



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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One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A.
Tel: 781.329.4700 www.analog.com
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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		V _{rms} 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		V _{rms}
		0.089		V p-p
MIC_1/2, LINE_IN, C/LFE With 20 dB Preamp		0.1		V _{rms}
		0.283		V p-p
MIC_1/2, LINE_IN, C/LFE With 10 dB Preamp		0.316		V _{rms}
		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

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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 Filters¹

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		μ s

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
Output Impedance ¹		2.83		V p-p
External Load Impedance ¹	10	300		Ω
Output Capacitance ¹		15		pF
External Load Capacitance			1,000	pF
FULL-SCALE OUTPUT VOLTAGE: HP_OUT, LINE_OUT		1		VRMS
Output Impedance ¹		2.83		V p-p
External Load Impedance ¹	32		1	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

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Table 11. Power Supply (Quiescent State)

Parameter	Min	Typ	Max	Unit
Power Supply Range—Analog ($AV_{DD} \pm 10\%$)	4.5		5.5	V
Power Supply Range—Digital ($DV_{DD} \pm 10\%$)	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.

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.



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
LFCSF	47°C/W	15°C/W	32°C/W