

FEATURES

DC Performance

- 400 μA max Quiescent Current
- 10 pA max Bias Current, Warmed Up (AD648B)
- 1 μV max Offset Voltage (AD648B)
- 10 $\mu\text{V}/^\circ\text{C}$ max Drift (AD648B)
- 2 μV p-p Noise, 0.1 Hz to 10 Hz

AC Performance

- 1.8 V/ μs Slew Rate
- 1 MHz Unity Gain Bandwidth

Available in Plastic Mini-DIP, Cerdip, and Plastic SOIC Packages

MIL-STD-883B Parts Available

Surface Mount (SOIC) Package Available in Tape and Reel in Accordance with EIA-481A Standard
Single Version: AD548

PRODUCT DESCRIPTION

The AD648 is a matched pair of low power, precision monolithic operational amplifiers. It offers both low bias current (10 pA max, warmed up) and low quiescent current (400 μA max) and is fabricated with ion-implanted FET and laser wafer trimming technologies. Input bias current is guaranteed over the AD648's entire common-mode voltage range.

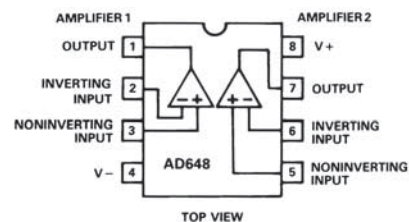
The economical J grade has a maximum guaranteed offset voltage of less than 2 mV and an offset voltage drift of less than 20 $\mu\text{V}/^\circ\text{C}$. This level of dc precision is achieved using Analog's laser wafer drift trimming process. The combination of low quiescent current and low offset voltage drift minimizes changes in input offset voltage due to self-heating effects. Five grades are offered over the commercial, industrial and military temperature ranges.

The AD648 is recommended for any dual supply op amp application requiring low power and excellent dc and ac performance. In applications such as battery-powered, precision instrument front ends and CMOS DAC buffers, the AD648's excellent combination of low input offset voltage and drift, low bias current, and low 1/f noise reduces output errors. High common-mode rejection (82 dB, min on the "B" grade) and high open-loop gain ensures better than 12-bit linearity in high impedance, buffer applications.

The AD648 is pinned out in a standard dual op amp configuration and is available in seven performance grades. The AD648J and AD648K are rated over the commercial temperature range of 0°C to 70°C. The AD648 and AD648B are rated over the industrial temperature range of -40°C to +85°C. The AD648S and AD648T are rated over the military temperature range of

CONNECTION DIAGRAM

Plastic Mini-Dip (N) Package,
Plastic SOIC (R) Package
and
CERDIP (Q) Package



-55°C to +125°C and the AD648T* grade is available processed to MIL-STD-883B, Rev. C.

The AD648 is available in an 8-lead plastic mini-DIP, Cerdip, and SOIC.

*Not for new design, obsolete April 2002.

PRODUCT HIGHLIGHTS

1. A combination of low supply current, excellent dc and ac performance and low drift makes the AD648 the ideal op amp for high performance, low power applications.
2. The AD648 is pin compatible with industry standard dual op amps such as the LF442, TL062, and AD642, enabling designers to improve performance while achieving a reduction in power dissipation of up to 85%.
3. Guaranteed low input offset voltage (2 mV max) and drift (20 $\mu\text{V}/^\circ\text{C}$ max) for the AD648J are achieved using Analog Devices' laser drift trimming technology.
4. Analog Devices specifies each device in the warmed-up condition, insuring that the device will meet its published specifications in actual use.
5. Matching characteristics are excellent for all grades. The input offset voltage matching between amplifiers in the AD648J is within 2 mV.
6. Crosstalk between amplifiers is less than -120 dB at 1 kHz.

AD648—SPECIFICATIONS (@ + 25°C and $V_S = \pm 15$ V dc, unless otherwise noted.)

