

FEATURES

- Low offset voltage: 100 μV maximum at $V_S = 5\text{ V}$
- Low input bias current: 1 pA maximum
- Single-supply operation: 5 V to 16 V
- Low noise: 10 nV/ $\sqrt{\text{Hz}}$
- Wide bandwidth: 4 MHz
- Unity-gain stable
- Small package options
 - 3 mm \times 3 mm 8-lead LFCSP
 - 8-lead MSOP and narrow SOIC
 - 14-lead TSSOP and narrow SOIC

APPLICATIONS

- Sensors
- Medical equipment
- Consumer audio
- Photodiode amplification
- ADC drivers

GENERAL DESCRIPTION

The AD8661/AD8662/AD8664¹ are rail-to-rail output, single-supply amplifiers that use the Analog Devices, Inc., patented DigiTrim[®] trimming technique to achieve low offset voltage. The AD8661/AD8662/AD8664 series features extended operating ranges, with supply voltages up to 16 V. It also features low input bias current, wide signal bandwidth, and low input voltage and current noise.

The combination of low offset, very low input bias current, and a wide supply range makes these amplifiers useful in a wide variety of applications usually associated with higher priced JFET amplifiers. Systems using high impedance sensors, such as photodiodes, benefit from the combination of low input bias current, low noise, low offset, and wide bandwidth. The wide operating voltage range meets the demands of high performance analog-to-digital converters (ADCs) and digital-to-analog

¹ Protected by U.S. Patents 6,194,962 and 6,696,894.

Rev. E

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PIN CONFIGURATIONS

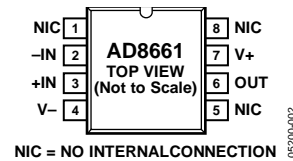


Figure 1. AD8661, 8-Lead SOIC (R-8)

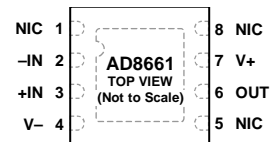


Figure 2. AD8661, 8-Lead LFCSP (CP-8-13)

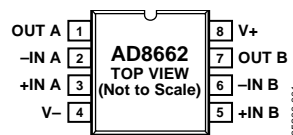


Figure 3. AD8662, 8-Lead SOIC (R-8)

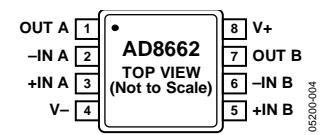


Figure 4. AD8662, 8-Lead MSOP (RM-8)

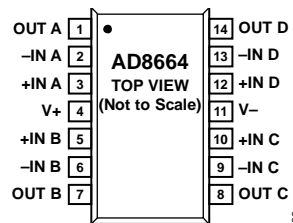


Figure 5. AD8664, 14-Lead SOIC (R-14)

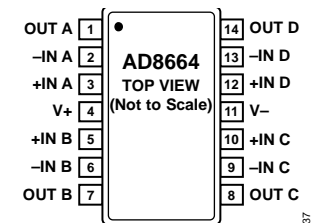


Figure 6. AD8664, 14-Lead TSSOP (RU-14)

converters (DACs). Audio applications and medical monitoring equipment can take advantage of the high input impedance, low voltage, low current noise, and wide bandwidth.

The single AD8661 is available in a narrow 8-lead SOIC package and a very thin, dual lead, 8-lead LFCSP. The AD8661 SOIC package is specified over the extended industrial temperature range of -40°C to $+125^{\circ}\text{C}$. The AD8661 LFCSP is specified over the industrial temperature range of -40°C to $+85^{\circ}\text{C}$. The AD8662 is available in a narrow 8-lead SOIC package and an 8-lead MSOP, both specified over the extended industrial temperature range of -40°C to $+125^{\circ}\text{C}$. The AD8664 is available in a narrow 14-lead SOIC package and a 14-lead TSSOP, both with an extended industrial temperature range of -40°C to $+125^{\circ}\text{C}$.

SPECIFICATIONS

AD8661/AD8662/AD8664 ELECTRICAL CHARACTERISTICS—SOIC, MSOP, AND TSSOP

$V_S = 5.0\text{ V}$, $V_{CM} = V_S/2$, $T_A = 25^\circ\text{C}$, unless otherwise noted.

Table 1.

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	$V_{CM} = V_S/2$		30	100	μV
AD8661		$-40^\circ\text{C} < T_A < +85^\circ\text{C}$			1000	μV
AD8661		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			1400	μV
AD8662		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			1000	μV
AD8664		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			1200	μV
Input Bias Current	I_B			0.3	1	pA
		$-40^\circ\text{C} < T_A < +85^\circ\text{C}$			50	pA
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			300	pA
Input Offset Current	I_{OS}			0.2	0.5	pA
		$-40^\circ\text{C} < T_A < +85^\circ\text{C}$			20	pA
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			75	pA
Input Voltage Range			-0.1		+3.0	V
Common-Mode Rejection Ratio	CMRR	$V_{CM} = -0.1\text{ V to }+3.0\text{ V}$	85	100		dB
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$		80	100	
Large Signal Voltage Gain	A_{VO}	$R_L = 2\text{ k}\Omega$, $V_O = 0.5\text{ V to }4.5\text{ V}$	100	220		V/mV
Offset Voltage Drift	TCV_{OS}					
AD8661		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$		3	10	$\mu\text{V}/^\circ\text{C}$
AD8662, AD8664		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$		2	9	$\mu\text{V}/^\circ\text{C}$
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	$I_L = 1\text{ mA}$	4.85	4.93		V
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$	4.80			V
Output Voltage Low	V_{OL}	$I_L = 1\text{ mA}$		50	100	mV
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			110	mV
Short-Circuit Current	I_{SC}			± 19		mA
Closed-Loop Output Impedance	Z_{OUT}	$f = 1\text{ MHz}$, $A_V = 1$		50		Ω
POWER SUPPLY						
Supply Current per Amplifier	I_{SY}	$V_O = V_S/2$		1.15	1.40	mA
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			2.0	mA
DYNAMIC PERFORMANCE						
Slew Rate	SR	$R_L = 2\text{ k}\Omega$		3.5		$\text{V}/\mu\text{s}$
Gain Bandwidth Product	GBP			4		MHz
Phase Margin	Φ_O			65		Degrees
NOISE PERFORMANCE						
Peak-to-Peak Noise	e_n p-p	$f = 0.1\text{ Hz to }10\text{ Hz}$		2.5		$\mu\text{V p-p}$
Voltage Noise Density	e_n	$f = 1\text{ kHz}$		12		$\text{nV}/\sqrt{\text{Hz}}$
		$f = 10\text{ kHz}$		10		$\text{nV}/\sqrt{\text{Hz}}$
Current Noise Density	i_n	$f = 1\text{ kHz}$		0.1		$\text{pA}/\sqrt{\text{Hz}}$

