Precision, Low Noise, CMOS, Rail-to-Rail, Input/Output Operational Amplifier

FEATURES

- **Low offset voltage: 300µV maximum**
- **Low input bias currents: 5pA maximum**
- **Low noise: 9nV/√Hz**
- **Wide bandwidth: 10MHz**
- **High slew rate: 5V/µs**
- **High open-loop gain: 120dB**
- **Unity gain stable**
- **Single-supply operation: 5.5V**
- **Low supply current: 1.15mA/amplifier**

APPLICATIONS

- **Photodiode amplification**
- **Optical control loops**
- **Battery-powered instrumentation**
- **Loop-powered instrumentation**
- **Multipole filters**
- **Sensors**
- **Barcode scanners**
- **Audio**

GENERAL DESCRIPTION

The MAX74821 is a dual rail-to-rail input and output, single-supply amplifier. The MAX74821 features very low offset voltage, low input voltage and current noise, and wide signal bandwidth. The MAX74821 uses the Analog Devices Inc. patented DigiTrim® trimming technique[1], which achieves superior precision without the switching noise associated with chopping or auto-zeroing techniques.

The combination of low offsets, low noise, very low input bias currents, and high speed makes this amplifier useful in a wide variety of applications. Filters, integrators, photodiode amplifiers, and high impedance sensors all benefit from the combination of performance features. Audio and other AC applications benefit from the wide bandwidth and low distortion. Applications for these amplifiers include optical control loops, portable and loop-powered instrumentation, and audio amplification for portable devices.

The MAX74821 is specified over the extended industrial temperature range (−40°C to +125°C). The MAX74821 dual is available in an 8-lead MSOP package.

[1] Protected by U.S. Patent No. 5,969,657.

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SPECIFICATIONS

5V Electrical Specifications

Table 1. Electrical Characteristics

(V_S = 5V, V_{CM} = V_S/2, T_A = 25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	V_S = 5V, V_{CM} = 0V to 5V		80	300	µV
		−40°C < T_A < +125°C		750		µV
Input Bias Current	I_B			0.25	5	pA
		−40°C < T_A < +125°C		175		pA
Input Offset Current	I_{OS}			0.15	2.5	pA
		−40°C < T_A < +125°C		85		pA
Input Voltage Range			-0.1		5.1	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = 0V to 5V	85	100		dB
		−40°C < T_A < +125°C		90		dB
Large Signal Voltage Gain	A_{VO}	R_L = 2kΩ, V_O = 0.5V to 4.5V	108	120		dB
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +125°C		1		µV/°C
INPUT CAPACITANCE						
Common-Mode Input Capacitance	C_{COM}			8.8		pF
Differential Input Capacitance	C_{DIFF}			2.6		pF
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	I_L = 1mA	4.96	4.98		V
		−40°C < T_A < +125°C		4.6		V
Output Voltage Low	V_{OL}	I_L = 1mA		20	40	mV
		−40°C < T_A < +125°C		290		mV
Output Current	I_{OUT}			±80		mA
Closed-Loop Output Impedance	Z_{OUT}	f = 1MHz, A_V = +1		1		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_S = 2.7V to 5.5V	80	95		dB
		−40°C < T_A < +125°C		90		dB
Supply Current/Amplifier	I_{SY}	I_{OUT} = 0mA		1	1.15	mA
		−40°C < T_A < +125°C		1.4		mA
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 2kΩ, C_L = 16pF		5		V/µs

(V_S = 5V, V_{CM} = V_S/2, T_A = 25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Settling Time	t_S	To 0.01%, 0V to 2V step A_V = +1		<1		µs
Unity Gain Bandwidth Product	GBP			10		MHz
Phase Margin	Φ_M			65		Degrees
NOISE PERFORMANCE						
Peak-to-Peak Noise	e_n p-p	f = 0.1Hz to 10Hz		2.3		µV p-p
Voltage Noise Density	e_n	f = 1kHz		9		nV/√Hz
		f = 10kHz		7.3		nV/√Hz
Current Noise Density	i_n	f = 1kHz		10		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	±5V
Input Current (Indefinite)	±10mA
Input Current (Duration < 1 sec)	±100mA
Output Short-Circuit Duration to GND	Indefinite
Operating Temperature Range	−40°C to +125°C
Storage Temperature Range	−65°C to +150°C
Junction Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 60 sec)	300°C
ESD HBM	±4000V
ESD FICDM 8-Lead MSOP	±1000V

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.

