# High Definition Audio
# SoundMAX Codec

# AD1984A

## FEATURES

**Microsoft Vista Premium Logo for desktop**
 96+ dB audio outputs, 90 dB audio inputs
 WLP 3.0 and 4.0
**Security feature prevents unauthorized recording**
**2 stereo headphone amplifiers**
**Internal 32-bit arithmetic for greater accuracy**
**Impedance and presence detection on all jacks**
**Full analog mixer with DAC inputs**
**3 independent microphone bias pins**
**Digital and analog PCBeep**
**3 general-purpose digital I/O (GPIO) pins**
**3.3 V analog supply voltage**
**1.7 V to 1.9 V or 3.3 V digital supply voltages**
**1.5 V or 3.3 V HD Audio link signaling voltage**
**Advanced power management modes**
**48-lead, RoHS compliant LFCSP_VQ package**

## 192 kHz DACs/ADCs

**2 independent stereo DAC/ADC pairs**
**Simultaneous record of 2 stereo channels**
**Simultaneous playback of 2 stereo channels**
**Independent 8 kHz, 11.025 kHz, 16 kHz, 22.05 kHz, 32 kHz,
 44.1 kHz, 48 kHz, 88.2 kHz, 96 kHz, 176.4 kHz, and 192 kHz
 sample rates**
**16-, 20-, and 24-bit resolution**
**Selectable stereo mixer on outputs**

## STEREO DIGITAL MICROPHONE INTERFACE

**Two 192 kHz digital microphone channels**
**Supports 1 or 2 microphones per pin**
**Selectable bit clock rates of 1.5 MHz, 2.0 MHz, and 3.0 MHz**
**Mono and stereo array support**
**8 kHz, 11.025 kHz, 16 kHz, 22.05 kHz, 32 kHz, 44.1 kHz,
 48 kHz, 88.2 kHz, 96 kHz, 176.4 kHz, and 192 kHz
 sample rates**
**16-, 20-, and 24-bit resolution**

## S/PDIF OUTPUT

**Supports 44.1 kHz, 48 kHz, 88.2 kHz, 96 kHz, 176.4 kHz, and
 192 kHz sample rates**
**16-, 20-, and 24-bit data; PCM and AC3 formats**
**Digital PCM gain control**

## AUXILIARY PINS

**Stereo CD/auxiliary I/O port with ground sense**
**Stereo auxiliary/dock I/O port**
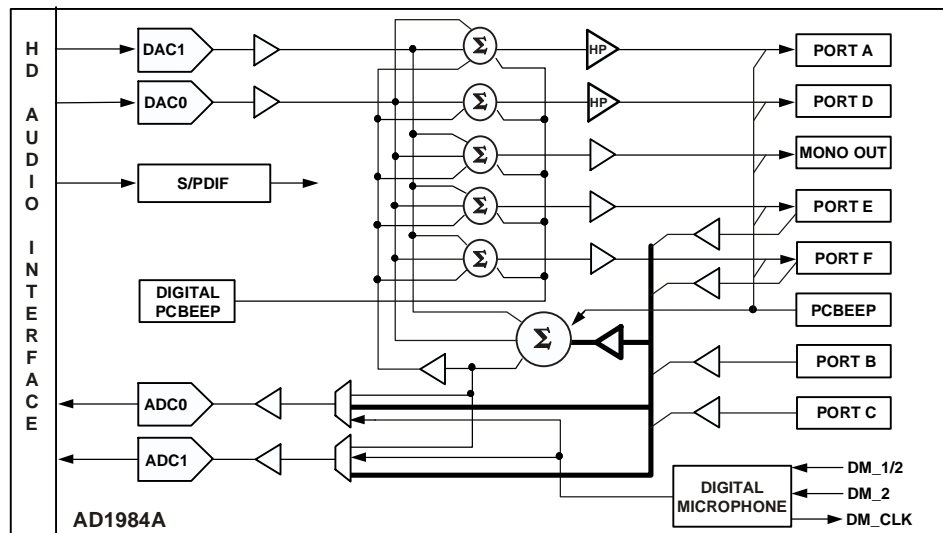**Mono out pin for internal speakers or telephony**



*Figure 1. Functional Block Diagram*

**Rev. 0**

# AD1984A

## TABLE OF CONTENTS

## REVISION HISTORY

**4/08—Rev 0. Initial version**

# GENERAL DESCRIPTION

The AD1984A audio codec and SoundMAX® software provide superior high definition audio quality that exceeds Vista Premium performance. The AD1984A has two 192 kHz DAC pairs, two 192 kHz ADC pairs, an S/PDIF output, a 2-channel digital microphone interface, and digital and analog PCBeep. These features make the AD1984A the right choice for desktop and notebook PCs where performance is key.

The AD1984A is available in a 48-lead, RoHS compliant lead frame chip scale package in both reels and trays. See Ordering Guide on Page 19.

## ADDITIONAL INFORMATION

This data sheet provides a general overview of the AD1984A SoundMAX codec's architecture and functionality. Detailed widget information is available in the AD1984A Programmers Reference Manual. Please contact your local Analog Devices, Inc., sales representative for more information.

## JACK CONFIGURATION

The guidelines shown in Table 1 through Table 3 should be used when selecting ports for particular functions.

**Table 1.  Typical Desktop Configuration**

| Port | Function |
|------|----------|
| Port A | Front Panel Headphone |
| Port B | Front Panel Microphone |
| Port C | Rear Panel Line-In/Microphone |
| Port D | Rear Panel Line-Out/Headphone |
| S/PDIF | Optical/RCA S/PDIF Output |

**Table 2.  Typical Notebook Configuration**

| Port | Function |
|------|----------|
| Port A | Headphone |
| Port B | Microphone |
| Port C | Internal Microphone |
| Port F | Internal Stereo Speakers |
| S/PDIF | Optical/RCA S/PDIF Output |

**Table 3.  Typical Notebook Configuration with Dock Interface**

| Port | Function |
|------|----------|
| Port A | Headphone |
| Port B | Microphone |
| Port C | Internal Microphone |
| Port D | Dock Line-Out/Headphone |
| Port E | Dock Line-In/Microphone |
| Port F | Internal Stereo Speakers |
| S/PDIF | Optical/RCA S/PDIF Output |

## AD1984A SPECIFICATIONS

### TEST CONDITIONS

| Parameter | Test Condition |
|---|---|
| Temperature | 25℃ |
| Digital Supply | 3.3 V |
| Analog Supply | 3.3 V |
| MIC_BIAS_IN (via Low-Pass Filter) | 5.0 V |
| Sample Rate $F_S$ | 48 kHz |
| Input Signal (Frequency Sine Wave) | 1008 Hz |
| Amplitude for THD + N | –3.0 dB Full Scale |
| Analog Output Pass Band | 20 Hz to 20 kHz |
| DAC[1] | 10 kΩ Output Load: Line-Out Tests |
| | 32 Ω Output Load: Headphone Tests |
| ADC | 0 dB Gain |

[1] DAC/ADC tests are performed with AES-17 filter enabled.

