5MHz, 3V/µs, Low Power Single Supply, Dual and Quad Precision Op Amps

FEATURES

- **Gain-Bandwidth Product: 5MHz Typ**
- **Slew Rate: 3V/µs Typ**
- **Low Supply Current per Amplifier: 0.55mA Max**
- **Input Offset Voltage: 180µV Max**
- Input Offset Voltage Drift: 3µV/°C Max
- Input Offset Current: 20nA Max
- Input Bias Current: 100nA Max
- Open-Loop Gain: 1500V/mV Min (V_S = ±15V)
- Low Input Noise Voltage: 16.5nV/√Hz
- Low Input Noise Current: 0.14pA/√Hz
- Large Output Drive Current: 20mA Min
- Single Supply Operation
  - Input Voltage Range Includes Ground
  - Output Swings to Ground While Sinking Current
- Wide Supply Voltage Range: 2.5V to 36V
- Specified on 3.3V, 5V and ±15V
- Dual in 8-Pin PDIP and SO Package
- Quad in a Narrow 16-Pin SO Package

APPLICATIONS

- Battery-Powered Systems
  - Portable Instrumentation
- Active Filters
- Photodiode Amplifiers
- DAC Current to Voltage Amplifiers

DESCRIPTION

The LT®1492/LT1493 are dual/quad, low power, single supply precision op amps with 5MHz gain-bandwidth product, 3V/µs slew rate and only 450µA of quiescent supply current per amplifier.

With a maximum input offset voltage of only 180µV, the LT1492/LT1493 eliminate trims in most systems while providing high frequency performance not usually found in low power single supply amplifiers.

The LT1492/LT1493 will operate on any supply greater than 2.5V and less than 36V total, and are specified on single 3.3V, single 5V and ±15V supplies. Even with their low quiescent supply current the minimum output drive is 20mA, ideal for driving low impedance loads.

The inputs can be driven beyond the supplies without damage or phase reversal of the output. The low operating voltage and wide input and output range make the LT1492/LT1493 amplifiers ideal for battery-powered applications.

For applications requiring faster precision single supply amplifiers, see the 14MHz, 7V/µs LT1211/LT1212, the 28MHz, 12V/µs LT1213/LT1214 or the 23MHz, 50V/µs LT1215/LT1216.

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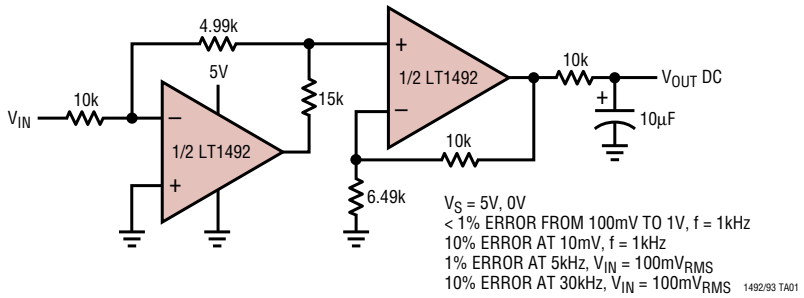
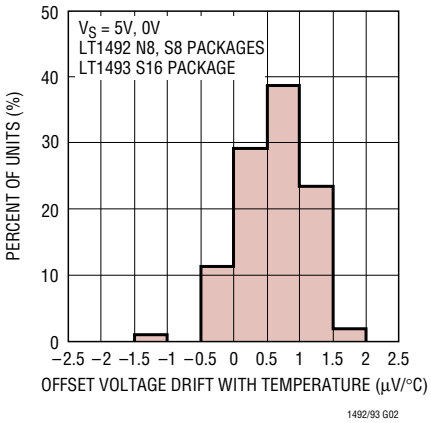
TYPICAL APPLICATION

Precision AC to DC Converter (Full Wave Rectifier and Filter)



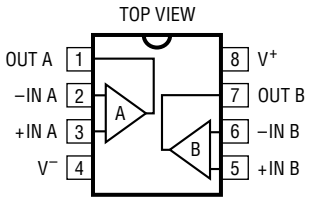
Distribution of Offset Voltage Drift with Temperature



ABSOLUTE MAXIMUM RATINGS

Total Supply Voltage (V^+ to V^-) 36V
Input Current ..... ±15mA
Output Short-Circuit Duration (Note 1) ..... Continuous
Operating Temperature Range ..... –40°C to 85°C
Specified Temperature Range (Note 2) ..... –40°C to 85°C
Junction Temperature ..... 150°C
Storage Temperature Range ..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec) ..... 300°C

PACKAGE/ORDER INFORMATION



N8 PACKAGE
8-LEAD PDIP
S8 PACKAGE
8-LEAD PLASTIC SO

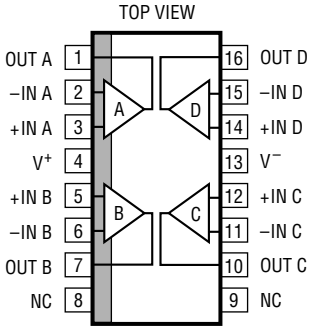
T_{JMAX} = 150°C, θ_{JA} = 130°C/W (N8)
T_{JMAX} = 150°C, θ_{JA} = 190°C/W (S8)

ORDER PART NUMBER

LT1492CN8
LT1492CS8

S8 PART MARKING

1492



S PACKAGE
16-LEAD PLASTIC SO

T_{JMAX} = 150°C, θ_{JA} = 150°C/W

ORDER PART NUMBER

LT1493CS

Consult factory for Industrial and Military grade parts.

5V ELECTRICAL CHARACTERISTICS

V_S = 5V, 0V; V_{CM} = 0.5V, V_{OUT} = 0.5V, T_A = 25°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage			100	180	µV
$\frac{\Delta V_{OS}}{\Delta Time}$	Long-Term Input Offset Voltage Stability			0.6		µV/Mo
I_{OS}	Input Offset Current			5	20	nA
I_B	Input Bias Current			50	100	nA
	Input Noise Voltage	0.1Hz to 10Hz		330		nV_{P-P}
e_n	Input Noise Voltage Density	f_O = 10Hz f_O = 1000Hz		17.3 16.5		nV/√Hz nV/√Hz
i_n	Input Noise Current Density	f_O = 10Hz f_O = 1000Hz		0.78 0.14		pA/√Hz pA/√Hz
	Input Resistance (Note 3)	Differential Mode Common Mode	10	40 800		MΩ MΩ
	Input Capacitance	f = 1MHz		10		pF
	Input Voltage Range		3.4 0	3.60 –0.25		V V
CMRR	Common Mode Rejection Ratio	V_{CM} = 0V to 3.4V	86	102		dB
PSRR	Power Supply Rejection Ratio	V_S = 2.5V to 12.5V	90	110		dB

