



1.8 nV/ $\sqrt{\text{Hz}}$, 36 V Precision Single and Dual Amplifier

Preliminary Technical Data

ADA4004-1 and ADA4004-2

FEATURES

- Very low voltage noise: 1.8 nV/ $\sqrt{\text{Hz}}$
- Low input bias current: 100 nA maximum
- Offset voltage: 100 μV maximum
- High gain: 120 dB
- Wide bandwidth: 12 MHz
- $\pm 5\text{ V}$ to $\pm 15\text{ V}$ operation

APPLICATIONS

- Precision instrumentation
- Filter blocks
- Microphone preamplifier
- Industrial control
- Thermocouples and RTDs
- Reference buffers

GENERAL DESCRIPTION

The ADA4004-1 and ADA4004-2 are single and dual precision bipolar op amps that featuring a 1.8 nV/ $\sqrt{\text{Hz}}$ precision, 40 μV offset, 0.7 $\mu\text{V}/^\circ\text{C}$ drift, 12 MHz bandwidth, and low 1.7 mA/amplifier supply current.

The ADA4004 is designed on the high performance *iPolar*[™] process, enabling improvements such as reduced noise and power consumption, increased speed and stability, and a smaller footprint size. Novel design techniques enable the ADA4004 to achieve 1.8 nV/ $\sqrt{\text{Hz}}$ voltage noise density and a low 6 Hz 1/f noise corner frequency while consuming just 1.7 mA/amplifier. The small package saves board space, reduces cost, and improves layout flexibility.

Applications for these amplifiers include high precision controls, PLL filters, high performance precision filters, medical and analytical instrumentation, precision power supply controls, ATE, and data acquisition systems.

The high performance ADA4004 is offered in the very small 5-lead SOT and 8-lead SOIC for the single (ADA4004-1) and the 8-lead MSOP for the dual (ADA4004-2), lead-free, surface-mount packages. Operation is fully specified from $\pm 5\text{ V}$ to $\pm 15\text{ V}$ from -40°C to $+125^\circ\text{C}$.

PIN CONFIGURATIONS

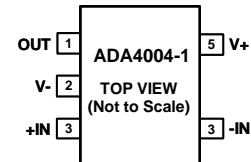


Figure 1. 5-Lead SOT (RJ-5)

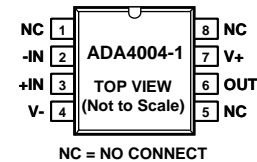
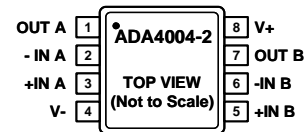


Figure 2. 8-Lead SOIC (R-8)



8-Lead MSOP (RM-8)

Rev. PrA

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SPECIFICATIONS

$V_S = \pm 5.0\text{ V}$, $V_{CM} = 0\text{ V}$, $T_A = +25^\circ\text{C}$, unless otherwise specified.

