

### FEATURES

**Low supply current:** 250  $\mu$ A max  
**Very low input bias current:** 1 pA max  
**Low offset voltage:** 750  $\mu$ V max  
**Single-supply operation:** 5 V to 26 V  
**Dual-supply operation:**  $\pm 2.5$  V to  $\pm 13$  V  
**Rail-to-rail output**  
**Unity-gain stable**  
**No phase reversal**  
**SC70 package**

### APPLICATIONS

**Line-/battery-powered instruments**  
**Photodiode amplifiers**  
**Precision current sensing**  
**Medical instrumentation**  
**Industrial controls**  
**Precision filters**  
**Portable audio**  
**ATE**

### GENERAL DESCRIPTION

The [AD8641/AD8642/AD8643](#) are low power, precision JFET input amplifiers featuring extremely low input bias current and rail-to-rail output. The ability to swing nearly rail-to-rail at the input and rail-to-rail at the output enables designers to buffer complementary metal-oxide semiconductor digital-to-analog converters (CMOS DACs), ASICs, and other wide output swing devices in single-supply systems. The outputs remain stable with capacitive loads of more than 500 pF.

The [AD8641/AD8642/AD8643](#) are suitable for applications utilizing multichannel boards that require low power to manage heat. Other applications include photodiodes, ATE reference level drivers, battery management, and industrial controls.

The [AD8641/AD8642/AD8643](#) are fully specified over the extended industrial temperature range of  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . The [AD8641](#) is available in 5-lead SC70 and 8-lead SOIC lead-free packages. The [AD8642](#) is available in 8-lead MSOP and 8-lead SOIC lead-free packages. The [AD8643](#) is available in 14-lead SOIC and 16-lead, 3 mm  $\times$  3 mm, LFCSP lead-free packages.

### PIN CONFIGURATIONS

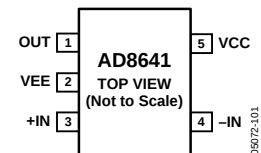
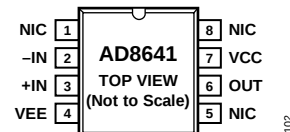


Figure 1. 5-Lead SC70 (KS-5)



NIC = NO INTERNAL CONNECTION.

Figure 2. 8-Lead SOIC (R-8)

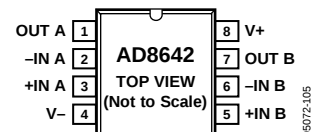


Figure 3. 8-Lead SOIC (R-8)

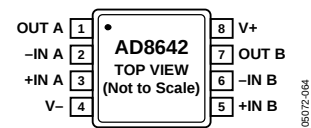


Figure 4. 8-Lead MSOP (RM-8)

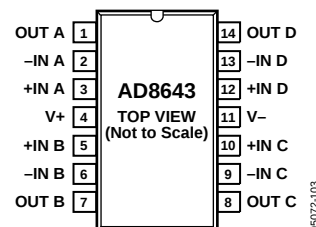
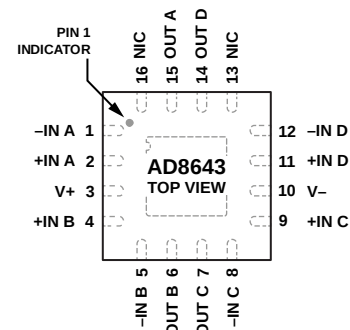


Figure 5. 14-Lead SOIC (R-14)



#### NOTES

1. NIC = NO INTERNAL CONNECTION.
2. EXPOSED PAD SHOULD BE CONNECTED TO V+.

Figure 6. 16-Lead LFCSP (CP-16-27) (Not Drawn to Scale)

Rev. F

[Document Feedback](#)

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## REVISION HISTORY

### 4/16—Rev. E to Rev. F

|                                        |            |
|----------------------------------------|------------|
| Changed CP-16-3 to CP-16-27 .....      | Throughout |
| Changes to Figure 2 and Figure 6 ..... | 1          |
| Updated Outline Dimensions .....       | 13         |
| Changes to Ordering Guide .....        | 14         |

### 9/11—Rev. D to Rev. E

|                                             |   |
|---------------------------------------------|---|
| Changes to Thermal Resistance Section ..... | 5 |
|---------------------------------------------|---|

### 7/11—Rev. C to Rev. D

|                           |   |
|---------------------------|---|
| Changes to Figure 6 ..... | 1 |
|---------------------------|---|

### 11/10—Rev. B to Rev. C

|                                                    |    |
|----------------------------------------------------|----|
| Changes to Figure 6 .....                          | 1  |
| Added Thermal Resistance Section and Table 4 ..... | 5  |
| Updated Outline Dimensions .....                   | 13 |
| Changes to Ordering Guide .....                    | 15 |

### 4/05—Rev. A to Rev. B

|                                  |           |
|----------------------------------|-----------|
| Added AD8643 .....               | Universal |
| Added 14-Lead SOIC .....         | Universal |
| Added 16-Lead LFCSP .....        | Universal |
| Updated Outline Dimensions ..... | 13        |
| Changes to Ordering Guide .....  | 14        |

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| Ordering Guide .....                      | 14 |

### 3/05—Rev. 0 to Rev. A

|                                           |           |
|-------------------------------------------|-----------|
| Added AD8642 .....                        | Universal |
| Changes to General Description .....      | 1         |
| Added Figure 3 and Figure 4 .....         | 1         |
| Changes to Specifications .....           | 3         |
| Changes to Absolute Maximum Ratings ..... | 5         |
| Changes to Figure 22 .....                | 8         |
| Changes to Figure 23 .....                | 9         |
| Changes to Figure 41 .....                | 12        |
| Updated Outline Dimensions .....          | 13        |
| Changes to Ordering Guide .....           | 14        |

### 10/04—Initial Version: Revision 0

## SPECIFICATIONS

## ELECTRICAL CHARACTERISTICS

$V_S = 5.0\text{ V}$ ,  $V_{CM} = 2.5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 1.

