JBL

Instruction Manual

Motion Picture Loudspeaker Systems:
A Guide To Proper Selection And Installation

A. Introduction:

In recent years, JBL has emerged as the predominant manufacturer of loudspeaker systems for the motion picture theater. Our products are to be found in the most prestigious screening rooms and dubbing theaters in Hollywood, including Warner Hollywood Studios, Glen Glenn Sound, The Burbank Studios, Universal Studios, and Todd-AO. The recent installation of a JBL system in the Goldwyn Theater of the Academy of Motion Picture Arts and Sciences represents a benchmark for our company. Our components have also been selected by Lucasfilm, Ltd., for their THX theater system.

There are several reasons for JBL's success in motion picture sound. Foremost here is our concept of flat power response, which results in an order of improvement in sound coverage in the theater. Second, our components are of proven reliability and have extended, inherently smooth response. In addition, we manufacture components for all aspects of theater sound. JBL's systems are very cost effective when compared to the vented horn/multicell designs of earlier years.

This manual is intended for both theater dealers and prospective purchasers of theater systems. It will be useful as a guide to the selection and installation of systems, and it will provide considerable theoretical background for the specifying engineer.

B. Systems for Smaller Houses:

1. A Summary of House Types:

By far, most of the theaters constructed today are relatively small rectangular rooms. They are usually built in groups known as multiplex theaters for economic reasons. Most of these theaters are monophonic, with a single loudspeaker behind the screen, and seating capacity ranges from 200 up to 500.

2. General Acoustical Characteristics:

Motion picture theaters are generally acoustically "dead" rooms, with reverberation time, even in the largest houses, not exceeding 1.25 seconds. In most multiplex theaters, reverberation times are on the order of 0.5 seconds. The short reverberation time ensures clear dialog throughout the house.

The most common interior treatment of theaters is double-fold velour, which may be placed on the side and rear walls. This will provide freedom from unwanted reflections, but it does nothing to isolate one multiplex space from the adjacent one. Here, the architect must rely on solid block walls for good isolation.

Any unusual acoustical problems should be referred to a qualified acoustical consultant.

3. Sound Level Requirements:

Normal peak levels of 85 dB SPL are common in the theater. A minimum headroom level above this figure would be 10 dB; that is, the system should be capable of handling peaks up to 95 dB-SPL. Wherever possible, JBL recommends that a headroom figure of 15 dB be designed into the system.

The following factors have been taken into account in determining system and amplifier choice for various house sizes:

a. Room volume
b. Room boundary
c. Reverberation time
d. System sensitivity and power rating
e. System directivity index

4. Recommendations for Various Size Theaters:

A. For theaters seating up to 200 patrons; volume approximately 1700 cubic meters (60,000 cubic feet):

***Preferred system:** Model 4673 (direct radiator LF)

Power needed for 100 dB: 46 watts
Recommended power amplifier: JBL 6230 in bridged mode (300 watts into 8 ohms)
Characteristics: Broad-band sensitivity 97 dB, one watt at one meter; 500-Hz crossover into Bi-Radial horn; integral power response correction; smooth response down to 45 Hz; ideal quality for both dialog and music; shallow profile.

***Alternate system:** Model 4671 (direct radiator LF)

Power needed for 100 dB: 46 watts
Recommended power amplifier: JBL 6230 in bridged mode (300 watts into 8 ohms)
Characteristics: Broad-band sensitivity, 97 dB, one watt at one meter; 800-Hz crossover with integral power response correction; smooth response down to 45 Hz; slightly less realistic on dialog than recommended system; shallow profile

***Alternate vented horn systems:**

Models 4672A and 4674A
Power needed for 100 dB: 23 watts
Characteristics: Mid-band sensitivity, 103 dB, one watt at one meter; LF response limited due to horn loading; to be specified where available amplifier power is limited (typically, 50 watts or less)

B. For theaters seating up to 350 patrons: volume approximately 2800 cubic meters (100,000 cubic feet):

***Preferred system:** Model 4670B

Power needed for 100 dB: 30 watts
Recommended power amplifier: Single section of JBL 6230 (75 watts into 4 ohms, the impedance of the low-frequency section of the 4670B system.)
Characteristics: Sensitivity, 100 dB, one watt at one meter; 500-Hz crossover for most natural dialog and music quality; integral power response correction; LF response smooth down to 45 Hz; shallow profile

***Alternate vented horn systems:** Models 4672A and 4674A

Power needed for 100 dB: 30 watts
Characteristics: Mid-band sensitivity, 103 dB, one watt at one meter; LF response limited due to horn loading; to be specified where available amplifier power is limited (typically, 50 watts or less)

C. For theaters seating up to 500 patrons: volume approximately 4500 cubic meters (160,000 cubic feet):

***Preferred system:** Model 4670B

Power needed for 100 dB: 50 watts
Recommended power amplifier: single section of JBL 6260 (300 watts can be delivered into 4 ohms, the impedance of the low-frequency section of the 4670B system)
Characteristics: Sensitivity, 100 dB, one watt at one meter; 500-Hz crossover for most natural dialog and music quality; integral power response correction; smooth response down to 45 Hz; shallow profile

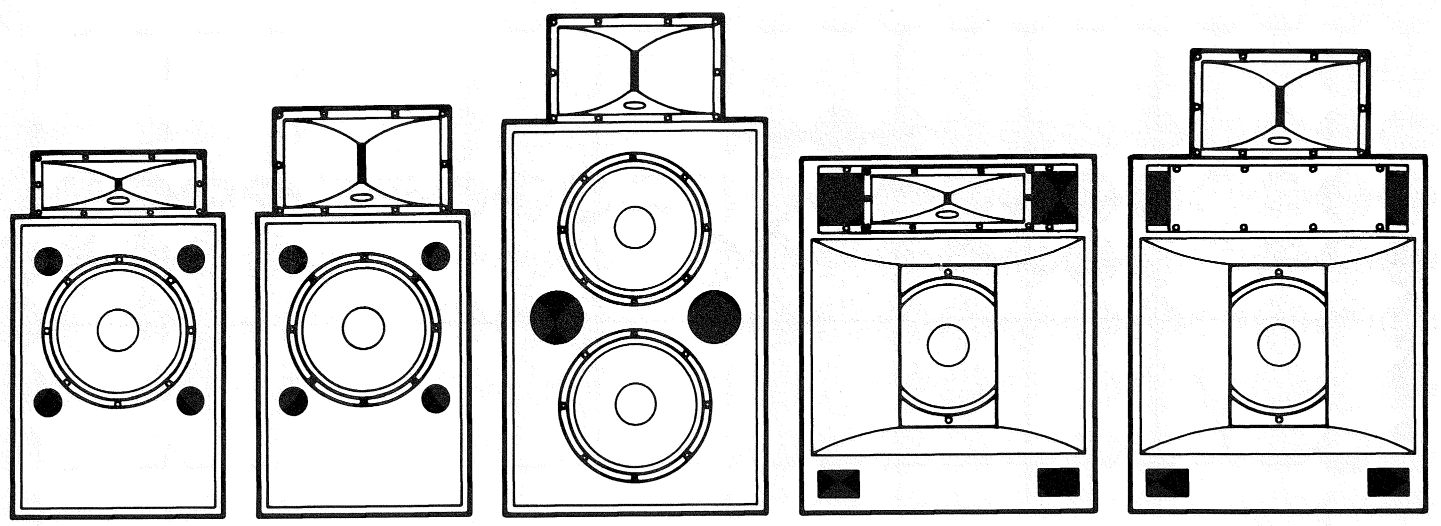
***Alternate vented horn system:** Model 4674A

Power needed for 100 dB: 50 watts
Characteristics: Mid-band sensitivity, 103 dB, one watt at one meter; LF response limited due to horn loading; should be specified only where available amplifier power is limited (100 watts or less)

The systems discussed above are shown in Figure 1A, and typical free-field response curves are shown at B and C.

FIGURE 1. SYSTEMS FOR SMALLER HOUSES

FIGURE 1A. LINE DRAWINGS



4671	4673	4670B	4672A	4674A
PMAX = 150 W	PMAX = 150 W	PMAX = 300 W	PMAX = 150 W	PMAX = 150 W
SENSITIVITY: 97 dB, 1 W, 1 M	SENSITIVITY: 97 dB, 1 W, 1 M	SENSITIVITY: 100 dB, 1 W, 1 M,	SENSITIVITY: 103 dB, 1 W, 1 M	SENSITIVITY: 103 dB 1 W, 1 M

FIGURE 1B. ON-AXIS RESPONSE OF 4670B (2π LOADING); HIGH-FREQUENCY POWER RESPONSE CORRECTED.

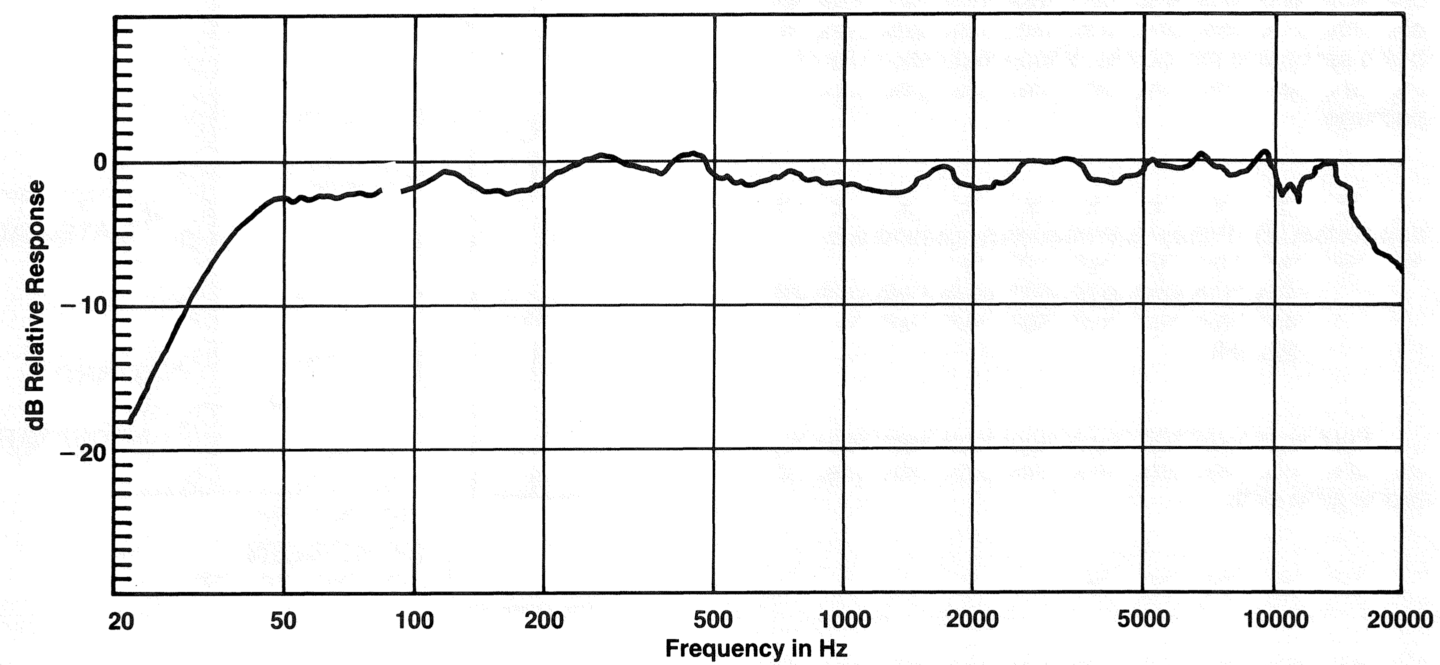
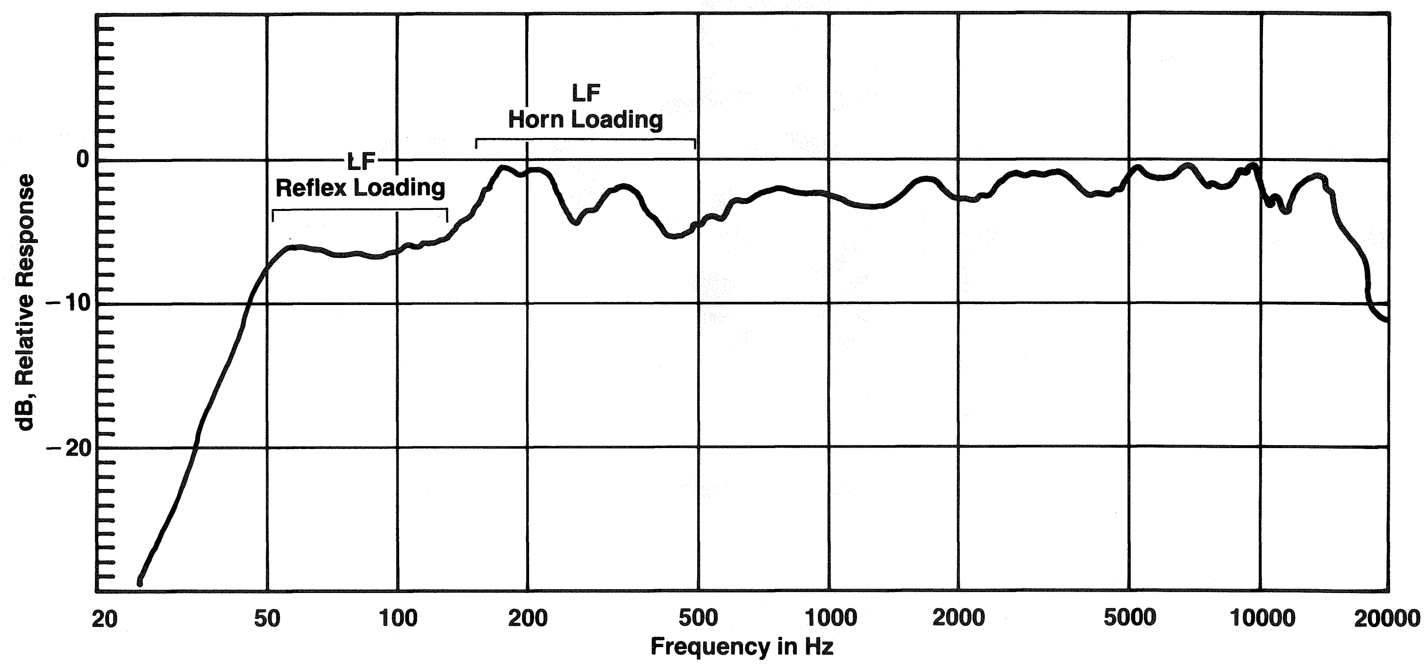


FIGURE 1C. ON-AXIS RESPONSE OF 4674A (2π LOADING); HIGH-FREQUENCY POWER RESPONSE CORRECTED.