AD8661/AD8662/AD8664 ELECTRICAL CHARACTERISTICS—SOIC, MSOP, AND TSSOP

$V_S = 16.0\text{ V}$, $V_{CM} = V_S/2$, $T_A = 25^\circ\text{C}$, unless otherwise noted.

Table 2.

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	$V_{CM} = V_S/2$		50	160	μV
AD8661		$-40^\circ\text{C} < T_A < +85^\circ\text{C}$			1000	μV
AD8661		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			1400	μV
AD8662		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			1000	μV
AD8664		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			1200	μV
Input Bias Current	I_B			0.3	1	pA
		$-40^\circ\text{C} < T_A < +85^\circ\text{C}$			50	pA
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			300	pA
Input Offset Current	I_{OS}			0.2	0.5	pA
		$-40^\circ\text{C} < T_A < +85^\circ\text{C}$			20	pA
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			75	pA
Input Voltage Range			-0.1		+14.0	V
Common-Mode Rejection Ratio	CMRR	$V_{CM} = -0.1\text{ V to }+14.0\text{ V}$	90	110		dB
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$	90	110		dB
Large Signal Voltage Gain	A_{VO}	$R_L = 2\text{ k}\Omega$, $V_O = 0.5\text{ V to }15.5\text{ V}$	200	360		V/mV
Offset Voltage Drift	TCV_{OS}					
AD8661		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$		3	10	$\mu\text{V}/^\circ\text{C}$
AD8662, AD8664		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$		2	9	$\mu\text{V}/^\circ\text{C}$
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	$I_L = 1\text{ mA}$	15.93	15.97		V
		$I_L = 10\text{ mA}$	15.60	15.70		V
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$	15.50			V
Output Voltage Low	V_{OL}	$I_L = 1\text{ mA}$		24	50	mV
		$I_L = 10\text{ mA}$		190	300	mV
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			350	mV
Short-Circuit Current	I_{SC}			± 140		mA
Closed-Loop Output Impedance	Z_{OUT}	$f = 1\text{ MHz}$, $A_V = 1$		45		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	$V_S = 5\text{ V to }16\text{ V}$	95	110		dB
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$	95	115		dB
Supply Current per Amplifier	I_{SY}	$V_O = V_S/2$		1.25	1.55	mA
		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$			2.1	mA
DYNAMIC PERFORMANCE						
Slew Rate	SR	$R_L = 2\text{ k}\Omega$		3.5		$\text{V}/\mu\text{s}$
Gain Bandwidth Product	GBP			4		MHz
Phase Margin	Φ_O			65		Degrees
NOISE PERFORMANCE						
Peak-to-Peak Noise	$e_n\text{ p-p}$	$f = 0.1\text{ Hz to }10\text{ Hz}$		2.5		$\mu\text{V p-p}$
Voltage Noise Density	e_n	$f = 1\text{ kHz}$		12		$\text{nV}/\sqrt{\text{Hz}}$
		$f = 10\text{ kHz}$		10		$\text{nV}/\sqrt{\text{Hz}}$
Current Noise Density	i_n	$f = 1\text{ kHz}$		0.1		$\text{pA}/\sqrt{\text{Hz}}$

AD8661 ELECTRICAL CHARACTERISTICS—LFCSP ONLY

$V_S = 5.0\text{ V}$, $V_{CM} = V_S/2$, $T_A = 25^\circ\text{C}$, unless otherwise noted.

Table 3.

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	$V_{CM} = V_S/2$ $-40^\circ\text{C} < T_A < +85^\circ\text{C}$		50	300	μV
Input Bias Current	I_B	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$		0.3	1	pA
Input Offset Current	I_{OS}	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$		0.2	0.5	pA
Input Voltage Range			-0.1		+3.0	V
Common-Mode Rejection Ratio	CMRR	$V_{CM} = -0.1\text{ V to }+3.0\text{ V}$ $-40^\circ\text{C} < T_A < +85^\circ\text{C}$	85	100		dB
Large Signal Voltage Gain	A_{VO}	$R_L = 2\text{ k}\Omega$, $V_O = 0.5\text{ V to }4.5\text{ V}$	100	240		V/mV
Offset Voltage Drift	TCV_{OS}	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$		4	17	$\mu\text{V}/^\circ\text{C}$
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	$I_L = 1\text{ mA}$ $-40^\circ\text{C} < T_A < +85^\circ\text{C}$	4.85	4.93		V
Output Voltage Low	V_{OL}	$I_L = 1\text{ mA}$ $-40^\circ\text{C} < T_A < +85^\circ\text{C}$	4.80	50	100	V
Short-Circuit Current	I_{SC}			± 19	120	mV
Closed-Loop Output Impedance	Z_{OUT}	$f = 1\text{ MHz}$, $A_V = 1$		65		Ω
POWER SUPPLY						
Supply Current per Amplifier	I_{SY}	$V_O = V_S/2$ $-40^\circ\text{C} < T_A < +85^\circ\text{C}$		1.15	1.40	mA
DYNAMIC PERFORMANCE						
Slew Rate	SR	$R_L = 2\text{ k}\Omega$		3.5		V/ μs
Gain Bandwidth Product	GBP			4		MHz
Phase Margin	Φ_O			65		Degrees
NOISE PERFORMANCE						
Peak-to-Peak Noise	$e_n\text{ p-p}$	$f = 0.1\text{ Hz to }10\text{ Hz}$		2.5		$\mu\text{V p-p}$
Voltage Noise Density	e_n	$f = 1\text{ kHz}$		12		$\text{nV}/\sqrt{\text{Hz}}$
		$f = 10\text{ kHz}$		10		$\text{nV}/\sqrt{\text{Hz}}$
Current Noise Density	i_n	$f = 1\text{ kHz}$		0.1		$\text{pA}/\sqrt{\text{Hz}}$

