

## FEATURES

### Low offset voltage and low offset voltage drift

Maximum offset voltage: 90  $\mu\text{V}$  at  $T_A = 25^\circ\text{C}$

Maximum offset voltage drift: 1.2  $\mu\text{V}/^\circ\text{C}$

### Moisture sensitivity level 1 (MSL1) rated

Low input bias current: 1 nA maximum at  $T_A = 25^\circ\text{C}$

Low voltage noise density: 6.9 nV/ $\sqrt{\text{Hz}}$  typical at  $f = 1000$  Hz

CMRR, PSRR, and  $A_V > 120$  dB minimum

Low supply current: 400  $\mu\text{A}$  per amplifier typical

Wide gain bandwidth product: 3.9 MHz at  $V_{SY} = \pm 5$  V

Dual-supply operation:  $\pm 2.5$  V to  $\pm 15$  V

Unity gain stable

No phase reversal

## ENHANCED PRODUCT FEATURES

Supports defense and aerospace applications (AQEC standard)

Extended industrial temperature range:  $-55^\circ\text{C}$  to  $+125^\circ\text{C}$

Controlled manufacturing baseline

1 assembly/test site

1 fabrication site

Product change notification

Qualification data available upon request

## APPLICATIONS

Process control front-end amplifiers

Wireless base station control circuits

Optical network control circuits

Instrumentation

Sensors and controls: thermocouples, RTDs, strain gages, and shunt current measurements

Precision filters

## GENERAL DESCRIPTION

The dual [ADA4077-2-EP](#) amplifier features extremely low offset voltage and drift, and low input bias current, noise, and power consumption. Outputs are stable with capacitive loads of more than 1000 pF with no external compensation.

Applications for this amplifier include sensor signal conditioning (such as thermocouples, RTDs, and strain gages), process control front-end amplifiers, and precision diode power measurement in optical and wireless transmission systems. The [ADA4077-2-EP](#) is useful in line powered and portable instrumentation, precision filters, and voltage or current measurement and level setting.

Unlike amplifiers by some competitors, the [ADA4077-2-EP](#) has an MSL1 rating that is compliant with the most stringent of assembly processes, and is specified over the extended industrial temperature range from  $-55^\circ\text{C}$  to  $+125^\circ\text{C}$  for the most demanding operating environments.

Rev. 0

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## PIN CONNECTION DIAGRAM



Figure 1.

15063-001

The [ADA4077-2-EP](#) is available in an 8-lead MSOP.

Additional application and technical information can be found in the [ADA4077-2](#) data sheet.

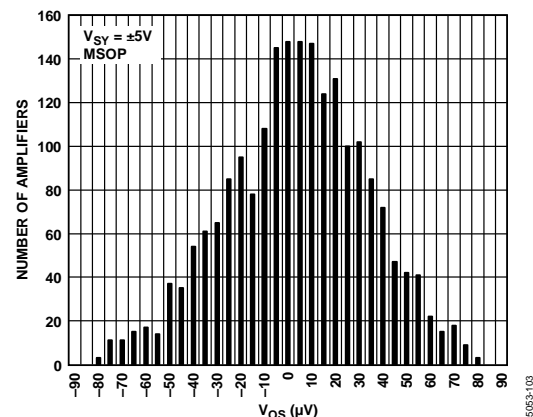


Figure 2. Offset Voltage Distribution

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**REVISION HISTORY**

12/2016—Revision 0: Initial Version

**SPECIFICATIONS****ELECTRICAL CHARACTERISTICS,  $\pm 5$  V**

$V_{SY} = \pm 5.0$  V,  $V_{CM} = 0$  V,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 1.

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
<b>INPUT CHARACTERISTICS</b>						
Offset Voltage	$V_{OS}$	$-55^\circ\text{C} < T_A < +125^\circ\text{C}$		50	90	$\mu\text{V}$
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$-55^\circ\text{C} < T_A < +125^\circ\text{C}$		0.5	1.2	$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$I_B$	$-55^\circ\text{C} < T_A < +125^\circ\text{C}$	-1	-0.4	+1	nA
Input Offset Current	$I_{OS}$	$-55^\circ\text{C} < T_A < +125^\circ\text{C}$	-1.5		+1.5	nA
Input Voltage Range		$-55^\circ\text{C} < T_A < +125^\circ\text{C}$	-1.0	+0.1	+0.5	nA
Common-Mode Rejection Ratio	CMRR	$V_{CM} = -3.8$ V to +3 V	-3.8	140	+3	V
		$V_{CM} = -3.8$ V to +3 V, $-55^\circ\text{C} < T_A < +85^\circ\text{C}$	122			dB
		$V_{CM} = -3.8$ V to +2.8 V, $85^\circ\text{C} < T_A < 125^\circ\text{C}$	120			dB
Large Signal Voltage Gain	$A_V$	$R_L = 2$ k $\Omega$ , $V_O = -3.0$ V to +3.0 V	121	130		dB
		$-55^\circ\text{C} < T_A < +125^\circ\text{C}$	120			dB
Input Capacitance	$C_{INCM}$	Common mode		5		pF
Input Resistance	$R_{IN}$	Common mode		70		G $\Omega$
<b>OUTPUT CHARACTERISTICS</b>						
Output Voltage High	$V_{OH}$	$I_L = 1$ mA $-55^\circ\text{C} < T_A < +125^\circ\text{C}$	3.8			V
			3.7			V
Output Voltage Low	$V_{OL}$	$I_L = 1$ mA $-55^\circ\text{C} < T_A < +125^\circ\text{C}$			-3.8	V
					-3.7	V
Output Current	$I_{OUT}$	$V_{DROPOUT} < 1.6$ V		$\pm 10$		mA
Short-Circuit Current	$I_{SC}$	$T_A = 25^\circ\text{C}$		22		mA
Closed-Loop Output Impedance	$Z_{OUT}$	$f = 1$ kHz, $A_V = +1$		0.05		$\Omega$
<b>POWER SUPPLY</b>						
Power Supply Rejection Ratio	PSRR	$V_S = \pm 2.5$ V to $\pm 18$ V $-55^\circ\text{C} < T_A < +125^\circ\text{C}$	123	128		dB
			120			dB
Supply Current per Amplifier	$I_{SY}$	$V_O = 0$ V $-55^\circ\text{C} < T_A < +125^\circ\text{C}$		400	450	$\mu\text{A}$
					650	$\mu\text{A}$
<b>DYNAMIC PERFORMANCE</b>						
Slew Rate	SR	$R_L = 2$ k $\Omega$		1.2		V/ $\mu\text{s}$
Settling Time to 0.1%	$t_S$	$V_{IN} = 1$ V step, $R_L = 2$ k $\Omega$ , $A_V = -1$		3		$\mu\text{s}$
Gain Bandwidth Product	GBP	$V_{IN} = 10$ mV p-p, $R_L = 2$ k $\Omega$ , $A_V = +100$		3.9		MHz
Unity-Gain Crossover	UGC	$V_{IN} = 10$ mV p-p, $R_L = 2$ k $\Omega$ , $A_V = +1$		3.9		MHz
-3 dB Closed-Loop Bandwidth	-3 dB	$A_V = +1$ , $V_{IN} = 10$ mV p-p, $R_L = 2$ k $\Omega$		5.9		MHz
Phase Margin	$\Phi_M$	$V_{IN} = 10$ mV p-p, $R_L = 2$ k $\Omega$ , $A_V = +1$		55		Degrees
Total Harmonic Distortion Plus Noise	THD + N	$V_{IN} = 1$ V rms, $A_V = +1$ , $R_L = 2$ k $\Omega$ , $f = 1$ kHz		0.004		%
<b>NOISE PERFORMANCE</b>						
Voltage Noise	$e_n$ p-p	0.1 Hz to 10 Hz		0.25		$\mu\text{V}$ p-p
Voltage Noise Density	$e_n$	$f = 1$ Hz		13		nV/ $\sqrt{\text{Hz}}$
		$f = 100$ Hz		7		nV/ $\sqrt{\text{Hz}}$
		$f = 1000$ Hz		6.9		nV/ $\sqrt{\text{Hz}}$
Current Noise Density	$i_n$	$f = 1$ kHz		0.2		pA/ $\sqrt{\text{Hz}}$
<b>MULTIPLE AMPLIFIERS CHANNEL SEPARATION</b>						
	$C_S$	$f = 1$ kHz, $R_L = 10$ k $\Omega$		-125		dB

**ELECTRICAL CHARACTERISTICS, ±15 V**

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

Table 2.

