

TLC2274-HT 高级 LinCMOS™ 轨到轨运算放大器

1 特性

- 符合汽车应用要求
- 符合 AEC-Q100 标准
- 输出摆幅包括两个电源轨
- 低噪声 $f = 1\text{kHz}$ 时典型值为 $9\text{nV}/\sqrt{\text{Hz}}$
- 低输入偏置电流：典型值 1pA
- 完全符合单电源及分离电源操作的要求
- 共模输入电压范围包括负轨
- 高增益带宽：典型值 2.2MHz
- 高转换率：典型值 $3.6\text{V}/\mu\text{s}$
- $T_A = 25^\circ\text{C}$ 时低输入偏移电压最大为 $2500\mu\text{V}$
- 包含宏观模型

2 应用

- 支持极限温度应用：
 - 受控基线
 - 同一组装和测试场所
 - 同一制造场所
 - 在极限 (-40°C 至 150°C) 温度范围内可用 ⁽¹⁾
 - 延长的产品生命周期
 - 延长的产品变更通知
 - 产品可追溯性
 - 德州仪器 (TI) 高温产品利用高度优化的硅 (芯片) 解决方案, 通过设计和制造工艺方面的改进, 能够在广泛的温度范围内最大限度提升性能。所有器件在最高额定温度下均可连续正常运行 1000 小时。

(1) 可定制工作温度范围

3 说明

TLC2274 是一款由德州仪器 (TI) 生产的四通道运算放大器。此器件在单电源或分离电源应用中表现出优异的轨到轨输出性能, 能够进一步扩大动态范围。

TLC2274 带宽为 2MHz , 转换率为 $3\text{V}/\mu\text{s}$, 适用于高速应用。这些器件能够提供出色的交流性能, 其噪声、输入偏移电压和功耗均低于现有 CMOS 运算放大器。TLC2274 的电压噪声为 $9\text{nV}/\sqrt{\text{Hz}}$, 是竞争对手解决方案的二分之一。

TLC2274 放大器具有高输入阻抗和低噪声特性, 是用于高阻抗源 (如压电传感器) 小信号调节的绝佳选择。该器件属于低功耗级别, 因此手持式监控和遥感应用中运转良好。此外, 该器件的单电源或分离电源具有轨到轨输出特性, 是与模数转换器 (ADC) 对接的理想选择。该器件系列的额定工作电压为 5V 或 $\pm 5\text{V}$ 。

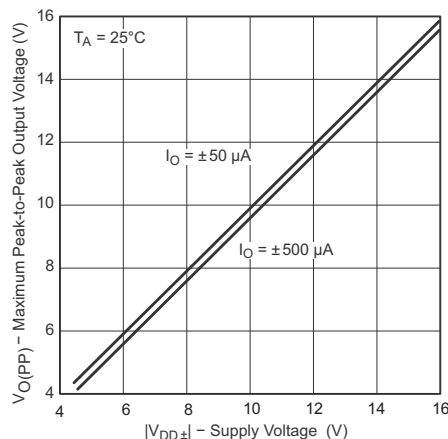
它可提供更大的输出动态范围, 更低的电压噪声和更小的输入偏移电压。凭借这一系列增强特性, 该器件能够用于更广泛的应用。

器件信息⁽¹⁾

| 器件型号 | 封装 | 封装尺寸 (标称值) |
|------------|------------|-----------------|
| TLC2274-HT | TSSOP (14) | 6.60mm x 5.10mm |

(1) 要了解所有可用封装, 请见数据表末尾的可订购产品附录。

最大峰峰值输出电压 与电源电压



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4 修订历史记录

| 日期 | 修订版本 | 注释 |
|------------|------|-------|
| 2015 年 1 月 | * | 最初发布。 |

5 Pin Configuration and Functions

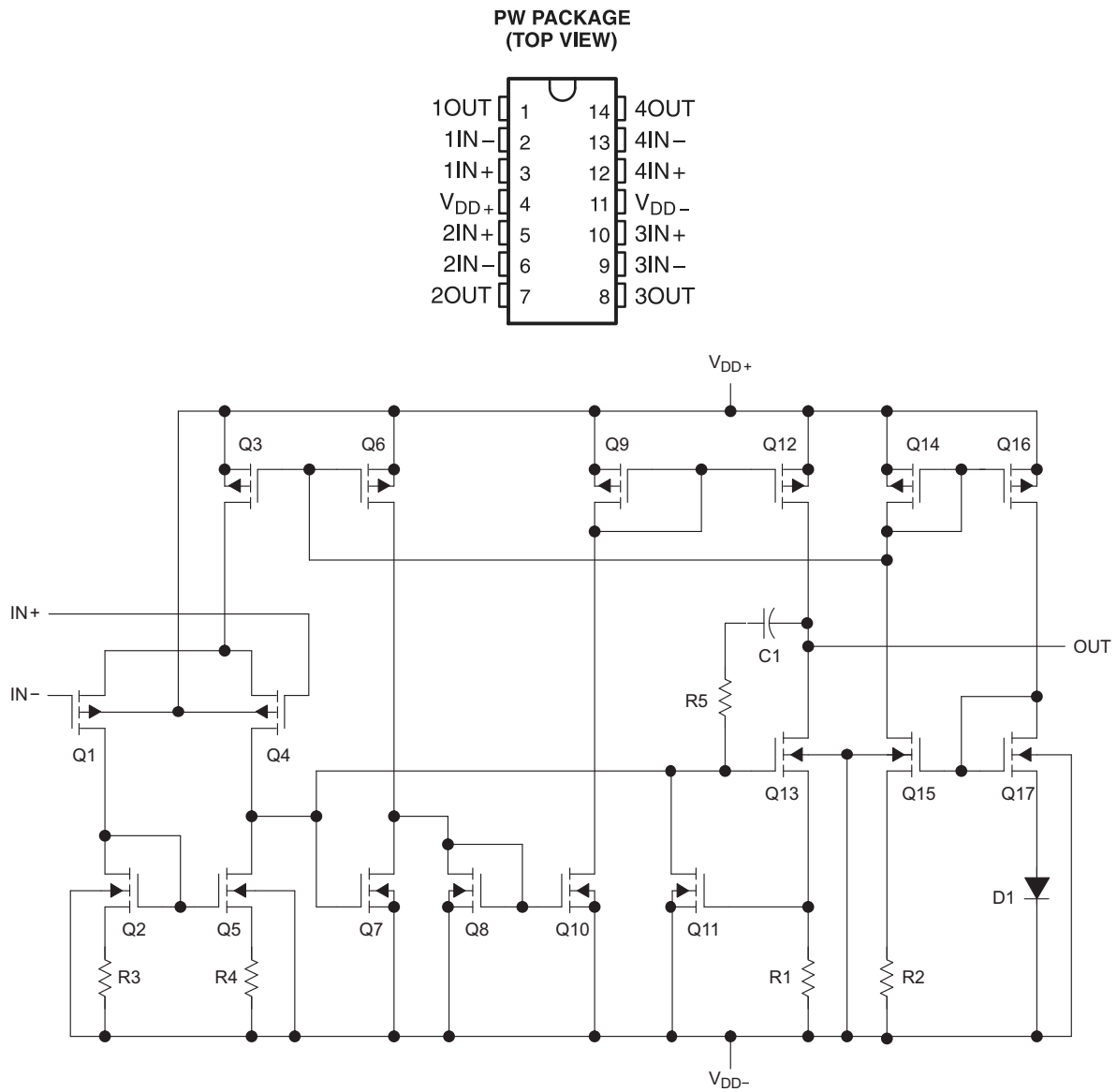


Figure 1. Equivalent Schematic (Each Amplifier)

Table 1. Actual Device Component Count⁽¹⁾

| COMPONENT | TLC2274 |
|-------------|---------|
| Transistors | 76 |
| Resistors | 52 |
| Diodes | 18 |
| Capacitors | 6 |

(1) Includes both amplifiers and all ESD, bias, and trim circuitry

6 Specifications

6.1 Absolute Maximum Ratings⁽¹⁾

over operating free-air temperature range (unless otherwise noted)

| | | MIN | MAX | UNIT | |
|------------------|---|-----------|------------------------|------------------|----|
| V _{DD+} | Supply voltage ⁽²⁾ | | 8 | V | |
| V _{DD-} | Supply voltage ⁽²⁾ | | -8 | V | |
| V _{ID} | Differential input voltage ⁽³⁾ | -16 | 16 | V | |
| V _I | Input voltage ⁽²⁾ | Any input | V _{DD-} - 0.3 | V _{DD+} | V |
| I _I | Input current | Any input | -5 | 5 | mA |
| I _O | Output current | | -50 | 50 | mA |
| | Total current into V _{DD+} | | -50 | 50 | mA |
| | Total current out of V _{DD-} | | -50 | 50 | mA |
| | Duration of short-circuit current at (or below) 25°C ⁽⁴⁾ | | Unlimited | | |
| T _A | Operating free-air temperature | -40 | 150 | °C | |
| | Lead temperature 1.6 mm (1/16 inch) from case for 10 s | | 260 | °C | |
| T _{stg} | Storage temperature | -65 | 150 | °C | |

- (1) Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values, except differential voltages, are with respect to the midpoint between V_{DD+} and V_{DD-}.
- (3) Differential voltages are at I_{N+} with respect to I_{N-}. Excessive current will flow if input is brought below V_{DD-} - 0.3 V.
- (4) The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.

6.2 ESD Ratings

| | | | VALUE | UNIT |
|--------------------|-------------------------|---|----------|------|
| V _(ESD) | Electrostatic discharge | Human-body model (HBM), per AEC Q100-002 ⁽¹⁾ | ±2500 | V |
| | | Charged-device model (CDM), per AEC Q100-011 | All pins | |

- (1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

| | | MIN | MAX | UNIT |
|------------------|--------------------------------|------------------|------------------------|------|
| V _{DD±} | Supply voltage | ±2.2 | ±8 | V |
| V _I | Input voltage | V _{DD-} | V _{DD+} - 1.5 | V |
| V _{IC} | Common-mode input voltage | V _{DD-} | V _{DD+} - 1.5 | V |
| T _A | Operating free-air temperature | -40 | 150 | °C |

6.4 Thermal Information

| THERMAL METRIC ⁽¹⁾ | | TLC2274 | UNIT |
|-------------------------------|--|---------|------|
| | | PW | |
| | | 14 PINS | |
| R _{θJA} | Junction-to-ambient thermal resistance | 106.0 | °C/W |
| R _{θJC(top)} | Junction-to-case (top) thermal resistance | 35.5 | |
| R _{θJB} | Junction-to-board thermal resistance | 47.6 | |
| ψ _{JT} | Junction-to-top characterization parameter | 2.4 | |
| ψ _{JB} | Junction-to-board characterization parameter | 47.1 | |

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).

