19-2103; Rev 1; 10/06

Quad, General-Purpose, Low-Voltage, Rail-to-Rail Output Op Amps

General Description

The LMX321/LMX358/LMX324 are single/dual/quad, low-cost, low-voltage, pin-to-pin compatible upgrades to the LMV321/LMV358/LMV324 family of general purpose op amps. These devices offer rail-to-rail outputs and an input common-mode range that extends below ground. These op amps draw only 105µA of quiescent current per amplifier, operate from a single +2.3V to +7V supply, and drive 2kΩ resistive loads to within 40mV of either rail. The LMX321/LMX358/LMX324 are unity-gain stable with a 1.3MHz gain-bandwidth product capable of driving capacitive loads up to 400pF. The combination of low voltage, low cost, and small package size makes these amplifiers ideal for portable/battery-powered equipment.

The LMX321 single op amp is available in ultra-small 5-pin SC70 and space-saving 5-pin SOT23 packages. The LMX358 dual op amp is available in the tiny 8-pin SOT23 or the 8-pin µMAX® package. The LMX324 quad op amp is available in 14-pin TSSOP and SO packages.

Applications

Cellular Phones

Laptops

Low-Power, Low-Voltage Applications

Portable/Battery-Powered Equipment

Cordless Phones

Active Filters

Features

- **Upgrade to LMV321/LMV358/LMV324 Family**
- **Single +2.3V to +7V Supply Voltage Range**
- **Available in Space-Saving Packages**
  5-Pin SC70 (LMX321)
  8-Pin SOT23 (LMX358)
  14-Pin TSSOP (LMX324)
- **1.3MHz Gain-Bandwidth Product**
- **105µA Quiescent Current per Amplifier (V_{CC} = +2.7V)**
- **No Phase Reversal for Overdriven Inputs**
- **No Crossover Distortion**
- **Rail-to-Rail Output Swing**
- **Input Common-Mode Voltage Range: V_{EE} - 0.2V to V_{CC} - 0.8V**
- **Drives 2kΩ Resistive Loads**

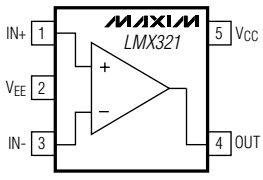
Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	PKG CODE
LMX321AXK-T	-40°C to +125°C	5 SC70-5	X5-1
LMX321AUK-T	-40°C to +125°C	5 SOT23-5	U5-1
LMX358AKA-T	-40°C to +125°C	8 SOT23-8	K8-2
LMX358ASA	-40°C to +125°C	8 SO	S8-2
LMX358AUA-T	-40°C to +125°C	8 µMAX-8	U8-1
LMX324ASD	-40°C to +125°C	14 SO	S14-4
LMX324AUD	-40°C to +125°C	14 TSSOP	U14-1

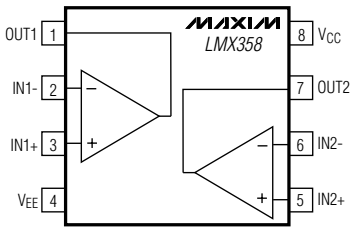
Selector Guide appears at end of data sheet.

Pin Configurations

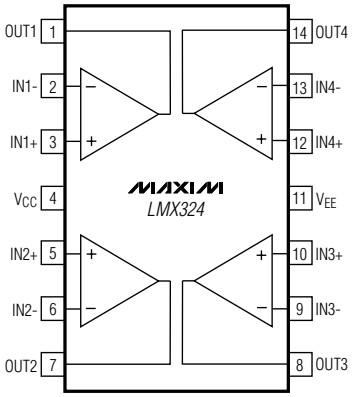
TOP VIEW



SC70-5/SOT23-5



SOT23-8/SO/µMAX



TSSOP/SO

For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

Quad, General-Purpose, Low-Voltage, Rail-to-Rail Output Op Amps

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{CC} to V_{EE}) .....-0.3V to +8V
Differential Input Voltage (V_{IN+} - V_{IN-}) .....V_{EE} to V_{CC}
OUT_ to V_{EE} .....-0.3V to (V_{CC} + 0.3V)
Output Short-Circuit Duration
OUT_ Shorted to V_{CC} or V_{EE}.....Continuous
Continuous Power Dissipation (T_A = +70°C)
5-Pin SC70-5 (derate 3.1mW/°C above +70°C).....247mW
5-Pin SOT23-5 (derate 7.1mW/°C above +70°C) 571mW
8-Pin SOT23-8 (derate 7.52mW/°C above +70°C) 602mW
8-Pin SO (derate 5.9mW/°C above +70°C).....471mW
8-Pin µMAX (derate 4.5mW/°C above +70°C) 362mW
14-Pin TSSOP (derate 9.1mW/°C above +70°C) 727mW
14-Pin SO (derate 8.3mW/°C above +70°C).....667mW
Operating Temperature Range .....-40°C to +125°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_{CC} = +2.7V, V_{EE} = 0V, V_{OUT} = V_{CC}/2, V_{CM} = 1V, R_L > 1MΩ, **T_A = +25°C**, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DC CHARACTERISTICS							
Input Offset Voltage	V_{OS}				1	6	mV
Input Offset Voltage Average Drift	TCV_{OS}				6		µV/°C
Input Bias Current	I_B				18	50	nA
Input Offset Current	I_{OS}				1	8	nA
Common-Mode Rejection Ratio	CMRR	-0.2V < V_{CM} < 1.8V		72	92		dB
Power-Supply Rejection Ratio	PSRR	2.3V ≤ V_{CC} ≤ 7V, V_{OUT} = 1V		82	96		dB
Input Common-Mode Voltage Range	V_{CM}	For CMRR ≥ 72dB	Limit	-0.2		+1.8	V
			Typ	-0.2		+1.9	
Large-Signal Voltage Gain	A_{VOL}	R_L = 2kΩ to V_{EE}, 0.3V < V_{OUT} < 2.4V		20	120		V/mV
Output-Voltage Swing	V_{OUT}	R_L = 10kΩ to 1.35V	V_{CC} - V_{OH}		12	50	mV
			V_{OL}		10	40	
		R_L = 2kΩ to 1.35V	V_{CC} - V_{OH}		40	110	
			V_{OL}		25	60	
Supply Current	I_{CC}	LMX321 (single)			105	150	µA
		LMX358 (dual)			210	300	
		LMX324 (quad)			420	600	
AC CHARACTERISTICS							
Slew Rate	SR	1V step Input			1		V/µs
Gain-Bandwidth Product	GBW	C_L = 200pF			1.3		MHz
Phase Margin	ϕM				64		degrees
Gain Margin	GM				24		dB
Input Noise-Voltage Density	e_n	f = 1kHz			66		nV/√Hz
Input Current-Noise Density	i_n	f = 1kHz			0.13		pA/√Hz

ELECTRICAL CHARACTERISTICS

(V_{CC} = +2.7V, V_{EE} = 0V, V_{OUT} = V_{CC}/2, V_{CM} = 1V, R_L > 1MΩ, T_A = **-40°C to +125°C**, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DC CHARACTERISTICS							
Input Offset Voltage	V_{OS}					9	mV
Input Bias Current	I_B					70	nA
Input Offset Current	I_{OS}					15	nA
Common-Mode Rejection Ratio	CMRR	-0.1 < V_{CM} < +1.7V		60			dB
Power-Supply Rejection Ratio	PSRR	2.3V ≤ V_{CC} ≤ 7V, V_{OUT} = 1V		75			dB
Input Common-Mode Voltage Range	V_{CM}	For CMRR ≥ 60dB	Limit	-0.1		+1.7	V
			Typ	-0.1		+1.8	
Large-Signal Voltage Gain	A_{VOL}	R_L = 2kΩ to V_{EE}, 0.3V ≤ V_{OUT} ≤ 2.4V		10			V/mV
Output-Voltage Swing	V_{OUT}	R_L = 10kΩ to 1.55V	V_{CC} - V_{OH}			130	mV
			V_{OL}			50	
		R_L = 2kΩ to 1.35V	V_{CC} - V_{OH}			150	
			V_{OL}			70	
Supply Current	I_{CC}	LMX321 (single)				180	μA
		LMX358 (dual)				360	
		LMX324 (quad)				720	

