

### FEATURES

- 2 DAC channels: 16-, 20-, or 24-bit
- 2 ADC channels: 16- or 20-bit
- HD audio sample rates
  - 8 kHz, 11.025 kHz, 16 kHz, 22.05 kHz, 32 kHz, 44.1 kHz, 48 kHz
- Greater than 90 dB dynamic range
- S/PDIF output: 32 kHz, 44.1 kHz or 48 kHz, 16- or 24-bit
- Digital beep and analog PC beep pass-through
- Integrated headphone amplifiers on two ports
- Port retasking
- Selectable microphone and line inputs
- Full analog mixer
- Legacy inputs: CD and auxiliary inputs
- External amplifier power-down (EAPD)
- 48-pin, Pb-free LQFP

### ENHANCED FEATURES

- No AFILT pins, results in BOM savings
- 5.0 V AV<sub>DD</sub> supply, 3.3 V DV<sub>DD</sub> supply
- Jack-sensing autoconfiguration options
  - Mute line output and monaural output (MONO\_OUT) when headphones are used
  - Mute MONO\_OUT when a device is in the line out jack
- Selectable trip level: high/low supports all jack types
- Peripheral identification/enumeration
- Jack event/presence detection using SENSE or GPIO pins
- Microphone to MONO\_OUT for speakerphone applications
- Advanced power management modes
- 4 software-controlled microphone bias pins
- Up to 30 dB microphone boost
- 4 GPIOs—external control or traditional jack sense

### FUNCTIONAL BLOCK DIAGRAM

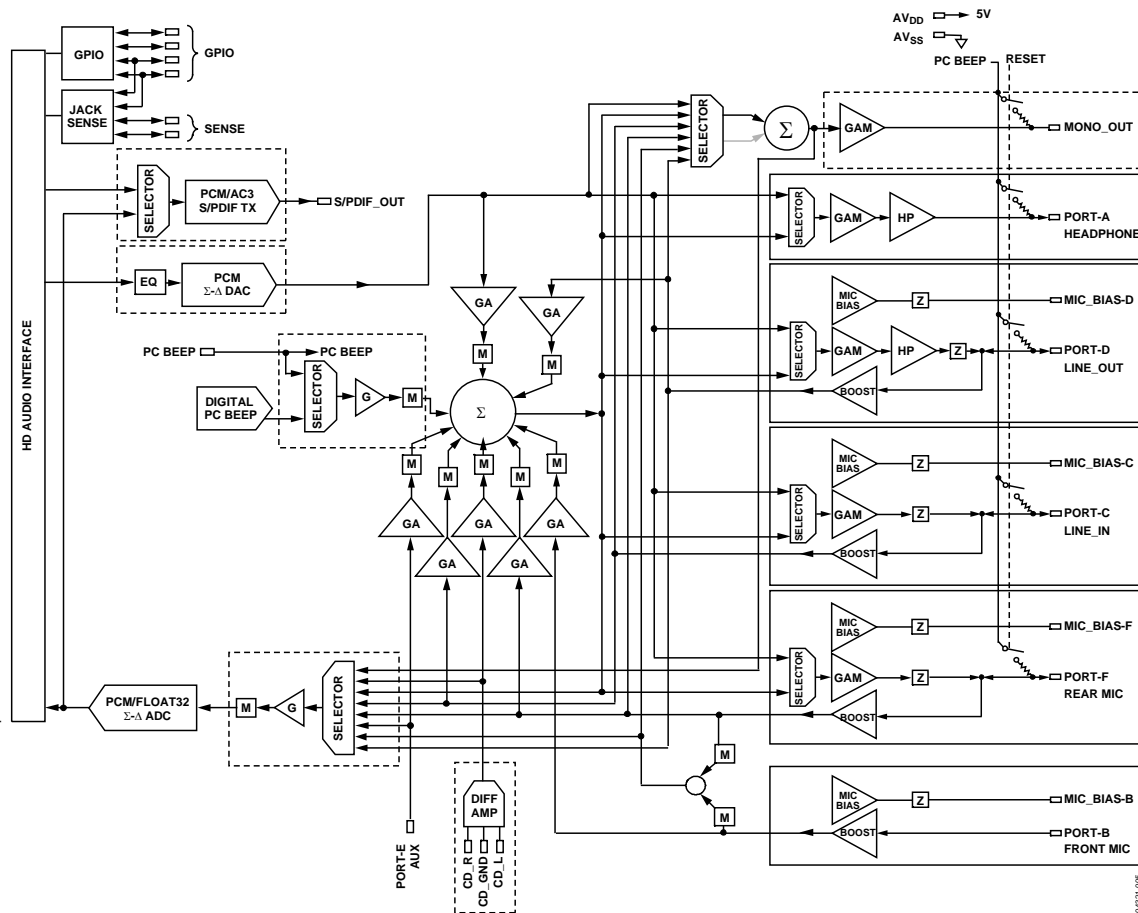


Figure 1.

