

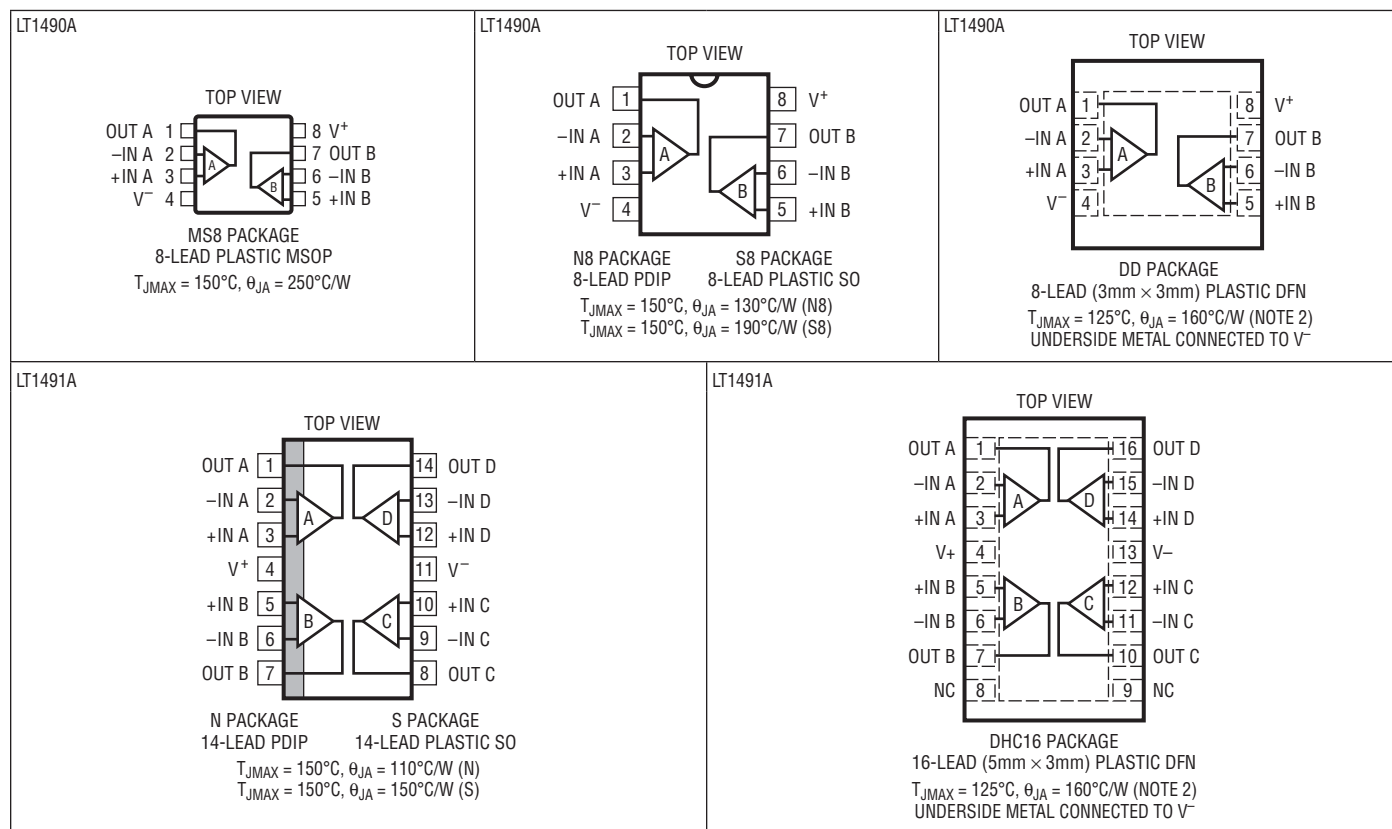
# LT1490A/LT1491A

## ABSOLUTE MAXIMUM RATINGS (Note 1)

Total Supply Voltage ( $V_+$  to  $V_-$ ) ..... 44V  
 Differential Input Voltage ..... 44V  
 Input Current (Note 9) .....  $\pm 12\text{mA}$   
 Output Short-Circuit Duration (Note 2) ..... Continuous  
 Operating Temperature Range (Note 3)  
     LT1490AC/LT1491AC .....  $-40^\circ\text{C}$  to  $85^\circ\text{C}$   
     LT1490AI/LT1491AI .....  $-40^\circ\text{C}$  to  $85^\circ\text{C}$   
     LT1490AH/LT1491AH .....  $-40^\circ\text{C}$  to  $125^\circ\text{C}$

Specified Temperature Range (Note 4)  
     LT1490AC/LT1490AI .....  $-40^\circ\text{C}$  to  $85^\circ\text{C}$   
     LT1491AC/LT1491AI .....  $-40^\circ\text{C}$  to  $85^\circ\text{C}$   
     LT1490AH/LT1491AH .....  $-40^\circ\text{C}$  to  $125^\circ\text{C}$   
 Junction Temperature .....  $150^\circ\text{C}$   
 Junction Temperature (DD/DHC Package) .....  $125^\circ\text{C}$   
 Storage Temperature Range .....  $-65^\circ\text{C}$  to  $150^\circ\text{C}$   
 Storage Temperature Range  
     DD/DHC Package .....  $-65^\circ\text{C}$  to  $125^\circ\text{C}$   
 Lead Temperature (Soldering, 10 sec) .....  $300^\circ\text{C}$

## PIN CONFIGURATION



## ORDER INFORMATION

LEAD FREE FINISH	TAPE AND REEL	PART MARKING*	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE
LT1490ACMS8#PBF	LT1490ACMS8#TRPBF	LTNG	8-Lead Plastic MSOP	0°C to 70°C
LT1490AIMS8#PBF	LT1490AIMS8#TRPBF	LTPU	8-Lead Plastic MSOP	-40°C to 85°C
LT1490AHMS8#PBF	LT1490AHMS8#TRPBF	LTRK	8-Lead Plastic MSOP	-40°C to 125°C
LT1490ACS8#PBF	LT1490ACS8#TRPBF	1490A	8-Lead Plastic SO	0°C to 70°C
LT1490AIS8#PBF	LT1490AIS8#TRPBF	1490AI	8-Lead Plastic SO	-40°C to 85°C
LT1490AHS8#PBF	LT1490AHS8#TRPBF	1490AH	8-Lead Plastic SO	-40°C to 125°C
LT1490ACN8#PBF	LT1490ACN8#TRPBF	LT1490ACN8	8-Lead PDIP	0°C to 70°C
LT1490AIN8#PBF	LT1490AIN8#TRPBF	LT1490AIN8	8-Lead PDIP	-40°C to 85°C
LT1490ACDD#PBF	LT1490ACDD#TRPBF	LA AH	8-Lead (3mm × 3mm) Plastic DFN	0°C to 70°C
LT1490AIDD#PBF	LT1490AIDD#TRPBF	LA AH	8-Lead (3mm × 3mm) Plastic DFN	-40°C to 85°C
LT1491ACS#PBF	LT1491ACS#TRPBF	LT1491ACS	14-Lead Plastic SO	0°C to 70°C
LT1491AIS#PBF	LT1491AIS#TRPBF	LT1491AIS	14-Lead Plastic SO	-40°C to 85°C
LT1491AHS#PBF	LT1491AHS#TRPBF	LT1491AHS	14-Lead Plastic SO	-40°C to 125°C
LT1491ACN#PBF	LT1491ACN#TRPBF	LT1491ACN	14-Lead PDIP	0°C to 70°C
LT1491AIN#PBF	LT1491AIN#TRPBF	LT1491AIN	14-Lead PDIP	-40°C to 85°C
LT1491ACDHC#PBF	LT1491ACDHC#TRPBF	1491A	16-Lead (5mm × 3mm) Plastic DFN	0°C to 70°C
LT1491AIDHC#PBF	LT1491AIDHC#TRPBF	1491A	16-Lead (5mm × 3mm) Plastic DFN	-40°C to 85°C

Consult LTC Marketing for parts specified with wider operating temperature ranges. \*The temperature grade is identified by a label on the shipping container. Consult LTC Marketing for information on non-standard lead based finish parts.