ELECTRICAL CHARACTERISTICS

(V_{CC} = +5V, V_{EE} = 0V, V_{OUT} = V_{CC}/2, V_{CM} = 2V, R_L > 1MΩ, **T_A = +25°C**, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DC CHARACTERISTICS							
Input Offset Voltage	V_{OS}				1	6	mV
Input Offset Voltage Average Drift	TCV_{OS}				6		μV/°C
Input Bias Current	I_B				18	50	nA
Input Offset Current	I_{OS}				1	8	nA
Input Differential Clamp Voltage	V_{CLAMP}	Force 100μA into IN+, IN- = GND measure V_{IN+} - V_{IN-}, Figure 1			3.1		V
Common-Mode Rejection Ratio	CMRR	-0.2 < V_{CM} < +4.1V		72	92		dB
Power-Supply Rejection Ratio	PSRR	2.3V ≤ V_{CC} ≤ 7V, V_{OUT} = 1V, V_{CM} = 1V		82	96		dB
Input Common-Mode Voltage Range	V_{CM}	For CMRR ≥ 72dB	Limit	-0.2		+4.1	V
			Typ	-0.2		+4.2	
Large-Signal Voltage Gain	A_{VOL}	R_L = 2kΩ to V_{EE}, 0.3V ≤ V_{OUT} ≤ 4.7V		40	200		V/mV

Quad, General-Purpose, Low-Voltage, Rail-to-Rail Output Op Amps

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +5V, V_{EE} = 0V, V_{OUT} = V_{CC}/2, V_{CM} = 2V, R_L > 1MΩ, **T_A = +25°C**, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Output-Voltage Swing	V_{OUT}	R_L = 10kΩ to 2.5V	V_{CC} - V_{OH}		20	60	mV
			V_{OL}		12	40	
		R_L = 2kΩ to 2.5V	V_{CC} - V_{OH}		65	130	
			V_{OL}		40	80	
Output Short-Circuit Current	I_{SC}	Sourcing, V_{OUT} = 0V		5	25		mA
		Sinking, V_{OUT} = 5V		10	28		
Supply Current	I_{CC}	LMX321 (single)			120	170	µA
		LMX358 (dual)			240	340	
		LMX324 (quad)			480	680	
AC CHARACTERISTICS							
Slew Rate	SR	3V step input			1		V/µs
Gain-Bandwidth Product	GBW	C_L = 200pF			1.3		MHz
Phase Margin	ϕ_M				65		degrees
Gain Margin	GM				25		dB
Input Noise-Voltage Density	e_n	f = 1kHz			65		nV/√Hz
Input Noise-Current Density	i_n	f = 1kHz			0.13		pA/√Hz

ELECTRICAL CHARACTERISTICS

(V_{CC} = +5V, V_{EE} = 0V, V_{OUT} = V_{CC}/2, V_{CM} = 2V, R_L > 1MΩ, **T_A = -40°C to +125°C**, unless otherwise noted.) (Note 1)

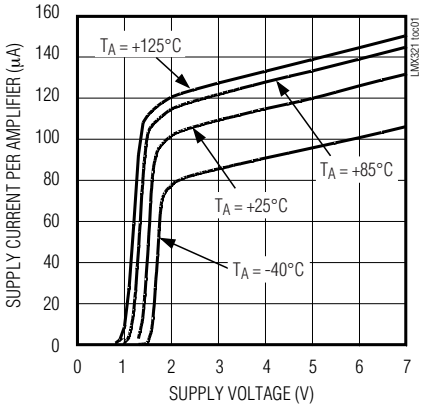
PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DC CHARACTERISTICS							
Input Offset Voltage	V_{OS}					9	mV
Input Bias Current	I_B					70	nA
Input Offset Current	I_{OS}					15	nA
Common-Mode Rejection Ratio	CMRR	-0.1 < V_{CM} < +4.0V		63			dB
Power-Supply Rejection Ratio	PSRR	2.3V ≤ V_{CC} ≤ 7V, V_{OUT} = 1V, V_{CM} = 1V		75			dB
Input Common-Mode Voltage Range	V_{CM}	For CMRR ≥ 63dB	Limit	-0.1		+4.0	V
			Typ	-0.1		+4.1	
Large-Signal Voltage Gain	A_{VOL}	R_L = 2kΩ to V_{EE}, 0.3V ≤ V_{OUT} ≤ 4.7V		20			V/mV
Output-Voltage Swing	V_{OUT}	R_L = 10kΩ to 2.5V	V_{CC} - V_{OH}			170	mV
			V_{OL}			70	
		R_L = 2kΩ to 2.5V	V_{CC} - V_{OH}			190	
			V_{OL}			90	
Supply Current	I_{CC}	LMX321 (single)				210	µA
		LMX358 (dual)				420	
		LMX324 (quad)				840	

Note 1: Specifications are 100% tested at T_A = +25°C (exceptions noted). All temperature limits are guaranteed by design.

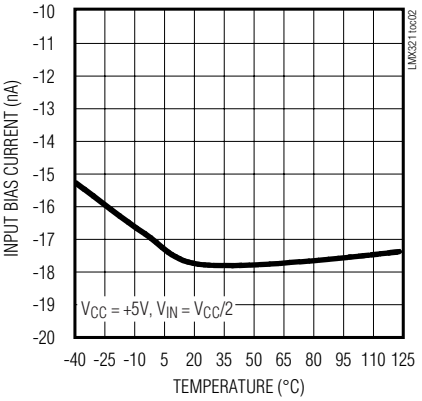
Typical Operating Characteristics

(T_A = +25°C, V_{EE} = 0V, unless otherwise noted.)

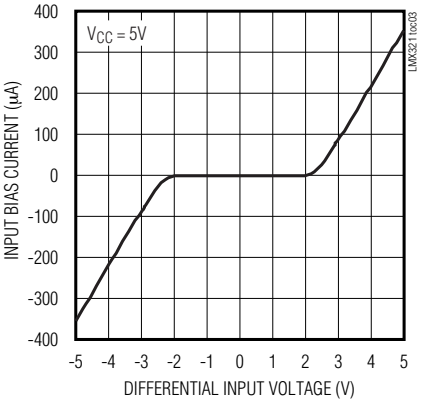
SUPPLY CURRENT PER AMPLIFIER vs. SUPPLY VOLTAGE



