# 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

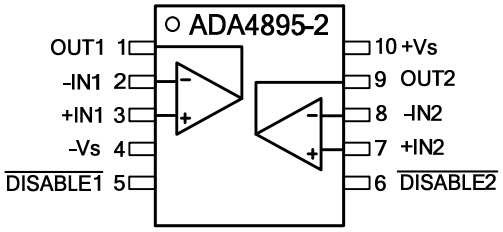


*Figure 1. 10-Lead MSOP (ADA4895-2)*

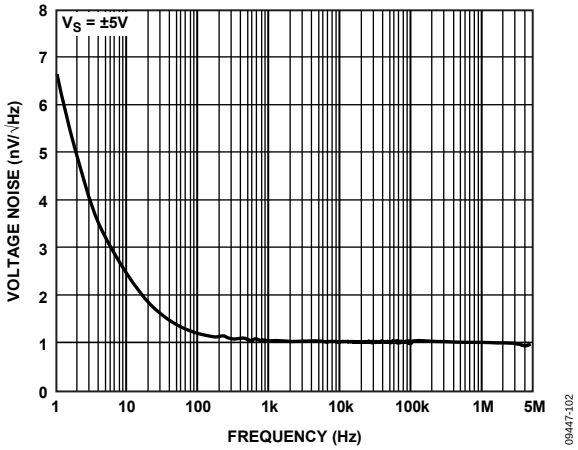


*Figure 2. Voltage Noise vs. Frequency*

**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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# 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

