Dual/Quad Over-The-Top Micropower Rail-to-Rail Input and Output Op Amps

FEATURES

- **Low Input Offset Voltage: 500μV Max**
- **Output Swings to 10mV Max from V⁻**
- **Rail-to-Rail Input and Output**
- **Micropower: 50μA/Amplifier Max**
- **MSOP Package**
- Over-The-Top™ Input Common Mode Range Extends 44V Above V⁻, Independent of V⁺
- Specified on 3V, 5V and ±15V Supplies
- High Output Current: 20mA
- Output Drives 10,000pF with Output Compensation
- Reverse Battery Protection to 18V
- No Supply Sequencing Problems
- High Voltage Gain: 1500V/mV
- High CMRR: 98dB
- No Phase Reversal
- Gain Bandwidth Product: 200kHz

APPLICATIONS

- Battery- or Solar-Powered Systems
  - Portable Instrumentation
  - Sensor Conditioning
- Supply Current Sensing
- Battery Monitoring
- Micropower Active Filters
- 4mA to 20mA Transmitters

DESCRIPTION

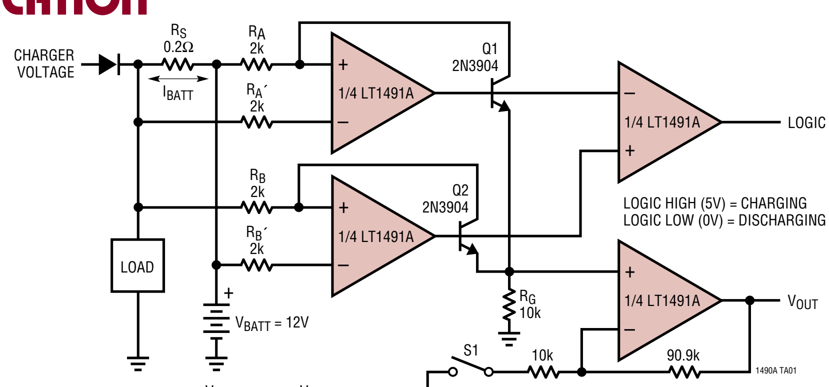
The LT®1490A/LT1491A are enhanced versions of the popular LT1490/LT1491 dual and quad op amps with improved input offset voltage (500μV max) and output voltage swing (10mV max from V⁻). They are recommended as replacements for the LT1490/LT1491 in all new designs. The LT1490A/LT1491A operate on all single and split supplies with a total voltage of 2V to 44V, drawing only 40μA of quiescent current per amplifier. These amplifiers are reverse supply protected; they draw virtually no current for reverse supply up to 18V. The input range of the LT1490A/LT1491A includes both supplies and the output swings to both supplies. Unlike most micropower op amps, the LT1490A/LT1491A can drive heavy loads; their rail-to-rail outputs drive 20mA. The LT1490A/LT1491A are unity-gain stable and drive all capacitive loads up to 10,000pF when optional 0.22μF and 150Ω compensation is used.

The LT1490A/LT1491A have a unique input stage that operates and remains high impedance when above the positive supply. The inputs take 44V both differential and common mode even when operating on a 3V supply. Built-in resistors protect the inputs for faults below the negative supply up to 15V. There is no phase reversal of the output for inputs 15V below V⁻ or 44V above V⁻, independent of V⁺.

The LT1490A dual op amp is available in the 8-pin MSOP, PDIP and SO packages. The quad LT1491A is available in the 14-pin SO and PDIP packages.

TYPICAL APPLICATION

Battery Monitor

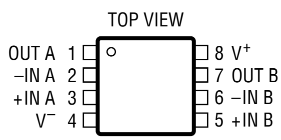


$$|I_{BATT}| = \frac{V_{OUT}}{(R_S)(R_G/R_A)(GAIN)} = \frac{V_{OUT}}{GAIN} \text{ AMPS}$$

ABSOLUTE MAXIMUM RATINGS (Note 1)

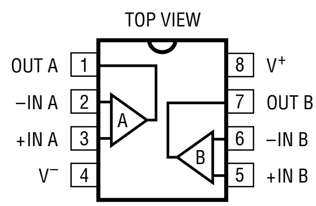
Total Supply Voltage (V^+ to V^-) 44V
Differential Input Voltage 44V
Input Current .... ±12mA
Output Short-Circuit Duration (Note 2) .... Continuous
Operating Temperature Range (Note 3)
  LT1490AC/LT1491AC .... –40°C to 85°C
  LT1490AI/LT1491AI .... –40°C to 85°C
  LT1490AH/LT1491AH .... –40°C to 125°C
Specified Temperature Range (Note 4)
  LT1490AC/LT1490AI .... –40°C to 85°C
  LT1491AC/LT1491AI .... –40°C to 85°C
  LT1490AH/LT1491AH .... –40°C to 125°C
Junction Temperature .... 150°C
Storage Temperature Range .... –65°C to 150°C
Lead Temperature (Soldering, 10 sec) .... 300°C

PACKAGE/ORDER INFORMATION



MS8 PACKAGE
8-LEAD PLASTIC MSOP

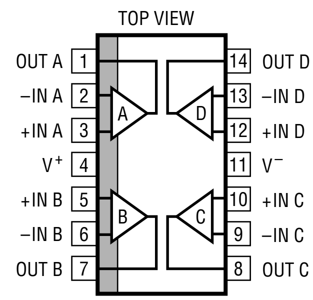
T_{JMAX} = 150°C, θ_{JA} = 250°C/W



N8 PACKAGE
8-LEAD PDIP

S8 PACKAGE
8-LEAD PLASTIC SO

T_{JMAX} = 150°C, θ_{JA} = 130°C/W (N8)
T_{JMAX} = 150°C, θ_{JA} = 190°C/W (S8)



N PACKAGE
14-LEAD PDIP

S PACKAGE
14-LEAD PLASTIC SO

T_{JMAX} = 150°C, θ_{JA} = 110°C/W (N)
T_{JMAX} = 150°C, θ_{JA} = 150°C/W (S)

ORDER PART NUMBER	MS8 PART MARKING	ORDER PART NUMBER	S8 PART MARKING	ORDER PART NUMBER	
LT1490ACMS8	LTNG	LT1490ACN8	1490A	LT1491ACN	LT1491AIS
LT1490AIMS8	LTPU	LT1490ACS8	1490AI	LT1491ACS	LT1491AHS
LT1490AHMS8	LTRK	LT1490AIN8	1490AH	LT1491AIN	
		LT1490AIS8			
		LT1490AHS8			

Consult factory for Military grade parts.

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range of –40°C ≤ T_A ≤ 85°C, otherwise specifications are at T_A = 25°C. V_S = 3V, 0V; V_S = 5V, 0V; V_{CM} = V_{OUT} = half supply unless otherwise noted. (Note 4)

SYMBOL	PARAMETER	CONDITIONS		LT1490AC/LT1491AC LT1490AI/LT1491AI MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage (Note 5)	LT1490A N, S Packages			110	500	µV
		0°C ≤ T_A ≤ 70°C	●			700	µV
		–40°C ≤ T_A ≤ 85°C	●			800	µV
		LT1490A MS8 Package, LT1491A N, S Packages			220	1000	µV
		0°C ≤ T_A ≤ 70°C	●			1200	µV
		–40°C ≤ T_A ≤ 85°C	●			1400	µV
	Input Offset Voltage Drift (Note 9)	–40°C ≤ T_A ≤ 85°C	●		2	4	µV/°C

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range of $-40°C \le T_A \le 85°C$, otherwise specifications are at $T_A = 25°C$. $V_S = 3V$, 0V; $V_S = 5V$, 0V; $V_{CM} = V_{OUT}$ = half supply unless otherwise noted. (Note 4)

