

JBL 5234A INSTALLATION AND SERVICE MANUAL

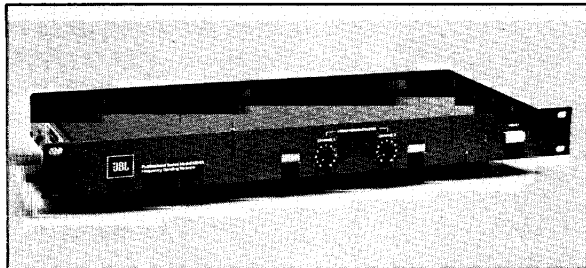


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ARCHITECTURAL SPECIFICATIONS

The electronic frequency dividing network shall contain two channels, each with low-level active filters that separate the program into low and high frequency bands at designated crossover frequency points. Each channel shall have a transformerless, differential amplifier input and separate buffer amplifiers for its low and high frequency outputs. Input and output connections shall be made via either 1/4 inch (6.3 mm) phone jacks or screw terminals provided on the unit's rear panel.

Crossover frequency selection shall be accomplished by internally mounted plug-in circuit modules, one per channel. Each module shall be designated with the crossover frequency, printed in such a position as to be easily read through a window in the unit's front panel. The designated crossover frequency shall be the point at which the slopes of the pass band curves cross, and where each is 3 dB down from the average pass band output level; this point shall be within $\pm 10\%$ of the designated frequency. A variety of modules shall be available, not only with different crossover frequency points, but also with 12 dB or 18 dB per octave filter slopes. Blank plug-in modules shall be available, allowing for the installation of suitable capacitors and resistors to achieve custom crossover frequency points.

In addition, internally switch selectable low frequency equalization and subsonic filtering shall be provided for each channel, enabling low frequency response to be optimized while blocking subsonic energy below the lowest usable speaker frequency. These dual in line switches shall allow the following programmable options, all with 12 dB per octave slope rates (except the flat response setting):

- Flat frequency response (e.g., no L.F. cut-off filter).
- 20 Hz high pass filter, $Q = 0.707$ (Butterworth).
- 20 Hz high pass filter, $Q = 2$ (6 dB boost at 20 Hz).
- 30 Hz high pass filter, $Q = 0.54$.
- 30 Hz high pass filter, $Q = 0.84$.
- 30 Hz high pass filter, $Q = 2$ (6 dB boost at 30 Hz).
- 40 Hz high pass filter, $Q = 0.707$ (Butterworth).
- 40 Hz high pass filter, $Q = 2$ (6 dB boost at 40 Hz).

The internal switching shall also allow both channels' low frequency outputs to be combined into a monaural signal which, with an appropriate crossover frequency, is suitable for driving a subwoofer channel while the high frequency outputs drive a full-range stereo speaker system.

The unit shall fit in a 44 mm (1-3/4 inch) high space in a standard 483 mm (19 inch) equipment rack. Recessed front-panel adjustments shall be provided for the high frequency output level of each channel. A recessed rear panel slide switch shall allow operation with nominal 100 to 120 V

WARNING: To prevent fire or shock hazard, do not expose this unit to rain or moisture.

AC or 200 to 240 V AC power mains.

The unmodified frequency response of the dividing network shall be 20 Hz to 20 kHz, ± 0.5 dB. Distortion shall be less than 0.01% THD at +18 dBV* into 100 kohms or greater, or 0.03% THD at +18 dBV into a 600 ohm load. Signal-to-noise ratio shall be greater than 90 dB, measured over a 20 Hz to 20 kHz equivalent bandwidth. Isolation between channels shall be greater than 70 dB.

The electronic frequency dividing network shall be a JBL Model 5234A.

PRODUCT SPECIFICATIONS

ELECTRICAL

Gain

0 dB in the pass band

Rated Output Level

6.2 V rms (+18 dBV*) measured with 20 Hz to 20 kHz equivalent bandwidth filter

Distortion

0.01% THD, 20 Hz to 20 kHz @ +18 dBV into a load greater than 10 Ω

Frequency Response

± 0.5 dB, 20 Hz to 20 kHz (high-pass functions disengaged)

Input Impedance

Greater than 50 Ω , transformerless differential amplifiers for balanced or unbalanced line level sources

Output Source Impedance

50 ohms, unbalanced

Output Load Impedance

600 ohms or greater

Channel Isolation

Greater than 70 dB, 20 Hz to 20 kHz

Signal/Noise Ratio

Greater than 90 dB, 20 kHz equivalent bandwidth

Controls

CH1 & CH2 High Frequency Level (front)

Power On/Off (front)

CH1 & CH2 Subsonic Filter Characteristic (internal)

Line Voltage Selector (rear)

Crossover Frequency & Filter Slope

Selectable by plug-in modules, 12 dB or 18 dB/octave, at factory determined frequencies ($\pm 10\%$), special modules for certain JBL monitor speakers, or at customer determined frequencies (via blank plug-in modules)

NOTE: One module is required for each channel, the unit comes from the factory with "jumper" modules that pass the signal unfiltered so the unit functions a 1:2 line amplifier.

12 dB/octave		18 dB/octave	
Model 52-	Freq.	Model 51-	Freq.
5120	Blank	5130	Blank
5121	250 Hz	5132	500 Hz
5122	500 Hz	5133	800 Hz
5123	800 Hz	5145 (Special for	JBL 4345 & 4355)
5124	1200 Hz		
5125	5000 Hz		
5127	7000 Hz		
5130 (Special for JBL 4430 & 4435)			
5140 (Special for JBL 4343 & 4350)			

*The 0 dBV reference is 0.775 V rms. Across a 600 ohm load, this voltage represents a power level of 1 mW (0 dBm).

High Pass Filter (Subsonic Cutoff)

12 dB per octave rolloff, the cutoff frequency and Q switch selectable

NOTE: These characteristics are switch selectable via the internal DIP switches, one per channel.

Filter Frequency	Level at Filter Frequency	Filter Q
20 Hz	-3 dB	0.707
20 Hz	+6 dB	2.0
30 Hz	-5.5 dB	0.54
30 Hz	-1.5 dB	0.84
30 Hz	+6 dB	2.0
40 Hz	-3 dB	0.707
40 Hz	+6 dB	2.0

Power Requirements

6 watts, 100 – 120 or 200 – 240 V AC, 50 or 60 Hz

Operating Temperature

5° C (41° F) to 55° C (132° F)

PHYSICAL

Mounting Dimensions

44 mm x 483 mm x 194 mm deep
(1-3/4 in x 19 in x 7-5/8 in deep)

Net Weight

1.8 kg (4 lb)

Shipping Weight

3.0 kg (6-1/2 lb)

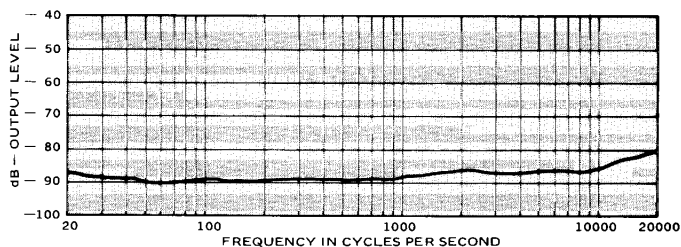


Figure 1 – Total Harmonic Distortion
(Distortion components in dB below +18dBV output)

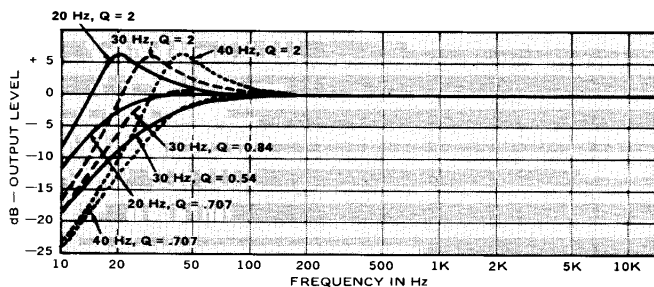


Figure 2 – 5234A Low Frequency Cutoff Characteristics
(Selectable each channel by means of internal switches)

JBL continually engages in research related to product improvement. New material, production methods and design refinements are introduced into existing products without notice as a routine expression of that philosophy. For this reason, any current JBL product may differ in some respect from its published description, but will always equal or exceed the original design specifications unless otherwise stated.

INSTALLATION

WARNING: In many cases, installation of the JBL 5234A Electronic Frequency Dividing Network involves opening the cover to gain access to internal circuit modules and programming switches. In addition, conversion of the line voltage may involve installation of a new power cord. Since dangerous AC voltages exist inside the unit, caution must be exercised. These instructions are intended for use by qualified service personnel only.

Installation of Standard Crossover Frequency Modules

The dividing network is shipped with a pair of 52-5120 crossover modules (cards), each with two 100 ohm resistors that convert each channel into a one-input, two-output unity gain distribution amplifier. The two cards therefore equip the 5234A to function as a pair of independent one-input, two-output amplifiers; the network inputs can be paralleled to provide four outputs from a single source. The HIGH outputs will be at unity gain when the HIGH FREQUENCY LEVEL controls are set at maximum (the controls can be turned down if loss is desired).

Prior to its use as a frequency dividing network, these jumpered "blank" cards must be removed from the 5234A and the appropriate frequency selection cards must be installed in their place. To install the cards:

1. Place the 5234A upside down on a soft surface, remove the two Phillips-head screws from either side of the case, and lift the bottom cover from the chassis (Figure 3).
2. Remove the old crossover cards by lifting both sides of a card simultaneously and gently (Figure 4). Friction from the three mounting pins and the electrical connector must be overcome.
3. Align the three holes in each new crossover card with the corresponding mounting pins on the main printed circuit board (Figure 5). The components on the card should face toward the chassis, with the frequency designation label toward the front panel.
4. As each card is gently pressed against the mounting pin stops (roughly 6 mm, 1/4 in), electrical connection will be made between the card connector and six pins on the printed circuit board.
5. Unless LF programming is to be reset (refer to next topic in this manual), replace the bottom cover, observing the proper orientation. The cover will not seat properly in the chassis if rotated 180°. Secure the cover with the four screws. The unit is now ready for mounting and connection of the various inputs and outputs.

NOTE: Operation of the 5234A without a crossover card will not damage the unit, although neither will it pass any audio signals.