5V ELECTRICAL CHARACTERISTICS

V_S = 5V, 0V; V_{CM} = 0.5V, V_{OUT} = 0.5V, T_A = 25°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
A_{VOL}	Large-Signal Voltage Gain	V_O = 0.05V to 3.7V, R_L = 2k	175	350		V/mV
	Maximum Output Voltage Swing (Note 4)	Output High, No Load Output High, I_{SOURCE} = 1mA Output High, I_{SOURCE} = 15mA	4.2 4.1 3.0	4.35 4.25 3.15		V V V
		Output Low, No Load Output Low, I_{SINK} = 1mA Output Low, I_{SINK} = 15mA		0.003 0.062 0.362	0.006 0.075 0.500	V V V
I_O	Maximum Output Current (Note 8)		±20	±60		mA
SR	Slew Rate	A_V = –2		1.8		V/µs
GBW	Gain-Bandwidth Product	f = 100kHz		4.5		MHz
I_S	Supply Current per Amplifier			425	550	µA
	Minimum Supply Voltage			2.1	2.5	V
	Full Power Bandwidth	A_V = 1, V_O = 2.5V_{P-P}		150		kHz
t_r, t_f	Rise Time, Fall Time	A_V = 1, 10% to 90%, V_O = 100mV		100		ns
OS	Overshoot	A_V = 1, V_O = 100mV		20		%
t_{PD}	Propagation Delay	A_V = 1, V_O = 100mV		100		ns
t_S	Settling Time	0.01%, A_V = 1, ΔV_O = 2V		2.6		µs
	Open-Loop Output Resistance	I_O = 0mA, f = 2MHz		130		Ω
THD	Total Harmonic Distortion	A_V = 1, V_O = 1V_{RMS}, f = 20Hz to 20kHz		0.005		%

V_S = 5V, 0V; V_{CM} = 0.5V, V_{OUT} = 0.5V, 0°C ≤ T_A ≤ 70°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage		●		120	280	µV
$\frac{V_{OS}}{\Delta T}$	Input Offset Voltage Drift (Note 3)		●		1	3	µV/°C
I_{OS}	Input Offset Current		●		5	25	nA
I_B	Input Bias Current		●		55	110	nA
	Input Voltage Range		● ●	3.4 0	3.55 –0.15		V V
CMRR	Common Mode Rejection Ratio	V_{CM} = 0V to 3.4V	●	84	102		dB
PSRR	Power Supply Rejection Ratio	V_S = 2.5V to 12.5V	●	90	110		dB
A_{VOL}	Large-Signal Voltage Gain	V_O = 0.05V to 3.7V, R_L = 2k	●	140	250		V/mV
	Maximum Output Voltage Swing (Note 4)	Output High, No Load Output High, I_{SOURCE} = 1mA Output High, I_{SOURCE} = 15mA	● ● ●	4.1 4.0 2.9	4.25 4.15 3.05		V V V
		Output Low, No Load Output Low, I_{SINK} = 1mA Output Low, I_{SINK} = 15mA	● ● ●		0.004 0.070 0.390	0.007 0.085 0.525	V V V
I_S	Supply Current per Amplifier		●		470	650	µA

5V ELECTRICAL CHARACTERISTICS

V_S = 5V, 0V; V_{CM} = 0.5V, V_{OUT} = 0.5V, −40°C ≤ T_A ≤ 85°C, unless otherwise noted. (Note 2)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage		●		150	325	µV
$\frac{V_{OS}}{\Delta T}$	Input Offset Voltage Drift (Note 3)		●		1	3	µV/°C
I_{OS}	Input Offset Current		●		5	40	nA
I_B	Input Bias Current		●		55	130	nA
	Input Voltage Range		● ●	3.4 0	3.5 −0.1		V V
CMRR	Common Mode Rejection Ratio	V_{CM} = 0V to 3.4V	●	80	90		dB
PSRR	Power Supply Rejection Ratio	V_S = 2.5V to 12.5V	●	90	110		dB
A_{VOL}	Large-Signal Voltage Gain	V_O = 0.05V to 3.7V, R_L = 2k	●	140	220		V/mV
	Maximum Output Voltage Swing (Note 4)	Output High, No Load Output High, I_{SOURCE} = 1mA Output High, I_{SOURCE} = 15mA	● ● ●	3.95 3.85 2.75	4.15 4.05 2.95		V V V
		Output Low, No Load Output Low, I_{SINK} = 1mA Output Low, I_{SINK} = 15mA	● ● ●		0.005 0.073 0.400	0.008 0.095 0.575	V V V
I_S	Supply Current per Amplifier		●		480	700	µA

±15V ELECTRICAL CHARACTERISTICS

V_S = ±15V, V_{CM} = 0V, V_{OUT} = 0V, T_A = 25°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage			120	450	µV
I_{OS}	Input Offset Current			5	20	nA
I_B	Input Bias Current			45	100	nA
	Input Voltage Range		13.4 −15.0	13.6 −15.2		V V
CMRR	Common Mode Rejection Ratio	V_{CM} = −15V to 13.4V	86	102		dB
PSRR	Power Supply Rejection Ratio	V_S = ±2V to ±16V	90	113		dB
A_{VOL}	Large-Signal Voltage Gain	V_O = ±10V, R_L = 5k	1500	6500		V/mV
	Maximum Output Voltage Swing	Output High, I_{SOURCE} = 15mA Output Low, I_{SINK} = 15mA	12.9 −14.4	13.15 −14.6		V V
I_O	Maximum Output Current	(Note 8)	±20	±55		mA
SR	Slew Rate	A_V = −2, (Note 5)	2	3		V/µs
GBW	Gain-Bandwidth Product	f = 100kHz	3	5		MHz
I_S	Supply Current per Amplifier			500	800	µA
	Channel Separation	V_O = ±10V, R_L = 5k	128	140		dB
	Minimum Supply Voltage			±1.4	±2	V
	Full Power Bandwidth	A_V = 1, V_O = $20V_{P-P}$		30		kHz
t_S	Settling Time	0.01%, A_V = 1, ΔV_O = 10V		5.8		µs

±15V ELECTRICAL CHARACTERISTICS

V_S = ±15V, V_{CM} = 0V, V_{OUT} = 0V, 0°C ≤ T_A ≤ 70°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage		●		160	550	µV
$\frac{V_{OS}}{\Delta T}$	Input Offset Voltage Drift (Note 3)		●		1	3	µV/°C
I_{OS}	Input Offset Current		●		10	30	nA
I_B	Input Bias Current		●		55	120	nA
	Input Voltage Range		● ●	13.4 −15.0	13.5 −15.1		V V
CMRR	Common Mode Rejection Ratio	V_{CM} = −15V to 13.4V	●	84	101		dB
PSRR	Power Supply Rejection Ratio	V_S = ±2V to ±16V	●	90	108		dB
A_{VOL}	Large-Signal Voltage Gain	V_O = ±10V, R_L = 5k	●	1200	4000		V/mV
	Maximum Output Voltage Swing	Output High, I_{SOURCE} = 15mA Output Low, I_{SINK} = 15mA	● ●	12.7 −14.2	13.0 −14.6		V V
I_S	Supply Current per Amplifier		●		600	930	µA

V_S = ±15V, V_{CM} = 0V, V_{OUT} = 0V, −40°C ≤ T_A ≤ 85°C, unless otherwise noted. (Note 2)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage		●		180	650	µV
$\frac{V_{OS}}{\Delta T}$	Input Offset Voltage Drift (Note 3)		●		1	3	µV/°C
I_{OS}	Input Offset Current		●		10	50	nA
I_B	Input Bias Current		●		55	150	nA
	Input Voltage Range		● ●	13.4 −15.0	13.45 −15.05		V V
CMRR	Common Mode Rejection Ratio	V_{CM} = −15V to 13.4V	●	82	101		dB
PSRR	Power Supply Rejection Ratio	V_S = ±2V to ±16V	●	90	108		dB
A_{VOL}	Large-Signal Voltage Gain	V_O = ±10V, R_L = 5k	●	1000	3500		V/mV
	Maximum Output Voltage Swing	Output High, I_{SOURCE} = 15mA Output Low, I_{SINK} = 15mA	● ●	12.5 −14.1	12.9 −14.6		V V
I_S	Supply Current per Amplifier		●		620	1000	µA

