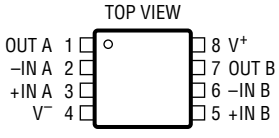
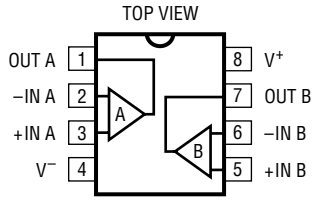


LT1490A

ABSOLUTE MAXIMUM RATINGS (Note 1)

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

PACKAGE/ORDER INFORMATION

 <p>TOP VIEW</p> <p>OUT A 1 8 V^+</p> <p>-IN A 2 7 OUT B</p> <p>+IN A 3 6 -IN B</p> <p>V^- 4 5 +IN B</p> <p>MS8 PACKAGE 8-LEAD PLASTIC MSOP</p> <p>$T_{JMAX} = 150^\circ\text{C}$, $\theta_{JA} = 250^\circ\text{C/W}$</p>	ORDER PART NUMBER	 <p>TOP VIEW</p> <p>OUT A 1 8 V^+</p> <p>-IN A 2 7 OUT B</p> <p>+IN A 3 6 -IN B</p> <p>V^- 4 5 +IN B</p> <p>N8 PACKAGE 8-LEAD PDIP</p> <p>S8 PACKAGE 8-LEAD PLASTIC SO</p> <p>$T_{JMAX} = 150^\circ\text{C}$, $\theta_{JA} = 130^\circ\text{C/W}$ (N8)</p> <p>$T_{JMAX} = 150^\circ\text{C}$, $\theta_{JA} = 190^\circ\text{C/W}$ (S8)</p>	ORDER PART NUMBER
	LT1490ACMS8		LT1490ACN8
	LT1490AIMS8		LT1490ACS8
			LT1490AIN8
MS8 PART MARKING		S8 PART MARKING	
LTNG			1490A
LTPU			1490AI

Consult factory for Military grade parts.

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25^\circ\text{C}$. $V_S = 3\text{V}$, 0V ; $V_S = 5\text{V}$, 0V unless otherwise noted. (Note 4)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage (Note 5)	N8, S8 Package $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	●	110	500	μV
			●		700	μV
		MS8 Package $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	●	220	1000	μV
			●		1200	μV
	Input Offset Voltage Drift (Note 9)	$-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	●	2	4	$\mu\text{V}/^\circ\text{C}$
I_{OS}	Input Offset Current	$V_{CM} = 44\text{V}$ (Note 6)	●	0.2	0.8	nA
			●		0.8	μA
I_B	Input Bias Current	$V_{CM} = 44\text{V}$ (Note 6) $V_S = 0\text{V}$	●	1	8	nA
			●	3	10	μA
			●	0.3		nA
	Input Noise Voltage	0.1Hz to 10Hz		1		μV_{p-p}
e_n	Input Noise Voltage Density	$f = 1\text{kHz}$		50		$\text{nV}/\sqrt{\text{Hz}}$
i_n	Input Noise Current Density	$f = 1\text{kHz}$		0.03		$\text{pA}/\sqrt{\text{Hz}}$
R_{IN}	Input Resistance	Differential Common Mode, $V_{CM} = 0\text{V}$ to 44V		6	17	$\text{M}\Omega$
				4	11	$\text{M}\Omega$

ELECTRICAL CHARACTERISTICS The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25^\circ\text{C}$. $V_S = 3\text{V}, 0\text{V}$; $V_S = 5\text{V}, 0\text{V}$ unless otherwise noted. (Note 4)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	
C_{IN}	Input Capacitance			4.6		pF	
	Input Voltage Range	●	0		44	V	
CMRR	Common Mode Rejection Ratio (Note 6)	$V_{CM} = 0\text{V to } V_{CC} - 1\text{V}$	●	84	98	dB	
		$V_{CM} = 0\text{V to } 44\text{V}$	●	80	98	dB	
A_{VOL}	Large-Signal Voltage Gain	$V_S = 3\text{V}, V_O = 500\text{mV to } 2.5\text{V}, R_L = 10\text{k}$ $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	●	200	1500	V/mV	
			●	133		V/mV	
		$V_S = 5\text{V}, V_O = 500\text{mV to } 4.5\text{V}, R_L = 10\text{k}$ $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	●	400	1500	V/mV	
			●	250		V/mV	
V_{OL}	Output Voltage Swing Low	$V_S = 3\text{V}, \text{No Load}$ $V_S = 3\text{V}, I_{SINK} = 5\text{mA}$	●		3	10	mV
			●		250	450	mV
		$V_S = 5\text{V}, \text{No Load}$ $V_S = 5\text{V}, I_{SINK} = 5\text{mA}$ $V_S = 5\text{V}, I_{SINK} = 10\text{mA}$	●		3	10	mV
			●		250	500	mV
V_{OH}	Output Voltage Swing High	$V_S = 3\text{V}, \text{No Load}$ $V_S = 3\text{V}, I_{SOURCE} = 5\text{mA}$	●	2.95	2.978	V	
			●	2.55	2.6	V	
		$V_S = 5\text{V}, \text{No Load}$ $V_S = 5\text{V}, I_{SOURCE} = 10\text{mA}$	●	4.95	4.978	V	
			●	4.30	4.6	V	
I_{SC}	Short-Circuit Current (Note 2)	$V_S = 3\text{V}, \text{Short to GND}$ $V_S = 3\text{V}, \text{Short to } V_{CC}$		10	15	mA	
				10	30	mA	
		$V_S = 5\text{V}, \text{Short to GND}$ $V_S = 5\text{V}, \text{Short to } V_{CC}$		15	25	mA	
				15	30	mA	
PSRR	Power Supply Rejection Ratio	$V_S = 2.5\text{V to } 12.5\text{V}, V_{CM} = V_O = 1\text{V}$	●	84	98	dB	
	Minimum Operating Supply Voltage		●	2	2.5	V	
	Reverse Supply Voltage	$I_S = -100\mu\text{A per Amplifier}$	●	18	27	V	
I_S	Supply Current per Amplifier (Note 7)		●	40	50	μA	
					55	μA	
GBW	Gain Bandwidth Product (Note 6)	$f = 1\text{kHz}$	●	110	180	kHz	
		$0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$	●	100		kHz	
		$-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	●	90		kHz	
SR	Slew Rate (Note 8)	$A_V = -1, R_L = \infty$	●	0.035	0.06	V/ μs	
		$0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$	●	0.031		V/ μs	
		$-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	●	0.030		V/ μs	

