MX300i

OPERATING MANUAL

for the MX300i

Close Coupled Electronic Processor

MX300i CCEP

ELECTRONIC SIGNAL PROCESSING UNIT
OPERATING MANUAL
VERSION 2.0

EAW PUB# MX300MAN-223
SECOND EDITION
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INTRODUCTION

The MX300i CCEP™ is a two channel, three-way electronic crossover designed for use in both fixed installations and touring sound reinforcement. As a Closely Coupled Electronic Processor™, the MX300i is factory configured for use with specific EAW loudspeaker systems. This removes the burden of "setting up" from the end user and ensures optimum system performance under all conditions. The MX300i is compact, robust and very reliable, yet simple to service should the need arise.

FEATURES OVERVIEW

The MX300i incorporates a unique combination of features and design innovations that set it apart from conventional crossover networks. Their specific benefits are outlined below.

Overload Protection

Each frequency band has its own overload protection circuitry. A true-RMS above threshold infinite compressor momentarily reduces gain whenever the preset output limit is approached. This is normally set to prevent the power amplifiers from being driven into clipping, but may also be intentionally set lower to protect particularly delicate drivers or to limit the maximum long term output of the system.

Dynamic Bass Control

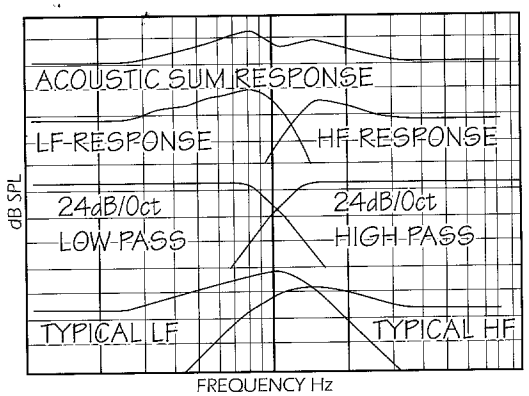
The MX300i's lowest operating output (SUB or LOW depending upon subwoofer operating mode) incorporates a low frequency excursion control circuit to provide both stepdown alignment equalization and high pass filtering to prevent operation below system cutoff. This filter is equalized to provide maximally extended low frequency response and is controlled at high power output levels to maintain freedom from distortion. This circuit tracks the master threshold control: its relative threshold is pre-set at the factory.

Sub-Bass Mode

The front panel switchable sub-bass modes - "OFF", "ADJacent" and "DIStant" - enable you to maintain the correct sound balance and source localization with and without subwoofers and whether the subwoofers, if used, are adjacent to the main speaker stacks or located remotely. This is particularly valuable when sub-bass systems are mounted at ground level and the rest of the system is flown.

Phase Compensation

Each MX300i configuration incorporates phase correction circuitry, tailored to the specific systems for which it is designed. This technique compensates for the phase response of the drivers and their relative placement in the enclosure to present the listener with accurate, phase coherent sound. At the crossover points of any multi-way system, the sum of the upper and lower output bands should be flat. This state of affairs occurs only when the two signals being summed are in phase with each other. The amplitude responses of the filter and loudspeaker may each be correct, but when they are combined, phase errors can easily be introduced, so that the overall response is not flat. Definition and intelligibility are lost. Attempts to correct crossover-related phase errors through equalization may disguise the problem, but cannot cure it. The result may produce acceptable measurements with low resolution test equipment such as 1/3 octave analyzers. More detailed measurements as well as simple listening tests confirm that attempts to compensate for phase errors with equalization produce an inconsistent system with audible irregularities.



TYPICAL RESPONSE WITH SYMMETRICAL FILTERS

Asymmetrical Filters

The MX300i CCEP™ incorporates independent internal settings for each of the six filters on each channel. Within each filter's individual settings, both pairs of second order filters used to create the fourth order ultimate slope are independently adjustable. This is a key element in the close coupling of the crossover to a particular speaker system, to compensate for acoustical response of individual elements. The graphic representations on this and the preceding page illustrate the different effects of conventional and asymmetrical filter designs.

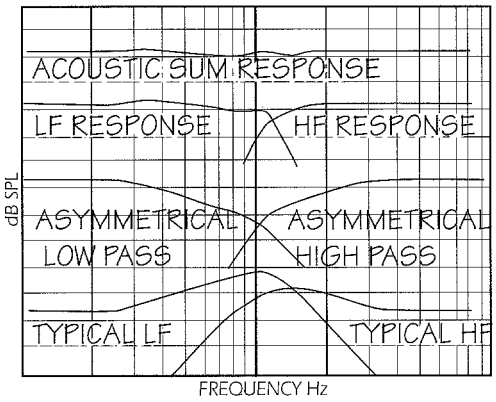
TECHNICAL DESCRIPTION

Power Supply

The MX300i CCEP™ has a universal power supply that is compatible with virtually any mains power source in use throughout the world today. The power supply design is shielded to minimize the effect of magnetic interference on other equipment and effectively eliminate supply-induced hum pickup. The high current capabilities of the power supply permit the MX300i to reliably produce the high output levels required to drive multiple professional amplifiers.

Enclosure

The heavy gauge steel chassis of the MX300i is designed to ensure reliable operation even under the repeated abuse sometimes encountered in portable applications. To further ensure reliability, the power transformer is bolted directly to the chassis and all circuitry is mounted on glass fiber printed circuit boards interconnected with computer grade ribbon cables.