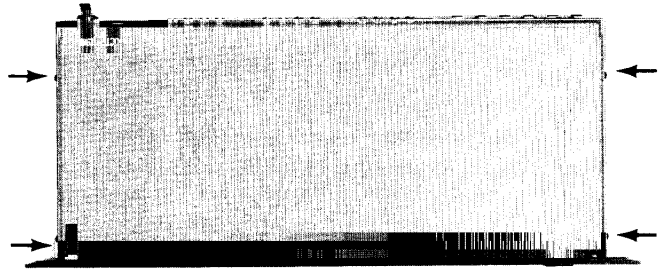


Figure 3 — Remove These Screws to Lift Off the Bottom Cover

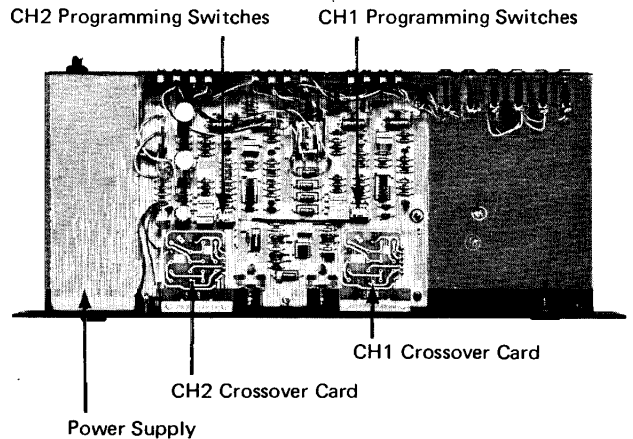


Figure 4 — Identification of Major Components Inside 5234A

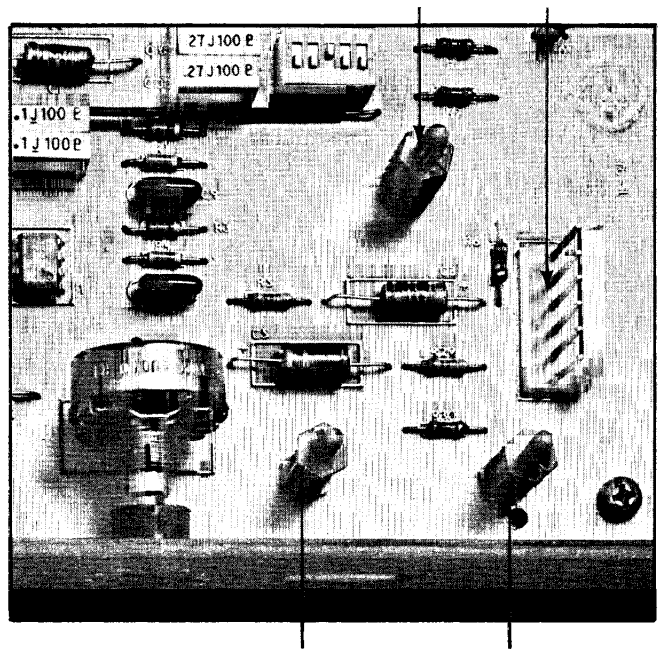


Figure 5 — Carefully Align Crossover Card with Three Mounting Pins & Male Chassis Connector

NOTE: Information regarding the capacitor and resistor values necessary to "make up" 12 dB/octave and 18 dB/octave cards, as well as the components used on standard JBL cards, is given near the end of this manual.

Programming the Internal High-Pass Filters

Inside the 5234A, each channel is equipped with a miniature bank of five On-Off slide switches. Each bank of sliders is housed in small rectangular package resembling an integrated circuit, and since the multi-switch housing has two rows of pins which secure it to the circuit board, it is known as a dual in-line pin switch (hence "DIP"). Each of the two DIP switches performs the identical functions, one for Channel 1 and the other for Channel 2 (Figure 4).

Of the five sliders on each DIP switch, #1 through #4 determine the high-pass filter characteristics of the channel, while #5 is reserved for creating a monaural low frequency output for the two channels (Figure 6).

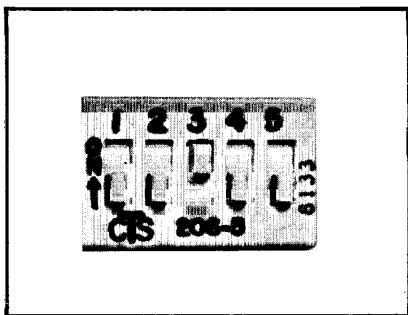


Figure 6 – One of the Two DIP Switches that Allow Programming of the Model 5234A Low Frequency Characteristics

The 5234A is shipped with the switches set for flat low frequency response and discrete low frequency outputs. In the Setup and Operation section of this manual, considerations in selecting the various low frequency cutoff characteristics are discussed. If a characteristic other than the factory preset is desired, it can be established as follows:

1. Place the 5234A upside down on a soft surface, remove the two Phillips-head screws from either side of the case, and lift the bottom cover from the chassis (Figure 3).

CAUTION: The 5234A AC power cord should not be connected to the power receptacle. Also, any power amplifiers to which the Frequency Dividing Network may be connected should be turned Off during this procedure.

2. Locate the DIP switch(es) for the channel(s) to be programmed.

NOTE: In a triamplified system, use high-pass filtering only on the channel used for the low-mid/high transition; the mid/high channel should be set for flat response. In a bi-amplified system with a mono subwoofer, both channels' DIP switch "mono" sliders must be engaged.

3. Set the DIP switch(es) according to the information in Figure 7.

4. Replace the bottom cover, observing the proper orientation. The cover will not seat properly in the chassis if rotated 180°. Secure the cover with the four screws. The unit is now ready for mounting and connection of the various inputs and outputs.

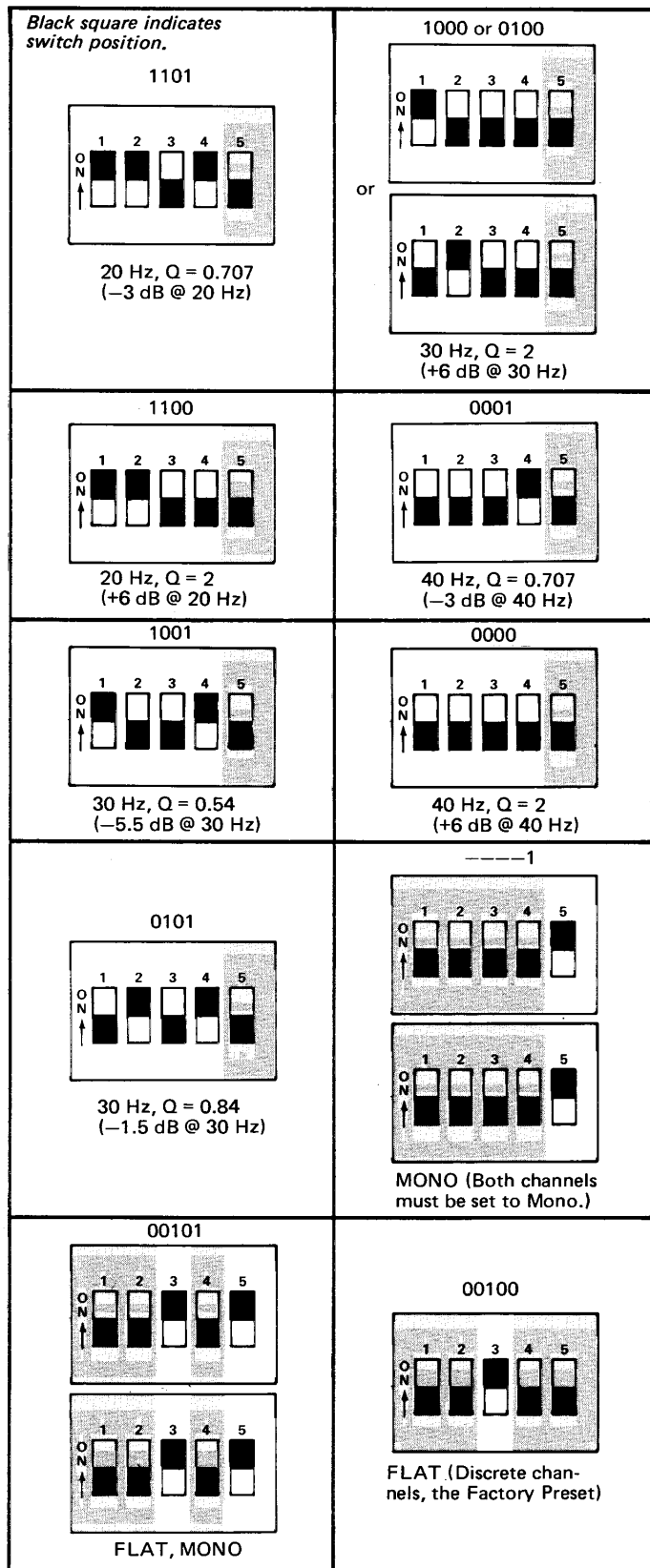


Figure 7 – DIP Switch Programming for the Various High-Pass Filter Characteristics, & Mono Mode

NOTES:

1. Curves are labeled by a binary code. A "1" = ON (switch closed), and a "0" = OFF (switch open).
2. Bit positions #1 and #2 select the cutoff frequency.
3. Bit position #3, when closed, gives flat response.
4. Bit position #4, when closed, lowers the Q.
5. Bit position #5, when closed on both channels, combines the LF outputs to a mono summed signal.
6. Shaded areas are not relevant to function being described.

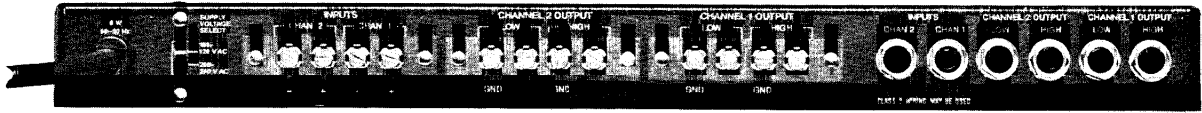


Figure 8 – Model 5234A Rear Panel

Mounting

The 5234A is suitable for mounting in one EIA standard rack space without additional bracing or ventilation. A full set of mounting hardware is included. Alternatively, the unit may be placed on a shelf or counter top. As with any low level signal processing electronics, it is advisable not to mount the unit near a strong source of stray electromagnetic fields, such as immediately next to the power transformer or a large amplifier. In any installation, bear in mind that all external connections are made on the rear panel, and the maximum allowable ambient temperature for the unit is 55°C (132°F).

Input Connections

Input connections to the 5234A may be either unbalanced or symmetrical (i.e., floating or balanced). Clearly labeled screw terminals and parallel-wired phone jacks on the rear panel accept the line level input to each channel (Figure 8). The phone jacks are 6.3 mm (1/4 in) diameter 3-circuit type, wired so the tip is for audio high, the ring is for audio low, and the sleeve is for shield ground. With a balanced or floating source, use a 3-circuit ("stereo" type) phone plug. With an unbalanced source, the ring and sleeve of the 3-circuit plug must be shorted; this is automatically accomplished by instead using a standard 2-circuit phone plug.

NOTES:

1. Exchange of the HIGH (+) and LOW (-) connections will result in a reversal of signal polarity.
2. Figures 9, 10 & 11 illustrate balanced or floating input and output connections. Figures 18 through 20 illustrate wiring for typical installations.

Output Connections

The 5234A outputs are unbalanced, delivering up to 6.2 V rms into a 600 ohm or higher impedance load (+18 dBv). Each channel has a HIGH frequency and LOW frequency output, and each of these outputs is available at two points on the rear panels: a set of screw terminals or a parallel-wired phone jack (Figure 8). The phone jacks are 6.3 mm (1/4 in) diameter 2-circuit type, wired so the tip is for the audio signal and the sleeve is for the common (shield ground).

Use Floating or Balanced Cables for Longer Runs

Shielded cables are required for all input and output signals. If the output cable lengths are greater than 4.5 m to 6 m (15 to 20 ft), we recommend installing isolation transformers (600Ω : 600Ω) at each end of the cable. This allows dual-conductor shielded cable to be used in a floating mode, greatly reducing the possibility of radio frequency interference (RFI) or hum. If the amplifier to which the 5234A output is connected has a balanced or floating input, only one transformer need be installed — at the end of the cable connected to the 5234A output.

Similarly, longer input cables should be balanced or floating to reduce susceptibility to RFI and hum. If the output of the device feeding the 5234A is balanced or floating, no transformer is required at all; simply use a dual-conductor shielded cable. If the input source is unbalanced, an isolation transformer should be used at the source device's output.

With shorter cables, particularly where interconnected equipment is mounted in a single rack or is powered by the same AC receptacle, there is less need for balanced or floating input and output cables.

