



## AC '97 FEATURES

### Fully Compliant AC '97 Analog I/O Component

### 48-Terminal TQFP Package

## Multibit $\Sigma\Delta$ Converter Architecture for Improved S/N Ratio >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

## Power Management Support

## ENHANCED FEATURES

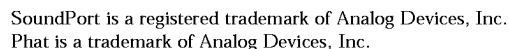
## Support for Multiple Codec Communications

### DSP 16-Bit Serial Port Format

### Variable 7 kHz to 48 kHz Sampling Rate with 1 Hz Resolution

### Supports Modem Sample Rates and Filtering

## Phat™ Stereo 3D Stereo Enhancement



REV. 0

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# AD1819

## PRODUCT OVERVIEW

The AD1819 SoundPort 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](http://www.Intel.com). In addition, the AD1819 supports multiple codec configurations (up to three per AC Link), a DSP serial mode, variable sample rates, modem sample rates and filtering, and built-in Phat Stereo 3D enhancement.

The AD1819 is an analog front end for high performance PC audio, modem, or DSP 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 AD1819 are the high quality analog mixer section, two channels of  $\Sigma\Delta$  ADC conversion, two channels of  $\Sigma\Delta$  DAC conversion and Data Direct Scrambling (D2S) rate generators. The AD1819'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 AD1819 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.

### 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 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. All programmed sample rates from 7 kHz to 48 kHz have a resolution of 1 Hz. The AD1819 also supports irrational V.34 sample rates.

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

The AD1819 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 AD1819 sample rate generator allows the codec to instantaneously change and process sample rates from 7 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 AD1819 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 D/A conversion process 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 -46.5 dB in 1.5 dB steps or muted.

### Host-Based Echo Cancellation Support

The AD1819 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.

### Telephony Modem Support

The AD1819 contains a V.34-capable analog front end for supporting host-based and data pump modems. The modem DAC typical dynamic range is 90 dB over a 4.2 kHz analog output passband where  $F_s = 12.8$  kHz. The left channel of the ADC and DAC may be used to convert modem data at the same sample rate in the range between 7 kHz and 48 kHz. All programmed sample rates have a resolution of 1 Hz. The AD1819 supports irrational V.34 sample rates with 8/7 and 10/7 selectable multiplier coefficients.

# SPECIFICATIONS

AD1819

## STANDARD TEST CONDITIONS UNLESS OTHERWISE NOTED

|                               |                 |     |
|-------------------------------|-----------------|-----|
| Temperature                   | 25              | °C  |
| Digital Supply ( $V_{DD}$ )   | 5.0             | V   |
| Analog Supply ( $V_{CC}$ )    | 5.0             | V   |
| Sample Rate ( $F_S$ )         | 48              | kHz |
| Input Signal                  | 1008            | Hz  |
| Analog Output Passband        | 20 Hz to 20 kHz |     |
| $V_{IH}$ (AC Link)            | 2.0             | V   |
| $V_{IL}$ (AC Link)            | 0.8             | V   |
| $V_{IH}$ (CS0, CS1, CHAIN_IN) | 4.0             | V   |
| $V_{IL}$ (CHAIN_CLK)          | 1.0             | V   |

### DAC Test Conditions

|                           |
|---------------------------|
| Calibrated                |
| 0 dB Attenuation          |
| Input 0 dB                |
| 10 k $\Omega$ Output Load |
| Mute Off                  |

### ADC Test Conditions

|                                    |
|------------------------------------|
| Calibrated                         |
| 0 dB Gain                          |
| Input -3 dB Relative to Full Scale |
| Line Input Selected                |

## ANALOG INPUT

| Parameter   | Min | Typ   | Max | Units      |
|---|-----|-------|-----|------------|
| Input Voltage (RMS Values Assume Sine Wave Input)<br>LINE_IN, AUX, CD, VIDEO, PHONE_IN, PC_BEEP |     | 1     |     | V rms      |
|   |     | 2.83  |     | V p-p      |
| MIC1, MIC2 with +20 dB Gain ( $M20 = 1$ )   |     | 0.1   |     | V rms      |
|   |     | 0.283 |     | V p-p      |
| MIC1, MIC2 with 0 dB Gain ( $M20 = 0$ )   |     | 1     |     | V rms      |
|   |     | 2.83  |     | V p-p      |
| Input Impedance*  | 10  |       |     | k $\Omega$ |
| Input Capacitance*  |     | 15    |     | pF         |

## PROGRAMMABLE GAIN AMPLIFIER—ADC

| Parameter                   | Min | Typ  | Max | Units |
|-----------------------------|-----|------|-----|-------|
| 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 | Units |
|---|-----|------|-----|-------|
| Dynamic Range (-60 dB Input THD+N, Referenced to Full Scale, A-Weighted)<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<br>MIC, LINE_IN, AUX, CD, VIDEO, PHONE_IN, DAC                       |     | 46.5 |     | dB    |
| Step Size (0 dB to -45 dB): (All Steps Tested)<br>PC_BEEP   |     | 3.0  |     | dB    |
| Input Gain/Attenuation Range: PC_BEEP   |     | 45   |     | dB    |

## DIGITAL DECIMATION AND INTERPOLATION FILTERS\*

| Parameter                           | Min              | Typ | Max              | Units   |
|-------------------------------------|------------------|-----|------------------|---------|
| 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 |

\*Guaranteed, not tested.

Specifications subject to change without notice.

# AD1819—SPECIFICATIONS

## ANALOG-TO-DIGITAL CONVERTERS

| Parameter   | Min | Typ  | Max         | Units   |
|---|-----|------|-------------|---------|
| Resolution  |     | 16   |             | Bits    |
| Total Harmonic Distortion (THD)   |     |      | 0.02<br>–74 | %<br>dB |
| Dynamic Range (–60 dB Input THD+N Referenced to Full Scale, A-Weighted) | 84  | 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 to Other   |     | –90  | –85         | dB      |
| Gain Error (Full-Scale Span Relative to Nominal Input Voltage)          |     |      | ±10         | %       |
| Interchannel Gain Mismatch (Difference of Gain Errors)                  |     |      | ±0.5        | dB      |
| ADC Offset Error  |     |      | ±5          | mV      |

## DIGITAL-TO-ANALOG CONVERTERS

| Parameter   | Min | Typ | Max         | Units   |
|---|-----|-----|-------------|---------|
| Resolution  |     | 16  |             | Bits    |
| Total Harmonic Distortion (THD) LINE_OUT  |     |     | 0.02<br>–74 | %<br>dB |
| Dynamic Range (–60 dB Input THD+N Referenced to Full Scale, A-Weighted)                   | 85  | 90  |             | dB      |
| Signal-to-Intermodulation Distortion* (CCIF Method)                                       |     | 85  |             | dB      |
| Gain Error (Full-Scale Span Relative to Nominal Input Voltage)                            |     |     | ±10         | %       |
| Interchannel Gain Mismatch (Difference of Gain Errors)                                    |     |     | ±0.5        | dB      |
| DAC Crosstalk* (Input L, Zero R, Measure LINE_OUT_R; Input R, Zero L, Measure LINE_OUT_L) |     |     | –80         | dB      |
| Total Out-of-Band Energy (Measured from $0.6 \times F_S$ to 20 kHz)*                      |     | –40 |             | dB      |

## MASTER VOLUME

| Parameter  | Min | Typ  | Max | Units |
|--|-----|------|-----|-------|
| Step Size (0 dB to –46.5 dB)<br>LINE_OUT_L, LINE_OUT_R, MONO_OUT |     | 1.5  |     | dB    |
| Output Attenuation Range Span*                                   |     | 46.5 |     | dB    |
| Mute Attenuation of 0 dB Fundamental*                            |     |      | 75  | dB    |

## ANALOG OUTPUT

| Parameter   | Min  | Typ       | Max  | Units                                |
|---|------|-----------|------|--------------------------------------|
| Full-Scale Output Voltage                                   |      | 1<br>2.83 |      | V <sub>rms</sub><br>V <sub>p-p</sub> |
| Output Impedance*   |      |           | 800  | Ω                                    |
| External Load Impedance                                     | 10   |           |      | kΩ                                   |
| Output Capacitance*   |      | 15        |      | pF                                   |
| External Load Capacitance                                   |      |           | 100  | pF                                   |
| V <sub>REF</sub>  | 2.00 | 2.25      | 2.50 | V                                    |
| V <sub>REF</sub> Current Drive                              |      |           | 100  | μA                                   |
| V <sub>REFOUT</sub>   |      | 2.25      |      | V                                    |
| V <sub>REFOUT</sub> Current Drive                           |      |           | 5    | mA                                   |
| Mute Click (Muted Output Minus Unmuted Midscale DAC Output) |      | ±5        |      | mV                                   |

\*Guaranteed, not tested.

Specifications subject to change without notice.

