

MAXIM

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

General Description

Maxim's LT1178 and LT1179 are dual and quad micro-power, precision op amps. Both devices 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.

Both the LT1178 and LT1179 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.

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

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

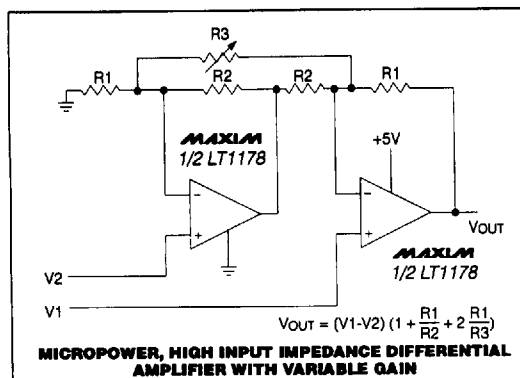
Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
LT1178ACN8	0 $^{\circ}$ C to +70 $^{\circ}$ C	8 Plastic DIP
LT1178CN8	0 $^{\circ}$ C to +70 $^{\circ}$ C	8 Plastic DIP
LT1178S	0 $^{\circ}$ C to +70 $^{\circ}$ C	16 Wide SO
LT1178IN8	-40 $^{\circ}$ C to +85 $^{\circ}$ C	8 Plastic DIP
LT1179ACN	0 $^{\circ}$ C to +70 $^{\circ}$ C	14 Plastic DIP
LT1179CN	0 $^{\circ}$ C to +70 $^{\circ}$ C	14 Plastic DIP
LT1179S	0 $^{\circ}$ C to +70 $^{\circ}$ C	16 Wide SO
LT1179IN	-40 $^{\circ}$ C to +85 $^{\circ}$ C	14 Plastic DIP

MAXIM INTEGRATED PRODUCTS

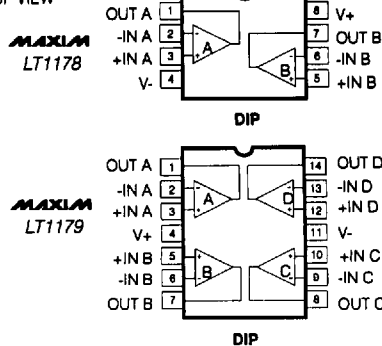
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Typical Operating Circuit



Pin Configurations

TOP VIEW



Pin Configurations continued on last page.

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MAXIM

Maxim Integrated Products 3-85

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MAXIM INTEGRATED PRODUCTS

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	$\pm 22\text{V}$
Differential Input Voltage	$\pm 30\text{V}$
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:

LT117_AC_/C_/S. 0°C to $+70^\circ\text{C}$ LT117_... -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

(VS = 5V, 0V, VCM = 0.1V, VO = 1.4V, TA = $+25^\circ\text{C}$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	LT1178AC LT1179AC			LT1178C/VS LT1179C/VS			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	VOS	LT1178		30	70		40	120	μV
		LT1179		35	100		40	150	
		LT1178S					80	450	
		LT1179S					90	600	
Long-Term Input Offset-Voltage Stability	$\frac{\Delta V_{OS}}{\Delta \text{Time}}$			0.5			0.6		$\mu\text{V/Mo}$
Input Offset Current	Ios			0.05	0.25		0.05	0.35	nA
Input Bias Current	IB			3	5		3	6	nA
Input Noise Voltage	en	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	in	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	RIN	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	VCM = 0V to 3.5V	93	103		90	102		dB
Power-Supply Rejection Ratio	PSRR	VS = 2.2V to 12V	94	104		92	104		dB
Large-Signal Voltage Gain	AVOL	VO = 0.03V to 4V, no load (Note 1)	140	700		110	700		V/mV
		VO = 0.03V to 3.5V, RL = 50k Ω	80	200		70	200		
Maximum Output Voltage Swing	VOUT	Output low, no load		6.5	9.0		6.5	9.0	mV
		Output low, 2k Ω to GND		0.2	0.6		0.2	0.6	
		Output low, ISINK = 100 μA		120	160		120	160	
		Output high, no load	4.2	4.4		4.2	4.4		V
		Output high, 2k Ω to GND	3.5	3.8		3.5	3.8		
Slew Rate	SR	AV = +1, CL = 10pF (Note 1)	0.013	0.025		0.013	0.025		V/ μs
Gain-Bandwidth Product	GBW	$f_0 \leq 5\text{kHz}$		60			60		kHz
Supply Current per Amplifier	IS	VS = 5V, 0V, VO = 1.4V		13	18		14	21	μA
		VS = $\pm 1.5\text{V}$, VO = 0V		12	17		13	20	
Channel Separation		$\Delta V_{IN} = 3\text{V}$, RL = 10k Ω		130			130		dB
Minimum Supply Voltage	VS	(Note 2)		2.0	2.2		2.0	2.2	V

