

Volumax

FM Volumax
FM Stereo Volumax

Automatic peak controller

OPERATING AND MAINTENANCE INSTRUCTIONS

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**CBS LABORATORIES**

Stamford, Connecticut

A Division of Columbia Broadcasting System, Inc.

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SECTION I

INTRODUCTION

1-1 GENERAL

This instruction book contains complete maintenance and operating instructions for the Model 410 and Model 411 (Stereo) FM Volumax. The instrument has been designed for the FM and TV broadcaster and will enable him to use his full modulation capability with no risk of overmodulation or distortion. Used with SCA systems, it prevents crosstalk caused by overmodulation into adjacent channels. It replaces any limiter or clipper that may now be in use and should be used with well-controlled input levels such as those provided by the CBS Laboratories' Audimax automatic level control.

The various problems associated with FM and TV broadcasting and their solutions are discussed at length in Section IV of this book.

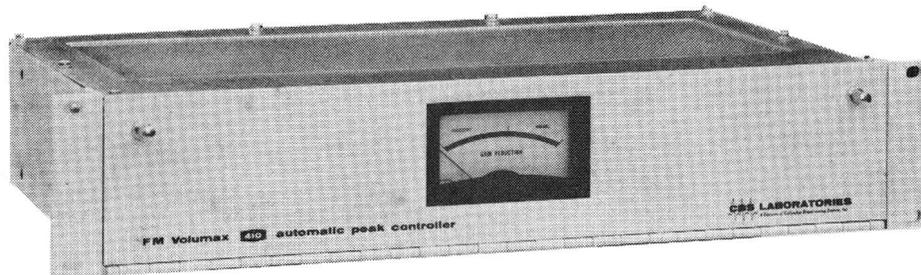


Figure 1-1 The FM Volumax Automatic Peak Controller

1-2 WARRANTY

A standard warranty card with a return post card has been included with your FM Volumax. Fill out the card and return it to CBS Laboratories as soon as possible in order to validate your warranty.

Your new FM Volumax is warranted against electrical and mechanical defects for a period of one year after you register the warranty. Refer to the warranty card for the specifics on our responsibilities and yours.

1-3 FACTORY SERVICE AND REPAIR

If you should experience difficulty in installing or operating the FM Volumax, please contact the Professional Products Department at CBS Laboratories in Stamford, Conn. Within the continental limits of the United States, call collect area code (203) 327-2000.

1-4 SPECIFICATIONS

Dimensions: Fits standard 19-inch rack, 3-1/2" high and 9-5/8" deep.

Frequency Response: Below threshold of limiting:

Flat within 1 dB, 50 Hz* to 15,000 Hz.

Above threshold: Variable depending on level.

At maximum level, response follows 75-microsecond de-emphasis curve within 1 dB.

Harmonic Distortion: Less than 1% from 50 to 15,000 Hz throughout entire control range.

Input Level: -24 to +8 dBm

Maximum Peak Output Level: +21 dBm

Input and Output Impedance: 600 ohms balanced or unbalanced (150 ohms available on request).

Noise Level: Below -70 dB re +21 dBm output

Maximum Gain: 50 dB

Attack Time: Less than 1 microsecond or 2 milliseconds depending on program waveform

Recovery Time: Low Frequency Loop: 140 milliseconds

High Frequency Loop: 10 milliseconds

Maximum Operating Temperature: 55° C

Power Required: 15 watts at 115-230 V AC, 50/60 Hz.

* Hz, abbreviation for Hertz, has been adopted as the new engineering term for cycles per second. KHz is 1000 cps.

SECTION II
 INSTALLATION INSTRUCTIONS

2-1 UNPACKING

Examine your FM Volumax carefully for evidence of possible shipping damage. If the equipment is damaged, file a claim with the carrier and notify us immediately. If future transportation of the instrument is anticipated, save the shipping carton and the packing material.

2-2 POWER SUPPLY (See Figure 2-1)

The transformer in the power supply of the FM Volumax allows the selection of either 115 or 230 volt operation. The unit is shipped for 115 volt operation. If 230 volt operation is required, remove the jumpers on the power supply board between lugs 1 to 2 and 3 to 4. Reconnect a single jumper between lugs 2 and 3. Replace the fuse with a type 3AG rated 0.10 Amp.

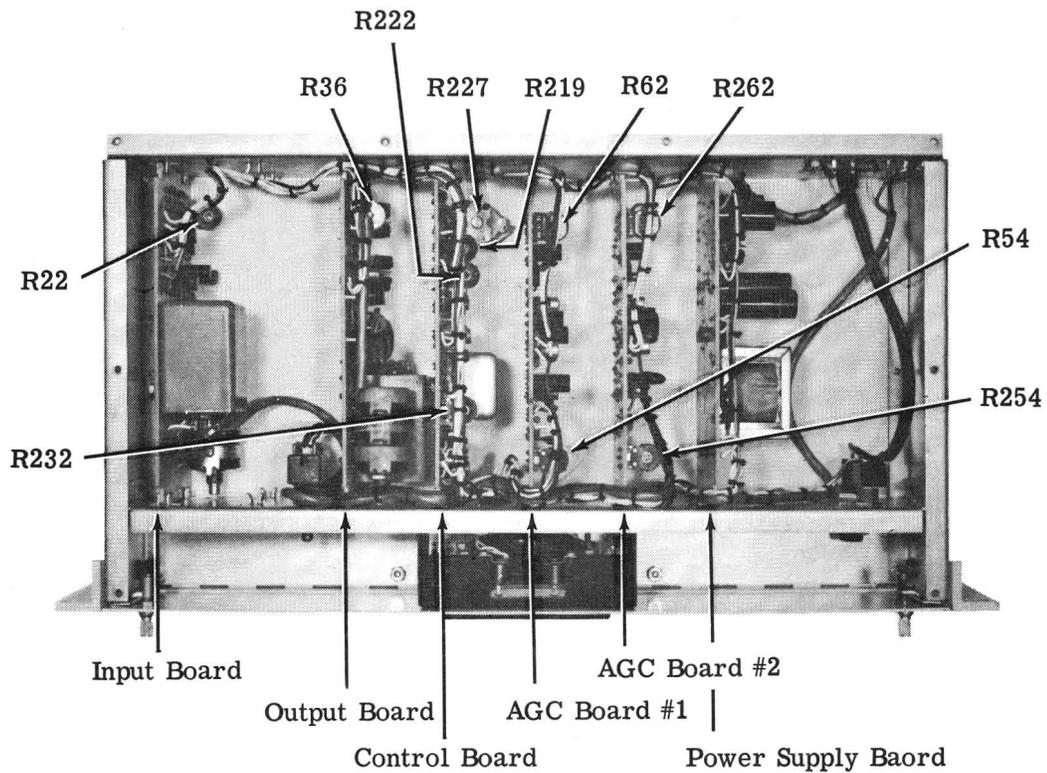


Figure 2-1 Circuit Board Layout

2-3 INSTALLATION

FM Volumax is designed to be mounted in a standard 19"-wide rack. It requires 3-1/2" panel space and is slightly less than 10" deep. As with all transistorized equipment, the unit must be installed in a reasonably well-ventilated position, with no high heat-producing equipment beneath it.

