MAX74811

5V, CMOS, Zero-Drift, Rail-to-Rail, Dual Operational Amplifier

FEATURES

- Unity gain stable
- Low offset voltage: 1µV
- Input offset drift: 5nV°/C
- Gain Bandwidth: 2.5MHz
- Rail-to-rail input and output swing
- 5V single-supply operation
- High gain and CMRR: 150dB
- High PSRR: 120dB
- Very low input bias current: 150pA maximum
- Low supply current: 800µA
- Overload recovery time: 50µs
- No phase reversal

APPLICATIONS

- Pressure and position sensors
- Strain gage amplifiers
- Medical instrumentation
- Thermocouple amplifiers
- Precision current sensing
- Photodiode amplifiers

GENERAL DESCRIPTION

The MAX74811 is a wide bandwidth auto-zero amplifier featuring rail-to-rail input and output swing and low noise. 5V single supply operation is specified.

The MAX74811 zero-drift amplifier combines low cost with high accuracy and low noise. In addition, the MAX74811 greatly reduces the digital switching noise found in most chopper-stabilized amplifiers.

With an offset voltage of only 1µV (typ), drift of 5nV/°C (typ), and noise of only 0.5µV p-p (0.1Hz to 10Hz) (typ), the MAX74811 is suited for applications where error sources cannot be tolerated. Position and pressure sensors, medical equipment, and strain gauge amplifiers benefit greatly from nearly zero drift over their operating temperature range. Many systems can take advantage of the rail-to-rail input and output swings provided by the MAX74811 to reduce input biasing complexity and maximize signal-to-noise ratio (SNR).

The MAX74811 is specified for the extended industrial temperature range (−40°C to +125°C). The MAX74811 is available in the standard 8-lead MSOP plastic package.

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SPECIFICATIONS

Electrical Characteristics (V_S = 5.0V)

Table 1. Electrical Characteristics

(V_S = 5.0V, V_{CM} = 2.5V, T_A = 25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}			1	5	µV
		−40°C ≤ T_A ≤ +125°C			10	µV
Input Bias Current	I_B			30	150	pA
		−40°C ≤ T_A ≤ +125°C		1		nA
Input Offset Current	I_{OS}			60	300	pA
		−40°C ≤ T_A ≤ +125°C		150		pA
Input Voltage Range			0		5	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = 0V to 5V	130	150		dB
		−40°C ≤ T_A ≤ +125°C		130		dB
Large Signal Voltage Gain	A_{VO}	R_L = 10kΩ, V_O = 0.3V to 2.4V	125	150		dB
		−40°C ≤ T_A ≤ +125°C		150		dB
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C ≤ T_A ≤ +125°C		5	20	nV/°C
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	R_L = 10kΩ to ground	4.95	4.98		V
		−40°C ≤ T_A ≤ +125°C		4.97		V
Output Voltage Low	V_{OL}	R_L = 10kΩ to V+		10	50	mV
		−40°C ≤ T_A ≤ +125°C		15		mV
Short-Circuit Limit	I_{SC}			±80		mA
		−40°C ≤ T_A ≤ +125°C		±60		mA
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_S = 2.7V to 5.5V	115	120		dB
		V_S = 2.7V to 5.5V, −40°C ≤ T_A ≤ +125°C		120		dB
Supply Current per Amplifier	I_{SY}	V_O = V_S/2		800	950	µA
		−40°C ≤ T_A ≤ +125°C		1.0		mA
INPUT CAPACITANCE						
Differential	C_{IN}			1.5		pF
Common Mode	C_{IN}			8.0		pF
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 10kΩ		1.0		V/µs
Overload Recovery Time				0.05		ms

(V_S = 5.0V, V_{CM} = 2.5V, T_A = 25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Gain Bandwidth Product	GBP			2.5		MHz
NOISE PERFORMANCE						
Voltage Noise	e_n p-p	0.1Hz to 10Hz		0.5		µV p-p
Voltage Noise Density	e_n	f = 1kHz		22		nV/√Hz
Current Noise Density	i_n	f = 10Hz		5		fA/√Hz

ABSOLUTE MAXIMUM RATINGS

T_A = 25°C unless otherwise specified.

