Dual Micropower Chopper Stabilized Operational Amplifier with Internal Capacitors

FEATURES

- **No External Components Required**
- Supply Current 80μA
- **Maximum Offset Voltage 10μV**
- **Maximum Offset Voltage Drift 50nV/°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

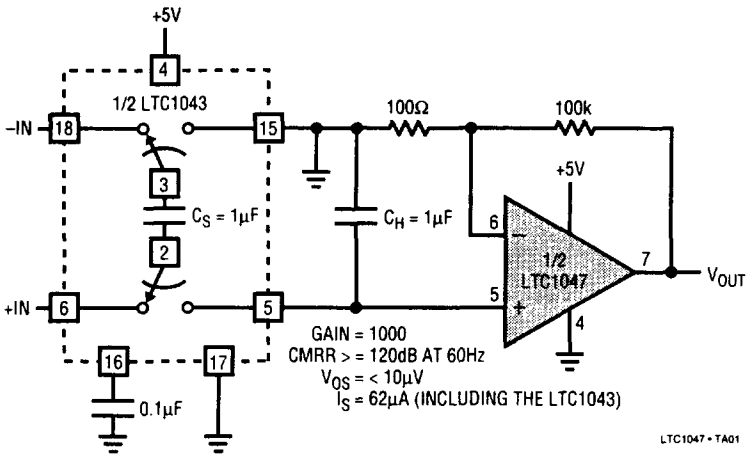
The LTC1047 is a micropower, high performance dual chopper stabilized operational amplifier. The sample-and-hold capacitors usually required by other chopper amplifiers are integrated on-chip, minimizing the need for external components.

The LTC1047 has a typical offset voltage of 3μV, drift of 10nV/°C, input noise voltage typically 3.5μVp-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/μs 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.

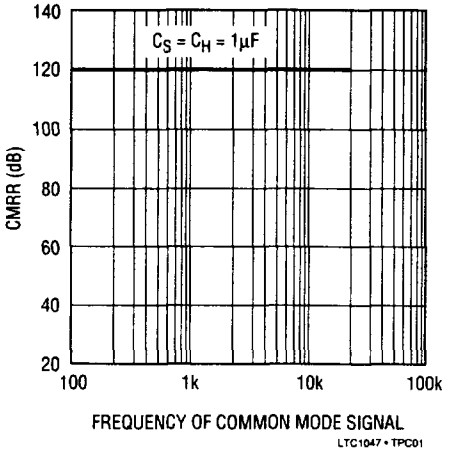
The LTC1047 is available in a standard plastic 8-pin DIP as well as a 16-pin SOL package. The LTC1047 is a plug-in replacement for most dual op amps with improved DC performance and substantial power savings.

TYPICAL APPLICATION

Micropower Single Supply Instrumentation Amplifier



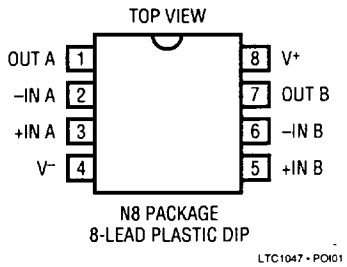
CMRR vs Frequency



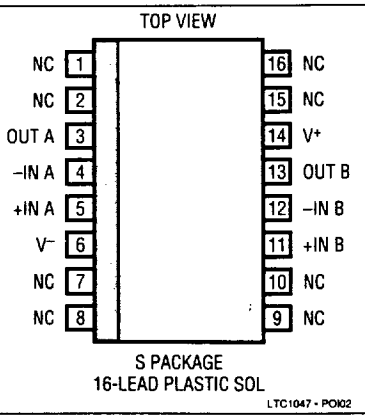
ABSOLUTE MAXIMUM RATINGS (Note 1)

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: LTC1047CN8



ORDER PART NUMBER: LTC1047CS

ELECTRICAL CHARACTERISTICS $V_S = \pm5V$, T_A = Operating Temperature Range, unless otherwise noted.

