



# 17µA Max, Dual/Quad, Single-Supply, Precision Op Amps

MXL1178/MXL1179

## General Description

Maxim's MXL1178 and MXL1179 are dual and quad micropower, precision op amps. They feature an extremely low 17µA max per op amp supply current, as well as precision offset specifications: 30µV offset voltage, and 50pA offset current. Both offset parameters have low drift over temperature and time.

The MXL1178 and MXL1179 can operate from a single supply (e.g., one lithium cell or two NiCd cells). The input voltage range includes ground. The output stage swings to within a few millivolts of ground while sinking current, which eliminates pull-down resistors and saves power.

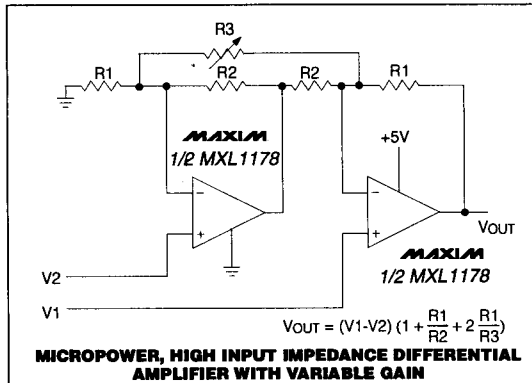
Both devices are optimized for +5V single-supply operation, but specifications for ±15V operation are also provided.

Maxim's MXL1178 and MXL1179 are pin compatible with industry standards such as the LT1178 and LT1179. For applications that require smaller packaging, see the MAX478/MAX479 data sheet. For applications that require lower power, see the MAX406/MAX407/MAX409 1µA op amp data sheet.

## Applications

- Battery- or Solar-Powered Systems:
  - Portable Instrumentation
  - Remote Sensor Amplifier
  - Satellite Circuitry
- Micropower Sample-and-Hold
- Thermocouple Amplifier
- Micropower Filters
- Single Lithium Cell-Powered Systems

## Typical Operating Circuit



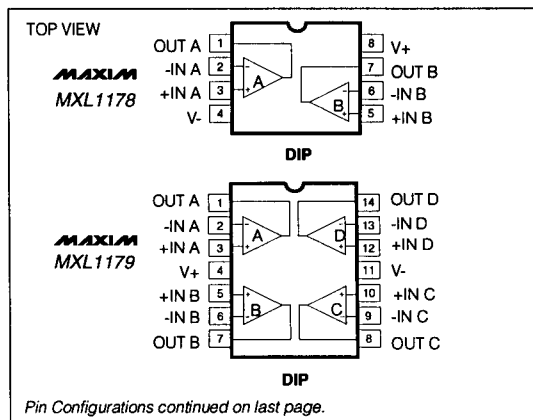
## Features

- ◆ 17µA Max Supply Current per Amplifier
- ◆ 70µV Max Offset Voltage
- ◆ 250pA Max Offset Current
- ◆ 5nA Max Input Bias Current
- ◆ 0.9µV<sub>p-p</sub> 0.1Hz to 10Hz Voltage Noise
- ◆ 1.5pA<sub>p-p</sub> 0.1Hz to 10Hz Current Noise
- ◆ 0.5µV/°C Offset-Voltage Drift
- ◆ 85kHz Gain-Bandwidth Product
- ◆ 0.04V/µs Slew Rate
- ◆ Single-Supply Operation:
  - Input Voltage Range Includes Ground
  - Output Swings to Ground while Sinking Current
  - No Pull-Down Resistors Required
- ◆ Output Sources and Sinks 5mA Load Current

## Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MXL1178ACN8	0°C to +70°C	8 Plastic DIP
MXL1178CN8	0°C to +70°C	8 Plastic DIP
MXL1178S	0°C to +70°C	16 Wide SO
MXL1178IN8	-40°C to +85°C	8 Plastic DIP
MXL1179ACN	0°C to +70°C	14 Plastic DIP
MXL1179CN	0°C to +70°C	14 Plastic DIP
MXL1179S	0°C to +70°C	16 Wide SO
MXL1179IN	-40°C to +85°C	14 Plastic DIP