Model	AD648J/A/S			AD648K/B/T			Unit
	Min	Typ	Max	Min	Typ	Max	
INPUT OFFSET VOLTAGE¹							
Initial Offset		0.75	2.0		0.3	1.0	mV
T_{MIN} to T_{MAX} vs. Temperature			3.0/3.0/3.0			1.5/1.5/2.0	$\mu\text{V}/^\circ\text{C}$
vs. Supply	80		20	86		10	dB
vs. Supply, T_{MIN} to T_{MAX}	76/76/76			80			dB
Long-Term Offset Stability		15			15		$\mu\text{V}/\text{month}$
INPUT BIAS CURREN							
Either Input, ² $V_{CM} = 0$		5	20		3	10	pA
Either Input ² at T_{MAX} , $V_{CM} = 0$			0.45/1.3/20			0.25/0.65/10	nA
Max Input Bias Current Over Common-Mode Voltage Range			30			15	pA
Offset Current, $V_{CM} = 0$		5	10		2	5	pA
Offset Current at T_{MAX}			0.25/0.7/10			0.15/0.35/5	nA
MATCHING CHARACTERISTICS³							
Input Offset Voltage		1.0	2.0		0.5	1.0	mV
Input Offset Voltage T_{MIN} to T_{MAX}			3.0/3.0/3.0			1.5/1.5/2.0	mV
Input Offset Voltage vs. Temperature		8			5		$\mu\text{V}/^\circ\text{C}$
Input Bias Current			10			5	pA
Crosstalk		-120			-120		dB
INPUT IMPEDANCE							
Differential		$1 \times 10^{12} \parallel 3$			$1 \times 10^{12} \parallel 3$		$\Omega \parallel \text{pF}$
Common Mode		$3 \times 10^{12} \parallel 3$			$3 \times 10^{12} \parallel 3$		$\Omega \parallel \text{pF}$
INPUT VOLTAGE RANGE							
Differential ⁴		± 20			± 20		V
Common Mode	± 11	± 12		± 11	± 12		V
Common-Mode Rejection							dB
$V_{CM} = \pm 10$ V	76			82			dB
T_{MIN} to T_{MAX}	76/76/76			82			dB
$V_{CM} = \pm 11$ V	70			76			dB
T_{MIN} to T_{MAX}	70/70/70			76			dB
INPUT VOLTAGE NOISE							
Voltage 0.1 Hz to 10 Hz		2			2		$\mu\text{V p-p}$
$f = 10$ Hz		80			80		$\text{nV}/\sqrt{\text{Hz}}$
$f = 100$ Hz		40			40		$\text{nV}/\sqrt{\text{Hz}}$
$f = 1$ kHz		30			30		$\text{nV}/\sqrt{\text{Hz}}$
$f = 10$ kHz		30			30		$\text{nV}/\sqrt{\text{Hz}}$
INPUT CURRENT NOISE							
$f = 1$ kHz		1.8			1.8		$\text{fA}/\sqrt{\text{Hz}}$
FREQUENCY RESPONSE							
Unity Gain, Small Signal	0.8	1.0		0.8	1.0		MHz
Full Power Response		30			30		kHz
Slew Rate, Unity Gain	1.0	1.8		1.0	1.8		V/ μs
Settling Time to $\pm 0.01\%$		8			8		μs
OPEN-LOOP GAIN							
$V_O = \pm 10$ V, $R_L \geq 10$ k Ω	300	1000		300	1000		V/mV
T_{MIN} to T_{MAX} , $R_L \geq 10$ k Ω	300/300/300	700		300	700		V/mV
$V_O = \pm 10$ V, $R_L \geq 5$ k Ω	150	500		150	500		V/mV
T_{MIN} to T_{MAX} , $R_L \geq 5$ k Ω	150/150/150	300		150	300		V/mV

SPECIFICATIONS (Continued)

Model	AD648J/A/S			AD648K/B/T			Unit
	Min	Typ	Max	Min	Typ	Max	
OUTPUT CHARACTERISTICS							
Voltage @ $R_L \geq 10 \text{ k}\Omega$, T_{MIN} to T_{MAX}	$\pm 12/\pm 12/\pm 12$			± 12 ± 13			V
Voltage @ $R_L \geq 5 \text{ k}\Omega$, T_{MIN} to T_{MAX}	$\pm 11/\pm 11/\pm 11$			± 11 ± 12			V
Short Circuit Current	15			15			mA
POWER SUPPLY							
Rated Performance	± 15			± 15			V
Operating Range	± 4.5		± 18	± 4.5		± 18	V
Quiescent Current (Both Amplifiers)	340 400			340 400			μA
TEMPERATURE RANGE							
Operating, Rated Performance							
Commercial (0°C to 70°C)	AD648J			AD648K			
Industrial (-40°C to $+85^\circ\text{C}$)	AD648A			AD648B			
Military (-55°C to $+125^\circ\text{C}$)	AD648S			AD648T			
PACKAGE OPTIONS							
SOIC (R-8)	AD648JR			AD648KR			
Plastic (N-8)	AD648JN			AD648KN			
CERDIP (Q-8)	AD648AQ ⁵ , AD648SQ ⁵			AD648BQ ⁵ , AD648TQ/883B ⁵			
Tape and Reel	AD648JR-REEL, AD648JR-REEL7			AD648KR-REEL, AD648KR-REEL7			

NOTES

¹Input Offset Voltage specifications are guaranteed after five minutes of operation at $T_A = 25^\circ\text{C}$.

²Bias Current specifications are guaranteed maximum at either input after five minutes of operation at $T_A = 25^\circ\text{C}$. For higher temperature, the current doubles every 10°C .

