

### AC'97 2.1 FEATURES

- Variable Sample Rate
- True Line-Level Output
- Supports Secondary Codec Modes

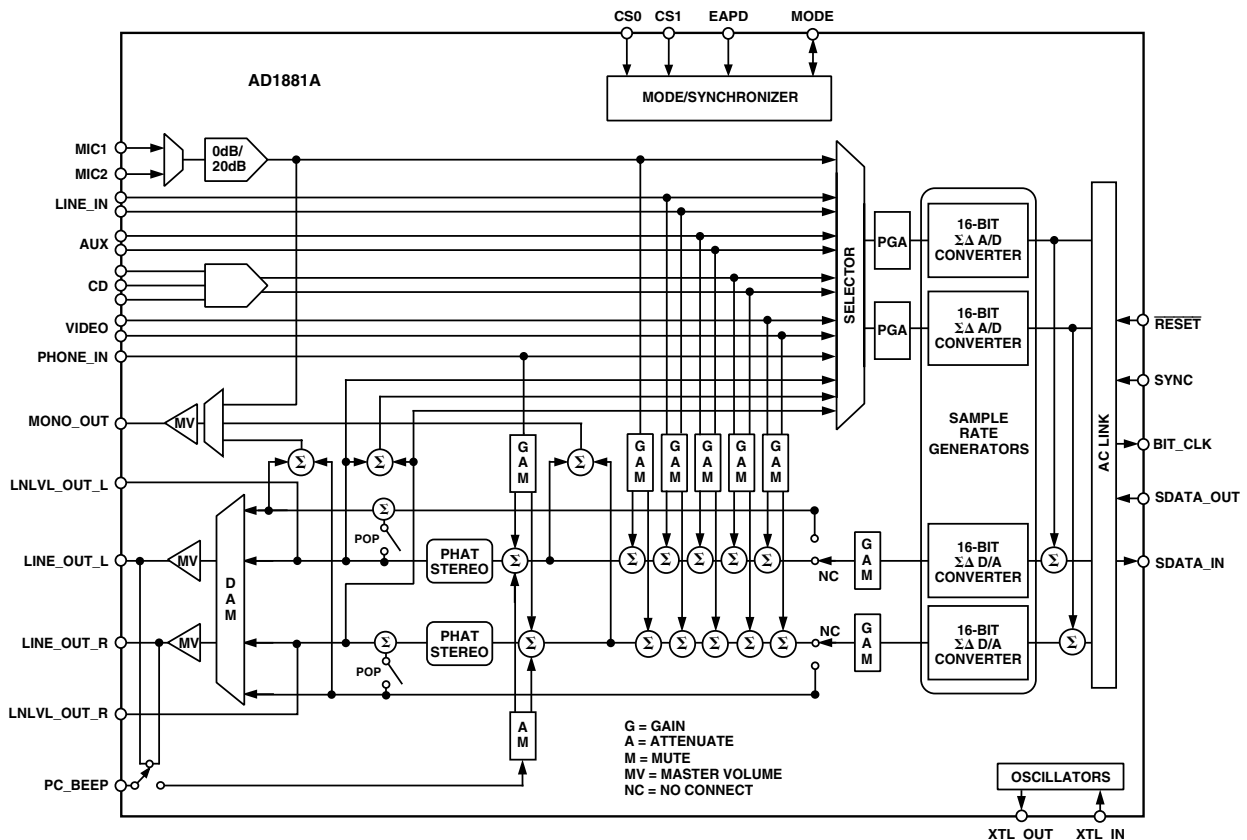
### AC'97 FEATURES

- Designed for AC'97 Analog I/O Component
- 48-Lead LQFP Package
- Multibit  $\Sigma\Delta$  Converter Architecture for Improved S/N Ratio Greater than 90 dB
- 16-Bit Stereo Full-Duplex Codec
- Four Analog Line-Level Stereo Inputs for Connection from LINE, CD, VIDEO, and AUX
- Two Analog Line-Level Mono Inputs for Speakerphone and PC BEEP
- Mono MIC Input Switchable from Two External Sources
- High Quality CD Input with Ground Sense
- Stereo Line-Level Output
- Mono Output for Speakerphone or Internal Speaker
- Power Management Support

### ENHANCED FEATURES

- Mobile Low Power Mixer Mode
- Digital Audio Mixer Mode
- Full Duplex Variable 8 kHz to 48 kHz Sampling Rate with 1 Hz Resolution
- PHAT™ Stereo 3D Stereo Enhancement
- Split Power Supplies (3.3 V Digital/5 V Analog)
- Extended 6-Bit Master Volume Control
- Audio Amp Power-Down Signal

### FUNCTIONAL BLOCK DIAGRAM



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# AD1881A—SPECIFICATIONS

## STANDARD TEST CONDITIONS UNLESS OTHERWISE NOTED

|                             |      |     |  |
|-----------------------------|------|-----|--|
| Temperature                 | 25   | °C  | <i>DAC Test Conditions</i>               |
| Digital Supply ( $V_{DD}$ ) | 3.3  | V   | Calibrated                               |
| Analog Supply ( $V_{CC}$ )  | 5.0  | V   | -3 dB Attenuation Relative to Full-Scale |
| Sample Rate ( $F_S$ )       | 48   | kHz | Input 0 dB                               |
| Input Signal                | 1008 | Hz  | 10 k $\Omega$ Output Load                |
|                             |      |     | <i>ADC Test Conditions</i>               |
|                             |      |     | Calibrated                               |
|                             |      |     | 0 dB Gain                                |
|                             |      |     | Input -3.0 dB Relative to Full-Scale     |

## ANALOG INPUT

| Parameter   | Min | Typ       | Max | Unit           |
|---|-----|-----------|-----|----------------|
| Input Voltage (RMS Values Assume Sine Wave Input)<br>LINE_IN, AUX, CD, VIDEO, PHONE_IN, PC_BEEP |     | 1<br>2.83 |     | V rms<br>V p-p |
| MIC with +20 dB Gain (M20 = 1)  |     | 0.1       |     | V rms<br>V p-p |
| MIC with 0 dB Gain (M20 = 0)  |     | 1<br>2.83 |     | V rms<br>V p-p |
| Input Impedance*  |     | 20        |     | k $\Omega$     |
| Input Capacitance*  |     | 5         | 7.5 | pF             |

## MASTER VOLUME

| Parameter  | Min | Typ   | Max | Unit |
|--|-----|-------|-----|------|
| Step Size (0 dB to -94.5 dB); LINE_OUT_L, LINE_OUT_R |     | 1.5   |     | dB   |
| Output Attenuation Range Span*                       |     | -94.5 |     | dB   |
| Step Size (0 dB to -46.5 dB); MONO_OUT               |     | 1.5   |     | dB   |
| Output Attenuation Range Span*                       |     | -46.5 |     | dB   |
| Mute Attenuation of 0 dB Fundamental*                |     |       | 80  | dB   |

## PROGRAMMABLE GAIN AMPLIFIER—ADC

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

## ANALOG MIXER—INPUT GAIN/AMPLIFIERS/ATTENUATORS

| Parameter   | Min | Typ   | Max | Unit |
|---|-----|-------|-----|------|
| Signal-to-Noise Ratio (SNR)<br>CD to LINE_OUT   |     | 90    |     | dB   |
| Other to LINE_OUT   |     | 90    |     | dB   |
| Step Size (+12 dB to -34.5 dB): (All Steps Tested)<br>MIC, LINE_IN, AUX, CD, VIDEO, PHONE_IN, DAC |     | 1.5   |     | dB   |
| Input Gain/Attenuation Range: MIC, LINE, AUX, CD, VIDEO, PHONE_IN, DAC                            |     | -46.5 |     | dB   |
| Step Size (0 dB to -45 dB): (All Steps Tested) PC_BEEP  |     | 3.0   |     | dB   |
| Input Gain/Attenuation Range: PC_BEEP   |     | -45   |     | dB   |

\*Guaranteed, not tested.

Specifications subject to change without notice.

## DIGITAL DECIMATION AND INTERPOLATION FILTERS\*

| Parameter                           | Min              | Typ | Max              | Unit    |
|-------------------------------------|------------------|-----|------------------|---------|
| Passband                            | 0                |     | $0.4 \times F_S$ | Hz      |
| Passband Ripple                     |                  |     | $\pm 0.09$       | dB      |
| Transition Band                     | $0.4 \times F_S$ |     | $0.6 \times F_S$ | Hz      |
| Stopband                            | $0.6 \times F_S$ |     | $\infty$         | Hz      |
| Stopband Rejection                  | -74              |     |                  | dB      |
| Group Delay                         |                  |     | $12/F_S$         | sec     |
| Group Delay Variation Over Passband |                  |     | 0.0              | $\mu$ s |

## ANALOG-TO-DIGITAL CONVERTERS

| Parameter   | Min | Typ  | Max        | Unit |
|---|-----|------|------------|------|
| Resolution  |     | 16   |            | Bits |
| Total Harmonic Distortion (THD)   |     |      | 0.02       | %    |
|   |     |      | -74        | dB   |
| Dynamic Range (-60 dB Input THD+N Referenced to Full Scale, A-Weighted) |     | 87   |            | dB   |
| Signal-to-Intermodulation Distortion* (CCIF Method)                     |     | 85   |            | dB   |
| ADC Crosstalk*  |     |      |            |      |
| Line Inputs (Input L, Ground R, Read R; Input R, Ground L, Read L)      |     | -100 | -90        | dB   |
| LINE_IN to Other  |     | -90  | -85        | 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  |     |      | $\pm 10.5$ | mV   |

## DIGITAL-TO-ANALOG CONVERTERS

| Parameter   | Min | Typ      | Max       | Unit |
|---|-----|----------|-----------|------|
| Resolution  |     | 16       |           | Bits |
| Total Harmonic Distortion (THD) LINE_OUT, LNLVL_OUT                             |     |          | 0.02      | %    |
|   |     |          | -74       | dB   |
| Dynamic Range (-60 dB Input THD+N Referenced to Full Scale, A-Weighted)         |     | 90       |           | dB   |
| Signal-to-Intermodulation Distortion* (CCIF Method)                             |     | 85       |           | 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* (Input L, Zero R, Measure R_OUT; Input R, Zero L, Measure L_OUT) |     |          | -80       | dB   |
| Total Audible Out-of-Band Energy (Measured from $0.6 \times F_S$ to 20 kHz)*    |     | -40      |           | dB   |

## ANALOG OUTPUT

| Parameter   | Min | Typ     | Max | Unit       |
|---|-----|---------|-----|------------|
| Full-Scale Output Voltage (LINE_OUT, LNLVL_OUT)             |     | 1       |     | V rms      |
|   |     | 2.83    |     | V p-p      |
| Output Impedance*   |     |         | 500 | $\Omega$   |
| External Load Impedance*                                    | 10  |         |     | k $\Omega$ |
| Output Capacitance*   |     | 15      |     | pF         |
| External Load Capacitance                                   |     |         | 100 | pF         |
| V <sub>REF</sub>  | 2.0 | 2.2     | 2.5 | V          |
| V <sub>REF_OUT</sub>  |     | 2.2     |     | V          |
| Mute Click (Muted Output Minus Unmuted Midscale DAC Output) |     | $\pm 5$ |     | mV         |

\*Guaranteed, not tested.

Specifications subject to change without notice.

