



Single/Dual/Quad, Low-Cost, Single-Supply, Rail-to-Rail Op Amps with Shutdown

General Description

The MAX4480–MAX4483 low-cost, general-purpose op amps offer Rail-to-Rail® outputs, draw only 50µA of quiescent current, and operate from a single +2.5V to +5.5V supply. For additional power conservation, the MAX4481 offers a low-power shutdown mode that reduces supply current to 0.5µA (max) and puts the amplifier's output in a high-impedance state. These devices are unity-gain stable with capacitive loads up to 400pF. The MAX4480–MAX4483 are specified to +125°C, making them suitable for use in a variety of harsh environments, such as automotive applications.

The MAX4480 is a single amplifier offered in a tiny 5-pin SC70 package. The MAX4481 is a single amplifier with a low-power shutdown mode that reduces supply current to <0.5µA and comes in a 6-pin SC70 package. The MAX4482 is a dual amplifier and comes in the space-saving 8-pin SOT23 package. The MAX4483 is a quad amplifier and comes in a 14-pin TSSOP package. All devices are specified for operation across the -40°C to +125°C automotive temperature range.

Selector Guide

PART	NO. OF AMPLIFIERS PER PACKAGE	SHUTDOWN MODE
MAX4480	1	No
MAX4481	1	Yes
MAX4482	2	No
MAX4483	4	No

Applications

Single-Supply Zero-Crossing Detectors
Instruments and Terminals
Portable Communications
Electronic Ignition Modules
Infrared Receivers
Sensor Signal Detection

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

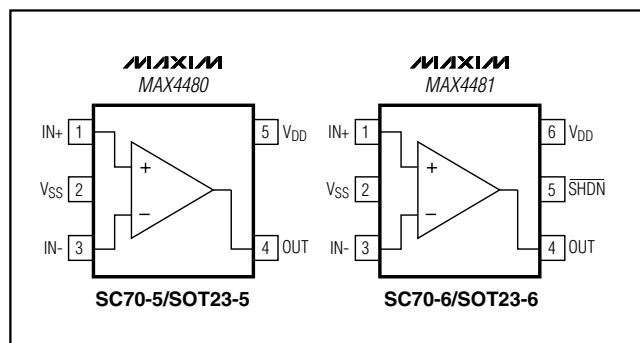
Features

- ◆ Single +2.5V to +5.5V Supply Voltage Range
- ◆ 50µA Quiescent Current per Amplifier
- ◆ 0.5µA (max) Shutdown Mode (MAX4481)
- ◆ Available in Space-Saving Packages
 - 5-Pin SC70 (MAX4480)
 - 6-Pin SC70 (MAX4481)
 - 8-Pin SOT23 (MAX4482)
- ◆ 105dB A_{VOL} with 5kΩ Load
- ◆ 0.005% THD with 100kΩ Load
- ◆ Rail-to-Rail Output Voltage Swing
- ◆ 3.0mA of Sink and Source Load Current
- ◆ Unity-Gain Stable up to $C_{LOAD} = 400pF$

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE	TOP MARK
MAX4480AXK-T	-40°C to +125°C	5 SC70	ABU
MAX4480AUK-T	-40°C to +125°C	5 SOT23	ADPJ
MAX4481AXT-T	-40°C to +125°C	6 SC70	AAN
MAX4481AUT-T	-40°C to +125°C	6 SOT23	AAOS
MAX4482AKA-T	-40°C to +125°C	8 SOT23	AAEJ
MAX4482ASA	-40°C to +125°C	8 SO	—
MAX4482AUA	-40°C to +125°C	8 µMAX	—
MAX4483ASD	-40°C to +125°C	14 SO	—
MAX4483AUD	-40°C to +125°C	14 TSSOP	—

Pin Configurations



Pin Configurations continued at end of data sheet.



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ABSOLUTE MAXIMUM RATINGS

Power-Supply Voltage (V_{DD} to V_{SS})-0.3V to +6V	8-Pin SOT23 (derate 9.1mW/°C above +70°C)727mW
All Other Pins	.....($V_{SS} - 0.3V$) to ($V_{DD} + 0.3V$)	8-Pin μ MAX (derate 4.5mW/°C above +70°C)	..... 362mW
Output Short-Circuit Duration (OUT shorted to V_{SS} or V_{DD})	..... Continuous	8-Pin SO (derate 5.88mW/°C above +70°C)	..... 471mW
Continuous Power Dissipation ($T_A = +70^\circ\text{C}$)		14-Pin TSSOP (derate 9.03mW/°C above +70°C)	.....727mW
5-Pin SC70 (derate 3.1mW/°C above +70°C)	..... 247mW	14-Pin SO (derate 8.33mW/°C above +70°C)	..... 667mW
6-Pin SC70 (derate 3.1mW/°C above +70°C)	.....245mW	Operating Temperature Range	.....-40°C to +125°C
5-Pin SOT23 (derate 7.1mW/°C above +70°C)	.....571mW	Junction Temperature	.....150°C
6-Pin SOT23 (derate 8.7mW/°C above +70°C)	.....696mW	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

($V_{DD} = +5V$, $V_{SS} = 0$, $V_{CM} = 0$, $V_{OUT} = V_{DD}/2$, $R_L \geq 1M\Omega$ connected to $V_{DD}/2$, $\overline{SHDN} = V_{DD}$ (MAX4481 only), $T_A = +25^\circ\text{C}$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage Range	V_{DD}	Inferred from PSRR test		2.5		5.5	V
Supply Current per Amplifier	I_{DD}	$V_{DD} = 2.5V$			45		μA
		$V_{DD} = 5.0V$			50	100	
Supply Current in Shutdown	I_{SHDN}	$\overline{SHDN} = V_{SS}$ (MAX4481 only)			0.05	0.5	μA
Input Offset Voltage	V_{OS}				± 1	± 5.5	mV
Input Bias Current	I_B	(Note 1)			± 0.1	± 100	pA
Input Offset Current	I_{OS}	(Note 1)			± 0.1	± 100	pA
Input Resistance	R_{IN}	Differential or common mode			1000		$M\Omega$
Input Common-Mode Voltage Range	V_{CM}	Inferred from CMRR test		V_{SS}		$V_{DD} - 1.3$	V
Common-Mode Rejection Ratio	CMRR	$V_{SS} \leq V_{CM} \leq V_{DD} - 1.3V$		71	86		dB
Power-Supply Rejection Ratio	PSRR	$2.5V \leq V_{DD} \leq 5.5V$		82	92		dB
Large-Signal Voltage Gain	A_{VOL}	$V_{SS} + 0.02V \leq V_{OUT} \leq V_{DD} - 0.03V$	$R_L = 100k\Omega$		110		dB
		$V_{SS} + 0.10V \leq V_{OUT} \leq V_{DD} - 0.20V$	$R_L = 5k\Omega$	94	105		
Output Voltage High	V_{OH}	Specified as $V_{DD} - V_{OUT}$	$R_L = 100k\Omega$		4		mV
			$R_L = 5k\Omega$		80	150	
Output Voltage Low	V_{OL}	Specified as $V_{OUT} - V_{SS}$	$R_L = 100k\Omega$		1		mV
			$R_L = 5k\Omega$		8	30	
Output Short-Circuit Current	I_{SC}	Sourcing			3		mA
		Sinking			17		
Shutdown Mode Output Leakage	$I_{OUTSHDN}$	Device in shutdown mode, $\overline{SHDN} = V_{SS}$, $V_{SS} < V_{OUT} < V_{CC}$ (MAX4481 only)			± 0.01	± 0.1	μA
\overline{SHDN} Logic Low	V_{IL}	MAX4481 only			$0.3 \times V_{DD}$		V
\overline{SHDN} Logic High	V_{IH}	MAX4481 only		$0.7 \times V_{DD}$			V
\overline{SHDN} Input Current	I_{IL}, I_{IH}	$\overline{SHDN} = V_{DD}$ or V_{SS} (MAX4481 only)		± 0.001	± 1	± 500	nA
Gain-Bandwidth Product	GBW				140		kHz