SYMBOL	PARAMETER	CONDITIONS		LT1490AC/LT1491AC LT1490AI/LT1491AI MIN	TYP	MAX	UNITS
I_{OS}	Input Offset Current	 V_{CM} = 44V (Note 6)	● ●		0.2	0.8 0.8	nA µA
I_B	Input Bias Current	 V_{CM} = 44V (Note 6) V_S = 0V	● ●		1 3 0.3	8 10	nA µA nA
	Input Bias Current Drift	$-40°C \le T_A \le 85°C$	●		2		pA/°C
	Input Noise Voltage	0.1Hz to 10Hz			1		μV_{P-P}
e_n	Input Noise Voltage Density	f = 1kHz			50		$nV/\sqrt{Hz}$
i_n	Input Noise Current Density	f = 1kHz			0.015		$pA/\sqrt{Hz}$
R_{IN}	Input Resistance	Differential Common Mode, V_{CM} = 0V to 44V		6 4	17 11		MΩ MΩ
C_{IN}	Input Capacitance				4.6		pF
	Input Voltage Range		●	0		44	V
CMRR	Common Mode Rejection Ratio (Note 6)	V_{CM} = 0V to V_{CC} – 1V V_{CM} = 0V to 44V	● ●	84 80	98 98		dB dB
A_{VOL}	Large-Signal Voltage Gain	V_S = 3V, V_O = 500mV to 2.5V, R_L = 10k $0°C \le T_A \le 70°C$ $-40°C \le T_A \le 85°C$	 ● ●	200 133 100	1500		V/mV V/mV V/mV
		V_S = 5V, V_O = 500mV to 4.5V, R_L = 10k $0°C \le T_A \le 70°C$ $-40°C \le T_A \le 85°C$	 ● ●	400 250 200	1500		V/mV V/mV V/mV
V_{OL}	Output Voltage Swing Low	V_S = 3V, No Load V_S = 3V, I_{SINK} = 5mA	● ●		3 250	10 450	mV mV
		V_S = 5V, No Load V_S = 5V, I_{SINK} = 5mA V_S = 5V, I_{SINK} = 10mA	● ●		3 250 330	10 500 500	mV mV mV
V_{OH}	Output Voltage Swing High	V_S = 3V, No Load V_S = 3V, I_{SOURCE} = 5mA	● ●	2.95 2.55	2.978 2.6		V V
		V_S = 5V, No Load V_S = 5V, I_{SOURCE} = 10mA	● ●	4.95 4.30	4.978 4.6		V V
I_{SC}	Short-Circuit Current (Note 2)	V_S = 3V, Short to GND V_S = 3V, Short to V_{CC}		10 10	15 30		mA mA
		V_S = 5V, Short to GND V_S = 5V, Short to V_{CC}		15 15	25 30		mA mA
PSRR	Power Supply Rejection Ratio	V_S = 2.5V to 12.5V, $V_{CM} = V_O$ = 1V	●	84	98		dB
	Minimum Operating Supply Voltage		●		2	2.5	V
	Reverse Supply Voltage	I_S = –100µA per Amplifier	●	18	27		V
I_S	Supply Current per Amplifier (Note 7)		 ●		40	50 55	µA µA
GBW	Gain Bandwidth Product (Note 6)	f = 1kHz $0°C \le T_A \le 70°C$ $-40°C \le T_A \le 85°C$	 ● ●	110 100 90	180		kHz kHz kHz
SR	Slew Rate (Note 8)	A_V = –1, $R_L = \infty$ $0°C \le T_A \le 70°C$ $-40°C \le T_A \le 85°C$	 ● ●	0.035 0.031 0.030	0.06		V/µs V/µs V/µs

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range of $-40°C \le T_A \le 85°C$, otherwise specifications are at $T_A = 25°C$. $V_S = \pm15V$; $V_{CM} = 0V$, $V_{OUT} = 0V$ unless otherwise noted. (Note 4)

SYMBOL	PARAMETER	CONDITIONS		LT1490AC/LT1491AC LT1490AI/LT1491AI MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage (Note 5)	LT1490A N, S Packages			150	700	µV
		$0°C \le T_A \le 70°C$	●			950	µV
		$-40°C \le T_A \le 85°C$	●			1100	µV
		LT1490A MS8 Package, LT1491A N, S Packages			250	1200	µV
		$0°C \le T_A \le 70°C$	●			1350	µV
		$-40°C \le T_A \le 85°C$	●			1500	µV
	Input Offset Voltage Drift (Note 9)	$-40°C \le T_A \le 85°C$	●		2	6	µV/°C
I_{OS}	Input Offset Current		●		0.2	0.8	nA
I_B	Input Bias Current		●		1	8	nA
	Input Bias Current Drift	$-40°C \le T_A \le 85°C$	●		5		pA/°C
	Input Noise Voltage	0.1Hz to 10Hz			1		$µV_{P-P}$
e_n	Input Noise Voltage Density	f = 1kHz			50		$nV/\sqrt{Hz}$
i_n	Input Noise Current Density	f = 1kHz			0.015		$pA/\sqrt{Hz}$
R_{IN}	Input Resistance	Differential		6	17		MΩ
		Common Mode, $V_{CM} = -15V$ to 14V			15000		MΩ
C_{IN}	Input Capacitance				4.6		pF
	Input Voltage Range		●	–15		29	V
CMRR	Common Mode Rejection Ratio	$V_{CM} = -15V$ to 29V	●	80	98		dB
A_{VOL}	Large-Signal Voltage Gain	$V_O = \pm14V$, $R_L = 10k$		100	250		V/mV
		$0°C \le T_A \le 70°C$	●	75			V/mV
		$-40°C \le T_A \le 85°C$	●	50			V/mV
V_O	Output Voltage Swing	No Load	●	±14.9	±14.978		V
		$I_{OUT} = \pm5mA$	●	±14.5	±14.750		V
		$I_{OUT} = \pm10mA$		±14.5	±14.670		V
I_{SC}	Short-Circuit Current (Note 2)	Short to GND		±20	±25		mA
		$0°C \le T_A \le 70°C$	●	±15			mA
		$-40°C \le T_A \le 85°C$	●	±10			mA
PSRR	Power Supply Rejection Ratio	$V_S = \pm1.25V$ to $\pm22V$	●	88	98		dB
I_S	Supply Current per Amplifier				50	70	µA
			●			85	µA
GBW	Gain Bandwidth Product	f = 1kHz		125	200		kHz
		$0°C \le T_A \le 70°C$	●	110			kHz
		$-40°C \le T_A \le 85°C$	●	100			kHz
SR	Slew Rate	$A_V = -1$, $R_L = \infty$, $V_O = \pm10V$, Measure at $V_O = \pm5V$		0.0375	0.07		V/µs
		$0°C \le T_A \le 70°C$	●	0.0330			V/µs
		$-40°C \le T_A \le 85°C$	●	0.0300			V/µs

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range of $-40°C \le T_A \le 125°C$. V_S = 3V, 0V; V_S = 5V, 0V; V_{CM} = V_{OUT} = half supply unless otherwise noted. (Note 4)