# AD1881A—SPECIFICATIONS

## STATIC DIGITAL SPECIFICATIONS

| Parameter  | Min                   | Typ | Max                   | Unit    |
|--|-----------------------|-----|-----------------------|---------|
| High Level Input Voltage ( $V_{IH}$ ): Digital Inputs      | $0.65 \times DV_{DD}$ |     |                       | V       |
| Low Level Input Voltage ( $V_{IL}$ )                       |                       |     | $0.35 \times DV_{DD}$ | V       |
| High Level Output Voltage ( $V_{OH}$ ), $I_{OH} = -0.5$ mA | $0.9 \times DV_{DD}$  |     |                       | V       |
| Low Level Output Voltage ( $V_{OL}$ ), $I_{OL} = +0.5$ mA  |                       |     | $0.1 \times DV_{DD}$  | V       |
| Input Leakage Current                                      | -10                   |     | +10                   | $\mu$ A |
| Output Leakage Current                                     | -10                   |     | +10                   | $\mu$ A |

## POWER SUPPLY

| Parameter   | Min  | Typ | Max  | Unit |
|---|------|-----|------|------|
| Power Supply Range – Analog   | 4.75 |     | 5.25 | V    |
| Power Supply Range – Digital (3.3 V)  | 3.0  |     | 3.6  | V    |
| Power Dissipation – 5 V/3.3 V   |      | 280 |      | mW   |
| Analog Supply Current – 5 V   |      | 40  |      | mA   |
| Digital Supply Current – 3.3 V  |      | 23  |      | mA   |
| Power Supply Rejection (100 mV p-p Signal @ 1 kHz)*<br>(At Both Analog and Digital Supply Pins, Both ADCs and DACs) |      | 40  |      | dB   |

## CLOCK SPECIFICATIONS\*

| Parameter                    | Min | Typ    | Max | Unit |
|------------------------------|-----|--------|-----|------|
| Input Clock Frequency        |     | 24.576 |     | MHz  |
| Recommended Clock Duty Cycle | 45  | 50     | 55  | %    |

## POWER-DOWN MODE

| Parameter                        | Set Bits                     | $DV_{DD}$ (3.3 V)<br>Typ | $AV_{DD}$ (5 V)<br>Typ | Unit |
|----------------------------------|------------------------------|--------------------------|------------------------|------|
| ADC                              | PR0                          | 17                       | 30                     | mA   |
| DAC                              | PR1                          | 17                       | 26                     | mA   |
| ADC and DAC                      | PR1, PR0                     | 4                        | 20                     | mA   |
| ADC + DAC + Mixer (Analog CD On) | LPMIX, PR1, PR0              | 4                        | 12                     | mA   |
| Mixer                            | PR2                          | 20                       | 18                     | mA   |
| ADC + Mixer                      | PR2, PR0                     | 17                       | 12                     | mA   |
| DAC + Mixer                      | PR2, PR1                     | 17                       | 8                      | mA   |
| ADC + DAC + Mixer                | PR2, PR1, PR0                | 4                        | 2                      | mA   |
| Analog CD Only (AC-Link On)      | LPMIX, PR5, PR1, PR0         | 4                        | 12                     | mA   |
| Analog CD Only (AC-Link Off)     | LPMIX, PR1, PR0, PR4, PR5    | 0                        | 12                     | mA   |
| Standby                          | PR5, PR4, PR3, PR2, PR1, PR0 | 0                        | 0.1                    | mA   |

\*Guaranteed, not tested.

Specifications subject to change without notice.

TIMING PARAMETERS<sup>1</sup> (GUARANTEED OVER OPERATING TEMPERATURE RANGE)

| Parameter  | Symbol                   | Min   | Typ    | Max   | Unit |
|--|--------------------------|-------|--------|-------|------|
| $\overline{\text{RESET}}$ Active Low Pulsewidth                                  | t <sub>RST_LOW</sub>     | 50    |        |       | ns   |
| $\overline{\text{RESET}}$ Inactive to BIT_CLK Startup Delay                      | t <sub>RST2CLK</sub>     |       | 833    |       | μs   |
| SYNC Active High Pulsewidth  | t <sub>SYNC_HIGH</sub>   | 80    |        |       | ns   |
| SYNC Low Pulsewidth  | t <sub>SYNC_LOW</sub>    |       | 19.5   |       | μs   |
| SYNC Inactive to BIT_CLK Startup Delay   | t <sub>SYNC2CLK</sub>    | 162.8 |        |       | ns   |
| BIT_CLK Frequency  |                          |       | 12.288 |       | MHz  |
| BIT_CLK Period   | t <sub>CLK_PERIOD</sub>  |       | 81.4   |       | ns   |
| BIT_CLK Output Jitter <sup>2</sup>   |                          |       |        | 750   | ps   |
| BIT_CLK High Pulsewidth  | t <sub>CLK_HIGH</sub>    | 36.62 | 40.69  | 44.76 | ns   |
| BIT_CLK Low Pulsewidth   | t <sub>CLK_LOW</sub>     | 36.62 | 40.69  | 44.76 | ns   |
| SYNC Frequency   |                          |       | 48.0   |       | kHz  |
| SYNC Period  | t <sub>SYNC_PERIOD</sub> |       | 20.8   |       | μs   |
| Setup to Falling Edge of BIT_CLK   | t <sub>SETUP</sub>       | 5     | 2.5    |       | ns   |
| Hold from Falling Edge of BIT_CLK  | t <sub>HOLD</sub>        | 5     |        |       | ns   |
| BIT_CLK Rise Time  | t <sub>RISECLK</sub>     | 2     | 4      | 10    | ns   |
| BIT_CLK Fall Time  | t <sub>FALLCLK</sub>     | 2     | 4      | 10    | ns   |
| SYNC Rise Time   | t <sub>RISESYNC</sub>    | 2     | 4      | 10    | ns   |
| SYNC Fall Time   | t <sub>FALLSYNC</sub>    | 2     | 4      | 10    | ns   |
| SDATA_IN Rise Time   | t <sub>RISEDIN</sub>     | 2     | 4      | 10    | ns   |
| SDATA_IN Fall Time   | t <sub>FALLDIN</sub>     | 2     | 4      | 10    | ns   |
| SDATA_OUT Rise Time  | t <sub>RISEDOUT</sub>    | 2     | 4      | 10    | ns   |
| SDATA_OUT Fall Time  | t <sub>FALLDOUT</sub>    | 2     | 4      | 10    | ns   |
| End of Slot 2 to BIT_CLK, SDATA_IN Low   | t <sub>S2_PDOWN</sub>    | 0     |        | 10    | ms   |
| Setup to Trailing Edge of $\overline{\text{RESET}}$ (Applies to SYNC, SDATA_OUT) | t <sub>SETUP2RST</sub>   | 15    |        |       | ns   |
| Rising Edge of $\overline{\text{RESET}}$ to HI-Z Delay (ATE Test Mode)           | t <sub>OFF</sub>         |       |        | 25    | ns   |
| Propagation Delay  |                          |       |        | 15    | ns   |
| RESET Rise Time  |                          |       |        | 50    | ns   |

## NOTES

<sup>1</sup>Guaranteed, not tested.<sup>2</sup>Output jitter is directly dependent on crystal input jitter.

Specifications subject to change without notice.

# AD1881A

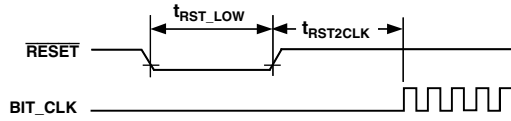


Figure 1. Cold Reset

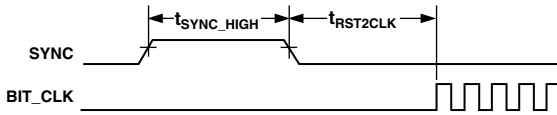


Figure 2. Warm Reset

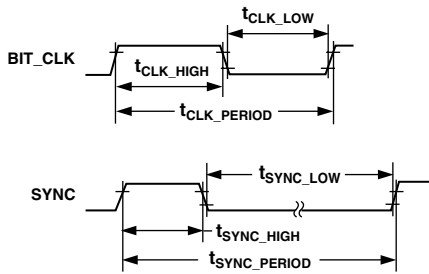


Figure 3. Clock Timing

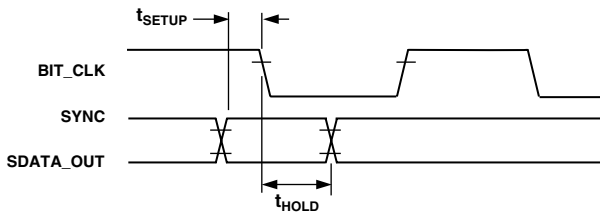


Figure 4. Data Setup and Hold

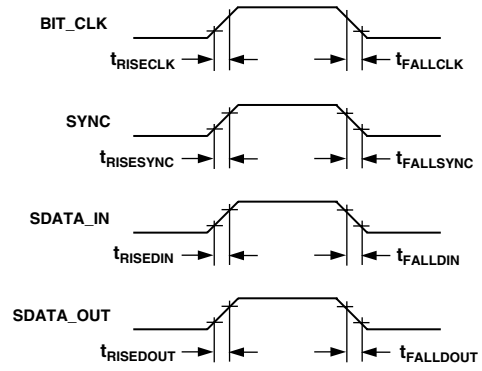


Figure 5. Signal Rise and Fall Time

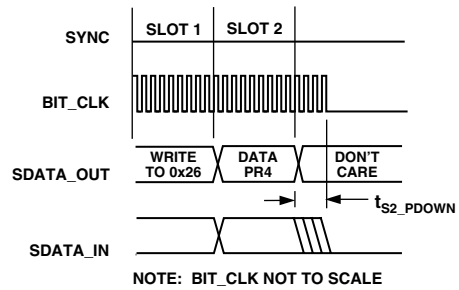


Figure 6. AC Link Low Power Mode Timing

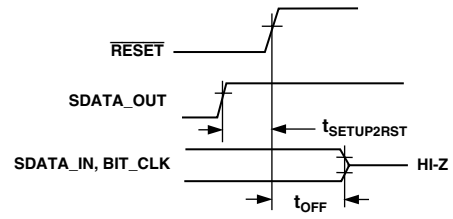


Figure 7. ATE Test Mode

## ABSOLUTE MAXIMUM RATINGS\*

| Parameter                           | Min  | Max            | Unit |
|-------------------------------------|------|----------------|------|
| Power Supplies                      |      |                |      |
| Digital ( $V_{DD}$ )                | -0.3 | +3.6           | V    |
| Analog ( $V_{CC}$ )                 | -0.3 | +6.0           | V    |
| Analog Input Voltage (Signal Pins)  | -0.3 | $V_{CC} + 0.3$ | V    |
| Digital Input Voltage (Signal Pins) | -0.3 | $V_{DD} + 0.3$ | V    |
| Ambient Temperature (Operating)     | 0    | +70            | °C   |
| Storage Temperature                 | -65  | +150           | °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.

