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REVISION HISTORY

6/15—Rev. E to Rev. F

Changes to Figure 3	1
Change to Total Harmonic Distortion + Noise Parameter, Table 2	4
Changes to Figure 17 and Figure 19	8
Changes to Figure 52	17
Changes to Ordering Guide	18

1/14—Rev. D to Rev. E

Changes to Output Phase Reversal Section	15
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10/10—Rev. C to Rev. D

Changes to Figure 1 and General Description Section	1
Changes to Ordering Guide	18

7/10—Rev. B to Rev. C

Added ADA4637-1	Universal
Added Figure 2; Renumbered Sequentially	1

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Changes to Table 2	3
Change to Table 3	5
Changes to Typical Performance Characteristics Section	6
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10/09—Rev. A to Rev. B

Changes to Figure 2	1
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9/09—Rev. 0 to Rev. A

Changes to General Description Section	1
Changes to Table 2	3
Updated Outline Dimensions	14
Changes to Ordering Guide	15

7/09—Revision 0: Initial Version

SPECIFICATIONS

ELECTRICAL CHARACTERISTICS—30 V OPERATION

$V_{SY} = \pm 15 \text{ V}$, $V_{CM} = 0 \text{ V}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.

Table 2.

Parameter	Symbol	Test Conditions/Comments	B Grade			A Grade			Unit
			Min	Typ	Max	Min	Typ	Max	
INPUT CHARACTERISTICS									
Offset Voltage ¹	V _{OS}			70	200		120	300	μV
		−40°C ≤ T _A ≤ +85°C			350			410	μV
		−40°C ≤ T _A ≤ +125°C			400			660	μV
Offset Voltage Drift, Average	ΔV _{OS} /ΔT	−40°C ≤ T _A ≤ +125°C		1	2		1	3	μV/°C
Power Supply Rejection Ratio	PSRR	V _{SY} = ±4.5 V to ±18 V	106	112		103	108		dB
		−40°C ≤ T _A ≤ +125°C	101			99			dB
Input Bias Current ²	I _B	−40°C ≤ T _A ≤ +85°C		1	5		1	5	pA
		−40°C ≤ T _A ≤ +125°C			0.5			0.5	nA
Input Offset Current	I _{OS}	−40°C ≤ T _A ≤ +125°C			2			2	nA
		−40°C ≤ T _A ≤ +85°C		0.5	5		0.5	5	pA
		−40°C ≤ T _A ≤ +125°C			0.5			0.5	nA
		−40°C ≤ T _A ≤ +125°C			2			2	nA
NOISE PERFORMANCE									
Voltage Noise Density	e _n	f = 10 Hz		16.5	40		16.5	40	nV/√Hz
		f = 100 Hz		7.9	20		7.9	20	nV/√Hz
		f = 1 kHz		6.1	8		6.1	8	nV/√Hz
		f = 10 kHz		4.8	6		4.8	6	nV/√Hz
Voltage Noise	e _n p-p	0.1 Hz to 10 Hz		0.7	1.6		0.7	1.6	μV p-p
Current Noise Density	i _n	f = 100 Hz		1.6			2.5		fA/√Hz
Current Noise	i _n p-p	0.1 Hz to 10 Hz		30			48		fA p-p
Input Resistance	R _{IN}			10			10		TΩ
Input Capacitance, Differential Mode	C _{INDM}			8			8		pF
Input Capacitance, Common Mode	C _{INCM}			7			7		pF
Input Voltage Range	IVR		−11		+11	−11		+11	V
		−40°C ≤ T _A ≤ +125°C	−10.5		+10.5	−10.5		+10.5	V
Common-Mode Rejection Ratio	CMRR	T _A = 25°C, V _{CM} = −11 V to +11 V	106	116		100	110		dB
		−40°C ≤ T _A ≤ +125°C, V _{CM} = −10.5 V to +10.5 V	98			97			dB
Large Signal Voltage Gain	A _{VO}	R _L = 1 kΩ, V _O = −10 V to +10 V	112	120		106	120		dB
		−40 ≤ T _A ≤ +85°C	110			104			dB
		−40 ≤ T _A ≤ +125°C	102			100			dB
DYNAMIC PERFORMANCE									
Slew Rate ADA4627-1	SR	±10 V step, R _L = 1 kΩ, C _L = 100 pF, A _V = +1	40	56/78 ³		40	56/78 ³		V/μs
	SR	±10 V step, R _L = 1 kΩ, C _L = 100 pF, R _S = R _f = 1 kΩ, A _V = −1	40	82/84 ³		40	82/84 ³		V/μs
Slew Rate ADA4637-1	SR	±10 V out, C _f = 4.8 pF, A _V = −4		170			170		V/μs
	SR	±10 V out, C _f = 4.8 pF, A _V = +5		170			170		V/μs

Parameter	Symbol	Test Conditions/Comments	B Grade			A Grade			Unit
			Min	Typ	Max	Min	Typ	Max	
Settling Time to 0.01% ADA4627-1	t_s	$V_{IN} = 10\text{ V step, } C_L = 35\text{ pF, } R_L = +1\text{ k}\Omega, A_V = -1$		550			550		ns
ADA4637-1		$V_{IN} = 10\text{ V step, } C_L = 35\text{ pF, } R_L = +1\text{ k}\Omega, A_V = -4$		300			300		ns
Settling Time to 0.1% ADA4627-1	t_s	$V_{IN} = 10\text{ V step, } C_L = 35\text{ pF, } R_L = +1\text{ k}\Omega, A_V = -1$		450			450		ns
ADA4637-1		$V_{OUT} = 10\text{ V step, } C_L = 35\text{ pF, } R_L = +1\text{ k}\Omega, A_V = -4$		200			200		ns
Gain Bandwidth Product ADA4627-1 ADA4637-1	GBP	$R_L = 1\text{ k}\Omega, C_L = 20\text{ pF, } A_V = 1$ $A_V = 10$	16^4	19 79.9		16^4	19 79.9		MHz
Phase Margin ADA4627-1 ADA4637-1	Φ_M	$R_L = 1\text{ k}\Omega, C_L = 20\text{ pF, } A_V = 1$ $A_V = 10$		72 85			72 85		Degrees
Total Harmonic Distortion + Noise	THD + N	$V_{IN} = 6\text{ V rms, } f = 1\text{ kHz, } A_V = 1,$ ADA4627-1		0.000045			0.000045		%
POWER SUPPLY									
Supply Current per Amplifier	I_{SY}	$I_O = 0\text{ mA}$ $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		± 7.0	± 7.5		± 7.0	± 7.5	mA
					± 7.8			± 7.8	mA
OUTPUT CHARACTERISTICS									
Output Voltage High	V_{OH}	$R_L = 1\text{ k}\Omega\text{ to } V_{CM}$ $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	12.0 11.8 11.7	12.3		12.0 11.8 11.7	12.3		V V V
Output Voltage Low	V_{OL}	$R_L = 1\text{ k}\Omega\text{ to } V_{CM}$ $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		-12.7	-12.3 -12.1 -12.0		-12.7	-12.3 -12.1 -12.0	V V V
Output Current	I_{OUT}	$V_O = \pm 10\text{ V}$		± 45			± 45		mA
Short-Circuit Current	I_{SC}	$T_A = 25^\circ\text{C}$		+70/-55			+70/-55		mA
Closed-Loop Output Impedance	Z_{OUT}	$f = 1\text{ MHz, } A_V = -100$		41			41		Ω

¹ V_{OS} is measured fully warmed up.² Tested/extrapolated from 125°C .³ Rising/falling.⁴ Not tested. Guaranteed by simulation and characterization.

ABSOLUTE MAXIMUM RATINGS

Table 3.