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Input Offset Voltage	$T_A = 25°C$ (Note 3)			±3	±10	µV
Average Input Offset Voltage Drift	(Note 3)	●		±0.01	±0.05	µV/°C
Long Term Offset Drift				100		nV/rt mo.
Input Bias Current	$T_A = 25°C$			±5	±30	pA
		●			±300	pA
Input Offset Current	$T_A = 25°C$			±10	±60	pA
		●			±150	pA
Input Noise Voltage	0.1Hz to 10Hz			3.5		µVp-p
	0.1Hz to 1Hz			0.8		µVp-p
Input Noise Current	f = 10Hz (Note 4)			1.5		fA/rtHz
Common Mode Rejection Ratio	$V_{CM} = V^-$ to +2.7V, $T_A = 25°C$		110	130		dB
		●	105			dB
Power Supply Rejection Ratio	$V_S = \pm2.375V$ to ±8V	●	105	122		dB
Large Signal Voltage Gain	$R_L = 100k$, $V_{OUT} = \pm4V$	●	120	150		dB
Maximum Output Voltage Swing	$R_L = 10k$			+4.3/–4.8		V
	$R_L = 100k$	●	+4.8/–4.9	±4.95		V
Slew Rate	$R_L = 100k$, $C_L = 50pF$			0.2		V/µs
Gain Bandwidth Product				200		kHz
Supply Current/Amplifier	No Load, $25°C \le T_A \le 70°C$			60	150	µA
	No Load, $0°C \le T_A \le 25°C$			80	275	µA
Internal Sampling Frequency	$T_A = 25°C$			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.

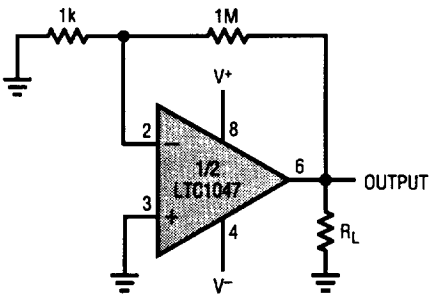
Note 2: Connecting any terminal to voltages greater than V+ or less than V– may cause destructive latch-up. It is recommended that no sources operating from external supplies be applied prior to power-up of the LTC1047.

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: $I_n = \sqrt{(2q \bullet I_B)}$ where $q = 1.6 \times 10^{-19}$ Coulomb.

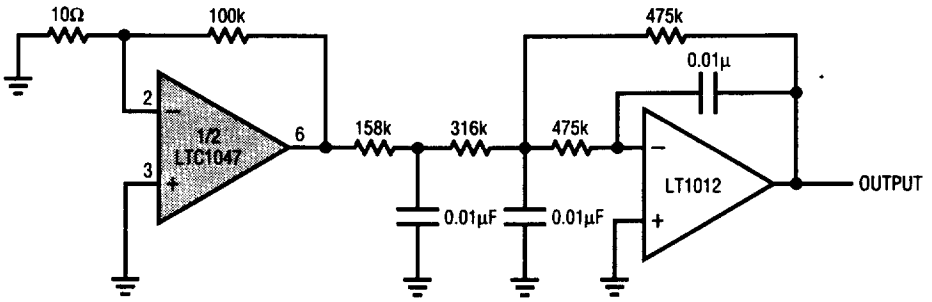
TEST CIRCUITS

Electrical Characteristics Test Circuit



LTC1047 • TC01

DC-10Hz Noise Test Circuit

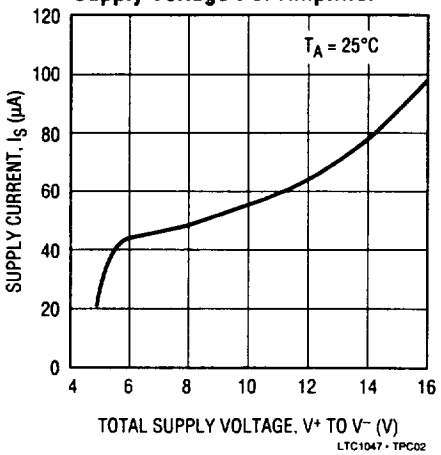


FOR 1Hz NOISE BANDWIDTH, INCREASE ALL CAPACITORS BY A FACTOR OF 10.

