High Speed, Precision JFET Input Operational Amplifier

FEATURES

- *Guaranteed* Slew Rate 23V/μs Min.
- *Guaranteed* Offset Voltage 250μV Max.
  - −55°C to 125°C 750μV Max.
- *Guaranteed* Drift 5μV/°C Max.
- *Guaranteed* Bias Current
  - 70°C 180pA Max.
  - 125°C 4nA Max.
- Gain-Bandwidth Product 8.5MHz Typ.
- Settling Time to 0.05% (10V Step) 0.9μs Typ.

APPLICATIONS

- Fast D/A Output Amplifiers (12, 14, 16 Bits)
- High Speed Instrumentation
- Fast, Precision Sample and Hold
- Voltage-to-Frequency Converters
- Logarithmic Amplifiers

DESCRIPTION

The LT1022 JFET input operational amplifier combines high speed and precision performance.

A 26V/μs slew rate and 8.5MHz gain-bandwidth product are simultaneously achieved with offset voltage of typically 80μV, 1.5μV/°C drift, bias currents of 50pA at 70°C, 500pA at 125°C. The output delivers 20mA of load current without gain degradation.

The 250μV maximum offset voltage specification represents less than ½ least significant bit error in a 14-bit, 10V system.

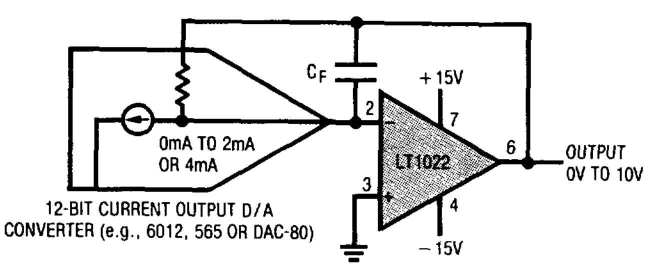
The LT1022A meets or exceeds all OP-16A and OP-16E specifications. It is faster and more accurate without stability problems at cold temperatures.

The LT1022 can be used as the output amplifier for 12-bit current output D/A converters, as shown below.

For a more accurate, lower power dissipation, but slower JFET input op amp, please refer to the LT1055 data sheet.

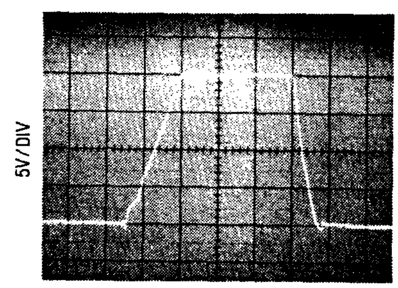
2

12-Bit Voltage Output D/A Converter



C_F = 15pF TO 33pF
SETTLING TIME TO 2mV (0.8 LSB) = 1.5μs TO 2μs

Large Signal Response

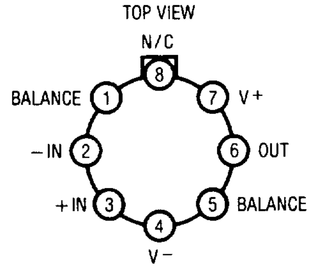
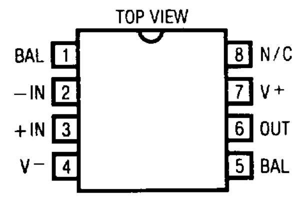


$A_V = 1$, $C_L = 100pF$, 0.5μs/DIV
$T_A = 25°C$, $V_S = \pm 15V$

ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... ±20V
Differential Input Voltage .... ±40V
Input Voltage .... ±20V
Output Short Circuit Duration .... Indefinite
Operating Temperature Range
  LT1022AM/1022M .... −55°C to 125°C
  LT1022AC/1022C .... 0°C to 70°C
Storage Temperature Range
  All Devices .... −65°C to 150°C
Lead Temperature (Soldering, 10 sec.) .... 300°C

