

FEATURES

- **SO Package with Standard Pinout**
- **Supply Current per Amplifier: 17 μ A Max**
- **Offset Voltage: 70 μ V Max**
- Offset Current: 250pA Max
- Input Bias Current: 5nA Max
- Voltage Noise: 0.9 μ V_{P-P}, 0.1Hz to 10Hz
- Current Noise: 1.5pA_{P-P}, 0.1Hz to 10Hz
- Offset Voltage Drift: 0.5 μ V/°C
- Gain Bandwidth Product: 85kHz
- Slew Rate: 0.04V/ μ s
- Single Supply Operation
 - Input Voltage Range Includes Ground
 - Output Swings to Ground while Sinking Current
 - No Pull-Down Resistors Needed
- Output Sources and Sinks 5mA Load Current

APPLICATIONS

- Battery- or Solar-Powered Systems
 - Portable Instrumentation
 - Remote Sensor Amplifier
 - Satellite Circuitry
- Micropower Sample-and-Hold
- Thermocouple Amplifier
- Micropower Filters

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DESCRIPTION

The LT[®]2178 is a micropower dual op amp in a surface mount standard 8-pin configuration, the LT2179 is a micropower quad op amp offered in a surface mount 14-pin package. Both devices are optimized for single supply operation at 5V. Specifications are also provided at ± 15 V supply.

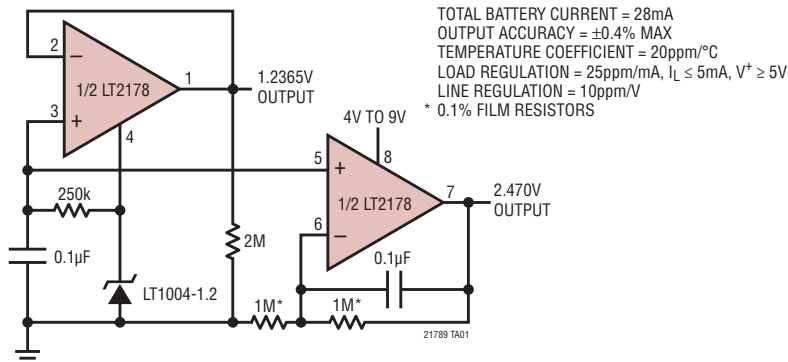
The extremely low supply current is combined with true precision specifications: offset voltage is 30 μ V and offset current is 50pA. Both offset parameters have low drift with temperature. The 1.5pA_{P-P} current noise and picoampere offset current permit the use the megohm level source resistors without introducing serious errors. Voltage noise, at 0.9 μ V_{P-P}, is remarkably low considering the low supply current.

The LT2178/LT2179 can be operated from a single supply (as low as one lithium-cell or two NiCd batteries). The input range goes below ground. The all-NPN output stage swings to within a few millivolts of ground while sinking current. No power consuming pull down resistors are needed.

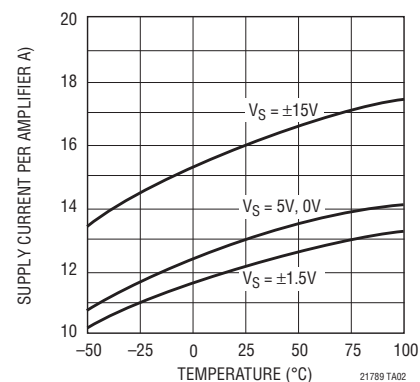
For surface mount applications where three times higher supply current is acceptable, the micropower LT1077 single, LT2078 dual and LT2079 quad are recommended. The LT1077/LT2078/LT2079 have significantly higher bandwidth, slew rate, lower voltage noise and better output drive capability. For applications requiring DIP packages refer to the LT1178/LT1179.

TYPICAL APPLICATION

Self-Buffered, Dual Output, Micropower Reference



Supply Current vs Temperature



21789fc

LT2178/LT2179

ABSOLUTE MAXIMUM RATINGS

Supply Voltage $\pm 22V$
 Differential Input Voltage $\pm 30V$
 Input Voltage Equal to Positive Supply Voltage
 5V Below Negative Supply Voltage
 Output Short-Circuit Duration Indefinite

Specified Temperature Range
 Commercial $0^{\circ}C$ to $70^{\circ}C$
 Industrial $-40^{\circ}C$ to $85^{\circ}C$
 Storage Temperature Range $-65^{\circ}C$ to $150^{\circ}C$
 Lead Temperature (Soldering, 10 sec) $300^{\circ}C$

