

Low Noise, High Speed Precision Operational Amplifiers

FEATURES

- *Guaranteed* $4.5\text{nV}/\sqrt{\text{Hz}}$ 10Hz Noise
- *Guaranteed* $3.8\text{nV}/\sqrt{\text{Hz}}$ 1kHz Noise
- 0.1 Hz to 10Hz Noise, 60nVp-p, Typical
- *Guaranteed* 5 Million Min. Voltage Gain, $R_L = 2\text{k}\Omega$
- *Guaranteed* 2 Million Min. Voltage Gain, $R_L = 600\Omega$
- *Guaranteed* $60\mu\text{V}$ Max. Offset Voltage
- *Guaranteed* $1.0\mu\text{V}/^\circ\text{C}$ Max. Drift with Temperature
- *Guaranteed* $11\text{V}/\mu\text{sec}$ Min. Slew Rate (LT1037)
- *Guaranteed* 110dB Min. CMRR

APPLICATIONS

- Low Noise Signal Processing
- Microvolt Accuracy Threshold Detection
- Strain Gauge Amplifiers
- Direct Coupled Audio Gain Stages
- Sine Wave Generators
- Tape Head Preamplifiers
- Microwave Preamplifiers

DESCRIPTION

Next to the LT1028, the LT1007/LT1037 series features the lowest noise performance available to date for monolithic operational amplifiers: $2.5\text{nV}/\sqrt{\text{Hz}}$ wideband noise (less than the noise of a 400Ω resistor), $1/f$ corner frequency of 2Hz and 60nV peak to peak 0.1Hz to 10Hz noise. Low noise is combined with outstanding precision and speed specifications: $20\mu\text{V}$ offset voltage, $0.3\mu\text{V}/^\circ\text{C}$ drift, 126dB common-mode and power supply rejection, and 60MHz gain-bandwidth-product on the decompensated LT1037, which is stable for closed loop gains of 5 or greater.

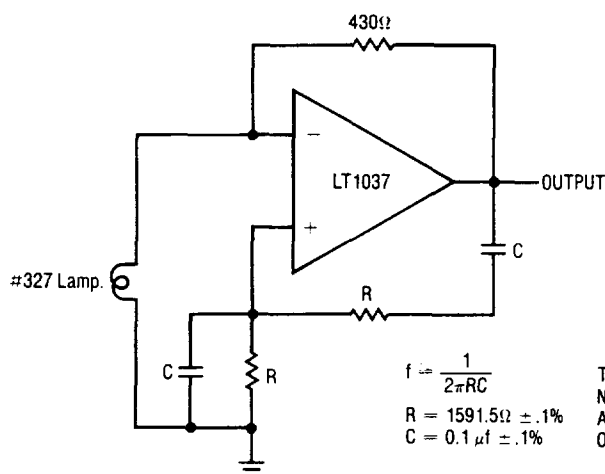
The voltage gain of the LT1007/LT1037 is an extremely high 20 million driving a $2\text{k}\Omega$ load and 12 million driving a 600Ω load to $\pm 10\text{V}$.

In the design, processing, and testing of the device, particular attention has been paid to the optimization of the entire distribution of several key parameters. Consequently, the specifications have been spectacularly improved compared to competing amplifiers.

The sine wave generator application shown below utilizes the low noise and low distortion characteristics of the LT1037.

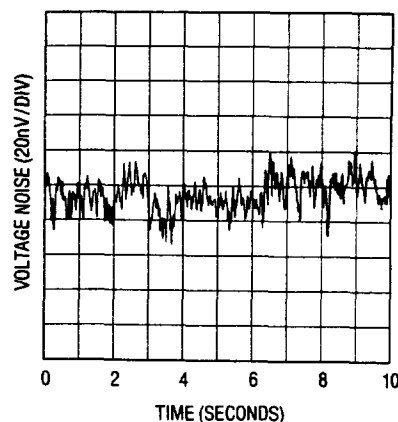
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Ultra-Pure 1kHz Sine Wave Generator



Total Harmonic Distortion = $< .0025\%$
 Noise = $< .0001\%$
 Amplitude = ± 8 volts
 Output Frequency = 1.000kHz for values given $\pm .4\%$

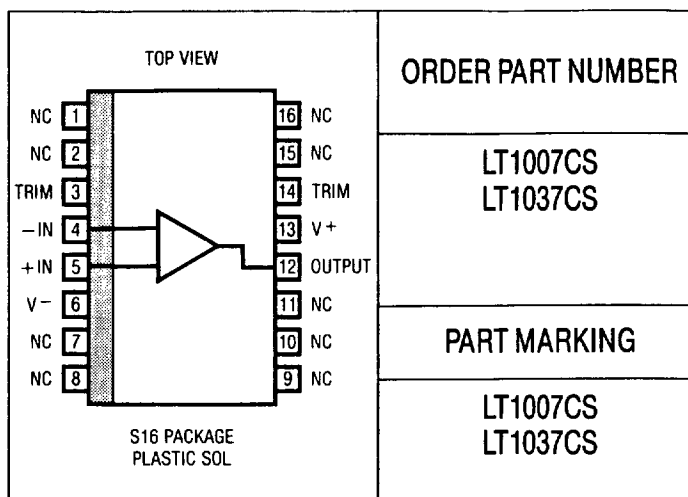
0.1Hz to 10Hz Noise



ABSOLUTE MAXIMUM RATINGS

Supply Voltage $\pm 22\text{V}$
 Input Voltage Equal to Supply Voltage
 Output Short Circuit Duration Indefinite
 Differential Input Current (Note 5) $\pm 25\text{mA}$
 Lead Temperature (Soldering, 10 sec.) 300°C
 Operating Temperature Range 0°C to 70°C
 Storage Temperature Range
 All Devices -65°C to 150°C

