19-0104; Rev 1; 8/94

MAXIM

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

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

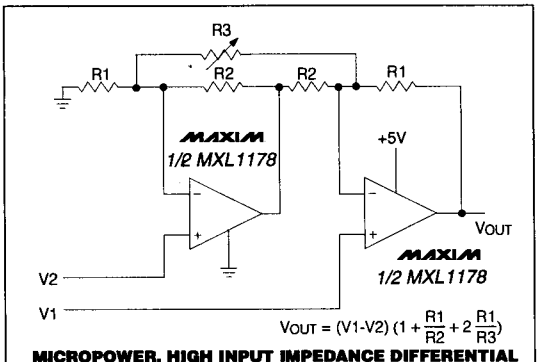
Features

- ♦ **17µA Max Supply Current per Amplifier**
- ♦ **70µV Max Offset Voltage**
- ♦ **250pA Max Offset Current**
- ♦ **5nA Max Input Bias Current**
- ♦ **0.9µV$_{p-p}$ 0.1Hz to 10Hz Voltage Noise**
- ♦ **1.5pA$_{p-p}$ 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

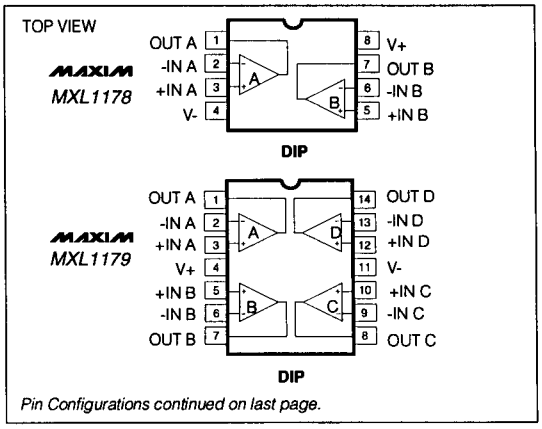
PART	TEMP. RANGE	PIN-PACKAGE
MXL1178ACN8	0°C to +70°C	8 Plastic DIP
MXL1178CN8	0°C to +70°C	8 Plastic DIP
MXL1178S	0°C to +70°C	16 Wide SO
MXL1178IN8	-40°C to +85°C	8 Plastic DIP
MXL1179ACN	0°C to +70°C	14 Plastic DIP
MXL1179CN	0°C to +70°C	14 Plastic DIP
MXL1179S	0°C to +70°C	16 Wide SO
MXL1179IN	-40°C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

Typical Operating Circuit



MICROPOWER, HIGH INPUT IMPEDANCE DIFFERENTIAL AMPLIFIER WITH VARIABLE GAIN

Pin Configurations



Pin Configurations continued on last page.