3.3V ELECTRICAL CHARACTERISTICS

V_S = 3.3V, 0V; V_{CM} = 0.5V, V_{OUT} = 0.5V, T_A = 25°C, unless otherwise noted. (Note 6)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage			100	180	µV
	Input Voltage Range (Note 7)		1.7 0	1.9 −0.2		V V
	Maximum Output Voltage Swing	Output High, No Load Output High, I_{SOURCE} = 1mA Output High, I_{SOURCE} = 15mA	2.50 2.40 1.30	2.65 2.55 1.45		V V V
		Output Low, No Load Output Low, I_{SINK} = 1mA Output Low, I_{SINK} = 15mA		0.003 0.062 0.362	0.006 0.075 0.500	V V V
I_O	Maximum Output Current		±20	±50		mA

V_S = 3.3V, 0V; V_{CM} = 0.5V, V_{OUT} = 0.5V, 0°C ≤ T_A ≤ 70°C, unless otherwise noted. (Note 6)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage		●		120	280	µV
	Input Voltage Range (Note 7)		● ●	1.7 0	1.8 −0.1		V V
	Maximum Output Voltage Swing	Output High, No Load Output High, I_{SOURCE} = 1mA Output High, I_{SOURCE} = 15mA	● ● ●	2.4 2.3 1.2	2.55 2.45 1.35		V V V
		Output Low, No Load Output Low, I_{SINK} = 1mA Output Low, I_{SINK} = 15mA	● ● ●		0.004 0.070 0.390	0.007 0.085 0.525	V V V

V_S = 3.3V, 0V; V_{CM} = 0.5V, V_{OUT} = 0.5V, −40°C ≤ T_A ≤ 85°C, unless otherwise noted. (Notes 2, 6)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage		●		150	325	µV
	Input Voltage Range (Note 7)		● ●	1.7 0	1.75 −0.05		V V
	Maximum Output Voltage Swing	Output High, No Load Output High, I_{SOURCE} = 1mA Output High, I_{SOURCE} = 15mA	● ● ●	2.25 2.15 1.05	2.45 2.35 1.25		V V V
		Output Low, No Load Output Low, I_{SINK} = 1mA Output Low, I_{SINK} = 15mA	● ● ●		0.005 0.073 0.400	0.008 0.095 0.575	V V V

The ● denotes specifications that apply over the full operating temperature range.

Note 1: A heat sink may be required to keep the junction temperature below absolute maximum when the output is shorted indefinitely.

Note 2: The LT1492/LT1493 are designed, characterized and expected to meet these extended temperature limits, but are not tested at −40°C and 85°C. Guaranteed I grade parts are available. Consult factory.

Note 3: This parameter is not 100% tested.

Note 4: Guaranteed by correlation to V_S = 3.3V and V_S = ±15V tests.

Note 5: Slew rate is measured between ±5V on an output swing of ±10V on ±15V supplies.

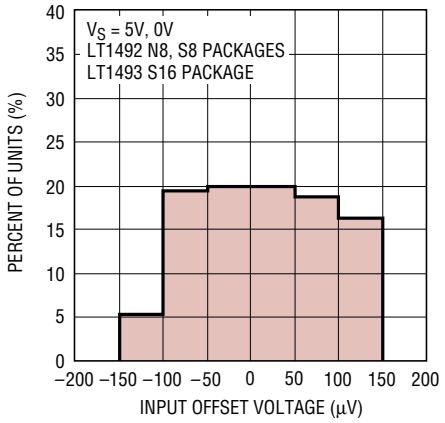
Note 6: Most LT1492/LT1493 electrical characteristics change very little with supply voltage. See the 5V tables for characteristics not listed in the 3.3V table.

Note 7: Guaranteed by correlation to V_S = 5V and V_S = ±15V tests.

Note 8: Guaranteed by correlation to V_S = 3.3V tests.

