Electro-Voice®

SIGNAL PROCESSING

EX-24 ELECTRONIC CROSSOVER

OWNER'S MANUAL

Channel Configurations:	Stereo two-way or monaural three-way
Filter Type:	4th-order Linkwitz-Riley
Filter Slope:	24 dB/octave
Crossover Frequencies:	80, 125, 160, 250, 500, 630, 800, 1.25k, 1.6k, 2.5k, 5k, and 6.3k Hz
Gain:	Adjustable, off to +12 dB; center detent at unity gain
Frequency Response:	30 Hz to 20 kHz, ±3 dB (sum of outputs)
THD: (20 Hz-20 kHz)	<0.05% typical
IMD (SMPTE 4:1):	<0.05% typical
Noise: (Each output; 20 Hz-20 kHz NBW)	-90 dBu typical
Crosstalk:	-70 dB typical
Inputs:	
Type:	Electronically differential balanced
Maximum level:	+20 dBu (7.75 V rms)
Impedance:	15 kΩ unbalanced 30 kΩ balanced
CMRR:	40 dB minimum 55 dB typical
Connectors:	Female 3-pin XLR-type and ¼" phone
Outputs:	
Type:	Electronically servo-balanced
Maximum level:	+18 dBm
Impedance:	100 Ω unbalanced 200 Ω balanced
Minimum load impedance:	600 Ω
Connectors:	Male 3-pin XLR-type and ¼" phone
Power Requirements:	100, 120, 220, 240 Vac, 50/60 Hz, 8 W
Fuse Type:	Littlefuse Type 3AB 175 mA/250 V Slo-Blo®, or equivalent
Dimensions:	1.75 in H x 19 in W x 5.88 in D (4.4 cm H x 48.3 cm W x 14.9 cm D)
Shipping Weight:	7.0 lbs (3.2 kg)
Net Weight:	5.4 lbs (2.5 kg)
Enclosure:	Rack mount chassis, 18 GA steel; ⅛" aluminum front panel
Colors:	Gray front panel, black chassis

Electro-Voice® continually strives to improve products and performance. Therefore, the specifications are subject to change without notice.

Slo-Blo® is a registered trademark of Littlefuse, Inc.

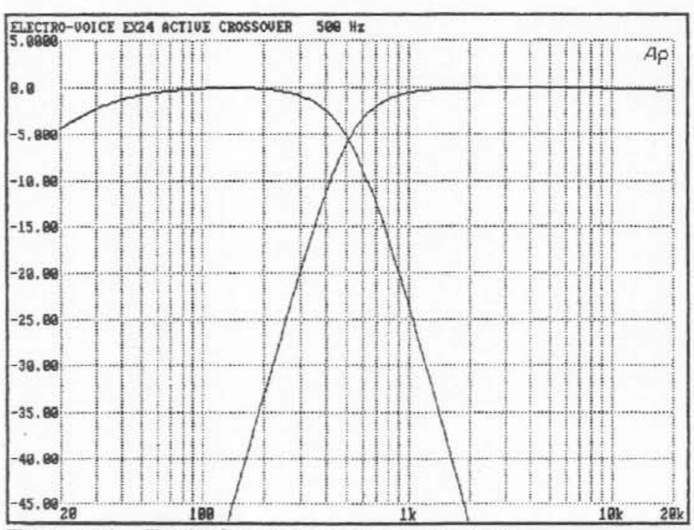

Figure 1. Typical two-way crossover curve.

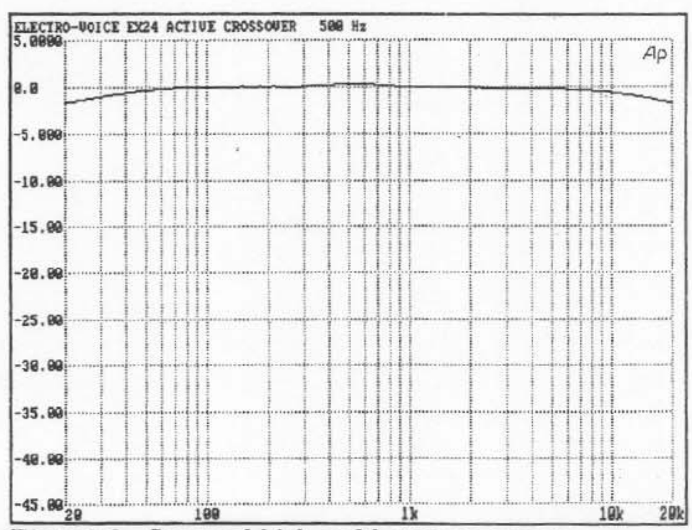

Figure 2. Summed high and low pass outputs.

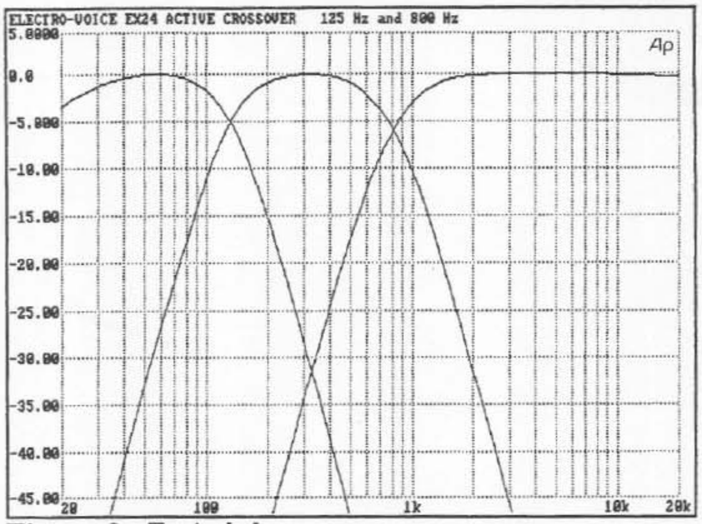

Figure 3. Typical three-way crossover curve.

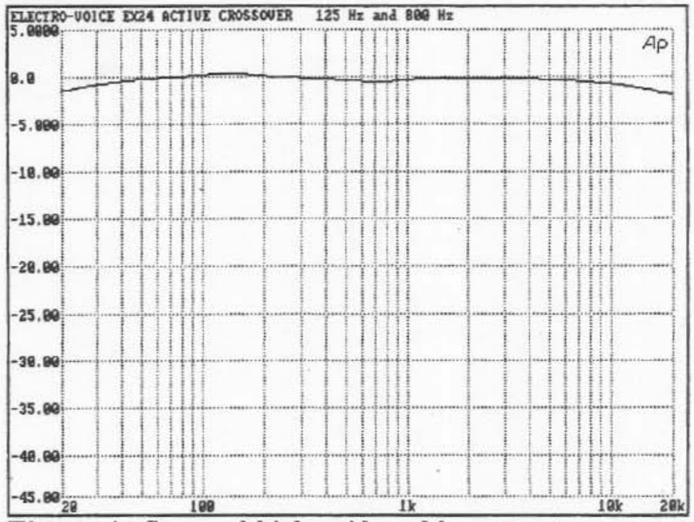

Figure 4. Summed high, mid, and low outputs.

