



Simulation Tools in Sound Reinforcement: Multichannel Digital Audio Cinema Design

**Athens Course UPM94
17-21 November 2014
Madrid**



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SCREEN CHANNELS



- In cinema theaters the existence of the center channel in the display sets the dialog in the middle of the screen as well as reduces the amount of information in the common way that must carry the stereo L and R channels and allows that away listeners perceive perfectly the three channels without that signal seems to come from the speaker more close.
- To get coverage in the room are typically used horns of mid/high frequency with 90° horizontal coverage angle and converge towards the Center screen L and R speakers.



SCREEN CHANNELS



- In very large rooms, the dispersion of the high frequencies above 5 kHz to pass through the screen to angles very off-axis, it helps to get desired coverage.
- Another important consideration is the maintain an even distribution of sound pressure level in the room. To do this, usually point systems of medium and high frequency (horizontal) towards the central point at $2/3$ of the length of the room (this takes into account the law of the spherical divergence to the level in the axis of screen speakers).



SCREEN CHANNELS



- This is usually to get the difference in level between the front and back of the room is within the margin of ± 4 dB.
- There are different alternatives, depending on the type of room, or rather his inclination in medium and high frequency systems pointing.
- In cinemas of more than 250 seats, the first rows of seats should not be slaughtered to place corridors.
- In the first type of room the speakers are inclined to point also to the point $2/3$ of the length of the room (as in horizontal).



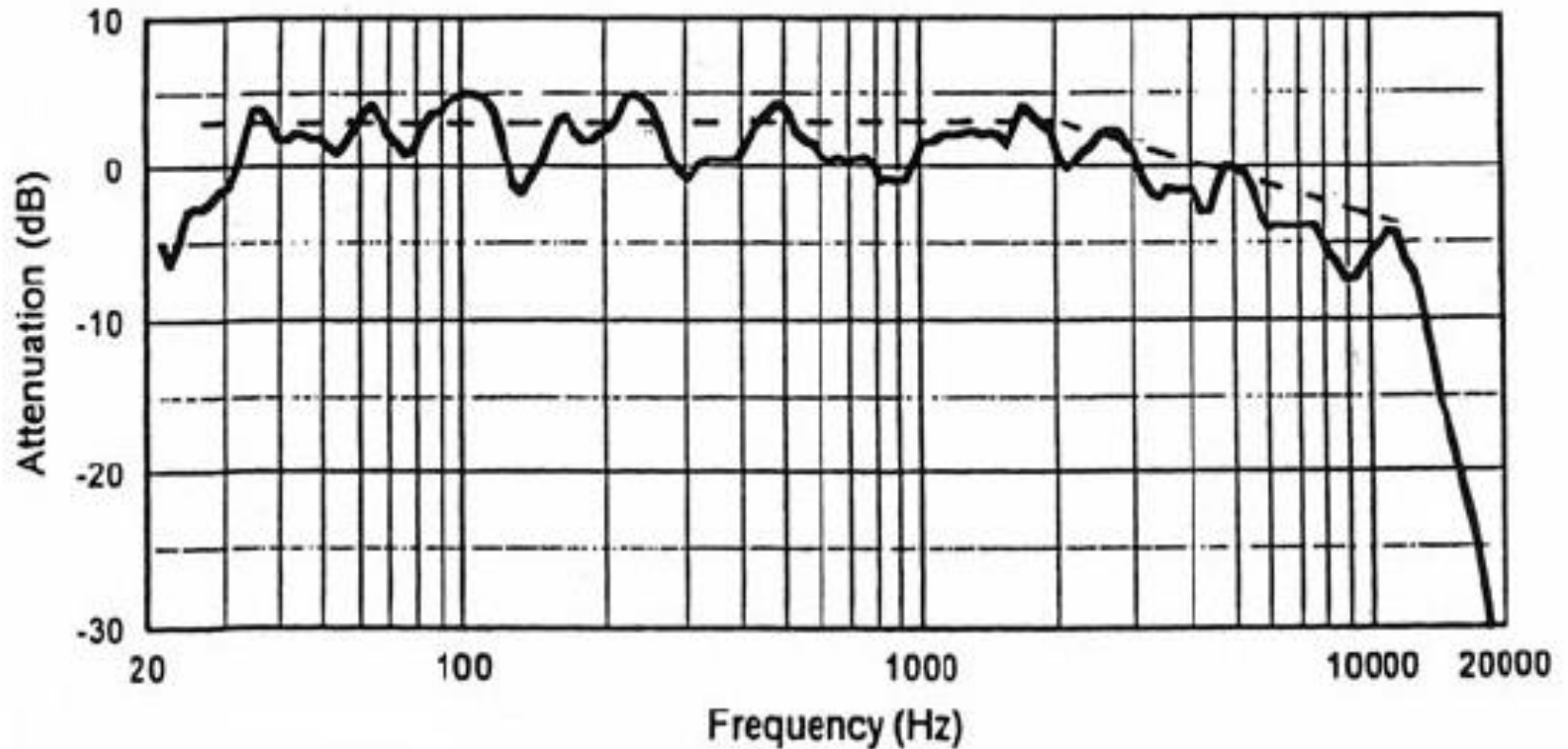
SCREEN CHANNELS



- In the other two types of rooms the inclination of the speakers is usually done to the last row of seats, although the speakers that are used are different in both cases.
- This will be done so long as the back wall of the room is very absorbent. Otherwise, always the speakers must bend to the point $\frac{2}{3}$ of the length of the room.
- In the case of the cinemas in descent, the speakers that are used are symmetrical with angles of $90^\circ \times 40^\circ$ coverage.
- In the case of the type Stadium cinemas, tend to employ asymmetric speakers of $95^\circ - 80^\circ \times 50^\circ$.



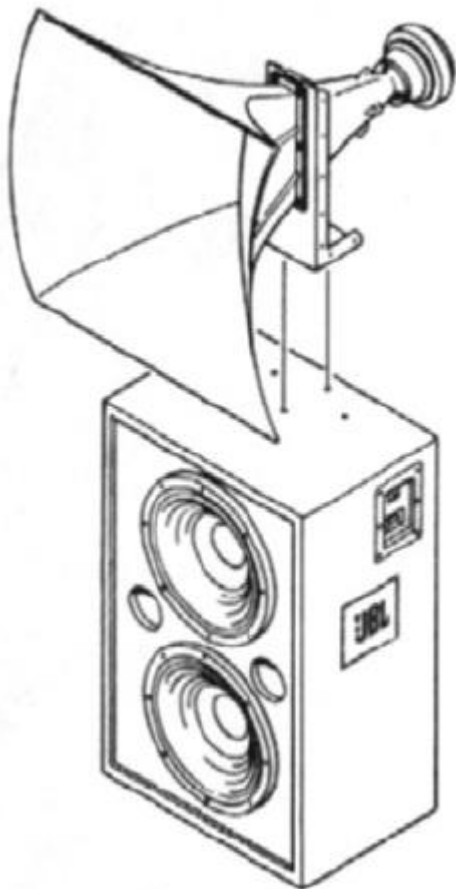
SCREEN CHANNELS



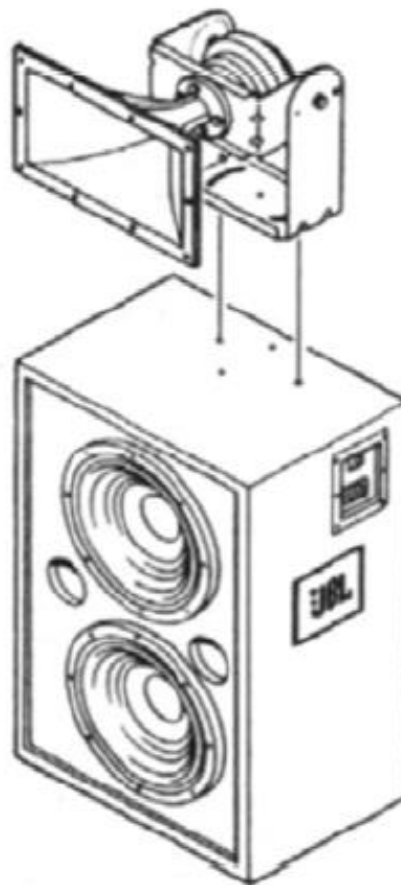
Frequency response at 2/3 of length in a traditional room



SCREEN CHANNELS



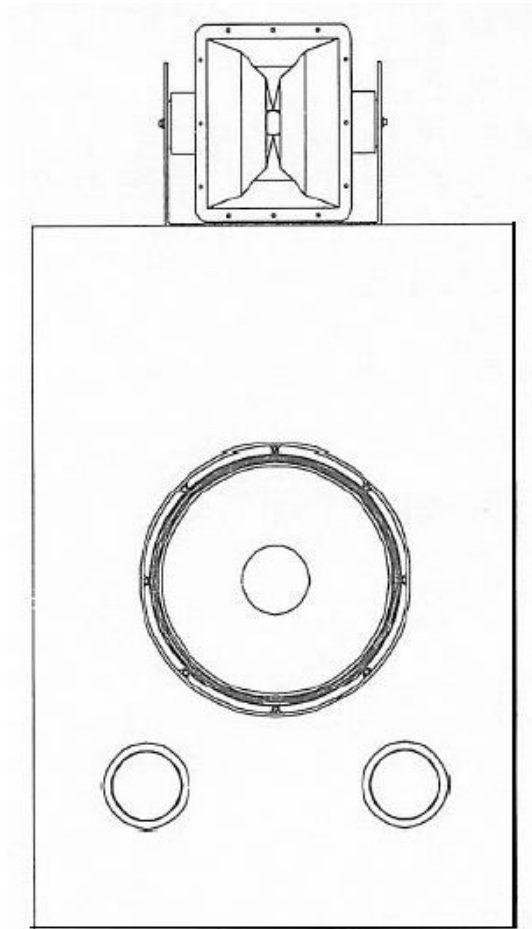
JBL 4675



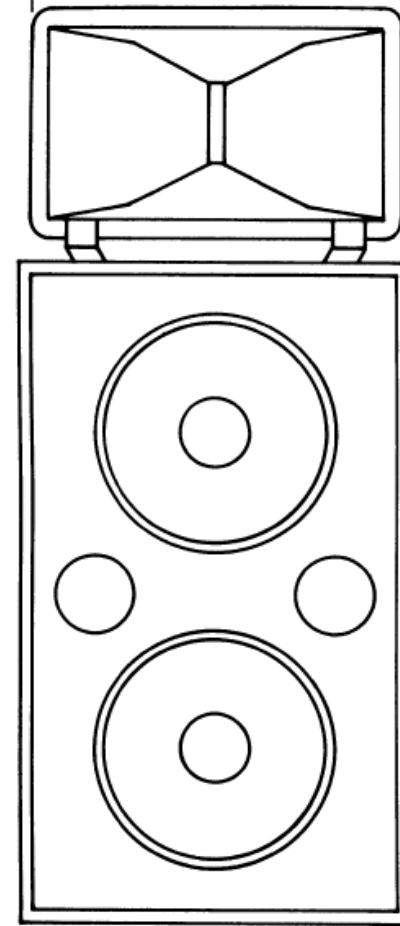
JBL 4670



SCREEN CHANNELS



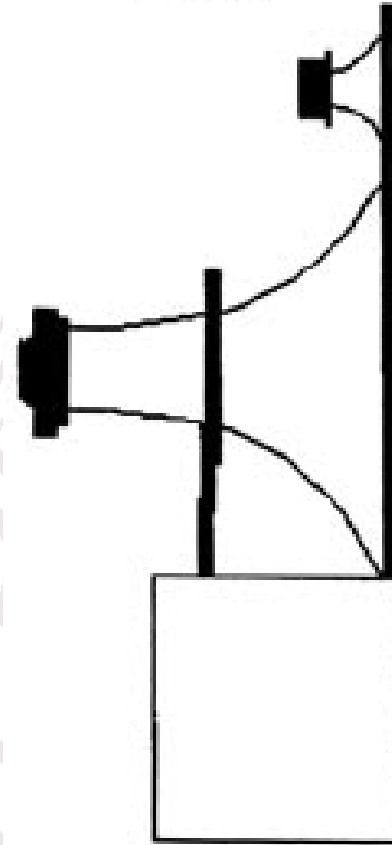
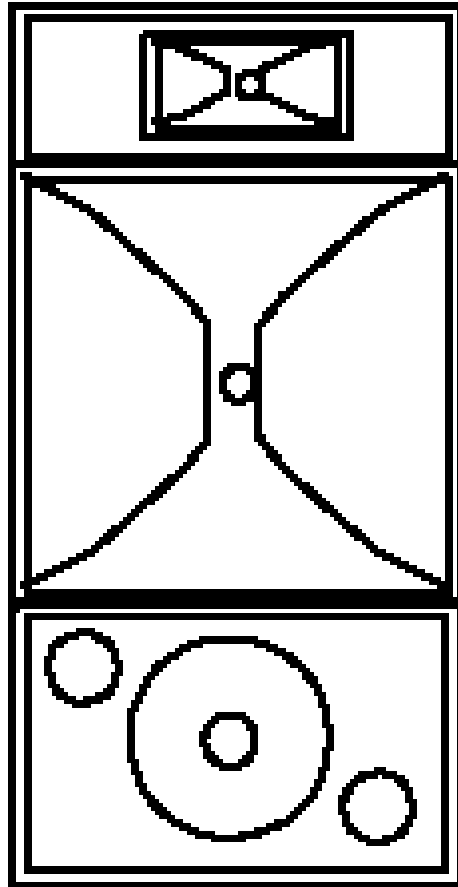
EV TS992E



EV TS940D



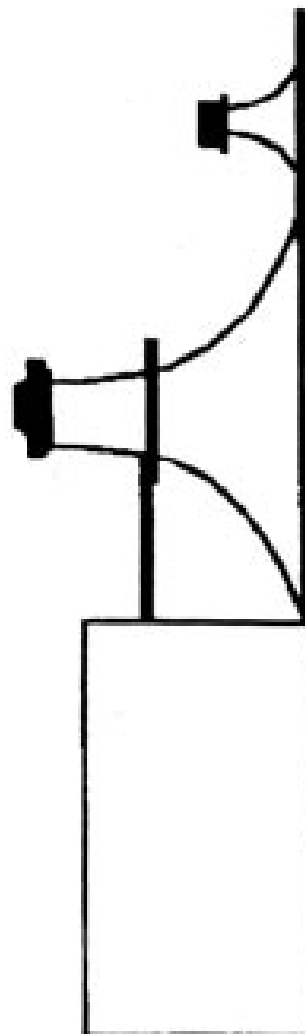
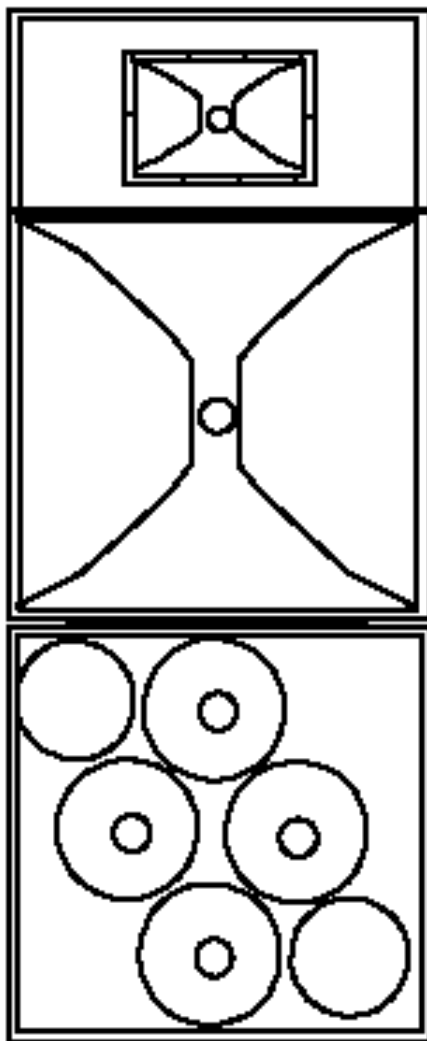
SCREEN CHANNELS



JBL 5671



SCREEN CHANNELS



JBL 5675



SCREEN CHANNELS

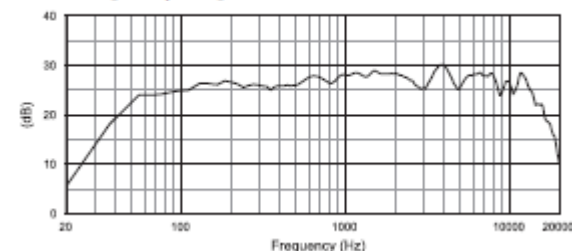


5674 Three-Way Screen Channel System

Specifications:

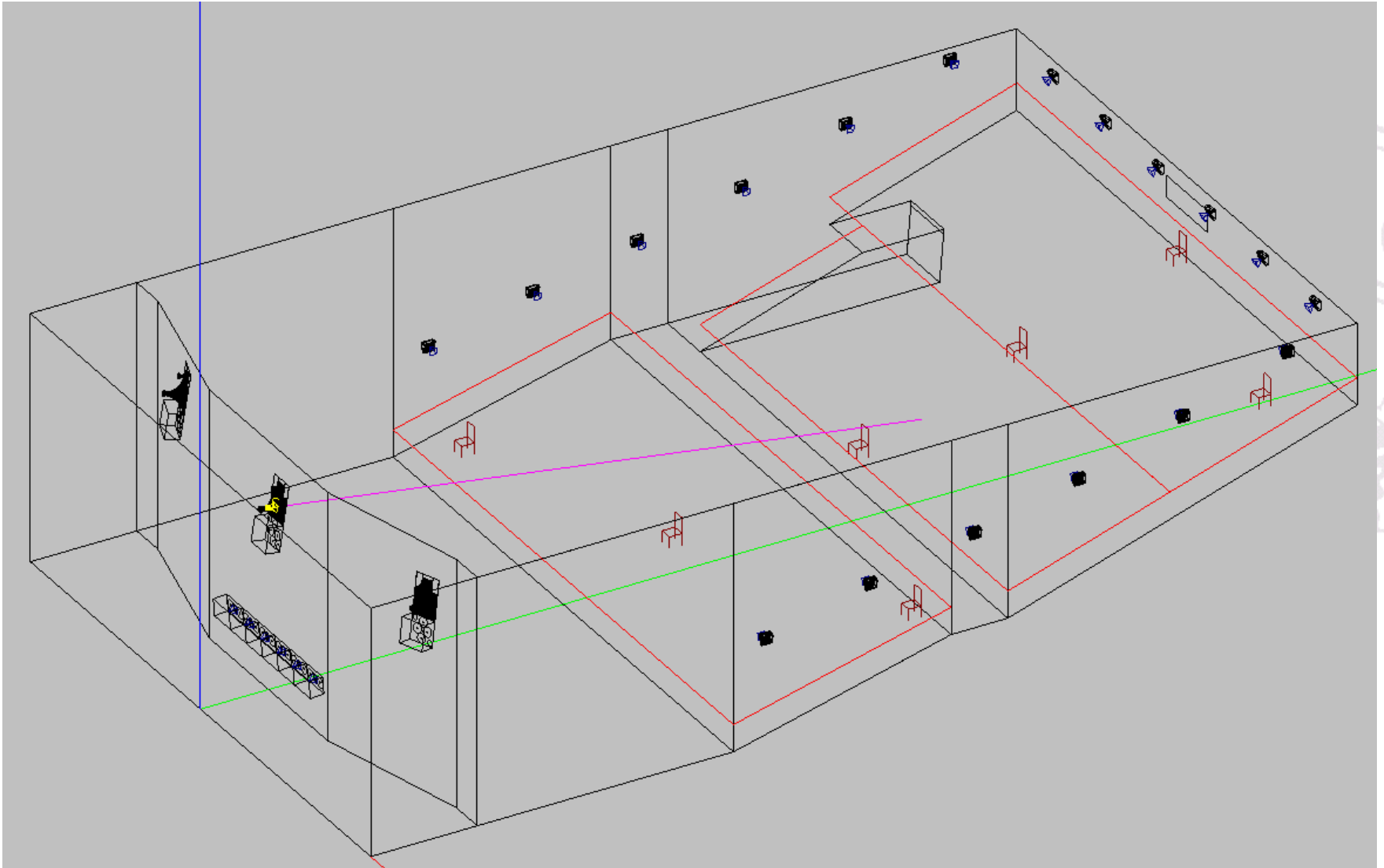
Frequency Range (-10 dB):	35 Hz - 16 kHz
Frequency Response (± 3 dB):	45 Hz - 12.5 kHz
Hor. Coverage Angle (-6 dB):	80°, averaged 300 Hz to 16 kHz
Vert. Coverage Angle (-6 dB):	45°, averaged 300 Hz to 16 kHz
Directivity Factor (Q):	10.4
Directivity Index (DI):	11
Maximum peak output (1 m):	LF: 142.8 dB, MF: 140 dB, HF: 136.8 dB
Recommended Crossover Freq.	LF/MF: 297 Hz, MF/HF: 2.5 kHz
Recommended Controller:	JBL DSG family of digital controllers; tunings available in memory
Dimensions (HxWxD):	2895.6 mm x 1118 mm x 812.8 mm (114 in. x 44 in. x 34 in.)
Net Weight:	171.69 kg (378.5 lbs.)
Shipping Weight:	190.5 kg (420 lbs.)
Transducers:	
Model 5644 Low Frequency:	Four 2226H1 380 mm (15 in.) dia., 100 mm (4 in.) edgewound ribbon voice coil mounted in 5504 LF enclosure in DiamondQuad driver array
Nominal impedance:	Each pair in parallel; 4 ohm loads per driver pair
Input Power Rating:	2400 W, AES; two channels of 1200 W Recommended Amplifier per driver pair
Sensitivity:	103 dB, 1 W @ 1 m (3.3 ft.)
Input Connectors:	Barrier Strip
Dimensions (HxWxD):	1118 mm x 1118 mm x 623 mm (44 in. x 44 in. x 24.5 in.)
Net Weight:	136 kg (300 lbs.)
Shipping Weight:	145.2 kg (320 lbs.)
Model 5674-19/HF Mid Frequency:	2392 midrange horn 2490H midrange driver; 100 mm (4 in.) edgewound ribbon voice coil
Nominal impedance:	8 Ohms
Input Power Rating:	100 W, AES; 300 W Recommended Amplifier
Sensitivity:	114 dB, 1 W @ 1 m (3.3 ft.)
Net Weight:	28.35 kg (62.5 lbs.)
High Frequency:	2352 midrange horn 2451H midrange driver; 100 mm (4 in.) edgewound ribbon voice coil
Nominal impedance:	8 Ohms
Input Power Rating:	75 W, AES; 200 W Recommended Amplifier
Sensitivity:	112 dB, 1 W @ 1 m (3.3 ft.)
Net Weight:	7.26 kg (16 lbs.)
Mounting Accessories:	HF horn baffle board and mounting frame which couples MF and HF; mounts to LF enclosure for aiming/tilting

Axial Frequency Response, 1/3 octave resolution





SCREEN CHANNELS





SCREEN CHANNELS



C Edit Loudspeaker \ kinopolis_tipo11 - EASE 4.3

< C > ☒ Visible ☒ Image visible

Loudspeaker Label : C

Mirror Image :

Group Label :

Image Group :

Point of Reference : Angles :

x : 0.00 m hor : 180.0

y : 3.00 m ver : -8.7

z : 8.00 m rot : 0.0

Color : ...

