

# Film-Tech

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# Owner's Manual

## XC-1 Cinema Crossover



TD-000039-00



Rev. B

# XC-1 CINEMA CROSSOVER

## I. INTRODUCTION

The QSC XC-1 Cinema Crossover is specifically designed for bi-amplification of cinema loudspeakers. The XC-1 can be configured to provide all required signal processing for the most common screen channel loudspeaker systems. Adjustments for all crossover parameters, except output level, are accomplished by setting the user-programmable DIP switches.

The crossover installs in the rear accessory panel of the QSC MXa and CX Series power amplifiers. The MXa Series provides high power required for digital sound in a low-profile package. Up to 350 W/Ch at 8Ω is available in a 3.5" tall amplifier. The larger amplifiers are only 5.25" tall and they provide up to 800 W/Ch at 8Ω.



Figure 1

### Features of the XC-1 include:

- Fourth Order, 24 dB/Octave Crossover slopes with compensation for horn roll-off below the crossover frequency.
- Selectable 500 and 800 Hz crossover frequencies.
- Separate time delays to compensate for short and long high frequency horns.
- Separate, switch-selectable, high frequency response correction for screen loss and constant-directivity horn equalization.
- Subsonic filter for the low frequency output protects woofers from damage due to over-excursion at frequencies below the box tuning frequency.
- Screwdriver-adjustable trimpot on the rear panel is provided for the high frequency level. The low frequency output level is fixed and set for optimum gain for most cinema sound processors.
- Loudspeakers supported include: JBL 4670, 4673, 4675 and EV TS9040DLX and TS940DLX.

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## **II. ACTIVE AND PASSIVE CROSSOVER BASICS**

### **A. Basic Function of a Crossover**

In its most basic form, the purpose of the crossover is to divide the audio spectrum and send appropriate frequency ranges to the correct loudspeaker components for reproduction. The high frequency sounds are typically directed to a horn and compression driver. The low frequency sounds are usually routed to large cone woofers.

### **B. Passive Crossovers**

Until very recently, most cinema loudspeaker systems have used passive crossovers placed after the power amplifiers, but before the loudspeakers. One channel from the power amp is split into separate feeds to the woofer and compression driver. Because no active electronic components are used in these devices, they are limited in the types of signal processing they can perform.

In the past, the primary reason for the use of passive crossovers was economy. High quality power amps used to be very expensive and the passive crossovers allowed one amplifier channel to power both the woofer and the horn in a typical cinema loudspeaker. The quality limitations of the film soundtrack would mask the performance liabilities of the passive crossover.

Improvements in stereo soundtrack technology led to the introduction of active electronic crossovers to the cinema. The use of such crossovers is frequently referred to as bi-amplification, as two amplifier channels power each loudspeaker system. This technique has typically been used for larger sound systems and in premium, flagship theatres. The XC-1 allows bi-amplification on a regular basis in all stereo installations.

### **C. Benefits of Bi-amplification**

Active electronic crossovers are capable of performing more signal processing than their passive counterparts. They also allow increased performance of the amplifiers and speakers. The cost of quality power amplifiers has gone down and the cost of large, passive circuits, such as those used in passive crossovers, has gone up. Electronic crossovers are becoming an economical choice when compared to passive systems.

Passive crossovers are typically limited to providing frequency separation at the crossover frequency, adding some response correction to the high frequency horn, and matching the output levels between the high and low frequency components. Active crossovers can perform these functions as well as a few that are not possible with passive devices.

Active crossovers typically have a more rapid cutoff at the crossover point between the woofer and the horn. This results in a smaller overlap of frequencies that are reproduced by both devices. Cancellations and interference of the two devices, in the overlap region, can cause problems with proper auditorium coverage and frequency response. A steep roll-off of 24 dB per octave (fourth order) is readily available with active crossovers, such as the XC-1. Most passive devices are only capable of a 12 dB per octave (second order) roll-off.