### PERFORMANCE

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Line-Out Drive (10 kΩ loads—DAC to Pin) | | | | |
| Total Harmonic Distortion (THD + N) | | –86 | | dB |
| Dynamic Range (–60 dB in ref to $f_S$ A-Weighted) | | 96 | | dB |
| Signal-to-Noise Ratio | | 96 | | dB |
| Headphone Drive (32 Ω loads—DAC to Pin) | | | | |
| Total Harmonic Distortion (THD + N) | | –80 | | dB |
| Dynamic Range (–60 dB in ref to $f_S$ A-Weighted) | | 96 | | dB |
| Signal-to-Noise Ratio | | 96 | | dB |
| Microphone/Line-In (Pin to ADC, Mic Boost = 0 dB) | | | | |
| Total Harmonic Distortion (THD + N) | | –81 | | dB |
| Dynamic Range (–60 dB in ref to $f_S$ A-Weighted) | | 90 | | dB |
| Signal-to-Noise Ratio | | 90 | | dB |

### GENERAL SPECIFICATIONS

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| DIGITAL DECIMATION AND INTERPOLATION FILTERS—$f_S$ = 8 kHz to 192 kHz[1] | | | | |
| Pass Band | 0 | | 0.4 $f_S$ | Hz |
| Pass-Band Ripple | | | ±0.005 | dB |
| Stop Band | 0.6 $f_S$ | | | Hz |
| Stop-Band Rejection | | | –100 | dB |
| Group Delay | | 20 | | 1/$f_S$ |
| Group Delay Variation over Pass Band | | 0 | | µs |
| ANALOG-TO-DIGITAL CONVERTERS | | | | |
| Resolution | | 24 | | Bits |
| Gain Error (Full-Scale Span Relative to Nominal Input Voltage) | | | ±10 | % |
| Interchannel Gain Mismatch (Difference of Gain Errors) | | ±0.2 | ±0.5 | dB |
| ADC Offset Error[1] | | | ±5 | mV |
| ADC Crosstalk[1] | | | | |
| Line Inputs (Input L, Ground R, Read R; Input R, Ground L, Read L) | | –85 | | dB |
| Line Inputs to Other | | –100 | –80 | dB |

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| DIGITAL-TO-ANALOG CONVERTERS | | | | |
| Resolution | | 24 | | Bits |
| Gain Error (Full-Scale Span Relative to Nominal Input Voltage)[1] | | | ±10 | % |
| Interchannel Gain Mismatch (Difference of Gain Errors) | | | ±0.5 | dB |
| Total Audible Out-of-Band Energy (Measured from $0.6 \times f_S$ to 20 kHz)[1] | | −85 | | dB |
| DAC Crosstalk (Input L, Zero R, Measure R_OUT; Input R, Zero L, Measure L_OUT)[1] | | −95 | | dB |
| DAC VOLUMES | | | | |
| Step Size | | 1.5 | | dB |
| Output Gain/Attenuation Range | −58.5 | | 0 | dB |
| Mute Attenuation of 0 dB Fundamental[1] | | −80 | | dB |
| ADC VOLUMES | | | | |
| Step Size | | 1.5 | | dB |
| PGA Gain/Attenuation Range | −58.5 | | +22.5 | dB |
| ANALOG MIXER | | | | |
| Signal-to-Noise Ratio Input to Output—Ports B, C, E, or F to Port D Output | | 95 | | dB |
| Step Size: All Mixer Inputs | | −1.5 | | dB |
| Input Gain/Attenuation Range: All Mixer Inputs | −34.5 | | +12.0 | dB |
| ANALOG LINE LEVEL OUTPUTS | | | | |
| Full-Scale Output Voltage | 1.0 | | | V rms |
|  | 2.83 | | | V p-p |
| Ports A, D, E, F, and Mono Out | | | | |
| Output Impedance[1] | | 190 | | Ω |
| External Load Impedance[1] | 10 | | | kΩ |
| Output Capacitance[1] | | 15 | | pF |
| External Load Capacitance | | | 1000 | pF |
| ANALOG HP DRIVE OUTPUTS | | | | |
| Full-Scale Output Voltage | 1.0 | | | V rms |
|  | 2.83 | | | V p-p |
| Ports A and D | | | | |
| Output Impedance[1] | | | 0.5 | Ω |
| External Load Impedance[1] | 32 | | | Ω |
| Output Capacitance[1] | | 15 | | pF |
| External Load Capacitance[1] | | | 1000 | pF |
| ANALOG INPUTS | | | | |
| Input Voltages—Ports B, C, E, or F | | | | |
| Mic Boost = 0 dB | | 1 | | V rms |
|  | | 2.83 | | V p-p |
| Input Voltages—Microphone Boost Amplifier, Ports B, C, or E — Mic Boost = 10 dB | | 0.316 | | V rms |
|  | | 0.894 | | V p-p |
| Mic Boost = 20 dB | | 0.1 | | V rms |
|  | | 0.283 | | V p-p |
| Mic Boost = 30 dB | | 0.032 | | V rms |
|  | | 0.089 | | V p-p |
| Input Impedance | | | | |
| PCBeep | | 23 | | kΩ |
| Ports B, C, E (Mic Boost = 0 dB) | | 150 | | kΩ |
| Port F | | 45 | | kΩ |
| Input Capacitance[1] | | 5 | 7.5 | pF |