NOTE:

Ambient temperature should not exceed 130° F.

FM Volumax is normally installed at the transmitter, immediately preceding the transmitter audio input terminals. However, it may be installed at the studio ahead of the program line to the transmitter, when the phase-amplitude characteristic between studio and transmitter are known to be uniform under all climatic conditions and telephone company equipment changes.

For optimum operation, the FM Volumax should be fed uniform average program levels and -- as in the case with all limiters -- should not be used to perform a gain-riding function. The use of CBS Laboratories' Audimax is recommended with the FM Volumax. Any wave shaping or phase scrambling devices should be used ahead of the instrument.

The FM Volumax has sufficient gain to correct for the long-line and equalizer losses incurred when the transmitter site is remotely located, and input levels as low as -24 dBm can be tolerated. However, if input levels exceeding +8 dBm are used, the range of attenuation on the input pad will not be sufficient. Such is the case when a CBS Laboratories' tube-type Audimax is connected directly to the FM Volumax input.

If a CBS Laboratories' Model 440, 441 or 443 Audimax is used to feed the FM Volumax, the attenuator circuit shown in Figure 2-2 must be inserted in the line between the units. An attenuator is not necessary when using the Model 444 Audimax III.

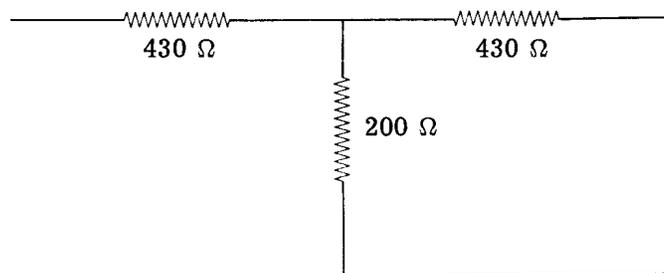


Figure 2-2 600 ohm, 16 dB Attenuation Network

The standard FM Volumax is designed to work in conjunction with a 75-microsecond transmitter pre-emphasis network. However, if operation into a 50-microsecond network is required, such as the CCIR standard, modify the instrument as outlined in Section V of this manual.

For stereophonic transmission, the Model 411 FM Volumax is used. This instrument consists of two Model 410 FM Volumax coupled mechanically and electrically in a single frame. For field conversion of a monaural FM Volumax Model 410 to stereo, order a second Model 410 and a Stereophonic Cable Assembly # 200354 directly from CBS Laboratories. Connect the two units with the cable assembly and adjust R227 on both units so that the gain reduction meters read full scale in the absence of signal.

Install your FM Volumax in a standard 19-inch mounting rack but do not depend on the mounting hardware for grounding. In some installations, an excessive amount of RF pickup may be present on the input leads to the Volumax, causing undesirable gain reduction and distortion. Careful grounding techniques will cure this problem. Be sure a good bond exists between the Volumax metal chassis and the equipment rack. Lead shields should be connected at only one end and should not be used for ground strapping. Additionally, if the transmitter site is remote from the studio, make certain that the TELCO service entry box is appropriately grounded.

2-4 ELECTRICAL CONNECTIONS

The input and output leads should be connected to the five-terminal strip at the rear of the unit chassis. Terminals 1 and 2 are for the input, and terminals 4 and 5 are for the output. The unit may be connected for balanced or unbalanced operation. Terminal 3 is the chassis ground.

The FM Volumax is normally designed for 600 ohm operation. However, it may be set up for 150 ohm operation by using special input and output pads and by strapping transformers T2 and T3. If you require 150 ohm operation and did not request it when placing your order, refer to the schematic diagram in Section V and contact CBS Laboratories for the required parts.

SECTION III
SET-UP PROCEDURES

3-1 GENERAL

All of the set-up and operating controls are located behind the front panel of the unit. With all the input, output, and ground connections properly made (Refer to Section II) turn the power switch ON and proceed as follows to set up a Model 410 FM Volumax for monophonic operation:

- a. Rotate both the **INPUT LEVEL** and **OUTPUT LEVEL** controls fully counter-clockwise.
- b. Feed a 400 Hz signal into the **FM Volumax**. Adjust the **INPUT LEVEL** control, or the signal generator, so that the meter on the **FM Volumax** is deflected to the red/green junction.
- c. Depress the **MODULATION SET** switch and, holding it in this position, turn the **OUTPUT LEVEL** control clockwise to produce 100%, or any maximum desired, modulation. This step provides a precise setting of the modulation level with tone signals. However, it should be recognized that phase-shifts in transmitting equipment may cause previously limited complex program waveforms to slightly exceed the 100% point. A slight re-adjustment of the **OUTPUT LEVEL** control may be necessary if modulation appears excessive.

NOTE:

The phase-shift problem may be reduced at installations where it is easy to disable or remove the pre-emphasis circuit from the transmitter. If this is done, the de-emphasis network at the output of the **FM Volumax** must also be disabled. This can be accomplished at the output board by disconnecting C204 and placing a jumper across L200.

- d. Release the **MODULATION SET** switch and remove the 400 Hz signal.
- e. Feed typical level-controlled program into the instrument.

- f. Adjust the INPUT LEVEL control to cause the GAIN REDUCTION meter to operate in the green or normal area with occasional peaks deflecting into the red region.

NOTE:

It should be noted that the design calibration of the meter is, of necessity, based on subjective considerations. Not all users will want to operate with the same degree of limiting action. A setting for heavy limiting action will produce higher average modulation, but with a potential loss of brilliance at high levels. In general, FM broadcasters with wide-range programming will re-adjust the input level to operate with less limiting action than FM or TV broadcasters who normally transmit narrow-band material.

3-2 STEREOPHONIC OPERATION

For FM stereophonic broadcasting, two FM Volumax units are used, one for each channel. To prevent any possible change of stereophonic perspective, the two units are coupled to provide tracking of gain reduction. This is accomplished by interconnecting Control Board points F and I, between the two units. If this modification is performed in the field, R227 in each unit must be readjusted to provide full-scale deflection of both meters with no input signal. In the FM Stereo Volumax Model 411, the two units are coupled by a plug-in cable assembly at the rear. This cable may be disconnected for independent operation if that is desired.

On the current model of the Model 410 FM Volumax (monophonic) provision has been made so that an FM station which is converting to stereo can simply add another Model 410 to its system rather than buy a new Model 411. However, when this is done, the two Model 410 units must be re-adjusted so that their gain reduction meters track. Refer to Section II for the proper procedure.