Typical cinema loudspeaker systems have very predictable requirements for high frequency response equalization. There is a reduction in high frequency response that is a characteristic of constant directivity horns as well as a loss of high frequencies due to the speaker being mounted behind a motion picture screen. High frequencies are further reduced by atmospheric absorption in the room.

Passive crossovers can provide limited correction for these frequency response errors. They utilize greater attenuation of midrange frequencies to give an apparent boost to the high frequency content of the signal being sent to the speaker. Attenuation is also used to match the volume level of the compression driver to that of the woofers. However, amplifier power is wasted as heat loss in the passive crossover components because of the need to attenuate high-frequency signal levels

High frequency response correction can be more accurately controlled in an active crossover. The filter circuits in some active crossovers can even be tailored for specific cinema loudspeakers. The signal that reaches the amplifiers has been corrected for frequency response and level balance. There is no need for power-wasting attenuation of the amplifier output.

One very important advantage of active crossovers is the ability to provide time correction for the physical placement of the high and low frequency loudspeaker components. The typical cinema loudspeaker system has the high-frequency compression driver placed several inches behind the woofer. This causes the sound from the woofer to reach the audience more quickly than the sound from the horn. This is a problem because of the frequency overlap around the crossover frequency.

Because passive crossovers cannot correct for time-alignment errors, their typically larger frequency overlap accentuates the coverage and response errors caused by the misalignment. Active crossovers can provide time delay for the signal to the woofers. This will allow the sound from both speakers to reach the audience at the same time, resulting in smoother frequency response and better coverage of the entire audience.

Protection of loudspeakers is also an important advantage of active crossovers. The rapid frequency response roll-off at the crossover point prevents low frequency signals from damaging the compression driver due to over-excursion. The use of a stereo amplifier for powering the system will also reduce the chance of clipping (overdriving) the high frequency amplifier. Low frequencies require much more power and will reach their limit first. This serves as a guide to the upper limit of the system capability. This limit will occur long before the high frequency channel clips.

With a passive system, clipping is usually caused by low-frequency signals. The distortion, produced by clipping the amp, is produced at high power and at high frequencies. This distortion is passed directly to the compression driver by the passive crossover, usually causing damage or destruction of the device. An under powered system is more likely to blow loudspeakers than an overpowered system. Clipping distortion is far more harmful to speakers than a clean, high-power signal. Clipping of the low-frequency channel in a bi-amp installation will have no effect on the compression driver and the woofers cannot reproduce the high-frequency distortion at a very loud level. The woofers are also extremely rugged and durable, compared to compression drivers. The bi-amp system will sound audibly superior when driven into clipping and will be less likely to suffer speaker damage.

Some active crossovers also provide subsonic filters to protect woofers from damage due to extremely low frequency signals. Extremely low frequency signals can drive a woofer beyond its physical range of motion, causing permanent damage. The filters also conserve amplifier power by limiting the audio signal to a more useful and audible range. These circuits are not practical with passive crossovers.

The direct connection of the woofers to the power amp provides better control of the loudspeaker cone motion. The series elements of passive crossovers degrade the control of speaker cone by adding resistance between the amp and the speaker. This is similar to the effect caused by using speaker cable of an insufficient diameter.

## D. Implementing a Bi-amplified System

The simplest and most economical active crossovers are installed in the power amplifiers, as with the XC-1. It requires no additional power connections or rackspace. Wiring is also greatly simplified. The XC-1 is tailored to the specific needs of the cinema and is relatively easy to set up.

## E. Summary of Active Crossover Benefits

Active crossovers offer superior performance at an economical price. It would not be possible to duplicate the performance of a bi-amp system by using passive crossovers and the passive system would need far larger power amplifiers. Digital sound systems will require performance levels that are just not practical without bi-amplification. The XC-1, combined with MXa Series power amplifiers, are the ideal choice for economical digital cinema sound systems.

