load	N. A.

- b. Turn the Avenger on.
- c. Set the signal generator attenuator to 10 mV.
- d. Adjust the frequency at 14.2 MHz so that a signal is present at the audio output.
- e. Set the generator frequency so that the S-meter indication is maximum.
- f. Tune the RF Tune control to peak the S-meter reading.
- g. Adjust R359 on the IF board until the S-meter reads 40.

7.3.3 1 kHz OSCILLATOR ADJUSTMENT

Equipment required: Oscilloscope with calibrated sweep.
Can of circuit cooler
Hand key

- a. Set the Avenger controls as follows:

Bandswitch	80 meters
VFO A	N. A.
VFO B	N. A.
Noise Blanker	OFF
VFO Sel.	N. A.
Xmit Pwr.	OFF
Function	VLX
Xmit Drive	Full counterclockwise
Mode	CW
RF Tune	N. A.
RF Gain	Full clockwise
Audio Gain	Where desired
P. A. Tune	N. A.
P. A. Load	N. A.

- b. Connect the input lead of the oscilloscope to the

emitter of Q405. Connect the ground lead of the oscilloscope to the chassis.

- c. Turn the Avenger on by pushing the audio gain control.
- d. Key the Avenger with the external key.
- e. Set the oscilloscope for 1 millisecond/division.
- f. Adjust R404, R405, and R406 for a 1000 Hz signal observed on the oscilloscope.
- g. Adjust R406 for maximum undistorted level as shown on the scope.
- h. Using the circuit cooler, spray Q403 and Q404 liberally to obtain a simulated cold condition and repeat steps f and g until the circuit will start every time.

7.3.4 PA NEUTRALIZATION

Neutralization should be checked at any indication of instability, or when the plate current dip and relative RF output peak do not occur at the same time. It should also be checked any time the power amplifier tubes are replaced. Neutralization is accomplished by making small adjustments of C133 during the loading process.

- a. Remove the chassis enclosure.
- b. Locate C133. It is located on the PA compartment enclosure, facing the front of the radio, directly behind the IF board.
- c. Tune the Avenger up on 28.0 MHz.
- d. Adjust C133 in small increments until the plate current dip and the relative RF power output peaks occur at the same time.

7.3.5 CW DRIVE ADJUSTMENT

Equipment required: Audio Oscilloscope
Audio VTVM - Heath IM-21
Hand key

- a. Connect the input lead of the audio VTVM to the emitter of Q405. Q405 is located on the audio printed circuit board. Connect the ground lead to the chassis.
- b. Connect the input lead of the oscilloscope to the collector of Q405. Connect the ground lead of the oscilloscope to the chassis.
- c. Turn the Avenger on.
- d. Set the Avenger up for CW operation.
- e. Connect a hand key to the key jack. Key the Aveng-

MAINTENANCE (cont'd)

er with the key.

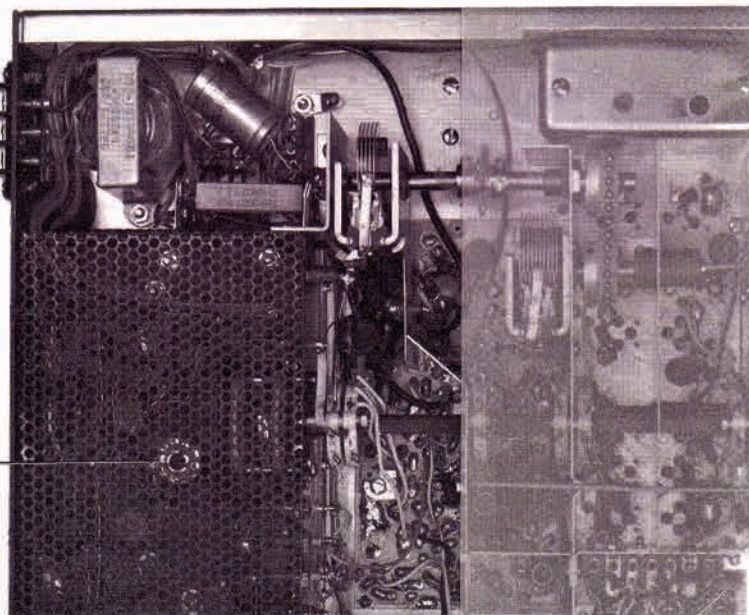
- f. Adjust R491 (located on the audio circuit board) for 90 mV as indicated on the AC-VTVM. The waveform on the oscilloscope should be a symmetrical 1000 Hz signal.

7.3.6 PA IDLING ADJUSTMENT

NOTE: This adjustment should always be checked whenever the power amplifier tubes are replaced or whenever you change power supplies. Set the idling current at 28 MHz.

- a. Locate R107. It is mounted on the PA grid assembly. Access is gained through a hole in the bottom shield of the PA compartment.
- b. A thin insulated flat tipped alignment tool is required for the following step.
- c. Key the transmitter by depressing the push-to-tune switch.
- d. Adjust R107 for 60 to 70 mA as indicated on the plate current meter.

R107
(PA IDLING CURRENT
ADJUSTMENT, SECTION 7.3.6)



BOTTOM VIEW SHOWING
R107 LOCATION
FIGURE 7-3

MAINTENANCE (cont'd)

Table 7-3
DC READINGS OF TRANSISTORS

Transistor Number	Collector		Base		Emitter	
	Trans.	Rec.	Trans.	Rec.	Trans.	Rec.
Q01 *****	---	3.9	---	-2.2	---	---
Q02 *****	---	3.8	---	-2.6	---	---
Q101	13.4 Y	-8.6 Y	13.2 Y	-6.9 Y	13.7 Y	0 Y
Q102 *	12.1 *	5.5	1.3 *	1.47	0.66 *	0.67
Q201	0	0	0.7	0.7	0	0
Q202	13.0	13.0	0	4.3	0	3.5
Q203	0.01	0.07	0.67	0.7	0	0
Q204	13.0	13.1	4.4	0	4.5	0
Q205	0	12.75	0	4.0	0	3.3
Q206	6.66	6.5	3.8	3.7	3.2	3.1
Q207	0	13.3	0	0.35	0	0
Q208 ***	4.27 ***	26.0 ***	4.9 ***	0 ***	4.3 ***	0 ***
Q301	0.21	0.025	0.72	0.72	0	0
Q302	13.5	13.1	4.3	4.1	3.5	3.5
Q303	13.1	12.65	4.0	3.9	3.3	3.2
Q304	12.45	12.0	3.8	3.7	3.2	3.0
Q305	4.5	4.3	0	0.37	0	0
Q306	0	13.2	0	0	0	0.36
Q307	0	13.3	0	0	0	0
Q308	0	13.2	0	0	0	0
Q309	0	13.3	0	0.1	0	0
Q310	13.4	7.25	13.3	3.3	13.7	2.6
Q311	7.77	7.0	3.4	3.0	2.7	2.3
Q401 *	12.1 *	12.6	3.9 *	4.0	3.2 *	3.3
Q402 *	3.6 *	4.0	1.2 *	1.2	0.5 *	0.5
Q403 *	6.9	6.1	3.5	3.6	2.8	2.9
Q404 *	11.2	11.4	5.7	5.8	5.5	5.3
Q405	9.2	9.0	2.2	2.2	1.7	1.55
Q406	7.9	7.9	1.4	1.4	1.1	1.1
Q407	4.5	4.4	3.1	3.1	2.5	2.5
Q408	5.7	5.0	3.0	3.0	2.5	2.4
Q409	0	0	0	0	0	0
Q410	11.2	11.0	0	0	0	0
Q411	7.5	7.6	3.3	3.2	2.6	2.6
Q412	7.9	7.6	0.5	0.5	0	0
Q413	7.0	6.6	6.9	6.6	6.3	6.1
Q414	10.0	11.0	2.1	2.0	1.4	6.7
Q415	7.6	7.4	7.0	6.7	7.7	7.4
Q416 **	0	5.8	7.5	7.3	7.6	7.4
Q417 **	0	13.0	0.5	5.3	0	5.3
Q418 **	13.4	0	12.8	13.1	13.6	13.2
Q419 **	0.1	13.3	0.75	0	0	0
Q501 *****	13.1	13.0	3.8	3.7	3.3	3.3
Q701	0	0	0.8	0.78	1.5	1.45
Q702	4.5	4.5	1.6	1.68	1.1	1.1
Q801	11.2	10.9	4.1	3.8	4.3	4.1
Q802	8.0	7.9	1.1	1.1	0.4	0.35
Q901	13.3	13.1	4.3	4.1	3.5	3.5
Q902	9.3	8.6	2.1	2.0	1.2	1.2
Q903	9.8	0	4.1	0	3.2	0

MAINTENANCE (cont'd)

Pin	V1		V2		V3	
	Trans.	Rec.	Trans.	Rec.	Trans.	Rec.
1	11.5 VAC	11.5 VAC	0	0	4.5	28
2	0	0	0	0	0	0
3	150	150	150	150	4.5	28
4	0	0	0	0	0	0
5	-60	-120	-60	-120	6.7 VAC	6.2 VAC
6	150	150	150	150	205	260
7	0	0	0	0	240	260
8	150	150	150	150	205	260
9	-60	-120	-60	-120	4.2	26
10	0	0	0	0		
11	150	150	150	150		
12	5.8 VAC	5.7 VAC	5.8 VAC	5.7 VAC		
Plate Cap	815 VAC	830	815 VAC	830		

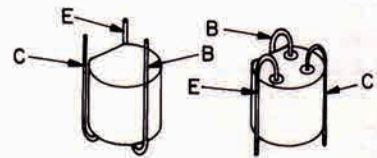
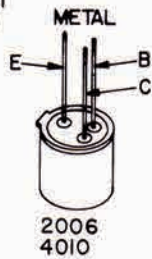
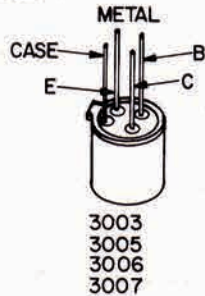
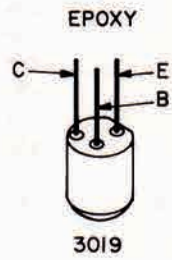
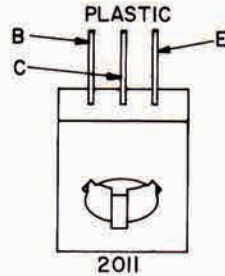
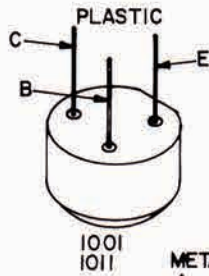
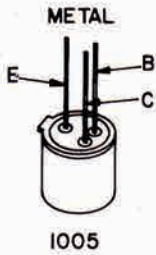
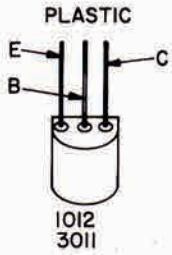
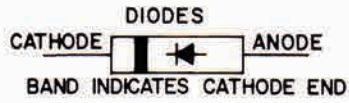
Conditions

- RF Gain - Max.
- Audio Gain - Min.
- Band - 40 meters
- Freq. - 7.2 MHz
- Mode - USB
- Function - VLX
- Anti-Trip - Full CW
- Delay - Full CW
- Sens. - Full CW

NOTES:

- * Mode switch at CW position
- ** Function switch at PTT position
- *** High voltage on
- **** Series 50 μ H choke
- ***** Function switch at Calibrate position

All readings are typical and may vary widely; the pattern of readings is typical for all units.



