

## 22AH784-44 Stereo Receiver

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# Service Manual

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**PHILIPS HIGH FIDELITY LABORATORIES, LTD.**

**SERVICE DEPT.**

**P.O. BOX 2208**

**FORT WAYNE, INDIANA 46801**

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## CHASSIS IDENTIFICATION

The number on the label affixed to the inside of the back panel (e.g., R351-01-AA) identifies the chassis. The first three numbers (351) identifies the basic chassis series. The next two numbers (01) are used to identify the chassis version within the series. The last two letters are used to indicate production change codes, (AA being the original production). A change in the first letter will identify

an important electrical change and a change in the second letter will identify a major mechanical change. Minor changes may not be identified within these letters, however, they will be called out on the schematic as early and late production. These minor changes will not necessarily affect the performance of the chassis.

## SPECIFICATIONS\*

### Amplifier Section

Continuous Power	18 watts/channel
Band	20-20 KHz
Total Harmonic Distortion	0.1%
Load	8 Ohms
IM Distortion, @ Rated Power	0.07%
Distortion, @ 2 watts	
THD	0.05%
IM (SMPTE 4:1)	0.05%
Continuous Power @ 1 KHz @ 0.1% THD	22 watts/channel
Damping Factor	25
Frequency Response	
Phono, ± 0.5dB	RIAA
Aux ± 0.5dB	20-20 KHz
Input Sensitivity	
Phono	2.5mV
Aux. Tape	150mV
Signal-to-Noise	
Phono	70 dB (A weighting)
Aux, Tape	90 dB (A weighting)
Phono Overload (ref. 2.5 mV Input)	150 mV
Impedance	
Phono Input	50K ohms
Aux, Tape Inputs	100K ohms
Tape Record Outputs	1K ohms
Control Range	
Bass @ 50 Hz	±12dB
Treble @ 10 KHz	±12dB
Loudness Action @ -30dB	
@ 50 Hz	+10dB
@ 10 KHz	+4dB
Separation, Aux, 1 KHz	45dB

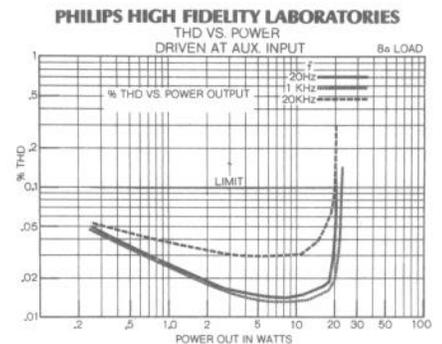
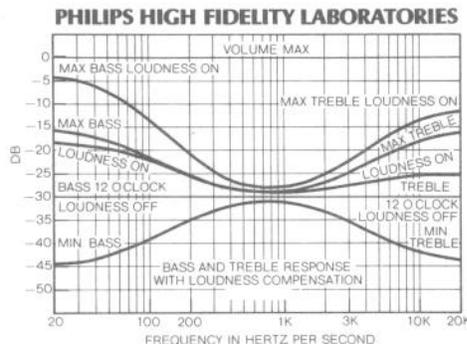
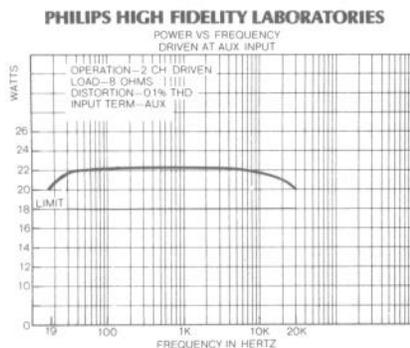
### FM Section

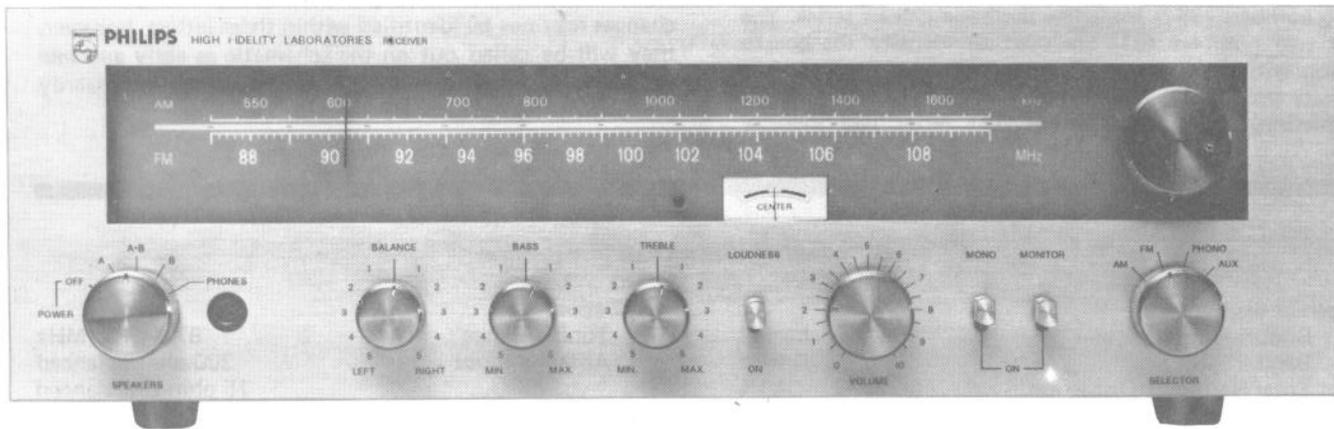
Tuning Range	87.5 - 108 MHz
Antenna Input	300 ohm Balanced 75 ohm Unbalanced
Usable Sensitivity	
Mono	2.2uV
Stereo	5.5uV
50dB Quieting Sensitivity	
Mono	3.5uV
Stereo	42uV
Total Harmonic Distortion @ 1 KHz	
Mono	0.15%
Stereo	0.3%
Signal to Noise Ratio @ 65dBf	
Mono	65dB
Stereo	60dB
Capture Ratio	1.7dB
Selectivity	
(Single Generator)	82 dB
(Dual Generator)	62 dB
Stereo Separation @ 1 KHz	45 dB
IF Rejection	90dB
Image Rejection	70dB
Spurious Rejection	75dB
AM Rejection	40dB
Muting Threshold	3uV

### AM Section

Tuning Range	540-1605 KHz
Usable Sensitivity	350 uV/m
Selectivity	20dB
Signal-to-Noise Ratio (100% Mod.)	45 dB
Image Rejection	50 dB
IF Rejection	45 dB

\*Subject to Modification





### FRONT PANEL FUNCTIONS

**Power/Speakers Switch** - Rotating the Power/Speaker switch clockwise applies AC power to the receiver while also activating the desired Speaker System. The Power/Speaker switch permits the selection of speaker system A only, speaker system B only, or both A and B systems simultaneously (if both systems are connected to the unit). Rotating the Power/Speaker switch to the Phones position activates the stereo Headphone jack for use. Rotating the switch counterclockwise to Off, turns the unit Off.

**NOTE:** Do not activate any of the Speaker Systems with the Volume control rotated to a high level setting.

**NOTE:** If only one set of speakers is connected no sound will be heard in the A + B mode.

**Balance Control** - Rotating the Balance control will accentuate the volume of one channel by decreasing the volume in the other channel. The Balance control is used to compensate for volume differences between channels, either in presentation, or caused by acoustical situations.

**Bass Control** - Rotating this control in a clockwise direction will increase the bass response; counterclockwise will decrease the Bass response. The lower the frequency, the more the effect. Placing the control at the "12 o'clock" setting provides a flat response for the low frequencies.

**Treble Control** - Rotating this control in a clockwise direction will increase the treble response; counterclockwise will decrease the treble response. The higher the frequency, the more the effect. Placing the control at the "12 o'clock" setting provides a flat response for the high frequencies.

**Loudness Switch** - The Loudness switch is used to boost the low and high frequencies at low volume settings. This is necessary to compensate for the human ear's tendency to hear mid-range frequencies as being louder than low and high frequency sounds at low volume levels.

**Volume Control** - The volume control varies the volume of both channels equally and simultaneously.

**Mono Switch** - Placing the Mono switch in the ON position combines the two stereo channels into one and provides monaural output to the speakers. The Mono switch may

also be employed during excessively noisy stereo FM broadcasts. The program will no longer be reproduced in stereo but the noise level will be reduced. In the Mono ON position, the mute mechanism, which eliminates the hissing noise between stations is disabled.

**Monitor Switch** - Placing the Monitor switch in the ON position applies the signal present at the tape play jacks to the amplifier sections of the receiver. Therefore, the Monitor switch must be in the ON position while playing back a tape or while monitoring a recording in progress with a 3-Head tape deck. The Monitor switch may be in either the ON or the OFF position during recording.

**Selector Switch** - The Selector switch is used to select the function as follows:

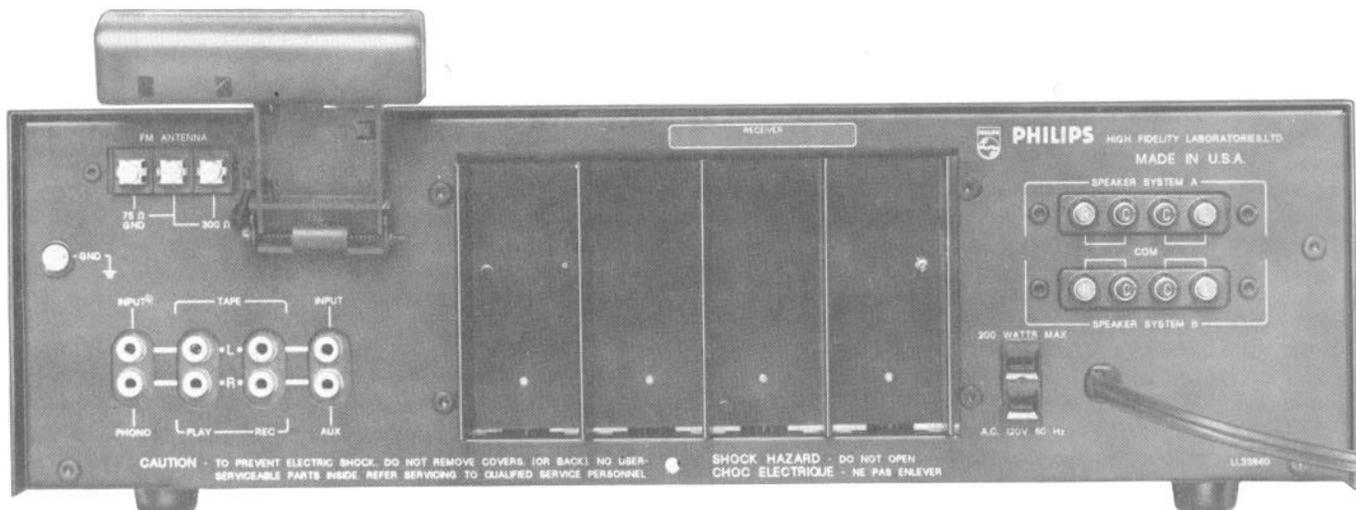
- AM - for reception of AM radio broadcasts.
- FM - for reception of FM radio broadcasts.
- PHONO - Permits the receiver to amplify signals applied to the Phono jacks from a magnetic phono cartridge.
- AUX - Allows the receiver to amplify signals applied to the Aux jacks from a tape unit or other suitable source.

**Tuning Knob** - The Tuning Knob is used to tune in the desired AM or FM station.

**Tuning Meter** - The Tuning Meter is used for accurately tuning to an AM or FM radio station. Optimum FM reception is at center deflection, while optimum AM reception is at maximum deflection.

**Stereo Indicator** - The FM Stereo light will illuminate if the Selector switch is in the FM position, and an FM stereo broadcast is being received. The Mono switch must be in the OFF position for the Indicator to light.

**Headphones** - The Phones jack makes it possible to connect a pair of stereo headphones via a standard ¼ inch stereo plug for private listening. Be certain that the Volume control is at a low setting when the plug is inserted and that the Power/Speakers switch is in the Phones position. In the Phones position, the speakers are disconnected.



### REAR PANEL FUNCTIONS

**Phono Inputs** - The left and right channel signals from a record changer or turntable with a magnetic cartridge may be connected to the Phono inputs. If the record player has a separate ground wire, it should be connected to the ground terminal on the rear panel.

**Aux Jacks** - The Aux inputs can be used to connect the left and right channel signals from the higher level pre-amp or line outputs of an additional source (such as a stereo tape deck or other component capable of providing 150 mv at approximately 100K ohms) to the input circuits of the amplifier section.

**AM Antenna** - The AM antenna is used to receive AM broadcasts when the Selector switch is in the AM position. The 3-dimensional mounting allows you to position the antenna to eliminate interference and increase signal strength.

**FM Antenna Terminals** - A folded dipole FM antenna has been provided with this receiver. Connect this antenna to the 300 ohm terminals. Terminals have been provided for the connection of an alternate antenna with 75 ohm coaxial type lead-in.

**Tape Record Outputs** - These jacks are used to supply left and right channel signals from the receiver to the line in or high level inputs of a tape recorder. The signal present at the Tape Record outputs is unaffected by the Volume, Bass, Treble and Balance controls.