| Parameter                    | Symbol               | Test Conditions/Comments                                                                                        | Min  | Typ       | Max  | Unit                 |
|------------------------------|----------------------|-----------------------------------------------------------------------------------------------------------------|------|-----------|------|----------------------|
| INPUT CHARACTERISTICS        |                      |                                                                                                                 |      |           |      |                      |
| Offset Voltage               | V <sub>OS</sub>      | AD8643 LFCSP only<br>−40°C < T <sub>A</sub> < +85°C<br>+85°C < T <sub>A</sub> < +125°C, V <sub>CM</sub> = 1.5 V |      | 50        | 750  | μV<br>mV<br>mV<br>mV |
| Input Bias Current           | I <sub>B</sub>       | −40°C < T <sub>A</sub> < +125°C                                                                                 |      | 0.25      | 1    | pA                   |
| Input Offset Current         | I <sub>OS</sub>      | −40°C < T <sub>A</sub> < +125°C                                                                                 |      |           | 180  | pA                   |
| Input Voltage Range          |                      |                                                                                                                 | 0    |           | 60   | pA                   |
| Common-Mode Rejection Ratio  | CMRR                 | V <sub>CM</sub> = 0 V to 2.5 V                                                                                  | 74   | 93        | 3    | V<br>dB              |
| Large Signal Voltage Gain    | A <sub>VO</sub>      | R <sub>L</sub> = 10 kΩ, V <sub>O</sub> = 0.5 to 4.5 V                                                           | 80   | 140       |      | V/mV                 |
| Offset Voltage Drift         | ΔV <sub>OS</sub> /ΔT | −40°C < T <sub>A</sub> < +125°C                                                                                 |      | 2.5       |      | μV/°C                |
| OUTPUT CHARACTERISTICS       |                      |                                                                                                                 |      |           |      |                      |
| Output Voltage High          | V <sub>OH</sub>      | I <sub>L</sub> = 1 mA, −40°C to +125°C                                                                          | 4.95 |           |      | V                    |
| Output Voltage Low           | V <sub>OL</sub>      | I <sub>L</sub> = 1 mA, −40°C to +125°C                                                                          | 4.94 |           | 0.05 | V<br>V               |
| Output Current               | I <sub>OUT</sub>     |                                                                                                                 |      | 0.01      | 0.05 | V<br>mA              |
| POWER SUPPLY                 |                      |                                                                                                                 |      |           |      |                      |
| Power Supply Rejection Ratio | PSRR                 | V <sub>S</sub> = 5 V to 26 V                                                                                    | 90   | 107       |      | dB                   |
| Supply Current/Amplifier     | I <sub>SY</sub>      | −40°C < T <sub>A</sub> < +125°C                                                                                 |      | 195       | 250  | μA<br>μA             |
| DYNAMIC PERFORMANCE          |                      |                                                                                                                 |      |           |      |                      |
| Slew Rate                    | SR                   |                                                                                                                 |      | 2         |      | V/μs                 |
| Gain Bandwidth Product       | GBP                  | AD8641, AD8642<br>AD8643                                                                                        |      | 3         |      | MHz<br>MHz           |
| Phase Margin                 | ∅ <sub>m</sub>       |                                                                                                                 |      | 2.5<br>50 |      | MHz<br>Degrees       |
| NOISE PERFORMANCE            |                      |                                                                                                                 |      |           |      |                      |
| Voltage Noise                | e <sub>N</sub> p-p   | f = 0.1 Hz to 10 Hz                                                                                             |      | 4.0       |      | μV p-p               |
| Voltage Noise Density        | e <sub>N</sub>       | f = 1 kHz                                                                                                       |      | 28.5      |      | nV/√Hz               |
| Current Noise Density        | i <sub>N</sub>       | f = 1 kHz                                                                                                       |      | 0.5       |      | fA/√Hz               |

$V_S = \pm 13\text{ V}$ ,  $V_{CM} = 0\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 2.

| Parameter                     | Symbol                   | Test Conditions/Comments                                                   | Min    | Typ      | Max    | Unit                         |
|-------------------------------|--------------------------|----------------------------------------------------------------------------|--------|----------|--------|------------------------------|
| <b>INPUT CHARACTERISTICS</b>  |                          |                                                                            |        |          |        |                              |
| Offset Voltage                | $V_{OS}$                 | <b>AD8643</b> LFCSP only<br>$-40^\circ\text{C} < T_A < +125^\circ\text{C}$ |        | 70       | 750    | $\mu\text{V}$                |
|                               |                          |                                                                            |        |          | 1      | mV                           |
| Input Bias Current            | $I_B$                    | $-40^\circ\text{C} < T_A < +125^\circ\text{C}$                             |        | 0.25     | 1.5    | pA                           |
| Input Offset Current          | $I_{OS}$                 | $-40^\circ\text{C} < T_A < +125^\circ\text{C}$                             |        |          | 260    | pA                           |
|                               |                          |                                                                            |        |          | 0.5    | pA                           |
| Input Voltage Range           |                          | $-40^\circ\text{C} < T_A < +125^\circ\text{C}$                             | -13    |          | 65     | pA                           |
| Common-Mode Rejection Ratio   | CMRR                     | $V_{CM} = -13\text{ V to } +10\text{ V}$                                   | 90     | 107      | +10    | V                            |
| Large Signal Voltage Gain     | $A_{VO}$                 | $R_L = 10\text{ k}\Omega$ , $V_O = -11\text{ V to } +11\text{ V}$          | 215    | 290      |        | dB                           |
| Offset Voltage Drift          | $\Delta V_{OS}/\Delta T$ | $-40^\circ\text{C} < T_A < +125^\circ\text{C}$                             |        | 2.5      |        | V/mV                         |
| <b>OUTPUT CHARACTERISTICS</b> |                          |                                                                            |        |          |        |                              |
| Output Voltage High           | $V_{OH}$                 | $I_L = 1\text{ mA}$ , $-40^\circ\text{C to } +125^\circ\text{C}$           | +12.95 |          |        | $\mu\text{V}/^\circ\text{C}$ |
| Output Voltage Low            | $V_{OL}$                 | $I_L = 1\text{ mA}$ , $-40^\circ\text{C to } +125^\circ\text{C}$           | +12.94 |          | -12.95 | V                            |
|                               |                          |                                                                            |        |          | -12.94 | V                            |
| Output Current                | $I_{OUT}$                |                                                                            |        | $\pm 12$ |        | mA                           |
| <b>POWER SUPPLY</b>           |                          |                                                                            |        |          |        |                              |
| Power Supply Rejection Ratio  | PSRR                     | $V_S = \pm 2.5\text{ V to } \pm 13\text{ V}$                               | 90     | 107      |        | dB                           |
| Supply Current/Amplifier      | $I_{SY}$                 | $-40^\circ\text{C} < T_A < +125^\circ\text{C}$                             |        | 200      | 290    | $\mu\text{A}$                |
|                               |                          |                                                                            |        |          | 330    | $\mu\text{A}$                |
| <b>DYNAMIC PERFORMANCE</b>    |                          |                                                                            |        |          |        |                              |
| Slew Rate                     | SR                       |                                                                            |        | 3        |        | V/ $\mu\text{s}$             |
| Gain Bandwidth Product        | GBP                      |                                                                            |        | 3.5      |        | MHz                          |
| Phase Margin                  | $\phi_m$                 |                                                                            |        | 60       |        | Degrees                      |
| <b>NOISE PERFORMANCE</b>      |                          |                                                                            |        |          |        |                              |
| Voltage Noise                 | $e_N$ p-p                | $f = 0.1\text{ Hz to } 10\text{ Hz}$                                       |        | 4.2      |        | $\mu\text{V p-p}$            |
| Voltage Noise Density         | $e_N$                    | $f = 1\text{ kHz}$                                                         |        | 27.5     |        | nV/ $\sqrt{\text{Hz}}$       |
| Current Noise Density         | $i_N$                    | $f = 1\text{ kHz}$                                                         |        | 0.5      |        | fA/ $\sqrt{\text{Hz}}$       |

## ABSOLUTE MAXIMUM RATINGS

Absolute maximum ratings apply at 25°C, unless otherwise noted.