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

ABSOLUTE MAXIMUM RATINGS

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

Operating Temperature Ranges:
MXL117_AC__/C__/S ..... 0°C to +70°C
MXL117_I_ ..... -40°C to +85°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (soldering, 10sec) ..... +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_S = 5V, 0V, V_{CM} = 0.1V, V_O = 1.4V, T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MXL1178AC MXL1179AC			MXL1178C/I/S MXL1179C/I/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	$\frac{\Delta V_{OS}}{\Delta Time}$			0.5			0.6		µV/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_O = 10Hz (Note 1)		50	75		50		$nV/\sqrt{Hz}$
		f_O = 1000Hz (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_O = 10Hz (Note 1)		0.03	0.07		0.03		$pA/\sqrt{Hz}$
		f_O = 1000Hz		0.01			0.01		
Input Resistance	R_{IN}	Differential mode (Note 1)	0.8	2.0		0.6	2.0		GΩ
		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} = 0V to 3.5V	93	103		90	102		dB
Power-Supply Rejection Ratio	PSRR	V_S = 2.2V to 12V	94	104		92	104		dB
Large-Signal Voltage Gain	A_{VOL}	V_O = 0.03V to 4V, no load (Note 1)	140	700		110	700		V/mV
		V_O = 0.03V to 3.5V, R_L = 50kΩ	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, 2kΩ to GND		0.2	0.6		0.2	0.6	
		Output low, I_{SINK} = 100µA		120	160		120	160	
		Output high, no load	4.2	4.4		4.2	4.4		V
		Output high, 2kΩ to GND	3.5	3.8		3.5	3.8		
Slew Rate	SR	A_V = +1, C_L = 10pF (Note 1)	0.013	0.025		0.013	0.025		V/µs
Gain-Bandwidth Product	GBW	$f_O \le$ 5kHz		60			60		kHz
Supply Current per Amplifier	I_S	V_S = 5V, 0V, V_O = 1.4V		13	18		14	21	µA
		V_S = ±1.5V, V_O = 0V		12	17		13	20	
Channel Separation		ΔV_{IN} = 3V, R_L = 10kΩ		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°C to +85°C for I grades, T_A = 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_{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	µV/°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 = 50kΩ	35	130		45	160		
Maximum Output Voltage Swing	V_{OUT}	Output low, no load		9	13		8	11	mV
		Output low, I_{SINK} = 100µA		160	220		140	190	
		Output high, no load	3.9	4.2		4.1	4.3		V
		Output high, 2kΩ 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°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_{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	µV/°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 = 50kΩ	55	160		45	160		
Maximum Output Voltage Swing	V_{OUT}	Output low, no load		8	11		8	11	mV
		Output low, I_{SINK} = 100µA		140	190		140	190	
		Output high, no load	4.1	4.3		4.1	4.3		V
		Output high, 2kΩ to GND	3.3	3.8		3.3	3.8		
Supply Current per Amplifier	I_S			14	21		15	24	µA

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

ELECTRICAL CHARACTERISTICS

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

PARAMETER	SYMBOL	CONDITIONS	MXL1178AC MXL1179AC			MXL1178C/I/S MXL1179C/I/S			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_O ≤ 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

ELECTRICAL CHARACTERISTICS

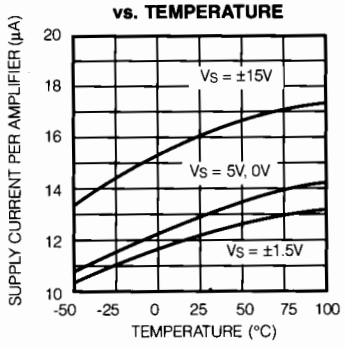
(V_S = ±15V, T_A = 0°C to +70°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MXL1178AC MXL1179AC			MXL1178C MXL1179C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{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	µV/°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 = ±10V, R_L = 50kΩ	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 ±18V	93	110		91	110		dB
Maximum Output Voltage Swing	V_{OUT}	R_L = 5kΩ	±11.0	±13.6		±11.0	±13.6		V
Supply Current per Amplifier	I_S			17	24		18	28	µA

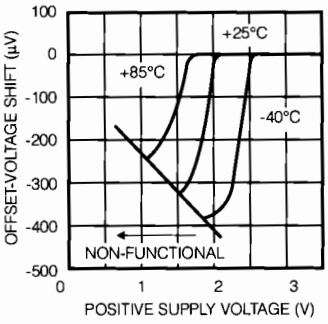
Note 1: Guaranteed by design.
Note 2: Power-supply rejection ratio is measured at the minimum supply voltage. The op amps actually work at 1.7V supply, but with additional input offset-voltage skew.
Note 3: During testing at -40°C, the 5V power-supply turn-on time is less than 0.5sec.