**Tape Play Inputs** - The Tape Play Inputs can be used to connect the left and right channel signals from the higher level preamp (or line outputs) of a tape player or recorder to the amplifier sections of the receiver. The inputs can also be used for reverberation units, tape equalizers, or for monitoring with a 3-Head tape deck (see TAPE MONITOR SWITCH).

**Speaker System A** - These terminals are used to supply left and right output signals to a pair of 8 ohm speakers. The A speakers are considered the primary speakers.

**Speaker System B** - These terminals are used to supply left and right output signals to an additional pair of 8 ohm speakers. The optional B Speakers may be used as extension speakers remotely located.

**NOTE:** To avoid possible damage to the receiver, the bare wire or connector inserted into a black or red terminal must not make a contact to a bare wire or connector inserted into a black terminal or to any adjacent metal chassis surface.

**Unswitched AC Receptacle** - The UNSWITCHED AC RECEPTACLE is a source of 120 VAC which may be used to power another component such as a turntable or tape deck that does not exceed the wattage rating stamped above the receptacle. This receptacle has power at any time the AC line cord of this tuner is connected to an AC source.

### OUTPUT TRANSISTOR REPLACEMENT

Since transformerless quasi-complementary output circuitry is utilized in this chassis, extreme care should be exercised when servicing or replacing the transistors. It is imperative that the transistors be isolated from the heat sink by means of a mica insulator coated on both sides with Dow-Corning DC4 silicon grease, or equivalent.

When replacing an output transistor, make certain the replacement transistor has the same beta range (i.e. yellow or blue) as the defective transistor. The beta range of the transistor is indicated by a yellow or blue dot next to a

red dot (on the body of the transistor). The red dot indicates that the transistor is an NPN. Failure to replace a defective output transistor with one having the same beta characteristics could be detrimental to the performance of the receiver.

After servicing or replacing an output transistor, the Idle Current Adjustment must be performed in the affected channel. Misadjustment of the output transistors' idle current can cause crossover distortion or possible premature failure of the output transistors.

## CIRCUIT DESCRIPTION

### Power Supply and Audio Delay Circuitry

The power supply circuitry develops the DC voltages necessary for the operation of the receiver as well as the AC voltage needed to light the five dial lamps. There are six sources available from the power supply circuitry; +28V, -28V, +16V, -16V, +12V and 6 VAC.

The following is a description of how these source voltages are obtained. When the receiver is plugged in and the Power/Speaker switch (S501-E) is closed, 120 VAC is applied to the primary of power transformer T601. The stepped down AC voltage at the secondary of T601 is used to develop the sources. The main secondary winding, with its center-tap grounded, is connected to a full-wave bridge rectifier. The positive output of this rectifier is filtered by C605 and becomes the +28V source, while the negative output is filtered by C604 and becomes the -28V source. Both of these filtered outputs are also used to develop the regulated +16V and -16V sources. The +16V source is derived from the +28V source via dropping resistor R605 and series regulator Q601. The -16V source is derived from the -28V source via dropping resistor R607 and series regulator Q602. The +28V output of the bridge rectifier is also used to develop the +12V supply. This is accomplished by dropping the +28V source through two cascaded low pass RC filter networks comprised of R604, C606, R611 and C607 to Z601 which regulates the voltage at +12V.

The +28V and -28V sources supply power to the audio amplifier sections of the receiver, with the +28V source also applied through R603 to forward bias the Stereo Indicator diode (D301) when the unit is tuned to a FM Stereo station. The +16V and -16V sources are developed to supply power to the Dual Operational Amplifiers (IC401, 402 and 403), as well as Aux. input amplifiers - Q401 and Q402.

The +12V source supplies unswitched power to the FM IF section, the Stereo Demodulator IC (IC301), the delay circuitry containing Q603 and Q604, and the FM audio amplifiers Q301 and Q302. This same source is also connected through Selector switch S401 to provide a switched source to either the AM section or the remaining FM areas. With S401 in the AM position, +12V is applied to the AM section of the receiver, the base of meter bias transistor Q205 (via R218), and through R306 and D302 to pin 14 of IC301. In the FM position, +12V is applied to the FM RF and Mixer-Oscillator sections as well as being applied through R142 to the base of switching transistor Q106. With S401 in the PHONO or the AUX. position, the +12V source is applied through R312 and D302 to pin 14 of IC301. In this position, +12V is also applied through R312 and R306 to the AM portion of the receiver, however, no AM audio will reach the amplifier section due to the switching action of Selector switch S401. The +12V source is also applied through R312 and R306 to the base of meter bias transistor Q205 (via R218) when S401 is in the PHONO or AUX position. Another function of the +12V source is that it also provides an unswitched source to supply the audio output delay circuitry which contains P-channel FETS, Q603 and Q604.

The delay circuitry (which also contains switching transistors Q605 and Q606) is connected to the outputs of the

left and right channel Pre Amp section. The purpose of the circuit is to delay, for a brief period, any signal from reaching the speakers when the unit is first turned on. This is necessary due to the transient voltages that are present in the circuits immediately after power is applied. If the audio signal were allowed to pass immediately through to the amplifier section and then the speakers, the transient voltages may be amplified and cause objectionable noise from the speakers or damage them.

The following is a description of how the delay circuitry performs its function. When power is first applied (S501-E closed), to the unit, +12V is dropped through R613 to the base of switching transistor Q605, turning the transistor on. With Q605 on, its collector will drop to near ground. The collector of Q605 is connected to the gates of P-channel FETS Q603 and Q604 so a drop to near ground on the collector of Q605 will cause a no bias state to exist from gate to source of both Q603 and Q604. P-channel FETS in a no bias state will act as low resistance values. Therefore, when the unit is first turned on, Q603 and Q604 exhibit low resistance and pass any audio signal from the left or right channel to ground. Since supply voltage is now applied to the delay circuitry, capacitor C614 begins to charge through R616 at a rate determined by the RC time constant. When C614 reaches a positive potential that becomes sufficient to forward bias switching transistor Q606, then the voltage on the collector of Q606 will drop to near ground. The collector of Q606 is connected directly to the base of NPN transistor Q605 so the drop in collector voltage on Q606 will remove bias from Q605 and turn the transistor off. With Q605 off, the supply voltage of +12V will be applied through R612 to the gates of the P-channel FETS Q603 and Q604. This positive voltage on the gates of Q603 and Q604 will now cause the FETS to become very high in resistance (similar to an open switch). The audio signal from the pre amp circuits is no longer passed through the FETS to ground but now passes directly through the audio amplifier stage to the speakers. Diode D605 is placed in the delay circuit to shorten the discharge time of C614.

### AM and FM Circuitry Description

#### AM Section

With the Function/Selector switch in the AM position, supply voltage from the +12V switched source is applied to the AM section of the receiver (for a discussion of the +12V switched and unswitched source, see the Power Supply and Audio Delay Circuit Description). With +12V applied, the AM RF amplifier, Q201, becomes forward biased. When an AM station is selected, the input signal from the AM antenna, T201, is coupled through C202 to the base of Q201. The gain of Q201 is controlled by an AM RF AGC voltage applied to its base from the anode of detector diode D202. Detector diode, D202, rectifies the signal from AM IF transformer, T204, and develops a negative voltage which is proportional to signal strength. This negative voltage is applied through the filter components, R213, C211 and R212 to C210 where it is also filtered and subtracts from the positive potential present at C210. This lower positive potential is applied through R201 to the base of Q201 and is used for RF AGC. As the signal strength increases, the positive potential on the

base of Q201 will decrease causing a reduction in gain. Under a no signal condition, the voltage at the anode of D202 will become the slightly positive voltage drop of the diode itself. This voltage will no longer subtract from the positive potential present at C210 and the voltage on the base of Q201 will become more positive allowing the RF amplifier to operate at maximum amplification. When the bias voltage on the base of Q201 is varied, it will cause the emitter voltage to vary also (emitter voltage follows base voltage). The voltage change on the emitter will be felt through the filter network consisting of R209, C208 and T203B to the base of AM IF amplifier, Q203 affecting it's gain. Therefore, the AGC voltage affecting the gain of Q201, also affects the gain of Q203 providing for less distortion.

The amplified signal at the collector of Q201 is applied through C204 to the base of Q202, the AM converter. The AM converter combines the RF signal from the AM antenna with the AM oscillator signal of T202 to produce the 455 KHz IF signal. The frequency of the AM oscillator is varied by the variable tuning capacitor C201, to operate 455 KHz above the incoming RF signal frequency. The output of the AM oscillator is coupled from the center-tap of T202 through C207 to the emitter of AM Converter, Q202, where it is mixed with the incoming RF signal. The output present at the collector of Q202 consists of the sum and difference frequencies as well as both of the original input signals. The difference frequency (455 KHz) is passed through the tuned IF transformer, T203A,B. From the center-tap of T203B, the 455 KHz IF signal is direct coupled to the base of Q203, an AM IF amplifier. The gain of this stage is controlled by the AGC circuitry as mentioned earlier. From the collector of Q203, the amplified 455 KHz signal is applied directly to the AM detector circuitry consisting of IF transformer T204 and detector diodes D201 and D202. The detected audio signal from D202 is coupled through R215 and C215 to the Function/Selector switch, S401. The signal from the anode of D202 is also used for RF AGC as mentioned earlier. The detected audio signal from D201 is filtered by R214 and C213 resulting in a negative DC potential proportional to the signal strength. This potential is applied to the negative side of the tuning meter through S401 when the Function/Selector switch is in the AM position. The positive side of the tuning meter is effectively placed at ground by Q205 which is driven into saturation by the +12 volts applied to it's base through R218. The potential connected across the tuning meter causes the needle to deflect to the right by a distance directly proportional to the signal strength.

### FM Section

With the Selector switch in the FM position, supply voltage from the +12 volt switched source is applied to the FM RF amplifier, the FM oscillator, and the FM Mixer (for a discussion of the +12V switched and unswitched sources, see the Power Supply and Audio Delay Circuit Description).

When an FM station is selected, the input signal from the FM antenna is coupled to the base of RF amplifier, Q102. This stage is tuned to the frequency of the incoming RF signal by the tuned circuits in the base and collector of Q102. Bias is supplied to the base of Q102 through a voltage divider network formed by R145, R101, R135 and the circuitry at pin 15 within IC101. The gain of

Q102 is controlled by the RF AGC voltage applied to it's base. Under a no signal condition, the AGC circuitry within IC101 establishes a positive voltage of approximately 5.9 volts at pin 15. Due to the divider action of R135, R101, and R145, the base of Q102 is set to provide maximum gain. When a strong signal is received, the AGC circuitry within IC101 establishes a less positive voltage at pin 15 of the IC. Due to the divider action under these conditions, the base bias of Q102 is reduced, which in turn reduces the gain of the stage. The amplified signal present at the collector of Q102 is coupled through C137 to G1 of the FM Mixer, Q103. Q103 is an N-channel, Dual-Gate, MOS Field Effect transistor with gate to source diode protection. A MOSFET combines a high input impedance and a very high signal-to-noise ratio with relatively high power gain. The output of Q101 (the FM oscillator) is coupled through C111 to G2 of Mixer Q103. The FM oscillator runs 10.7 MHz above the incoming RF frequency. The Mixer circuit combines this oscillator signal with the selected RF signal to produce a 10.7 MHz IF signal. The 10.7 MHz IF signal present at the drain of Q103 is coupled through an FM IF transformer, T101 and is amplified by the FM IF amplifier, Q104. The output of Q104 is coupled from it's collector to CF101, the first of two ceramic IF filters. (Note: These filters are only available in pairs and must be replaced as a set). From CF101, the signal is coupled through R119 and C121 to the base of Q105 which functions as a second IF amplifier. The IF signal present at the Q105 collector is then passed through the second ceramic IF filter, CF102 via R125 to the IF inputs of IC101. The use of ceramic filters in place of a tuned inductance increases the selectivity of the IF section.

Further IF amplification and FM detection are the primary functions of IC101. However, pins on IC101 also provide outputs for the FM center-tune meter and mute control. The audio output of IC101 is applied to the Stereo Demodulator, IC301.

The following is a brief pin by pin summary of IC101. Pins 1, 2 and 3 are the IF inputs. The 10.7 MHz IF signal is coupled from CF102 directly to pin 1, through R126 to pin 3 and from there through C125 to pin 2. Pin 4 is ground. Pin 5 is the mute control output and is directly connected to the Mono switch, S403. When S403 is placed in the "On" position and the Function/Selector switch (S401) is in the FM position, the output voltage at pin 5 of IC101 is grounded through the Mute switch transistor, Q106. This action disables the mute circuitry within IC101 allowing low level monaural as well as stereo signals to be amplified. At pin 6 is the audio output of IC101. From pin 6, the composite audio signal from IC101 is coupled through compensating coil L109 and C136 to pin 2 of the Stereo Demodulator, IC301. Pins 7 and 10 are connected across the tuning meter to allow for FM center tuning. Pin 10 is a reference voltage established by the circuits within IC101. When the positive DC voltage at pin 7 equals the DC voltage at pin 10, the meter needle will not be deflected. As the receiver is tuned off station, the voltage at pin 7 will vary more positive or less positive depending upon the direction that the receiver dial is tuned. When the DC voltage between pin 7 and pin 10 varies, the meter will deflect off-center. Pin 8 is the IF output of IC101. The IF signal from pin 8 is shifted 90 degrees by L107 and the quadrature coils T102 and T103 to develop the input for pin 9 of IC101. Quadrature detection is performed by circuitry in IC101 and pin 9 is the input to the detection circuits. Pin 11 is the B+ input for IC101. Pin 12 is the mute logic

output which sets the mute level for an incoming signal. Since pin 13 is not used, it is connected through C132 to ground. Pin 14 is connected to ground. Pin 15 is the RF AGC output as mentioned earlier.

