

LT2178/LT2179

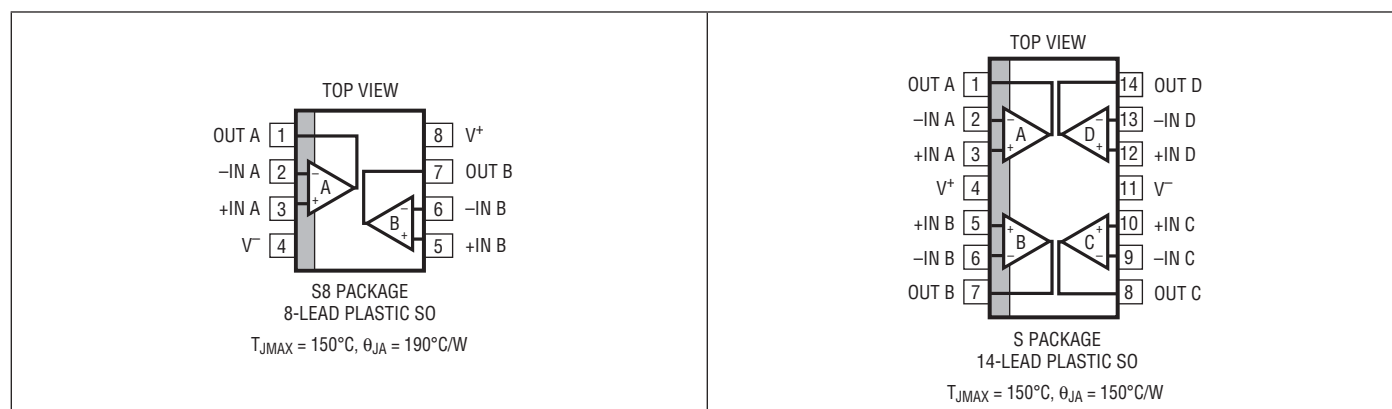
ABSOLUTE MAXIMUM RATINGS

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 Indefinite

Specified Temperature Range

Commercial..... 0°C to 70°C
 Industrial -40°C to 85°C
 Storage Temperature Range..... -65°C to 150°C
 Lead Temperature (Soldering, 10 sec) 300°C

PIN CONFIGURATION



ORDER INFORMATION

LEAD FREE FINISH	TAPE AND REEL	PART MARKING	PACKAGE DESCRIPTION	TEMPERATURE RANGE
LT2178ACS8#PBF	LT2178ACS8#TRPBF	2178A	8-Lead Plastic SO	0°C to 70°C
LT2178AIS8#PBF	LT2178AIS8#TRPBF	2178AI	8-Lead Plastic SO	-40°C to 85°C
LT2178CS8#PBF	LT2178CS8#TRPBF	2178	8-Lead Plastic SO	0°C to 70°C
LT2178IS8#PBF	LT2178IS8#TRPBF	2178I	8-Lead Plastic SO	-40°C to 85°C
LT2179ACS8#PBF	LT2179ACS8#TRPBF	2179A	14-Lead Plastic SO	0°C to 70°C
LT2179CS8#PBF	LT2179CS8#TRPBF	2179	14-Lead Plastic SO	0°C to 70°C
LT2179IS8#PBF	LT2179IS8#TRPBF	2179I	14-Lead Plastic SO	-40°C to 85°C
LEAD BASED FINISH	TAPE AND REEL	PART MARKING	PACKAGE DESCRIPTION	TEMPERATURE RANGE
LT2178ACS8	LT2178ACS8#TR	2178A	8-Lead Plastic SO	0°C to 70°C
LT2178AIS8	LT2178AIS8#TR	2178AI	8-Lead Plastic SO	-40°C to 85°C
LT2178CS8	LT2178CS8#TR	2178	8-Lead Plastic SO	0°C to 70°C
LT2178IS8	LT2178IS8#TR	2178I	8-Lead Plastic SO	-40°C to 85°C
LT2179ACS8	LT2179ACS8#TR	2179A	14-Lead Plastic SO	0°C to 70°C
LT2179CS8	LT2179CS8#TR	2179	14-Lead Plastic SO	0°C to 70°C
LT2179IS8	LT2179IS8#TR	2179I	14-Lead Plastic SO	-40°C to 85°C

Consult LTC Marketing for parts specified with wider operating temperature ranges.