## Pin Configurations



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## ABSOLUTE MAXIMUM RATINGS

Supply Voltage.....	$\pm 22$ V
Differential Input Voltage.....	$\pm 30$ V
Input Voltage.....	Equal to Positive Supply Voltage
.....	5V Below Negative Supply Voltage
Output Short-Circuit Duration.....	Continuous
Continuous Power Dissipation ( $T_A = +70^\circ\text{C}$ )	
8-Pin Plastic DIP (derate 9.09mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$ )	727mW
14-Pin Plastic DIP (derate 10.00mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$ )	800mW
16-Pin Wide SO (derate 9.52mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$ )	762mW

## Operating Temperature Ranges:

MXL117_AC_/C_/S.....	$0^\circ\text{C}$ to $+70^\circ\text{C}$
MXL117_I.....	$-40^\circ\text{C}$ to $+85^\circ\text{C}$
Storage Temperature Range.....	$-65^\circ\text{C}$ to $+150^\circ\text{C}$
Lead Temperature (soldering, 10sec).....	$+300^\circ\text{C}$

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.

## ELECTRICAL CHARACTERISTICS

( $V_S = 5\text{V}$ ,  $0\text{V}$ ,  $V_{CM} = 0.1\text{V}$ ,  $V_O = 1.4\text{V}$ ,  $T_A = +25^\circ\text{C}$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MXL1178AC MXL1179AC			MXL1178C/S MXL1179C/S			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	$V_{OS}$	MXL1178	30	70	40	120	$\mu\text{V}$		
		MXL1179	35	100	40	150			
		MXL1178S			80	450			
		MXL1179S			90	600			
Long-Term Input Offset-Voltage Stability	$\frac{\Delta V_{OS}}{\Delta \text{Time}}$		0.5		0.6	$\mu\text{V}/\text{Mo}$			
Input Offset Current	$I_{OS}$		0.05	0.25	0.05	0.35	nA		
Input Bias Current	$I_B$		3	5	3	6	nA		
Input Noise Voltage	$e_n$	0.1Hz to 10Hz (Note 1)	0.9	2.0	0.9		$\mu\text{V}_{p-p}$		
Input Noise Voltage Density		$f_O = 10\text{Hz}$ (Note 1)	50	75	50		$\text{nV}/\sqrt{\text{Hz}}$		
		$f_O = 1000\text{Hz}$ (Note 1)	49	65	49				
Input Noise Current	$i_n$	0.1Hz to 10Hz (Note 1)	1.5	2.5	1.5		$\text{pA}_{p-p}$		
Input Noise Current Density		$f_O = 10\text{Hz}$ (Note 1)	0.03	0.07	0.03		$\text{pA}/\sqrt{\text{Hz}}$		
		$f_O = 1000\text{Hz}$	0.01		0.01				
Input Resistance	$R_{IN}$	Differential mode (Note 1)	0.8	2.0	0.6	2.0	$\text{G}\Omega$		
		Common mode		12		12			
Input Voltage Range			3.5	3.9	3.5	3.9	V		
			0	-0.3	0	-0.3			
Common-Mode Rejection Ratio	CMRR	$V_{CM} = 0\text{V}$ to $3.5\text{V}$	93	103	90	102	dB		
Power-Supply Rejection Ratio	PSRR	$V_S = 2.2\text{V}$ to $12\text{V}$	94	104	92	104	dB		
Large-Signal Voltage Gain	$A_{VOL}$	$V_O = 0.03\text{V}$ to $4\text{V}$ , no load (Note 1)	140	700	110	700	$\text{V}/\text{mV}$		
		$V_O = 0.03\text{V}$ to $3.5\text{V}$ , $R_L = 50\text{k}\Omega$	80	200	70	200			
Maximum Output Voltage Swing	$V_{OUT}$	Output low, no load	6.5	9.0	6.5	9.0	$\text{mV}$		
		Output low, $2\text{k}\Omega$ to GND	0.2	0.6	0.2	0.6			
		Output low, $I_{SINK} = 100\mu\text{A}$	120	160	120	160			
		Output high, no load	4.2	4.4	4.2	4.4	V		
		Output high, $2\text{k}\Omega$ to GND	3.5	3.8	3.5	3.8			
Slew Rate	SR	$A_V = +1$ , $C_L = 10\text{pF}$ (Note 1)	0.013	0.025	0.013	0.025	$\text{V}/\mu\text{s}$		
Gain-Bandwidth Product	GBW	$f_O \leq 5\text{kHz}$		60		60	kHz		
Supply Current per Amplifier	$I_S$	$V_S = 5\text{V}$ , $0\text{V}$ , $V_O = 1.4\text{V}$	13	18	14	21	$\mu\text{A}$		
		$V_S = \pm 1.5\text{V}$ , $V_O = 0\text{V}$	12	17	13	20			
Channel Separation		$\Delta V_{IN} = 3\text{V}$ , $R_L = 10\text{k}\Omega$	130		130		dB		
Minimum Supply Voltage	$V_S$	(Note 2)	2.0	2.2	2.0	2.2	V		

