



AUTO RADIO SERVICE MANUAL

1967 SAPPHIRE VI FM-AM All Transistor Radio

Bendix Models	Description	Serial Number Prefix
7FBVW	VOLKSWAGEN SEDAN	7FBV
7FBVT	TRANSPORTER	7FBV
7FBVG	KARMANN GHIA	7FBV
7FBV3	VOLKSWAGEN 1600 (Type 3)	7FBV



WARRANTY SERVICE PROCEDURE

Warranty service for the SAPPHIRE VI radio and accessories will be handled by the Bendix Radio Division through its authorized service dealers.

GENERAL

This manual contains trouble-shooting procedures, general and functional schematics, alignment instructions, plus essential information for servicing Bendix Sapphire VI FM-AM radio models 7FBVW, 7FBVT, 7FBVG and 7FBV3.

TYPE:--The 1967 Sapphire VI is a completely transistorized FM-AM receiver. A slide bar, on the front panel of the radio, permits selection of FM or AM reception. Pushbuttons, beneath the slide bar, permit selecting and locking in five different stations (for automatic selection). The Sapphire VI circuitry includes eleven transistors, one zener diode, one varactor diode, and five signal diodes.

TUNING RANGE:

FM—88 to 108 MC AM—540 to 1605 KC

INTERMEDIATE FREQUENCY:

FM—10.7 MC AM—262.5 KC

POWER INPUT:--+12 volt storage battery, negative terminal to ground.
Voltage +14.4 VDC

CURRENT:--Approximately 1 ampere excluding dial lamp current.

AUDIO OUTPUT:--6 watts minimum

SPEAKER IMPEDANCE:--8 ohms

THE BENDIX CORPORATION • BENDIX RADIO DIVISION • BALTIMORE, MARYLAND, 21204

AUTOMOTIVE PRODUCTS DEPARTMENT

TO SET PUSHBUTTONS

1. Turn on radio. Extend antenna 38 inches.
2. Set slide bar to FM or AM.
3. Pull out pushbutton to be set. Rotate manual tuning knob until desired station is properly tuned in.
4. Press pushbutton, then release it. Repeat this procedure for the remaining pushbuttons.

DESCRIPTION OF CIRCUIT

The receiver can be divided into three basic sections: FM, AM, and audio. The AM section is integrated with the FM section, while the audio section is used for both FM and AM reception. The master schematic diagram shows that transistor Q4 is used as a 10.7 MC amplifier for FM and as the RF amplifier for AM. Likewise, transistor Q5 doubles as a 10.7 MC FM IF amplifier and as the AM converter. Transistor Q6 serves as a 10.7 MC FM IF amplifier and as the 262.5 KC AM IF amplifier.

The radio will amplify AM or FM signals depending on the position of the DPDT switch (S2). When in the AM position, S2-A grounds the AM detector and simultaneously removes the reverse bias from the AM detector diode D5 to allow detection of AM signals.

In FM position, S2-A grounds the AM antenna circuit to prevent AM signals from interfering with FM IF, removes the ground from resistor R34 to reverse bias the AM detector diode D5, and removes ground from the AM detector stage to eliminate demphasis of signals from the FM detector (which is a requirement for stereo capability). When in the AM position, S2-B removes the A+ voltage from the FM RF, oscillator, and mixer stages, thereby eliminating these stages as a source of interference during AM operation. In the FM position, S2-B applies A+ to the FM front end stages and places a low impedance across the AM oscillator tank circuit. This turns off the AM oscillator and eliminates this source of interference during FM operation.

When receiving AM, signal currents flow through the FM IF transformers (T2, T3, T4, and T6) as well as through the AM tuned circuits. The FM IF transformers have very low impedance at the lower AM frequencies and hence are not shown on the functional AM schematic.

During FM operation, the inductive AM elements are bypassed by capacitors. Most of these capacitors are also part of the various AM RF and AM IF tuned circuits, but at the 10.7 MC IF, these capacitors have very low impedance and completely bypass the AM coils.

FM Section

(See Fig. 1, Functional FM Schematic)

Front End. The FM front end consists of a grounded base RF amplifier, a Colpitts oscillator, and a grounded

emitter mixer. The RF amplifier uses the grounded base configuration for maximum stability. The RF tuned circuit, composed of C7, C8, L2, and C9, is a PI circuit to afford a better impedance match between Q1 collector and Q2 base.

The regenerative feedback for the Colpitts oscillator (Q3) is supplied by C18, C16, and the base-to-emitter capacitance of the transistor. The oscillator tank circuit, composed of C19, C20, and L3 is resonant at a frequency 10.7 MC higher than the resonant frequencies of the RF and antenna circuits. Varactor diode (D2) supplies an additional capacitance to the oscillator tank circuit. This capacitance, which is approximately inversely proportional to the square root of the diode voltage, is controlled by the AFC voltage from the discriminator.

The base of the mixer transistor (Q2) receives oscillator voltage through C14 and signal voltage through C10. The mixer, due to its non-linear operating characteristics, produces the 10.7 MC IF which is the difference between the oscillator and signal frequencies. C11 and L8 form a series resonant 10.7 MC trap to make the receiver more stable at the IF.

Zener diode (D1) regulates the A+ voltage for the three transistors in the FM front end and the varactor bias at +7 VDC. (This is the nominal value. The actual voltage may vary 12% between different receivers.) This regulation is necessary since any change in DC voltage to varactor or oscillator transistor would cause excessive oscillator drift.

IF and Limiter. It is the purpose of the IF section to select a relatively narrow band of frequencies centered at 10.7 MC from the mixer stage and to amplify them to a level that will saturate (over drive) the limiter stage. An IF bandwidth of 200 KC at 6 DB down is retained so that the side bands of weak signals will not be attenuated. The IF stages use neutralizing capacitors (C26, C32, C39, and C47) to compensate for the base-to-collector transistor capacitances. These capacitors prevent self-sustaining oscillations of the IF section which could easily suppress any 10.7 MC signal present.

The limiter stage is similar to the other IF stages except that the limiter operates with a higher emitter voltage. When fully limiting, the current alternates between cutoff and saturation on the respective positive and negative voltage swings applied to the base. (Limiting is the normal mode of operation for an FM receiver since the receiver will then have a much higher signal-to-noise ratio than when not limiting.) Any increase in IF voltage to the limiter base will not increase the discriminator output, once the limiting level is reached.

Discriminator and AFC. The Foster Seeley Discriminator, like all types of FM detectors, has an instantaneous output voltage which is proportional to the difference between the applied signal frequency and the resonant frequency of the discriminator secondary circuit. A typical discriminator response curve is shown in Fig.

2. It is desirable that the IF be centered at 10.7 MC so that the discriminator will operate over the central region of its response curve. This requires that the oscillator be tuned exactly 10.7 MC higher than the RF signal frequency. The AFC circuit greatly facilitates this requirement.

To illustrate the operation of the AFC circuit, assume the oscillator frequency is too high, producing an IF that is centered at some value greater than 10.7 MC. As seen from Fig. 2, the discriminator will produce a positive DC output component when operating at frequencies above 10.7 MC. This positive voltage is filtered and applied to the anode of the varactor (D5). The voltage across the varactor is reduced, and its capacitance is increased. Part of the increase in capacitance adds to the oscillator tank circuits capacitance which reduces the oscillator frequency.

FM Alignment
(Refer to Table 2.)

Note

DO NOT REMOVE COVERS DURING FM ALIGNMENT.

Access holes for probe are identified in Figure 4. Detector Probe is shown in Figure 3.

1. Connect jumper from T.P. AFC-2 to ground to disable AFC.

2. Set FM-AM selector to FM. Set tuner to high-frequency-end stop.
3. Perform steps 1, 2, 4, and 6 below limiting level. Determine limiting level by increasing generator voltage until there is no further increase in probe voltage. Note probe voltage. The limiting level is 70% of this value (3 DB down).
4. Use a sweep generator and oscilloscope for Step 4. Feed 10.7 MC marker frequency into radio IF strip.

REMOVAL AND INSTALLATION OF FM PRINTED CIRCUIT BOARD

1. The FM printed circuit board is mounted on the radio tuner, directly over the FM tuner coils. Locate, carefully unsolder, and remove the six FM coil copper ribbon leads, at their printed circuit board terminals.
- IMPORTANT:** Avoid applying excessive heat to prevent loosening of the terminals and possible damage to the printed circuit board.
2. Disconnect the six leads soldered to the FM-AM switch S2, and dress them away from the printed circuit board. Unsolder all other leads from the board as required.
 3. Remove the five printed circuit board mounting screws and the top cover mounting bracket.
 4. Make note of all printed circuit board lead dress. Carefully tilt the front of the printed circuit board