Table 3. Package Type

PACKAGE TYPE	θ_{JA}[1]	θ_{JC}	UNIT
8-Lead MSOP (RM)	206	44	°C/W

[1] θ_{JA} is specified for the worst-case conditions, that is, a device soldered in a circuit board for surface-mount packages.

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

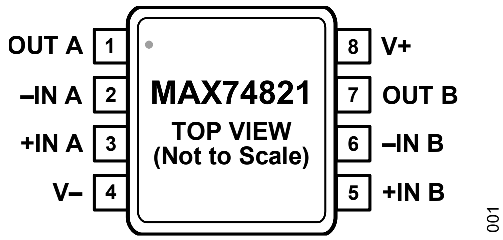

Figure 1. 8-Lead MSOP (RM Suffix)

TYPICAL PERFORMANCE CHARACTERISTICS

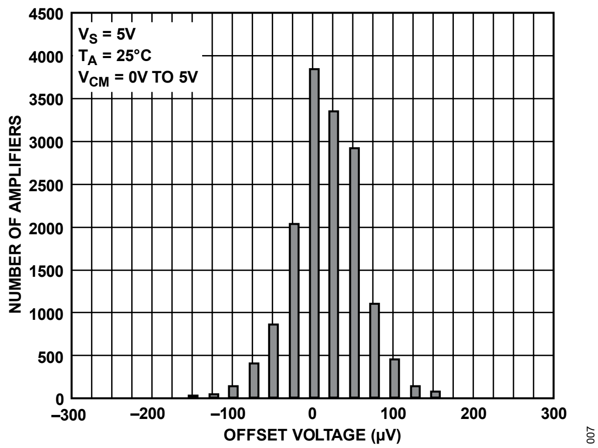

Figure 2. Input Offset Voltage Distribution

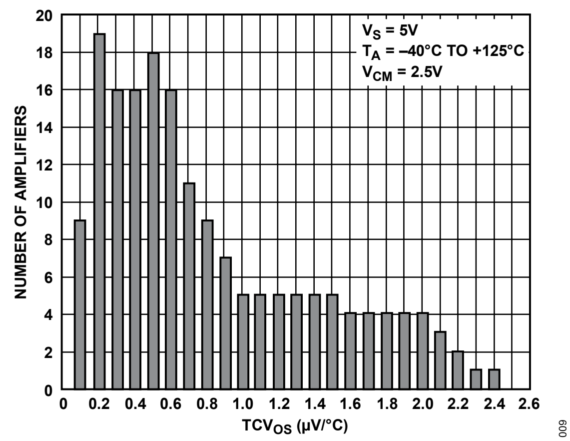

Figure 3. Input Offset Voltage Drift Distribution

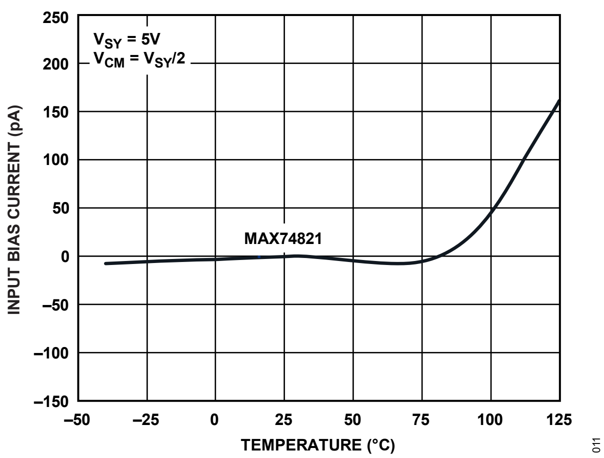

Figure 4. Input Bias Current vs. Temperature

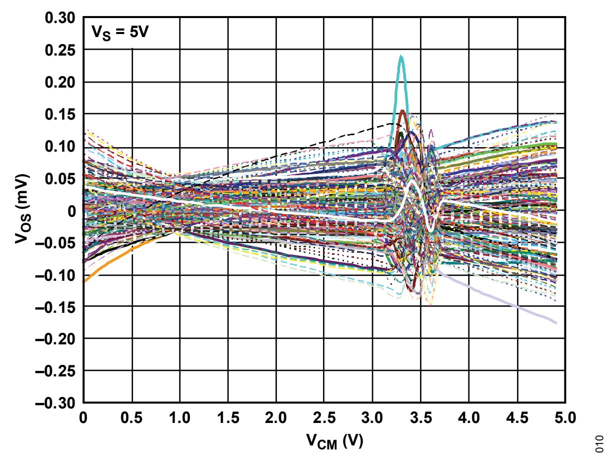

Figure 5. Input Offset Voltage vs. Common-Mode Voltage (200 Units, 5 Wafer Lots, Including Process Skews)

