LMC662
CMOS Dual Operational Amplifier

General Description

The LMC662 CMOS Dual operational amplifier is ideal for operation from a single supply. It operates from +5V to +15V and features rail-to-rail output swing in addition to an input common-mode range that includes ground. Performance limitations that have plagued CMOS amplifiers in the past are not a problem with this design. Input V_{OS}, drift, and broadband noise as well as voltage gain into realistic loads (2 kΩ and 600Ω) are all equal to or better than widely accepted bipolar equivalents.

This chip is built with National's advanced Double-Poly Silicon-Gate CMOS process.

See the LMC660 datasheet for a Quad CMOS operational amplifier with these same features.

Features

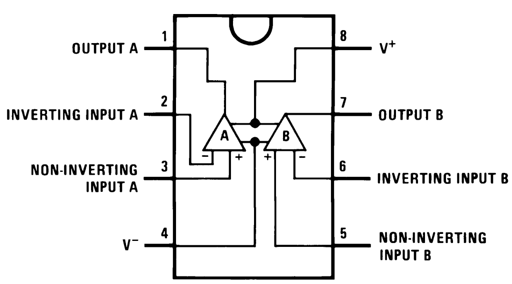
- Rail-to-rail output swing
- Specified for 2 kΩ and 600Ω loads
- High voltage gain: 126 dB
- Low input offset voltage: 3 mV
- Low offset voltage drift: 1.3 μV/˚C
- Ultra low input bias current: 2 fA
- Input common-mode range includes V^-
- Operating range from +5V to +15V supply
- I_{SS} = 400 μA/amplifier; independent of V+
- Low distortion: 0.01% at 10 kHz
- Slew rate: 1.1 V/μs

Applications

- High-impedance buffer or preamplifier
- Precision current-to-voltage converter
- Long-term integrator
- Sample-and-hold circuit
- Peak detector
- Medical instrumentation
- Industrial controls
- Automotive sensors

Connection Diagram

8-Pin DIP/SO



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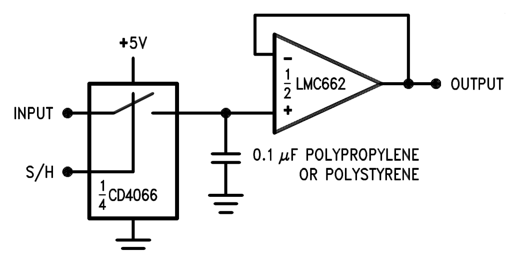
Typical Application

Low-Leakage Sample-and-Hold



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Ordering Information

Package	Temperature Range		NSC Drawing	Transport Media
	Industrial	Commercial		
8-Pin Small Outline	LMC662AIM LMC662AIMX	LMC662CM LMC662CMX	M08A	Rail Tape and Reel
8-Pin Molded DIP	LMC662AIN	LMC662CN	N08E	Rail

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Absolute Maximum Ratings (Note 3)

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

Differential Input Voltage	±Supply Voltage
Supply Voltage ($V^+ - V^-$)	16V
Output Short Circuit to V^+	(Note 12)
Output Short Circuit to V^-	(Note 1)
Lead Temperature	
(Soldering, 10 sec.)	260˚C
Storage Temp. Range	−65˚C to +150˚C
Voltage at Input/Output Pins	(V^+) +0.3V, (V^-) −0.3V
Current at Output Pin	±18 mA
Current at Input Pin	±5 mA
Current at Power Supply Pin	35 mA
Power Dissipation	(Note 2)
Junction Temperature	150˚C
ESD Tolerance (Note 8)	1000V

Operating Ratings (Note 3)

Temperature Range	
LMC662AI	$-40˚C \le T_J \le +85˚C$
LMC662C	$0˚C \le T_J \le +70˚C$
Supply Voltage Range	4.75V to 15.5V
Power Dissipation	(Note 10)
Thermal Resistance (θ_{JA}) (Note 11)	
8-Pin Molded DIP	101˚C/W
8-Pin SO	165˚C/W

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.