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LT1178/LT1179

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	LT1178I LT1179I			LT1178S LT1179S			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}	LT1178		80	315		120	650	μV
		LT1179		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

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

PARAMETER	SYMBOL	CONDITIONS	LT1178AC LT1179AC			LT1178C LT1179C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}	LT1178		50	170		65	250	μV
		LT1179		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 = $\pm$ 15V, T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	LT1178AC LT1179AC			LT1178C/S LT1179C/S			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V _{OS}		80	350		100	480		μ V
		LT1178S				150	900		
		LT1179S				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 Ω	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 Ω	$\pm$ 13.0	$\pm$ 14.2		$\pm$ 13.0	$\pm$ 14.2		V
		R _L = 2k Ω	$\pm$ 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/ μ s
Gain Bandwidth Product	GBW	f _O $\leq$ 5kHz	85			85			kHz
Supply Current per Amplifier	I _S		16	21		17	25		μ A

ELECTRICAL CHARACTERISTICS

(V_S = $\pm$ 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	LT1178I LT1179I			LT1178S LT1179S			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V _{OS}	LT1178	130	740		190	1150		μ V
		LT1179	130	740		200	1300		
Input Offset-Voltage Drift	$\frac{\Delta V_{OS}}{\Delta T}$	(Note 1)	0.7	4.0		0.9	5.5		μ V/°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 Ω	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 Ω	$\pm$ 11.0	$\pm$ 13.5		$\pm$ 11.0	$\pm$ 13.5		V
Supply Current per Amplifier	I _S		19	30		18	28		μ A

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ELECTRICAL CHARACTERISTICS

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

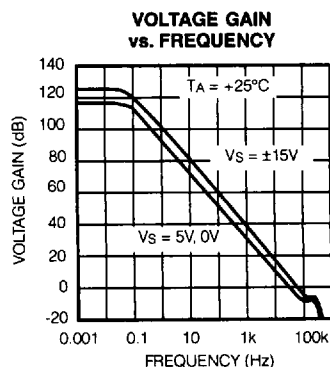
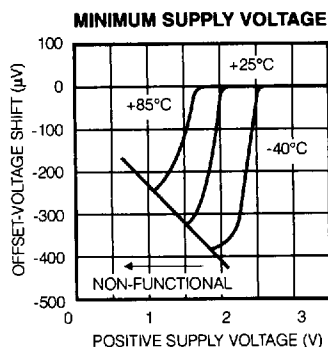
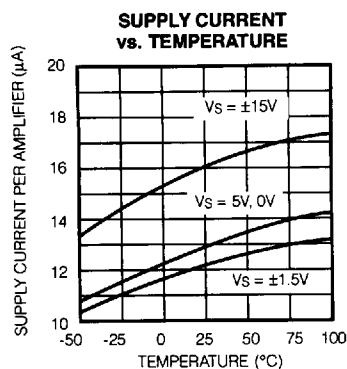
PARAMETER	SYMBOL	CONDITIONS	LT1178AC LT1179AC			LT1178C LT1179C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V _{OS}			100	480		130	660	μ V
Input Offset-Voltage Drift	$\frac{\Delta V_{OS}}{\Delta T}$	(Note 1)		0.6	2.8		0.7	4.0	μ V/°C
Input Offset Current	I _{OS}			0.06	0.35		0.06	0.35	nA
Input Bias Current	I _B			3	6		3	7	nA
Large-Signal Voltage Gain	A _{VOL}	V _O = $\pm$ 10V, R _L = 50k Ω	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 Ω	$\pm$ 11.0	$\pm$ 13.6		$\pm$ 11.0	$\pm$ 13.6		V
Supply Current per Amplifier	I _S			17	24		18	28	μ 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°C, the 5V power-supply turn-on time is less than 0.5sec.

