



SC70, Low-Power, General-Purpose, Dual-Supply, Rail-to-Rail Op Amps

General Description

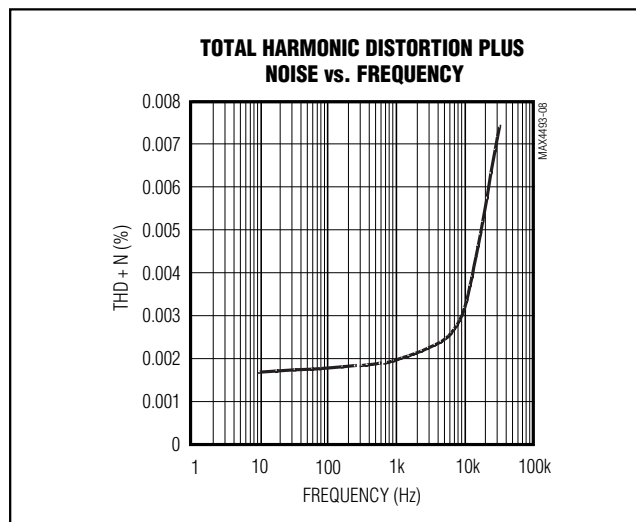
The MAX4493/MAX4494/MAX4495 single/dual/quad general-purpose operational amplifiers are designed for use in systems powered with dual supplies from $\pm 2.25\text{V}$ to $\pm 5.5\text{V}$. These op amps provide a unity-gain bandwidth of 5MHz with only 770 μA of quiescent current per amplifier. The wide input common-mode range extends from 200mV beyond the negative rail to within 1.5V of the positive supply rail while the output swings within 10mV ($R_L = 100\text{k}\Omega$) of either rail.

These amplifiers have excellent (110dB) open-loop gain with very low THD+N of 0.002% ($f = 1\text{kHz}$). The single MAX4493 is available in a tiny 5-pin SC70 package and the dual MAX4494 is available in the space-saving 8-pin SOT23. The quad MAX4495 is available in both 14-pin TSSOP and 14-pin SO packages. All products are rated at the automotive temperature range of -40°C to $+125^\circ\text{C}$.

Applications

Battery-Powered Systems
DAC Output Amplifiers
Industrial Control Systems
Voltage Reference Generators
Signal Conditioning

Typical Operating Characteristic



Typical Operating Circuit appears at end of data sheet.

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

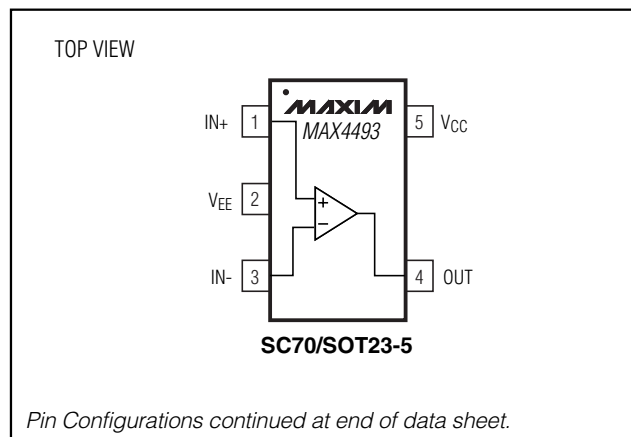
Features

- ◆ 770 μA Supply Current per Amplifier
- ◆ Operates from Dual $\pm 2.25\text{V}$ to $\pm 5.5\text{V}$ Supplies
- ◆ 5MHz Gain-Bandwidth Product
- ◆ Rail-to-Rail® Output Swing
- ◆ Input Voltage Range Extends 200mV Below the Negative Rail
- ◆ 110dB Open-Loop Gain ($R_L = 100\text{k}\Omega$)
- ◆ Low THD+N of 0.002% ($f = 1\text{kHz}$)
- ◆ No Phase Reversal for Overdriven Inputs
- ◆ Unity-Gain Stable
- ◆ Available in Space-Saving Packages
 - 5-Pin SC70 (MAX4493)
 - 8-Pin SOT23 (MAX4494)
 - 14-Pin TSSOP (MAX4495)

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE	TOP MARK
MAX4493AXK-T	-40°C to $+125^\circ\text{C}$	5 SC70-5	ABR
MAX4493AUK-T	-40°C to $+125^\circ\text{C}$	5 SOT23-5	ADPG
MAX4494AKA-T	-40°C to $+125^\circ\text{C}$	8 SOT23-8	AAEM
MAX4494AUA	-40°C to $+125^\circ\text{C}$	8 μMAX	—
MAX4494ASA	-40°C to $+125^\circ\text{C}$	8 SO	—
MAX4495AUD	-40°C to $+125^\circ\text{C}$	14 TSSOP	—
MAX4495ASD	-40°C to $+125^\circ\text{C}$	14 SO	—

Pin Configurations



SC70, Low-Power, General-Purpose, Dual-Supply, Rail-to-Rail Op Amps

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{CC} to V_{EE}).....+12V
 Voltage from Any Pin to Ground or
 Any Other Pin.....($V_{EE} - 0.3V$) to ($V_{CC} + 0.3V$)
 Output Short-Circuit Duration to
 V_{CC} , V_{EE} , or GroundContinuous
 Continuous Power Dissipation ($T_A = +70^\circ\text{C}$)
 5-Pin SC70 (derate 3.1mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$).....247mW
 5-Pin SOT23 (derate 7.1mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$).....571mW

8-Pin SOT23 (derate 9.1mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$).....727mW
 8-Pin μMAX (derate 4.5mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$)362mW
 8-Pin SO (derate 5.9mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$).....471mW
 14-Pin TSSOP (derate 9.1mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$)727mW
 14-Pin SO (derate 8.3mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$).....667mW
 Operating Temperature Range -40°C to $+125^\circ\text{C}$
 Storage Temperature Range -65°C to $+150^\circ\text{C}$
 Lead Temperature (soldering, 10s) $+300^\circ\text{C}$

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.