To set up the Model 411 FM Volumax, or two Model 410 units, for stereophonic operation, make sure that all of the input, output, and ground connections have been properly made (Refer to Section II) and proceed as follows:

- a. Rotate the INPUT LEVEL and OUTPUT LEVEL controls on both the left and right channels fully counter-clockwise.
- b. Feed a 400 Hz signal into the left channel FM Volumax only. Adjust that channel's INPUT LEVEL control so that the meters on both channels are deflected to the red/green junctions.
- c. Depress the left channel MODULATION SET switch and, holding it in this position, turn the OUTPUT LEVEL control clockwise to produce the maximum desired modulation for that channel. Remove the 400 Hz signal from the left channel.

NOTE:

This switch is spring-loaded. If one man is doing proof of performance or installation, a wooden brace 1-5/8 inches long can be used to hold the switch in the down position.

- d. Perform steps a. through c. above, on the right channel.
- e. Feed a 400 Hz signal to the left channel again and adjust the INPUT LEVEL control to produce a meter deflection approximately 1/4-inch into the green region on the meter face.
- f. Remove the 400 Hz signal from the left channel, apply it to the right channel and perform step e. , above, on that channel.
- g. A final check of output hum levels should be made. If the hum in either channel is higher when both units are operating together, as compared with uncoupled operation, reverse the AC power plug of one of the units.

A slight re-adjustment of the INPUT LEVEL control may be necessary to accommodate a particular station's normal programming. It should be noted here that the meter on the FM Volumax is necessarily based on subjective considerations and that all users will not want to operate with the same degree of limiting action. If the FM Volumax is set up for heavy limiting action, higher average modulation will result, but with a potential loss of brilliance at high levels. In general, FM broadcasters with wide-range programming will operate with less limiting action than FM or TV broadcasters, who normally transmit narrow-band material.

To re-adjust for normal programming, apply a typical level monophonic signal to one channel at a time. This signal should be representative of the station's normal program material.

Then adjust the INPUT LEVEL control to produce meter deflection in the green region.

Occasional high level, bright passages should drive the meter into the red region.

3-3 PROOF OF PERFORMANCE MEASUREMENTS

Generally accepted procedures for proof of performance tests usually call for making these measurements "without compression." In the FM Volumax, the compression action can be disabled by depressing the MODULATION SET switch. However, in so doing, care must be taken to ensure that the audio program amplifier section of this device is not operated at levels significantly different from normal operation.

Although other methods may also be acceptable, the following suggestions are made:

a. Frequency Response:

1. With the MODULATION SET switch depressed, feed excessive level at 100 Hz to produce a clipped waveform at the output of the FM Volumax. If the clipping level is at less than 100% modulation, turn up the OUTPUT LEVEL control so that clipping occurs slightly above the 100% point.
2. Reduce the input for 100% modulation. No clipping should occur.
3. Measure the system frequency response by noting variations required at the audio channel input for constant modulation at specified modulation levels. The resulting response characteristic should be the inverse of the standard 75-microsecond pre-emphasis curve.

(Do not attempt to feed constant maximum level at frequencies above 1 KHz. The combination of Volumax pre-emphasis, limited amplifier headroom, zener clipping, and the de-emphasis network will produce a falling characteristic, even with the AGC action disabled.)

b. Distortion Measurements:

Harmonic distortion in the FM Volumax has been minimized for operation in the normal limiting mode.

Measured values of distortion may not be quite as low when the unit is operated at high level without compression, but nevertheless, should be within required specifications. To measure distortion; with MODULATION SET switch depressed:

1. Feed a 100 Hz signal to cause a front panel reading in the center of the normal (green) operating range. The output signal should produce a modulation level approximately 2 dB less than that established by the clipping level. (As read on the peak modulation monitor, not on a signal VTVM.)
2. Increase the OUTPUT LEVEL control setting for 100% modulation.
3. Adjust signal input and make the required FCC measurements.

SECTION IV

PRINCIPLES OF OPERATION

4-1 GENERAL

FM Volumax is functionally similar to conventional peak limiters in that it prevents over-modulation of a radio frequency carrier by instantaneous program peaks. However, the FM Volumax overcomes the handicaps inherent in peak limiters and also controls high level, high frequency signals which, because of pre-emphasis, could cause overmodulation.

Significant differences in peak factors may exist between various program waves of the same average level as indicated by a standard VU meter. When program with a high peak factor is fed into a conventional limiter, it will normally be passed at a lower gain than other program waves with a smaller peak factor, even though both programs may have the same average level. This discrepancy in volume level prevents the optimum utilization of transmitter capability and handicaps the broadcaster who is trying to achieve maximum average modulation.

Another limitation in the operation of a conventional peak limiter exists during the interval immediately following a train of program waves with high peak factor. It is during this period that the limiter is recovering from a condition of reduced gain. Thus, for a second or two, program will be transmitted at less than optimum gain. If recovery time of the limiter is reduced so that gain is increased more rapidly during this period, then the familiar "pumping" effect will be heard.

A third problem peculiar to FM broadcasting, including TV audio, is the effect of pre-emphasis on high level, high frequency signals. The standard 75 microsecond pre-emphasis curve lifts 3 KHz signals by 5 dB and 10 KHz signals by 14 dB. Consequently, if a high frequency component is present in the program signal at an amplitude similar to that of the mid and low frequency components, the pre-emphasis network will raise the level of the high frequency component considerably above that of the majority of the program. Therefore, to prevent over-modulation, the average level must be kept sufficiently low so that an adequate margin exists to accommodate the occasional high level burst of high frequency energy. The most common sources of such signals are cymbal crashes, muted trumpets and sibilant speech.

FM Volumax solves these problems in a precise and esthetically acceptable manner. It prevents overmodulation of the carrier, while providing a high level signal with no audible distortion.

FM Volumax limits audio level in three steps:

1. Limiting action operates on the low and middle frequency range of the program signal.
2. An automatically variable equalizer, the Dynamic Frequency Compensator, operates on the high frequency range of the program signal. This action is weighted by a pre-emphasis network that anticipates the effect of transmitter pre-emphasis.
3. Final instantaneous diode limiting prevents overmodulation by initial transient peaks.

4-2 CIRCUIT OPERATION (See Figures 4-1 and 4-2)

Input signal is applied through the input attenuator R-8 and input transformer T-2. Push-pull amplifiers Q4-5, rectifier CR11-12 and the variolossor network CR7-10 constitute an AGC loop which provides the first limiting action. Gain variation is achieved by changing the shunt impedance of the variolossor diodes by the control signal fed through R24. High frequency roll-off in the rectifier driver amplifier Q10-13 raises the effective threshold of limiting of frequencies above 2 KHz.

The first AGC amplifier maintains low frequency output at the correct level, but its attack time of two milliseconds precludes operation on short duration peaks, In the event that program material causes gain reduction in this loop, recovery is quite rapid to prevent a condition of unnecessarily low gain. A recovery time of 140 milliseconds is used, coinciding with the syllabic rate. At this speed no audible pumping will occur, provided the specified limits of gain reduction are not exceeded.

