

## AD8691/AD8692

### FEATURES

- Offset voltage: 400  $\mu$ V typ**
- Low offset voltage drift: 6  $\mu$ V/ $^{\circ}$ C max (AD8692)**
- Very low input bias currents: 1 pA max**
- Low noise: 8 nV/ $\sqrt{\text{Hz}}$**
- Low distortion: 0.0006%**
- Wide bandwidth: 10 MHz**
- Unity-gain stable**
- Single-supply operation: 2.7 V to 6 V**

### APPLICATIONS

- Photodiode amplification**
- Battery-powered instrumentation**
- Medical instruments**
- Multipole filters**
- Sensors**
- Portable audio devices**

### GENERAL DESCRIPTION

The AD8691 and AD8692 are low cost, single and dual rail-to-rail output, single-supply amplifiers featuring low offset and input voltages, low current noise, and wide signal bandwidth. The combination of low offset, low noise, very low input bias currents, and high speed make these amplifiers useful in a wide variety of applications. Filters, integrators, photodiode amplifiers, and high impedance sensors all benefit from this combination of performance features. Audio and other ac applications benefit from the wide bandwidth and low distortion of these devices.

#### Rev. A

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### PIN CONFIGURATIONS

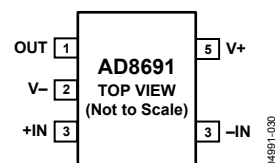


Figure 1. 5-Lead TSOT

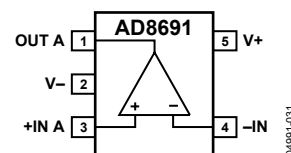


Figure 2. 5-Lead SC70



Figure 3. 8-Lead MSOP

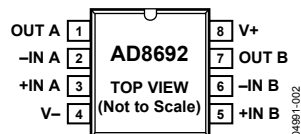


Figure 4. 8-Lead SOIC

Applications for these amplifiers include PA controls, laser diode control loops, portable and loop-powered instrumentation, audio amplification for portable devices, and ASIC input and output amplifiers.

The small SC70 and TSOT package options for the AD8691 allow it to be placed next to sensors, thereby reducing external noise pickup.

The AD8691 and AD8692 are specified over the extended industrial temperature range of  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . The AD8691 is available in 5-lead SC70 and TSOT packages. The AD8692 is available in 8-lead MSOP and narrow SOIC surface-mount packages.

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**REVISION HISTORY**

**1/05 — Rev. 0 to Rev. A**

Added AD8691 .....	Universal
Changes to Features.....	1
Added Figure 1 and Figure 2.....	1
Changes to Electrical Characteristics .....	3
Changes to Figure 6 caption.....	6
Changes to Figure 9.....	6
Updated Outline Dimensions .....	11
Changes to Ordering Guide .....	11

**10/04—Revision 0: Initial Version**

## ELECTRICAL CHARACTERISTICS

$V_S = 2.7\text{ V}$ ,  $V_{CM} = V_S/2$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 1.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>INPUT CHARACTERISTICS</b>						
Offset Voltage	$V_{OS}$	$V_{CM} = -0.3\text{ V to }+1.6\text{ V}$ $V_{CM} = -0.1\text{ V to }+1.6\text{ V}; -40^\circ\text{C} < T_A < +125^\circ\text{C}$		0.4	2.0	mV
Input Bias Current	$I_B$	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$ $-40^\circ\text{C} < T_A < +125^\circ\text{C}$		0.2	1	pA
Input Offset Current	$I_{OS}$	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$ $-40^\circ\text{C} < T_A < +125^\circ\text{C}$		0.1	0.5	pA
Input Voltage Range			-0.3		+1.6	V
Common-Mode Rejection Ratio	CMRR	$V_{CM} = -0.3\text{ V to }+1.6\text{ V}$ $V_{CM} = -0.1\text{ V to }+1.6\text{ V}; -40^\circ\text{C} < T_A < +125^\circ\text{C}$	70	90		dB
Large Signal Voltage Gain	$A_{VO}$	$R_L = 2\text{ k}\Omega$ , $V_O = 0.5\text{ V to }2.2\text{ V}$	65	85		dB
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$		90	250		V/mV
AD8691				2	12	$\mu\text{V}/^\circ\text{C}$
AD8692				1.3	6	$\mu\text{V}/^\circ\text{C}$
<b>OUTPUT CHARACTERISTICS</b>						
Output Voltage High	$V_{OH}$	$I_L = 1\text{ mA}$ $-40^\circ\text{C} < T_A < +125^\circ\text{C}$	2.64	2.66		V
Output Voltage Low	$V_{OL}$	$I_L = 1\text{ mA}$ $-40^\circ\text{C} < T_A < +125^\circ\text{C}$	2.6	25	40	V
Short-Circuit Current	$I_{SC}$			±20	50	mV
Closed-Loop Output Impedance	$Z_{OUT}$	$f = 1\text{ MHz}$ , $A_V = 1$		12		mV
<b>POWER SUPPLY</b>						
Power-Supply Rejection Ratio	PSRR	$V_S = 2.7\text{ V to }5.5\text{ V}$ $-40^\circ\text{C} < T_A < +125^\circ\text{C}$	80	95		dB
Supply Current/Amplifier	$I_{SY}$	$V_O = 0\text{ V}$ $-40^\circ\text{C} < T_A < +125^\circ\text{C}$	75	95		dB
				0.85	0.95	mA
					1.2	mA
<b>DYNAMIC PERFORMANCE</b>						
Slew Rate	SR	$R_L = 2\text{ k}\Omega$		5		V/ $\mu\text{s}$
Settling Time	$t_S$	To 0.01%		1		$\mu\text{s}$
Gain Bandwidth Product	GBP			10		MHz
Phase Margin	$\phi_o$			60		Degrees
Total Harmonic Distortion + Noise	THD + N	$G = 1$ , $R_L = 600\ \Omega$ , $f = 1\text{ kHz}$ , $V_O = 250\text{ mV p-p}$		0.003		%
<b>NOISE PERFORMANCE</b>						
Voltage Noise	$e_{n\text{ p-p}}$	$f = 0.1\text{ Hz to }10\text{ Hz}$		1.6	3.0	$\mu\text{V p-p}$
Voltage Noise Density	$e_n$	$f = 1\text{ kHz}$		8	12	nV/ $\sqrt{\text{Hz}}$
	$e_n$	$f = 10\text{ kHz}$		6.5		nV/ $\sqrt{\text{Hz}}$
Current Noise Density	$i_n$	$f = 1\text{ kHz}$		0.05		pA/ $\sqrt{\text{Hz}}$

