SUNAIR VHF TRANSCEIVER MODEL SA-90
14 OR 28 VOLTS DC
12-15 WATTS
118.0 TO 126.9 MEGACYCLES

VHF TRANSCEIVER
MODEL SA-90

SUNAIR ELECTRONICS, INC.
3101 SOUTHWEST THIRD AVENUE
FORT LAUDERDALE, FLORIDA, U. S. A.

TABLE OF CONTENTS

SunAir Service Manual:
1st Edition 12 - 62 s.t.a.

ILLUSTRATIONS

Transfer switch 802 provides the same conditions of operation, however, for three different SunAir VHF Transceivers.

The connection of the transfer switches simply takes place by using the standard connectors and plugging those into the transfer switch box. Each transfer switch comes with an appropriate number of plugs.

Complete factory service is available on any SunAir equipment. Repairs, adjustments or modifications which require factory service will be made in accordance with the instructions of the customer.

A labor charge of $7.50 per hour, cost of parts and shipping charges will apply to all non-warranty work.

To return equipment or material under warranty or otherwise, advise SunAir Electronics, Inc., giving full particulars.

If the item is thought to be defective, give full information concerning the nature of the defect. SunAir will then authorize the return. Failure to secure this authorization prior to forwarding the equipment or material or failure to provide complete information may cause unnecessary delay in processing. Shipments to the factory shall be prepaid.

SunAir reserves the right to change the design of the equipment without advance notice.

Replacement crystal units must be ordered from SunAir in order to secure the required accuracy and in order not to exceed frequency tolerances as prescribed by the FCC.

WARRANTY

The products of SunAir Electronics, Inc., are guaranteed against defects in workmanship and materials for a period of six (6) months from the date of installation. This Warranty does not include tubes and transistors. Repair or replacement will be made without charges, provided:

a) The warranty card was completely filled out and mailed to SunAir Electronics, Inc., within ten (10) days of the date of installation.

b) Notice of claim was made within six (6) months of the date of installation and defective parts returned to the factory in accordance with manufacturer's instructions.

c) Upon examination of the defective item, the fault, in the opinion of the manufacturer, was not caused by misuse, exposure to abnormal atmospheric conditions, improper installation or adjustment, or incorrect wiring in the field; the equipment had not been improperly repaired, altered or damaged; and the equipment serial number had not been removed, defaced or changed.

6. MINIMUM PERFORMANCE SPECIFICATIONS

SunAir VHF Transceiver Model SA-90

Frequency Range:	118.0 - 126.9 Mcps.
Number of Channels:	90
Channel Spacing:	100 Kcps.
Nominal R.F. Power Output into 50 ohm. resistance load:	12 Watts min. up to 15 Watts
Frequency Tolerance:	0.005%
Modulation:	High level plate and screen, up to 95%, speech clipper and filter provided
Receiver Sensitivity:	1 Microvolt for 50 mw power output at a signal plus noise to noise ratio of 6 db min. 5 Microvolts for 6 Watts power output at a signal plus noise to noise ratio of 20 db min.
Receiver Selectivity:	16 Kcps. at 6 db down 60 Kcps. at 60 db down
Spurious Responses:	Better than 60 db down at all frequencies more than 40 Kcps. removed from desired signal.
Squelch:	Automatic, carrier operated continiously adjustable Min. signal for enabling squelch .5 microvolt
Nominal A.F. Power Output:	6 Watts
Noise Limiter:	Automatic
Indicators and Controls:	Mcps. Switch Kcps. Switch Volume and On-Off Switch combined Squelch Control
Power Requirements:	14 Volt Models: Receive Position: 2.0 A Transmit Position: 8 A 28 Volt Models: Receive Position: 1.2 A Transmit Position: 5 A

TRANSCEIVER SA-90

Description:

The SA-90 Transceiver consists of a VHF Transmitter and Receiver mounted within a single panel unit. The modulator/power supply for use with the transceiver is mounted remotely and interconnected to the transceiver by means of the main cable assembly.

The VHF Transceiver utilizes 100 KC channel spacing to provide 90 crystal-controlled channels from 118.0 to 126.9 MC. The 90 channel transmitter provides a minimum of 12 Watts up to a maximum of 15 Watts R.F. power output across the frequency range. The unit contains a variable squelch control in the receiver to eliminate background noise when no signal is present. The Transceiver contains a 90 channel crystal-controlled receiver with a sensitivity of 1 microvolt for a 50 mw power output at a signal plus noise to noise ratio of 6 db. The receiver sensitivity is 5 microvolts for a 6 Watt power output at a signal plus noise to noise ratio of 20 db.

FRONT PANEL

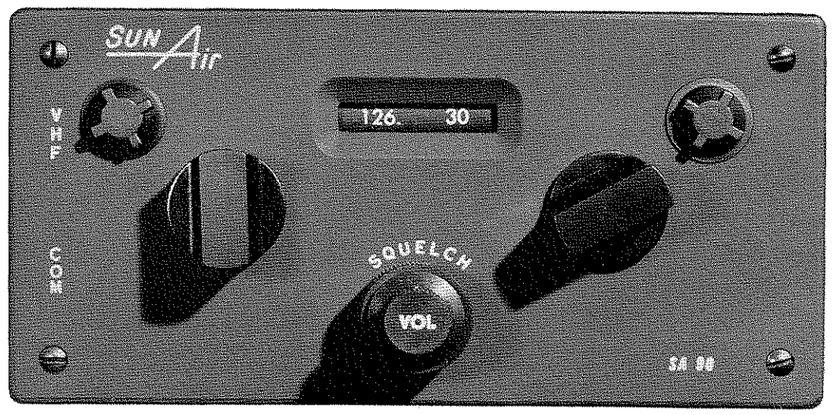


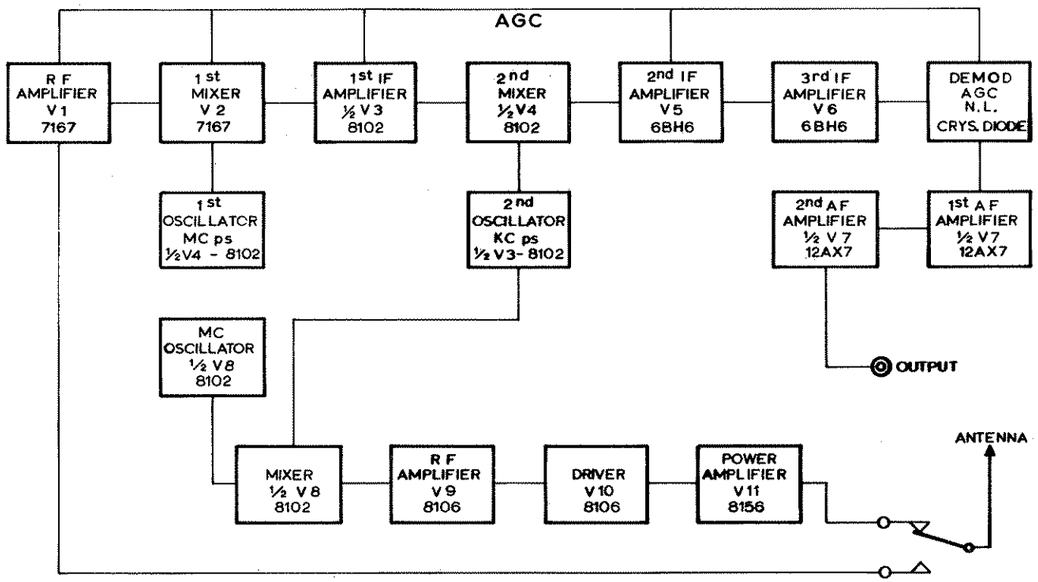
FIG. 1

Theory of Operation of the SA-90 Transceiver:

For convenience the theory of operation of the Transceiver is divided into two sections: 1. The Receiver, and 2. The Transmitter.

BLOCK DIAGRAM

FIG. 2



1. RECEIVER

The principle of the double conversion superheterodyne is employed for the receiver in order to obtain high image rejection and a high attenuation of spurious responses. V_1 a special purpose VHF tetrode is used in the R.F. amplifier section. The signal is coupled into the circuit with a single turn loop in order to achieve a high loaded Q with a bandwidth of approximately 1 mcps. The variable inductance wafer W_1 is connected in series with the antenna transformer L_1 and in turn is varied with the megacycle switch. The plate load of V_1 consists of two tuned circuits L_2 and L_3 which are in series with the variable inductance wafers W_2 and W_3. A second VHF tetrode is employed for the converter stage. Oscillator injection takes place at the control grid of V_2. The oscillator frequency is varied in steps of 1 mcps with the megacycle switch. The difference frequency is filtered out with the double tuned first I.F. filter consisting of L_4 and L_5.

L_6 in the plate circuit of V_3 is tuned to the center frequency of the first I.F. bandpass thus insuring a maximum flatness of the bandpass characteristics. V_4 is employed for the second converter and mixing takes place at the control grid. The second oscillator frequency is varied in steps of 100 kcps. The double tuned I.F. transformer T_1 with a center frequency of 3.0 mcps filters out the difference frequency between the second oscillator and the first I.F. frequency. Transformers T_2 and T_3 are also tuned to the center frequency of 3.0 mcps. and provide the required gain and selectivity for 50 KC channel spacing. The demodulator circuit consisting of the diodes CR_1 and CR_2 is connected to the secondary of T_3. The AGC voltage is developed across the resistor R_{30} after rectification with the crystal diode CR_4. CR_3 is used for efficient noise limiting.

Volume control is regulated by means of the potentiometer R_{26}. Adjustment of the squelch level is accomplished by means of the potentiometer R_{28}. A twin triode V-7 is employed for audio amplification. The required drive voltage for the transistorized audio amplifier is developed with a cathode follower system providing the low impedance source for driver transistor Q202 in the modulator/power supply unit SAV 901/902.

2. TRANSMITTER

The transmitter frequency generation is facilitated by two oscillator circuits. The triode section of V_8 is used for the generation of a signal varying between 84.55 and 92.55 megacycles in steps of one megacycle and is fed to the control grid of the pentode section of V_8. The second source is the triode section of V_3 which is also used for the second oscillator of the receiver portion of the SA-90 Transceiver, and provides signals between 33.45 and 34.55 megacycles in steps of 100 kcps. The sum of these two frequencies constitutes the final output frequency. V_9 and V_{10} are connected as R.F. amplifiers, tuned to the signal frequency with a single tuned circuit. V_{11} a frame grid power pentode delivers, at the specified plate voltage, an output of 12 to 15 Watts into a 50 ohm load. Undesired harmonics are removed by a filter circuit following the tank circuit of V_{11}. Modulation takes place on the plate and screen grid of V_{11}.