Parameter	Conditions	Typ (Note 4)	LMC662AI Limit (Note 4)	LMC662C Limit (Note 4)	Units
Input Offset Voltage		1	3 **3.3**	6 **6.3**	mV max
Input Offset Voltage Average Drift		1.3			μV/˚C
Input Bias Current		0.002	**4**	**2**	pA max
Input Offset Current		0.001	**2**	**1**	pA max
Input Resistance		>1			TeraΩ
Common Mode Rejection Ratio	$0V \le V_{CM} \le 12.0V$ V^+ = 15V	83	70 **68**	63 **62**	dB min
Positive Power Supply Rejection Ratio	$5V \le V^+ \le 15V$ V_O = 2.5V	83	70 **68**	63 **62**	dB min
Negative Power Supply Rejection Ratio	$0V \le V^- \le -10V$	94	84 **83**	74 **73**	dB min
Input Common-Mode Voltage Range	V^+ = 5V & 15V For CMRR ≥ 50 dB	−0.4	−0.1 **0**	−0.1 **0**	V max
		V^+ − 1.9	V^+ − 2.3 **V^+ − 2.5**	V^+ − 2.3 **V^+ − 2.4**	V min
Large Signal Voltage Gain	R_L = 2 kΩ (Note 5) Sourcing	2000	440 **400**	300 **200**	V/mV min
	Sinking	500	180 **120**	90 **80**	V/mV min
	R_L = 600Ω (Note 5) Sourcing	1000	220 **200**	150 **100**	V/mV min
	Sinking	250	100 **60**	50 **40**	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.

Parameter	Conditions	Typ (Note 4)	LMC662AI Limit (Note 4)	LMC662C Limit (Note 4)	Units
Output Swing	V^+ = 5V R_L = 2 kΩ to $V^+/2$	4.87	4.82 **4.79**	4.78 **4.76**	V min
		0.10	0.15 **0.17**	0.19 **0.21**	V max
	V^+ = 5V R_L = 600Ω to $V^+/2$	4.61	4.41 **4.31**	4.27 **4.21**	V min
		0.30	0.50 **0.56**	0.63 **0.69**	V max
	V^+ = 15V R_L = 2 kΩ to $V^+/2$	14.63	14.50 **14.44**	14.37 **14.32**	V min
		0.26	0.35 **0.40**	0.44 **0.48**	V max
	V^+ = 15V R_L = 600Ω to $V^+/2$	13.90	13.35 **13.15**	12.92 **12.76**	V min
		0.79	1.16 **1.32**	1.45 **1.58**	V max
Output Current V^+ = 5V	Sourcing, V_O = 0V	22	16 **14**	13 **11**	mA min
	Sinking, V_O = 5V	21	16 **14**	13 **11**	mA min
Output Current V^+ = 15V	Sourcing, V_O = 0V	40	28 **25**	23 **21**	mA min
	Sinking, V_O = 13V (Note 12)	39	28 **24**	23 **20**	mA min
Supply Current	Both Amplifiers V_O = 1.5V	0.75	1.3 **1.5**	1.6 **1.8**	mA 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.

Parameter	Conditions	Typ (Note 4)	LMC662AI Limit (Note 4)	LMC662C Limit (Note 4)	Units
Slew Rate	(Note 6)	1.1	0.8 **0.6**	0.8 **0.7**	V/μs min
Gain-Bandwidth Product		1.4			MHz
Phase Margin		50			Deg
Gain Margin		17			dB
Amp-to-Amp Isolation	(Note 7)	130			dB
Input-Referred Voltage Noise	F = 1 kHz	22			$nV/\sqrt{Hz}$
Input-Referred Current Noise	F = 1 kHz	0.0002			$pA/\sqrt{Hz}$

AC 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.

Parameter	Conditions	Typ (Note 4)	LMC662AI	LMC662C	Units
			Limit (Note 4)	Limit (Note 4)	
Total Harmonic Distortion	F = 10 kHz, A_V = −10 R_L = 2 kΩ, V_O = 8 V_{PP} V^+ = 15V	0.01			%

Note 1: Applies to both single-supply and split-supply operation. Continuous short circuit operation at elevated ambient temperature and/or multiple Op Amp shorts 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 2: 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 3: 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 4: Typical values represent the most likely parametric norm. Limits are guaranteed by testing or correlation.

Note 5: 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 6: V^+ = 15V. Connected as Voltage Follower with 10V step input. Number specified is the slower of the positive and negative slew rates.

Note 7: Input referred. V^+ = 15V and R_L = 10 kΩ connected to $V^+/2$. Each amp excited in turn with 1 kHz to produce V_O = 13 V_{PP}.

Note 8: Human body model, 1.5 kΩ in series with 100 pF.

