A History of Dolby Laboratories

-Found by Ray Dolby in 1965.
-Developed Noise Reduction System to remove hiss noise in professional tape recording.
-Named the developed system as Dolby A-Type Noise Reduction.

Dolby Stereo

- Introduced Dolby Stereo as 3D surround system adapting 6 channels in late 1970.
-Developed for use in theater.
-Synthesizes 4-channel sound as 2-channel audio signals using Dolby MP(Motion Picture) matrix encoder to enable stereo recording.
-Enables the 2-channel stereo signals recorded to be decoded as 4-channel, which enhances action and dramatic elements by distributing sound surround from behind left and right.

Dolby Surround

- Remodeled the surround system for home theater as a home surround system and copyrighted it in 1982.
-Adapts dematrix architecture, which does not process center signals and replays them with L/R speakers. (implementing Phantom image)
-Extracts and replays surround signals as differential signals between L-R.
-Sometimes called Passive Surround.

Dolby Pro Logic

-Developed in 1987 as a home theater format.
-Uses Adaptive Matrix technology to enhance separation between channels.
-4.0 channel architecture (Left/Center/Right/Surround)
-Directional phase boost

DOLBY DIGITAL

▸ Digital Surrond System

1.AC (Audio Coding) - 1

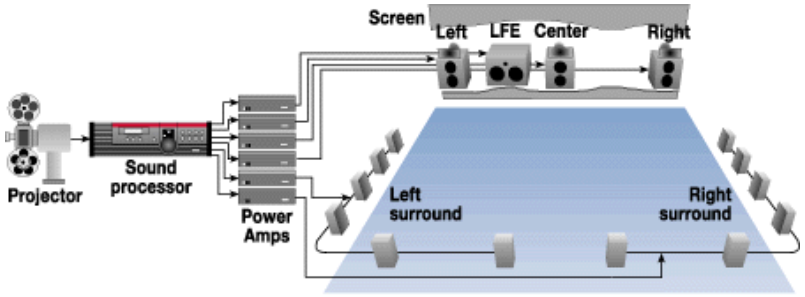
-4-2-4 Multi Ch' System (like Dolby Pro Logic)
-2:1 Bit Rate Reduction
-Developed in 1984.

2.AC-2

-2ch' Stereo System
-Psycho-acoustic Model
-Based On Tdac Filter Banks
-Pr ofessiona l Quality Audio

3.AC-3

-Multi Channel Digital Audio Coding Technology
-5.1ch'(L,R,C,SL,SR,LFE) System
-Psycho-acoustic Model
-Based On Tdac Filter Banks
-Selected as ATSC broadcasting and DVD sound standard
-Named as Dolby Digital.



Dolby Digital cinema system

Dolby Surround System Types

- DOLBY SURROUND (PASSIVE SURROUND)
- DOLBY PROLOGIC (ACTIVE SURROUND)
- VIRTUAL DOLBY (VDS , VDD)
  - 3D-Phonic :JVC
  - Virtual Sonic :Matsushita
  - VMAx :Harman
  - A3D :Aureal
  - Qsurround :Qsound
  - N-2-2 DVS :Spatializer
  - TruSurround :SRS
  - Sensaura :EMI/CRL
  - Incredible Cinema :Philips
  - 3D-Panorama :Micronas
- DOLBY DIGITAL
  - AC-1
  - AC-2
  - DOLBY DIGITAL(AC-3)

Dolby Surround System Overview

1.DOLBY SURROUND

- ▶ Input signal: Lt/Rt or L/R (Lt/Rt: Signals recorded with Dolby Surround)
- ▶ Playbacks sound field with time delaying L-R signals(surround signal).
- ▶ No Matrix type and does not playback directional phases.
- ▶ Currently, not used in TV or audio products.
- ▶ Center channel is optional.
- ▶ Channels: L, R, S