Table 2. Absolute Maximum Ratings

PARAMETER	RATING
Supply Voltage	6V
Input Voltage	GND – 0.3V to V_S + 0.3V
Differential Input Voltage[1]	±5V
Input Current (Indefinite)	±10mA
Input Current (Duration < 1 sec)	±100mA
Output Short-Circuit Duration to GND	Indefinite
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	−40°C to +125°C
Junction Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 60 sec.)	300°C
ESD MM	±200V
ESD HBM	±4000V
ESD FICDM 8-Lead MSOP	±1500V

[1] Differential input voltage is limited to ±5V or the supply voltage, whichever is less.

Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings 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 Characteristics

θ_{JA} is specified for worst-case conditions, that is, θ_{JA} is specified for the device soldered in a circuit board for surface-mount packages. This was measured using a standard two-layer board.

Table 3. Package Type

PACKAGE TYPE	θ_{JA}	θ_{JC}	UNIT
8-Lead MSOP (RM-8)	190	44	°C/W

ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

PIN CONFIGURATION

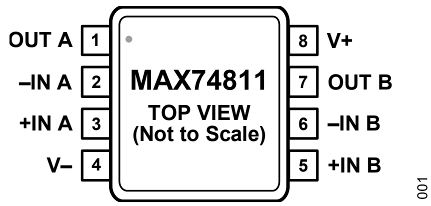

Figure 1. 8-Lead MSOP (RM-8)

