19-2422; Rev 0; 4/02

Low-Cost, 230MHz, Single/Quad Op Amps with Rail-to-Rail Outputs and ±15kV ESD Protection

General Description

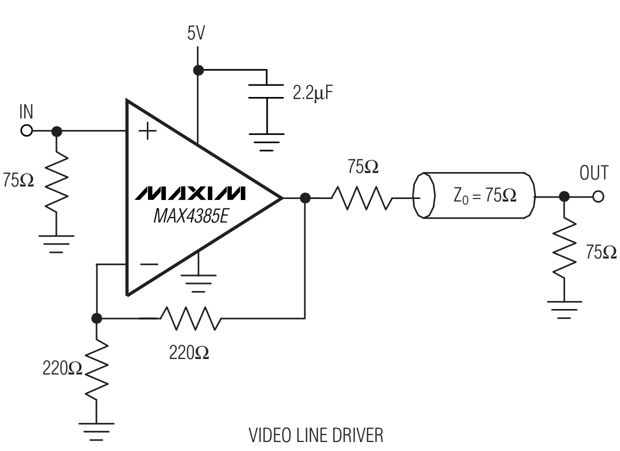
The MAX4385E/MAX4386E op amps are unity-gain stable devices that combine high-speed performance, Rail-to-Rail® outputs, and ±15kV ESD protection. Targeted for applications where an input or an output is exposed to the outside world, such as video and communications, these devices are compliant with International ESD Standards: ±15kV IEC 1000-4-2 Air-Gap Discharge, ±8kV IEC 1000-4-2 Contact Discharge, and the ±15kV Human Body Model.

The MAX4385E/MAX4386E operate from a single 5V supply with a common-mode input voltage range that extends beyond V_{EE}. The MAX4385E/MAX4386E consume only 5.5mA of quiescent supply current per amplifier while achieving a 230MHz -3dB bandwidth, 30MHz 0.1dB gain flatness and a 450V/µs slew rate.

Applications

- Set-Top Boxes
- Surveillance Video Systems
- Battery-Powered Instruments
- Analog-to-Digital Converter Interface
- CCD Imaging Systems
- Video Routing and Switching Systems
- Digital Cameras
- Video-on-Demand
- Video Line Driver

Typical Operating Circuit



Rail-to-Rail is a registered trademark of Nippon Motorola, Ltd.

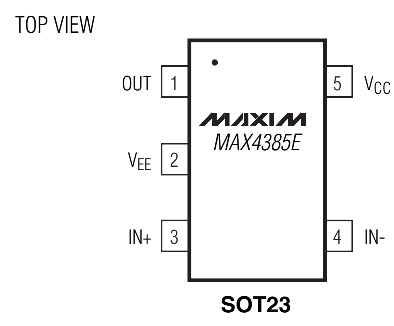
Features

- ♦ **ESD-Protected Inputs and Outputs**
  - **±15kV—Human Body Model**
  - **±8kV—IEC 1000-4-2 Contact Discharge**
  - **±15kV—IEC 1000-4-2 Air-Gap Discharge**
- ♦ **Low Cost and High Speed**
  - **230MHz -3dB Bandwidth**
  - **30MHz 0.1dB Gain Flatness**
  - **450V/µs Slew Rate**
- ♦ **Rail-to-Rail Outputs**
- ♦ **Input Common-Mode Range Extends Beyond V_{EE}**
- ♦ **Low Differential Gain/Phase: 0.02%/0.01°**
- ♦ **Low Distortion at 5MHz**
  - **-60dBc SFDR**
  - **-58dB Total Harmonic Distortion**
- ♦ **Ultra-Small 5-Pin SOT23 and 14-Pin TSSOP Packages**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX4385EEUK-T	-40°C to +85°C	5 SOT23-5	ADZL
MAX4386EESD	-40°C to +85°C	14 SO	—
MAX4386EEUD	-40°C to +85°C	14 TSSOP	—

Pin Configurations



Pin Configurations continued at end of data sheet.

ABSOLUTE MAXIMUM RATINGS

Power-Supply Voltage (V_{CC} to V_{EE}) ....-0.3V to +6V
IN_+, IN_-, OUT_, ...(V_{EE} - 0.3V) to (V_{CC} + 0.3V)
Output Short-Circuit Duration to
V_{CC} or V_{EE} ....Continuous
Continuous Power Dissipation (T_A = +70°C)
5-Pin SOT23 (derate 8.7mW/°C above +70°C)...........696mW
14-Pin SO (derate 8.33mW/°C above +70°C).............667mW
14-Pin TSSOP (derate 10mW/°C above +70°C) 727mW
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 at 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.

DC ELECTRICAL CHARACTERISTICS

(V_{CC} = 5V, V_{EE} = 0, V_{CM} = V_{CC}/2, V_{OUT} = V_{CC}/2, R_L = ∞ to V_{CC}/2, C_{BYPASS} = 2.2µF, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input Common-Mode Voltage Range	V_{CM}	Guaranteed by CMRR		V_{EE} - 0.2		V_{CC} - 2.25	V
Input Offset Voltage	V_{OS}	T_A = +25°C			0.2	20	mV
		T_A = -40°C to +85°C				28	
Input Offset Voltage Matching		MAX4386E			1		mV
Input Offset Voltage Tempco	TC_{VOS}				8		µV/°C
Input Bias Current	I_B				6.5	20	µA
Input Offset Current	I_{OS}				0.5	7	µA
Input Resistance	R_{IN}	Differential mode (-1V ≤ V_{IN} ≤ +1V)			70		kΩ
		Common mode (-0.2V ≤ V_{CM} ≤ +2.75V)			3		MΩ
Common-Mode Rejection Ratio	CMRR	V_{EE} - 0.2V ≤ V_{CM} ≤ V_{CC} - 2.25V		70	95		dB
Open-Loop Gain	A_{VOL}	0.25V ≤ V_{OUT} ≤ 4.75V, R_L = 2kΩ		50	61		dB
		0.8V ≤ V_{OUT} ≤ 4.5V, R_L = 150Ω		48	63		
		1V ≤ V_{OUT} ≤ 4V, R_L = 50Ω			58		
Output Voltage Swing	V_{OUT}	R_L = 2kΩ	V_{CC} - V_{OH}		0.05	0.270	V
			V_{OL} - V_{EE}		0.05	0.150	
		R_L = 150Ω	V_{CC} - V_{OH}		0.3	0.5	
			V_{OL} - V_{EE}		0.25	0.8	
		R_L = 75Ω	V_{CC} - V_{OH}		0.5	0.8	
			V_{OL} - V_{EE}		0.5	1.75	
		R_L = 75Ω to ground	V_{CC} - V_{OH}		1	1.7	
			V_{OL} - V_{EE}		0.025	0.125	
Output Current	I_{OUT}	Sinking from R_L = 50Ω to V_{CC}		40	55		mA
		Sourcing into R_L = 50Ω to V_{EE}		25	50		
Output Short-Circuit Current	I_{SC}	Sinking or sourcing			±100		mA
Open-Loop Output Resistance	R_{OUT}				8		Ω
Power-Supply Rejection Ratio	PSRR	V_S = 4.5V to 5.5V		50	62		dB