PACKAGE/ORDER INFORMATION

	ORDER PART NUMBER
 METAL CAN H PACKAGE	LT1022AMH LT1022MH LT1022ACH LT1022CH
 PLASTIC DIP N8 PACKAGE	LT1022CN8

ELECTRICAL CHARACTERISTICS

$V_S = \pm 15V$, $T_A = 25°C$, $V_{CM} = 0V$ unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS	LT1022AM LT1022AC MIN	TYP	MAX	LT1022M LT1022CH LT1022CN8 MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage (Note 1)	H Package N8 Package	— —	80 —	250 —	— —	100 160	600 1000	μV μV
I_{OS}	Input Offset Current	Fully Warmed Up	—	2	10	—	2	20	pA
I_B	Input Bias Current	Fully Warmed Up $V_{CM} = +10V$	— —	±10 +30	±50 +100	— —	±10 +30	±50 +150	pA pA
	Input Resistance—Differential —Common-Mode	 $V_{CM} = -11V$ to $+8V$ $V_{CM} = +8V$ to $+11V$	— — —	10^{12} 10^{12} 10^{11}	— — —	— — —	10^{12} 10^{12} 10^{11}	— — —	Ω Ω Ω
	Input Capacitance		—	4	—	—	4	—	pF
e_n	Input Noise Voltage	0.1Hz to 10Hz	—	2.5	—	—	2.8	—	μVp-p
e_n	Input Noise Voltage Density	$f_0 = 10Hz$ (Note 2) $f_0 = 1kHz$ (Note 3)	— —	28 14	50 20	— —	30 15	60 22	$nV/\sqrt{Hz}$ $nV/\sqrt{Hz}$
i_n	Input Noise Current Density	$f_0 = 10Hz$, 1kHz (Note 4)	—	1.8	4	—	1.8	4	$fA/\sqrt{Hz}$
A_{VOL}	Large Signal Voltage Gain	$V_O = \pm 10V$ $R_L = 2k$ $R_L = 1k$	150 130	400 300	— —	120 100	400 300	— —	V/mV V/mV
	Input Voltage Range		±10.5	±12	—	±10.5	±12	—	V
CMRR	Common-Mode Rejection Ratio	$V_{CM} = \pm 10.5V$	86	94	—	82	92	—	dB
PSRR	Power Supply Rejection Ratio	$V_S = \pm 10V$ to $\pm 18V$	88	104	—	86	102	—	dB
V_{OUT}	Output Voltage Swing	$R_L = 2k$	±12	±13.2	—	±12	±13.2	—	V
SR	Slew Rate		23	26	—	18	24	—	V/μs
GBW	Gain-Bandwidth Product	f = 1MHz	—	8.5	—	—	8.0	—	MHz
I_S	Supply Current		—	5.2	7.0	—	5.2	7.0	mA
	Settling Time	A = +1 or A = −1 10V Step to 0.05% 10V Step to 0.02%	 — —	 0.9 1.3	 — —	 — —	 0.9 1.3	 — —	 μs μs
	Offset Voltage Adjustment Range	$R_{POT} = 100k$	—	±7	—	—	±7	—	mV

ELECTRICAL CHARACTERISTICS $V_S = \pm 15V$, $V_{CM} = 0V$, $0°C \le T_A \le 70°C$ unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS		LT1022AC MIN	LT1022AC TYP	LT1022AC MAX	LT1022CH / LT1022CN8 MIN	LT1022CH / LT1022CN8 TYP	LT1022CH / LT1022CN8 MAX	UNITS
V_{OS}	Input Offset Voltage (Note 1)	H Package	●	—	140	480	—	180	1000	μV
		N8 Package	●	—	—	—	—	300	1700	μV
	Average Temperature Coefficient of Input Offset Voltage	H Package	●	—	1.3	5.0	—	1.8	9.0	μV/°C
		N8 Package (Note 5)	●	—	—	—	—	3.0	15.0	μV/°C
I_{OS}	Input Offset Current	Warmed Up, $T_A = 70°C$	●	—	15	80	—	18	100	pA
I_B	Input Bias Current	Warmed Up, $T_A = 70°C$	●	—	±50	±200	—	±60	±250	pA
A_{VOL}	Large Signal Voltage Gain	$V_O = \pm 10V$, $R_L = 2k$	●	80	250	—	60	250	—	V/mV
CMRR	Common-Mode Rejection Ratio	$V_{CM} = \pm 10.4V$	●	85	93	—	80	91	—	dB
PSRR	Power Supply Rejection Ratio	$V_S = \pm 10V$ to $\pm 18V$	●	86	103	—	84	101	—	dB
V_{OUT}	Output Voltage Swing	$R_L = 2k$	●	±12	±13.1	—	±12	±13.1	—	V