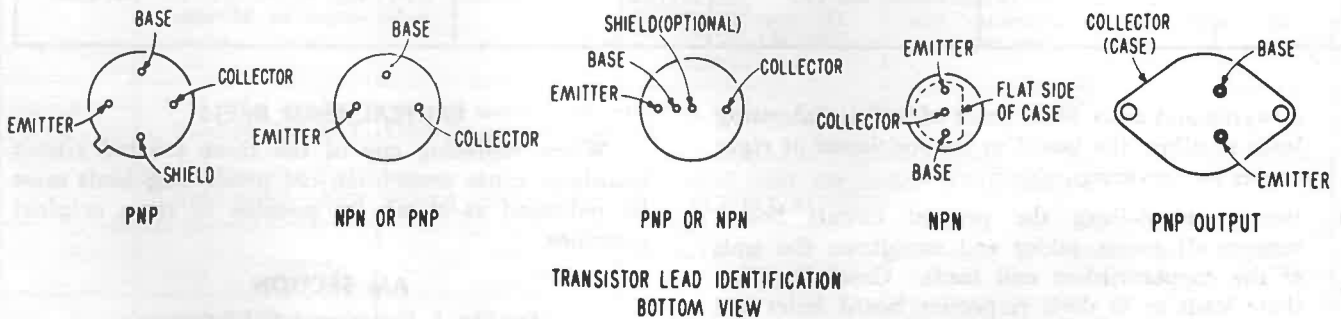


TABLE 2
FM ALIGNMENT PROCEDURE

STEP	GENERATOR CONNECTION	GENERATOR FREQUENCY	METER AND/OR SCOPE CONNECTION	PROCEDURE
1	FM injection point (T2-3)	10.7 MC (unmodulated)	VTVM connected to Detector Probe. Probe connected to T6-2.	Keep signal generator adjusted to a level that produces approximately +0.50 VDC. Adjust T3-P, T3-S, T4-P, T4-S, and T6 for maximum probe voltage. Reduce generator voltage as required to maintain 0.50 VDC reading.
2	Same as step 1	Same as Step 1	VTVM connected to Test Point AFC-1.	Maintain level and frequency setting of generator and carefully adjust T8-S for zero discriminator voltage. A plus and minus voltage will be obtained on either side of zero setting.
3	Same as step 1	10.7 MC modulated at 400 CPS ± 75 KC deviation.	AC meter connected to speaker or 8-ohm dummy load.	Set signal generator level at approximately 300 UV and adjust volume control for 1 watt (2.8 VRMS) audio output. Adjust T8-P for maximum audio output. Reset volume control for 1 watt if necessary.
4	Sweep generator to dummy antenna. Signal generator as indicated to PROCEDURE Column.	98 MC sweep width 500 KC 10.7 MC (unmodulated.)	Scope connected to detector probe. Probe connected to T6-2.	Tune receiver until bandpass appears on scope. Loosely couple a 10.7 MC marker generator to the insulated wires between T1 and T2. Adjust marker to lowest level that will produce a discernible pip on the response pattern. Adjust T1-P, T1-S, T2-P, T2-S for maximum amplitude and bandwidth. NOTE: Marker frequency should be exactly as used in Step 2. This may be reset by adjusting marker generator frequency for zero discriminator voltage. (No sweep.)
5	Dummy Antenna	108.5 MC (unmodulated)	Same as Step 2.	Tune receiver to high-end stop. Adjust FM oscillator C-20 for zero discriminator voltage.
6	Dummy Antenna	98 MC (unmodulated)	Same as Step 1.	Keep generator level adjusted below limiting level, but above noise level. Adjust FM RF C-8 and FM antenna C-3 for maximum detector probe voltage.
7	Dummy Antenna	98 MC ± 75 KC deviation 400 CPS	Remove probe from T6-2.	Keep generator level below limiting level and adjust T6 for maximum audio output on AC meter.

upwards and away from front of radio, undressing leads to allow the board to be positioned at right angles for servicing.

5. Before reinstalling the printed circuit board, remove all excess solder and straighten the ends of the copper ribbon coil leads. Carefully align these leads to fit their respective board holes and place the board in its mounting position. Carefully crimp and resolder the coil leads to their respective terminals.
6. Secure the printed board and the top cover mounting bracket, using the 5 mounting screws removed in Step 3.
7. Reconnect all leads removed in Step 2.
8. The set is now ready for testing.

CRITICAL LEAD DRESS

When replacing any of the three printed circuit boards or tuner assemblies, the connecting leads must be redressed as closely as possible to their original positions.

AM SECTION

(See Fig. 5, Functional AM Schematic)

A tuned RF stage (Q4) is used to obtain good sensitivity and selectivity. The antenna and RF circuits are tuned to the signal frequency by varying the permeability of the tuner coils. Capacitors C33 and C34 provide a low impedance pick-off point for Q5 base. Capacitor C31C resonates with L5 at the image frequency for improved image rejection. Base bias voltage for the RF amplifier is provided by the AGC

circuit. The DC emitter current is stabilized by voltage feedback from R17 and current feedback from R16.

The converter (Q5), a combination oscillator and mixer, is biased to operate over the non-linear part of its curve to insure that the gain at 262.5 KC will be high. The oscillator tank circuit, composed of L6, C31B, C36 and C37 is resonant at a frequency 262.5 KC higher than the resonant frequency of the antenna and RF circuits. Base bias voltage is obtained from the bleeder network of R21 and R19.

The IF current flowing in Q5 collector circuit is coupled to IF transistor (Q6) base by T5 sharply resonant at the IF. T5 also matches the high impedance of Q5 collector circuit to the lower impedance of Q6 base circuit. Capacitor C41 is a "boot strap" to provide a signal return path between base and emitter circuit. Base bias voltage is obtained from resistors R26, R28, and R30.

The AGC circuit controls the gain of the RF and converter stages to prevent strong signals from overloading the receiver and to obtain an audio voltage which does not increase appreciably as the input signal increases. The AGC diode D4 rectifies some of the IF current which reduces the positive charge, in proportion to signal level, on capacitors C45 and CE3. The voltage on these capacitors controls the forward bias and the gain of the RF amplifier and to a lesser extent, the converter.

AUDIO AMPLIFIER

(See Fig. 6, Functional Audio Schematic)

The audio amplifier is composed of three stages—a predriver (Q8), a driver (Q9), and a Class B push-pull output (Q10 and Q11). The predriver stage is direct coupled to the driver, and the driver stage is coupled to the output by the interstage transformer (T9) which supplies the out-of-phase signals necessary to operate the class B push-pull power output stage. Several loops of AC negative feedback are used to provide low distortion and broad frequency response.

Negative DC feedback is applied to the base of Q8 from the emitter of Q9 by resistors R52 and R54 and is proportional to the emitter current of Q9. This helps to stabilize the voltage and current bias points of the driver stages for variation in transistor gain and temperature. Resistors R50 and R56 provide for increased DC stabilization and for some local negative AC feedback. Capacitor C67 filters out all of the AC component so that only DC is fed back in this circuit. The circuit values are chosen to stabilize the collector current of Q9 at about 9 MA DC.

The output transistors are biased by resistors R58 and R60 to maintain a no-signal collector current of approximately 300 MA DC (total). At full output, this current increases to about 1 ampere. The emitter winding of transformer T10 is for feedback only and not for power transfer. The output winding functions

TABLE 3
AM ALIGNMENT PROCEDURES

STEP	GENERATOR CONNECTION	GENERATOR FREQUENCY	ADJUST	PRECEDURE
1	Through 0.1 UF capacitor to T2-3.	262.5 KC	T7-S, T7-P, T5-S, T5-P	Adjust for maximum meter reading.
2	Through dummy antenna to antenna socket (J1).	1605 KC	AM OSC. (C31B) AM RF (C31A) AM ANT. (C28)	Set tuner to high end stop. Adjust trimmer capacitors in order shown for maximum meter reading.
3	With radio installed in car and antenna fully extended, tune in a weak station above 1400 KC. Readjust AM ANT (C28) for maximum volume.			
PERFORM THE FOLLOWING STEPS ONLY IF TUNING COIL OR CORES HAVE BEEN REPLACED. NEW TUNER ASSEMBLIES ARE FACTORY ALIGNED.				
4	L4, L5, L6	Set tuner to high-end stop. Replace coils or cores as required.
5	Through dummy antenna to antenna socket (J1).	1605 KC	AM OSC. (C31B) AM RF (C31A) AM ANT. (C28)	Adjust in order shown for maximum meter reading.
6	Same as Step 5.	1000 KC	L6, L5, L4	Adjust manual tuner until carriage is 0.477 inches from high-end stop. Set one of the pushbuttons at this setting for reference. Adjust core in order shown for maximum reading.
7	Repeat Steps 5 and 6 until no further gain is evident.			

essentially the same as a tapped choke output. Negative AC feedback is applied from the collector of Q10 to the emitter of Q8 via resistors R51 and R57 and is developed across resistor R50. Resistors R57 and R55 and capacitor C68 form a phase shift network which is designed to prevent the AC feedback from going positive at frequencies above the audible range. Installing transformers T9 and T10 other than as shown in the schematic could result in instability and oscillation.

TRANSISTOR FAILURE

Transistors are soldered to the printed circuit boards and should not be checked by the substitution method. Most transistor (and stage) failures will alter the normal transistor currents and may be diagnosed by the following DC method.

TRANSISTOR TROUBLE SHOOTING (DC Method)

PURPOSE:

- A) To determine if each transistor stage is conducting at a normal level.
- B) To determine whether the transistor or the biasing circuit is defective if the current level is abnormal.

PROCEDURE:

- A) Measure the voltage drop across the resistor or component specified in the table for the stage in question. Compare measured value with normal range given under VOLTAGE in table. See TROUBLE SHOOTING PRECAUTIONS.

CAUTION

DO NOT SERVICE THE RADIO WITH UN-GROUNDED AC POWERED EQUIPMENT

- B) If measured voltage is within given range, assume that stage is functioning normally.
- C) If measured voltage is not within given range, that stage is definitely not operating properly. To determine if the transistor is defective, proceed as follows:

- 1) Calculate the collector current (I_c) by dividing the measured voltage drop by the value of the resistor.

$$I_c \text{ (ma)} = \frac{V \text{ (volts)}}{R \text{ (K ohms)}}$$

- 2) Measure the base voltage of that transistor with respect to the emitter (V_{be}). Use a meter of at least 20,000 ohms per volt.
- 3) Plot the V_{be} and I_c from 1 and 2 above on the applicable curve (PNP or NPN) of the graph, Fig. 7, TRANSISTOR CONDUCTION CHARACTERISTICS.
- 4) If plotted point falls on or near curve, transistor is not defective and abnormal I_c is caused by circuit defects external to the transistor. Plotted points not in region of curve indicate transistor is defective.

Note

If I_c is much greater than the range specified in TABLE 4, and the plotted point falls to the left of the PNP curve or to the right of the NPN curve, the transistor may be saturated. Saturated transistors are not defective; the V_{be} is abnormally high in the forward direction. This may be caused by a defect in the base biasing circuit.

TABLE 4. TRANSISTOR TROUBLE SHOOTING — DC METHOD

TRANSISTOR	COLLECTOR CURRENT (I_c) MA	VOLTAGE	MEASURED ACROSS
†Q1	0.3 to 0.6	0.36 to 0.72	R1
†Q2	0.75 to 1.5	0.75 to 1.5	R7
†Q3	0.3 to 0.6	0.66 to 1.32	R11
*Q4	1.0 to 2.0	0.18 to 0.36	R16
*Q5	0.4 to 0.8	0.9 to 1.7	R23
*Q6	1.7 to 2.7	2.5 to 4.1	R27
†Q7	1.5 to 2.5	3.7 to 5.9	R38
Q8	0.75 to 1.5	0.075 to 0.15	R50
Q9	6 to 12	1.32 to 2.65	R56
Q10, Q11		0.07 to 0.14 volts at each collector to ground	

†Selector switch (S2) in FM position.

*Selector switch (S2) in AM position.