TYPICAL PERFORMANCE CHARACTERISTICS

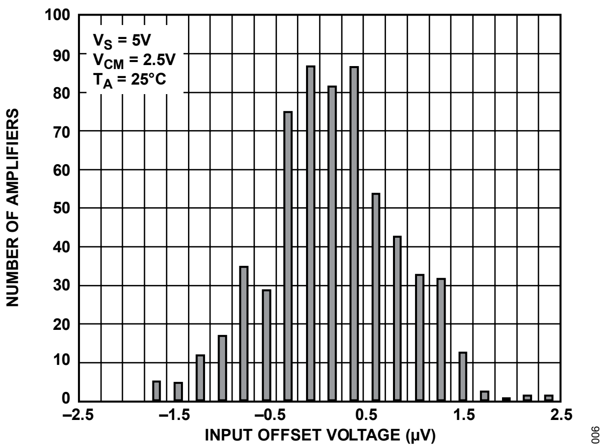

Figure 2. Input Offset Voltage

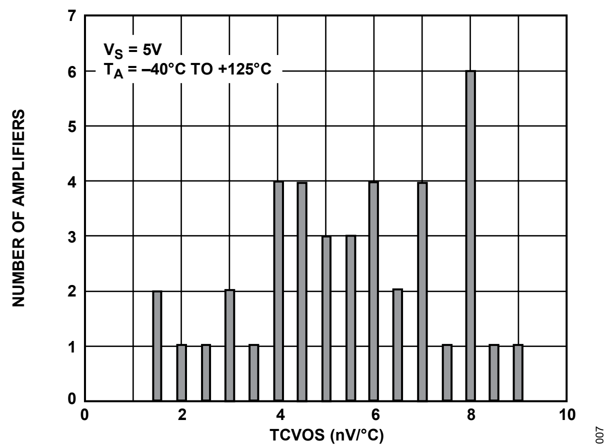

Figure 3. Input Offset Voltage Drift

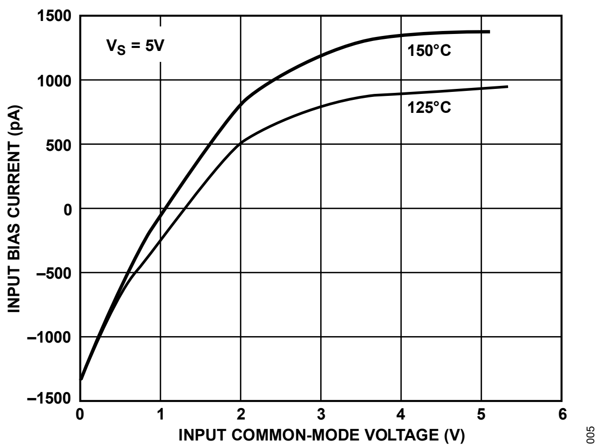

Figure 4. Input Bias Current vs. Input Common-Mode Voltage

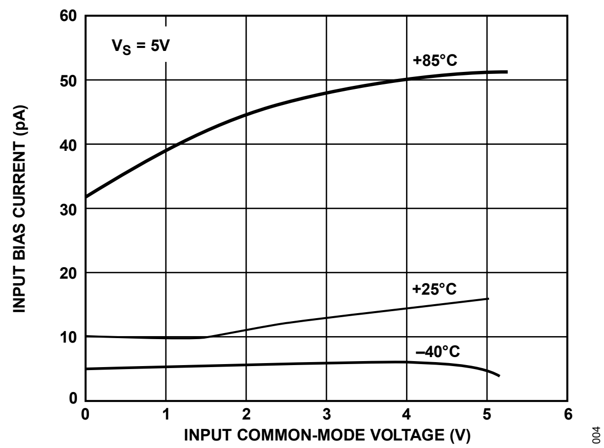

Figure 5. Input Bias Current vs. Input Common-Mode Voltage

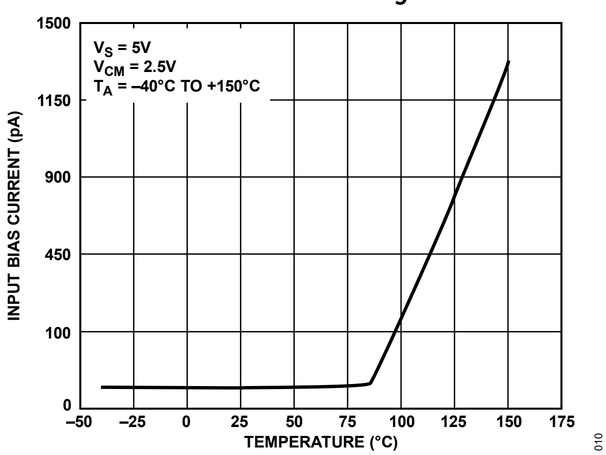

Figure 6. Input Bias Current vs. Temperature

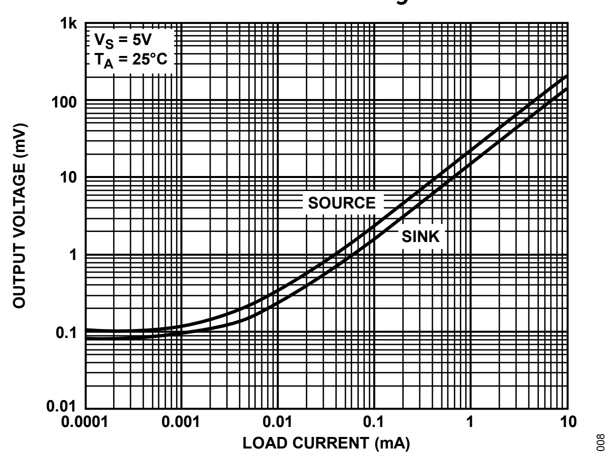

Figure 7. Output Voltage to Supply Rail vs. Load Current

