



# Zero-Drift, Single-Supply, Rail-to-Rail I/O Quad, Operational Amplifier

## AD8574-EP

### FEATURES

Supports defense and aerospace applications (AQEC standard)

Military temperature range ( $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ )

Controlled manufacturing baseline

One assembly/test site

One fabrication site

Enhanced product change notification

Qualification data available on request

Low offset voltage:  $1\ \mu\text{V}$

Input offset drift:  $0.005\ \mu\text{V}/^{\circ}\text{C}$

Rail-to-rail input and output swing

5 V/2.7 V single-supply operation

High gain: 145 dB typical

CMRR: 140 dB typical

PSRR: 130 dB typical

Ultralow input bias current: 10 pA typical

Low supply current: 750  $\mu\text{A}$  per op amp

Overload recovery time: 50  $\mu\text{s}$

No external capacitors required

### APPLICATIONS

Temperature sensors

Pressure sensors

Precision current sensing

Strain gage amplifiers

### GENERAL DESCRIPTION

This amplifier has ultralow offset, drift, and bias current. The AD8574-EP is a quad amplifier, featuring rail-to-rail input and output swings. It is guaranteed to operate from 2.7 V to 5 V single supply.

### PIN CONFIGURATIONS

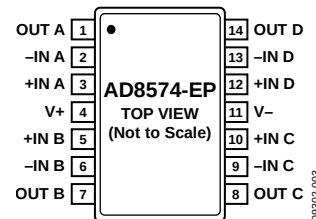


Figure 1. 14-Lead TSSOP (RU Suffix)

The AD8574-EP provides benefits previously found only in expensive auto-zeroing or chopper-stabilized amplifiers. Using a patented spread-spectrum, auto-zero technique, the AD8574 eliminates the intermodulation effects from interaction of the chopping function with the signal frequency in ac applications.

With an offset voltage of only  $1\ \mu\text{V}$  and drift of  $0.005\ \mu\text{V}/^{\circ}\text{C}$ , the AD8574-EP is perfectly suited for applications where error sources must be minimized.

The AD8574-EP is specified for the military temperature range ( $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ). The AD8574-EP quad amplifier is available in a 14-lead TSSOP package.

Additional applications and technical information is available in the [AD8571/AD8572/AD8574](#) data sheets.

Rev. 0

Information furnished by Analog Devices is believed to be accurate and reliable. However, no responsibility is assumed by Analog Devices for its use, nor for any infringements of patents or other rights of third parties that may result from its use. Specifications subject to change without notice. No license is granted by implication or otherwise under any patent or patent rights of Analog Devices. Trademarks and registered trademarks are the property of their respective owners.

One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A.

Tel: 781.329.4700

Fax: 781.461.3113

[www.analog.com](http://www.analog.com)

©2010 Analog Devices, Inc. All rights reserved.

TABLE OF CONTENTS

|                                     |   |                                           |    |
|-------------------------------------|---|-------------------------------------------|----|
| Features .....                      | 1 | 2.7 V Electrical Characteristics .....    | 4  |
| Applications.....                   | 1 | Absolute Maximum Ratings .....            | 5  |
| General Description .....           | 1 | Thermal Characteristics .....             | 5  |
| Pin Configurations .....            | 1 | ESD Caution.....                          | 5  |
| Revision History .....              | 2 | Typical Performance Characteristics ..... | 6  |
| Specifications.....                 | 3 | Outline Dimensions .....                  | 14 |
| 5 V Electrical Characteristics..... | 3 | Ordering Guide .....                      | 14 |

REVISION HISTORY

8/10—Revision 0: Initial Version

## SPECIFICATIONS

### 5 V ELECTRICAL CHARACTERISTICS

$V_S = 5\text{ V}$ ,  $V_{CM} = 2.5\text{ V}$ ,  $V_O = 2.5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 1.

| Parameter                              | Symbol                   | Conditions                                                                      | Min      | Typ      | Max  | Unit                         |
|----------------------------------------|--------------------------|---------------------------------------------------------------------------------|----------|----------|------|------------------------------|
| INPUT CHARACTERISTICS                  |                          |                                                                                 |          |          |      |                              |
| Offset Voltage                         | $V_{OS}$                 | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                            |          | 1        | 5    | $\mu\text{V}$                |
|                                        |                          |                                                                                 |          |          | 15   | $\mu\text{V}$                |
| Input Bias Current                     | $I_B$                    | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                            |          | 10       | 50   | pA                           |
|                                        |                          |                                                                                 |          | 1.0      | 1.5  | nA                           |
| Input Offset Current                   | $I_{OS}$                 | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                            |          | 20       | 70   | pA                           |
|                                        |                          |                                                                                 |          | 150      | 200  | pA                           |
| Input Voltage Range                    |                          |                                                                                 | 0        |          | 5    | V                            |
| Common-Mode Rejection Ratio            | CMRR                     | $V_{CM} = 0\text{ V to } 5\text{ V}$                                            | 120      | 140      |      | dB                           |
|                                        |                          | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                            | 115      | 130      |      | dB                           |
| Large Signal Voltage Gain <sup>1</sup> | $A_{VO}$                 | $R_L = 10\text{ k}\Omega$ , $V_O = 0.3\text{ V to } 4.7\text{ V}$               | 125      | 145      |      | dB                           |
|                                        |                          | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                            | 120      | 135      |      | dB                           |
| Offset Voltage Drift                   | $\Delta V_{OS}/\Delta T$ | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                            |          | 0.005    | 0.04 | $\mu\text{V}/^\circ\text{C}$ |
| OUTPUT CHARACTERISTICS                 |                          |                                                                                 |          |          |      |                              |
| Output Voltage High                    | $V_{OH}$                 | $R_L = 100\text{ k}\Omega$ to GND                                               | 4.99     | 4.998    |      | V                            |
|                                        |                          | $R_L = 100\text{ k}\Omega$ to GND @ $-55^\circ\text{C}$ to $+125^\circ\text{C}$ | 4.99     | 4.997    |      | V                            |
|                                        |                          | $R_L = 10\text{ k}\Omega$ to GND                                                | 4.95     | 4.98     |      | V                            |
|                                        |                          | $R_L = 10\text{ k}\Omega$ to GND @ $-55^\circ\text{C}$ to $+125^\circ\text{C}$  | 4.95     | 4.975    |      | V                            |
| Output Voltage Low                     | $V_{OL}$                 | $R_L = 100\text{ k}\Omega$ to V+                                                |          | 1        | 10   | mV                           |
|                                        |                          | $R_L = 100\text{ k}\Omega$ to V+ @ $-55^\circ\text{C}$ to $+125^\circ\text{C}$  |          | 2        | 10   | mV                           |
|                                        |                          | $R_L = 10\text{ k}\Omega$ to V+                                                 |          | 10       | 30   | mV                           |
|                                        |                          | $R_L = 10\text{ k}\Omega$ to V+ @ $-55^\circ\text{C}$ to $+125^\circ\text{C}$   |          | 15       | 30   | mV                           |
| Short-Circuit Limit                    | $I_{SC}$                 |                                                                                 | $\pm 25$ | $\pm 50$ |      | mA                           |
|                                        |                          | $-55^\circ\text{C}$ to $+125^\circ\text{C}$                                     |          | $\pm 40$ |      | mA                           |
| Output Current                         | $I_O$                    |                                                                                 |          | $\pm 30$ |      | mA                           |
|                                        |                          | $-55^\circ\text{C}$ to $+125^\circ\text{C}$                                     |          | $\pm 15$ |      | mA                           |
| POWER SUPPLY                           |                          |                                                                                 |          |          |      |                              |
| Power Supply Rejection Ratio           | PSRR                     | $V_S = 2.7\text{ V to } 5.5\text{ V}$                                           | 120      | 130      |      | dB                           |
|                                        |                          | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                            | 115      | 130      |      | dB                           |
| Supply Current per Amplifier           | $I_{SY}$                 | $V_O = 0\text{ V}$                                                              |          | 850      | 975  | $\mu\text{A}$                |
|                                        |                          | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                            |          | 1000     | 1075 | $\mu\text{A}$                |
| DYNAMIC PERFORMANCE                    |                          |                                                                                 |          |          |      |                              |
| Slew Rate                              | SR                       | $R_L = 10\text{ k}\Omega$                                                       |          | 0.4      |      | V/ $\mu\text{s}$             |
| Overload Recovery Time                 |                          |                                                                                 |          | 0.05     | 0.3  | ms                           |
| Gain Bandwidth Product                 | GBP                      |                                                                                 |          | 1.5      |      | MHz                          |
| NOISE PERFORMANCE                      |                          |                                                                                 |          |          |      |                              |
| Voltage Noise                          | $e_n$ p-p                | 0 Hz to 10 Hz                                                                   |          | 1.3      |      | $\mu\text{V p-p}$            |
|                                        |                          | 0 Hz to 1 Hz                                                                    |          | 0.41     |      | $\mu\text{V p-p}$            |
| Voltage Noise Density                  | $e_n$                    | $f = 1\text{ kHz}$                                                              |          | 51       |      | nV/ $\sqrt{\text{Hz}}$       |
| Current Noise Density                  | $i_n$                    | $f = 10\text{ Hz}$                                                              |          | 2        |      | fA/ $\sqrt{\text{Hz}}$       |