# AD1984A

| Parameter | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| MICROPHONE BIAS | | | | | |
| MIC_BIAS-B, MIC_BIAS-C | | | | | |
| MIC_BIAS_IN (Pin 33) = 5 V or 3.3 V | $V_{REF}$ Setting = High-Z | | High-Z | | |
| | $V_{REF}$ Setting = 0 V | | 0 | | V dc |
| | $V_{REF}$ Setting = 50% | | 1.65 | | V dc |
| MIC_BIAS_IN (Pin 33) = 5 V | $V_{REF}$ Setting = 80% | | 3.7 | | V dc |
| | $V_{REF}$ Setting = 100% | | 3.9 | | V dc |
| MIC_BIAS_IN (Pin 33) = 3.3 V | $V_{REF}$ Setting = 80% | | 2.86 | | V dc |
| | $V_{REF}$ Setting = 100% | | 3.0 | | V dc |
| MIC_BIAS-E (When Enabled as BIAS) | $V_{REF}$ Setting = High-Z | | High-Z | | |
| | $V_{REF}$ Setting = 0 V | | 0 | | V dc |
| | $V_{REF}$ Setting = 50% | | 1.65 | | V dc |
| | $V_{REF}$ Setting = 80% | | 2.86 | | V dc |
| | $V_{REF}$ Setting = 100% | | 3.0 | | V dc |
| Output Drive Current | $V_{REF}$ Setting = 50%, 80%, or 100% | | 1.6 | | mA |
| GPIO 0 | | | | | |
| Input Signal High ($V_{IH}$) | | $DV_{IO} \times 0.60$ | | $DV_{IO}$ | V |
| Input Signal Low ($V_{IL}$) | | 0 | | $DV_{IO} \times 0.24$ | V |
| Output Signal High ($V_{OH}$) | $I_{OUT} = -500\ \mu A$ | $DV_{IO} \times 0.72$ | | $DV_{IO}$ | V |
| Output Signal Low ($V_{OL}$) | $I_{OUT} = +1500\ \mu A$ | 0 | | $DV_{IO} \times 0.10$ | V |
| Input Leakage Current (Signal High) ($I_{IH}$) | | | 150 | | nA |
| Input Leakage Current (Signal Low) ($I_{IL}$) | | | −50 | | μA |
| GPIO 1 and GPIO 2 | | | | | |
| Input Signal High ($V_{IH}$) | | $AV_{DD} \times 0.60$ | | $AV_{DD}$ | V |
| Input Signal Low ($V_{IL}$) | | 0 | | $AV_{DD} \times 0.24$ | V |
| Output Signal High ($V_{OH}$) | $I_{OUT} = -500\ \mu A$ | $AV_{DD} \times 0.72$ | | $AV_{DD}$ | V |
| Output Signal Low ($V_{OL}$) | $I_{OUT} = +1500\ \mu A$ | 0 | | $AV_{DD} \times 0.10$ | V |
| Input Leakage Current (Signal High) ($I_{IH}$) | | | 150 | | nA |
| Input Leakage Current (Signal Low) ($I_{IL}$) | | | −50 | | μA |
| DM Clock | | | | | |
| Output Signal High ($V_{OH}$) | $I_{OUT} = -500\ \mu A$ | $AV_{DD} \times 0.72$ | | $AV_{DD}$ | V |
| Output Signal Low ($V_{OL}$) | $I_{OUT} = +1500\ \mu A$ | 0 | | $AV_{DD} \times 0.10$ | V |
| DM_1/2 and DM_2 | | | | | |
| Input Signal High ($V_{IH}$) | | $AV_{DD} \times 0.60$ | | $AV_{DD}$ | V |
| Input Signal Low ($V_{IL}$) | | 0 | | $AV_{DD} \times 0.24$ | V |
| Input Leakage Current (Signal High) ($I_{IH}$) | | | −150 | | nA |
| Input Leakage Current (Signal Low) ($I_{IL}$) | | | −50 | | nA |
| S/PDIF | | | | | |
| Input Signal High ($V_{IH}$) | | $DV_{IO} \times 0.60$ | | $DV_{IO}$ | V |
| Input Signal Low ($V_{IL}$) | | 0 | | $DV_{IO} \times 0.24$ | V |
| Output Signal High ($V_{OH}$) | $I_{OUT} = -500\ \mu A$ | $DV_{IO} \times 0.72$ | | $DV_{IO}$ | V |
| Output Signal Low ($V_{OL}$) | $I_{OUT} = +1500\ \mu A$ | 0 | | $DV_{IO} \times 0.10$ | V |
| Input Leakage Current (Signal High) ($I_{IH}$) | | | 150 | | nA |
| Input Leakage Current (Signal Low) ($I_{IL}$) | | | −50 | | μA |

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| POWER SUPPLY | | | | |
| Analog ($AV_{DD}$) 3.3 V ± 5% | | | | |
| Power Supply Range | 3.13 | 3.30 | 3.46 | V |
| Power Dissipation | | 75.9 | | mW |
| Supply Current | | 23 | | mA |
| Digital ($DV_{DD}$) 3.3 V ± 10% | | | | |
| Power Supply Range | 2.97 | 3.30 | 3.63 | V |
| Power Dissipation | | 141.9 | | mW |
| Supply Current | | 43 | | mA |
| Digital ($DV_{CORE}$) 1.7 through 1.9 V ± 10% | | | | |
| Power Supply Range | 1.615 | 1.70 | 1.995 | V |
| Power Dissipation | | 61 | | mW |
| Supply Current | | 36 | | mA |
| Digital I/O ($DV_{IO}$) 3.3 V ± 10% | | | | |
| Power Supply Range | 2.97 | 3.30 | 3.63 | V |
| Power Dissipation | | 3.3 | | mW |
| Supply Current | | 1 | | mA |
| Digital I/O ($DV_{IO}$) 1.5 V ± 5.5% | | | | |
| Power Supply Range | 1.418 | 1.50 | 1.583 | V |
| Power Dissipation | | 0.08 | | mW |
| Supply Current | | 0.05 | | mA |
| Power Supply Rejection (Reference to $f_S$ 100 mV p-p Signal @ 1 kHz)[1] | | 80 | | dB |

[1] Guaranteed but not tested.

## HD AUDIO LINK SPECIFICATION

High definition audio signals comply with the High Definition Audio Specification. Please refer to these specifications at www.intel.com/standards/hdaudio.

## POWER-DOWN STATES

| Parameter | $ID_{VDD}$ Typ (1.7 V) | $ID_{VDD}$ Typ (3.3 V) | $IA_{VDD}$ Typ | Unit |
|---|---|---|---|---|
| Function Node in D0, All Nodes Active | 36 | 43 | 23 | mA |
| Function Node in D3 | 15.75 | 17 | 1 | mA |
| Function Node in D3[1] | 7.5 | 7.5 | 1 | mA |
| Codec in $\overline{RESET}$ | 3 | 3 | 3 | mA |
| Individual Block Power Savings | | | | |
| DAC Pair Powered Down Saves (Each) | 4.5 | 6 | 5 | mA |
| ADC Pair Powered Down Saves (Each) | 4.5 | 6 | 3 | mA |
| Mixer Power Control (and Associated Amps) Saves | 0 | 0 | 2 | mA |
| DM_CLK Powered Down Saves[2] | 0 | 0 | 1 | mA |
| MIC_BIAS Powered Down Saves[3] | 0 | 0 | 0.1 | mA |

[1] Maximum power saving mode; Register 0x31FD, Bit 4.

[2] Test conditions: 30 pF load, 2.0 MHz frequency, 3.3 V $A_{VDD}$.

[3] Powering down the MIC_BIAS powers down all port MIC_BIAS pins. This disables all microphone bias circuits set to 100% or 50%, setting them to the high-Z state. The 0 V and high-Z states remain unaffected by the MIC_BIAS power state.

