

Dual Micropower Chopper Stabilized Operational Amplifier with Internal Capacitors

FEATURES

- No External Components Required
- Supply Current 80 μ A
- Maximum Offset Voltage 10 μ V
- Maximum Offset Voltage Drift 50nV/ $^{\circ}$ C
- Minimum CMRR 110dB
- Minimum PSRR 110dB
- Single Supply Operation 4.75V to 16V
- Common Mode Range Includes GND
- Output Swings to GND
- Typical Overload Recovery Time 70ms
- Pin Compatible with Industry Standard Dual Op Amps

APPLICATIONS

- Thermocouple Amplifiers
- Electronic Scales
- Battery Powered Instrumentation
- Strain Gauge Amplifiers
- Remote Located Sensors

DESCRIPTION

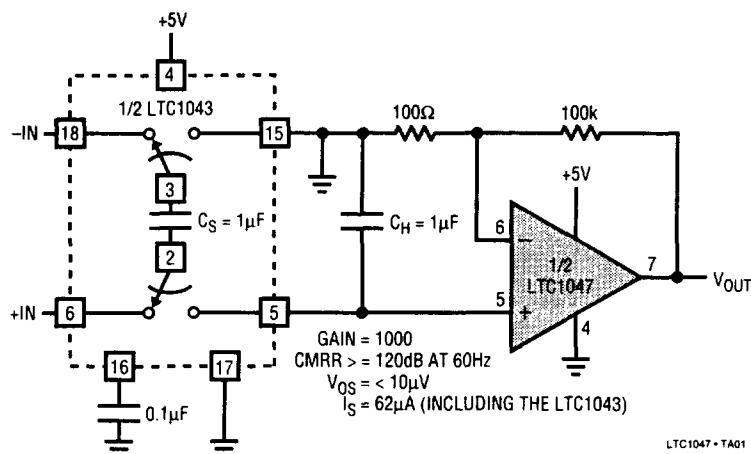
The LTC1047 is a micropower, high performance dual chopper stabilized operational amplifier. The sample-and-hold capacitors usually required by other chopper amplifiers are integrated on-chip, minimizing the need for external components.

The LTC1047 has a typical offset voltage of 3 μ V, drift of 10nV/ $^{\circ}$ C, input noise voltage typically 3.5 μ Vp-p, and typical voltage gain of 150dB. The common mode rejection is 110dB minimum, with minimum power supply rejection of 110dB. The LTC1047 also offers 0.2V/ μ s slew rate and a gain bandwidth product of 200kHz. Overload recovery time from saturation is 70ms, four times faster than chopper amplifiers with external capacitors.

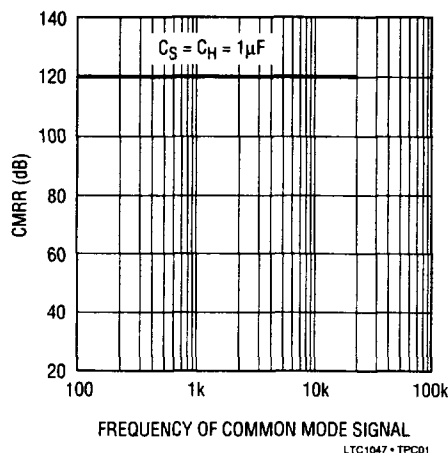
The LTC1047 is available in a standard plastic 8-pin DIP as well as a 16-pin SOL package. The LTC1047 is a plug-in replacement for most dual op amps with improved DC performance and substantial power savings.

TYPICAL APPLICATION

Micropower Single Supply Instrumentation Amplifier



CMRR vs Frequency

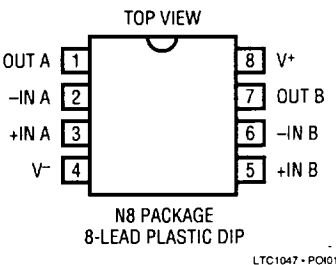
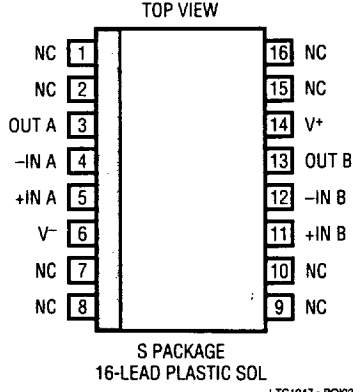


ABSOLUTE MAXIMUM RATINGS (Note 1)