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MAX4480-MAX4483

ELECTRICAL CHARACTERISTICS (continued)

($V_{DD} = +5V$, $V_{SS} = 0$, $V_{CM} = 0$, $V_{OUT} = V_{DD}/2$, $R_L \geq 1M\Omega$ connected to $V_{DD}/2$, $\overline{SHDN} = V_{DD}$ (MAX4481 only), $T_A = +25^\circ C$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Phase Margin	ϕ_M				70		degrees
Gain Margin					30		dB
Slew Rate	SR				80		V/ms
Input Voltage Noise Density	e_n	$f = 10kHz$			100		nV/ \sqrt{Hz}
Input Current Noise Density	i_n	$f = 10kHz$			1		fA/ \sqrt{Hz}
Capacitive-Load Stability	C_{LOAD}	$A_V = +1V/V$			400		pF
Shutdown Delay Time	t_{SHDN}	MAX4481 only			0.4		μs
Enable Delay Time	t_{EN}	MAX4481 only			12		μs
Power-On Time	t_{ON}				15		μs
Input Capacitance	C_{IN}				2.0		pF
Total Harmonic Distortion	THD	$f = 1kHz$, $V_{OUT} = 2V_{p-p}$, $A_V = +1V/V$	$R_L = 100k\Omega$		0.005		%
Settling Time to 0.1%	t_S	$V_{OUT} = 2V$ step			50		μs

ELECTRICAL CHARACTERISTICS

($V_{DD} = +5V$, $V_{SS} = 0$, $V_{CM} = 0$, $V_{OUT} = V_{DD}/2$, $R_L \geq 1M\Omega$ connected to $V_{DD}/2$, $\overline{SHDN} = V_{DD}$ (MAX4481 only), $T_A = -40^\circ C$ to $+125^\circ C$, unless otherwise noted.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage Range	V_{DD}	Inferred from PSRR test		2.5		5.5	V
Supply Current per Amplifier	I_{DD}					120	μA
Supply Current in Shutdown	I_{SHDN}	$\overline{SHDN} = V_{SS}$, (MAX4481 only)				1.0	μA
Input Offset Voltage	V_{OS}					9	mV
Input Offset Voltage Drift	TC_{VOS}				± 3		$\mu V/^\circ C$
Input Bias Current	I_B	(Note 1)				± 100	pA
Input Offset Current	I_{OS}	(Note 1)				± 100	pA
Input Common-Mode Voltage Range	V_{CM}	Inferred from CMRR test		V_{SS}		$V_{DD} - 1.4$	V
Common-Mode Rejection Ratio	CMRR	$V_{SS} \leq V_{CM} \leq V_{DD} - 1.4V$		67			dB
Power-Supply Rejection Ratio	PSRR	$2.5V \leq V_{CC} \leq 5.5V$		77			dB
Shutdown Mode Output Leakage	$I_{OUTSHDN}$	Device in shutdown mode, $\overline{SHDN} = V_{SS}$, $V_{SS} < V_{OUT} < V_{CC}$ (MAX4481 only)	$-40^\circ C$ to $+85^\circ C$			± 0.5	μA
			$+85^\circ C$ to $+125^\circ C$			± 2.5	
\overline{SHDN} Logic Low	V_{IL}	MAX4481 only				$0.3 \times V_{DD}$	V
\overline{SHDN} Logic High	V_{IH}	MAX4481 only		$0.7 \times V_{DD}$			V
\overline{SHDN} Input Current	I_{IL} , I_{IH}	$\overline{SHDN} = V_{DD}$ or V_{SS} (Note 1) (MAX4481 only)				1	μA
Large-Signal Voltage Gain	A_{VOL}	$V_{SS} + 0.1V \leq V_{OUT} \leq V_{DD} - 0.20V$, $R_L = 5k\Omega$		84			dB
Output Voltage High	V_{OH}	Specified as $V_{DD} - V_{OUT}$, $R_L = 5k\Omega$				200	mV
Output Voltage Low	V_{OL}	Specified as $V_{OUT} - V_{SS}$, $R_L = 5k\Omega$				50	mV