SYMBOL	PARAMETER	CONDITIONS		LT1490AH/LT1491AH MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage (Note 5)	LT1490AHS8			110	500	µV
			●			2500	µV
		LT1490AHMS8, LT1491AHS			220	1000	µV
			●			3000	µV
	Input Offset Voltage Drift (Note 9)		●		3	6	µV/°C
I_{OS}	Input Offset Current		●			2	nA
		V_{CM} = 44V (Note 6)	●			1.5	µA
I_B	Input Bias Current		●			20	nA
		V_{CM} = 44V (Note 6)	●			15	µA
	Input Voltage Range		●	0.3		44	V
CMRR	Common Mode Rejection Ratio	V_{CM} = 0.3V to V_{CC} –1V	●	60			dB
	(Note 6)	V_{CM} = 0.3V to 44V	●	74			dB
A_{VOL}	Large-Signal Voltage Gain	V_S = 3V, V_O = 500mV to 2.5V, R_L = 10k		200	1500		V/mV
			●	25			V/MV
		V_S = 5V, V_O = 500mV to 4.5V, R_L = 10k		400	1500		V/mV
			●	50			V/mV
V_{OL}	Output Voltage Swing Low	V_S = 3V, No Load	●			15	mV
		V_S = 3V, I_{SINK} = 2.5mA	●			450	mV
		V_S = 5V, No Load	●			15	mV
		V_S = 5V, I_{SINK} = 2.5mA	●			500	mV
V_{OH}	Output Voltage Swing High	V_S = 3V, No Load	●	2.925			V
		V_S = 3V, I_{SOURCE} = 5mA	●	2.350			V
		V_S = 5V, No Load	●	4.925			V
		V_S = 5V, I_{SOURCE} = 10mA	●	4.100			V
PSRR	Power Supply Rejection Ratio	V_S = 2.5V to 12.5V, V_{CM} = V_O = 1V	●	80			dB
	Minimum Operating Supply Voltage		●			2.5	V
	Reverse Supply Voltage	I_S = –100µA per Amplifier	●	18			V
I_S	Supply Current per Amplifier (Note 7)				40	50	µA
			●			70	µA
GBW	Gain Bandwidth Product (Note 6)	f = 1kHz		110	180		kHz
			●	60			kHz
SR	Slew Rate (Note 8)	A_V = –1, R_L = ∞		0.035	0.06		V/µs
			●	0.015			V/µs

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range of $-40°C \le T_A \le 125°C$. $V_S = \pm15V$, $V_{CM} = 0V$, $V_{OUT} = 0V$ unless otherwise noted. (Note 4)

SYMBOL	PARAMETER	CONDITIONS		LT1490AH/LT1491AH MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage (Note 5)	LT1490AHS8			150	700	µV
			●			2700	µV
		LT1490AHMS8, LT1491AHS			250	1200	µV
			●			3200	µV
	Input Offset Voltage Drift (Note 9)		●		3	7	µV/°C
I_{OS}	Input Offset Current		●			2	nA
I_B	Input Bias Current		●			20	nA
	Input Voltage Range		●	–14.7		29	V
CMRR	Common Mode Rejection Ratio	V_{CM} = –14.7V to 29V	●	72			dB
A_{VOL}	Large-Signal Voltage Gain	V_O = ±14V, R_L = 10k		100	250		V/mV
			●	4			V/mV
V_O	Output Voltage Swing	No Load	●	±14.8			mV
		I_{OUT} = ±2.5mA	●	±14.3			mV
PSRR	Power Supply Rejection Ratio	V_S = ±1.25V to ±22V	●	84			dB
I_S	Supply Current per Amplifier				50	70	µA
			●			95	µA
GBW	Gain Bandwidth Product	f = 1kHz		125	200		kHz
			●	75			kHz
SR	Slew Rate	A_V = –1, R_L = ∞		0.0375	0.07		V/µs
			●	0.02			V/µs

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

Note 2: A heat sink may be required to keep the junction temperature below absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted.

Note 3: The LT1490AC/LT1491AC and LT1490AI/LT1491AI are guaranteed functional over the operating temperature range of –40°C to 85°C. The LT1490AH/LT1491AH are guaranteed functional over the operating temperature range of –40°C to 125°C.

Note 4: The LT1490AC/LT1491AC are guaranteed to meet specified performance from 0°C to 70°C. The LT1490AC/LT1491AC are designed, characterized and expected to meet specified performance from –40°C to 85°C but are not tested or QA sampled at these temperatures. The LT1490AI/LT1491AI are guaranteed to meet specified performance from –40°C to 85°C. The LT1490AH/LT1491AH are guaranteed to meet specified performance from –40°C to 125°C.

Note 5: ESD (Electrostatic Discharge) sensitive device. Extensive use of ESD protection devices are used internal to the LT1490A/LT1491A. However, high electrostatic discharge can damage or degrade the device. Use proper ESD handling precautions.

Note 6: V_S = 5V limits are guaranteed by correlation to V_S = 3V and V_S = ±15V tests.

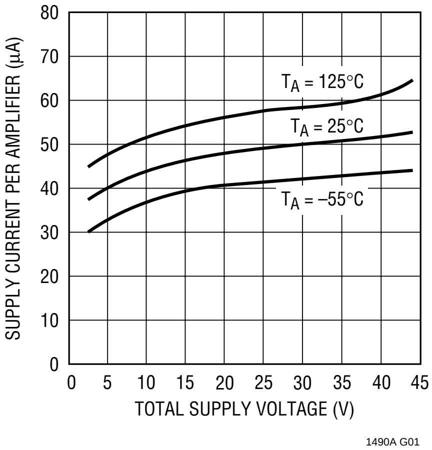
Note 7: V_S = 3V limits are guaranteed by correlation to V_S = 5V and V_S = ±15V tests.

Note 8: Guaranteed by correlation to slew rate at V_S = ±15V and GBW at V_S = 3V and V_S = ±15V tests.

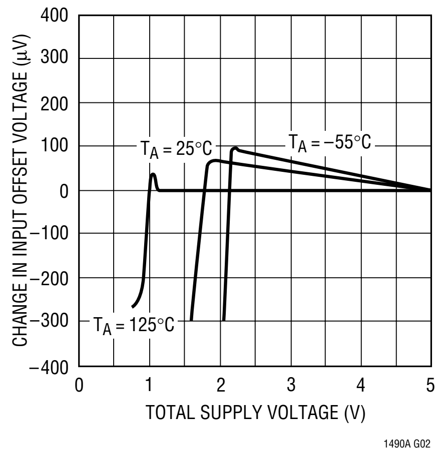
Note 9: This parameter is not 100% tested.

TYPICAL PERFORMANCE CHARACTERISTICS

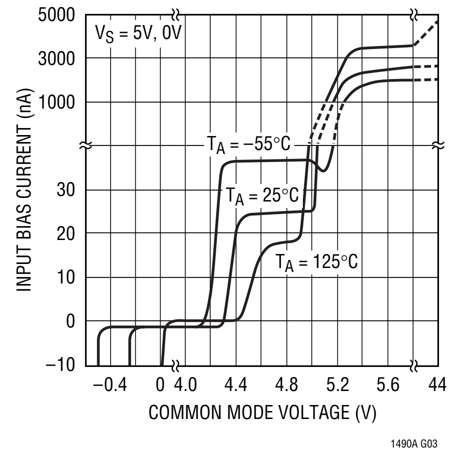
Supply Current vs Supply Voltage



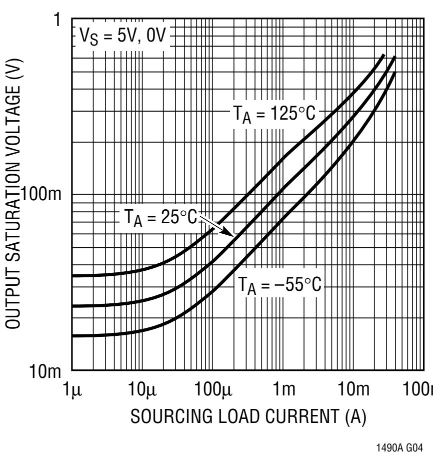
Minimum Supply Voltage



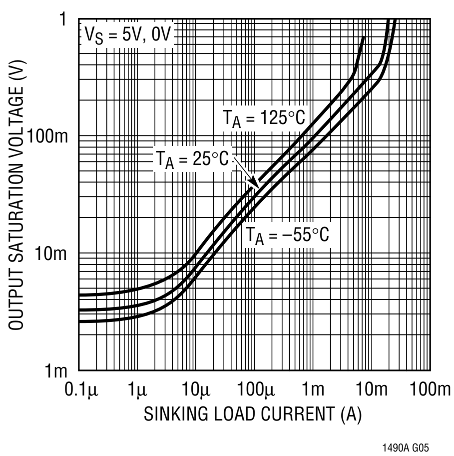
Input Bias Current vs Common Mode Voltage