<sup>1</sup> Gain testing is dependent upon test bandwidth.

## 2.7 V ELECTRICAL CHARACTERISTICS

$V_S = 2.7\text{ V}$ ,  $V_{CM} = 1.35\text{ V}$ ,  $V_O = 1.35\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 2.

| Parameter                              | Symbol                   | Conditions                                                                        | Min      | Typ      | Max  | Unit                         |
|----------------------------------------|--------------------------|-----------------------------------------------------------------------------------|----------|----------|------|------------------------------|
| <b>INPUT CHARACTERISTICS</b>           |                          |                                                                                   |          |          |      |                              |
| Offset Voltage                         | $V_{OS}$                 | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                              |          | 1        | 5    | $\mu\text{V}$                |
| Input Bias Current                     | $I_B$                    | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                              |          | 10       | 50   | $\text{pA}$                  |
| Input Offset Current                   | $I_{OS}$                 | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                              |          | 1.0      | 1.5  | $\text{nA}$                  |
| Input Voltage Range                    |                          | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                              |          | 10       | 50   | $\text{pA}$                  |
| Common-Mode Rejection Ratio            | CMRR                     | $V_{CM} = 0\text{ V to } 2.7\text{ V}$                                            |          | 150      | 200  | $\text{pA}$                  |
| Large Signal Voltage Gain <sup>1</sup> | $A_{VO}$                 | $R_L = 10\text{ k}\Omega$ , $V_O = 0.3\text{ V to } 2.4\text{ V}$                 | 0        |          | 2.7  | $\text{V}$                   |
| Offset Voltage Drift                   | $\Delta V_{OS}/\Delta T$ | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                              | 115      | 130      |      | $\text{dB}$                  |
| <b>OUTPUT CHARACTERISTICS</b>          |                          |                                                                                   |          |          |      |                              |
| Output Voltage High                    | $V_{OH}$                 | $R_L = 100\text{ k}\Omega$ to GND                                                 | 2.685    | 2.697    |      | $\text{V}$                   |
|                                        |                          | $R_L = 100\text{ k}\Omega$ to GND @ $-55^\circ\text{C}$ to $+125^\circ\text{C}$   | 2.685    | 2.696    |      | $\text{V}$                   |
|                                        |                          | $R_L = 10\text{ k}\Omega$ to GND                                                  | 2.67     | 2.68     |      | $\text{V}$                   |
|                                        |                          | $R_L = 10\text{ k}\Omega$ to GND @ $-55^\circ\text{C}$ to $+125^\circ\text{C}$    | 2.67     | 2.675    |      | $\text{V}$                   |
| Output Voltage Low                     | $V_{OL}$                 | $R_L = 100\text{ k}\Omega$ to $V_+$                                               |          | 1        | 10   | $\text{mV}$                  |
|                                        |                          | $R_L = 100\text{ k}\Omega$ to $V_+$ @ $-55^\circ\text{C}$ to $+125^\circ\text{C}$ |          | 2        | 10   | $\text{mV}$                  |
|                                        |                          | $R_L = 10\text{ k}\Omega$ to $V_+$                                                |          | 10       | 20   | $\text{mV}$                  |
|                                        |                          | $R_L = 10\text{ k}\Omega$ to $V_+$ @ $-55^\circ\text{C}$ to $+125^\circ\text{C}$  |          | 15       | 20   | $\text{mV}$                  |
| Short-Circuit Limit                    | $I_{SC}$                 | $-55^\circ\text{C}$ to $+125^\circ\text{C}$                                       | $\pm 10$ | $\pm 15$ |      | $\text{mA}$                  |
| Output Current                         | $I_O$                    | $-55^\circ\text{C}$ to $+125^\circ\text{C}$                                       |          | $\pm 10$ |      | $\text{mA}$                  |
|                                        |                          | $-55^\circ\text{C}$ to $+125^\circ\text{C}$                                       |          | $\pm 10$ |      | $\text{mA}$                  |
|                                        |                          | $-55^\circ\text{C}$ to $+125^\circ\text{C}$                                       |          | $\pm 5$  |      | $\text{mA}$                  |
| <b>POWER SUPPLY</b>                    |                          |                                                                                   |          |          |      |                              |
| Power Supply Rejection Ratio           | PSRR                     | $V_S = 2.7\text{ V to } 5.5\text{ V}$                                             | 120      | 130      |      | $\text{dB}$                  |
|                                        |                          | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                              | 115      | 130      |      | $\text{dB}$                  |
| Supply Current per Amplifier           | $I_{SY}$                 | $V_O = 0\text{ V}$                                                                |          | 750      | 900  | $\mu\text{A}$                |
|                                        |                          | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                              |          | 950      | 1000 | $\mu\text{A}$                |
| <b>DYNAMIC PERFORMANCE</b>             |                          |                                                                                   |          |          |      |                              |
| Slew Rate                              | SR                       | $R_L = 10\text{ k}\Omega$                                                         |          | 0.5      |      | $\text{V}/\mu\text{s}$       |
| Overload Recovery Time                 |                          |                                                                                   |          | 0.05     |      | $\text{ms}$                  |
| Gain Bandwidth Product                 | GBP                      |                                                                                   |          | 1        |      | $\text{MHz}$                 |
| <b>NOISE PERFORMANCE</b>               |                          |                                                                                   |          |          |      |                              |
| Voltage Noise                          | $e_n$ p-p                | 0 Hz to 10 Hz                                                                     |          | 2.0      |      | $\mu\text{V p-p}$            |
| Voltage Noise Density                  | $e_n$                    | $f = 1\text{ kHz}$                                                                |          | 94       |      | $\text{nV}/\sqrt{\text{Hz}}$ |
| Current Noise Density                  | $i_n$                    | $f = 10\text{ Hz}$                                                                |          | 2        |      | $\text{fA}/\sqrt{\text{Hz}}$ |

<sup>1</sup> Gain testing is dependent upon test bandwidth.

