

MAXIM

17 μ A 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 17 μ A max per op amp supply current, as well as precision offset specifications: 30 μ V 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.

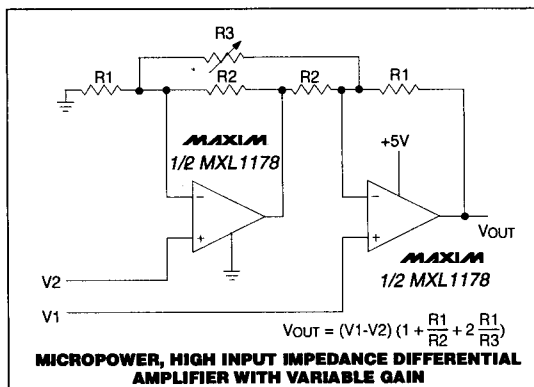
Both devices are optimized for +5V single-supply operation, but specifications for $\pm$ 15V operation are also provided.

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 1 μ A 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



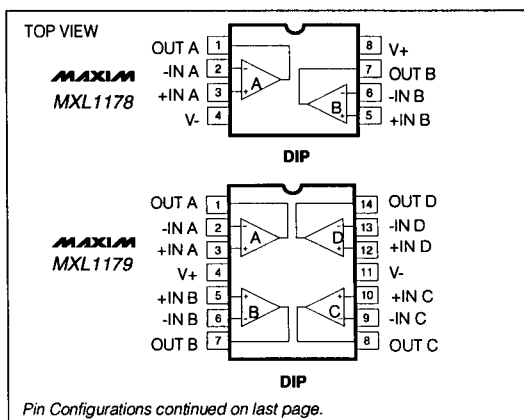
Features

- ◆ 17 μ A Max Supply Current per Amplifier
- ◆ 70 μ V Max Offset Voltage
- ◆ 250pA Max Offset Current
- ◆ 5nA Max Input Bias Current
- ◆ 0.9 μ V_{p-p} 0.1Hz to 10Hz Voltage Noise
- ◆ 1.5pA_{p-p} 0.1Hz to 10Hz Current Noise
- ◆ 0.5 μ V/ $^{\circ}$ C Offset-Voltage Drift
- ◆ 85kHz Gain-Bandwidth Product
- ◆ 0.04V/ μ s 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 $^{\circ}$ C to +70 $^{\circ}$ C	8 Plastic DIP
MXL1178CN8	0 $^{\circ}$ C to +70 $^{\circ}$ C	8 Plastic DIP
MXL1178S	0 $^{\circ}$ C to +70 $^{\circ}$ C	16 Wide SO
MXL1178IN8	-40 $^{\circ}$ C to +85 $^{\circ}$ C	8 Plastic DIP
MXL1179ACN	0 $^{\circ}$ C to +70 $^{\circ}$ C	14 Plastic DIP
MXL1179CN	0 $^{\circ}$ C to +70 $^{\circ}$ C	14 Plastic DIP
MXL1179S	0 $^{\circ}$ C to +70 $^{\circ}$ C	16 Wide SO
MXL1179IN	-40 $^{\circ}$ C to +85 $^{\circ}$ C	14 Plastic DIP

Pin Configurations



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ABSOLUTE MAXIMUM RATINGS

Supply Voltage..... ± 22 V
 Differential Input Voltage..... ± 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°C to $+70^\circ\text{C}$
 MXL117_I..... -40°C to $+85^\circ\text{C}$
 Storage Temperature Range..... -65°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