# AD8691/AD8692

$V_S = 5.0\text{ V}$ ,  $V_{CM} = V_S/2$ ,  $T_A = 5^\circ\text{C}$ , unless otherwise noted.

**Table 2.**

Parameter	Symbol	Conditions	A Grade			Unit
			Min	Typ	Max	
<b>INPUT CHARACTERISTICS</b>						
Offset Voltage	$V_{OS}$	$V_{CM} = -0.3\text{ V to }+3.9\text{ V}$ $V_{CM} = -0.1\text{ V to }+3.9\text{ V}; -40^\circ\text{C} < T_A < +125^\circ\text{C}$		0.4	2.0	mV
Input Bias Current	$I_B$	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$ $-40^\circ\text{C} < T_A < +125^\circ\text{C}$		0.2	1	pA
Input Offset Current	$I_{OS}$	$-40^\circ\text{C} < T_A < +85^\circ\text{C}$ $-40^\circ\text{C} < T_A < +125^\circ\text{C}$		0.1	0.5	pA
Input Voltage Range			-0.3		+3.9	V
Common-Mode Rejection Ratio	CMRR	$V_{CM} = -0.3\text{ V to }+3.9\text{ V}$ $V_{CM} = -0.1\text{ V to }+3.9\text{ V}; -40^\circ\text{C} < T_A < +125^\circ\text{C}$	75	95		dB
Large Signal Voltage Gain	$A_{VO}$	$V_O = 0.5\text{ V to }4.5\text{ V}$ , $R_L = 2\text{ k}\Omega$ , $V_{CM} = 0\text{ V}$	250	2000		V/mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$					$\mu\text{V}/^\circ\text{C}$
AD8691				2	12	$\mu\text{V}/^\circ\text{C}$
AD8692				1.3	6	$\mu\text{V}/^\circ\text{C}$
<b>OUTPUT CHARACTERISTICS</b>						
Output Voltage High	$V_{OH}$	$I_L = 1\text{ mA}$ $I_L = 10\text{ mA}$ $-40^\circ\text{C to }+125^\circ\text{C}$	4.96	4.98		V
Voltage Low	$V_{OL}$	$I_L = 1\text{ mA}$ $I_L = 10\text{ mA}$ $-40^\circ\text{C to }+125^\circ\text{C}$	4.7	4.78		V
Short-Circuit Current	$I_{SC}$			±80		mA
Closed-Loop Output Impedance	$Z_{OUT}$	$f = 1\text{ MHz}$ , $A_V = 1$		10		$\Omega$
<b>POWER SUPPLY</b>						
Power Supply Rejection Ratio	PSRR	$V_S = 2.7\text{ V to }5.5\text{ V}$ $-40^\circ\text{C} < T_A < +125^\circ\text{C}$	80	95		dB
Supply Current/Amplifier	$I_{SY}$	$V_O = 0\text{ V}$ $-40^\circ\text{C} < T_A < +125^\circ\text{C}$	75	95		dB
				0.95	1.05	mA
					1.3	mA
<b>DYNAMIC PERFORMANCE</b>						
Slew Rate	SR	$R_L = 2\text{ k}\Omega$		5		V/ $\mu\text{s}$
Settling Time	$t_s$	To 0.01%		1		$\mu\text{s}$
Full Power Bandwidth	$BW_P$	<1% distortion		360		kHz
Gain Bandwidth Product	GBP			10		MHz
Phase Margin	$\phi_o$			65		Degrees
Total Harmonic Distortion + Noise	THD + N	$G = 1$ , $R_L = 600\ \Omega$ , $f = 1\text{ kHz}$ , $V_o = 1\text{ V p-p}$		0.0006		%
<b>NOISE PERFORMANCE</b>						
Voltage Noise	$e_{n\text{ p-p}}$	$f = 0.1\text{ Hz to }10\text{ Hz}$		1.6	3.0	$\mu\text{V p-p}$
Voltage Noise Density	$e_n$	$f = 1\text{ kHz}$		8	12	nV/ $\sqrt{\text{Hz}}$
	$e_n$	$f = 10\text{ kHz}$		6.5		nV/ $\sqrt{\text{Hz}}$
Current Noise Density	$i_n$	$f = 1\text{ kHz}$		0.05		pA/ $\sqrt{\text{Hz}}$

## ABSOLUTE MAXIMUM RATINGS

$T_A = 25^\circ\text{C}$ , unless otherwise noted.

