1 nV/√Hz, Low Power,G≥10 Stable Rail-to-Rail Output Amplifier

Preliminary Data Sheet

ADA4895-2

FEATURES

- **Low wideband noise**
  - **1 nV/√Hz**
  - **2.8 pA/√Hz**
- **Low 1/f noise**
  - **2.4 nV/√Hz @ 10 Hz**
- **Low distortion: −115 dBc @ 100 kHz, V_{OUT} = 2 V p-p**
- **Low power: 3 mA/amp**
- **Low input offset voltage: 0.5 mV maximum**
- **High speed**
  - **230 MHz, −3 dB bandwidth (G = +10)**
  - **500 V/µs slew rate**
  - **TBD ns settling time to 0.1%**
- **Rail-to-rail output**
- **Wide supply range: 3 V to 10 V**
- **Disable feature**

APPLICATIONS

- **Low noise preamplifier**
- **Ultrasound amplifiers**
- **PLL loop filters**
- **High performance ADC drivers**
- **DAC buffers**

GENERAL DESCRIPTION

The ADA4895-2 is gain 10 stable, low noise, rail-to-rail output, high speed voltage feedback amplifier having a quiescent current of 3 mA. With the 1/f noise of 2.4 nV/√Hz at 10 Hz and a spurious-free dynamic range of −63 dBc at 2 MHz, the ADA4895-2 is an ideal solution in a variety of applications, including ultrasound, low noise preamplifiers, and drivers of high performance ADCs. The Analog Devices, Inc., proprietary next generation SiGe bipolar process and innovative architecture enable such high performance amplifiers.

The ADA4895-2 has 1500 MHz Gain bandwidth product, 500 V/µs slew rate, and settle to 0.1% in TBD ns. With a wide supply voltage range (3 V to 10 V), the ADA4895-2 is ideal candidates for systems that require high dynamic range, high gain, precision, and high speed.

The ADA4895-2 is available in 10-lead MSOP package and itoperates over the extended industrial temperature range of −40°C to +125°C.

FUNCTIONAL BLOCK DIAGRAM

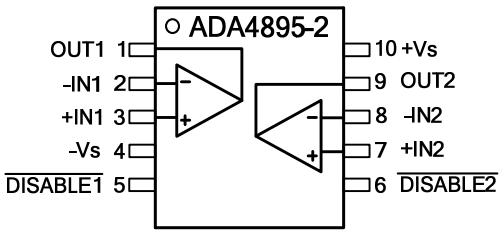

Figure 1. 10-Lead MSOP (ADA4895-2)

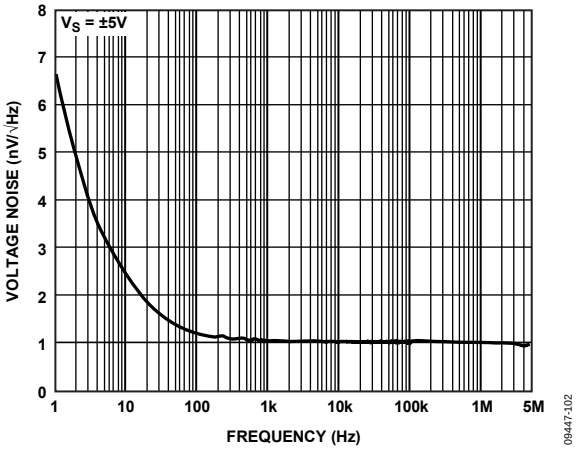

Figure 2. Voltage Noise vs. Frequency

Table 1. Other Low Noise Amplifiers

Part Number	V_N (nV/√Hz) @ 1 kHz	V_N (nV/√Hz) @ 100 kHz	BW (MHz)	Supply Voltage (V)
AD797	0.9	0.9	8	10 to 30
AD8021	5	2.1	490	5 to 24
AD8099	7	0.95	510	5 to 12
AD8045	6	3	1000	3.3 to 12
ADA4897-1	1	1	230	3 to 10
ADA4896-2	1	1	230	3 to 10
ADA4899-1	1.4	1	600	5 to 12
ADA4898-1/ ADA4898-2	0.9	0.9	65	10 to 32

Table 2. Complementary ADCs

Part Number	Bits	Speed (MSPS)	Power (mW)
AD7944	14	2.5	15.5
AD7985	16	2.5	15.5
AD7986	18	2	15

Rev. PrB

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TABLE OF CONTENTS

SPECIFICATIONS

±5 V SUPPLY

T_A = 25°C, G = +10, R_L = 1 kΩ to ground, unless otherwise noted.

