CMI-8338/PCI - C3D*X*

PCI-Based HRTF 3D extension Positional Audio Chip

Features

- ✓ **HRTF-based 3D extension positional audio, supports Microsoft®'s DirectSound® 3D and Aureal®'s A3D® interface**
- ✓ **Supports rear side speaker, C3D*X* positional audio in 4 CH speaker mode(CMI8338-4S)**
- ✓ **Legacy audio SB16™ compatible**
- ✓ **DLS-based wavetable music synthesizer, supports Direct Music®**
- ✓ **Professional digital audio interface that supports 24 bits SPDIF IN and OUT**
- **Driver supports WIN95®, WIN®98, NT®4.0..**
- **MPU-401 port**
- **Dual game port**
- **16bits full duplex CODEC**
- **4 CH 16bits DAC(CMI8338-4S)**
- **32 bit PCI bus master**
- **Competitive price**
- **Single chip design, +5V, 100 pins QFP**

With high speed PCI v2.1 bus controller and legacy audio SB16™ DSP emulator, CMI8338 is designed for PC add-on card and all-in-one motherboard.

There is no external CODEC needed for CMI8338: CMI-8338 supports the legacy audio – SB16™, FM emulator/DLS wavetable music synthesis, and HRTF 3D positional audio functions.

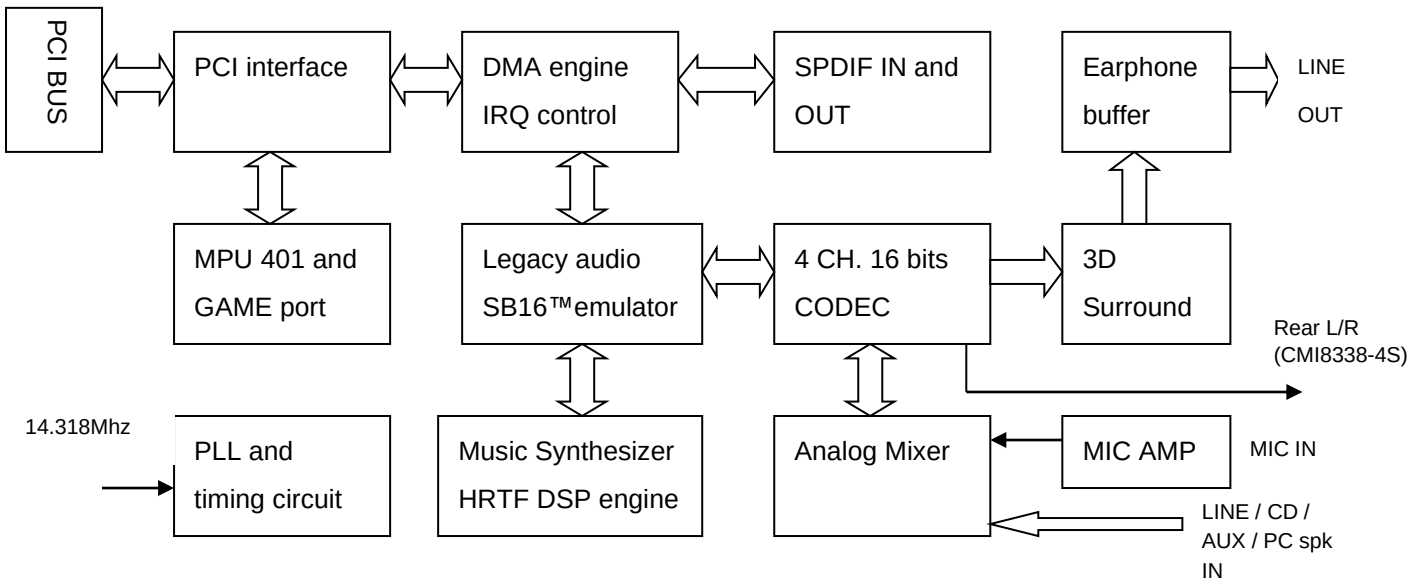
Besides, this 3D positional audio interface is compatible with A3D® and DirectSound® 3D. CMI8338 meets PC98® requirements, and supports professional digital audio interface as 24 bits SPDIF IN and OUT.

3D positional audio assumes the user's site at the sweet spot to design crosstalk-cancellation circuit; therefore, if the user wants to have the 3D positional audio effect, he can't move his head out of the spot, or freely turn his head. To remedy this, CMI8338-4S uses HRTF 3D extension technology to enhance traditional HRTF 3D positional audio from two speakers system to four speakers. It supports additional 2CH 16bits DAC for rear side speakers. It improves HRTF 3D positional audio quality and remove the limitation of environment, users can enjoy the real 3D audio gaming effect, and don't have to worry about the sweet spot limitation any more.

Being outstanding for its full audio functions, competitive price, and power management, CMI-8338 is the best choice for people seeking for optimum use of the PC applications.

C-Media's HRTF 3D library is licensed from Central Research Lab (CRL®), U.K, which presents one of the world's best HRTF libraries (CRL® also licensed its audio technology to YAMAHA®, ESS®, and other name-brand sound chip makers).

