



# THE DATASHEET OF MAX478CSA-T



## **Not Recommended for New Designs**

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This product was manufactured for Maxim by an outside wafer foundry using a process that is no longer available. It is not recommended for new designs. The data sheet remains available for existing users.

A Maxim replacement or an industry second-source may be available. Please see the QuickView data sheet for this part or contact technical support for assistance.

For further information, [contact Maxim's Applications Tech Support](#).



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

MAX478/MAX479

## General Description

The MAX478 and MAX479 are dual and quad micro-power, precision op amps available in 8-pin and 14-pin DIP and small-outline packages, respectively. Both devices feature an extremely low, 17 µA max supply current per op amp, 70µV max offset voltage, 2.2µV/°C max offset voltage drift (0.5µV/°C typ), and 250pA max input offset current.

The MAX478 and MAX479 operate from a single supply. The input voltage range includes ground, and the output swings to within a few millivolts of ground, which eliminates pull-down resistors and saves power.

Both devices are optimized for single 3V and 5V supply operation, with guaranteed specifications at each supply voltage. Specifications for ±15V operation are also provided.

## Applications

Battery- or Solar-Powered Systems:

- Portable Instrumentation
- Remote Sensor Amplifier
- Satellite Circuitry

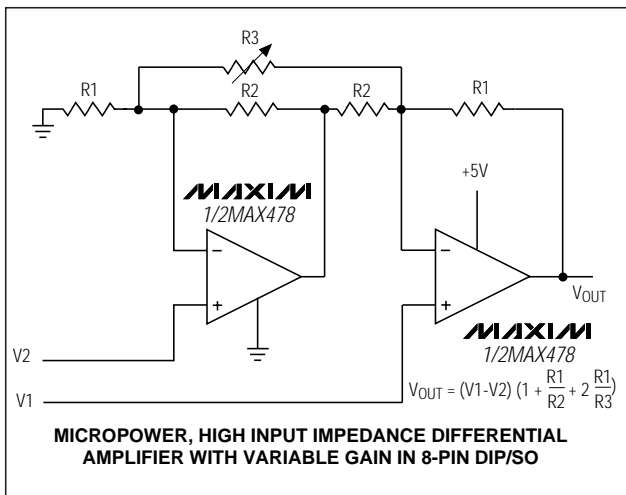
Micropower Sample-and-Hold

Thermocouple Amplifier

Micropower Filters

Single Lithium Cell Powered Systems

## Typical Operating Circuit



## Features

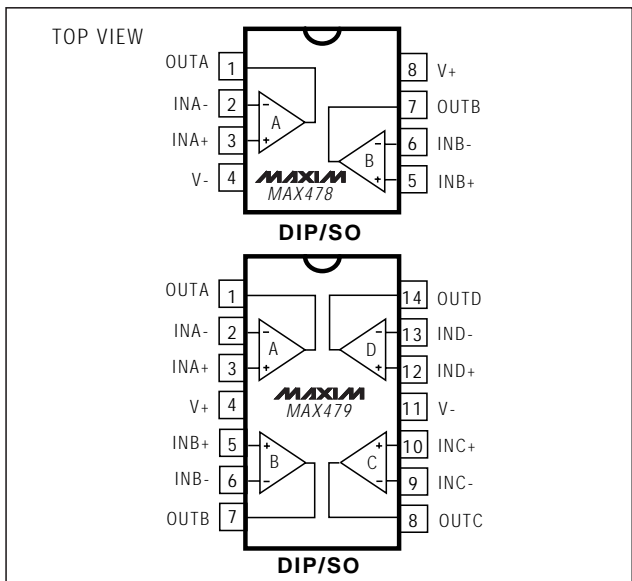
- ◆ 17µA Max Supply Current (MAX478A/MAX479A)
- ◆ 70µV Max Offset Voltage (MAX478A)
- ◆ Single-Supply Operation:
  - Input Voltage Range Includes Ground
  - Output Swings to Ground While Sinking Current
  - No Pull-Down Resistors Required
- ◆ Dual Op Amp in 8-Pin DIP/SO Package (MAX478)  
Quad Op Amp in 14-Pin DIP/SO Package (MAX479)
- ◆ 250pA Max Input Offset Current (MAX478A/MAX479A)
- ◆ 0.5µV/°C Offset-Voltage Drift
- ◆ Output Sources and Sinks 5mA Load Current

## Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX478ACPA	0°C to +70°C	8 Plastic DIP
MAX478CPA	0°C to +70°C	8 Plastic DIP
MAX478CSA	0°C to +70°C	8 SO
MAX478C/D	0°C to +70°C	Dice*
MAX478EPA	-40°C to +85°C	8 Plastic DIP
MAX478ESA	-40°C to +85°C	8 SO
MAX479ACPD	0°C to +70°C	14 Plastic DIP
MAX479CPD	0°C to +70°C	14 Plastic DIP
MAX479CSD	0°C to +70°C	14 SO
MAX479EPD	-40°C to +85°C	14 Plastic DIP
MAX479ESD	-40°C to +85°C	14 SO

\* Dice are specified at  $T_A = +25^\circ\text{C}$ , DC parameters only.

## Pin Configurations





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

MAX478/MAX479

## ELECTRICAL CHARACTERISTICS: 5V (continued)

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

PARAMETER	SYMBOL	CONDITIONS	MAX478AC MAX479AC			MAX478C/E MAX479C/E			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
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, $I_{SINK} = 100\mu A$	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	$A_V = +1$ , $C_L = 1pF$ (Note 1)	0.013	0.025		0.013	0.025	V/μs	
Gain-Bandwidth Product	GBW	$f_O \leq 5kHz$		60			60	kHz	
Supply Current per Amplifier	$I_S$			13	18		14	21	μA
		$V_S = \pm 1.5V$ , $V_O = 0V$		12	17		13	20	
Channel Separation		$\Delta V_{IN} = 3V$ , $R_L = 10k\Omega$		130			130	dB	
Minimum Supply Voltage	$V_S$	(Note 2)		2.0	2.2		2.0	2.2	V

## ELECTRICAL CHARACTERISTICS: 5V

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

PARAMETER	SYMBOL	CONDITIONS	MAX478AC MAX479AC			MAX478C MAX479C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	$V_{OS}$	MAX478ACP/CP		50	170		65	250	μV
		MAX479ACP/CP		60	200		70	290	
		MAX478CS					120	300	
		MAX479CS					130	400	
Input Offset Voltage Drift	$\frac{\Delta V_{OS}}{\Delta T}$	MAX47_ACP/CP (Note 1)		0.5	2.2		0.6	3.0	μV/°C
		MAX47_CS (Note 1)					0.8	4.5	
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	
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, 2kΩ to GND		3.3	3.8		3.3	3.8	
Supply Current per Amplifier	$I_S$			14	21		15	24	μA

# 17 $\mu$ A Max, Dual/Quad, Single-Supply, Precision Op Amps

## ELECTRICAL CHARACTERISTICS: 5V

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

PARAMETER	SYMBOL	CONDITIONS	MAX478EP MAX479EP			MAX478ES MAX479ES			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	$V_{OS}$	MAX478	80	315		150	400	$\mu V$	
		MAX479	80	345		160	530		
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		0.07	0.7	nA	
Input Bias Current	$I_B$		4	8		4	8	nA	
Common-Mode Rejection Ratio	CMRR	$V_{CM} = 0.05V$ to $3.2V$	84	98		84	98	dB	
Power-Supply Rejection Ratio	PSRR	$V_S = 3.0V$ to $12V$	86	100		86	100	dB	
Large-Signal Voltage Gain	$A_{VOL}$	$V_O = 0.05V$ to $4V$ , no load (Note 1)	55	350		55	350	V/mV	
		$V_O = 0.05V$ to $3.5V$ , $R_L = 50k\Omega$	35	130		35	130		
Output Voltage Swing	$V_{OUT}$	Output low, no load	9	13		9	13	mV	
		Output low, $I_{SINK} = 100\mu A$	160	220		160	220		
		Output high, no load	3.9	4.2		3.9	4.2	V	
		Output high, $2k\Omega$ to GND	3.0	3.7		3.0	3.7		
Supply Current per Amplifier	$I_S$		15	27		15	27	$\mu A$	