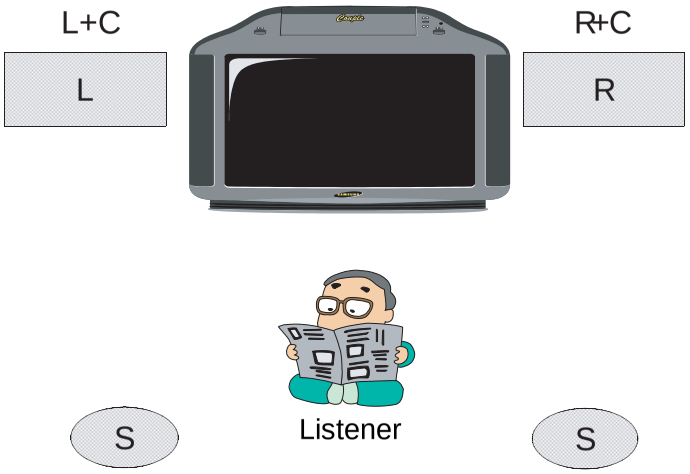


Figure 1. Dolby Surround Speaker Map

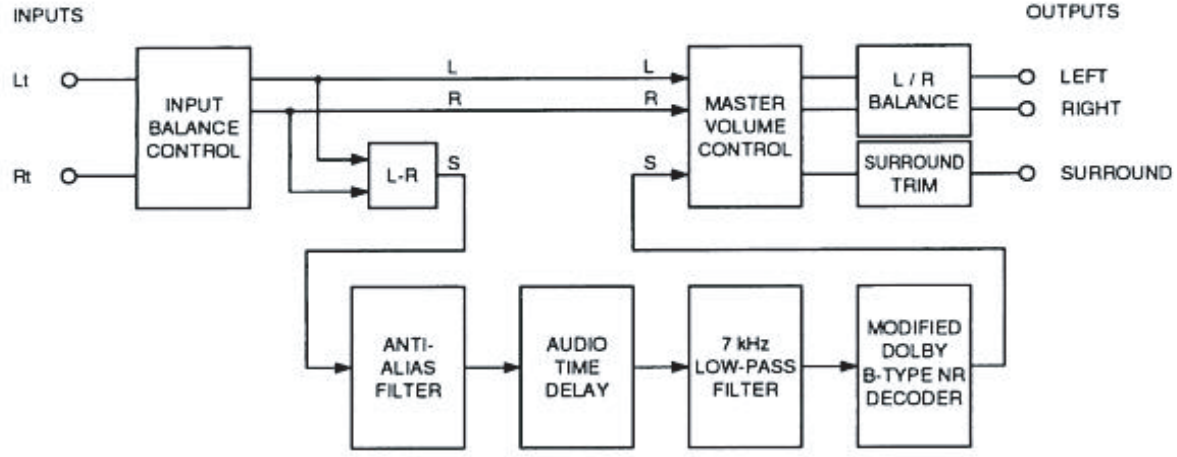


Fig. 2. Passive surround decoder block diagram.

2. DOLBY PRO LOGIC

2-1. Overview

- ▶ Input signal: Lt/Rt or L/R (Lt/Rt: Signals recorded with Dolby Surround)
- ▶ Pro Logic Adaptive Matrix separates four signals, i.e., L, R, C, S.
- ▶ Adaptive Matrix extracts preference signals for each channel. (Directional phase boost)
- ▶ Processing surround signals are the same as Dolby Surround.
- ▶ Used in analog TV, analog A/V and home audio system.
- ▶ Dolby Pro Logic is continually increasing its production continually. (See Dolby Lab. documentation.)
- ▶ Channel: L,R,C,S (4-channel out)
- ▶ Center mode (Normal, Wide, Phantom) can be controlled according to the condition of the center speaker.
- ▶ Variable channels depending on presence of Surround channel: 3ch' or 4ch'