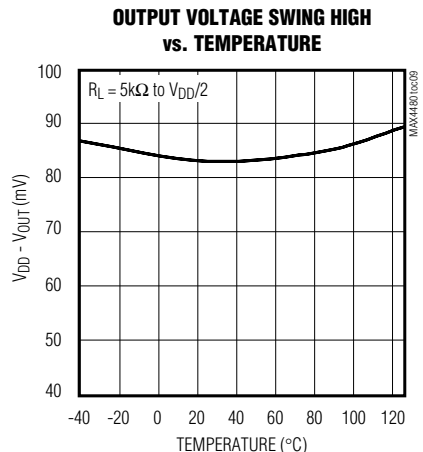
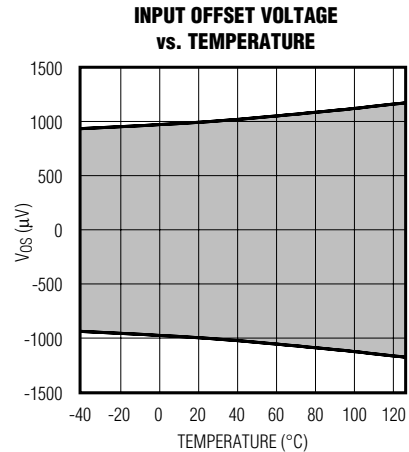
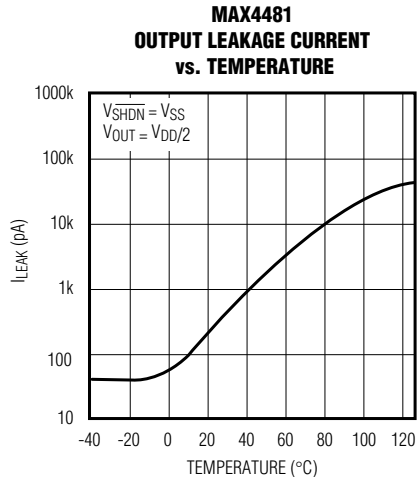
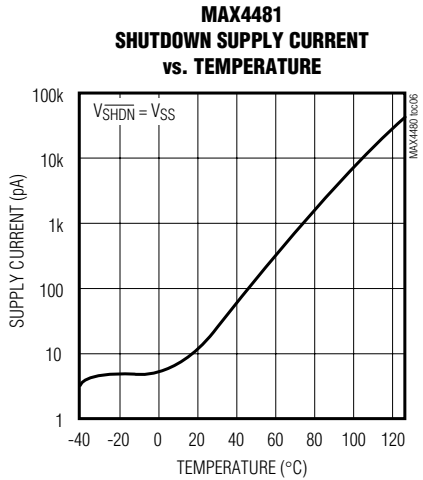
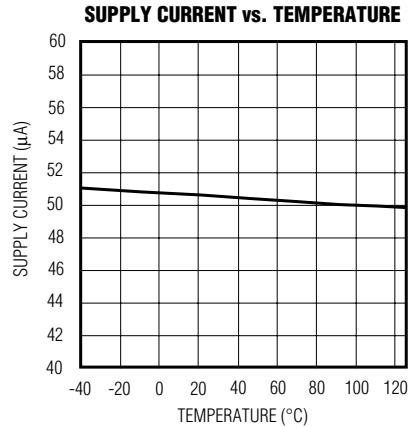
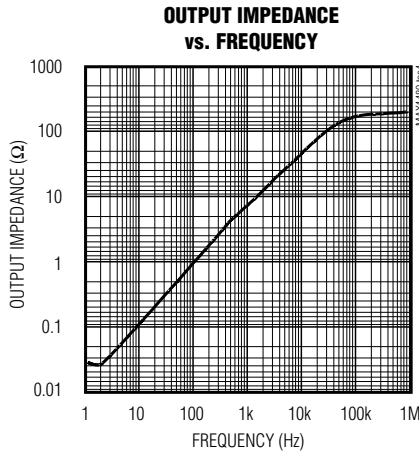
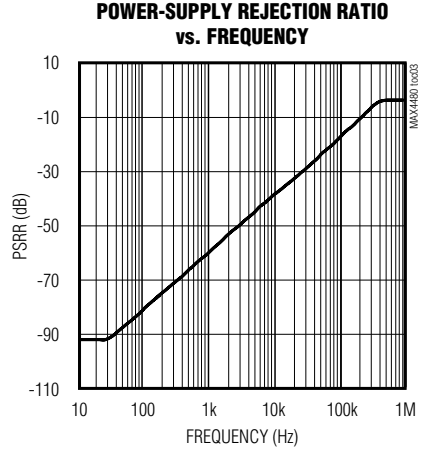
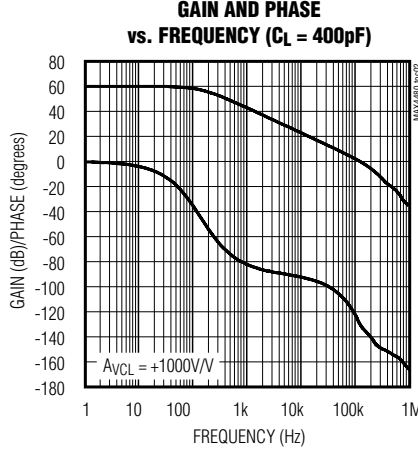
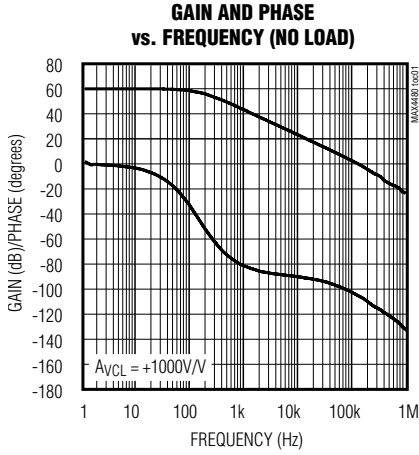
Note 1: Guaranteed by design.

Note 2: Specifications are 100% tested at $T_A = +25^\circ C$ (exceptions noted). All temperature limits are guaranteed by design.

Single/Dual/Quad, Low-Cost, Single-Supply, Rail-to-Rail Op Amps with Shutdown

Typical Operating Characteristics

($V_{DD} = +5V$, $V_{SS} = 0$, $V_{CM} = V_{DD}/2$, $V_{SHDN} = 5V$, $R_L \geq 1M\Omega$ connected to $V_{DD}/2$, $T_A = +25^\circ C$, unless otherwise noted.)



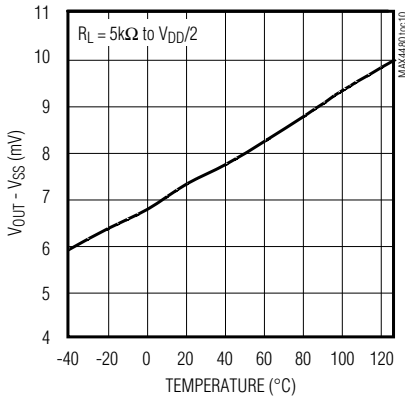
Single/Dual/Quad, Low-Cost, Single-Supply, Rail-to-Rail Op Amps with Shutdown

Typical Operating Characteristics (continued)

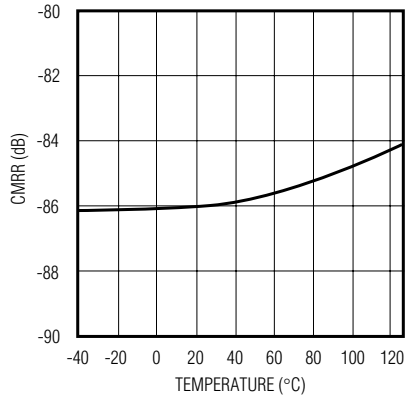
($V_{DD} = +5V$, $V_{SS} = 0$, $V_{CM} = V_{DD}/2$, $V_{SHDN} = 5V$, $R_L \geq 1M\Omega$ connected to $V_{DD}/2$, $T_A = +25^\circ C$, unless otherwise noted.)