For more information on lead free part marking, go to: <http://www.linear.com/leadfree/>

For more information on tape and reel specifications, go to: <http://www.linear.com/tapeandreel/>

# LT1490A/LT1491A

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

SYMBOL	PARAMETER	CONDITIONS	LT1490AC/LT1491AC LT1490AI/LT1491AI			UNITS	
			MIN	TYP	MAX		
V <sub>OS</sub>	Input Offset Voltage (Note 5)	LT1490A N, S Packages 0°C ≤ T <sub>A</sub> ≤ 70°C −40°C ≤ T <sub>A</sub> ≤ 85°C	● ●	110	500 700 800	μV μV μV	
		LT1490A MS8 Package, LT1491A N, S Packages 0°C ≤ T <sub>A</sub> ≤ 70°C −40°C ≤ T <sub>A</sub> ≤ 85°C	● ●	220	1000 1200 1400	μV μV μV	
		LT1490A DD, LT1491A DHC 0°C ≤ T <sub>A</sub> ≤ 70°C −40°C ≤ T <sub>A</sub> ≤ 85°C	● ●	250	1200 1400 1600	μV μV μV	
	Input Offset Voltage Drift (Note 9)	−40°C ≤ T <sub>A</sub> ≤ 85°C LT1490A DD, LT1491A DHC, −40°C ≤ T <sub>A</sub> ≤ 85°C	● ●	2 2	4 6	μV/°C μV/°C	
I <sub>OS</sub>	Input Offset Current	V <sub>CM</sub> = 44V (Note 6)	● ●	0.2	0.8 0.8	nA μA	
I <sub>B</sub>	Input Bias Current	V <sub>CM</sub> = 44V (Note 6) V <sub>S</sub> = 0V	● ●	1 3 0.3	8 10	nA μA nA	
	Input Bias Current Drift	−40°C ≤ T <sub>A</sub> ≤ 85°C	●	2		pA/°C	
	Input Noise Voltage	0.1Hz to 10Hz		1		μV <sub>P-P</sub>	
e <sub>n</sub>	Input Noise Voltage Density	f = 1kHz		50		nV/√Hz	
i <sub>n</sub>	Input Noise Current Density	f = 1kHz		0.015		pA/√Hz	
R <sub>IN</sub>	Input Resistance	Differential Common Mode, V <sub>CM</sub> = 0V to 44V		6 4	17 11	MΩ MΩ	
C <sub>IN</sub>	Input Capacitance			4.6		pF	
	Input Voltage Range		●	0	44	V	
CMRR	Common Mode Rejection Ratio (Note 6)	V <sub>CM</sub> = 0V to V <sub>CC</sub> − 1V V <sub>CM</sub> = 0V to 44V	● ●	84 80	98 98	dB dB	
A <sub>VOL</sub>	Large-Signal Voltage Gain	V <sub>S</sub> = 3V, V <sub>O</sub> = 500mV to 2.5V, R <sub>L</sub> = 10k 0°C ≤ T <sub>A</sub> ≤ 70°C −40°C ≤ T <sub>A</sub> ≤ 85°C	● ●	200 133 100	1500	V/mV V/mV V/mV	
		V <sub>S</sub> = 5V, V <sub>O</sub> = 500mV to 4.5V, R <sub>L</sub> = 10k 0°C ≤ T <sub>A</sub> ≤ 70°C −40°C ≤ T <sub>A</sub> ≤ 85°C	● ●	400 250 200	1500	V/mV V/mV V/mV	
V <sub>OL</sub>	Output Voltage Swing Low	V <sub>S</sub> = 3V, No Load V <sub>S</sub> = 3V, I <sub>SINK</sub> = 5mA	● ●	3 250	10 450	mV mV	
		V <sub>S</sub> = 5V, No Load V <sub>S</sub> = 5V, I <sub>SINK</sub> = 5mA V <sub>S</sub> = 5V, I <sub>SINK</sub> = 10mA	● ●	3 250 330	10 500 500	mV mV mV	
V <sub>OH</sub>	Output Voltage Swing High	V <sub>S</sub> = 3V, No Load V <sub>S</sub> = 3V, I <sub>SOURCE</sub> = 5mA	● ●	2.95 2.55	2.978 2.6	V V	
		V <sub>S</sub> = 5V, No Load V <sub>S</sub> = 5V, I <sub>SOURCE</sub> = 10mA	● ●	4.95 4.30	4.978 4.6	V V	
I <sub>SC</sub>	Short-Circuit Current (Note 2)	V <sub>S</sub> = 3V, Short to GND V <sub>S</sub> = 3V, Short to V <sub>CC</sub>		10 10	15 30	mA mA	
		V <sub>S</sub> = 5V, Short to GND V <sub>S</sub> = 5V, Short to V <sub>CC</sub>		15 15	25 30	mA mA	

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

SYMBOL	PARAMETER	CONDITIONS		LT1490AC/LT1491AC LT1490AI/LT1491AI			UNITS
				MIN	TYP	MAX	
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 55	$\mu\text{A}$ $\mu\text{A}$
GBW	Gain Bandwidth Product (Note 6)	$f = 1\text{kHz}$ $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$ $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$	● ● ●	110 100 90	180		kHz kHz kHz
SR	Slew Rate (Note 8)	$A_V = -1$ , $R_L = \infty$ $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$ $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$	● ● ●	0.035 0.031 0.030	0.06		V/ $\mu\text{s}$ V/ $\mu\text{s}$ V/ $\mu\text{s}$

The ● denotes specifications which apply over the full operating temperature range of  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , otherwise specifications are at  $T_A = 25^{\circ}\text{C}$ .  $V_S = \pm 15\text{V}$ ,  $V_{CM} = 0\text{V}$ ,  $V_{OUT} = 0\text{V}$  unless otherwise noted. (Note 4)

SYMBOL	PARAMETER	CONDITIONS		LT1490AC/LT1491AC LT1490AI/LT1491AI			UNITS
				MIN	TYP	MAX	
$V_{OS}$	Input Offset Voltage (Note 5)	LT1490A N, S Packages $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$ $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$	● ●		150	700 950 1100	$\mu\text{V}$ $\mu\text{V}$ $\mu\text{V}$
		LT1490A MS8 Package, LT1491A N, S Packages $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$ $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$	● ●		250	1200 1350 1500	$\mu\text{V}$ $\mu\text{V}$ $\mu\text{V}$
		LT1490A DD, LT1491A DHC $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$ $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$	● ●		285	1400 1550 1700	$\mu\text{V}$ $\mu\text{V}$ $\mu\text{V}$
	Input Offset Voltage Drift (Note 9)	$-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$	●		2	6	$\mu\text{V}/^{\circ}\text{C}$
		LT1490A DD, LT1491A DHC, $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$	●		2	7	$\mu\text{V}/^{\circ}\text{C}$
$I_{OS}$	Input Offset Current		●		0.2	0.8	nA
$I_B$	Input Bias Current		●		1	8	nA
	Input Bias Current Drift	$-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$	●		5		pA/ $^{\circ}\text{C}$
	Input Noise Voltage	0.1Hz to 10Hz			1		$\mu\text{V}_{P-P}$
$e_n$	Input Noise Voltage Density	$f = 1\text{kHz}$			50		nV/ $\sqrt{\text{Hz}}$
$i_n$	Input Noise Current Density	$f = 1\text{kHz}$			0.015		pA/ $\sqrt{\text{Hz}}$
$R_{IN}$	Input Resistance	Differential Common Mode, $V_{CM} = -15\text{V to } 14\text{V}$		6	17 15000		M $\Omega$ M $\Omega$
$C_{IN}$	Input Capacitance				4.6		pF
	Input Voltage Range		●	-15		29	V
CMRR	Common Mode Rejection Ratio	$V_{CM} = -15\text{V to } 29\text{V}$	●	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	●	$\pm 14.9$	$\pm 14.978$		V
		$I_{OUT} = \pm 5\text{mA}$	●	$\pm 14.5$	$\pm 14.750$		V
		$I_{OUT} = \pm 10\text{mA}$	●	$\pm 14.5$	$\pm 14.670$		V

# LT1490A/LT1491A

**ELECTRICAL CHARACTERISTICS** The ● denotes specifications which apply over the full operating temperature range of  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , otherwise specifications are at  $T_A = 25^{\circ}\text{C}$ .  $V_S = \pm 15\text{V}$ ,  $V_{\text{CM}} = 0\text{V}$ ,  $V_{\text{OUT}} = 0\text{V}$  unless otherwise noted. (Note 4)

SYMBOL	PARAMETER	CONDITIONS	LT1490AC/LT1491AC LT1490AI/LT1491AI			UNITS
			MIN	TYP	MAX	
$I_{\text{SC}}$	Short-Circuit Current (Note 2)	Short to GND $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$ $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$	$\pm 20$ $\pm 15$ $\pm 10$	$\pm 25$		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	$\mu\text{A}$ $\mu\text{A}$
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	$A_V = -1$ , $R_L = \infty$ , $V_O = \pm 10\text{V}$ , Measured 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		$\text{V}/\mu\text{s}$ $\text{V}/\mu\text{s}$ $\text{V}/\mu\text{s}$

