19-3406; Rev 1; 10/05

200kHz, 4µA, Rail-to-Rail I/O Op Amps with Shutdown

General Description

The single MAX9910/MAX9911 and dual MAX9912/MAX9913 operational amplifiers (op amps) feature a maximized ratio of gain bandwidth (GBW) to supply current and are ideal for battery-powered applications such as portable instrumentation, portable medical equipment, and wireless handsets. These CMOS op amps feature an ultra-low input-bias current of 1pA, rail-to-rail inputs and outputs, low supply current of 4µA, and operate from a single 1.8V to 5.5V supply. For additional power conservation, the MAX9911/MAX9913 feature a low-power shutdown mode that reduces supply current to 1nA, and puts the amplifiers' outputs in a high-impedance state. These devices are unity-gain stable with a 200kHz GBW product.

The MAX9910/MAX9911 are available in 5-pin and 6-pin SC70 packages, respectively. The MAX9912 is available in an 8-pin SOT23 package, and the MAX9913 is available in a 10-pin µMAX® package. All devices are specified over the -40°C to +85°C extended operating temperature range.

Applications

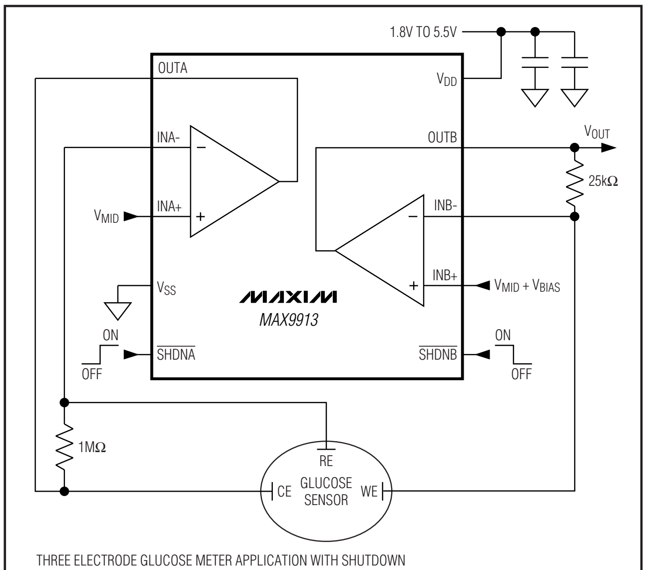
Portable Medical Devices

Portable Test Equipment

Laptops

Data-Acquisition Equipment

Typical Operating Circuit



Features

- ♦ 200kHz GBW
- ♦ Ultra-Low 4µA Supply Current
- ♦ Single 1.8V to 5.5V Supply Voltage Range
- ♦ Ultra-Low 1pA Input Bias Current
- ♦ Rail-to-Rail Input and Output Voltage Ranges
- ♦ Low ±200µV Input Offset Voltage
- ♦ Low 0.001µA Shutdown Current
- ♦ High-Impedance Output During Shutdown (MAX9911/MAX9913)
- ♦ Unity-Gain Stable
- ♦ Available in Tiny SC70, SOT23, and µMAX Packages

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX9910EXK+T	-40°C to +85°C	5 SC70-5	AGA
MAX9910EXK-T	-40°C to +85°C	5 SC70-5	AGA
MAX9911EXT+T	-40°C to +85°C	6 SC70-6	ACA
MAX9911EXT-T	-40°C to +85°C	6 SC70-6	ACA
MAX9912EKA+T	-40°C to +85°C	8 SOT23-8	AEJY
MAX9912EKA-T	-40°C to +85°C	8 SOT23-8	AEJY
MAX9913EUB	-40°C to +85°C	10 µMAX	—
MAX9913EUB+	-40°C to +85°C	10 µMAX	—

+Denotes lead-free package.

Selector Guide

PART	AMPLIFIERS PER PACKAGE	SHUTDOWN MODE
MAX9910EXK-T	1	No
MAX9911EXT-T	1	Yes
MAX9912EKA-T	2	No
MAX9913EUB	2	Yes

200kHz, 4µA, Rail-to-Rail I/O Op Amps with Shutdown

ABSOLUTE MAXIMUM RATINGS

Power-Supply Voltage (V_{DD} to V_{SS}) ....-0.3V to +6.0V
IN_+, IN_-, OUT_, $\overline{SHDN\_}$ .... (V_{SS} - 0.3V) to (V_{DD} + 0.3V)
Current into IN_+, IN_- ....±20mA
Output Short-Circuit Duration to V_{DD} or V_{SS} ....Continuous
Continuous Power Dissipation (T_A = +70°C)
5-Pin SC70 (derate 3.1mW/°C above +70°C) 247mW
6-Pin SC70 (derate 3.1mW/°C above +70°C) 245mW
8-Pin SOT23 (derate 9.1mW/°C above +70°C) 727mW
10-Pin µMAX (derate 5.6mW/°C above +70°C) 444mW
Operating Temperature Range .... -40°C to +85°C
Junction Temperature ....+150°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10s) .... +300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{DD} = 1.8V to 5.5V, V_{SS} = 0V, V_{CM} = 0V, V_{OUT} = V_{DD} / 2, R_L = ∞ connected to V_{DD} / 2, $\overline{SHDN\_}$ = V_{DD}, **T_A = +25°C**, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage Range	V_{DD}	Guaranteed by PSRR test		1.8		5.5	V
Supply Current	I_{DD}	MAX9910/MAX9911	V_{DD} = 1.8V		4		µA
			V_{DD} = 5.5V		4	5.0	
		MAX9912/MAX9913	V_{DD} = 1.8V		7		
			V_{DD} = 5.5V		7	9	
Shutdown Supply Current	$I_{DD(\overline{SHDN\_})}$	$\overline{SHDN\_}$ = GND, MAX9911/MAX9913			0.001	0.5	µA
Input Offset Voltage	V_{OS}				±0.2	±1	mV
Input-Offset-Voltage Matching		MAX9912/MAX9913			±250		µV
Input Bias Current	I_B	(Note 2)			±1	±10	pA
Input Offset Current	I_{OS}	(Note 2)			±1	±10	pA
Input Resistance	R_{IN}	Common mode			1		GΩ
		Differential mode, -1mV < V_{IN} < +1mV			10		
Input Common-Mode Range	V_{CM}	Guaranteed by CMRR test		V_{SS} - 0.1		V_{DD} + 0.1	V
Common-Mode Rejection Ratio	CMRR	-0.1V < V_{CM} < V_{DD} + 0.1V, V_{DD} = 5.5V		70	80		dB
Power-Supply Rejection Ratio	PSRR	1.8V < V_{DD} < 5.5V		65	95		dB
Open-Loop Gain	A_{VOL}	25mV < V_{OUT} < V_{DD} - 25mV, R_L = 100kΩ, V_{DD} = 5.5V		95	120		dB
		100mV < V_{OUT} < V_{DD} - 100mV, R_L = 5kΩ, V_{DD} = 5.5V		95	110		
Output-Voltage-Swing High	V_{OH}	V_{DD} - V_{OUT}	R_L = 100kΩ		2.5	5	mV
			R_L = 5kΩ		50	70	
			R_L = 1kΩ		250		
Output-Voltage-Swing Low	V_{OL}	V_{OUT} - V_{SS}	R_L = 100kΩ		2.5	5	mV
			R_L = 5kΩ		50	70	
			R_L = 1kΩ		250		
Channel-to-Channel Isolation	CH_{ISO}	Specified at DC, MAX9912/MAX9913			100		dB
Output Short-Circuit Current	$I_{OUT(SC)}$				±15		mA

