

AD1851/AD1861

FEATURES

- 110 dB SNR**
- Fast Settling Permits $16 \times$ Oversampling**
- ± 3 V Output**
- Optional Trim Allows Super-Linear Performance**
- ± 5 V Operation**
- 16-Pin Plastic DIP and SOIC Packages**
- Pin-Compatible with AD1856 & AD1860 Audio DACs**
- 2s Complement, Serial Input**

APPLICATIONS

- High-End Compact Disc Players**
- Digital Audio Amplifiers**
- DAT Recorders and Players**
- Synthesizers and Keyboards**

PRODUCT DESCRIPTION

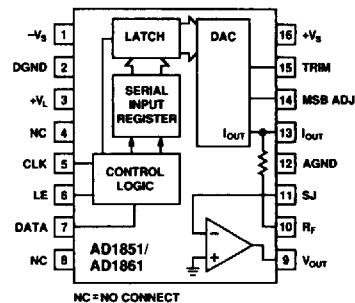
The AD1851/AD1861 is a monolithic PCM audio DAC. The AD1851 is a 16-bit device, while the AD1861 is an 18-bit device. Each device provides a voltage output amplifier, DAC, serial-to-parallel register and voltage reference. The digital portion of the AD1851/AD1861 is fabricated with CMOS logic elements that are provided by Analog Devices' 2 μ m ABCMOS process. The analog portion of the AD1851/AD1861 is fabricated with bipolar and MOS devices as well as thin-film resistors.

This combination of circuit elements, as well as careful design and layout techniques, results in high performance audio playback. Laser-trimming of the linearity error affords low total harmonic distortion. An optional linearity trim pin is provided to allow residual differential linearity error at midscale to be eliminated. This feature is particularly valuable for low distortion reproductions of low amplitude signals. Output glitch is also small, contributing to the overall high level of performance. The output amplifier achieves fast settling and high slew rates, providing a full ± 3 V signal at load currents up to 8 mA. When used in current output mode, the AD1851/AD1861 provides a ± 1 mA output signal. The output amplifier is short circuit protected and can withstand indefinite shorts to ground.

The serial input interface consists of the clock, data and latch enable pins. The serial 2s complement data word is clocked into the DAC, MSB first, by the external clock. The latch enable signal transfers the input word from the internal serial input register to the parallel DAC input register. The AD1851 input clock can support a 12.5 MHz data rate, while the AD1861 input clock can support a 13.5 MHz data rate. This serial input port is compatible with second generation digital filter chips used in consumer audio products. These filters operate at oversampling rates of $2 \times$, $4 \times$, $8 \times$ and $16 \times$ sampling frequencies.

The critical specifications of THD+N and signal-to-noise ratio are 100% tested for all devices.

FUNCTIONAL BLOCK DIAGRAM



The AD1851/AD1861 operates with ± 5 V power supplies, making it suitable for home use markets. The digital supply, V_L , can be separated from the analog supplies, V_S and $-V_S$, for reduced digital crosstalk. Separate analog and digital ground pins are also provided. Power dissipation is 100 mW typical.

The AD1851/AD1861 is available in either a 16-pin plastic DIP or a 16-pin plastic SOIC package. Both packages incorporate the industry standard pinout found on the AD1856 and AD1860 PCM audio DACs. As a result, the AD1851/AD1861 is a drop-in replacement for designs where ± 5 V supplies have been used with the AD1856/AD1860. Operation is guaranteed over the temperature range of -25°C to $+70^\circ\text{C}$ and over the voltage supply range of ± 4.75 V to ± 5.25 V.

PRODUCT HIGHLIGHTS

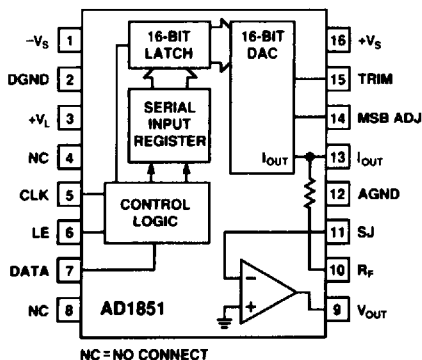
1. AD1851 16-bit resolution provides 96 dB dynamic range. AD1861 18-bit resolution provides 108 dB dynamic range.
2. No external components are required.
3. Operates with ± 5 V supplies.
4. Space saving 16-pin SOIC and plastic DIP packages.
5. 100 mW power dissipation.
6. High input clock data rates and 1.5 μ s settling time permits $2 \times$, $4 \times$, $8 \times$ and $16 \times$ oversampling.
7. ± 3 V or ± 1 mA output capability.
8. THD + Noise and SNR are 100% tested.
9. Pin-compatible with AD1856 & AD1860 PCM audio DACs.