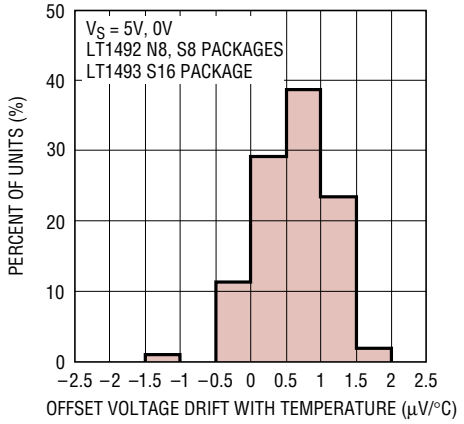
TYPICAL PERFORMANCE CHARACTERISTICS

Distribution of Input Offset Voltage



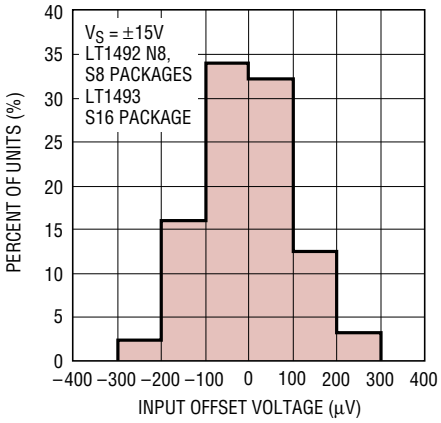
1492/93 G01

Distribution of Offset Voltage Drift with Temperature



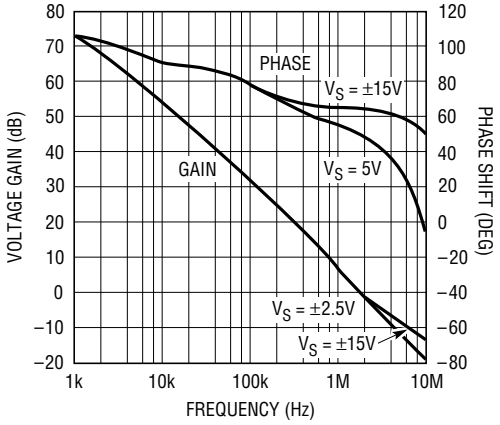
1492/93 G02

Distribution of Input Offset Voltage



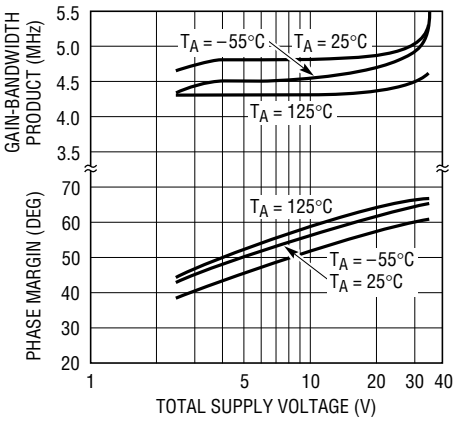
1492/93 G03

Voltage Gain, Phase vs Frequency



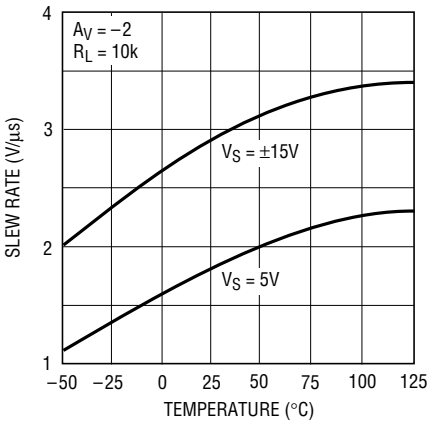
1492/93 G04

Gain-Bandwidth Product, Phase Margin vs Supply Voltage



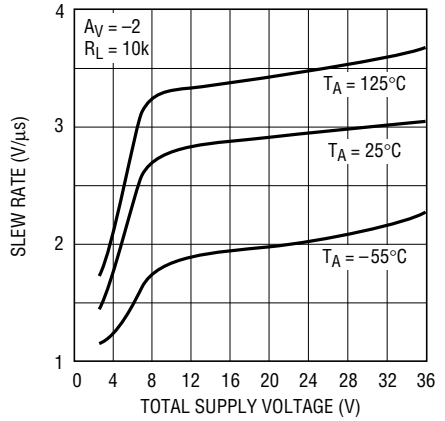
1492/93 G05

Slew Rate vs Temperature



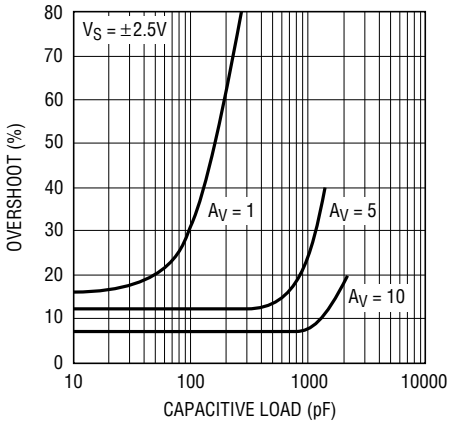
1492/93 G06

Slew Rate vs Supply Voltage



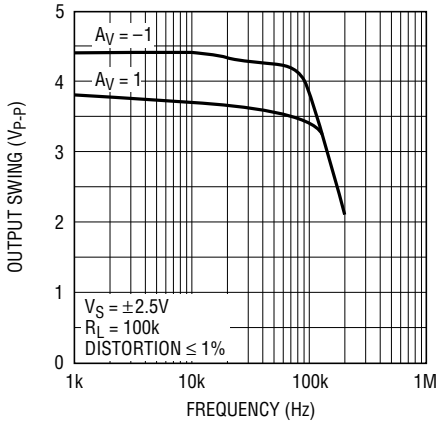
1492/93 G07

Capacitive Load Handling



1492/93 G08

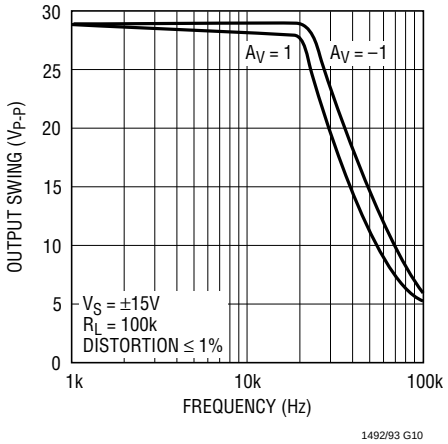
Undistorted Output Swing vs Frequency, V_S = ±2.5V



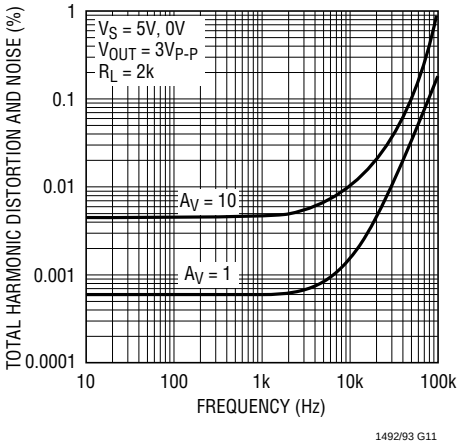
1492/93 G09

TYPICAL PERFORMANCE CHARACTERISTICS

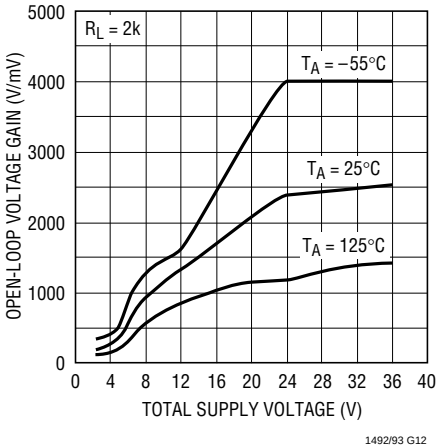
Undistorted Output Swing vs Frequency, $V_S = \pm15V$



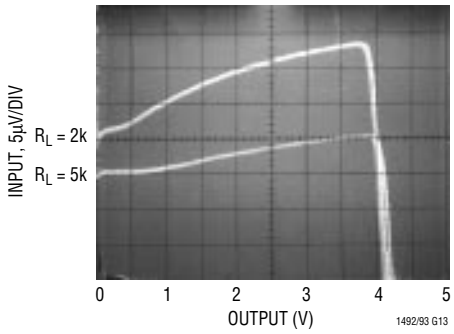
Total Harmonic Distortion and Noise vs Frequency



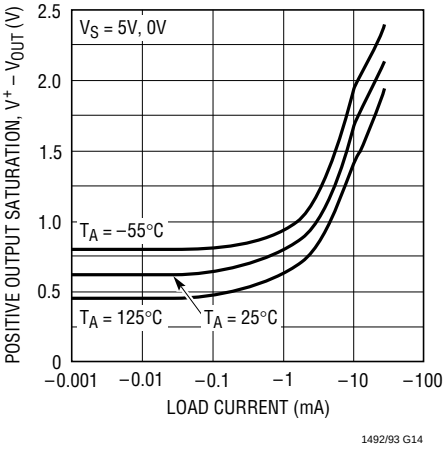
Open-Loop Voltage Gain vs Supply Voltage



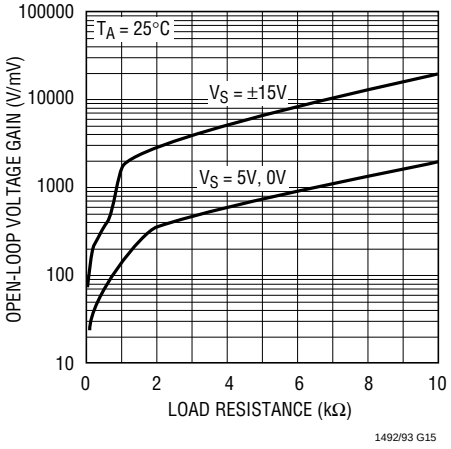
Open-Loop Gain, $V_S = 5V$



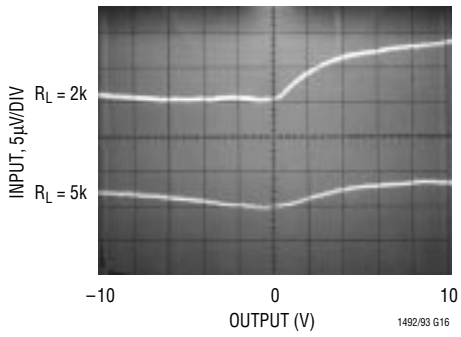
Positive Output Saturation Voltage vs Load Current