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25^\circ\text{C}$. $V_S = \pm 15\text{V}$ unless otherwise noted. (Note 4)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	
V_{OS}	Input Offset Voltage (Note 5)	N8, S8 Package $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	●		150	700	μV
			●			950	μV
		MS8 Package $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	●		250	1200	μV
			●			1350	1500

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25^\circ\text{C}$. $V_S = \pm 15\text{V}$ unless otherwise noted. (Note 4)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
	Input Offset Voltage Drift (Note 9)	$-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	●	2	6	$\mu\text{V}/^\circ\text{C}$
I_{OS}	Input Offset Current		●	0.2	0.8	nA
I_B	Input Bias Current		●	1	8	nA
	Input Noise Voltage	0.1Hz to 10Hz		1		μV_{P-P}
e_n	Input Noise Voltage Density	$f = 1\text{kHz}$		50		$\text{nV}/\sqrt{\text{Hz}}$
i_n	Input Noise Current Density	$f = 1\text{kHz}$		0.03		$\text{pA}/\sqrt{\text{Hz}}$
R_{IN}	Input Resistance	Differential Common Mode, $V_{CM} = -15\text{V}$ to 14V		6 17 15000		$\text{M}\Omega$ $\text{M}\Omega$
C_{IN}	Input Capacitance			4.6		pF
	Input Voltage Range		●	-15	29	V
CMRR	Common Mode Rejection Ratio	$V_{CM} = -15\text{V}$ to 29V	●	80	98	dB
A_{VOL}	Large-Signal Voltage Gain	$V_O = \pm 14\text{V}$, $R_L = 10\text{k}$ $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	● ● ●	100 75 50	250	V/mV V/mV V/mV
V_O	Output Voltage Swing	No Load $I_{OUT} = \pm 5\text{mA}$ $I_{OUT} = \pm 10\text{mA}$	● ● ●	± 14.9 ± 14.5 ± 14.5	± 14.978 ± 14.750 ± 14.670	V V V
I_{SC}	Short-Circuit Current (Note 2)	Short to GND $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	● ● ●	± 20 ± 15 ± 10	± 25	mA mA mA
PSRR	Power Supply Rejection Ratio	$V_S = \pm 1.25\text{V}$ to $\pm 22\text{V}$	●	88	98	dB
I_S	Supply Current per Amplifier		●	50	70 85	μA μA
GBW	Gain Bandwidth Product	$f = 1\text{kHz}$ $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	● ● ●	125 110 100	200	kHz kHz kHz
SR	Slew Rate	$A_V = -1$, $R_L = \infty$, $V_O = \pm 10\text{V}$, Measure at $V_O = \pm 5\text{V}$ $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$	● ●	0.0375 0.0330 0.0300	0.07	$\text{V}/\mu\text{s}$ $\text{V}/\mu\text{s}$ $\text{V}/\mu\text{s}$

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 and LT1490AI are guaranteed functional over the operating temperature range of -40°C to 85°C .

Note 4: The LT1490AC is guaranteed to meet specified performance from 0°C to 70°C . The LT1490AC is designed, characterized and expected to meet specified performance from -40°C to 85°C but is not tested or QA sampled at these temperatures. The LT1490I is guaranteed to meet specified performance from -40°C to 85°C .

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

Note 6: $V_S = 5\text{V}$ limits are guaranteed by correlation to $V_S = 3\text{V}$ and $V_S = \pm 15\text{V}$ tests.

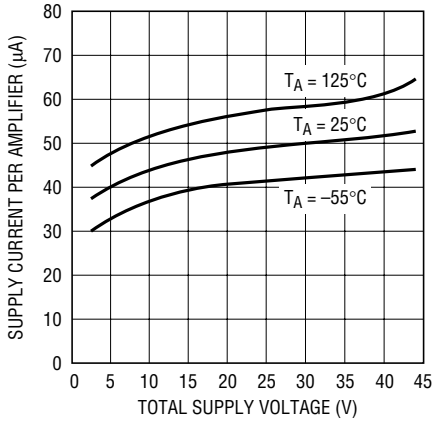
Note 7: $V_S = 3\text{V}$ limits are guaranteed by correlation to $V_S = 5\text{V}$ and $V_S = \pm 15\text{V}$ tests.

