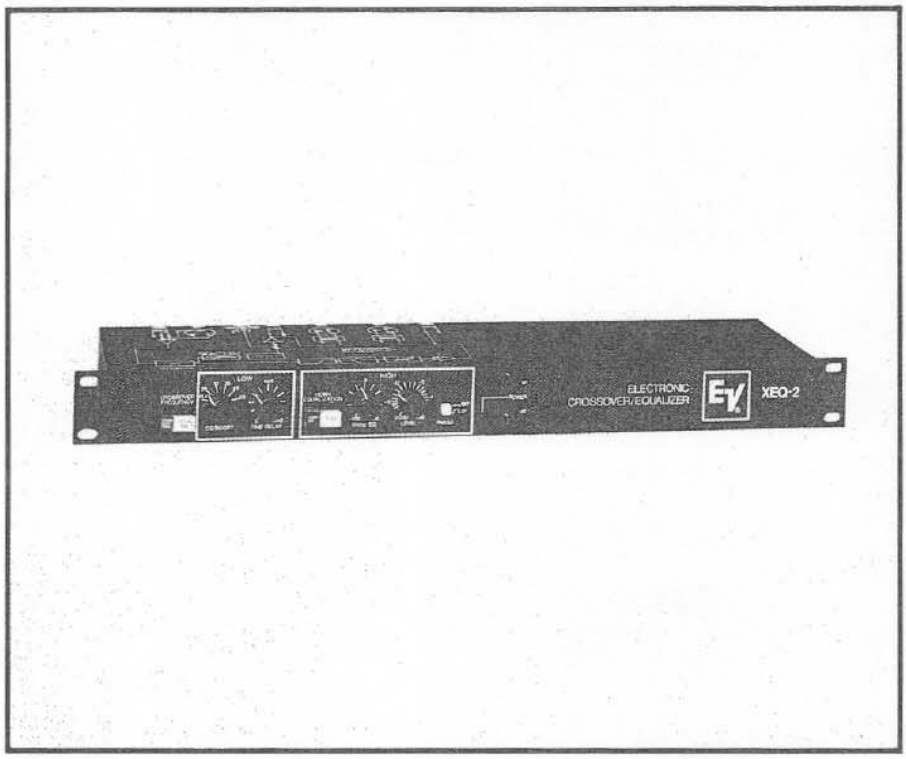

Electro-Voice®
a MARK IV company

Model XEQ-2 Electronic Crossover

SPECIFICATIONS

Channel Configuration:
One input, one high-pass output, one low-pass output.
Relative Phase,
Low Channel:
Output is phase with input, with delay control at minimum
High Channel:
Switchable, 0 or 180 degrees
Frequency Response (sum of outputs, controls flat):
±0.5 dB 30-20 kHz
Noise Output (20-20 kHz bandwidth):
-90 dBV maximum (88 dBm)
Total Harmonic and Intermodulation Distortion (controls flat):
.02 typical; 0.1 maximum at 20 kHz, +20 dBm
Output Configuration:
Unbalanced; balanced and isolated with optional accessory transformers
Maximum Output Level:
+18 dBV (+20 dBm)
Minimum Load Impedance:
600 ohms
Output Protection:
Safe for short circuit or ±25 volts DC
Output Internal Impedance:
47 ohms
Common Bass Tie Line Impedance:
2000 ohms
Input Configuration:
Balanced or unbalanced, user selectable
Input Impedance,
Bridging:
15,000 ohms unbalanced
Balanced:
30,000 ohms
Input Common-Mode Rejection:
55 dB, typical 60-1000 Hz
Delay (low frequency channel):
Adjustable, 25 μ sec to msec at 100 Hz
Overall Gain (controls flat):
0 dB into high-Z load
Crossover Frequency Range (determined by module):
100 to 8000 Hz
Filter Type,
Normally Supplied:
Third-order Butterworth (18 dB per octave)
Possible Constructions:
First-, second-, third-order Butterworth, Bessel, or Chebyshev, high and low channel independently chosen
High/Low Channel Crosstalk (ultimate rejection):
60 dB typical
Low-Frequency Equalization for "Step-Down" Operation of TL Bass Speaker Systems:
Second-order under-damped filter with switchable plus-6-dB peak boost frequencies of 29, 32, 35, 45, and 60 Hz, plus "flat" with a high-pass f_3 of 30 Hz
Plug-In Module Horn/Driver Equalization,
Normally Supplied:
"Flat" module
Available Modules:
EQA, EQB...modules for EV horns (see Table 1)
Continuously Variable High-Frequency Equalization:
±4 dB at 10 kHz, Q = 3
High-Frequency Channel Level Control:
0 to 20 dB relative to low-frequency channel
Transient Performance:
Not limited by slew rate or power bandwidth over 20-20 kHz under any normal operating condition
Power Requirements:
90 to 120 V, 50/60 Hz, 8 watts, maximum
Mounting:
Standard 19" rack panel, 1¾" high, 5" depth behind panel
Overall Dimensions:
44 mm (1.73 in.) high,
483 mm (19.0 in.) wide,
124 mm (4.875 in.) deep
Net Weight:
2.15 kg (4.74 lbs)