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

SYMBOL	PARAMETER	CONDITIONS	LT1490AH/LT1491AH			UNITS
			MIN	TYP	MAX	
$V_{\text{OS}}$	Input Offset Voltage (Note 5)	LT1490AHS8	●	110	500 2500	$\mu\text{V}$ $\mu\text{V}$
		LT1490AHMS8, LT1491AHS	●	220	1000 3000	$\mu\text{V}$ $\mu\text{V}$
	Input Offset Voltage Drift (Note 9)		●	3	6	$\mu\text{V}/^{\circ}\text{C}$
$I_{\text{OS}}$	Input Offset Current	$V_{\text{CM}} = 44\text{V}$ (Note 6)	● ●		2 1.5	nA $\mu\text{A}$
		$V_{\text{CM}} = 44\text{V}$ (Note 6)	● ●		20 15	nA $\mu\text{A}$
	Input Voltage Range		●	0.3	44	V
CMRR	Common Mode Rejection Ratio (Note 6)	$V_{\text{CM}} = 0.3\text{V}$ to $V_{\text{CC}} - 1\text{V}$	●	60		dB
		$V_{\text{CM}} = 0.3\text{V}$ to $44\text{V}$	●	74		dB
$A_{\text{VOL}}$	Large-Signal Voltage Gain	$V_S = 3\text{V}$ , $V_O = 500\text{mV}$ to $2.5\text{V}$ , $R_L = 10\text{k}$	●	200 25	1500	$\text{V}/\text{mV}$ $\text{V}/\text{mV}$
		$V_S = 5\text{V}$ , $V_O = 500\text{mV}$ to $4.5\text{V}$ , $R_L = 10\text{k}$	●	400 50	1500	$\text{V}/\text{mV}$ $\text{V}/\text{mV}$
$V_{\text{OL}}$	Output Voltage Swing Low	$V_S = 3\text{V}$ , No Load	●		15	mV
		$V_S = 3\text{V}$ , $I_{\text{SINK}} = 2.5\text{mA}$	●		450	mV
		$V_S = 5\text{V}$ , No Load	●		15	mV
		$V_S = 5\text{V}$ , $I_{\text{SINK}} = 2.5\text{mA}$	●		500	mV
$V_{\text{OH}}$	Output Voltage Swing High	$V_S = 3\text{V}$ , No Load	●	2.925		V
		$V_S = 3\text{V}$ , $I_{\text{SOURCE}} = 5\text{mA}$	●	2.350		V
		$V_S = 5\text{V}$ , No Load	●	4.925		V
		$V_S = 5\text{V}$ , $I_{\text{SOURCE}} = 10\text{mA}$	●	4.100		V
PSRR	Power Supply Rejection Ratio	$V_S = 2.5\text{V}$ to $12.5\text{V}$ , $V_{\text{CM}} = V_O = 1\text{V}$	●	80		dB
	Minimum Operating Supply Voltage		●		2.5	V
	Reverse Supply Voltage	$I_S = -100\mu\text{A}$ per Amplifier	●	18		V

# ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range of  $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$ .  $V_S = \pm 15\text{V}$ ,  $V_{CM} = 0\text{V}$ ,  $V_{OUT} = 0\text{V}$  unless otherwise noted. (Note 4)

SYMBOL	PARAMETER	CONDITIONS	LT1490AH/LT1491AH			UNITS
			MIN	TYP	MAX	
$I_S$	Supply Current per Amplifier (Note 7)	●		40	50 70	$\mu\text{A}$ $\mu\text{A}$
GBW	Gain Bandwidth Product (Note 6)	$f = 1\text{kHz}$ ●	110 60	180		$\text{kHz}$ $\text{kHz}$
SR	Slew Rate (Note 8)	$A_V = -1$ , $R_L = \infty$ ●	0.035 0.015	0.06		$\text{V}/\mu\text{s}$ $\text{V}/\mu\text{s}$
$V_{OS}$	Input Offset Voltage (Note 5)	LT1490AHS8 ●		150	700 2700	$\mu\text{V}$ $\mu\text{V}$
		LT1490AHMS8, LT1491AHS ●		250	1200 3200	$\mu\text{V}$ $\mu\text{V}$
	Input Offset Voltage Drift (Note 9)	●		3	7	$\mu\text{V}/^{\circ}\text{C}$
$I_{OS}$	Input Offset Current	●			2	$\text{nA}$
$I_B$	Input Bias Current	●			20	$\text{nA}$
	Input Voltage Range	●	-14.7		29	$\text{V}$
CMRR	Common Mode Rejection Ratio	$V_{CM} = -14.7\text{V}$ to $29\text{V}$ ●	72			$\text{dB}$
$A_{VOL}$	Large-Signal Voltage Gain	$V_O = \pm 14\text{V}$ , $R_L = 10\text{k}$ ●	100 4	250		$\text{V}/\text{mV}$ $\text{V}/\text{mV}$
$V_O$	Output Voltage Swing	No Load ●	$\pm 14.8$			$\text{V}$
		$I_{OUT} = \pm 2.5\text{mA}$ ●	$\pm 14.3$			$\text{V}$
PSRR	Power Supply Rejection Ratio	$V_S = \pm 1.25\text{V}$ to $\pm 22\text{V}$ ●	84			$\text{dB}$
$I_S$	Supply Current per Amplifier	●		50	70 95	$\mu\text{A}$ $\mu\text{A}$
GBW	Gain Bandwidth Product	$f = 1\text{kHz}$ ●	125 75	200		$\text{kHz}$ $\text{kHz}$
SR	Slew Rate	$A_V = -1$ , $R_L = \infty$ ●	0.0375 0.02	0.07		$\text{V}/\mu\text{s}$ $\text{V}/\mu\text{s}$

**Note 1:** Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

**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. The  $\theta_{JA}$  specified for the DD and DHC package is with minimal PCB heat spreading metal. Using expanded metal area on all layers of a board reduces this value.

**Note 3:** The LT1490AC/LT1491AC and LT1490AI/LT1491AI are guaranteed functional over the operating temperature range of  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The LT1490AH/LT1491AH are guaranteed functional over the operating temperature range of  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

**Note 4:** The LT1490AC/LT1491AC are guaranteed to meet specified performance from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ . The LT1490AC/LT1491AC are designed, characterized and expected to meet specified performance from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  but are not tested or QA sampled at these temperatures. The LT1490AI/LT1491AI are guaranteed to meet specified performance from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The LT1490AH/LT1491AH are guaranteed to meet specified performance from  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

