

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.

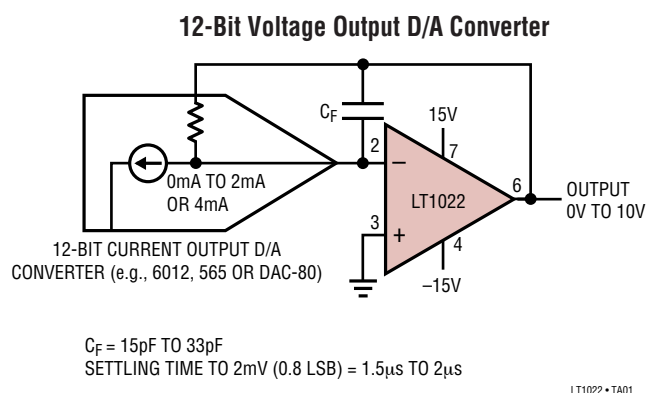
The LT1022A meets or exceeds all OP-16A and OP-16E specifications. It is faster and more accurate without stability problems at cold temperatures.

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

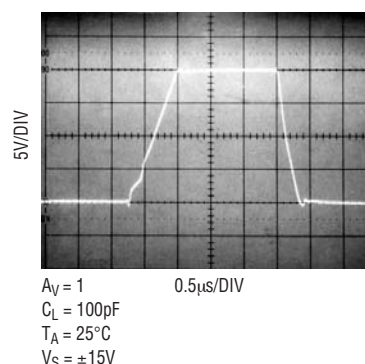
For a more accurate, lower power dissipation, but slower JFET input op amp, please refer to the LT1055 data sheet.

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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

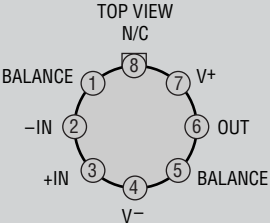
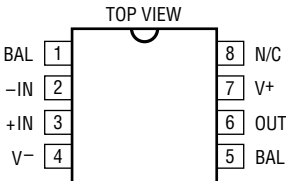
LT1022AM/1022M (**OBSOLETE**).....–55°C to 125°C

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		$\mu\text{V}/\text{p-P}$
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
		(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.

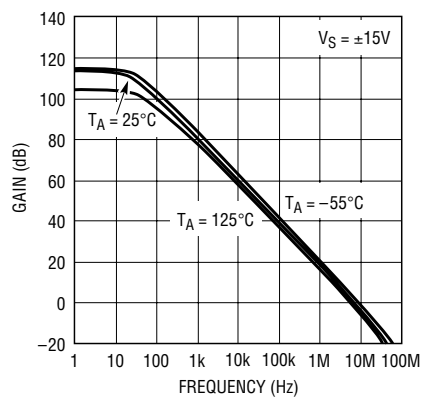
Note 5: Current noise is calculated from the formula: $i_n = (2qI_B)^{1/2}$, where $q = 1.6 \cdot 10^{-19}$ coulomb. The noise of source resistors up to $1G\Omega$ swamps the contribution of current noise.

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.

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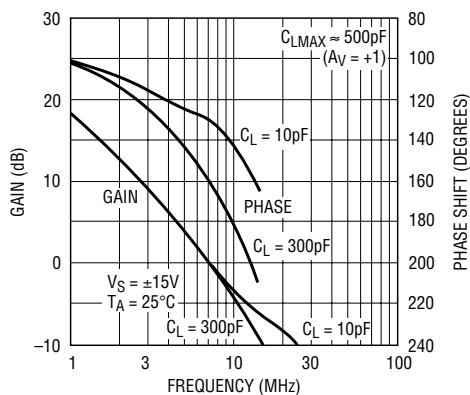
TYPICAL PERFORMANCE CHARACTERISTICS