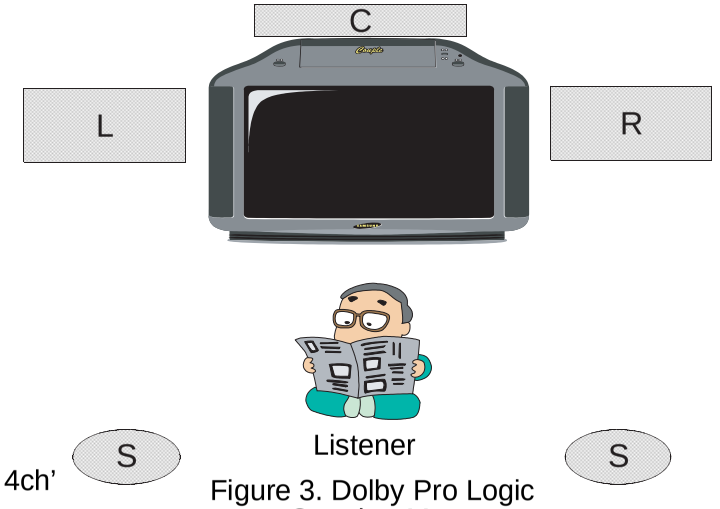


Figure 3. Dolby Pro Logic Speaker Map

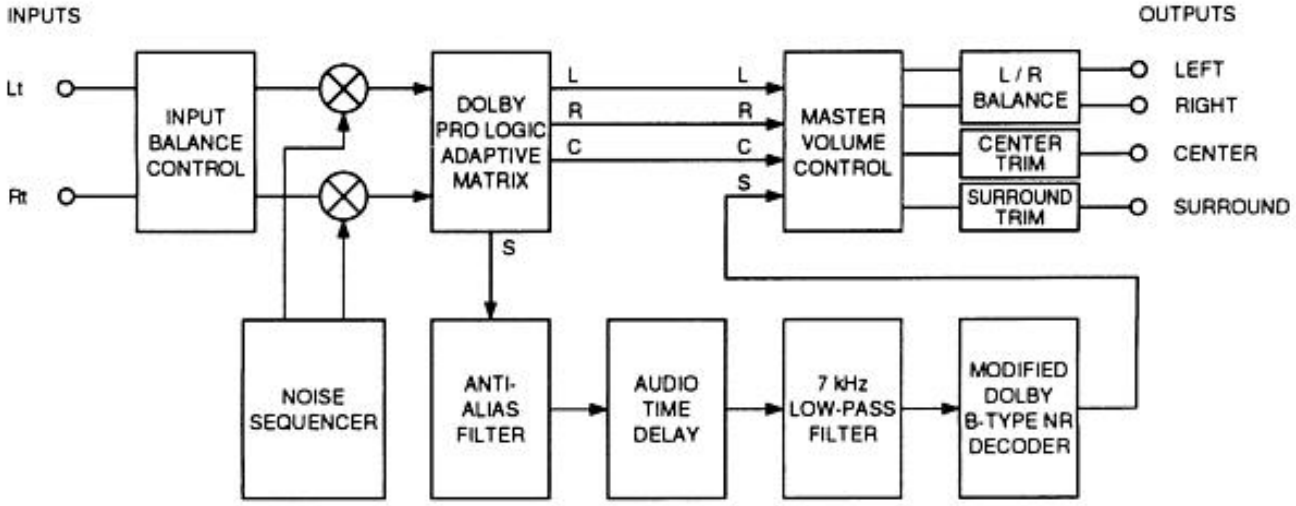


Figure 4. Dolby Pro Logic Block Diagram

2-2. PRO LOGIC MODE

2-2-1.CENTER MODE CONTROL

►Dolby Pro Logic allows for mode control according to the condition of the center speaker.

1) NORMAL MODE

-Used when there is a the center speaker but is smaller than the main L/R speakers.

-Bass component of central channel is played back with the main L/R speakers.

-Frequency bandwidth of center channel
Playback bandwidth:100Hz~20KHz

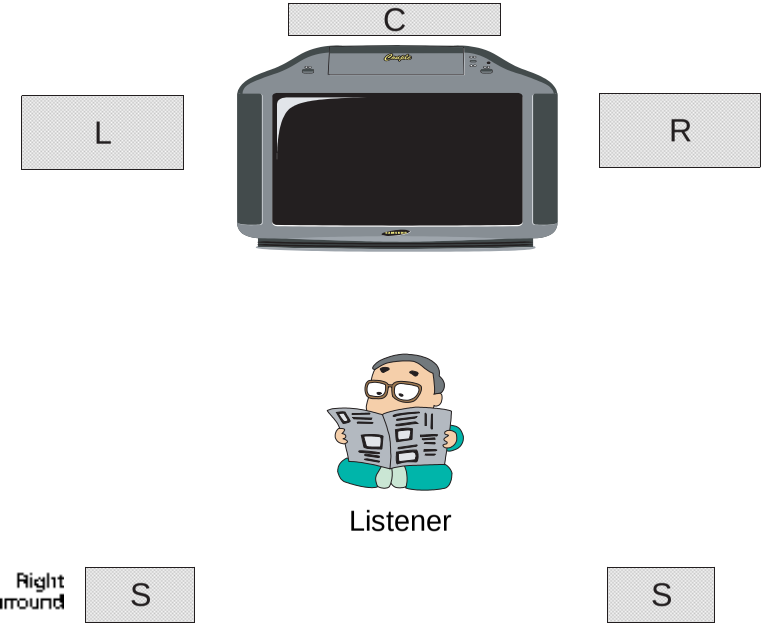


Figure 5. NORMAL MODE

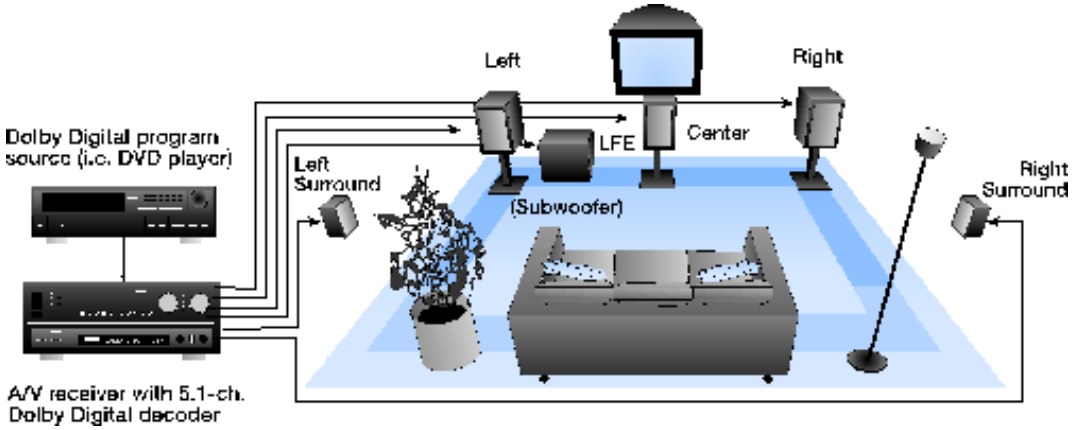


Figure 6. Dolby Digital Home System

2)WIDE MODE

-Used when there is a center speaker but is the same size as the main speakers.