## ORDERING GUIDE

| Model      | Temperature Range | Package Description | Package Option |
|------------|-------------------|---------------------|----------------|
| AD1881AJST | 0°C to 70°C       | 48-Lead LQFP        | ST-48          |

## ENVIRONMENTAL CONDITIONS

Ambient Temperature Rating

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

$T_{CASE}$  = Case Temperature in °C

$P_D$  = 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)

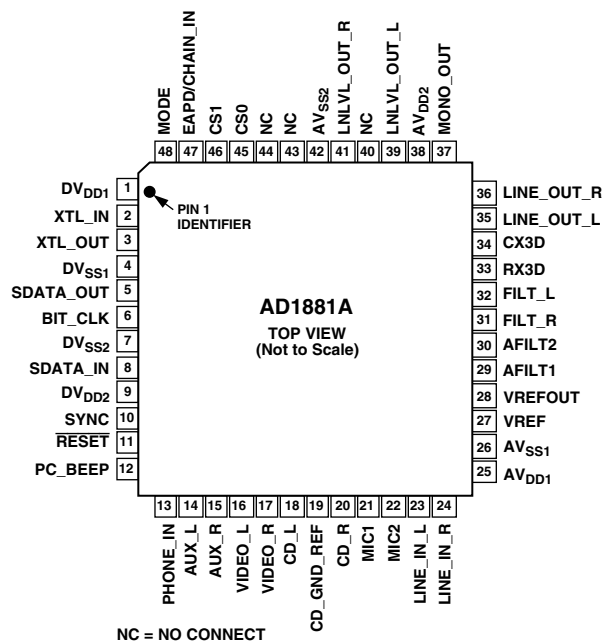
| Package | $\theta_{JA}$ | $\theta_{JC}$ | $\theta_{CA}$ |
|---------|---------------|---------------|---------------|
| LQFP    | 76.2°C/W      | 17°C/W        | 59.2°C/W      |

## 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 the AD1881A 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.



## PIN CONFIGURATION 48-Lead LQFP



# AD1881A

## PIN FUNCTION DESCRIPTIONS

### Digital I/O

| Pin Name                  | LQFP | I/O | Description  |
|---------------------------|------|-----|--|
| XTL_IN                    | 2    | I   | Crystal (or Clock) Input, 24.576 MHz.                                      |
| XTL_OUT                   | 3    | O   | Crystal Output.  |
| SDATA_OUT                 | 5    | I   | AC-Link Serial Data Output, AD1881A Input Stream.                          |
| BIT_CLK                   | 6    | O   | AC-Link Bit Clock. 12.288 MHz Serial Data Clock. Daisy Chain Output Clock. |
| SDATA_IN                  | 8    | O   | AC-Link Serial Data Input. AD1881A Output Stream.                          |
| SYNC                      | 10   | I   | AC-Link Frame Sample Sync 48 kHz Fixed Rate.                               |
| $\overline{\text{RESET}}$ | 11   | I   | AC-Link Reset. AD1881A Master H/W Reset.                                   |

### Miscellaneous Connections

| Pin Name | LQFP | I/O | Description   |
|----------|------|-----|---|
| CS0      | 45   | I   | Chip Select 0.  |
| CS1      | 46   | I   | Chip Select 1.  |
| EAPD     | 47   | O   | External Amp Power-Down Control Signal, Default LO, Active HI |
| MODE     | 48   | I   | MODE Select.  |

### Analog I/O

These signals connect the AD1881A component to analog sources and sinks, including microphones and speakers.

| Pin Name    | LQFP | I/O | Description  |
|-------------|------|-----|--|
| PC_BEEP     | 12   | I   | PC Beep. PC Speaker Beep Passthrough.                              |
| PHONE_IN    | 13   | I   | Phone. From Telephony Subsystem Speakerphone or Handset.           |
| AUX_L       | 14   | I   | Auxiliary Input Left Channel.                                      |
| AUX_R       | 15   | I   | Auxiliary Input Right Channel.                                     |
| VIDEO_L     | 16   | I   | Video Audio Left Channel.  |
| VIDEO_R     | 17   | I   | Video Audio Right Channel.   |
| CD_L        | 18   | I   | CD Audio Left Channel.   |
| CD_GND_REF  | 19   | I   | CD Audio Analog Ground Reference for Pseudo-Differential CD Input. |
| CD_R        | 20   | I   | CD Audio Right Channel.  |
| MIC1        | 21   | I   | Microphone 1. Desktop Microphone Input.                            |
| MIC2        | 22   | I   | Microphone 2. Second Microphone Input.                             |
| LINE_IN_L   | 23   | I   | Line In Left Channel.  |
| LINE_IN_R   | 24   | I   | Line In Right Channel.   |
| LINE_OUT_L  | 35   | O   | Line Out Left Channel.   |
| LINE_OUT_R  | 36   | O   | Line Out Right Channel.  |
| MONO_OUT    | 37   | O   | Monaural Output to Telephony Subsystem Speakerphone.               |
| LNLVL_OUT_L | 39   | O   | Line-Level Output Left Channel.                                    |
| LNLVL_OUT_R | 41   | O   | Line-Level Output Right Channel.                                   |

### Filter/Reference

These signals are connected to resistors, capacitors, or specific voltages.

| Pin Name | LQFP | I/O | Description  |
|----------|------|-----|--|
| VREF     | 27   | O   | Voltage Reference Filter.                                    |
| VREFOUT  | 28   | O   | Voltage Reference Output 5 mA Drive (Intended for MIC Bias). |
| AFILT1   | 29   | O   | Antialiasing Filter Capacitor—ADC Right Channel.             |
| AFILT2   | 30   | O   | Antialiasing Filter Capacitor—ADC Left Channel.              |
| FILT_R   | 31   | O   | AC-Coupling Filter Capacitor—ADC Right Channel.              |
| FILT_L   | 32   | O   | AC-Coupling Filter Capacitor—ADC Left Channel.               |
| RX3D     | 33   | O   | 3D PHAT Stereo Enhancement—Capacitor.                        |
| CX3D     | 34   | I   | 3D PHAT Stereo Enhancement—Capacitor.                        |



## Power and Ground Signals

| Pin Name          | LQFP | Type | Description                   |
|-------------------|------|------|-------------------------------|
| DV <sub>DD1</sub> | 1    | I    | Digital V <sub>DD</sub> 3.3 V |
| DV <sub>SS1</sub> | 4    | I    | Digital GND                   |
| DV <sub>SS2</sub> | 7    | I    | Digital GND                   |
| DV <sub>DD2</sub> | 9    | I    | Digital V <sub>DD</sub> 3.3 V |
| AV <sub>DD1</sub> | 25   | I    | Analog V <sub>DD</sub> 5.0 V  |
| AV <sub>SS1</sub> | 26   | I    | Analog GND                    |
| AV <sub>DD2</sub> | 38   | I    | Analog V <sub>DD</sub> 5.0 V  |
| AV <sub>SS2</sub> | 42   | I    | Analog GND                    |

## No Connects

| Pin Name | LQFP | Type | Description |
|----------|------|------|-------------|
| NC       | 40   |      | No Connect  |
| NC       | 43   |      | No Connect  |
| NC       | 44   |      | No Connect  |

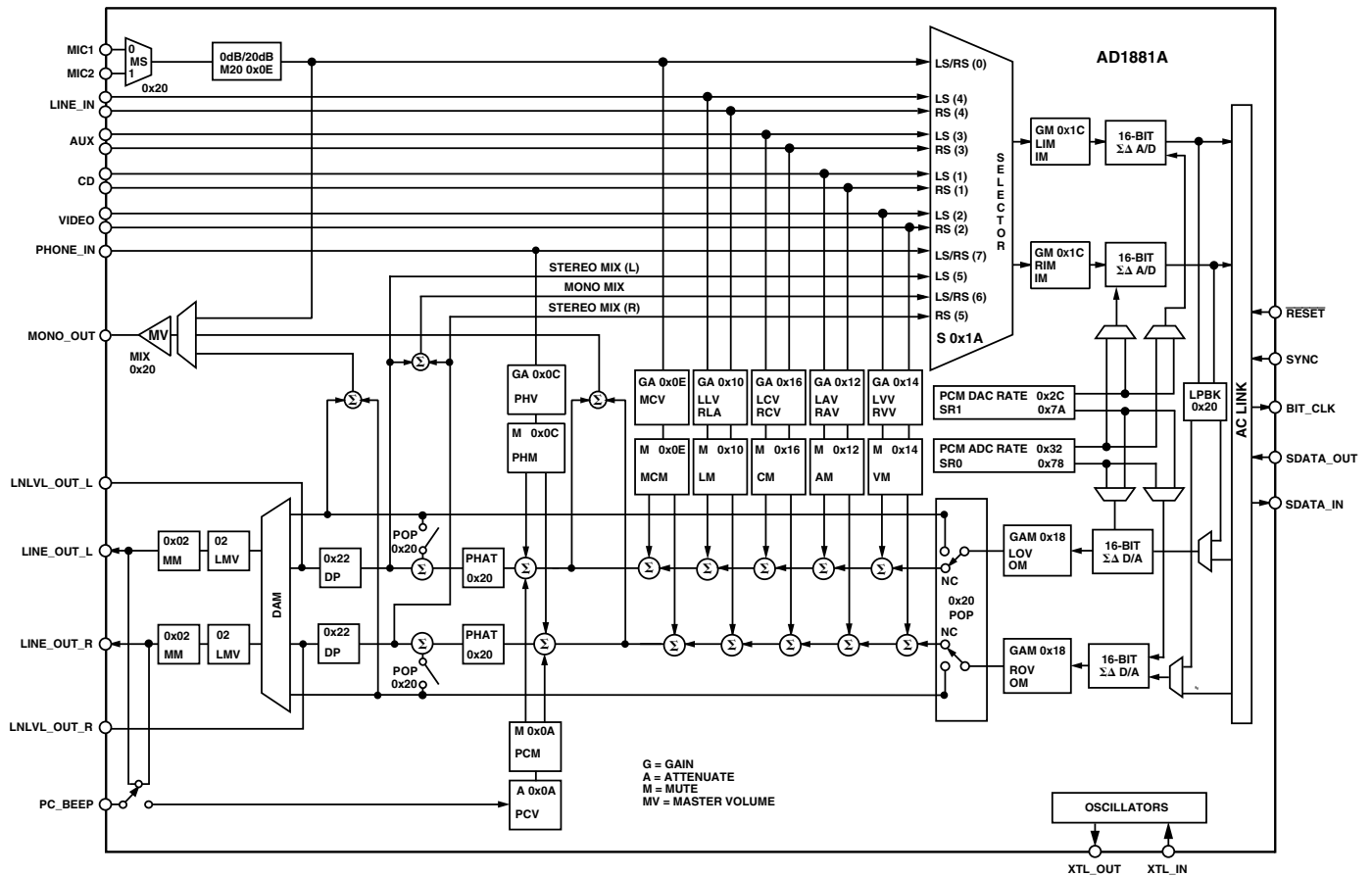


Figure 8. Block Diagram Register Map

# AD1881A

## PRODUCT OVERVIEW

The AD1881A meets the *Audio Codec '97 2.0 and 2.1 Extensions*. In addition, the AD1881A SoundMAX Codec is designed to meet all requirements of the *Audio Codec '97, Component Specification, Revision 1.03*, © 1996, Intel Corporation, found at *www.Intel.com*. The AD1881A also includes some other Codec enhanced features such as the built-in PHAT Stereo 3D enhancement.

The AD1881A is an analog front end for high performance PC audio applications. The AC'97 architecture defines a 2-chip audio solution comprising a digital audio controller, plus a high quality analog component that includes Digital-to-Analog Converters (DACs), Analog-to-Digital Converters (ADCs), mixer and I/O.

The main architectural features of the AD1881A are the high quality analog mixer section, two channels of  $\Sigma\Delta$  ADC conversion, two channels of  $\Sigma\Delta$  DAC conversion with Data Directed Scrambling (D<sup>2</sup>S) rate generators. The AD1881A's left channel ADC and DAC are compatible for modem applications supporting irrational sample rates and modem filtering requirements.

