



CINEMA SOUND SYSTEM MANUAL

JBL 2003 Cinema Sound System Manual

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I. INTRODUCTION

The decade of the 1980's saw many improvements in the quality of cinema sound. Dolby Laboratories began the cinema sound revolution during the middle 1970's with the introduction of noise reduction and equalization of cinema loudspeaker systems to match a consistent power response standard. In 1981, JBL demonstrated the first flat power response loudspeaker systems at the Academy of Motion Picture Arts and Sciences. In 1983, Lucasfilm introduced the THX[®] standard screen system, along with a program of cinema product and performance certification that covered aspects of audio and projection quality, theater-to-theater isolation, as well as environmental acoustics. As the 1980's progressed, Dolby stereo optical sound tracks gained in favor, increasing the number of stereo houses significantly. The application of Dolby Spectral Recording™ (SR) to cinema release prints represented another step forward in sound quality.

By the mid 1990s, three digital systems had been introduced into the cinema, Dolby SR-D, Digital Theater Sound (DTS), and Sony Dynamic Digital Sound (SDDS). These systems offered similar digital performance characteristics, and they all provided analog stereo optical tracks for overall compatibility and operational redundancy, should the digital portion of the system fail, or momentarily go into a mute mode. DTS makes use of a CD-ROM running in sync with the print for its digital program, while the other two formats include the digital information on the print itself.

As new cinema complexes are being planned and constructed, acoustical engineers are now more than ever before being engaged to deal with problems of architectural acoustics and sound isolation between adjacent exhibit spaces. More attention is being paid to the specification of sound equipment and its careful integration into the cinema environment. In recent years we have seen a new trend in cinema design, stadium seating. This facilitates a wider screen presentation, with a greater sense of audience participation.

JBL has a strong commitment to the cinema market. We have become the acknowledged leader in the field, and our products are routinely specified for major studios and post-production houses throughout the world. JBL continues its rapid pace in new product development aimed at increasing performance levels in the cinema.

This manual has several goals. First, it will provide a background in basic systems concepts, and then move on to acoustical considerations in the cinema. The subject of electroacoustical specification will be discussed, as will the problems of mounting and aiming of the components. Electrical interface and system checkout will be covered in detail.

II. BASIC SYSTEM CONCEPTS

A. Analog Film Formats:

There are two film sizes for theatrical exhibition: 35 mm and 70 mm. The projection image aspect ratios for 35 mm can be either 1.85:1 ("flat") or 2.35:1 ("scope"). 70-millimeter prints are normally projected at a ratio of 2.2:1. The advantages of 70 mm have, in the past, been the availability of six magnetic tracks and large image area. The cost of a 70 mm print is quite high, and these prints have normally been made in limited quantities for exhibition in premier houses in large metropolitan locations. Today, the general practice with 70 mm is to use three channels behind the screen (left, center, and right) and a single surround channel feeding multiple loudspeakers. Options are to use the two remaining magnetic tracks for subwoofer signals and/or split (dual channel) surrounds. The 35 mm format was modified during the 1950's to handle four magnetic tracks: three screen channels and a single surround channel. At the same time, the standard monophonic variable area optical track was maintained. Figures 1A and B shows the channel layout for both 70 mm and 35 mm magnetic standards. At present, the 35 mm magnetic standard is no longer in general use.

Dolby Stereo Optical system is the standard format on non-digital 35 mm film. In this process, the dual bilateral variable area optical sound tracks, which were formerly modulated with a monophonic signal, are now modulated in stereo, as shown in Figure 2A. Recording on the two sound tracks is accomplished through a matrix, which accepts inputs for the three screen channels and the single surround channel. The signals

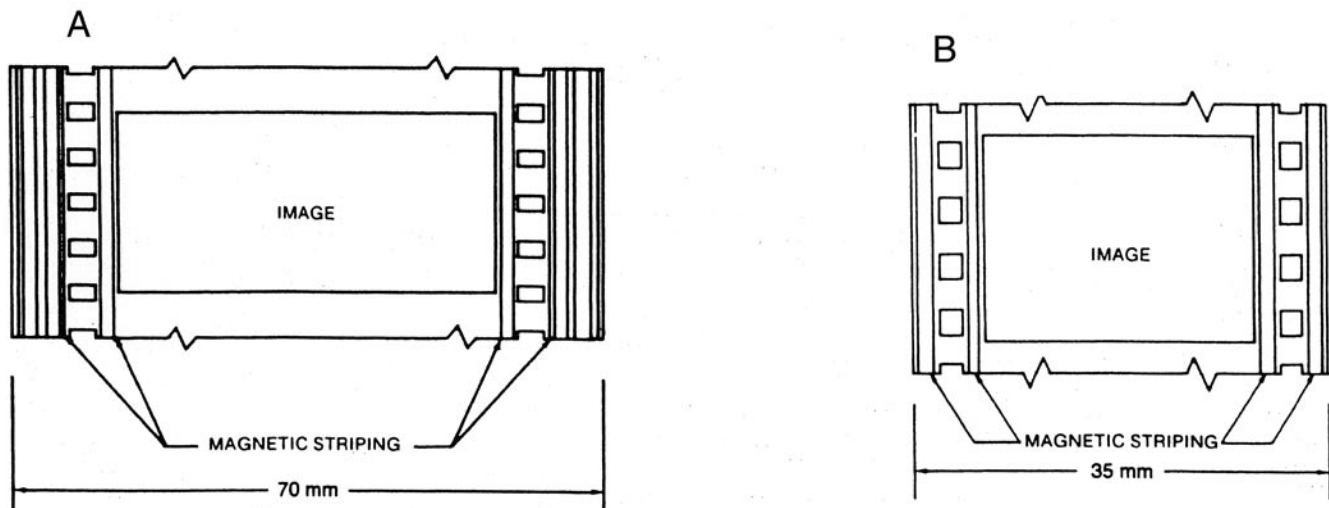


Figure 1: Magnetic film formats. 70-mm (A); 35-mm (B)

intended primarily for the left and right screen loudspeakers are fed to the left and right channels. Program material intended for the center screen loudspeaker, including most on-screen dialog, is fed to both stereo channels in phase. The in-phase relationship between the stereo channels triggers the playback matrix to steer that information primarily to the center screen loudspeaker, through a combination of gain control and altering of separation coefficients within the matrix. In a similar manner, information intended for the surround channels is fed to both stereo channels so that there is a 180° phase relationship between them. This phase relationship triggers the playback matrix to steer that information primarily to the surround loudspeaker array. [Figure 2B](#) shows details of the playback matrix used for the Dolby Stereo Optical format.

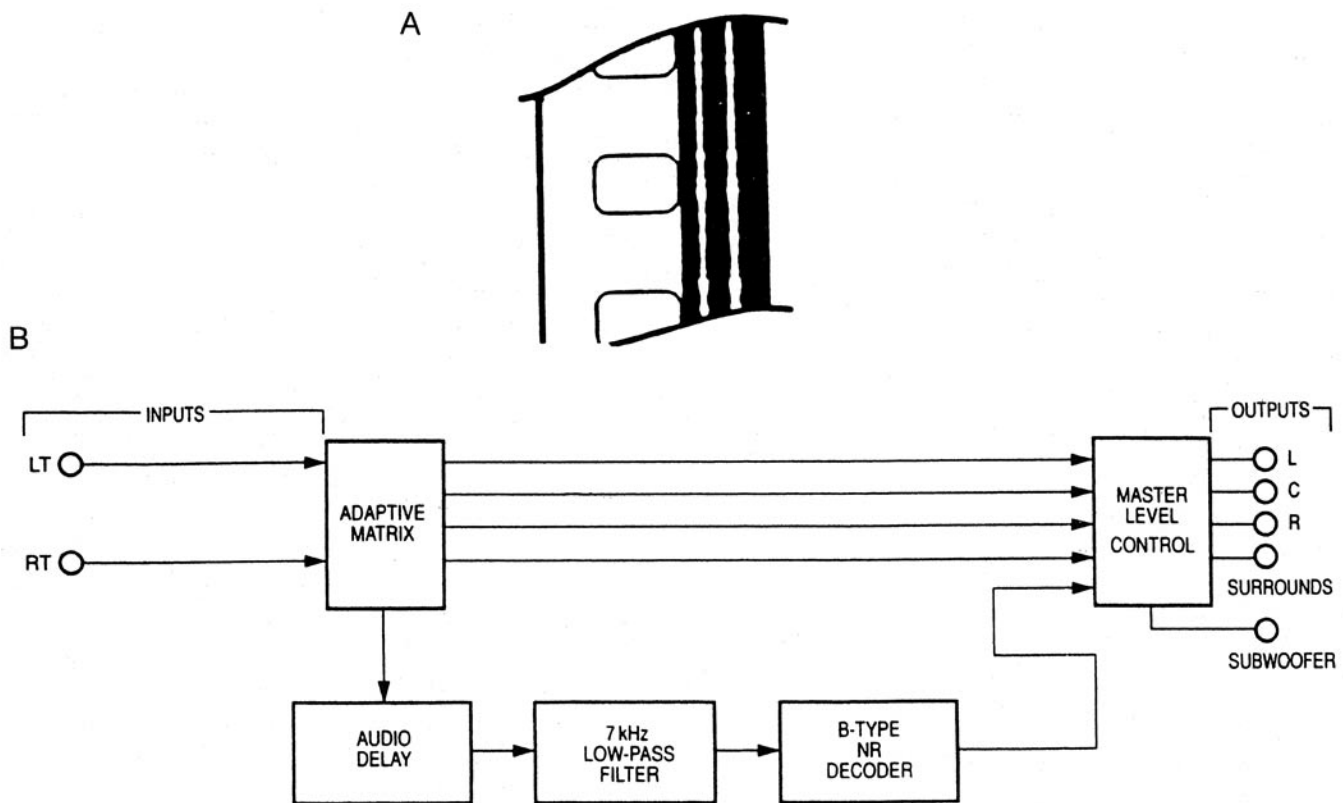
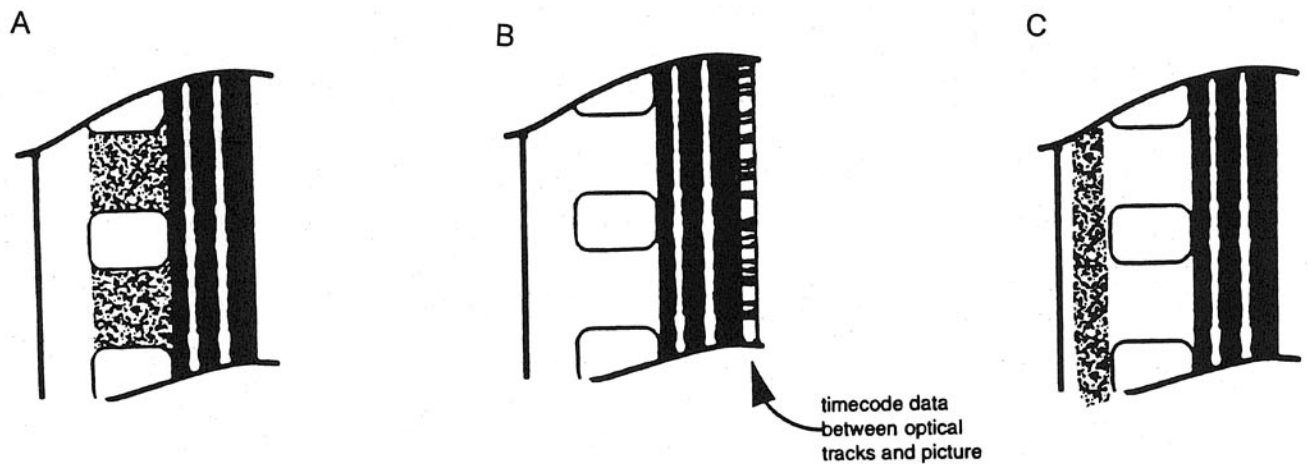


Figure 2: Dolby Stereo Optical format. 35-mm Dolby SR format (A); playback matrix (B)

B. Digital Film Formats

The Dolby SR-D format, introduced in 1992, is shown in [Figure 3A](#). It has exactly the same optical sound tracks as shown in [Figure 2A](#) with the addition of digital information located in the otherwise unused space between sprocket holes. This new digital format provides the usual three screen channels plus a split surround pair and a single low frequency (subwoofer) channel that operates below 100 Hz. This is commonly referred to as a “5.1” channel system and uses an elaborate perceptual encoding process known as AC-3. The Dolby SR-D format is usually referred to as “Dolby Digital.”

[Figure 3B](#) shows the format used in DTS. Here we see only the stereo optical tracks and a sync track for maintaining control of the associated CD ROM player.



[Figure 3C](#) shows the format used in SDDS. In addition to the stereo optical tracks, there are two digital tracks, one at each edge of the film.

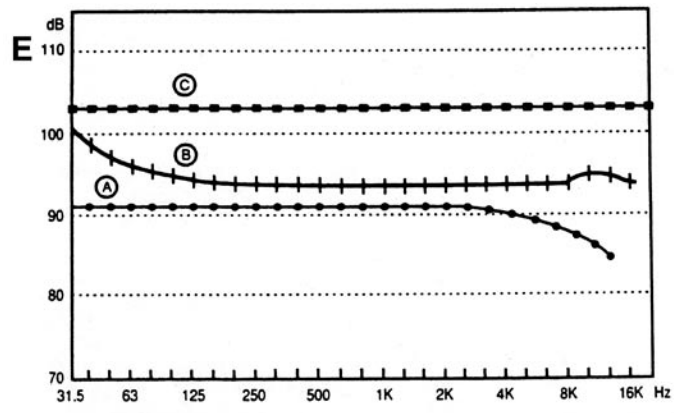
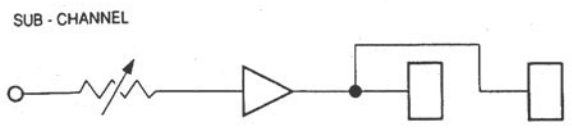
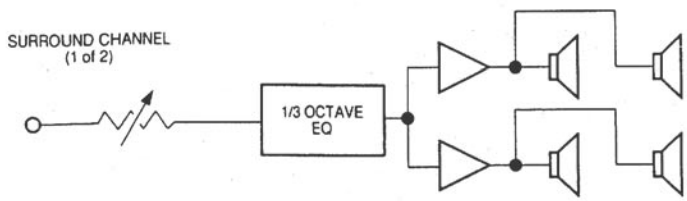
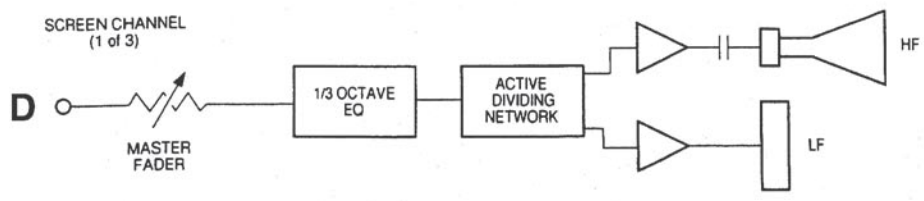
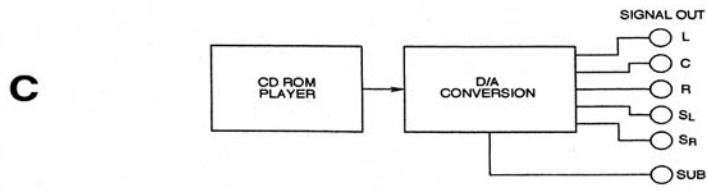
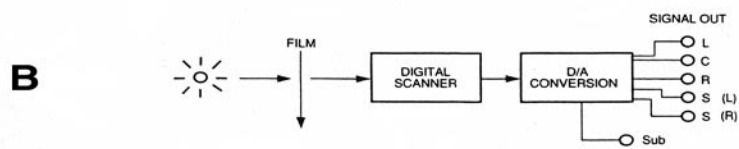
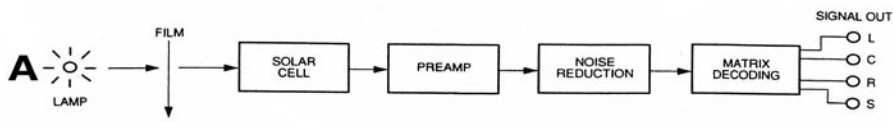
Like Dolby Digital, DTS and SDDS make use of perceptual encoding methods for reducing the amount of digital data required for system operation. DTS and SDDS also support the 5.1 channel format used in most cinemas, but SDDS also supports as many as 5 screen channels for special applications, making a total of eight channels.

All digital formats discussed here have a fall-back (failsafe) mode in which the analog tracks will be used in case of failure of the digital portion of the systems.

C. A- and B-Chains:

For convenience in defining responsibilities for system specification and alignment, the playback chain is customarily broken down into the A-chain and the B-chain, as shown in [Figure 4](#). The A-chain is comprised of the preamplifiers (optical or magnetic), light source (optical), magnetic heads, solar cells (optical), associated equalization (signal de-emphasis), and noise reduction and directional decoding required for flat electrical output at the end of that chain. For digital reproduction, a digital optical reader is used and the digital signal is fed to a digital-to-analog conversion system. The analog A-chain is shown in [Figure 4A](#), and the digital A-chain is shown at [4B](#) and [4C](#). The B-chain, including split surround channels and subwoofer channel, is shown at [4D](#).

The B-chain is comprised of one-third-octave equalization, dividing networks (low- or high-level), power amplification, and loudspeakers. JBL Professional products are used extensively in the B-chain of the system.



Peak power levels - (A) A-type, (B) SR, (C) SR-D
 Figure 4: Analog A-chain (A); Digital A-chain, Dolby SR-D (B); Digital B-chain, DTS (C);
 Block diagram of B-chain with split surrounds (D); Dynamic range requirements for Dolby
 A, Dolby SR and and Dolby Digital formats (E)

D. Evolving Dynamic Range Requirements in the Cinema:

Figure 4E shows details of the headroom capabilities of cinema sound formats. The reference level of dialog in the cinema is 85 dB-A, while added headroom is used primarily for more realistic peak levels for sound effects and music. Depending on specific signal content, the peak level capability of Dolby SR analog tracks can be 3 dB greater in the mid-band than with Dolby A, rising to about 9 dB at the frequency extremes. The digital formats can provide 12 dB headroom relative to Dolby A, with overall characteristics that are flat over the frequency band.

All digital formats are adjusted in the cinema so that a digital signal level of -20 dBFS (level relative to full scale) will produce a sound pressure level at a distance two-thirds back in the house of 85 dB. This will then allow a full-scale level of 105 dB, per channel two-thirds back in the house.

E. Integration of Loudspeakers into the Acoustical Environment:

The motion picture industry made the transition from old-style loudspeaker systems to the newer flat power response systems during the early 1980s. The new systems could easily be matched to existing cinemas inasmuch as both on-axis response and total power response were essentially flat, since they made use of uniform coverage high frequency horns and simple ported LF enclosures. Like their predecessors, the new systems were two-way in design.