DC ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = 5V, V_{EE} = 0, V_{CM} = $V_{CC}/2$, V_{OUT} = $V_{CC}/2$, R_L = ∞ to $V_{CC}/2$, C_{BYPASS} = 2.2µF, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Supply Voltage Range	V_S	Guaranteed by PSRR	4.5		5.5	V
Quiescent Supply Current (per Amplifier)	I_S			5.5	9	mA
ESD Protection Voltage (Note 2)		Human Body Model		±15		kV
		IEC 1000-4-2 Contact Discharge		±8		kV
		IEC 1000-4-2 Air-Gap Discharge		±15		kV

AC ELECTRICAL CHARACTERISTICS

(V_{CC} = 5V, V_{EE} = 0, V_{CM} = 1.5V, R_L = 100Ω to $V_{CC}/2$, V_{OUT} = $V_{CC}/2$, A_{VCL} = 1V/V, T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small-Signal -3dB Bandwidth	BW_{SS}	V_{OUT} = $100mV_{P-P}$		230		MHz
Large-Signal -3dB Bandwidth	BW_{LS}	V_{OUT} = $2V_{P-P}$		180		MHz
Small-Signal 0.1dB Gain Flatness	$BW_{0.1dBSS}$	V_{OUT} = $100mV_{P-P}$		33		MHz
Large-Signal 0.1dB Gain Flatness	$BW_{0.1dBLS}$	V_{OUT} = $2V_{P-P}$		30		MHz
Slew Rate	SR	V_{OUT} = 2V step		450		V/µs
Settling Time to 0.1%	t_S	V_{OUT} = 2V step		14		ns
Rise/Fall Time	t_R , t_F	V_{OUT} = $100mV_{P-P}$		4		ns
Spurious-Free Dynamic Range	SFDR	f_C = 5MHz, V_{OUT} = $2V_{P-P}$		-60		dBc
Harmonic Distortion	HD	f_C = 5MHz, V_{OUT} = $2V_{P-P}$; 2nd harmonic		-70		dBc
		3rd harmonic		-60		dBc
		total harmonic		-58		dBc
Two-Tone, Third-Order Intermodulation Distortion	IP3	f1 = 4.7MHz, f2 = 4.8MHz, V_{OUT} = $1V_{P-P}$		-60		dBc
Channel-to-Channel Isolation	CH_{ISO}	Specified at DC		-95		dB
Input 1dB Compression Point		f_C = 10MHz, A_{VCL} = 2V/V		13		dBm
Differential Phase Error	DP	NTSC, R_L = 150Ω		0.01		Degrees
Differential Gain Error	DG	NTSC, R_L = 150Ω		0.02		%
Input Noise-Voltage Density	e_n	f = 10kHz		11.5		$nV/\sqrt{Hz}$
Input Noise-Current Density	i_n	f = 10kHz		2		$pA/\sqrt{Hz}$
Input Capacitance	C_{IN}			8		pF
Output Impedance	Z_{OUT}	f = 10MHz		2.2		Ω

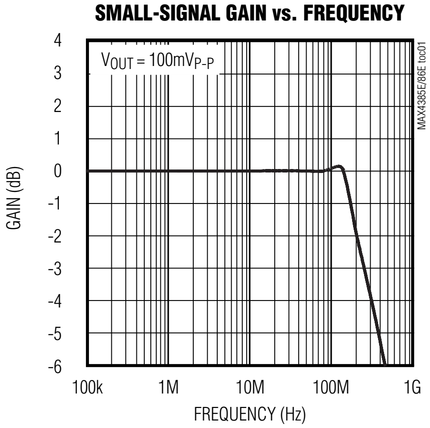
Note 1: All devices are 100% production tested at T_A = +25°C. Specifications over temperature limits are guaranteed by design.
Note 2: ESD protection is specified for test point A and test point B only (Figure 6).

Low-Cost, 230MHz, Single/Quad Op Amps with Rail-to-Rail Outputs and ±15kV ESD Protection

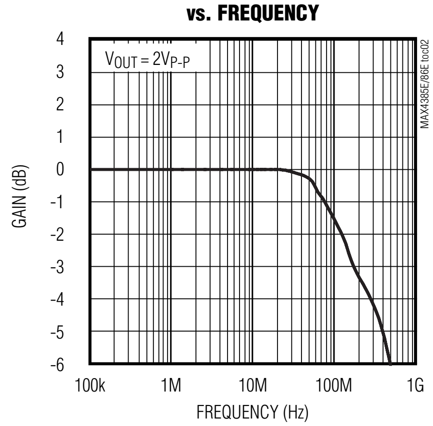
Typical Operating Characteristics

(V_{CC} = 5V, V_{EE} = 0, V_{CM} = 1.5V, A_{VCL} = 1V/V, R_L = 100Ω to V_{CC}/2, T_A = +25°C, unless otherwise noted.)

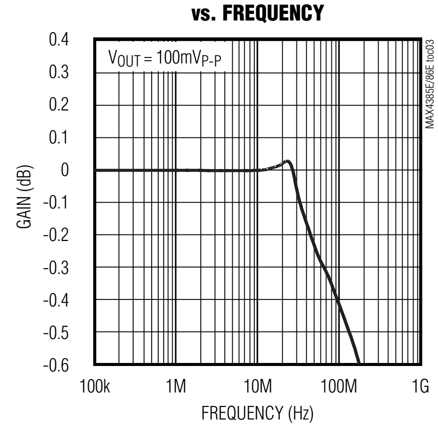
SMALL-SIGNAL GAIN vs. FREQUENCY



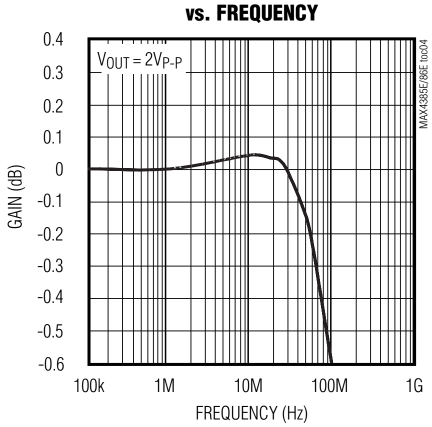
LARGE-SIGNAL GAIN vs. FREQUENCY



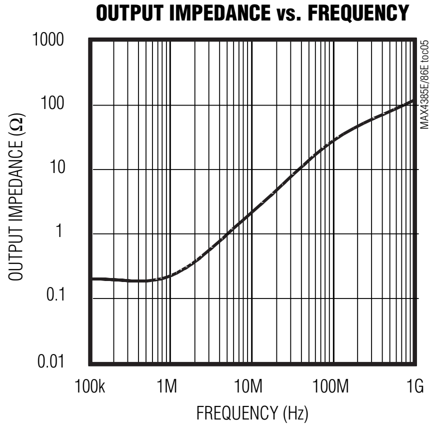
SMALL-SIGNAL GAIN FLATNESS vs. FREQUENCY