DC ELECTRICAL CHARACTERISTICS

($V_{CC} = +5V$, $V_{EE} = -5V$, $R_L = 100k\Omega$ to ground, $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$. Typical values are at $T_A = +25^\circ\text{C}$, unless otherwise noted.)
 (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Supply Voltage Range	V_S	Guaranteed by PSRR test	± 2.25		± 5.5	V
Quiescent Supply Current per Amplifier	I_S			770	1100	μA
Input Offset Voltage	V_{OS}	$T_A = +25^\circ\text{C}$		0.3	5	mV
		$T_A = T_{MIN}$ to T_{MAX}			10	
Input Offset Voltage Drift	TCV_{OS}			3		$\mu\text{V}/^\circ\text{C}$
Input Offset Voltage Channel Matching		MAX4494 and MAX4495		1		mV
Input Bias Current	I_B			0.2	1	μA
Input Offset Current	I_{OS}			5	300	nA
Input Resistance	R_{IN}	Differential mode ($-1V \leq V_{IN} \leq +1V$)		250		$k\Omega$
		Common mode ($V_{EE} - 0.2V \leq V_{CM} \leq V_{CC} - 1.5V$)		110		$M\Omega$
Common-Mode Input Voltage Range	V_{CM}	Guaranteed by CMRR test	$V_{EE} - 0.2V$		$V_{CC} - 1.5V$	V
Common-Mode Rejection Ratio	CMRR	$V_{EE} - 0.2V \leq V_{CM} \leq V_{CC} - 1.5V$	65	90		dB
Power-Supply Rejection Ratio	PSRR	$V_S = \pm 2.25V$ to $\pm 5.5V$	65	80		dB
Large-Signal Voltage Gain	A_{VOL}	$R_L = 100k\Omega$, $V_{EE} + 0.25V \leq V_{OUT} \leq V_{CC} - 0.25V$	85	110		dB
		$R_L = 1k\Omega$, $V_{EE} + 0.5V \leq V_{OUT} \leq V_{CC} - 0.5V$	65	90		
Output Voltage Swing	V_{OUT}	$R_L = 100k\Omega$, $V_{CC} - V_{OH}$ and $V_{OL} - V_{EE}$		10	150	mV
		$R_L = 1k\Omega$, $V_{CC} - V_{OH}$ and $V_{OL} - V_{EE}$		200	450	
Output Short-Circuit Current	I_{SC}	Sourcing or sinking		15		mA

Note 1: All devices are 100% production tested at $T_A = +25^\circ\text{C}$. Limits over the operating temperature range are guaranteed by design and not production tested.

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MAX4493/MAX4494/MAX4495

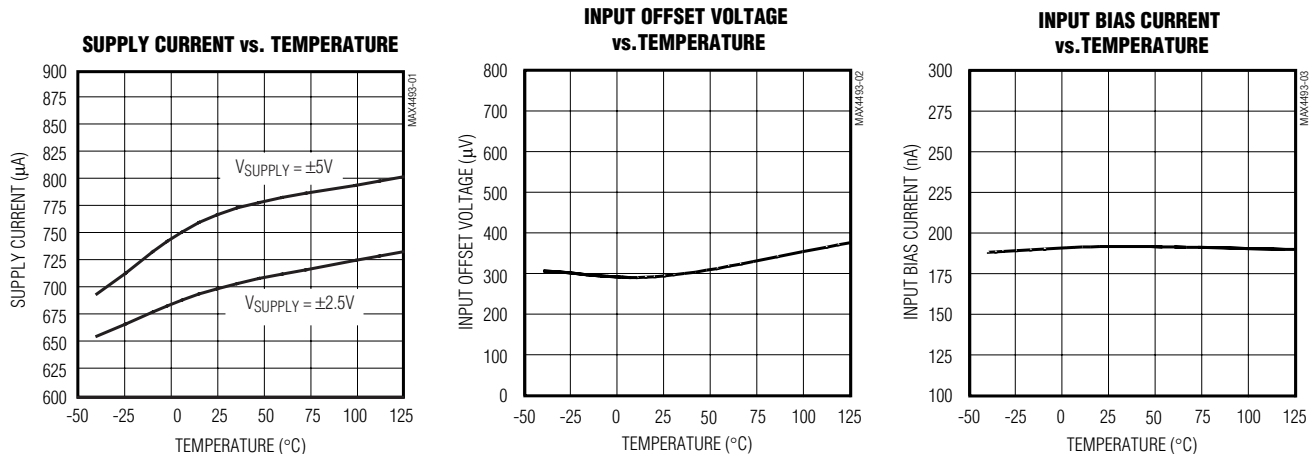
AC ELECTRICAL CHARACTERISTICS

($V_{CC} = +5V$, $V_{EE} = -5V$, $R_L = 100k\Omega$ to ground, $C_L = 15pF$, $T_A = +25^\circ C$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Gain-Bandwidth Product	GBWP			5		MHz
Full-Power Bandwidth	FPBW	$V_{OUT} = 5V_{p-p}$		190		kHz
Slew Rate	SR	$V_{OUT} = 5V_{p-p}$		3		V/ μs
Phase Margin				75		degrees
Gain Margin				15		dB
Total Harmonic Distortion Plus Noise	THD+N	$f = 1kHz$, $V_{OUT} = 5V_{p-p}$, $A_V = +1V/V$		0.002		%
Settling Time to 0.01%	t_S	$A_V = +1V/V$, $V_{OUT} = 5V$ step		4		μs
Input Capacitance	C_{IN}			2		pF
Input Noise Voltage Density	e_{IN}	$f = 1kHz$		8		$nV/\sqrt{Hz}$
Input Noise Current Density	i_{IN}	$f = 1kHz$		0.2		$pA/\sqrt{Hz}$
All-Hostile Crosstalk		$f = 1kHz$, MAX4494 and MAX4495		-100		dB
Capacitive-Load Stability		$A_V = +1V/V$, no sustained oscillations		300		pF
Power-Up Time	t_{ON}	$V_{OUT} = 1V$, $1\mu s$ power supply rise-time		3		μs