DESCRIPTION

The EV XEQ-2 electronic crossover/equalizer is a single-channel, high-performance device, intended primarily for professional sound reinforcement applications. It combines an active, two-way frequency dividing network, a five-position "Thiele" low-frequency equalizing network, and a variable high-frequency horn-driver equalizer which are compatible with the Electro-Voice TL bass speaker systems and high-frequency drivers. Two series of miniature, plug-in modules provide for the selection of crossover frequency and custom equalization of various horn/driver combinations. Such equalization has heretofore been unavailable as part of an active crossover, making the XEQ-2 an extraordinarily useful component in high-performance fixed and portable sound systems.

NOTE: One crossover and one horn/driver equalization (or flat) module must be installed in their respective sockets for the XEQ-2 to be operative. To insert a module, carefully align the pins with socket openings and push inward until the module is fully seated against the socket face. When properly oriented, the diagonal corner of the module will be on the upper right, and printing will appear right-side-up. Unused modules should be stored carefully in the protective box provided to prevent inadvertent bending of pins.

The XEQ-2 is rack mountable with a 1¾" panel height. All controls are on the front panel but are protected from uninvited knob twisting by a see-through removable plastic cover.

LOW-FREQUENCY CHANNEL PHASE

This crossover has been designed so that over the flat portion of the low-frequency channel, and with the delay control set at minimum (fully CCW), a positive polarity signal at the input (tip or pin 2) will result in a positive polarity voltage at the output (tip or pin 2). Thus, no basic phase

will result from the insertion of an XEQ-2 into the system.

LOW-FREQUENCY EQUALIZATION

The XEQ-2 provides the low-frequency contouring necesary for "step-down" operation of Electro-Voice TL bass speaker systems. The peak frequency for each switch position is shown in Figure 3 along with the appropriate TL speaker system.

A feature of the circuit for low-frequency equalization is a high-pass filter with 12-dB-per- octave slope below the peak-boost frequency for removing subsonic energy below the lowest usable speaker frequency. Such energy is not audible in itself but wastes amplifier power, modulates (distorts) the higher bass and mid- bass frequencies within the speaker system's effective range, and can destroy the woofer due to excessive cone excursion.

A high-pass filter is also part of the Flat (no equalization) switch position, with a 3-dB-down point of 30 Hz and a 12-dB-per-octave slope.

TIME DELAY CONTROL

A delay control is provided which electronically delays the low-frequency channel with respect to the high-frequency channel. The amount of delay is continuously variable between 25 μ sec (essentially zero) and 2 msec. The primary use of this control is to help flatten the system response through the crossover region. Adjusting the delay control is acoustically equivalent to physically moving the drivers with respect to each other. Thus, the acoustical centers of the drivers may be aligned electronically, in real time, from the listeners vantage point.

The second order Pade time delay circuit used in the XEQ-2 provides a delay, T_D, which is essentially constant over frequency up to the frequency, f_D, where $f_D = 1/T_D$. See Figure 4 for a graph of delay vs. frequency for various settings of the delay control. The frequency response of this circuit is always flat and is independent of the delay setting.

HIGH-FREQUENCY EQUALIZATION

The active, high-frequency equalization accurately compensates for the falling high- frequency response of a high-performance compression driver used with a constant directivity horn. This falling response occurs because the efficiency of all compression drivers begins to decrease above about 2500 Hz. When the driver is placed on a constant directivity horn, one which spreads driver output over a uniform coverage angle throughout the frequency range, the response of the driver/horn combination falls. Because directivity is determined by horn size, desired coverage angle, and other design factors, the required equalization is strongly a function of horn model. Therefore, the XEQ-2 utilizes a series of plug-in modules, each one optimized for a particular Electro-Voice HR, HP or RC series constant-directivity horn. Table 1 lists the available modules, together with the horn/driver with which they are intended to be used. A flat module is supplied with the XEQ-2 for applications not requiring horn equalization, or when it is provided elsewhere in the system. It is necessary to have a module installed in the horn equalization socket at all times when the unit is being operated.