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
<b>INPUT CHARACTERISTICS</b>						
Offset Voltage	$V_{OS}$			50	90	$\mu\text{V}$
		$-55^\circ\text{C} < T_A < +125^\circ\text{C}$			220	$\mu\text{V}$
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$-55^\circ\text{C} < T_A < +125^\circ\text{C}$		0.5	1.2	$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$I_B$		-1	-0.4	+1	nA
		$-55^\circ\text{C} < T_A < +125^\circ\text{C}$			+1.5	nA
Input Offset Current	$I_{OS}$		-0.5	+0.1	+0.5	nA
		$-55^\circ\text{C} < T_A < +125^\circ\text{C}$			+1.0	nA
Input Voltage Range			-13.8		+13	V
Common-Mode Rejection Ratio	CMRR	$V_{CM} = -13.8\text{ V to }+13\text{ V}$ $-55^\circ\text{C} < T_A < +125^\circ\text{C}$	132	150		dB
			130			dB
Large Signal Voltage Gain	$A_V$	$R_L = 2\text{ k}\Omega$ , $V_O = -13.0\text{ V to }+13.0\text{ V}$ $-55^\circ\text{C} < T_A < +125^\circ\text{C}$	125	130		dB
			120			dB
Input Capacitance	$C_{INDM}$	Differential mode		3		pF
	$C_{INCM}$	Common mode		5		pF
Input Resistance	$R_{IN}$	Common mode		70		G $\Omega$
<b>OUTPUT CHARACTERISTICS</b>						
Output Voltage High	$V_{OH}$	$I_L = 1\text{ mA}$ $-55^\circ\text{C} < T_A < +125^\circ\text{C}$	13.8			V
			13.7			V
Output Voltage Low	$V_{OL}$	$I_L = 1\text{ mA}$ $-55^\circ\text{C} < T_A < +125^\circ\text{C}$			-13.8	V
					-13.7	V
Output Current	$I_{OUT}$	$V_{DROPOUT} < 1.2\text{ V}$		$\pm 10$		mA
Short-Circuit Current	$I_{SC}$	$T_A = 25^\circ\text{C}$		22		mA
Closed-Loop Output Impedance	$Z_{OUT}$	$f = 1\text{ kHz}$ , $A_V = +1$		0.05		$\Omega$
<b>POWER SUPPLY</b>						
Power Supply Rejection Ratio	PSRR	$V_S = \pm 2.5\text{ V to } \pm 18\text{ V}$ $-55^\circ\text{C} < T_A < +125^\circ\text{C}$	123	128		dB
			120			dB
Supply Current per Amplifier	$I_{SY}$	$V_O = 0\text{ V}$ $-55^\circ\text{C} < T_A < +125^\circ\text{C}$		400	500	$\mu\text{A}$
					650	$\mu\text{A}$
<b>DYNAMIC PERFORMANCE</b>						
Slew Rate	SR	$R_L = 2\text{ k}\Omega$		1.2		V/ $\mu\text{s}$
Settling Time to 0.01%	$t_s$	$V_{IN} = 10\text{ V p-p}$ , $R_L = 2\text{ k}\Omega$ , $A_V = -1$		16		$\mu\text{s}$
Settling Time to 0.1%	$t_s$	$V_{IN} = 10\text{ V p-p}$ , $R_L = 2\text{ k}\Omega$ , $A_V = -1$		10		$\mu\text{s}$
Gain Bandwidth Product	GBP	$V_{IN} = 10\text{ mV p-p}$ , $R_L = 2\text{ k}\Omega$ , $A_V = +100$		3.6		MHz
Unity-Gain Crossover	UGC	$V_{IN} = 10\text{ mV p-p}$ , $R_L = 2\text{ k}\Omega$ , $A_V = +1$		3.9		MHz
-3 dB Closed-Loop Bandwidth	-3 dB	$A_V = +1$ , $V_{IN} = 10\text{ mV p-p}$ , $R_L = 2\text{ k}\Omega$		5.5		MHz
Phase Margin	$\Phi_M$	$V_{IN} = 10\text{ mV p-p}$ , $R_L = 2\text{ k}\Omega$ , $A_V = +1$		58		Degrees
Total Harmonic Distortion Plus Noise	THD + N	$V_{IN} = 1\text{ V rms}$ , $A_V = +1$ , $R_L = 2\text{ k}\Omega$ , $f = 1\text{ kHz}$		0.004		%
<b>NOISE PERFORMANCE</b>						
Voltage Noise	$e_n$ p-p	0.1 Hz to 10 Hz		0.25		$\mu\text{V p-p}$
Voltage Noise Density	$e_n$	$f = 1\text{ Hz}$		13		nV/ $\sqrt{\text{Hz}}$
		$f = 100\text{ Hz}$		7		nV/ $\sqrt{\text{Hz}}$
		$f = 1000\text{ Hz}$		6.9		nV/ $\sqrt{\text{Hz}}$
Current Noise Density	$i_n$	$f = 1\text{ kHz}$		0.2		pA/ $\sqrt{\text{Hz}}$
<b>MULTIPLE AMPLIFIERS CHANNEL SEPARATION</b>						
	$C_S$	$f = 1\text{ kHz}$ , $R_L = 10\text{ k}\Omega$		-125		dB

**ABSOLUTE MAXIMUM RATINGS**

Table 3.

Parameter	Rating
Supply Voltage	36 V
Input Voltage	$\pm V_{SY}$
Input Current <sup>1</sup>	$\pm 10$ mA
Differential Input Voltage	$\pm V_{SY}$
Output Short-Circuit Duration to GND	Indefinite
Storage Temperature Range	-65°C to +150°C
Operating Temperature Range	-55°C to +125°C
Junction Temperature Range	-65°C to +150°C
Maximum Reflow, Soldering (10 sec)	260°C
ESD Human Body Model (HBM) <sup>2</sup>	6 kV
Field Induced Charge Device Model (FICDM) <sup>3</sup>	1.25 kV

<sup>1</sup> The input pins have clamp diodes to the power supply pins and to each other. Limit the input current to 10 mA or less whenever input signals exceed the power supply rail by 0.3 V.

<sup>2</sup> ESDA/JEDEC JS-001-2011 applicable standard.

<sup>3</sup> JESD22-C101 (ESD FICDM standard of JEDEC) applicable standard.

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**

Thermal performance is directly linked to printed circuit board (PCB) design and operating environment. Careful attention to PCB thermal design is required.

$\theta_{JA}$  is the natural convection junction to ambient thermal resistance measured in a one cubic foot sealed enclosure.  $\theta_{JC}$  is the junction to case thermal resistance.

Table 4. Thermal Resistance

Package Type	$\theta_{JA}$	$\theta_{JC}$	Unit
RM-8 <sup>1</sup>	170	77	°C/W

<sup>1</sup> Thermal impedance simulated values are based on JEDEC JESD51-12.

**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.

## PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

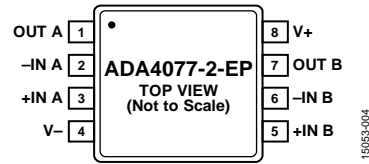


Figure 3. Pin Configuration

Table 5. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	OUT A	Output Channel A.
2	-IN A	Inverting Input Channel A.
3	+IN A	Noninverting Input Channel A.
4	V-	Negative Supply Voltage.
5	+IN B	Noninverting Input Channel B.
6	-IN B	Inverting Input Channel B.
7	OUT B	Output Channel B.
8	V+	Positive Supply Voltage.