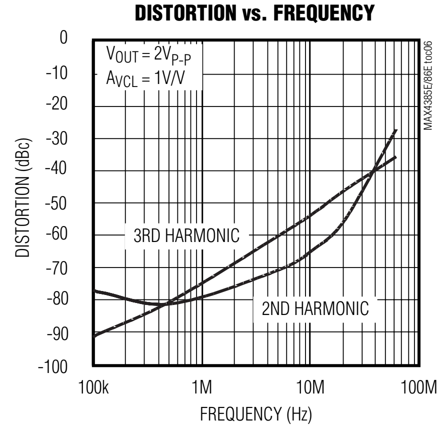
LARGE-SIGNAL GAIN FLATNESS vs. FREQUENCY



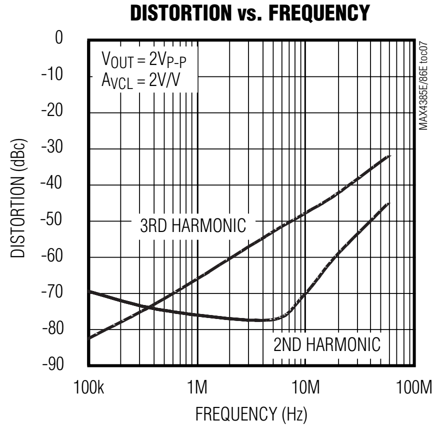
OUTPUT IMPEDANCE vs. FREQUENCY



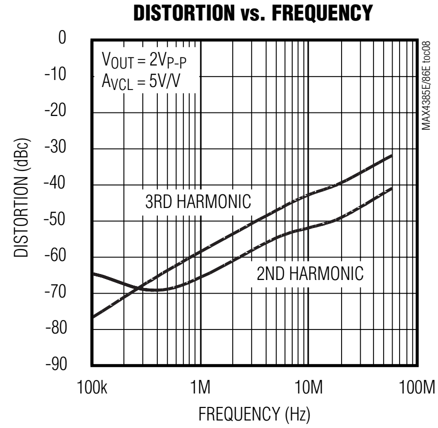
DISTORTION vs. FREQUENCY



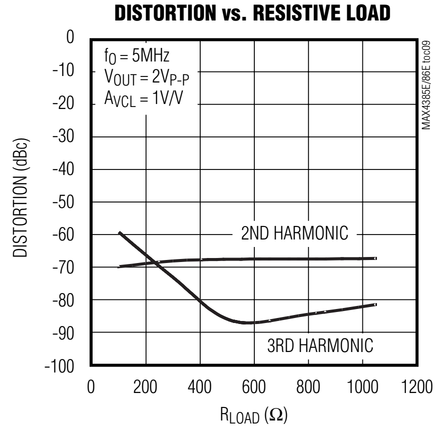
DISTORTION vs. FREQUENCY



DISTORTION vs. FREQUENCY



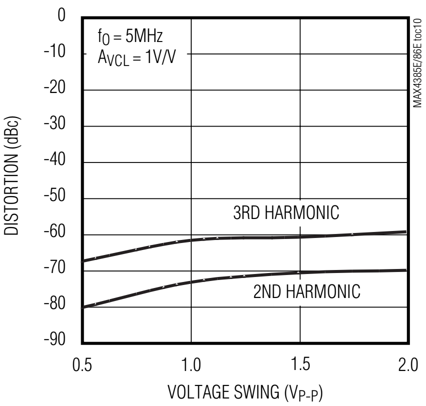
DISTORTION vs. RESISTIVE LOAD



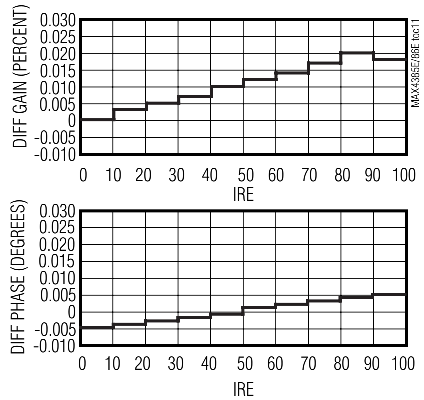
Typical Operating Characteristics (continued)

(V_{CC} = 5V, V_{EE} = 0, V_{CM} = 1.5V, A_{VCL} = 1V/V, R_L = 100Ω to V_{CC}/2, T_A = +25°C, unless otherwise noted.)