5. Installation of the systems:

A. General Comments:

JBL's theater systems are shipped to the dealer in component form. Every attempt is made to ship the components complete so that the systems can be readily assembled. All components should be inspected prior to being sent out to the job site. Wiring instructions for all theater systems are included in the dividing network package.

Many dealers will want to take advantage of the fact that certain JBL theater low-frequency systems are available loaded from the factory. These are:

4647 (consisting of 4507 loaded with 2225H)
4648 (consisting of 4508 loaded with 2-2225H)

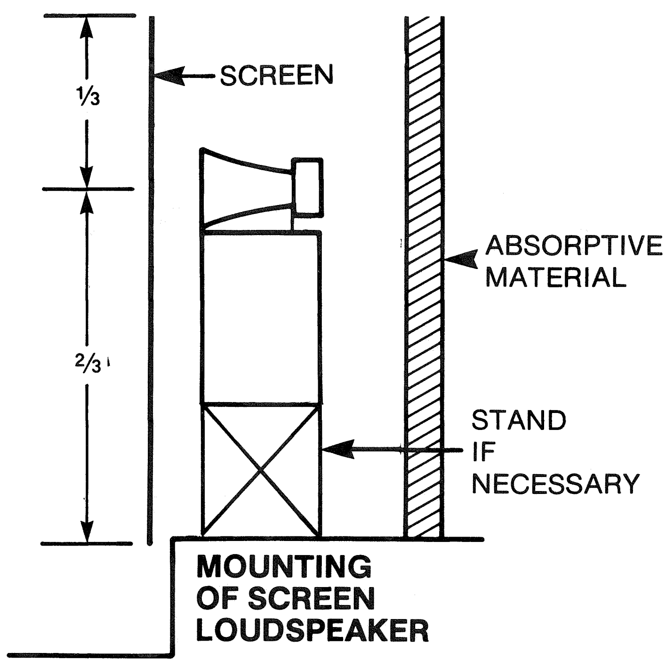
Further, the 46710K is a factory preassembled version of the utility system with an oak vinyl enclosure and brown grille cloth.

B. Physical Considerations:

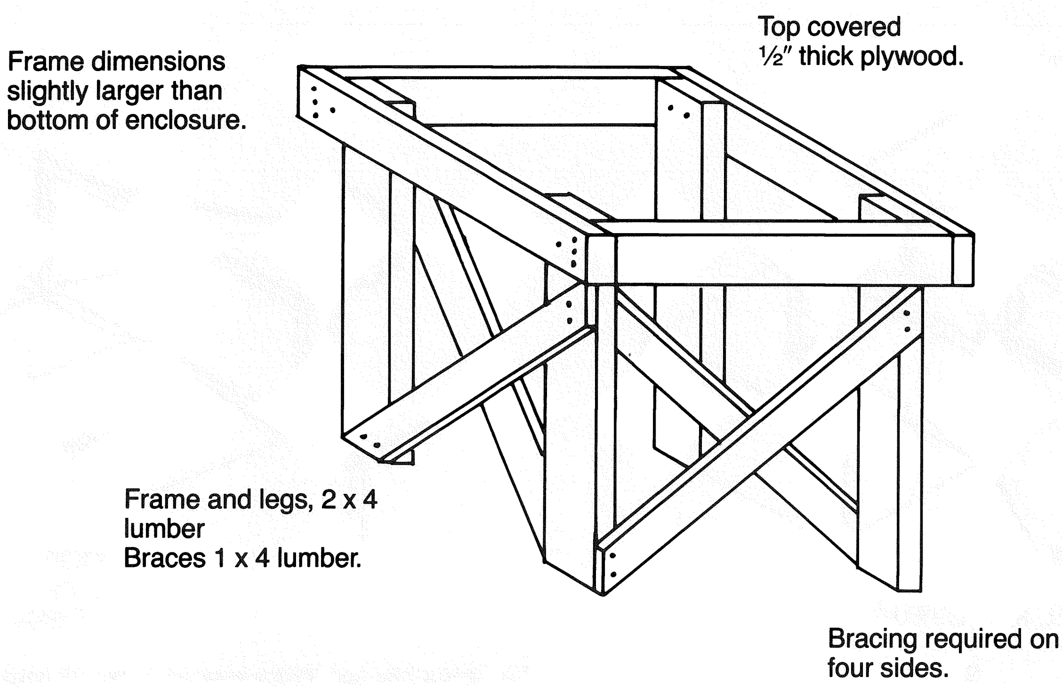
Mounting the system behind the screen is shown in Figure 2A. The preferred location is two-thirds the distance up the screen, and this may require a platform. Details of this are shown at B.

FIGURE 2. MOUNTING THE SYSTEM

A. Position Behind The Screen



B. Platform Details



All JBL theater systems must be oriented as shown in Figure 1A. In particular, the models 4670B and 4675A should NOT be assembled with the low-frequency enclosure lying on its side.

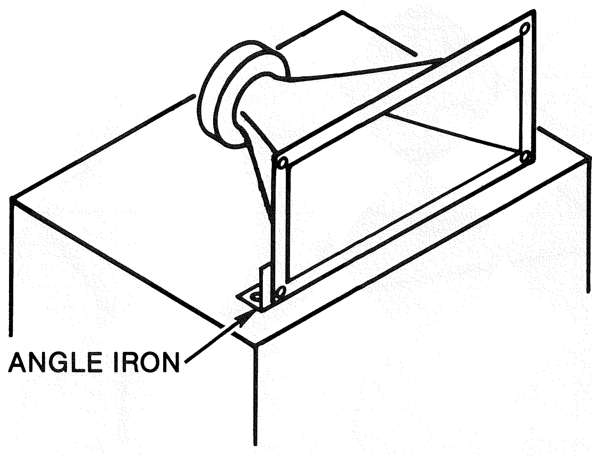
The loudspeaker should be placed on a dense foam rubber pad or section of carpet so that it cannot possibly rattle when driven at high levels. When the loudspeaker is placed on an elevated support, it is advisable to anchor the loudspeaker with four or more angle irons so that it cannot possibly shift position.

The back wall behind the screen should be covered with a sound absorptive material.

1. High-frequency Horn Aiming:

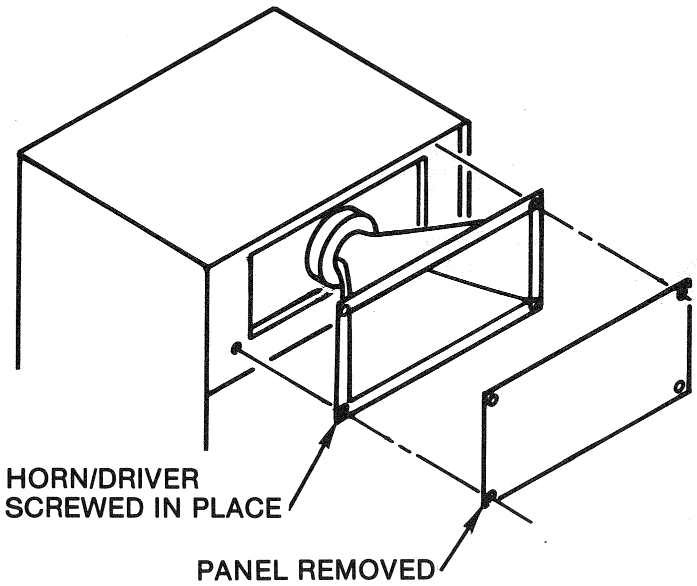
Figure 3 shows details of mounting the components in the various systems. Note that the high-frequency horns are aimed straight out into the theater. JBL has found that this mounting will be best for most installations for the reasons shown in Figure 4A. Since the off-axis response of our new horns is quite uniform out to 12 kHz, we can trade off the inverse square losses in the room with the off-axis horn losses to provide more even front-to-back coverage in the seating area.

FIGURE 3. INSTALLING TRANSDUCERS AND COMPONENTS IN SYSTEMS

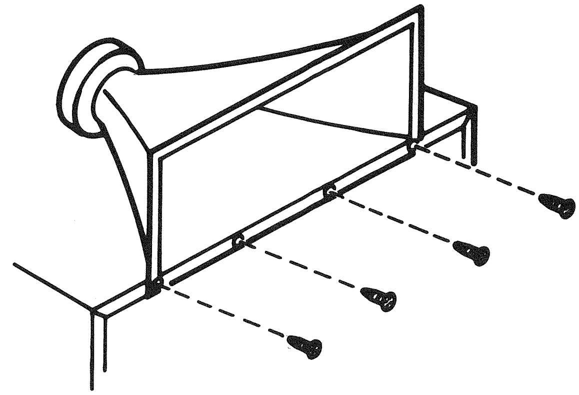


A.

FIGURE 3, Cont'd

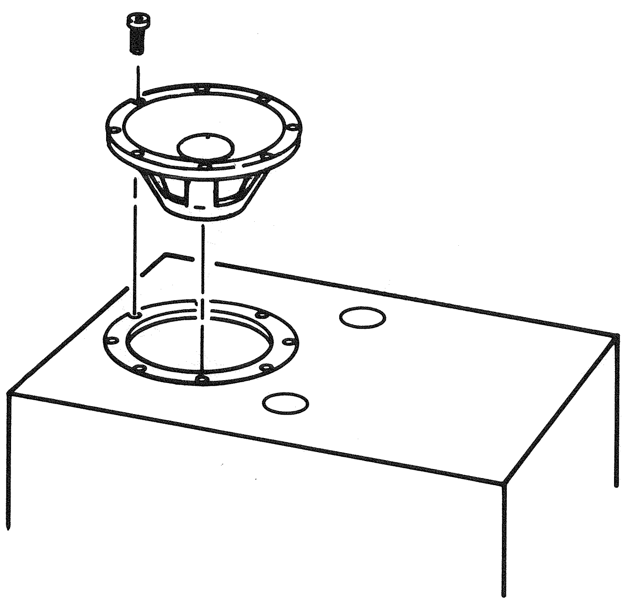


B.

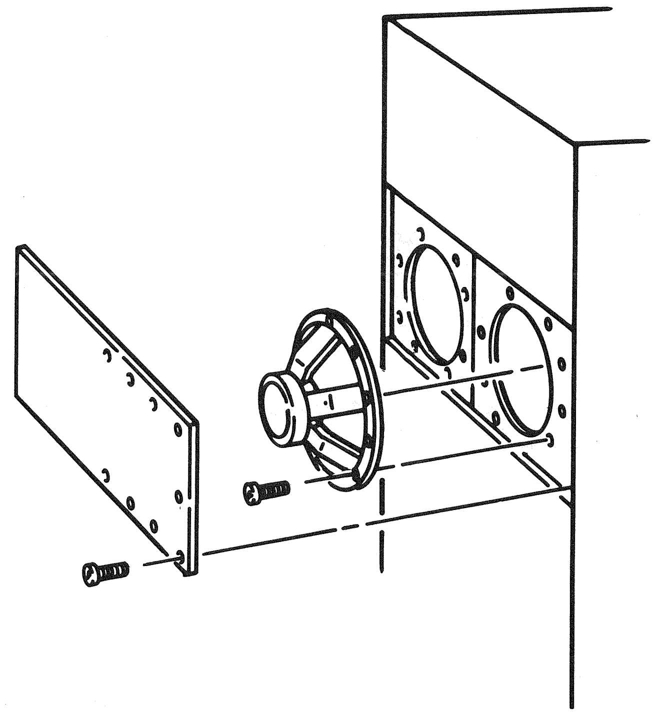


C. 4 WOOD SCREWS*
INTO FRONT EDGES
OF LF ENCLOSURE

*Use #10 x 2 flat-head Philips wood screw; pre-drill holes with 1/8" bit.

