Simulation Tools in Sound Reinforcement: Multichannel Digital Audio Cinema Design

Athens Course UPM94
17-21 November 2014
Madrid

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7. SURROUND CHANNELS
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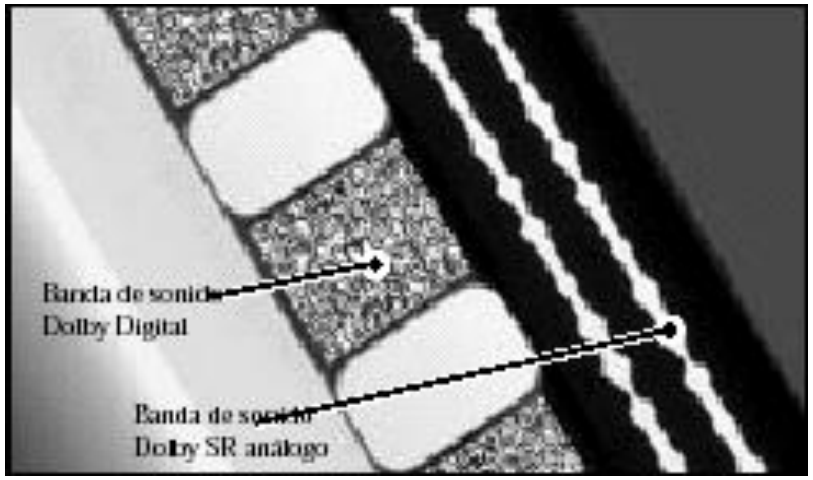
CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS



DOLBY DIGITAL AC-3 (Dolby SR - D)

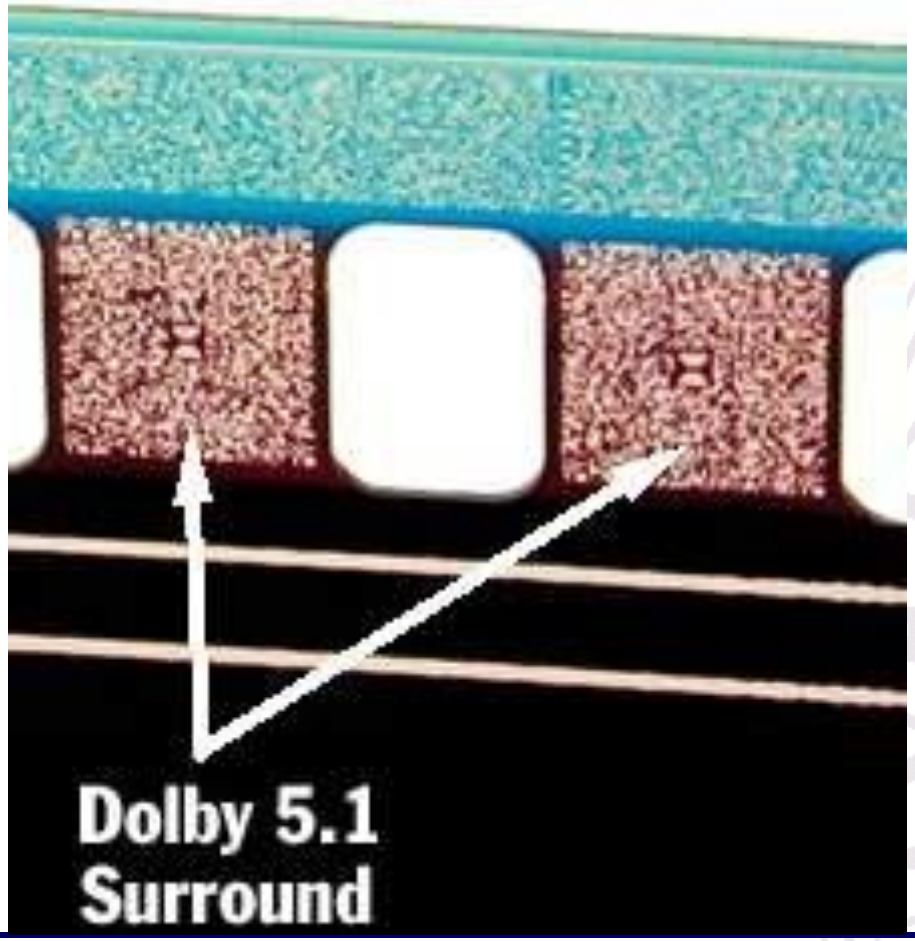
- ✓ 5.1 System (6 independent channels: L, R, C, LS, RS, and LFE (20 - 120 Hz, channel "0.1")

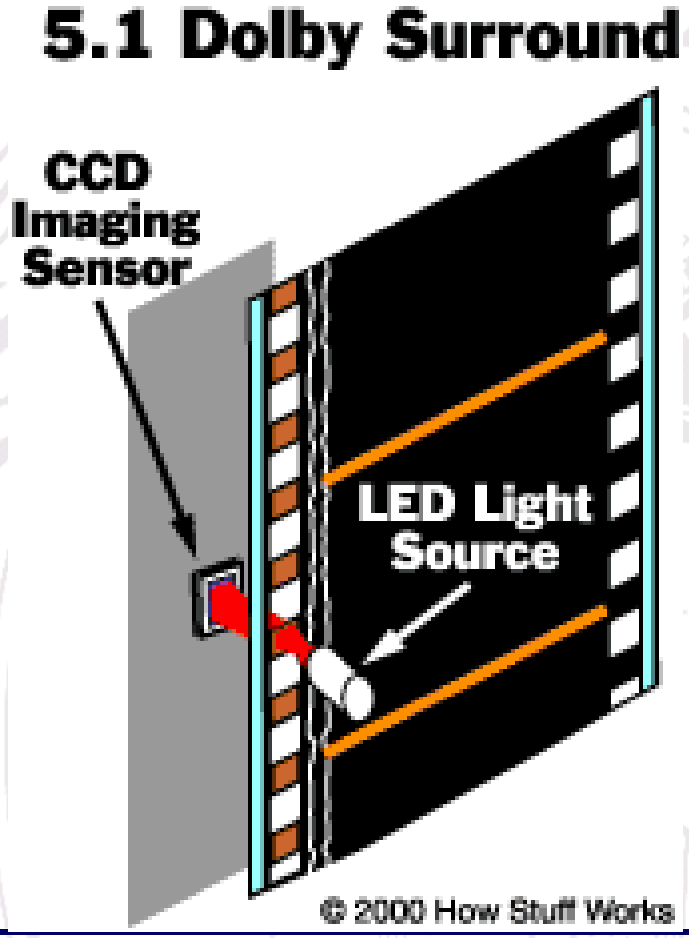
Audio coding (AC-3 encoding perceptual to reduce the binary rate)

- ✓ Data compression (12:1 (Dolby Digital 5.1) compared to 16-bit linear PCM at 45 kHz
- ✓ Sampling rate → 16, 18, 20 or 24 bits (typical value: 20-bit)
- ✓ sampling frequency → 32, 44.1, and 48 kHz
- ✓ bit rate → 32-640 kbps (typical value: 384 kbps)

CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

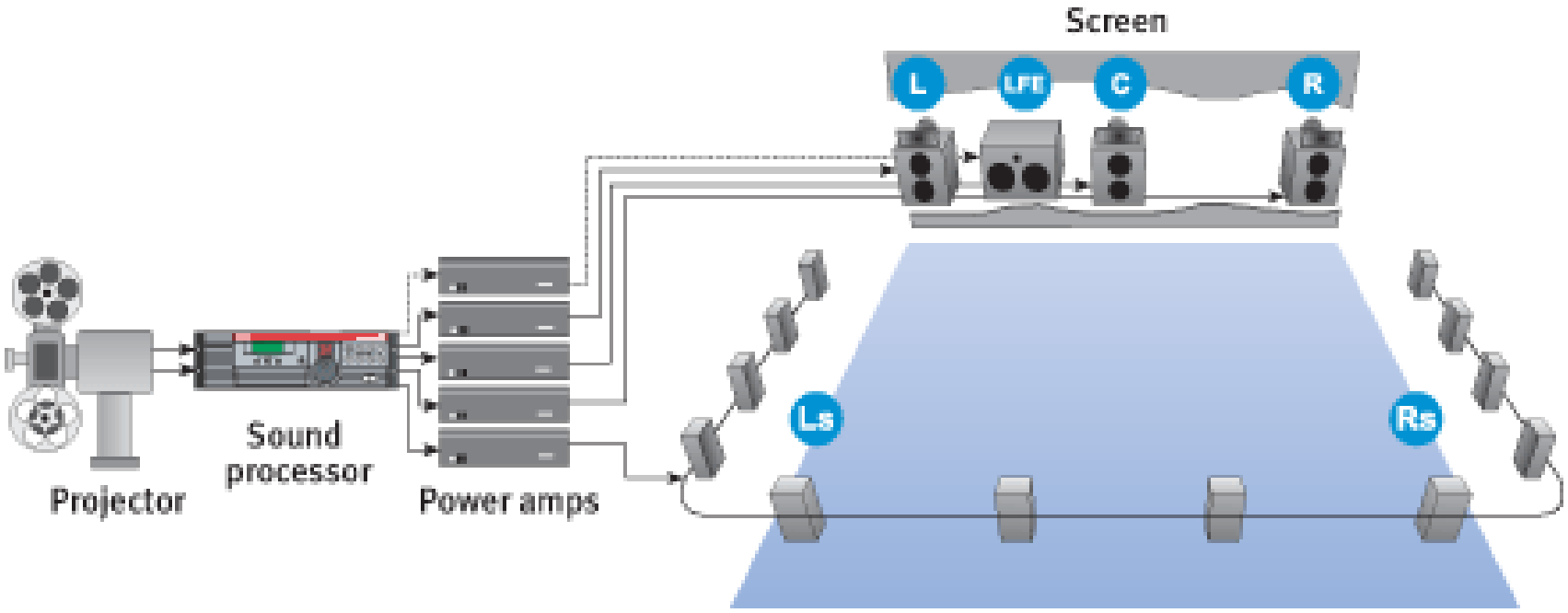
DOLBY DIGITAL AC-3 (Dolby SR - D)





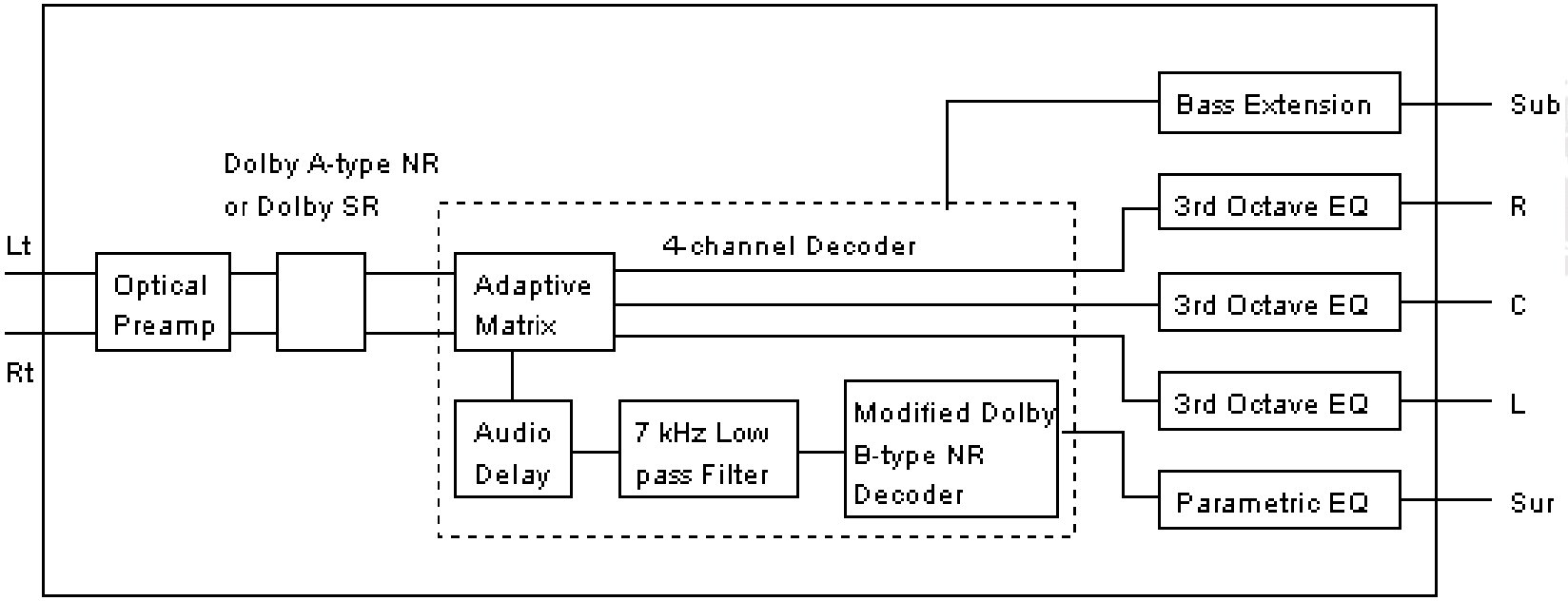
CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

DOLBY SURROUND (Dolby SR - D)



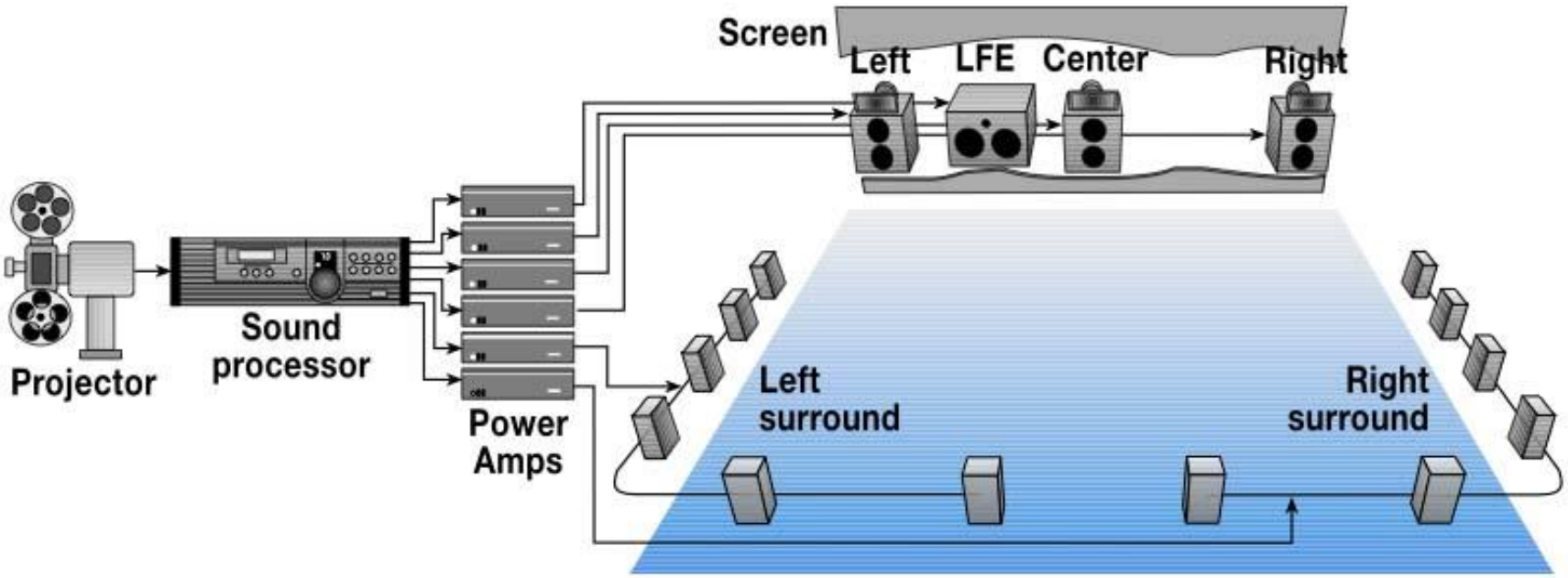
CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