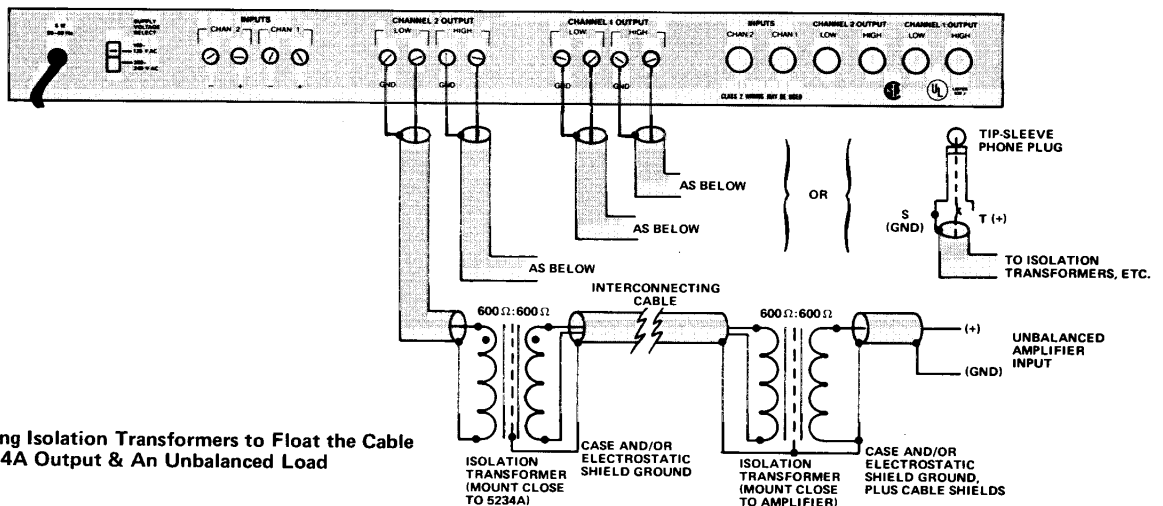


Figure 9 – Using Isolation Transformers to Float the Cable Between a 5234A Output & An Unbalanced Load

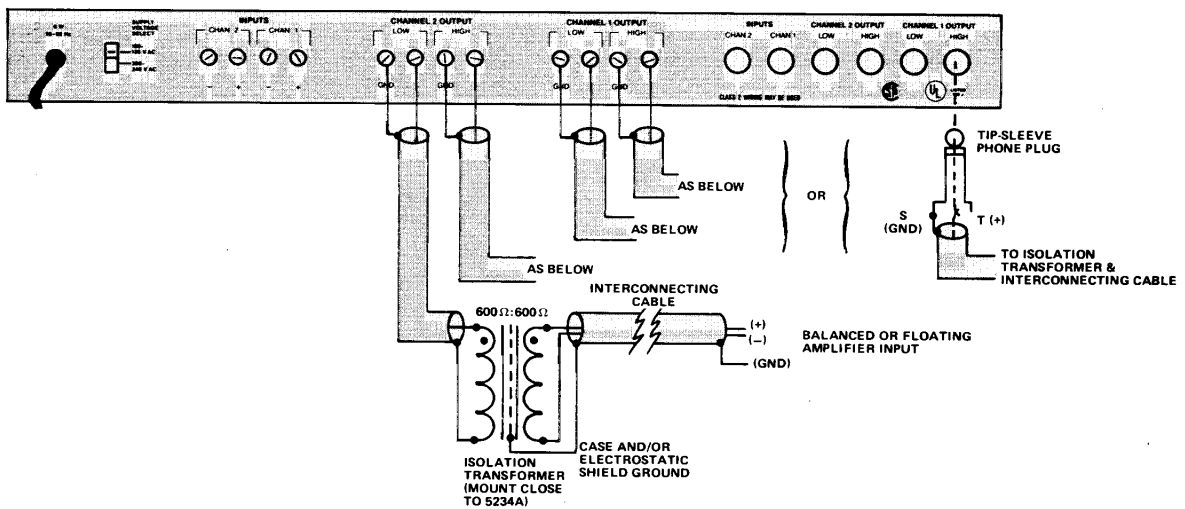


Figure 10 – Using An Isolation Transformer to Float (or Balance) the Cable Between a 5234A Output & a Floating (or Balanced) Load

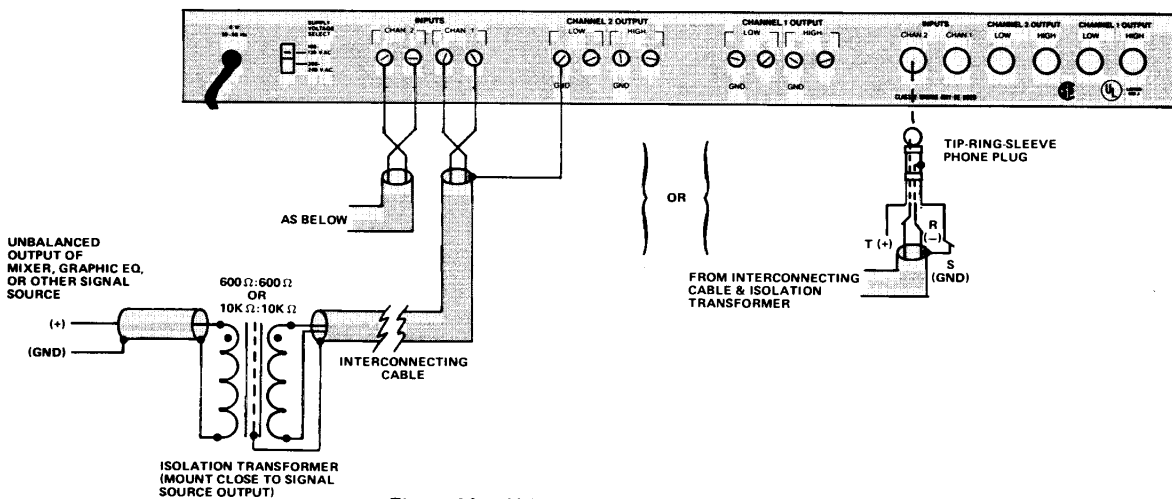


Figure 11 – Using An Isolation Transformer to Float the Input Cable to the 5234A

AC Power Connection & Line Voltage Conversion

The 5234A can be powered from either 100 to 120 V AC or 200 to 240 V AC 50 or 60 Hz mains. The SUPPLY VOLTAGE SELECT switch on the rear panel converts the unit from one operating range to the other (Figure 8). As shipped, the unit is set for 100 to 120 V AC operation, and the line cord provided is suitable for use in the U.S., Canada or Japan. To convert the unit for operation with other mains voltages or outlet types, use the following procedure.

1. Be sure the 5234A is not connected to any power source.
2. Slide the SUPPLY VOLTAGE SELECT switch to the appropriate range.
3. Execute one of these two alternatives:
 - a) Remove the bottom cover by removing the two small Phillips head screws on each side of the case, (Figure 3) and change the line cord to one whose attachment plug matches the power receptacle. Secure the new cord to the chassis with a feed through cable clamp. Also,

be sure to solder the high, neutral and ground conductors to the same terminals from which the corresponding conductors of the original cord were removed.*

— or —

- b) Install a suitable adapter to mate the plug on the existing line cord with the power receptacle.

NOTE: Any line cord or adapter used for 200-240 V operation in the U.S., Canada or Japan must be both U.L. listed and C.S.A. certified. For 240 V AC, 50/60 Hz operation in other countries, select a line cord based on governing local regulations.

CAUTION: This unit may be damaged if operated with the supply voltage select switch set incorrectly for the line voltage applied. Also, verify the mains are AC since, in some countries as well as certain areas within the U.S., DC mains exist.

*In U.S.A. versions, the black wire is "hot", the white wire is "neutral," and the green wire is ground. In European versions, blue is "hot", brown is "neutral," and green/yellow is ground.

Protection of Compression Drivers

Whenever a midrange or high frequency compression driver is connected directly to a power amplifier, it is recommended that a capacitor be wired in series with the driver in order to attenuated unwanted low frequency and switching transient signals, and to block DC components, any of which can damage the driver. This applies to most biamplified and triamplified systems employing compression drivers. (In conventional systems with passive, high-level dividing networks, the network comes between the power amplifier and the driver(s) so the protection is already built-in.)

NOTES:

1. In all JBL monitors which are designed for biamplification, the dividing networks already incorporate the required attenuation capacitors between the input(s) and the compression driver(s).

2. Series capacitors are not required for low frequency and midrange cone or dome type transducers.

CAUTION: It is imperative that each output of the 5234A electronic frequency dividing network be properly connected. Inadvertent exchange of low and high frequency output connections (at the 5234A, the power amplifiers, or the transducers) may result in severe damage to midrange or high frequency loudspeaker system components. If in doubt, always test the low frequency loudspeaker(s) first, since the presence of high frequencies there will be less apt to cause damage than the converse.

The low frequency series protection capacitors should be non-polarized electrolytics, either mylar, metallized polyester or polyester type with working voltages of at least 50 V. DO NOT USE POLARIZED ELECTROLYTIC CAPACITORS. Maximum capacitance depends not only on the crossover frequency used for the driver, but also on the driver's impedance, as listed in Table 1. Suitable 10% tolerance capacitors are available directly from a JBL professional products dealer or JBL directly; the recommended values for specific cutoff frequencies, and their JBL part numbers, are listed in the Table 2.

Crossover Frequency	Capacitor Values (Driver Impedance)		
	16Ω	8Ω	4Ω
250 Hz to 500 Hz	40μF	80μF	150μF
500 Hz to 5000 Hz	20μF	40μF	80μF
Above 5000 Hz	2μF	5μF	8μF

Table 1: Maximum Values for Low Frequency Attenuating Protection Capacitors

Capacitor Value	JBL Part Number	For Optimum Results at These Crossover Frequencies (Based on Driver Impedance)		
		16Ω	8Ω	4Ω
72 μF	52938	275 Hz	550 Hz	1100 Hz
52 μF	52939	400 Hz	750 Hz	1500 Hz
20 μF	53881	1000 Hz	2000 Hz	4000 Hz
16.5μF	10358	1200 Hz	2500 Hz	5000 Hz
13.5μF	10359	1500 Hz	3000 Hz	6000 Hz
12 μF	10434	1700 Hz	3500 Hz	7000 Hz
8 μF	10391	2500 Hz	5000 Hz	10000 Hz
7 μF	57529	3000 Hz	6000 Hz	11000 Hz
6 μF	10296	3500 Hz	7000 Hz	13000 Hz
4 μF	41040	5000 Hz	10000 Hz	----
3 μF	11937	7000 Hz	13000 Hz	----

Table 2: JBL Protection Capacitors for Compression Drivers

NOTES:

1. The optimum value cited in Table 2 assumes that the capacitor is active at approximately one octave below the listed crossover frequency, assuring minimum acoustical interference with crossover region performance while maintaining a good degree of protection.

2. Somewhat smaller capacitor values may be required for additional protection in high-power sound reinforcement systems.

3. To shunt the reactive component of the compression driver's impedance below horn cutoff, a 50 W resistor having a value of two to three times the rated impedance of the compression driver should be connected across the driver's terminals.

CAUTION: Below the cutoff frequency of the capacitor, the power amplifier will be unterminated. If the power amplifier has an output transformer (typical of vacuum tube amps and some solid state amps designed to drive constant voltage lines), a 20 W resistor equal to ten times the compression driver impedance should be installed across the amplifier output terminals.