GAIN MEASUREMENTS

It is possible that all the transistors will appear to be operating normally, but that the receiver will be inoperative or have low gain. Under these conditions, individual stage gain measurements would be useful in pinpointing the defective stage.

Measuring AM Gain

Equipment Needed: AM generator with calibrated attenuator, AC meter.

Procedure: Connect meter across speaker or 8 ohm dummy load. Set selector switch to AM position, volume and tone controls to maximum clockwise positions. Modulate generator 30% at 400 CPS. TABLE lists sensitivities for one watt (2.8 VAC) output. (Use a 0.1 UF blocking capacitor in series with transistor collectors.)

GAIN MEASUREMENTS AM

Generator Connection	Frequency	1 Watt Sensitivity
R46A (Direct)	400 CPS	15 MV
Q6-C	262.5 KC	150 KUV
Q5-C	262.5 KC	10 KUV
Q4-C	262.5 KC	5-10 UV
Dummy Antenna	1000 KC	1-11 UV

Measuring FM Gain

Equipment Needed: FM generator with calibrated attenuator, AC meter.

Procedure: Set FM generator for 22.5 KC deviation at 400 CPS. Use a 0.01 UF capacitor in series with generator lead. Connect AC meter across speaker or 8 ohm dummy load. Set volume control to produce about 3 VAC when set is limiting. (The limiting sensitivity is the generator voltage when the audio drops 1 DB from its value at maximum generator output.)

GAIN MEASUREMENTS FM

Generator Connection	Frequency	Limiting Sensitivity
Q5-C	10.7 MC	10 KUV— 50 KUV
Q4-C	10.7 MC	500 UV —1000 UV
*T2 (FM Injection Point)	10.7 MC	100 UV — 500 UV
**Dummy Antenna	98 MC	1.5 UV — 7 UV

*Perform with covers in place.

**See Master Schematic for Dummy Antenna values.

TROUBLE SHOOTING PRECAUTIONS

1. Measure all DC voltages with a 20,000 ohms per volt meter. Disconnect antenna to assure a true no-signal condition.
2. Do not connect ammeter or otherwise short the power transistors (Q10 and Q11) collector to ground.
3. If signal injection is employed, use a suitable capacitor in series with a generator lead to eliminate any possible DC ground path through the generator.
4. Connect the radio power (A) lead to the positive terminal of power supply through a 2 ampere "Slo-Blo" fuse.
5. When it becomes necessary to disconnect leads, take great care to redress them as they were originally found.

CAUTION

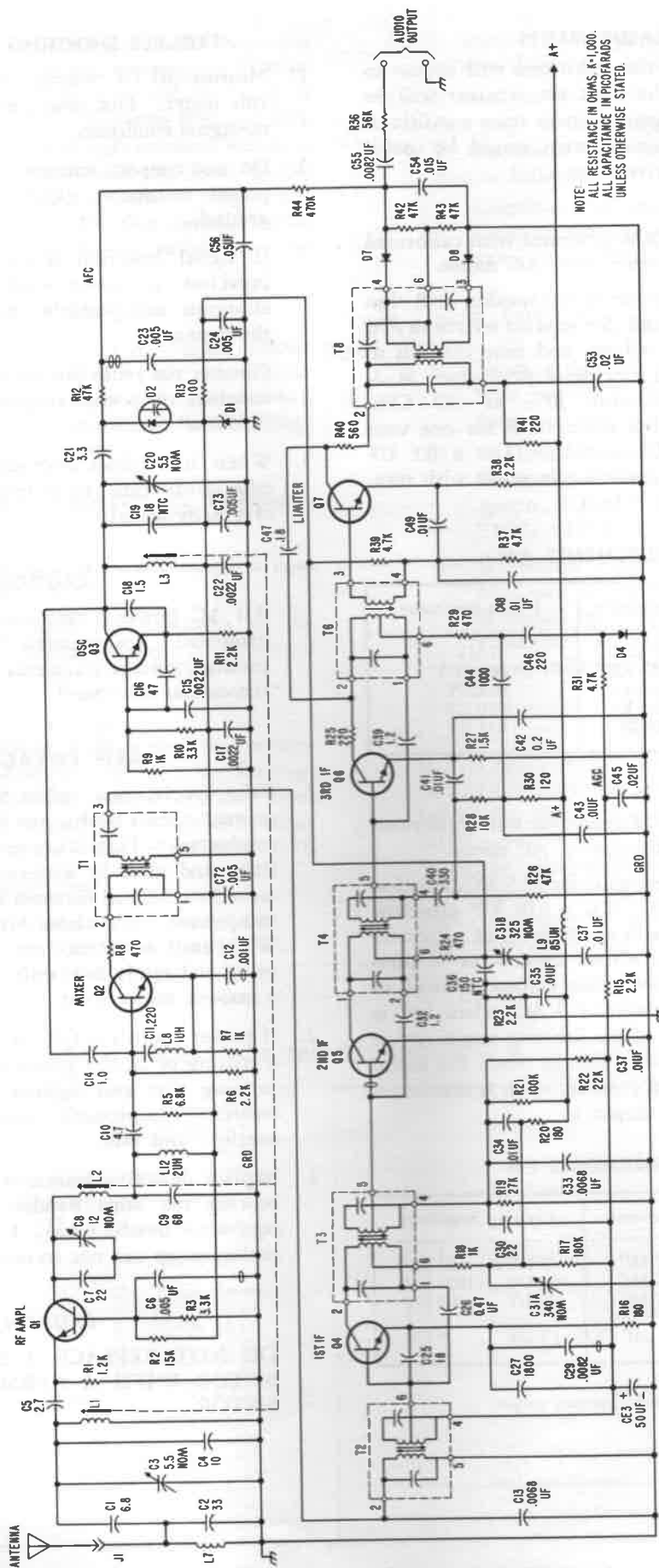
All AC powered test equipment should be grounded. Ungrounded AC equipment can produce voltage transients greater than transistors can withstand.

PARTS REPLACEMENT

1. Take special care, when soldering parts to the printed circuit board, not to overheat the printed conductors. Transistors and diodes are heat sensitive and must be soldered with a heat sink attached to the lead between the solder joint and the component. (Flat nose Mini-clips may be used.) Wait until soldering iron is fully heated before using and apply heat only long enough to insure a smooth solder joint.
2. If power transistor Q10 or Q11 is replaced, apply a coating of silicon grease to each side of the insulating disc and tighten the mounting screws securely. Improperly mounted transistors may overheat and fail.
3. Replace defective transistors with identical units bearing the same Bendix part number (or an equivalent Bendix part). Universal type transistor replacements are not recommended.

CAUTION

DO NOT REPLACE A SILICON TRANSISTOR WITH A GERMANIUM TRANSISTOR.



NOTE:
ALL RESISTANCE IN OHMS & 1,000.
ALL CAPACITANCE IN PICOFARADS
UNLESS OTHERWISE STATED.