In addition to the module, a continuously variable control is provided to trim the equalization at 10 kHz over the range of 4 dB to+4 dB with respect to nominal. Figure 5A shows the maximum and minimum setting when used with the "flat" module. This control has negligible effect below 5 kHz and allows the user to select the optimum response to suit his acoustic environment and taste. It is also useful in compensating minor driver response differences. Figure 5B shows the overall response with the EQA module in place.

Horn/Driver Equalization Modules

Model	Used With	
	Horn	Driver
EQA	HR90	DH101DA DH1506
EQB	HR120, SM120	
EQC	HR40, HR60	
EQD	HR9040A,HR4020A	
EQE	HR6040A	
EQF	FLAT	
EQG	HR90	DH2012
EQH	HR120	
EQJ	HR40, HR60	
EQK	HR9040A,HR4020A	
EQL	HR6040A	
EQM	HP940	DH1, DH2
EQN	HP1240	
EQO	HP420, HP640	
EQP	HP9040, HP4020	
EQQ	HP640	
EQR	HP940	DH1A DH2A
EQS	HP1240	
EQT	HP640	
EQU	HP4020, HP6040,HP9040	
EQV	HP420	
EQW	HP64, HP94	

Model Number	Frequency
X125	125 Hz
*X500	500 Hz
*X800	800 Hz
X1250	1250 Hz
X3500	3500 Hz
X7000	7000 Hz
*BMK	(Blank Module Kit)

Crossover modules listed are third-order Butterworth characteristic.

***Supplied with XEQ-2**

Table 1. Accessory Plug-in Modules

HIGH-FREQUENCY LEVEL CONTROL

A continuously variable calibrated gain control affects only the high-frequency channel. Its primary use is to compensate for differences in efficiency between low-frequency speaker systems and high-frequency speaker systems. The control covers a range in gain of 20 dB and provides equal gain of the high and low channels when in its fully clockwise position.

POLARITY REVERSAL SWITCH

A two-position push-button switch is provided to change the phase on the high-frequency channel relative to the low-frequency channel by 180. Although the "normal" position provides the conventional phase relationship between high and low output channels for a third-order Butterworth (18-dB-per-octave slope) system, it may be advantageous in certain practical acoustic situations to reverse the phase. This will allow the user to optimize crossover response for drivers having widely different phase characteristics or polarity.

CROSSOVER MODULE

Two plug-in modules are supplied with the XEQ-2 crossover for obtaining 500-Hz and 800-Hz crossover frequencies. See Figure 6 for a typical crossover curve. Both crossover plug-in modules have maximally flat third-order Butterworth filter characteristics (18-dB-per-octave slope). Optional modules providing other frequencies are available as accessories, and are listed in Table 1.

An extra 16 pin dual-in-line (DIP) plug has been provided for custom module assembly. This allows construction of crossover frequencies or characteristics not provided as standard. Assembly should be undertaken only by those persons having experience in precision soldering. Aside from the plug, cap, and label (supplied), the only other parts required are ¼-watt resistors calculated from the formula given below.

Since all six of the crossover determining resistors are a part of the plug-in module, the user has complete freedom in choosing the order, characteristic, and frequency of the high- and low-pass sections. Each section may be considered independently, thus allowing for crossover frequency overlap or spread. For the sake of simplicity, information is given below only for the case of the third-order Butterworth filters. This configuration gives a maximally flat response shape near the crossover frequency with 18-dB-per-octave slopes which gives the best all around performance for the vast majority of applications.

In the following formulas, f_3 is the crossover frequency desired, sometimes referred to as the "knee" of the curve. Specifically, it is that frequency at which the response has been attenuated by 3 dB (0.7 times the voltage or 0.5 times the power) from the flat portion of the curve. When the f_3's of the low- and high-pass sections are made to coincide in frequency, as is usually the case, the total energy of the output channels, when added, is independent of frequency, thus providing a "flat" response. Resistors RL1, RL2, and RL3 determine the characteristic of the low-pass filter section. Similarly, RH1, RH2, and RH3 determine the high-pass section characteristics. One-quarter watt film resistors having a resistance tolerance of 1 or 2 are recommended. In less critical applications, 5 resistors may suffice. Mil type RN55D resistors are easiest to use; however, conformally coated resistors may also be used.