Table 1.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit	
INPUT CHARACTERISTICS							
Offset Voltage	V_{OS}	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		40	140	μV	
Input Bias Current	I_B	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		40	85	nA	
Input Offset Current	I_{OS}	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		40	85	nA	
Input Voltage Range			-3.5		+3.5	V	
Common-Mode Rejection Ratio	CMRR	$V_{CM} = -3.0\text{ V to }+3.0\text{ V}$ $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	105	111		dB	
Open-Loop Gain	A_{VO}	$R_L = 2\text{ k}\Omega$, $V_O = -2.5\text{ V to }+2.5\text{ V}$ $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	95	110		dB	
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		0.7	1	$\mu\text{V}/^\circ\text{C}$	
OUTPUT CHARACTERISTICS							
Output Voltage High	V_{OH}	$R_L = 2\text{ k}\Omega$ to ground $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	3.7	3.9		V	
Output Voltage Low	V_{OL}	$R_L = 2\text{ k}\Omega$ to ground $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	3.4	3.6		V	
Short Circuit Limit	I_{SC}	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		-3.6	-3.55	V	
Output Current	I_O	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ $V_{OUT} = \pm 3.6\text{ V}$		25	-3.6	-3.5	mA
POWER SUPPLY							
Power Supply Rejection Ratio	PSRR	$V_S = \pm 5.0\text{ V to } \pm 15.0\text{ V}$ $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	110	118		dB	
Supply Current/Amplifier	I_{SY}	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	110		1.7	dB	
					2.0	mA	
DYNAMIC PERFORMANCE							
Slew Rate	SR	$R_L = 2\text{ k}\Omega$ to ground		2.7		$\text{V}/\mu\text{s}$	
Gain Bandwidth Product	GBP			12		MHz	
NOISE PERFORMANCE							
Voltage Noise	$e_{n\text{ p-p}}$	0.1 Hz to 10 Hz		0.1		$\mu\text{V p-p}$	
Voltage Noise Density	e_n	$f = 1\text{ kHz}$		1.8		$\text{nV}/\sqrt{\text{Hz}}$	
Current Noise Density	i_n	$f = 10\text{ Hz}$		3.5		$\text{pA}/\sqrt{\text{Hz}}$	
Current Noise Density	i_n	$f = 200\text{ Hz}$		1.2		$\text{pA}/\sqrt{\text{Hz}}$	

$V_S = \pm 15\text{ V}$, $V_{CM} = 0\text{ V}$, $T_A = +25^\circ\text{C}$, unless otherwise specified.

Table 2.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		40	125	μV
Input Bias Current	I_B	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		40	90	nA
Input Offset Current	I_{OS}	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$			165	nA
Input Voltage Range		$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$			100	nA
Common-Mode Rejection Ratio	CMRR	$V_{CM} = -12.5\text{ V to } +12.5\text{ V}$ $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	-12.5	110	113	V
Open-Loop Gain	A_{VO}	$R_L = 2\text{ k}\Omega$, $V_O = -12.5\text{ V to } +12.5\text{ V}$ $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	100	500	1200	dB
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	250	500		V/mV
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	$R_L = 2\text{ k}\Omega$ to ground $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	13.4	13.6		V
Output Voltage Low	V_{OL}	$R_L = 2\text{ k}\Omega$ to ground $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	13.1	13.3		V
Short Circuit Limit	I_{SC}			25		mA
Output Current	I_O	$V_{OUT} = \pm 13.6\text{ V}$		± 10		mA
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	$V_S = \pm 5.0\text{ V to } \pm 15.0\text{ V}$ $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	110	118		dB
Supply Current/Amplifier	I_{SY}	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	110		1.775	dB
					2.10	mA
DYNAMIC PERFORMANCE						
Slew Rate	SR	$R_L = 2\text{ k}\Omega$ to ground		2.7		V/ μs
Gain Bandwidth Product	GBP			12		MHz
NOISE PERFORMANCE						
Voltage Noise	$e_{n\text{ p-p}}$	0.1 Hz to 10 Hz		0.15		$\mu\text{V p-p}$
Voltage Noise Density	e_n	$f = 1\text{ kHz}$		1.8		nV/ $\sqrt{\text{Hz}}$
Current Noise Density	i_n	$f = 10\text{ Hz}$		3.5		pA/ $\sqrt{\text{Hz}}$
Current Noise Density	i_n	$f = 200\text{ Hz}$		1.2		pA/ $\sqrt{\text{Hz}}$

ABSOLUTE MAXIMUM RATINGS

Table 3.

Parameter	Rating
Supply Voltage	$\pm 18\text{ V}/+36\text{ V}$
Input Voltage	$\pm V$ supply
Differential Input Voltage	$\pm V$ supply
Output Short-Circuit Duration to GND	Indefinite
Storage Temperature Range	-65°C to $+150^{\circ}\text{C}$
Operating Temperature Range	-40°C to $+125^{\circ}\text{C}$
Junction Temperature Range	-65°C to $+150^{\circ}\text{C}$
Lead Temperature (Soldering 60 sec)	300°C

Stresses above 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.