ELECTRICAL CHARACTERISTICS $V_S = \pm 15V$, $V_{CM} = 0V$, $-55°C \le T_A \le 125°C$ unless otherwise noted

SYMBOL	PARAMETER	CONDITIONS		LT1022AM MIN	LT1022AM TYP	LT1022AM MAX	LT1022M MIN	LT1022M TYP	LT1022M MAX	UNITS
V_{OS}	Input Offset Voltage	(Note 1)	●	—	230	750	—	300	1500	μV
	Average Temperature Coefficient of Input Offset Voltage	(Note 5)	●	—	1.5	5.0	—	2.0	9.0	μV/°C
I_{OS}	Input Offset Current	Warmed Up, $T_A = 125°C$	●	—	0.3	2.0	—	0.30	3.0	nA
I_B	Input Bias Current	Warmed Up, $T_A = 125°C$	●	—	±0.5	±4.0	—	±0.7	±6.0	nA
A_{VOL}	Large Signal Voltage Gain	$V_O = \pm 10V$, $R_L = 2k$	●	40	120	—	35	120	—	V/mV
CMRR	Common-Mode Rejection Ratio	$V_{CM} = \pm 10.4V$	●	85	92	—	80	90	—	dB
PSRR	Power Supply Rejection Ratio	$V_S = \pm 10V$ to $\pm 17V$	●	86	102	—	84	100	—	dB
V_{OUT}	Output Voltage Swing	$R_L = 2k$	●	±12	±12.9	—	±12	±12.9	—	V

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

Note 1: Offset voltage is measured under two different conditions:
(a) approximately 0.5 seconds after application of power;
(b) at $T_A = 25°C$, with the chip self-heated to approximately 45°C to account for chip temperature rise when the device is fully warmed up.

Note 2: 10Hz noise voltage density is sample tested on every lot of A grades. Devices 100% tested at 10Hz are available on request.

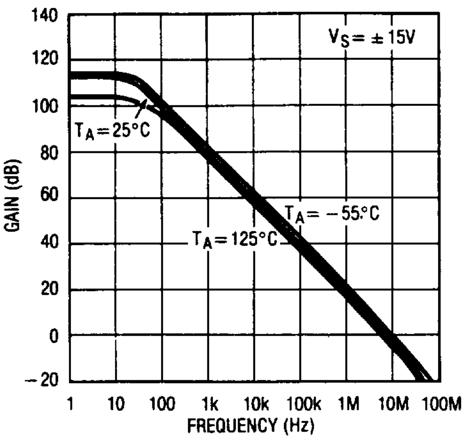
Note 3: This parameter is tested on a sample basis only.

Note 4: Current noise is calculated from the formula: $i_n = (2qI_B)^{1/2}$, where $q = 1.6 \times 10^{-19}$ coulomb. The noise of source resistors up to 1GΩ swamps the contribution of current noise.

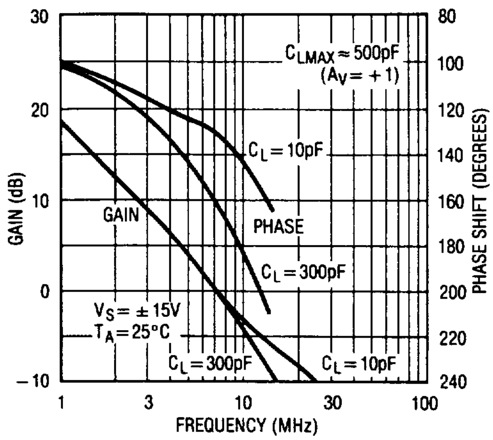
Note 5: Offset voltage drift with temperature is practically unchanged when the offset voltage is trimmed to zero with a 100k potentiometer between the balance terminals and the wiper tied to V^+. Devices tested to tighter drift specifications are available on request.