Alignment (µsec) : 0.000

Delay (msec) : 0.000

Speaker Model : 5674 ...

☒ Show dB Cov. Cone

☐ Show Image dB Cov. Cone

Frequ.	Ele.Power	SPL (1m)
100 Hz	400.0	129.02
125 Hz	400.0	129.02
160 Hz	400.0	129.02
200 Hz	400.0	129.02
250 Hz	400.0	129.02
315 Hz	400.0	129.02
400 Hz	12.50	124.97
500 Hz	12.50	124.97
630 Hz	12.50	124.97
800 Hz	12.50	124.97
1000 Hz	12.50	124.97
1250 Hz	12.50	124.97
1600 Hz	12.50	124.97
2000 Hz	12.50	124.97
2500 Hz	10.71	122.30
3150 Hz	10.71	122.30
4000 Hz	10.71	122.30
5000 Hz	10.71	122.30
6300 Hz	10.71	122.30
8000 Hz	10.71	122.30
10000 Hz	10.71	122.30

Level

+10 dB All To Max

+1 dB Flat Max

-1 dB

-10 dB All Off

Insert Filter

Order : 1

Cut Off [Hz] : 1000

Insert Add

dB SPL (1m)

Max 140

112

84

56

28

0

125 250 500 1000 2000 4000 8000 Hz

Min

Max Curr 2400 W 2400 W 100 W 100 W 75 W 75 W

Graph

Cursor : Freq : 160 Hz SPL : 153,66 dB

Scale : Full ☐ As Head Room

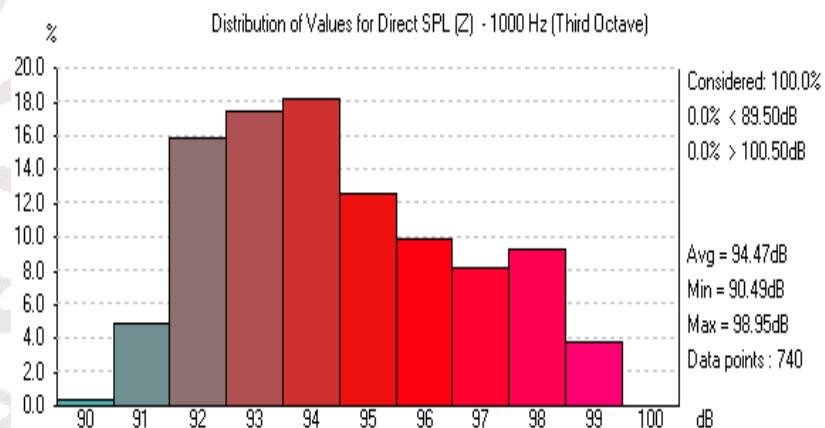
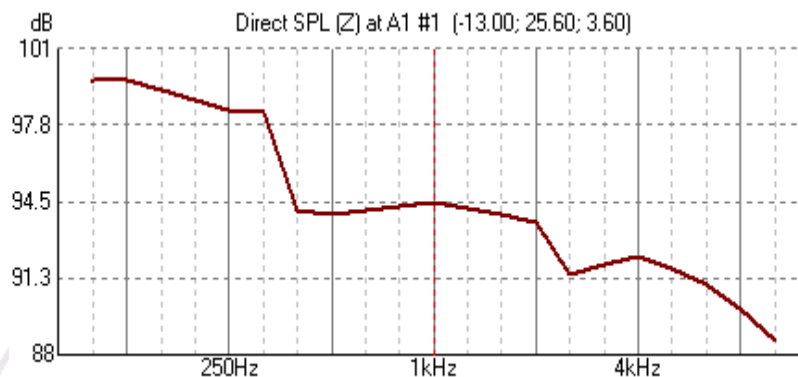
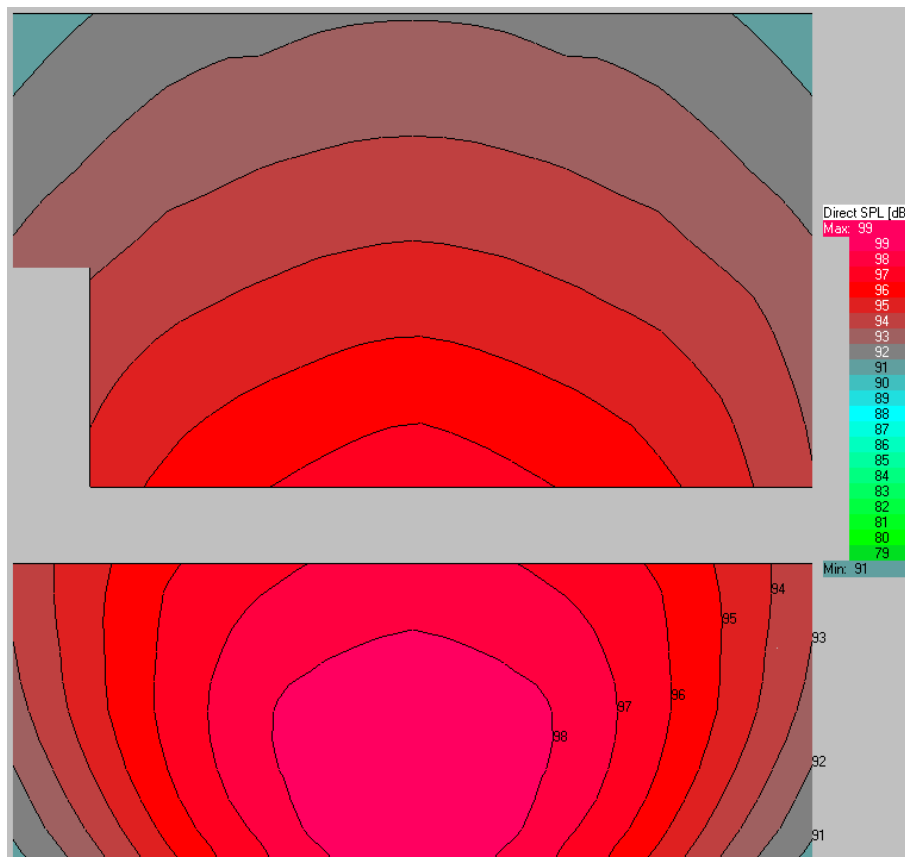
All To Sel. Sel. To Max

Load File Save File

Apply Ok Cancel

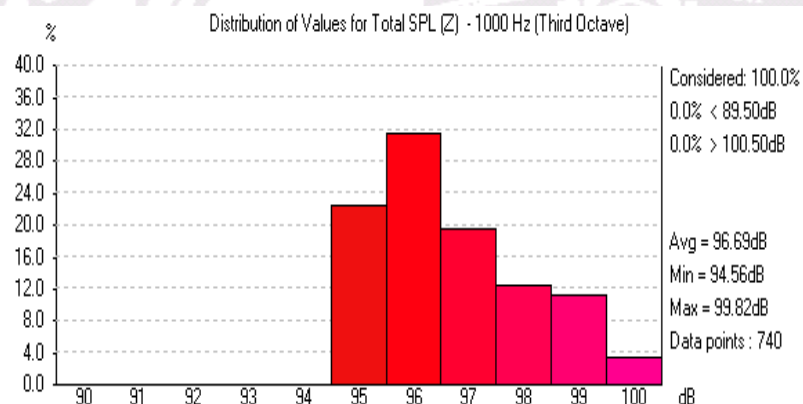
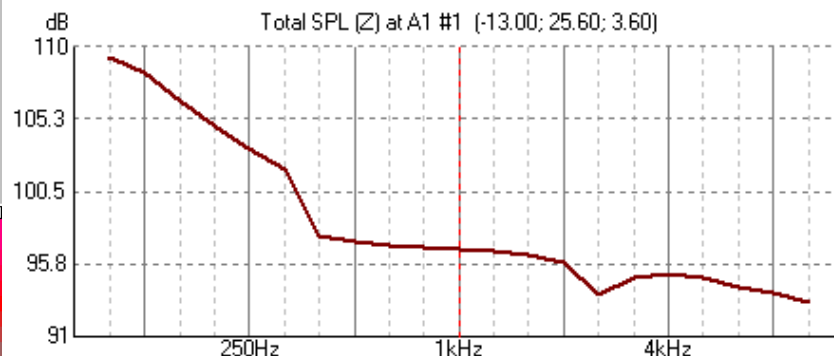
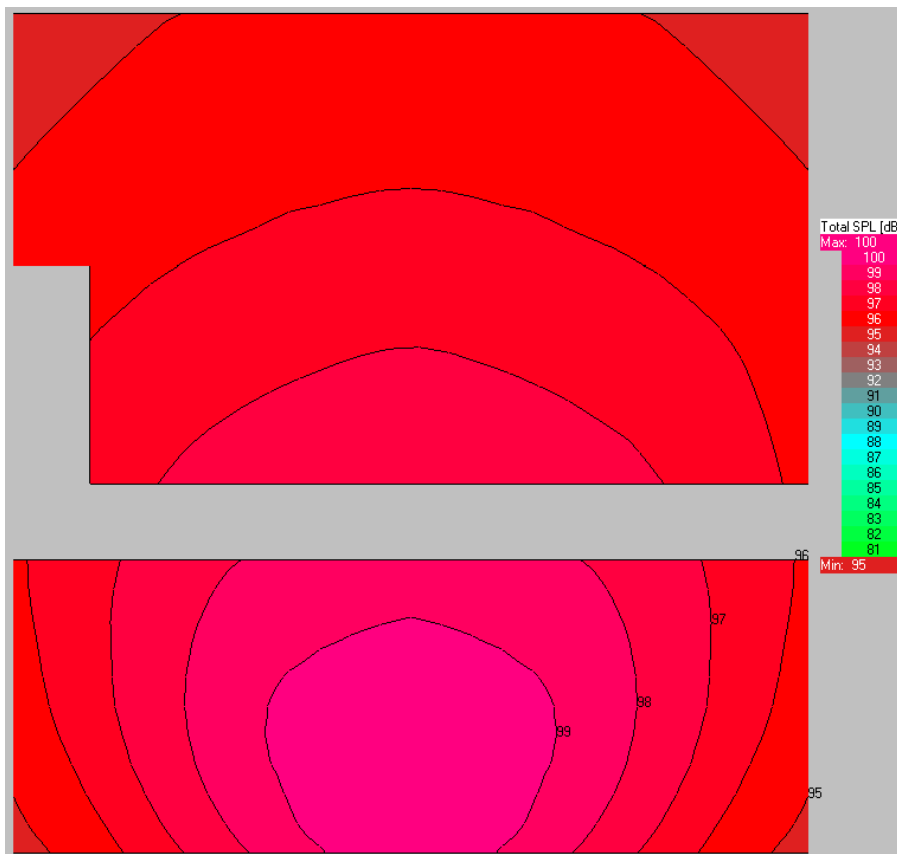


SCREEN CHANNELS





SCREEN CHANNELS

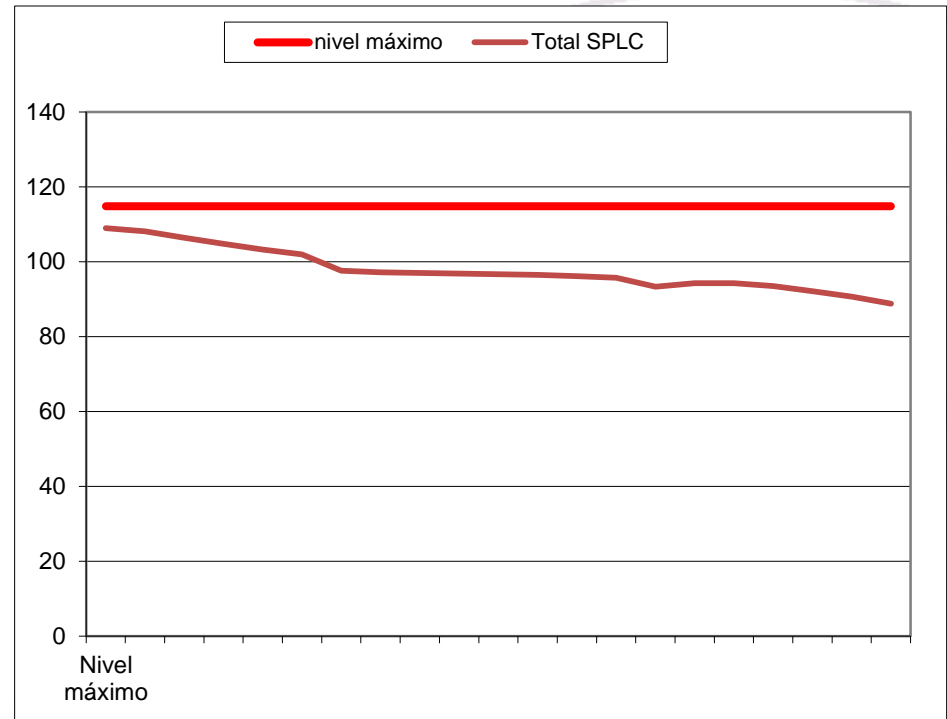




SCREEN CHANNELS



Altavoz C inicial				
Frequency	Direct SPL	Total SPL	curva C	Total SPLC
100 Hz	99,7	109,25	-0,30	108,95
125 Hz	99,69	108,34	-0,17	108,17
160 Hz	99,27	106,47	-0,08	106,39
200 Hz	98,85	104,83	-0,03	104,80
250 Hz	98,42	103,26	0,00	103,26
315 Hz	98,29	101,97	0,02	101,99
400 Hz	94,11	97,59	0,03	97,62
500 Hz	93,97	97,15	0,03	97,18
630 Hz	94,14	96,99	0,03	97,02
800 Hz	94,3	96,85	0,02	96,87
1000 Hz	94,47	96,69	0,00	96,69
1250 Hz	94,2	96,55	-0,03	96,52
1600 Hz	93,92	96,29	-0,09	96,20
2000 Hz	93,62	95,87	-0,17	95,70
2500 Hz	91,41	93,64	-0,30	93,34
3150 Hz	91,8	94,76	-0,50	94,26
4000 Hz	92,12	95,09	-0,83	94,26
5000 Hz	91,64	94,76	-1,29	93,47
6300 Hz	90,95	94,14	-1,99	92,15
8000 Hz	89,94	93,77	-3,05	90,72
10000 Hz	88,59	93,22	-4,41	88,81
Nivel en banda ancha [dBC]				114,86





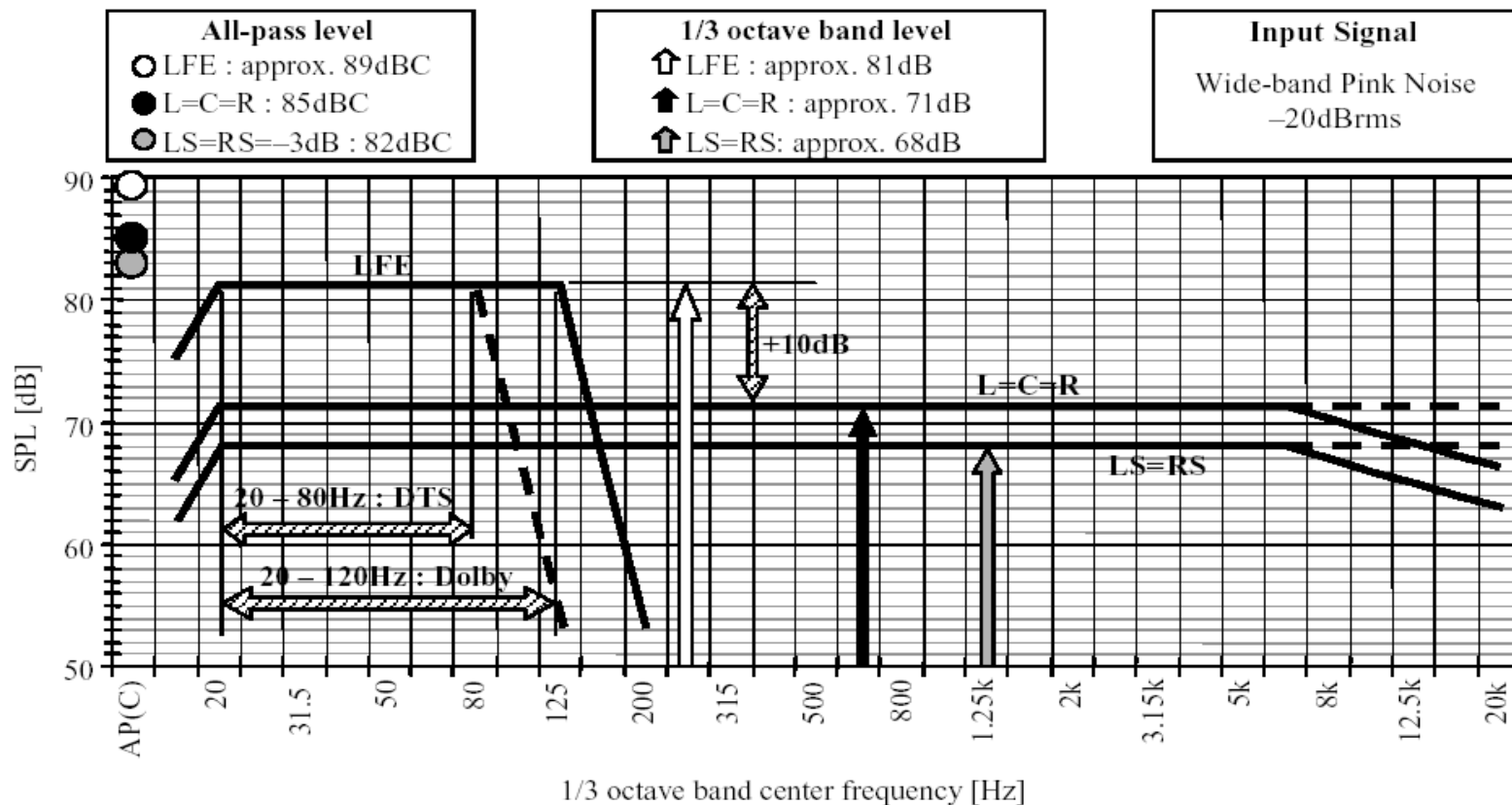
SCREEN CHANNELS



- The level of reference for dialogue in the film is 85 dBC (according to Dolby Laboratories).
- All digital cinema formats conform to make to a digital signal level of - 20 dBFS (relative to full scale level) a pressure level at a distance of 2/3 of the back of the room of 85 dBC.
- This will allow, to full scale of the digital signal, a 105 dBC sound pressure level, by channel, in the position previously specified (115 dBC for LFE channel).



SCREEN CHANNELS



[Level balance of the surround channels]

For film productions, set the playback level of the surround channels at -3 dB relative to the front channels.

In the case of $L = C = R = 85 \text{ dBC}$,

3-1: $LS = RS = 82 \text{ dB}$; in other words, $S (LS+RS) = 85 \text{ dBC}$

5.1: $LS = RS = 82 \text{ dBC}$

6.1: $LS = RS = BS = 82 \text{ dB}$

[X Curve of the B-Chain: SMPTE 202M-1998]



SCREEN CHANNELS



- The need for systems with response as more possible flat has dealt with systems of two or three ways, depending on the size of the room.
- The system of low frequency (LF) usually with type "bass-reflex" speakers and systems of medium/high frequency (MF/HF) with constant directivity horns attached to compression-ignition engines (normally equilized those of HF, for flat response above 3.5 kHz).



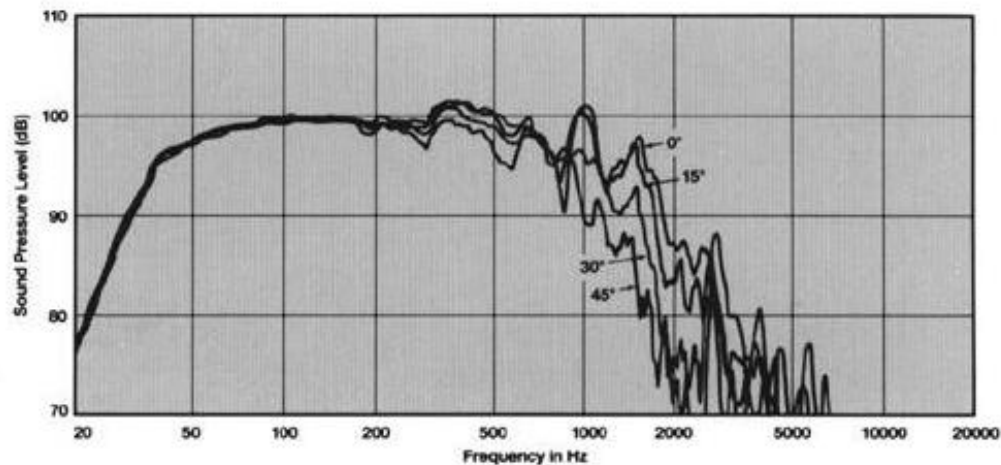
SCREEN CHANNELS



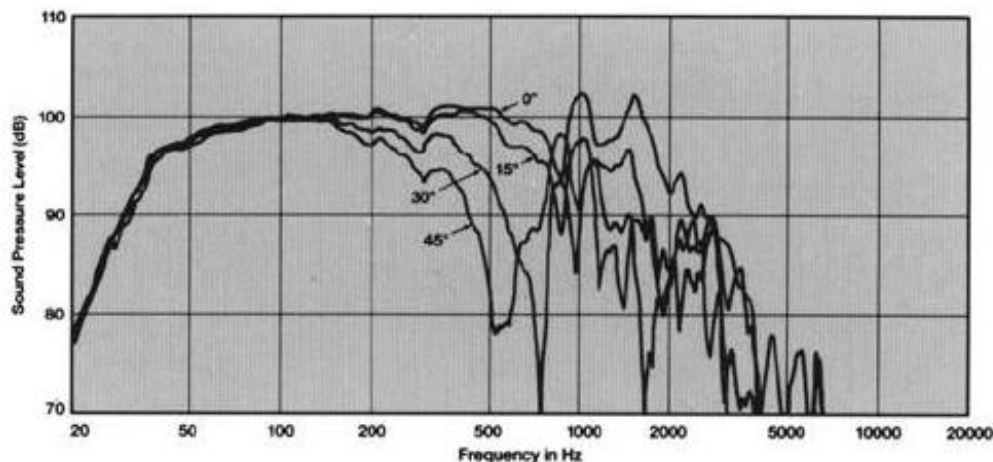
4648A



4648A system half-space (2π) response. 100 watts at one meter on-axis; distortion raised 20 dB.



4648A system horizontal off-axis response (0, 15, 30 and 45 degrees); one watt at one meter.