MODULATOR/POWER SUPPLY

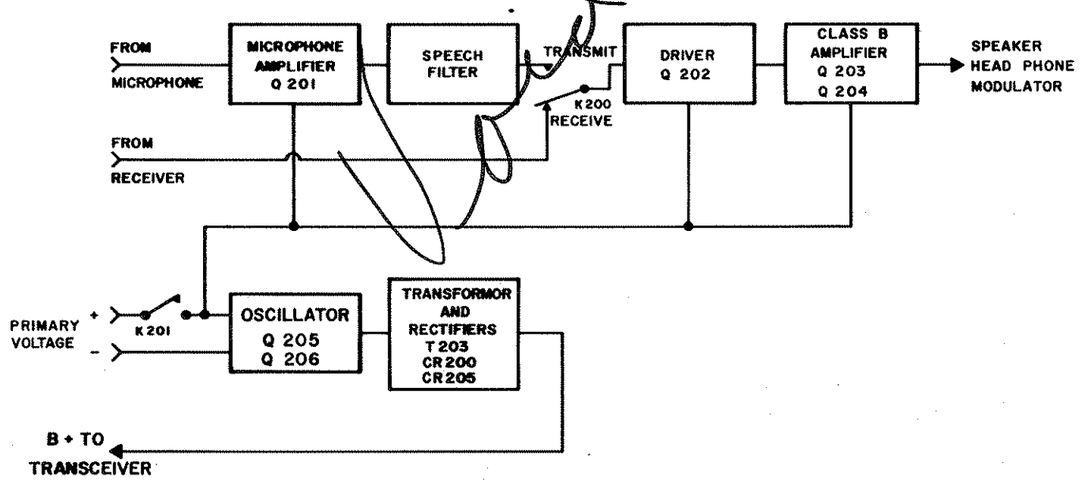
Description:

The modulator/power supply for use with the SunAir SA-90 Transceiver consists of a one unit package which contains the power supply, the audio amplifier and the modulator circuits of the system. Two units are available, the SAV 901 for 14 volt operation, and the SAV 902 for 28 volt operation. The modulator/power supply, when used in conjunction with SunAir transfer switch 802, can be used with three different SunAir Transceivers.

Theory of Operation of the SAV 901/902 Modulator/Power Supply Units:

BLOCK DIAGRAM

FIG. 3



Each of the SunAir Modulator/Power Supply units are completely transistorized. Their special design permits proper operation of all transistors up to ambient temperatures of 55° C. A large surface, finned heatsink with low thermal resistance insures fast dissipation of heat developed by the Class B A.F. power amplifier, which is used for both receiver output and transmitter modulation. Three major etched circuit boards are employed for the power supply, audio amplifier and bias networks. Adequate shielding eliminates interference of power supply switching pulses with other equipment.

MODULATOR/POWER SUPPLY

Description:

The modulator/power supply for use with the Sunair SA-360 Transceiver consists of a one unit package which contains the high voltage power supply, the audio amplifier and the modulator circuits of the system. Two units are available, the SAV 901 for 14 volt and the SAV 902 for 28 volt operation. Both units are applicable for all Sunair VHF Transceivers, such as the SA-90 and the SA-1036

Theory of Operation:

BLOCK DIAGRAM

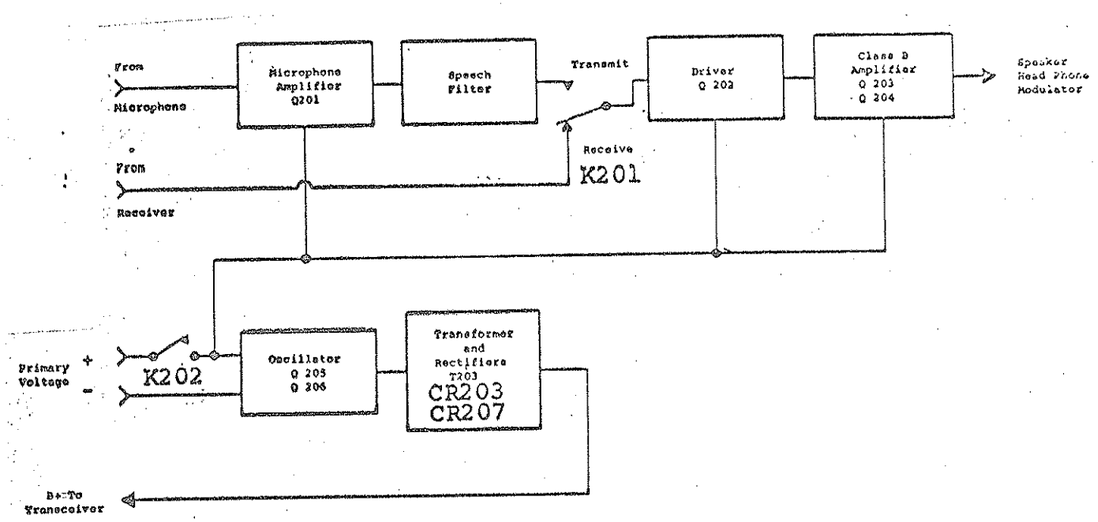


Fig. 3

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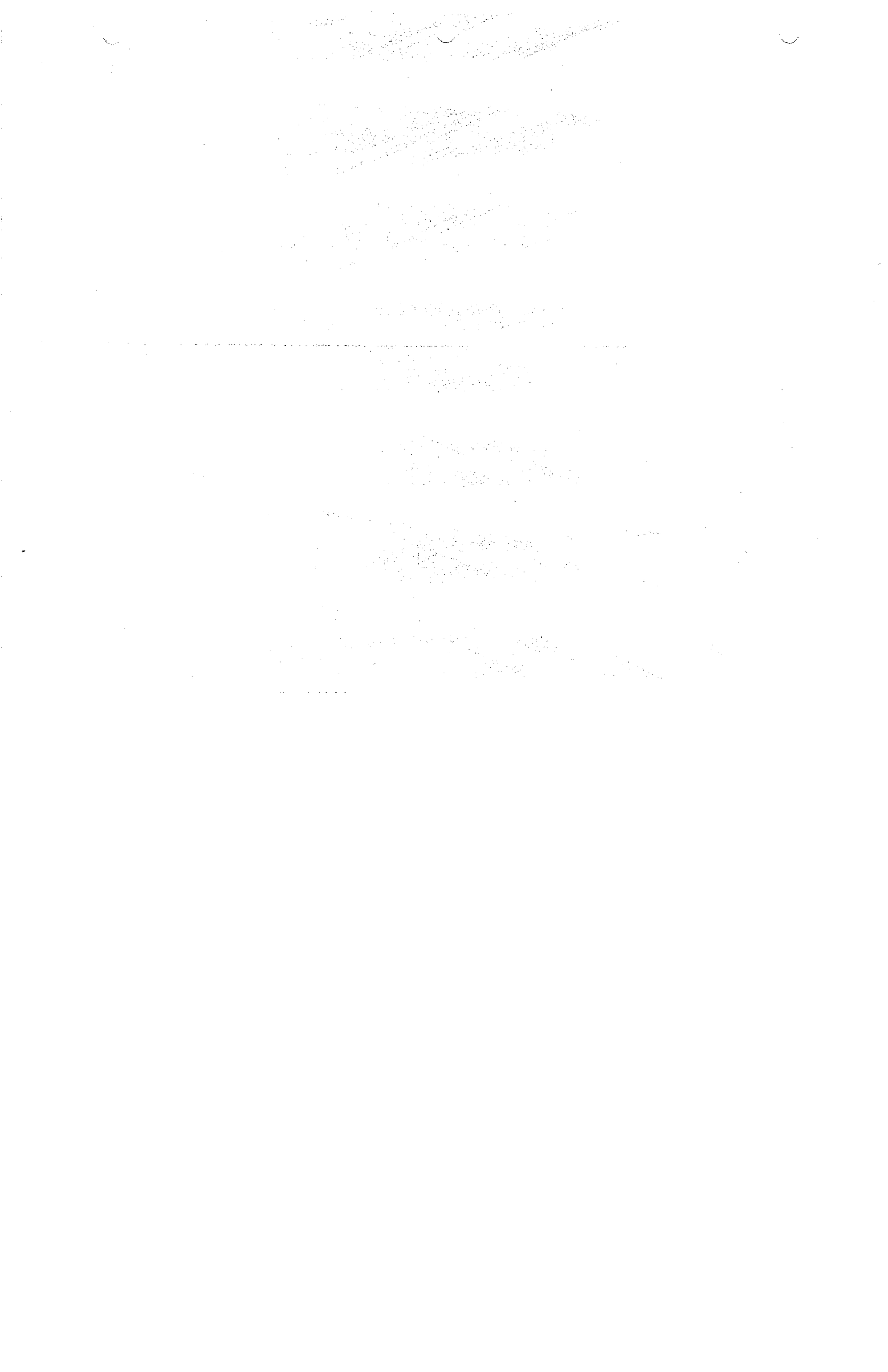
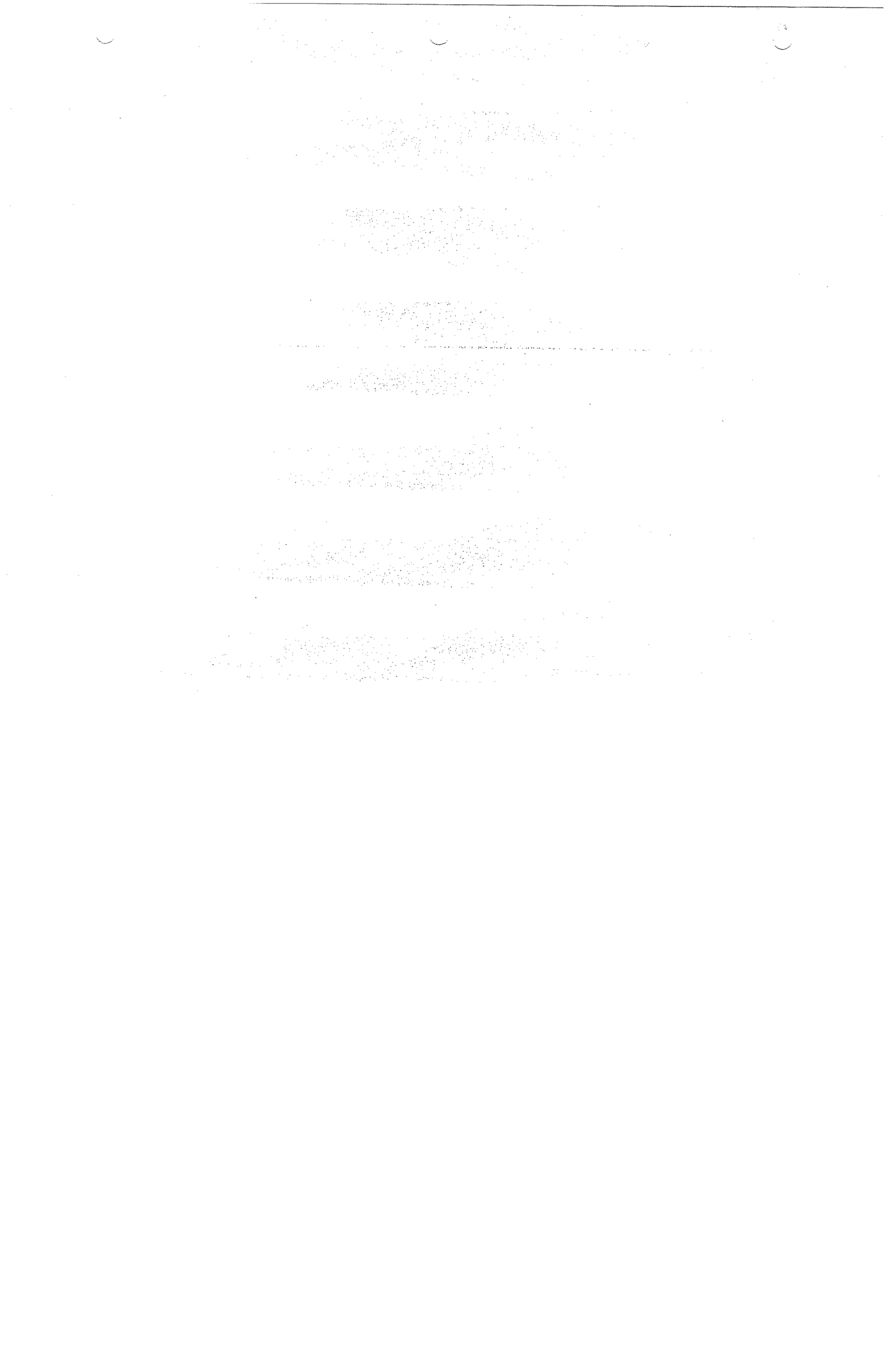