ELECTRICAL CHARACTERISTICS (continued)

(V_{DD} = 1.8V to 5.5V, V_{SS} = 0V, V_{CM} = 0V, V_{OUT} = V_{DD} / 2, R_L = ∞ connected to V_{DD} / 2, $\overline{SHDN}$_ = V_{DD}, **T_A = +25°C**, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
$\overline{SHDN}$_ Logic Low	V_{IL}	V_{DD} = 1.8V to 3.6V, MAX9911/MAX9913			0.4	V
		V_{DD} = 3.6V to 5.5V, MAX9911/MAX9913			0.8	
$\overline{SHDN}$_ Logic High	V_{IH}	V_{DD} = 1.8V to 3.6V, MAX9911/MAX9913	1.4			V
		V_{DD} = 3.6V to 5.5V, MAX9911/MAX9913	2			
$\overline{SHDN}$_ Input Bias Current	I_{IL}	$\overline{SHDN}$_ = V_{SS}, MAX9911/MAX9913 (Note 2)			1	nA
	I_{IH}	$\overline{SHDN}$_ = V_{DD} , MAX9911/MAX9913			500	
Output Leakage in Shutdown	$I_{OUT(\overline{SHDN}\_)}$	$\overline{SHDN}$_ = V_{SS}, V_{OUT} = 0V to V_{DD}, MAX9911/MAX9913		1	500	nA
Gain-Bandwidth Product				200		kHz
Slew Rate				0.1		V/µs
Capacitive-Load Stability (See the *Driving Capacitive Loads* Section)	C_{LOAD}	No sustained oscillations, A_V = 1V/V		30		pF
		No sustained oscillations, A_V = 10V/V		250		
		No sustained oscillations, R_L = 5kΩ, A_V = 1V/V		200		
		No sustained oscillations, R_{ISO} = 1kΩ, A_V = 1V/V		100		
Input Voltage-Noise Density		f = 1kHz		400		nV/√Hz
Input Current-Noise Density		f = 1kHz		0.001		pA/√Hz
Settling Time		To 0.1%, V_{OUT} = 2V step, A_V = -1V/V		18		µs
Delay Time to Shutdown	t_{SH}	I_{DD} = 5% of normal operation, V_{DD} = 5.5V, $V_{\overline{SHDN}\_}$ = 5.5V to 0 step		2		µs
Delay Time to Enable	t_{EN}	V_{OUT} = 2.7V, V_{OUT} settles to 0.1%, V_{DD} = 5.5V, $V_{\overline{SHDN}\_}$ = 0 to 5.5V step		30		µs
Power-Up Time		V_{DD} = 0 to 5.5V step		5		µs

ELECTRICAL CHARACTERISTICS

(V_{DD} = 1.8V to 5.5V, V_{SS} = 0V, V_{CM} = 0V, V_{OUT} = V_{DD} / 2, R_L = ∞ connected to V_{DD} / 2, $\overline{SHDN}$_ = V_{DD}, **T_A = -40°C to +85°C**, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage Range	V_{DD}	Guaranteed by PSRR test	1.8		5.5	V
Supply Current	I_{DD}	MAX9910/MAX9911, V_{DD} = 5.5V			5.5	µA
		MAX9912/MAX9913, V_{DD} = 5.5V			11	
Shutdown Supply Current	$I_{DD(\overline{SHDN}\_)}$	$\overline{SHDN}$_ = GND, MAX9911/MAX9913			1	µA
Input Offset Voltage	V_{OS}				±5	mV
Input-Offset-Voltage Temperature Coefficient	TC_{VOS}			±5		µV/°C

200kHz, 4µA, Rail-to-Rail I/O Op Amps with Shutdown

ELECTRICAL CHARACTERISTICS (continued)

(V_{DD} = 1.8V to 5.5V, V_{SS} = 0V, V_{CM} = 0V, V_{OUT} = V_{DD} / 2, R_L = ∞ connected to V_{DD} / 2, $\overline{SHDN\_}$ = V_{DD}, **T_A = -40°C to +85°C**, unless otherwise noted.) (Note 1)

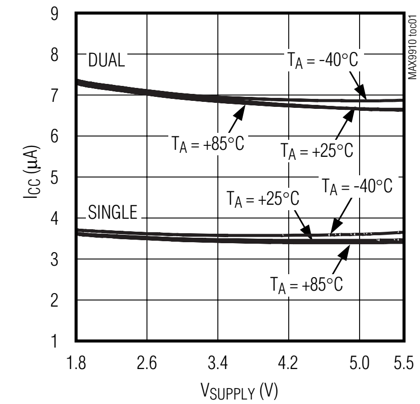
PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input Bias Current	I_B					±30	pA
Input Offset Current	I_{OS}					±20	pA
Input Common-Mode Range	V_{CM}	Guaranteed by CMRR test		V_{SS} - 0.05		V_{DD} + 0.05	V
Common-Mode Rejection Ratio	CMRR	-0.05V < V_{CM} < V_{DD} + 0.05V, V_{DD} = 5.5V		60			dB
Power-Supply Rejection Ratio	PSRR	1.8V < V_{DD} < 5.5V		59			dB
Open-Loop Gain	A_{VOL}	25mV < V_{OUT} < V_{DD} - 25mV, R_L = 100kΩ, V_{DD} = 5.5V		85			dB
		150mV < V_{OUT} < V_{DD} - 150mV, R_L = 5kΩ, V_{DD} = 5.5V		80			
Output-Voltage-Swing High	V_{OH}	V_{DD} - V_{OUT}	R_L = 100kΩ			5	mV
			R_L = 5kΩ			90	
Output-Voltage-Swing Low	V_{OL}	V_{OUT} - V_{SS}	R_L = 100kΩ			5	mV
			R_L = 5kΩ			90	
$\overline{SHDN\_}$ Logic Low	V_{IL}	V_{DD} = 1.8V to 3.6V				0.4	V
		V_{DD} = 3.6V to 5.5V				0.8	
$\overline{SHDN\_}$ Logic High	V_{IH}	V_{DD} = 1.8V to 3.6V, MAX9911/MAX9913		1.4			V
		V_{DD} = 3.6V to 5.5V, MAX9911/MAX9913		2			
$\overline{SHDN\_}$ Input-Bias Current	I_{IL}	$\overline{SHDN\_}$ = V_{SS}, MAX9911/MAX9913				5	nA
	I_{IH}	$\overline{SHDN\_}$ = V_{DD}, MAX9911/MAX9913				1000	nA
Output Leakage in Shutdown	$I_{OUT(\overline{SHDN\_})}$	$\overline{SHDN\_}$ = V_{SS}, V_{OUT} = 0V to V_{DD}, MAX9911/MAX9913				1000	nA

Note 1: Specifications are 100% tested at T_A = +25°C (exceptions noted). All temperature limits are guaranteed by design.
Note 2: Guaranteed by design, not production tested.