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 | $0^{\circ}C$ to $70^{\circ}C$ |
| LT2178AIS8#PBF | LT2178AIS8#TRPBF | 2178AI | 8-Lead Plastic SO | $-40^{\circ}C$ to $85^{\circ}C$ |
| LT2178CS8#PBF | LT2178CS8#TRPBF | 2178 | 8-Lead Plastic SO | $0^{\circ}C$ to $70^{\circ}C$ |
| LT2178IS8#PBF | LT2178IS8#TRPBF | 2178I | 8-Lead Plastic SO | $-40^{\circ}C$ to $85^{\circ}C$ |
| LT2179ACS#PBF | LT2179ACS#TRPBF | 2179A | 14-Lead Plastic SO | $0^{\circ}C$ to $70^{\circ}C$ |
| LT2179CS#PBF | LT2179CS#TRPBF | 2179 | 14-Lead Plastic SO | $0^{\circ}C$ to $70^{\circ}C$ |
| LT2179IS#PBF | LT2179IS#TRPBF | 2179I | 14-Lead Plastic SO | $-40^{\circ}C$ to $85^{\circ}C$ |
| LEAD BASED FINISH | TAPE AND REEL | PART MARKING | PACKAGE DESCRIPTION | TEMPERATURE RANGE |
| LT2178ACS8 | LT2178ACS8#TR | 2178A | 8-Lead Plastic SO | $0^{\circ}C$ to $70^{\circ}C$ |
| LT2178AIS8 | LT2178AIS8#TR | 2178AI | 8-Lead Plastic SO | $-40^{\circ}C$ to $85^{\circ}C$ |
| LT2178CS8 | LT2178CS8#TR | 2178 | 8-Lead Plastic SO | $0^{\circ}C$ to $70^{\circ}C$ |
| LT2178IS8 | LT2178IS8#TR | 2178I | 8-Lead Plastic SO | $-40^{\circ}C$ to $85^{\circ}C$ |
| LT2179ACS | LT2179ACS#TR | 2179A | 14-Lead Plastic SO | $0^{\circ}C$ to $70^{\circ}C$ |
| LT2179CS | LT2179CS#TR | 2179 | 14-Lead Plastic SO | $0^{\circ}C$ to $70^{\circ}C$ |
| LT2179IS | LT2179IS#TR | 2179I | 14-Lead Plastic SO | $-40^{\circ}C$ to $85^{\circ}C$ |

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/tapeandreeel/>

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 | | 6.5 | 9 | | 6.5 | 9 | mV |
| | | Output Low, 2k to GND | | 0.2 | 0.6 | | 0.2 | 0.6 | mV |
| | | Output Low, $I_{SINK} = 100\mu A$ | | 120 | 160 | | 120 | 160 | mV |
| | | Output High, No Load | | 4.2 | 4.4 | | 4.2 | 4.4 | V |
| | Output High, 2k to GND | | 3.5 | 3.8 | | 3.5 | 3.8 | 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) | ● 75 | 350 | | 50 | 350 | | V/mV |
| | | V _O = 0.05V to 3.5V, R _L = 50k | ● 40 | 130 | | 30 | 130 | | V/mV |
| | Maximum Output Voltage Swing | Output Low, No Load | ● | 9 | 13 | | 9 | 13 | mV |
| | | Output Low, I _{SINK} = 100μA | ● | 160 | 220 | | 160 | 220 | mV |
| | | Output High, No Load | ● 3.9 | 4.2 | | 3.9 | 4.2 | | V |
| I _S | Supply Current per Amplifier | Output High, 2k to GND | ● 3 | 3.7 | | 3 | 3.7 | | V |
| | | | ● | 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 | ● | 50 | 170 | | 65 | 250 | V/mV |
| | | LT2179 | ● | 60 | 200 | | 70 | 290 | V/mV |
| $\frac{\Delta V_{OS}}{\Delta T}$ | Input Offset Voltage Drift | LT2178 (Note 5) | ● | 0.4 | 1.8 | | 0.5 | 2.5 | mV |
| | | LT2179 | ● | 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) | ● 150 | 500 | | 80 | 500 | | V/mV |
| | | V _O = 0.05V to 3.5V, R _L = 50k | ● 55 | 160 | | 45 | 160 | | V/mV |
| | Maximum Output Voltage Swing | Output Low, No Load | ● | 8 | 11 | | 8 | 11 | mV |
| | | Output Low, I _{SINK} = 100μA | ● | 140 | 190 | | 140 | 190 | mV |
| | | Output High, No Load | ● 4.1 | 4.3 | | 4.1 | 4.3 | | V |
| I _S | Supply Current per Amplifier | Output High, 2k to GND | ● 3.3 | 3.8 | | 3.3 | 3.8 | | V |
| | | | ● | | | | | | |

$V_S = \pm 15V, T_A = 25^\circ C$, 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 | | 70 | 300 | | 90 | 400 | μV |
| | | LT2179 | | 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 ±18V | | 96 | 112 | | 94 | 112 | dB |
| A _{VOL} | Large-Signal Voltage Gain | V _O = ±10V, R _L = 50k | | 300 | 1200 | | 250 | 1000 | V/mV |
| | | V _O = ±10V, No Load | | 600 | 2500 | | 400 | 2500 | V/mV |
| V _{OUT} | Maximum Output Voltage Swing | R _L = 50k | | ±13 | ±14.2 | | ±13 | ±14.2 | V |
| | | R _L = 2k | | ±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 $-300\mu V$.