TYPICAL RESPONSE WITH ASYMMETRICAL FILTERS

Power Connection

Mains power is supplied to the unit via an IEC 230 connector on the rear panel of the unit. A two position voltage selector switch, giving a choice of 115V and 230V operation at either 50 or 60Hz, is located directly to the left of the connector. The operating voltage setting is indicated on this switch. With the unit switched in the 115V position the unit should be connected to a 90 to 135 VAC, 50 to 60 Hz source. When the unit is switched in the 230V position the unit should be connected to a 195 to 270 VAC, 50 to 60 Hz source.

WARNING: Make sure that the voltage setting is correct before first powering up the unit. A setting lower than the mains supply may cause damage to the unit.

Directly below the power connector is located a fuse holder for a 5 mm x 20 mm fuse. The fuse holder accommodates two fuses, the innermost receptacle is the active fuse and the outer fuse is a spare. It is important to always use the proper fuse for the voltage selected. These values are as follows:

For 115V Operation 0.5A GMA

For 230V Operation 0.25A GMA

WARNING: All units are supplied with a 0.5A GMA fuse intended for 115 VAC operation. Be sure to replace the fuse with a 0.25A GMA fuse for 230 VAC operation.

When the unit is powered up, a relay mutes all outputs for a few seconds by shorting them to ground. This measure effectively prevents potentially damaging turn-on transients being fed to the drivers via the power amplifiers.

Signal Connection

Input signal connection is by means of female XLR connectors to an electronically balanced differential input amplifier. The outputs are driven via a high-current single-ended output amplifier through male XLR connectors.

All XLR connectors are wired pin 2 hot (positive) and phase integrity is maintained between the inputs and outputs subject to any internal phase compensation.

Grounding Considerations

Chassis ground is connected to the mains or safety ground via the AC line cord, and is also connected to all XLR cases. For maximum resistance to RF interference, signal ground is not directly connected to the chassis ground but is capacitively coupled. In normal operation all XLR pin 1's are connected to signal ground. Pressing the rear panel ground lift switch (into the "LIFT" position) disconnects all output pin 1's from signal ground (referred to as floating the shields). This can be useful in eliminating ground loop induced hum when used with long cable runs.

WARNING: Under no circumstances should equipment requiring a mains ground be run with the ground wire disconnected.

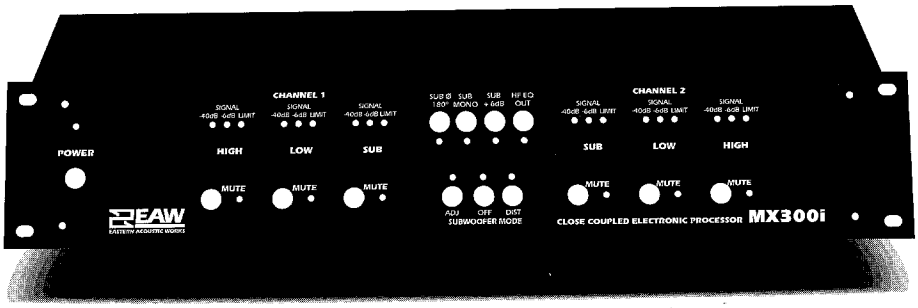
Internal Servicing

With the exception of the master limit threshold control, there are no user serviceable parts inside the unit. Under no circumstances should the presets, SIP or PCB Programming modules be adjusted or modified by anyone other than an authorized service engineer. These modules hold the components that define the filter frequencies, phase correction, channel gains and channel limit thresholds. Also, on these modules are the components that preset the degree of high frequency boost in the High EQ On position, the degree of bass boost in the Sub-bass excursion control circuit and the frequency of the system high-pass filter that removes unwanted frequencies below the cutoff point of the sub-bass speakers. These settings have been optimized at the factory after careful testing and are not intended to be modified in the field.

The two internal fuses are designed solely to protect internal circuitry from damage in the event of catastrophic power supply failure. If one or both of the internal fuses blows, immediately bring the unit to an authorized service agency. In the event of a rear panel AC line fuse failure, replace only with the type and rating specified on the rear panel and in the power connection section of this manual. If the rear panel AC line fuse blows repeatedly, have the unit checked by an authorized service agency.

CONTROL DESCRIPTION

By closely coupling the exact performance parameters of the MX300i at the factory to a specific loudspeaker system (i.e. EAW's KF300is, MH662E) we can provide better performance than is possible with normal crossover units. As a side benefit we have significantly reduced the number of adjustments and controls the end user must deal with. The few controls present on the MX300i are switches rather than continuously variable controls. This simplifies operation, minimizes the risk of incorrect setup, and maximizes repeatability.



GENERAL CONTROLS & INDICATORS

Power Switch

The power switch is located at the extreme left of the front panel. Above it is a green LED power indicator. When the unit is powered up, a relay mutes all outputs for few seconds by shorting them to ground. This effectively prevents potentially damaging transients being fed to the drivers via the power amplifiers.

Mute Switch & LED

Each channel has independent mute switches for each of the three frequency bands. The mute switches are useful at setup time as diagnostic aids for verifying the correct operation of individual speaker/amplifier elements. When a band is muted, a red LED illuminates above the appropriate mute switch. Typically these mute switches would only be used during setup and troubleshooting.