## ABSOLUTE MAXIMUM RATINGS

Table 3.

| Parameter                               | Rating                                          |
|-----------------------------------------|-------------------------------------------------|
| Supply Voltage                          | 6 V                                             |
| Input Voltage                           | GND to $V_S + 0.3$ V                            |
| Differential Input Voltage <sup>1</sup> | $\pm 5.0$ V                                     |
| ESD (Human Body Model)                  | 2000 V                                          |
| Output Short-Circuit Duration to GND    | Indefinite                                      |
| Storage Temperature Range               | $-65^{\circ}\text{C}$ to $+150^{\circ}\text{C}$ |
| Operating Temperature Range             | $-55^{\circ}\text{C}$ to $+125^{\circ}\text{C}$ |
| Junction Temperature Range              | $-65^{\circ}\text{C}$ to $+150^{\circ}\text{C}$ |
| Lead Temperature (Soldering, 60 sec)    | $300^{\circ}\text{C}$                           |

<sup>1</sup> Differential input voltage is limited to  $\pm 5.0$  V or the supply voltage, whichever is less.

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### THERMAL CHARACTERISTICS

$\theta_{JA}$  is specified for the worst-case conditions, that is,  $\theta_{JA}$  is specified for a device soldered in a circuit board for TSSOP packages.

Table 4. Thermal Resistance

| Package Type       | $\theta_{JA}$ | $\theta_{JC}$ | Unit                        |
|--------------------|---------------|---------------|-----------------------------|
| 14-Lead TSSOP (RU) | 180           | 36            | $^{\circ}\text{C}/\text{W}$ |