CMI-8338 Block Diagram



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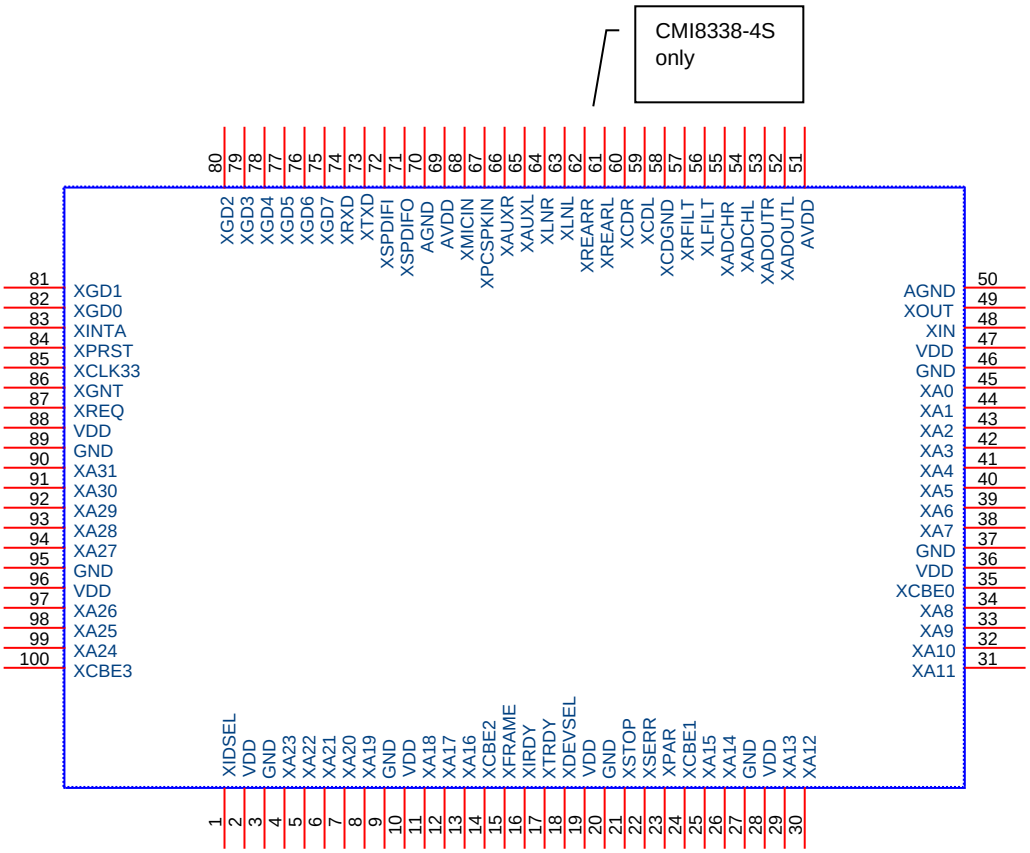
PINOUT



CMI8338/PCI AUDIO CHIP
QFP 100 PINS

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DIGITAL PIN DESCRIPTION

Name	Number	PIN Type	Definition
XA31-XA0	90-94,97-99,4-8,11-13,25-26,29-34,38-45	I/O	PCI bus address and data lines
XINTA	83	O	Interrupt request , active-low.
XPRST	84	I	Reset
XCLK33	85	I	PCI bus clock.
XGNT	86	I	Bus master grant, active-low.
XREQ	87	O	Bus master request, tri-state output, active-low.
XIDSEL	1	I	ID select, active-high.
XFRAME	15	I/O	Cycle frame, active-low.
XIRDY	16	I/O	Initiator ready, active-low. The bus master device is ready to transmit or receive data
XTRDY	17	I/O	Target ready, active-low. The target device is ready to transmit or receive data
XDEVSEL	18	I/O	Device select, active-low. The target device has decoded the address of the current transaction as its own chip select range.
XSTOP	21	I/O	Stop transaction, active-low. The target device request to the master to stop the current transaction.
XSERR	22	I/O	System error. The target device request system NMI service routing.
XPAR	23	I/O	Parity. The pin indicates even parity across XA31-XA9 and XCBE3-0 for both address and data phases.
XCBE3,2,1,0	100,14,24,35	I/O	Multiplexed command/byte enable. These pins indicate cycle type during the address phase of a transaction.
DVDD	2,10,19,28,36,47,88,96	+5V	Digital and PCI I/O power pin
DGND	3,9,20,27,37,46,89,95	GND	Digital and PCI I/O ground
XIN	35	I	14.318Mhz crystal, or external clock input
XOUT	49	O	14.318Mhz crystal
XGD7-XGD4	75-78	I	Game port switch input pin. Switch D to switch A
XGD4-XGD7	79-82	I/O	Game port resistor input pin. RC3 to RC0
XTXD	73	O	MIDI transmit data
XRXD	74	I	MIDI receive data
XSPDIFO	71	O	44.1kHZ SPDIF output
XSPDIFI	72	I	44.1kHZ SPDIF input

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ANALOG PIN DESCRIPTION

AVDD	**51,69**	**+5V**	**Analog power**
AGND	**50,70**	**GND**	**Analog ground**
XADOUTL-R	**52,53**	**AO1**	**Line out**
XADCHL-R	**54,55**	**AI/O**	**ADC filter**
XLFILT	**56**	**AI/O**	**Left channel DAC filter**
XRFILT	**57**	**AI/O**	**Right channel DAC filter**
XCDGND	**58**	**AI**	**CD audio differential ground**
XCDL-R	**59,60**	**AI**	**CD audio differential input**
XREARL-R	**61,62**	**AO**	**Optional rear side audio output, These pins only supported by CMI8338-4S.**
XLNL-R	**63,64**	**AI**	**Line in**
XAUXL-R	**65,66**	**AI**	**Aux. Line in**
XPCSPKIN	**67**	**AI**	**PC beep signal**
XMICIN	**68**	**AI**	**Microphone in**

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ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

