LT-1012 Low-Power Precision Operational Amplifiers

Features

- Low input bias current
  +25°C, 100 pA max
  -55°C to +125°C, 600 pA max
- Low input offset voltage — 35μV max
- Low V_{OS} drift — 1.5 μV/°C max
- Low supply current — 600 μA max
- High gain — 300 V/mV min
- High CMRR — 114 dB min
- High PSRR — 114 dB min
- Low noise — 0.5 μV_{p-p} (0.1 to 10 Hz)

Description

The LT-1012 is an instrumentation-type operational amplifier that combines the low input bias currents of a FET-type op amp with the low noise and low input offset voltage drift of a precision bipolar op amp. For a similar device with yet tighter specifications, refer to the RC4097 Data Sheet. The LT-1012 can improve the performance of a wide range of precision operational amplifier applications, including reference circuits, thermocouple amplifiers, charge integrators, sample-and-hold circuits, data conversion circuits, log amplifiers, and differential instrumentation amplifiers.

The superior performance of the LT-1012 is a result of advanced design and processing techniques, including post-package trimming of the input offset voltage, and superbeta processing of the input transistors. Picoampere input bias currents are maintained over the full military temperature range through the use of bias current cancellation techniques in the design of the input stage. The entire spectrum of input parameters, such as CMRR and PSRR, are specified very tightly so as to support the low I_B and low V_{OS} in maintaining overall system accuracy.

The LT-1012 is a direct replacement for industry-standard LT-1012 types except for lacking the over-compensation function at pin 5 (the LT-1012 is internally compensated for unity-gain stability).

The LT-1012 is available in plastic DIPs or TO-99 metal cans. The devices are specified over both commercial and military temperature ranges, and can be ordered with Mil-Std-883 processing.

Ordering Information

Part Number	Package	Operating Temperature Range
LT-1012CT LT-1012CN	T N	0°C to +70°C 0°C to +70°C
LT-1012MT LT-1012MT/883B	T T	-55°C to +125°C -55°C to +125°C

Notes:
/883B suffix denotes Mil-Std-883, Level B processing
N = 8-lead plastic DIP
T = 8-lead metal can (TO-99)
Contact a Raytheon sales office or representative for ordering information on special package/temperature range combinations.

Absolute Maximum Ratings

Supply Voltage ..... ±22V
Input Voltage* ..... ±22V
Differential Input Voltage ..... ±0.7V
Internal Power Dissipation** ..... 500 mW
Output Short Circuit Duration ..... Indefinite
Storage Temperature
Range ..... -65°C to +150°C
Operating Temperature Range
M Suffix ..... -55°C to +125°C
C Suffix ..... 0°C to +70°C
Lead Soldering Temperature
(60 sec) ..... +300°C

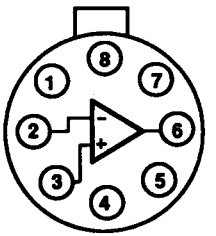
*For supply voltages less than ±22V, the absolute maximum input voltage is equal to the supply voltage.
**Observe package thermal characteristics.

Thermal Characteristics

	8-Lead TO-99 Metal Can	8-Lead Plastic DIP
Max. Junction Temp.	+175°C	+125°C
Max. P_D T_A <50°C	658 mW	468 mW
Therm. Res θ_{JC}	507°C/W	—
Therm. Res. θ_{JA}	190°C/W	160°C/W
For T_A <50°C Derate at	5.26 mW/°C	6.25 mW/°C

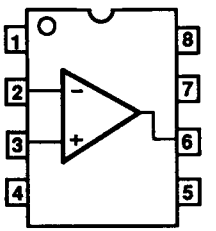
Connection Information

8-Lead TO-99 Metal Can
(Top View)



65-03205A

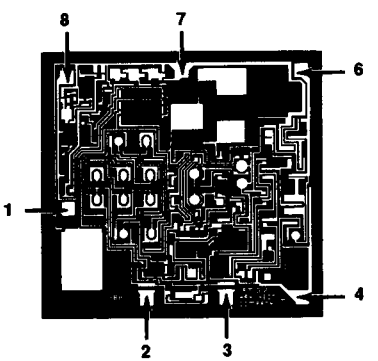
8-Lead Dual In-Line Package
(Top View)



65-03206A

Pin	Function
1	V_{OS} Trim
2	-Input
3	+Input
4	$-V_S$
5	NC
6	Output
7	$+V_S$
8	V_{OS} Trim

Mask Pattern



Die Size: 75 x 78 mils
Min. Pad Dimensions: 4 x 4 mils

65-4238

Electrical Characteristics ($V_S = \pm 15V$ and $T_A = +25°C$, unless otherwise noted)