Gain vs Frequency



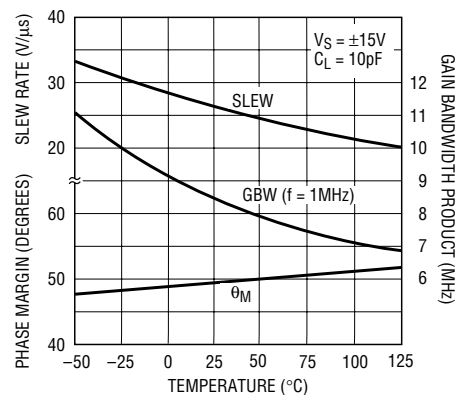
LT1022 • TPC01

Gain, Phase Shift vs Frequency



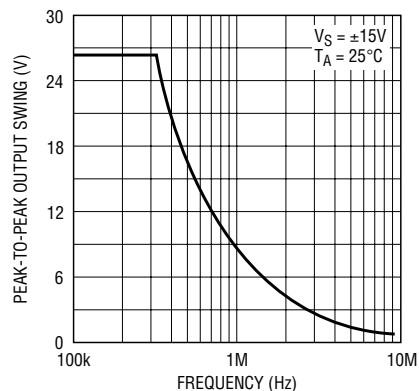
LT1022 • TPC02

Phase Margin, Gain Bandwidth Product, Slew Rate vs Temperature



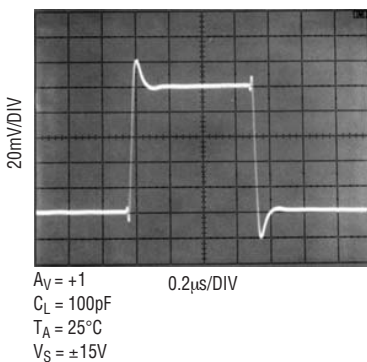
LT1022 • TPC03

Undistorted Output Swing vs Frequency

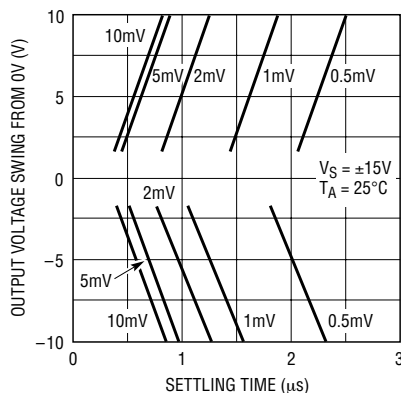


LT1022 • TPC04

Small-Signal Response



Settling Time



LT1022 • TPC05

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

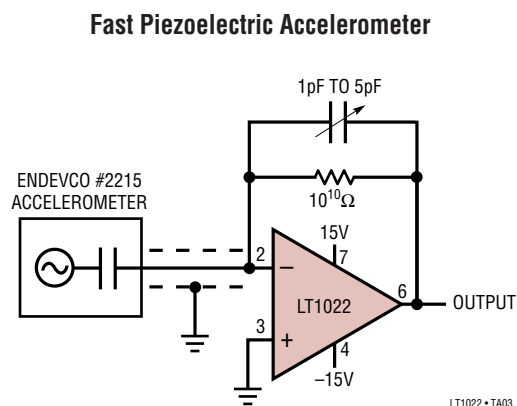
- Short Circuit Current vs Time
- Output Impedance vs Frequency
- Common Mode Range vs Temperature
- Common Mode and Power Supply Rejections vs Temperature
- Common Mode Rejection Ratio vs Frequency
- Power Supply Rejection Ratio vs Frequency
- Voltage Gain vs Temperature
- Supply Current vs Supply Voltage
- 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:

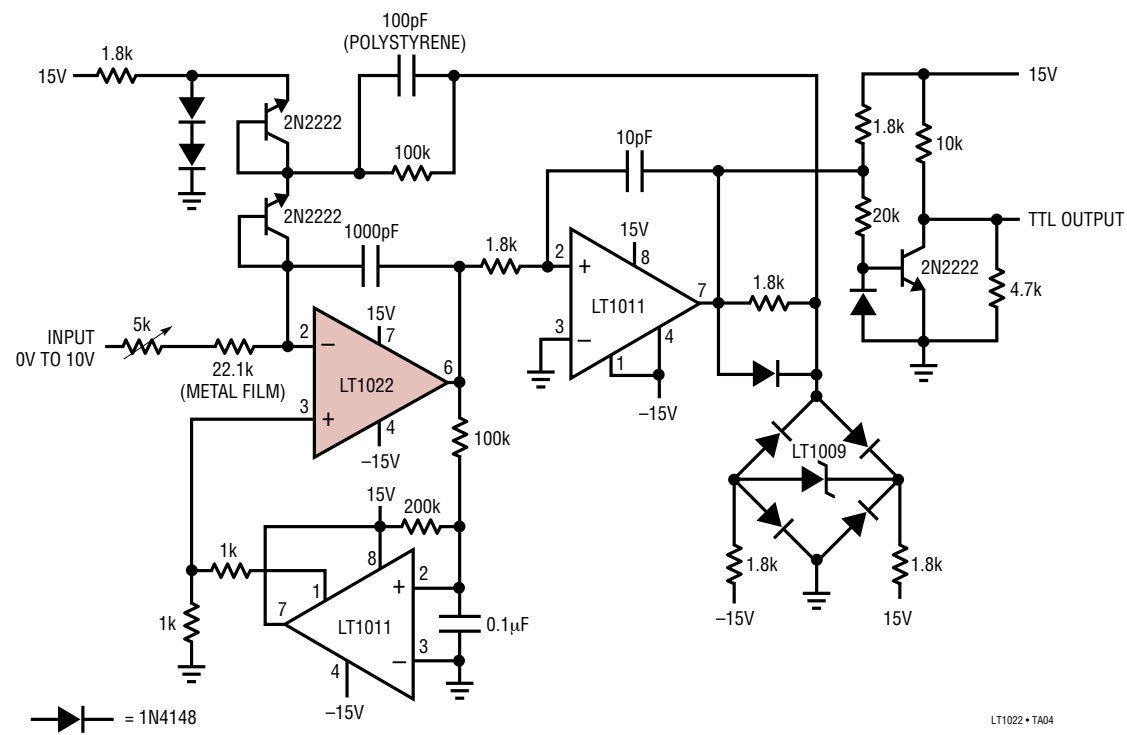
- (1) plug-in compatibility to industry standard devices
- (2) offset nulling
- (3) achieving picoampere/microvolt performance
- (4) phase-reversal protection
- (5) high speed operation (including settling time test circuit)
- (6) noise performance
- (7) simplified circuit schematic