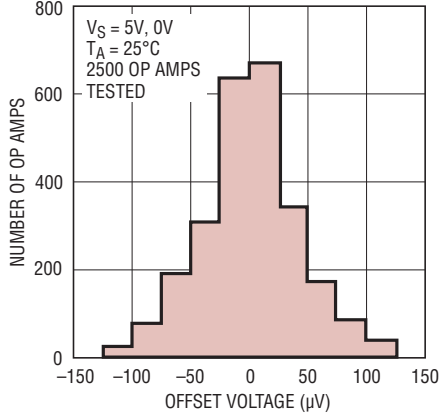
Note 6: This parameter is not 100% tested.

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.

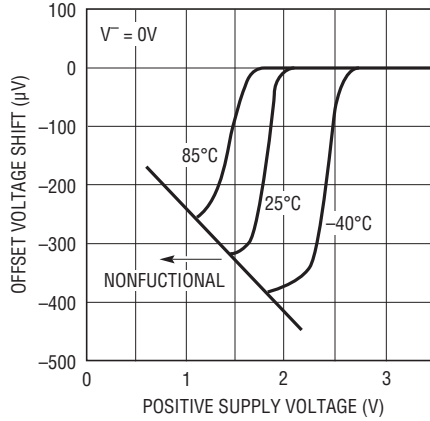
TYPICAL PERFORMANCE CHARACTERISTICS

Distribution of Input Offset Voltage



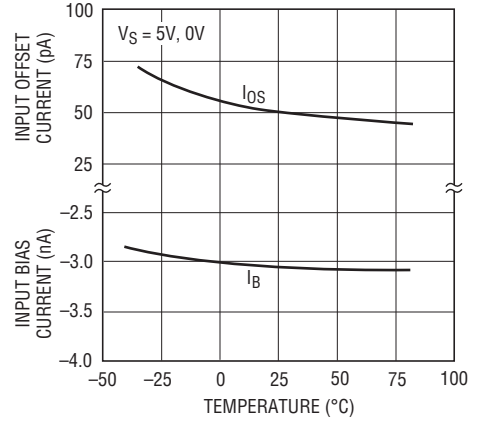
21789 G01

Minimum Supply Voltage



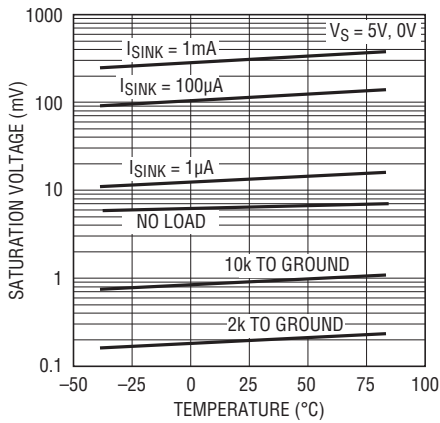
21789 G02

Input Bias and Offset Currents vs Temperature



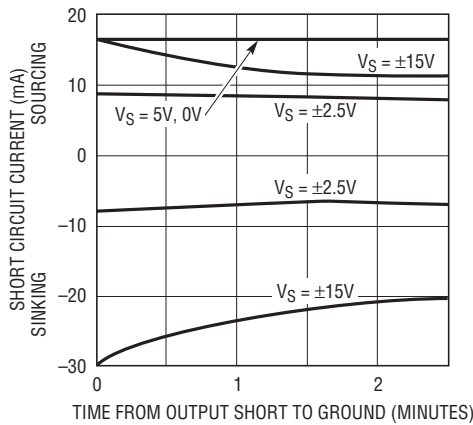
21789 G03

Output Saturation vs Temperature vs Sink Current



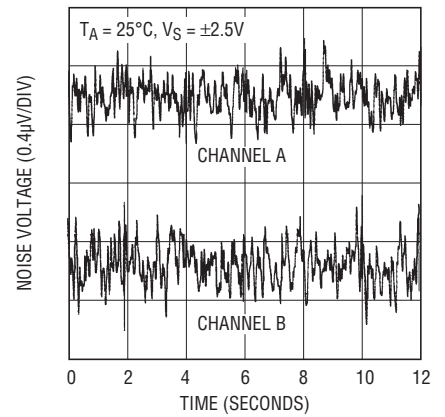
21789 G04

Short-Circuit Current



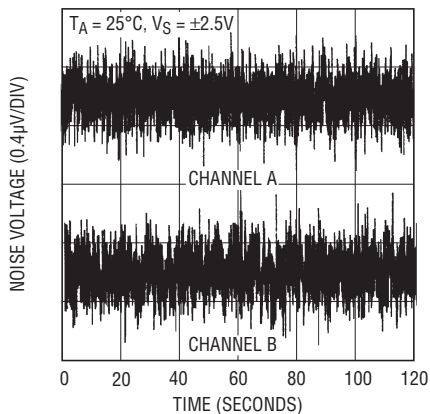
