

High Speed, Precision JFET Input Operational Amplifier

FEATURES

- **Guaranteed** Slew Rate: 23V/ μ s Min
- **Guaranteed** Offset Voltage: 250 μ V Max
–55°C to 125°C: 750 μ V Max
- **Guaranteed** Drift: 5 μ V/°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): 0.9 μ s 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 LT[®]1022 JFET input operational amplifier combines high speed and precision performance.

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

The 250 μ V maximum offset voltage specification represents less than 1/2 least significant bit error in a 14-bit, 10V system.

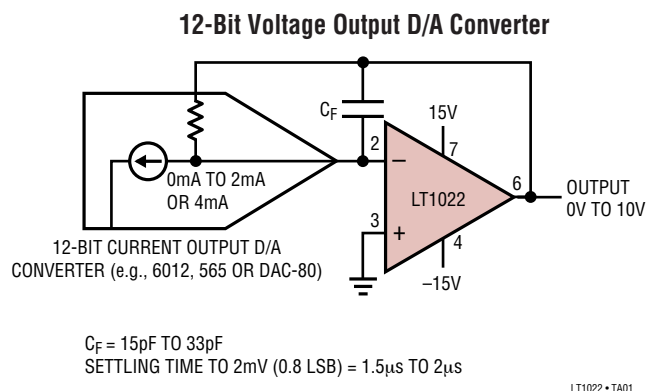
The LT1022A meets or exceeds all OP-16A and OP-16E specifications. It is faster and more accurate without stability problems at cold temperatures.

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

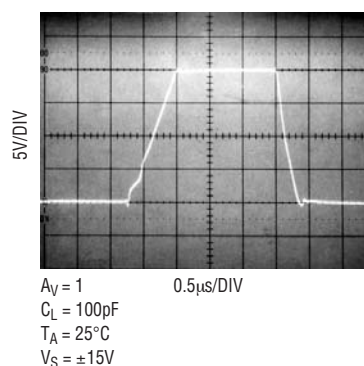
For a more accurate, lower power dissipation, but slower JFET input op amp, please refer to the LT1055 data sheet.

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TYPICAL APPLICATION



Large-Signal Response



LT1022

ABSOLUTE MAXIMUM RATINGS

(Note 1)

Supply Voltage	±20V
Differential Input Voltage	±40V
Input Voltage	±20V
Output Short Circuit Duration	Indefinite

Operating Temperature Range

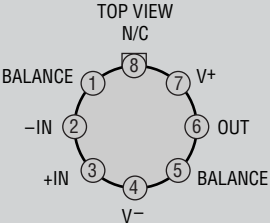
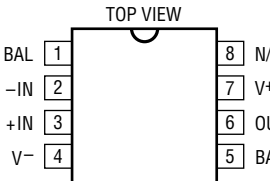
LT1022AM/1022M (**OBSOLETE**).....–55°C to 125°C

LT1022AC/1022C 0°C to 70°C

Storage Temperature Range –65°C to 150°C

Lead Temperature (Soldering, 10 sec.) 300°C

PACKAGE/ORDER INFORMATION

 METAL CAN H PACKAGE $T_{JMAX} = 150^{\circ}\text{C}$, $\theta_{JA} = 150^{\circ}\text{C/W}$, $\theta_{JC} = 45^{\circ}\text{C/W}$ OBSOLETE PACKAGE Consider the N8 Package as an Alternate Source	ORDER PART NUMBER LT1022AMH LT1022MH LT1022ACH LT1022CH	 N8 PACKAGE 8-LEAD PDIP $T_{JMAX} = 100^{\circ}\text{C}$, $\theta_{JA} = 130^{\circ}\text{C/W}$	ORDER PART NUMBER LT1022CN8
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Consult LTC Marketing for parts specified with wider operating temperature ranges.

