0.4 μV/°C Offset Drift, 105 MHz Low Power, Low Noise, Rail-to-Rail Amplifier

Enhanced Product

ADA4805-2-EP

FEATURES

Low input offset voltage: 125 μV (maximum)
Low input offset voltage drift
- **0.4 μV/°C (typical)**
- **2.7 μV/°C (maximum)**

Ultralow supply current: 500 μA per amplifier
Fully specified at V_S = 3 V, 5 V, ±5 V
High speed performance
- **−3 dB bandwidth: 105 MHz**
- **Slew rate: 160 V/μs**
- **Settling time to 0.1%: 35 ns**

Rail-to-rail outputs
Input common-mode range: $-V_S - 0.1$ V to $+V_S - 1$ V
Low noise: 5.9 nV/√Hz at 100 kHz; 0.6 pA/√Hz at 100 kHz
Low distortion: −102 dBc/−126 dBc HD2/HD3 at 100 kHz
Low input bias current: 470 nA (typical)
Small packaging
- **8-lead MSOP**

ENHANCED PRODUCT FEATURES

Supports defense and aerospace applications (AQEC standard)
Extended industrial temperature range (−55°C to +125°C)
Controlled manufacturing baseline
1 assembly/test site
1 fabrication site
Enhanced product change notification
Qualification data available upon request

APPLICATIONS

High resolution, high precision analog-to-digital converter (ADC) drivers
Battery-powered instrumentation
Micropower active filters
Portable point of sales terminals
Active radio frequency identification (RFID) readers
Photomultipliers
ADC reference buffers

GENERAL DESCRIPTION

The ADA4805-2-EP is a high speed voltage feedback, rail-to-rail output amplifier with an exceptionally low quiescent current of 500 μA, making it ideal for low power, high resolution data conversion systems. Despite being low power, this amplifier provides excellent overall performance. It offers a high bandwidth of 105 MHz at a gain of +1, a high slew rate of 160 V/μs, and a low input offset voltage of 125 μV (maximum).

TYPICAL APPLICATIONS CIRCUIT

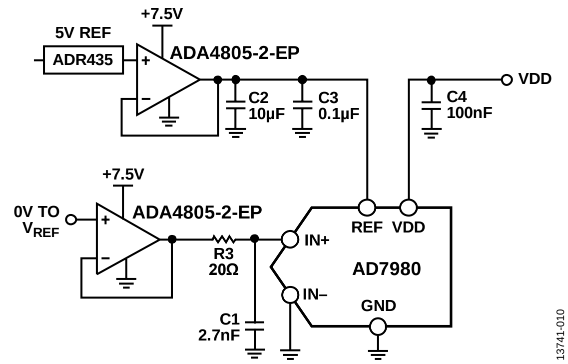

Figure 1. Driving the AD7980 with the ADA4805-2-EP

The Analog Devices, Inc., proprietary extra fast complementary bipolar (XFCB) process allows both low voltage and low current noise (5.9 nV/√Hz, 0.6 pA/√Hz). The ADA4805-2-EP operates over a wide range of supply voltages from ±1.5 V to ±5 V, as well as single 3 V and 5 V supplies, making it ideal for high speed, low power instruments.

The ADA4805-2-EP is available in an 8-lead MSOP package and is rated to work over the extended industrial temperature range of −55°C to +125°C. Additional application and technical information can be found in the ADA4805-1/ADA4805-2 data sheet.

