LAMPIRAN A
HASIL PELATIHAN ANFIS

AC '97 and HD Audio SoundMAX Codec

AD1986A

FEATURES

- Supports both AC '97 and HD audio interfaces
- 6 DAC channels for 5.1 surround
- S/PDIF output
- Integrated headphone amplifiers
- Variable rate audio
- Double rate audio (F_s = 96 kHz)
- Greater than 90 dB dynamic range
- 20-bit resolution on all DACs
- 20-bit resolution on all ADCs
- Line-level mono phone input
- High quality differential CD input
- Selectable MIC input with preamp
- AUX and line-in stereo inputs
- External amplifier power down (EAPD)
- Power management modes
- Jack sensing and device identification
- 48-lead LQFP package

ENHANCED FEATURES

- Integrated parametric speaker equalizer
- Stereo microphone with up to 30 dB gain boost
- Integrated PLL for system clocking
- Variable sample rate: 7 kHz to 96 kHz
  - 7 kHz to 48 kHz in 1 Hz increments
  - 96 kHz for double rate audio
- Jack sense with autotopology switching
- Jack presence detection on up to 8 jacks
- Three software-controlled microphone bias signals
- Software-enabled outputs for jack sharing
- Auto-down mix and channel spreading
- Microphone-to-mono output for speakerphone
- Stereo microphone pass-through to mixer
- Built-in microphone/center/LFE/line-in sharing
- Built-in SURROUND/LINE_IN sharing
- Center/LFE swapping supporting all vendor speakers
- Microphone left/right swapping
- Reduced support component count
- General-purpose digital output pin (GPO)
- LINE_OUT and HP_OUT, headphone drive on both

Rev. 0

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NOTES

REDUCED SUPPORT COMPONENTS

The AD1986A includes many improvements that reduce external support components for particular applications.

- **Multiple Microphone Sourcing:** The MIC_1/2, LINE_IN and C/LFE pins can all be selected as sources for microphone input (boost amplifier).
- **Multiple VREF_OUT Pins:** Each microphone-capable pin group (MIC_1/2, LINE_IN and C/LFE) has separate, software controllable VREF_OUT pins, reducing the need for external biasing components.
- **Internal Microphone Mixing:** Any combination of the MIC_1/2, LINE_IN and C/LFE pins can be summed to produce the microphone input. This removes the need for external mixing components in applications that externally mix microphone sources.
- **Advanced Jack Presence Detection:** Using two codec pins, eight resistors and isolated switch jacks, the AD1986A can detect jack insertion on eight separate jacks.
- **Internal Microphone/Line In/C/LFE Sharing:** On systems that share the microphone with the C/LFE jack no external components are required. The microphone selector can select the LINE_IN pins when the microphone and line input devices are swapped.
- **Internal Line In/Microphone/Surround Sharing:** On systems that share the line in with the surround jack no external components are required.
- **Dual Headphone Amplifiers:** The AD1986A can drive headphones out of the HP_OUT or LINE_OUT pins.

SPECIFICATIONS

Test conditions, unless otherwise noted.

Table 1.

Parameter	Typ	Unit
Temperature	25	°C
Digital Supply (DV_{DD})	3.3 ± 10%	V
Analog Supply (AV_{DD})	5.0 ± 10%	V
Sample Rate (F_S)	48	kHz
Input Signal	1.0	kHz
Analog Output Pass Band	20 Hz–20 kHz	
V_{IH}	2.0	V
V_{IL}	0.8	V
V_{IH}	2.4	V
V_{IL}	0.6	V

DAC Test Conditions
Calibrated
Output −3 dB Relative to Full Scale
10 kΩ Output Load: Line (Surround), Mono
32 Ω Output Load: Headphone
2 kΩ Output Load: Center, LFE

ADC Test Conditions
Calibrated
0 dB PGA Gain
Input −3.0 dB Relative to Full Scale

Table 2. Analog Input

Input Voltage	Min	Typ	Max	Unit
MIC_1/2, LINE_IN, CD, AUX, PHONE_IN (No Preamp)		1		Vrms[1]
C/LFE and SURROUND (When Used as Inputs)		2.83		V p-p
MIC_1/2, LINE_IN, C/LFE With 30 dB Preamp		0.032		Vrms
		0.089		V p-p
MIC_1/2, LINE_IN, C/LFE With 20 dB Preamp		0.1		Vrms
		0.283		V p-p
MIC_1/2, LINE_IN, C/LFE With 10 dB Preamp		0.316		Vrms
		0.894		V p-p
Input Impedance[2]		20		kΩ
Input Capacitance[2]		5	7.5	pF

[1] RMS values assume sine wave input.
[2] Guaranteed by design, not production tested.