Typical Operating Characteristics

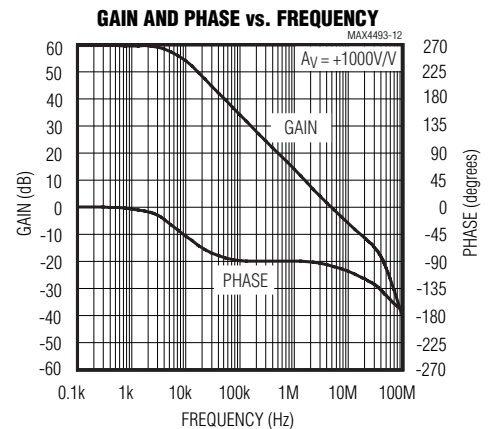
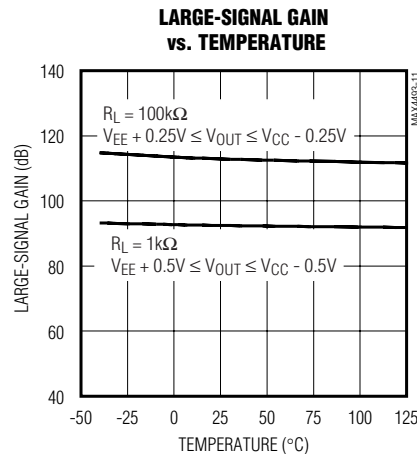
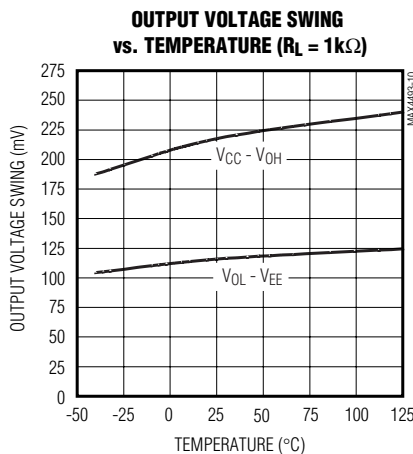
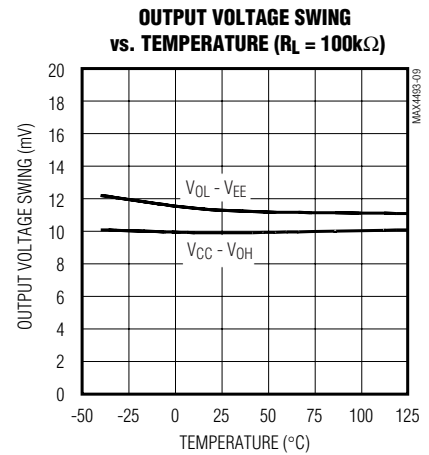
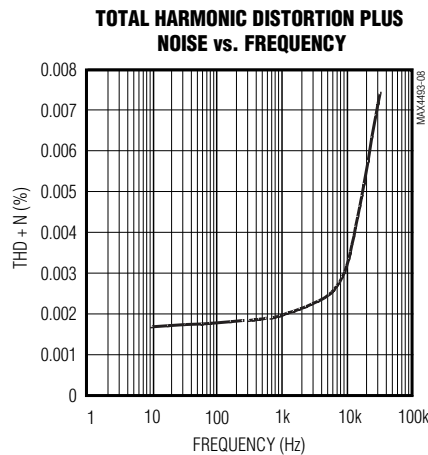
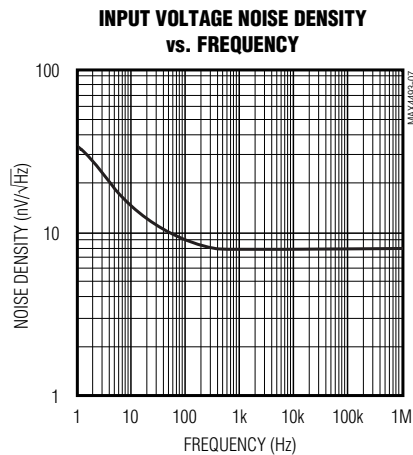
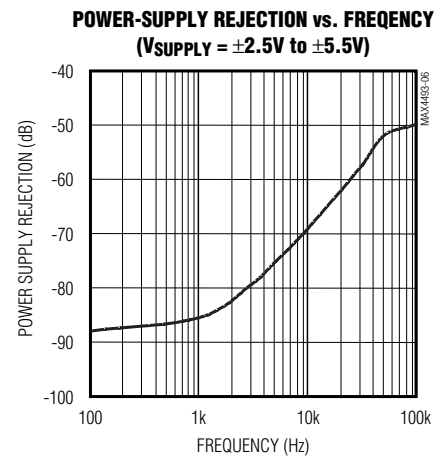
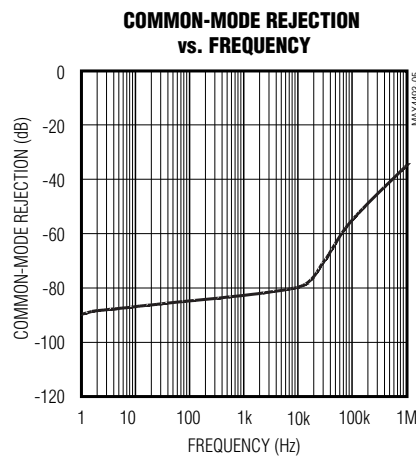
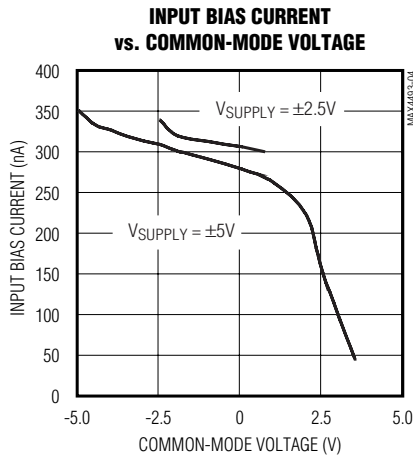
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Typical Operating Characteristics (continued)