**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.

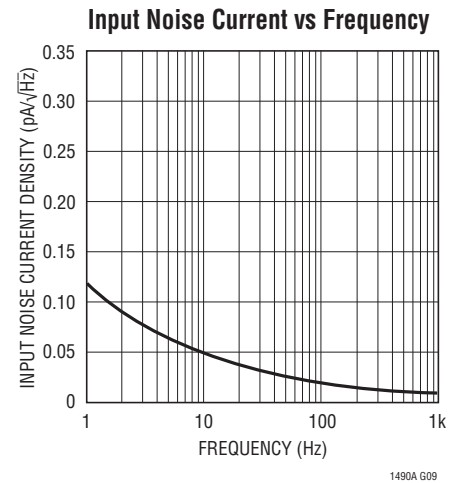
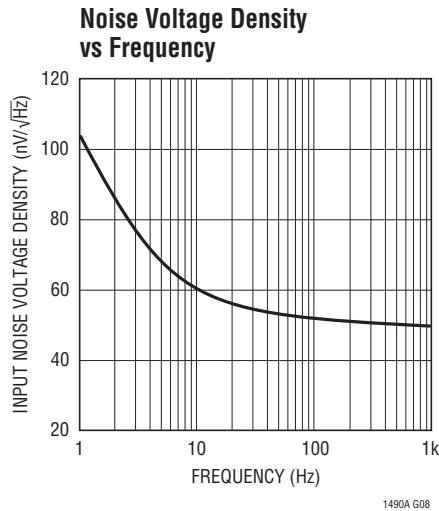
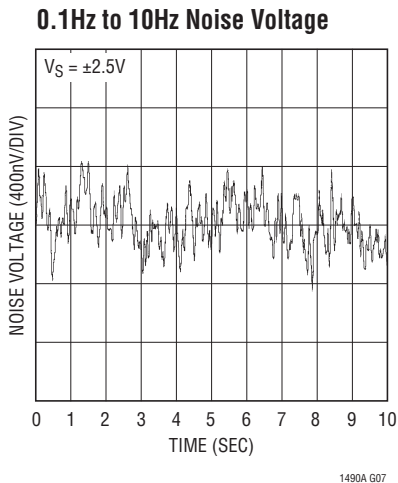
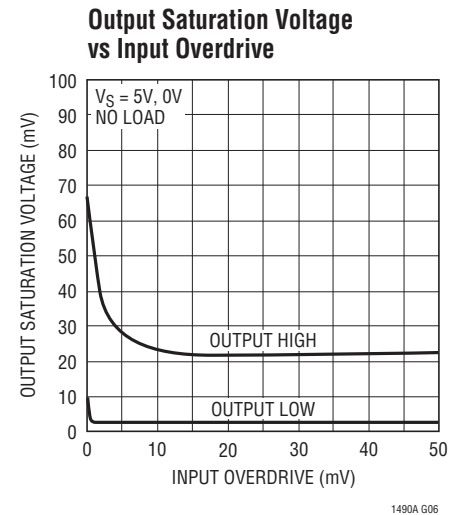
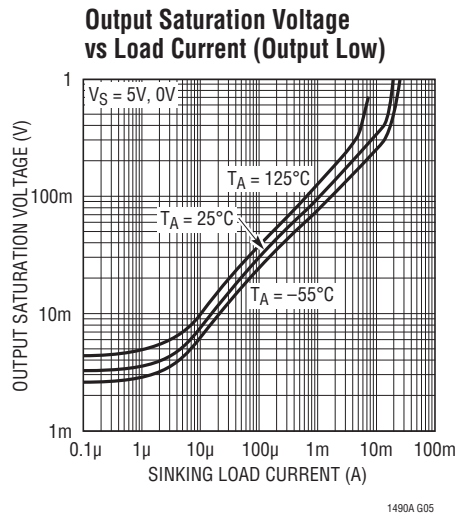
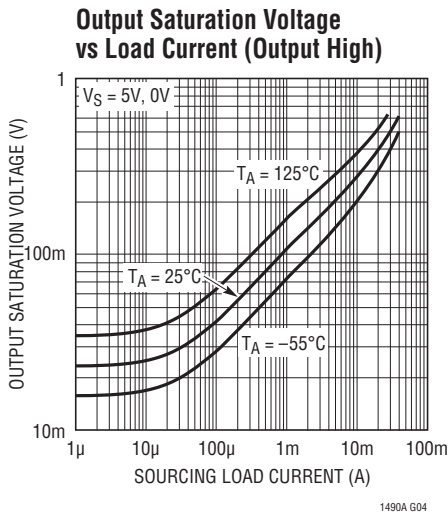
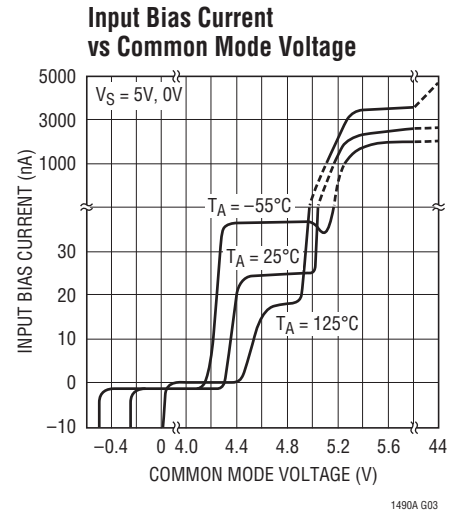
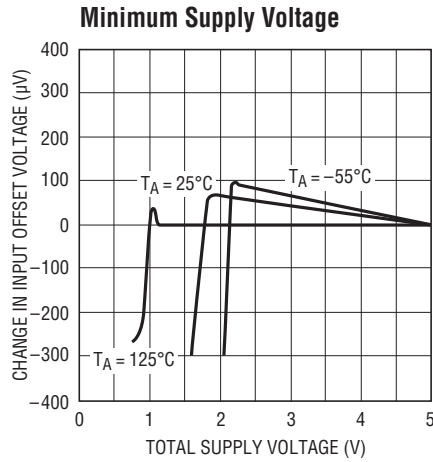
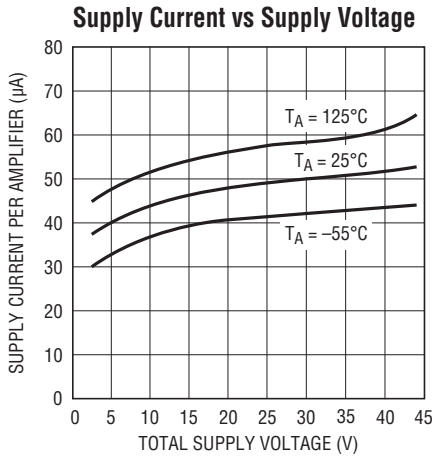
**Note 6:**  $V_S = 5\text{V}$  limits are guaranteed by correlation to  $V_S = 3\text{V}$  and  $V_S = \pm 15\text{V}$  tests.

**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.

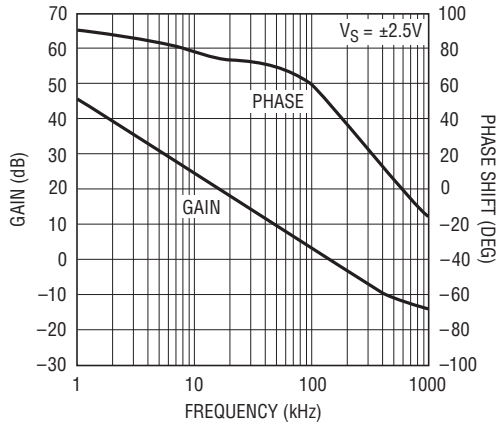
**Note 9:** This parameter is not 100% tested.

