

## FEATURES

### Very low power

330  $\mu$ A supply current

### Fully differential or single-ended inputs/outputs

#### Differential output designed to drive precision ADCs

Drives switched capacitor and  $\Sigma$ - $\Delta$  ADCs

Rail-to-rail outputs

### VOCM pin adjusts output common mode

### Robust overvoltage up to 18 V beyond supplies

### High performance

Suitable for driving 16-bit converter up to 250 kSPS

39 nV/ $\sqrt{\text{Hz}}$  output noise

1 ppm/ $^{\circ}\text{C}$  gain drift maximum

200  $\mu$ V maximum output offset

10 V/ $\mu$ s slew rate

5 MHz bandwidth

Single supply: 3 V to 18 V

Dual supplies:  $\pm 1.5$  V to  $\pm 9$  V

## APPLICATIONS

### ADC driver

### Differential instrumentation amplifier building block

### Single-ended-to-differential converter

### Battery-powered instruments

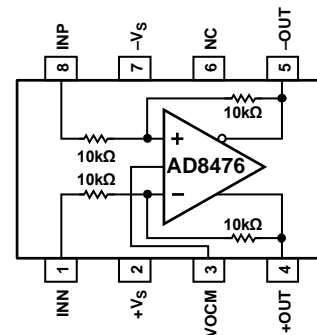
## GENERAL DESCRIPTION

The **AD8476** is a very low power, fully differential precision amplifier with integrated gain resistors for unity gain. It is an ideal choice for driving low power, high performance ADCs as a single-ended-to-differential or differential-to-differential amplifier. It provides a precision gain of 1, common-mode level shifting, low temperature drift, and rail-to-rail outputs for maximum dynamic range.

The **AD8476** also provides overvoltage protection from large industrial input voltages up to  $\pm 23$  V while operating on a dual 5 V supply. Power dissipation on a single 5 V supply is only 1.5 mW.

The **AD8476** works well with SAR,  $\Sigma$ - $\Delta$ , and pipeline converters. The high current output stage of the part allows it to drive the

## FUNCTIONAL BLOCK DIAGRAM



NOTES  
1. NC = NO CONNECT.  
DO NOT CONNECT TO THIS PIN.

Figure 1.

10195F-001

switched capacitor front-end circuits of many ADCs with minimal error.

Unlike many differential drivers on the market, the **AD8476** is a high precision amplifier. With 200  $\mu$ V maximum output offset, 39 nV/ $\sqrt{\text{Hz}}$  noise, and  $-102$  dB THD + N at 10 kHz, the **AD8476** pairs well with low power, high accuracy converters.

Considering its low power consumption and high precision, the slew-enhanced **AD8476** has excellent speed, settling to 16-bit precision for 250 kSPS acquisition times.

The **AD8476** is available in a space-saving 8-lead MSOP package. It is fully specified over the  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  temperature range.

### Rev. A

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## REVISION HISTORY

### 11/11—Rev. 0 to Rev. A

Changes to Table 1 .....	3
Changes to Typical Performance Characteristics.....	7
Added Figure 39; Renumbered Sequentially .....	13
Added Table 5.....	18
Removed Low Power ADC Driving Section.....	19
Removed Figure 52.....	19

### 10/11—Revision 0: Initial Version

## SPECIFICATIONS

$V_S = +5$  to  $\pm 5$  V,  $VOCM = \text{midsupply}$ ,  $V_{OUT} = V_{+OUT} - V_{-OUT}$ ,  $R_L = 2$  k $\Omega$  differential, referred to output (RTO),  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 1.

Parameter	Test Conditions/Comments	B Grade			A Grade			Unit
		Min	Typ	Max	Min	Typ	Max	
<b>DYNAMIC PERFORMANCE</b>								
-3 dB Small Signal Bandwidth	$V_{OUT} = 200$ mV p-p		5		5			MHz
-3 dB Large Signal Bandwidth	$V_{OUT} = 2$ V p-p		1		1			MHz
Slew Rate	$V_{OUT} = 2$ V step		10		10			V/ $\mu\text{s}$
Settling Time to 0.01%	$V_{OUT} = 2$ V step		1.0		1.0			$\mu\text{s}$
Settling Time to 0.001%	$V_{OUT} = 2$ V step		1.6		1.6			$\mu\text{s}$
<b>NOISE/DISTORTION<sup>1</sup></b>								
THD + N	$f = 10$ kHz, $V_{OUT} = 2$ V p-p, 22 kHz filter		-102		-102			dB
HD2	$f = 10$ kHz, $V_{OUT} = 2$ V p-p		-120		-120			dB
HD3	$f = 10$ kHz, $V_{OUT} = 2$ V p-p		-122		-122			dB
IMD3	$f_1 = 95$ kHz, $f_2 = 105$ kHz, $V_{OUT} = 2$ V p-p		-82		-82			dBc
Output Voltage Noise	$f = 0.1$ Hz to 10 Hz		6		6			$\mu\text{V}$ p-p
Spectral Noise Density	$f = 10$ kHz		39		39			nV/ $\sqrt{\text{Hz}}$
<b>GAIN</b>								
Gain Error	$R_L = \infty$			0.02		0.04		%
Gain Drift	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$			1		1		ppm/ $^\circ\text{C}$
Gain Nonlinearity	$V_{OUT} = 4$ V p-p		5		5			ppm
<b>OFFSET AND CMRR</b>								
Differential Offset <sup>2</sup>			50	200		50	500	$\mu\text{V}$
vs. Temperature	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$			900			900	$\mu\text{V}$
Average TC	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		1	4		1	4	$\mu\text{V}/^\circ\text{C}$
vs. Power Supply (PSRR)	$V_S = \pm 2.5$ V to $\pm 9$ V	90			90			dB
Common-Mode Offset <sup>2</sup>			50		50			$\mu\text{V}$
Common-Mode Rejection Ratio	$V_{IN,cm} = \pm 5$ V	90			80			dB
<b>INPUT CHARACTERISTICS</b>								
Input Voltage Range <sup>3</sup>	Differential input	$-V_S + 0.05$		$+V_S - 0.05$	$-V_S + 0.05$		$+V_S - 0.05$	V
	Single-ended input	$2(-V_S + 0.05)$		$2(+V_S - 0.05)$	$2(-V_S + 0.05)$		$2(+V_S - 0.05)$	V
Impedance <sup>4</sup>	$V_{cm} = V_S/2$							
Single-Ended Input			13.3		13.3			k $\Omega$
Differential Input			20		20			k $\Omega$
Common-Mode Input			10		10			k $\Omega$
<b>OUTPUT CHARACTERISTICS</b>								
Output Swing	$V_S = +5$ V	$-V_S + 0.125$		$+V_S - 0.14$	$-V_S + 0.125$		$+V_S - 0.14$	
	$V_S = \pm 5$ V	$-V_S + 0.155$		$+V_S - 0.18$	$-V_S + 0.155$		$+V_S - 0.18$	
Output Balance Error	$\Delta V_{OUT,cm}/\Delta V_{OUT,dm}$	90			80			dB
Output Impedance			0.1		0.1			$\Omega$
Capacitive Load	Per output		20		20			pF
Short-Circuit Current Limit			35		35			mA
<b>VOCM CHARACTERISTICS</b>								
VOCM Input Voltage Range		$-V_S + 1$		$+V_S - 1$	$-V_S + 1$		$+V_S - 1$	V
VOCM Input Impedance			500		500			k $\Omega$
VOCM Gain Error				0.05			0.05	%

Parameter	Test Conditions/Comments	B Grade			A Grade			Unit
		Min	Typ	Max	Min	Typ	Max	
POWER SUPPLY								
Specified Supply Voltage			±5			±5		V
Operating Supply Voltage Range		3		18	3		18	V
Supply Current	$V_S = +5\text{ V}, T_A = 25^\circ\text{C}$		300	330		300	330	μA
	$V_S = \pm 5\text{ V}, T_A = 25^\circ\text{C}$		330	380		330	380	μA
Over Temperature	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		400	500		400	500	μA
TEMPERATURE RANGE								
Specified Performance Range		-40		+125	-40		+125	°C

<sup>1</sup> Includes amplifier voltage and current noise, as well as noise of internal resistors.

<sup>2</sup> Includes input bias and offset current errors.

<sup>3</sup> The input voltage range is a function of the voltage supplies and ESD diodes.

<sup>4</sup> Internal resistors are trimmed to be ratio matched but have ±20% absolute accuracy.

## ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Supply Voltage	$\pm 10\text{ V}$
Maximum Voltage at Any Input Pin	$+V_S + 18\text{ V}$
Minimum Voltage at Any Input Pin	$-V_S - 18\text{ V}$
Storage Temperature Range	$-65^\circ\text{C}$ to $+150^\circ\text{C}$
Specified Temperature Range	$-40^\circ\text{C}$ to $+125^\circ\text{C}$
Package Glass Transition Temperature ( $T_G$ )	$150^\circ\text{C}$
ESD (Human Body Model)	$2500\text{ V}$

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 RESISTANCE

The  $\theta_{JA}$  values in Table 3 assume a 4-layer JEDEC standard board with zero airflow.