# TYPICAL PERFORMANCE CHARACTERISTICS

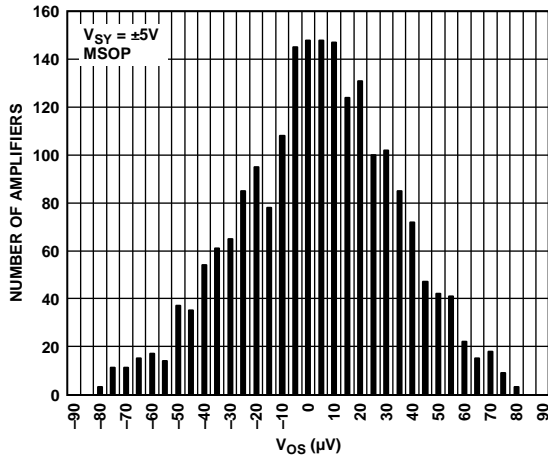


Figure 4. Offset Voltage ( $V_{OS}$ ) Distribution,  $V_{SY} = \pm 5V$

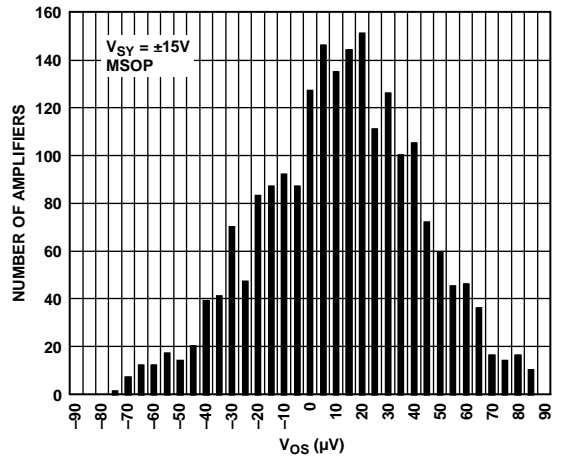


Figure 7. Offset Voltage ( $V_{OS}$ ) Distribution,  $V_{SY} = \pm 15V$

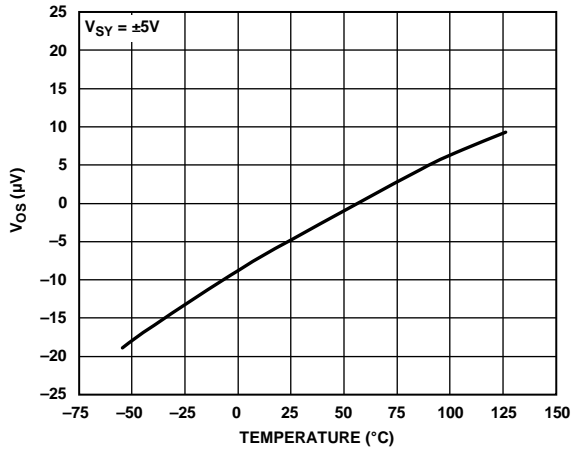


Figure 5. Offset Voltage ( $V_{OS}$ ) vs. Temperature,  $V_{SY} = \pm 5V$

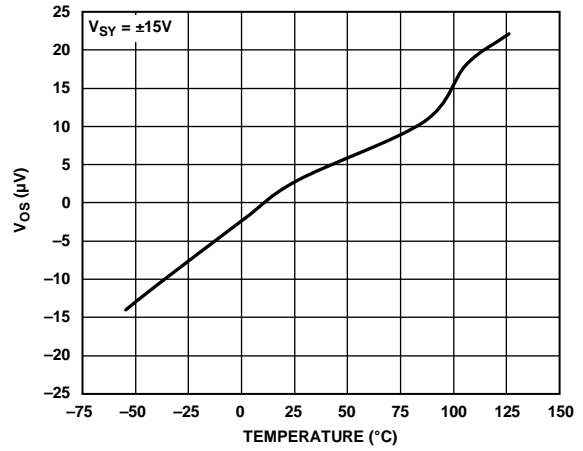


Figure 8. Offset Voltage ( $V_{OS}$ ) vs. Temperature,  $V_{SY} = \pm 15V$

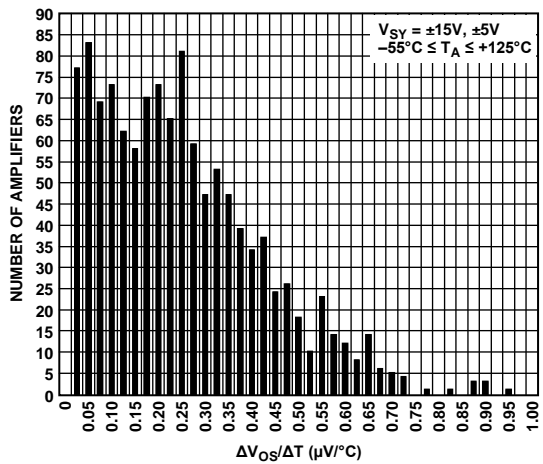


Figure 6. Offset Voltage Drift ( $\Delta V_{OS}/\Delta T$ ) Distribution

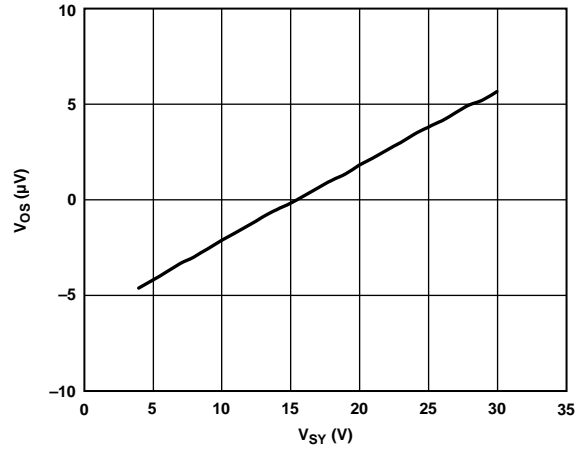


Figure 9. Offset Voltage ( $V_{OS}$ ) vs. Power Supply Voltage ( $V_{SY}$ )

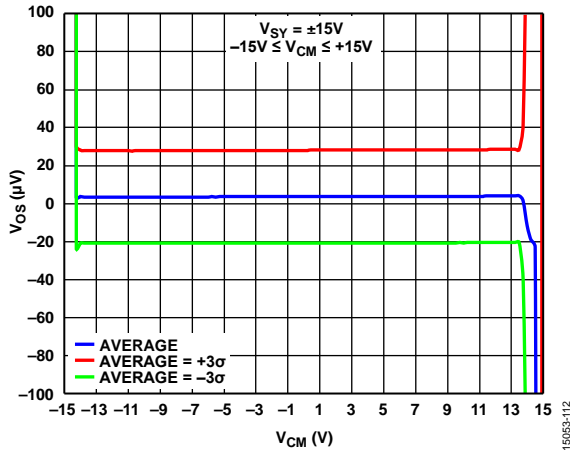


Figure 10. Offset Voltage ( $V_{OS}$ ) vs. Common-Mode Voltage ( $V_{CM}$ ),  $V_{SY} = \pm 15 V$

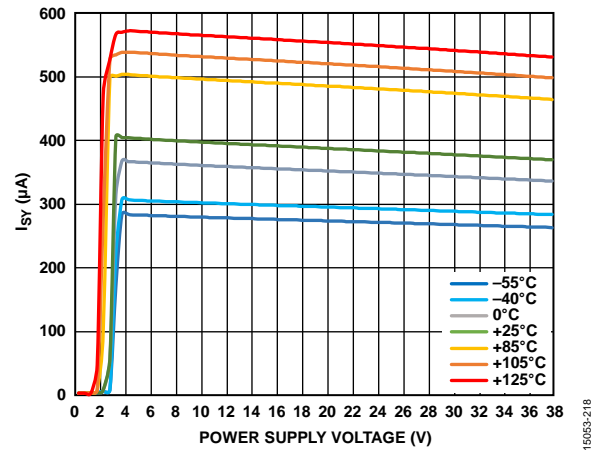


Figure 13. Supply Current per Amplifier ( $I_{SY}$ ) vs. Power Supply Voltage ( $V_{SY}$ )