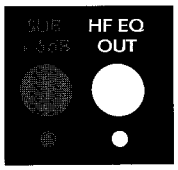
Signal Level Indicators

Located above the mute and level controls are three output signal level indicator LEDs. The green LED lights at signal levels above -40 dB (relative to the limit threshold) and is generally used to indicate signal presence. The yellow LED indicates signal levels above -6 dB (relative to limit threshold) and is used to indicate the approach of limiting. The red LED indicates the activation of the limiter protection circuit. Relative limiter thresholds among the bands are set by the factory for the specific system configuration. Once set, they track as a group with the internal master limit threshold control.

FUNCTION CONTROLS

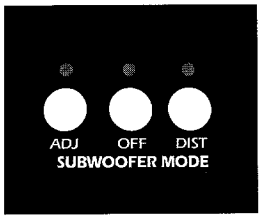
The other user selectable functions, controlled by push-buttons associated with green indicator LEDs, are as follows:

High Frequency EQ



The high frequency equalization switch enables or defeats the programmed high frequency equalization. The specific characteristics of this equalization are preset at the factory with the programming modules. In most applications this is used to provide power response EQ for a large diaphragm compression driver on a true constant coverage horn. In other instances it is used to compensate for the increase in low frequency efficiency that occurs when several bass cabinets are mounted together.

When the MX300i is set up for use with the KF300is system this equalization is required to maintain flat response out to 20k Hz. Check with the factory for the best settings of the high frequency equalization control for your particular system and MX300i configuration. The ideal setting for a particular application changes with different versions of the loudspeaker system and the different configuration modules installed in the MX300i.



Subwoofer Mode

These controls configure the crossover, low frequency equalization and protection for the subwoofer and low frequency subsystems. There are three different operational modes as listed below:

ADJacent Mode

The ADJacent mode provides a true HP/LP crossover between the low frequency and subwoofer subsystems. This mode is typically used when the full range enclosures and the subwoofers are arrayed together. For example in the KF300i/SB330 configuration the ADJacent mode rolls off the low frequency section of the KF300i below 80 Hz, while the SB330 rolls off above 80 Hz. This configuration will typically provide the flattest overall response.

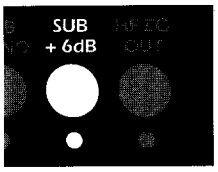
DISTant Mode

The DIStant mode provides an overlap in frequency passband of the low frequency subsystem and subwoofer subsystem. This is useful for applications where the subwoofers are located remotely from the main speaker system. For example in the MH662E/SB250 configuration the low frequency section of the MH662E rolls off gradually below 60 Hz while the subwoofer rolls off above 80 Hz, creating a 40 to 80 Hz passband overlap. This overlap minimizes the dislocation of the sonic image caused by the remote location of the subwoofers.

OFF Mode

The OFF mode is intended for applications where no subwoofer is required (e.g. industrial and speech applications where high output at extended low frequencies are not required). The OFF mode mutes the subwoofer outputs and configures the low frequency output for extended bandwidth operation. This includes lowering the high pass cutoff frequency and adjusting the low frequency equalization and protection circuitry. For example in the KF300i configuration the low frequency section of the KF300is produces usable response to below 80 Hz.

SUBwoofer +6dB



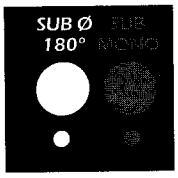
The SUB +6dB switch selects between reference flat low frequency response or a +6 dB increase in subwoofer output. The +6 dB boost is particularly useful in correcting the loss of low frequency output in situations where the subwoofer enclosures are not coupled well to the room. Poor room coupling can occur when the subwoofers are hung in the air or placed on portable staging. For more information regarding subwoofer room coupling please refer to Appendix A.

The subwoofer boost can also be used to increase the low frequency output for aesthetic reasons (as in dance music playback systems where emphasized bass performance is desirable), but it is generally recommended that you tune the system aesthetically with the house equalizer.

SUBwoofer MONO Mode

Pressing the SUB MONO switch sums the two subwoofer channels at -3dB relative to their normal operating levels. This mode is useful when a single subwoofer cluster is used with a stereo main system as is popular due to the inherent omnidirectionality of frequencies below 120 Hz. This is particularly true when direct radiating subwoofers are used, where an array of eight units coupled together provides maximum performance. Additionally, when the main system is flown with the subwoofers on the floor, it is typically easier to build a single array of subs.

SUBwoofer ø (Phase) 180°



Pressing the SUB ø 180° switch inverts the polarity of the subwoofer outputs. This is used to optimize the summing of the low frequency and subwoofer acoustical outputs. Correct polarity will depend on the relative location of the main loudspeaker system and the subwoofer system. In the absence of proper test equipment the optimum position of this switch can be determined empirically.

PRACTICAL CONSIDERATIONS

Physical

The case of the MX300i CCEP is fully enclosed to prevent the ingress of foreign matter. It should be mounted no closer than two inches from the nearest power amplifier, to avoid picking up hum from inadequately shielded transformers, and should not be located where convection currents from power amplifiers could cause undue heating. Adequate ventilation should be ensured. In applications where it will be mounted along with power amps, forced ventilation (the use of fans) of the rack case assembly is strongly recommended to prevent heat buildup within the rack that could cause premature failure of the MX300i's electronic components and/or power supply. The use of shock mounted equipment racks is recommended to prevent undue stress on the front panel during transit.