Parameter	Rating
Supply Voltage	36 V
Input Voltage Range ¹	(V ₋) – 0.3 V to (V ₊) + 0.3 V
Input Current ¹	±10 mA
Differential Input Voltage ²	±V _{SY}
Output Short-Circuit Duration to GND	Indefinite
Storage Temperature Range	–65°C to +150°C
Operating Temperature Range	–40°C to +125°C
Junction Temperature Range	–65°C to +150°C
Lead Temperature (Soldering, 60 sec)	300°C
ESD Human Body Model	4 kV

¹ Input pin has clamp diodes to the power supply pins. Input current should be limited to 10 mA or less whenever input signals exceed the power supply rail by 0.3 V.

² Differential input voltage is limited to ±30 V or the supply voltage, whichever is less.

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. This was measured using a standard 2-layer board. For the LFCSP package, the exposed pad should be soldered to a copper plane.

Table 4. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
8-Lead SOIC_N (R-8)	155	45	°C/W
8-Lead LFCSP (CP-8-2)	77	14	°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

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

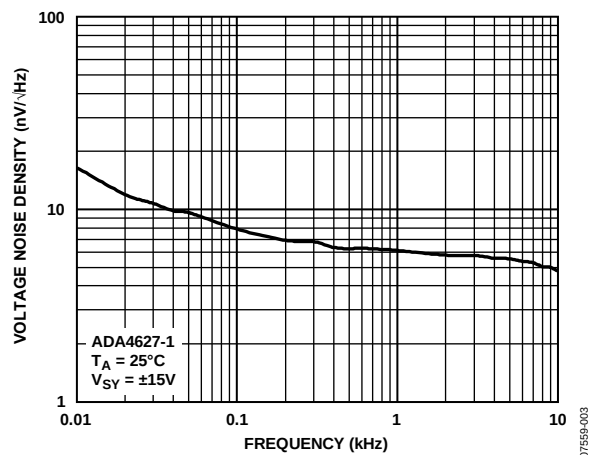


Figure 4. Voltage Noise Density vs. Frequency

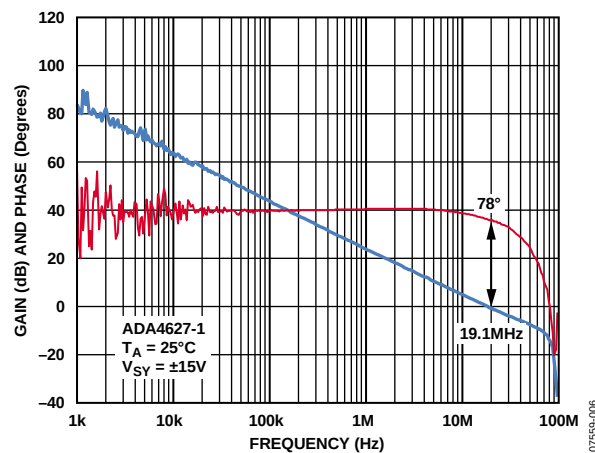


Figure 7. Open-Loop Gain and Phase vs. Frequency

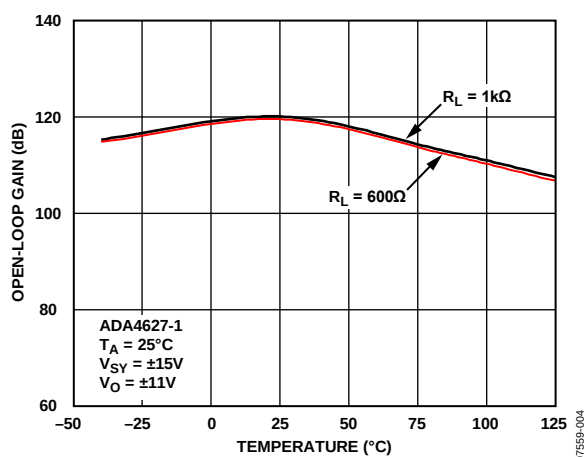


Figure 5. Open-Loop Gain vs. Temperature

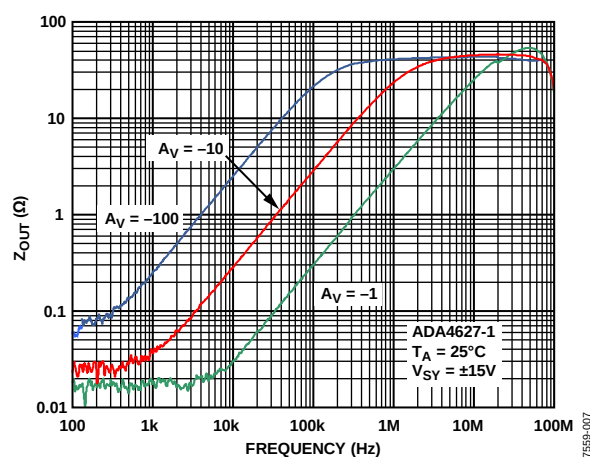


Figure 8. Closed-Loop Z_{OUT} vs. Frequency

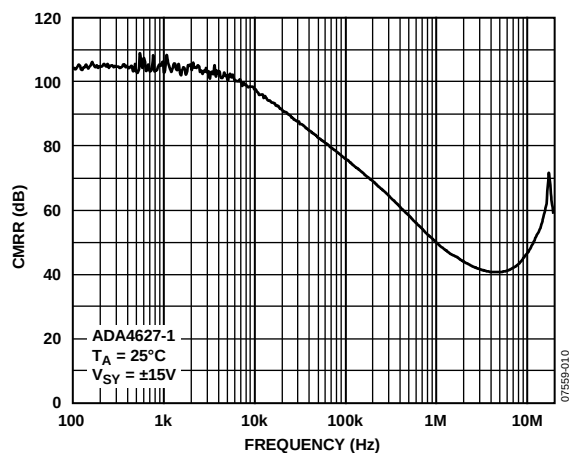


Figure 6. CMRR vs. Frequency

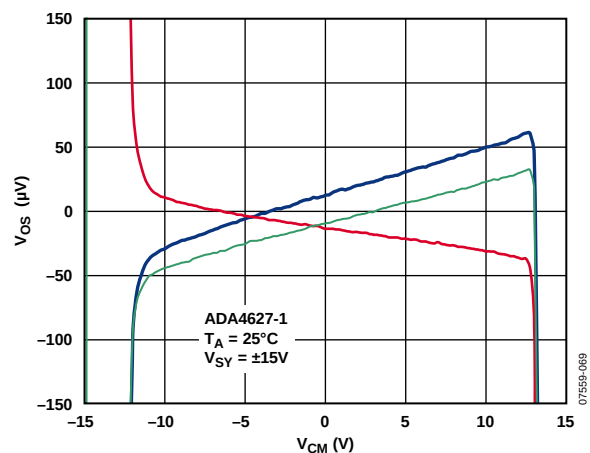


Figure 9. V_{OS} vs. Common-Mode Voltage

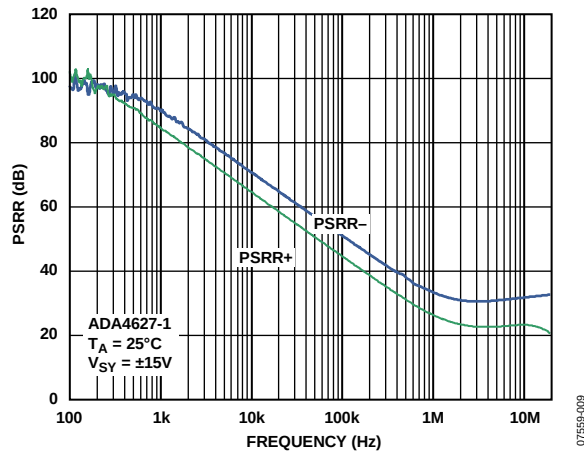


Figure 10. PSRR vs. Frequency

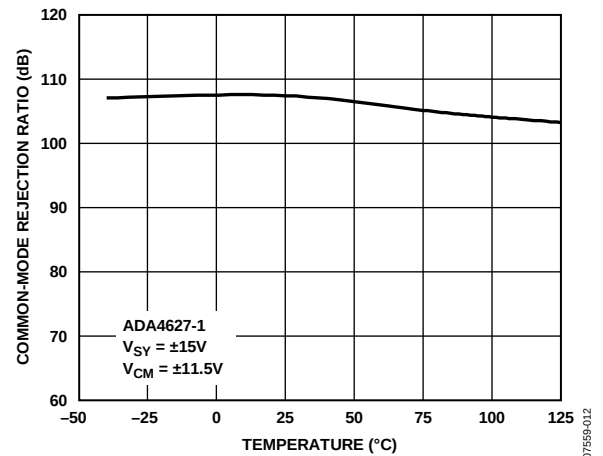


Figure 13. CMRR vs. Temperature

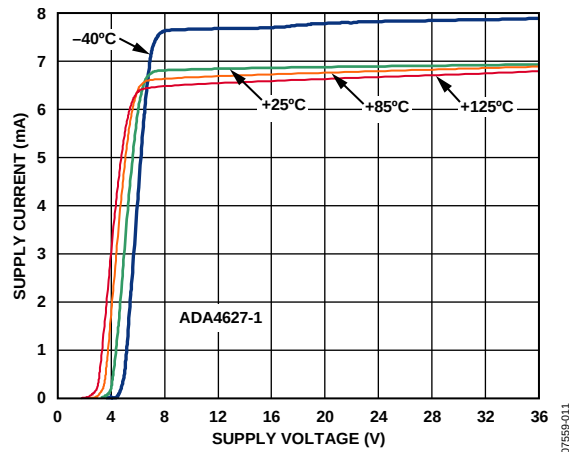


Figure 11. Supply Current vs. Supply Voltage and Temperature

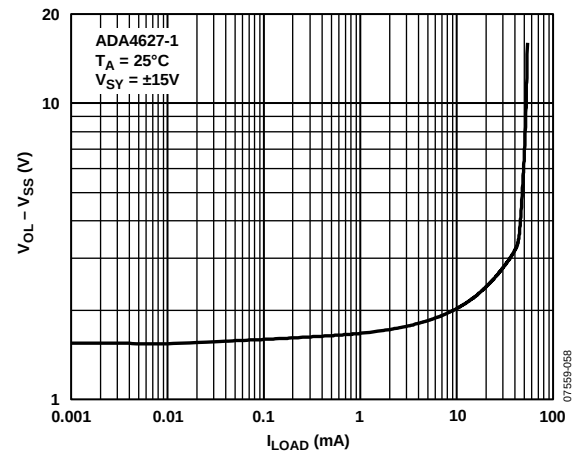
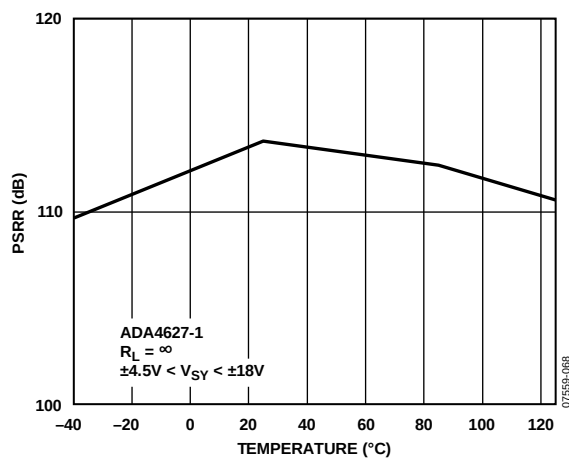
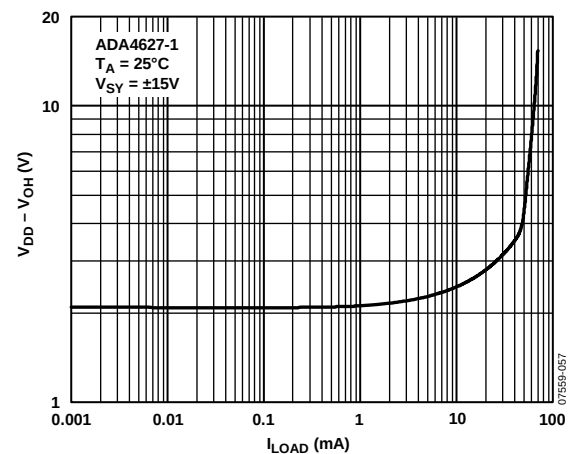
Figure 14. V_{OUT} Sinking vs. I_{LOAD} Current