Total Supply Voltage (V^+ to V^-) 16V
 Input Voltage (Note 2) ($V^+ + 0.3V$) to ($V^- - 0.3V$)
 Output Short Circuit Duration Indefinite
 Storage Temperature Range -65°C to 150°C

Operating Temperature Range
 LTC1047C 0°C to 70°C
 Lead Temperature (Soldering, 10 sec.) 300°C

PACKAGE/ORDER INFORMATION

	ORDER PART NUMBER		ORDER PART NUMBER
	LTC1047CN8		LTC1047CS

ELECTRICAL CHARACTERISTICS $V_S = \pm 5V$, $T_A = \text{Operating Temperature Range}$, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$T_A = 25^\circ\text{C}$ (Note 3)		± 3	± 10	μV
Average Input Offset Voltage Drift	(Note 3)	●	± 0.01	± 0.05	$\mu\text{V}/^\circ\text{C}$
Long Term Offset Drift			100		nV/rt mo.
Input Bias Current	$T_A = 25^\circ\text{C}$	●	± 5	± 30 ± 300	pA pA
Input Offset Current	$T_A = 25^\circ\text{C}$	●	± 10	± 60 ± 150	pA pA
Input Noise Voltage	0.1Hz to 10Hz 0.1Hz to 1Hz		3.5 0.8		$\mu\text{Vp-p}$ $\mu\text{Vp-p}$
Input Noise Current	$f = 10\text{Hz}$ (Note 4)		1.5		fA/rtHz
Common Mode Rejection Ratio	$V_{CM} = V^-$ to $+2.7V$, $T_A = 25^\circ\text{C}$	●	110 105	130	dB dB
Power Supply Rejection Ratio	$V_S = \pm 2.375V$ to $\pm 8V$	●	105	122	dB
Large Signal Voltage Gain	$R_L = 100k$, $V_{OUT} = \pm 4V$	●	120	150	dB
Maximum Output Voltage Swing	$R_L = 10k$ $R_L = 100k$	●	$+ 4.3/- 4.8$ $+ 4.8/- 4.9$	± 4.95	V V
Slew Rate	$R_L = 100k$, $C_L = 50pF$		0.2		V/ μs
Gain Bandwidth Product			200		kHz
Supply Current/Amplifier	No Load, $25^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ No Load, $0^\circ\text{C} \leq T_A \leq 25^\circ\text{C}$		60 80	150 275	μA μA
Internal Sampling Frequency	$T_A = 25^\circ\text{C}$		680		Hz

The ● denotes specifications which apply over the full operating temperature range.

Note 1: Absolute Maximum Ratings are those values beyond which life of the device may be impaired.

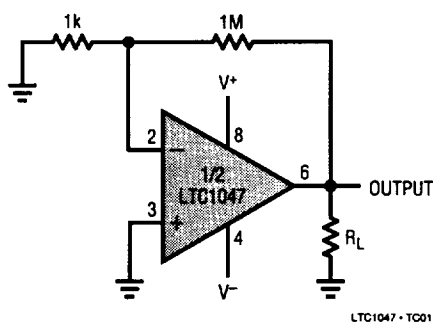
Note 2: Connecting any terminal to voltages greater than V_+ or less than V_- may cause destructive latch-up. It is recommended that no sources operating from external supplies be applied prior to power-up of the LTC1047.

Note 3: These parameters are guaranteed by design. Thermocouple effects preclude measurements of these voltage levels in high speed automatic test systems. V_{OS} is measured to a limit determined by test equipment capability.

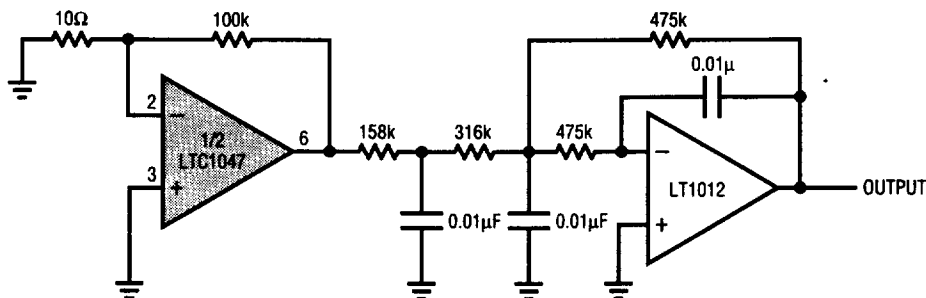
Note 4: Current Noise is calculated from the formula: $I_n = \sqrt{(2q \cdot I_B)}$ where $q = 1.6 \times 10^{-19}$ Coulomb.