AD8661 ELECTRICAL CHARACTERISTICS—LFCSP ONLY

$V_S = 16.0\text{ V}$, $V_{CM} = V_S/2$, $T_A = 25^\circ\text{C}$, unless otherwise noted.

Table 4.

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	$V_{CM} = V_S/2$ $-40^\circ\text{C} < T_A < +85^\circ\text{C}$		50	300	μV
Input Bias Current	I_B	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$		0.3	1	μA
Input Offset Current	I_{OS}	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$		0.2	0.5	μA
Input Voltage Range			-0.1		+14.0	V
Common-Mode Rejection Ratio	CMRR	$V_{CM} = -0.1\text{ V to }+14.0\text{ V}$ $-40^\circ\text{C} < T_A < +85^\circ\text{C}$	90	110		dB
Large Signal Voltage Gain	A_{VO}	$R_L = 2\text{ k}\Omega$, $V_O = 0.5\text{ V to }15.5\text{ V}$	200	420		V/mV
Offset Voltage Drift	TCV_{OS}	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$		4	17	$\mu\text{V}/^\circ\text{C}$
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	$I_L = 1\text{ mA}$ $I_L = 10\text{ mA}$ $-40^\circ\text{C} < T_A < +85^\circ\text{C}$	15.95 15.60 15.50	15.97 15.70		V V V
Output Voltage Low	V_{OL}	$I_L = 1\text{ mA}$ $I_L = 10\text{ mA}$ $-40^\circ\text{C} < T_A < +85^\circ\text{C}$		24 210	50 350	mV mV mV
Short-Circuit Current	I_{SC}			± 140		mA
Closed-Loop Output Impedance	Z_{OUT}	$f = 1\text{ MHz}$, $A_V = 1$		45		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	$V_S = 5\text{ V to }16\text{ V}$ $-40^\circ\text{C} < T_A < +85^\circ\text{C}$	95 95	110 115		dB dB
Supply Current per Amplifier	I_{SY}	$V_O = V_S/2$ $-40^\circ\text{C} < T_A < +85^\circ\text{C}$		1.25	1.55 1.9	mA mA
DYNAMIC PERFORMANCE						
Slew Rate	SR	$R_L = 2\text{ k}\Omega$		3.5		V/ μs
Gain Bandwidth Product	GBP			4		MHz
Phase Margin	Φ_O			65		Degrees
NOISE PERFORMANCE						
Peak-to-Peak Noise	$e_n\text{ p-p}$	$f = 0.1\text{ Hz to }10\text{ Hz}$		2.5		$\mu\text{V p-p}$
Voltage Noise Density	e_n	$f = 1\text{ kHz}$ $f = 10\text{ kHz}$		12 10		nV/ $\sqrt{\text{Hz}}$ nV/ $\sqrt{\text{Hz}}$
Current Noise Density	i_n	$f = 1\text{ kHz}$		0.1		pA/ $\sqrt{\text{Hz}}$

ABSOLUTE MAXIMUM RATINGS

Table 5.

Parameter	Rating
Supply Voltage	18V
Input Voltage	-0.1 V to V_S
Differential Input Voltage	18V
Output Short-Circuit Duration to GND	Indefinite
Storage Temperature Range	-60°C to +150°C
Operating Temperature Range	
R-8, RM-8, R-14, and RU-14	-40°C to +125°C
CP-8-13	-40°C to +85°C
Junction Temperature Range	-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

θ_{JA} is specified for the worst-case conditions, that is, a device soldered in a circuit board for surface-mount packages.

Table 6. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
8-Lead SOIC	121	43	°C/W
8-Lead LFCSP	75 ¹	18 ¹	°C/W
8-Lead MSOP	142	44	°C/W
14-Lead SOIC	88.2	56.3	°C/W
14-Lead TSSOP	114	23.3	°C/W

¹ Exposed pad soldered to application board.