## STATIC DIGITAL SPECIFICATIONS

| Parameter   | Min                  | Typ | Max                  | Units   |
|---|----------------------|-----|----------------------|---------|
| High-Level Input Voltage ( $V_{IH}$ ): Digital Inputs   | $0.4 \times DV_{DD}$ |     |                      | V       |
| Low-Level Input Voltage ( $V_{IL}$ )                    |                      |     | $0.2 \times DV_{DD}$ | V       |
| High-Level Output Voltage ( $V_{OH}$ ), $I_{OH} = 2$ mA | $0.5 \times DV_{DD}$ |     |                      | V       |
| Low-Level Output Voltage ( $V_{OL}$ ), $I_{OL} = 2$ mA  |                      |     | $0.2 \times DV_{DD}$ | V       |
| Input Leakage Current                                   | -10                  |     | 10                   | $\mu$ A |
| Output Leakage Current                                  | -10                  |     | 10                   | $\mu$ A |

## POWER SUPPLY

| Parameter   | Min | Typ | Max | Units |
|---|-----|-----|-----|-------|
| Power Supply Range—Analog   | 4.5 |     | 5.5 | V     |
| Power Supply Range—Digital  | 4.5 |     | 5.5 | V     |
| Power Supply Current  |     | 120 |     | mA    |
| Power Dissipation   |     | 600 |     | mW    |
| Analog Supply Current   |     | 60  |     | mA    |
| Digital Supply Current  |     | 60  |     | 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 | Units |
|------------------------------|-----|--------|-----|-------|
| Input Clock Frequency        |     | 24.576 |     | MHz   |
| Recommended Clock Duty Cycle | 40  | 50     | 60  | %     |

## POWER-DOWN STATES

| Parameter   | Set Bits                     | Min | Typ | Max | Units   |
|---|------------------------------|-----|-----|-----|---------|
| ADCs and Input Mux Power-Down                             | PR0                          |     | 110 |     | mA      |
| DACs Power-Down   | PR1                          |     | 100 |     | mA      |
| Analog Mixer Power-Down ( $V_{REF}$ and $V_{REFOUT}$ On)  | PR1, PR2                     |     | 54  |     | mA      |
| Analog Mixer Power-Down ( $V_{REF}$ and $V_{REFOUT}$ Off) | PR0, PR1, PR3                |     | 47  |     | mA      |
| Digital Interface Power-Down                              | PR4                          |     | 120 |     | mA      |
| Internal Clocks Disabled                                  | PR0, PR1, PR4, PR5           |     | 85  |     | mA      |
| ADC and DAC Power-Down                                    | PR0, PR1                     |     | 85  |     | mA      |
| $V_{REF}$ Standby Mode                                    | PR0, PR1, PR2, PR4, PR5      |     | 55  |     | mA      |
| Total Power-Down  | PR0, PR1, PR2, PR3, PR4, PR5 |     | 220 |     | $\mu$ A |
| RESET   |                              |     | 250 |     | $\mu$ A |

\*Guaranteed, not tested.

Specifications subject to change without notice.

# AD1819

## TIMING PARAMETERS (GUARANTEED OVER OPERATING TEMPERATURE RANGE)

| Parameter  | Symbol                    | Min    | Typ    | Max   | Units         |
|--|---------------------------|--------|--------|-------|---------------|
| $\overline{\text{RESET}}$ Active Low Pulse Width             | $t_{\text{RST\_LOW}}$     | 1.0    |        |       | $\mu\text{s}$ |
| $\overline{\text{RESET}}$ Inactive to BIT_CLK Start-Up Delay | $t_{\text{RST2CLK}}$      | 162.8  |        |       | ns            |
| SYNC Active High Pulse Width                                 | $t_{\text{SYNC\_HIGH}}$   | 0.0814 | 1.3    |       | $\mu\text{s}$ |
| SYNC Low Pulse Width   | $t_{\text{SYNC\_LOW}}$    |        | 19.5   |       | $\mu\text{s}$ |
| SYNC Inactive to BIT_CLK Start-Up Delay                      | $t_{\text{SYNC2CLK}}$     | 162.8  |        |       | ns            |
| BIT_CLK Frequency  |                           |        | 12.288 |       | MHz           |
| BIT_CLK Period   | $t_{\text{CLK\_PERIOD}}$  |        | 81.4   |       | ns            |
| BIT_CLK Output Jitter*                                       |                           |        |        | 750   | ps            |
| BIT_CLK High Pulse Width                                     | $t_{\text{CLK\_HIGH}}$    | 32.56  | 40.7   | 48.84 | ns            |
| BIT_CLK Low Pulse Width                                      | $t_{\text{CLK\_LOW}}$     | 32.56  | 40.7   | 48.84 | ns            |
| SYNC Frequency   |                           |        | 48.0   |       | kHz           |
| SYNC Period  | $t_{\text{SYNC\_PERIOD}}$ |        | 20.8   |       | $\mu\text{s}$ |
| Setup to Falling Edge of BIT_CLK                             | $t_{\text{SETUP}}$        | 15.0   |        |       | ns            |
| Hold from Falling Edge of BIT_CLK                            | $t_{\text{HOLD}}$         | 15.0   |        |       | ns            |
| BIT_CLK Rise Time  | $t_{\text{RISE CLK}}$     |        | 4      |       | ns            |
| BIT_CLK Fall Time  | $t_{\text{FALL CLK}}$     |        | 4      |       | ns            |
| SYNC Rise Time   | $t_{\text{RISE SYNC}}$    |        | 4      |       | ns            |
| SYNC Fall Time   | $t_{\text{FALL SYNC}}$    |        | 4      |       | ns            |
| SDATA_IN Rise Time   | $t_{\text{RISE DIN}}$     |        | 4      |       | ns            |
| SDATA_IN Fall Time   | $t_{\text{FALL DIN}}$     |        | 4      |       | ns            |
| SDATA_OUT Rise Time  | $t_{\text{RISE DOUT}}$    |        | 4      |       | ns            |
| SDATA_OUT Fall Time  | $t_{\text{FALL DOUT}}$    |        | 4      |       | ns            |
| End of Slot 2 to BIT_CLK, SDATA_IN Low                       | $t_{\text{S2\_PDOWN}}$    |        |        | 1.0   | $\mu\text{s}$ |
| Setup to Trailing Edge of RESET (Applies to SYNC, SDATA_OUT) | $t_{\text{SETUP2RST}}$    | 15     |        |       | ns            |
| Rising Edge of $\overline{\text{RESET}}$ to HI-Z Delay       | $t_{\text{OFF}}$          |        |        | 25    | ns            |

\*Output Jitter is directly dependent on crystal input jitter.

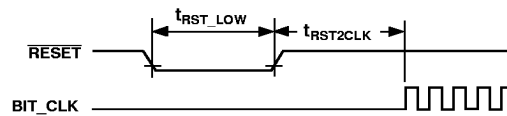


Figure 1. Cold Reset

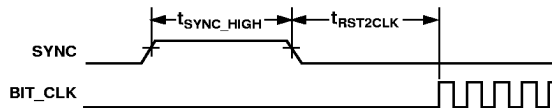


Figure 2. Warm Reset

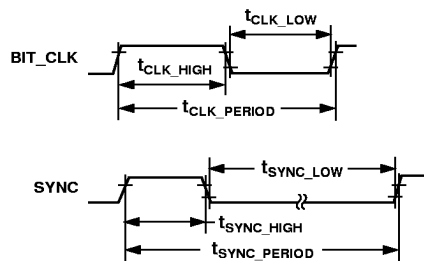


Figure 3. Clock Timing

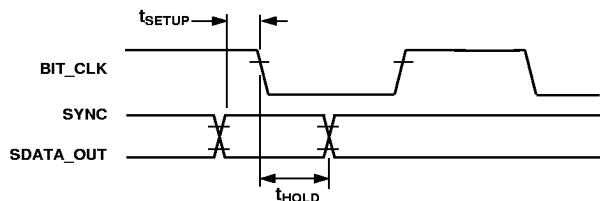


Figure 4. Data Setup and Hold

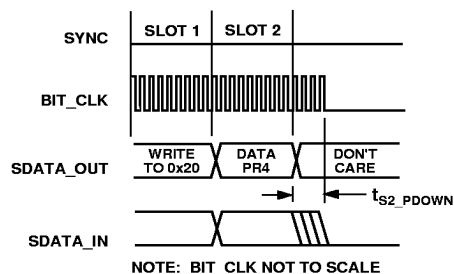


Figure 6. AC Link, Link Low Power Mode Timing

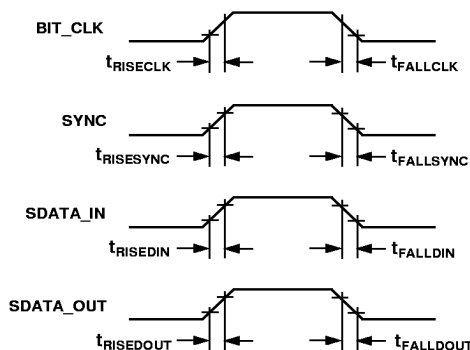


Figure 5. Signal Rise and Fall Time

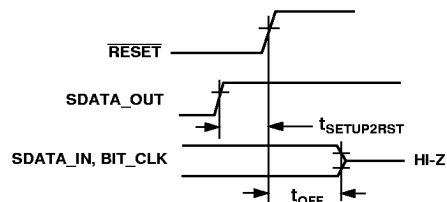


Figure 7. ATE Test Mode

## ABSOLUTE MAXIMUM RATINGS\*

| Parameter                           | Min  | Max             | Units |
|-------------------------------------|------|-----------------|-------|
| Power Supplies                      |      |                 |       |
| Analog ( $AV_{DD}$ )                | -0.3 | 6.0             | V     |
| Digital ( $DV_{DD}$ )               | -0.3 | 6.0             | V     |
| Input Current (Except Supply Pins)  |      | $\pm 10.0$      | mA    |
| Analog Input Voltage (Signal Pins)  | -0.3 | $AV_{DD} + 0.3$ | V     |
| Digital Input Voltage (Signal Pins) | -0.3 | $DV_{DD} + 0.3$ | V     |
| Ambient Temperature (Operating)     | -40  | +85             | °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* |
|-----------|-------------------|---------------------|-----------------|
| AD1819JST | -40°C to +85°C    | 48-Terminal TQFP    | ST-48           |

\*ST = Thin Quad Flatpack.