## FUNCTIONAL DESCRIPTION

This section overviews the functionality of the AD1881A and is intended as a general introduction to the capabilities of the device. Detailed reference information may be found in the descriptions of the Indexed Control Registers.

### Analog Inputs

The Codec contains a stereo pair of  $\Sigma\Delta$  ADCs. Inputs to the ADC may be selected from the following analog signals: telephony (PHONE\_IN), mono microphone (MIC1 or MIC2), stereo line (LINE\_IN), auxiliary line input (AUX), stereo CD ROM (CD), stereo audio from a video source (VIDEO) and post-mixed stereo or mono line output (LINE\_OUT).

### Analog Mixing

PHONE\_IN, MIC1 or MIC2, LINE\_IN, AUX, CD and VIDEO can be mixed in the analog domain with the stereo output from the DACs. Each channel of the stereo analog inputs may be independently gained or attenuated from +12 dB to -34.5 dB in 1.5 dB steps. The summing path for the mono inputs (PHONE\_IN, MIC1, and MIC2 to LINE\_OUT) duplicates mono channel data on both the left and right LINE\_OUT. Additionally, the PC attention signal (PC\_BEEP) may be mixed with the line output. A switch allows the output of the DACs to bypass the PHAT Stereo 3D enhancement.

### Digital Audio Mode

The AD1881A is designed with a Digital Audio Mode (DAM) that allows mixing of all analog inputs independent of the DAC output signal path. Mixed analog input signals may be sent to the ADCs for processing by the controller or the host, and may be used during simultaneous capture and playback at different sample rates.

### Analog-to-Digital Signal Path

The selector sends left and right channel information to the programmable gain amplifier (PGA). The PGA following the selector allows independent gain control for each channel entering the ADC from 0 dB to +22.5 dB in 1.5 dB steps. Each channel of the ADC is independent, and can process left and right channel data at different sample rates.

### Sample Rates and D<sup>2</sup>S

The AD1881A default mode sets the Codec to operate at 48 kHz sample rates. The converter pairs may process left and right channel data at different sample rates. The AD1881A sample rate generator allows the Codec to instantaneously change and process sample rates from 8 kHz to 48 kHz with a resolution of 1 Hz. The in-band integrated noise and distortion artifacts introduced by rate conversions are below -90 dB. The AD1881A uses a 4-bit D/A structure and Data Directed Scrambling (D<sup>2</sup>S) to enhance noise immunity on motherboards and in PC enclosures, and to suppress idle tones below the device's quantization noise floor. The D<sup>2</sup>S process pushes noise and distortion artifacts caused by errors in the multibit DAC to frequencies beyond the auditory response of the human ear and then filters them.

### Digital-to-Analog Signal Path

The analog output of the DAC may be gained or attenuated from +12 dB to -34.5 dB in 1.5 dB steps, and summed with any of the analog input signals. The summed analog signal enters the Master Volume stage where each channel of the mixer output may be attenuated from 0 dB to -94.5 dB in 1.5 dB steps or muted.

### Line-Level Outputs

The AD1881A offers a true line-level output for notebook docking station and home theater applications. The line-level output does not change with master volume settings.

### Host-Based Echo Cancellation Support

The AD1881A supports time correlated I/O data format by presenting MIC data on the left channel of the ADC and the mono summation of left and right output on the right channel. The ADC is splittable; left and right ADC data can be sampled at different rates.

### Power Management Modes

The AD1881A is designed to meet ACPI power consumption requirements through flexible power management control of all internal resources.

## Indexed Control Registers

| Reg Num         | Name                     | D15        | D14       | D13  | D12  | D11  | D10  | D9   | D8   | D7        | D6          | D5         | D4   | D3   | D2   | D1   | D0   | Default |
|-----------------|--------------------------|------------|-----------|------|------|------|------|------|------|-----------|-------------|------------|------|------|------|------|------|---------|
| 00h             | Reset                    | X          | SE4       | SE3  | SE2  | SE1  | SE0  | ID9  | ID8  | ID7       | ID6         | ID5        | ID4  | ID3  | ID2  | ID1  | ID0  | 0410h   |
| 02h             | Master Volume            | MM         | X         | LMV5 | LMV4 | LMV3 | LMV2 | LMV1 | LMV0 | X         | X           | RMV5       | RMV4 | RMV3 | RMV2 | RMV1 | RMV0 | 8000h   |
| 04h             | Reserved                 | X          | X         | X    | X    | X    | X    | X    | X    | X         | X           | X          | X    | X    | X    | X    | X    | X       |
| 06h             | Master Volume Mono       | MMM        | X         | X    | X    | X    | X    | X    | X    | X         | X           | X          | MMV4 | MMV2 | MMV2 | MMV1 | MMV0 | 8000h   |
| 08h             | Reserved                 | X          | X         | X    | X    | X    | X    | X    | X    | X         | X           | X          | X    | X    | X    | X    | X    | X       |
| 0Ah             | PC Beep Volume           | PCM        | X         | X    | X    | X    | X    | X    | X    | X         | X           | X          | PCV3 | PCV2 | PCV1 | PCV0 | X    | 8000h   |
| 0Ch             | Phone In Volume          | PHM        | X         | X    | X    | X    | X    | X    | X    | X         | X           | X          | PHV4 | PHV3 | PHV2 | PHV1 | PHV0 | 8008h   |
| 0Eh             | MIC Volume               | MCM        | X         | X    | X    | X    | X    | X    | X    | X         | M20         | X          | MCV4 | MCV3 | MCV2 | MCV1 | MCV0 | 8008h   |
| 10h             | Line In Volume           | LM         | X         | X    | LLV4 | LLV3 | LLV2 | LLV1 | LLV0 | X         | X           | X          | RLV4 | RLV3 | RLV2 | RLV1 | RLV0 | 8808h   |
| 12h             | CD Volume                | CVM        | X         | X    | LCV4 | LCV3 | LCV2 | LCV1 | LCV0 | X         | X           | X          | RCV4 | RCV3 | RCV2 | RCV1 | RCV0 | 8808h   |
| 14h             | Video Volume             | VM         | X         | X    | LVV4 | LVV3 | LVV2 | LVV1 | LVV0 | X         | X           | X          | RVV4 | RVV3 | RVV2 | RVV1 | RVV0 | 8808h   |
| 16h             | Aux Volume               | AM         | X         | X    | LAV4 | LAV3 | LAV2 | LAV1 | LAV0 | X         | X           | X          | RAV4 | RAV3 | RAV2 | RAV1 | RAV0 | 8808h   |
| 18h             | PCM Out Vol              | OM         | X         | X    | LOV4 | LOV3 | LOV2 | LOV1 | LOV0 | X         | X           | X          | ROV4 | ROV3 | ROV2 | ROV1 | ROV0 | 8808h   |
| 1Ah             | Record Select            | X          | X         | X    | X    | X    | LS2  | LS1  | LS0  | X         | X           | X          | X    | X    | RS2  | RS1  | RS0  | 0000h   |
| 1Ch             | Record Gain              | IM         | X         | X    | X    | LIM3 | LIM2 | LIM1 | LIM0 | X         | X           | X          | X    | RIM3 | RIM2 | RIM1 | RIM0 | 8000h   |
| 1Eh             | Reserved                 | X          | X         | X    | X    | X    | X    | X    | X    | X         | X           | X          | X    | X    | X    | X    | X    | X       |
| 20h             | General Purpose          | POP        | X         | 3D   | X    | X    | X    | MIX  | MS   | LPBK      | X           | X          | X    | X    | X    | X    | X    | 0000h   |
| 22h             | 3D Control               | X          | X         | X    | X    | X    | X    | X    | X    | X         | X           | X          | X    | DP3  | DP2  | DP1  | DP0  | 0000h   |
| 26h             | Power-Down Cntrl/Stat    | EAPD       | X         | PR5  | PR4  | PR3  | PR2  | PR1  | PR0  | X         | X           | X          | X    | REF  | ANL  | DAC  | ADC  | 000Xh   |
| 28h             | Extended Audio ID        | ID1        | ID0       | X    | X    | X    | X    | X    | X    | X         | X           | X          | X    | X    | X    | X    | VRA  | 0001h   |
| 2Ah             | Extended Audio Stat/Ctrl | X          | X         | X    | X    | X    | X    | X    | X    | X         | X           | X          | X    | X    | X    | X    | VRA  | 0000h   |
| 2Ch/<br>(7Ah)*  | PCM DAC Rate (SR1)       | SR15       | SR14      | SR13 | SR12 | SR11 | SR10 | SR9  | SR8  | SR7       | SR6         | SR5        | SR4  | SR3  | SR2  | SR1  | SR0  | BB80h   |
| 32h /<br>(78h)* | PCM ADC Rate (SR0)       | SR15       | SR14      | SR13 | SR12 | SR11 | SR10 | SR9  | SR8  | SR7       | SR6         | SR5        | SR4  | SR3  | SR2  | SR1  | SR0  | BB80h   |
| 34h             | Reserved                 | X          | X         | X    | X    | X    | X    | X    | X    | X         | X           | X          | X    | X    | X    | X    | X    | X       |
| 5ah<br>70h      | Vendor Reserved**        | ..         | ..        | ..   | ..   | ..   | ..   | ..   | ..   | ..        | ..          | ..         | ..   | ..   | ..   | ..   | ..   | ..      |
| 72h             | Reserved                 | X          | X         | X    | X    | X    | X    | X    | X    | X         | X           | X          | X    | X    | X    | X    | X    | X       |
| 74h             | Serial Configuration     | SLOT<br>16 | X         | X    | X    | X    | X    | X    | X    | X         | X           | X          | X    | X    | X    | X    | X    | 7X0Xh   |
| 76h             | Misc. Control Bits       | DAC<br>Z   | LPMI<br>X | X    | DAM  | DMS  | DLSR | X    | ALSR | MOD<br>EN | SRX<br>10D7 | SRX<br>8D7 | X    | X    | DRSR | X    | ARSR | 0404h   |
| 7Ch             | Vendor ID1               | F7         | F6        | F5   | F4   | F3   | F2   | F1   | F0   | S7        | S6          | S5         | S4   | S3   | S2   | S1   | S0   | 4144h   |
| 7Eh             | Vendor ID2               | T7         | T6        | T5   | T4   | T3   | T2   | T1   | T0   | REV7      | REV6        | REV5       | REV4 | REV3 | REV2 | REV1 | REV0 | 5348h   |

## NOTES

All registers not shown and bits containing an X are assumed to be reserved.

Odd register addresses are aliased to the next lower even address.

Reserved registers should not be written.

Zeros should be written to reserved bits.

\*Indicates Aliased register for AD1819, AD1819A backward compatibility.

\*\*Vendor Reserved registers should not be written.

# AD1881A

## Reset (Index 00h)

| Reg Num | Name  | D15 | D14 | D13 | D12 | D11 | D10 | D9  | D8  | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  | Default |
|---------|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---------|
| 00h     | Reset | X   | SE4 | SE3 | SE2 | SE1 | SE0 | ID9 | ID8 | ID7 | ID6 | ID5 | ID4 | ID3 | ID2 | ID1 | ID0 | 0410h   |

Note: Writing any value to this register performs a register reset, which causes all registers to revert to their default values (except 74h, which forces the serial configuration). Reading this register returns the ID code of the part and a code for the type of 3D Stereo Enhancement.