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**MXL1178/MXL1179**

## ELECTRICAL CHARACTERISTICS

(V<sub>S</sub> = 5V, 0V, V<sub>CM</sub> = 0.1V, V<sub>O</sub> = 1.4V, T<sub>A</sub> = -40°C to +85°C for I grades, T<sub>A</sub> = 0°C to +70°C for S grades, unless otherwise noted.)  
(Note 3)

PARAMETER	SYMBOL	CONDITIONS	MXL1178I MXL1179I			MXL1178S MXL1179S			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V <sub>OS</sub>	MXL1178	80	315		120	650	$\mu$ V	
		MXL1179	80	345		130	800		
Input Offset-Voltage Drift	$\frac{\Delta V_{OS}}{\Delta T}$	(Note 1)	0.6	3.0		0.8	4.5	$\mu$ V/°C	
Input Offset Current	I <sub>OS</sub>		0.07	0.7		0.06	0.50	nA	
Input Bias Current	I <sub>B</sub>		4	8		3	7	nA	
Common-Mode Rejection Ratio	CMRR	V <sub>CM</sub> = 0.05V to 3.2V for I grade	84	98				dB	
		V <sub>CM</sub> = 0V to 3.4V for S grade				86	100		
Power-Supply Rejection Ratio	PSRR	V <sub>S</sub> = 3.0V to 12V for I grade	86	100				dB	
		V <sub>S</sub> = 2.5V to 12V for S grade				88	102		
Large-Signal Voltage Gain	A <sub>VOL</sub>	V <sub>O</sub> = 0.05V to 4V, no load (Note 1)	55	350		80	500	V/mV	
		V <sub>O</sub> = 0.05V to 3.5V, R <sub>L</sub> = 50k $\Omega$	35	130		45	160		
Maximum Output Voltage Swing	V <sub>OUT</sub>	Output low, no load		9	13		8	11	mV
		Output low, I <sub>SINK</sub> = 100 $\mu$ A		160	220		140	190	
		Output high, no load	3.9	4.2		4.1	4.3	V	
		Output high, 2k $\Omega$ to GND	3.0	3.7		3.3	3.8		
Supply Current per Amplifier	I <sub>S</sub>		15	27		15	24	$\mu$ A	