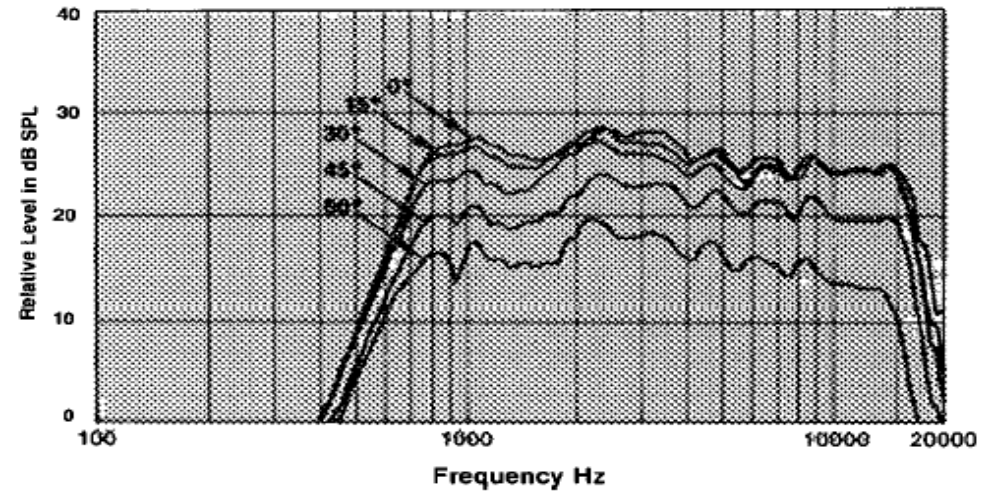
SCREEN CHANNELS



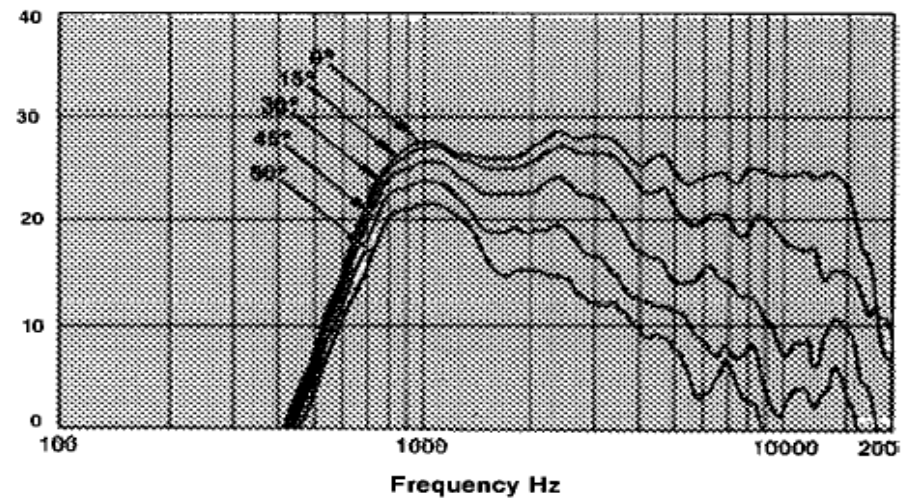
2370A



Horizontal Off-Axis Response



Vertical Off-Axis Response



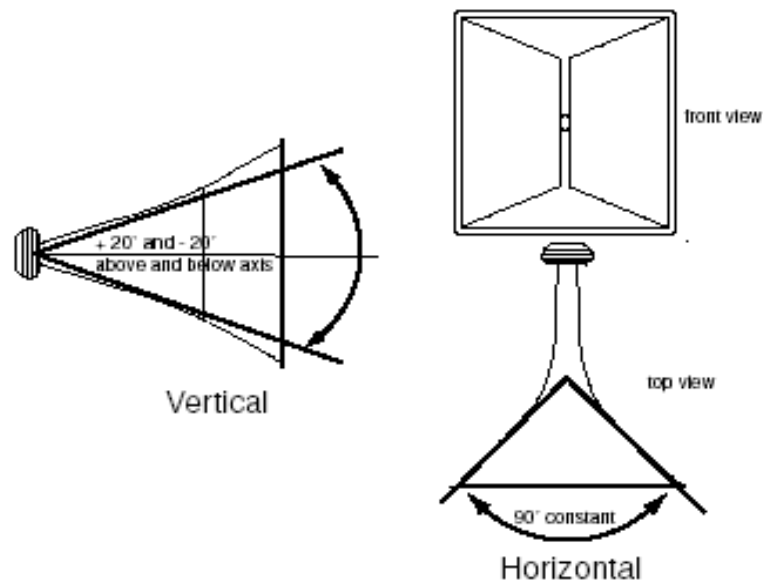


SCREEN CHANNELS

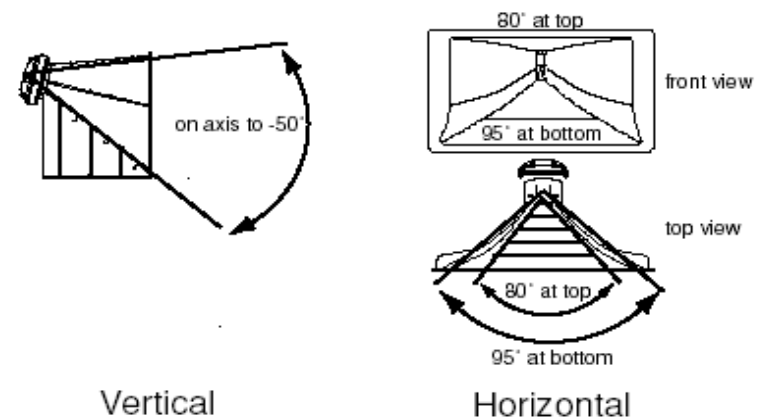


- The asymmetric speakers gets better coverage towards the back of the room and the lower part of the audience area without sending power to the ceiling, avoiding possible reflections that may worsen the intelligibility.

Conventional horn

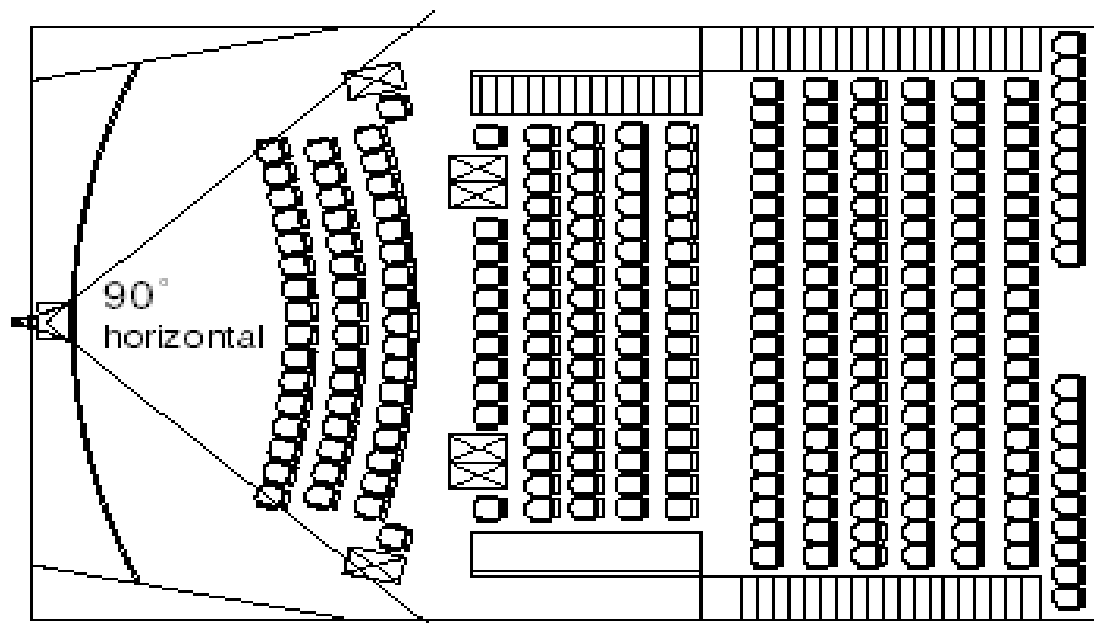
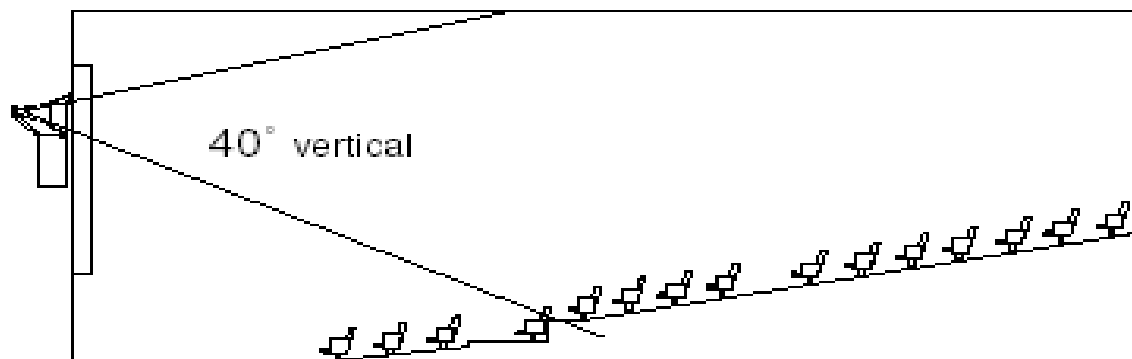


Asymmetric horn





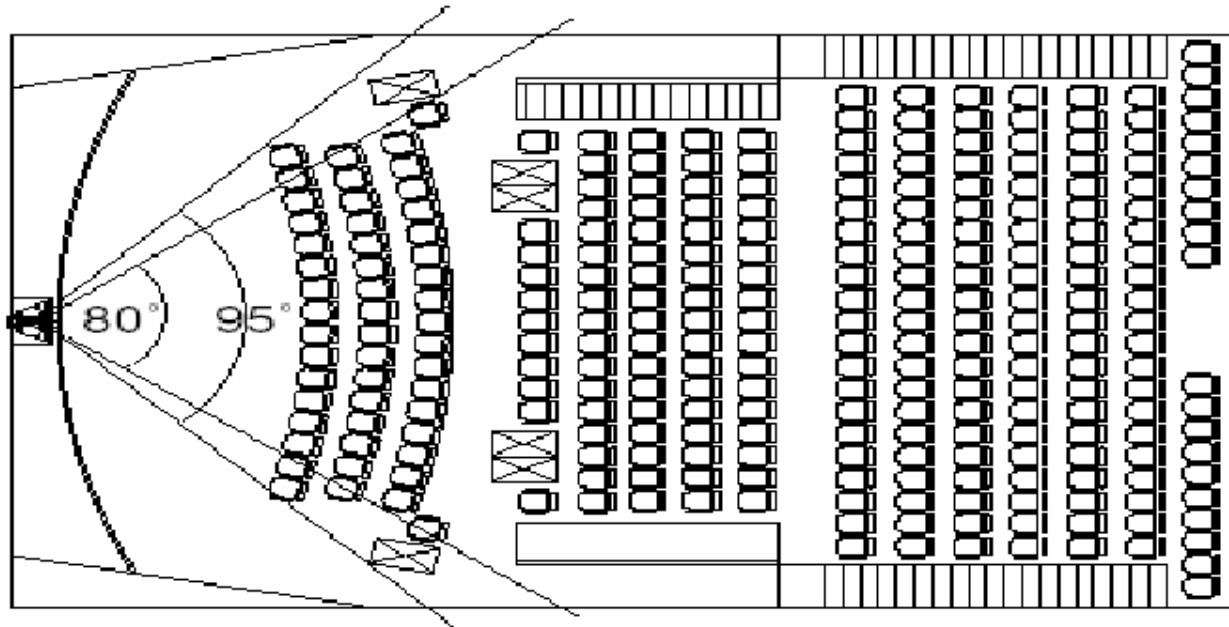
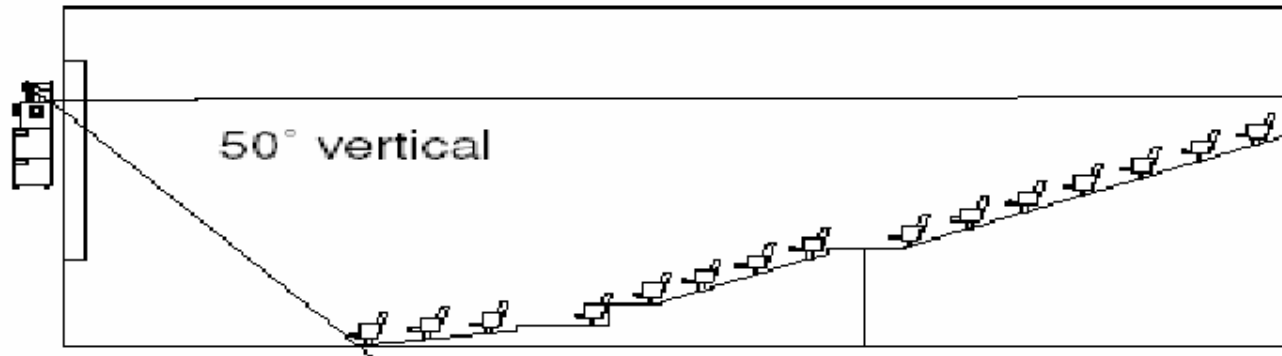
SCREEN CHANNELS



Elevation and plan view of cinema, illustrating conventional 40 by 90 coverage pattern.



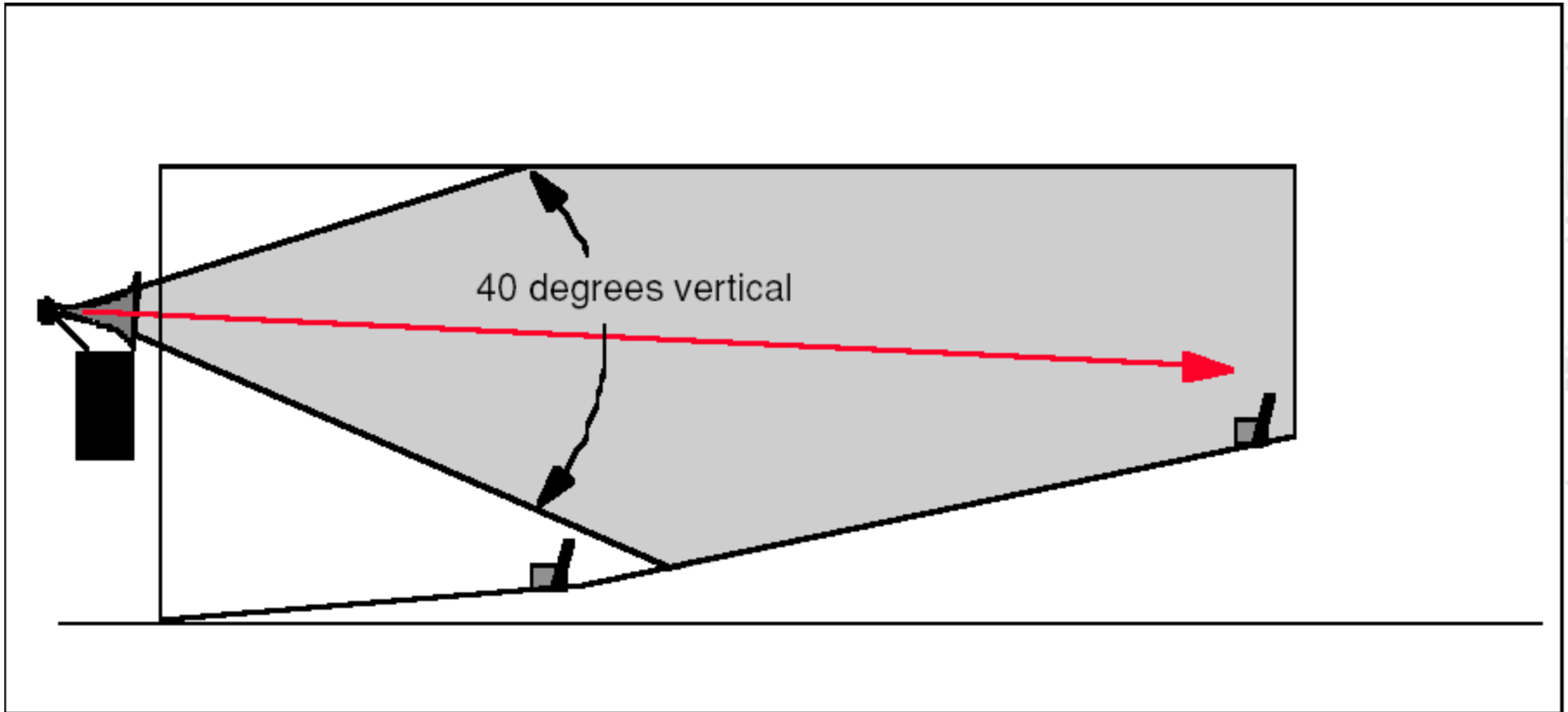
SCREEN CHANNELS



Asymmetrical horn in a stadium seating theatre.