# AD1984A

## ABSOLUTE MAXIMUM RATINGS

Stresses greater than those listed below may 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 may affect device reliability.

| Parameter | Rating |
|---|---|
| Digital ($DV_{DD}$) | −0.30 V to +3.65 V |
| Digital ($DV_{CORE}$) | −0.30 V to +2.10 V |
| Digital I/O ($DV_{IO}$) | −0.30 V to +3.65 V |
| Analog ($AV_{DD}$) | −0.30 V to +3.65 V |
| Input Current (Except Supply Pins) | ±10.0 mA |
| Analog Input Voltage (Signal Pins) | −0.30 V to $AV_{DD}$ +0.3 V |
| Digital Input Voltage (Signal Pins) | −0.30 V to $DV_{IO}$ +0.3 V |
| Ambient Temperature (Operating) | 0°C to +70°C |
| Storage Temperature | −65°C to +150°C |

## ESD CAUTION

**ESD (electrostatic discharge) sensitive device.**
Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken 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
$\theta_{CA}$ = thermal resistance (case-to-ambient)
$\theta_{JA}$ = thermal resistance (junction-to-ambient)
$\theta_{JC}$ = thermal resistance (junction-to-case)

All measurements per EIA-JESD51 with 2S2P test board per EIA-JESD51-7.

| Package | $\theta_{JA}$ | $\theta_{JC}$ | $\theta_{CA}$ | Unit |
|---|---|---|---|---|
| LFCSP_VQ | 47 | 15 | 32 | °C/W |

# PIN CONFIGURATION AND FUNCTION DESCRIPTIONS



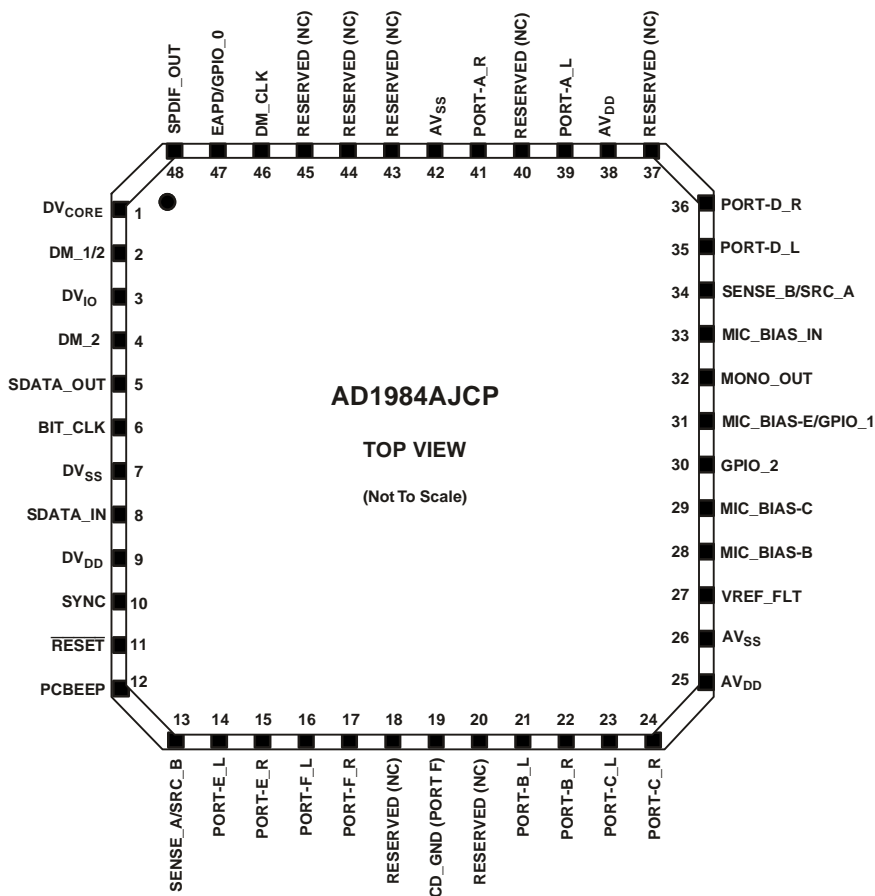*Figure 2. AD1984A 48-Lead Package and Pinout*

# AD1984A

**Table 4. Pin Function Descriptions**

| Mnemonic | Pin No. | I/O | Description |
|---|---|---|---|
| DIGITAL INTERFACE | | | |
| SDATA_OUT | 5 | I | Link Serial Data Output. AD1984A input stream. Clocked on both edges of the BIT_CLK. |
| BIT_CLK | 6 | I | Link Bit Clock. 24.000 MHz serial data clock. |
| SDATA_IN | 8 | I/O | Link Serial Data Input. AD1984A output stream clocked only on one edge of BIT_CLK. Link Frame Sync. |
| SYNC | 10 | I | Link Reset. AD1984A master hardware reset. |
| $\overline{\text{RESET}}$ | 11 | I | |
| DIGITAL I/O and EAPD | | | |
| DM_1/2 | 2 | I | Digital Microphone 1 and 2 Inputs (for Biphase Microphones), or Digital Microphone 1 Input (for Single-phase Microphones). |
| DM_2 | 4 | I | Digital Microphone 2 Input (for Single-phase Microphones). |
| DM_CLK | 46 | O | Clock to Drive External Digital Microphones. |
| GPIO_2 | 30 | I/O | General-Purpose Input/Output Pins. Digital signals used to control or sense external circuitry. |
| MIC_BIAS-E/GPIO_1 | 31 | I/O | Microphone Bias for Port E/General-Purpose Input/Output. Capable of high-Z, 1.65 V, and 2.86 V. Pin 31 shares functionality between MIC_BIAS_E (default) and GPIO_1. These functions are mutually exclusive and the MIC_BIAS function takes priority over the GPIO function. |
| EAPD/GPIO_0 | 47 | I/O | EAPD/General-Purpose Input/Output pin. Pin 47 shares functionality between GPIO_0 and EAPD. These functions are mutually exclusive and the EAPD function takes priority over the GPIO function. By default, the pin is in a high-Z state. External resistors should be used to ensure the proper circuit state when this pin is in high-Z. |
| SPDIF_OUT | 48 | O | Supports S/PDIF Output. |
| JACK SENSE | | | |
| SENSE_A/SRC_B | 13 | I/O | Jack Sense A-D Input/Sense B drive. |
| SENSE_B/SRC_A | 34 | I/O | Jack Sense E-F Input/Sense A drive. |
| ANALOG I/O | | | |
| PCBEEP | 12 | LI | Monaural Input from System for Analog PCBeep. |
| PORT-E_L | 14 | LI, MIC, LO | Auxiliary Input/Output Left Channel. |
| PORT-E_R | 15 | LI, MIC, LO | Auxiliary Input/Output Right Channel. |
| PORT-F_L | 16 | LI, LO | Auxiliary Input/Output Left Channel. |
| PORT-F_R | 17 | LI, LO | Auxiliary Input/Output Right Channel. |
| CD_GND (PORT F) | 19 | I | CD Audio Analog Ground Reference. Must be connected to AGND via a 0.1 μF capacitor if not in use as CD_GND. MUST always be ac-coupled. |
| PORT-B_L | 21 | LI, MIC | Front Panel Stereo MIC/Line-In. |
| PORT-B_R | 22 | LI, MIC | Front Panel Stereo MIC/Line-In. |
| PORT-C_L | 23 | LI, MIC | Rear Panel Stereo MIC/Line-In. |
| PORT-C_R | 24 | LI, MIC | Rear Panel Stereo MIC/Line-In. |
| MONO_OUT | 32 | LO | Monaural Output to Internal Speaker or Telephony Subsystem Speakerphone. |
| PORT-D_L | 35 | HP, LO | Rear Panel Headphone/Line-Out. |
| PORT-D_R | 36 | HP, LO | Rear Panel Headphone/Line-Out. |
| PORT-A_L | 39 | HP, LO | Front Panel Headphone/Line-Out. |
| PORT-A_R | 41 | HP, LO | Front Panel Headphone/Line-Out. |

The symbols used in this table are defined as: I = input, O = output, LI = line level input, LO = line level output, HP = output capable of driving headphone load, MIC = input supports microphones with MIC bias and boost amplifier.