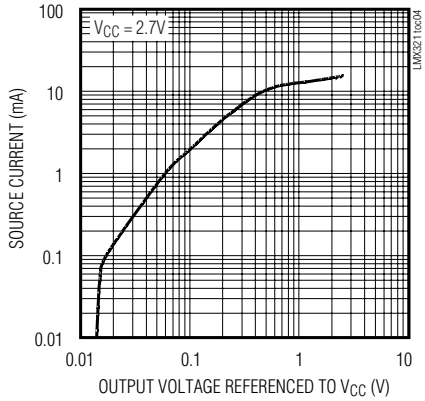
INPUT BIAS CURRENT vs. TEMPERATURE



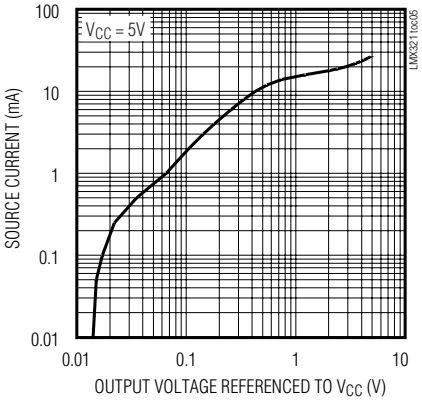
INPUT BIAS CURRENT vs. DIFFERENTIAL INPUT VOLTAGE



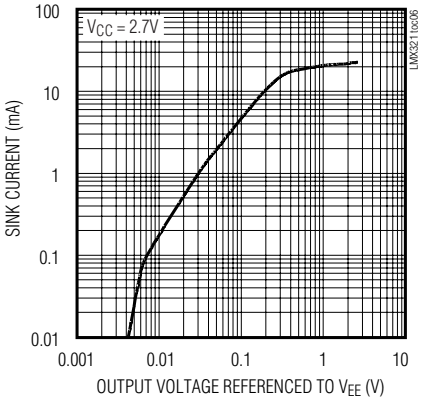
SOURCE CURRENT vs. OUTPUT VOLTAGE



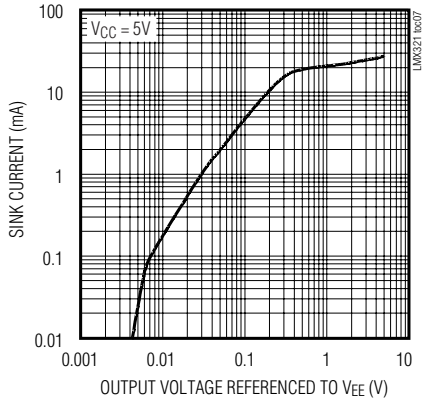
SOURCE CURRENT vs. OUTPUT VOLTAGE



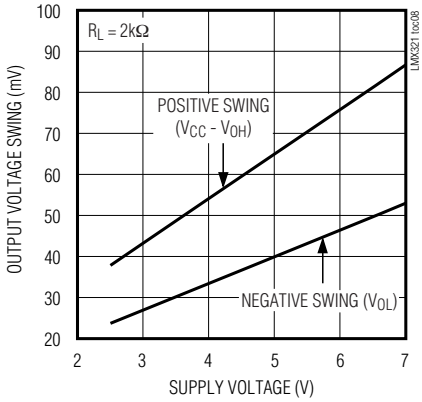
SINK CURRENT vs. OUTPUT VOLTAGE



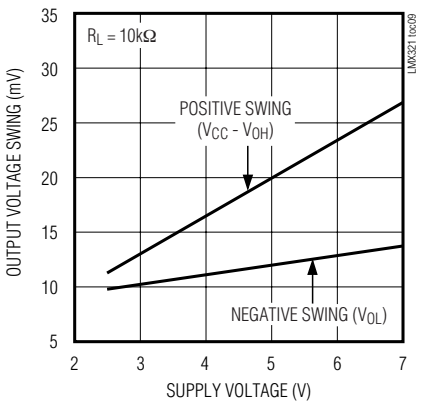
SINK CURRENT vs. OUTPUT VOLTAGE



OUTPUT VOLTAGE SWING vs. SUPPLY VOLTAGE



OUTPUT VOLTAGE SWING vs. SUPPLY VOLTAGE

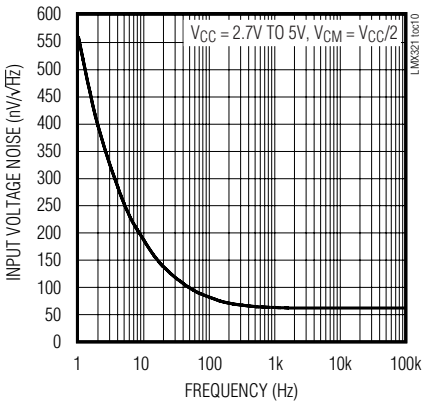


Quad, General-Purpose, Low-Voltage, Rail-to-Rail Output Op Amps

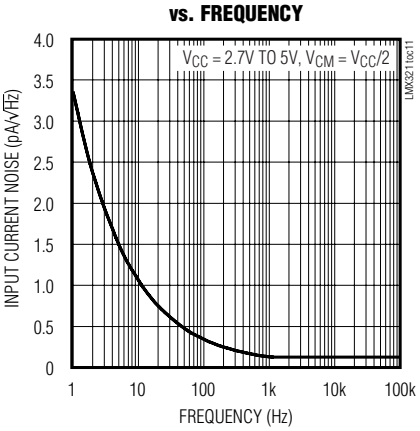
Typical Operating Characteristics (continued)

(T_A = +25°C, V_{EE} = 0V, unless otherwise noted.)

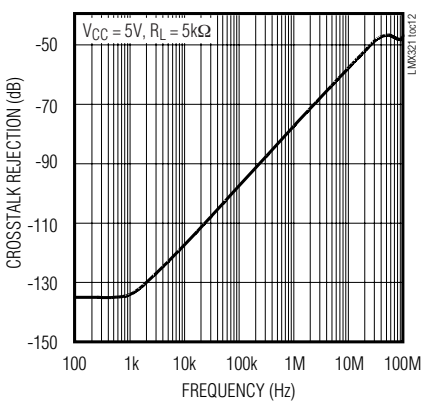
INPUT VOLTAGE NOISE vs. FREQUENCY



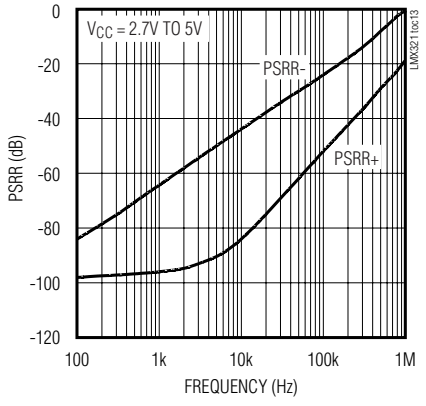
INPUT CURRENT NOISE vs. FREQUENCY



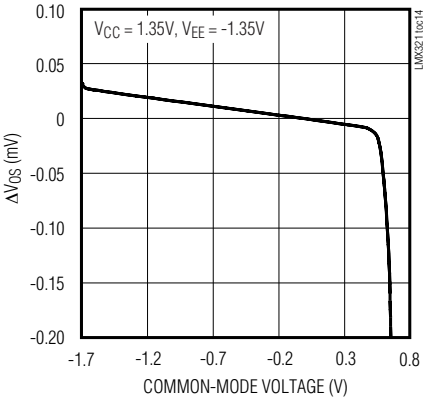
CROSSTALK REJECTION vs. FREQUENCY



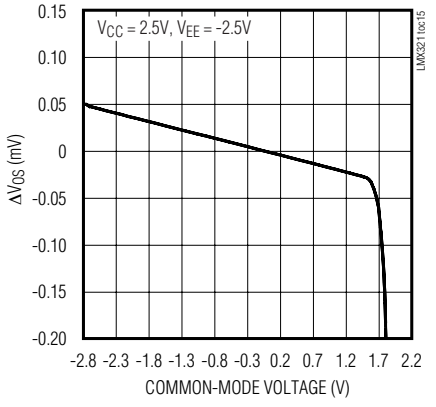
POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