Note 8: Guaranteed by correlation to slew rate at $V_S = \pm 15\text{V}$ and GBW at $V_S = 3\text{V}$ and $V_S = \pm 15\text{V}$ tests.

Note 9: This parameter is not 100% tested.

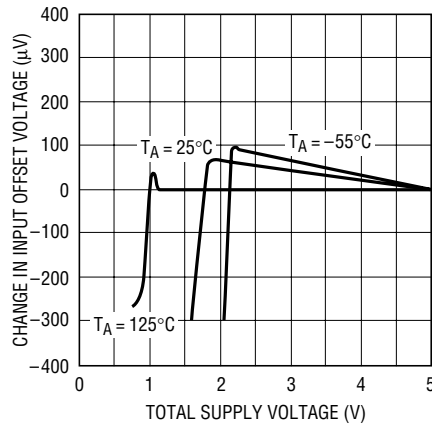
TYPICAL PERFORMANCE CHARACTERISTICS

Supply Current vs Supply Voltage



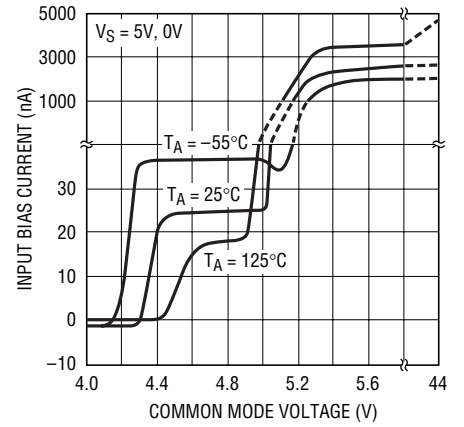
1490A G01

Minimum Supply Voltage



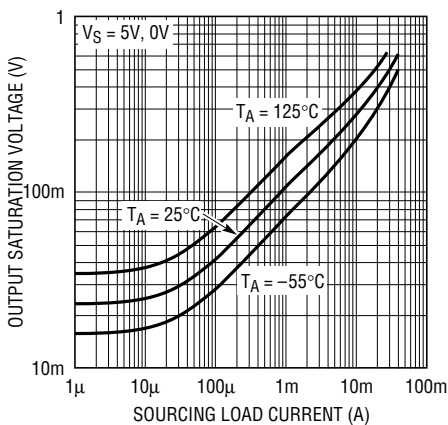
1490A G02

Input Bias Current vs Common Mode Voltage



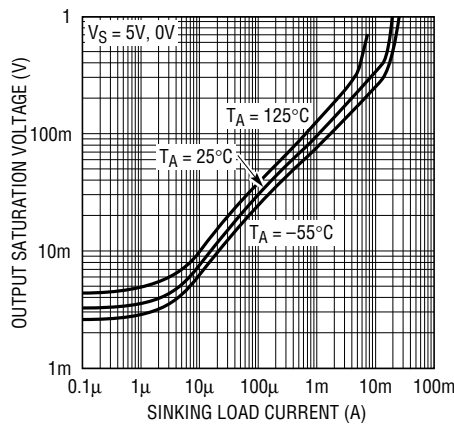
1490A G03

Output Saturation Voltage vs Load Current (Output High)



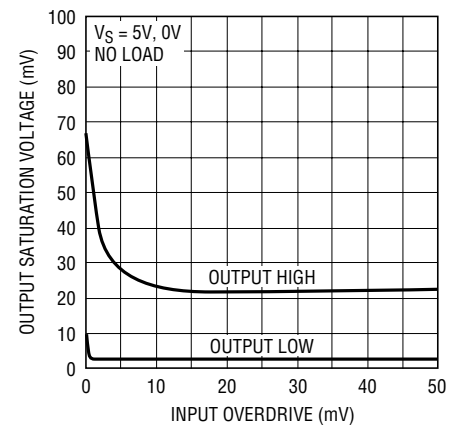
1490A G04

Output Saturation Voltage vs Load Current (Output Low)