ELECTRICAL CHARACTERISTICS

$V_S = \pm 15\text{V}$, $T_A = 25^{\circ}\text{C}$, $V_{CM} = 0\text{V}$ unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	LT1022AM LT1022AC			LT1022M, LT1022CH LT1022CN8			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{OS}	Input Offset Voltage (Note 2)	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 $V_{CM} = +10\text{V}$		±10 30	±50 100		±10 30	±50 150	pA pA
	Input Resistance—Differential	$V_{CM} = -11\text{V}$ to 8V $V_{CM} = 8\text{V}$ to 11V		10^{12}			10^{12}		Ω
	—Common Mode			10^{12}			10^{12}		Ω
				10^{11}			10^{11}		Ω
	Input Capacitance			4			4		pF
e_n	Input Noise Voltage	0.1Hz to 10Hz		2.5			2.8		$\mu\text{V/p-P}$
e_n	Input Noise Voltage Density	$f_0 = 10\text{Hz}$ (Note 3) $f_0 = 1\text{kHz}$ (Note 4)		28 14	50 20		30 15	60 22	$\text{nV}/\sqrt{\text{Hz}}$ $\text{nV}/\sqrt{\text{Hz}}$
i_n	Input Noise Current Density	$f_0 = 10\text{Hz}$, 1kHz (Note 5)		1.8	4		1.8	4	$\text{fA}/\sqrt{\text{Hz}}$
A_{VOL}	Large Signal Voltage Gain	$V_0 = \pm 10\text{V}$ $R_L = 2\text{k}$ $R_L = 1\text{k}$	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	$V_{CM} = \pm 10.5\text{V}$	86	94		82	92		dB
PSRR	Power Supply Rejection Ratio	$V_S = \pm 10\text{V}$ to ±18V	88	104		86	102		dB
V_{OUT}	Output Voltage Swing	$R_L = 2\text{k}$	±12	±13.2		±12	±13.2		V
SR	Slew Rate		23	26		18	24		V/ μs

1022fa

ELECTRICAL CHARACTERISTICS $V_S = \pm 15V$, $T_A = 25^\circ C$, $V_{CM} = 0V$ unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	LT1022AM LT1022AC			LT1022M, LT1022CH LT1022CN8			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
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

The ● denotes the specifications which apply over the full operating temperature range of $V_{CM} = 0V$, $0^\circ C \leq T_A \leq 70^\circ C$. $V_S = \pm 15V$, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		LT1022AC			LT1022CH LT1022CN8			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{OS}	Input Offset Voltage (Note 2)	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	$\mu V/^\circ C$
		N8 Package (Note 6)	●					3.0	15.0	$\mu V/^\circ C$
I_{OS}	Input Offset Current	Warmed Up, $T_A = 70^\circ C$	●		15	80		18	100	pA
I_B	Input Bias Current	Warmed Up, $T_A = 70^\circ C$	●		± 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

The ● denotes the specifications which apply over the full operating temperature range of $-55^\circ C \leq T_A \leq 125^\circ C$. $V_S = \pm 15V$, $V_{CM} = 0V$, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		LT1022AM			LT1022M			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{OS}	Input Offset Voltage	(Note 2)	●		230	750		300	1500	μV
	Average Temperature Coefficient of Input Offset Voltage	(Note 6)	●		1.5	5.0		2.0	9.0	$\mu V/^\circ C$
I_{OS}	Input Offset Current	Warmed Up, $T_A = 125^\circ C$	●		0.3	2.0		0.30	3.0	nA
I_B	Input Bias Current	Warmed Up, $T_A = 125^\circ C$	●		± 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

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

Note 2: Offset voltage is measured under two different conditions:
(a) approximately 0.5 seconds after application of power;
(b) at $T_A = 25^\circ C$, with the chip self-heated to approximately $45^\circ C$ to account for chip temperature rise when the device is fully warmed up.

Note 3: 10Hz noise voltage density is sample tested on every lot of A grades. Devices 100% tested at 10Hz are available on request.

Note 4: This parameter is tested on a sample basis only.