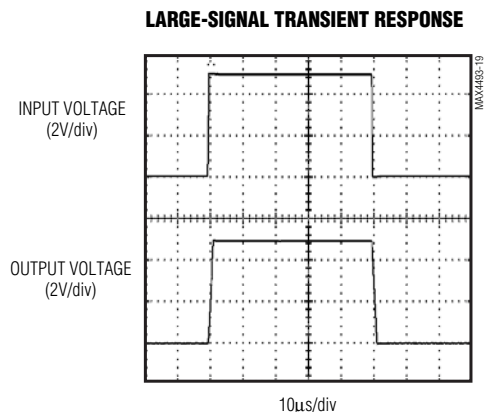
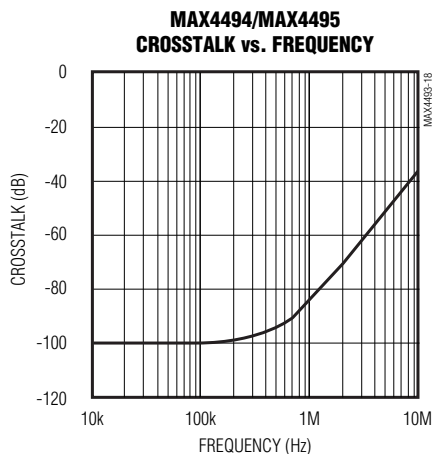
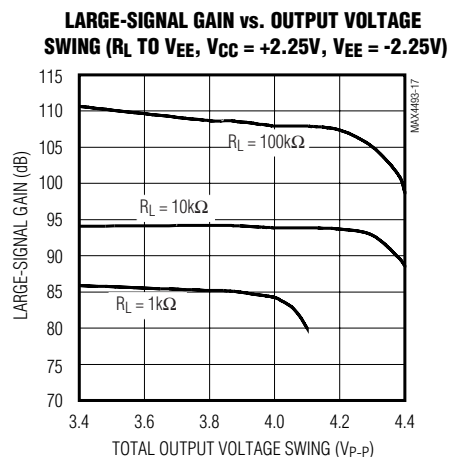
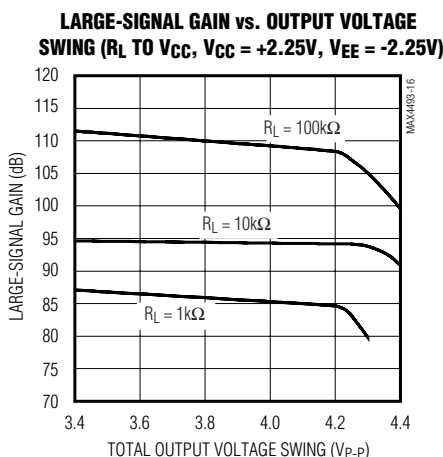
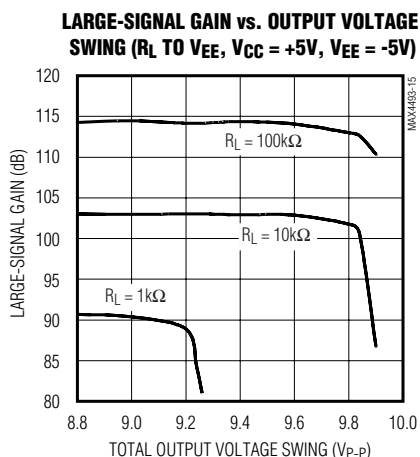
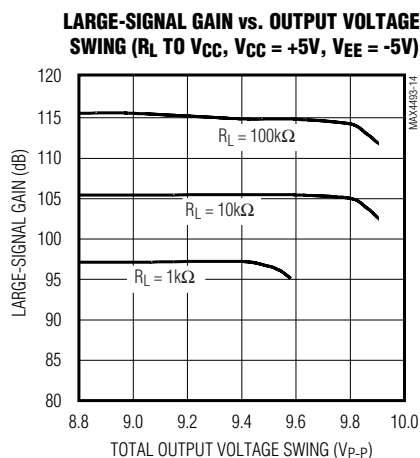
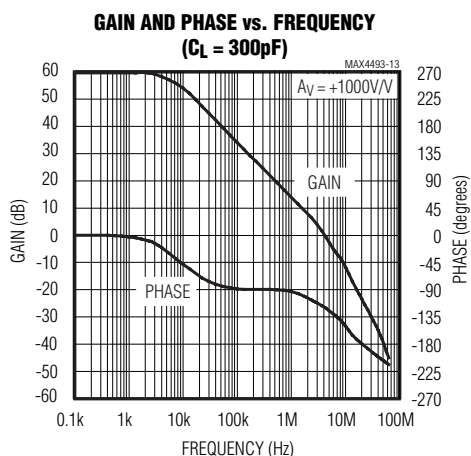
($V_{CC} = +5V$, $V_{EE} = -5V$, $V_{CM} = 0$, $R_L = 100k\Omega$ to ground, $C_L = 15pF$, $T_A = +25^\circ C$, unless otherwise noted.)



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Typical Operating Characteristics (continued)

($V_{CC} = +5V$, $V_{EE} = -5V$, $V_{CM} = 0$, $R_L = 100k\Omega$ to ground, $C_L = 15pF$, $T_A = +25^\circ C$, unless otherwise noted.)