## ELECTRICAL CHARACTERISTICS

(V<sub>S</sub> = 5V, 0V, V<sub>CM</sub> = 0.1V, V<sub>O</sub> = 1.4V, T<sub>A</sub> = 0°C to +70°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MXL1178AC MXL1179AC			MXL1178C MXL1179C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V <sub>OS</sub>	MXL1178	50	170		65	250	$\mu$ V	
		MXL1179	60	200		70	290		
Input Offset-Voltage Drift	$\frac{\Delta V_{OS}}{\Delta T}$	(Note 1)	0.5	2.2		0.6	3.0	$\mu$ V/°C	
Input Offset Current	I <sub>OS</sub>		0.06	0.35		0.06	0.50	nA	
Input Bias Current	I <sub>B</sub>		3	6		3	7	nA	
Common-Mode Rejection Ratio	CMRR	V <sub>CM</sub> = 0V to 3.4V	90	101		86	100	dB	
Power-Supply Rejection Ratio	PSRR	V <sub>S</sub> = 2.5V to 12V	90	102		88	102	dB	
Large-Signal Voltage Gain	A <sub>VOL</sub>	V <sub>O</sub> = 0.05V to 4V, no load (Note 1)	105	500		80	500	V/mV	
		V <sub>O</sub> = 0.05V to 3.5V, R <sub>L</sub> = 50k $\Omega$	55	160		45	160		
Maximum Output Voltage Swing	V <sub>OUT</sub>	Output low, no load		8	11		8	11	mV
		Output low, I <sub>SINK</sub> = 100 $\mu$ A		140	190		140	190	
		Output high, no load	4.1	4.3		4.1	4.3	V	
		Output high, 2k $\Omega$ to GND	3.3	3.8		3.3	3.8		
Supply Current per Amplifier	I <sub>S</sub>		14	21		15	24	$\mu$ A	

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## ELECTRICAL CHARACTERISTICS

( $V_S = \pm 15V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MXL1178AC MXL1179AC			MXL1178C/S MXL1179C/S			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	$V_{OS}$		80	350		100	480	$\mu V$	
		MXL1178S				150	900		
		MXL1179S				160	1050		
Input Offset Current	$I_{OS}$		0.05	0.25		0.05	0.35	nA	
Input Bias Current	$I_B$		3	5		3	6	nA	
Input Voltage Range			13.5 -15.0	13.9 -15.3		13.5 -15.0	13.9 -15.3	V	
Common-Mode Rejection Ratio	CMRR	$V_{CM} = +13.5V, -15V$	97	106		94	106	dB	
Power-Supply Rejection Ratio	PSRR	$V_S = 5V, 0V$ to $\pm 18V$	96	112		94	112	dB	
Large-Signal Voltage Gain	$A_{VOL}$	$V_O = \pm 10V, R_L = 50k\Omega$	300	1200		250	1000	V/mV	
		$V_O = \pm 10V$ , no load	600	2500		400	2500		
Maximum Output Voltage Swing	$V_{OUT}$	$R_L = 50k\Omega$	$\pm 13.0$	$\pm 14.2$		$\pm 13.0$	$\pm 14.2$	V	
		$R_L = 2k\Omega$	$\pm 11.0$	$\pm 12.7$		$\pm 11.0$	$\pm 12.7$		
Slew Rate	SR	$A_V = +1V$	0.02	0.04		0.02	0.04	V/ $\mu s$	
Gain Bandwidth Product	GBW	$f_0 \leq 5kHz$		85			85	kHz	
Supply Current per Amplifier	$I_S$		16	21		17	25	$\mu A$	

## ELECTRICAL CHARACTERISTICS

( $V_S = \pm 15V$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$  for I grades,  $T_A = 0^\circ C$  to  $+70^\circ C$  for S grades, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MXL1178I MXL1179I			MXL1178S MXL1179S			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	$V_{OS}$	MXL1178	130	740		190	1150	$\mu V$	
		MXL1179	130	740		200	1300		
Input Offset-Voltage Drift	$\frac{\Delta V_{OS}}{\Delta T}$	(Note 1)	0.7	4.0		0.9	5.5	$\mu V/^\circ C$	
Input Offset Current	$I_{OS}$		0.07	0.7		0.06	0.35	nA	
Input Bias Current	$I_B$		4	8		3	7	nA	
Large-Signal Voltage Gain	$A_{VOL}$	$V_O = \pm 10V, R_L = 50k\Omega$	100	500		150	750	V/mV	
Common-Mode Rejection Ratio	CMRR	$V_{CM} = +13V, -14.9V$	88	103		91	104	dB	
Power-Supply Rejection Ratio	PSRR	$V_S = 5V, 0V$ to $\pm 18V$	88	109		91	110	dB	
Maximum Output Voltage Swing	$V_{OUT}$	$R_L = 5k\Omega$	$\pm 11.0$	$\pm 13.5$		$\pm 11.0$	$\pm 13.5$	V	
Supply Current per Amplifier	$I_S$		19	30		18	28	$\mu A$	