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

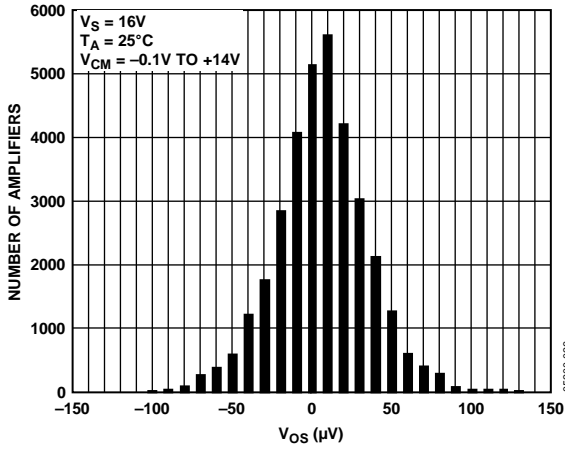


Figure 7. Input Offset Voltage Distribution

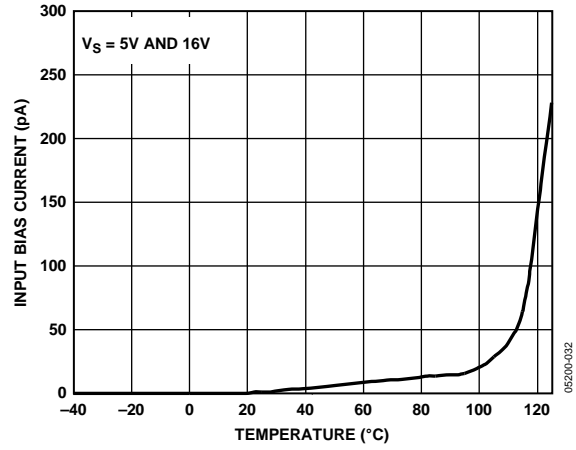


Figure 10. Input Bias Current vs. Temperature

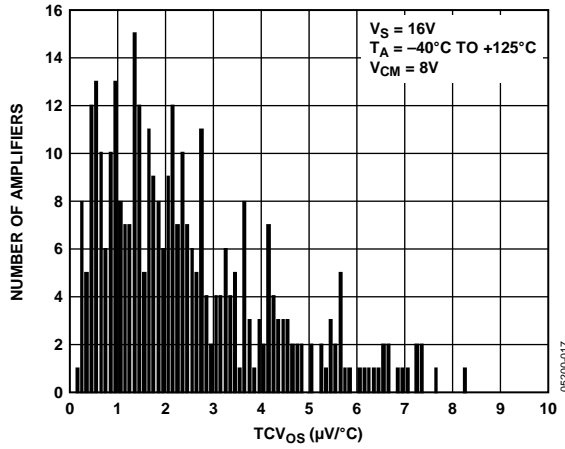


Figure 8. Offset Voltage Drift Distribution

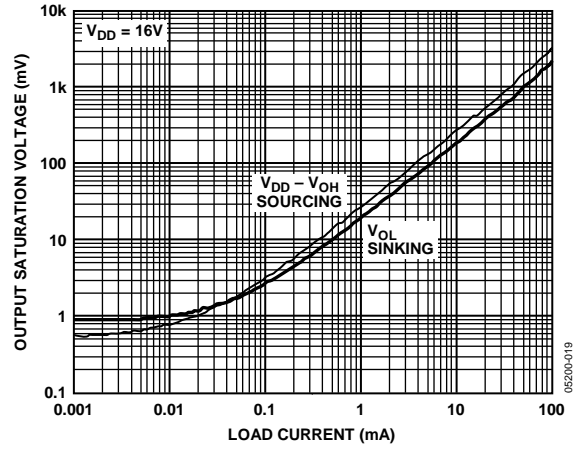


Figure 11. Output Swing Saturation Voltage vs. Load Current

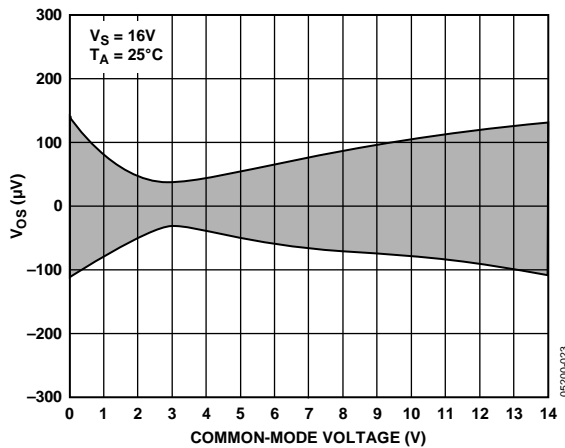


Figure 9. Input Offset Voltage vs. Common-Mode Voltage

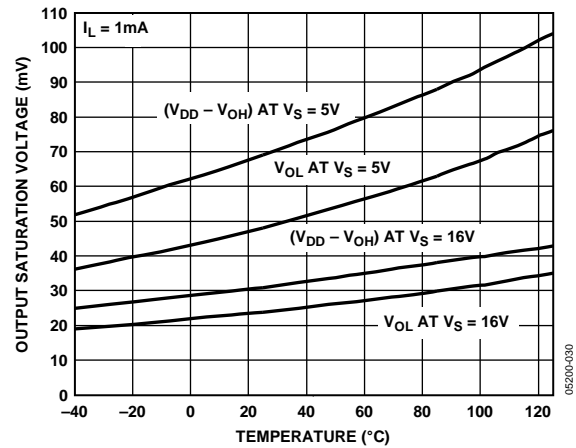


Figure 12. Output Swing Saturation Voltage vs. Temperature, $I_L = 1 \text{ mA}$

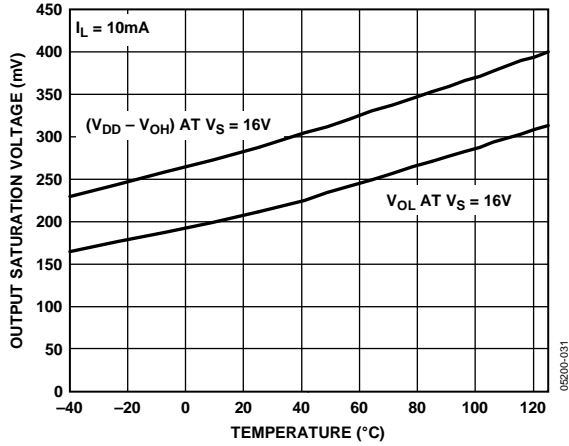


Figure 13. Output Swing Saturation Voltage vs. Temperature, $I_L = 10\text{mA}$