SETUP & OPERATION

General Applications

When used for two-channel bi-amplification, each channel INPUT of the 5234A receives the full-range program signal from a line level source such as a preamplifier, mixing console or graphic equalizer. Identical frequency selection modules are installed in both channels, and the dividing network separates each of the two channel's signals into high and low frequency bands. Each channel's LOW and HIGH outputs then feed individual power amplifiers (or discrete amplifier channels), which in turn drive their respective loudspeaker components.

The 5234A also may be used as a dividing network for a single channel of tri-amplification. In this application, Channel 1 of the 5234A receives the full-range program signal, and separates it into two bands, one consisting of low and mid frequencies, the other of high frequencies only. The Channel 1 HIGH output then feeds the amplifier which drives the high frequency driver, while the Channel 1 LOW output (carrying low and mid frequencies) is connected to the 5234A's Channel 2 INPUT. The Channel 2 crossover point is chosen to fall in the region where the low frequency loudspeaker's operating range ends and the midrange driver's operating range begins. Therefore, Channel 2's LOW output is suitable for feeding the amplifier which drives the low frequency loudspeaker, while its HIGH output is suitable for feeding the amplifier which drives the midrange driver. In this way, the CHANNEL 2 HIGH FREQUENCY LEVEL control becomes a midrange driver level control and is independent of the CHANNEL 1 HIGH FREQUENCY LEVEL control, which affects only the high frequency driver.*

As a convenience, the 5234A is supplied with "blank" frequency dividing modules that have jumper resistors installed in such a way that the input signal is split and fed to the channel's HIGH and LOW outputs. As such, the 5234A operates as a fully buffered dual distribution amplifier (described in the Installation section of this manual). While this is not the primary purpose of the unit, the capability can be useful when it is necessary to split a signal and drive separate lines and prevent any short or noise source on one line from causing problems on the other.

Typical Systems Employing the 5234A

Figures 12 and 13 illustrate conventional loudspeaker/amplifier systems for reference. Figures 14 through 17 depict various bi-amplified and tri-amplified systems; these show typical examples of 5234A applications, although by no means are they all-inclusive. Figures 18 through 20 provide wiring details for typical systems.

*The frequency division could be done differently, with one channel handling the low-to-mid/high transition, and that channel's HIGH output feeding the second channel, which handles the mid-to-high transition. In that case, however, the HF LEVEL control of the first channel would affect both the midrange and high frequency drivers, while the HF LEVEL control of the second channel would affect only the high frequency driver. The scheme presented here avoids this overlapping of function, preserving discrete control for the midrange and high frequency drivers.

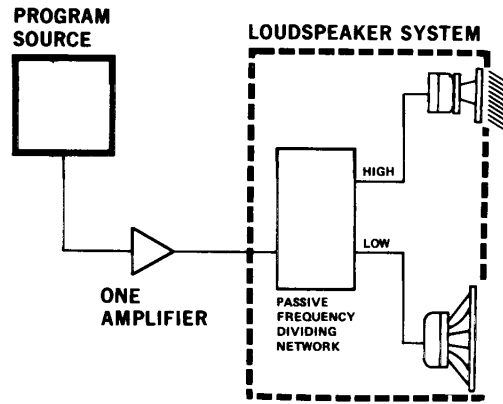


Figure 12 – Conventional Two-Way System (Passive Network)

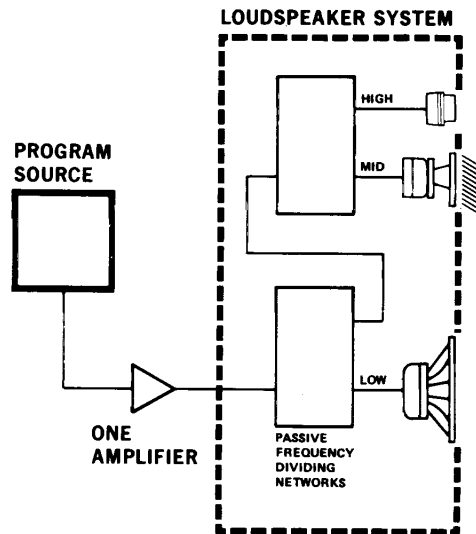


Figure 13 – Conventional Three-Way System (Passive Network)

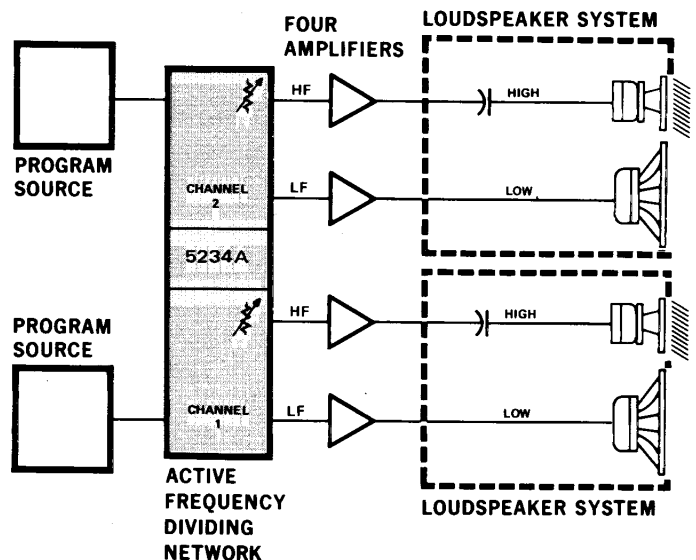


Figure 14 – Dual Channel Two-Way System (Bi-amplified)

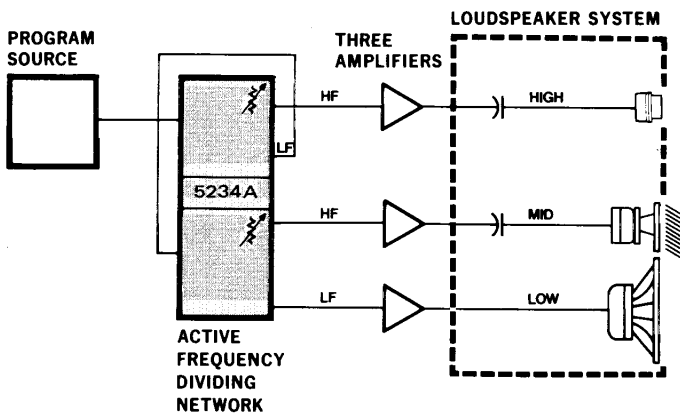


Figure 15 – Single Channel Three-Way System (Triamplified)
(Duplicate this setup for a stereo three-way system.)

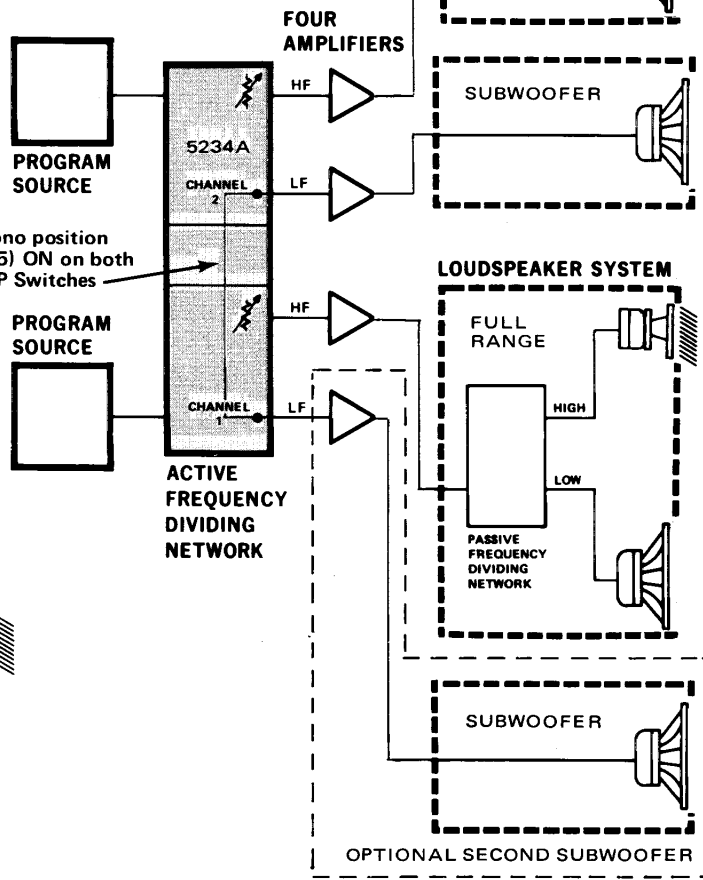
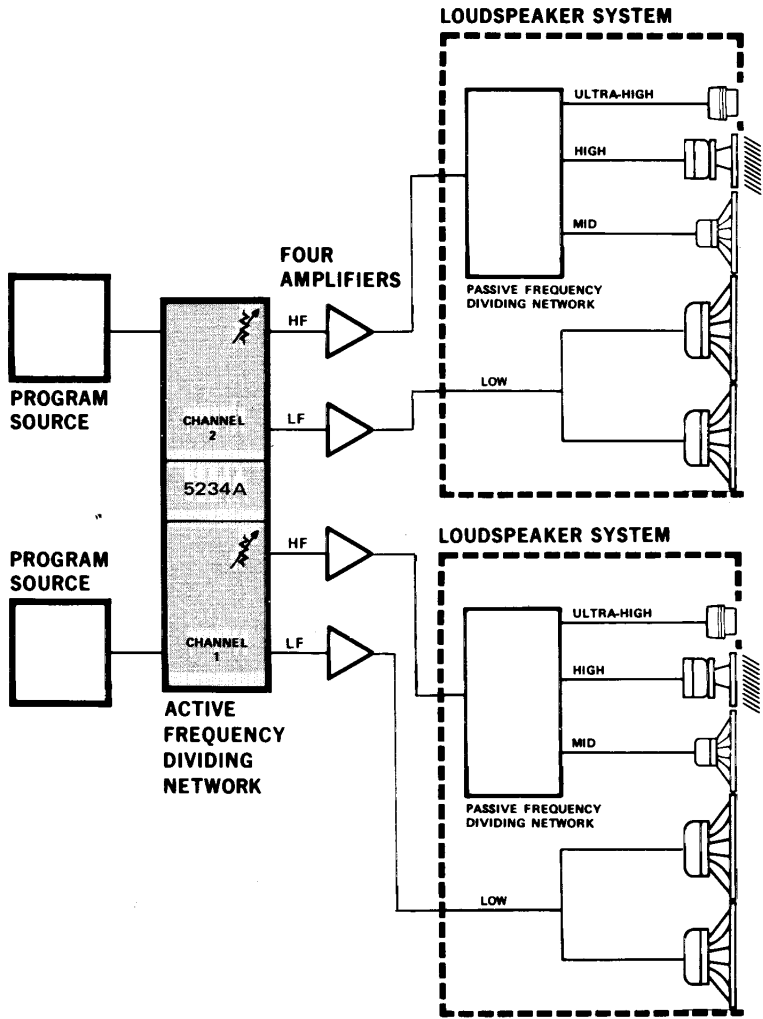


Figure 16 – Dual Channel Two-Way System with Monaural Subwoofer(s)