**Table 4. Pin Function Descriptions (Continued)**

| Mnemonic | Pin No. | I/O | Description |
|---|---|---|---|
| FILTER/MIC_BIAS | | | |
| VREF _FILT | 27 | O | Voltage Reference Filter. |
| MIC_BIAS-B | 28 | O | Switchable Microphone Bias. For use with Port B (Pins 21, 22). |
| MIC_BIAS-C | 29 | O | Switchable Microphone Bias. For use with Port C (Pins 23, 24). |
| | | | Both MIC bias pins are capable of high-Z, 0 V, 1.65 V, 3.7 V, and 3.9 V (with 5.0 V on Pin 33), high-Z, 0 V, 1.65 V, 2.86 V, and 3.0 V (with 3.3 V on Pin 33). |
| MIC_BIAS_IN 5.0 V or 3.3 V | 33 | I | Source Power for Microphone Bias Boost Circuitry. |
| | | | Connect this pin to 5.0 V via a low-pass filter. When connected this way the AD1984A is capable of providing 3.9 V as a mic bias to all of the mic bias pins (except on Pin 31). If 5 V is not available, connect this pin to 3.3 V ($AV_{DD}$) via a low-pass filter. |
| POWER AND GROUND | | | |
| $DV_{CORE}$ 1.7 V to 1.9 V or FILTER | 1 | I/O | CAUTION: DO NOT APPLY 3.3 V TO THIS PIN! Filter connection for internal core voltage regulator. |
| | | | If Pin 9 is connected to 3.3V $DV_{DD}$, this pin must be connected to filter caps: 10μF, 1.0 μF, and 0.1 μF connected in parallel between Pin 1 and $DV_{SS}$ (pin 7). Direct, filtered 1.7 V to 1.9 V $DV_{DD}$ may be applied to Pin 1 to lower the digital power requirements. Pin 9 MUST be connected to Pin 1 in this case. |
| $DV_{IO}$ 1.5 V or 3.3 V | 3 | I | Link Digital I/O Voltage Reference. 3.3 V ± 10% or 1.5 V ± 5.5% |
| $DV_{SS}$ | 7 | I | Digital Supply Return (Ground). |
| $DV_{DD}$ 1.7 V to 1.9 V or 3.3 V | 9 | I | Digital Supply Voltage 3.3 V ± 10%. This is regulated down to $DV_{CORE}$ on Pin 1 to supply the internal digital core internal to the AD1984A. Direct, filtered 1.7 V to 1.9 V $DV_{DD}$ may be applied to Pin 1 to lower the digital power requirements. Pin 9 MUST be connected to Pin 1 in this case. |
| $AV_{DD}$ 3.3 V | 25, 38 | I | CAUTION: DO NOT APPLY 5 V TO THESE PINS! Analog Supply Voltage 3.3 V ONLY. |
| | | | Note: $AV_{DD}$ supplies should be well regulated and filtered as supply noise degrades audio performance. |
| $AV_{SS}$ | 26, 42 | I | Analog Supply Return (Ground). $AV_{SS}$ should be connected to $DV_{SS}$ using a conductive trace under, or close to, the AD1984A. |

The symbols used in this table are defined as: I = input, O = output, LI = line level input, LO = line level output, HP = output capable of driving headphone load, MIC = input supports microphones with MIC bias and boost amplifier.

# AD1984A

## DIGITAL MICROPHONE INTERFACE TIMING SPECIFICATIONS

The digital microphone interface can support one or two digital microphones using two or three codec pins. Both uniplex (one microphone per data pin) and multiplex (two microphones sharing the same data pin) are supported. The timing for these configurations is shown in Table 5 and Figure 3, Figure 4 and Figure 5. The interface can generate a microphone clock at 1.5 MHz, 2.0 MHz, or 3.0 MHz to suit quality and power requirements.

**Table 5. Microphone Timing Parameters**

| Parameter | Description | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| *Timing Requirements* | | | | | |
| $t_0$ | DM_CLK (1.5 MHz) Period | | 667 | | ns |
| | Duty Cycle | | 50/50 | | % |
| $t_0$ | DM_CLK (2.0 MHz) Period | | 500 | | ns |
| | Duty Cycle | | 50/50 | | % |
| $t_0$ | DM_CLK (3.0 MHz) Period | | 333 | | ns |
| | Duty Cycle | | 50/50 | | % |
| $t_1$ | DM_CLK Rise Time | | | 5 | ns |
| $t_2$ | DM_CLK Fall Time | | | 5 | ns |
| $t_3$ | Data Setup to DM_CLK Edge | 10 | | | ns |
| $t_4$ | Data Hold from DM_CLK Edge | 5 | | | ns |



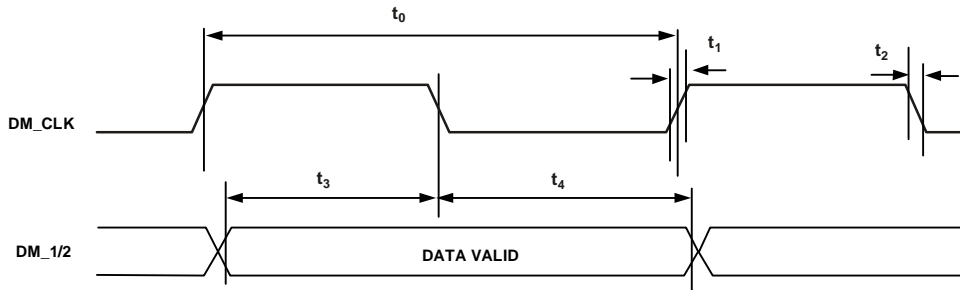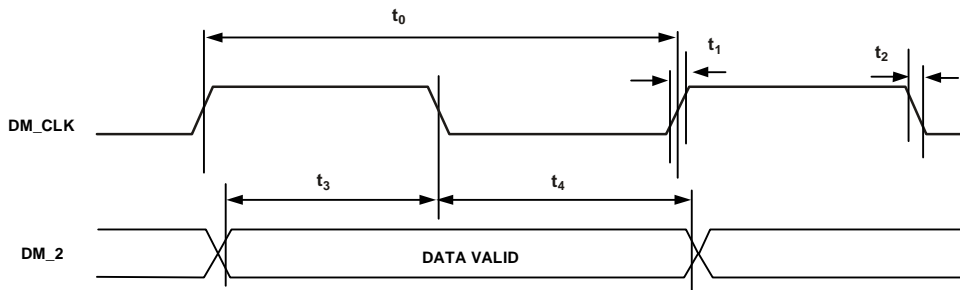*Figure 3.  Uniplex Microphone Timing*