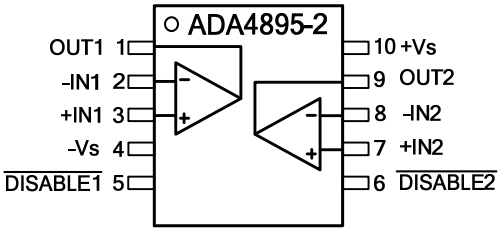


*Figure 3. 10-Lead ADA4895-2 MSOP (10)*

**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.

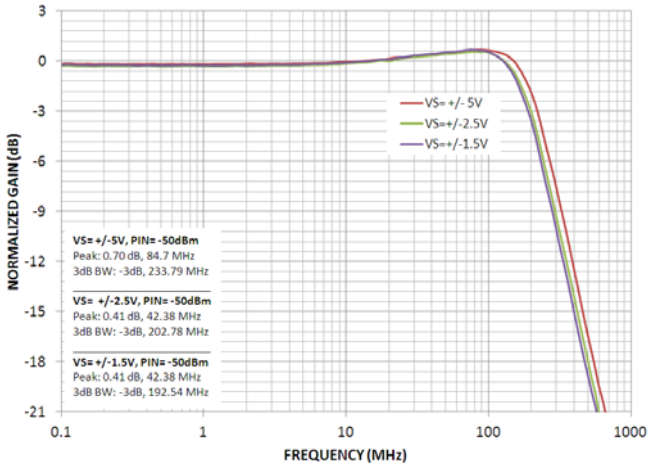


*Figure 4. Small Signal Frequency Response vs. Supply Voltage*

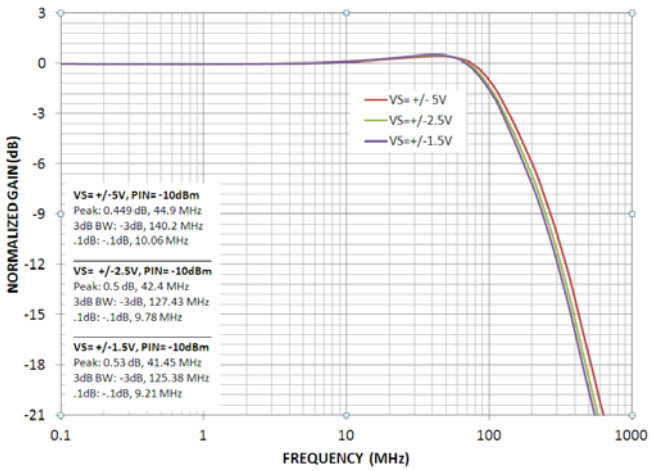


*Figure 7. Large Signal Frequency Response vs. Supply Voltage*

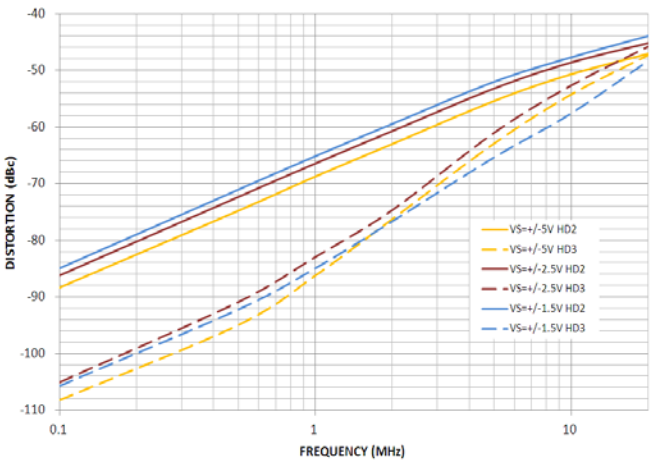


*Figure 5. Harmonic Distortion vs. Frequency for various supplies*

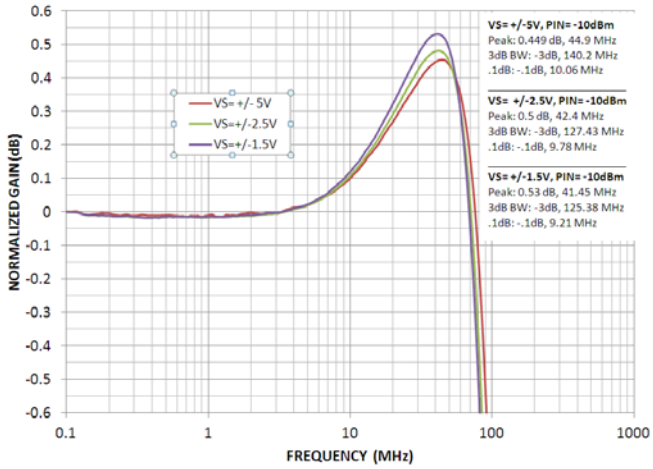


*Figure 8. 0.1 dB Bandwidth at Selected $R_F$ Value*

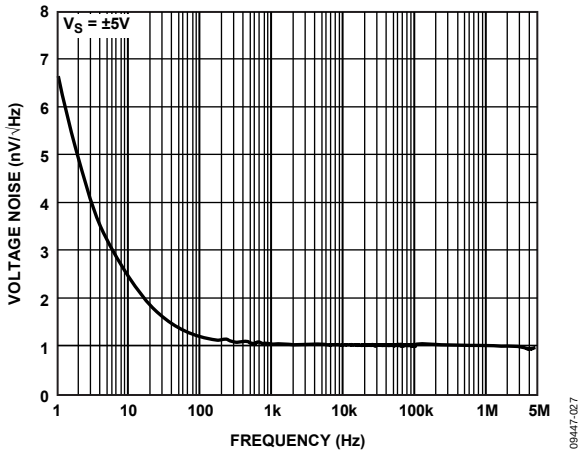


*Figure 6. Voltage Noise vs. Frequency*