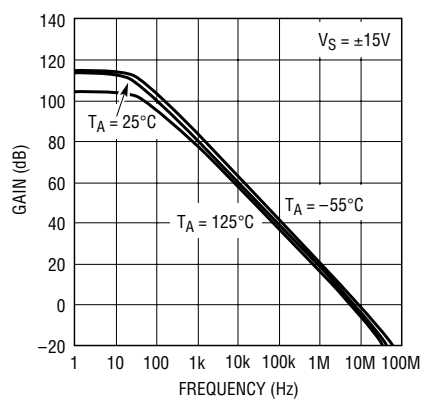
Note 5: Current noise is calculated from the formula: $i_n = (2qI_B)^{1/2}$, where $q = 1.6 \cdot 10^{-19}$ coulomb. The noise of source resistors up to $1G\Omega$ swamps the contribution of current noise.

Note 6: 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.

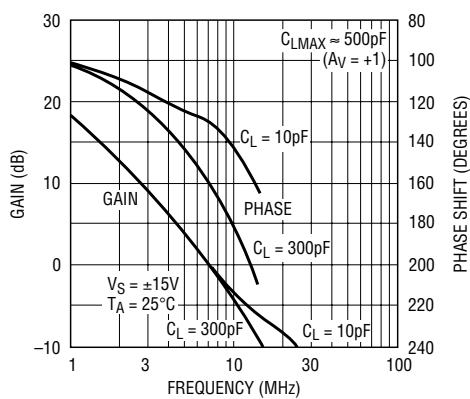
1022fa

TYPICAL PERFORMANCE CHARACTERISTICS

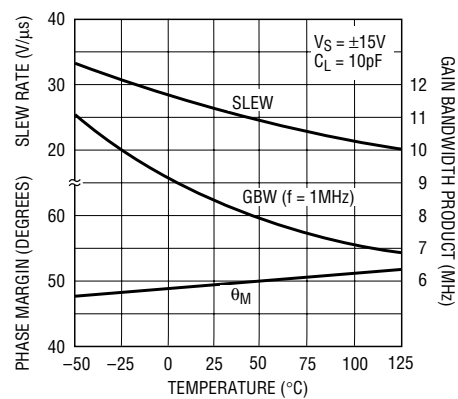
Gain vs Frequency



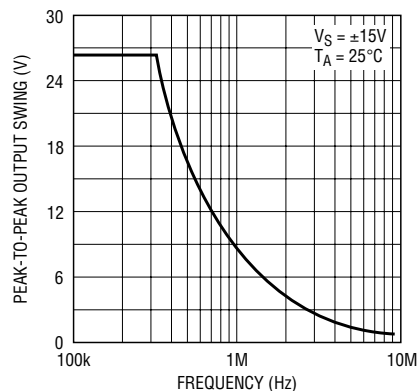
Gain, Phase Shift vs Frequency



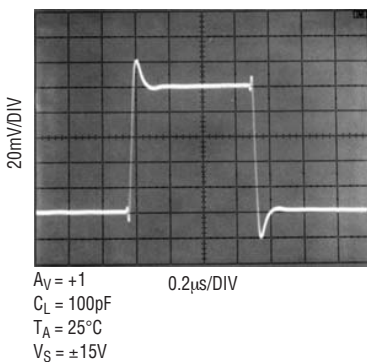
Phase Margin, Gain Bandwidth Product, Slew Rate vs Temperature