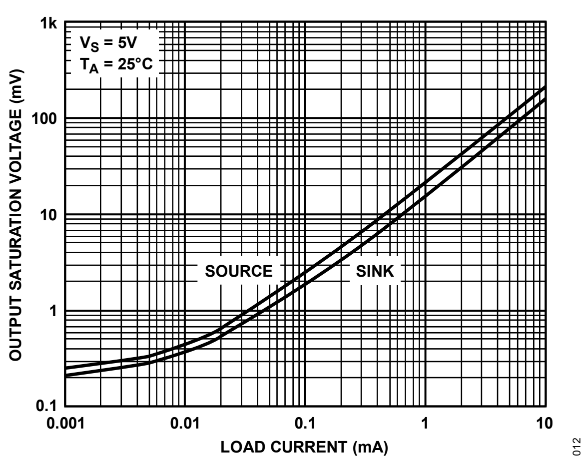

Figure 6. Output Saturation Voltage vs. Load Current

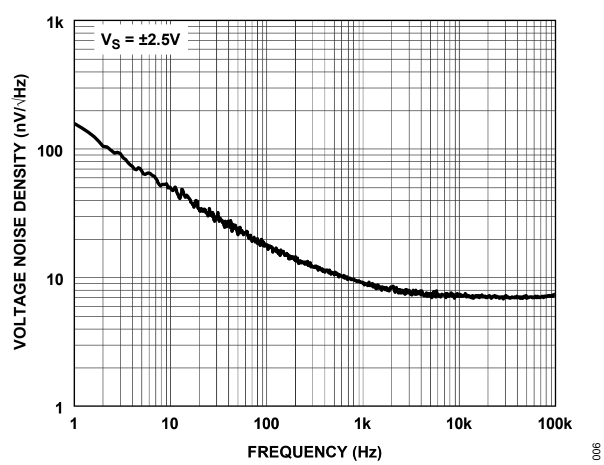

Figure 7. Voltage Noise Density vs. Frequency

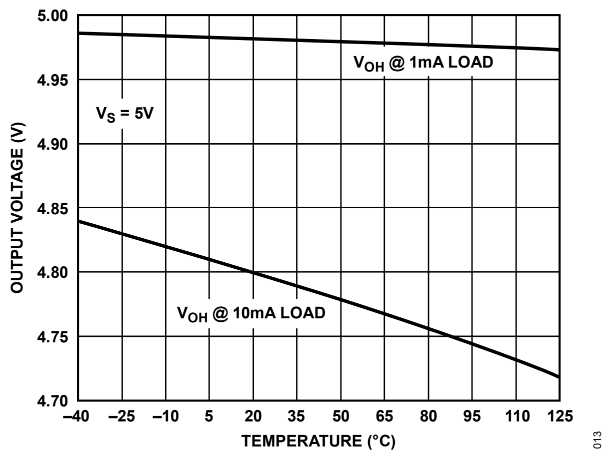

Figure 8. Output Voltage Swing High vs. Temperature