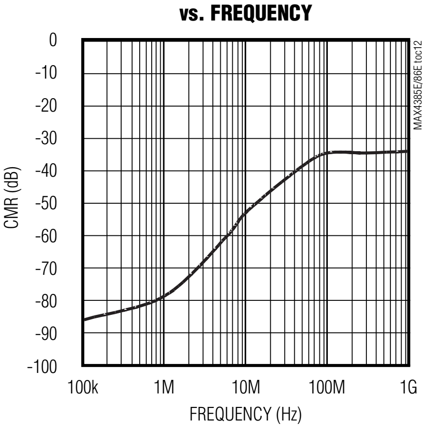
DISTORTION vs. VOLTAGE SWING



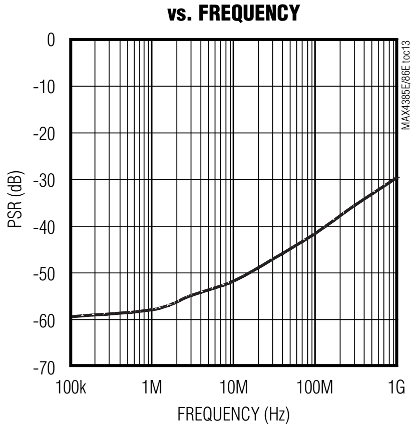
DIFFERENTIAL GAIN AND PHASE



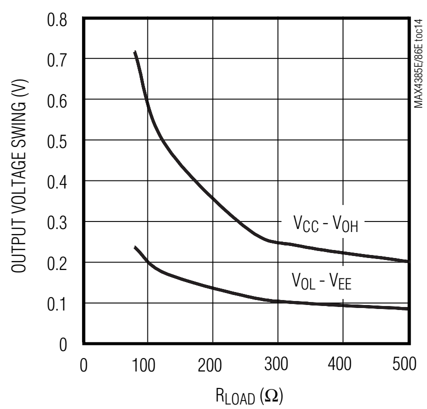
COMMON-MODE REJECTION vs. FREQUENCY



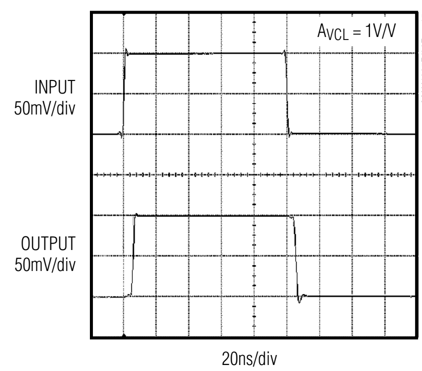
POWER-SUPPLY REJECTION vs. FREQUENCY



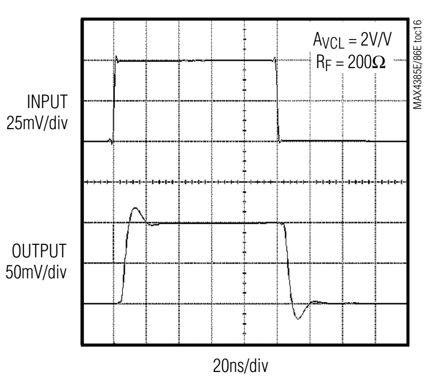
OUTPUT VOLTAGE SWING vs. RESISTIVE LOAD



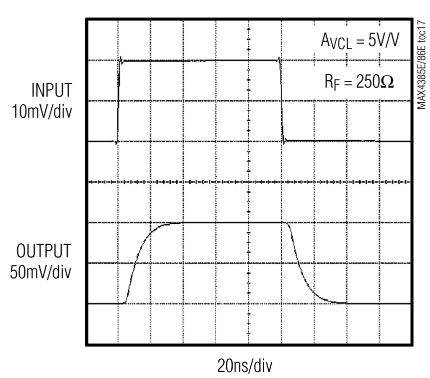
SMALL-SIGNAL PULSE RESPONSE



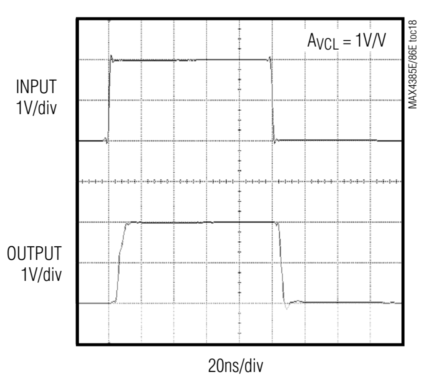
SMALL-SIGNAL PULSE RESPONSE



SMALL-SIGNAL PULSE RESPONSE



LARGE-SIGNAL PULSE RESPONSE

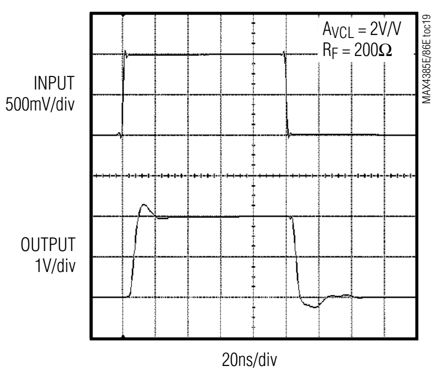


Low-Cost, 230MHz, Single/Quad Op Amps with Rail-to-Rail Outputs and ±15kV ESD Protection

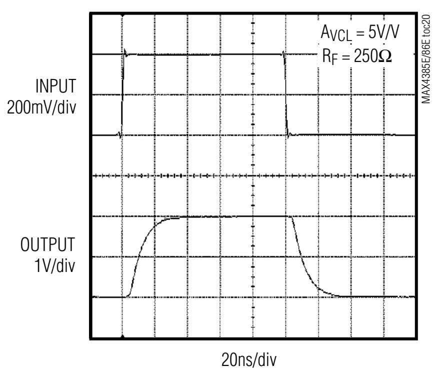
Typical Operating Characteristics (continued)

(V_{CC} = 5V, V_{EE} = 0, V_{CM} = 1.5V, A_{VCL} = 1V/V, R_L = 100Ω to $V_{CC}/2$, T_A = +25°C, unless otherwise noted.)

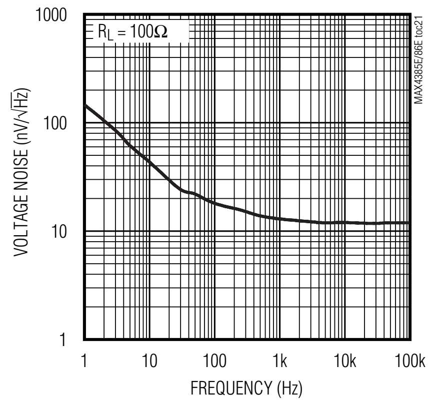
LARGE-SIGNAL PULSE RESPONSE



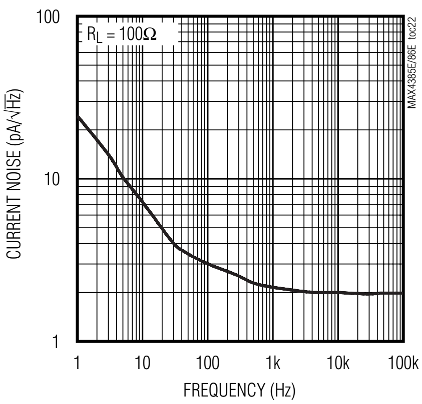
LARGE-SIGNAL PULSE RESPONSE



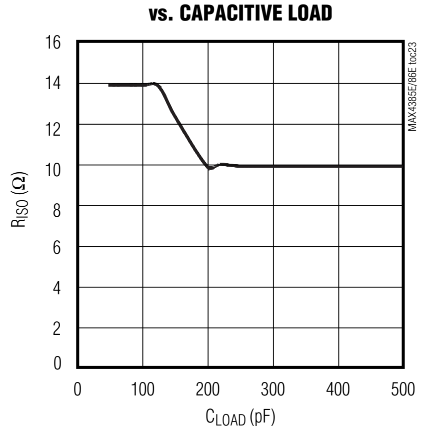
VOLTAGE NOISE vs. FREQUENCY



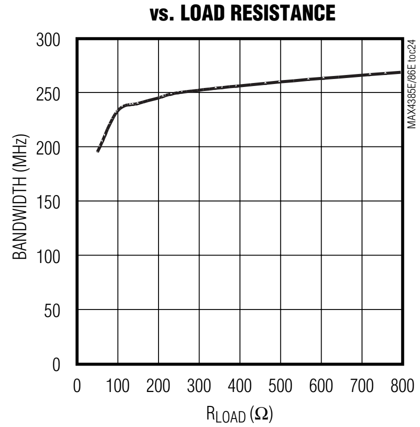
CURRENT NOISE vs. FREQUENCY



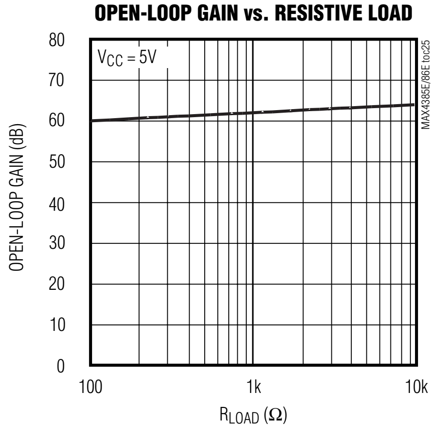
ISOLATION RESISTANCE vs. CAPACITIVE LOAD



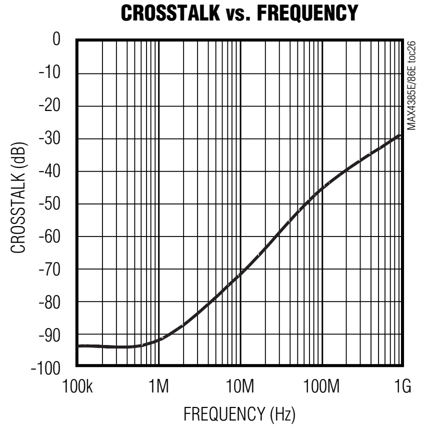
SMALL-SIGNAL BANDWIDTH vs. LOAD RESISTANCE