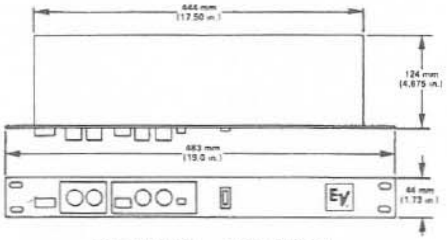

FIGURE 1 – Dimensions

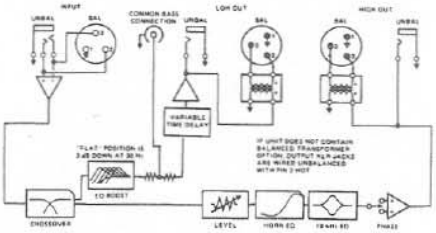

FIGURE 2 – XEQ-2 Crossover Block Diagram

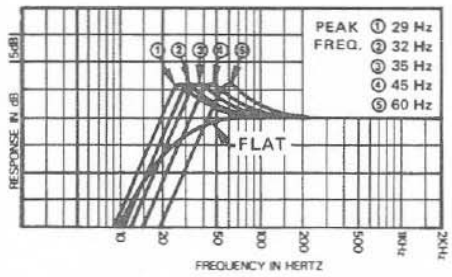

FIGURE 3 – Low-Frequency Equalization

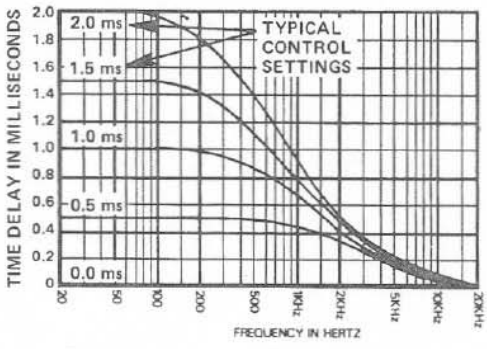

FIGURE 4 – Low-Frequency Time Delay

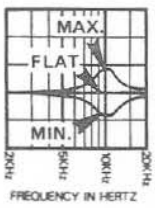

FIGURE 5a
10 kHz Equalization
Module EQ F

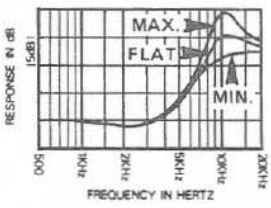

FIGURE 5b
Typical Horn Equalization
Module EQ A

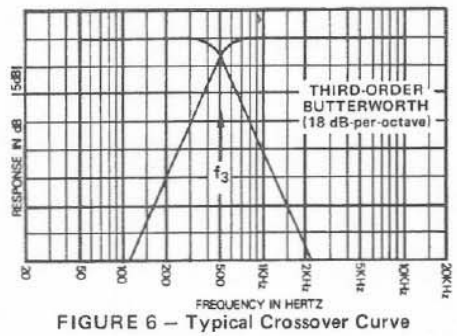

FIGURE 6 – Typical Crossover Curve

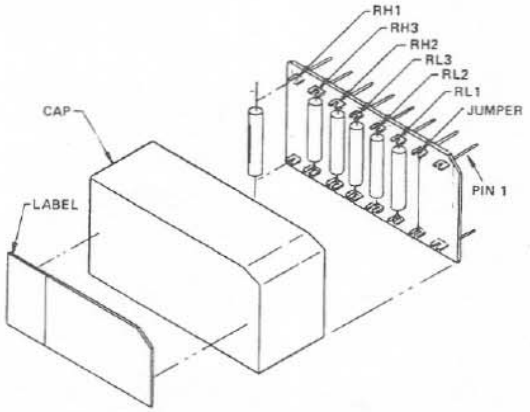

FIGURE 7 – Crossover Module Assembly

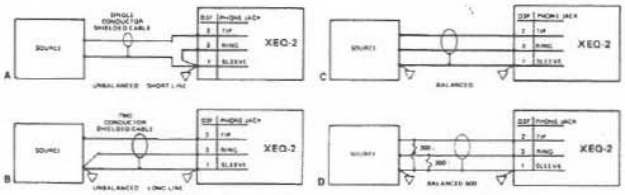

FIGURE 8 – Input Connections to the XEQ-2

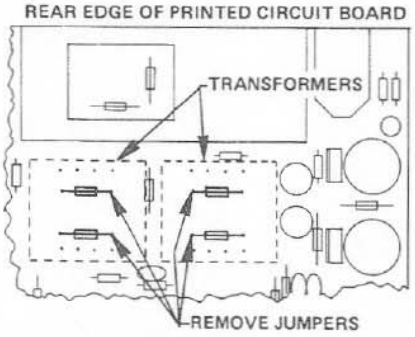

FIGURE 9 – Mounting Location of Optional TRB-1 Transformers

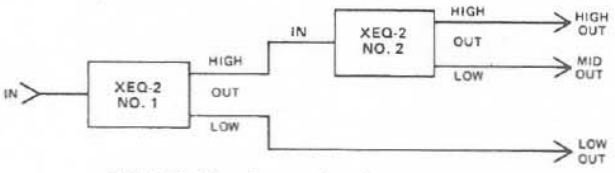

FIGURE 10 – Connection for Tri-Amping Using the XEQ-2

In the following formulas, R is given in ohms and f_3 in Hertz. M stands for meg or one million.

LOW PASS SECTION

$RL1 = 16.39M/(f_3+6)$
$RL2 = 116.97M/(f_3+6)$
$RL3 = 21.03M/(f_3+6)$

HIGH PASS SECTION

$RH1 = 24.32M/f_3$
$RH2 = 9.55M/f_3$
$RH3 = 167.3M/(f_3-7.6)$

After calculating the exact values, select the nearest standard value. In general, raising the value of all three resistors by a fixed percentage will lower the crossover frequency of that section by the same percentage, while maintaining the same shape of curve. Altering the resistance ratios among the three resistors will change the shape of the knee of the curve, causing either a more gradual crossover, or else a peaked response. It should not, therefore, be attempted indiscriminately. For specialized applications, it is recommended that the factory engineering department be consulted.

CUSTOM MODULE CONSTRUCTION

In addition to the Electro-Voice Model BMK blank module kit, the following items are required:

1. Six resistors, calculated from formulas, as given above.
2. Low wattage soldering iron with small chisel tip.
3. Electronic grade solder, 63/37 or 60/40 alloy, rosin core.
4. Flush cutting diagonal cutters.
5. A spare 16 pin DIP socket.
6. Adhesives: epoxy, super glue or hot melt.
7. Various hand tools, as needed.

Refer to diagram in Figure 7.