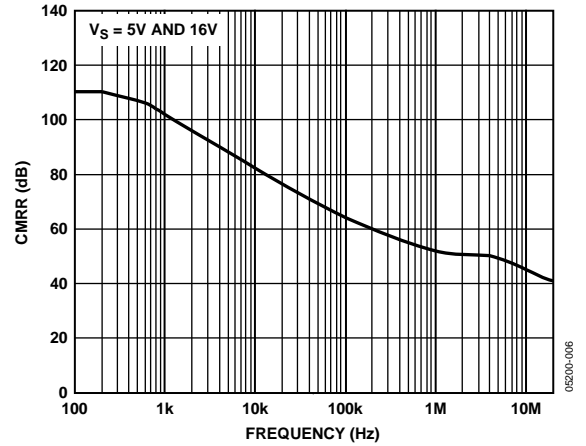


Figure 16. CMRR vs. Frequency

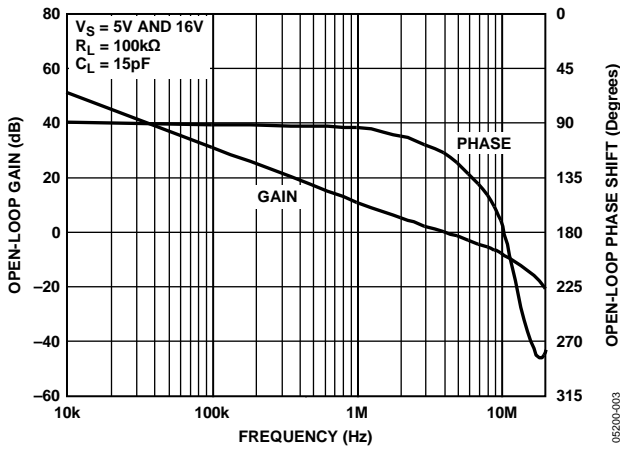


Figure 14. Open-Loop Gain and Phase Shift vs. Frequency

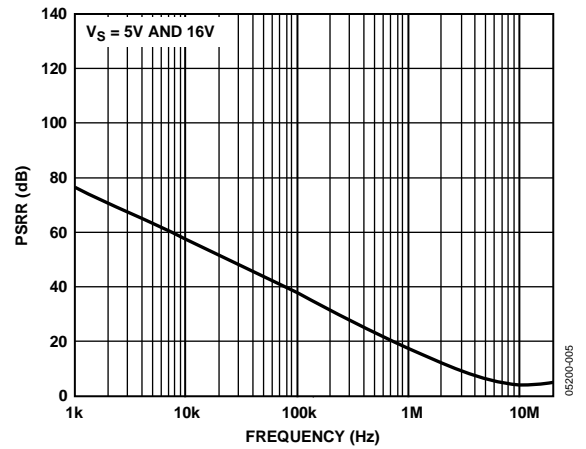


Figure 17. PSRR vs. Frequency

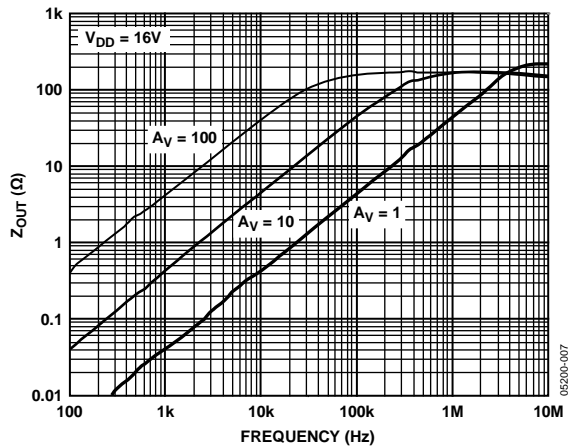


Figure 15. Closed-Loop Output Impedance vs. Frequency

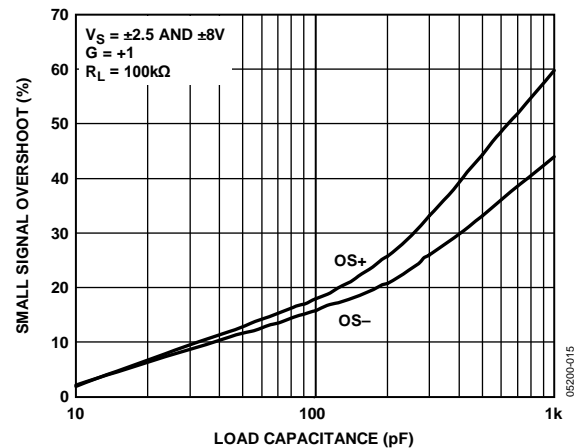


Figure 18. Small Signal Overshoot vs. Load Capacitance

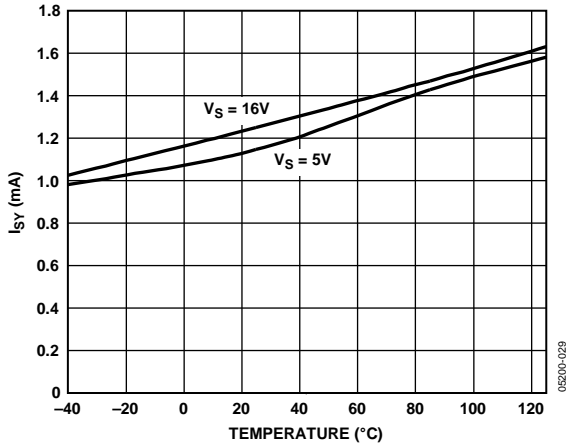


Figure 19. Supply Current vs. Temperature

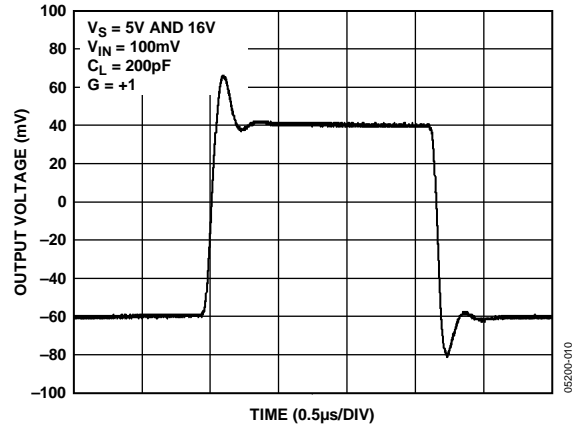


Figure 22. Small Signal Transient Response

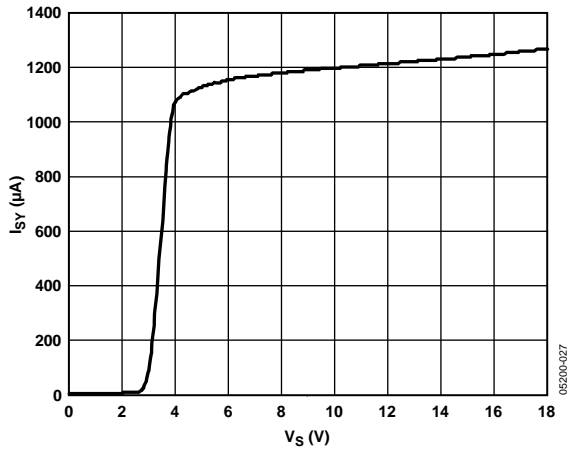


Figure 20. Supply Current vs. Supply Voltage (Dual-Supply Configuration), $T_A = 25^\circ\text{C}$