In order to anticipate the effect of transmitter pre-emphasis, high frequency signals are next passed through a pre-emphasis stage Q200-201. Following this is a second AGC loop consisting of amplifiers Q202-203, rectifier CR200-201, 211-212 and the Dynamic Frequency Compensator

A400388. Unlike the variollosser of the first limiting section which adjusts the amplitude of all frequency components of a complex waveform by the same amount, the Dynamic Frequency Compensator is a voltage-controlled equalizer which operates only on frequencies above 2 KHz. Rectifier time constants for the latter section are 2 and 10 milliseconds for "attack" and "recovery" times respectively. However, it should be pointed out that these terms do not describe normal gain reduction but rather changing response characteristics of the Dynamic Frequency Compensator.

Program peaks which do not significantly contribute to the average power level of the signal, and are therefore passed without gain reduction by either the variollosser or the Dynamic Frequency Compensator, are limited in amplitude finally by diodes CR208-209 at the output of amplifier Q6-9. Instantaneous action is employed here to provide an absolute amplitude limit for the passing signal, thus assuring that no overmodulation of the carrier will occur. Following the output transformer T3, a de-emphasis network, complimentary to the pre-emphasis stage Q200-201, is used to restore the low level frequency to a flat condition.

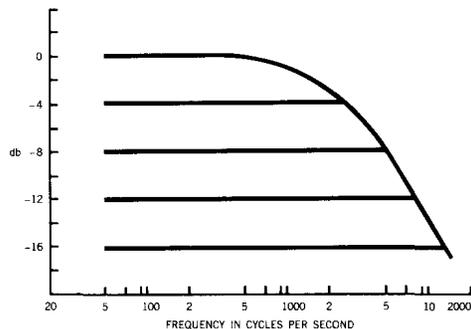


Figure 4-1 FM Volumax Amplitude Response

Figure 4-1 shows the steady-state amplitude vs frequency characteristic of the FM Volumax. For input levels 20 dB below the limiter threshold, the input-output curve is perfectly flat. Therefore, any input frequency at this level is passed through a completely flat amplifier before emerging to feed the transmitter. At the opposite extreme, consider a signal above the threshold. The output is in heavy gain reduction and the frequency response of the maximum output curve is the inverse of the response of the 75 microsecond pre-emphasis network. Consequently, the subsequent passage of the signal through the pre-emphasis network at the transmitter will raise it to precisely 100% modulation at all frequencies and no overmodulation

will result. At an intermediate level, such as 10 dB below the threshold, the output will be flat up to the frequency where pre-emphasis would normally cause overmodulation (7 KHz in this case). Above this frequency, the curve will follow the balance of the inverse 75 micro-second curve as shown in the diagram. Similarly, at other program levels, only those frequencies which would cause overmodulation of the carrier after pre-emphasis are reduced. Therefore, the resultant amount of limiting-frequency compensation of the FM Volumax is a threshold function controlled by the INPUT LEVEL attenuator. At the highest input levels some reduction of high frequencies may be apparent. During quieter program intervals, or if the input level is reduced, a lesser reduction will occur. Control action is monitored by the front panel meter. As shown in the block diagram, resistors R220 and R221 pass portions of the low and high frequency control signals, respectively. The meter thus indicates both control actions, but no scale calibration can adequately describe the situation for all high frequencies as well as for the low frequency control.

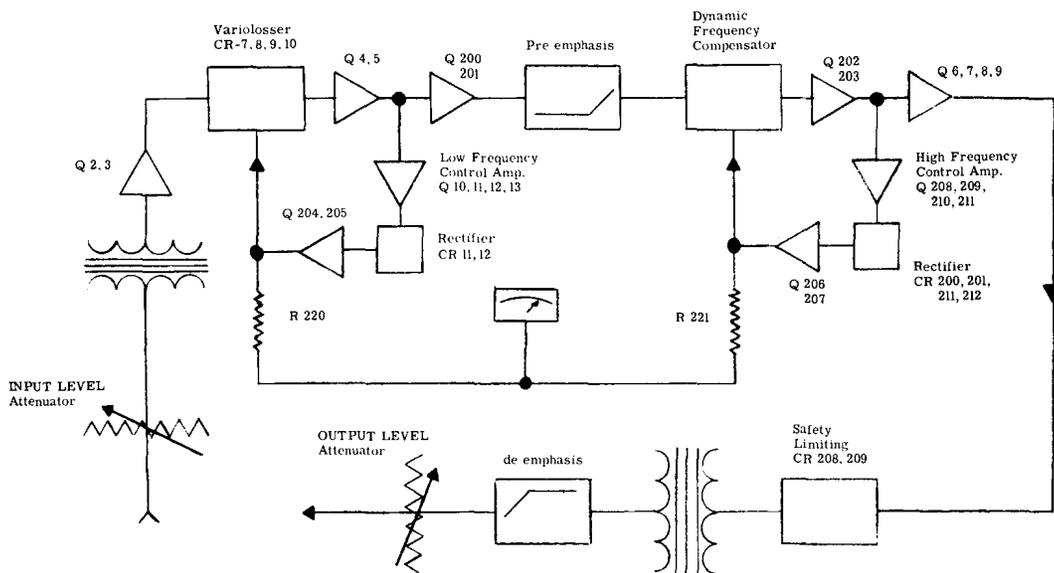


Figure 4-2. FM Volumax Block Diagram

SECTION V
MAINTENANCE

5-1 ELECTRICAL ALIGNMENT

The following steps are suggested as a comprehensive alignment procedure. Such alignment is usually performed to compensate for normal component tolerances. It should not be necessary to completely re-align your unit unless certain component changes are made. However, an occasional meter realignment or distortion improvement may be required. For these purposes steps 1, 7 and 19 through 21 may be performed separately. (See Figure 2-1 for potentiometer locations.)

1. Terminate the unit with a 600 ohm load and drive it with a 600 ohm signal source. Set INPUT and OUTPUT LEVEL controls fully clockwise. Allow unit to warm up for 15 minutes before commencing electrical alignment.
2. Apply a 100 Hz signal at 1.6 millivolts.
3. Adjust R219 for output of 0.5 volts.
4. Switch to 10 KHz, maintaining constant input. Adjust R222 for output of 0.5 volts.
5. Recheck output at 100 Hz and readjust R219 if necessary.
6. Check output at 1 KHz. It should be 0.5 volts \pm 1 dB.
7. Adjust R227 for full-scale (to the right) meter deflection. (This meter adjustment may also be made with no signal input.)
8. With input frequency of 100 Hz, increase input level to cause meter to read at red/green junction.
9. Adjust R54 for maximum output voltage.
10. Rotate R62 fully clockwise.
11. While observing output at 100 Hz on an oscilloscope, increase input to determine output level at verge of clipping. This should be 8.5 volts \pm 0.5 dB. Record this level for reference in Step 12.
12. Alternately adjust R62 and input signal to achieve an output voltage 2 dB below the output of Step 11, with the meter reading at the red/green junction.
13. Depress the MODULATION SET switch and check for symmetrical clipping. Release.