Environmental

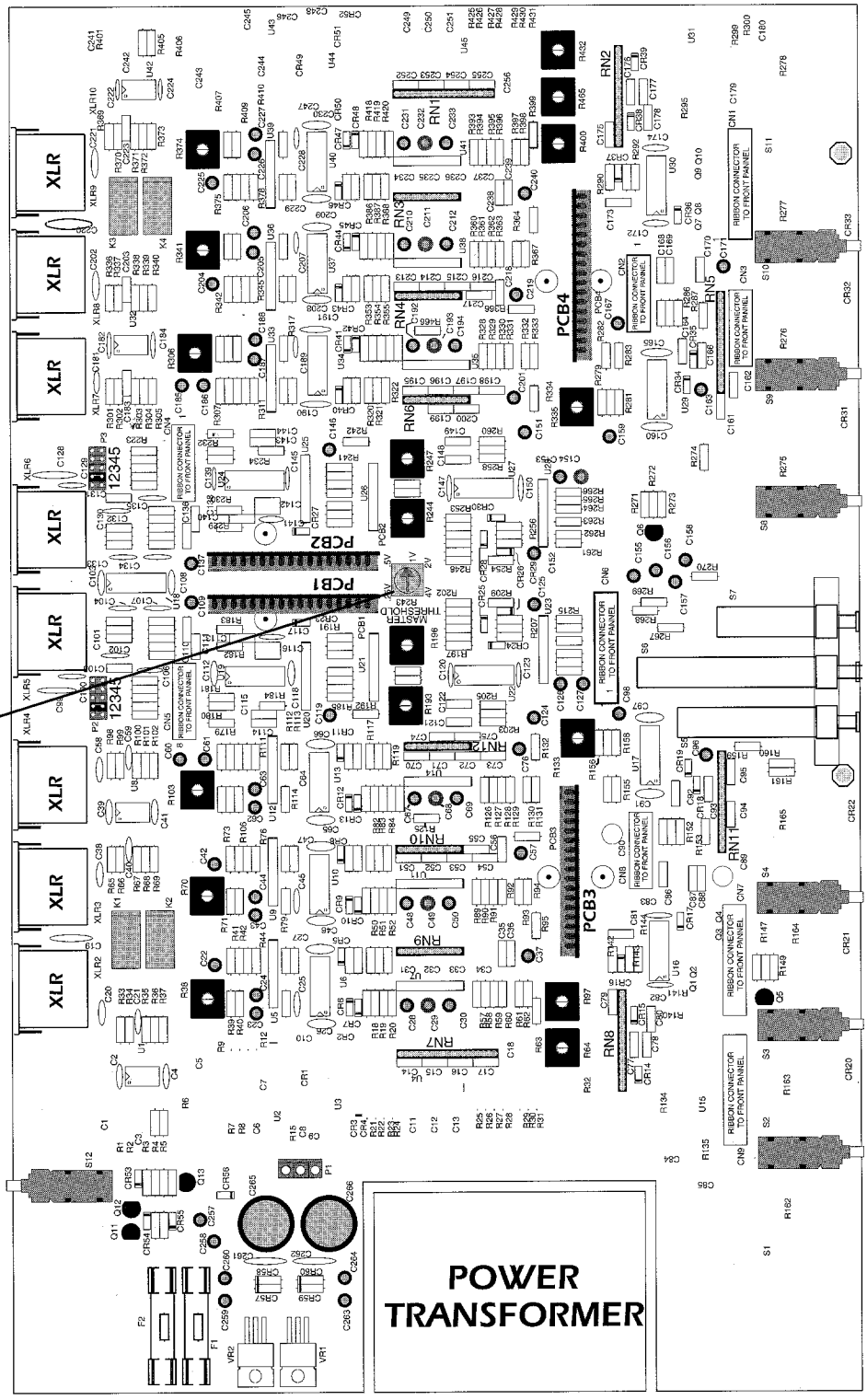
As with all electronic equipment, it is unwise to use the MX300i CCEP in damp or excessively humid conditions and so attention should be given to proper positioning in outdoor concert applications. If the unit should get damp due to uncontrollable circumstances, make sure the unit is thoroughly dry before operation.

Cleaning

The MX300i CCEP may be cleaned with a damp cloth to which a little light detergent or cleaning liquid has been added, but the use of petroleum spirits, thinners or other solvent cleaner is not advised as it might result in serious damage to the finish of the unit.

INSTALLATION NOTES

The MX300i CCEP normally arrives from the factory with Programming Modules configured for use with your specified loudspeaker system (e.g. EAW KF300i or MH662E). These modules contain all of the information to program the MX300i with the optimal crossover frequencies, slopes, phase angles, and level for the specified loudspeaker system. To change the configuration of the MX300i we recommend that you send the unit back to the factory for updating where it can fully tested on our automated equipment. In the unlikely event that you need to change the configuration in the field, please refer to Appendix B of this manual.



Master Threshold Control

The master threshold control adjusts the overall output level before protection limiting is triggered. It is a PC board mounted rotary potentiometer located internally and requires the removal of the top cover and a small flat head screwdriver for adjustment. The MX300i's master threshold control is normally set for use with amplifiers having an input sensitivity of 1.0 Volts for maximum output. You can adjust the master threshold control inside the MX300i if you are using amplifiers of different sensitivity. Additionally, the master threshold may be lowered for additional driver protection or to reduce the maximum output of the system.

A simple method for setting the master threshold control to allow maximum output from your amplifiers is to calibrate the MX300i's low frequency band limit signal LED to the amplifier's clip or error lights. The LF amplifier should be used for calibration purposes unless you are specifically trying to protect a particular driver. In that case, the clip lights on that driver's amplifier can be used for calibration. Drive the calibration amp with a signal (typically a 150 Hz sine wave when the LF amplifier is used) of sufficient level to trigger the limiter. Then back off the master threshold control until the amplifier's clip indicators no longer light.