TEST CIRCUITS

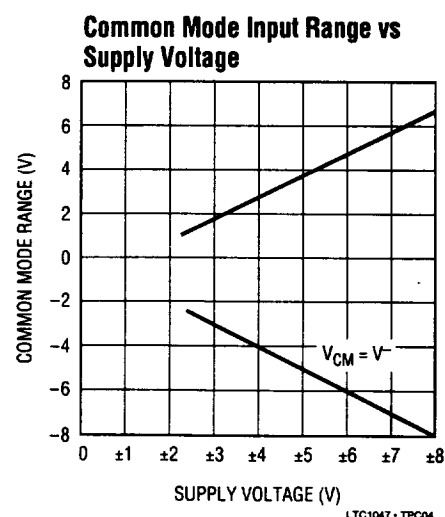
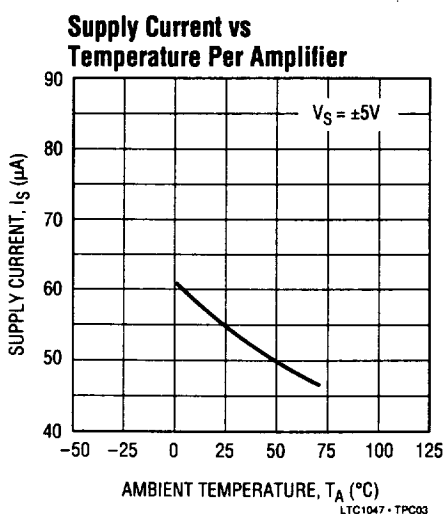
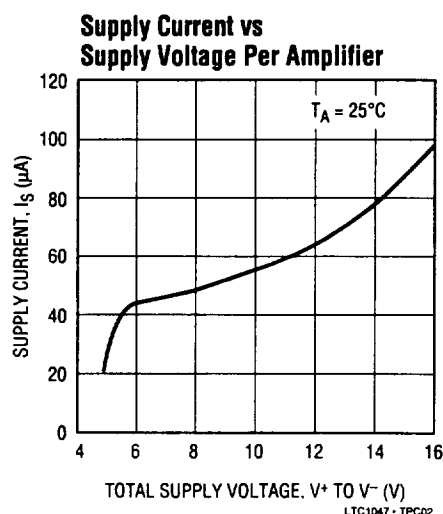
Electrical Characteristics Test Circuit



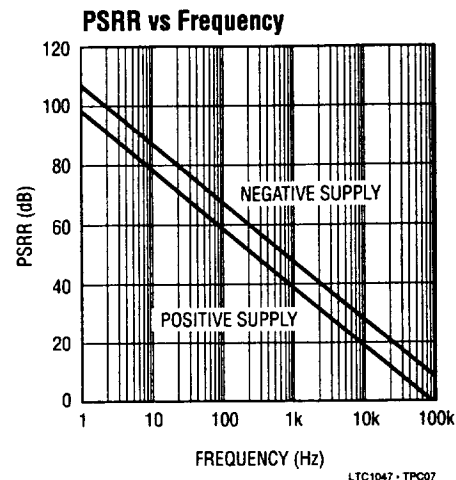
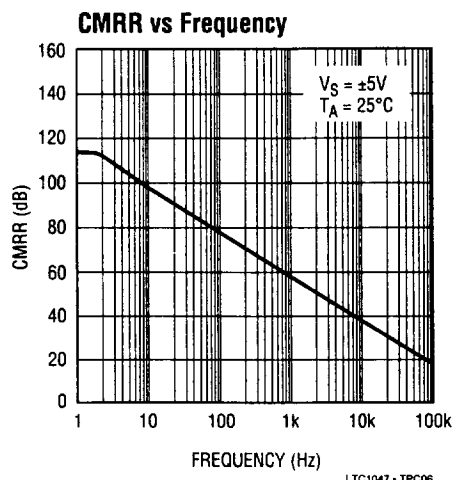
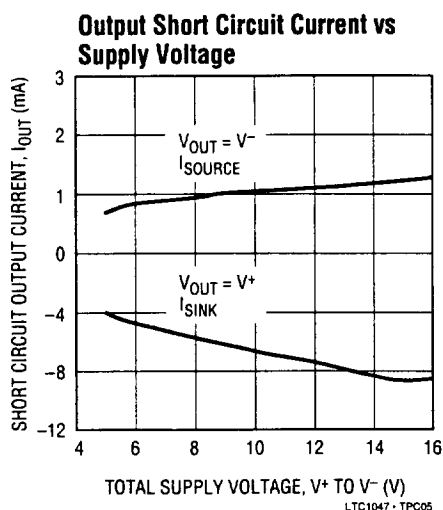
DC-10Hz Noise Test Circuit