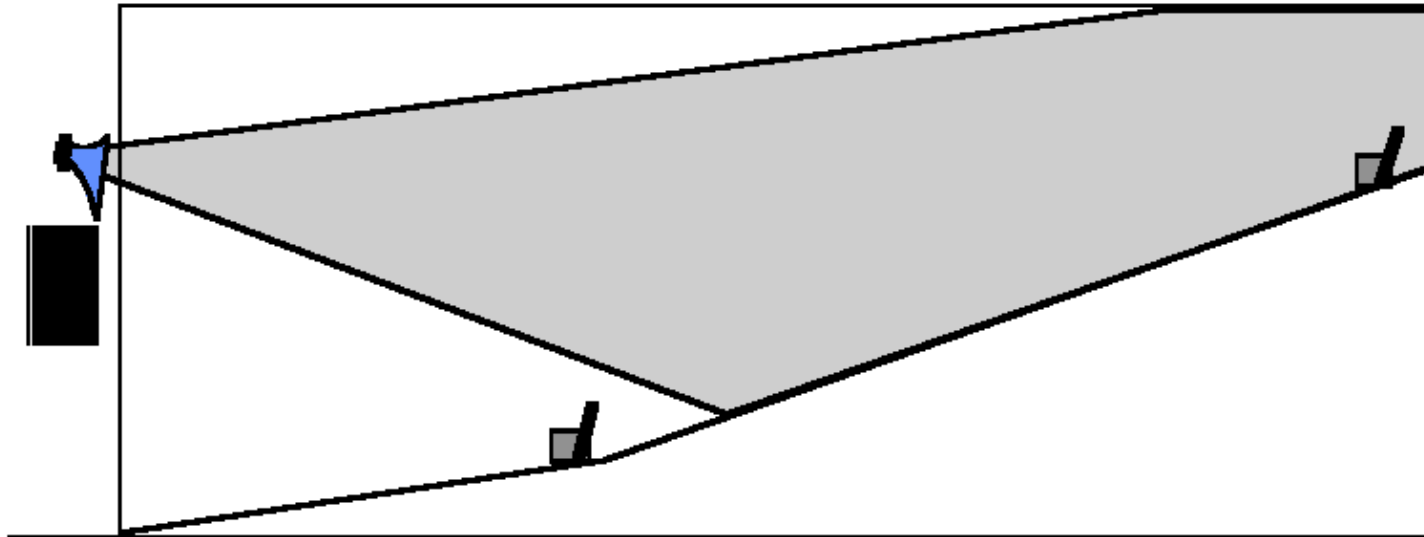


SCREEN CHANNELS



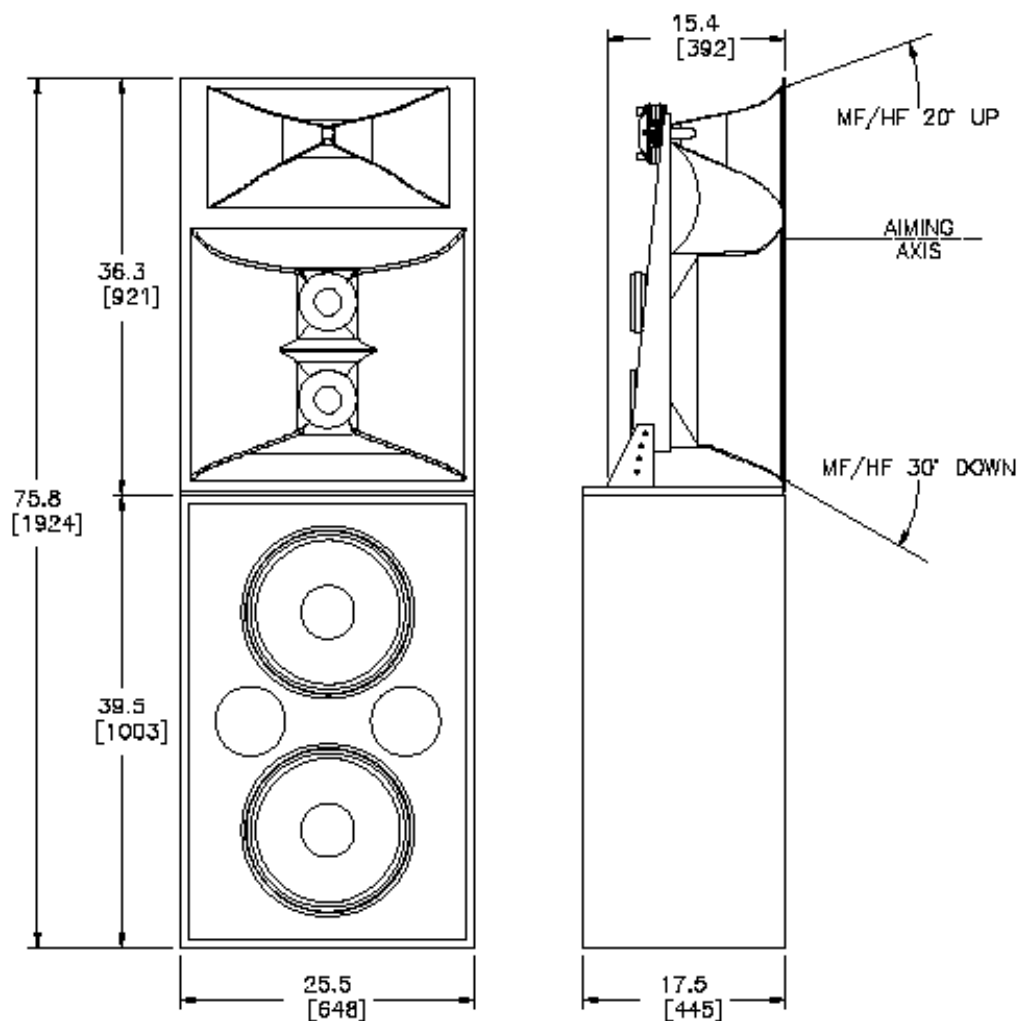


SCREEN CHANNELS





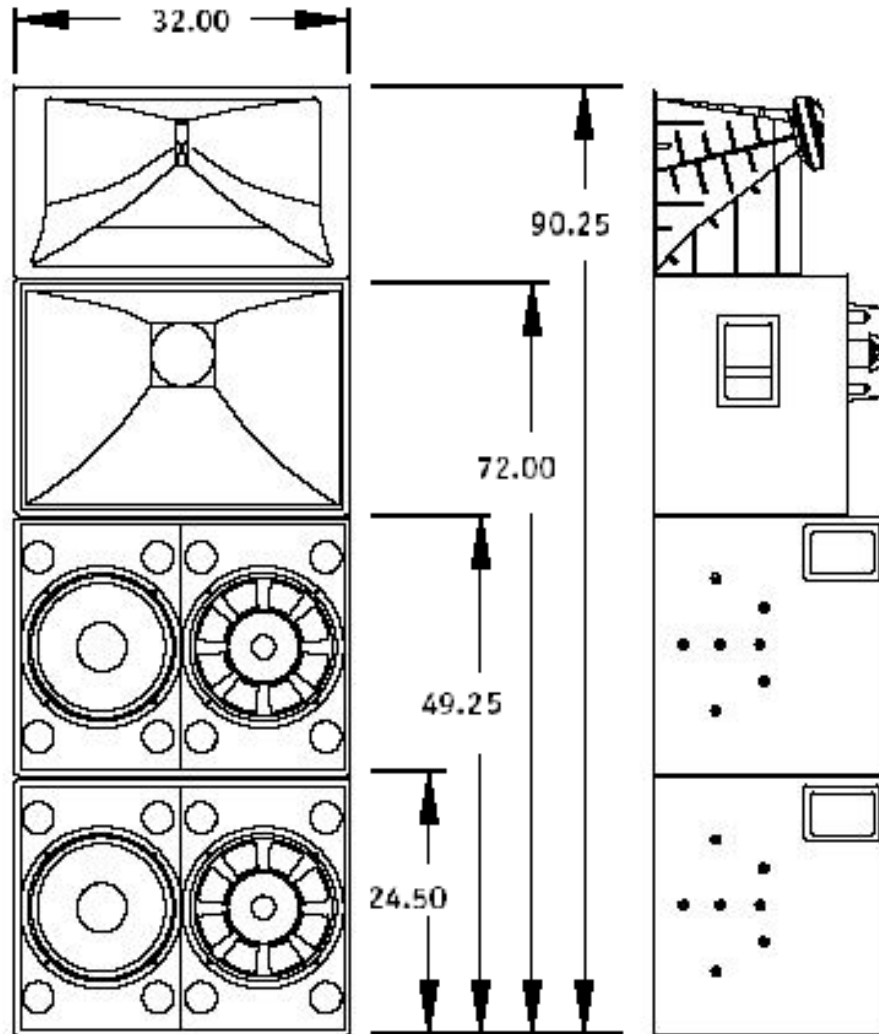
SCREEN CHANNELS



ElectroVoice Variplex II



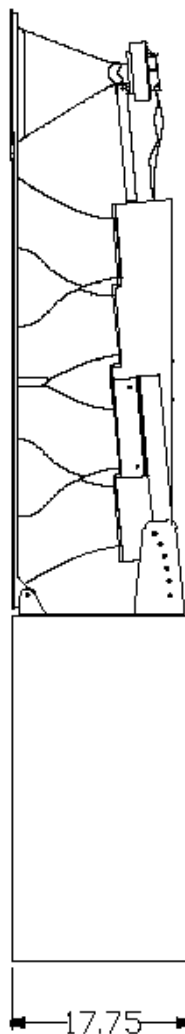
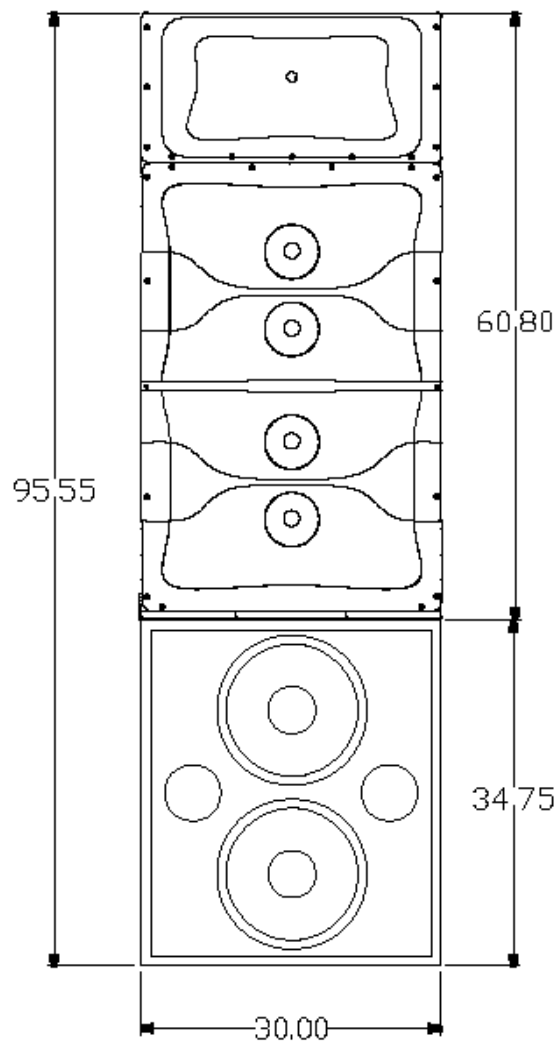
SCREEN CHANNELS



EAW CSC 923



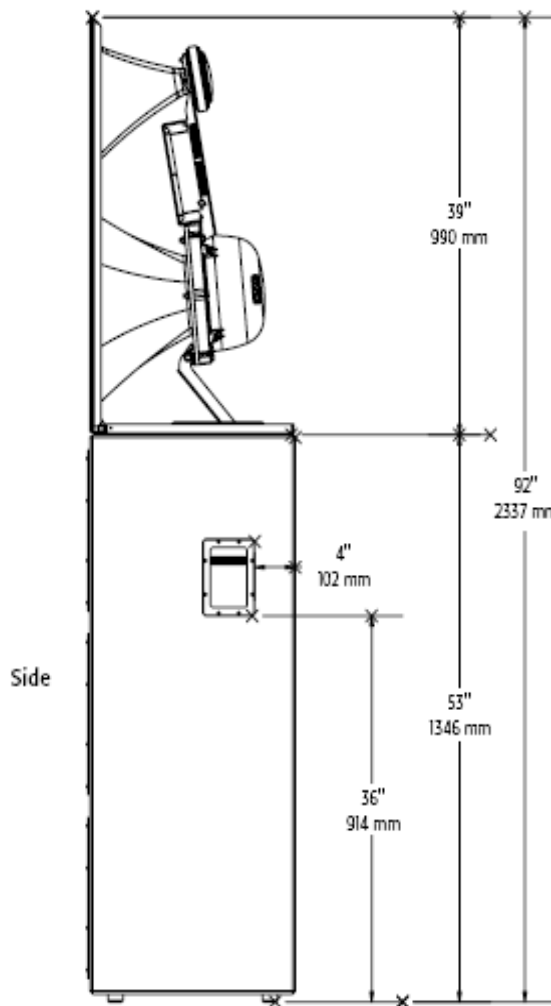
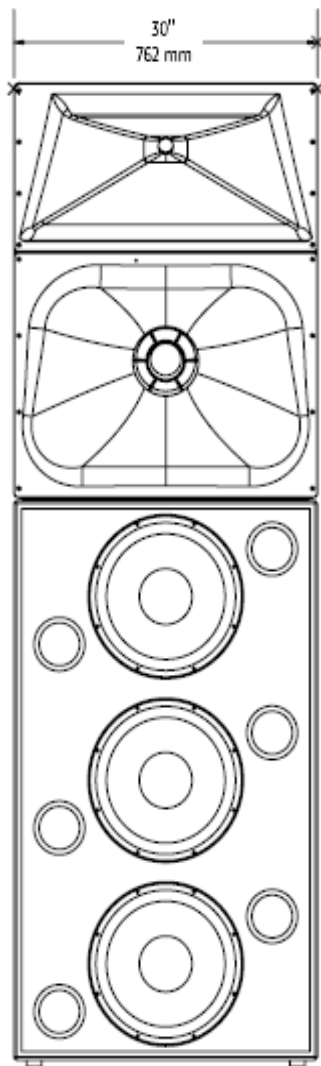
SCREEN CHANNELS



JBL ScreenArray 4632



SCREEN CHANNELS



QSC DSC 433



SCREEN CHANNELS



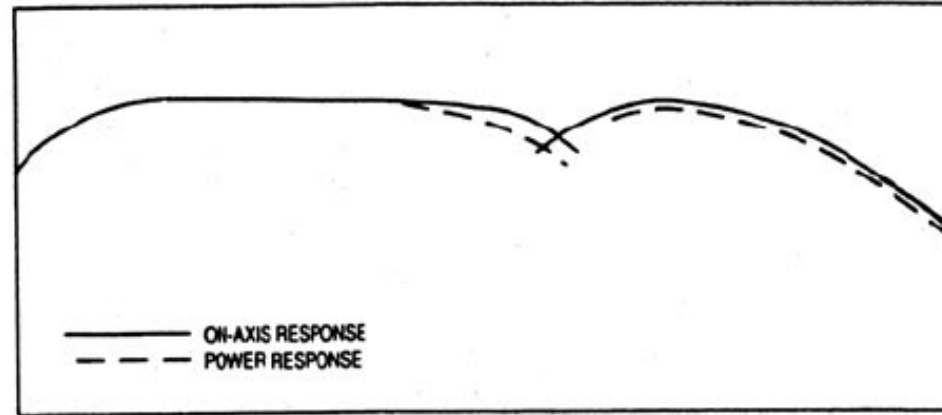
- Properly combining systems of those described above, are systems of two and three-way full range for use in cinemas, which keeps the beam width to - 6 dB at 500 Hz to 12.5 kHz 90° horizontal and 40° vertically. Low-frequency system is virtually Omni-directional frequency below 100 Hz.
- When a system such as the one described is equalized for cinema environment, you can check that both the direct field and the reverberant field has the same spectral characteristics. When you get this condition the sound reproduction is very natural.



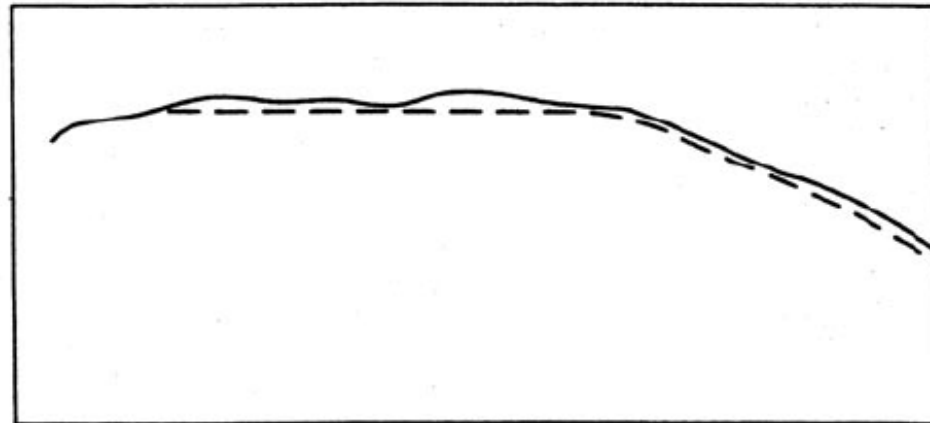
SCREEN CHANNELS



- Standard ISO 2969, known as curve X, is used for cinema equalization.



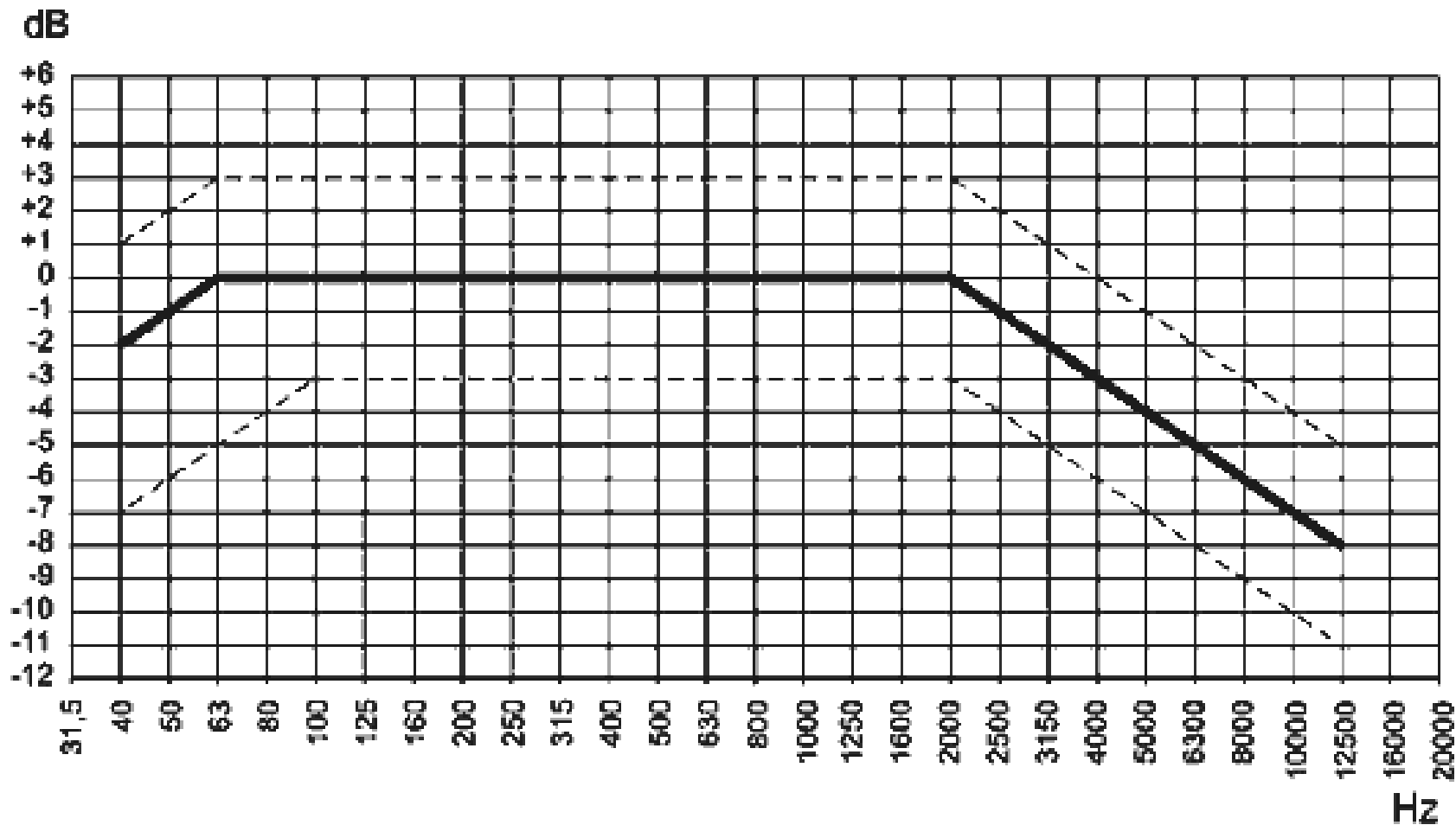
UNEQUALIZED



EQUALIZED



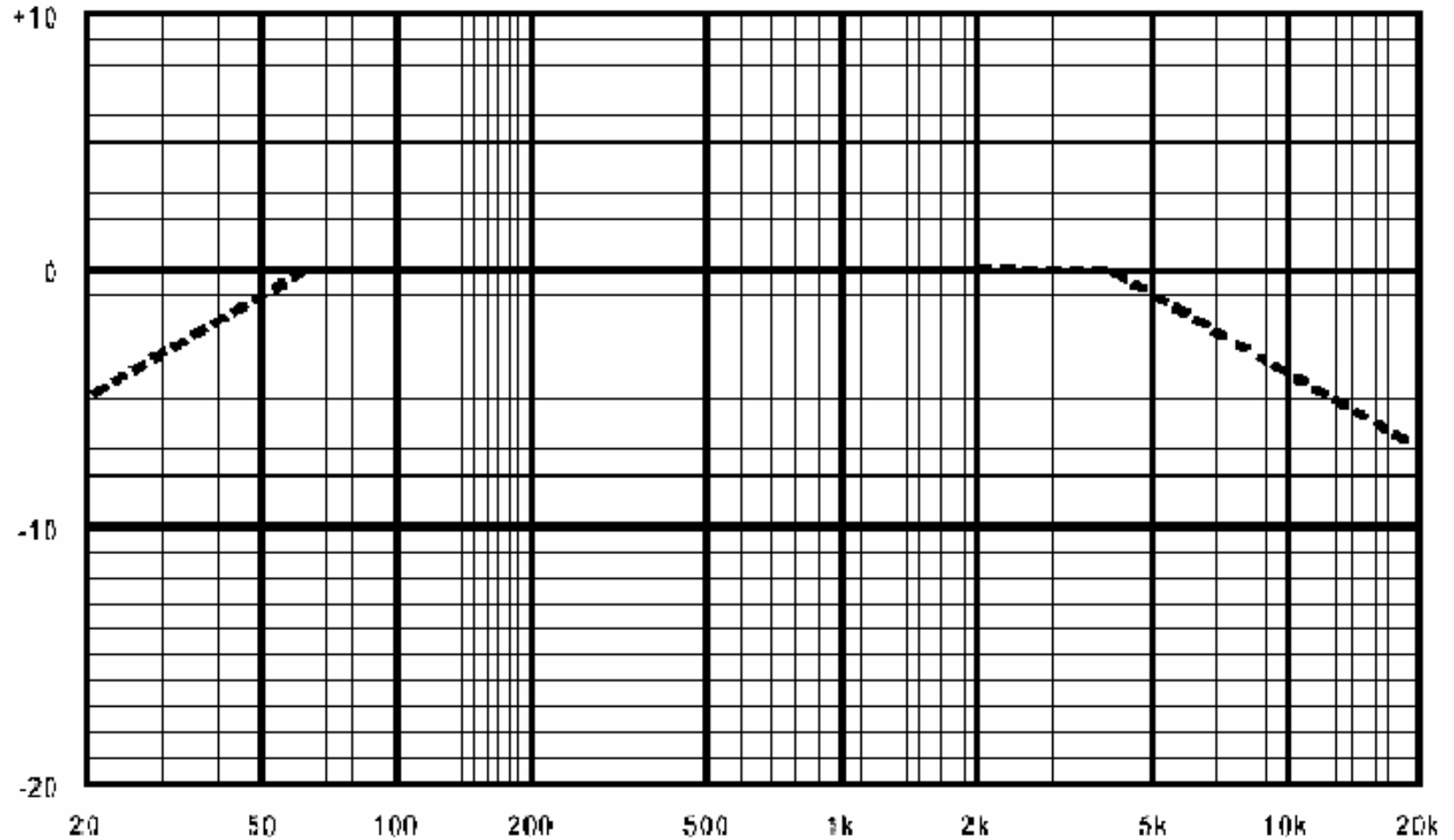
SCREEN CHANNELS



Ecualización ISO 2969 Curva-X



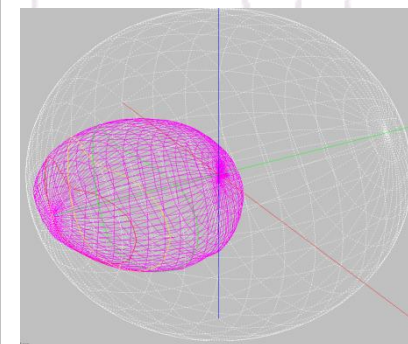
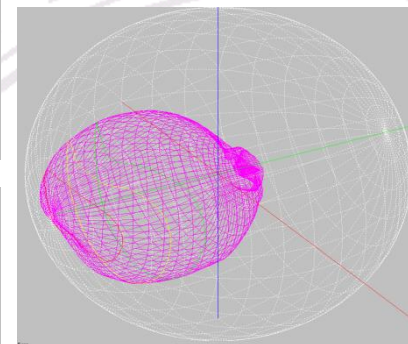
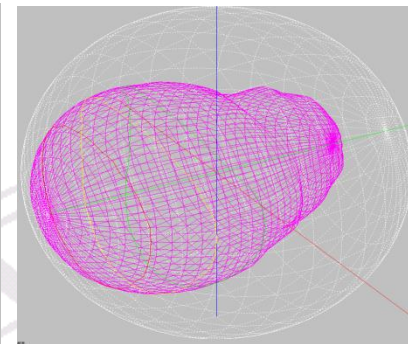
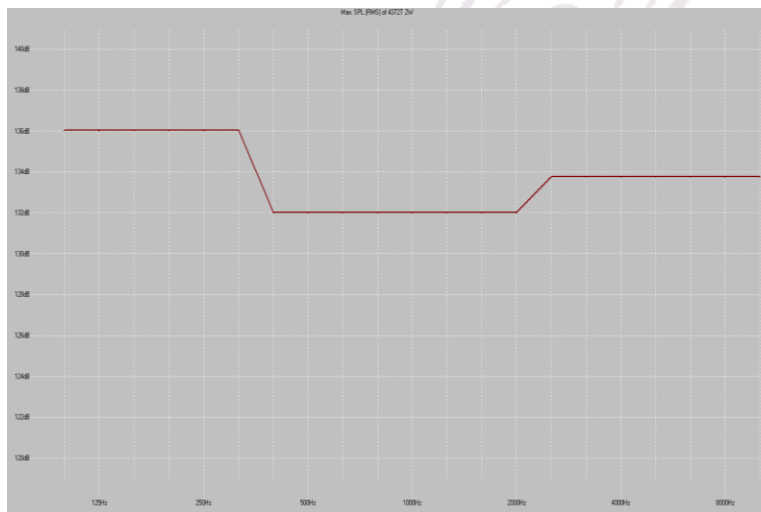
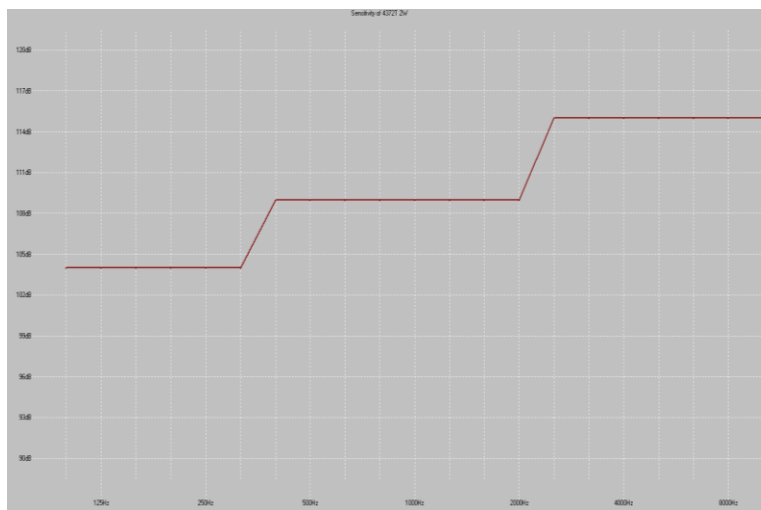
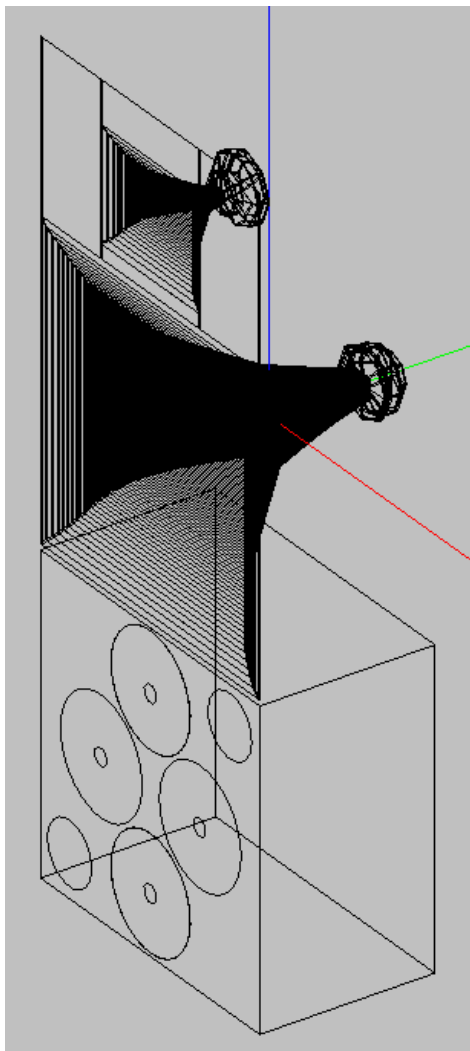
SCREEN CHANNELS