**Table 3.**

Parameters	Ratings
Supply Voltage	6 V
Input Voltage	$V_{SS} - 0.3\text{ V}$ to $V_{DD} + 0.3\text{ V}$
Differential Input Voltage	$\pm 6\text{ V}$
Output Short-Circuit Duration to GND	Observe derating curves
Storage Temperature Range	$-65^\circ\text{C}$ to $+150^\circ\text{C}$
Operating Temperature Range	$-40^\circ\text{C}$ to $+125^\circ\text{C}$
Junction Temperature Range	$-65^\circ\text{C}$ to $+150^\circ\text{C}$
Lead Temperature Range (Soldering, 60 sec)	$300^\circ\text{C}$

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

**Table 4.**

Package Type	$\theta_{JA}^1$	$\theta_{JC}$	Unit
8-Lead MSOP (RM)	210	45	$^\circ\text{C}/\text{W}$
8-Lead SOIC (R)	158	43	$^\circ\text{C}/\text{W}$
5-Lead TSOT (UJ-5)	207	61	$^\circ\text{C}/\text{W}$
5-Lead SC70 (KS)	376	126	$^\circ\text{C}/\text{W}$

<sup>1</sup>  $\theta_{JA}$  is specified for the worst-case conditions, that is, the device soldered in the circuit board for surface-mount packages.

## ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



## TYPICAL PERFORMANCE CHARACTERISTICS

$V_S = +5\text{ V}$  or  $\pm 2.5\text{ V}$ , unless otherwise noted.

