National Semiconductor

LMC6062
Precision CMOS Dual Micropower Operational Amplifier

General Description

The LMC6062 is a precision dual low offset voltage, micropower operational amplifier, capable of precision single supply operation. Performance characteristics include ultra low input bias current, high voltage gain, rail-to-rail output swing, and an input common mode voltage range that includes ground. These features, plus its low power consumption, make the LMC6062 ideally suited for battery powered applications.

Other applications using the LMC6062 include precision full-wave rectifiers, integrators, references, sample-and-hold circuits, and true instrumentation amplifiers.

This device is built with National's advanced double-Poly Silicon-Gate CMOS process.

For designs that require higher speed, see the LMC6082 precision dual operational amplifier.

PATENT PENDING

Features

(Typical Unless Otherwise Noted)

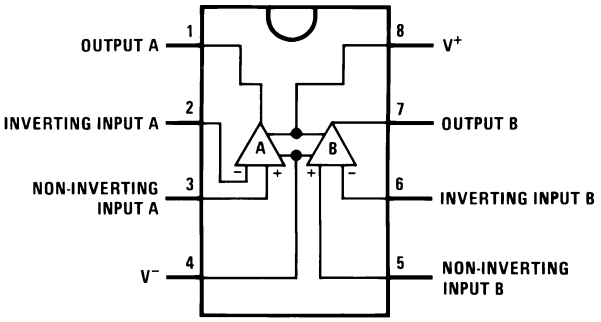
- Low offset voltage 100µV
- Ultra low supply current 16µA/Amplifier
- Operates from 4.5V to 15V single supply
- Ultra low input bias current 10fA
- Output swing within 10mV of supply rail, 100k load
- Input common-mode range includes V^-
- High voltage gain 140dB
- Improved latchup immunity

Applications

- Instrumentation amplifier
- Photodiode and infrared detector preamplifier
- Transducer amplifiers
- Hand-held analytic instruments
- Medical instrumentation
- D/A converter
- Charge amplifier for piezoelectric transducers

Connection Diagram

8-Pin DIP/SO



Top View

Ordering Information

Package	Temperature Range		NSC Drawing	Transport Media
	Military −55˚C to +125˚C	Industrial −40˚C to +85˚C		
8-Pin Molded DIP	LMC6062AMN	LMC6062AIN LMC6062IN	N08E	Rail
8-Pin Small Outline		LMC6062AIM LMC6062IM	M08A	Rail
8-Pin Ceramic DIP	LMC6062AMJ/883		J08A	Rail

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Differential Input Voltage	±Supply Voltage
Voltage at Input/Output Pin	(V^+) +0.3V, (V^-) −0.3V
Supply Voltage ($V^+ - V^-$)	16V
Output Short Circuit to V^+	(Note 11)
Output Short Circuit to V^-	(Note 2)
Lead Temperature (Soldering, 10 sec.)	260˚C
Storage Temp. Range	−65˚C to +150˚C
Junction Temperature	150˚C
ESD Tolerance (Note 4)	2 kV
Current at Input Pin	±10 mA
Current at Output Pin	±30 mA
Current at Power Supply Pin	40 mA
Power Dissipation	(Note 3)

Operating Ratings (Note 1)

Temperature Range	
LMC6062AM	$-55^\circ C \le T_J \le +125^\circ C$
LMC6062AI, LMC6082I	$-40^\circ C \le T_J \le +85^\circ C$
Supply Voltage	$4.5V \le V^+ \le 15.5V$
Thermal Resistance (θ_{JA}) (Note 12)	
8-Pin Molded DIP	115˚C/W
8-Pin SO	193˚C/W
Power Dissipation	(Note 10)

DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for T_J = 25˚C. **Boldface** limits apply at the temperature extremes. V^+ = 5V, V^- = 0V, V_{CM} = 1.5V, V_O = 2.5V and R_L > 1M unless otherwise specified.