Figure 17 – Combining Electronic & Passive Frequency Dividing Networks



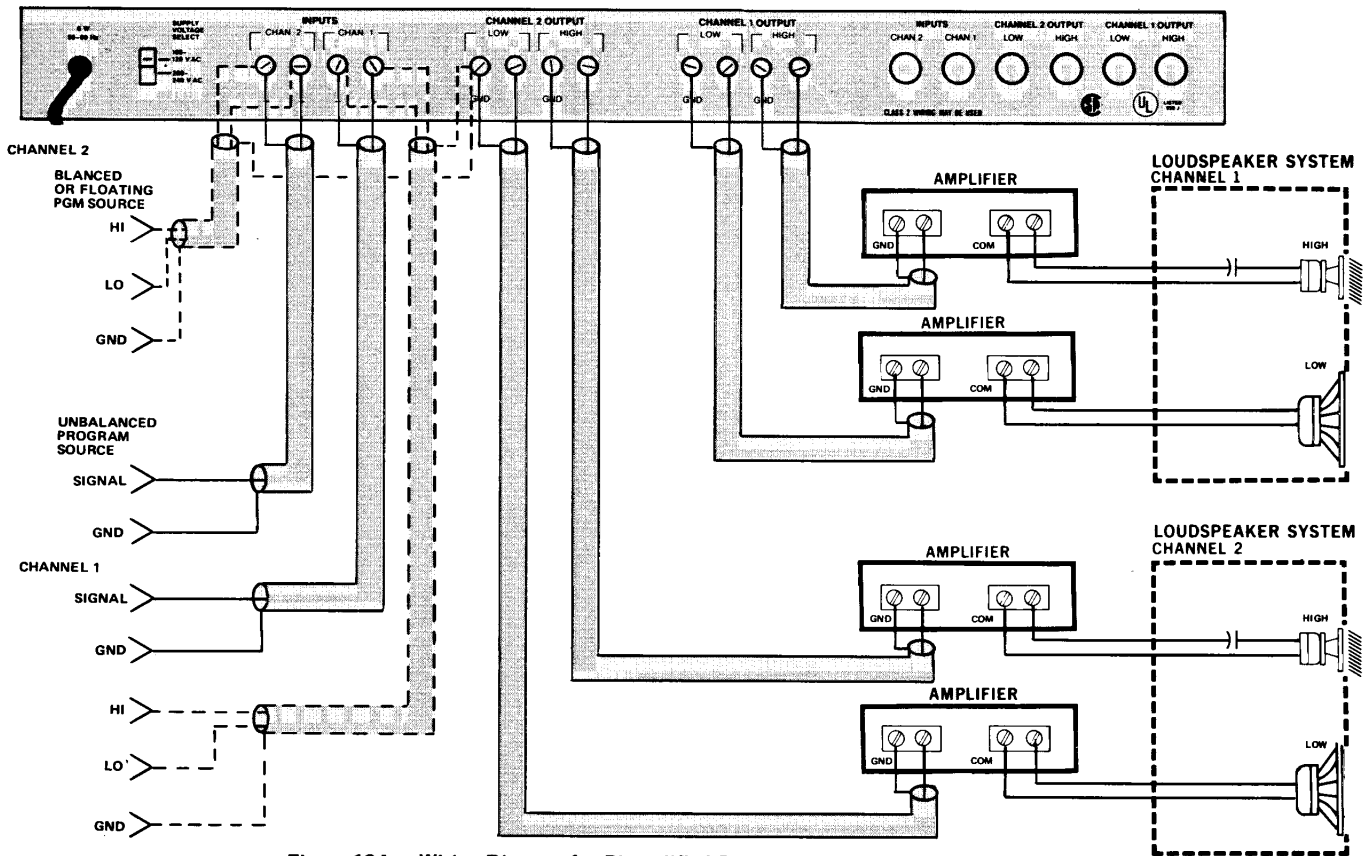


Figure 18A – Wiring Diagram for Bi-amplified System Using Screw Terminals for Connections. (Dash lines indicate balanced connections, solid lines unbalanced connections.)

Input and output wiring may be used in any combination, phone jacks or screw terminals.

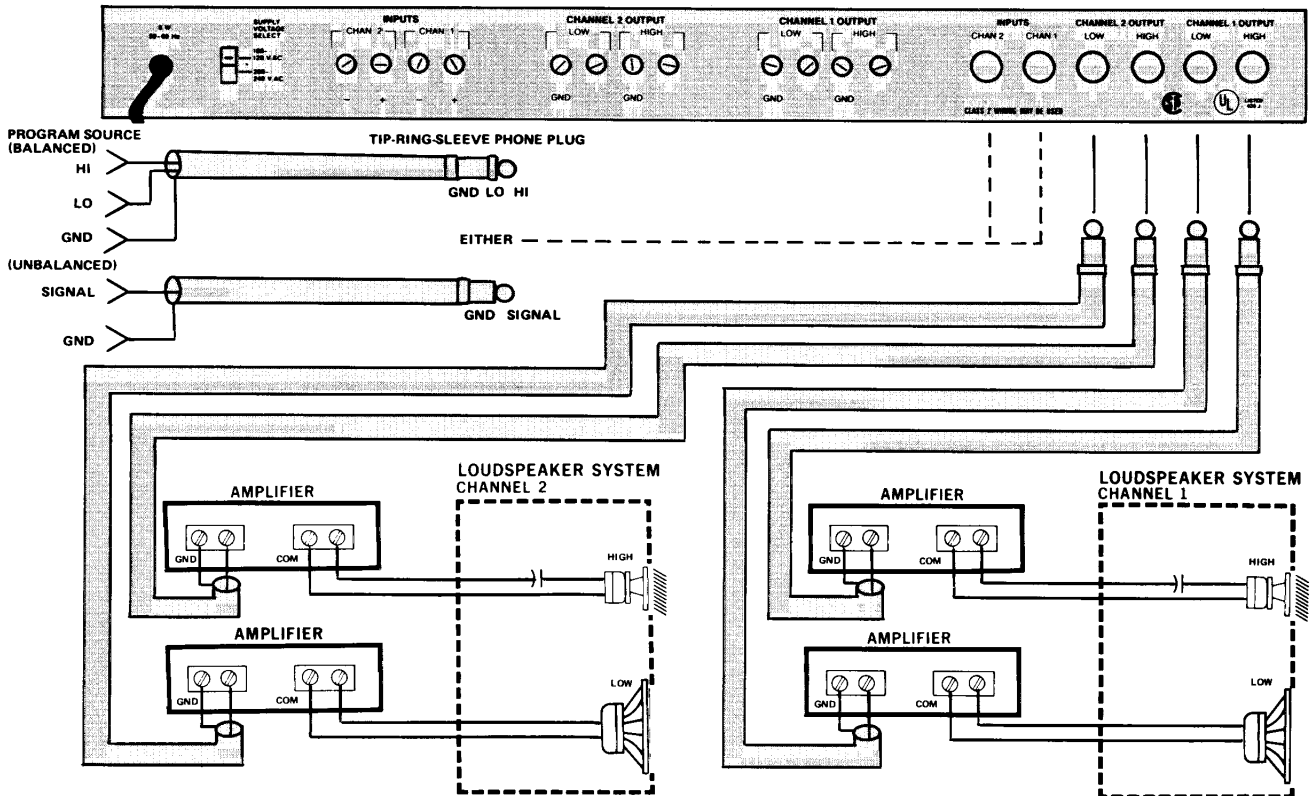


Figure 18B – Wiring Diagram for Bi-amplified System Using Phone Jacks for Connections.

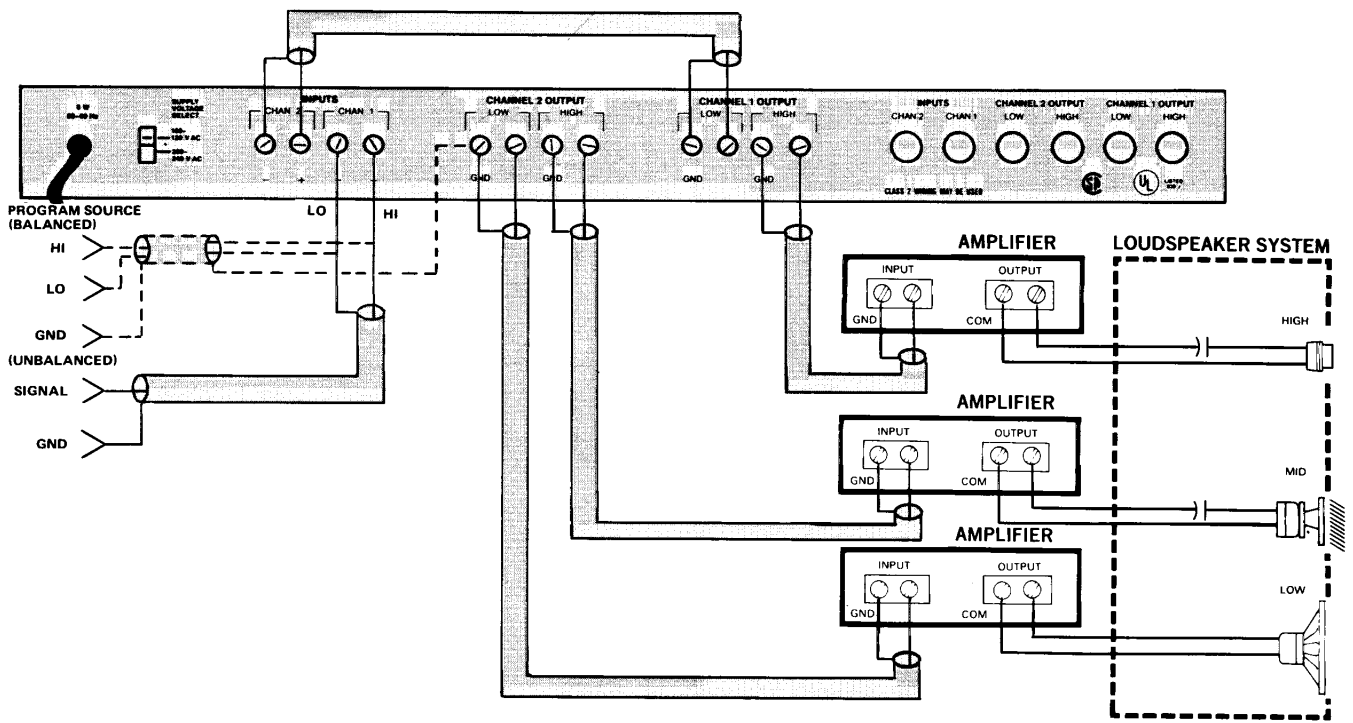


Figure 19A – Wiring Diagram for Triamplified System Using Screw Terminal Connections

Input and output wiring may be used in any combination, phone jacks or screw terminals.