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## III. SETTING THE CROSSOVER PARAMETERS

The XC-1 contains one eight-position DIP switch and one ten-position DIP switch that are used to configure the crossover for a specific application. The switches should be set correctly before the XC-1 is installed in the back of the amplifier. See Fig. 2 for locations of the switches on the XC-1 circuit board.

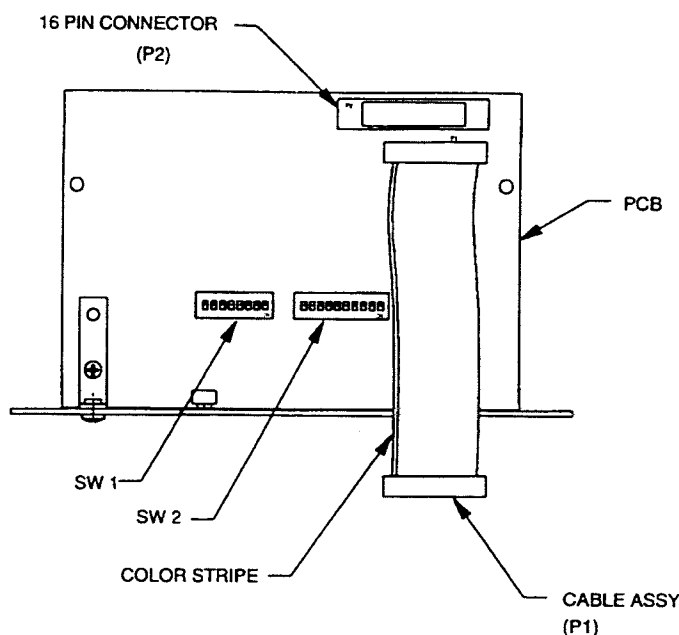


Figure 2

- A. Crossover Frequency**—The crossover frequency may be selected at 500 or 800 Hz. Loudspeaker systems with large format high frequency horns should use the 500 Hz setting. Typical systems include the JBL 4675 and the EV TS9040DLX. Certain older types of cinema loudspeakers are also designed to operate with a 500 Hz crossover frequency. Modern speaker systems utilizing small format horns typically make use of the 800 Hz crossover frequency. Common examples of such systems include the JBL 4670 and 4673 and the EV TS9040DLX.

The high pass and low pass outputs of the crossover are independently adjustable. It is critical that both high pass and low pass crossovers be set to the same frequency for proper operation. The frequency selection for the low pass output feeding the woofer is accomplished via DIP switch 1, sections 1 through 4. See Fig. 3 for details of switch settings for 500 and 800 Hz operation.

The high pass output may be set for a conventional -24 dB/Octave roll off as well as a special dual-slope cinema roll off. The cinema roll off setting takes into account the natural roll off of the horn and driver below 300 Hz to produce a smooth acoustic roll off of high frequencies. A standard Linkwitz-Riley electrical roll off will not produce the uniform acoustic response of the dual slope cinema roll off. All modern loudspeakers, utilizing constant directivity horns, should make use of the cinema crossover slope. Older speaker designs and non-standard applications may require the use of the basic Linkwitz-Riley crossover slope. The setting of the high pass crossover is accomplished via DIP switch 2, sections 1-7. See Fig. 3 for details of switch settings for 500 and 800 Hz operation.