ARCHITECT'S AND ENGINEER'S SPECIFICATIONS

The crossover shall be a two-way stereo or three-way monaural active crossover. Each crossover section shall provide adjustable crossover frequencies from 80 Hz to 6.3 kHz in two ranges. Level controls and on/off switches for each output shall be provided to facilitate setup and operation of any multi-way sound system. The high-frequency output of each channel shall exhibit a polarity inversion switch and switchable constant-directivity horn equalization to allow optimum speaker response through the crossover region. A "mono low" function shall be included to provide a ensure maximum system output capability at low frequencies. A mode switch shall allow easy conversion from two-way to three-way operation.

The active crossover shall meet or exceed the following performance criteria. Electronically differential balanced inputs and servo-balanced outputs. Maximum input level: 7.75 V rms. Input inpedance: 15 kohms, unbalanced; 30 kohms, balanced. CMRR: 55 dB typical. Maximum output level: +18 dBm. Output impedance: 100 ohms, unbalanced; 200 ohms, balanced. Minimum load impedance: 600 ohms. Frequency response: 30 Hz to 20 kHz, +0/–3 dB. THD: <0.05% from 20 Hz to 20 kHz. IMD (SMPTE 4:1): <0.05%. Noise: –90 dBu, typical, 20 Hz to 20 kHz NBW. Crosstalk: –70 dB, typical. Input connections shall be made with female 3-pin XLR-type connectors and ¼ inch phone jacks. The output connections shall be made with male 3-pin XLR-type connectors and ¼ inch phone jacks. AC power shall be provided by a detachable IEC power cord receptacle. A detachable power cord shall be included. A universal power transformer shall permit use with 100, 120, 220, 240 Vac 50/60 Hz lines. Power consumption shall be 8 watts. The active crossover shall be enclosed in a black 18 GA steel rack mount chassis with a gray ⅛ inch aluminum front panel. The unit shall conform to the following dimensions: 1.75 in H x 19.0 in W x 5.88 in D, with a weight of 5.4 pounds.

The active crossover shall be the Electro-Voice® EX24.

TABLE OF CONTENTS

1 ELECTRICAL

1.1 120 Vac, 50/60 Hz Power Connections

The crossover is provided with the primary of the power transformer strapped for 120 Vac operation from the factory. Refer to Figure 6b for wiring details.

WARNING: *Verify that the power transformer's primary circuit configuration is correct for the intended ac line voltage **BEFORE** applying power to the crossover.*

1.2 100, 220, 240 Vac, 50/60 Hz Power Connections

The crossover may be powered from line voltages other than 120 volts by re-strapping the primary of the power transformer. Use the following procedures to change the factory strapping to the desired line voltage.

1. Disconnect the crossover from the ac power source.
2. Remove and save the seven screws securing the top cover. There are two screws on each side, two screws on the rear, and one screw inset into the front panel. Refer to Figure 5 for exact screw locations.
3. Locate the eight voltage select solder cups near the power transformer. Referring to Figure 6, reconnect the leads corresponding to the desired primary voltage.
4. Install the top cover with the seven screws previously removed.

Table I. Fuse Selection Chart

AC Line Voltage	AC Line Fuse
100 V	175 mA/250 V
120 V	175 mA/250 V
220 V	80 mA/250 V
240 V	80 mA/250 V

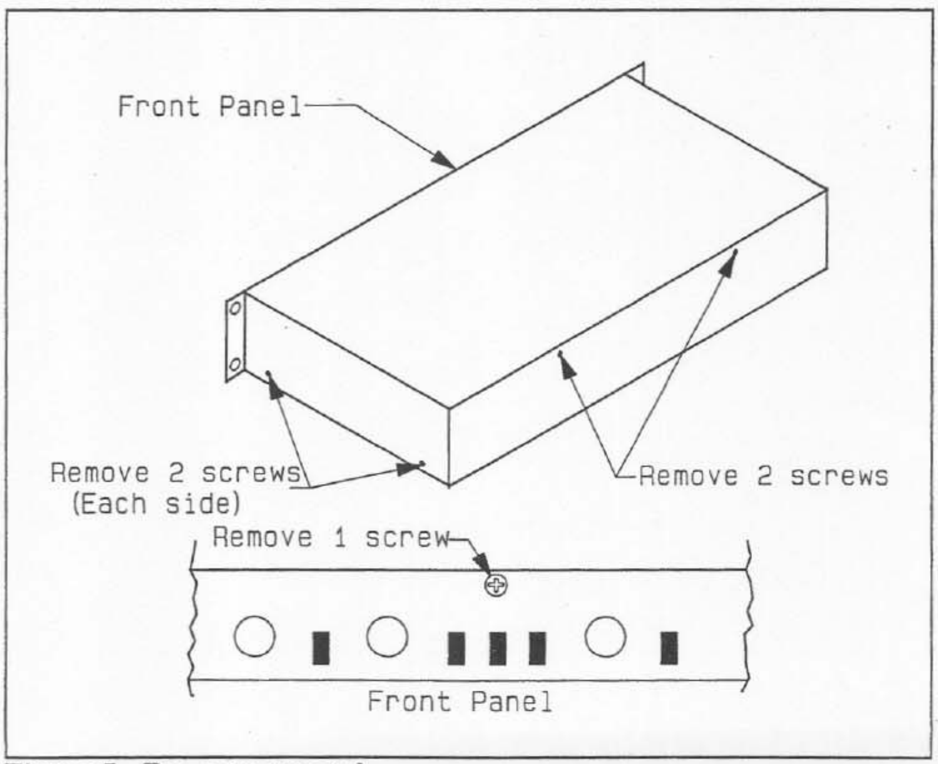

Figure 5. Top cover removal.

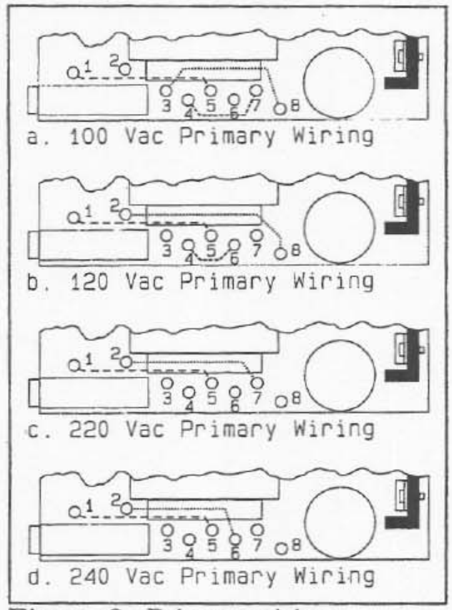

Figure 6. Primary wiring.

5. Install the proper fuse value from Table I.

2 INSTALLATION

2.1 Rack Mounting

The crossover may be installed in a standard 19 inch equipment rack. It requires 1.75 inches of vertical space and mounting is accomplished by using the appropriate four screws supplied.

2.2 Ventilation

The crossover should not be used in areas where the ambient temperature exceeds 60°C (140°F).

3 SIGNAL CONNECTIONS

3.1 Input Connections

Balanced input connections may be made to either the female 3-pin XLR-type or the ¼" phone (TRS) connector. For single-ended inputs, strap the low (–) input to ground (pin 3 on XLR or *Ring* on ¼" phone). Otherwise, the electronically differential balanced input stage will see 6 dB less input signal level than with a balanced input. Refer to Figure 7 for typical input connections.