21789 G05

0.1Hz to 10Hz Noise



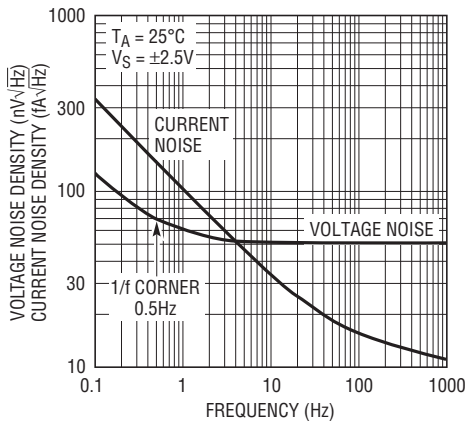
21789 G06

0.01Hz to 10Hz Noise



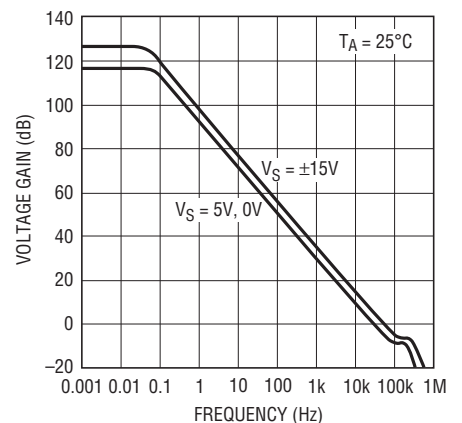
21789 G07

Noise Spectrum



21789 G08

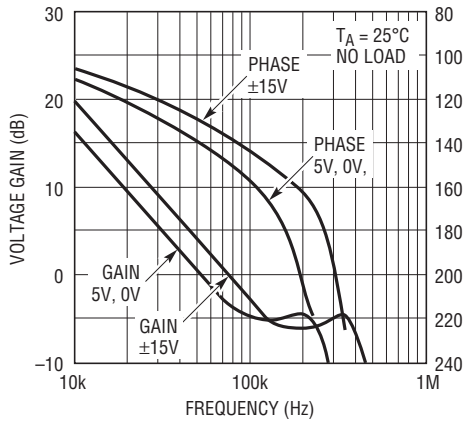
Voltage Gain vs Frequency



21789 G09

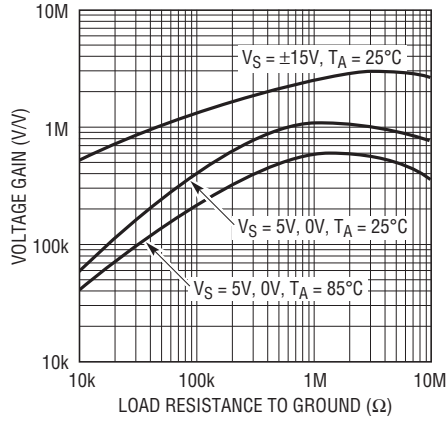
TYPICAL PERFORMANCE CHARACTERISTICS

Gain, Phase vs Frequency



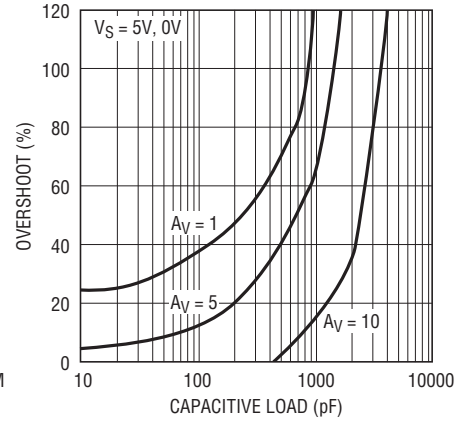
21789 G10

Voltage Gain vs Load Resistance



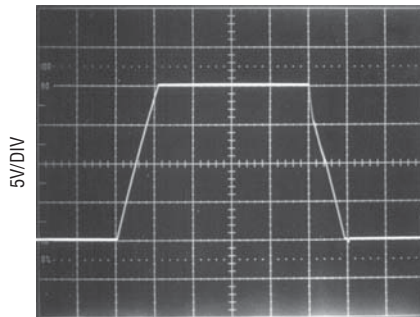
21789 G11

Capacitive Load Handling



20789 G12

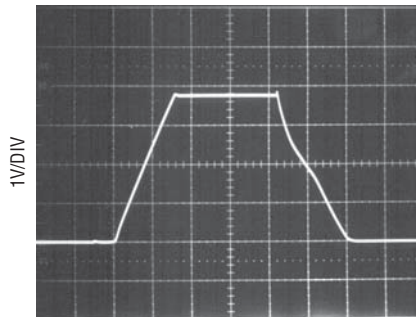
**Large-Signal Transient Response
VS = ±15V**