- B. Subsonic Protection**—A built-in high pass filter is provided to protect the woofers from damage by excessively low frequencies. The filter is set at 30 Hz for standard bi-amplified applications.
- C. Constant Directivity Horn Equalization**—The high pass output may be configured with one of two high frequency boost curves or flat response, to suit the type of speaker being used. The size of the constant directivity horn will determine which response curve is likely to yield the best response. Older style multi-cell and radial horns may work best with flat response. Also note that excessive high frequency equalization may damage older compression drivers that have limited power handling capability. Some experimentation may be required to determine the best setting for a particular installation. The setting of the constant directivity horn equalization is accomplished via DIP switch 1, sections 5-6. See Fig. 3 for details of switch settings for large and small horns or flat response (disabled horn EQ).
- D. Screen Loss Equalization**—The motion picture screen produces a roll off of the high frequency response of speakers mounted behind the screen. This high frequency boost can be used to compensate for this roll off to yield a flatter response without using the house equalizers. This EQ should be disabled if the speakers are not mounted behind a screen or inadequate roll off of the high frequency response is obtained in a given room. This is most likely to occur in a very small auditorium. The activation of the screen loss equalization is accomplished via DIP switch 2, section 8, see Fig. 3 for details.
- E. Low Frequency Delay**—Modern direct radiator cinema speakers have an offset in the physical locations of the woofer and the high frequency compression driver. The length of the horn places the high frequency driver behind the woofers. The XC-1 contains two delay circuits to compensate for the extra distance that the high frequencies must travel, compared to the low frequencies. The short delay setting should be used for small format horns and the long delay setting for large format horns. Typical systems using the short delay setting include the JBL 4670 and 4673, the EV TS940, and the Altec A6. Systems using the long delay include the JBL 4675, the EV TS9040DLX, and the Altec A10. No delay should be selected for older systems using bass horns, such as the Altec A4 and A5. The selection of the delay setting is accomplished via DIP switch 1, sections 7-9. See Fig. 3 for details.

SWITCH 1	S1-1	S1-2	S1-3	S1-4	S1-5	S1-6	S1-7	S1-8	S1-9
500 Hz L-R LOW-PASS	OFF	OFF	OFF	OFF	-	-	-	-	-
800 Hz L-R LOW-PASS	ON	ON	ON	ON	-	-	-	-	-
SMALL CD HORN EQ	-	-	-	-	ON	OFF	-	-	-
LARGE CD HORN EQ	-	-	-	-	OFF	ON	-	-	-
DISABLE CD HORN EQ	-	-	-	-	OFF	OFF	-	-	-
NO DELAY	-	-	-	-	-	-	OFF	OFF	ON
SHORT DELAY (0.7 mS)	-	-	-	-	-	-	ON	OFF	OFF
LONG DELAY (1.9 mS)	-	-	-	-	-	-	OFF	ON	OFF
SWITCH 2	S2-1	S2-2	S2-3	S2-4	S2-5	S2-6	S2-7	S2-8	
500 Hz CINEMA HIGH-PASS	ON	OFF	OFF	OFF	OFF	OFF	OFF	-	
800 Hz CINEMA HIGH-PASS	ON	OFF	ON	ON	OFF	ON	OFF	-	
500 Hz L-R HIGH-PASS	OFF	OFF	OFF	OFF	OFF	OFF	OFF	-	
800 Hz L-R HIGH-PASS	OFF	ON	ON	OFF	ON	OFF	ON	-	
SCREEN LOSS EQ ENABLE	-	-	-	-	-	-	-	ON	
SCREEN LOSS EQ DISABLE	-	-	-	-	-	-	-	OFF	

Figure 3

#### IV. TYPICAL SWITCH SETTINGS:

Typical switch settings for common speaker types are given below. Typical settings are only intended to serve as a likely starting point for most installations. The settings may not be optimum for all applications of a given type of loudspeaker. In some installations, experimentation with EQ settings may be required to achieve desired results.

##### A. Large Format High Frequency Horn, See Fig. 4

Typical models include JBL 4675, EV TS9040DLX, and Altec A10.

SWITCH 1	S1-1	S1-2	S1-3	S1-4	S1-5	S1-6	S1-7	S1-8	S1-9
500 Hz L-R LOW-PASS	OFF	OFF	OFF	OFF	-	-	-	-	-
LARGE CD HORN EQ	-	-	-	-	OFF	ON	-	-	-
LONG DELAY (1.9 mS)	-	-	-	-	-	-	OFF	ON	OFF
SWITCH 2	S2-1	S2-2	S2-3	S2-4	S2-5	S2-6	S2-7	S2-8	
500 Hz CINEMA HIGH-PASS	ON	OFF	OFF	OFF	OFF	OFF	OFF	-	
SCREEN LOSS EQ ENABLE	-	-	-	-	-	-	-	ON	

Figure 4



**B. Small Format High Frequency Horn, See Fig. 5**

Typical models include JBL 4670 and 4673, EV TS940DLX, and Altec A6.