Table 3. Thermal Resistance

Package Type	$\theta_{JA}$	Unit
8-Lead MSOP	209.0	$^\circ\text{C}/\text{W}$

## MAXIMUM POWER DISSIPATION

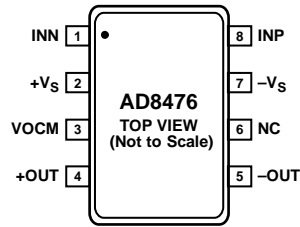
The maximum safe power dissipation for the AD8476 is limited by the associated rise in junction temperature ( $T_J$ ) on the die. At approximately  $150^\circ\text{C}$ , which is the glass transition temperature, the properties of the plastic change. Even temporarily exceeding this temperature limit may change the stresses that the package exerts on the die, permanently shifting the parametric performance of the amplifiers. Exceeding a temperature of  $150^\circ\text{C}$  for an extended period may result in a loss of functionality.

## 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



NOTES  
 1. NC = NO CONNECT.  
 DO NOT CONNECT TO THIS PIN.

10195-004

Figure 2. 8-Lead MSOP Pin Configuration

Table 4. 8-Lead MSOP Pin Function Descriptions

Pin No.	Mnemonic	Description
1	INN	Negative Input .
2	+V <sub>s</sub>	Positive Supply.
3	VOCM	Output Common-Mode Adjust.
4	+OUT	Noninverting Output.
5	-OUT	Inverting Output.
6	NC	No Connect.
7	-V <sub>s</sub>	Negative Supply.
8	INP	Positive Input.

### TYPICAL PERFORMANCE CHARACTERISTICS

$V_S = +5\text{ V}$ ,  $G = 1$ ,  $\text{VOCM}$  connected to  $2.5\text{ V}$ ,  $R_L = 2\text{ k}\Omega$  differentially,  $T_A = 25^\circ\text{C}$ , referred to output (RTO), unless otherwise noted.

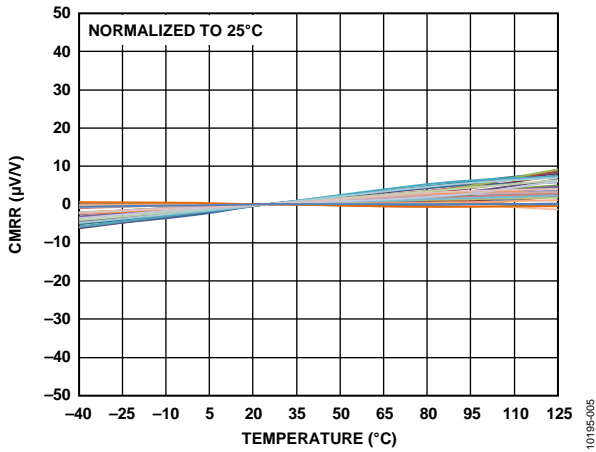


Figure 3. CMRR vs. Temperature

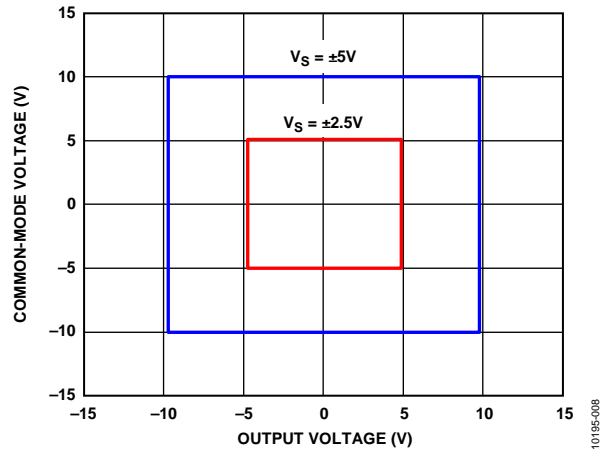


Figure 6. Input Common-Mode Voltage vs. Output Voltage,  $V_S = \pm 5\text{ V}$  and  $\pm 2.5\text{ V}$

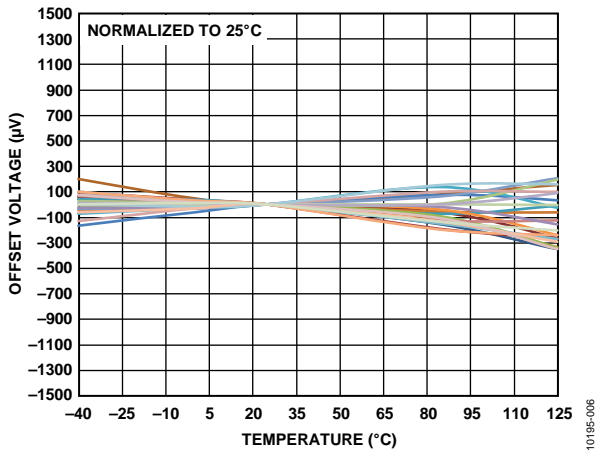


Figure 4. System Offset Temperature Drift

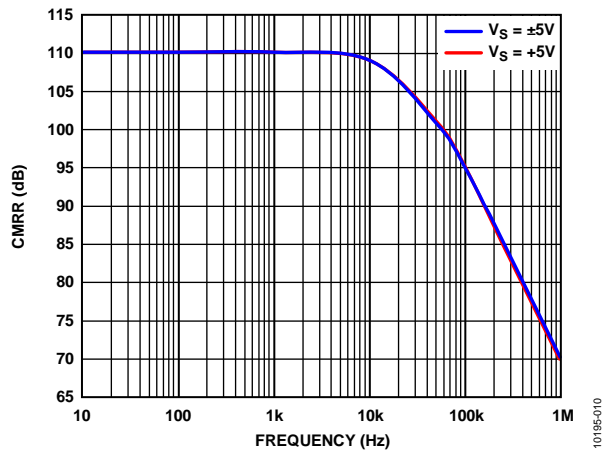


Figure 7. Common-Mode Rejection vs. Frequency

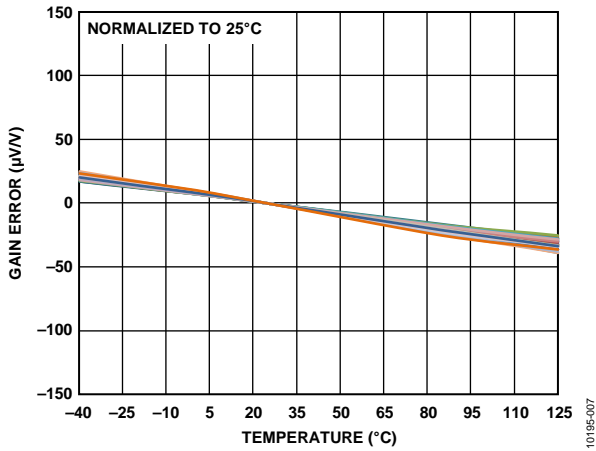


Figure 5. Gain Error vs. Temperature

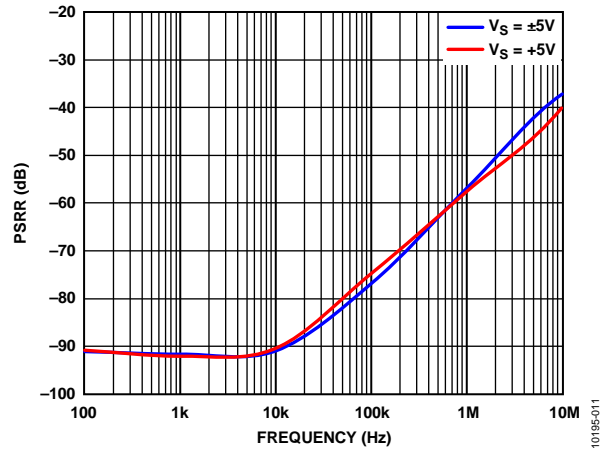


Figure 8. Power Supply Rejection vs. Frequency

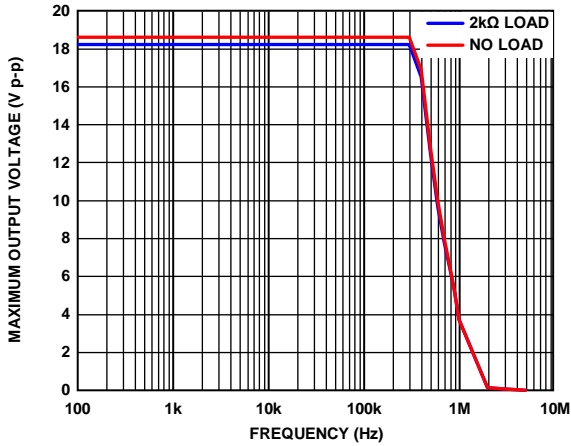


Figure 9. Maximum Output Voltage vs. Frequency

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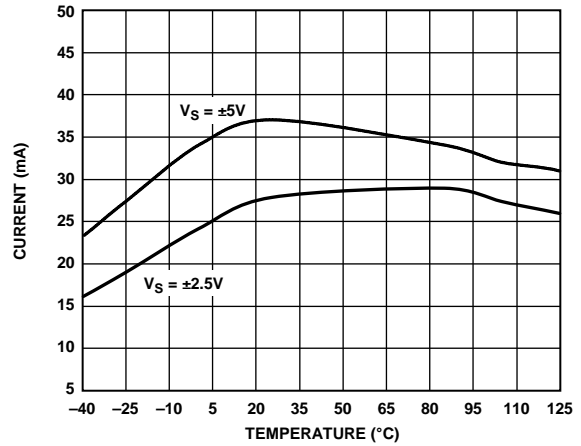