Ecualización Curva-X Salas Pequeñas



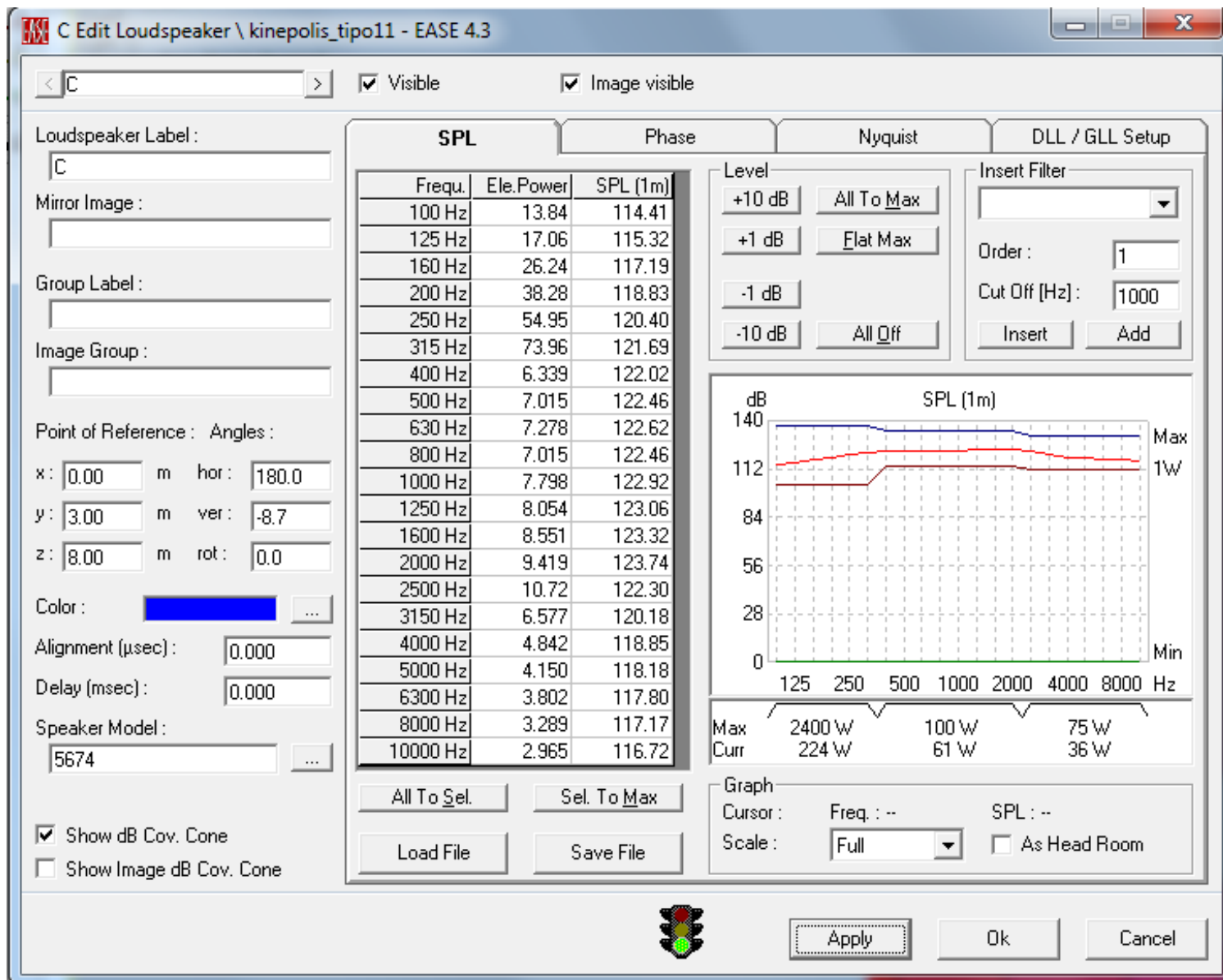
SCREEN CHANNELS



JBL 5674

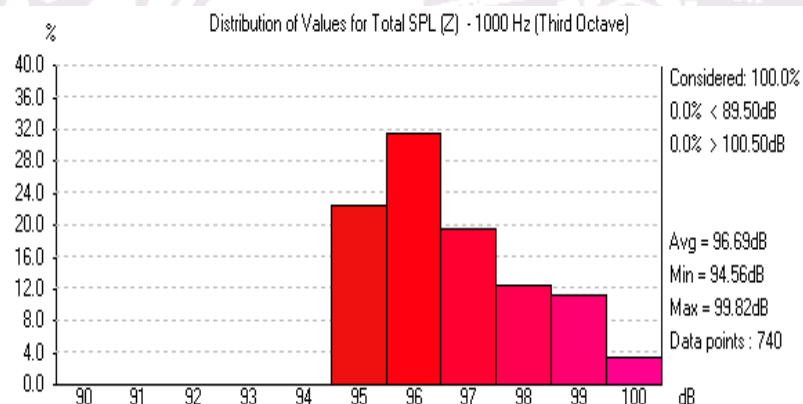
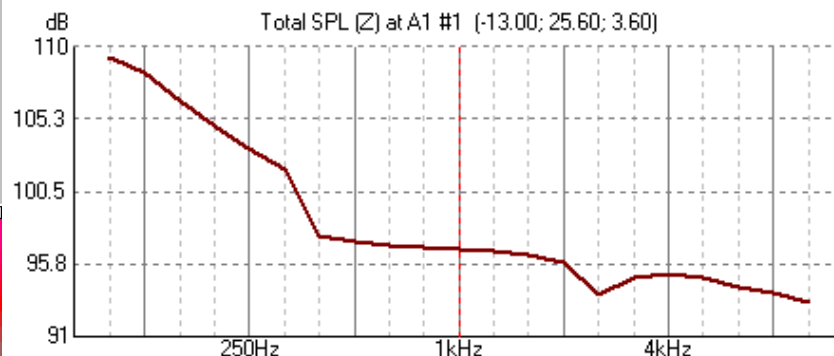
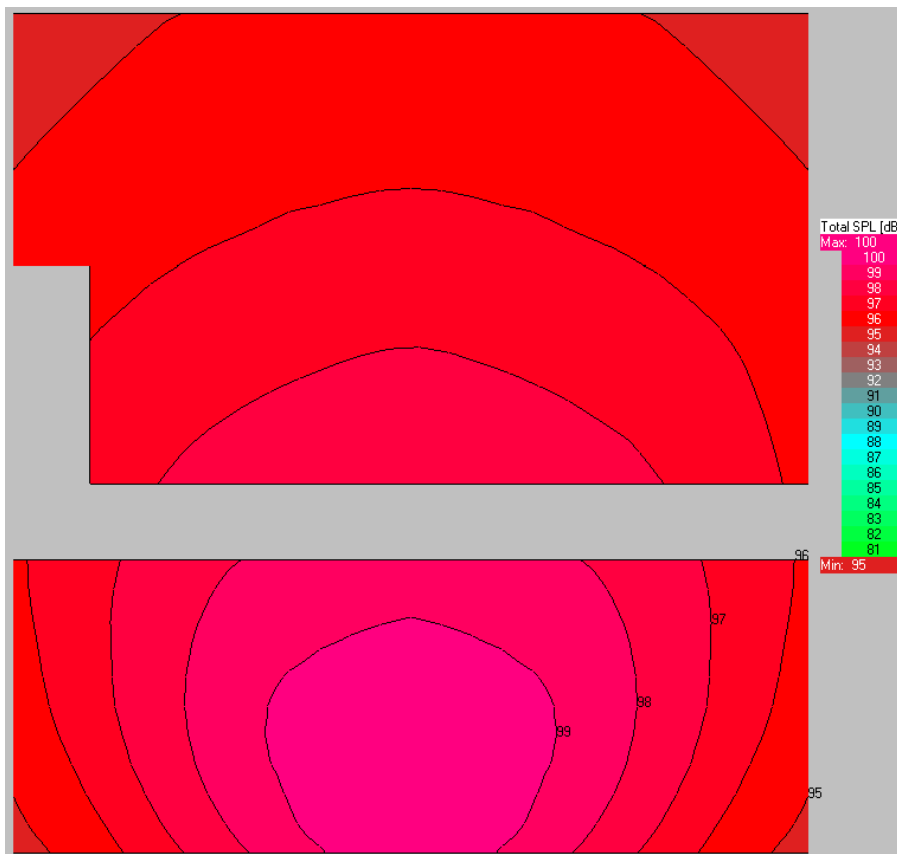


SCREEN CHANNELS





SCREEN CHANNELS

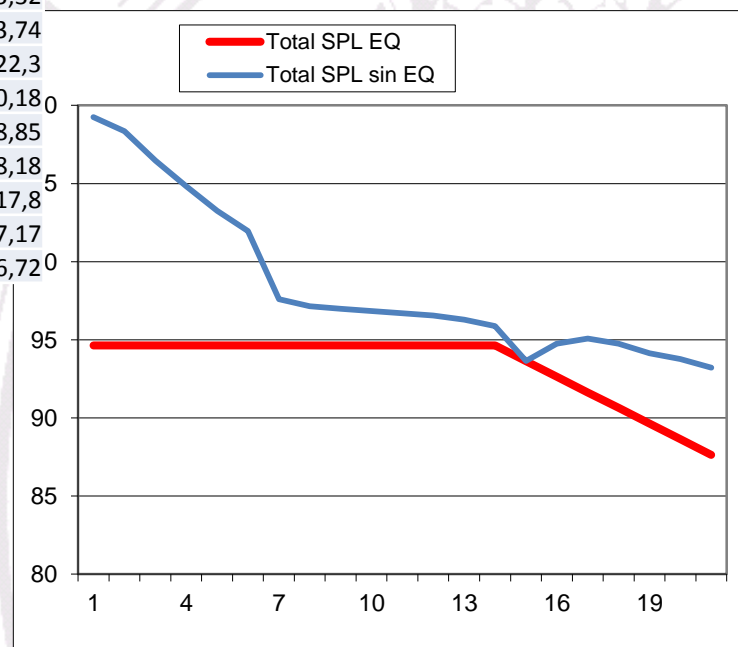




SCREEN CHANNELS

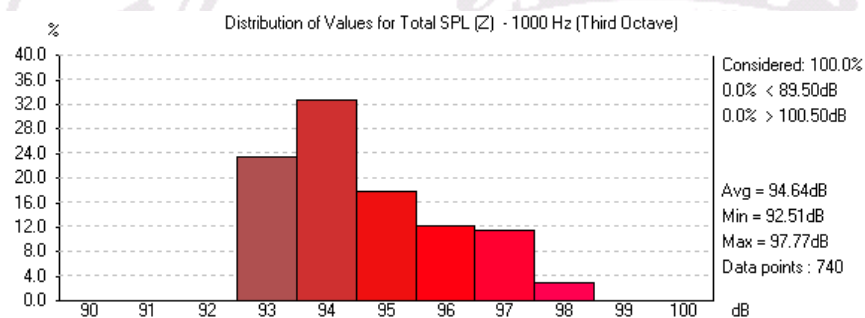
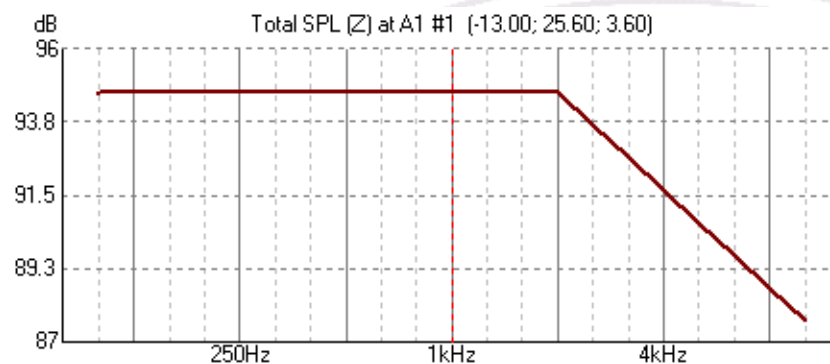
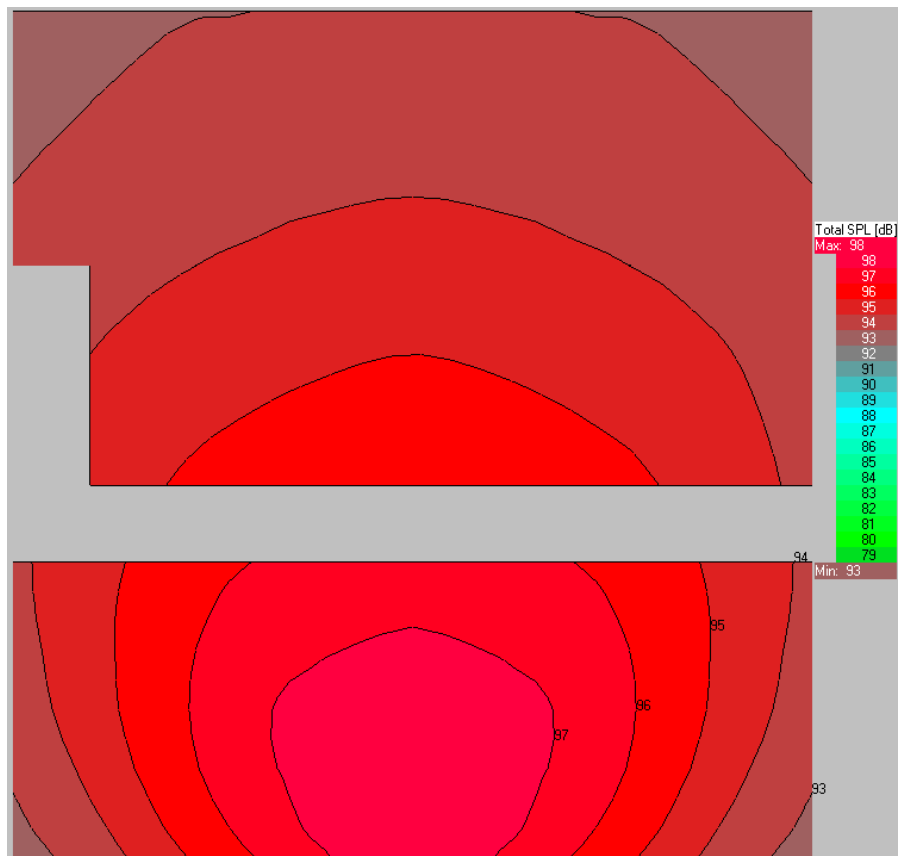


Frequency	Total SPL sin EQ	CurvaX	Atenuación	Total SPL EQ	SPL 1m sin EQ	SPL 1m EQ
100 Hz	109,25	0	-14,61	94,64	129,02	114,41
125 Hz	108,34	0	-13,7	94,64	129,02	115,32
160 Hz	106,47	0	-11,83	94,64	129,02	117,19
200 Hz	104,83	0	-10,19	94,64	129,02	118,83
250 Hz	103,26	0	-8,62	94,64	129,02	120,4
315 Hz	101,97	0	-7,33	94,64	129,02	121,69
400 Hz	97,59	0	-2,95	94,64	124,97	122,02
500 Hz	97,15	0	-2,51	94,64	124,97	122,46
630 Hz	96,99	0	-2,35	94,64	124,97	122,62
800 Hz	96,85	0	-2,21	94,64	124,97	122,76
1000 Hz	96,69	0	-2,05	94,64	124,97	122,92
1250 Hz	96,55	0	-1,91	94,64	124,97	123,06
1600 Hz	96,29	0	-1,65	94,64	124,97	123,32
2000 Hz	95,87	0	-1,23	94,64	124,97	123,74
2500 Hz	93,64	-1	0	93,64	122,3	122,3
3150 Hz	94,76	-2	-2,12	92,64	122,3	120,18
4000 Hz	95,09	-3	-3,45	91,64	122,3	118,85
5000 Hz	94,76	-4	-4,12	90,64	122,3	118,18
6300 Hz	94,14	-5	-4,5	89,64	122,3	117,8
8000 Hz	93,77	-6	-5,13	88,64	122,3	117,17
10000 Hz	93,22	-7	-5,58	87,64	122,3	116,72





SCREEN CHANNELS

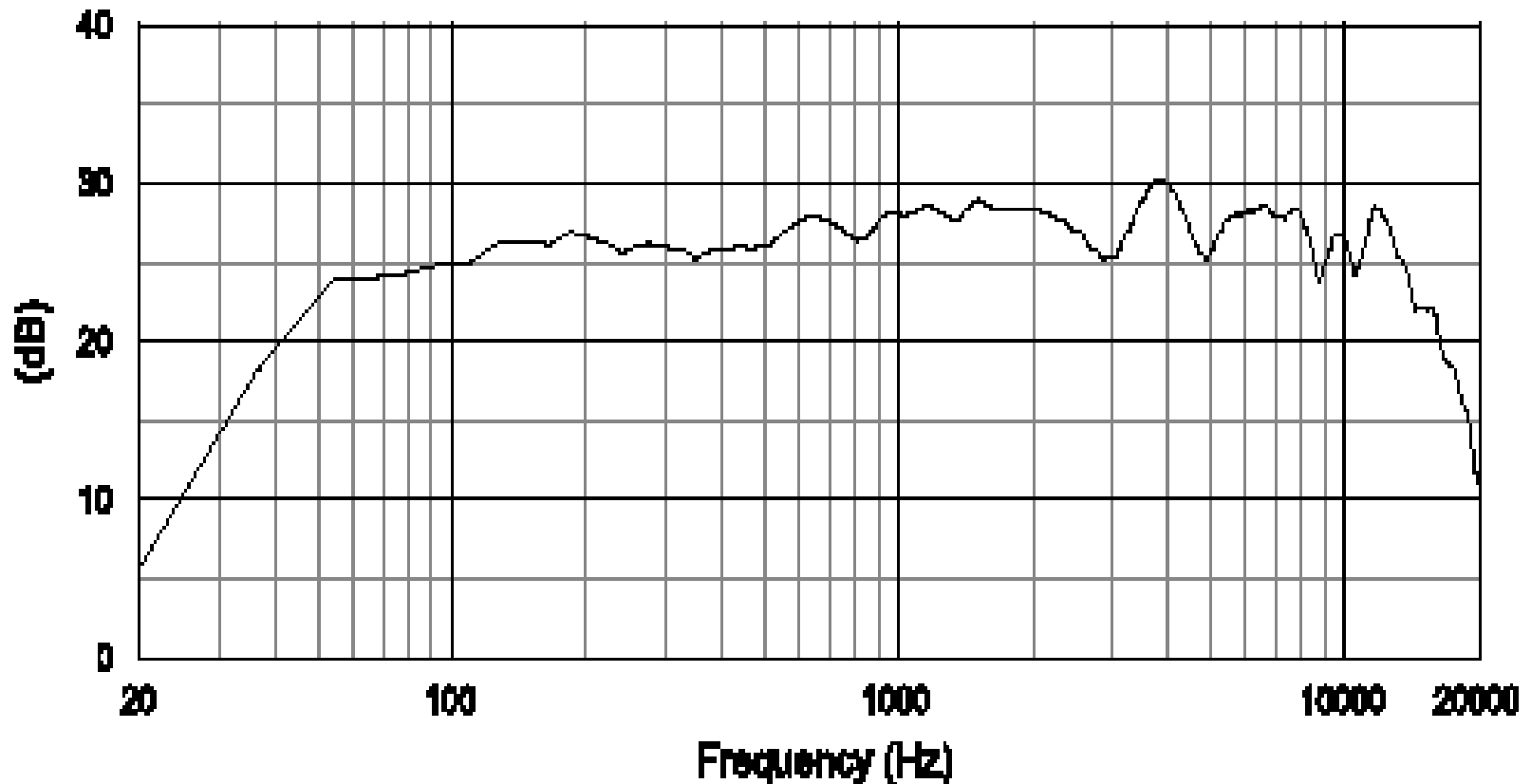




SCREEN CHANNELS

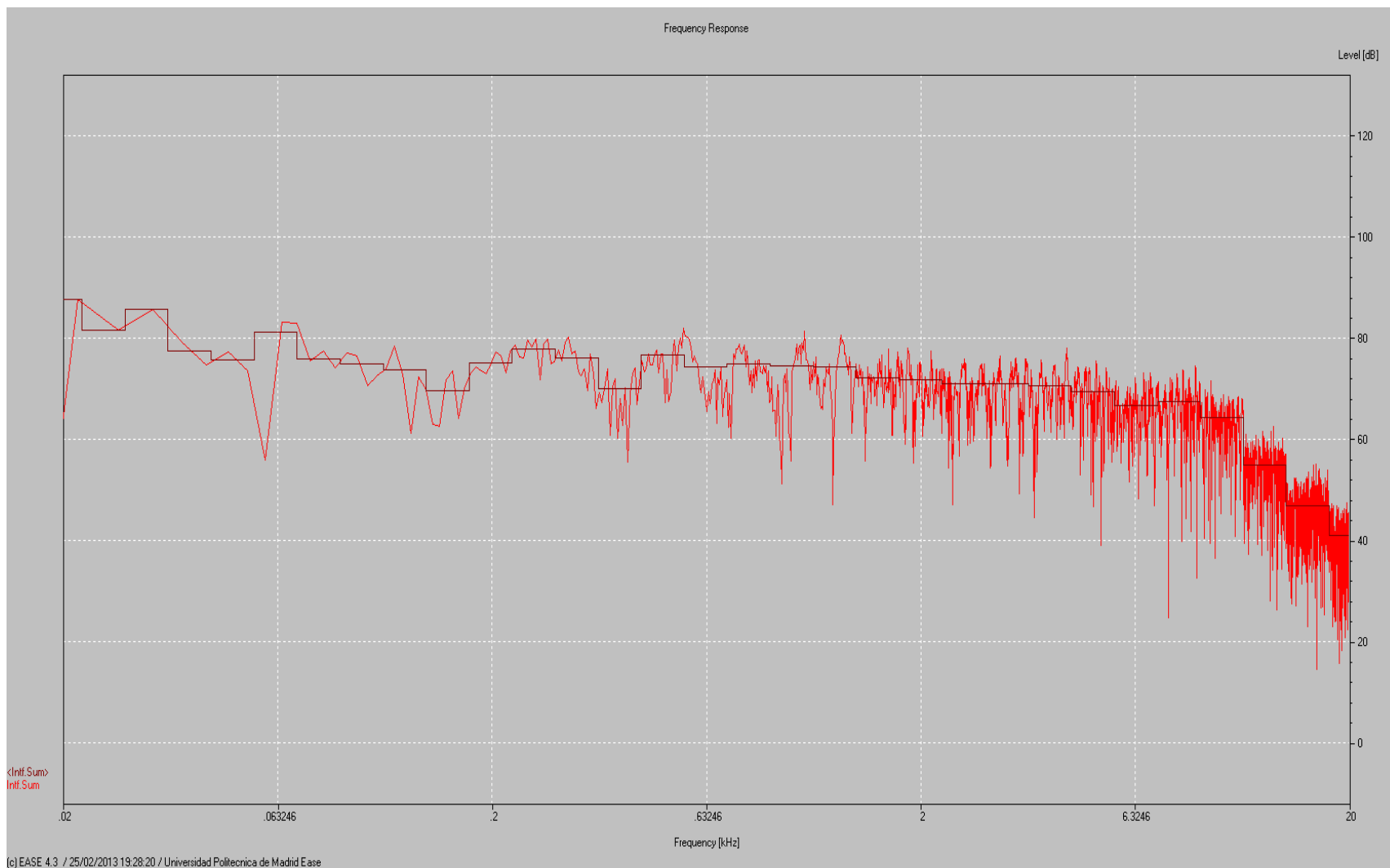


Axial Frequency Response, 1/3 octave resolution





SCREEN CHANNELS





SCREEN CHANNELS



- With these considerations in mind, the dimension of the calibration point of the room "sweet point" may be defined (at 2/3 of the total length of the same), depending on the dimensions of the same.