### Rev. 0

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## REVISION HISTORY

6/05—Initial Version: Revision 0

FUNCTIONAL BLOCK DIAGRAM DETAILS

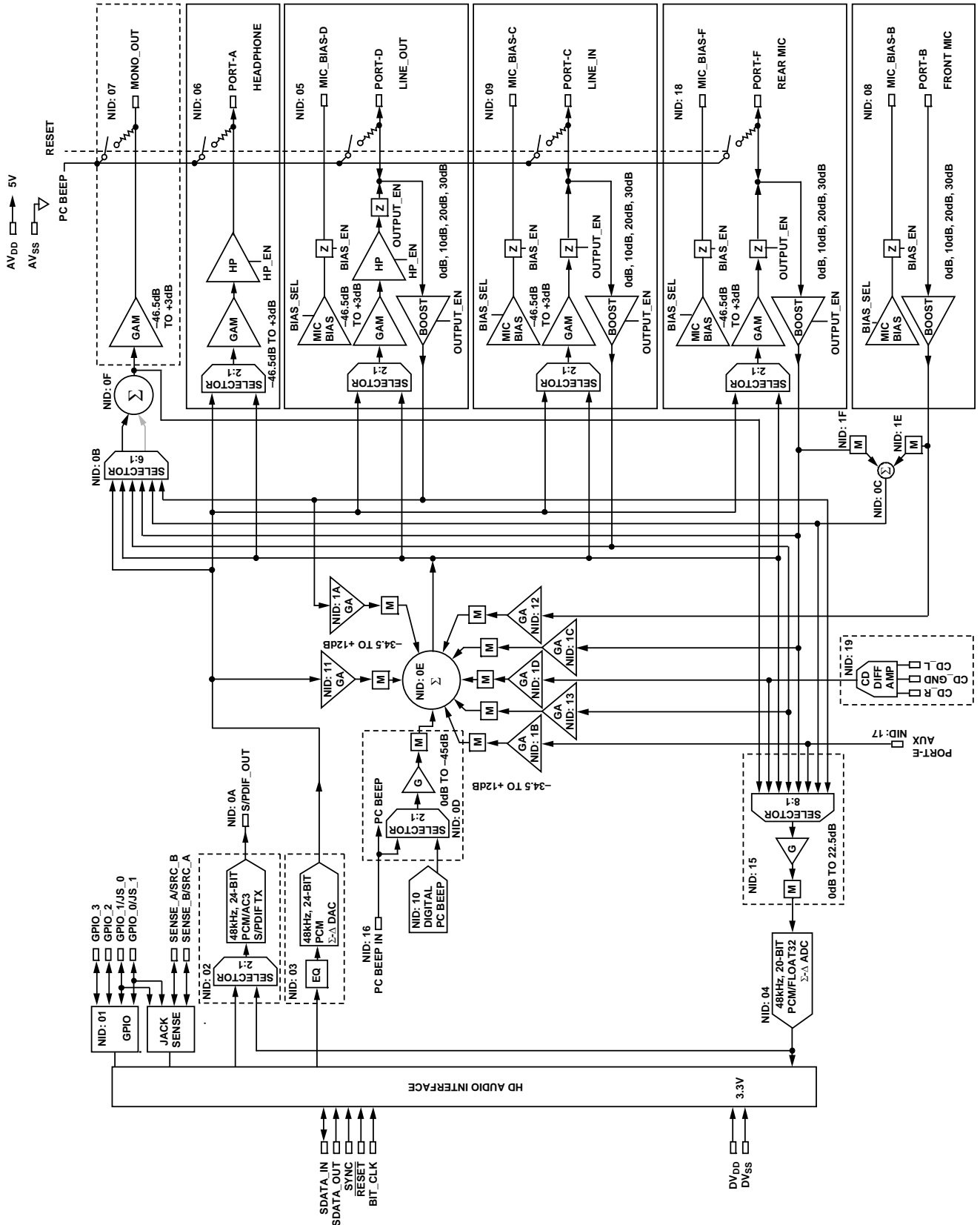


Figure 2.

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## SPECIFICATIONS

Test conditions, unless otherwise noted.

**Table 1. Test Conditions**

| Parameter                          | Typ          | Unit |
|------------------------------------|--------------|------|
| TEMPERATURE                        | 25           | °C   |
| DIGITAL SUPPLY (DV <sub>DD</sub> ) | 3.3 ±10%     | V    |
| ANALOG SUPPLY (AV <sub>DD</sub> )  | 5.0 ±10%     | V    |
| SAMPLE RATE (F <sub>S</sub> )      | 48           | kHz  |
| INPUT SIGNAL                       | 1.0          | kHz  |
| ANALOG OUTPUT PASS BAND            | 20 to 20,000 | Hz   |
| V <sub>IH</sub>                    | 2.0          | V    |
| V <sub>IL</sub>                    | 0.8          | V    |
| V <sub>IH</sub>                    | 2.4          | V    |
| V <sub>IL</sub>                    | 0.6          | V    |

### DAC Test Conditions

Calibrated  
Output –3 dB relative to full scale  
10 kΩ output load, Ports C, D, E, and mono  
32 Ω output load, Port A

### ADC Test Conditions

Calibrated  
0 dB PGA gain  
Input –3.0 dB relative to full scale  
Input sourced on Port B, 0 dB boost

**Table 2. Analog Input**

| Parameter                    | Min | Typ   | Max | Unit                          |
|------------------------------|-----|-------|-----|-------------------------------|
| PORTS B, C, D, E: 0 dB       |     | 1     |     | V <sub>rms</sub> <sup>1</sup> |
|                              |     | 2.83  |     | V <sub>p-p</sub>              |
| PORTS B, C, D, E: 30 dB      |     | 0.032 |     | V <sub>rms</sub>              |
|                              |     | 0.089 |     | V <sub>p-p</sub>              |
| PORTS B, C, D, E: 20 dB      |     | 0.1   |     | V <sub>rms</sub>              |
|                              |     | 0.283 |     | V <sub>p-p</sub>              |
| PORTS B, C, D, E: 10 dB      |     | 0.316 |     | V <sub>rms</sub>              |
|                              |     | 0.894 |     | V <sub>p-p</sub>              |
| PORT F, CD IN                |     | 1     |     | V <sub>rms</sub>              |
|                              |     | 2.83  |     | V <sub>p-p</sub>              |
| INPUT IMPEDANCE <sup>2</sup> |     | 20    |     | kΩ                            |
| INPUT CAPACITANCE            |     | 5     | 7.5 | pF                            |

<sup>1</sup> RMS values assume sine wave input.

<sup>2</sup> Guaranteed by design; not production tested.

**Table 3. Master Volume**

| Parameter                                 | Min   | Typ | Max | Unit |
|---|-------|-----|-----|------|
| STEP SIZE (Ports A, B, C, D, E, MONO_OUT) |       | 1.5 |     | dB   |
| OUTPUT GAIN RANGE                         | –46.5 |     | +3  | dB   |
| MUTE ATTENUATION OF 0 dB FUNDAMENTAL      | 80    |     |     | dB   |

<sup>1</sup> Guaranteed by design; not production tested.

Table 4. Programmable Gain Amplifier—ADC

| Parameter           | Min | Typ | Max  | Unit |
|---------------------|-----|-----|------|------|
| STEP SIZE           |     | 1.5 |      | dB   |
| PGA GAIN RANGE SPAN | 0.0 |     | 22.5 | dB   |

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

| Parameter   | Min   | Typ | Max   | Unit |
|---|-------|-----|-------|------|
| SIGNAL-TO-NOISE RATIO (SNR)<br>Line In to Line Out  |       | 85  |       | dB   |
| Microphone In to Line Out <sup>1</sup>              |       | 80  |       | dB   |
| STEP SIZE: ALL MIXER INPUTS (Except PC BEEP)        |       | 1.5 |       | dB   |
| STEP SIZE: PC BEEP                                  |       | 3.0 |       | dB   |
| INPUT GAIN RANGE: ALL MIXER INPUTS (Except PC BEEP) | −34.5 |     | +12.0 | dB   |
| DIGITAL PC BEEP                                     | −45.0 |     | 0.0   | dB   |

<sup>1</sup> Guaranteed by design; not production tested.