6.5 Electrical Characteristics, $V_{DD} = 5\text{ V}$

at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | T_A ⁽¹⁾ | MIN | TYP | MAX | UNIT | |
|-----------------|--|---|---|----------------------|---|-------------|------|------------------------------|------|
| V_{IO} | Input offset voltage | | | 25°C | | 300 | 2500 | μV | |
| | | | | Full range | | | 3000 | | |
| αV_{IO} | Temperature coefficient of input offset voltage | | | 25°C to 125°C | | 2 | | $\mu\text{V}/^\circ\text{C}$ | |
| | Input offset voltage long-term drift ⁽²⁾ | $V_{IC} = 0\text{ V},$ $V_O = 0\text{ V},$ | $V_{DD\pm} = \pm 2.5\text{ V},$ $R_S = 50\ \Omega$ | 25°C | | 0.002 | | $\mu\text{V}/\text{mo}$ | |
| I_{IO} | Input offset current | | | 25°C | | 0.5 | 60 | pA | |
| | | | | Full range | | | 7000 | | |
| I_{IB} | Input bias current | | | 25°C | | 1 | | pA | |
| | | | | Full range | | | | | |
| V_{ICR} | Common-mode input voltage range | $R_S = 50\ \Omega$ | $ V_{IO} \leq 5\text{ mV}$ | 25°C | 0 to 4 | -0.3 to 4.2 | | V | |
| | | | | Full range | 0 to 3.5 | | | | |
| V_{OH} | High-level output voltage | | | 25°C | | 4.99 | | V | |
| | | | | 25°C | $I_{OH} = -20\ \mu\text{A}$ | 4.85 | 4.93 | | |
| | | | | | $I_{OH} = -200\ \mu\text{A}$ | 4.84 | | | |
| | | | | 25°C | $I_{OH} = -1\text{ mA}$ | 4.25 | 4.65 | | |
| Full range | | 4.20 | | | | | | | |
| V_{OL} | Low-level output voltage | | | 25°C | | 0.01 | | V | |
| | | | | 25°C | $V_{IC} = 2.5\text{ V},$ $I_{OL} = 50\ \mu\text{A}$ | 0.09 | 0.15 | | |
| | | | | | $V_{IC} = 2.5\text{ V},$ $I_{OL} = 500\ \mu\text{A}$ | | 0.16 | | |
| | | | | 25°C | $V_{IC} = 2.5\text{ V},$ $I_{OL} = 5\text{ mA}$ | 0.9 | 1.5 | | |
| Full range | | 1.6 | | | | | | | |
| A_{VD} | Large-signal differential voltage amplification | $V_{IC} = 2.5\text{ V},$ $V_O = 1\text{ V to }4\text{ V},$ | | 25°C | $R_L = 10\text{ k}\Omega$ ⁽³⁾ | | 10 | 35 | V/mV |
| | | | | | Full range | | 8 | | |
| | | | | 25°C | $R_L = 1\text{ M}\Omega$ ⁽³⁾ | | | 175 | |
| r_{id} | Differential input resistance | | | 25°C | | 10^{12} | | Ω | |
| r_i | Common-mode input resistance | | | 25°C | | 10^{12} | | Ω | |
| C_i | Common-mode input capacitance | $f = 10\text{ kHz},$ | N package | 25°C | | 8 | | pF | |
| Z_o | Closed-loop output impedance | $f = 1\text{ MHz},$ | $A_V = 10$ | 25°C | | 140 | | Ω | |
| CMRR | Common-mode rejection ratio | $V_{IC} = 0\text{ V to }2.7\text{ V},$ $V_O = 2.5\text{ V},$ | | 25°C | 70 | 75 | | dB | |
| | | | | Full range | 69 | | | | |
| k_{SVR} | Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{DD} = 4.4\text{ V to }16\text{ V},$ $V_{IC} = V_{DD}/2,$ | | 25°C | 80 | 95 | | dB | |
| | | | | Full range | 80 | | | | |
| I_{DD} | Supply current | $V_O = 2.5\text{ V},$ | | 25°C | | 4.4 | 6 | mA | |
| | | | | Full range | | | 6 | | |

(1) Full range is -40°C to 150°C for this part.

(2) Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

(3) Referenced to 2.5 V

6.6 Operating Characteristics, $V_{DD} = 5\text{ V}$

 at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $T_A^{(1)}$ | MIN | TYP | MAX | UNIT |
|------------------------|---|---|--------------------------------------|-------------|---------|------|-----|------------------------|
| SR | Slew rate at unity gain | $V_O = 0.5\text{ V to }2.5\text{ V}, R_L = 10\text{ k}\Omega^{(2)}$ $C_L = 100\text{ pF}^{(2)}$ | | 25°C | 2.3 | 3.6 | | V/ μs |
| | | | | Full range | 1.2 | | | |
| V_n | Equivalent input noise voltage | | | 25°C | | 50 | | nV/ $\sqrt{\text{Hz}}$ |
| | | | | 25°C | | 9 | | |
| $V_{N(pp)}$ | Peak-to-peak equivalent input noise voltage | | | 25°C | | 1 | | μV |
| | | | | 25°C | | 1.4 | | |
| I_n | Equivalent input noise current | | | 25°C | | 0.6 | | fA/ $\sqrt{\text{Hz}}$ |
| THD + N | Total harmonic distortion plus noise | $V_O = 0.5\text{ V to }2.5\text{ V}, R_L = 10\text{ k}\Omega, f = 20\text{ kHz}^{(2)}$ | | 25°C | 0.0013% | | | |
| | | | | | 0.004% | | | |
| | | | | | 0.03% | | | |
| Gain-bandwidth product | | $f = 10\text{ kHz}, C_L = 100\text{ pF}^{(2)}$ | $R_L = 10\text{ k}\Omega^{(2)}$ | 25°C | | 2.18 | | MHz |
| B_{OM} | Maximum output-swing bandwidth | $V_{O(pp)} = 2\text{ V}, R_L = 10\text{ k}\Omega^{(2)}$ | $A_V = 1, C_L = 100\text{ pF}^{(2)}$ | 25°C | | 1 | | MHz |
| t_s | Settling time | $A_V = -1, \text{ Step} = 0.5\text{ V to }2.5\text{ V}, R_L = 10\text{ k}\Omega^{(2)}, C_L = 100\text{ pF}^{(2)}$ | | 25°C | 1.5 | | | μs |
| | | | | | 2.6 | | | |
| ϕ_m | Phase margin at unity gain | $R_L = 10\text{ k}\Omega, C_L = 100\text{ pF}^{(2)}$ | | 25°C | | 50° | | |
| | Gain margin | | | 25°C | | 10 | | dB |

 (1) Full range is -40°C to 150°C for this part.

(2) Referenced to 2.5 V

6.7 Electrical Characteristics, $V_{DD\pm} = \pm 5\text{ V}$

at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $T_A^{(1)}$ | MIN | TYP | MAX | UNIT |
|-----------------|--|---|-----------------------------|---------------|---------|-------------|----------|------------------------------|
| V_{IO} | Input offset voltage | $V_{IC} = 0\text{ V},$ $R_S = 50\ \Omega$ $V_O = 0\text{ V}$ | | 25°C | | 300 | 2500 | μV |
| | | | | Full range | | | 3000 | |
| αV_{IO} | Temperature coefficient of input offset voltage | | | 25°C to 125°C | | 2 | | $\mu\text{V}/^\circ\text{C}$ |
| | | | | 25°C | | 0.002 | | $\mu\text{V}/\text{mo}$ |
| I_{IO} | Input offset current | 25°C | | 0.5 | 60 | pA | | |
| | | Full range | | | 7000 | | | |
| I_{IB} | Input bias current | 25°C | | 1 | 60 | pA | | |
| | | Full range | | | 7000 | | | |
| V_{ICR} | Common-mode input voltage range | $R_S = 50\ \Omega$ | $ V_{IO} \leq 5\text{ mV}$ | 25°C | -5 to 4 | -5.3 to 4.2 | | V |
| | | | | Full range | | -5 to 3.5 | | |
| V_{OM+} | Maximum positive peak output voltage | | | 25°C | | 4.99 | | V |
| | | | | 25°C | | 4.85 | 4.93 | |
| | | | | Full range | | 4.84 | | |
| | | | | 25°C | | 4.25 | 4.65 | |
| V_{OM-} | Maximum negative peak output voltage | | | 25°C | | -4.99 | | V |
| | | | | 25°C | | -4.85 | -4.91 | |
| | | | | Full range | | -4.85 | | |
| | | | | 25°C | | -3.5 | -4.1 | |
| A_{VD} | Large-signal differential voltage amplification | $V_O = \pm 4\text{ V},$ | $R_L = 10\text{ k}\Omega$ | 25°C | 20 | 50 | | V/mV |
| | | | | Full range | 16 | | | |
| | | | $R_L = 1\text{ M}\Omega$ | 25°C | | 300 | | |
| | | | | Full range | | | | |
| r_{id} | Differential input resistance | | | 25°C | | 10^{12} | Ω | |
| r_i | Common-mode input resistance | | | 25°C | | 10^{12} | Ω | |
| c_i | Common-mode input capacitance | f = 10 kHz, | N package | 25°C | | 8 | pF | |
| z_o | Closed-loop output impedance | f = 1 MHz, | AV = 10 | 25°C | | 130 | Ω | |
| CMRR | Common-mode rejection ratio | $V_{IC} = -5\text{ V to } 2.7\text{ V},$ $V_O = 0\text{ V},$ $R_S = 50\ \Omega$ | | 25°C | 75 | 80 | | dB |
| | | | | Full range | 73 | | | |
| k_{SVR} | Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{DD} = \pm 2.2\text{ V to } \pm 8\text{ V},$ $V_{IC} = 0\text{ V},$ No load | | 25°C | 80 | 95 | | dB |
| | | | | Full range | 80 | | | |
| I_{DD} | Supply current | $V_O = 0\text{ V},$ No load | | 25°C | | 4.4 | 6 | mA |
| | | | | Full range | | | 6 | |

(1) Full range is -40°C to 150°C for this part.