## TYPICAL PERFORMANCE CHARACTERISTICS



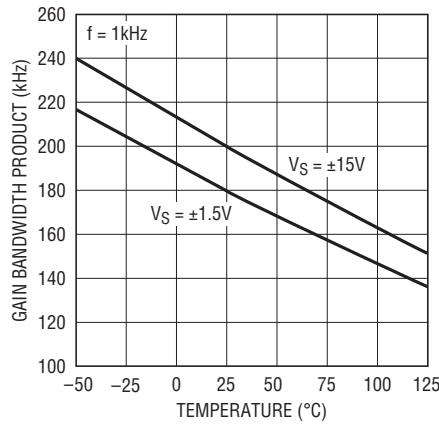
# TYPICAL PERFORMANCE CHARACTERISTICS

**Gain and Phase Shift vs Frequency**



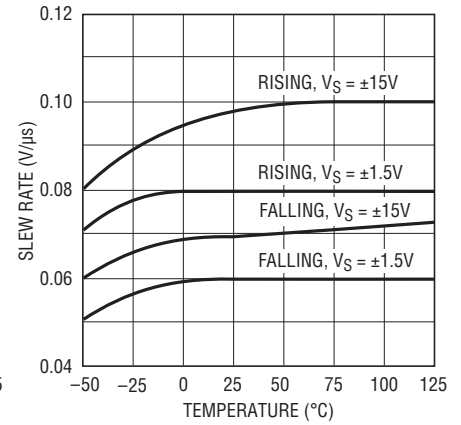
1490A G10

**Gain Bandwidth Product vs Temperature**



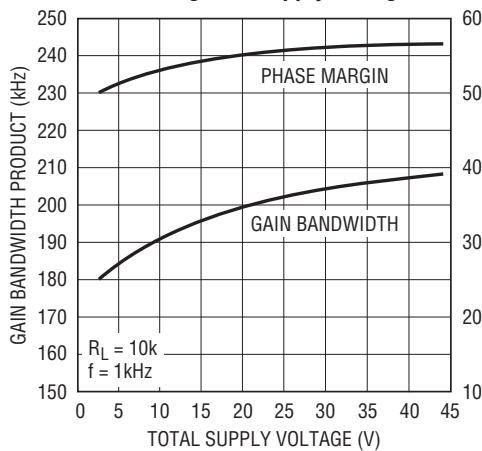
1490A G11

**Slew Rate vs Temperature**



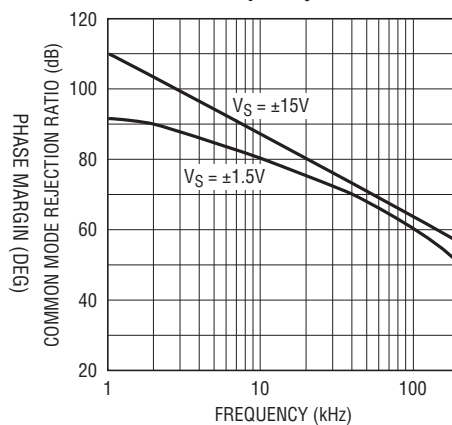
1490A G12

**Gain Bandwidth Product and Phase Margin vs Supply Voltage**



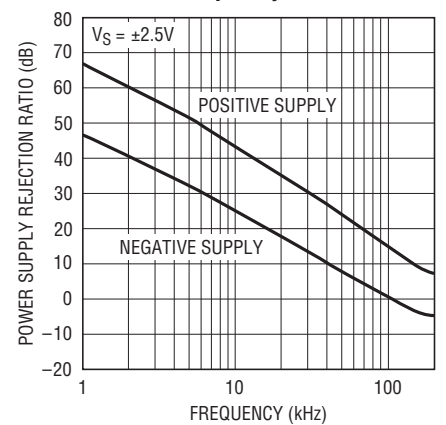
1490A G13

**CMRR vs Frequency**



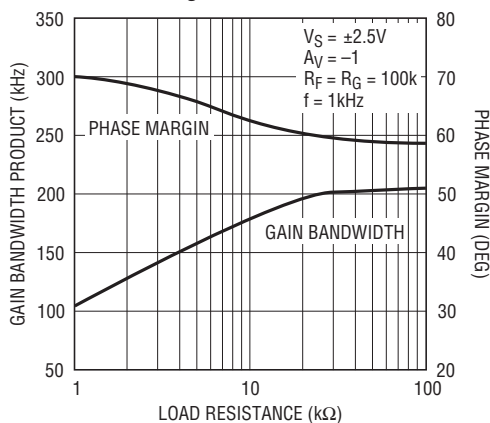
1490A G14

**PSRR vs Frequency**



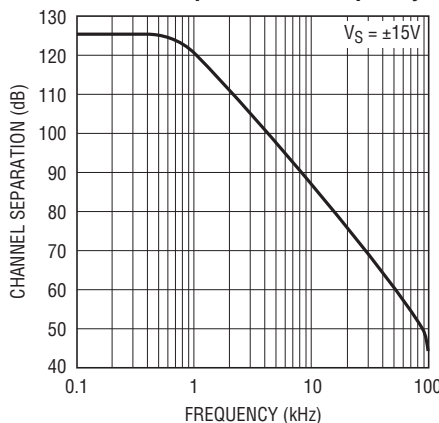
1490A G15

**Gain Bandwidth Product and Phase Margin vs Load Resistance**



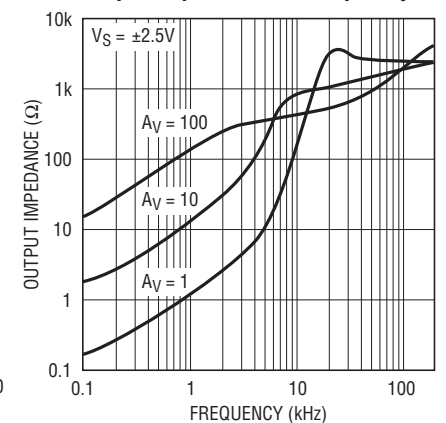
1490A G16

**Channel Separation vs Frequency**



1490A G17

**Output Impedance vs Frequency**

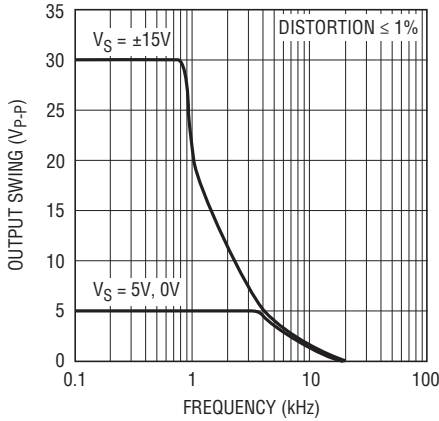


1490A G18

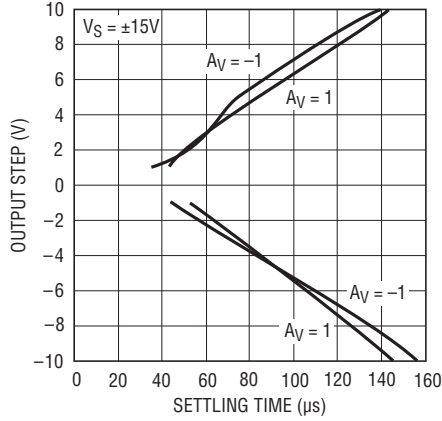


## TYPICAL PERFORMANCE CHARACTERISTICS

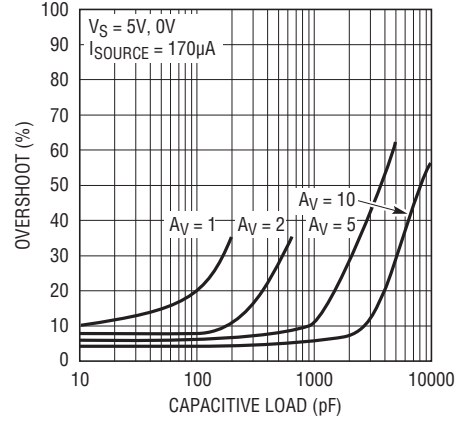
**Undistorted Output Swing vs Frequency**



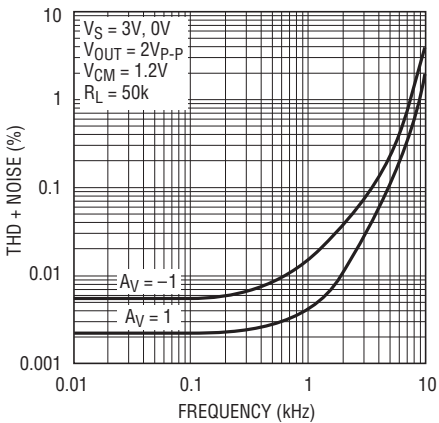
**Settling Time to 0.1% vs Output Step**



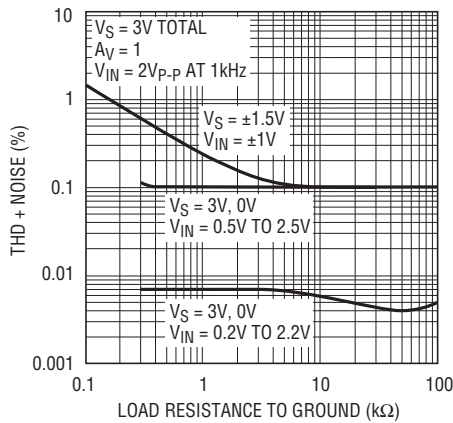
**Capacitive Load Handling, Overshoot vs Capacitive Load**



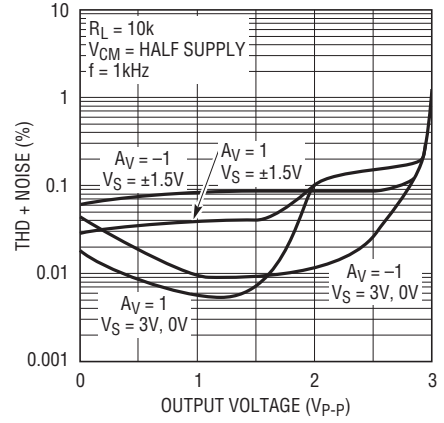
**Total Harmonic Distortion + Noise vs Frequency**



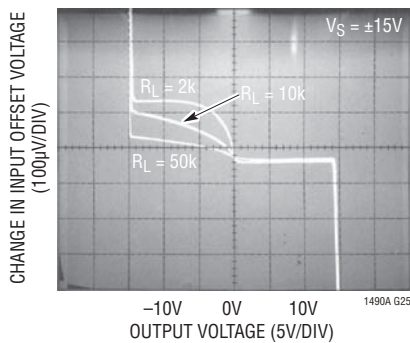
**Total Harmonic Distortion + Noise vs Load Resistance**



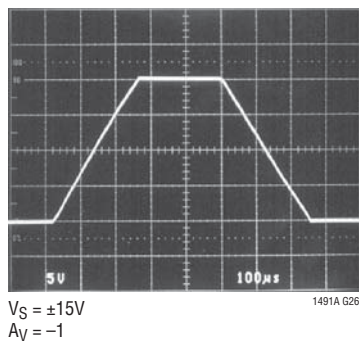
**Total Harmonic Distortion + Noise vs Output Voltage**



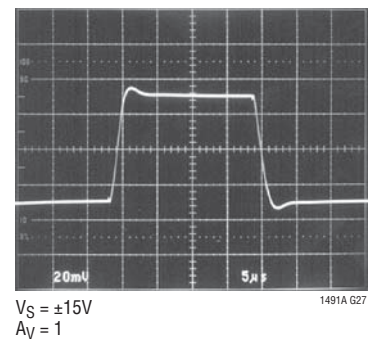
**Open-Loop Gain**



**Large-Signal Response**



**Small-Signal Response**



## APPLICATIONS INFORMATION

### Supply Voltage

The positive supply pin of the LT1490A/LT1491A 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/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  $1\mu\text{s}$ . 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  $7.5\Omega$  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  $-1\text{nA}$ . 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/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  $3\mu\text{A}$  at room temperature. The input offset voltage is typically  $700\mu\text{V}$  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  $0.22\mu\text{F}$  capacitor in series with a  $150\Omega$  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  $(V^+ - 0.8\text{V})$ . See the Typical Performance Characteristics curves.