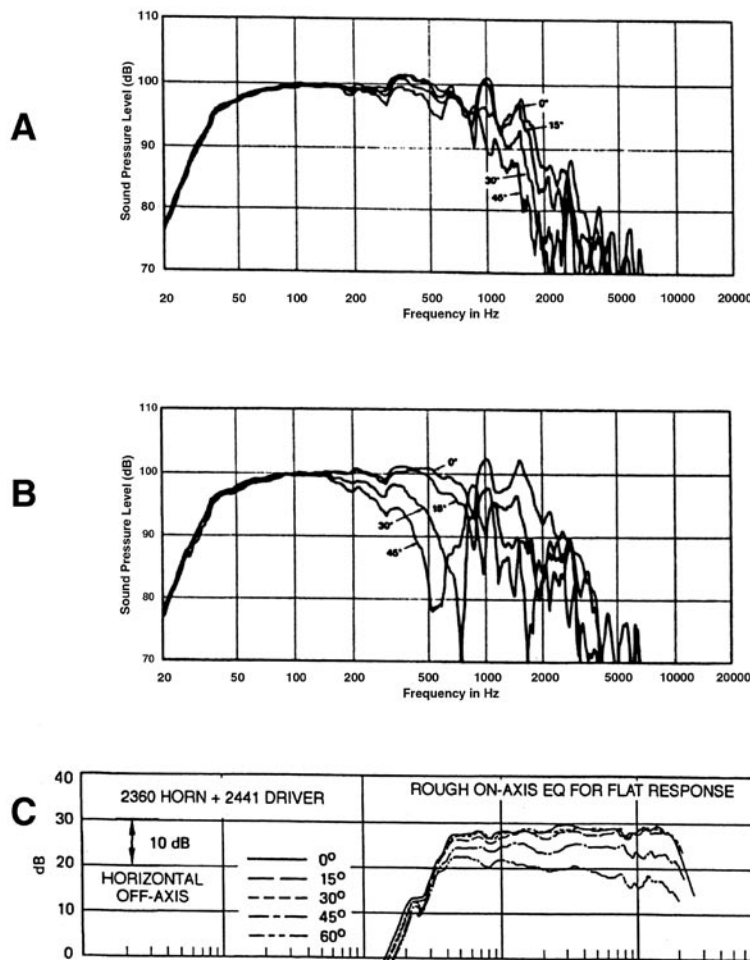


Figure 5: Off-axis characteristics of ported LF systems and Bi-Radial horns. Horizontal off-axis response of 4648A (A); vertical off-axis response of 4648A (B); horizontal off-axis response of 2360 horn/driver equalized for flat power response (C)

With the coming of digital sound tracks during the early 1990's, the need was felt for greater power output capability with even lower distortion. The answer here was to be found in newly engineered three-way systems.

F. Power Response and Power-Flat Systems:

The discrepancy between on-axis and reverberant room response in the older systems was solved with the introduction of a new family of systems based on uniform coverage high-frequency horns and straightforward ported low-frequency enclosures. Figure 5A shows the horizontal off-axis response of the JBL 4648A low-frequency system. Note that the response is uniform below 500 Hz over a wide angle. At 5B we show the vertical off-axis response of the 4648A system. Note that the response begins to narrow just below 200 Hz. The net result of this pattern narrowing in the horizontal and vertical planes is that they make a good match for the pattern control of the JBL 2360B horn at the normal crossover frequency of 500 Hz.

Figure 5C shows the off-axis response curves for the 2360 Bi-Radial[®] horn, coupled to a JBL 2446 high-frequency driver which has been equalized for flat power response. Note that the off-axis curves are essentially parallel, indicating that the horn produces a solid radiation angle which is uniform with respect

to frequency. The need for equalization of the compression driver comes as a result of the natural high frequency roll-off, which occurs in high frequency drivers above about 3.5 kHz. This frequency is known as the mass break point and is a function of diaphragm mass and various electrical and magnetic constants in the design of all compression drivers.

When the 4648A or 4638 low-frequency system and the 2360/2446 combination are integrated into a full range system for cinema use, the -6 dB beamwidth above 500 Hz is smoothly maintained at 90° in the horizontal plane and 40° in the vertical plane out to 12.5 kHz. At lower frequencies, the system’s coverage broadens, eventually becoming essentially omnidirectional in the range below 100 Hz.

When the system described above is equalized in a typical cinema environment, both direct sound and reverberant sound can be maintained quite smoothly, as shown in [Figure 6A](#). The system’s reverberant response is proportional to its power output, or to its power response, and the matching of the system’s on-axis and power response indicate that the reflected sound field in the cinema will have the same spectral characteristics as the direct sound from the loudspeaker. When this condition exists, sound reproduction, especially dialog, will sound extremely natural. The frequency response contour shown in [Figure 6B](#) is the so-called X-curve recommended for cinema equalization, as specified in ISO Document 2969.

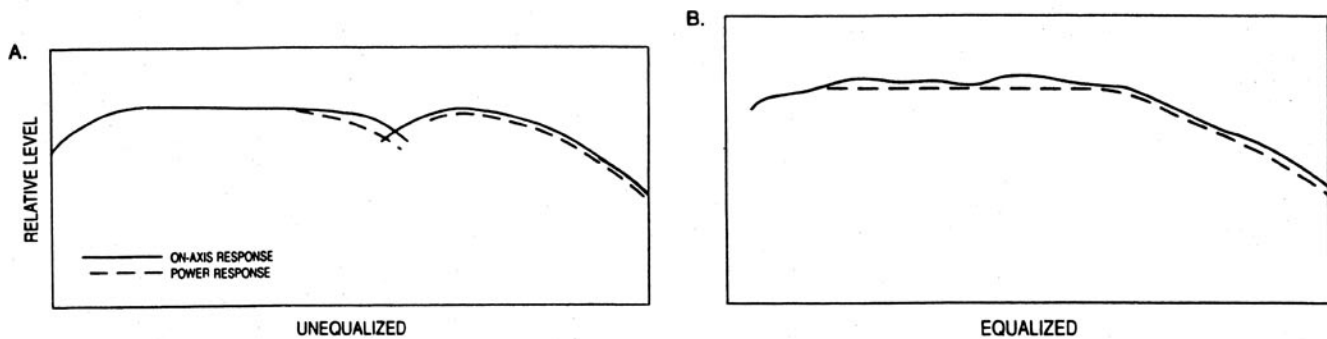


Figure 6: Cinema equalization of power-flat systems. Unequalized system (A); equalized to match ISO 2969 “X” curve standard (B)

JBL pioneered the concept of flat power response in the cinema (2, 3). It has become the guiding principle in much of JBL’s product design, and it has been adopted by the industry at large.

G. Coverage Requirements for Proper Stereo Reproduction:

In the cinema, it is expected that all patrons will be able to appreciate convincing stereo reproduction. By contrast, standard two-channel stereo in the home environment often imposes strict limitations on where the listener must sit in order to perceive correct stereo imaging. The factor that makes the big difference in the cinema is the presence of the center channel. Not only does the center loudspeaker lock dialog into the center of the screen, it further reduces the amount of common mode information the left and right channels must carry, thus making it possible for listeners far from the axis of symmetry to hear the three channels with no ambiguity or tendency for the signal to “collapse” toward the nearer loudspeaker. In the Dolby stereo matrix, the same convincing effect is largely maintained through gain coefficient manipulation during playback.

Ideally, each patron in the house should be within the nominal horizontal and vertical coverage angles of all the high-frequency horns. This requirement can usually be met by using horns with a nominal 90° horizontal dispersion and by toeing in the left and right screen loudspeakers. In very wide houses, the spreading of high frequencies above approximately 5 kHz, as they pass through the screen at high off-axis angles, actually helps in providing the desired coverage.

Another desirable condition is maintaining levels as uniformly as possible throughout the house. We have found that aiming the screen system’s mid and high frequency horns toward the seating area at a point two-thirds back in the house helps in this regard, by offsetting normal inverse square losses with the on-axis “gain” of the screen systems. Measurements made at the Goldwyn Theater of the Academy of Motion Picture Arts and Sciences in Beverly Hills, California, show that, over most of the frequency range, front-to-back levels in the house are maintained within ± 4 dB.

This performance is seen in Figure 7. At 7A we show in plan view the direct field coverage given by the center channel JBL 5674 system aimed at the audience approximately two-thirds from front to back, with coverage at 2 kHz maintained within a range of ± 4 dB overall. A side section view of the theater is shown at 7B. Figure 7C shows similar coverage in a large stadium cinema with the center channel aimed at the audience approximately two-thirds from front to back. A side section view of the stadium theater is shown at 7D. Typical response in the Goldwyn Theatre is shown at 7E.

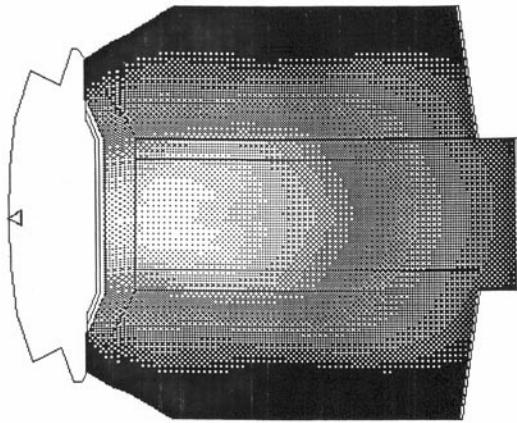


Figure 7A

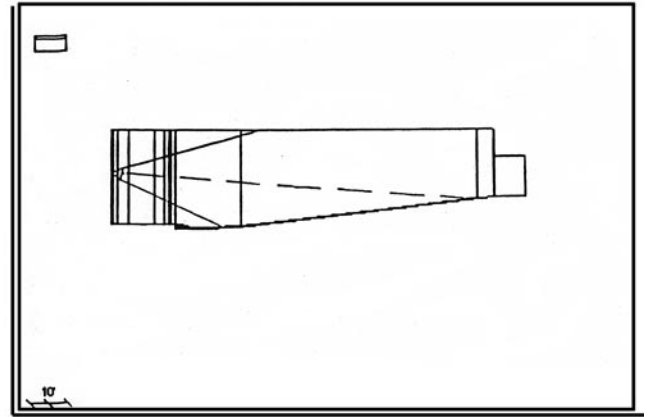
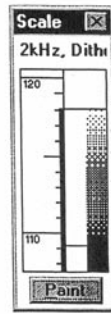


Figure 7B

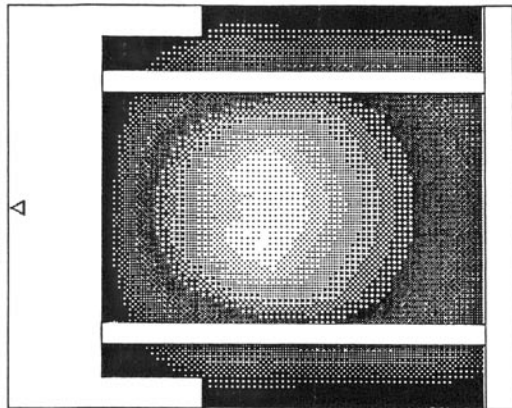


Figure 7C

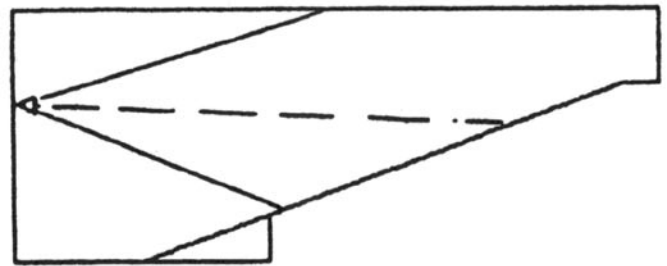
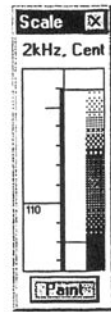


Figure 7D

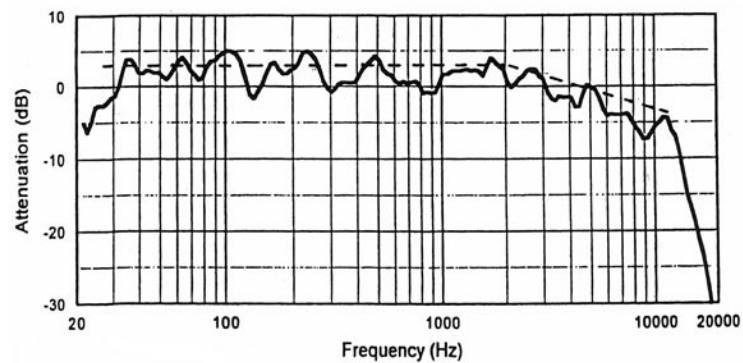


Figure 7E

Figure 7: Center channel coverage in traditional and in stadium cinemas. Computer acoustical modeling plot at 2 kHz in traditional house (A); center section view (B); Computer acoustical modeling plot at 2 kHz in stadium house (C); center section view (D); typical frequency response at 2/3 position in traditional house (E)

The surround ensemble of loudspeakers, if properly specified, can easily produce a sound field that is uniform throughout the back two-thirds of the house, and level variations can often be held within a range of 2 to 3 dB. Details of surround system specification will be covered in a later section.

When all of the above points are properly addressed, the sound in a cinema can approach that which we take for granted in a post-production screening facility — which is, after all, how the picture director intended it to sound. It is only when such details as these have been carefully worked out that the effects intended by the sound mixer can be appreciated by the viewing audience.

III. ACOUSTICAL CONSIDERATIONS

A. Noise Criterion (NC) Requirements:

The usual sources of noise in a cinema, outside of the patrons themselves, are air handling and transmission of noise from the outside. In the case of multiplex installations, there can be leakage from adjacent cinemas as well. Not much can be done about a noisy audience, but it is true that at the post-production stage, mixing engineers take into account certain masking noise levels which may be encountered in the field and may even make the final mix under simulated noisy conditions (5).

Acoustical engineers make use of what are called Noise Criterion (NC) curves in attempting to set a noise performance goal for cinemas. The octave band values of these curves are shown in Figure 8. In implementing this data, the acoustical designer settles on a given criterion and then determines the cost and other factors involved in realizing it. Low-noise air handling requires large ductwork and is expensive. Even more likely to be a problem is

through-the-wall isolation from adjacent cinemas.

The general recommendation made by Lucasfilm (6)

is that interference from adjacent cinemas should be audible no more than 1% of the time. Considering that NC-30 may represent a typical air conditioning noise level for a cinema, the desired degree of isolation between adjacent spaces does not represent a financial hardship in terms of wall construction. The need for improving NC standards in cinemas is a natural consequence of better recording technology and is the only way that the capabilities and benefits of digital sound can be fully appreciated.

As an example of what may be required, let us assume that the normal maximum levels in a multiplex cinema are 95 dB-SPL, with levels exceeding this value only about 1% of the time. It is clear that the isolation from an adjacent cinema must be on the order of 65 dB if the NC-30 criterion is to be met, and this will call for a wall structure that will satisfy a Sound Transmission Class (STC) of 65 dB. There are a number of double wall, or single concrete block wall, constructions that will satisfy this requirement, and economic considerations usually take over at this point. Acoustical engineers and consultants are usually on firm scientific ground in these matters. Typical standard STC curves are shown in Figure 9.

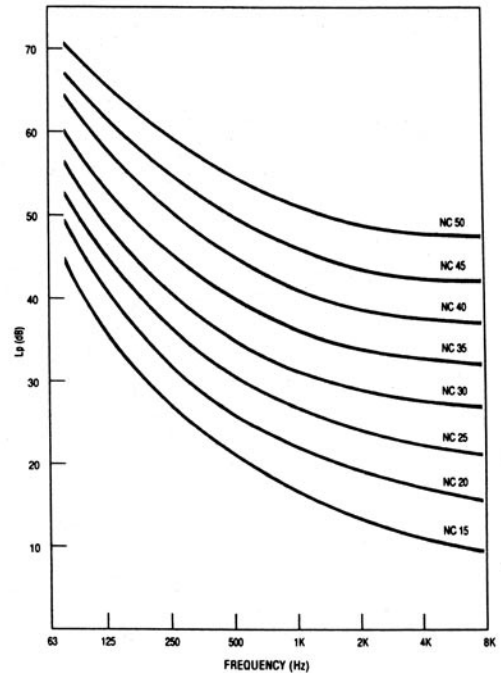


Figure 8: Noise Criterion (NC) curves, octave band data

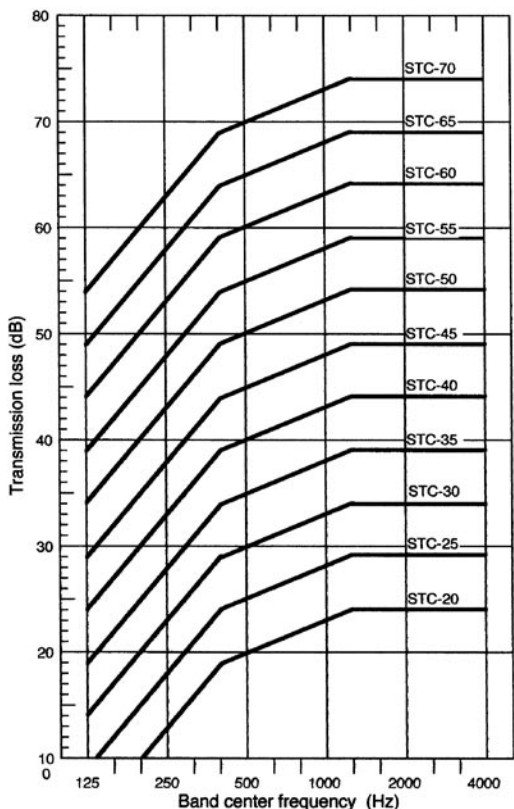


Figure 9: Sound Transmission Curves (STC)

The isolation task is certainly easier with new construction, since buffer areas can be designed between adjacent exhibition spaces. The most difficult problems occur when older spaces are to be subdivided to make multiplex cinemas, inasmuch as the chances of coupling through walls or through common air handling are compounded.

It is obvious that the architect must work closely with an acoustical engineer if the job of isolating adjacent spaces is to be done correctly. All of this yields to straightforward analysis, but the job is often a tedious one.

B. Control of Reverberation and Discrete Reflections:

After the problems of sound isolation have been addressed, the acoustical engineer then turns to those problems that are generated entirely within the cinema itself, reverberation and echoes. The acoustical “signature” of a cinema should be neutral. Reverberation per se is not generally apparent in most houses, and any perceived sense of reverberation or ambience during film exhibition normally comes as a result of surround channel program content.

This is not to say that the cinema environment should be absolutely reflection free. Strong initial reflections from the sides of the house may be beneficial in a concert hall, where they are needed to produce a sense of natural acoustical space; however, in the cinema pronounced initial reflections from any direction should be eliminated.

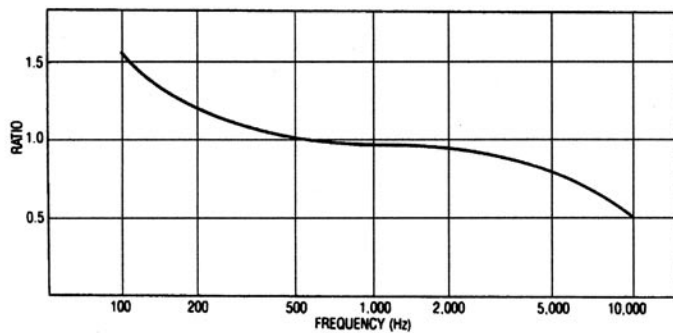


Figure 10: Variation of reverberation time with frequency relative to the value at 500 Hz

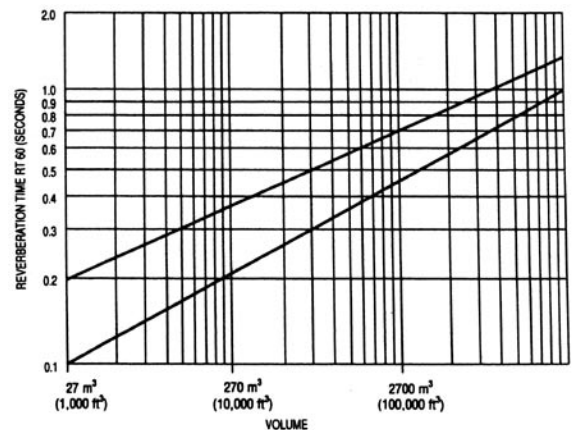


Figure 11: Suggested range of cinema reverberation time at 500 Hz as a function of room volume

Traditionally, reverberation time in auditoriums increases at low frequencies and decreases at high frequencies. This is a natural consequence of the fact that many surfaces that are absorptive at middle and high frequencies are not very effective sound absorbers at low frequencies. At higher frequencies, there is additional absorption due to the air itself, and this excess attenuation of high frequencies tends to lower the reverberation time. [Figure 10](#) shows the normal range of reverberation time, as a function of the value at 500 Hz, while [Figure 11](#) shows the acceptable range of reverberation time at 500 Hz as a function of room volume.