The Stereo Demodulator IC performs several functions. The output signals are determined by the presence or absence of voltages at various pins on the chip.

The following is a brief pin by pin summary of the Stereo Demodulator, IC301. Pin 1 is used for connection of the B+ voltage. Pin 2 is the input terminal. The composite audio signal from pin 6 of IC101 is coupled to pin 2 through the filter network of C135, L109 and C151. Capacitor C136 keeps any DC potential on this line from affecting pin 2, but has no effect on the input signal. Pins 3 and 11 are used for phase compensation. Capacitor C301 between pins 3 and 11 causes a phase shift in the regenerated 38 KHz subcarrier so that it is reproduced in phase with the suppressed carrier. Pin 6 is connected to the cathode of the stereo indicator LED, D301. The anode of D301 is connected to a positive voltage developed by the voltage divider network of R602 and R603. The internal circuitry of the IC which connects to pin 6, functions as an electronic switch. During non-stereo operation, this internal switch acts as an open circuit and the stereo indicator does not light. However, when a stereo signal is present, the internal circuitry connected to pin 6 acts like a closed switch, connecting pin 6 to ground and forward biasing D301. In this condition, the stereo indicator will light, indicating that a stereo signal is being received. Pin 7 is ground. Pins 8 and 9 are used for external monaural/stereo switching with C308 as the switch filter capacitor. When the Mono switch (S403) is in the "On" position, a ground is applied to pin 8 of IC301. With this ground potential on pin 8, all input signals will be reproduced monaurally at pins 4 and 5.

At pin 10 of IC301 is the 19 KHz output signal. A frequency counter may be connected to this point to measure the oscillator free-running frequency for alignment. Pins 12 and 13 contain the phase-locked loop filter components (R303, C310 and C311). At pin 14 is the oscillator timing network which consists of C312, R307 and the 19 KHz oscillator adjust, R308. When the Mono Switch, S403 is in the "On" position, pin 14 is grounded, disabling the 19 KHz oscillator.

Audio is available from the Stereo Demodulator (IC301), at pins 4 and 5. For monaural operation, the same information is present at both outputs. But during stereo operation, right channel information is present at pin 5 and left channel information is present at pin 4. From pins 4 and 5 of IC301, the audio is passed through identical but separate audio channels. Because the channels are identical, only the right channel circuits will be discussed.

From pin 5, the right channel output signal is coupled through the 19 KHz and 38 KHz filter network consisting of L302 and C314. From L302, the signal is coupled via C305 to the base of FM preamplifier, Q302. FM preamplifier Q302 and its associated circuitry, boost the FM audio signal to insure full power output in the FM mode. The output signal from the collector of Q302 is coupled through C322 to the Function/Selector switch, S401.

#### Auxiliary/Phono Input Circuitry

The Auxiliary and Phono input circuitry is designed with a

high input impedance and a low output impedance. This prevents loading of the source and also helps eliminate hum and noise.

Since the input circuitry for the left and right Aux. input jacks is identical, only the right channel will be discussed. The input impedance (approximately 100K ohms) of the emitter follower, Q401, is determined by R401 and R405. An emitter follower exhibits the high input and low output impedance that is desired for impedance matching. The Aux. input signal applied to the right input jack is coupled through C401 and R409 to the base of Q401. The output of the emitter follower is applied to Function/Selector switch, S401, through C413.

The input circuits for the left and right channel Phono jacks are also identical, therefore, the right channel will be discussed. The input signal from the right Phono jack is coupled through C403 and R411 to pin 5 of IC401A. Phono preamplifier, IC401 (a Dual Operational Amplifier), provides a high input impedance and a low output impedance as did the emitter follower mentioned above. Since the input impedance of the IC alone is in the megohm range, R403 and R407 are incorporated to bring the input impedance down to approximately 50K ohms, which is an acceptable input impedance for magnetic cartridges. The operational amplifier, IC401, is used in the Phono input circuitry because the signal level at the Phono jacks is extremely low. Operational amplifier IC401A employs RIAA compensation which is formed by the feedback network consisting of R417, R419, C407, C409, C405 and R415. The amplified signal is coupled from pin 7 of IC401 through C411 to the Function/Selector switch (S401).

From the Function/Selector switch, the right channel audio signal is passed to the right Tape Record jack and the Tape Monitor switch, S402. With the Tape Monitor switch in the "Off" condition, the right channel signal is passed directly through the Monitor switch and R425 to the top of the Volume control, R450A. The Tape Monitor switch allows the operator to monitor the audio signal while recording it with an externally connected three-head tape recorder. By connecting the inputs of the tape recorder to the Tape Record jacks of the receiver and connecting the output of the recorder to the Tape Play jacks, the receiver is set to monitor the recording of the audio signal. Placing the Monitor switch (S402) in the "On" position causes the audio signal to be directed through the Tape Record jacks into the recorder. Also, due to the action of Switch S402, the Volume controls and output stages are no longer connected to the audio signals present at the Tape Record jacks, but are now connected to the Tape Play jacks. From the recorder, the signal is passed through the Tape Play jacks to the audio circuitry within the receiver and from there to the speakers. This action allows the operator to monitor the audio signal an instant after it is recorded (due to the spacing of the record and play heads). The monitor switch may be in either the "On" or the "Off" position during recording and it will not affect the recorded signal, however, the switch must be in the "On" position while playing back a tape. The right channel signal is passed from the Monitor switch through R425 to the top of the Volume control (R450A) and the Mono switch (S403). When the Mono switch is placed in the "On" position, the right channel signal is combined with the left channel signal through the switching action of S403. The right channel audio signal is also applied to the filter network of R427 and C417. This network is connected to the Loudness switch S404.

The Loudness switch and its associated circuitry provides a method to boost the low and high frequencies at low volume settings. This is necessary because at low volume levels, the human ear has a tendency to hear midrange signals as being louder than high and low frequency signals. With the Loudness switch in the "Off" position, the filter network of R427 and C417 is disconnected from the circuit and the right channel audio signal is passed on to the top of the Volume control, R450A. A tap on the Volume control, R450A, is connected to another filter network consisting of C415 and R429. When the Loudness switch is in the "Off" position, C415 is shunted by a switch contact. This action places R429 in parallel with the resistance of R450A (below the center tap), effectively lowering the resistance of this portion of the Volume control. Volume control R450A, being purely resistive, now attenuates the low, midrange and high frequencies equally at any setting of the Volume control. When the Loudness switch is placed in the "On" position, C415 is no longer shunted, but is placed in series with R429. The other filter network consisting of R427 and C417 is placed in parallel with the top half of the Volume control. The Volume control/Loudness circuit is now resistive and capacitive. Because of the component values used, the Volume control above the center-tap is relatively unaffected, while the portion of the volume control below the center-tap now contains boosted high and low frequencies.

#### Tone Control and Audio Output Circuitry

The Tone control circuitry is used to vary the frequency content of the signal being amplified. The Bass and Treble controls change the level of the low and high frequencies that are present in the signal applied to dual operational amplifier, IC403. With the Bass and Treble controls set at the flat (center) position, the signal at each input of IC403 will consist of low, midrange and high frequencies at approximately the same relative level. Varying the Bass control can raise or lower the level of the low frequencies in the signal present at its wiper. This is done by attenuating the low frequencies more or less than the midrange frequencies. The Treble control works basically the same as the Bass control except that it varies the level of the high frequencies in the signal. The Op Amp, IC403, provides the gain necessary to offset any attenuation caused by the Bass and Treble controls.

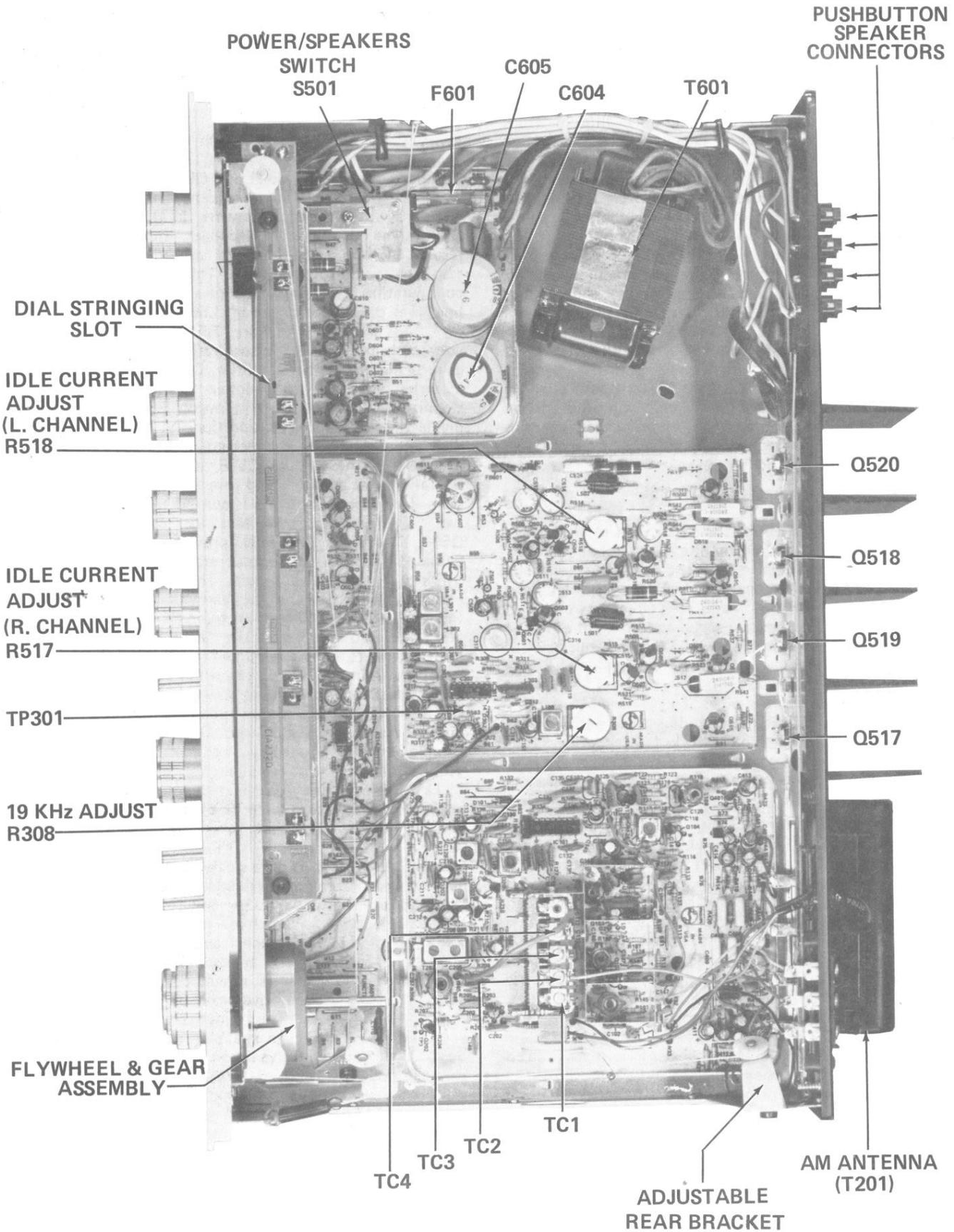
Since the left and right channels of the Tone circuitry are identical, only the right will be discussed. From the wiper arm of the Volume control, R450A, the signal is coupled through C419 to pin 3 of operational amplifier, IC402A. From pin 1 of IC402A, the amplified signal is coupled through C423 to the Tone control circuitry. A portion of the signal at pin 1 is fed back to pin 2 via R435, R433 and C421. This feedback network determines the gain and frequency characteristics of Op Amp, IC402A. From C423, the signal is applied to Treble control R451A and through R437 to the Bass control, R452A. From the junction of R439 and R441, the signal is then coupled directly to pin 6 of operational amplifier, IC403A. The frequency content of the signal at the junction of R439 and R441 is determined by the settings of the Bass and Treble controls. This is accomplished by changing the RC networks contained in the Bass and Treble circuits as the wipers are moved from one end of the controls to the

other. The tone compensated signal applied to pin 6 of Op Amp IC403A, is amplified, inverted and then coupled from pin 7 through C501 and R501 to the Balance control (R453) and the audio output stage. The Balance control determines the amount of audio signal that will be present in the output stage of each channel. By varying the Balance control to the right or left of center, the operator can decrease the volume of one channel without affecting the volume of the other channel.