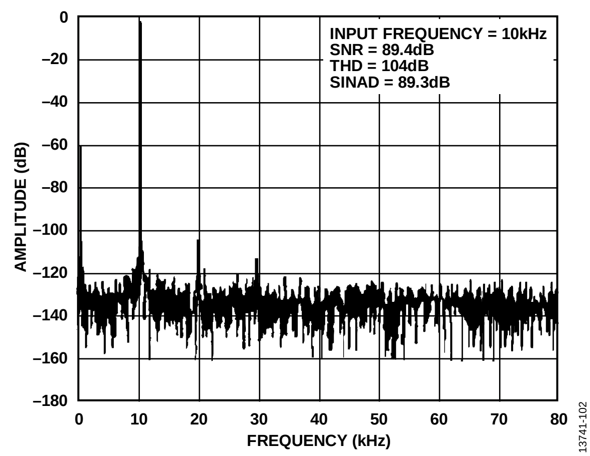

Figure 2. FFT Plot for the Circuit Configuration in Figure 1

Table 1. Complementary ADCs to the ADA4805-2-EP

Product	ADC Power (mW)	Throughput (MSPS)	Resolution (Bits)	SNR (dB)
AD7982	7.0	1	18	98
AD7984	10.5	1.33	18	98.5
AD7980	4.0	1	16	91
AD7685	10	0.25	16	88

Rev. 0
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REVISION HISTORY

4/16—Revision 0: Initial Version

SPECIFICATIONS

±5 V SUPPLY

V_S = ±5 V at T_A = 25°C; R_F = 0 Ω for G = +1; otherwise, R_F = 1 kΩ; R_L = 2 kΩ to ground; unless otherwise noted. All specifications are per amplifier.

Table 2.

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit
DYNAMIC PERFORMANCE					
−3 dB Bandwidth	G = +1, V_{OUT} = 0.02 V p-p		120		MHz
	G = +1, V_{OUT} = 2 V p-p		40		MHz
Bandwidth for 0.1 dB Flatness	G = +1, V_{OUT} = 0.02 V p-p		18		MHz
Slew Rate	G = +1, V_{OUT} = 2 V step		190		V/µs
	G = +2, V_{OUT} = 4 V step		250		V/µs
Settling Time to 0.1%	G = +1, V_{OUT} = 2 V step		35		ns
	G = +2, V_{OUT} = 4 V step		78		ns
NOISE/DISTORTION PERFORMANCE					
Harmonic Distortion, HD2/HD3[1]	f_C = 20 kHz, V_{OUT} = 2 V p-p		−114/−140		dBc
	f_C = 100 kHz, V_{OUT} = 2 V p-p		−102/−128		dBc
	f_C = 20 kHz, V_{OUT} = 4 V p-p, G = +1		−109/−143		dBc
	f_C = 100 kHz, V_{OUT} = 4 V p-p, G = +1		−93/−130		dBc
	f_C = 20 kHz, V_{OUT} = 4 V p-p, G = +2		−113/−142		dBc
	f_C = 100 kHz, V_{OUT} = 4 V p-p, G = +2		−96/−130		dBc
Input Voltage Noise	f = 100 kHz		5.2		nV/√Hz
Input Voltage Noise 1/f Corner Frequency			8		Hz
0.1 Hz to 10 Hz Voltage Noise			44		nV rms
Input Current Noise	f = 100 kHz		0.7		pA/√Hz
DC PERFORMANCE					
Input Offset Voltage			13	125	µV
Input Offset Voltage Drift[2]	T_{MIN} to T_{MAX}		0.4	2.7	µV/°C
Input Bias Current			550	800	nA
Input Offset Current			2.1	25	nA
Open-Loop Gain	V_{OUT} = −4.0 V to +4.0 V	107	111		dB
INPUT CHARACTERISTICS					
Input Resistance					
Common Mode			50		MΩ
Differential Mode			260		kΩ
Input Capacitance			1		pF
Input Common-Mode Voltage Range		−5.1		+4	V
Common-Mode Rejection Ratio	$V_{IN, CM}$ = −4.0 V to +4.0 V	103	130		dB
OUTPUT CHARACTERISTICS					
Output Overdrive Recovery Time (Rising/Falling Edge)	V_{IN} = +6 V to −6 V, G = +2		95/100		ns
Output Voltage Swing	R_L = 2 kΩ	−4.98		+4.98	V
Short-Circuit Current	Sinking/sourcing		85/73		mA
Linear Output Current	<1% THD at 100 kHz, V_{OUT} = 2 V p-p		±58		mA
Capacitive Load Drive	30% overshoot		15		pF
POWER SUPPLY					
Operating Range		2.7		10	V
Quiescent Current per Amplifier			570	625	µA
Power Supply Rejection Ratio					
Positive	$+V_S$ = 3 V to 5 V, $-V_S$ = −5 V	100	119		dB
Negative	$+V_S$ = 5 V, $-V_S$ = −3 V to −5 V	100	122		dB