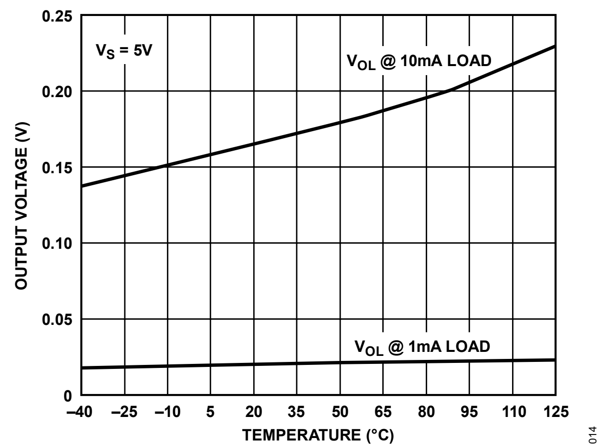

Figure 9. Output Voltage Swing Low vs. Temperature

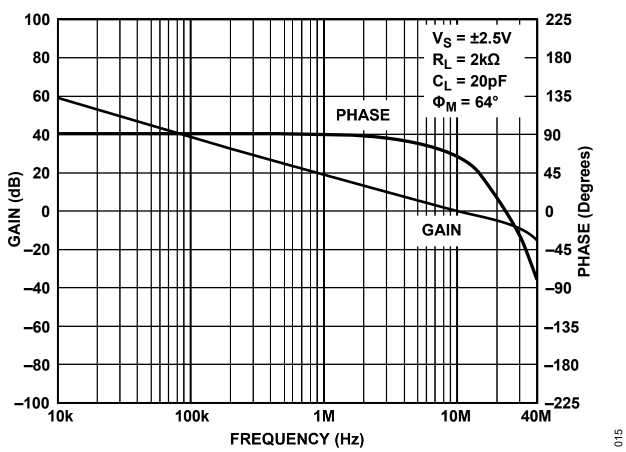

Figure 10. Open-Loop Gain and Phase vs. Frequency

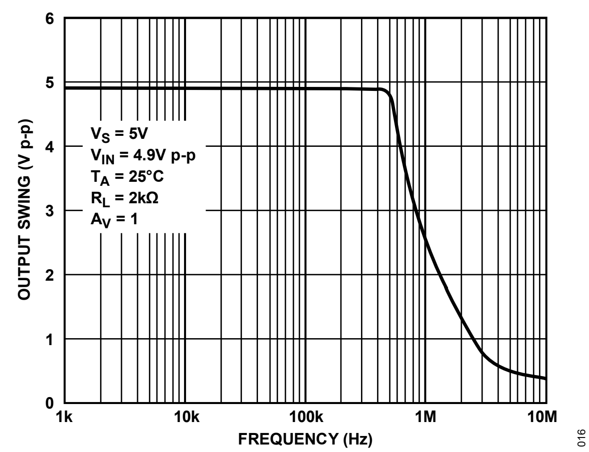

Figure 11. Closed-Loop Output Voltage Swing (FPBW)