For more information on lead free part marking, go to: <http://www.linear.com/leadfree/>

For more information on tape and reel specifications, go to: <http://www.linear.com/tapeandreel/>

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

SYMBOL	PARAMETER	CONDITIONS	LT2178AC/LT2178AI LT2179AC			LT2178C/LT2178I LT2179C/LT2179I			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{OS}	Input Offset Voltage	LT2178 LT2179		30 35	70 100		40 40	120 150	μV μV
$\frac{\Delta V_{OS}}{\Delta Time}$	Long Term Input Offset Voltage Stability			0.5			0.6		$\mu V/Mo$
I_{OS}	Input Offset Current			0.05	0.25		0.05	0.35	nA
I_B	Input Bias Current			3	5		3	6	nA
e_n	Input Noise Voltage	0.1Hz to 10Hz (Note 2)		0.9	2.0		0.9		μV_{P-P}
	Input Noise Voltage Density	$f_0 = 10Hz$ (Note 2) $f_0 = 1000Hz$ (Note 2)		50 49	75 65		50 49		$nV/\sqrt{Hz}$ $nV/\sqrt{Hz}$
i_n	Input Noise Current	0.1Hz to 10Hz (Note 2)		1.5	2.5		1.5		pA_{P-P}
	Input Noise Current Density	$f_0 = 10Hz$ (Note 2) $f_0 = 1000Hz$		0.03 0.01	0.07		0.03 0.01		$pA/\sqrt{Hz}$ $pA/\sqrt{Hz}$
	Input Resistance Differential Mode Common Mode	(Note 3)	0.8	2 12		0.6	2 12		$G\Omega$ $G\Omega$
	Input Voltage Range		3.5 0	3.9 -0.3		3.5 0	3.9 -0.3		V V
CMRR	Common Mode Rejection Ratio	$V_{CM} = 0V$ to 3.5V	93	103		90	102		dB
PSRR	Power Supply Rejection Ratio	$V_S = 2.2V$ to 12V	94	104		92	104		dB
A_{VOL}	Large-Signal Voltage Gain	$V_O = 0.03V$ to 4V, No Load (Note 3) $V_O = 0.03V$ to 3.5V, $R_L = 50k$	140 80	700 200		110 70	700 200		V/mV V/mV
	Maximum Output Voltage Swing	Output Low, No Load Output Low, 2k to GND Output Low, $I_{SINK} = 100\mu A$		6.5 0.2 120	9 0.6 160		6.5 0.2 120	9 0.6 160	mV mV mV
		Output High, No Load Output High, 2k to GND	4.2 3.5	4.4 3.8		4.2 3.5	4.4 3.8		V V
SR	Slew Rate	$A_V = 1, C_L = 10pF$ (Note 3)	0.013	0.025		0.013	0.025		V/ μs
GBW	Gain Bandwidth Product	$f_0 \leq 5kHz$		60			60		kHz
I_S	Supply Current per Amplifier	$V_S = \pm 1.5V, V_O = 0V$		13 12	18 17		14 13	21 20	μA μA
	Channel Separation	$\Delta V_{IN} = 3V, R_L = 10k$		110			110		dB
	Minimum Supply Voltage	(Note 4)		2	2.2		2	2.2	V

The ● denotes the specifications which apply over the full operating temperature range. $V_S = 5V, 0V, V_{CM} = 0.1V, V_O = 1.4V, -40^\circ C \leq T_A \leq 85^\circ C$ for I grades, unless otherwise noted. (Note 6)

SYMBOL	PARAMETER	CONDITIONS		LT2178AI			LT2178I/LT2179I			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{OS}	Input Offset Voltage	LT2178 LT2179	● ●		70 80	270 300		95 100	370 400	μV μV
$\frac{\Delta V_{OS}}{\Delta T}$	Input Offset Voltage Drift	LT2178 (Note 5) LT2179	●		0.4 0.5	1.8 3		0.5 0.6	2.3 3.5	$\mu V/^\circ C$ $\mu V/^\circ C$
I_{OS}	Input Offset Current		●		0.07	0.70		0.1	1	nA
I_B	Input Bias Current		●		3	7		4	8	nA
CMRR	Common Mode Rejection Ratio	$V_{CM} = 0.05V$ to 3.2V	●	86	100		84	98		dB
PSRR	Power Supply Rejection Ratio	$V_S = 3V$ to 12V	●	88	100		86	100		dB

LT2178/LT2179

ELECTRICAL CHARACTERISTICS The ● denotes the specifications which apply over the full operating temperature range. $V_S = 5V$, $0V$, $V_{CM} = 0.1V$, $V_O = 1.4V$, $-40^\circ C \leq T_A \leq 85^\circ C$ for I grades, unless otherwise noted. (Note 6)

SYMBOL	PARAMETER	CONDITIONS		LT2178AI			LT2178I/LT2179I			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
A_{VOL}	Large-Signal Voltage Gain	$V_O = 0.05V$ to $4V$, No Load (Note 3) $V_O = 0.05V$ to $3.5V$, $R_L = 50k$	●	75	350		50	350		V/mV
			●	40	130		30	130		V/mV
	Maximum Output Voltage Swing	Output Low, No Load Output Low, $I_{SINK} = 100\mu A$	●		9	13		9	13	mV
			●		160	220		160	220	mV
		Output High, No Load Output High, $2k$ to GND	●	3.9	4.2		3.9	4.2		V
			●	3	3.7		3	3.7		V
I_S	Supply Current per Amplifier		●		15	24		15	27	μA