# 17 $\mu$ A Max, Dual/Quad, Single-Supply, Precision Op Amps

MAX478/MAX479

## ELECTRICAL CHARACTERISTICS: 3V

( $V_S = 3V$ ,  $0V$ ,  $V_{CM} = 0.1V$ ,  $V_O = 0.8V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MAX478AC MAX479AC			MAX478C/E MAX479C/E			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	$V_{OS}$	MAX478ACP/CP/EP	30	90		40	140	$\mu V$	
		MAX479ACP/CP/EP	35	120		40	170		
		MAX478CS/ES				80	200		
		MAX479CS/ES				90	270		
Input Offset Current	$I_{OS}$		0.05		0.05		nA		
Input Bias Current	$I_B$		3		3		nA		
Input Noise Voltage	$e_N$	0.1Hz to 10Hz		1.0		1.0	$\mu V_{p-p}$		
Input Voltage Range	$V_{IN(CM)}$	Upper limit	1.7	1.9		1.7	1.9	V	
		Lower limit	0	-0.3		0	-0.3		
Common-Mode Rejection Ratio	CMRR	$V_{CM} = 0V$ to 1.7V	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 2V, no load (Note 1)	100	600		100	600	V/mV	
		$V_O = 0.03V$ to 1.5V, $R_L = 50k\Omega$	30	180		30	180		
Output Voltage Swing	$V_{OUT}$	Output low, no load		6	9		6	9	mV
		Output low, 2k $\Omega$ to GND		0.2	0.6		0.2	0.6	
		Output high, no load		2.2	2.4		2.2	2.4	V
		Output high, 2k $\Omega$ to GND		1.8	2.0		1.8	2.0	
Gain-Bandwidth Product	GBW	$f_O \leq 5kHz$		50		50		kHz	
Supply Current per Amplifier	$I_S$		12	17		13	20	$\mu A$	
Minimum Supply Voltage	$V_S$			2.2		2.2		V	
		With 300 $\mu V$ $V_{OS}$ degradation		1.7			1.7		

# 17 $\mu$ A Max, Dual/Quad, Single-Supply, Precision Op Amps

## ELECTRICAL CHARACTERISTICS: $\pm 15$ V

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

PARAMETER	SYMBOL	CONDITIONS	MAX478AC MAX479AC			MAX478C/E MAX479C/E			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	$V_{OS}$		80	350		100	480	$\mu\text{V}$	
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	$V_{IN(CM)}$	Upper limit	13.5	13.9		13.5	13.9	V	
		Lower limit	-15.0	-15.3		-15.0	-15.3		
Common-Mode Rejection Ratio	CMRR	$V_{CM} = +13.5\text{V}, -15\text{V}$	97	106		94	106	dB	
Power-Supply Rejection Ratio	PSRR	$V_S = 5\text{V}, 0\text{V to } \pm 15\text{V}$	96	112		94	112	dB	
Large-Signal Voltage Gain	$A_{VOL}$	$V_O = \pm 10\text{V}, R_L = 50\text{k}\Omega$	300	1200		250	1000	V/mV	
		$V_O = \pm 10\text{V}, \text{no load}$	600	2500		400	2500		
Output Voltage Swing	$V_{OUT}$	$R_L = 50\text{k}\Omega$	$\pm 13.0$	$\pm 14.2$		$\pm 13.0$	$\pm 14.2$	V	
		$R_L = 2\text{k}\Omega$	$\pm 11.0$	$\pm 12.7$		$\pm 11.0$	$\pm 12.7$		
Slew Rate	SR	$A_V = +1\text{V}, C_L = 15\text{pF}$	0.02	0.04		0.02	0.04	V/ $\mu\text{s}$	
Gain-Bandwidth Product	GBW	$f_O \leq 5\text{kHz}$		85			85	kHz	
Supply Current per Amplifier	$I_S$		16	21		17	25	$\mu\text{A}$	