ID[9:0] Identify Capability. The ID decodes the capabilities of AD1881A based on the following:

| Bit = 1 | Function                          | AD1881A |
|---------|-----------------------------------|---------|
| ID0     | Dedicated MIC PCM In Channel      | 0       |
| ID1     | Modem Line Codec Support          | 0       |
| ID2     | Bass and Treble Control           | 0       |
| ID3     | Simulated Stereo (Mono to Stereo) | 0       |
| ID4     | Headphone Out/True Line-Level Out | 1       |
| ID5     | Loudness (Bass Boost) Support     | 0       |
| ID6     | 18-Bit DAC Resolution             | 0       |
| ID7     | 20-Bit DAC Resolution             | 0       |
| ID8     | 18-Bit ADC Resolution             | 0       |
| ID9     | 20-Bit ADC Resolution             | 0       |

SE[4:0] Stereo Enhancement. The 3D stereo enhancement identifies the Analog Devices 3D stereo enhancement.

## Master Volume Registers (Index 02h)

| Reg Num | Name          | D15 | D14 | D13  | D12  | D11  | D10  | D9   | D8   | D7 | D6 | D5   | D4   | D3   | D2   | D1   | D0   | Default |
|---------|---------------|-----|-----|------|------|------|------|------|------|----|----|------|------|------|------|------|------|---------|
| 02h     | Master Volume | MM  | X   | LMV5 | LMV4 | LMV3 | LMV2 | LMV1 | LMV0 | X  | X  | RMV5 | RMV4 | RMV3 | RMV2 | RMV1 | RMV0 | 8000h   |

RMV[5:0] Right Master Volume Control. The least significant bit represents 1.5 dB. This register controls the output from 0 dB to a maximum attenuation of -94.5 dB.

LMV[5:0] Left Master Volume Control. The least significant bit represents 1.5 dB. This register controls the output from 0 dB to a maximum attenuation of -94.5 dB.

MM Master Volume Mute. When this bit is set to “1,” the channel is muted.

| MM | xMV5 . . . xMV0 | Function             |
|----|-----------------|----------------------|
| 0  | 00 0000         | 0 dB Attenuation     |
| 0  | 01 1111         | -46.5 dB Attenuation |
| 0  | 11 1111         | -94.5 dB Attenuation |
| 1  | xx xxxx         | -∞ dB Attenuation    |

## Master Volume Mono (Index 06h)

| Reg Num | Name               | D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4   | D3   | D2   | D1   | D0   | Default |
|---------|--------------------|-----|-----|-----|-----|-----|-----|----|----|----|----|----|------|------|------|------|------|---------|
| 06h     | Master Volume Mono | MMM | X   | X   | X   | X   | X   | X  | X  | X  | X  | X  | MMV4 | MMV3 | MMV2 | MMV1 | MMV0 | 8000h   |

MMV[4:0] Mono Master Volume Control. The least significant bit represents 1.5 dB. This register controls the output from 0 dB to a maximum attenuation of -46.5 dB.

MMM Mono Master Volume Mute. When this bit is set to “1,” the channel is muted.

## PC Beep Register (Index 0Ah)

| Reg Num | Name           | D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4   | D3   | D2   | D1   | D0 | Default |
|---------|----------------|-----|-----|-----|-----|-----|-----|----|----|----|----|----|------|------|------|------|----|---------|
| 0Ah     | PC_BEEP Volume | PCM | X   | X   | X   | X   | X   | X  | X  |    |    | X  | PCV3 | PCV2 | PCV1 | PCV0 | X  | 8000h   |

PCV[3:0] PC Beep Volume Control. The least significant bit represents 3 dB attenuation. This register controls the output from 0 dB to a maximum attenuation of -45 dB. The PC Beep is routed to Left and Right Line outputs even when the  $\overline{\text{RESET}}$  pin is asserted. This is so that Power on Self-Test (POST) codes can be heard by the user in case of a hardware problem with the PC.

PCM PC Beep Mute. When this bit is set to “1,” the channel is muted.

| PCM | PCV3 . . . PCV0 | Function                 |
|-----|-----------------|--------------------------|
| 0   | 0000            | 0 dB Attenuation         |
| 0   | 1111            | -45 dB Attenuation       |
| 1   | xxxx            | $-\infty$ dB Attenuation |

## Phone Volume (Index 0Ch)

| Reg Num | Name         | D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4   | D3   | D2   | D1   | D0   | Default |
|---------|--------------|-----|-----|-----|-----|-----|-----|----|----|----|----|----|------|------|------|------|------|---------|
| 0Ch     | Phone Volume | PHM | X   | X   | X   | X   | X   | X  | X  |    |    | X  | PHV4 | PHV3 | PHV2 | PHV1 | PHV0 | 8008h   |

PHV[4:0] Phone Volume. Allows setting the Phone Volume Attenuator in 32 steps. The LSB represents 1.5 dB, and the range is +12 dB to -34.5 dB. The default value is 0 dB, mute enabled.

PHM Phone Mute. When this bit is set to “1,” the channel is muted.

## MIC Volume (Index 0Eh)

| Reg Num | Name       | D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6  | D5 | D4   | D3   | D2   | D1   | D0   | Default |
|---------|------------|-----|-----|-----|-----|-----|-----|----|----|----|-----|----|------|------|------|------|------|---------|
| 0Eh     | Mic Volume | MCM | X   | X   | X   | X   | X   | X  | X  | X  | M20 | X  | MCV4 | MCV3 | MCV2 | MCV1 | MCV0 | 8008h   |

MCV[4:0] MIC Volume Gain. Allows setting the MIC Volume attenuator in 32 steps. The LSB represents 1.5 dB, and the range is +12 dB to -34.5 dB. The default value is 0 dB, mute enabled.

M20 Microphone 20 dB Gain Block  
 0 = Disabled; Gain = 0 dB.  
 1 = Enabled; Gain = 20 dB.

MCM MIC Mute. When this bit is set to “1,” the channel is muted.

## Line In Volume (Index 10h)

| Reg Num | Name          | D15 | D14 | D13 | D12  | D11  | D10  | D9   | D8   | D7 | D6 | D5 | D4   | D3   | D2   | D1   | D0   | Default |
|---------|---------------|-----|-----|-----|------|------|------|------|------|----|----|----|------|------|------|------|------|---------|
| 10h     | Line InVolume | LM  | X   | X   | LLV4 | LLV3 | LLV2 | LLV1 | LLV0 | X  | X  | X  | RLV4 | RLV3 | RLV2 | RLV1 | RLV0 | 8808h   |

RLV[4:0] Right Line In Volume. Allows setting the Line In right channel attenuator in 32 steps. The LSB represents 1.5 dB, and the range is +12 dB to -34.5 dB. The default value is 0 dB, mute enabled.

LLV[4:0] Line In Volume Left. Allows setting the Line In left channel attenuator in 32 steps. The LSB represents 1.5 dB, and the range is +12 dB to -34.5 dB. The default value is 0 dB, mute enabled.

LM Line In Mute. When this bit is set to “1,” the channel is muted.

# AD1881A

## CD Volume (Index 12h)

| Reg Num | Name      | D15 | D14 | D13 | D12  | D11  | D10  | D9   | D8   | D7 | D6 | D5 | D4   | D3   | D2   | D1   | D0   | Default |
|---------|-----------|-----|-----|-----|------|------|------|------|------|----|----|----|------|------|------|------|------|---------|
| 12h     | CD Volume | CVM | X   | X   | LCV4 | LCV3 | LCV2 | LCV1 | LCV0 | X  | X  | X  | RCV4 | RCV3 | RCV2 | RCV1 | RCV0 | 8808h   |

RCV[4:0] Right CD Volume. Allows setting the CD right channel attenuator in 32 steps. The LSB represents 1.5 dB, and the range is +12 dB to -34.5 dB. The default value is 0 dB, mute enabled.

LCV[4:0] Left CD Volume. Allows setting the CD left channel attenuator in 32 steps. The LSB represents 1.5 dB, and the range is +12 dB to -34.5 dB. The default value is 0 dB, mute enabled.

CVM CD Volume Mute. When this bit is set to "1," the channel is muted.

## Video Volume (Index 14h)

| Reg Num | Name         | D15 | D14 | D13 | D12  | D11  | D10  | D9   | D8   | D7 | D6 | D5 | D4   | D3   | D2   | D1   | D0   | Default |
|---------|--------------|-----|-----|-----|------|------|------|------|------|----|----|----|------|------|------|------|------|---------|
| 14h     | Video Volume | VM  | X   | X   | LVV4 | LVV3 | LVV2 | LVV1 | LVV0 | X  | X  | X  | RVV4 | RVV3 | RVV2 | RVV1 | RVV0 | 8808h   |

RVV[4:0] Right Video Volume. Allows setting the Video right channel attenuator in 32 steps. The LSB represents 1.5 dB, and the range is +12 dB to -34.5 dB. The default value is 0 dB, mute enabled.

LVV[4:0] Left Video Volume. Allows setting the Video left channel attenuator in 32 steps. The LSB represents 1.5 dB, and the range is +12 dB to -34.5 dB. The default value is 0 dB, mute enabled.

VM Video Mute. When this bit is set to "1," the channel is muted.

## AUX Volume (Index 16h)

| Reg Num | Name       | D15 | D14 | D13 | D12  | D11  | D10  | D9   | D8   | D7 | D6 | D5 | D4   | D3   | D2   | D1   | D0   | Default |
|---------|------------|-----|-----|-----|------|------|------|------|------|----|----|----|------|------|------|------|------|---------|
| 16h     | Aux Volume | AM  | X   | X   | LAV4 | LAV3 | LAV2 | LAV1 | LAV0 | X  | X  | X  | RAV4 | RAV3 | RAV2 | RAV1 | RAV0 | 8808h   |

RAV[4:0] Right Aux. Volume. Allows setting the Aux right channel attenuator in 32 steps. The LSB represents 1.5 dB, and the range is +12 dB to -34.5 dB. The default value is 0 dB, mute enabled.

LAV[4:0] Left Aux. Volume. Allows setting the Aux left channel attenuator in 32 steps. The LSB represents 1.5 dB, and the range is +12 dB to -34.5 dB. The default value is 0 dB, mute enabled.

AM Aux. Mute. When this bit is set to "1," the channel is muted.

## PCM Out Volume (Index 18h)

| Reg Num | Name           | D15 | D14 | D13 | D12  | D11  | D10  | D9   | D8   | D7 | D6 | D5 | D4   | D3   | D2   | D1   | D0   | Default |
|---------|----------------|-----|-----|-----|------|------|------|------|------|----|----|----|------|------|------|------|------|---------|
| 18h     | PCM Out Volume | OM  | X   | X   | LOV4 | LOV3 | LOV2 | LOV1 | LOV0 | X  | X  | X  | ROV4 | ROV3 | ROV2 | ROV1 | ROV0 | 8808h   |

ROV[4:0] Right PCM Out Volume. Allows setting the PCM right channel attenuator in 32 steps. The LSB represents 1.5 dB, and the range is +12 dB to -34.5 dB. The default value is 0 dB, mute enabled.

LOV[4:0] Left PCM Out Volume. Allows setting the PCM left channel attenuator in 32 steps. The LSB represents 1.5 dB, and the range is +12 dB to -34.5 dB. The default value is 0 dB, mute enabled.

OM PCM Out Volume Mute. When this bit is set to "1," the channel is muted.