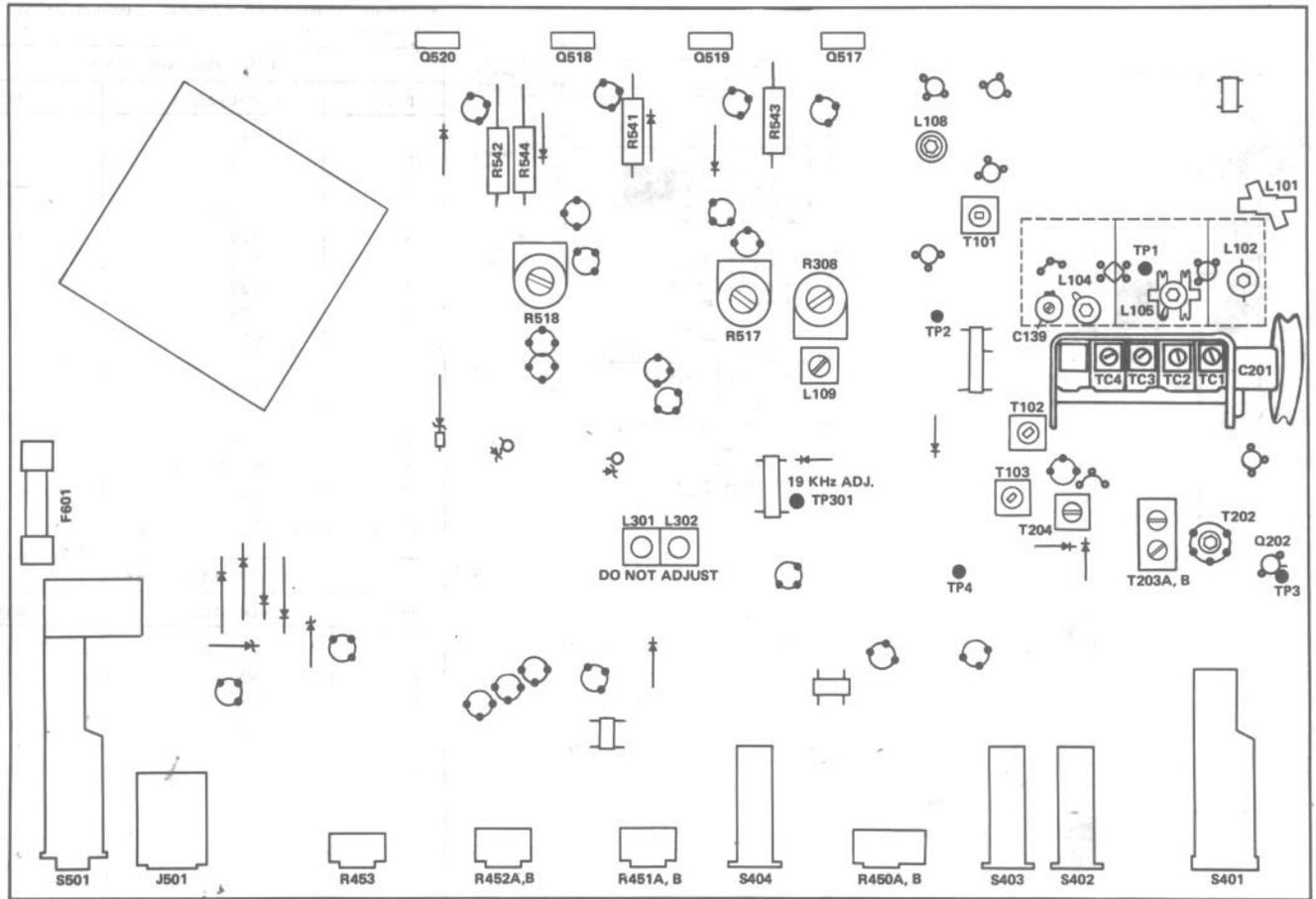
From Pin 7 of IC403A, the right channel audio signal is coupled through C501, R501, R531 and C505 to the base of Q501. Transistors, Q501 and Q503, form a differential amplifier whose gain and frequency response are determined by the feedback network in the base circuit of Q503. The degenerative feedback from this network results in less distortion and an improved frequency response in the output stage. This differential amplifier configuration also allows for a near zero volt DC feedback line from the speakers, through L501 and R513 to the base of Q503. Dropping resistors, R513 and R511, form a voltage divider network whose ratio determines the audio gain of the differential amplifier. Capacitor C511 is placed in series with R511 to maintain 100% DC feedback and stabilize the output while allowing R513 and R511 to divide the AC feedback proportionally. The output of the differential amplifier is direct coupled from the collector of Q501 to the base of Q505, a common emitter configuration that amplifies and inverts the signal. The output from the collector of Q505 is applied to the base of Q513 (via R549) and the VBE Multiplier circuitry containing Q507. The VBE Multiplier provides temperature compensated bias to the output stage to prevent thermal overload of the output circuits. The VBE multiplier acts as a low resistance to AC signals and will pass the signal from the Q505 collector directly to the base of Q515. The VBE multiplier also establishes the DC bias required by the output circuits, so the AC signal on the base of Q515 will be offset from the AC signal on the base of Q513 by the DC voltage from collector to emitter of Q507. Transistors, Q513 and Q515, are arranged in conjunction with the audio output transistors (Q517 and Q519) to form a quasi-complementary Symmetry configuration. The audio output is taken from the junction of emitter resistors, R541 and R543. The signal is then coupled through L501 to the Power/Speaker switch (S501) and through L501 and R547 to the Headphone jack.

Diodes, D509 and D511 are safety devices that protect the output stage from any inductive kick that may result from an open in the speaker circuitry. Capacitor C517 (called a bootstrap capacitor) is employed to prevent distortion of the right channel audio output signal during high level negative peaks. It essentially tracks the audio output line and becomes a temporary negative source during the high level negative peaks by adding its negative charge to the peaks. This temporary source voltage is applied through R521 to the base of Q515. The charge on C517 provides enough bias on Q515 to allow sufficient base current to flow at all times. Therefore, Q515 never shuts completely off on the high negative peaks of the audio signal. Zener diode, Z501 is used as a filter to eliminate the normal charge time associated with capacitors which could cause objectionable noise or popping in the output circuits.

CHASSIS TOP VIEW



## ALIGNMENT REFERENCE GUIDE (TOP VIEW)



## ALIGNMENT AND ADJUSTMENTS

**CAUTION: BEFORE ATTEMPTING TO ALIGN THIS RADIO CHASSIS, READ THE PROCEDURE TO ASSURE THAT ALL TEST EQUIPMENT IS AVAILABLE.**

Test Equipment Required:

- AC VTVM, DC VTVM
- Frequency Counter
- AM Sweep Generator
- 19 KHz/38 KHz Filter
- Oscilloscope (with Detector Probe)
- Distortion Analyzer
- 50 ohm-300 ohm Matching Transformer with 1:1 voltage ratio.
- Sound Technology - Model 1000A (or equivalent) FM Alignment Generator

**Note:** The RF shields should not be removed during alignment.

**Note:** When tuning the receiver to a specific frequency, set the dial pointer at the center of the desired number. For example, when tuning to 106 MHz, set the dial pointer at the center of the "0".

### FM IF ALIGNMENT

1. Place the Function/Selector Switch in the FM position and tune the receiver to an unused frequency near 98 MHz.
2. Connect a 10.7 MHz sweep input at 60 mv to TP1 and preset L108 to maximum inductance. (**Note:** To preset L108 to maximum inductance, screw it's core into the winding so that the top of the core is even with the top of the winding.)
3. Connect an oscilloscope with detector probe to TP2.
4. Tune T101 for maximum output and symmetry.

### FM DETECTOR ALIGNMENT

1. Tune the radio to an unused frequency near 98 MHz.
2. Set the slug of T103 flush with the top of it's can.
3. Adjust T102 to center the tuning meter.

### FM DISTORTION ALIGNMENT

1. Connect an FM signal generator with a 98 MHz mono signal at 1000 uV, modulated with 1 KHz at  $\pm 75$  KHz deviation, through a 50 to 300 ohm matching transformer to the 300 ohm FM antenna terminals.
2. Tune the receiver to 98 MHz and place the Mono switch in the "On" position. Make sure that the center tune meter is indicating center.
3. Connect a distortion analyzer to the A speaker system right channel terminals.
4. Tune T103 for minimum mono distortion in the right channel.
5. Modulate the FM generator with a right stereo signal and connect a 19 KHz/38 KHz filter in series with the distortion analyzer. Place the Mono switch in the "Off" position.
6. Tune L108 counterclockwise for minimum stereo distortion.
7. Monitor the Speaker System A left channel output with an AC VTVM while modulating the right stereo signal.
8. Tune L109 for minimum output in the left channel.

### FM RF ALIGNMENT

1. Connect an FM signal generator of 106 MHz with 1 KHz modulation, 75 KHz deviation through a 50-300 ohm matching transformer to the 300 ohm FM antenna terminals.
2. Connect an oscilloscope to the Speaker System A right channel terminals, place the Mono switch in the "On" position and tune the receiver dial to 106 MHz. Set the output of the FM signal generator to below limiting as indicated on the oscilloscope.
3. Adjust C139 and the two FM trimmer capacitors (TC1 and TC3) for maximum output as indicated on the oscilloscope.
4. Reset the FM signal generator for 90 MHz with 1 KHz modulation and 75 KHz deviation.
5. Tune the receiver dial to 90 MHz and adjust the FM RF and oscillator coils (L102, L104 and L105) for maximum output as indicated on the oscilloscope.
6. Repeat steps 1 through 5 until no further improvement can be obtained.

### FM STEREO ALIGNMENT

1. Tune the receiver to an unused frequency near 98 MHz and be sure that the Mono switch is in the "Off" position.
2. Connect a frequency counter through a 10K ohm resistor to the 19 KHz Test Point, TP301, (pin 10 of IC301) and adjust R308 for 19 KHz  $\pm 50$  Hz.

### AM IF ALIGNMENT

1. Place the Function/Selector switch in the AM position and tune the receiver to a point of non interference at the extreme low end of the band.
2. Using the AM Sweep Generator, inject a 455 KHz RF signal at 30 mV, through a 100K ohm resistor to TP3 on the base of the AM Converter, Q202.
3. Connect an oscilloscope to TP4.
4. Align T203 and T204 for maximum output and symmetry.

### AM RF ALIGNMENT

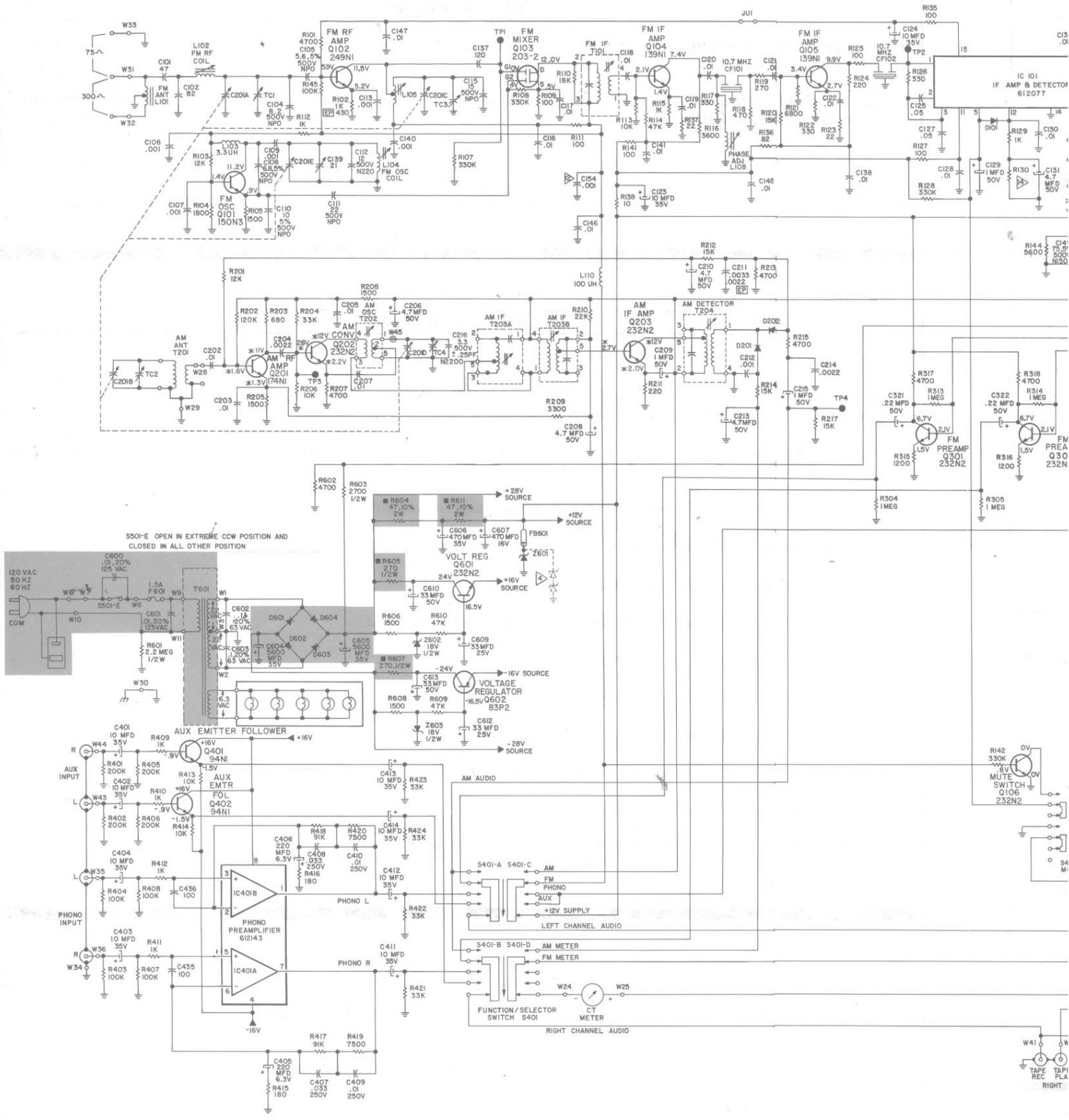
1. Short the AM antenna primary to ground with a clip lead.
2. Connect an oscilloscope to the Speaker System A right channel terminals (for peak tuning, an AC VTVM may also be connected to the speaker terminals.). Tune the receiver to 1400 KHz on the dial.
3. Using an RF signal generator, radiate a 1400 KHz signal using a standard AM loop antenna. (The output of the generator should be as low as possible while maintaining a usable indication on the oscilloscope.)
4. Adjust the AM oscillator trimmer capacitor, TC4, for maximum output.
5. Tune the receiver to 600 KHz on the dial and reset the generator for 600 KHz.
6. Adjust the AM oscillator coil, T202, for maximum output.
7. Repeat steps 2 through 6 until no further improvement can be obtained.
8. Remove the clip lead from the AM antenna.
9. Tune the receiver to 1400 KHz and radiate a 1400 KHz signal from the RF generator.
10. Adjust the AM antenna trimmer capacitor, TC2, for maximum output.
11. Tune the receiver to 600 KHz on the dial and adjust the RF generator to 600 KHz.
12. Adjust the AM rod antenna for maximum output.
13. Repeat steps 9 through 12 until no further improvement can be obtained.