If your amplifier does not have clip indicators, or if you would like to ensure the accuracy of the calibration procedure, amplifier clipping can be observed by watching the waveform on an oscilloscope.

It should be noted that the master threshold control affects both channels and all frequency bands. The individual band limit settings are preset at the factory on the program modules.

This limit level may be set even lower if additional driver protection is required, as may be the case in discotheque installations operated by non-technical personnel. In such cases, it is prudent to set the limiters so that the maximum output voltage of the power amplifiers cannot exceed the rated speaker power at the appropriate impedance. This may be simply calculated by:

$$\text{Maximum Voltage} = \sqrt{\text{Maximum Power (Watts)} \times \text{Impedance (Ohms)}}$$

This table shows the voltage for various power levels at 4Ω, 8Ω and 16Ω

Maximum Power Level	Maximum Voltage 4Ω	Maximum Voltage 8Ω	Maximum Voltage 16Ω
10 Watts	6.3 Volts	8.9 Volts	12.6 Volts
20 Watts	8.9 Volts	12.6 Volts	17.9 Volts
40 Watts	12.6 Volts	17.9 Volts	25.3 Volts
50 Watts	14.1 Volts	20.0 Volts	28.3 Volts
60 Watts	15.5 Volts	21.9 Volts	31.0 Volts
75 Watts	17.3 Volts	24.5 Volts	34.6 Volts
100 Watts	20.0 Volts	28.3 Volts	40.0 Volts
125 Watts	22.4 Volts	31.6 Volts	44.7 Volts
150 Watts	24.5 Volts	34.6 Volts	49.0 Volts
200 Watts	28.3 Volts	40.0 Volts	56.6 Volts
250 Watts	31.6 Volts	44.7 Volts	63.2 Volts
300 Watts	34.6 Volts	49.0 Volts	69.3 Volts
350 Watts	37.4 Volts	52.9 Volts	74.8 Volts
400 Watts	40.0 Volts	56.6 Volts	80.0 Volts
500 Watts	44.7 Volts	63.2 Volts	89.4 Volts
1000 Watts	63.2 Volts	89.4 Volts	126.5 Volts

Individual Band Thresholds

Should you want to limit power to individual bands for additional protection, to limit band output or to compensate for different amplifier sensitivities, you can use the following formula to set the appropriate resistor:

R_{TH}= threshold resistor value in ohms

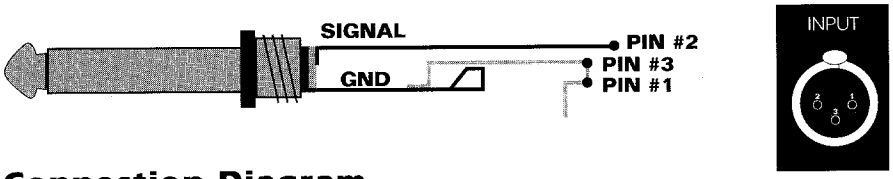
V_{SENS}= amplifer input sensitiity

A_{dB}= level in dB of threshold level relative to V_{SENS}

$$R_{TH} = \frac{4 \times 10^6}{20 \log V_{SENS} + A_{dB} + 28.947}$$

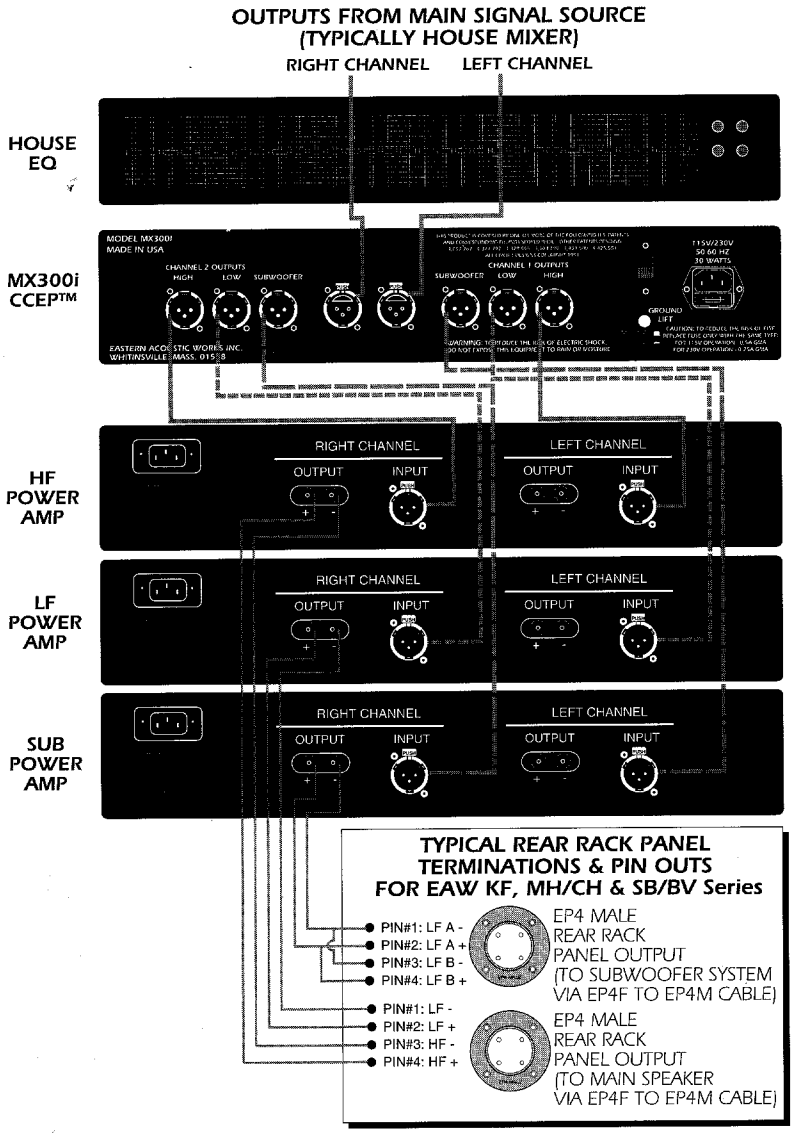
Input Connections

Care should be taken to insure that pin #3 of the MX300i input XLR is always connected. If connected to a balanced (differential) signal source, pin #3 should be connected to the negative (i.e., inverting or "-") signal line. If driven by an unbalanced (single-ended) source, pin #3 must be tied to ground in order to avoid a significant loss in signal. The following diagram illustrates one example of how this is done.

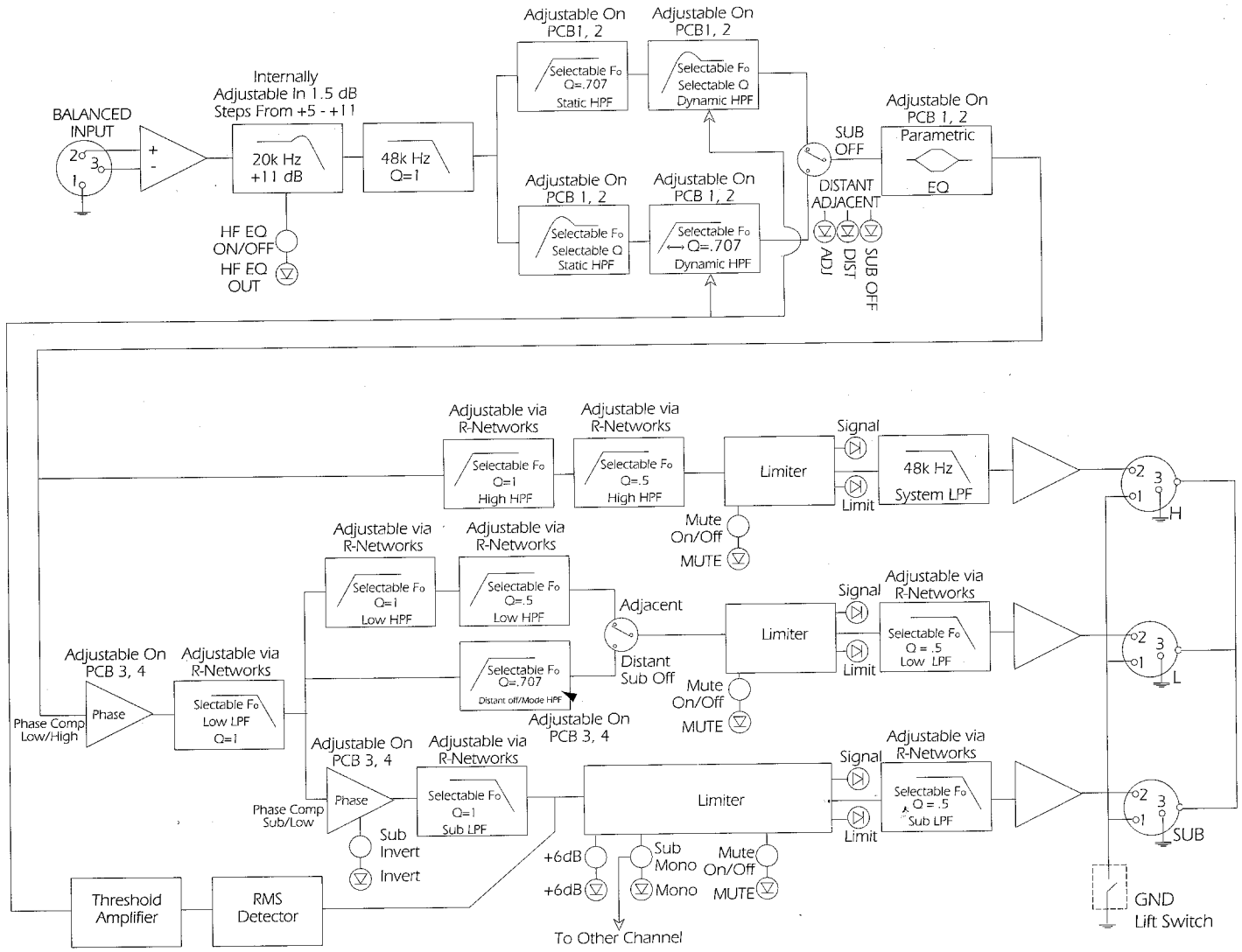


Connection Diagram

The diagram below shows the typical high and low level cabling for using KF300i/SB330 and MH662E/SB250 or SB625 systems.