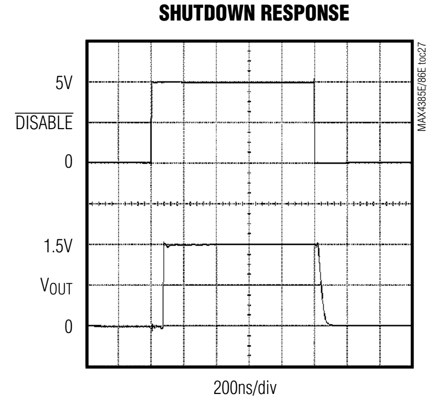
OPEN-LOOP GAIN vs. RESISTIVE LOAD



CROSSTALK vs. FREQUENCY

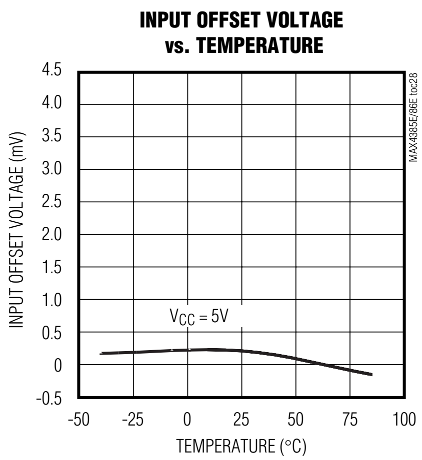


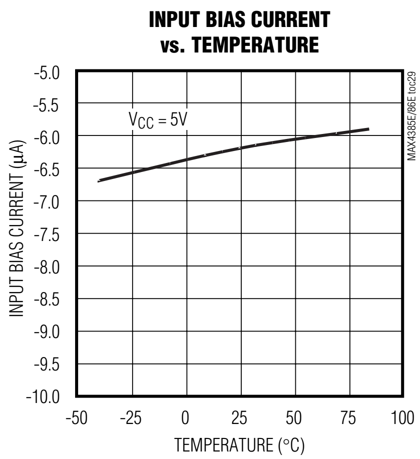
SHUTDOWN RESPONSE

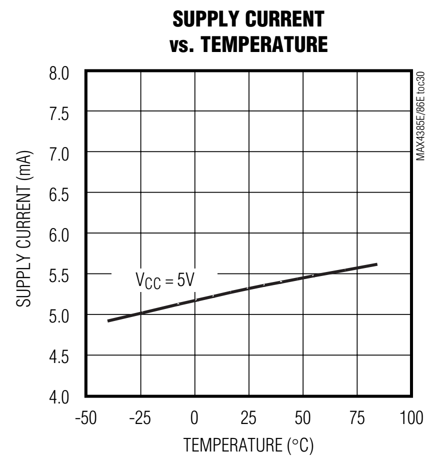


Typical Operating Characteristics (continued)

(V_{CC} = 5V, V_{EE} = 0, V_{CM} = 1.5V, A_{VCL} = 1V/V, R_L = 100Ω to V_{CC}/2, T_A = +25°C, unless otherwise noted.)







Pin Description

PIN		NAME	FUNCTION
MAX4385E	MAX4386E		
SOT23	SO/TSSOP		
1	—	OUT	Amplifier Output
2	11	V_{EE}	Negative Power Supply
3	—	IN+	Noninverting Input
4	—	IN-	Inverting Input
5	4	V_{CC}	Positive Power Supply. Connect a 2.2µF and 0.1µF capacitor to GND.
—	1	OUTA	Amplifier A Output
—	2	INA-	Amplifier A Inverting Input
—	3	INA+	Amplifier A Noninverting Input
—	5	INB+	Amplifier B Noninverting Input
—	6	INB-	Amplifier B Inverting Input
—	7	OUTB	Amplifier B Output
—	8	OUTC	Amplifier C Output
—	9	INC-	Amplifier C Inverting Input
—	10	INC+	Amplifier C Noninverting Input
—	12	IND+	Amplifier D Noninverting Input
—	13	IND-	Amplifier D Inverting Input
—	14	OUTD	Amplifier D Output

Detailed Description

The MAX4385E/MAX4386E are single/quad, 5V, rail-to-rail, voltage-feedback amplifiers that employ current-feedback techniques to achieve 450V/µs slew rates and 230MHz bandwidths. High ±15kV ESD protection guards against unexpected discharge. Excellent harmonic distortion and differential gain/phase performance make these amplifiers an ideal choice for a wide variety of video and RF signal-processing applications.

Applications Information

The output voltage swings to within 50mV of each supply rail. Local feedback around the output stage ensures low open-loop output impedance to reduce gain sensitivity to load variations. The input stage permits common-mode voltages beyond V_{EE} and to within 2.25V of the positive supply rail.

Choosing Resistor Values

Unity-Gain Configuration

The MAX4385E/MAX4386E are internally compensated for unity gain. When configured for unity gain, a 24Ω resistor (R_F) in series with the feedback path optimizes AC performance. This resistor improves AC response by reducing the Q of the parallel LC circuit formed by the parasitic feedback capacitance and inductance.

Video Line Driver

The MAX4385E/MAX4386E are low-power, voltage-feedback amplifiers featuring bandwidths up to 230MHz, 0.1dB gain flatness to 30MHz. They are designed to minimize differential-gain error and differential-phase error to 0.02% and 0.01°, respectively. They have a 14ns settling time to 0.1%, 450V/µs slew rates, and output-current-drive capability of up to 50mA, making them ideal for driving video loads.

Inverting and Noninverting Configurations

Select the gain-setting feedback (R_F) and input (R_G) resistor values to fit your application. Large resistor values increase voltage noise and interact with the amplifier's input and PC board capacitance. This can generate undesirable poles and zeros and decrease bandwidth or cause oscillations. For example, a noninverting gain-of-two configuration ($R_F = R_G$) using 1kΩ resistors, combined with 8pF of amplifier input capacitance and 1pF of PC board capacitance, causes a pole at 35.4MHz. Since this pole is within the amplifier bandwidth, it jeopardizes stability. Reducing the 1kΩ resistors to 100Ω extends the pole frequency to 353.8MHz, but could limit output swing by adding 200Ω in parallel with the amplifier's load resistor (Figures 1a and 1b).