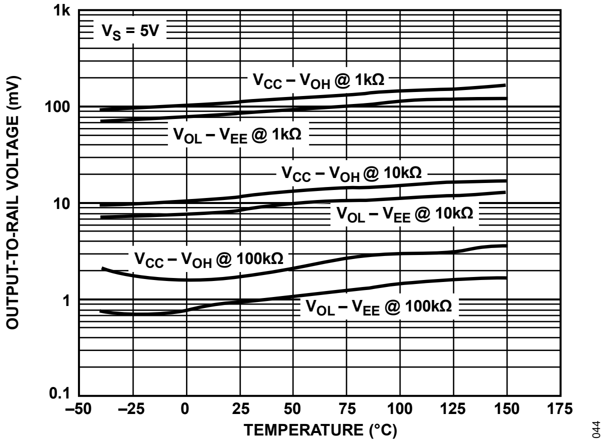

Figure 8. Output-to-Rail Voltage vs. Temperature

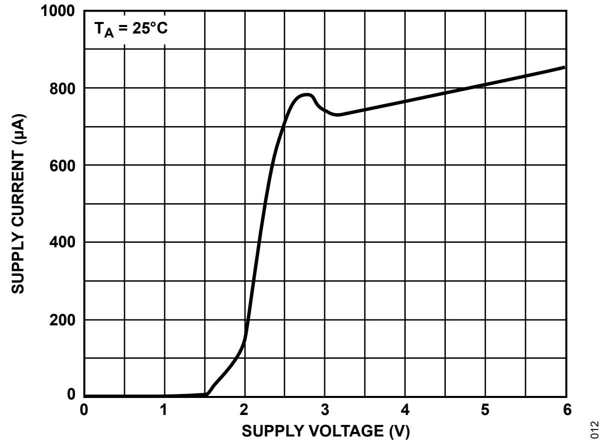

Figure 9. Supply Current vs. Supply Voltage

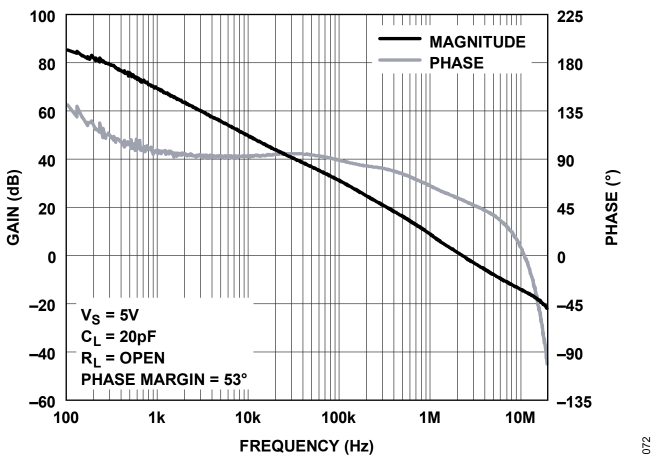

Figure 10. Open-Loop Gain and Phase vs. Frequency

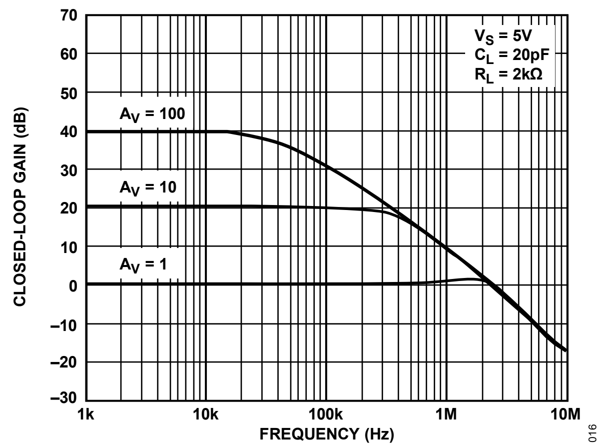

Figure 11. Closed-Loop Gain vs. Frequency

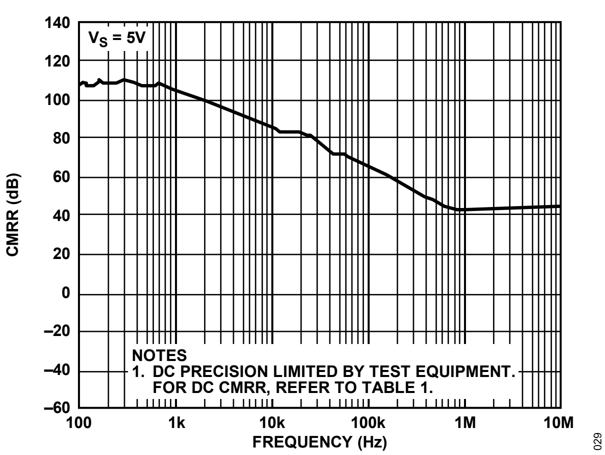

Figure 12. CMRR vs. Frequency

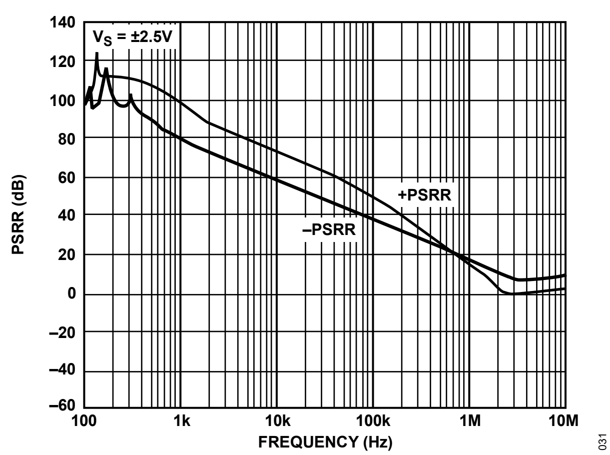

Figure 13. PSRR vs. Frequency

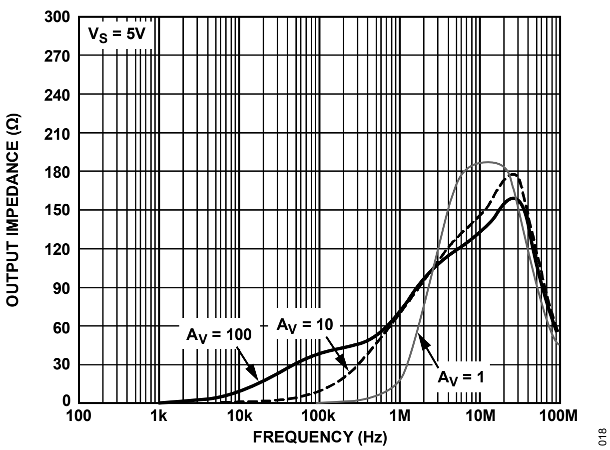

Figure 14. Output Impedance vs. Frequency

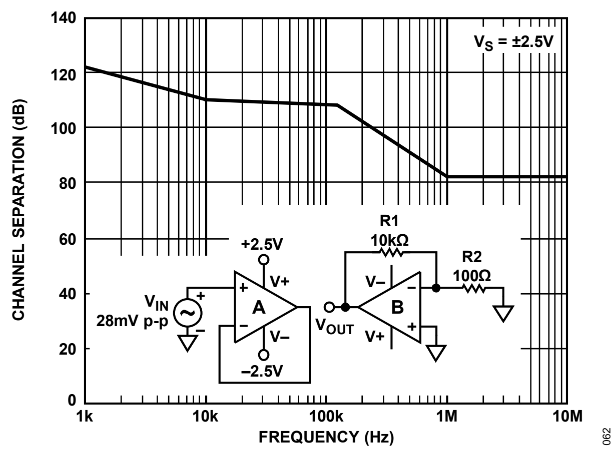