3.2 Output Connections

The outputs of the crossover are electronically servo-balanced. Balanced output connections may be made to either the male 3-pin XLR-type or the ¼" phone (TRS) connectors. For single-ended outputs, strap the low (-) output to ground (pin 3 on the XLR or *Ring* on ¼" phone). Otherwise, the electronically servo-balanced output stage will produce 6 dB less output signal level than with a balanced output. Refer to Figure 8 for typical output connections.

4 OPERATION

4.1 Front Panel Controls and Indicators
(Refer to Figure 9.)

1. *CHANNEL 1 and 2 FREQUENCY controls:* These frequency controls set the channel crossover frequencies. At this frequency both crossover outputs are 6 dB down from their passband levels. The crossover frequency may be adjusted from 80 Hz to 6.3 kHz. In the two-way mode, each frequency control is independent of the other. In the three-way mode, the Channel 1 control adjusts the low-to-mid crossover frequency and the Channel 2 control adjusts the mid-to-high crossover frequency.

2. *Range switches:* The range switches shift the range of each respective frequency control by a factor of 10 (when pressed, multiply the front panel marking by 10). With this switch depressed, the range of the crossover frequency control becomes 800 Hz to 6.3 kHz. This allows the selection of crossover points desired in two- and three-way systems. These switches should not be changed when the amplifiers are on.

3. *LEVEL controls:* The level controls set the output levels of the high- and low-frequency outputs. They should be set for the most pleasing high-frequency balance. In three-way operation, the Channel 1 high-frequency control adjusts the midrange output and the Channel 2 high-frequency control adjusts the high-frequency output. Again, they should be set for the most pleasing musical balance. In both cases, this should be done with other system equalization (output channel of graphic) set flat.

4. *Output ON/OFF switches:* These switches turn the output on and off. This is useful for testing and setup when it is necessary to hear the outputs separately.

5. *Polarity switches:* The polarity switches reverse the polarity of their respective output. For two-way operation, the high-frequency outputs are controlled. For three-way operation, the midrange and high-frequency outputs are controlled. Operating the polarity switch is similar to reversing the wires at the loudspeaker terminals. The polarity switch allows instant

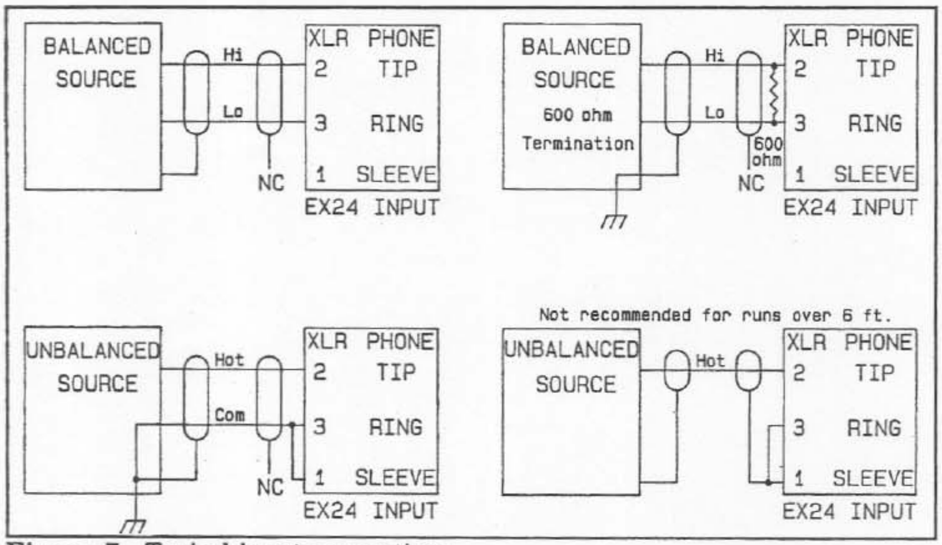

Figure 7. Typical input connections.

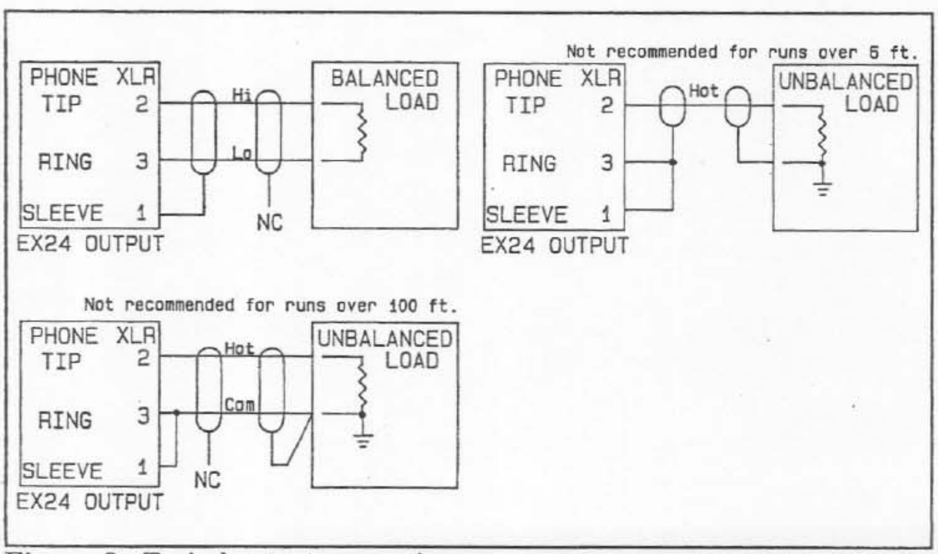

Figure 8. Typical output connections.

determination of the system's phasing at the crossover frequency. The normal setting of the polarity switch is the out (+) position. This results in the flattest frequency response for most loudspeaker systems, when the drivers are physically time-aligned.

6. *Horn EQ switches:* The horn EQ switches turn on equalization for constant-directivity horns. The horn EQ should not be used with the older radial-type horns. It is also not used for passively crossed-over mid-high sections, such as the EV **SH1810** in biamp mode, or when subwoofers are used with full-range loudspeakers in biamp (two-way) mode.

4.2 Rear Panel Controls and Connections

(Refer to Figure 10.)

1. *IEC connector:* This connector is for the supplied three-prong power cord.

2. *Fuse holder:* The fuse holder requires a 175 mA/250 V Slo-Blo® fuse with 120 Vac line.

3. *HIGH, LOW, AND MID CHANNEL OUTPUTS:* These 3-pin XLR-type and ¼" phone jacks are electronically servo-balanced outputs. These connectors are compatible with both balanced and unbalanced connections.

4. *MONO LOW/STEREO LOW:* The mono low switch sums together the low outputs from both channels if depressed. This is necessary with single-channel subwoofer systems or for maximizing low-frequency output for stereo setups.