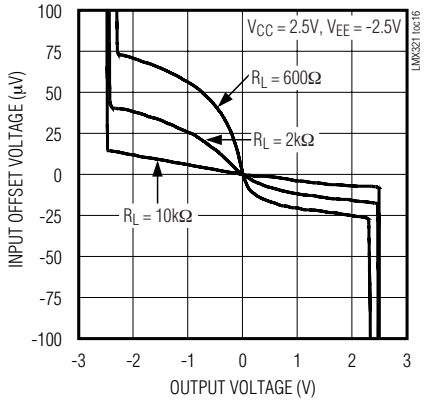
INPUT OFFSET VOLTAGE vs. COMMON-MODE VOLTAGE



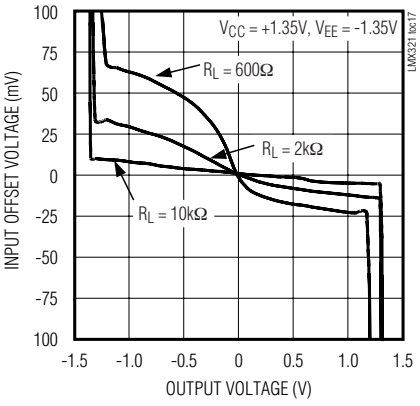
INPUT OFFSET VOLTAGE vs. COMMON-MODE VOLTAGE



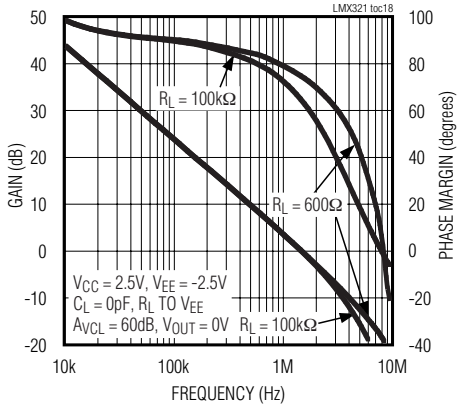
INPUT OFFSET VOLTAGE vs. OUTPUT VOLTAGE



INPUT OFFSET VOLTAGE vs. OUTPUT VOLTAGE



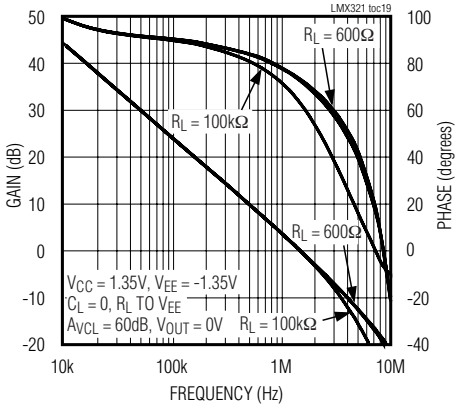
GAIN AND PHASE vs. FREQUENCY and RESISTIVE LOAD



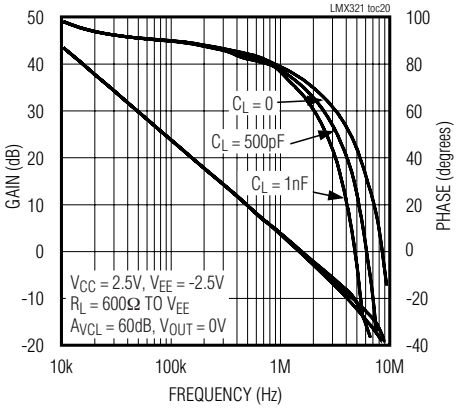
Typical Operating Characteristics (continued)

(T_A = +25°C, V_{EE} = 0V, unless otherwise noted.)

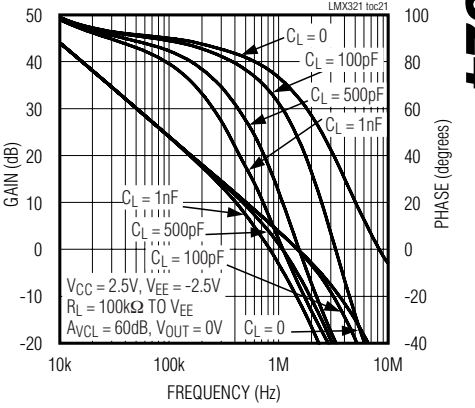
GAIN AND PHASE vs. FREQUENCY and RESISTIVE LOAD



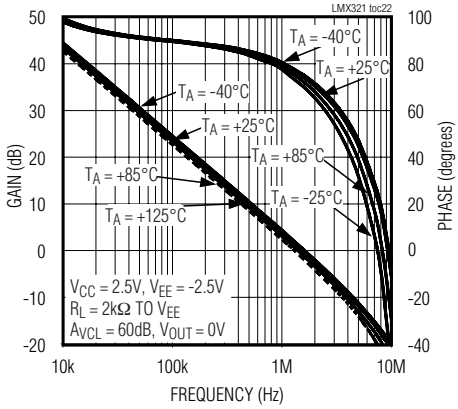
GAIN AND PHASE vs. FREQUENCY AND CAPACITIVE LOAD



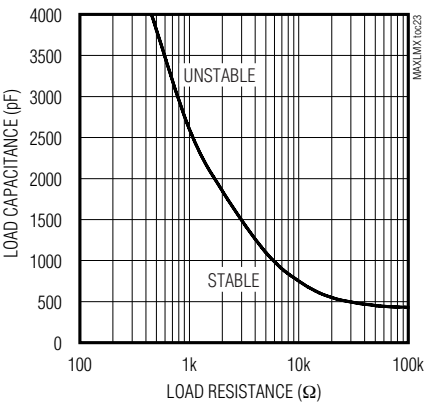
GAIN AND PHASE vs. FREQUENCY AND CAPACITIVE LOAD



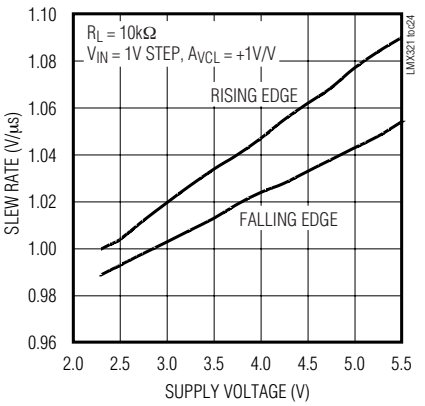
GAIN AND PHASE vs. FREQUENCY AND TEMPERATURE