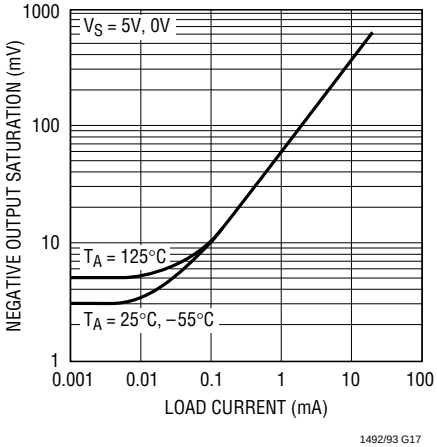
Voltage Gain vs Load Resistance



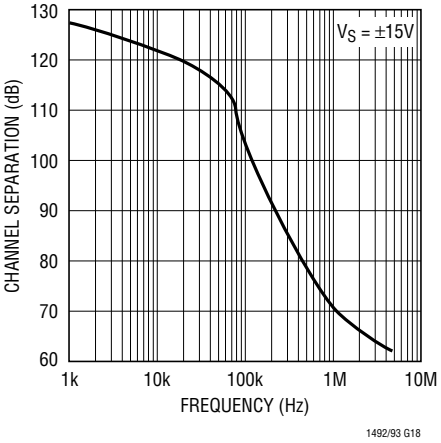
Open-Loop Gain, $V_S = \pm15V$



Negative Output Saturation Voltage vs Load Current

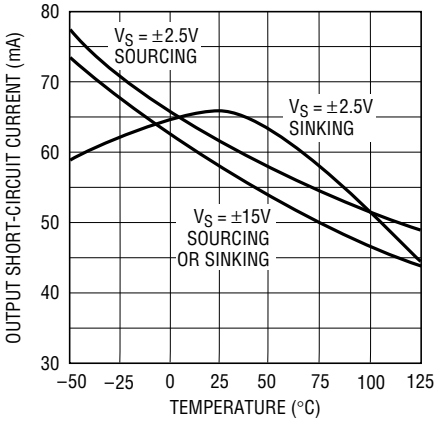


Channel Separation vs Frequency

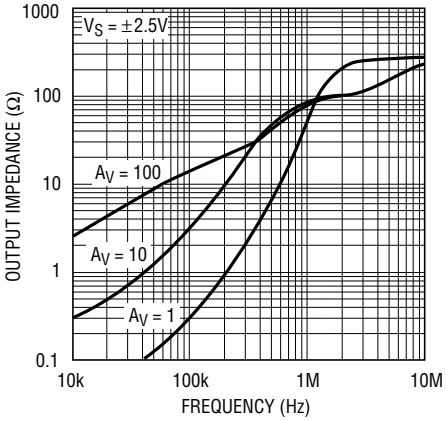


TYPICAL PERFORMANCE CHARACTERISTICS

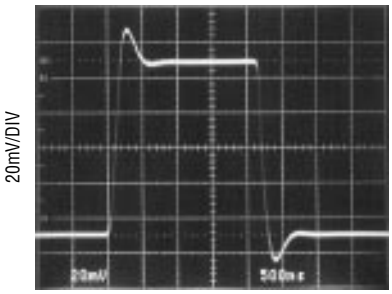
Output Short-Circuit Current vs Temperature



Output Impedance vs Frequency

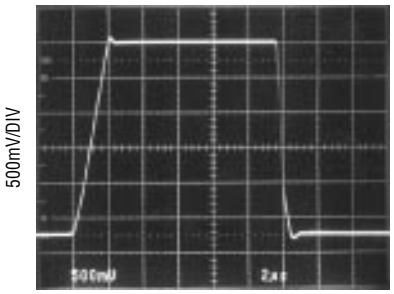


5V Small-Signal Response



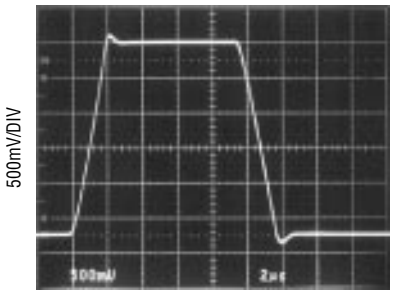
V_S = 5V 500ns/DIV
A_V = 1

5V Large-Signal Response



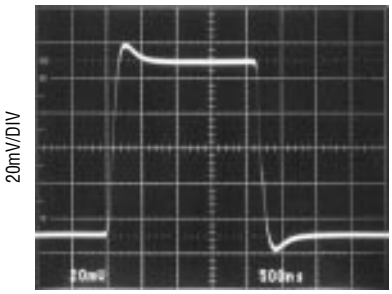
V_S = 5V 2µs/DIV
A_V = 1

5V Large-Signal Response



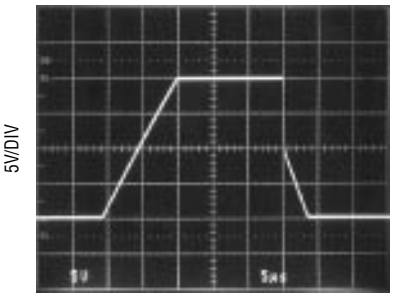
V_S = 5V 2µs/DIV
A_V = –1
$R_F = R_G$ = 2k

±15V Small-Signal Response



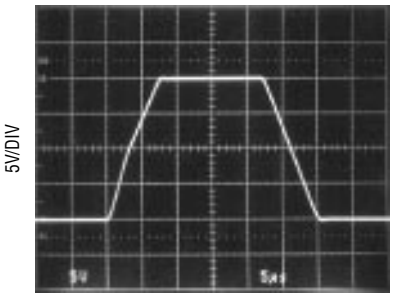
V_S = ±15V 500ns/DIV
A_V = 1

±15V Large-Signal Response



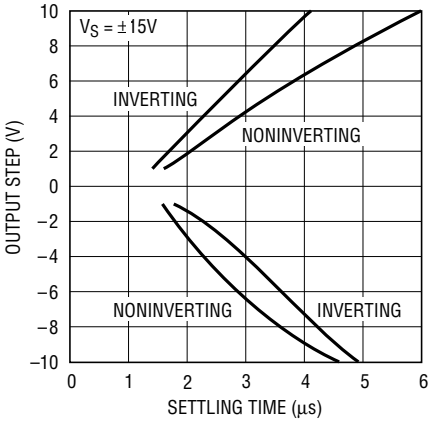
V_S = ±15V 5µs/DIV
A_V = 1

±15V Large-Signal Response



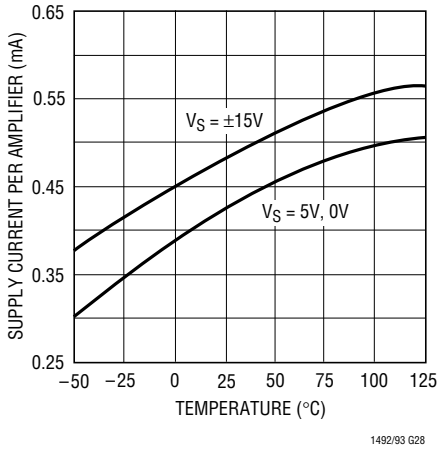
V_S = ±15V 5µs/DIV
A_V = –1
$R_F = R_G$ = 2k