($V_S = 5\text{V}$, 0V , $V_{CM} = 0.1\text{V}$, $V_O = 1.4\text{V}$, $T_A = +25^\circ\text{C}$, 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		μV
		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			μV_{p-p}
Input Noise Voltage Density		$f_0 = 10\text{Hz}$ (Note 1)	50	75		50			$\text{nV}/\sqrt{\text{Hz}}$
		$f_0 = 1000\text{Hz}$ (Note 1)	49	65		49			
Input Noise Current	i_n	0.1Hz to 10Hz (Note 1)	1.5	2.5		1.5			pA_{p-p}
Input Noise Current Density		$f_0 = 10\text{Hz}$ (Note 1)	0.03	0.07		0.03			$\text{pA}/\sqrt{\text{Hz}}$
		$f_0 = 1000\text{Hz}$	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 3.5V	93	103		90	102		dB
Power-Supply Rejection Ratio	PSRR	$V_S = 2.2\text{V}$ to 12V	94	104		92	104		dB
Large-Signal Voltage Gain	A_{VOL}	$V_O = 0.03\text{V}$ to 4V , no load (Note 1)	140	700		110	700		V/mV
		$V_O = 0.03\text{V}$ to 3.5V , $R_L = 50\text{k}\Omega$	80	200		70	200		
Maximum Output Voltage Swing	V_{OUT}	Output low, no load	6.5	9.0		6.5	9.0		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	$f_0 \leq 5\text{kHz}$		60			60		kHz
Supply Current per Amplifier	I_S	$V_S = 5\text{V}$, 0V , $V_O = 1.4\text{V}$	13	18		14	21		μA
		$V_S = \pm 1.5\text{V}$, $V_O = 0\text{V}$	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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ELECTRICAL CHARACTERISTICS

($V_S = 5V$, $0V$, $V_{CM} = 0.1V$, $V_O = 1.4V$, $T_A = -40^\circ C$ to $+85^\circ C$ for I grades, $T_A = 0^\circ C$ to $+70^\circ C$ for S grades, unless otherwise noted.)
(Note 3)

PARAMETER	SYMBOL	CONDITIONS	MXL1178I MXL1179I			MXL1178S MXL1179S			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}	MXL1178		80	315		120	650	μV
		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	$\mu V/^\circ C$
Input Offset Current	I_{OS}			0.07	0.7		0.06	0.50	nA
Input Bias Current	I_B			4	8		3	7	nA
Common-Mode Rejection Ratio	CMRR	$V_{CM} = 0.05V$ to $3.2V$ for I grade	84	98					dB
		$V_{CM} = 0V$ to $3.4V$ for S grade				86	100		
Power-Supply Rejection Ratio	PSRR	$V_S = 3.0V$ to $12V$ for I grade	86	100					dB
		$V_S = 2.5V$ to $12V$ for S grade				88	102		
Large-Signal Voltage Gain	A_{VOL}	$V_O = 0.05V$ to $4V$, no load (Note 1)	55	350		80	500		V/mV
		$V_O = 0.05V$ to $3.5V$, $R_L = 50k\Omega$	35	130		45	160		
Maximum Output Voltage Swing	V_{OUT}	Output low, no load		9	13		8	11	mV
		Output low, $I_{SINK} = 100\mu A$		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_S			15	27		15	24	μA

ELECTRICAL CHARACTERISTICS

($V_S = 5V$, $0V$, $V_{CM} = 0.1V$, $V_O = 1.4V$, $T_A = 0^\circ C$ to $+70^\circ C$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MXL1178AC MXL1179AC			MXL1178C MXL1179C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}	MXL1178		50	170		65	250	μV
		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	$\mu V/^\circ C$
Input Offset Current	I_{OS}			0.06	0.35		0.06	0.50	nA
Input Bias Current	I_B			3	6		3	7	nA
Common-Mode Rejection Ratio	CMRR	$V_{CM} = 0V$ to $3.4V$	90	101		86	100		dB
Power-Supply Rejection Ratio	PSRR	$V_S = 2.5V$ to $12V$	90	102		88	102		dB
Large-Signal Voltage Gain	A_{VOL}	$V_O = 0.05V$ to $4V$, no load (Note 1)	105	500		80	500		V/mV
		$V_O = 0.05V$ to $3.5V$, $R_L = 50k\Omega$	55	160		45	160		
Maximum Output Voltage Swing	V_{OUT}	Output low, no load		8	11		8	11	mV
		Output low, $I_{SINK} = 100\mu A$		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_S			14	21		15	24	μA