SWITCH 1	S1-1	S1-2	S1-3	S1-4	S1-5	S1-6	S1-7	S1-8	S1-9
800 Hz L-R LOW-PASS	ON	ON	ON	ON	-	-	-	-	-
SMALL CD HORN EQ	-	-	-	-	ON	OFF	-	-	-
SHORT DELAY (0.7 mS)	-	-	-	-	-	-	ON	OFF	OFF
SWITCH 2	S2-1	S2-2	S2-3	S2-4	S2-5	S2-6	S2-7	S2-8	
800 Hz CINEMA HIGH-PASS	ON	OFF	ON	ON	OFF	ON	OFF	-	
SCREEN LOSS EQ ENABLE	-	-	-	-	-	-	-	ON	

Figure 5

**C. Older Horn-Loaded type Loudspeakers, See Fig. 6**

SWITCH 1	S1-1	S1-2	S1-3	S1-4	S1-5	S1-6	S1-7	S1-8	S1-9
500 Hz L-R LOW-PASS	OFF	OFF	OFF	OFF	-	-	-	-	-
DISABLE CD HORN EQ	-	-	-	-	OFF	OFF	-	-	-
NO DELAY	-	-	-	-	-	-	OFF	OFF	ON
SWITCH 2	S2-1	S2-2	S2-3	S2-4	S2-5	S2-6	S2-7	S2-8	
500 Hz L-R HIGH-PASS	OFF	OFF	OFF	OFF	OFF	OFF	OFF	-	
SCREEN LOSS EQ ENABLE	-	-	-	-	-	-	-	ON	

Figure 6

## V. INSTALLING THE CROSSOVER IN THE AMPLIFIER



**CAUTION—INSTALLATION OF THE XC-1 SHOULD BE ATTEMPTED ONLY BY QUALIFIED THEATRE SOUND TECHNICIANS. CONTACT YOUR QSC CINEMA DEALER IF YOU NEED ADVICE ON CHOOSING AN INSTALLER FOR THIS CROSSOVER.**

After all switch settings have been properly configured, the crossover should be installed in the upper Open Input Architecture™ accessory slot of the MXa power amplifiers.

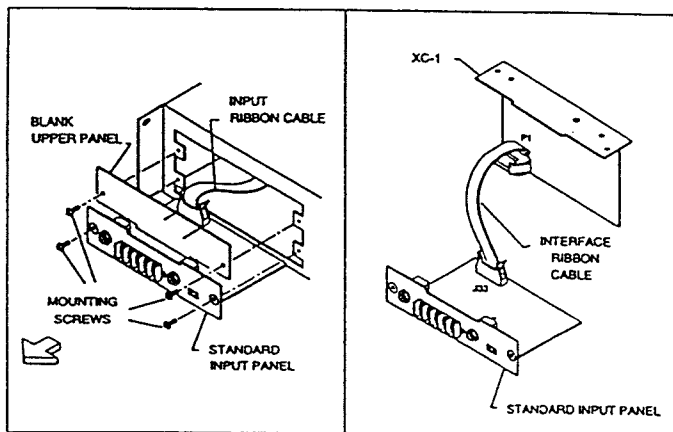
**WARNING! Before proceeding with installation, unplug the amplifier from power line.**

1. Position the amplifier so that the rear panel is facing you and locate the accessory slots.
2. Remove four mounting screws: the two holding the blank upper panel and the two holding the standard input panel. (See Fig. 7).
3. Locate the 16 pin input ribbon cable that connects to the standard input panel. Disconnect the ribbon cable from the standard input panel.
4. Position the XC-1 as shown in Fig. 8 so the connectors (J33 and J1 on MXa; J32 and J1 on CX) are facing each other.
5. Install the ribbon interface cable from J1 on the XC-1 to the 16 pin connector on the standard input panel (see Fig. 8), making sure that the headers are properly lined up and the ribbon cable is not twisted before pressing them together.