## ENVIRONMENTAL CONDITIONS

Ambient Temperature Rating

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

$T_{CASE}$  = 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 | $\theta_{JA}$ | $\theta_{JC}$ | $\theta_{CA}$ |
|---------|---------------|---------------|---------------|
| TQFP    | 76.2°C/W      | 17°C/W        | 59.2°C/W      |

## CAUTION

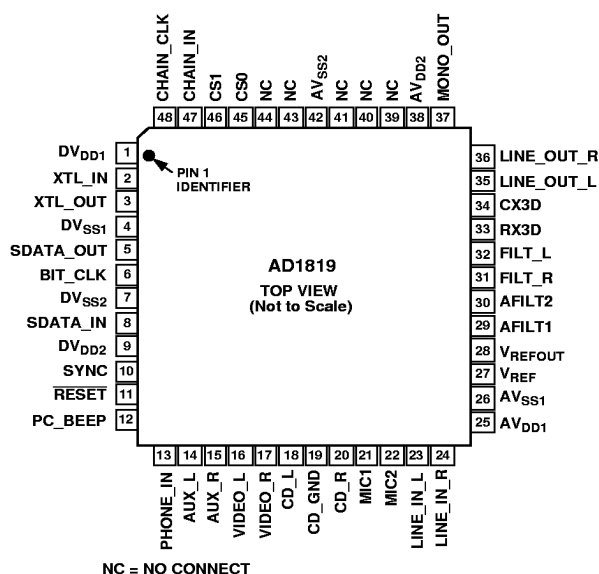
ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the AD1819 features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



# AD1819

## PIN CONFIGURATION

### 48-Terminal TQFP (ST-48)



## PIN FUNCTION DESCRIPTION

### Digital I/O

| Pin Name     | TQFP | I/O  | Description  |
|--------------|------|------|--|
| XTL_IN       | 2    | I    | 24.576 MHz Crystal or Clock Input  |
| XTL_OUT      | 3    | O    | 24.576 MHz Crystal Output  |
| SDATA_OUT    | 5    | I    | Serial Data Output. Serial, Time Division Multiplexed, AD1819 Input Stream |
| BIT_CLK      | 6    | O/I* | Bit Clock Input, 12.288 MHz Serial Data Clock. Daisy Chain Output Clock    |
| SDATA_IN     | 8    | O    | Serial Data Input. Serial, Time Division Multiplexed, AD1819 Output Stream |
| SYNC         | 10   | I    | 48 kHz Fixed Rate Sample Sync Clock  |
| <u>RESET</u> | 11   | I    | Reset. AD1819 Master Hardware Reset  |

\*Input if the AD1819 is configured as Slave 1 or Slave 2.

### Daisy Chain Connections

| Pin Name  | TQFP | I/O  | Description                            |
|-----------|------|------|--|
| CS0       | 45   | I    | Daisy Chain Codec Select               |
| CS1       | 46   | I    | Daisy Chain Codec Select               |
| CHAIN_IN  | 47   | I    | Daisy Chain Data Input                 |
| CHAIN_CLK | 48   | I/O* | 24.576 MHz Buffered Clock Input/Output |

\*Output when configured as Master. Input when configured as Slave 1 or Slave 2.



**Analog I/O**

These signals connect the AD1819 component to analog sources and sinks, including microphones and speakers.

| Pin Name   | TQFP | I/O | Description   |
|------------|------|-----|---|
| PC_BEEP    | 12   | I   | PC Beep. PC Speaker Beep Pass-Through                   |
| 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     | 19   | I   | CD Audio Analog Ground Sense for 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     |

**Filter/Reference**

| Pin Name            | TQFP | I/O | Description   |
|---------------------|------|-----|---|
| V <sub>REF</sub>    | 27   | O   | Voltage Reference Filter                                    |
| V <sub>REFOUT</sub> | 28   | O   | Voltage Reference Output 5 mA Drive (Intended for Mic Bias) |
| AFILT1              | 29   | O   | Antialiasing Filter Capacitor—ADC Channel                   |
| AFILT2              | 30   | O   | Antialiasing Filter Capacitor—ADC Channel                   |
| FILT_R              | 31   | O   | AC-Coupling Filter Capacitor—ADC Left                       |
| FILT_L              | 32   | O   | AC-Coupling Filter Capacitor—ADC Right                      |
| RX3D                | 33   | O   | 3D Phat Stereo Enhancement—Resistor                         |
| CX3D                | 34   | I   | 3D Phat Stereo Enhancement—Capacitor                        |

**Power and Ground Signals**

| Pin Name          | TQFP | I/O | Description                    |
|-------------------|------|-----|--------------------------------|
| DV <sub>DD1</sub> | 1    | I   | Digital V <sub>DD</sub> —5.0 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> —5.0 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 | TQFP | I/O | Description |
|----------|------|-----|-------------|
| NC       | 39   |     | No Connect  |
| NC       | 40   |     | No Connect  |
| NC       | 41   |     | No Connect  |
| NC       | 43   |     | No Connect  |
| NC       | 44   |     | No Connect  |