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**MXL1178/MXL1179**

## ELECTRICAL CHARACTERISTICS

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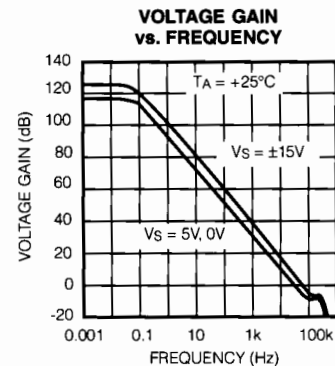
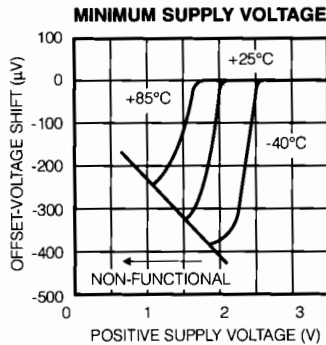
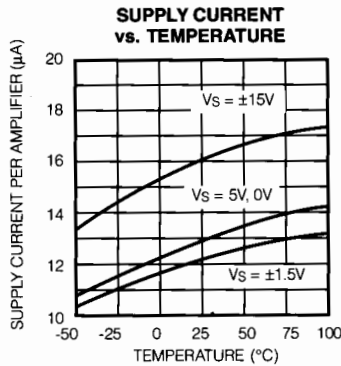
PARAMETER	SYMBOL	CONDITIONS	MXL1178AC MXL1179AC			MXL1178C MXL1179C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	$V_{OS}$			100	480		130	660	$\mu V$
Input Offset-Voltage Drift	$\frac{\Delta V_{OS}}{\Delta T}$	(Note 1)		0.6	2.8		0.7	4.0	$\mu V/^\circ C$
Input Offset Current	$I_{OS}$			0.06	0.35		0.06	0.35	nA
Input Bias Current	$I_B$			3	6		3	7	nA
Large-Signal Voltage Gain	$A_{VOL}$	$V_O = \pm 10V$ , $R_L = 50k\Omega$	200	800		150	750		V/mV
Common-Mode Rejection Ratio	CMRR	$V_{CM} = +13V, -15V$	94	104		91	104		dB
Power-Supply Rejection Ratio	PSRR	$V_S = 5V, 0V$ to $\pm 18V$	93	110		91	110		dB
Maximum Output Voltage Swing	$V_{OUT}$	$R_L = 5k\Omega$	$\pm 11.0$	$\pm 13.6$		$\pm 11.0$	$\pm 13.6$		V
Supply Current per Amplifier	$I_S$			17	24		18	28	$\mu A$

**Note 1:** Guaranteed by design.

**Note 2:** Power-supply rejection ratio is measured at the minimum supply voltage. The op amps actually work at 1.7V supply, but with additional input offset-voltage skew.