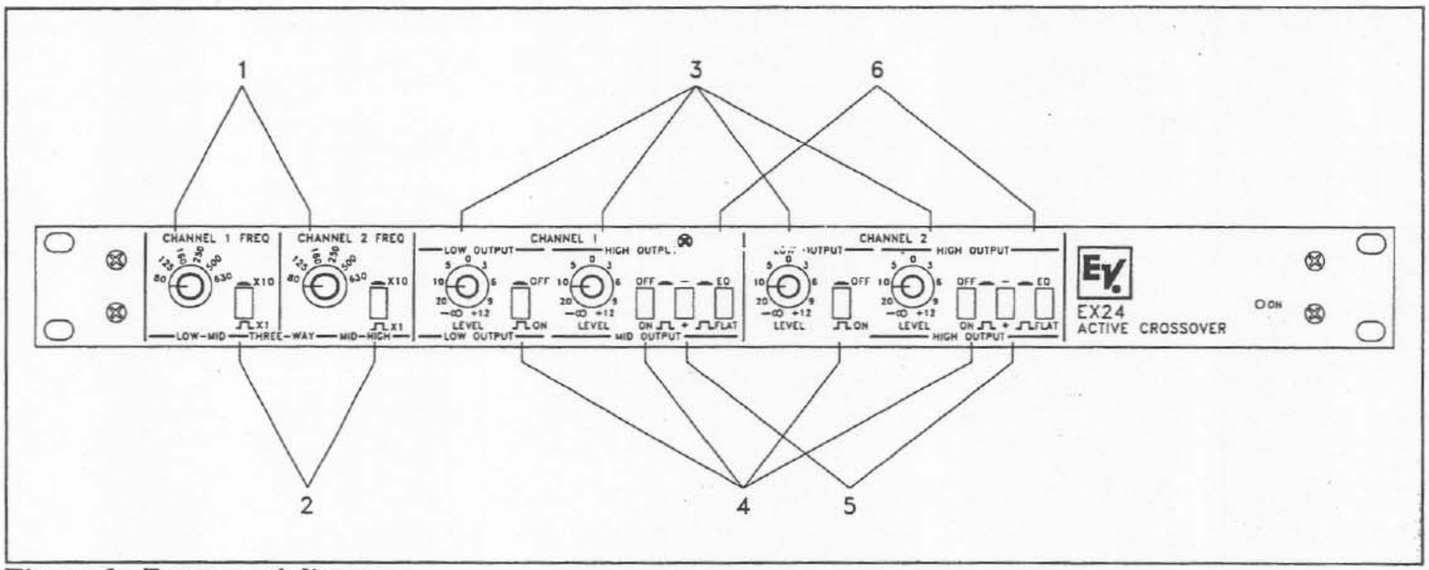

Figure 9. Front panel diagram.

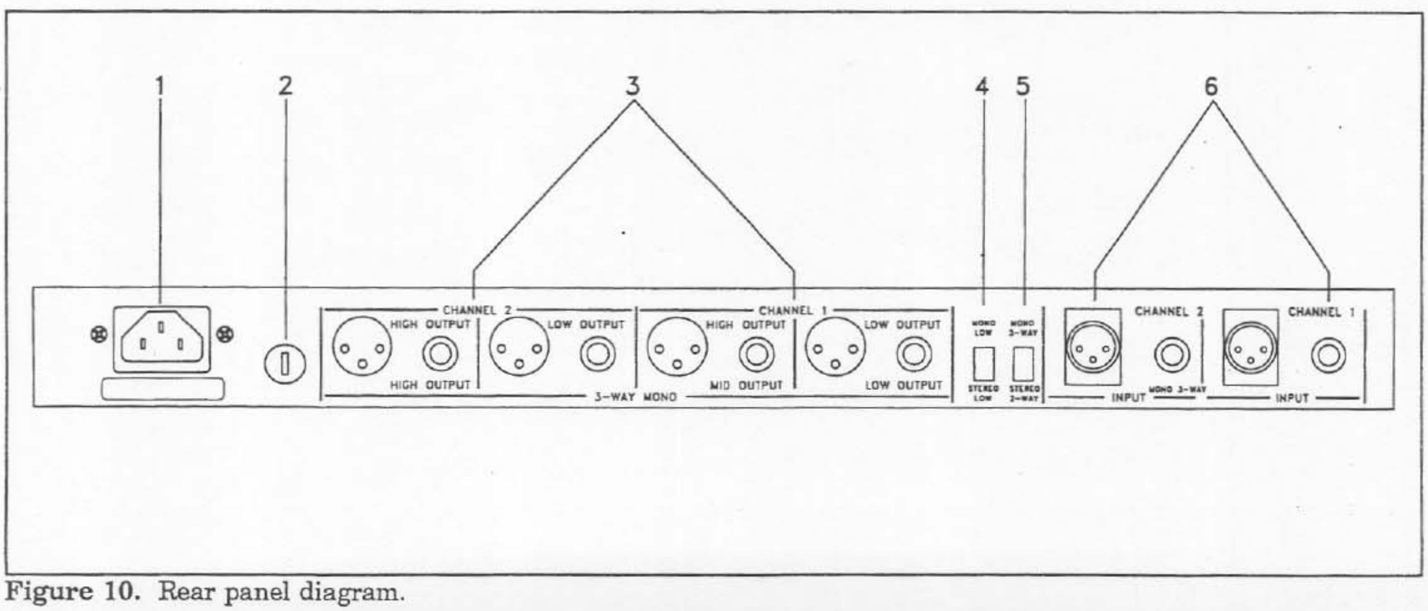

Figure 10. Rear panel diagram.

5. *MONO 3-WAY/STEREO 2-WAY Mode switch:* This switches between the mono three-way mode of operation or the stereo two-way mode of operation.

6. *CHANNEL 1 and CHANNEL 2 INPUTS:* These input are electronically differential balanced and are compatible with both balanced and unbalanced connections.

4.3 Optional Fixed Frequency Modification

Provisions have been designed into the crossover that allow the user to bypass the front panel FREQUENCY controls and permanently set the crossover frequency to one fixed value. This may be used in the event that one of the selectable frequencies will not suit a particular application or the user may simply wish to permanently set the unit to one of the frequencies already provided. In either case, the unit's crossover frequency will be fixed at one set value.

This modification is performed by adding four resistors to each crossover circuit. The resistor locations are designated by R18, R19, R20, R21 in Channel 1 and R118, R119, R120, R121 in Channel 2. These resistor locations are shown in Figure 11.

NOTE: *By performing this modification the user forfeits the ability to use the modified channel's FREQUENCY control. Resistors R18 - R21 in Channel 1 and R118 - R121 in Channel 2 **MUST** be removed in order to return that channel to the FREQUENCY selectable state.*

The front panel FREQUENCY control must be in the 80 Hz position and the selected fixed frequency must be greater than 80 Hz. If the desired crossover frequency is between 80 Hz and 800 Hz, ensure that the RANGE switch is *out* and use Equation 1 to obtain the resistor value. If the