Ratings	Symbol	Value	Units
Digital power voltage	VDD	VDD±5%	V
Analog power voltage	AVDD	AVDD±5%	V
Operating temperature range	TO	0 to 70	°C
Storage temperature range	TST	-40 to 125	°C
Maximum power dissipation	PDMAX	300	mW

Digital Characteristics

PARAMETER	Symbol	Min	Typ	Max	Unit
Input high voltage(PCI I/O)	VIH	2.		VDD+0.5	V
Input low voltage (PCI I/O)	VIL	-0.5		0.8	V
Output high voltage	VOH	2.4		VDD	V
Output low voltage	VOL	0.0	0.2	0.4	V
Output buffer current			5		mA

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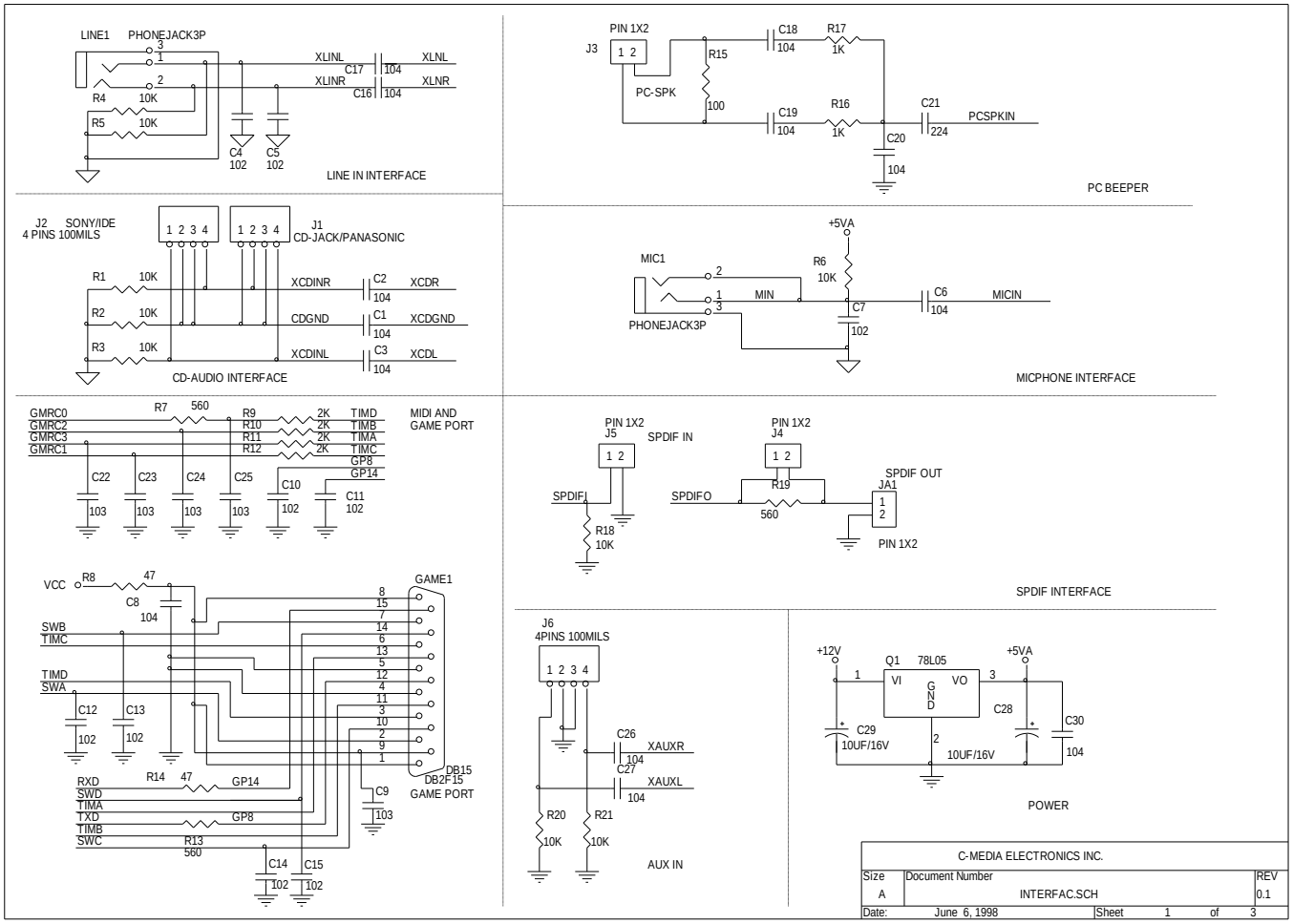
Application circuit: sheet1