The requirements of specifying the right finishing materials for wall surfaces, along with any special needs for added low-frequency absorption, fall squarely in the hands of the acoustical designer. In smaller houses, there is often little choice but to make the space acoustically “dead;” however, a slight degree of reflectivity, even though it may not be easily perceived as such, will be beneficial. The important factor here is that any echoes, which may exist, should be some 10 dB below the direct sound.

Discrete reflections are likely to be a problem only if they clearly are displaced from the direct sound in both time and spatial orientation. The listener usually perceives sidewall reflections well within a time interval which does not allow them to be heard as such. However, a reflection off the back wall can rebound from the screen itself, creating a “round trip” echo that may be delayed by as much as 100 milliseconds. The effect here is to render dialog difficult to understand. In older cinemas with balconies, such reflections were often generated by the balcony front (or fascia) itself. Substantial acoustical damping had to be placed on that surface in order to diminish the problem.

In most cinemas constructed today, echo problems can generally be dealt with by ensuring that the back wall is very absorptive and that substantial damping is installed behind the screen on the baffle-wall.

C. The Role of the Acoustical Consultant:

An acoustical consultant should be chosen on the basis of previous jobs well done. There is much that is learned simply by having encountered — and solved — many problems. Stating it another way, an experienced consultant has probably seen most of the common mistakes and knows how to spot them before they become problems. While much of what a consultant does may seem obvious, and even simple, it is the breadth of experience that qualifies a good consultant to take on a difficult task and succeed at it.

In addition to the points discussed so far in this section, the consultant will look for potential difficulties in the following areas:

1. Flanking leakage paths. When acoustical isolation has been addressed in wall construction, flanking paths through, or around, the wall may become significant. For example, sound often leaks through electrical or air conditioning conduit, even though the wall itself may act as a good barrier to sound transmission. Such paths can crop up in many places and need to be identified early in the construction phase of the project.
2. Integrity in construction. Many building contractors routinely take shortcuts, and somebody needs to watch them carefully. The acoustical isolation of double wall construction can be nullified by the presence of material left between them bridging the air barrier between the two sections.
3. Impact and structure-borne noise. These are some of the most difficult problems to fix, since they are literally “built in.” Plumbing noises, elevator motors, and air handling machinery located on the roof are just a few of the offenders here. Once the installation has been made, the problem is very expensive to correct, and a good consultant will have an eye out for such things at the design stage of the project. Related problems, such as projector noise and other noises associated with concession activities need to be identified early in the project and corrected before construction begins.

As standards for film exhibition continue to improve, such points as we have raised here will become more important. Loan Allen of Dolby Laboratories has stressed the need for noise ratings in the cinema lower than NC-25, with NC-30 representing the worst acceptable case (7).

IV. SPECIFYING THE CORRECT LOUDSPEAKERS AND AMPLIFIERS

A. Hardware Class vs. Room Size:

JBL has cinema loudspeaker product groups that fall into three basic categories:

The 3000 Series is a lower cost line for use in small to medium cinemas. The series now includes the 3622N and 3632 ScreenArray systems.

The 4000 Series includes JBL's traditional line of cinema products, which have been the standard of the industry for fifteen years. The series now includes the 4622 and 4632 ScreenArray systems.

The 5000 Series consists of 3-way high performance, low distortion systems intended for use in critical motion picture creative environments and in showcase theaters around the world.

Specifying loudspeakers and amplifiers for cinemas is a straightforward design problem. Some years ago, a survey of modern cinemas found relatively few major variations in the design parameters. The average room volume per seat is about 5.6 cubic meters (200 cubic feet), and this leads to a method of determining average room dimensions for theaters of various sizes (Data courtesy of THX® Division of Lucasfilm, Ltd.) Furthermore, the reverberation time in modern theaters is so low that considerations of so-called “room gain,” or reverberant field contribution at middle and higher frequencies, in determining reproduced levels at various distances from screen

loudspeakers is not justified. We will therefore use inverse square calculations in determining loudspeaker levels in the cinema. Because of their frequency range and low directivity, subwoofer calculations can be made taking into account total room volume.

Guidelines for digital films state that full modulation of a digital sound track should be capable of producing, per screen channel, peak levels of 105 dB SPL at a distance approximately two-thirds the depth of the house. The following table gives average dimensions for houses of various seating capacities:

Seating:	Room Volume:	Two-thirds Distance: (front-to-back)
75-125	695 m ³ (25,000 cu ft)	12.0 meters (40 feet)
125-250	1390 m ³ (50,000 cu ft)	14.2 meters (47 feet)
250-500	2780 m ³ (100,000 cu ft)	16.4 meters (54 feet)
500-1000	5560 m ³ (200,000 cu ft)	18.0 meters (60 feet)

We will now consider the peak output capability of the 3000 and 4000 Series screen loudspeakers in these four environments:

Model:	Sensitivity: (1W@1m)	Rated Power:	Maximum continuous level (dB) at:				
			1 m:	12 m:	14.2 m:	16.4 m:	18 m:
3622N	101 dB	400 W	127	105.4	104	103	102
3632	104 dB	500 W	131	109.4	108	107	106
3678	98 dB	300 W	123	101.4	100	99	98
4622	101 dB	600 W	129	107.4	106	105	104
4632	106 dB	800 W	135	113.4	112	111	110
4670D	100 dB	600 W	128	106.4	105	104	103
4675C	100 dB	600 W	128	106.4	105	104	103

When all three screen channels are running at full modulation, the loudspeaker output level will be approximately 5 dB greater than for a single channel. As we can see from Table 1B, the models 3622N and 3678 can deliver the required total output in rooms up to 50,000 cubic feet (200 to 250 patrons) when driven with rated power, but should not be specified for larger spaces.

Both 4670D and 4675C models can handle the largest spaces listed here with no problem at all. In fact, a single screen channel is capable of delivering 105 dB at the required distance in the 250-seat house. JBL recommends driving these models with amplifiers equal to their rated power, regardless of the application.

We will now consider the maximum output capability of the 4675C-4(8)LF system in biamplified mode, taking into account the 6 dB crest factor of the test signal. This is the absolute peak output capability of the system:

JBL recommends that the 4675C-4(8)LF system be used in biamplified mode in cinemas seating 500 or more patrons.

Sensitivity (1W@1 m)	Rated Power	Maximum level (dB) at:				
		1 m:	12 m:	14.2 m:	16.4 m:	18 m:
100 dB	1200 W (LF)	130.8	109	107.7	106.5	105.7

The 5000 Series three-way loudspeakers were developed over an intensive two year period, with much of the later work done at the Academy of Motion Picture Arts and Sciences, in Beverly Hills, California, with technical input from the Academy Theater Standards Committee, which includes many of Hollywood's leading studio sound personnel. The aim was to produce a new state of the art design that could truly do justice to digital sound tracks, with their demanding effects and virtually flat power bandwidth. The advantage of the three-way systems is the reduction in distortion which the three-way concept affords through splitting the overall acoustical load over multiple elements, use of multi-amplification and digital control, and the use of rapid-flare drivers and horns for significant improvements in high frequency distortion.

Table 1D. Output capability of the 5000 Series Loudspeakers:							
Model:	Sensitivity:	Rated Power:	Maximum level (dB) at: (1W @ 1m)				
			1 m:	12 m:	14.2 m:	16.4 m:	18 m:
5671	97	600 W	124.8	103	101.7	100.5	99.7
5672	100	1200 W	130.8	109	107.7	106.5	105.7
5674	103	2400 W	136.6	115	113.7	112.5	111.7

B. Cinema Playback Level Calibration:

The actual level requirements on the filmmaker's dubbing stage are established by relating them directly with modulation level on the recorded medium. For magnetic media, this is established as 85 dB-SPL in the house when the modulation on the track is so-called zero level, or 185 nanowebers/meter. This last quantity has to do with recording technology, and we need not concern ourselves with it further, except to note that modulation peaks often exceed zero level by 8 to 10 dB. Thus, the peak output per loudspeaker may be only 95 dB. Good engineering practice allows additional headroom of 6 to 8 dB above this, so it is clear that the values we have listed in Tables 1A through 1D are not excessive in the cases of the larger houses. In the smaller houses, we can certainly use smaller amplifiers than indicated in the table; but even then, the cost of the added power is very slight, while the benefit is substantial. The amplifier output powers recommended in Tables 1A through 1D are in accordance with the suggestions made by Lucasfilm Ltd. (5) in the specification of THX® systems.

C. JBL Driver Developments:

Our studies have indicated that, in passive systems, maximum power input to the screen loudspeakers is essentially network limited. As a result of this, many cinema applications ordinarily will not require the high power Vented Gap Cooling (VGC™) performance designed into the 2226 driver. A more recent model, the 2035, was subsequently designed with a 76 mm voice coil, retaining the same sensitivity of the 2226. Resulting economies can thus be passed on to the user.

In biamplified systems for larger houses we strongly recommend that the 2226 LF transducers be used, because of their higher peak power and transient capabilities.

Figure 12 shows the horizontal off-axis response of the dual low frequency 4638 system, which incorporates two of the 2035 transducers.

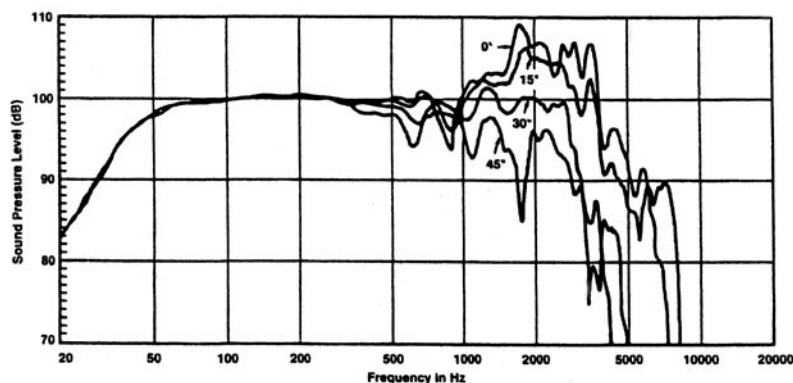


Figure 12: Horizontal-axis response of JBL 4638 LF system

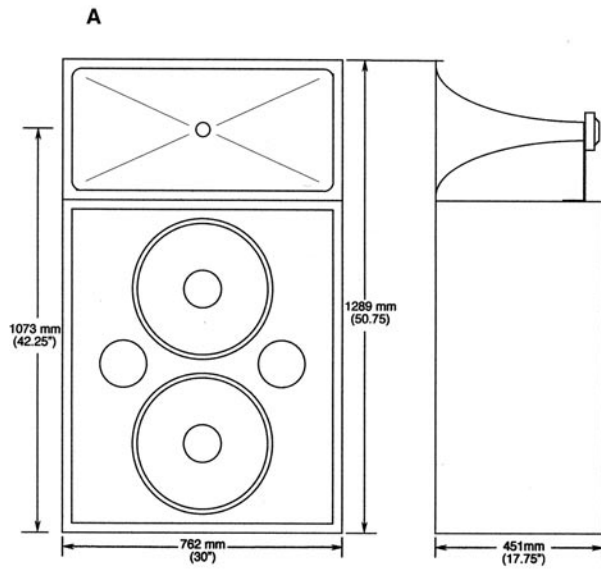


Figure 13: Drawings of 3000 Series screen systems. Front and side drawings of 3622N (A) and 3678 (B)

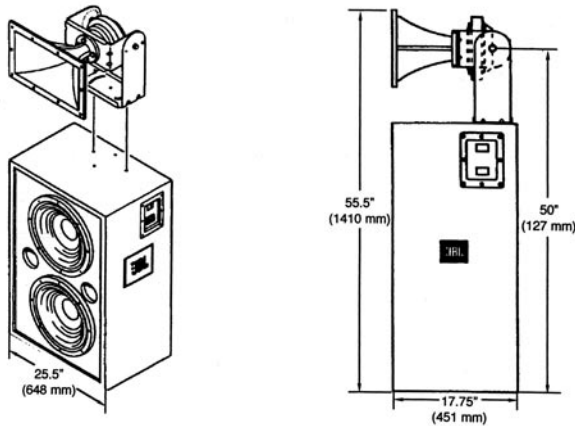


Figure 14: 4000 Series screen systems. Perspective and side drawings of 4670D

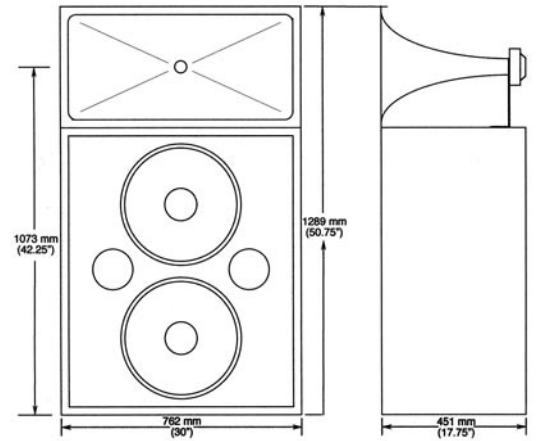


Figure 15: Drawings of 4000 Series screen systems. Front and side drawings of 4622N

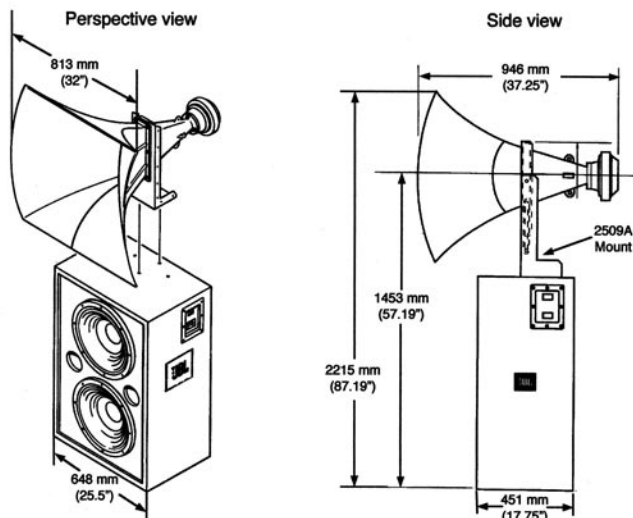


Figure 16: 4000 Series screen systems. Perspective and side drawings of 4675

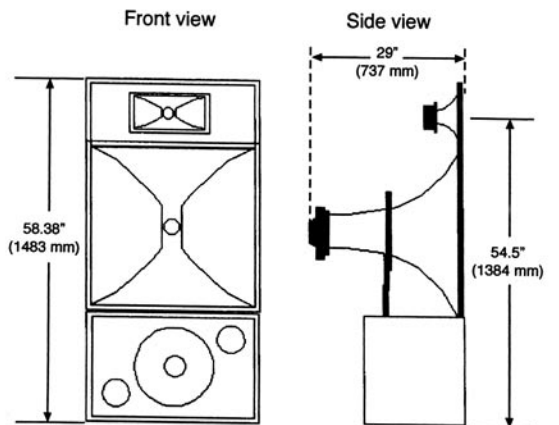


Figure 17: Model 5671 screen system, front and side views

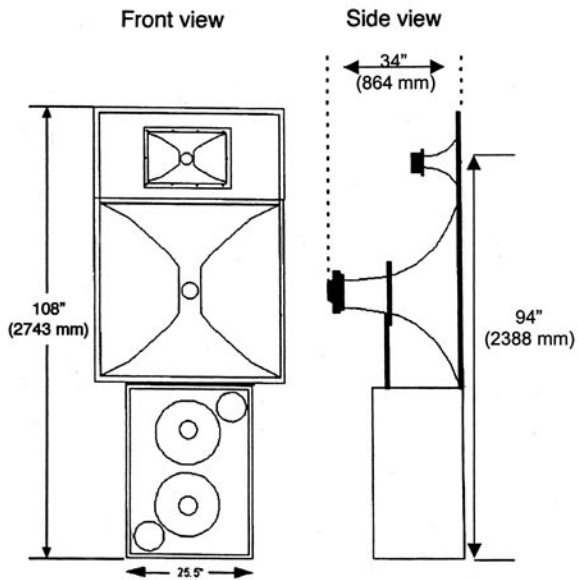


Figure 18: 5672 screen system, front and side views.

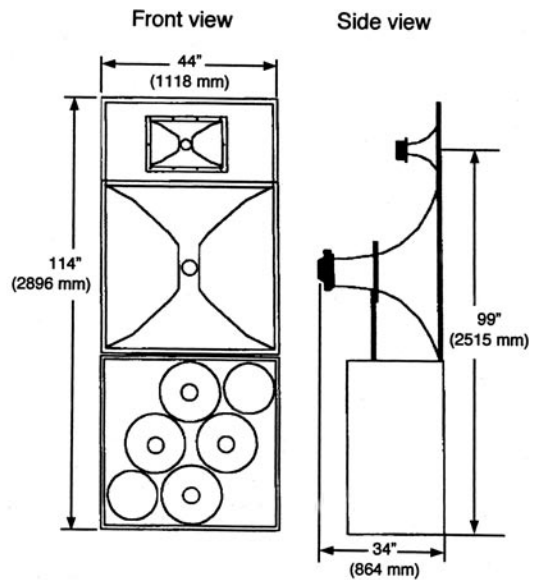


Figure 19: 5674 screen system, front and side views.