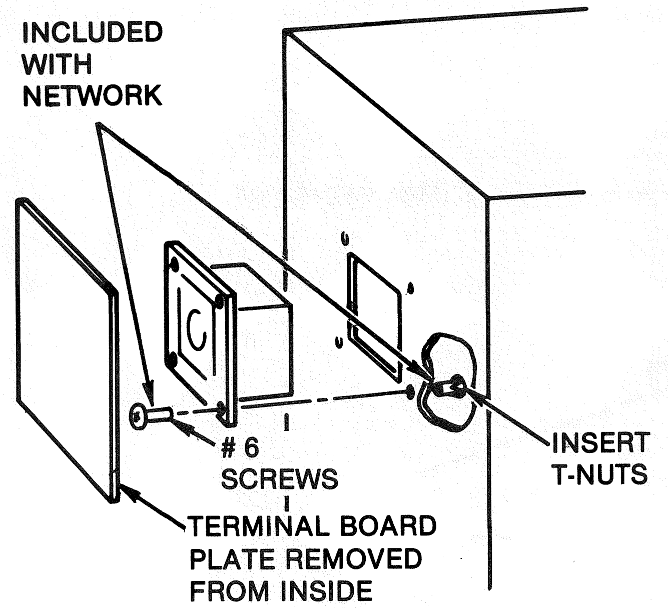


D. MOUNTING LF TRANSDUCERS IN 4507, 4508, AND 4518

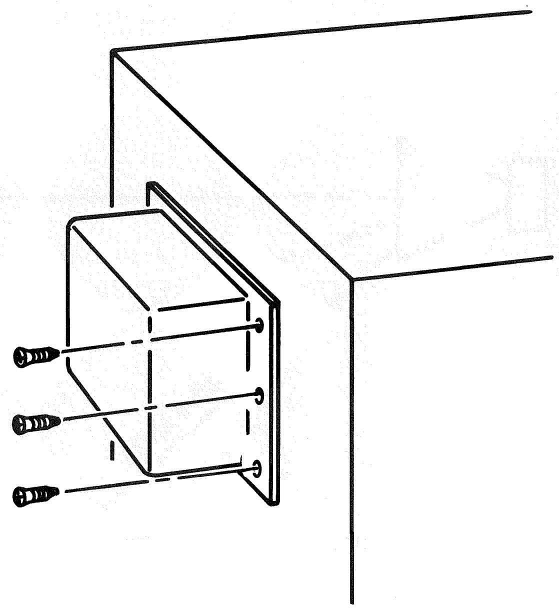


E. MOUNTING LF TRANSDUCERS IN 4550BKA AND 4560BKA

FIGURE 3, Cont'd

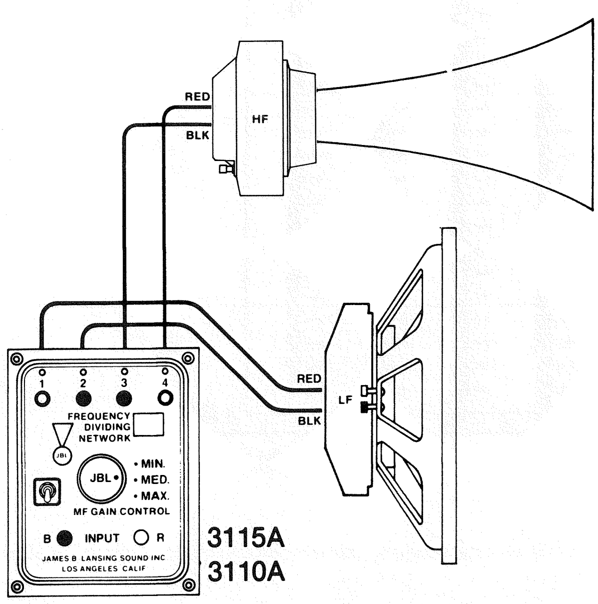


F.



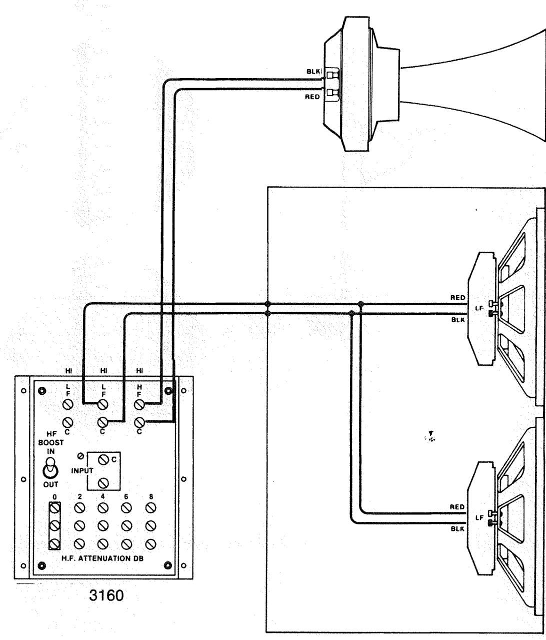
G.

For 4671, 4672A, 4673, 4674A:



H. (See note in text concerning polarity)

For 4670B:



J.

FIGURE 4. PROPER AIMING OF HIGH-FREQUENCY HORNS

A. INVERSE SQUARE, OFF-AXIS TRADE-OFF

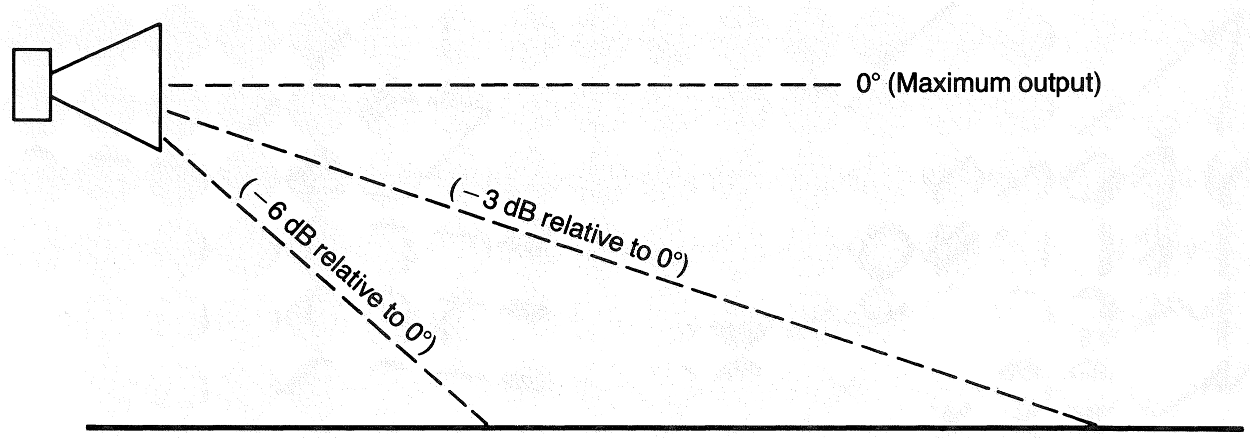
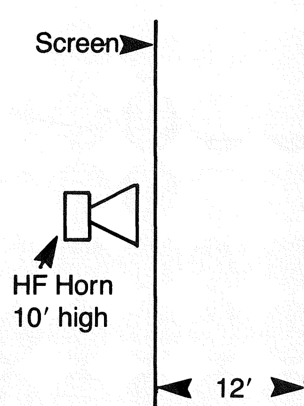


FIGURE 4B. CADP DISPLAY; HF HORN AIMED STRAIGHT AHEAD



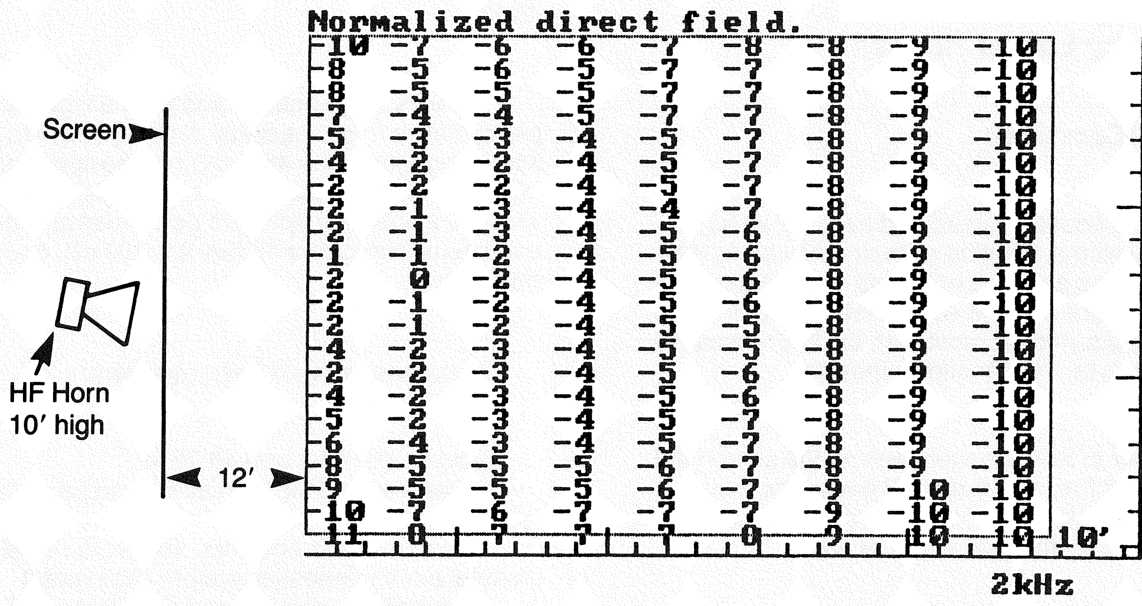
Normalized direct field.

-11	-6	-5	-4	-5	-5	-5	-6	-6
-9	-6	-4	-4	-4	-5	-5	-6	-6
-9	-4	-3	-4	-4	-4	-5	-6	-6
-7	-3	-2	-3	-4	-4	-6	-6	-7
-6	-3	-2	-3	-3	-4	-5	-6	-7
-5	-2	-2	-2	-3	-4	-5	-6	-7
-4	-2	-2	-2	-3	-4	-5	-6	-6
-4	-1	-2	-2	-3	-4	-5	-5	-6
-4	-1	-1	-1	-3	-4	-4	-5	-6
-3	-1	0	-1	-3	-4	-4	-5	-6
-3	-1	-1	-2	-3	-3	-4	-5	-6
-3	-1	-1	-2	-3	-3	-4	-5	-6
-3	-1	-2	-2	-3	-4	-4	-5	-6
-5	-2	-1	-2	-3	-4	-4	-5	-6
-4	-4	-2	-2	-3	-4	-5	-5	-6
-4	-3	-2	-3	-4	-4	-5	-6	-6
-5	-2	-2	-3	-3	-4	-5	-6	-7
-6	-3	-3	-3	-3	-4	-5	-6	-7
-8	-5	-3	-4	-4	-4	-6	-6	-7
-9	-5	-4	-4	-4	-5	-6	-7	-7
-11	-6	-5	-4	-4	-5	-6	-7	-7
11	0	6	4	5	5	6	7	0

10′

2kHz

FIGURE 4C. CADP DISPLAY; HF HORN AIMED 10° DOWN



Further evidence of this benefit is shown in the CADP (see reference) coverage plot shown at B. Here, the front-to-back variation in coverage is only 5 dB, and this means that the majority of patrons will receive excellent coverage. Compare this with the coverage shown at C. Here, we have tilted the high-frequency horn down by only 10 degrees! The resulting coverage variation has increased to 8 dB.

Only where there is a pronounced rake (8 degrees or more) to the floor should the system be angled slightly upward toward the back wall. This can be accomplished by placing a strip of wood beneath the front edge of the loudspeaker.

C. Wiring Considerations:

All JBL network and transducer terminals are color coded so that consistent polarity (phase) of all systems is assured.

In the following systems, all connections between transducers and networks should be between like coded terminals. In other words, red to red, and black to black:

4671
4672A
4674A

In the following systems, the low-frequency section should be wired red to red and black to black, **but the high-frequency section should be wired in reverse polarity:**

4670B
4673

The reason for this has to do with the precise positioning of the high-frequency driver with respect to the low-frequency acoustic center. There is one-half wavelength shift at the crossover frequency in these systems which requires the polarity change to maintain proper summation with the low-frequency section.