DOLBY SURROUND (Dolby SR - D)



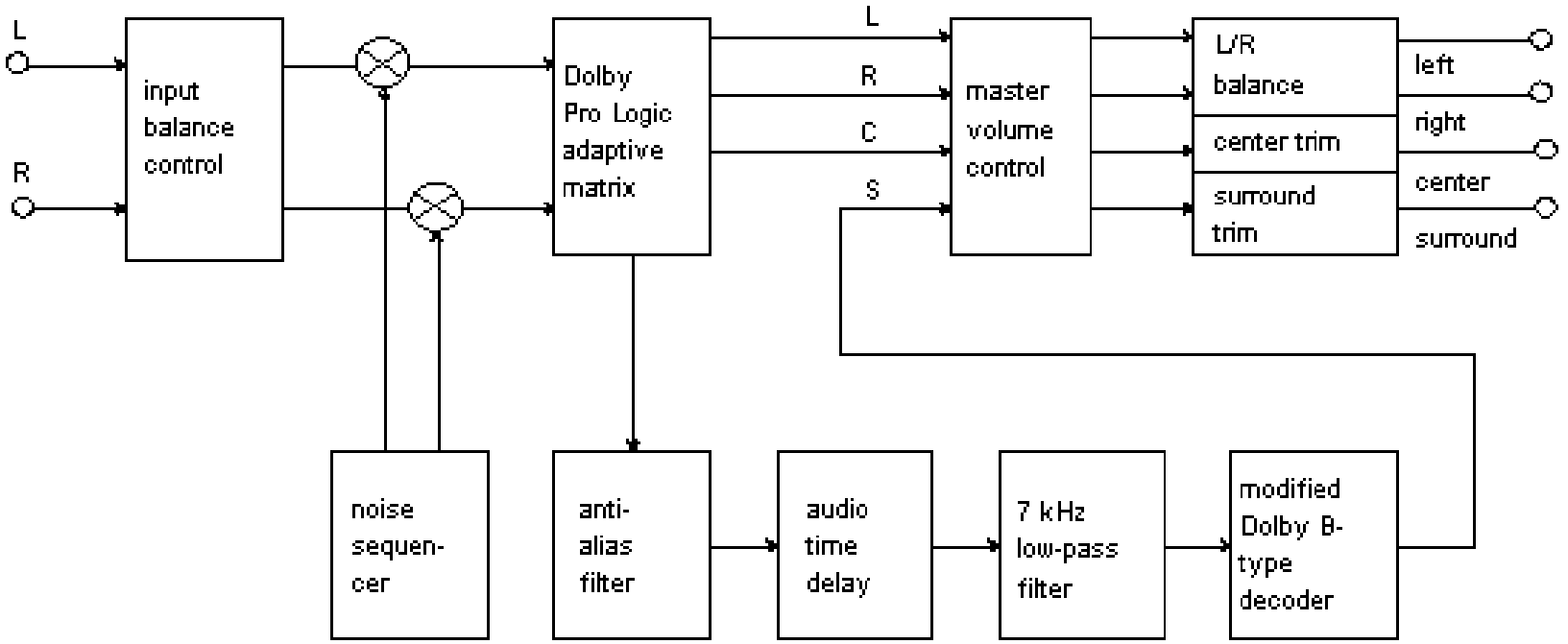
CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

DOLBY DIGITAL 5.1



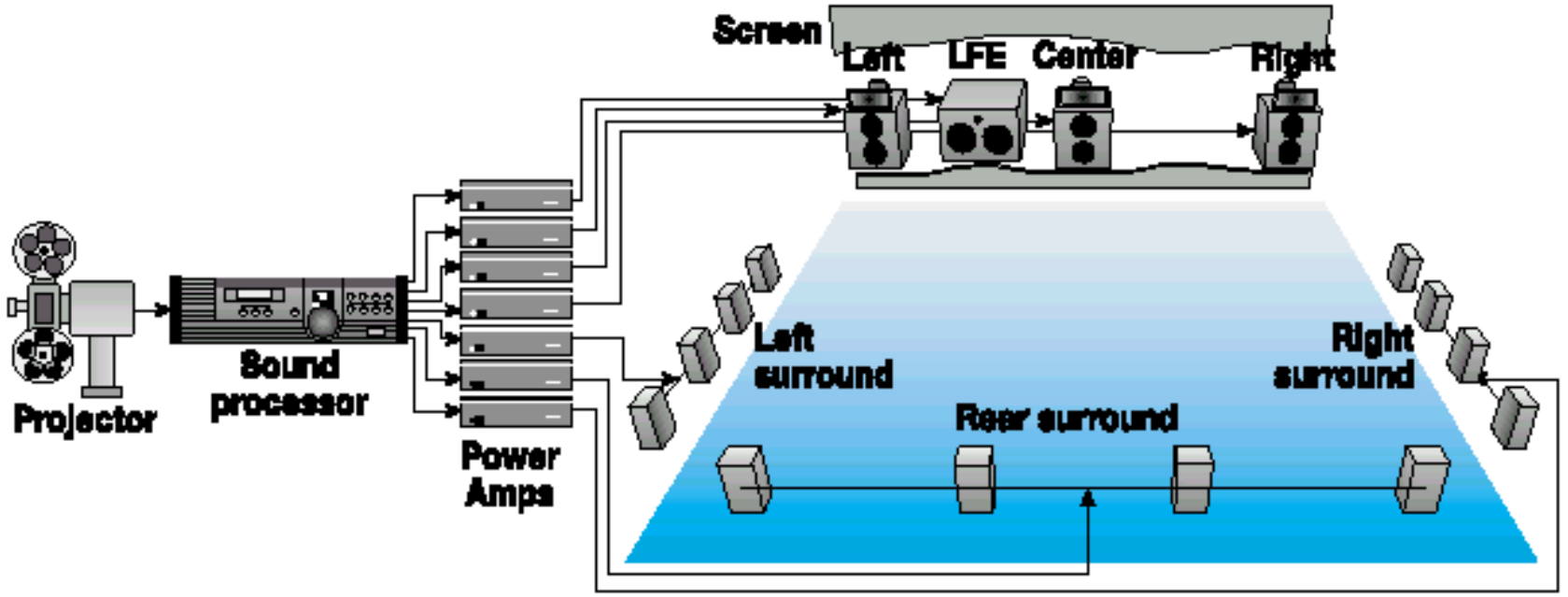
CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

DOLBY DIGITAL 5.1



CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

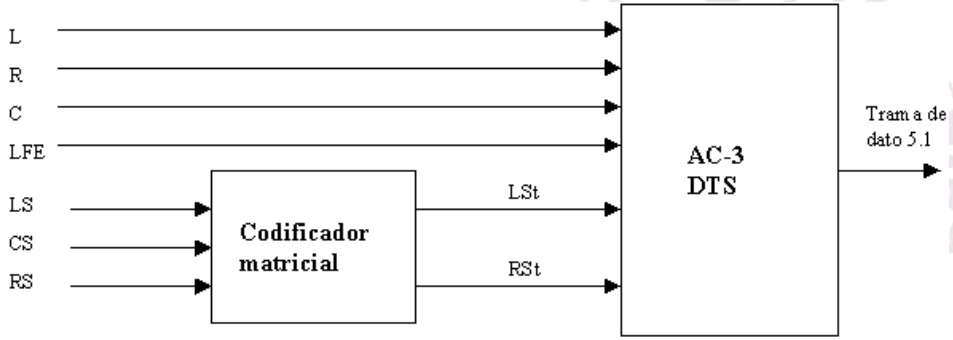
DOLBY DIGITAL SURROUND EX (THX SURROUND EX) 6.1

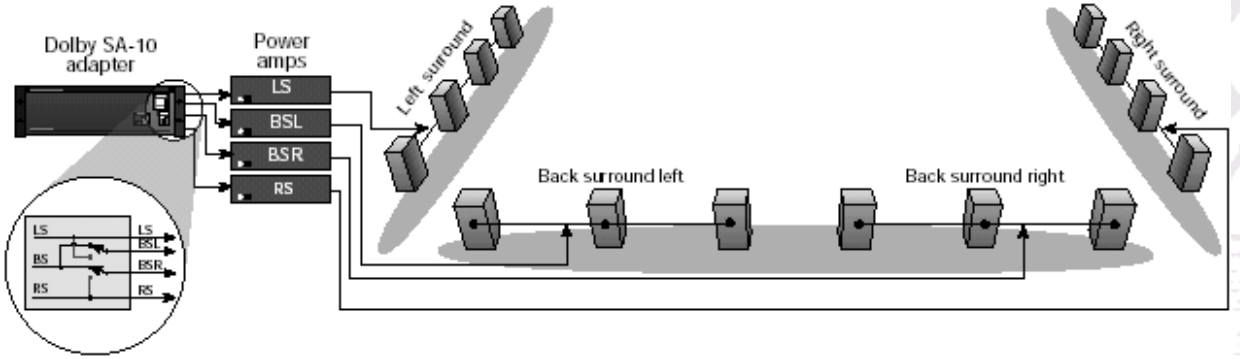


CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

DOLBY DIGITAL SURROUND EX (THX SURROUND EX)

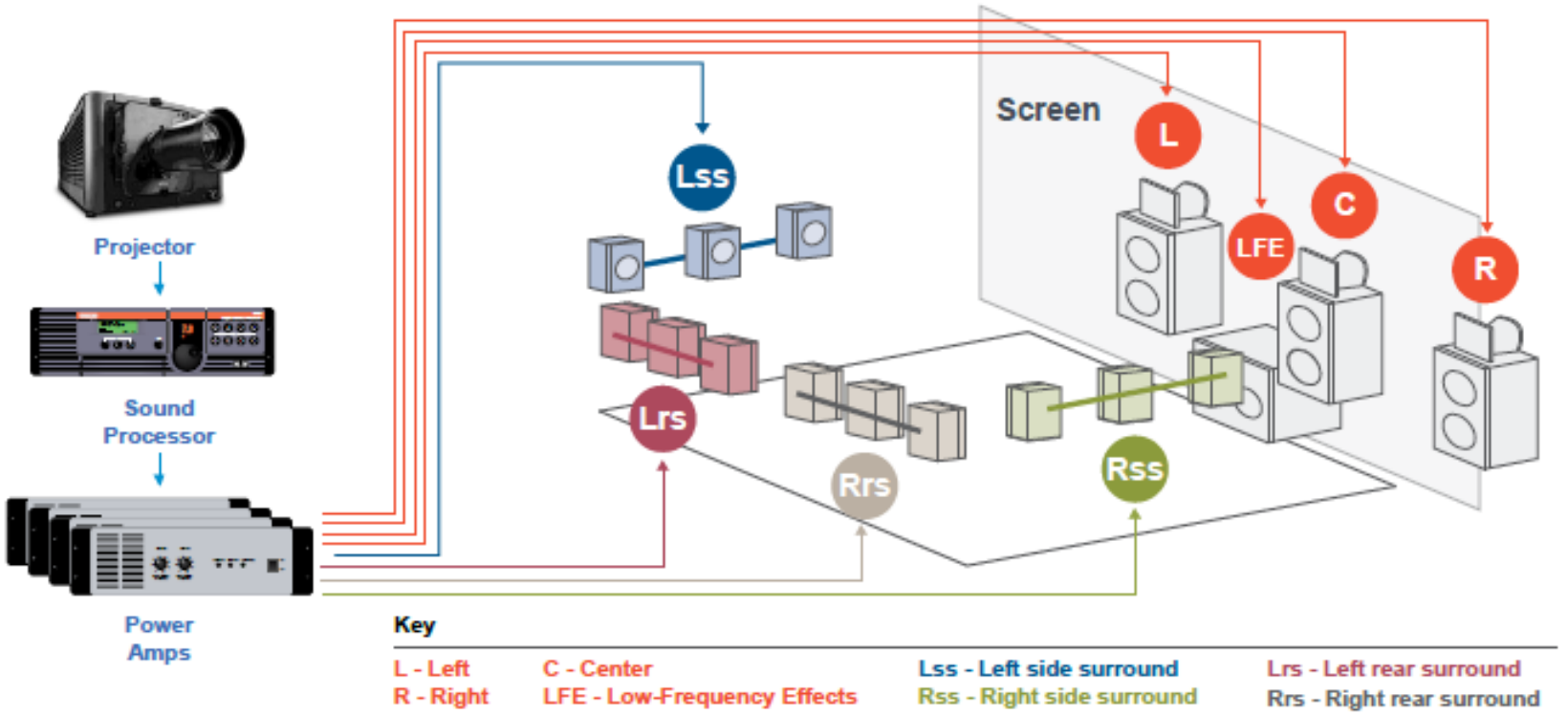
- ✓ Dolby 5.1 matrixed encoding of LS, RS y BS in LS_t y RS_t
- ✓ It is not a true 6.1
- ✓ Can be added a matrix decoder to 5.1 processors
- ✓ Can be switched easily between Dolby 5.1 and Dolby Surround EX





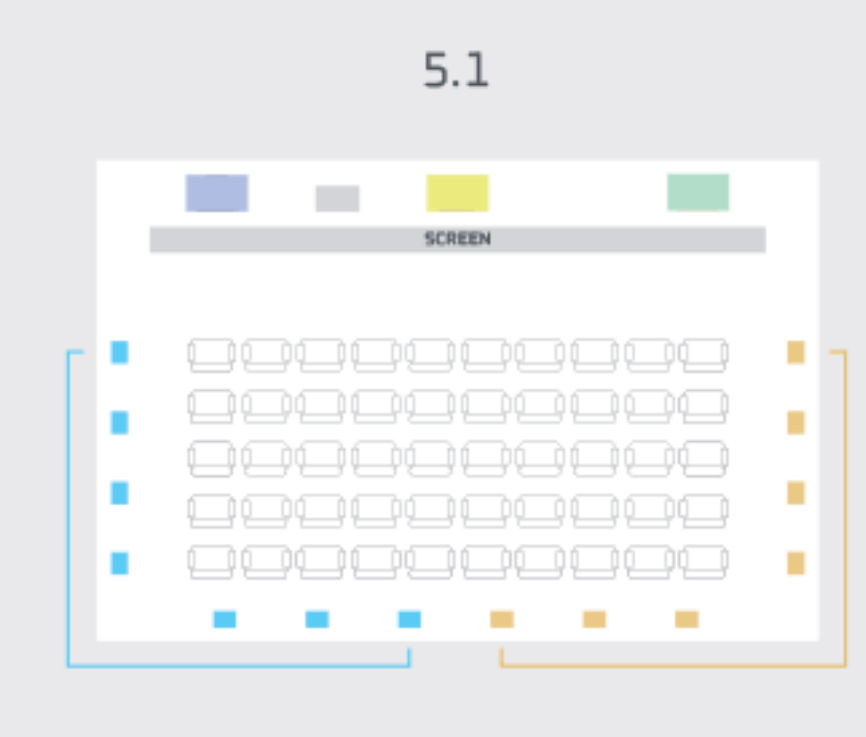
CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