### ESD CAUTION



**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

## TYPICAL PERFORMANCE CHARACTERISTICS

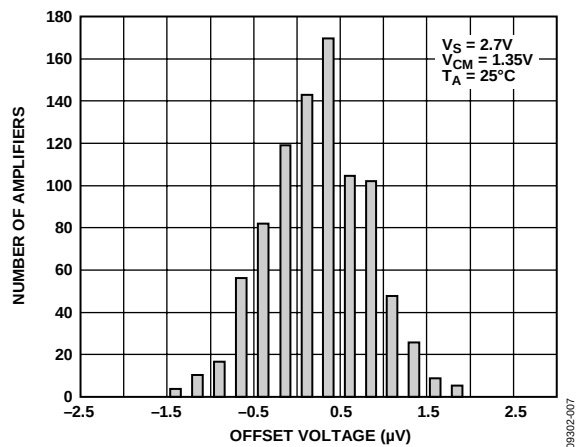


Figure 2. Input Offset Voltage Distribution

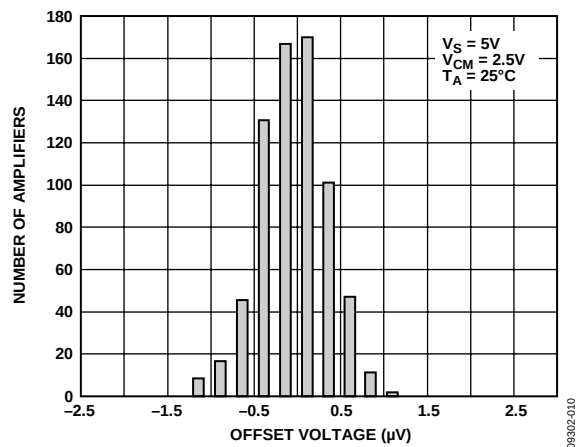


Figure 5. Input Offset Voltage Distribution

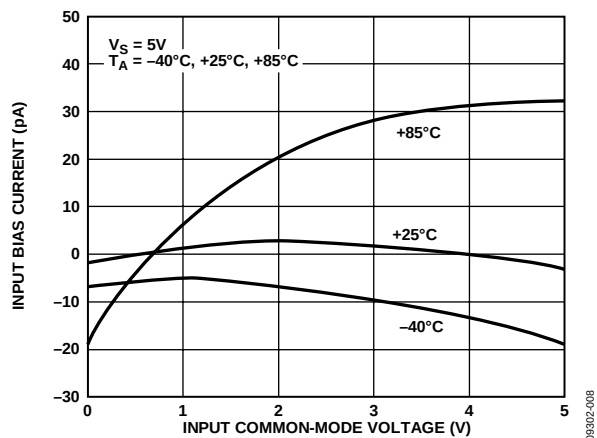


Figure 3. Input Bias Current vs. Input Common-Mode Voltage

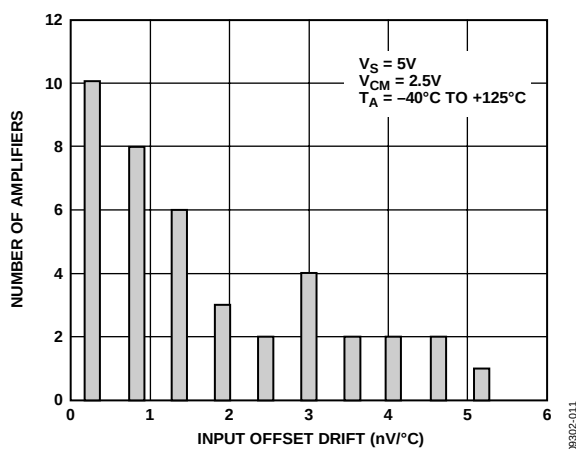


Figure 6. Input Offset Voltage Drift Distribution

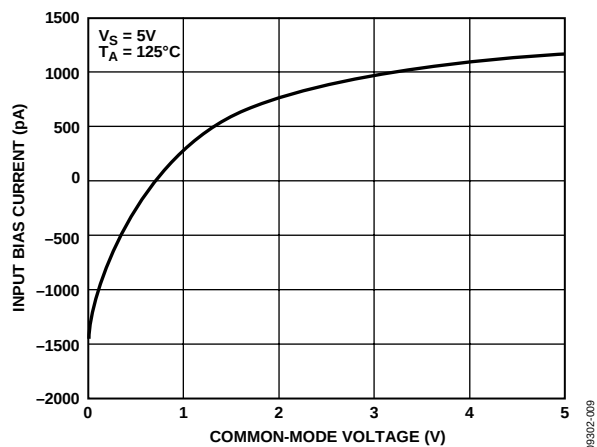


Figure 4. Input Bias Current vs. Common-Mode Voltage

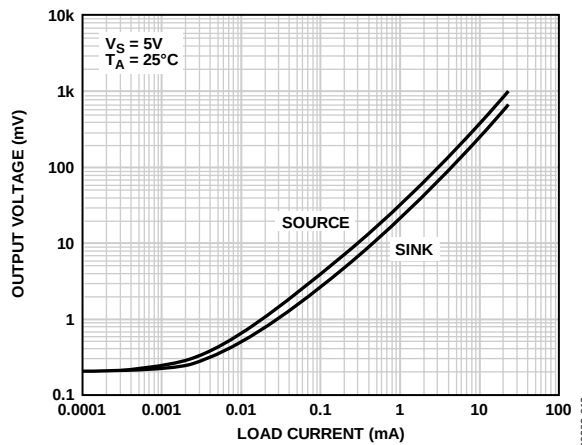


Figure 7. Output Voltage to Supply Rail vs. Load Current

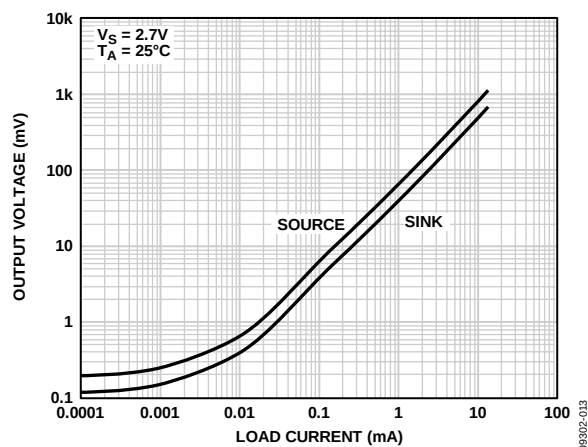


Figure 8. Output Voltage to Supply Rail vs. Load Current

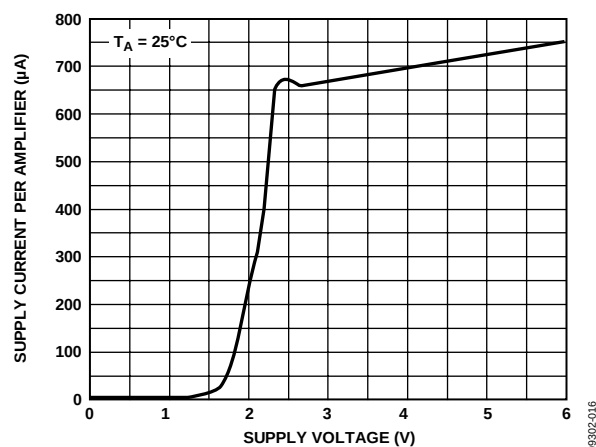


Figure 11. Supply Current per Amplifier vs. Supply Voltage