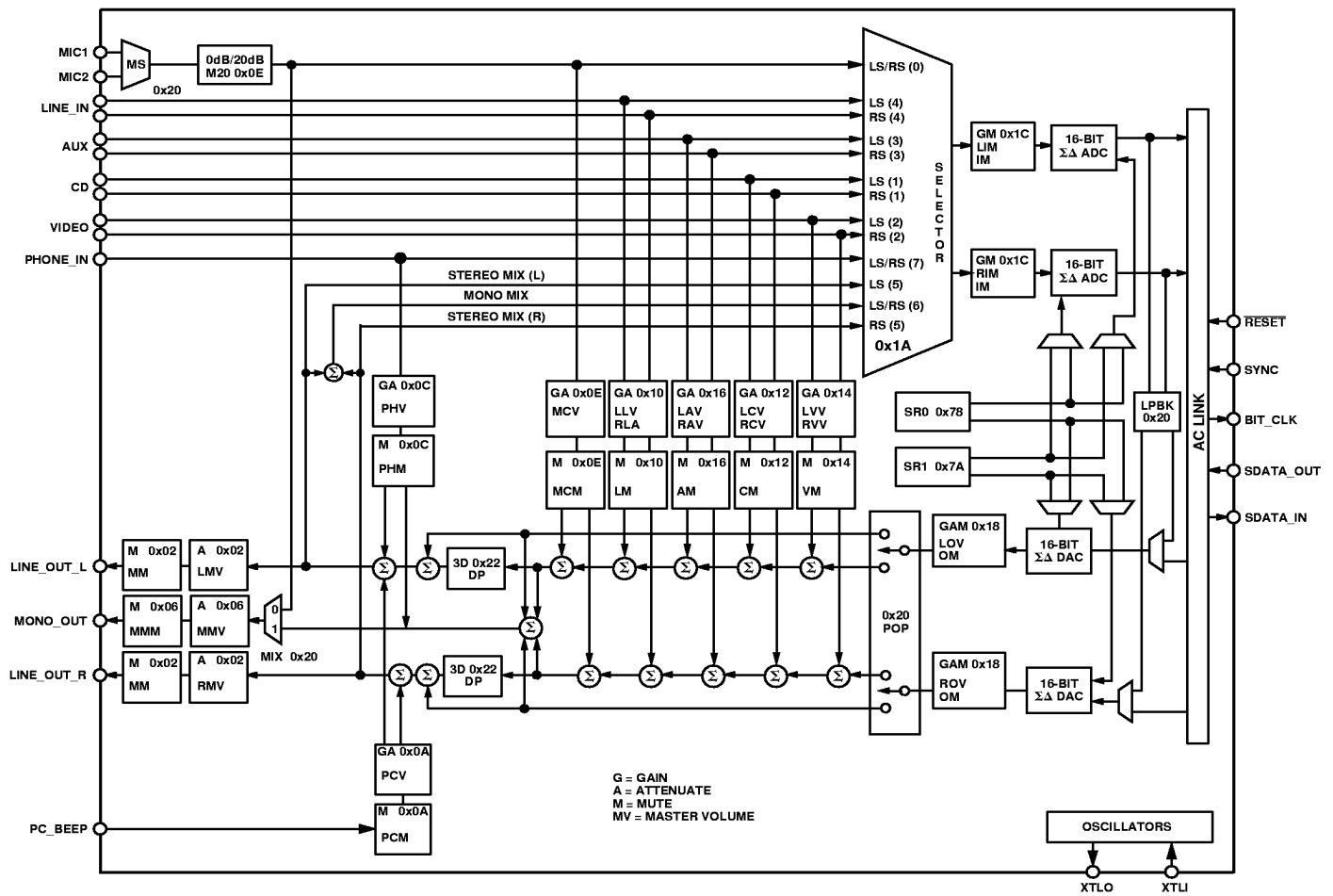


Figure 8. Block Diagram Register Map

## 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       | 0400h   |
| 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           | MMV5       | MMV4 | MMV3 | 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 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   |
| 24h     | Reserved              | X          | X         | X         | X         | X         | X         | X         | X         | X         | X           | X          | X    | X    | X         | X         | X         | X       |
| 26h     | Power-Down Contr/Stat | X          | X         | PR5       | PR4       | PR3       | PR2       | PR1       | PR0       | X         | X           | X          | X    | REF  | ANL       | DAC       | ADC       | 0000h   |
| 28h     | Reserved              | X          | X         | X         | X         | X         | X         | X         | X         | X         | X           | X          | X    | X    | X         | X         | X         | X       |
|         |                       |            |           |           |           |           |           |           |           |           |             |            |      |      |           |           |           |         |
| 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 | REGM<br>2 | REGM<br>1 | REGM<br>0 | DRQE<br>N | DLRQ<br>2 | DLRQ<br>1 | DLRQ<br>0 | X         | X           | X          | X    | X    | DRRQ<br>2 | DRRQ<br>1 | DRRQ<br>0 | 7000h   |
| 76h     | Misc Control Bits     | DACZ       | X         | X         | X         | X         | DLSR      | X         | ALSR      | MOD<br>EN | SRX1<br>0D7 | SRX8<br>D7 | X    | X    | DRSR      | X         | ARSR      | 0000h   |
| 78h     | Sample Rate 0         | SR015      | SR014     | SR013     | SR012     | SR011     | SR010     | SR09      | SR08      | SR07      | SR06        | SR05       | SR04 | SR03 | SR02      | SR01      | SR00      | BB80h   |
| 7Ah     | Sample Rate 1         | SR115      | SR114     | SR113     | SR112     | SR111     | SR110     | SR19      | SR18      | SR17      | SR16        | SR15       | SR14 | SR13 | SR12      | SR11      | SR10      | BB80h   |
| 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      | 53xxh   |

## NOTES

1. All registers not shown and bits containing an X are reserved.
2. Odd register addresses are aliased to the next lower even address.
3. Reserved registers should not be written.
4. Zeros should be written to reserved bits.

# AD1819

## 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 | 0400h   |

Note: Writing any value to this register performs a register reset, which cause 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 AD1819 on the following:

| Bit | Function                          | AD1819* |
|-----|-----------------------------------|---------|
| 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 Support             | 0       |
| 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       |

\*The AD1819 contains none of the optional features identified by these bits.

SE [4:0] Stereo Enhancement. The 3D stereo enhancement identifies the Analog Devices 3D Phat Stereo enhancement (00001)

## Master Volume (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 [4:0] 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 -46.5 dB.

RMV5 Right Master Volume Maximum Attenuation. Forces RMV [4:0] to all “1s,” -46.5 dB.

LMV [4:0] 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 -46.5 dB.

LMV5 Left Master Volume Maximum Attenuation. Forces LMV [4:0] to all “1s,” -46.5 dB.

MM Master Volume Mute. When this bit is set to “1,” the left and right channels are muted.

| MM | xMV5 . . . xMV0 | Function             |
|----|-----------------|----------------------|
| 0  | 00 0000         | 0 dB Attenuation     |
| 0  | 01 1111         | -46.5 dB Attenuation |
| 0  | 1x xxxx         | -46.5 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  | MMV5 | 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.

MMV5 Mono Master Volume Maximum Attenuation -46.5 dB.

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

| MMM | MMV5 . . . MMV0 | Function                |
|-----|-----------------|-------------------------|
| 0   | 00 0000         | 0 dB Attenuation        |
| 0   | 01 1111         | -46.5 dB Attenuation    |
| 0   | 1x xxxx         | -46.5 dB Attenuation    |
| 1   | xx xxxx         | $\infty$ dB Attenuation |

**PC Beep (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  | X  | X  | PCV3 | PCV2 | PCV2 | PCV0 | X  | 8008h   |

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 the Left and Right Line outputs even when AD1819 is in a RESET State. 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  | 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 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_IN Volume | 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] Left Line In Volume. 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.

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## 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   | LTV4 | LTV3 | LTV2 | LTV1 | LTV0 | 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.

LTV [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)

| Mute | 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 (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 |

**General Purpose (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   |

LPBK Loopback Control. ADC/DAC digital loopback mode.

MS MIC Select.

0 = MIC1.

1 = MIC2.

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|     |  |
|-----|--|
| MIX | Mono Output Select.<br>0 = Mix.<br>1 = Mic.  |
| 3D  | Phat Stereo Enhancement.<br>0 = Phat Stereo is off.<br>1 = Phat Stereo is on.  |
| POP | PCM Output Path. The POP bit controls the optional PCM out 3D bypass path (the pre- and post-3D PCM outpaths are mutually exclusive).<br>0 = Pre-3D.<br>1 = Post-3D.<br><br>The register should be read before writing to generate a mask for only the bit(s) that need to be changed. The default value is 0000h. |

## 3D Control (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  |
|---------------|--------|
| 0             | 0%     |
| 1             | 6.67%  |
| 14            | 93.33% |
| 15            | 100%   |

## Power-Down Control/Status (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 | X   | X   | PR5 | PR4 | PR3 | PR2 | PR1 | PR0 | X  | X  | X  | X  | REF | ANL | DAC | ADC | 0000h   |

Ready Bits: The ready bits are read only, writing to REF, ANL, DAC, ADC will have no effect. These bits indicate the status for the AD1819 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 gainuators, attenuators, and mixers ready.  |
| REF      | Voltage References, $V_{REF}$ and $V_{REFOUT}$ up to nominal level.  |
| PR [5:0] | Power-Down Bits. 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. |

| Power-Down State  | Set Bits                     |
|---|------------------------------|
| ADCs and Input Mux Power-Down                             | PR0                          |
| DACs Power-Down   | PR1                          |
| Analog Mixer Power-Down ( $V_{REF}$ and $V_{REFOUT}$ On)  | PR1, PR2                     |
| Analog Mixer Power-Down ( $V_{REF}$ and $V_{REFOUT}$ Off) | PR0, PR1, PR3                |
| AC-Link Interface Power-Down                              | PR4                          |
| Internal Clocks Disabled                                  | PR0, PR1, PR4, PR5           |
| ADC and DAC Power-Down                                    | PR0, PR1                     |
| $V_{REF}$ Standby Mode                                    | PR0, PR1, PR2, PR4, PR5      |
| Total Power-Down  | PR0, PR1, PR2, PR3, PR4, PR5 |



**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 | SLOT 16 | REGM 2 | REGM 1 | REGM 0 | DRQE N | DLRQ 2 | DLRQ 1 | DLRQ 0 | X  | X  | X  | X  | X  | DRRQ 2 | DRRQ 1 | DRRQ 0 | 7000h   |

DRRQ0 Master AC '97 Codec DAC Right Request.

DRRQ1 Slave 1 Codec DAC Right Request.

DRRQ2 Slave 2 Codec DAC Right Request.

DLRQ0 Master AC '97 Codec DAC Left Request.

DLRQ1 Slave 1 Codec DAC Left Request.

DLRQ2 Slave 2 Codec DAC Left Request.

DRQEN Fills idle status slots with DAC request reads, and stuffs DAC requests into LSB of output address slot. (AC Link Slot 1.)

REGM0 Master Codec Register Mask.

REGM1 Slave 1 Codec Register Mask.

REGM2 Slave 2 Codec Register Mask.

SLOT16 Enable 16-Bit Slots.

If your system uses only a single AD1819, 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. The DxRQx bits are read-only.

The codec asserts the DxRQx bit when the corresponding DAC channel can accept data in the next frame. These bits are snapshots of the codec state taken when the current frame began (effectively, on the rising edge of SYNC), but they also take notice of DAC samples sent in the current frame.

If you set the DRQEN bit, the AD1819 will fill all otherwise unused AC Link status address and data slots with the contents of register 74h. That makes it somewhat simpler to access the information, because you don't need to continually issue AC Link read commands to get the register contents.

Also, the DAC requests are reflected in Slot 1, Bits (11 . . . 6). These bits are active Low.

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 | DACZ | X   | X   | X   | X   | DLSR | X  | ALSR | MOD EN | SRX10 D7 | SRX8 D7 | X  | X  | DRSR | X  | ARSR | 0000h   |

ARSR ADC Right Sample Generator Select. Connects right ADC channel to SR0 or SR1.

0 = SR0 Selected.

1 = SR1 Selected.

DRSR DAC Right Sample Generator Select. Connects right DAC channel to SR0 or SR1.

0 = SR0 Selected.

1 = SR1 Selected.

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 inactive.

ALSR ADC Left Sample Generator Select. Connects left ADC channel to SR0 or SR1.

0 = SR0 Selected.

1 = SR1 Selected.

DLSR DAC Left Sample Generator Select. Connects left DAC channel to SR0 or SR1.

0 = SR0 Selected.

1 = SR1 Selected.

DACZ Zero-Fill (vs. repeat sample) if DAC is starved.

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## 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   |

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 Hz increments. The resultant sample rate value may be multiplied by 8/7 and 10/7 (SRX8D7 and SRX10D7 in register 0x76h). Programming a value greater than 48 kHz or less than 7 kHz may cause unpredictable results.

## 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   |

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 Hz increments. The sample rate may be multiplied by 8/7 or 10/7 by setting Bits D6 and D5 in Register 76h.

## Vendor ID (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 | 53XXh   |

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

REV [7:0] Revision Register field contains the revision number.