AV = 1
CL = 12pF

21789 G13

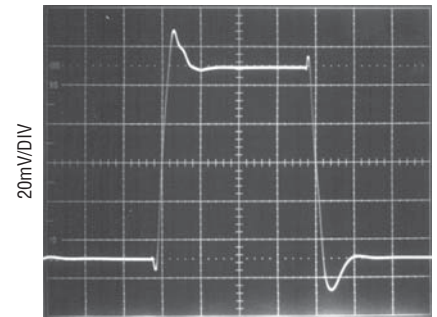
**Large-Signal Transient Response
VS = 5V, 0V**



AV = 1
CL = 12pF
INPUT PULSE = 0V TO 3.8V

21789 G14

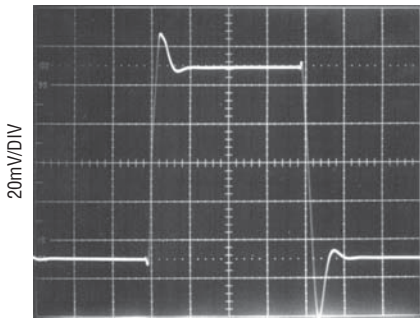
**Small-Signal Transient Response
VS = ±2.5V**



AV = 1
CL = 12pF

21789 G15

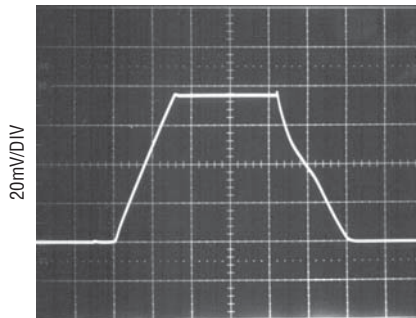
**Small-Signal Transient Response
VS = ±15V**



AV = 1
CL = 12pF

21789 G16

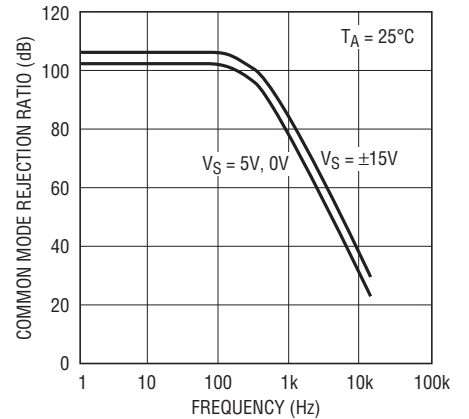
**Small-Signal Transient Response
VS = 5V, 0V**