14. Increase input, forcing meter into red area. Clipping should not occur before meter goes off-scale.
15. Reduce input at 100 Hz 4 dB below that which produces a reading at the red/green junction. Note output voltage for Step 17.
16. Switch to 3 KHz. Place 10X oscilloscope probe on Point I with vertical sensitivity at 100 mv/Cm, sweep speed 50 microseconds/Cm. Adjust R254 for equal amplitude of alternate cycles. Verify that both sides of the rectifier are working by noting pulse separation. It should be 150 microseconds,
17. Adjust R262 for output voltage 6 dB below Step 15 output ± 0.5 dB.
18. Check 8 KHz, output should be 11.5 dB below Step 16 output ± 0.5 dB.
19. Switch to 1 KHz and set input level to cause reading at the center of the green region. Adjust R22 for minimum distortion.
20. Switch to 5 KHz and adjust input signal for a reading at the center of the green region. Adjust R232 for minimum distortion.
21. Change frequency for 50 Hz, set input for center of the green region, and adjust R36 for minimum distortion. (It may also be necessary to make a slight readjustment of R54.)

5-2 TROUBLESHOOTING

CAUTION:

Make sure all power is off before removing or inserting any transistors. If soldering of any component is necessary, avoid overheating by using standard heat-sink soldering practices.

Troubleshooting of any apparent malfunction of the FM Volumax should begin with a check of the power supply. DC voltage, as measured with a VTVM, should fall between the upper and lower limits as shown in Figure 5-1. Accidental shorting of the ± 20 V supply could cause Q1 to develop a collector-to-emitter short thereby impressing an unregulated +28 V at point D. If this transistor is replaced, be sure to install the heat sink on the new transistor. Check for open filter capacitors in the event of excessive 120 Hz hum. If the power supply checks

out satisfactorily, proceed with the following checks for possible trouble.

In the extreme case -- no output at all -- check input and output connections to the printed circuit boards for possible open leads. If this visual inspection does not uncover any defects, stage-by-stage signal tracing of the input and output boards is necessary.

With the input and output level controls fully clockwise, feed in a 1 KHz 10 millivolt signal. The signal at points P and R on the input board should be about 0.20 volts measured with a VTVM to ground. If this voltage appears to be incorrect, localize the trouble by removing the harness leads from P and R thereby eliminating any loading effects by the Control and AGC # 1 boards. Voltage at these points should now be 0.6 to 0.7 volts. Obtaining the correct voltage at these points would indicate a malfunction of either the control board or the AGC # 1 board. However, if this measurement does not check, then the input board must be investigated further.

With the input maintained at 10 millivolts, the following signal voltages should be present: Q2 and Q3 collectors - 70 millivolts; Q4 and Q5 bases - 10 millivolts. With correct voltages at Q2 and Q3, but incorrect at Q4 and Q5, remove harness lead from point E and observe the increase in level at Q4 and Q5 bases. If the increase is more than 4 dB, the quiescent control voltage is incorrect. This may be due to an incorrect setting of R219 or a failure of Q204 or Q205.

If transistors Q4 or Q5 are defective, replace them with a pair of transistors of beta matched to within 20%. If it is not practical to match betas, select replacement transistors such that the collector DC voltages of Q4 and Q5 differ by less than 1 volt.

Diodes CR7 and CR8 are matched as are CR9 and CR10. To match a replacement diode, feed 1 milliampere from a regulated power supply through a high resistance in series with the diode. Forward voltage drop across the diode under test must be within 10 millivolts of the other diode under the same conditions.

With the input at 10 millivolts and 1 KHz, the signal at points P2 and R2 should be approx-

imately 0.15 volts measured with a VTVM to ground. If this voltage appears to be incorrect, localize the trouble by removing the harness leads from P2 and R2 thereby eliminating any loading by the Output and AGC # 2 boards. Voltage at P2 and R2 should now be 0.6 to 0.7 volts. If the correct voltages appear at P2 and R2, the trouble probably lies in the output board. If trouble in the Control board is indicated, the following procedures should be followed.

Maintaining the input signal of 10 millivolts and 1 KHz, the following signal voltages should occur: Q200 and Q201 emitters - 200 millivolts; Q202 and Q203 collectors - 150 millivolts. With correct voltages at Q200 and Q201 but incorrect at Q202 and Q203, unsolder the green lead of the Dynamic Frequency Compensator and observe the level change at P2 and R2. If it changes more than 1 dB the quiescent control voltage is incorrect, which may be due to a failure of Q206-Q207 or an incorrect adjustment of R222.

As with the input board, if transistors Q202 and Q203 are defective, replace them with a pair of transistors of beta matched to within 20% of each other. If it is not practical to match betas, select replacement transistors such that the collector DC voltages of Q202 and Q203 differ by less than 1 volt.

If trouble with the Dynamic Frequency Compensator is indicated, a new unit must be ordered from CBS Laboratories (refer to parts list for correct part number). This unit is a balanced non-linear network and field repair is not practical.