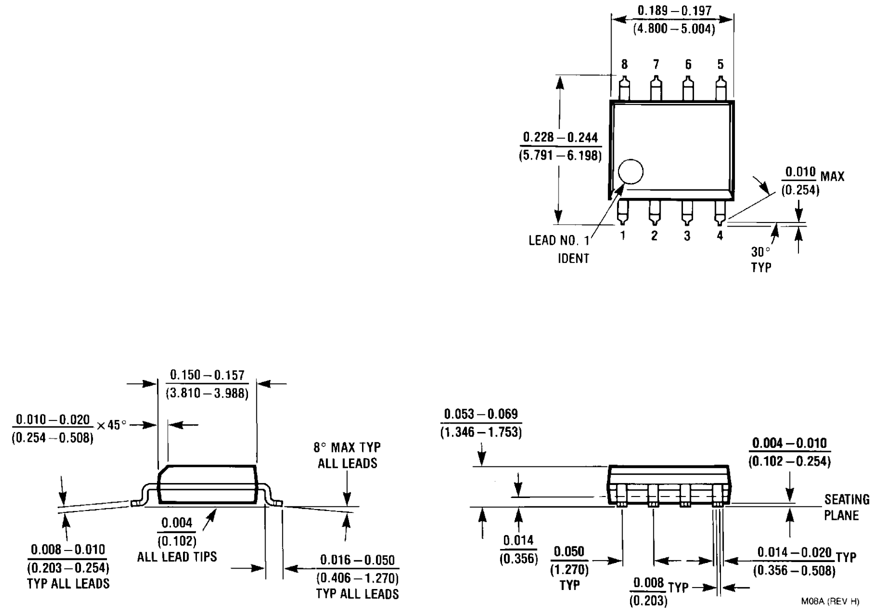
Note 9: A military RETS electrical test specification is available on request.

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

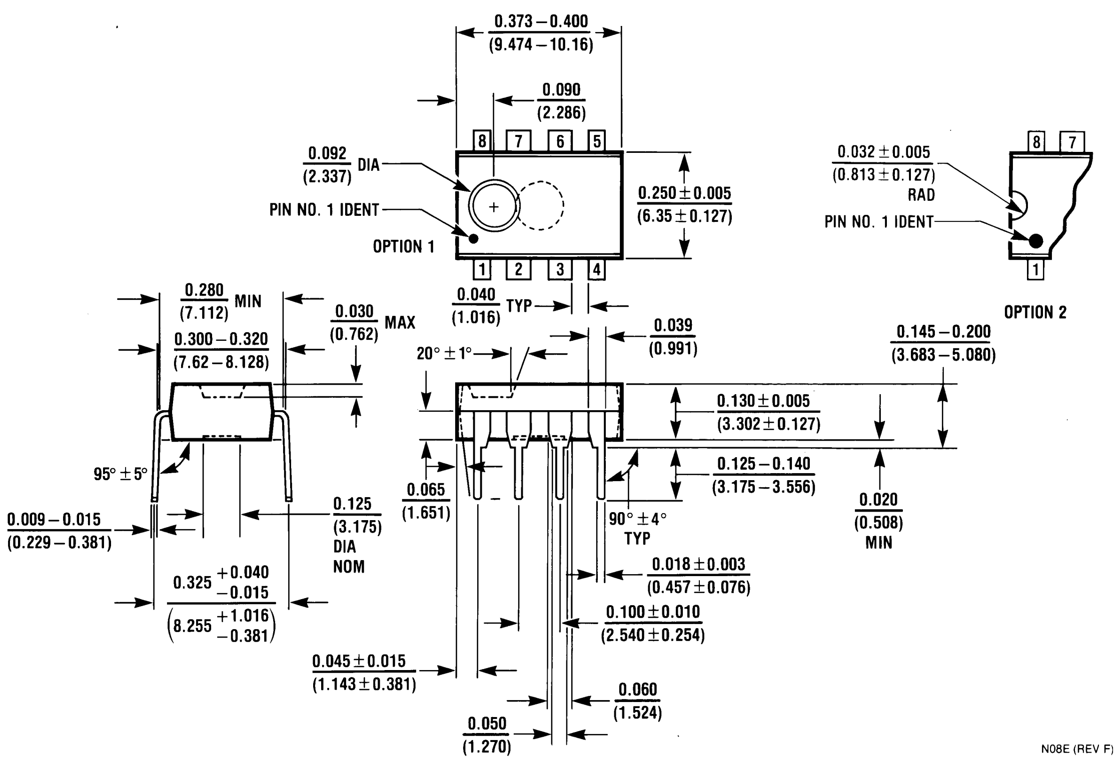
Note 11: All numbers apply for packages soldered directly into a PC board.

Note 12: Do not connect output to V^+ when V^+ is greater than 13V or reliability may be adversely affected.

Physical Dimensions inches (millimeters) unless otherwise noted



Small Outline Dual-In-Line Pkg. (M)
Order Number LMC662AIM, LMC662CM, LMC662AIMX or LMC662CMX
NS Package Number M08A



Molded Dual-In-Line Pkg. (N)
Order Number LMC662AIN, LMC662CN
NS Package Number N08E