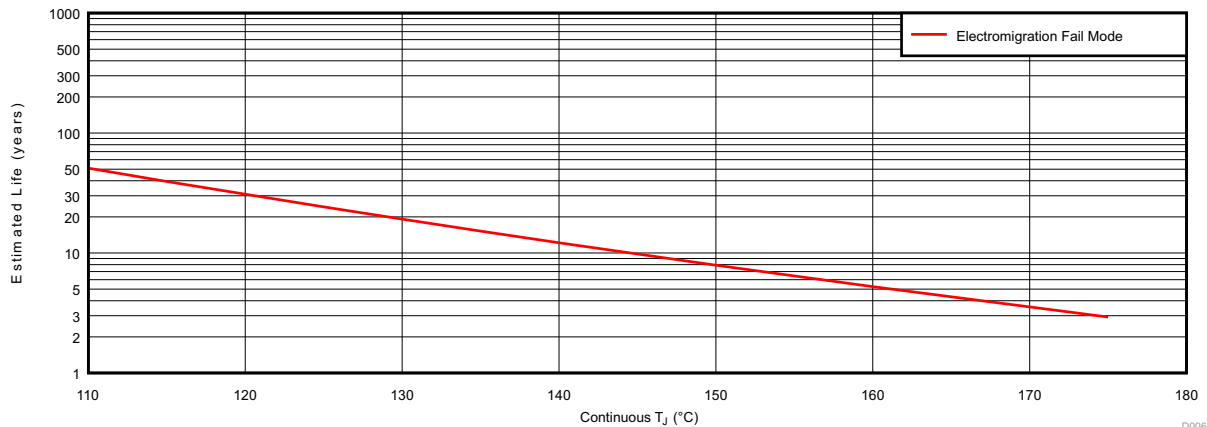
(2) Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

6.8 Operating Characteristics, $V_{DD\pm} = \pm 5\text{ V}$

at specified free-air temperature, $V_{DD\pm} = \pm 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | $T_A^{(1)}$ | MIN | TYP | MAX | UNIT |
|-------------|--|--|--------------------------------------|---------|------|------------------------|
| SR | Slew rate at unity gain $V_O = \pm 2.3\text{ V}$, $R_L = 10\text{ k}\Omega$ | $C_L = 100\text{ pF}$ | 25°C | 2.3 | 3.6 | V/ μs |
| | | | Full range | 1.2 | | |
| V_n | Equivalent input noise voltage | $f = 10\text{ Hz}$ | 25°C | 50 | | nV/ $\sqrt{\text{Hz}}$ |
| | | $f = 1\text{ kHz}$ | 25°C | 9 | | |
| $V_{N(pp)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ to }1\text{ Hz}$ | 25°C | 1 | | μV |
| | | $f = 0.1\text{ to }10\text{ Hz}$ | 25°C | 1.4 | | |
| I_n | Equivalent input noise current | | 25°C | 0.6 | | fA/ $\sqrt{\text{Hz}}$ |
| THD + N | Total harmonic distortion plus noise $V_O = \pm 2.3\text{ V}$, $f = 20\text{ kHz}$, $R_L = 10\text{ k}\Omega$ | $A_V = 1$ | 25°C | 0.0011% | | |
| | | $A_V = 10$ | | 0.004% | | |
| | | $A_V = 100$ | | 0.03% | | |
| | Gain-bandwidth product | $f = 10\text{ kHz}$, $C_L = 100\text{ pF}$ | $R_L = 10\text{ k}\Omega$ | 25°C | 2.25 | MHz |
| B_{OM} | Maximum output-swing bandwidth | $V_{O(pp)} = 4.6\text{ V}$, $R_L = 10\text{ k}\Omega$ | $A_V = 1$, $C_L = 100\text{ pF}$ | 25°C | 0.54 | MHz |
| t_s | Settling time | $A_V = -1$, Step = $-2.3\text{ V to }2.3\text{ V}$, $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | To 0.1% | 25°C | 1.5 | μs |
| | | | To 0.01% | | 3.2 | |
| Φ_m | Phase margin at unity gain | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 25°C | 52° | | |
| | Gain margin | | 25°C | 10 | | dB |

(1) Full range is -40°C to 150°C for this part.



- A. See data sheet for *Absolute Maximum Ratings* and minimum *Recommended Operating Conditions*.
- B. Silicon operating life design goal is 10 years at 105°C junction temperature (does not include package interconnect life).

Figure 2. TLC2274EPWRQ1 Operating Life Derating Chart

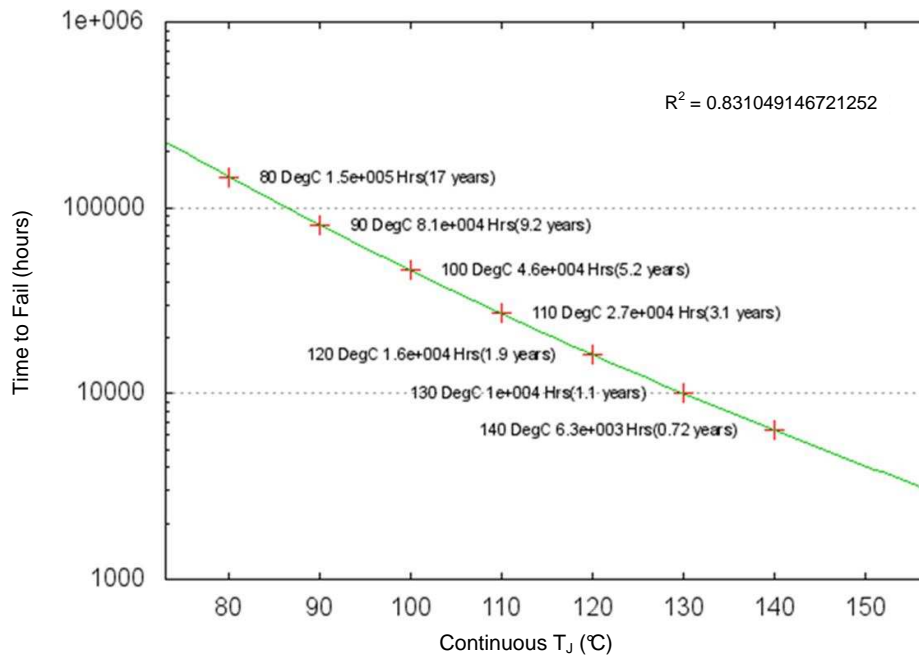


Figure 3. Estimated Wire Bond Life

6.9 Typical Characteristics

Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the devices.

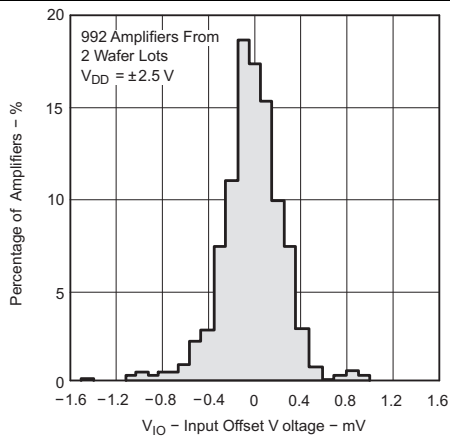


Figure 4. Distribution of TLC2274 Input Offset Voltage

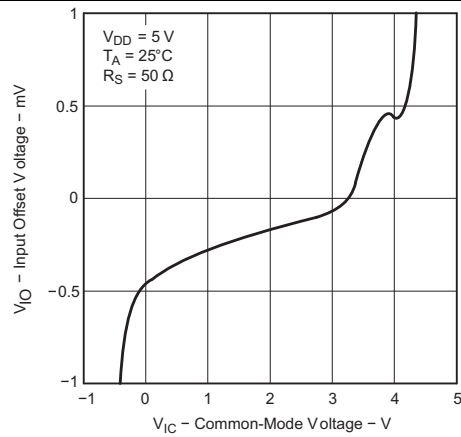


Figure 5. Input Offset Voltage vs Common-Mode Voltage

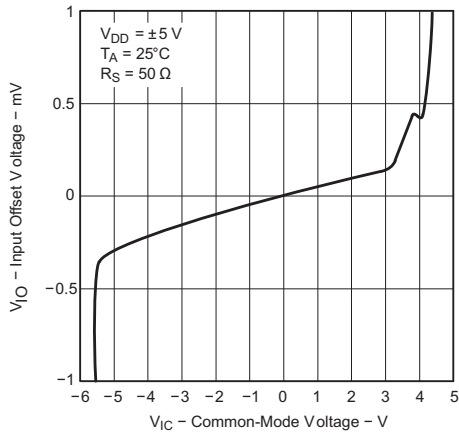


Figure 6. Input Offset Voltage vs Common-Mode Voltage

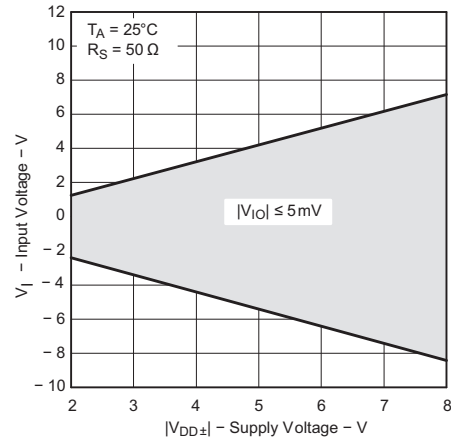


Figure 7. Input Voltage vs Supply Voltage

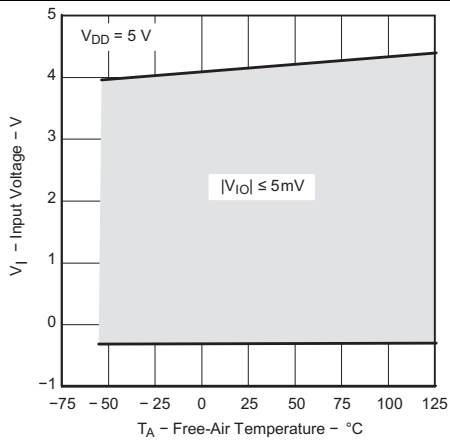


Figure 8. Input Voltage vs Free-Air Temperature

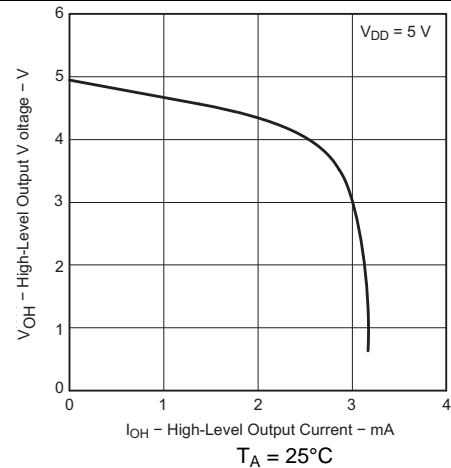


Figure 9. High-Level Output Voltage vs High-Level Output Current

Typical Characteristics (continued)

Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the devices.