Analog interface



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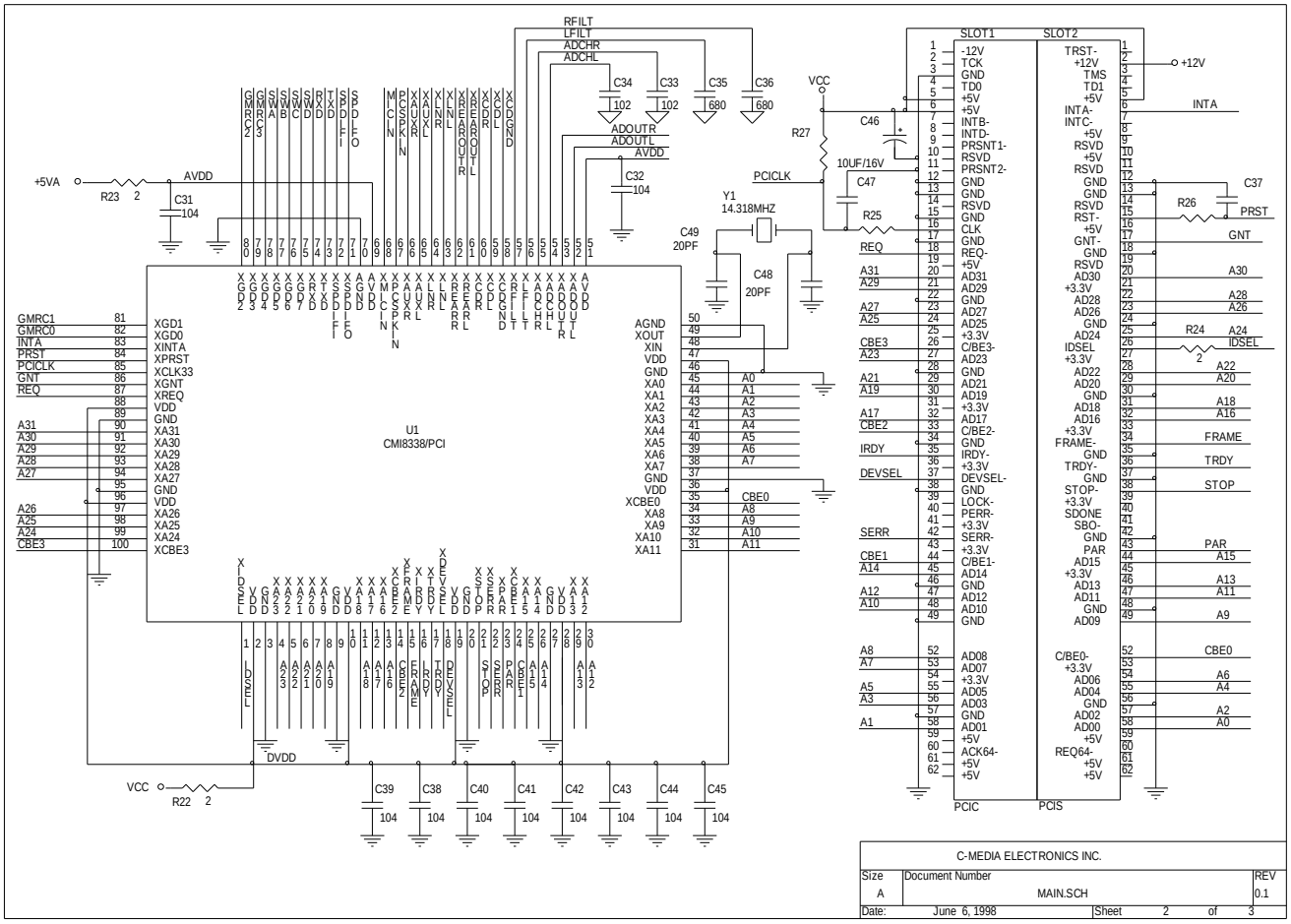
Application circuit: sheet2

Sound chip and PCI bus



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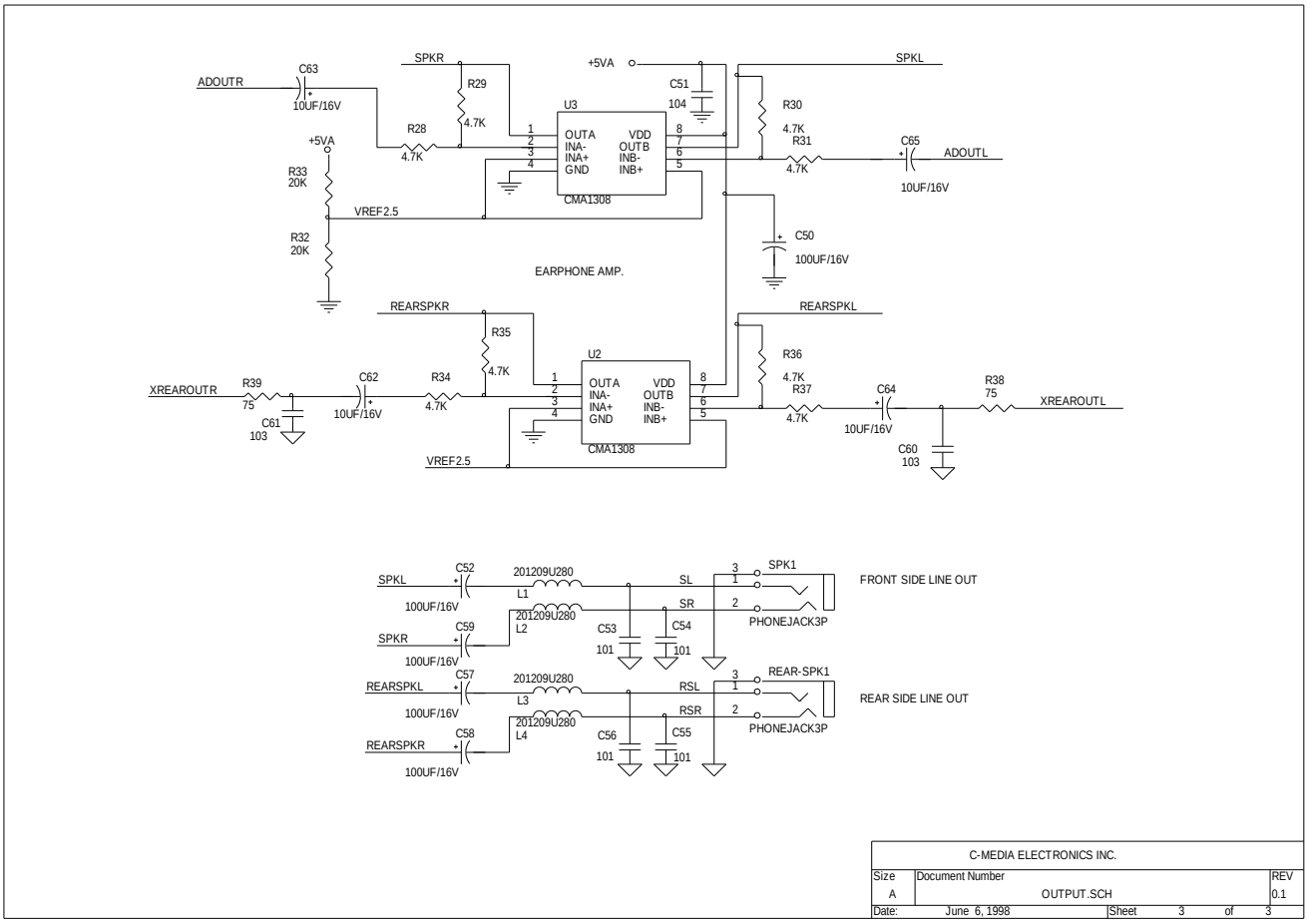
Application circuit: sheet 3