PLASTIC TRANSISTORS
WITH FORMED LEADS

SEMICONDUCTOR CASE DIAGRAMS
FIGURE 7-4

SECTION 8 PARTS LIST

SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.	SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.
BRACKETS			C172	Same as C168	
BKT1	Push-to-tune switch supporting	017-0558-001	C173	Same as C168	
BKT2	Tuning capacitor support	017-0540-001	C174	Same as C168	
BKT3	Coarse load capacitor supporting	017-1140-001	C175	75 pF $\pm 5\%$ 100 V mica	510-0002-750
BKT4	Meter mounting	017-0503-001	C176	Same as C175	
CAPACITORS			C177	Same as C175	
C101	50 pF $\pm 10\%$ 2500 V molded mica	510-0010-500	C178	Same as C175	
C102	270 pF $\pm 10\%$ 2500 V molded mica	510-0010-271	C179	Same as C175	
C103	0.001 μ F $\pm 20\%$ 1.5 kV ceramic disc	510-3158-103	C180	Same as C175	
C104	0.01 μ F $\pm 20\%$ 1.5 kV ceramic disc	510-3158-102	C181	Same as C175	
C125	450 pF differential air variable 1000 V	149-0315-003	C182	Same as C175	
C126	50 & 160 pF dual air variable 1000 V	149-0905-002	C183	91 pF $\pm 5\%$ 100 V mica	510-0002-910
C127	430 pF $\pm 10\%$ 500 V mica	510-0005-431	C184	Same as C183	
C128	Same as C125		C185	Same as C183	
C129	Same as C125		C186	Same as C183	
C130	Same as C125		C187	200 pF $\pm 5\%$ 100 V mica	510-0001-201
C131	Same as C125		C188	0.002 μ F $+80\%$ -20% 500 V ceramic disc	510-3005-202
C132	0.002 μ F $\pm 20\%$ 6 kV Y5U ceramic disc	510-3081-202	C189	0.01 μ F $\pm 20\%$ 50 V ceramic disc	510-3002-103
C134	3.7 - 9 pF air variable 2100 V	148-0103-056	C190	1000 μ F 16 V electrolytic	510-4006-005
C135	1000 pF $\pm 20\%$ feed thru ceramic 500 VWDC	510-3153-002	C191	0.01 μ F $+100\%$ -10% 50 V ceramic disc	510-3002-103
C136	Same as C135		C192	39 pF $\pm 5\%$ 100 V mica	510-0002-390
C137	Same as C135		C193	Same as C192	
C138	Same as C135		C194	56 pF $\pm 5\%$ 100 V mica	510-0002-560
C141	0.01 μ F $\pm 20\%$ 50 V ceramic disc	510-3002-103	C195	150 pF $\pm 5\%$ 100 V mica	510-0002-151
C143	Same as C141		C196	0.01 μ F $\pm 20\%$ 50 V ceramic disc	510-3002-103
C147	Same as C141		C197	Same as C196	
C148	Same as C141		C198	Same as C196	
C149	10 - 100 pF air variable RF tuning 100 VRMS	512-0002-001	C199	Same as C196	
C150	330 pF $\pm 5\%$ 100 V mica	510-0001-331	C1100	0.01 μ F $\pm 20\%$ 50 V ceramic disc	510-3002-103
C151	47 pF $\pm 5\%$ 100 V mica	510-0002-470	C1101	Same as C1100	
C152	27 pF $\pm 5\%$ 100 V mica	510-0002-270	C1102	Same as C1100	
C153	18 pF $\pm 5\%$ 100 V mica	510-0002-180	C1103	7.5 pF $\pm 5\%$ 500 V	510-9002-759
C154	68 pF $\pm 5\%$ 100 V mica	510-0002-680	C1104	5.0 pF $\pm 5\%$ NPO ceramic disc	510-3013-509
C155	0.01 μ F $\pm 20\%$ 50 V ceramic disc	510-3002-103	C1105	15 pF $\pm 5\%$ 100 V mica	510-0001-150
C156	Same as C155		C1106	56 pF $\pm 5\%$ 100 V mica	510-0002-560
C157	Same as C155		C1107	0.01 μ F $\pm 20\%$ 50 V ceramic disc	510-3002-103
C158	Same as C155		C1108	0.01 μ F $\pm 20\%$ 500 V ceramic disc	510-3004-103
C159	3 pF $\pm 10\%$ 500 V mica	510-0005-309	C1109	0.01 μ F $\pm 20\%$ 50 V ceramic disc	510-3002-103
C160	0.01 μ F $\pm 20\%$ 50 V ceramic disc	510-3002-103	C1111	Same as C1109	
C161	Same as C160		C1112	Same as C1109	
C162	Same as C160		C1113	0.002 μ F $+80\%$ -20% 500 V ceramic disc	510-3005-202
C163	Same as C160		CHASSIS PARTS		
C164	Same as C160		CH1	Chassis main, formed	017-0527-002
C165	15 - 250 pF RF tuning	512-0002-002	CH2	Cabinet shell assembly includes: Cabinet shell (formed) Cabinet support bracket Bumper grommet	023-2375-002 017-0532-002 017-1312-002 574-1001-001
C166	0.01 μ F $\pm 20\%$ 50 V ceramic	510-3002-103	CH3	Trim, Johnson logo	559-9001-001
C167	Same as C166		DIODES		
C168	1.6 - 6.7 pF air variable 530 VRMS	189-0502-004	D103	WG-316	523-0006-002
C169	Same as C168		D104	Same as D103	
C170	Same as C168		D105	Same as D103	
C171	Same as C168				

PARTS LIST (cont'd)

SCHMATIC SYMBOL NO.	DESCRIPTION	PART NO.	SCHMATIC SYMBOL NO.	DESCRIPTION	PART NO.
ELECTRICAL PARTS					
E1	Standoff, phenolic, 3 used	586-9001-001	HW	Screw, 4-40 x 1 1/4 RH NPB	011-0011-040
E2	Bushing, nylon shoulder (audio output transistor insulator)	018-0036-017	HW	Screw, 6-32 x 1/8 BH NPB	011-0114-004
E3	Standoff, ceramic (PA output coil) 2 used	010-0156-001	HW	Screw, 6-32 x 3/16 BH NPB	011-0114-006
E4	Washer, #6 insulating (PA output coil) 4 used	029-0062-001	HW	Screw, 6-32 x 1/4 BH NPB	011-0114-008
E5	Standoff, ceramic (10 Meter coil mounting)	010-0019-001	HW	Screw, 6-32 x 5/16 BH NPB	011-0114-010
E6	Bushing, bakelite shoulder (neutralizing capacitor) 1 used	029-0209-005	HW	Screw, 6-32 x 3/8 BH NPB	011-0114-012
E7	Washer, insulating (neutralizing capacitor) 1 used	029-0213-004	HW	Screw, 6-32 x 3/16 RH NPB	011-0016-006
E8	Standoff, Rib-Loc, double turret	260-0102-001	HW	Screw, 6-32 x 7/16 RH NPB	011-0016-014
E9	Feedthru, Rib-Loc, double turret	260-0302-001	HW	Screw, 6-32 x 5/8 RH NPB	011-0016-020
E10	Feedthru, Rib-Loc, special	260-0502-001	HW	Screw, 6-32 x 7/8 RH NPB	011-0016-028
E11	Washer, insulating (RF tune cap) (ceramic bandswitch wafer mtg.)	029-0073-001	HW	Screw, 6-32 x 3/8 RH NPB	011-0016-012
		029-0421-001	HW	Screw, 6-32 x 1 1/8 RH NPB	011-0016-040
E12	Washer, shoulder (RF tune cap)	029-0210-001	HW	Screw, 8-32 x 3/8 RH NPB	011-0021-012
E13	Band switch shaft, phenolic	018-0784-005	HW	Screw, 10-32 x 1/4 RH NPB	011-0028-008
E14	Washer, nylon insulating (VFO)	029-0308-009	HW	Screw, 2-56 x 1/4 RH NPB	011-0005-008
E15	Fastener, insulating (variable cap.) (all type U's on chassis mtg.)	115-0189-001	HW	Screw, 1-72 BH	011-0824-007
E16	Cap, connector (power input plug)	515-9012-005	HW	Screw, 4-40 x 3/8 BH nylon	011-1014-012
E17	Knob, tune switch	547-0006-001	HW	Shake, int. lug #4	586-0005-104
E18	Washer, cork	029-0029-001	HW	Shake, int. washer 3/8 large	029-0065-003
E101	Parasitic Suppressor assembly (2 used) includes:	023-2402-001	HW	Shake, int. #6	029-0069-003
	Parasitic suppressor	023-0912-010	HW	Shake, int. lug #6 short	586-0005-106
	Tube cap	016-0035-001	HW	Shake, int. lug #8 long	586-0005-008
E102	Same as E101		HW	Shake, int. lug #6 long	586-0005-006
			HW	Shake, int. #4	029-0116-003
			HW	Shake, int. #10	029-0001-003
			HW	Shake, int. 1/4"	029-0410-003
			HW	Shake, int. 3/8 small	029-0386-003
			HW	Shake, int. washer #2	029-0178-001
			HW	Washer, split lock #4	029-0082-002
			HW	Flatwasher, #4	029-0040-001
			HW	Flatwasher, #6 (dial drum)	029-0002-001
			HW	Flatwasher, #8	029-0003-001
			HW	Flatwasher, 3/8"	029-0098-002
			HW	Hex nut, #4-40 x 1/4 x 3/32	012-0001-001
			HW	Hex nut, #4-40 x 3/16 x 1/16	012-0163-003
			HW	Hex nut, 6-32 x 1/4	012-0002-001
			HW	Hex nut, 1/4 - 32 x 3/8	012-0098-003
			HW	Hex nut, 3/8 - 32 x 1/2	012-0040-003
			HW	Hex nut, 2-56 x 3/32	012-0038-002
GROMMET			BULBS		
G1	3/4" OD x 7/16 ID (cable harness, through chassis)	574-0002-006	I107	Bulb, regulating #1739	549-3001-010
G2	7/16" OD x 3/16 ID	574-0002-003	I108	Same as I107	
G3	3/8" OD x 1/4 ID (coaxial protection through panel)	574-0002-001	I109	Bulb, dial lighting, red	549-0502-002
			I110	Same as I109	
			I111	Same as I109	
			I112	Same as I109	
			I113	Bulb, dial lighting, clear	549-0502-001
			I114	Same as I113	
			I115	Same as I113	
HARDWARE			JACKS		
HW	Setscrew, 4-40 x 1/8 hex socket	011-0127-004	J101	Jack, mike input	515-2004-003
HW	Setscrew, 8-32 x 3/16 hex socket	011-0122-006	J102	Jack, headphones	515-2003-001
HW	Setscrew, 6-32 x 3/16 hex socket	011-0112-004	J103	Jack, key	515-2003-002
HW	Setscrew, 6-32 x 3/16 slot socket	011-0019-006	J104	Receptacle, antenna connecting	515-3003-001
HW	Setscrew, 4-40 x 3/16 hex socket	011-0127-008			
HW	Screw, 4-40 x 1/8 RH NPB	011-0127-004			
HW	Screw, 4-40 x 3/16 BH NPB	011-0012-006			
HW	Screw, 4-40 x 1/4 BH NPB	011-0012-008			
HW	Screw, 4-40 x 1/8 RH NPB	011-0011-004			
HW	Screw, 4-40 x 5/16 RH NPB	011-0011-010			
HW	Screw, 4-40 x 7/16 RH NPB	011-0011-014			
HW	Screw, 4-40 x 1/2 RH NPB	011-0011-016			
HW	Screw, 4-40 x 5/8 RH NPB	011-0011-020			
HW	Screw, 4-40 x 3/4 RH NPB	011-0011-024	L101	Choke, 50 μ H	542-3002-003
HW	Screw, 4-40 x 7/8 RH NPB	011-0011-028	L102	Same as L101	
CHOKES AND COILS					