³Matching is defined as the difference between parameters of the two amplifiers.

⁴Defined as voltages between inputs, such that neither exceeds $\pm 10 \text{ V}$ from ground.

⁵Not for new design. Obsolete April 2002.

Specifications subject to change without notice.

AD648

ABSOLUTE MAXIMUM RATINGS¹

Supply Voltage	±18 V
Internal Power Dissipation ²	500 mW
Input Voltage ³	±18 V
Output Short Circuit Duration	Indefinite
Differential Input Voltage	+V _S and -V _S
Storage Temperature Range (Q, H)	-65°C to +150°C
(N, R)	-65°C to +125°C
Operating Temperature Range	
AD648J/K	0°C to 70°C
AD648A/B	-40°C to +85°C
AD648S/T	-55°C to +125°C
Lead Temperature Range (Soldering 60 sec)	300°C

NOTES

¹Stresses above 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.

²Thermal Characteristics:

8-Pin Plastic Package: $\theta_{JA} = 165^{\circ}\text{C}/\text{Watt}$

8-Pin CERDIP Package: $\theta_{JC} = 22^{\circ}\text{C}/\text{Watt}$; $\theta_{JA} = 110^{\circ}\text{C}/\text{Watt}$

8-Pin SOIC Package: $\theta_{JC} = 42^{\circ}\text{C}/\text{Watt}$; $\theta_{JA} = 160^{\circ}\text{C}/\text{Watt}$

³For supply voltages less than ±18 V, the absolute maximum input voltage is equal to the supply voltage.

CAUTION

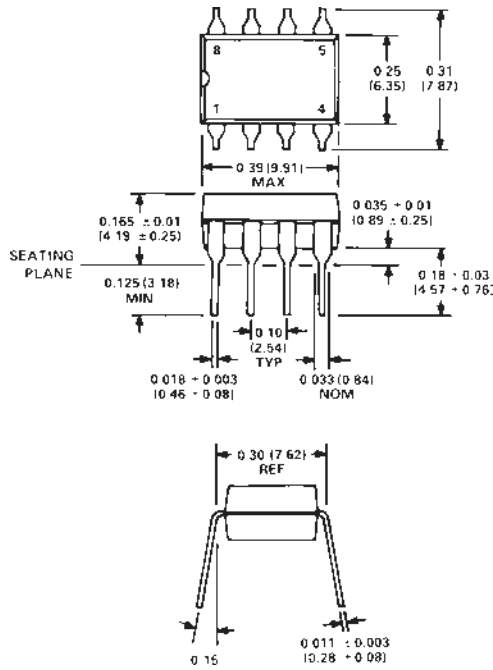
ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the AD648 features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high-energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



OUTLINE DIMENSIONS

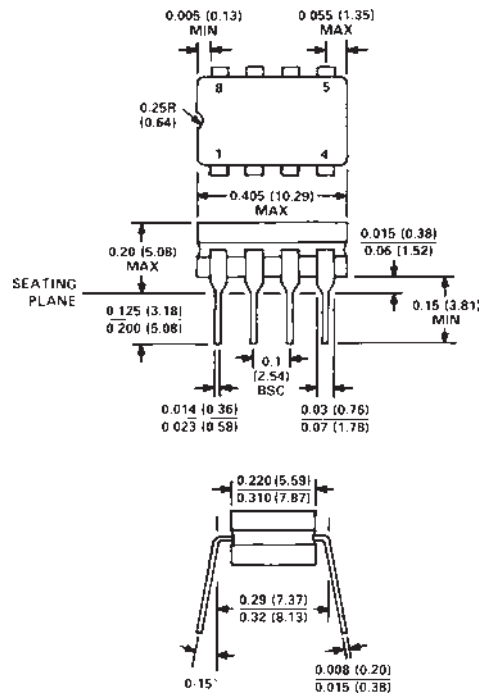
Mini-DIP (N) Package

Dimensions shown in inches and (millimeters)



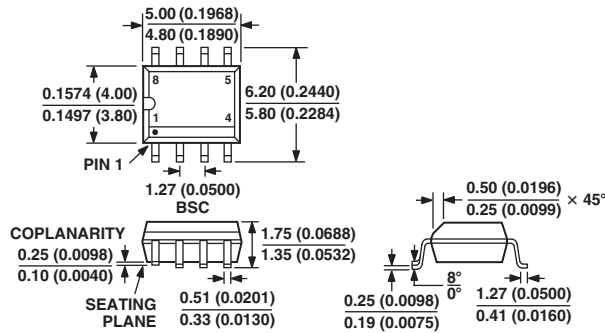
CERDIP (Q) Package

Dimensions shown in inches and (millimeters)



8-Lead SOIC (R) Package

Dimensions shown in millimeters and (inches)



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