The ● denotes the specifications which apply over the full operating temperature range. $V_S = 5V$, $0V$, $V_{CM} = 0.1V$, $V_O = 1.4V$, $0^\circ C \leq T_A \leq 70^\circ C$, unless otherwise noted. (Note 7)

SYMBOL	PARAMETER	CONDITIONS		LT2178AC/LT2179AC			LT2178C/LT2179C			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{OS}	Input Offset Voltage	LT2178 LT2179	●		50	170		65	250	V/mV
			●		60	200		70	290	V/mV
$\frac{\Delta V_{OS}}{\Delta T}$	Input Offset Voltage Drift	LT2178 (Note 5) LT2179	●		0.4	1.8		0.5	2.5	mV
			●		0.5	3		0.6	3.5	mV
I_{OS}	Input Offset Current		●		0.06	0.35		0.06	0.5	nA
I_B	Input Bias Current		●		3	6		3	7	nA
CMRR	Common Mode Rejection Ratio	$V_{CM} = 0V$ to $3.4V$	●	90	101		86	100		dB
PSRR	Power Supply Rejection Ratio	$V_S = 2.5V$ to $12V$	●	90	102		88	102		dB
A_{VOL}	Large-Signal Voltage Gain	$V_O = 0.05V$ to $4V$, No Load (Note 3) $V_O = 0.05V$ to $3.5V$, $R_L = 50k$	●	150	500		80	500		V/mV
			●	55	160		45	160		V/mV
	Maximum Output Voltage Swing	Output Low, No Load Output Low, $I_{SINK} = 100\mu A$	●		8	11		8	11	mV
			●		140	190		140	190	mV
		Output High, No Load Output High, $2k$ to GND	●	4.1	4.3		4.1	4.3		V
			●	3.3	3.8		3.3	3.8		V
I_S	Supply Current per Amplifier		●		14	21		15	24	μA

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

SYMBOL	PARAMETER	CONDITIONS		LT2178AC/LT2178AI LT2179AC			LT2178C/LT2178I LT2179C/LT2179I			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{OS}	Input Offset Voltage	LT2178 LT2179			70	300		90	400	μV
					80	350		100	450	μV
I_{OS}	Input Offset Current				0.05	0.25		0.05	0.35	nA
I_B	Input Bias Current				3	5		3	6	nA
	Input Voltage Range			13.5	13.9		13.5	13.9		V
				-15	-15.3		-15	-15.3		V
CMRR	Common Mode Rejection Ratio	$V_{CM} = 13.5V$ to $-15V$		96	106		93	106		dB
PSRR	Power Supply Rejection Ratio	$V_S = 5V$, $0V$ to $\pm 18V$		96	112		94	112		dB
A_{VOL}	Large-Signal Voltage Gain	$V_O = \pm 10V$, $R_L = 50k$ $V_O = \pm 10V$, No Load		300	1200		250	1000		V/mV
				600	2500		400	2500		V/mV
V_{OUT}	Maximum Output Voltage Swing	$R_L = 50k$ $R_L = 2k$		± 13	± 14.2		± 13	± 14.2		V
				± 11	± 12.7		± 11	± 12.7		V
SR	Slew Rate	$A_V = 1$		0.02	0.04		0.02	0.04		V/ μs

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range. $V_S = 5V$, $0V$, $V_{CM} = 0.1V$, $V_O = 1.4V$, $-40^\circ C \leq T_A \leq 85^\circ C$ for I grades, unless otherwise noted. (Note 6)

SYMBOL	PARAMETER	CONDITIONS	LT2178AC/LT2178AI LT2179AC			LT2178C/LT2178I LT2179C/LT2179I			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
GBW	Gain Bandwidth Product	$f_0 \leq 5kHz$		85			85		kHz
I_S	Supply Current per Amplifier			16	21		17	25	μA

The ● denotes the specifications which apply over the full operating temperature range. $V_S = \pm 15V$, $-40^\circ C \leq T_A \leq 85^\circ C$ for I grades, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		LT2178AI			LT2178I/LT2179I			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{OS}	Input Offset Voltage	LT2178	●		100	650		130	740	μV
		LT2179	●		100	650		130	740	μV
$\frac{\Delta V_{OS}}{\Delta T}$	Input Offset Voltage Drift	LT2178 (Note 5)	●		0.6	1.8		0.7	2.5	$\mu V/^\circ C$
		LT2179			0.7	3		0.9	4	$\mu V/^\circ C$
I_{OS}	Input Offset Current		●		0.07	0.7		0.1	1	nA
I_B	Input Bias Current		●		3	7		4	8	nA
A_{VOL}	Large-Signal Voltage Gain	$V_O = \pm 10V$, $R_L = 50k$	●		150	500		100	500	V/mV
CMRR	Common Mode Rejection Ratio	$V_{CM} = 13V$, $-14.9V$	●		90	105		88	103	dB
PSRR	Power Supply Rejection Ratio	$V_S = 0V$, $5V$ to $\pm 18V$	●		92	110		88	109	dB
	Maximum Output Voltage Swing	$R_L = 5k$	●		± 11	± 13.5		± 11	± 13.5	V
I_S	Supply Current per Amplifier		●		18	28		19	30	μA