Figure 15. Channel Separation vs. Frequency

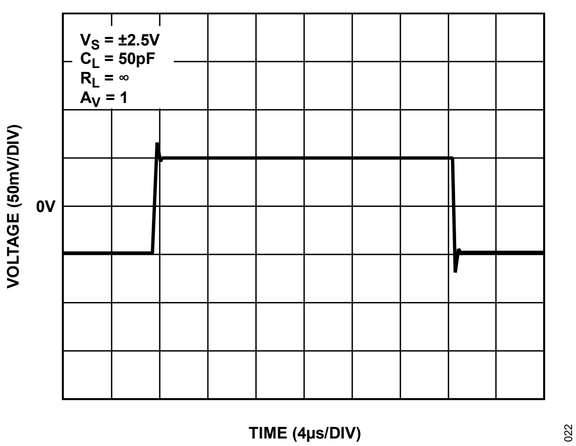

Figure 16. Small Signal Transient Response

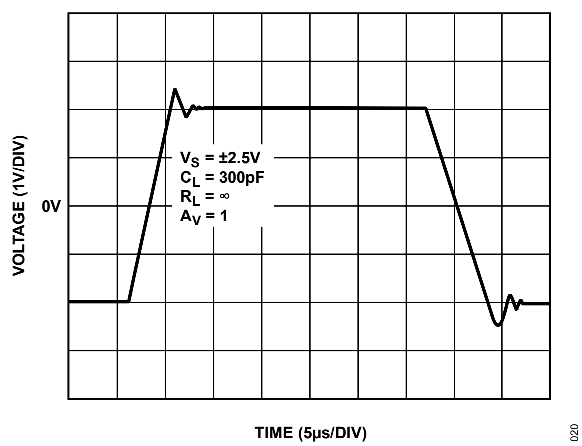

Figure 17. Large Signal Transient Response

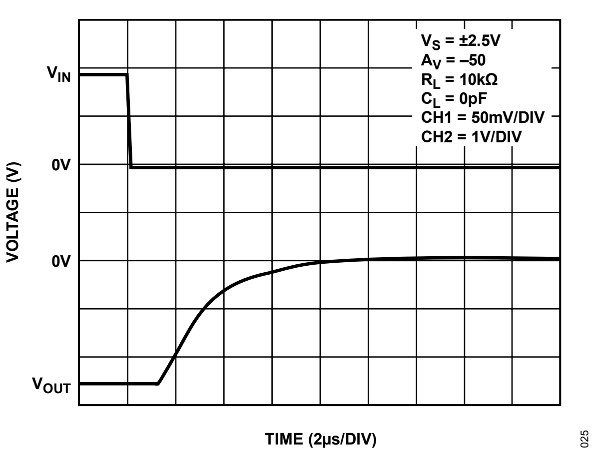

Figure 18. Positive Overvoltage Recovery

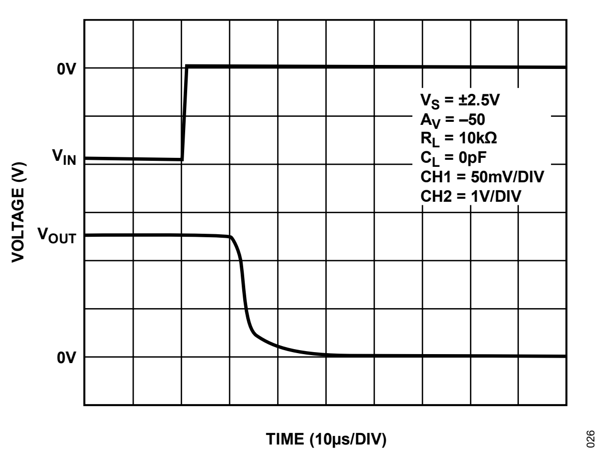

Figure 19. Negative Overvoltage Recovery

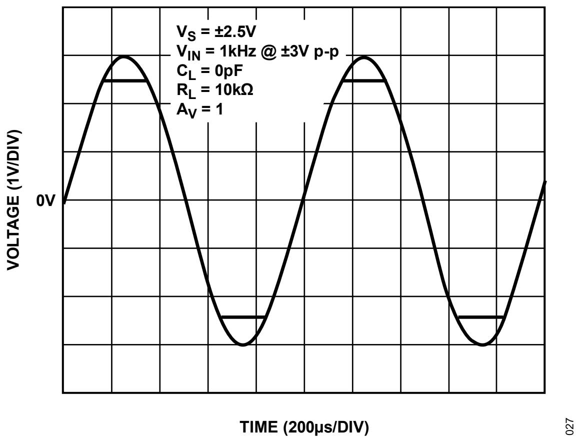

Figure 20. No Phase Reversal

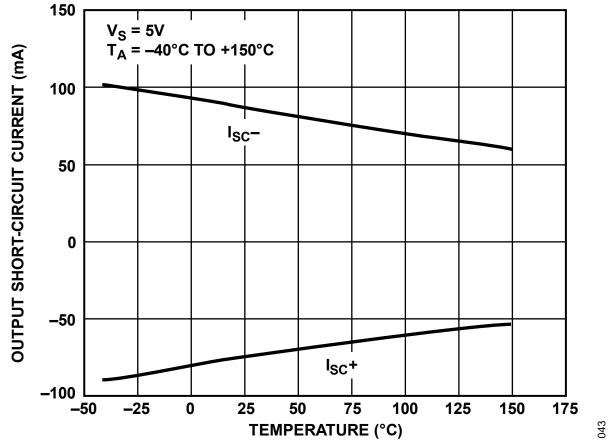

Figure 21. Output Short-Circuit Current vs. Temperature

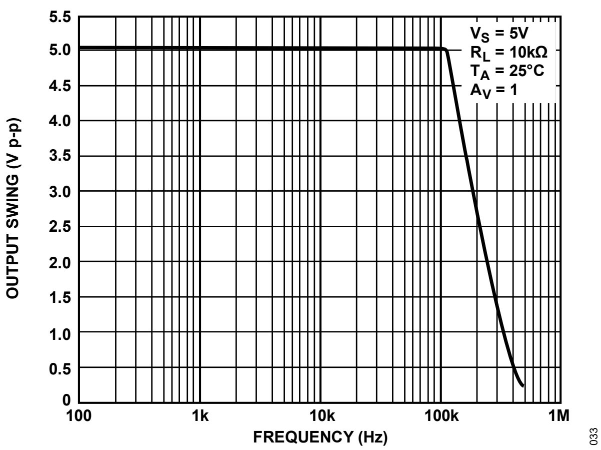

