



# 1 $\mu$ Micropower Precision CMOS Operational Amplifier

Preliminary Technical Data

## AD8502/AD8504

### FEATURES

- Supply current: 1  $\mu$ A maximum/amplifier
- Offset voltage: 3 mV maximum
- Single-supply or dual-supply operation
- Rail-to-rail input and output
- No phase reversal
- Unity gain stable

### APPLICATIONS

- Portable equipment
- Remote sensors
- Low power filters
- Threshold detectors
- Current sensing

### GENERAL DESCRIPTION

The AD850x family are low power, precision CMOS op amps featuring a maximum supply current of 1  $\mu$ A. The AD850x family has a maximum offset voltage of 3 mV and a typical input bias current of 1 pA, and it operates rail-to-rail on both the input and output. The AD850x family can operate from a single-supply voltage of +1.8 V to +5.5 V or a dual-supply voltage of  $\pm 0.9$  V to  $\pm 2.75$  V.

With its low power consumption, low input bias current, and rail-to-rail input and output, the AD850x family is ideally suited for a variety of battery-powered portable applications. Potential applications include bedside monitors, pulse monitors, glucose meters, smoke and fire detectors, vibration monitors, and backup battery sensors.

### PIN CONFIGURATIONS

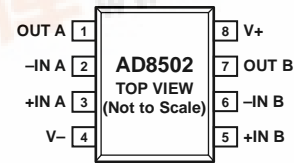


Figure 1. 8-Lead SOT23

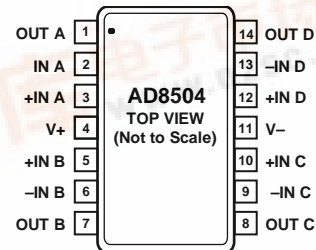


Figure 2. 14-Lead TSSOP (RU-14)

The ability to swing rail-to-rail at both the input and output helps maximize dynamic range and signal-to-noise ratio in systems that operate at very low voltages. The low offset voltage allows the AD850x family to be used in systems with high gain without having excessively large output offset errors, and it provides high accuracy without the need for system calibration.

The AD850x family is fully specified over the industrial temperature range ( $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ) and is operational over the extended industrial temperature range ( $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ). The AD8502 is available in a 8-lead, SOT23 surface-mount package. The AD8504 is available in 14-lead TSSOP surface-mount package.



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**REVISION HISTORY**

## SPECIFICATIONS

## ELECTRICAL CHARACTERISTICS

@  $V_S = +5\text{ V}$ ,  $V_{CM} = V_S/2$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 1.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>INPUT CHARACTERISTICS</b>						
Offset Voltage	$V_{OS}$	$0\text{ V} < V_{CM} < 5\text{ V}$		0.5	3	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$			10	$\mu\text{V}/^\circ\text{C}$
Input Voltage Range			-0.3		+5.3	V
Input Bias Current	$I_B$	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$		1	10	pA
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			100	pA
Input Offset Current	$I_{OS}$	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$		0.5	5	pA
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			50	pA
Common-Mode Rejection Ratio	CMRR	$0\text{ V} < V_{CM} < 5\text{ V}$	75			dB
		$-40^\circ\text{C} < T_A < +85^\circ\text{C}$	65			dB
Large Signal Voltage Gain	$A_{VO}$	$0.1\text{ V} < V_{OUT} < 4.9\text{ V}$	98			dB
		$0.1\text{ V} < V_{OUT} < 4.9\text{ V}; -40^\circ\text{C} < T_A < +85^\circ\text{C}$	80			dB
Input Capacitance	$C_{DIFF}$			2		pF
	$C_{CM}$			4.5		pF
<b>OUTPUT CHARACTERISTICS</b>						
Output Voltage High	$V_{OH}$	$R_{LOAD} = 100\text{ k}\Omega$ to GND	4.970			V
		$R_{LOAD} = 10\text{ k}\Omega$ to GND	4.900			V
Output Voltage Low	$V_{OL}$	$R_{LOAD} = 100\text{ k}\Omega$ to $V_S$			5	mV
		$R_{LOAD} = 10\text{ k}\Omega$ to $V_S$			20	mV
Short-Circuit Current	$I_{SC}$	$V_{OUT} = \text{GND}$				mA
<b>POWER SUPPLY</b>						
Power Supply Rejection Ratio	PSRR	$1.8\text{ V} < V_S < 5\text{ V}$	90			dB
		$-40^\circ\text{C} < T_A < +85^\circ\text{C}$	70			dB
Supply Current/Amplifier	$I_{SY}$	$V_O = V_S/2$			1	$\mu\text{A}$
		$-40^\circ\text{C} < T_A < +85^\circ\text{C}$			1.5	$\mu\text{A}$
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			2	$\mu\text{A}$
<b>DYNAMIC PERFORMANCE</b>						
Slew Rate	SR			0.004		V/ $\mu\text{s}$
Gain Bandwidth Product	GBP			7		kHz
Phase Margin	$\phi_O$			60		Degrees
<b>NOISE PERFORMANCE</b>						
Peak-to-Peak Noise		0.1 Hz to 10 Hz		6		$\mu\text{V p-p}$
Voltage Noise Density	$e_n$	$f = 1\text{ kHz}$		190		$\text{nV}/\sqrt{\text{Hz}}$
Current Noise Density	$i_n$	$f = 1\text{ kHz}$		0.1		$\text{pA}/\sqrt{\text{Hz}}$