Table 3.

| Parameter                             | Rating          |
|---------------------------------------|-----------------|
| Supply Voltage                        | 27.3 V          |
| Input Voltage                         | VS– to VS+      |
| Differential Input Voltage            | ±Supply Voltage |
| Output Short-Circuit Duration         | Indefinite      |
| Storage Temperature Range             |                 |
| KS-5, R-8, RM-8, R-14, CP-16 Packages | –65°C to +150°C |
| Operating Temperature Range           | –40°C to +125°C |
| Junction Temperature Range            |                 |
| KS-5, R-8, RM-8, R-14, CP-16 Packages | –65°C to +150°C |
| Lead Temperature (Soldering, 60 sec)  | 300°C           |

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

## THERMAL RESISTANCE

$\theta_{JA}$  is specified for the worst-case conditions, that is, a device soldered in a circuit board for surface-mount packages. This was measured using a standard 4-layer board. For the LFCSP, solder the exposed pad to a copper plane, which should be connected to V+.

Table 4.

| Package Type       | $\theta_{JA}$ | $\theta_{JC}$ | Unit |
|--------------------|---------------|---------------|------|
| 5-Lead SC70 (KS)   | 430           | 149           | °C/W |
| 8-Lead SOIC (R)    | 121           | 43            | °C/W |
| 8-Lead MSOP (RM)   | 142           | 45            | °C/W |
| 14-Lead SOIC (R)   | 110           | 36            | °C/W |
| 16-Lead LFCSP (CP) | 81            | 16            | °C/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

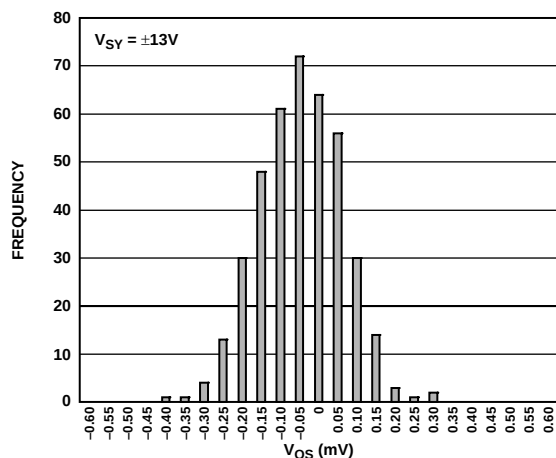


Figure 7. Input Offset Voltage

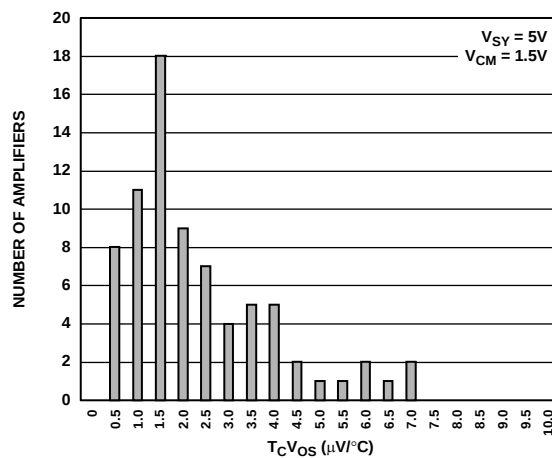


Figure 10. Offset Voltage Drift

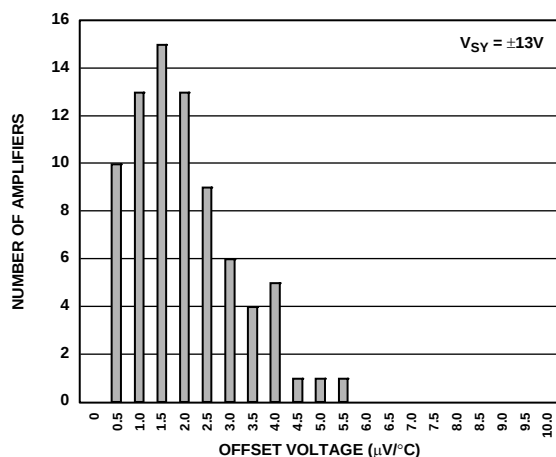


Figure 8. Offset Voltage Drift

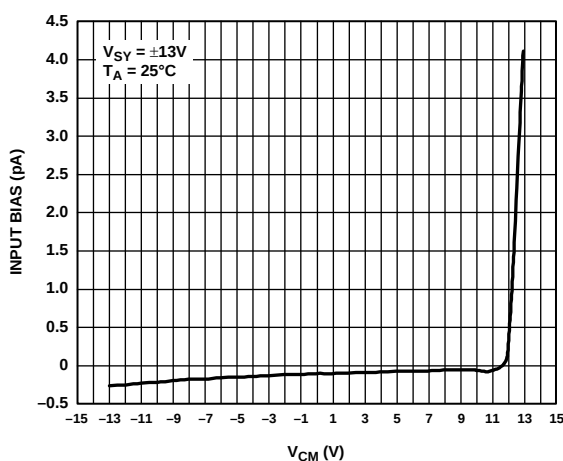
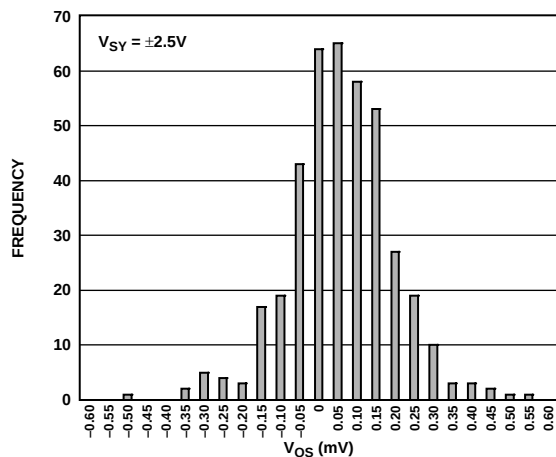
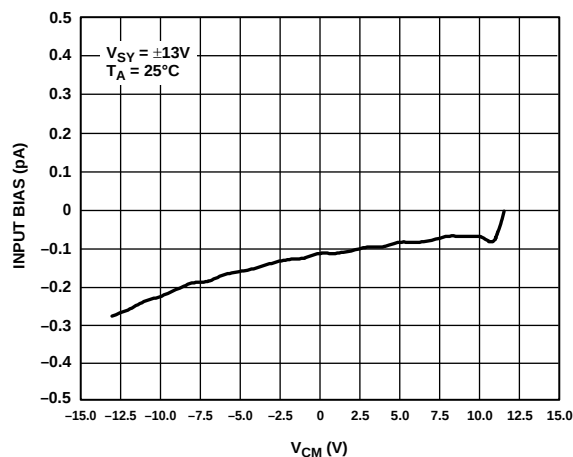
Figure 11. Input Bias Current vs.  $V_{CM}$ 