Figure 12. Short-Circuit Current vs. Temperature

10195-016

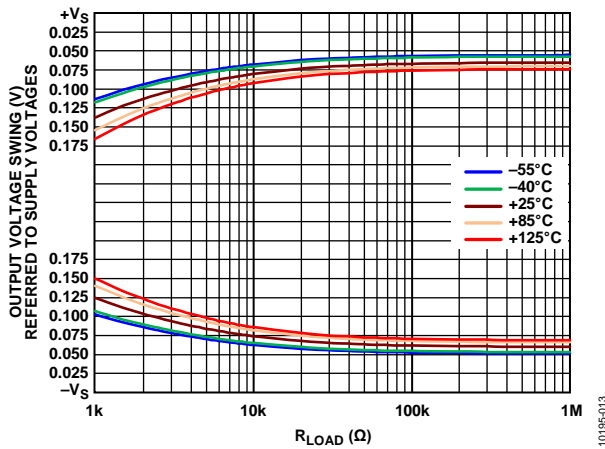


Figure 10. Output Voltage Swing vs.  $R_{LOAD}$  vs. Temperature,  $V_S = \pm 5 V$

10195-013

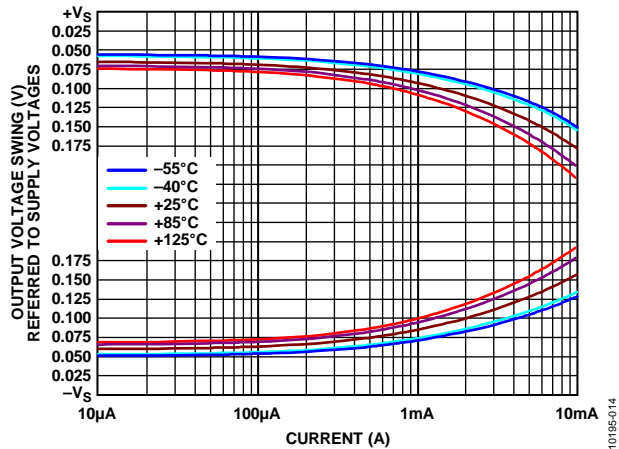


Figure 13. Output Voltage Swing vs. Load Current vs. Temperature,  $V_S = \pm 5 V$