Figure 12. PSRR vs. Temperature

Figure 15. V_{OUT} Sourcing vs. I_{LOAD} Current

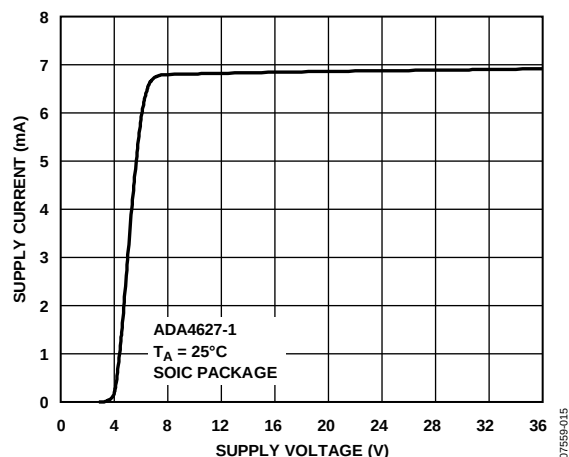


Figure 16. Supply Current vs. Supply Voltage

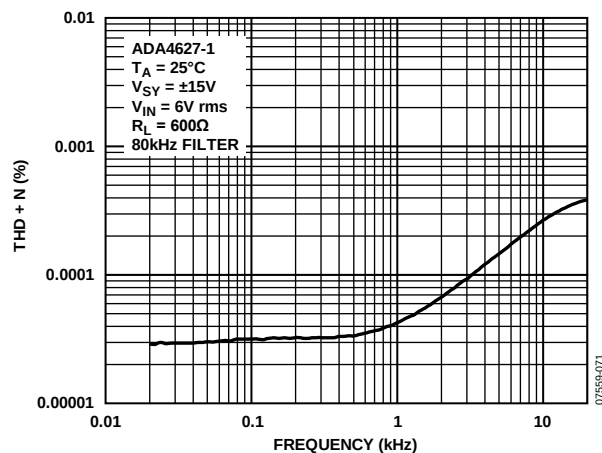


Figure 19. THD + N vs. Frequency

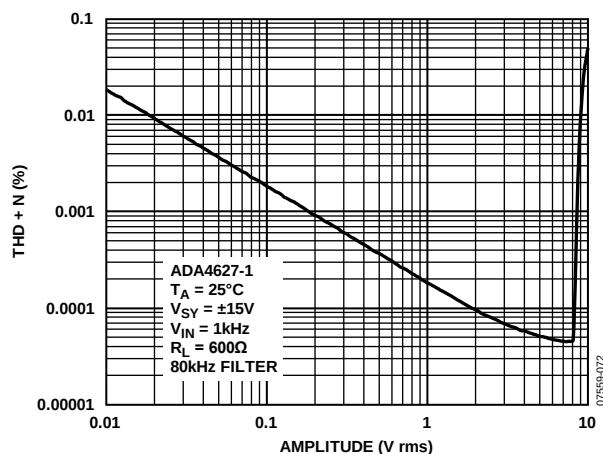


Figure 17. THD + N vs. V_{IN}

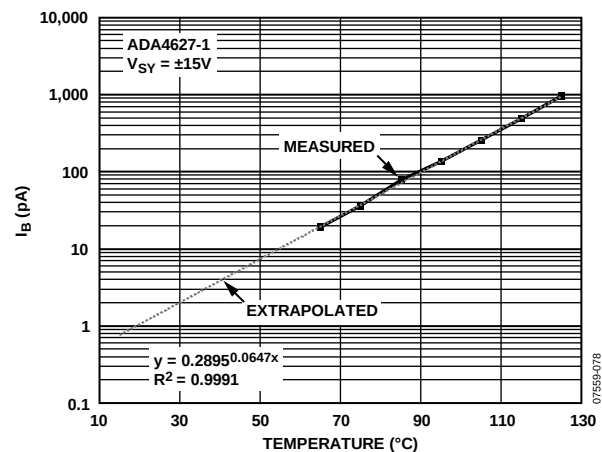


Figure 20. Input Bias Current vs. Temperature

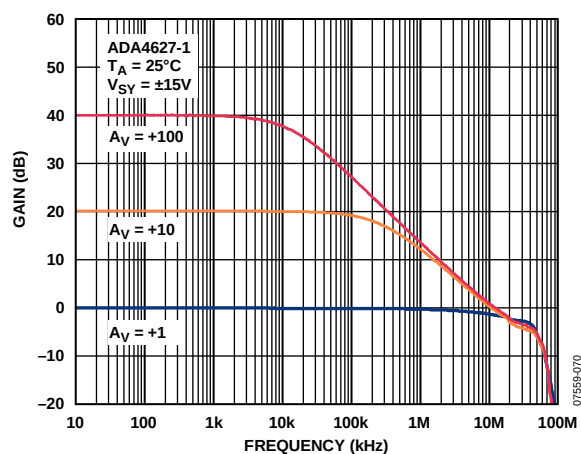


Figure 18. Closed-Loop Gain vs. Frequency

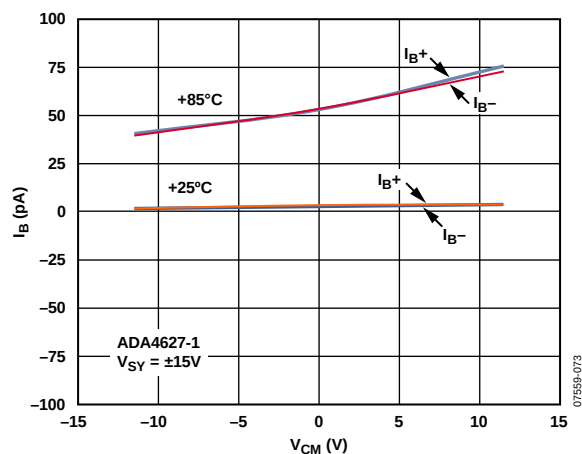


Figure 21. Input Bias Current vs. V_{CM} and Temperature

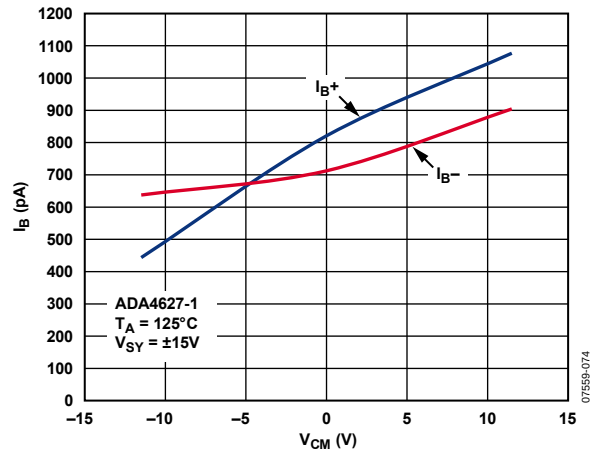
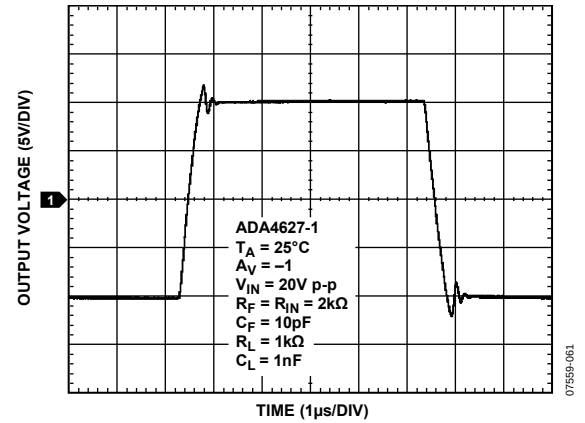
Figure 22. Input Bias Current vs. V_{CM} at 125°C 