Wiring from the projection booth to the screen loudspeakers should conform to local codes. The wire gauge selected should be such that electrical loss at the loudspeaker does not exceed 0.5 dB. For most applications in smaller houses, AWG #12 (2.053 mm) copper wire will be sufficient. The table shown in Figure 5 shows the wire resistance for various double runs of copper at various gauges. For 8-ohm loudspeakers, the total wire resistance should not exceed 0.552 ohms.

FIGURE 5. TABLE OF WIRE LOSSES

WIRE RUN (DOUBLE; COPPER)	NO. 10	NO .12	NO .14	NO .16	NO. 18
10M (33')	.02	.032	.05	.08	.125
20M (66')	.04	.064	.10	.16	.250
30M (100')	.06	.096	.15	.24	.375
40M (132')	.08	.128	.20	.32	.500
50M (165')	.1	.160	.25	.40	.625
60M (200')	.12	.192	.30	.48	.750
FOR 8Ω LOAD, LINE RESISTANCE SHOULD BE 0.552 OR LESS.					

The models 4670B and 4675A have 4-ohm low-frequency sections, and the total wire resistance should not exceed 0.276 ohms.

C. Systems for Larger Houses:

1. General Comments:

The class of houses considered here will all have multichannel systems. Seating capacity may be as little as 500 and as large as some of the old movie palaces of yesterday. There are few of the latter left, except in large metropolitan areas. For the most part, the larger theaters have been converted into multiplex theaters.

The number of loudspeakers behind the screen will be either three or five, and there will always be a surround channel consisting of six or more smaller loudspeakers arrayed on the side and rear walls.

These systems will be capable of playing Dolby films, and third-octave equalization will be employed, as part of the Dolby equipment, to adjust the system to the room according to a standard response curve.

In general, the class of audio equipment used in these installations will be the equal of the finest equipment specified for high-quality sound reinforcement systems in auditoriums and concert halls.

DO NOT mix different systems in the multichannel screen loudspeaker array. Not only will there be differences in power handling, there may be polarity differences, and these will adversely affect stereophonic performance.

We will now cover in detail the requirements for these systems.

2. System Recommendations for Large Houses; 500 to 2000 seats; volume 14,000 cubic meters (500,000 cubic feet):

***Preferred system:** Model 4675A (direct radiator LF)

Power needed for 100 dB: 90 watts
Recommended power amplifier: JBL 6260, one loudspeaker system per channel (300 watts into 4 ohms)
Characteristics: Broad-band sensitivity 100 dB-SPL, one watt at one meter; JBL's most power-flat and accurate system; uses large Bi-Radial horn for precise 90-by-40 degree pattern control down to 500 Hz; integral power response correction; extended response down to 45 Hz

For very large houses and for the highest degree of performance in professional dubbing theaters and screening rooms, the 4675A-2 may be specified. We recommend that biamplification be seriously considered with this system for optimum performance. The broad-band sensitivity of the 4675A-2 is 103 dB, one watt at one meter.

***Alternate vented horn systems:**

Models 4676B-1 and 4676B-2
Power needed for 100 dB: 80 and 53 watts, respectively
Recommended amplifier: JBL model 6260, one channel per loudspeaker system (300 watts)
Characteristics: Mid-band sensitivity, 106 and 109 dB-SPL, respectively; recommended for retrofit in large, older houses where a complete conversion to all-new hardware is not feasible. LF response rolls off below 80 Hz

The systems discussed in this section are shown in Figure 6A. Response curves are shown at B and C.

3. System implementation:

A. Electrical considerations:

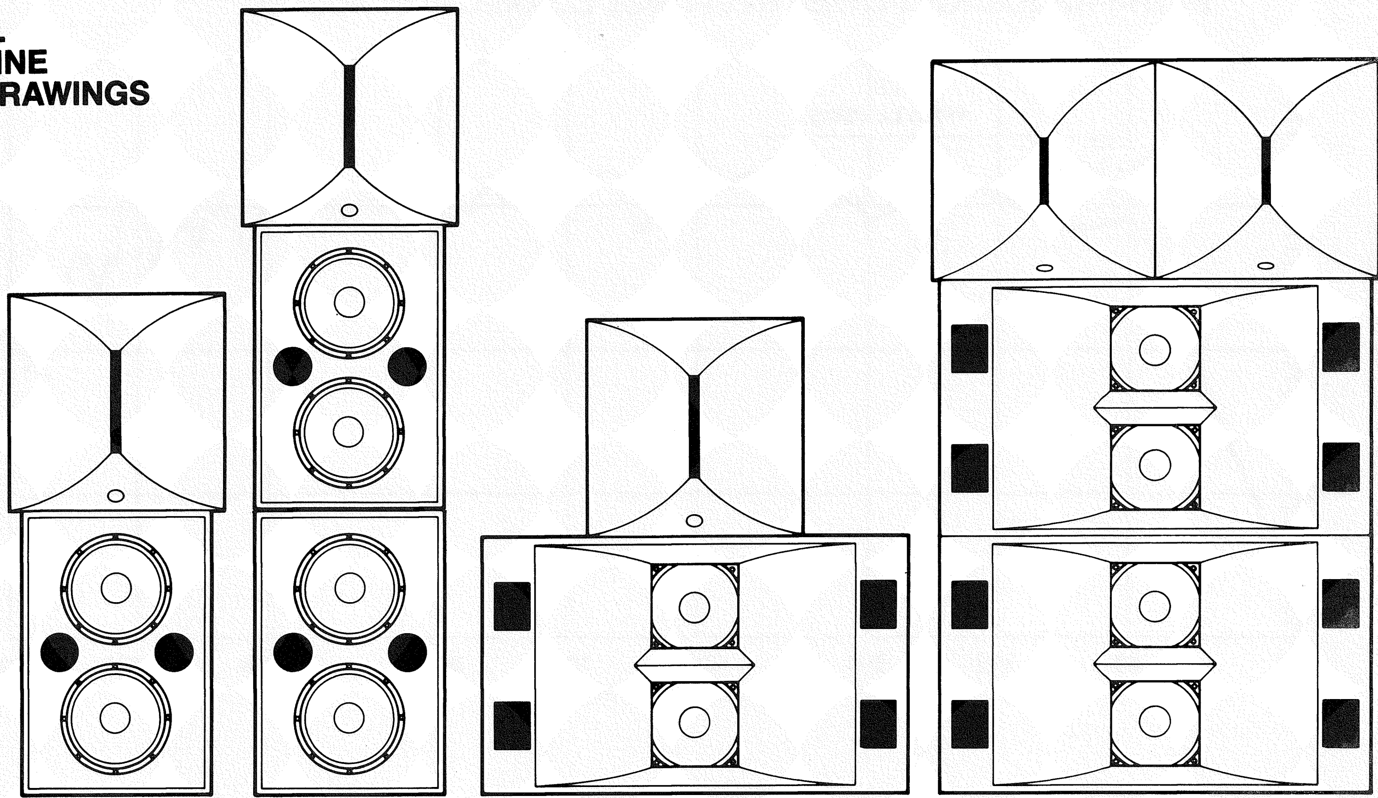
The systems intended for larger houses may be implemented with JBL's 3160 high-level network, with wiring as shown in Figure 7A through B.

However, for optimum performance, we recommend biamplification using the JBL model 5234A electronic dividing network. The 5234A is available with a 500-Hz card which contains high-frequency power response correction. Implementation of biamplification is shown in Figure 7C.

The chief value of biamplification is the reduction of intermodulation distortion on peak program signals. Furthermore, larger power amplifiers may be specified for the LF sections than those indicated for use with the high-level dividing network.

FIGURE 6. SYSTEMS FOR LARGE THEATERS

A. LINE DRAWINGS



4675A	4675A-2	4676B-1	4676B-2
PMAX = 300 W	PMAX = 300 W	PMAX = 300 W	PMAX = 300 W
SENSITIVITY: 100 dB, 1 W, 1 M	SENSITIVITY: 100 dB, 1 W, 1 M	SENSITIVITY: 106 dB, 1 W, 1 M	SENSITIVITY: 109 dB, 1 W, 1 M

FIGURE 6B. ON-AXIS RESPONSE, 4675A (2π LOADING); HIGH-FREQUENCY POWER RESPONSE CORRECTION ADDED.

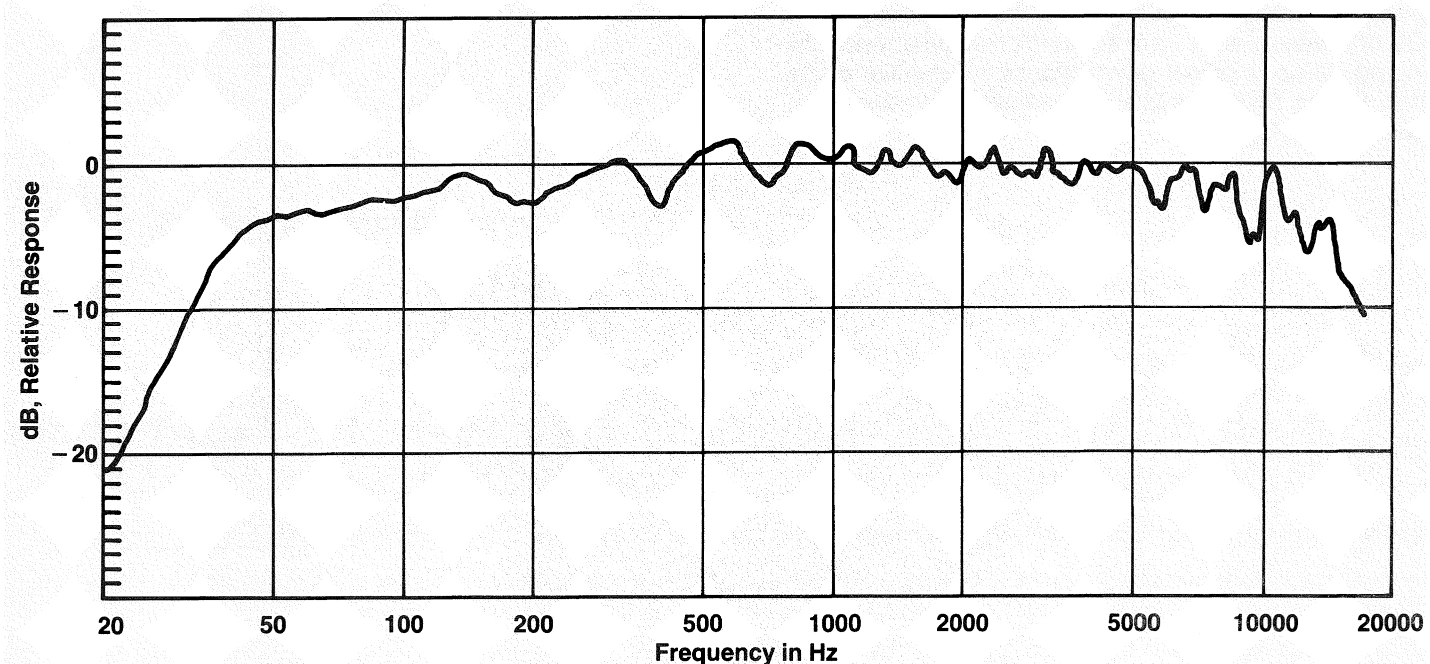
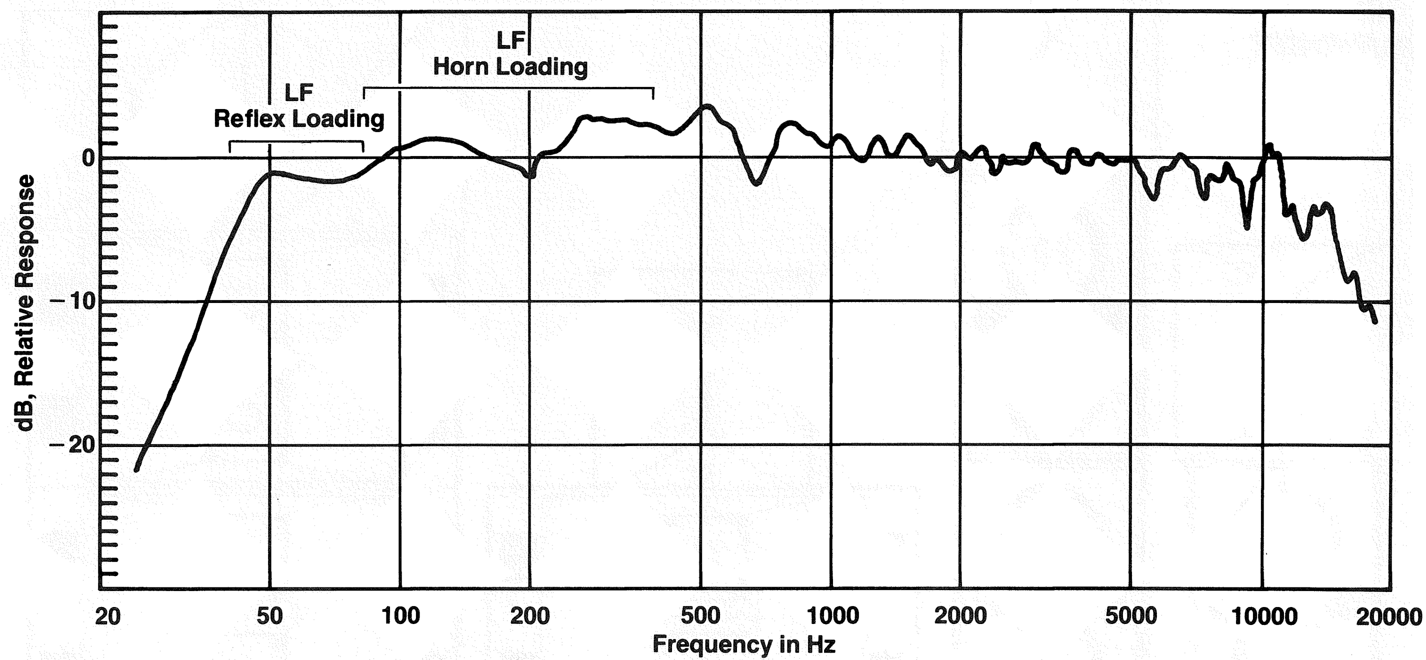


FIGURE 6C. ON-AXIS RESPONSE OF 4676B-1 (2π LOADING); HIGH-FREQUENCY POWER RESPONSE CORRECTION ADDED.