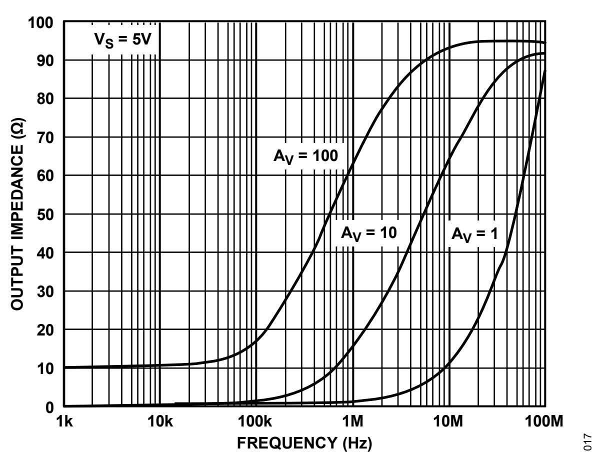

Figure 12. Output Impedance vs. Frequency

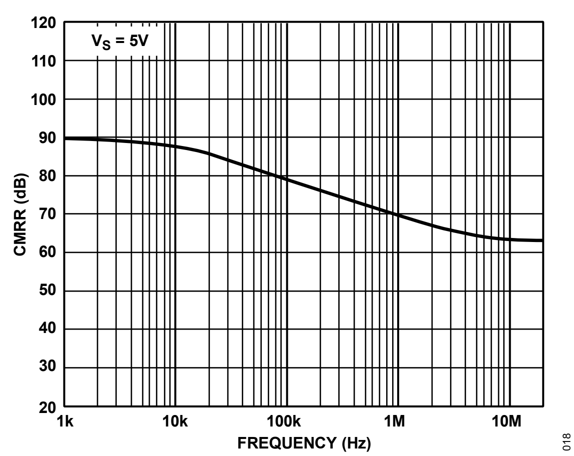

Figure 13. Common-Mode Rejection Ratio (CMRR) vs. Frequency

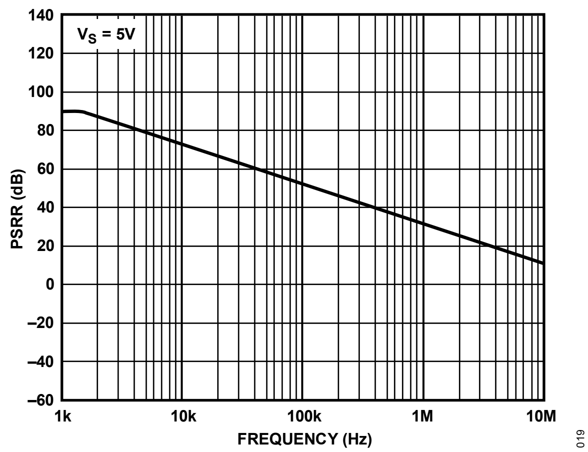

Figure 14. PSRR vs. Frequency

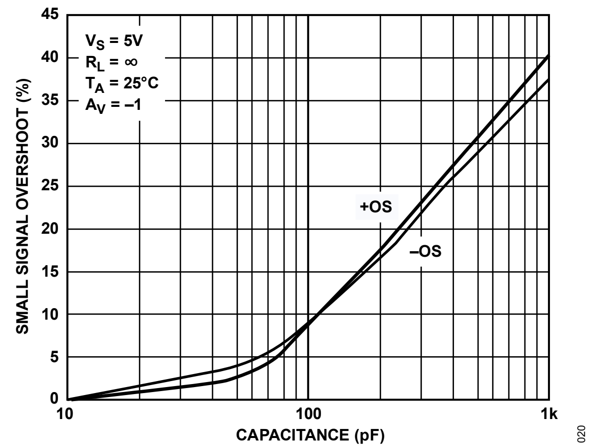

Figure 15. Small Signal Overshoot vs. Load Capacitance

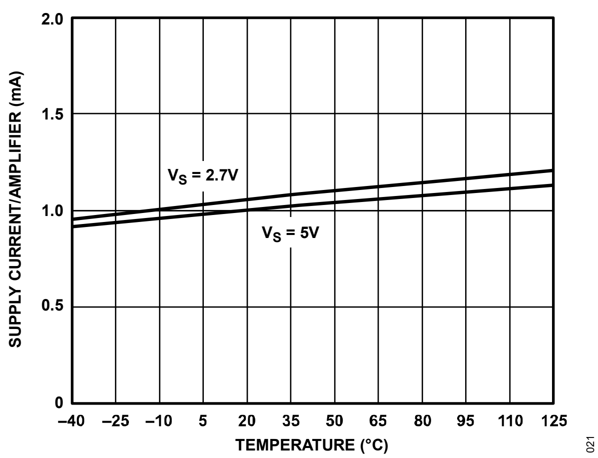

Figure 16. Supply Current/Amplifier vs. Temperature

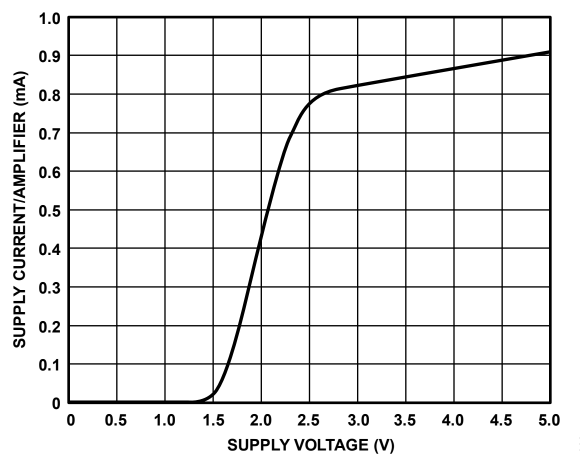

Figure 17. Supply Current/Amplifier vs. Supply Voltage

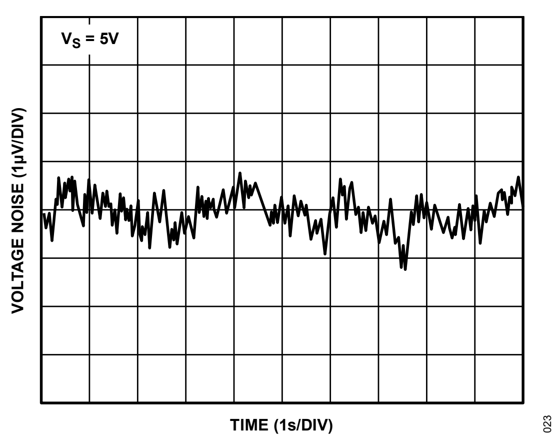

Figure 18. 0.1Hz to 10Hz Input Voltage Noise

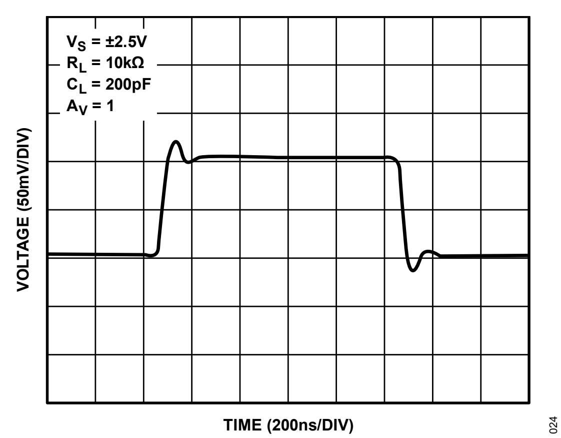

Figure 19. Small Signal Transient Response

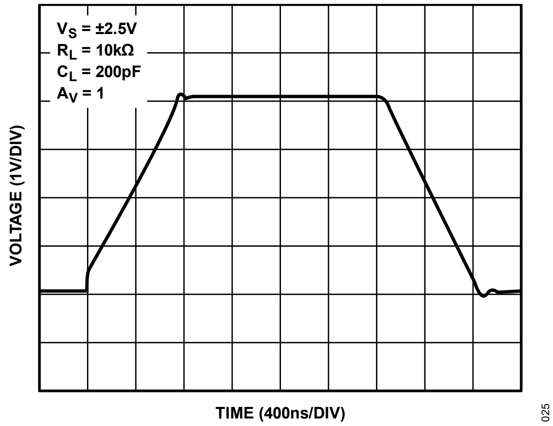

Figure 20. Large Signal Transient Response

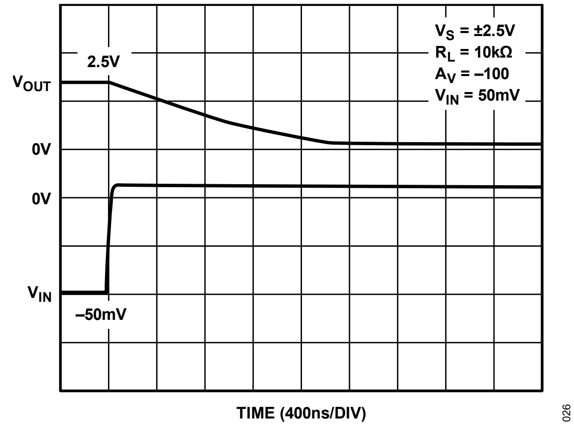

Figure 21. Positive Overload Recovery