DOLBY DIGITAL 7.1

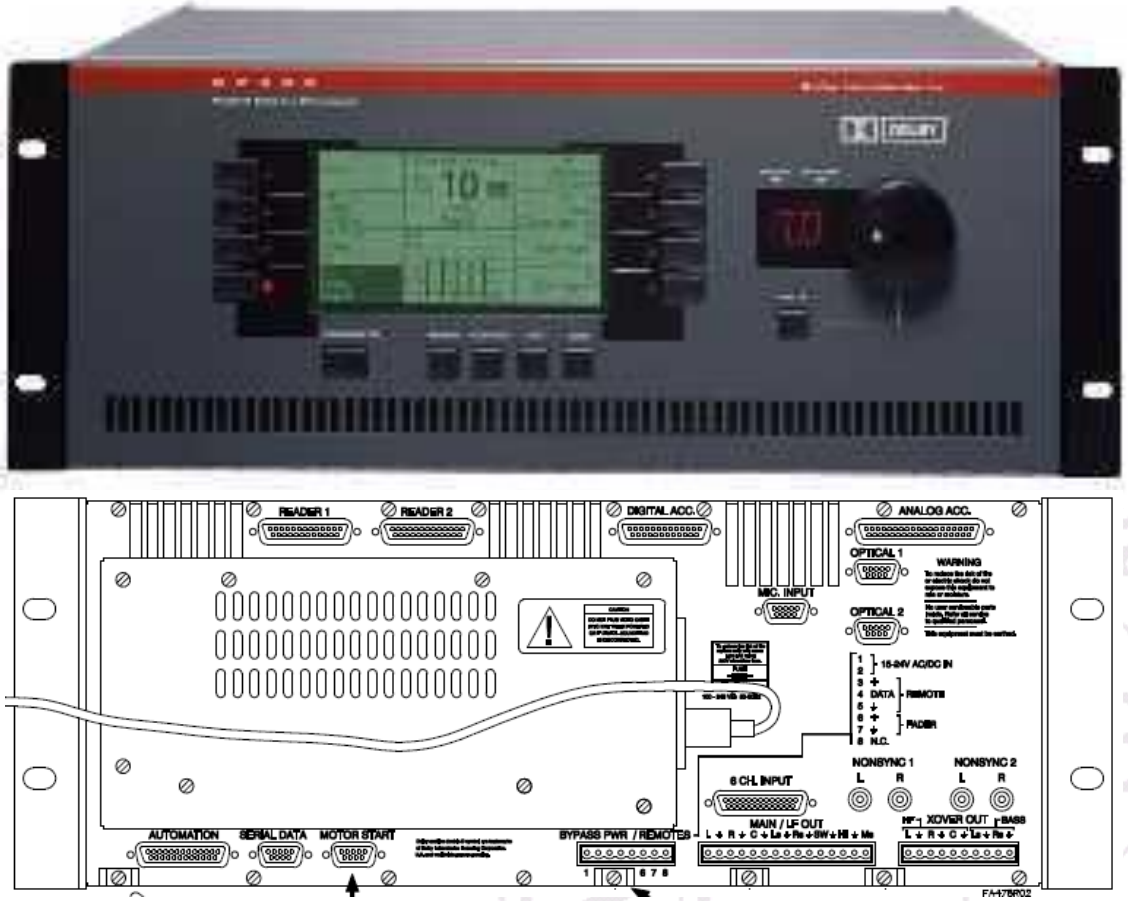


CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

DOLBY DIGITAL 7.1



CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

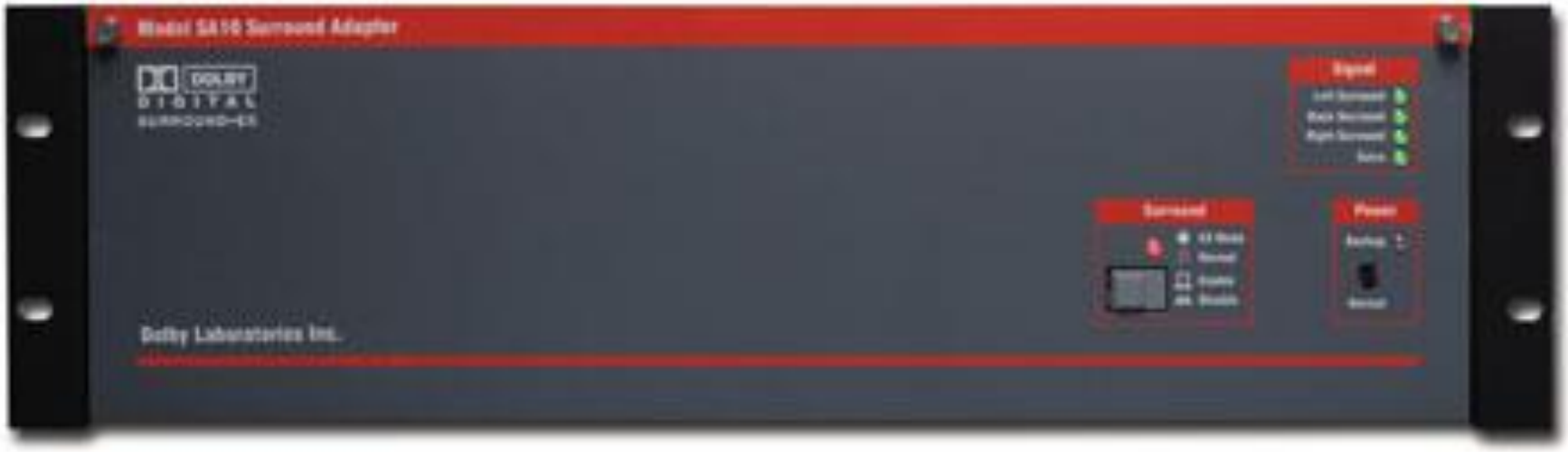


Digital Processor Dolby CP500

CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

Digital Processor Dolby DA20

CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

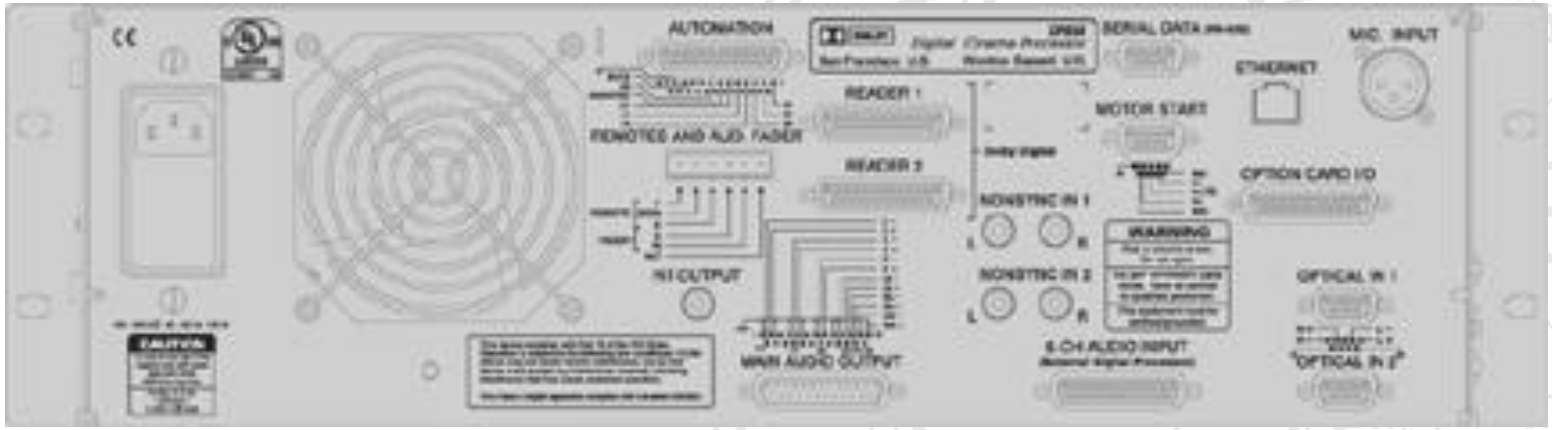


Dolby EX Adaptor SA10

CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

DOLBY DIGITAL

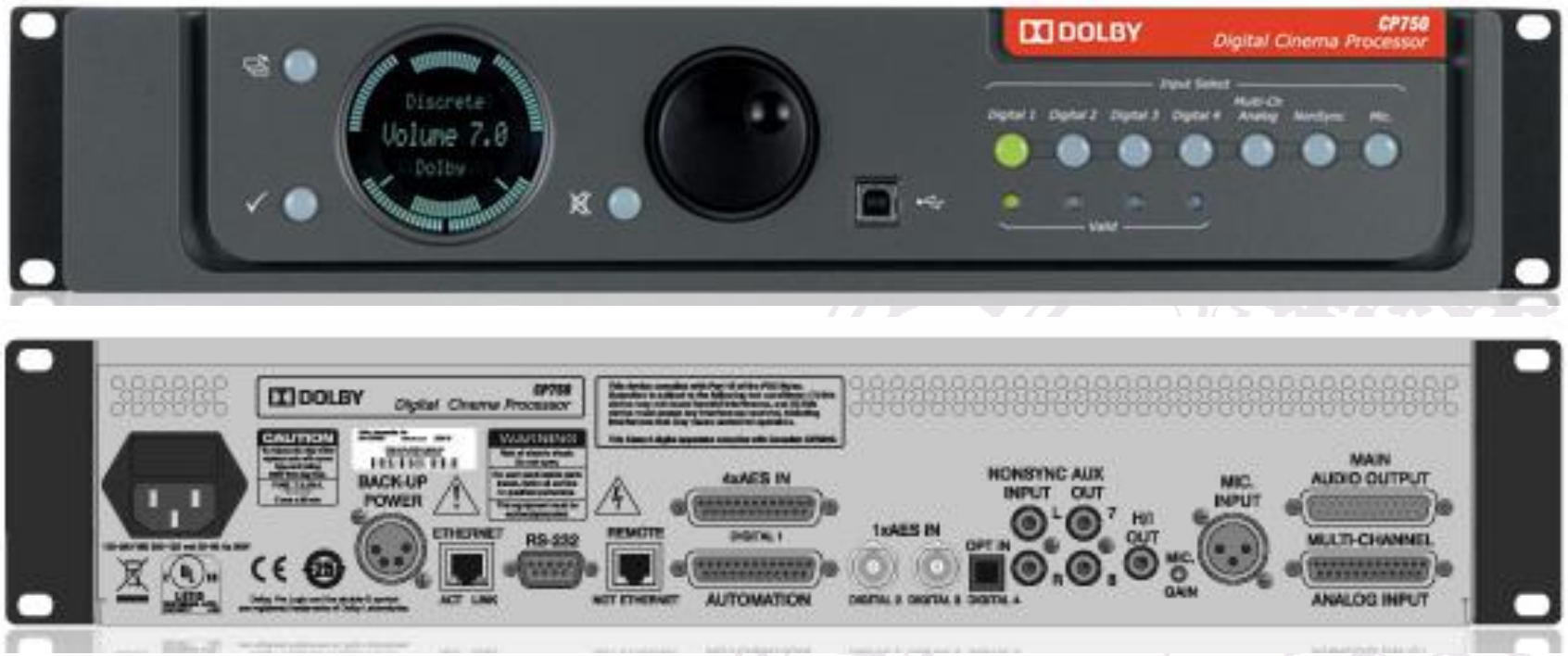
DOLBY DIGITAL SURROUND EX



Digital Processor Dolby CP650

CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

DOLBY SURROUND 7.1



Digital Processor Dolby CP750

CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

Digital Optical Reader Dolby

CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

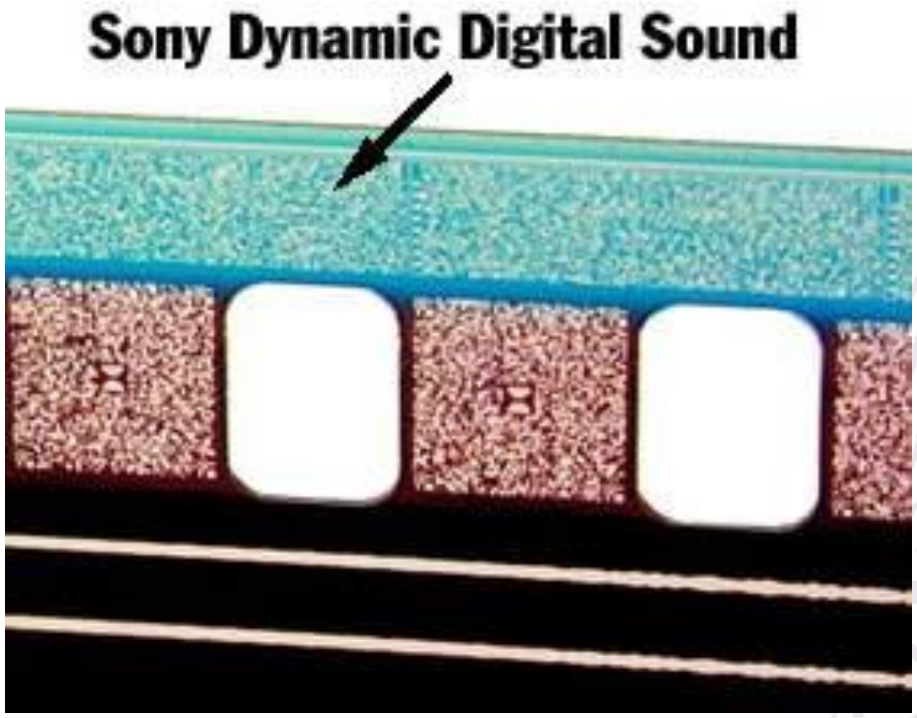
SDDS (Sony Dynamic Digital Sound)

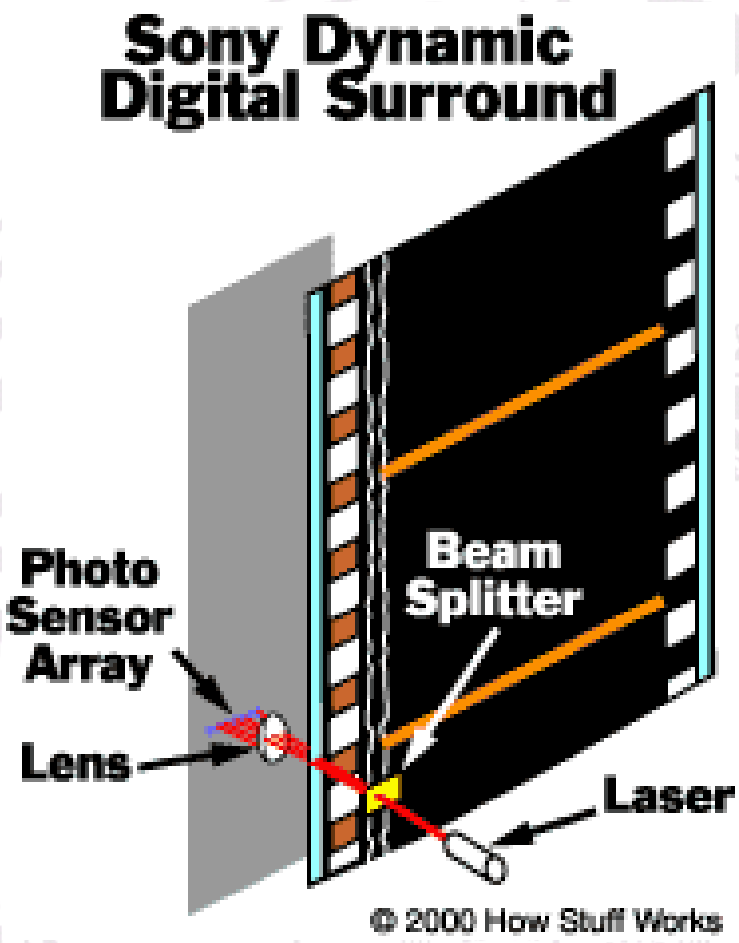
- ✓ Only in cinemas (35 mm film)
- ✓ 8 (7.1), 6 (5.1) y 4 (4.0) channels
- ✓ ATRAC coding (just like on the minidisc), 5:1 compression
- ✓ 100% redundancy on digital track
- ✓ Analog track preservation for safety and compatibility
- ✓ Maximum binary rate admitted 2.46 Mbps
- ✓ Quantization: 20bits
- ✓ Sampling rate: 44.1 kHz
- ✓ Compatible with Dolby analogue
- ✓ Compatible with other multi-channel chain B 5.1 systems

CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

SDDS (Sony Dynamic Digital Sound)

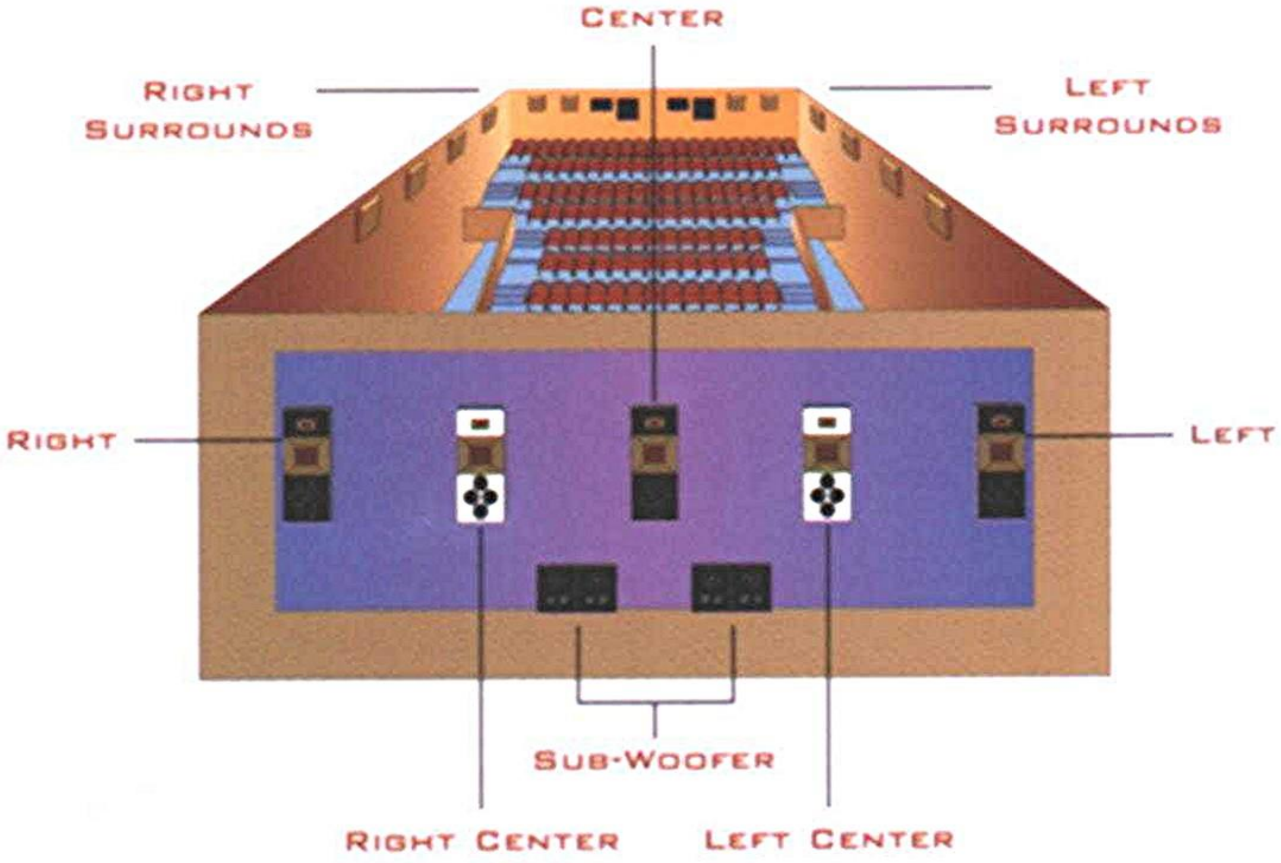
SDDS Sony Dynamic Digital Sound





CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

SDDS (Sony Dynamic Digital Sound)



CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

SDDS (Sony Dynamic Digital Sound)

CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

SDDS Sony Dynamic Digital Sound

Digital Film Sound Reader DFP-R3000

CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

Digital Processor SONY DFP-D3000

CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

SDDS Sony Dynamic Digital Sound

Digital Processor SONY DFP-D6000

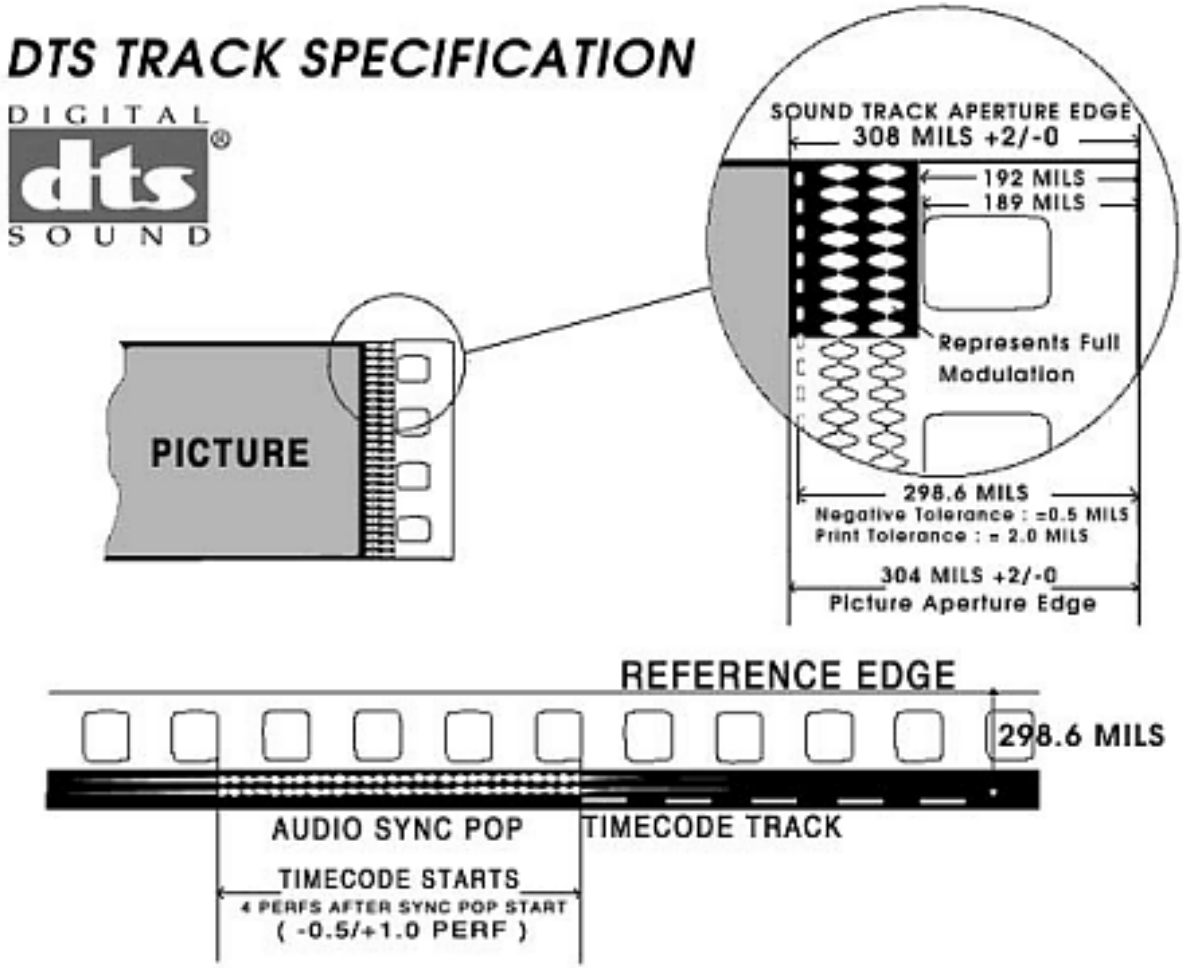
CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

DTS (*Digital Theatre System*)

- ✓ 8 (7.1) or 6 (5.1) channels
- ✓ Cinema and domestic (CD y DVD)
- ✓ Coding → Coherent Acoustics
  - Compression → 4:1
  - Quantization → 16 a 24 bits
  - Sampling frequency→ 24 a 192 kHz
  - Binary rate→ variable, up to 4.096 Mbps
- ✓ Cinema theatres (only digital 70mm filmtrack system)
  - Audio on D-ROM disc (100') and timecode in filmtrack
  - The time code is very robust against wear and tear
  - Delay 3.56 s
  - Preservation of optical stereo analog filmtrack by safety
- ✓ Frequency response: screen: 20-20 kHz, surround: 80-20 kHz (bass-management), LFE: 20-80 Hz

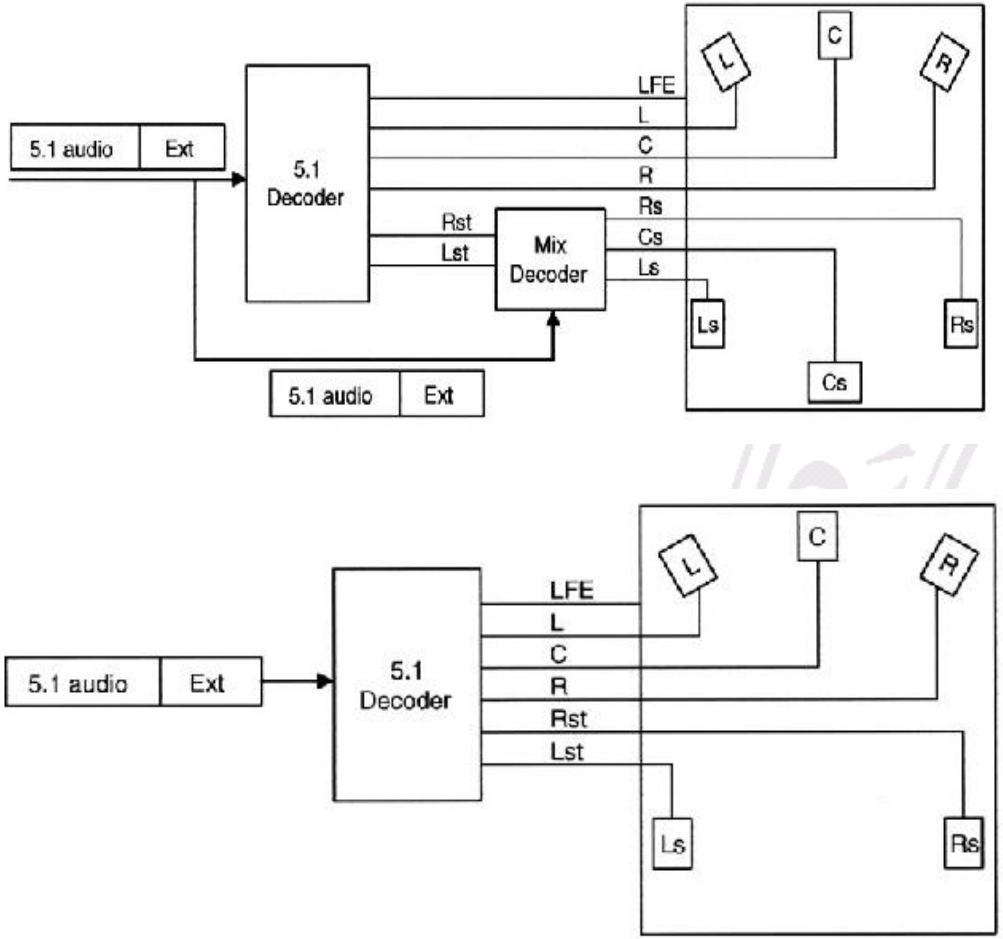
CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

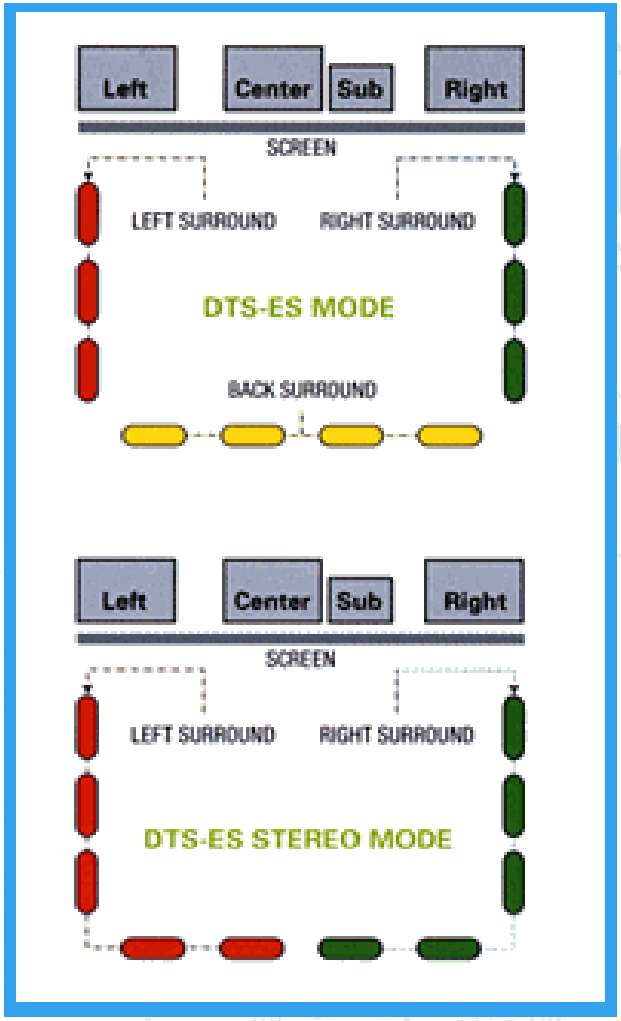
DTS (*Digital Theatre System*)



CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

DTS - ES 6.1 discrete





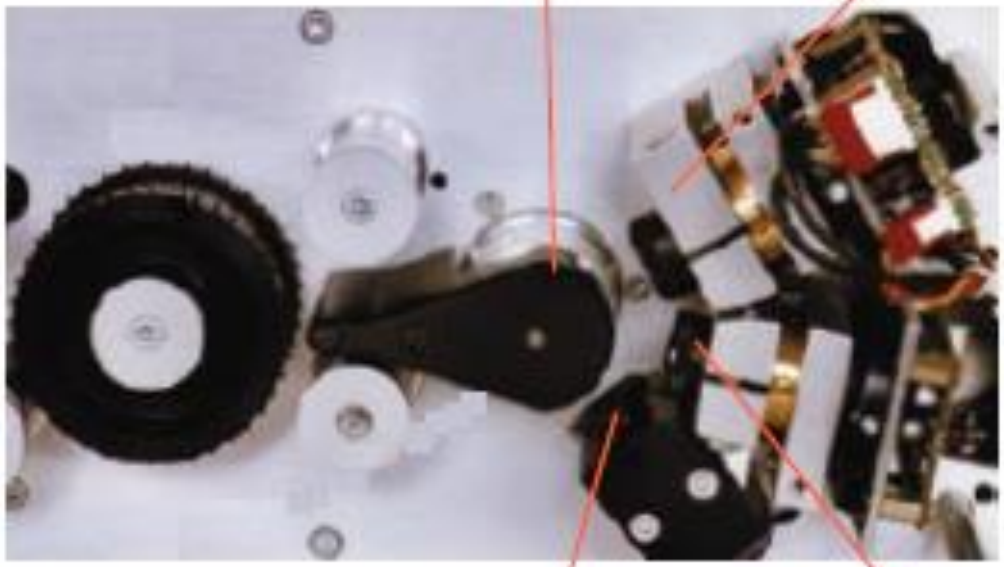
CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