The LF sections of these systems are four ohms in impedance, and that consideration should, as in the previous section, dictate the choice of wire gauge for hook-up.

It is important in any biamplified installation to include DC blocking capacitors in output of the high-frequency amplifier, as shown in Figure 7C. The capacitor protects the high-frequency driver from any inadvertent DC or low-frequency transients which could develop during power-up or power-down phases of amplifier operation. Figure 7D presents a table of capacitor sizes for various applications.

FIGURE 7. WIRING DIAGRAMS FOR LARGER SYSTEMS

FIGURE 7A.

For 4675 and 4676 B-1 (See note in text concerning polarity)

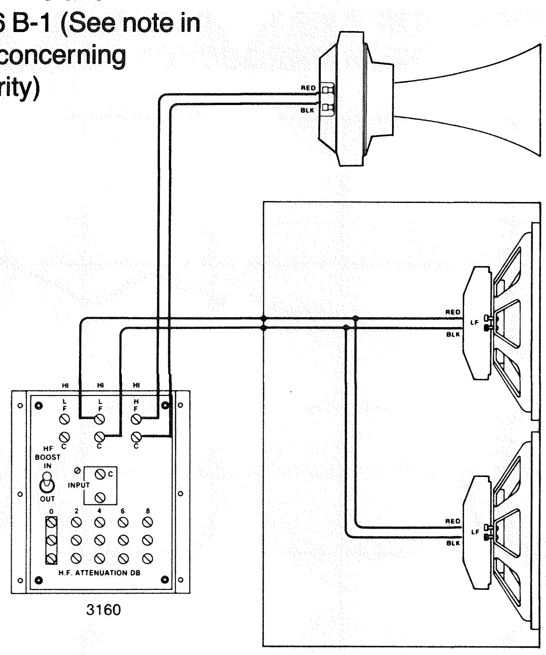


FIGURE 7, Cont'd.

FIGURE 7B.

For 4676 B-2
(Note: Splay each HF horn 22½° off center; total splay is 45°)

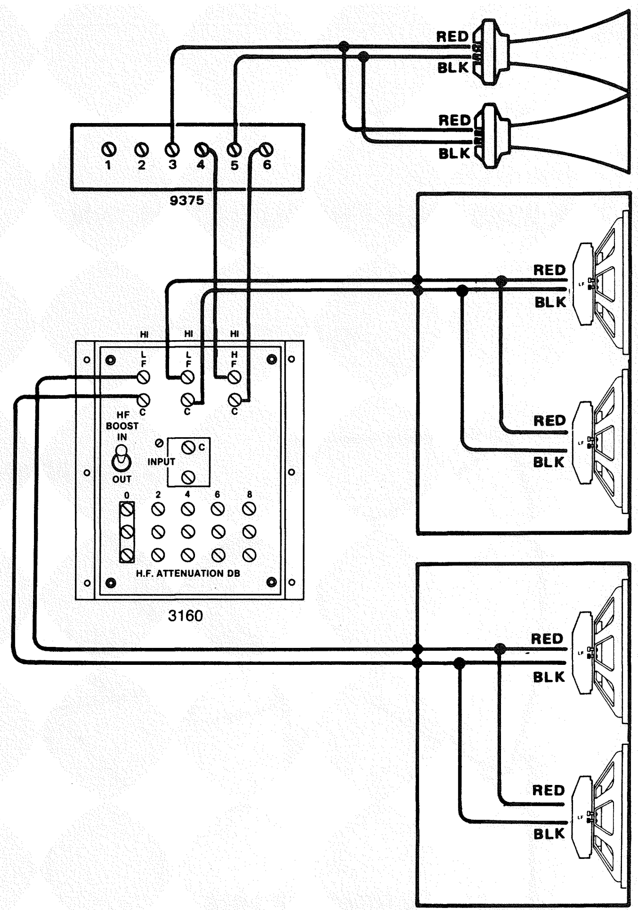
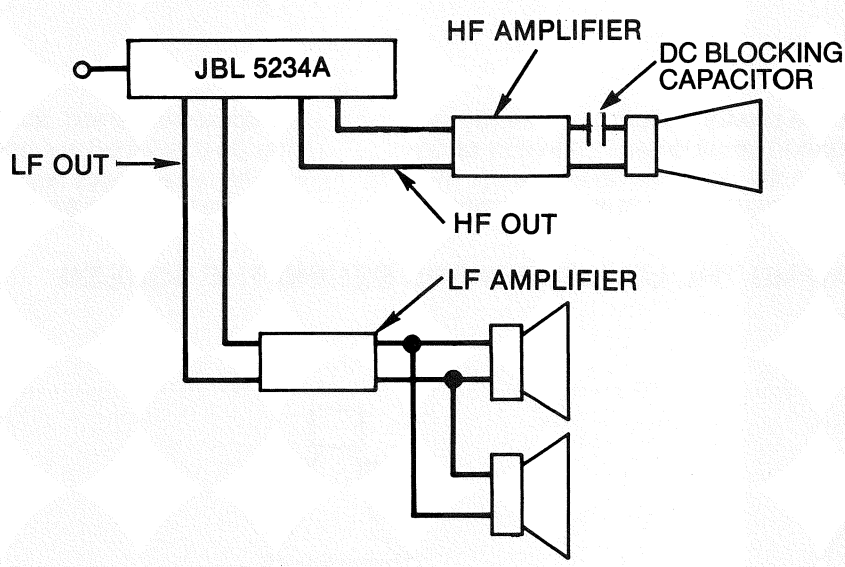


FIGURE 7C.

Biamplification with the 5234A,
Use plug-in 500-Hz card 52-5222 with high-frequency power response equalization



BIAMPLIFICATION

FIGURE 7D. BLOCKING CAPACITOR VALUES FOR DRIVER PROTECTION

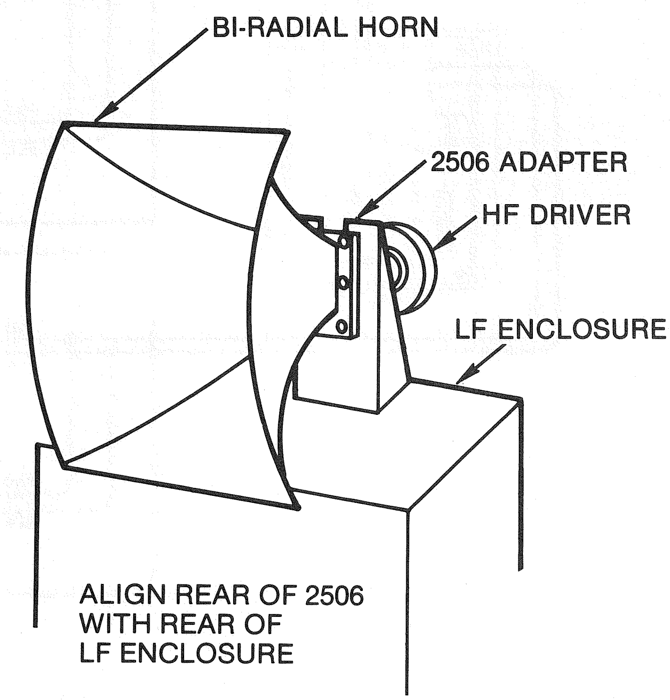
CAPACITOR VALUE	JBL PART NUMBER	FOR OPTIMUM RESULTS AT THESE CROSSOVER FREQUENCIES*
36 µF	62772-0360	500 Hz
24 µF	62772-0240	800 Hz

*16Ω OPERATION ASSUMED

B. Physical considerations:

High-frequency components should be mounted as shown in Figure 8.

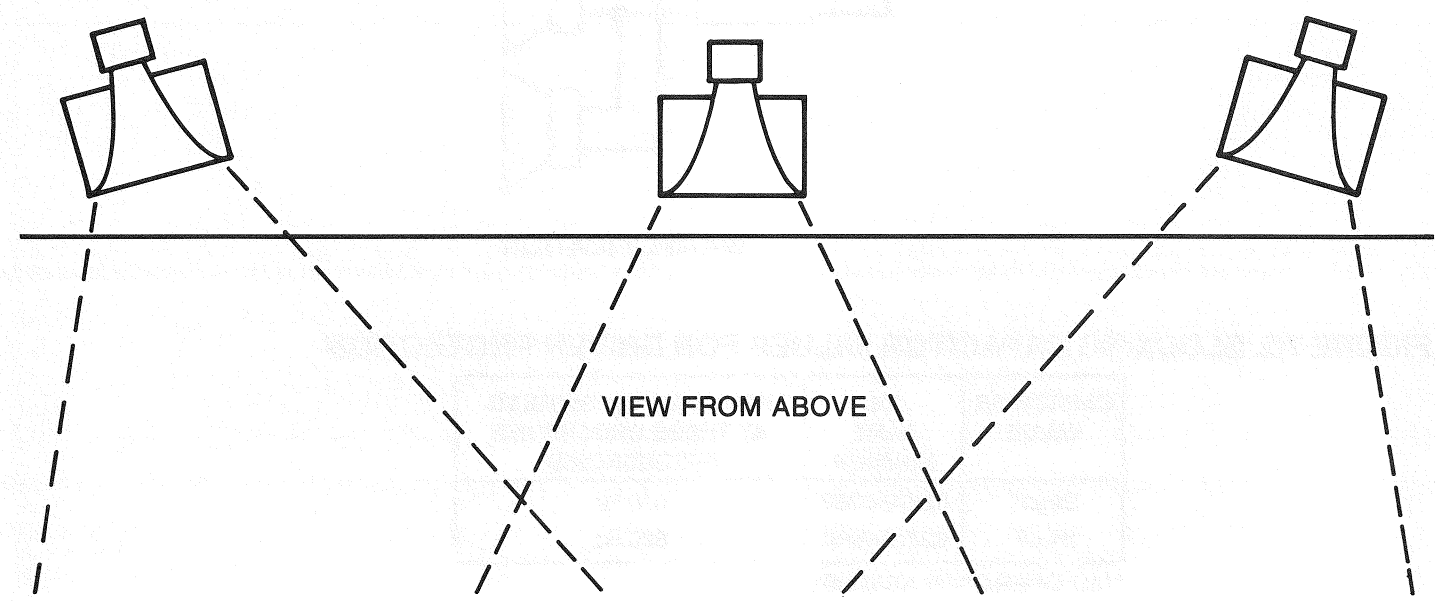
FIGURE 8. MOUNTING THE 2360 HIGH-FREQUENCY HORN



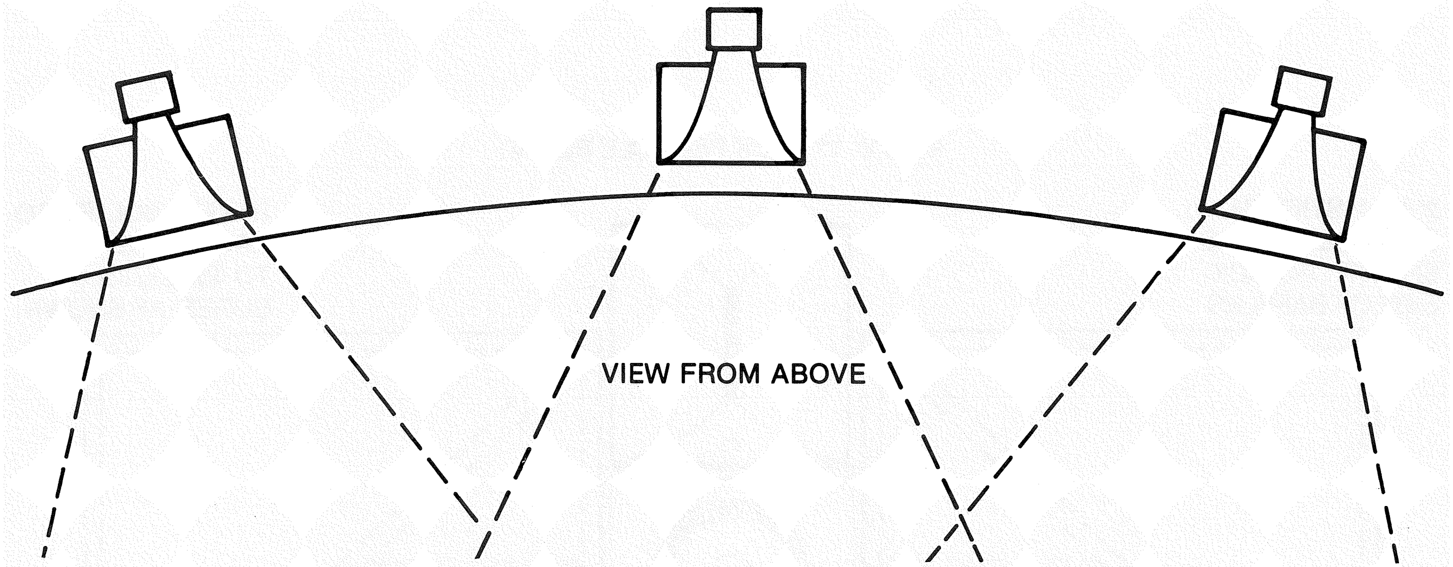
As indicated in the previous section, the loudspeakers should be positioned about one-third the way up the screen. If the screen is flat, as shown in Figure 9A, the flanking loudspeakers should be toed in slightly. Where the screen is curved, as shown at B, the loudspeakers may be positioned normal to the screen at each position. The high-frequency horns should be placed within 75–100 mm (3 to 4 in) from the screen.