PARTS LIST (cont'd)

SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.	SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.
MP41	Knob, 1 1/8" dia. (band sw.)	013-1148-001	MP68	Panel, access (cabinet-accessory jack cover)	017-0588-001
MP42	Knob, 1 1/8" dia.	013-1149-001	MP69	Plug button (calibrate hole plug)	537-9001-011
MP43	Knob, 1 1/8" dia. (on-off mate)	013-1149-002	MP70	Spacer (PA tune 80 and 40 Meter padding, green)	013-0155-149
MP44	Panel bearing (RF tune shaft and PA tune shaft)	013-0123-012	MP71	"E" ring, 0.102 diameter	537-1001-001
MP45	Panel bearing (Front panel PA tune)	013-0123-022	MP72	Coupling, flexible	104-0264-001
MP46	Oilite bearing (coarse load switch shaft)	013-0123-023	MP73	Panel bearing	013-0123-020
MP47	Plate, parasitic suppressor (power amp)	016-1717-001		TRANSISTORS	
MP48	Pulley assembly includes: Bead chain pulley Rd. Hd. M. Screw #4-40 Slotted S. Screw #10-32 Hub Hub Rd. Hd. M. Screw #4-40 Slotted S. Screw #4-40	023-1634-002 526-3001-003 011-0011-020 011-0029-008 013-1067-001 013-1067-002 011-0011-012 011-0175-008	Q102	NPN, Si, 2011, audio output	576-0002-011
MP49	Hub assembly, 5/8 dia. (PA tune capacitor stop, fixed) includes: Hub 5/8 dia. Roll pin 1/16 dia. x 3/8 lg.	023-2369-001 013-1154-001 031-0345-002		RESISTORS	
MP50	Stop assembly, 15/16 dia. (PA tune capacitor stop, rotating) includes: Hub, 15/16 dia. Roll pin 1/16 dia. x 3/8 lg.	023-2368-001 013-1153-001 031-0345-002	R109	2.2 K $\pm 10\%$ 1/4 W composition	569-1002-222
MP51	Wheel assembly (coarse load switch drive wheel) includes: Wheel Hub	023-1399-001 016-1458-001 013-0985-001	R110	6.8 K $\pm 10\%$ 1/4 W composition	569-1002-682
MP52	Spring extension	022-1212-001	R111	Potentiometer, 10 K $\pm 30\%$ 1/4 W	562-0002-007
MP53	Drive shaft, dial drum	013-0173-048	R112	Same as R111	
MP54	Tinnerman clips (overlay)	012-0503-005	R113	6.8 K $\pm 10\%$ 1/4 W composition	569-1002-682
MP55	Spring, extension (dial string tension)	580-0001-001	R114	100 $\Omega \pm 10\%$ 1/2 W composition	569-1004-101
MP56	Drive pulley, dial string	013-1184-001	R115	1.8 K $\pm 10\%$ 1/4 W composition	569-1002-182
MP57	Pulley idler dial string	032-0169-002	R116	1 $\Omega \pm 10\%$ 1 W, wirewound	569-2003-109
MP58	Steel shaft assembly, RF tuning PA includes: Shaft, concentric, outer Pulley, bead chain	023-2411-001 013-1156-001 526-3001-002	R117	Potentiometer, 100 $\Omega \pm 30\%$ 1/4 W	562-0002-010
MP59	Flexible shaft assembly includes: Shaft, flexible Coupling Coupling	023-2373-001 016-0172-008 013-1155-001 013-0079-008	R118	Potentiometer, 50 K $\pm 30\%$ 1/4 W	562-0002-008
MP60	Shaft, inner, RF tuning	013-1158-001	R119	Potentiometer, 500 $\Omega \pm 30\%$ 1/4 W	562-0002-009
MP61	Shaft, concentric, inner (PA loading drive)	013-1157-001	R121	Potentiometer, dual with switch (S-2); Section A 1500 Ω , Section B 5000 Ω	562-0021-001
MP62	Tuning capacitor, shaft (PA grid tune drive shaft)	013-0826-005	R122	Same as R121	
MP63	Pin, contact (power plug pin male) 12 used	515-9012-041	R123	10 $\Omega \pm 10\%$ 1 W composition	569-1006-100
MP64	Bead chain, continuous (drive chain, PA grid timing)	526-1001-001	R124	1 K $\pm 10\%$ 1/4 W composition	569-1002-102
MP65	Bead chain, PA RF tuning	526-1002-003	R125	10 $\Omega \pm 10\%$ 1/2 W composition	569-1004-100
MP66	Lug, pot grounding (function switch rotor ground & RF gain ground) 2 used	022-1924-001	R126	7.5 Ω , $\pm 5\%$ 7 W wirewound	569-2007-759
MP67	Spring, extension	022-1272-001		RELAYS	
			RY101	Relay, coaxial switching	567-6001-001
			RY102	Relay, general purpose	567-0003-012
				SWITCHES	
			S1A	Switch wafer, bandswitch	583-2019-001
			S1B	Same as S1A	
			S1C	Same as S1A	
			S1D	Same as S1A	
			S1E	Same as S1A	
			S1F	Same as S1A	
			S1G	Same as S1A	
			S1H	Same as S1A	
			S1J	Same as S1A	
			S1K	Same as S1A	
			S1L	Switch wafer, ceramic (band-switch)	583-2015-001
			S1M	Switch wafer, ceramic (band-switch)	583-2016-001
			S3	Switch rocker (VFO selector)	583-3004-004
			S4	Switch rotary	583-2014-001
			S5	Switch rocker, SPDT (NB on/off)	583-3004-002

PARTS LIST (cont'd)

SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.	SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.
ASSEMBLIES			L103	Choke, 13 mH	542-3003-001
Z103	Term. strip assembly, pwr. out indicating	023-2430-001	DZ101	Diode, zener 91V	523-2002-910
Z104	PA grid assembly	023-2400-001	Q101	Transistor, PNP, Si. 1011	576-0001-011
Z200	RF board assembly	023-2391-001	R101	Resistor, .33 Ω $\pm 5\%$ 1/2 W wirewound	569-2002-338
Z300	IF board assembly	023-2392-001		Resistor, 100 Ω $\pm 10\%$ 1/2 W, comp.	569-1004-101
Z400	Audio board assembly	023-2393-001	R102	Resistor, 100 Ω $\pm 10\%$ 1/2 W "	569-1004-101
Z500	Carrier osc. board assembly	023-2388-001	R103	Same as R102	
Z600	Balanced mod. board assembly	023-2389-001	R104	Resistor, 22 K Ω $\pm 10\%$ 1/2 W "	569-1004-223
Z700A	VFO assembly, left	023-2398-002	R105	Resistor, 27 K Ω $\pm 10\%$ 1/4 W "	569-1002-273
Z700B	VFO assembly, right	023-2398-001	R106	Same as R105	
Z800	Crystal osc. board assembly	023-2390-001	R107	Potentiometer, 10K $\pm 30\%$ 1/4 W "	562-0003-003
Z900	Heterodyne mixer board assembly	023-2395-001	R108	Resistor, 10K Ω $\pm 10\%$ 1/2 W "	569-1004-103
Z1000	100 kHz osc. board assembly	023-2396-001		Assembly, PA grid chassis spotwelded & riveted	023-2399-001
RF DETECTOR ASSEMBLY				Grommet, 11/32 x 1/8 ID	574-0002-003
C139	Capacitor, 1.5 pF $\pm 10\%$ 500 V mica	510-0005-159		Lug, int.shake #6	586-0005-106
C140	Capacitor, 39 pF $\pm 5\%$ 100 V mica	510-0001-390		Nut, hex, 6-32 NPB	012-0002-001
C144	Capacitor, .05 μ F $+80\%$ -20% 25 V ceramic disc	510-3007-503		Riblock, double turret standoff	260-0102-001
C145	Same as C144			Screw, 6-32 x 3/16 BH, NPB	011-0114-006
C146	Same as C144			Strap 1/8" silver plated	071-0041-006
D101	Diode, WG-316	523-0006-002		Wire, #16 stranded, brown	071-0911-951
D102	Same as D101			Wire, #18 stranded, red	071-0471-362
R109	Resistor, 22K $\pm 10\%$ 1/4 W Terminal strip, 5 terminal	569-1004-223 586-1001-024	VFO ASSEMBLIES		
PA ASSEMBLY				Plate, gear mounting, right hand	014-0617-001
C105	Capacitor, .002 μ F $\pm 20\%$ 600 V ceramic disc	510-3004-202		Standoff	013-1139-002
C106	Same as C105			Assembly, printed circuit board, VFO	023-2394-001
C107	Same as C105			Screw, machine, binding head, #4-40	011-0012-008
C108	Same as C105			Flatwasher #4	029-0409-003
C109	Same as C105			Shield, interior, VFO	017-0506-001
C110	Same as C105			Panel, bottom	017-0510-001
C111	Capacitor, .01 μ F $+80\%$ -20% 600 V ceramic disc	510-3005-103		Coil assembly	023-2421-001
C112	Same as C111			Wire, stranded, #22 AWG	071-0911-929
C113	Same as C111			Screw, Machine, binding head, #4-40	011-0012-006
C114	Capacitor, .001 μ F $\pm 20\%$ 1 KV Y55 ceramic disc	510-3061-102		Capacitor, VFO	512-0003-001
C115	Capacitor, .005 μ F $+80\%$ -20% 500 V ceramic disc	510-3005-502		Panel, side	017-0508-001
C116	Same as C115			Shaft and gear assembly	023-2408-001
C117	Same as C115			Gear and hub assembly	023-2370-001
C118	Capacitor, .01 μ F $\pm 20\%$ 50 V ceramic disc	510-3002-103		Screw, Machine, right hand #8-32	011-0021-008
C119	Same as C118			"C" washer	016-0059-001
C120	Capacitor, .01 μ F $+80\%$ -20% 600 V ceramic disc	510-3005-103		Shaft & gear assembly	023-2409-001
C121	Capacitor, .01 μ F $\pm 20\%$ 50 V ceramic disc	510-3002-103		Bearing, oilite	505-1501-001
C122	Same as C121			Washer, nylon	029-0308-010
C123	Same as C121			Gear & hub assembly	023-2370-002
C124	Same as C121			Set screw, #8-32, hex socket	011-0122-006
C142	Capacitor, .01 μ F $\pm 20\%$ 50 V ceramic disc	510-3002-103		Screw, machine, right hand #8-32	011-0021-016
				Spacer	013-0155-155
				Hex nut, #6-32	012-0002-001
				Flatwasher, #6	029-0002-001
				Terminal lug, #4	586-0005-004
				Screw, machine, right hand #10-32	011-0028-016
				#10 flatwasher	029-0004-001