Figure 9. Input Offset Voltage

Figure 12. Input Bias Current vs.  $V_{CM}$

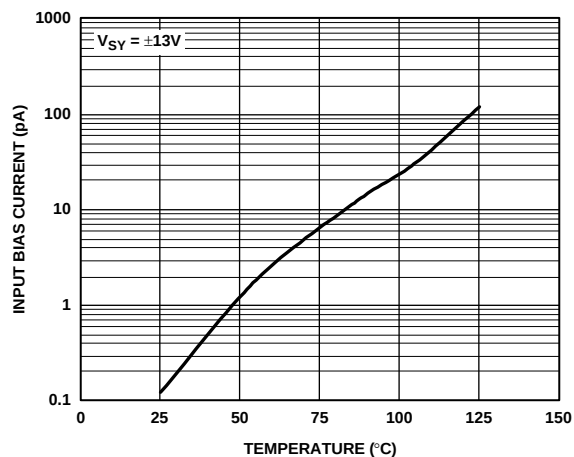
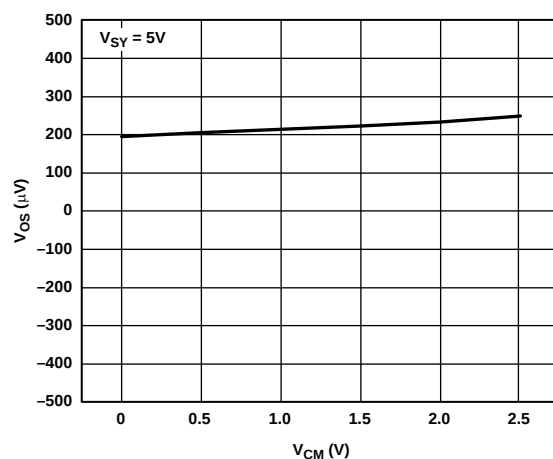
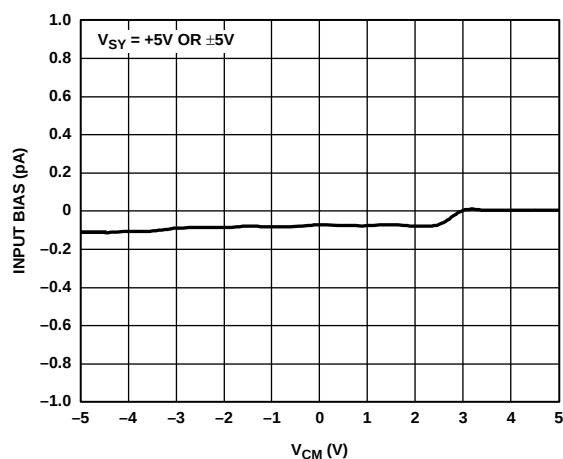


Figure 13. Input Bias Current vs. Temperature

05072-008

Figure 16. Input Offset Voltage vs.  $V_{CM}$ 

05072-011

Figure 14. Input Bias Current vs.  $V_{CM}$ 

05072-009

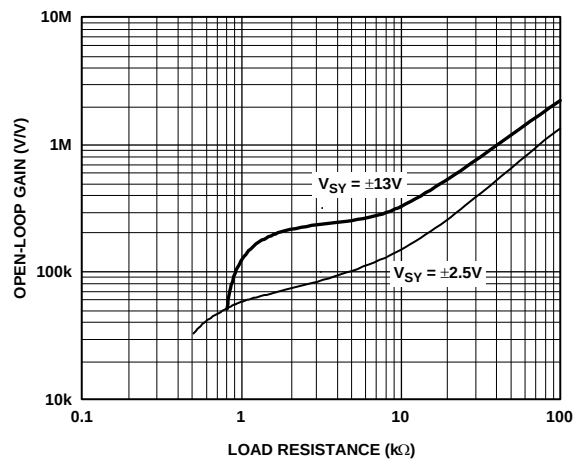
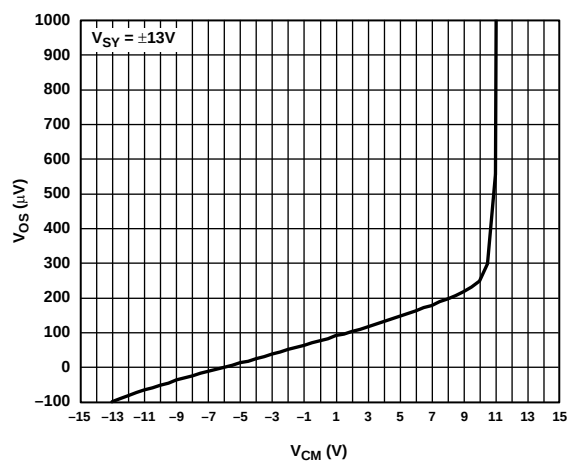