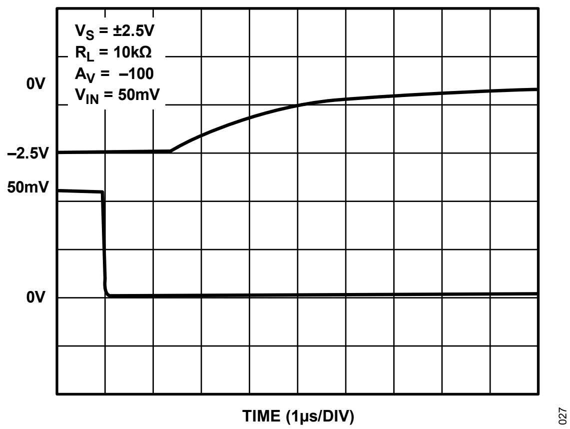

Figure 22. Negative Overload Recovery

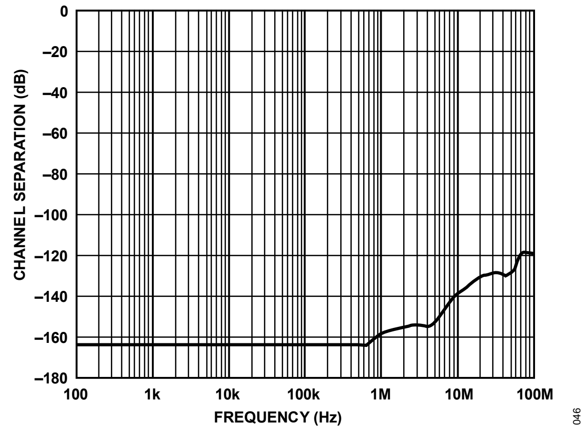

Figure 23. Channel Separation vs. Frequency

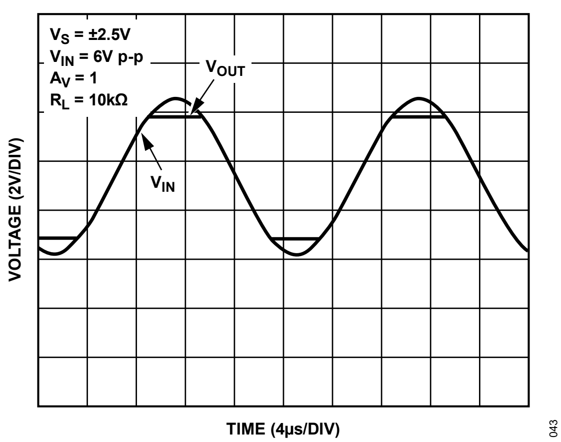

Figure 24. No Phase Reversal

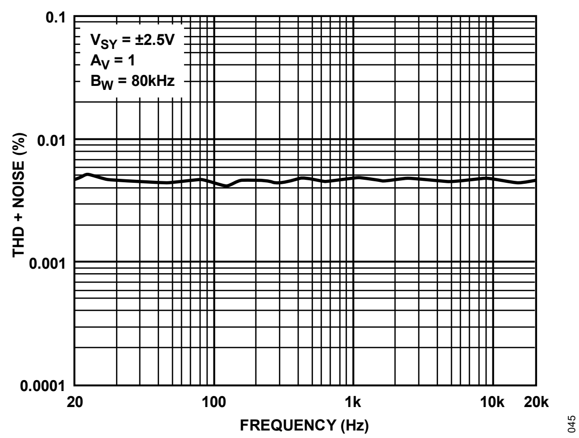

Figure 25. THD + Noise vs. Frequency

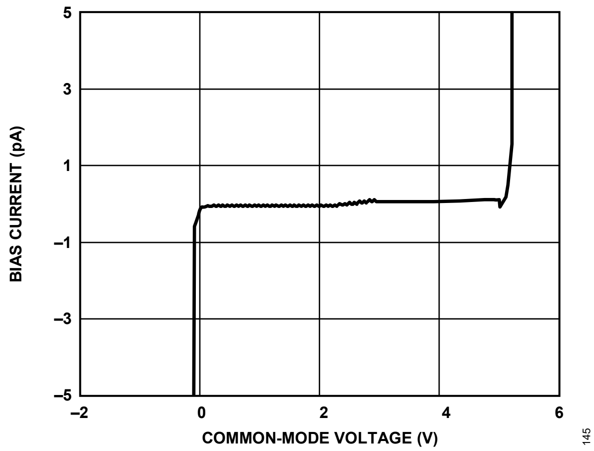

Figure 26. Noninverting Input Bias Current vs. Common-Mode Voltage

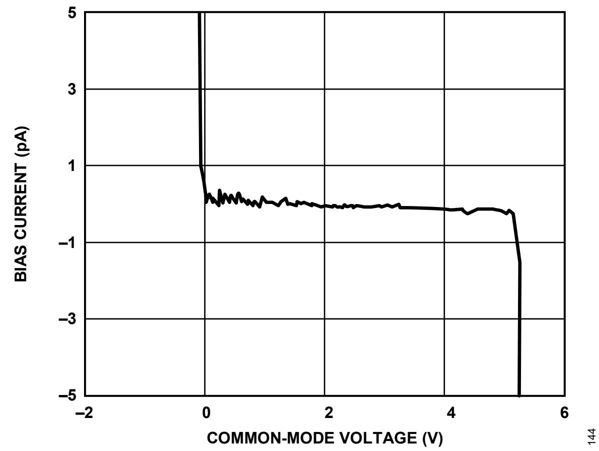

Figure 27. Inverting Input Bias Current vs. Common-Mode Voltage

APPLICATIONS INFORMATION

Output Phase Reversal

Phase reversal is defined as a change in polarity at the output of the amplifier when a voltage that exceeds the maximum input common-mode voltage drives the input.

Phase reversal can cause permanent damage to the amplifier; it can also cause system lockups in feedback loops. The MAX74821 does not exhibit phase reversal even for inputs exceeding the supply voltage by more than 2 V.