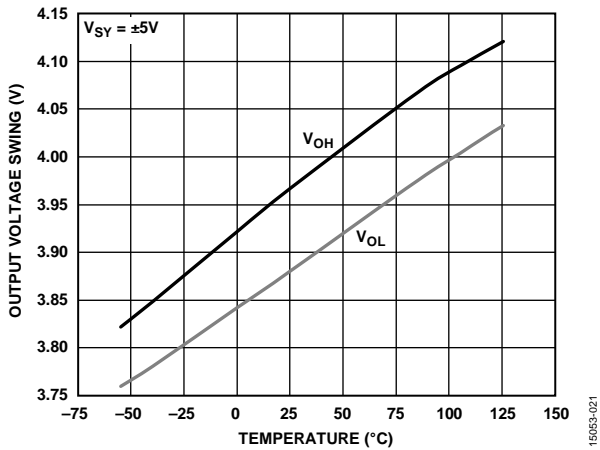


Figure 11. Output Voltage Swing vs. Temperature,  $V_{SY} = \pm 5 V$

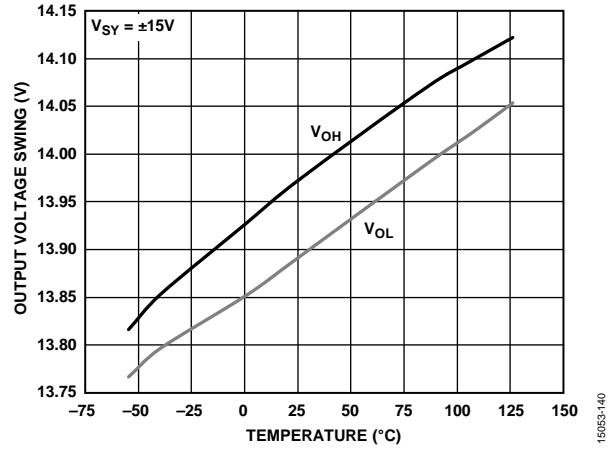


Figure 14. Output Voltage Swing vs. Temperature,  $V_{SY} = \pm 15 V$

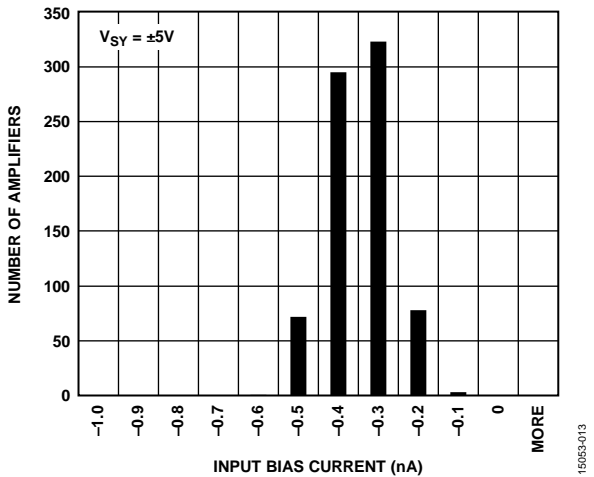


Figure 12. Input Bias Current Distribution,  $V_{SY} = \pm 5 V$

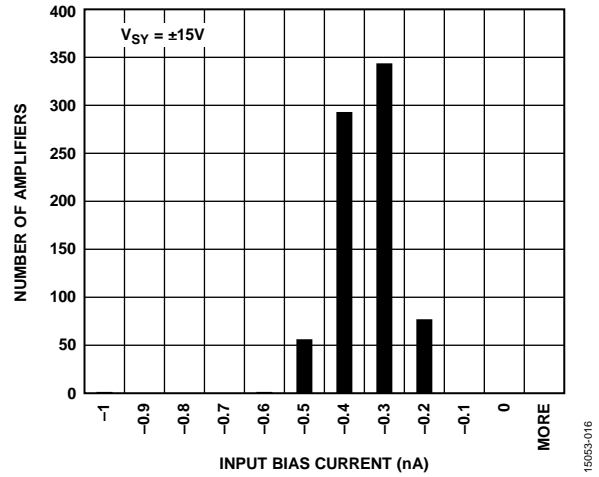


Figure 15. Input Bias Current Distribution,  $V_{SY} = \pm 15 V$



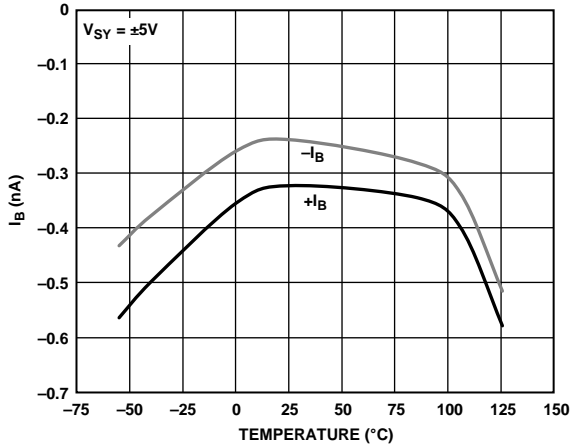


Figure 16. Input Bias Current ( $I_b$ ) vs. Temperature,  $V_{SY} = \pm 5V$

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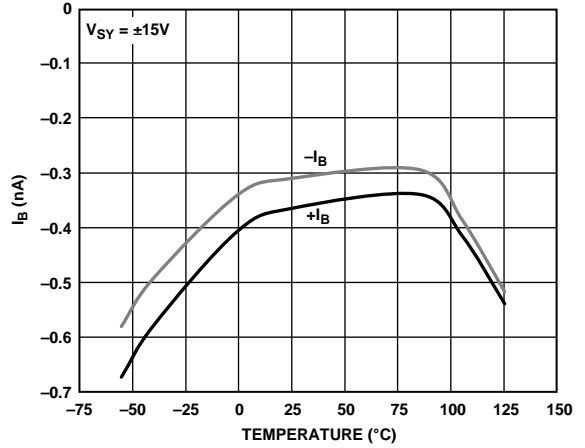