PARTS LIST (cont'd)

SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.	SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.
C336	Capacitor, .1 μ F +80% -20% 25 V ceramic	510-3007-104	PC301	Printed circuit board	035-0046-001
C337	Same as C336		Q301	Transistor, Si, NPN, 3007	576-0003-007
C340	Capacitor, 22 μ F \pm 20% 15 V tantalum	510-2003-220	Q302	Same as Q301	
C341	Same as C340		Q303	Same as Q301	
C342	Capacitor, 5.6 μ F \pm 20% 35 V tantalum	510-2005-569	Q304	Same as Q301	
C343	Capacitor, 1 μ F \pm 20% 35 V tantalum	510-2005-109	Q305	Transistor, Si, NPN, 3007	576-0003-007
C344	Capacitor, 220 pF \pm 5% 100 V mica	510-0001-221	Q306	Transistor, Si, NPN, 1004	576-0001-004
C345	Same as C344		Q307	Same as Q306	
C346	Same as C344		Q308	Same as Q306	
C347	Capacitor, .01 μ F \pm 20% 50 V ceramic	510-3002-103	Q309	Same as Q306	
C348	Capacitor, 20 μ F +100% -10% 16 V electrolytic	510-4006-009	Q310	Same as Q306	
C349	Capacitor, 1 μ F \pm 20% 35 V tantalum	510-2005-109	Q311	Same as Q306	
C350	Capacitor, 50 μ F +50% -10% 6.4 V electrolytic	510-4003-004	R301	Resistor, 6.8K \pm 10% 1/4 W comp.	569-1002-682
C351	Capacitor, 1 μ F \pm 20% 35 V tantalum	510-2005-109	R302	Resistor, 1.5K \pm 10% 1/4 W "	569-1002-152
C352	Capacitor, .01 μ F \pm 20% 50 V ceramic disc	510-3002-103	R303	Resistor, .270 Ω \pm 10% 1/4 W "	569-1002-271
C353	Same as C352		R304	Resistor, 2.7K \pm 10% 1/4 W "	569-1002-272
C354	Same as C352		R305	Resistor, 1.5K \pm 10% 1/4 W "	569-1002-152
D301	Diode, WG-286 or WG-316	523-0006-002	R306	Resistor, 22K \pm 10% 1/4 W "	569-1002-223
D302	Same as D301		R307	Resistor, 470 Ω \pm 10% 1/4 W "	569-1002-471
D303	Same as D301		R308	Resistor, 390 Ω \pm 10% 1/4 W "	569-1002-391
D304	Same as D301		R309	Resistor, 47 Ω \pm 10% 1/4 W "	569-1002-470
D305	Same as D301		R310	Resistor, 33K \pm 10% 1/4 W "	569-1002-333
D306	Same as D301		R311	Resistor, 10K \pm 10% 1/4 W "	569-1002-103
D307	Same as D301		R312	Resistor, 1.5 K \pm 10% 1/4 W "	560-1002-152
D308	Same as D301		R313	Resistor, 47K \pm 10% 1/4 W "	569-1002-473
D309	Diode, germanium, 30 V, 100 mA	523-0005-001	R314	Resistor, 2K \pm 10% 1/4 W "	569-1002-332
D310	Diode, WG-286 or WG-316	523-0006-002	R315	Resistor, 1.5K \pm 10% 1/4 W "	569-1002-152
D311	Same as D310		R316	Resistor, 330 Ω \pm 10% 1/4 W "	569-1002-331
D312	Same as D310		R317	Resistor, 47 Ω \pm 10% 1/4 W "	569-1002-470
D313	Same as D310		R318	Resistor, 220 Ω \pm 10% 1/4 W "	569-1002-221
D314	Diode, 2.7 V forward drop diode	523-0012-001	R319	Resistor, 560 Ω \pm 10% 1/4 W "	569-1002-561
D315	Diode, WG-286 or WG-316	523-0006-002	R320	Resistor, 560 Ω \pm 10% 1/4 W "	569-1002-561
D316	Diode, germanium, 30 V, 100 mA	523-0005-001	R321	Resistor, 470 Ω \pm 10% 1/4 W "	569-1002-471
D317	Same as D316		R322	Resistor, 2.2K \pm 10% 1/4 W "	569-1002-222
L301	Transformer, IF intermediate	592-5007-004	R323	Resistor, 1.8K \pm 10% 1/4 W "	569-1002-182
L302	Same as L301		R324	Resistor, 4.7K \pm 10% 1/4 W "	569-1002-472
L303	Transformer, IF output	592-5007-005	R325	Resistor, 15K \pm 10% 1/4 W "	569-1002-153
L304	Choke, 50 μ H	542-3002-003	R326	Resistor, 6.8K \pm 10% 1/4 W "	569-1002-682
L305	Same as L304		R327	Resistor, 470 Ω \pm 10% 1/4 W "	569-1002-471
L306	Same as L304		R328	Resistor, 2.7K \pm 10% 1/4 W "	569-1002-272
L307	Same as L304		R329	Resistor, 1.2K \pm 10% 1/4 W "	569-1002-122
L308	Same as L304		R330	Resistor, 10 Ω \pm 10% 1/4 W "	569-1002-100
L309	Same as L304		R331	Resistor, 100 Ω \pm 10% 1/4 W "	569-1002-101
L310	Same as L304		R332	Resistor, 47 Ω \pm 10% 1/4 W "	569-1002-470
L312	Same as L304		R333	Resistor, 3.3K \pm 10% 1/4 W "	569-1002-332
L313	Same as L304		R334	Resistor, 1.5K \pm 10% 1/4 W "	569-1002-152
L314	Same as L304		R335	Resistor, 1.2K \pm 10% 1/4 W "	569-1002-122
MP301	Bracket, hinge, right hand	017-0568-001	R336	Resistor, 100 Ω \pm 10% 1/4 W "	569-1002-101
MP302	Bracket, hinge, left hand	017-0569-001	R337	Same as R336	
			R338	Resistor, 3.3K \pm 10% 1/4 W "	569-1002-332
			R339	Resistor, 100 Ω \pm 10% 1/4 W "	569-1002-101
			R340	Resistor, 1.5K \pm 10% 1/4 W "	569-1002-152
			R341	Resistor, 1.2K \pm 10% 1/4 W "	569-1002-122
			R342	Resistor, 470 Ω \pm 10% 1/4 W "	569-1002-471
			R343	Resistor, 2.2K \pm 10% 1/4 W "	569-1002-222
			R344	Resistor, 1K \pm 10% 1/4 W "	569-1002-102
			R346	Resistor, 47K \pm 10% 1/4 W "	569-1002-473
			R347	Resistor, 750 Ω \pm 5% 1/4 W "	569-1001-751
			R348	Resistor, 10 Ω \pm 10% 1/4 W "	569-1002-100
			R349	Resistor, 750 Ω \pm 5% 1/4 W "	569-1001-751
			R350	Resistor, 15 Ω \pm 10% 1/4 W "	569-1002-150
			R351	Resistor, 330 Ω \pm 10% 1/4 W "	569-1002-331
			R352	Resistor, 10 Ω \pm 10% 1/4 W "	569-1002-100
			R353	Resistor, 220 Ω \pm 10% 1/4 W "	569-1002-221

PARTS LIST (cont'd)

SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.	SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.
R354	Resistor, 3.3K $\pm 10\%$ 1/4 W comp.	569-1002-332	C430	Same as C429	
R355	Resistor, 1.5K $\pm 10\%$ 1/4 W "	569-1002-152	C431	Capacitor, 640 μF 16 V elec- trolytic	510-4006-003
R356	Resistor, 100 Ω $\pm 10\%$ 1/4 W "	569-1002-101	C432	Capacitor, 47 μF $\pm 20\%$ 20 V tantalum	510-2004-470
R357	Same as R356		C433	Capacitor, 20 μF +100% -10% 16 V electrolytic	510-4006-009
R358	Resistor, 1K $\pm 10\%$ 1/4 W "	569-1002-102	C434	Capacitor, .1 μF $\pm 20\%$ 35 V tantalum	510-2005-108
R359	Potentiometer, 150 Ω $\pm 30\%$ 1/8 W	562-0004-151	C435	Capacitor, 8 μF +50% -10% 40 V electrolytic	510-4009-008
R360	Resistor, 470 Ω $\pm 10\%$ 1/4 W comp.	569-1002-471	C436	Capacitor, 50 μF +50% -10% 6.4 V electrolytic	510-4003-004
R361	Resistor, 150 Ω $\pm 10\%$ 1/4 W "	569-1002-151	C437	Capacitor, 1 μF $\pm 20\%$ 35 V tantalum	510-2005-109
R362	Resistor, 330 Ω $\pm 10\%$ 1/2 W "	569-1004-331	C438	Capacitor, .1 μF $\pm 20\%$ 35 V tantalum	510-2005-108
SH301	Shield assembly	023-2363-001	C439	Capacitor, 56 μF $\pm 20\%$ tantalum, 6 V	510-2001-560
W301	Wire #22 stranded, red	071-0911-902	C440	Capacitor, 1 μF $\pm 20\%$ 35 V tantalum	510-2005-109
W302	Wire #22 stranded, gray	071-0911-908	C441	Capacitor, .1 μF $\pm 20\%$ 35 V tantalum	510-2005-108
W303	Spaghetti, .034 ID #20 black	042-0240-770	C442	Capacitor, 1 μF $\pm 20\%$ 35 V tantalum	510-2005-109
AUDIO PRINTED CIRCUIT BOARD					
C401	Capacitor, 100 μF +50% -10% 6.4 V electrolytic	510-4003-005	C443	Capacitor, 8 μF +50% -10% 40 V electrolytic	510-4009-008
C402	Capacitor, 20 μF +100% -10% 16 V electrolytic	510-4006-009	C444	Capacitor, 1 μF $\pm 20\%$ 35 V tantalum	510-2005-109
C404	Capacitor, 50 μF +50% -10% 6.4 V electrolytic	510-4003-004	C445	Capacitor, 20 μF +100% -10% 16 V electrolytic	510-4006-009
C405	Capacitor, 250 μF +50% -10% 4 V electrolytic	510-4002-005	C446	Same as C445	
C406	Capacitor, 8 μF +50% -10% 40 V electrolytic	510-4009-008	C447	Same as C445	
C407	Capacitor, 20 μF +100% -10% 16 V electrolytic	510-4006-009	C448	Capacitor, 22 μF $\pm 20\%$ tantalum	510-2003-220
C408	Capacitor, 6800 pF $\pm 5\%$ 500 V mica	510-0008-682	C449	Capacitor, .1 μF $\pm 20\%$ 35 V tantalum	510-2005-108
C409	Same as C408		C450	Capacitor, 1 μF $\pm 20\%$ 35 V tantalum	510-2005-109
C410	Same as C408		C451	Capacitor, 5.6 μF $\pm 20\%$ 35 V tantalum	510-2005-569
C411	Capacitor, 5.6 μF $\pm 20\%$ tantalum	510-2005-569	D401	Diode, WG-316	523-0006-002
C412	Capacitor, .02 μF $\pm 20\%$ 50 V	510-3002-203	D402	Same as D401	
C413	Capacitor, 8 μF +50% -10% 40 V electrolytic	510-4009-008	D403	Same as D401	
C414	Capacitor, 1 μF $\pm 20\%$ 35 V tantalum	510-2005-109	D404	Same as D401	
C415	Same as C414		D405	Diode, germanium	523-0005-001
C416	Same as C414		D406	Diode, WG-316	523-0006-002
C417	Same as C414		D407	Same as D406	
C418	Same as C414		D408	Diode, 1N295	523-1000-295
C419	Capacitor, 20 μF +100% -10% 16 V electrolytic	510-4006-009	D409	Diode, germanium	523-0005-001
C420	Same as C419		D410	Same as D409	
C421	Capacitor, .01 μF $\pm 20\%$ 50 V ceramic disc	510-3002-103	D411	Diode, WG-316	523-0006-002
C422	Same as C421		D412	Same as D411	
C423	Capacitor, 1 μF $\pm 20\%$ 35 V tantalum	510-2005-109	DZ401	Diode, zener, 6.8 V	523-2003-689
C424	Capacitor, 8 μF +50% -10% 40 V electrolytic	510-4009-008	DZ402	Same as DZ401	
C425	Capacitor, 1 μF $\pm 20\%$ 35Vtantalum	510-2005-109	DZ403	Diode, zener, 9.1 V	523-2003-919
C426	Capacitor, 20 μF +100% -10% 16 V electrolytic	510-4006-009	DZ404	Same as DZ403	
C427	Capacitor, .01 μF $\pm 20\%$ 50 V ceramic disc	510-3002-103	MP401	Board hinge, right hand	017-0568-001
C428	Capacitor, 20 μF +100% -10% 16 V electrolytic	510-4006-009	MP402	Board hinge, left hand	017-0569-001
C429	Capacitor, 1 μF $\pm 20\%$ 35 V tantalum	510-2005-109	PC401	Printed circuit board	035-0045-001
			Q401	Transistor, Si, NPN, 1004	576-0001-004
			Q402	Same as Q401	
			Q403	Transistor, Si, NPN, 3011	576-0003-011

PARTS LIST (cont'd)

SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.	SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.
Q404	Transistor, Si, NPN, 1004	576-0001-004	R448	Resistor, 1.5K $\pm 10\%$ 1/4 W comp.	569-1002-152
Q405	Same as Q404		R449	Resistor, 4.7K $\pm 10\%$ 1/4 W "	569-1002-472
Q406	Transistor, Si, NPN, low noise, 1005	576-0001-005	R450	Resistor, 5.6K $\pm 10\%$ 1/4 W "	569-1002-562
Q407	Same as Q406		R451	Same as R450	
Q408	Same as Q406		R452	Resistor, 220 Ω $\pm 10\%$ 1/4 W "	569-1002-221
Q409	Transistor, Si, NPN, 1004	576-0001-004	R453	Resistor, 3.3K $\pm 10\%$ 1/4 W "	569-1002-332
Q410	Same as Q409		R454	Resistor, 1.5K $\pm 10\%$ 1/4 W "	569-1002-152
Q411	Same as Q409		R455	Resistor, 150 Ω $\pm 10\%$ 1/4 W "	569-1002-151
Q412	Transistor, Si, NPN, 3011	576-0003-011	R456	Same as R455	
Q413	Same as Q412		R457	Resistor, 2.2K $\pm 10\%$ 1/4 W "	569-1002-222
Q414	Same as Q412		R458	Resistor, 33 Ω $\pm 10\%$ 1/4 W "	569-1002-330
Q415	Transistor, Si, PNP, 1001	576-0001-001	R459	Resistor, 1K $\pm 10\%$ 1/4 W "	569-1002-102
Q416	Same as Q415		R460	Resistor, 1.5K $\pm 10\%$ 1/4 W "	569-1002-152
Q417	Transistor, Si, NPN, 3011	576-0003-011	R461	Resistor, 3.3K $\pm 10\%$ 1/4 W "	569-1002-332
Q418	Transistor, Si, PNP, 1001	576-0001-001	R462	Resistor, 150 Ω $\pm 10\%$ 1/4 W "	569-1002-151
Q419	Transistor, Si, NPN, 2006	576-0002-006	R463	Resistor, 2.2K $\pm 10\%$ 1/4 W "	569-1002-222
R401	Resistor, 8.2K $\pm 10\%$ 1/4 W comp.	569-1002-822	R464	Resistor, 1K $\pm 10\%$ 1/4 W "	569-1002-102
R402	Same as R401		R465	Resistor, 22K $\pm 10\%$ 1/4 W "	569-1002-223
R403	Resistor, 6.8K $\pm 10\%$ 1/4 W comp.	569-1002-682	R466	Resistor, 220 Ω $\pm 10\%$ 1/4 W "	569-1002-221
R404	Resistor, variable 10K	562-0022-103	R467	Resistor, 2.2K $\pm 10\%$ 1/4 W "	569-1002-222
R405	Same as R404		R468	Resistor, 100 Ω $\pm 10\%$ 1/4 W "	569-1002-101
R406	Same as R404		R469	Resistor, 1.5K $\pm 10\%$ 1/4 W "	569-1002-152
R407	Resistor, 1.2K $\pm 10\%$ 1/4 W comp.	569-1002-122	R470	Same as R469	
R408	Resistor, 27K $\pm 10\%$ 1/4 W "	569-1002-273	R471	Resistor, 3.3K $\pm 10\%$ 1/4 W "	569-1002-332
R409	Resistor, 2.2K $\pm 10\%$ 1/4 W "	569-1002-222	R472	Same as R471	
R410	Resistor, 22 Ω $\pm 10\%$ 1/4 W "	569-1002-220	R473	Resistor, 22K $\pm 10\%$ 1/4 W "	569-1002-223
R411	Resistor, 27K $\pm 10\%$ 1/4 W "	569-1002-273	R474	Resistor, 12K $\pm 10\%$ 1/4 W "	569-1002-123
R412	Resistor, 1K $\pm 10\%$ 1/4 W "	569-1002-102	R475	Resistor, 10K $\pm 10\%$ 1/4 W "	569-1002-103
R413	Resistor, 270 Ω $\pm 10\%$ 1/4 W "	569-1002-271	R476	Resistor, 270 Ω $\pm 10\%$ 1/4 W "	569-1002-271
R414	Resistor, 2.2K $\pm 10\%$ 1/4 W "	569-1002-222	R477	Resistor, 120 Ω $\pm 10\%$ 1/4 W "	569-1002-121
R415	Resistor, 1.5K $\pm 10\%$ 1/4 W "	569-1002-152	R478	Resistor, 3.3K $\pm 10\%$ 1/4 W "	569-1002-332
R416	Resistor, 2.2K $\pm 10\%$ 1/4 W "	569-1002-222	R479	Resistor, 560 Ω $\pm 10\%$ 1/4 W "	569-1002-561
R417	Resistor, 150 Ω $\pm 10\%$ 1/4 W "	569-1002-151	R480	Resistor, 1K $\pm 10\%$ 1/4 W "	569-1002-102
R418	Resistor, 2.2K $\pm 10\%$ 1/4 W "	569-1002-222	R481	Resistor, 100K $\pm 10\%$ 1/4 W "	569-1002-104
R419	Resistor, 100 Ω $\pm 10\%$ 1/4 W "	569-1002-101	R482	Resistor, 330K $\pm 10\%$ 1/4 W "	569-1002-334
R420	Resistor, 560 Ω $\pm 10\%$ 1/4 W "	569-1002-561	R483	Resistor, 100K $\pm 10\%$ 1/4 W "	569-1002-104
R421	Resistor, 1K $\pm 10\%$ 1/4 W "	569-1002-102	R484	Resistor, 1K $\pm 10\%$ 1/4 W "	569-1002-102
R422	Resistor, 56K $\pm 10\%$ 1/4 W "	569-1002-563	R485	Same as R484	
R423	Resistor, 3.3K $\pm 10\%$ 1/4 W "	569-1002-332	R486	Resistor, 5.6K $\pm 10\%$ 1/4 W "	569-1002-562
R424	Resistor, 6.8K $\pm 10\%$ 1/4 W "	569-1002-682	R487	Resistor, 100K $\pm 10\%$ 1/4 W "	569-1002-104
R425	Resistor, 10K $\pm 10\%$ 1/4 W "	569-1002-103	R488	Resistor, 560 Ω $\pm 10\%$ 1/2 W "	569-1004-561
R426	Resistor, 3.3K $\pm 10\%$ 1/4 W "	569-1002-332	R489	Resistor, 82 Ω $\pm 10\%$ 1/4 W "	569-1002-820
R427	Resistor, 6.8K $\pm 10\%$ 1/4 W "	569-1002-682	R490	Same as R489	
R428	Resistor, 1K $\pm 10\%$ 1/4 W "	569-1002-102	R491	Resistor, variable, 10K	562-0022-103
R429	Resistor, 10K $\pm 10\%$ 1/4 W "	569-1002-103	R492	Resistor, 220 Ω $\pm 10\%$ 1/4 W "	569-1002-221
R430	Resistor, 1K $\pm 10\%$ 1/4 W "	569-1002-102	R493	Resistor 470 Ω $\pm 10\%$ 1/4 W "	569-1002-471
R431	Same as R430		W401	Wire, stranded, red	071-0911-902
R432	Resistor, 3.3K $\pm 10\%$ 1/4 W "	569-1002-332	W402	Wire, stranded, black	071-0911-910
R433	Resistor, 1K $\pm 10\%$ 1/4 W "	569-1002-102	W403	Wire, stranded, red	071-0911-902
R434	Resistor, 1.5K $\pm 10\%$ 1/4 W "	569-1002-152			
R435	Resistor, 1K $\pm 10\%$ 1/4 W "	569-1002-102			
R436	Resistor, 10K $\pm 10\%$ 1/4 W "	569-1002-103			
R437	Resistor, 2.2K $\pm 10\%$ 1/4 W "	569-1002-222			
R438	Same as R437				
R439	Same as R437				
R440	Resistor, 470 Ω $\pm 10\%$ 1/4 W "	569-1002-471			
R441	Resistor, 12K $\pm 10\%$ 1/4 W "	569-1002-123			
R442	Resistor, 1K $\pm 10\%$ 1/4 W "	569-1002-102			
R443	Resistor, 47K $\pm 10\%$ 1/4 W "	569-1002-473			
R444	Resistor, 10K $\pm 10\%$ 1/4 W "	569-1002-103			
R445	Resistor, 56K $\pm 10\%$ 1/4 W "	569-1002-563			
R446	Resistor, 270K $\pm 10\%$ 1/4 W "	569-1002-274			
R447	Resistor, 10K $\pm 10\%$ 1/4 W "	569-1002-103			