Table 3. Master Volume

Parameter	Min	Typ	Max	Unit
Step Size (LINE_OUT, HP Out, Mono Out, SURROUND, CENTER, LFE)		−1.5		dB
Output Attenuation Range (0 dB to −46.5 dB)		−46.5		dB
Mute Attenuation of 0 dB Fundamental[2]	−80			dB

Table 4. Programmable Gain Amplifier—ADC

Parameter	Min	Typ	Max	Unit
Step Size		1.5		dB
PGA Gain Range Span (0 dB to 22.5 dB)		22.5		dB

Table 5. Analog Mixer—Input Gain/Amplifiers/Attenuators

Parameter	Min	Typ	Max	Unit
Signal-to-Noise Ratio (SNR)				
CD to LINE_OUT		90		dB
LINE, AUX, PHONE to LINE_OUT[1]		88		dB
MIC_1 or MIC_2 to LINE_OUT[1]		80		dB
Step Size: All Mixer Inputs (Except PC Beep)		−1.5		dB
Step Size: PC Beep		−3.0		dB
Input Gain/Attenuation Range: All Mixer Inputs (+12 dB to −34.5 dB)		−46.5		dB

[1] Guaranteed by design, not production tested.

Table 6. Digital Decimation and Interpolation Filters[1]

Parameter	Min	Typ	Max	Unit
Pass Band	0		$0.4 \times F_S$	Hz
Pass-Band Ripple			±0.09	dB
Transition Band	$0.4 \times F_S$		$0.6 \times F_S$	Hz
Stop Band	$0.6 \times F_S$		∞	Hz
Stop-Band Rejection	−74			dB
Group Delay		$16/F_S$		S
Group Delay Variation Over Pass Band		0		µs

Table 7. Analog-to-Digital Converters

Parameter	Min	Typ	Max	Unit
Resolution		20		Bits
Total Harmonic Distortion (THD)		−95		dB
Dynamic Range (−60 dB Input, THD + N Referenced to Full Scale, A-Weighted)		−85		dB
Crosstalk: Line Inputs (Input L, Ground R, Read R; Input R, Ground L, Read L)		−80		dB
Crosstalk: LINE_IN to Other Inputs		−100	−80	dB
Gain Error (Full-Scale Span Relative to Nominal Input Voltage)		±10		%
Interchannel Gain Mismatch (Difference of Gain Errors)			±0.5	dB
ADC Offset Error			±5	mV

Table 8. Digital-to-Analog Converters

Parameter	Min	Typ	Max	Unit
Resolution		20/24		Bits
Total Harmonic Distortion (LINE_OUT Drive)		−92		dB
Total Harmonic Distortion (HP_OUT)		−75		dB
Dynamic Range (−60 dB Input, THD + N Referenced to Full-Scale, A-Weighted)		91		dB
Gain Error (Full-Scale Span Relative to Nominal Input Voltage)		±10		%
Interchannel Gain Mismatch (Difference of Gain Errors)			±0.7	dB
DAC Crosstalk[1] (Input L, Zero R, Read R_OUT; Input R, Zero L, Read L_OUT)			−80	dB

[1] Guaranteed by design, not production tested.

Table 9. Analog Output

Parameter	Min	Typ	Max	Unit
FULL-SCALE OUTPUT VOLTAGE: SURROUND, CENTER/LFE, MONO_OUT		1		VRMS
		2.83		V p-p
Output Impedance[1]		300		Ω
External Load Impedance[1]	10			kΩ
Output Capacitance[1]		15		pF
External Load Capacitance			1,000	pF
FULL-SCALE OUTPUT VOLTAGE: HP_OUT, LINE_OUT		1		VRMS
		2.83		V p-p
Output Impedance[1]			1	Ω
External Load Impedance[1]	32			Ω
Output Capacitance[1]		15		pF
External Load Capacitance[1]			1,000	pF
VREF_FILT	2.050	2.250	2.450	V
VREF_OUT(MIC, C/LFE, LIN) (xVREF [2:0] = 001)		2.250		V
(xVREF [2:0] = 100, A_{VDD} = 5.0 V)		3.700		V
(xVREF [2:0] = 010)		0.0		V
Current Drive			5	mA
Mute Click (Muted Output, Unmuted Midscale DAC Output)		±5		mV

[1] Guaranteed by design, not production tested.