Figure 25. Large Signal Transient Response

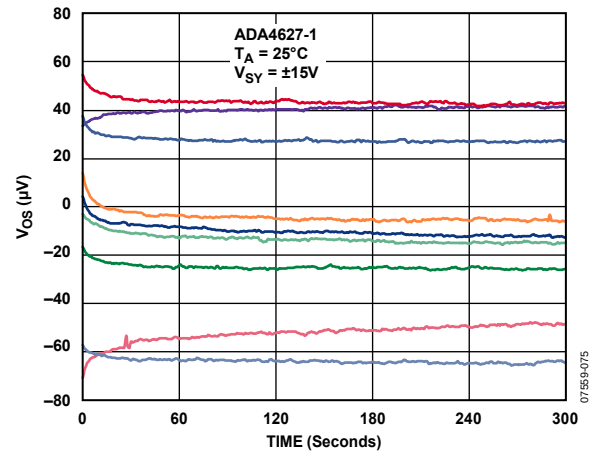


Figure 23. Input Offset Voltage vs. Time

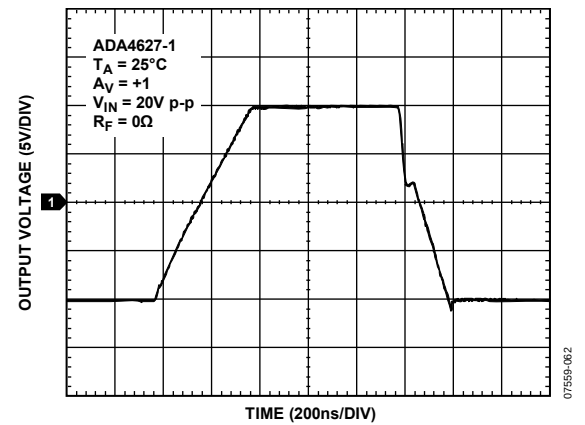


Figure 26. Large Signal Transient Response

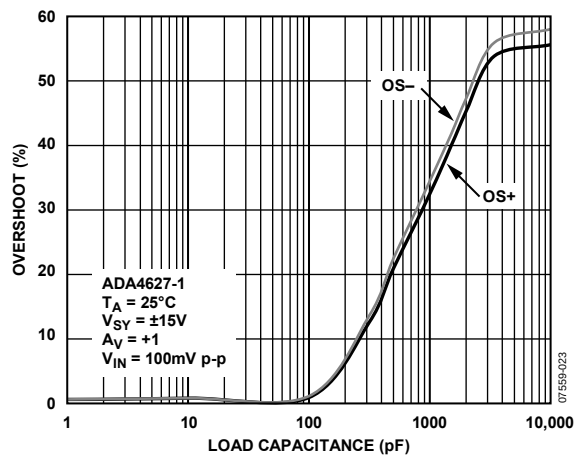


Figure 24. Small Signal Overshoot vs. Load Capacitance

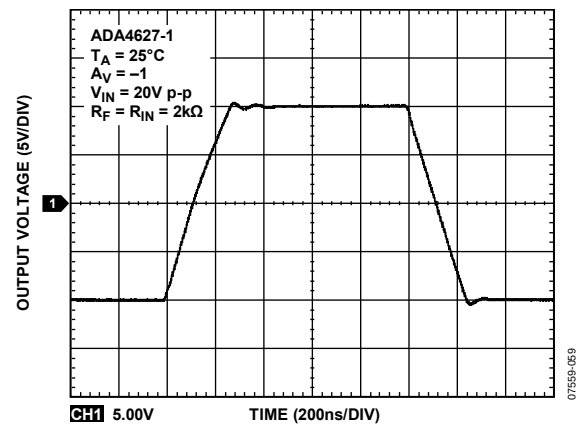


Figure 27. Large Signal Transient Response

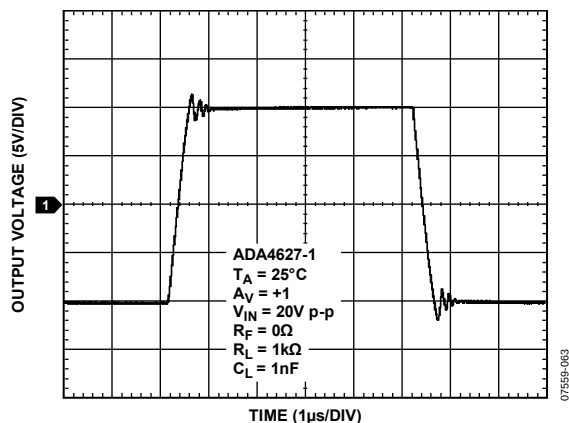


Figure 28. Large Signal Transient Response

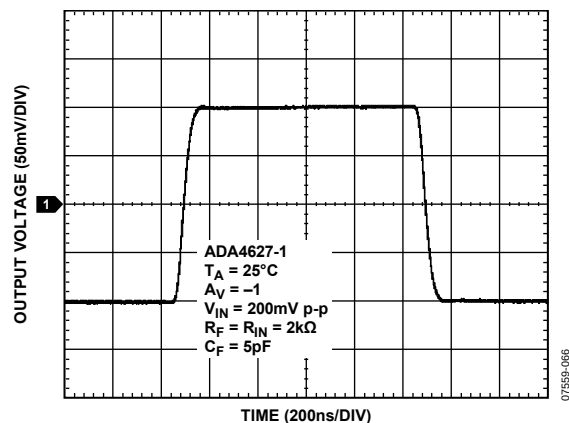


Figure 31. Small Signal Transient Response

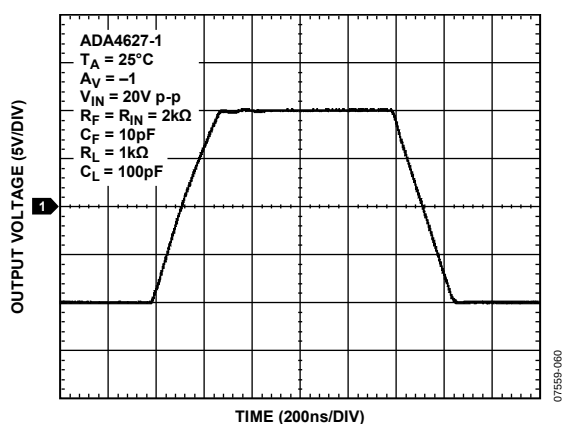


Figure 29. Large Signal Transient Response

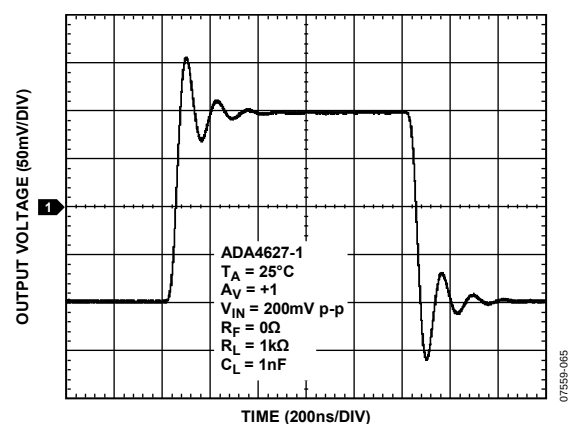


Figure 32. Small Signal Transient Response

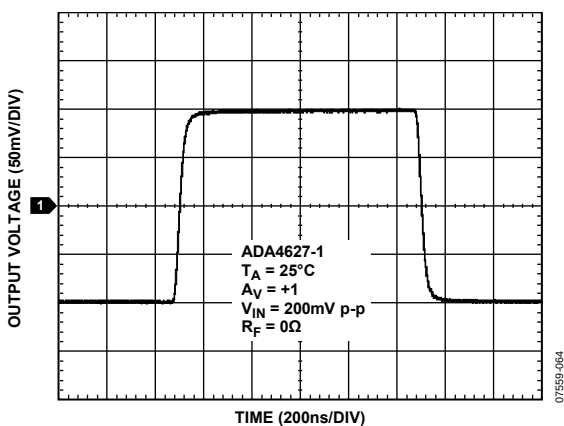


Figure 30. Small Signal Transient Response

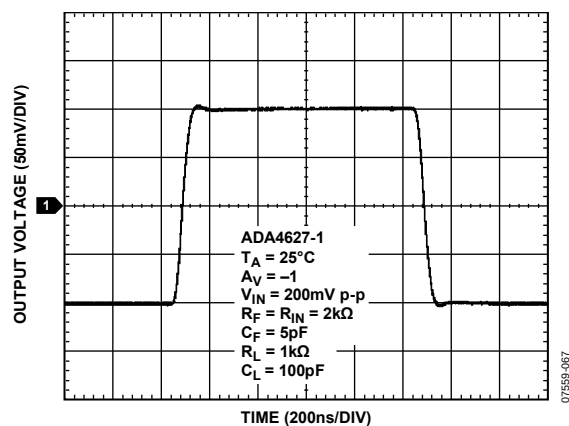


Figure 33. Small Signal Transient Response

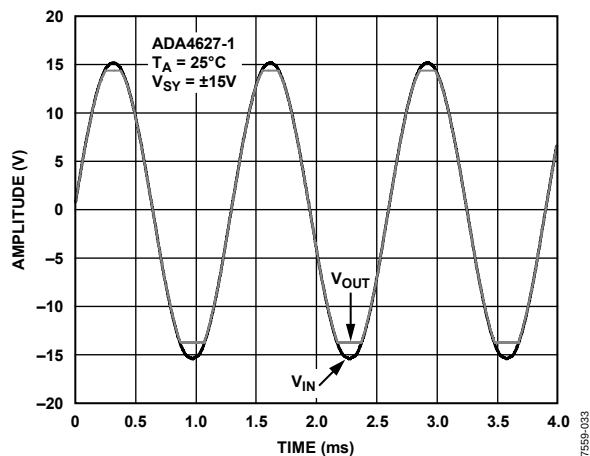


Figure 34. No Phase Reversal

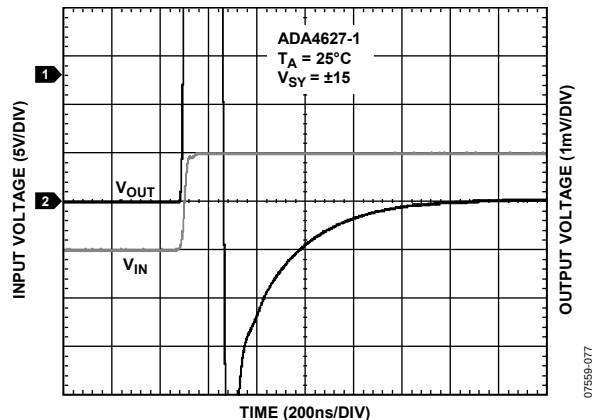


Figure 37. Positive Settling Time to 0.01%

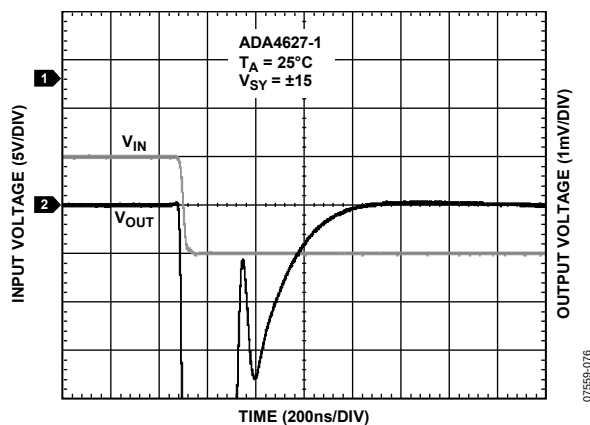


Figure 35. Negative Settling Time to 0.01%

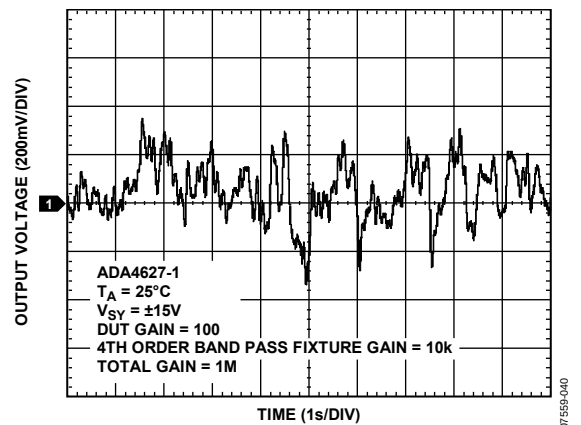


Figure 38. 0.1 Hz to 10 Hz Noise

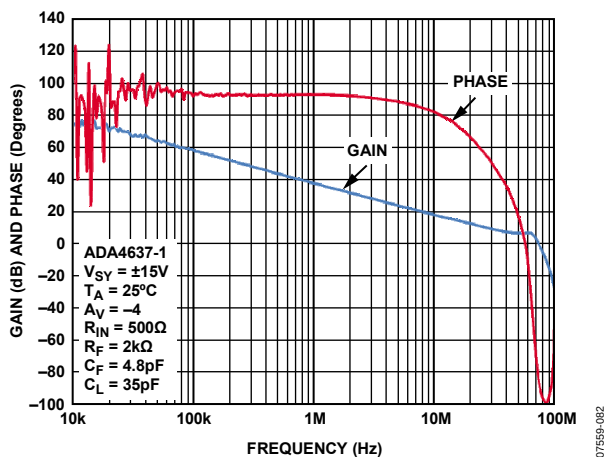


Figure 36. Open-Loop Gain and Phase vs. Frequency

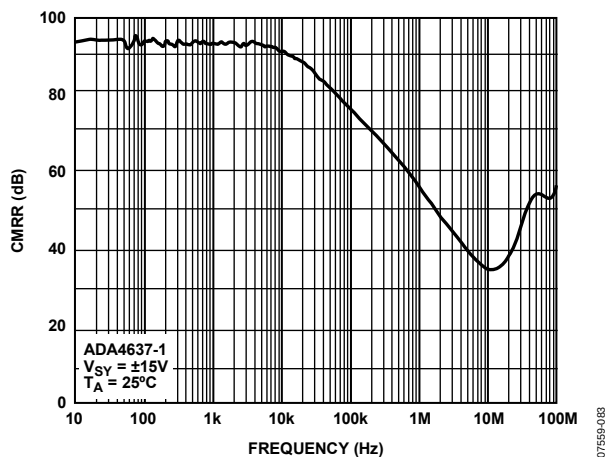


Figure 39. CMRR vs. Frequency

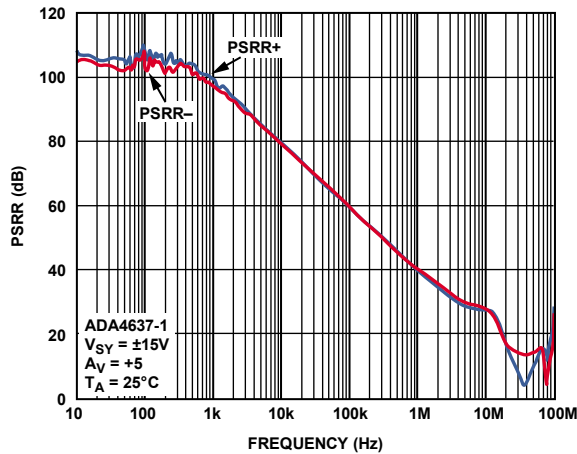


Figure 40. PSRR vs. Frequency

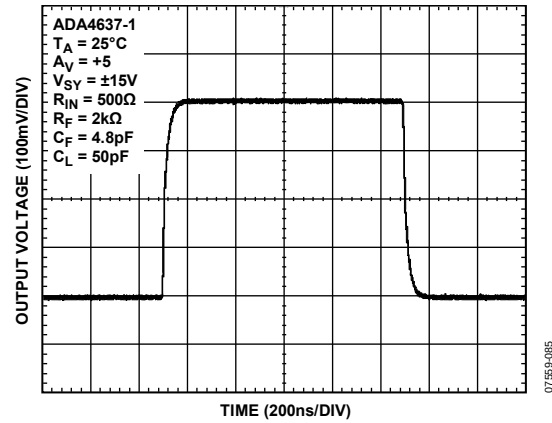


Figure 43. Small Signal Transient Response

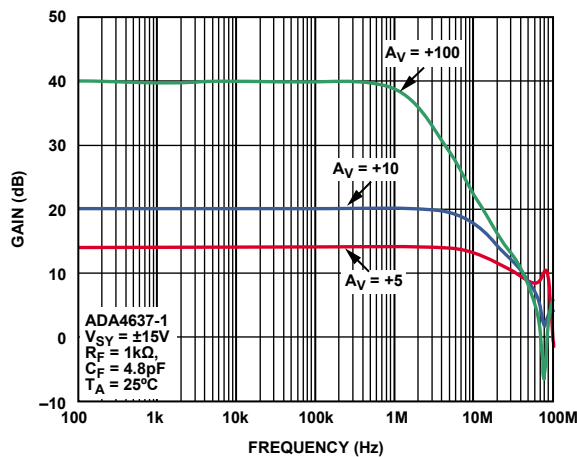


Figure 41. Closed-Loop Gain vs. Frequency

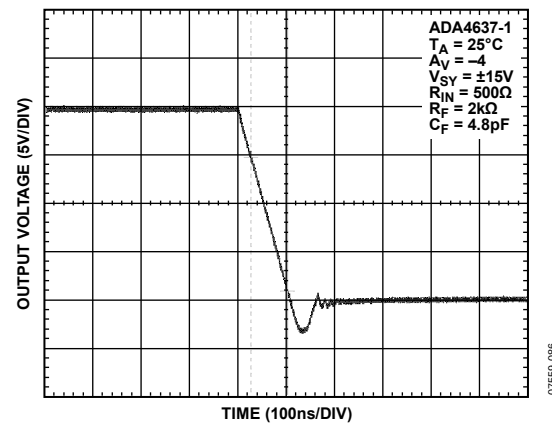


Figure 44. Slew Rate Falling

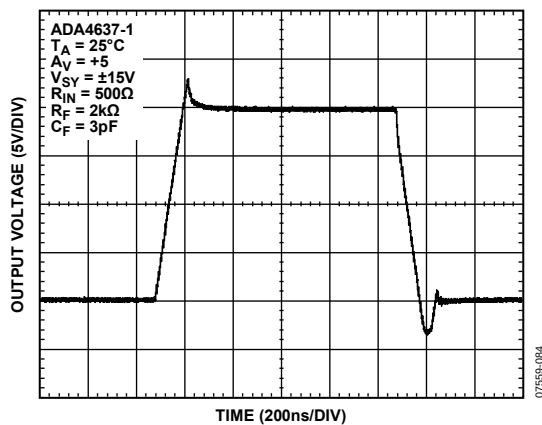


Figure 42. Large Signal Transient Response

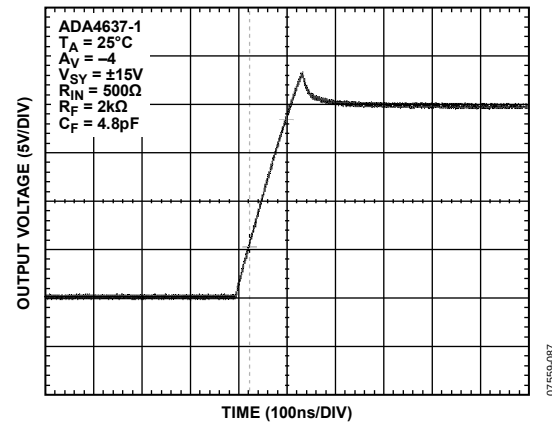


Figure 45. Slew Rate Rising

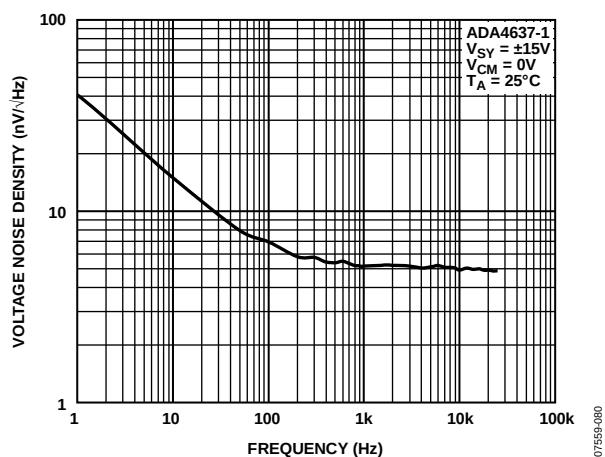


Figure 46. Voltage Noise Density vs. Frequency

THEORY OF OPERATION

The [ADA4627-1](#) is a high speed, unity gain stable amplifier with excellent dc characteristics. The [ADA4637-1](#) is a decompensated version that is stable at a gain of 5 or greater. The typical offset voltage of 70 μV allows the amplifiers to be easily configured for high gains without the risk of excessive output voltage errors. The small temperature drift of 2 $\mu\text{V}/^\circ\text{C}$ ensures a minimum offset voltage error over the entire temperature range of -40°C to $+125^\circ\text{C}$, making the amplifiers ideal for a variety of sensitive measurement applications in harsh operating environments.

INPUT VOLTAGE RANGE