*Figure 4.  DM_2 Uniplex Microphone Timing*
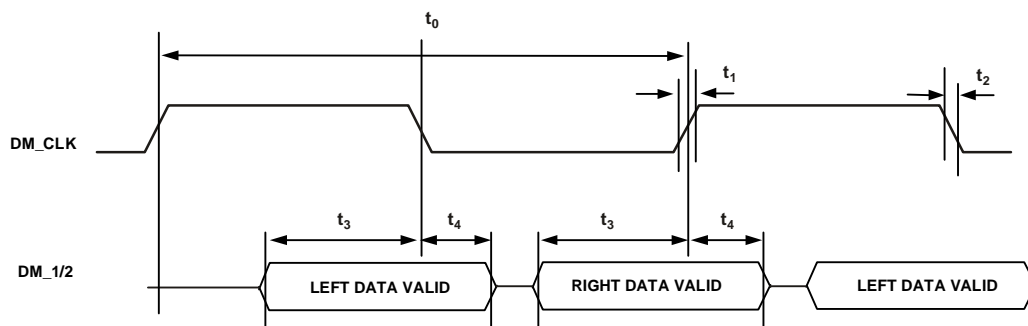
*Figure 5.  Multiplex Microphone Timing*

## HD AUDIO WIDGETS

**Table 6. HD Audio Widgets[1]**

| Node ID | Name | Type ID | Type | Description |
|---------|------|---------|------|-------------|
| 0x00 | ROOT | x | Root | Device identification |
| 0x01 | FUNCTION | x | Function | Designates this device as an audio codec |
| 0x02 | S/PDIF DAC | 0 | Audio Output | S/PDIF digital stream output interface |
| 0x03 | DAC_0 | 0 | Audio Output | Stereo headphone channel digital/audio converter |
| 0x04 | DAC_1 | 0 | Audio Output | Stereo front channel digital/audio converter |
| 0x07 | Port A Mixer | 2 | Audio Mixer | Mixes the DAC_(0, 1) and analog mixer output to drive Port A |
| 0x08 | ADC_0 | 1 | Audio Input | Stereo record Channel 0 audio/digital converters |
| 0x09 | ADC_1 | 1 | Audio Input | Stereo record Channel 1 audio/digital converters |
| 0x0A | Port D Mixer | 2 | Audio Mixer | Mixes the DAC_1 and analog mixer output to drive Port D |
| 0x0B | Port F Mixer | 2 | Audio Mixer | Mixes the DAC_(0, 1) and analog mixer output to drive Port F |
| 0x0C | ADC Selector 0 | 3 | Audio Selector | Selects and amplifies/attenuates the input to ADC_0 |
| 0x0D | ADC Selector 1 | 3 | Audio Selector | Selects and amplifies/attenuates the input to ADC_1 |
| 0x0E | Mono Out Selector | 3 | Audio Selector | Selects the mono out DAC_(0, 1) |
| 0x0F | Port F Out Selector | 3 | Audio Selector | Selects the Port F DAC_(0, 1) |
| 0x10 | Digital Beep | 7 | Beep Generator | Internal digital PCBeep signal |
| 0x11 | Port A (Headphone) | 4 | Pin Complex | Headphone jack pins |
| 0x12 | Port D (Line Out) | 4 | Pin Complex | Line out jack pins |
| 0x13 | Mono Out | 4 | Pin Complex | Monaural output pin (internal speakers or telephony system) |
| 0x14 | Port B (Mic In) | 4 | Pin Complex | Microphone in jack pins |
| 0x15 | Port C (Line In) | 4 | Pin Complex | Line in jack pins |
| 0x16 | Port F (Aux In/Out) | 4 | Pin Complex | Auxiliary I/O pins |
| 0x17 | Dig Microphone | 4 | Pin Complex | Digital microphone input pin |
| 0x19 | Mixer Power Down | 5 | Power Widget | Powers down the analog mixer and associated amps |
| 0x1A | Analog PCBeep | 4 | Pin Complex | External analog PCBeep signal input |
| 0x1B | S/PDIF-Out | 4 | Pin Complex | S/PDIF output pin |
| 0x1C | Port E (Dock I/O) | 4 | Pin Complex | Analog dock I/O pins |
| 0x1D | $V_{REF}$ Power Down | F | Vendor Defined | Powers down the $V_{REF}$ circuitry |
| 0x1E | Mono Out Mixer | 2 | Audio Mixer | Mixes the DAC_(0, 1) and analog mixer output to drive mono out |
| 0x1F | Stereo Mix-Down | 2 | Audio Mixer | Mixes the stereo L/R channels to drive mono output |
| 0x20 | Analog Mixer | 2 | Audio Mixer | Mixes individually gainable analog inputs |
| 0x21 | Mixer Output Atten | 3 | Audio Selector | Attenuates the analog mixer output to drive the port mixers |
| 0x22 | Port A Out Selector | 3 | Audio Selector | Selects the Port A DAC_(0, 1) |
| 0x23 | Port E Out Selector | 3 | Audio Selector | Selects the Port E DAC_(0, 1) |
| 0x24 | Port E Mixer | 2 | Audio Mixer | Mixes the DAC_(0, 1) and analog mixer output to drive Port E |
| 0x25 | Port E Mic Boost | 3 | Audio Selector | 0 dB, 10 dB, 20 dB, or 30 dB gain boost for Port E |
| 0x26 | BIAS Power Down | F | Vendor Defined | Powers down the internal MIC_BIAS_FILT and all MIC_BIAS pins |

[1] All node IDs (NIDs) are sequential in the codec. Any NIDs missing for this table are vendor defined.

# HD AUDIO PARAMETERS

**Table 7. Root and Function Node Parameters**

| Node ID | Name | Vendor ID 00 | Revision ID 02[1] | Sub Node Count 04 | Func. Group Type 05 | Audio F.G. Caps 08 | GPIO Caps 11 |
|---------|------|--------------|-------------------|-------------------|---------------------|--------------------|--------------| 
| 0x00 | ROOT | 0x11D4 194A | 0x0010 0400 | 0x0001 0001 | | | |
| 0x01 | FUNCTION | | | 0x0002 0029 | 0x0000 0001 | 0x0001 0C0C | 0x4000 0003 |

[1] Subject to change with silicon stepping.