-Frequency bandwidth of center channel
Playback bandwidth:20Hz~20KHz

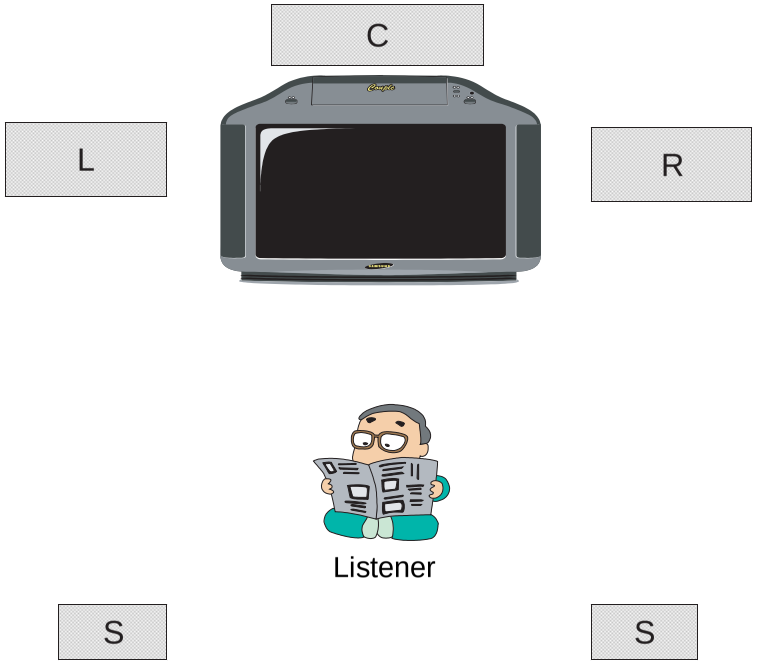


Figure 7. WIDE MODE

3)Phantom Mode

-Used when the center speaker is not used.

-Center channel signals are distributed to the main L/R speakers.

-Center channel outputs no signal.

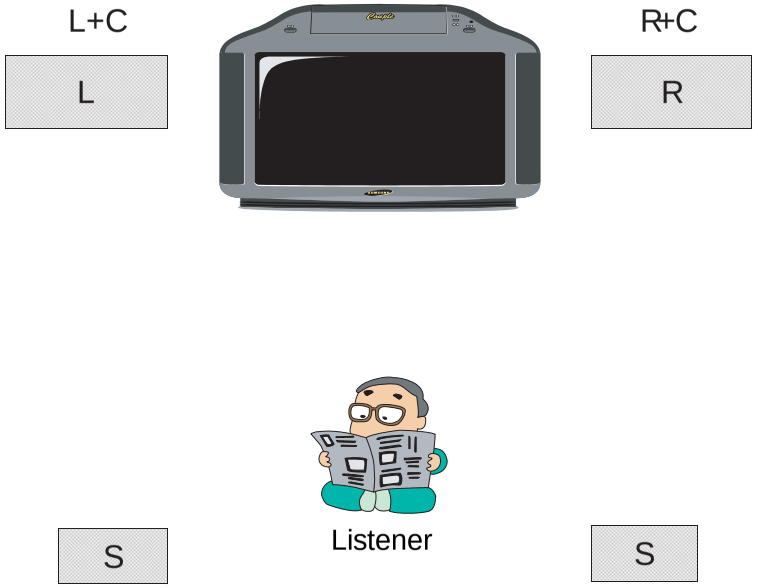


Figure 8. PHANTOM MODE

2-2-2. 3ch'/4ch' Mode Control

1)3-channel Mode Control

-Used when the surround speaker is not used.

-Surround signals are synthesized in main L/R speakers.

2) 4-Channel Mode Control

-Use when both surround and center speakers are used.

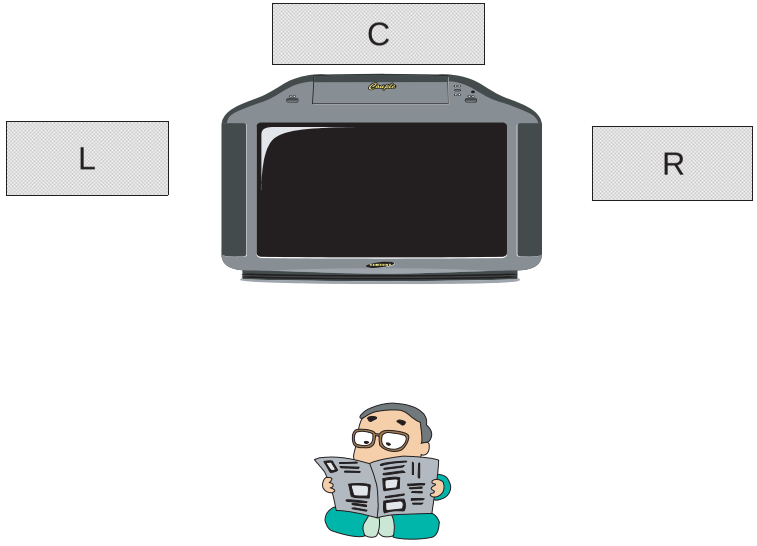


Figure 9. 3ch' MODE

2-2-3. Other Mode Control

1)Center Level Control

-Used to adjust the volume difference between main speakers (L,R channels) and center speaker.

2)Surround Level

-Used to adjust the volume difference between main speakers (L,R channels) and surround speaker.

3)Delay Time

-Delays surround sound to optimize surround effect because the location of a surround speaker differs depending on the audio environment.

4)Test Tone

-Test noise (white noise) for controlling the volume of the center and surround speakers.