Figure 17. Open-Loop Gain vs. Load Resistance

05072-012

Figure 15. Input Offset Voltage vs.  $V_{CM}$ 

05072-010

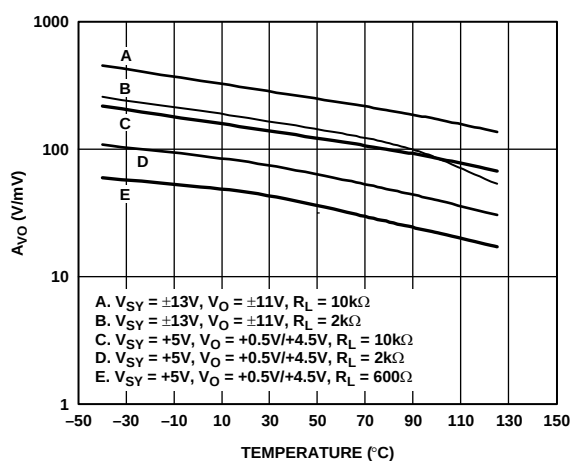


Figure 18. Open-Loop Gain vs. Temperature

05072-013

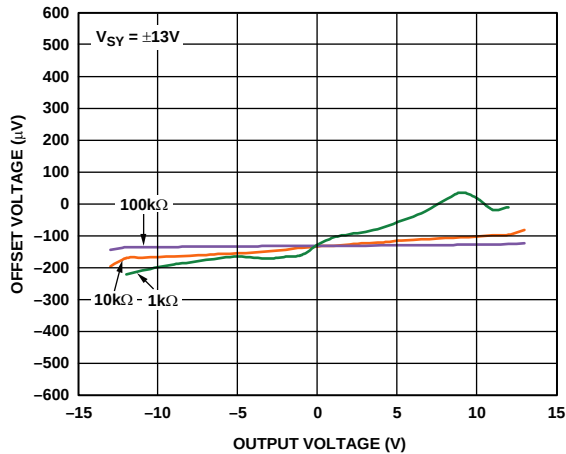


Figure 19. Input Error Voltage vs. Output Voltage for Resistive Loads

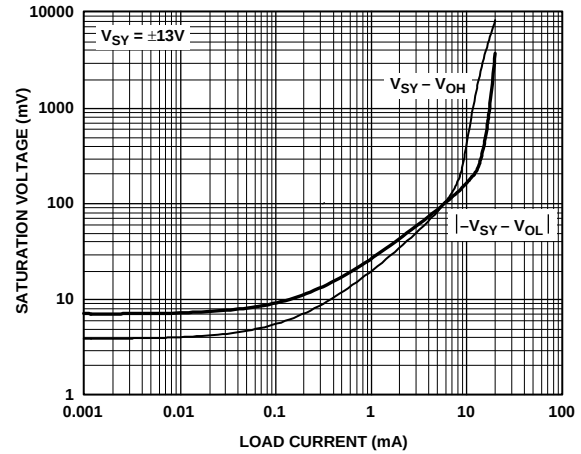


Figure 22. Output Saturation Voltage vs. Load Current

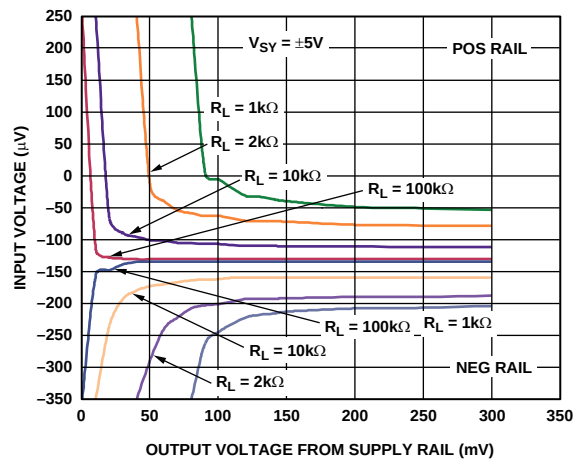


Figure 20. Input Error Voltage vs. Output Voltage Within 300 mV of Supply Rails

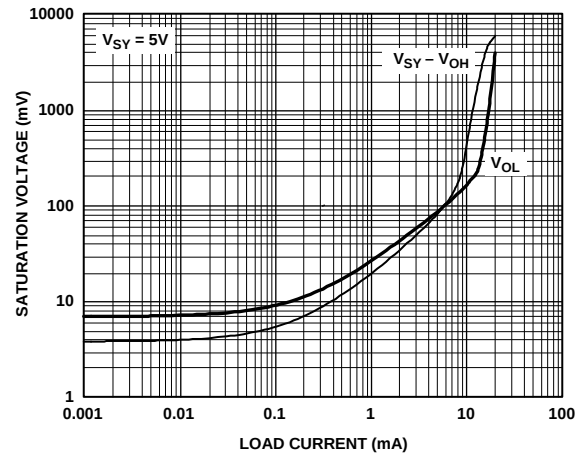


Figure 23. Output Saturation Voltage vs. Load Current

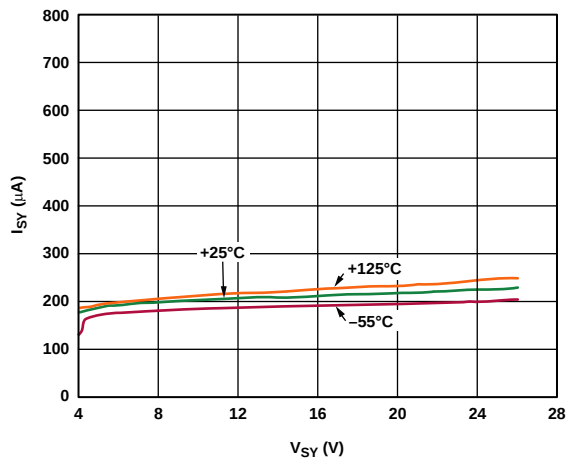


Figure 21. Quiescent Current vs. Supply Voltage at Different Temperatures

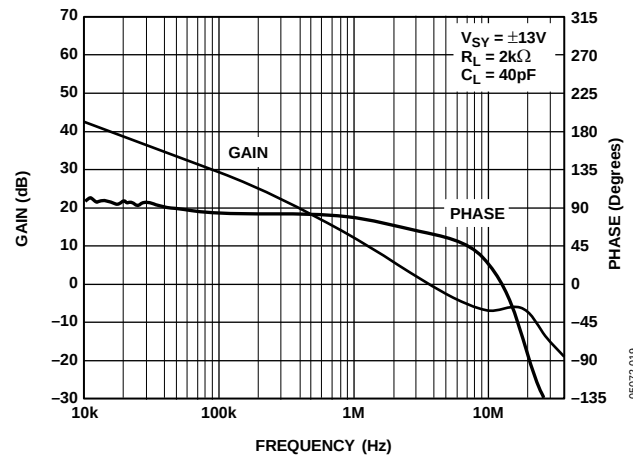