Parameters	Test Conditions	LT-1012M Min	LT-1012M Typ	LT-1012M Max	LT-1012C Min	LT-1012C Typ	LT-1012C Max	Units
Input Offset Voltage[1]	See Note 2		7.0 20	35 90		10 25	50 120	µV
Long Term Input Offset Voltage Stability[4,5]			0.2			0.2		µV/Mo
Input Offset Current	See Note 2		20 30	100 150		20 30	150 200	pA
Input Bias Current	See Note 2		±20 ±30	±100 ±150		±20 ±30	±150 ±200	pA
Input Noise Voltage[3]	0.1 Hz to 10 Hz		0.5			0.5		μV_{PP}
Input Noise Voltage Density[3,6]	F_O = 10 Hz		17	30		17	30	$\frac{nV}{\sqrt{Hz}}$
	F_O = 100 Hz		14	22		14	22	
Input Noise Current[3]	0.1 Hz to 10 Hz		20			20		fA/√Hz
Input Voltage Range		±13	±14		±13	±14		V
Common Mode Rejection Ratio	$V_{CM} = \pm 13V$	114	130		110	126		dB
Power Supply Rejection Ratio	$V_S = \pm 3V$ to $\pm 18V$	114	130		110	126		dB
Large Signal Voltage Gain	$R_L \geq 10 k\Omega$, $V_O = \pm 12V$	300	2000		200	1500		V/mV
	$R_L \geq 2 k\Omega$, $V_O = \pm 10V$	200	1000		120	1200		
Output Voltage Swing	$R_L \geq 2 k\Omega$	±13	±14		±13	±14		V
Slew Rate	$R_L \geq 2 k\Omega$	0.1	0.3		0.1	0.3		V/µS
Unity Gain Bandwidth	$A_{VCL} = +1.0$	0.4	0.8		0.4	0.8		MHz
Supply Current	See Note 2		400	600		400	600	µA

Notes:
1. Input Offset Voltage measurements are performed by automated test equipment approximately 0.5 seconds after application of power. LT-1012M grade is measured after the device is fully warmed up.
2. These specifications apply for $\pm 2.5V \leq V_S \leq \pm 20V$ and $-13V \leq V_{CM} \leq +13V$ (at $V_S = \pm 15V$).
3. This parameter is tested on a sample basis only.
4. This parameter is guaranteed by design.
5. Long Term Input Offset Voltage Stability refers to the average trend line of V_{OS} vs. Time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in V_{OS} during the first 30 operating days are typically 2.5 µV.
6. 10 Hz input noise voltage density is sample tested on every lot. Devices 100% tested at 10 Hz are available on request.

Electrical Characteristics (V_S = ±15V, 0°C ≤ T_A ≤ +70°C for LT-1012C and -55°C ≤ T_A ≤ +125°C for LT-1012M unless otherwise noted)

Parameters	Test Conditions	LT-1012M Min	LT-1012M Typ	LT-1012M Max	LT-1012C Min	LT-1012C Typ	LT-1012C Max	Units
Input Offset Voltage[1]			30	180		20	120	µV
	See Note 2		40	250		30	200	
Average Input Offset Voltage Drift			0.2	1.5		0.2	1.5	µV/°C
Input Offset Current			30	250		20	230	pA
	See Note 2		70	350		40	300	
Average Input Offset Current Drift[3]			0.3	2.5		0.3	2.5	pA/°C
Input Bias Current			±80	±600		±35	±230	pA
	See Note 2		±150	±800		±50	±300	
Average Input Bias Current Drift[3]			0.6	6.0		0.3	2.5	pA/°C
Input Voltage Range		±13			±13			V
Common Mode Rejection Ratio	V_{CM} = ±13V	108	126		108	126		dB
Power Supply Rejection Ratio	V_S = ±3V to ±18V	108	126		108	126		dB
Large Signal Voltage Gain	R_L ≥ 10 kΩ, V_{OUT} = ±12V	150	1000		150	1500		V/mV
	R_L ≥ 2 kΩ, V_{OUT} = ±10V	100	600		100	800		
Output Voltage Swing	R_L ≥ 10 kΩ	±13	±14		±13	±14		V
Supply Current	R_L = ∞		450	800		450	800	µA

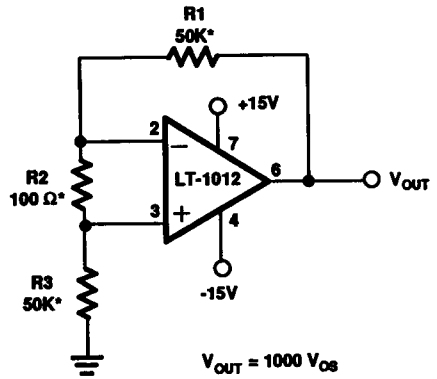
Notes:
1. Input offset voltage measurements are performed by automatic test equipment approximately 0.5 seconds after the application of power. The LT-1012M grade is tested fully warmed up.
2. These specifications apply for ±3V ≤ V_S ≤ ±20V and -13V ≤ V_{CM} ≤ 13V (at V_S = ±15V).
3. This parameter is tested on a sample basis only.