TYPICAL PERFORMANCE CHARACTERISTICS

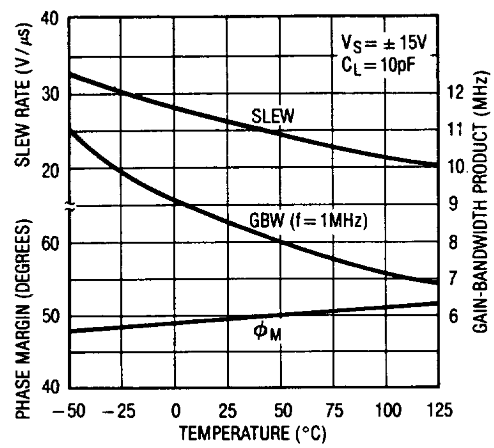
Gain vs Frequency



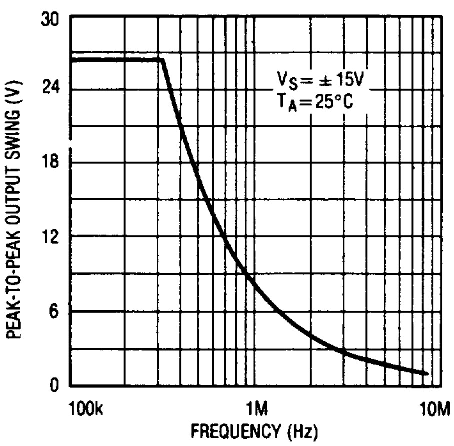
Gain, Phase Shift vs Frequency



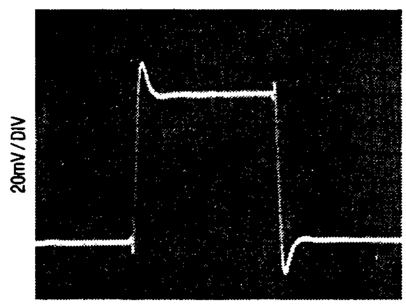
Phase Margin, Gain Bandwidth Product, Slew Rate vs Temperature



Undistorted Output Swing vs Frequency

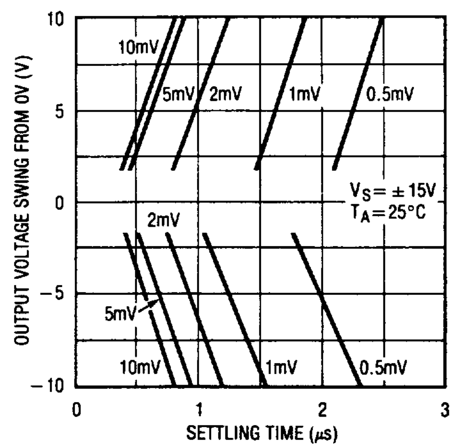


Small Signal Response



$A_V = +1$, $C_L = 100pF$, $0.2\mu s/DIV$
$T_A = 25°C$, $V_S = \pm 15V$

Settling Time



The typical behavior of many LT1022 parameters is identical to the LT1056. Please refer to the LT1055/1056 data sheet for the following typical performance characteristics:

- **Input Bias and Offset Currents vs Temperature**
- **Input Bias Current Over the Common-Mode Range**
- **Distribution of Input Offset Voltage (H and N8 Package)**
- **Distribution of Offset Voltage Drift with Temperature**
- **Warm-Up Drift**
- **Long Term Drift of Representative Units**
- **0.1Hz to 10Hz Noise**
- **Voltage Noise vs Frequency**
- **Noise vs Chip Temperature**
- **Output Impedance vs Frequency**
- **Common-Mode Range vs Temperature**
- **Common-Mode and Power Supply Rejections vs Temperature**
- **Common-Mode Rejection Ratio vs Frequency**
- **Power Supply Rejection Ratio vs Frequency**
- **Voltage Gain vs Temperature**
- **Supply Current vs Supply Voltage**
- **Output Swing vs Load Resistance**
- **Short Circuit Current vs Time**

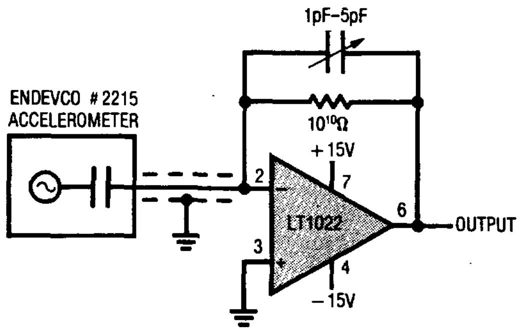
APPLICATIONS INFORMATION

The LT1056 applications information is directly applicable to the LT1022. Please consult the LT1055/1056 data sheet for details on:

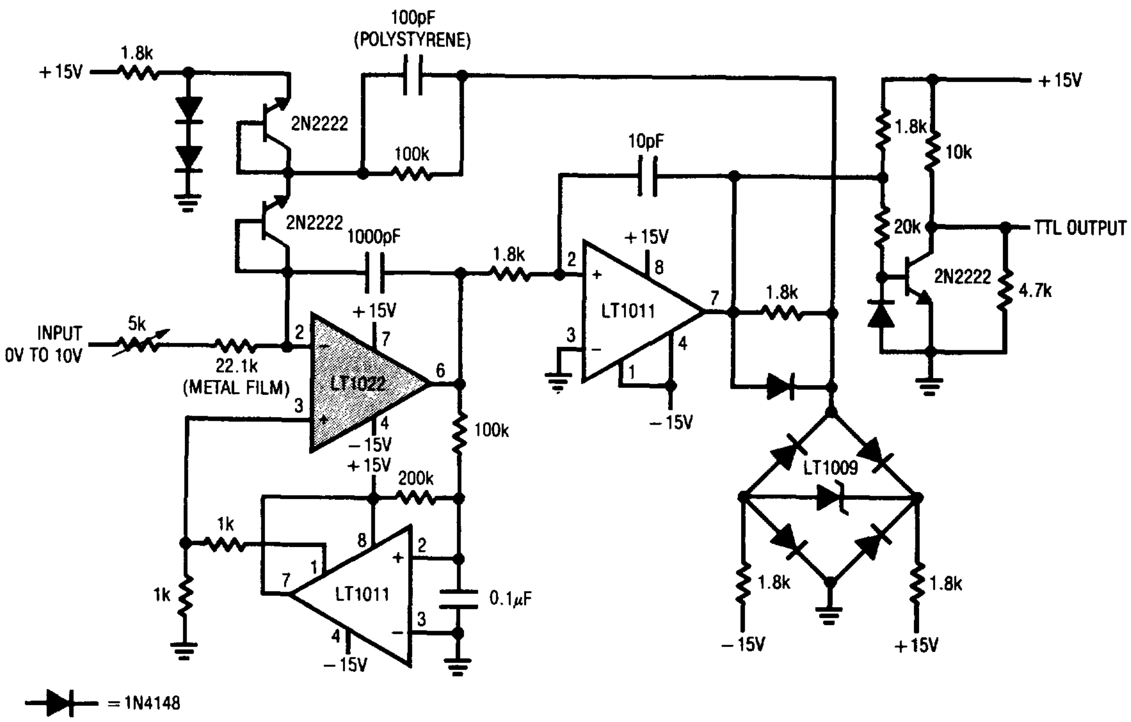
(1) plug-in compatibility to industry standard devices
(2) offset nulling
(3) achieving picoampere/microvolt performance
(4) phase-reversal protection
(5) high speed operation (including settling time test circuit)
(6) noise performance
(7) simplified circuit schematic.