Symbol	Parameter	Conditions		Typ (Note 5)	LMC6062AM Limit (Note 6)	LMC6062AI Limit (Note 6)	LMC6062I Limit (Note 6)	Units
V_{OS}	Input Offset Voltage			100	350 **1200**	350 **900**	800 **1300**	µV Max
TCV_{OS}	Input Offset Voltage Average Drift			1.0				µV/˚C
I_B	Input Bias Current			0.010	 **100**	 **4**	 **4**	pA Max
I_{OS}	Input Offset Current			0.005	 **100**	 **2**	 **2**	pA Max
R_{IN}	Input Resistance			>10				Tera Ω
CMRR	Common Mode Rejection Ratio	0V ≤ V_{CM} ≤ 12.0V V^+ = 15V		85	75 **70**	75 **72**	66 **63**	dB Min
+PSRR	Positive Power Supply Rejection Ratio	5V ≤ V^+ ≤ 15V V_O = 2.5V		85	75 **70**	75 **72**	66 **63**	dB Min
−PSRR	Negative Power Supply Rejection Ratio	0V ≤ V^- ≤ −10V		100	84 **70**	84 **81**	74 **71**	dB Min
V_{CM}	Input Common-Mode Voltage Range	V^+ = 5V and 15V for CMRR ≥ 60 dB		−0.4	−0.1 **0**	−0.1 **0**	−0.1 **0**	V Max
				$V^+ - 1.9$	$V^+ - 2.3$ **$V^+ - 2.6$**	$V^+ - 2.3$ **$V^+ - 2.5$**	$V^+ - 2.3$ **$V^+ - 2.5$**	V Min
A_V	Large Signal Voltage Gain	R_L = 100 kΩ (Note 7)	Sourcing	4000	400 **200**	400 **300**	300 **200**	V/mV Min
			Sinking	3000	180 **70**	180 **100**	90 **60**	V/mV Min
		R_L = 25 kΩ (Note 7)	Sourcing	3000	400 **150**	400 **150**	200 **80**	V/mV Min
			Sinking	2000	100 **35**	100 **50**	70 **35**	V/mV Min

DC Electrical Characteristics (Continued)

Unless otherwise specified, all limits guaranteed for T_J = 25˚C. **Boldface** limits apply at the temperature extremes. V^+ = 5V, V^- = 0V, V_{CM} = 1.5V, V_O = 2.5V and R_L > 1M unless otherwise specified.

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6062AM Limit (Note 6)	LMC6062AI Limit (Note 6)	LMC6062I Limit (Note 6)	Units
V_O	Output Swing	V^+ = 5V	4.995	4.990	4.990	4.950	V
		R_L = 100 kΩ to 2.5V		**4.970**	**4.980**	**4.925**	Min
			0.005	0.010	0.010	0.050	V
				0.030	**0.020**	**0.075**	Max
		V^+ = 5V	4.990	4.975	4.975	4.950	V
		R_L = 25 kΩ to 2.5V		**4.955**	**4.965**	**4.850**	Min
			0.010	0.020	0.020	0.050	V
				0.045	**0.035**	**0.150**	Max
		V^+ = 15V	14.990	14.975	14.975	14.950	V
		R_L = 100 kΩ to 7.5V		**14.955**	**14.965**	**14.925**	Min
			0.010	0.025	0.025	0.050	V
				0.050	**0.035**	**0.075**	Max
		V^+ = 15V	14.965	14.900	14.900	14.850	V
		R_L = 25 kΩ to 7.5V		**14.800**	**14.850**	**14.800**	Min
			0.025	0.050	0.050	0.100	V
				0.200	**0.150**	**0.200**	Max
I_O	Output Current	Sourcing, V_O = 0V	22	16	16	13	mA
	V^+ = 5V			**8**	**10**	**8**	Min
		Sinking, V_O = 5V	21	16	16	16	mA
				7	**8**	**8**	Min
I_O	Output Current	Sourcing, V_O = 0V	25	15	15	15	mA
	V^+ = 15V			**9**	**10**	**10**	Min
		Sinking, V_O = 13V	35	20	20	20	mA
		(Note 11)		**7**	**8**	**8**	Min
I_S	Supply Current	Both Amplifiers	32	38	38	46	µA
		V^+ = +5V, V_O = 1.5V		**60**	**46**	**56**	Max
		Both Amplifiers	40	47	47	57	µA
		V^+ = +15V, V_O = 7.5V		**70**	**55**	**66**	Max

AC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for T_J = 25˚C, **Boldface** limits apply at the temperature extremes. V^+ = 5V, V^- = 0V, V_{CM} = 1.5V, V_O = 2.5V and R_L > 1M unless otherwise specified.