10195-014

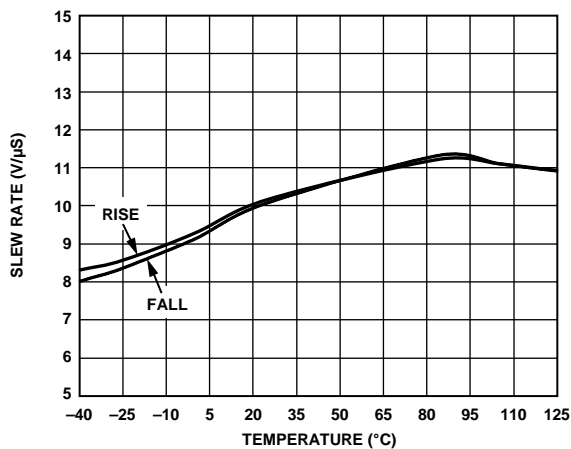


Figure 11. Slew Rate vs. Temperature

10195-015

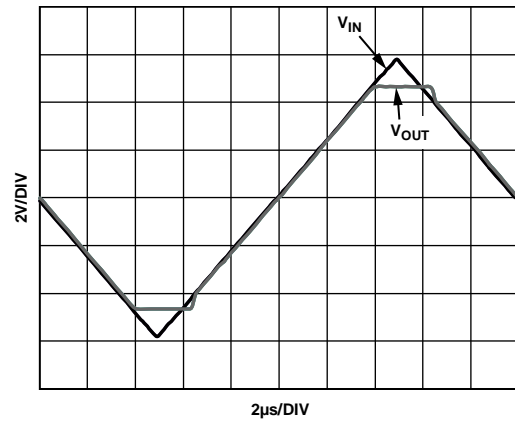


Figure 14. Overdrive Recovery,  $V_S = +5 V$

10195-051



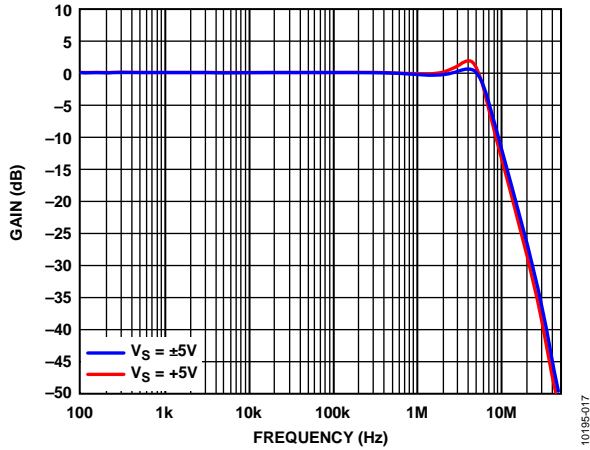


Figure 15. Small Signal Frequency Response for Various Supplies

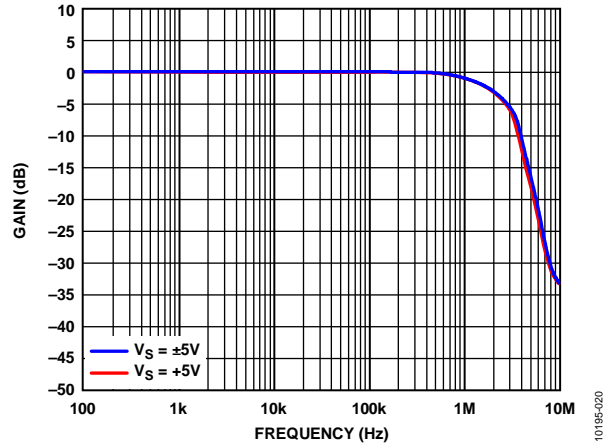


Figure 18. Large Signal Frequency Response for Various Supplies

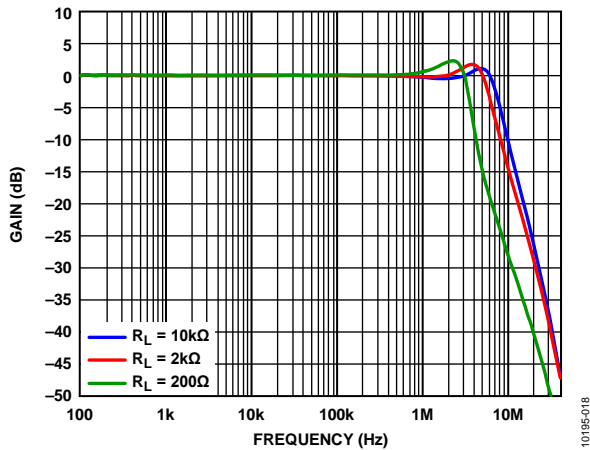


Figure 16. Small Signal Frequency Response for Various Loads

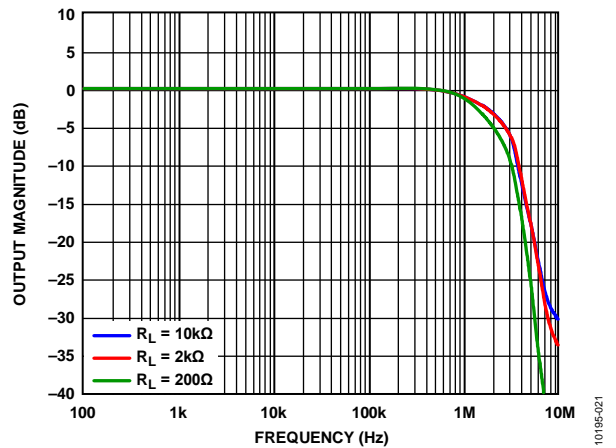


Figure 19. Large Signal Frequency Response for Various Loads

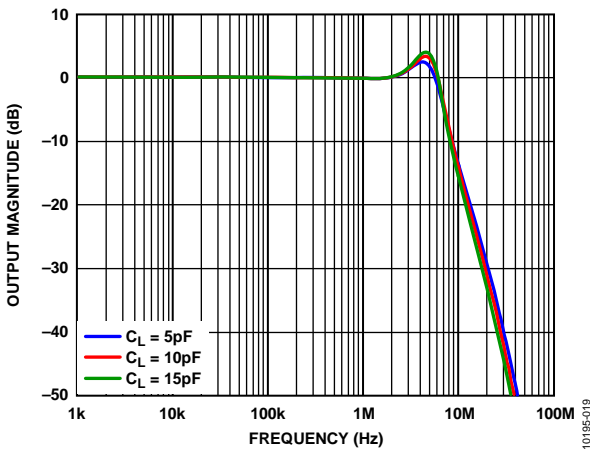


Figure 17. Small Signal Frequency Response for Various Capacitive Loads

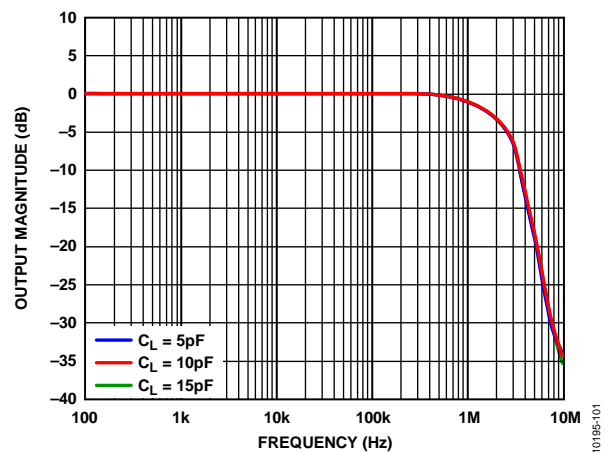


Figure 20. Large Signal Frequency Response for Various Capacitive Loads

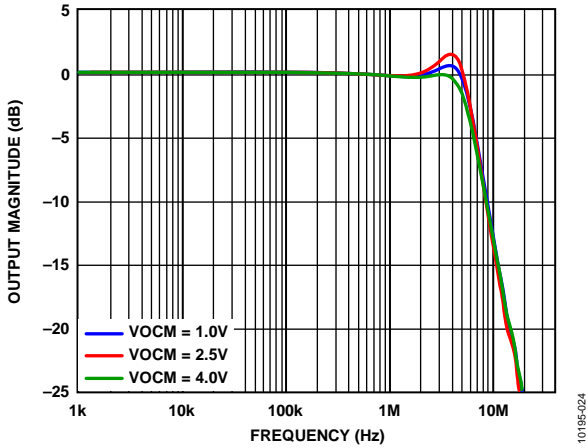


Figure 21. Small Signal Frequency Response for Various V<sub>O</sub>CM Levels

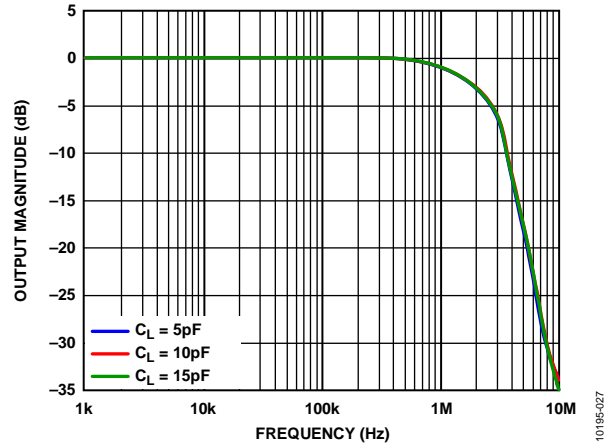


Figure 24. Large Signal Frequency Response for Various V<sub>O</sub>CM Level

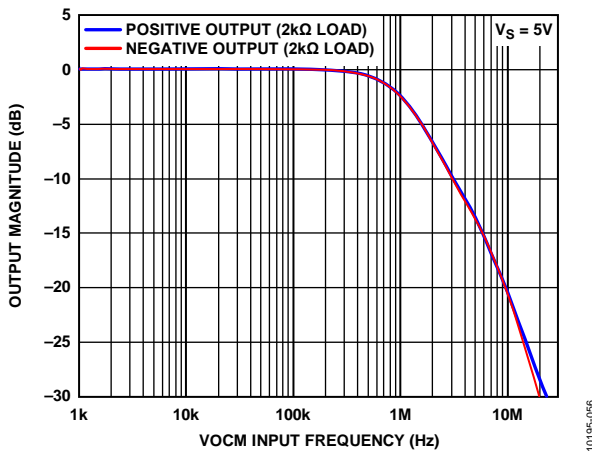


Figure 22. V<sub>O</sub>CM Small Signal Frequency Response

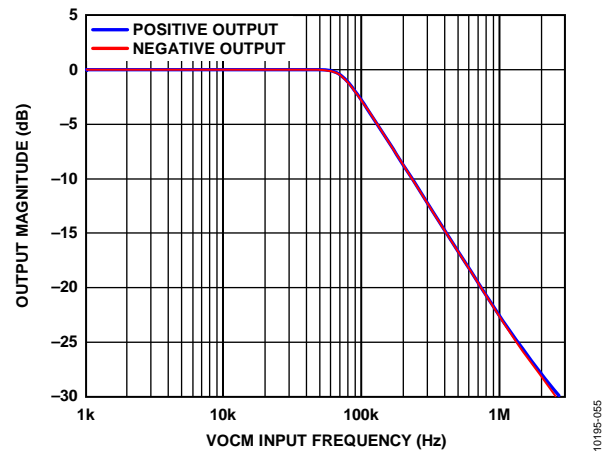


Figure 25. V<sub>O</sub>CM Large Signal Frequency Response

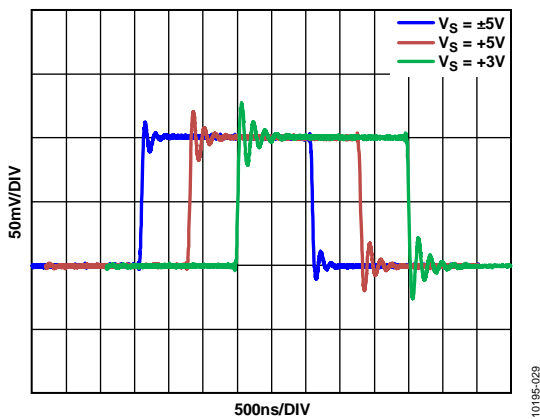


Figure 23. Small Signal Pulse Response for Various Supplies

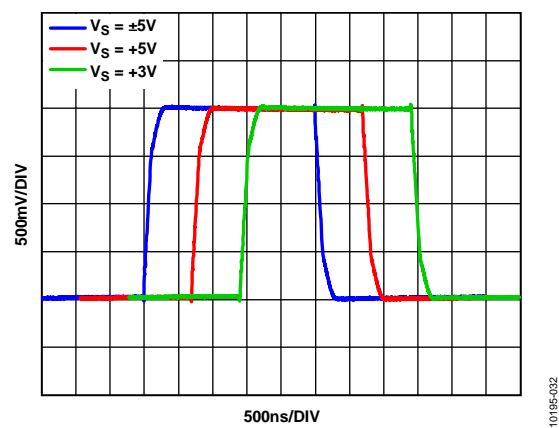
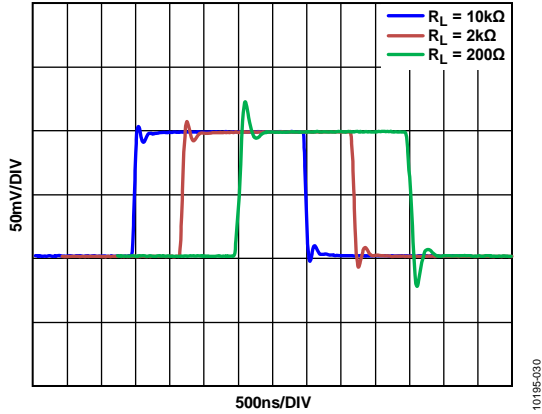
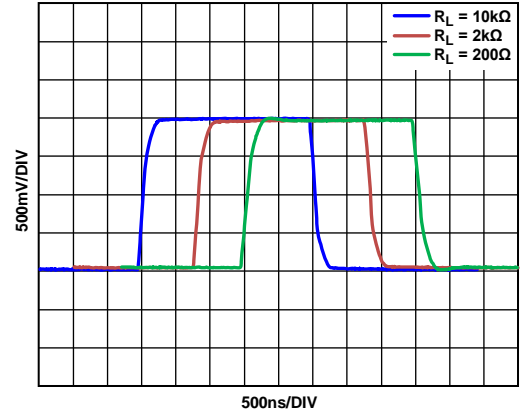