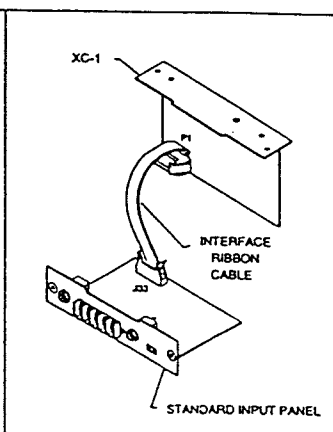
**Excessive force may cause permanent damage to the assembly.**

6. Install the 16 pin ribbon input cable from the amplifier's interior to the J2 connector on the XC-1 (See Fig. 9). Take care not to twist the ribbon input cable.
7. The interface ribbon should neatly tuck between the circuit boards (see Fig. 10). Secure the XC-1 and the standard input circuit board to the rear chassis using the four screws removed in Fig. 7.

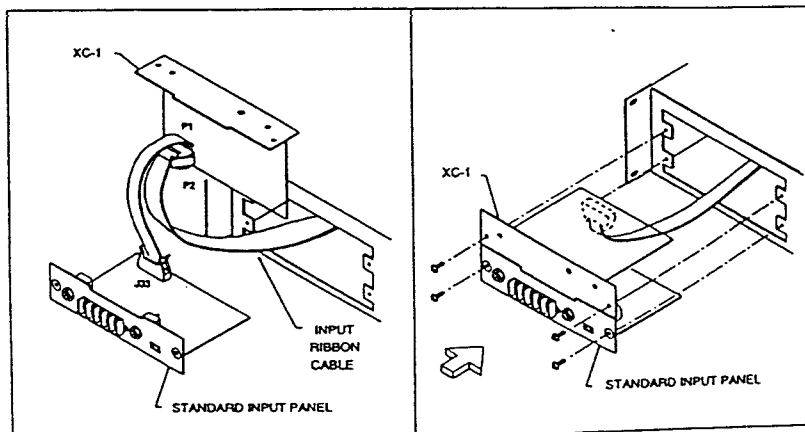
**Do not over-torque screws.**



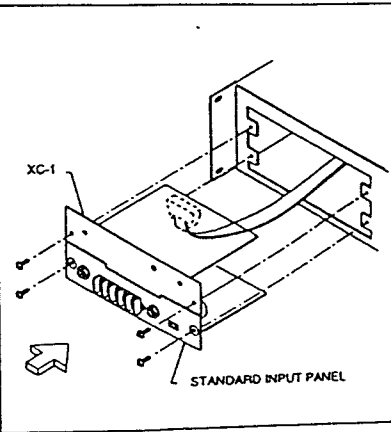
(Fig. 7)



(Fig. 8)



(Fig. 9)



(Fig. 10)

## VI. WIRING THE CROSSOVER AND AMPLIFIER

1. The input to the crossover is made through the Ch. 1 input connectors only! The Ch. 2 connectors are not used. The mono bridge switch should be set for stereo operation. The input is electronically balanced.
2. The speakers are connected to the “touch-proof” binding posts or the output barrier terminal strip of the amplifier. Be certain to use heavy gauge speaker cable and securely fasten the cable with bare wire, banana plugs or crimp type terminals. Connect the woofers to channel one and the high frequency driver to channel two. Reversal of this connection will result in the immediate DESTRUCTION of the high frequency driver when the sound is turned on! Refer to the amplifier owner’s manual for additional information on locating the connectors or making appropriate connections.