Figure 24. Open-Loop Gain and Phase Margin vs. Frequency

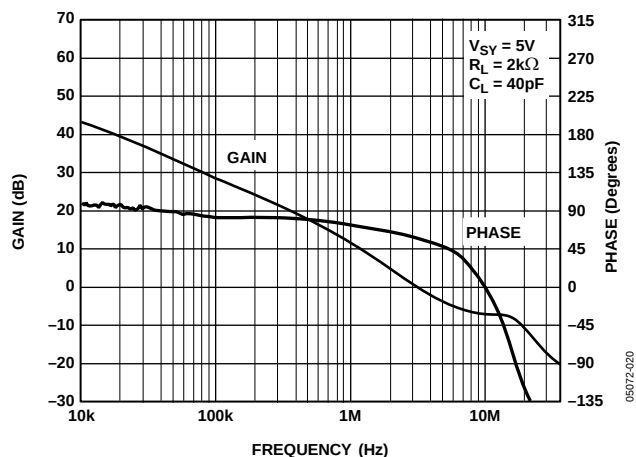


Figure 25. Open-Loop Gain and Phase Margin vs. Frequency

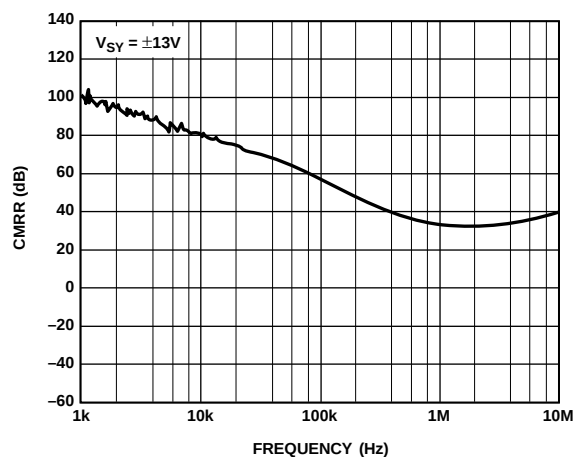


Figure 28. CMRR vs. Frequency

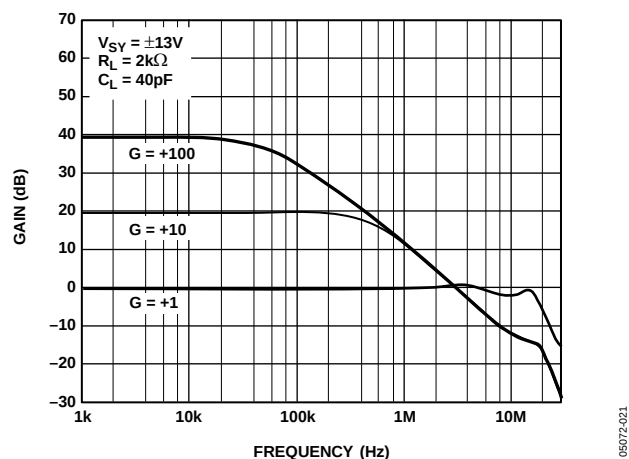


Figure 26. Closed-Loop Gain vs. Frequency

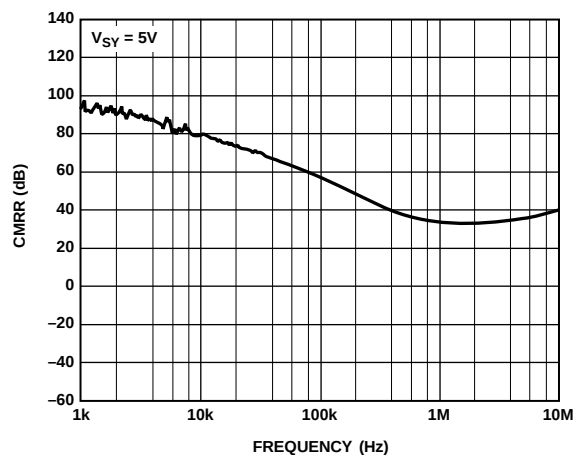


Figure 29. CMRR vs. Frequency

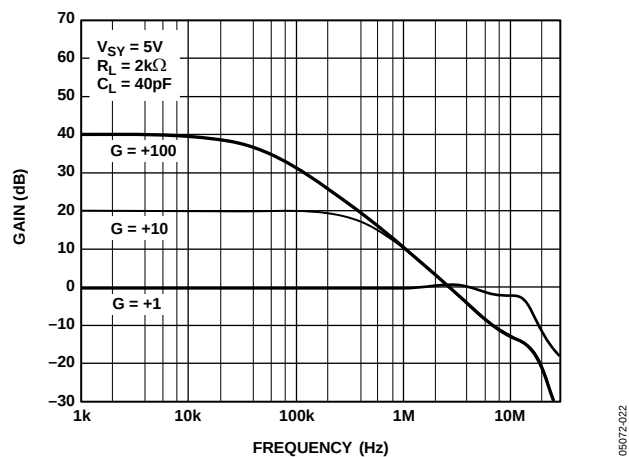


Figure 27. Closed-Loop Gain vs. Frequency

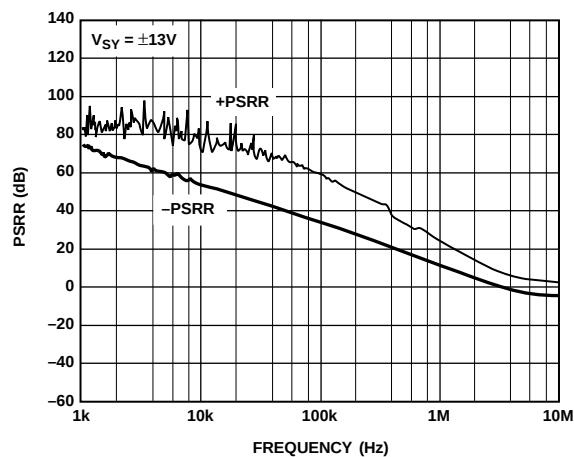


Figure 30. PSRR vs. Frequency

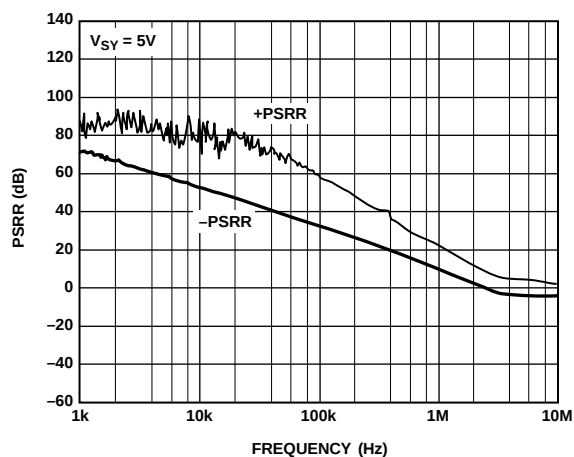


Figure 31. PSRR vs. Frequency

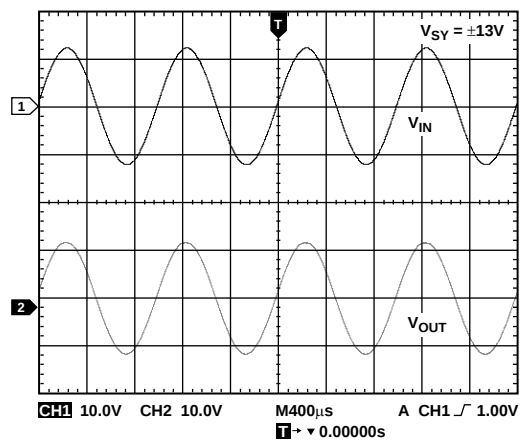


Figure 34. No Phase Reversal

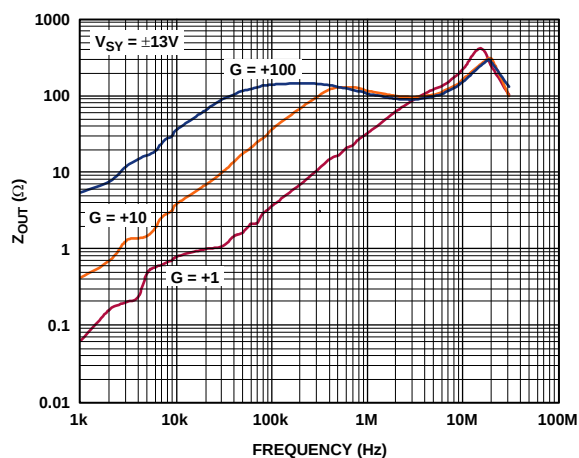


Figure 32. Output Impedance vs. Frequency