AV = 1
CL = 12pF
INPUT PULSE = 50mV TO 150mV

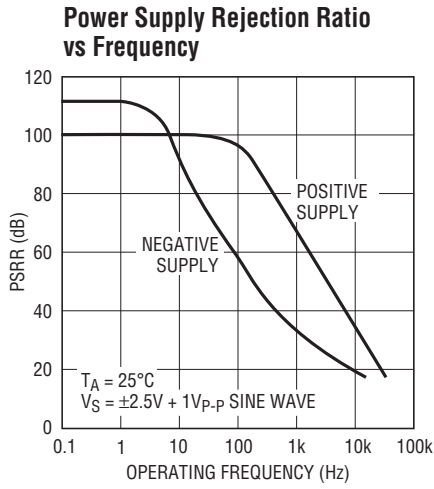
21789 G17

**Common Mode Rejection Ratio
vs Frequency**

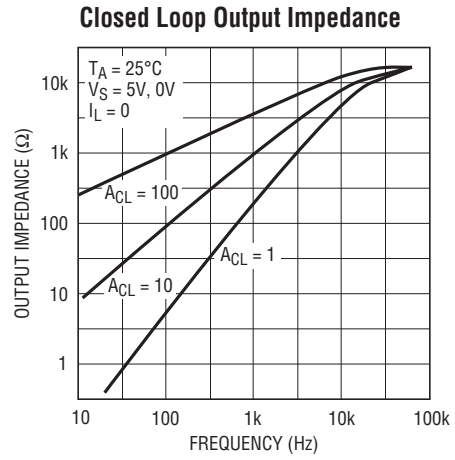


21789 G18

TYPICAL PERFORMANCE CHARACTERISTICS



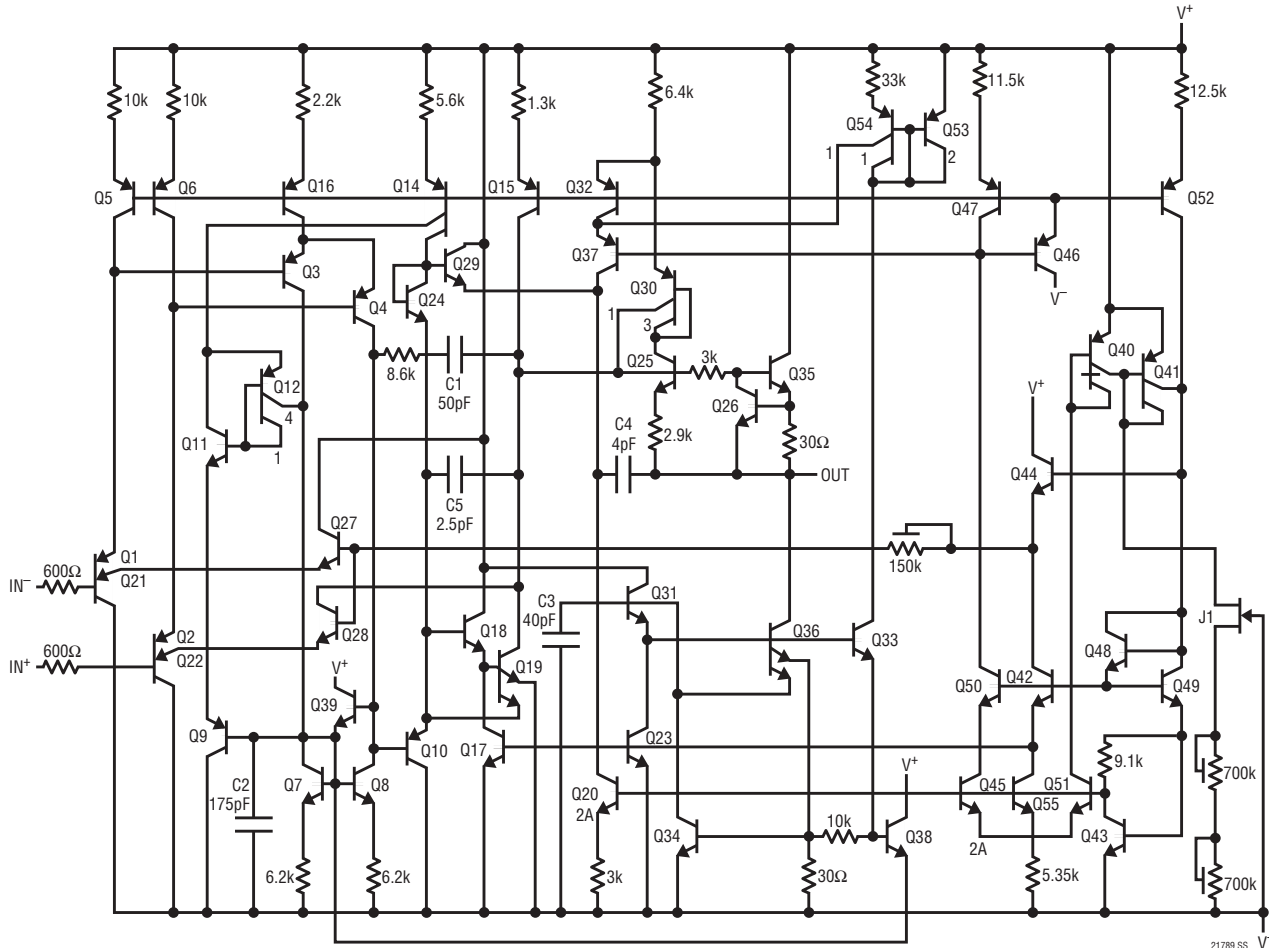
21789 G19



21789 G20

SIMPLIFIED SCHEMATIC

1/2 LT2178
1/4 LT2179



21789 SS V

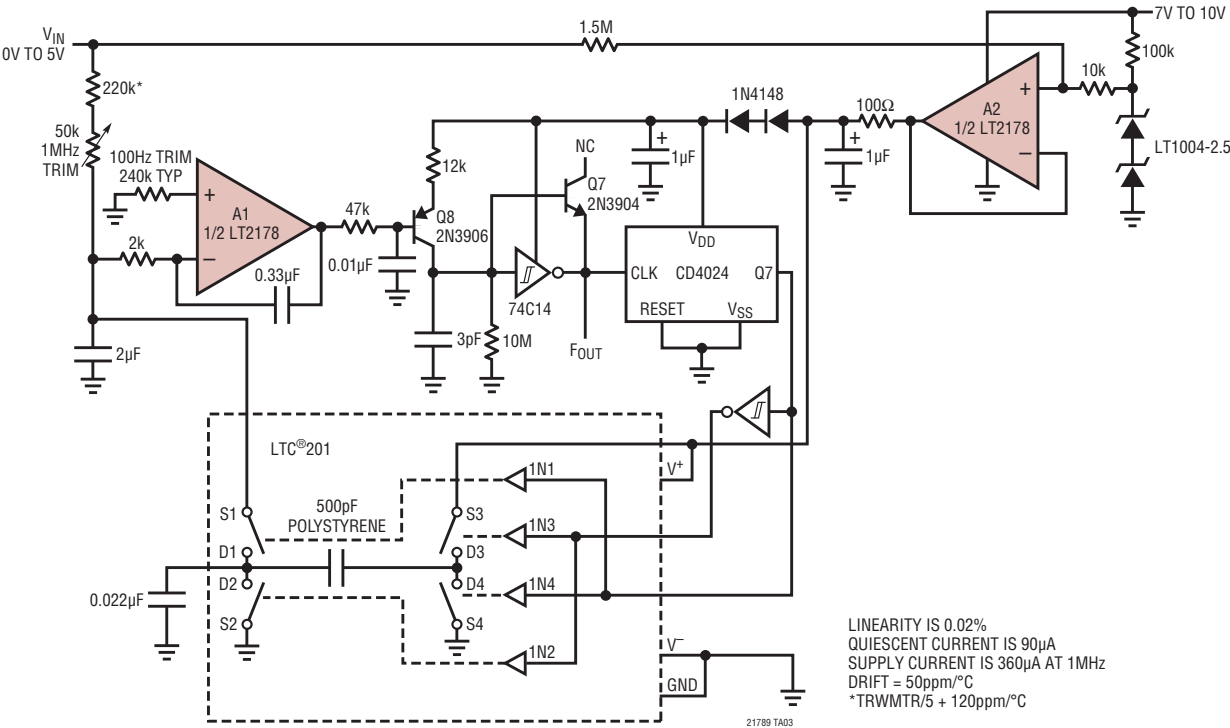
21789fc

APPLICATIONS INFORMATION