[1] f_C is the fundamental frequency.
[2] Guaranteed, but not tested.

5 V SUPPLY

V_S = 5 V at T_A = 25°C; R_F = 0 Ω for G = +1; otherwise, R_F = 1 kΩ; R_L = 2 kΩ to midsupply; unless otherwise noted. All specifications are per amplifier.

Table 3.

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit
DYNAMIC PERFORMANCE					
−3 dB Bandwidth	G = +1, V_{OUT} = 0.02 V p-p		105		MHz
	G = +1, V_{OUT} = 2 V p-p		35		MHz
Bandwidth for 0.1 dB Flatness	G = +1, V_{OUT} = 0.02 V p-p		20		MHz
Slew Rate	G = +1, V_{OUT} = 2 V step		160		V/μs
	G = +2, V_{OUT} = 4 V step		220		V/μs
Settling Time to 0.1%	G = +1, V_{OUT} = 2 V step		35		ns
	G = +2, V_{OUT} = 4 V step		82		ns
NOISE/DISTORTION PERFORMANCE					
Harmonic Distortion, HD2/HD3[1]	f_C = 20 kHz, V_{OUT} = 2 V p-p		−114/−135		dBc
	f_C = 100 kHz, V_{OUT} = 2 V p-p		−102/−126		dBc
	f_C = 20 kHz, G = +2, V_{OUT} = 4 V p-p		−107/−143		dBc
	f_C = 100 kHz, G = +2, V_{OUT} = 4 V p-p		−90/−130		dBc
Input Voltage Noise	f = 100 kHz		5.9		nV/√Hz
Input Voltage Noise 1/f Corner			8		Hz
0.1 Hz to 10 Hz Voltage Noise			54		nV rms
Input Current Noise	f = 100 kHz		0.6		pA/√Hz
DC PERFORMANCE					
Input Offset Voltage			9	125	μV
Input Offset Voltage Drift[2]	T_{MIN} to T_{MAX}		0.4	2.7	μV/°C
Input Bias Current			470	720	nA
Input Offset Current			0.4		nA
Open-Loop Gain	V_{OUT} = 1.25 V to 3.75 V	105	109		dB
INPUT CHARACTERISTICS					
Input Resistance					
Common Mode			50		MΩ
Differential Mode			260		kΩ
Input Capacitance			1		pF
Input Common-Mode Voltage Range		−0.1		+4	V
Common-Mode Rejection Ratio	$V_{IN, CM}$ = 1.25 V to 3.75 V	103	133		dB
OUTPUT CHARACTERISTICS					
Overdrive Recovery Time (Rising/Falling Edge)	V_{IN} = −1 V to +6 V, G = +2		130/145		ns
Output Voltage Swing	R_L = 2 kΩ	0.02		4.98	V
Short-Circuit Current	Sinking/sourcing		73/63		mA
Linear Output Current	<1% THD at 100 kHz, V_{OUT} = 2 V p-p		±47		mA
Capacitive Load Drive	30% overshoot		15		pF
POWER SUPPLY					
Operating Range		2.7		10	V
Quiescent Current per Amplifier			500	520	μA
Power Supply Rejection Ratio					
Positive	$+V_S$ = 1.5 V to 3.5 V, $−V_S$ = −2.5 V	100	120		dB
Negative	$+V_S$ = 2.5 V, $−V_S$ = −1.5 V to −3.5 V	100	126		dB

[1] f_C is the fundamental frequency.
[2] Guaranteed, but not tested.