Table 3.

Parameter	Conditions	Min	Typ	Max	Unit
DYNAMIC PERFORMANCE					
–3 dB Bandwidth	G = +10, V_{OUT} = 0.2 V p-p		233		MHz
	G = +10, V_{OUT} = 2 V p-p		140		MHz
	G = +20, V_{OUT} = 0.2 V p-p		TBD		MHz
Bandwidth for 0.1 dB Flatness	G = +10, V_{OUT} = 2 V p-p, R_L = 100 Ω		10		MHz
Slew Rate	G = +10, V_{OUT} = 6 V step		500		V/µs
Settling Time to 0.1%	G = +10, V_{OUT} = 2 V step		TBD		ns
Settling Time to 0.01%	G = +10, V_{OUT} = 2 V step		TBD		ns
NOISE/HARMONIC PERFORMANCE					
Harmonic Distortion (dBc) SFDR	f_C = 100 kHz, V_{OUT} = 2 V p-p		–88		dBc
	f_C = 1 MHz, V_{OUT} = 2 V p-p		–68		dBc
	f_C = 2 MHz, V_{OUT} = 2 V p-p		–63		dBc
	f_C = 5 MHz, V_{OUT} = 2 V p-p		–55		dBc
Input Voltage Noise	f = 10 Hz		2.4		nV/√Hz
	f = 100 kHz		1		nV/√Hz
Input Current Noise	f = 10 Hz		24		pA/√Hz
	f = 100 kHz		2.94		pA/√Hz
0.1 Hz to 10 Hz Noise	G = +101, R_F = 1 kΩ, R_G = 10 Ω		99		nV p-p
DC PERFORMANCE					
Input Offset Voltage		–500	–28	+500	µV
Input Offset Voltage Drift			0.2		µV/°C
Input Bias Current		–17	–11	–4	µA
Input Bias Current Drift			3		nA/°C
Input Bias Offset Current		–0.6	–0.02	+0.6	µA
Open-Loop Gain	V_{OUT} = –4 V to +4 V	100	110		dB
INPUT CHARACTERISTICS					
Input Resistance	Common mode/differential		10 M/10 k		Ω
Input Capacitance	Common mode/differential		3/11		pF
Input Common-Mode Voltage Range			–4.9 to +4.1		V
Common-Mode Rejection	V_{CM} = –2 V to +2 V	–92	–120		dB
OUTPUT CHARACTERISTICS					
Output Overdrive Recovery Time	V_{IN} = ±5 V, G = +2		81		ns
+Output Voltage Swing	R_L = 1 kΩ	4.85	4.96		V
–Output Voltage Swing	R_L = 1 kΩ	–4.85	–4.97		V
+Output Voltage Swing	R_L = 100 Ω	4.5	4.73		V
–Output Voltage Swing	R_L = 100 Ω	–4.5	–4.84		V
Output Current	45 dBc SFDR		80		mA
Short-Circuit Current	Sinking/sourcing		135		mA
Capacitive Load Drive	30% overshoot, G = +2		39		pF
POWER SUPPLY					
Operating Range			3 to 10		V
Quiescent Current per Amplifier		2.8	3	3.2	mA
	$\overline{\text{DISABLE}}$ = –5 V		0.25		mA
Positive Power Supply Rejection	$+V_S$ = 4 V to 6 V, $-V_S$ = –5 V	–96	–125		dB
Negative Power Supply Rejection	$+V_S$ = 5 V, $-V_S$ = –4 V to –6 V	–96	–121		dB

Parameter	Conditions	Min	Typ	Max	Unit
$\overline{\text{DISABLE}}$ PIN					
$\overline{\text{DISABLE}}$ Voltage	Enabled		>+V_S − 0.5		V
	Disabled		<+V_S − 2		V
Input Current					
Enabled	$\overline{\text{DISABLE}}$ = +5 V		−2.5		µA
Disabled	$\overline{\text{DISABLE}}$ = −5 V		−80		µA
Switching Speed					
Enabled			0.25		µs
Disabled			12		µs

+5 V SUPPLY

T_A = 25°C, G = +10, R_L = 1 kΩ to midsupply, unless otherwise noted.