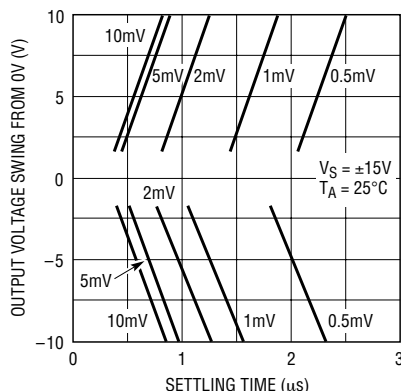
Undistorted Output Swing vs Frequency



Small-Signal Response



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

Short Circuit Current vs Time

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

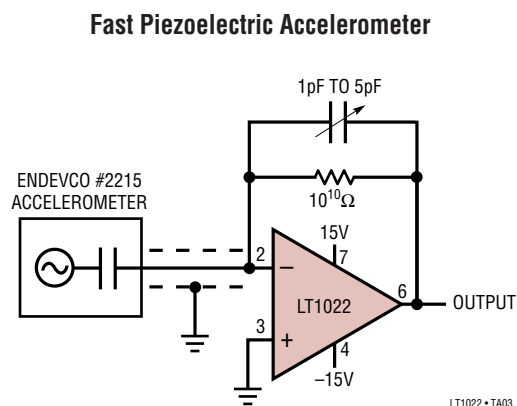
Output Swing vs Load Resistance

APPLICATIONS INFORMATION

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

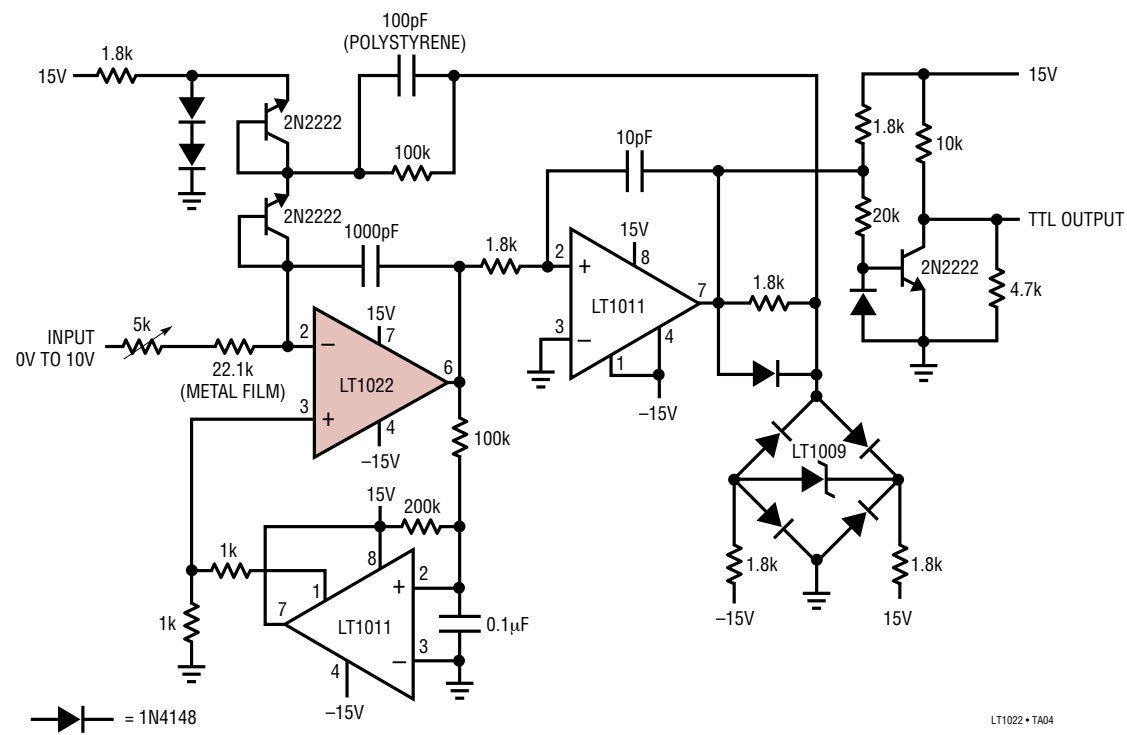
- (1) plug-in compatibility to industry standard devices
- (2) offset nulling
- (3) achieving picoampere/microvolt performance
- (4) phase-reversal protection
- (5) high speed operation (including settling time test circuit)
- (6) noise performance
- (7) simplified circuit schematic