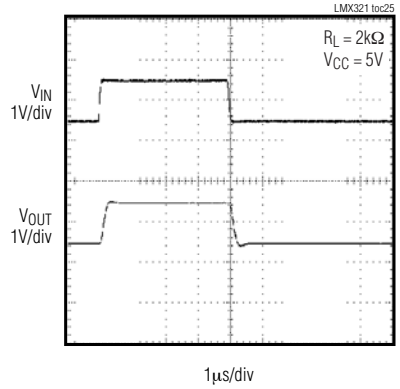
CAPACITIVE-LOAD STABILITY



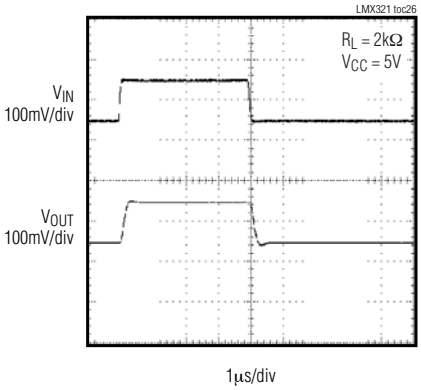
SLEW RATE vs. SUPPLY VOLTAGE



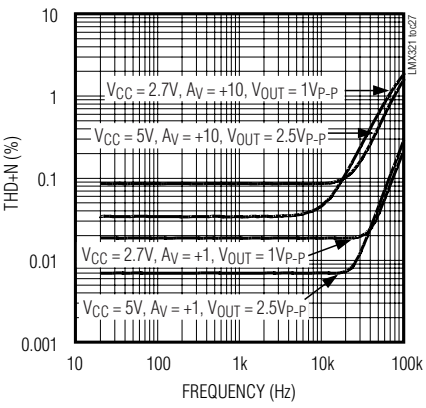
NONINVERTING LARGE-SIGNAL RESPONSE



NONINVERTING SMALL-SIGNAL RESPONSE



TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY

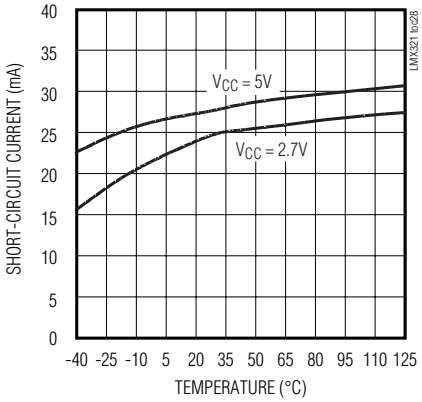


Quad, General-Purpose, Low-Voltage, Rail-to-Rail Output Op Amps

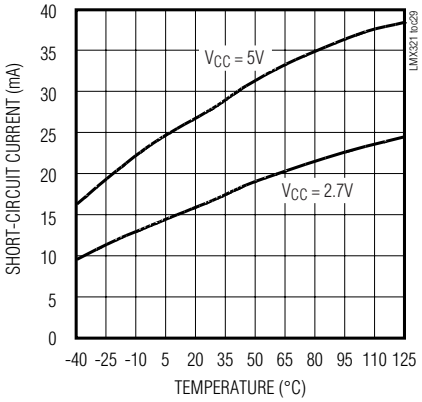
Typical Operating Characteristics (continued)

(T_A = +25°C, V_{EE} = 0V, unless otherwise noted.)

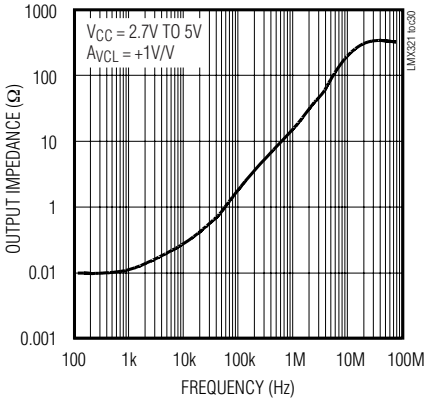
SHORT-CIRCUIT CURRENT vs. TEMPERATURE (SINKING)



SHORT-CIRCUIT CURRENT vs. TEMPERATURE (SOURCING)



OUTPUT IMPEDANCE vs. FREQUENCY



Pin Description

PIN			NAME	FUNCTION
LMX321	LMX358	LMX324		
1	—	—	IN+	Noninverting Amplifier Input
2	4	11	V_{EE}	Negative Supply. Connect to ground for single-supply operation.
3	—	—	IN-	Inverting Amplifier Input
4	—	—	OUT	Output
5	8	4	V_{CC}	Positive Supply
—	1	1	OUT1	Output for Amplifier 1
—	2	2	IN1-	Inverting Input for Amplifier 1
—	3	3	IN1+	Noninverting Input for Amplifier 1
—	7	7	OUT2	Output for Amplifier 2
—	6	6	IN2-	Inverting Input for Amplifier 2
—	5	5	IN2+	Noninverting Input for Amplifier 2
—	—	8	OUT3	Output for Amplifier 3
—	—	9	IN3-	Inverting Input for Amplifier 3
—	—	10	IN3+	Noninverting Input for Amplifier 3
—	—	14	OUT4	Output for Amplifier 4
—	—	13	IN4-	Inverting Input for Amplifier 4
—	—	12	IN4+	Noninverting Input for Amplifier 4

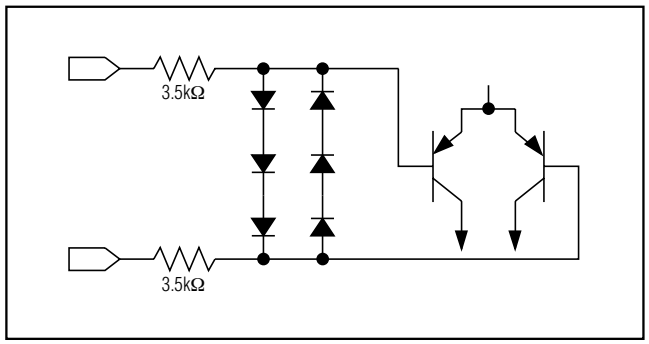


Figure 1. Input Protection Circuit

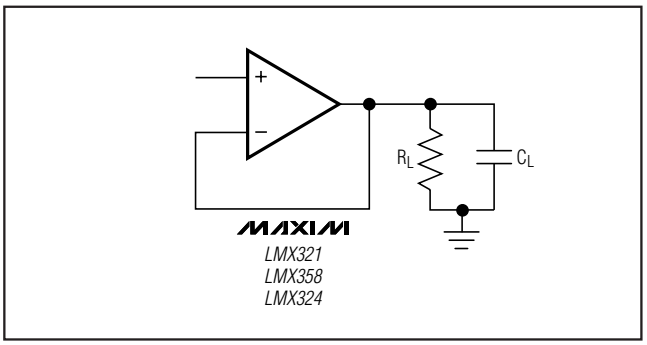


Figure 3. Capacitive-Load-Driving Circuit

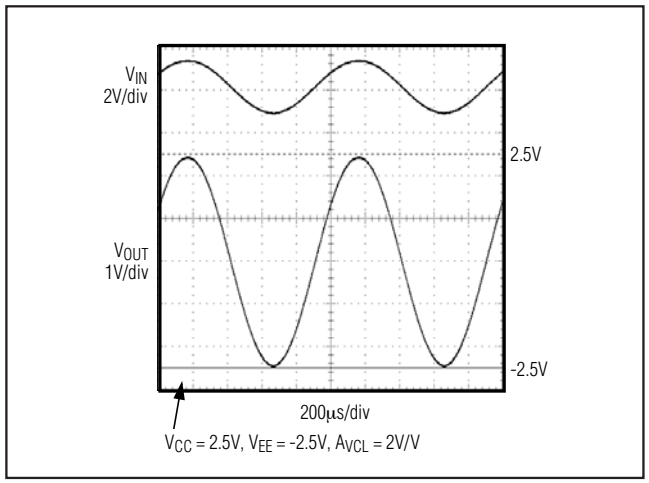


Figure 2. Rail-to-Rail Output Swing

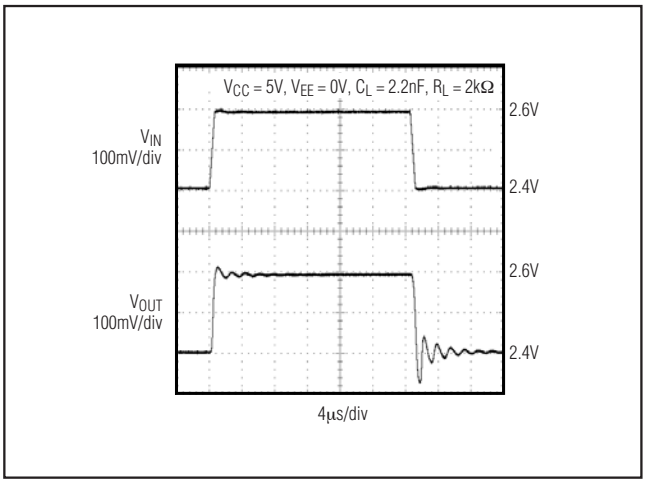


Figure 4. Output With Excessive Capacitive Load

Detailed Description

Input Protection Circuit

The LMX321/LMX358/LMX324's inputs are protected from large differential input voltages by internal 3.5kΩ series resistors and back-to-back triple diode stacks across the inputs (Figure 1). For differential input voltages (much less than 1.8V), input resistance is typically 3MΩ. For differential input voltages greater than 1.8V, input resistance is around 7kΩ, and the input bias current can be approximated by the following equation:

$$I_{BIAS} = (V_{DIFF} - 1.8V) / 7k\Omega$$

In the region where the differential input voltage approaches 1.8V, input resistance decreases exponentially from 3MΩ to 7kΩ as the diode block begins conducting. Inversely, the bias current increases with the same curve.

Rail-to-Rail Output Stage

The LMX321/LMX358/LMX324 drive 2kΩ loads and still typically swing within 40mV of the supply rails. Figure 2 shows the output voltage swing of the LMX321 configured with A_{VCL} = +2V/V.

Driving Capacitive Loads

Driving a capacitive load can cause instability in many op amps, especially those with low quiescent current. The LMX321/LMX358/LMX324 are unity-gain stable for a range of capacitive loads to above 400pF. Figure 4 shows the response of the LMX321 with an excessive capacitive load. Adding a series resistor between the output and the load capacitor (Figure 5) improves the circuit's response by isolating the load capacitance from the op amp's output.

Quad, General-Purpose, Low-Voltage, Rail-to-Rail Output Op Amps

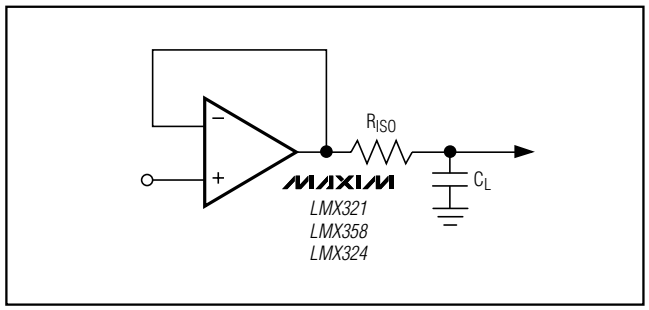


Figure 5. Capacitive-Load-Driving Circuit With Isolation Resistor

Applications Information

Power-Up

The LMX321/LMX358/LMX324 outputs typically settle within 10µs after power-up. Figure 6 shows the output voltage on power-up and power-down.

Power Supplies and Layout

The LMX321/LMX358/LMX324 operate from a single +2.3V to +7V power supply. Bypass the power supply with a 0.1µF capacitor to ground as close to V_{CC} as possible.

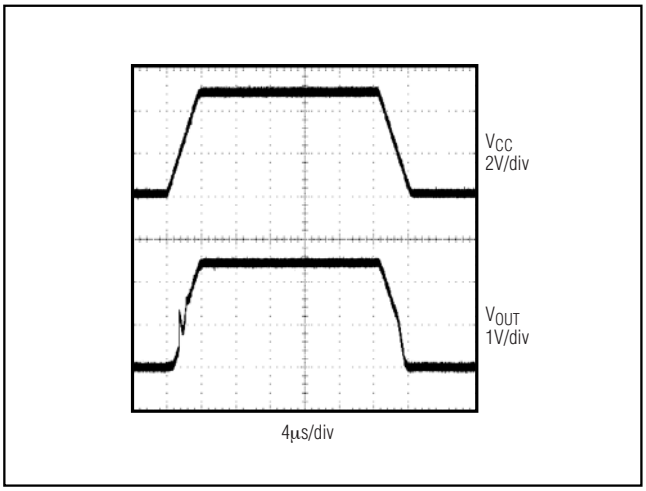


Figure 6. Power-Up/Power-Down Waveform

Good layout techniques optimize performance by minimizing the amount of stray capacitance at the op amp's inputs and outputs. Place external components close to the op amp to minimize trace lengths and stray capacitance.

Selector Guide

PART	AMPLIFIERS PER PACKAGE	TOP MARK
LMX321AXK-T	1	ACP
LMX321AUK-T	1	ADSQ
LMX358AKA-T	2	AAIR
LMX358ASA	2	—
LMX358AUA-T	2	—
LMX324ASD	4	—
LMX324AUD	4	—