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ELECTRICAL CHARACTERISTICS

(V_S = ±15V, T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MXL1178AC MXL1179AC			MXL1178C/VS MXL1179C/VS			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V _{OS}		80	350		100	480		μV
		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 ±18V	96	112		94	112		dB
Large-Signal Voltage Gain	A _{VOL}	V _O = ±10V, R _L = 50kΩ	300	1200		250	1000		V/mV
		V _O = ±10V, no load	600	2500		400	2500		
Maximum Output Voltage Swing	V _{OUT}	R _L = 50kΩ	±13.0	±14.2		±13.0	±14.2		V
		R _L = 2kΩ	±11.0	±12.7		±11.0	±12.7		
Slew Rate	SR	A _V = +1V	0.02	0.04		0.02	0.04		V/μs
Gain Bandwidth Product	GBW	f ₀ ≤ 5kHz		85			85		kHz
Supply Current per Amplifier	I _S		16	21		17	25		μA

ELECTRICAL CHARACTERISTICS

(V_S = ±15V, T_A = -40°C to +85°C for I grades, T_A = 0°C to +70°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		μV
		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		μV/°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 = ±10V, R _L = 50kΩ	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 ±18V	88	109		91	110		dB
Maximum Output Voltage Swing	V _{OUT}	R _L = 5kΩ	±11.0	±13.5		±11.0	±13.5		V
Supply Current per Amplifier	I _S		19	30		18	28		μA

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ELECTRICAL CHARACTERISTICS

($V_S = \pm 15V$, $T_A = 0^\circ C$ to $+70^\circ C$, unless otherwise noted.)

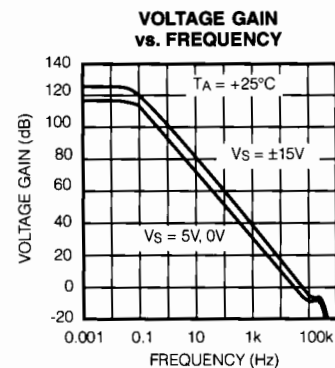
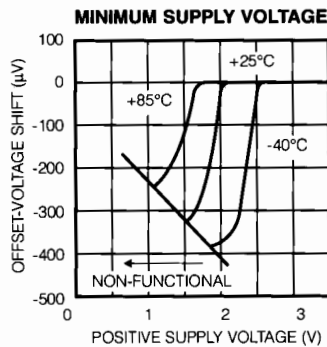
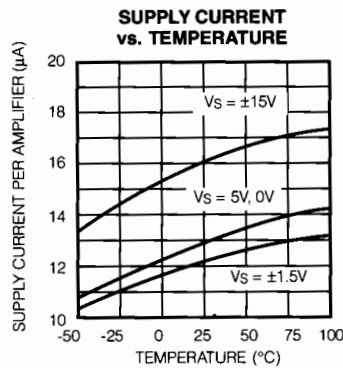
PARAMETER	SYMBOL	CONDITIONS	MXL1178AC MXL1179AC			MXL1178C MXL1179C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}			100	480		130	660	μV
Input Offset-Voltage Drift	$\frac{\Delta V_{OS}}{\Delta T}$	(Note 1)		0.6	2.8		0.7	4.0	$\mu V/^\circ C$
Input Offset Current	I_{OS}			0.06	0.35		0.06	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}	$R_L = 5k\Omega$	± 11.0	± 13.6		± 11.0	± 13.6		V
Supply Current per Amplifier	I_S			17	24		18	28	μA

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.