TYPICAL APPLICATIONS

Fast Piezoelectric Accelerometer

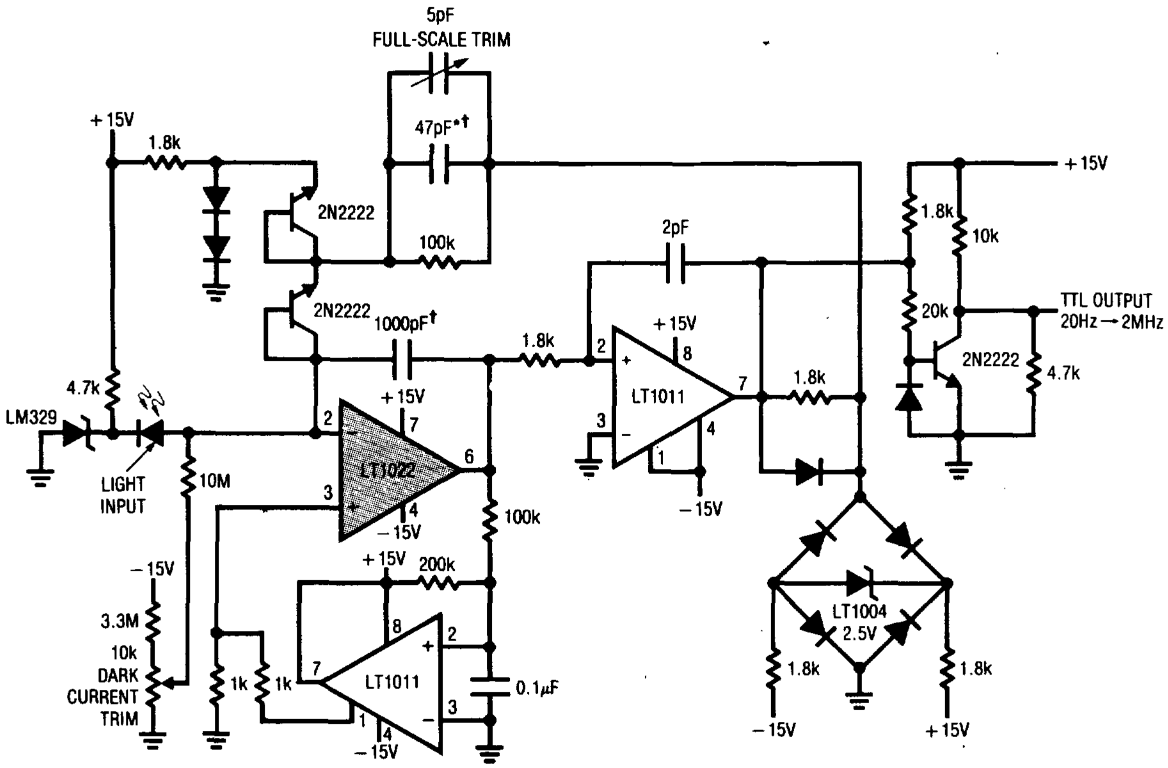


10Hz to 1MHz Voltage-to-Frequency Converter



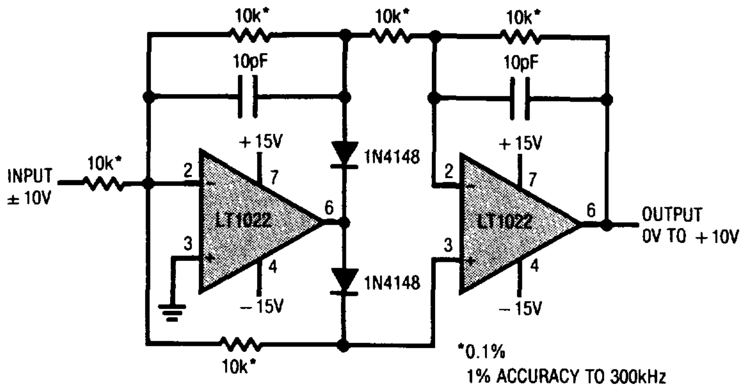
TYPICAL APPLICATIONS

Photodiode-to-Frequency Converter



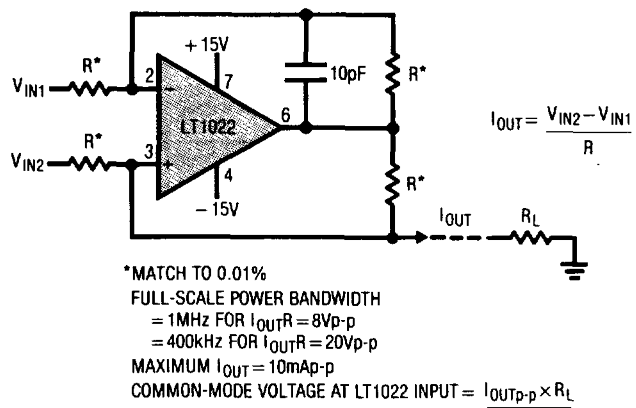
SCALE FACTOR =
1nW/Hz AT 900 NANOMETERS FROM 20nW TO 2mW
= HEWLETT PACKARD PHOTODIODE HP5082-4204
= 1N4148
†POLYSTYRENE
*SELECT VALUE FOR 2mW IN = 2MHz OUT.

Wide Bandwidth Absolute Value Circuit



*0.1%
1% ACCURACY TO 300kHz
5% ACCURACY TO 700kHz

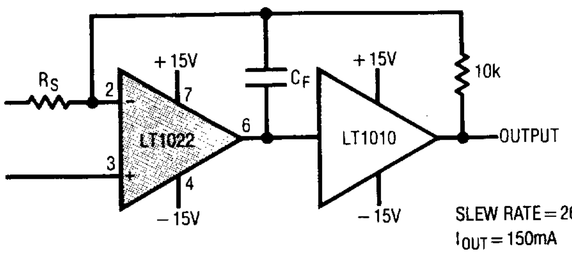
Fast, Differential Input Current Source



*MATCH TO 0.01%
FULL-SCALE POWER BANDWIDTH
= 1MHz FOR $I_{OUT}R = 8Vp\text{-}p$
= 400kHz FOR $I_{OUT}R = 20Vp\text{-}p$
MAXIMUM $I_{OUT} = 10mAp\text{-}p$
COMMON-MODE VOLTAGE AT LT1022 INPUT = $\frac{I_{OUTp\text{-}p} \times R_L}{2}$