Typical Operating Characteristics

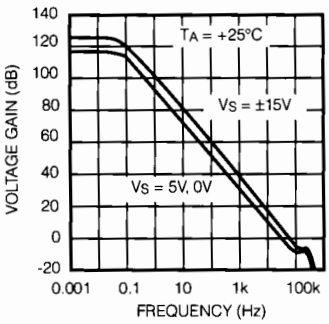
SUPPLY CURRENT vs. TEMPERATURE



MINIMUM SUPPLY VOLTAGE



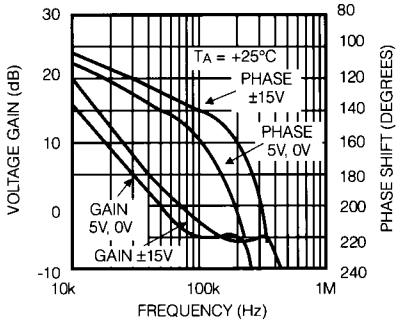
VOLTAGE GAIN vs. FREQUENCY



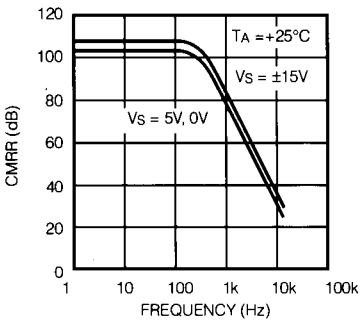
17µA Max, Dual/Quad, Single-Supply, Precision Op Amps

Typical Operating Characteristics (continued)

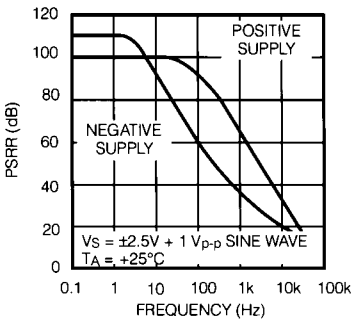
GAIN, PHASE vs. FREQUENCY



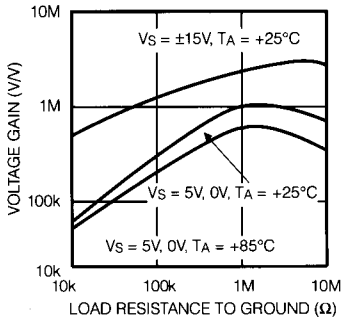
COMMON-MODE REJECTION RATIO vs. FREQUENCY



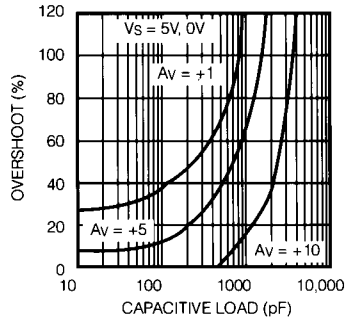
POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