5-3 TRANSIENT CHARACTERISTICS

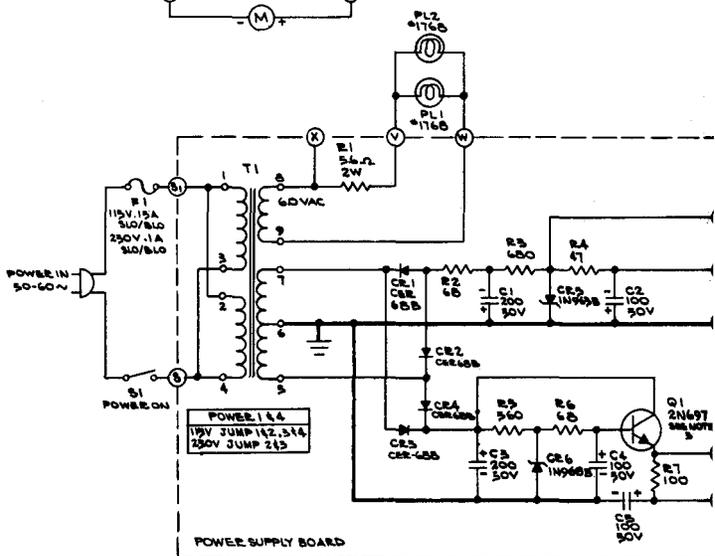
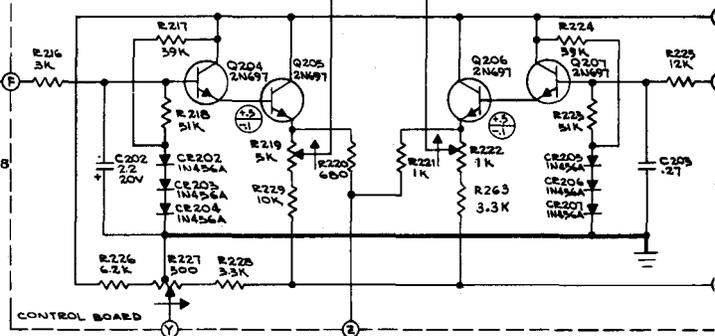
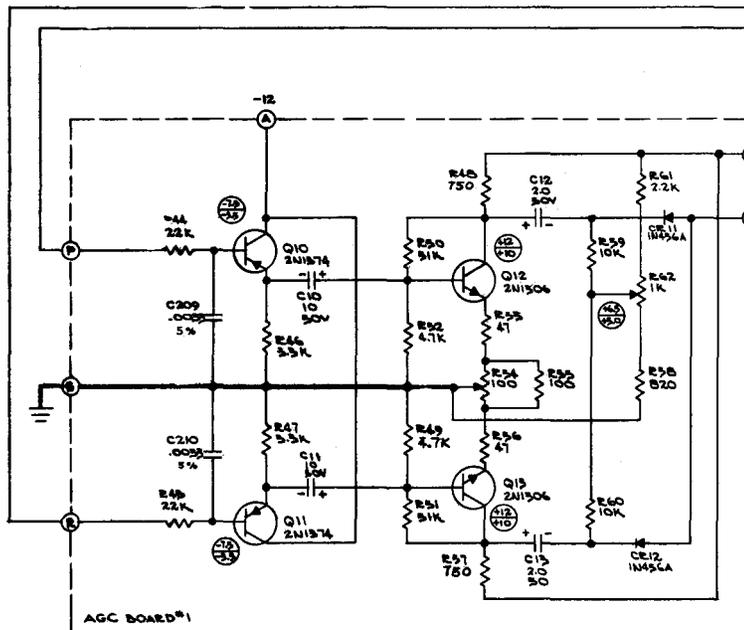
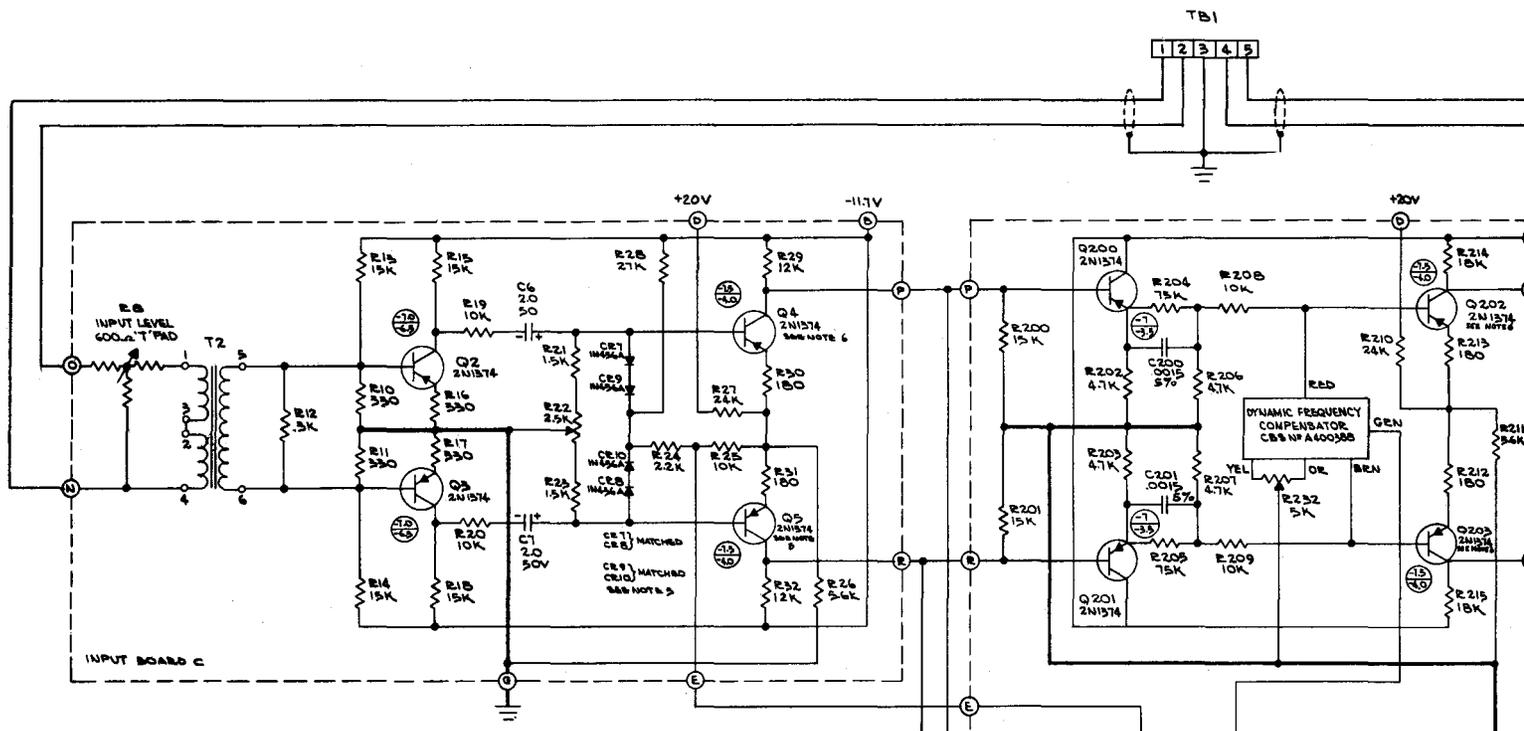
Operation of the low frequency gain reduction characteristics of the FM Volumax can be checked as follows: Turn the input and output controls fully clockwise and feed a 400 Hz signal to cause the meter to deflect a small amount into the green area. Output voltage should read 5 volts \pm 0.5 dB. A 6 dB increase in input level will deflect the meter to the red-green interface and cause approximately a 1 to 1.5 dB increase in output level. This output, when observed on an oscilloscope, should appear undistorted. Depressing the MODULATION SET switch should cause the output to increase and become squared-off. If output increases, but does not become squared-off, replace the limiting diodes CR208 and CR209. If the gain does not

increase, check the AGC # 1 and Control boards as follows: First check DC voltages of Q204 and Q205 against the schematic. Depressing the MODULATION SET switch should not alter these voltages under no-signal conditions. When feeding a 1 KHz signal at 10 millivolts, voltage present at points P and R with respect to ground will be approximately 200 millivolts rms. Gain of the AGC circuit measured to the collectors of Q12 and Q13 should be approximately 17 dB.

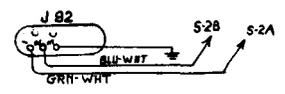
5-4 50 MICROSECOND OPERATION

To convert the FM Volumax to 50 microsecond operation, revise the following components as indicated: Change C200 and C201 (.0015 mfd) to .001 mfd capacitors, change C204 (.15 mfd) to a .05 mfd capacitor, change C209 and C210 (.0033 mfd) to .0022 mfd capacitors. Capacitors should be rated at 50 V DC, or greater.