Figure 22. Maximum Output Swing vs. Frequency

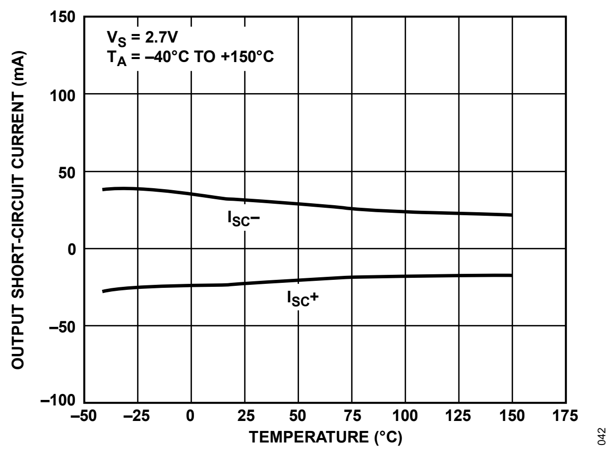

Figure 23. Output Short-Circuit Current vs. Temperature

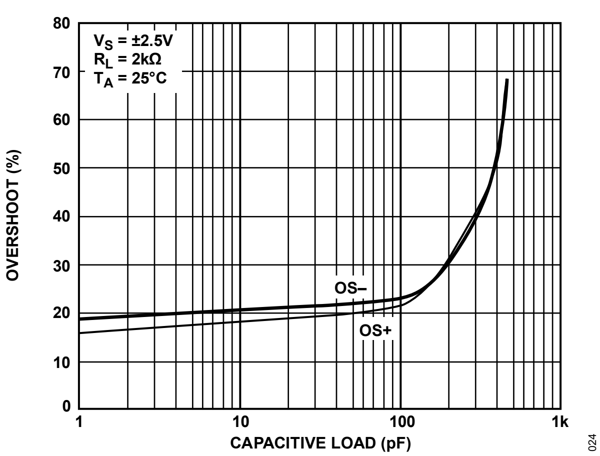

Figure 24. Small Signal Overshoot vs. Load Capacitance

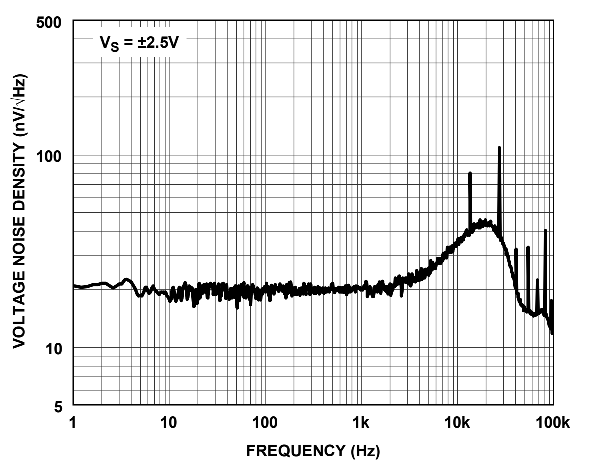

Figure 25. Input-Referred Voltage Noise Density

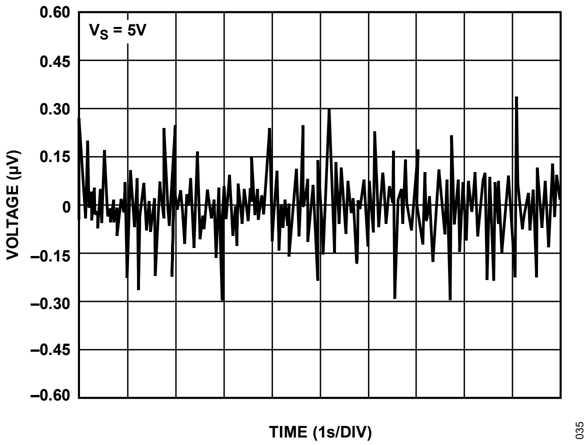

Figure 26. 0.1Hz to 10Hz Noise

FUNCTIONAL DESCRIPTION

The MAX74811 is a single-supply, ultrahigh precision rail-to-rail input and output operational amplifier. The typical offset voltage of less than 1µV allows this amplifier to be easily configured for high gains without risk of excessive output voltage errors. The extremely small temperature drift of 5nV/°C ensures a minimum offset voltage error over its entire temperature range of −40°C to +125°C, making this amplifier ideal for a variety of sensitive measurement applications in harsh operating environments.

The MAX74811 achieves a high degree of precision through a patented combination of auto-zeroing and chopping. This unique topology allows the MAX74811 to maintain its low offset voltage over a wide temperature range and over its operating lifetime.