This is an abridged data sheet. To obtain the most complete, current version, call our DSP Bulletin Board Service at 617-461-4258 (8 data bits, no parity, 1 stop bit, 300/1200/2400/9600/14400 baud).

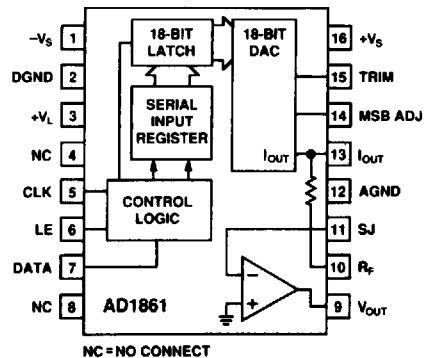
AD1851/AD1861 — SPECIFICATIONS (T_A @ +25°C and ±5 V supplies, unless otherwise noted)

	Min	Typ	Max	Units
DIGITAL INPUTS				
V_{IH}	2.0		+ V_L	V
V_{IL}			0.8	V
$I_{IH}, V_{IH} = V_L$			1.0	μA
$I_{IL}, V_{IL} = 0.4$			-10	μA
ACCURACY				
Gain Error		±1		%
Midscale Output Voltage		±10		mV
DRIFT (0°C to +70°C)				
Total Drift		±25		ppm of FSR/°C
Bipolar Zero Drift		±4		ppm of FSR/°C
SETTLING TIME (T_o ±0.0015% of FSR)				
Voltage Output				
6 V Step		1.5		μs
1 LSB Step		1.0		μs
Slew Rate		9		V/μs
Current Output				
1 mA Step 10 Ω to 100 Ω Load		350		ns
1 kΩ Load		350		ns
OUTPUT				
Voltage Output Configuration				
Bipolar Range	±2.88	±3.0	±3.12	V
Output Current	±8			mA
Output Impedance		0.1		Ω
Short Circuit Duration		Indefinite to Common		
Current Output Configuration				
Bipolar Range (±30%)		±1.0		mA
Output Impedance (±30%)		1.7		kΩ
POWER SUPPLY				
Voltage				
+ V_L and + V_S	4.75		5.25	V
- V_S	-5.25		-4.75	V
TEMPERATURE RANGE				
Specification	0	+25	+70	°C
Operation	-25		+70	°C
Storage	-60		+100	°C
WARMUP TIME				
	1			min

Specifications subject to change without notice.



AD1851 Functional Block Diagram



AD1861 Functional Block Diagram

AD1851

	Min	Typ	Max	Units
RESOLUTION			16	Bits
TOTAL HARMONIC DISTORTION + NOISE				
0 dB, 990.5 Hz				
AD1851N-J, R-J		0.003	0.004	%
AD1851N, R		0.004	0.008	%
-20 dB, 990.5 Hz				
AD1851N-J, R-J		0.009	0.016	%
AD1851N, R		0.009	0.040	%
-60 dB, 990.5 Hz				
AD1851N-J, R-J		0.9	1.6	%
AD1851N, R		0.9	4.0	%
D-RANGE* (With A-Weight Filter)				
-60 dB, 990.5 Hz AD1851N, R	88			dB
AD1851N-J, R-J	96			dB
SIGNAL-TO-NOISE RATIO	107	110		dB
MAXIMUM CLOCK INPUT FREQUENCY	12.5			MHz
ACCURACY				
Differential Linearity Error		±0.001		% of FSR
MONOTONICITY		14		Bits
POWER SUPPLY				
Current				
+I		10.0	13.0	mA
-I		-10.0	-15.0	mA
Power Dissipation		100		mW