Table 10. Static Digital Specifications—AC '97

Parameter	Min	Typ	Max	Unit
High Level Input Voltage (V_{IH}), Digital Inputs	0.65 × DV_{DD}			V
Low Level Input Voltage (V_{IL})			0.35 × DV_{DD}	V
High Level Output Voltage (V_{OH}), I_{OH} = 2 mA	0.90 × DV_{DD}			V
Low Level Output Voltage (V_{OL}), I_{OL} = 2 mA			0.10 × DV_{DD}	V
Input Leakage Current	−10		10	µA
Output Leakage Current	−10		10	µA
Input/Output Pin Capacitance			7.5	pF

Table 11. Power Supply (Quiescent State)

Parameter	Min	Typ	Max	Unit
Power Supply Range—Analog (AV_{DD}) ± 10%	4.5		5.5	V
Power Supply Range—Digital (DV_{DD}) ± 10%	2.97		3.63	V
Power Dissipation—Analog (AV_{DD})/Digital (DV_{DD})		365/171.6		mW
Analog Supply Current—Analog (AV_{DD})		62.0		mA
Digital Supply Current—Digital (DV_{DD})		53.2		mA
Power Supply Rejection (100 mV p–p Signal @ 1 kHz)		40		dB

Table 12. Power-Down States—AC '97 (Quiescent State)

Parameter	Set Bits	AV_{DD} Typ	DV_{DD} Typ	Unit
ADC	PR0	53.0	45.7	mA
FRONT DAC	PR1	53.7	47.7	mA
CENTER DAC	PRI	62.0	53.2	mA
SURROUND DAC	PRJ	53.5	47.1	mA
LFE DAC	PRK	62.0	52.8	mA
ADC + ALL DACs	PR1, PR0, PRI, PRJ, PRK	27.0	14.5	mA
Mixer	PR2	36.6	53.2	mA
ADC + Mixer	PR2, PR0	27.6	45.7	mA
ALL DACs + Mixer	PR2, PR1, PRI, PRJ, PRK	12.6	33.0	mA
ADC + ALL DACs + Mixer	PR2, PR1, PR0, PRI, PRJ, PRK	2.4	14.5	mA
Standby	PR5, PR4, PR3, PR2, PR1(IJK), PR0	0.0	0.05	mA
Headphone Standby	PR6	55.0	53.2	mA
LINE_OUT HP Standby	LOHPEN = 0	62.0	53.2	mA

Table 13. Clock Specifications

Parameter	Min	Typ	Max	Unit
Input Clock Frequency (Reference Clock Mode)		14.31818 48.000		MHz MHz
Recommended Clock Duty Cycle	40	50	60	%

ABSOLUTE MAXIMUM RATINGS

Table 14.

Power Supply	Min	Max	Unit
Digital (DV_{DD})	−0.3	+3.6	V
Analog (AV_{DD})	−0.3	+6.0	V
Input Current (Except Supply Pins)		±10.0	mA
Analog Input Voltage (Signal Pins)	−0.3	AV_{DD} + 0.3	V
Digital Input Voltage (Signal Pins)	−0.3	DV_{DD} + 0.3	V
Ambient Temperature (Operating)			°C
Commercial	0	+70	
Industrial	−40	+85	
Storage Temperature	−65	+150	°C

Stresses greater than those listed under Absolute Maximum Ratings can cause permanent damage to the device. This is a stress rating only, functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods can affect device reliability.