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

MAX478/MAX479

## ELECTRICAL CHARACTERISTICS: ±15V

(V<sub>S</sub> = ±15V, T<sub>A</sub> = 0°C to +70°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MAX478AC MAX479AC		MAX478C MAX479C		UNITS
			MIN	TYP	MAX	MIN	
Input Offset Voltage	V <sub>OS</sub>		100	480	130	660	μV
Input Offset-Voltage Drift	$\frac{\Delta V_{OS}}{\Delta T}$	MAX47_ACP/CP (Note 1)	0.6	2.8	0.7	4.0	μV/°C
		MAX47_CS (Note 1)			0.9	5.5	
Input Offset Current	I <sub>OS</sub>		0.06	0.35	0.06	0.35	nA
Input Bias Current	I <sub>B</sub>		3	6	3	7	nA
Large-Signal Voltage Gain	A <sub>VOL</sub>	V <sub>O</sub> = ±10V, R <sub>L</sub> = 50kΩ	200	800	150	750	V/mV
Common-Mode Rejection Ratio	CMRR	V <sub>CM</sub> = +13V, -15V	94	104	91	104	dB
Power-Supply Rejection Ratio	PSRR	V <sub>S</sub> = 5V, 0V to ±15V	93	110	91	110	dB
Output Voltage Swing	V <sub>OUT</sub>	R <sub>L</sub> = 5kΩ	±11.0	±13.5	±11.0	±13.5	V
Supply Current per Amplifier	I <sub>S</sub>		17	24	18	28	μA

# 17 $\mu$ A Max, Dual/Quad, Single-Supply, Precision Op Amps

## ELECTRICAL CHARACTERISTICS: $\pm 15V$

( $V_S = \pm 15V$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MAX478EP MAX479EP			MAX478ES MAX479ES			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	$V_{OS}$			130	740		130	740	$\mu V$
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	0.70		0.07	0.70	nA
Input Bias Current	$I_B$			4	8		4	8	nA
Large-Signal Voltage Gain	$A_{VOL}$	$V_O = \pm 10V$ , $R_L = 50k\Omega$	100	500		100	500		V/mV
Common-Mode Rejection Ratio	CMRR	$V_{CM} = +13V$ , $-14.9V$	88	103		88	103		dB
Power-Supply Rejection Ratio	PSRR	$V_S = 5V$ , $0V$ to $\pm 15V$	88	109		88	109		dB
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		19	30	$\mu A$