Please see the LT2078/LT2079 data sheet for applications information. All comments relating to specifications, single

supply operation and phase reversal protection are directly applicable to the LT2178/LT2179.

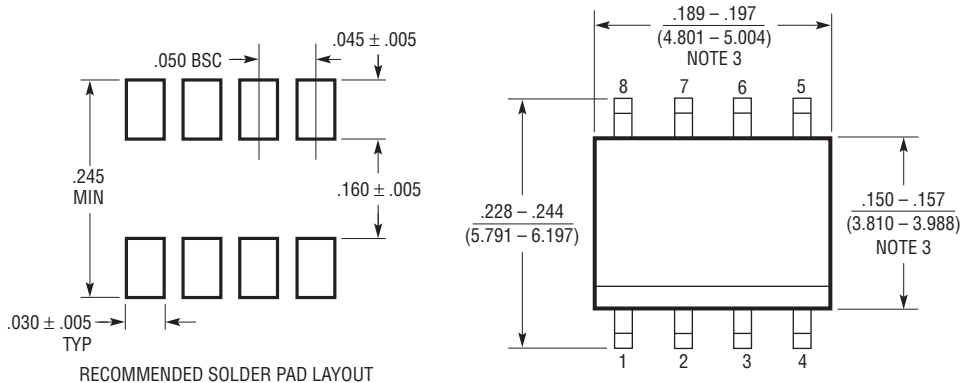
Micropower 100Hz to 1MHz V-to-F Converter



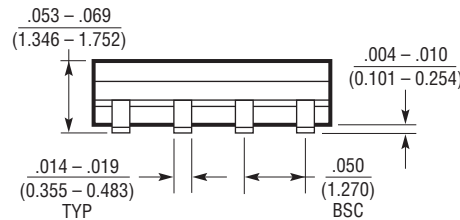
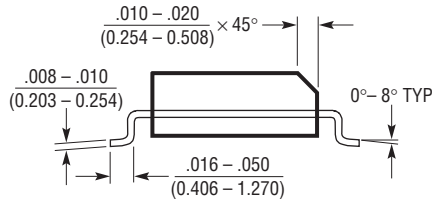
LINEARITY IS 0.02%
 QUIESCENT CURRENT IS 90µA
 SUPPLY CURRENT IS 360µA AT 1MHz
 DRIFT = 50ppm/°C
 *TRWMTR/5 + 120ppm/°C