The [ADA4627-1/ADA4637-1](#) are not rail-to-rail input amplifiers; therefore, care is required to ensure that both inputs do not exceed the input voltage range. Under normal negative feedback operating conditions, the amplifier corrects its output to ensure that the two inputs are at the same voltage. However, if either input exceeds the input voltage range, the loop opens, and large currents begin to flow through the ESD protection diodes in the amplifier.

These diodes are connected between the inputs and each supply rail to protect the input transistors against an electrostatic discharge event, and they are normally reverse-biased. However, if the input voltage exceeds the supply voltage, these ESD diodes can become forward-biased. Without current limiting, excessive amounts of current can flow through these diodes, causing permanent damage to the device. If inputs are subject to overvoltage, insert appropriate series resistors to limit the diode current to less than 5 mA.

INPUT OFFSET VOLTAGE ADJUST RANGE

The [ADA4627-1/ADA4637-1](#) SOIC packages have offset adjust pins for compatibility with some existing designs. The recommended offset nulling circuit is shown in Figure 47.

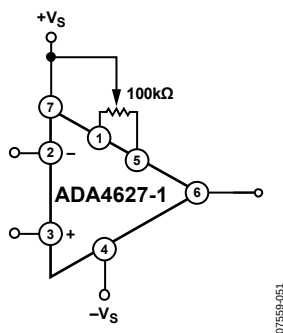


Figure 47. Standard Offset Null Circuit

With a 100 k Ω potentiometer, the adjustment range is more than ± 11 mV. However, the V_{OS} temperature drift increases by several $\mu\text{V}/^\circ\text{C}$ for every millivolt of offset adjust. The [ADA4627-1/ADA4637-1](#) have matching thin film resistors that are laser trimmed at two temperatures to minimize both offset voltage and offset voltage drift. The offset voltage at room temperature is less than 0.5 mV, and the offset voltage drift is only a few $\mu\text{V}/^\circ\text{C}$ or less; therefore, it is not recommended to

use the offset adjust pins, especially for offset adjust of a complete signal chain. Signal chain offset can be addressed with an auto-zero amplifier used to form a composite amplifier; or, if the [ADA4627-1](#) or the [ADA4637-1](#) is in an inverting amplifier stage, it can be modified easily to add a potentiometer (see Figure 48). The LFCSP package does not have offset adjust pins.

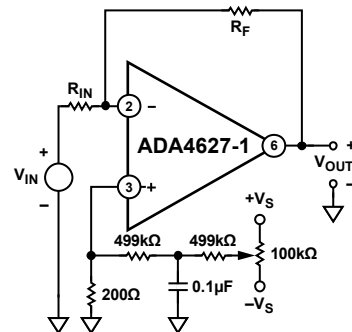


Figure 48. Alternate Offset Null Circuit for Inverting Stage

INPUT BIAS CURRENT

Because the [ADA4627-1/ADA4637-1](#) have a JFET input stage, the input bias current, due to the reverse-biased junction, has a leakage current that approximately doubles every 10°C . The power dissipation of the device, combined with the thermal resistance of the package, results in the junction temperature increasing 20°C to 30°C above ambient. This parameter is tested with high speed ATE equipment, which does not result in the die temperature reaching equilibrium. This is correlated with bench measurements to match the guaranteed maximum at room temperature shown in Table 2.