Previous designs used either auto-zeroing or chopping to add precision to the specifications of an amplifier. Auto-zeroing results in low noise energy at the auto-zeroing frequency, at the expense of higher low frequency noise due to aliasing of wideband noise into the auto-zeroed frequency band. Chopping results in lower low frequency noise at the expense of larger noise energy at the chopping frequency. The MAX74811 uses both auto-zeroing and chopping in a patented ping-pong arrangement to obtain lower low frequency noise together with lower energy at the chopping and auto-zeroing frequencies, maximizing the signal-to-noise ratio for the majority of applications without the need for additional filtering.

The MAX74811 has low noise over a relatively wide bandwidth (0Hz to 10kHz) and can be used where the highest DC precision is required. In systems with signal bandwidths from 5kHz to 10kHz, the MAX74811 provides true 16-bit accuracy, making it the best choice for very high-resolution systems.

1/f Noise

1/f noise, also known as pink noise, is a major contributor to errors in DC-coupled measurements. This 1/f noise error term can be in the range of several µV or more, and, when amplified with the closed-loop gain of the circuit, can show up as a large output offset. For example, when an amplifier with a 5µV p-p 1/f noise is configured for a gain of 1000, its output has 5mV of error due to the 1/f noise. However, the MAX74811 eliminates 1/f noise internally, thereby greatly reducing output errors.

The internal elimination of 1/f noise is accomplished as follows. 1/f noise appears as a slowly varying offset to the MAX74811 inputs. Auto-zeroing corrects any DC or low frequency offset. Therefore, the 1/f noise component is essentially removed, leaving the MAX74811 free of 1/f noise.

For a first-order filter, the total integrated noise from the MAX74811 is lower than the noise of Competitor A.

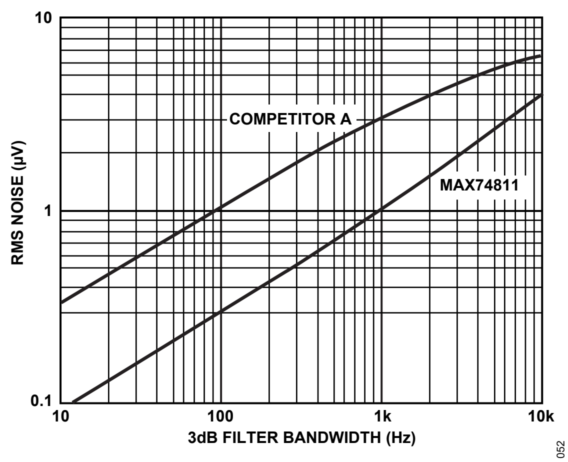

Figure 27. Total Integrated Noise

OUTLINE DIMENSIONS

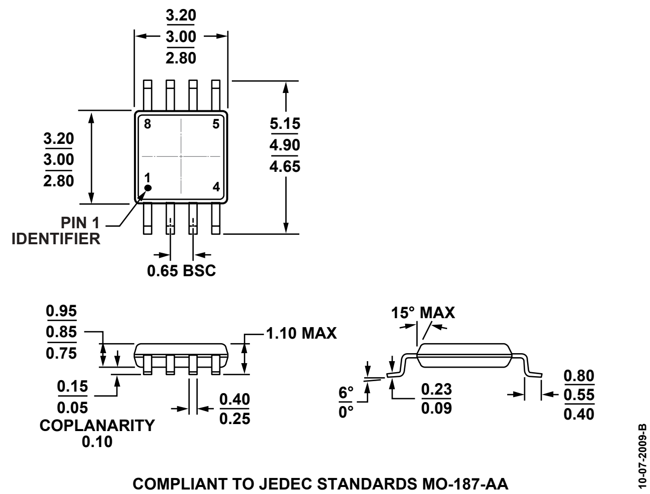

Figure 28. 8-Lead Mini Small Outline Package [MSOP] (RM-8) Dimensions shown in millimeters

ORDERING GUIDE

Table 4. Ordering Guide

MODEL[1]	TEMPERATURE RANGE	PACKAGE DESCRIPTION	PACKAGE OPTION	Marking Code
MAX74811ARMZ	−40°C to +125°C	8-Lead MSOP	RM-8	A6P
MAX74811ARMZ-RL	−40°C to +125°C	8-Lead MSOP	RM-8	A6P
MAX74811ARMZ-R7	−40°C to +125°C	8-Lead MSOP	RM-8	A6P

[1] Z = RoHS compliant part

REVISION HISTORY

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGE NUMBERS
0	04/25	Initial release	—