TYPICAL APPLICATIONS



TYPICAL APPLICATIONS

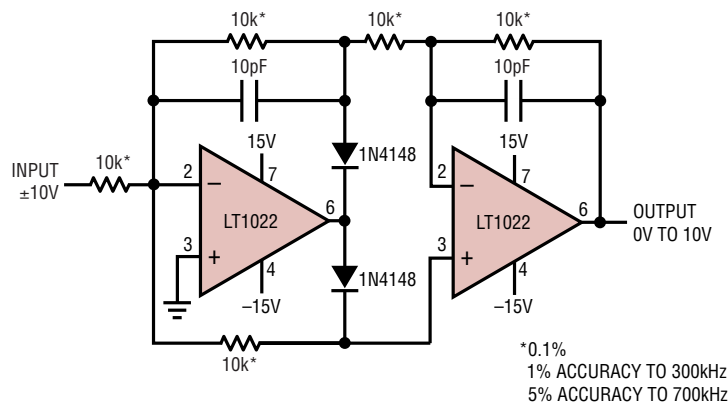
10Hz to 1MHz Voltage-to-Frequency Converter



LT1022 • TA05

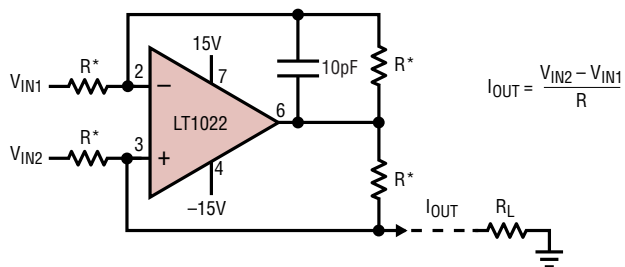
TYPICAL APPLICATIONS

Wide Bandwidth Absolute Value Circuit



LT1022 • TA06

Fast, Differential Input Current Source



*MATCH TO 0.01%
FULL-SCALE POWER BANDWIDTH
= 1MHz FOR $I_{OUT}R = 8V_{P-P}$
= 400kHz FOR $I_{OUT}R = 20V_{P-P}$
MAXIMUM $I_{OUT} = 10mA_{P-P}$
COMMON-MODE VOLTAGE AT LT1022 INPUT = $\frac{I_{OUTP-P} \cdot R_L}{2}$

LT1022 • TA07

SLEW RATE = 26V/ μ S
 $I_{OUT} = 150\text{mA}$
 C_L CAN BE 1 μ F
 $A_V = +1$, $C_F = 1000\text{pF}$
 $A_V = -1$, $C_F = 10\text{pF}$