The input current can be reduced by keeping the temperature as low as possible and using a light load on the output.

NOISE CONSIDERATIONS

The JFET input stage offers very low input voltage noise and input current noise. The thermal noise of a 1 k Ω resistor at room temperature is 4 nV/ $\sqrt{\text{Hz}}$; therefore, low values of resistance should be used for dc-coupled inverting and noninverting amplifier configurations. In the case of transimpedance amplifiers (TIAs), current noise is more important.

The [ADA4627-1/ADA4637-1](#) are an excellent choice for both of these applications. Analog Devices offers a wide variety of low voltage noise and low current noise op amps in a variety of processes that are optimized for different supply voltage ranges. Refer to [Application Note AN-940](#) for a discussion of noise, calculations, and selection tables for more than three dozen low noise, op amp families.

THD + N MEASUREMENTS

Total harmonic distortion plus noise (THD + N) is usually measured with an audio analyzer, such as those from Audio Precision, Inc[™]. The analyzer consists of a low distortion oscillator that is swept from the starting frequency to the ending frequency. The oscillator is connected to the circuit under test, and the output of the circuit goes back to the analyzer.

The analyzer has a tunable notch filter in lock step with the swept oscillator. This removes the fundamental frequency but allows all of the harmonics and wideband noise to be measured with an integrating voltmeter. However, there is a switchable low-pass filter in series with the notch filter. If the sine wave is at 100 Hz, then the tenth harmonic is still at 1 kHz; therefore, having a low pass at 80 kHz is not a problem. When the oscillator reaches 20 kHz, the fourth harmonic (80 kHz) is partially attenuated, resulting in a lower reading from the voltmeter. When evaluating THD + N curves from any manufacturer, careful attention should be paid to the test conditions. The difference between an 80 kHz low-pass filter and a 500 kHz filter is shown in Figure 49.

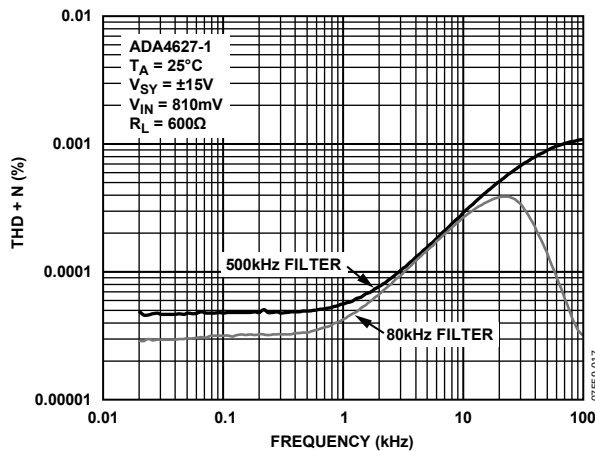


Figure 49. THD + N vs. Frequency

PRINTED CIRCUIT BOARD LAYOUT, BIAS CURRENT, AND BYPASSING

To take advantage of the very low input bias current of the ADA4627-1/ADA4637-1 at room temperature, leakage paths must be considered. A printed circuit board (PCB), with dust and humidity, can have 100 MΩ of resistance over a few tenths of an inch. A 1 mV differential between the two points results in 10 pA of leakage current, more than the guaranteed maximum.