The ● denotes the specifications which apply over the full operating temperature range. $V_S = \pm 15V$, $0^\circ C \leq T_A \leq 70^\circ C$, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		LT2178AC/LT2179AC			LT2178C/LT2179C			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{OS}	Input Offset Voltage	LT2178	●		100	480		130	660	μV
		LT2179	●		120	550		150	750	μV
$\frac{\Delta V_{OS}}{\Delta T}$	Input Offset Voltage Drift	LT2178 (Note 5)	●		0.6	1.5		0.7	2.5	$\mu V/^\circ C$
		LT2179			0.7	3		0.9	4	$\mu V/^\circ C$
I_{OS}	Input Offset Current		●		0.06	0.35		0.06	0.35	nA
I_B	Input Bias Current		●		3	6		3	7	nA
A_{VOL}	Large-Signal Voltage Gain	$V_O = \pm 10V$, $R_L = 50k$	●		200	800		150	750	V/mV
CMRR	Common Mode Rejection Ratio	$V_{CM} = 13V$, $-15V$	●		94	104		91	104	dB
PSRR	Power Supply Rejection Ratio	$R_L = 5k$	●		93	110		91	110	dB
	Maximum Output Voltage Swing	$R_L = 5k$	●		± 11	± 13.6		± 11	± 13.6	V
I_S	Supply Current per Amplifier		●		17	24		18	28	μA

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: Typical parameters are defined as the 60% yield of parameter distributions of individual amplifiers, i.e., out of 100 LT2179s (or 100 LT2178s) typically 240 op amps (or 120) will be better than the indicated specification.

Note 3: This parameter is tested on a sample basis only. All noise parameters are tested with $V_S = \pm 2.5V$, $V_O = 0V$.

Note 4: This parameter is guaranteed by design and is not tested.

Note 5: Power supply rejection ratio is measured at the minimum supply voltage. The op amps actually work at 1.7V supply but with a typical offset skew of $-300\mu V$.

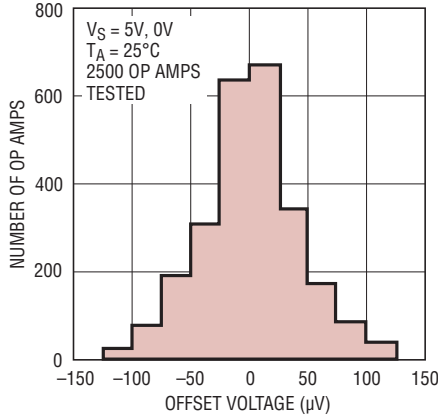
Note 6: This parameter is not 100% tested.

Note 7: During testing at $-40^\circ C$, the 5V power supply turn-on time is less than 0.5s.

Note 8: The LT2178C/LT2179C are designed, characterized and expected to meet the industrial temperature limits, but are not tested at $-40^\circ C$ and $85^\circ C$. I-grade parts are guaranteed.