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SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.	SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.
	RF PRINTED CIRCUIT BOARD				
BKT201	Bracket, center support PC	017-0542-001	C245	Capacitor, .01 μ F +80% -20% 600 V ceramic disc	510-3005-103
C201	Capacitor, 15 pF \pm 5% 100 V mica	510-0001-150	C246	Capacitor, 1.2-4.2 pF air variable	189-0501-005
C202	Capacitor, .01 μ F +80% -20% 600 V ceramic disc	510-3005-103	C247	Capacitor, 1 μ F \pm 20% 35 V tantalum	510-2005-109
C203	Capacitor, 5.6 μ F \pm 20% 35 VDC tantalum	510-2005-569	C248	Capacitor, 68 pF \pm 5% 100 V mica	510-0001-680
C204	Capacitor, .01 μ F +80% -20% 600 V ceramic disc	510-3005-103	C249	Capacitor, 100 pF \pm 5% 100 V mica	510-0001-101
C205	Capacitor, .01 μ F \pm 20% 50 V ceramic disc	510-3002-103	C250	Capacitor, 180 pF \pm 5% 100 V mica	510-0001-181
C206	Same as C205		C251	Capacitor, 330 pF \pm 5% 100 V mica	510-0001-331
C207	Same as C205		C252	Capacitor, 680 pF \pm 5% 100 V mica	510-0001-681
C208	Capacitor, .01 μ F \pm 20% 50 V ceramic disc	510-3002-103	C253	Capacitor, 120 pF \pm 5% 100 V mica	510-0001-121
C209	Capacitor, 2.2 nF 500 V ceramic disc	510-3004-202	C254	Capacitor, 10 pF \pm 5% 100 V mica	510-0001-100
C210	Capacitor, .014 μ F \pm 20% 50 V ceramic disc	510-3002-103	C255	Capacitor, 20 μ F +100% -10% 16 V electrolytic	510-4006-009
C211	Same as C210		C256	Capacitor, 1.5-11.6 pF air variable	189-0504-005
C212	Same as C210		C257	Capacitor, .01 μ F \pm 20% 50 V ceramic disc	510-3002-103
C213	Capacitor, .01 μ F \pm 20% 50 V ceramic disc	510-3002-103	C258	Capacitor, .001 μ F \pm 20% 1 KV ceramic disc Y5S	510-3061-102
C214	Capacitor, .001 μ F \pm 20% 1 KV ceramic disc Y5S	510-3061-102	C259	Capacitor, .01 μ F \pm 20% 50 V ceramic disc	510-3002-103
C215	Capacitor, .01 μ F \pm 20% 50 V ceramic disc	510-3002-103	C260	Same as C259	
C216	Same as C215		C261	Capacitor, 4.7 nF \pm 20% 50 V	510-3002-472
C218	Same as C215		C262	Capacitor, .01 μ F \pm 20% 50 V ceramic disc	510-3002-103
C220	Same as C215		C263	Same as C262	
C221	Same as C215		C264	Capacitor, 2.2 nF 500 V ceramic disc	510-3004-222
C222	Same as C215		C265	Capacitor, .01 μ F \pm 20% 50 V ceramic disc	510-3002-103
C223	Same as C215		C266	Same as C265	
C224	Same as C215		C267	Same as C265	
C225	Same as C215		C268	Capacitor, 4.7 nF \pm 20% 50 V	510-3002-472
C226	Same as C215		C269	Same as C268	
C227	Same as C215		C270	Same as C268	
C228	Same as C215		C271	Capacitor, 2.2 nF 500 V ceramic	510-3004-202
C229	Same as C215		C272	Same as C271	
C230	Capacitor, .01 μ F +80% -20% 600 V ceramic disc	510-3005-103	C273	Capacitor, .01 μ F +80% -20% 600 V ceramic disc	510-3005-103
C231	Capacitor, .01 μ F \pm 20% 50 V ceramic disc	510-3002-103	C274	Capacitor, .01 μ F \pm 20% 50 V ceramic disc	510-3002-103
C232	Same as C231		D203	Diode, WG-316	523-0006-002
C233	Same as C231		D204	Same as D203	
C234	Same as C231		D205	Same as D203	
C235	Same as C231		D206	Same as D203	
C236	Same as C231		D207	Same as D203	
C237	Capacitor, .01 μ F \pm 20% 50 V ceramic disc	510-3002-103	D208	Same as D203	
C238	Capacitor, .01 μ F +80% -20% 600 V ceramic disc	510-3005-103	D209	Same as D203	
C239	Capacitor, .001 μ F \pm 20% 1KV ceramic disc	510-3061-102	D210	Same as D203	
C240	Capacitor, 100 pF \pm 5% 100 V mica	510-0001-101	D211	Same as D203	
C242	Capacitor, 5.6 μ F \pm 20% 35 VDC tantalum	510-2005-569	D212	Diode, FD777	523-0007-001
C243	Capacitor, .01 μ F \pm 20% 50 V ceramic disc	510-3002-103	D213	Diode, 1N295	523-1000-295
C244	Capacitor, 2.2 nF 500 V ceramic disc	510-3004-202	D214	Same as D213	
			L201	Coil, 7 MHz	542-1009-001

PARTS LIST (cont'd)

SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.	SCHEMATIC SYMBOL NO.	DESCRIPTION	PART NO.
L202	Coil, 14 MHz	542-1009-002	R218	Resistor, 1.2K $\pm 10\%$ 1/4 W comp.	569-1002-122
L203	Coil, 21 MHz	542-1009-003	R219	Resistor, 220 Ω $\pm 10\%$ 1/4 W "	569-1002-221
L204	Coil, 28-30 MHz	542-1009-004	R220	Resistor, 470K $\pm 10\%$ 1/4 W "	569-1002-474
L205	Coil, mixer	542-1009-010	R221	Resistor, 1.5K $\pm 10\%$ 1/4 W "	569-1002-152
L206	Coil, 7 MHz	542-1009-006	R222	Resistor, 3.9K $\pm 10\%$ 1/4 W "	569-1002-392
L207	Coil, 14 MHz	542-1009-007	R223	Resistor, 1.5K $\pm 10\%$ 1/4 W "	569-1002-152
L208	Coil, 21 MHz	542-1009-008	R224	Resistor, 2.2K $\pm 10\%$ 1/4 W "	569-1002-222
L209	Coil, 28 MHz	542-1009-009	R225	Same as R224	
L210	Coil, mixer	542-1009-005	R226	Resistor, 22K $\pm 10\%$ 1/4 W "	569-1002-223
L212	Choke, 50 μ H	542-3002-003	R227	Resistor, 1.5K $\pm 10\%$ 1/4 W "	569-1002-152
L213	Same as L212		R228	Resistor, 2.2K $\pm 10\%$ 1/4 W "	569-1002-222
L214	Same as L212		R229	Resistor, 1K $\pm 10\%$ 1/4 W "	569-1002-102
L215	Same as L212		R230	Same as R229	
L216	Same as L212		R231	Resistor, 4.7K $\pm 10\%$ 1/4 W "	569-1002-472
L217	Same as L212		R232	Resistor, 2.7K $\pm 10\%$ 1/4 W "	569-1002-272
L219	Same as L212		R233	Same as R232	
L220	Same as L212		R234	Same as R232	
L221	Same as L212		R235	Resistor, 4.7K $\pm 10\%$ 1/4 W "	569-1002-472
L223	Same as L212		R236	Resistor, 100 Ω $\pm 10\%$ 1/2 W "	569-1004-101
L224	Same as L212		R237	Resistor, 10K $\pm 10\%$ 1/4 W "	569-1002-103
L226	Same as L212		R239	Resistor, 12K $\pm 10\%$ 1/2 W "	569-1004-123
L227	Same as L212		R240	Resistor, 270 Ω $\pm 10\%$ 1 W "	569-1006-271
L230	Choke, 13 mH	542-3003-001	R241	Resistor, 470 Ω $\pm 10\%$ 1/4 W "	569-1002-471
Q201	Transistor, Si, NPN, 3011	576-0003-011	R243	Resistor, 1K $\pm 10\%$ 1/4 W "	569-1002-102
Q202	Same as Q201		R244	Resistor, 180 Ω $\pm 10\%$ 1/4 W "	569-1002-181
Q203	Same as Q201		R245	Resistor, 820K $\pm 10\%$ 1/4 W "	569-1002-824
Q204	Same as Q201	576-0004-006	R246	Resistor, 100K $\pm 10\%$ 1/4 W "	569-1002-104
Q205	Transistor, Si, NPN, 3005	576-0003-005	SH201	Contact shield	016-1579-001
Q206	Transistor, Si, NPN, 3011	576-0003-011	T201	Transformer	592-9002-016
Q207	Same as Q206		W201	Strap, 1/8" silver plated copper	071-0041-006
Q208	Transistor, Si, NPN, 2006	576-0002-006	W202	Wire, #18 stranded, green	071-0912-045
R201	Resistor, 6.8K $\pm 10\%$ 1/4 W comp.	569-1002-682	W203	Wire, 18" stranded, gray	071-0912-048
R202	Same as R201		W204	Strap, 1/8" silver plate	071-0041-006
R203	Resistor, 5.6K $\pm 10\%$ 1/4 W comp.	569-1002-562	XY201	Tube socket	515-1018-009
R204	Resistor, 1.8K $\pm 10\%$ 1/4 W "	569-1002-182		Flatwasher, #4	029-0040-001
R205	Resistor, 470 Ω $\pm 10\%$ 1/4 W "	569-1002-471		Printed circuit board	035-0038-001
R206	Same as R205			Riblock double turret feedthru	260-0302-001
R207	Resistor, 15K $\pm 10\%$ 1/4 W "	569-1002-153		Rivet, .125 x 5/16 NP	031-0102-003
R208	Resistor, 6.8K $\pm 10\%$ 1/4 W "	569-1002-682		Screw, #4-40 x 4/16 BH, NPB	011-0012-010
R209	Resistor, 10 Ω $\pm 10\%$ 1/4 W "	569-1002-100		Shield base (9 pin socket)	016-1072-004
R210	Resistor, 1.2K $\pm 10\%$ 1/4 W "	569-1002-122		Spacer 1/8 ID x 1/4 OD x 1/8 long	013-0155-167
R211	Resistor, 3.3K $\pm 10\%$ 1/4 W "	569-1002-332		Tubing, .053 ID black varnished	042-0240-500
R212	Resistor, 1.5K $\pm 10\%$ 1/4 W "	569-1002-152		Tubing, 3/32 dia, shrinkable	042-0241-552
R213	Resistor, 470 Ω $\pm 10\%$ 1/4 W "	569-1002-471		Wire, #22 solid tinned buss	071-0271-240
R214	Resistor, 47 Ω $\pm 10\%$ 1/4 W "	569-1002-470			
R215	Resistor, 100 Ω $\pm 10\%$ 1/4 W "	569-1002-101			
R216	Resistor, 1.5K $\pm 10\%$ 1/4 W "	569-1002-152			
R217	Resistor, 3.3K $\pm 10\%$ 1/4 W "	569-1002-332			