PACKAGE/ORDER INFORMATION



ELECTRICAL CHARACTERISTICS $V_S = \pm 15\text{V}$, $T_A = 25^{\circ}\text{C}$, unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS	LT1007C LT1037C			UNITS
			MIN	TYP	MAX	
V_{OS}	Input Offset Voltage	(Note 1)		20	60	μV
$\frac{V_{OS}}{\Delta\text{Time}}$	Long Term Input Offset Voltage Stability	(Notes 2 and 3)		0.2	1.0	$\mu\text{V/Mo}$
I_{OS}	Input Offset Current			12	50	nA
I_B	Input Bias Current			± 15	± 55	nA
e_n	Input Noise Voltage	0.1Hz to 10Hz (Note 3)		0.06	0.13	$\mu\text{Vp-p}$
	Input Noise Voltage Density	$f_o = 10\text{Hz}$ (Note 3)		2.8	4.5	$\text{nV}/\sqrt{\text{Hz}}$
		$f_o = 1000\text{Hz}$ (Note 3)		2.5	3.8	$\text{nV}/\sqrt{\text{Hz}}$
i_n	Input Noise Current Density	$f_o = 10\text{Hz}$ (Note 3)		1.5	4.0	$\text{pA}/\sqrt{\text{Hz}}$
		$f_o = 1000\text{Hz}$ (Note 3)		0.4	0.6	$\text{pA}/\sqrt{\text{Hz}}$
	Input Resistance—Common-Mode			5		G Ω
	Input Voltage Range		± 11.0	± 12.5		V
CMRR	Common-Mode Rejection Ratio	$V_{CM} = \pm 11\text{V}$	110	126		dB
PSRR	Power Supply Rejection Ratio	$V_S = \pm 4\text{V}$ to $\pm 18\text{V}$	106	126		dB
A_{VOL}	Large Signal Voltage Gain	$R_L \geq 2\text{k}\Omega$, $V_O = \pm 12\text{V}$	5.0	20.0		$\text{V}/\mu\text{V}$
		$R_L \geq 1\text{k}\Omega$, $V_O = \pm 10\text{V}$	3.5	16.0		$\text{V}/\mu\text{V}$
		$R_L \geq 600\Omega$, $V_O = \pm 10\text{V}$	2.0	12.0		$\text{V}/\mu\text{V}$
V_{OUT}	Maximum Output Voltage Swing	$R_L \geq 2\text{k}\Omega$	± 12.5	± 13.5		V
		$R_L \geq 600\Omega$	± 10.5	± 12.5		V
SR	Slew Rate	LT1007 $R_L \geq 2\text{k}\Omega$	1.7	2.5		$\text{V}/\mu\text{s}$
		LT1037 $A_{VOL} \geq 5$	11	15		$\text{V}/\mu\text{s}$
GBW	Gain-Bandwidth Product	LT1007 $f_o = 100\text{kHz}$ (Note 4)	5.0	8.0		MHz
		LT1037 $f_o = 10\text{kHz}$ (Note 4) ($A_{VOL} \geq 5$)	45	60		MHz
Z_o	Open Loop Output Resistance	$V_O = 0$, $I_O = 0$		70		Ω
P_d	Power Dissipation	LT1007		80	140	mW
		LT1037		85	140	mW

ELECTRICAL CHARACTERISTICS $V_S = \pm 15V, 0^\circ C \leq T_A \leq 70^\circ C$, unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS		LT1007C/LT1037C			UNITS
				MIN	TYP	MAX	
V_{OS}	Input Offset Voltage	(Note 1)	●		35	110	μV
$\frac{\Delta V_{OS}}{\Delta Temp}$	Average Input Offset Drift	(Note 6)	●		0.3	1.0	$\mu V/^\circ C$
I_{OS}	Input Offset Current		●		15	70	nA
I_B	Input Bias Current		●		± 20	± 75	nA
	Input Voltage Range		●	± 10.5	± 11.8		V
CMRR	Common-Mode Rejection Ratio	$V_{CM} = \pm 10.5V$	●	106	120		dB
PSRR	Power Supply Rejection Ratio	$V_S = \pm 4.5V$ to $\pm 18V$	●	102	120		dB
A_{VOL}	Large Signal Voltage Gain	$R_L \geq 2k\Omega, V_O = \pm 10V$	●	2.5	18.0		$V/\mu V$
		$R_L \geq 1k\Omega, V_O = \pm 10V$	●	2.0	14.0		$V/\mu V$
V_{OUT}	Maximum Output Voltage Swing	$R_L \geq 2k\Omega$	●	± 12.0	± 13.6		V
P_d	Power Dissipation		●		90	160	mW

The ● denotes the specifications which apply over full operating temperature range.

Note 1: Input Offset Voltage measurements are performed by automatic test equipment approximately 0.5 seconds after application of power.

Note 2: Long Term Input Offset Voltage Stability refers to the average trend line of Offset Voltage vs. Time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in V_{OS} during the first 30 days are typically $2.5\mu V$.

Note 3: This parameter is tested on a sample basis only.

Note 4: This parameter is guaranteed by design and is not tested.

Note 5: The inputs are protected by back-to-back diodes. Current limiting resistors are not used in order to achieve low noise. If differential input voltage exceeds $\pm 0.7V$, the input current should be limited to 25mA.

Note 6: The Average Input Offset Drift performance is within the specifications unnullled or when nulled with a pot having a range of $8k\Omega$ to $20k\Omega$.