Table 6. Digital Decimation and Interpolation Filters<sup>1</sup>

| Parameter                            | Min              | Typ      | Max              | Unit    |
|--------------------------------------|------------------|----------|------------------|---------|
| PASS BAND                            | 0                |          | $0.4 \times F_s$ | Hz      |
| PASS-BAND RIPPLE                     |                  |          | $\pm 0.09$       | dB      |
| TRANSITION BAND                      | $0.4 \times F_s$ |          | $0.6 \times F_s$ | Hz      |
| STOP BAND                            | $0.6 \times F_s$ |          | $\infty$         | Hz      |
| STOP-BAND REJECTION                  | −74              |          |                  | dB      |
| GROUP DELAY                          |                  | $16/F_s$ |                  | sec     |
| GROUP DELAY VARIATION OVER PASS BAND |                  | 0        |                  | $\mu$ s |

<sup>1</sup> Guaranteed by design; not production tested.

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 INPUTS AND OTHER INPUTS                                       |     | −100     | −80       | dB   |
| GAIN ERROR (Full-Scale Span Relative to Nominal Input Voltage)                |     | $\pm 10$ |           | %    |
| INTERCHANNEL GAIN MISMATCH (Difference of Gain Errors)                        |     |          | $\pm 0.5$ | dB   |
| ADC OFFSET ERROR  |     |          | $\pm 5$   | mV   |

Table 8. Digital-to-Analog Converters

| Parameter   | Min | Typ      | Max       | Unit |
|---|-----|----------|-----------|------|
| RESOLUTION  |     | 24       |           | Bits |
| TOTAL HARMONIC DISTORTION (Line Out)  |     | −92      |           | dB   |
| TOTAL HARMONIC DISTORTION (Headphone Out)   |     | −75      |           | dB   |
| DYNAMIC RANGE (−60 dB Input, THD + N Referenced to Full Scale, A-Weighted)            |     | 90       |           | dB   |
| GAIN ERROR (Full-Scale Span Relative to Nominal Input Voltage)                        |     | $\pm 10$ |           | %    |
| INTERCHANNEL GAIN MISMATCH (Difference of Gain Errors)                                |     |          | $\pm 0.7$ | dB   |
| DAC CROSSTALK <sup>1</sup> (Input L, Zero R, Read R Out; Input R, Zero L, Read L Out) |     |          | −80       | dB   |

<sup>1</sup> Guaranteed by design; not production tested.

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**Table 9. Analog Output**

| Parameter  | Min   | Typ   | Max   | Unit  |
|--|-------|-------|-------|-------|
| FULL-SCALE OUTPUT VOLTAGE (Headphone Disabled)         |       | 1     |       | V rms |
|  |       | 2.83  |       | V p-p |
| Output Impedance <sup>1</sup>                          |       | 300   |       | Ω     |
| External Load Impedance                                | 10    |       |       | kΩ    |
| Output Capacitance                                     |       | 15    |       | pF    |
| External Load Capacitance                              |       |       | 1000  | pF    |
| FULL-SCALE OUTPUT VOLTAGE (Headphone Out)              |       | 1     |       | V rms |
|  |       | 2.83  |       | V p-p |
| Output Impedance                                       |       |       | 1     | Ω     |
| External Load Impedance                                | 32    |       |       | Ω     |
| Output Capacitance                                     |       | 15    |       | pF    |
| External Load Capacitance                              |       |       | 1000  | pF    |
| VREF_FILT  | 2.050 | 2.250 | 2.450 | V     |
| MIC_BIAS (Ports B, C, D)                               |       | 2.250 |       | V     |
| (xVREF [2:0] = 100, AVDD = 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    |

<sup>1</sup> Guaranteed by design; not production tested.

**Table 10. Static Digital Specifications**

| Parameter  | Min                     | Typ | Max | Unit                    |
|--|-------------------------|-----|-----|-------------------------|
| HIGH LEVEL INPUT VOLTAGE (V <sub>IH</sub> ), DIGITAL INPUTS          | 0.65 × DV <sub>DD</sub> |     |     | V                       |
| LOW LEVEL INPUT VOLTAGE (V <sub>IL</sub> )                           |                         |     |     | 0.35 × DV <sub>DD</sub> |
| HIGH LEVEL OUTPUT VOLTAGE (V <sub>OH</sub> ), I <sub>OH</sub> = 2 mA | 0.90 × DV <sub>DD</sub> |     |     | V                       |
| LOW LEVEL OUTPUT VOLTAGE (V <sub>OL</sub> ), I <sub>OL</sub> = 2 mA  |                         |     |     | 0.10 × DV <sub>DD</sub> |
| INPUT LEAKAGE CURRENT  | -10                     |     | +10 | μA                      |
| OUTPUT LEAKAGE CURRENT   | -10                     |     | +10 | μA                      |
| INPUT/OUTPUT PIN CAPACITANCE   |                         |     | 7.5 | pF                      |

**Table 11. Power Supply**

| Parameter  | Min  | Typ     | Max  | Unit |
|--|------|---------|------|------|
| POWER SUPPLY RANGE—ANALOG (AV <sub>DD</sub> ) ±10%                       | 4.5  |         | 5.5  | V    |
| POWER SUPPLY RANGE—DIGITAL (DV <sub>DD</sub> ) ±10%                      | 2.97 |         | 3.63 | V    |
| POWER DISSIPATION—ANALOG (AV <sub>DD</sub> )/DIGITAL (DV <sub>DD</sub> ) |      | 275/132 |      | mW   |
| ANALOG SUPPLY CURRENT—ANALOG (AV <sub>DD</sub> )                         |      | 43      |      | mA   |
| DIGITAL SUPPLY CURRENT—DIGITAL (DV <sub>DD</sub> )                       |      | 40      |      | mA   |
| POWER SUPPLY REJECTION (100 mV p-p Signal @ 1 kHz)                       |      | 40      |      | dB   |

**Table 12. D3 Power-Down Savings**

| Parameter     | DV <sub>DD</sub> | AV <sub>DD</sub> | Unit |
|---------------|------------------|------------------|------|
| FUNCTION NODE | 0.5              | 0.0              | mA   |
| DAC           | 6.2              | 9.0              | mA   |
| ADC           | 8.0              | 8.0              | mA   |
| MIXER         | 0.0              | 15               | mA   |

## ABSOLUTE MAXIMUM RATINGS

Table 13.

| Power Supply                        | Min   | Max                    | Unit |
|-------------------------------------|-------|------------------------|------|
| Digital (DV <sub>DD</sub> )         | -0.3  | +3.6                   | V    |
| Analog (AV <sub>DD</sub> )          | -0.3  | +6.0                   | V    |
| Input Current (Except Supply Pins)  |       | ±10.0                  | mA   |
| Analog Input Voltage (Signal Pins)  | -0.3  | AV <sub>DD</sub> + 0.3 | V    |
| Digital Input Voltage (Signal Pins) | -0.3  | DV <sub>DD</sub> + 0.3 | V    |
| Ambient Temperature (Operating)     |       |                        |      |
| Commercial                          | 0°C   | 70°C                   | °C   |
| Industrial                          | -40°C | +85°C                  | °C   |
| Storage Temperature                 | -65°C | +150°C                 | °C   |

Stresses greater than those listed under Absolute Maximum Ratings 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.