-Sequence: Left -> Center -> Right -> Surround -> Left

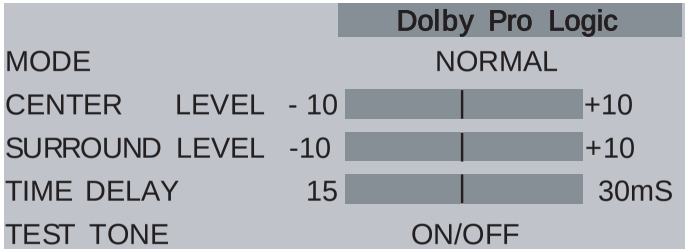


Figure 10. OSD MENU

3.VIRTUAL DOLBY

- ▶ Input signal: Lt/Rt or L/R (Lt/Rt: Signals recorded with Dolby Surround)
- ▶ Pro Logic Adaptive Matrix separates four signals, i.e., L, R, C, S.
- ▶ Down mixes into 2 channels the 4 signals processed in the Pro Logic Decoder.
- ▶ L and R signals are passed directly and center channel is synthesized with L and R channels.
- ▶ Surround signals pass through the block called Virtualizer.
  During the pass through, stereo signals are created using a specific algorithm and synthesized with L and R channels.
- ▶ Dolby Pro Logic requires 4 channels and 5 speakers. But, Virtual Dolby implements surround effect with 2 speakers.
- ▶ Production of adaptive Virtual Dolby and adaptive Dolby Pro Logic is increasing. (See Dolby Lab. documentation.)
- ▶ Virtual Dolby technologies are registered with Dolby Lab. by the companies that use them.

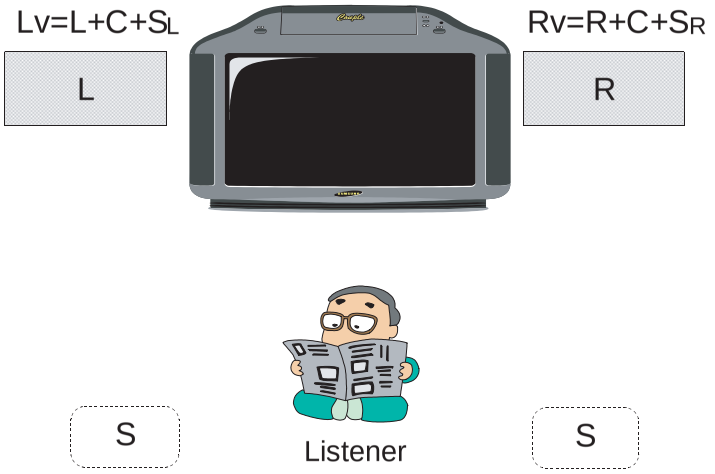


Figure 11. VIRTUAL DOLBY SPEAKER Map

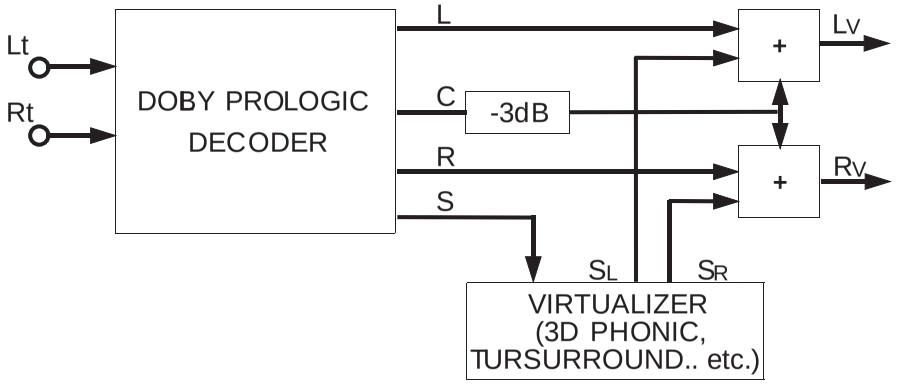


Figure 12. VIRTUAL DOLBY BLOCK DIAGRAM

DOLBY SURROUND SIGNAL

1)DOLBY SURROUND ENCODER

- $Lt = L + 1/\sqrt{2}(C - jS)$
- $Rt = R + 1/\sqrt{2}(C + jS)$

-L/R signals bypass without transformation.
-Center signals decline by 3dB and are uniformly distributed to L/R channels.
-Surround signals decline by 3dB, pass through 100Hz~7KHz BPF, are encoded to Dolby B NR and have phase differences of +90¡,-90¡ (180¡ phase difference). Then, they are synthesized with L/R channels to create Dolby surround signals.

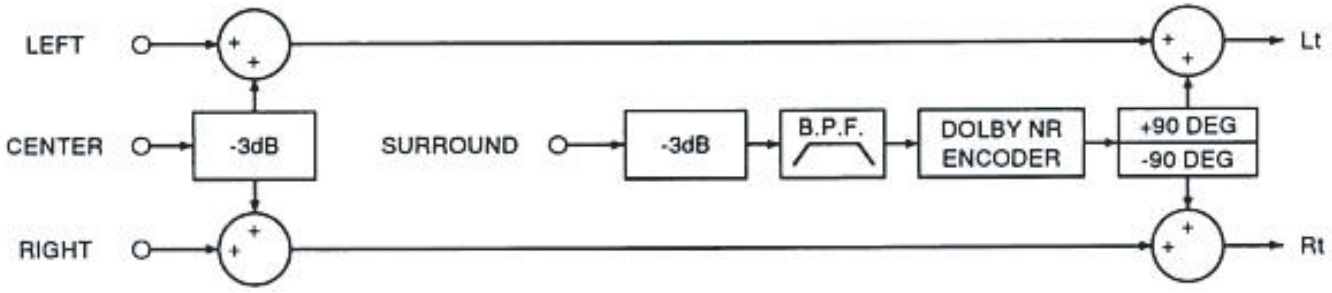


Figure 13. DOLBY SURROUND ENCODER

INTRODUCTION

- Adapts 5.1channel system to enhance 3D surround effect.
- 5.1 CHANNEL
  -L,R,C,SL,SR,LFE(Low Freq. Effect)
- FULLY DIGITAL SYSTEM
  -Sampling Frequency :32,44.1,48KHz
  -Quantization:16,18,20bits
  -Typical bit rate:384kbps
  (13:1 compression)