LTC1047 • TC02

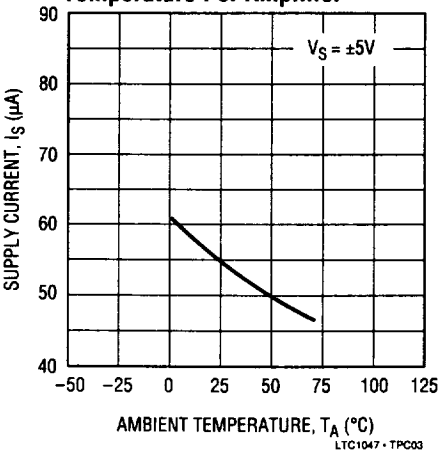
TYPICAL PERFORMANCE CHARACTERISTICS

Supply Current vs Supply Voltage Per Amplifier



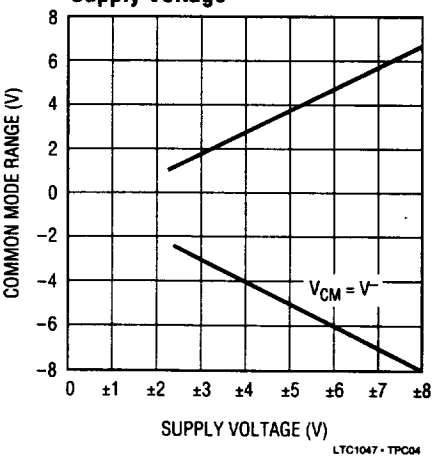
LTC1047 • TPC02

Supply Current vs Temperature Per Amplifier



LTC1047 • TPC03

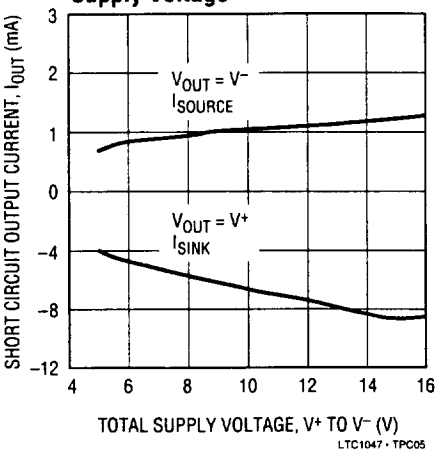
Common Mode Input Range vs Supply Voltage



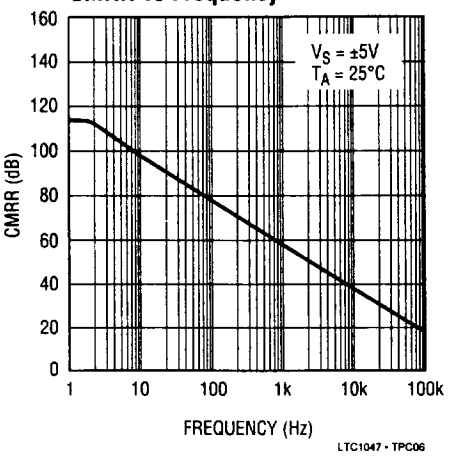
LTC1047 • TPC04

TYPICAL PERFORMANCE CHARACTERISTICS

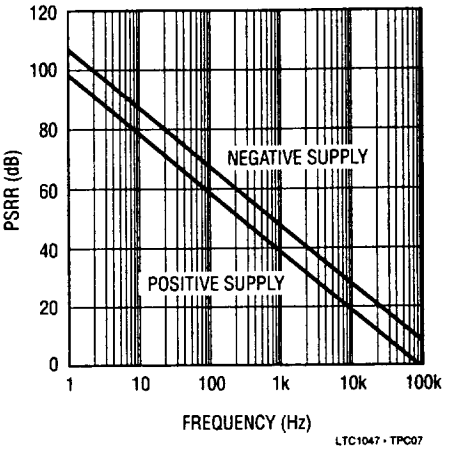
Output Short Circuit Current vs Supply Voltage