MAX4480-MAX4483

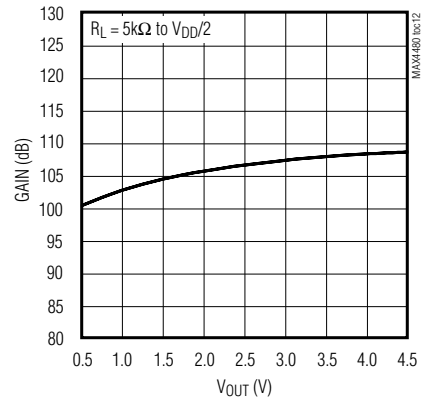
OUTPUT VOLTAGE SWING LOW vs. TEMPERATURE



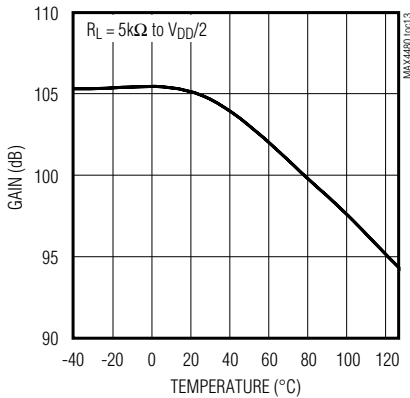
COMMON-MODE REJECTION RATIO vs. TEMPERATURE



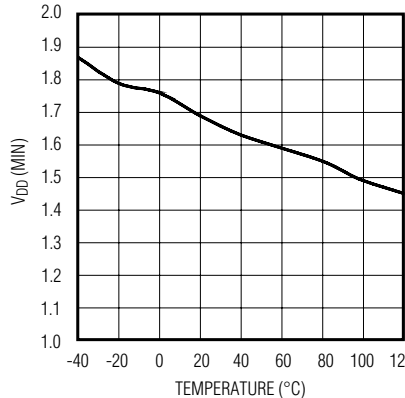
LARGE-SIGNAL GAIN vs. OUTPUT VOLTAGE



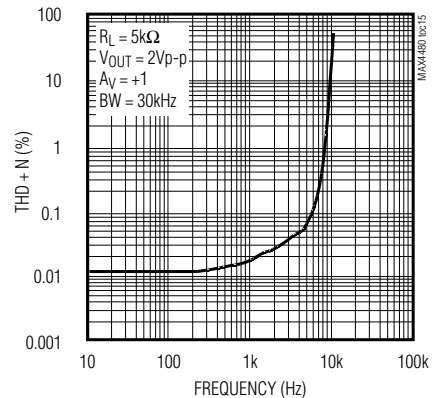
LARGE-SIGNAL GAIN vs. TEMPERATURE



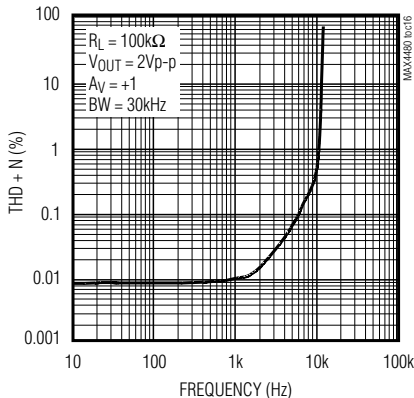
MINIMUM OPERATING VOLTAGE vs. TEMPERATURE



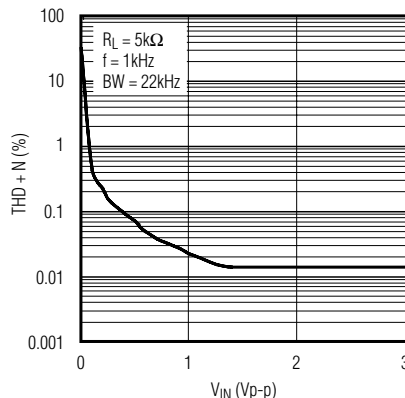
TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



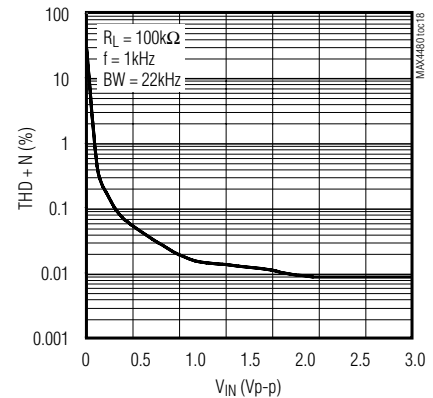
TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



TOTAL HARMONIC DISTORTION PLUS NOISE vs. INPUT AMPLITUDE



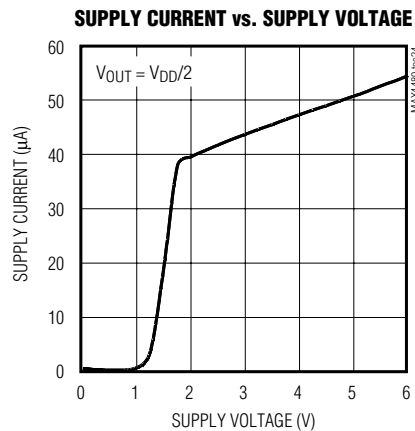
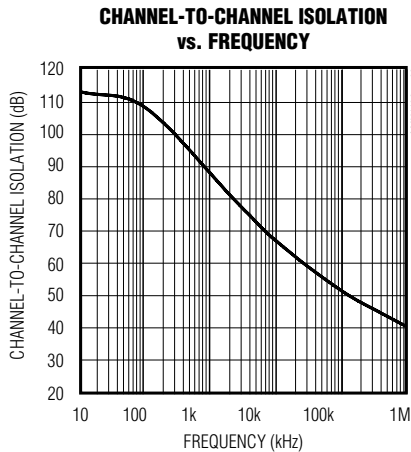
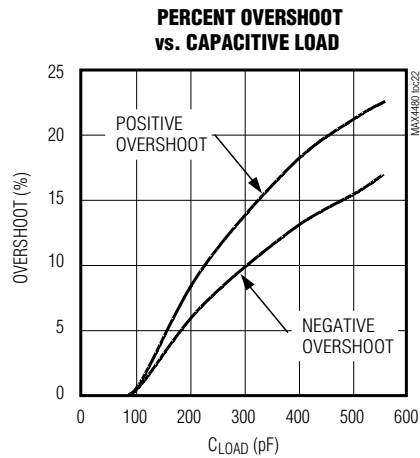
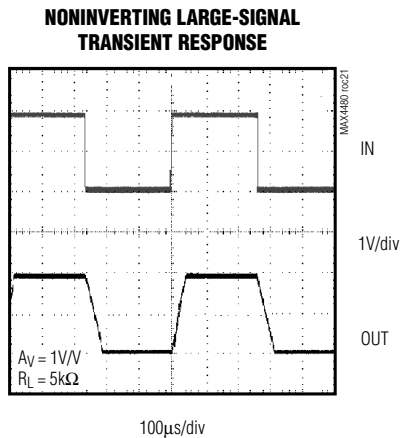
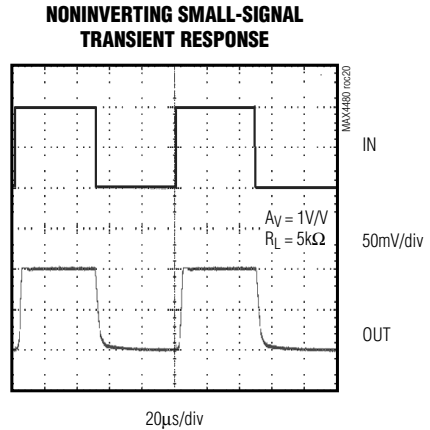
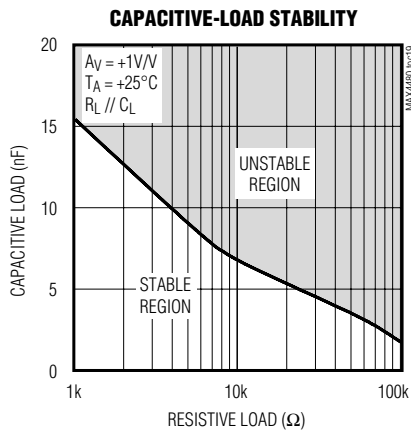
TOTAL HARMONIC DISTORTION PLUS NOISE vs. INPUT AMPLITUDE