Digital Processor DTS XD-10

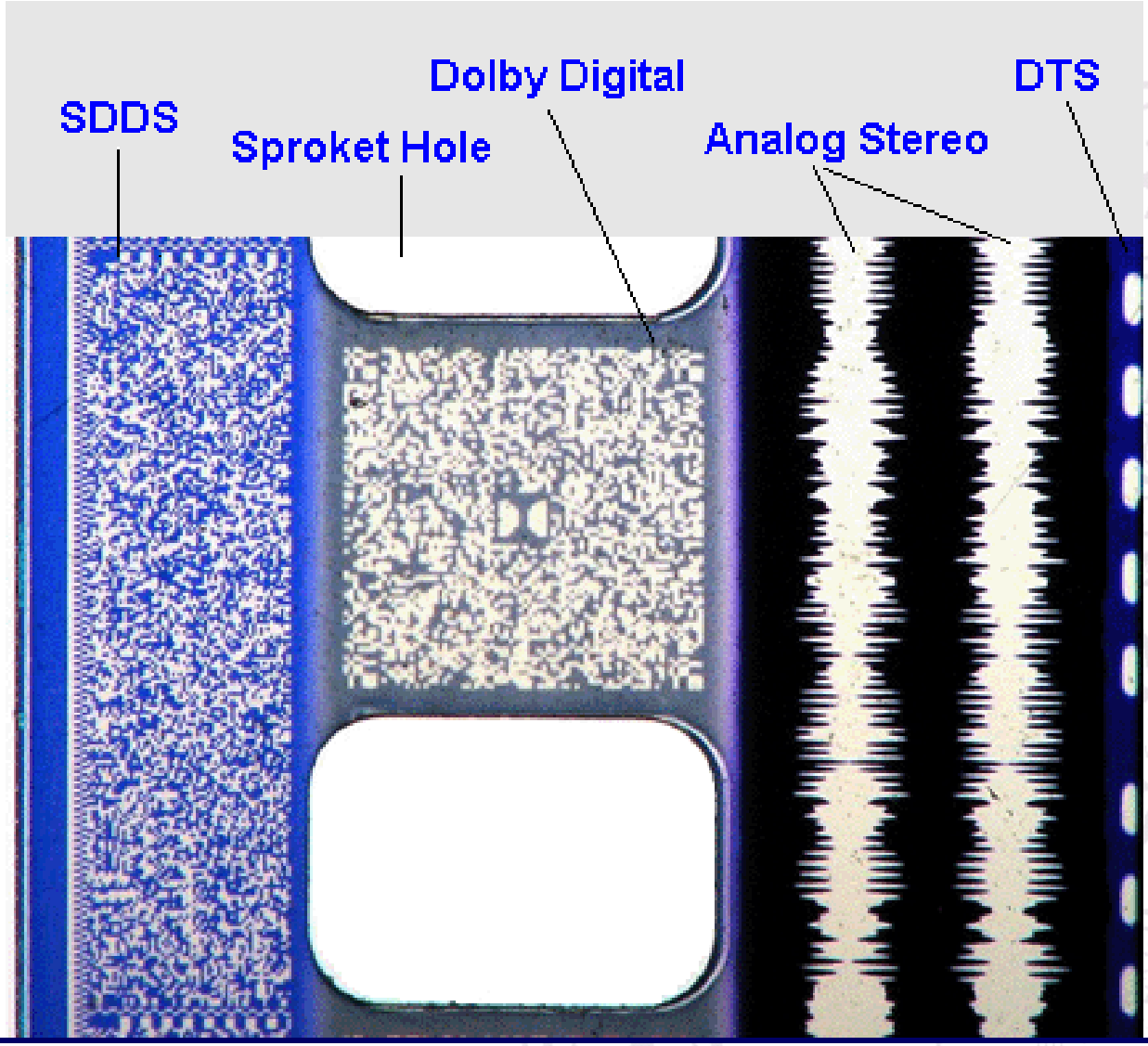
CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

Digital Processor DTS 6AD

CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS



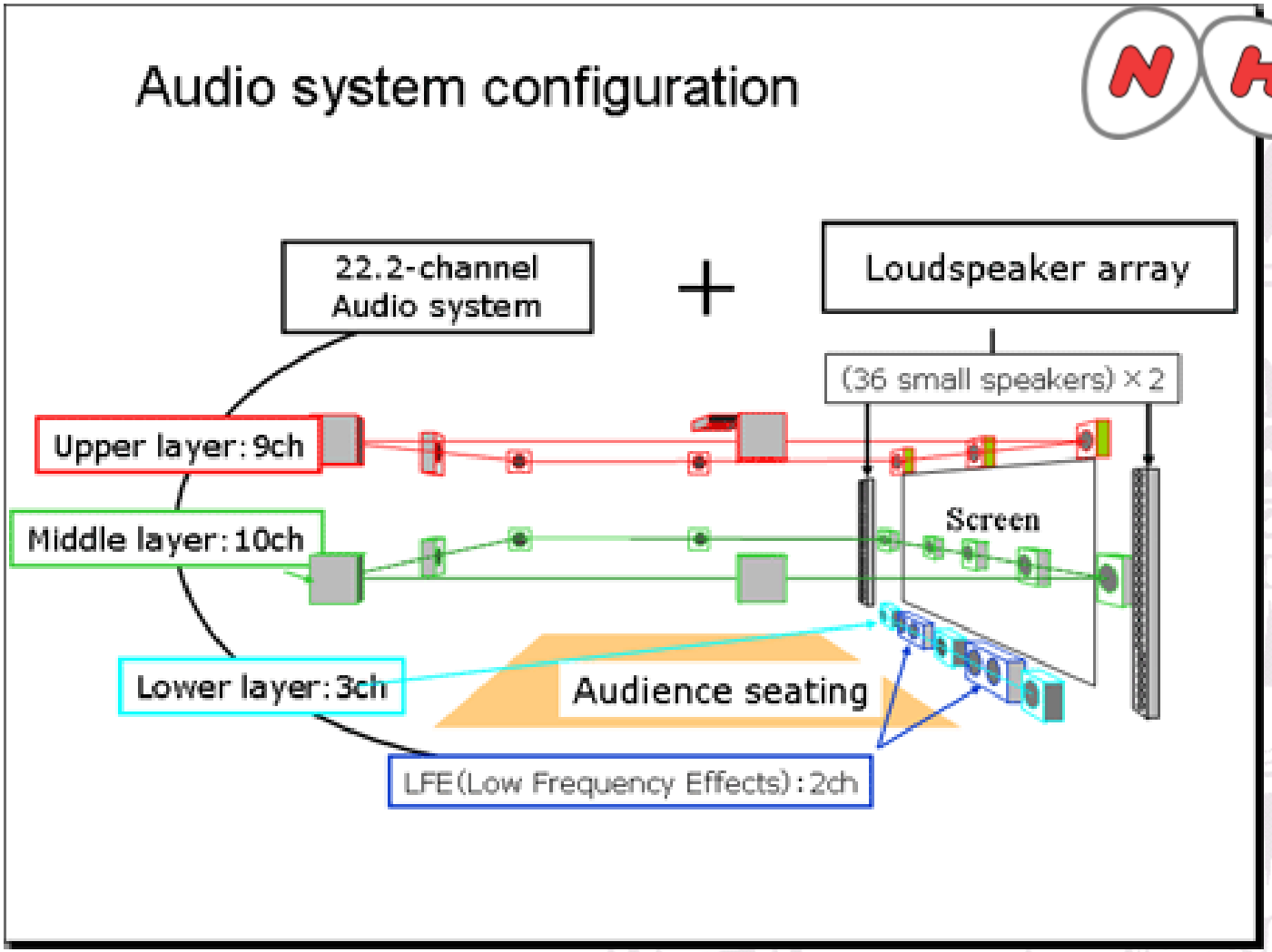
CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS



CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

Especificaciones	*Dolby Stereo*	*Dolby Digital*	*DTS*	*SDDS*
Sistema	Analógico	Digital	Digital	Digital
Pistas	2 ópticas	1 óptica		
Canales	4: L,C,R,S	6:L,C,R,RS,LS,LFE	8	8
ΔB Canales	R,L:20Hz-20kHz C:100Hz-20kHz S:100Hz-7kHz	L,C,R:20Hz-20kHz x 0.5dB LFE:20Hz-120Hz x 0.5dB	L,C,R:20Hz-20kHz RS,LS:80Hz-20kHz LFE:20Hz-80Hz	20Hz-20kHz ±1dB
Separación entre canales		>90dB incluido canal LFE	>90dB incluido canal LFE	<80dB
Frecuencia de muestreo		32kHz, 44,1kHz, 48kHz	24kHz-192kHz	44,1kHz
Muestreo		16,18,20 o 24	16 – 24bits	20
Margen dinámico		96dB	96dB	>90dB
Régimen binario		32 – 640kbps	Variable hasta 4096kbps/canal	2.46Mbps
Compresión		12:1 (5.acanales,384kbps)	4:1	5:1
Distorsión THD				
Codificaicón		AC-3	Coherent Acoustics	ATRAC

3D SOUND DIGITAL FORMATS



NHK 22.2

3D SOUND DIGITAL FORMATS

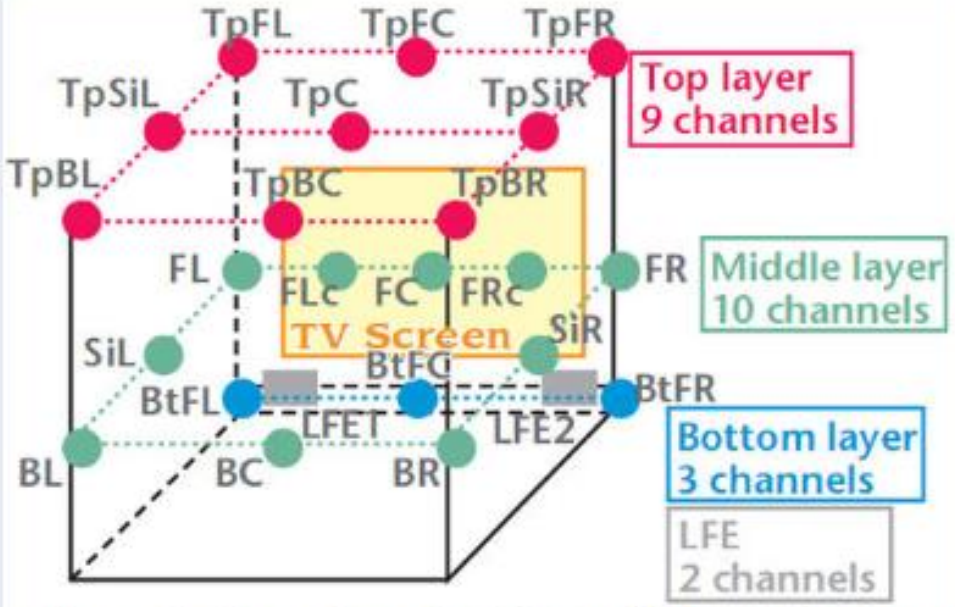


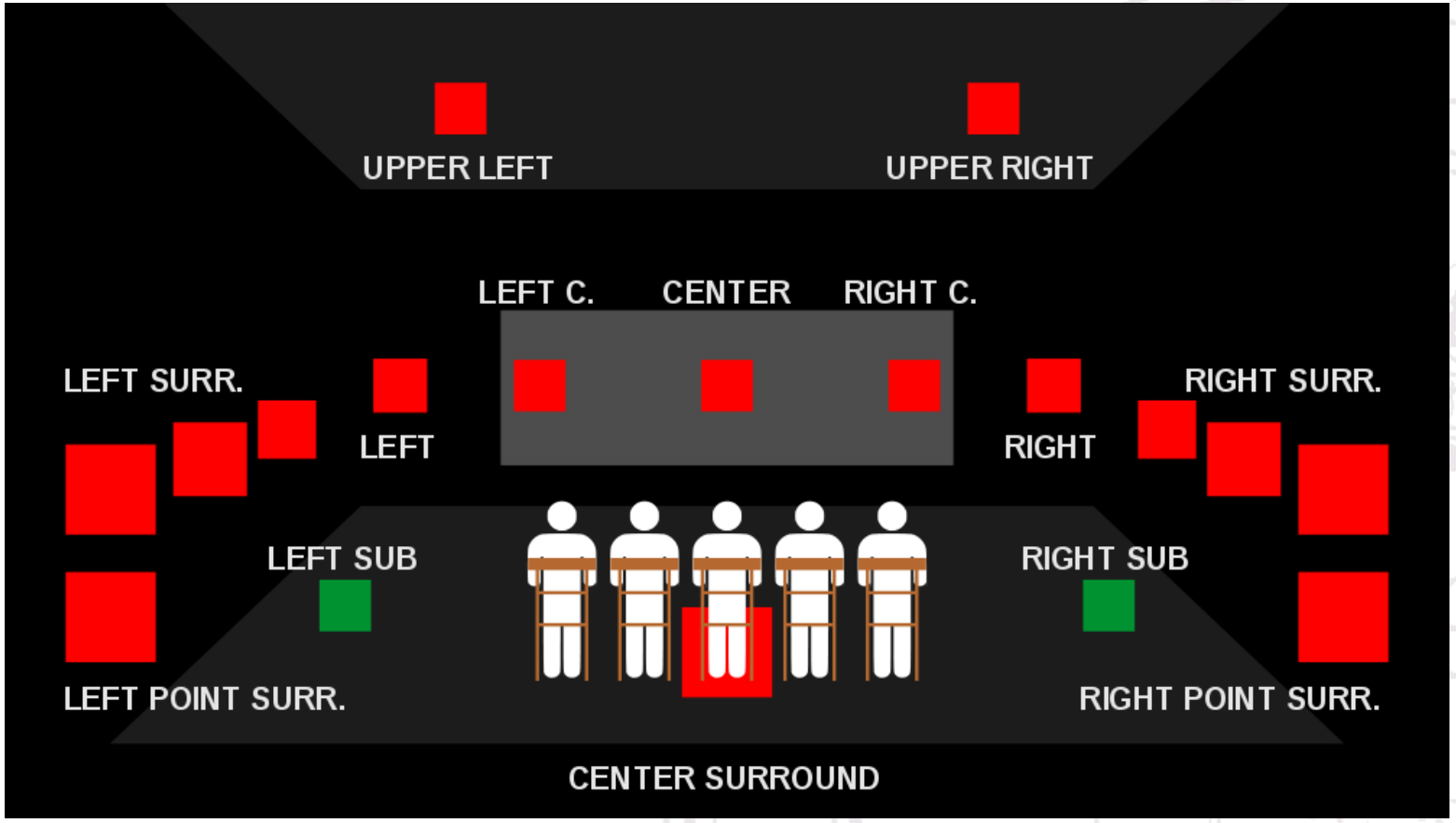
Figure 1. Overview of 22.2 multichannel sound channel labels and mappings standardized in SMPTE2036-2-2008.

Table 1. 22.2 multichannel sound channel labels and mappings standardized in SMPTE2036-2-2008.