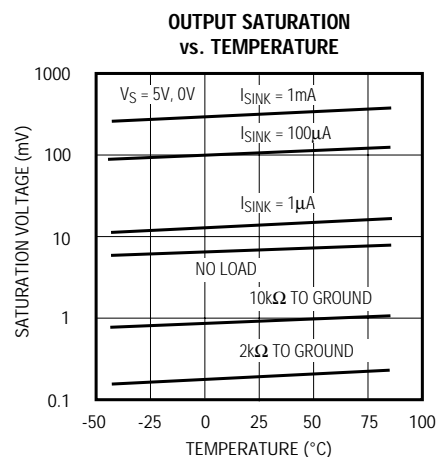
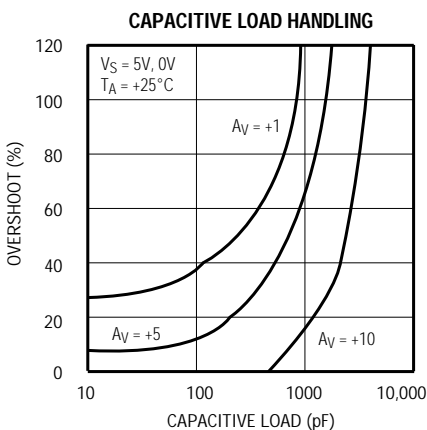
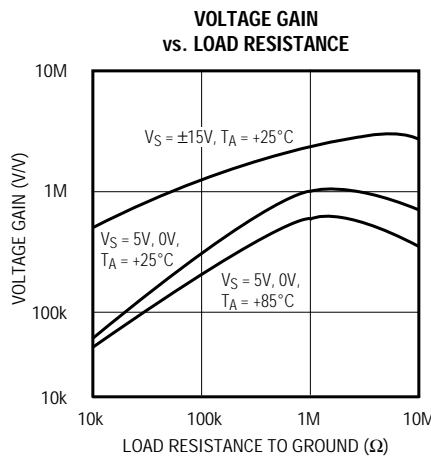
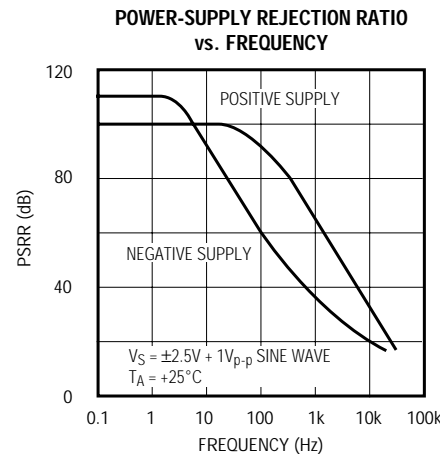
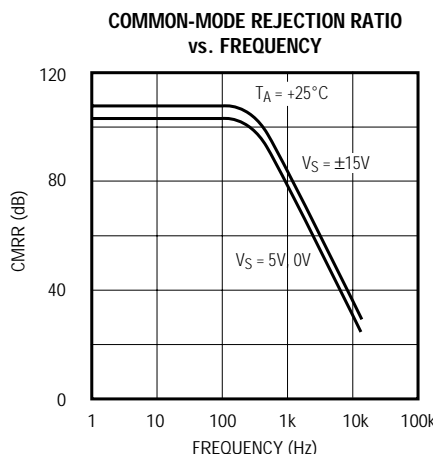
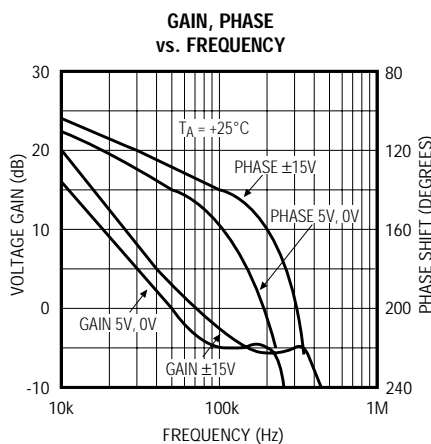
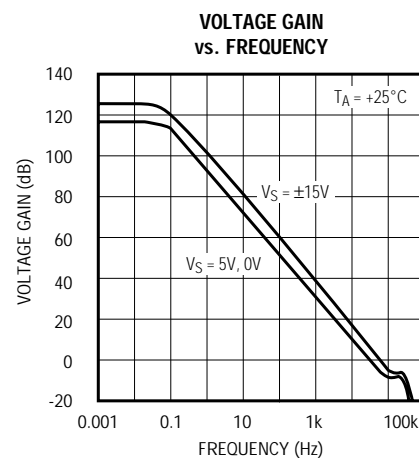
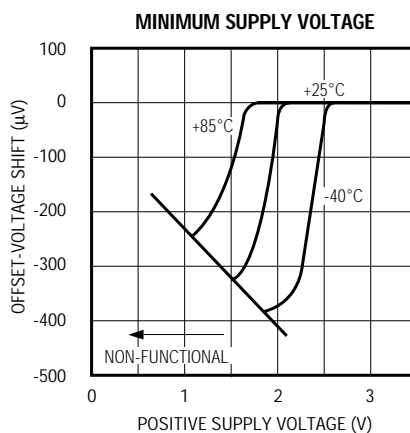
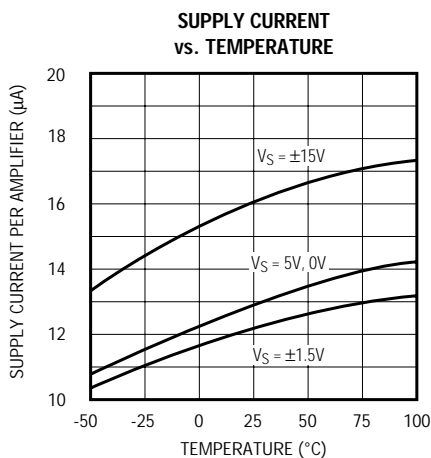
**Note 1:** Guaranteed by design.