### 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

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

where:

T<sub>CASE</sub> is the case temperature in °C

PD is the power dissipation in W

θ<sub>CA</sub> is the thermal resistance (case-to-ambient)

Table 14. Thermal Resistance

| Package | θ <sub>JA</sub> <sup>1</sup> | θ <sub>JC</sub> <sup>2</sup> | θ <sub>CA</sub> |
|---------|------------------------------|------------------------------|-----------------|
| LQFP    | 76.2°C/W                     | 17°C/W                       | 59.2°C/W        |

<sup>1</sup> θ<sub>JA</sub> is the thermal resistance (junction-to-ambient).

<sup>2</sup> θ<sub>JC</sub> is the thermal resistance (junction-to-case).

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## PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

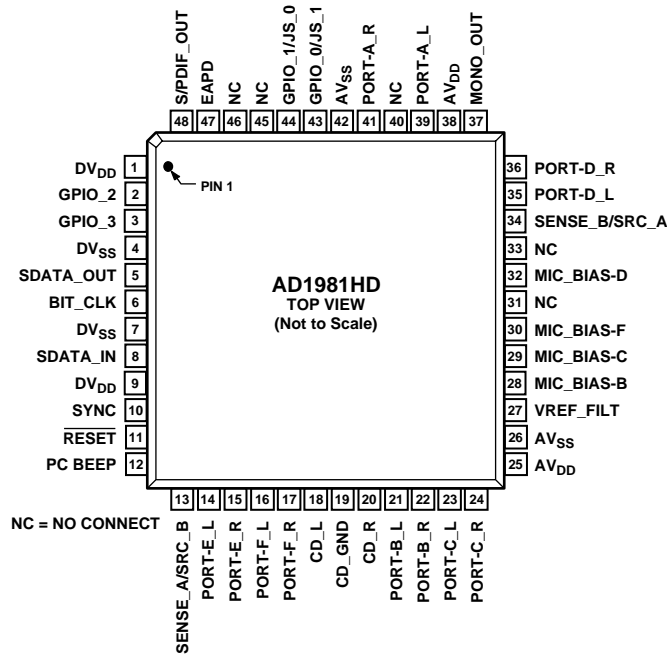


Figure 3. Pin Configuration

Table 15. Pin Function Descriptions

| Mnemonic  | Pin No. | I/O | Description   |
|-----------|---------|-----|---|
| SDATA_OUT | 5       | I   | HD Audio Link Serial Data Output. Codec input stream. |
| BIT_CLK   | 6       | I   | HD Audio Link Bit Clock Input. 24 MHz.                |
| SDATA_IN  | 8       | I/O | HD Audio Link Serial Data Input. Codec output stream. |
| SYNC      | 10      | I   | HD Audio Link Frame Sync.                             |
| RESET#    | 11      | I   | HD Audio Link Reset. Master hardware reset.           |

Table 16. Digital Input/Output Pin Function Descriptions

| Mnemonic      | Pin No. | I/O | Description  |
|---------------|---------|-----|--|
| GPIO_2        | 2       | I/O | General-Purpose Input/Output. Digital signal used to sense/control external circuits.  |
| GPIO_3        | 3       | I/O | General-Purpose Input/Output. Digital signal used to sense/control external circuits.  |
| GPIO_0/JS_1   | 43      | I/O | GPIO_0—General-Purpose Input/Output. Digital signal used to sense/control external circuits.<br>JS_1—Classic (DC) Jack Sense for Headphone Out Pins. Low indicates that nothing is plugged into the jack; high indicates that a peripheral is plugged into the jack. |
| GPIO_1/JS_0   | 44      | I/O | GPIO_1—General-Purpose Input/Output. Digital signal used to sense/control external circuits<br>JS_0—Classic (DC) Jack Sense for Line Out Pins. Low indicates that nothing is plugged into the jack; high indicates that a peripheral is plugged into the jack.       |
| SENSE_A/SRC_B | 13      | I/O | SENSE_A—Jack Sense A–D Input. For use with isolated switches on audio jacks. <sup>1</sup>  |
| SENSE_B/SRC_A | 34      | I/O | SENSE_B—Jack Sense E–F Input. For use with isolated switches on audio jacks. <sup>1</sup>  |
| EAPD          | 47      | O   | External Amplifier Power-Down Output.  |
| S/PDIF_OUT    | 48      | O   | S/PDIF Output.   |

<sup>1</sup> To reduce SENSE\_A/B static current draw, connect a single 2.69 kΩ resistor between Pins 13 and 34. Remove the resistors from Pins 33 and 13 to AVDD.



Table 17. Analog Input/Output Pin Function Descriptions

| Mnemonic | Pin No. | I/O | Channel | Description   | Function <sup>1</sup> |
|----------|---------|-----|---------|---|-----------------------|
| PC Beep  | 12      | I   | N/A     | Analog Input for PC Beep Pass-Through, Even While in Reset. | LI                    |
| PORT-E_L | 14      | I   | Left    | Line Input (Typically Auxiliary Input).                     |                       |
| PORT-E_R | 15      | I   | Right   | Line Input (Typically Auxiliary Input).                     | LI                    |
| PORT-F_L | 16      | I/O | Left    | Multifunction Analog I/O Jack (Typically Rear Microphone).  | MIC, LI, LO           |
| PORT-F_R | 17      | I/O | Right   | Multifunction Analog I/O Jack (Typically Rear Microphone).  | MIC, LI, LO           |
| CD_L     | 18      | I   | Left    | CD Input, Left Channel.                                     | LI                    |
| CD_GND   | 19      | I   | Ground  | CD Input, Ground.   | LI                    |
| CD_R     | 20      | I   | Right   | CD Input, Right Channel.                                    | LI                    |
| PORT-B_L | 21      | I   | Left    | Multifunction Analog I/O Jack (Typically Front Microphone). | MIC, LI               |
| PORT-B_R | 22      | I   | Right   | Multifunction Analog I/O Jack (Typically Front Microphone). | MIC, LI               |
| PORT-C_L | 23      | I/O | Left    | Multifunction Analog I/O Jack (Typically Rear Line Input).  | MIC, LI, LO           |
| PORT-C_R | 24      | I/O | Right   | Multifunction Analog I/O Jack (Typically Rear Line Input).  | MIC, LI, LO           |
| PORT-D_L | 35      | I/O | Left    | Multifunction Analog I/O Jack (Typically Rear Line Output). | MIC, LI, LO           |
| PORT-D_R | 36      | I/O | Right   | Multifunction Analog I/O Jack (Typically Rear Line Output). | MIC, LI, LO           |
| MONO_OUT | 37      | O   | -       | Monaural Output to Telephony Subsystem Speakerphone.        | LO                    |
| PORT-A_L | 39      | O   | Left    | Headphone Output, Left Channel.                             | LO, HP                |
| PORT-A_R | 41      | O   | Right   | Headphone Output, Right Channel.                            | LO, HP                |

<sup>1</sup> MIC—Microphone capable, includes programmable MIC\_BIAS pins and integrated boost amplifier; LI—line level analog inputs; LO— line level analog outputs; HP—headphone support, includes integrated headphone amplifier.