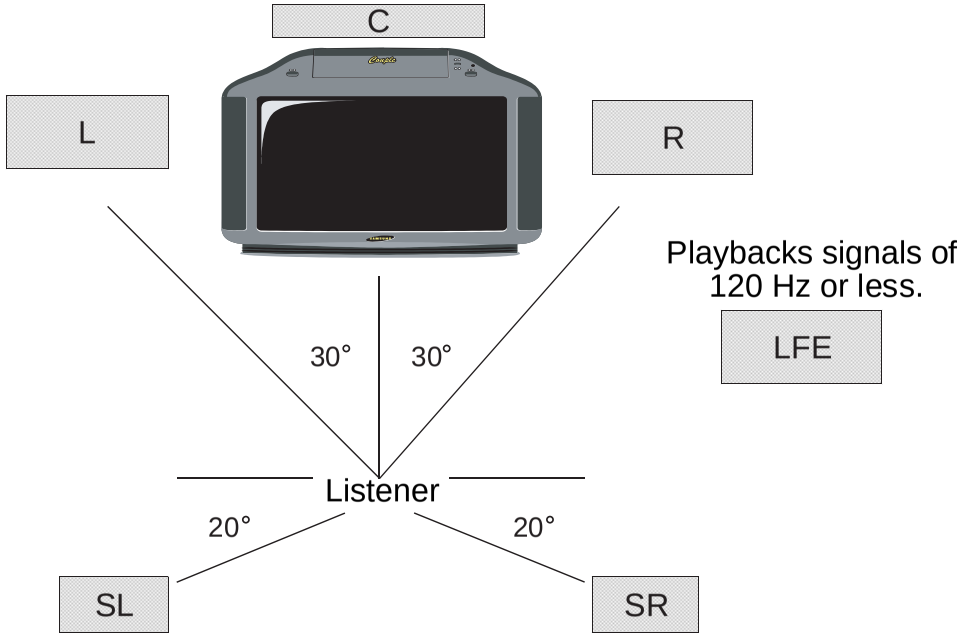


Figure 14. Dolby AC-3 Speaker Map

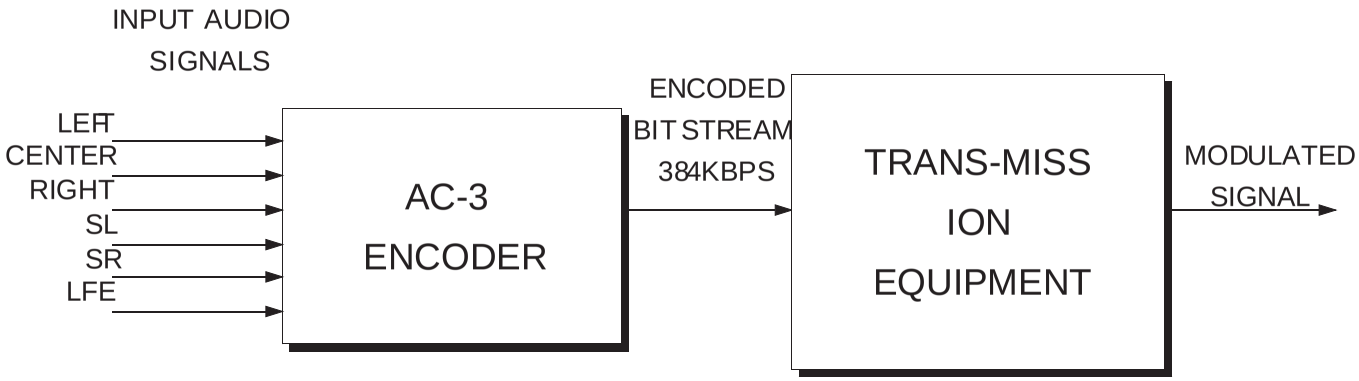


Figure 15. AC-3 TRANSMISSION

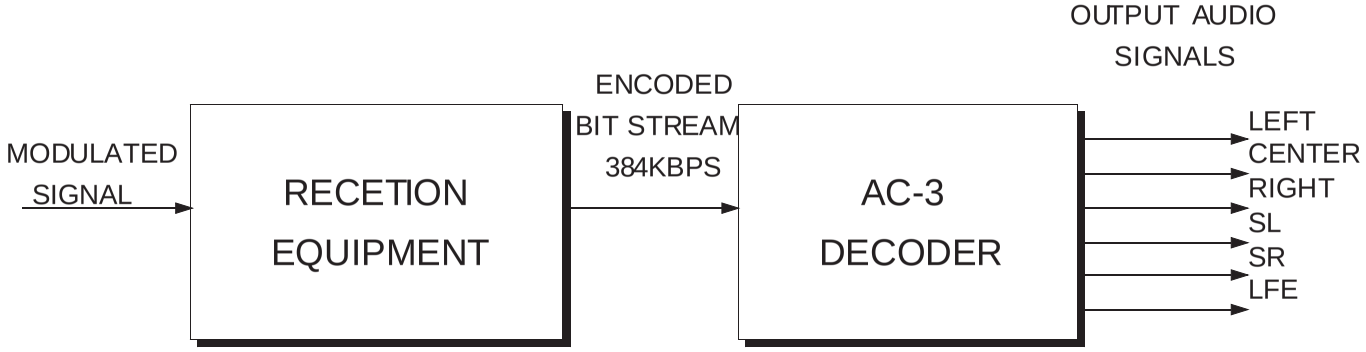


