

# Zero-Drift Operational Amplifier in SOT-23

November 1999

## FEATURES

- SOT-23 Package
- Maximum Offset Voltage of  $3\mu\text{V}$
- Maximum Offset Voltage Drift of  $30\text{nV}/^\circ\text{C}$
- Noise:  $1.5\mu\text{V}_{\text{P-P}}$  (0.1Hz to 10Hz Typ)
- Voltage Gain: 140dB (Typ)
- PSRR: 130dB (Typ)
- CMRR: 130dB (Typ)
- Supply Current: 0.8mA (Typ)
- Single Supply Operation: 2.7V to 6V
- Extended Common Mode Input Range
- Output Swings Rail-to-Rail
- Overload Recovery Time: 2ms (Typ)

## APPLICATIONS


- Thermocouple Amplifiers
- Electronic Scales
- Medical Instrumentation
- Strain Gauge Amplifiers
- High Resolution Data Acquisition
- DC Accurate RC Active Filters

## DESCRIPTION

The LTC<sup>®</sup>2050 is a low drift operational amplifier available in the 5- or 6-lead SOT-23 and SO-8 packages. It operates from a single 2.7V supply while still supporting 5V applications. The power consumption is  $800\mu\text{A}$  and the versions in the 6-lead SOT-23 and SO-8 packages offer power shutdown (active low).

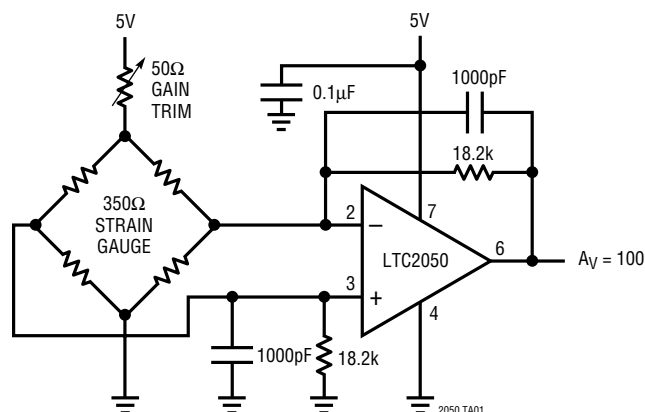
The LTC2050, despite its miniature size, features uncompromising DC performance. The typical input offset voltage and offset drift are  $0.5\mu\text{V}$  and  $10\text{nV}/^\circ\text{C}$ . The almost zero DC offset and drift are supported with a power supply rejection ratio (PSRR) and common mode rejection ratio (CMRR) of more than 130dB.

The input common mode voltage ranges from the negative supply up to 1V from the positive supply. The LTC2050 also has an enhanced output stage capable of driving loads as low as  $1\text{k}\Omega$  to both supply rails. The open-loop gain, loaded with  $1\text{k}\Omega$ , is in excess of 140dB. The LTC2050 also features a  $1.5\mu\text{V}_{\text{P-P}}$  DC to 10Hz noise and a 3MHz gain bandwidth product.

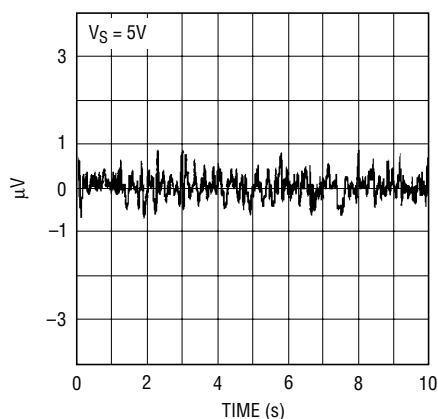
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## TYPICAL APPLICATION

Differential Bridge Amplifier



Input Referred Noise 0.1Hz to 10Hz

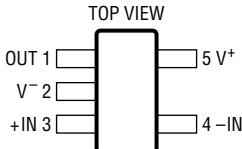
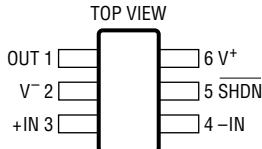
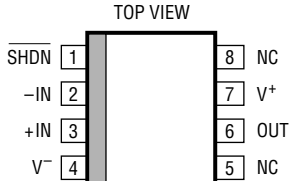


LTC2050 TA02

## ABSOLUTE MAXIMUM RATINGS (Note 1)

Total Supply Voltage ( $V^+$ to $V^-$ ) .....	7V	Specified Temperature Range (Note 3) ..	$-40^{\circ}\text{C}$ to $85^{\circ}\text{C}$
Input Voltage .....	( $V^+ + 0.3\text{V}$ ) to ( $V^- - 0.3\text{V}$ )	Storage Temperature Range .....	$-65^{\circ}\text{C}$ to $150^{\circ}\text{C}$
Output Short-Circuit Duration .....	Indefinite	Lead Temperature (Soldering, 10 sec) .....	$300^{\circ}\text{C}$
Operating Temperature Range .....	$-40^{\circ}\text{C}$ to $85^{\circ}\text{C}$		

