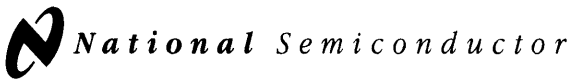


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LMC6034

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 k Ω and 600 Ω .

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

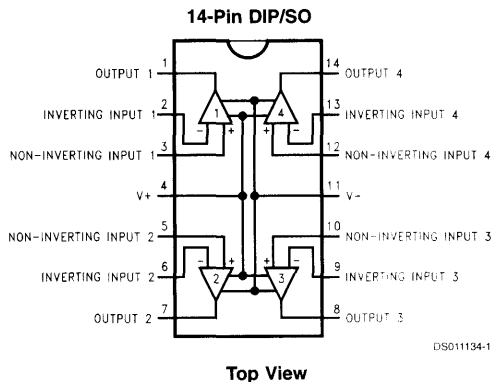
- Specified for 2 k Ω and 600 Ω loads
- High voltage gain: 126 dB

- Low offset voltage drift: 2.3 $\mu\text{V}/^\circ\text{C}$
- Ultra low input bias current: 40 fA
- Input common-mode range includes V^-
- Operating Range from +5V to +15V supply
- $I_{SS} \approx 400 \mu\text{A}/\text{amplifier}$; independent of V^+
- Low distortion: 0.01% at 10 kHz
- Slew rate: 1.1 V/ μs
- Improved performance over TLC274

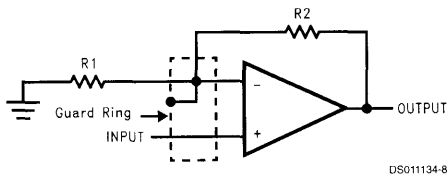
Applications

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

Connection Diagram



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 ≤ T_J ≤ +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 $T_J = 25^\circ\text{C}$. **Boldface** limits apply at the temperature extremes. $V^+ = 5\text{V}$, $V^- = \text{GND} = 0\text{V}$, $V_{\text{CM}} = 1.5\text{V}$, $V_{\text{OUT}} = 2.5\text{V}$, and $R_L > 1\text{M}$ unless otherwise specified.

| Symbol | Parameter | Conditions | Typical (Note 5) | LMC6034I Limit (Note 6) | Units |
|---------------------------------|--|--|---------------------|--|------------------------------|
| V_{OS} | Input Offset Voltage | | 1 | 9 11 | mV max |
| $\Delta V_{\text{OS}}/\Delta T$ | Input Offset Voltage Average Drift | | 2.3 | | $\mu\text{V}/^\circ\text{C}$ |
| I_{B} | Input Bias Current | | 0.04 | 200 | pA max |
| I_{OS} | Input Offset Current | | 0.01 | 100 | pA max |
| R_{IN} | Input Resistance | | >1 | | Tera Ω |
| CMRR | Common Mode Rejection Ratio | $0\text{V} \leq V_{\text{CM}} \leq 12\text{V}$ $V^+ = 15\text{V}$ | 83 | 63 60 | dB min |
| +PSRR | Positive Power Supply Rejection Ratio | $5\text{V} \leq V^+ \leq 15\text{V}$ $V_{\text{O}} = 2.5\text{V}$ | 83 | 63 60 | dB min |
| -PSRR | Negative Power Supply Rejection Ratio | $0\text{V} \leq V^- \leq -10\text{V}$ | 94 | 74 70 | dB min |
| V_{CM} | Input Common-Mode Voltage Range | $V^+ = 5\text{V} \ \& \ 15\text{V}$ For CMRR ≥ 50 dB | -0.4 | -0.1 0 | V max |
| | | | $V^+ - 1.9$ | $V^+ - 2.3$ $V^+ - 2.6$ | V min |
| A_{V} | Large Signal Voltage Gain | $R_L = 2 \text{ k}\Omega$ (Note 7) Sourcing Sinking | 2000 | 200 100 | V/mV min |
| | | | 500 | 90 40 | V/mV min |
| | | $R_L = 600\Omega$ (Note 7) Sourcing Sinking | 1000 | 100 75 | V/mV min |
| | | | 250 | 50 20 | V/mV min |