Applications Information

The LT-1012 units may be inserted directly into OP-07, OP-05, 725, 108A or 101A sockets with or without removal of external frequency compensation or nulling components. The LT-1012 can also be used in 741 applications provided that the nulling circuitry is removed.

Unless proper care is exercised, thermocouple effects caused by temperature gradients across dissimilar metals at the contacts to the input terminals, can exceed the inherent drift of the amplifier. Air currents over device leads should be minimized, package leads should be short, and the two input leads should be as close together as possible and maintained at the same temperature.

Input bias currents may flow either into or out of the input terminals, depending on the value of I_{OS}. In high-source impedance applications, the pc board layout includes guard rings and must be well cleaned of solder flux. Teflon sockets may aid in keeping leakage currents low.



* Resistors must have low thermoelectric potential.

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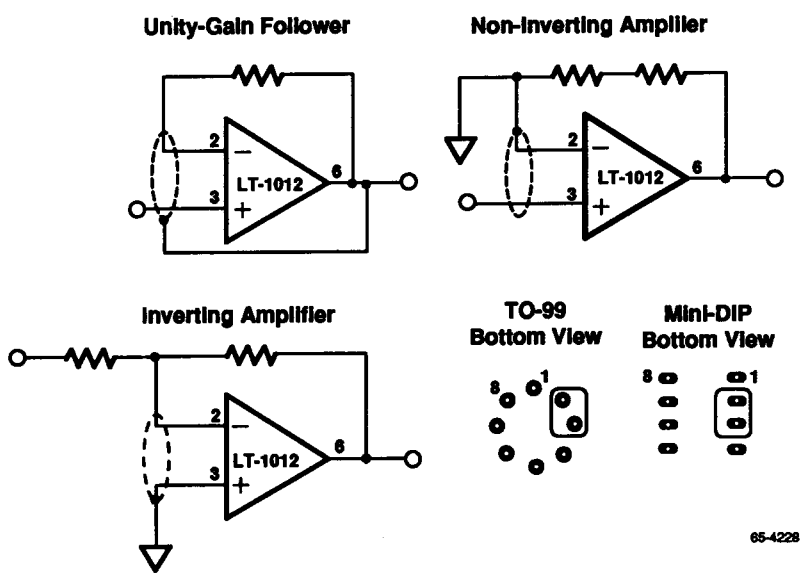
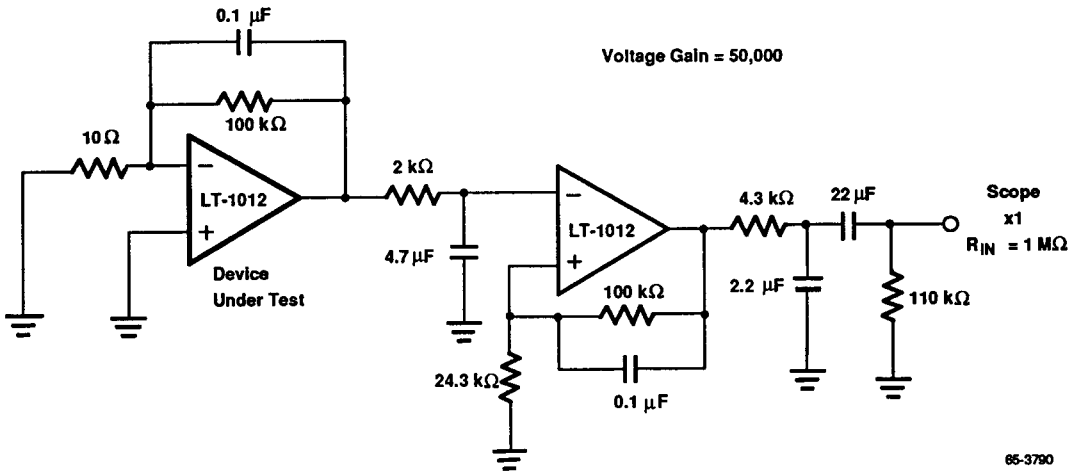
Test Circuit for Offset Voltage and its Drift With Temperature