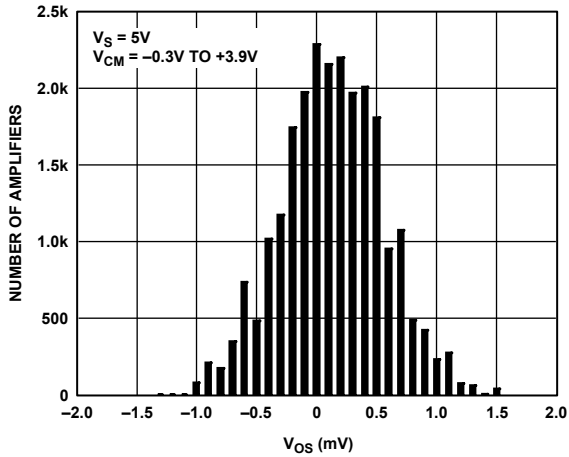


Figure 5. Input Offset Voltage Distribution

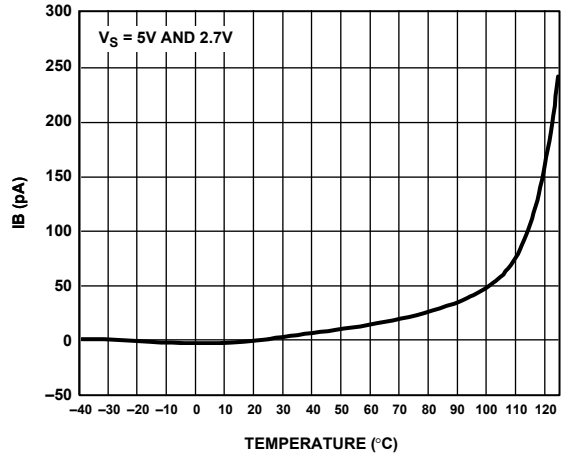


Figure 8. Input Bias Current vs. Temperature

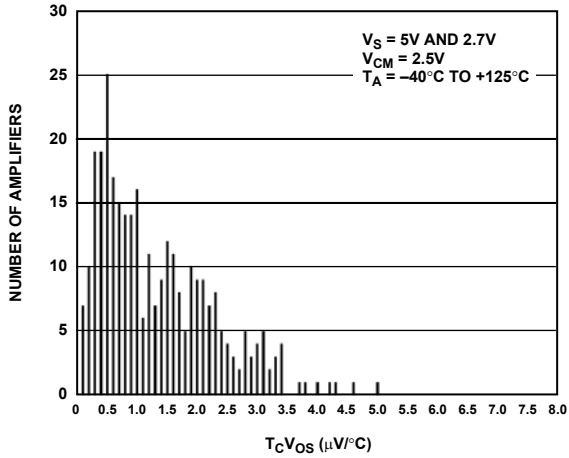


Figure 6. AD8692 Input Offset Voltage Drift Distribution

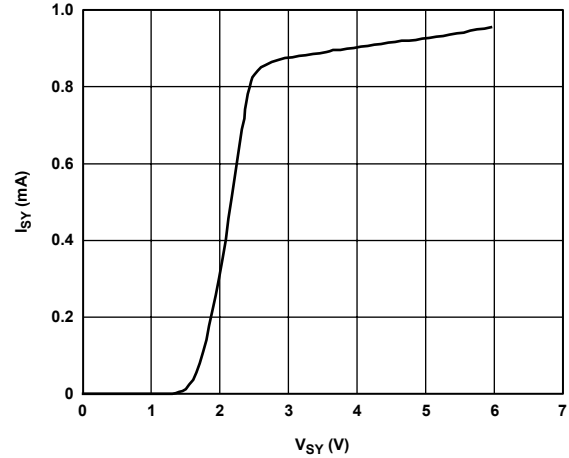


Figure 9. Supply Current vs. Supply Voltage

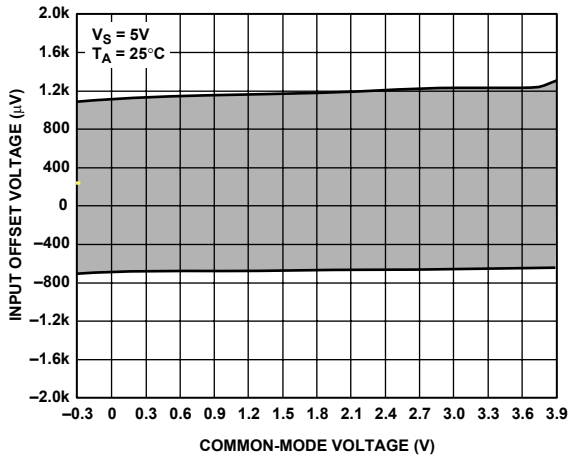


Figure 7. Input Offset Voltage vs. Common-Mode Voltage

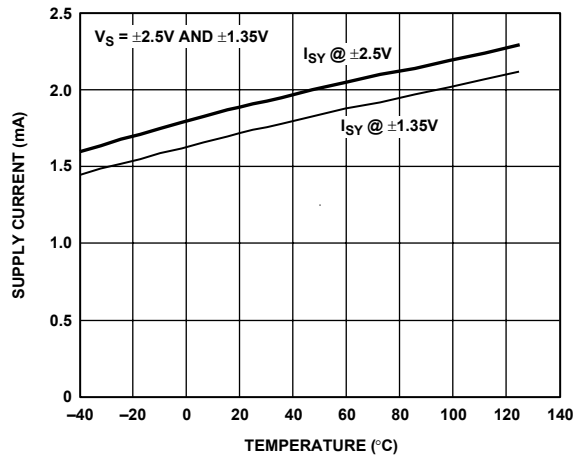


Figure 10. Supply Current vs. Temperature

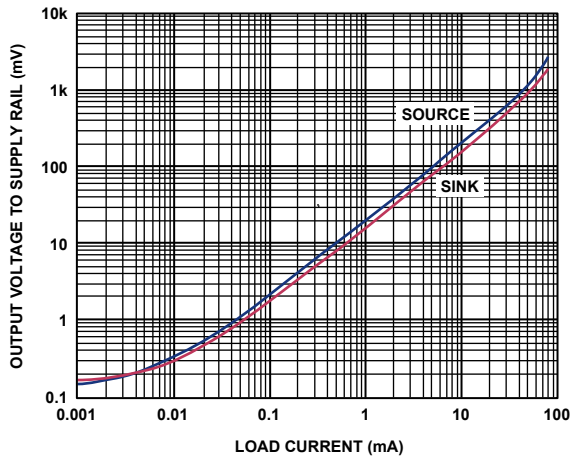


Figure 11. Output Voltage to Supply Rail vs. Load Current

04891-009

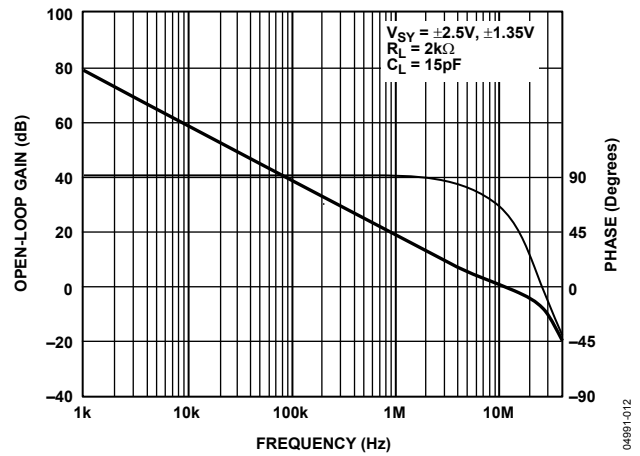


Figure 14. Open-Loop Gain and Phase vs. Frequency

04891-012

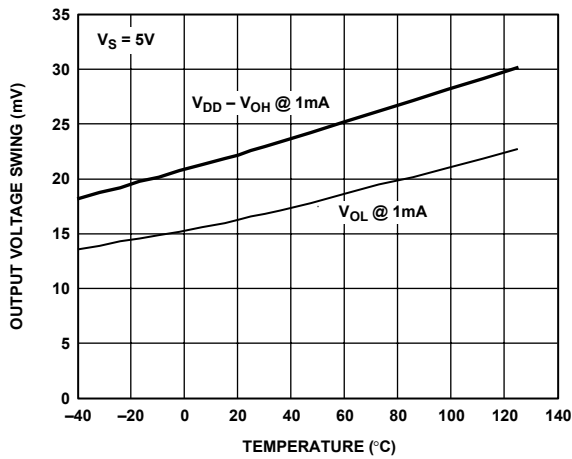


Figure 12. Output Voltage Swing vs. Temperature ( $I_L = 1 \text{ mA}$ )