**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.

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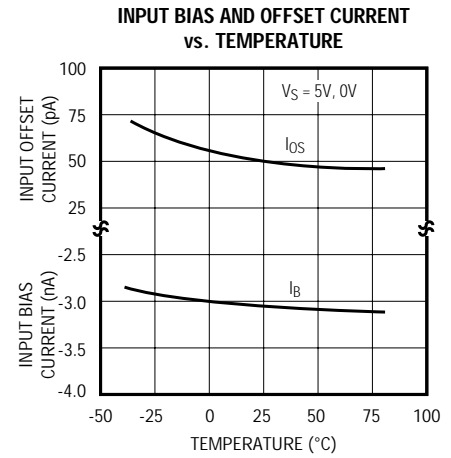
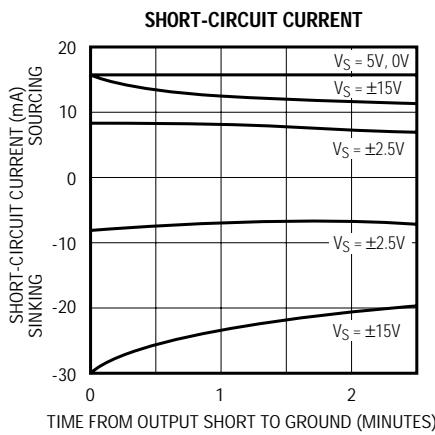
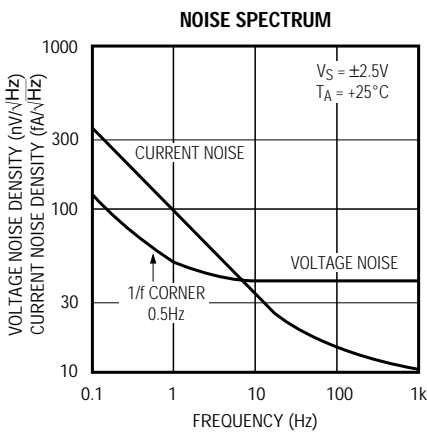
## Typical Operating Characteristics

MAX478/MAX479

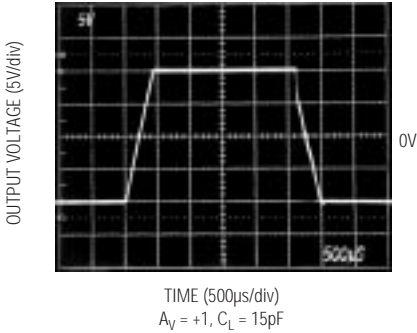


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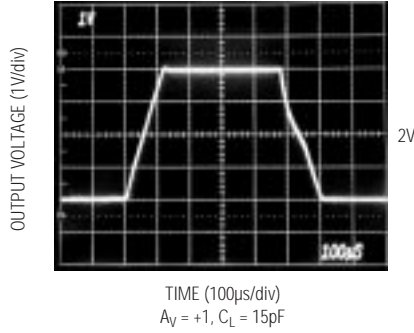
Typical Operating Characteristics (continued)