Figure 1. FUNCTIONAL FM SCHEMATIC

3403024

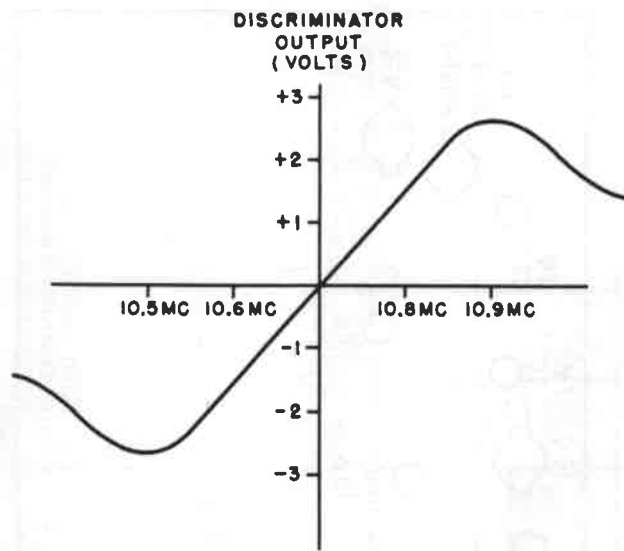


Figure 2. DISCRIMINATOR CURVE

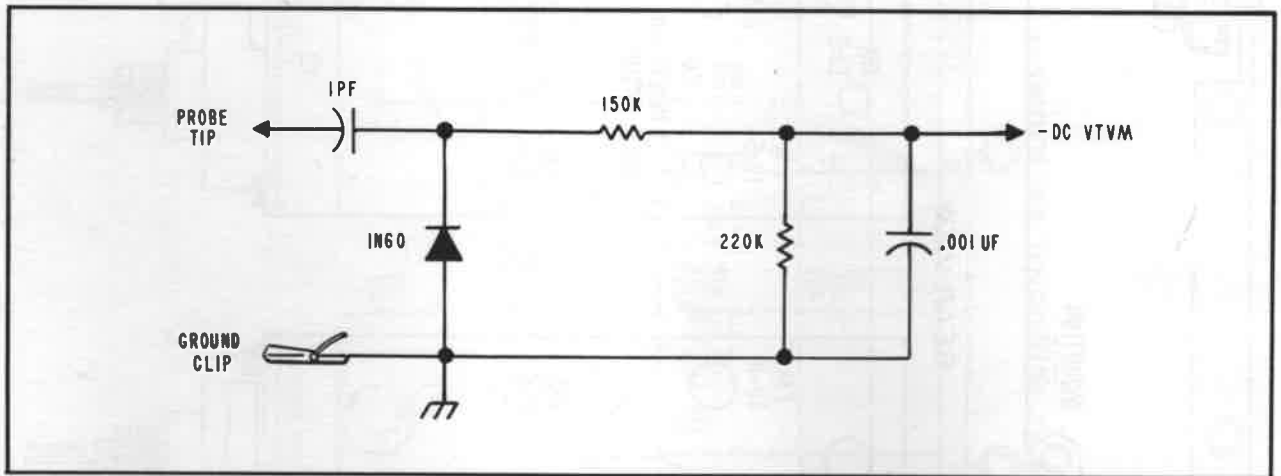


Figure 3. DETECTOR PROBE

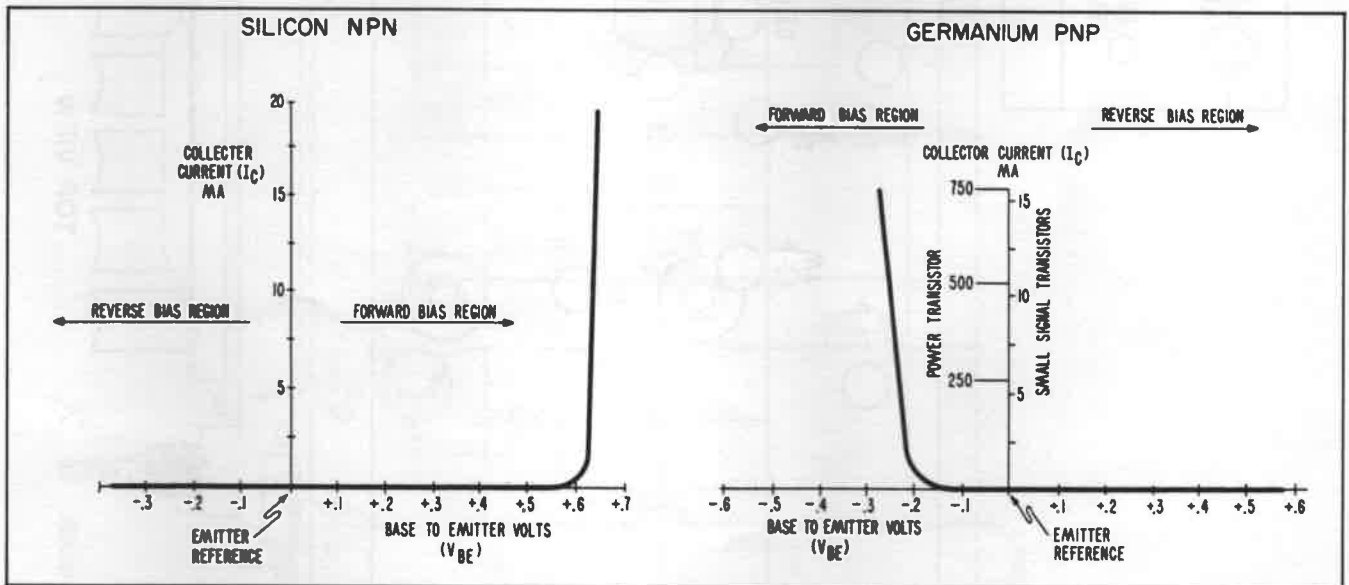
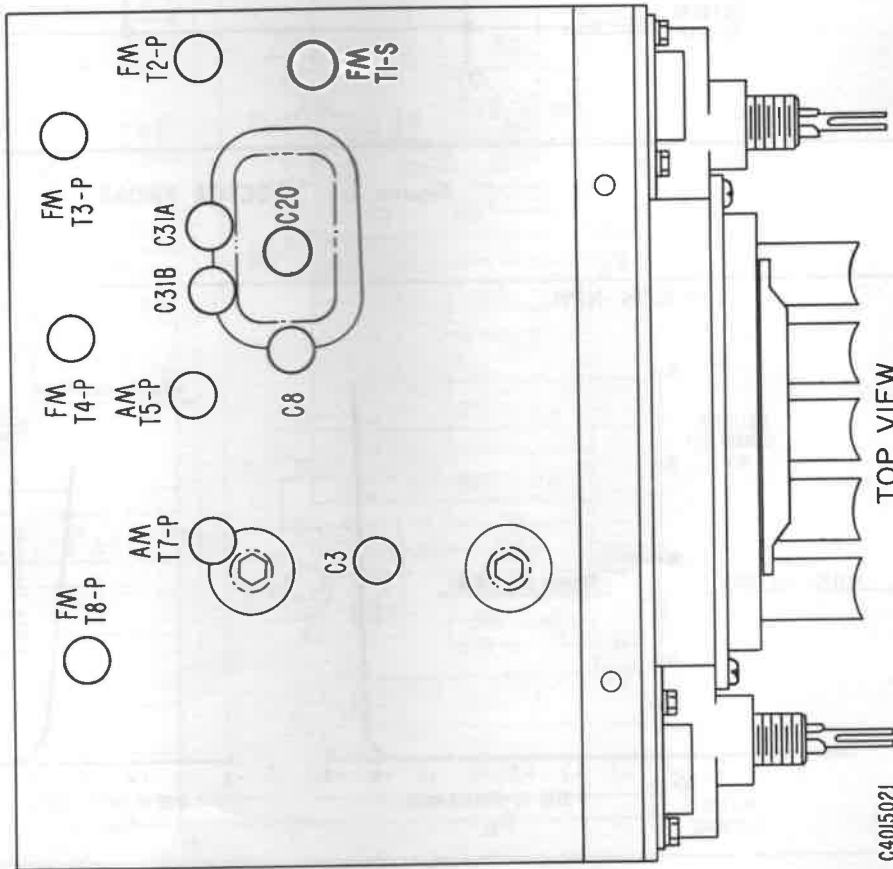
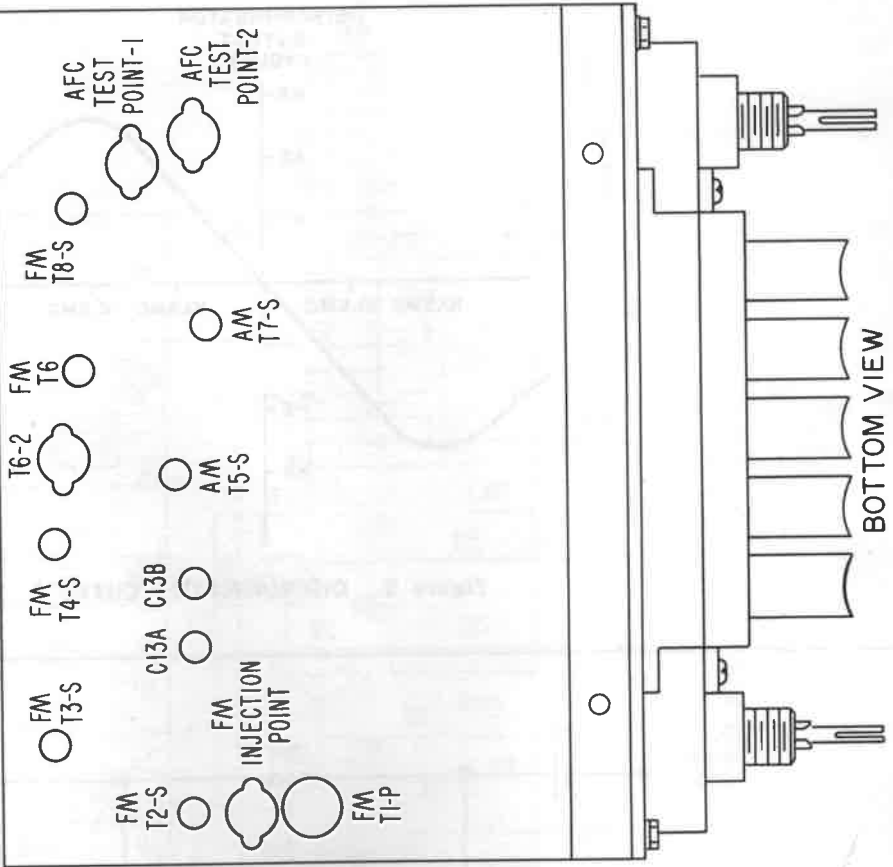
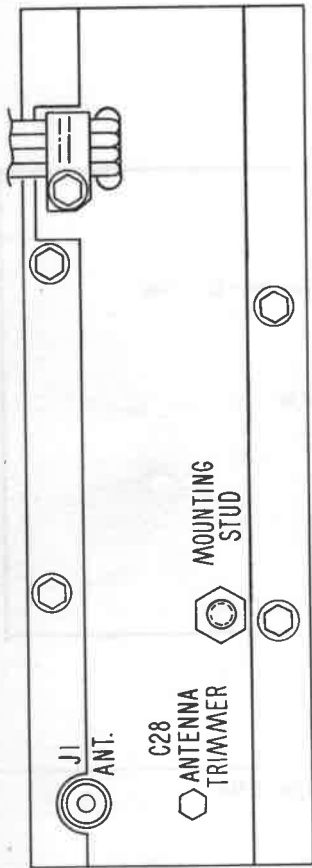