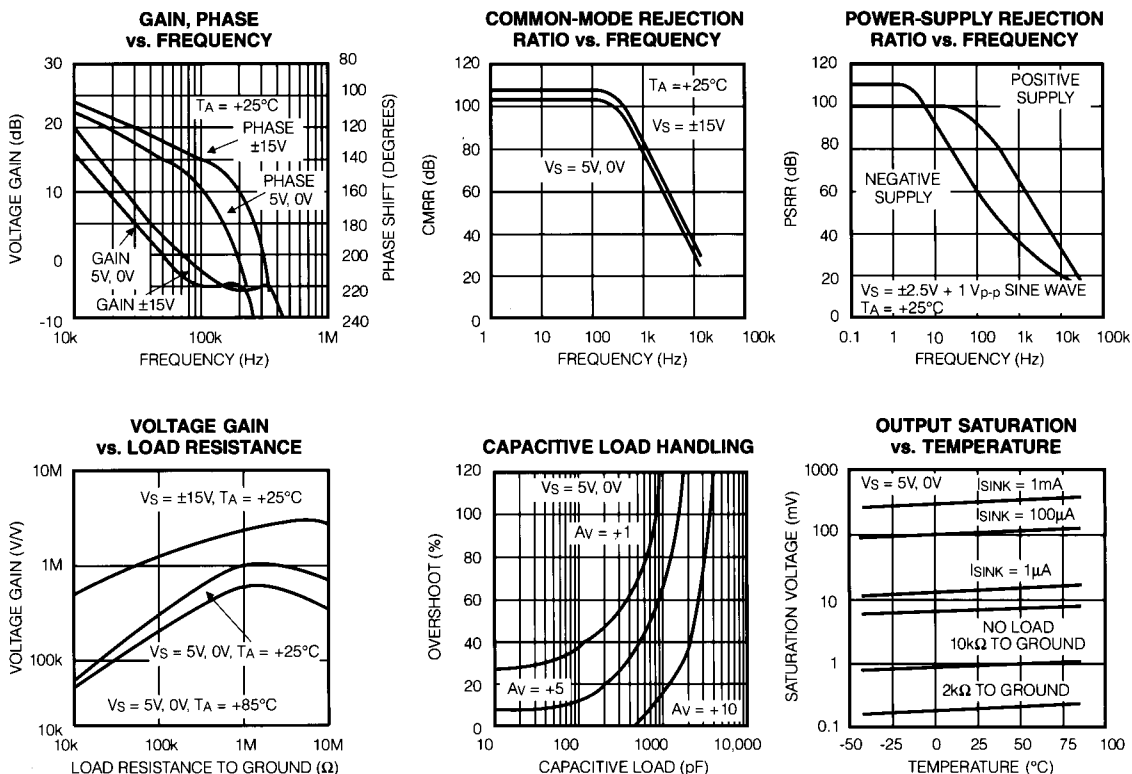
Note 3: During testing at $-40^\circ C$, the 5V power-supply turn-on time is less than 0.5sec.

Typical Operating Characteristics

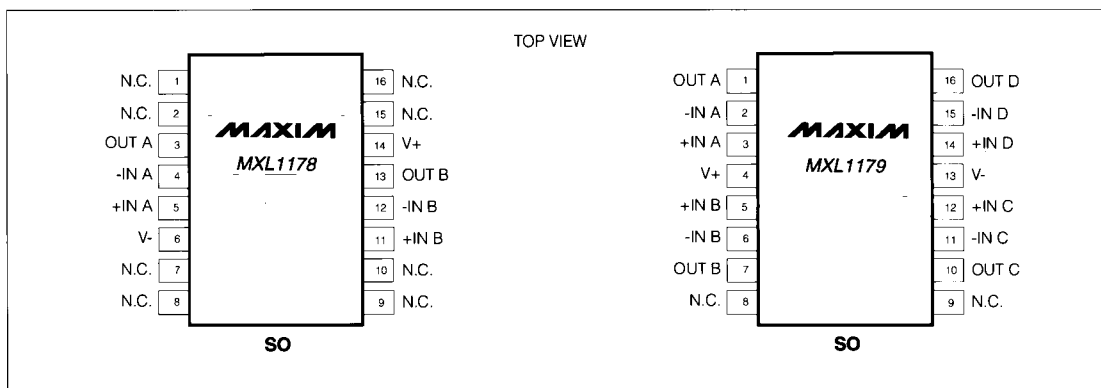


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Typical Operating Characteristics (continued)