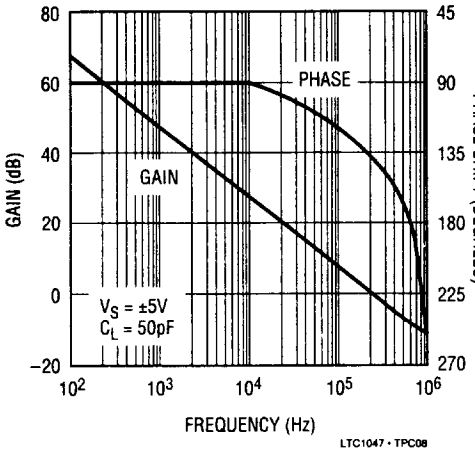
CMRR vs Frequency



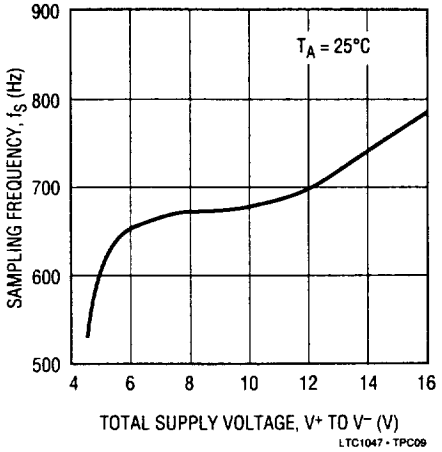
PSRR vs Frequency



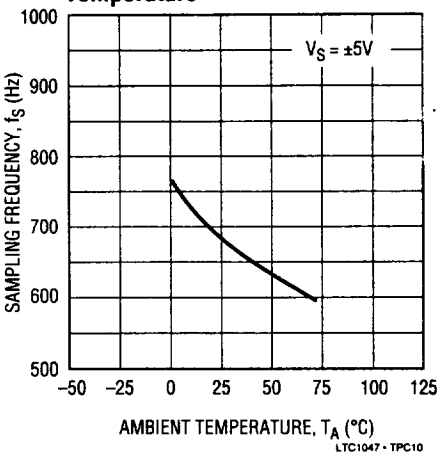
Gain, Phase vs Frequency, ±5V



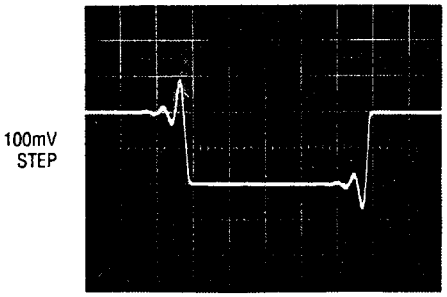
Sampling Frequency vs Supply Voltage



Sampling Frequency vs Temperature

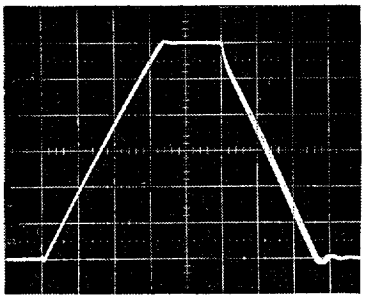


Small Signal Transient Response



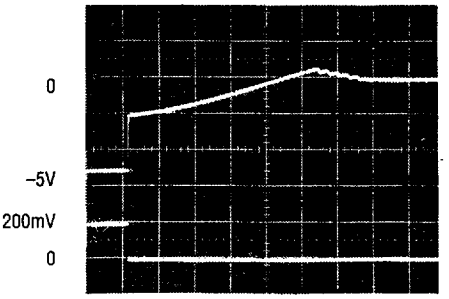
A_V = +1, R_L = 100k, C_L = 50pF, V_S = ±5V
HORIZONTAL = 10µs/DIV
LTC1047 • TPC11

Large Signal Transient Response



A_V = +1, R_L = 100k, C_L = 50pF, V_S = ±5V
HORIZONTAL = 10µs/DIV
LTC1047 • TPC12

Overload Recovery



A_V = –100, V_S = ±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

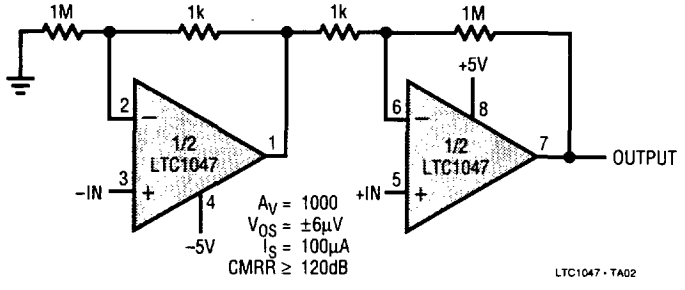
Like all sampled data systems, the LTC1047 will alias input signals near its internal sampling frequency. The design includes internal circuitry to minimize this effect; as a result, most applications do not exhibit aliasing problems. For a complete discussion of the correction circuitry and aliasing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

Single Supply Operation

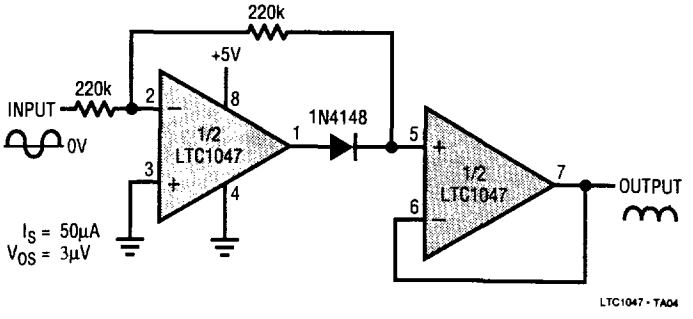
The LTC1047 is compatible with all single supply applications. It has an input common mode range which includes V–, and an output which will swing within millivolts of the negative power supply. The LTC1047 is guaranteed functional down to 4.75V total supply, allowing it to run from minimum TTL voltage 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