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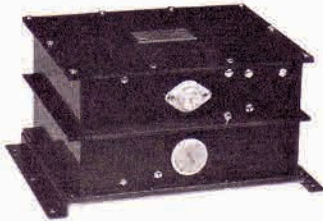
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AVENGER ACCESSORIES

DC POWER SUPPLY

The Avenger DC power supply is a compact, conservatively designed unit which will help give you the best mobile station you have ever operated. Conservative design and over-rated components assure long life even under extremes of operating conditions. Complete with an Avenger mobile mounting kit and cables, hardware and instructions to help you put your mobile station on the air quickly. For 12 volt negative ground systems only.

Model No. 239-252 Avenger DC Power Supply



MOBILE MICROPHONE

A ruggedly designed, convenient to use wide range PTT (push-to-talk) microphone suitable for mobile or base station use. Sensitivity 57 ± 3 dB below 1 volt/microbar at 1 kHz.

Model No. 250-882-1 Mobile Microphone



JOHNSON COMPONENTS

The E. F. Johnson Company has earned a reputation among radio amateurs as well as professional radio specialists for the manufacture of fine high quality components.

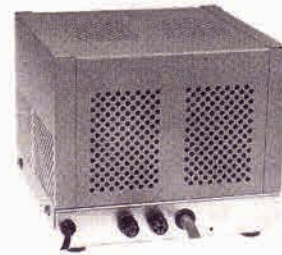
Johnson components include air and solid dielectric variable and trimmer capacitors, pilot lights, jacks and plugs, binding posts, insulators, tube sockets, inductors, chokes and other RF components. A new line of economical "Rib-Loc" miniature plugs and jacks, feed-thrus, pilot lights and stand-offs can help you add economical compact quality to your projects.

Consult your distributor for complete information on Johnson components.

AC POWER SUPPLY

The Avenger AC power supply has been designed and manufactured with the same conservative, quality conscious approach which characterizes the Avenger. Complete with all necessary cables, hardware and instructions. For 110-120 VAC 50-60 Hz.

Model No. 239-251 Avenger AC Power Supply



AVENGER SPEAKER

An attractive addition to any installation, the Avenger accessory speaker is a 3.2 ohm, 10 watt unit which matches the Avenger size and styling. 6 1/2 inches high, 5 1/4 inches wide, 5 inches deep. Includes a bracket and hardware for mobile mounting and a desk-top stand for base station use.

Model No. 250-55 Avenger Speaker



OTHER JOHNSON EQUIPMENT

E. F. Johnson Company Amateur Radio accessories are known for their quality and dependable performance. Following is a representative sampling of available equipment. Contact your distributor for further information or for information on products not listed here.

THUNDERBOLT II

The Viking Thunderbolt II is the smallest self-contained full legal limit linear amplifier on the market. Grounded grid input using two rugged 3-400Z zero bias tubes. Silent, instantaneous T-R switching incorporating power reed relays. Internal dummy load for quick exciter tuning. Built in 110-120, 220-230 VAC, 50-60 Hz operated power supply. Conservatively rated throughout. 80 through 10 meter coverage. 7 inches high, 15 1/2 inches wide, 14 inches deep.

Thunderbolt II

Model No. 240-355



LOW PASS FILTER

Handles up to 1 kW CW input. 75 dB or more attenuation of harmonic and spurious frequencies above 54 MHz. Less than 0.25 dB insertion loss. Not for use on 6 Meters. 2 5/16 inches diameter, 9 inches long.

Low Pass Filter, 52 ohm impedance Model No. 250-20

Low Pass Filter, 72 ohm impedance Model No. 250-35

275 WATT MATCHBOX

Similar to kW Matchbox except: matches unbalanced line impedances of 25-1500 ohms, balanced line impedances of 25-3000 ohms. 9 7/8 inches wide, 10 1/2 inches deep, 7 inches high. For 275 watt CW input transmitters.

275 W. Matchbox with Directional Coupler and Indicator Model No. 250-23-3

275 W. Matchbox less Directional Coupler and Indicator Model No. 250-23-1

PHONE PATCH

Compact unit allows PTT or manual transmit operation as well as VOX or VLX in SSB, OSB or AM. Adjustable line null control. Separate receive and transmit gain controls. RF filtering and bypassing prevents RF feedback to telephone line. 2 x 6 x 2 1/2 inches.

Phone Patch

Model No. 250-46



KILOWATT MATCHBOX

Matches unbalanced line impedance of from 50 to 2,000 ohms, balanced line impedance of from 50 to 1500 ohms to a 52 ohm coaxial link line. Feed-thru insulators for connecting balanced or unbalanced lines and a SO-239 connector for coaxial lines are supplied. Unit is capable of tuning out large amounts of inductive or capacitive reactance. Handles one kW CW, up to 3 kW PEP input. Includes directional coupler and indicator for continuous monitoring of incident or reflected transmission line power. 80 through 10 meter coverage. 17 1/4 inches wide x 12 1/8 inches deep x 10 7/8 inches high.

Kilowatt Matchbox

Model No. 250-30-3



KEYS

The E. F. Johnson Company manufactures a complete line of semi-automatic and manual keys. Known for their smooth action and rugged construction, these keys help anyone develop a good "fist".

E. F. JOHNSON COMPANY, VIKING EQUIPMENT QUESTIONNAIRE

Your cooperation in returning this questionnaire along with your warranty card to the E. F. JOHNSON COMPANY at your earliest convenience will help us in designing our future amateur equipment.

NAME _____ CALL _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

1. Equipment _____ Serial No. _____ Date of Delivery _____

2. Distributor from whom purchased? _____

3. Was the equipment delivered from your distributor's stock? _____

4. If not, how long did you wait for delivery? _____

5. Was the workmanship satisfactory? _____

6. Were there any obvious defects? _____

7. Were there any shortages? _____

8. Was there any shipping damage? _____

9. Was any difficulty experienced in placing the unit on the air? _____

10. Did you read the instruction manual before turning the unit on? _____

11. Is the unit's styling pleasing? _____

12. Is the panel layout pleasing? _____

13. Are the controls convenient to use? _____

14. Is the owner's manual clear and easy to use? _____

15. Are you entirely satisfied with your unit and its performance on the air? _____

16. If not, explain. _____

17. What features do you find the most desirable in this unit? _____

18. What features do you like least in this unit? _____

19. What improvements would you recommend in this unit? _____

20. What improvements would you recommend in the owner's manual? _____

21. How did you become interested in this new piece of equipment? _____

22. How do you learn about equipment and features before you buy? _____

23. What type of antenna(s) do you use? _____

24. Are you using an antenna coupler? _____ Type _____
25. Are you using a directional coupler and indicator? _____ Type _____
26. What operating accessories (such as monitors, calibrators, phone patches, etc.) do you use? _____

27. What make and model of other receivers, transmitters or transceivers did you or do you use? _____

28. What percentage of time is spent operating barefoot? _____ High Power? _____
29. What percentage of time is spent operating SSB? _____ CW? _____ AM? _____
30. What percentage of operating time is spent on the following? DX _____ Ragchewing _____
 Contests _____ Experimenting _____
31. What percentage of time do you operate on the following bands? 160M _____ 80M _____
 40M _____ 20M _____ 15M _____ 10M _____ 6M _____ 2M _____ 220MHz _____
 UHF _____ Mars _____ Others _____
32. How do you rate Johnson equipment in terms of:
- | | | | |
|-------------|------------|------------|------------|
| Quality | Good _____ | Fair _____ | Poor _____ |
| Value | Good _____ | Fair _____ | Poor _____ |
| Performance | Good _____ | Fair _____ | Poor _____ |
| Appearance | Good _____ | Fair _____ | Poor _____ |
33. What piece of amateur equipment do you believe to be the best buy on the market, considering its price, quality and features? _____

34. What additional items of amateur equipment would you like to see on the market and what would you consider a reasonable price for each item? _____

35. Additional comments. _____

THANK YOU!