## Volume Table (Index 0Ch to 18h)

| MM | x4 . . . x0 | Function      |
|----|-------------|---------------|
| 0  | 00000       | +12 dB Gain   |
| 0  | 01000       | 0 dB Gain     |
| 0  | 11111       | -34.5 dB Gain |
| 1  | xxxxx       | -∞ dB Gain    |

## Record Select Control Register (Index 1Ah)

| Reg Num | Name          | D15 | D14 | D13 | D12 | D11 | D10 | D9  | D8  | D7 | D6 | D5 | D4 | D3 | D2  | D1  | D0  | Default |
|---------|---------------|-----|-----|-----|-----|-----|-----|-----|-----|----|----|----|----|----|-----|-----|-----|---------|
| 1Ah     | Record Select | X   | X   | X   | X   | X   | LS2 | LS1 | LS0 | X  | X  | X  | X  | X  | RS2 | RS1 | RS0 | 0000h   |

RS[2:0] Right Record Select

LS[2:0] Left Record Select.

Used to select the record source independently for right and left. See table for legend.

The default value is 0000h, which corresponds to MIC in.

| RS2 . . . RS0 | Right Record Source |
|---------------|---------------------|
| 0             | MIC                 |
| 1             | CD_R                |
| 2             | VIDEO_R             |
| 3             | AUX_R               |
| 4             | LINE_IN_R           |
| 5             | Stereo Mix (R)      |
| 6             | Mono Mix            |
| 7             | PHONE_IN            |

| LS2 . . . LS0 | Left Record Source |
|---------------|--------------------|
| 0             | MIC                |
| 1             | CD_L               |
| 2             | VIDEO_L            |
| 3             | AUX_L              |
| 4             | LINE_IN_L          |
| 5             | Stereo Mix (L)     |
| 6             | Mono Mix           |
| 7             | PHONE_IN           |

## Record Gain (Index 1Ch)

| Reg Num | Name        | D15 | D14 | D13 | D12 | D11  | D10  | D9   | D8   | D7 | D6 | D5 | D4 | D3   | D2   | D1   | D0   | Default |
|---------|-------------|-----|-----|-----|-----|------|------|------|------|----|----|----|----|------|------|------|------|---------|
| 1Ch     | Record Gain | IM  | X   | X   | X   | LIM3 | LIM2 | LIM1 | LIM0 | X  | X  | X  | X  | RIM3 | RIM2 | RIM1 | RIM0 | 8000h   |

RIM[3:0] Right Input Mixer Gain Control. Each LSB represents 1.5 dB, 0000 = 0 dB and the range is 0 dB to +22.5 dB.

LIM[3:0] Left Input Mixer Gain Control. Each LSB represents 1.5 dB, 0000 = 0 dB and the range is 0 dB to +22.5 dB.

IM Input Mute.  
 0 = Unmuted,  
 1 = Muted or  $-\infty$  dB gain.

| IM | xIM3 . . . xIM0 | Function          |
|----|-----------------|-------------------|
| 0  | 1111            | +22.5 dB Gain     |
| 0  | 0000            | 0 dB Gain         |
| 1  | xxxxx           | $-\infty$ dB Gain |

# AD1881A

## General Purpose Register (Index 20h)

| Reg Num | Name            | D15 | D14 | D13 | D12 | D11 | D10 | D9  | D8 | D7   | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|---------|-----------------|-----|-----|-----|-----|-----|-----|-----|----|------|----|----|----|----|----|----|----|---------|
| 20h     | General Purpose | POP | X   | 3D  | X   | X   | X   | MIX | MS | LPBK | X  | X  | X  | X  | X  | X  | X  | 0000h   |

Note: This register should be read before writing to generate a mask for only the bit(s) that need to be changed. The function default value is 0000h which is all off.

LPBK Loopback Control. ADC/DAC Digital Loopback Mode

MS MIC Select  
 0 = MIC1.  
 1 = MIC2.

MIX Mono Output Select  
 0 = Mix.  
 1 = MIC.

3D 3D PHAT Stereo Enhancement  
 0 = PHAT Stereo is off.  
 1 = PHAT Stereo is on.

POP PCM Output Path and Mute. The POP bit controls the optional PCM out 3D bypass path (the pre- and post-3D PCM out paths are mutually exclusive).  
 0 = pre-3D.  
 1 = post-3D.

## 3D Control Register (Index 22h)

| Reg Num | Name       | D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4 | D3  | D2  | D1  | D0  | Default |
|---------|------------|-----|-----|-----|-----|-----|-----|----|----|----|----|----|----|-----|-----|-----|-----|---------|
| 22h     | 3D Control | X   | X   | X   | X   | X   | X   | X  | X  | X  | X  | X  | X  | DP3 | DP2 | DP1 | DP0 | 0000h   |

DP[2:0] Depth Control. Sets 3D “Depth” PHAT Stereo enhancement according to table below.

| DP3 . . . DP0 | Depth  |
|---------------|--------|
| 0000          | 0%     |
| 0001          | 6.67%  |
| .             | .      |
| .             | .      |
| 1110          | 93.33% |
| 1111          | 100%   |



## Subsection Ready Register (Index 26h)

| Reg Num | Name                  | D15  | D14 | D13 | D12 | D11 | D10 | D9  | D8  | D7 | D6 | D5 | D4 | D3  | D2  | D1  | D0  | Default |
|---------|-----------------------|------|-----|-----|-----|-----|-----|-----|-----|----|----|----|----|-----|-----|-----|-----|---------|
| 26h     | Power-Down Cntrl/Stat | EAPD | X   | PR5 | PR4 | PR3 | PR2 | PR1 | PR0 | X  | X  | X  | X  | REF | ANL | DAC | ADC | N/A     |

Note: The ready bits are read only, writing to REF, ANL, DAC, ADC will have no effect. These bits indicate the status for the AD1881A subsections. If the bit is a one, then that subsection is “ready.” Ready is defined as the subsection able to perform in its nominal state.

ADC                    ADC section ready to transmit data.

DAC                    DAC section ready to accept data.

ANL                    Analog gain, attenuators and mute blocks, and mixers ready.

REF                    Voltage References, VREF and VREFOUT up to nominal level.

PR[5:0]                AD1881A Power-Down Modes. The first three bits are to be used individually rather than in combination with each other. The last bit PR3 can be used in combination with PR2 or by itself. The mixer and reference cannot be powered down via PR3 unless the ADCs and DACs are also powered down. Nothing else can be powered up until the reference is up.

PR5 has no effect unless all ADCs, DACs, and the AC-Link are powered down. The reference and the mixer can either be up or down, but all power-up sequences must be allowed to run to completion before PR5 and PR4 are both set.

In multiple-codec systems, the master codec’s PR5 and PR4 bits control the slave codec. PR5 is also effective in the slave codec if the master’s PR5 bit is clear, but the PR4 bit has no effect except to enable or disable PR5.

EAPD                    External Audio Amp Power Down. Available when programmed as an AC’97 codec.  
                               0 = Pin 47 set to LO state (default).  
                               1 = Pin 47 set to HI state.

| Power-Down State             | PR5 | PR4 | PR3 | PR2 | PR1 | PR0 |
|------------------------------|-----|-----|-----|-----|-----|-----|
| ADC Power-Down               | 0   | 0   | 0   | 0   | 0   | 1   |
| DAC Power-Down               | 0   | 0   | 0   | 0   | 1   | 0   |
| ADC and DAC Power-Down       | 0   | 0   | 0   | 0   | 1   | 1   |
| Mixer Power-Down             | 0   | 0   | 0   | 1   | 0   | 0   |
| ADC + Mixer Power-Down       | 0   | 0   | 0   | 1   | 0   | 1   |
| DAC + Mixer Power-Down       | 0   | 0   | 0   | 1   | 1   | 0   |
| ADC + DAC + Mixer Power-Down | 0   | 0   | 0   | 1   | 1   | 1   |
| Standby                      | 1   | 1   | 1   | 1   | 1   | 1   |

## Extended Audio ID Register (Index 28h)

| Reg Num | Name              | D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0  | Default |
|---------|-------------------|-----|-----|-----|-----|-----|-----|----|----|----|----|----|----|----|----|----|-----|---------|
| 28h     | Extended Audio ID | ID1 | ID0 | X   | X   | X   | X   | X  | X  | X  | X  | X  | X  | X  | X  | X  | VRA | 0000h   |

Note: The Extended Audio ID is a read only register.

VRA                    Variable Rate Audio. VRA = 1 enables Variable Rate Audio.

ID[1:0]                ID1, ID0 is a 2-bit field that indicates the codec configuration: Primary is 00; Secondary is 01, 10, or 11.

# AD1881A

## Extended Audio Status and Control Register (Index 2Ah)

| Reg Num | Name                   | D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0  | Default |
|---------|------------------------|-----|-----|-----|-----|-----|-----|----|----|----|----|----|----|----|----|----|-----|---------|
| 2Ah     | Extended Audio St/Ctrl | X   | X   | X   | X   | X   | X   | X  | X  | X  | X  | X  | X  | X  | X  | X  | VRA | 0000h   |

Note: The Extended Audio Status and Control Register is a read/write register that provides status and control of the extended audio features.

VRA Variable Rate Audio. VRA = 1 enables Variable Rate Audio mode (sample rate control registers and SLOTREQ signaling).

## PCM DAC Rate Register (Index 2Ch)

| Reg Num   | Name         | D15  | D14  | D13  | D12  | D11  | D10  | D9  | D8  | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  | Default |
|-----------|--------------|------|------|------|------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---------|
| 2Ch/(7Ah) | PCM DAC Rate | SR15 | SR14 | SR13 | SR12 | SR11 | SR10 | SR9 | SR8 | SR7 | SR6 | SR5 | SR4 | SR3 | SR2 | SR1 | SR0 | BB80h   |

Note: 2Ch is an alias for 7Ah. The VRA bit in register 2Ah must be set for the alias to work; if a zero is written to VRA, both sample rates are reset to 48k.

SR[15:0] Writing to this register allows programming of the sampling frequency from 8 kHz (1B80h) to 48 kHz (BB80h) in 1 Hz increments. Programming a value outside of the range 7040 Hz (1b80h) to 48000 Hz (bb80h) causes the codec to saturate to 48 kHz if a rate greater than 48 kHz is programmed or to 7.040 kHz if a rate less than 7.040 kHz is programmed. For all rates, if the value written to the register is supported, that value will be echoed back when read, otherwise the closest rate supported is returned.

## PCM ADC Rate Register (Index 32h)

| Reg Num   | Name         | D15  | D14  | D13  | D12  | D11  | D10  | D9  | D8  | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  | Default |
|-----------|--------------|------|------|------|------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---------|
| 32h/(78h) | PCM ADC Rate | SR15 | SR14 | SR13 | SR12 | SR11 | SR10 | SR9 | SR8 | SR7 | SR6 | SR5 | SR4 | SR3 | SR2 | SR1 | SR0 | BB80h   |

Note: 32h is an alias for 78h. The VRA bit in register 2Ah must be set for the alias to work; if a zero is written to VRA, both sample rates are reset to 48k.

SR[15:0] Writing to this register allows programming of the sampling frequency from 8 kHz (1B80) to 48 kHz (BB80h) in 1 Hz increments. Programming a value outside of the range 7040 Hz (1b80h) to 48000 Hz (bb80h) causes the codec to saturate to 48 kHz if a rate greater than 48 kHz is programmed, or to 7.040 kHz if a rate less than 7.040 kHz is programmed. For all rates, if the value written to the register is supported, that value will be echoed back when read, otherwise the closest rate supported is returned.