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

## DIGITAL INTERFACE

### AD1819 AC Link Digital Serial Interface Protocol

The AD1819 incorporates an AC '97 5-pin digital serial interface that links it to a digital controller. AC Link is a bidirectional, fixed rate, serial PCM digital stream. It handles multiple input, and output audio streams, as well as control register accesses employing a time division multiplexed (TDM) scheme. The AC Link architecture divides each audio frame into 12 outgoing and 12 incoming data streams, up to 20-bit sample resolution. The AD1819 uses 16-bit samples. The data streams include:

AC '97 Protocol

- |  |                           |
|--|---------------------------|
| • <b>TAG</b>   | <b>1 Input and Output</b> |
| • <b>Control</b><br>Control Register Write Port                  | <b>2 Output Slots</b>     |
| • <b>Status</b><br>Control Register Read Port                    | <b>2 Input Slots</b>      |
| • <b>PCM Playback</b><br>2-Channel Composite PCM Output Stream   | <b>2 Output Slots</b>     |
| • <b>PCM Record Data</b><br>2-Channel Composite PCM Input Stream | <b>2 Input Slots</b>      |

Synchronization of all AC Link data transactions is signaled by the AC '97 controller. The AD1819 drives the serial bit clock onto AC Link, which the AC '97 controller then qualifies with a synchronization signal to construct audio frames.

SYNC, which is fixed at 48 kHz, is derived by dividing down the serial bit clock (BIT\_CLK) by 256. The BIT\_CLK is fixed at 12.288 MHz. AC Link serial data is updated on each rising edge of BIT\_CLK. The receiver of AC Link data, the AD1819 for outgoing data and the AC '97 controller for incoming data, samples each serial bit on the falling edge of BIT\_CLK. SYNC may remain high for a minimum of 1 BIT\_CLK up to a maximum duration of 16 BIT\_CLKs at the beginning of each audio frame. The first 16 bits of the audio frame is defined as the “Tag Phase.” The remainder of the audio frame is the “Data Phase.” The AD1819 uses SYNC to define the beginning of the audio frame.

The AC Link protocol provides for a special 16-bit time slot (Slot 0) wherein each bit conveys a valid tag for its corresponding time slot within the current audio frame. A “1” in a given bit position of Slot 0 indicates that the corresponding time slot within the current audio frame has been assigned to a data stream, and contains valid data. If a slot is “tagged” invalid, it is the responsibility of the source of the data, (AD1819 for the input stream, AC '97 controller for the output stream), to stuff all bit positions with 0s during that slot's active time. The AD1819 stuffs all invalid slots with zeros and ignores invalid input slots.

Additionally, for power savings, all clock sync and data signals can be halted.

For multiple codec operations, the AD1819 supports an enhanced mode for communicating with up to two additional codecs. The Slave 1 AD1819 codec uses Slots 5 and 6, while Slave 2 uses Slots 7 and 8 as shown in the following diagram.

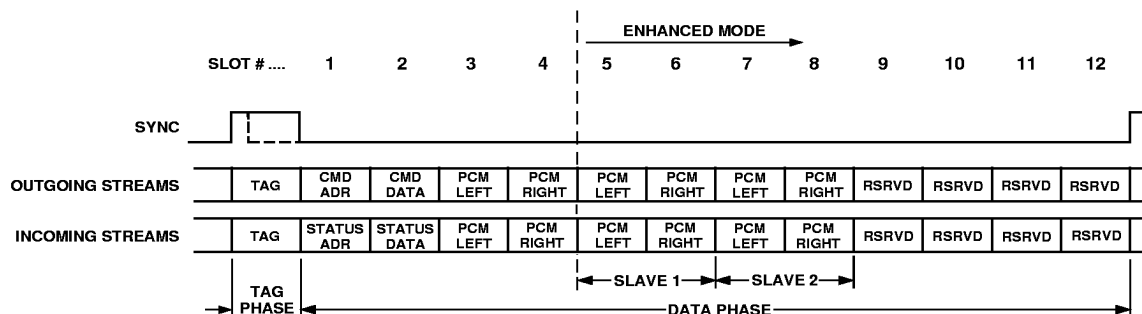


Figure 9. Standard Bidirectional Audio Frame

## AC Link Audio Output Frame (SDATA\_OUT)

The audio output frame data streams correspond to the multiplexed bundles of all digital output data targeting AD1819's DAC inputs and control registers. As briefly mentioned earlier, each audio output frame supports up to twelve 20-bit outgoing data time slots. Slot 0 is a special reserved time slot containing 16 bits that are used for AC Link protocol infrastructure.

Within Slot 0 the first bit is a global bit (SDATA\_OUT Slot 0, Bit 15), which flags the validity for the entire audio frame. If the “Valid Frame” bit is a 1, this indicates that the current audio frame contains at least one slot time of valid data. The next 12-bit positions sampled by AC '97 indicate which of the corresponding 12 time slots contain valid data. In this way input DAC data streams of differing sample rates can be transmitted across AC Link at its fixed 48 kHz audio frame rate. The following diagram illustrates the time-slot-based AC Link protocol.

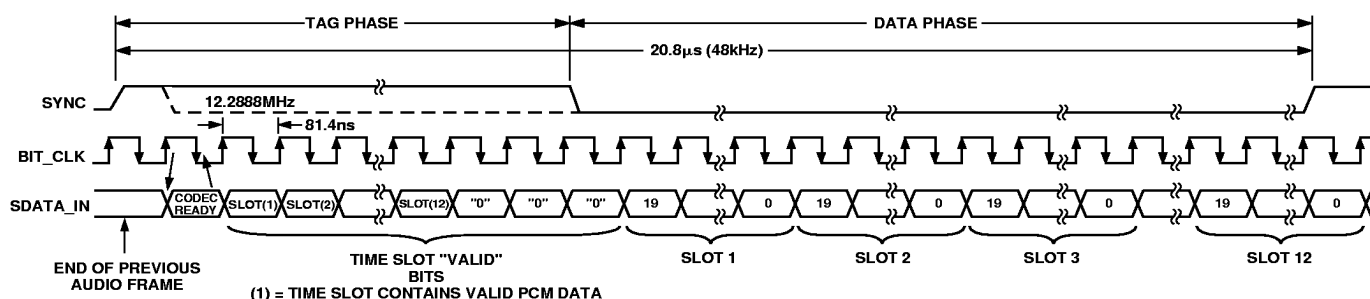


Figure 10. AC Link Audio Output Frame

A new audio output frame begins with a low-to-high transition of SYNC. SYNC is synchronous to the rising edge of BIT\_CLK. On the immediately following falling edge of BIT\_CLK, the AD1819 samples the assertion of SYNC. This falling edge marks the time when both sides of AC Link are aware of the start of a new audio frame. On the next rising of BIT\_CLK, the AC '97 controller transitions SDATA\_OUT into the first bit position of Slot 0 (Valid Frame Bit). Each new bit position is presented to AC Link on a rising edge of BIT\_CLK, and subsequently sampled by AD1819 on the following falling edge of BIT\_CLK. This sequence ensures that data transitions, and subsequent sample points for both incoming and outgoing data streams are time aligned.

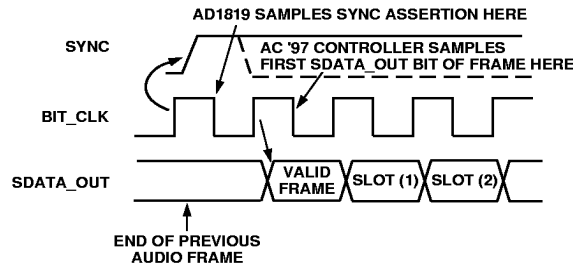


Figure 11. Start of an Audio Output Frame

SDATA\_OUT's composite stream is MSB justified (MSB first) with all nonvalid slots' bit positions stuffed with 0s by the AC '97 controller. The AD1819 ignores invalid slots.

In the event that there are less than 20 valid bits within an assigned and valid time slot, the AC '97 controller always stuffs all trailing nonvalid bit positions of the 20-bit slot with 0s. The AD1819 ignores unused bits.

As an example, consider an 8-bit sample stream being played out to one of AD1819's DACs. The first 8-bit positions are presented to the DAC (MSB justified), followed by the next 12 bit positions, which are stuffed with 0s by the AC '97 controller.

When mono audio sample streams are output from the AC '97 controller, it is necessary that BOTH left and right stream time slots be filled with the same data.

#### Slot 1: Command Address Port

The command port is used to control features and request status (see Audio Input Frame Slots 1 and 2) for AD1819 functions including, but not limited to, mixer settings and power management (refer to the control register section of this specification).

The control interface architecture supports up to sixty-four 16-bit read/write registers, addressable on even byte boundaries. Only the even registers (00h, 02h, etc.) are valid, odd register (01h, 03h, etc.) accesses are discouraged (defaulting to the preceding even byte boundary—i.e., a read to 01h will return the 16-bit contents of 00h). Note that shadowing of the control register file on the AC '97 controller is an option left open to the implementation of the AC '97 controller. The AD1819's control register file is readable as well as writable. Odd register addresses are mapped to the preceding even register address.

Audio output frame Slot 1 communicates control register address, and write/read command information to AD1819.

#### Command Address Port Bit Assignments:

|             |                        |  |
|-------------|------------------------|--|
| Bit (19)    | Read/Write Command     | (1 = Read, 0 = Write)                                    |
| Bit (18:12) | Control Register Index | (64 16-Bit Locations, Addressed On Even Byte Boundaries) |
| Bit (11:0)  | Reserved               | (Stuffed with 0s)  |

The first bit (MSB) sampled by the AD1819 indicates whether the current control transaction is a read or a write operation. The following 7-bit positions communicate the targeted control register address. The trailing 12-bit positions within the slot are reserved.