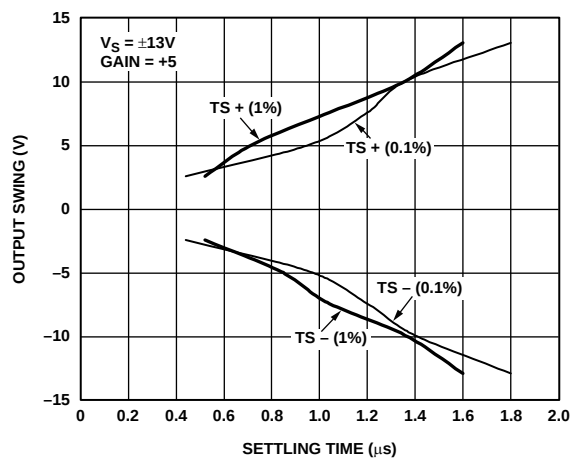


Figure 35. Output Swing and Error vs. Settling Time

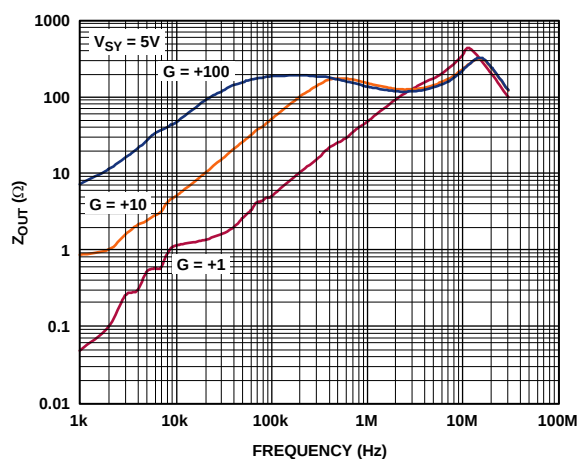


Figure 33. Output Impedance vs. Frequency

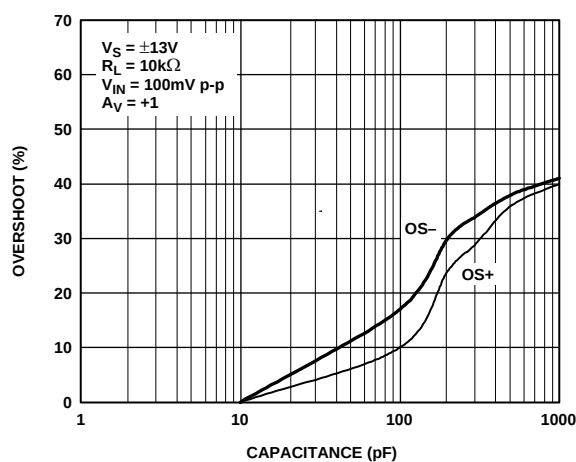


Figure 36. Small Signal Overshoot vs. Load Capacitance

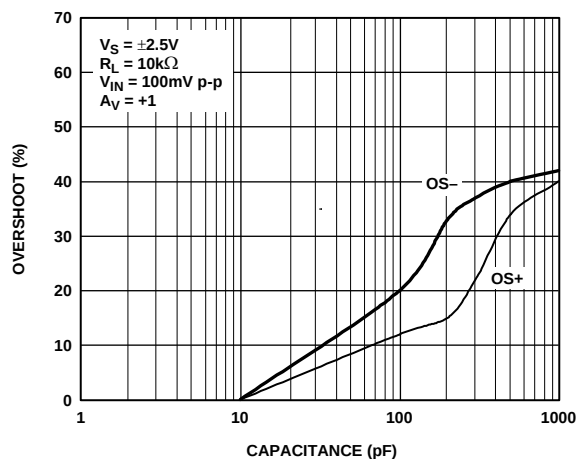


Figure 37. Small Signal Overshoot vs. Load Capacitance

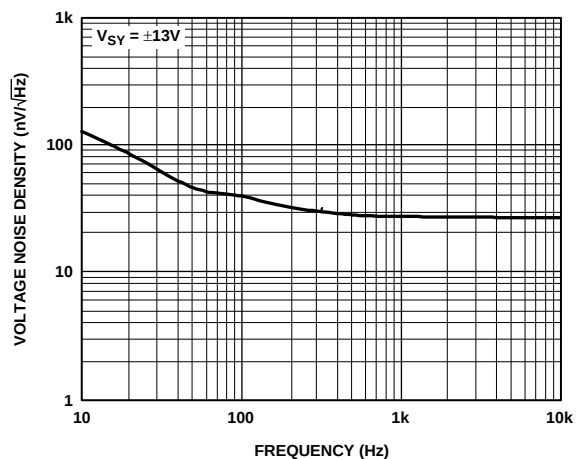


Figure 40. Voltage Noise Density

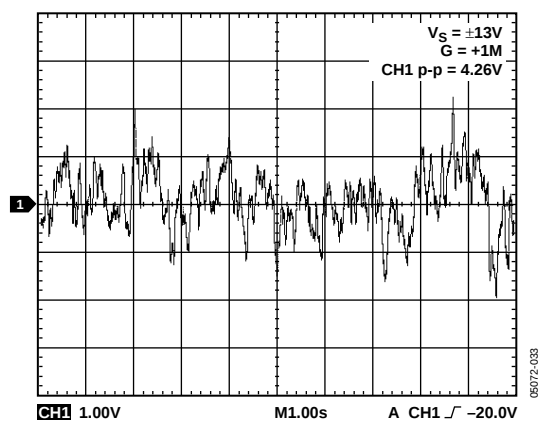


Figure 38. 0.1 Hz to 10 Hz Noise

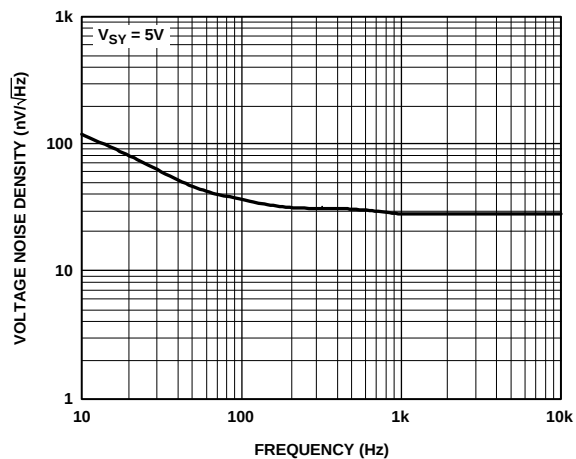


Figure 41. Voltage Noise Density

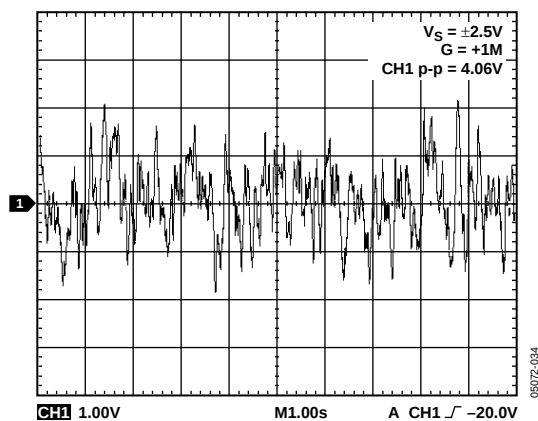


Figure 39. 0.1 Hz to 10 Hz Noise

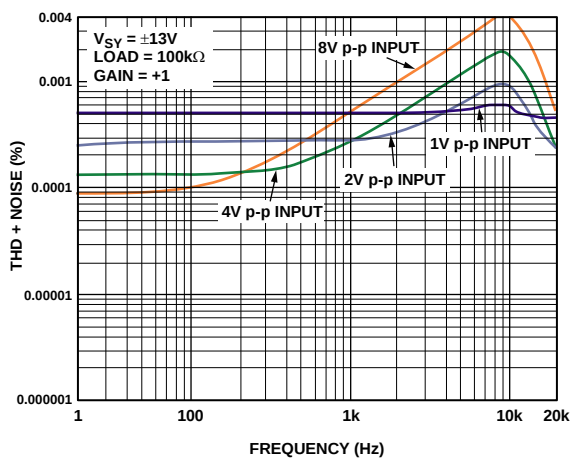
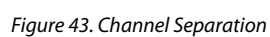
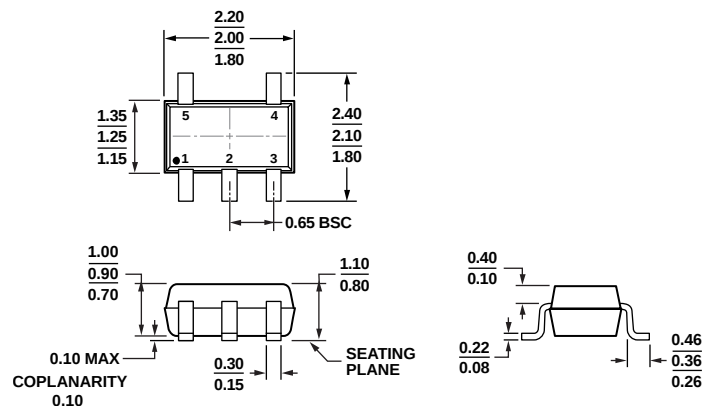