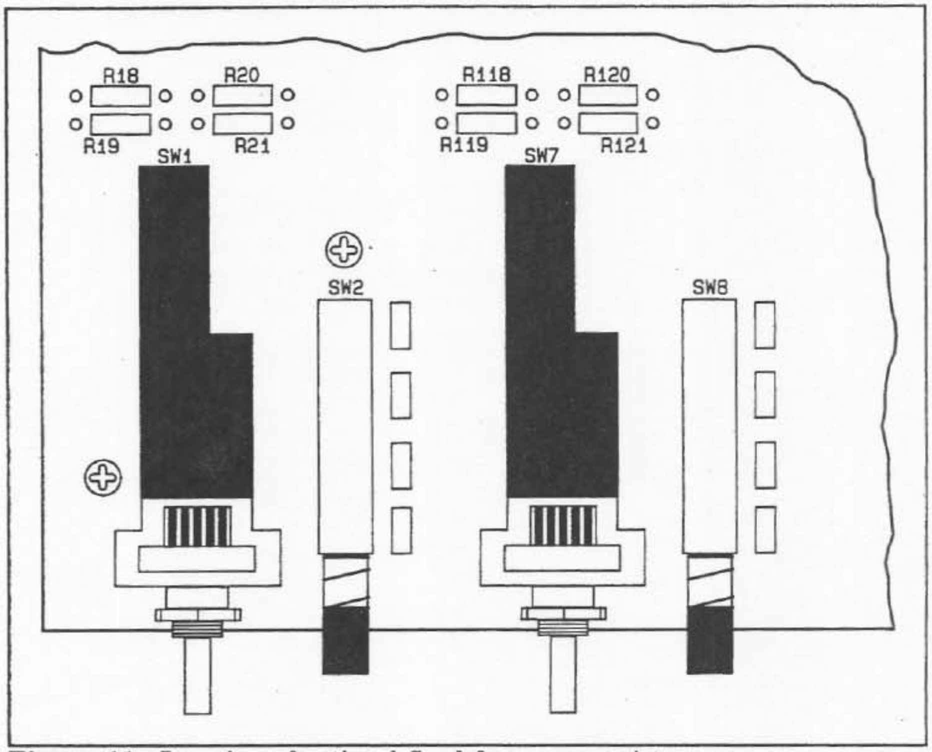

Figure 11. Location of optional fixed frequency resistors.

desired crossover frequency is greater than 800 Hz, ensure that the RANGE switch is *in* and use Equation 2.

$$R = (8 \times 10^6) / (f_c - 80) \quad (1)$$
$$R = (8 \times 10^7) / (f_c - 800) \quad (2)$$

where R = R18(R118) = R19(R119) = R20(R120) = R21(R121) in ohms and f_c is the desired crossover frequency in hertz. Choose the nearest standard value.

NOTE: *Metal film 1% resistors are highly recommended for this modification.*

To implement this modification, follow these procedures:

1. Disconnect the crossover from the ac power source.

2. Remove and save the seven screws securing the top cover. There are two screws on each side, two screws on the rear, and one screw inset into the front panel. Refer to Figure 5 for exact screw locations.

3. Find the resistor locations R18 - R21 and/or R118 - R121. Refer to Figure 11.

4. At each location, solder the calculated valued resistor into the solder pads from the top side of the printed circuit board.

5. Verify that the FREQUENCY controls are in the 80 Hz position and that the RANGE switch is in the desired position.

6. Replace the top cover with the seven screws previously removed.

5 SETUP PROCEDURE

1. Ensure that all power amplifiers are off.

2. Check the loudspeaker connections. Be certain that the high-frequency amplifier actually

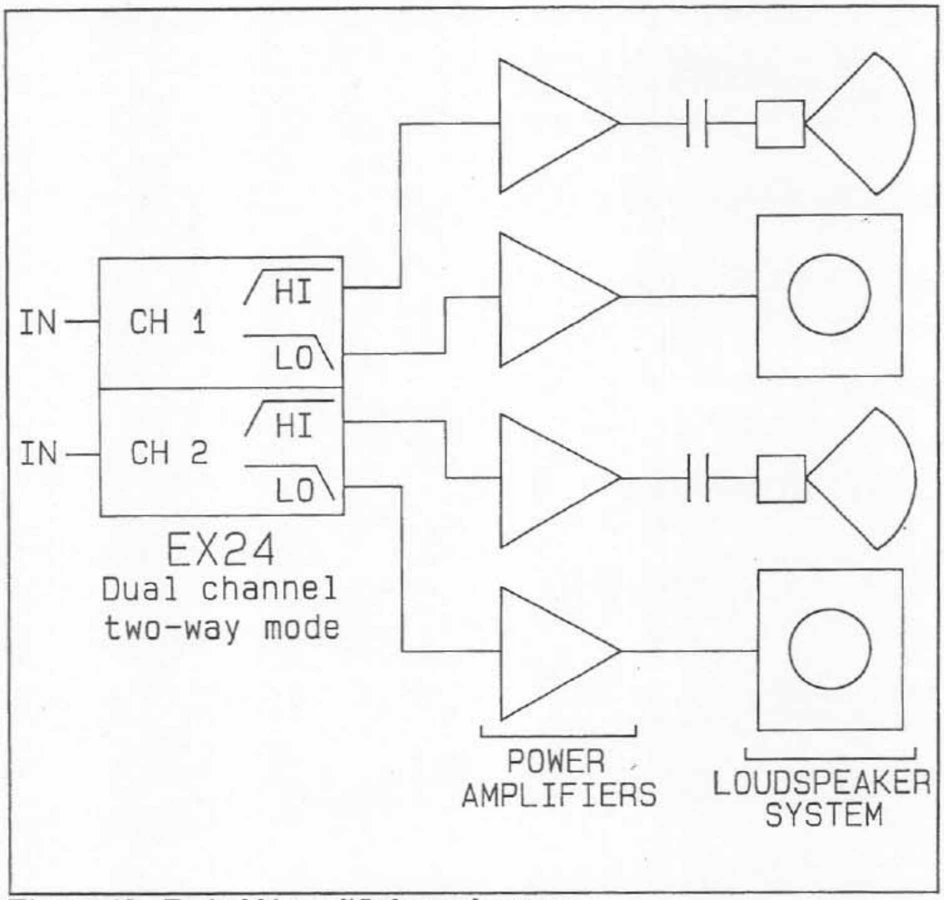

Figure 12. Typical bi-amplified sound system.

feeds the high-frequency loudspeakers and that the low-frequency amplifier actually feeds the low-frequency loudspeakers.

3. Select proper mode(s) and crossover frequency(s) for the system. Consult the loudspeaker manufacturer for choice of crossover frequency. If constant-directivity horns are used (without passive crossover/EQ) then switch on the appropriate channel horn EQ.

4. Switch off all outputs on the crossover. Set gain controls to 0 dB (center detent).

5. Turn on the crossover, mixer(s), and signal processing equipment.

6. Set any overall system equalization (graphic, parametric, or other) to flat.

7. Turn on the power amplifiers.

8. Feed a signal to the crossover input. Switch on the high-frequency outputs on the crossover. Slowly advance the high-frequency power amplifier level control. Check to be sure that the sound heard is actually coming from the high-frequency loudspeakers. The power amplifier level control should be left between full up and about 12 dB down from that, depending on the amplifier's sensitivity. Typically, turning the amplifier down about 6 dB from full up (a sensitivity of about +10 dBu) will reduce the system noise level while maintaining clean sound. Switch off the high output(s).

9. Repeat steps 7 and 8 with the mid output (if used) and then the low output(s).

10. When all outputs are functional and amplifier levels are approximately set, switch on all of the outputs.

11. Using a wide-range signal source, adjust the crossover level controls for proper frequency balance.

12. Remember, when using the system, always switch the power amplifiers **on last and off first**.

6 APPLICATIONS

For most sound system applications, bi- or tri-amplification can provide a significant performance advantage over conventional passive crossovers. A bi-amplified system (Figure 12) uses a separate power amplifier for each loudspeaker (woofer and tweeter) in the system. Similarly, the tri-amplified system (Figure 13) would require three amplifiers. The crossover is placed before the amplifiers and after the mixer, preamplifier, or equalizer. Thus, each amplifier need only handle the frequency range of its respective loudspeaker(s). This arrangement allows each loudspeaker(s) to be driven by an amplifier that exactly suits the needs of that particular loudspeaker. For a low-frequency loudspeaker, this means having enough power to insure adequate low-frequency headroom. The absence of the passive crossover eliminates the crossover network unit's insertion loss and improves the damping factor seen by the woofer. This improves low-frequency performance allowing the woofers cone movement to be more precisely controlled.