#### Slot 2: Command Data Port

The command data port is used to deliver 16-bit control register write data in the event that the current command port operation is a write cycle (as indicated by Slot 1, Bit 19).

|            |                             |   |
|------------|-----------------------------|---|
| Bit (19:4) | Control Register Write Data | (Stuffed with 0s If Current Operation Is Not a Write) |
| Bit (3:0)  | Reserved                    | (Stuffed with 0s)                                     |

If the current command port operation is not a write, the entire slot time should be stuffed with 0s by the AC '97 controller.

#### Slot 3: PCM Playback Left Channel

Audio output frame Slot 3 is the composite digital audio left playback stream. In a typical "Games Compatible" PC this slot is composed of standard PCM (.wav) output samples digitally mixed (on the AC '97 controller or host processor) with music synthesis output samples. If a sample stream of resolution less than 20 bits is transferred, the AC '97 controller should stuff all trailing nonvalid bit positions within this time slot with 0s.

#### Slot 4: PCM Playback Right Channel

Audio output frame Slot 4 is the composite digital audio right playback stream. In a typical "Games Compatible" PC this slot is composed of standard PCM (.wav) output samples digitally mixed (on the AC '97 controller or host processor) with music synthesis output samples. If a sample stream of resolution less than 20 bits is transferred, the AC '97 controller should stuff all trailing nonvalid bit positions within this time slot with 0s.

**Slot 5–Slot 8: Multicodec Communication**

- Slot 5 Slave 1 PCM Playback Left Channel
- Slot 6 Slave 1 PCM Playback Right Channel
- Slot 7 Slave 2 PCM Playback Left Channel
- Slot 8 Slave 2 PCM Playback Right Channel

**Slot 6–Slot 12: Reserved**

Audio output frame Slot 6 to Slot 12 are reserved for future use and should always be stuffed with 0s by the digital controller.

**AC Link Audio Input Frame (SDATA\_IN)**

The audio input frame data streams correspond to the multiplexed bundles of all digital input data targeting the AC '97 controller. As is the case for audio output frame, each AC Link audio input frame consists of twelve 20-bit time slots. Slot 0 is a special reserved time slot containing 16 bits used for AC Link protocol infrastructure.

Within Slot 0 the first bit is a global bit (SDATA\_IN Slot 0, Bit 15) which flags whether or not AD1819 is in the “Codec Ready” state. If the “Codec Ready” bit is a 0, this indicates that AD1819 is not ready for normal operation. This condition is normal following the deassertion of power-on reset, for example, while AD1819’s voltage references settle. When the AC Link “Codec Ready” indicator bit is a 1, it indicates that the AC Link and AD1819 control and status registers are in a fully operational state and all sub-sections are ready.

Prior to any attempts at putting AD1819 into operation the AC '97 controller should poll the first bit in the audio input frame (SDATA\_IN Slot 0, Bit 15) for an indication that the AD1819 has asserted “Codec Ready.” Once the AD1819 is sampled, “Codec Ready” is asserted the next 12-bit positions sampled by the AC '97 controller indicate which of the corresponding 12 time slots are assigned to input data streams and that they contain valid data. The following diagram illustrates the time-slot-based AC Link protocol

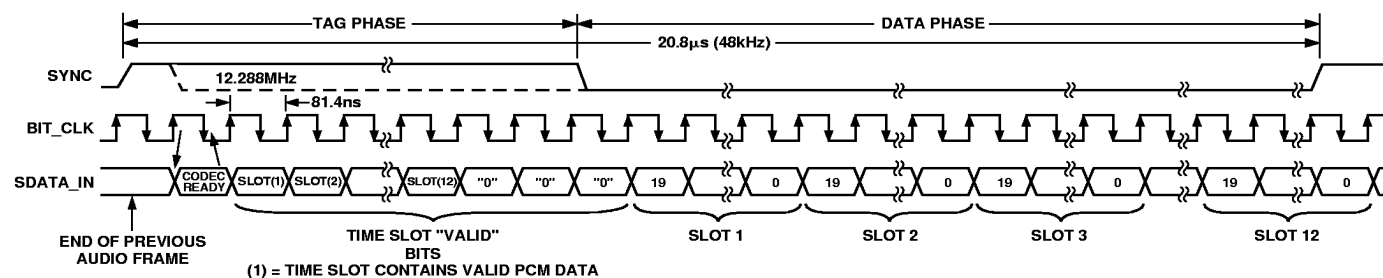


Figure 12. AC Link Audio Input Frame

A new audio input frame begins with a low-to-high transition of SYNC. SYNC is synchronous to the rising edge of BIT\_CLK. On the immediately following falling edge of BIT\_CLK, AD1819 samples the assertion of SYNC. This falling edge marks the time when both sides of AC Link are aware of the start of a new audio frame. On the next rising of BIT\_CLK, AD1819 transitions SDATA\_IN into the first bit position of Slot 0 (“Codec Ready” bit). Each new bit position is presented to AC Link on a rising edge of BIT\_CLK, and subsequently sampled by the AC '97 controller on the following falling edge of BIT\_CLK. This sequence ensures that data transitions, and subsequent sample points for both incoming and outgoing data streams, are time aligned.

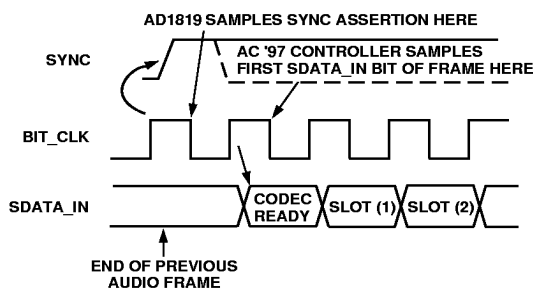


Figure 13. Start of an Audio Input Frame

SDATA\_IN’s composite stream is MSB justified (MSB first) with all nonvalid bit positions (for assigned and/or unassigned time slots) stuffed with 0s by AD1819. (SDATA\_IN data should be sampled on the falling edges of BIT\_CLK.)

**Slot 0: Tag Phase SDATA\_IN**

The AD1819 is capable of sampling data from 7 kHz to 48 kHz with a resolution of 1 kHz. To enable a sample rate other than the default 48 kHz, set the DRQEN bit (Register 74h Bit 11). This allows DAC request bits to be output on the SDATA\_IN stream. The digital controller should monitor the ADC valid bits to determine when the codec has valid data ready to send (these are low active).

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## ***TAG Phase Bit Assignments:***

|           |   |
|-----------|---|
| Bit (15)  | Codec Ready   |
| Bit (14)  | Slot 1 Valid  |
| Bit (13)  | Slot 2 Valid  |
| Bit (12)  | Slot 3 Valid/ADC Left Data Is Valid on Slot 3       |
| Bit (11)  | Slot 4 Valid/ADC Right Data Is Valid on Slot 4      |
| Bit (10)  | Slot 5 Valid/ADC Left Data Slave 1 Valid on Slot 5  |
| Bit (9)   | Slot 6 Valid/ADC Right Data Slave 1 Valid on Slot 6 |
| Bit (8)   | Slot 7 Valid/ADC Left Data Slave 2 Valid on Slot 7  |
| Bit (7)   | Slot 8 Valid/ADC Right Data Slave 2 Valid on Slot 8 |
| Bit (6:0) | Not Used  |

## ***Slot 1: Status Address Port***

The status port is used to monitor status for AD1819 functions including, but not limited to, mixer settings and power management.

Audio input frame Slot 1's stream echoes the control register index, for historical reference, for the data to be returned in Slot 2 (assuming that Slots 1 and 2 had been tagged "valid" by AD1819 during Slot 0).

## ***Status Address Port Bit Assignments:***

|             |                        |   |
|-------------|------------------------|---|
| Bit (19)    | RESERVED               | (Stuffed with 0)  |
| Bit (18:12) | Control Register Index | (Echo of Register Index for Which Data Is Being Returned) |
| Bit (11)    | DAC Request Slot 3     | (0 = Request, 1 = No Request)                             |
| Bit (10)    | DAC Request Slot 4     | (0 = Request, 1 = No Request)                             |
| Bit (9)     | DAC Request Slot 5     | (0 = Request, 1 = No Request); Slave 1                    |
| Bit (8)     | DAC Request Slot 6     | (0 = Request, 1 = No Request); Slave 1                    |
| Bit (7)     | DAC Request Slot 7     | (0 = Request, 1 = No Request); Slave 2                    |
| Bit (6)     | DAC Request Slot 8     | (0 = Request, 1 = No Request); Slave 2                    |
| Bit (5:0)   | RESERVED               | (Stuffed with 0s)   |

The first bit (MSB) generated by AD1819 is always stuffed with a 0. The following 7-bit positions communicate the associated control register address, and the trailing 12-bit positions are stuffed with 0s by AD1819.

## ***Slot 2: Status Data Port***

The status data port delivers 16-bit control register read data.

|            |                            |   |
|------------|----------------------------|---|
| Bit (19:4) | Control Register Read Data | (Stuffed with 0s If Tagged "Invalid" by AD1819) |
| Bit (3:0)  | RESERVED                   | (Stuffed with 0s)                               |

If Slot 2 is tagged "invalid" by AD1819, the entire slot will be stuffed with 0s by AD1819.