Figure 26. Large Signal Pulse Response for Various Supplies



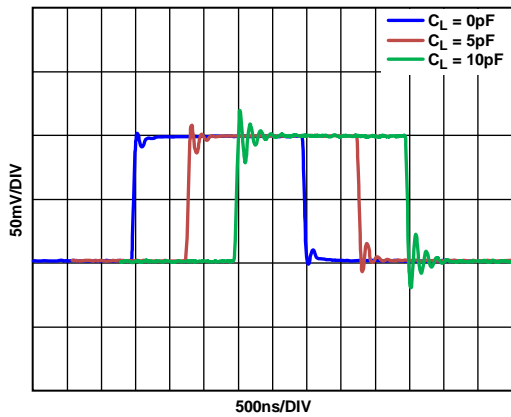
10195-030



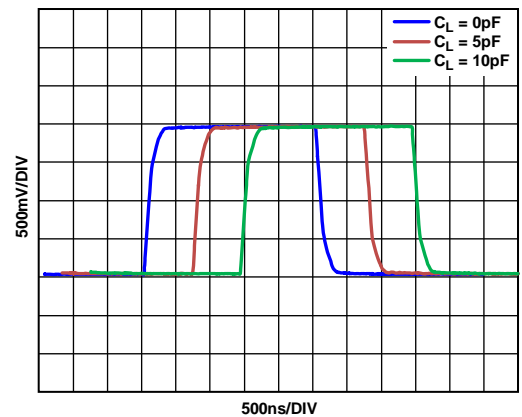
10195-033

Figure 27. Small Signal Step Response for Various Resistive Loads,  $V_S = \pm 5\text{ V}$

Figure 30. Large Signal Step Response for Various Resistive Loads,  $V_S = \pm 5\text{ V}$



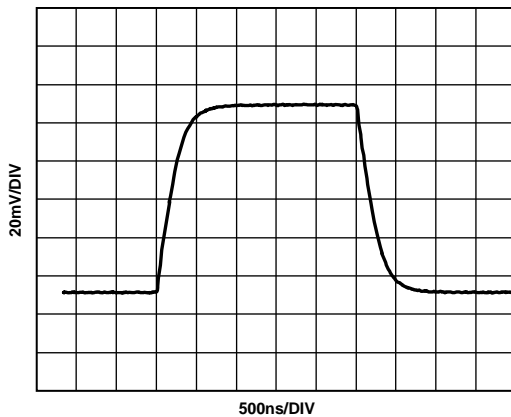
10195-031



10195-034

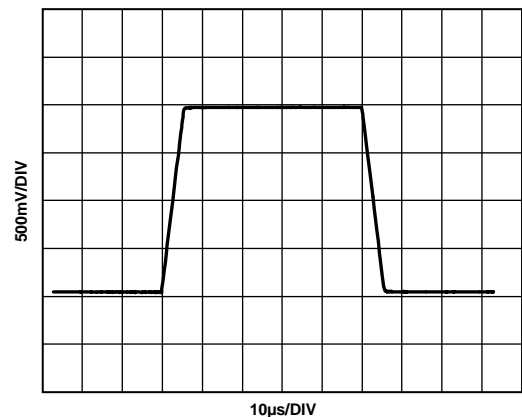
Figure 28. Small Signal Step Response for Various Capacitive Loads,  $V_S = \pm 5\text{ V}$

Figure 31. Large Signal Step Response for Various Capacitive Loads,  $V_S = \pm 5\text{ V}$