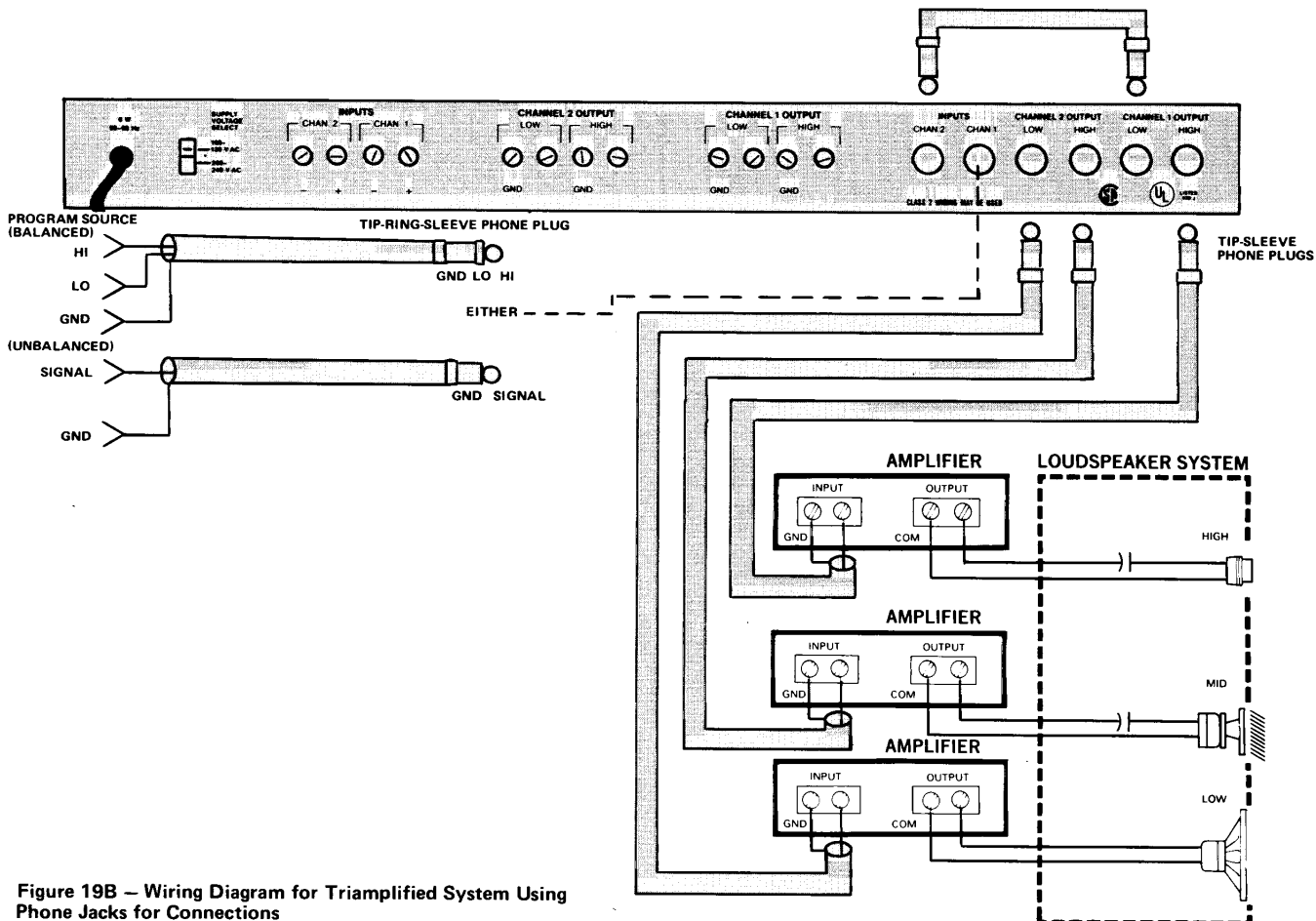


Figure 19B – Wiring Diagram for Triamplified System Using Phone Jacks for Connections

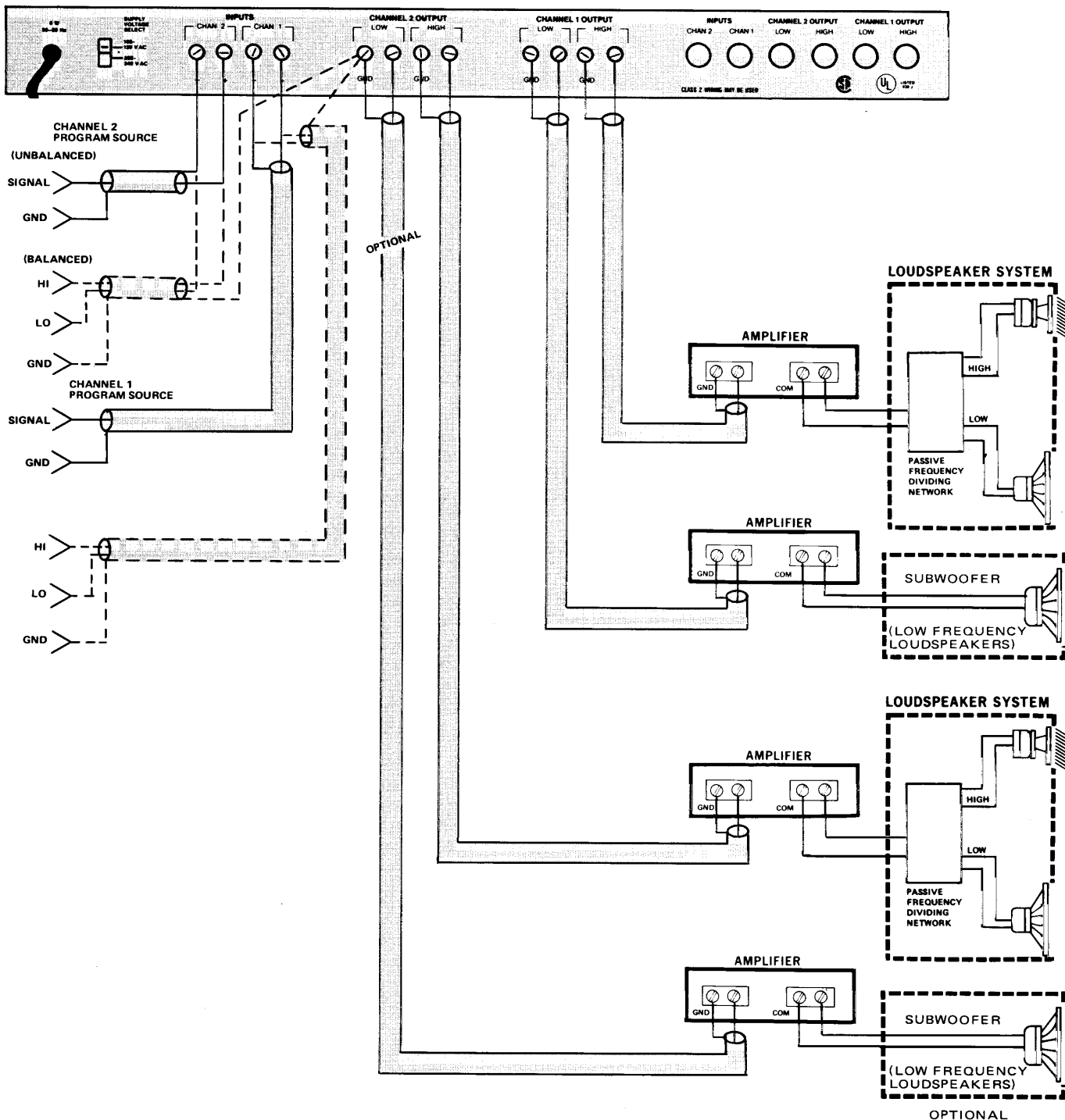


Figure 20 – Wiring Diagram for Two-Way System with Monaural Subwoofer(s) Using Screw Terminals. Use corresponding phone jacks if desired.

NOTE: Use crossover frequency cards for approximately 80 Hz to 150 Hz crossover point. Set both DIP switches for mono. Second subwoofer and amplifier are optional, and will be driven by the same signal as the other subwoofer.

A Safety Procedure for Initial Powering Up of The System

Prior to full operation of the dividing network/amplifier/loudspeaker system, it is important to verify that the various frequency bands are connected to the correct amplifiers and loudspeakers. The following procedure should be followed for *each* program channel prior to operation.

1. With all POWER off (amplifiers included), set the 5234A HIGH FREQUENCY LEVEL control at #2, and adjust the program source output to minimum level. (The source may be wideband pink noise or music.)

2. If the power amplifiers are equipped with level controls, adjust them to approximately one quarter of the maximum.

3. Turn on the program source, the 5234A, and the power amplifier(s) for the channel under test.

4. Gradually increase the program source level until it just becomes audible.

CAUTION: If the sound comes mainly from the midrange or high frequency driver(s), shut off all power immediately and check all wiring. Since the HIGH FREQUENCY LEVEL control is turned down, the low frequency transducer should become audible first; if this is not the case, and low frequency sounds are emerging from higher frequency drivers, the output wiring is reversed somewhere between the 5234A and the loudspeaker system. Continued operation could easily damage compression drivers.

5. With the low frequency transducers producing bass, gradually increase the 5234A HIGH FREQUENCY LEVEL control. (In a triamplified system, do this first on the channel which feeds the high frequency driver, Channel 1.) Correct system wiring will be verified if the treble component of the program material increases in level and is emerging from the high frequency driver. (In a triamplified system, repeat this procedure for the channel feeding the midrange driver, and verify the HF LEVEL control increases midrange output.)

Level Control Adjustment

There are several points in the sound system where levels can be set. Naturally, it is important that the gain structure be established correctly so that no input is overdriven, and so that the best signal-to-noise ratio possible is maintained. Beyond that, however, it becomes necessary to obtain the correct level balance between the various frequency bands so that overall frequency response conforms to the desired characteristic.

In many instances, manufacturers of multi-amplified loudspeaker systems provide instructions for balancing levels of the individual drivers in the system. In the absence of formal instructions, or in the case of custom loudspeaker systems, balance can be established by adjusting levels to achieve the flattest response as measured with a real-time analyzer and a pink noise source (much like the technique described in the System Phasing and Signal Polarity Section of this manual). Alternately, subjective evaluation of familiar program material can provide a good means to balance levels. In

fact, perfectly flat electro-acoustic response is seldom desirable for the listener, so subjective evaluation may be the preferable technique.

NOTE: Each program channel should be adjusted individually. Subjective evaluation should be made while seated in the normal listening location. If subjective analysis is to be used and the power amplifiers are equipped with level controls, initially adjust those controls to one half their rotation and then regulate as necessary.

Subjective Adjustment of Bi-amplified Systems

NOTE: The following procedure applies to each channel of a 5234A used in a dual channel bi-amplified system.

1. With the HIGH FREQUENCY LEVEL control at #0, adjust the program source output for a comfortable listening level.

2. Rotate the HIGH FREQUENCY LEVEL control clockwise until a satisfactory high frequency balance has been obtained in the program material. If necessary, trim the source and/or amplifier levels.

3. Turn off the first channel's signal source and/or amplifiers, and adjust the other channel per steps 1 and 2 above.

NOTE: Once the HIGH FREQUENCY LEVEL and amplifier level controls have been adjusted in this manner, readjustment is not generally needed. Some method of locking the power amplifier level controls (or at least marking the desired settings) is recommended.

Subjective Adjustment of Tri-amplified Systems

NOTE: When both channels of the 5234A are used for a tri-amplified loudspeaker system, the recommended installation is such that the CHANNEL 1 HIGH FREQUENCY LEVEL CONTROL regulates the output of the midrange driver, and the CHANNEL 2 HIGH FREQUENCY LEVEL CONTROL governs the high frequency driver (Refer to the General Applications Section and Figure 19).

1. With both HIGH FREQUENCY LEVEL controls at #0, adjust the program source output for a comfortable listening level.

2. Rotate the CHANNEL 1 HIGH FREQUENCY LEVEL control clockwise until a satisfactory midrange level has been obtained.

3. Rotate the CHANNEL 2 HIGH FREQUENCY LEVEL control clockwise until a satisfactory high frequency balance has been obtained. If necessary, trim the source and/or amplifier levels.

4. It may be necessary to readjust the midrange, source and amplifier levels to achieve the most desirable overall balance of the loudspeaker system.

5. In a two-channel system, turn off the first channel's signal source and/or amplifiers, and adjust the other channel per steps 1 through 4 above.

NOTE: After the HIGH FREQUENCY LEVEL controls and amplifier level controls have been adjusted in this manner, readjustment is not generally needed. Some method of locking the power amplifier level controls (or at least marking the desired settings) is recommended.