Chip Information

LMX321 TRANSISTOR COUNT: 88

LMX358 TRANSISTOR COUNT: 175

LMX324 TRANSISTOR COUNT: 349

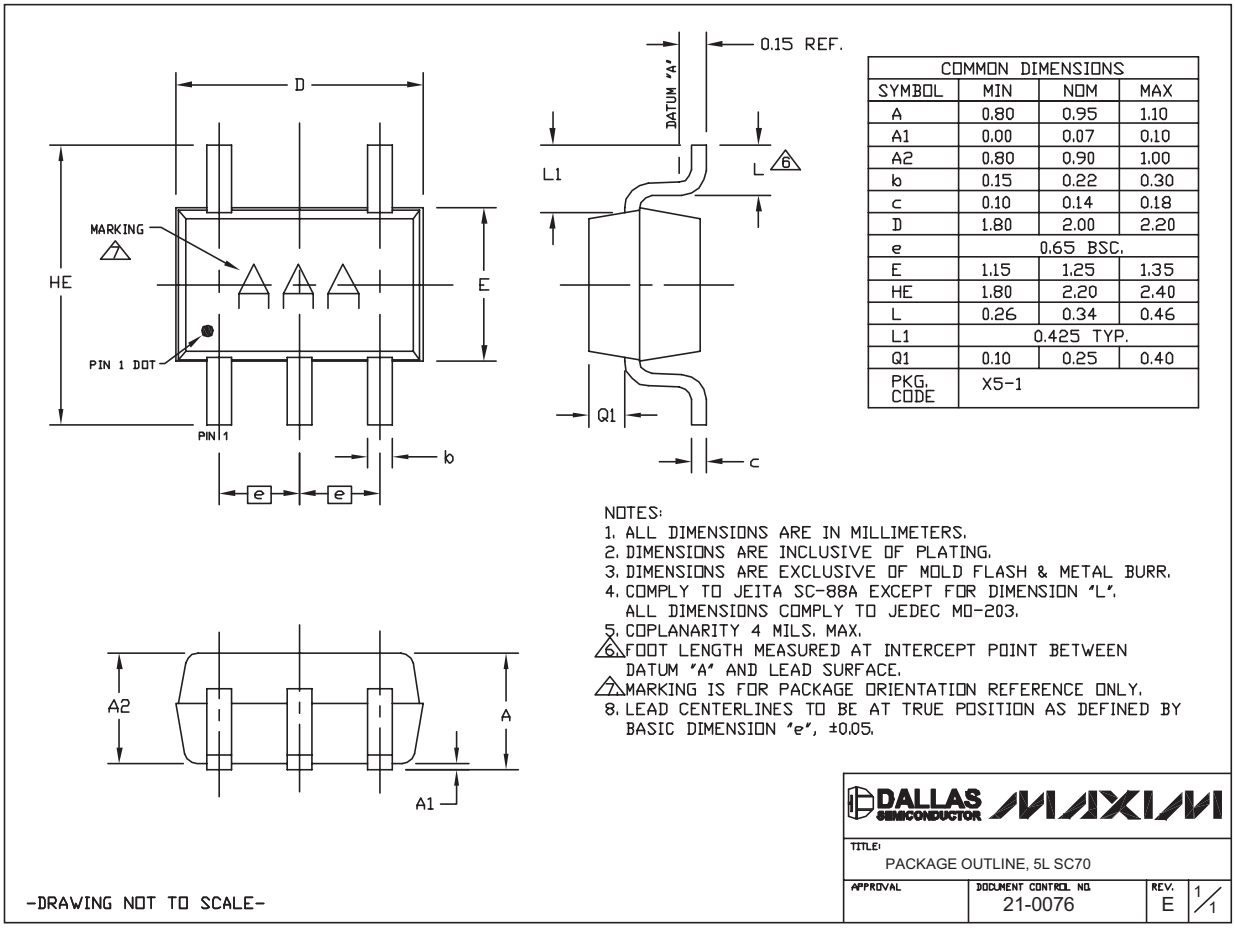
PROCESS: Bipolar

Quad, General-Purpose, Low-Voltage, Rail-to-Rail Output Op Amps

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	NOM	MAX
A	0.80	0.95	1.10
A1	0.00	0.07	0.10
A2	0.80	0.90	1.00
b	0.15	0.22	0.30
c	0.10	0.14	0.18
D	1.80	2.00	2.20
e	0.65 BSC.		
E	1.15	1.25	1.35
HE	1.80	2.20	2.40
L	0.26	0.34	0.46
L1	0.425 TYP.		
Q1	0.10	0.25	0.40
PKG. CODE	X5-1		

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONS ARE INCLUSIVE OF PLATING.
3. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH & METAL BURR.
4. COMPLY TO JEITA SC-88A EXCEPT FOR DIMENSION "L". ALL DIMENSIONS COMPLY TO JEDEC MO-203.
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

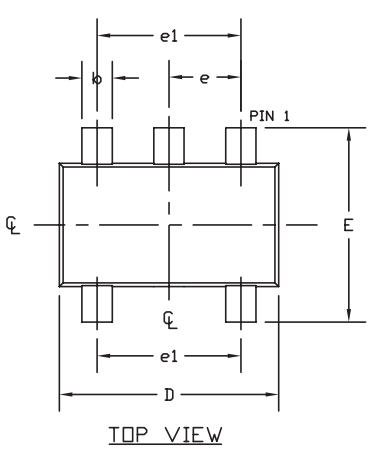
APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0076	E	1/1

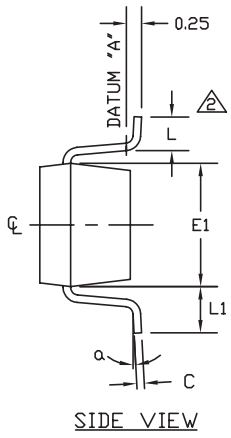
Quad, General-Purpose, Low-Voltage, Rail-to-Rail Output Op Amps

Package Information (continued)

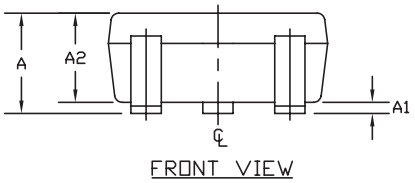
(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to **www.maxim-ic.com/packages**.)

SOT-23 5L .EPS





SYMBOL	MIN	NOM	MAX
A	0.90	1.25	1.45
A1	0.00	0.05	0.15
A2	0.90	1.10	1.30
b	0.35	0.40	0.50
C	0.08	0.15	0.20
D	2.80	2.90	3.00
E	2.60	2.80	3.00
E1	1.50	1.625	1.75
L	0.35	0.45	0.60
L1	0.60 REF		
e	0.95 BSC.		
e1	1.90 BSC.		
α	0°	2.5°	8°
PKG CODES: U5-1, U5-2			



NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. FOOT LENGTH MEASURED AT INTERCEPT POINT BETWEEN DATUM A & LEAD SURFACE.
3. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & METAL BURR. MOLD FLASH, PROTRUSION OR METAL BURR SHOULD NOT EXCEED 0.25 MM.
4. PACKAGE OUTLINE INCLUSIVE OF SOLDER PLATING.
5. MEETS JEDEC MO178, VARIATION AA.
6. LEADS TO BE COPLANAR WITHIN 0.10 mm.
7. SOLDER THICKNESS MEASURED AT FLAT SECTION OF LEAD BETWEEN 0.08mm AND 0.15mm FROM LEAD TIP.

DALLAS SEMICONDUCTOR MAXIM
PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE, SOT-23, 5L

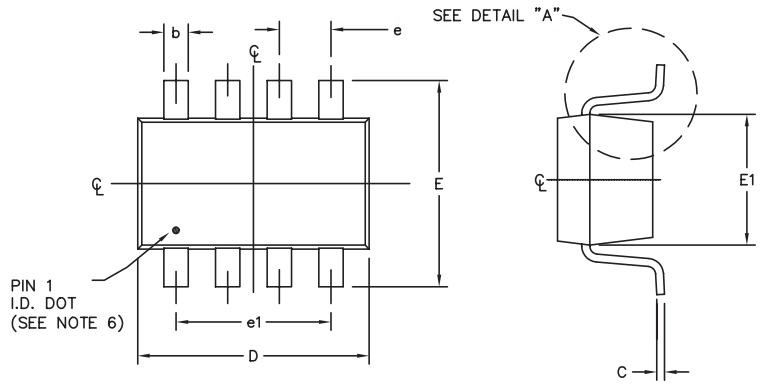
APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0057	F	1/1

Quad, General-Purpose, Low-Voltage, Rail-to-Rail Output Op Amps

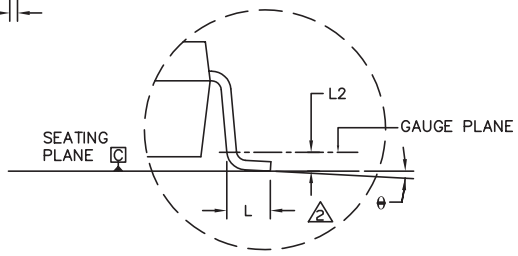
Package Information (continued)

(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	NOM	MAX
A	0.90	1.25	1.45
A1	0.00	0.06	0.15
A2	0.90	1.10	1.30
b	0.22	0.30	0.38
C	0.08	0.15	0.22
D	2.80	2.90	3.00
E	2.60	2.80	3.00
E1	1.50	1.625	1.75
L	0.30	0.45	0.60
L2	0.25 BSC.		
e	0.65 BSC.		
e1	1.95 REF.		
θ	0°	3°	8°
PKG CODES: K8-1, K8-2, K8S-3, K8F-4, K8FH-4, K8-5, K8C-6			



DETAIL "A"

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 ø 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 VARIATION BA.