### IDLE CURRENT ADJUSTMENT

**Note:** This adjustment must be performed while the unit is cold, therefore, the unit must have been turned off for at least one hour before this adjustment is attempted.

1. With no signal applied, connect a DC VTVM across R541 and R543 in the right channel output stage.
2. Adjust R517 until a reading of  $15\text{ mv} \pm 3\text{ mv}$  is obtained.
3. With no signal applied, connect a DC VTVM across R542 and R544 in the left channel output stage.
4. Adjust R518 until a reading of  $15\text{ mv} \pm 3\text{ mv}$  is obtained.

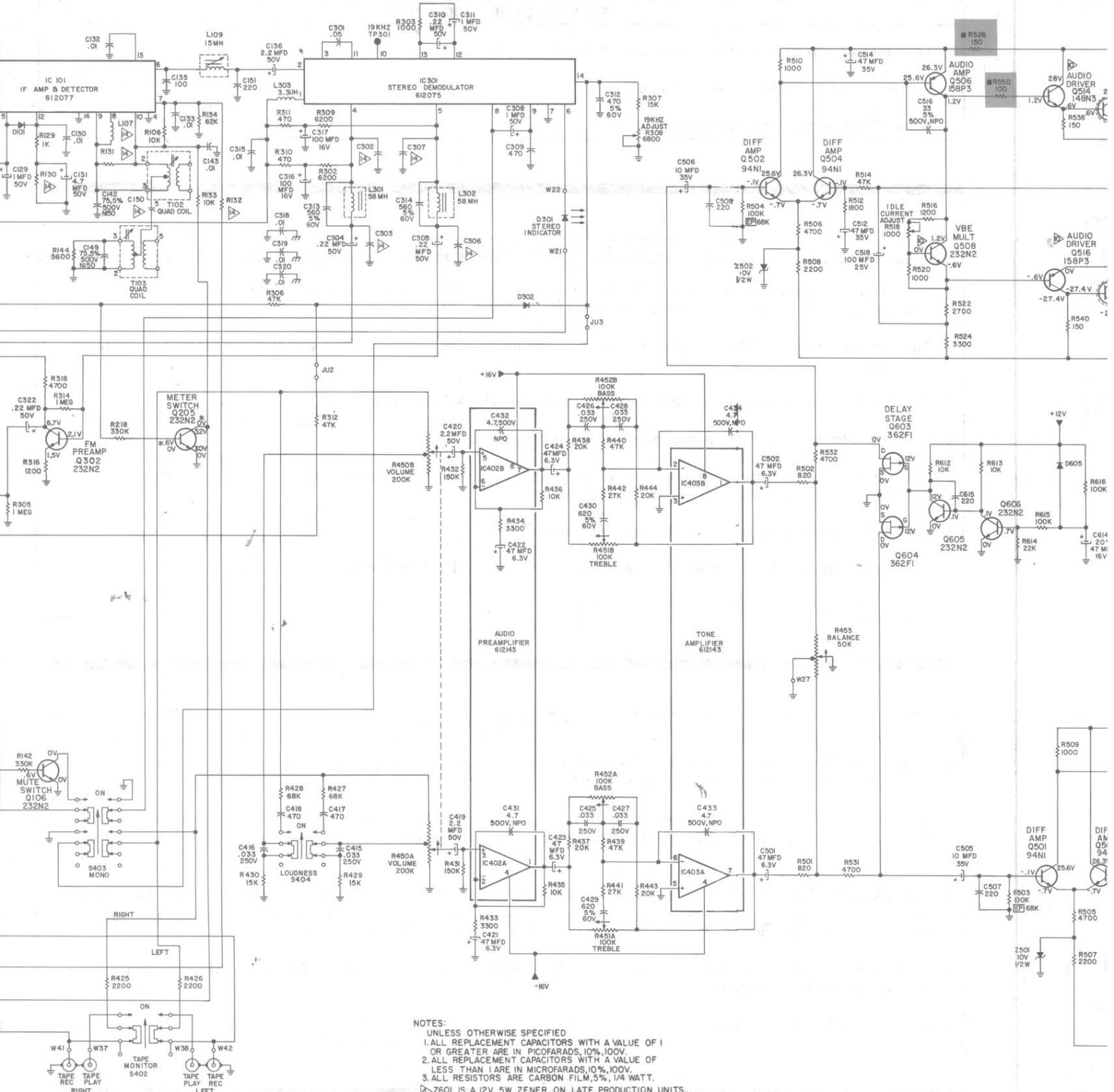
**Note:** This adjustment must be performed in the affected channel when any of the output transistors covered by note 10 on the schematic are replaced. Misadjustment may cause crossover distortion or premature failure of the output transistor(s).



COMPONENT VERSION CHART

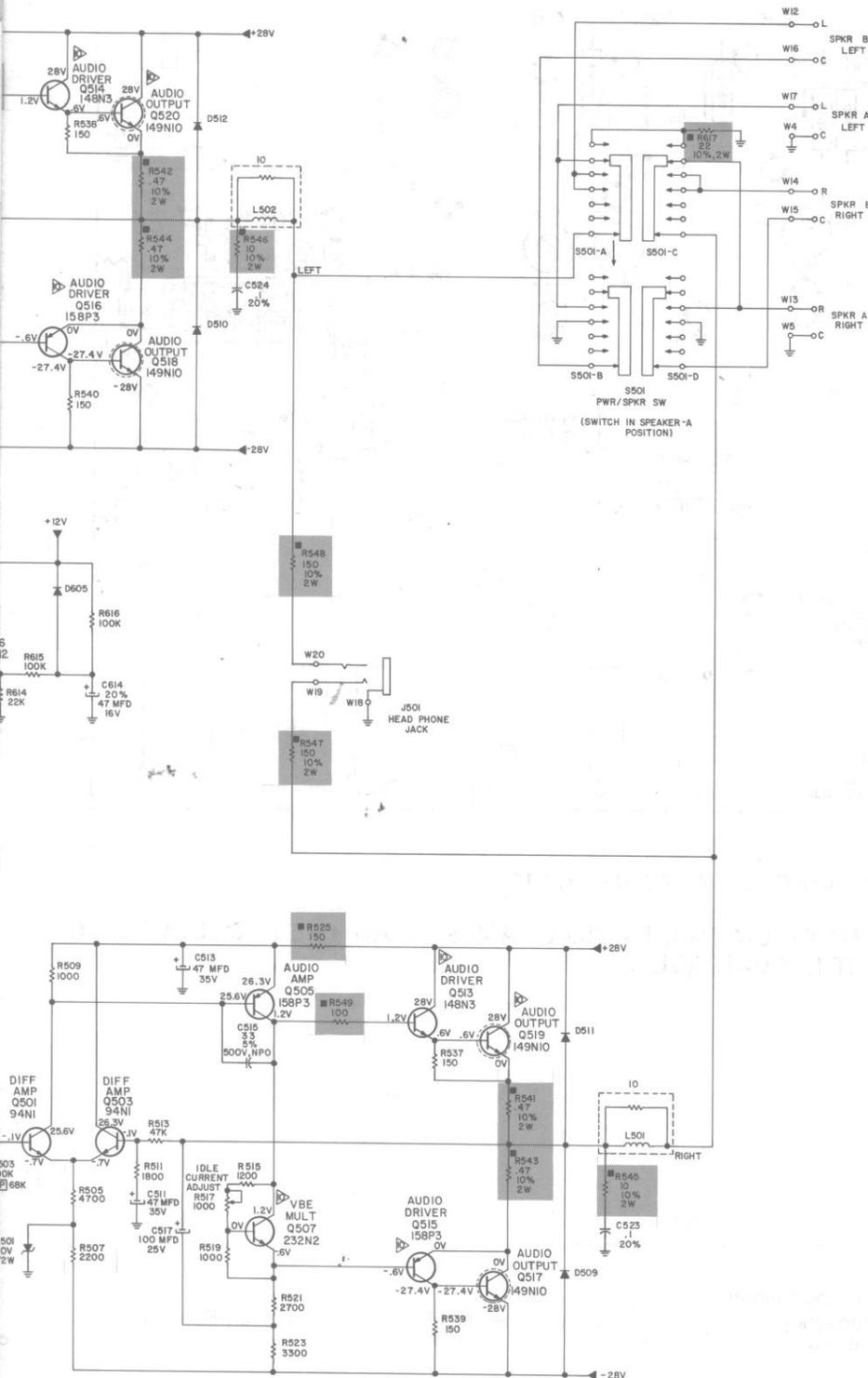
Chassis Version	R130	R131	R132	L107	C302	C307	C303	C306	C150
-AA	18K	3.9K	22K	22 uH	1800 pf.	1800 pf.	.015 mfd.	.015 mfd.	3.9 pf. ± .25 pf., 500V, NPO
-BA	36K	6.8K	39K	27 uH	1500 pf.	1500 pf.	.012 mfd.	.012 mfd.	3 pf. ± .25 pf., 500V, NPO

# 22AH784-44 SCHEMATIC DIAGRAM



**NOTES:**

- 1. ALL REPLACEMENT CAPACITORS WITH A VALUE OF 1 OR GREATER ARE IN PICOFARADS, 10<sup>4</sup>, 100V.
- 2. ALL REPLACEMENT CAPACITORS WITH A VALUE OF LESS THAN 1 ARE IN MICROFARADS, 10<sup>4</sup>, 100V.
- 3. ALL RESISTORS ARE CARBON FILM, 5%, 1/4 WATT.
- 4. Z601 IS A 12V, 5W ZENER ON LATE PRODUCTION UNITS. EARLY PRODUCTION UNITS USED TWO 6.2V, 1W ZENERS CONNECTED IN SERIES.
- 5. COMPONENT MUST BE ELEVATED 1/4 INCH ABOVE PC BOARD.
- 6. ALL VOLTAGES MEASURED WITH A DVM WITH NO SIGNAL APPLIED, SELECTOR SW IN FM POSITION, SPEAKER SWITCH IN SPEAKER POSITION AND SPEAKERS CONNECTED.
- 7. \* VOLTAGES MEASURED WITH SELECTOR SWITCH IN AM POSITION AND NO SIGNAL APPLIED.
- 8. ARROWS → ON CONTROLS INDICATE CLOCKWISE ROTATION.
- 9. TRANSISTORS SURROUNDED WITH A DOTTED LINE INDICATE TRANSISTOR IS MOUNTED TO A HEATSINK.
- 10. IF THIS TRANSISTOR IS REPLACED, IDLE CURRENT MUST BE READJUSTED.
- 11. ⊕ INDICATES POWER SUPPLY GROUND AND ⊞ INDICATES CHASSIS GROUND.
- 12. ⊞ COMPONENT MOUNTED ON COPPER SIDE OF PC BOARD IN EARLY PRODUCTION UNITS.
- 13. EP = EARLY PRODUCTION.
- 14. ▶ SEE COMPONENT VERSION CHART.



All IC voltages taken with Function/Selector switch in FM position and Speaker switch in Speaker - A position (unless otherwise specified).

IC101 VOLTAGE CHART		
PIN	VOLTAGE	NOTE
1	1.7V	.....
2	1.7V	.....
3	1.7V	.....
4	0V (Ground)	.....
5	2.2V	1
6	5.3V	2
7	5.2V	.....
8	5.3V	.....
9	5.3V	.....
10	5.3V	.....
11	10.1V	.....
12	2.2V	.....
13	1.3V	.....
14	0V (Ground)	.....
15	5.9V	.....
16	0V	.....

IC301 VOLTAGE CHART		
PIN	VOLTAGE	NOTE
1	12V	.....
2	3.0V	.....
3	5.0V	.....
4	7.7V	.....
5	7.7V	.....
6	16V	.....
7	0V (Ground)	.....
8	2.3V	1
9	2.3V	.....
10	1.5V	3
11	2.3V	.....
12	2.3V	.....
13	2.3V	.....
14	3.0V	1

**NOTES:**

1. Goes to 0V when Mono Switch placed in "On" position.
2. Goes to 5.8V when Mono Switch placed in "On" position.
3. Goes to 2.9V when Mono Switch placed in "On" position.