R262 on AGC board # 2 will have to be readjusted. Feed a 500 Hz signal into the FM Volumax, driving the meter a small amount in the green region. Note the output voltage across a 600 ohm termination. Increase frequency to 5 KHz, maintaining constant input level, and adjust R262 for an output 5 dB below that noted for 500 Hz.



- Note: Unless otherwise specified
1. All resistors are 1/2 watts $\pm 5\%$
 2. All capacitors are in microfarads
 3. Transistors Q1, 8, 9, Q202 & Q203 must have required heat sinks, Wakefield Eng. Type NF-207
 4. Shown for 600 Ω operation
 5. Matching - V_{be} matched to within 10 mV at $I_c = 1$ mA
 6. Beta of Q4 & Q5 should be between 80 and 180
 7. All DC voltages measured with VTVM
 8. For stereo operation install J92 and interconnect left & right Volumax with CBS Cable Assy. No. A28715
 9. J92 pre-wired in units Ser. # 180 up



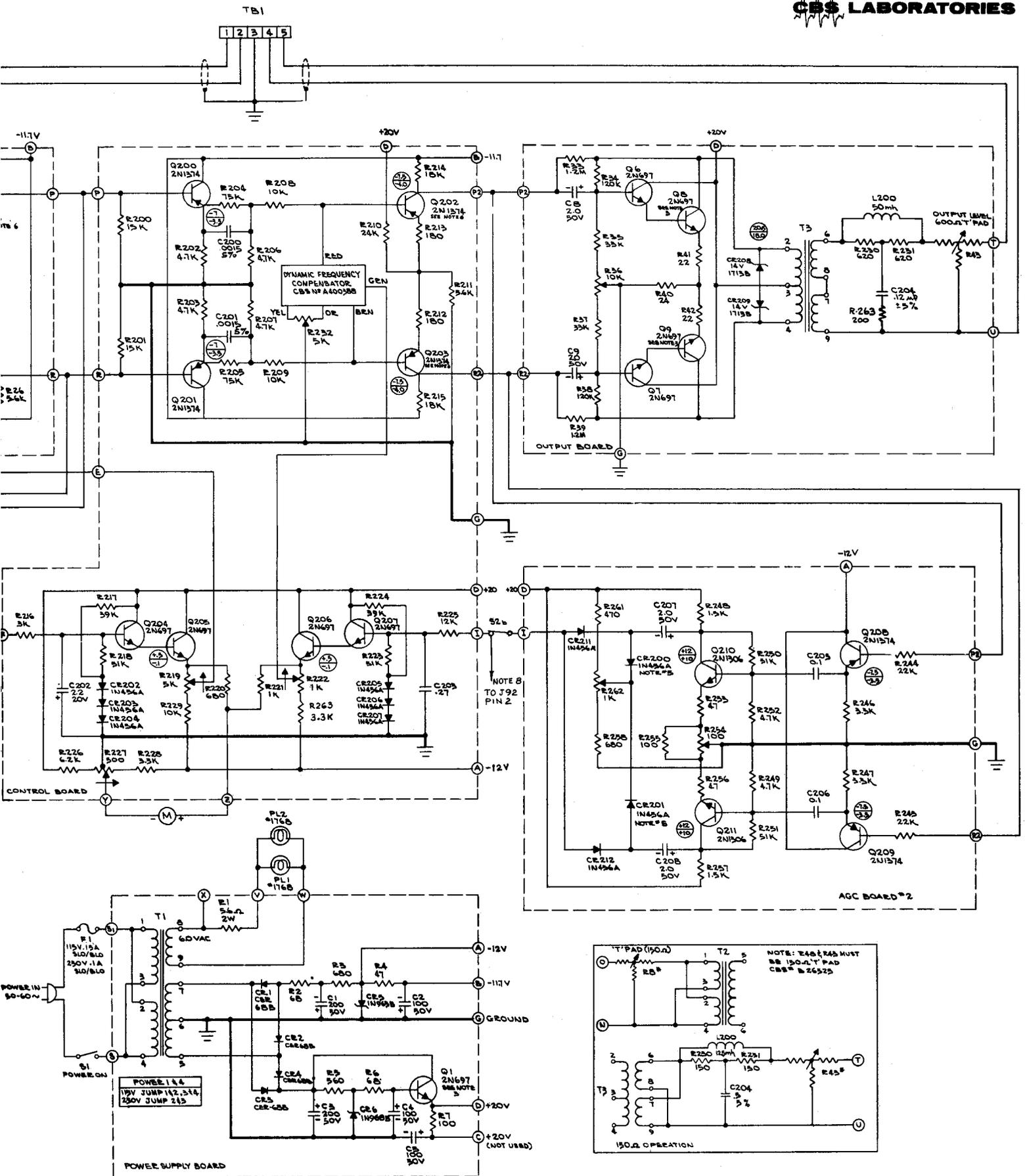


Figure 5-1 FM Volumax Schematic Diagram

SECTION VI

PARTS LIST

6-1 INPUT BOARD ASSEMBLY

T2	Input Transformer	CBS A-23935-H
C6, C7	Capacitor, Electrolytic 2 mfd; 50V	Aerovox BCD 50002 or IEI HNC-2-L-1
CR7, CR8, CR9, CR10	Diode, Silicon, Matched Pairs *	IN 456A
Q2, Q3, Q4, Q5	Transistor, Matched *	2N1374
R8	T-Pad, 600 ohms	CBS B-23982-A
R10, R11, R16, R17	Resistor, 330 ohms **	RC20GF331J
R12	Resistor, 3K	RC20GF302J
R13, R14, R15, R18	Resistor, 15K	RC20GF153J
R19, R20, R25	Resistor, 10K	RC20GF103J
R21, R23	Resistor, 1.5K	RC20GF152J
R22	Potentiometer, 2.5K, $\pm 20\%$, 1/6W	CTS XPE 200-1
R24	Resistor, 2.2K	RC20GF222J
R26	Resistor, 5.6K	RC20GF562J
R27	Resistor, 24K	RC20GF243J
R28	Resistor, 27K	RC20GF273J
R29, R32	Resistor, 12K	RC20GF183J
R30, R31	Resistor, 180 ohm	RC20GF181

6-2 POWER SUPPLY BOARD

T1	Power Transformer	CBS A-23936-G
C1, C3	Capacitor, Electrolytic, 200 mfd; 50V	IEI HPC-200-K-O
C2, C4, C5	Capacitor, Electrolytic, 100 mfd; 50V	IEI HPC-100-L-O
CR1, CR2, CR3, CR4	Diode, Rectifier, Silicon	Solitron CER-68B
CR5	Diode, Zener	IN963B
CR6	Diode, Zener	IN968B
Q1	Transistor *	2N696/2N697
R1	Resistor, 5.6 ohm, 2 W	IRC No. BWH