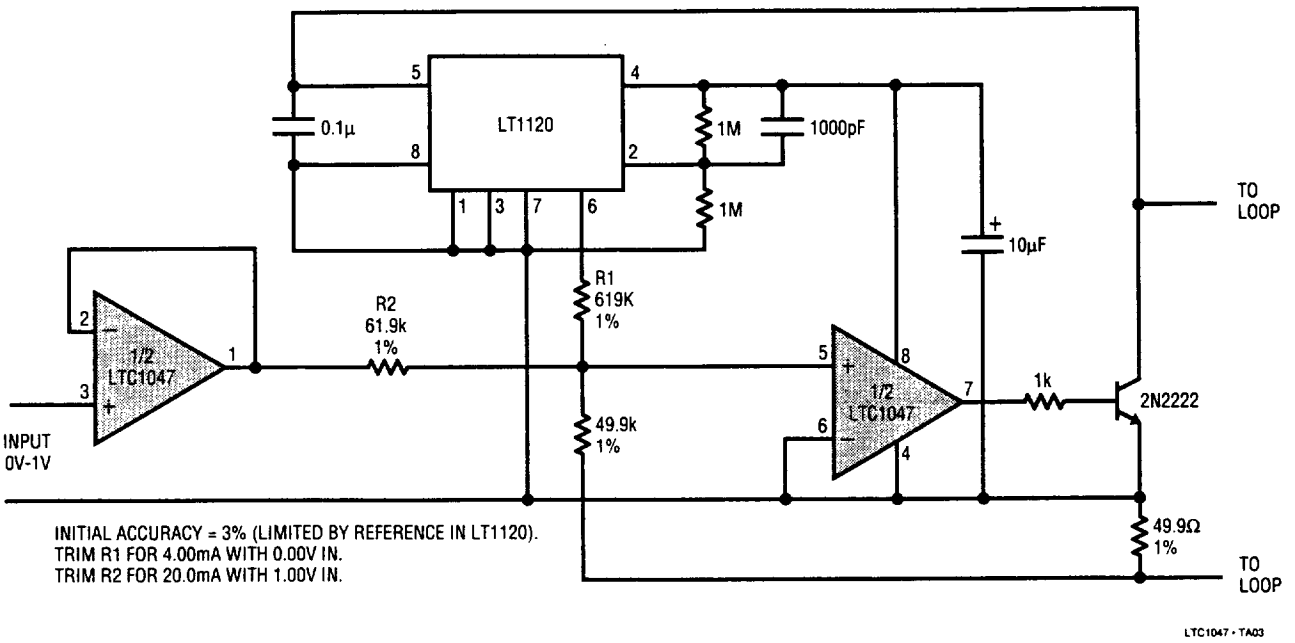


Precise DC Full Wave Rectifier (Absolute Value Circuit)