04891-010

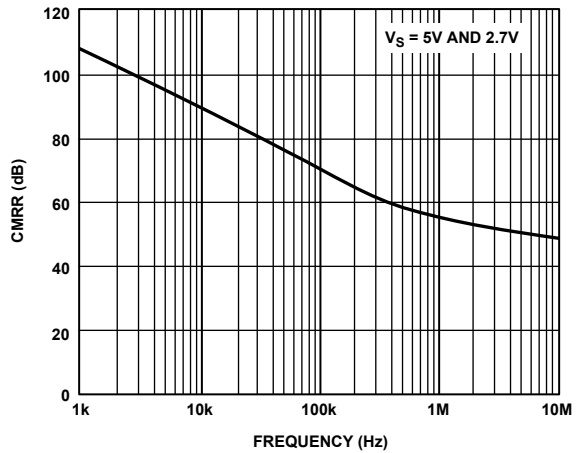


Figure 15. CMRR vs. Frequency

04891-013

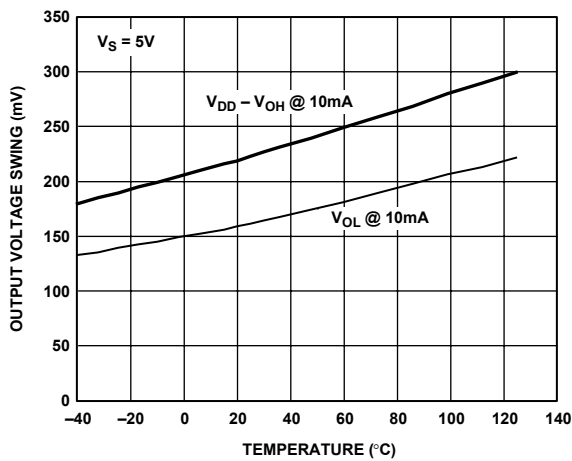


Figure 13. Output Voltage Swing vs. Temperature ( $I_L = 10 \text{ mA}$ )