4CH earphone output



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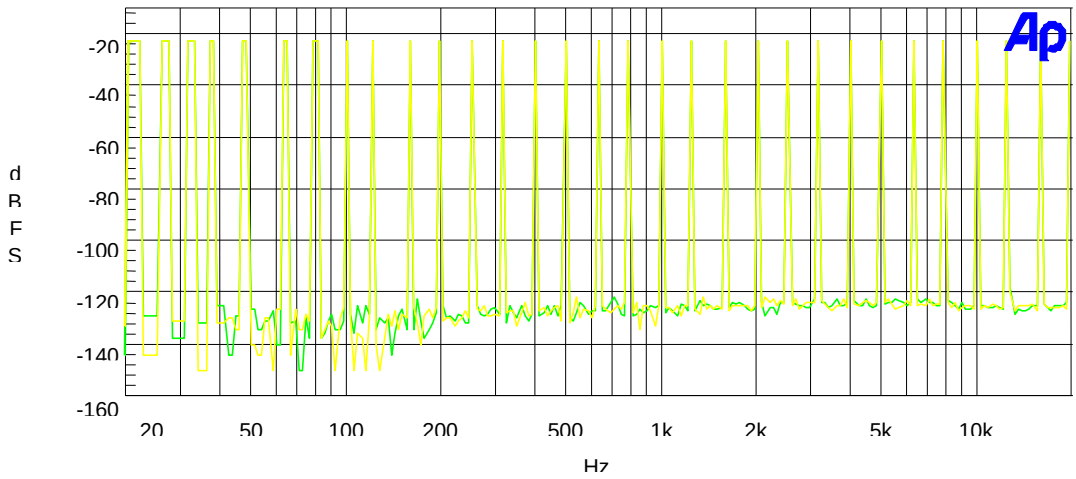
CMI8338 SPDIF IN/OUT Testing Report

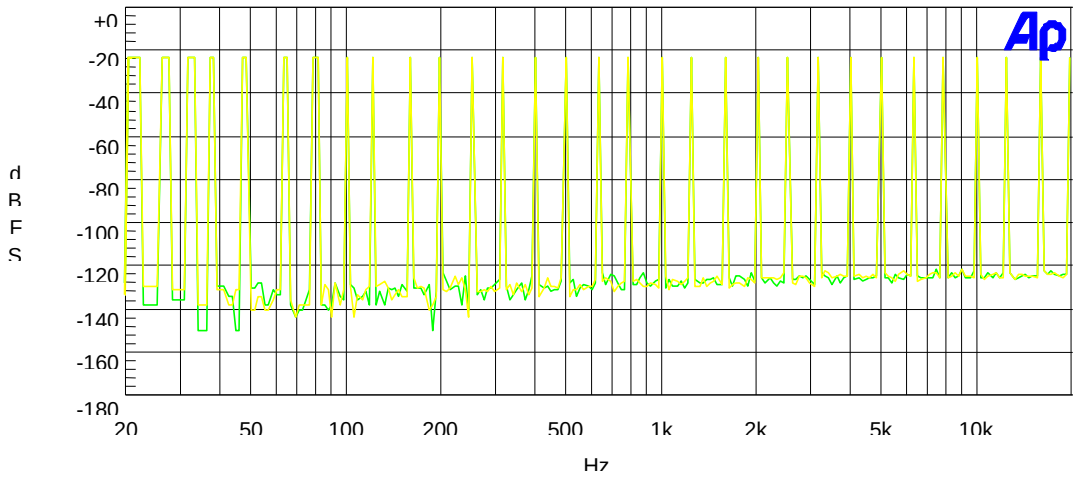
CMI8338 SPDIF-out Frequency, Distortion Noise Response 05/18/98 16:18:46



Color	Line Style	Thick	Data	Axis
Green	Solid	1	Fasttest Ch 1 Ampl	Left
Yellow	Solid	1	Fasttest Ch 2 Ampl	Left

PC-SPDIF-MEET at2

CMI8338 SPDIF-in Frequency, Distortion Noise Response 05/15/98 16:31:38



Color	Line Style	Thick	Data	Axis
Green	Solid	1	Fasttest Ch 1 Ampl	Left
Yellow	Solid	1	Fasttest Ch 2 Ampl	Left