## ***Slot 3: PCM Record Left Channel***

Audio input frame Slot 3 is the left channel output of AD1819's input MUX, post-ADC.

AD1819 ships out its ADC output data (MSB first), and stuffs the trailing nonvalid bit positions with 0s to fill out its 20-bit time slot.

## ***Slot 4: PCM Record Right Channel***

Audio input frame Slot 4 is the right channel output of AD1819's input MUX, post-ADC.

AD1819 ships out its ADC output data (MSB first), and stuffs the trailing nonvalid bit positions with 0s to fill out its 20-bit time slot.

## ***Slot 5–Slot 8: Multicodec Communication***

- Slot 5 Slave 1 PCM Record Left Channel
- Slot 6 Slave 1 PCM Record Right Channel
- Slot 7 Slave 2 PCM Record Left Channel
- Slot 8 Slave 2 PCM Record Right Channel

## ***Slot 9–Slot 12: Reserved***

Audio input frame Slots 9–12 are reserved for future use and are always stuffed with 0s by AD1819.

## ***AC Link Low Power Mode***

The AC Link signals can be placed in a low power mode. When AD1819's Power-Down Register (26h) is programmed to the appropriate value, both BIT\_CLK and SDATA\_IN will be brought to a logic low voltage level.

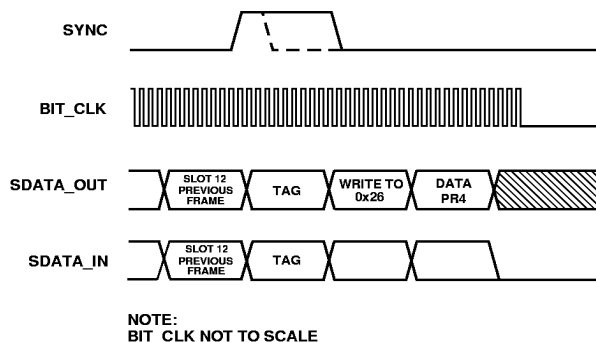


Figure 14. AC Link Power-Down Timing

BIT\_CLK and SDATA\_IN are transitioned low immediately<sup>1</sup> following the decode of the write to the Power-Down Register (26h) with PR4. When the AC '97 controller driver is at the point where it is ready to program the AC Link into its low power mode, Slots (1 and 2) must be the only valid stream in the audio output frame<sup>2</sup>.

The AC '97 controller should also drive SYNC and SDATA\_OUT low after programming AD1819 to this low power “halted” mode.

Once AD1819 has been instructed to halt BIT\_CLK, a special “wake-up” protocol must be used to bring the AC Link to the active mode, since normal audio output and input frames can not be communicated in the absence of BIT\_CLK.

#### Waking up the AC Link

There are two methods for bringing the AC Link out of a low power, halted mode. Regardless of the method, it is the AC '97 controller that performs the wake-up task.

AC Link protocol provides for a “Cold AC '97 Reset,” and a “Warm AC '97 Reset.” The current power-down state would ultimately dictate which form of AC '97 reset is appropriate. Unless a “cold” or “register” reset (a write to the Reset Register) is performed, wherein the AD1819 registers are initialized to their default values, registers are required to keep state during all power-down modes. The Serial Configuration Register (0x74) maintains state during a register reset.

Once powered down, reactivation of the AC Link via reassertion of the SYNC signal may be immediate. When the AD1819 powers up, it indicates readiness via the Codec Ready Bit (Input Slot 0, Bit 15).

#### Cold AC '97 Reset

A cold reset is achieved by asserting  $\overline{\text{RESET}}$  for at least the minimum specified time. By driving  $\overline{\text{RESET}}$ , BIT\_CLK and SDATA\_OUT will be activated, and all AD1819 control registers will be initialized to their default power-on reset values.

$\overline{\text{RESET}}$  is an asynchronous AD1819 input.

#### Warm AC '97 Reset

A warm AC '97 reset will reactivate the AC Link without altering the current AD1819 register values. A warm reset is signaled by driving SYNC high for a minimum of 1  $\mu\text{s}$  in the absence of BIT\_CLK.

Within normal audio frames SYNC is a synchronous AD1819 input. In the absence of BIT\_CLK, however, SYNC is treated as an asynchronous input used in the generation of a warm reset to the AD1819.

# AD1819

## MULTIPLE CODE CONFIGURATION

### Setting Up Multiple Codecs

The AD1819 may be used with up to two additional AD1819 codecs. In order to configure the codecs as Master, Slave 1 or Slave 2, refer to the following table.

| CS1 | CS0 | Configuration     |
|-----|-----|-------------------|
| 0   | 0   | Slave 1 Codec     |
| 0   | 1   | Slave 2 Codec     |
| 1   | 0   | Master Codec      |
| 1   | 1   | AC '97 Mode Codec |

0 = Ground; 1 = V<sub>DD</sub>.

XTALI pin on the Slave Codecs “must” be tied to ground and the CHAIN\_IN pin “must” be tied to ground on the last codec Slave 1 (on a 2-codec design) or SLAVE 2 (on a 3-codec design). See Figures 9 and 10.

### Configure the Codec Resources

Programing REGM (2:0) bits in the Serial Configuration Register (74h) allows the digital controller read write access to all the internal registers on each codec according to the following table.

| REGM2 | REGM1 | REGM0 | Read    | Write                    |
|-------|-------|-------|---------|--------------------------|
| 0     | 0     | 0     | x       | x                        |
| 0     | 0     | 1     | Master  | Master                   |
| 0     | 1     | 0     | Slave 1 | Slave 1                  |
| 0     | 1     | 1     | Master  | Master, Slave 1          |
| 1     | 0     | 0     | Slave 2 | Slave 2                  |
| 1     | 0     | 1     | Master  | Master, Slave 2          |
| 1     | 1     | 0     | Slave 1 | Slave 1, Slave 2         |
| 1     | 1     | 1     | Master  | Master, Slave 1, Slave 2 |



## APPLICATIONS CIRCUITS

The AD1819 has been designed to require a minimum number of external circuitry. The recommended applications circuits are shown in Figures 15–18. Reference designs for the AD1819 are available and may be obtained by contacting your local Analog Devices' sales representative or authorized distributor. Example shell programs for establishing a communications path between the AD1819 and an ADSP-21xx are also available.