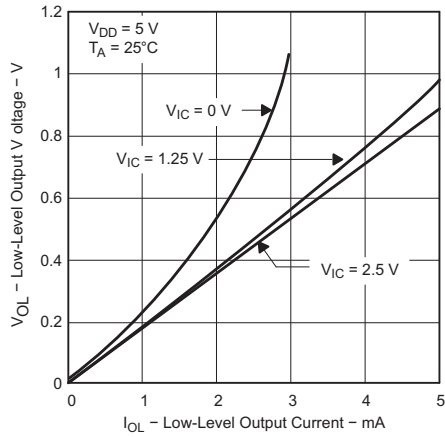


Figure 10. Low-Level Output Voltage vs Low-Level Output Current

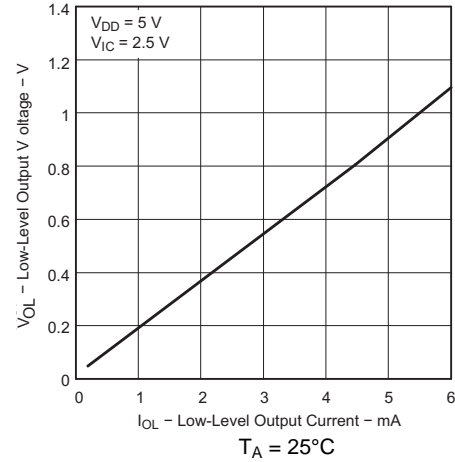


Figure 11. Low-Level Output Voltage vs Low-Level Output Current

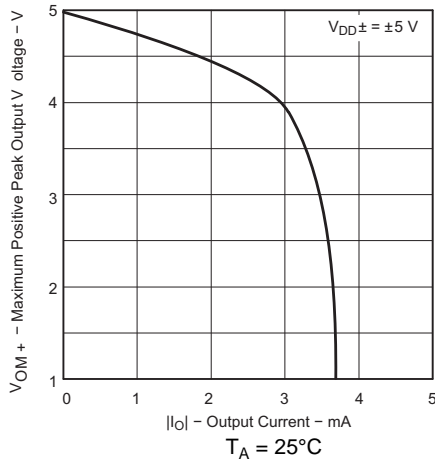


Figure 12. Maximum Positive Peak Output Voltage vs Output Current

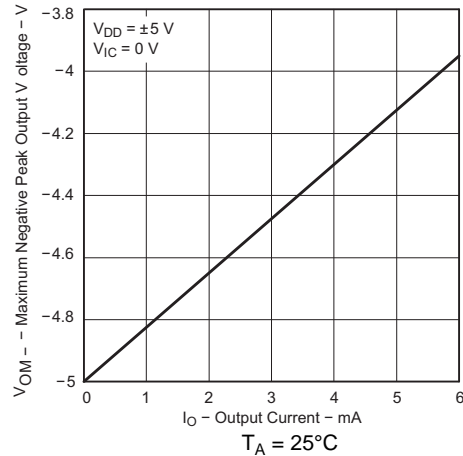


Figure 13. Maximum Negative Peak Output Voltage vs Output Current

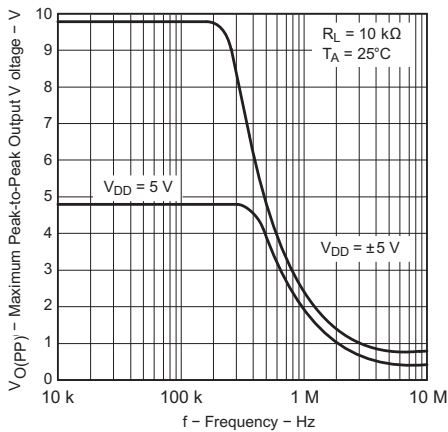


Figure 14. Maximum Peak-to-Peak Output Voltage vs Frequency

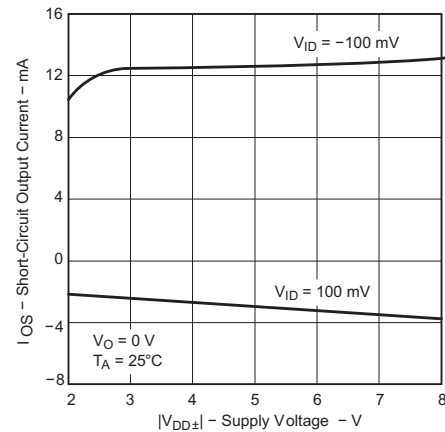


Figure 15. Short-Circuit Output Current vs Supply Voltage

Typical Characteristics (continued)

Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the devices.

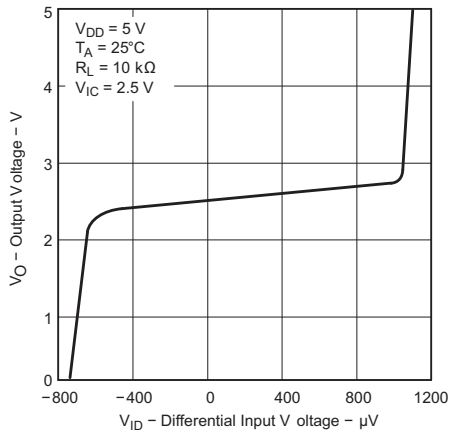


Figure 16. Output Voltage vs Differential Input Voltage

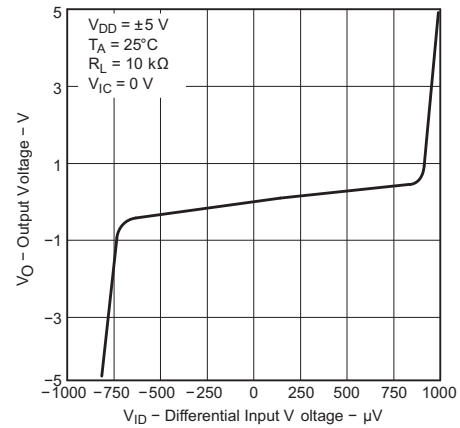


Figure 17. Output Voltage vs Differential Input Voltage

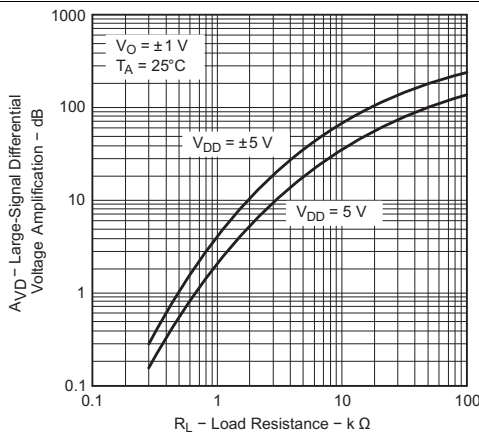


Figure 18. Large-Signal Differential Voltage Amplification vs Load Resistance

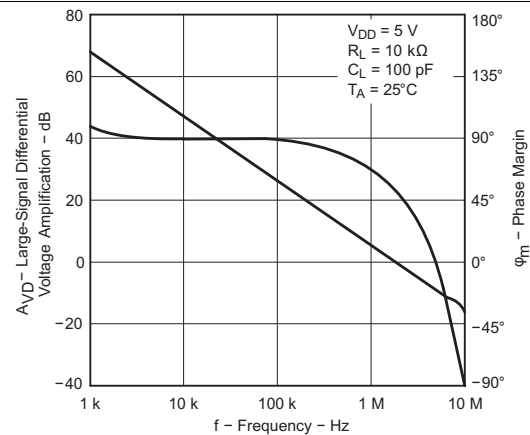


Figure 19. Large-Signal Differential Voltage Amplification and Phase Margin vs Frequency

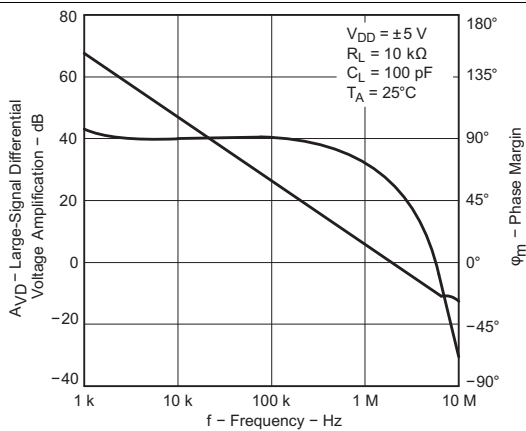


Figure 20. Large-Signal Differential Voltage Amplification and Phase Margin vs Frequency

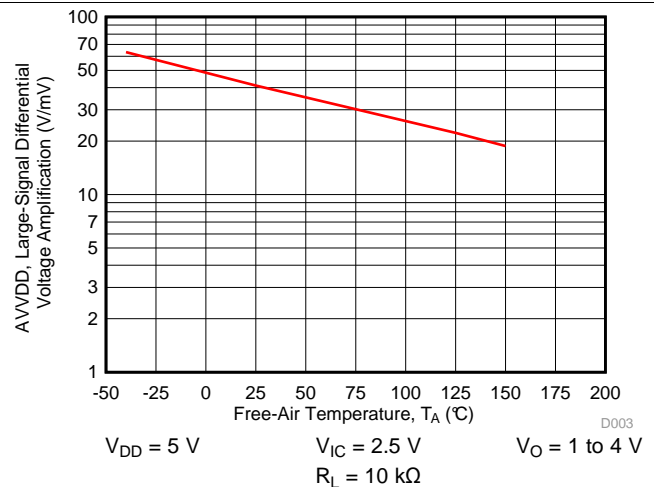


Figure 21. Large-Signal Differential Voltage Amplification vs Free-Air Temperature

Typical Characteristics (continued)

Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the devices.