Figure 19. Input Bias Current ( $I_b$ ) vs. Temperature,  $V_{SY} = \pm 15V$

15063-017

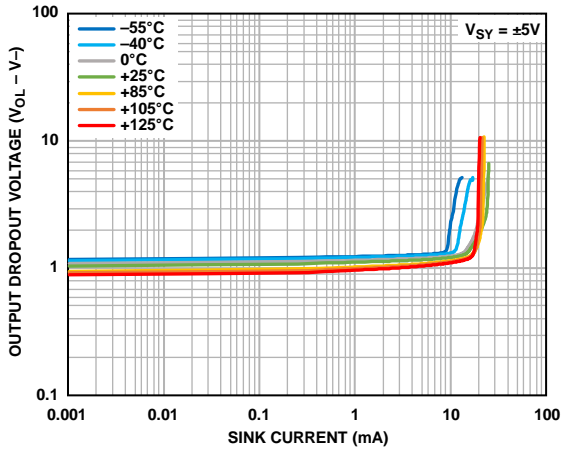


Figure 17. Output Dropout Voltage vs. Sink Current,  $V_{SY} = \pm 5V$

15063-222

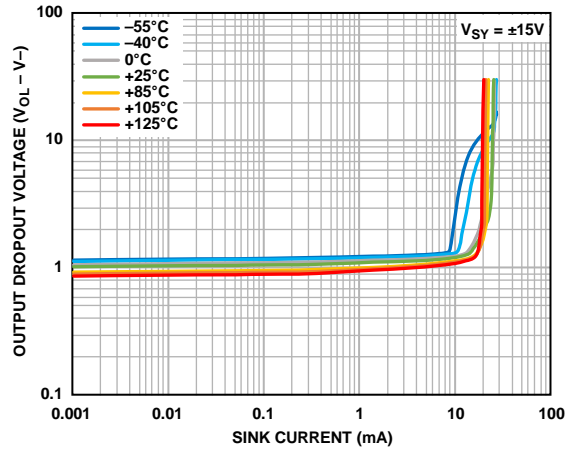


Figure 20. Output Dropout Voltage vs. Sink Current,  $V_{SY} = \pm 15V$

15063-225

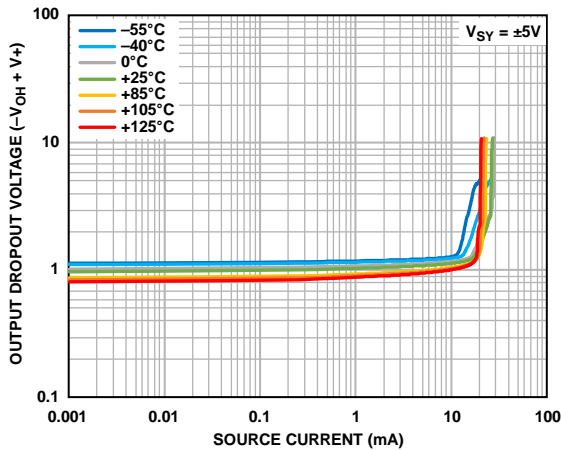


Figure 18. Output Dropout Voltage vs. Source Current,  $V_{SY} = \pm 5V$

15063-226

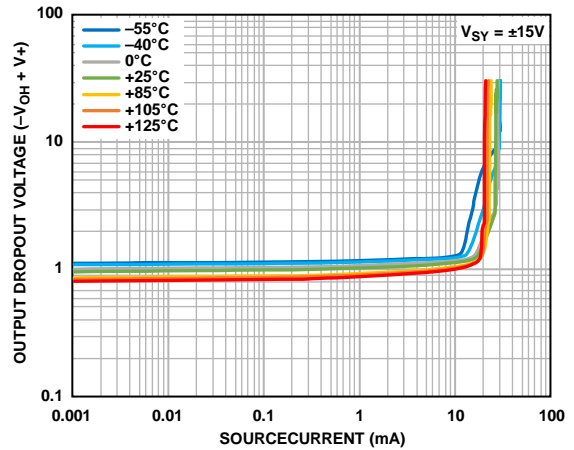


Figure 21. Output Dropout Voltage vs. Source Current,  $V_{SY} = \pm 15V$

15063-229

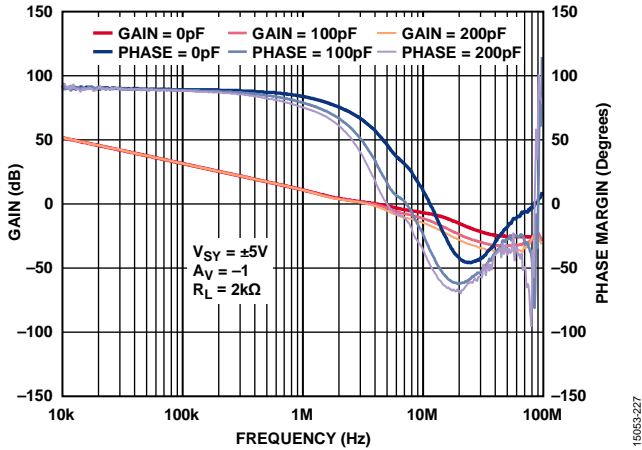


Figure 22. Open-Loop Gain and Phase Margin vs. Frequency,  $V_{SY} = \pm 5 V$

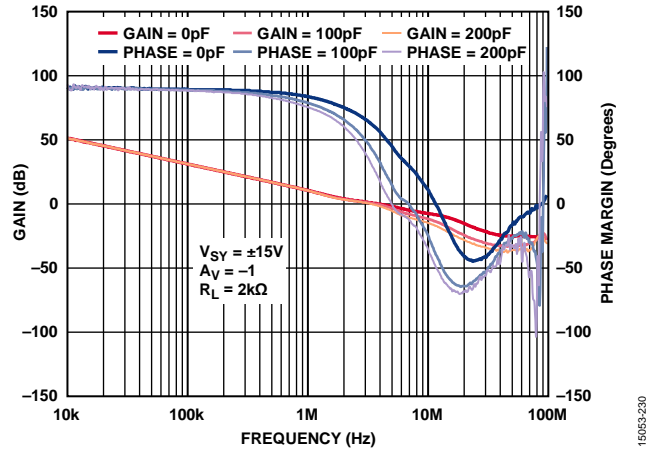


Figure 25. Open-Loop Gain and Phase Margin vs. Frequency,  $V_{SY} = \pm 15 V$

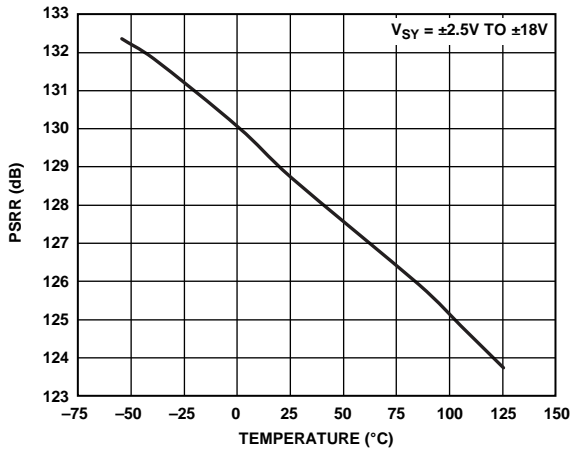


Figure 23. PSRR vs. Temperature,  $V_{SY} = \pm 2.5 V$  to  $\pm 18 V$

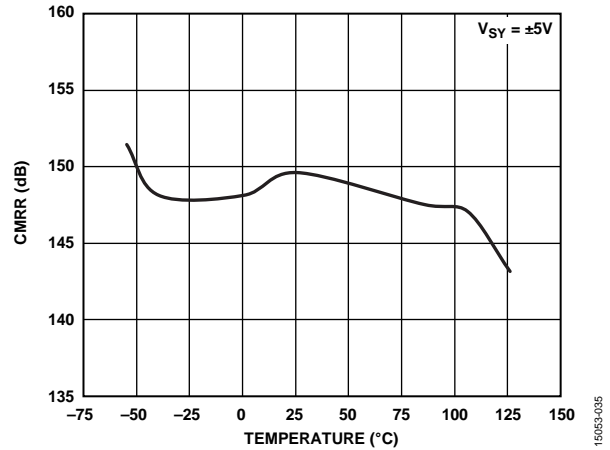


Figure 26. CMRR vs. Temperature,  $V_{SY} = \pm 5 V$

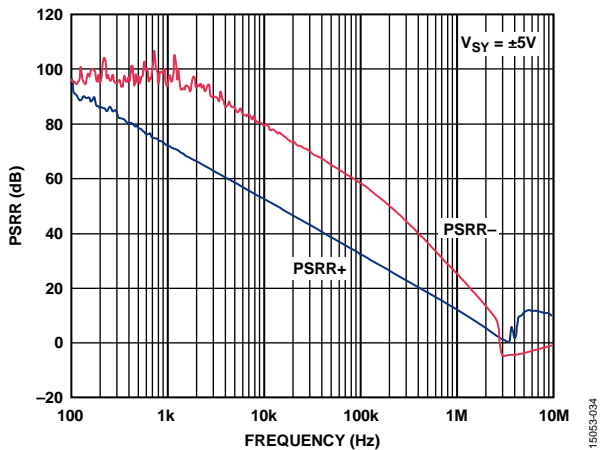


Figure 24. PSRR vs. Frequency,  $V_{SY} = \pm 5 V$

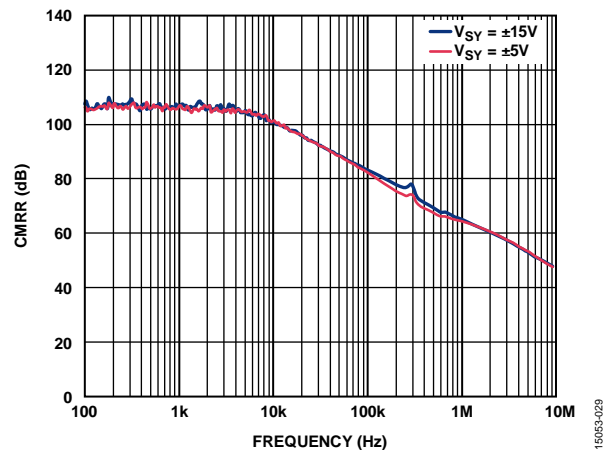


Figure 27. CMRR vs. Frequency,  $V_{SY} = \pm 5 V$  and  $V_{SY} = \pm 15 V$