Single/Dual/Quad, Low-Cost, Single-Supply, Rail-to-Rail Op Amps with Shutdown

Typical Operating Characteristics (continued)

($V_{DD} = +5V$, $V_{SS} = 0$, $V_{CM} = V_{DD}/2$, $V_{SHDN} = 5V$, $R_L \geq 1M\Omega$ connected to $V_{DD}/2$, $T_A = +25^\circ C$, unless otherwise noted.)



Single/Dual/Quad, Low-Cost, Single-Supply, Rail-to-Rail Op Amps with Shutdown

MAX4480-MAX4483

Pin Description

PIN				NAME	FUNCTION
MAX4480	MAX4481	MAX4482	MAX4483		
1	1	—	—	IN+	Noninverting Amplifier Input
—	—	3	3	INA+	Noninverting Amplifier Input A
—	—	5	5	INB+	Noninverting Amplifier Input B
—	—	—	10	INC+	Noninverting Amplifier Input C
—	—	—	12	IND+	Noninverting Amplifier Input D
2	2	4	11	V _{SS}	Negative Supply. Connect to ground for single-supply operation. Use a 0.01 μ F bypass capacitor to GND.
3	3	—	—	IN-	Inverting Amplifier Input
—	—	2	2	INA-	Inverting Amplifier Input A
—	—	6	6	INB-	Inverting Amplifier Input B
—	—	—	9	INC-	Inverting Amplifier Input C
—	—	—	13	IND-	Inverting Amplifier Input D
4	4	—	—	OUT	Amplifier Output
—	—	1	1	OUTA	Amplifier Output A
—	—	7	7	OUTB	Amplifier Output B
—	—	—	8	OUTC	Amplifier Output C
—	—	—	14	OUTD	Amplifier Output D
5	6	8	4	V _{DD}	Positive Supply. Use a 0.01 μ F bypass capacitor to GND.
—	5	—	—	$\overline{\text{SHDN}}$	Active-Low Shutdown Input. Connect to V _{DD} for normal operation. Do not leave floating.

Detailed Description

Rail-to-Rail Output Stage

The MAX4480–MAX4483 can drive a 5k Ω load and still typically swing within 80mV of the supply rails. Figure 1 shows the MAX4480 output voltage swing configured with A_v = +10V/V.

Driving Capacitive Loads

Driving a capacitive load can cause instability in many op amps, especially those with low quiescent current. The MAX4480–MAX4483 are unity-gain stable for a range of capacitive loads to above 400pF. Figure 2 shows the MAX4480 response with an excessive capacitive load. Adding a series resistor between the output and the load capacitor (Figure 3) improves the