SPDIF- PC-

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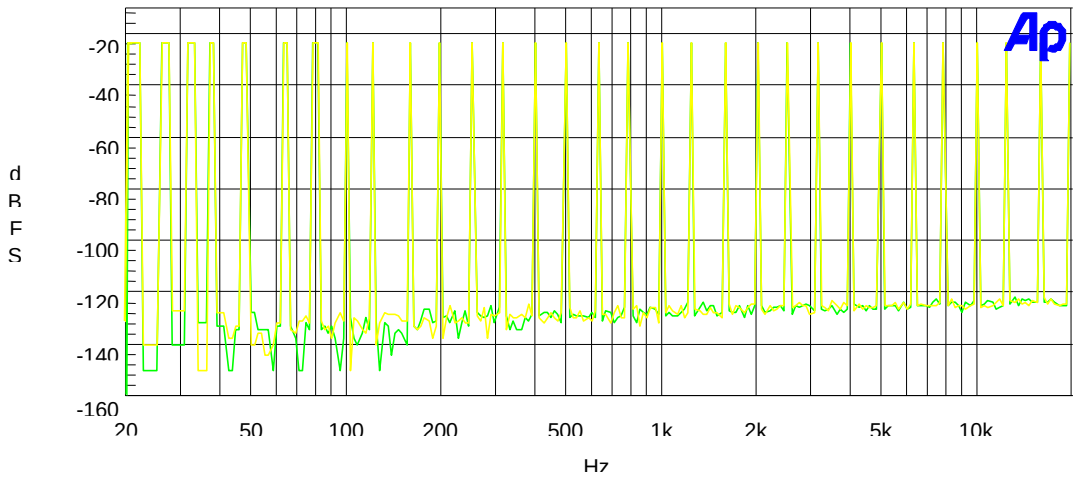
CMI8338 SPDIF-thru Frequency, Distortion Noise Response 05/15/98 15:56:48



Color	Line Style	Thick	Data	Axis
Green	Solid	1	Fasttest Ch 1 Ampl	Left
Yellow	Solid	1	Fasttest Ch 2 Ampl	Left

PC-SPDIF-MEET.at2

1. **SPDIF OUT (playback)= 120db**
2. **SPDIF IN (recording)= 120db**
3. **SPDIF through mode (bypass)= 120db**

* This report tested by audio precision multi-tone mode

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The technology of C3D HRTF Positional Audio

The technology of C3D is licensed from CRL (Central Research Lab.) using an audio filter called Head Related Transfer Functions (HRTFs). The basic concept of C3D : Since we can hear sound three dimensionally in the real world only using two ears, it must be possible to regenerate the same sound effect from two loud speakers.

What is HRTF ?

HRTF (Head Related Transfer Functions) is a set of audio filters which are varying locations of sound effects (spatial hearing cues) in three-dimension measured from listener's eardrum.
Using this technology and special digital signal processing to re-create spatial hearing cues makes our ears to hear a realistic and three-dimensional sounds coming from a pairs of loud speakers or headphones.

There are several listening cues that allows us to hear sounds three-dimensionally :

(I). Spatial hearing : Primary 3D-cues

1. IAD

   The head shadowing effect creates differences in the amplitudes of the sound signals arriving at each ear from the source. The effects of diffraction are most noticeable in the range between about 700 Hz to 8 KHz, where the A and S functions periodically converge and diverge gently. This Inter-aural Amplitude difference (IAD) is one of the primary 3D sound cues.

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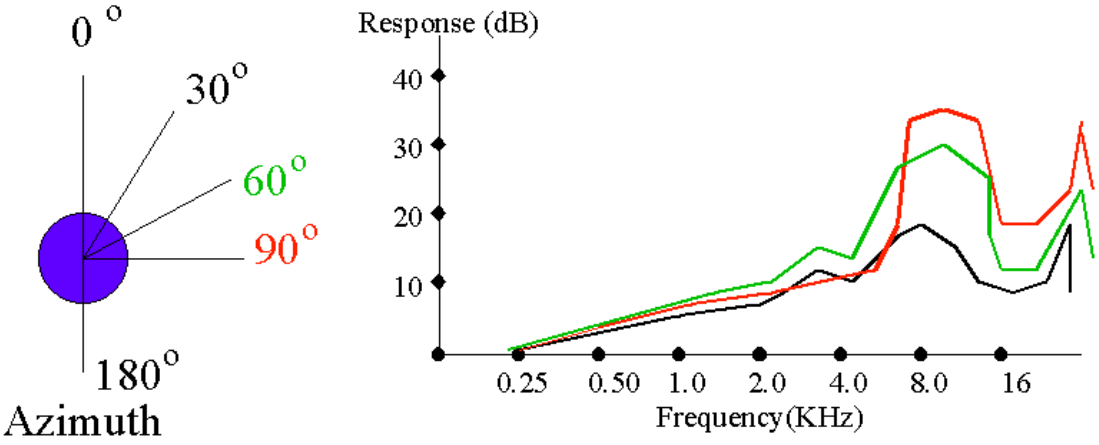
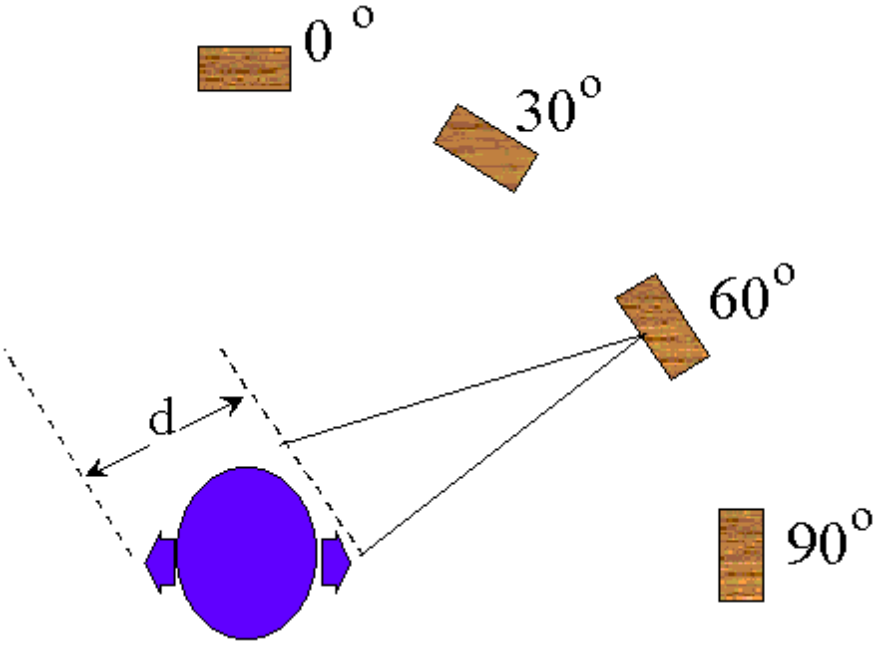