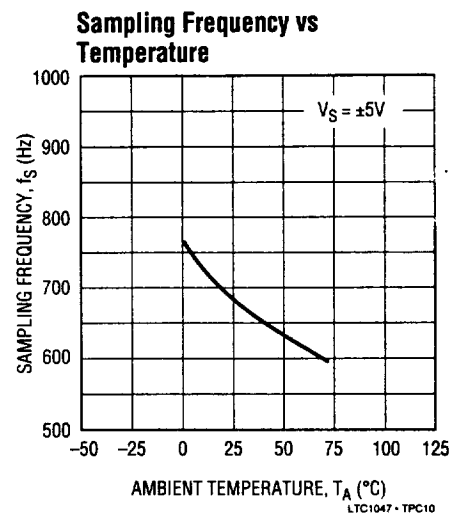
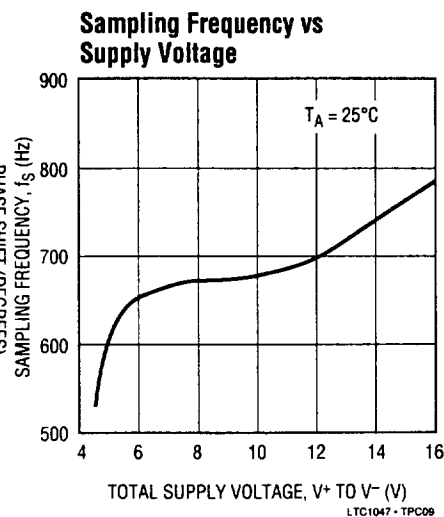
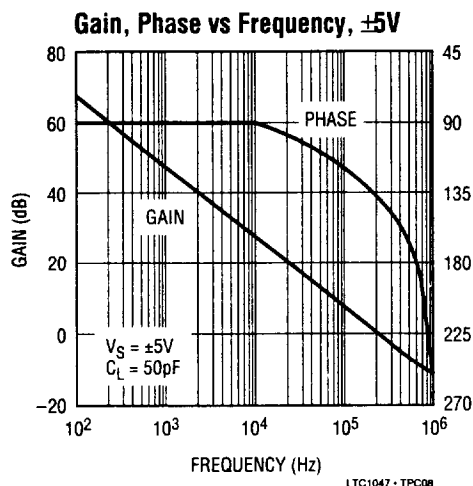
TYPICAL PERFORMANCE CHARACTERISTICS



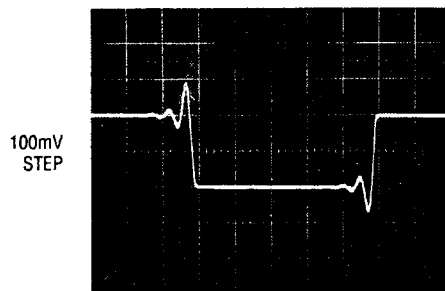
TYPICAL PERFORMANCE CHARACTERISTICS



2



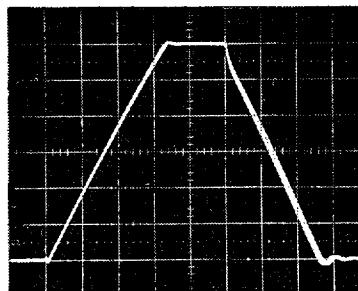
Small Signal Transient Response



$A_V = +1$, $R_L = 100k$, $C_L = 50pF$, $V_S = \pm 5V$
HORIZONTAL = 10 μs /DIV

LTC1047 • TPC11

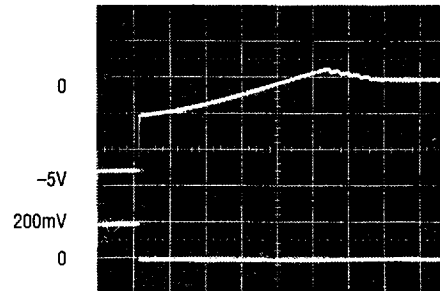
Large Signal Transient Response



$A_V = +1$, $R_L = 100k$, $C_L = 50pF$, $V_S = \pm 5V$
HORIZONTAL = 10 μs /DIV

LTC1047 • TPC12

Overload Recovery



$A_V = -100$, $V_S = \pm 5V$
HORIZONTAL = 10ms/DIV

LTC1047 • TPC13

APPLICATIONS INFORMATION

Input Considerations

Frequently circuits built with parts as precise as the LTC1047 show errors at the output far greater than the designer expects. Rarely is the problem the op amp; more often the surrounding circuitry is causing errors several orders of magnitude greater than those due to the LTC1047. Such obscure effects as leakage between pins due to residual solder flux and thermocouple effects between the tin/lead solder and the copper PC board traces can overwhelm the pA-level bias currents and the μV -level offset of the LTC1047. For a more complete description of these types of problems (and some advice on avoiding them), see the LTC1051/53 data sheet.