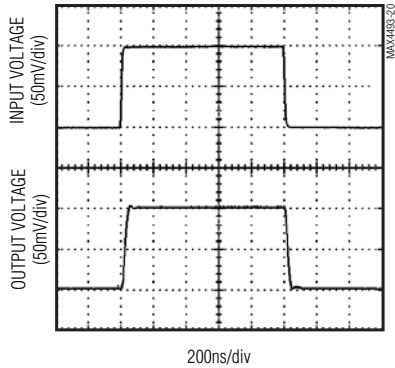


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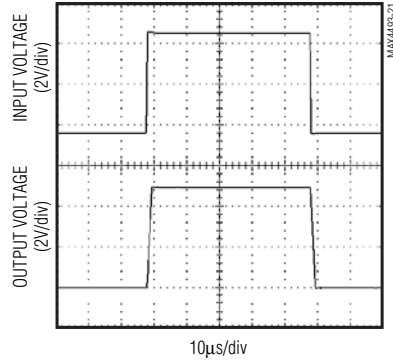
Typical Operating Characteristics (continued)

($V_{CC} = +5V$, $V_{EE} = -5V$, $V_{CM} = 0$, $R_L = 100k\Omega$ to ground, $C_L = 15pF$, $T_A = +25^\circ C$, unless otherwise noted.)

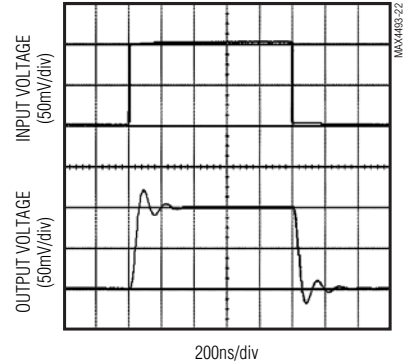
SMALL-SIGNAL TRANSIENT RESPONSE



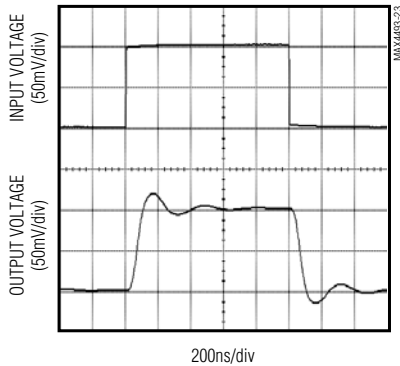
LARGE-SIGNAL CAPACITIVE-LOAD STABILITY
($C_L = 1200pF$)



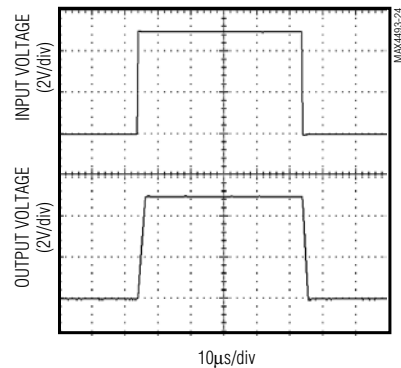
SMALL-SIGNAL CAPACITIVE-LOAD STABILITY
($C_L = 300pF$)



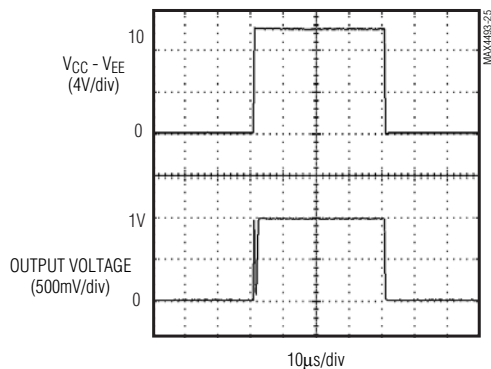
SMALL-SIGNAL TRANSIENT RESPONSE
($R_{ISO} = 15\Omega$, $C_L = 1000pF$)



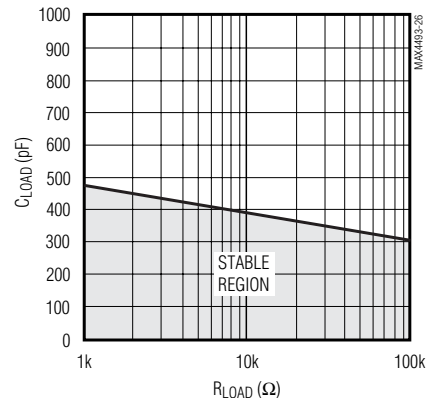
LARGE-SIGNAL TRANSIENT RESPONSE
($R_{ISO} = 15\Omega$, $C_L = 0.01\mu F$)



POWER-UP TIME ($V_{IN} = +1V$)



STABILITY vs. CAPACITIVE AND RESISTIVE LOADS



SC70, Low-Power, General-Purpose, Dual-Supply, Rail-to-Rail Op Amps

Pin Description

MAX4493/MAX4494/MAX4495

PIN			NAME	FUNCTION
MAX4493	MAX4494	MAX4495		
—	1	1	OUTA	Channel A Output
—	2	2	INA-	Channel A Inverting Input
—	3	3	INA+	Channel A Noninverting Input
—	7	7	OUTB	Channel B Output
—	6	6	INB-	Channel B Inverting Input
—	5	5	INB+	Channel B Noninverting Input
—	—	8	OUTC	Channel C Output
—	—	9	INC-	Channel C Inverting Input
—	—	10	INC+	Channel C Noninverting Input
—	—	14	OUTD	Channel D Output
—	—	13	IND-	Channel D Inverting Input
—	—	12	IND+	Channel D Noninverting Input
4	—	—	OUT	Output
1	—	—	IN+	Noninverting Input
3	—	—	IN-	Inverting Input
5	8	4	VCC	Positive Supply
2	4	11	VEE	Negative Supply

Applications Information

Rail-to-Rail Output Stage

The MAX4493/MAX4494/MAX4495 output stage can drive up to 1k Ω and still swing within 200mV of the rails.

Capacitive-Load Stability

Driving large capacitive loads can cause instability in many op amps. The MAX4493/MAX4494/MAX4495 are stable with capacitive loads up to 300pF. The

Capacitive-Load Stability graph in the *Typical Operating Characteristics* gives the stable operation region for capacitive versus resistive load. Stability with higher capacitive loads can be improved by adding an isolation resistor in series with the op-amp output, as shown in Figure 1. This resistor improves the circuit's phase margin by isolating the load capacitor from the amplifier's output. As seen in the *Typical Operating Characteristics*, driving capacitive loads with an isolation resistor exhibits some overshoot, but no oscillation.