**WARNING**

Philips High Fidelity Laboratories, Ltd. is committed to marketing safe products which meet or exceed applicable safety standards of industry, government agencies and independent laboratories. It therefore uses parts in its products designed for maximum safety, reliability and performance.

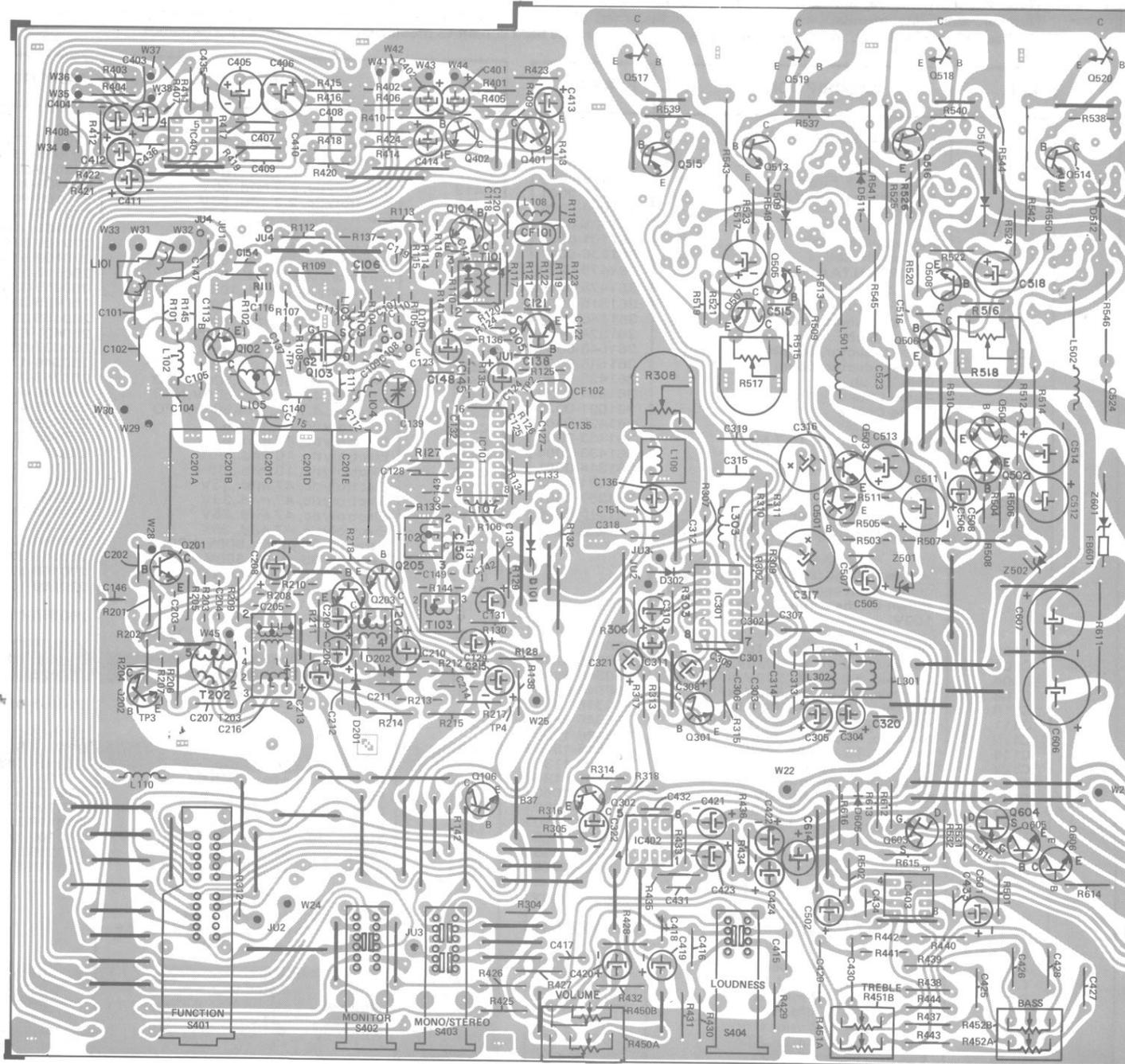
For continued safety of this product, parts shown in the shaded areas of this schematic must be replaced with only those identified in the Parts List of this manual. Use of substitute replacement parts which do not have the same

safety characteristics as specified, may create shock, fire or other hazards.

For maximum reliability and performance, all other parts must be replaced by those having identical specifications.

Under no circumstances may the original design be modified or altered without permission from Philips High Fidelity Laboratories, Ltd., otherwise the consumer may be exposed to fire and/or shock hazards.

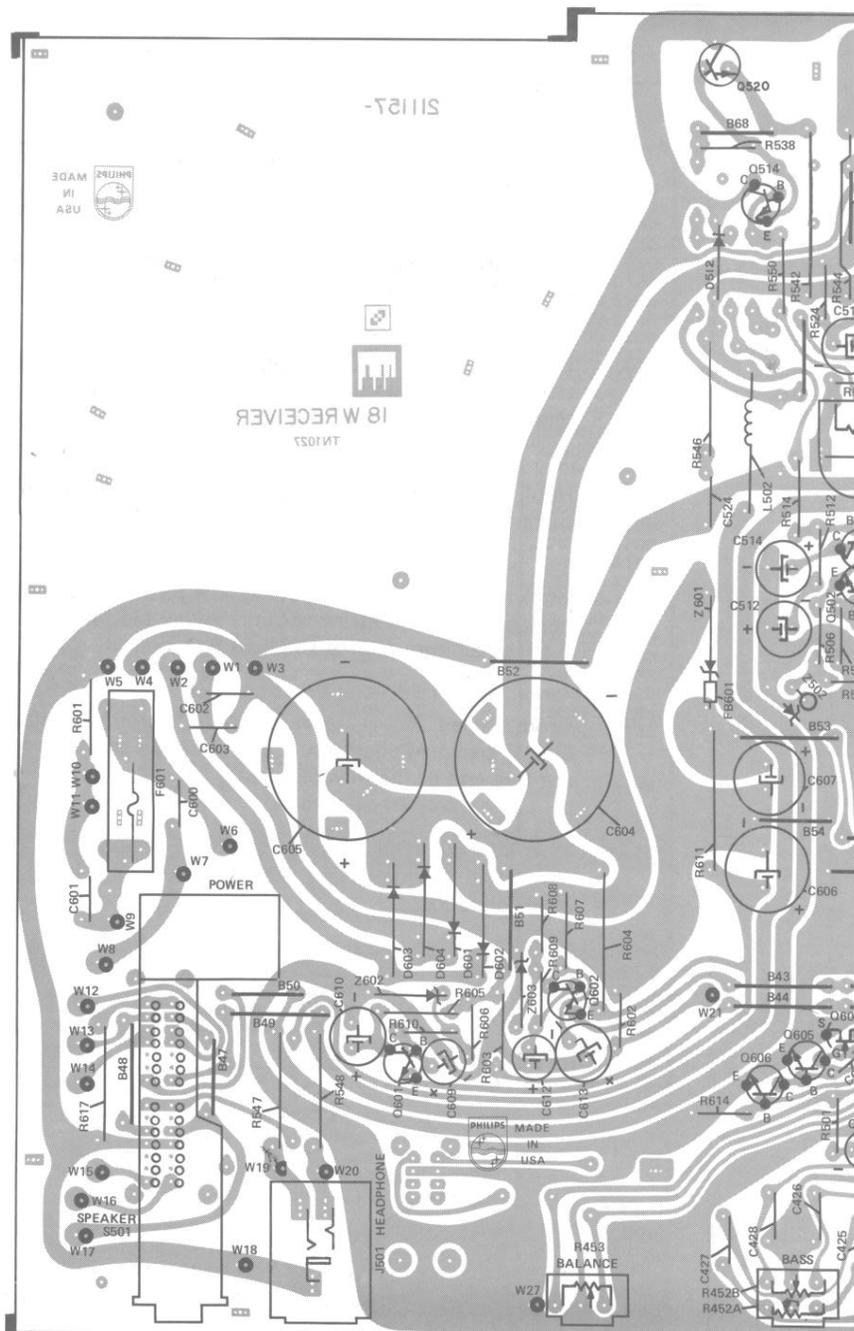
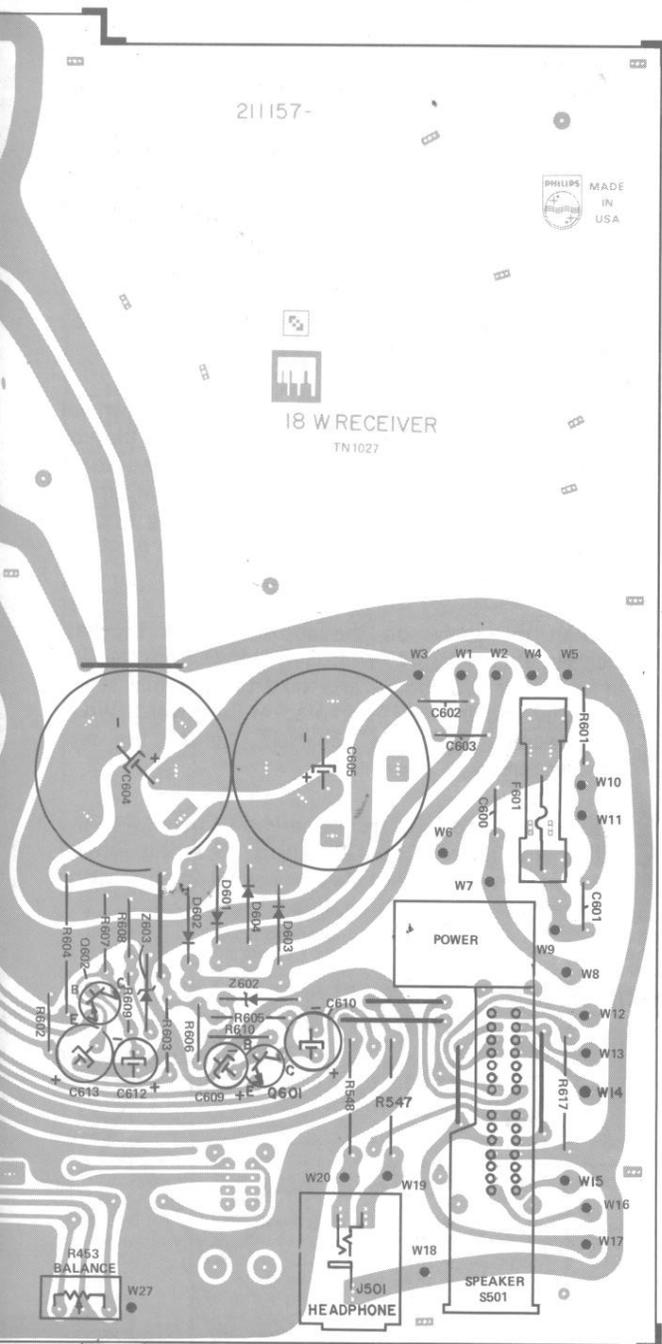
# MAIN P.C. BOARD (COPPER SIDE)



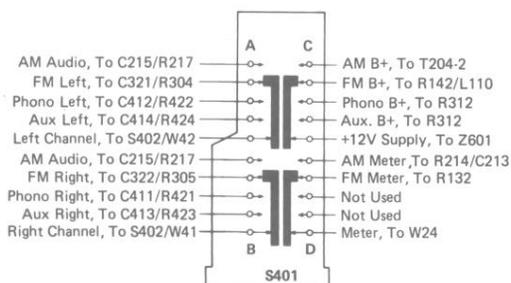
## NOTES:

Component screening as shown above is correct, however, on some units:

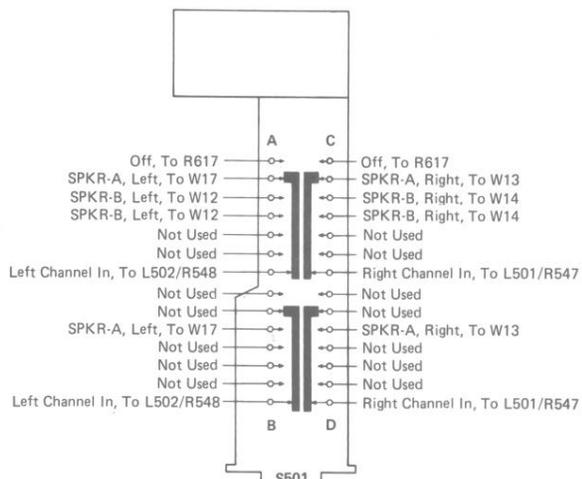
1. C150 was incorrectly screened as C151.
2. C433 was incorrectly screened as C443.
3. R547 was incorrectly screened as R549.
4. R303 was incorrectly screened as R503.
5. R306 was incorrectly screened as R506.
6. C322 was incorrectly screened with it's polarity reversed.
7. C614 was not screened.
8. Q201 basing was incorrectly screened.
9. C154 may not be screened on board, component may be mounted on copper side.
10. C145 not used, but screening may be present.
11. T101 basing was incorrectly screened.
12. B90 was incorrectly screened as B18.
13. B92 was incorrectly screened as B37.
14. W15 was incorrectly screened as W18.
15. C317 was not screened.
16. W14 was not screened.
17. C320 was not screened.