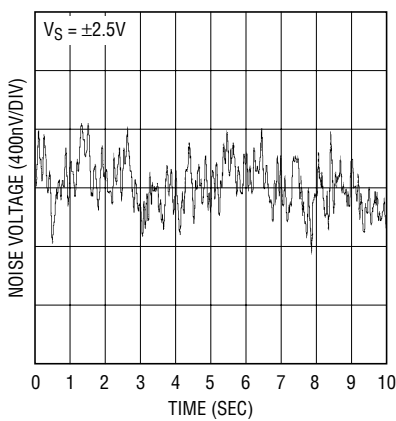
1490A G05

Output Saturation Voltage vs Input Overdrive



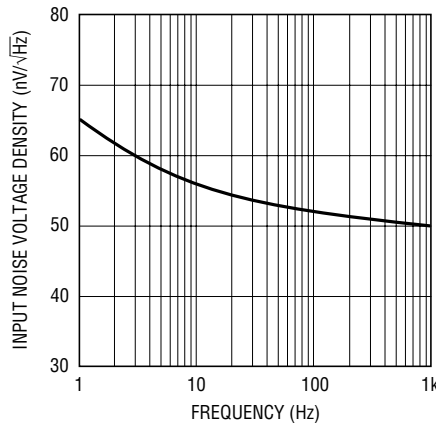
1490A G06

0.1Hz to 10Hz Noise Voltage



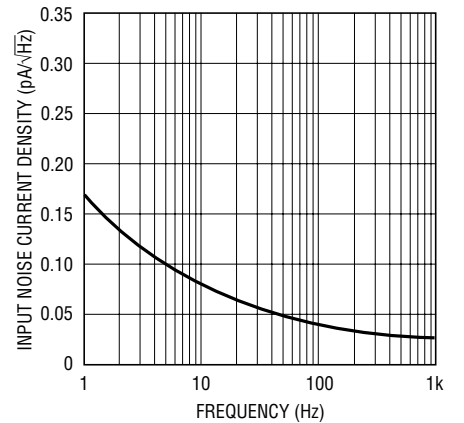
1490A G07

Noise Voltage Density vs Frequency



1490A G08

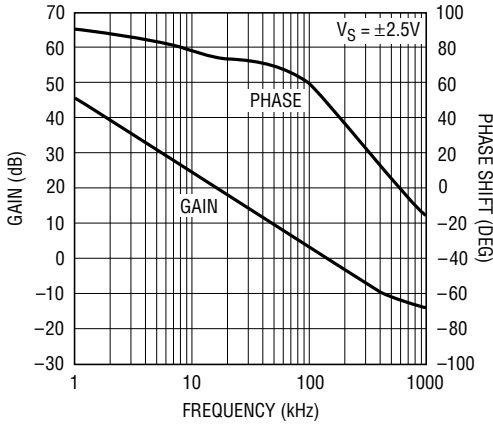
Input Noise Current vs Frequency



1490A G09

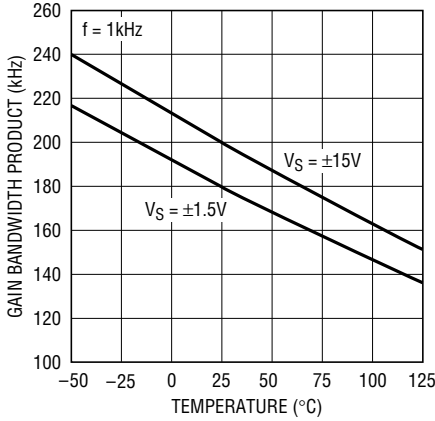
TYPICAL PERFORMANCE CHARACTERISTICS

Gain and Phase Shift vs Frequency



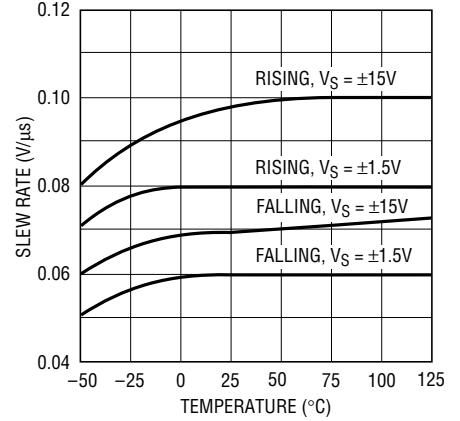
1490A G10

Gain Bandwidth Product vs Temperature



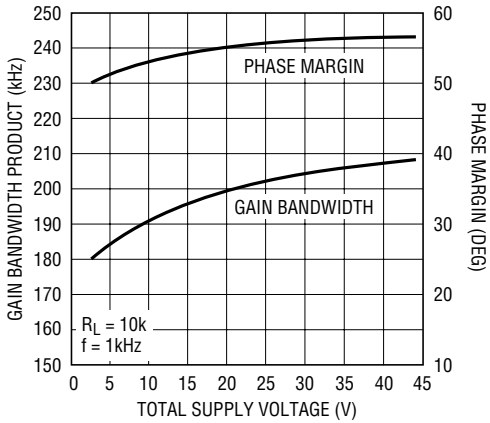
1490A G11

Slew Rate vs Temperature



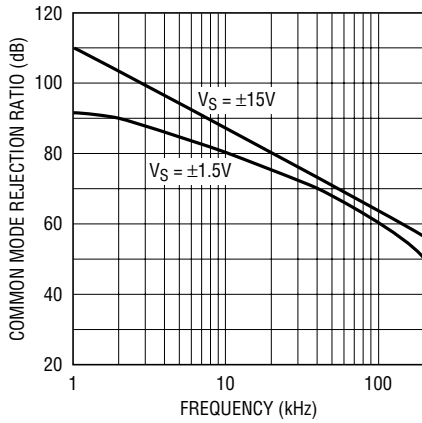
1490A G12

Gain Bandwidth Product and Phase Margin vs Supply Voltage



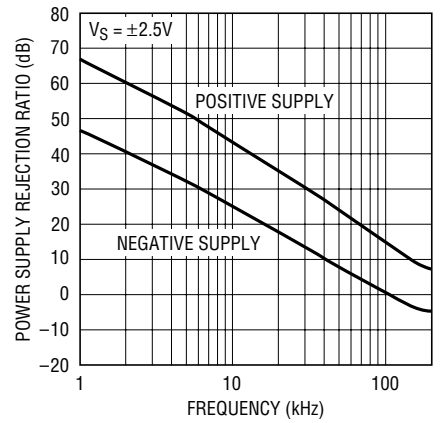
1490A G13

CMRR vs Frequency



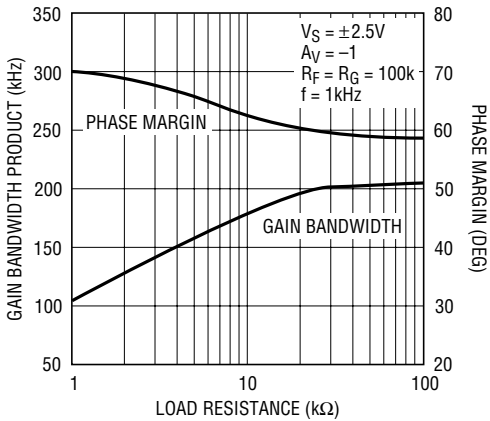
1490A G14

PSRR vs Frequency



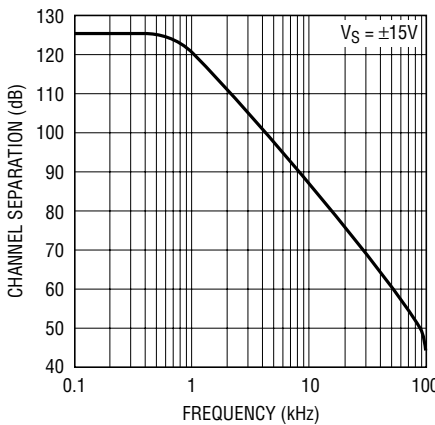
1490A G15

Gain Bandwidth Product and Phase Margin vs Load Resistance



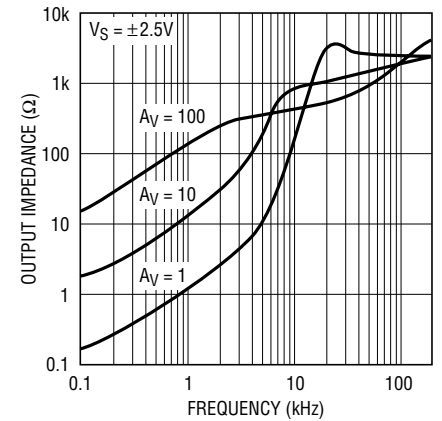
1490A G16

Channel Separation vs Frequency



1490A G17

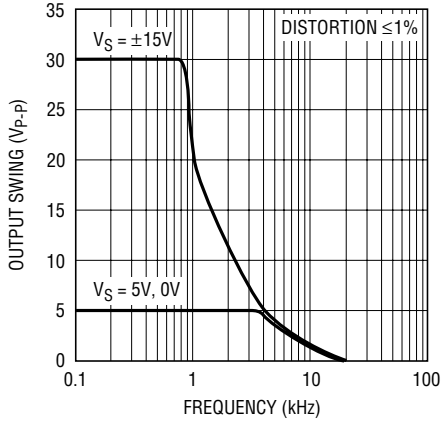
Output Impedance vs Frequency



1490A G18

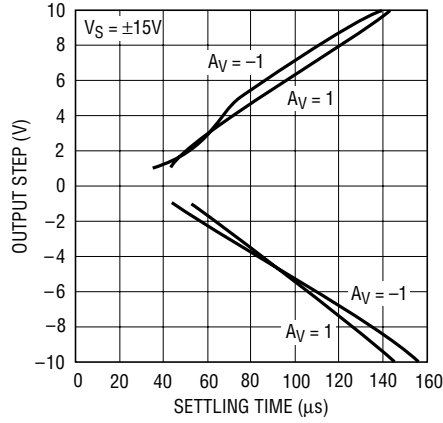