LT1022 • TA08

327 LAMP

0.033 μ F†

15V

430 Ω

LT1022

OUTPUT

0.033 μ F†

-15V

10k

953 Ω *

953 Ω *

10k

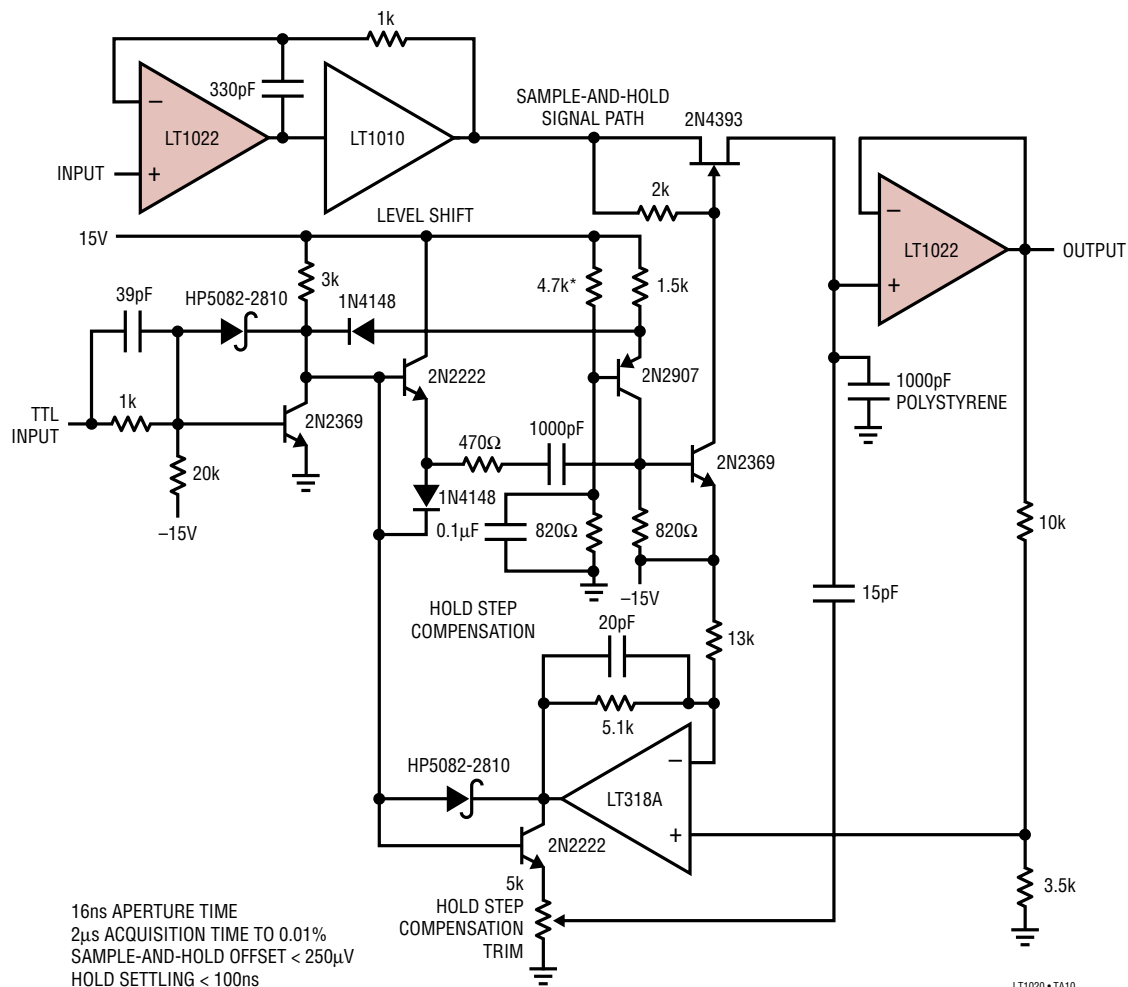
*1% FILM
10k DUAL POTENTIOMETER —
‡MATCH TRACKING TO 0.1%
†MATCH CAPACITORS TO 0.1%