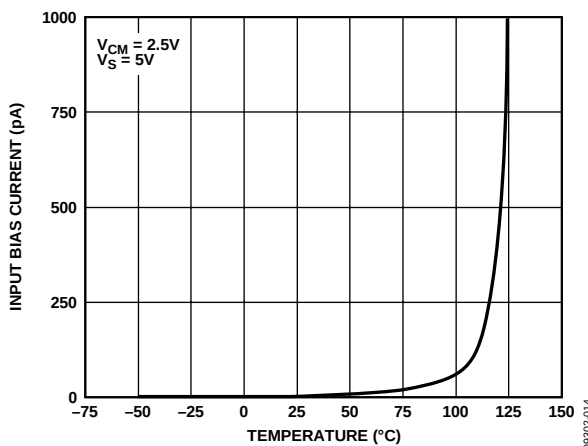


Figure 9. Input Bias Current vs. Temperature

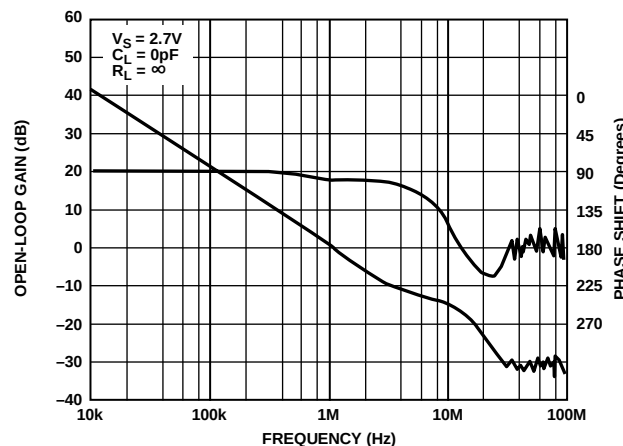


Figure 12. Open-Loop Gain and Phase Shift vs. Frequency

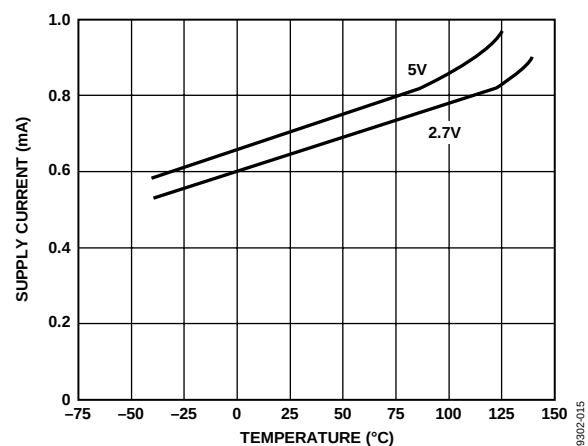


Figure 10. Supply Current vs. Temperature

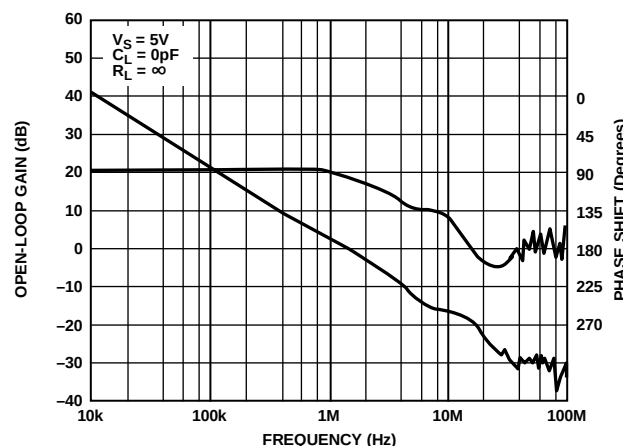


Figure 13. Open-Loop Gain and Phase Shift vs. Frequency

# AD8574-EP

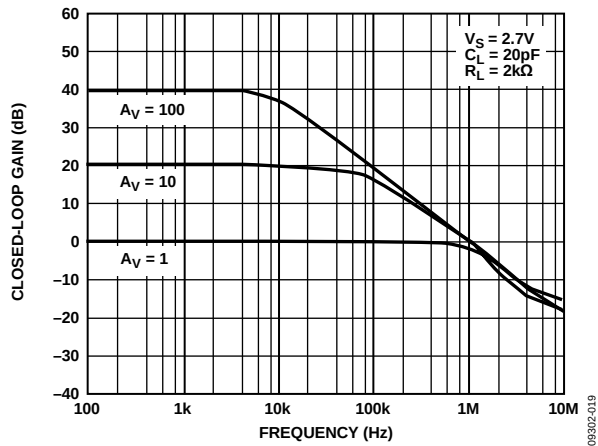


Figure 14. Closed-Loop Gain vs. Frequency

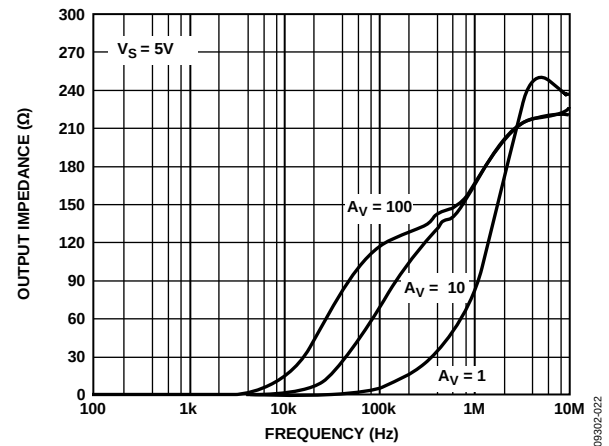


Figure 17. Output Impedance vs. Frequency

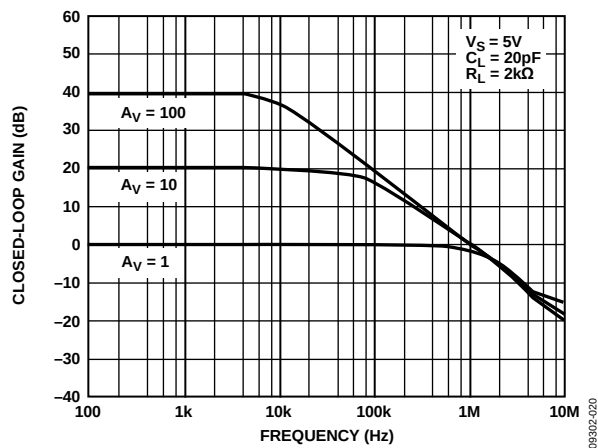


Figure 15. Closed-Loop Gain vs. Frequency

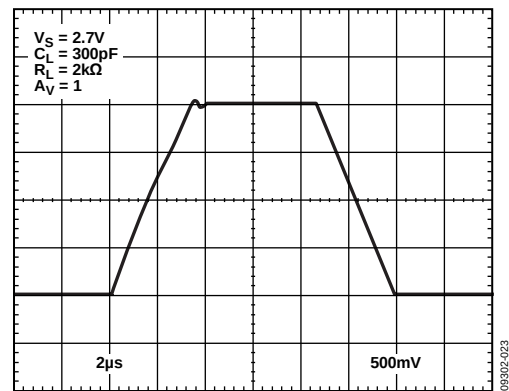


Figure 18. Large Signal Transient Response

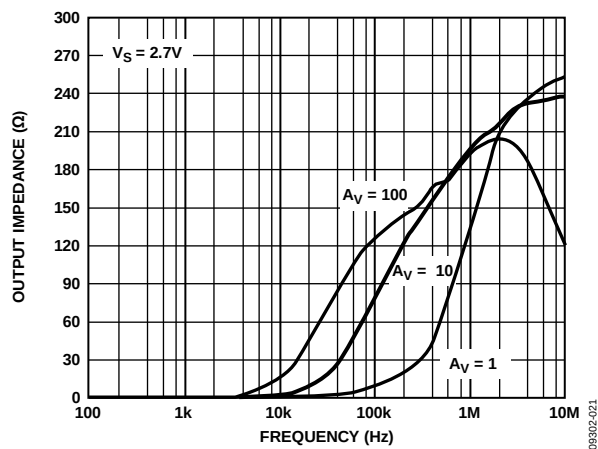


Figure 16. Output Impedance vs. Frequency

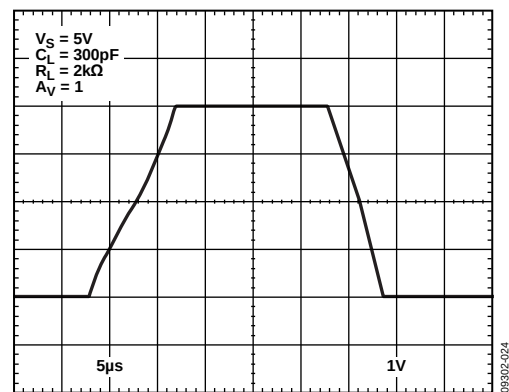


Figure 19. Large Signal Transient Response



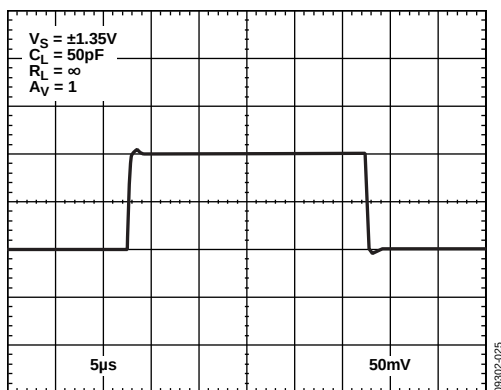