PACKAGE DESCRIPTION

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



RECOMMENDED SOLDER PAD LAYOUT

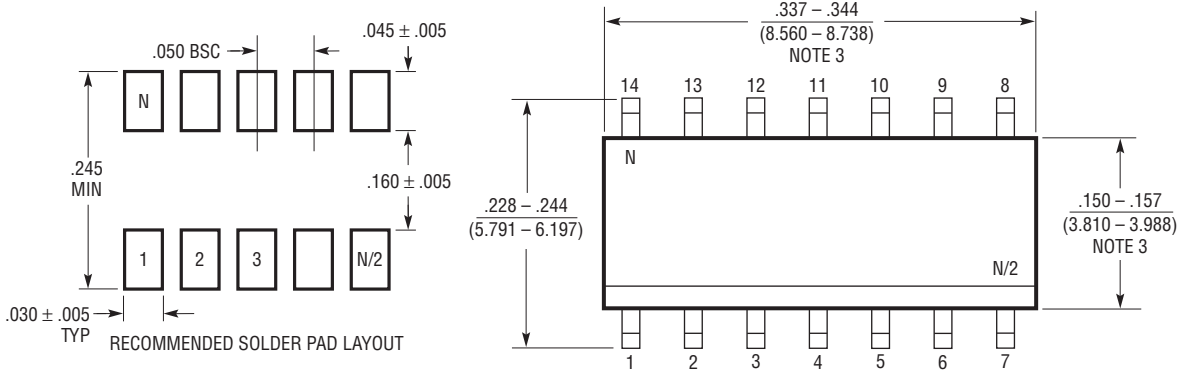


NOTE:
 1. DIMENSIONS IN $\frac{\text{INCHES}}{\text{MILLIMETERS}}$
 2. DRAWING NOT TO SCALE

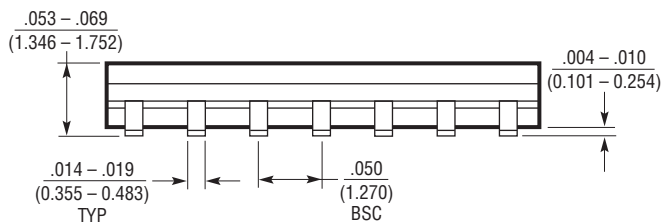
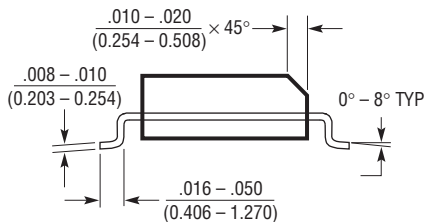
3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
 MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)

S08 0303

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



RECOMMENDED SOLDER PAD LAYOUT



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)

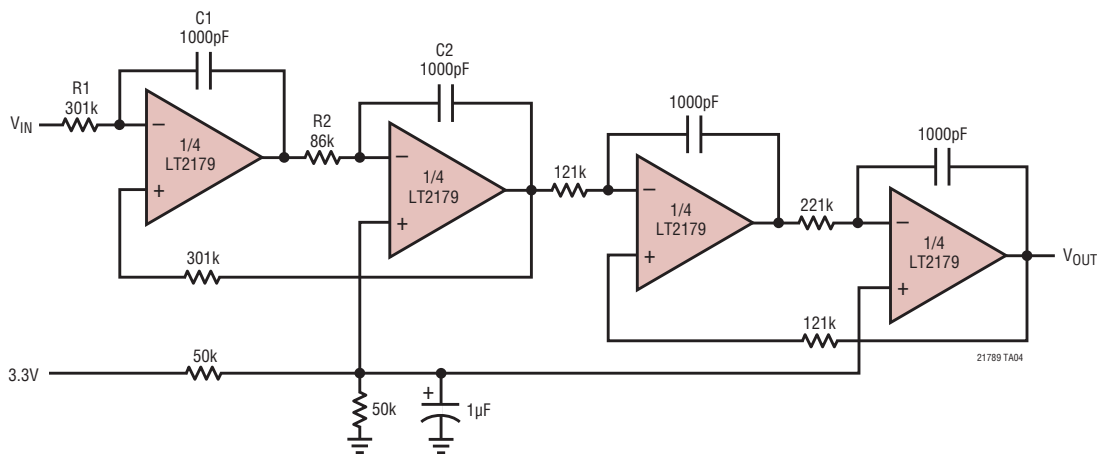
S14 0502

REVISION HISTORY (Revision history begins at Rev C)

| REV | DATE | DESCRIPTION | PAGE NUMBER |
|-----|------|---|-------------|
| C | 3/10 | Correct the part numbers on S Package in the Order Information Section. | 2 |
| | | Update to graph G04 | 6 |

TYPICAL APPLICATION

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



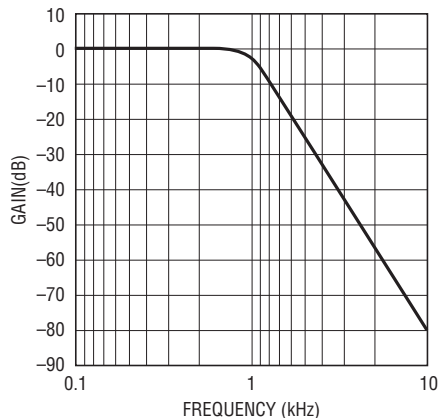
12-BIT ACCURATE SIGNAL RANGE FROM 6mV TO 1.8V ON 3.3V SINGLE SUPPLY.
MAXIMUM OUTPUT OFFSET ERROR IS 448µV.

FOR EACH 2ND ORDER SECTION:

$$W_0^2 = \frac{1}{C_1 C_2 R_1 R_2}$$

$$R_1 = \frac{1}{W_0 Q C_1}$$

$$R_2 = \frac{Q}{W_0 C_2}$$



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 |