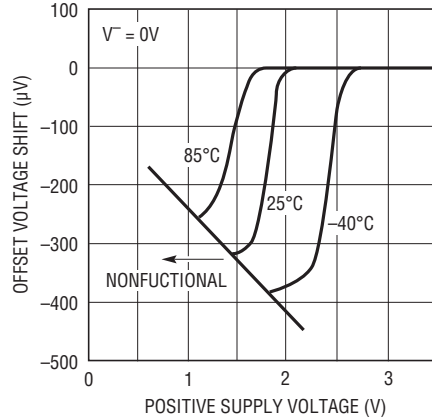
TYPICAL PERFORMANCE CHARACTERISTICS

Distribution of Input Offset Voltage



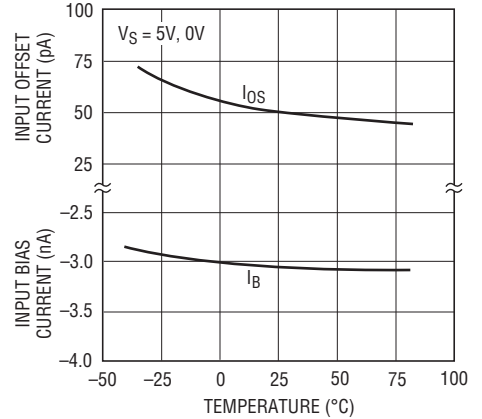
21789 G01

Minimum Supply Voltage



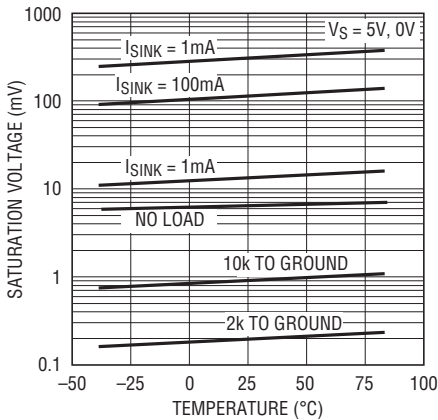
21789 G02

Input Bias and Offset Currents vs Temperature



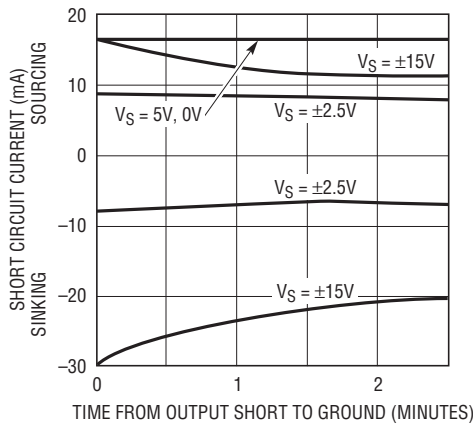
21789 G03

Output Saturation vs Temperature vs Sink Current



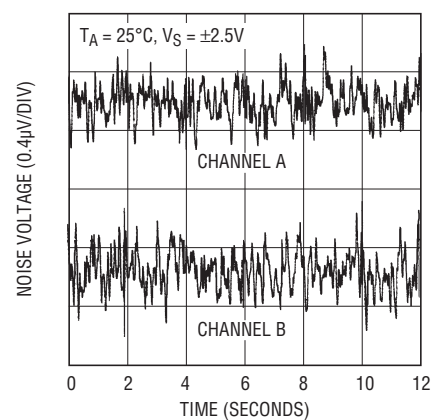
21789 G04

Short-Circuit Current



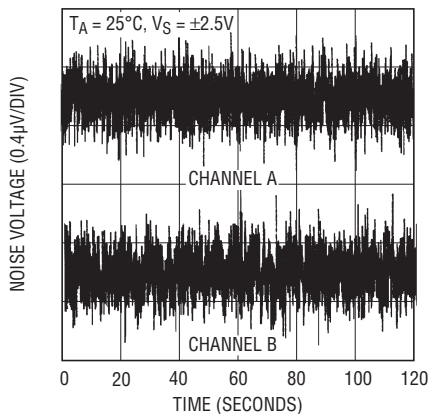
21789 G05

0.1Hz to 10Hz Noise



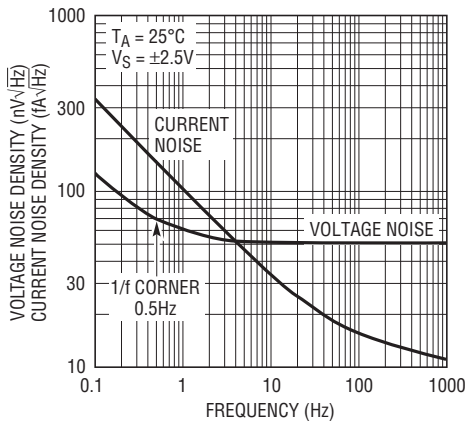
21789 G06

0.01Hz to 10Hz Noise



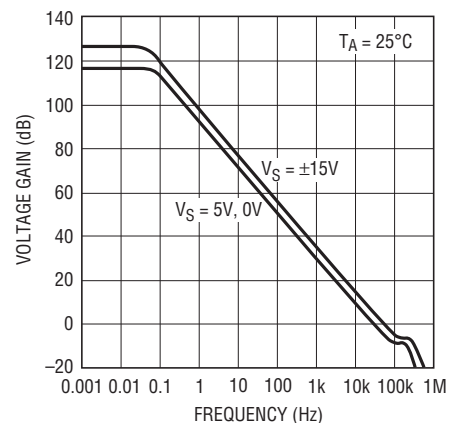
21789 G07

Noise Spectrum



21789 G08

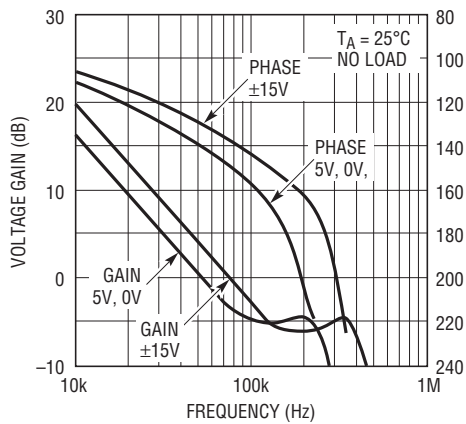
Voltage Gain vs Frequency



21789 G09

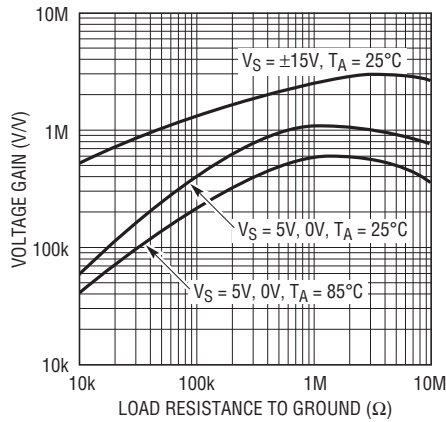
TYPICAL PERFORMANCE CHARACTERISTICS