## APPLICATIONS INFORMATION

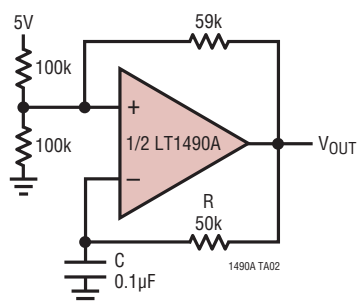
### Gain

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

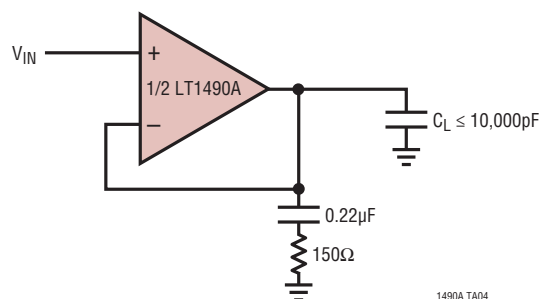
**Square Wave Oscillator**



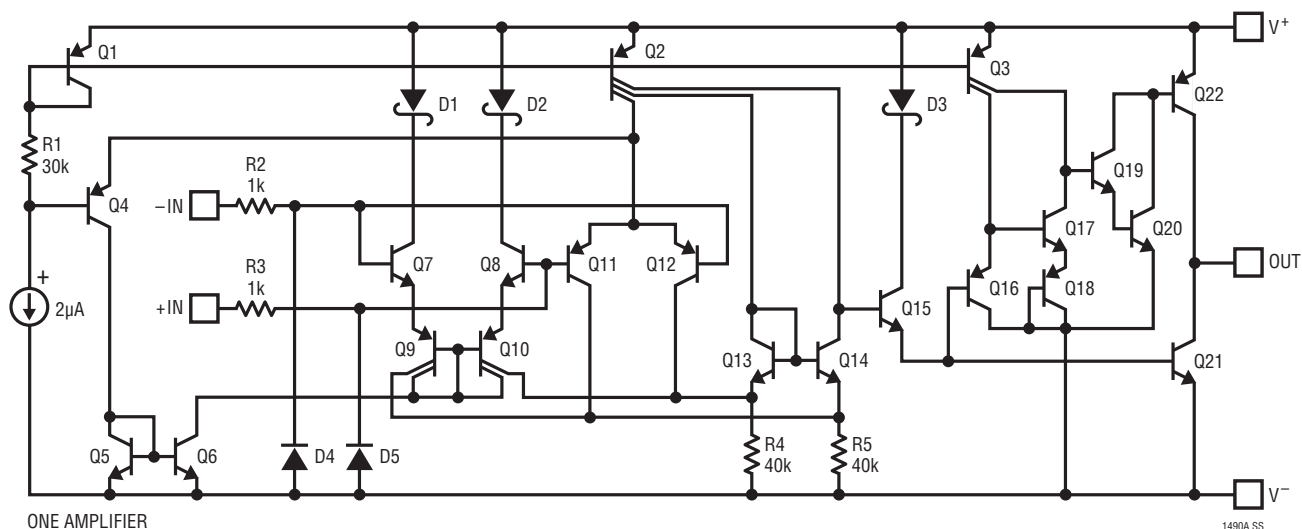
$$f = \frac{1}{2RC}$$

$V_{OUT} = 5V_{P-P}$  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**



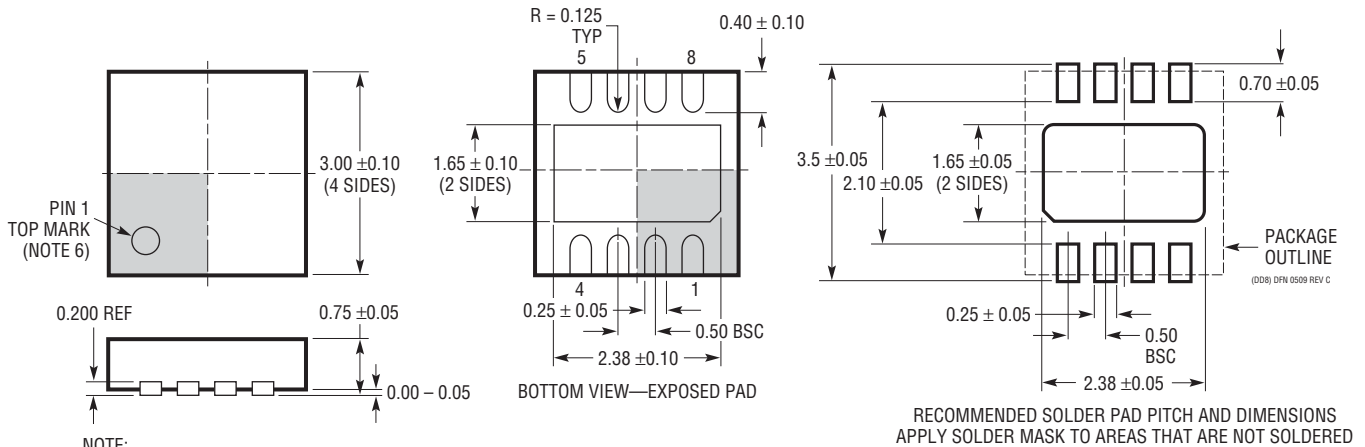
## SIMPLIFIED SCHEMATIC



# PACKAGE DESCRIPTION

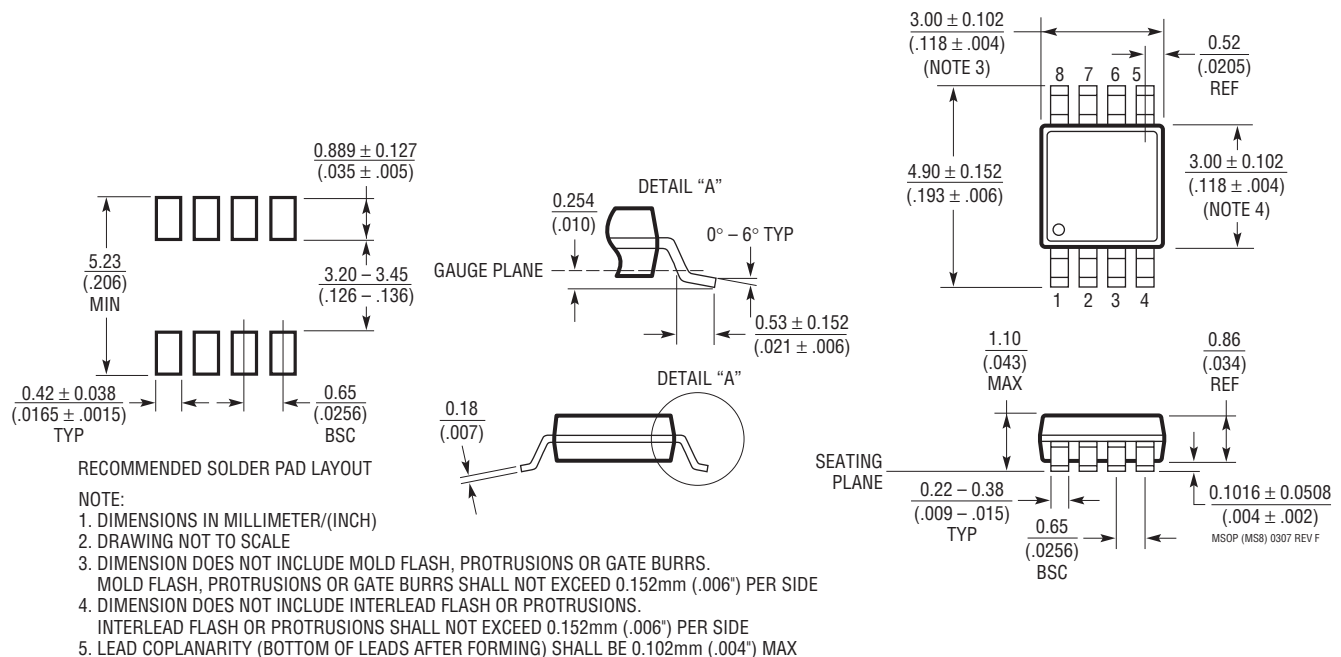
Please refer to <http://www.linear.com/designtools/packaging/> for the most recent package drawings.