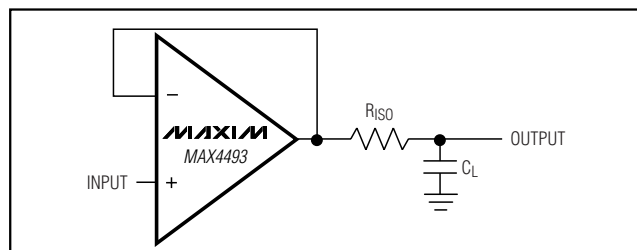


Figure 1. Capacitive Load Driving Circuit

Full-Power Bandwidth

The FPBW is given by:

$$\text{FPBW(Hz)} = \frac{\text{SR}}{\pi[V_{\text{OUTp-p(max)}}]}$$

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where the slew rate (SR) is $3\text{V}/\mu\text{s}$. Figure 2 shows the full-power bandwidth as a function of the peak-to-peak AC output voltage.

Power-Up Conditions

The MAX4493/MAX4494/MAX4495 typically settle within $3\mu\text{s}$ after power-up. See Power-Up Time in *Typical Operating Characteristics*.

Power Supplies and Layout

The MAX4493/MAX4494/MAX4495 operate with dual supplies from $\pm 2.25\text{V}$ to $\pm 5.5\text{V}$. Bypass both V_{CC} and V_{EE} with their own $0.1\mu\text{F}$ capacitor to ground.

Good layout technique helps optimize performance by decreasing the amount of stray capacitance at the op amp's inputs and outputs. To decrease stray capacitance, minimize trace lengths by placing external components close to the op amp's pins.

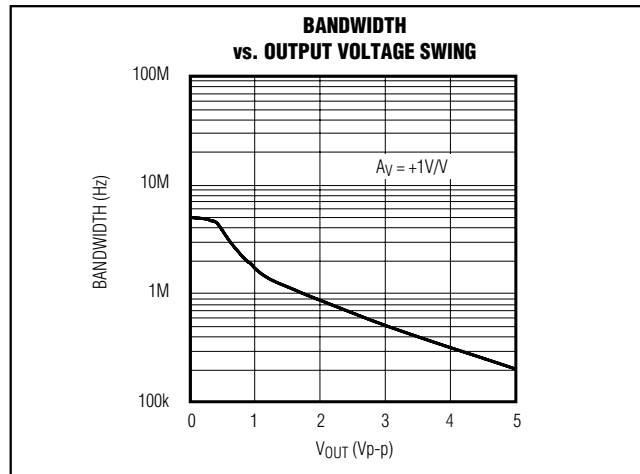
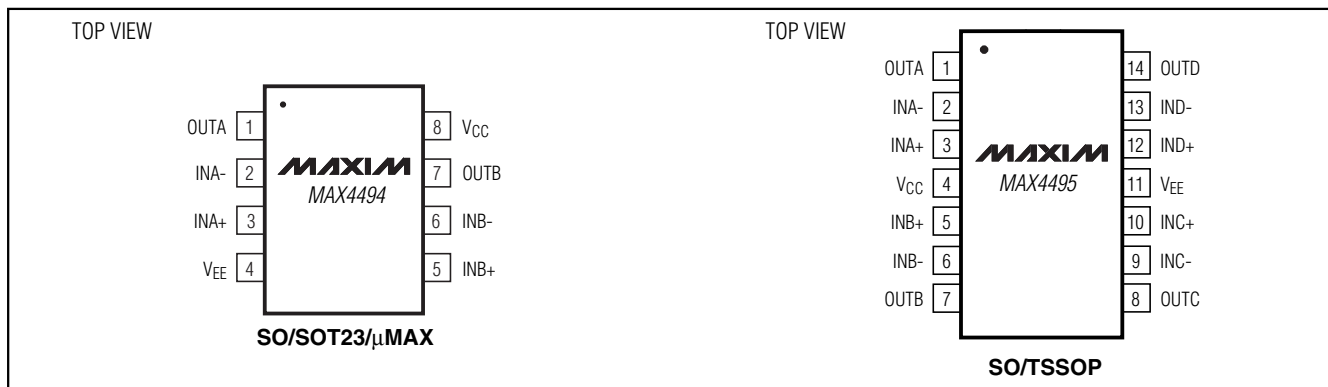
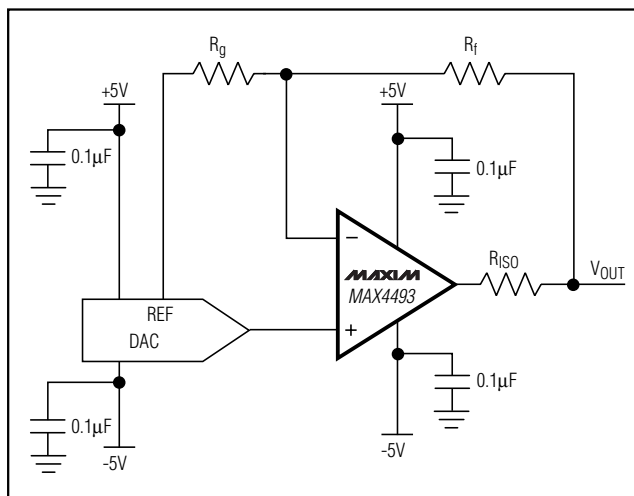


Figure 2. Bandwidth vs. Peak-to-Peak AC Voltage Plot

Pin Configurations (continued)