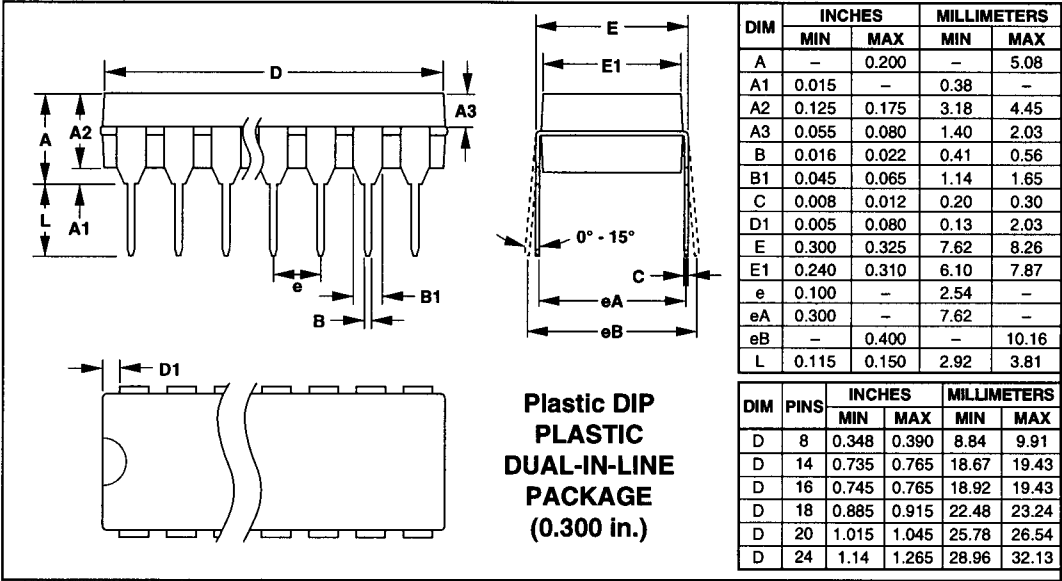
Pin Configurations (continued)



**17 μ A Max, Dual/Quad, Single-Supply,
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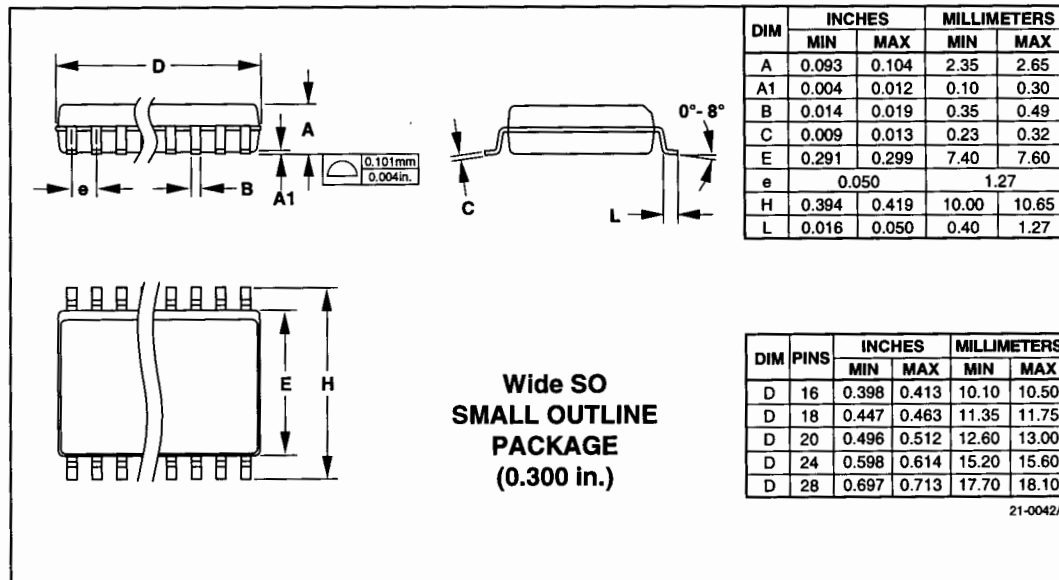
Package Information

MXL1178/MXL1179



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Package Information (continued)



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