1. Insert the DIP plug into the spare socket or use the one on the XEQ-2. This helps to keep the pins in alignment during soldering.
2. Locate pin 1 by the cut-off corner on the plug.
3. Place and solder the resistors one by one and trim each lead close enough to the pin to allow later installation of the cap. If you are using conformally coated (dipped) resistors, be sure the leads are free of the coating material where they emerge from the resistor eddy. Be careful not to overheat the pins as the plastic base will melt.
4. Use 22 AWG bus wire for the jumper, or a remnant of a resistor lead.
5. Check all connections and resistor values.
6. Attach cap by means of glue.
7. A self-adhesive label is included for either a crossover frequency module or horn EQ module.

CONTROL COVER

A transparent plastic control cover is provided to cover all the controls so that they will not be altered unintentionally. The cover is held in place with four 6-32 screws.

INPUT CONNECTIONS

The XEQ-2 input circuit is designed to accommodate any balanced or unbalanced, high- or low-impedance, active or passive source, which is capable of providing a line-level signal. The good common-mode rejection, coupled with low radio-frequency-interference susceptibility, makes it ordinarily unnecessary to use an input transformer. The XEQ-2 is typically installed in the audio signal chain immediately preceding the power amplifiers.

Unbalanced (One Side Grounded) Sources

When using a conventional single-circuit phone plug for the input connector, no further input connections are required. If using an XLR-type connector, the input normally goes to pin 2, with pin 1 connected to the shield (ground). Pin 3 must also be tied to pin 1. Connection should not be made to both the phone jack and the XLR connector at the same time (see Figure 8A).

Under adverse conditions (i.e. when the source is located over 10 feet away, and/or in a dif- ferent equipment rack) it may be possible to reduce hum and noise generated in the input system by adopting the highly recommended circuit of Figure 8B. This will minimize the effect of any ground loop currents which are normally associated with unbalanced systems. The requisite two-conductor shielded cable may be connected either to the 3-pin XLR connector input or to the two-circuit (stereo) phone-jack input.