–DRAWING NOT TO SCALE–

DALLAS SEMICONDUCTOR MAXIM

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

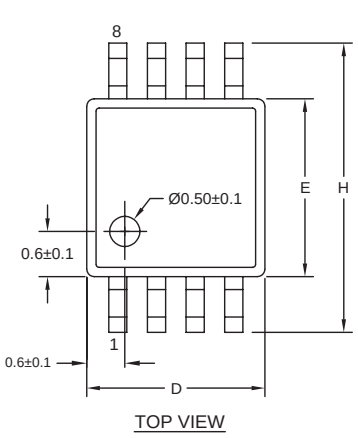
APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0078	F	1/1

Quad, General-Purpose, Low-Voltage, Rail-to-Rail Output Op Amps

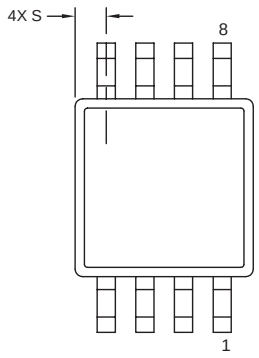
Package Information (continued)

(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**.)

8LUMAXD.EPS

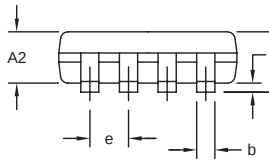


TOP VIEW

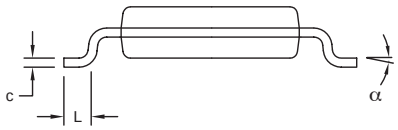


BOTTOM VIEW

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	-	0.043	-	1.10
A1	0.002	0.006	0.05	0.15
A2	0.030	0.037	0.75	0.95
b	0.010	0.014	0.25	0.36
c	0.005	0.007	0.13	0.18
D	0.116	0.120	2.95	3.05
e	0.0256 BSC		0.65 BSC	
E	0.116	0.120	2.95	3.05
H	0.188	0.198	4.78	5.03
L	0.016	0.026	0.41	0.66
α	0°	6°	0°	6°
S	0.0207 BSC		0.5250 BSC	



FRONT VIEW



SIDE VIEW

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-AA.

DALLAS SEMICONDUCTOR MAXIM

PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE, 8L uMAX/uSOP

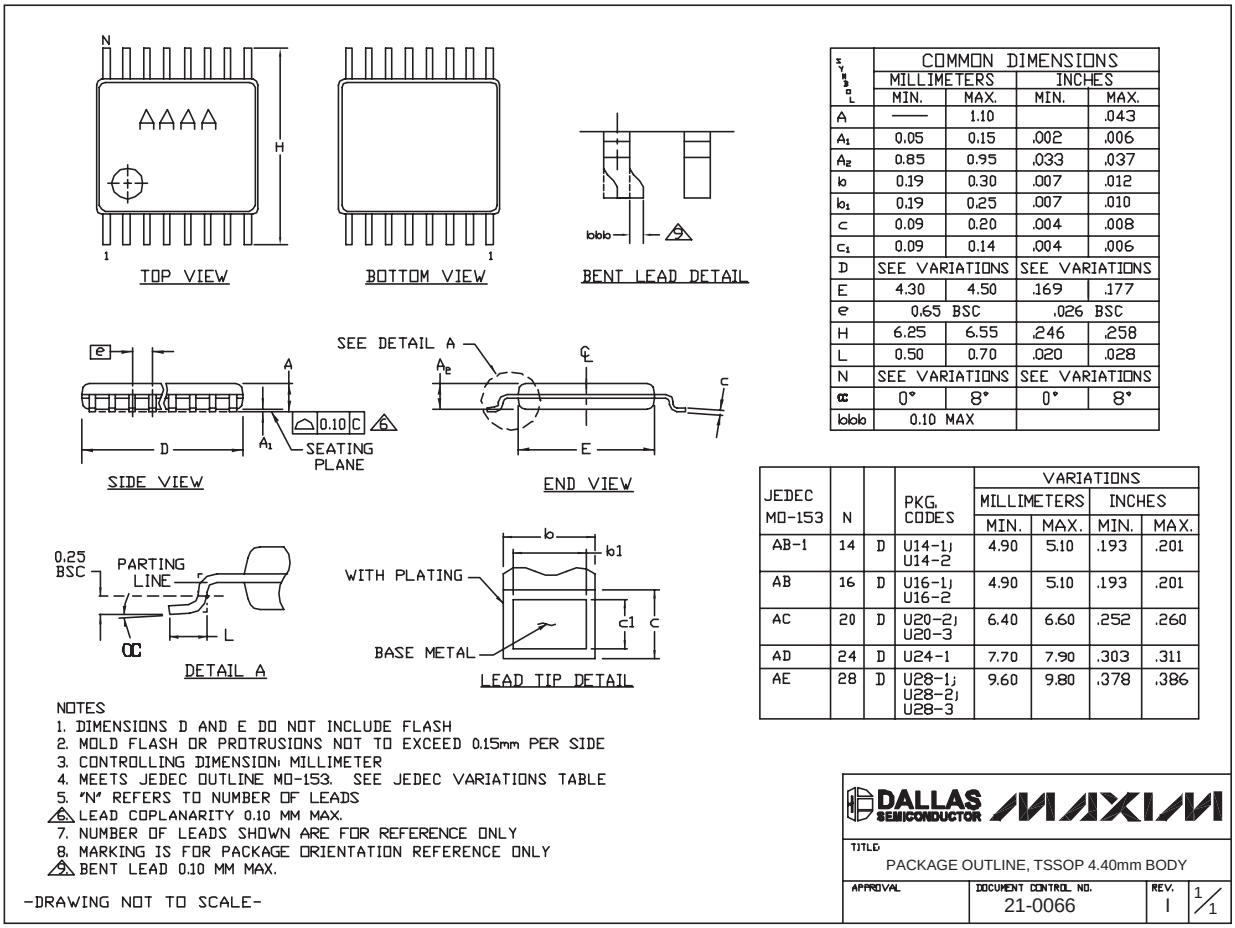
APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0036	J	1/1

Quad, General-Purpose, Low-Voltage, Rail-to-Rail Output Op Amps

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**.)

TSSOP4.40mm.EPS



SYMBOL	COMMON DIMENSIONS			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	——	1.10		.043
A_1	0.05	0.15	.002	.006
A_2	0.85	0.95	.033	.037
b	0.19	0.30	.007	.012
b_1	0.19	0.25	.007	.010
c	0.09	0.20	.004	.008
c_1	0.09	0.14	.004	.006
D	SEE VARIATIONS		SEE VARIATIONS	
E	4.30	4.50	.169	.177
e	0.65 BSC		.026 BSC	
H	6.25	6.55	.246	.258
L	0.50	0.70	.020	.028
N	SEE VARIATIONS		SEE VARIATIONS	
α	0°	8°	0°	8°
bbb	0.10 MAX			

JEDEC MO-153	N		PKG. CODES	VARIATIONS			
				MILLIMETERS		INCHES	
				MIN.	MAX.	MIN.	MAX.
AB-1	14	D	U14-1, U14-2	4.90	5.10	.193	.201
AB	16	D	U16-1, U16-2	4.90	5.10	.193	.201
AC	20	D	U20-2, U20-3	6.40	6.60	.252	.260
AD	24	D	U24-1	7.70	7.90	.303	.311
AE	28	D	U28-1, U28-2, U28-3	9.60	9.80	.378	.386

NOTES
1. DIMENSIONS D AND E DO NOT INCLUDE FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm PER SIDE
3. CONTROLLING DIMENSION: MILLIMETER
4. MEETS JEDEC OUTLINE MO-153. SEE JEDEC VARIATIONS TABLE
5. "N" REFERS TO NUMBER OF LEADS
6. LEAD COPLANARITY 0.10 MM MAX.
7. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY
8. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY
9. BENT LEAD 0.10 MM MAX.

-DRAWING NOT TO SCALE-

DALLAS SEMICONDUCTOR MAXIM

TITLE: PACKAGE OUTLINE, TSSOP 4.40mm BODY

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0066	I	1/1

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