10195-035

Figure 29. VOVM Small Signal Step Response



10195-038

Figure 32. VOVM Large Signal Step Response

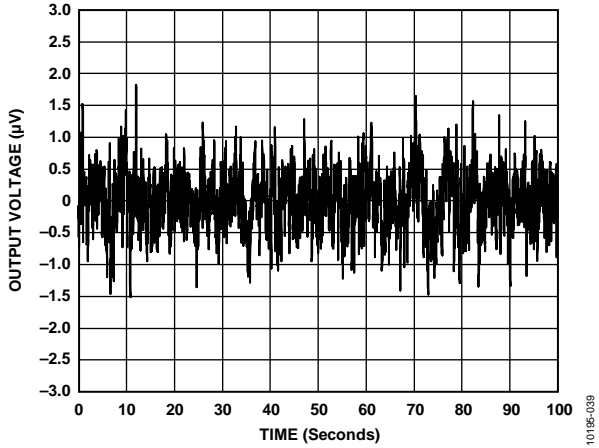


Figure 33. 0.1 Hz to 10 Hz Voltage Noise

10195-039

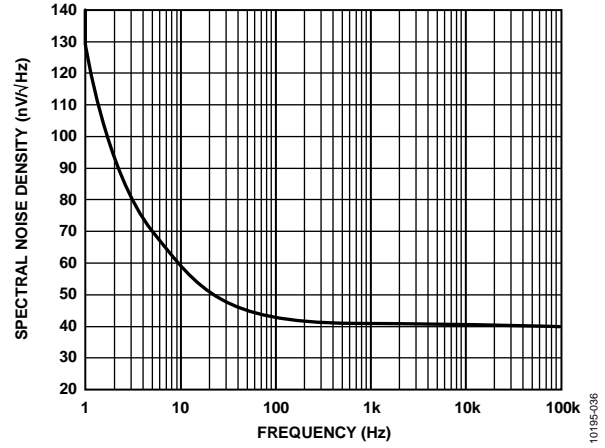


Figure 36. Voltage Noise Density vs. Frequency

10195-038

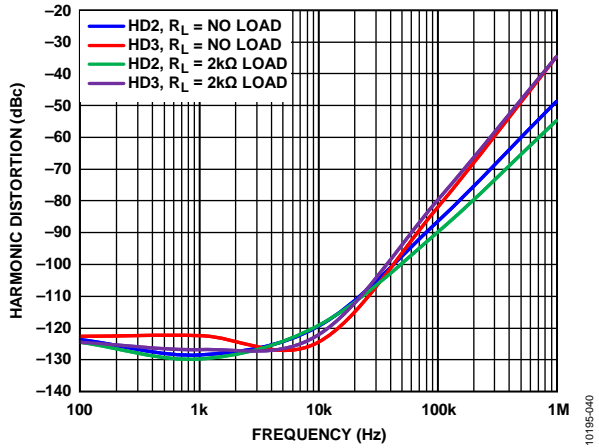


Figure 34. Harmonic Distortion vs. Frequency at Various Loads

10195-040

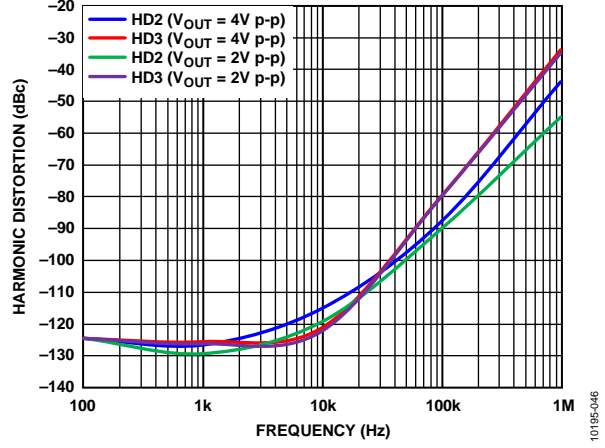


Figure 37. Harmonic Distortion vs. Frequency at Various  $V_{OUT,dm}$

10195-046

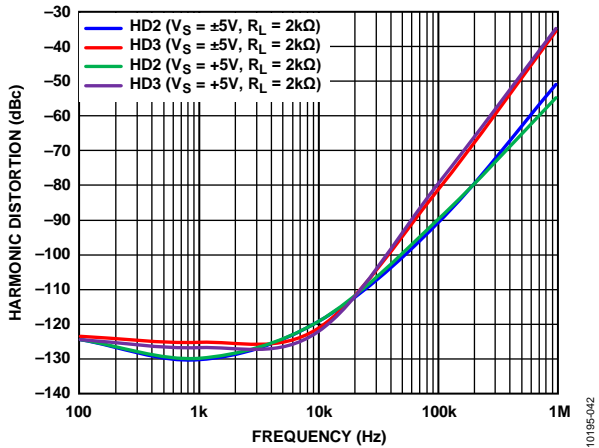


Figure 35. Harmonic Distortion vs. Frequency at Various Supplies

10195-042

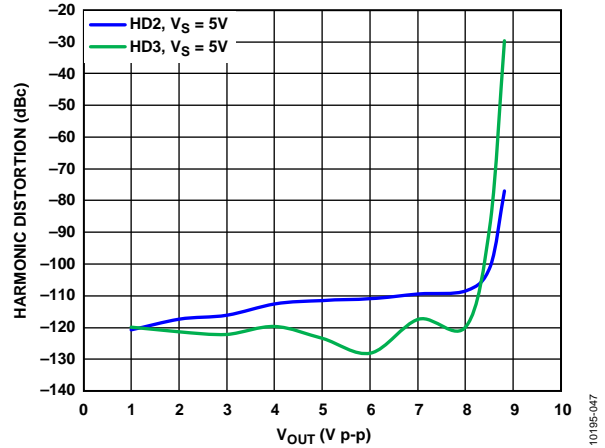


Figure 38. Harmonic Distortion vs.  $V_{OUT,dm}$   $f = 10$  kHz

10195-047

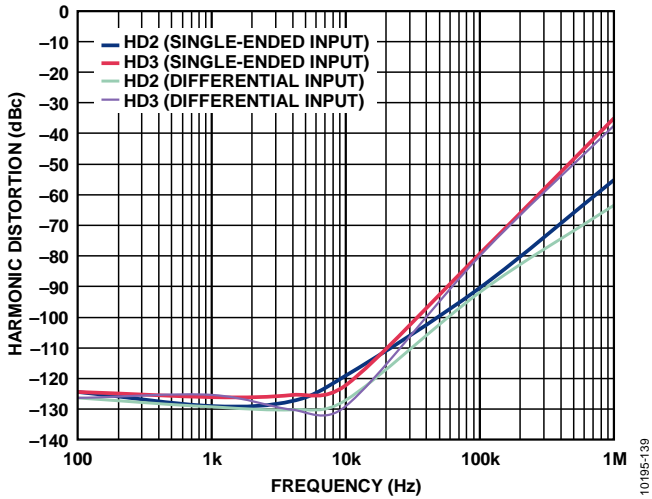


Figure 39. Harmonic Distortion vs. Input Drive

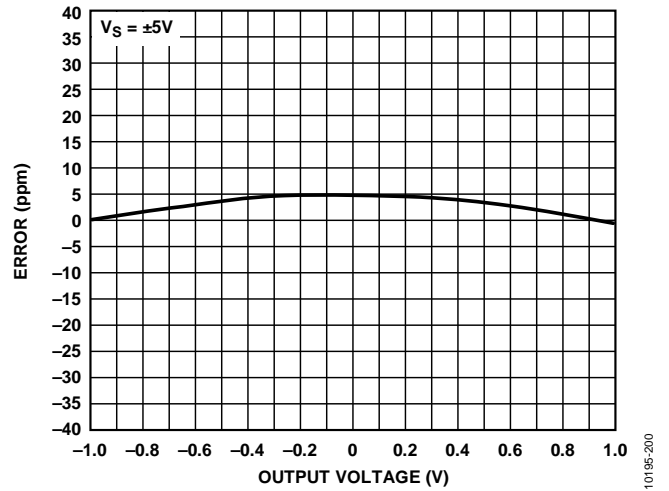


Figure 42. Gain Nonlinearity

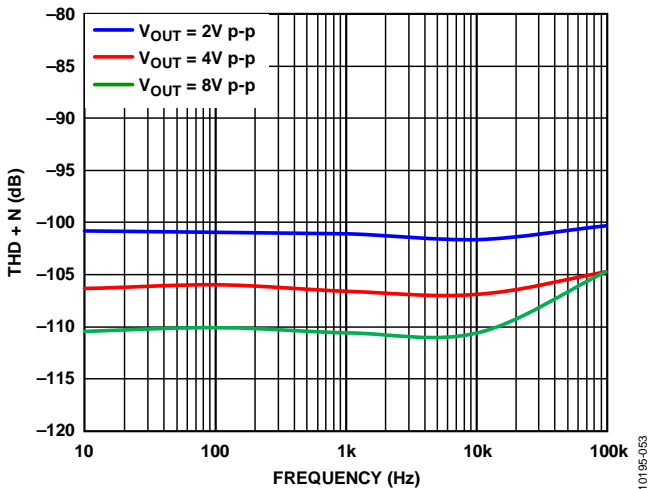


Figure 40. Total Harmonic Distortion + Noise vs. Frequency

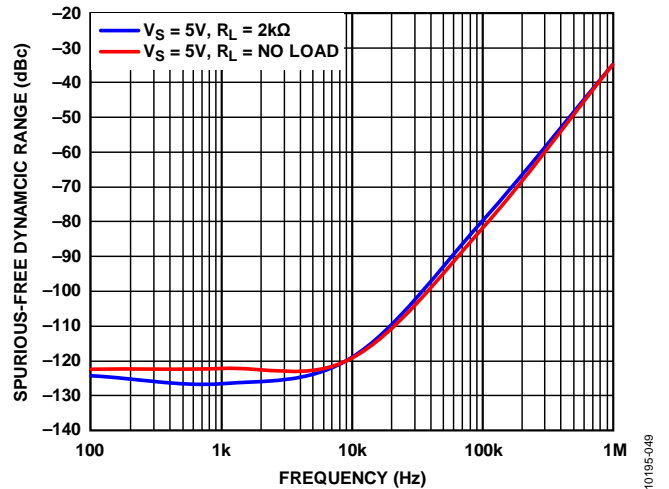


Figure 43. Spurious-Free Dynamic Range vs. Frequency at Various Loads

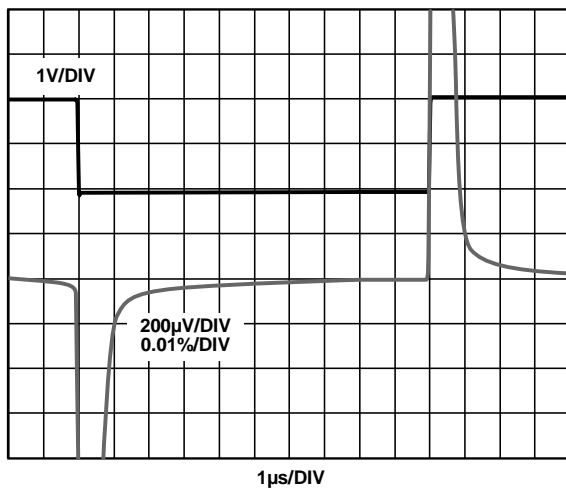


Figure 41. Settling Time to 0.01% of 2 V Step

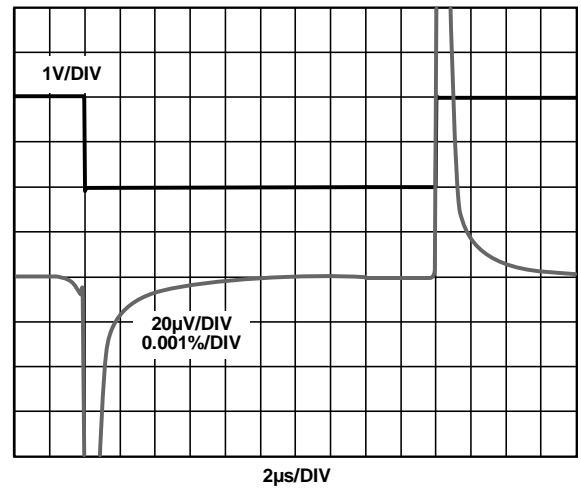


Figure 44. Settling Time to 0.001% of 2 V Step

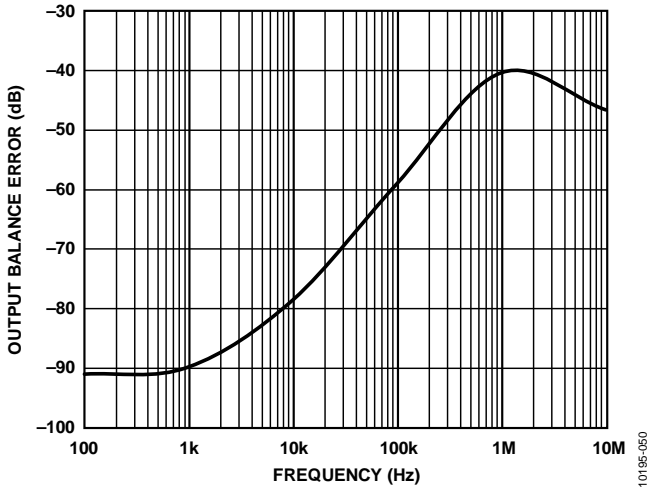


Figure 45. Output Balance Error vs. Frequency

10195-050

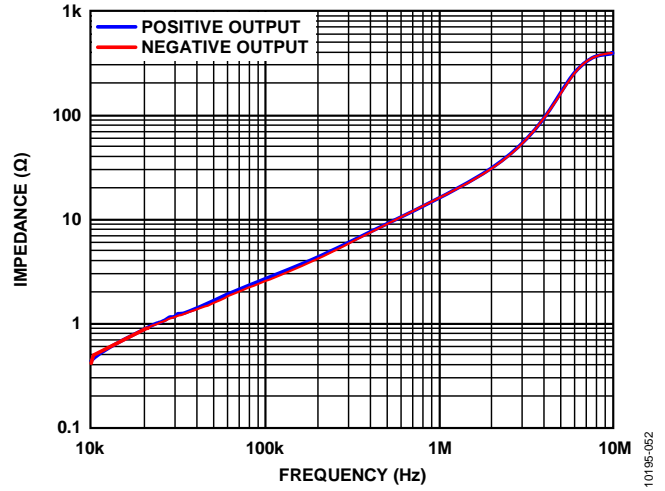


Figure 47. Output Impedance vs. Frequency

10195-052

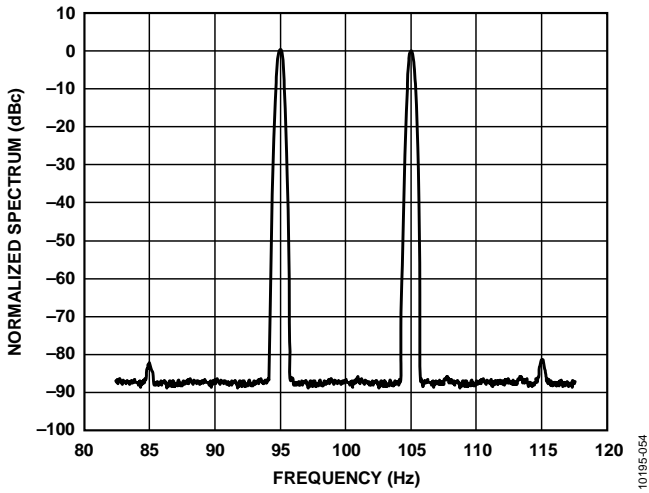


Figure 46. 100 kHz Intermodulation Distortion

10195-054

## TERMINOLOGY

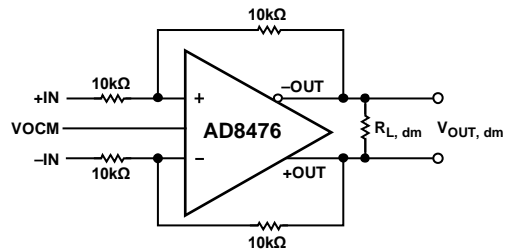


Figure 48. Signal and Circuit Definitions

### Differential Voltage

Differential voltage refers to the difference between two node voltages. For example, the output differential voltage (or equivalently, output differential mode voltage) is defined as

$$V_{OUT, dm} = (V_{+OUT} - V_{-OUT})$$

where  $V_{+OUT}$  and  $V_{-OUT}$  refer to the voltages at the +OUT and -OUT terminals with respect to a common ground reference. Similarly, the differential input voltage is defined as

$$V_{IN, dm} = (V_{+IN} - V_{-IN})$$

### Common-Mode Voltage

Common-mode voltage refers to the average of two node voltages with respect to the local ground reference. The output common-mode voltage is defined as

$$V_{OUT, cm} = (V_{+OUT} + V_{-OUT})/2$$

### Balance

Output balance is a measure of how close the output differential signals are to being equal in amplitude and opposite in phase. Output balance is most easily determined by placing a well-matched resistor divider between the differential voltage nodes and comparing the magnitude of the signal at the divider midpoint with the magnitude of the differential signal. By this definition, output balance is the magnitude of the output common-mode voltage divided by the magnitude of the output differential mode voltage.

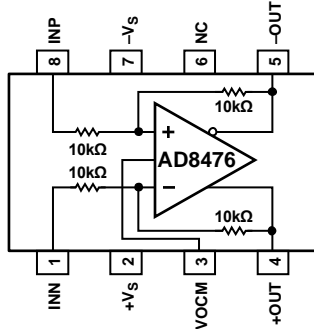
$$\text{Output Balance Error} = \left| \frac{\Delta V_{OUT, cm}}{\Delta V_{OUT, dm}} \right|$$

## THEORY OF OPERATION

### OVERVIEW

The AD8476 is a fully differential amplifier, with integrated laser-trimmed resistors, that provides a precision gain of 1. The internal differential amplifier of the AD8476 differs from conventional operational amplifiers in that it has two outputs whose voltages are equal in magnitude, but move in opposite directions (180° out of phase).

The AD8476 is designed to greatly simplify single-ended-to-differential conversion, common-mode level shifting and precision driving of differential signals into low power, differential input ADCs. The VOCM input allows the user to set the output common-mode voltage to match with the input range of the ADC. Like an operational amplifier, the VOCM function relies on high open-loop gain and negative feedback to force the output nodes to the desired voltages.