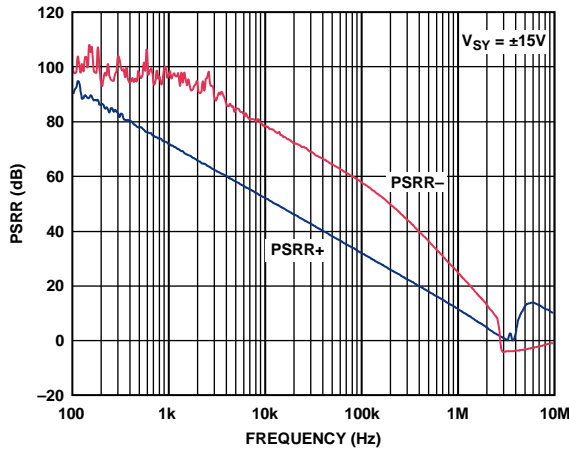


Figure 28. PSRR vs. Frequency,  $V_{SY} = \pm 15 V$

15063-037

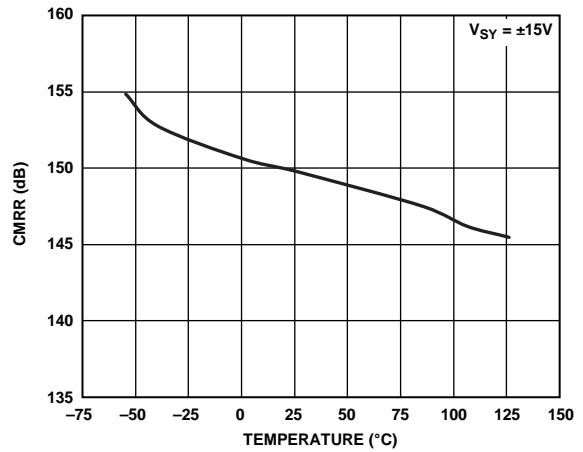


Figure 31. CMRR vs. Temperature,  $V_{SY} = \pm 15 V$

15063-033

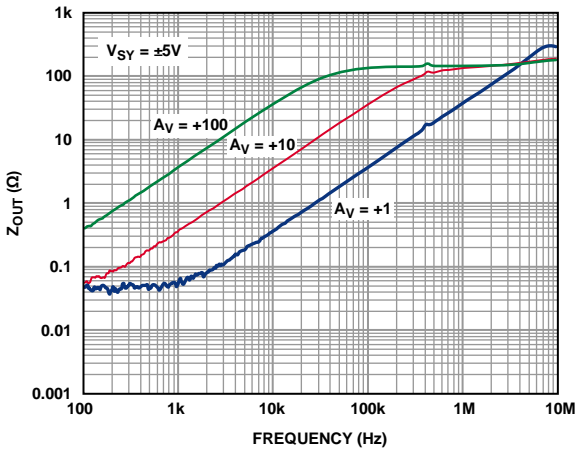


Figure 29. Output Impedance ( $Z_{OUT}$ ) vs. Frequency,  $V_{SY} = \pm 5 V$

15063-036

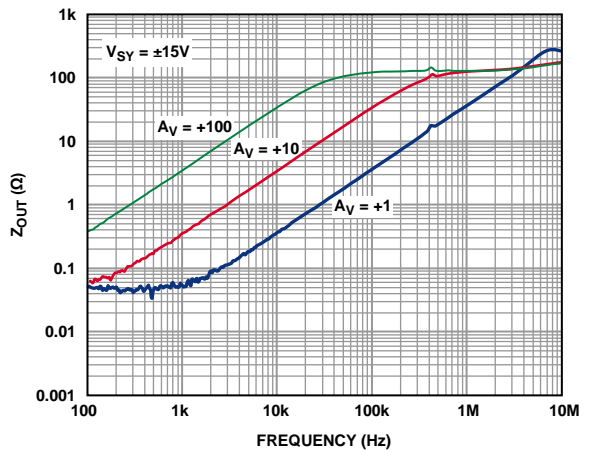


Figure 32. Output Impedance ( $Z_{OUT}$ ) vs. Frequency,  $V_{SY} = \pm 15 V$

15063-039

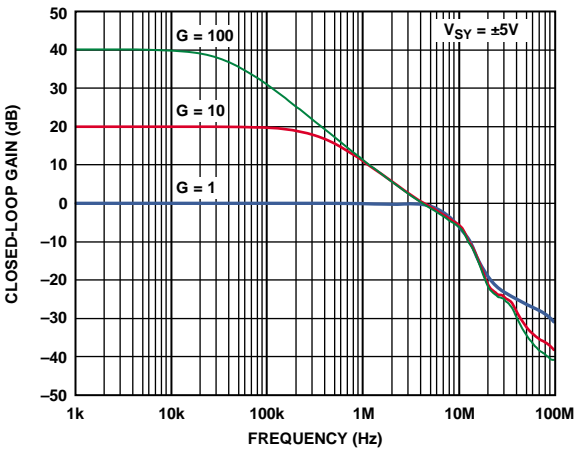


Figure 30. Closed-Loop Gain vs. Frequency,  $V_{SY} = \pm 5 V$

15063-028

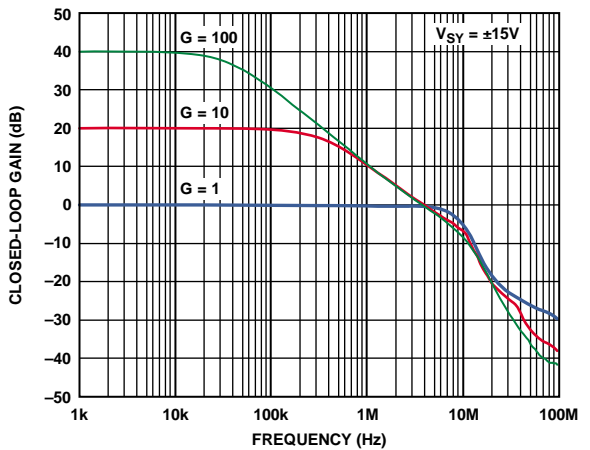


Figure 33. Closed-Loop Gain vs. Frequency,  $V_{SY} = \pm 15 V$

15063-031

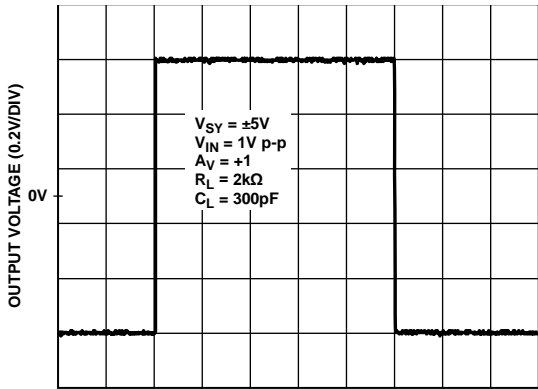


Figure 34. Large Signal Transient Response,  $V_{SY} = \pm 5 V$

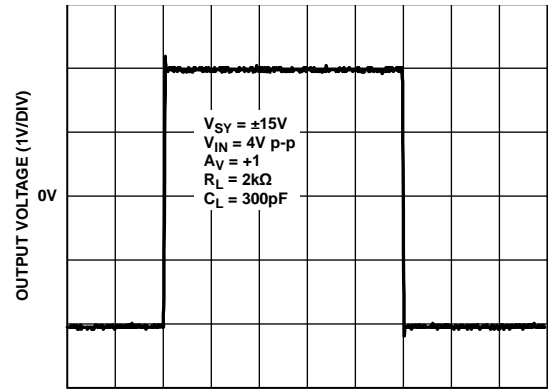


Figure 37. Large Signal Transient Response,  $V_{SY} = \pm 15 V$

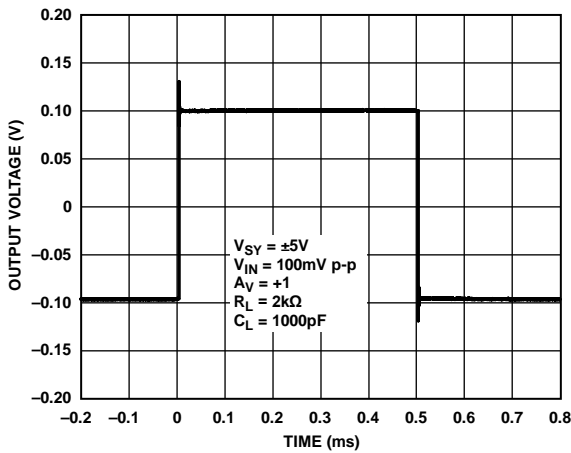


Figure 35. Small Signal Transient Response,  $V_{SY} = \pm 5 V$

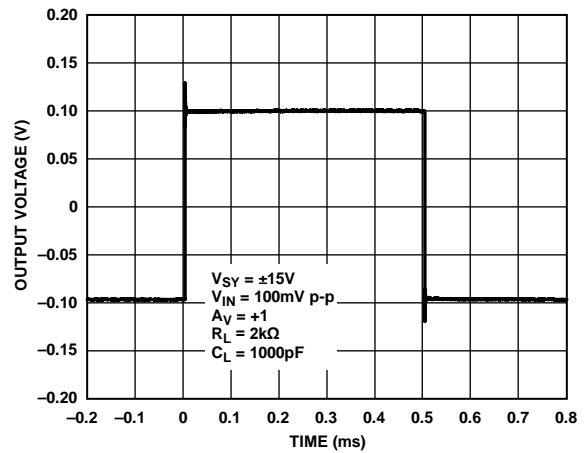


Figure 38. Small Signal Transient Response,  $V_{SY} = \pm 15 V$

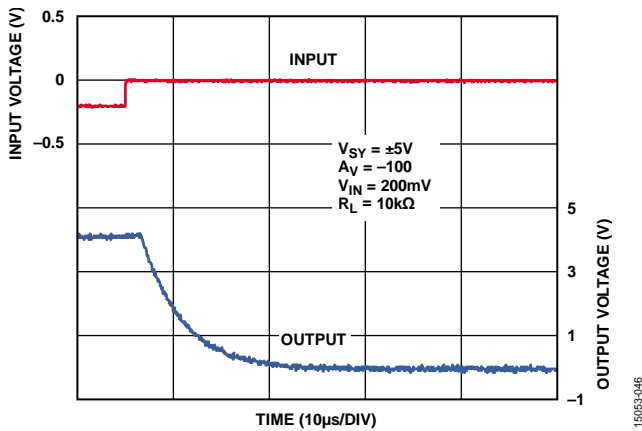


Figure 36. Positive Overload Recovery,  $V_{SY} = \pm 5 V$