and bias networks. Adequate shielding eliminates interference of power supply switching pulses with other equipment.

With the transceiver in the receive position, the high B plus, 415 volt DC, is inoperative, while only the low B plus of 200 volts DC is being supplied to the receiver portion of the transceiver. Relay K 201 normally is not energized and thus connects the output of the cathode follower A.F. amplifier in the receiver to the base of the driver transistor Q 202. A resistor of suitable value, in most cases 1.5 K ohm is connected in series with the base and the audio source to equalize the gain of the unit and provide linearization of the base current. The collector of Q 202 feeds the primary of the driver transformer T 201 which in turn provides out-of-phase drive currents for the class B power amplifier. The bias network for the power amplifier adjusts the quiescent collector currents to a value of approxiamtely 50 ma to prevent crossover distortion at low signal levels. The output transformer T 202 assures proper loading of class B amplifier in order to obtain the required output power. Secondary No. 1, designed for a load of 4 K ohm is used to modulate the R.F. amplifier, while secondary No. 2 provides outputs for a speaker with nominal impedance of 3 ohms and for headphones with an impedance of 400 ohms. In the transmit position, the secondary No. 2 is disconnected from ground and thus does not load the amplifier.

In the transmit position, the relay K 201 disconnects the base of Q 202 from the receiver output and switches it to the output of Q 201. At the same time, high B plus is applied through the secondary No. 1 of T 202 to the R.F. power amplifier. The carbon microphone obtains through the microphone potentiometer R 201 the required DC power in order to produce a modulated DC voltage at the rotor of R 201. The magnitude of the microphone signal can be adjusted by moving the rotor of R 201. The small signal transistor Q 201 is biased in such a manner that above a certain signal level symetrical clipping will take place. The resulting harmonic distortion is then removed in the speech filter consisting of the inductor L 201 and the capacitors C 205 and C 206. Over modulation can thus be safely prevented, and by proper adjustment of the microphone potentiometer R 201, a consistent modulation level of 95 per cent is assured.

The high voltage power supply consists of a matched pair of switching transistors which generate a square wave alternating current through the primary of T 203, which then is transformed into the secondary winding. The high B plus of 415 volts DC uses a full wave bridge rectifier circuit, while the low B plus is taken from the center tap.



Large filter capacitors and inductors eliminate remaining ripple and provide almost pure DC to the transceiver.

The modulator/power supply differs in design for the 14 and 28 volt units, therefore, when ordering the unit the available power system voltage of the aircraft must be specified.

CAUTION:

Do not install the SAV 901 or 902 directly above or beside a heat generating piece of equipment and always insure there is a supply of cool air to the modulator/power supply. Do not short the cases of the power transistors to ground; these are the collectors and carry signal voltages. A protective circuit prevents damage to the system in case plus and minus have been interchanged.