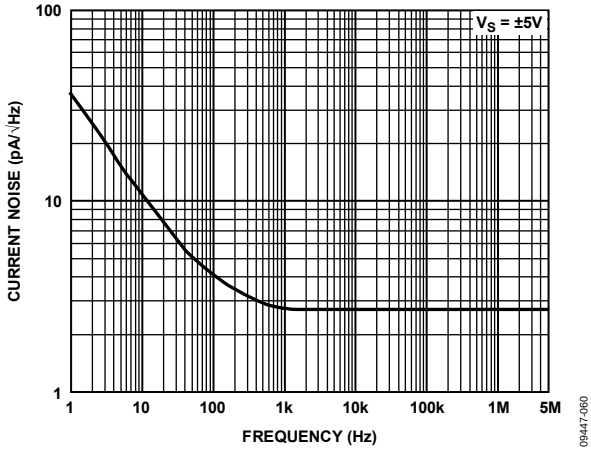


*Figure 9. Current Noise vs. Frequency*

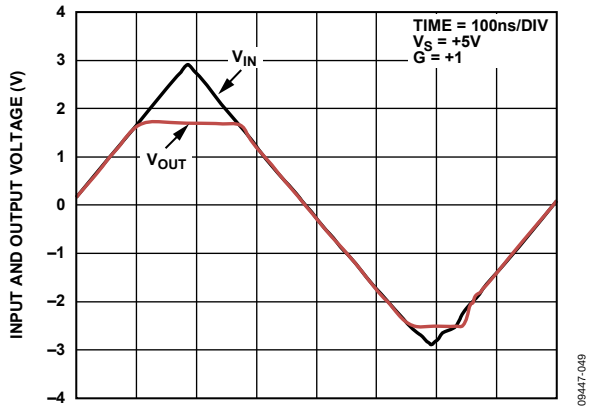


*Figure 10. Input Overdrive Recovery*

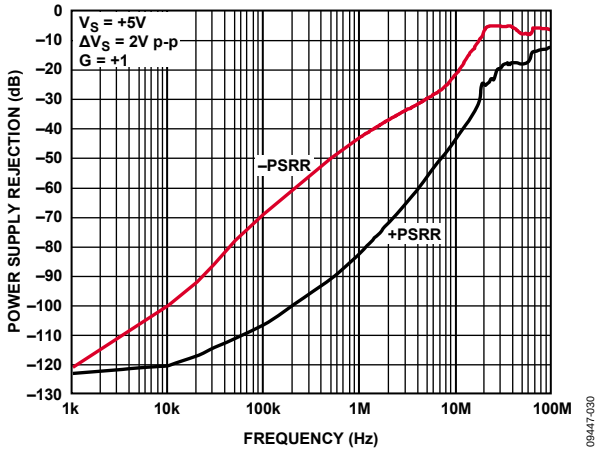


*Figure 12. PSRR vs. Frequency*

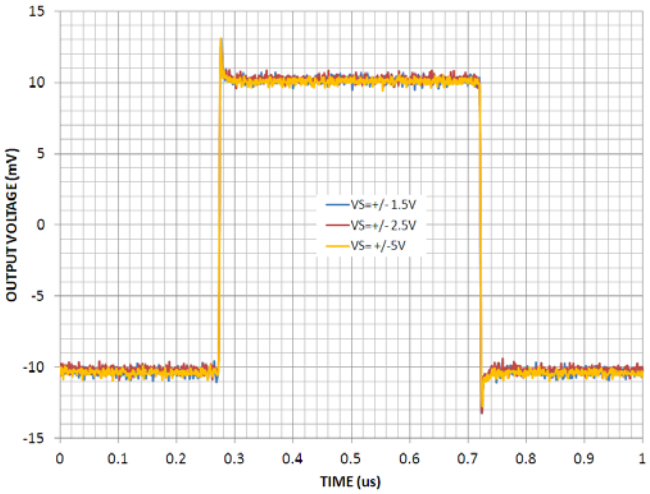


*Figure 11.Small Signal Transient Response for Various Supplies*

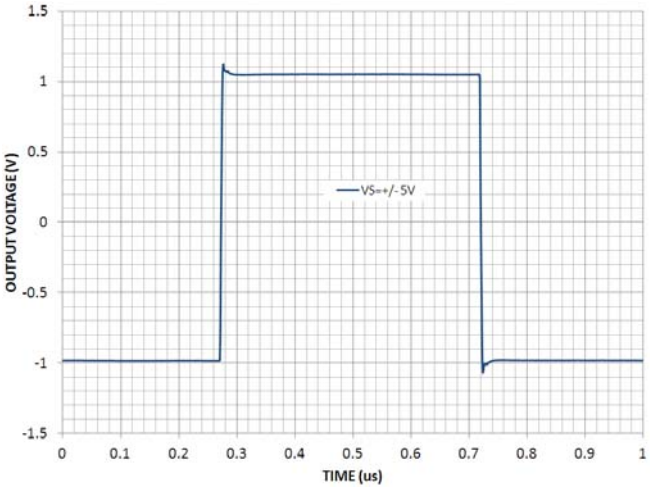


*Figure 13. Large Signal Transient Response for Various Gains*

# OUTLINE DIMENSIONS

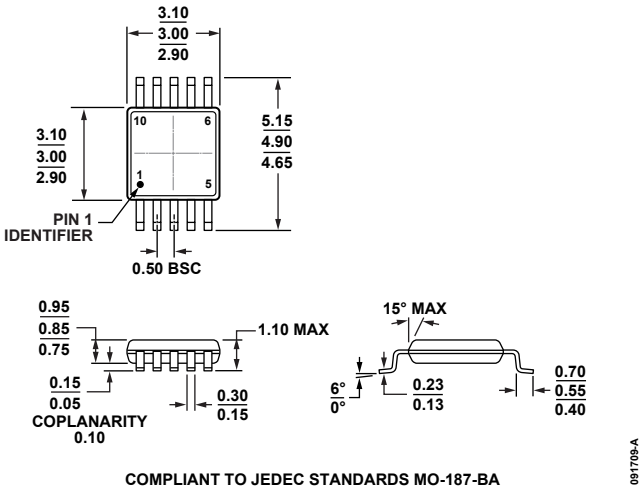


*Figure 14. 10-Lead Mini Small Outline Package [MSOP] (RM-10)*
*Dimensions shown in millimeters*


PR10186-0-9/11(PrB)