DC Electrical Characteristics (Continued)

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

| Symbol | Parameter | Conditions | Typical (Note 5) | LMC6034I Limit (Note 6) | Units | | |
|--------|----------------------|---|---------------------|---|----------|-------------------|-----------|
| V_O | Output Voltage Swing | $V^+ = 5\text{V}$ $R_L = 2\text{ k}\Omega$ to 2.5V | 4.87 | 4.20 4.00 | V min | | |
| | | | 0.10 | 0.25 0.35 | V max | | |
| | | $V^+ = 5\text{V}$ $R_L = 600\Omega$ to 2.5V | 4.61 | 4.00 3.80 | V min | | |
| | | | 0.30 | 0.63 0.75 | V max | | |
| | | $V^+ = 15\text{V}$ $R_L = 2\text{ k}\Omega$ to 7.5V | 14.63 | 13.50 13.00 | V min | | |
| | | | 0.26 | 0.45 0.55 | V max | | |
| | | $V^+ = 15\text{V}$ $R_L = 600\Omega$ to 7.5V | 13.90 | 12.50 12.00 | V min | | |
| | | | 0.79 | 1.45 1.75 | V max | | |
| | | I_O | Output Current | $V^+ = 5\text{V}$ Sourcing, $V_O = 0\text{V}$ Sinking, $V_O = 5\text{V}$ | 22 | 13 9 | mA min |
| | | | | | 21 | 13 9 | mA min |
| | | | | $V^+ = 15\text{V}$ Sourcing, $V_O = 0\text{V}$ Sinking, $V_O = 13\text{V}$ (Note 10) | 40 | 23 15 | mA min |
| | | | | | 39 | 23 15 | mA min |
| I_S | Supply Current | | | All Four Amplifiers $V_O = 1.5\text{V}$ | 1.5 | 2.7 3.0 | mA max |

AC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_J = 25^\circ\text{C}$. **Boldface** limits apply at the temperature extremes. $V^+ = 5\text{V}$, $V^- = \text{GND} = 0\text{V}$, $V_{\text{CM}} = 1.5\text{V}$, $V_{\text{OUT}} = 2.5\text{V}$, and $R_L > 1\text{M}$ 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 | $F = 1\text{ kHz}$ | 22 | | $\text{nV}/\sqrt{\text{Hz}}$ |
| i_n | Input-Referred Current Noise | $F = 1\text{ kHz}$ | 0.0002 | | $\text{pA}/\sqrt{\text{Hz}}$ |
| THD | Total Harmonic Distortion | $F = 10\text{ kHz}$, $A_V = -10$ $R_L = 2\text{ k}\Omega$, $V_O = 8\text{ V}_{\text{PP}}$ $\pm 5\text{V Supply}$ | 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 $\pm 30\text{ mA}$ over long term may adversely affect reliability.

Note 3: The maximum power dissipation is a function of $T_{\text{J(max)}}$, θ_{JA} , T_{A} . The maximum allowable power dissipation at any ambient temperature is $P_{\text{D}} = (T_{\text{J(max)}} - T_{\text{A}})/\theta_{\text{JA}}$.

Note 4: Human body model, 100 pF discharged through a 1.5 k Ω 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: $V^+ = 15\text{V}$, $V_{\text{CM}} = 7.5\text{V}$, and R_L connected to 7.5V. For Sourcing tests, $7.5\text{V} \leq V_O \leq 11.5\text{V}$. For Sinking tests, $2.5\text{V} \leq V_O \leq 7.5\text{V}$.

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

Note 9: Input referred. $V^+ = 15\text{V}$ and $R_L = 10\text{ k}\Omega$ connected to $V^+/2$. Each amp excited in turn with 1 kHz to produce $V_O = 13\text{ V}_{\text{PP}}$.

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 $P_{\text{D}} = (T_J - T_A)/\theta_{\text{JA}}$.

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