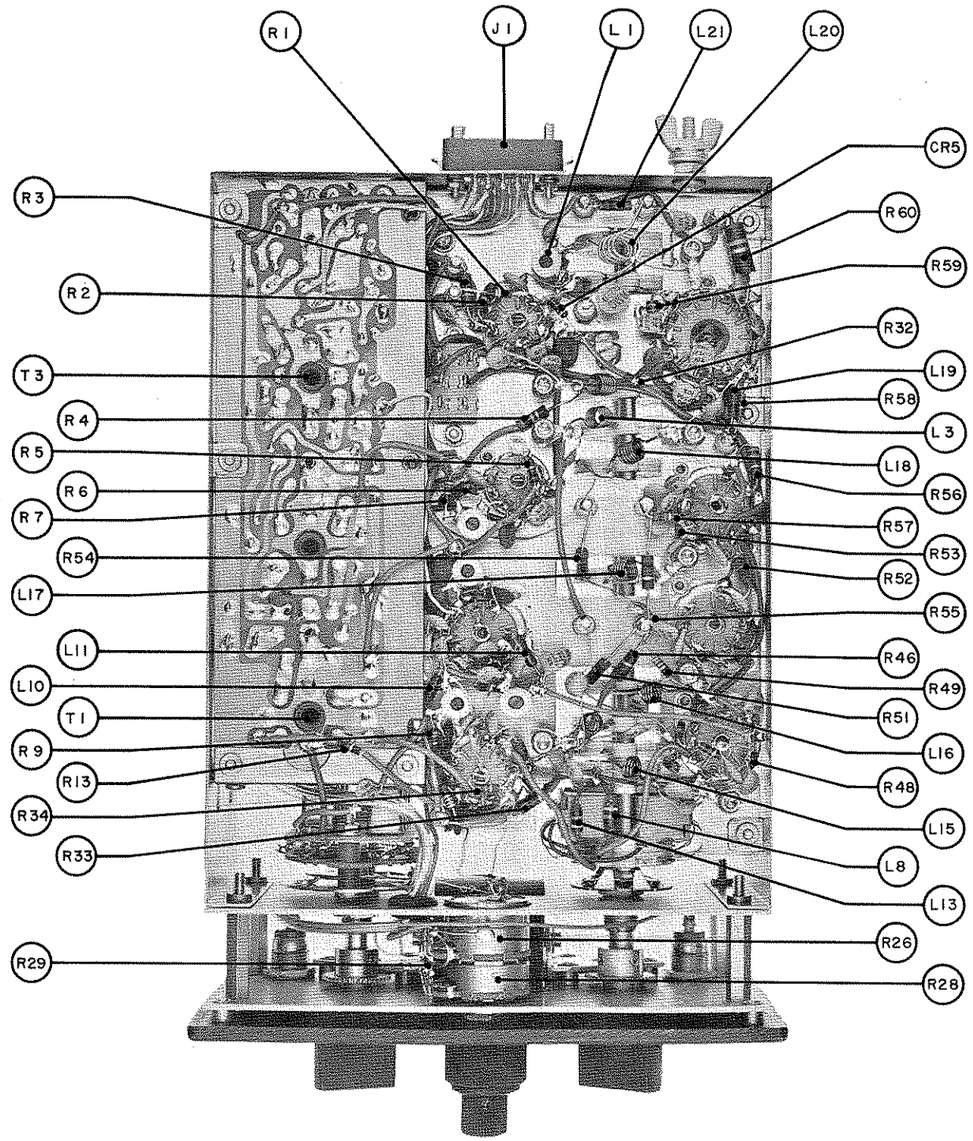


FIG. 4 BOTTOM VIEW SA-90

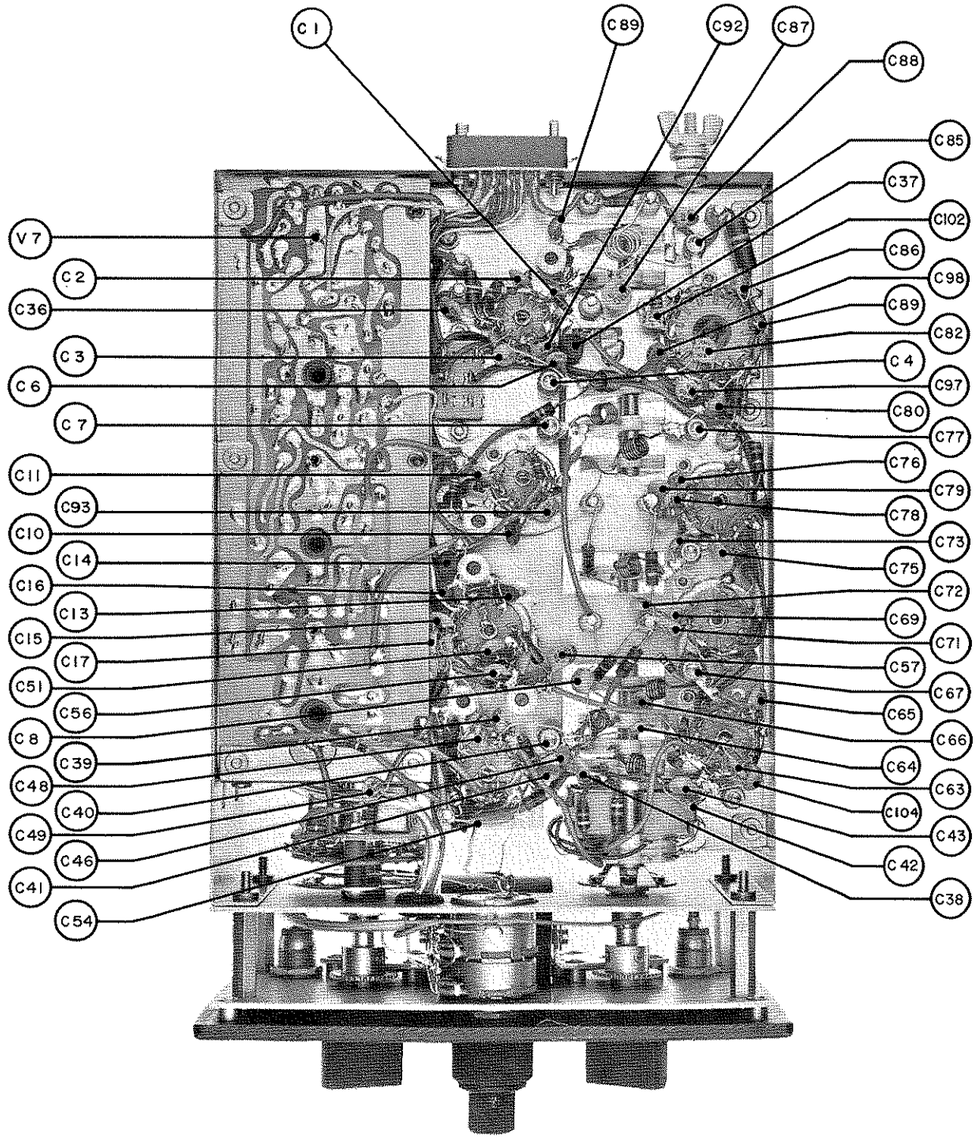


FIG.5 BOTTOM VIEW SA-90

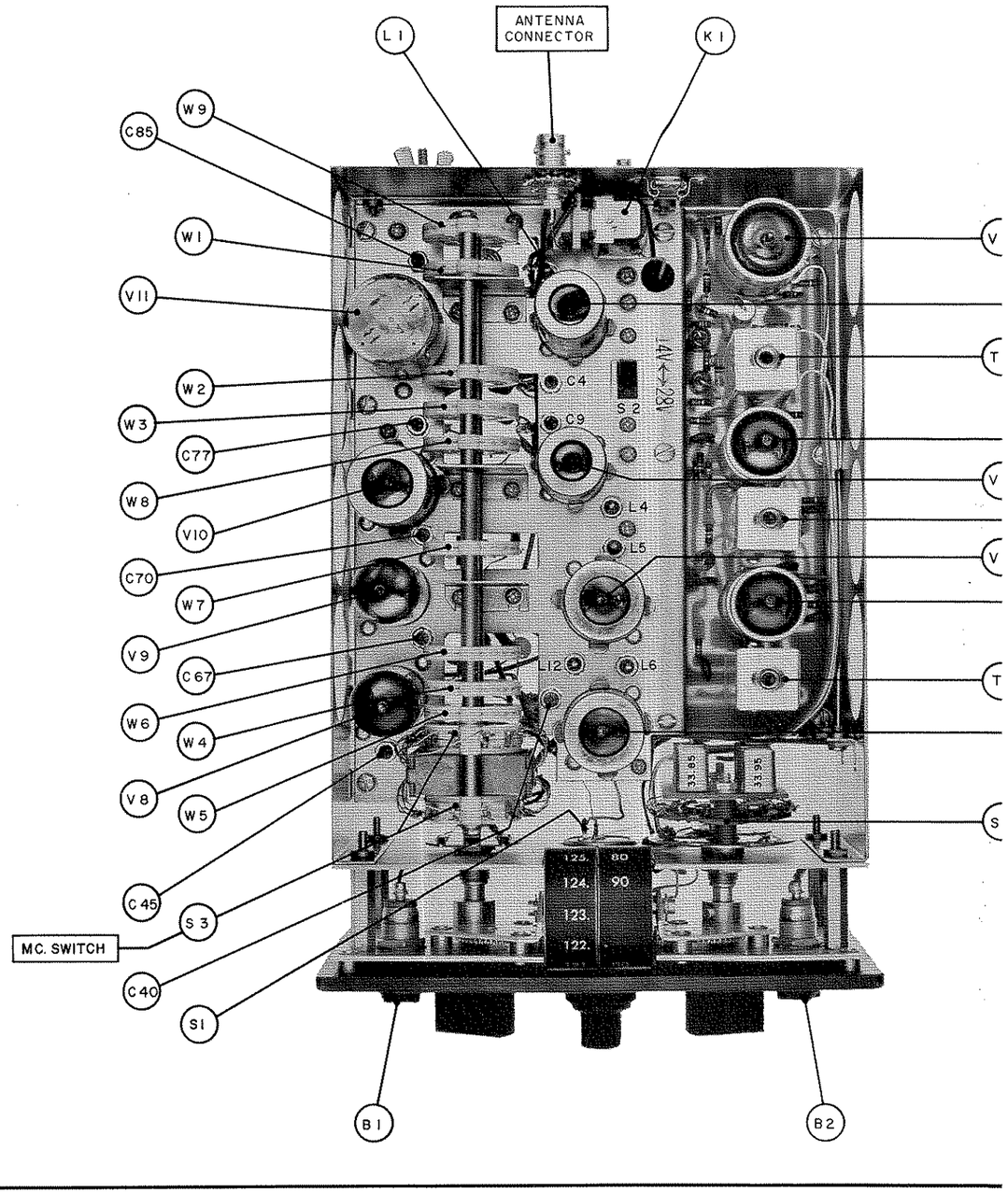


FIG.6 TOP VIEW SA-90

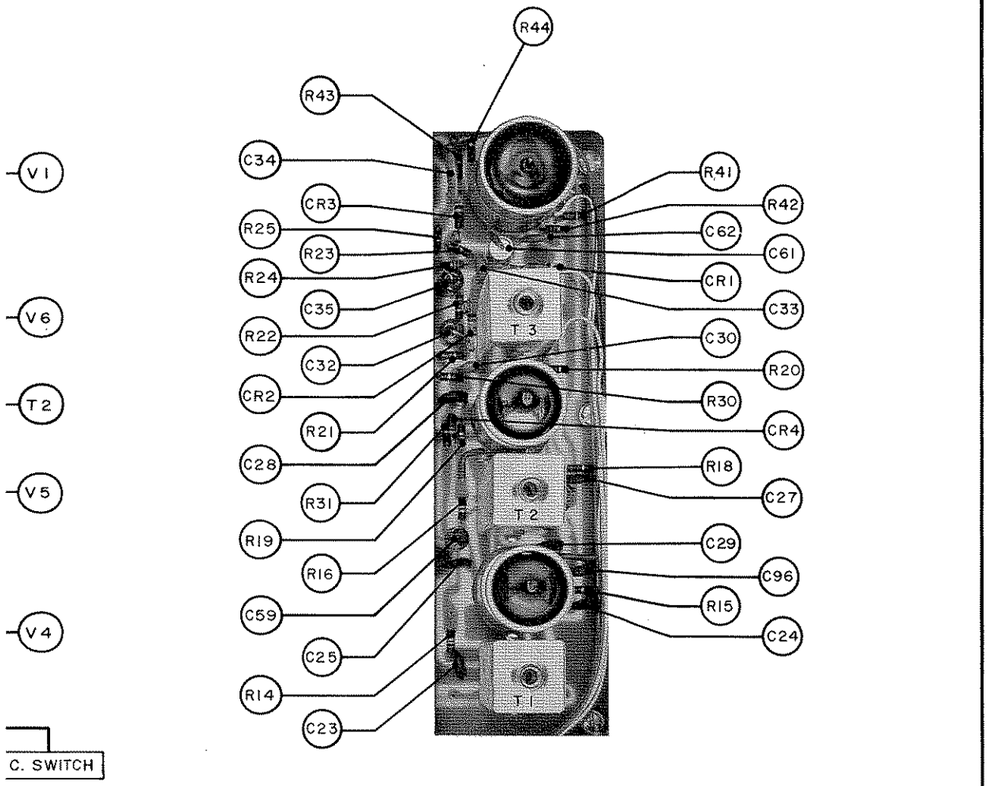


FIG.7 I.F. STRIP SA-90

ECN.NO.	SYM.	DESCRIPTION	DATE
844	K	SEE ECN NO 844	6-27-65
809	J	ADDED T203	3-8-65
798	I	SEE ECN NO 798	2-16-65
778	H	SEE ECN NO 778	12-15-64
745	G	ADDED DIODE ON J201	10-1-64
710	F	C216 & L207 RELOCATED	8-27-64
672	E	SEE ECN 672	5-21-64
654	D	CHANGED COLOR CODE	2-26-64
606	C	SEE ECN NO. 1207	12-16-63
598	B	ADDED R234 AND CR208	11-29-63
588	A	ADDED R235 1K 3W	11-27-63

REVISIONS

TITLE: SCHEMATIC POWER SUPPLY & MODULATOR SA-VHF

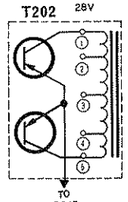
DRAWN: Lloyd Hall — DATE: 4-26-65

APPROVED: [illegible] — CHECKED: [illegible]

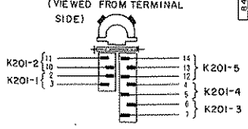
DWG. NO. 13631

SUNAIR ELECTRONICS, INC.

T202 28V



RELAY K201 (VIEWED FROM TERMINAL SIDE)



28 VOLT COMPONENT CHART

CKT.SYM.	VALUE FOR 28V UNITS ONLY
R 212	100 Ω 3W
R 213	450 Ω 3W
R 219	75 Ω 3W
R 220	75 Ω 3W
R 221	75 Ω 3W
R 232	100 Ω 3W
R 233	40 Ω 3W
R 234	4.7 K .25W
CR208	1E36Z
F 201	10 AMP.

NOTE:
UNLESS OTHERWISE NOTED, RESISTANCE VALUES ARE IN OHMS 1/4 W.

SCHEMATIC APPLIES TO SER. NO. 3000 AND SUBSEQUENT.

ECN.#	SYM	DESCRIPTION	DATE
522	A	ADDED CAP. C218 & FILTER HASH	2-7-63

REVISIONS

DRAWN
CHECKED
APPROVED
DATE 10-14-62
DWG. NO. 12962

TITLE SCHEMATIC POWER SUPPLY AND MODULATOR

SUNAIR ELECTRONICS, INC.

Void

J201

MICROPHONE GROUND	BLACK
MICROPHONE A.F	CO-AX
A.F. RECEIVER	CO-AX
RECEIVER LOW B+	RED
FILAMENTS A+	BLUE
3 OHM OUTPUT	WHITE
TRANSMITTER LOW B+	WHT.-GREEN
MICROPHONE KEY	GREY
ANTENNA RELAY K1	WHT.-YELLOW
(VHF ONLY) KC OSCILLATOR B+	WHT.-RED
500 OHM OUTPUT	GREEN
TRANSMITTER B+ MOD.	WHT.-BROWN
ON-OFF SWITCH	WHT.-BLUE

J A E M D N H R B F L K C

GROUNDING STUD

A+ NO 12 GA. WHT.