**SWITCH BASINGS**  
(Shown from Copper Side)

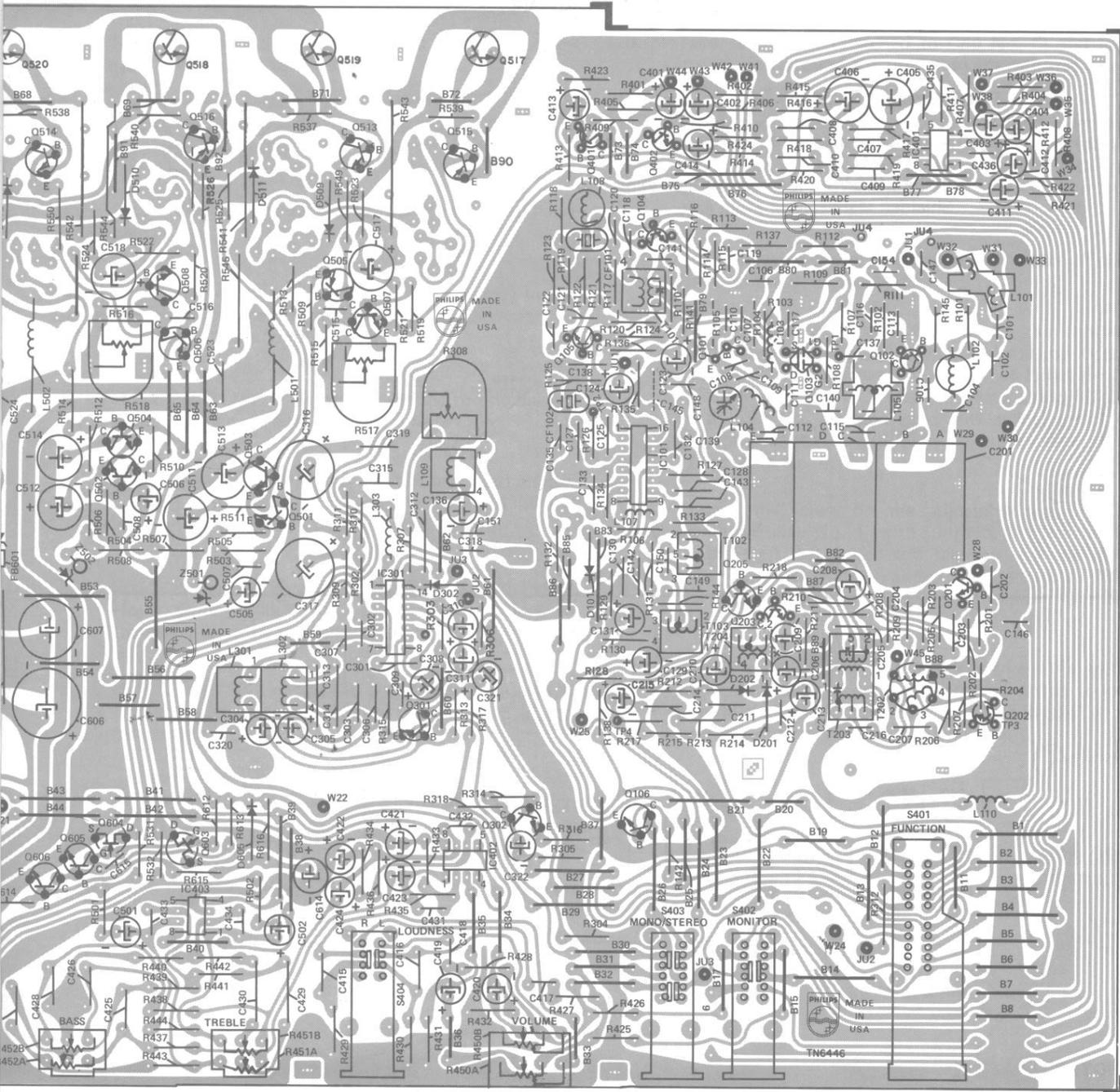


S401 shown in FM position



S501 shown in Speaker-A position

MAIN P.C. BOARD (COMPONENT SIDE)



NOTES:

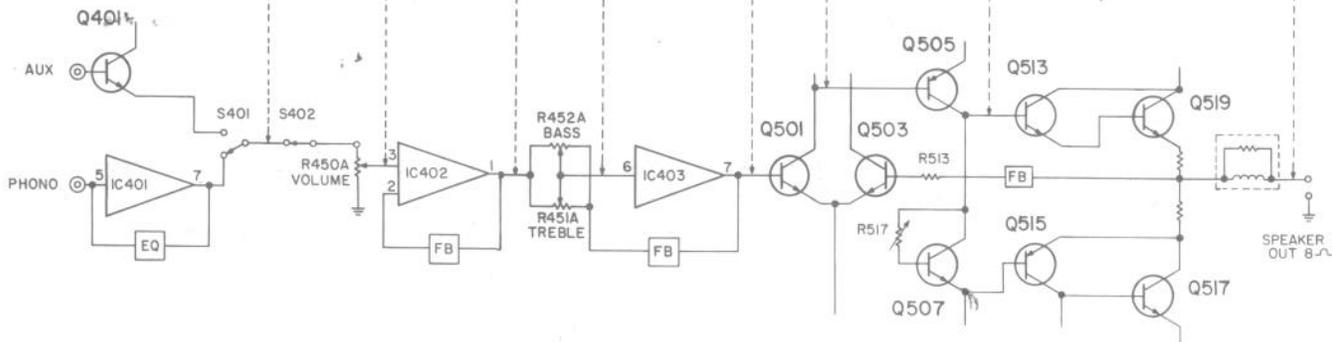
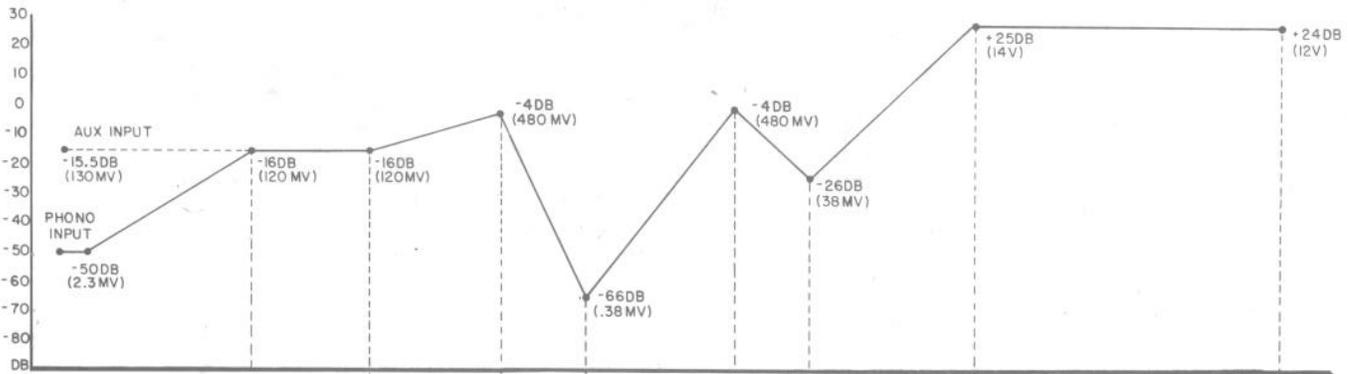
Component screening as shown above is correct, however, on some units:

1. R303 was incorrectly screened as R503.
2. R306 was incorrectly screened as R506.
3. C322 was incorrectly screened with it's polarity reversed.
4. T101 basing was incorrectly screened.
5. B90 was incorrectly screened as B91.
6. C154 may not be screened on board, component may be mounted on copper side.

## GAIN DIAGRAM

### Test Equipment Required:

Audio generator with variable output  
 AC VTVM  
 8 ohm, 100 Watt load resistors - 2 used  
 Shielded test cables.



### NOTES:

1. 8 ohm, 100 watt load resistors connected to left and right speaker-A outputs.
2. Tone Controls set for flat response (12 o'clock setting).
3. Balance control set to middle position.
4. Volume control fully clockwise (max.).
5. Loudness, Mono, Monitor switches in OFF position.
6. Selector Switch in PHONO or AUX position, depending upon test being performed.
7. Power/Speakers switch to speaker-A position.
8. 1000 Hz tone at 2.3 mV (-50dB), applied to the Phono Input jacks for Phono gain test.
9. 1000 Hz tone at 130 mV. (-15.5 dB), applied to the Aux input jacks for Aux gain test.
10. 0 dB is equal to .775 VRMS, each 6 dB change indicates a doubling or halving of the signal level.
11. All measurements are made with respect to ground.



22AH784-44 REPLACEMENT PARTS LIST

Note: When ordering replacement parts please specify the part number as shown in this list including Description, Chassis, and Model Number. Complete information will help expedite the order. Replacement parts may occasionally differ in part number or value from the Factory installed part. In either event the replacement part has been chosen to provide equal or improved performance.

REF.	DESCRIPTION	PART NO.
<b>COILS &amp; TRANSFORMERS</b>		
CF101, CF102	10.7 MHz IF Filter*	361479-0009
L101	FM Antenna Transformer	361108-0001
L102	FM RF Coil	361080-0006
L103	Coil, 3.3 uh	361425-0339
L104	FM Oscillator Coil	361101-0001
L105	Adjustable Coil	361536-0001
L107	Coil, 22 uH (AA Version Only)	361475-0220
L107	Coil, 27 uH (BA Version Only)	361475-0270
L108	FM IF Phasing Coil	361515-0002
L109	FM Compensating Coil	361546-0004
L110	Coil, 100 uh	361324-0101
L301	Fixed Inductor, 58 mh	361546-0003
L302	Fixed Inductor, 58 mh	361546-0003
L303	Coil, 3.3 uh	361425-0339
L501	Audio Choke	361091-0020
L502	Audio Choke	361091-0020
T101	10.7 MHz IF Transformer	361433-0001
T102	FM Phasing Coil, 10.7 MHz	361433-0005
T103	FM Phasing Coil, 10.7 MHz	361433-0005
T201	AM Rod Antenna	361314-0001
T202	AM Oscillator Coil	361031-0003
T203	AM IF Transformer	361357-0001
T204	AM IF Transformer	361315-0004
T601	Power Transformer	300360-0001
<b>CAPACITORS</b>		
Values, tolerances & voltage ratings for replacement capacitors not listed are shown on the schematic, or are 10% 100V.		
C102	Dura Mica, 82 pf., 10%, 100V	250607-1947
C104	Ceramic, 8.2 pf., 10%, 500V, NPO	250546-8299
C105	Ceramic, 5.6 pf., 5%, 500V, NPO	250546-5695
C108	Ceramic, 6.8 pf., 5%, 500V, NPO	250546-6895
C110	Ceramic, 10 pf., 5%, 500V, NPO	250546-1005
C111	Ceramic, 22 pf., 10%, 500V, NPO	250546-2209
C112	Ceramic, 12 pf., 10%, 500V, N220	250666-1209
C115	Ceramic, 15 pf., 10%, 500V, NPO	250546-1509
C123	Electrolytic, 10 mfd., 35V	270109-1135
C124	Electrolytic, 10 mfd., 35V	270109-1135
C129	Electrolytic, 1 mfd., 50V	270109-1050
C131	Electrolytic, 4.7 mfd., 50V	270109-5050
C136	Electrolytic, 2.2 mfd., 50V	270109-2050
C139	Trimmer, 2 pf., 22 pf., 100V	260220-0005
C142	Ceramic, 75 pf., 5%, 500V, N150	250527-7505
C149	Ceramic, 75 pf., 5%, 500V, N150	250527-7505
C150	Ceramic, 3.9 pf., ± .25 pf., 500V, NPO (AA Version Only)	250546-3997
C150	Ceramic, 3 pf., ± .25 pf., 500V, NPO (BA Version Only)	250546-3097
C201A,B, C,D,E	Variable Tuning Capacitor	260213-0003
C206	Electrolytic, 4.7 mfd., 50V	270109-5050
C208	Electrolytic, 4.7 mfd., 50V	270109-5050
C209	Electrolytic, 1 mfd., 50V	270109-1050
C210	Electrolytic, 4.7 mfd., 50V	270109-5050
C213	Electrolytic, 4.7 mfd., 50V	270109-5050
C215	Electrolytic, 1 mfd., 50V	270109-1050
C216	Ceramic, 3.3 pf., ± .25 pf., 500V, N2200	250584-3396
C304	Electrolytic, .22 mfd., 50V	270134-2240
C305	Electrolytic, .22 mfd., 50V	270134-2240
C308	Electrolytic, 1 mfd., 50V	270109-1050
C310	Electrolytic, .22 mfd., 50V	270134-2240
C311	Electrolytic, 1 mfd., 50V	270111-1050
C312	Polystyrene, 470 pf., 5%, 60V	250637-4715
C313	Polystyrene, 560 pf., 5%, 60V	250637-5615
C314	Polystyrene, 560 pf., 5%, 60V	250637-5615
C316	Electrolytic, 100 mfd., 16V	270109-1215
C317	Electrolytic, 100 mfd., 16V	270109-1215
C321	Electrolytic, .22 mfd., 50V	270134-2240
C322	Electrolytic, .22 mfd., 50V	270134-2240
C401	Electrolytic, 10 mfd., 35V	270109-1135
C402	Electrolytic, 10 mfd., 35V	270109-1135
C403	Electrolytic, 10 mfd., 35V	270109-1135
C404	Electrolytic, 10 mfd., 35V	270109-1135
C405	Electrolytic, 220 mfd., 6.3V	270109-2206
C406	Electrolytic, 220 mfd., 6.3V	270109-2206
C407	Polyester, .033 mfd., 10%, 250V	250655-3339
C408	Polyester, .033 mfd., 10%, 250V	250655-3339
C409	Polyester, .01 mfd., 10%, 250V	250655-1039
C410	Polyester, .01 mfd., 10%, 250V	250655-1039
C411	Electrolytic, 10 mfd., 35V	270109-1135
C412	Electrolytic, 10 mfd., 35V	270109-1135
C413	Electrolytic, 10 mfd., 35V	270109-1135