**Table 8. Subsystem ID**

| Node ID | Name | Type | Value | 31:16 SSID | 15:8 SKU | 7:0 ASM ID |
|---------|------|------|-------|------------|----------|------------|
| 0x01 | FUNCTION | Function | 0xBFD4 0000 | 0xBFD4 | 0x00 | 0x00 |

# WIDGET PARAMETERS

**Table 9. Widget Parameters**

| Node ID | Widget Capabilities 0x09 | PCM Size, Rate 0x0A | Stream Formats 0x0B | Pin Capabilities 0x0C | Input Amp Capabilities 0x0D | Con. List Length 0x0E | Power States 0x0F | Output Amp Capabilities 0x12 |
|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x0000 04C0 | 0x000E 07FF | 0x0000 0001 | | 0x8000 0000 | | 0x0000 0009 | 0x0005 2727 |
| 0x02 | 0x0003 0211 | 0x000E 07E0 | 0x0000 0005 | | | 0x0000 0000 | | |
| 0x03 | 0x0000 0405 | 0x000E 07FF | 0x0000 0001 | | | 0x0000 0000 | 0x0000 0009 | 0x0005 2727 |
| 0x04 | 0x0000 0405 | 0x000E 07FF | 0x0000 0001 | | | 0x0000 0000 | 0x0000 0009 | 0x0005 2727 |
| 0x07 | 0x0020 0103 | | | | 0x8000 0000 | 0x0000 0002 | | |
| 0x08 | 0x0010 0501 | 0x000E 07FF | 0x0000 0001 | | | 0x0000 0001 | 0x0000 0009 | |
| 0x09 | 0x0010 0501 | 0x000E 07FF | 0x0000 0001 | | | 0x0000 0001 | 0x0000 0009 | |
| 0x0A | 0x0020 0103 | | | | 0x8000 0000 | 0x0000 0002 | | |
| 0x0B | 0x0020 0103 | | | | 0x8000 0000 | 0x0000 0002 | | |
| 0x0C | 0x0030 010D | | | | | 0x0000 0006 | | 0x8005 3627 |
| 0x0D | 0x0030 010D | | | | | 0x0000 0006 | | 0x8005 3627 |
| 0x0E | 0x0030 0101 | | | | | 0x0000 0002 | | |
| 0x0F | 0x0030 0101 | | | | | 0x0000 0002 | | |
| 0x10 | 0x0070 000C | | | | | 0x0000 0000 | | 0x800B 0F0F |
| 0x11 | 0x0040 018D | | | 0x0000 001F | | 0x0000 0001 | | 0x8000 0000 |
| 0x12 | 0x0040 058D | | | 0x0001 001F | | 0x0000 0001 | 0x0000 0009 | 0x8000 0000 |
| 0x13 | 0x0040 050C | | | 0x0001 0010 | | 0x0000 0001 | 0x0000 0009 | 0x8005 1F1F |
| 0x14 | 0x0040 008B | | | 0x0000 3727 | 0x0027 0300 | 0x0000 0000 | | |
| 0x15 | 0x0040 008B | | | 0x0000 3727 | 0x0027 0300 | 0x0000 0000 | | |
| 0x16 | 0x0040 058D | | | 0x0001 0037 | | 0x0000 0001 | 0x0000 0009 | 0x8000 0000 |
| 0x17 | 0x0040 020B | | | 0x0000 0020 | 0x0017 0300 | 0x0000 0000 | | |
| 0x19 | 0x0050 0500 | | | | | 0x0000 0002 | 0x0000 0009 | |
| 0x1A | 0x0040 0000 | | | 0x0000 0020 | | 0x0000 0000 | | |
| 0x1B | 0x0040 038D | | | 0x0000 0014 | | 0x0000 0001 | | 0x8005 2727 |
| 0x1C | 0x0040 018D | | | 0x0000 3737 | | 0x0000 0001 | | 0x8000 0000 |
| 0x1D | 0x00F0 0100 | | | | | 0x0000 000A | | |
| 0x1E | 0x0020 0103 | | | | 0x8000 0000 | 0x0000 0002 | | |
| 0x1F | 0x0020 0100 | | | | | 0x0000 0001 | | |
| 0x20 | 0x0020 010B | | | | 0x8005 1F17 | 0x0000 0007 | | |
| 0x21 | 0x0030 010D | | | | | 0x0000 0001 | | 0x8005 1F1F |
| 0x22 | 0x0030 0101 | | | | | 0x0000 0002 | | |
| 0x23 | 0x0030 0101 | | | | | 0x0000 0002 | | |
| 0x24 | 0x0020 0103 | | | | 0x8000 0000 | 0x0000 0002 | | |
| 0x25 | 0x0030 010D | | | | | 0x0000 0001 | | 0x0027 0300 |
| 0x26 | 0x00F0 0100 | | | | | 0x0000 0003 | | |

# CONNECTION LIST

**Table 10. Connection List**

| Node ID | Connections [0–3] | [4–7] | [8–11] | 0 NID | 1 R¹ | 1 NID | 2 R | 2 NID | 3 R | 3 NID | 4 R | 4 NID | 5 R | 5 NID | 6 R | 6 NID | 7 R | 7 NID | 8 R | 8 NID | 9 R | 9 NID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0x02 | | | | | | | | | | | | | | | | | | | | | | |
| 0x03 | | | | | | | | | | | | | | | | | | | | | | |
| 0x04 | | | | | | | | | | | | | | | | | | | | | | |
| 0x07 | 0x0000 2122 | | | 0x22 | | 0x21 | | | | | | | | | | | | | | | | |
| 0x08 | 0x0000 000C | | | 0x0C | | | | | | | | | | | | | | | | | | |
| 0x09 | 0x0000 000D | | | 0x0D | | | | | | | | | | | | | | | | | | |
| 0x0A | 0x0000 2104 | | | 0x04 | | 0x21 | | | | | | | | | | | | | | | | |
| 0x0B | 0x0000 210F | | | 0x0F | | 0x21 | | | | | | | | | | | | | | | | |
| 0x0C | 0x2016 1514 | 0x0000 1725 | | 0x14 | | 0x15 | | 0x16 | | 0x20 | | 0x25 | | 0x17 | | | | | | | | |
| 0x0D | 0x2016 1514 | 0x0000 1725 | | 0x14 | | 0x15 | | 0x16 | | 0x20 | | 0x25 | | 0x17 | | | | | | | | |
| 0x0E | 0x0000 0403 | | | 0x03 | | 0x04 | | | | | | | | | | | | | | | | |
| 0x0F | 0x0000 0403 | | | 0x03 | | 0x04 | | | | | | | | | | | | | | | | |
| 0x10 | | | | | | | | | | | | | | | | | | | | | | |
| 0x11 | 0x0000 0007 | | | 0x07 | | | | | | | | | | | | | | | | | | |
| 0x12 | 0x0000 000A | | | 0x0A | | | | | | | | | | | | | | | | | | |
| 0x13 | 0x0000 001F | | | 0x1F | | | | | | | | | | | | | | | | | | |
| 0x14 | | | | | | | | | | | | | | | | | | | | | | |
| 0x15 | | | | | | | | | | | | | | | | | | | | | | |
| 0x16 | 0x0000 000B | | | 0x0B | | | | | | | | | | | | | | | | | | |
| 0x17 | | | | | | | | | | | | | | | | | | | | | | |
| 0x19 | 0x0000 2120 | | | 0x20 | | 0x21 | | | | | | | | | | | | | | | | |
| 0x1A | | | | | | | | | | | | | | | | | | | | | | |
| 0x1B | 0x0000 0002 | | | 0x02 | | | | | | | | | | | | | | | | | | |
| 0x1C | 0x0000 0024 | | | 0x24 | | | | | | | | | | | | | | | | | | |
| 0x1D | 0x118F 0A07 | 0x1C1A 1996 | 0x0000 A61E | 0x07 | | 0x0A | 1 | 0x0F | | 0x11 | 1 | 0x16 | | 0x19 | | 0x1A | | 0x1C | | 0x1E | 1 | 0x26 |
| 0x1E | 0x0000 210E | | | 0x0E | | 0x21 | | | | | | | | | | | | | | | | |
| 0x1F | 0x0000 001E | | | 0x1E | | | | | | | | | | | | | | | | | | |
| 0x20 | 0x1A16 1514 | 0x004 0325 | | 0x14 | | 0x15 | | 0x16 | | 0x1A | | 0x25 | | 0x03 | | 0x04 | | | | | | |
| 0x21 | 0x0000 0020 | | | 0x20 | | | | | | | | | | | | | | | | | | |
| 0x22 | 0x0000 0403 | | | 0x03 | | 0x04 | | | | | | | | | | | | | | | | |
| 0x23 | 0x0000 0403 | | | 0x03 | | 0x04 | | | | | | | | | | | | | | | | |
| 0x24 | 0x0000 2123 | | | 0x23 | | 0x21 | | | | | | | | | | | | | | | | |
| 0x25 | 0x0000 001C | | | 0x1C | | | | | | | | | | | | | | | | | | |
| 0x26 | 0x001C 1514 | | | 0x14 | | 0x15 | | 0x1C | | | | | | | | | | | | | | |