Gain, Phase vs Frequency



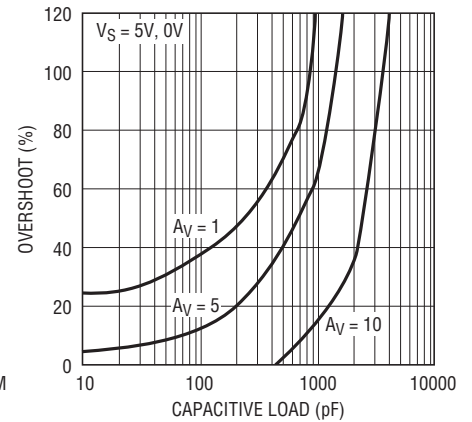
21789 G10

Voltage Gain vs Load Resistance



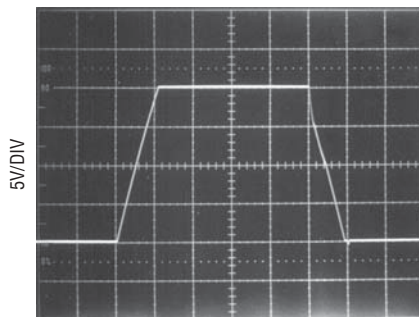
21789 G11

Capacitive Load Handling



20789 G12

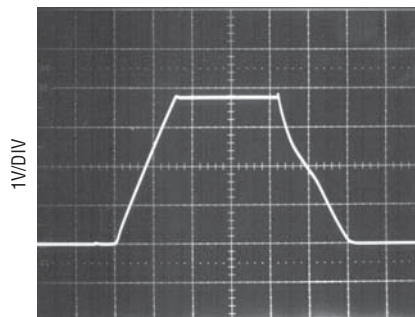
Large-Signal Transient Response
 $V_S = \pm 15V$



$A_V = 1$
 $C_L = 12pF$

21789 G13

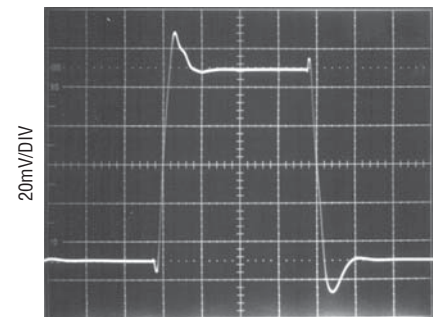
Large-Signal Transient Response
 $V_S = 5V, 0V$



$A_V = 1$
 $C_L = 12pF$
INPUT PULSE = 0V TO 3.8V

21789 G14

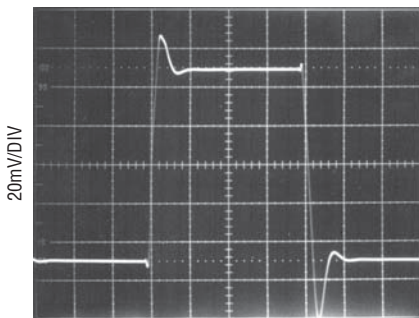
Small-Signal Transient Response
 $V_S = \pm 2.5V$



$A_V = 1$
 $C_L = 12pF$

21789 G15

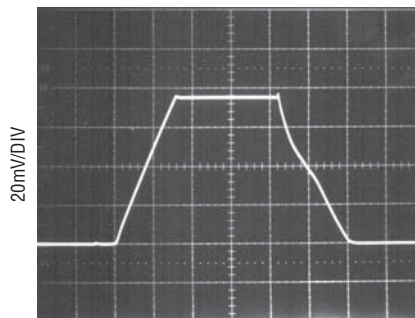
Small-Signal Transient Response
 $V_S = \pm 15V$



$A_V = 1$
 $C_L = 12pF$

21789 G16

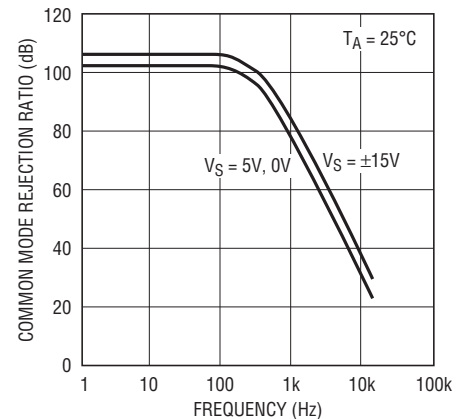
Small-Signal Transient Response
 $V_S = 5V, 0V$