ENVIRONMENTAL CONDITIONS

Ambient Temperature Rating

$T_{AMB} = T_{CASE} - (PD \times \theta_{CA})$

T_{CASE} = case temperature in °C

PD = power dissipation in W

θ_{CA} = thermal resistance (case-to-ambient)

θ_{JA} = thermal resistance (junction-to-ambient)

θ_{JC} = thermal resistance (junction-to-case)

Table 15. Thermal Resistance

Package	θ_{JA}	θ_{JC}	θ_{CA}
LQFP	48°C/W	17°C/W	31°C/W
LFCSP	47°C/W	15°C/W	32°C/W

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

Root Mean Square Error (RMSE) hasil pelatihan ANFIS dengan epoch 5 adalah sebagai berikut :

Start training ANFIS ...

1	0.00159521
2	0.00159519
3	0.0015952
4	0.0015952
5	0.0015952

Designated epoch number reached --> ANFIS training completed at epoch 5.

Root Mean Square Error (RMSE) hasil pelatihan ANFIS dengan epoch 10 adalah sebagai berikut :

Start training ANFIS ...

1	0.00159521
2	0.00159553
3	0.00159539
4	0.00159547
5	0.00159548
6	0.00159547
7	0.00159522
8	0.00159548
9	0.00159526
10	0.00159548

Designated epoch number reached --> ANFIS training completed at epoch 10.

Root Mean Square Error (RMSE) hasil pelatihan ANFIS dengan epoch 50 adalah sebagai berikut :

Start training ANFIS ...

1	0.00159521
2	0.00159519
3	0.0015952
4	0.0015952
5	0.0015952
6	0.00159519

Step size decreases to 0.009000 after epoch 6.

7	0.0015952
8	0.00159519

9 0.00159519
10 0.00159518
Step size decreases to 0.008100 after epoch 10.
11 0.00159515
12 0.00159517
13 0.00159513
14 0.00159515
15 0.0015951
Step size decreases to 0.007290 after epoch 15.
16 0.00159512
17 0.0015951
18 0.0015952
19 0.0015951
Step size decreases to 0.006561 after epoch 19.
20 0.00159519
21 0.0015951
22 0.00159518
23 0.0015951
Step size decreases to 0.005905 after epoch 23.
24 0.00159518
25 0.00159509
26 0.00159517
27 0.00159509
Step size decreases to 0.005314 after epoch 27.
28 0.00159517
29 0.00159508
30 0.00159517
31 0.00159508
Step size decreases to 0.004783 after epoch 31.
32 0.00159516
33 0.00159507
34 0.00159516
35 0.00159507
Step size decreases to 0.004305 after epoch 35.
36 0.00159516
37 0.00159506
38 0.00159515
39 0.00159506
Step size decreases to 0.003874 after epoch 39.
40 0.00159514
41 0.00159506
42 0.00159513
43 0.00159505
Step size decreases to 0.003487 after epoch 43.
44 0.00159513
45 0.00159505
46 0.00159512

47 0.00159504
Step size decreases to 0.003138 after epoch 47.
48 0.00159511
49 0.00159504
50 0.0015951

Designated epoch number reached --> ANFIS training completed at epoch 50.

Root Mean Square Error (RMSE) hasil pelatihan ANFIS dengan epoch 100 adalah sebagai berikut :

Start training ANFIS ...

1 0.00159521
2 0.00159519
3 0.0015952
4 0.0015952
5 0.0015952
6 0.00159519
Step size decreases to 0.009000 after epoch 6.
7 0.0015952
8 0.00159519
9 0.00159519
10 0.00159518
Step size decreases to 0.008100 after epoch 10.
11 0.00159515
12 0.00159517
13 0.00159513
14 0.00159515
15 0.0015951
Step size decreases to 0.007290 after epoch 15.
16 0.00159512
17 0.0015951
18 0.0015952
19 0.0015951
Step size decreases to 0.006561 after epoch 19.
20 0.00159519
21 0.0015951
22 0.00159518
23 0.0015951
Step size decreases to 0.005905 after epoch 23.
24 0.00159518
25 0.00159509
26 0.00159517
27 0.00159509
Step size decreases to 0.005314 after epoch 27.
28 0.00159517