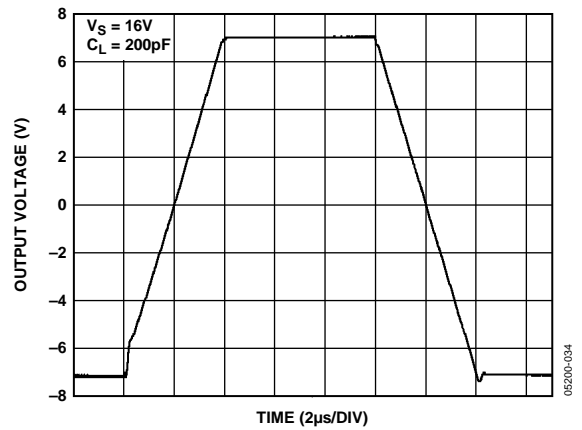


Figure 23. Large Signal Transient Response

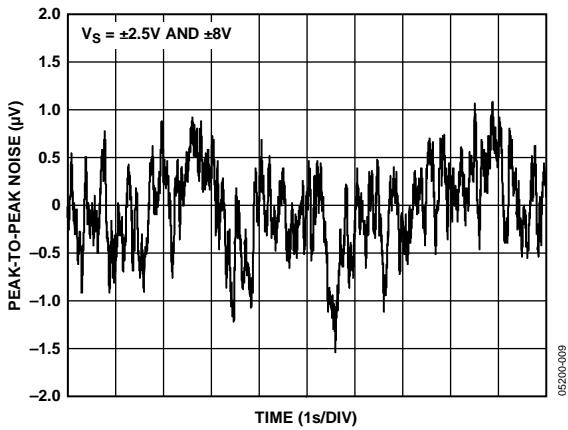


Figure 21. 0.1 Hz to 10 Hz Input Voltage Noise

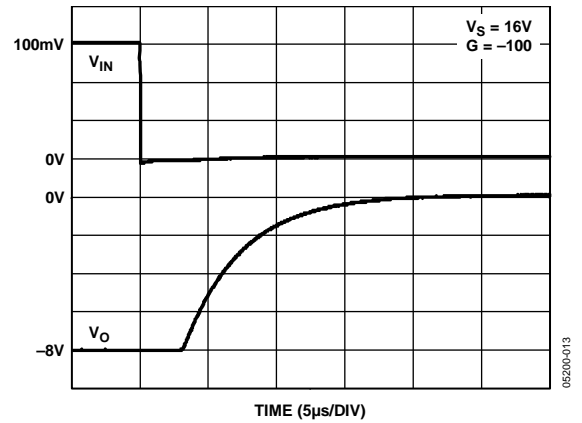


Figure 24. Positive Overload Recovery

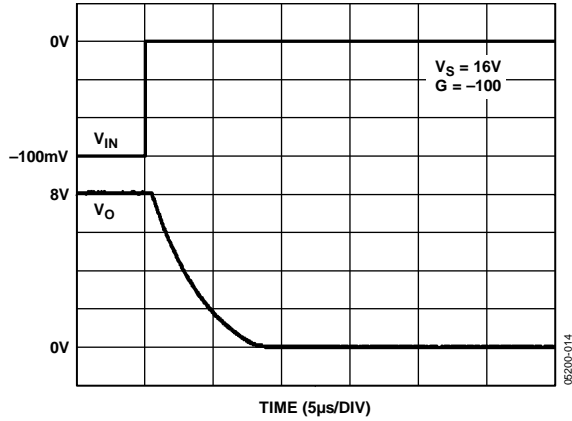


Figure 25. Negative Overload Recovery

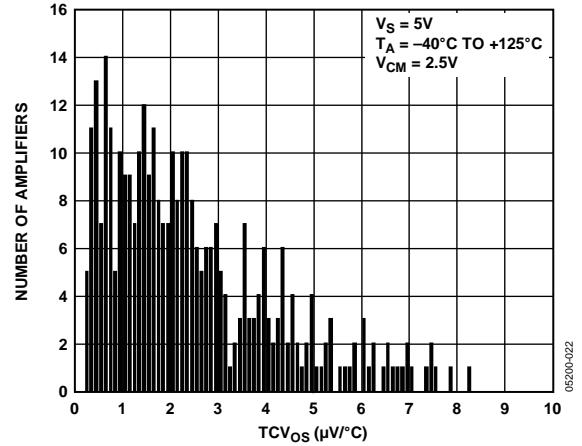


Figure 28. Offset Voltage Drift Distribution

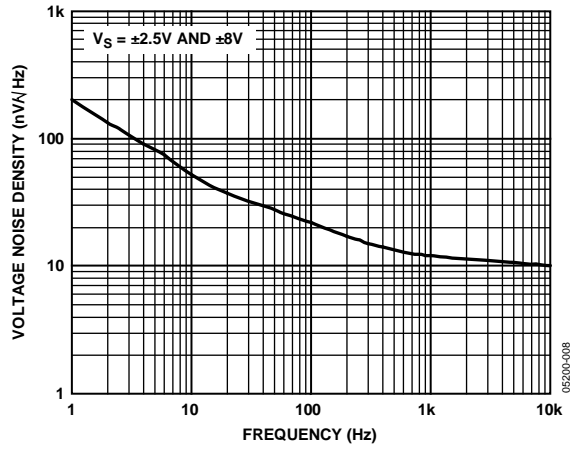


Figure 26. Voltage Noise Density vs. Frequency

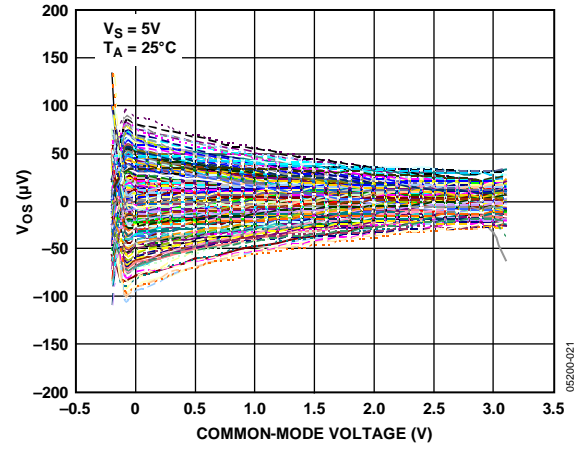


Figure 29. Input Offset Voltage vs. Common-Mode Voltage

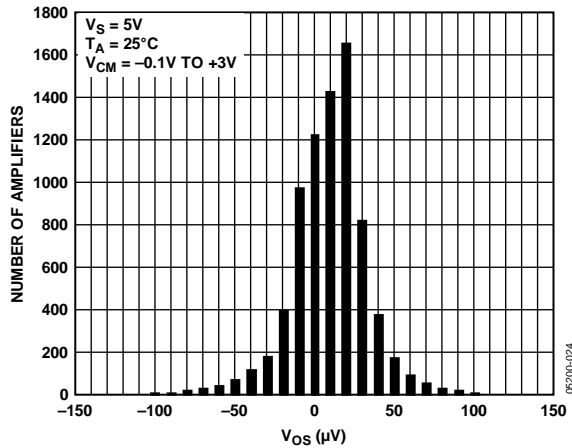


Figure 27. Input Offset Voltage Distribution

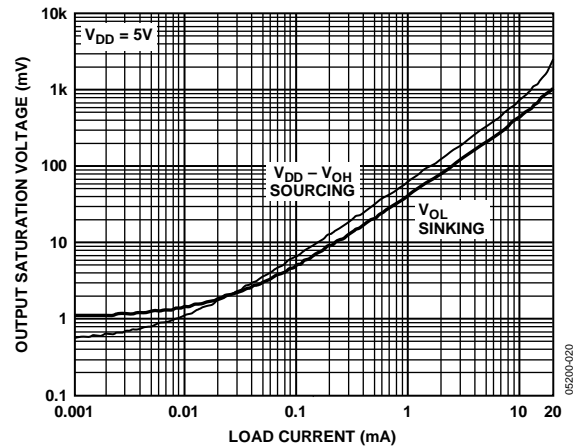


Figure 30. Output Swing Saturation Voltage vs. Load Current

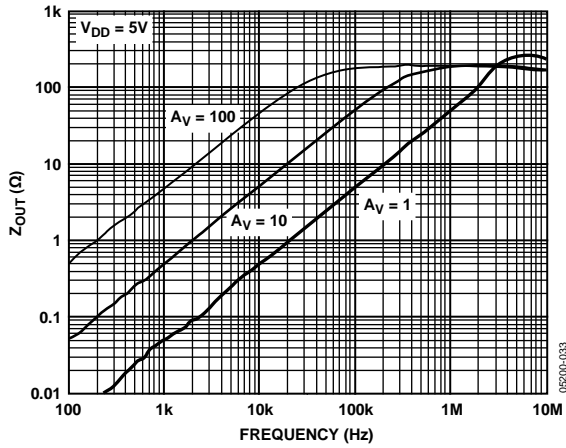


Figure 31. Closed-Loop Output Impedance vs. Frequency

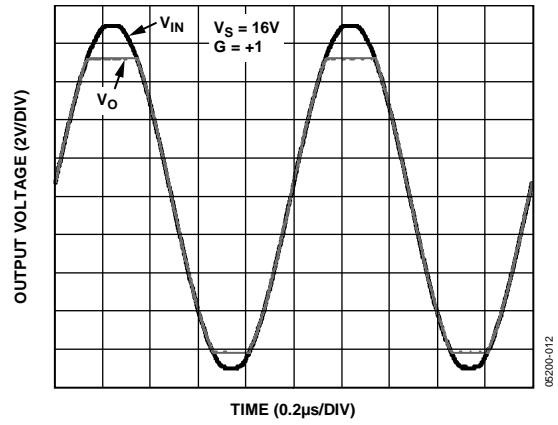