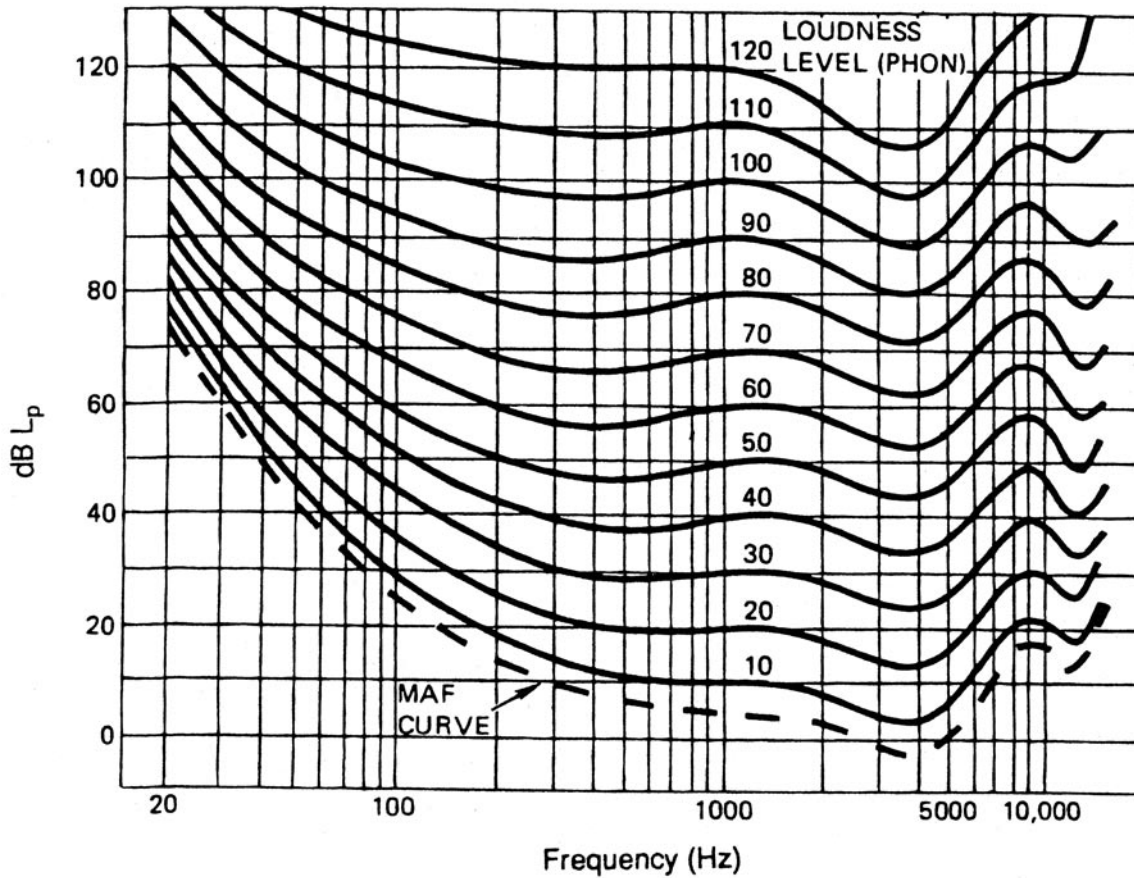


Figure 20: Robinson-Dadson equal loudness contours.

D. Mechanical Details of JBL Screen Loudspeaker Systems:

Most JBL screen channel systems are intended for field assembly, and instructions for their assembly are contained in the shipment. Here, we will show assembled and dimensioned line drawings in front and side views so that the user can determine the actual space requirements behind the screen. The height from base to the center of the HF or MF horn is also given as a guide to determining vertical positioning so that the horn will be approximately at 2/3 the height of the screen.

Figure 13A and B shows front and side views, of the 3622N and 3678 systems. The model 4670D is shown in Figure 14. Figure 15 shows front and side views of the 4622N passive system. The model 4675C is shown in Figure 16. Figures 17, 18, and 19 show the large three-way models 5671, 5672, and 5674, respectively. Figure 27 shows the 4632 and 3632 ScreenArray models.

E. Subwoofers:

Subwoofers are an integral part of cinema loudspeaker systems installed in mid and large size houses. In specifying them, the designer must take into account the reduced sensitivity of the ear to low frequency sounds. Figure 20 shows the Robinson-Dadson equal loudness contours. Note that, for a reference level of 85 dB at 1 kHz, frequencies in the range of 30 to 40 Hz will have to be reproduced 15 to 20 dB louder in order to be perceived at the same subjective level.

Because of the relative non-directionality of very low frequencies, the number of subwoofers specified for a given cinema must bear some relationship to the total volume in the space. JBL's experience in specifying subwoofer units has led us to the following empirical recommendations:

1. For each 5,666 cubic meters (25,000 cu ft), specify one 2241 or 2242 transducer in a suitable enclosure.
2. All systems should be mounted in very close proximity to one another in order to maximize mutual coupling among them.
3. All subwoofer systems should be mounted at the base of the screen, preferably hard up against the screen wall and the floor. This boundary condition is known as a "quarter-space," or "1-pi" mounting, and this will further increase the output of the subwoofers at very low frequencies. When specified in this manner, the entire subwoofer array should be capable of generating low frequency sound pressure levels in the range of 110 to 115 dB in the 40 Hz range. (See mounting details in Section V-C.)

Figure 21 shows mechanical views of the JBL 4645C. Each subwoofer unit should be driven with its own amplifier capable of producing up to 800 continuous watts of sine wave power into a rated impedance of 8 ohms.

Figure 22 shows views of the model 4641 subwoofer, which has a single 2241H driver rated at 600 watts continuous. A pair of subwoofer modules can be driven by a single stereo amplifier that is capable of producing continuous sine wave power of 600 watts into each of two 8-ohm loads. The model 4642A is shown in Figure 23 and contains a pair of 2241H drivers, each brought out to its own pair of terminals.

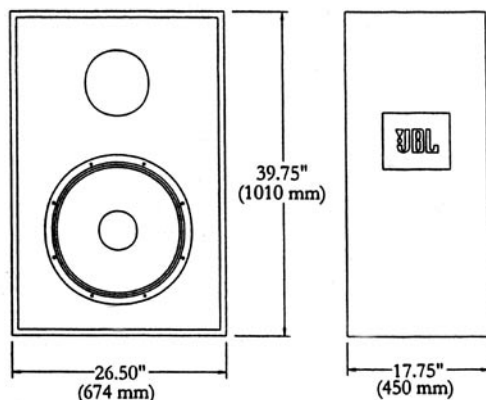


Figure 21: Front and side drawings of 4645C subwoofer

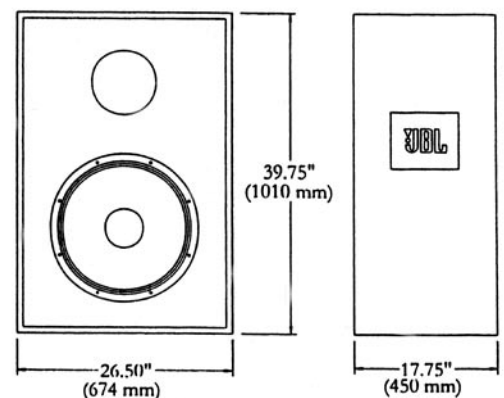


Figure 22: Front and side drawings of 4641 subwoofer

Figure 24 shows mechanical views of the 3635 subwoofer, which is intended for use with the other models in the 3000 Series product group. The 3635 subwoofer has a useful lower frequency limit of 28 Hz (- 3 dB), as compared to 18 Hz for the 4645C. The power rating of the 3635 subwoofer is 300 watts, as compared to 800 watts for the 4645C. One is clearly not a substitute for the other, so specify accordingly. The 3635 is intended for use only in small room applications with the other members of the 3000 Series family.

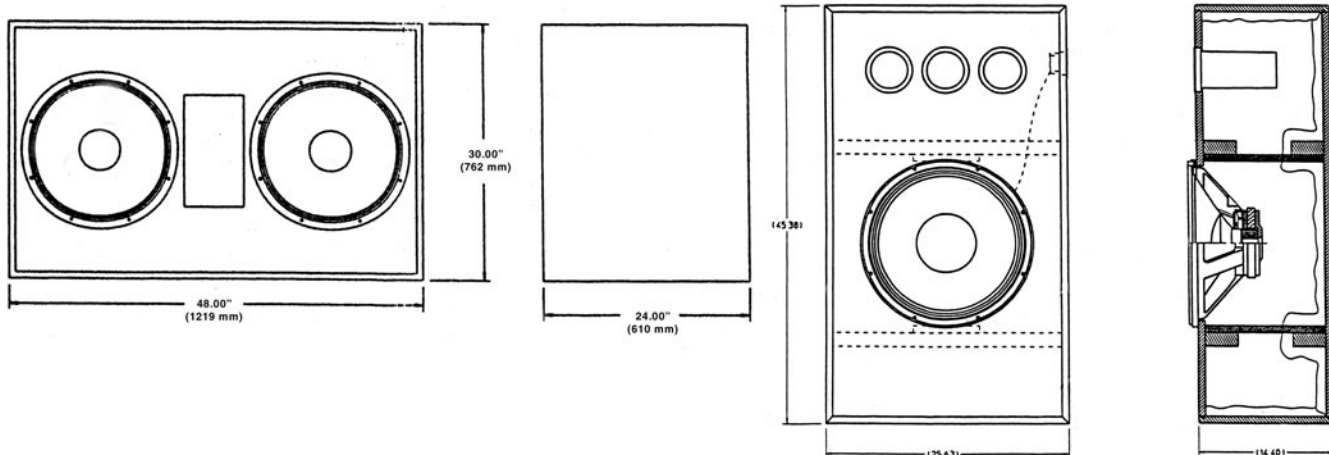


Figure 23: Front and side drawings of 4642A subwoofer.

Figure 24: Front and side drawings of the 3635 subwoofer.

F. Surround Requirements:

As a general rule, the total ensemble of surround loudspeakers should be capable of producing as much acoustical power as a single screen channel. Today, the JBL 8340A surround loudspeaker is capable of producing total acoustical power output in the range of about 2 acoustical watts. Since a typical dual woofer JBL screen loudspeaker is capable of producing continuous acoustic power output of 28 watts, it is clear that 14 of the 8340A's will be required for power matching. Typically, in a large house, 12 to 16 units will suffice. The careful designer should not specify less than this quantity. In smaller houses a similar quantity of 8330A's may be specified. The 3310 surround is normally specified in smaller spaces as a complement to the other systems in the 3000 Series. The specific arraying of surround loudspeakers will be covered in Section V-C.

Several views of the surround models 8330A, 8340A are shown in Figure 25A and 3310 are shown in Figure 25B.

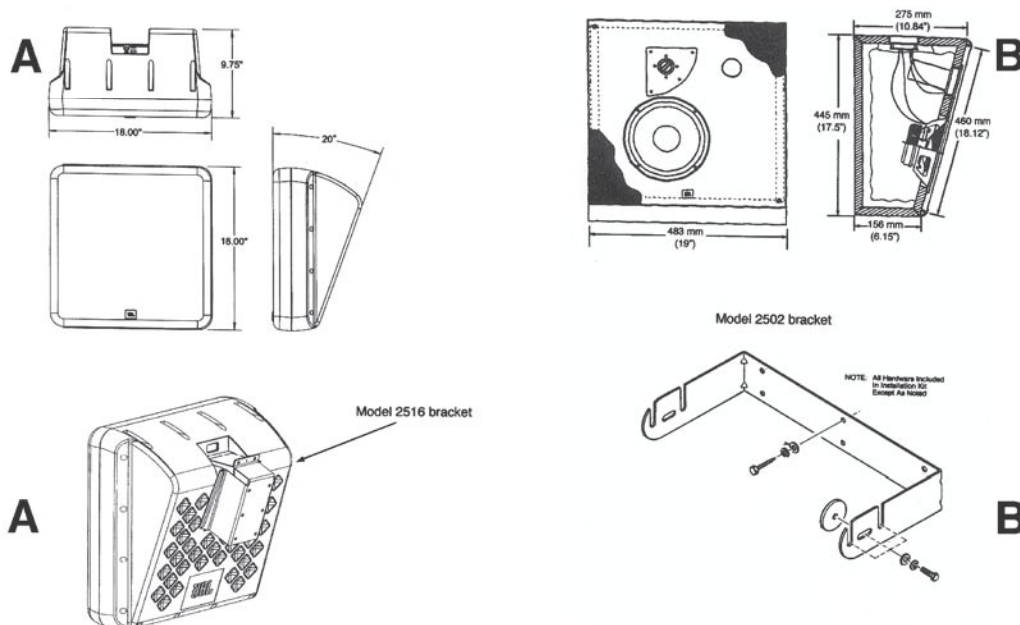


Figure 25A: Front and side drawings of JBL surround loudspeakers. 8330A and 8340A (A); 3310 and 2502 bracket (B).

G. Screen Losses:

Through-the-screen losses are complex to analyze in detail. The on-axis loss is approximately a 6 dB/octave rolloff commencing at about 5 kHz. However, off-axis response is quite different. At certain angles, high frequencies are transmitted through the screen with relatively little loss. When an on-axis HF boost is applied to the signal for proper system response on-axis, patrons seated toward the sides (off-axis) will hear more HF than those listeners on-axis. This, coupled with the normal off-axis fall-off of the horn's response, tends to maintain a good balance of high and mid frequency program and enables patrons seated to the sides to enjoy good dialog intelligibility. The patented technology of Screen Spreading Compensation in the JBL ScreenArray models compensate for the high frequency energy loss of screen.

From a design viewpoint, the engineer must ensure that there is adequate electrical headroom in the high frequency drivers to attain flat power response above 3 kHz. This usually requires that the signal be boosted 6 dB/octave above 3 kHz, and this requires that the drive level at 12 kHz will be 10 to 12 dB greater than at mid frequencies. A driver must be specified that can handle this increased input — and at the same time be able to provide a good match with the low frequency system. All JBL cinema systems have been engineered with this requirement in mind.

In mid-size screening rooms there is less air loss to deal with, and it is often the case that no more than a 10 dB boost is required to meet the equalization requirements above 10 kHz. Many conservative engineers feel that a 10 dB boost should never be exceeded.

H. JBL's New ScreenArray Loudspeaker Systems:

The ScreenArray series consists of two new 2-way and two new 3-way systems that bring significant improvements to mid-size cinemas and embody the following characteristics:

1. Shallow design. Intended for use in theaters with limited space behind the screen
2. Low distortion high frequency section using Progressive Transition™ Waveguides
3. SSC™ Screen Spreading Compensation to take advantage of the screen's transmission characteristics in maintaining uniform high frequency coverage throughout the cinema
4. Focused Coverage Technology™ to maintain absolutely uniform midrange coverage in the cinema

Figure 26A and B show front and side views of the model 4632. This model is intended for use in cinemas seating up to 500 patrons. Figure 26C and D show front and side views of the model 3632, which is intended for use in cinemas seating up to 300 patrons.

The remarkable axial frequency response, beamwidth and directivity of the 4632 are shown in Figure 27A, B and C. Equivalent data for the 3632 are shown in Figure 27D, E and F.

The model 3632 and 4632 must be operated in biamped mode. The 3632T and 4632T are operated in triamped mode for THX® certified installations.

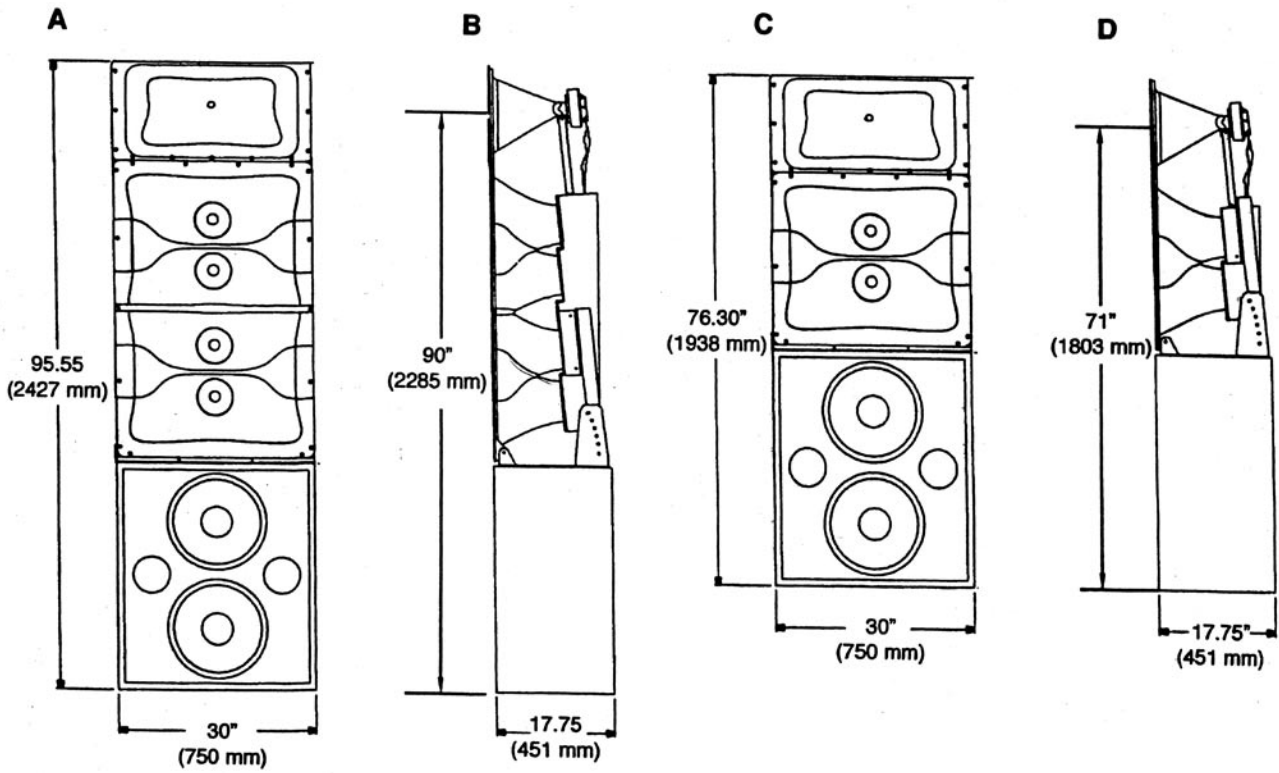


Figure 26: ScreenArray loudspeakers. Front (A) and side (B) views of model 4632; front (C) and side (D) views of model 3632.

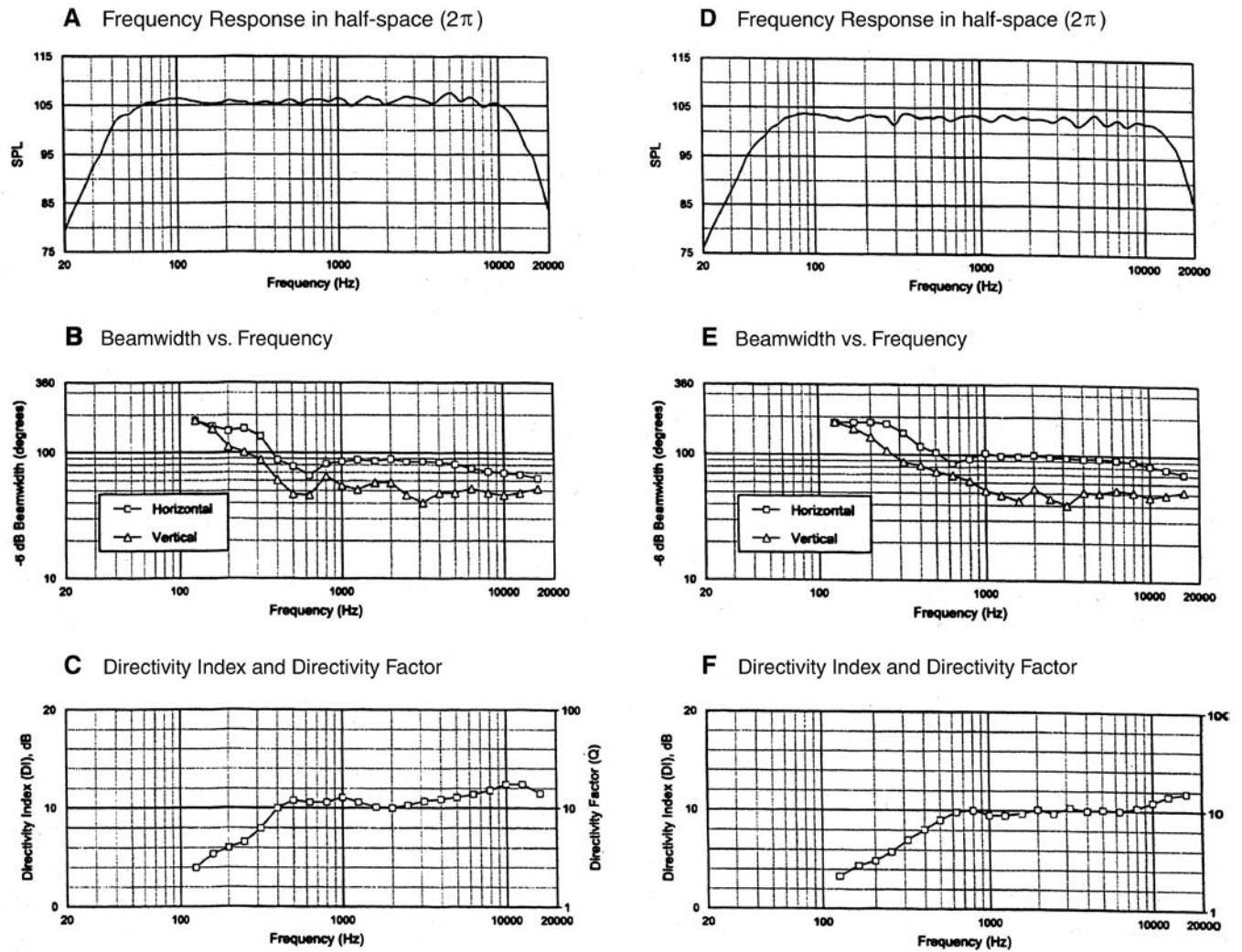


Figure 27: Performance of ScreenArray loudspeakers. Axial response (A), beamwidth (B) and directivity (C) of model 4632; axial response (D), beamwidth (E) and directivity (F) of model 3632.