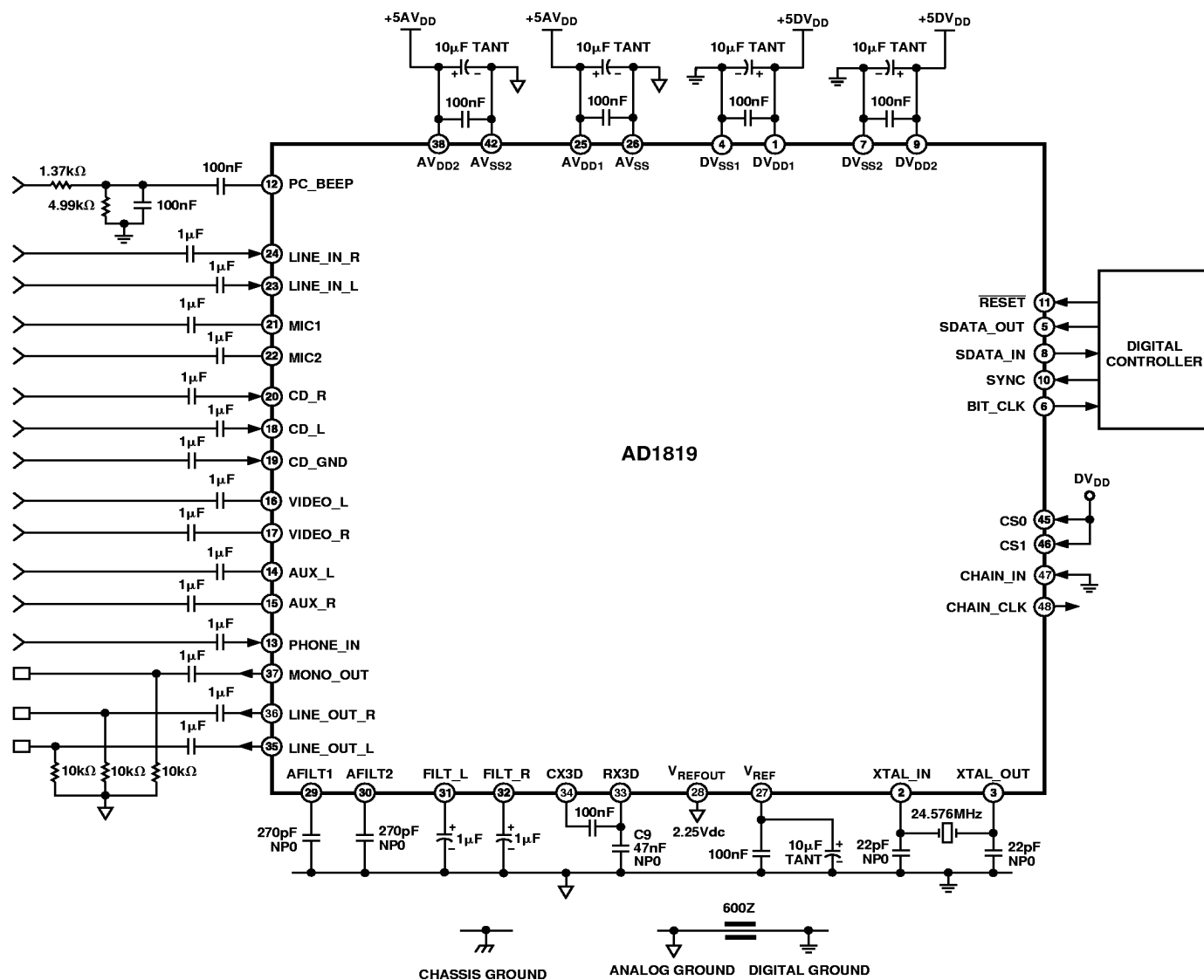


Figure 15. Recommended One Codec Application Circuit

# AD1819

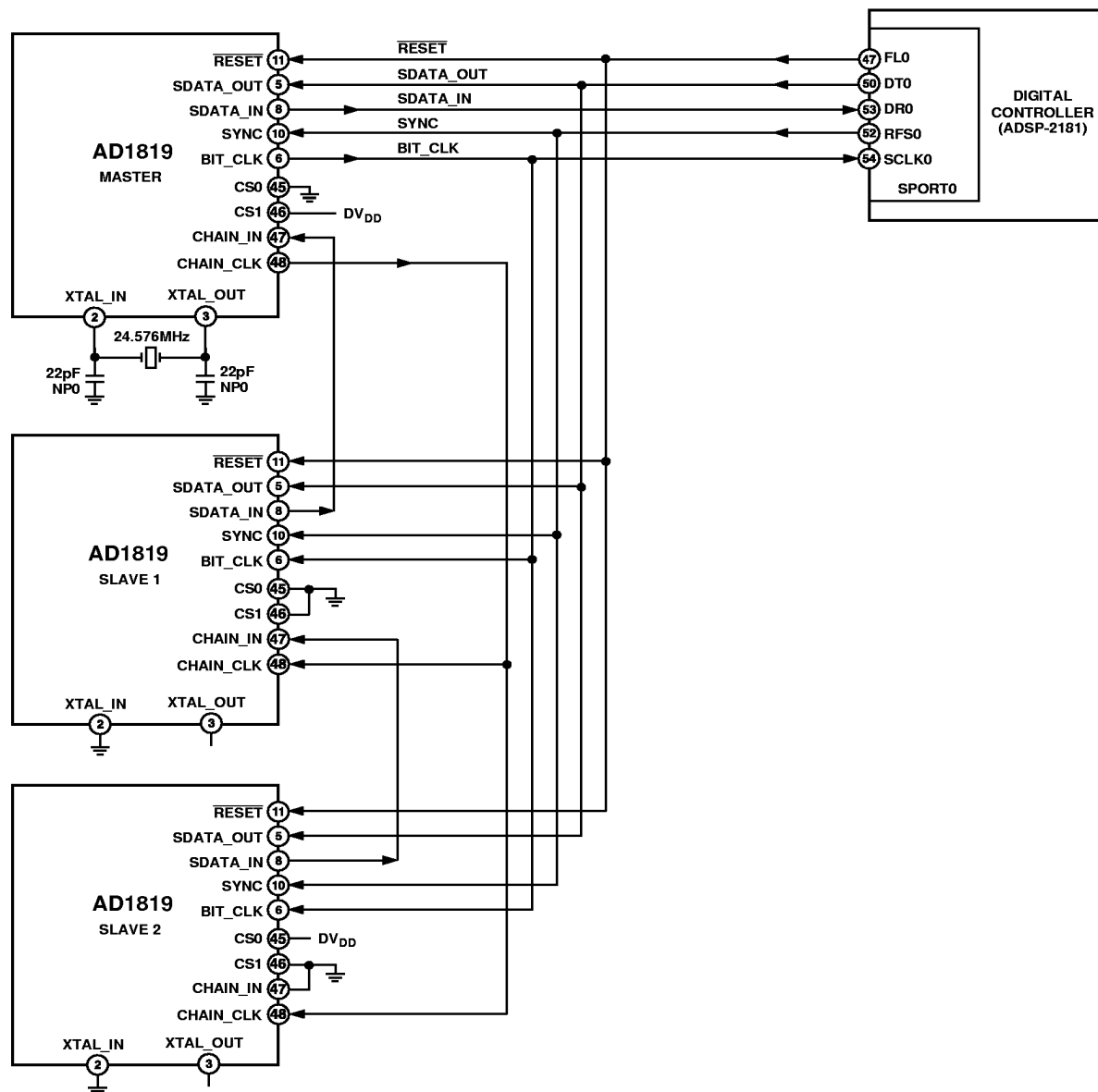


Figure 16. Three Codec System Example

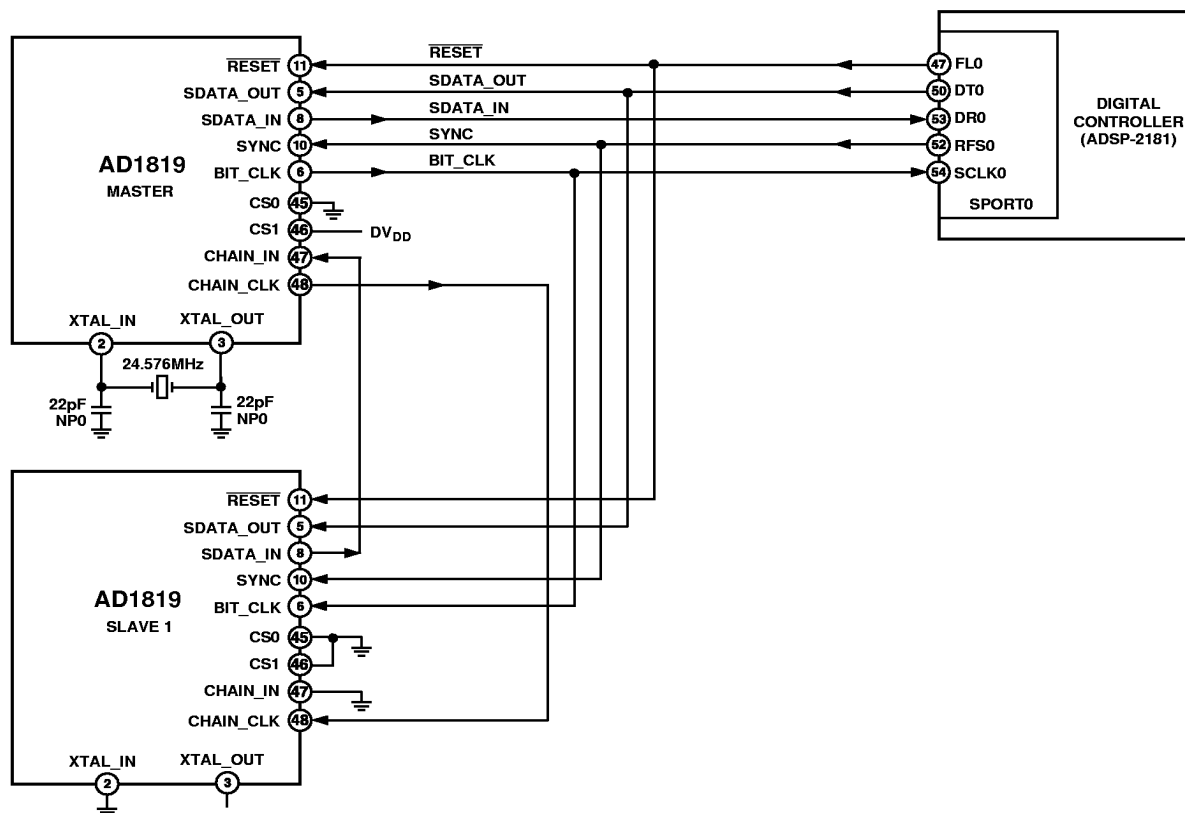


Figure 17. Two Codec System Example

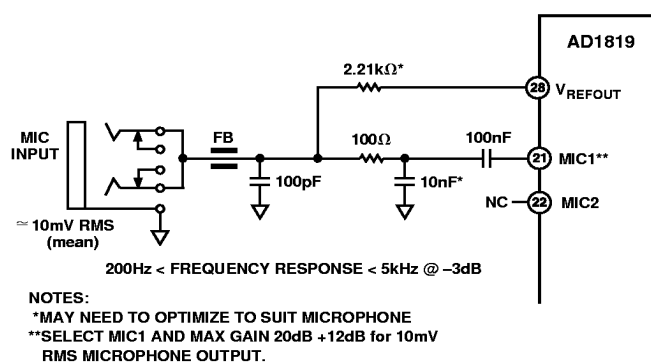
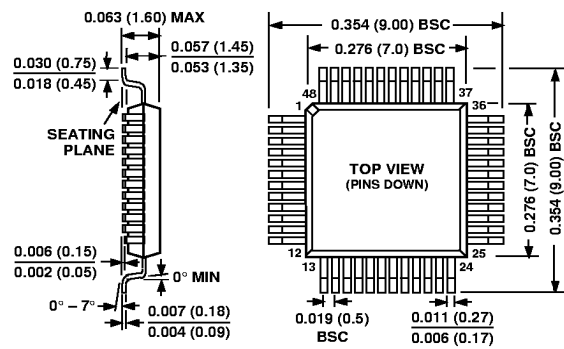


Figure 18. Microphone Input

OUTLINE DIMENSIONS  
Dimensions shown in inches and (mm).

48-Terminal TQFP  
(ST-48)



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