5kHz TO 50kHz RANGE
DISTORTION < 0.1%
AMPLITUDE = 18V_{P-P}

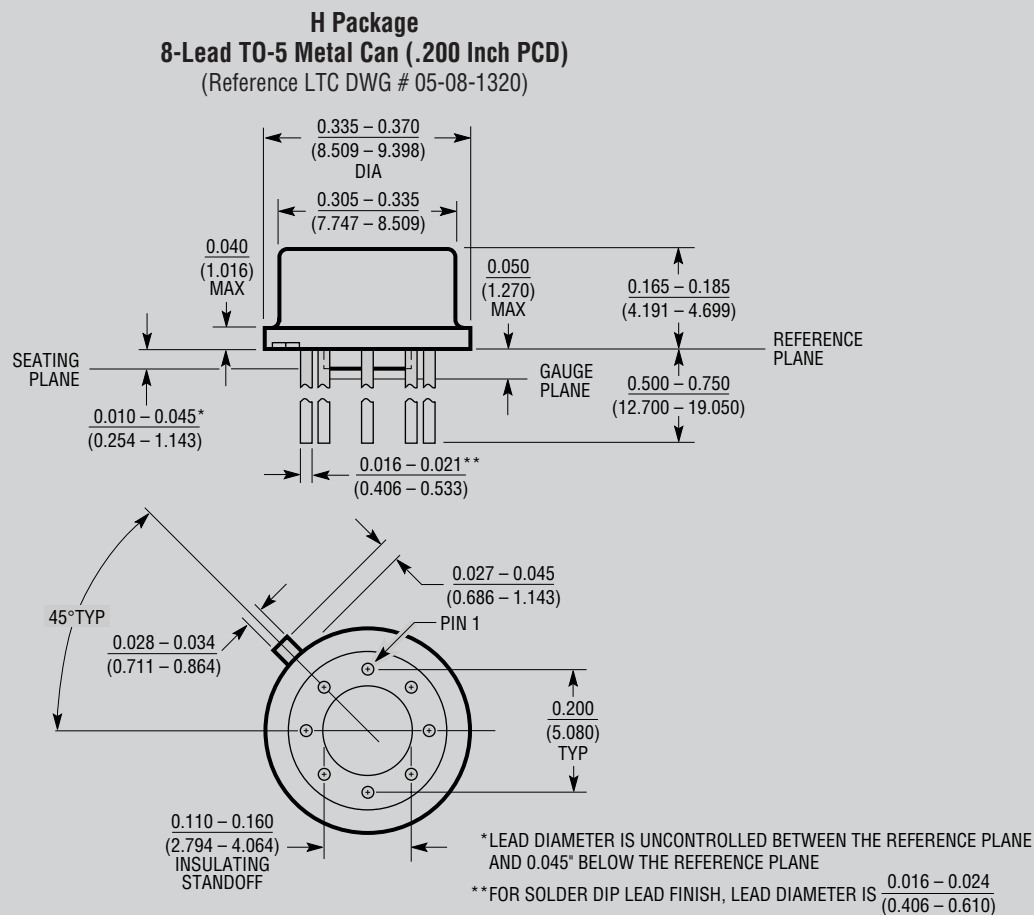
LT1022 • TA08

TYPICAL APPLICATIONS

Fast, Precision Sample-And-Hold



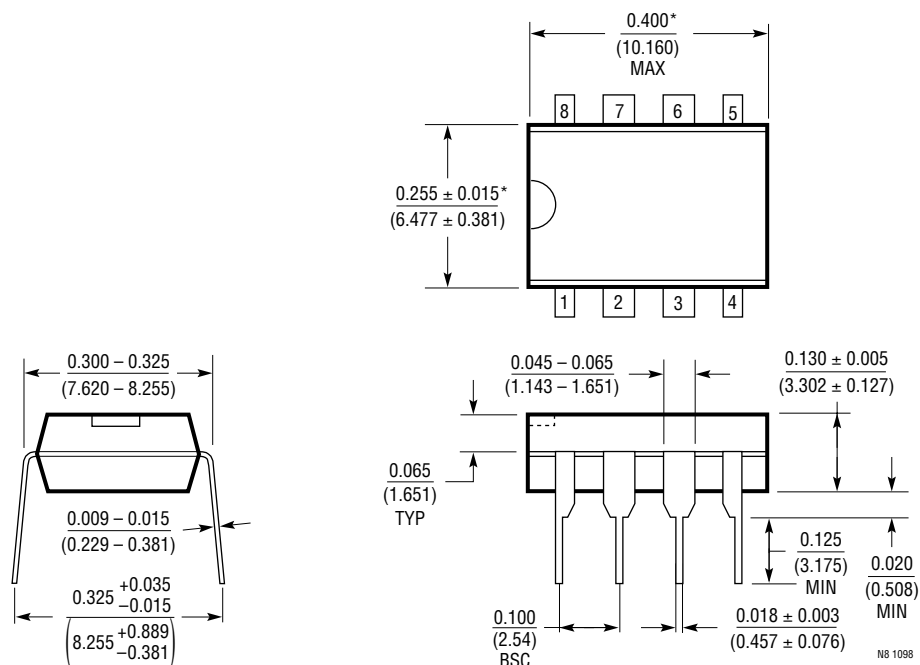
PACKAGE DESCRIPTION



OBSOLETE PACKAGE

PACKAGE DESCRIPTION

N8 Package
8-Lead PDIP (Narrow .300 Inch)
 (Reference LTC DWG # 05-08-1510)



*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
 MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.010 INCH (0.254mm)