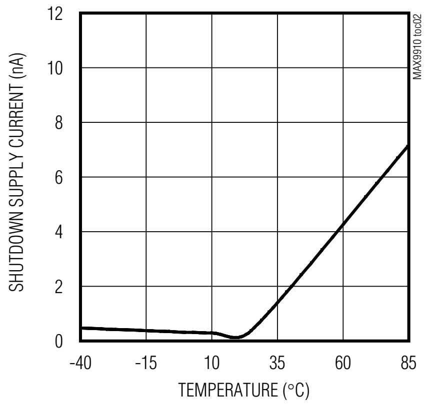
Typical Operating Characteristics

(V_{DD} = 3V, V_{SS} = V_{CM} = 0V, R_L to V_{DD} / 2, T_A = +25°C, unless otherwise noted.)

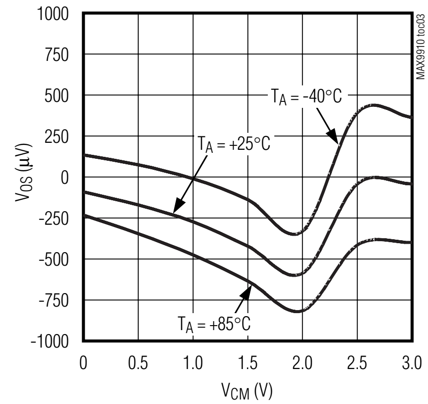
SUPPLY CURRENT vs. SUPPLY VOLTAGE



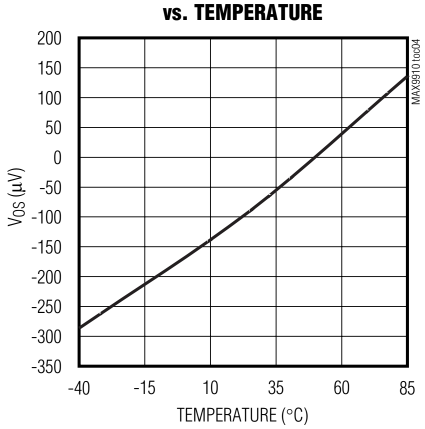
SHUTDOWN SUPPLY CURRENT vs. TEMPERATURE



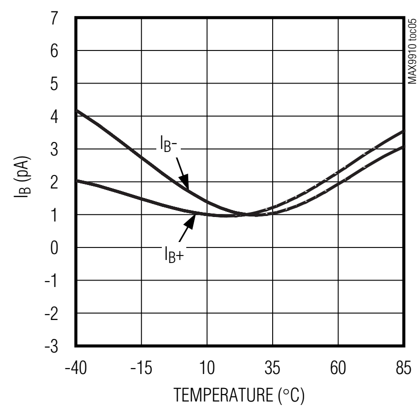
INPUT OFFSET VOLTAGE vs. INPUT COMMON-MODE VOLTAGE



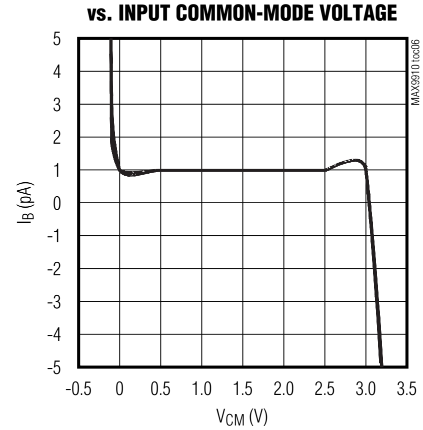
INPUT OFFSET VOLTAGE vs. TEMPERATURE



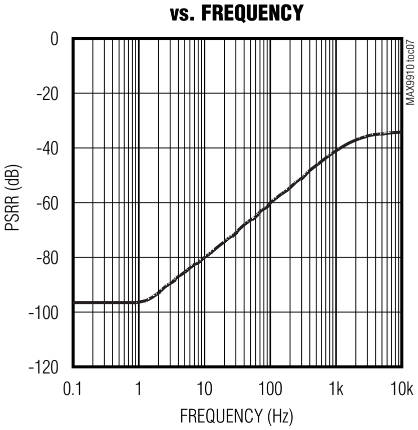
INPUT BIAS CURRENT vs. TEMPERATURE



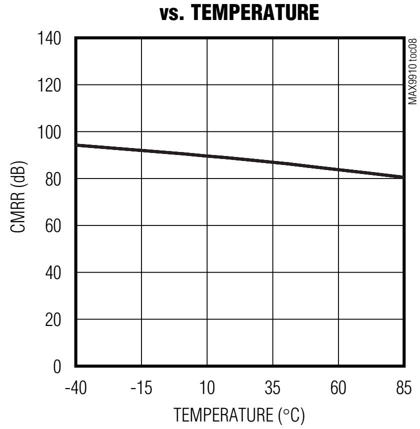
INPUT BIAS CURRENT vs. INPUT COMMON-MODE VOLTAGE



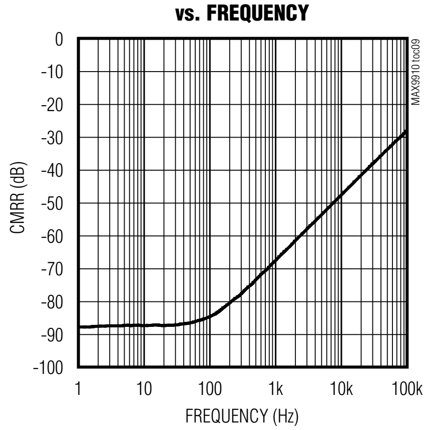
POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



COMMON-MODE REJECTION RATIO vs. TEMPERATURE



COMMON-MODE REJECTION RATIO vs. FREQUENCY

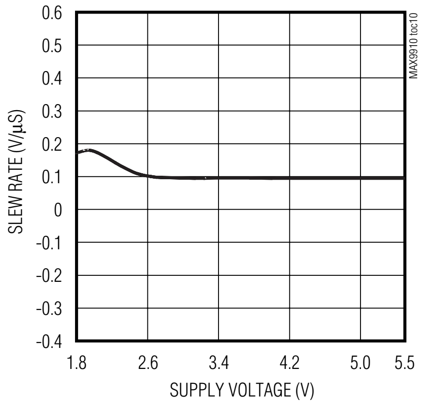


200kHz, 4µA, Rail-to-Rail I/O Op Amps with Shutdown

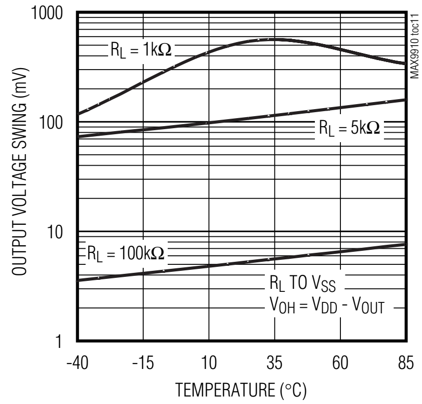
Typical Operating Characteristics (continued)

(V_{DD} = 3V, V_{SS} = V_{CM} = 0V, R_L to V_{DD} / 2, T_A = +25°C, unless otherwise noted.)