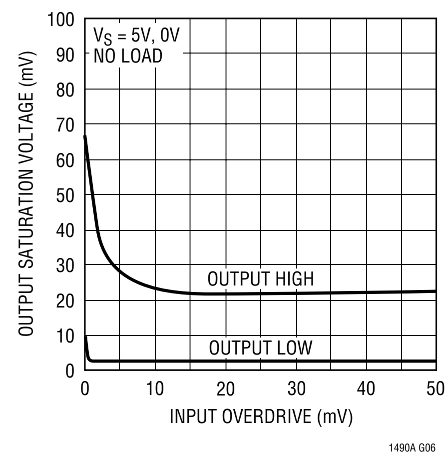
Output Saturation Voltage vs Load Current (Output High)



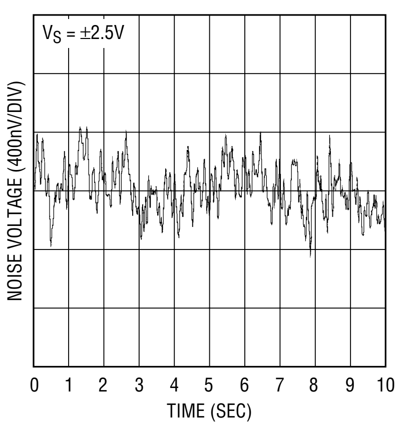
Output Saturation Voltage vs Load Current (Output Low)



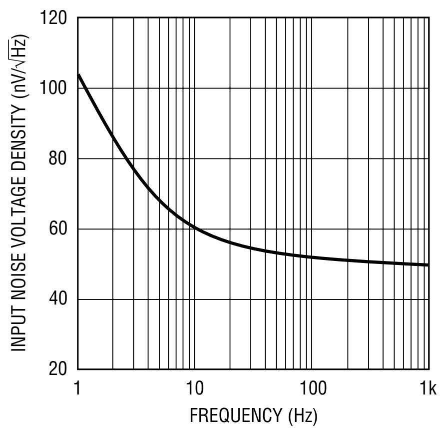
Output Saturation Voltage vs Input Overdrive