System Phasing & Signal Polarity

A major factor in the natural sound character of a multi-way loudspeaker system is the relative polarity and phase relationship between the various

transducers. Physical driver positioning and relative electrical polarity will affect frequency response in the crossover region, and improper phase or polarity relationships between channels can cause a loss of bass response and/or degradation of the stereo image.

NOTE: *Where this discussion involves the exchange of signal-carrying conductors, POLARITY is the topic, not phase. Polarity reversal is not a 180° PHASE SHIFT, although some people loosely describe it as such.*

Physical driver positioning affects the relative phase of signals, but, for the purposes of this discussion, it is assumed that the loudspeaker system is already constructed and therefore nothing can be done to alter the phase relationship between transducers. It is true that in a multi-way system with separately packaged mid and high frequency horns and bass bins, it is advisable to experiment with relative phasing by moving drivers to align the acoustic plane of all the transducer diaphragms. These techniques are beyond the scope of this manual, however. We have limited this discussion to the method of establishing the correct signal polarity for the components in any one channel multi-way system, as well as the correct polarity relationship between channels.

Two suitable methods for establishing polarity of components in a two-way system are described in the following paragraphs. Either one may be used, depending on the availability of test equipment. A three-way or four-way system would be treated in a similar manner by first establishing the proper polarity for the transducers of the low frequency transducers, and then progressing to the midrange and high or ultra-high frequency transducers, as applicable.

Objective Method of Polarity Determination

The following test equipment is necessary:

- a. A real-time 1/3 octave or continuous spectrum frequency response analyzer.
- b. A microphone of known, calibrated frequency response.
- c. A pink noise source.

NOTE: *To optimize the results obtained with this procedure, the loudspeaker systems should be placed in their normal operating locations.*

NOTE: *If different loudspeaker systems are used, or in a stereo system, first establish common polarity among the low frequency drivers as follows:*

1. Connect the pink noise source to two channels, set the two channels for the same comfortable level, and observe low frequency response on the real-time analyzer (RTA).

2. Now intentionally reverse the polarity of one low frequency transducer and see whether the low frequency response diminishes or increases. If it diminishes, the system had been correctly wired initially; return the transducer wiring to the original polarity. If low frequency response increases, the two channels' low frequency transducers were reversed in polarity relative to one another; leave the wiring in the "improved" configuration.

NOTE: *In stereo or multi-channel systems, follow steps 3 and 4 below for one channel at a time.*

3. Using pink noise as program material, adjust the system volume to a comfortable listening level. Then set the level of individual transducers to display the flattest overall frequency response on the real-time analyzer.

4. Reverse the polarity of the high frequency driver and observe the effect on the frequency response through the crossover region. Proper transducer polarity is indicated by the flattest frequency response through the crossover region (as shown by the RTA).

5. Once proper polarity among the transducers of a loudspeaker system has been determined, other loudspeakers systems in the installation (assuming they are the same model) may be connected accordingly and double-checked with the RTA.

Subjective Method of Polarity Determination

The following method is recommended to establish proper polarity of the loudspeaker system when no test equipment is available. To optimize the results obtained with this procedure, the loudspeaker systems should be placed in their normal operating locations.

NOTE: *If different loudspeaker systems are used, or in a stereo system, first establish common polarity among the low frequency drivers as follows:*

1. Connect a program source known to contain substantial bass to two channels, set the two channels for the same comfortable level, and listen to the intensity of the low frequencies.

2. Now intentionally reverse the polarity of one low frequency transducer and see whether the low frequency response diminishes or increases. If it diminishes, the system had been correctly wired initially; return the transducer wiring to the original polarity. If low frequency response improves, the two low channels' low frequency transducers were reversed in polarity relative to one another; leave the wiring in the "improved" configuration.

NOTE: *In stereo or multi-channel systems, follow steps 3 through 5 for one channel at a time.*

3. Adjust the volume for a comfortable listening level and set the approximate system balance using the noise heard between stations of an un-muted FM tuner.

4. Listen to a recording of a male voice long enough to be accustomed to the performance of the loudspeaker system.

5. Reverse the polarity of the high frequency loudspeaker, which will produce a change in voice character. When the transducers are in correct polarity, a recorded male voice should sound natural and exhibit presence (an "up front" quality), in contrast to the undesirable "hollow" sound heard when the transducers are out of phase.

NOTE: *If the crossover point lies above 2 kHz, reversing the polarity of the high frequency driver will create little (if any) perceptible difference in system performance. The*

“correct” polarity in such a case will be that which yields the most natural quality with a variety of program material.

6. Once proper polarity among the transducers of a loudspeaker system has been determined, other loudspeaker systems in the installation (assuming they are the same model) may be connected accordingly.

Selecting the Low Frequency High-Pass Filter Options

As described in the Installation Section of this manual, the 5234A provides for low frequency high-pass contouring by use of binary DIP switches. While the method of setting these switches was discussed, it remains to treat the reasons for choosing various settings.

In the most basic terms, one can select flat response (no rolloff), or a 12 dB per octave roll-off below 20 Hz, 30 Hz or 40 Hz. While the specific filter characteristics can be further modified, in general the major purpose of high-pass filtering is to remove subsonic signal energy below the lowest useable loudspeaker frequency. Without high-pass filtering, subsonic signal content can waste amplifier power (lowering the available headroom), and induce distortion in audible regions by modulating the higher bass and midrange frequencies.

One of the special features of the 5234A is the 6 dB boost at 20 Hz, 30 Hz or 40 Hz selectable with the DIP switches (the Q=2 setting). This moderate boost equalization, coupled with the high-pass filtering, can often improve the acoustical response of a sound system.

The use of the 6 dB boost/high-pass filter option maximizes the useful low frequency acoustic output while minimizing cone excursions both in and out of the system operating range. The use of this option requires certain precautions, and care should be taken not to exceed the power ratings of the system. Bear in mind that the 6 dB of boost results in a four-times increase in power from the amplifier to the loudspeaker system. However, this boost is restricted to the octave just above the system's lower cutoff.

The boost/high-pass filter function should normally be applied to vented box systems, set to the box tuning frequency. The boost/high-pass filter can be used with closed-box (sealed) loudspeaker systems, but because of the high cone excursions of these systems near cutoff, caution must be taken so that the cones do not “bottom out” during high level passages. In general, for sealed box systems it is better to use one of the high-pass filter settings that produce a rolloff without a peak (e.g., with a Q 0.707). If it is desirable that the loudspeaker system have a slight peak near an acoustic cutoff of 30 Hz, the 5234A's slightly underdamped rolloff (Q=0.84) may be selected.

Suggestions for JBL Professional Series Products

1. Generally, JBL studio monitors should have high-pass filtering at 30 Hz.

2. Sound reinforcement systems tuned to 40 Hz should use 40 Hz high-pass filtering. This includes most 4500 series enclosures and 4600 systems.

3. For very low crossover frequency points in subwoofer applications, monaural summing of the low frequency outputs will tend to cancel extraneously generated, oppositely polarized low frequency signals such as turntable rumble, disc warp and acoustic feedback. Therefore, setting the DIP switches for a monaural LOW output can increase the maximum usable acoustic output level.

4. The 6 dB boost/high-pass filter option may be used with any JBL Professional Series system when required to flatten and extend the low-frequency response, provided that the filter frequency is appropriately chosen.

Blank Crossover Card Assembly

In addition to the standard crossover cards, circuits for other crossover frequencies may be assembled on blank crossover cards using standard components. Filter slopes (12 dB or 18 dB per octave) are identical to those of the standard crossover cards. The crossover frequency can be written on the card bracket and will appear through the front panel window of the network.

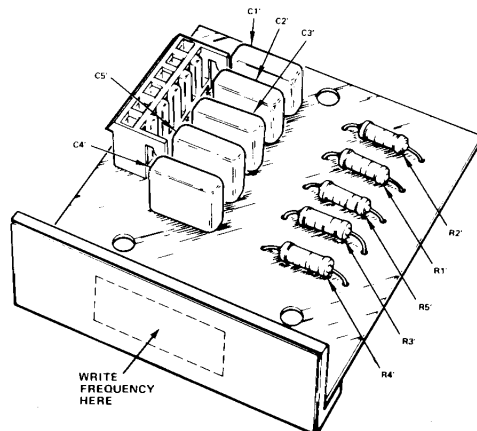


Figure 21 – 12 dB/Octave Crossover Card (JBL Model 52-5120)

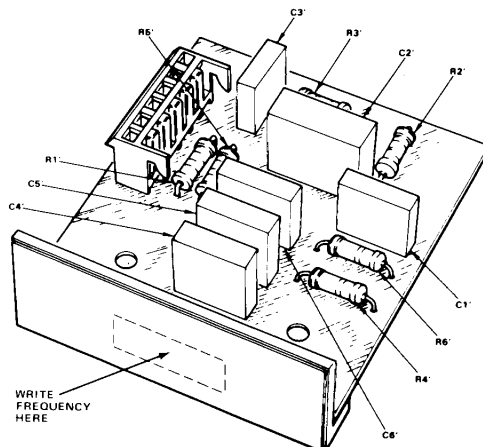


Figure 22 – 18 dB/Octave Crossover Card (JBL Model 51-5130)

Table 3: 12 dB/Octave Crossover Card Component Values

Resistors are all 1/4 W, ±5% tolerance. Capacitors are all ±5% tolerance, metallized polyester unless otherwise noted.

Crossover Frequency	Capacitors (C1'-C5')	Resistors (R1'-R5')
50 Hz	.22 μF	10 kΩ
70 Hz	.22 μF	7.5 kΩ
100 Hz	.22 μF	4.7 kΩ
200 Hz	.12 μF	4.7 kΩ
250 Hz (JBL Part No. 52-5121)	.018 μF	24 kΩ
300 Hz	.082 μF	4.7 kΩ
400 Hz	.056 μF	5.1 kΩ
500 Hz (JBL Part No. 52-5122)	.015 μF	15 kΩ
600 Hz	.039 μF	4.7 kΩ
700 Hz	.032 μF	5.1 kΩ
800 Hz (JBL Part No. 52-5123)	.027 μF	4.7 kΩ
900 Hz	.027 μF	4.7 kΩ
1.1 kHz	.022 μF	4.7 kΩ
1.2 kHz (JBL Part No. 52-5124)	.082 μF	11 kΩ
1.5 kHz	.012 μF	6.2 kΩ
2 kHz	.012 μF	4.7 kΩ
2.5 kHz	.0082 μF	5.6 kΩ
3 kHz	.0068 μF	5.6 kΩ
3.5 kHz	.0068 μF	4.7 kΩ
4 kHz	.0056 μF	5.1 kΩ
4.5 kHz	.0039 μF	6.2 kΩ
5 kHz (JBL Part No. 52-5125)	.0015 μF	15 kΩ
5.5 kHz	.0033 μF	6.2 kΩ
6 kHz	.0033 μF	5.6 kΩ
7 kHz (JBL Part No. 52-5127)	.018 μF	11 kΩ
7.5 kHz	.0027 μF	5.6 kΩ
8 kHz	.0027 μF	5.1 kΩ
8.5 kHz	.0012 μF	11 kΩ
9 kHz	.0022 μF	5.6 kΩ
9.5 kHz	.0012 μF	10 kΩ
10 kHz	.0022 μF	5.1 kΩ
JBL Part No. 52-5140 Designed for the 4343 and 4350 Studio Monitors	.018 μF	R1 27 kΩ R2 27 kΩ R3 22 kΩ R4 22 kΩ R5 22 kΩ
JBL Part No. 52-5130 Designed for the 4435 and 4430 Studio Monitors	C1' 0.039 μF C2' 0.082 μF C3' 0.0013 μF C4' 0.01 μF C5' jumper C6' jumper	R1' 11 kΩ R2' 11 kΩ R3' 11 kΩ R4' 13 kΩ R5' N/A R6' N/A

NOTE: The values for the crossover frequencies can be calculated by using the formula $RC = \frac{0.1125}{F}$. Where R is the resistance in kΩ,

C is the capacitance in μF, and F is the frequency in Hz. The recommended value for R is 4.7 kΩ.