Table 18. Filter/Reference Pin Function Descriptions

| Mnemonic   | Pin No. | I/O | Description   |
|------------|---------|-----|---|
| VREF_FILT  | 27      | O   | Voltage Reference Filter.   |
| MIC_BIAS-B | 28      | O   | Programmable Microphone Bias Output. Intended for connection to Port B. |
| MIC_BIAS-C | 29      | O   | Programmable Microphone Bias Output. Intended for connection to Port C. |
| MIC_BIAS-F | 30      | O   | Programmable Microphone Bias Output. Intended for connection to Port F. |
| MIC_BIAS-D | 32      | O   | Programmable Microphone Bias Output. Intended for connection to Port D. |

Table 19. Power and Ground Pin Function Descriptions

| Mnemonic         | Pin No. | I/O | Description                     |
|------------------|---------|-----|---------------------------------|
| DV <sub>SS</sub> | 4, 7    | I   | Digital Supply Return (Ground). |
| DV <sub>DD</sub> | 1, 9    | I   | Digital Supply Voltage (3.3 V). |
| AV <sub>SS</sub> | 26, 42  | I   | Analog Supply Return (Ground).  |
| AV <sub>DD</sub> | 25, 38  | I   | Analog Supply Voltage (5.0 V).  |

AV<sub>DD</sub> supplies should be well filtered because supply noise degrades audio performance.

## HD AUDIO CODEC INFORMATION

Table 20. Widget List and Descriptions

| NID | Name                      | Type ID | Type           | Description  |
|-----|---------------------------|---------|----------------|--|
| 00  | ROOT                      | x       | Root           | Device identification.   |
| 01  | FUNCTION                  | x       | Function       | Designates this device as an audio codec.  |
| 02  | S/PDIF                    | 0       | Audio output   | Designates the codec S/PDIF digital stream output interface.   |
| 03  | Front DAC                 | 0       | Audio output   | Designates the playback channel digital/audio converters.  |
| 04  | Record ADC                | 1       | Audio input    | Designates the record channel audio/digital converters.  |
| 05  | Port-D (Line Out)         | 4       | Pin complex    | Port-D pin drivers. Typically used as rear panel line output.  |
| 06  | Port-A (Headphone Out)    | 4       | Pin complex    | Port-A pin drivers. Typically used as front panel headphone output.  |
| 07  | MONO_OUT                  | 4       | Pin complex    | Monaural output pin driver. Typically used to drive an internal speaker or as a microphone selector on a telephony system.   |
| 08  | Port-B (Front Microphone) | 4       | Pin complex    | Port-B pin drivers. Typically used as front panel microphone.  |
| 09  | Port-C (Line In)          | 4       | Pin complex    | Port-C pin drivers. Typically used as rear panel line input.   |
| 0A  | S/PDIF_OUT                | 4       | Pin complex    | S/PDIF output digital interface.   |
| 0B  | Monaural Selector         | 3       | Audio selector | Chooses which signals drive the monaural output mixer and pin.   |
| 0C  | Microphone Mixer          | 2       | Audio mixer    | Allows selective mixing of the front/rear microphone sources to a single combined signal.  |
| 0D  | PC Beep Selector          | 3       | Audio selector | Selects between the digital beep generator and the analog PC BEEP pin as the source for the analog mixer.  |
| 0E  | Analog Mixer              | 2       | Audio mixer    | Selectively mixes analog input signals into a single signal.   |
| 0F  | Monaural Mixer            | 2       | Audio mixer    | Stereo-to-monaural mixer for MONO_OUT.   |
| 10  | Digital PC Beep           | 7       | Beep generator | Digital PC beep generator.   |
| 11  | Front Mix Amp             | 3       | Audio selector | Individual gain control for the DAC (front) input to the Analog Mixer.   |
| 12  | Port-B Mix Amp            | 3       | Audio selector | Individual gain control for the Port-B (front microphone) input to the analog mixer.   |
| 13  | Port-C Mix Amp            | 3       | Audio selector | Individual gain control for the Port-C (line in) input to the analog mixer.  |
| 14  | Analog Power-Down         | 5       | Power widget   | Power control on the analog mixer and associated amplifiers.   |
| 15  | Record Selector           | 3       | Audio selector | Chooses which signal is recorded by the record ADC. Also contains the record gain controls.  |
| 16  | PC Beep In                | 4       | Pin complex    | Analog PC Beep in pin drivers. This signal is coupled to the outputs while the codec is held in reset. This may be selected as an input to the analog mixer after reset has been released. |
| 17  | Port-E (Aux In)           | 4       | Pin complex    | Port-E pin drivers. Typically used as auxiliary input.   |
| 18  | Port-F (Rear Microphone)  | 4       | Pin complex    | Port-F pin drivers. Typically used as rear panel microphone.   |
| 19  | CD In                     | 4       | Pin complex    | CD in pin drivers.   |
| 1A  | Port-D Mix Amp            | 3       | Audio selector | Individual gain control for the Port D (front) input to the analog mixer.  |
| 1B  | Port-E Mix Amp            | 3       | Audio selector | Individual gain control for the Port E (aux) input to the analog mixer.  |
| 1C  | Port-F Mix Amp            | 3       | Audio selector | Individual gain control for the Port F (rear microphone) input to the analog mixer.  |
| 1D  | CD Mix Amp                | 3       | Audio selector | Individual gain control for the CD input to the analog mixer.  |
| 1E  | Front Microphone Mute     | 3       | Audio selector | Mute control for Port B (front microphone) into microphone mixer.  |
| 1F  | Rear Microphone Mute      | 3       | Audio selector | Mute control for Port F (rear microphone) into the microphone mixer.   |

Table 21. Root and Function Node Parameters

| NID | Name     | Type ID | Vendor ID PID 00 <sup>1</sup> | Revision ID PID 02 | Sub Node Count PID 04 | Function Group Type PID 05 | Audio F.G. Caps PID 08 | GPIO Caps PID 11 |
|-----|----------|---------|-------------------------------|--------------------|-----------------------|----------------------------|------------------------|------------------|
| 00  | ROOT     | X       | 11D41981                      | 00100200           | 00010001              |                            |                        |                  |
| 01  | FUNCTION | X       |                               |                    | 0002001E              | 00000001                   | 00010C0C               | 40000004         |

<sup>1</sup> PID = parameter ID.