Figure 20. Small Signal Transient Response

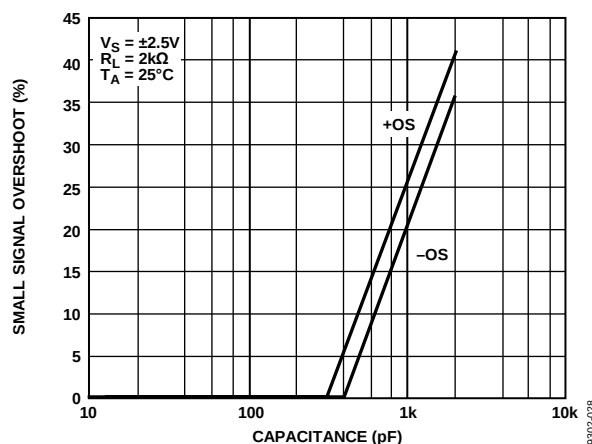


Figure 23. Small Signal Overshoot vs. Load Capacitance

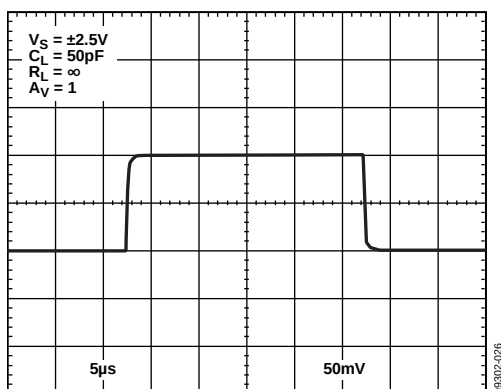


Figure 21. Small Signal Transient Response

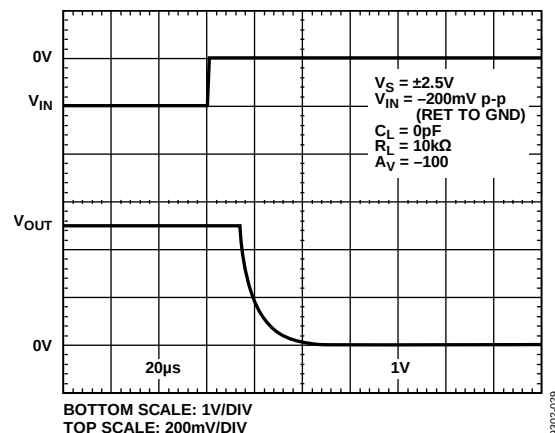


Figure 24. Positive Overvoltage Recovery

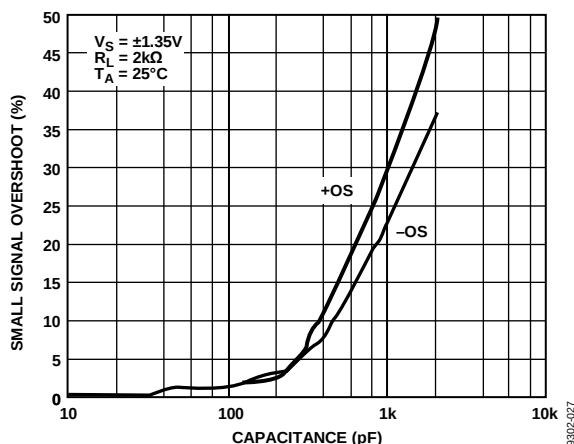


Figure 22. Small Signal Overshoot vs. Load Capacitance

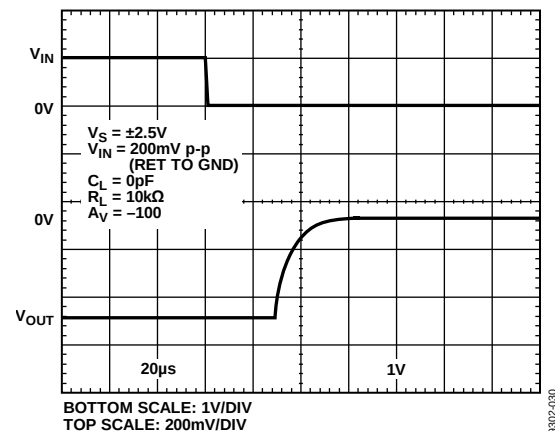


Figure 25. Negative Overvoltage Recovery

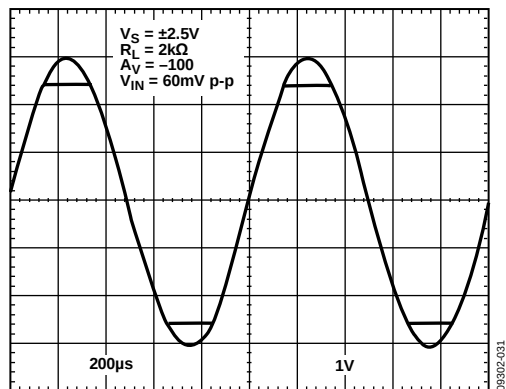


Figure 26. No Phase Reversal

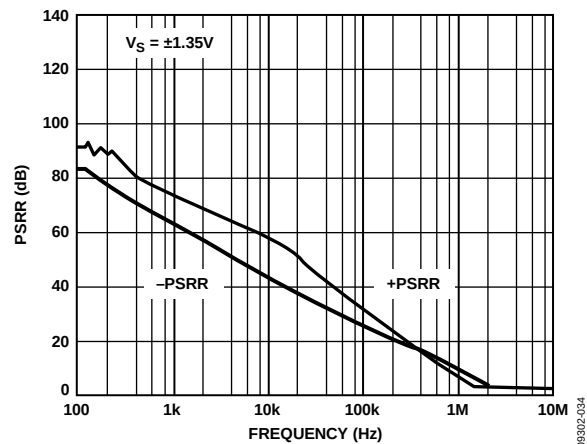


Figure 29. PSRR vs. Frequency

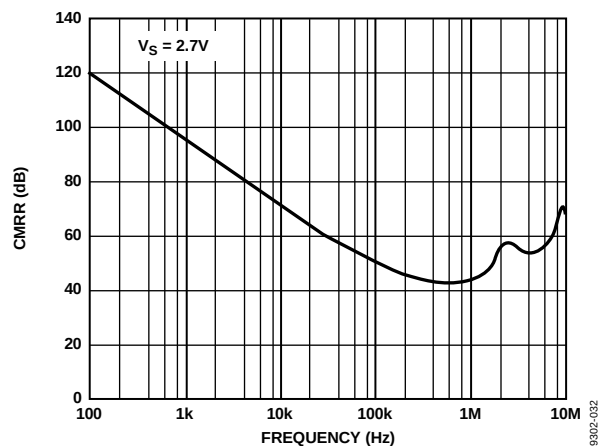


Figure 27. CMRR vs. Frequency

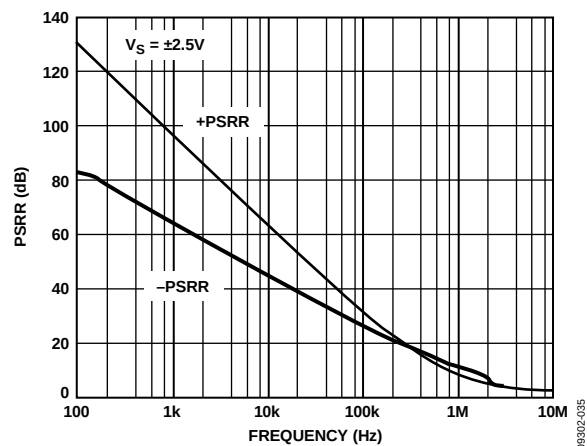


Figure 30. PSRR vs. Frequency

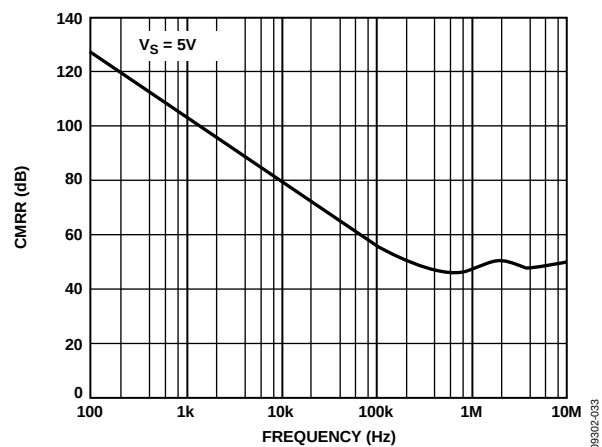


Figure 28. CMRR vs. Frequency

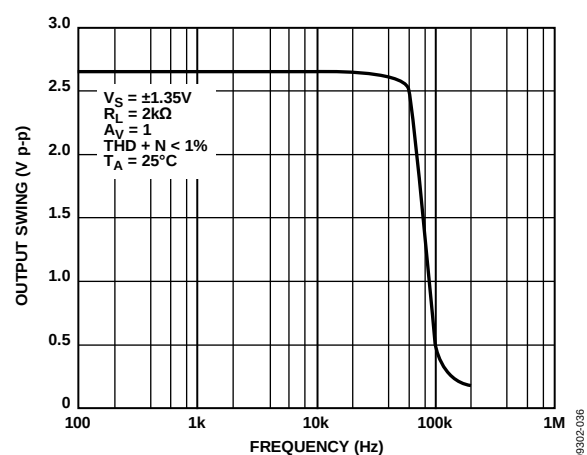