Figure 7. TRANSISTOR CONDUCTION CHARACTERISTICS



C4015021

Figure 4. ALIGNMENT ACCESS HOLES

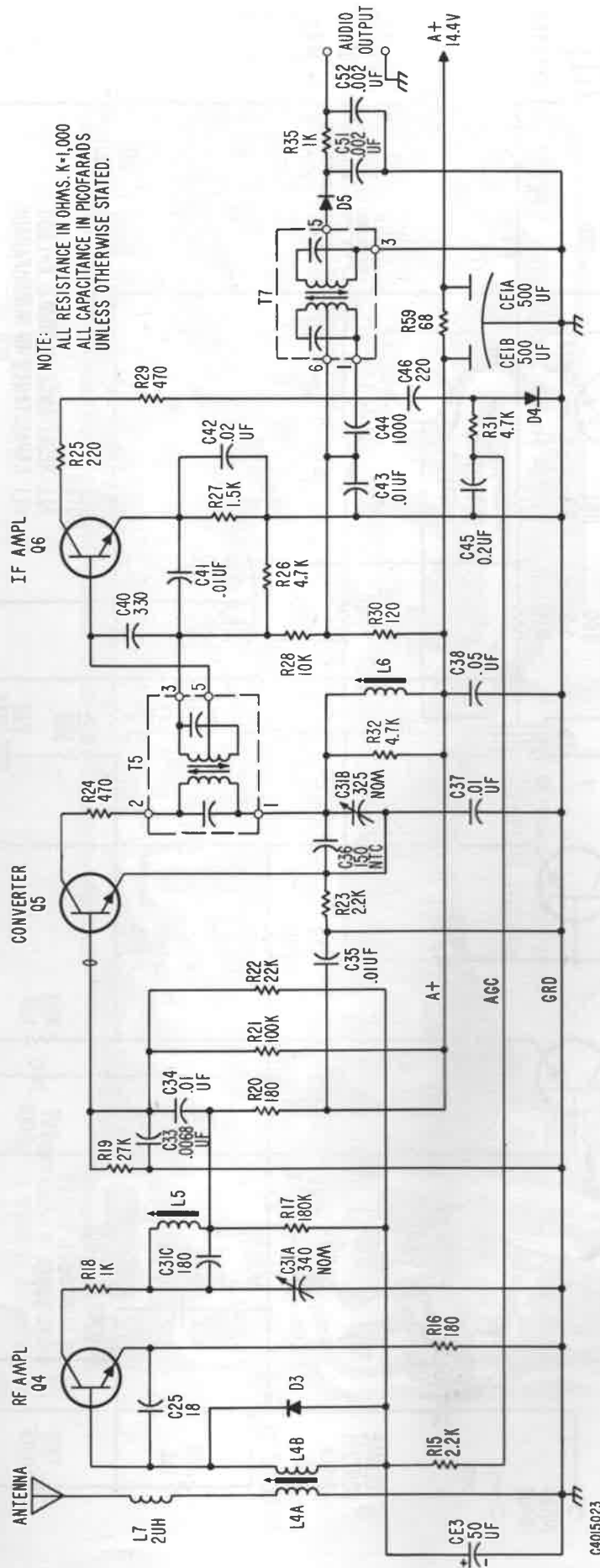


Figure 5. FUNCTIONAL AM SCHEMATIC

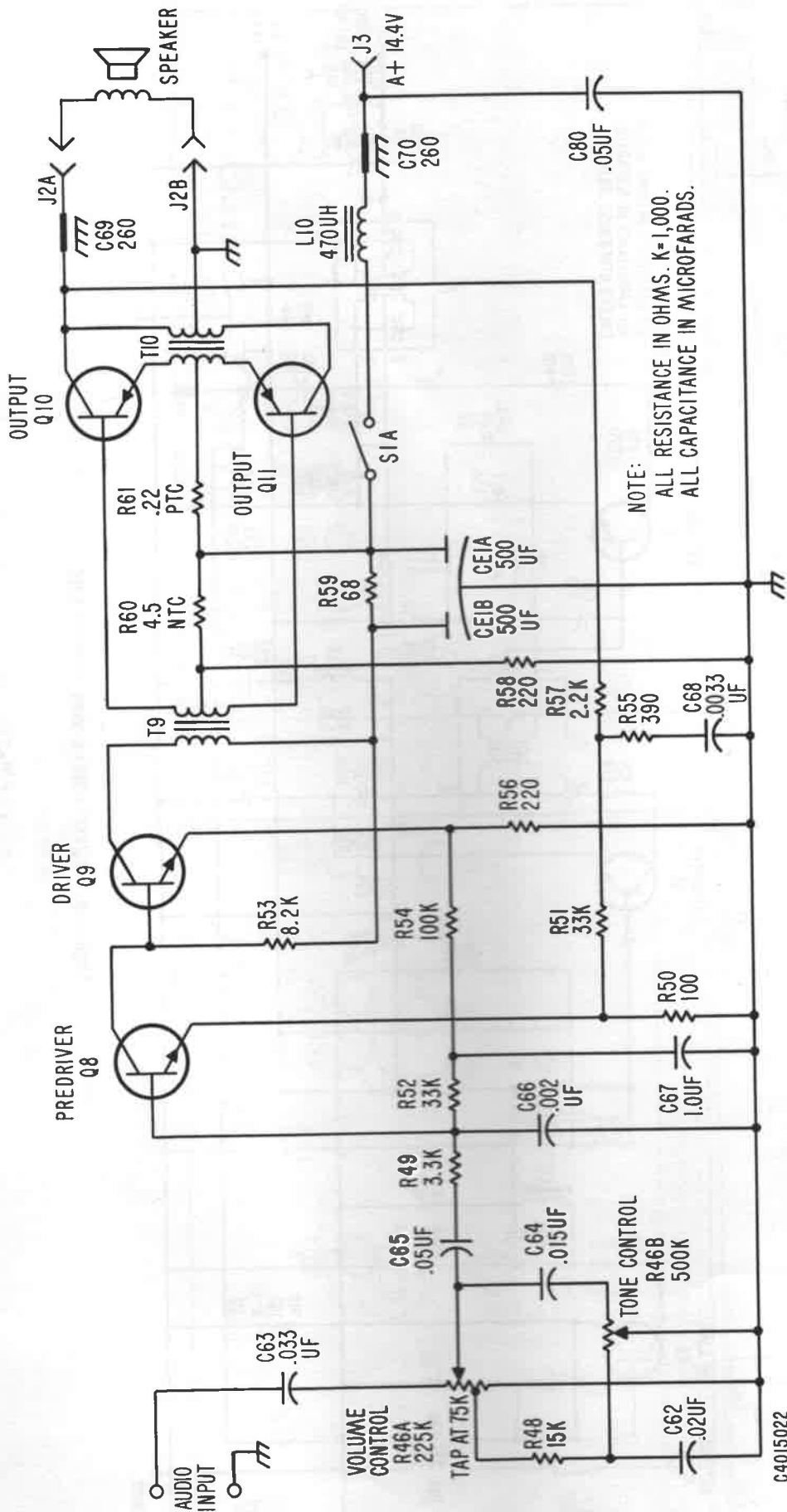
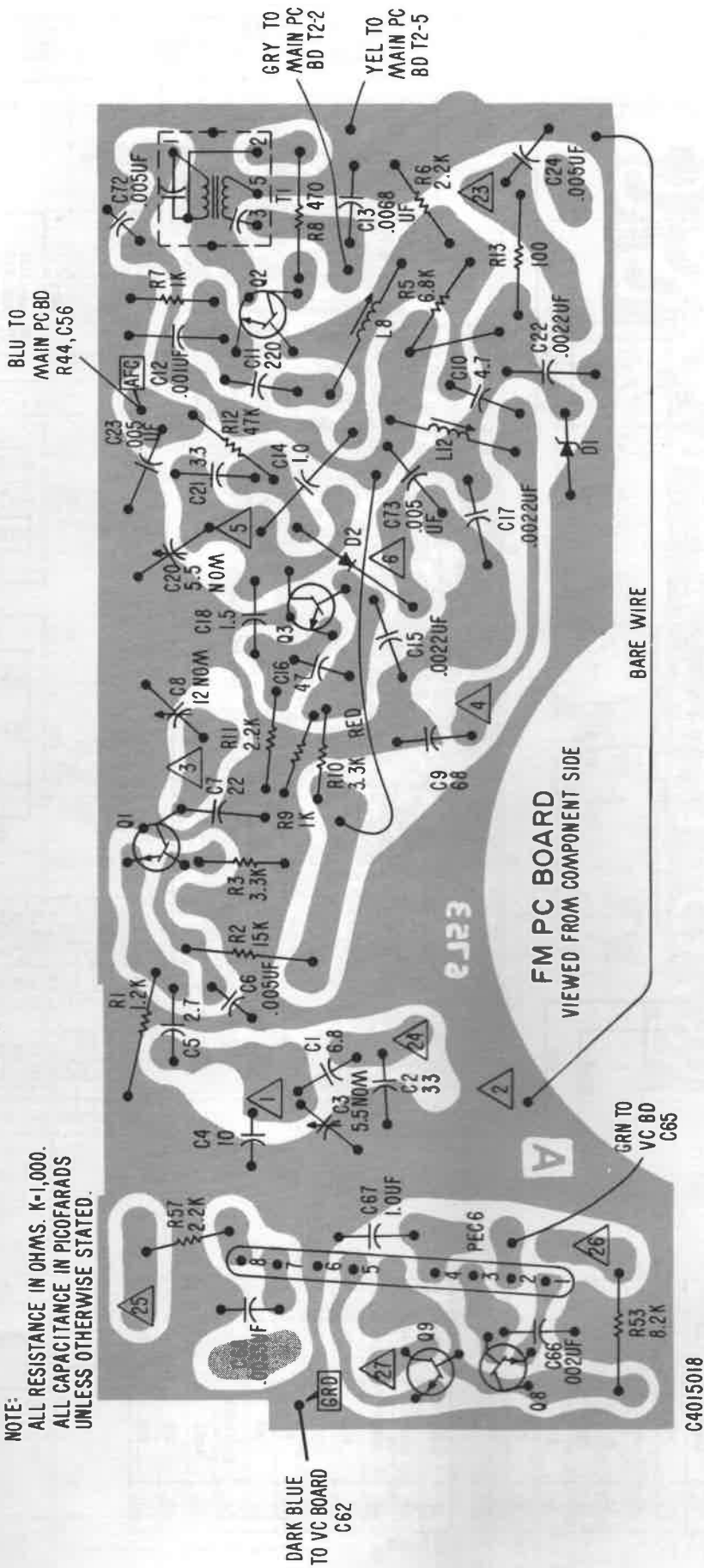


Figure 6. FUNCTIONAL AUDIO SCHEMATIC

NOTE:
 ALL RESISTANCE IN OHMS. K=1,000.
 ALL CAPACITANCE IN PICOFARADS
 UNLESS OTHERWISE STATED.