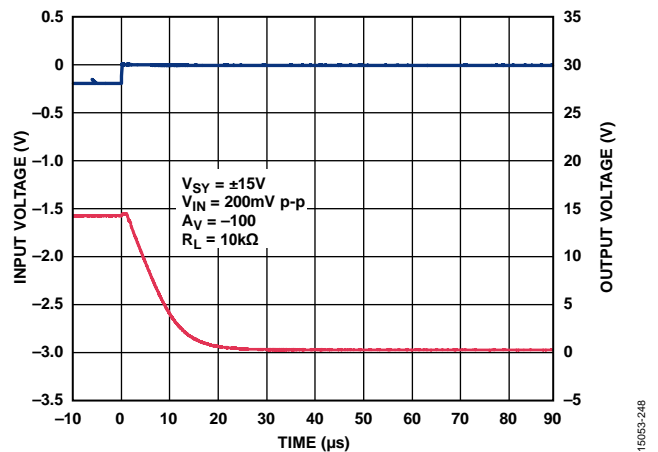


Figure 39. Positive Overload Recovery,  $V_{SY} = \pm 15 V$

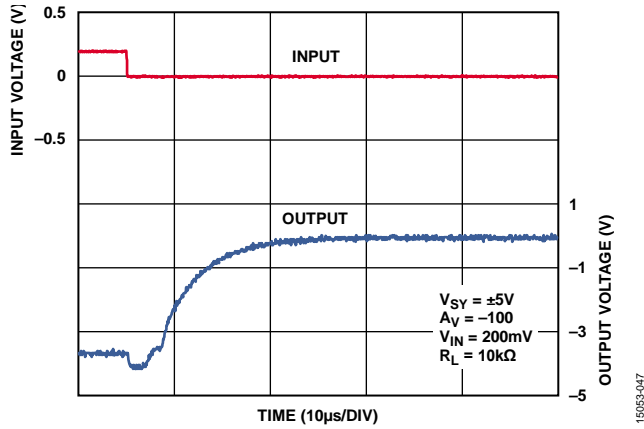


Figure 40. Negative Overload Recovery,  $V_{SY} = \pm 5 V$

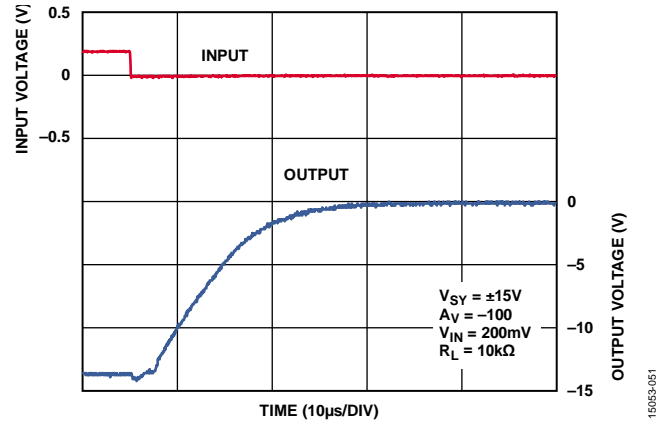


Figure 43. Negative Overload Recovery,  $V_{SY} = \pm 15 V$

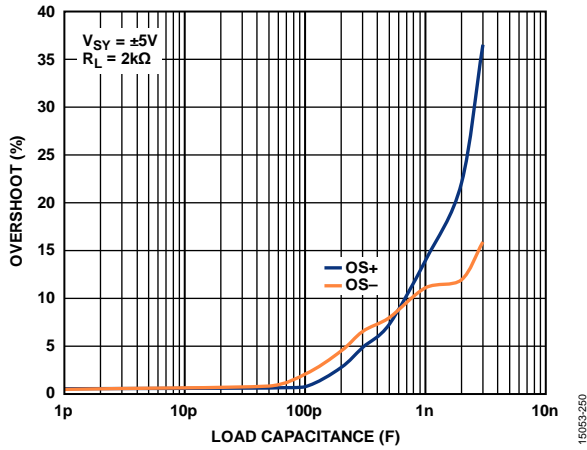


Figure 41. Small Signal Overshoot vs. Load Capacitance,  $V_{SY} = \pm 5 V$

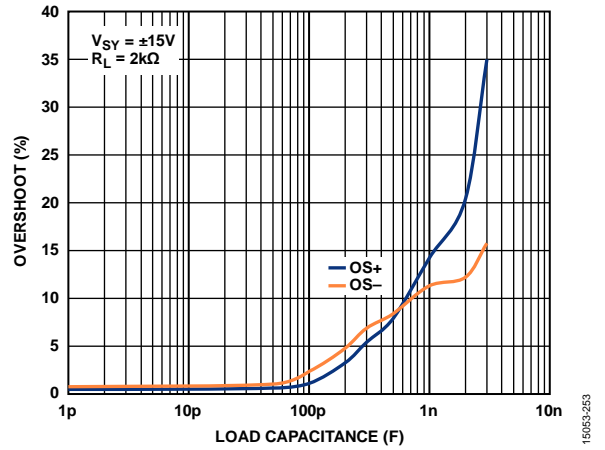


Figure 44. Small Signal Overshoot vs. Load Capacitance,  $V_{SY} = \pm 15 V$

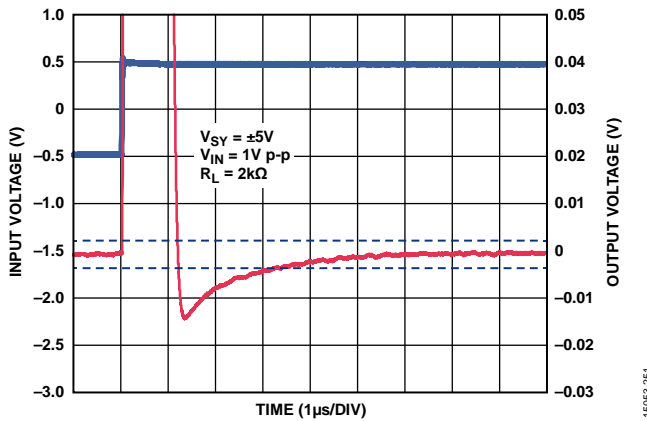


Figure 42. Positive 0.1% Settling Time,  $V_{SY} = \pm 5 V$

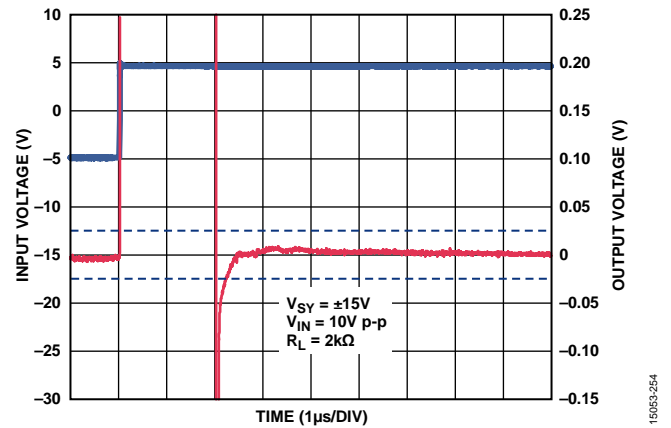


Figure 45. Positive 0.1% Settling Time,  $V_{SY} = \pm 15 V$

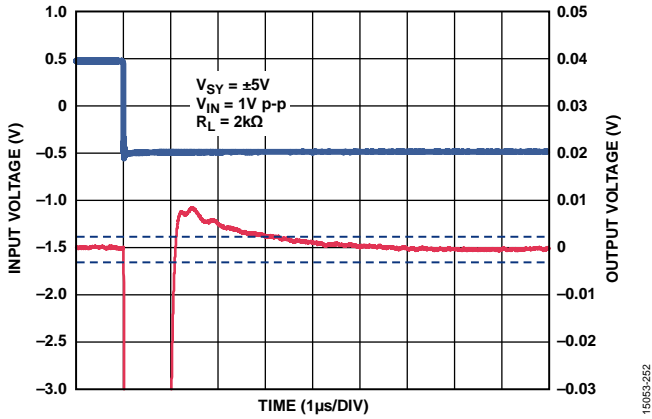


Figure 46. Negative 0.1% Settling Time,  $V_{SY} = \pm 5V$

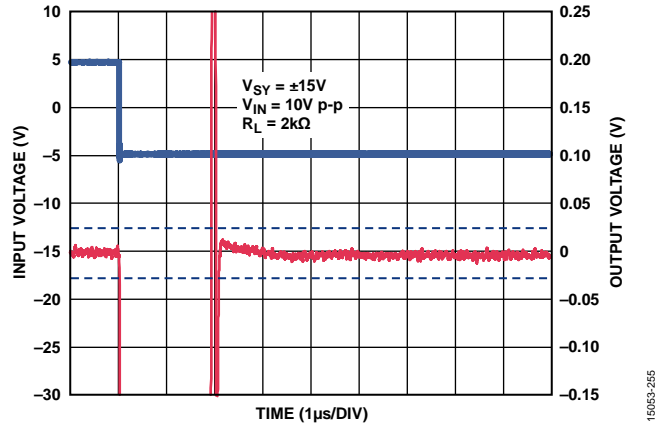


Figure 49. Negative 0.1% Settling Time,  $V_{SY} = \pm 15V$

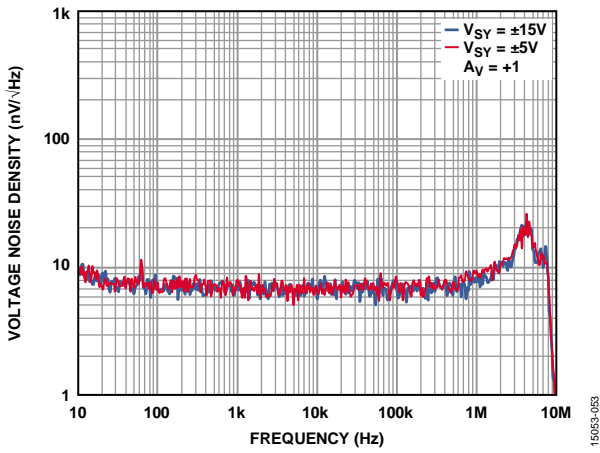


Figure 47. Voltage Noise Density vs. Frequency,  $V_{SY} = \pm 5V$  and  $V_{SY} = \pm 15V$

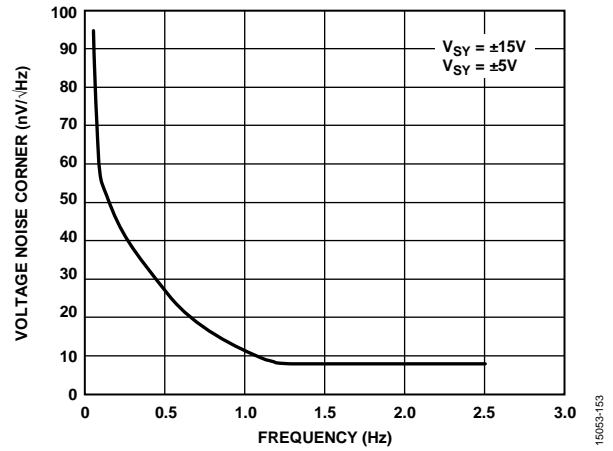


Figure 50. Voltage Noise Corner vs. Frequency,  $V_{SY} = \pm 15V$  and  $V_{SY} = \pm 5V$