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6062AM Limit (Note 6)	LMC6062AI Limit (Note 6)	LMC6062I Limit (Note 6)	Units
SR	Slew Rate	(Note 8)	35	20 **8**	20 **10**	15 **7**	V/ms Min
GBW	Gain-Bandwidth Product		100				kHz
θ_m	Phase Margin		50				Deg
	Amp-to-Amp Isolation	(Note 9)	155				dB
e_n	Input-Referred Voltage Noise	F = 1 kHz	83				nV/$\sqrt{Hz}$
i_n	Input-Referred Current Noise	F = 1 kHz	0.0002				pA/$\sqrt{Hz}$
T.H.D.	Total Harmonic Distortion	F = 1 kHz, A_V = −5 R_L = 100 kΩ, V_O = 2 V_{PP} ±5V Supply	0.01				%

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed.

Note 2: Applies to both single-supply and split-supply operation. Continous short circuit operation at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of 150˚C. Output currents in excess of ±30 mA over long term may adversely affect reliability.

Note 3: The maximum power dissipation is a function of $T_{J(Max)}$, θ_{JA}, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(Max)} - T_A)/\theta_{JA}$.

Note 4: Human body model, 1.5 kΩ in series with 100 pF.

Note 5: Typical values represent the most likely parametric norm.

Note 6: All limits are guaranteed by testing or statistical analysis.

Note 7: V^+ = 15V, V_{CM} = 7.5V and R_L connected to 7.5V. For Sourcing tests, 7.5V ≤ V_O ≤ 11.5V. For Sinking tests, 2.5V ≤ V_O ≤ 7.5V.

Note 8: V^+ = 15V. Connected as Voltage Follower with 10V step input. Number specified is the slower of the positive and negative slew rates.

Note 9: Input referred V^+ = 15V and R_L = 100 kΩ connected to 7.5V. Each amp excited in turn with 100 Hz to produce V_O = 12 V_{PP}.

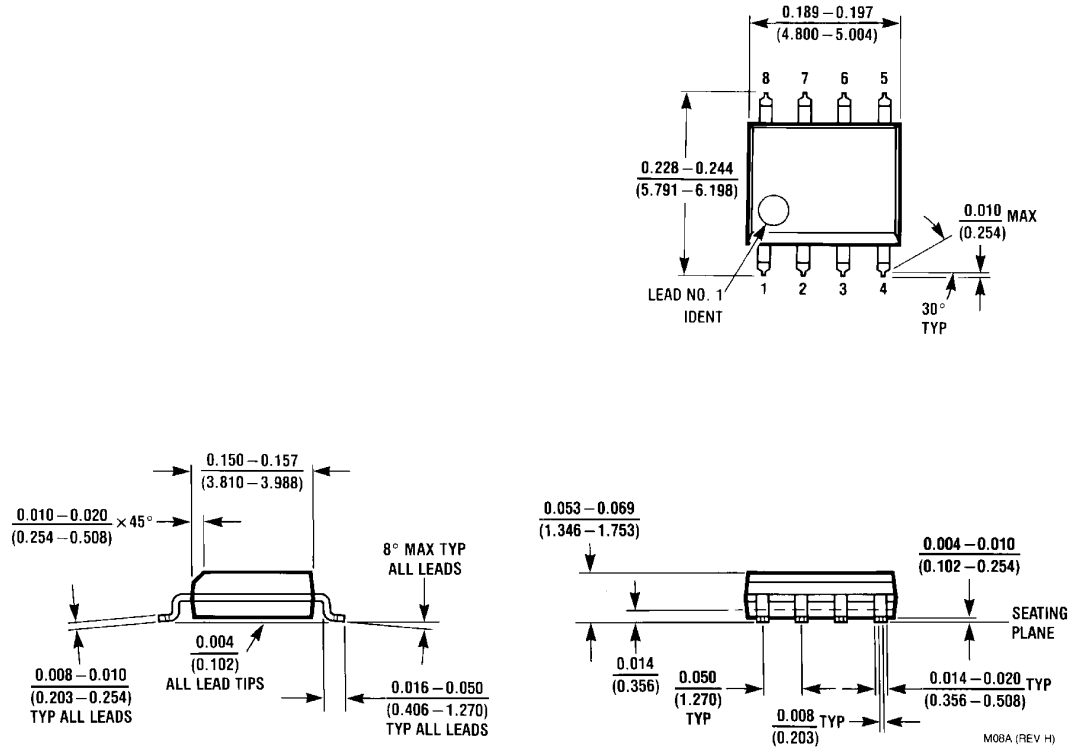
Note 10: For operating at elevated temperatures the device must be derated based on the thermal resistance θ_{JA} with $P_D = (T_J - T_A)/\theta_{JA}$.