Figure 31. Maximum Output Swing vs. Frequency

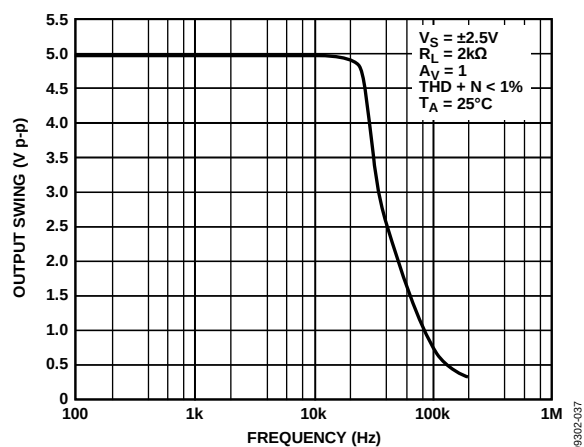


Figure 32. Maximum Output Swing vs. Frequency

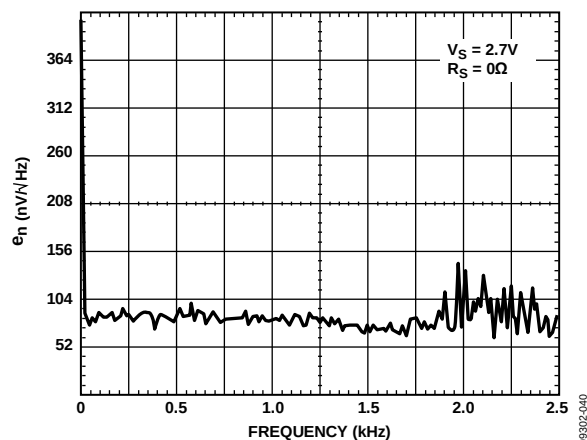


Figure 35. Voltage Noise Density from 0 Hz to 2.5 kHz

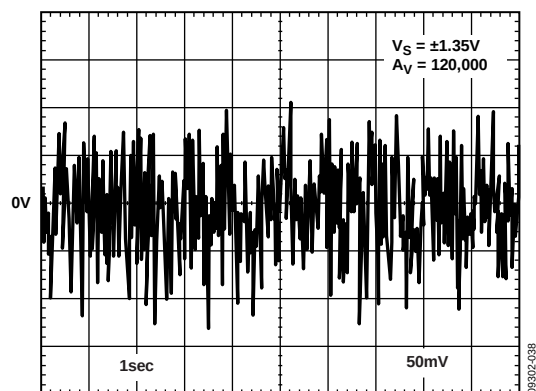


Figure 33. 0.1 Hz to 10 Hz Noise

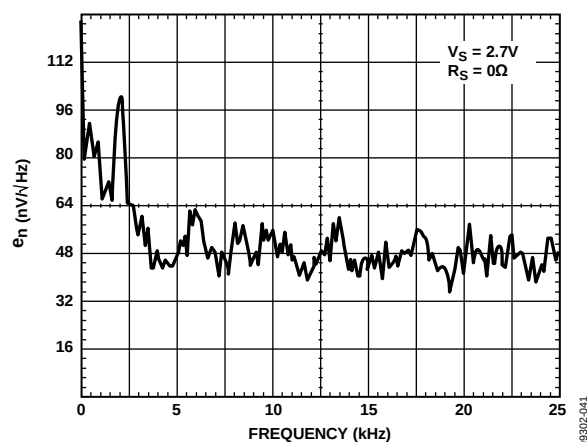


Figure 36. Voltage Noise Density from 0 Hz to 25 kHz

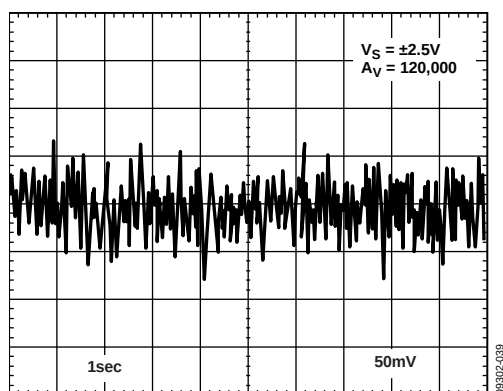


Figure 34. 0.1 Hz to 10 Hz Noise

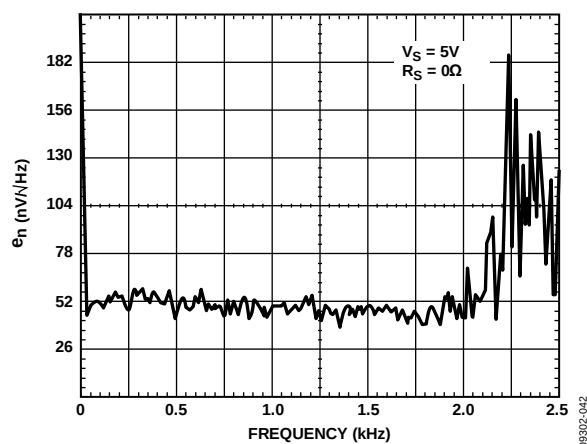


Figure 37. Voltage Noise Density from 0 Hz to 2.5 kHz

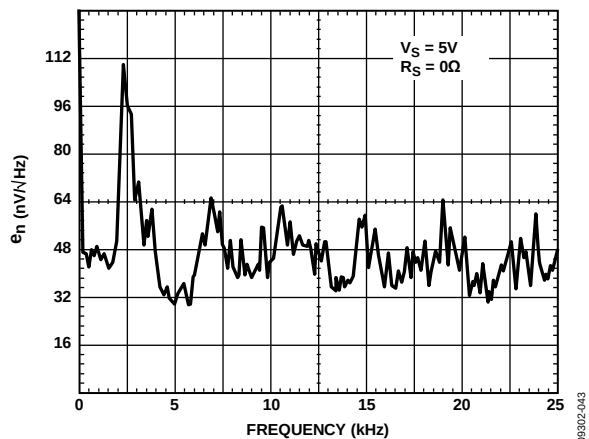


Figure 38. Voltage Noise Density from 0 Hz to 25 kHz

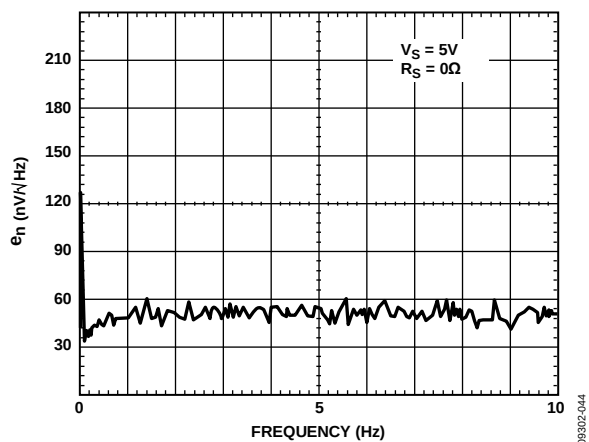


Figure 39. Voltage Noise Density from 0 Hz to 10 Hz

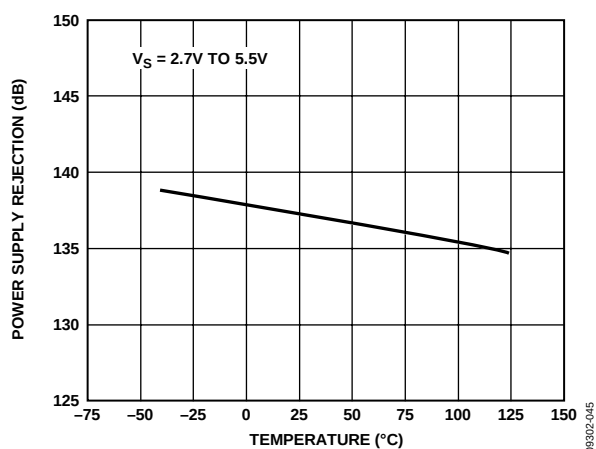


Figure 40. Power Supply Rejection vs. Temperature

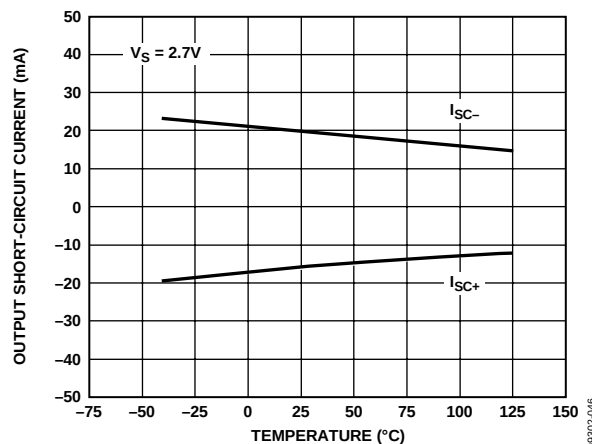