FIGURE 9. PLACING THE LOUDSPEAKERS BEHIND THE SCREEN

A. FLAT SCREEN



B. CURVED SCREEN



The best possible acoustical loading of the system to the room is obtained when the loudspeakers are mounted in a large flat baffle, as shown in Figure 10. Here, the 4675A-2 system has been specified for extra acoustical power output in the 40 Hz to 500 Hz range.

The baffle should not be interrupted, and it should extend the entire width of the loudspeaker array. Mechanical details of this baffle are given in Figure 11. Ideally the baffle should be continuous in a multi-loudspeaker screen array.

FIGURE 10. PHOTO OF ACADEMY OF MOTION PICTURE ARTS AND SCIENCES SYSTEM

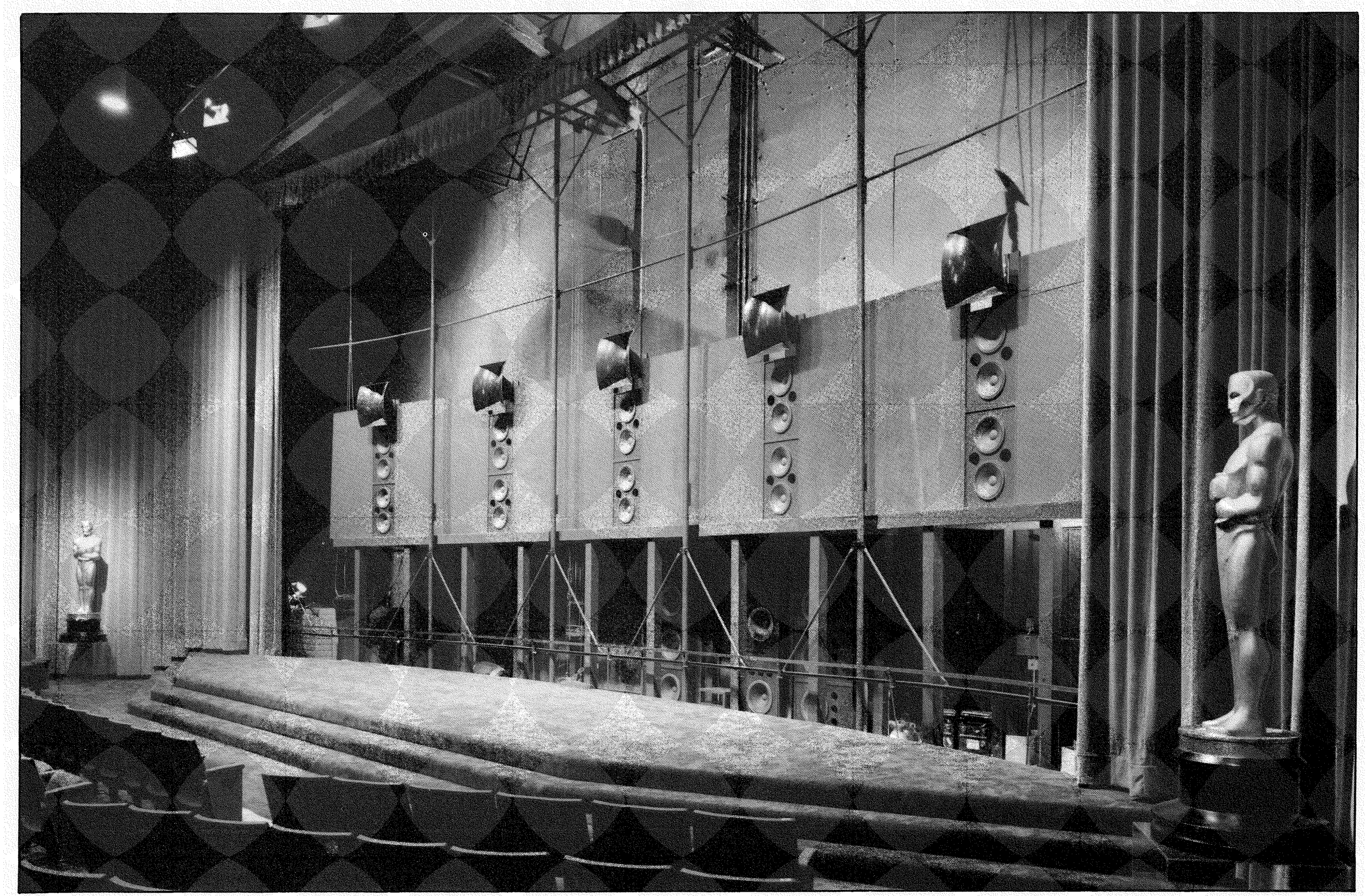
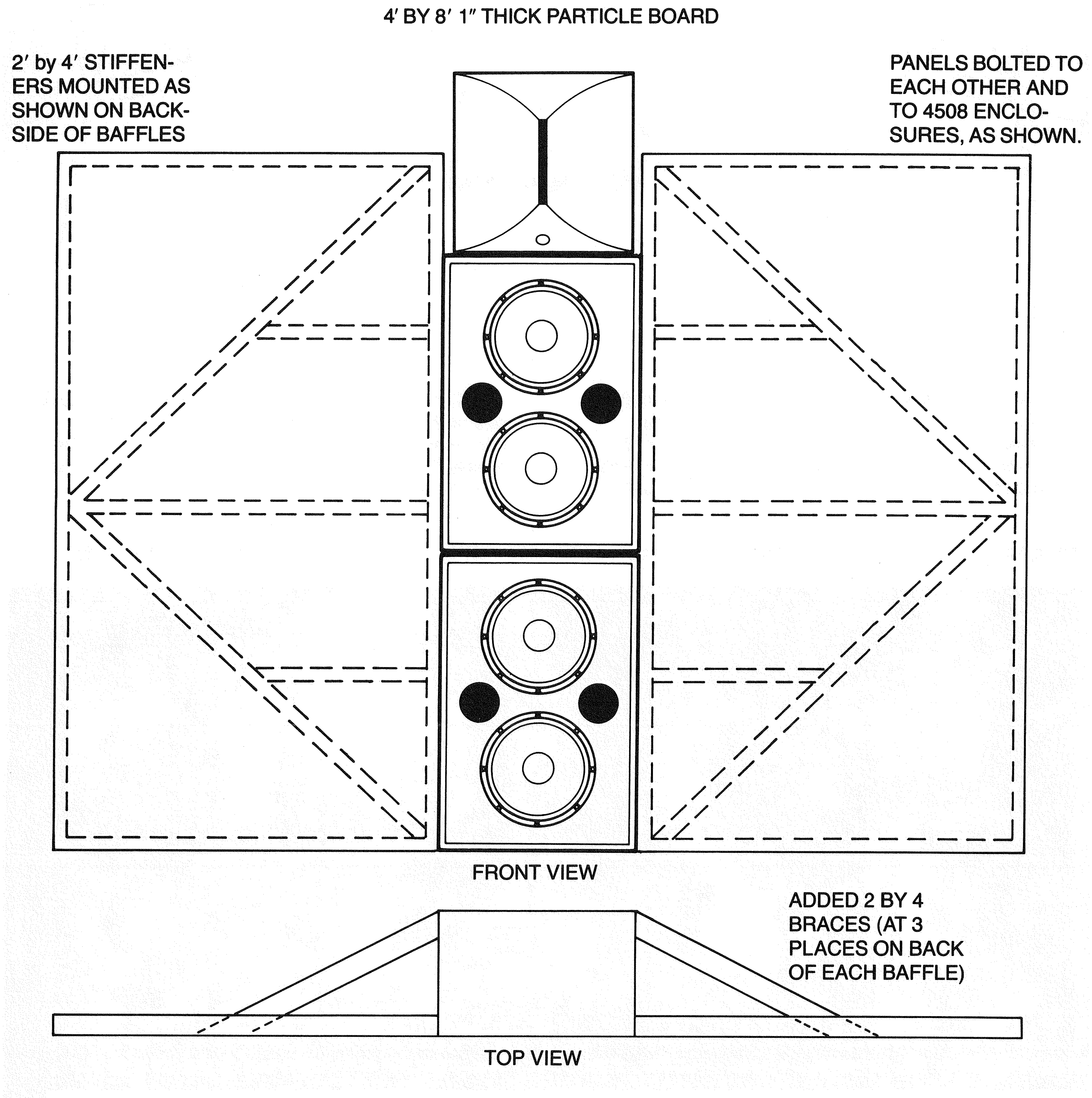


FIGURE 11. DETAILS OF LARGE FLAT BAFFLE



D. Surround Systems:

1. General comments:

While there is little consistent practice in specifying and implementing surround channels, we can set down the following general requirements:

a. The total acoustical power delivered by the ensemble of surround loudspeakers should be equal to one of the screen channels. There are probably not many surround systems which meet this requirement, but it is essential if the full impact of surround information is to be appreciated. While a 15-dB headroom factor is a part of the power calculations for the screen channels, it may be unreasonable to demand that of the surround channel. Thus, a requirement that the surround channel be able to produce a level in the house of 95 dB will suffice. In the case of distributed 200 mm (8 in) loudspeakers, a level of 92dB is deemed sufficient.

b. The quantity of surround loudspeakers should be sufficient so the listeners are not aware of any one of them. This usually means a minimum of eight: three each on the side walls and two on the back wall.

c. The surround loudspeakers should exhibit wide dispersion so that the entire audience area can appreciate smooth coverage across the frequency range.

d. Surround loudspeakers should be unobtrusive and not interfere with theater decor. This requirement may run counter to some of the acoustical requirements in that size is related to system efficiency.

2. Choosing the right surround loudspeakers:

JBL has recently introduced the model 8325A three-way system for surround applications. With input power capacity of 80 watts and a sensitivity of 91 dB, one watt at one meter, ten to twelve of these systems are a reasonable match for a screen array of 4675A systems. More than ten may be required for broader coverage in larger houses.

In larger theaters, the 46120K has been successfully used as a surround loudspeaker. This system has a sensitivity of 97 dB, one watt at one meter, and power input is 400 watts. Obviously, fewer of these systems would be required than with the 8325A.

In general, we would recommend the following quantities of the various surround loudspeakers for reasonable matching with a screen loudspeaker array consisting of 4675A's:

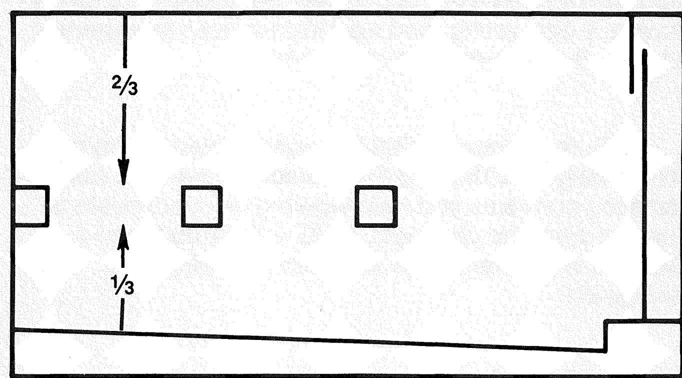
8325A	10 to 12
4671 or 4671OK	6 to 8
46120K	6 to 8

Dolby Laboratories has suggested the use of multiple 200 mm (8 in) loudspeakers for the surround channel. Upwards of 60 such loudspeakers may be used in this configuration, mounted in groups of six or eight and arrayed horizontally along the walls. The JBL model 8140 Co-Motional driver is ideal for this application because of its extremely smooth and wide high-frequency dispersion.