* Available matched from CBS Laboratories

** Unless otherwise indicated, all resistors are $\pm 5\%$, 1/2 W, Allen Bradley or equivalent.

R2, R6	Resistor, 68 ohm **	RC20GF680J
R3	Resistor, 680 ohm	RC20GF681J
R4	Resistor, 47 ohm	RC20GF470J
R5	Resistor, 560 ohm	RC20GF561J
R7	Resistor, 100 ohm	RC20GF101J

6-3 OUTPUT BOARD ASSEMBLY

T3	Transformer, Output	CBS 23934-1-H
C8, C9	Capacitor, Electrolytic, 2 mfd; 50V	Aerovox BCD 50002 or IEI HNC-2-L-1
Q6, Q7, Q8, Q9	Transistor *	2N696/2N697
R33, R39	Resistor, 1.2M **	RC20GF125J
R35, R37	Resistor, 33K	RC20GF333J
R34, R38	Resistor, 120K	RC20GF124J
R40	Resistor, 24 ohm	RC20GF240J
R41, R42	Resistor, 22 ohm	RC20GF220J
R36	Potentiometer, 10K, 1/6W ±20%	CTS XPE-200-1
R43	T-Pad, 600 ohm	CBS B-23982-A
L200	Inductor, 50MHY	Allen Organ Co. 50MHY N. C. T.
CR208, CR209	Diode	Comp. Diode 1713 B
C204	Capacitor, Mylar .12 mfd, 100V	Elmenco P91241I
R230, R231	Resistor, 620 ohm	RC20GF621J
R263	Resistor, 200 ohm	RC20GF201J

6-4 AGC BOARD ASSEMBLY # 1

C10, C11	Capacitor, Electrolytic, 10mfd, 50V	Aerovox BCD 50010 or IEI HPC-10-J-0
C12, C13	Capacitor, Electrolytic, 2mfd, 50V	Aerovox BCD - 50002
CR11, CR12	Diode	IN456A
Q10, Q11	Transistor, Matched *	2N1374
Q12, Q13	Transistor	2N1306
R44, R45	Resistor, 22K **	RC20GF223J
R46, R47	Resistor, 3.3K	RC20GF332J
R48, R57	Resistor, 750 ohm	RC20GF152J

* Available matched from CBS Laboratories

** Unless otherwise indicated, all resistors are ±5%, 1/2W, Allen Bradley or equivalent

R50, R51	Resistor, 51K **	RC20GF513J
R49, R52	Resistor, 4.7K	RC20GF472J
R53, R56	Resistor, 47 ohm	RC20GF470J
R55	Resistor, 100 ohm	RC20GF101J
R59, R60	Resistor, 10K	RC20GF103J
R61	Resistor, 2.2K	RC20GF222J
R58	Resistor, 820 ohm	RC20GF821J
R54	Potentiometer, 100 ohm, $\pm 20\%$, 1/6W	CTS-XPE 200-1
R62	Potentiometer, 1K, $\pm 20\%$, 1/6W	CTS-XPE 200-1
C209, C210	Capacitor, Mylar, .0033 mfd, 100V	Elmenco P-933211
 6-5 AGC BOARD ASSEMBLY # 2		
C205, C206	Capacitor, Mylar .1mfd, 100V	Elmenco P910411
C207, C208	Capacitor, Electrolytic, 2mfd, 50V	Aerovox BCD 50002 or IEI HNC-2-L-1
CR200, CR201, CR211, CR212	Diode	IN456A
Q208, Q209	Transistor, Matched *	2N1374
Q210, Q211	Transistor	2N1306
R244, R245	Resistor, 22K **	RC20GF223J
R246, R247	Resistor, 3.3K	RC20GF332J
R248, R257	Resistor, 1.5K	RC20GF152J
R250, R251	Resistor, 51K	RC20GF513J
R249, R252	Resistor, 4.7K	RC20GF472J
R253, R256	Resistor, 47 ohm	RC20GF470J
R254	Potentiometer, 100 ohm, 1/6W, $\pm 20\%$	CTS-XPE 200
R255	Resistor, 100 ohm	RC20GF101J
R261	Resistor, 470 ohm	RC20GF471J
R262	Potentiometer, 1K, 1/6W, $\pm 20\%$	CTS-XPE 200-1
R258	Resistor, 680 ohm	RC20GF681J

6-6 CONTROL BOARD

Q200, Q201, Q202, Q203	Transistor, Matched *	2N1374
Q204, Q205, Q206, Q207	Transistor *	2N696/2N697

* Available matched from CBS Laboratories

** Unless otherwise indicated, all resistors are $\pm 5\%$, 1/2W, Allen Bradley or equivalent

Z1	Assembly, Dynamic Frequency Compensator	CBS -A400388
CR202, CR203, CR204, CR205, CR206, CR207	Diode	IN456A
C200, C201	Capacitor, Mylar .0015 mfd, 100V	Elmenco P-915211
C202	Capacitor, Tantalex, 2.2mfd, 20V	Sprague 150D225X9020AO
C203	Capacitor, Tantalex, .27 mfd, 35V	Sprague 150D274X9035A0
R208, R209, R229	Resistor, 10K **	RC20GF103J
R202, R203, R206, R207	Resistor, 4.7K	RC20GF472J
R204, R205	Resistor, 75K	RC20GF753J
R210	Resistor, 24K	RC20GF243J
R211	Resistor, 5.6K	RC20GF562J
R212, R213	Resistor, 180 ohm	RC20GF181J
R214, R215	Resistor, 18K	RC20GF183J
R216	Resistor, 3K	RC20GF302J
R217, R224	Resistor, 39K	RC20GF393J
R218, R223	Resistor, 51K	RC20GF513J
R219, R222, R232	Potentiometer, 5K, 1/6W, $\pm 20\%$	CTS XPE-200-1
R220	Resistor, 680 ohm	RC20GF618J
R221	Resistor, 1K	RC20GF102J
R225	Resistor, 12K	RC20GF123J
R226	Resistor, 6.2K	RC20GF622J
R227	Potentiometer, 500 ohm	CTS XLE-47-1
R228	Resistor, 3.3K	RC20GF332J
R200, R201	Resistor, 15K ohms	RC20GF153J
 6-7 MISCELLANEOUS PARTS		
S1	Switch, toggle SPST	Cutler-Hammer 8381-K7 C-H
S2	Switch, toggle 2 PST N. C. momentary	AH & H 81054-Q
F1	Fuse, 3AG .15 amp. Slo Blo	Littlefuse 313.150
PL1, PL2	Lamp, 6V	Chic. Min. or G. E. 1768
M-1	Meter IMAFS, with special CBS face.	CBS A26501-A
	Connecting Cable, For stereo operation	CBS 200354

** Unless otherwise indicated, all resistors are $\pm 5\%$, 1/2W, Allen Bradley or equivalent