## PACKAGE/ORDER INFORMATION

 <p>S5 PACKAGE 5-LEAD PLASTIC SOT-23 <math>T_{JMAX} = 125^{\circ}\text{C}</math>, <math>\theta_{JA} = 250^{\circ}\text{C/W}</math></p>		 <p>S6 PACKAGE 6-LEAD PLASTIC SOT-23 <math>T_{JMAX} = 125^{\circ}\text{C}</math>, <math>\theta_{JA} = 230^{\circ}\text{C/W}</math></p>		 <p>S8 PACKAGE 8-LEAD PLASTIC SO <math>T_{JMAX} = 125^{\circ}\text{C}</math>, <math>\theta_{JA} = 190^{\circ}\text{C/W}</math></p>	
ORDER PART NUMBER	S5 PART MARKING	ORDER PART NUMBER	S6 PART MARKING	ORDER PART NUMBER	S8 PART MARKING
LTC2050CS5	LTIN	LTC2050CS6	LTIP	LTC2050CS8 LTC2050IS8	2050 2050I

Consult factory for Military grade parts.

## ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^{\circ}\text{C}$ .  $V_S = 3\text{V}$  unless otherwise noted. (Note 3)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	(Note 2)		$\pm 0.5$	$\pm 3$	$\mu\text{V}$
Average Input Offset Drift	(Note 2)	●		$\pm 0.03$	$\mu\text{V}/^{\circ}\text{C}$
Long-Term Offset Drift			50		$\text{nV}/\sqrt{\text{mo}}$
Input Bias Current			$\pm 20$	$\pm 75$	$\text{pA}$
		●		$\pm 300$	$\text{pA}$
Input Offset Current				$\pm 150$	$\text{pA}$
		●		$\pm 200$	$\text{pA}$
Input Noise Voltage	$R_S = 100\Omega$ , DC to 10Hz		1.5		$\mu\text{V}_{\text{p-p}}$
Common Mode Rejection Ratio	$V_{\text{CM}} = V^-$ to $V^+ - 1.3$	115 110	130 130		$\text{dB}$ $\text{dB}$
Power Supply Rejection Ratio		120 115	130 130		$\text{dB}$ $\text{dB}$
Large-Signal Voltage Gain	$R_L = 10\text{k}$	120 115	140 140		$\text{dB}$ $\text{dB}$
Maximum Output Voltage Swing	$R_L = 2\text{k}$ $R_L = 10\text{k}$	2.85 2.95	2.94 2.98		$\text{V}$ $\text{V}$
Slew Rate			2		$\text{V}/\mu\text{s}$
Gain Bandwidth Product			3		$\text{MHz}$
Supply Current	$V_{\text{SHDN}} = V^+$ , No Load	●	0.75	1.1	$\text{mA}$
	$V_{\text{SHDN}} = V^-$	●		10	$\mu\text{A}$

## ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ .  $V_S = 3\text{V}$  unless otherwise noted. (Note 3)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Shutdown Pin Input Low Voltage		●			$V^- + 0.5$	V
Shutdown Pin Input High Voltage		●	$V^+ - 0.5$			V
Shutdown Pin Input Current	$V_{\text{SHDN}} = V^-$	●		-0.5	-3	$\mu\text{A}$
Internal Sampling Frequency				7.5		kHz

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ .  $V_S = 5\text{V}$  unless otherwise noted. (Note 3)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Input Offset Voltage	(Note 2)			$\pm 0.5$	$\pm 3$	$\mu\text{V}$
Average Input Offset Drift	(Note 2)	●			$\pm 0.03$	$\mu\text{V}/^\circ\text{C}$
Long-Term Offset Drift				50		$\text{nV}/\sqrt{\text{mo}}$
Input Bias Current		●			$\pm 150$ $\pm 300$	pA pA
Input Offset Current		●			$\pm 300$ $\pm 400$	pA pA
Input Noise Voltage	$R_S = 100\Omega$ , DC to 10Hz			1.5		$\mu\text{V}_{\text{P-P}}$
Common Mode Rejection Ratio	$V_{\text{CM}} = V^-$ to $V^+ - 1.3$	●	120 115	130 130		dB dB
Power Supply Rejection Ratio		●	120 115	130 130		dB dB
Large-Signal Voltage Gain	$R_L = 10\text{k}$	●	125 120	140 140		dB dB
Maximum Output Voltage Swing	$R_L = 2\text{k}$ $R_L = 10\text{k}$	● ●	4.85 4.95	4.94 4.98		V V
Slew Rate				2		$\text{V}/\mu\text{s}$
Gain Bandwidth Product				3		MHz
Supply Current	$V_{\text{SHDN}} = V^+$ , No Load $V_{\text{SHDN}} = V^-$	● ●		0.8	1.2 10	mA $\mu\text{A}$
Shutdown Pin Input Low Voltage		●			$V^- + 0.5$	V
Shutdown Pin Input High Voltage		●	$V^+ - 0.5$			V
Shutdown Pin Input Current	$V_{\text{SHDN}} = V^-$	●		-0.5	-5	$\mu\text{A}$
Internal Sampling Frequency				7.5		kHz