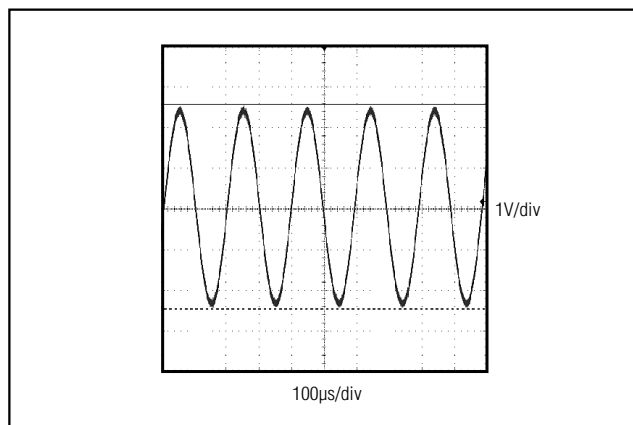


Figure 1. Rail-to-Rail Output Operation

Single/Dual/Quad, Low-Cost, Single-Supply, Rail-to-Rail Op Amps with Shutdown

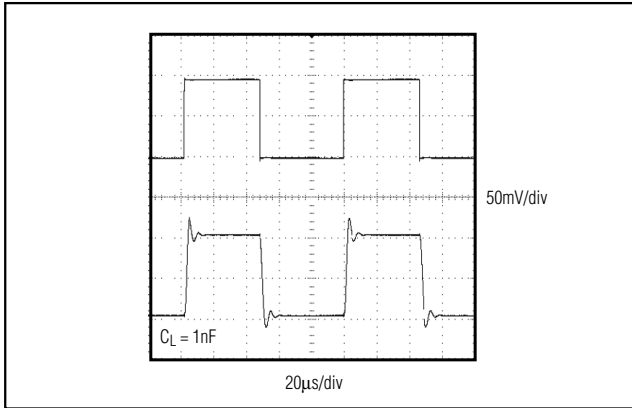


Figure 2. Small-Signal Transient Response with Excessive Capacitive Load

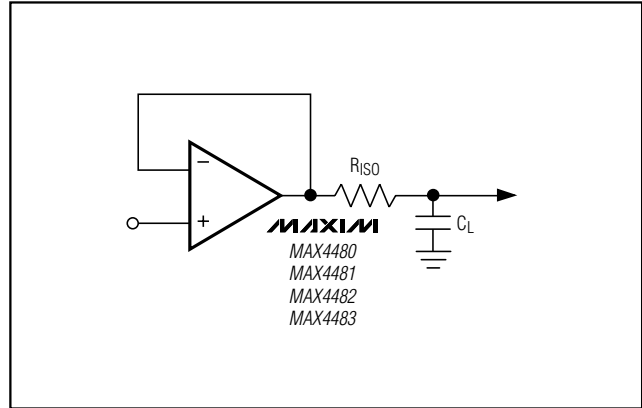


Figure 3. Capacitive-Load-Driving Circuit

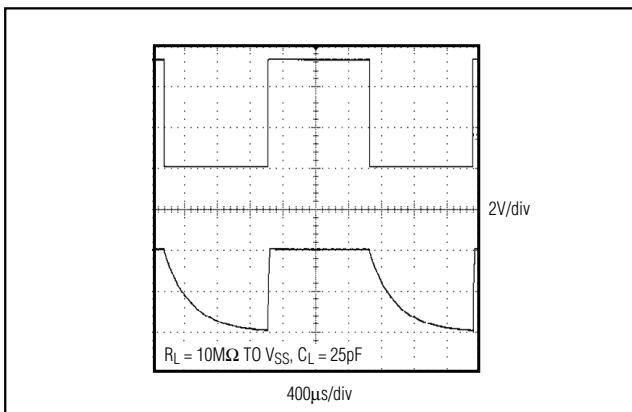


Figure 4. Shutdown Waveform

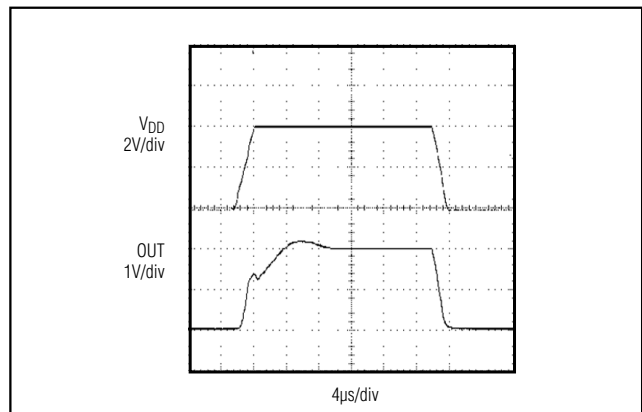


Figure 5. Power-Up/Down Waveform

circuit's response by isolating the load capacitance from the op amp's output.

Applications Information

Shutdown Mode

The MAX4481 features a low-power shutdown mode. When $\overline{\text{SHDN}}$ goes low, the supply current drops to 0.05 μA (typ) and the output enters a high-impedance state. Pull $\overline{\text{SHDN}}$ high to enable the amplifier. Do not leave $\overline{\text{SHDN}}$ floating. Figure 4 shows the shutdown waveform.

Power-Up

The MAX4480-MAX4483 outputs typically settle within 50 μs after power-up. Figure 5 shows the output voltage on power-up and power-down.

Power Supplies and Layout

The MAX4480-MAX4483 operate from a single +2.5V to +5.5V power supply. Bypass the power supply with a 0.1 μF capacitor to ground.

Good layout techniques 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.

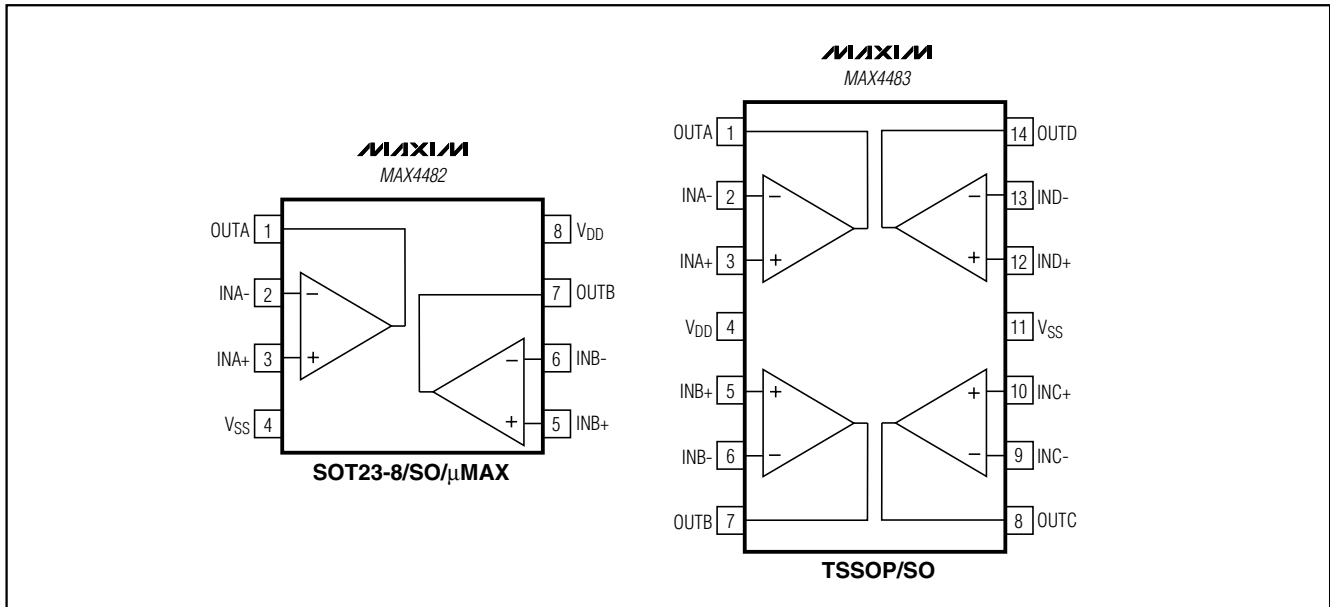
Chip Information

MAX4480/MAX4481 TRANSISTOR COUNT: 111
 MAX4482 TRANSISTOR COUNT: 209
 MAX4483 TRANSISTOR COUNT: 407

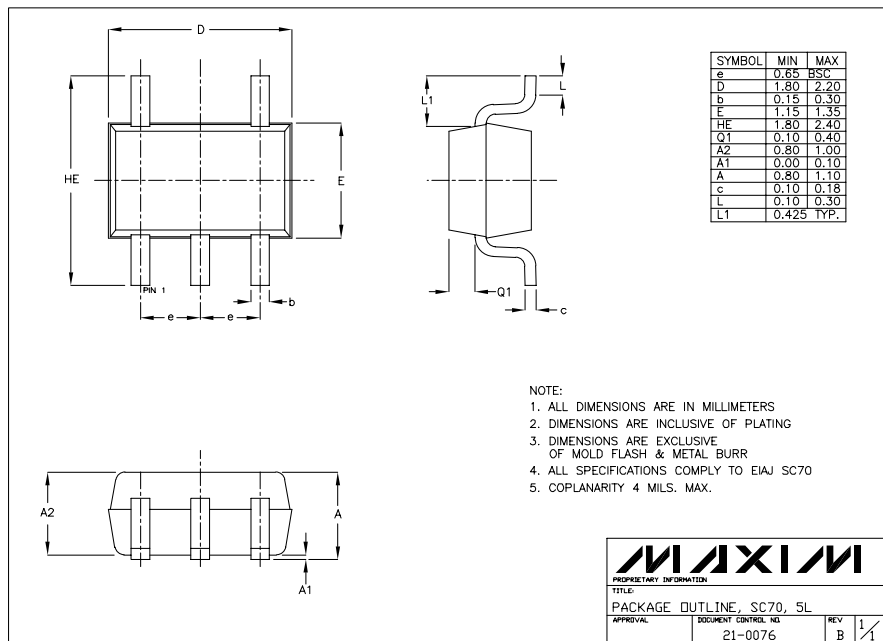
Single/Dual/Quad, Low-Cost, Single-Supply, Rail-to-Rail Op Amps with Shutdown