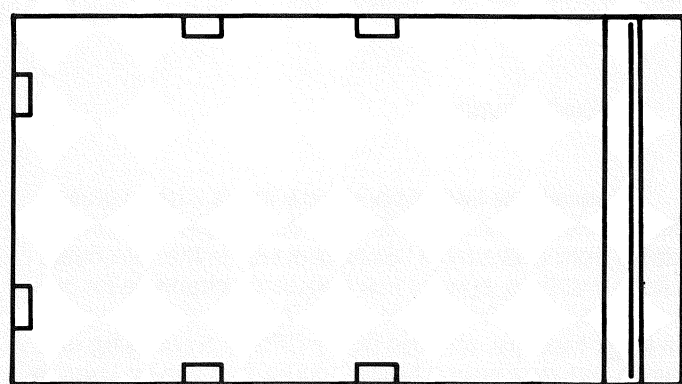
3. Implementation of the surround system:

Figure 12 shows the general mounting for surround loudspeakers. Note that they cover the back two-thirds of the house and that they are located one-third the distance up the walls.

FIGURE 12. LOCATING THE SURROUND LOUDSPEAKERS



A. SIDE VIEW



B. TOP VIEW

FIGURE 13. WIRING THE SURROUND LOUDSPEAKERS

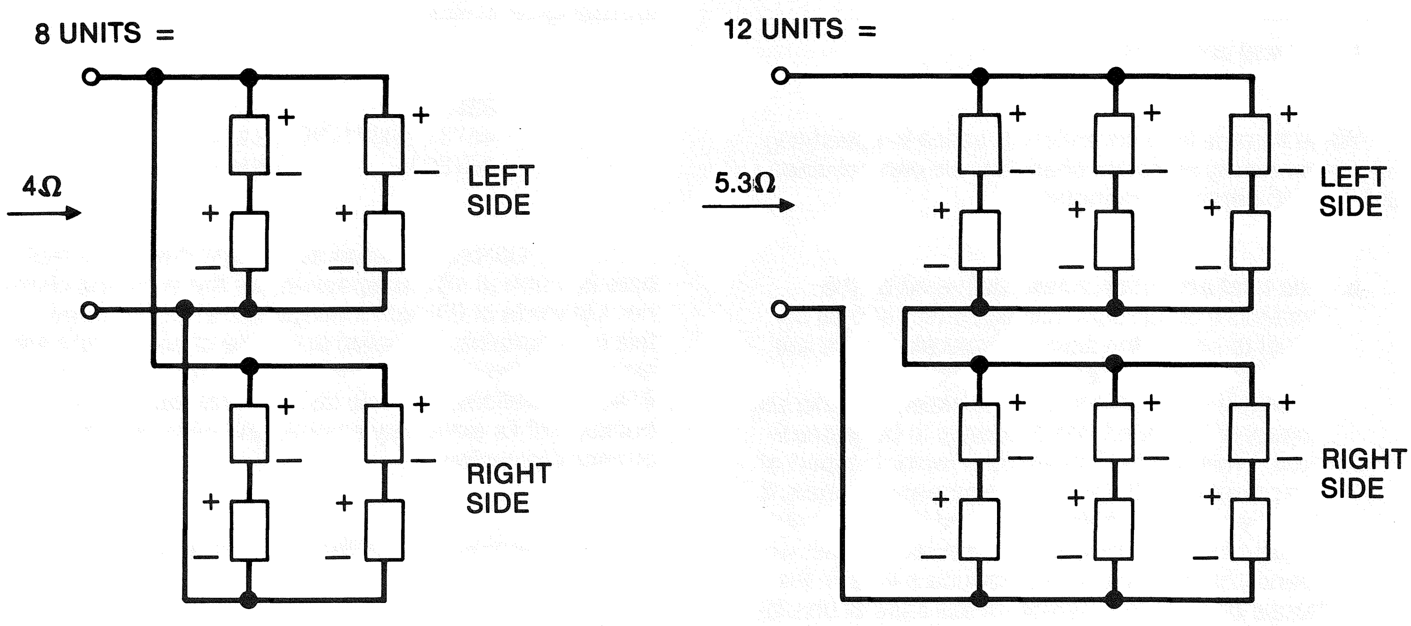


Figure 13 shows details of electrical hook-up. Series-parallel wiring will be necessary to ensure that each amplifier sees a proper load. Most amplifiers today have a 4-ohm rating, and load impedances anywhere in the 4 to 8-ohm range are acceptable.

JBL recommends that surround loudspeakers be individually wired back to the projection booth for ease in isolating problems and reconfiguring the loudspeakers for split surround channels. AWG #12 (2.053 mm) copper wire will generally be sufficient for wiring the surrounds.

E. Subwoofer Systems:

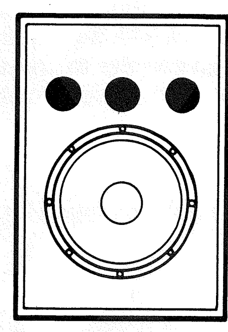
1. Background:

Special low-frequency effects in the motion picture theater date back to the thirties, but the present interest dates from Universal's "Sensurround" in the seventies. Since that time, special low-frequency channels for covering the range from 20 to 40 Hz have become common in large theaters, and the Dolby CP200 processing unit has a summed output below 100 Hz that can be used directly for driving subwoofer amplifiers.

2. Implementation:

JBL manufactures the 4645 subwoofer system for motion picture applications. This system, shown in Figure 14A, uses the 2245H 460 mm (18 in) transducer, which is noted for its low distortion and for its total excursion capability of 19 mm (0.75 in).

FIGURE 14A



4645 SUBWOOFER

PMAX = 300W

SENSITIVITY: 95 dB, 1 W, 1 M

The following table indicates the acoustical power output which can be expected in two sizes of theaters.

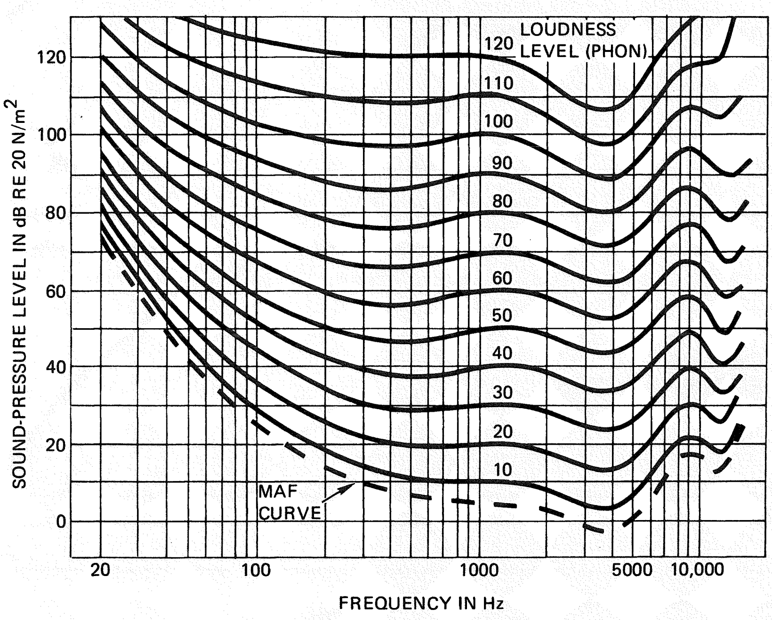
NUMBER OF MODULES	EFFICIENCY	MAXIMUM ELECTRICAL POWER INPUT	ACOUSTIC POWER	SOUND LEVELS 500-1000 SEATS	SOUND LEVELS 1000-2000 SEATS
1	2%	300 WATTS	6 WATTS	101 dB	100 dB
2	4%	600 WATTS	24 WATTS	107 dB	106 dB
4	8%	1200 WATTS	96 WATTS	113 dB	112 dB
8	16%	2400 WATTS	384 WATTS	119 dB	118 dB

It is essential that only the most stable amplifiers be used for subwoofer application. The transducers can be paralleled for 4-ohm operation.

Substantial sound pressure levels are necessary at very low frequencies to match the 85 dB reference level in the theater, as the equal loudness contours shown in Figure 14B indicate. Note that with each doubling of transducers, the maximum sound pressure level increases 6 dB. Three dB are due to doubling the power input capability, and another three dB are due to the increase in efficiency resulting from mutual acoustical coupling between transducers.

Subwoofer loudspeakers should be located fairly close together, and they should be placed at the intersection of a wall and floor. Careful bracing and mounting on rubber or Neoprene pads may be necessary to minimize rattling.

FIGURE 14B. ROBINSON-DADSON EQUAL LOUDNESS CONTOURS



F. Acoustical Response: The Concept of Flat Power Response

While loudspeaker systems are fairly flat on axis, they tend to narrow considerably in their coverage angles at high frequencies. Their power response rolls off naturally. If a loudspeaker maintains fairly constant horizontal and vertical coverage angles over most of its frequency range, then flat on-axis response will also imply flat power response. Since about half of the sound heard in the theater has been reflected at least once, it is important that loudspeakers exhibit fairly flat power response if the reproduced sound is to be natural.

Another consequence of using loudspeakers with flat power response is that little system equalization will be required. Figure 15 illustrates this. At A, we see the boundary absorption in a typical well-designed theater. Note that it is quite flat over the frequency range. High-frequency losses due to air absorption are shown at B, and typical high-frequency screen losses are shown at C. When we add all of these losses, we get the response shown at D, and this is exactly the acoustical response we would observe in the room if we were using a loudspeaker that had flat power response.

FIGURE 15. RESPONSE IN THE HOUSE

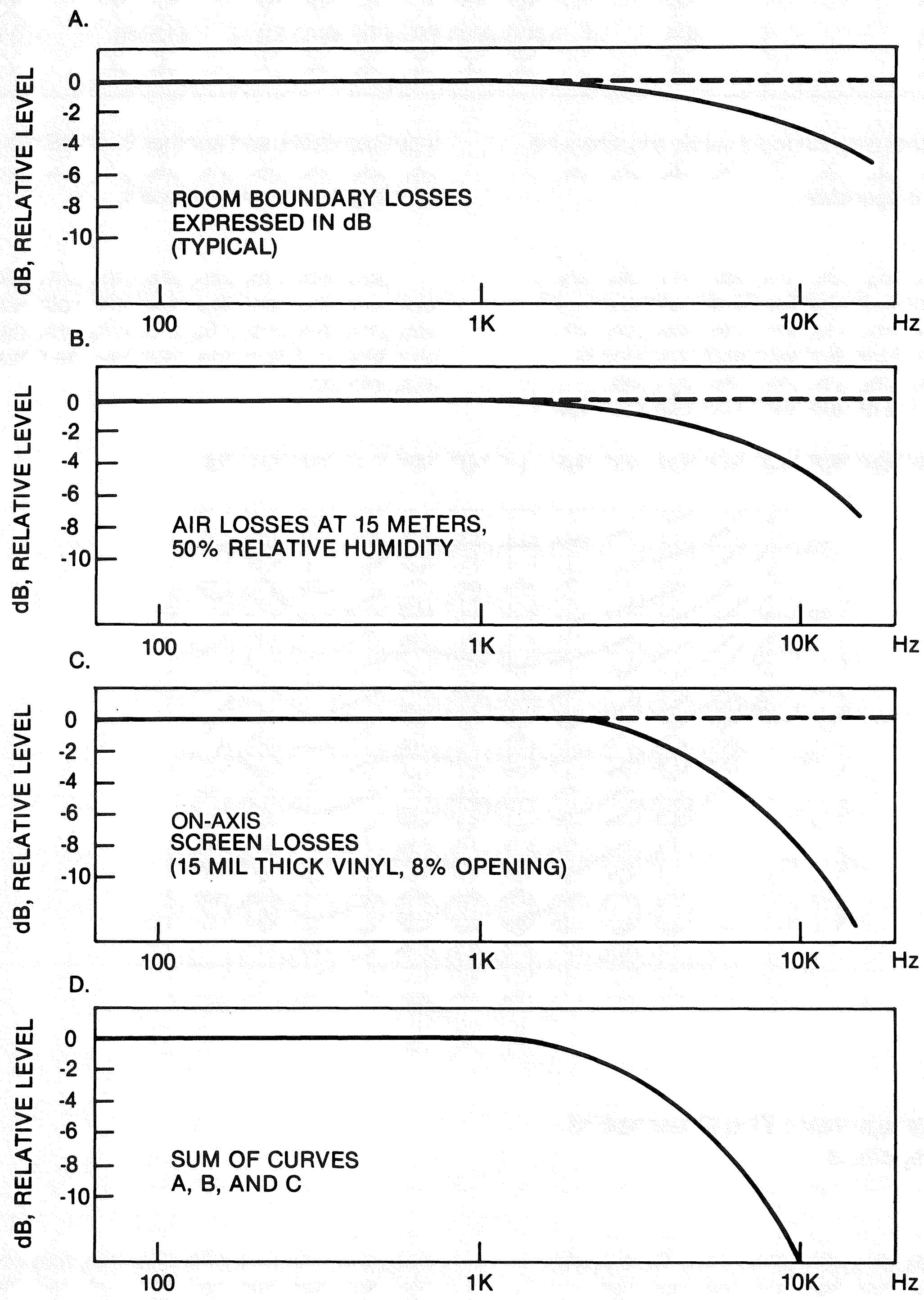
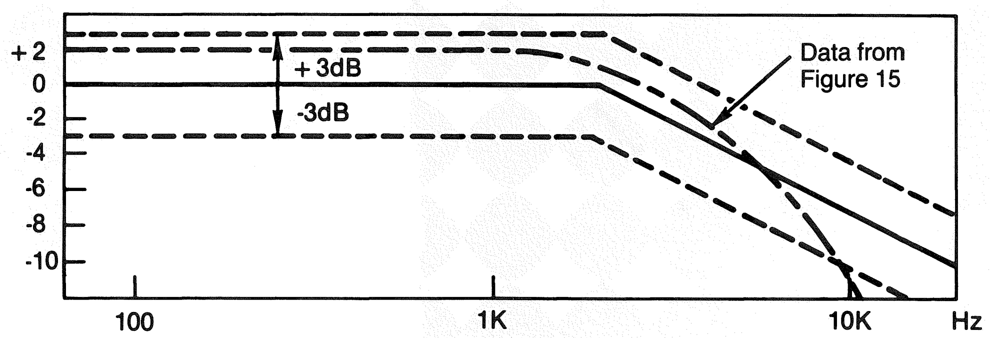