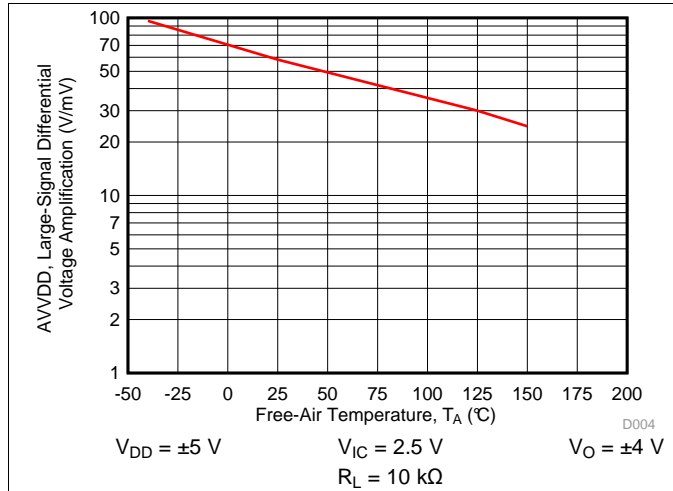


Figure 22. Large-Signal Differential Voltage Amplification vs Free-Air Temperature

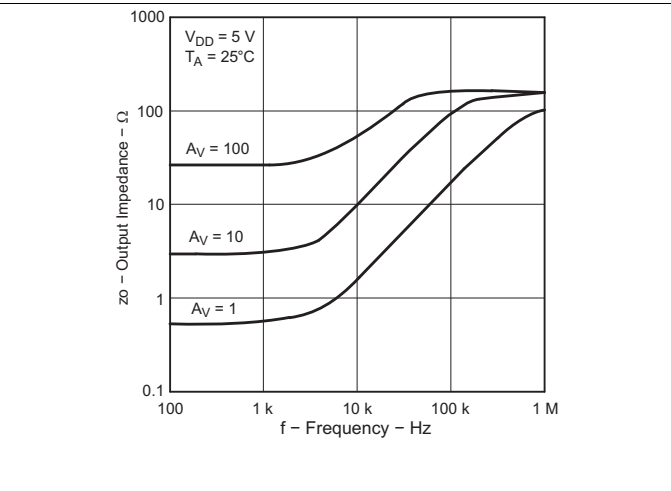


Figure 23. Output Impedance vs Frequency

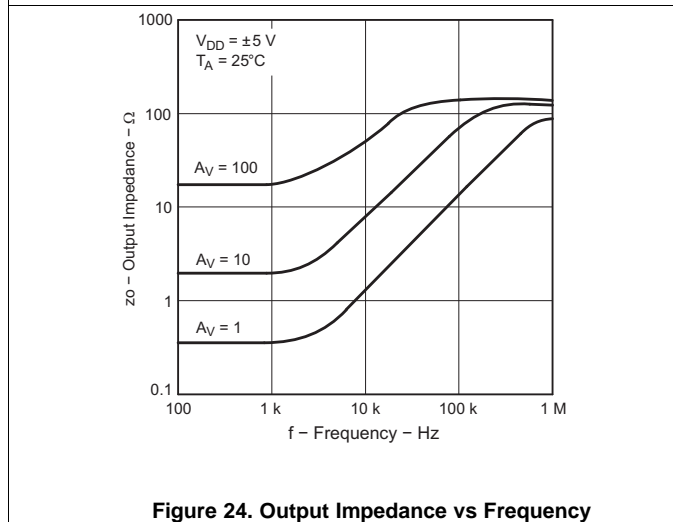


Figure 24. Output Impedance vs Frequency

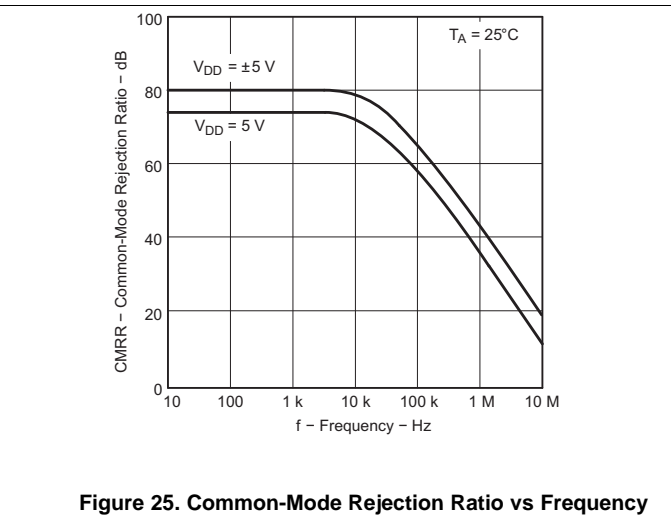


Figure 25. Common-Mode Rejection Ratio vs Frequency

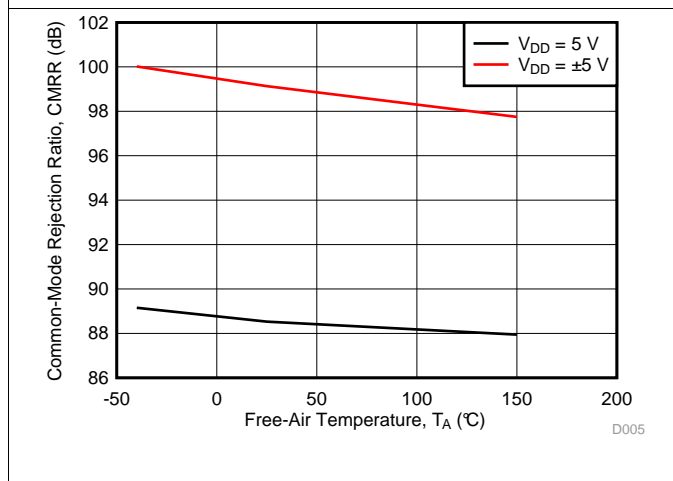


Figure 26. Common-Mode Rejection Ratio vs Free-Air Temperature

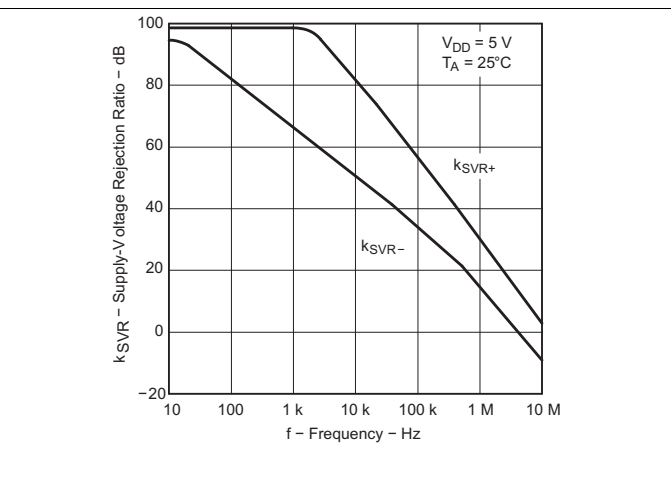


Figure 27. Supply-Voltage Rejection Ratio vs Frequency

Typical Characteristics (continued)

Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the devices.