29 0.00159508
30 0.00159517
31 0.00159508
Step size decreases to 0.004783 after epoch 31.
32 0.00159516
33 0.00159507
34 0.00159516
35 0.00159507
Step size decreases to 0.004305 after epoch 35.
36 0.00159516
37 0.00159506
38 0.00159515
39 0.00159506
Step size decreases to 0.003874 after epoch 39.
40 0.00159514
41 0.00159506
42 0.00159513
43 0.00159505
Step size decreases to 0.003487 after epoch 43.
44 0.00159513
45 0.00159505
46 0.00159512
47 0.00159504
Step size decreases to 0.003138 after epoch 47.
48 0.00159511
49 0.00159504
50 0.0015951
51 0.00159503
Step size decreases to 0.002824 after epoch 51.
52 0.00159509
53 0.00159502
54 0.00159508
55 0.00159502
Step size decreases to 0.002542 after epoch 55.
56 0.00159507
57 0.00159501
58 0.00159505
59 0.00159501
Step size decreases to 0.002288 after epoch 59.
60 0.00159505
61 0.001595
62 0.00159504
63 0.00159499
Step size decreases to 0.002059 after epoch 63.
64 0.00159503
65 0.00159499
66 0.00159502

67 0.00159499
Step size decreases to 0.001853 after epoch 67.
68 0.00159502
69 0.00159498
70 0.00159502
71 0.00159498
Step size decreases to 0.001668 after epoch 71.
72 0.00159501
73 0.00159498
74 0.00159501
75 0.00159498
Step size decreases to 0.001501 after epoch 75.
76 0.00159501
77 0.00159497
78 0.001595
79 0.00159497
Step size decreases to 0.001351 after epoch 79.
80 0.001595
81 0.00159497
82 0.00159499
83 0.00159497
Step size decreases to 0.001216 after epoch 83.
84 0.00159499
85 0.00159497
86 0.00159499
87 0.00159497
Step size decreases to 0.001094 after epoch 87.
88 0.00159499
89 0.00159497
90 0.00159498
91 0.00159497
Step size decreases to 0.000985 after epoch 91.
92 0.00159498
93 0.00159496
94 0.00159498
95 0.00159496
Step size decreases to 0.000886 after epoch 95.
96 0.00159498
97 0.00159496
98 0.00159497
99 0.00159496
Step size decreases to 0.000798 after epoch 99.
100 0.00159497

Designated epoch number reached --> ANFIS training completed at epoch 100.

LAMPIRAN B

SPESIFIKASI SOUNDCARD SB LIVE 24 BIT

General Specifications

PCI Bus Mastering

- PCI Specification Version 2.1, 2.2 and 2.3 compliant
- Bus mastering reduces latency and speeds up system performance

Sound Blaster Live! 24-bit Processor

- 64-voice wavetable synthesizer
- Professional quality digital mixing and equalization

High Quality Audio Path

- Selectable analog sources such as Line In and Microphone In
- Playback of 64 audio channels, each at an arbitrary sample rate
- 24-bit Analog-to-Digital conversion of analog inputs at 96 kHz sample rate
- 24-bit Digital-to-Analog conversion of digital sources at 96 kHz to analog 7.1 speaker output
- 16-bit to 24-bit recording sampling rates: 8, 11.025, 16, 22.05, 24, 32, 44.1, 48 and 96 kHz

Professional Digital Audio Processing

- Supports Sony/Philips Digital InterFace (SPDIF) format of up to 24-bit/96 kHz quality
- SPDIF input of up to 24-bit/96 kHz quality
- SPDIF output at selectable sampling rate of 48 or 96 kHz
- Software switching of SPDIF Input-to-Output (bypass) to minimize cable connection hassle

Note

- SPDIF input and output requires Digital I/O Module.
- SPDIF output not available during playback of protected digital audio contents authored with DRM (Digital Rights Management) technology.

Flexible Mixer Control

- Software playback control of CD Audio, Line In, Microphone In and Wave/DirectSound device
- Software recording control of selectable input of various audio sources for recording CD Audio and Line In, Microphone In and Wave/DirectSound device
- Adjustable master volume control

- Separate bass and treble control
- Front and rear balance control
- Muting and panning control for selectable sources

Creative Multi Speaker Surround (CMSS)

- Multispeaker technology
- Upmixes mono or stereo sources to 7.1 channels
- Professional-quality panning algorithm

LAMPIRAN C

SPESIFIKASI SOUNDCARD SOUNDMAX