R202 47K · R204 470 · C205 .001MF · C206 .047MF · Q201 2N1379 · L201 160 MH · C201 10MF 30V · C204 10MF 30V · R201 250 · R203 15K · C202 10MF 30V · R205 180 · C203 400MF 15V · R206 220 .5W · K201-1

R208 15K · Q202 2N669 · R207 3.3K · C207 10MF 30V · R209 10K · C208 400MF 15V · R210 .47 1W · L202 9 MH · T201 · R211 220 1/2W · C209 400 15V · R212 1.5 2W

Q203 2N277 · Q204 2N277 · T202 · C216 100MF 30V · C218 400 15V · R213 10K 1/2 W · L203 .4MH · CR208 IN534 · CR201 IN461 · K 202 · R220 28V ONLY · ON · F201 · A+ · C210 .05MF

R221 28V ONLY · K201 · R214 28V ONLY · K201-2

K201-3 · C214 .005 MF · C211 .01 MF · R215 330 · L204 10 MH · C212-1 C212-2 8+8 MF · R216 330 .5W · R217 270K 2W · K201-4 · K201-5 · L205 400 MH · C213-1 C213-2 8+8 MF · K201-6 · T203 · CR 202-205 · CR 206 · CR 207 · Q205 2N277 · Q206 2N277 · L206 .7 MH · R219 10 3W · R218 450 3W · C215 400 MF · FILTER HASH

28 VOLT COMPONENT CHART

CKT.SYM.	VALUE FOR 28V UNITS ONLY
R 206	820 Ω 1/2W
R 208	6800 1/4W
R 209	8K 1/4W
R 210	100 Ω 3W
R 211	350 Ω 3W
R 212	75 Ω 3W
R 218	1000 Ω 3W
R 219	20 Ω 3W
R 220	75 Ω 3W
R 221	75 Ω 3W
C 218	200 MF 30V
C 209	200 MF 30V
C 215	200 MF 30V
Q 203	2N278
Q 204	2N278
Q 205	2N278
Q 206	2N278

TRANSFORMER T203

MODEL	VOLTAGE	SUNAIR PART NO.
SA-90	14V	91815
SA-90	28V	92259
SA-14	14V	92247
SA-14	28V	92261

FUSE F201

MODEL	VOLTAGE	AMPERAGE
SA-90	14V	15 AMP
SA-90	28V	10 AMP
SA-14	14V	20 AMP
SA-14	28V	10 AMP

FIG. 14 POWER SUPPLY & MODULATOR SCHEMATIC

CAUTION:

When making tests on the receiver portion of the SA-90 Transceiver, do not close the microphone switch in order to protect the signal generator.

SENSITIVITY CHECK

1. Connect the Transceiver SA-90 and the modulator/power supply together with the prescribed cable.

2. Connect the audio wattmeter and the modulator/power supply

3. Set the Transceiver SA-90 and the signal generator to 118.00 mc. 1.5 uv. output, modulator 30% at 1000 cycles; connect the generator to the antenna connector of the Transceiver SA-90.

4. Adjust the squelch control to the fully clockwise position and the volume control to produce approximately 2 to 3 watts of audio on the wattmeter.

5. Remove the modulation and note the drop in db of output. This drop should be more than 6 db.

6. Repeat the test for every channel determining both crystal activity and sensitivity on all channels.

GAIN CHECK

1. Set the receiver and the signal generator to 118.0 mc modulated 30% at 1000 cycles.

2. With the squelch control and volume control set fully clockwise, insert 5 uv of signal into the receiver.

3. Note the reading on the wattmeter. This should be between 4 and 6 watts.

4. Repeat the test for as many of the KC channels and then the MC channels as possible.

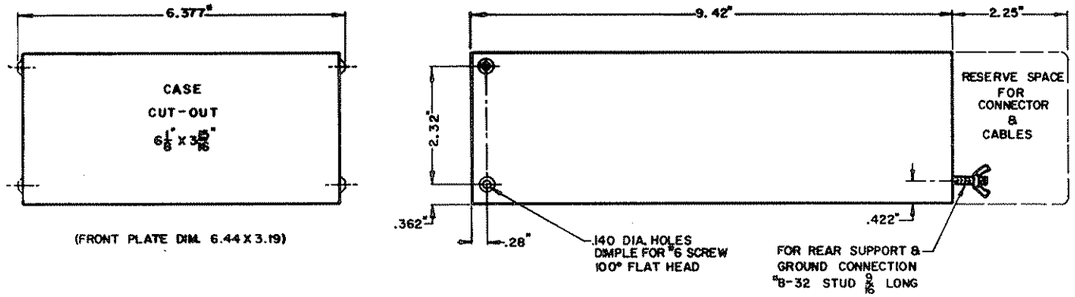
TRANSMITTER POWER OUTPUT CHECK

1. Connect the R.F. power wattmeter to the antenna connector of the Transceiver SA-90.

2. Connect the microphone to be used in the aircraft to the microphone connector of the audio cable.

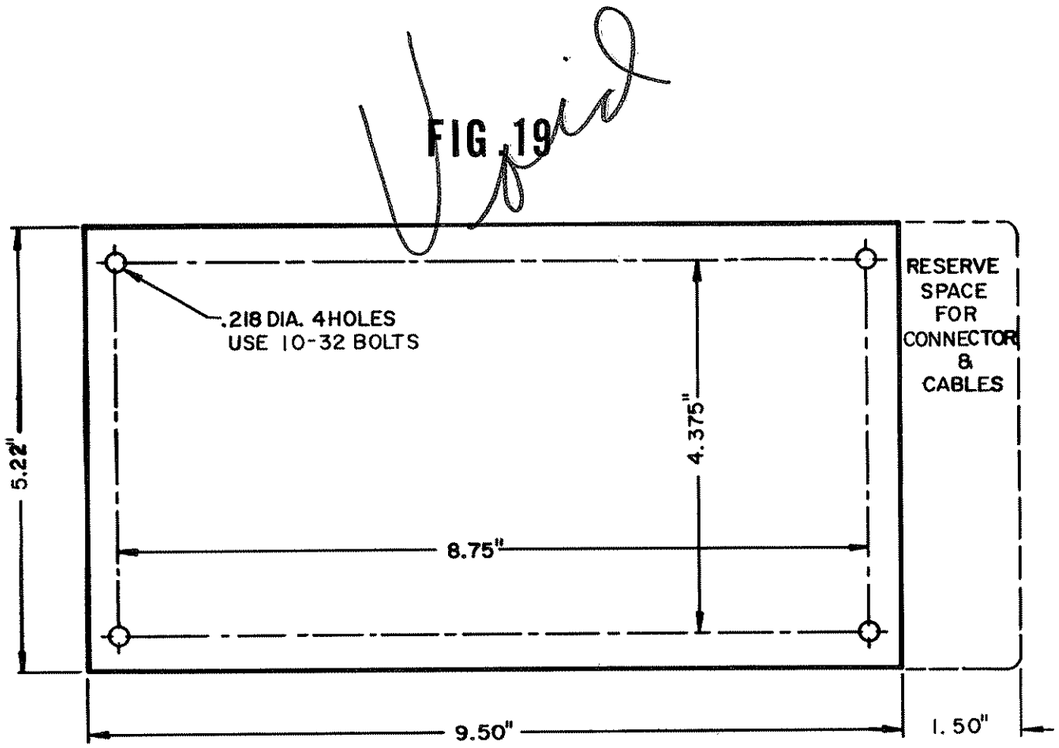
3. Key the microphone and note the power level on the R.F. Wattmeter. This reading should be at least 12 Watts. Be sure the A plus input to the unit is correct when the microphone is keyed.

FIG .18



SA-90 MOUNTING DIMENSIONS

FIG .19



POWER SUPPLY MODULATOR MOUNTING DIMENSIONS

CAUTION: An interchange of PLUS and MINUS connections can cause permanent damage to all transistors used in the modulator/power supply units SAV 901 and 902.

Do not install the SAV 901 or 902 directly beside or above a heat generating piece of other equipment and always insure there is a supply of cool air to the modulator/power supply. Do not short the cases of the power transistors to ground; these are the collectors and carry signal voltages.

ANTENNA REQUIREMENTS FOR USE WITH TRANSCEIVER SA-90

The SA-90 Transceiver has been designed for use with a 50 ohm antenna having a VSWR of 1.5 to 1 or less over the frequency range of 118 to 126.9 mcps. SunAir can provide the SunAir VHF-COM antenna which meets the above requirements.

CONNECTION OF CABLE ASSEMBLIES

Connect the transceiver to the modulator/power supply by means of the main cable assembly (See Fig.16).

Connect the transceiver to the antenna by means of the antenna cable assembly (See Fig.15.)

PERFORMANCE CHECK-OUT (IN AIRCRAFT)

After installation in the aircraft, the SA-90 Transceiver should be subjected to a complete performance check-out. This check-out should be performed on the ground with normal power ON and with the aircraft engines running.

EQUIPMENT REQUIRED FOR PERFORMANCE CHECK-OUT IN AIRCRAFT

a. Thru-line wattmeter with 25 watt insert (Bird or equivalent)

b. VHF Receiver

DETAILED CHECK-OUT PROCEDURE

1. Connect wattmeter between antenna and transceiver

2. Set transceiver to 118.00 MC

3. Press microphone transmitting button and check standing wave ratio by reading the forward and reflected power on the wattmeter.

4. The reflected power should not exceed a maximum of 2 watts on either frequency.

5. Follow the above procedure tuning the transceiver to several other frequencies and repeat the above procedure.

6. Perform a brief modulation check by monitoring the transmission with another VHF Receiver.

7. Check headphones for sidetone while transmitting.

To insure proper operation of the SA-90 system measure the primary voltages in the transmit position at the fuse inside the modulator/ power supply unit. This voltage should be 13.75 volts for 14 volt systems, and 27.5 volts for 28 volt systems.

This voltage cannot be obtained unless the aircraft engines are running. The generators and voltage regulators under this condition should provide the indicated voltages. If that is not the case, check the voltage drop across the primary power cables to the modulator/ power supply unit; and if necessary, use heavier wires for the connection to the battery.

Listen while the engines are idling for abnormal noise in the receiver output. Change the rpm of the engine and note a change in the noise frequency. This will indicate ignition or generator noise. In most instances, proper application of capacitors and noise suppressors will remove the trouble. If the voltage does not reach 13.75 volts, the voltage regulator may require adjustment.

A voltage tolerance of plus 10% is permissible, therefore, a voltage indication of 15 volts is within the permissible tolerance of the system.

On the other hand, a voltage of minus 10% from nominal while permissible, will somewhat affect the performance of the transceiver.

OPERATIONAL PROCEDURE

To operate the SA-90 Transceiver, proceed as follows:

1. Turn volume control knob clockwise (this will also turn on dial illumination)

2. A high-pitched sound can be heard in the headphone unit indicating proper operation of the power supply.

3. Turn squelch knob to the right for maximum sensitivity.

4. Tune MC switch to desired frequency; then tune the KC switch to the decimal desired.

5. Press microphone button and call station with which you wish to communicate.

6. Wait for reply and adjust volume to satisfactory level.

7. Reset the squelch knob until background noise disappears.

NOTE: If distance between stations is excessively large, squelch knob may have to remain at fully clockwise position for maximum sensitivity.

MAINTENANCE

General Information:

It is recommended that preventive maintenance be performed at regular intervals - at least every eight months - in order to assure trouble-free operation of the SA-90 Transceiver. This periodic maintenance should include a complete bench check-out as described on page 21. In addition to the bench check-out, it is recommended that all vacuum tubes be tested for performance with a standard tube tester. Lubrication at this time should not normally be necessary, however, all bearing surfaces of moving parts of the tuning mechanism and the bearings of the switches may be lubricated with a high temperature lubricant such as Dow-Corning No.4D compound.