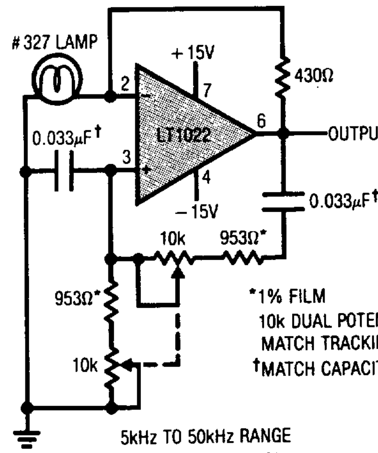
TYPICAL APPLICATIONS

High Output Current Op Amp



SLEW RATE = 26V/µs
I_{OUT} = 150mA
C_L CAN BE 1µF
A_V = +1, C_F = 1000pF
A_V = −1, C_F = 10pF

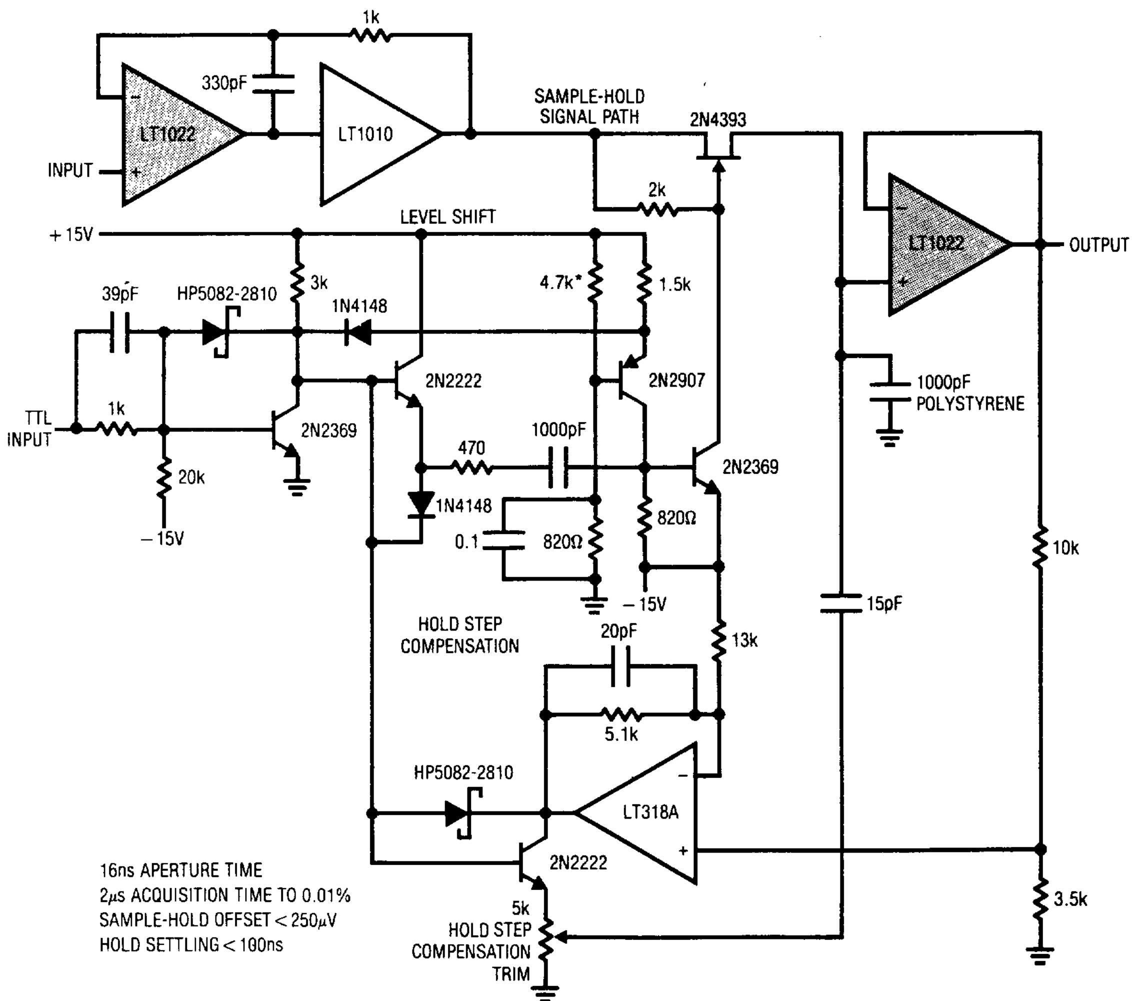
Low Distortion Sine Wave Oscillator



*1% FILM
10k DUAL POTENTIOMETER — MATCH TRACKING TO 0.1%
†MATCH CAPACITORS TO 0.1%

5kHz TO 50kHz RANGE
DISTORTION < 0.1%
AMPLITUDE = 18Vp-p.

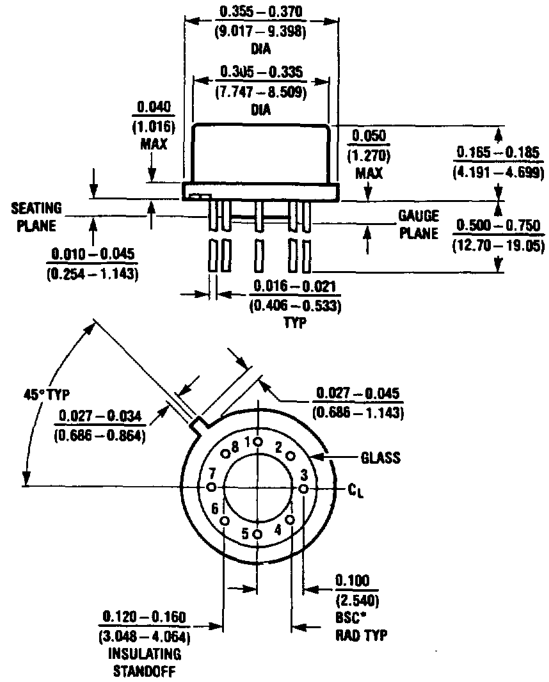