Most high-frequency loudspeakers are about 10 dB higher in efficiency than most low-frequency loudspeakers. This means that for the same acoustical output level, the power requirements are about 10:1. For example, if the tweeter requires 10 watts for a given sound pressure level, the woofers will require 10 times more power to produce the same level (100 watts). Since the high-frequency amplifier has limited power, it is less likely to damage the tweeters if a mistake occurs (dropped mic, loud feedback, etc.).

Musical signals demand the largest amount of power at low frequencies. This is compounded by the lower efficiency of most woofers. A passively crossed-over system requires tremendous amounts of power to accurately reproduce musical transients at real-life (live performance) levels. In this system, when a power amplifier clips, the only thing the loudspeaker system can do is to try to reproduce it. During the instant that the amplifier is clipped, all other signals going through it are also clipped. This means that all high-frequency are lost. The clipping is heard as harsh distortion and is especially hard on the tweeters which are ill-equipped to handle the drastically changed energy content. This is probably the number one cause of tweeter burnout.

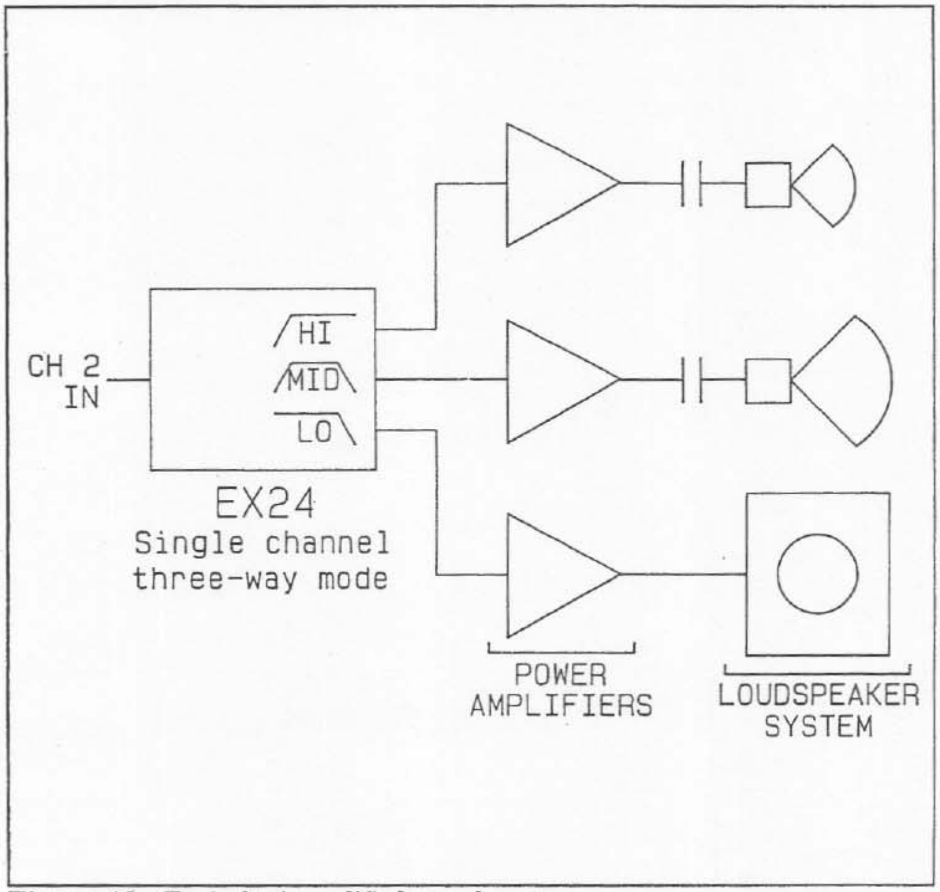

Figure 13. Typical tri-amplified sound system.

In a bi-amplified system, when a large low-frequency transient clips the low-frequency amplifier, the accompanying high frequencies are not clipped because they have their own amplifier. The low-frequency clipping is reproduced by the low-frequency loudspeaker, but is masked by the clean highs coming out of the tweeter. The net result is that the system will sound cleaner, longer.

7 HIGH-FREQUENCY DRIVER PROTECTION

In any bi-, tri-, or multi-amplified system, it is especially important to provide low-frequency roll-off for the high-frequency loudspeakers. This protection can take the form of a series capacitor. The roll-off should occur at about one octave below the crossover point. This will help protect the driver from dc should the amplifier short out, or from low-frequency energy if the high- and low-frequency sends get switched around. To find the capacitor value, use the equation,

$$C = 10^6 / \pi f Z$$

where, C is the capacitor value in microfarads, f is the crossover frequency in hertz, and Z is the loudspeaker impedance in ohms.

Use (in order of preference) mylar or film, nonpolar electrolytic or series-connected (+ to +, 2x the calculated value) polar or electrolytic capacitors with at least one having a 50 volt rating.

For the commonly used 16-ohm drivers: 500 Hz = 40 μF, 800 Hz = 24 μF, 1000 Hz = 20 μF. Eight-ohm drivers will require twice the capacitance of a 16-ohm driver: 500 Hz = 80 μF.

NOTICE: *Repairs performed by other than authorized warranty stations (Dealers) or qualified personnel shall void the warranty period of this unit. To avoid loss of warranty, see your nearest Electro-Voice® authorized dealer, or call Electro-Voice® Customer Service directly at (405) 324-5311, Telex 160369, FAX (405) 324-8981, or write:*

Electro-Voice® Customer Service/Repair
10500 West Reno Avenue
Oklahoma City, OK 73128 U.S.A.

EX24 Active Crossover

SERVICE INFORMATION

CAUTION

NO USER SERVICEABLE PARTS INSIDE. EXTREMELY HAZARDOUS VOLTAGES AND CURRENTS MAY BE ENCOUNTERED WITHIN THE CHASSIS. THE SERVICING INFORMATION CONTAINED WITHIN THIS DOCUMENT IS ONLY FOR USE BY ELECTRO-VOICE® AUTHORIZED WARRANTY REPAIR STATIONS AND QUALIFIED SERVICE PERSONNEL. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. OTHERWISE, REFER ALL SERVICING TO QUALIFIED SERVICE PERSONNEL.

8 SERVICE INFORMATION

WARNING: *No user serviceable parts inside. Extremely hazardous voltages and currents may be encountered within the chassis. The servicing information contained within this document is only for use by Electro-Voice® authorized warranty repair stations and qualified service personnel. To avoid electric shock DO NOT perform any servicing other than that contained in the Operating Instructions unless you are qualified to do so. Otherwise, refer all servicing to qualified service personnel.*

NOTICE: *Modifications to Electro-Voice® products are not recommended. Such modifications shall be at the sole expense of the person(s) or company responsible, and any damage resulting therefrom shall not be covered under warranty or otherwise.*

8.1 Ordering Replacement Parts

To order replacement parts, look up the ordering number from the component parts listing and call (405) 324-5311, Telex 160369, FAX (405) 324-8981, or write:

Electro-Voice®
Replacement Parts Sales
P.O. Box 26105
Oklahoma City, OK 73126-0105
U.S.A.