Settling Time to 1mV vs Output Step

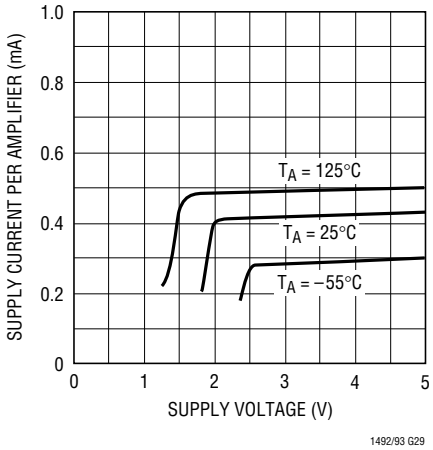


TYPICAL PERFORMANCE CHARACTERISTICS

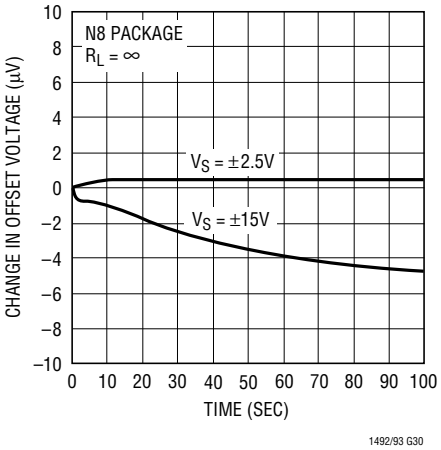
Supply Current vs Temperature



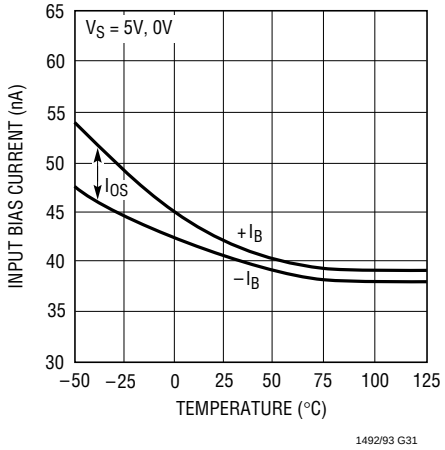
Supply Current vs Supply Voltage



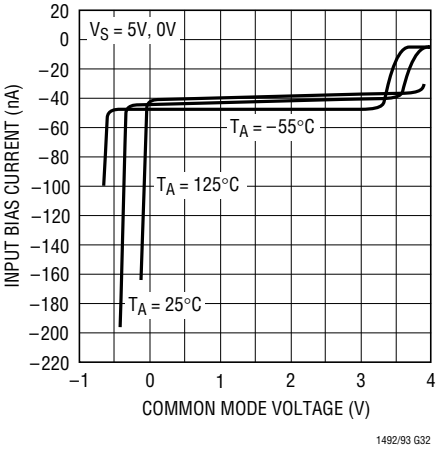
Warm-Up Drift vs Time



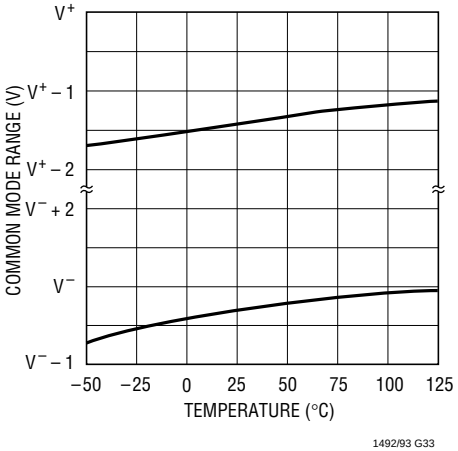
Input Bias Current vs Temperature



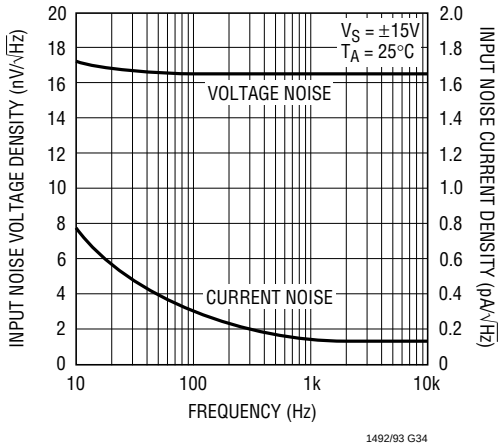
Input Bias Current vs Common Mode Voltage



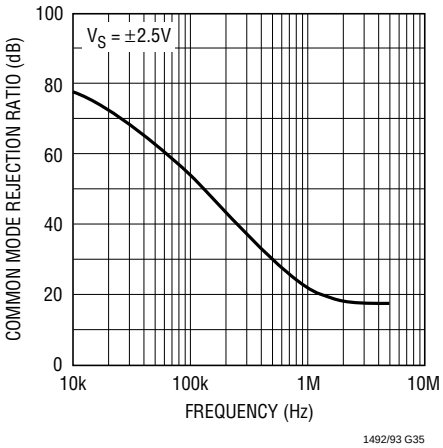
Common Mode Range vs Temperature



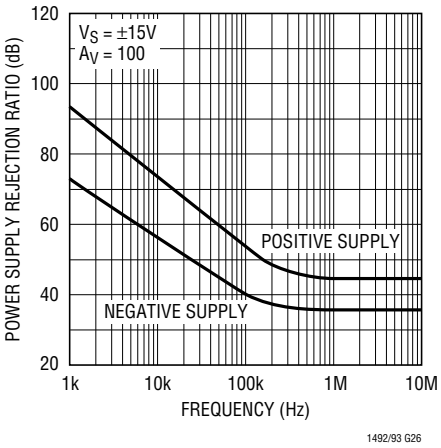
Input Noise Current, Noise Voltage Density vs Frequency



Common Mode Rejection Ratio vs Frequency



Input Referred Power Supply Rejection Ratio vs Frequency



APPLICATIONS INFORMATION

Supply Voltage

The LT1492/LT1493 op amps are fully functional and all internal bias circuits are in regulation with 2.1V of supply. The amplifiers will continue to function with as little as 1.6V, although the input common mode range and the phase margin are about gone. The minimum operating supply voltage is guaranteed by the PSRR tests that are done with the input common mode equal to 500mV and a minimum supply voltage of 2.5V.

The positive supply pin of the LT1492/LT1493 should be bypassed with a small capacitor (about 0.01μF) within an inch of the pin. When driving heavy loads and for good settling time, an additional 4.7μF capacitor should be used. When using split supplies, the same is true for the negative supply pin.