Figure 16 shows the standard "house curve" to which most theater systems are equalized. Note that it closely resembles the summed curve shown in Figure 15D, indicating that flat power response systems will require little, if any, added equalization in most houses. JBL's theater systems using Bi-Radial horns exhibit essentially flat power response as well as flat on-axis response. The smaller systems exhibit flat on-axis response, but their power response rolls off slightly at high frequencies. JBL's passive dividing networks provide for a high-frequency boost which effectively makes any of the systems power-flat at high frequencies. In the smaller systems, this may be accompanied by a slight on-axis rise at high frequencies. Nevertheless, we recommend that some degree of high-frequency boost be used in all theater applications.

FIGURE 16. ISO STANDARD PLAYBACK RESPONSE

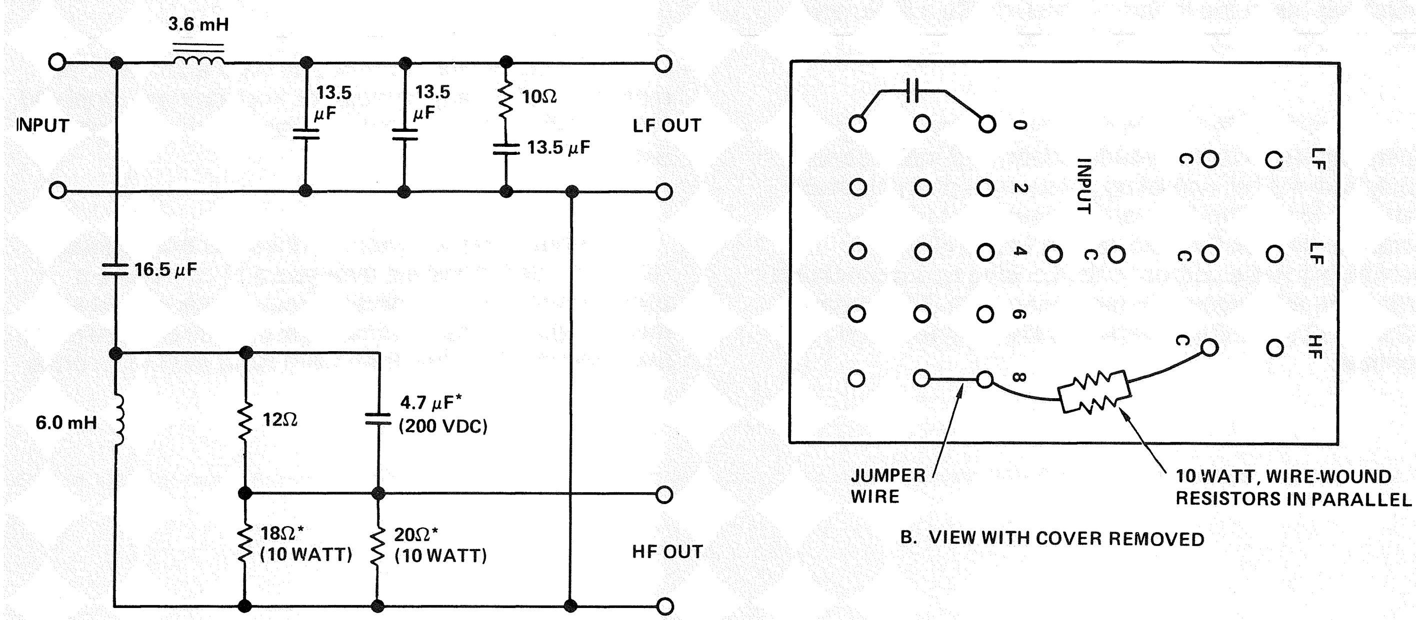


G. Model 3152A Field Network Modification:

The model 3152A network has been replaced by the 3160. There are two important differences between the old and new models. The impedance of the low-frequency section has been changed from eight to four ohms, thus providing a better sensitivity match between the low and high sections. Further, the new network has a switch which introduces a high-frequency boost for correcting the normal power response roll-off of the compression driver. JBL recommends that the boost be used in all theater systems.

There are, however, quite a few of the older 3152A networks in the field, and they can be modified to provide the required boost. Details for this modification are given in Technical Note Volume 1, Number 5. Figures 17 and 18 outline that modification for your convenience.

FIGURE 17. 3152A NETWORK MODIFICATIONS

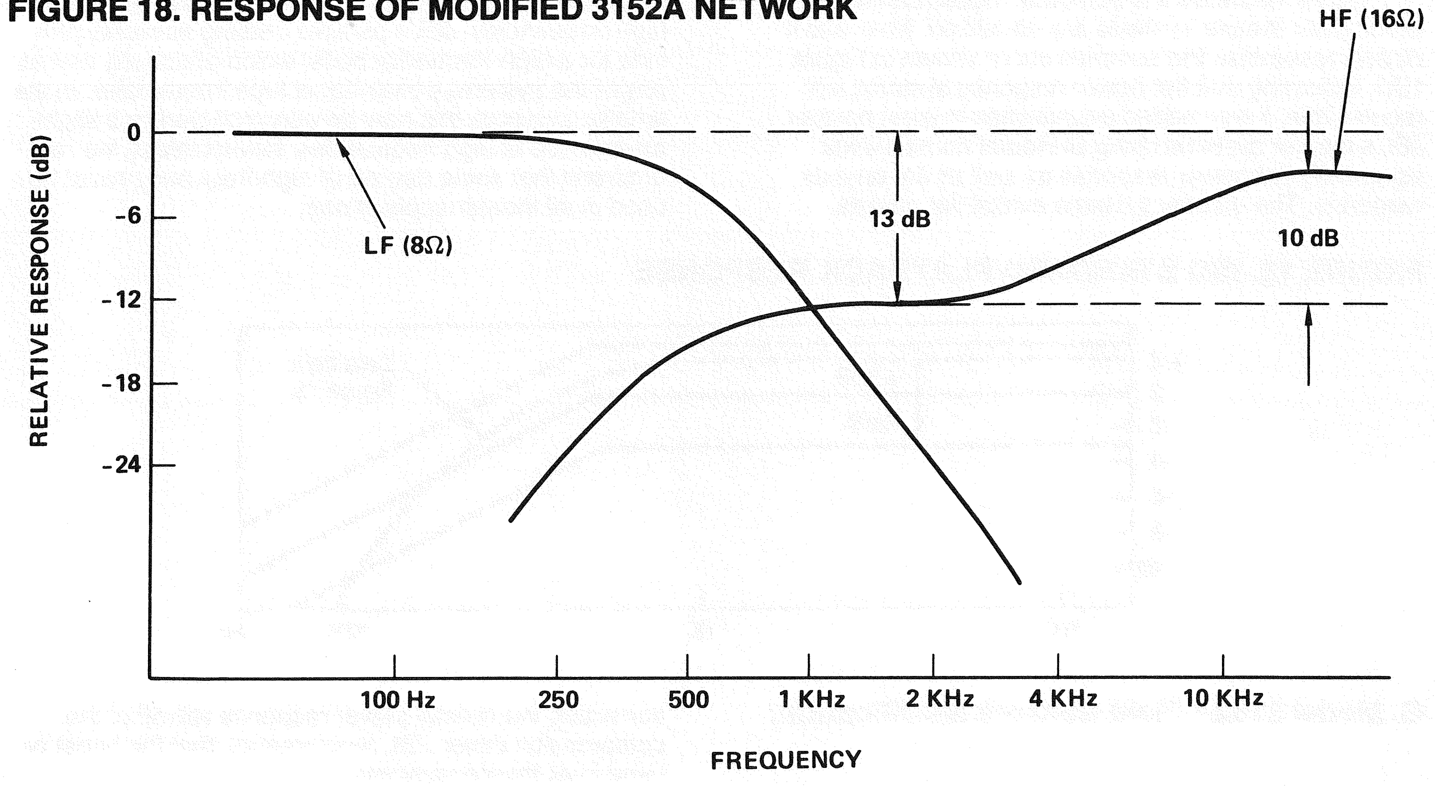


A. SCHEMATIC OF MODIFIED NETWORK

B. VIEW WITH COVER REMOVED

* NEW COMPONENTS

FIGURE 18. RESPONSE OF MODIFIED 3152A NETWORK



H. Notes on Preventive Maintenance:

Nothing lasts forever; however, a properly specified, installed, and operated motion picture sound system comes as close to beating the odds as anything we know of. There are a few points of preventive maintenance which will make the theater operator's life a little more bearable, and we present them below:

1. Establish fixed gain and equalization settings and operating levels in each audio chain, and make absolutely sure that all operating personnel adhere to those settings. Most high-frequency component failures reported to us from the field can be traced directly to overdriving those components. Locking type controls on amplifiers will discourage tampering. The JBL models 6230, 6260, and 6290 amplifiers are available with such controls.

2. An experienced technician should regularly check out each audio chain to ensure that no changes have been made.

3. Make sure that any changes in third-octave system equalization are carried out by an experienced engineer using the correct measuring instrumentation.

4. The audience is the first to hear a problem, so monitor carefully any complaints from patrons. Until you find out differently, assume that the patron's complaint is legitimate.

5. Routine replacement of drivers is not generally recommended; however, over years of operation, a compression driver diaphragm may simply give in to metal fatigue. Our current titanium diaphragms are much less susceptible to this than were older aluminum ones.

I. JBL THEATER SYSTEMS COMPONENTS

A. 4671:

- 1-4507 Low Frequency Enclosure
- 1-2225H Low Frequency Transducer
- 1-2370 High Frequency Horn
- 1-2425J High Frequency Driver
- 1-3110A Network

B. 4673:

- 1-4507 Low Frequency Enclosure
- 1-2225H Low Frequency Transducer
- 1-2380 High Frequency Horn
- 1-2445J High Frequency Driver
- 1-3115A Network

C. 4670B:

- 1-4508 Low Frequency Enclosure
- 2-2225H Low Frequency Transducers
- 1-2380 High Frequency Horn
- 1-2445J High Frequency Driver
- 1-3160 Network

D. 4672A:

- 1-4560BKA Low Frequency Enclosure
- 1-2225H Low Frequency Transducer
- 1-2370 High Frequency Horn
- 1-2425J High Frequency Driver
- 1-3110A Network

E. 4674A:

- 1-4560BKA Low Frequency Enclosure
- 1-2225H Low Frequency Transducer
- 1-2380 High Frequency Horn
- 1-2445J High Frequency Driver
- 1-3115A Network

F. 4675A:

- 1-4508 Low Frequency Enclosure
- 2-2225H Low Frequency Transducers
- 1-2360A High Frequency Horn
- 1-2445J High Frequency Driver
- 1-2506 Mounting Bracket
- 1-3160 Network

G. 4675A-2:

- 2-4508 BKA Low Frequency Enclosures
- 4-2225J Low Frequency Transducers
- 1-2360A High Frequency Horn
- 1-2445J High Frequency Driver
- 1-2506 Mounting Bracket
- 1-3160 Network

H. 4676B-1:

- 1-4550BKA Low Frequency Enclosure
- 2-2225H Low Frequency Transducers
- 1-2360A High Frequney Horn
- 1-2445J High Frequency Driver
- 1-2506 Mounting Bracket
- 1-3160 Network

I. 4676B-2:

- 2-4550BKA Low Frequency Enclosures
- 4-2225J Low Frequency Transducers
- 2-2365A High Frequency Horns
- 2-2445J High Frequency Drivers
- 2-2506 Mounting Brackets
- 1-3160 Network

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