Fast, Precision Sample-Hold



16ns APERTURE TIME
2µs ACQUISITION TIME TO 0.01%
SAMPLE-HOLD OFFSET < 250µV
HOLD SETTLING < 100ns

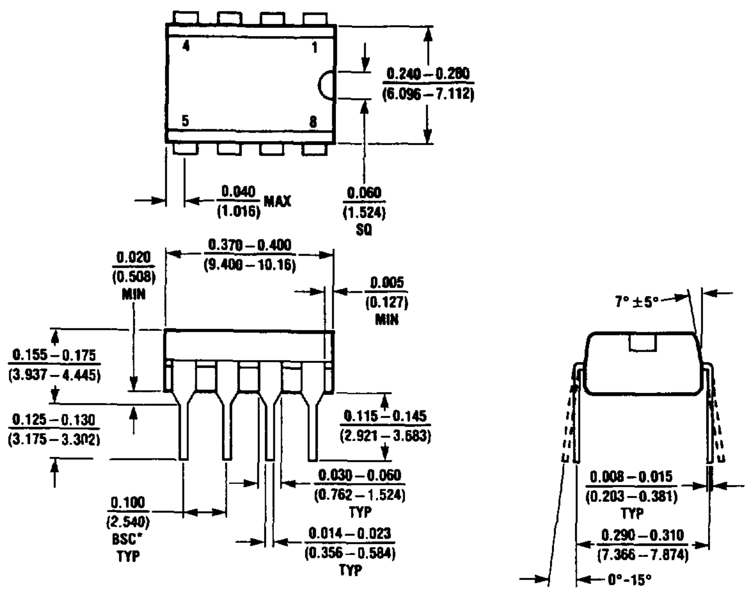
PACKAGE DESCRIPTION Dimensions in inches (millimeters) unless otherwise noted.

H Package
Metal Can



$T_j$max	θ_{ja}	θ_{jc}
150°C	150°C/W	45°C/W

N8 Package
8 Lead Plastic



*LEADS WITHIN 0.007 OF TRUE POSITION (TP) AT GAUGE PLANE

$T_j$max	θ_{ja}
100°C	130°C/W