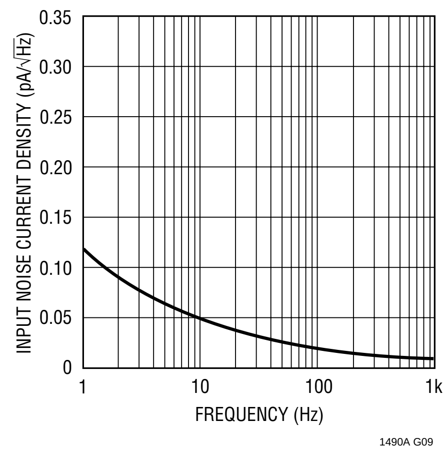
0.1Hz to 10Hz Noise Voltage



Noise Voltage Density vs Frequency

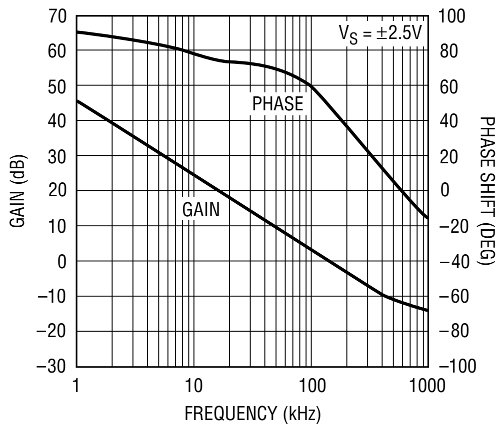


Input Noise Current vs Frequency



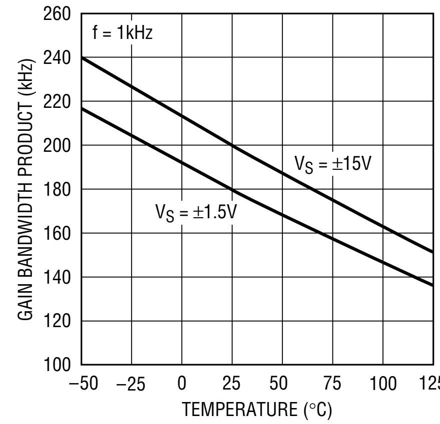
TYPICAL PERFORMANCE CHARACTERISTICS

Gain and Phase Shift vs Frequency



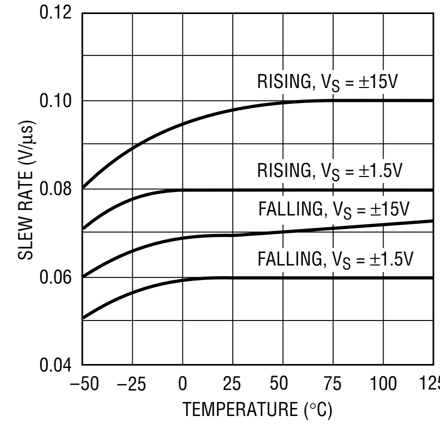
1490A G10

Gain Bandwidth Product vs Temperature



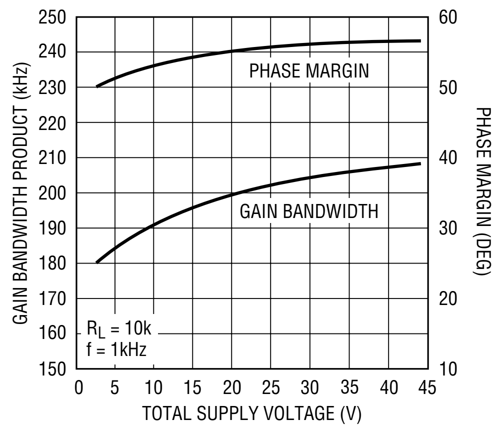
1490A G11

Slew Rate vs Temperature



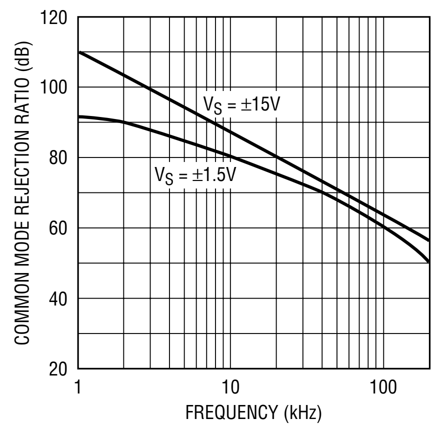
1490A G12

Gain Bandwidth Product and Phase Margin vs Supply Voltage



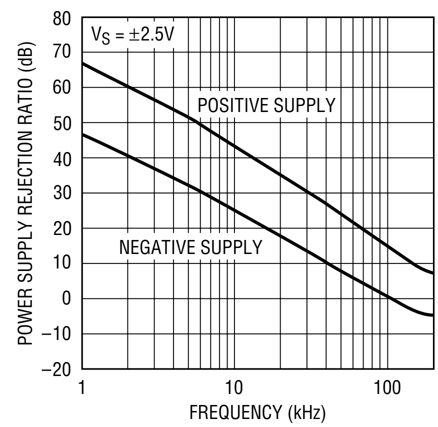
1490A G13

CMRR vs Frequency



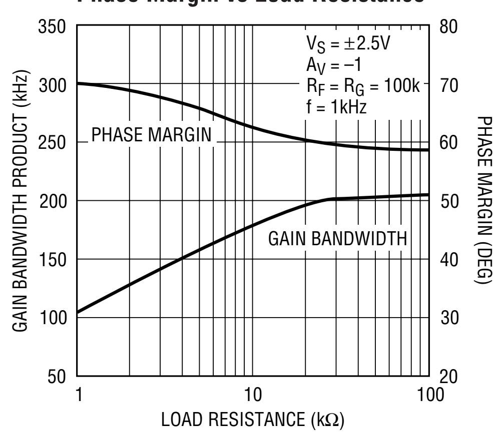
1490A G14

PSRR vs Frequency



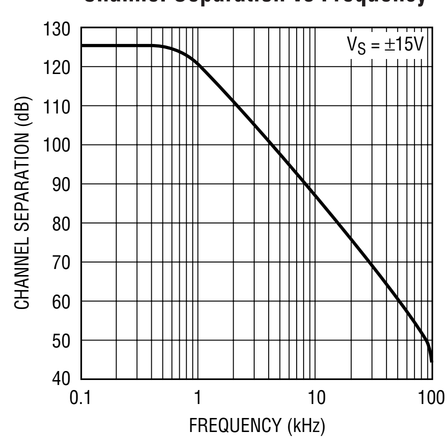
1490A G15

Gain Bandwidth Product and Phase Margin vs Load Resistance



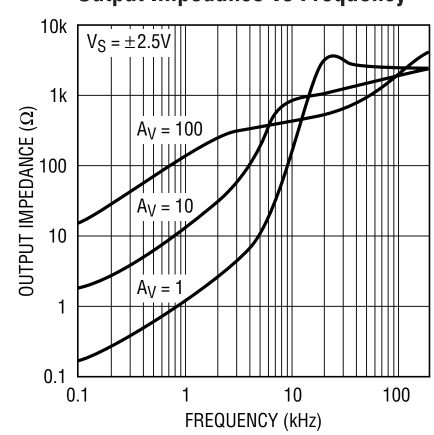
1490A G16

Channel Separation vs Frequency



1490A G17

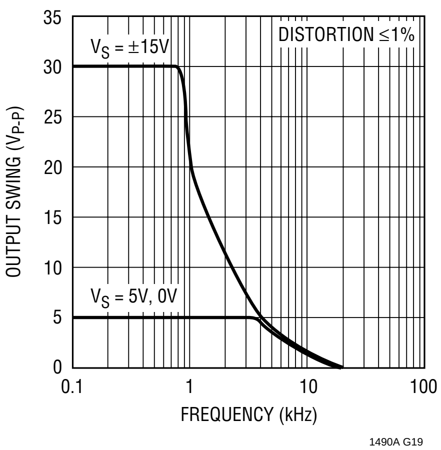
Output Impedance vs Frequency



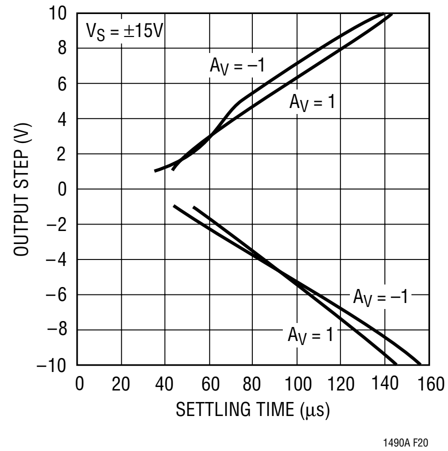
1490A G18

TYPICAL PERFORMANCE CHARACTERISTICS

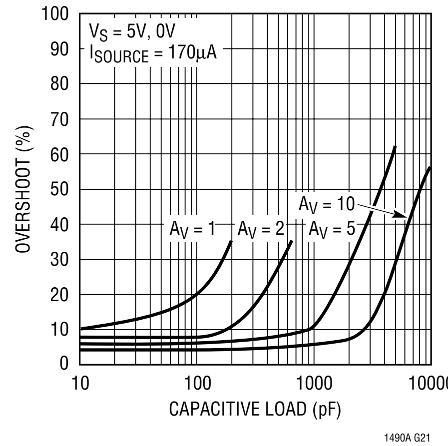
Undistorted Output Swing vs Frequency



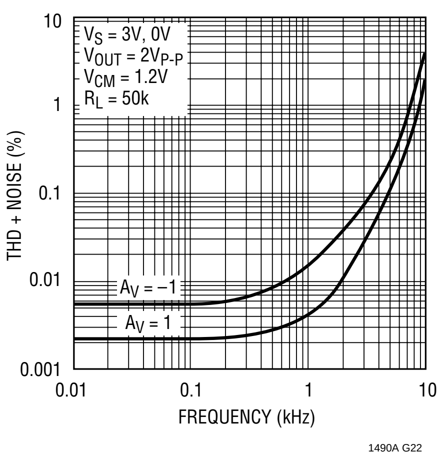
Settling Time to 0.1% vs Output Step



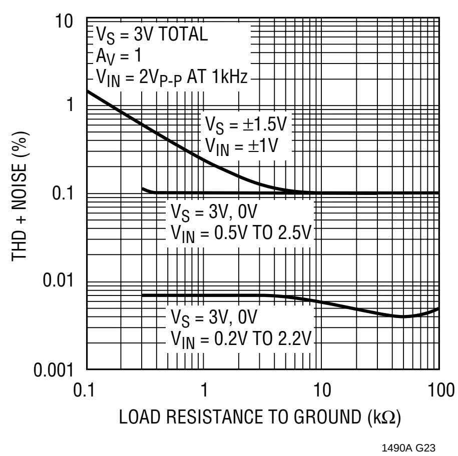
Capacitive Load Handling, Overshoot vs Capacitive Load



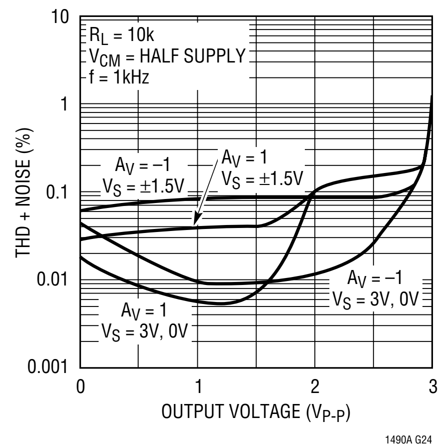
Total Harmonic Distortion + Noise vs Frequency



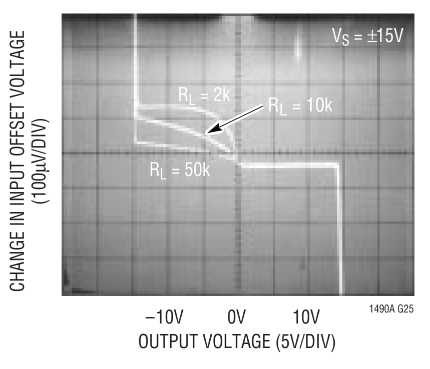
Total Harmonic Distortion + Noise vs Load Resistance



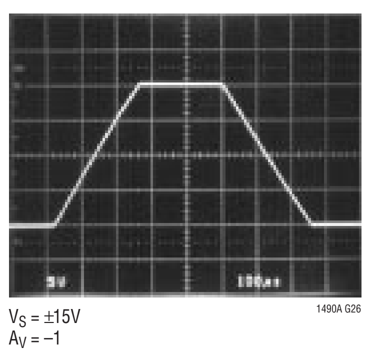
Total Harmonic Distortion + Noise vs Output Voltage



Open-Loop Gain

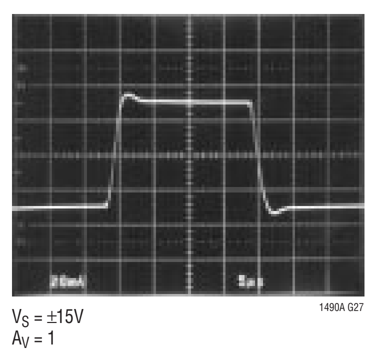


Large-Signal Response



V_S = ±15V
A_V = –1

Small-Signal Response



V_S = ±15V
A_V = 1

APPLICATIONS INFORMATION

Supply Voltage

The positive supply pin of the LT1490A/LT1491A should be bypassed with a small capacitor (about 0.01µF) within an inch of the pin. When driving heavy loads an additional 4.7µF electrolytic capacitor should be used. When using split supplies, the same is true for the negative supply pin.