04891-011

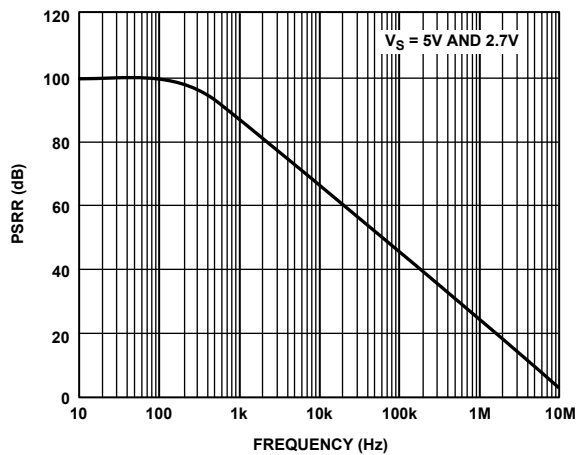


Figure 16. PSRR vs. Frequency

04891-014

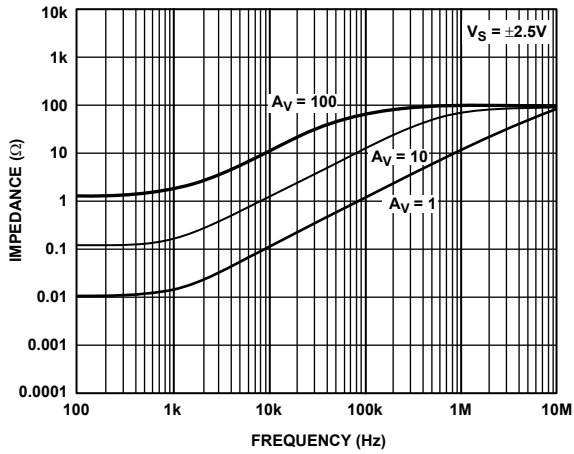


Figure 17. Closed-Loop Output Impedance vs. Frequency

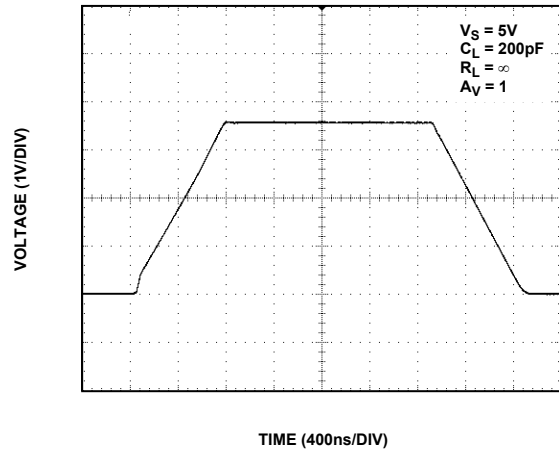


Figure 20. Large Signal Transient Response

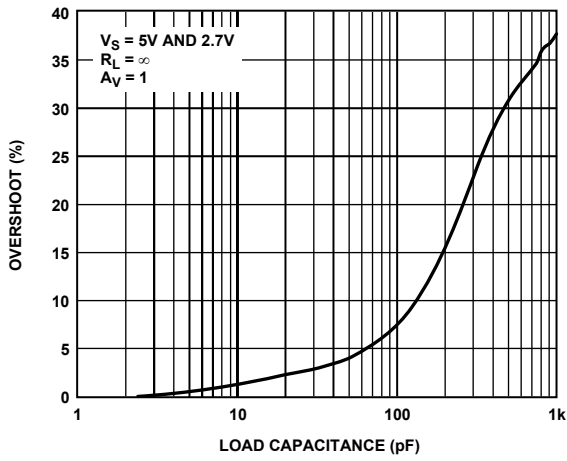


Figure 18. Small Signal Overshoot vs. Load Capacitance

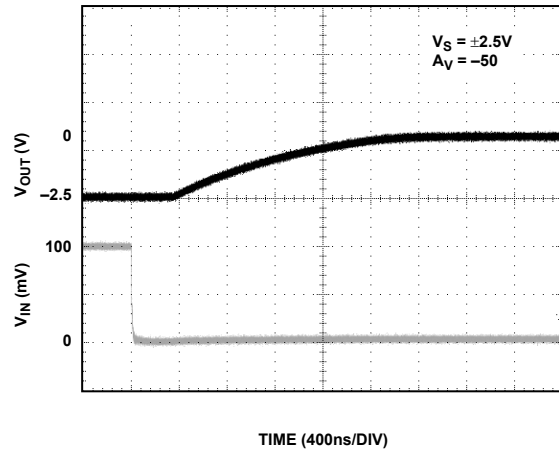


Figure 21. Positive Overload Recovery

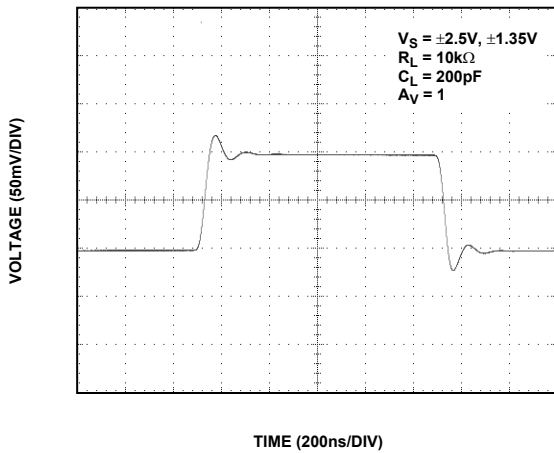


Figure 19. Small Signal Transient Response