$A_V = 1$
 $C_L = 12pF$
INPUT PULSE = 50mV TO 150mV

21789 G17

Common Mode Rejection Ratio
vs Frequency



21789 G18



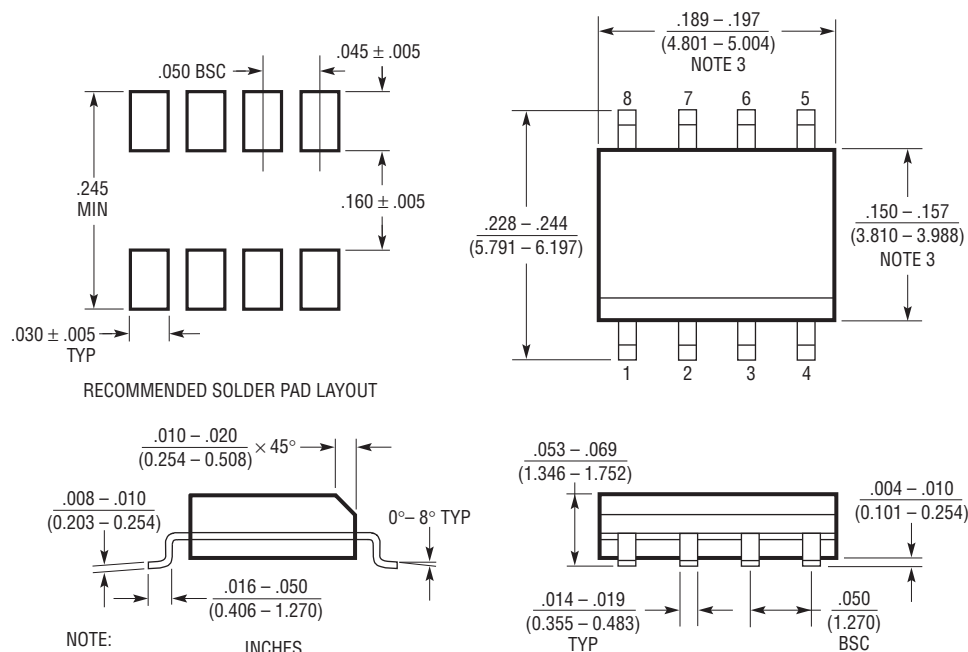
SIMPLIFIED SCHEMATIC

21789 SS $\bar{V}$

21789fb

PACKAGE DESCRIPTION Dimensions in inches (millimeters) unless otherwise noted.

S8 Package 8-Lead Plastic Small Outline (Narrow 0.150) (Reference LTC DWG # 05-08-1610)

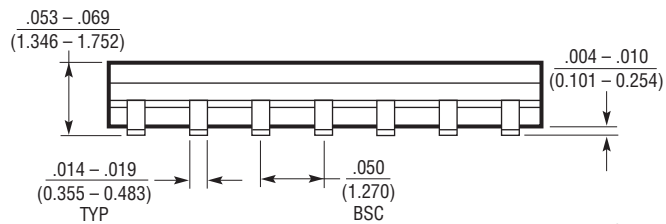
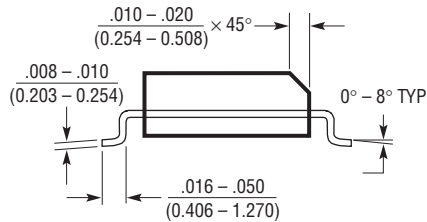
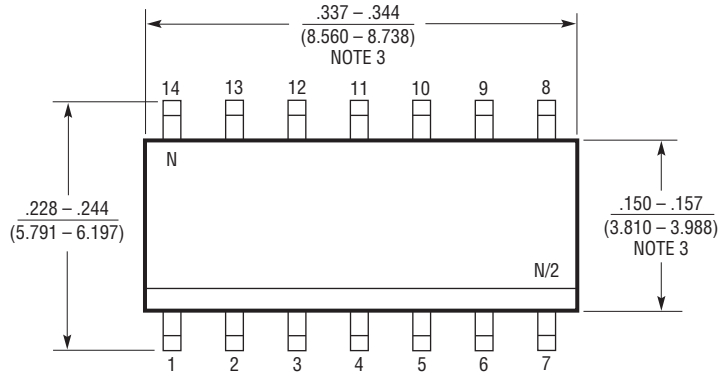
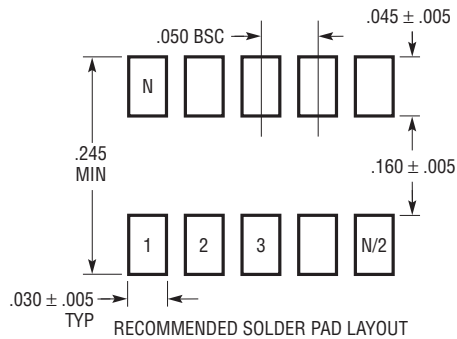


- NOTE:
1. DIMENSIONS IN $\frac{\text{INCHES}}{\text{MILLIMETERS}}$
 2. DRAWING NOT TO SCALE
 3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)

S08 0303

PACKAGE DESCRIPTION Dimensions in inches (millimeters) unless otherwise noted.