## Serial Configuration (Index 74h)

| Reg Num | Name                 | D15    | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|---------|----------------------|--------|-----|-----|-----|-----|-----|----|----|----|----|----|----|----|----|----|----|---------|
| 74h     | Serial Configuration | SLOT16 | X   | X   | X   | X   | X   | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | 7x0xh   |

Note: This register is not reset when the reset register (register 00h) is written.

SLOT16 Enable 16-bit slots.

DRQEN and DxRQx are retained only for compatibility with the AD1819. New controller designs should use the VRA bit in register 2Ah and the request bits in the status address slot instead.

If your system uses only a single AD1881A, you can ignore the register mask and the slave 1/slave 2 request bits. If you write to this register, write ones to all of the register mask bits.

SLOT16 makes all AC Link slots 16 bits in length, formatted into 16 slots.

## Miscellaneous Control Bits (Index 76h)

| Reg Num | Name              | D15   | D14    | D13 | D12 | D11 | D10  | D9 | D8   | D7     | D6       | D5      | D4 | D3 | D2   | D1 | D0   | Default |
|---------|-------------------|-------|--------|-----|-----|-----|------|----|------|--------|----------|---------|----|----|------|----|------|---------|
| 76h     | Misc Control Bits | DAC Z | LPMI X | X   | DAM | DMS | DLSR | X  | ALSR | MOD EN | SRX10 D7 | SRX8 D7 | X  | X  | DRSR | X  | ARSR | 0404h   |

- ARSR            ADC right sample generator select  
                  0 = SR0 Selected (32h)  
                  1 = SR1 Selected (2Ch).
- DRSR            DAC right sample generator select  
                  0 = SR0 Selected (32h)  
                  1 = SR1 Selected (2Ch).
- SRX8D7        Multiply SR1 rate by 8/7.
- SRX10D7      Multiply SR1 rate by 10/7. SRX10D7 and SRX8D7 are mutually exclusive; SRX10D7 has priority if both are set.
- MODEN        Modem filter enable (left channel only). Change only when DACs are powered down.
- ALSR            ADC left sample generator select  
                  0 = SR0 Selected (32h)  
                  1 = SR1 Selected (2Ch).
- DLSR            DAC left sample generator select  
                  0 = SR0 Selected (32h)  
                  1 = SR1 Selected (2Ch).
- DMS            Digital Mono Select.  
                  0 = Mixer  
                  1 = Left DAC and Right DAC.
- DAM            Digital Audio Mode. DAC Outputs bypass analog mixer and sent directly to the codec output.
- LPMIX         Low Power Mixer. Keeps CD to LINE\_OUT alive for notebook applications.
- DACZ          Zero fill (vs. repeat) if DAC is starved for data.

## Sample Rate 0 (Index 78h)

| Reg Num | Name          | D15   | D14   | D13   | D12   | D11   | D10   | D9   | D8   | D7   | D6   | D5   | D4   | D3   | D2   | D1   | D0   | Default |
|---------|---------------|-------|-------|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|------|---------|
| 78h     | Sample Rate 0 | SR015 | SR014 | SR013 | SR012 | SR011 | SR010 | SR09 | SR08 | SR07 | SR06 | SR05 | SR04 | SR03 | SR02 | SR01 | SR00 | BB80H   |

Note: 32h is an alias for 78h. The VRA bit in register 2Ah must be set for the alias to work; if a zero is written to VRA then both sample rates are reset to 48k.

- SR0[15:0]      Writing to this register allows the user to program the sampling frequency from 7 kHz (1B58h) to 48 kHz (BB80h) in 1 Hertz increments. Programming a value greater than 48 kHz or less than 7 kHz may cause unpredictable results.

# AD1881A

## Sample Rate 1 (Index 7Ah)

| Reg Num | Name          | D15   | D14   | D13   | D12   | D11   | D10   | D9   | D8   | D7   | D6   | D5   | D4   | D3   | D2   | D1   | D0   | Default |
|---------|---------------|-------|-------|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|------|---------|
| 7Ah     | Sample Rate 1 | SR115 | SR114 | SR113 | SR112 | SR111 | SR110 | SR19 | SR18 | SR17 | SR16 | SR15 | SR14 | SR13 | SR12 | SR11 | SR10 | BB80h   |

Note: 2Ch is an alias for 7Ah. The VRA bit in register 2Ah must be set for the alias to work; if a zero is written to VRA, both sample rates are reset to 48k.

SR1[15:0] Writing to this register allows the user to program the sampling frequency from 7 kHz (1B58h) to 48 kHz (BB80h) in 1 Hertz increments. Programming a value greater than 48 kHz or less than 7 kHz may cause unpredictable results.

## Vendor ID Registers (Index 7Ch-7Eh)

| Reg Num | Name       | D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|---------|------------|-----|-----|-----|-----|-----|-----|----|----|----|----|----|----|----|----|----|----|---------|
| 7Ch     | Vendor ID1 | F7  | F6  | F5  | F4  | F3  | F2  | F1 | F0 | S7 | S6 | S5 | S4 | S3 | S2 | S1 | S0 | 4144h   |

S[7:0] This register is ASCII encoded to "A."

F[7:0] This register is ASCII encoded to "D."

| Reg Num | Name       | D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7   | D6   | D5   | D4   | D3   | D2   | D1   | D0   | Default |
|---------|------------|-----|-----|-----|-----|-----|-----|----|----|------|------|------|------|------|------|------|------|---------|
| 7Eh     | Vendor ID2 | T7  | T6  | T5  | T4  | T3  | T2  | T1 | T0 | REV7 | REV6 | REV5 | REV4 | REV3 | REV2 | REV1 | REV0 | 5348h   |

T[7:0] This register is ASCII encoded to "S."

REV[7:0] Revision Register field.

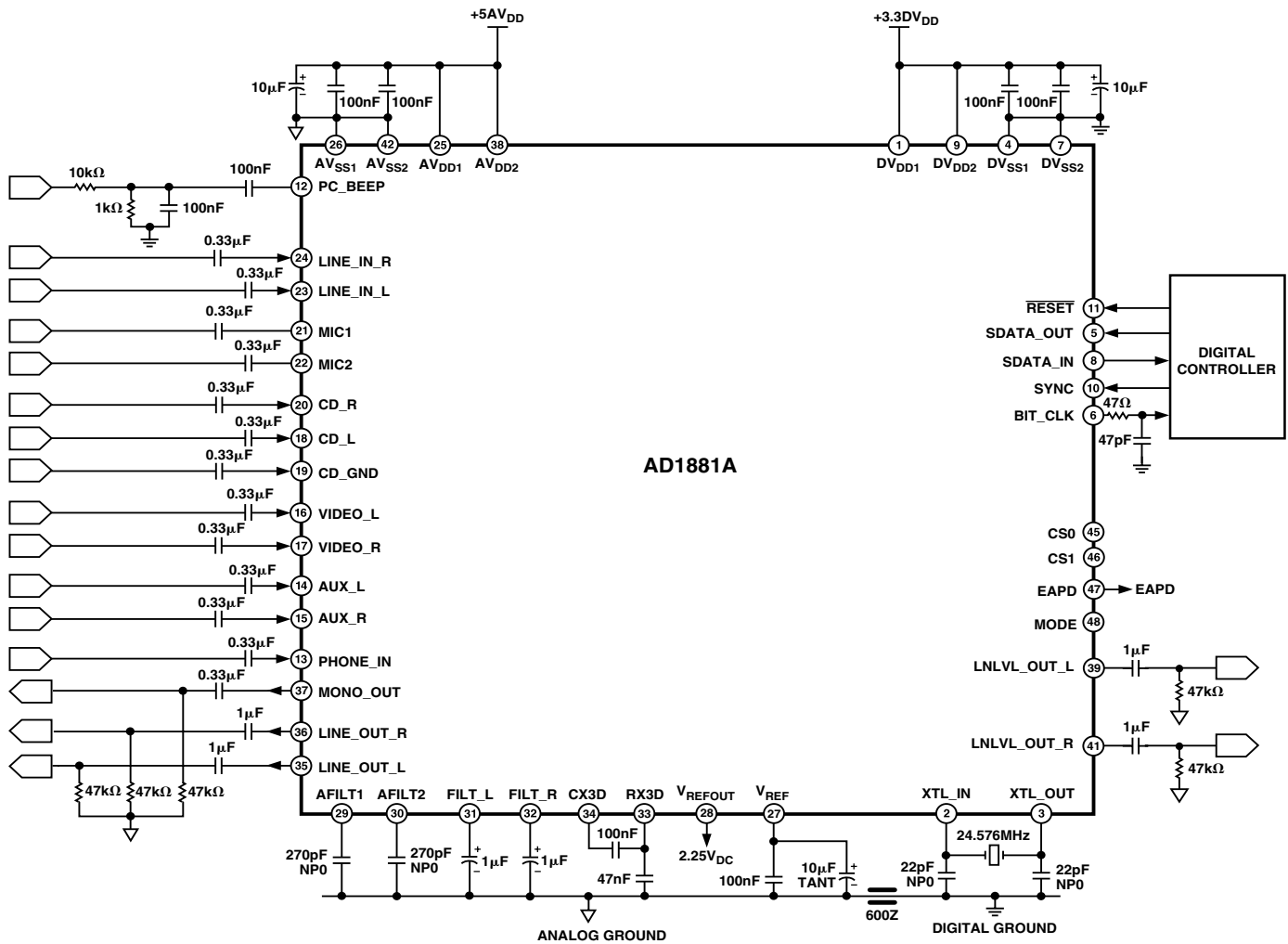
These bits are read-only and should be verified before accessing vendor defined features.

## AD1881A/AD1881 USER VISIBLE DIFFERENCES

- Pin 48 is now MODE pin, no longer CHAIN\_CLK.
- AD1881 chaining mode not supported.
- LSB of register 7Eh is 48h instead of 40h.

## APPLICATIONS CIRCUITS

The AD1881A has been designed to require a minimum amount of external circuitry. The recommended applications circuits are shown in Figure 9. Reference designs for the AD1881A are available and may be obtained by contacting your local Analog Devices' sales representative or authorized distributor.



NOTE: FOR OPTIMAL PERFORMANCE USE A REGULATED ANALOG POWER SUPPLY.

Figure 9. Recommended One Codec Application Circuit

# AD1881A

## CD-ROM CONNECTIONS

The CD-ROM audio output level should be investigated; typical drives generate 2 V rms output and require a voltage divider for compatibility with the Codec input (1 V rms range). The recommended circuit is basically a group of divide-by-two voltage dividers as shown on Figure 10.

The CD\_GND\_REF pin is used to cancel differential ground noise from the CD-ROM. For optimum noise cancellation, this section of the divider should have approximately half the impedance of the right and left channel section dividers.

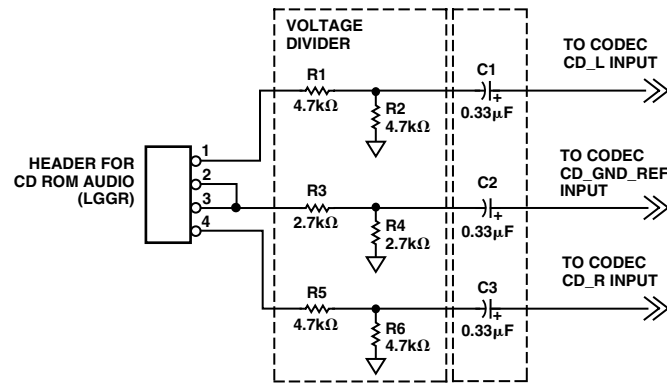


Figure 10. Typical CD-ROM Audio Connections

## LINE\_IN, AUX AND VIDEO INPUT CONNECTIONS

Most of these audio sources also generate 2 V rms audio level and require a -6 dB input voltage divider to be compatible with the Codec inputs. Figure 11 shows the recommended application circuit. For applications requiring EMC compliance, the EMC components should be configured and selected to provide adequate RF immunity and emissions control.