V. MOUNTING REQUIREMENTS

A. General Comments:

The following rules generally apply to screen loudspeakers:

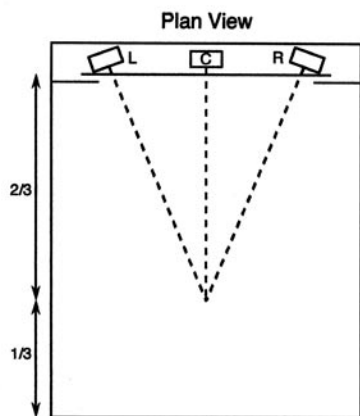
1. They should be positioned vertically so that the horns are about two-thirds the height of the screen.
2. They should be placed so that the horn flanges are within a distance of 5 to 7 cm (2 to 3 in) of the screen.
3. All reflective details, such as logos and polished transducer frames, should be painted matte black so that they will not show through the screen.
4. Platforms for loudspeaker mounting should be rigid and completely free from rattles; all exposed vertical surfaces should be finished with sound absorptive materials.
5. All other wall areas behind the screen should be finished with sound absorptive materials.

B. Screen Loudspeaker Aiming:

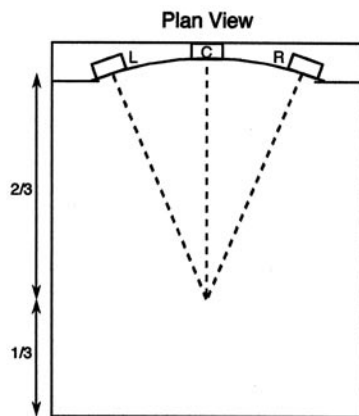
If a THX® system is specified, all details of the vertical baffle wall (or bafflette construction) will be taken care of. Where there is no such specification, the installer will have to construct one large platform, or a number of smaller ones, depending on costs. The loudspeakers should be mounted on sections of carpet or rubber pads to inhibit rattles. Enclosures should be secured with angle brackets so that they have no tendency to move. All wall surfaces behind the screen should be finished with sound absorptive material.

The screen loudspeakers should be spaced laterally so that good stereo imaging is ensured. The screen loudspeakers should be oriented so that they point to a location on the centerline of the house at a distance about two-thirds the length of the house. This will require that the left and right screen loudspeakers be toed in regardless of screen curvature. This will ensure that proper stereo imaging will be perceived by those patrons seated toward the sides of the house. Normally, if a curved screen is used, its radius of curvature will be struck from a center point in the room that is about two-thirds the depth of the room. Overall details here are shown in [Figures 28 and 29](#).

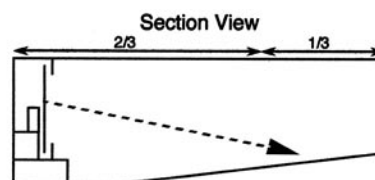
The HF and MF horns should be given a downward elevation angle so that they are aimed at the audience ear plane at the point two-thirds back in the house, as shown in [Figure 30](#).



Figures 28: Toeing in of screen loudspeakers behind a flat screen.



Figures 29: Screen loudspeakers normal to a curved screen.



Figures 30: Downward elevation of screen loudspeakers.

Taking into account the requirements for masking for various aspect ratios, the spacing between left and right loudspeakers should be broad enough to produce ideal stereo for the widest format. Acoustically transparent masking material should be used so that, when masking is in place, there is negligible high frequency loss. The wider loudspeaker spacing, when used for a narrower projection format, will be quite acceptable, even desirable.

C. Subwoofer Mounting:

For best results, the subwoofers should be placed on the floor below the screen loudspeakers and, if possible, against a vertical wall or baffle. They should be clustered together resting on rubber pads and be completely free of rattles.

D. Surround Mounting:

With traditional digital sound tracks there are two surround channels. [Figure 31A](#) shows a plan view of how a total of 12 surround loudspeakers would be divided into two channels. Normally, the surround loudspeakers are carried no farther forward in the house than a point about one-third the distance from the screen to the back of the space. The reason is simply that the surrounds should never be perceived as competing with the screen channels. [Figure 31B](#) shows a section view of the house looking toward the screen. JBL surround loudspeakers include an integral 20° downward tilt for ease in proper aiming. Generally, the surrounds should be placed 3 to 4.5 meters (10 to 15 ft) above the floor and aimed roughly at the wall/floor boundary on the far side of the space.

Since early 1999, an improvement in surround technology known as Surround EX uses a variation on matrix methods to produce a rear surround channel. When this option is called for, the surrounds will have to be reallocated electrically from the booth, as shown in [Figure 32](#). Dolby Laboratories has provided the necessary booth equipment to enable this change to be made easily.

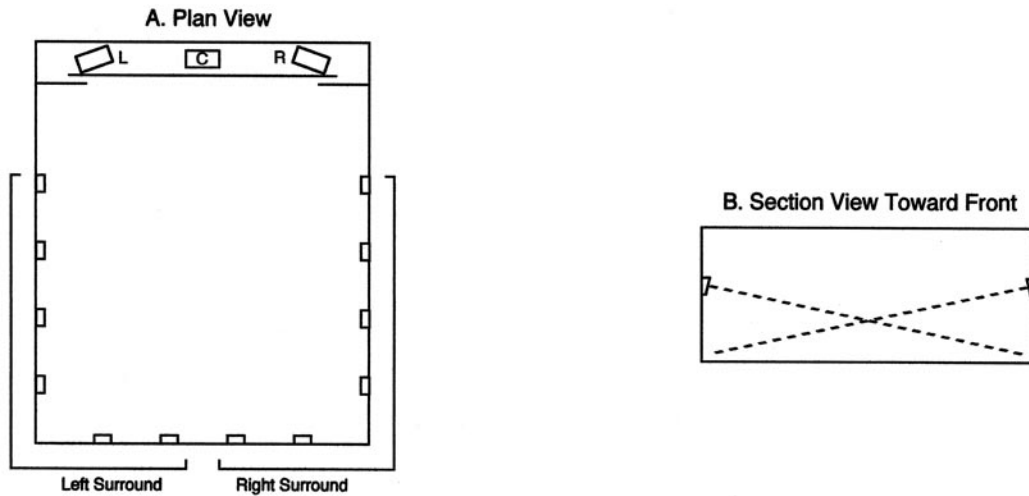


Figure 31: Surround loudspeaker placement. 12 surrounds in L and R, plan view (A)

Surround loudspeakers shown in section view (B).

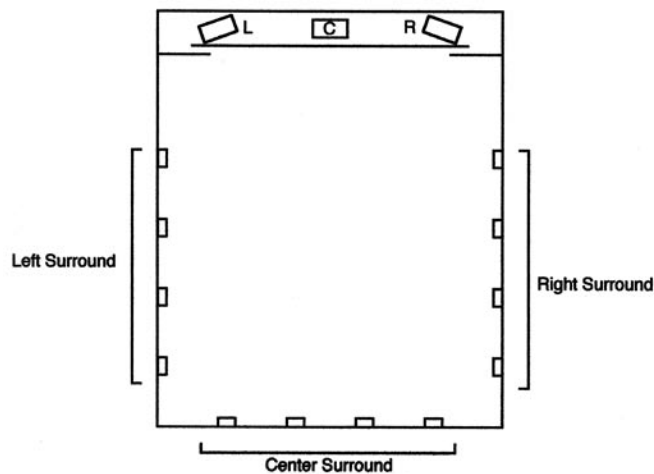


Figure 32: Surround loudspeaker placement. 12 surrounds in L, C and R, plan view.

VI. ELECTRICAL INTERFACE

A. JBL Polarity Conventions:

For reasons having to do with long-term product continuity and performance consistency in the field, many of JBL's older transducer and systems groups have what is called "negative polarity convention," that is, a positive-going voltage on the (+) or red terminal will result in an inward motion of the cone or driver diaphragm. Positive polarity (so-called EIA polarity) specifies that a positive-going voltage on the (+) or red terminal will result in an outward motion of the cone or driver diaphragm. (When applied to systems, the polarity convention refers to the observed motion of the LF driver only.)

When completely new product groups or model numbers are introduced, JBL is in compliance with the EIA standard. When older products are modified with no change in the basic model number, or where new products will be required to interface with older ones, JBL usually maintains the negative convention to avoid confusion in the marketplace. In any event, all new positive convention products carry a legend to that effect next to their input terminals. Here is a breakdown of polarity conventions for JBL cinema product groups:

3000-Series	All positive
4000-Series	
4670D	Positive
4675C	Positive
4675C-4(8)LF	Negative
5000-Series	All negative
4600-Series subwoofers	All positive
Surround systems	All positive
ScreenArray systems	All positive

For maintaining absolute system polarity through the entire A- and B-chain of theater systems, we strongly recommend that polarity inversions, when they are required, are made at the input terminals to the screen loudspeakers. Making the change at any other point in the chain is likely to cause confusion.

B. Wiring Diagrams for 3000 Series Screen Systems:

Figure 33A shows proper amplifier/loudspeaker hookup for the models 3677 and 3678, both operating in a single-amplifier mode. The model 3678 is also configured to operate in bi-amplified mode, as shown at Figure 33B. Note that this change requires removing four jumpers from the terminal strips of the dividing network.

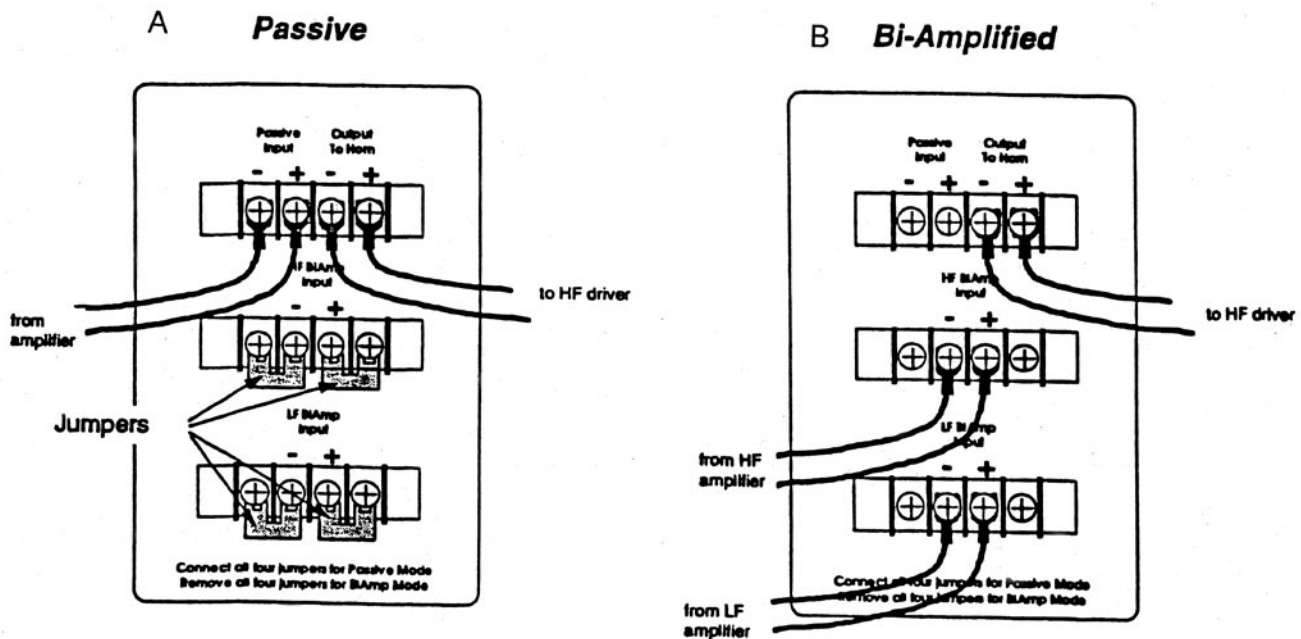


Figure 33: Wiring diagrams for 3000 Series. Passive network operation (A); bi-amplified operation of 3678 (B).

C. Wiring diagrams for 4000 Series Screen Systems:

Figure 34A shows the correct method for wiring the components of the 4675C, and Figure 34B shows the correct method for wiring the 4670D. The 4675C-4(8)LF combination is always bi-amplified, either using the THX electronic dividing network or one of the input options on the power amplifier. The correct wiring, with polarity adjustment, is shown in Figure 34C.

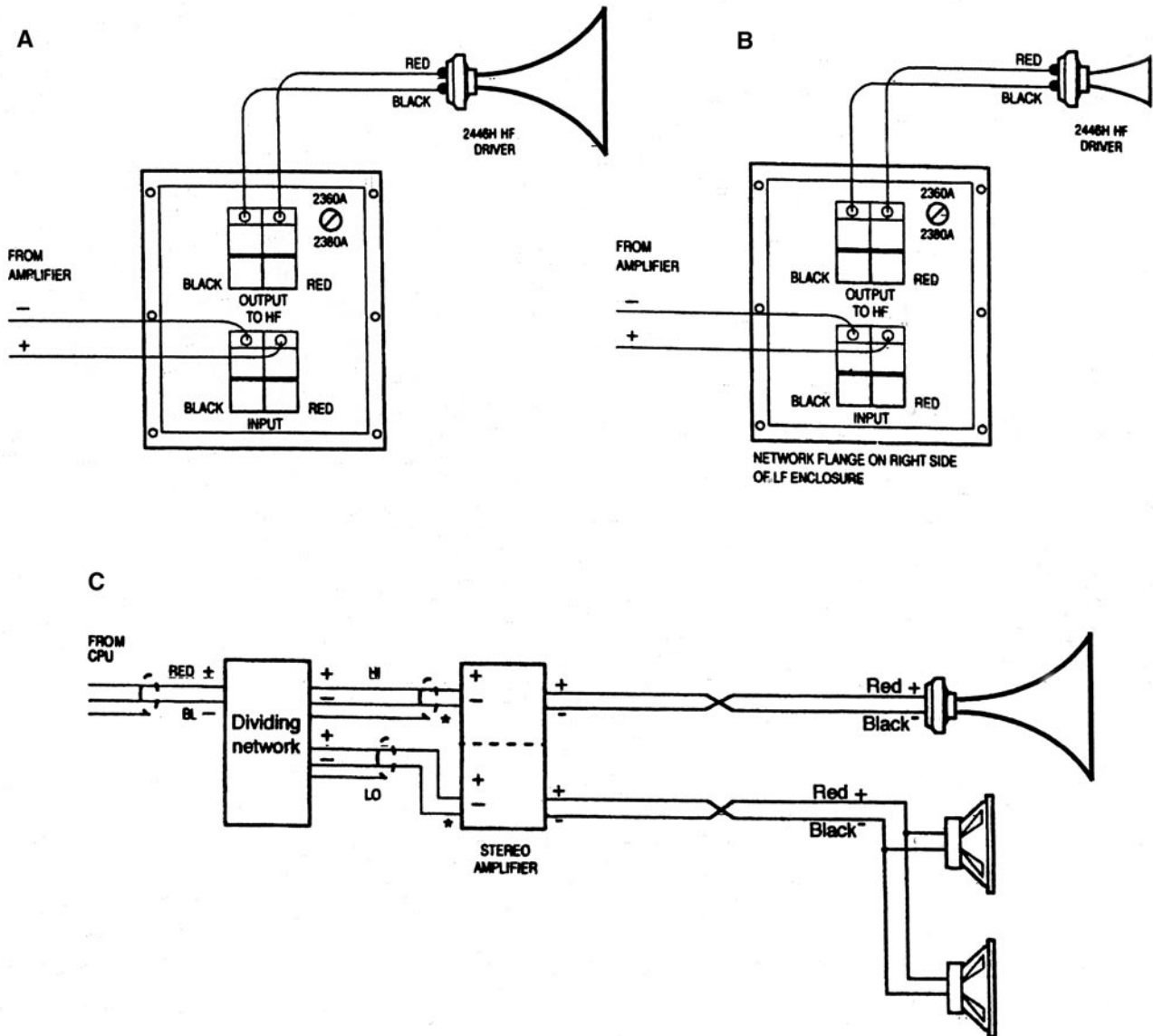


Figure 34: Wiring diagram for 4000 Series. Passive network operation of 4675C (A) and 4670D (B); biamped operation of 4675C (C).

D. Wiring Diagrams for 5000 Series Screen Systems:

The three models in the 5000-Series are always triamplified. Models 5671 and 5672 all use three power amplifier sections, while the 5674, due to the quadruple set of LF units, makes use of four amplifier sections. All aspects of frequency division, time correction, power response equalization, and room equalization are carried out by the JBL model DSC260A digital controller. Pertinent wiring diagrams are shown in [Figure 35A and B](#).