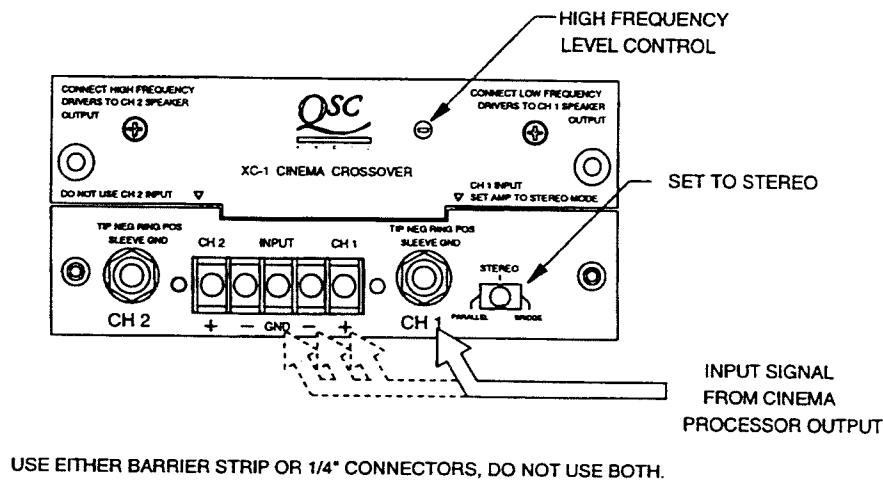


Figure 11

## VII. ADJUSTING THE XC-1 CROSSOVER

The XC-1 crossover requires specialized test equipment and adjustment by trained cinema sound technicians to ensure maximum performance. Required test equipment includes a real-time spectrum analyzer and a pink noise source. Some cinema processors may also require specialized equipment for proper adjustment. Consult the processor manual for details of the calibration procedure for the type of processor in use.

### Basic Adjustment Procedure

1. The gain controls on the amplifier should be set to the maximum gain position (“full up”) on both channels. The security covers, included with the amplifier, may be installed to prevent tampering with the gain control setting (see Fig. 12). A built-in pad reduces the input sensitivity to provide a good match to most cinema processors. The high frequency level should be set using the trimpot on the rear panel as shown in Fig. 11 of control locations. Typical installations will use a setting of about 12 o’clock, or “half up”.

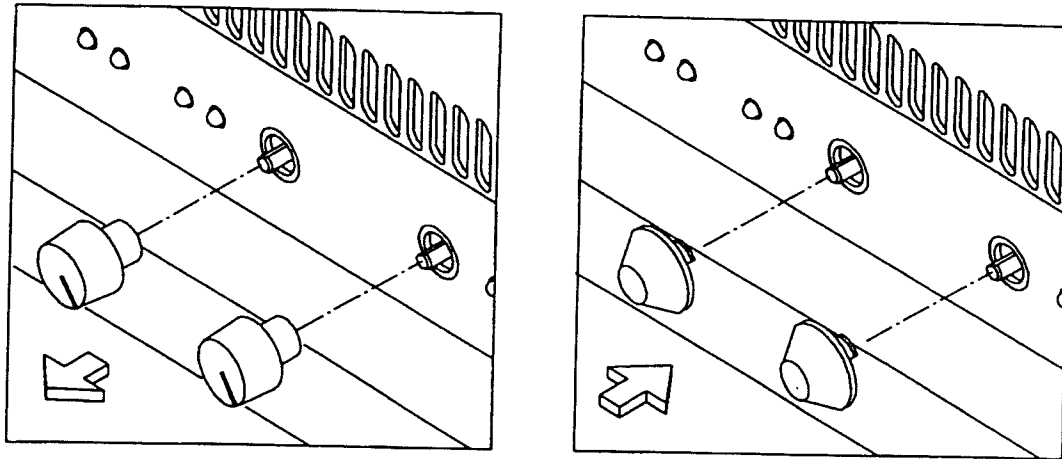


Figure 12

2. Play a pink noise source through the system at a level of about 85 dB-spl from the woofer section of the speaker system.
3. Raise or lower the level of the high frequency output, using the level control shown in Fig. 11, until it matches the level of the woofer near the crossover frequency.
4. The frequency response at the crossover should be free of major dips. It may be necessary to reverse the polarity of the high frequency driver to get a smooth response through the crossover region.