AES Pair No./Ch No.	Channel No.	Label	Name
1/1	1	FL	Front left
1/2	2	FR	Front right
2/1	3	FC	Front center
2/2	4	LFE1	LFE-1
3/1	5	BL	Back left
3/2	6	BR	Back right
4/1	7	FLc	Front left center
4/2	8	FRc	Front right center
5/1	9	BC	Back center
5/2	10	LFE2	LFE-2
6/1	11	SiL	Side left
6/2	12	SiR	Side right
7/1	13	TpFL	Top front left
7/2	14	TpFR	Top front right
8/1	15	TpFC	Top front center
8/2	16	TpC	Top center
9/1	17	TpBL	Top back left
9/2	18	TpBR	Top back right
10/1	19	TpSiL	Top side left
10/2	20	TpSiR	Top side right
11/1	21	TpBC	Top back center
11/2	22	BtFC	Bottom front center
12/1	23	BtFL	Bottom front left
12/2	24	BtFR	Bottom front right

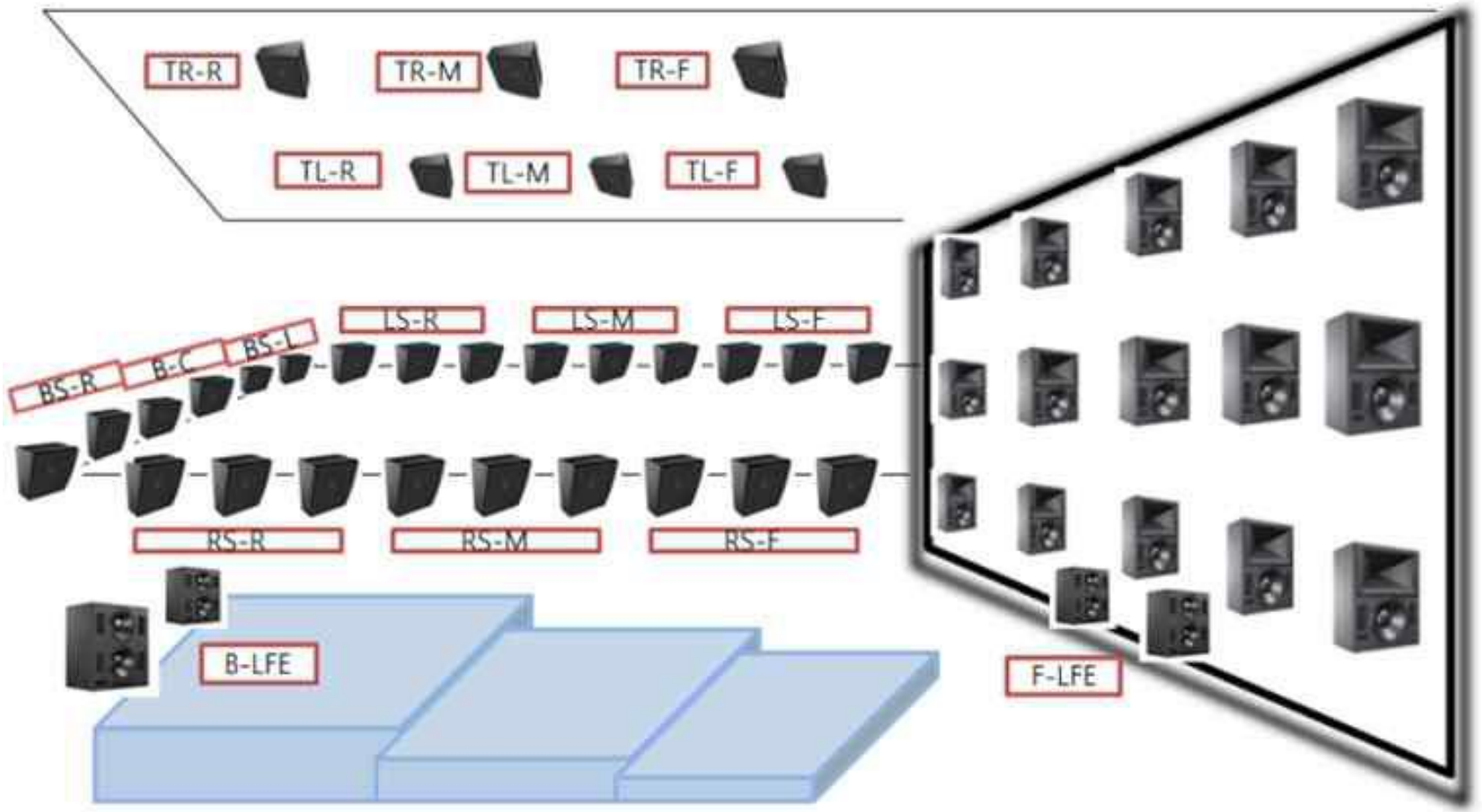
NHK 22.2

3D SOUND DIGITAL FORMATS



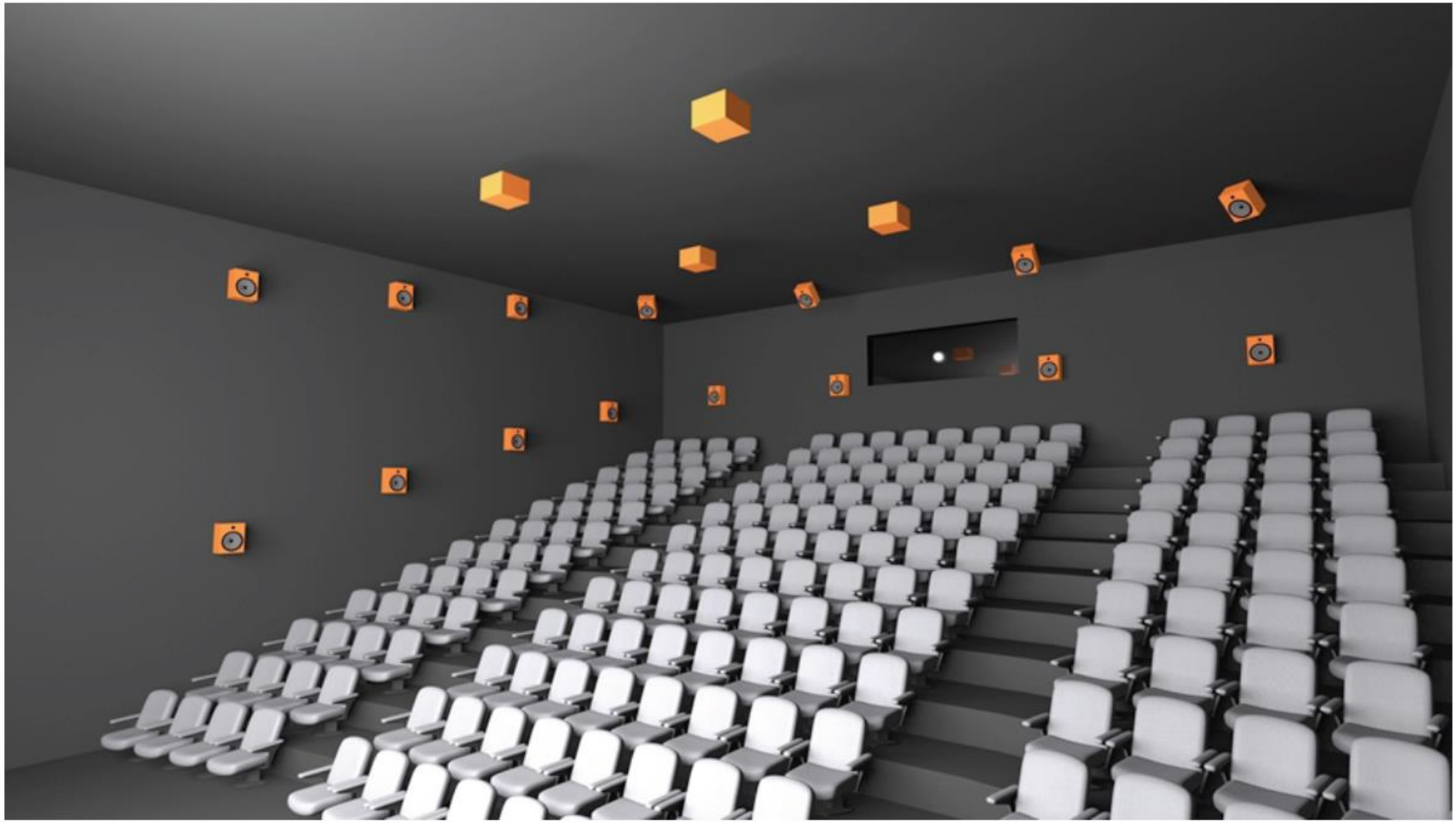
TMH 10.2

3D SOUND DIGITAL FORMATS



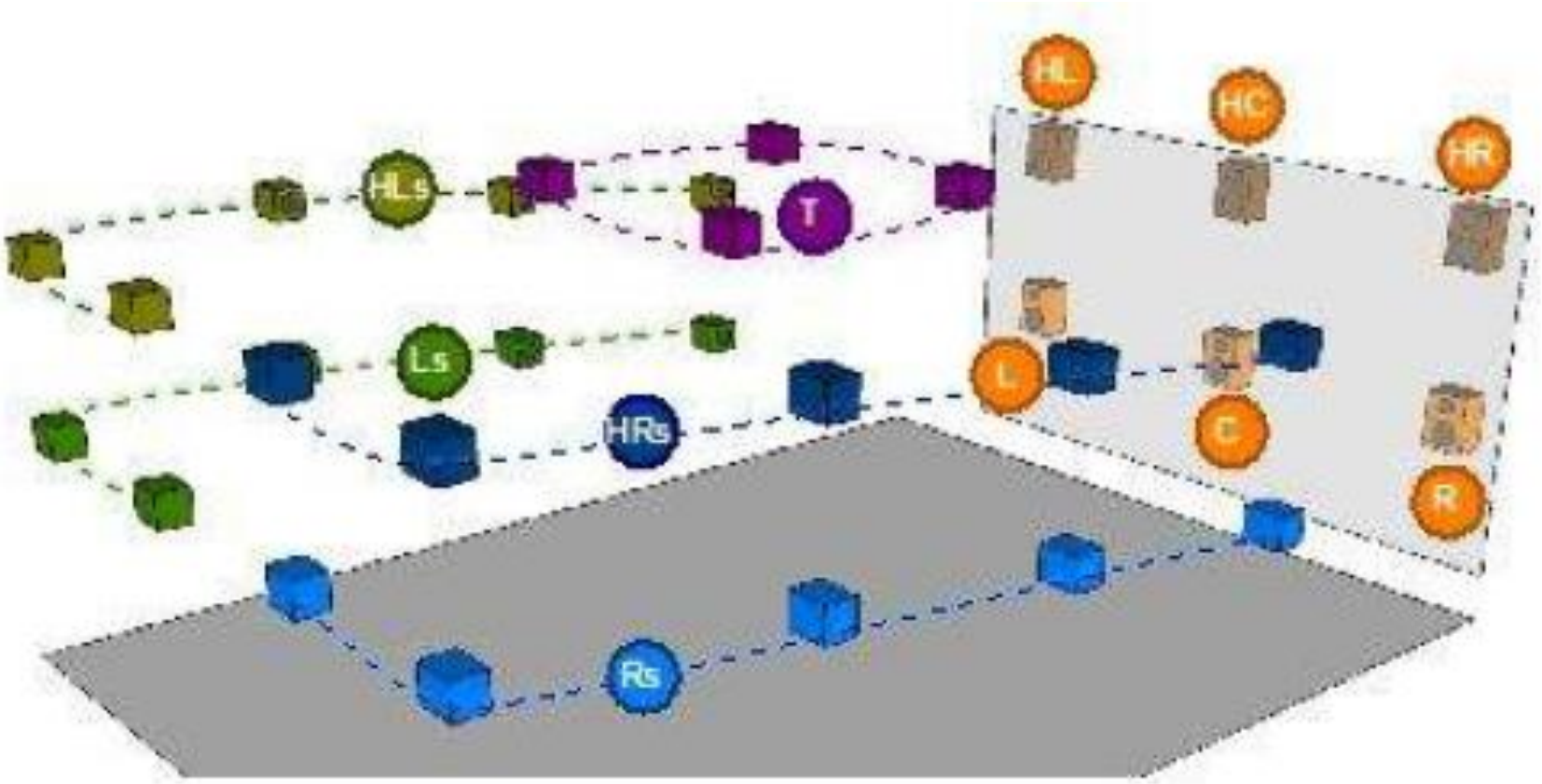
ETRI 30.2

3D SOUND DIGITAL FORMATS



AURO 11.1

3D SOUND DIGITAL FORMATS



AURO 11.1

3D SOUND DIGITAL FORMATS

AURO 11.1

3D SOUND DIGITAL FORMATS

AURO 11.1

3D SOUND DIGITAL FORMATS

Auro 3D

Specifications	
Audio channels	11.1 or 13.1 decoding from a 5.1 or 7.1 DCP
Compression	Lossless