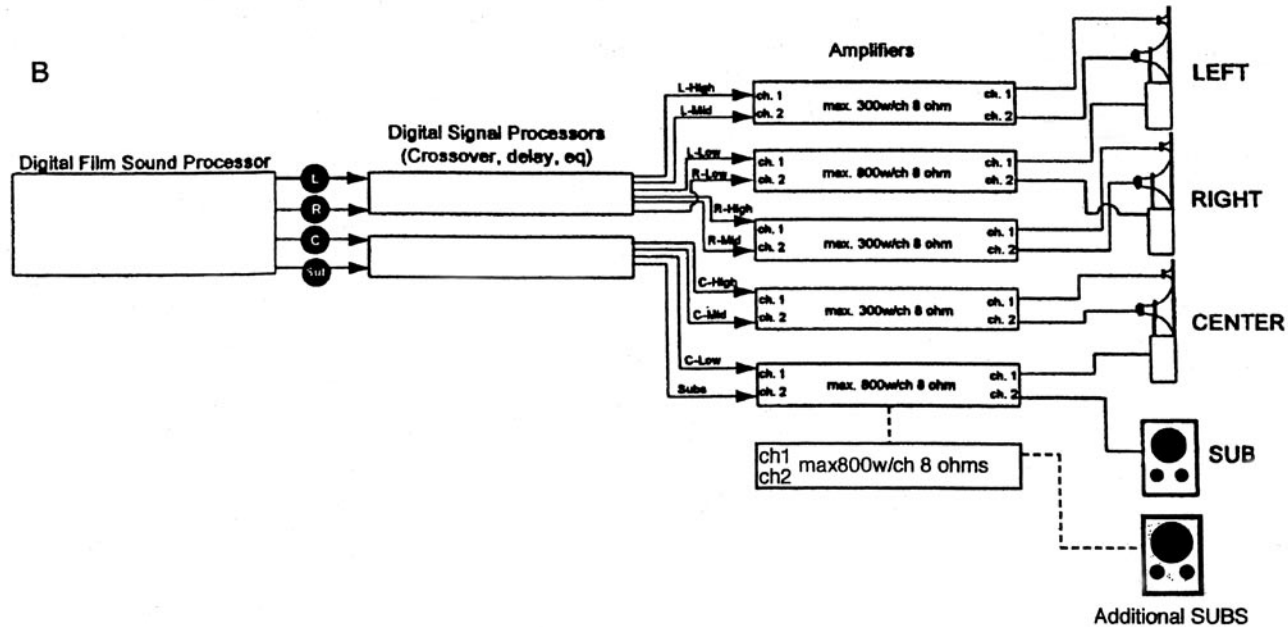
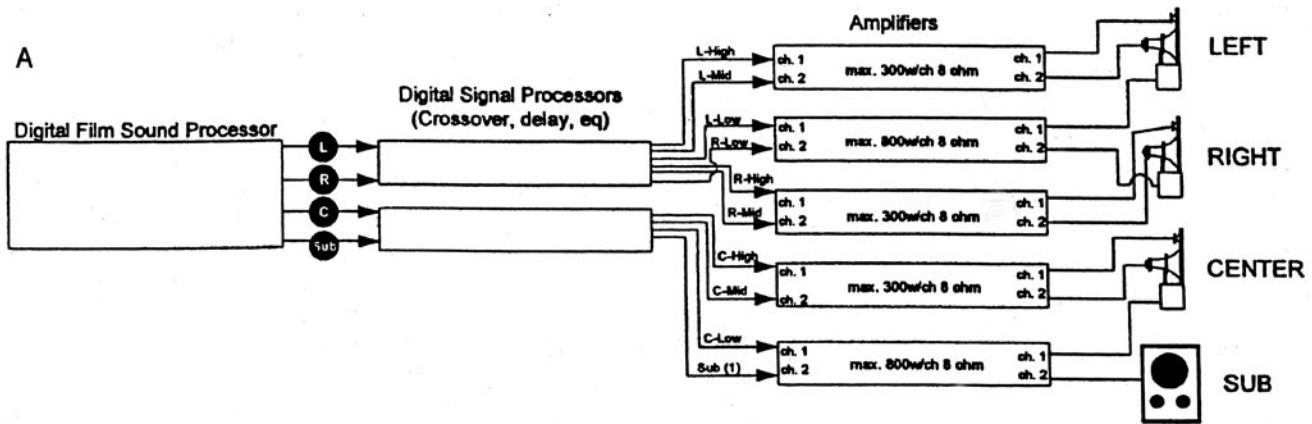


Figure 35: Wiring diagram for 5000-series systems. 5671 and 5672 (A); 5674 (B)

E. Wiring Diagrams for ScreenArray Systems:

The model 3632 wired for biamped operation is shown in [Figure 36A](#). The model 4632 is shown biamped in [Figure 36B](#); triamped wiring of the 4632 is shown at [36C](#).

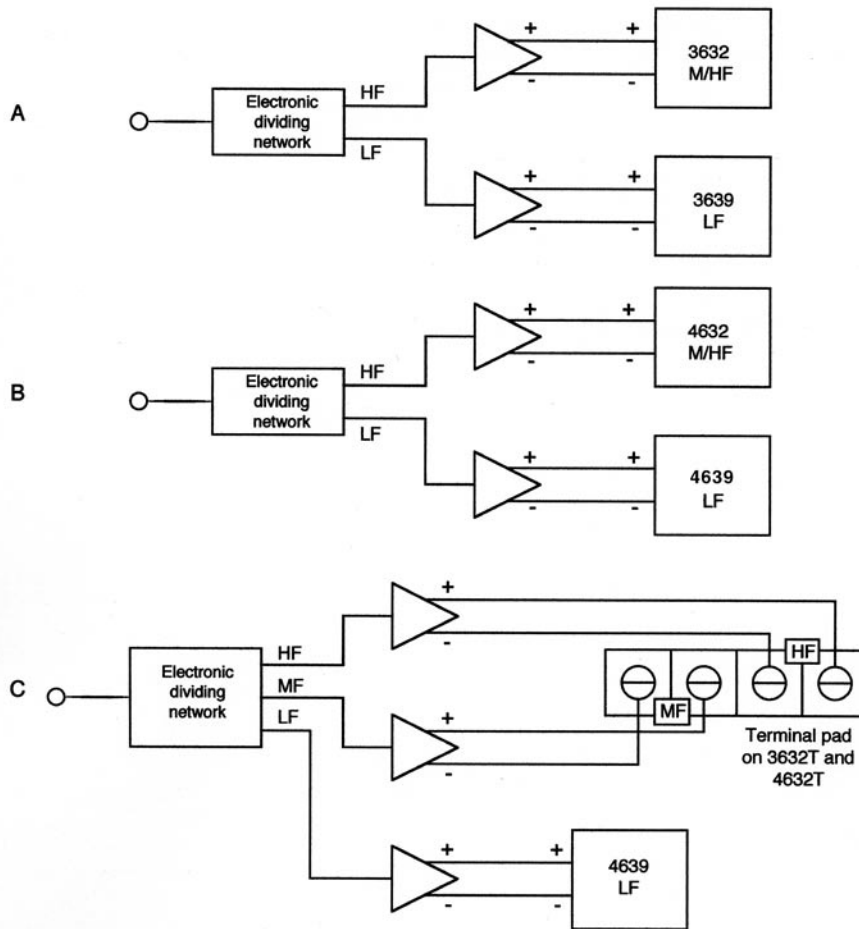


Figure 36: Wiring diagrams for ScreenArray systems. 3632 biamped mode (A); 4632 biamped mode (B); 4632T and 3632T triamped mode (C).

F. Surround Wiring Diagrams:

JBL strongly recommends that each surround loudspeaker be individually wired back to the projection booth, and that any paralleling of loudspeaker loads be made at that location. In general, we recommend that no more than a single pair of sound loudspeakers be paralleled for use with a single amplifier section. Thus the total number of surround loudspeakers in a given installation, divided by four, will give the total number of stereo power amplifiers that will be required for the entire complement of surround loudspeakers. This approach will also allow utmost flexibility in re-allocating surround loudspeakers for all eventualities in future A-chain technology.

Since all of JBL's surround models are nominally 8 ohms impedance, the parallel load of two of them will of course produce a 4-ohm load. Amplifiers should then be chosen that can deliver twice the loudspeaker rated power into 4 ohms, as compared with their 8-ohm ratings.

Be sure in surround amplifier specification:

1. That the amplifier will not be overdriven in normal operation, and
2. That the individual loudspeakers will receive a signal input within their power rating.

Typical stereo surround hookup is shown in [Figure 37](#). A typical Surround EX hookup is shown in [Figure 38](#).

In every case, we recommend that all loudspeaker paralleling be done in the booth, with "home run" lines to the individual surround loudspeakers.

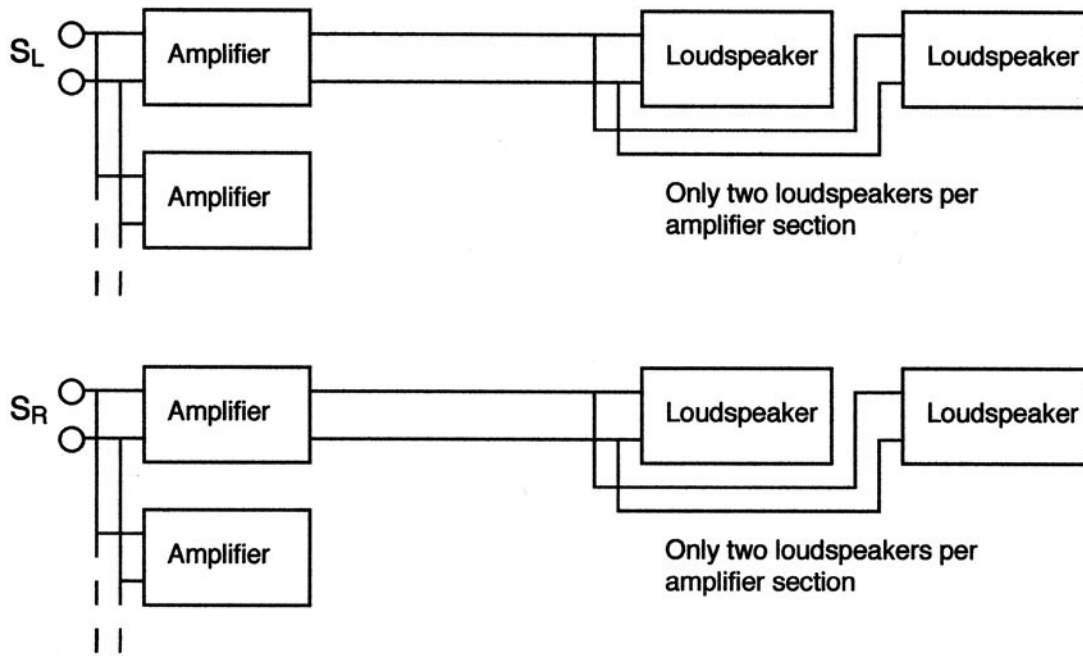


Figure 37: Typical stereo surround hookup.

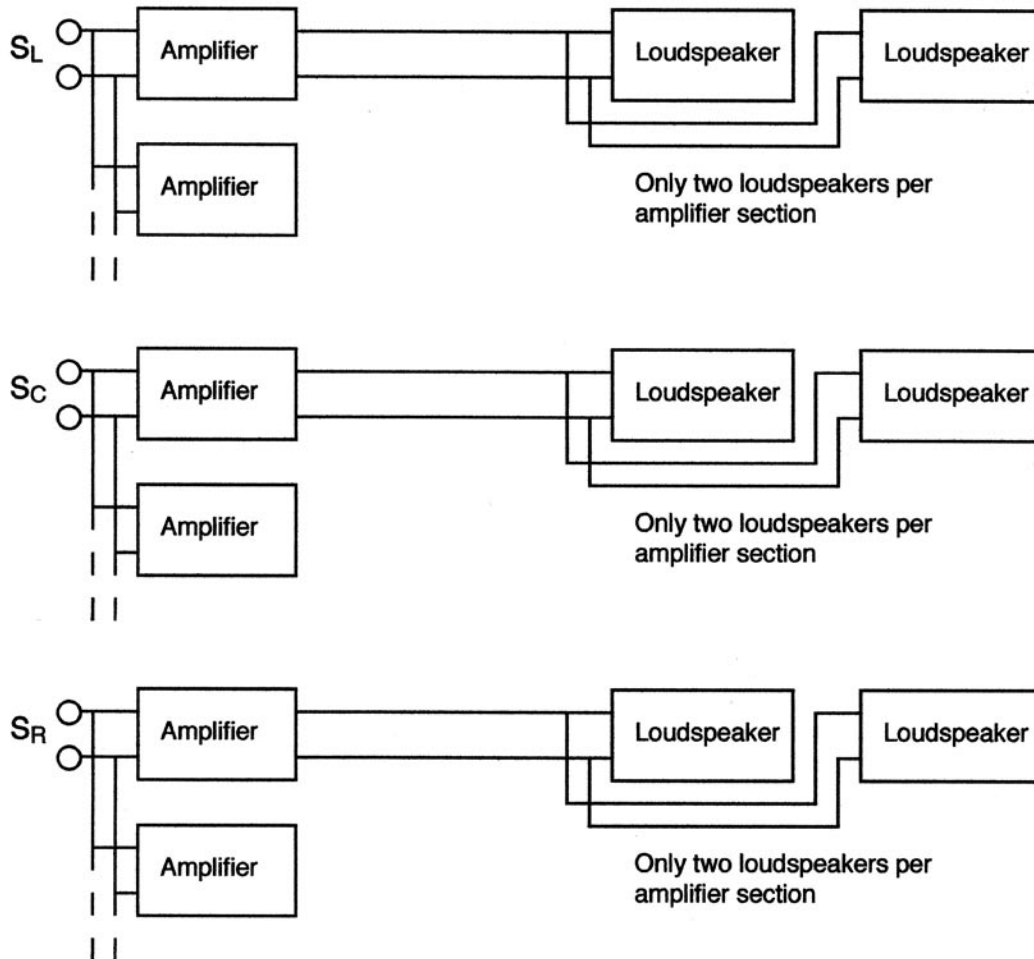


Figure 38: Surround-EX hookup.

G. Subwoofers:

The general rule here is one amplifier section to one subwoofer driver, as in the case of the 4641 and 4645C models. The model 4642A contains two 2441H drivers connected in parallel resulting in a 4-ohm load. This system is intended for use in those installations that require multiple drivers to attain the necessary acoustical level. They should be used with amplifiers capable of delivering continuous signals of 1200 watts into a 4-ohm load.

H. Wire Gauges and Line Losses:

The following table lists the recommended AWG and metric wire gauges to be used for the indicated load impedances and distances between amplifiers and their loads. These values are predicated on a maximum power loss of 5%, or approximately 0.25 dB:

AWG					
	25 ft	50 ft	100 ft	250 ft	500 ft
16 ohms	21	18	15	11	8
8 ohms	18	15	12	8	5
4 ohms	15	12	9	6	3
Metric					
	7.5 m:	15 m:	30 m:	75 m:	150 m:
16 ohms	0.7	1.0	1.5	2.5	3.5
8 ohms	1.0	1.5	2.0	3.5	4.5
4 ohms	1.5	2.0	3.0	4.0	6.0

(Note: Metric gauge values indicate the actual cross-sectional area of copper wire in square millimeters)

I. System Setup and Checkout:

The vast majority of system performance problems can be avoided through proper design procedures and proper assembly. If everything has gone well, the system will work, and the field crew can proceed with final calibration and equalization of the system. The following points need to be addressed:

1. When a loudspeaker has been assembled, either in the shop or in the field, it should be tested with an oscillator-amplifier combination to ensure that there are no buzzes or rattles.
2. As pairs of loudspeaker lines are installed, the ends at the loudspeaker should be shorted and a resistance check made at the booth to assure line continuity. Any discrepancies should be corrected.
3. Set up a gain-loss diagram for the system prior to making any adjustments on the system. An example is given in [Figure 39](#). Here we have shown the gain structure for the model 5674. We show here only the LF system section at full output; the MF and HF, sections operate at lower power amplifier levels so that the individual acoustical outputs of LF, MF, and HF sections will all be proportional.

All aspects of A-chain calibration should be performed according to the methods laid down in the various manuals supplied by the manufacturers of the cinema processing equipment. Since most cinema systems have the same basic architecture, it should be necessary to establish the operating norms only once.

The gain-loss diagram for this system indicates clearly maximum output levels of each component in the system as well as the noise floor of each component. The goal in proper systems engineering is to ensure that the widest possible dynamic range is preserved through the chain. No electronic device ahead of the power amplifier should be driven into distortion before the power amplifier itself has reached its maximum output capability. Additionally, the noise floor of the system, once it has been established at the preamp, should not be compromised by allowing the signal level to fall too low at any subsequent point in the chain. The gain-loss diagram is a convenient means of ensuring all these points. It is customary to carry the gain structure diagram into the acoustical domain in the cinema, indicating relevant levels of both signal and noise at some reference distance from the loudspeakers.

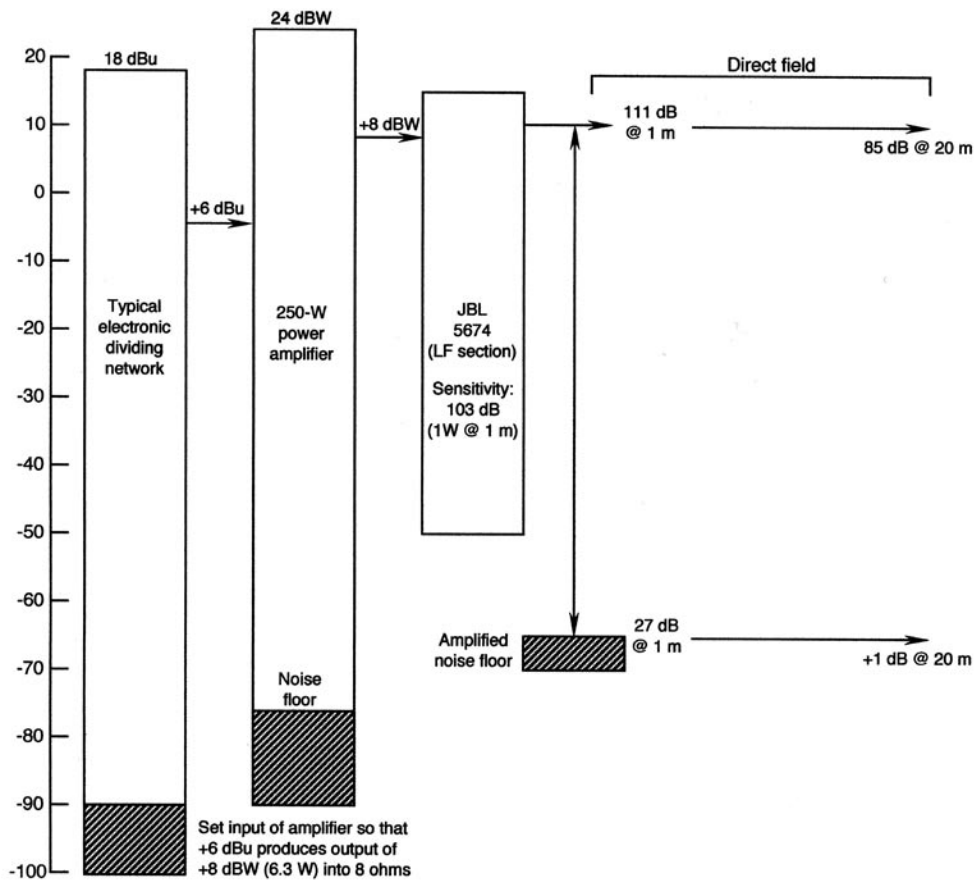


Figure 39: Level diagram for 5674 (LF section).

VII. SUMMARY OF RECOMMENDATIONS FOR SELECTING AND INSTALLING THEATER LOUDSPEAKER SYSTEMS

A. Specifying and Installing Screen Channels:

The following recommendations will give the reader a quick reference guide for specifying and installing loudspeakers in all cinema applications. These recommendations draw directly from the detailed information that has been presented before.

1. Screen channel assumptions:

- 15" LF drivers in the 95 to 97 dB sensitivity range (1 W at 1 m).
- LF power handling in the 300-watt range, per driver.
- HF systems with matching sensitivity and output capability.
- House sizes based on survey of the range of typical installations.