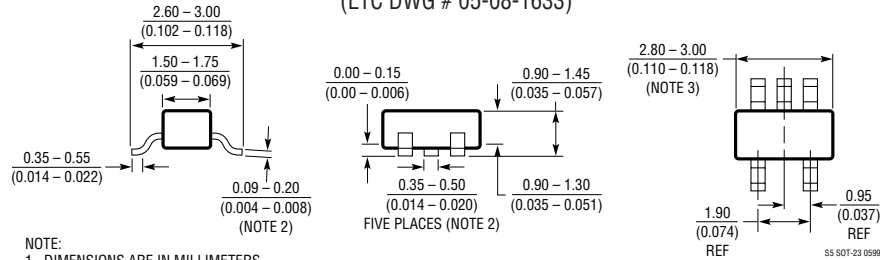
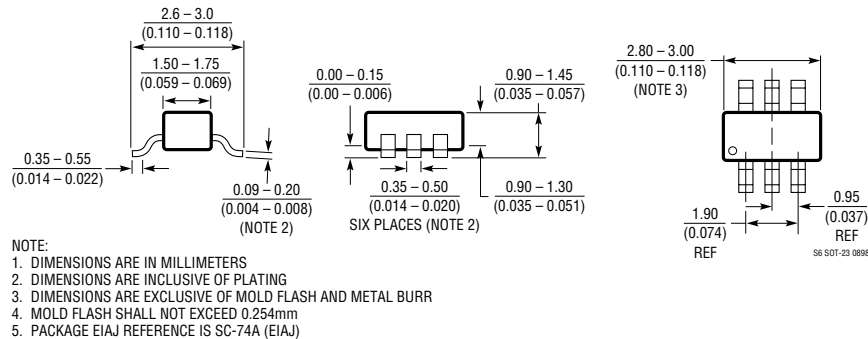
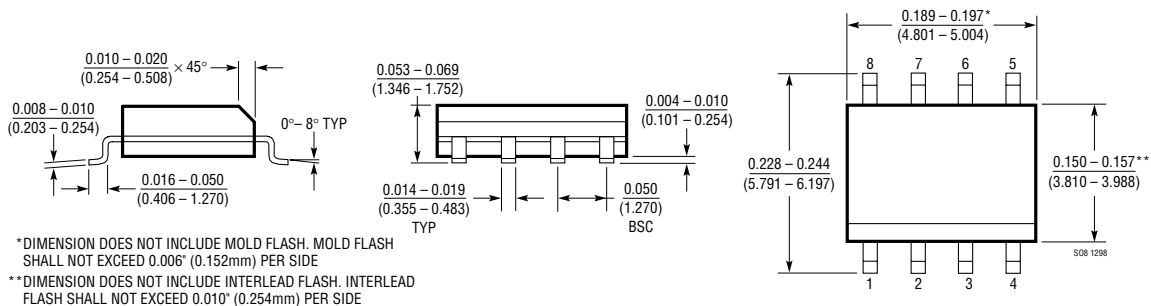
**Note 1:** Absolute Maximum Ratings are those values beyond which the life of the device may be impaired.

**Note 2:** These parameters are guaranteed by design. Thermocouple effects preclude measurements of these voltage levels during automated testing.

**Note 3:** The LTC2050C is guaranteed to meet specified performance from  $0^\circ\text{C}$  to  $70^\circ\text{C}$  and is designed, characterized and expected to meet these extended temperature limits, but is not tested at  $-40^\circ\text{C}$  and  $85^\circ\text{C}$ . The LTC2050I is guaranteed to meet the extended temperature limits.

**PACKAGE DESCRIPTION**

Dimensions in inches (millimeters) unless otherwise noted.

**S5 Package**  
**5-Lead Plastic SOT-23**  
(LTC DWG # 05-08-1633)**S6 Package**  
**6-Lead Plastic SOT-23**  
(LTC DWG # 05-08-1634)**S8 Package**  
**8-Lead Plastic Small Outline (Narrow 0.150)**  
(LTC DWG # 05-08-1610)**RELATED PARTS**

PART NUMBER	DESCRIPTION	COMMENTS
LTC1049	Low Power Zero-Drift Op Amp	Low Supply Current 200µA
LTC1050	Precision Zero-Drift Op Amp	Single Supply Operation 4.75V to 16V, Noise Tested and Guaranteed
LTC1051/LTC1053	Precision Zero-Drift Op Amp	Dual/Quad
LTC1150	±15V Zero-Drift Op Amp	High Voltage Operation ±18V
LTC1152	Rail-to-Rail Input and Output Zero-Drift Op Amp	Single Zero-Drift Op Amp with Rail-to-Rail Input and Output and Shutdown