8.2 Factory Service

If factory service is required, ship the unit in its original packing prepaid to:

Electro-Voice® Customer
Service/Repair
10500 West Reno Avenue
Oklahoma City, OK 73128 U.S.A.

Enclose a note describing the problem in as much detail as possible. Include any additional helpful information such as test conditions, where used, how used, etc.

8.3 Technical Assistance

For applications assistance or other technical information, contact the Technical Services Manager. You can call (616) 695-6831, TWX 810-270-31353, FAX (616) 695-1304, or write:

Electro-Voice®
Technical Services Manager
600 Cecil Street
Buchanan, MI 49107 U.S.A.

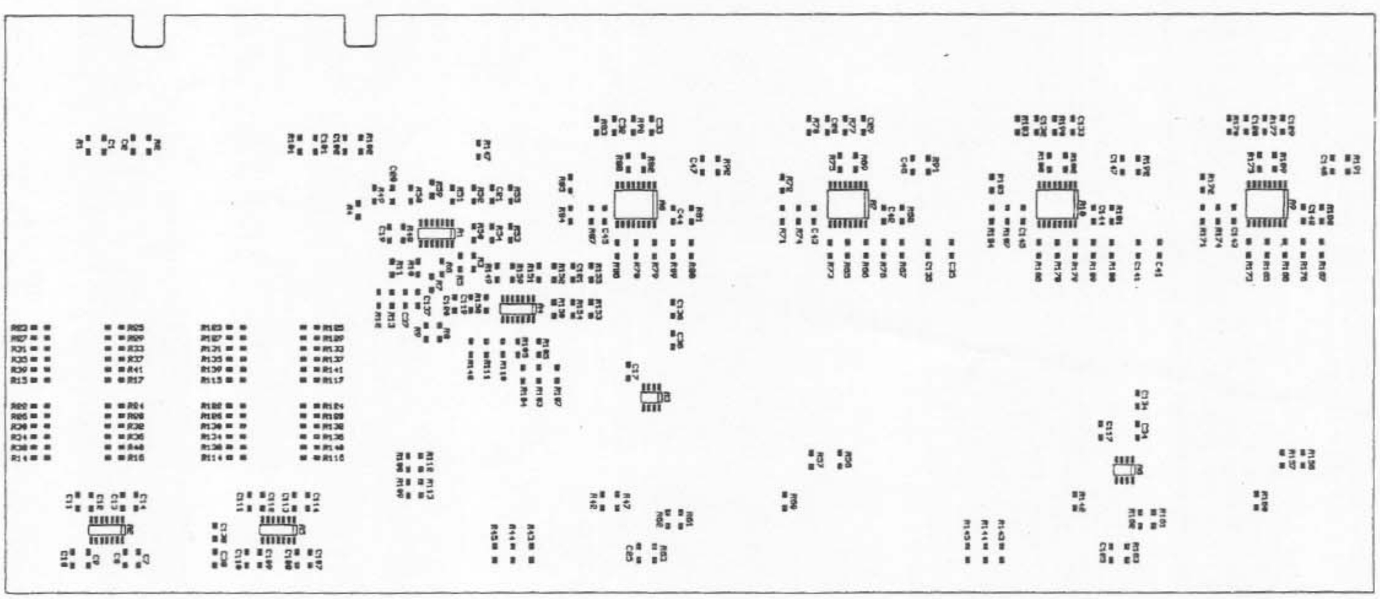

Figure 14. Component layout of underside of main board.

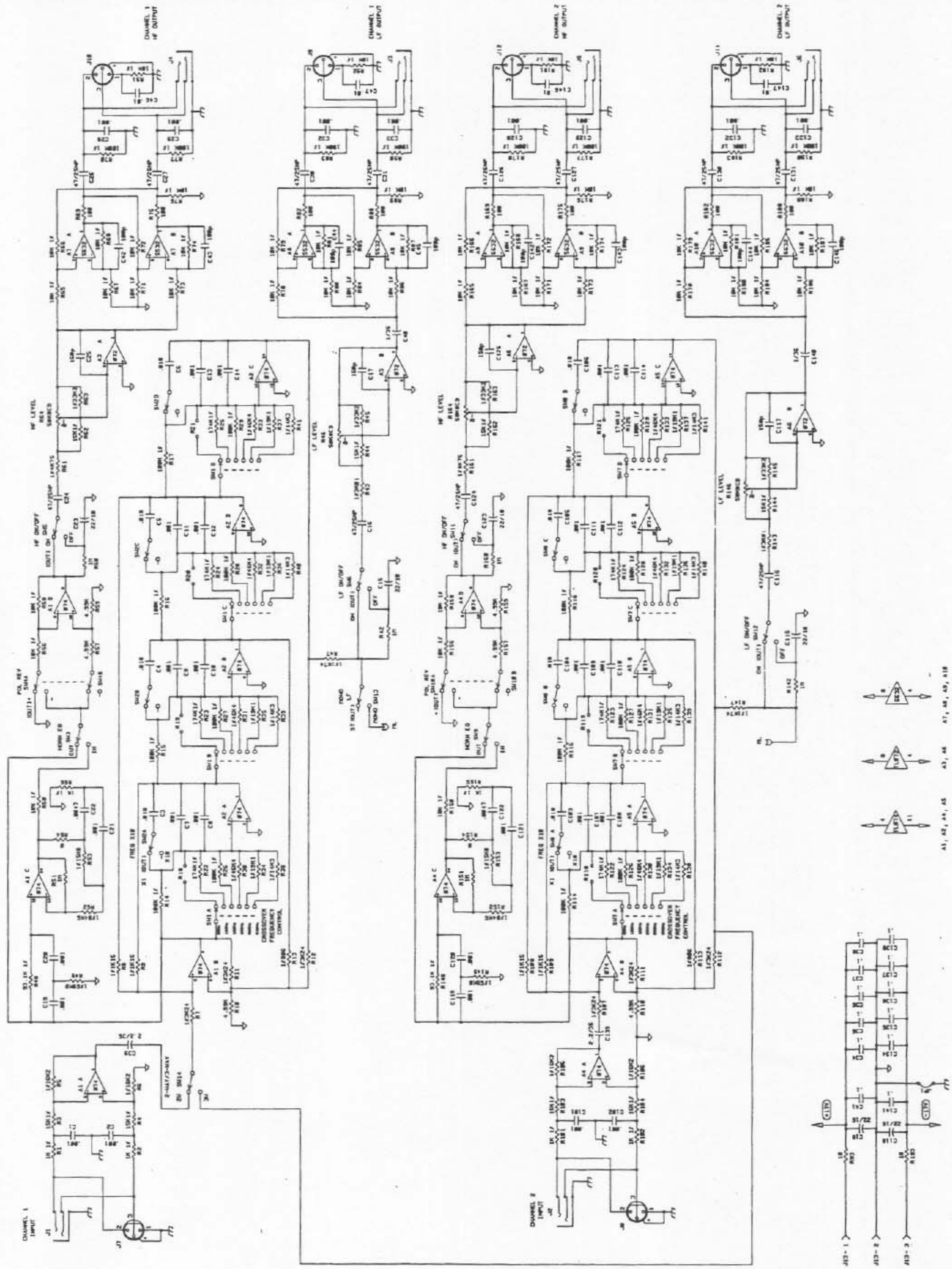

Figure 15. Schematic of the EX24.