MX300i BLOCK DIAGRAM

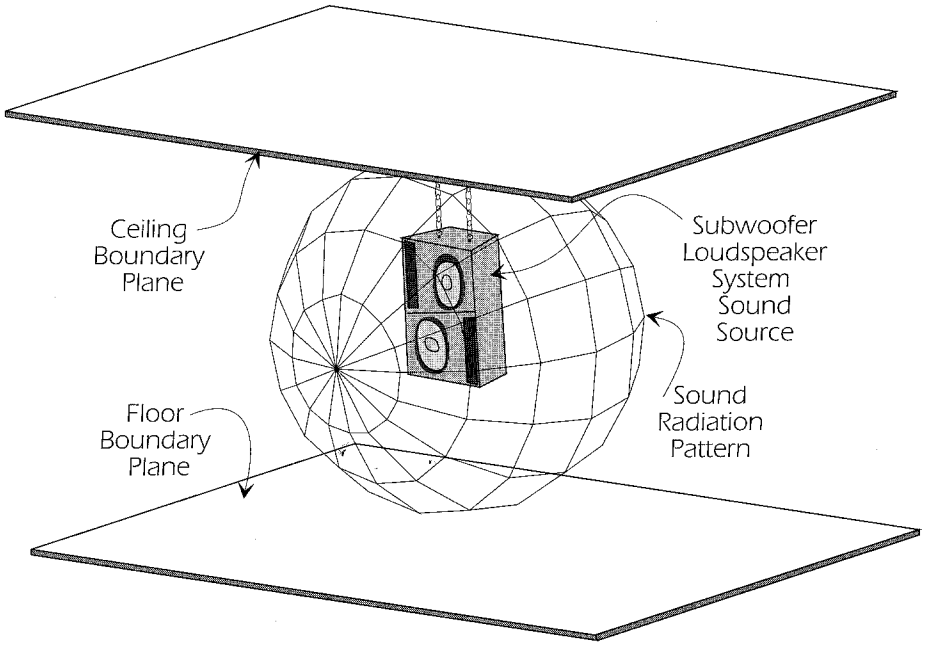


Schematic Diagrams

Schematic Diagrams and additional servicing information can be obtained by contacting the factory or the service department of the EAW distributor for your country.

APPENDIX A: SUBWOOFER PLACEMENT

The criteria for optimum subwoofer location are quite different than those for the main loudspeaker systems. While the main system is aimed for ideal coverage of the intended audience, the subwoofers' inherent omnidirectionality makes coverage virtually irrelevant. Subwoofers should be placed to optimize coupling to the room. A few examples of subwoofer placements and the effects they can have on performance follow.



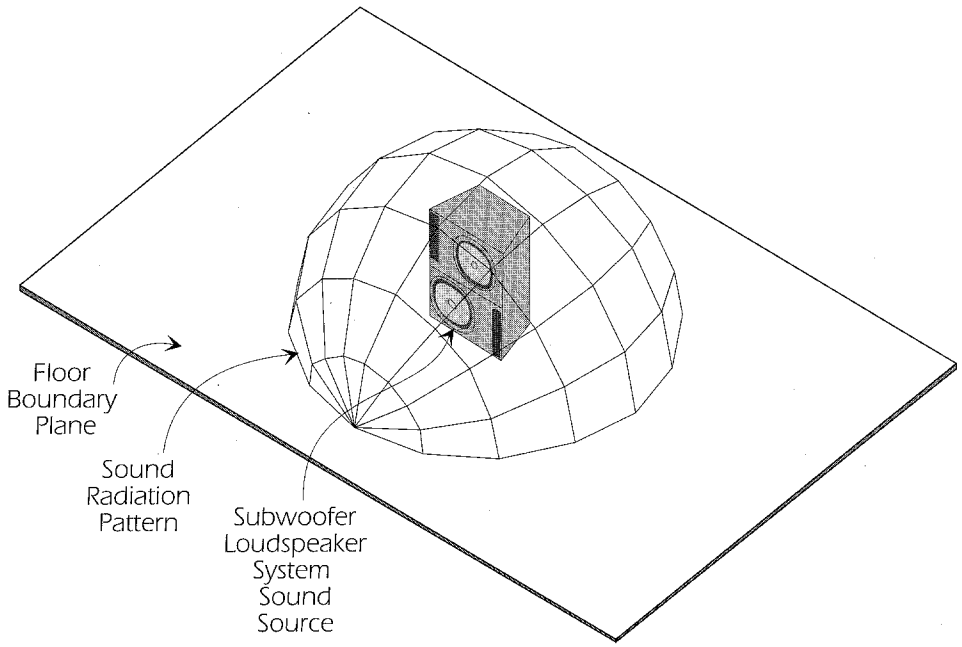
Spherical Radiation

When a loudspeaker system is suspended in free field and is reproducing frequencies whose wave lengths are larger than the size of the front baffle of the system, it radiates energy into a full sphere, as pictured above. Long, low frequency sound waves do not "see" the baffle, so the system acts as a true point source, radiating equal energy in all directions.

Subwoofers are suspended in free field when they are flown or hung in arrays with full range systems. As the illustration above shows, half the sound energy is radiated up into the ceiling, and is totally wasted in all but very few applications. You will experience the same loss of apparent low frequency output when subwoofers are placed on portable staging. Since the portable staging is "transparent" to low frequency sound waves, the same spherical radiation occurs and the subwoofers cannot couple to the room properly.

Subwoofers should be stacked on the ground, floor or other acoustic barrier even if you are flying the main system. If you must fly your subwoofers, use the subwoofer +6 dB boost. You will still need double the number of subs to produce the same apparent low frequency level as ground stacking.