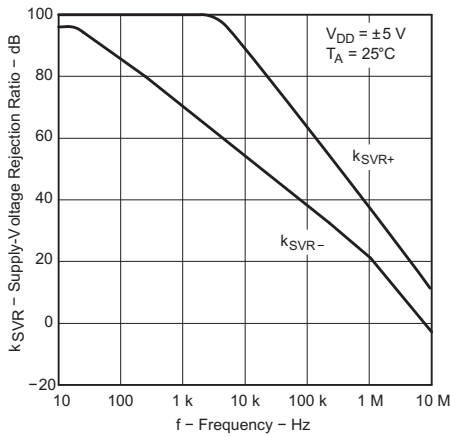


Figure 28. Supply-Voltage Rejection Ratio vs Frequency

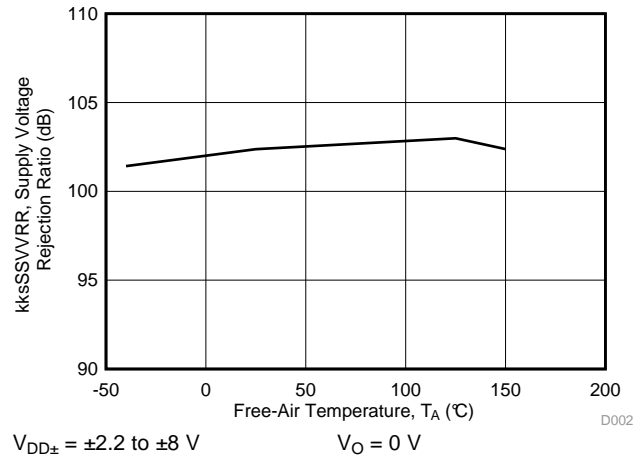


Figure 29. Supply-Voltage Rejection Ratio vs Free-Air Temperature

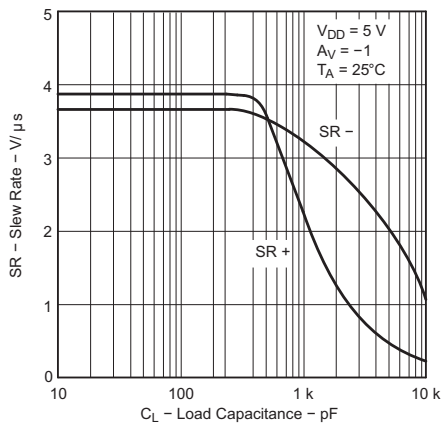


Figure 30. Slew Rate vs Load Capacitance

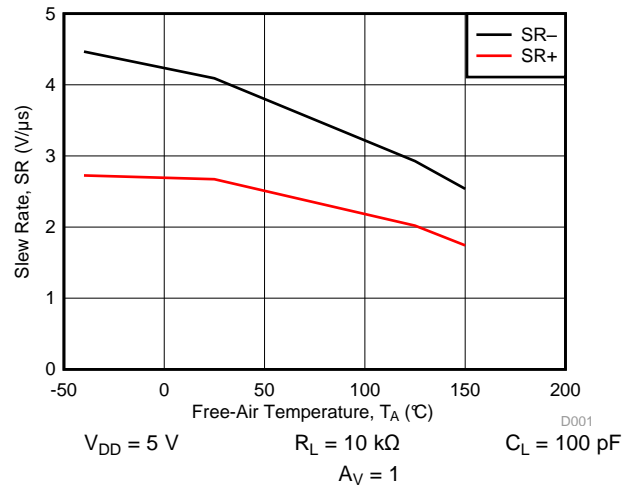


Figure 31. Slew Rate vs Free-Air Temperature

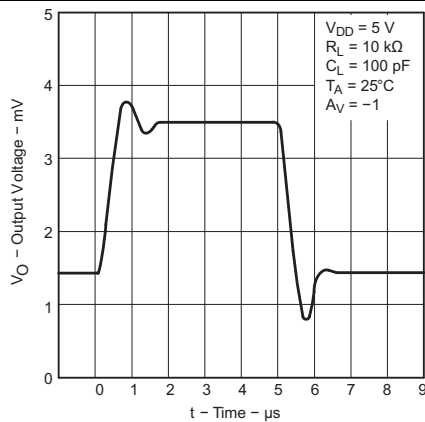


Figure 32. Inverting Large-Signal Pulse Response

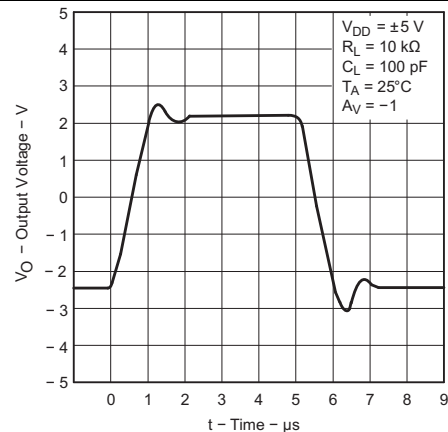


Figure 33. Inverting Large-Signal Pulse Response

Typical Characteristics (continued)

Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the devices.

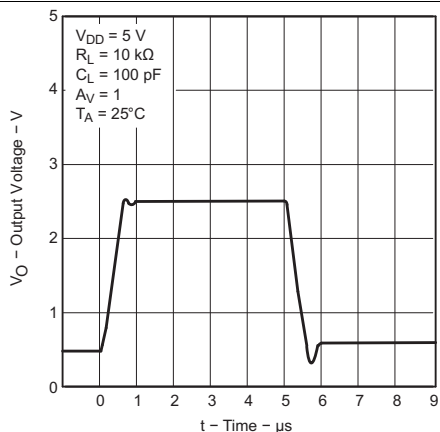


Figure 34. Voltage-Follower Large-Signal Pulse Response

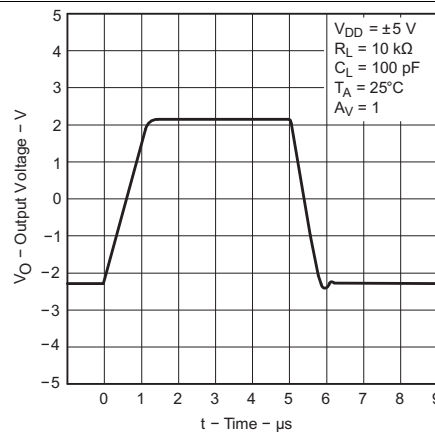


Figure 35. Voltage-Follower Large-Signal Pulse Response

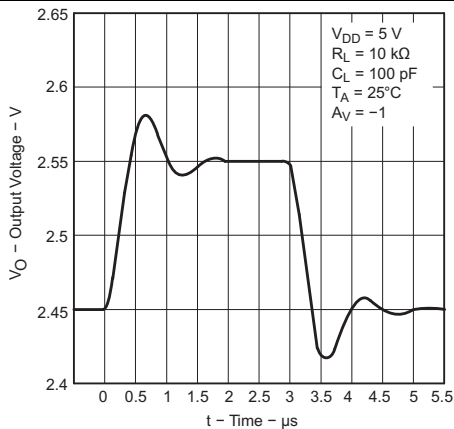


Figure 36. Inverting Small-Signal Pulse Response

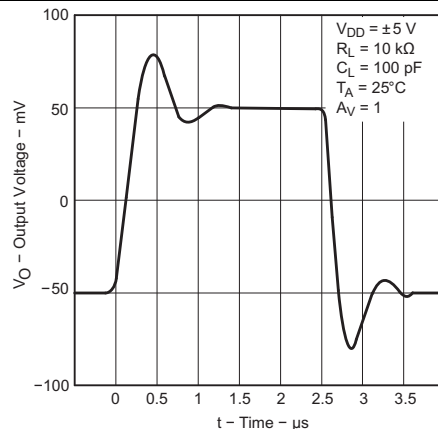


Figure 37. Inverting Small-Signal Pulse Response

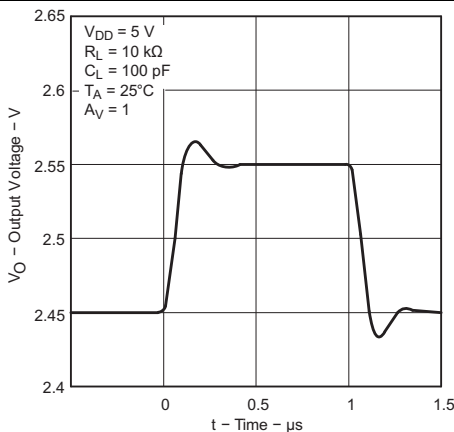


Figure 38. Voltage-Follower Small-Signal Pulse Response

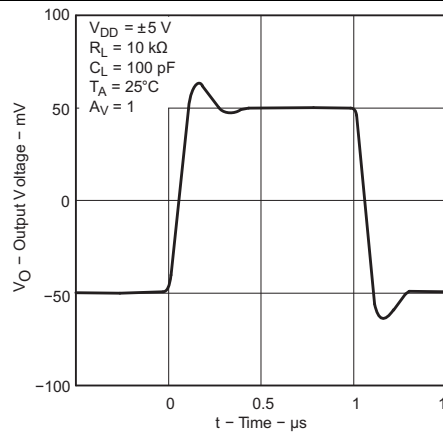


Figure 39. Voltage-Follower Small-Signal Pulse Response

Typical Characteristics (continued)

Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the devices.