Check to see that the woofers from all channels are wired with the correct polarity before making this wiring change. An increase in the bass response should be noticed when any two channels are turned on at the same time. Using one channel as a reference, play the speakers two at a time and reverse the polarity of the woofer connection on any channel that causes a decrease in bass response when played at the same time as the reference channel.

5. The high frequency response should be smooth and roll off to a good approximation of the X curve (the standard cinema house curve). Very little equalization will be required with modern constant directivity horns. Older systems will not be capable of the extended response and uniform coverage of more modern speaker systems.
6. If a smooth, uniform frequency response cannot be obtained, double check all wiring and connections. Check the settings of the two DIP switches if good results still cannot be obtained. Proper operation of the crossover can also be verified by swapping the crossover with another XC-1 that is known to operate correctly. If the problem does not go away after swapping, the crossover is not the likely cause of the problem. Be sure to check for blown or damaged speakers.
7. It may be necessary to experiment with different delay and equalization settings to get the optimum performance from non-standard installations or older speaker systems.

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## VIII. WARRANTY AND DISCLAIMERS

### Disclaimer

QSC Audio Products, Inc. is not liable for any damage to speakers, amplifiers, or any other equipment that is caused by negligence or improper installation and/or use of the XC-1.

### Product Warranty

QSC Audio Products, Inc. guarantees the XC-1 to be free from defective material and/or workmanship for a period of three years from date of sale, and will replace defective parts and repair malfunctioning products under this warranty when the defect occurs under normal installation and use—provided the unit is returned to our factory via prepaid transportation with proof of purchase (sales receipt). This warranty provides that examination of the returned product must disclose, in our judgment, a manufacturing defect. This warranty does not extend to any product which has been subject to misuse, neglect, accident, improper installation, or where the date code has been removed or defaced.

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## IX. TECHNICAL ASSISTANCE & SERVICE

Servicing your unit requires a trained technician capable of performing the type of service you need. There are no user serviceable components inside your unit and the danger of electric shock exists. Additionally, some of the components in your unit are QSC specific parts that require QSC replacements. Comprehensive service manuals for some models are available at QSC.

### Technical Assistance

If you suspect that your XC-1 is defective, check your system configuration and [product] settings to determine the origin of the problem. In many cases, incorrect audio interfacing, poor cabling, or other system level impairments are the cause of problems in audio systems. For technical assistance beyond the information given in this manual, QSC Technical Services may be contacted.

### Factory Service

In the event that your XC-1 does need factory service, you may reach QSC Technical Services for return instructions. A Return Authorization (RA) number must be obtained from QSC Technical Services. QSC may not account for products that are returned without a Return Authorization number.

#### *Product Return Guidelines*

1. Pack the product well for protection during shipment. QSC will provide the factory packaging free of charge upon request.
2. Include a copy of the sales receipt, your name, return address, phone number, and defect description with your return correspondence.
3. Call QSC Technical Services for a Return Authorization number.
4. Mark the Return Authorization number on the outside of the packaging.
5. Ship the product prepaid to QSC Audio Products. We recommend United Parcel Service (UPS).

**QSC Technical Services**

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**Qualified Service Centers**

QSC maintains a service center network for your convenience. If you choose to return your product to a local service center, you may call QSC Technical Services for a referral. Accessories, input modules and other peripheral QSC products must be returned to the factory for service.

**International Servicing**

For QSC products that are purchased outside of the United States, service must be referred to the distributor or dealer from where the product was purchased. There are numerous service centers in many countries. The service centers in your country may be located by your dealer, distributor, or by contacting QSC Technical Services.