Power Dissipation

The LT1492/LT1493 combine high speed and large output drive in small packages. Because of the wide supply voltage range, it is possible to exceed the maximum junction temperature under certain conditions. Maximum junction temperature (T_J) is calculated from the ambient temperature (T_A) and power dissipation (P_D) as follows:

LT1492CN8: $T_J = T_A + (P_D \bullet 130°C/W)$

LT1492CS8: $T_J = T_A + (P_D \bullet 190°C/W)$

LT1493CS: $T_J = T_A + (P_D \bullet 150°C/W)$

Worst-case power dissipation occurs at the maximum supply current and when the output voltage is at 1/2 of either supply voltage (or the maximum swing if less than 1/2 supply voltage). For each amplifier P_{DMAX} is:

$$P_{DMAX} = (V^+ - V^-)(I_{SMAX}) + (V^+/2)^2/R_L$$

Example: LT1493 at 70°C, $V_S = \pm 15V$, $R_L = 1k$

$$P_{DMAX} = (30V)(930\mu A) + (7.5V)^2/1k\Omega = 84.2mW$$

$$T_{JMAX} = 70°C + (4 \bullet 84.2mW)(150°C/W) = 121°C$$

Inputs

Typically, at room temperature, the inputs of the LT1492/LT1493 can common mode 400mV below ground (V^-) and to within 1.2V of the positive supply with the amplifier still functional. However, the input bias current will shift as shown in the characteristic curves. For full precision performance, the common mode range should be limited between ground (V^-) and 1.5V below the positive supply.

When either of the inputs is taken below ground (V^-) by more than about 700mV, that input current will increase dramatically. The current is limited by internal 100Ω resistors between the input pins and diodes to each supply. The output will remain low (no phase reversal) for inputs 1.3V below ground (V^-). If the output does not have to sink current, such as in a single supply system with a 1k load to ground, there is no phase reversal for inputs up to 8V below ground.

There are no clamps across the inputs of the LT1492/LT1493 and therefore each input can be forced to any voltage between the supplies. The input current will remain constant at about 50nA over most of this range. When an input gets closer than 1.5V to the positive supply, that input current will gradually decrease to zero until the input goes above the supply, then will increase due to the previously mentioned diodes. If the inverting input is held more positive than the noninverting input by 200mV or more, while at the same time the noninverting input is within 300mV to ground (V^-), then the supply current will increase by 1mA and the noninverting input current will increase to about 10μA. This should be kept in mind in comparator applications where the inverting input stays above ground (V^-) and the noninverting input is at or near ground (V^-).

Output

The output of the LT1492/LT1493 will swing to within 0.65V of the positive supply and to within 3mV of the negative supply with no load. Under loaded conditions see the Typical Performance curves for the output saturation voltage characteristics.

The output of the LT1492/LT1493 has reverse-biased diodes to each supply. If the output is forced beyond either supply, unlimited currents will flow. If the current is transient and limited to several hundred milliamps, no damage will occur.

APPLICATIONS INFORMATION

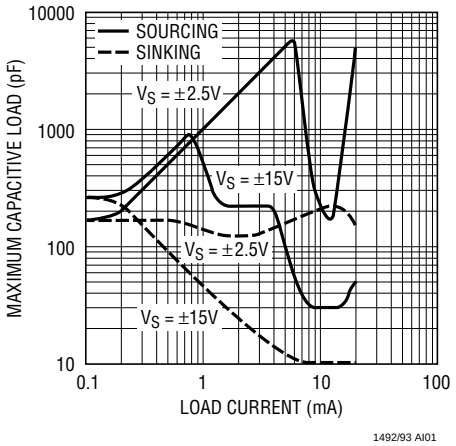
Feedback Components

Because the input currents of the LT1492/LT1493 are less than 100nA, it is possible to use high value feedback resistors to set the gain. However, care must be taken to insure that the pole that is formed by the feedback resistors and the input capacitance does not degrade the stability of the amplifier. For example, if a single supply, noninverting gain of 2 is set with two 62k resistors, the LT1492/LT1493 will probably oscillate. This is because the amplifier goes open-loop at 1MHz (6dB of gain) and has 50° of phase margin. The feedback resistors and the 10pF input capacitance generate a pole at 500kHz that introduces 63° of phase shift at 1MHz! The solution is simple, lower the values of the resistors or add a feedback capacitor of 10pF or more.

Capacitive Loading

The LT1492/LT1493 are optimized for low voltage, single supply operation. The Maximum Capacitive Load vs Load Current typical performance curve shows the circuit performance without any load resistance. When the output is sinking current or driving heavy loads with high supplies, capacitive load handling is degraded.

Maximum Capacitive Load vs Load Current

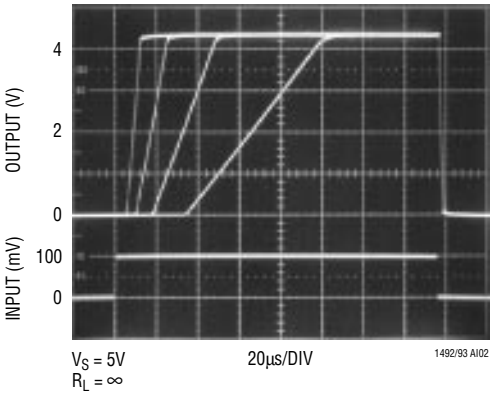


Comparator Applications

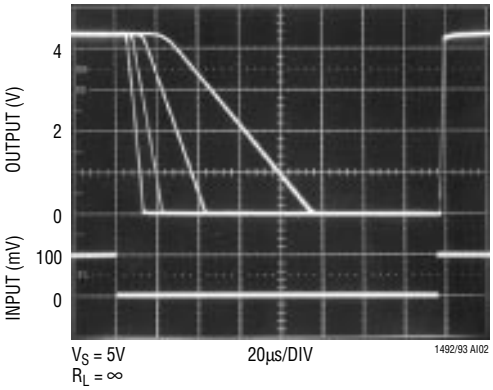
Sometimes it is desirable to use an op amp as a comparator. When operating the LT1492/LT1493 on a single 3.3V or 5V supply, the output interfaces directly with most TTL and CMOS logic.

The response time of the LT1492/LT1493 is a strong function of the amount of input overdrive as shown in the following photos. These amplifiers are unity-gain stable op amps and not fast comparators, therefore, the logic being driven may oscillate due to the long transition time. The output can be speeded up by adding 20mV or more of hysteresis (positive feedback), but the offset is then a function of the input direction.

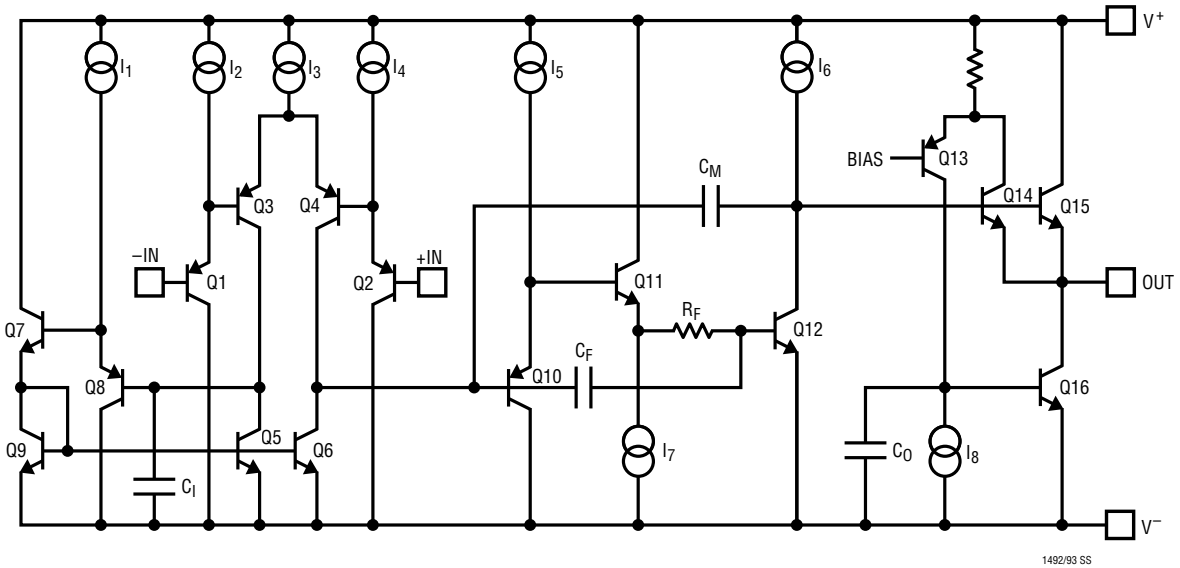
Comparator Response (+)
20mV, 10mV, 5mV, 2mV Overdrives