Table 22. Widget Parameters

| NID | Name                      | Widget Caps PID 09 <sup>1</sup> | PCM Size, Rate PID 0A | Stream Format PID 0B | Pin Caps PID 0C | Input Amp Caps PID 0D | Con. List Len PID 0E | Power States PID 0F | Processing Caps PID 10 | Output Amp Caps PID 12 | Vendor-Specific PID F0 |
|-----|---------------------------|---------------------------------|-----------------------|----------------------|-----------------|-----------------------|----------------------|---------------------|------------------------|------------------------|------------------------|
| 00  | ROOT                      |                                 |                       |                      |                 |                       |                      |                     |                        |                        |                        |
| 01  | FUNCTION                  |                                 | 000E007F              | 00000001             |                 | 00270300              |                      | 00000009            |                        | 80053F3D               | 00000004               |
| 02  | S/PDIF                    | 00030311                        | 00020060              | 00000005             |                 |                       | 00000002             |                     |                        |                        |                        |
| 03  | Front DAC                 | 00000441                        | 000E007F              | 00000001             |                 |                       | 00000000             | 00000009            | 00004601               |                        | 00000010               |
| 04  | Record ADC                | 00100511                        | 0006007F              | 00000001             |                 |                       | 00000001             | 00000009            |                        |                        |                        |
| 05  | Port-D (Line Out)         | 00400187                        |                       |                      | 0001173F        | 00270300              | 00000002             |                     |                        | 80053F3D               | 00000008               |
| 06  | Port-A (Headphone Out)    | 00400185                        |                       |                      | 0000001F        |                       | 00000002             |                     |                        | 80053F3D               | 00000008               |
| 07  | MONO_OUT                  | 00400104                        |                       |                      | 00000010        |                       | 00000001             |                     |                        | 80053F3D               |                        |
| 08  | Port-B (Front Microphone) | 00400083                        |                       |                      | 00001727        | 00270300              | 00000000             |                     |                        |                        | 00000008               |
| 09  | Port-C (Line In)          | 00400187                        |                       |                      | 00001737        | 00270300              | 00000002             |                     |                        | 80053F3D               | 00000008               |
| 0A  | S/PDIF_OUT                | 00400301                        |                       |                      | 00000010        |                       | 00000001             |                     |                        |                        |                        |
| 0B  | Monaural Selector         | 00300101                        |                       |                      |                 |                       | 00000006             |                     |                        |                        |                        |
| 0C  | Microphone Mixer          | 00200101                        |                       |                      |                 |                       | 00000002             |                     |                        |                        |                        |
| 0D  | PC Beep Selector          | 0030010C                        |                       |                      |                 |                       | 00000002             |                     |                        | 800B0F0F               |                        |
| 0E  | Analog Mixer              | 00200101                        |                       |                      |                 |                       | 00000008             |                     |                        |                        |                        |
| 0F  | Monaural Mixer            | 00200100                        |                       |                      |                 |                       | 00000001             |                     |                        |                        |                        |
| 10  | Digital PC Beep           | 00700000                        |                       |                      |                 |                       | 00000000             |                     |                        |                        |                        |
| 11  | Front Mix Amp             | 0030010D                        |                       |                      |                 |                       | 00000001             |                     |                        | 80051F17               |                        |
| 12  | Port-B Mix Amp            | 0030010D                        |                       |                      |                 |                       | 00000001             |                     |                        | 80051F17               |                        |
| 13  | Port-C Mix Amp            | 0030010D                        |                       |                      |                 |                       | 00000001             |                     |                        | 80051F17               |                        |
| 14  | Analog Power-Down         | 00500500                        |                       |                      |                 |                       | 00000006             | 00000009            |                        |                        |                        |
| 15  | Record Selector           | 0030010D                        |                       |                      |                 |                       | 00000008             |                     |                        | 80050F00               |                        |
| 16  | PC Beep In                | 00400000                        |                       |                      | 00000020        |                       | 00000000             |                     |                        |                        |                        |
| 17  | Port-E (Aux In)           | 00400081                        |                       |                      | 00000027        |                       | 00000000             |                     |                        |                        | 00000008               |
| 18  | Port-F (Rear Microphone)  | 00400187                        |                       |                      | 00001737        | 00270300              | 00000002             |                     |                        | 80053F3D               | 00000008               |
| 19  | CD In                     | 00400001                        |                       |                      | 00000020        |                       | 00000000             |                     |                        |                        |                        |
| 1A  | Port-D Mix Amp            | 0030010D                        |                       |                      |                 |                       | 00000001             |                     |                        | 80051F17               |                        |
| 1B  | Port-E Mix Amp            | 0030010D                        |                       |                      |                 |                       | 00000001             |                     |                        | 80051F17               |                        |
| 1C  | Port-F Mix Amp            | 0030010D                        |                       |                      |                 |                       | 00000001             |                     |                        | 80051F17               |                        |
| 1D  | CD Mix Amp                | 0030010D                        |                       |                      |                 |                       | 00000001             |                     |                        | 80051F17               |                        |
| 1E  | Front Microphone Mute     | 0030010D                        |                       |                      |                 |                       | 00000001             |                     |                        | 80000000               |                        |
| 1F  | Rear Microphone Mute      | 0030010D                        |                       |                      |                 |                       | 00000001             |                     |                        | 80000000               |                        |

<sup>1</sup> PID = parameter ID.