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Typical Operating Characteristics

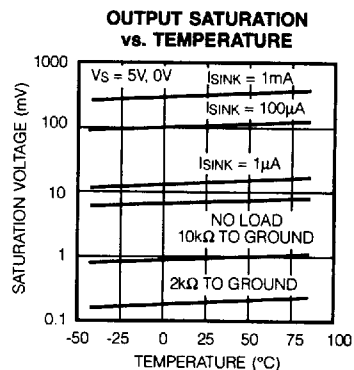
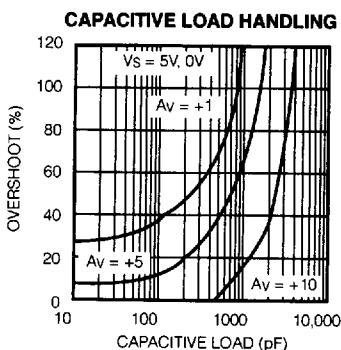
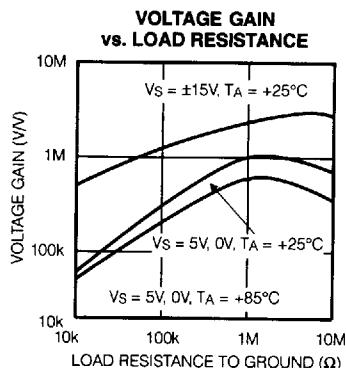
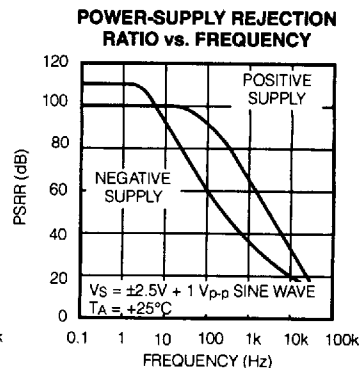
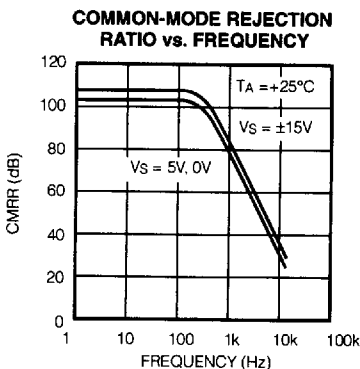
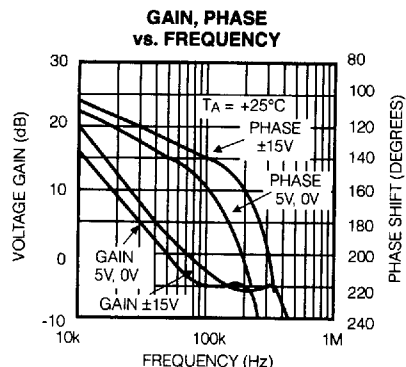


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MAXIM INTEGRATED PRODUCTS

Typical Operating Characteristics (continued)

LT1178/LT1179



Pin Configurations (continued)