## DD Package 8-Lead Plastic DFN (3mm × 3mm) (Reference LTC DWG # 05-08-1698 Rev C)



- NOTE:
1. DRAWING TO BE MADE A JEDEC PACKAGE OUTLINE M0-229 VARIATION OF (WEED-1)
  2. DRAWING NOT TO SCALE
  3. ALL DIMENSIONS ARE IN MILLIMETERS
  4. DIMENSIONS OF EXPOSED PAD ON BOTTOM OF PACKAGE DO NOT INCLUDE MOLD FLASH. MOLD FLASH, IF PRESENT, SHALL NOT EXCEED 0.15mm ON ANY SIDE
  5. EXPOSED PAD SHALL BE SOLDER PLATED
  6. SHADED AREA IS ONLY A REFERENCE FOR PIN 1 LOCATION ON TOP AND BOTTOM OF PACKAGE

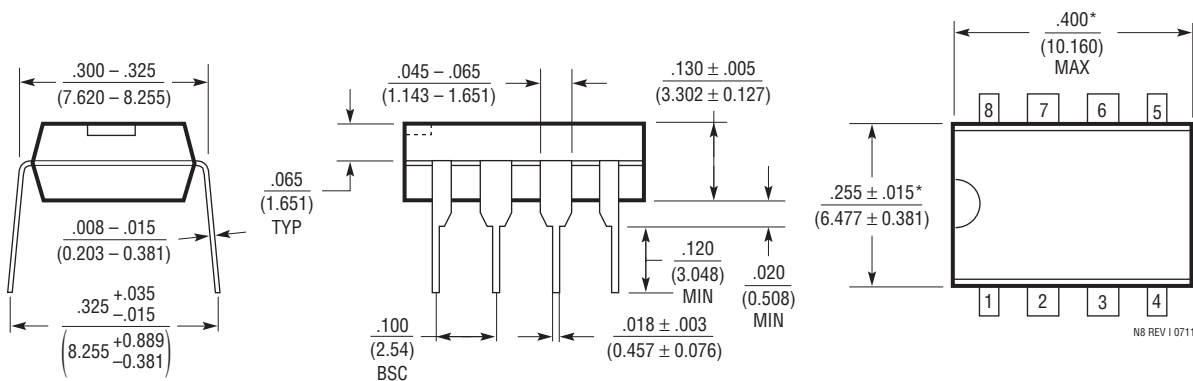
## MS8 Package 8-Lead Plastic MSOP (Reference LTC DWG # 05-08-1660 Rev F)



## PACKAGE DESCRIPTION

Please refer to <http://www.linear.com/designtools/packaging/> for the most recent package drawings.

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

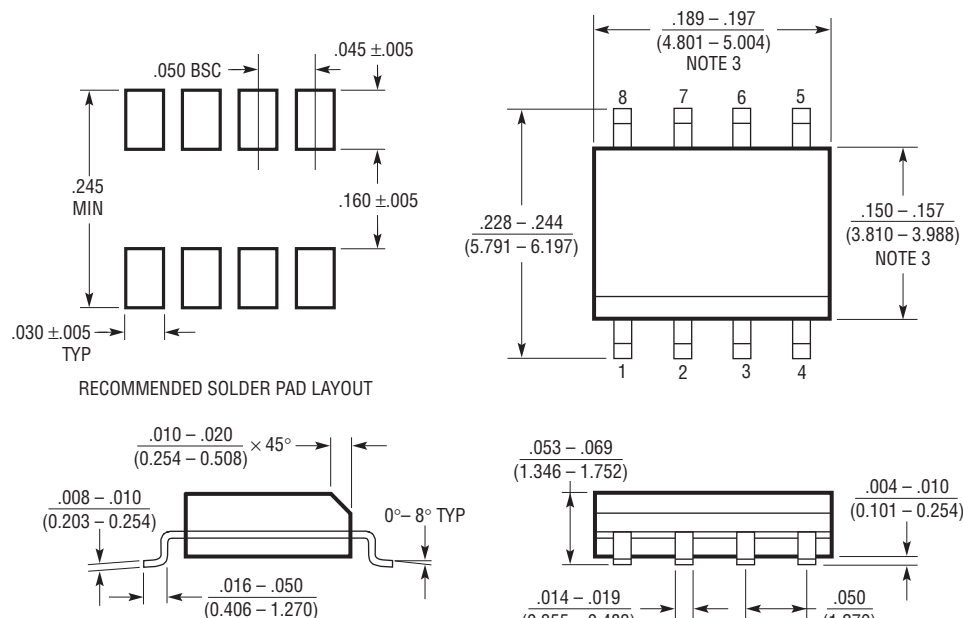


NOTE:

1. DIMENSIONS ARE  $\frac{\text{INCHES}}{\text{MILLIMETERS}}$

\*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.  
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 INCH (0.254mm)

### S8 Package 8-Lead Plastic Small Outline (Narrow .150 Inch) (Reference LTC DWG # 05-08-1610)



NOTE:

1. DIMENSIONS IN  $\frac{\text{INCHES}}{\text{MILLIMETERS}}$

2. DRAWING NOT TO SCALE

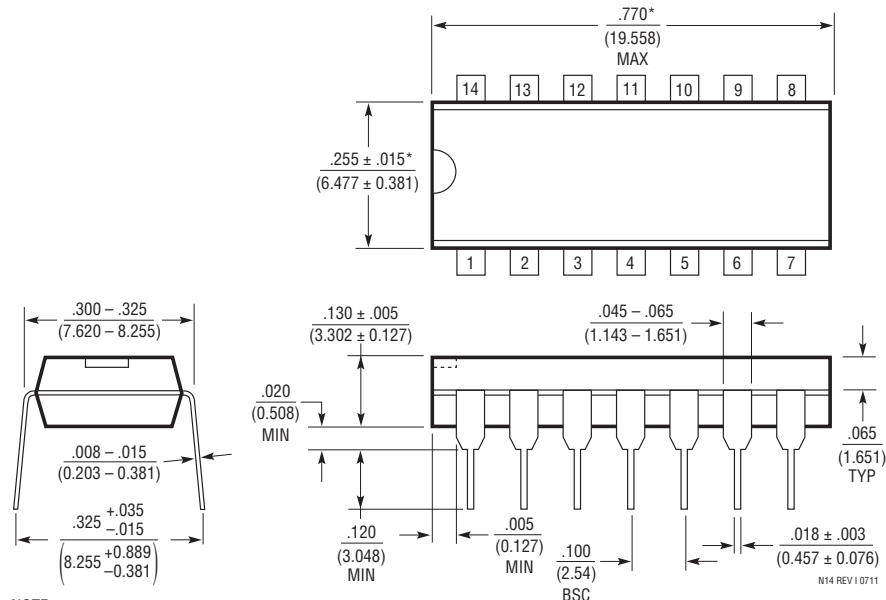
3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.  
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)

S08 0303

# PACKAGE DESCRIPTION

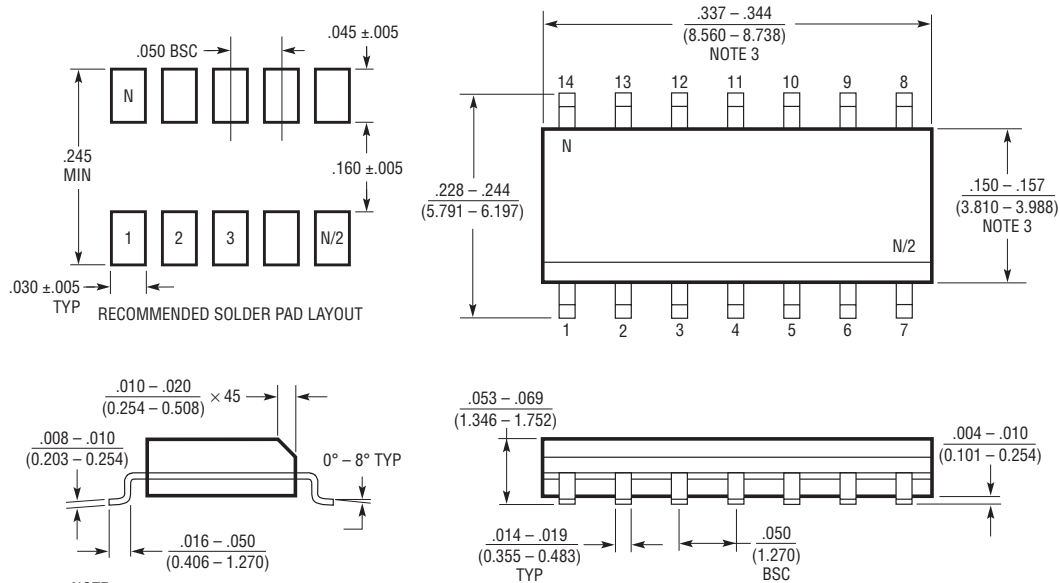
Please refer to <http://www.linear.com/designtools/packaging/> for the most recent package drawings.