Figure 16. AC-3 RECIEVER

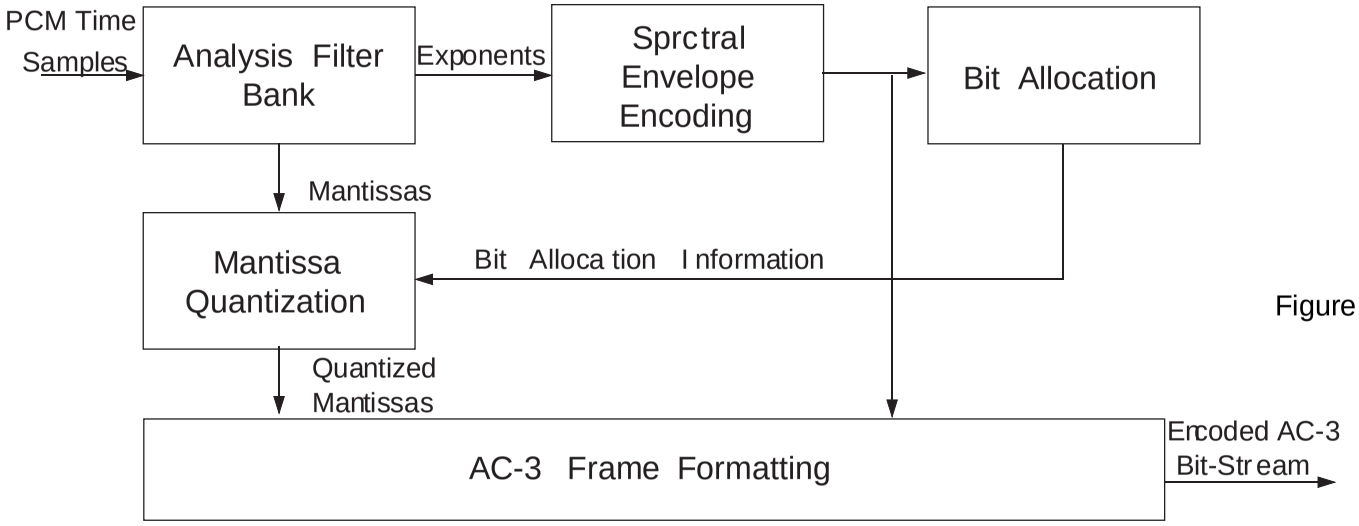


Figure 17. AC-3 ENCODER

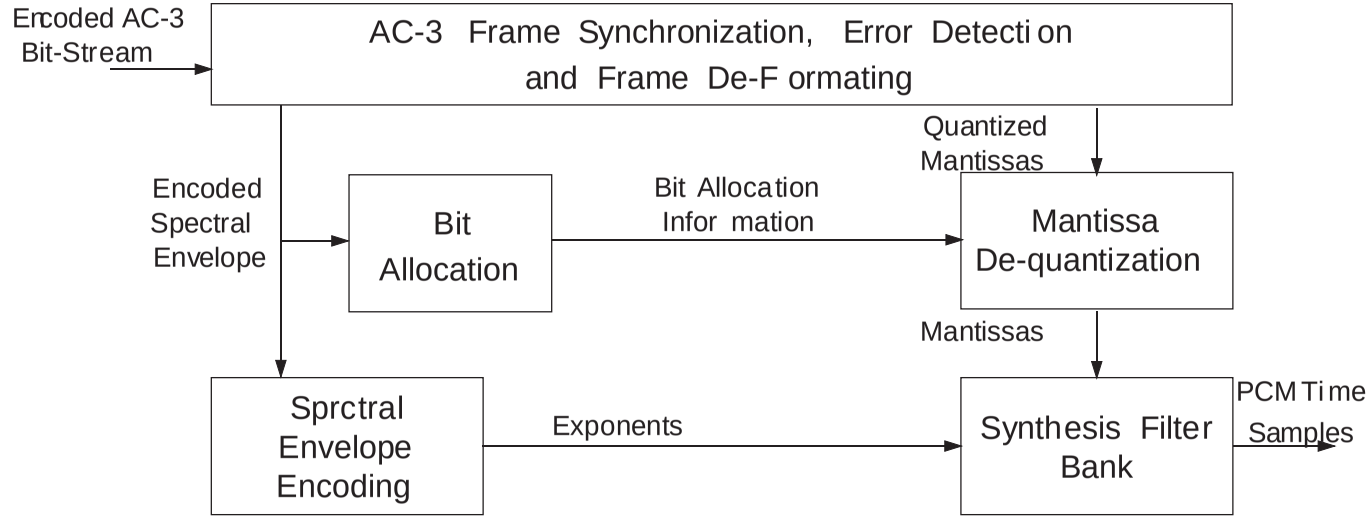
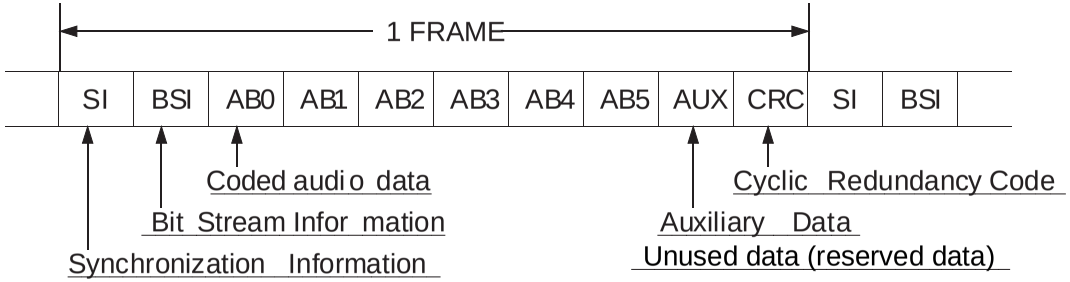