Table 4.

Parameter	Conditions	Min	Typ	Max	Unit
DYNAMIC PERFORMANCE					
−3 dB Bandwidth	G = +10, V_{OUT} = 0.2 V p-p		203		MHz
	G = +10, V_{OUT} = 2 V p-p		127		MHz
	G = +20, V_{OUT} = 0.2 V p-p		TBD		MHz
Bandwidth for 0.1 dB Flatness	G = +10, V_{OUT} = 2 V p-p, R_L = 100 Ω		9.8		MHz
Slew Rate	G = +10, V_{OUT} = 3 V step		451		V/µs
Settling Time to 0.1%	G = +10, V_{OUT} = 2 V step		TBD		ns
Settling Time to 0.01%	G = +10, V_{OUT} = 2 V step		TBD		ns
NOISE/HARMONIC PERFORMANCE					
Harmonic Distortion (dBc) SFDR	f_C = 100 kHz, V_{OUT} = 2 V p-p		−86		dBc
	f_C = 1 MHz, V_{OUT} = 2 V p-p		−66		dBc
	f_C = 2 MHz, V_{OUT} = 2 V p-p		−60		dBc
	f_C = 5 MHz, V_{OUT} = 2 V p-p		−53		dBc
Input Voltage Noise	f = 10 Hz		2.4		nV/√Hz
	f = 100 kHz		1		nV/√Hz
Input Current Noise	f = 10 Hz		24		pA/√Hz
	f = 100 kHz		2.94		pA/√Hz
0.1 Hz to 10 Hz Noise	G = +101, R_F = 1 kΩ, R_G = 10 Ω		99		nV p-p
DC PERFORMANCE					
Input Offset Voltage		−500	−30	+500	µV
Input Offset Voltage Drift			0.2		µV/°C
Input Bias Current		−17	−11	−4	µA
Input Bias Current Drift			3		nA/°C
Input Bias Offset Current		−0.6	−0.02	+0.6	µA
Open-Loop Gain	V_{OUT} = 0.5 V to 4.5 V	97	110		dB
INPUT CHARACTERISTICS					
Input Resistance	Common mode/differential		10 M/10 k		Ω
Input Capacitance	Common mode/differential		3/11		pF
Input Common-Mode Voltage Range			0.1 to 4.1		V
Common-Mode Rejection	V_{CM} = +1 V to +4 V	−91	−118		dB
OUTPUT CHARACTERISTICS					
Overdrive Recovery Time	V_{IN} = 0 V to 5 V, G = +2		96		ns
+Output Voltage Swing	R_L = 1 kΩ	4.85	4.98		V
−Output Voltage Swing	R_L = 1 kΩ	0.15	0.014		V
+Output Voltage Swing	R_L = 100 Ω	4.8	4.88		V
−Output Voltage Swing	R_L = 100 Ω	0.2	0.08		
Output Current	45 dBc SFDR		70		mA
Short-Circuit Current	Sinking/sourcing		125		mA
Capacitive Load Drive	30% overshoot, G = +2		39		pF
POWER SUPPLY					
Operating Range			3 to 10		V
Quiescent Current per Amplifier		2.7	2.9	3.1	mA
	$\overline{\text{DISABLE}}$ = 0 V		0.18		
Positive Power Supply Rejection	$+V_S$ = 4.5 V to 5.5 V, $-V_S$ = 0 V	−96	−123		dB
Negative Power Supply Rejection	$+V_S$ = 5 V, $-V_S$ = −0.5 V to +0.5 V	−96	−121		dB

Parameter	Conditions	Min	Typ	Max	Unit
$\overline{\text{DISABLE}}$ PIN					
$\overline{\text{DISABLE}}$ Voltage	Enabled		>+V_S − 0.5		V
	Disabled		<+V_S − 2		V
Input Current					
Enabled	$\overline{\text{DISABLE}}$ = +5 V		−2.5		µA
Disabled	$\overline{\text{DISABLE}}$ = 0 V		−50		µA
Switching Speed					
Enabled			0.25		µs
Disabled			12		µs

+3 V SUPPLY

T_A = 25°C, G = +1, R_L = 1 kΩ to midsupply, unless otherwise noted.

Table 5.