1967 VOLKSWAGEN FM-AM RADIO, MODEL 7FBV

C4015018

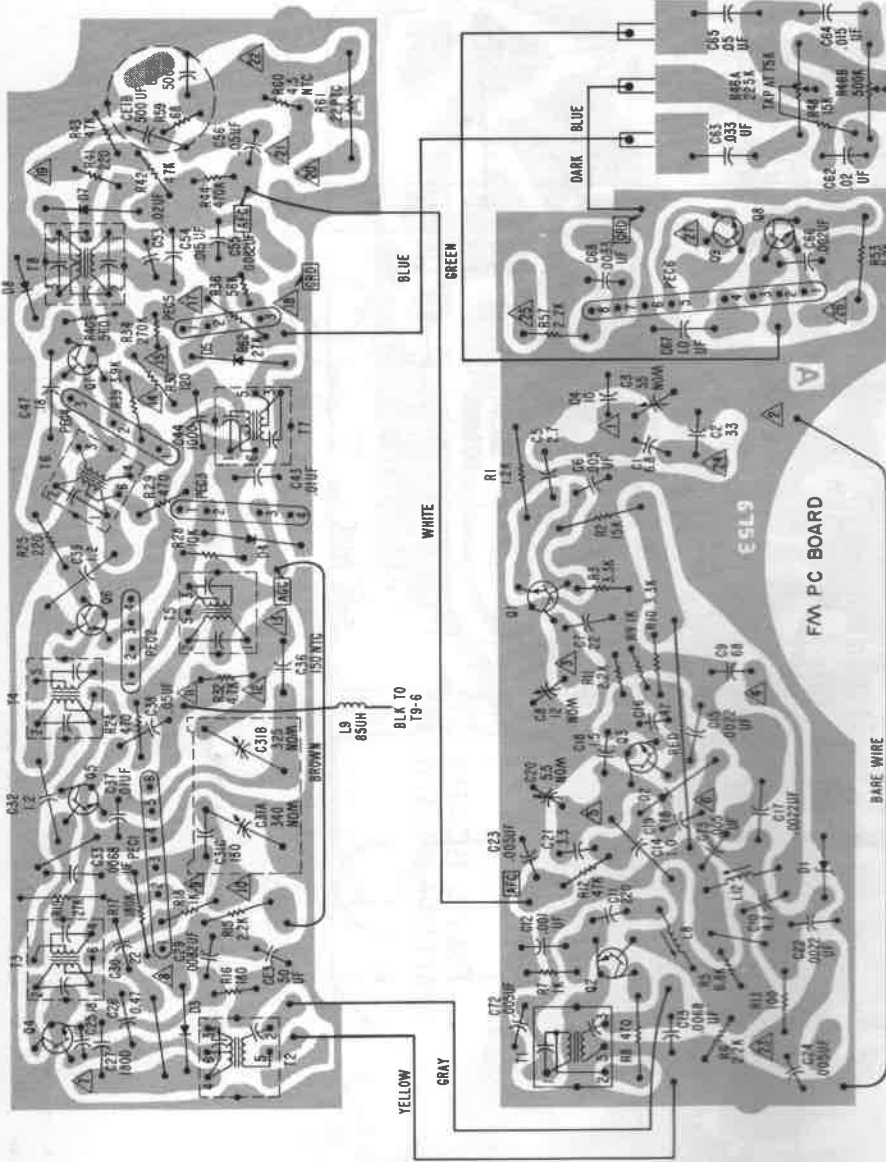
CONNECTIONS TO PC BOARD JACKS (PCJ)

PCJ #	LEAD COLOR	TERMINATION
1	COPPER STRAP	L1
2	"	L1
3	"	L2
4	"	L2
5	"	L3
6	"	L3
7	YELLOW	L4B
8	ORANGE	L4B
9	RED	L5
10	BLUE	L5
11	BLACK	L6
12	GREEN	L6
13	WHITE	S2-2
14	RED	S2-3
15	RED	T9-6

17	BLACK	S2-4
18	ORANGE	S2-5
19	ORANGE	T9-6
20	BLUE	T10-6
21	GREEN	T9-5
22	RED	81-A
23	RED	S2-3
24	BLACK (COAT)	J1
25	ORANGE	T10-C
26	RED	T9-6
27	BLUE	T9-4

NOTE
RESISTANCE IS IN OHMS, K=1,000
CAPACITANCE IS IN PICOFARADS UNLESS OTHERWISE STATED.
DC VOLTAGES MEASURED WITH 20,000 OHMS PER VOLT METER.
POWER SUPPLY SET AT +14.4V DC, NO SIGNAL INPUT.
NORMAL VOLTAGE WILL VARY ± 15% FROM VALUES SHOWN.
△ INDICATES PC BOARD JACK (PCJ).
ORIGINAL ISSUE PC BOARD.

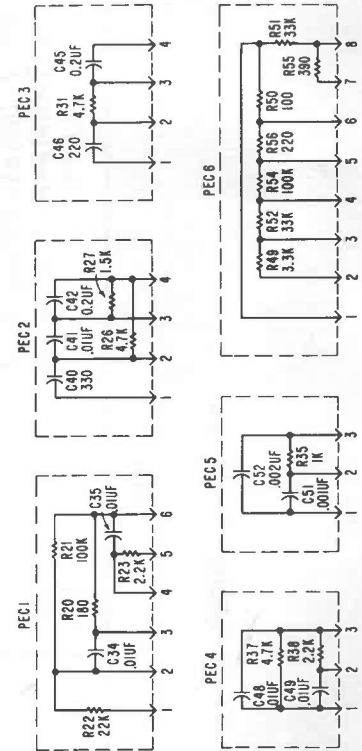
MAIN PC BOARD
VIEWED FROM TRACK SIDE



VOLUME CONTROL BOARD

NO.	EMITTER	BASE	COLLECTOR
Q1	.55V	1.1V	5.9V
Q2	1.0V	1.6V	6.5V
Q3	1.0V	1.55V	6.1V
Q4	0.25V FM	0.95V FM	6.6V FM
Q5	1.0V FM	1.6V FM	10.0V AM
Q6	1.3V AM	1.9V AM	12.2V AM
Q7	2.6V AM	3.2V FM	9.3V FM
Q8	4.0V FM	4.7V FM	11.0V AM
Q9	0V AM	0V AM	12.5V AM
Q10	0.1V	0.7V	2.7V
Q11	2.0V	2.7V	10.5V FM
Q12	14.0V	13.7V	12.5V AM
Q13	14.0V	13.7V	0.1V

TRANSISTOR VOLTAGES



**1967 BENDIX 7FBVW (VOLKSWAGEN SEDAN), 7FBVT (TRANSPORTER), 7FBVG (KARMANN GHIA), AND
7FBV3 (TYPE 3 VEHICLES) PUSHBUTTON FM-AM RADIOS REPLACEMENT PARTS LIST.**

CAPACITORS

Symbol No.	Description	Part No.	Unit List Price	Symbol No.	Description	Part No.	Unit List Price
C1	6.8 mmf 5%, ceramic, 100 V	2093195-0784	.35	C32,C39	1.2 mmf 10%, ceramic, 100 V	2093231-2129	.35
C2	33 mmf 5%, ceramic, 100 V	2093195-0788	.35	C33	6800 mmf 10%, mylar, 25 V	2094323-0743	.35
C3	FM-Ant. trimmer, 4-25 mmf	2093115-0704	.50	C34,C35	Part of PEC #1		
C5	2.7 mmf 10%, ceramic, 100 V	2093195-0789	.35	C36	150 mmf 10%, ceramic, 100 V	2093195-0757	.35
C6	5000 mmf 20%, ceramic, 100 V	2093229-0724	.35	C37	.01 mf 10%, mylar, 25 V	2094323-0708	.35
C7	22 mmf 10%, ceramic, 100 V	2093195-0780	.35	C38,C56	.05 mf 20%, mylar, 25 V	2094323-0733	.35
C8	FM-RF trimmer, 4-20 mmf	2094703-0702	.65	C40,C41,C42	Part of PEC #2		
C9	68 mmf 10%, ceramic, 100 V	2093195-0717	.35	C43	.01 mf 10%, mylar, 25 V	2094323-0741	.35
C10	4.7 mmf 10%, ceramic, 100 V	2093195-0753	.35	C44	1000 mmf 10%, mica, 100 V	2090926-0737	.45
C11	220 mmf 5%, mica, 100 V	2090926-0723	.45	C45,C46	Part of PEC #3		
C12	1000 mmf 10%, ceramic, 100 V	2093229-0712	.35	C47	.18 mmf 10%, ceramic, 100 V	2093231-2188	.35
C18	6800 mmf 10%, mylar, 100 V	2094323-0742	.35	C48,C49	Part of PEC #4		
C14	1.0 mmf 10%, ceramic, 100 V	2093231-2109	.35	C51, C52	Part of PEC #5		
C15,C17,C22	2200 mmf 20%, ceramic, 100 V	2093195-0758	.35	C53	.02 mf 20%, mylar, 25 V	2094323-0739	.35
C16	47 mmf 10%, mica, 100 V	2090926-0734	.45	C54,C64	.015 mf 10%, mylar, 25 V	2094323-0714	.35
C18	1.5 mmf 10%, ceramic, 100 V	2093195-0755	.35	C55	8200 mmf 10%, ceramic, 100 V	2090207-0040	.50
C19,C25	18 mmf 5%, ceramic, 100 V	2093195-0778	.35	C62	.02 mf 10%, mylar, 25 V	2094323-0724	.35
C20	FM-Osc. trimmer 3-8 mmf	2094703-0701	.65	C63	.033 mf 20%, mylar, 25 V	2094323-0713	.35
C21	3.3 mmf 10%, ceramic, 100 V	2093195-0790	.35	C65	.05 mf 20%, mylar, 25 V	2094323-0712	.35
C23,C24	5000 mmf 20%, ceramic, 100 V	2093195-0792	.35	C66	2000 mmf 10%, ceramic, 100 V	2093195-0797	.35
C26	.47 mmf 5%, ceramic, 100 V	2093231-2478	.35	C67	1.0 mf 20%, ceramic, 100 V	2090150-0727	.50
C27	1800 mmf 10%, ceramic, 100 V	2093195-0708	.35	C68	3300 mmf 20%, ceramic, 100 V	2093195-0791	.35
C28	AM-Antenna trimmer, 30-140 mmf	2093114-0709	.65	C69,C70,C81	275 mmf, spark plate	2093050-0002	.10
C29	8200 mmf 20%, ceramic, 100 V	2093229-0735	.35	C72,C73	5000 mmf 20%, ceramic, 100 V	2093195-0792	.35
C30	22 mmf 20%, ceramic, 100 V	2093195-0765	.35	CE1A,B	A-500 mf, B-500 mf, 16 V electrolytic	2091503-0712	3.00
C31A,B,C	AM-RF, OSC. trimmer, A-305-375 mmf, B-240-360 mmf, C-180 mmf	2092422-0716	1.60	CE3	50 mf, 8 V electrolytic	2093667-0711	1.70