Table 4: 18 dB/Octave Crossover Card Component Values

Resistors are all 1/4 W, ±5% tolerance. Capacitors are all ±5% tolerance, metallized polyester unless otherwise noted.

Crossover Frequency	Capacitors	Resistors
80 Hz (High Pass Only)	C1' N/A C2' N/A C3' N/A C4' .33 μF C5' .33 μF C6' .33 μF	R1' N/A R2' N/A R3' N/A R4' 11 kΩ R5' 4.3 kΩ R6' 75 kΩ
100 Hz	C1' .39 μF C2' 1.0 μF C3' .056 μF C4' .15 μF C5' .15 μF C6' .15 μF	R1' 6.8 kΩ R2' 6.8 kΩ R3' 6.8 kΩ R4' 9.1 kΩ R5' 3.6 kΩ R6' 62 kΩ
160 Hz	C1' .33 μF C2' .82 μF C3' .047 μF C4' .056 μF C5' .056 μF C6' .056 μF	R1' 4.3 kΩ R2' 4.3 kΩ R3' 4.3 kΩ R4' 13 kΩ R5' 5.1 kΩ R6' 5.1 kΩ

(Table 4 continued next column)

Crossover Frequency	Capacitors	Resistors
200 Hz	C1' .22 μF C2' .56 μF C3' .033 μF C4' .039 μF C5' .039 μF C6' .039 μF	R1' 5.1 kΩ R2' 5.1 kΩ R3' 5.1 kΩ R4' 15 kΩ R5' 5.6 kΩ R6' 100 kΩ
290 Hz (JBL Part No. 51-5145 Designed for the 4345 and 4355 Studio Monitors)	C1' .12 μF C2' .33 μF C3' .018 μF C4' .033 μF C5' .033 μF C6' .033 μF	R1' 6.2 kΩ R2' 6.2 kΩ R3' 6.2 kΩ R4' 12 kΩ R5' 4.7 kΩ R6' 82 kΩ
300 Hz	C1' .12 μF C2' .22 μF C3' .012 μF C4' .033 μF C5' .033 μF C6' .033 μF	R1' 5.1 kΩ R2' 5.1 kΩ R3' 5.1 kΩ R4' 6.8 kΩ R5' 2.7 kΩ R6' 47 kΩ
500 Hz (JBL Part No. 51-5132)	C1' .082 μF C2' .22 μF C3' .012 μF C4' .033 μF C5' .033 μF C6' .033 μF	R1' 5.1 kΩ R2' 5.1 kΩ R3' 5.1 kΩ R4' 6.8 kΩ R5' 2.7 kΩ R6' 47 kΩ
800 Hz (JBL Part No. 51-5133)	C1' .056 μF C2' .15 μF C3' .0082 μF C4' .012 μF C5' .012 μF C6' .012 μF	R1' 4.7 kΩ R2' 4.7 kΩ R3' 4.7 kΩ R4' 12 kΩ R5' 4.7 kΩ R6' 82 kΩ
1 kHz	C1' .039 μF C2' .1 μF C3' .0056 μF C4' .015 μF C5' .015 μF C6' .015 μF	R1' 5.6 kΩ R2' 5.6 kΩ R3' 5.6 kΩ R4' 7.5 kΩ R5' 3 kΩ R6' 51 kΩ
1.2 kHz	C1' .039 μF C2' .1 μF C3' .0056 μF C4' .0082 μF C5' .0082 μF C6' .0082 μF	R1' 4.7 kΩ R2' 4.7 kΩ R3' 4.7 kΩ R4' 12 kΩ R5' 4 kΩ R6' 82 kΩ
1.6 kHz	C1' .033 μF C2' .082 μF C3' .0047 μF C4' .0056 μF C5' .0056 μF C6' .0056 μF	R1' 4.3 kΩ R2' 4.3 kΩ R3' 4.3 kΩ R4' 13 kΩ R5' 5.1 kΩ R6' 91 kΩ
2 kHz	C1' 0.22 μF C2' 0.56 μF C3' .0033 μF C4' .0039 μF C5' .0039 μF C6' .0039 μF	R1' 5.1 kΩ R2' 5.1 kΩ R3' 5.1 kΩ R4' 15 kΩ R5' 5.6 kΩ R6' 100 kΩ
5 kHz	C1' .0082 μF C2' .022 μF C3' .0012 μF C4' .0015 μF C5' .0015 μF C6' .0015 μF	R1' 5.1 kΩ R2' 5.1 kΩ R3' 5.1 kΩ R4' 15 kΩ R5' 5.6 kΩ R6' 100 kΩ
5.5 kHz	C1' .0068 μF C2' .018 μF C3' .001 μF C4' .0018 μF C5' .0018 μF C6' .0018 μF	R1' 5.6 kΩ R2' 5.6 kΩ R3' 5.6 kΩ R4' 12 kΩ R5' 4.7 kΩ R6' 82 kΩ
8 kHz	C1' .0056 μF C2' .015 μF C3' .0082 μF (use Silver Mica only) C4' .0012 μF C5' .0012 μF C6' .0012 μF	R1' 4.7 kΩ R2' 4.7 kΩ R3' 4.7 kΩ R4' 12 kΩ R5' 4.7 kΩ R6' 82 kΩ
10 kHz	C1' .0039 μF C2' .01 μF C3' .00056 μF (use Silver Mica only) C4' .0015 μF C5' .0015 μF C6' .0015 μF	R1' 5.6 kΩ R2' 5.6 kΩ R3' 5.6 kΩ R4' 7.5 kΩ R5' 3 kΩ R6' 51 kΩ

JBL 5234A PARTS LIST

Circuit Description	JBL Part No.	Description/Notes
BARRIER INSULATOR		
	61656	
CAPACITOR — All capacitors are in μF unless otherwise noted.		
C201	13189	0.01 1400 V
JACKS		
PH1	82716	
PH2	82716	
PH3	82716	
PH4	82716	
PH5	61441	
PH6	61441	
KNOBS		
	54969	Power Switch
	52192	Level Control Qty. 2
LINE CORD (120 V)		
W301	59613	Black
POWER TRANSFORMER		
T1	61646	
SWITCHES		
S201	54953	DPDT Power Switch
S301	55355	Line Voltage Select
TERMINAL STRIPS		
TB1	86422	
TB2	86422	
TB3	86422	
CONNECTORS		
J1	52599	6 pin
J101	52599	6 pin
CAPACITORS — All capacitors are in μF unless otherwise noted.		
C1	48141	4.7 63 V
C2	48141	4.7 63 V
C3	48141	4.7 63 V
C4	48141	4.7 63 V
C5	11397	25 25 V
C6	48505	100 25 V
C7	54998	0.1 100 V metal poly.
C8	54998	0.1 100 V metal poly.
C9	48433	20 pF 500 V mica
C10	48433	20 pF 500 V mica
C11	54998	0.1 100 V metal poly.
C12	54998	0.1 100 V metal poly.
C13	59127	0.27 100 V metal poly.
C14	59127	0.27 100 V metal poly.
C15	59127	0.27 100 V metal poly.
C16	59127	0.27 100 V metal poly.
C17	58725-2206	220 pF 50 V
C18	58725-2206	220 pF 50 V
C19	58730-2206	220 pF 25 V
C101	48141	4.7 63 V
C102	48141	4.7 63 V
C103	48141	4.7 63 V
C104	48504	100 25 V
C105	11397	25 25 V
C106	48504	100 25 V
C107	54998	0.1 100 V
C108	54998	0.1 100 V
C109	48433	20 pF 500 V mica
C110	48433	20 pF 500 V mica
C113	59127	0.27 100 V
C114	59127	0.27 100 V
C115	59127	0.27 100 V
C116	59127	0.27 100 V

Circuit Description	JBL Part No.	Description/Notes
RESISTORS — Resistors are fixed, carbon-film, 1/4 W, \pm 5% unless otherwise indicated.		
R1	58683-4702	47 k \pm 2%
R2	58683-4702	47 k \pm 2%
R3	58683-4702	47 k \pm 2%
R4	58683-4702	47 k \pm 2%
R5	35549	100
R6	35621	100 k
R7	36538	2.7 m
R8	36538	2.7 m
R10	36425	47
R11	36481	10 k
R12	36481	10 k
R13	36410	10
R14	36410	10
R15	36410	10
R16	36410	10
R17	36425	47
R18	35621	100 k
R19	35621	100 k
R20	58683-330	3.3 k
R21	58683-3600	360
R22	58683-1200	1.2 k
R23	58683-3001	3 k
R24	58683-3001	3 k
R25	58683-3002	30 k \pm 2%
R26	58683-3002	30 k \pm 2%
R27	36481	10 k
R28	36481	10 k
R29	35549	100
R30	35621	100 k
R31	36482	11 k
R32	36483	12 k
R33	36410	10
R34	36410	10
R35	36465	2.2 k
R36	36465	2.2 k
R101	58683-4702	47 k \pm 2%
R102	58683-4702	47 k \pm 2%
R103	58683-4702	47 k \pm 2%
R104	58683-4702	47 k \pm 2%
R105	35549	100
R106	35621	100 k
R107	36538	2.7 m
R108	36538	2.7 m
R110	36425	47
R111	36481	10 k
R112	36481	10 k
R113	36410	10
R114	36410	10
R115	36410	10
R116	36410	10
R117	36425	47
R118	35621	100 k
R119	35621	100 k
R120	58683-3301	3.3 k
R121	58683-3600	360
R122	58683-1201	1.2 k
R123	58683-3001	3 k
R124	58683-3001	3 k
R125	58683-3002	30 k
R126	58683-3002	30 k
R127	36481	10 k
R128	36481	10 k
R129	35549	100
R130	35621	100 k

Parts list continued

Unit Description	JBL Part No.	Description/Notes
POTENTIOMETERS		
R9	51367	10 k
R109	51367	10 k
RELAYS		
S1	61322	
S101	61322	
SEMICONDUCTORS		
CR1	52544	1N914B
CR2	52544	1N914B
CR3	52544	1N914B
CR4	52544	1N914B
CR5	39869	1N4003
CR6	61324	16 V 1W ±5%
CR7	39869	1N4003
CR8	39869	1N4003
CR9	39869	1N4003
CR10	39869	1N4003
CR101	52544	1N914B
CR102	52544	1N914B
CR103	52544	1N914B
CR104	52544	1N914B
Q1	55201	
Q2	48340	
Q3	55201	
Q4	48340	
Q5	55411	
Q6	55201	
Q7	55201	
Q8	55412	
Q9	55411	
Q101	55201	
Q102	48340	
Q103	55201	
Q104	48340	
U1	59028	TL074CN Dual OP AMP
U2	61325	TL082CP Dual OP AMP
U101	59028	TLO74CN Dual OP AMP
SWITCHES		
S1	61322	
S101	61322	
SEMICONDUCTOR		
CR2	59894	Green LED
JUMPERS		
R1	51430	Jumper
CR1	51430	Jumper
LENS CAP		
	59893	Green
RESISTORS — All resistors are fixed, carbon-film, 1/2 W, +5% unless otherwise indicated.		
R7	10940	1 k
R8	10940	1 k
CONNECTOR		
	51634	

SCHEMATIC DIAGRAM