Parameter	Conditions	Min	Typ	Max	Unit
DYNAMIC PERFORMANCE					
−3 dB Bandwidth	G = +10, V_{OUT} = 0.2 V p-p		192		MHz
	G = +10, V_{OUT} = 1 V p-p		124		MHz
	G = +20, V_{OUT} = 0.2 V p-p		9.2		MHz
Bandwidth for 0.1 dB Flatness	G = +10, V_{OUT} = 2 V p-p, R_L = 100 Ω		TBD		MHz
Slew Rate	G = +10, V_{OUT} = 1 V step		450		V/µs
Settling Time to 0.1%	G = +10, V_{OUT} = 2 V step		TBD		ns
Settling Time to 0.01%	G = +10, V_{OUT} = 2 V step		TBD		ns
NOISE/HARMONIC PERFORMANCE					
Harmonic Distortion (dBc) SFDR	f_C = 100 kHz, V_{OUT} = 2 V p-p, G = +2		−85		dBc
	f_C = 1 MHz, V_{OUT} = 1 V p-p, G = −1		−65		dBc
	f_C = 2 MHz, V_{OUT} = 1 V p-p, G = −1		−59		dBc
	f_C = 5 MHz, V_{OUT} = 1 V p-p, G = −1		−52		dBc
Input Voltage Noise	f = 10 Hz		2.3		nV/√Hz
	f = 100 kHz		1		nV/√Hz
Input Current Noise	f = 10 Hz		24		pA/√Hz
	f = 100 kHz		2.94		pA/√Hz
0.1 Hz to 10 Hz Noise	G = +101, R_F = 1 kΩ, R_G = 10 Ω		99		nV p-p
DC PERFORMANCE					
Input Offset Voltage		−500	−30	+500	uV
Input Offset Voltage Drift			0.2		µV/°C
Input Bias Current		−17	−11	−4	µA
Input Bias Current Drift			3		nA/°C
Input Bias Offset Current		−0.6	−0.02	+0.6	µA
Open-Loop Gain	V_{OUT} = 0.5 V to 2.5 V	95	108		dB
INPUT CHARACTERISTICS					
Input Resistance	Common mode/differential		10 M/10 k		Ω
Input Capacitance	Common mode/differential		3/11		pF
Input Common-Mode Voltage Range			0.1 to 2.1		V
Common-Mode Rejection	V_{CM} = +1.1 V to +1.9 V	−90	−124		dB
OUTPUT CHARACTERISTICS					
Overdrive Recovery Time	V_{IN} = 0 V to +3 V, G = +2		83		ns
+Output Voltage Swing	R_L = 1 kΩ	2.85	2.97		V
−Output Voltage Swing	R_L = 1 kΩ	0.15	0.01		V
+Output Voltage Swing	R_L = 100 Ω	2.8	2.92		V
−Output Voltage Swing	R_L = 100 Ω	0.2	0.05		V
Output Current	45 dBc SFDR		60		mA
Short-Circuit Current	Sinking/sourcing		120		mA
Capacitive Load Drive	30% overshoot, G = +2		39		pF
POWER SUPPLY					
Operating Range			3 to 10		V
Quiescent Current per Amplifier		2.6	2.8	3	mA
	$\overline{\text{DISABLE}}$ = 0 V		0.15		
Positive Power Supply Rejection	$+V_S$ = 2.7 V to 3.7 V, $-V_S$ = 0 V	−96	−121		dB
Negative Power Supply Rejection	$+V_S$ = 3 V, $-V_S$ = −0.3 V to 0.7 V	−96	−120		dB

Parameter	Conditions	Min	Typ	Max	Unit
$\overline{\text{DISABLE}}$ PIN					
$\overline{\text{DISABLE}}$ Voltage	Enabled		>+V_S −0.5		V
	Disabled		<−V_S + 2		V
Input Current					
Enabled	$\overline{\text{DISABLE}}$ = +3 V		−2.5		µA
Disabled	$\overline{\text{DISABLE}}$ = 0 V		−40		µA
Switching Speed					
Enabled			0.25		µs
Disabled			12		µs

PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

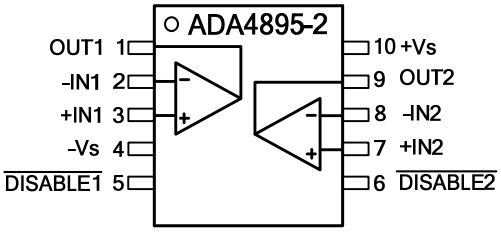

Figure 3. 10-Lead ADA4895-2 MSOP (10)

Table 6. ADA4895-2 Pin Function Descriptions

Pin No.	Mnemonic	Description
1	OUT1	Output 1.
2	–IN1	Inverting Input 1.
3	+IN1	Noninverting Input 1.
4	$-V_S$	Negative Supply.
5	$\overline{\text{DISABLE1}}$	Disable1.
6	$\overline{\text{DISABLE2}}$	Disable2.
7	+IN2	Noninverting Input 2.
8	–IN2	Inverting Input 2.
9	OUT2	Output 2.
10	$+V_S$	Positive Supply.
	EPAD	Exposed Pad. The exposed pad can be connected to GND or left floating.

TYPICAL PERFORMANCE CHARACTERISTICS

R_L = 1 kΩ,unless otherwise noted.When G = +10, R_F = 249 Ω.