Figure 33. No Phase Reversal

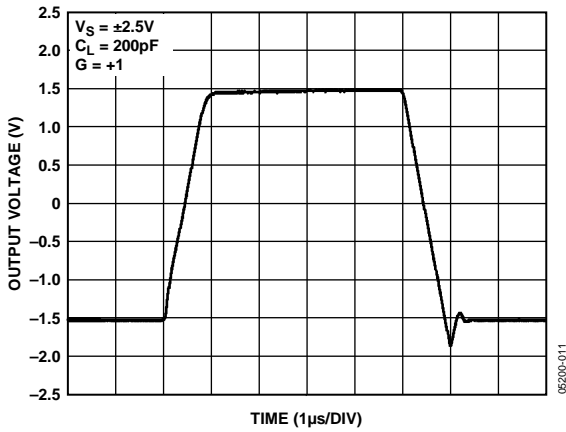


Figure 32. Large Signal Transient Response

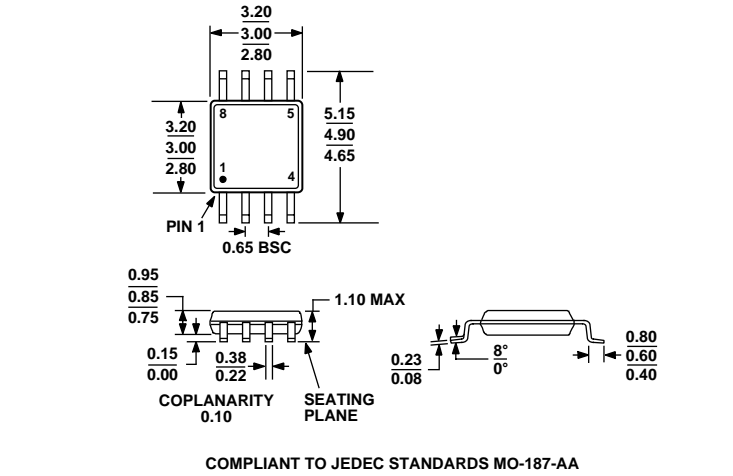


Figure 36. 8-Lead Mini Small Outline Package [MSOP] (RM-8)
Dimensions shown in millimeters

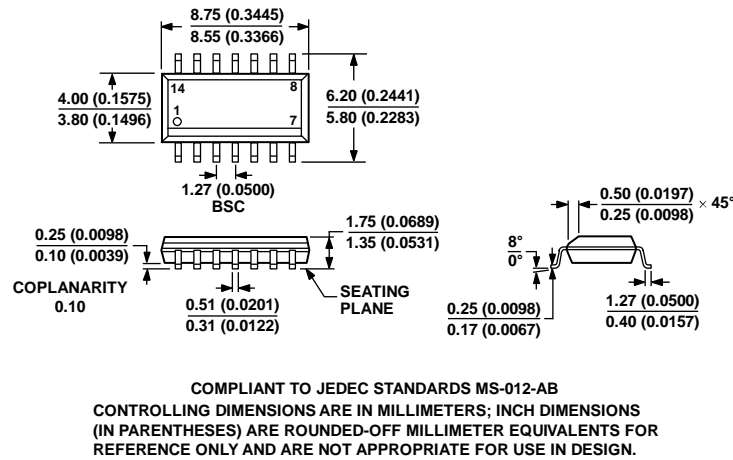


Figure 37. 14-Lead Standard Small Outline Package [SOIC_N] Narrow Body (R-14)
Dimensions shown in millimeters and (inches)

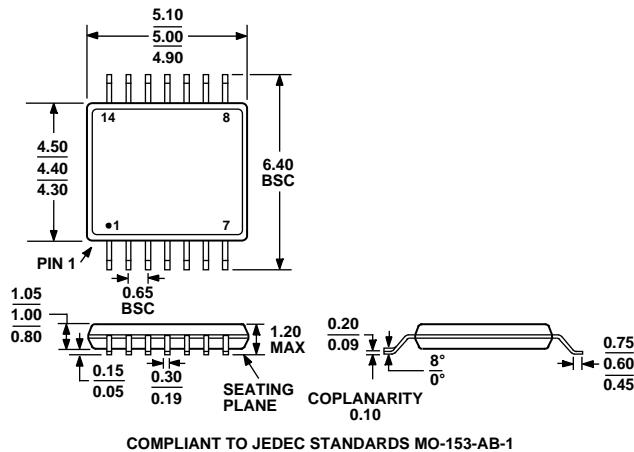


Figure 38. 14-Lead Thin Shrink Small Outline Package [TSSOP] (RU-14)
Dimensions shown in millimeters

ORDERING GUIDE

Model ¹	Temperature Range	Package Description	Package Option	Branding
AD8661ARZ	−40°C to +125°C	8-Lead Small Outline Package [SOIC_N]	R-8	
AD8661ARZ-REEL	−40°C to +125°C	8-Lead Small Outline Package [SOIC_N]	R-8	
AD8661ARZ-REEL7	−40°C to +125°C	8-Lead Small Outline Package [SOIC_N]	R-8	
AD8661ACPZ-R2	−40°C to +85°C	8-Lead Lead Frame Chip Scale Package [LFCSP]	CP-8-13	AOM