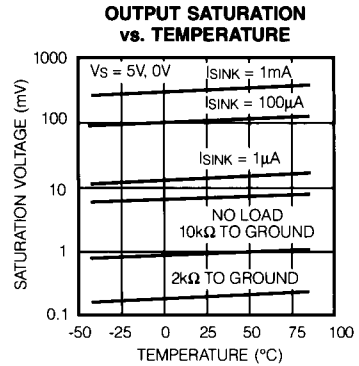
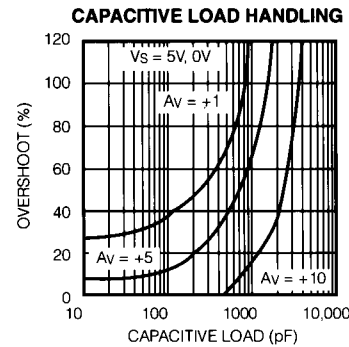
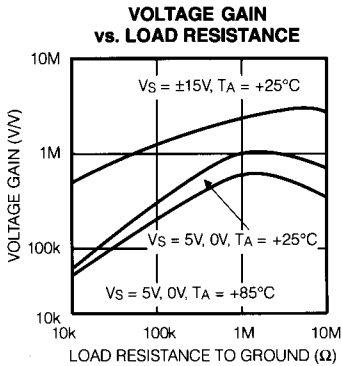
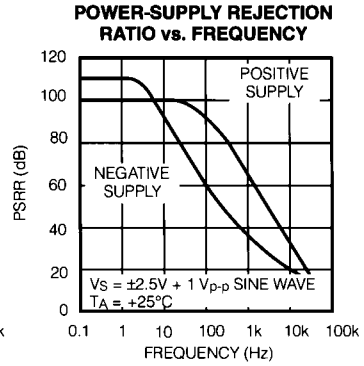
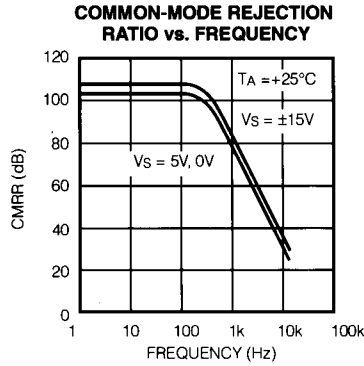
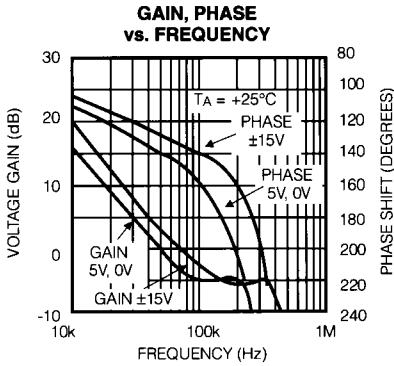
**Note 3:** During testing at  $-40^\circ C$ , the 5V power-supply turn-on time is less than 0.5sec.

## Typical Operating Characteristics

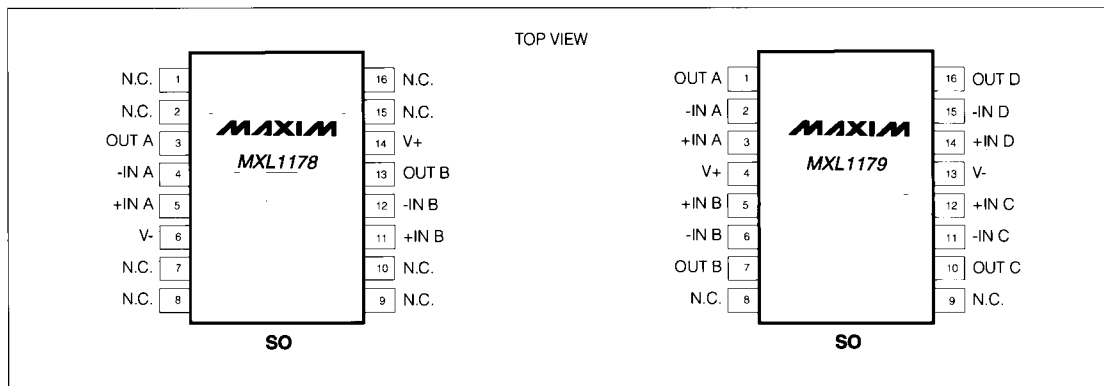


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## Typical Operating Characteristics (continued)