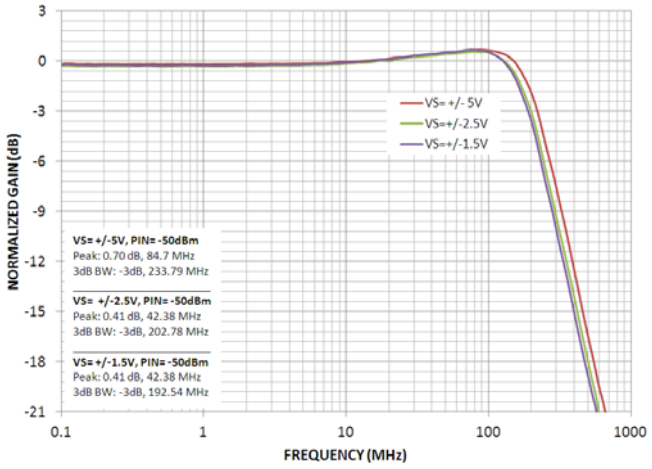

Figure 4. Small Signal Frequency Response vs. Supply Voltage

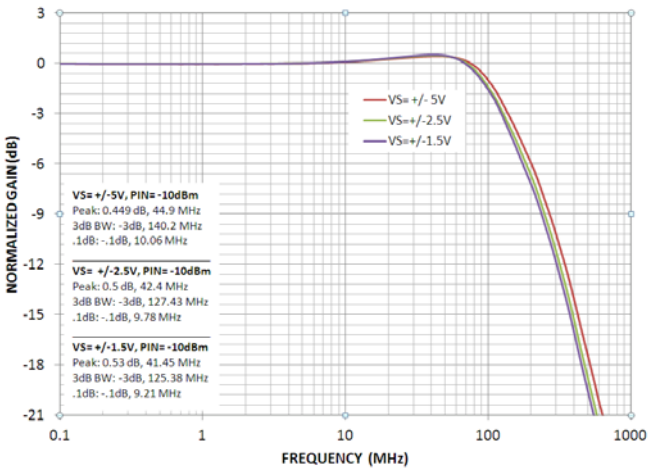

Figure 7. Large Signal Frequency Response vs. Supply Voltage

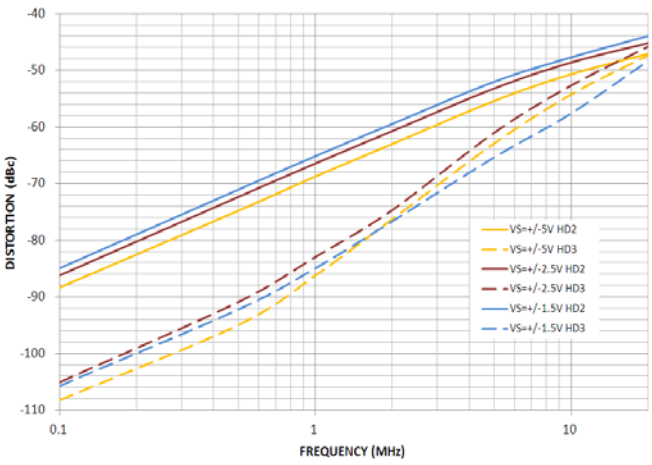

Figure 5. Harmonic Distortion vs. Frequency for various supplies

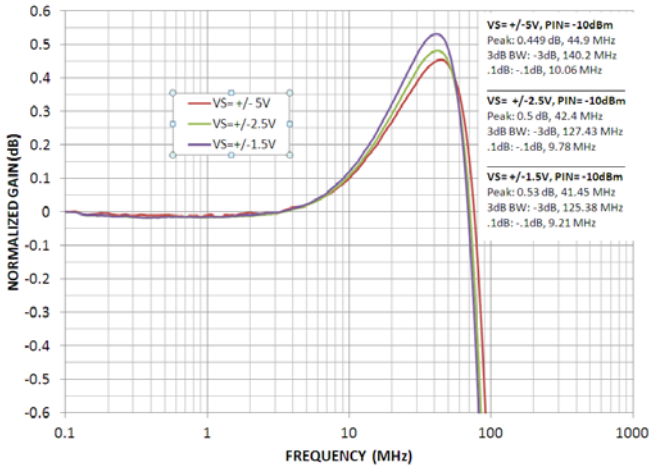

Figure 8. 0.1 dB Bandwidth at Selected R_F Value

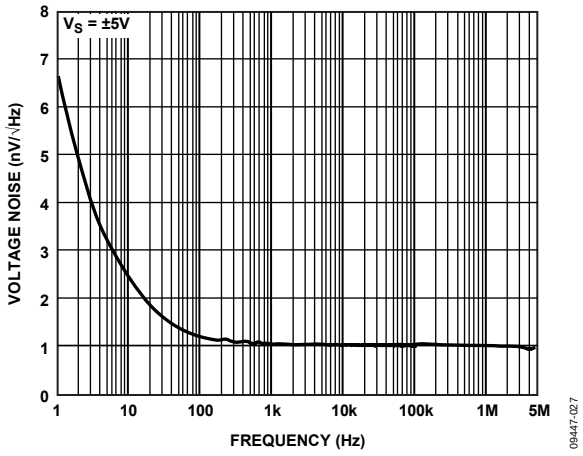

Figure 6. Voltage Noise vs. Frequency

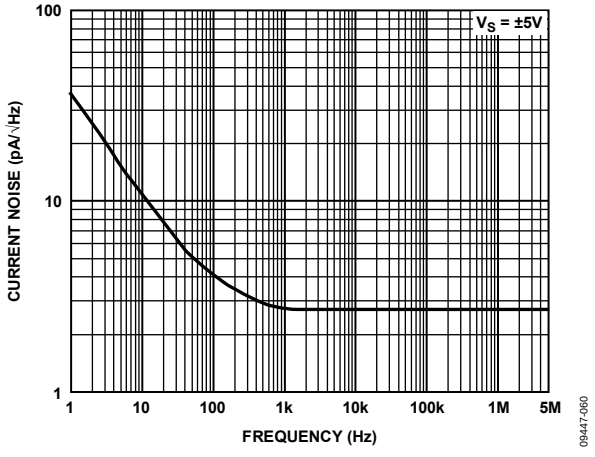

Figure 9. Current Noise vs. Frequency