@  $V_S = +1.8\text{ V}$ ,  $V_{CM} = V_S/2$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 2.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>INPUT CHARACTERISTICS</b>						
Offset Voltage	$V_{OS}$	$0\text{ V} < V_{CM} < 1.8\text{ V}$		0.5	3	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$		3.5	12	$\mu\text{V}/^\circ\text{C}$
Input Voltage Range			-0.3		+2.1	V
Input Bias Current	$I_B$	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$		1	10	pA
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			100	pA
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			600	pA
Input Offset Current	$I_{OS}$	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$		0.5	5	pA
		$-40^\circ\text{C} < T_A < +85^\circ\text{C}$			50	pA
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			100	pA
Common-Mode Rejection Ratio	CMRR	$0\text{ V} < V_{CM} < 1.8\text{ V}$	60			dB
		$-40^\circ\text{C} < T_A < +85^\circ\text{C}$	55			dB
Large Signal Voltage Gain	$A_{VO}$	$0.1\text{ V} < V_{OUT} < 1.7\text{ V}$	88			dB
		$0.1\text{ V} < V_{OUT} < 1.7\text{ V}; -40^\circ\text{C} < T_A < +85^\circ\text{C}$	70			dB
Input Capacitance	$C_{DIFF}$ $C_{CM}$			2 4.5		pF pF
<b>OUTPUT CHARACTERISTICS</b>						
Output Voltage High	$V_{OH}$	$R_{LOAD} = 100\text{ k}\Omega$ to GND	1.790			V
		$R_{LOAD} = 10\text{ k}\Omega$ to GND	1.760			V
Output Voltage Low	$V_{OL}$	$R_{LOAD} = 100\text{ k}\Omega$ to $V_S$			5	mV
		$R_{LOAD} = 10\text{ k}\Omega$ to $V_S$			20	mV
Short-Circuit Current	$I_{SC}$					mA
<b>POWER SUPPLY</b>						
Power Supply Rejection Ratio	PSRR	$1.8\text{ V} < V_S < 5\text{ V}$ $-40^\circ\text{C} < T_A < +85^\circ\text{C}$	90 70			dB dB
Supply Current/Amplifier	$I_{SY}$	$V_O = V_S/2$ $-40^\circ\text{C} < T_A < +85^\circ\text{C}$ $-40^\circ\text{C} < T_A < +125^\circ\text{C}$			1 1.5 2	$\mu\text{A}$ $\mu\text{A}$ $\mu\text{A}$
<b>DYNAMIC PERFORMANCE</b>						
Slew Rate	SR			0.004		V/ $\mu\text{s}$
Gain Bandwidth Product	GBP					kHz
Phase Margin	$\phi_o$					Degrees
<b>NOISE PERFORMANCE</b>						
Peak-to-Peak Noise		0.1 Hz to 10 Hz		6		$\mu\text{V p-p}$
Voltage Noise Density	$e_n$	$f = 1\text{ kHz}$		190		nV/ $\sqrt{\text{Hz}}$
Current Noise Density	$i_n$	$f = 1\text{ kHz}$		0.1		pA/ $\sqrt{\text{Hz}}$

## ABSOLUTE MAXIMUM RATINGS

T<sub>A</sub> = 25°C, unless otherwise noted.

Table 3.

Parameter	Rating
Supply Voltage	6 V
Input Voltage	V <sub>SS</sub> - 0.4 V to V <sub>DD</sub> + 0.4 V
Differential Input Voltage	±6 V
Output Short-Circuit Duration to GND	Indefinite
Storage Temperature Range	-65°C to +150°C
Lead Temperature (Soldering, 60 sec)	300°C
Operating Temperature Range	-40°C to +125°C
Junction Temperature Range	-65°C to +150°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.

Absolute maximum ratings apply at 25°C, unless otherwise noted.

## THERMAL RESISTANCE

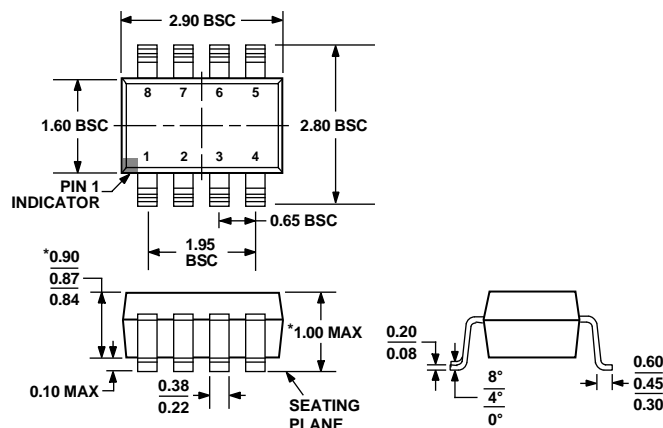
θ<sub>JA</sub> is specified for the worst-case conditions, that is, a device soldered in a circuit board for surface-mount packages.

Table 4. Thermal Characteristics

Package Type	θ <sub>JA</sub>	θ <sub>JC</sub>	Unit
8-lead SOT23 (RJ-8)	376	126	°C/W
14-lead TSSOP (RU-14)	180	35	°C/W

## ESD 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 this product 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.



\*COMPLIANT TO JEDEC STANDARDS MO-193-BA WITH THE EXCEPTION OF PACKAGE HEIGHT AND THICKNESS.

Figure 2. 8-Lead Thin Small Outline Transistor Package [TSOT] (UJ-8)

Dimensions shown in millimeters