¹ R = the MS bit of any node ID indicates a 2-tuple NID pair delineating a continuous range of nodes. If the MS bit is set (=1), that list entry forms a range of entries from the previous NID to the current NID. For additional information, see chapter 7.1.2, "Node Addressing" in the *High Definition Audio Specification*.

# AD1984A

## DEFAULT CONFIGURATION BYTES

**Table 11.  Default Configuration Bytes**

| Node ID | Name | Value | 31:30 Connectivity | 29:28 Chassis | 27:24 Position | 23:20 Def. Device |
|---|---|---|---|---|---|---|
| | | | | **Location** | | |
| 0x11 | Port A  (Headphone) | 0x0321 40F0 | Jack | External | Left | HP Out |
| 0x12 | Port D (Line Out) | 0x2121 4010 | Jack | Separate | Rear | HP Out |
| 0x13 | Mono Out | 0x9017 01F0 | Fixed | Internal | N/A | Speaker |
| 0x14 | Port B (Mic In) | 0x03A1 90F0 | Jack | External | Left | Mic In |
| 0x15 | Port C (Line In) | 0xB7A7 0121 | Fixed | Other | Special 1 | Mic In |
| 0x16 | Port F (Aux In/Out) | 0x9933 012E | Fixed | Internal | Special 3 | CD |
| 0x17 | Dig Mic Pin | 0x97A6 01F0 | None | Internal | Special 1 | Mic In |
| 0x1A | Analog PCBeep | 0x90F3 01F0 | Fixed | Internal | N/A | other |
| 0x1B | S/PDIF Out-1 | 0x0145 10F0 | Jack | External | Rear | SPDIF Out |
| 0x1C | Port E (Dock I/O) | 0x21A1 9020 | Jack | Separate | Rear | Mic In |

**Table 11.  Default Configuration Bytes  (Continued)**

| Node ID | Name | Value | 19:16 Conn Type | 15:12 Color | 8 JD OVRD | 7:4 Def Assn. | 3:0 Seq. |
|---|---|---|---|---|---|---|---|
| 0x11 | Port A  (Headphone) | 0x0321 40F0 | 1/8" Jack | Green | 0 | 0xF | 0x0 |
| 0x12 | Port D (Line Out) | 0x2121 4010 | 1/8" Jack | Green | 0 | 0x1 | 0x0 |
| 0x13 | Mono Out | 0x9017 01F0 | Other Analog | Unknown | 1 | 0xF | 0x0 |
| 0x14 | Port B (Mic In) | 0x03A1 90F0 | 1/8" Jack | Pink | 0 | 0xF | 0x0 |
| 0x15 | Port C (Line In) | 0xB7A7 0121 | Other Analog | Unknown | 1 | 0x2 | 0x1 |
| 0x16 | Port F (Aux In/Out) | 0x9933 012E | ATAPI | Unknown | 1 | 0x2 | 0xE |
| 0x17 | Dig Mic Pin | 0x97A6 01F0 | Other Digital | Unknown | 1 | 0xF | 0x0 |
| 0x1A | Analog PCBeep | 0x90F3 01F0 | ATAPI | Unknown | 1 | 0xF | 0x0 |
| 0x1B | S/PDIF Out-1 | 0x0145 10F0 | Optical | Black | 0 | 0xF | 0x0 |
| 0x1C | Port E (Dock I/O) | 0x21A1 9020 | 1/8" Jack | Pink | 0 | 0x2 | 0x0 |

## OUTLINE DIMENSIONS
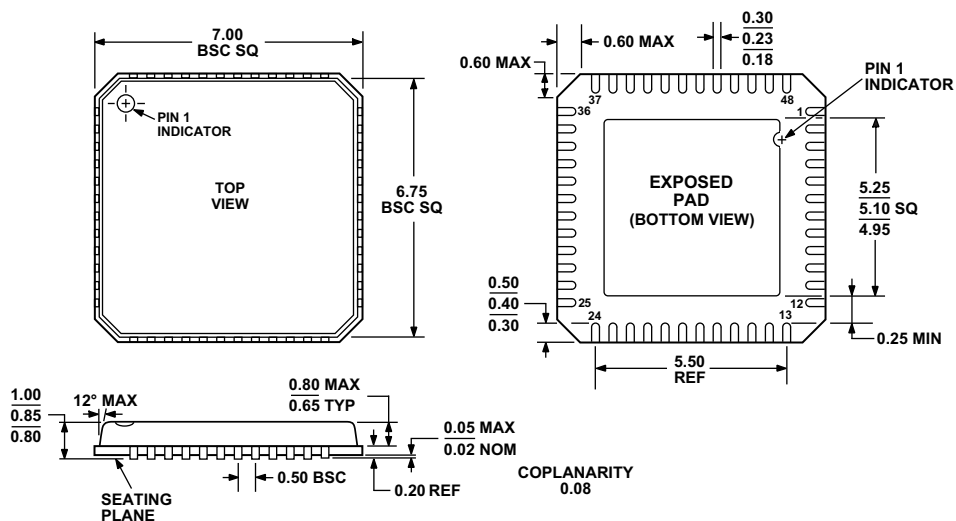


*Figure 6.  48-Lead Lead Frame Chip Scale Package [LFCSP_VQ]*
*7 mm x 7 mm Body, Very Thin Quad*
*(CP-48-1)*
*Dimensions shown in millimeters*

## ORDERING GUIDE

| Model | Temperature Range | Package Description | Package Option |
|---|---|---|---|
| AD1984AJCPZ[1] | 0°C to 70°C | 48-Lead LFCSP_VQ | CP-48-1 |
| AD1984AJCPZ-RL[1] | 0°C to 70°C | 48-Lead LFCSP_VQ, 13" Tape and Reel | CP-48-1 |

[1] Z = RoHS Compliant Part.

ANALOG
DEVICES

www.analog.com