3 V SUPPLY

V_S = 3 V at T_A = 25°C; R_F = 0 Ω for G = +1; otherwise, R_F = 1 kΩ; R_L = 2 kΩ to midsupply; unless otherwise noted. All specifications are per amplifier.

Table 4.

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit
DYNAMIC PERFORMANCE					
−3 dB Bandwidth	G = +1, V_{OUT} = 0.02 V p-p		95		MHz
	G = +1, V_{OUT} = 1 V p-p, $+V_S$ = 2 V, $−V_S$ = −1 V		30		MHz
Bandwidth for 0.1 dB Flatness	G = +1, V_{OUT} = 0.02 V p-p		35		MHz
Slew Rate	G = +1, V_{OUT} = 1 V step, $+V_S$ = 2 V, $−V_S$ = −1 V		85		V/µs
Settling Time to 0.1%	G = +1, V_{OUT} = 1 V step		41		ns
NOISE/DISTORTION PERFORMANCE					
Harmonic Distortion, HD2/HD3[1]	f_C = 20 kHz, V_{OUT} = 1 V p-p, $+V_S$ = 2 V, $−V_S$ = −1 V		−123/−143		dBc
	f_C = 100 kHz, V_{OUT} = 1 V p-p, $+V_S$ = 2 V, $−V_S$ = −1 V		−107/−133		dBc
Input Voltage Noise	f = 100 kHz		6.3		nV/√Hz
Input Voltage Noise 1/f Corner			8		Hz
0.1 Hz to 10 Hz Voltage Noise			55		nV rms
Input Current Noise	f = 100 kHz		0.8		pA/√Hz
DC PERFORMANCE					
Input Offset Voltage			7	125	µV
Input Offset Voltage Drift[2]	T_{MIN} to T_{MAX}		0.4	2.7	µV/°C
Input Bias Current			440	690	nA
Input Offset Current			0.5		nA
Open-Loop Gain	V_{OUT} = 1.1 V to 1.9 V	100	107		dB
INPUT CHARACTERISTICS					
Input Resistance					
Common Mode			50		MΩ
Differential Mode			260		kΩ
Input Capacitance			1		pF
Input Common-Mode Voltage Range		−0.1		+2	V
Common-Mode Rejection Ratio	$V_{IN, CM}$ = 0.5 V to 2 V	89	117		dB
OUTPUT CHARACTERISTICS					
Output Overdrive Recovery Time (Rising/Falling Edge)	V_{IN} = −1 V to +4 V, G = +2		135/175		ns
Output Voltage Swing	R_L = 2 kΩ	0.02		2.98	V
Short-Circuit Current	Sinking/sourcing		65/47		mA
Linear Output Current	<1% THD at 100 kHz, V_{OUT} = 1 V p-p		±40		mA
Capacitive Load Drive	30% overshoot		15		pF
POWER SUPPLY					
Operating Range		2.7		10	V
Quiescent Current per Amplifier			470	495	µA
Power Supply Rejection Ratio					
Positive	$+V_S$ = 1.5 V to 3.5 V, $−V_S$ = −1.5 V	96	119		dB
Negative	$+V_S$ = 1.5 V, $−V_S$ = −1.5 V to −3.5 V	96	125		dB

[1] f_C is the fundamental frequency.
[2] Guaranteed, but not tested.

ABSOLUTE MAXIMUM RATINGS

Table 5.