REF.	DESCRIPTION	PART NO.
C414	Electrolytic, 10 mfd., 35V	270109-1135
C415	Polyester, .033 mfd., 10%, 250V	250655-3339
C416	Polyester, .033 mfd., 10%, 250V	250655-3339
C419	Electrolytic, 2.2 mfd., 50V	270109-2050
C420	Electrolytic, 2.2 mfd., 50V	270109-2050
C421	Electrolytic, 47 mfd., 6.3V	270109-5106
C422	Electrolytic, 47 mfd., 6.3V	270109-5106
C423	Electrolytic, 47 mfd., 6.3V	270109-5106
C424	Electrolytic, 47 mfd., 6.3V	270109-5106
C425	Polyester, .033 mfd., 10%, 250V	250655-3339
C426	Polyester, .033 mfd., 10%, 250V	250655-3339
C427	Polyester, .033 mfd., 10%, 250V	250655-3339
C428	Polyester, .033 mfd., 10%, 250V	250655-3339
C429	Polystyrene, 620 pf., 5%, 60V	250637-6215
C430	Polystyrene, 620 pf., 5%, 60V	250637-6215
C431	Ceramic, 4.7 pf., 10%, 500V, NPO	250546-4799
C432	Ceramic, 4.7 pf., 10%, 500V, NPO	250546-4799
C433	Ceramic, 4.7 pf., 10%, 500V, NPO	250546-4799
C434	Ceramic, 4.7 pf., 10%, 500V, NPO	250546-4799
C501	Electrolytic, 47 mfd., 6.3V	270109-5106
C502	Electrolytic, 47 mfd., 6.3V	270109-5106
C505	Electrolytic, 10 mfd., 35V	270109-1135
C506	Electrolytic, 10 mfd., 35V	270109-1135
C511	Electrolytic, 47 mfd., 35V	270109-5135
C512	Electrolytic, 47 mfd., 35V	270109-5135
C513	Electrolytic, 47 mfd., 35V	270109-5135
C514	Electrolytic, 47 mfd., 35V	270109-5135
C515	Ceramic, 33 pf., 5%, 500V, NPO	250546-3305
C516	Ceramic, 33 pf., 5%, 500V, NPO	250546-3305
C517	Electrolytic, 100 mfd., 25V	270109-1225
C518	Electrolytic, 100 mfd., 25V	270109-1225
C523	Polyester, .1 mfd., 20%, 100 VDC (63 VAC)	250555-0184
C524	Polyester, .1 mfd., 20%, 100 VDC (63 VAC)	250555-0184
C600	By-Pass, .01 mfd., +80%-20%, 125 VAC	250626-0010
C601	By-Pass, .01 mfd., +80%-20%, 125 VAC	250626-0010
C602	Polyester, .1 mfd., 20%, 100 VDC (63 VAC)	250555-0184
C603	Polyester, .1 mfd., 20%, 100 VDC (63 VAC)	250555-0184
C604	Electrolytic, 5600 mfd., 35V	270139-5635
C605	Electrolytic, 5600 mfd., 35V	270139-5635
C606	Electrolytic, 470 mfd., 35V	270109-5235
C607	Electrolytic, 470 mfd., 16V	270109-5215
C609	Electrolytic, 33 mfd., 25V	270109-3125
C610	Electrolytic, 33 mfd., 50V	270109-3150
C612	Electrolytic, 33 mfd., 25V	270109-3125
C613	Electrolytic, 33 mfd., 50V	270109-3150
C614	Electrolytic, 47 mfd., 16V	270111-5115
<b>RESISTORS</b>		
Values, tolerances & wattages for resistors not listed, are shown on the schematic, or are 5%, ¼W.		
R525	Carbon Film, 150 ohm, 5%, ¼W	230218-1515
R526	Carbon Film, 150 ohm, 5%, ¼W	230218-1515
R541	Wire Wound, .47 ohm, 10%, 2W	240104-0001
R542	Wire Wound, .47 ohm, 10%, 2W	240104-0001
R543	Wire Wound, .47 ohm, 10%, 2W	240104-0001
R544	Wire Wound, .47 ohm, 10%, 2W	240104-0001
R545	Wire Wound, 10 ohm, 10%, 2W	230164-0062
R546	Wire Wound, 10 ohm, 10%, 2W	230164-0062
R547	Wire Wound, 150 ohm, 10%, 2W	230164-0076
R548	Wire Wound, 150 ohm, 10%, 2W	230164-0076
R549	Carbon Film, 100 ohm, 5%, ¼W	230218-1015
R550	Carbon Film, 100 ohm, 5%, ¼W	230218-1015
R604	Metal Film, 47 ohm, 10%, 2W	230192-4709
R605	Carbon Film, 270 ohm, 5%, ½W	230212-2715
R607	Carbon Film, 270 ohm, 5%, ½W	230212-2715
R611	Metal Film, 47 ohm, 10%, 2W	230192-4709
R617	Wire Wound, 22 ohm, 10%, 2W	230164-0066
<b>CONTROLS &amp; SWITCHES</b>		
R308	19 KHz, Oscillator Adjust, 6800, ¼W	220300-6822
R450A,B	Volume, 200K	220372-0001
R451A,B	Treble, 100K	220369-0002
R452A,B	Bass, 100K	220369-0002
R453	Balance, 50K	220368-0005
R517	Bias Adjust, 1K	220300-1022
R518	Bias Adjust, 1K	220300-1022
S401	Function/Selector Switch (Rotary Slide)	160595-0001
S402	Tape Monitor Switch (Lever Slide)	160600-0001
S403	Mono/Stereo Switch (Lever Slide)	160600-0002
S404	Loudness Switch (Lever Slide)	160600-0001
S501	Power/Speaker Switch (Rotary Slide)	160594-0002

REF.	DESCRIPTION	PART NO.
SEMICONDUCTORS		
D101	Germanium Diode	530092-1001
D201	Germanium Diode	530092-1001
D202	Germanium Diode	530092-1001
D301	Light Emitting Diode	530189-0001
D302	Silicon Diode	530181-1001
D509	Silicon Diode	530181-1002
D510	Silicon Diode	530181-1002
D511	Silicon Diode	530181-1002
D512	Silicon Diode	530181-1002
D601	Silicon Diode, 1A,200V	530171-1001
D602	Silicon Diode, 1A,200V	530171-1001
D603	Silicon Diode, 1A,200V	530171-1001
D604	Silicon Diode, 1A,200V	530171-1001
D605	Silicon Diode	530181-1001
Z501	10V Zener Diode, ½W	530157-0100
Z502	10V Zener Diode, ½W	530157-0100
Z601	6.2V Zener Diode, 1W (2 used-E.P.)	530192-0629
Z601	12V Zener Diode, 5W (L.P.)	530073-0032
Z602	18V Zener Diode, ½W	530157-3180
Z603	18V Zener Diode, ½W	530157-3180
Q101	NPN Silicon Transistor	610150-0003
Q102	NPN Silicon Transistor	610249-0002
Q103	Dual Gate-N-Channel FET	610203-0002
Q104	NPN Silicon Transistor	610139-0001
Q105	NPN Silicon Transistor	610139-0001
Q106	NPN Silicon Transistor	610232-0002
Q201	NPN Silicon Transistor	610174-0001
Q202	NPN Silicon Transistor	610232-0002
Q203	NPN Silicon Transistor	610232-0002
Q205	NPN Silicon Transistor	610232-0002
Q301	NPN Silicon Transistor	610232-0002
Q302	NPN Silicon Transistor	610232-0002
Q401	NPN Silicon Transistor	610094-0001
Q402	NPN Silicon Transistor	610094-0001
Q501	NPN Silicon Transistor	610094-0001
Q502	NPN Silicon Transistor	610094-0001
Q503	NPN Silicon Transistor	610094-0001
Q504	NPN Silicon Transistor	610094-0001
Q505	PNP Silicon Transistor	610158-0003
Q506	PNP Silicon Transistor	610158-0003
Q507	NPN Silicon Transistor**	610232-0002
Q508	NPN Silicon Transistor**	610232-0002
Q513	NPN Silicon Transistor**	610148-0003
Q514	NPN Silicon Transistor**	610148-0003
Q515	PNP Silicon Transistor**	610158-0003
Q516	PNP Silicon Transistor**	610158-0003
Q517,519	Matched Pair w/Mica Insulator**	171418-0002
Q518,520	Matched Pair w/Mica Insulator**	171418-0002
Q601	NPN Silicon Transistor	610232-0002
Q602	PNP Silicon Transistor	610083-0001
Q603	P-Channel FET	610362-0001
Q604	P-Channel FET	610362-0001
Q605	NPN Silicon Transistor	610232-0002
Q606	NPN Silicon Transistor	610232-0002
IC101	FM IF Amplifier & Detector IC	612077-0002
IC301	FM Stereo Demodulator IC	612075-0003
IC401	Dual Operational Amplifier IC	612143-0002
IC402	Dual Operational Amplifier IC	612143-0002
IC403	Dual Operational Amplifier IC	612143-0002

REF.	DESCRIPTION	PART NO.
MISCELLANEOUS		
F601	Fuse, 1.5 amp. 125V Slow-Blow	181021-5150
FB601	Ferrite Bead	364005-0003
J501	Headphone Jack	181218-0001
	Fuse Clip (2 used)	181007-0004
	AC Receptacle	181054-0014
	AC Line Cord	461276-0012
	Pilot Lamp (5 used)	180931-0002
	White Nylon Support Bushing f/LED	143991-0001
	Rubber Bushing f/LED	642954-0003
	Shoulder Rivet (Pulley Shaft-4 used)	102011-0036
	Idler Pulley (6 used)	141028-0005
	White Pulley Hook (2 used)	144036-0001
	Gang Pulley	143708-0001
	AC Line Cord Strain Release Bushing	102454-0012
	Antenna Strain Release Bushing	102454-0013
	Nut, 9m (f/Control Mtg.)	103269-0109
	Pushbutton Speaker Connector Assembly (2 used)	181286-0001
	Screw, 6 x 3/8, Black (f/Pushbutton Speaker Connector Assem. - 4 used)	103272-1805
	Screw, 8 x 3/8, PHST (Torx, Black)	103267-1810
	AM Antenna Cover	142209-0003
	Screw, 8 x 2, f/Antenna Cover Hinge (Black)	103130-1814
	Mtg. Bracket f/AM Antenna Cover	733387-0001
	Heatsink	733385-0001
	Screw, TAP, 4-40 x 3/8 (f/Mtg. Output Transistors to Heatsink - 4 used)	103244-0105
	Insulator Washer (f/Output Transistor-4 used)	142066-0002
	FM Antenna Assembly	703939-0001
	FM Antenna Terminal Block	144001-0002
	FM Antenna Terminal w/Screw	200488-0009
	Tuning Meter	702594-0003
	Flywheel and Gear Assembly	733115-0004
	Backplate	733377-0001
	Tension Spring	733383-0001
	Metal Cabinet	733373-0001
	Bezel	733310-0002
	Screw, M4 x 10, THST (f/Mtg. Metal Cabinet to Chassis, Black-4 used)	103270-1810
	Screw, M3 x 8 (Black-f/FM Antenna Terminal Block - 2 used)	103273-1808
	Foot - 4 used	120822-0006
	Carriage f/Dial Pointer	143863-0001
	Dial Pointer, Black	733446-0001
	Dial Scale Inlay	151620-0007
	Jack Board Assembly	180978-0009
	Insulator f/Jack Board Assembly	644053-0002
	Screw-Set, 4-40 x ¼ (f/Gang Pulley)	103250-0603
	Socket Clip f/Pilot Lamps (10 used)	181009-0003
	Control Knob-Bass, Treble, Balance	143730-0014
	Control Knob-Selector, Speakers, Volume	143730-0015
	Tuning Knob	143730-0016
	Knob f/Lever Switch (3 used)	144010-0001
	Dial Window	644054-0001

\*These filters can only be purchased in pairs and must be replaced as a set. The location of the Color Coded dot on the replacement filter must match the original filter.

\*\*When this transistor is replaced, Idle Current must be readjusted.

#### WARNING

For continued safety of this product, parts shown in the shaded areas of this Parts List must be used as replacements for those identified in the shaded areas of the schematic diagrams of this service manual. Use of substitute replacement parts which do not have the same safety characteristics as specified, may create shock, fire or other hazards.

For maximum reliability and performance, all other parts must be replaced by those having identical specifications.

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