TYPICAL APPLICATIONS



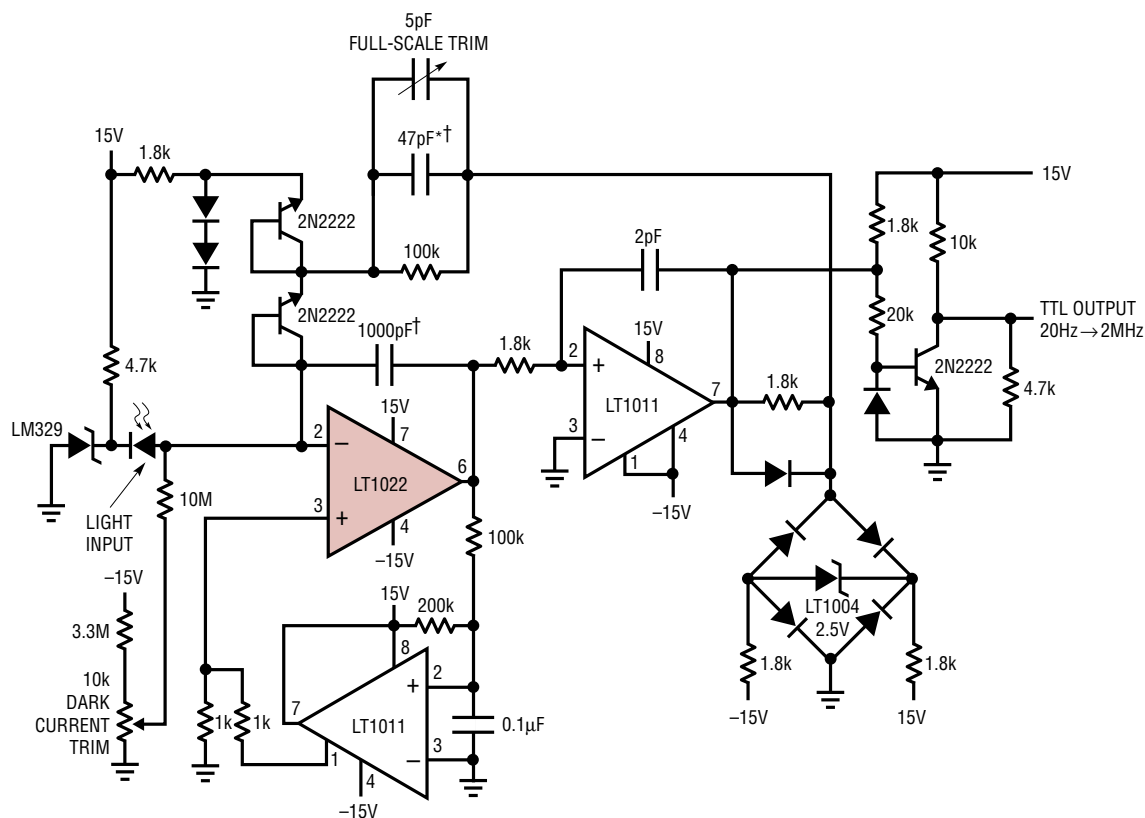
TYPICAL APPLICATIONS

10Hz to 1MHz Voltage-to-Frequency Converter



TYPICAL APPLICATIONS

PIN 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

LT1022 • TA05

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

$I_{OUT} = \frac{V_{IN2} - V_{IN1}}{R}$

*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 = $\frac{I_{OUT-P} \cdot R_L}{2}$