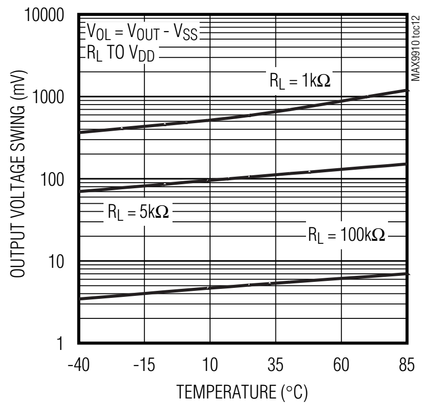
SLEW RATE vs. SUPPLY VOLTAGE



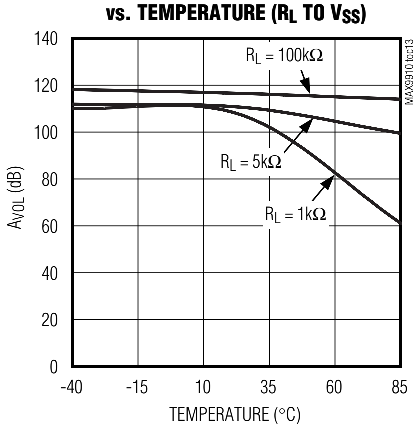
OUTPUT-SWING HIGH vs. TEMPERATURE



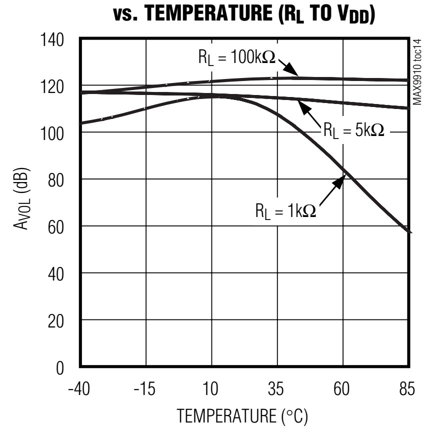
OUTPUT-SWING LOW vs. TEMPERATURE



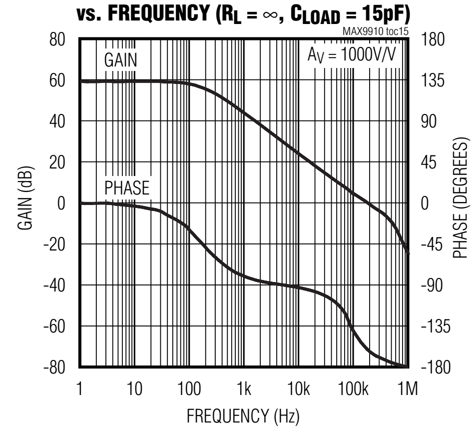
OPEN-LOOP GAIN vs. TEMPERATURE (R_L TO V_{SS})



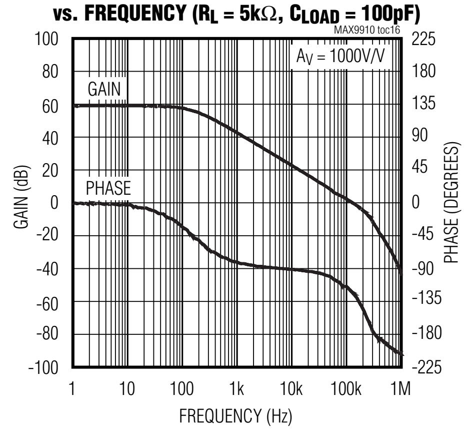
OPEN-LOOP GAIN vs. TEMPERATURE (R_L TO V_{DD})



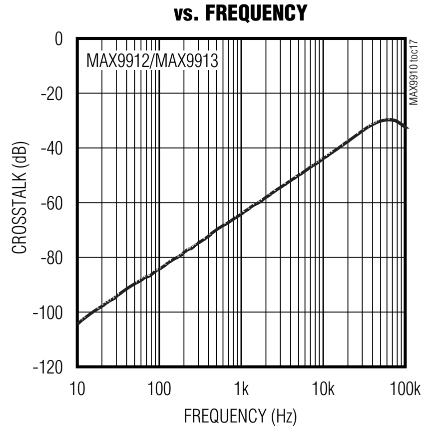
GAIN AND PHASE vs. FREQUENCY (R_L = ∞, C_{LOAD} = 15pF)



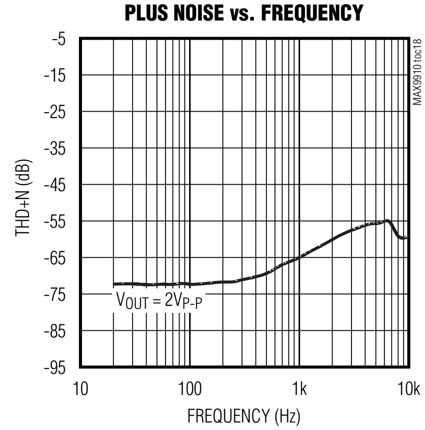
GAIN AND PHASE vs. FREQUENCY (R_L = 5kΩ, C_{LOAD} = 100pF)



CROSSTALK vs. FREQUENCY



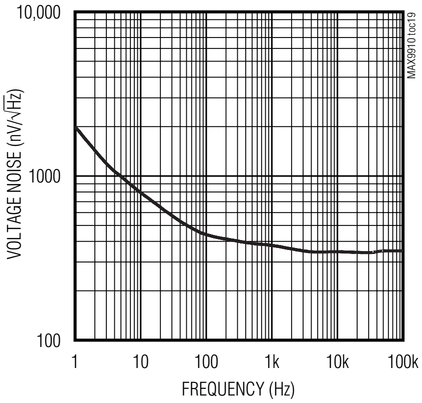
TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



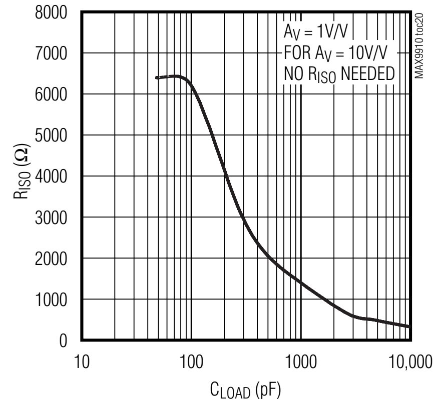
Typical Operating Characteristics (continued)

(V_{DD} = 3V, V_{SS} = V_{CM} = 0V, R_L to V_{DD} / 2, T_A = +25°C, unless otherwise noted.)