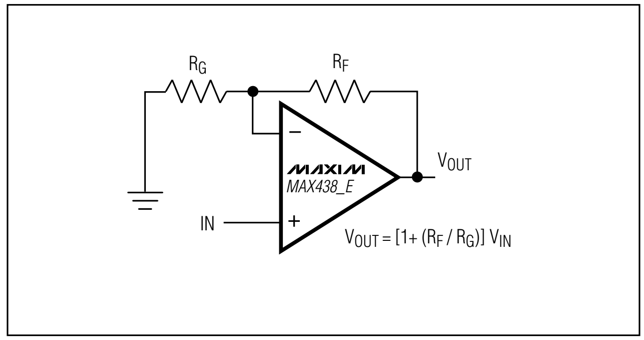


Figure 1a. Noninverting Gain Configuration

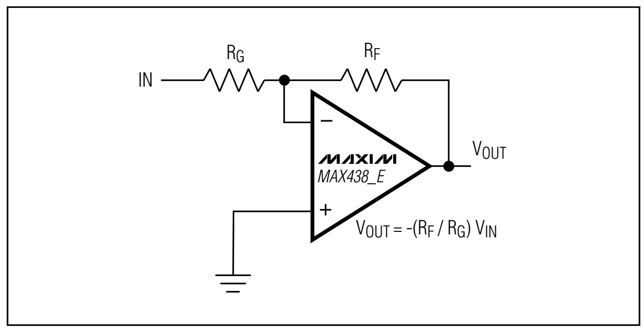


Figure 1b. Inverting Gain Configuration

Layout and Power-Supply Bypassing

These amplifiers operate from a single 5V power supply. Bypass V_{CC} to ground with 0.1µF and 2.2µF capacitors as close to the pin as possible.

Maxim recommends using microstrip and stripline techniques to obtain full bandwidth. To ensure that the PC board does not degrade the amplifier's performance, design it for a frequency greater than 1GHz. Pay careful attention to inputs and outputs to avoid large parasitic capacitance. Regardless of whether you use a constant-impedance board, observe the following design guidelines:

- Do not use wire-wrap boards; they are too inductive.
- Do not use IC sockets; they increase parasitic capacitance and inductance.
- Use surface mount instead of through-hole components for better high-frequency performance.
- Use a PC board with at least two layers; it should be as free from voids as possible.
- Keep signal lines as short and as straight as possible. Do not make 90° turns; round all corners.

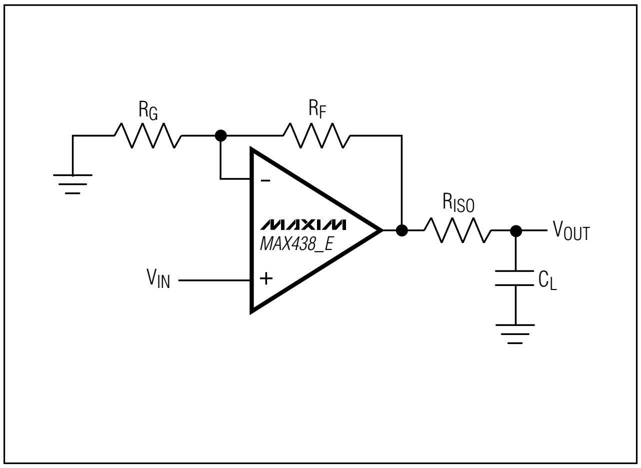


Figure 2. Driving a Capacitive Load Through an Isolation Resistor

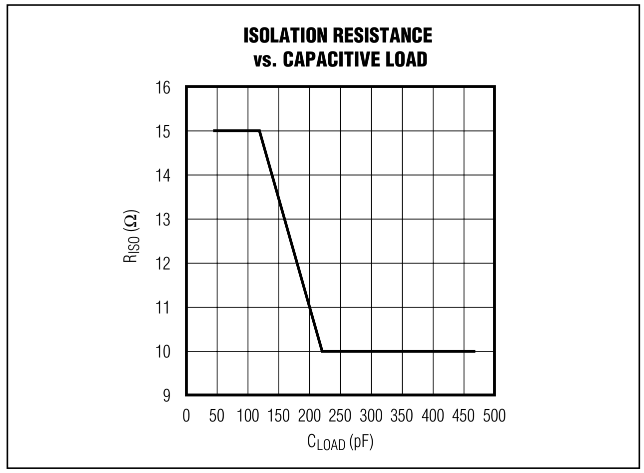


Figure 3. Isolation Resistance vs. Capacitive Load

Rail-to-Rail Outputs, Ground-Sensing Inputs

The input common-mode range extends from (V_{EE} - 200mV) to (V_{CC} - 2.25V) with excellent common-mode rejection. Beyond this range, the amplifier output is a nonlinear function of the input, but does not undergo phase reversal or latchup.

The output swings to within 50mV of either power-supply rail with a 2kΩ load. The input ground sensing and the rail-to-rail output substantially increase the dynamic range. The input can swing 2.95V_{P-P} and the output can swing 4.9V_{P-P} with minimal distortion.

Output Capacitive Loading and Stability

The MAX4385E/MAX4386E are optimized for AC performance and do not drive highly reactive loads, which decreases phase margin and may produce excessive ringing and oscillation. Figure 2 shows a circuit that eliminates this problem. Figure 3 is a graph of the Optimal Isolation Resistor (R_S) vs. Capacitive Load. Figure 4 shows how a capacitive load causes excessive peaking of the amplifier's frequency response if the capacitor is not isolated from the amplifier by a resistor. A small isolation resistor (usually 10Ω to 15Ω) placed before the reactive load prevents ringing and oscillation. At higher capacitive loads, the interaction of the load capacitance and the isolation resistor controls the AC performance. Figure 5 shows the effect of a 15Ω isolation resistor on closed-loop response.

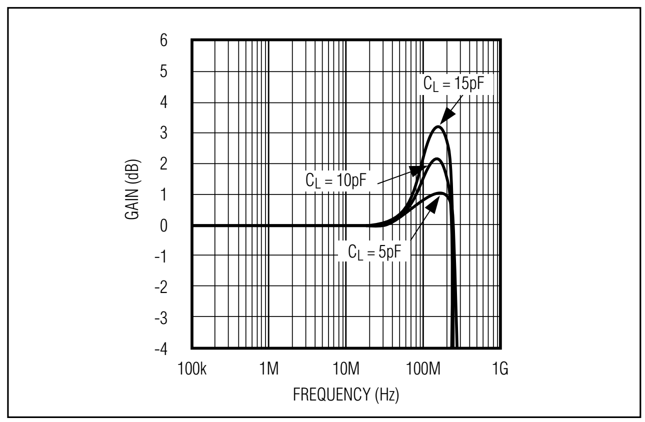


Figure 4. Small-Signal Gain vs. Frequency with Load Capacitance and No Isolation Resistor

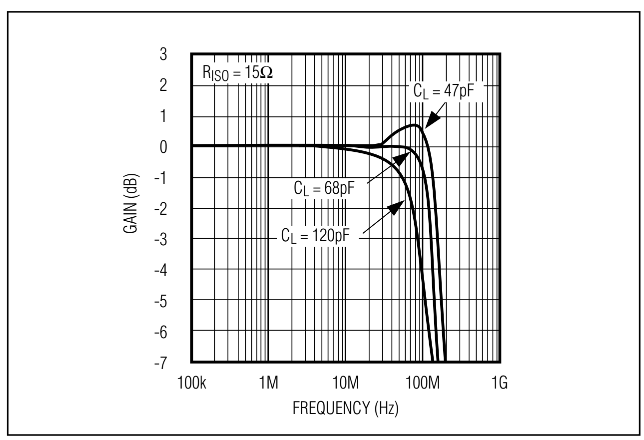


Figure 5. Small-Signal Gain vs. Frequency with Load Capacitance and 27Ω Isolation Resistor

ESD Protection

As with all Maxim devices, ESD protection structures are incorporated on all pins to protect against ESD encountered during handling and assembly. Input and output pins of the MAX4385E/MAX4386E have extra protection against static electricity. Maxim's engineers have developed state-of-the-art structures enabling these pins to withstand ESD up to ±15kV without damage when placed in the test circuit (Figure 6). The MAX4385E/MAX4386E are characterized for protection to the following limits:

- ±15kV using the Human Body Model
- ±8kV using the Contact Discharge method specified in IEC 1000-4-2
- ±15kV using the Air-Gap Discharge method specified in IEC 1000-4-2

Human Body Model

Figure 7 shows the Human Body Model, and Figure 8 shows the current waveform it generates when discharged into a low impedance. This model consists of a 150pF capacitor charged to the ESD voltage of interest, and then discharged into the test device through a 1.5kΩ resistor.