NOTE: Adjustments on frequency determining circuit parts, such as oscillators shall be performed by properly authorized technicians and require test equipment for frequencies of 30, 80 and 100 to 136 mcps as well as equipment enabling the servicing agency to certify the frequency accuracy of the transmitter.

TEST EQUIPMENT REQUIRED FOR RE-ALIGNMENT OF TRANSMITTER & RECEIVER

a. Frequency Counter (HP 524 or equivalent)
b. Calibration set-up for counter (WWV Receiver)
c. Oscilloscope (Tektronix 543 or equivalent)
d. Audio generator (HP 200 C or equivalent)
e. Audio VTVM
f. DC VTVM
g. Phantom microphone (see Appendix I)
h. DC voltmeter
i. DC amperemeter
j. Coaxial cables, connector, couplings, capacitors (see page 31)
k. R.F. load, 50 ohm, up to 250 mcps.
l. VHF signal generator HP Packard 608 A or equivalent
m. Signal generator HP 606 A or equivalent
n. Bird thruline wattmeter, 25 Watt insert 100-250 MC.

RE-ALIGNMENT PROCEDURE FOR TRANSMITTER PORTION OF TRANSCEIVER SA-90

NOTE: All voltages and currents are indicated on schematic diagram (See page 18).

1. Connect power supply to transceiver. Set power supply either to 13.75 or 27.5 volts according to system being used.

2. Switch on transceiver and re-adjust input voltage to nominal value if necessary.

A. Check of KC Oscillator for Proper Frequency:

1. Connect the frequency counter to potential No.88 with a 50 ohm coaxial cable. Switch the counter to 30 mcps and adjust the KC switch to .00. At this position the KC oscillator must oscillate on 33.450 mcps.
2. Adjust L_{12} in order that this frequency is generated with the smallest amount of inductance.
3. Switch the KC switch to the next position .10.
4. The oscillator must now produce a frequency of 33.550.
5. With every step on the KC switch, the KC oscillator increases its frequency of oscillation by 100 kcps.
6. The maximum tolerance of the oscillator frequency is .0025%.

B. Check of MC Oscillator for Proper Frequency:

1. Connect frequency counter with 100 mcps plug-in unit to potential No.81. Control grid of V_8 pentode with a 1.0 pf capacitor.
2. Switch counter to 80 mcps and set megacycle switch to 118. mcps. The oscillator must now generate a frequency of 84.550 mcps.
3. Adjust oscillator to frequency by adjusting C_{45} to the minimum capacitance with which the required frequency tolerance of plus 0.0025% can be obtained.
4. Control every position of the mcps switch for tolerance of generated frequency.
5. Connect DC VTVM to Potential No.75 set VTVM to 10.0 volts and check grid leak bias for required value.

C. Amplifier Alignment:

1. Set megacycle switch to 122,kilocycle switch to .50.
2. Connect the thru-line wattmeter to the antenna terminal of the transceiver and the 50 ohm 25 watt antenna load with 50 ohm coaxial cables.
3. Push the transmit button and align the transmitter by connecting the DC VTVM to potential No.105 adjusted for -100 volts DC.
4. Adjust in sequence C_{67}, C_{70} and C_{77} for maximum negative voltage at this potential number.
5. Adjust C_{85} for maximum power output.

D. Modulation Check-Out:

1. Connect the audio signal generator via the phantom microphone to the modulator and adjust the input voltage to the phantom microphone to 0.15 volts rms at 1,000 cps.

2. Connect the vertical deflection plates to ground and via a 1.0 pf capacitor to the center conductor of the output coaxial cable which in turn is terminated in the 50 ohms 25 watt load.

3. The horizontal input to the scope is connected to ground and to potential No.16.

4. Adjust the amplitude to a convenient value in order to observe the modulated carrier accurately.

5. At the indicated audio input voltage, the carrier should be modulated approximately 95%. A further increase in audio input voltage does not increase the modulation depth.

RE-ALIGNMENT PROCEDURE FOR RECEIVER PORTION OF TRANSCEIVER SA-90

NOTE: When making tests on the receiver portion of the transceiver, do not close the microphone switch in order to protect the signal generator.

1. Connect transceiver to power supply/modulator with prescribed test cable.

2. Turn on transceiver and adjust power supply to either 13.75 or 27.5 volts.

3. Connect the speaker output to a 3 ohm 10 watt resistor, non-inductive.

A. Check of KC Oscillator for Proper Frequency:

1. Connect the frequency counter to potential No.88 with a 50 ohm coaxial cable. Switch the counter to 30 mcps and adjust the kc switch to .00. At this position the KC oscillator must oscillate on 33.450 mcps.

2. Adjust L_{12} in order that this frequency is generated with the smallest amount of inductance.

3. Swtich the KC switch to the next position .10.

4. The oscillator must now produce a frequency of 33.550 mcps.

5. With every step on the KC switch, the KC oscillator increases its frequency of oscillation by 100 kcps.

6. The maximum tolerance of the oscillator frequency is .0025%.

B. Check of MC Oscillator for Proper Frequency:

1. Switch the frequency counter to 80 mcps and connect the coaxial cable to potential No.28 with a 1.0 pf capacitor.

2. Set the megacycle switch to 118.

3. The mcps oscillator will then oscillate on 81.550 mcps.

4. Capacitor C40 permits adjustment of the oscillator frequency and should be set to minimum capacitance (with adjustment screw turned out) in order to obtain 81.550 mcps.

5. Switch megacycle switch to the next higher position 119.

6. The megacycle oscillator now oscillates on 82.550 mcps.

7. With each further step, the oscillator frequency increases by 1.0 mcps.

C. Second I.F. Amplifier Check:

1. Connect the signal generator 606 A with a capacitor of 100pf to grid No.1, pf V_4 pentode, potential No.36 and set generator to 3.0 mcps by using the crystal calibrator of the generator.

2. Connect the audio VTVM across the 3 ohm load on the speaker output.

3. Set VTVM to 10 volt scale.

4. Set the volume control and open squelch. (fully CW).

5. Set the signal generator modulation to 1,000 cps at 30% and the output to 300 microvolts.

6. Begin adjusting the I.F. amplifier by tuning the last transformer T_3 for maximum voltage as indicated by audio output voltage.
(Care must be taken that the tuning cores are located on the very extreme ends of the coil former, otherwise serious deterioration of the bandwidth will occur.)

Modulator/Power Supply Checkout

1. Connect the MPS to 13.75 VDC source.

2. Connect the transceiver with main cable to the MPS.

3. Connect a 50 ohm load to the antenna terminal of the transceiver.

4. Turn the volume control of the transceiver fully counter-clockwise. Turn the squelch control fully counter-clockwise.

5. Set MC and KC switch to 118.00 Mcps.

6. Turn on the transceiver and readjust input to 13.75 VDC at MPS lead.

7. Adjust DC VTVM to 300 volt range for power supply receiver check.

8. Measure DC voltages at specified test points (see chart, page 35).

9. Adjust DC VTVM to 600 volt range for power supply, transmit check.

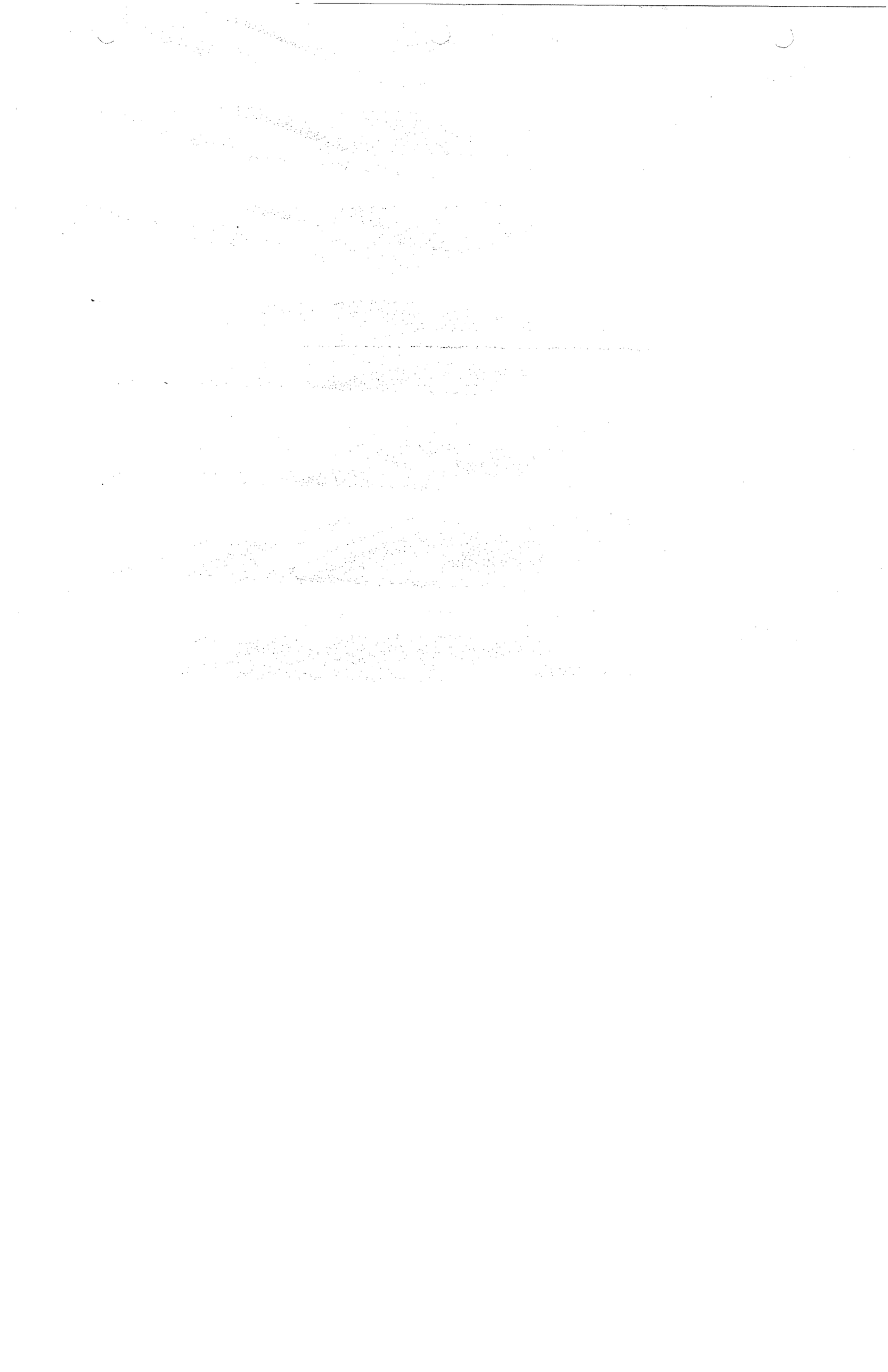
10. Depress microphone key and measure DC voltages on specified test points (see chart).