2. Low frequency driver count (per channel):

- For houses with 200 seats or less, specify systems with one LF driver per channel.
- For houses with 200 to 500 seats, specify systems with two LF drivers per channel.
- For houses with more than 500 seats, consider specifying systems with four LF drivers per channel for maximum performance.

REMEMBER: You can always specify a larger system for a smaller house, but not vice versa.

3. Placement of screen channels:

- Space horizontally to match the widest anticipated picture format.
- Elevate systems so that HF sections are about $2/3$ the screen height.
- Place the systems so that the HF sections are as close as possible to the screen.
- Paint matte black any reflecting surfaces.

4. Toe-in of screen loudspeakers:

- Whether the screen is curved or not, toe the outside loudspeakers inward so that their on-axis response will intersect at a point about $2/3$ the distance to the back wall. (See [Figure 40](#))

5. Downward tilt of HF sections:

- Tilt the HF elements downward so they point at ear level at about $2/3$ the distance to the back wall. (Note: This will not be necessary for systems that use asymmetrical horns, which already incorporate the downward tilt in their design. (See [Figure 41](#)))

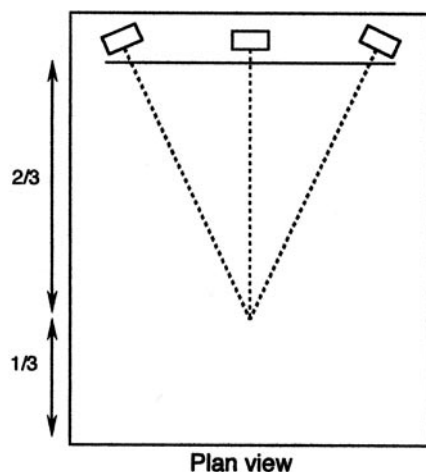


Figure 40: Screen channels, plan view.

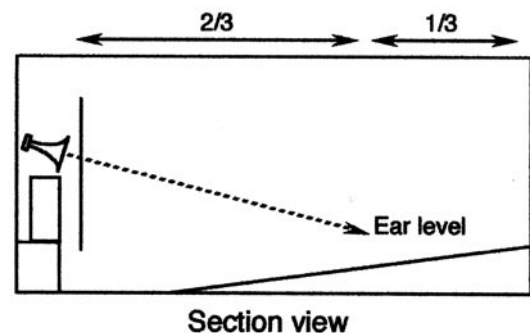


Figure 41: Screen channels, side section view.

B. Specifying and Installing Surround Channels:

1. Surround channel assumptions:
 - Moderate power surrounds (cone/dome): Sensitivity: 91 dB SPL, 1 W at 1 m, typical; power rating: 100 watts continuous.
 - High power surround (HF horn): Sensitivity 96 dB SPL, 1 W at 1 m, typical; power rating: 250 watts continuous. Note: Maximum output difference about 9 dB.
2. When to use which surround model?
 - For houses with seating no greater than 200 patrons, use either moderate or high power surrounds.
 - For houses with seating greater than 200 patrons, always use high power surrounds.
3. How many surrounds?
 - In most houses the ideal number will be 12 to 16.
 - Normally, specify at least four surrounds on the back wall.
 - An exception here is in very small houses, where there may be two on the back wall. In this case a total of eight surrounds (three on each side; two on the back wall) will be sufficient.
4. Surround wiring:
 - Always use a "home run" from the booth to each surround loudspeaker.
 - Do all of the loudspeaker paralleling in the booth.
 - Select wire gauges that will ensure insertion loss no greater than 0.5 dB.
5. How to position the surrounds:
 - The front-most surrounds are normally $2/3$ the distance from the back wall to the screen.
 - The back-most sidewall surrounds should be about nine to 12 feet from the back wall.
 - Surround density should be about one unit for each nine to 12 feet along the walls. (See [Figure 42](#))

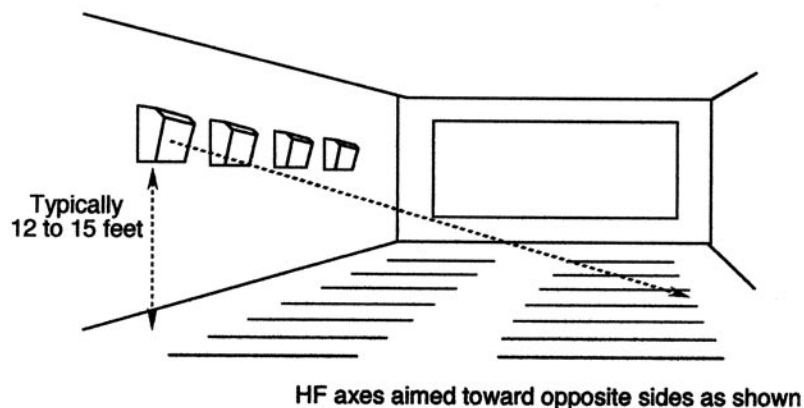


Figure 42: Surround channels, perspective view.

6. Surround height and wiring:
 - Height should normally be 12 to 15 feet above the floor.
 - The high frequency axis should be aimed at the seats along the opposite wall.
 - When possible, the surround positions should follow the rake of the floor. (See [Figure 43](#))
7. Be prepared for Surround EX:
 - Ideally, the three surround channels should have the same output capability. This calls for an equal number of loudspeakers per channel.
 - When possible, specify surrounds in a quantity divisible by 6 (12, 18 or 24) in order to ensure optimum load paralleling. (See [Figure 44](#))

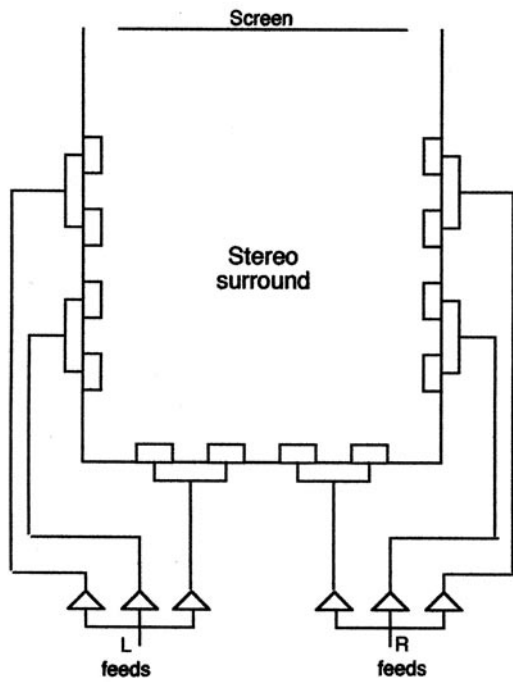


Figure 43: Surround channels, stereo wiring.

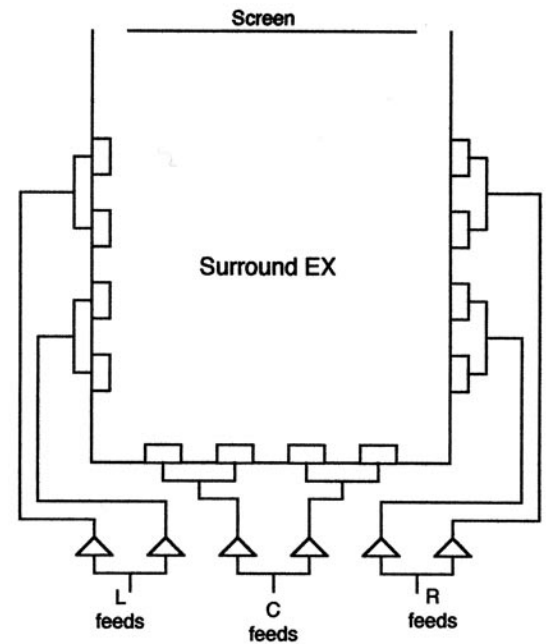


Figure 44: Surround channels, Surround EX wiring.

8. Selecting surround amplifiers:
 - Choose stereo amplifiers with a generous 4-ohm power rating equal to twice the individual surround loudspeaker power rating.
 - For example, using high power surrounds, select a stereo amplifier that can deliver 500 watts into four ohms.
9. If you have followed all of these rules:
 - Surround coverage in the back 2/3 of the house will be uniform within ± 2 dB.
 - Fine-tuning of drive levels may further improve uniformity
 - In deep houses, be prepared to zone surrounds with delay to maintain proper front/back perspectives.

C. Specifying and Installing Subwoofers:

1. Subwoofer assumptions:
 - Use 18" diameter drivers.
 - Sensitivity: no less than about 97 dB, 1 W at 1 m.
 - Power rating per-driver should be no less than about 400 watts continuous.
2. How many subwoofer drivers are necessary?
 - A safe rule is to specify one sub driver for each 25,000 cubic feet of house volume.
 - Always round upward; if your calculations indicate 5 1/2 subs, use 6.
 - You can always specify more subs for greater impact.
3. Subwoofer powering:
 - We recommend powering each subwoofer driver with its own amplifier section.
 - Choose amplifiers with an output rating that matches each driver at its rated impedance.

4. Subwoofer mounting:
- Mount the subwoofers at the base of the screen and as close as possible to the wall/floor intersection.
 - Cluster the individual units together in order to take maximum advantage of mutual coupling.
 - Watch out for rattles; use plenty of neoprene padding for isolation. (See [Figure 45](#))

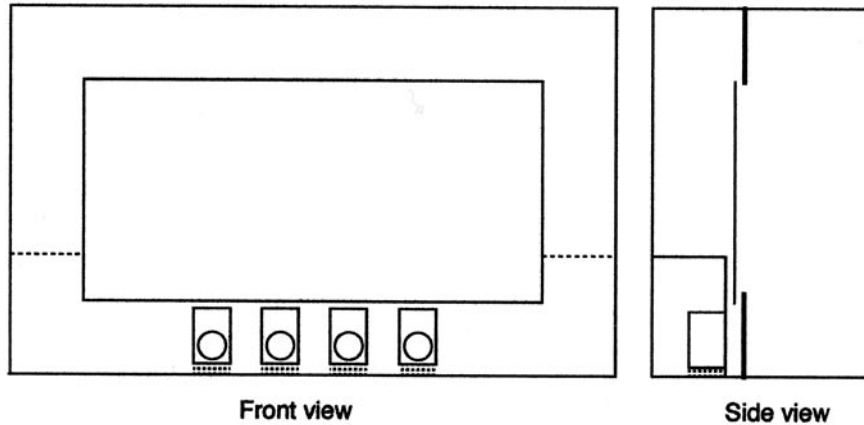


Figure 45: Subwoofer placement, front and side section views.

VIII. LISTING OF THX® APPROVED JBL PROFESSIONAL PRODUCTS

A. Screen systems:

3678	(3678-HF and 3678-LF)
3632T	(3632-M/HF-T and 4639)
4632T	(4632-M/HF-T and 4639)
4675C-8LF	(4675-HFA and 4648A-8)
5671	(5671-M/HF and 5641)
5671	(5674-M/HF and 4648A)
5674	(5674-M/HF and 5644)

B. Subwoofers:

4641
 4645C
 4642A
 4642A-GS (with grilles)

C: Surround Systems:

8330A
 8340A

XI. LOUDSPEAKER SIGNAL PROCESSING FOR JBL DSC260A

The following loudspeaker signal processing settings are intended for the JBL DSC260A digital system controller.

Different loudspeaker controllers may have channel-to-channel differences in delay settings. They may also have different definitions and implementations of parametric filter Q or bandwidth. As a result when alternative processors are used, field measurements, both electrically and acoustically, will ensure the maximum performance is retained.

Note that equal voltage gain for all amplifier channels is assumed. If power-amplifiers with different voltage gain are used then this difference must be compensated for.

**Recommended signal processing settings for DSC260A Digital System Controller.
See www.jblpro.com for most current processor settings**

Speaker System:	4675C-4LF			Date:	3/4/2003	
					DSC260	
Parameter	Input A	Input B	Input A+B			
Input Delay						
Input EQ1 Type						
Input EQ1 Frequency						
Input EQ1 +/-						
Input EQ1 Bandwidth						
Input EQ2 Type						
Input EQ2 Frequency						
Input EQ2 +/-						
Input EQ2 Bandwidth						
Input EQ3 Type						
Input EQ3 Frequency						
Input EQ3 +/-						
Input EQ3 Bandwidth						
Input EQ4 Type						
Input EQ4 Frequency						
Input EQ4 +/-						
Input EQ4 Bandwidth						
Input EQ4 Type						
Input EQ4 Frequency						
Input EQ4 +/-						
Input EQ4 Bandwidth						
Parameter	Output 1	Output 2	Output 3	Output 4	Output 5	Output 6
Output Name	UNUSED	L LOW	L HI	UNUSED	R LOW	R HI
Output Source		A	A		B	B
Output Gain		0.0	-6.0		0.0	-6.0
Output Limit		10.0	10.0		10.0	10.0
Output Delay		1.396	0.000		1.396	0.000
Output Delay Link		Off	Off		Off	Off
Polarity		Normal	Normal		Normal	Normal
Output Lo Shape		BUT18	BUT18		BUT18	BUT18
Output Lo Frequency		29.1	392.0		29.1	392.0
Output Hi Shape		L-R24	BUT12		L-R24	BUT12
Output Hi Frequency		482.0	Out		482.0	Out
Output EQ1 Type		Bell	Bell		Bell	Bell
Output EQ1 Frequency		153.0	659.0		153.0	659.0
Output EQ1 +/-		-0.5	2.0		-0.5	2.0
Output EQ1 Bandwidth		1.00	0.45		1.00	0.45
Output EQ2 Type			Bell			Bell
Output EQ2 Frequency			10.1k			10.1k
Output EQ2 +/-			2.0			2.0
Output EQ2 Bandwidth			0.50			0.50
Output EQ3 Type			Bell			Bell
Output EQ3 Frequency			12.9k			12.9k
Output EQ3 +/-			13.5			13.5
Output EQ3 Bandwidth			0.70			0.70
Output EQ4 Type						
Output EQ4 Frequency						
Output EQ4 +/-						
Output EQ4 Bandwidth						

**Recommended signal processing settings for DSC260A Digital System Controller.
See www.jblpro.com for most current processor settings**

Speaker System:	4675C-8LF			Date:	3/4/2003	
					<i>DSC260</i>	
Parameter	Input A	Input B	Input A+B			
Input Delay						
Input EQ1 Type						
Input EQ1 Frequency						
Input EQ1 +/-						
Input EQ1 Bandwidth						
Input EQ2 Type						
Input EQ2 Frequency						
Input EQ2 +/-						
Input EQ2 Bandwidth						
Input EQ3 Type						
Input EQ3 Frequency						
Input EQ3 +/-						
Input EQ3 Bandwidth						
Input EQ4 Type						
Input EQ4 Frequency						
Input EQ4 +/-						
Input EQ4 Bandwidth						
Input EQ4 Type						
Input EQ4 Frequency						
Input EQ4 +/-						
Input EQ4 Bandwidth						
Parameter	Output 1	Output 2	Output 3	Output 4	Output 5	Output 6
Output Name	UNUSED	L LOW	L HI	UNUSED	R LOW	R HI
Output Source		A	A		B	B
Output Gain		0.0	-6.0		0.0	-9.0
Output Limit		10.0	10.0		10.0	10.0
Output Delay		1.396	0.000		1.396	0.000
Output Delay Link		Off	Off		Off	Off
Polarity		Normal	Normal		Normal	Normal
Output Lo Shape		BUT18	BUT18		BUT18	BUT18
Output Lo Frequency		29.1	392.0		29.1	392.0
Output Hi Shape		L-R24	BUT12		L-R24	BUT12
Output Hi Frequency		482.0	Out		482.0	Out
Output EQ1 Type		Bell	Bell		Bell	Bell
Output EQ1 Frequency		153.0	659.0		153.0	659.0
Output EQ1 +/-		-0.5	2.0		-0.5	2.0
Output EQ1 Bandwidth		1.00	0.45		1.00	0.45
Output EQ2 Type			Bell			Bell
Output EQ2 Frequency			10.1k			10.1k
Output EQ2 +/-			2.0			2.0
Output EQ2 Bandwidth			0.50			0.50
Output EQ3 Type			Bell			Bell
Output EQ3 Frequency			12.9k			12.9k
Output EQ3 +/-			13.5			13.5
Output EQ3 Bandwidth			0.70			0.70
Output EQ4 Type						
Output EQ4 Frequency						
Output EQ4 +/-						
Output EQ4 Bandwidth						

**Recommended signal processing settings for DSC260A Digital System Controller.
See www.jblpro.com for most current processor settings**

Speaker System:	ScreenArray™ 4622 (Bi-Amp)			Date:	3/4/2003	
					DSC260	
Parameter	Input A	Input B	Input A+B			
Input Delay						
Input EQ1 Type	Bell*	Bell*				
Input EQ1 Frequency	50.7	50.7				
Input EQ1 +/-	3.0	3.0				
Input EQ1 Bandwidth	0.60	0.60				
Input EQ2 Type						
Input EQ2 Frequency						
Input EQ2 +/-						
Input EQ2 Bandwidth						
Input EQ3 Type						
Input EQ3 Frequency						
Input EQ3 +/-						
Input EQ3 Bandwidth						
Input EQ4 Type						
Input EQ4 Frequency						
Input EQ4 +/-						
Input EQ4 Bandwidth						
Input EQ4 Type						
Input EQ4 Frequency						
Input EQ4 +/-						
Input EQ4 Bandwidth						
Parameter	Output 1	Output 2	Output 3	Output 4	Output 5	Output 6
Output Name	UNUSED	L LOW	L HI	UNUSED	R LOW	R HI
Output Source		A	A		B	B
Output Gain		0.0	-4.0		0.0	-4.0
Output Limit		10.0	10.0		10.0	10.0
Output Delay		0.792	0.000		0.792	0.000
Output Delay Link		Off	Off		Off	Off
Polarity		Normal	Normal		Normal	Normal
Output Lo Shape		BUT12	BUT24		BUT12	BUT24
Output Lo Frequency		25.3	840.0		25.3	840.0
Output Hi Shape		BUT24	BUT12		BUT24	BUT12
Output Hi Frequency		683.0	Out		683.0	Out
Output EQ1 Type		Bell	Bell		Bell	Bell
Output EQ1 Frequency		406.0	1.46k		406.0	1.46k
Output EQ1 +/-		-5.5	-6.0		-5.5	-6.0
Output EQ1 Bandwidth		0.05	1.40		0.05	1.40
Output EQ2 Type		Bell	Bell		Bell	Bell
Output EQ2 Frequency		615.0	16.0k		615.0	16.0k
Output EQ2 +/-		-9.0	15.0		-9.0	15.0
Output EQ2 Bandwidth		0.10	0.30		0.10	0.30
Output EQ3 Type			Bell			Bell
Output EQ3 Frequency			9.18k			9.18k
Output EQ3 +/-			-4.5			-4.5
Output EQ3 Bandwidth			0.60			0.60
Output EQ4 Type						
Output EQ4 Frequency						
Output EQ4 +/-						
Output EQ4 Bandwidth						
(*) Set this filter to "0.0dB" if system is installed in a full baffle wall						

**Recommended signal processing settings for DSC260A Digital System Controller.
See www.jblpro.com for most current processor settings**