## N Package 14-Lead PDIP (Narrow .300 Inch) (Reference LTC DWG # 05-08-1510 Rev I)



NOTE:  
1. DIMENSIONS ARE IN INCHES (MILLIMETERS)  
\*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.  
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 INCH (0.254mm)

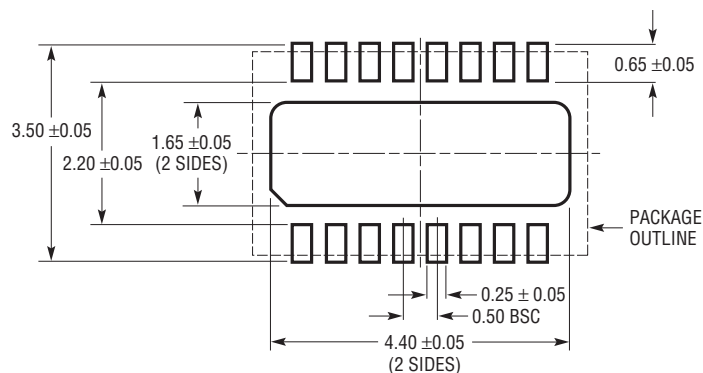
## S Package 14-Lead Plastic Small Outline (Narrow .150 Inch) (Reference LTC DWG # 05-08-1610)



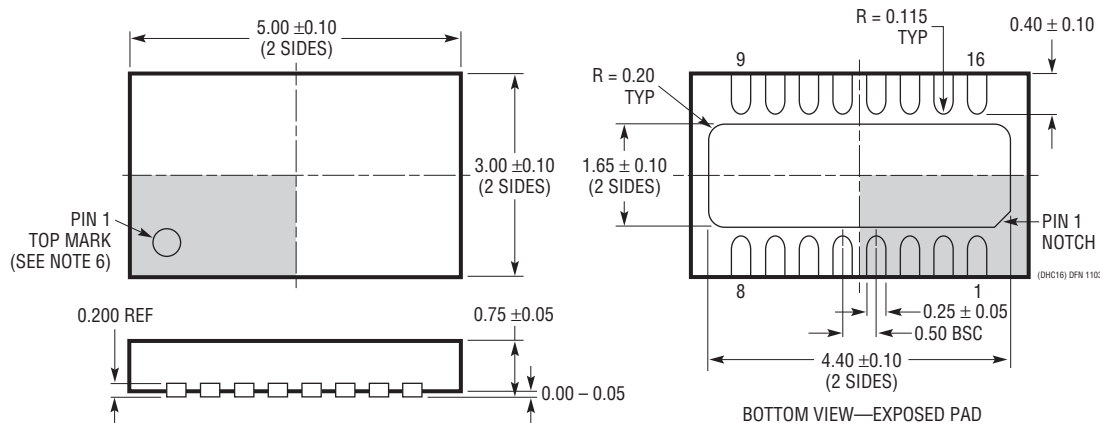
## PACKAGE DESCRIPTION

Please refer to <http://www.linear.com/designtools/packaging/> for the most recent package drawings.

### DHC Package 16-Lead Plastic DFN (5mm × 3mm) (Reference LTC DWG # 05-08-1706)



#### RECOMMENDED SOLDER PAD PITCH AND DIMENSIONS



#### NOTE:

1. DRAWING PROPOSED TO BE MADE VARIATION OF VERSION (WJED-1) IN JEDEC PACKAGE OUTLINE MO-229
2. DRAWING NOT TO SCALE
3. ALL DIMENSIONS ARE IN MILLIMETERS
4. DIMENSIONS OF EXPOSED PAD ON BOTTOM OF PACKAGE DO NOT INCLUDE MOLD FLASH. MOLD FLASH, IF PRESENT, SHALL NOT EXCEED 0.15mm ON ANY SIDE
5. EXPOSED PAD SHALL BE SOLDER PLATED
6. SHADED AREA IS ONLY A REFERENCE FOR PIN 1 LOCATION ON THE TOP AND BOTTOM OF PACKAGE

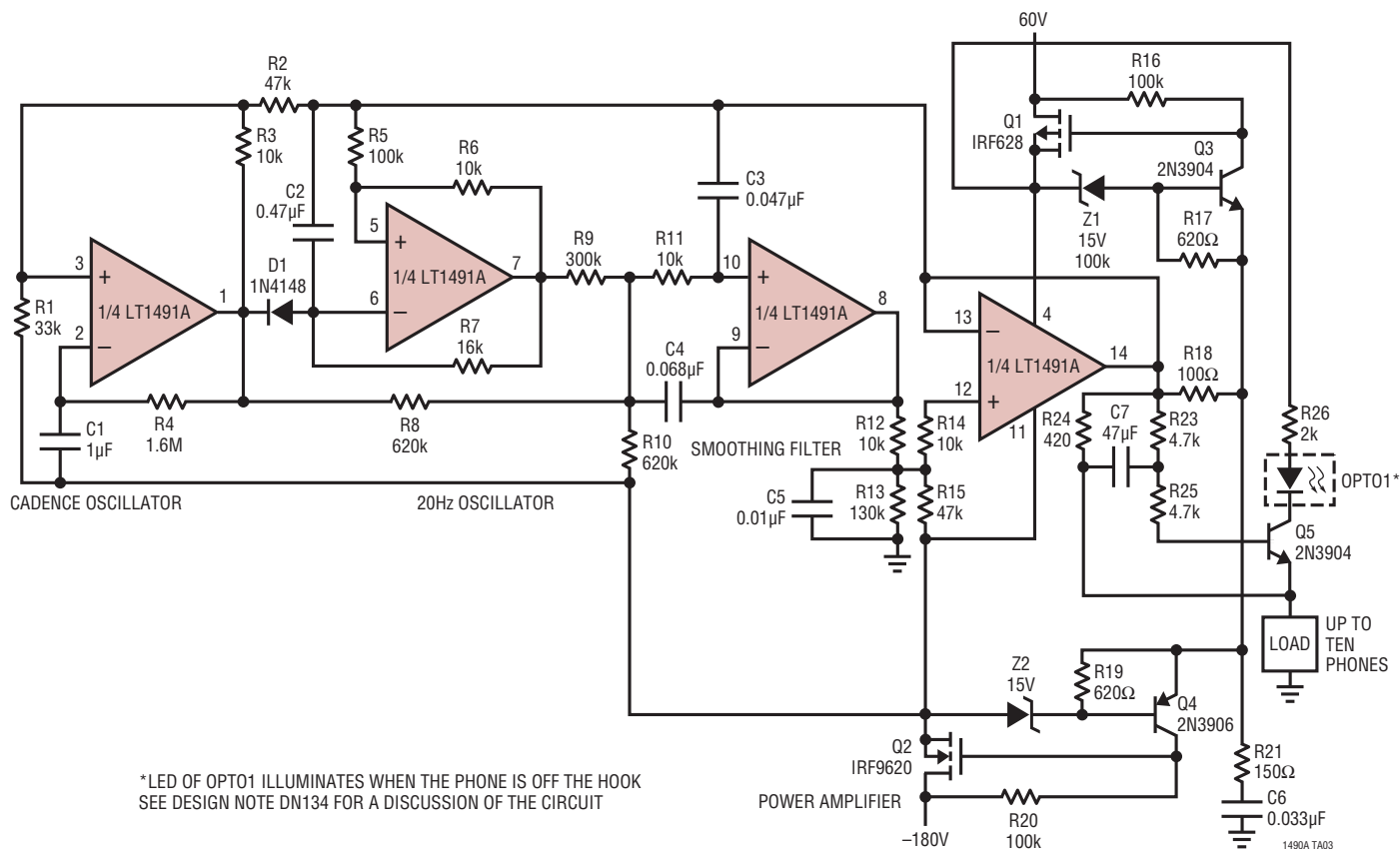
**REVISION HISTORY** (Revision history begins at Rev C)

REV	DATE	DESCRIPTION	PAGE NUMBER
C	10/10	Changed units from mV to V for $V_O$ in Electrical Characteristics	7
		Updated package drawings	13-16
D	12/11	Revised Order Information	3



## 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 <sub>OS(MAX)</sub> , 500V/mV A <sub>VOL(MIN)</sub> , 400kHz GBW
LT1636	Single Over-The-Top Micropower Rail-to-Rail Input and Output Op Amp	55µA Supply Current, V <sub>CM</sub> Extends 44V Above V <sub>EE</sub> , Independent of V <sub>CC</sub> , 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 <sub>OS(MAX)</sub> , I <sub>S</sub> = 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 <sub>OS(MAX)</sub> , I <sub>S</sub> = 300µA (Max), Gain-Bandwidth = 1.2MHz, Shutdown Pin