Parameter	Rating
Supply Voltage	11 V
Power Dissipation	See Figure 3
Common-Mode Input Voltage	$-V_S - 0.7$ V to $+V_S + 0.7$ V
Differential Input Voltage	±1 V
Storage Temperature Range	−65°C to +125°C
Operating Temperature Range	−55°C to +125°C
Lead Temperature (Soldering, 10 sec)	300°C
Junction Temperature	150°C

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating 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 RESISTANCE

θ_{JA} is specified for the worst case conditions, that is, θ_{JA} is specified for a device soldered in a circuit board for surface-mount packages. Table 6 lists the θ_{JA} for the ADA4805-2-EP.

Table 6. Thermal Resistance

Package Type	θ_{JA}	Unit
8-Lead MSOP	123.8	°C/W

MAXIMUM POWER DISSIPATION

The maximum safe power dissipation for the ADA4805-2-EP is limited by the associated rise in junction temperature (T_J) on the die. At approximately 150°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 ADA4805-2-EP. Exceeding a junction temperature of 175°C for an extended period of time can result in changes in silicon devices, potentially causing degradation or loss of functionality.

The power dissipated in the package (P_D) is the sum of the quiescent power dissipation and the power dissipated in the die due to the ADA4805-2-EP output load drive.

The quiescent power dissipation is the voltage between the supply pins (V_S) multiplied by the quiescent current (I_S).

$$P_D = Quiescent\ Power + (Total\ Drive\ Power - Load\ Power)$$

$$P_D = (V_S \times I_S) + \left(\frac{V_S}{2} \times \frac{V_{OUT}}{R_L}\right) - \frac{{V_{OUT}}^2}{R_L}$$

RMS output voltages must be considered. If R_L is referenced to $-V_S$, as in single-supply operation, the total drive power is $V_S \times I_{OUT}$. If the rms signal levels are indeterminate, consider the worst case, when $V_{OUT} = V_S/4$ for R_L to midsupply.

$$P_D = (V_S \times I_S) + \frac{(V_S/4)^2}{R_L}$$

In single-supply operation with R_L referenced to $-V_S$, worst case is $V_{OUT} = V_S/2$.

Airflow increases heat dissipation, effectively reducing θ_{JA}. Also, more metal directly in contact with the package leads and exposed pad from metal traces, through holes, ground, and power planes reduces θ_{JA}.

Figure 3 shows the maximum safe power dissipation in the package vs. the ambient temperature on a JEDEC standard, 4-layer board. θ_{JA} values are approximations.

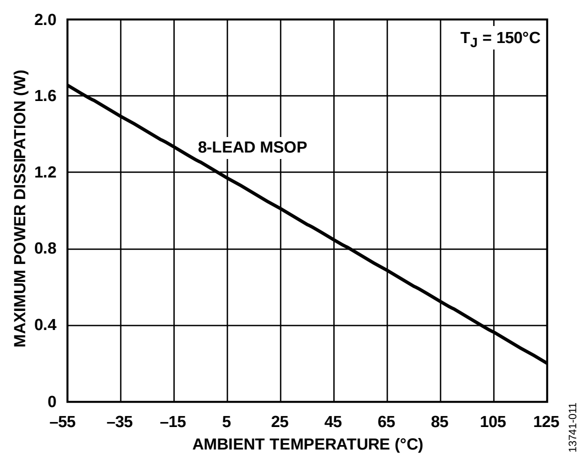

Figure 3. Maximum Power Dissipation vs. Temperature for a 4-Layer Board

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

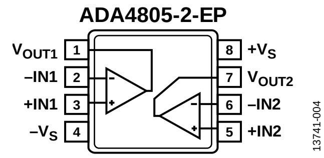

Figure 4. 8-Lead MSOP Pin Configuration

Table 7. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	V_{OUT1}	Output 1.
2	−IN1	Inverting Input 1.
3	+IN1	Noninverting Input 1.
4	$-V_S$	Negative Supply.
5	+IN2	Noninverting Input 2.
6	−IN2	Inverting Input 2.
7	V_{OUT2}	Output 2.
8	$+V_S$	Positive Supply.

TYPICAL PERFORMANCE CHARACTERISTICS

R_L = 2 kΩ, unless otherwise noted. When G = +1, R_F = 0 Ω.