RESISTORS

Symbol No.	Description	Part No.	Unit List Price	Symbol No.	Description	Part No.	Unit List Price
R1	1.2K ohms 10%, 1/2 W comp.	2093232-2122	.20	R32	4.7K ohms 10%, 1/4 W comp.	2093851-2472	.20
R2	15K ohms 10%, 1/2 W comp.	2093232-2153	.20	R34	270K ohms 10%, 1/2 W comp.	2093232-2274	.20
R3,R10	3.3K ohms 10%, 1/4 W comp.	2093851-2332	.15	R35	Part of PEC #5		
R4	1.5K ohms 10%, 1/2 W comp.	2093232-2152	.20	R36	56K ohms 10%, 1/4 W comp.	2093851-2563	.20
R5	6.8K ohms 10%, 1/4 W comp.	2093851-2682	.20	R37,R38	Part of PEC #4		
R6,R15	2.2K ohms 10%, 1/2 W comp.	2093232-2222	.20	R39	3.9K ohms 10%, 1/4 W comp.	2093851-2392	.20
R7,R9	1K ohms 10%, 1/4 W comp.	2093851-2102	.20	R40	560 ohms 20%, 1/4 W comp.	2093851-3561	.15
R8	470 ohms 20%, 1/4 W comp.	2093232-3471	.15	R41	220 ohms 10%, 1/4 W comp.	2093851-2221	.20
R11,R57	2.2K ohms 10%, 1/4 W comp.	2093851-2222	.20	R42,R43	47K ohms 5%, 1/4 W comp.	2093851-1473	.30
R12	47K ohms 10%, 1/4 W comp.	2093851-2473	.20	R44	470K ohms 10%, 1/4 W comp.	2093851-2474	.20
R13	100 ohms 10%, 1/4 W comp.	2093232-2101	.20	R45	10K ohms 10%, 1/2 W comp.	2093232-2103	.20
R16	180 ohms 10%, 1/4 W comp.	2093851-2181	.20	R46A,B	Volume and Tone Control, On-Off switch	2094685-0701	3.75
R17	180K ohms 10%, 1/2 W comp.	2093232-2184	.20	R47,R48	15K ohms 5%, 1/2 W comp.	2093232-1153	.30
R18	1K ohms 20%, 1/4 W comp.	2093851-3102	.15	R49,R50	Part of PEC #6		
R19	27K ohms 10%, 1/2 W comp.	2093232-2273	.20	R51,R52	Part of PEC #6		
R20,R21, R22,R23	Part of PEC #1			R53	8.2K ohms 10%, 1/2 W comp.	2093232-2822	.20
R24,R29	470 ohms 20%, 1/4 W comp.	2093851-3471	.15	R54,R55,R56	Part of PEC #6		
R25	220 ohms 20%, 1/4 W comp.	2093851-3221	.15	R58	220 ohms 10%, 2 W wirewound	2093141-2221	.45
R26,R27	Part of PEC #2			R59	68 ohms 10%, 1/2 W comp.	2092460-0001	.20
R28	10K ohms 10%, 1/4 W comp.	2093851-2103	.20	R60	4.5 ohms 10%, Thermistor	220629-0017	.75
R30	120 ohms 10%, 1/4 W comp.	2093851-2121	.20	R61	.22 ohms 10%, 2 W wirewound	2090948-0007	.45
R31	Part of PEC #3			R62	27K ohms 10%, 1/4 W comp.	2093851-2273	.20

DIODES AND TRANSISTORS

Symbol No.	Description	Part No.	Unit List Price	Symbol No.	Description	Part No.	Unit List Price
D1	Silicon, Zener	2092055-0710	1.75	Q3	FM-Oscillator	2092417-0713	2.50
D2	Silicon, Variable Capacitance	2092055-0003	2.25	Q4	FM-IF, AM-RF	2092418-0715	2.50
D3,D4	Germanium	2092055-0708	.60	Q5	FM-IF, AM-Converter	2092418-0716	2.50
D5	Germanium	2092055-0001	.60	Q6	FM-IF, AM-IF	2092418-0717	2.50
D7,D8	Germanium	2092055-0007	.60	Q7	FM-Limiter	2092418-0716	2.50
Q1	FM-RF	2092417-0711	3.00	Q8	Audio Pre-Driver	2092609-0707	2.00
Q2	FM-Mixer	2092417-0712	2.50	Q9	Audio Driver	2092609-0002	2.00
				Q10,Q11	Audio Output	2091859-0714	4.00

1967 BENDIX 7FBVW (VOLKSWAGEN SEDAN), 7FBVT (TRANSPORTER), 7FBVG (KARMANN GHIA), AND 7FBV3 (TYPE 3 VEHICLES) PUSHBUTTON FM-AM RADIOS REPLACEMENT PARTS LIST. (Cont.)

PACKAGED ELECTRONIC COMPONENTS

Symbol No.	Description	Part No.	Unit List Price	Symbol No.	Description	Part No.	Unit List Price
PEC #1	Module Assembly (includes R20, R21, R22, R23, C34 and C35)	2094687-0702	1.25	PEC #5	Module Assembly (includes R85, C51 and C52)	2094692-0701	1.25
PEC #2	Module Assembly (includes R26, R27, C40, C41 and C42)	2094688-0701	1.25	PEC #6	Module Assembly (includes R49, R50, R51, R52, R54, R55 and R56)	2056721-0701	1.25
PEC #3	Module Assembly (includes R31, C45 and C46)	2094690-0701	1.25				
PEC #4	Module Assembly (includes R37, R38, C48 and C49)	2094691-0701	1.25				

SWITCHES AND TRANSFORMERS

Symbol No.	Description	Part No.	Unit List Price	Symbol No.	Description	Part No.	Unit List Price	
S1	On-Off (Part of Volume-Tone Control R46)	2094685-0701	3.75	T5	AM-IF Input	262.5 kc	2092419-0720	2.50
S2	FM-AM, DPDT	2056700-0701	.50	T6	FM-Limiter	10.7 mc	2092421-0718	2.50
T1	FM-IF 10.7 mc	2093587-0706	2.50	T7	AM-IF Output	262.5 kc	2092419-0719	2.50
T2	FM-IF 10.7 mc	2093587-0708	2.50	T8	Discriminator	10.7 mc	2093856-0703	2.50
T3	FM-IF 10.7 mc	2092421-0717	2.50	T9	Audio Driver		2092192-0706	3.50
T4	FM-IF 10.7 mc	2093587-0703	2.50	T10	Audio Output		2094696-0703	3.85

MISCELLANEOUS ELECTRICAL

Symbol No.	Description	Part No.	Unit List Price	Symbol No.	Description	Part No.	Unit List Price
E1	Lampholder and lead assy.	2094520-0501	.30	L4,L5,L6	Coil assembly, AM tuner	See "Tuner Parts"	
I1	Lamp, dial (1892)	2091877-0004	.30	L7	Choke, RF (FM antenna isolation)	2092210-0007	.40
J1	Receptacle, antenna	223198-0002	.20	L8	Choke, RF (part of 10.7 mc trap)	2092210-0005	.60
J2	Cable assembly, speaker	2090613-0523	.30	L9	Choke, decoupling	2092210-0711	.45
J3	Cap and lead assy., fuseholder	2094348-0518	.50	L10	Choke, "A" line filter	2094209-0703	1.35
J4	Lead and receptacle assy., lamp	2091852-0521	.30	L12	Choke, dc collector feed	2092210-0007	.40
L1,L2,L3	Coil assembly, FM tuner	See "Tuner Parts"					

TUNER PARTS

Symbol No.	Description	Part No.	Unit List Price	Symbol No.	Description	Part No.	Unit List Price
	<u>GIC</u>						
	Tuner assembly, FM-AM (complete with pushbuttons)	2094066-0511	24.50		De-clutch lever	2091807-0011	.50
L1	FM coil, antenna	2056765-0001	.95		Pointer and arm assembly, red	2090129-0085	1.00
L2	FM coil, oscillator	2056766-0001	.95		Spring, pointer backdash	2090130-0017	.15
L3	FM coil, FM	2056767-0001	.95		Spring, core bar link retaining	2056768-0001	.15
L4,L5,L6	Coil assembly, AM	2090131-0097	3.50		Spring, slide bar detent	2056769-0001	.15
	Clutch and bracket assembly, manual	2090133-0070	1.50		Cam and fastening screw	2094036-0501	.25
					Pushbutton	2056519-0001	.50

1967 BENDIX 7FBVW (VOLKSWAGEN SEDAN), 7FBVT (TRANSPORTER), 7FBVG (KARMANN GHIA), AND 7FBV3 (TYPE 3 VEHICLES) PUSHBUTTON FM-AM RADIOS REPLACEMENT PARTS LIST. (Cont.)

MISCELLANEOUS MECHANICAL

Symbol No.	Description	Part No.	Unit List Price	Symbol No.	Description	Part No.	Unit List Price
	Escutcheon	2094551-0501	4.50		Insulator, transistor case (Q10, Q11)	2090882-0008	.20
	Dial glass assy. (includes slide bar)	2094184-0506	3.00		(NOTE: Do not use a substitute)		
	Sub-dial, calibrated	2094833-0002	.65		Shaft assembly, manual drive	2094578-0501	.85
	Printed circuit board assy., Main (includes transistor Q4 thru Q7)	2056817-0503	50.00		Shaft assembly, pinion	2093836-0506	.75
	Printed circuit board assy., FM (includes transistors Q1 thru Q3, Q8, and Q9)	2056817-0505	25.00		Clamp, cable	2091507-0002	.05
	Printed circuit board, small VC	2094598-0006	.10		Clamp, choke	2094588-0001	.15
	Cover, top	2094573-0002	.55		Spring, manual drive shaft retaining	2094568-0001	.35
	Cover, bottom	2094574-0002	.55		Bushing, transistor (Q10 and Q11)	2090026-0002	.03
					Bolt, 1/4-20 x 2/3", radio mounting	2090042-0002	.05
					Nut, 1/4-20, hexagon	2093220-1210	.05
					Nut, 1/8-32 hexagon	2093220-1215	.05

INSTALLATION PARTS

Quantity				Description	Part No.	Unit List Price	Quantity				Description	Part No.	Unit List Price
V*	T*	G*	3*				V*	T*	G*	3*			
1				Antenna assembly	2057289-0703	4.50	2	2	2	2	Knob, tuning or volume	2057270-0501	.75
	1			Antenna assembly	2093003-0701	4.85	2	2	2	2	Disc, tone control	2094480-0001	.50
		1		Antenna assembly	2091408-0002	6.50			1		Baffle, 6" speaker	2091219-0002	.85
			1	Antenna assembly	2057289-0704	4.65	1				Bezel, complete with air seal	[2056761-0001]	2.00
1				Speaker and baffle assembly, 6" PM, 8 ohms	2091246-0506	8.00				1	Bezel, complete with air seal	[2056762-0001]	2.00
	1			Speaker and baffle assembly, 6" PM, 8 ohms	2091247-0508	8.00			1		Bezel	[2094556-0501]	3.00
		1		Speaker ass'y., 6" PM, 8 ohms	2057037-0701	7.35	1				Bezel	[2094555-0502]	2.00
	1			Speaker ass'y., 5" PM, 8 ohms	2094857-0701	6.15			1		Gasket, chip board (6" spk. baffle)	2091212-0001	.15
		1		Speaker ass'y., 4 x 8" PM, 8 ohms	2057038-0701	7.00	1		1	1	Grill cloth	2092240-0001	.40
				Baffle, 6" speaker	2091211-0001	.75	4				Booklet, FM Facts	2094729-0001	N/C
								4			Screw-washer assy., # 8 S.T.	2090814-0002	.04
											Screw-washer assy., # 8 S.T.	2090814-0003	.04