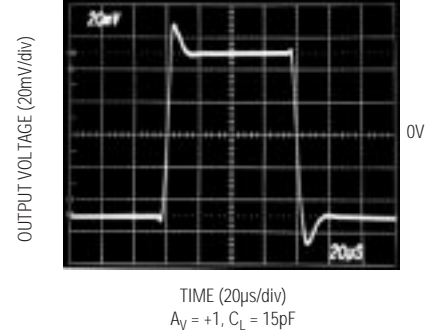
**LARGE-SIGNAL TRANSIENT RESPONSE**  
 $V_S = \pm 15V$



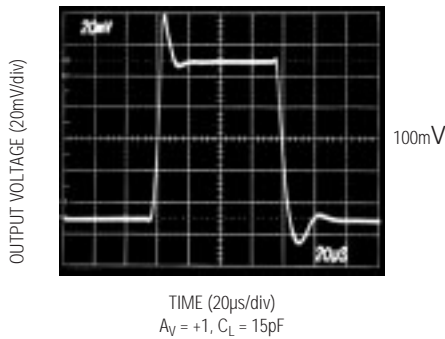
**LARGE-SIGNAL TRANSIENT RESPONSE**  
 $V_S = 5V, 0V$



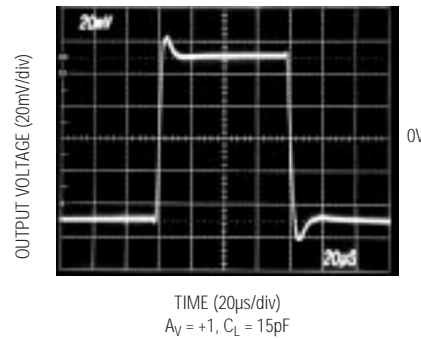
**SMALL-SIGNAL TRANSIENT RESPONSE**  
 $V_S = \pm 2.5V$



**SMALL-SIGNAL TRANSIENT RESPONSE**  
 $V_S = 5V, 0V$



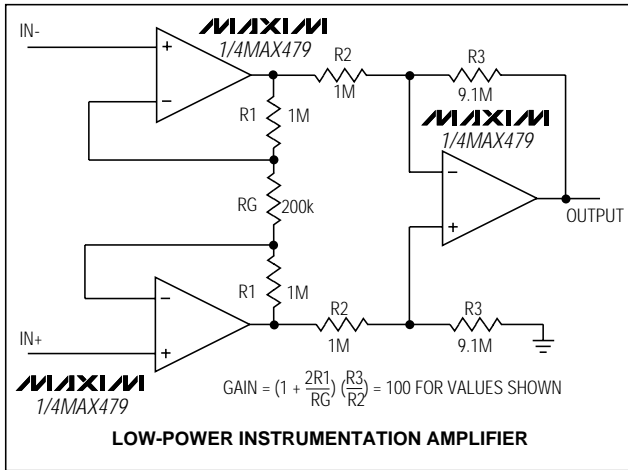
**SMALL-SIGNAL TRANSIENT RESPONSE**  
 $V_S = \pm 15V$



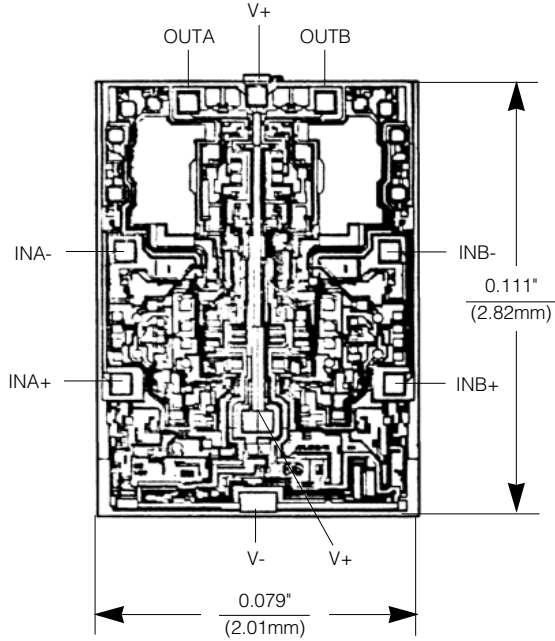
# 17µA Max, Dual/Quad, Single-Supply, Precision Op Amps