Input Capacitance

The LTC1047 has approximately 12pF of capacitance at each input pin. This will react with large series resistors to form a pole at the input, degrading the LTC1047's phase margin. The problem is especially common with micropower parts like the LTC1047 because high value resistors are often used to minimize power dissipation. As

a rule of thumb, bypass feedback resistors larger than 7k with a 20pF capacitor to minimize this effect.

Aliasing

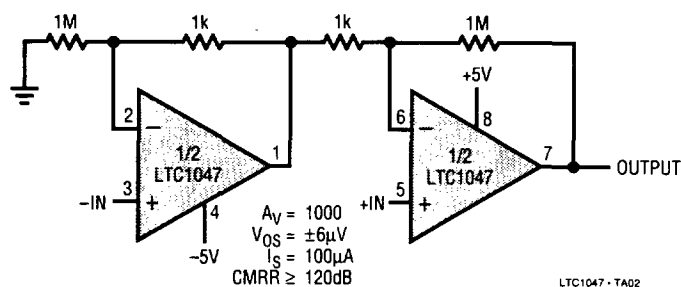
Like all sampled data systems, the LTC1047 will alias input signals near its internal sampling frequency. The design includes internal circuitry to minimize this effect; as a result, most applications do not exhibit aliasing problems. For a complete discussion of the correction circuitry and aliasing behavior, refer to the LTC1051/53 data sheet.

Single Supply Operation

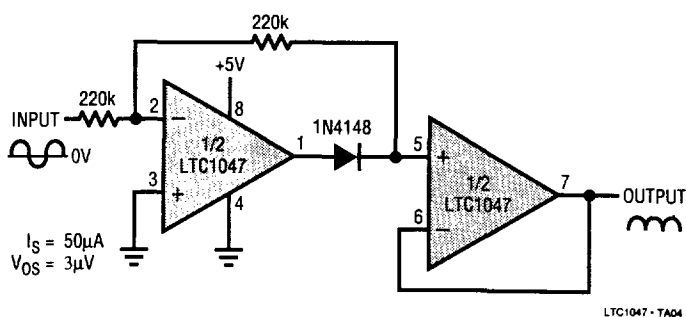
The LTC1047 is compatible with all single supply applications. It has an input common mode range which includes V_{-} , and an output which will swing within millivolts of the negative power supply. The LTC1047 is guaranteed functional down to 4.75V total supply, allowing it to run from minimum TTL voltage all the way up to 16V. See the Typical Applications section for examples of single supply operation.

TYPICAL APPLICATIONS

Low Offset, Low Drift Instrumentation Amplifier



Precise DC Full Wave Rectifier (Absolute Value Circuit)



2



INITIAL ACCURACY = 3% (LIMITED BY REFERENCE IN LT1120).
TRIM R1 FOR 4.00mA WITH 0.00V IN.
TRIM R2 FOR 20.0mA WITH 1.00V IN.

The circuit diagram shows a precision active low-pass filter. It consists of two LTC1047 comparators and one LT1012 op-amp. The comparators are configured as a differential input stage, with their non-inverting inputs connected to the filter input and their inverting inputs connected to the filter output. The comparators' outputs are connected to the inputs of the LT1012 op-amp, which is configured as a voltage follower. The op-amp's output is connected back to the comparators' inverting inputs. The circuit is powered by a +5V and a -5V supply. A 100k resistor is connected between the input and the comparators' non-inverting inputs. A 100k resistor is connected between the output and the comparators' inverting inputs. The comparators' outputs are connected to the op-amp's inputs through a 10k resistor. The op-amp's output is connected back to the comparators' inverting inputs through a 100k resistor. The circuit is also connected to a 100k resistor to ground. The output is labeled OUTPUT.

$V_{OS} = 3\mu V$
 $0.1\text{Hz}-10\text{Hz NOISE} = 0.7\mu V_{p-p}$
 $I_S = 490\mu A$

LTC1047 - TA05

TYPICAL APPLICATIONS

Ultra Low Noise Micropower Chopper