Figure 41. Output Short-Circuit Current vs. Temperature

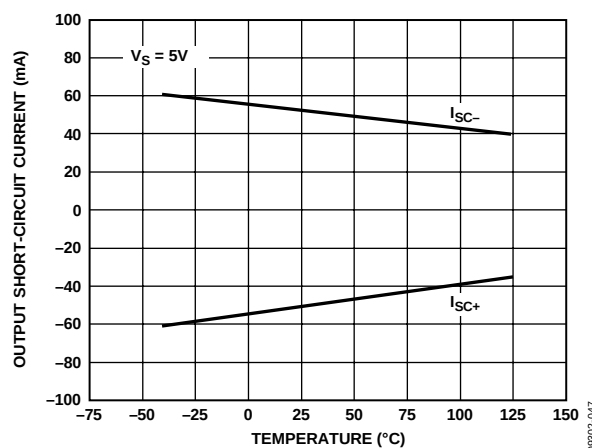


Figure 42. Output Short-Circuit Current vs. Temperature

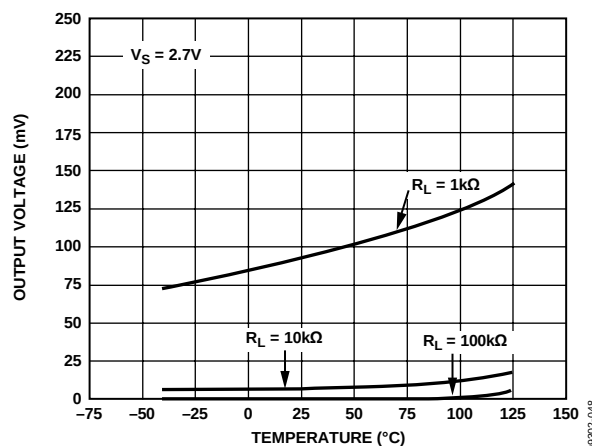


Figure 43. Output Voltage to Supply Rail vs. Temperature

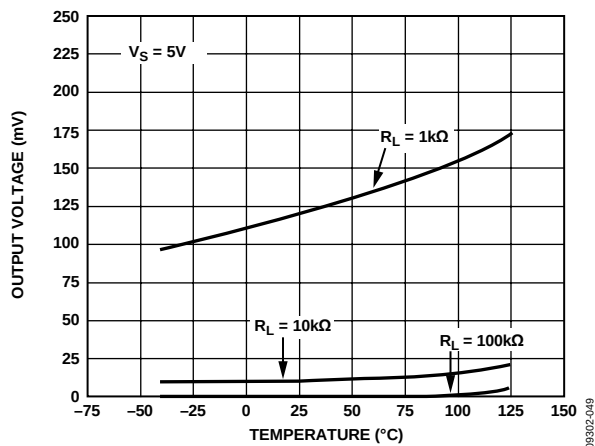


Figure 44. Output Voltage to Supply Rail vs. Temperature

AD8574-EP

OUTLINE DIMENSIONS

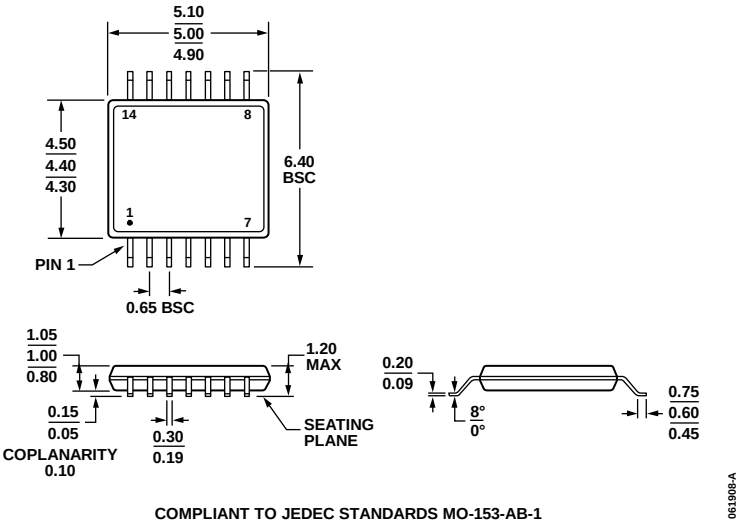


Figure 45. 14-Lead Thin Shrink Small Outline Package [TSSOP]  
(RU-14)  
Dimensions shown in millimeters

ORDERING GUIDE

| Model           | Temperature Range | Package Description | Package Option |
|-----------------|-------------------|---------------------|----------------|
| AD8574TRU-EP    | −55°C to +125°C   | 14-Lead TSSOP       | RU-14          |
| AD8574TRU-EP-RL | −55°C to +125°C   | 14-Lead TSSOP       | RU-14          |

## **NOTES**

## NOTES