The LT1490A/LT1491A are protected against reverse battery voltages up to 18V. In the event a reverse battery condition occurs, the supply current is less than 1nA.

The LT1490A/LT1491A can be shut down by removing V^+. In this condition the input bias current is typically less than 0.5nA, even if the inputs are 44V above the negative supply.

When operating the LT1490A/LT1491A on total supplies of 20V or more, the supply must not rise to its final voltage in less than 1µs. This is especially true if low ESR bypass capacitors are used. A series RLC circuit is formed from the supply lead inductance and the bypass capacitor. A resistance of 7.5Ω in the supply or in the bypass capacitor will dampen the tuned circuit enough to limit the rise time.

Inputs

The LT1490A/LT1491A have two input stages, NPN and PNP (see the Simplified Schematic), resulting in three distinct operating regions as shown in the Input Bias Current vs Common Mode typical performance curve.

For input voltages about 0.8V or more below V^+, the PNP input stage is active and the input bias current is typically –1nA. When the input voltage is about 0.5V or less from V^+, the NPN input stage is operating and the input bias current is typically 25nA. Increases in temperature will cause the voltage at which operation switches from the PNP stage to the NPN stage to move towards V^+. The input offset voltage of the NPN stage is untrimmed and is typically 600µV.

A Schottky diode in the collector of each NPN transistor of the NPN input stage allows the LT1490A/LT1491A to operate with either or both of their inputs above V^+. At about 0.3V above V^+ the NPN input transistor is fully saturated and the input bias current is typically 3µA at room temperature. The input offset voltage is typically 700µV when operating above V^+. The LT1490A/LT1491A will operate with their inputs 44V above V^- regardless of V^+.

The inputs are protected against excursions as much as 15V below V^- by an internal 1k resistor in series with each input and a diode from the input to the negative supply. There is no output phase reversal for inputs up to 15V below V^-. There are no clamping diodes between the inputs and the maximum differential input voltage is 44V.

Output

The output voltage swing of the LT1490A/LT1491A is affected by input overdrive as shown in the typical performance curves.

The output of the LT1490A/LT1491A can be pulled up to 18V beyond V^+ with less than 1nA of leakage current, provided that V^+ is less than 0.5V.

The normally reverse-biased substrate diode from the output to V^- will cause unlimited currents to flow when the output is forced below V^-. If the current is transient and limited to 100mA, no damage will occur.

The LT1490A/LT1491A are internally compensated to drive at least 200pF of capacitance under any output loading conditions. A 0.22µF capacitor in series with a 150Ω resistor between the output and ground will compensate these amplifiers for larger capacitive loads, up to 10,000pF, at all output currents.

Distortion

There are two main contributors of distortion in op amps: output crossover distortion as the output transitions from sourcing to sinking current and distortion caused by nonlinear common mode rejection. Of course, if the op amp is operating inverting there is no common mode induced distortion. When the LT1490A/LT1491A switch between input stages there is significant nonlinearity in the CMRR. Lower load resistance increases the output crossover distortion, but has no effect on the input stage transition distortion. For lowest distortion the LT1490A/LT1491A should be operated single supply, with the output always sourcing current and with the input voltage swing between ground and (V^+ – 0.8V). See the Typical Performance Characteristics curves.

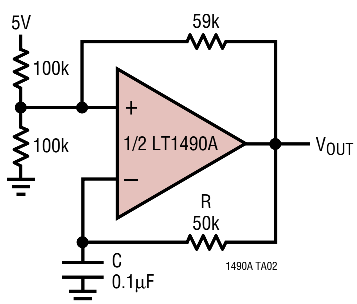
APPLICATIONS INFORMATION

Gain

The open-loop gain is almost independent of load when the output is sourcing current. This optimizes performance in single supply applications where the load is returned to ground. The typical performance photo of Open-Loop Gain for various loads shows the details.