1022fa

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†

430 Ω

15V

LT1022

6 OUTPUT

0.033 μ F†

-15V

10k

953 Ω *

953 Ω *

10k

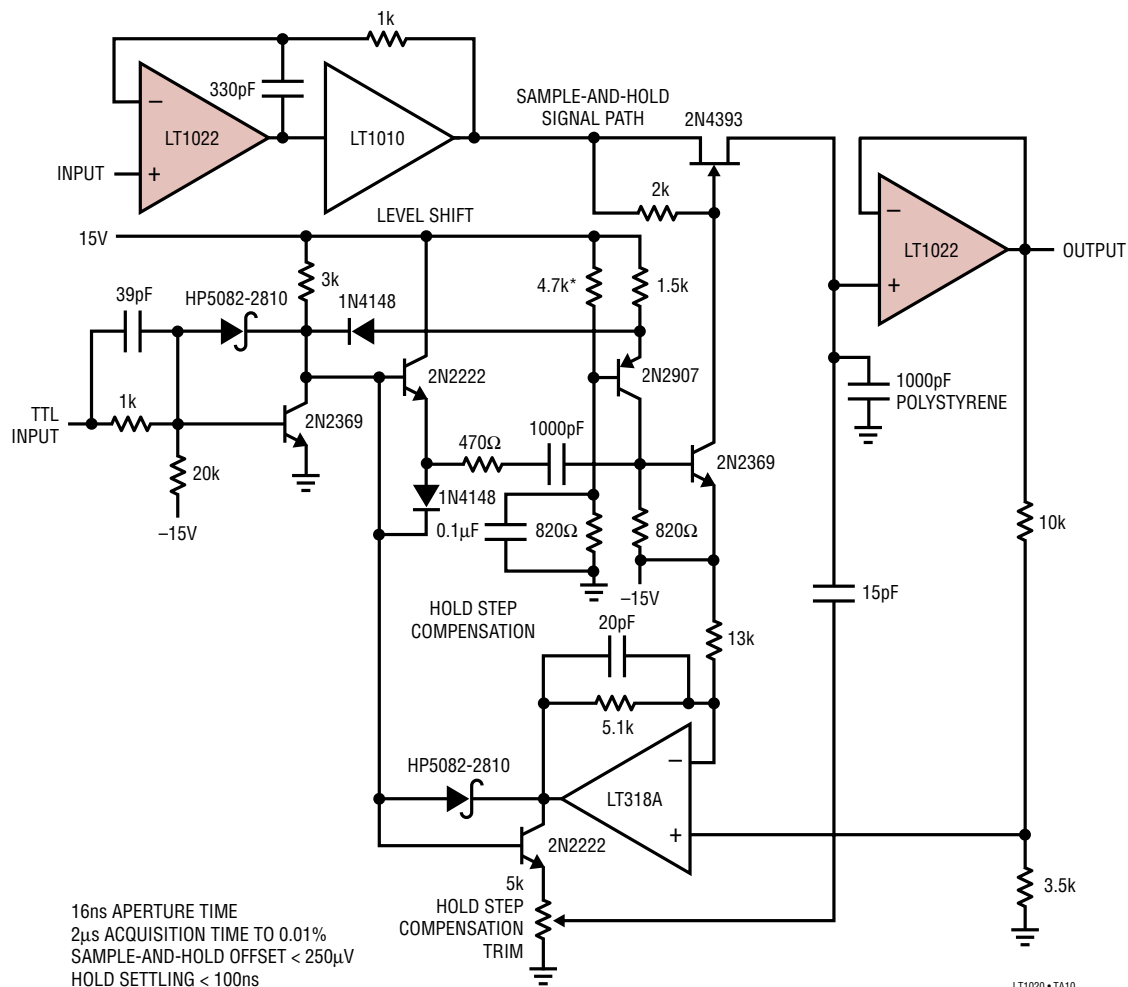
* 1% FILM
10k DUAL POTENTIOMETER —
MATCH TRACKING TO 0.1%
† MATCH CAPACITORS TO 0.1%