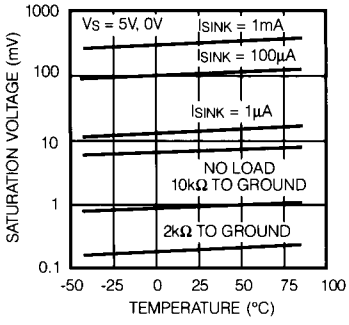
VOLTAGE GAIN vs. LOAD RESISTANCE



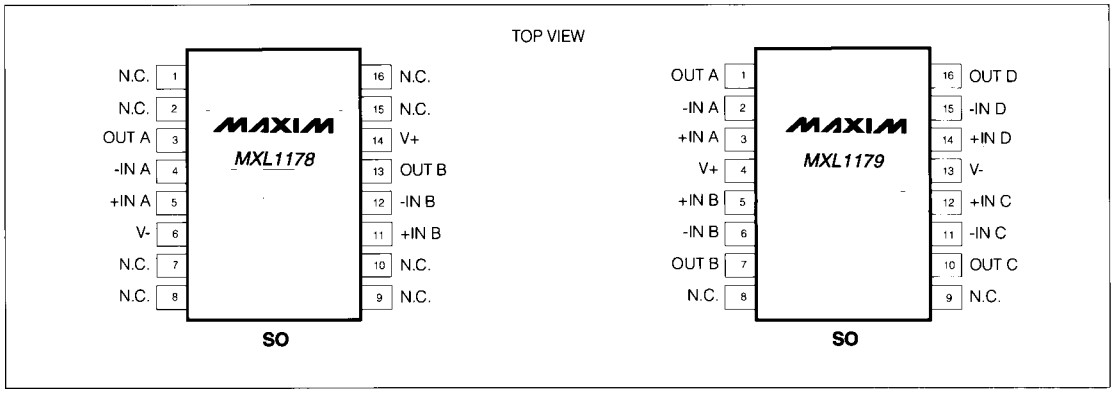
CAPACITIVE LOAD HANDLING



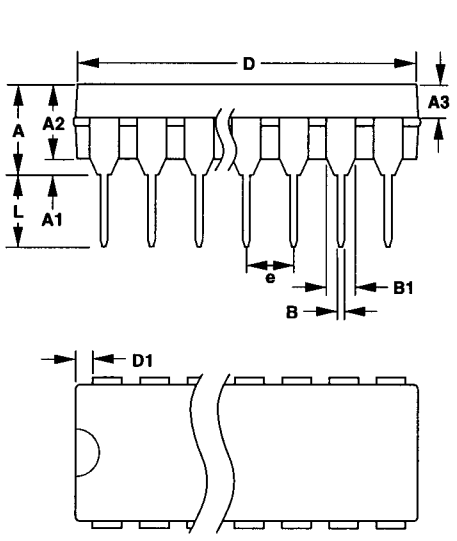
OUTPUT SATURATION vs. TEMPERATURE



Pin Configurations (continued)



Package Information



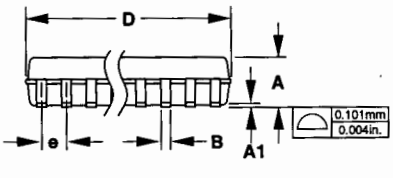
Plastic DIP
PLASTIC
DUAL-IN-LINE
PACKAGE
(0.300 in.)

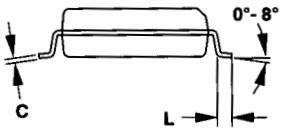
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	–	0.200	–	5.08
A1	0.015	–	0.38	–
A2	0.125	0.175	3.18	4.45
A3	0.055	0.080	1.40	2.03
B	0.016	0.022	0.41	0.56
B1	0.045	0.065	1.14	1.65
C	0.008	0.012	0.20	0.30
D1	0.005	0.080	0.13	2.03
E	0.300	0.325	7.62	8.26
E1	0.240	0.310	6.10	7.87
e	0.100	–	2.54	–
eA	0.300	–	7.62	–
eB	–	0.400	–	10.16
L	0.115	0.150	2.92	3.81

DIM	PINS	INCHES		MILLIMETERS	
		MIN	MAX	MIN	MAX
D	8	0.348	0.390	8.84	9.91
D	14	0.735	0.765	18.67	19.43
D	16	0.745	0.765	18.92	19.43
D	18	0.885	0.915	22.48	23.24
D	20	1.015	1.045	25.78	26.54
D	24	1.14	1.265	28.96	32.13

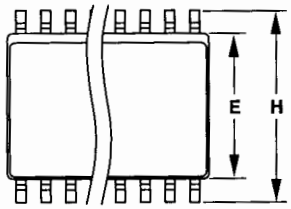
17µA Max, Dual/Quad, Single-Supply, Precision Op Amps

Package Information (continued)





DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.093	0.104	2.35	2.65
A1	0.004	0.012	0.10	0.30
B	0.014	0.019	0.35	0.49
C	0.009	0.013	0.23	0.32
E	0.291	0.299	7.40	7.60
e	0.050		1.27	
H	0.394	0.419	10.00	10.65
L	0.016	0.050	0.40	1.27



Wide SO
SMALL OUTLINE
PACKAGE
(0.300 in.)

DIM	PINS	INCHES		MILLIMETERS	
		MIN	MAX	MIN	MAX
D	16	0.398	0.413	10.10	10.50
D	18	0.447	0.463	11.35	11.75
D	20	0.496	0.512	12.60	13.00
D	24	0.598	0.614	15.20	15.60
D	28	0.697	0.713	17.70	18.10

21-0042A

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