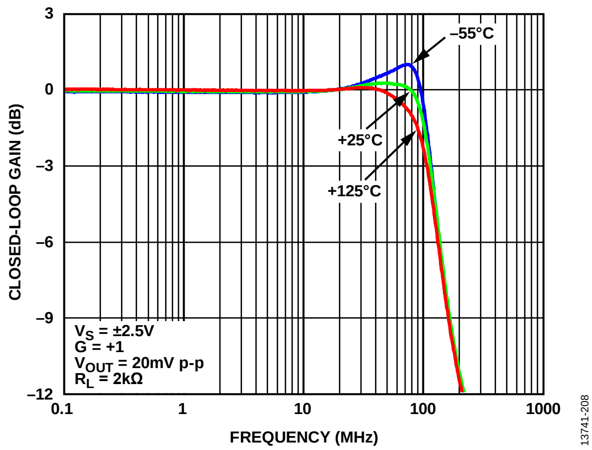

Figure 5. Small Signal Frequency Response for Various Temperatures

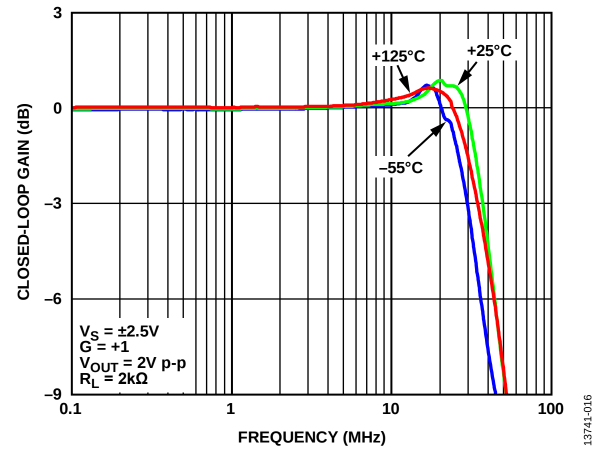

Figure 8. Large Signal Frequency Response for Various Temperatures

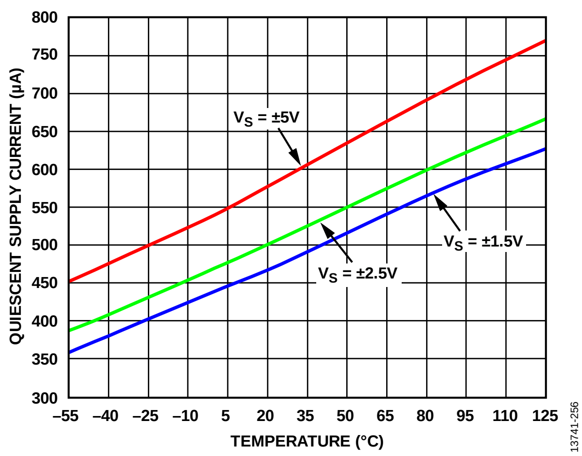

Figure 6. Quiescent Supply Current vs. Temperature for Various Supplies

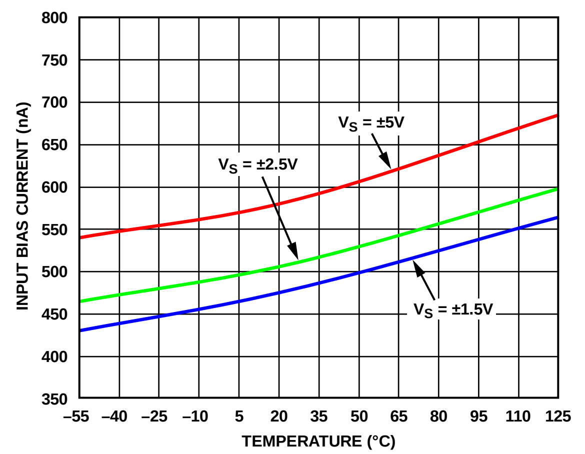

Figure 9. Input Bias Current vs. Temperature for Various Supplies

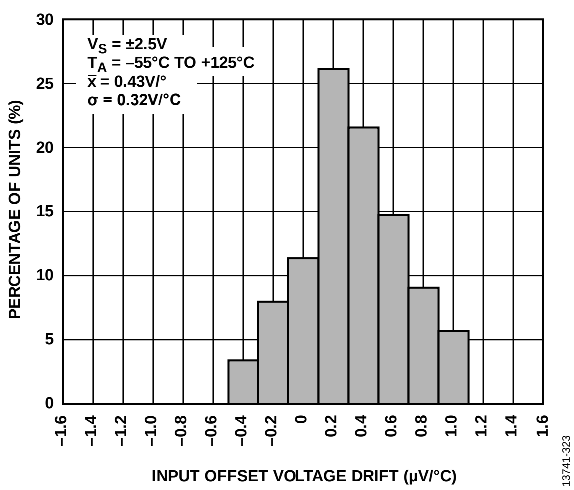

Figure 7. Input Offset Voltage Drift Distribution

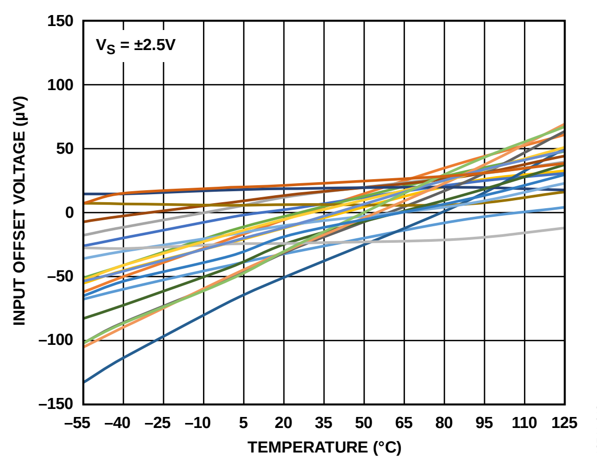