TYPICAL APPLICATIONS

Square Wave Oscillator



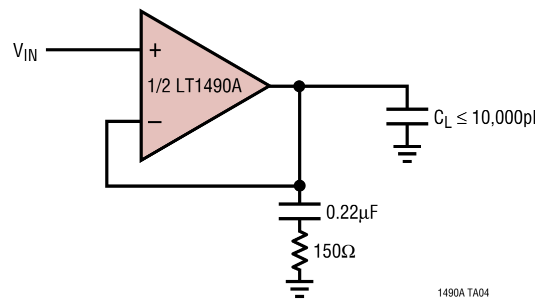
$f = \frac{1}{2RC}$

$V_{OUT} = 5V_{P-P}$ WITH 5V SUPPLY

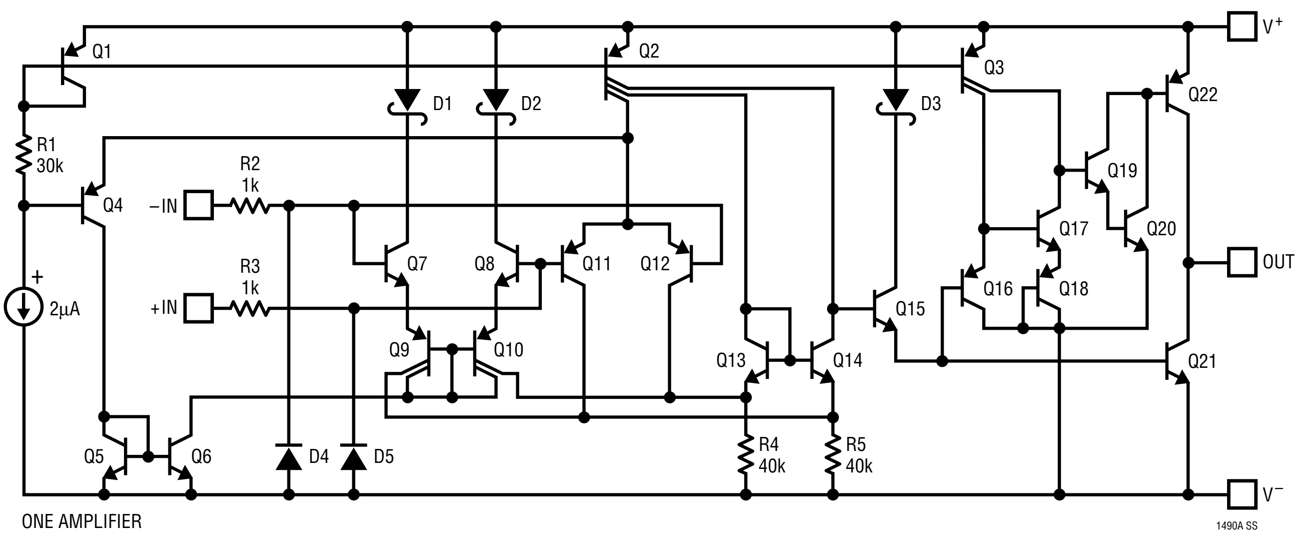
$I_S = 200\mu A$

AT $V_S = 5V$, R = 50k, C = 1nF
OUTPUT IS 5kHz SLEW LIMITED TRIANGLE WAVE

Optional Output Compensation for Capacitive Loads Greater Than 200pF



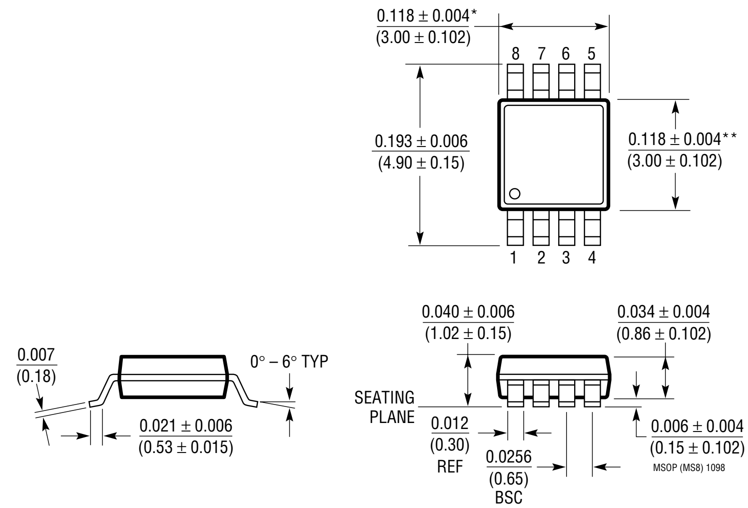
SIMPLIFIED SCHEMATIC



PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

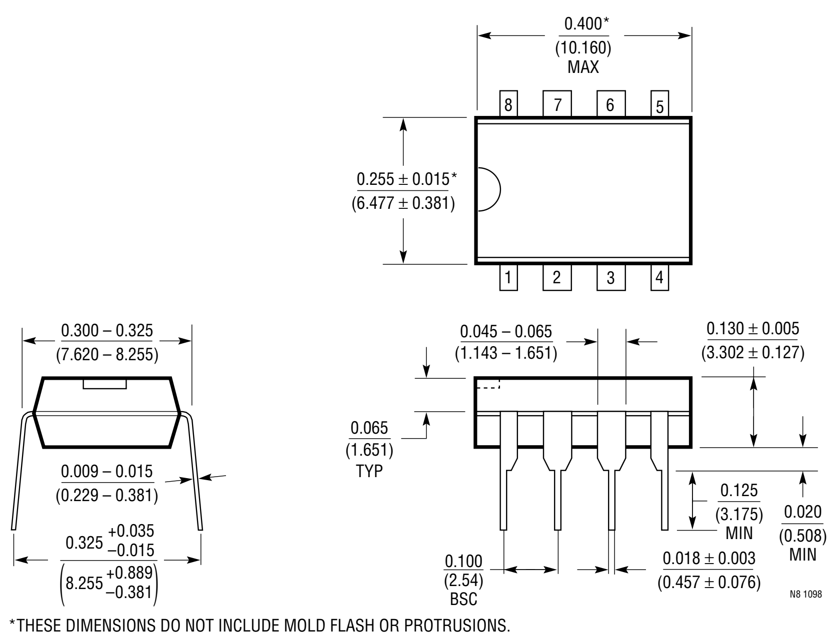
MS8 Package
8-Lead Plastic MSOP
(LTC DWG # 05-08-1660)



* DIMENSION DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

** DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS. INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

N8 Package
8-Lead PDIP (Narrow 0.300)
(LTC DWG # 05-08-1510)

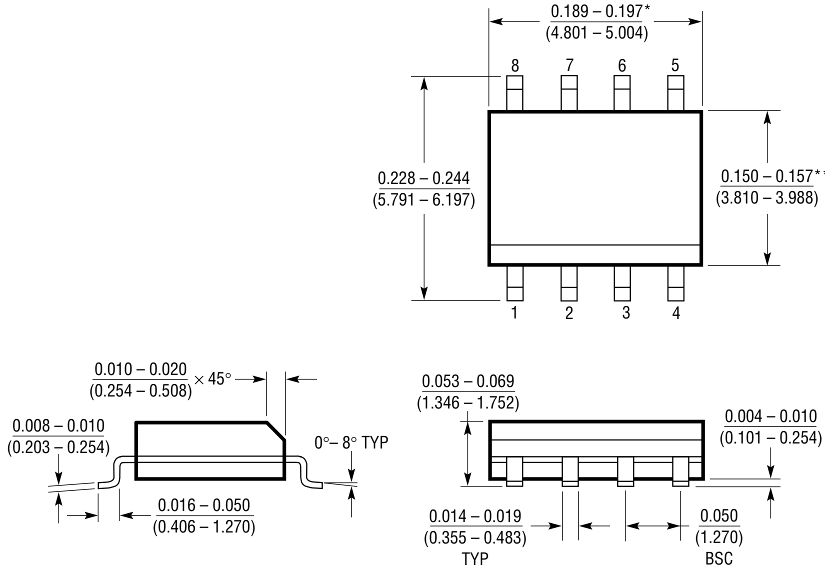


*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.010 INCH (0.254mm)

PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

S8 Package
8-Lead Plastic Small Outline (Narrow 0.150)
(LTC DWG # 05-08-1610)



*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

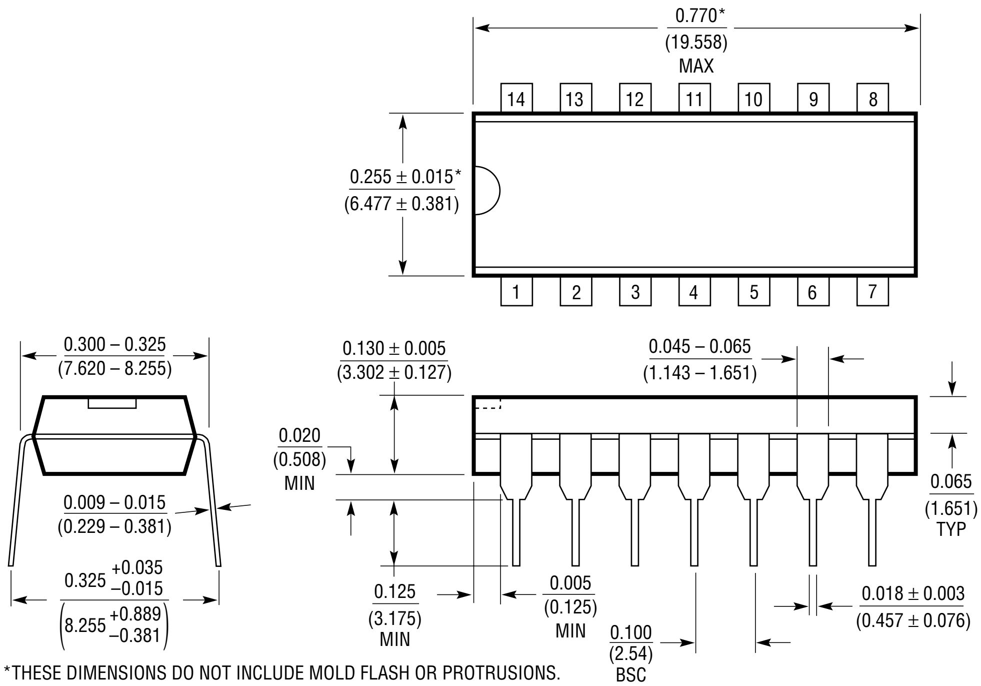
**DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