NOTE: Transmitter shall be operated at not more than 30% duty cycle. Observe input voltage and adjust if necessary.

11. Terminate speaker line (pin N of plug J201) with non-inductive 3 ohm 10 watt resistor.

12. Connect the audio signal generator to terminal A of J1. Adjust the generator to 1000 cps and inject 150 MV RMS into line.

13. Measure DC and AC voltages at specified test points with DC VTVM and AF VTVM (see chart).



MODULATOR/POWER SUPPLY CHECKOUT CHART

POWER SUPPLY CHECK

	TEST POINT	14 VOLT UNIT VOLTS DC	28 VOLT UNIT VOLTS DC
RECEIVE	152	13.5	27.3
	162	280	261
	163	568	530
	166	-35	-33
TRANSMIT	152	13.1	27.1
	162	262	257
	163	518	515
	166	-33	-33

AUDIO AMPLIFIER CHECK

	TEST POINT	14 VOLT UNIT VDC	14 VOLT UNIT VAC	28 VOLT UNIT VDC	28 VOLT UNIT VAC
RECEIVE	142	13.0	.01	10.0	.01
	143	1.7	.91	1.5	.92
	145	13.5	.42	27.1	.44
	148	.01	1.5	.4	.40
	7	-	1.7	-	2.2
	12	-	21	-	36

NOTE: ALL VOLTAGES MEASURED TO GROUND.
ALL READINGS ARE ± 10 PER CENT.

TROUBLE INDICATION	PROBABLE CAUSE	CORRECTIVE PROCEDURE
Power switch on, no B plus (cont'd)	Transistors inoperative	Check potential No.152 for battery voltage. Check potential No.153 for proper bias voltage Clean relay contacts. Change transistors NOTE: Switching transistors and audio power transistors are matched pairs and must be replaced in matched pairs.
	Short circuit in B plus line	Remove short circuit.
	Faulty Switch S_2	Check and replace
	Defective components	Check mainly electrolytic capacitors, replace if necessary.

NOTE: Operative high voltage power supply can easily be recognized by an audible high-pitched sound, generated by the switching of the transistors. When this sound is present, the high voltage power supply is operative.

RECEIVER SECTION OF TRANSCEIVER SA-90

It is assumed that the high voltage power supply A plus connections and all connections to antenna, speaker and headphones are in proper order; furthermore, that all tubes have been checked on a regular tube tester and have been found acceptable.

TROUBLE INDICATION	PROBABLE CAUSE	CORRECTIVE PROCEDURE
Volume fully clockwise, squelch control fully clockwise, no noise in speaker.	Audio amplifier inoperative	Check AF amplifiers performance by injecting an audio voltage of 1,000 cps into pin A of J 1 of pin A of J 201. Full AF power output must be obtained with 0.5 volts RMS. If no output or too low, check AF amplifier. Check voltage of V_7 for proper values. Check volume control.

TROUBLE INDICATION	PROBABLE CAUSE	CORRECTIVE PROCEDURE
No reception when signal generator is tuned to frequencies between 118.0 and 125.00 mcps.(con'd)	R.F. amplifier inoperative	Check V_1 for proper voltages as indicated on circuit diagram. check and clean if necessary antenna relay K_1. Check diode CR_5 and replace if required. Realign RF amplifier according to alignment procedure.

TRANSMITTER SECTION OF TRANSCEIVER SA-90:

It is recommended that another VHF Transceiver be tuned to the frequencies on which the check-out of the SA-90 Transmitter is to be made, and the results be monitored for modulation quality, frequency, etc. Disconnect signal generator and connect R.F. load and thru-line wattmeter before making this check.

TROUBLE INDICATION	PROBABLE CAUSE	CORRECTIVE PROCEDURE
No R.F. power output	Faulty components	Check V_8, V_9, V_{10} and V_{11} for proper voltages.
	Mcps oscillator inoperative	Check triode V_8 for proper voltages, realign in accordance with alignment procedure.
	KC oscillator	Check triode V_3, for proper voltages as indicated on circuit diagram, realign in accordance with circuit diagram.
	Antenna relay contacts	Check and clean if required.
No drive at potential No.105	R.F. amplifier inoperative	Check V_9 for proper voltages and realign if required.
	Mixer inoperative	Check pentode V_8 for proper voltages and realign if required.

TROUBLE INDICATION	PROBABLE CAUSE	CORRECTIVE PROCEDURE
Volume fully clockwise, squelch control fully clockwise, no noise in speaker (cont'd)	Detector circuit inoperative	Check CR_1 thru CR_3, replace if necessary.
	I.F. amplifier inoperative	Realign
NOTE: V_5, V_6 and V_7 and A.F. power amplifier operative, a noise will be present in the speaker and headphones.		
No reception when signal generator set to 36.450 mcps into antenna connector of transceiver, and KC switch set to .00 Signal generator output adjusted to 10 mv.	KC oscillator inoperative	Check KC oscillator circuit for voltage values as indicated on circuit diagram. Retune L_{11} according to alignment procedure. Check and replace defective crystals in KC crystal board. Check and clean KC switch assembly.
	First I.F. amplifier inoperative	Check for proper voltage as indicated on circuit diagram. Realign first I.F. amplifier according to alignment procedure.
No reception when signal generator is tuned to frequencies between 118.0 and 125.00 mcps.	Mixer inoperative	Check V_2 for proper operating voltages, as indicated on circuit diagram.
	Mcps.oscillator inoperative	Check megacycle oscillator tube V_4 for proper voltages as indicated on circuit diagram. Check megacycle switch. Clean if necessary,avoid solvents such as: benzine, benzol, use cleaning agents such as Contractrol, etc. Realign megacycle oscillator according to alignment procedure.

TROUBLE INDICATION	PROBABLE CAUSE	CORRECTIVE PROCEDURE
R.F. power output sufficient, no modulation	Defective microphone	Check and replace
	Relay contacts inoperative	Clean and adjust if required
	Microphone potentiometer R202 maladjusted or defective	Adjust and clean if required
	Transistors defective	Check Q201 for proper no signal voltages, replace if required. Check Q202 for proper no signal voltages, replace if required. Check Q203 and Q204 for proper operating voltages without AF input, replace if required.
	Modulation transformer defective	Check according to circuit diagram for proper resistance values and insulation.
	No A plus on one or more transistors	See above
R.F. power output sufficient, no modulation (cont'd)	Faulty connectors or inter-connecting	Check and remove fault
Modulation insufficient	Maladjusted microphone potentiometer	Adjust and check modulation depth with scope and calculate or adjust modulation by observation. Over-modulation is prevented by clipping Q201.

TUBE COMPLEMENT

Receiver		Transmitter	
R.F. Amplifier	7167*	Mixer and MC oscillator	8102*
1st Mixer	7167*	.R.F. Amplifier	8106*
I.F. Mixer and KC Oscillator	8102*	Driver	8106*
		R.F. Power Amplifier	8156*
2nd Mixer and MC Oscillator	8102*		
2nd I.F. Amplifier	6661 (6BH6)		
3rd I.F. Amplifier	6661 (6BH6)		
Demodulator, squelch noise limiter and AGC	(4) Crystal diodes		
1st and 2nd audio amplifier and cathode follower	6681 (12AX7)		

Modulator/Power Supply Model SAV 901 or 902:

The schematic diagram of the modulator/power supply provides all necessary information as to voltages and currents for trouble shooting the unit. The measurements should be taken with a multi-meter having not less than 20.000 ohms per volts impedance.

Modulator and Audio Amplifier:		Power Supply	
Transistor	2N1379	14 Volt Models (2)	2N277
Driver	2N669	28 Volt Models (2)	2N278
14 Volt Models (2) Class B push-pull	2N277		
28 Volt Models (2) Class B push-pull	2N278		

NOTE: Tubes marked with an asterisk may not be readily available outside of the United States as they have just recently been placed on the market and have been developed especially for airborne communications applications. In the opinion of SunAir, they have proven to be the most efficient for use with airborne communications equipment.
SunAir therefore, is prepared to supply spares in any quantities required. Please forward your request for replacement in accordance with the instructions shown on page 4 .

PARTS LIST

Circuit Symbol	Description	SunAir Part No.
C1	Capacitor, Ceram. Disc. 500 PF/± 10%/JF/500V DC	25098
C2	Capacitor, Ceram. Disc. 6 PF/± .25 PF/NPO/500V DC	25036
C3	Same as C2	
C4	Capacitor Variable .5 - 4.5 PF 500V DC	25139
C5	Same as C1	
C6	Same as C1	
C7	Same as C1	
C8	Capacitor, Ceram. Disc. 1.0 PF/± .25 PF/N33/1000V DC	24991
C9	Same as C4	
C10	Capacitor, Ceram. Disc. 50 PF/J/N30/500V DC	25842
C11	Same as C1	
C12	Capacitor, Ceram. Disc. 3300 PF/± 20%/X5U/500V	24422
C13	Capacitor, Ceram. Disc. 50 PF/J/N30/500V DC	25842
C14	Same as C12	
C15	Capacitor, Ceram. Disc. 27.0 PF/± 5%/N750/500V DC	25062
C16	Same as C103	
C17	Same as C12	
C18	Capacitor, Ceram. Disc. 22.0 PF/± 5%/N750/500V DC	25050
C19	Capacitor, Ceram. Disc. 2.2 PF/± .25 PF/N20?500V DC	25000
C20	Same as C12	
C21	Same as C12	
C22	Same as C12	
C23	Same as C12	
C24	Same as C12	
C25	Same as C12	
C26	Same as C12	
C27	Same as C12	
C28	Same as C12	
C29	Same as C12	
C30	Capacitor, Ceram. Disc. 10.0 PF/± 5%/N750/500V DC	25048
C31	Same as C16	
C32	Capacitor, Mylar .1 MF/± 10%/125V DC	25141
C33	Capacitor, Ceram. Disc. 100 PF/± 10%/JL/500V DC	25074
C34	Same as C16	
C35	Same as C32	
C36	Same as C1	
C37	Same as C12	
C38	Same as C2	
C39	Same as C30	
C40	Same as C4	
C41	Same as C30	
C42	Same as C30	
C43	Same as C2	
C44	Same as C30	
C45	Same as C4	
C46	Same as C1	
C47	Same as C1	
C48	Same as C1	
C49	Same as C1	
C50	Same as C1	
C51	Same as C1	
C52	Same as C1	
C53	Same as C1	
C54	Same as C1	
C55	Same as C2	
C56	Same as C15	
C57	Capacitor, Ceram. Disc. 220 PF/± 10%/JL/500V DC	25086
C58	Capacitor, Electrolytic, 10 MF/+/30V DC	25153
C59	Same as C103	
C60	Capacitor, Ceram. Disc. .01 MF/+ 80 -20/25U/500V DC	24355
C61	Same as C58	
C62	Capacitor, Ceram. Disc. 0.05 MF/± 35%/100V DC	25115
C63	Same as C1	
C64	Same as C1	
C65	Same as C1	
C66	Same as C1	
C67	Same as C4	
C68	Same as C1	
C69	Same as C1	
C70	Same as C4	
C71	Same as C1	
C72	Same as C1	
C73	Same as C30	
C74	Same as C1	
C75	Same as C1	
C76	Same as C1	
C77	Same as C4	
C78	Same as C1	
C79	Same as C1	
C80	Same as C2	
C81	Same as C1	
C82	Same as C1	
C83	Same as C1	
C84	Same as C1	
C85	Same as C4	
C86	Same as C1	
C87	Same as C1	
C88	Same as C1	
C89	Same as C1	
C90	Same as C2	
C91	Same as C30	
C92	Same as C1	
C93	Same as C1	
C94	Same as C1	
C95	Same as C12	
C96	Same as C12	
C97	Same as C1	
C98	Same as C1	
C99	Same as C1	
C100	Same as C1	
C101	Same as C16	
C102	Same as C1	
C103	Capacitor, Mylar, 0.47 MF/± 10%/125 V DC	25270
C104	Same as C1	
C105	Same as C2	
C106	Same as C30	
C107	Same as C2	
C108	Same as C2	