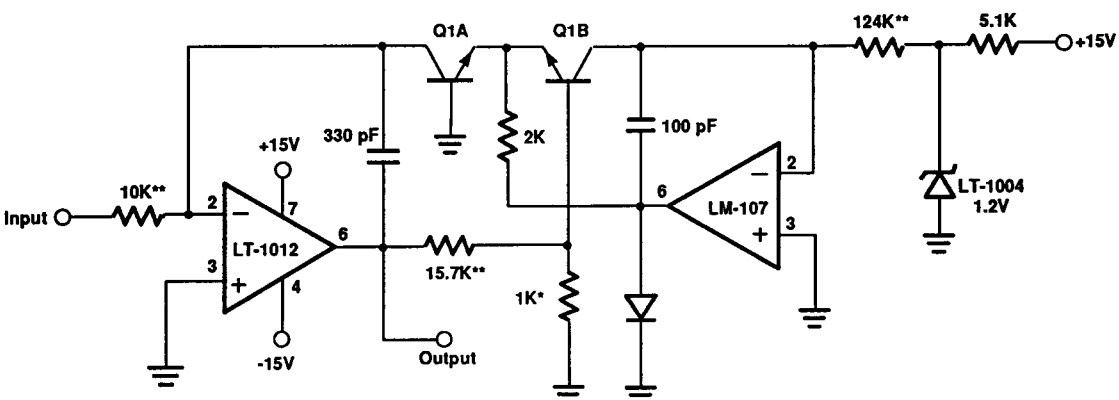
Guard Ring Layout and Connections



1. Peak-to-peak noise is measued in a 10-second interval.
2. The device under test should be warmed up for 3 minutes and shielded from air currents.

0.1 Hz to 10 Hz Noise Test Circuit

Typical Applications



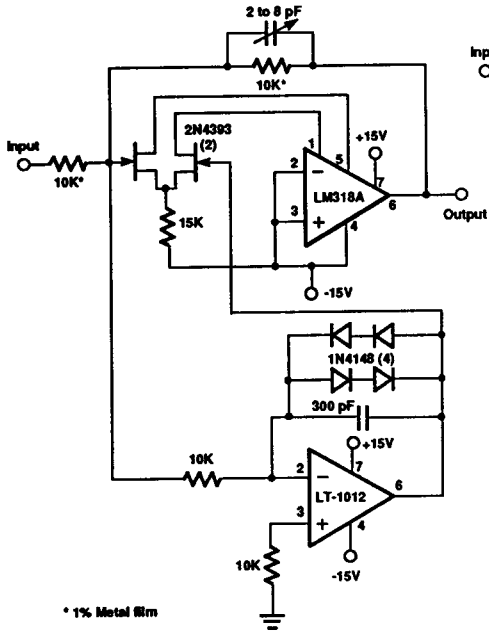
* Tel. labs, type Q81
** 1% Film resistor
Q1 = 2N2979

Low bias current and offset voltage of the LT-1012 allow 4.5 decades of voltage input logging.

65-4230

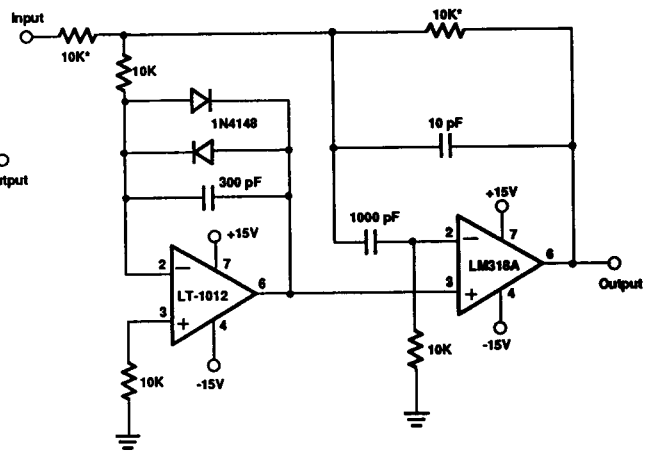
Logarithmic Amplifier

Typical Applications (Continued)



* 1% Metal film

Slew rate @ 100V/μS
Settling = 5 μS to 0.1%/10V step
Offset voltage = 30 μV
Bias current = 30 pA



* 1% Metal film

Full power bandwith = 2 MHz
Slew rate = 50V/ μS
Settling (10V step) = 12 μS to 0.01%
Bias current dc = 30 pA
Offset drift = 0.3 μV/°C
Offset voltage = 30 μV

Fast Precision Inverters

85-4231

Schematic Diagram