Note 11: Do not connect output to V^+, when V^+ is greater than 13V or reliability witll be adversely affected.

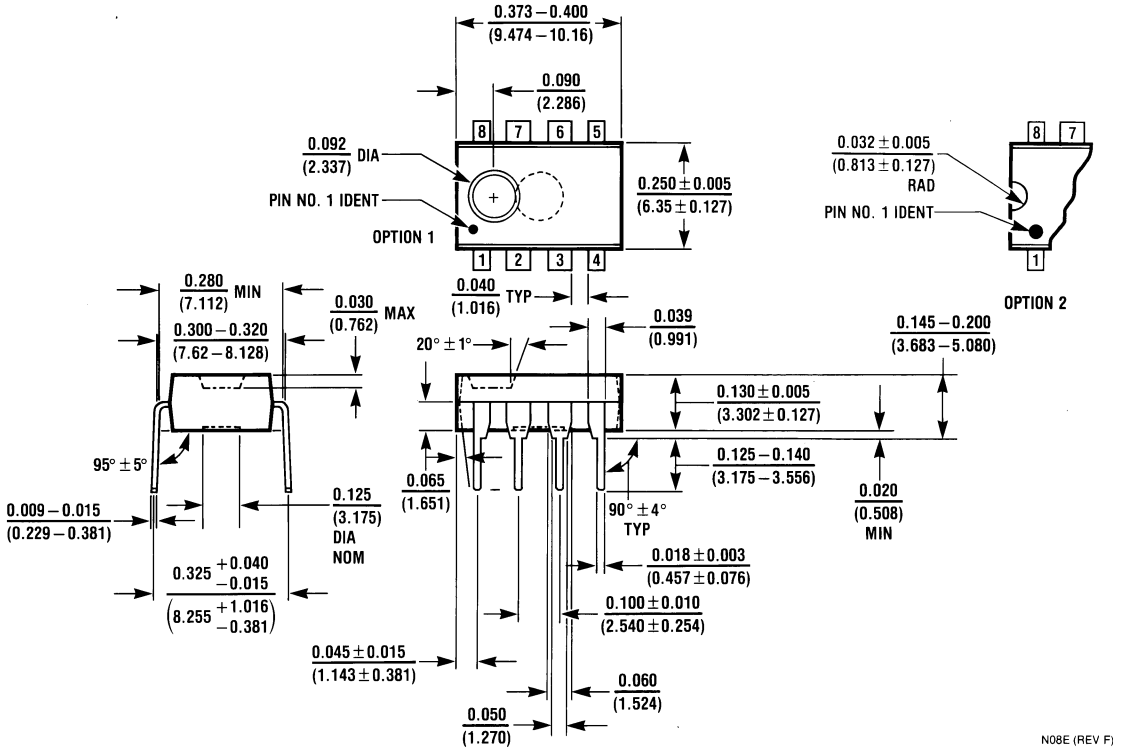
Note 12: All numbers apply for packages soldered directly into a PC board.

Note 13: For guaranteed Military Temperature Range parameters, see RETSMC6062X.

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



8-Pin Small Outline Package
Order Number LMC6062AIM or LMC6062IM
NS Package Number M08A



8-Pin Molded Dual-In-Line Package
Order Number LMC6062AIN, LMC6062AMN or LMC6062IN
NS Package Number N08E