Circuit Symbol	Description	SunAir Part No.
R1	Resistor, Comp. 100 K/± 10%/.25 W	17039
R2	Resistor, Comp. 10 K/± 10%/.5 W	16724
R3	Resistor, Comp. 22 K/± 10%/.5 W	17053
R4	Same as R2	
R5	Resistor, Comp. 1 Meg/± 10%/.25 W	17065
R6	Same as R1	
R7	Resistor, Comp. 4.7 K/± 10%/.25 W	17077
R8	Same as R1	
R9	Resistor, Comp. 3.3 K/± 10%/.25 W	17089
R10	Same as R1	
R11	Resistor, Comp. 330 ohms/± 10%/.25 W	17091
R12	Resistor, Comp. 47 K/± 10%/.25 W	17106
R13	Resistor, Comp. 1 K/± 10%/.25 W	17156
R14	Resistor, Comp. 270 K/± 10%/.25 W	17211
R15	Same as R13	
R16	Same as R1	
R17	Same as R13	
R18	Same as R13	
R19	Resistor, Comp. 22 K/± 10%/.25 W	17223
R20	Same as R13	
R21	Resistor Comp. 1.5 Meg/10%/⅛ W	17508
R22	Same as R12	
R23	Same as R1	
R24	Same as R14	
R25	Same as R1	
R26 & R28	Resistor Variable 100 K Audio Taper/½ W 100 K Linear/½ W	32596
R27	Resistor, Comp. 47 K/± 10%/.25 W	17106
R29	Same as R12	
R30	Same as R5	
R31	Same as R5	
R32	Same as R1	
R33	Resistor, Comp. 1 K/± 10%/.5 W	16748
R34	Resistor, Comp. 100 ohms/± 10%/.25 W	17118
R35	Resistor, Comp. 27 K/± 10%/.25 W	17120
R36	Same as R35	
R37	Resistor, Comp. 220 ohms/± 10%/.25 W	17132
R38	Resistor, Comp. 56 K/± 10%/.25 W	17144
R39	Same as R13	
R40	Resistor, Comp. 10 K/± 10%/.25 W	17041
R41	Resistor, Comp. 1.5 K/± 10%/.25 W	17247
R42	Same as R14	
R43	Same as R41	
R44	Same as R5	
R45	Same as R34	
R46	Same as R33	
R47	Same as R1	
R48	Same as R11	
R49	Same as R12	
R50	Same as R5	
R51	Same as R33	
R52	Resistor, Comp. 180 ohms/± 10%/.5 W	17364
R53	Same as R14	
R54	Same as R33	
R55	Same as R1	
R56	Resistor, Comp. 33 ohms/± 10%/.5 W	17170
R57	Same as R40	
R58	Resistor, Comp. 68 K/± 10%/.25 W	17352
R59	Same as R56	
R60	Resistor, Comp. 15 K/± 10%/1 W	17340
R61	Same as R1	
R62	Same as R21	

Circuit Symbol	Description	SunAir Part No.
L8	Inductor, Fix. .47 MH ± 20%	63428
L9	Inductor, Fix. 1.0 MH ± 20%	63430
L10	Inductor, Fix. 1.5 MH ± 20%	63442
L11	Inductor, Fix. 2.2 MH ± 20%	63454
L4	Inductor, Var.	
L5	Inductor, Var.	
L6	Inductor, Var.	
L12	Inductor, Var.	
CR1	Glass Diode, Ge.	40139
CR2	Glass Diode, Si.	40141
CR3	Same as CR2	
CR4	Same as CR2	
CR5	Same as CR2	
S1	On-Off Switch	
S2	Switch, Slide DPDT, 125 V DC/2A	32534
S3	Switch Assy. MC	91906
S4	Switch Assy. KC	91968
K1	Relay Antenna, 14 V SPDT	66286
V1	Tube, Vacuum, 7167	76334
V2	Same as V1	
V3	Tube, Vacuum, 8102	76346
V4	Same as V3	
V5	Tube, Vacuum, 6BH6	76372
V6	Same as V5	
V7	Tube, Vacuum, 12AX7	76384
V8	Same as V3	
V9	Tube, Vacuum, 8106	76358
V10	Same as V9	
V11	Tube, Vacuum, 8156	76463
Y1	Crystal Unit, 81.55 MC	80062
Y2	Crystal Unit, 82.55 MC	80074
Y3	Crystal Unit, 83.55 MC	80086
Y4	Crystal Unit, 84.55 MC	80098
Y5	Crystal Unit, 85.55 MC	80103
Y6	Crystal Unit, 86.55 MC	80115
Y7	Crystal Unit, 87.55 MC	80127
Y8	Crystal Unit, 88.55 MC	80139
Y9	Crystal Unit, 89.55 MC	80141
Y10	Crystal Unit, 90.55 MC	80256
Y11	Crystal Unit, 91.55 MC	80268
Y12	Crystal Unit, 92.55 MC	80270
Y13	Crystal Unit, 33.45 MC	80153
Y14	Crystal Unit, 33.55 MC	80165
Y15	Crystal Unit, 33.65 MC	80177
Y16	Crystal Unit, 33.75 MC	80189
Y17	Crystal Unit, 33.85 MC	80191
Y18	Crystal Unit, 33.95 MC	80206
Y19	Crystal Unit, 34.05 MC	80218
Y20	Crystal Unit, 34.15 MC	80220
Y21	Crystal Unit, 34.25 MC	80232
Y22	Crystal Unit, 34.35 MC	80244
T1	I.F. Transformer	48272-A
T2	Same as T1	
T3	Same as T1	
B1	Bulb, Min. 12V DC, .055a	84367
B2	Same as B1	

POWER SUPPLY & MODULATOR
14 V & 28 V

Circuit Symbol	Description	SunAir Part No.
C201	Capacitor, Electro. 10 mf/30 V	25153
C202	Same as C201	
C203	Capacitor, Electro. Printelyd 400 mf/15 V	25165
C204	Same as C201	
C205	Capacitor, Mylar Tropifoil-F 1000 pf/10%/400 V	25177
C206	Capacitor, Mylar, Tropifoil-M .047 mf/10%/125 V	25189
C207	Same as C201	
C208	Same as C203	
C210	Capacitor, Disc. .05 mf/75 V	24393
C211	Capacitor, Disc. .01 mf/1.4 KV	24410
C212	Capacitor, Electro. 8 + 8 mf/500 V	25193
C213	Same as C212	
C214	Capacitor .005 mf/1.4 KV	25700
C216	Capacitor, Electro. Printelyd 100 mf/15 V	25799
R201	Potentiometer 250 ohm/1 W ± 20%	32455
R202	Resistor, 47 K ohm/.25 W/10%	17106
R203	Resistor, 15 K ohm/.25 W/10%	17235
R204	Resistor, Comp. 470 ohm/¼ W/10%	17261
R205	Resistor, Comp. 180 ohm/.25 W/10%	17522
R207	Resistor, 3.3 K ohm/.25 W/10%	17089
R212	Resistor, Fixed w/w BW1 1.5 ohm/ 2 W/10%	17302
R213	Resistor, 10,000 ohm/½ W	16724
R215	Resistor, Comp. 330 ohm/½ W/10%	17338
R216	Same as R215	
R217	Resistor, Comp. 270 K ohm/2 W/10%	17405

Circuit Symbol	Description	SunAir Part No.
L201	Choke, filter 160 mh	56188
L202	Choke, 9 mh	56229
L203	Choke, .4 mh	56059
L204	Choke, 10 mh	56152
L205	Choke, 400 mh	56023
L206	Choke, 0.7 mh	56190
Q201	Transistor, 2N1379	44056
Q202	Transistor, 2N669	44135
K201	Relay, 14 V (Xmitt.)	66298
K202	Relay KD3D/12 V (On-Off)	66016
CR201	Diode 1N461	40141
CR202	Diode Sl 538	40153
CR203	Same as CR202	
CR204	Same as CR202	
CR205	Same as CR202	
CR206	Same as CR202	
CR207	Same as CR202	
CR208	Diode IN534	40165
T201	Transformer TR-64 (Driver)	48181
T202	Transformer Q-36473 (Mod.)	48296
	Filter, Hash Assy.	63727

14 VOLT ONLY

C218	Same as C203	
C209	Same as C203	
C215	Same as C203	
R206	Resistor, Comp. 220 ohm/⅔ W/10%	17285
R208	Same as R203	
R209	Resistor, 10 K ohm/¾ W/10%	1704
R210	Resistor, Fixed w/w BW -½ .47 ohm/ 1 W/10%	17297
R211	Same as R206	
R214	(28 V Only)	
R218	Resistor, 450 ohm/3 W	16281
R219	Resistor, 10 ohm/3 W	16322
R220	(28 V Only)	
R221	(28 V Only)	
Q203	Transistor, 2N277	44147
Q204	Same as Q203	
Q205	Same as Q203	
Q206	Same as Q203	
T203	Transformer, 14 V (Power)	91815
F201	Fuse, Slow Blow, 15A	84850

28 VOLT ONLY

C218	Same as C209	
C209	Capacitor, Electro. Printelyd 200 mf/30 V	25816
C215	Same as C209	
R206	Resistor, 820 ohm/⅔ W	17560
R208	Resistor, 6800/¾ W	17481
R209	Resistor, 15 K/¾ W	17572
R210	Resistor, 100 ohm/3 W	16308
R211	Resistor, 250 ohm/3 W	16293
R214	Resistor, 75 ohm/3 W	16944
R218	Resistor, 1000 ohm/3 W	16279
R219	Resistor, 20 ohm/3 W	17558
R220	Same as R214	
R221	Same as R214	
Q203	Transistor, 2N278	44159
Q204	Same as Q203	
Q205	Same as Q203	
Q206	Same as Q203	
T203	Transformer (Power)	92259
F201	Fuse, Slow Blow 10A	84848