AD1861

	Min	Typ	Max	Units
RESOLUTION			18	Bits
TOTAL HARMONIC DISTORTION + NOISE				
0 dB, 990.5 Hz				
AD1861N-J, R-J		0.003	0.004	%
AD1861N, R		0.004	0.008	%
-20 dB, 990.5 Hz				
AD1861N-J, R-J		0.009	0.016	%
AD1861N, R		0.009	0.040	%
-60 dB, 990.5 Hz				
AD1861N-J, R-J		0.9	1.6	%
AD1861N, R		0.9	4.0	%
D-RANGE* (With A-Weight Filter)				
-60 dB, 990.5 Hz AD1861N, R	88			dB
AD1861N-J, R-J	96			dB
SIGNAL-TO-NOISE RATIO	107	110		dB
MAXIMUM CLOCK INPUT FREQUENCY	13.5			MHz
ACCURACY				
Differential Linearity Error		±0.001		% of FSR
MONOTONICITY		15		Bits
POWER SUPPLY				
Current				
+I		10.0	13.0	mA
-I		-10.0	-15.0	mA
Power Dissipation		100		mW

*Tested in accordance with EIAJ Test Standard CP-307.
 Specifications subject to change without notice.

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DIGITAL AUDIO 4-7

AD1851/AD1861

ABSOLUTE MAXIMUM RATINGS*

V_L to DGND	0 V to 6.50 V
V_S to AGND	0 V to 6.50 V
$-V_S$ to AGND	-6.50 V to 0 V
Digital Inputs to DGND	-0.3 V to V_L
AGND to DGND	± 0.3 V
Short Circuit	Indefinite Short to Ground
Soldering	+300°C, 10 sec
Storage Temperature	-60°C to +100°C

*Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and 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.

PIN ASSIGNMENTS

1	$-V_S$	ANALOG NEGATIVE POWER SUPPLY
2	DGND	LOGIC GROUND
3	V_L	LOGIC POSITIVE POWER SUPPLY
4	NC	NO CONNECTION
5	CLK	CLOCK INPUT
6	LE	LATCH ENABLE INPUT
7	DATA	SERIAL DATA INPUT
8	NC	NO INTERNAL CONNECTION*
9	V_{OUT}	VOLTAGE OUTPUT
10	R_F	FEEDBACK RESISTOR
11	SJ	SUMMING JUNCTION
12	AGND	ANALOG GROUND
13	I_{OUT}	CURRENT OUTPUT
14	MSB ADJ	MSB ADJUSTMENT TERMINAL
15	TRIM	MSB TRIMMING POTENTIOMETER TERMINAL
16	V_S	ANALOG POSITIVE POWER SUPPLY

*PIN 8 HAS NO INTERNAL CONNECTION: $-V_L$ FROM AD1856 OR AD1860 SOCKET CAN BE SAFELY APPLIED.

CAUTION

ESD (electrostatic discharge) sensitive device. The digital control inputs are diode protected; however, permanent damage may occur on unconnected devices subject to high energy electrostatic fields. Unused devices must be stored in conductive foam or shunts. The protective foam should be discharged to the destination socket before devices are inserted.

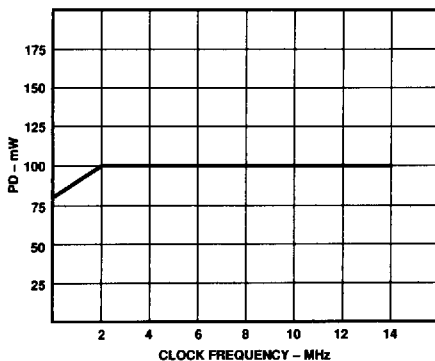


ORDERING GUIDE

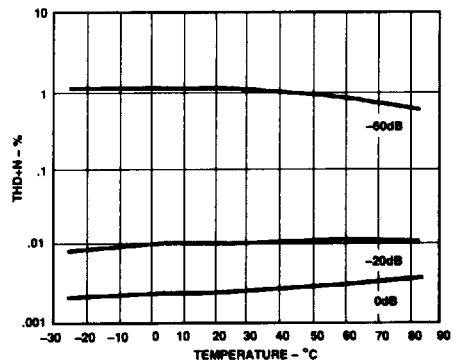
Model	Resolution	THD+N	Package Option*
AD1851N	16 Bits	0.008%	N-16
AD1851N-J	16 Bits	0.004%	N-16
AD1851R	16 Bits	0.008%	R-16
AD1851R-J	16 Bits	0.004%	R-16
AD1861N	18 Bits	0.008%	N-16
AD1861N-J	18 Bits	0.004%	N-16
AD1861R	18 Bits	0.008%	R-16
AD1861R-J	18 Bits	0.004%	R-16

*N = Plastic DIP Package; R = Small Outline (SOIC) Package.
For outline information see Package Information section.

Typical Performance



Power Dissipation vs. Clock Frequency



THD vs. Temperature