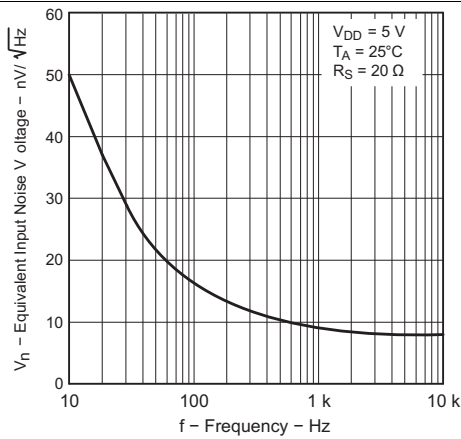


Figure 40. Equivalent Input Noise Voltage vs Frequency

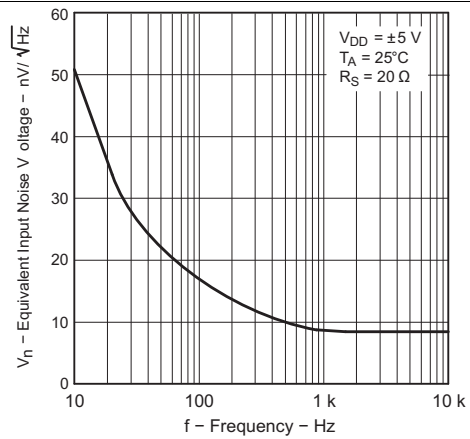


Figure 41. Equivalent Input Noise Voltage vs Frequency

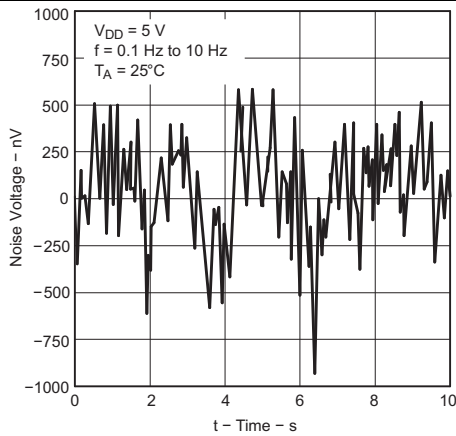


Figure 42. Noise Voltage Over a 10-s Period

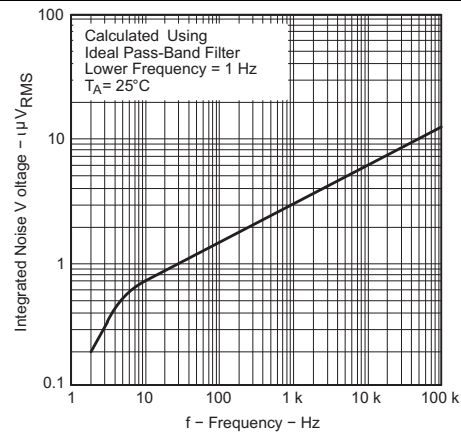


Figure 43. Integrated Noise Voltage vs Frequency

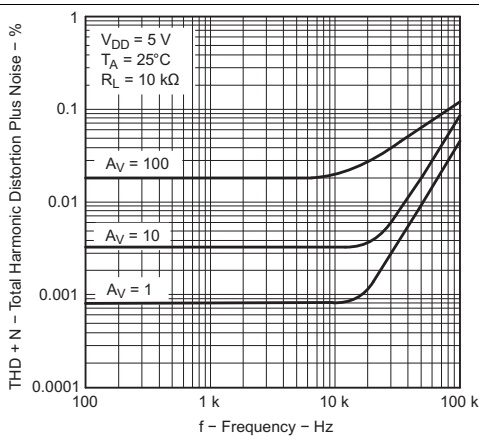


Figure 44. Total Harmonic Distortion Plus Noise vs Frequency

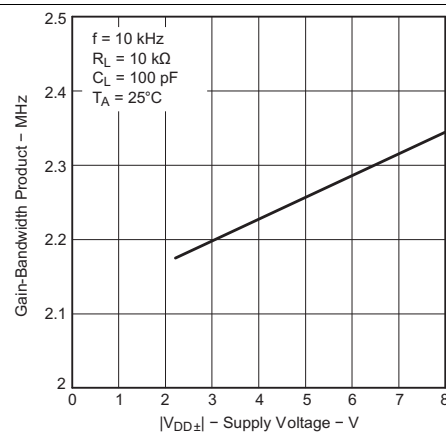


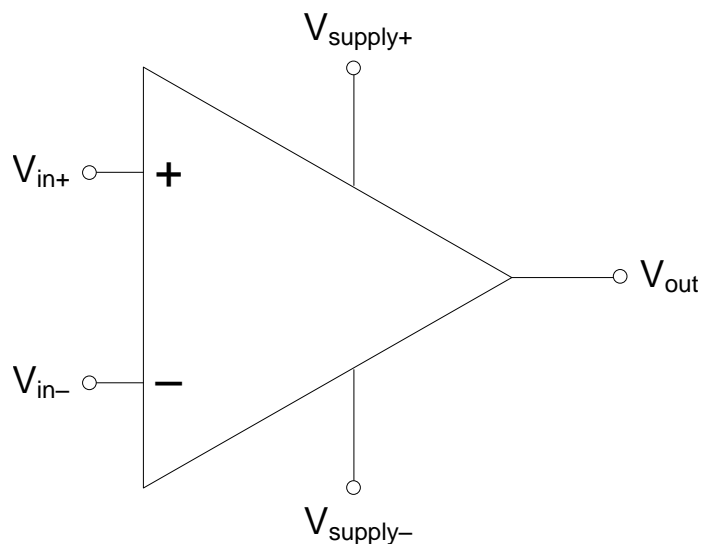
Figure 45. Gain-Bandwidth Product vs Supply Voltage

7 Detailed Description

7.1 Overview

The TLC2274 device exhibits rail-to-rail output performance for increased dynamic range in single- or split - supply applications. These device offers comparable ac performance while having better noise, input offset voltage and power dissipation than existing CMOS operational amplifiers. The TLC2274 device, exhibiting high input impedance and low noise, is excellent for small signal conditioning for high-impedance sources, such as piezoelectric transducers. It offers increased output dynamic range, lower noise voltage, and lower input offset voltage. This enhanced feature set allows the device to be used in a wider range of applications.

7.2 Functional Block Diagram



7.3 Feature Description

These devices use the Texas Instruments silicon gate LinCMOS™ process, giving them stable input offset voltages, very high input impedances, and extremely low input offset and bias currents. In addition, the rail-to-rail output feature with single- or split-supplies, makes this device a great choice when interfacing with analog-to-digital converters (ADCs).

8 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information

8.1.1 Macromodel Information

Macromodel information provided was derived using Microsim Parts, the model generation software used with Microsim PSpice. The Boyle macromodel ⁽¹⁾ and subcircuit in [Figure 46](#) are generated using the TLC227x typical electrical and operating characteristics at $T_A = 25^\circ\text{C}$. Using this information, output simulations of the following key parameters can be generated to a tolerance of 20% (in most cases):

- Maximum positive output voltage swing
- Maximum negative output voltage swing
- Slew rate
- Quiescent power dissipation
- Input bias current
- Open-loop voltage amplification
- Unity-gain frequency
- Common-mode rejection ratio
- Phase margin
- DC output resistance
- AC output resistance
- Short-circuit output current limit

(1) G. R. Boyle, B. M. Cohn, D. O. Pederson, and J. E. Solomon, "Macromodeling of Integrated Circuit Operational Amplifiers", IEEE Journal of Solid-State Circuits, SC-9, 353 (1974).

Application Information (continued)

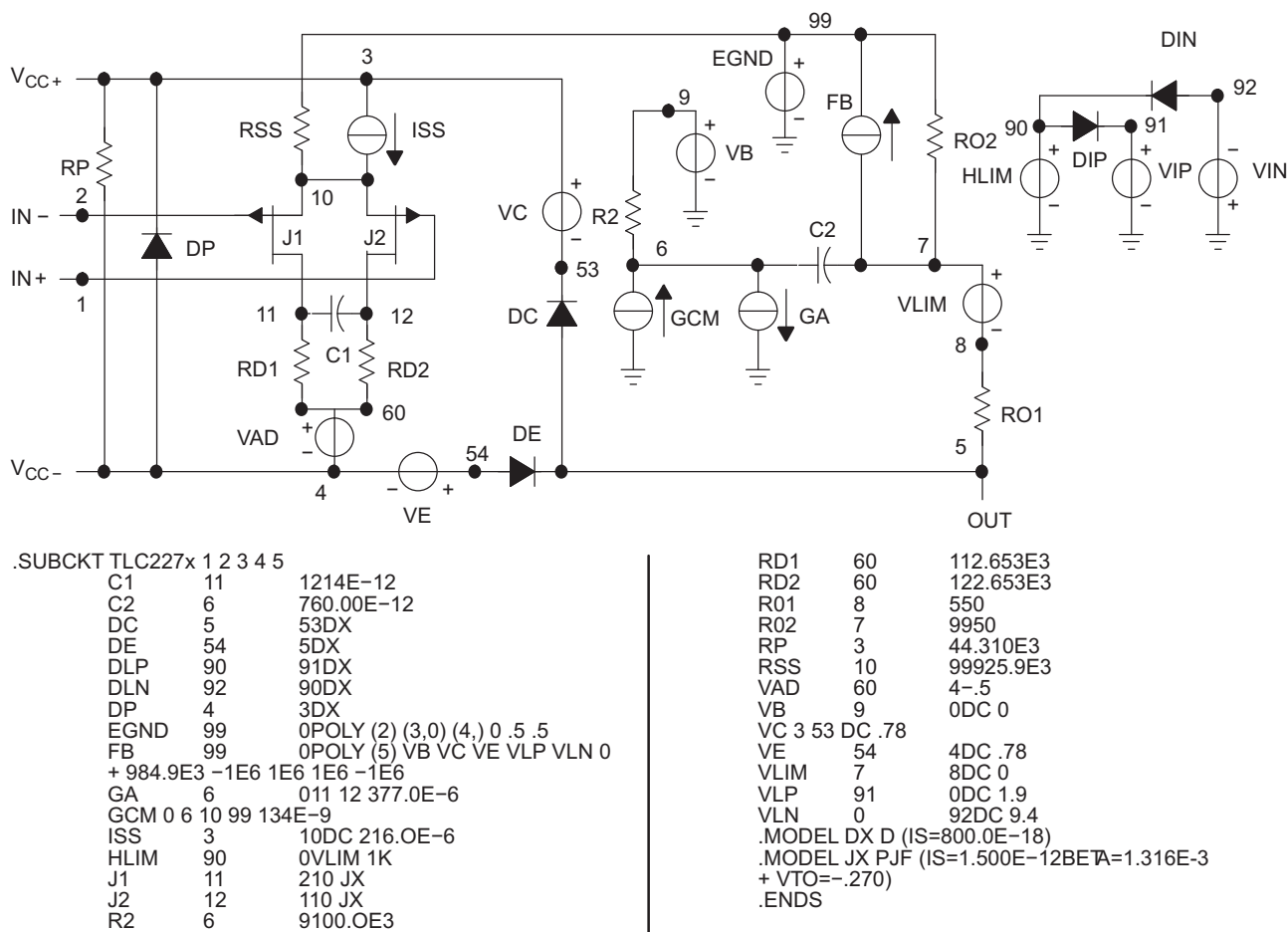


Figure 46. Boyle Macromodels and Subcircuit

8.2 Typical Application

The TLC2274 is designed to drive larger capacitive loads than most CMOS operational amplifiers. Figure 48 and Figure 49 show its ability to drive loads up to 1000 pF while maintaining good gain and phase margins (Rnull = 0).

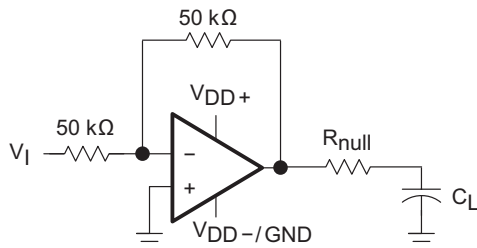


Figure 47. Typical Application Schematic

Typical Application (continued)

8.2.1 Design Requirements

As per Equation 1:

Table 2. Design Parameters

| Improvement in Phase Margin | UGBW (kHz) | R null (Ω) | CL (pF) |
|-----------------------------|------------|------------|---------|
| 0 | 1000 | 0 | 1000 |
| 7.15 | 1000 | 20 | 1000 |
| 17.43 | 1000 | 50 | 1000 |
| 32.12 | 1000 | 100 | 1000 |

8.2.2 Detailed Design Procedure

A smaller series resistor (R_{null}) at the output of the device (see Figure 47) improves the gain and phase margins when driving large capacitive loads. Figure 48 and Figure 49 show the effects of adding series resistances of 10 Ω, 50 Ω, 100 Ω, 200 Ω, and 500 Ω. The addition of this series resistor has two effects: the first is that it adds a zero to the transfer function and the second is that it reduces the frequency of the pole associated with the output load in the transfer function.