Maximum Power Dissipation

Power dissipated in an IC causes the die temperature to increase, which can affect the behavior of the IC and the application circuit performance.

The absolute maximum junction temperature of the MAX74821 is 150°C. Exceeding this temperature can damage or destroy the device.

The maximum power dissipation of the amplifier is calculated according to:

$$P_{DISS} = \frac{T_J - T_A}{\theta_{JA}}$$

where:
T_J is the junction temperature.
T_A is the ambient temperature.
θ_{JA} is the junction-to-ambient thermal resistance.

Input Overvoltage Protection

The MAX74821 has internal protective circuitry. However, if the voltage applied at either input exceeds the supplies by more than 0.3V, external resistors should be placed in series with the inputs. The resistor values can be determined by:

$$\frac{V_{IN} - V_S}{R_S} \leq 10\text{mA}$$

The remarkable low input offset current of the MAX74821 (<1pA) allows the use of larger value resistors. With a 10kΩ resistor at the input, the output voltage has less than 10nV of error voltage.

A 10kΩ resistor has less than 13nV/√Hz of thermal noise at room temperature.

OUTLINE DIMENSIONS

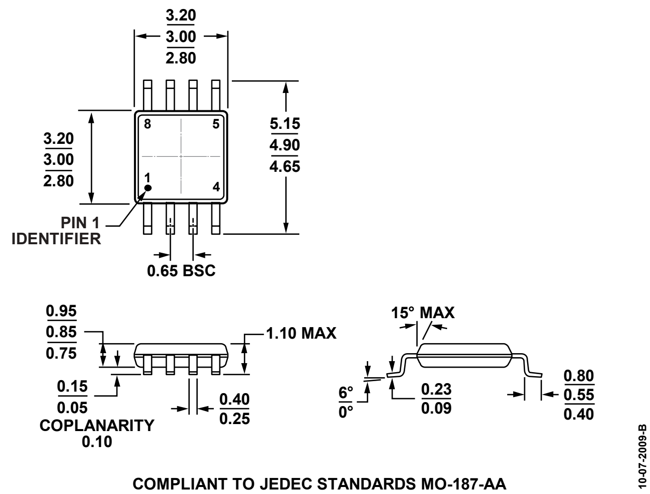

Figure 28. 8-Lead Mini Small Outline Package [MSOP] (RM-8) Dimensions shown in millimeters

ORDERING GUIDE

Table 4. Ordering Guide

MODEL[1]	TEMPERATURE RANGE	PACKAGE DESCRIPTION	PACKAGE OPTION	Marking Code
MAX74821ARMZ	−40°C to +125°C	8-Lead MSOP	RM-8	A6Q
MAX74821ARMZ-R7	−40°C to +125°C	8-Lead MSOP	RM-8	A6Q
MAX74821ARMZ-RL	−40°C to +125°C	8-Lead MSOP	RM-8	A6Q

[1] Z = RoHS compliant part

REVISION HISTORY

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