S Package 14-Lead Plastic Small Outline (Narrow 0.150) (Reference LTC DWG # 05-08-1610)



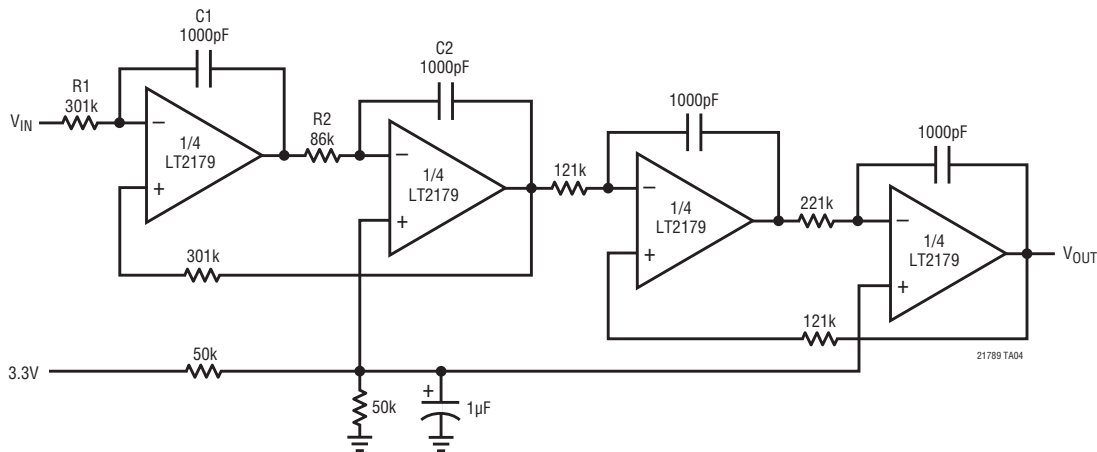
- NOTE:
1. DIMENSIONS IN $\frac{\text{INCHES}}{\text{MILLIMETERS}}$
2. DRAWING NOT TO SCALE
3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)

S14 0502

LT2178/LT2179

TYPICAL APPLICATION

Single Supply, 1kHz, 4th Order Butterworth Lowpass Filter



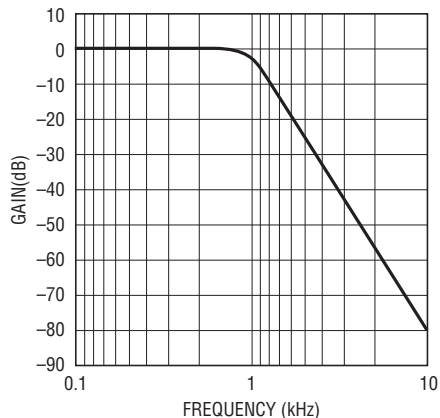
12-BIT ACCURATE SIGNAL RANGE FROM 6mV TO 1.8V ON 3.3V SINGLE SUPPLY.
MAXIMUM OUTPUT OFFSET ERROR IS 448μV.

FOR EACH 2ND ORDER SECTION:

$$W_0^2 = \frac{1}{C1C2R1R2}$$

$$R1 = \frac{1}{W_0QC1}$$

$$R2 = \frac{Q}{W_0C2}$$



21789 TA05

RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1078/LT1079	Dual/Quad 55μA Max, Single Supply Precision Op Amps	70μV V _{OS} Max and 2.5μV/°C Drift Max, 200kHz BBW, 0.07V/μs Slew Rate, Input/Output Common Mode Includes Ground
LT1211/LT1212	14MHz, 7V/μs Single Supply Dual and Quad Precision Op Amps	275μV V _{OS} Max, 6μV/°C Drift Max Input Voltage Range Includes Ground
LT1490/LT1491	Dual/ Quad Micropower Rail-to-Rail Input and Output Op Amps	Single Supply Input Range: -0.4V to 44V, Micropower 50μA Amplifier, Rail-to-Rail Input and Output, 200kHz GBW
LT2078/LT2079	Dual/Quad 55μA Max, Single Supply Precision Op Amps	70μV V _{OS} Max and 2.5μV/°C Drift Max, 200kHz BBW, 0.07V/μs Slew Rate, Input/Output Common Mode Includes Ground Surface Mount Standard Pinout

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