Pin Configurations (continued)

MAX4480-MAX4483

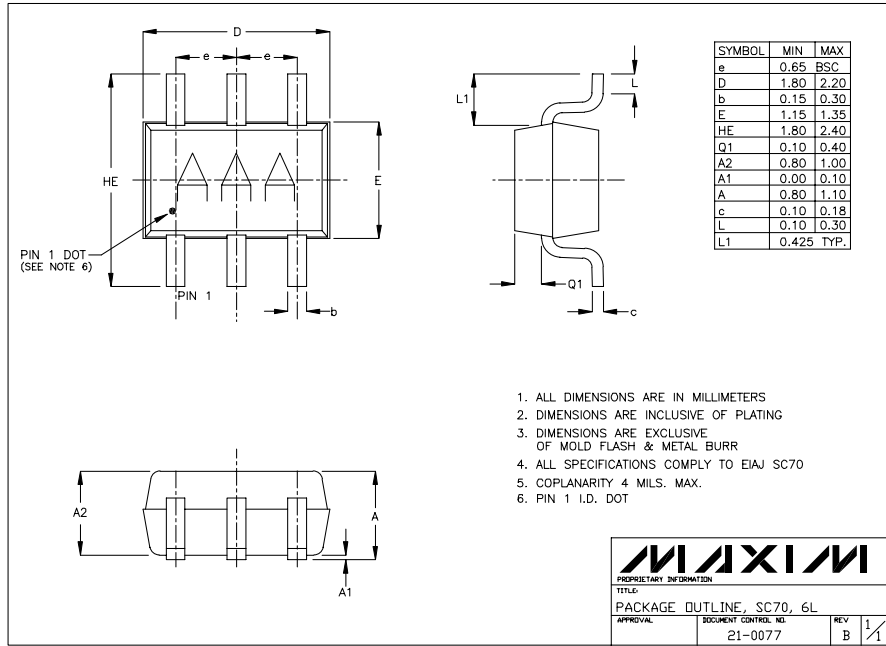


Package Information

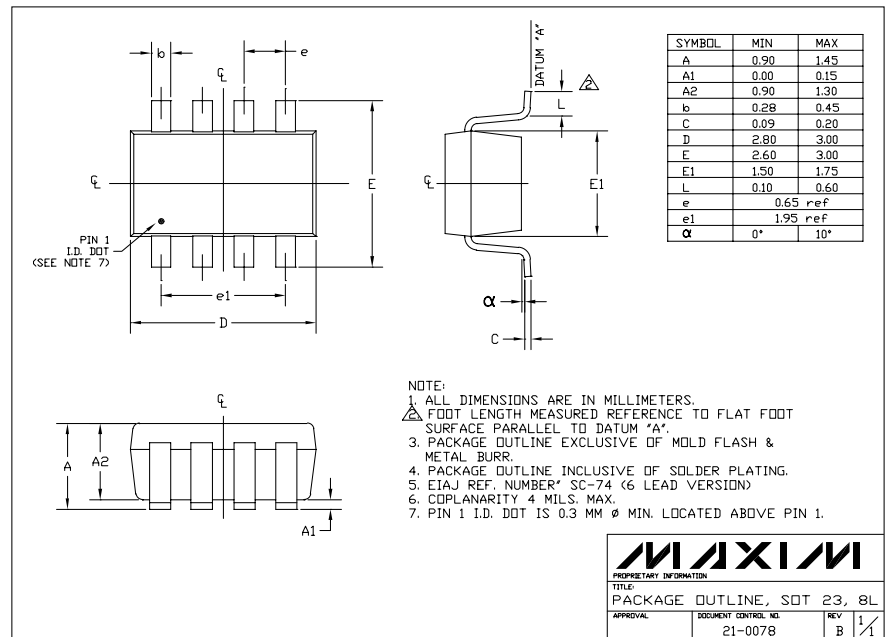


Single/Dual/Quad, Low-Cost, Single-Supply, Rail-to-Rail Op Amps with Shutdown

Package Information (continued)



SC70, 6LEPS

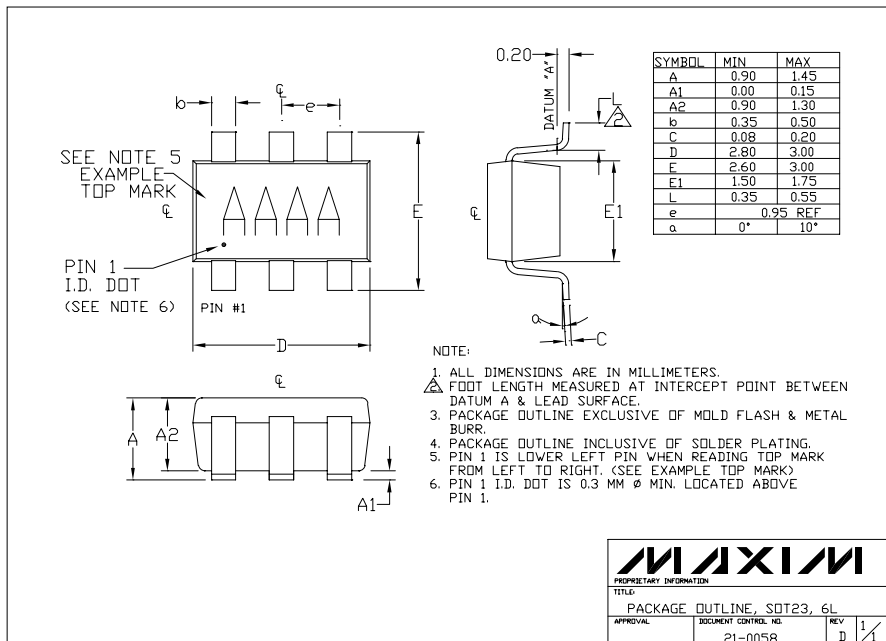
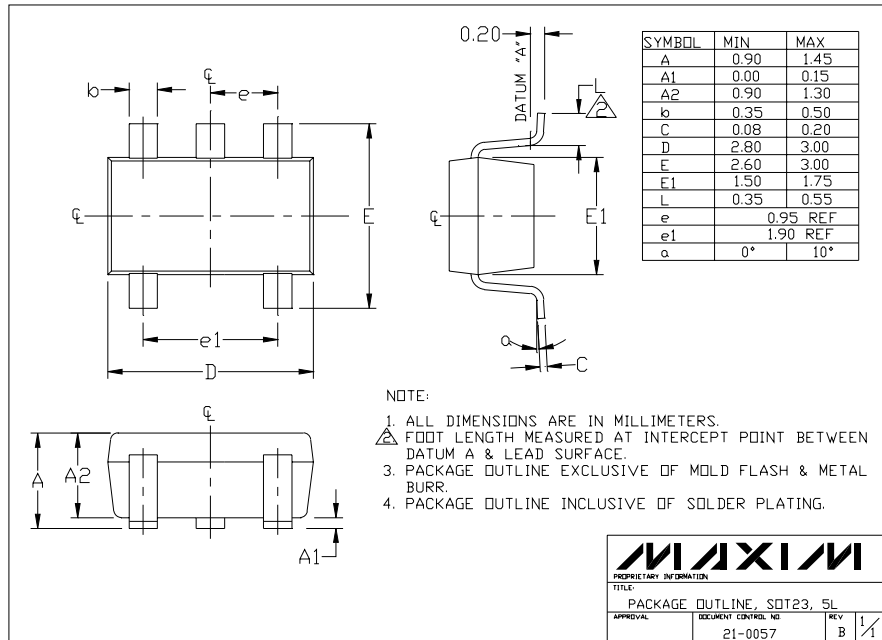