NOTES  
1. NC = NO CONNECT.  
DO NOT CONNECT TO THIS PIN.

Figure 49. Block Diagram

### CIRCUIT INFORMATION

The AD8476 amplifier uses a voltage feedback topology; therefore, the amplifier exhibits a nominally constant gain bandwidth product. Like a voltage feedback operational amplifier, the AD8476 also has high input impedance at its internal input terminals (the summing nodes of the internal amplifier) and low output impedance.

The AD8476 employs two feedback loops, one each to control the differential and common-mode output voltages. The differential feedback loop, which is fixed with precision laser-trimmed on-chip resistors, controls the differential output voltage.

#### Output Common-Mode Voltage (VOCM)

The internal common-mode feedback controls the common-mode output voltage. This architecture makes it easy for the user to set the output common-mode level to any arbitrary value independent of the input voltage. The output common-mode voltage is forced by the internal common-mode feedback loop to be equal to the voltage applied to the VOCM input. The VOCM pin can be left unconnected, and the output common-mode voltage self-biases to midsupply by the internal feedback control.

Due to the internal common-mode feedback loop and the fully differential topology of the amplifier, the AD8476 outputs are precisely balanced over a wide frequency range. This means that the amplifier's differential outputs are very close to the ideal of being identical in amplitude and exactly 180° out of phase.

### DC PRECISION

The dc precision of the AD8476 is highly dependent on the accuracy of its integrated gain resistors. Using superposition to analyze the circuit shown in Figure 50, the following equation shows the relationship between the input and output voltages of the amplifier:

$$\begin{aligned} V_{IN,cm}(R_P - R_N) + V_{IN,dm} \frac{1}{2}(2R_P R_N + R_P + R_N) \\ = V_{OUT,cm}(R_P - R_N) + V_{OUT,dm} \frac{1}{2}(2 + R_P + R_N) \end{aligned}$$

where:

$$R_P = \frac{RFP}{RGP}, \quad R_N = \frac{RFN}{RGN}$$

$$V_{IN,dm} = V_P - V_N$$

$$V_{IN,cm} = \frac{1}{2}(V_P + V_N)$$

The differential closed-loop gain of the amplifier is

$$\frac{V_{OUT,dm}}{V_{IN,dm}} = \frac{2R_P R_N + R_P + R_N}{2 + R_P + R_N}$$

and the common rejection of the amplifier is

$$\frac{V_{OUT,dm}}{V_{IN,cm}} = \frac{2(R_P - R_N)}{2 + R_P + R_N}$$

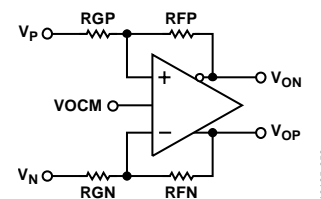


Figure 50. Functional Circuit Diagram of the AD8476 at a Given Gain

The preceding equations show that the gain accuracy and the common-mode rejection (CMRR) of the AD8476 are determined primarily by the matching of the feedback networks (resistor ratios). If the two networks are perfectly matched, that is, if  $R_P$  and  $R_N$  equal  $RF/RG$ , then the resistor network does not generate any CMRR errors and the differential closed loop gain of the amplifier reduces to

$$\frac{v_{OUT,dm}}{v_{IN,dm}} = \frac{RF}{RG}$$



The AD8476 integrated resistors are precision wafer-laser-trimmed to guarantee a minimum CMRR of 90 dB ( $32 \mu\text{V}/\text{V}$ ), and gain error of less than 0.02%. To achieve equivalent precision and performance using a discrete solution, resistors must be matched to 0.01% or better.

### INPUT VOLTAGE RANGE

The AD8476 can measure input voltages as large as the supply rails. The internal gain and feedback resistors form a divider, which reduces the input voltage seen by the internal input nodes of the amplifier. The largest voltage that can be measured properly is constrained by the output range of the amplifier and the capability of the amplifier's internal summing nodes. This voltage is defined by the input voltage, and the ratio between the feedback and the gain resistors.