AURO 3D DECODER

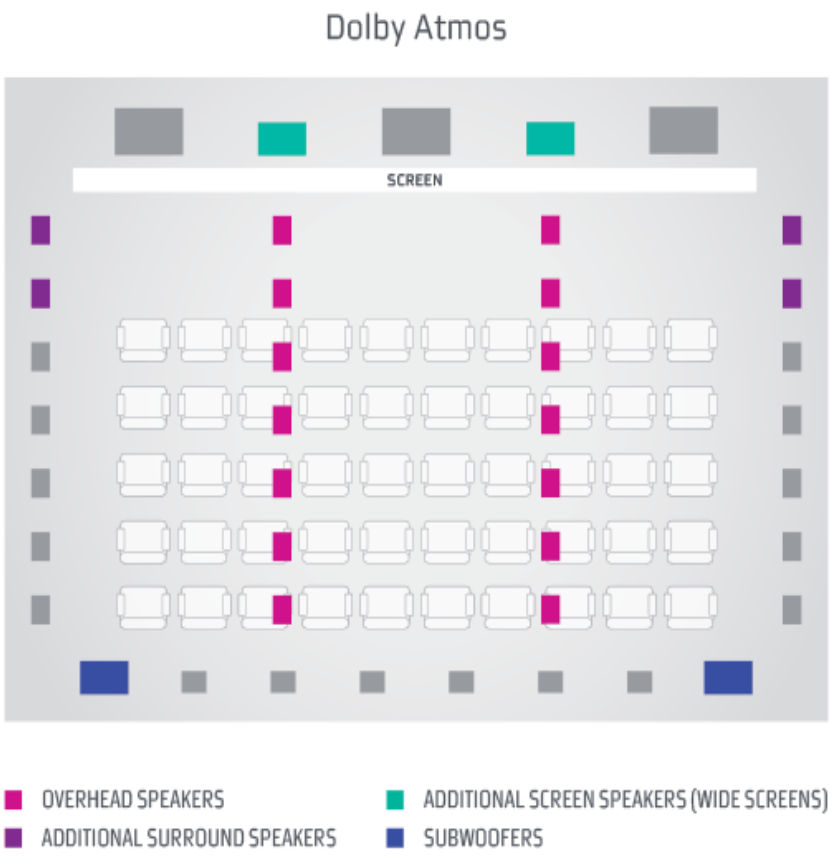
3D SOUND DIGITAL FORMATS

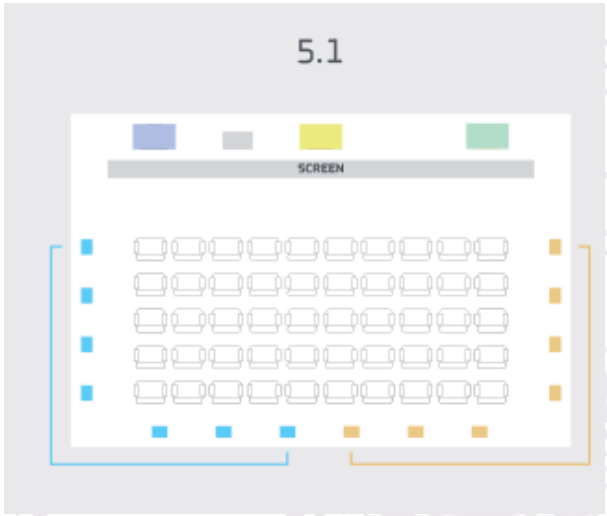
DOLBY ATMOS

Digital Processor Dolby CP850

3D SOUND DIGITAL FORMATS

DOLBY ATMOS





3D SOUND DIGITAL FORMATS

DOLBY ATMOS

3D SOUND DIGITAL FORMATS

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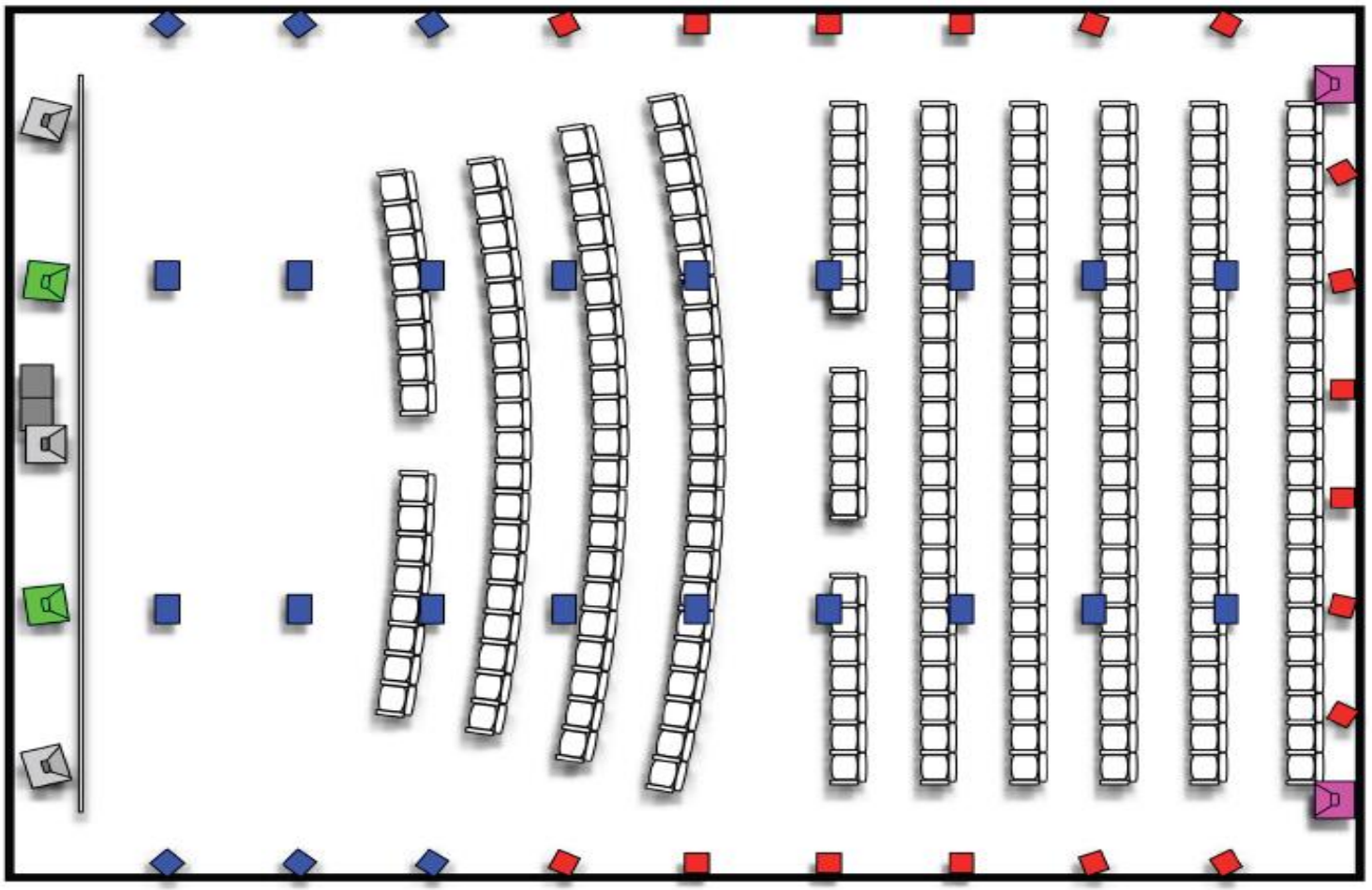
DOLBY ATMOS

3D SOUND DIGITAL FORMATS

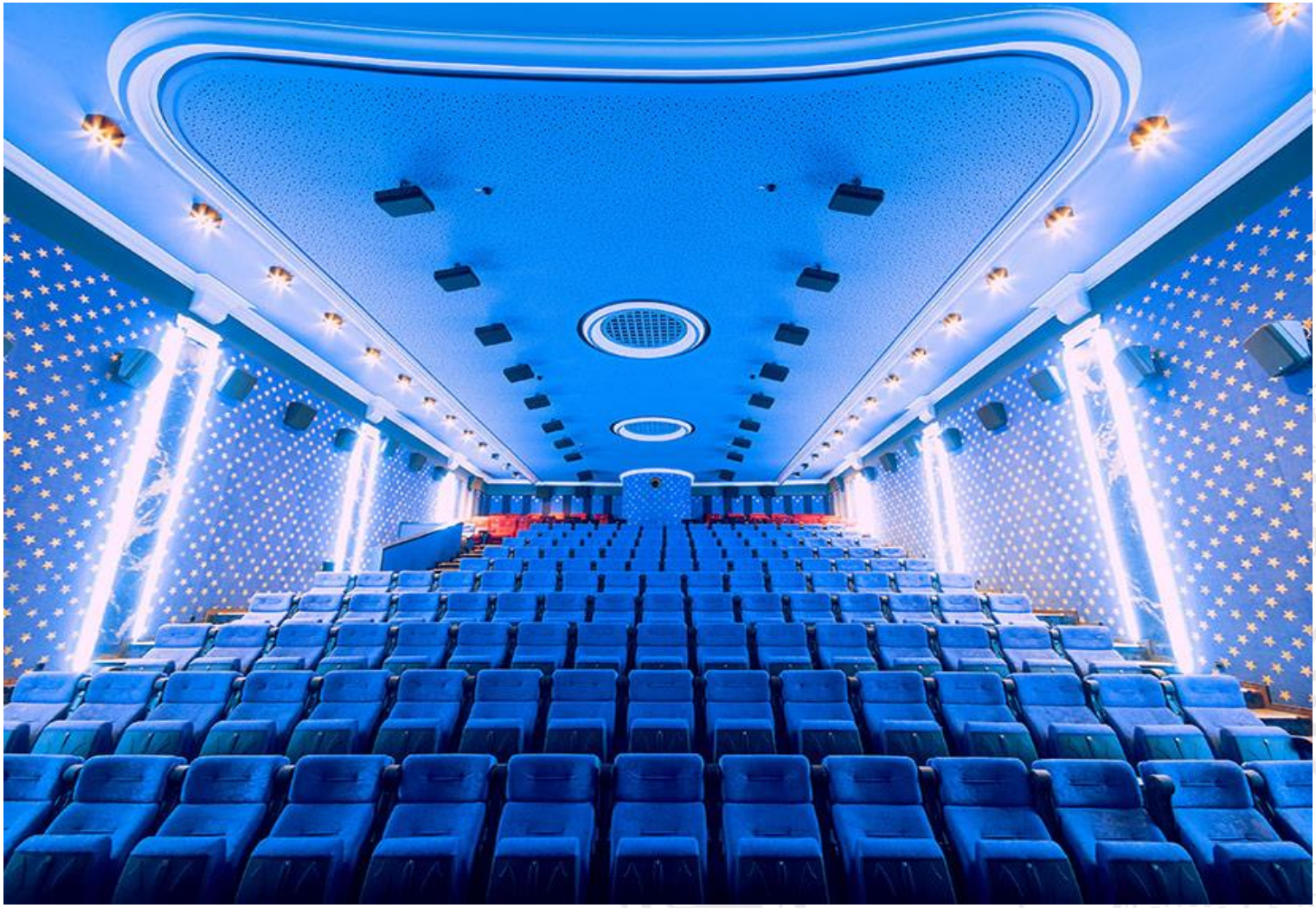
DOLBY ATMOS



3D SOUND DIGITAL FORMATS

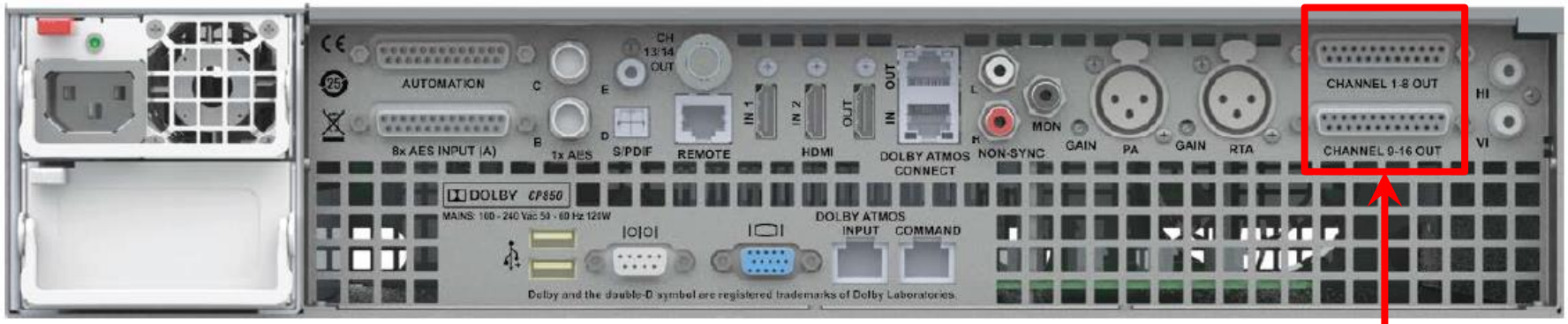
DOLBY ATMOS

3D SOUND DIGITAL FORMATS



DOLBY ATMOS

3D SOUND DIGITAL FORMATS



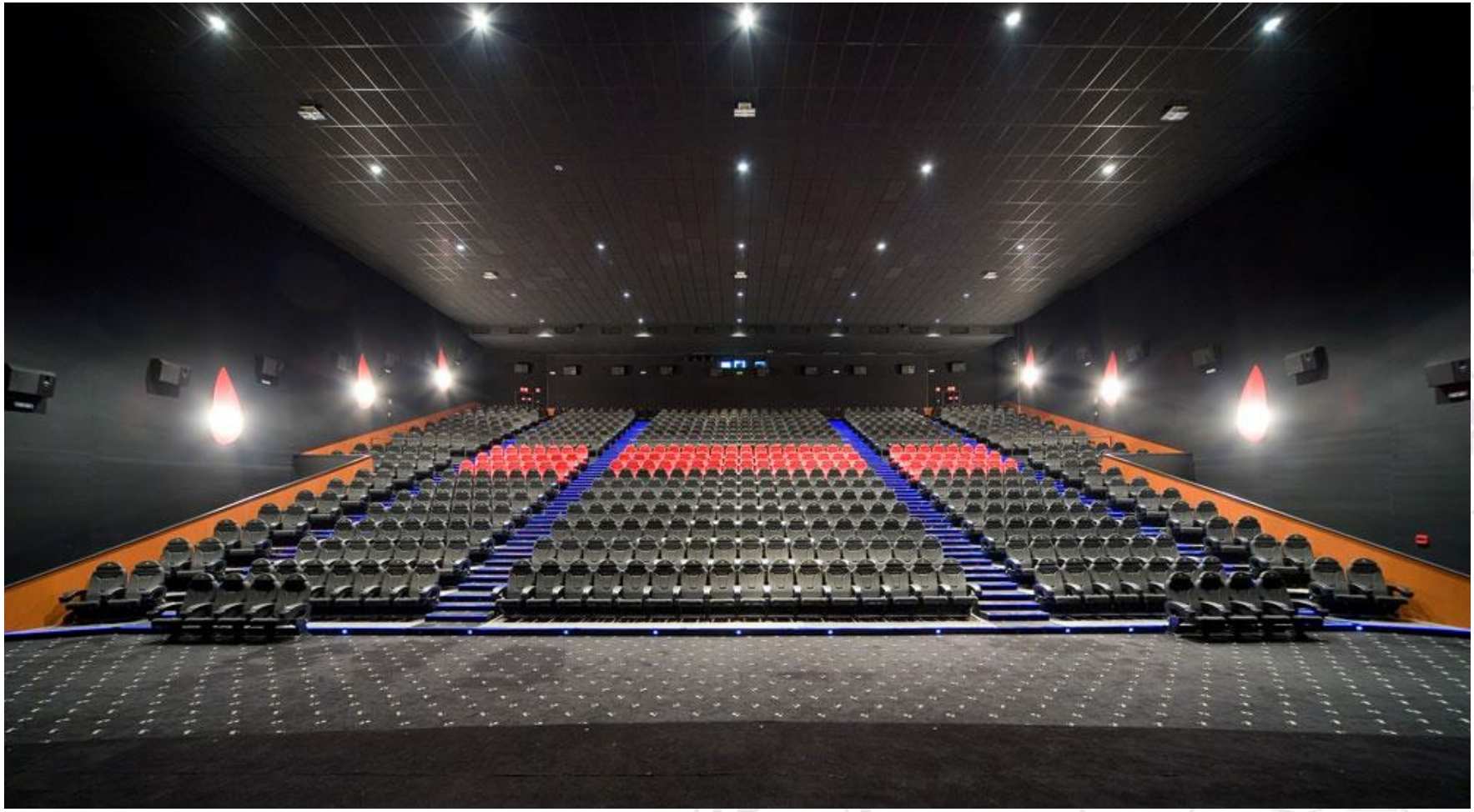
2 × DB25	16-channel electronically balanced analog outputs