2. ITD

In addition to the IAD, there will be a time-of-arrival difference between the left and right ears, unless the sound source is in one of the pole positions (i.e. directly in front, behind, above and below). This is known as the Inter-aural Time Delay (ITD).



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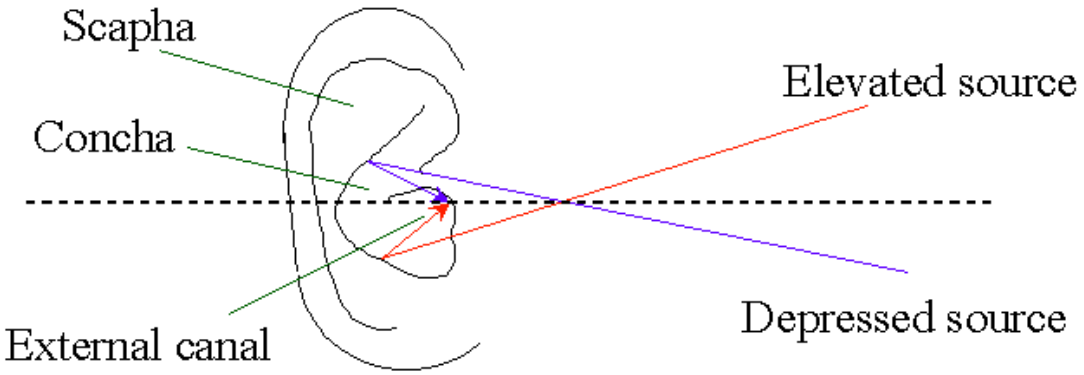
3. Pinna effects

It has been supposed by several researchers, that the convolutions of the pinna create the spectral features which constitute the 'height' cues. In practical experiments by Gardner, in which different parts of the pinna were occluded, and then the ability of a number of subjects to identify sound source positions at different heights was tested, it was shown that the different features all contributed by different amounts. For example, if the fossa is excluded, then height localization capability is impaired, but not totally extinguished. It would be reasonable to conclude that it is the combined effect of the pinna convolutions which create the various localization cues, and it is not valid - or logical - to attempt to assign particular spatial capabilities with individual physical features.



(II). Spatial hearing : Secondary 3D-cues (shoulder & local reflections)

In addition to the 'primary' 3D sound cues (IAD, ITD and pinna effects), there are several additional cues which do contribute to the localization capability; these will be referred to here as 'secondary' cue, and include should/torso reflections, local room reflections, and psychological cues.

1. Shoulder / Torso reflections

The presence of a torso attached to an artificial head has the effect of increasing the pressure in the vicinity of the ear up to frequencies of around 2 kHz. The effect is greater for frontal sources than lateral sources. In the experience, the presence of the torso does not appear to contribute much to spatial accuracy. However, the shoulder are located

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very close to the ears, and their effect is greater, this time, in respect of lateral sounds. If one listens to an artificial head first without - and then with - shoulder fitments, then it is clear that the shoulders do contribute to spatial effects in certain positions. The shoulders provide a strong reflection from lateral sources, with a short path-length of around 10 cm between direct sound and reflection. The effects are most important for side-positioned sources, especially for "height" effects, where the shoulders tend to mask sources which move below about 30 degrees depression.

2. Local, Room reflections

In simulations, it is clear that the incorporation of first-order simulated room reflections can help in the creation of sound images which have a "solid" nature. However, the effects - if accurately simulated - are relatively slight. Experience has shown that it is primarily the quality of the HRTFs themselves which determine the quality and solidity of the sound image. The furter addition of second-order reflections does not help significantly, because in reality, there is a great number of reflections in the average room. A method which does help to recreate the acoustic experience of a room, however, is to use approximate simulations of lateral reverb, using either 2 or 4 laterally placed "virtual" sources at, say, +-70 degrees and 80 degrees azimuth.

- The quality of the sound image relates to the HRTFs used.
- The quality of the room image relates to addition of reflections and reverb.

3. Psychological cues

There are clearly psychological cues present in everyday life which work together with the audio cues to tell us about the world around us. For example, if you hear the sound of a helicopter flying, you expect it to be up in the air, and not downwards. If a dog were to bark nearby, you would expect it to be downwards.