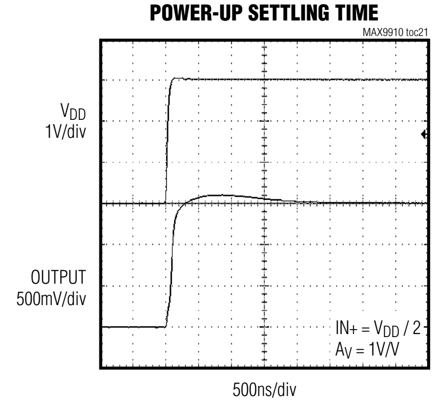
VOLTAGE-NOISE DENSITY vs. FREQUENCY



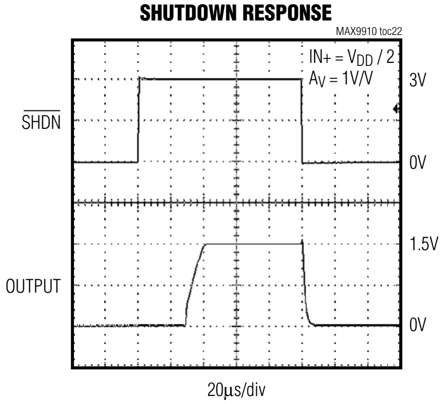
RESISTOR ISOLATION vs. CAPACITIVE LOAD



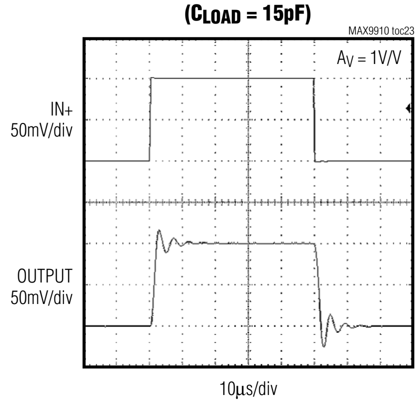
POWER-UP SETTLING TIME



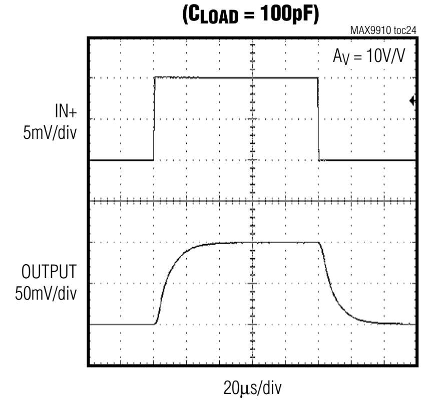
SHUTDOWN RESPONSE



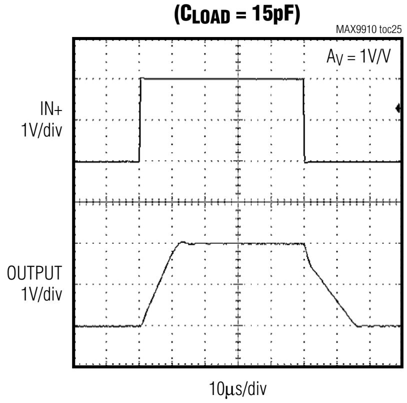
SMALL-SIGNAL PULSE RESPONSE (C_{LOAD} = 15pF)



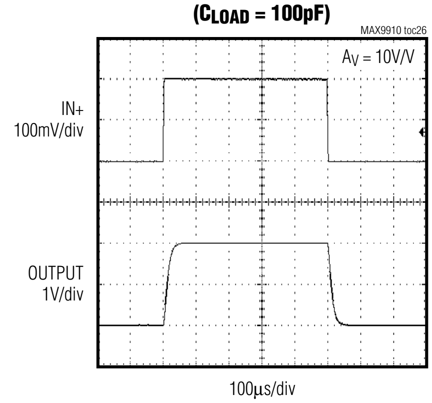
SMALL-SIGNAL PULSE RESPONSE (C_{LOAD} = 100pF)



LARGE-SIGNAL PULSE RESPONSE (C_{LOAD} = 15pF)



LARGE-SIGNAL PULSE RESPONSE (C_{LOAD} = 100pF)

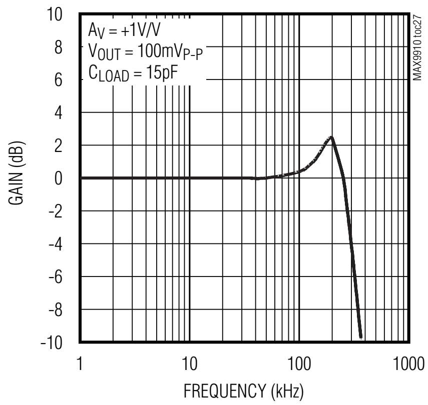


200kHz, 4µA, Rail-to-Rail I/O Op Amps with Shutdown

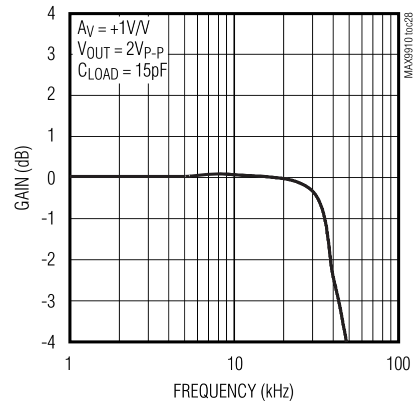
Typical Operating Characteristics (continued)

(V_{DD} = 3V, V_{SS} = V_{CM} = 0V, R_L to V_{DD} / 2, T_A = +25°C, unless otherwise noted.)

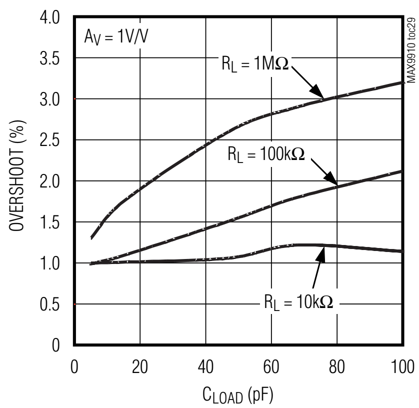
SMALL-SIGNAL GAIN vs. FREQUENCY



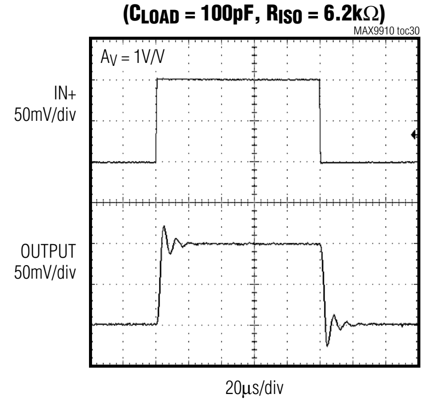
LARGE-SIGNAL GAIN vs. FREQUENCY



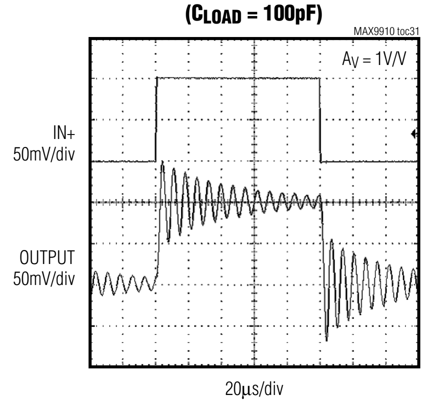
PERCENT OVERSHOOT vs. CAPACITIVE LOAD



OUTPUT WAVEFORM WITH R_{ISO} (C_{LOAD} = 100pF, R_{ISO} = 6.2kΩ)



OUTPUT WAVEFORM WITHOUT R_{ISO} (C_{LOAD} = 100pF)



Pin Description

PIN				NAME	FUNCTION
MAX9910	MAX9911	MAX9912	MAX9913		
1	1	—	—	IN+	Noninverting Amplifier Input
2	2	4	4	V_{SS}	Negative Supply Voltage
3	3	—	—	IN-	Inverting Amplifier Input
4	4	—	—	OUT	Amplifier Output
5	6	8	10	V_{DD}	Positive Supply Voltage
—	5	—	—	$\overline{SHDN}$	Shutdown
—	—	1	1	OUTA	Amplifier Output Channel A
—	—	2	2	INA-	Inverting Amplifier Input Channel A
—	—	3	3	INA+	Noninverting Amplifier Input Channel A
—	—	—	5	$\overline{SHDNA}$	Shutdown Channel A
—	—	—	6	$\overline{SHDNB}$	Shutdown Channel B
—	—	5	7	INB+	Noninverting Amplifier Input Channel B
—	—	6	8	INB-	Inverting Amplifier Input Channel B
—	—	7	9	OUTB	Amplifier Output Channel B