Figure 42. Total Harmonic Distortion + Noise vs. Frequency



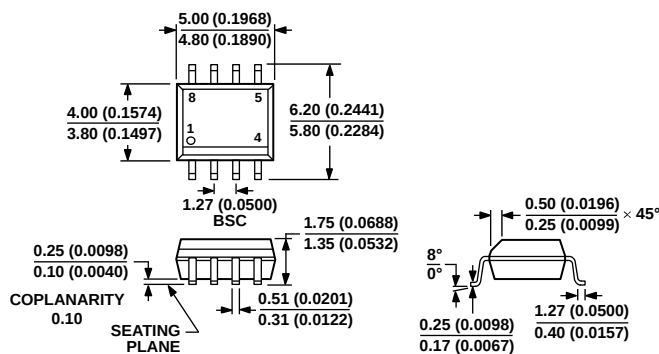
## OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-203-AA

Figure 44. 5-Lead Thin Shrink Small Outline Transistor Package [SC70] (KS-5)

Dimensions shown in millimeters

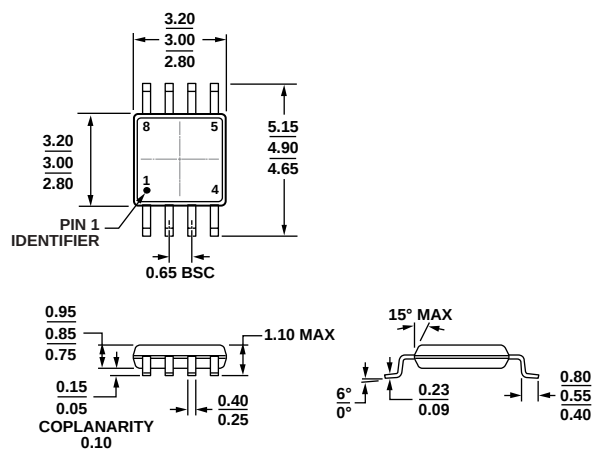


COMPLIANT TO JEDEC STANDARDS MS-012-AA

CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

Figure 45. 8-Lead Standard Small Outline Package [SOIC\_N] (R-8)

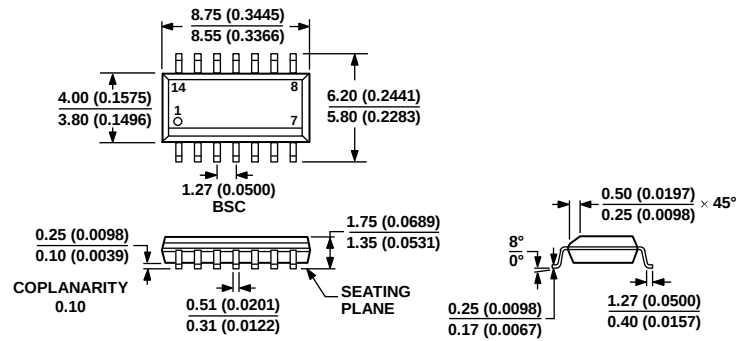
Dimensions shown in millimeters and (inches)



COMPLIANT TO JEDEC STANDARDS MO-187-AA

Figure 46. 8-Lead Mini Small Outline Package [MSOP] (RM-8)

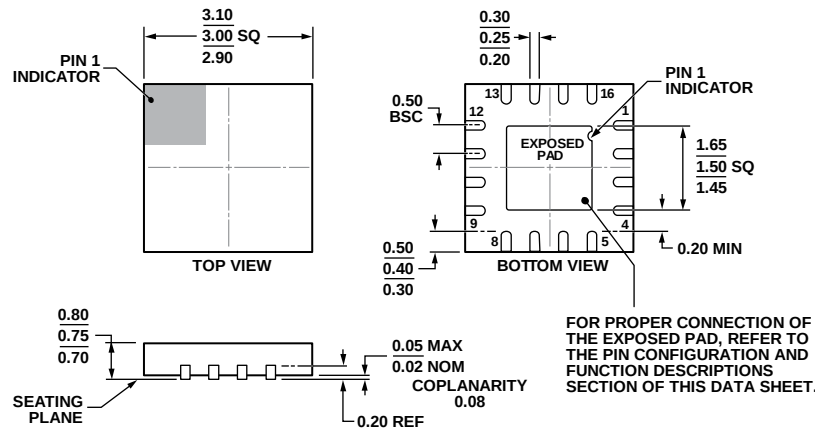
Dimensions shown in millimeters



COMPLIANT TO JEDEC STANDARDS MS-012-AB  
CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS  
(IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR  
REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

Figure 47. 14-Lead Standard Small Outline Package [SOIC\_N]  
(R-14)

Dimensions shown in millimeters and (inches)



COMPLIANT TO JEDEC STANDARDS MO-220-WEED-6.

Figure 48. 16-Lead Lead Frame Chip Scale Package [LFCSP]  
3 mm × 3 mm Body and 0.75 mm Package Height  
(CP-16-27)

Dimensions shown in millimeters

## ORDERING GUIDE

| Model <sup>1</sup> | Temperature Range | Package Description                                        | Package Option | Branding |
|--------------------|-------------------|------------------------------------------------------------|----------------|----------|
| AD8641AKSZ-R2      | −40°C to +125°C   | 5-Lead Thin Shrink Small Outline Transistor Package [SC70] | KS-5           | A07      |
| AD8641AKSZ-REEL7   | −40°C to +125°C   | 5-Lead Thin Shrink Small Outline Transistor Package [SC70] | KS-5           | A07      |
| AD8641ARZ          | −40°C to +125°C   | 8-Lead Standard Small Outline Package [SOIC_N]             | R-8            |          |
| AD8641ARZ-REEL7    | −40°C to +125°C   | 8-Lead Standard Small Outline Package [SOIC_N]             | R-8            |          |
| AD8642ARMZ         | −40°C to +125°C   | 8-Lead Mini Small Outline Package [MSOP]                   | RM-8           | A0A      |
| AD8642ARMZ-REEL    | −40°C to +125°C   | 8-Lead Mini Small Outline Package [MSOP]                   | RM-8           | A0A      |
| AD8642ARZ          | −40°C to +125°C   | 8-Lead Standard Small Outline Package [SOIC_N]             | R-8            |          |
| AD8642ARZ-REEL7    | −40°C to +125°C   | 8-Lead Standard Small Outline Package [SOIC_N]             | R-8            |          |
| AD8642ARZ-REEL     | −40°C to +125°C   | 8-Lead Standard Small Outline Package [SOIC_N]             | R-8            |          |
| AD8643ARZ          | −40°C to +125°C   | 14-Lead Standard Small Outline Package [SOIC_N]            | R-14           |          |
| AD8643ARZ-REEL7    | −40°C to +125°C   | 14-Lead Standard Small Outline Package [SOIC_N]            | R-14           |          |
| AD8643ACPZ-R2      | −40°C to +125°C   | 16-Lead Lead Frame Chip Scale Package [LFCSP]              | CP-16-27       | AUA      |
| AD8643ACPZ-REEL7   | −40°C to +125°C   | 16-Lead Lead Frame Chip Scale Package [LFCSP]              | CP-16-27       | AUA      |

<sup>1</sup> Z = RoHS Compliant Part.

## NOTES