IEC 1000-4-2

The IEC 1000-4-2 standard covers ESD testing and performance of finished equipment; it does not specifically refer to ICs. The MAX4385E/MAX4386E enable the design of equipment that meets the highest level (Level 4) of IEC 1000-4-2 without the need for additional ESD protection components. The major difference between tests done using the Human Body Model and IEC 1000-4-2 is higher peak current in IEC 1000-4-2. Because series resistance is lower in the IEC 1000-4-2 model, the ESD-withstand voltage measured to this standard is generally lower than that measured using the Human Body. Figure 10 shows the IEC 1000-4-2 model and Figure 9 shows the current waveform for the ±8kV IEC 1000-4-2 Level 4 ESD Contact Discharge test. The Air-Gap test involves approaching the device with a charged probe. The Contact Discharge method connects the probe to the device before the probe is energized.

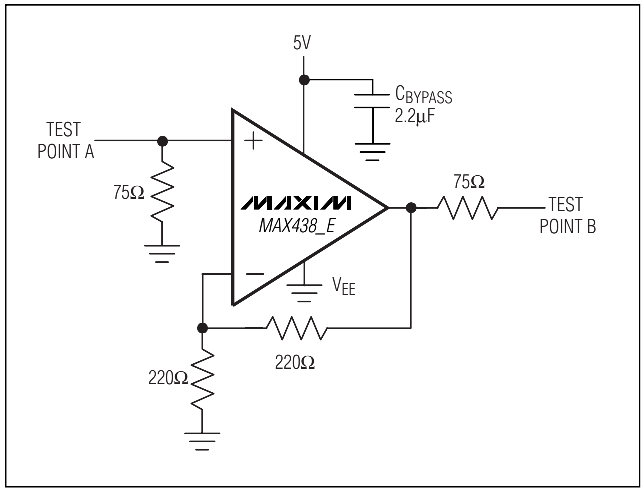


Figure 6. ESD Test Circuit

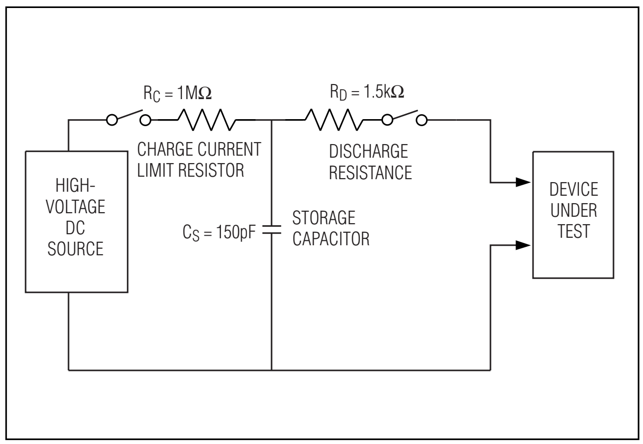


Figure 7. Human Body ESD Model

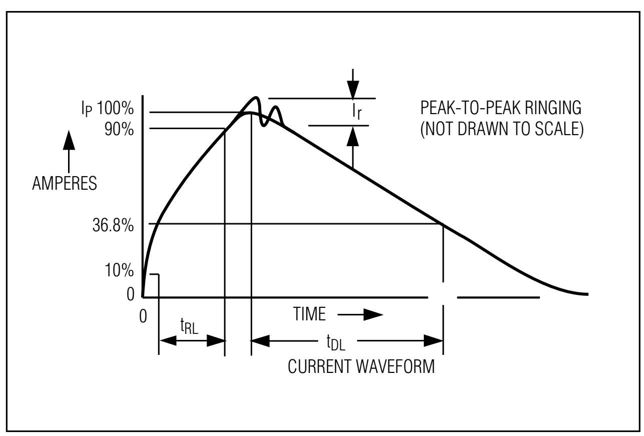


Figure 8. Human Body Current Waveform

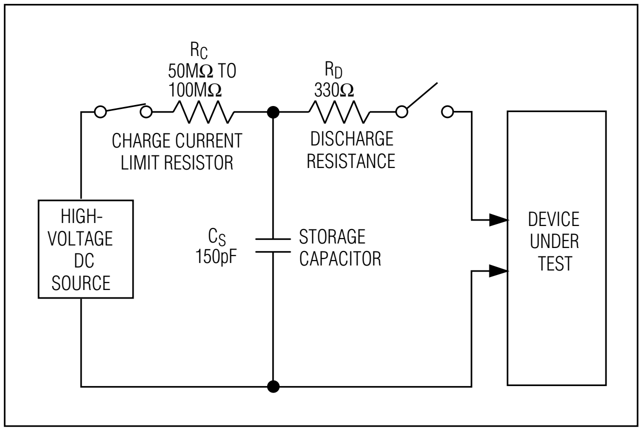


Figure 9. IEC 1000-4-2 ESD Test Model

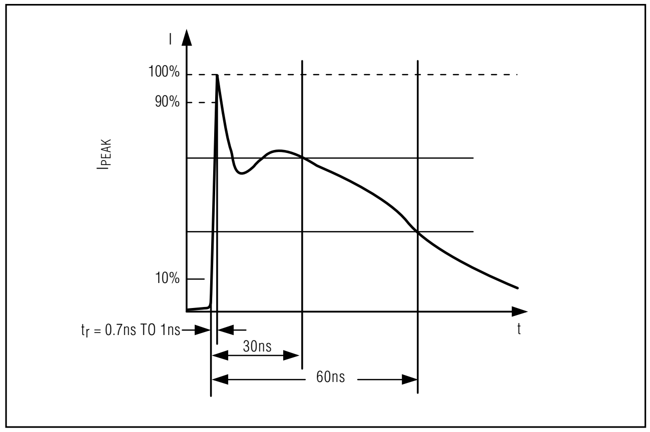
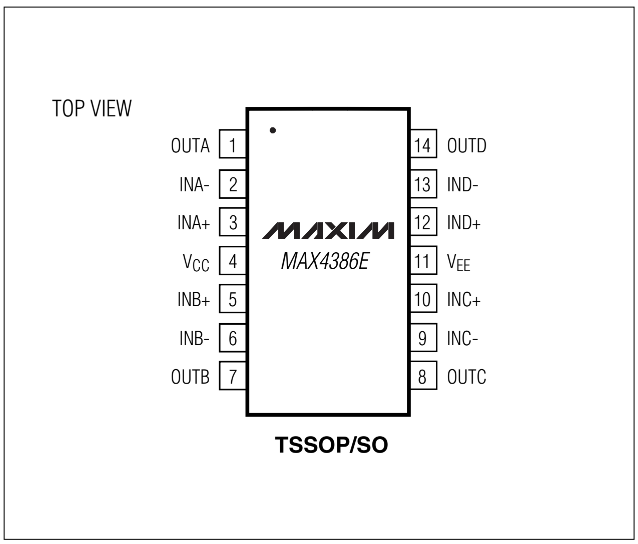