AD8661ACPZ-REEL7	−40°C to +85°C	8-Lead Lead Frame Chip Scale Package [LFCSP]	CP-8-13	AOM
AD8662ARZ	−40°C to +125°C	8-Lead Small Outline Package [SOIC_N]	R-8	
AD8662ARZ-REEL	−40°C to +125°C	8-Lead Small Outline Package [SOIC_N]	R-8	
AD8662ARZ-REEL7	−40°C to +125°C	8-Lead Small Outline Package [SOIC_N]	R-8	
AD8662ARMZ	−40°C to +125°C	8-Lead Mini Small Outline Package [MSOP]	RM-8	A10
AD8662ARMZ-REEL	−40°C to +125°C	8-Lead Mini Small Outline Package [MSOP]	RM-8	A10
AD8664ARZ	−40°C to +125°C	14-Lead Standard Small Outline Package [SOIC_N]	R-14	
AD8664ARZ-REEL	−40°C to +125°C	14-Lead Standard Small Outline Package [SOIC_N]	R-14	
AD8664ARZ-REEL7	−40°C to +125°C	14-Lead Standard Small Outline Package [SOIC_N]	R-14	
AD8664ARUZ	−40°C to +125°C	14-Lead Thin Shrink Small Outline Package [TSSOP]	RU-14	
AD8664ARUZ-REEL	−40°C to +125°C	14-Lead Thin Shrink Small Outline Package [TSSOP]	RU-14	

¹ Z = RoHS Compliant Part.

NOTES