SOT23, 8LEPS

Single/Dual/Quad, Low-Cost, Single-Supply, Rail-to-Rail Op Amps with Shutdown

Package Information (continued)

MAX4480-MAX4483



Single/Dual/Quad, Low-Cost, Single-Supply, Rail-to-Rail Op Amps with Shutdown

Package Information (continued)

	INCHES		MILLIMETERS		JEDEC			
	MIN	MAX	MIN	MAX	INCHES	MAX	MIN	MAX
A	0.037	0.043	0.94	1.10	---	0.043	---	1.10
A1	0.002	0.006	0.05	0.15	0.002	0.006	0.05	0.15
B	0.010	0.014	0.25	0.36	0.010	0.016	0.25	0.40
C	0.005	0.007	0.13	0.18	0.005	0.009	0.13	0.23
D	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
e	0.0256	BSC	0.65	BSC	0.0256	BSC	0.64	BSC
E	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
H	0.188	0.198	4.78	5.03	0.193	BSC	4.9	BSC
L	0.016	0.026	0.41	0.66	0.016	0.027	0.40	0.70
alpha	0°	6°	0°	6°	0°	6°	0°	6°
s	0.0207	BSC	0.5250	BSC				

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-187.

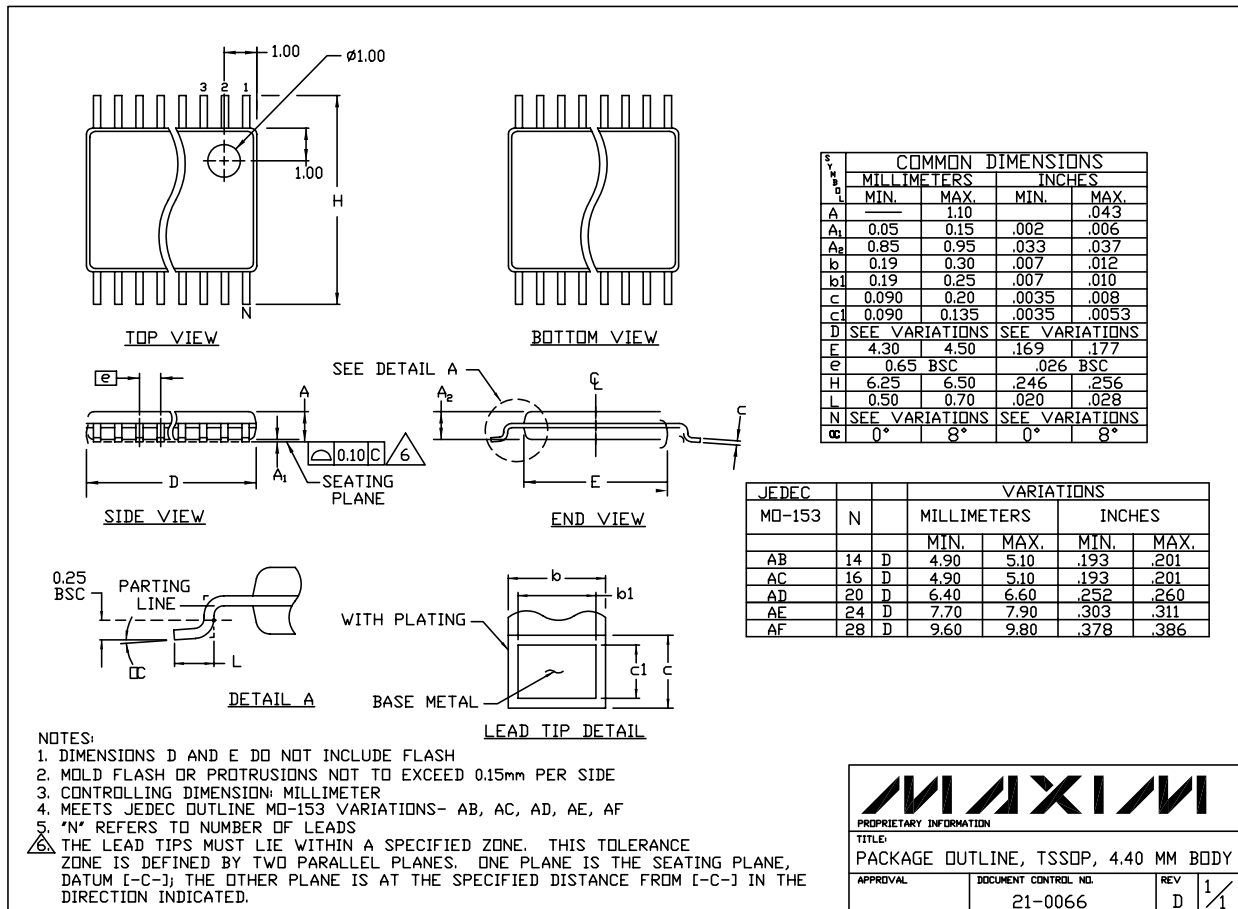
MAXIM
 PROPRIETARY INFORMATION
 TITLE: PACKAGE OUTLINE, 8L uMAX
 APPROVAL: _____ DOCUMENT CONTROL NO. 21-0036 REV I 1/1

8LUMAXD.EPS

Single/Dual/Quad, Low-Cost, Single-Supply, Rail-to-Rail Op Amps with Shutdown

Package Information (continued)

MAX4480-MAX4483



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