Detailed Description

Featuring a maximized ratio of GBW to supply current, low operating supply voltage, low input bias current, and rail-to-rail inputs and outputs, the MAX9910–MAX9913 are an excellent choice for precision or general-purpose, low-current, low-voltage, battery-powered applications. These CMOS devices consume an ultra-low 4µA (typ) supply current and a 200µV (typ) offset voltage. For additional power conservation, the MAX9911/MAX9913 feature a low-power shutdown mode that reduces supply current to 1nA (typ), and puts the amplifiers' output in a high-impedance state. These devices are unity-gain stable with a 200kHz GBW product, driving capacitive loads up to 30pF. The capacitive load can be increased to 250pF when the amplifier is configured for a 10V/V gain.

Rail-to-Rail Inputs and Outputs

All of the MAX9910–MAX9913 amplifiers have a parallel-connected n- and p-channel differential input stage that allows an input common-mode voltage range that extends 100mV beyond the positive and negative supply rails, with excellent common-mode rejection.

The MAX9910–MAX9913 are capable of driving the output to within 5mV of both supply rails with a 100kΩ load. These devices can drive a 5kΩ load with swings to within 60mV of the rails. Figure 1 shows the output voltage swing of the MAX9910–MAX9913 configured as a unity-gain buffer powered from a single 3V supply.

Low Input Bias Current

The MAX9910–MAX9913 feature ultra-low 1pA (typ) input bias current. The variation in the input bias current is minimal with changes in the input voltage due to very high input impedance (in the order of 1GΩ).

Applications Information

Driving Capacitive Loads

The MAX9910–MAX9913 amplifiers are unity-gain stable for loads up to 30pF. However, the capacitive load can be increased to 250pF when the amplifier is configured for a minimum gain of 10V/V. Applications that require greater capacitive-drive capability should use an isolation resistor between the output and the capacitive load (Figure 2). Also, in unity-gain applications with relatively small R_L (approximately 5kΩ), the capacitive load can be increased up to 200pF.

Power-Supply Considerations

The MAX9910–MAX9913 are optimized for single 1.8V to 5.5V supply operation. A high amplifier power-supply rejection ratio of 95dB (typ) allows the devices to be powered directly from a battery, simplifying design and extending battery life.

Power-Up Settling Time

The MAX9910–MAX9913 typically require 5µs after power-up. Supply settling time depends on the supply voltage, the value of the bypass capacitor, the output impedance of the incoming supply, and any lead resistance or inductance between components. Op-amp settling time depends primarily on the output voltage and is slew-rate limited. Figure 3 shows the MAX991_ in a noninverting voltage follower configuration with the input held at midsupply. The output settles in approximately 18µs for V_{DD} = 3V (see the *Typical Operating Characteristics* for power-up settling time).

Shutdown Mode

The MAX9911/MAX9913 feature active-low shutdown inputs. The MAX9911/MAX9913 enter shutdown in 2µs (typ) and exit in 30µs (typ). The amplifiers' outputs are in a high-impedance state in shutdown mode. Drive $\overline{SHDN}$ low to enter shutdown. Drive $\overline{SHDN}$ high to enable the amplifier. The MAX9913 dual-amplifier features separate shutdown inputs. Shut down both amplifiers for the lowest quiescent current.

Power-Supply Bypassing and Layout

To minimize noise, bypass V_{DD} with a 0.1µF capacitor to ground, as close to the pin as possible.

Good layout techniques optimize performance by decreasing the amount of stray capacitance and inductance to the op amps' inputs and outputs. Minimize stray capacitance and inductance by placing external components close to the IC.

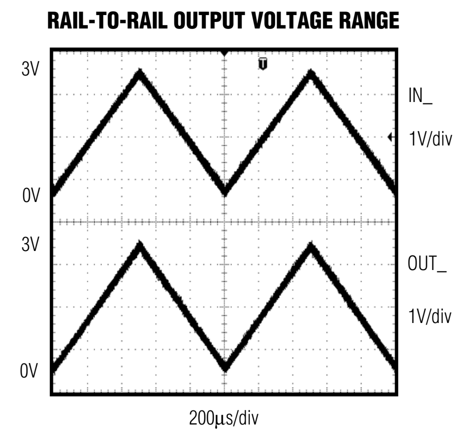


Figure 1. Rail-to-Rail Output Voltage Range

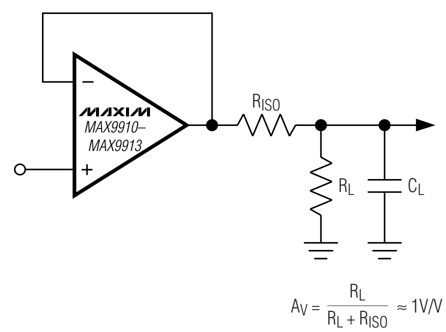


Figure 2. Using a Resistor to Isolate a Capacitive Load from the Op Amp

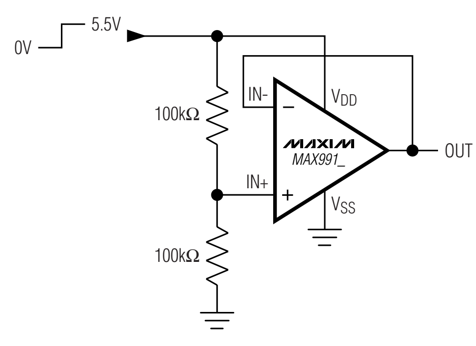
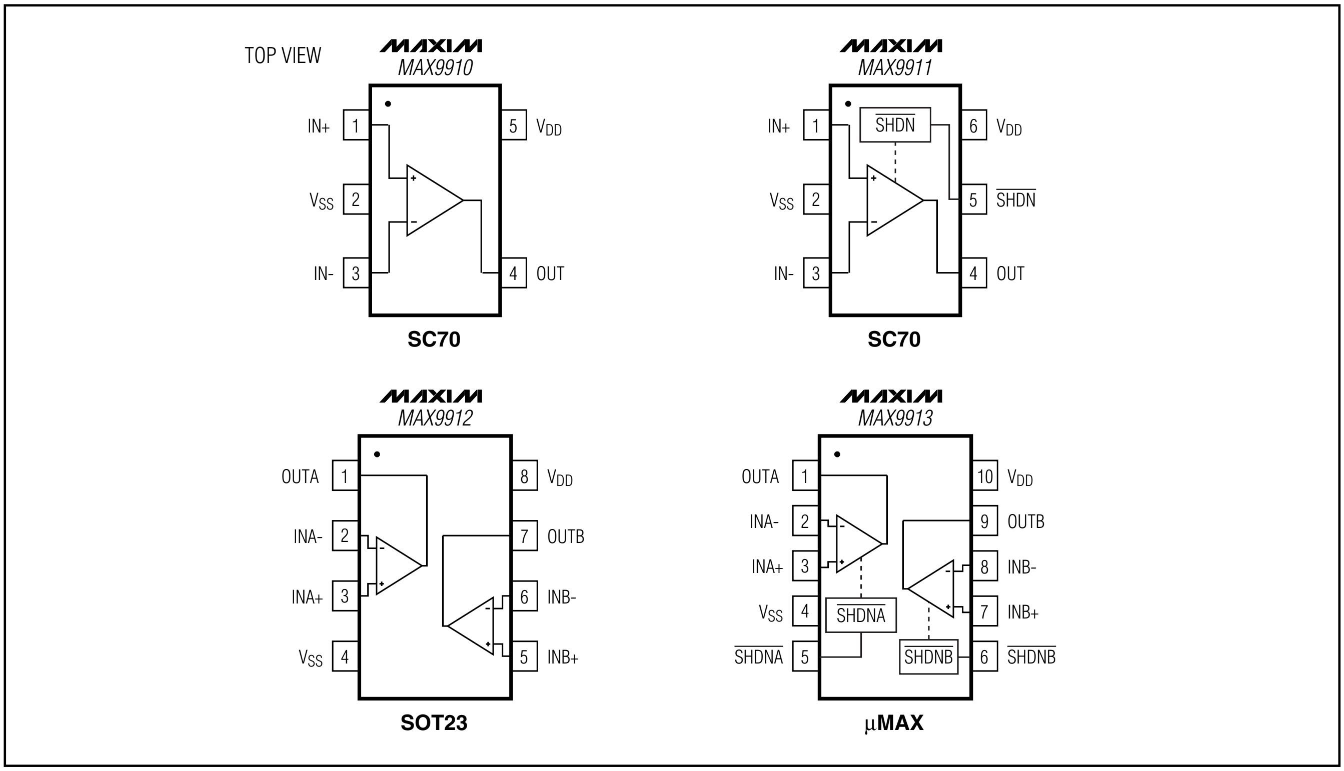