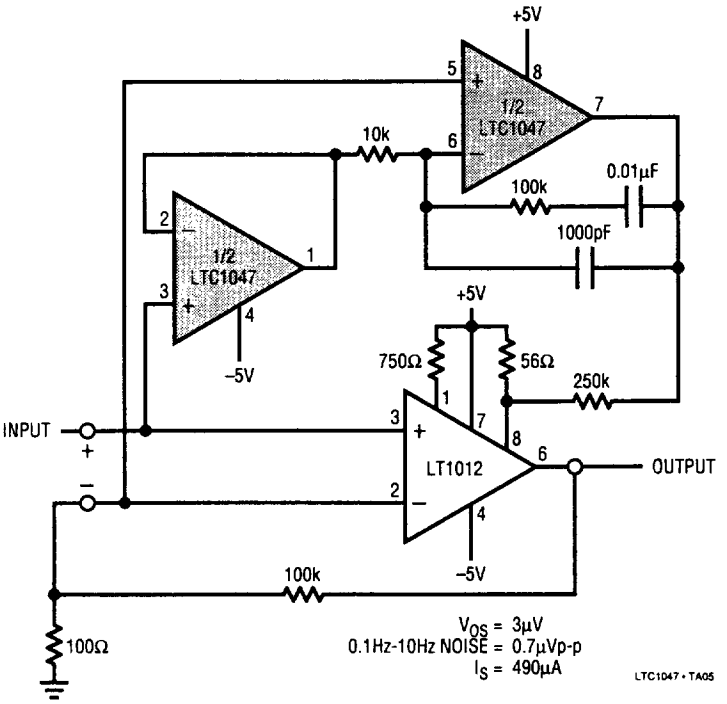


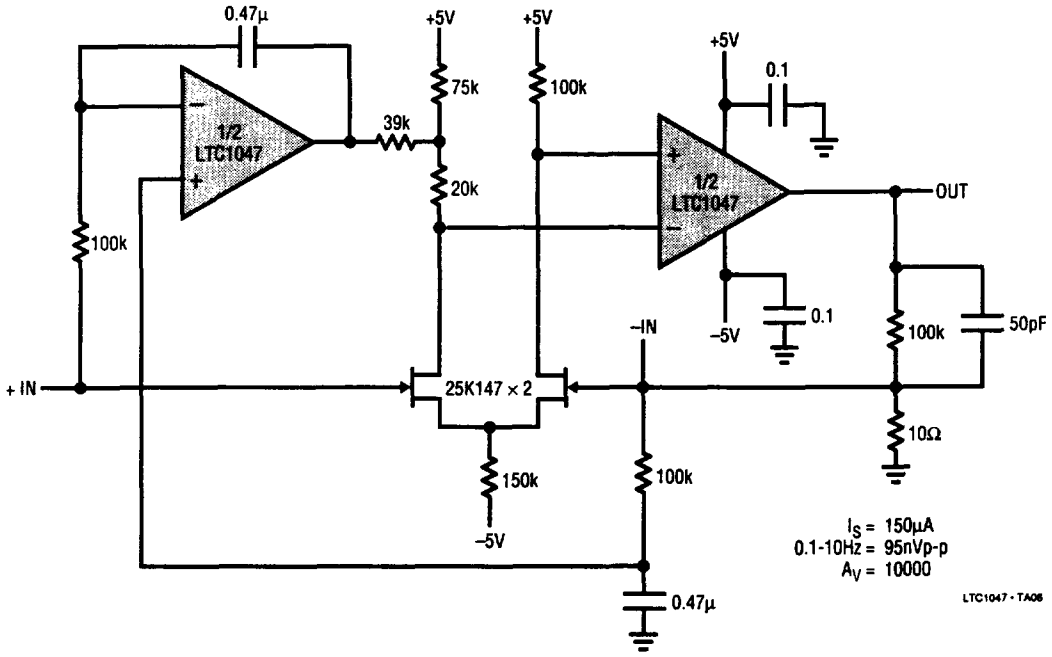
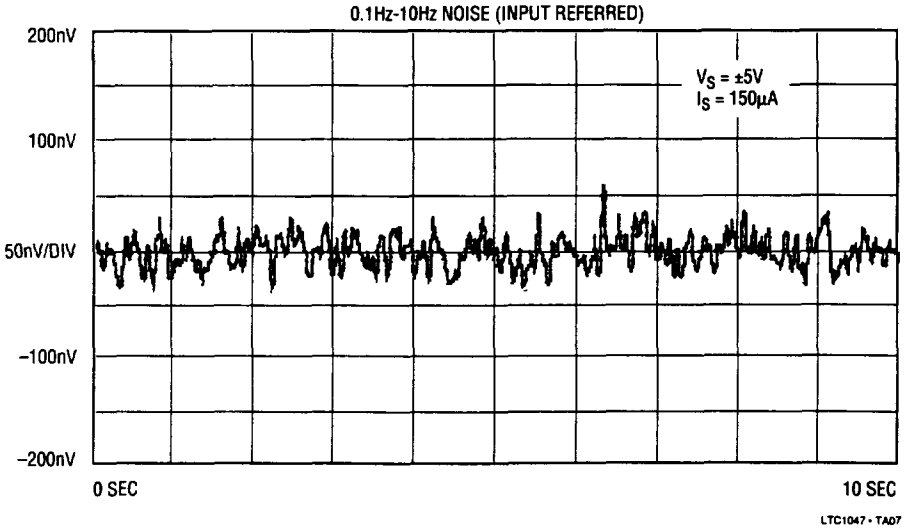
TYPICAL APPLICATIONS

4-20mA Transducer Amplifier



Low Noise, Low Drift Composite Amplifier



TYPICAL APPLICATIONS

Ultra Low Noise Micropower Chopper