TYPICAL PERFORMANCE CHARACTERISTICS

Undistorted Output Swing vs Frequency



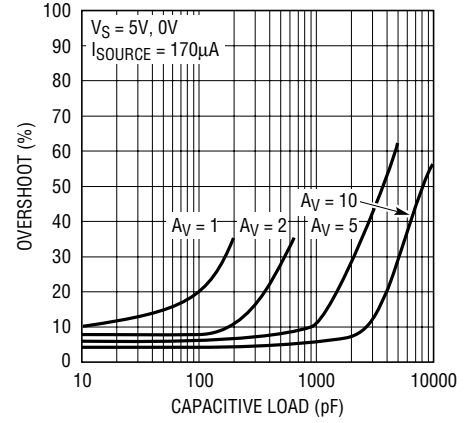
1490A G19

Settling Time to 0.1% vs Output Step



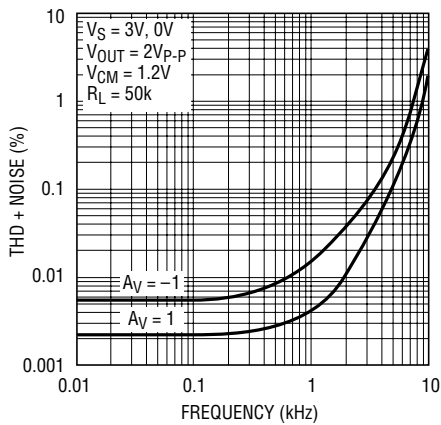
1490A F20

Capacitive Load Handling, Overshoot vs Capacitive Load



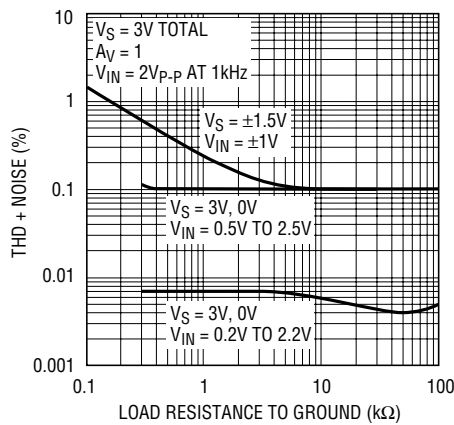
1490A G21

Total Harmonic Distortion + Noise vs Frequency



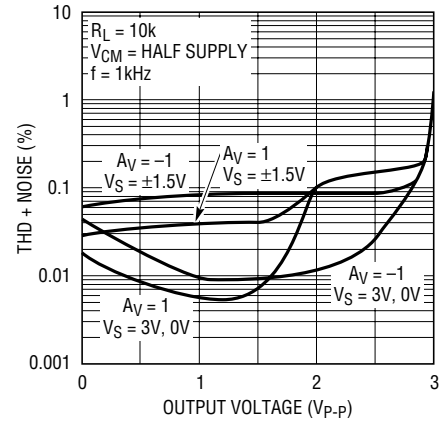
1490A G22

Total Harmonic Distortion + Noise vs Load Resistance



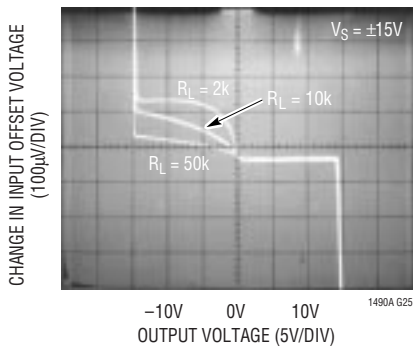
1490A G23

Total Harmonic Distortion + Noise vs Output Voltage



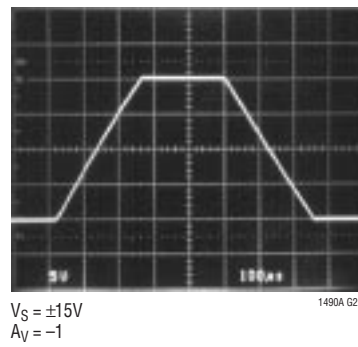
1490A G24

Open-Loop Gain



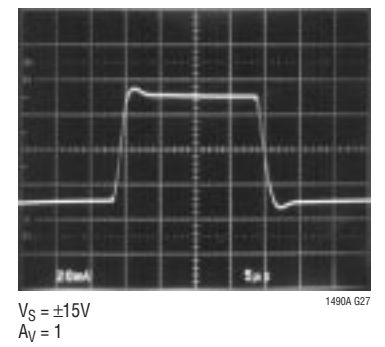
1490A G25

Large-Signal Response



1490A G26

Small-Signal Response



1490A G27

APPLICATIONS INFORMATION

Supply Voltage

The positive supply pin of the LT1490A should be bypassed with a small capacitor (about $0.01\mu\text{F}$) within an inch of the pin. When driving heavy loads an additional $4.7\mu\text{F}$ electrolytic capacitor should be used. When using split supplies, the same is true for the negative supply pin.

The LT1490A is 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 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 on total supplies of 20V or more, the supply must not rise to its final voltage in less than $1\mu\text{s}$. 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 has 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 $600\mu\text{V}$.

A Schottky diode in the collector of each NPN transistor of the NPN input stage allows the LT1490A to operate with either or both of its inputs above V^+ . At about 0.3V above V^+ the NPN input transistor is fully saturated and the input bias current is typically $3\mu\text{A}$ at room temperature. The input offset voltage is typically $700\mu\text{V}$ when operating above V^+ . The LT1490A will operate with its 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 is affected by input overdrive as shown in the typical performance curves.

The output of the LT1490A 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 is internally compensated to drive at least 200pF of capacitance under any output loading conditions. A $0.22\mu\text{F}$ 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 switches 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 should be operated single supply, with the output always sourcing current and with the input voltage swing between ground and $(V^+ - 0.8\text{V})$. See the Typical Performance Characteristics curves.