Typical Operating Circuit

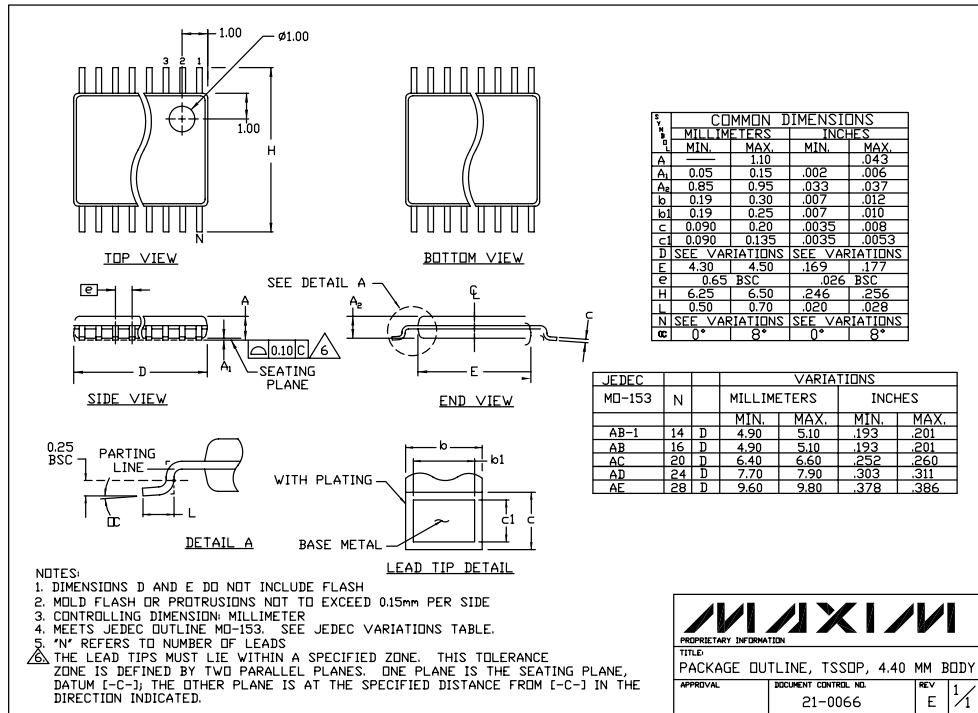


Chip Information

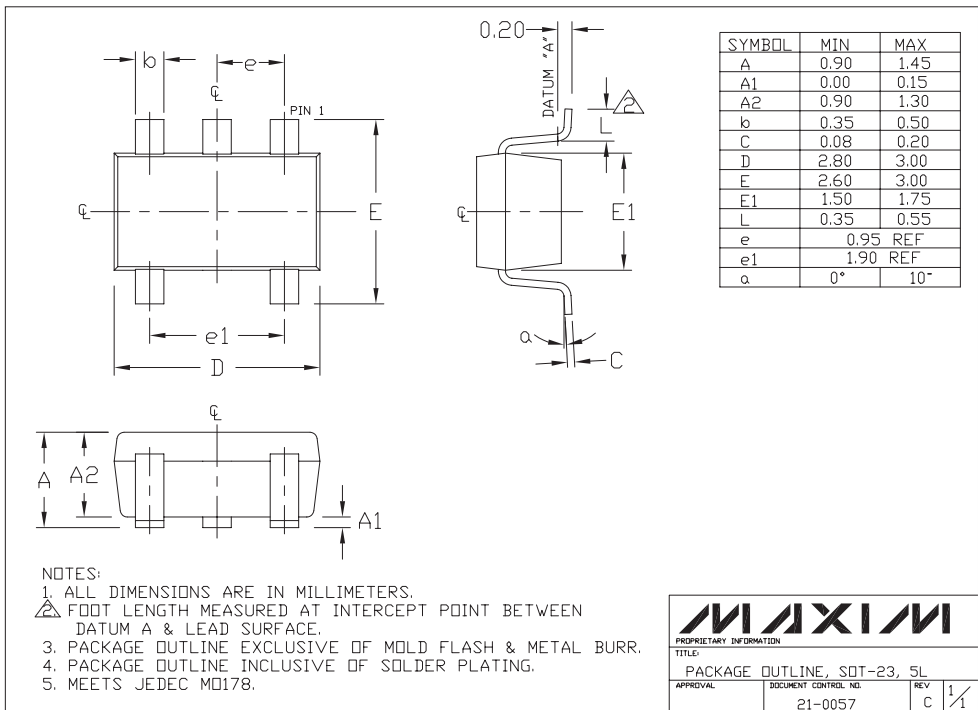
MAX4493 TRANSISTOR COUNT: 81
 MAX4494 TRANSISTOR COUNT: 159
 MAX4495 TRANSISTOR COUNT: 318
 PROCESS: Bipolar