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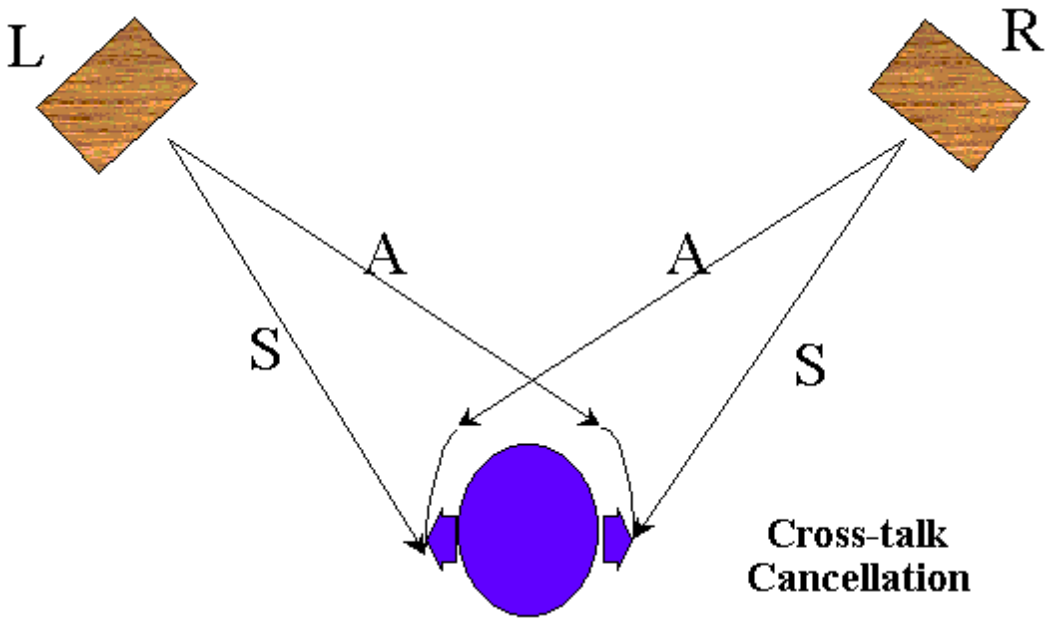
How to listen to C3D sound correctly and properly?

1. Use headphones to have much better effect

When you use headphones in listening, there will less interference such as outside voices or room reflections comparing to using speakers.

2. Choose correct output devices

Choose the correct output devices in the options of demo program in accordance with what listening devices you want to listen to. Because listening through speakers must be proceeded by crosstalk cancellation, if you choose the wrong output devices, there won't be any 3D positional audio effect..



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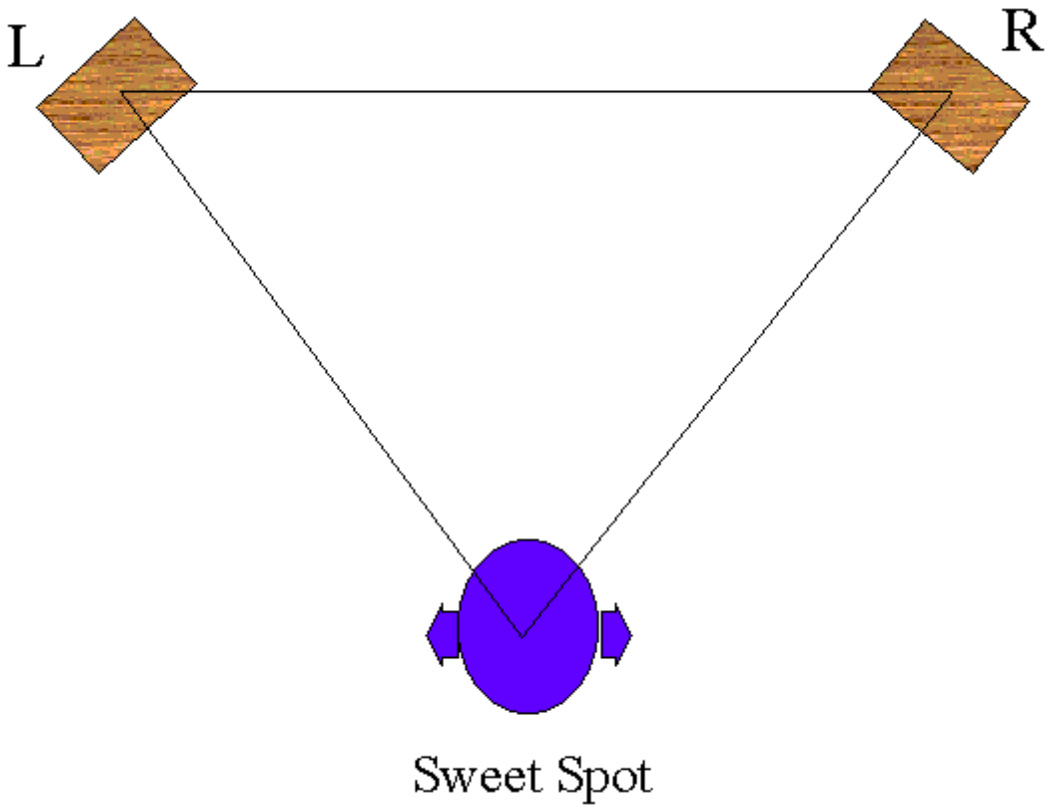
3. Location of speakers

If you listen through speakers, please do not inverse the left and right speakers. They must be in equal distance from the listener. That means the listener, the left, and the right speaker must be in the topmost of a right triangle. The point of the listener is called “sweet spot”. In addition, the height of the listener’s ears must be equal to that of the speakers.



4. Turn surround sound functions off

When the surround sound effect is enabled, it will cause confusion with C3D sound, and make positional sound effect invalid.

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