Default SSID: BFD10000

# AD1981HD

**Table 23. Default Configuration Parameters**

| Node ID | Name               | Value    | 31        | 29       | 27        | 23          | 19         | 15      | 8     | 7          | 3        |
|---------|--------------------|----------|-----------|----------|-----------|-------------|------------|---------|-------|------------|----------|
|         |                    |          | 30        | 28       | 24        | 20          | 16         | 12      | 8     | 4          | 0        |
|         |                    |          | Connector | Location |           | Def. Device | Conn. Type | Color   | Misc. | Def. Assn. | Sequence |
| Chassis | Position           | Ovrrd.   |           |          |           |             |            |         |       |            |          |
| 05      | Port-D (Line Out)  | 01014010 | Jack      | External | Rear      | Line Out    | 1/8" Jack  | Green   | 0     | 1          | 0        |
| 06      | Port-A (HP Out)    | 0221401F | Jack      | External | Front     | HP Out      | 1/8" Jack  | Green   | 0     | 1          | F        |
| 07      | Mono Out           | 90130130 | Fixed     | Internal | N/A       | Speaker     | ATAPI      | unknown | 1     | 3          | 0        |
| 08      | Port-B (Front MIC) | 02A19040 | Jack      | External | Front     | Mic In      | 1/8" Jack  | Pink    | 0     | 4          | 0        |
| 09      | Port-C (Line In)   | 01813041 | Jack      | External | Rear      | Line In     | 1/8" Jack  | Blue    | 0     | 4          | 1        |
| 0A      | S/PDIF Out         | 01451020 | Jack      | External | Rear      | SPDIF Out   | Optical    | Black   | 0     | 2          | 0        |
| 16      | PC Beep In         | 90F30150 | Fixed     | Internal | N/A       | other       | ATAPI      | unknown | 1     | 5          | 0        |
| 17      | Port-E (Aux In)    | 99930144 | Fixed     | Internal | Special 3 | AUX         | ATAPI      | unknown | 1     | 4          | 4        |
| 18      | Port-F (Rear MIC)  | 01A19043 | Jack      | External | Rear      | Mic In      | 1/8" Jack  | Pink    | 0     | 4          | 3        |
| 19      | CD In              | 99330142 | Fixed     | Internal | Special 3 | CD          | ATAPI      | unknown | 1     | 4          | 2        |

**Table 24. Widget Connection List**

| NID | Name                      | Index |     |     |     |     |     |     |     |     |     |
|-----|---------------------------|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|     |                           | 0     | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   |
|     |                           | NID   | NID | NID | NID | NID | NID | NID | NID | NID | NID |
| 2   | S/PDIF                    | 01    | 04  |     |     |     |     |     |     |     |     |
| 3   | Front DAC                 |       |     |     |     |     |     |     |     |     |     |
| 4   | Record ADC                | 15    |     |     |     |     |     |     |     |     |     |
| 5   | Port-D (Line Out)         | 03    | 0E  |     |     |     |     |     |     |     |     |
| 6   | Port-A (Headphone Out)    | 03    | 0E  |     |     |     |     |     |     |     |     |
| 7   | MONO_OUT                  | 0F    |     |     |     |     |     |     |     |     |     |
| 8   | Port-B (Front Microphone) |       |     |     |     |     |     |     |     |     |     |
| 9   | Port-C (Line In)          | 03    | 0E  |     |     |     |     |     |     |     |     |
| 0A  | S/PDIF_OUT                | 02    |     |     |     |     |     |     |     |     |     |
| 0B  | Monaural Selector         | 03    | 0C  | 09  | 0E  | 05  | 18  |     |     |     |     |
| 0C  | Microphone Mixer          | 1E    | 1F  |     |     |     |     |     |     |     |     |
| 0D  | PC Beep Selector          | 10    | 16  |     |     |     |     |     |     |     |     |
| 0E  | Analog Mixer              | 0D    | 11  | 12  | 13  | 1A  | 1B  | 1C  | 1D  |     |     |
| 0F  | Monaural Mixer            | 0B    |     |     |     |     |     |     |     |     |     |
| 10  | Digital PC Beep           |       |     |     |     |     |     |     |     |     |     |
| 11  | Front Mix Amp             | 03    |     |     |     |     |     |     |     |     |     |
| 12  | Port-B Mix Amp            | 08    |     |     |     |     |     |     |     |     |     |
| 13  | Port-C Mix Amp            | 09    |     |     |     |     |     |     |     |     |     |
| 14  | Analog Power-Down         | 0D    | 0E  | 10  | 11  | 12  | 13  | 1A  | 1B  | 1C  | 1D  |
| 15  | Record Selector           | 0C    | 09  | 0E  | 0F  | 19  | 05  | 18  | 17  |     |     |
| 16  | PC Beep In                |       |     |     |     |     |     |     |     |     |     |
| 17  | Port-E (Aux In)           |       |     |     |     |     |     |     |     |     |     |
| 18  | Port-F (Rear Microphone)  | 03    | 0E  |     |     |     |     |     |     |     |     |
| 19  | CD In                     |       |     |     |     |     |     |     |     |     |     |
| 1A  | Port-D Mix Amp            | 05    |     |     |     |     |     |     |     |     |     |
| 1B  | Port-E Mix Amp            | 17    |     |     |     |     |     |     |     |     |     |
| 1C  | Port-F Mix Amp            | 18    |     |     |     |     |     |     |     |     |     |
| 1D  | CD Mix Amp                | 19    |     |     |     |     |     |     |     |     |     |
| 1E  | Front Microphone Mute     | 08    |     |     |     |     |     |     |     |     |     |
| 1F  | Rear Microphone Mute      | 18    |     |     |     |     |     |     |     |     |     |

Table 25. Widget Verb Support

| NID | NAME                      | TYPE ID | GET SET | STREAM FORMAT | AMPLIFIER GAIN/MUTE | PROCESSING COEFFICIENT | COEFFICIENT INDEX | PARAMETER | CONNECTION SELECT | CONNECTION LIST ENTRY | PROCESSING STATE | SDATA_IN SELECT | POWER STATE | CHANNEL/STREAM ID | PIN WIDGET CONTROL | UNSOLICITED ENABLE | PIN SENSE | BEEP GENERATOR | EAPD/BTL ENABLE | DIGITAL CONVERTER 1 |       | DIGITAL CONVERTER 2 |       |
|-----|---------------------------|---------|---------|---------------|---------------------|------------------------|-------------------|-----------|-------------------|-----------------------|------------------|-----------------|-------------|-------------------|--------------------|--------------------|-----------|----------------|-----------------|---------------------|-------|---------------------|-------|
|     |                           |         |         |               |                     |                        |                   |           |                   |                       |                  |                 |             |                   |                    |                    |           |                |                 | 0xF00               | 0xF01 | 0xF02               | 0xF03 |
| 00  | ROOT                      | X       |         |               |                     |                        |                   | Y         |                   |                       |                  |                 |             |                   |                    |                    |           |                |                 |                     |       |                     |       |
| 01  | FUNCTION                  | X       |         |               |                     | 2                      | 2                 | Y         |                   |                       | 1                |                 | Y           |                   |                    |                    |           |                |                 |                     |       |                     |       |
| 02  | S/PDIF                    | 0       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  | 1               |             | Y                 |                    |                    |           |                |                 |                     | Y     |                     | Y     |
| 03  | FRONT DAC                 | 0       |         | Y             |                     | Y                      | Y                 | Y         |                   |                       | Y                | 1               | Y           | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 04  | RECORD ADC                | 1       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  | 1               | Y           | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 05  | PORT-D (LINE OUT)         | 4       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    | Y                  | Y         |                |                 | Y                   |       |                     |       |
| 06  | PORT-A (HEADPHONE OUT)    | 4       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    | Y                  | Y         |                |                 |                     |       |                     |       |
| 07  | MONO OUT                  | 4       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 08  | PORT-B (FRONT MICROPHONE) | 4       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    | Y                  | Y         |                |                 |                     |       |                     |       |
| 09  | PORT-C (LINE IN)          | 4       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    | Y                  | Y         |                |                 |                     |       |                     |       |
| 0A  | S/PDIF OUT                | 4       |         |               |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 0B  | MONAURAL SELECTOR         | 3       |         |               |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 0C  | MICROPHONE MIXER          | 2       |         |               |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 0D  | PC BEEP SELECTOR          | 3       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 0E  | ANALOG MIXER              | 2       |         |               |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 0F  | MONAURAL MIXER            | 2       |         |               |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 10  | DIGITAL PC BEEP           | 7       |         |               |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 11  | FRONT MIX AMP             | 3       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 12  | PORT-B MIX AMP            | 3       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 13  | PORT-C MIX AMP            | 3       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 14  | ANALOG POWER-DOWN         | 5       |         |               |                     |                        |                   | Y         | Y                 | Y                     |                  |                 | Y           |                   |                    |                    |           |                |                 |                     |       |                     |       |
| 15  | RECORD SELECTOR           | 3       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 16  | PC BEEP IN                | 4       |         |               |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 17  | PORT-E (AUX IN)           | 4       |         |               |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 18  | PORT-F (REAR MICROPHONE)  | 4       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 19  | CD IN                     | 4       |         |               |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 1A  | PORT-D MIX AMP            | 3       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 1B  | PORT-E MIX AMP            | 3       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 1C  | PORT-F MIX AMP            | 3       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 1D  | CD MIX AMP                | 3       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 1E  | FRONT MICROPHONE MUTE     | 3       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |
| 1F  | REAR MICROPHONE MUTE      | 3       |         | Y             |                     |                        |                   | Y         | Y                 | Y                     |                  |                 |             | Y                 |                    |                    |           |                |                 |                     |       |                     |       |