Speaker System:	ScreenArray™ 3632 (Bi-Amp)			Date:	3/4/2003	
					DSC260	
Parameter	Input A	Input B	Input A+B			
Input Delay						
Input EQ1 Type	Bell*	Bell*				
Input EQ1 Frequency	50.7	50.7				
Input EQ1 +/-	3.0	3.0				
Input EQ1 Bandwidth	0.60	0.60				
Input EQ2 Type						
Input EQ2 Frequency						
Input EQ2 +/-						
Input EQ2 Bandwidth						
Input EQ3 Type						
Input EQ3 Frequency						
Input EQ3 +/-						
Input EQ3 Bandwidth						
Input EQ4 Type						
Input EQ4 Frequency						
Input EQ4 +/-						
Input EQ4 Bandwidth						
Input EQ4 Type						
Input EQ4 Frequency						
Input EQ4 +/-						
Input EQ4 Bandwidth						
Parameter	Output 1	Output 2	Output 3	Output 4	Output 5	Output 6
Output Name	UNUSED	L LOW	L HI	UNUSED	R LOW	R HI
Output Source		A	A		B	B
Output Gain		-5.0	-2.0		-5.0	-2.0
Output Limit		10.0	10.0		10.0	10.0
Output Delay		0.396	0.000		0.396	0.000
Output Delay Link		Off	Off		Off	Off
Polarity		Normal	Normal		Normal	Normal
Output Lo Shape		BUT12	BUT48		BUT12	BUT48
Output Lo Frequency		30.1	450.0		30.1	450.0
Output Hi Shape		BUT48	BUT12		BUT48	BUT12
Output Hi Frequency		378.0	Out		378.0	Out
Output EQ1 Type		Bell	Bell		Bell	Bell
Output EQ1 Frequency		138.0	6.06k		138.0	6.06k
Output EQ1 +/-		-2.0	-4.0		-2.0	-4.0
Output EQ1 Bandwidth		0.30	0.35		0.30	0.35
Output EQ2 Type			Bell			Bell
Output EQ2 Frequency			16k			16k
Output EQ2 +/-			11.0			11.0
Output EQ2 Bandwidth			0.45			0.45
Output EQ3 Type						
Output EQ3 Frequency						
Output EQ3 +/-						
Output EQ3 Bandwidth						
Output EQ4 Type						
Output EQ4 Frequency						
Output EQ4 +/-						
Output EQ4 Bandwidth						
(*) Set this filter to "0.0dB" if system is installed in a full baffle wall						

**Recommended signal processing settings for DSC260A Digital System Controller.
See www.jblpro.com for most current processor settings**

Speaker System:	ScreenArray™ 3632-T (Tri-Amp)			Date:	3/4/2003	
					DSC260	
Parameter	Input A	Input B	Input A+B			
Input Delay						
Input EQ1 Type	Bell*	Bell*				
Input EQ1 Frequency	50.7	50.7				
Input EQ1 +/-	3.0	3.0				
Input EQ1 Bandwidth	0.60	0.60				
Input EQ2 Type						
Input EQ2 Frequency						
Input EQ2 +/-						
Input EQ2 Bandwidth						
Input EQ3 Type						
Input EQ3 Frequency						
Input EQ3 +/-						
Input EQ3 Bandwidth						
Input EQ4 Type						
Input EQ4 Frequency						
Input EQ4 +/-						
Input EQ4 Bandwidth						
Input EQ4 Type						
Input EQ4 Frequency						
Input EQ4 +/-						
Input EQ4 Bandwidth						
Parameter	Output 1	Output 2	Output 3	Output 4	Output 5	Output 6
Output Name	L LOW	L MID	L HI	R LOW	R MID	R HI
Output Source	A	A	A	B	B	B
Output Gain	1.0	-4.0	-11.0	1.0	-4.0	-10.0
Output Limit	10.0	10.0	10.0	10.0	10.0	10.0
Output Delay	1.582	0.125	0.000	1.582	0.125	0.000
Output Delay Link	Off	Off	Off	Off	Off	Off
Polarity	Normal	Normal	Normal	Normal	Normal	Normal
Output Lo Shape	L-R12	L-R24	BUT18	L-R12	L-R24	BUT18
Output Lo Frequency	25.0	450.0	1.31k	25.0	450.0	1.31k
Output Hi Shape	L-R24	BUT18	BUT12	L-R24	BUT18	BUT12
Output Hi Frequency	353.0	1.46k	Out	353.0	1.46k	Out
Output EQ1 Type	Bell	Bell	Bell	Bell	Bell	Bell
Output EQ1 Frequency	176.0	707.0	2.37k	176.0	707.0	2.37k
Output EQ1 +/-	-5.0	-3.0	-2.0	-5.0	-3.0	-2.0
Output EQ1 Bandwidth	0.35	0.55	1.00	0.35	0.55	1.00
Output EQ2 Type	Bell	Bell	Bell	Bell	Bell	Bell
Output EQ2 Frequency	341.0	2.54k	4.43k	341.0	2.54k	4.43k
Output EQ2 +/-	3.0	-9.0	3.0	3.0	-9.0	3.0
Output EQ2 Bandwidth	0.35	0.50	0.25	0.35	0.50	0.25
Output EQ3 Type			Hi12			Hi12
Output EQ3 Frequency			8.57k			8.57k
Output EQ3 +/-			14.0			14.0
Output EQ3 Bandwidth						
Output EQ4 Type						
Output EQ4 Frequency						
Output EQ4 +/-						
Output EQ4 Bandwidth						
(*) Set this filter to "0.0dB" if system is installed in a full baffle wall						

**Recommended signal processing settings for DSC260A Digital System Controller.
See www.jblpro.com for most current processor settings**

Speaker System:	ScreenArray™ 4632 (Bi-Amp)			Date:	3/4/2003	
					DSC260	
Parameter	Input A	Input B	Input A+B			
Input Delay						
Input EQ1 Type	Bell*	Bell*				
Input EQ1 Frequency	50.7	50.7				
Input EQ1 +/-	3.0	3.0				
Input EQ1 Bandwidth	0.60	0.60				
Input EQ2 Type						
Input EQ2 Frequency						
Input EQ2 +/-						
Input EQ2 Bandwidth						
Input EQ3 Type						
Input EQ3 Frequency						
Input EQ3 +/-						
Input EQ3 Bandwidth						
Input EQ4 Type						
Input EQ4 Frequency						
Input EQ4 +/-						
Input EQ4 Bandwidth						
Input EQ4 Type						
Input EQ4 Frequency						
Input EQ4 +/-						
Input EQ4 Bandwidth						
Parameter	Output 1	Output 2	Output 3	Output 4	Output 5	Output 6
Output Name	UNUSED	L LOW	L MID+HI	UNUSED	R LOW	R MID+HI
Output Source		A	A		B	B
Output Gain		-2.0	-7.0		-2.0	-7.0
Output Limit		10.0	10.0		10.0	10.0
Output Delay		0.354	0.000		0.354	0.000
Output Delay Link		Off	Off		Off	Off
Polarity		Normal	Normal		Normal	Normal
Output Lo Shape		BUT12	BUT48		BUT12	BUT48
Output Lo Frequency		30.1	250.0		30.1	250.0
Output Hi Shape		BUT48	BUT12		BUT48	BUT12
Output Hi Frequency		225.0	Out		225.0	Out
Output EQ1 Type		Bell	Bell		Bell	Bell
Output EQ1 Frequency		138.0	307.0		138.0	307.0
Output EQ1 +/-		-3.0	3.0		-3.0	3.0
Output EQ1 Bandwidth		0.45	0.30		0.45	0.30
Output EQ2 Type			Bell			Bell
Output EQ2 Frequency			637.0			637.0
Output EQ2 +/-			3.5			3.5
Output EQ2 Bandwidth			0.15			0.15
Output EQ3 Type			Hi12			Hi12
Output EQ3 Frequency			10.1k			10.1k
Output EQ3 +/-			9.0			9.0
Output EQ3 Bandwidth						
Output EQ4 Type						
Output EQ4 Frequency						
Output EQ4 +/-						
Output EQ4 Bandwidth						
(*) Set this filter to "0.0dB" if system is installed in a full baffle wall						

**Recommended signal processing settings for DSC260A Digital System Controller.
See www.jblpro.com for most current processor settings**

Speaker System:	ScreenArray™ 4632-T (Tri-Amp)			Date:	3/4/2003	
					DSC260	
Parameter	Input A	Input B	Input A+B			
Input Delay						
Input EQ1 Type	Bell*	Bell*				
Input EQ1 Frequency	50.7	50.7				
Input EQ1 +/-	3.0	3.0				
Input EQ1 Bandwidth	0.60	0.60				
Input EQ2 Type						
Input EQ2 Frequency						
Input EQ2 +/-						
Input EQ2 Bandwidth						
Input EQ3 Type						
Input EQ3 Frequency						
Input EQ3 +/-						
Input EQ3 Bandwidth						
Input EQ4 Type						
Input EQ4 Frequency						
Input EQ4 +/-						
Input EQ4 Bandwidth						
Input EQ4 Type						
Input EQ4 Frequency						
Input EQ4 +/-						
Input EQ4 Bandwidth						
Parameter	Output 1	Output 2	Output 3	Output 4	Output 5	Output 6
Output Name	L LOW	L MID	L HI	R LOW	R MID	R HI
Output Source	A	A	A	B	B	B
Output Gain	-1.0	-3.5	-14.5	-1.0	-3.5	-14.5
Output Limit	10.0	10.0	10.0	10.0	10.0	10.0
Output Delay	1.271	0.125	0.000	1.271	0.125	0.000
Output Delay Link	Off	Off	Off	Off	Off	Off
Polarity	Normal	Normal	Normal	Normal	Normal	Normal
Output Lo Shape	BUT12	BUT48	BUT24	BUT12	BUT48	BUT24
Output Lo Frequency	30.1	258.0	1.51k	30.1	258.0	1.51k
Output Hi Shape	BUT48	BUT24	BUT12	BUT48	BUT24	BUT12
Output Hi Frequency	225.0	1.1k	Out	225.0	1.1k	Out
Output EQ1 Type	Bell	Bell	Bell	Bell	Bell	Bell
Output EQ1 Frequency	138.0	1.23k	3.03k	138.0	1.23k	3.03k
Output EQ1 +/-	-3.0	6.0	-3.0	-3.0	6.0	-3.0
Output EQ1 Bandwidth	0.45	0.20	0.30	0.45	0.20	0.30
Output EQ2 Type		Bell	Bell		Bell	Bell
Output EQ2 Frequency		500.0	16.0k		500.0	16.0k
Output EQ2 +/-		-4.5	10.0		-4.5	10.0
Output EQ2 Bandwidth		0.80	0.30		0.80	0.30
Output EQ3 Type			Hi6			Hi6
Output EQ3 Frequency			10.9k			10.9k
Output EQ3 +/-			13.0			13.0
Output EQ3 Bandwidth						
Output EQ4 Type						
Output EQ4 Frequency						
Output EQ4 +/-						
Output EQ4 Bandwidth						
(*) Set this filter to "0.0dB" if system is installed in a full baffle wall						

DSC Recommended Settings Cinema 5000

March 23, 1999

	System	Output	5674	5672	5671
DELAY ms					
	A	Subs	0.000	0.000	0.000
	B	Lows	1.656	1.656	1.604
	C	Mids	0.000	0.000	0.000
	D	Highs	1.854	1.854	1.739
Polarity [+] unless noted					
EQ					
A1	Frequency (Hz)	Subs	Not Used	Not Used	Not Used
	Bandwidth in Octaves				
	dB				
A2	Frequency (Hz)	Subs	Not Used	Not Used	Not Used
	Bandwidth in Octaves				
	dB				
B1	Frequency (Hz)	Lows	Not Used	Not Used	203
	Bandwidth in Octaves				0.4
	dB				2
B2	Frequency (Hz)	Lows	Not Used	Not Used	Not Used
	Bandwidth in Octaves				
	dB				
C1	Frequency (Hz)	Mids	Not Used	Not Used	Not Used
	Bandwidth in Octaves				
	dB				
C2	Frequency (Hz)	Mids	Not Used	Not Used	Not Used
	Bandwidth in Octaves				
	dB				
D1	Frequency (Hz)	Highs	9.18k	9.18k	11.7k
	Bandwidth in Octaves		12 Hi Shelf	12 Hi Shelf	12 Hi Shelf
	dB		5	5	7.5
D2	Frequency (Hz)	Highs	2.82k	2.82k	3.36k
	Bandwidth in Octaves		0.4	0.4	0.3
	dB		2.5	2.5	-3.5
CROSSOVER					
A	Gain dB	Subs	Not Used	Not Used	Not Used
	Limit*				
	Slope - low, hi				
	FR - low, hi Hz				
B	Gain dB	Lows	0	3	5
	Limit*		2.2	2.2	2.2
	Slope - low, hi		LR 24,LR24	LR 24,LR24	LR 24,LR24
	FR - low, hi Hz		32, 297	32, 297	32, 366
C	Gain dB	Mids	-10	-10	-14.5
	Limit*		-1	-1	-1
	Slope - low, hi		LR24, LR24	LR24, LR24	LR24, LR24
	FR - low, hi Hz		297, 2.54k	297, 2.54k	297, 2.73k
D	Gain dB	Highs	-9	-9	-11.5
	Limit*		-1	-1	-1
	Slope - low, hi		LR24, Out	LR24, Out	LR24, Out
	FR - low, hi Hz		2.54k, Out	2.54k, Out	2.14k, Out

Note: Subwoofers are considered stereo. They can be summed to mono if desired.

* Limits are amplifier specific. Consult the Cinema 5000 owners manual for additional information.

Cross Reference of JBL Cinema Speakers to Crown Power Amplifiers.

JBL PROFESSIONAL		JBL Cinema - Product Line		Crown Power Amplifiers				
ScreenArray Series		Good	Better	Crossover Option For CL Amplifiers	Best	Crossover Option for CTs Amplifiers		
Model:	Description:	Nom. Imp:	System Power Handling:	Good	Better	Crossover Option For CL Amplifiers	Best	Crossover Option for CTs Amplifiers
3622N	2-way Passive	4 Ω	400 Watt (thru network)	XLS402	CL2	NA	CTs600	IQPIPUSP3
3632	3-way Bi-Amp	4/8 Ω	500 + 200 Watt (thru network)	XLS602	CL2	SSST-3632	CTs1200	PIP3632
3632-T *	3-way Tri-Amp	4/12/8 Ω	800 + 150 + 50 Watt	XLS402/CL1 Bridged	CL1/CL1 Bridged	SBSC-3632T	CTs1200 Bridged/CTs600	PIP3632/IQPIPUSP3
4622N	2-way Passive	4 Ω	600 Watt (thru network)	XLS602	CL2	NA	CTs1200	NA
4622	2-way Bi-Amp	4/8 Ω	600 + 100 Watt	XLS602	CL2	SSST-4622	CTs2000	PIP4622
4632	3-way Bi-Amp	4/4 Ω	800 + 400 Watt (thru network)	XLS602Bridged/XLS402	CL4	SSST-4632	CTs3000/CTs2000	PIP4632
4632-T *	3-way Tri-Amp	4/4/8 Ω	800 + 200 + 50 Watt	XLS602/CL2 Bridged	CL2/CL2 Bridged	SBSC-4632T	CTs3000/CTs2000	IQPIPUSP3/PIP4632
3000 Series								
Model:	Description:	Nom. Imp:	System Power Handling:	Good	Better	Crossover Option For CL Amplifiers	Best	Crossover Option for CTs Amplifiers
3677	2-way Passive (all-in-one)	8 Ω	250 Watt (thru network)	XLS402	CL1	NA	CTs600	NA
3678	2-way Passive or Bi-Amp as above in Blamp mode	8 Ω	300 Watt (thru network)	XLS602	CL4	NA	CTs600	NA
3678 *	2-way Passive or Bi-Amp as above in Blamp mode	8/8 Ω	600 + 50 Watt	XLS602 Bridged/XLS202	CL2	NA	CTs1200	IQPIPUSP3
3635	Subwoofer System	8 Ω	300 Watt	XLS402	CL2	NA	CTs600	IQPIPUSP3
3310A	2-way Surround	8 Ω	75 Watt system	XLS202	CL1	NA	CTs600	NA
4000 Series								
Model:	Description:	Nom. Imp:	System Power Handling:	Good	Better	Crossover Option For CL Amplifiers	Best	Crossover Option for CTs Amplifiers
4670D	2-way Passive	4 Ω	600 Watt (thru network)	XLS602	CL4	NA	CTs2000	NA
4675C	2-way Passive	4 Ω	600 Watt (thru network)	XLS602	CL4	NA	CTs2000	NA
4675C-4LF	2-way Bi-Amp	4/8 Ω	1200 + 100 Watt	XLS602	CL2	XSBSC.JBL4675	CTs2000	IQPIPUSP3
4675C-8LF *	2-way Bi-Amp	8/8 Ω	1200 + 100 Watt	XLS602 Bridged/XLS402	CL2	XSBSC.JBL4675	CTs2000	IQPIPUSP3
4641 *	Subwoofer System	8 Ω	600 Watt	XLS602	CL2	NA	CTs2000	IQPIPUSP3
4642A *	Subwoofer System	4 Ω	1200 Watt	XLS602 Bridged	CL4	NA	CTs3000	IQPIPUSP3
4645C *	Subwoofer System	8 Ω	800 Watt	XLS602 Bridged	CL2 Bridged	NA	CTs2000	IQPIPUSP3
5000 Series								
Model:	Description:	Nom. Imp:	System Power Handling:	Good	Better	Crossover Option For CL Amplifiers	Best	Crossover Option for CTs Amplifiers
5671 *	3-way Tri-Amp	8/8/8 Ω	600 + 200 + 100 Watt	XLS602 Br/XLS402	CL2 Br/CL1	NA	CTs1200/CTs600	IQPIPUSP3
5672 *	3-way Tri-Amp	4/8/8 Ω	1200 + 200 + 100 Watt	CL4 /XLS402	CL4 Br/CL2	XSBSC.JBL5672	CTs2000 Br/CTs600	IQPIPUSP3
5674 *	3-way Tri-Amp	4/4/8/8 Ω	1200/1200 + 200 + 100 Watt	CL4 /XLS402	CL4 /CL2	NA	CTs3000/CTs600	IQPIPUSP3
Surrounds								
Model:	Description:	Nom. Imp:	System Power Handling:	Good	Better	Crossover Option For CL Amplifiers	Best	Crossover Option for CTs Amplifiers
8330A *	3-way Surround	8 Ω	100 Watt system	XLS402	CL1	NA	CTs1200	NA
8340A *	2-way Surround	8 Ω	250 Watt system	XLS602	CL2	NA	CTs2000	NA

*THX approved model speakers
 **Models CL1 & CL2 THX approved
 *CTs series in THX approval process Multiple Surrounds can be run with the CTs4200 or CTs8200 Multi Channel Amps.

See: www.crownaudio.com/apps_htm/cinema_apps.htm

IX. REFERENCES AND ADDITIONAL READING:

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4. W. Gelow and John Eargle, "Cinema Sound Reproduction Systems: Evolving Technical Requirements and Architectural Considerations," Presented at the 105th Convention of the AES, San Francisco, CA, 26-29 September 1998, Preprint number 4831.
5. SMPTE Engineering Guideline: Acoustical Background Noise Levels in Dubbing Stages, EG 14-1987
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9. M. Gander and J. Eargle, "Measurement and Estimation of Large Loudspeaker Array Performance," Journal AES, vol. 38, no. 4 (April 1990).
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This document is available for download at: <http://www.jblpro.com/pub/cinema/cinedsgn.pdf>.

Specification sheets and other support documentation for all JBL Professional Cinema Products can also be found on the JBL Professional web site.



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Revised 6/11/03