SO8 1298

PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

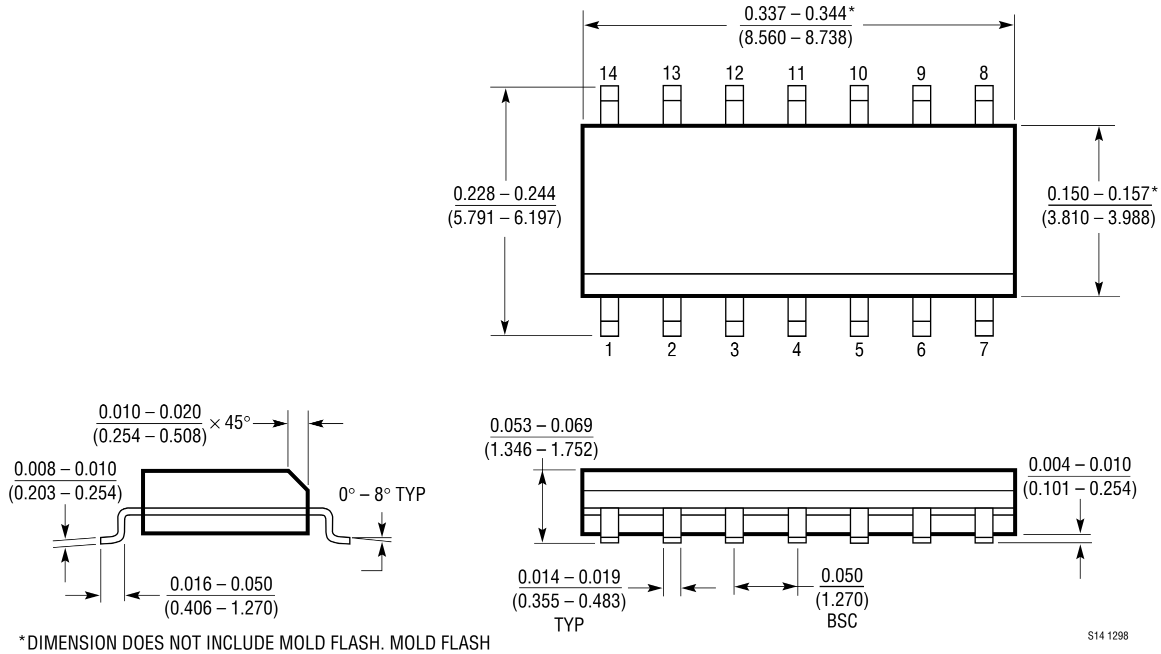
N Package
14-Lead PDIP (Narrow 0.300)
(LTC DWG # 05-08-1510)



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

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

S Package
14-Lead Plastic Small Outline (Narrow 0.150)
(LTC DWG # 05-08-1610)

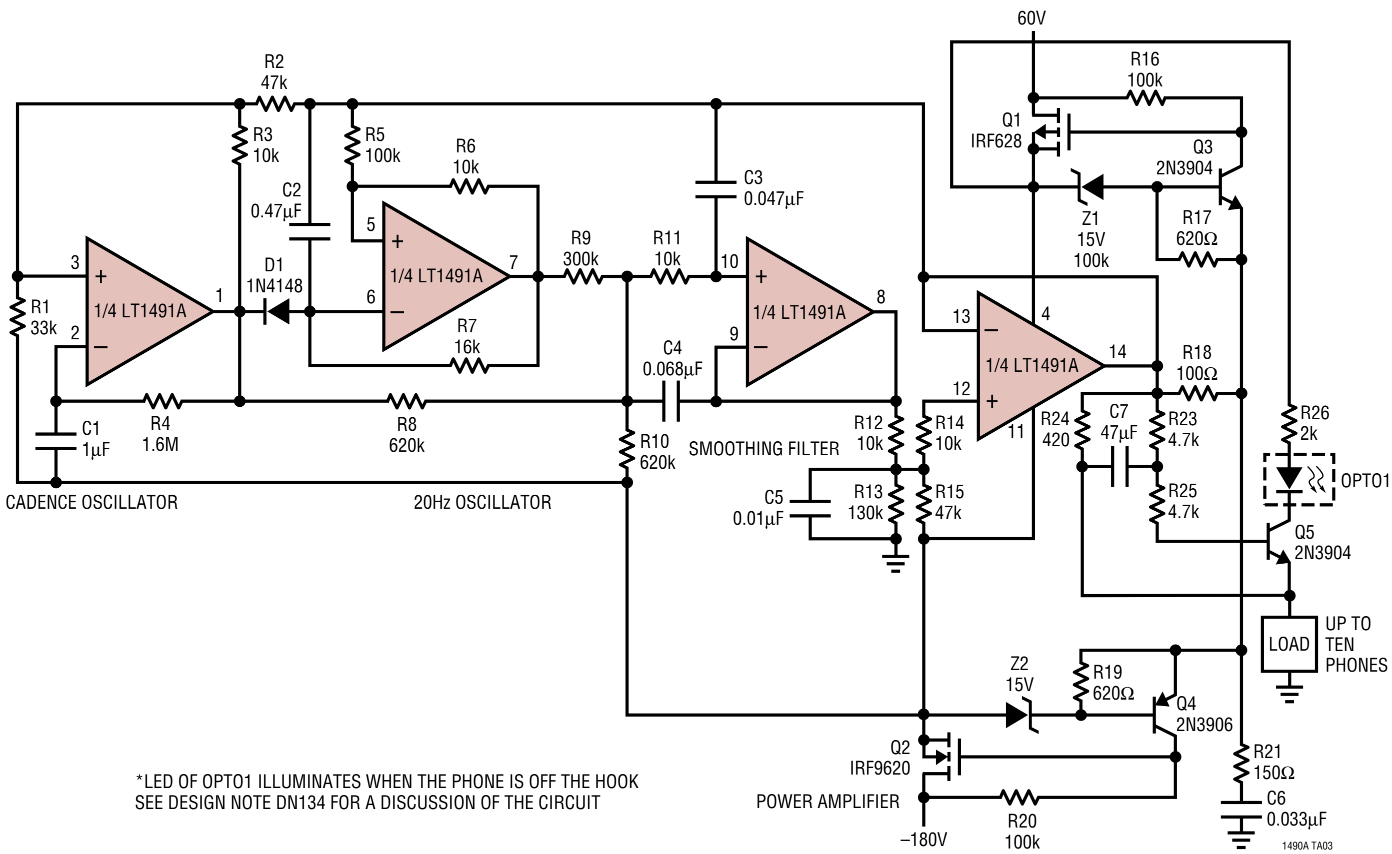


*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

**DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

TYPICAL APPLICATION

Ring-Tone Generator



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1366/LT1367	Dual/Quad Precision, Rail-to-Rail Input and Output Op Amps	475µV $V_{OS(MAX)}$, 500V/mV $A_{VOL(MIN)}$, 400kHz GBW
LT1636	Single Over-The-Top Micropower Rail-to-Rail Input and Output Op Amp	55µA Supply Current, V_{CM} Extends 44V above V_{EE}, Independent of V_{CC}, MSOP Package, Shutdown Function
LT1638/LT1639	Dual/Quad 1.2MHz Over-The-Top Micropower, Rail-to-Rail Input and Output Op Amps	0.4V/µs Slew Rate, 230µA Supply Current per Amplifier
LT1782	Micropower, Over-The-Top, SOT-23, Rail-to-Rail Input and Output Op Amp	SOT-23, 800µV $V_{OS(MAX)}$, I_S =55µA (Max), Gain-Bandwidth = 200kHz, Shutdown Pin
LT1783	1.2MHz, Over-The-Top, Micropower, Rail-to-Rail Input and Output Op Amp	SOT-23, 800µV $V_{OS(MAX)}$, I_S =300µA (Max), Gain-Bandwidth = 1.2MHz, Shutdown Pin

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