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National Semiconductor

LMC6034
CMOS Quad Operational Amplifier

General Description

The LMC6034 is a CMOS quad operational amplifier which can operate from either a single supply or dual supplies. Its performance features include an input common-mode range that reaches ground, low input bias current, and high voltage gain into realistic loads, such as 2 kΩ and 600Ω.

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

See the LMC6032 datasheet for a CMOS dual operational amplifier with these same features. For higher performance characteristics refer to the LMC660.

Features

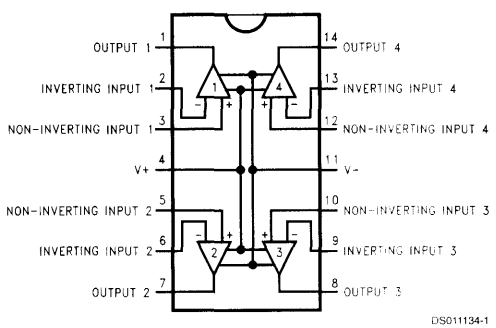
- Specified for 2 kΩ and 600Ω loads
- High voltage gain: 126 dB
- Low offset voltage drift: 2.3 μV/°C
- Ultra low input bias current: 40 fA
- Input common-mode range includes V^-
- Operating Range from +5V to +15V supply
- I_{SS} = 400 μA/amplifier; independent of V^+
- Low distortion: 0.01% at 10 kHz
- Slew rate: 1.1 V/μs
- Improved performance over TLC274

Applications

- High-impedance buffer or preamplifier
- Current-to-voltage converter
- Long-term integrator
- Sample-and-hold circuit
- Medical instrumentation

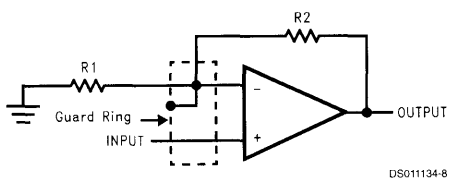
Connection Diagram

14-Pin DIP/SO



Top View

Guard Ring Connections
Non-Inverting Amplifier



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
Supply Voltage ($V^+ - V^-$)	16V
Output Short Circuit to V^+	(Note 10)
Output Short Circuit to V^-	(Note 2)
Lead Temperature (Soldering, 10 sec.)	260°C
Storage Temperature Range	−65°C to +150°C
Power Dissipation	(Note 3)
Voltage at Output/Input Pin	(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
Junction Temperature (Note 3)	150°C
ESD Tolerance (Note 4)	1000V

Operating Ratings (Note 1)

Temperature Range	$-40°C \le T_J \le +85°C$
Supply Voltage Range	4.75V to 15.5V
Power Dissipation	(Note 11)
Thermal Resistance (θ_{JA}), (Note 12)	
14-Pin DIP	85°C/W
14-Pin SO	115°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^- = GND = 0V, V_{CM} = 1.5V, V_{OUT} = 2.5V, and R_L > 1M unless otherwise specified.

Symbol	Parameter	Conditions	Typical (Note 5)	LMC6034I Limit (Note 6)	Units
V_{OS}	Input Offset Voltage		1	9	mV
				11	max
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Average Drift		2.3		µV/°C
I_B	Input Bias Current		0.04		pA
				200	max
I_{OS}	Input Offset Current		0.01		pA
				100	max
R_{IN}	Input Resistance		>1		TeraΩ
CMRR	Common Mode Rejection Ratio	$0V \le V_{CM} \le 12V$ $V^+ = 15V$	83	63	dB
				60	min
+PSRR	Positive Power Supply Rejection Ratio	$5V \le V^+ \le 15V$ $V_O = 2.5V$	83	63	dB
				60	min
−PSRR	Negative Power Supply Rejection Ratio	$0V \le V^- \le -10V$	94	74	dB
				70	min
V_{CM}	Input Common-Mode Voltage Range	V^+ = 5V & 15V For CMRR ≥ 50 dB	−0.4	−0.1	V
				0	max
			$V^+ - 1.9$	$V^+ - 2.3$	V
				$V^+ - 2.6$	min
A_V	Large Signal Voltage Gain	R_L = 2 kΩ (Note 7) Sourcing	2000	200	V/mV
				100	min
		Sinking	500	90	V/mV
				40	min
		R_L = 600Ω (Note 7) Sourcing	1000	100	V/mV
				75	min
		Sinking	250	50	V/mV
				20	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^- = GND = 0V, V_{CM} = 1.5V, V_{OUT} = 2.5V, and R_L > 1M unless otherwise specified.

Symbol	Parameter	Conditions	Typical (Note 5)	LMC6034I Limit (Note 6)	Units
V_O	Output Voltage Swing	V^+ = 5V R_L = 2 kΩ to 2.5V	4.87	4.20 **4.00**	V min
			0.10	0.25 **0.35**	V max
		V^+ = 5V R_L = 600Ω to 2.5V	4.61	4.00 **3.80**	V min
			0.30	0.63 **0.75**	V max
		V^+ = 15V R_L = 2 kΩ to 7.5V	14.63	13.50 **13.00**	V min
			0.26	0.45 **0.55**	V max
		V^+ = 15V R_L = 600Ω to 7.5V	13.90	12.50 **12.00**	V min
			0.79	1.45 **1.75**	V max
I_O	Output Current	V^+ = 5V Sourcing, V_O = 0V	22	13 **9**	mA min
		Sinking, V_O = 5V	21	13 **9**	mA min
		V^+ = 15V Sourcing, V_O = 0V	40	23 **15**	mA min
		Sinking, V_O = 13V (Note 10)	39	23 **15**	mA min
I_S	Supply Current	All Four Amplifiers V_O = 1.5V	1.5	2.7 **3.0**	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^- = GND = 0V, V_{CM} = 1.5V, V_{OUT} = 2.5V, and R_L > 1M unless otherwise specified.

Symbol	Parameter	Conditions	Typical (Note 5)	LMC6034I Limit (Note 6)	Units
SR	Slew Rate	(Note 8)	1.1	0.8 **0.4**	V/μs min
GBW	Gain-Bandwidth Product		1.4		MHz
ϕ_M	Phase Margin		50		Deg
G_M	Gain Margin		17		dB
	Amp-to-Amp Isolation	(Note 9)	130		dB
e_n	Input-Referred Voltage Noise	F = 1 kHz	22		nV/$\sqrt{Hz}$
i_n	Input-Referred Current Noise	F = 1 kHz	0.0002		pA/$\sqrt{Hz}$
THD	Total Harmonic Distortion	F = 10 kHz, A_V = −10 R_L = 2 kΩ, V_O = 8 V_{PP} ±5V Supply	0.01		%

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the component 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. 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 3: The maximum power dissipation is a function of $T_{J(max)}$, θ_{JA}, 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, 100 pF discharged through a 1.5 kΩ resistor.

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

Note 6: All limits are guaranteed at room temperature (standard type face) or at operating temperature extremes (**bold type face**).

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 = 10 kΩ connected to $V^+/2$. Each amp excited in turn with 1 kHz to produce V_O = 13 V_{PP}.

Note 10: Do not connect output to V^+, when V^+ is greater than 13V or reliability may be adversely affected.

Note 11: 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 12: All numbers apply for packages soldered directly into a PC board.