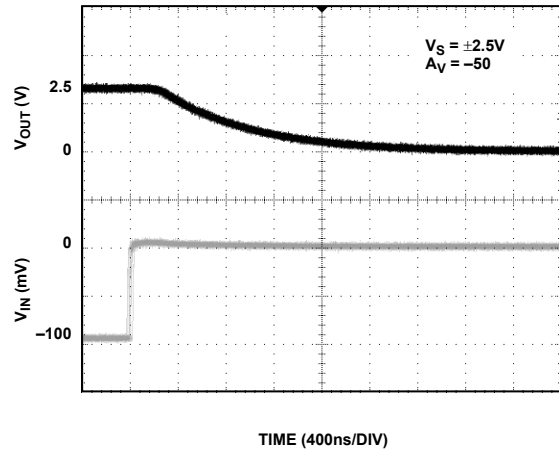


Figure 22. Negative Overload Recovery

04891-015

04891-018

04891-016

04891-019

04891-017

04891-020



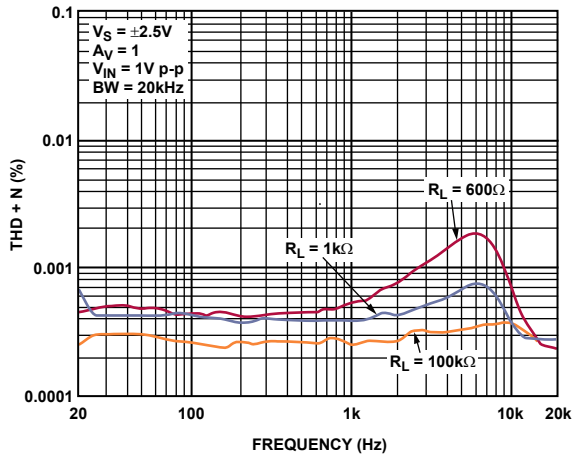


Figure 23. THD + N vs. Frequency

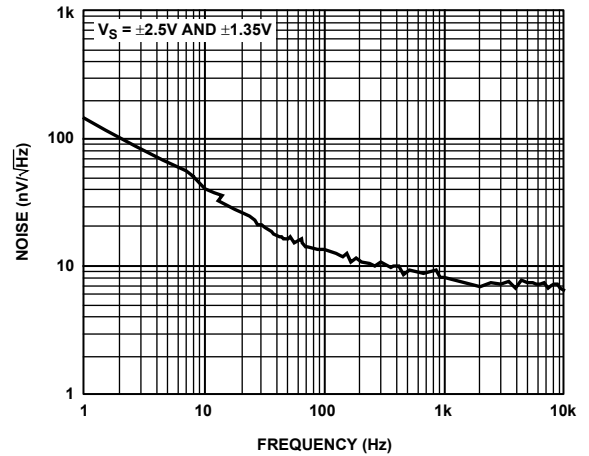


Figure 25. Voltage Noise Density

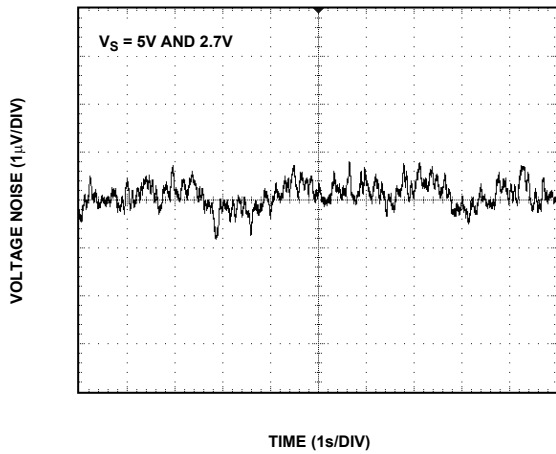


Figure 24. 0.1 Hz to 10 Hz Input Voltage Noise

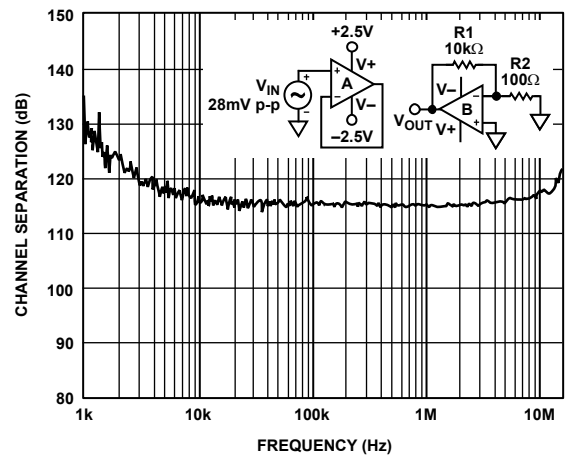


Figure 26. AD8692 Channel Separation

# AD8691/AD8692

$V_S = +2.7\text{ V}$  or  $\pm 1.35\text{ V}$ , unless otherwise noted.