Asientos	Volumen	2/3 Longitud	Longitud
75-125	695 m ³ (25000 ft ³)	12.0 m (40.0 ft)	18.0 m (60.0 ft)
125-250	1390 m ³ (50000 ft ³)	14.2 m (47.0 ft)	21.3 m (70.5 ft)
250-500	2780 m ³ (100000 ft ³)	16.4 m (54.0 ft)	26.6 m (81.0 ft)
500-1000	5560 m ³ (200000 ft ³)	18.0 m (60.0 ft)	27.0 m (90.0 ft)



SCREEN CHANNELS



- It is known that the digital sound system should be capable of producing 105 dB peak levels, and by applying the law of the spherical divergence we can calculate the maximum signal level that will produce display systems (per channel) at different distances.
- When all screen systems are running at maximum power, the total level in adds approximately 5 dB for three channels systems (L, C, R) and 7 dB for five channel systems (L, CL, CR, C, R).



SCREEN CHANNELS



JBL Output Capabilities of 3000,4000 and 5000 Series Loudspeakers:

Model:	Sensitivity:	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
5671	97 dB	600 W	124.8	103	101.7	100.5	99.7
5672	100 dB	1200 W	130.8	109	107.7	106.5	105.7
5674	103 dB	2400 W	136.6	115	113.7	112.5	111.7



SCREEN CHANNELS



- Normally, the sound system calibration in the room usually with a peak level 95 dB channel, but leaving a margin of overload ("headroom") of 6 to 8 dB above this value, that we approaching the value of 105 dB established as a maximum level of digital system.
- As it is already mentioned above, the position of the display systems has to be such that the center of the MF or HF systems is $\frac{2}{3}$ of the total height of the screen.



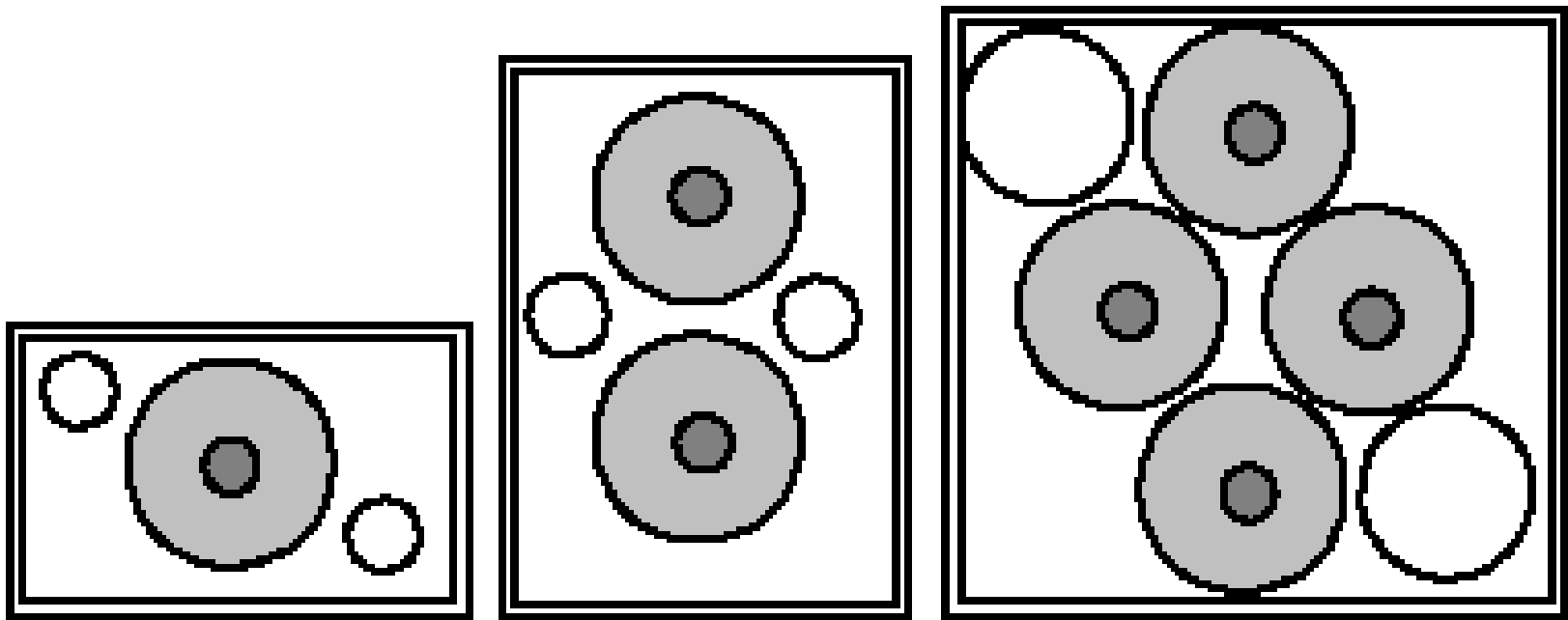
SCREEN CHANNELS



- Bass (LF) speakers 15" with sensitivities in the range of 95 - 97 dB SPL (*1 W @ 1 m @ on axis*).
- LF speakers with power rating in the range of 400 - 600 W per unit.
- Middle-frequency speakers (MF) and high frequency speakers (HF) with similar sensitivities to the LF speakers.
- For rooms up to 200 seats, you must choose systems with a LF speaker per channel. For rooms between 200 and 500 seats, you must choose systems with two LF speakers per channel. For rooms with more than 500 seats, you must choose systems with four LF speakers per channel.



SCREEN CHANNELS





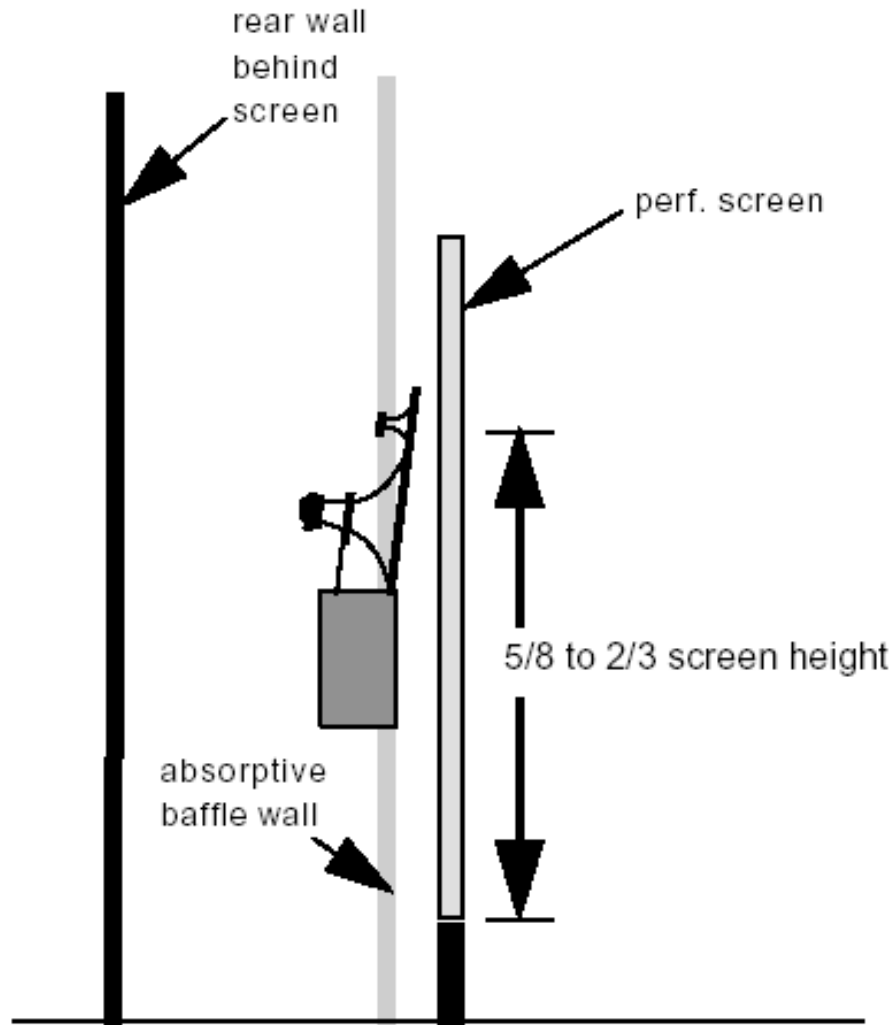
SCREEN CHANNELS



- You can always specify a system oversized for a room more small, but never backward.
- Most of the commercial theaters doubled LF 15" speakers regardless of the dimensions of the room.
- Separate channels horizontally to fit the width of the screen.
- Raise the systems so that the HF units are $\frac{2}{3}$ of the screen height.
- Place systems so that HF units are closer from the screen as possible (5-7 cm).
- Pintar todas las superficies reflectantes de los sistemas con pintura negra mate.



SCREEN CHANNELS



The assembly of the system elements must not have moving parts that can sound and all vertical surfaces that are exposed are covered with absorbent material.



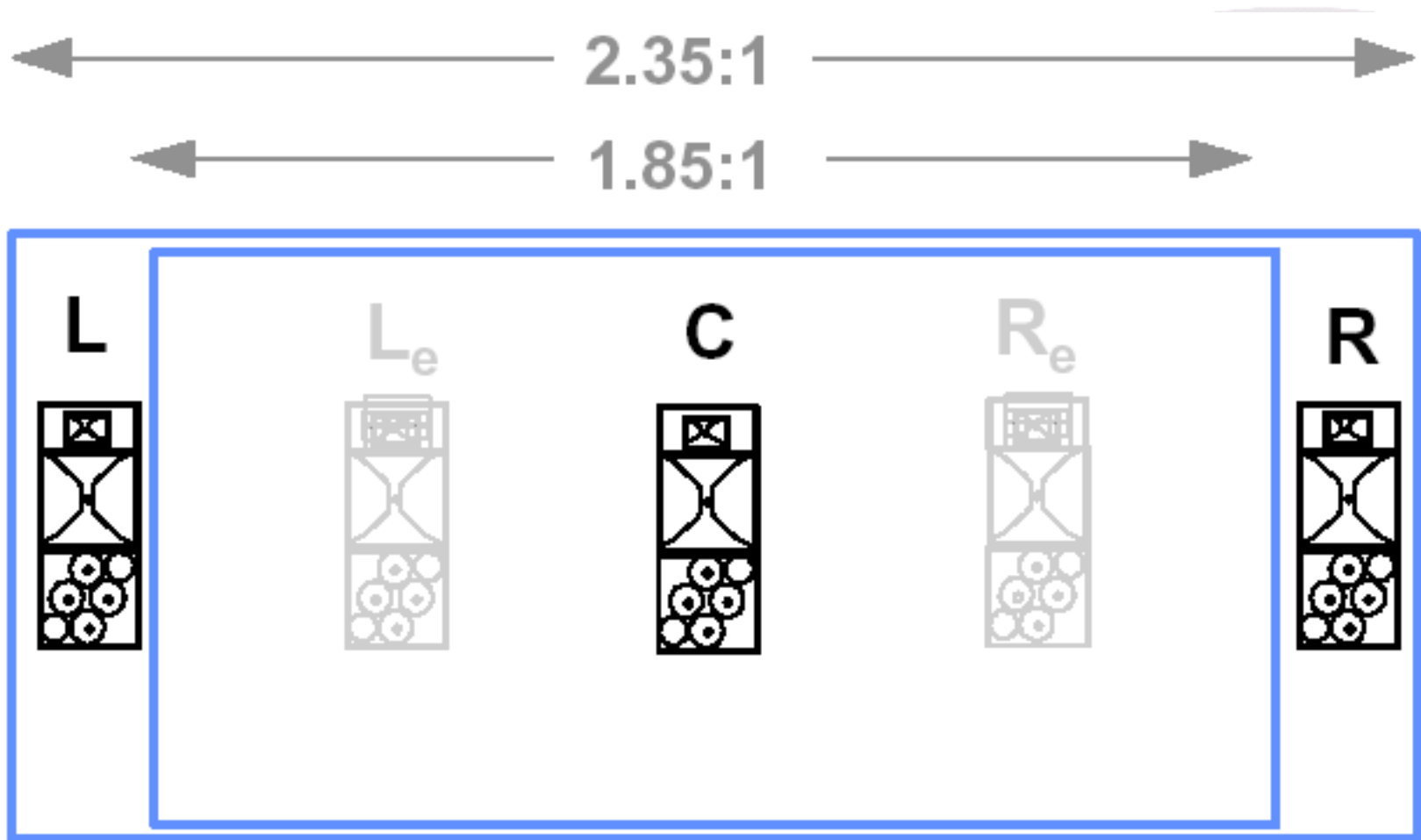
SCREEN CHANNELS



- Para sistemas de tres canales (L, C, R), los canales L y R se colocarán equidistantes del canal central de manera queden en los extremos de la pantalla de mayor anchura (relación de aspecto 2.35: 1).
- Estos altavoces quedarán en el exterior de la pantalla con menor anchura (relación de aspecto 1.85). Se suelen ocultar con una máscara de tela negra transparente al sonido de la misma altura la pantalla.
- En los sistemas de cinco canales (L, LC, C, RC, R), los canales adicionales LC y RC se colocarán equidistantes de L-C y R-C, respectivamente.