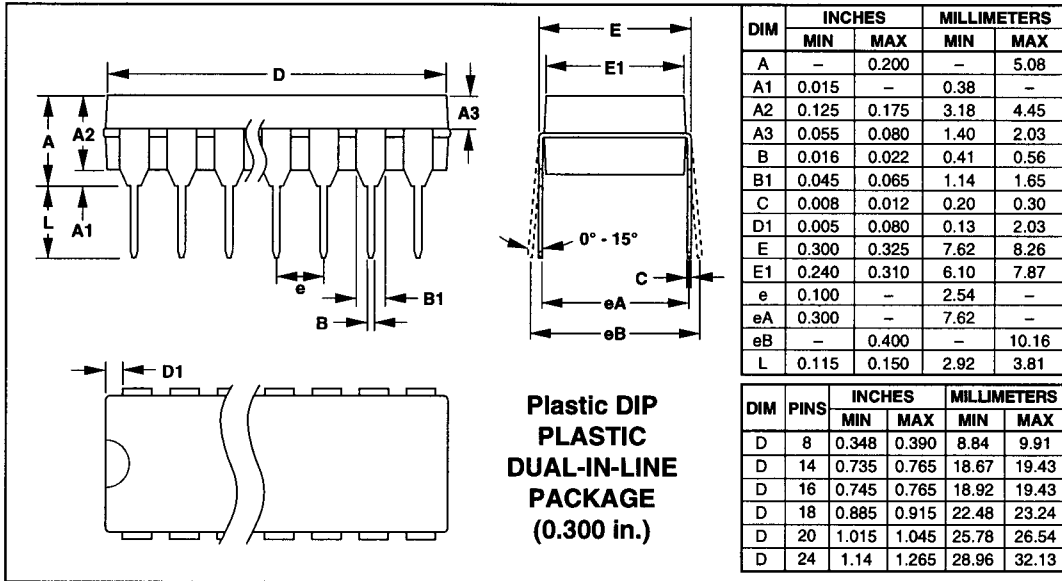


## Pin Configurations (continued)



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## Package Information

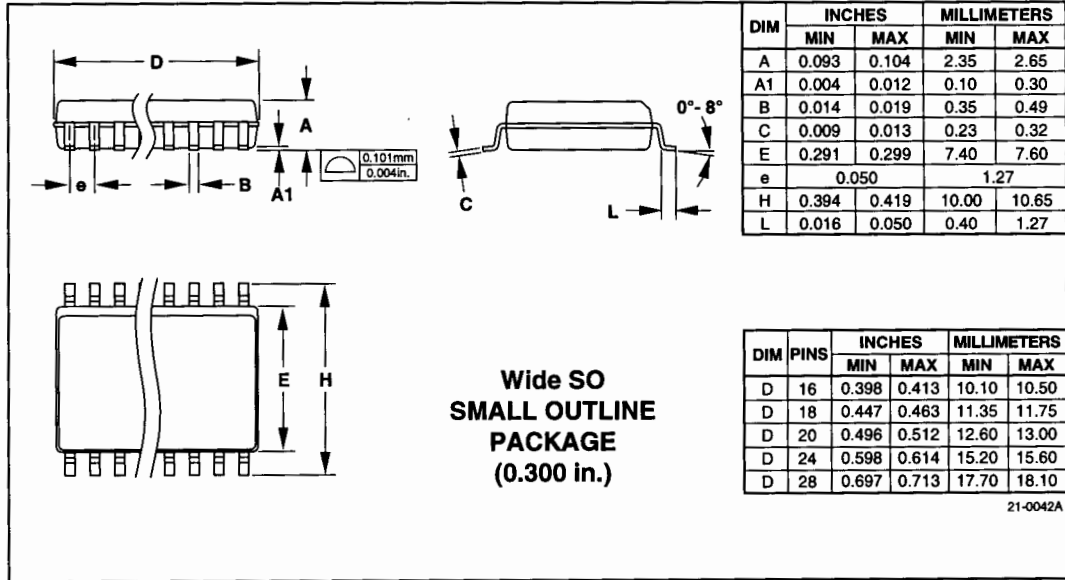


**MXL1178/MXL1179**

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## Package Information (continued)



Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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