The zero introduced to the transfer function is equal to the series resistance times the load capacitance. To calculate the improvement in phase margin, Equation 1 can be used.

$$\Delta\phi_{m1} = \tan^{-1} (2 \times \pi \times \text{UGBW} \times R_{null} \times C_L)$$

where

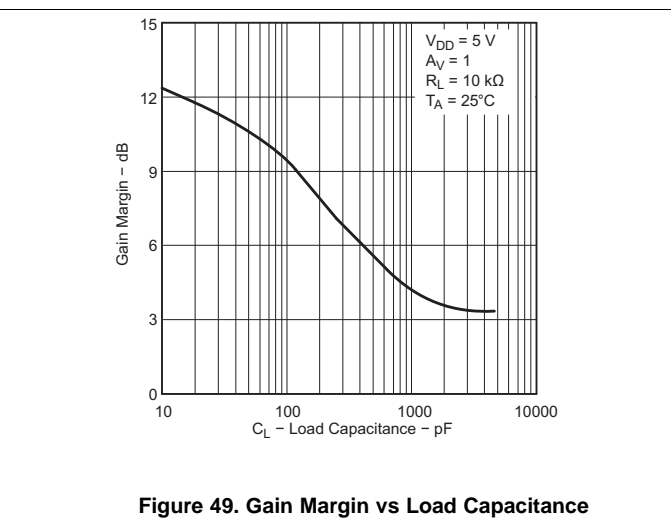
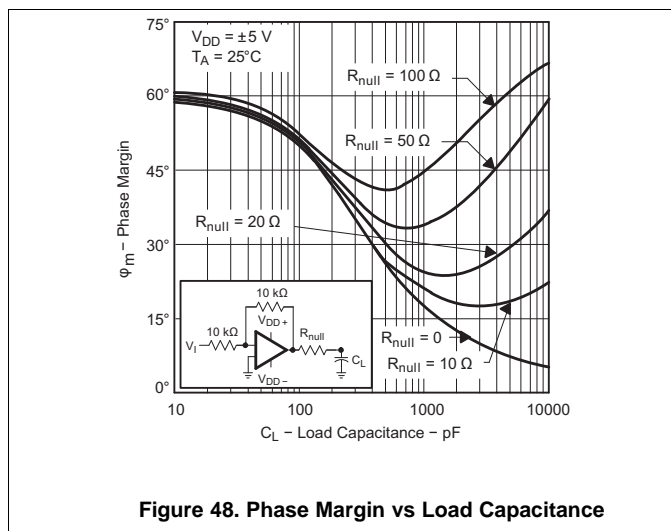
- $\Delta\phi_{m1}$ = Improvement in phase margin
- UGBW = Unity-gain bandwidth frequency
- R_{null} = Output series resistance
- C_L = Load capacitance

(1)

The unity-gain bandwidth (UGBW) frequency decreases as the capacitive load increases (see Figure 47). To use equation 1, UGBW must be approximated from Figure 47. Using Equation 1 alone overestimates the improvement in phase margin, as illustrated in Figure 51. The overestimation is caused by the decrease in the frequency of the pole associated with the load, thus providing additional phase shift and reducing the overall improvement in phase margin. Using Figure 47, with Equation 1 enables the designer to choose the appropriate output series resistance to optimize the design of circuits driving large capacitance loads.

8.2.3 Application Curves

$T_A = 25^\circ\text{C}$



$T_A = 25^\circ\text{C}$

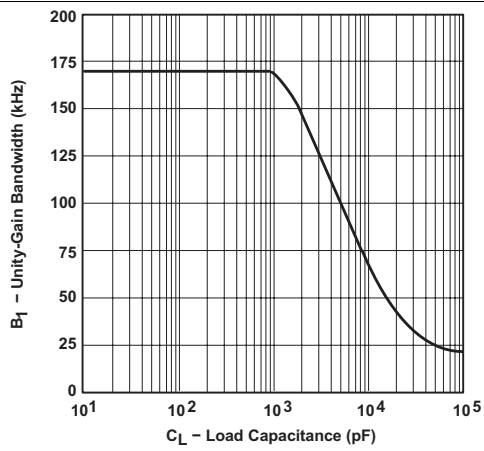


Figure 50. Unity-Gain Bandwidth vs Load Capacitance

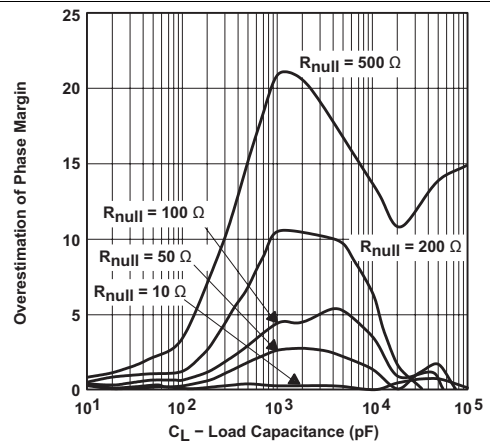


Figure 51. Overestimation of Phase Margin vs Load Capacitance

9 Power Supply Recommendations

TLC2274 operates from ± 2.2 - to ± 8 -V. In addition, key parameters are assured over the specified temperature range, -55°C to 125°C . Parameters which vary significantly with operating voltage or temperature are shown in the *Typical Characteristics*.

10 Layout

10.1 Layout Guidelines

The TLC2274 has very-low offset voltage and drift. To achieve highest performance, optimize circuit layout and mechanical conditions. Offset voltage and drift can be degraded by small thermoelectric potentials at the operational amplifier inputs. Connections of dissimilar metals generate thermal potential, which can degrade the ultimate performance of the TLC2274. Cancel these thermal potentials by assuring that they are equal in both input terminals.

- Keep the thermal mass of the connections made to the two input terminals similar.
- Locate heat sources as far as possible from the critical input circuitry.
- Shield operational amplifier and input circuitry from air currents such as cooling fans.

10.2 Layout Example

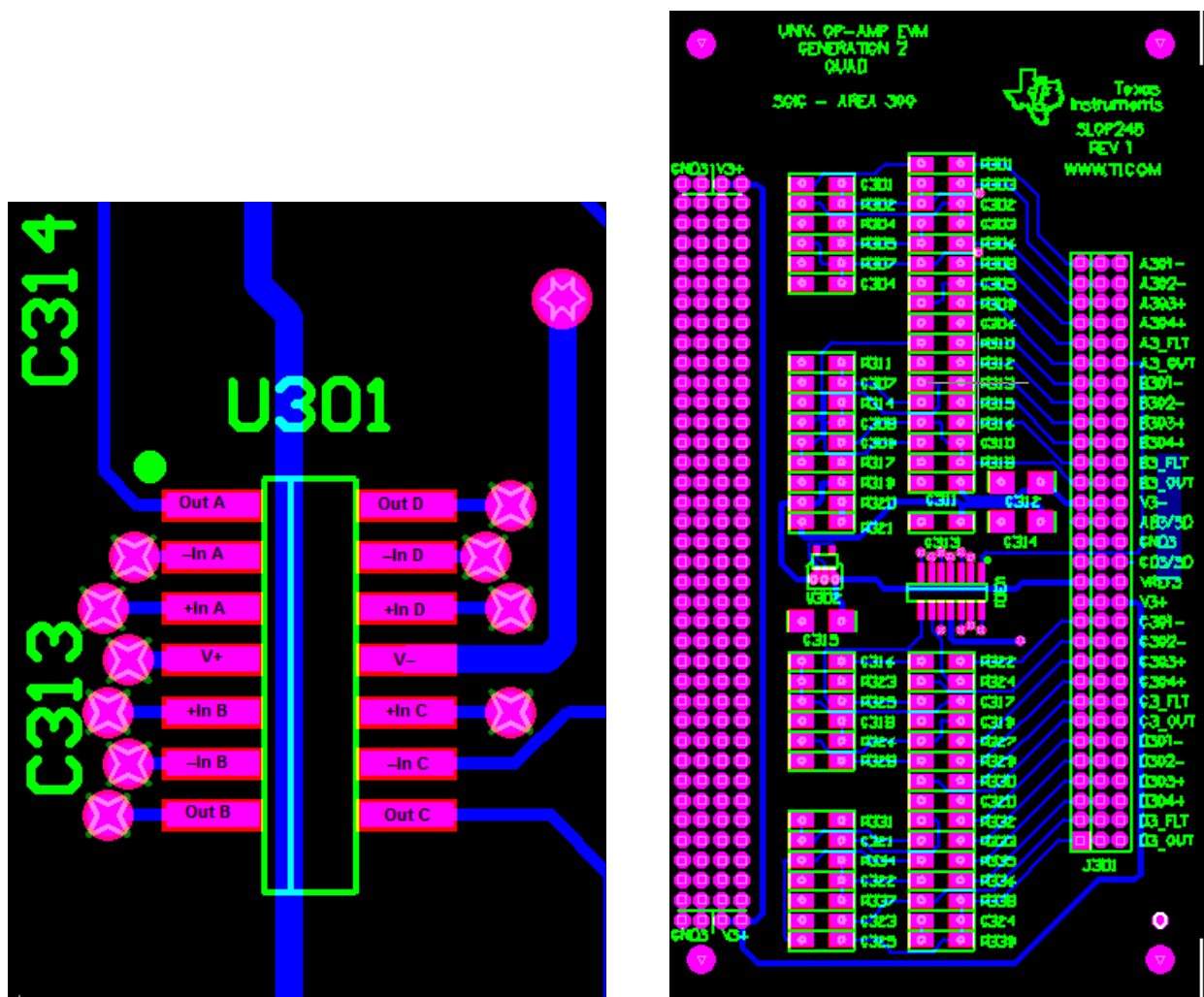


Figure 52. Board Layout Example

11 器件和文档支持

11.1 商标

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All other trademarks are the property of their respective owners.

11.2 静电放电警告



这些装置包含有限的内置 ESD 保护。存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

11.3 术语表

[SLYZ022](#) — *TI* 术语表。

这份术语表列出并解释术语、首字母缩略词和定义。

12 机械封装和可订购信息

以下页中包括机械封装和可订购信息。 这些信息是针对指定器件可提供的最新数据。 这些数据会在无通知且不对本文档进行修订的情况下发生改变。 欲获得该数据表的浏览器版本，请查阅左侧的导航栏。

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PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|---------|
| TLC2274EPWRQ1 | ACTIVE | TSSOP | PW | 14 | 2000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 150 | 2274EQ1 | Samples |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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