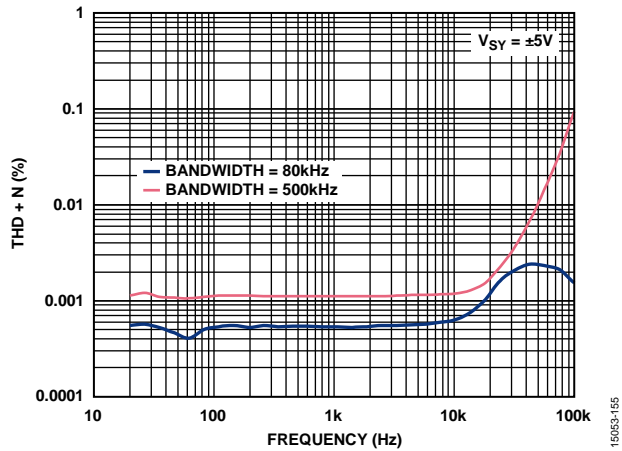


Figure 48. THD + N vs. Frequency,  $V_{SY} = \pm 5V$

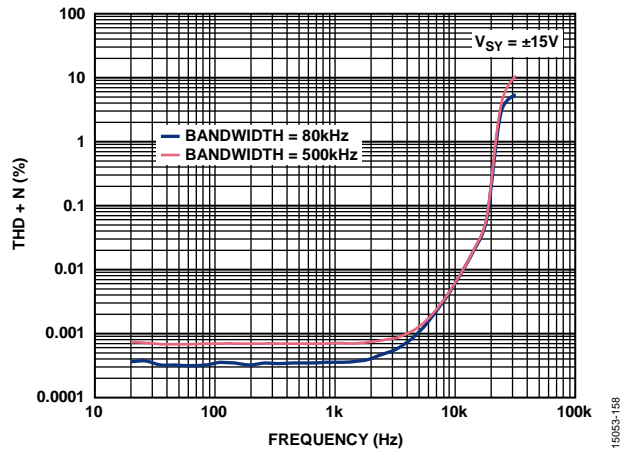


Figure 51. THD + N vs. Frequency,  $V_{SY} = \pm 15V$

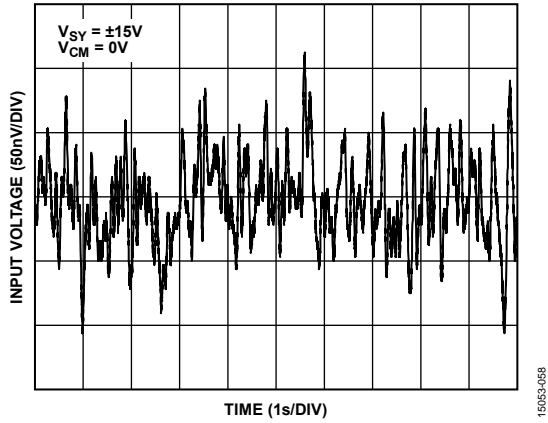


Figure 52. 0.1 Hz to 10 Hz Noise,  $V_{SV} = \pm 15 V$

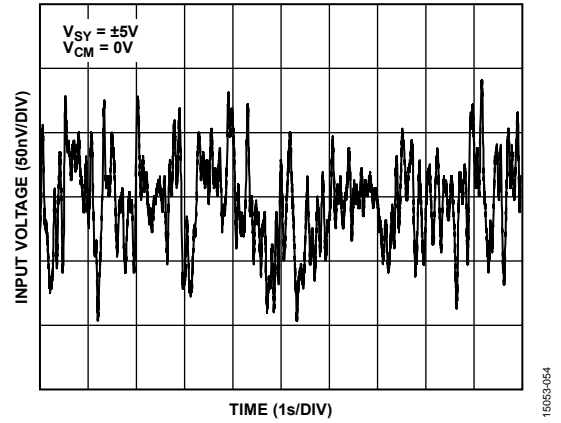


Figure 55. 0.1 Hz to 10 Hz Noise,  $V_{SV} = \pm 5 V$

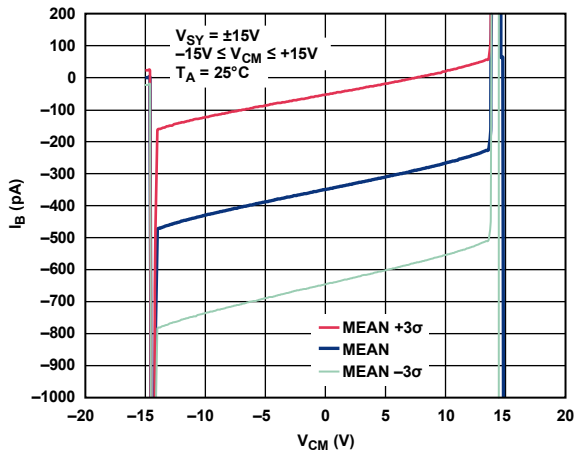


Figure 53. Input Bias Current ( $I_b$ ) vs. Common-Mode Voltage ( $V_{CM}$ )

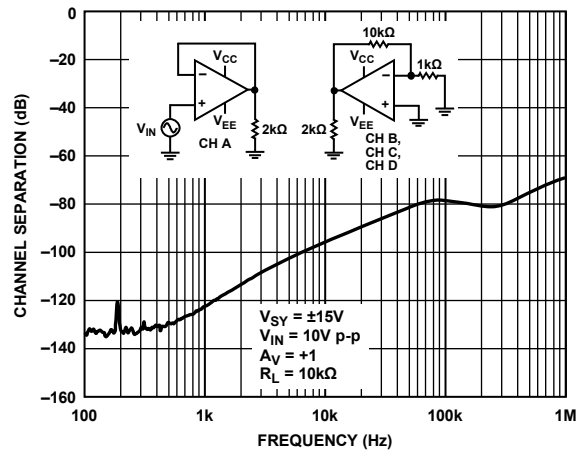


Figure 56. Channel Separation,  $V_{SV} = \pm 15 V$

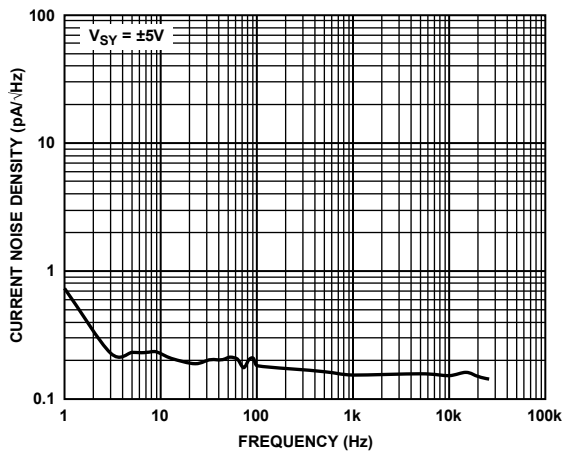


Figure 54. Current Noise Density vs. Frequency,  $V_{SV} = \pm 5 V$

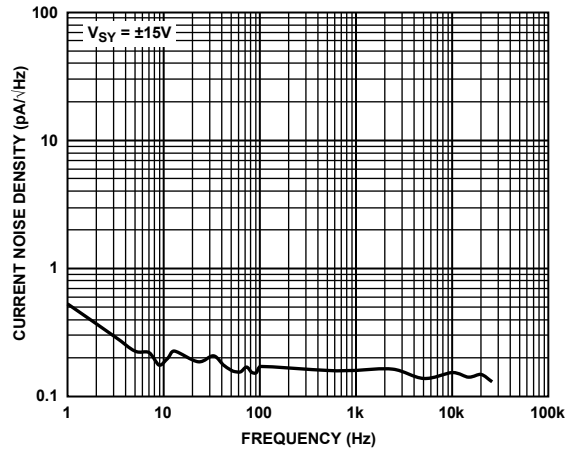


Figure 57. Current Noise Density vs. Frequency,  $V_{SV} = \pm 15 V$

OUTLINE DIMENSIONS

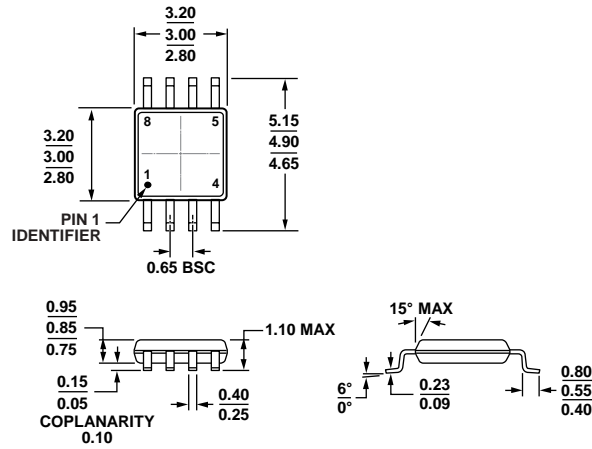


Figure 58. 8-Lead Mini Small Outline Package [MSOP] (RM-8)  
Dimensions shown in millimeters

ORDERING GUIDE

Model <sup>1</sup>	Temperature Range	Package Description	Package Option	Branding
ADA4077-2TRMZ-EP	-55°C to +125°C	8-Lead Mini Small Outline Package [MSOP]	RM-8	Y6Q
ADA4077-2TRMZ-EPR7	-55°C to +125°C	8-Lead Mini Small Outline Package [MSOP]	RM-8	Y6Q

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