Component Listing for the EX24

Main Board Assembly (27-01-036046)

Reference Designator	Ordering Number	Name and Description
A1, A2, A4, A5	17-01-125143	IC, TL074, smd
A3, A6	17-01-125141	IC, TL072, smd
A7, A8, A9, A10	17-01-125142	IC, NE5532, smd
C1, C2, C28, C29, C32, C33, C101, C102, C128, C129, C132, C133	15-02-125147	Capacitor, .001 μF, 100 V, 10%, smd
C3, C4, C5, C6, C103, C104, C105, C106	15-06-028019	Capacitor, .018 μF, 100 V, 10%, mylar
C7, C8, C9, C10, C11, C12, C13, C14, C19, C20, C21, C107, C108, C109, C110, C111, C112, C113, C114, C119, C120, C121	15-02-125148	Capacitor, .001 μF, 50 V, 5%, smd
C15, C23, C115, C123	15-01-026793	Capacitor, 22 μF, 10 V, electrolytic, radial
C16, C24, C26, C27, C30, C31, C116, C124, C126, C127, C130, C131	15-01-027327	Capacitor, 47 μF, 25 V, 20%, electrolytic, radial
C17, C25, C117, C125	15-02-125146	Capacitor, 150 pF, 100 V, 10%, smd
C18, C118	15-01-028154	Capacitor, 22 μF, 16 V, electrolytic, radial
C22, C122	15-06-026824	Capacitor, .0047 μF, 50 V, 5%
C34, C35, C36, C37, C38, C41, C134, C135, C136, C137, C138, C141	15-02-125144	Capacitor, .1 μF, 50 V, 10%, smd
C39, C139	15-01-028851	Capacitor, 2.2 μF, 35 V, electrolytic, radial
C40, C140	15-01-028850	Capacitor, 1 μF, 35 V, electrolytic, radial
C42, C43, C44, C45, C142, C143, C144, C145	15-02-125149	Capacitor, 100 pF, 50 V, 10%, smd
C46, C47, C146, C147	15-02-125145	Capacitor, .01 μF, 100 V, 10%, smd
JP1	21-01-110310	Resistor, 0 Ω jumper
R1, R2, R55, R101, R102, R155	47-03-125153	Resistor, 1.00 kΩ, 0.125 watt, 1%, smd
R3, R4, R44, R62, R103, R104, R144, R162	47-03-125155	Resistor, 15.0 kΩ, 0.125 watt, 1%, smd
R5, R6, R105, R106	47-03-125157	Resistor, 16.2 kΩ, 0.125 watt, 1%, smd
R7, R11, R12, R107, R111, R112	47-03-125161	Resistor, 3.24 kΩ, 0.125 watt, 1%, smd
R8, R9, R108, R109	47-03-125162	Resistor, 1.15 kΩ, 0.125 watt, 1%, smd
R10, R57, R59, R110, R157, R159	47-03-125160	Resistor, 4.99 kΩ, 0.125 watt, 1%, smd
R13, R113	47-03-125163	Resistor, 806 Ω, 0.125 watt, 1%, smd
R14, R15, R16, R17, R26, R27, R28, R29, R70, R77, R83, R90, R114, R115, R116, R117, R126, R127, R128, R129, R170, R177, R183, R190	47-03-125152	Resistor, 100 kΩ, 0.125 watt, 1%, smd
R22, R23, R24, R25, R122, R123, R124, R125	47-03-125167	Resistor, 174 kΩ, 0.125 watt, 1%, smd
R30, R31, R32, R33, R130, R131, R132, R133	47-03-125173	Resistor, 46.4 kΩ, 0.125 watt, 1%, smd
R34, R35, R36, R37, R134, R135, R136, R137	47-03-125165	Resistor, 19.1 kΩ, 0.125 watt, 1%, smd
R38, R39, R40, R41, R138, R139, R140, R141	47-03-125159	Resistor, 14.3 kΩ, 0.125 watt, 1%, smd
R42, R51, R60, R142, R151, R160	47-01-125150	Resistor, 1 MΩ, 0.125 watt, 5%, smd
R43, R143	47-03-125164	Resistor, 3.01 kΩ, 0.125 watt, 1%, smd
R45, R63, R145, R163	47-03-125169	Resistor, 33.2 kΩ, 0.125 watt, 1%, smd
R46, R64, R146, R164	47-06-027344	Potentiometer, 50 kΩ, linear taper, center detent, 20%

Main Board Assembly (27-01-036046) con't

Reference Designator	Ordering Number	Name and Description
R47, R147	47-03-125168	Resistor, 1.74 kΩ, 0.125 watt, 1%, smd
R48, R148	47-03-125156	Resistor, 93.1 kΩ, 0.125 watt, 1%, smd
R49, R149	47-03-125172	Resistor, 59.0 kΩ, 0.125 watt, 1%, smd
R50, R56, R58, R65, R66, R67, R68, R71, R72, R73, R74, R76, R78, R79, R80, R81, R84, R85, R86, R87, R89, R91, R92, R150, R156, R158, R165, R166, R167, R168, R171, R172, R173, R174, R176, R178, R179, R180, R181, R184, R185, R186, R187, R189, R191, R192	47-03-125154	Resistor, 10.0 kΩ, 0.125 watt, 1%, smd
R52, R152	47-03-125158	Resistor, 84.5 kΩ, 0.125 watt, 1%, smd
R53, R153	47-03-125170	Resistor, 15.8 kΩ, 0.125 watt, 1%, smd
R54, R154	47-01-125171	Resistor, 0 Ω jumper, smd
R61, R161	47-03-125166	Resistor, 4.75 kΩ, 0.125 watt, 1%, smd
R69, R75, R82, R88, R169, R175, R182, R188	47-01-125151	Resistor, 100 Ω, 0.125 watt, 5%, smd
R93, R193	47-01-102030	Resistor, 10 Ω, 0.25 watt, 5%
SW1, SW7	51-01-027347	Switch, rotary, 4P6T
SW2, SW8	51-02-028058	Switch, push button, 4PDT
SW3, SW4, SW5, SW6, SW9, SW10, SW11, SW12, SW13, SW14	51-02-026810	Switch, push button, DPDT

Power Supply Board Assembly (27-01-036009)

Reference Designator	Ordering Number	Name and Description
C1, C2	15-01-124505	Capacitor, 1000 μF, 50 V, electrolytic, radial
C3, C4	15-01-124502	Capacitor, 10 μF, 50 V, electrolytic, radial
CR1	48-02-125062	Bridge Rectifier, 1 A, pc mount
CR5, CR6	48-02-042787	Diode, 1N4004, 400 V
F1	51-04-124634	Fuse, 175 mA, 250 V, Slo-Blo®
R1	47-01-102080	Resistor, 1.2 kΩ, 0.25 watt, 5%
T1	56-08-025906	Transformer, power
U1	17-01-121660	IC, 7815, +15 V, regulator
U2	17-01-121659	IC, 7915, -15 V, regulator