Figure 10. IEC 1000-4-2 ESD Generator Current Waveform

Pin Configurations (continued)



Chip Information

MAX4385E TRANSISTOR COUNT: 124

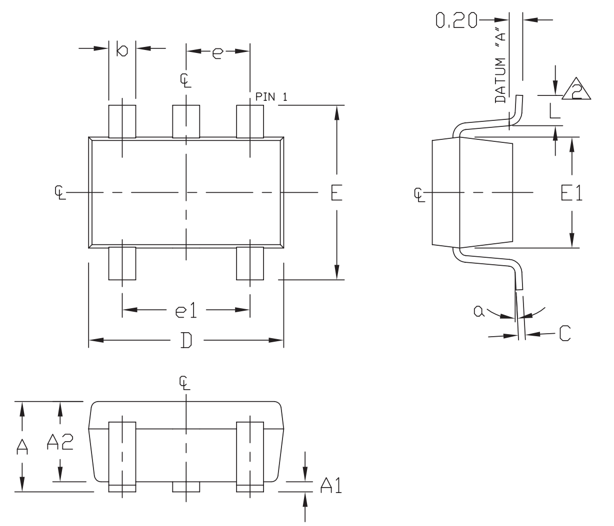
MAX4386E TRANSISTOR COUNT: 264

Low-Cost, 230MHz, Single/Quad Op Amps with Rail-to-Rail Outputs and ±15kV ESD Protection

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**.)

SOT5L.EPS

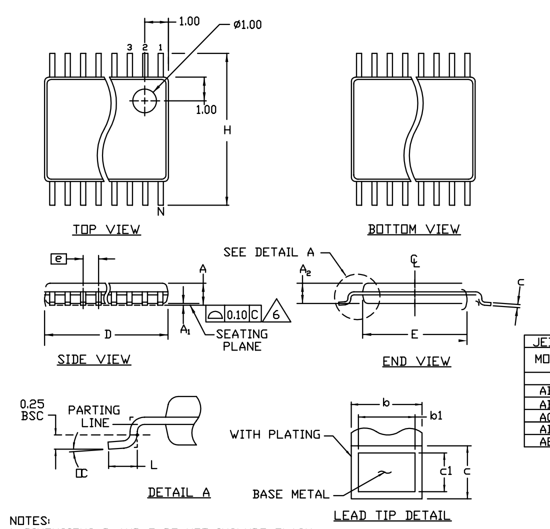


SYMBOL	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.35	0.50
C	0.08	0.20
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.75
L	0.35	0.55
e	0.95 REF	
e1	1.90 REF	
a	0°	10°

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.
4. PACKAGE OUTLINE INCLUSIVE OF SOLDER PLATING.
5. MEETS JEDEC MO178.

MAXIM
PROPRIETARY INFORMATION
TITLE: PACKAGE OUTLINE, SOT-23, 5L
APPROVAL | DOCUMENT CONTROL NO. 21-0057 | REV C | 1/1

TSSOP,NO PADS.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
b1	0.19	0.25	.007	.010
c	0.090	0.20	.0035	.008
c1	0.090	0.135	.0035	.0053
D	SEE VARIATIONS		SEE VARIATIONS	
E	4.30	4.50	.169	.177
e	0.65 BSC		.026 BSC	
H	6.25	6.50	.246	.256
L	0.50	0.70	.020	.028
N	SEE VARIATIONS		SEE VARIATIONS	
α	0°	8°	0°	8°

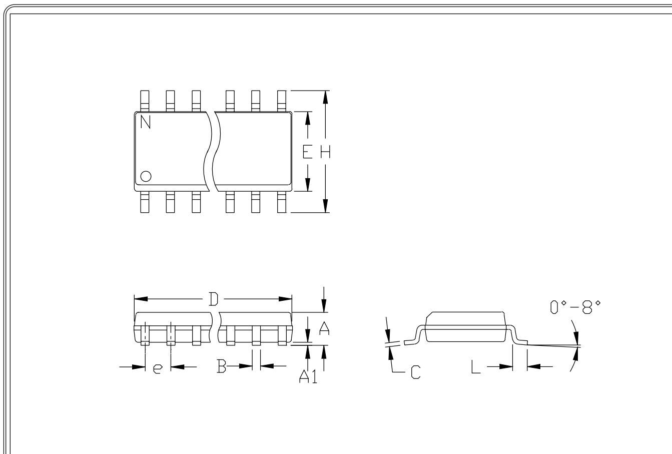
JEDEC			VARIATIONS			
MO-153	N		MILLIMETERS		INCHES	
			MIN.	MAX.	MIN.	MAX.
AB-1	14	D	4.90	5.10	.193	.201
AB	16	D	4.90	5.10	.193	.201
AC	20	D	6.40	6.60	.252	.260
AD	24	D	7.70	7.90	.303	.311
AE	28	D	9.60	9.80	.378	.386

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. THE LEAD TIPS MUST LIE WITHIN A SPECIFIED ZONE. THIS TOLERANCE ZONE IS DEFINED BY TWO PARALLEL PLANES. ONE PLANE IS THE SEATING PLANE, DATUM [-C-]; THE OTHER PLANE IS AT THE SPECIFIED DISTANCE FROM [-C-] IN THE DIRECTION INDICATED.

MAXIM
PROPRIETARY INFORMATION
TITLE: PACKAGE OUTLINE, TSSOP, 4.40 MM BODY
APPROVAL | DOCUMENT CONTROL NO. 21-0066 | REV E | 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**.)



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
e	0.050		1.27	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
h	0.010	0.020	0.25	0.50
L	0.016	0.050	0.40	1.27

	INCHES		MILLIMETERS			
	MIN	MAX	MIN	MAX	N	MS012
D	0.189	0.197	4.80	5.00	8	A
D	0.337	0.344	8.55	8.75	14	B
D	0.386	0.394	9.80	10.00	16	C

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. LEADS TO BE COPLANAR WITHIN .102mm (.004")
4. CONTROLLING DIMENSION: MILLIMETER
5. MEETS JEDEC MS012-XX AS SHOWN IN ABOVE TABLE
6. N = NUMBER OF PINS

MAXIM 120 SAN GABRIEL DR. SUNNYVALE CA 94086 FAX (408) 737 7194 PROPRIETARY INFORMATION | TITLE: PACKAGE FAMILY OUTLINE: SOIC .150" | 1/1 | DOCUMENT CONTROL NUMBER: 21-0041 REV: A

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