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Package Information



TSSOP NO PADS EPS

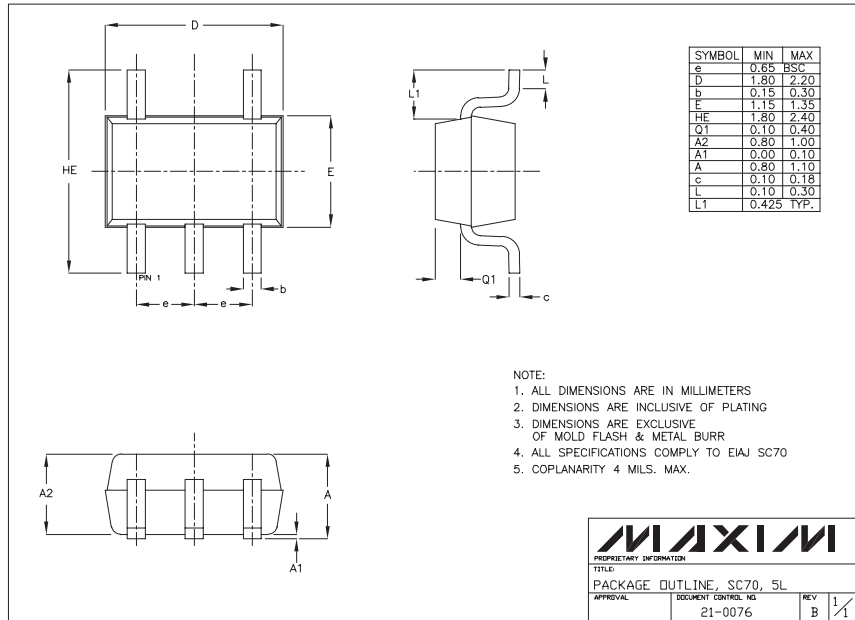


SOT23 EPS

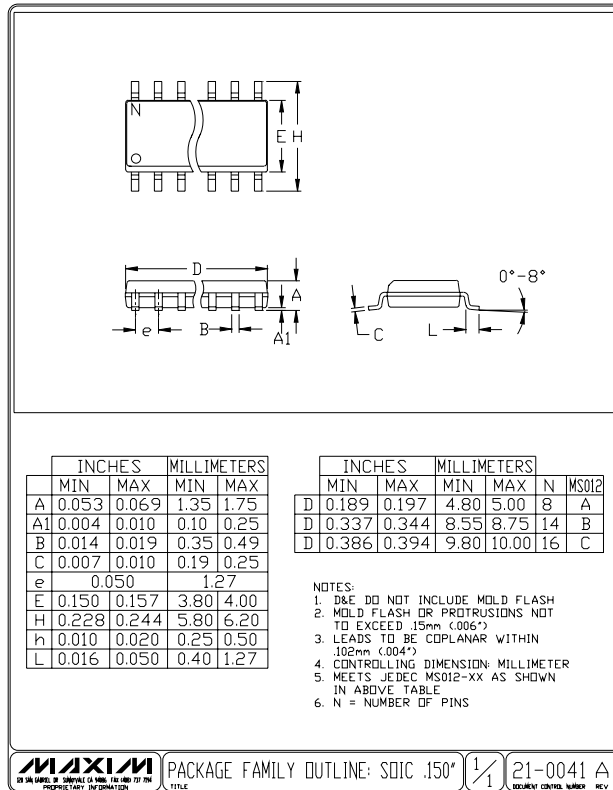
MAX4493/MAX4494/MAX4495

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Package Information (continued)

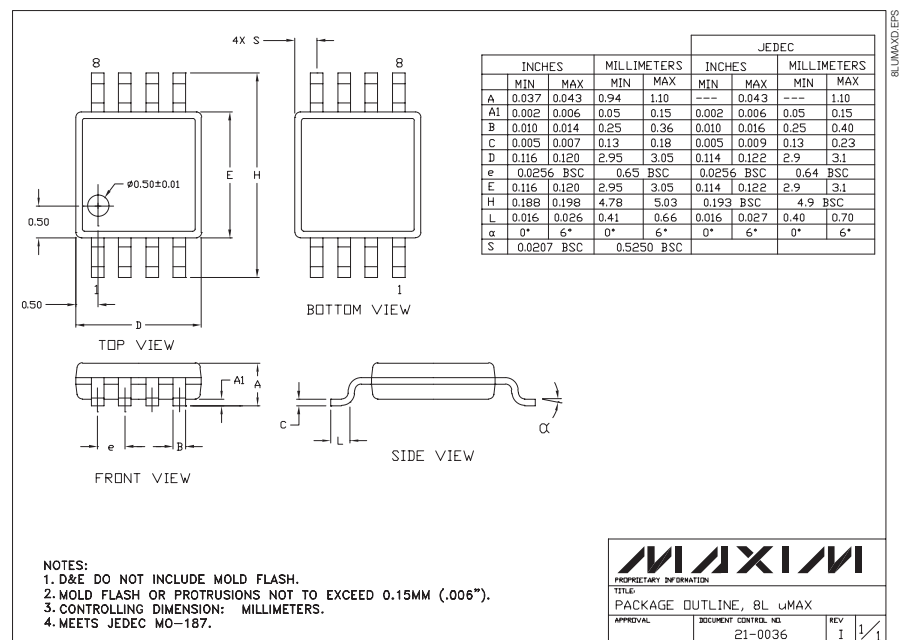
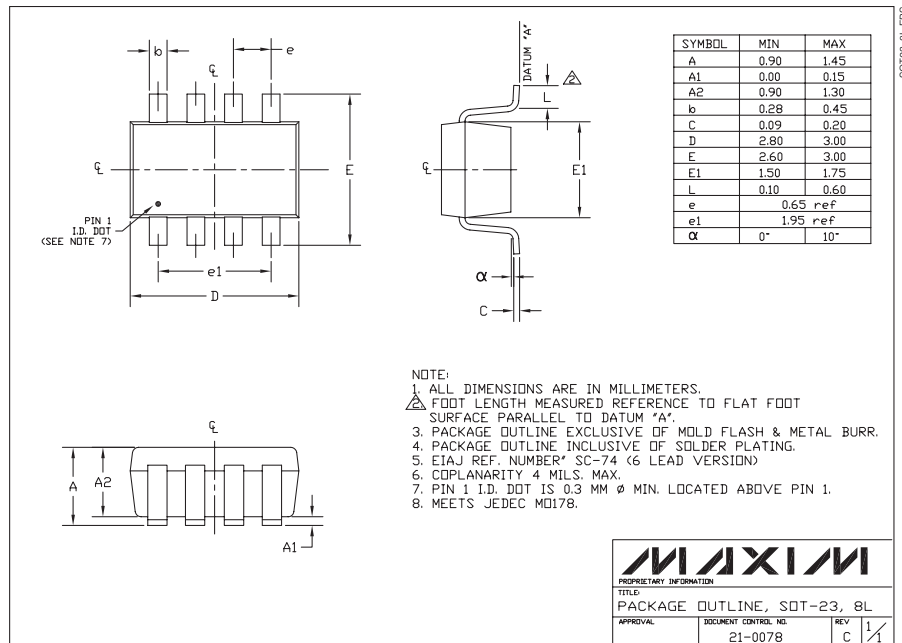


SC70, 5L EFS



SC70, Low-Power, General-Purpose, Dual-Supply, Rail-to-Rail Op Amps

Package Information (continued)



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