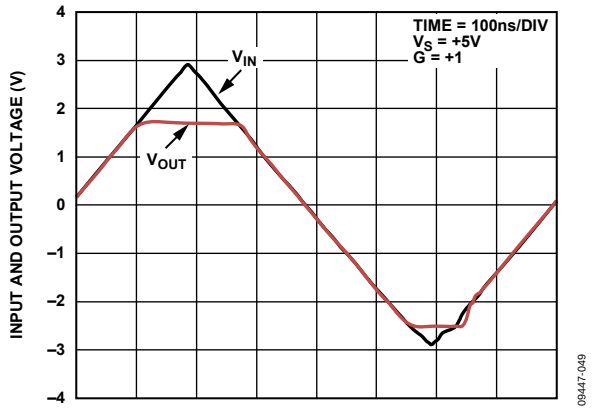

Figure 10. Input Overdrive Recovery

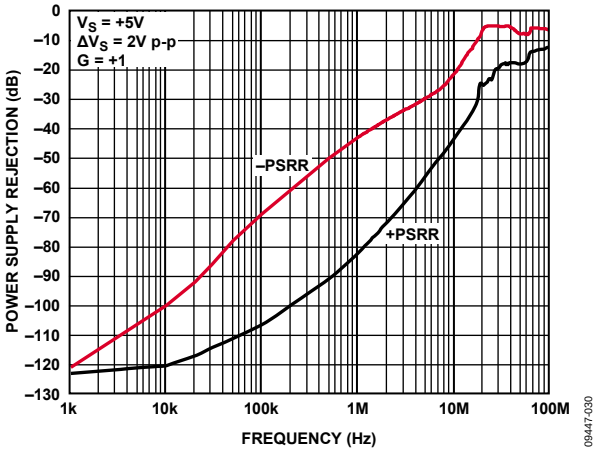

Figure 12. PSRR vs. Frequency

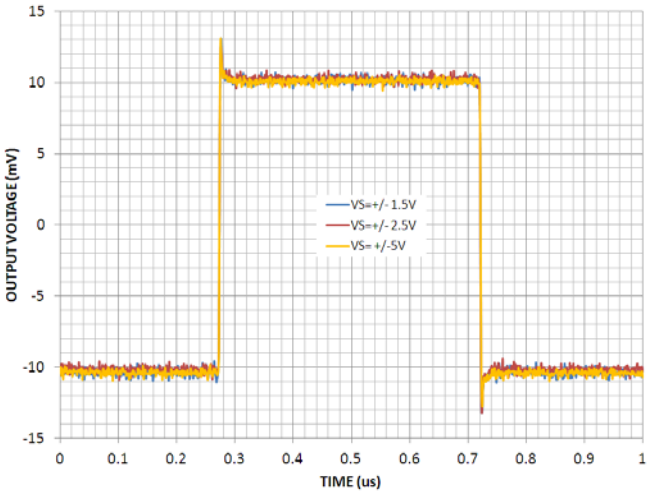

Figure 11.Small Signal Transient Response for Various Supplies

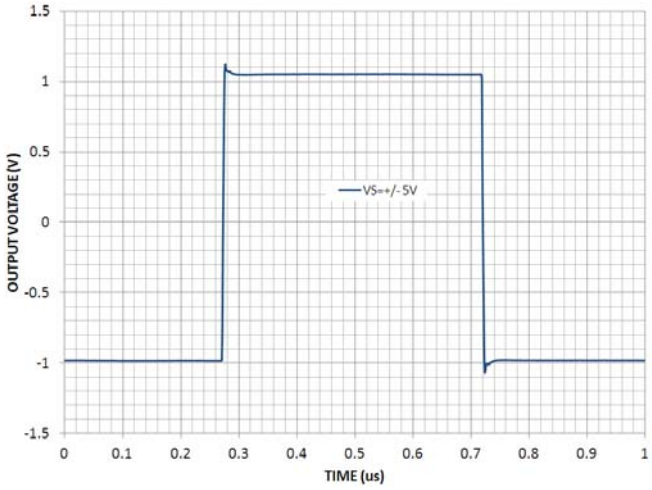

Figure 13. Large Signal Transient Response for Various Gains

OUTLINE DIMENSIONS

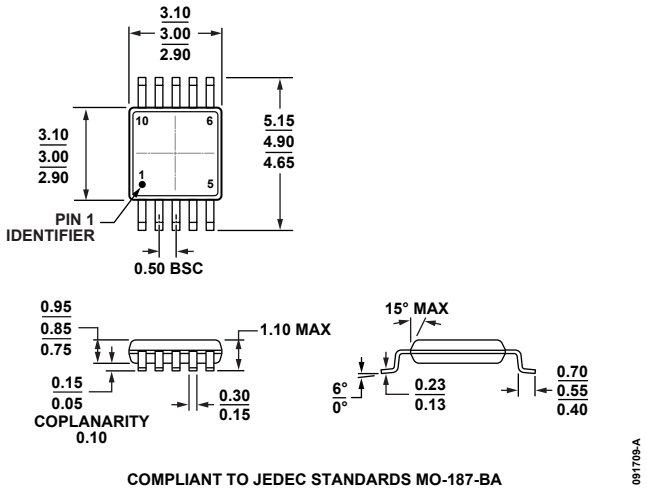

Figure 14. 10-Lead Mini Small Outline Package [MSOP]
(RM-10)
Dimensions shown in millimeters

PR10186-0-9/11(PrB)