DOLBY ATMOS PROCESSOR

3D SOUND DIGITAL FORMATS

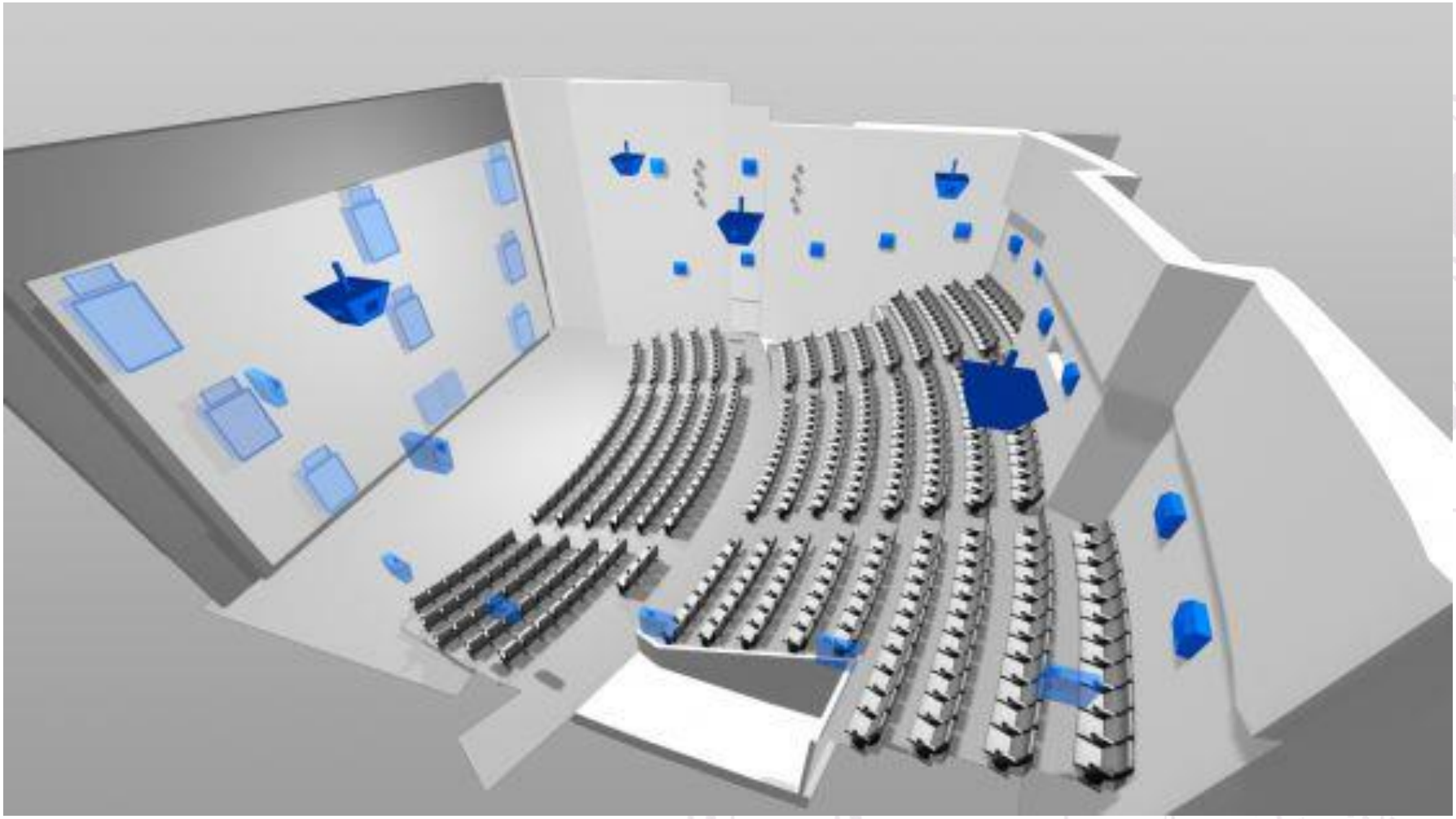
IMM SOUND

3D SOUND DIGITAL FORMATS



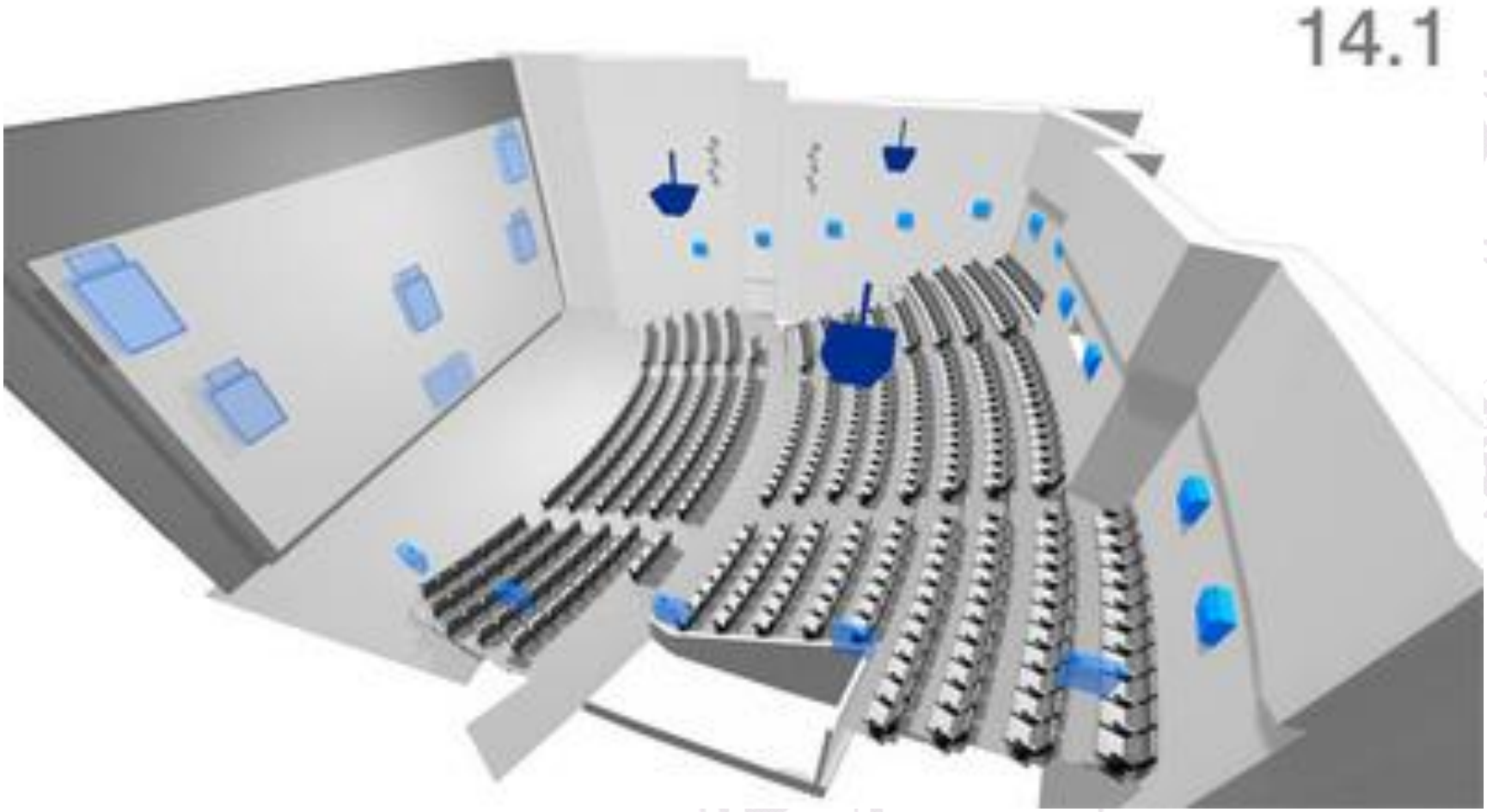
IMM SOUND 14.1

3D SOUND DIGITAL FORMATS



IMM SOUND 23.1

3D SOUND DIGITAL FORMATS



IMM SOUND 14.1

3D SOUND DIGITAL FORMATS

IMM SOUND

3D SOUND DIGITAL FORMATS

16 balanced analog XLR line-out

ILLUSONIC PROCESSOR

DIGITAL CINEMA

- Digital cinema refers to the use of digital technology to distribute or project images moving against the traditional cinema film.
- Digital films are projected using a digital projector instead of a conventional analog projector.
- In digital cinema, the resolutions are represented by the number of horizontal pixels, usually 2K (2048 × 1080) or 4K (4096 × 2160).

DIGITAL CINEMA

- *Digital Cinema Initiatives*, *LLC* o *DCI* is a joint venture of the major film studios, formed to establish a standard for digital cinema systems architecture.

- The Organization was formed in March 2002 by the following studies:
  - Metro-Goldwyn-Mayer
  - Paramount Pictures
  - Sony Pictures Entertainment
  - 20th Century Fox
  - Universal Studios
  - The Walt Disney Company
  - Warner Bros.

DIGITAL CINEMA

- In 2005, DCI released version 1.0 of its "Digital Cinema System Specification". Version 1.1 was launched in 2008 and 2012 version 1.2 has been released.

- The document describes overall system requirements and specifications for digital cinema.

- It is based on SMPTE and ISO standards, such as JPEG 2000 compression of images and sound PCM/WAV, explains how to create around a "Digital Cinema Package" (DCP) from a collection of files known as the "Digital Cinema Distributor Manager" (DCDM), as well as the details of its content protection and encryption.

DIGITAL CINEMA

- Information about digital cinema has also been published by National Association of Theaters Owners (NATO), in their paper "Digital Cinema System Requirements" of 2008, and Society Motion Picture and Television Engineers, SMPTE, in its document "D-cinema Distribution Master" and "D-cinema Packaging".

DCI Specifications

- 2D Image:
  - 2048x1080 (2K) at 24 frame/s or 48 frame/s, or 4096x2160 (4K) at 24 frame/s
    - In 2K, for Scope (2.39:1) presentation 2048x858 pixels of the imager is used
    - In 2K, for Flat (1.85:1) presentation 1998x1080 pixels of the imager is used
    - In 4K, for Scope (2.39:1) presentation 4096x1716 pixels of the imager is used
    - In 4K, for Flat (1.85:1) presentation 3996x2160 pixels of the imager is used
  - 12 bits per color component (36 bits per pixel) via dual HD-SDI (encrypted). 10 bits only permitted for 2K at 48 frame/s
  - CIE XYZ color space
  - TIFF 6.0 container format (one file per frame)
  - JPEG 2000 compression
    - from 0 to 5 or from 1 to 6 wavelet decomposition levels for 2K or 4K resolutions, respectively
    - Compression rate of 4.71 bits/pixel (2K @ 24 frame/s), 2.35 bits/pixel (2K @ 48 frame/s), 1.17 bits/pixel (4K @ 24 frame/s)
  - 250 Mbit/s maximum image bit rate

DCI Specifications

- Stereoscopic 3D Image
  - 2048x1080 (2K) at 48 frame/s - 24 frame/s per eye (4096x2160 4K not supported)
    - In 2K, for Scope (2.39:1) presentation 2048x858 pixels of the imager is used
    - In 2K, for Flat (1.85:1) presentation 1998x1080 pixels of the imager is used
  - Optionally, in the HD-SDI link only: 10 bit color, YCbCr 4:2:2, each eye in separate stream

- Audio
  - 24 bits per sample, 48 kHz or 96 kHz
  - Up to 16 channels
  - WAV container, uncompressed PCM

DIGITAL CINEMA

Dolby DMA8

Dolby DLS100

DIGITAL CINEMA

Dolby DSP100 DSS100

DIGITAL CINEMA

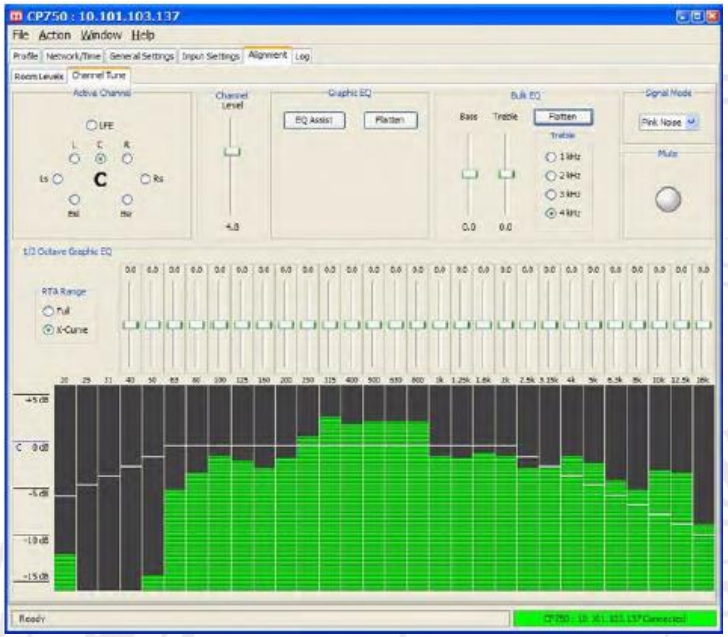
Dolby Digital Cinema Player and Store

DIGITAL CINEMA

Dolby DLS200

Dolby DLS220

CINEMA MULTICHANNEL DIGITAL AUDIO FORMATS

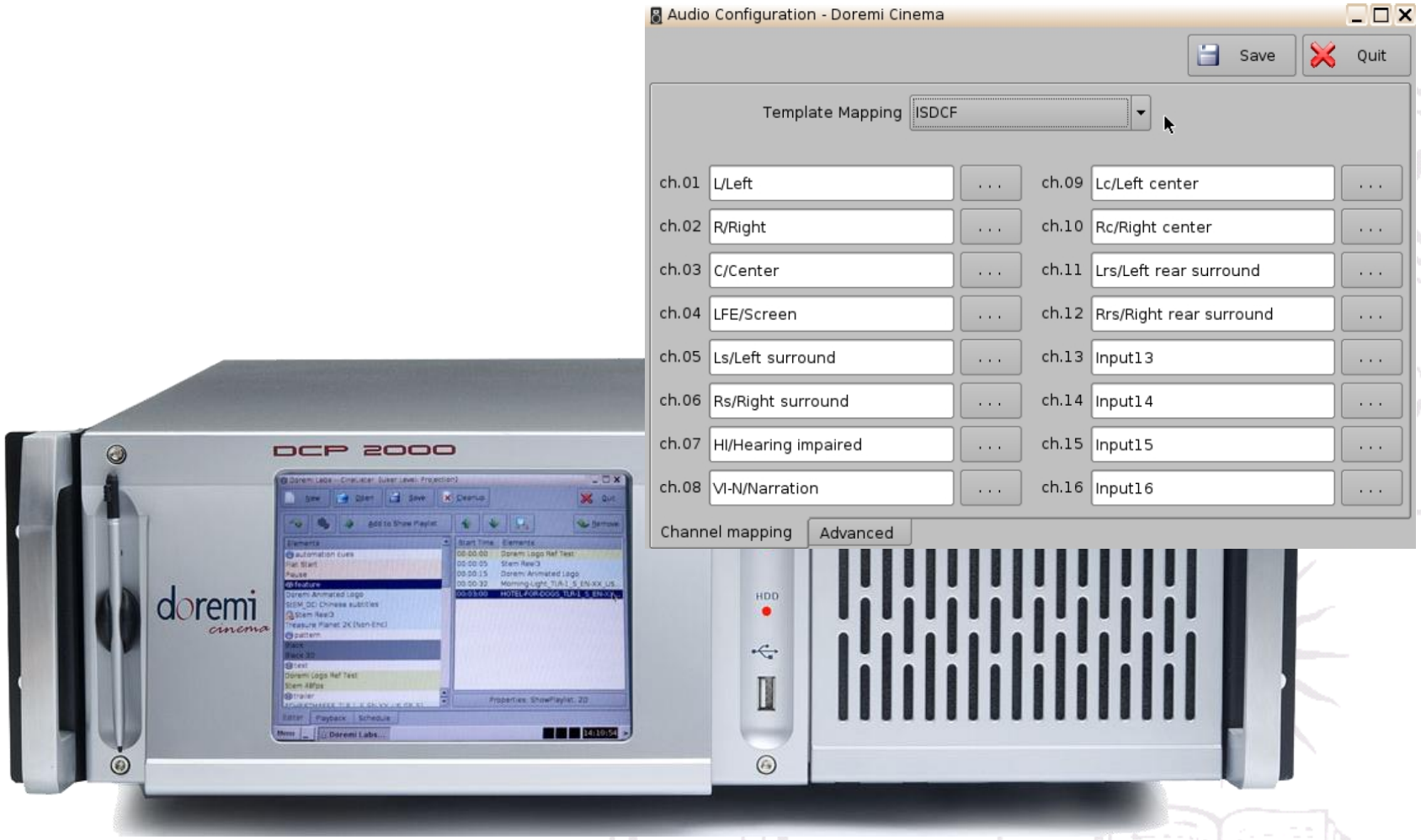


Digital Processor Dolby CP750

3D SOUND DIGITAL FORMATS

QSC DCP 300

3D SOUND DIGITAL FORMATS



DOREMI DCP 2000 2K

DIGITAL CINEMA