APPLICATIONS INFORMATION

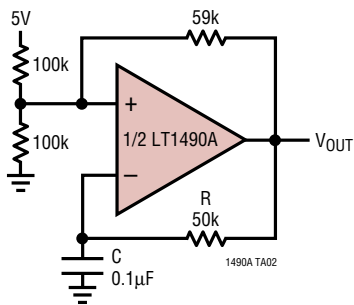
Gain

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



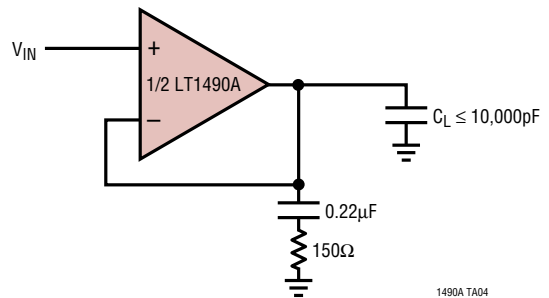
$$f = \frac{1}{2RC}$$

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

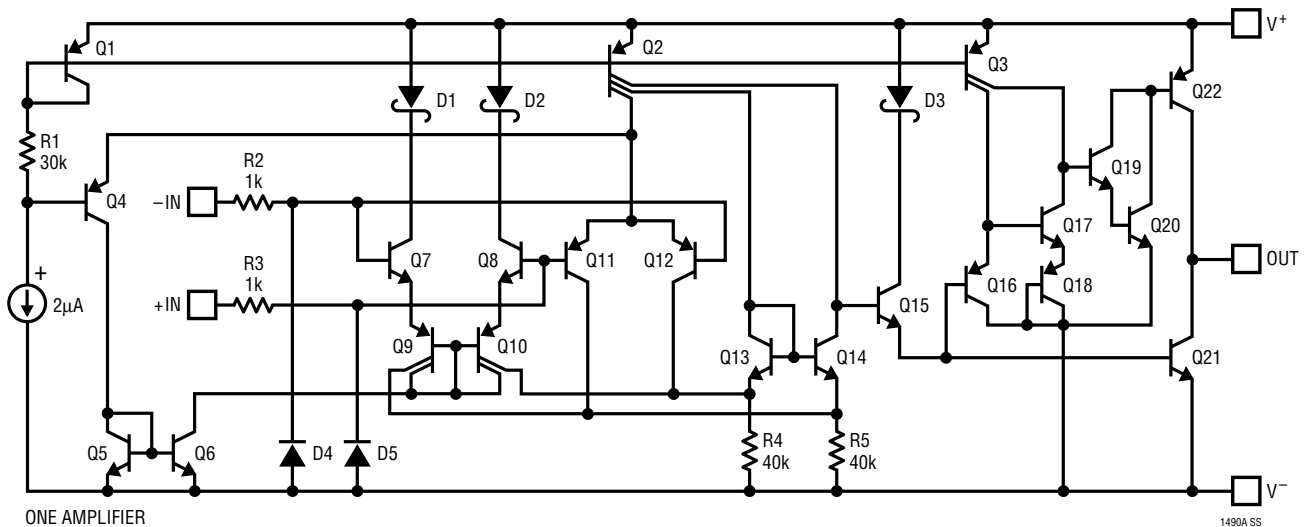
$I_S = 200\mu A$

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

Optional Output Compensation for Capacitive Loads Greater Than 200pF

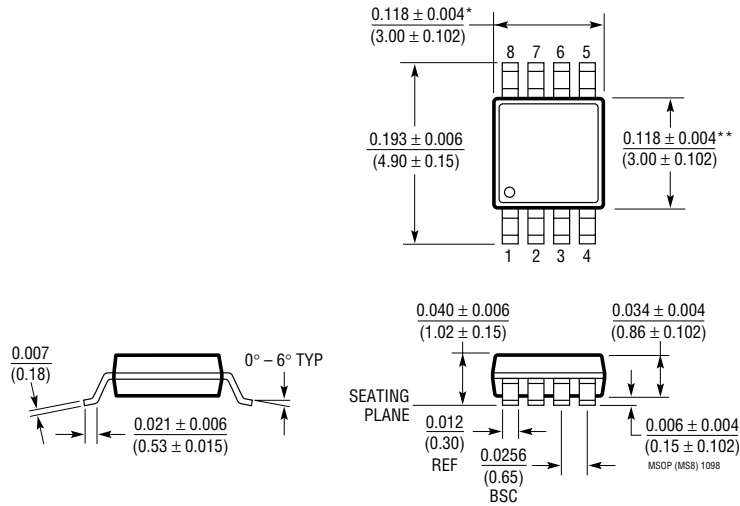


SIMPLIFIED SCHEMATIC



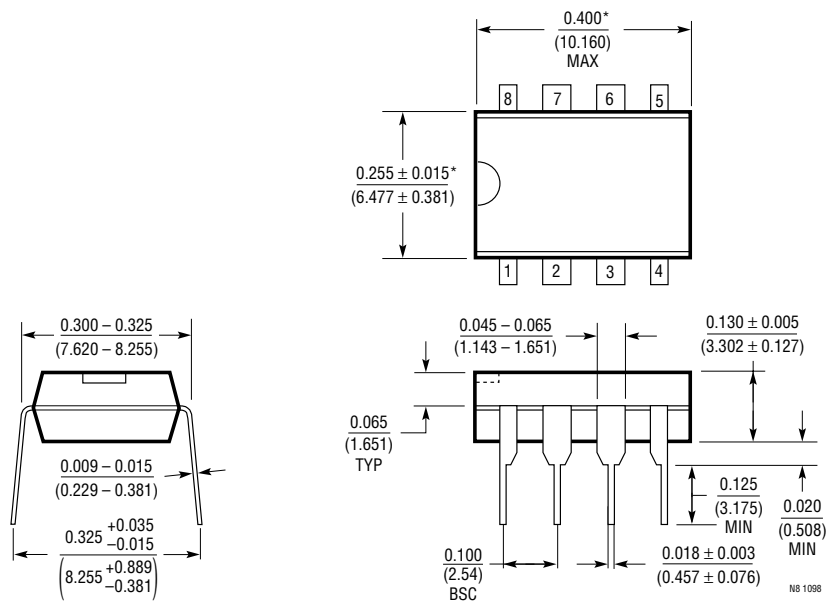
PACKAGE DESCRIPTION Dimensions in inches (millimeters) unless otherwise noted.