<sup>1</sup>UNSUPPORTED IN THE AD1981HD. GET VERB ALWAYS RETURNS 0: SET VERBS IGNORED.  
<sup>2</sup>SUPPORTS ADI SPECIFIC FUNCTIONALITY. REFER TO THE AD1981HD PROGRAMMER'S MANUAL FOR MORE INFORMATION.



## JACK PRESENCE DETECTION

### HD AUDIO STYLE JACK PRESENCE DETECTION

The AD1981HD uses two jack sense lines for jack presence detection. Combined with the peripheral enumeration engines, this enables software to determine if there is a device plugged into the circuit and what type of device it is. Software can also reconfigure jacks and amplifiers as necessary, ensuring proper audio operation and providing jack retasking.

Jack presence is detected using a resistor tree arrangement outlined in the HD audio specification. Up to four jacks can be sensed on a single sense line by using different value resistors for each jack between the sense line and ground ( $AV_{SS}$ ). Jacks must normally have open, isolated switches to use this method of jack presence detection.

Jack presence is reflected in the HD audio pin widget pin sense verb. The MSB (Bit 31) indicates the current plugged state of the connected jack. Jack change interrupts can be enabled using the unsolicited response verb on each of these nodes. Each jack can be set to generate a different value to provide event identification within the software interrupt.

There are two methods to connect the codec to the jack presence detection pins. In the first method, use a single 2.69 k $\Omega$  1% resistor between the SENSE\_A and SENSE\_B lines, but no capacitor. In the second method use a single 2.69 k $\Omega$  resistor between SENSE\_A and  $AV_{DD}$  and between SENSE\_B and  $AV_{DD}$ . In the second method, the designer can add up to 1  $\mu$ F of capacitance on each sense line. Designers should offer both methods for maximum flexibility.

The specific resistor value for each jack is shown in Table 27. Use 1% resistors for all jack presence detect circuitry to ensure accurate detection.

### CLASSIC JACK PRESENCE DETECTION

The AD1981HD GPIO pins can be used as classic jack sense pins in JS\_0- and JS\_1-style operation (similar to AD1981B operation). Only two jacks, typically line out and headphone out, are supported in this configuration. The GPIO pins can be connected to the left channel wrap-back switch on the jack via a 2.2 k $\Omega$  (typical) resistor. The left channel needs a 20 k $\Omega$  (typical) resistor-to-analog ground to complete the circuit. This configuration allows autoconfiguration when other devices are plugged in; for example, when headphones are plugged in, the external speakers are disabled for private listening.

Table 27. Jack Sense Mapping

| Resistor<br>(1% tolerance) | SENSE_A          |      |                  | SENSE_B         |      |                  |
|----------------------------|------------------|------|------------------|-----------------|------|------------------|
|                            | Name             | Port | HD Audio Node ID | Name            | Port | HD Audio Node ID |
| 5.1 k $\Omega$             | Line Out         | D    | 0x05             | N/A             | N/A  | N/A              |
| 10.0 k $\Omega$            | Line In          | C    | 0x09             | N/A             | N/A  | N/A              |
| 20.0 k $\Omega$            | Front Microphone | B    | 0x08             | Rear Microphone | F    | 0x18             |
| 39.2 k $\Omega$            | Headphone Out    | A    | 0x06             | Aux In          | E    | 0x17             |

## OUTLINE DIMENSIONS

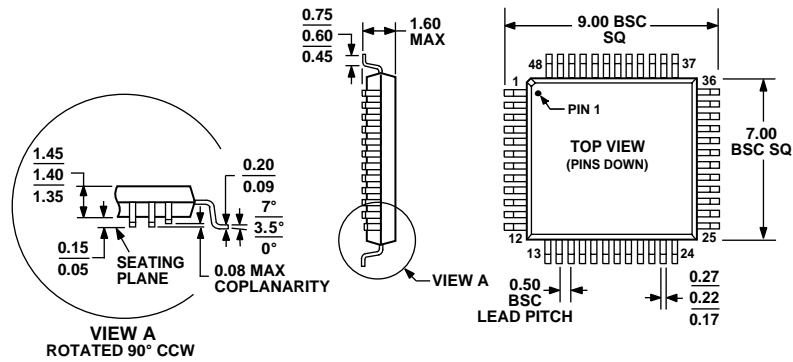


Figure 4. 48-Lead Low Profile Quad Flat Package [LQFP]  
(ST-48)  
Dimensions shown in millimeters

## ORDERING GUIDE

| Model                     | Temperature Range | Package Description        | Package Option |
|---------------------------|-------------------|----------------------------|----------------|
| AD1981HDJSTZ <sup>1</sup> | 0°C to +70°C      | 48-Lead LQFP, Tray Version | ST-48          |
| AD1981HDJSTZ-REEL         | 0°C to +70°C      | 48-Lead LQFP, Reel Version | ST-48          |

<sup>1</sup> Z = Pb-free part.