Figure 10. Input Offset Voltage vs. Temperature

OUTLINE DIMENSIONS

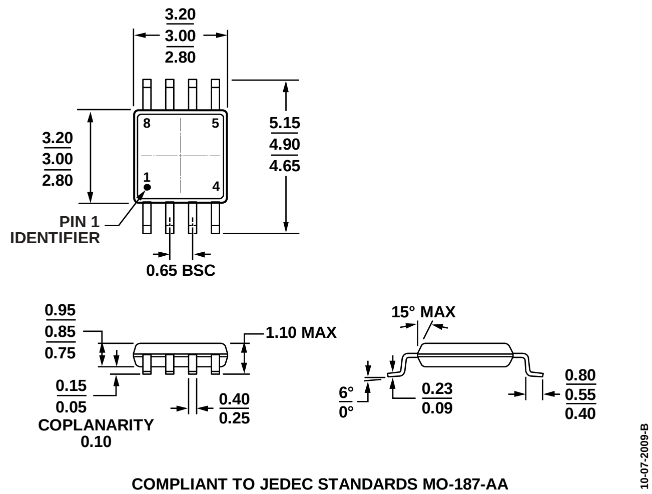

Figure 11. 8-Lead Mini Small Outline Package [MSOP]
(RM-8)
Dimensions shown in millimeters

ORDERING GUIDE

Model[1]	Temperature Range	Package Description	Package Option	Branding
ADA4805-2TRMZ-EP	−55°C to +125°C	8-Lead Mini Small Outline Package [MSOP]	RM-8	Y5W
ADA4805-2TRMZ-EPR7	−55°C to +125°C	8-Lead Mini Small Outline Package [MSOP]	RM-8	Y5W

[1] Z = RoHS Compliant Part.

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