Figure 51 shows the voltage at the internal summing nodes of the amplifier, defined by the input voltage and internal resistor network. If  $V_N$  is grounded, the expression shown reduces to

$$V_{PLUS} = V_{MINUS} = \frac{RG}{RF + RG} \left( VO_{CM} + \frac{1}{2} \frac{RF}{RG} V_P \right)$$

The internal amplifier of the AD8476 has rail-to-rail inputs. To obtain accurate measurements with minimal distortion, the voltage at the internal inputs of the amplifier must stay below  $+V_S - 1 \text{ V}$  and above  $-V_S$ .

The AD8476 provides overvoltage protection for excessive input voltages beyond the supply rails. Integrated ESD protection diodes

at the inputs prevent damage to the AD8476 up to  $+V_S + 18 \text{ V}$  and  $-V_S - 18 \text{ V}$ .

### DRIVING THE AD8476

Care should be taken to drive the AD8476 with a low impedance source: for example, another amplifier. Source resistance can unbalance the resistor ratios and, therefore, significantly degrade the gain accuracy and common-mode rejection of the AD8476. For the best performance, source impedance to the AD8476 input terminals should be kept below  $0.1 \Omega$ . Refer to the DC Precision section for details on the critical role of resistor ratios in the precision of the AD8476.

### POWER SUPPLIES

The AD8476 operates over a wide range of supply voltages. It can be powered on a single supply as low as 3 V and as high as 18 V. The AD8476 can also operate on dual supplies from  $\pm 1.5 \text{ V}$  to  $\pm 9 \text{ V}$ .

A stable dc voltage should be used to power the AD8476. Note that noise on the supply pins can adversely affect performance. For more information, see the PSRR performance curve in Figure 8.

Place a bypass capacitor of  $0.1 \mu\text{F}$  between each supply pin and ground, as close as possible to each supply pin. Use a tantalum capacitor of  $10 \mu\text{F}$  between each supply and ground. It can be farther away from the supply pins and, typically, it can be shared by other precision integrated circuits.

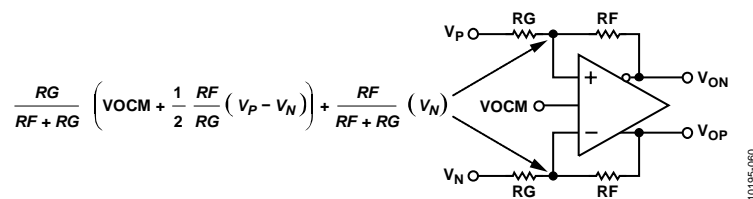


Figure 51. Voltages at the Internal Op Amp Inputs of the AD8476

## APPLICATIONS INFORMATION

### TYPICAL CONFIGURATION

The AD8476 is designed to facilitate single-ended-to-differential conversion, common-mode level shifting, and precision processing of signals so that they are compatible with low voltage ADCs.

Figure 52 shows a typical connection diagram of the AD8476.

### SINGLE-ENDED-TO-DIFFERENTIAL CONVERSION

Many industrial systems have single-ended inputs from input sensors; however, the signals are frequently processed by high performance differential input ADCs for higher precision. The AD8476 performs the critical function of precisely converting single-ended signals to the differential inputs of precision ADCs, and it does so with no need for external components.

To convert a single-ended signal to a differential signal, connect one input to the signal source and the other input to ground (see Figure 52). Note that either input can be driven by the source with the only effect being that the outputs have reversed polarity. The AD8476 also accepts truly differential input signals in precision systems with differential signal paths.

### SETTING THE OUTPUT COMMON-MODE VOLTAGE

The V<sub>OCM</sub> pin of the AD8476 is internally biased by a precision voltage divider comprising of two 1 M $\Omega$  resistors between the supplies. This divider level shifts the output to midsupply. Relying on the internal bias results in an output common-mode voltage that is within 0.05% of the expected value.

In cases where control of the output common-mode level is desired, an external source or resistor divider can be used to drive the V<sub>OCM</sub> pin. If driven directly from a source, or with a resistor divider of unequal resistor values, the resistance seen by the V<sub>OCM</sub> pin should be less than 1 k $\Omega$ . If an external voltage divider consisting of equal resistor values is used to set V<sub>OCM</sub> to midsupply, higher values can be used because the external resistors are placed in parallel with the internal resistors. The output common-mode offset listed in the Specifications section assumes that the V<sub>OCM</sub> input is driven by a low impedance voltage source.

Because of the internal divider, the V<sub>OCM</sub> pin sources and sinks current, depending on the externally applied voltage and its associated source resistance.

It is also possible to connect the V<sub>OCM</sub> input to the common-mode level output of an ADC; however, care must be taken to ensure that the output has sufficient drive capability. The input impedance of the V<sub>OCM</sub> pin is 500 k $\Omega$ . If multiple AD8476 devices share one ADC reference output, a buffer may be necessary to drive the parallel inputs.

Table 5. Differential Input ADCs<sup>1</sup>

ADC	Resolution	Throughput Rate	Power Dissipation
AD7674	16 Bits	100 kSPS	25 mW
AD7684	16 Bits	100 kSPS	6 mW
AD7687	16 Bits	250 kSPS	12.5 mW
AD7688	16 Bits	500 kSPS*	21.5 mW

<sup>1</sup> Depending on measurement/application type, check that the AD8476 meets settling time requirements.

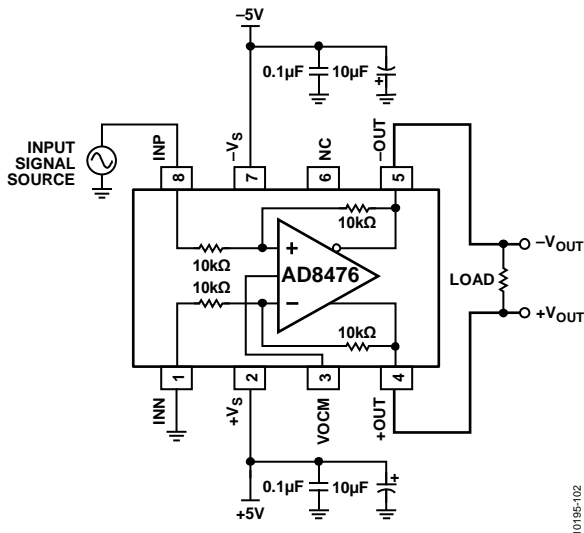
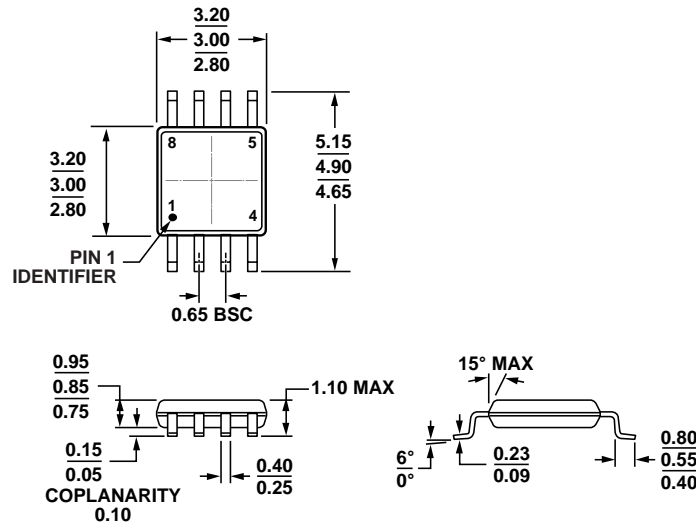


Figure 52. Typical Configuration—8-Lead MSOP

### OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-187-AA

Figure 53. 8-Lead Mini Small Outline Package [MSOP] (RM-8)

Dimensions shown in millimeters

10-07-2009-B

### ORDERING GUIDE

Model <sup>1</sup>	Temperature Range	Package Description	Package Option	Branding
AD8476BRMZ	-40°C to +125°C	8-Lead Mini Small Outline Package [MSOP]	RM-8	Y47
AD8476BRMZ-R7	-40°C to +125°C	8-Lead Mini Small Outline Package [MSOP]	RM-8	Y47
AD8476BRMZ-RL	-40°C to +125°C	8-Lead Mini Small Outline Package [MSOP]	RM-8	Y47
AD8476ARMZ	-40°C to +125°C	8-Lead Mini Small Outline Package [MSOP]	RM-8	Y46
AD8476ARMZ-R7	-40°C to +125°C	8-Lead Mini Small Outline Package [MSOP]	RM-8	Y46
AD8476ARMZ-RL	-40°C to +125°C	8-Lead Mini Small Outline Package [MSOP]	RM-8	Y46
AD8476-EVALZ		Evaluation Board	RM-8	Y46

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

**NOTES**