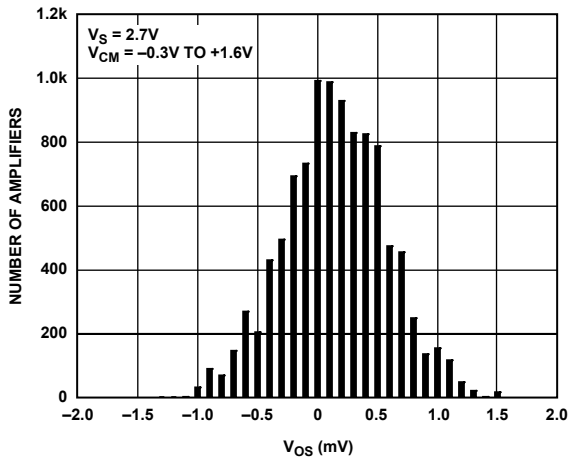


Figure 27. Input Offset Voltage Distribution

04891-025

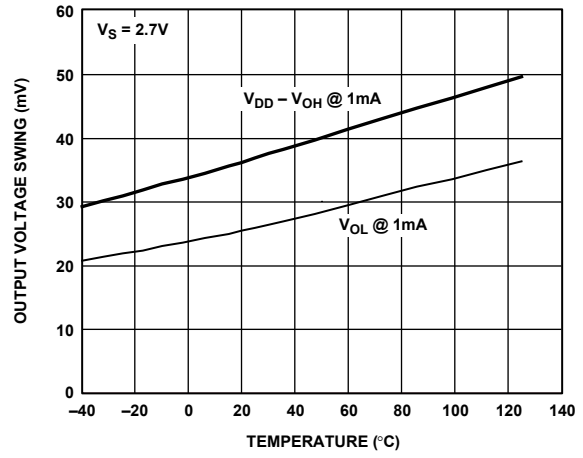


Figure 30. Output Voltage Swing vs. Temperature

04891-028

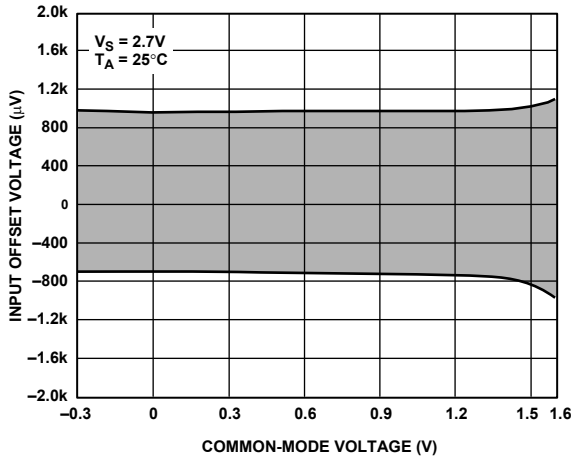


Figure 28. Input Offset Voltage vs. Common-Mode Voltage

04891-026

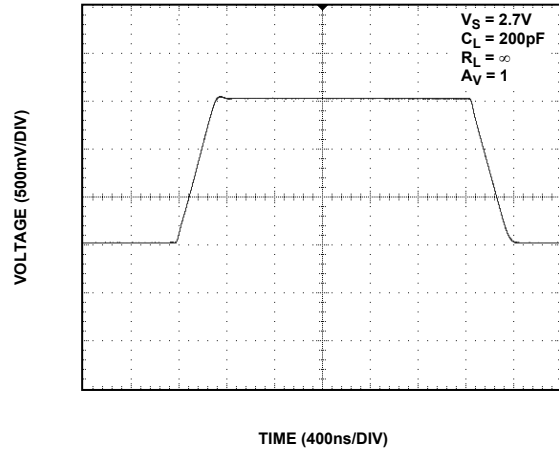


Figure 31. Large Signal Transient Response

04891-029

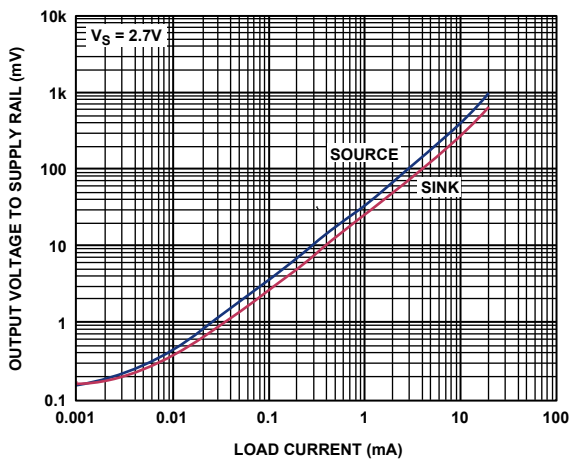


Figure 29. Output Voltage to Supply Rail vs. Load Current

04891-027

# OUTLINE DIMENSIONS

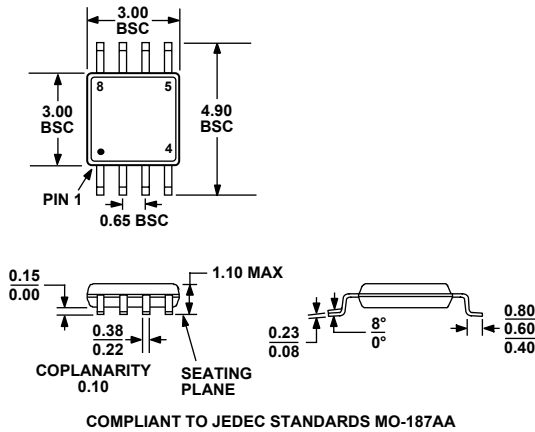


Figure 32. 8-Lead Mini Small Outline Package [MSOP] (RM-8)  
Dimensions shown in millimeters

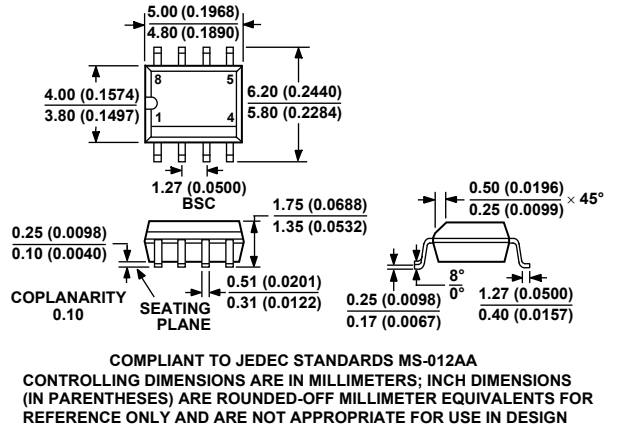


Figure 34. 8-Lead Standard Small Outline Package [SOIC] Narrow Body (R-8)  
Dimensions shown in millimeters and (inches)

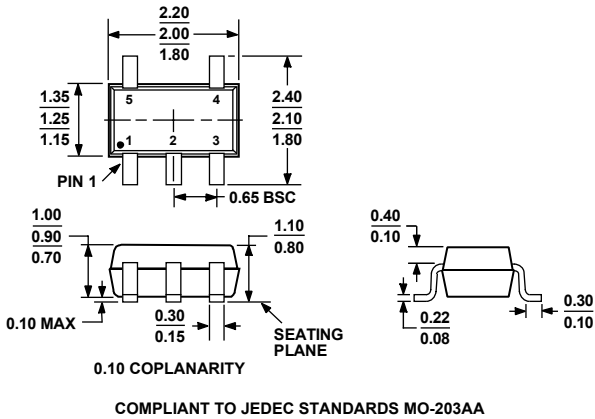


Figure 33. 5-Lead Thin Shrink Small Outline Package [SC70] (KS-5)  
Dimensions shown in millimeters

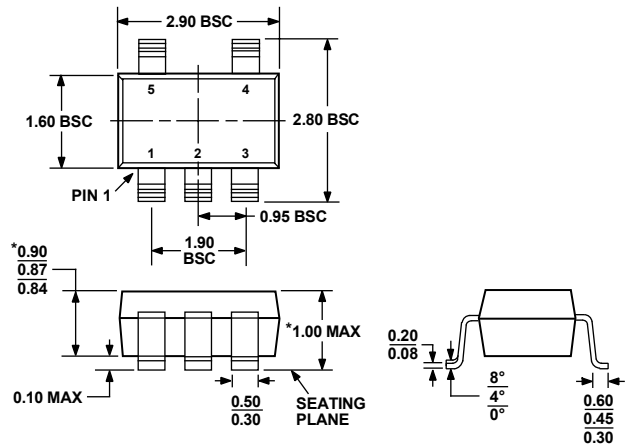


Figure 35. 5-Lead Thin Small Outline Transistor Package [TSOT] (UJ-5)  
Dimensions shown in millimeters

# AD8691/AD8692

## ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option	Branding
AD8691AUJZ-R2 <sup>1</sup>	-40°C to +125°C	5-Lead TSOT	UJ-5	ACA
AD8691AUJZ-REEL <sup>1</sup>	-40°C to +125°C	5-Lead TSOT	UJ-5	ACA
AD8691AUJZ-REEL7 <sup>1</sup>	-40°C to +125°C	5-Lead TSOT	UJ-5	ACA
AD8691AKSZ-R2 <sup>1</sup>	-40°C to +125°C	5-Lead SC70	KS-5	ACA
AD8691AKSZ-REEL <sup>1</sup>	-40°C to +125°C	5-Lead SC70	KS-5	ACA
AD8691AKSZ-REEL7 <sup>1</sup>	-40°C to +125°C	5-Lead SC70	KS-5	ACA
AD8692ARMZ-R2 <sup>1</sup>	-40°C to +125°C	8-Lead MSOP	RM-8	APA
AD8692ARMZ-REEL <sup>1</sup>	-40°C to +125°C	8-Lead MSOP	RM-8	APA
AD8692ARZ <sup>1</sup>	-40°C to +125°C	8-Lead SOIC	R-8	
AD8692ARZ-REEL <sup>1</sup>	-40°C to +125°C	8-Lead SOIC	R-8	
AD8692ARZ-REEL7 <sup>1</sup>	-40°C to +125°C	8-Lead SOIC	R-8	

<sup>1</sup> Z = Pb-free part.