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

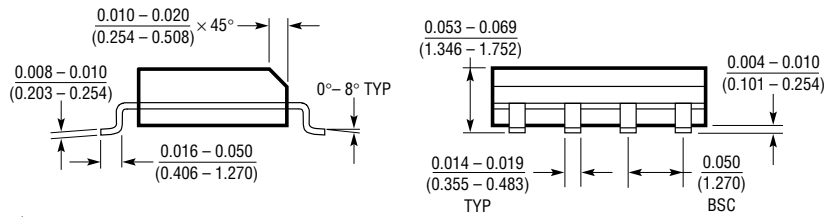
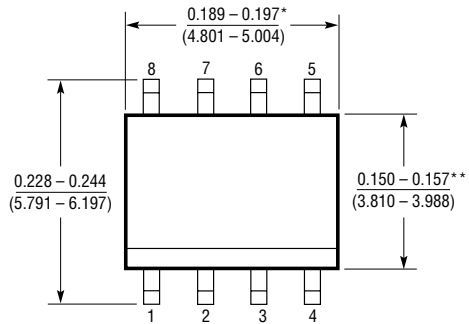
N8 Package
8-Lead PDIP (Narrow 0.300)
 (LTC DWG # 05-08-1510)



* 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)

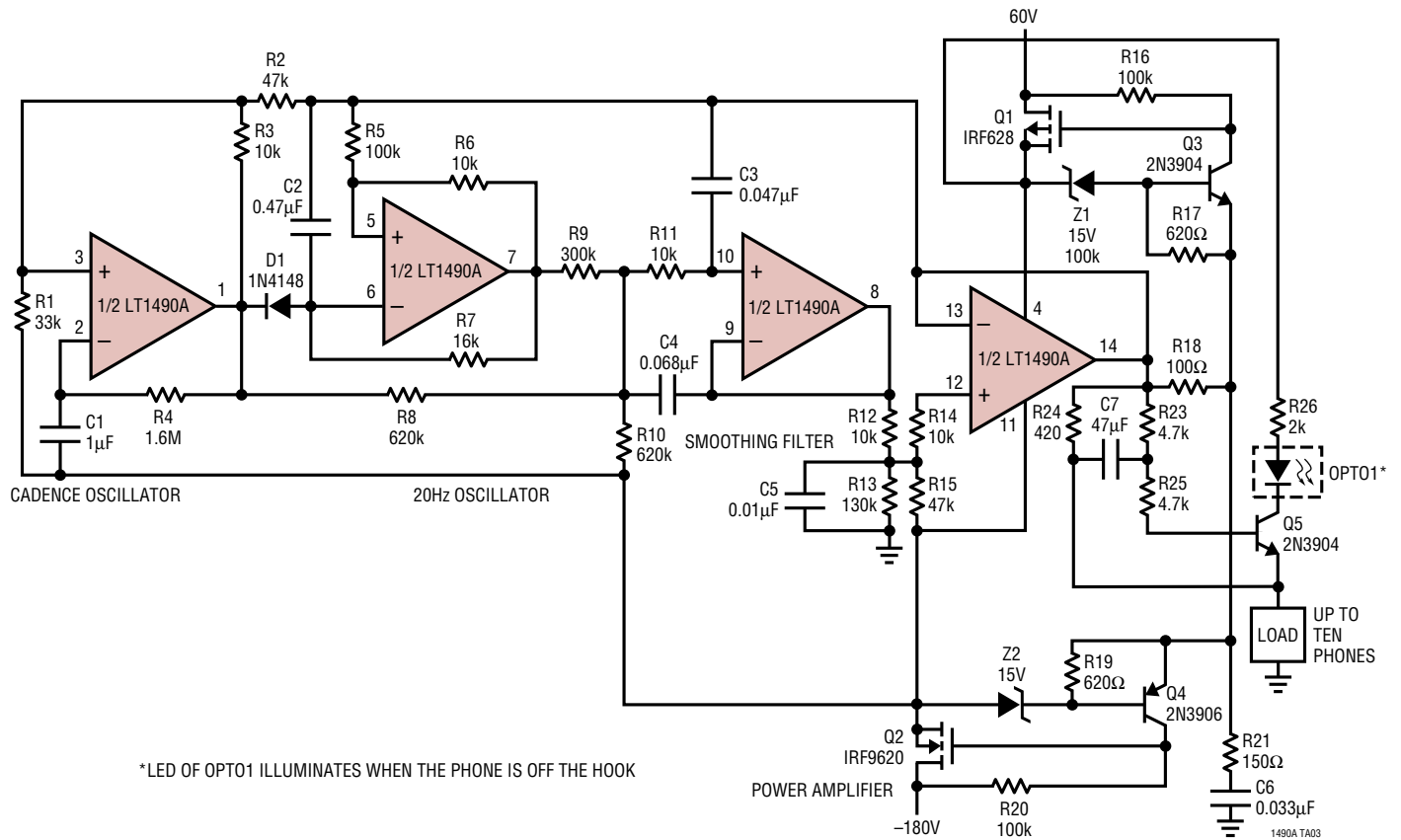


* DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE
 ** DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

S08 1298

TYPICAL APPLICATION

Ring-Tone Generator



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1078/LT1079 LT2078/LT2079	Dual/Quad 55μA Max, Single Supply, Precision Op Amps	Input/Output Common Mode Includes Ground, 70μV V _{OS(MAX)} and 2.5μV/°C Drift (Max), 200kHz GBW, 0.07V/μs Slew Rate
LT1178/LT1179 LT2178/LT2179	Dual/Quad 17μA Max, Single Supply, Precision Op Amps	Input/Output Common Mode Includes Ground, 70μV V _{OS(MAX)} and 4μV/°C Drift (Max), 85kHz GBW, 0.04V/μs Slew Rate
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