Figure 18. AC-3 DECODER

AC-3 BIT STREAM

- Base unit is a frame
- 1 Frame:32mS(5.1CH')
  - -1frame:256x6x1/48K+32mS
- 6 Block
  - -1block:256samples
- SI:Synchronization Information
  - -0x0b77
  - -Sampling rate, Frame size code
- CRC:Cyclic Redundancy Code
  - -Error detection
- BSI:Bit Stream Information
- AB0~AB5:Code Audio Data
  - (256samplesx6channelsx6blocks)
- AUX:Auxiliry Data



AC-3 Bit Stream Architecture

■ PSYCHO-ACOUSTIC MODEL

- Masking Property

-Masking Property masks low sound so that only loud sound is heard when two adjacent sound signals exist in a frequency or time range, which removes quantum noises that occur during signaling.

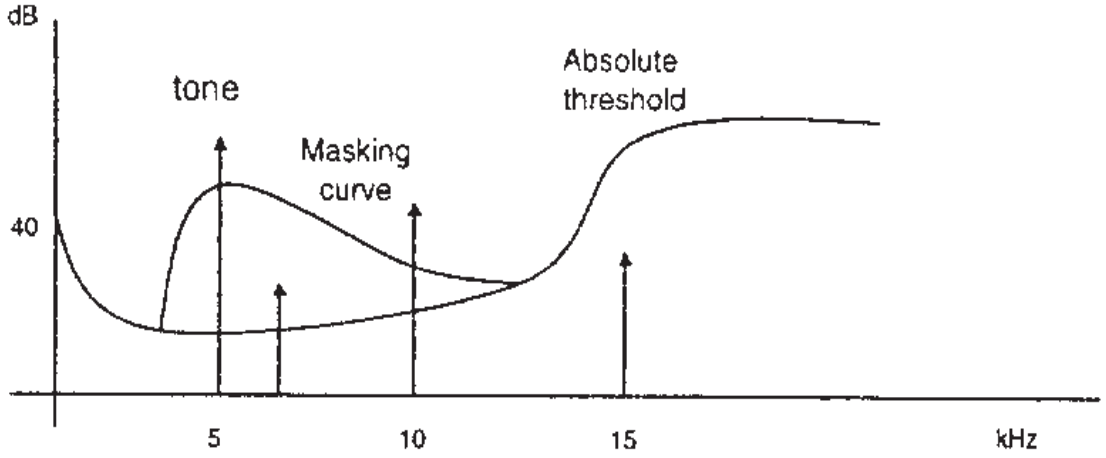


Figure 19. MASKING EFFECT CURVE

■ AC-3 Audio System Effects

1.Multi Channel Surround Sound

- Implements 3D effect with 5.1 channels.
  -L,R,C,SL,SR,LFE(SUB-WOOFER)
- Variablerate
  -Sampling rate:32,44.1,48KHz
  -Bit rate:32~640kbps
- Resolution:16,18,20bits
- Psycho-acoustic Model
  -Masking effect is applied.

2.Problems

- Sound quality degradation due to compression
  -Compression rate: 13:1 (typical)
- Increased spending due to multi-channel
  -6-channel AMP is required → additional channel: 4CH'

3.Solution

- Sound quality degradation due to compression
  -Bit rate should be raised to the maximum allowed.
- Increased spending due to multi-channel
  -3D audio system (emulates 5.1 channel to 2 channel)

■ Technology Trend

1.Multi CH'

- DOLBY AC-3: 5.1CH'
- MPEG II AUDIO:5.1CH'
- DTS(Dgital Theater Systems):5.1CH' (for theater)
- SDDS(Sony Dynamic Digital Sound):5.1CH'

2.Multi CH' → 2CH'

- 3D-PHONIC:JVC
- True-surround:SRS
- Q-S ound:Q-S ound
- Vmax:Madianix
- Aureal:Aureal

MEMO