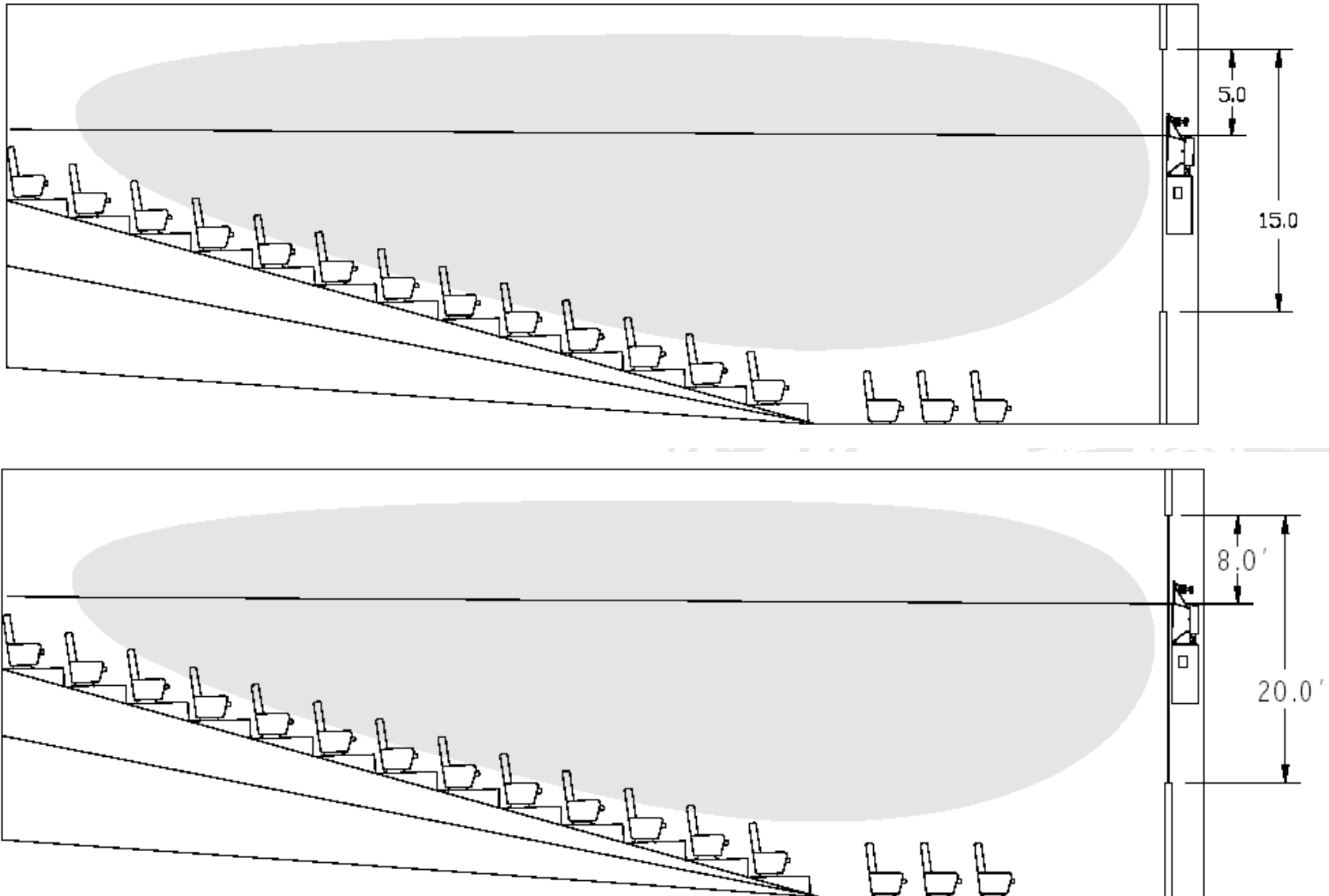


SCREEN CHANNELS



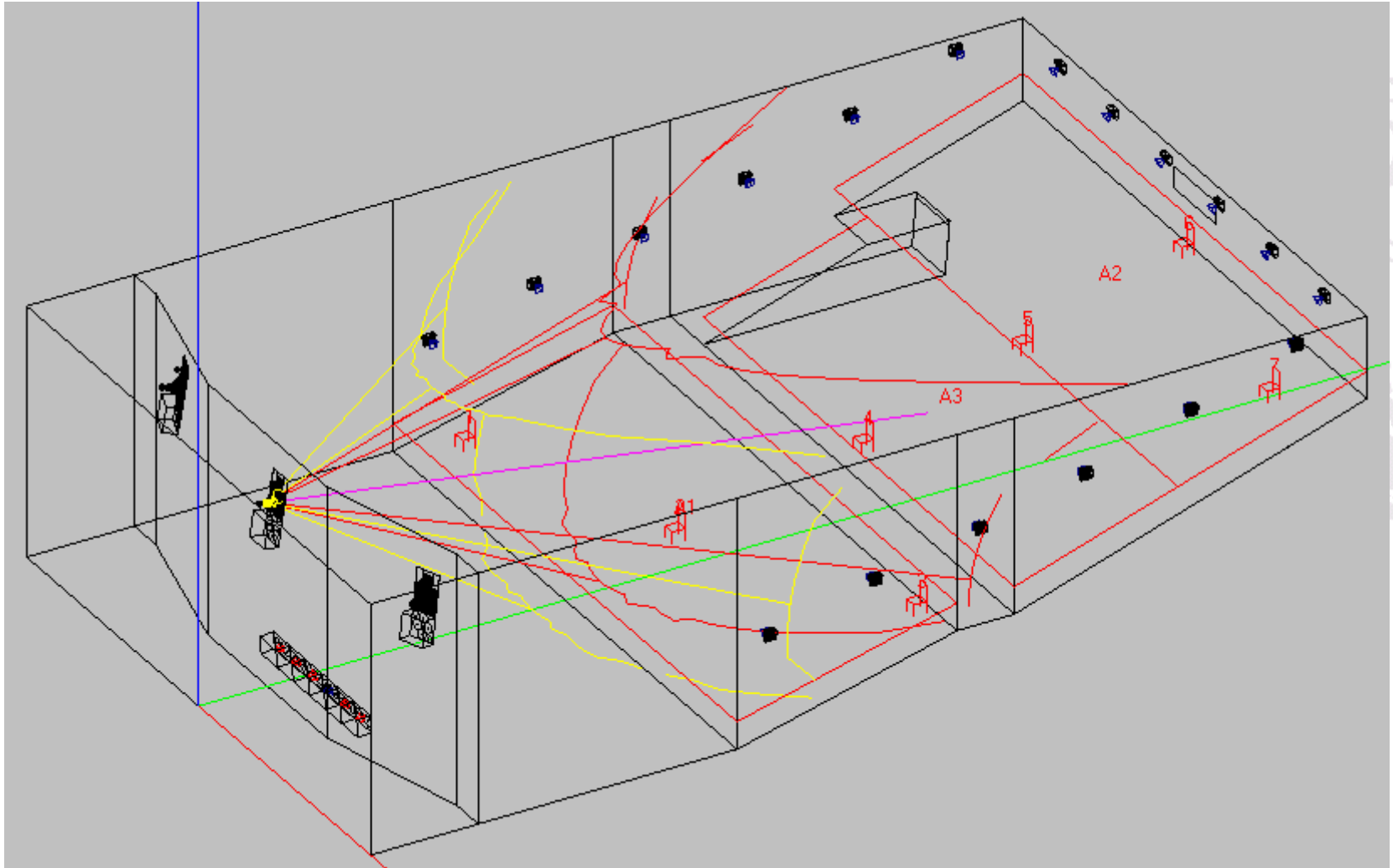


SCREEN CHANNELS



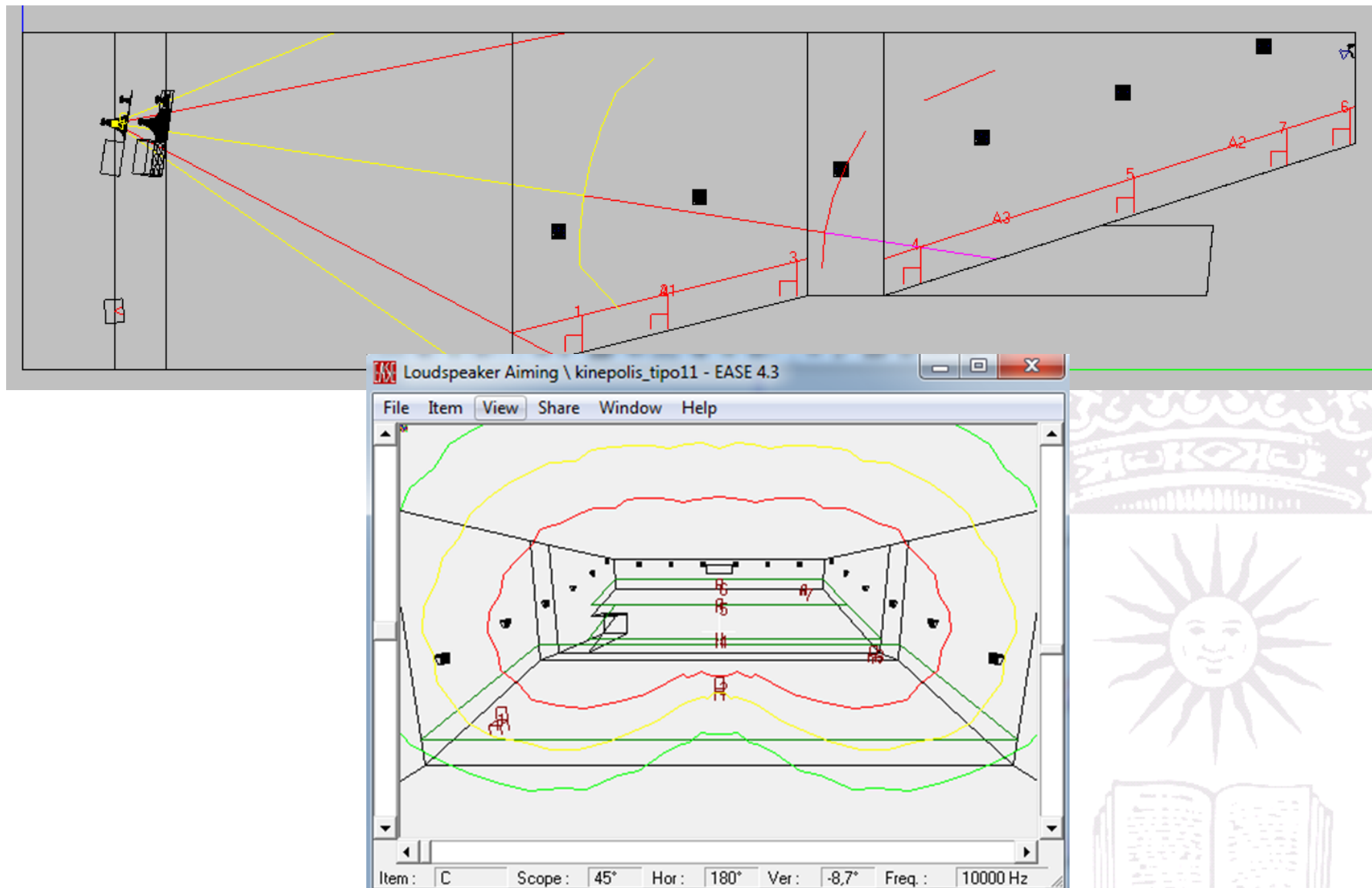


SCREEN CHANNELS



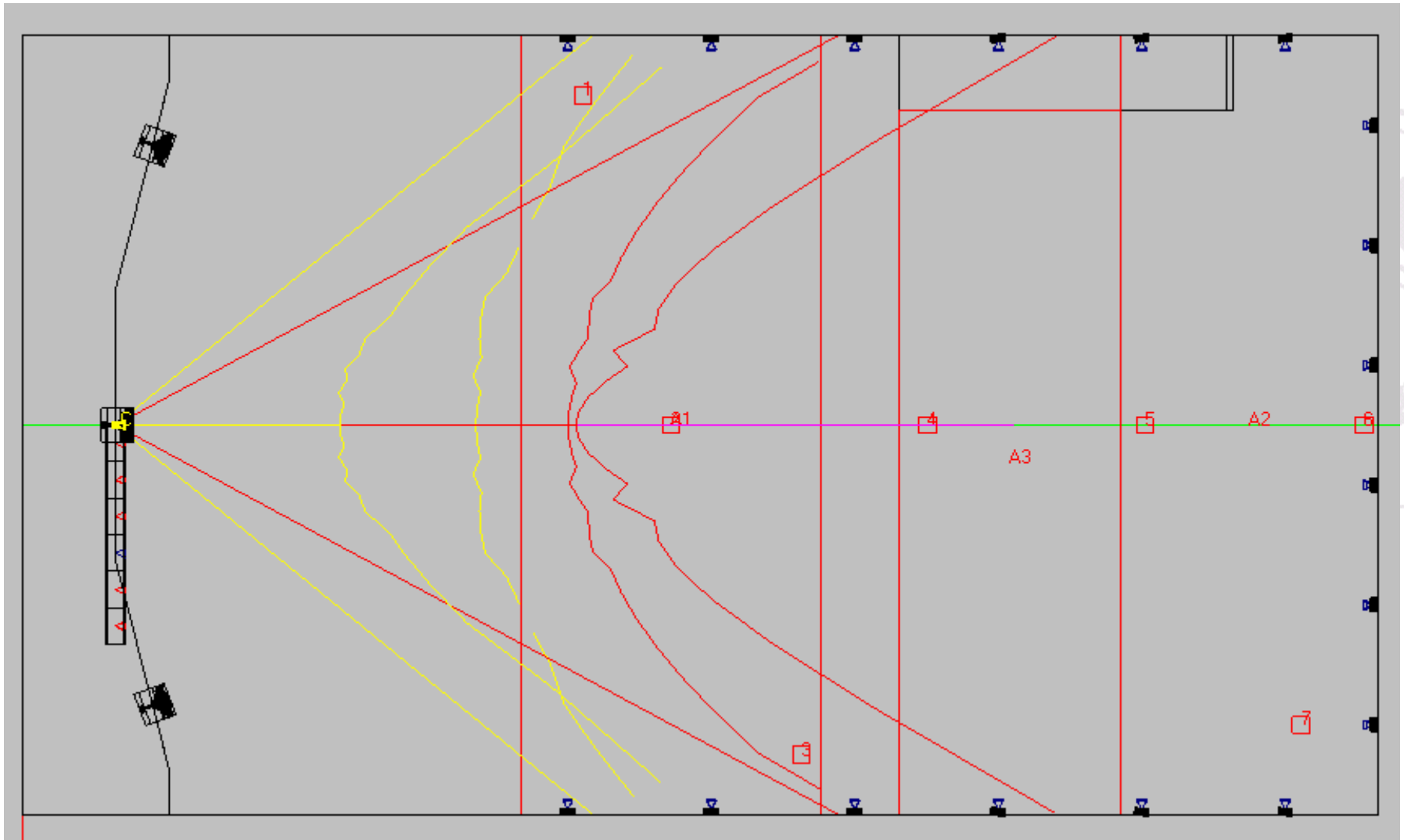


SCREEN CHANNELS



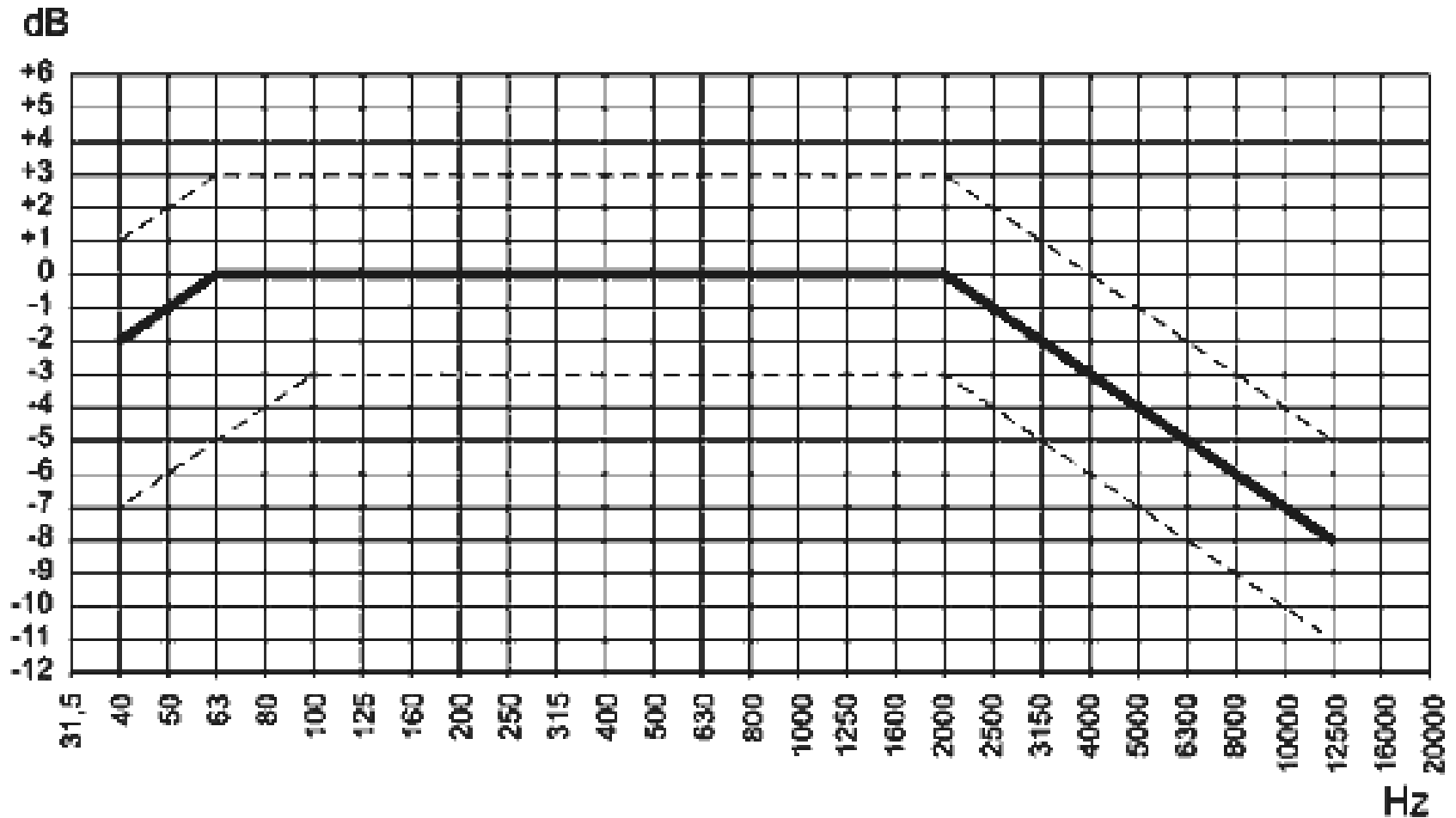


SCREEN CHANNELS





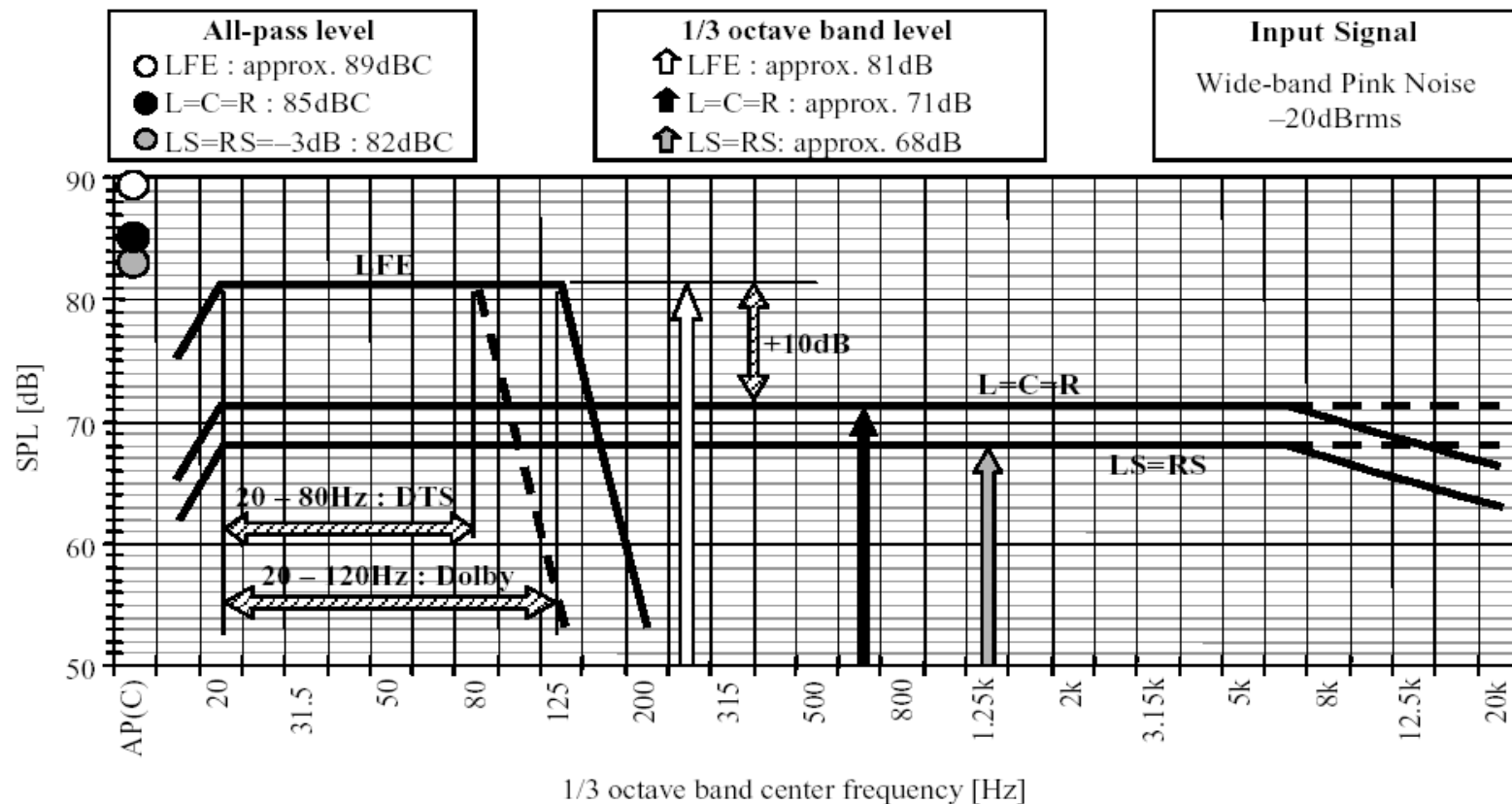
SCREEN CHANNELS



Ecualización ISO 2969 Curva-X



SCREEN CHANNELS



[Level balance of the surround channels]

For film productions, set the playback level of the surround channels at -3 dB relative to the front channels.

In the case of $L = C = R = 85 \text{ dBC}$,

3-1: $LS = RS = 82 \text{ dB}$; in other words, $S (LS+RS) = 85 \text{ dBC}$

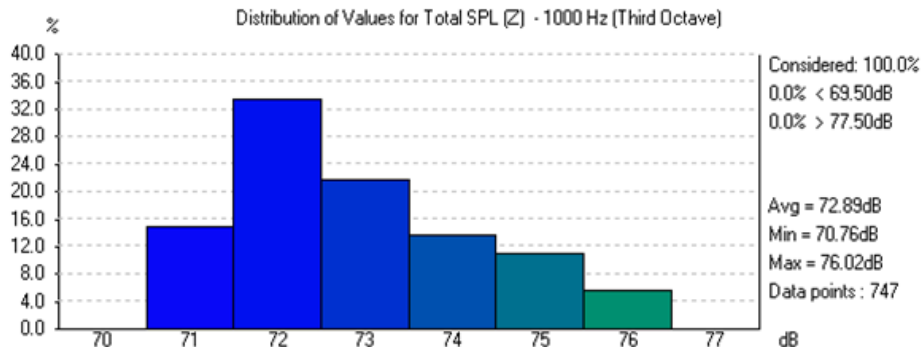
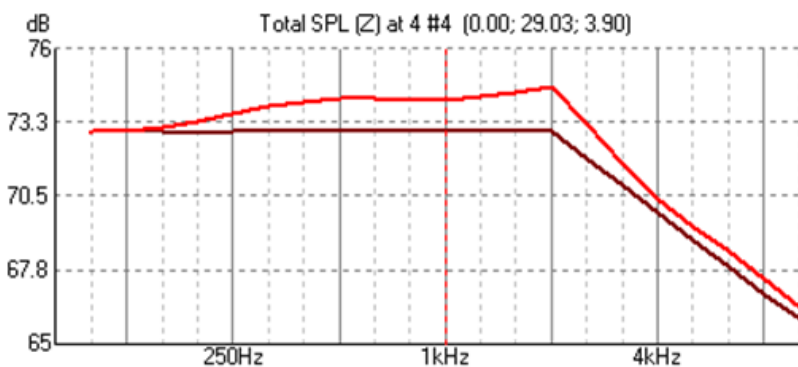
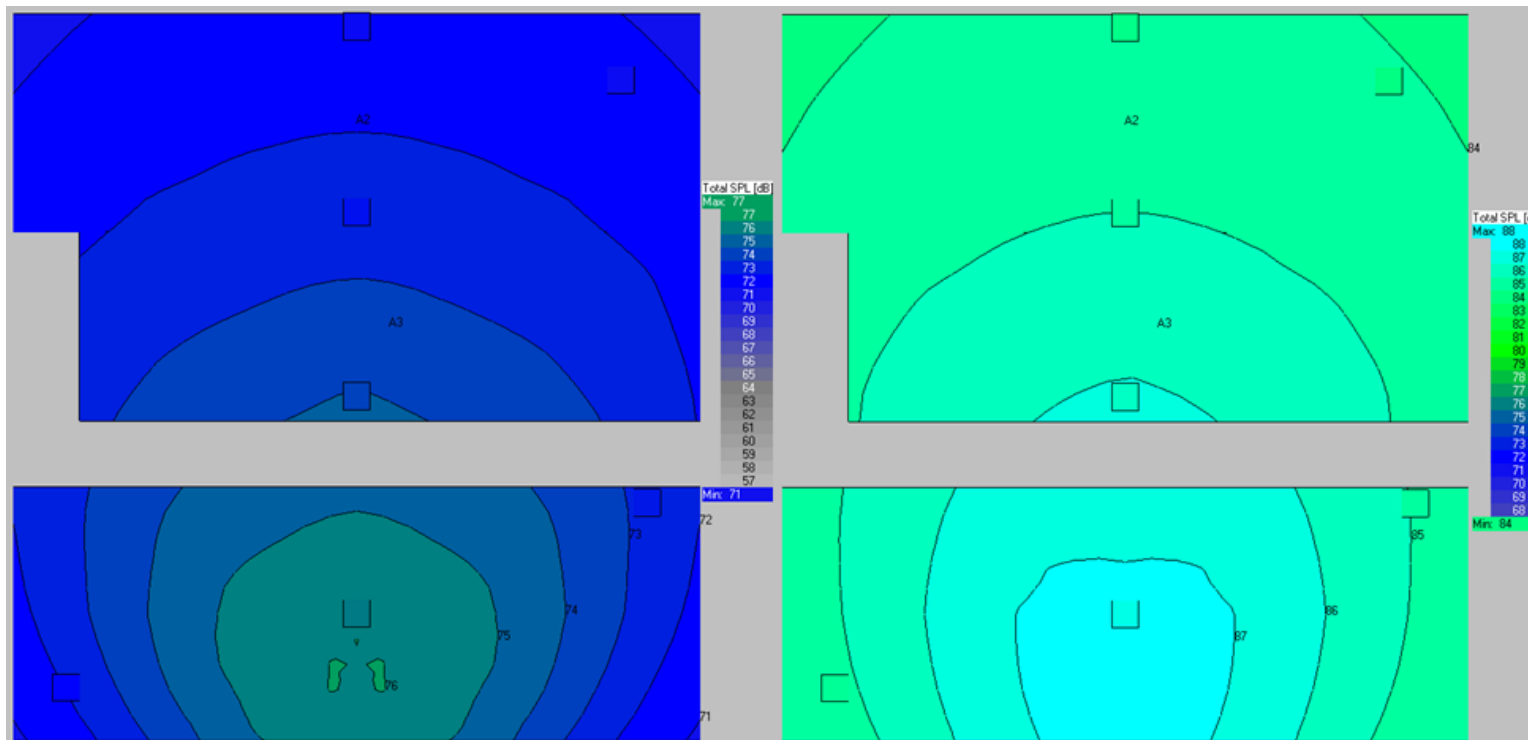
5.1: $LS = RS = 82 \text{ dBC}$

6.1: $LS = RS = BS = 82 \text{ dB}$

[X Curve of the B-Chain: SMPTE 202M-1998]