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

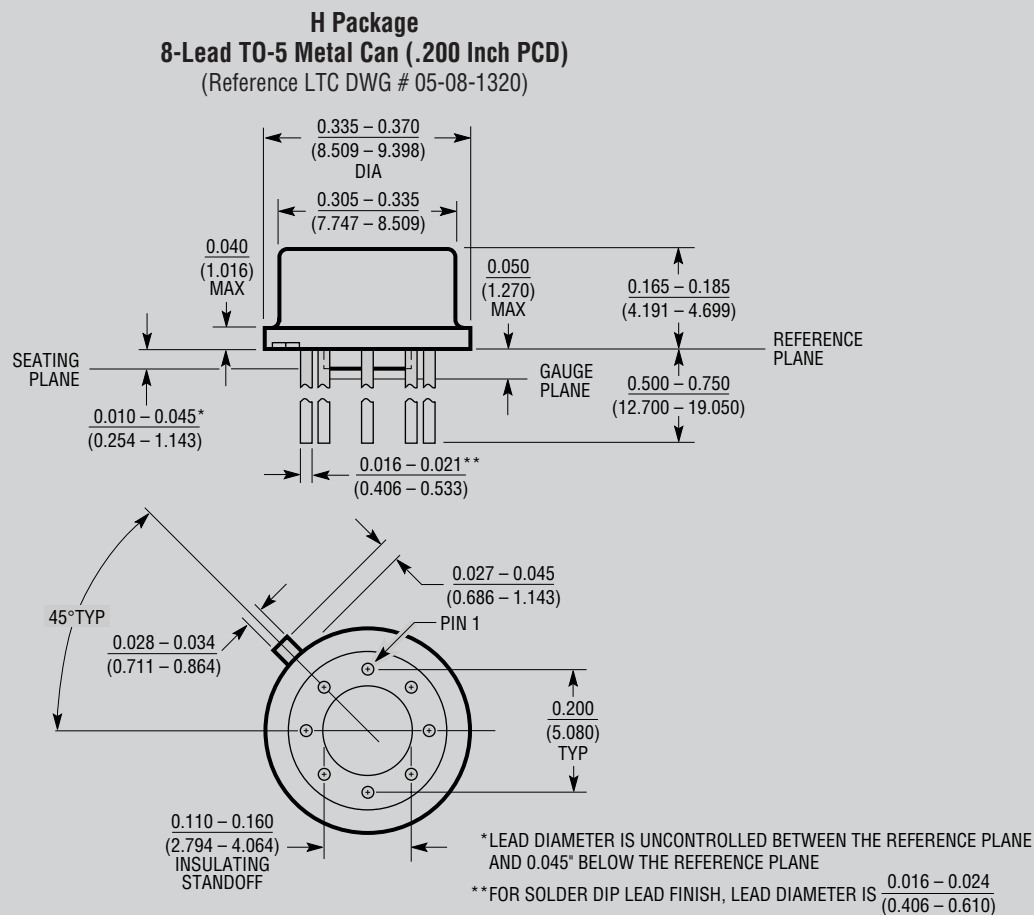
LT1022 • TA08

TYPICAL APPLICATIONS

Fast, Precision Sample-And-Hold



PACKAGE DESCRIPTION

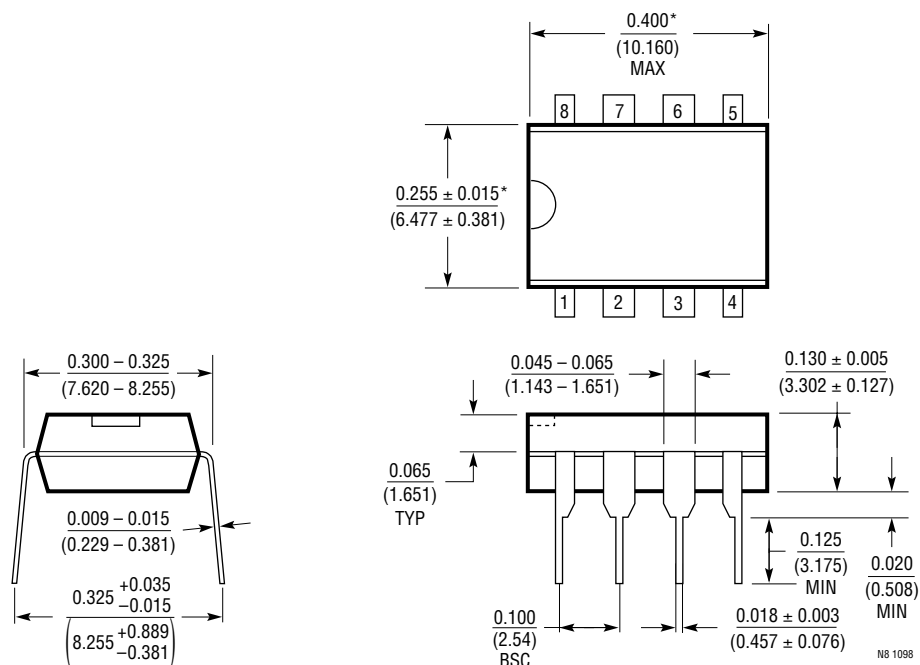


H8(TO-5) 0.200 PCD 1197

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)

N8 1098

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