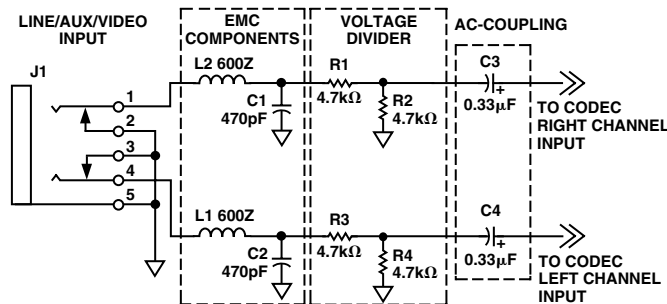


Figure 11. LINE\_IN, AUX, and Video Input Connections

## MICROPHONE CONNECTIONS

The AD1881A contains an internal microphone preamp with 20 dB gain, in most cases a direct microphone connection as shown in Figure 12 is adequate. If the microphone level is too low, an external preamp can be added as shown in Figure 13. In either case the microphone bias can be derived from the Codec's internal reference ( $V_{REFOUT}$ ) using a 2.2 kΩ resistor. For the preamp circuit, the  $V_{REFOUT}$  signal can also provide the mid-point bias for the amplifier.

To meet the PC99 1.0A requirements, the MIC signal should be placed on the microphone jack tip and the bias on the ring. This configuration supports electret microphones with three conductor plugs, as well as dynamic microphones with two conductor plugs (ring and sleeve shorted together).

Additional filtering may be required to limit the microphone response to the audio band of interest.

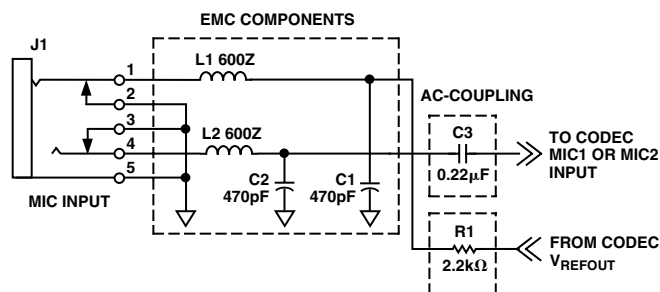


Figure 12. Recommended Microphone Input Connections

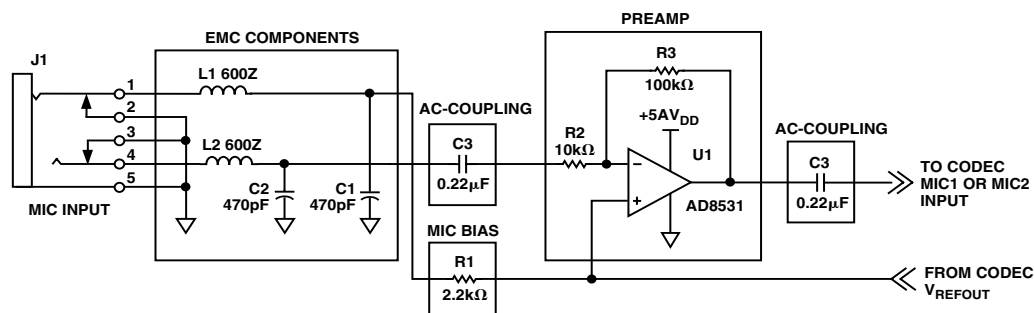
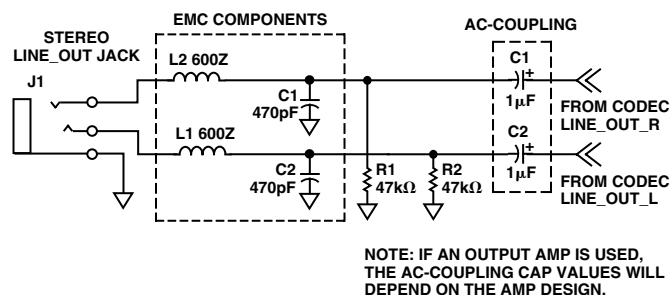


Figure 13. Microphone with Additional External Preamp (20 dB Gain)

### LINE OUTPUT CONNECTIONS

The AD1881A Codec provides stereo `LINE_OUT` signals at a standard 1 V rms level. These signals must be ac-coupled before they can be connected to an external load. After the ac-coupling, a minimal resistive load is recommended to keep the capacitors properly biased and reduce click and pop when plugging stereo equipment into the output jack. The capacitor values should be selected to provide a desired frequency response, taking into account the nominal impedance of the external load. To meet the PC99 specification for PCs, testing must be performed with a 10 k $\Omega$  load, therefore a 1  $\mu$ F value is recommended to achieve less than -3 dB roll-off at 20 Hz.

Figure 14. Recommended `LINE_OUT` Connections

### USING AN EXTERNAL HEADPHONE/POWER AMP

The SSM2250 Power Amplifier is an ideal companion for the AD1881A. The amplifier can provide up to 250 mW output in stereo mode and up to 1.5 W into a mono speaker connected in a bridge-tied load (BTL) configuration.

The SSM2250 has a mode control pin that can be used to switch between the stereo output mode and the mono BTL speaker.

Figure 15 shows a typical PC configuration where the SSM2250 drives a set of stereo headphones or external speakers, as well as an internal mono speaker. One of the normalizing pins on the stereo jack senses the stereo plug insertion and automatically switches from driving the internal mono speaker to driving the external stereo load.

To conserve power, the SSM2250 can be shut down by the EAPD pin on the AD1881A, using proper power management software. This is particularly important for portable applications. In shutdown mode, the SSM2250 consumes only 60  $\mu$ A.

# AD1881A

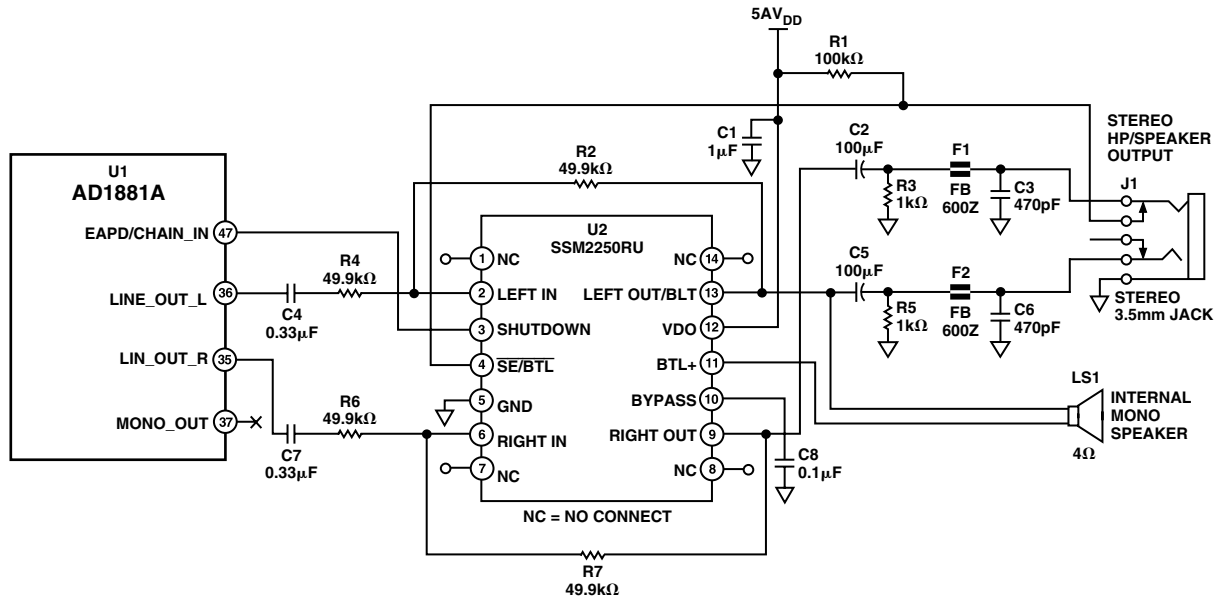


Figure 15. Using the SSM2250 Amplifier for Stereo and Mono Output

## GROUNDING AND LAYOUT

To reduce noise and emissions, Analog Devices recommends a split ground plane as shown in Figure 16. The purpose of splitting the ground plane is to create a low noise analog area that is somewhat isolated from the digital ground current noise generated by the system's logic. All the analog circuitry should be placed on the analog ground plane area.

For reference purposes, and to return power supply currents, the analog and digital ground planes must be connected at some point, ideally a small bridge under or near the Codec should be provided. A 0 Ω resistor or a ferrite bead should also be considered since these allow some flexibility in optimizing the layout to meet EMC requirements.

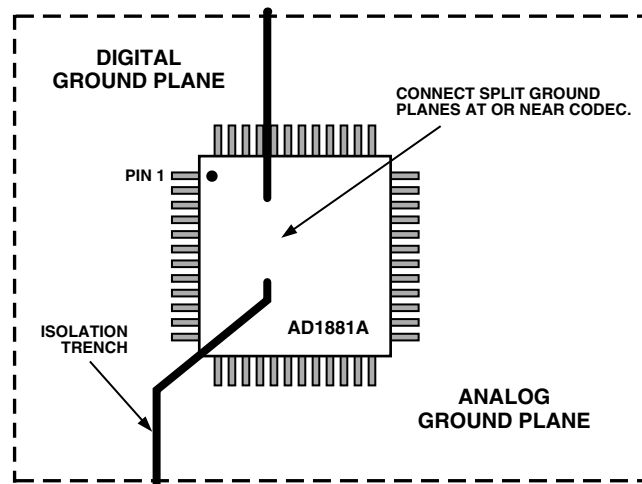


Figure 16. Recommended Split Ground Plane

## ANALOG POWER SUPPLY

To minimize audio noise, the Codec analog power supply (AVDD) should be well decoupled and regulated. In PC systems it is recommended that the analog supply be derived from the 12 V PC power supply using a localized linear voltage regulator. Preferably, the analog power supply should be connected to the Codec's analog section using a ferrite bead.



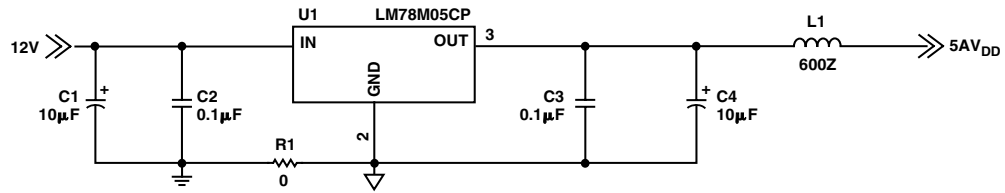


Figure 17. Recommended Regulator Circuit for Analog Power Supply

If a power plane layer is being used in the system design, it is recommended that the analog power plane for the Codec also be split (mirroring the analog ground plane). In this case, the analog power supply ferrite bead should bridge the isolation trench, close to the Codec location.

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

48-Lead Thin Plastic Quad Flatpack (LQFP)  
(ST-48)