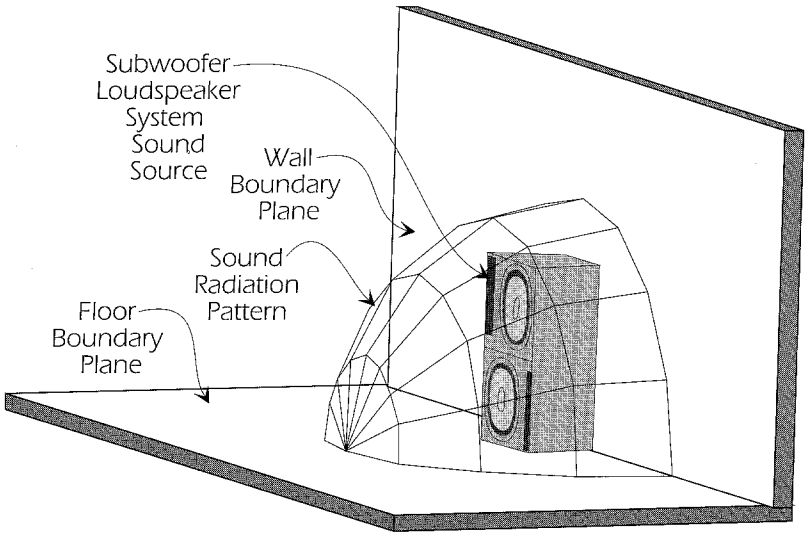
Most manufacturers, including EAW, specify low frequency systems into half space (see next section). You should decrease the rated sensitivity and maximum sound pressure level specifications by 3 dB (or half) if you plan to fly your subwoofers.



Half Sphere Radiation

Half sphere radiation, as its name implies, occurs when a subwoofer system is loaded into half space, by simply placing it on the floor. This increases the output at any point at a given distance within its radiation pattern by 3 dB as compared to its free field performance.

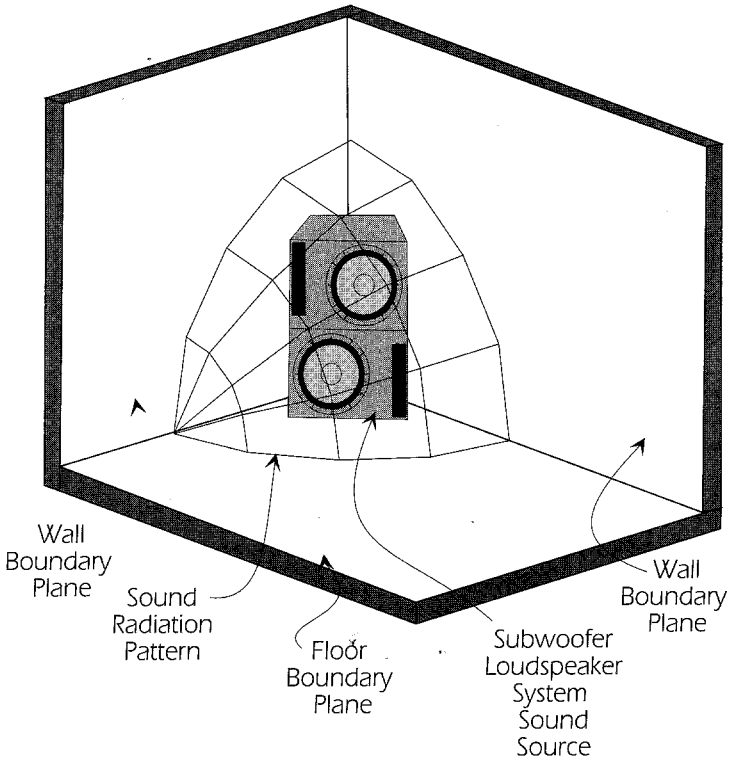
This is the typical situation in most applications, and the use of the sub bass boost EQ becomes a question of personal taste. With most systems (KF300i/SB330) reference flat response occurs when the sub bass boost is defeated, but many people prefer a slightly emphasized deep bass and use the sub bass boost to produce it.



Quarter Sphere Radiation

Quarter sphere radiation occurs when the subwoofer is placed at the intersection of the floor and a wall. If a given venue allows this type of placement, it is a good way to increase low frequency output. It should be noted that for this placement to work the wall must be acoustically reflective at low frequencies. Most walls built with a wood frame and plaster do not reflect low frequencies. Instead, they pass them through or absorb them by vibrating sympathetically with the sound source.

Subwoofers placed so as to offer quarter sphere radiation exhibit 6 dB more output at a given distance than in free field and 3 dB more output than if radiating into half space. In most applications when a subwoofer is radiating into quarter space the use of the sub bass boost EQ is not recommended, unless you want strongly emphasized bass.



Eighth Sphere Radiation

Eighth sphere radiation occurs when the subwoofer is placed on the floor in a corner. While this type of location is rare in portable applications, it can be effectively used in many permanent applications. As noted above, the walls must be rigid and acoustically reflective for this technique to work.

Eighth sphere radiation increases the output of a subwoofer at a given distance by 9 dB as compared to free field, 6 dB as compared to sitting on the floor in half space, and an additional 3 dB as compared to quarter space loading. In many installed applications, corner placement allows the use of fewer subwoofers than normal. The need for the sub bass boost EQ will be determined by the ratio of subwoofers to main systems in a particular application. Ideally audio test equipment would be used to determine the optimum MX300i setting in these conditions.