The op amp inputs should be guarded by surrounding the nets with a metal trace maintained at the predicted voltage. In the case of an inverting configuration or transimpedance amplifier, (see Figure 50), the inverting and noninverting nodes can be surrounded by traces held at a quiet analog ground.

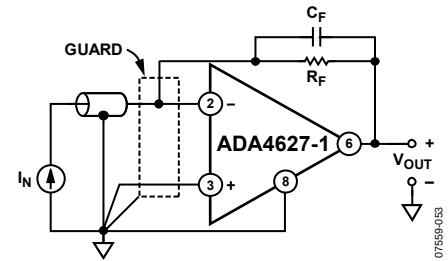


Figure 50. Inverting Amplifier with Guard

For a noninverting configuration, the trace can be driven from the feedback divider, but the resistors should be chosen to offer a low impedance drive to the trace (see Figure 51).

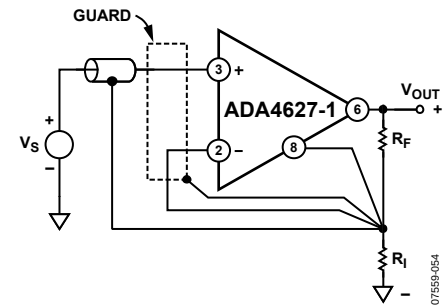


Figure 51. Noninverting Amplifier with Guard

The board layout should be compact with traces as short as possible. For second-order board considerations, such as triboelectric effects and piezoelectric effects, as well as a table of insulating material properties, see the AD549 data sheet.

In some cases, shielding from air currents may be helpful. A general rule of thumb, for op amps with gain bandwidth products higher than 1 MHz, bypass capacitors should be very close to the device, within 3 mm. Each supply should be bypassed with a 0.01 μF ceramic capacitor in parallel with a 1 μF bulk decoupling capacitor. The ceramic capacitors should be closer to the op amp. Sockets, which add inductance and capacitance, should not be used.

OUTPUT PHASE REVERSAL

Output phase reversal occurs in some amplifiers when the input common-mode voltage range is exceeded. As common-mode voltage is moved outside the common-mode range, the outputs of these amplifiers can suddenly jump in the opposite direction to the supply rail. This is the result of the differential input pair shutting down, causing a radical shifting of internal voltages that results in the erratic output behavior.

The ADA4627-1/ADA4637-1 amplifiers are carefully designed to prevent any output phase reversal if both inputs are maintained within or slightly above the power supply rails. The ADA4627-1/ADA4637-1 do not phase reverse, as shown in Figure 34.

DECOMPENSATED OP AMPS

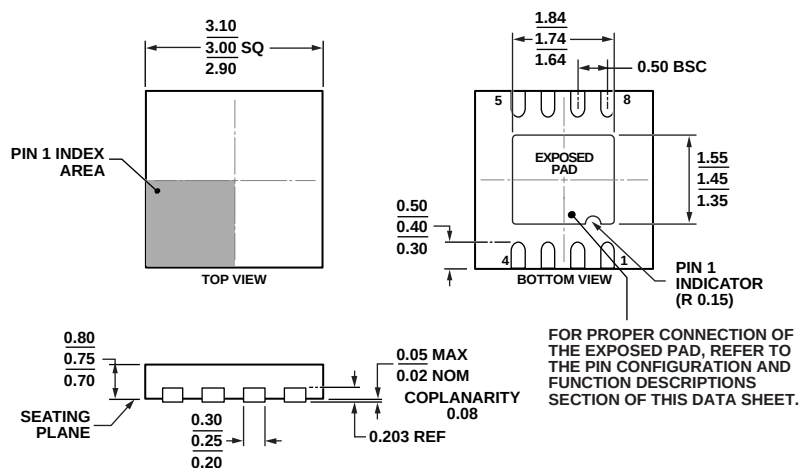
The [ADA4637-1](#) is a decompensated op amp, and, as such, must always be operated at a noise gain of 5 or greater. See tutorial [MT-033, Voltage Feedback Op Amp Gain and Bandwidth](#), at www.analog.com for more information.

DRIVING CAPACITIVE LOADS

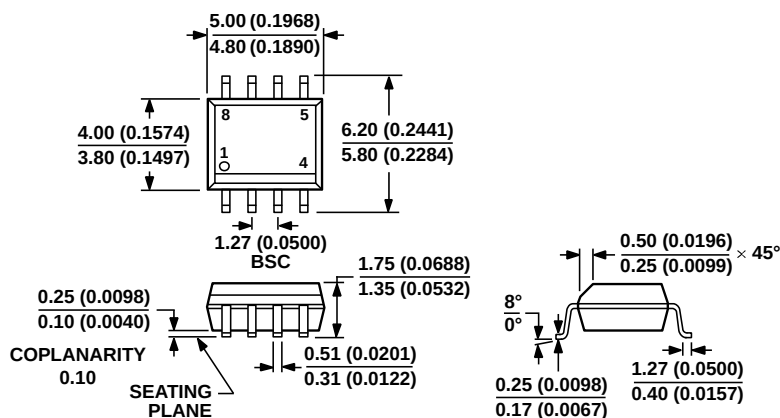
Adding capacitance to the output of any op amp results in additional phase shift, which reduces stability and leads to overshoot or oscillation.

The [ADA4627-1/ADA4637-1](#) have a high phase margin and low output impedance, so they can drive reasonable values of capacitance. This is a common situation when an amplifier is used to drive the input of switched capacitor ADCs. For other considerations and various circuit solutions, see the Analog Dialogue article titled [Ask the Applications Engineer-25, Op Amps Driving Capacitive Loads](#).

OUTLINE DIMENSIONS



12-07-2010-A



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ORDERING GUIDE

Model ¹	Temperature Range	Package Description	Package Option	Branding
ADA4627-1ACPZ-R2	–40°C to +125°C	8-Lead LFCSP_WD	CP-8-13	A29
ADA4627-1ACPZ-RL	–40°C to +125°C	8-Lead LFCSP_WD	CP-8-13	A29
ADA4627-1ACPZ-R7	–40°C to +125°C	8-Lead LFCSP_WD	CP-8-13	A29
ADA4627-1ARZ	–40°C to +125°C	8-Lead SOIC_N	R-8	
ADA4627-1ARZ-RL	–40°C to +125°C	8-Lead SOIC_N	R-8	
ADA4627-1ARZ-R7	–40°C to +125°C	8-Lead SOIC_N	R-8	
ADA4627-1BRZ	–40°C to +125°C	8-Lead SOIC_N	R-8	
ADA4627-1BRZ-R7	–40°C to +125°C	8-Lead SOIC_N	R-8	
ADA4627-1BRZ-RL	–40°C to +125°C	8-Lead SOIC_N	R-8	
ADA4637-1ACPZ-R2	–40°C to +125°C	8-Lead LFCSP_WD	CP-8-13	A2S
ADA4637-1ACPZ-RL	–40°C to +125°C	8-Lead LFCSP_WD	CP-8-13	A2S
ADA4637-1ACPZ-R7	–40°C to +125°C	8-Lead LFCSP_WD	CP-8-13	A2S
ADA4637-1ARZ	–40°C to +125°C	8-Lead SOIC_N	R-8	
ADA4637-1ARZ-RL	–40°C to +125°C	8-Lead SOIC_N	R-8	
ADA4637-1ARZ-R7	–40°C to +125°C	8-Lead SOIC_N	R-8	
ADA4637-1BRZ	–40°C to +125°C	8-Lead SOIC_N	R-8	
ADA4637-1BRZ-R7	–40°C to +125°C	8-Lead SOIC_N	R-8	
ADA4637-1BRZ-RL	–40°C to +125°C	8-Lead SOIC_N	R-8	

¹ Z = RoHS Compliant Part.

NOTES

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