MAX478/MAX479

Typical Application Circuit



Chip Topography



Package Information

	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
e	0.050		1.27	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
h	0.010	0.020	0.25	0.50
L	0.016	0.050	0.40	1.27

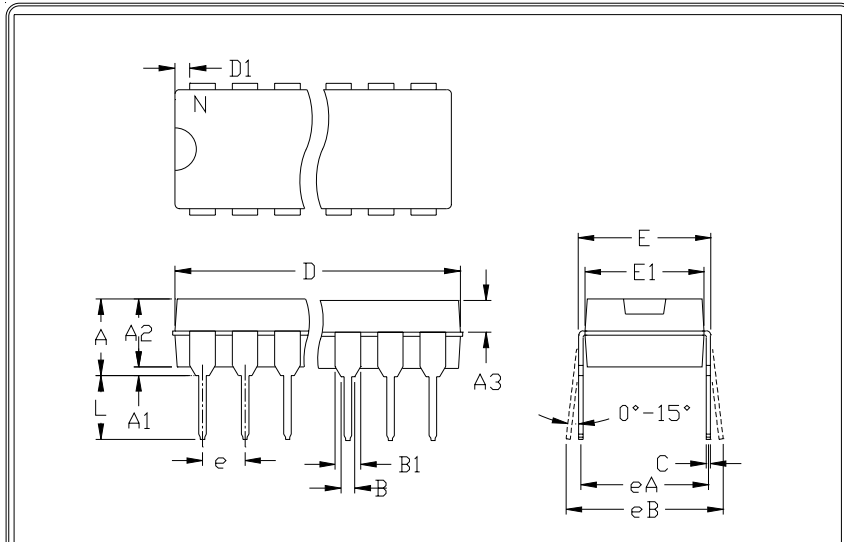
	INCHES		MILLIMETERS		N	MS012
	MIN	MAX	MIN	MAX		
D	0.189	0.197	4.80	5.00	8	A
D	0.337	0.344	8.55	8.75	14	B
D	0.386	0.394	9.80	10.00	16	C

NOTES:  
 1. D&E DO NOT INCLUDE MOLD FLASH  
 2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")  
 3. LEADS TO BE COPLANAR WITHIN .102mm (.004")  
 4. CONTROLLING DIMENSION: MILLIMETER  
 5. MEETS JEDEC MS012-XX AS SHOWN IN ABOVE TABLE  
 6. N = NUMBER OF PINS

**MAXIM** PACKAGE FAMILY OUTLINE: SOIC .150" 1/1 21-0041 A

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

Package Information (continued)



	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

	INCHES		MILLIMETERS		N	MS001
	MIN	MAX	MIN	MAX		
D	0.348	0.390	8.84	9.91	8	AB
D	0.735	0.765	18.67	19.43	14	AC
D	0.745	0.765	18.92	19.43	16	AA
D	0.885	0.915	22.48	23.24	18	AD
D	1.015	1.045	25.78	26.54	20	AE
D	1.14	1.265	28.96	32.13	24	AF
D	1.360	1.380	34.54	35.05	28	*5

- NOTES:  
 1. D&E DO NOT INCLUDE MOLD FLASH  
 2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")  
 3. CONTROLLING DIMENSION: MILLIMETER  
 4. MEETS JEDEC MS001-XX AS SHOWN IN ABOVE TABLE  
 5. SIMILAR TO JEDEC MO-058AB  
 6. N = NUMBER OF PINS

**MAXIM** PACKAGE FAMILY OUTLINE: PDIP .300" 1/1 21-0043 A  
120 SAN GABRIEL DR. SUNNYVALE, CA 94086 FAX (408) 737-7794 PROPRIETARY INFORMATION TITLE DOCUMENT CONTROL NUMBER REV

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