Figure 3. Power-Up Test Configuration

Pin Configurations



Chip Information

MAX9910 TRANSISTOR COUNT: 180

MAX9911 TRANSISTOR COUNT: 180

MAX9912 TRANSISTOR COUNT: 292

MAX9913 TRANSISTOR COUNT: 292

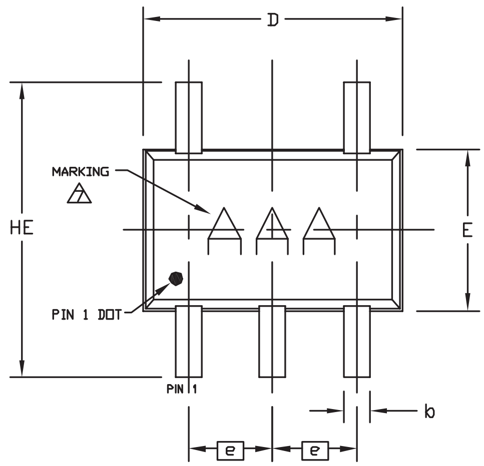
PROCESS: BiCMOS

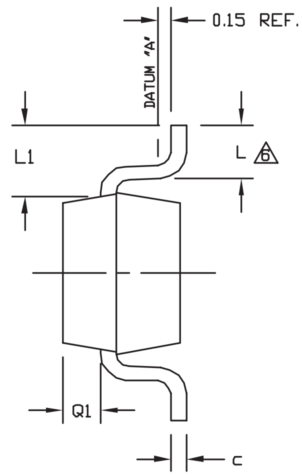
200kHz, 4µA, Rail-to-Rail I/O Op Amps with Shutdown

Package Information

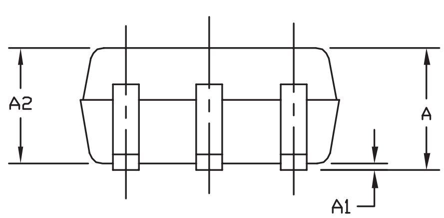
(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

SC70, 5L.EPS





COMMON DIMENSIONS		
SYMBOL	MIN	MAX
A	0.80	1.10
A1	0.00	0.10
A2	0.80	1.00
b	0.15	0.30
c	0.10	0.18
D	1.80	2.20
e	0.65 BSC.	
E	1.15	1.35
HE	1.80	2.40
L	0.10	0.40
L1	0.425 TYP.	
Q1	0.10	0.40



NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONS ARE INCLUSIVE OF PLATING.
3. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH & METAL BURR.
4. COMPLY TO EIAJ SC70 EXCEPT FOR PIN COUNT AND DIMENSION "b".
5. COPLANARITY 4 MILS. MAX.
6. FOOT LENGTH MEASURED AT INTERCEPT POINT BETWEEN DATUM "A" AND LEAD SURFACE.
7. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
8. LEAD CENTERLINES TO BE AT TRUE POSITION AS DEFINED BY BASIC DIMENSION "e", ±0.05.

DALLAS SEMICONDUCTOR MAXIM

TITLE: PACKAGE OUTLINE, 5L SC70

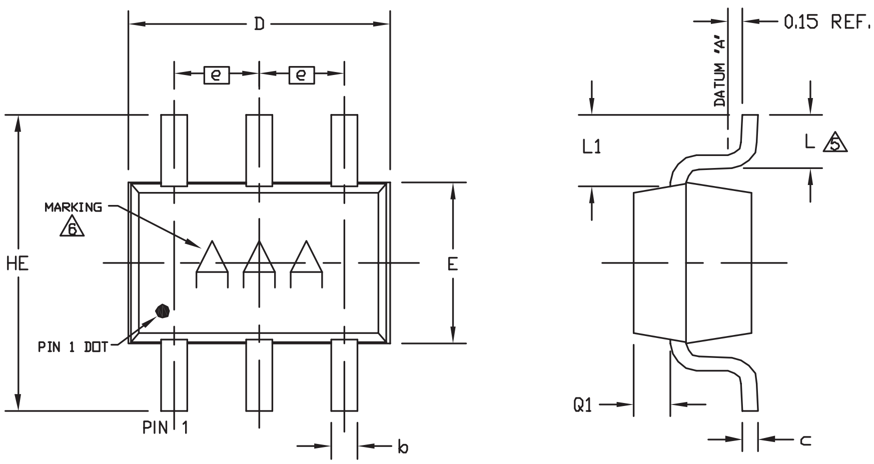
APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0076	C	1/1

-DRAWING NOT TO SCALE-

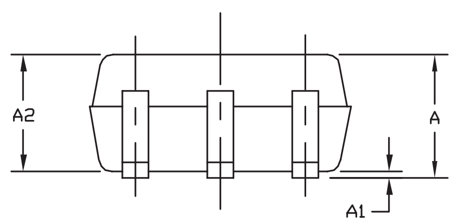
Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

SC70, 6L.EPS



COMMON DIMENSIONS		
SYMBOL	MIN	MAX
A	0.80	1.10
A1	0.00	0.10
A2	0.80	1.00
b	0.15	0.30
c	0.10	0.18
D	1.80	2.20
e	0.65 BSC.	
E	1.15	1.35
HE	1.80	2.40
L	0.10	0.41
L1	0.425 TYP.	
Q1	0.10	0.40



NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONS ARE INCLUSIVE OF PLATING.
3. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH & METAL BURR.
4. COPLANARITY 4 MILS. MAX.
5. (5) FOOT LENGTH MEASURED AT INTERCEPT POINT BETWEEN DATUM "A" AND LEAD SURFACE.
6. (6) MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
7. LEAD CENTERLINES TO BE AT TRUE POSITION AS DEFINED BY BASIC DIMENSION "e", ±0.05.