SCREEN CHANNELS

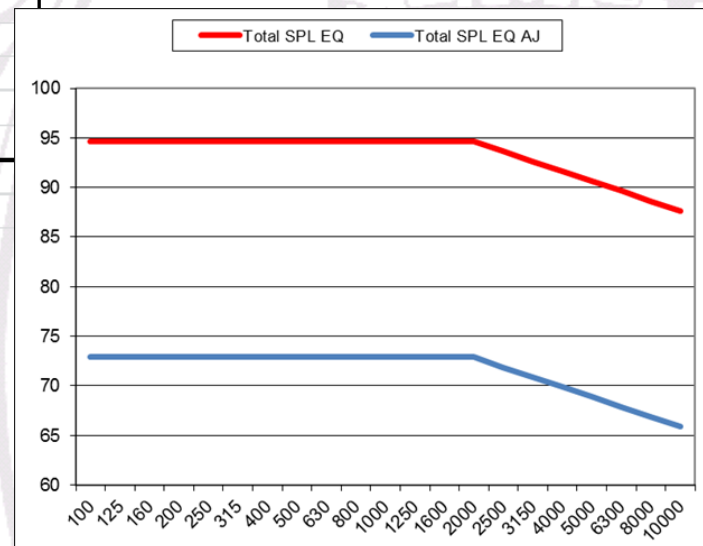




SCREEN CHANNELS

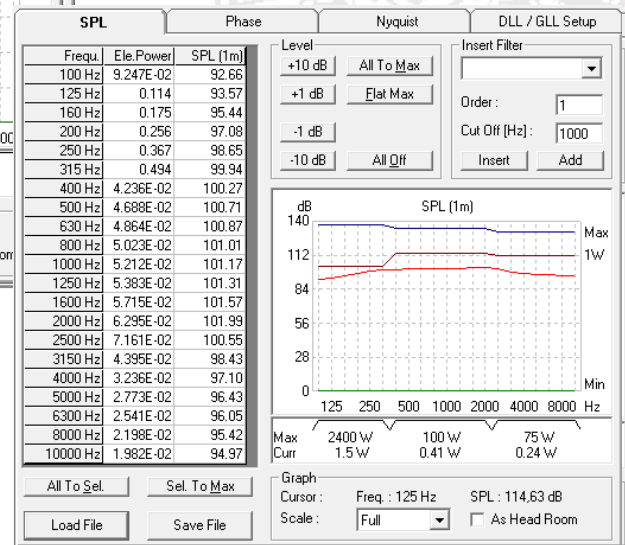
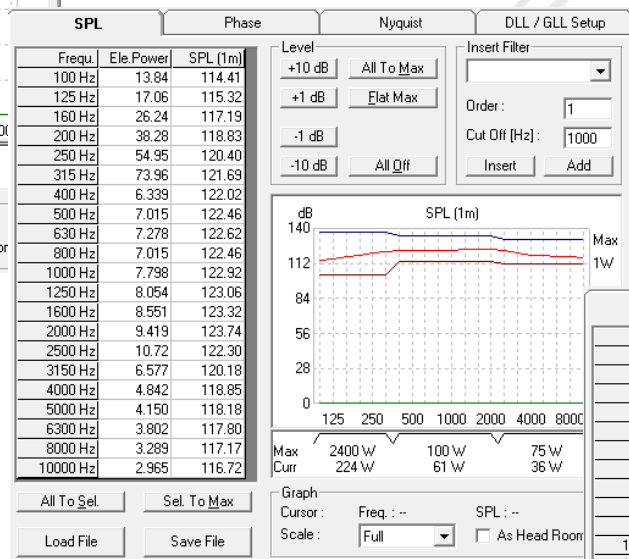
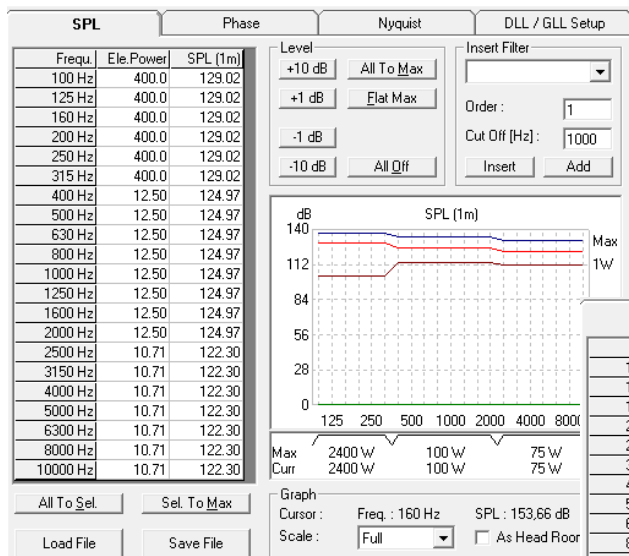


Altavoz C							
Frequency	Total SPL EQ	cuna C	Total SPL EQ C	Ajuste	SPL 1m EQ	SPL 1m EQ AJ	SPL sim
100	94,64	-0,30	94,34	-21,75	114,41	92,66	72,89
125	94,64	-0,17	94,47	-21,75	115,32	93,57	72,89
160	94,64	-0,08	94,56	-21,75	117,19	95,44	72,89
200	94,64	-0,03	94,61	-21,75	118,83	97,08	72,89
250	94,64	0,00	94,64	-21,75	120,4	98,65	72,89
315	94,64	0,02	94,66	-21,75	121,69	99,94	72,89
400	94,64	0,03	94,67	-21,75	122,02	100,27	72,89
500	94,64	0,03	94,67	-21,75	122,46	100,71	72,89
630	94,64	0,03	94,67	-21,75	122,62	100,87	72,9
800	94,64	0,02	94,66	-21,75	122,76	101,01	72,89
1000	94,64	0,00	94,64	-21,75	122,92	101,17	72,89
1250	94,64	-0,03	94,61	-21,75	123,06	101,31	72,89
1600	94,64	-0,09	94,55	-21,75	123,32	101,57	72,89
2000	94,64	-0,17	94,47	-21,75	123,74	101,99	72,89
2500	93,64	-0,30	93,34	-21,75	122,3	100,55	71,88
3150	92,64	-0,50	92,14	-21,75	120,18	98,43	70,89
4000	91,64	-0,83	90,81	-21,75	118,85	97,10	69,89
5000	90,64	-1,29	89,35	-21,75	118,18	96,43	68,89
6300	89,64	-1,99	87,65	-21,75	117,8	96,05	67,89
8000	88,64	-3,05	85,59	-21,75	117,17	95,42	66,88
10000	87,64	-4,41	83,23	-21,75	116,72	94,97	65,89
Nivel en banda ancha [dBC]			106,75	Nivel en banda ancha [dBC]			85,22
Nivel ajuste en banda ancha [dBC]			85,00				





SCREEN CHANNELS





SCREEN CHANNELS



- They are placed in such a way that the edges of the speakers (MF or HF) are between 5 and 7 cm screen.
- Must be placed so the edges of the speakers (or MF HF) are between 5 and 7 cm screen.
- In systems with symmetric speakers, never will publish these with their axes that are perpendicular to the screen.
- In systems with asymmetric speakers, it is not necessary to take the above account.
- Reflective details should be painted in Matt Black, to not be seen through the screen.



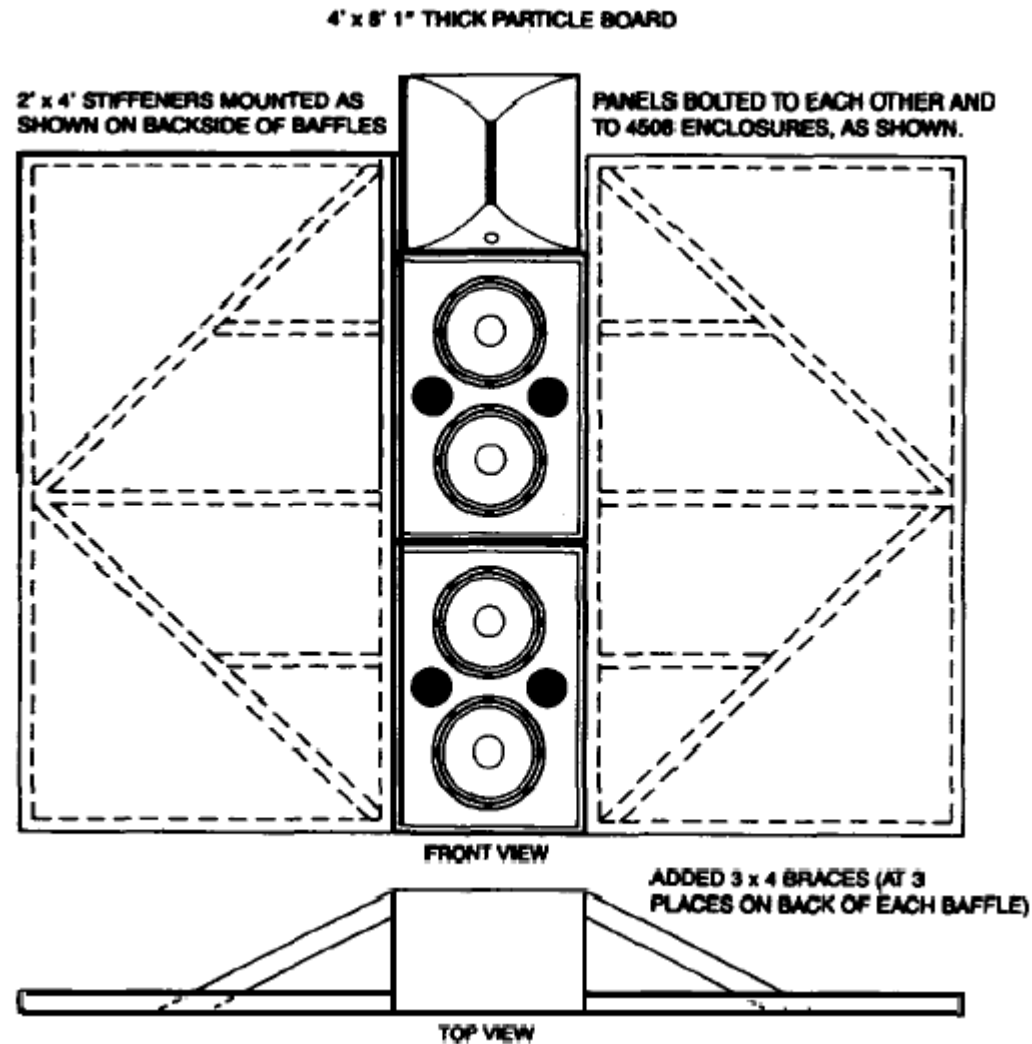
SCREEN CHANNELS



- The assembly of the system elements must not have moving parts may sound and all vertical surfaces are exposed should be covered with absorbent material.
- The posterior wall of the screen should be covered with absorbent material, to prevent the formation of standing waves. The ceiling and the back wall of the room must be equally absorbing material.
- All display systems are running horizontally towards the point on the central axis that is encuantra to $2/3$ of the length of the room (between the screen and the rear wall).

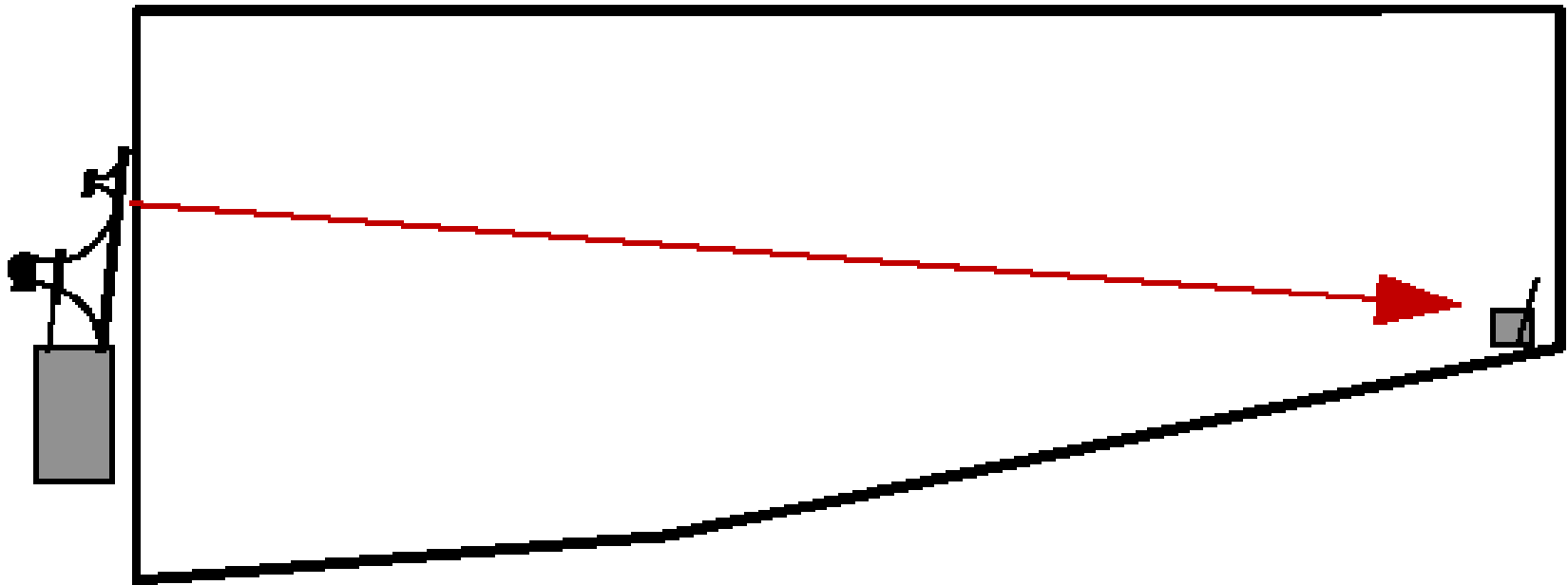


SCREEN CHANNELS



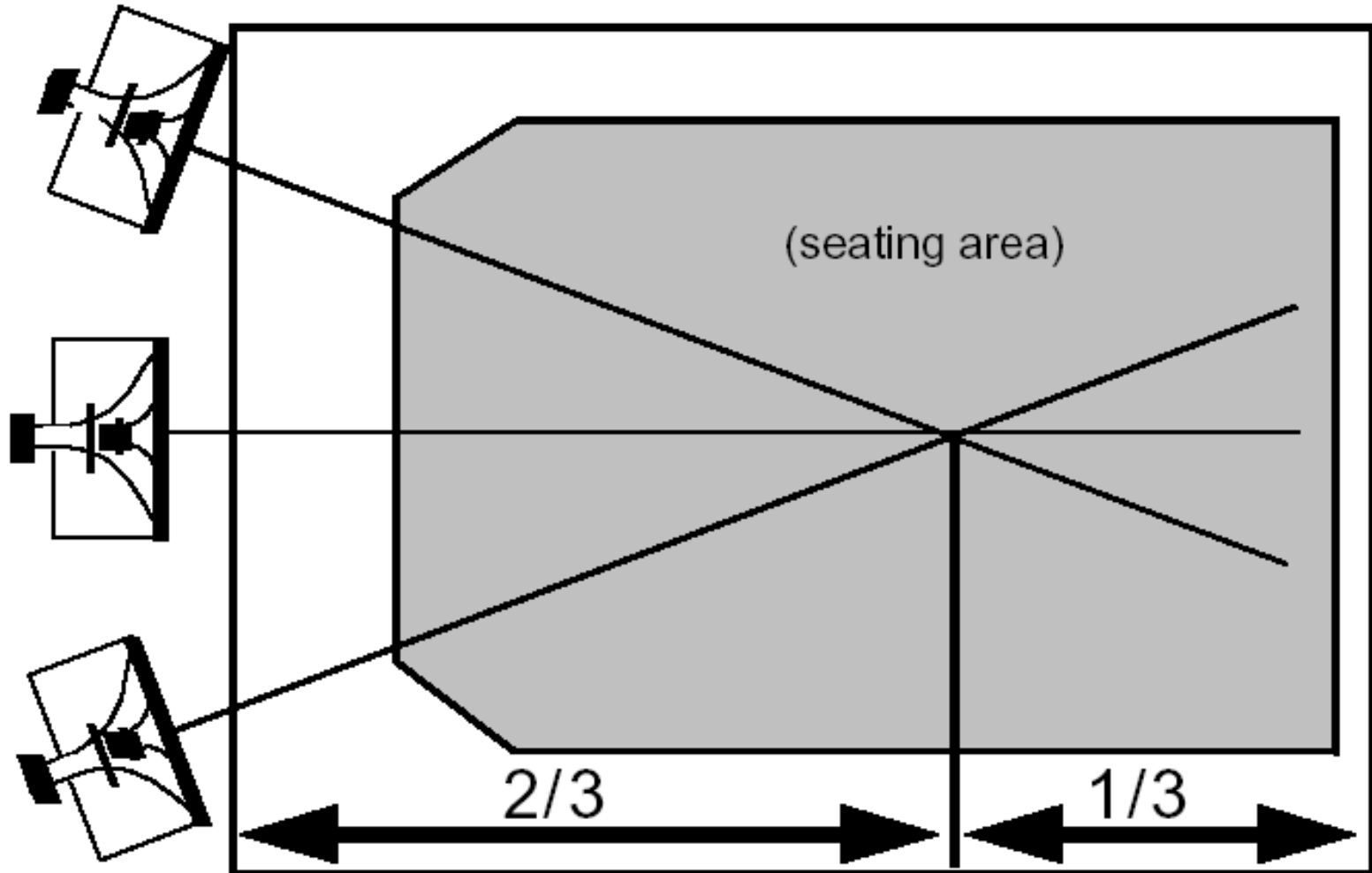


SCREEN CHANNELS



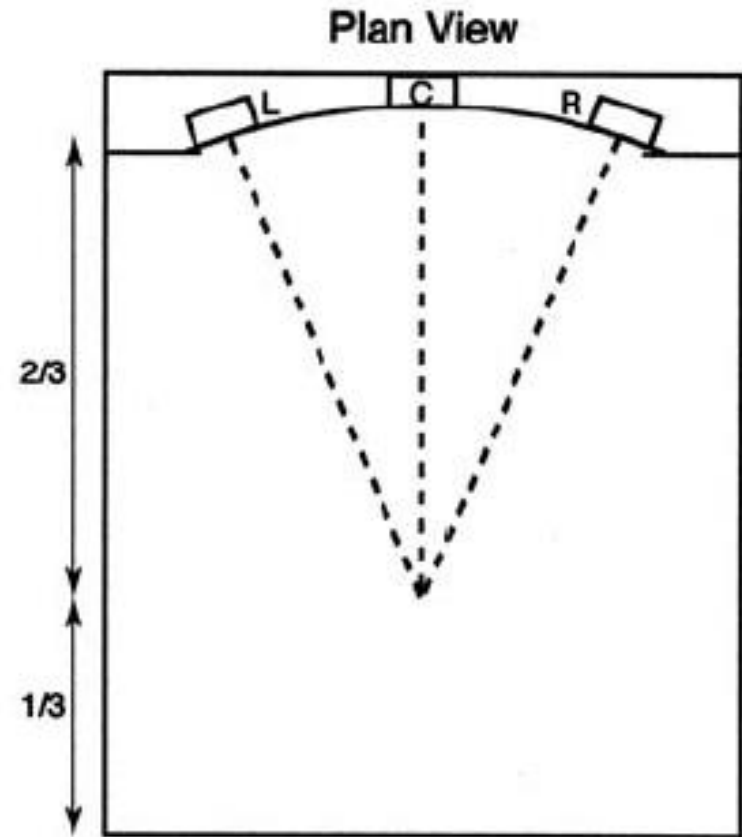
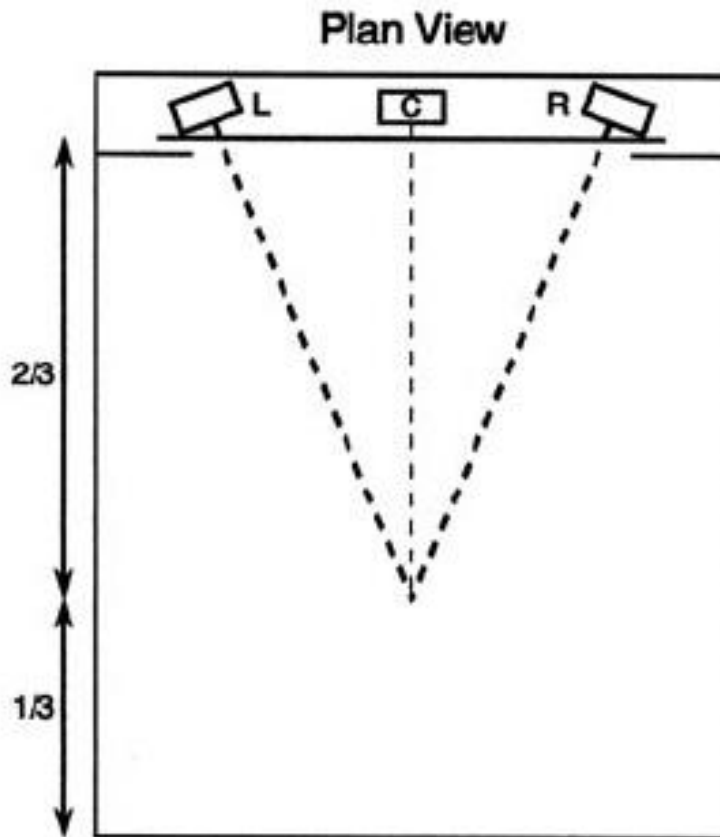


SCREEN CHANNELS





SCREEN CHANNELS

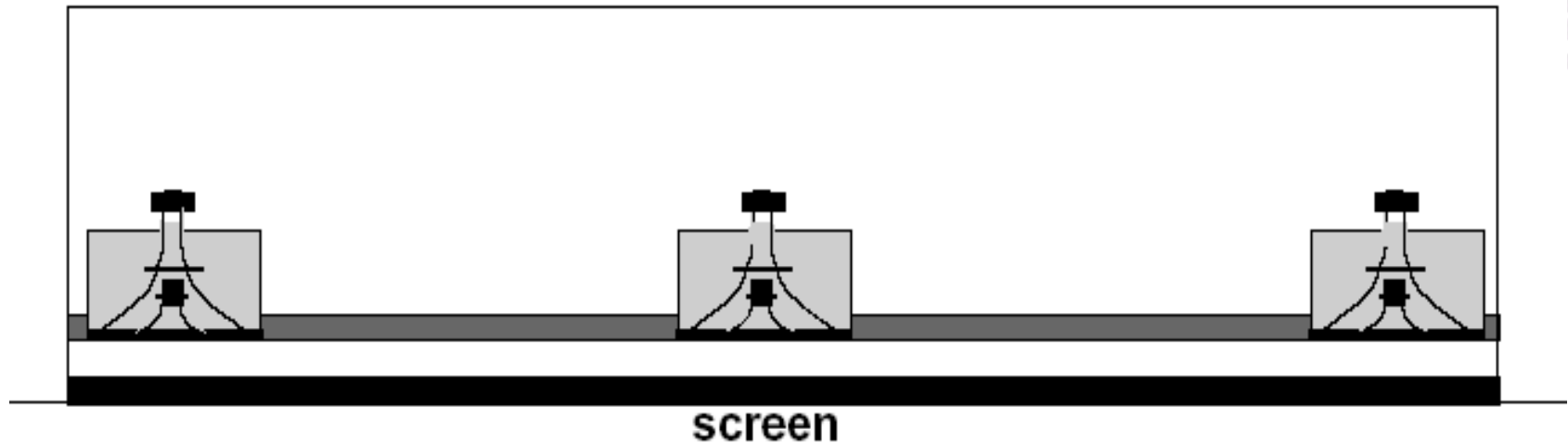




SCREEN CHANNELS



- It is advisable to mount the screen speakers embedded in a wall of absorbent material.
- This wall would go from side to side of the room and from the floor to the ceiling, creating a new enclosure behind the screen.





SCREEN CHANNELS



JBL Professional Custom Shop ScreenArray™ Speakers at the Academy of Television Arts & Sciences Leonard H. Goldenson Theatre



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JBL Professional Custom Shop Screen Array™ Speakers at the Academy of Television Arts & Sciences Leonard H. Goldenson Theatre



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