Balanced Sources

When possible, it is always desirable to feed the XEQ-2 with a balanced source. This will minimize hum and other extraneous noise picked up in the input cable, or induced by a system ground loop. Figure 8C illustrates this connection. In unusual cases, where the driving unit (source) must see a load of exactly 600 ohms, a resistor may be placed across the line (or two 300-ohm resistors as shown in Figure 8D). One-quarter or one-half watt, 5 tolerance units are usually adequate.

OUTPUT CONNECTIONS

Unbalanced Outputs

Output is unbalanced (single ended) without the accessory transformers, and is present at the phone jack for each output. The XLR-type connectors are wired to the DIN (European) standard, that is, pin 2 hot, pins 1 and 3 ground.

Balanced Outputs

Balanced and isolated outputs may be obtained from the XLR connector by utilizing Electro-Voice Model TRB-1 accessory transformer kit. These must be user installed on the circuit board. See Diagram, Figure 9.

NOTE: Two jumpers (look like resistors with no color bands) on the circuit board assembly must be removed before the transformers may be installed. The transformer lead layout is assymetrical, so verify the orientation of the transformer printed circuit pins with the holes in the board before installing. Solder all connec- tions on the foil side of the board.

Load Impedance Requirements

All XEQ-2 outputs have an internal impedance of 47 ohms in the unbalanced condition (100 ohms balanced). This is suitably low for driving one or several loads whose combined impedance is 600 ohms or greater. Where an actual 600-ohm source is desirable, an external 560-ohm series build-out resistor may be used. In balanced operation, two 240-ohm series resistors may be used, one in series with each of the output leads. In either case, there is a 6-dB drop in gain due to the matched impedance termination. It is possible to use the phone jack and XLR connector at the same time to drive multiple loads. The maximum load impedance in this case is 1200 ohms per jack (or in any event the parallel combination of both loads should not be less than 600 ohms).

Common Bass Operation

When common bass operation is required from two (or more) XEQ-2's, the low-frequency out- put channels may be summed (mixed) by inter- connecting the "common bass" phono jacks on the rear panels. The common bass power amplifier may then be driven from the regular low channel output of either crossover. Since the low channel output of each interconnected XEQ-2 is identical, it is unnecessary to make connection to more than one. However, the "delay" control of only the connected unit will be operative.

The jumper used for common bass inter-connection is not critical, but should be shielded. Typically, a six-inch length of single conductor phono cable with a phono plug termination on each end would be satisfactory.

TRI-AMPING

Two XEQ-2's may be "stacked" to provide tri-amp capability as shown in Figure 10. Crossover number 1 should incorporate a module to select the lower (mid/low) crossover frequency. XEQ-2 number 2 should be used for the upper (mid/high) crossover. Thiele equalization should be carried out in unit number 1, with low-frequency equalization in number 2 set "flat." High-frequency equalization may be used as needed, with number 1 adjustments affecting both mid and high channels, and number 2 adjustments influencing only the high channel. Typical crossover points might be 500 Hz for unit number 1 and 3500 Hz for unit number 2, depending upon requirements of the speaker system.

WARRANTY (Limited)

Electro-Voice Professional Sound Reinforcement Electronic Components are guaranteed for two years from date of original purchase against malfunction due to defects in workmanship and materials. If such malfunction occurs, unit will be repaired or replaced (at our option) without charge for materials or labor if delivered prepaid to the proper Electro-Voice service facility. Unit will be returned prepaid. Warranty does not extend to finish, appearance items or malfunction due to abuse or operation under other than specified conditions, nor does it extend to incidental or consequential damages. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above exclusion may not apply to you. Repair by other than Electro-Voice or its authorized service agencies will void this guarantee. A list of authorized service centers is available from Electro-Voice, Inc., 600 Cecil Street, Buchanan, MI 49107 (AC/616-695-6831); or Electro-Voice West, 8234 Doe Avenue, Visalia, CA 93291 (AC/209-651-7777). This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Service and repair address for this product: Electro-Voice, Inc., 600 Cecil Street, Buchanan, Michigan 49107 (Phone 616/695-6831).

Specifications subject to change without notice.

ELECTRO-VOICE, INC., 600 Cecil Street, Buchanan, Michigan 49107
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