INSTALLATION KITS

Quantity				Description	Part No.	Unit List Price	Quantity				Description	Part No.	Unit List Price
V*	T*	G*	3*				V*	T*	G*	3*			
X				Installation Kit (complete)**	2056955-0019	2.25			1	1	Strap, grounding (6")	2091754-0004	.90
	X			Installation Kit (complete)**	2056955-0020	3.50	1	1	2	1	Nut, 1/4 x 20 hexagon	274247-0002	.03
		X		Installation Kit (complete)**	2056955-0021	3.00	2	2	2	2	Nut, 1/2 x 28 hexagon	2093220-1219	.10
			X	Installation Kit (complete)**	2056955-0022	3.00			4		Nut, lock, for #8A screw	295360-0006	.05
1				Bracket, radio mounting	2094589-0001	.25			4	2	Nut and lockwasher #10-24	295341-0004	.05
	1			Bracket, radio mounting	2094590-0001	.25			2		Screw, #10-12 x 1/2 S.T.	295609-0007	.03
		1		Bracket, radio mounting	2094591-0001	.25			4		Screw, #8-18 x 1/8 hex., S.T.	2092150-0002	.02
			1	Bracket, radio mounting	2094557-0002	.20			1		Screw, #1/4-20 x 1/2 Machine	2093228-0702	.05
1				Capacitor, generator	2094064-0701	.95			2	2	Screw, #10-24 x 1/2 Pan Hd.	2090236-0708	.05
1	1			Plate, radio mounting	2092237-0002	.40			1	1	Screw, #10-12 x 1/2 hex., S.T.	2092485-0714	.05
1	1	1		Fuseholder and lead ass'y.	2094348-0508	.50			2	2	Screw and washer #8 hex. S.T.	2090814-0003	.04
1	1	1		Fuse, 5 amperes (AGA-5)	2091811-0009	.15	1				Installation Instructions	2094105-0008	N/C
1	1	1		Adapter, terminal	2092257-0001	.10			1	1	Installation Instructions	2094105-0009	N/C
1				Insulator tubing (1/4 x 1 1/2")	2091827-0004	.02			1		Installation Instructions	2094105-0010	N/C
			1	Suppression ignition cable, 20" (distributor to high voltage coil)	2093935-0702	.40				1	Installation Instructions	2094105-0011	N/C

1967 VOLKSWAGEN REAR SEAT SPEAKER KIT (SKBV7)

Qty.	Description	Part No.	Unit List Price	Qty.	Description	Part No.	Unit List Price
1	Housing, speaker (black)	2094506-0001	2.50	1	Nut, 1/8-32 hexagon	2093220-1314	.05
1	Speaker ass'y., 5 x 7" PM--8 ohms	2057035-0701	6.95	2	Nut, #8 speed	295360-0005	.05
1	Seal, decorative	2094564-0001	.25	2	Nut, #10 speed	2093421-0703	.05
1	Fader control and bracket ass'y.	2092258-0504	4.25	2	Screw, #10-16 x 1/2 S.T.	2090139-0008	.02
1	Knob assembly, fader control	2057270-0501	.75	2	Screw, #8-15 x 1/2 S.T.	2091584-0001	.05
1	Lead assembly, speaker (216 inch)	2092825-0505	1.15	1	Template, assembly mounting	2094694-0002	N/C
1	Bracket, mounting (spk. housing)	2094541-0001	.50	1	Installation Instructions	2092265-0007	N/C
4	Tubing, (7/32 x .410)	2094598-0004	.05				

V*—Denotes Volkswagen

T*—Denotes Transporter

G*—Denotes Karmann Ghia

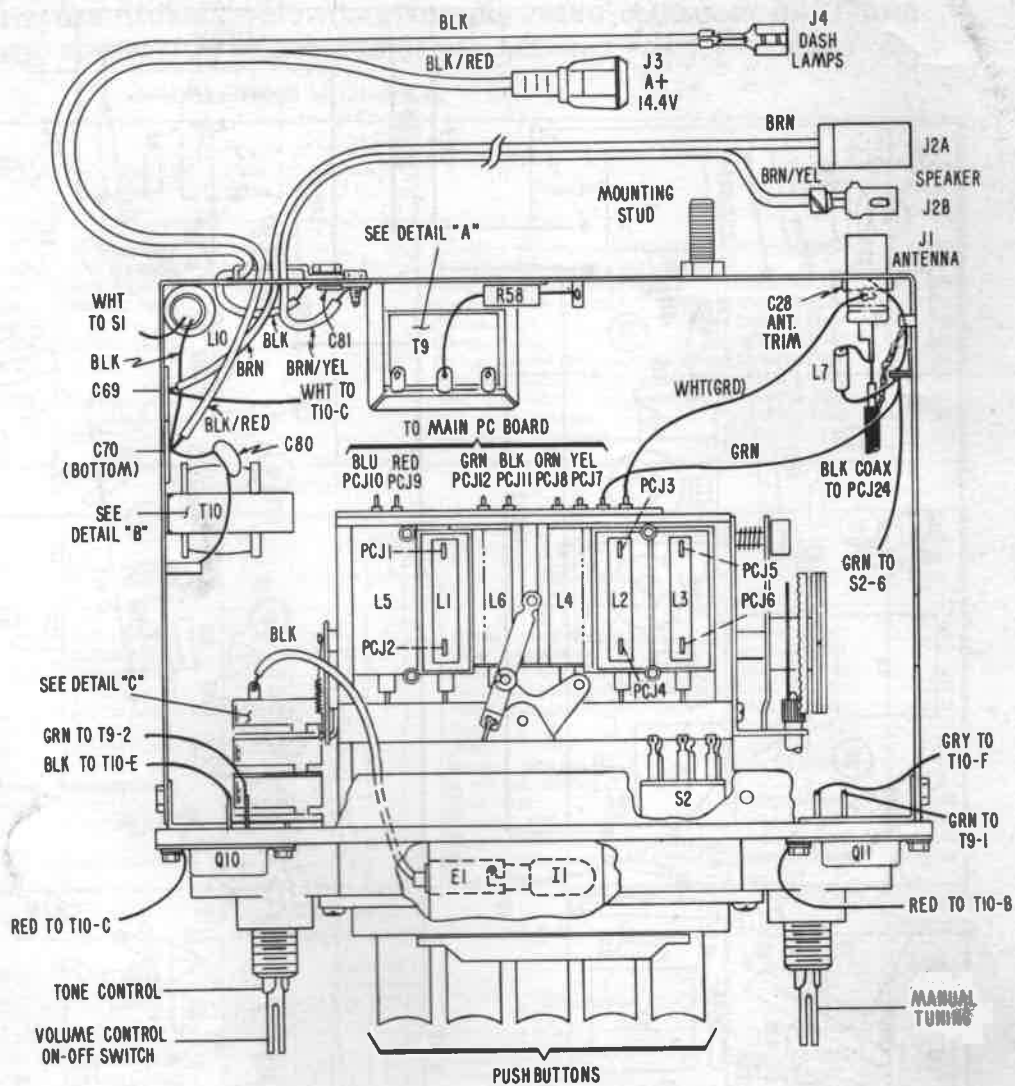
3*—Denotes Type 3 Vehicles

[]—Furnished for replacement purposes only, in limited quantities.

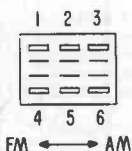
Quantity orders will be honored only on a part for part exchange basis.

**Supplied only during radio model year. Beyond radio model year order individual kit parts.

PRICES SUBJECT TO CHANGE WITHOUT NOTICE



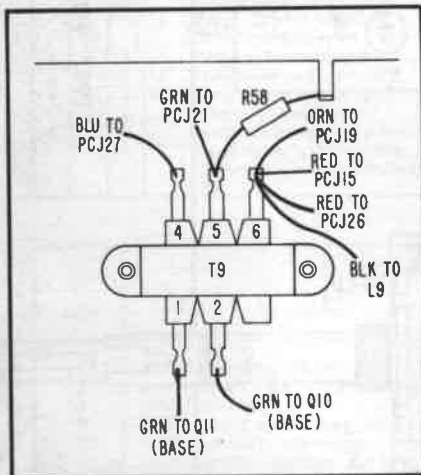
S2 VIEWED FROM CONTACT SIDE. SEE TABLE FOR CONNECTIONS.



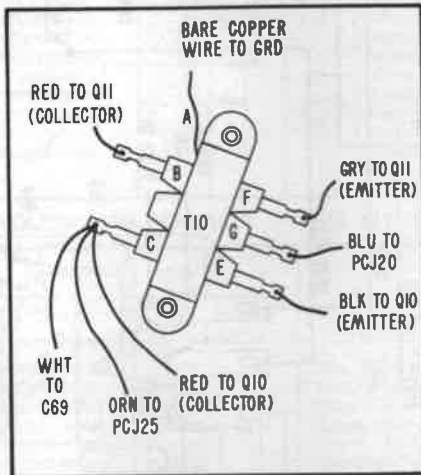
AM-FM SELECTION SWITCH (S2) CONNECTIONS

TERMINAL NO.	COLOR	TERMINATION POINT
1	-	NC
2	WHT	PCJ13
3	RED	PCJ23
4	BLK	PCJ14
5	ORN	PCJ18
6	GRN	L7, C28

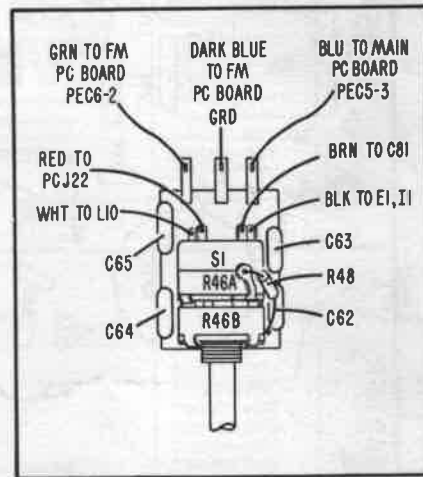
DETAIL "A"



DETAIL "B"



DETAIL "C"



D4015020

1967 VOLKSWAGEN FM-AM RADIO, MODEL 7FBV