DALLAS SEMICONDUCTOR MAXIM

TITLE: PACKAGE OUTLINE, 6L SC70

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0077	C	1/1

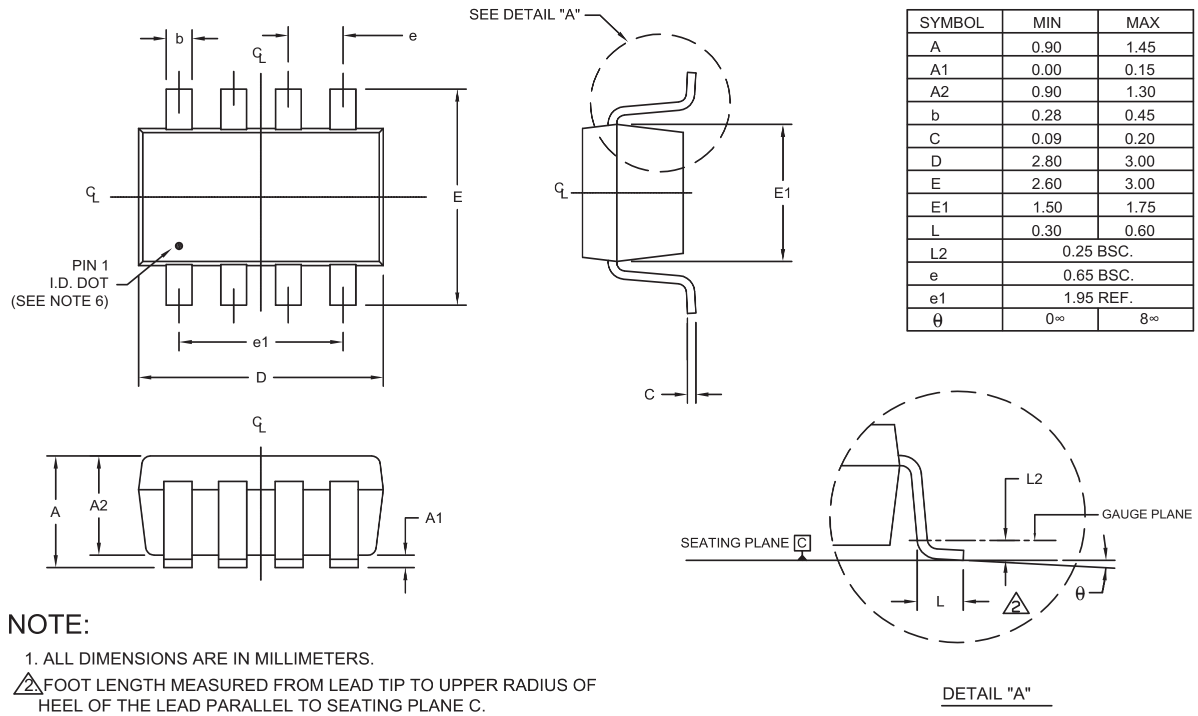
-DRAWING NOT TO SCALE-

200kHz, 4µA, Rail-to-Rail I/O Op Amps with Shutdown

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

SOT23, 8L .EPS



SYMBOL	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.28	0.45
C	0.09	0.20
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.75
L	0.30	0.60
L2	0.25 BSC.	
e	0.65 BSC.	
e1	1.95 REF.	
θ	0∞	8∞

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. FOOT LENGTH MEASURED FROM LEAD TIP TO UPPER RADIUS OF HEEL OF THE LEAD PARALLEL TO SEATING PLANE C.
3. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & METAL BURR.
4. PACKAGE OUTLINE INCLUSIVE OF SOLDER PLATING.
5. COPLANARITY 4 MILS. MAX.
6. PIN 1 I.D. DOT IS 0.3 MM ÿ MIN. LOCATED ABOVE PIN 1.
7. SOLDER THICKNESS MEASURED AT FLAT SECTION OF LEAD BETWEEN 0.08mm AND 0.15mm FROM LEAD TIP.
8. MEETS JEDEC MO178.

DALLAS SEMICONDUCTOR MAXIM

PROPRIETARY INFORMATION

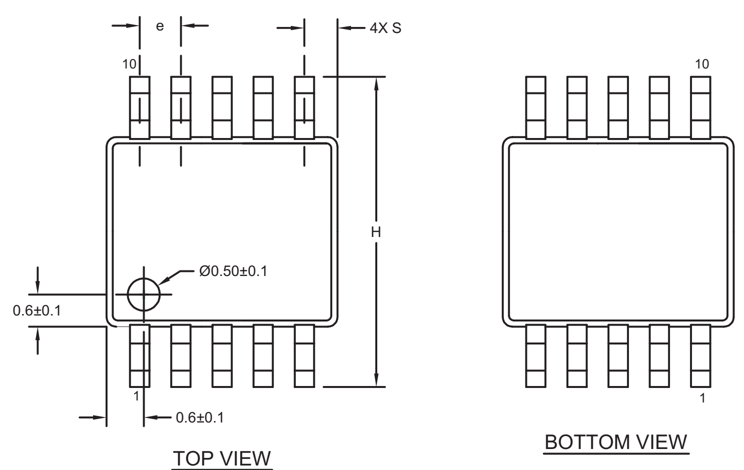
TITLE: PACKAGE OUTLINE, SOT-23, 8L BODY

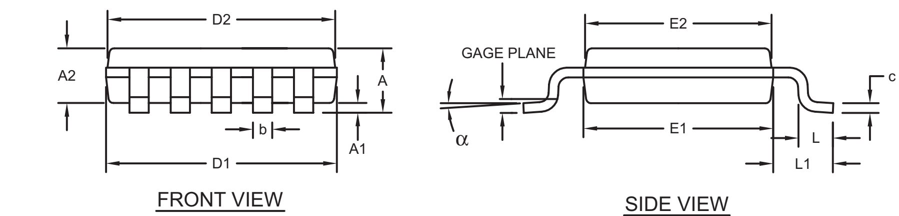
APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0078	D	1/1

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

10LUMAX.EPS





DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	-	0.043	-	1.10
A1	0.002	0.006	0.05	0.15
A2	0.030	0.037	0.75	0.95
D1	0.116	0.120	2.95	3.05
D2	0.114	0.118	2.89	3.00
E1	0.116	0.120	2.95	3.05
E2	0.114	0.118	2.89	3.00
H	0.187	0.199	4.75	5.05
L	0.0157	0.0275	0.40	0.70
L1	0.037 REF		0.940 REF	
b	0.007	0.0106	0.177	0.270
e	0.0197 BSC		0.500 BSC	
c	0.0035	0.0078	0.090	0.200
S	0.0196 REF		0.498 REF	
α	0°	6°	0°	6°

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. MEETS JEDEC MO-187C-BA.

DALLAS SEMICONDUCTOR MAXIM

PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE, 10L uMAX/uSOP

APPROVAL | DOCUMENT CONTROL NO. 21-0061 | REV. I | 1/1