QUALITY ELECTRONIC PRODUCTS SINCE 1923

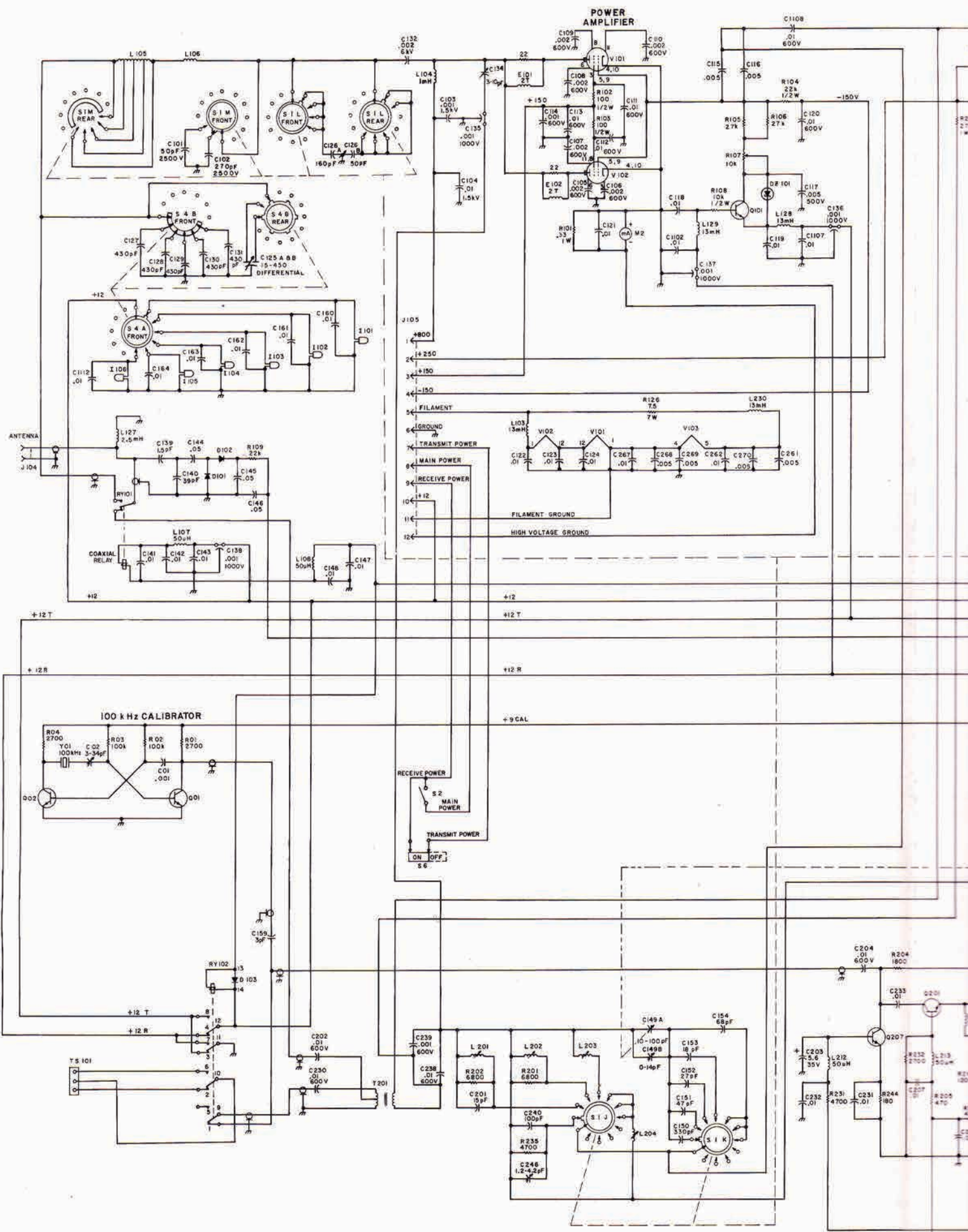


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WASECA, MINNESOTA 56093

PART NO. 002-0064-001

10-68

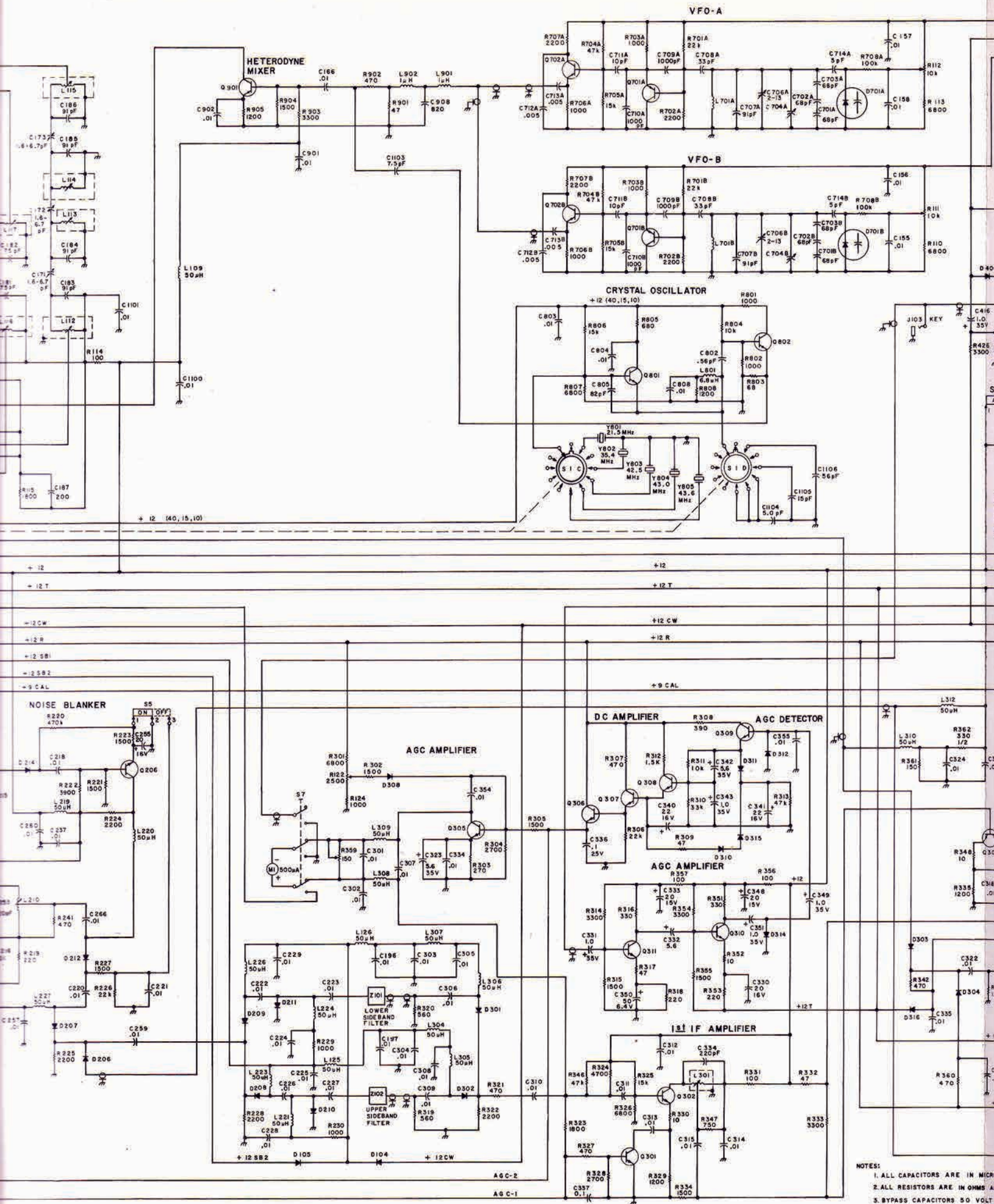
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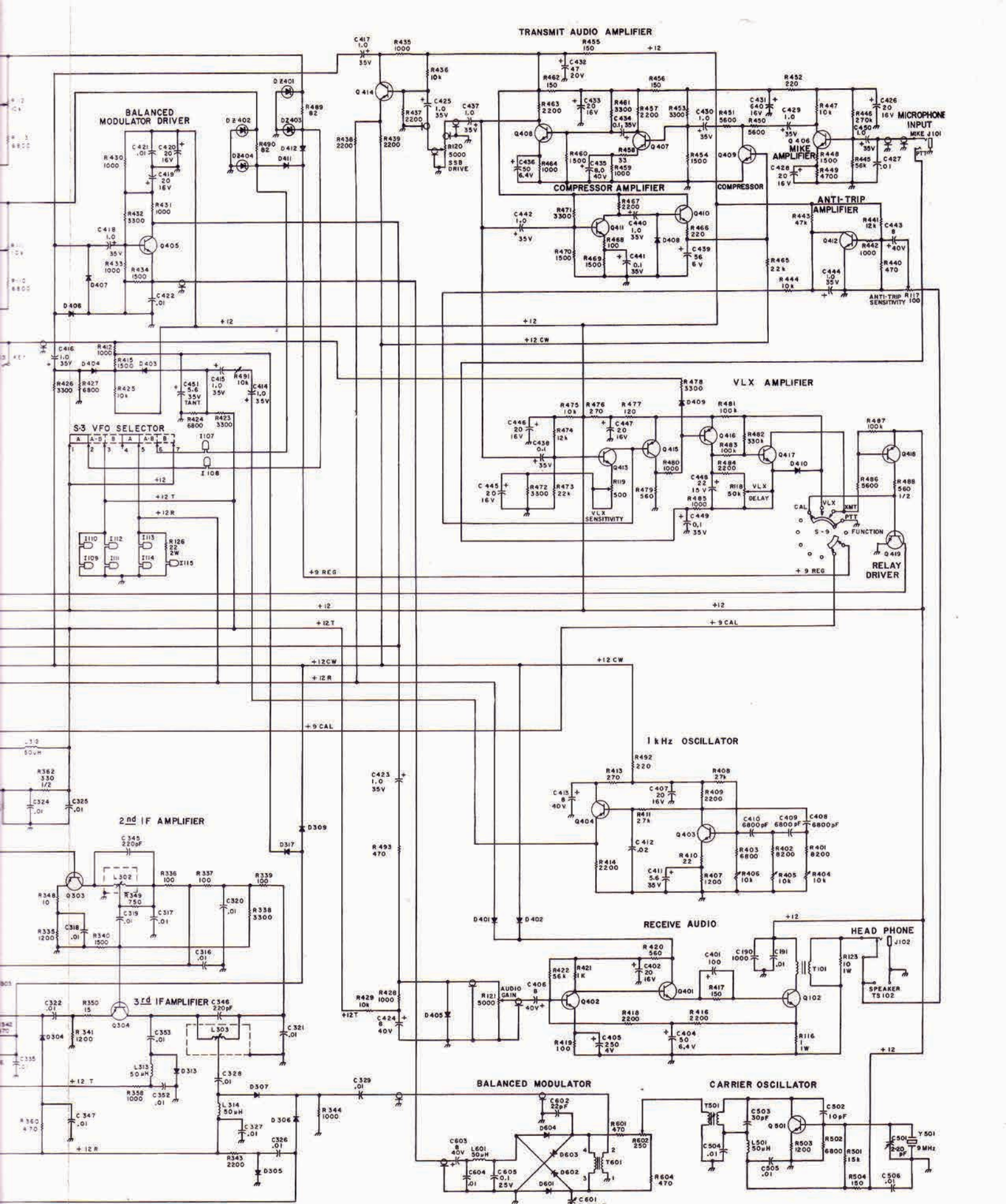
POWER AMPLIFIER

100 kHz CALIBRATOR

RECEIVE POWER
S2 MAIN POWER
TRANSMIT POWER
ON OFF S6



NOTES:
 1. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
 2. ALL RESISTORS ARE IN OHMS UNLESS OTHERWISE SPECIFIED.
 3. BYPASS CAPACITORS 50 VOLT



RESISTORS ARE IN OHMS UNLESS OTHERWISE DESIGNATED.
 RESISTORS ARE IN OHMS AND ARE 1/4WATT UNLESS OTHERWISE DESIGNATED.
 CAPACITORS 50 VOLT UNLESS OTHERWISE DESIGNATED.

4. ROTARY SWITCHES SHOWN IN 80 METER POSITION AS VIEWED
 FROM FRONT UNLESS OTHERWISE DESIGNATED.
 5 ALL VOLTAGES MEASURED TO CHASSIS GROUND.