Comparator Response (–)
20mV, 10mV, 5mV, 2mV Overdrives

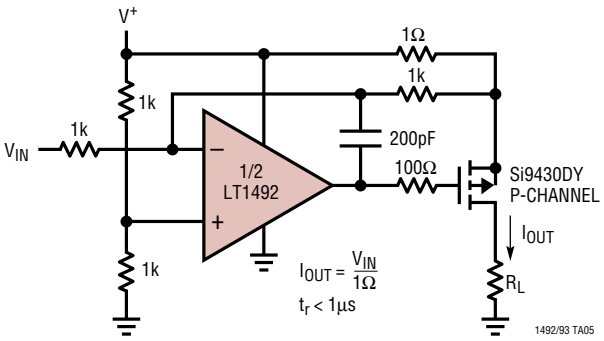


SIMPLIFIED SCHEMATIC

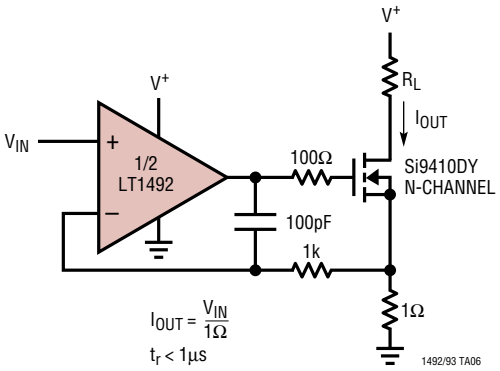


TYPICAL APPLICATIONS

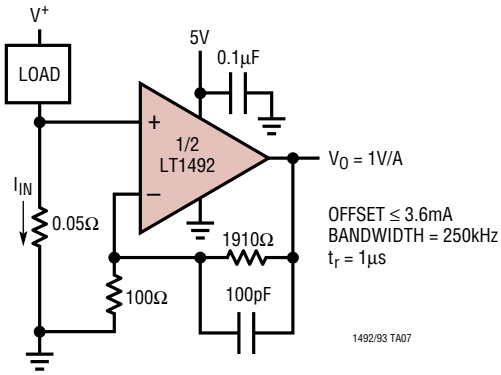
1A Voltage-Controlled Current Source



1A Voltage-Controlled Current Sink



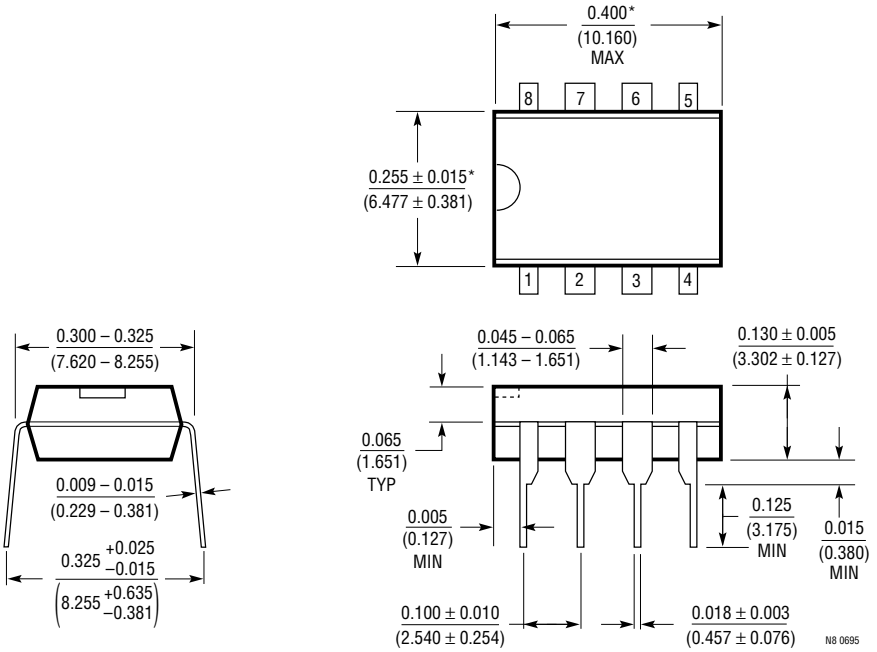
Ground Current Sense Amplifier



PACKAGE DESCRIPTION

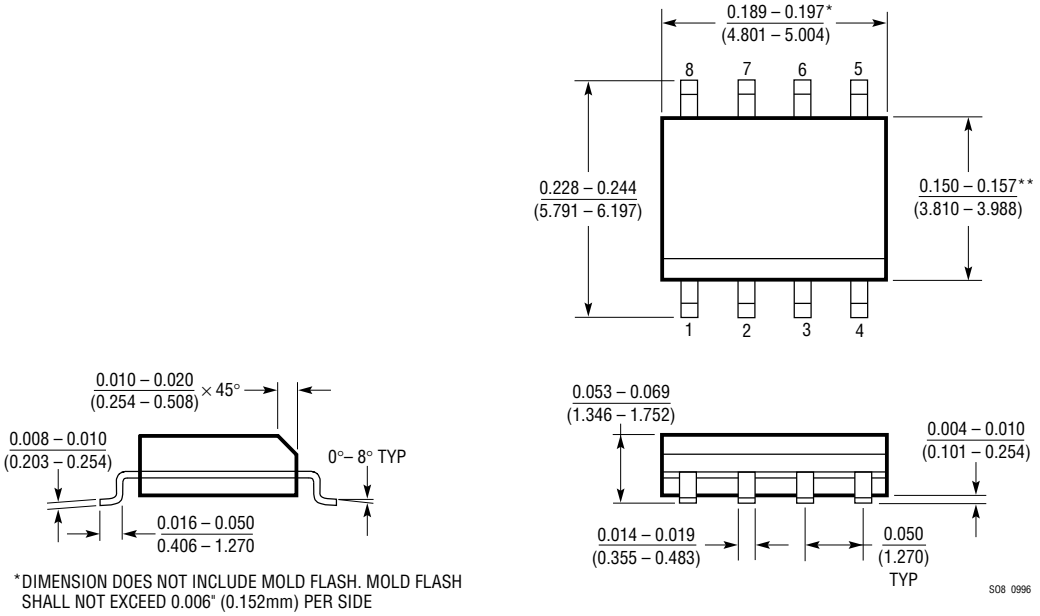
Dimensions in inches (millimeters) unless otherwise noted.

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)

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



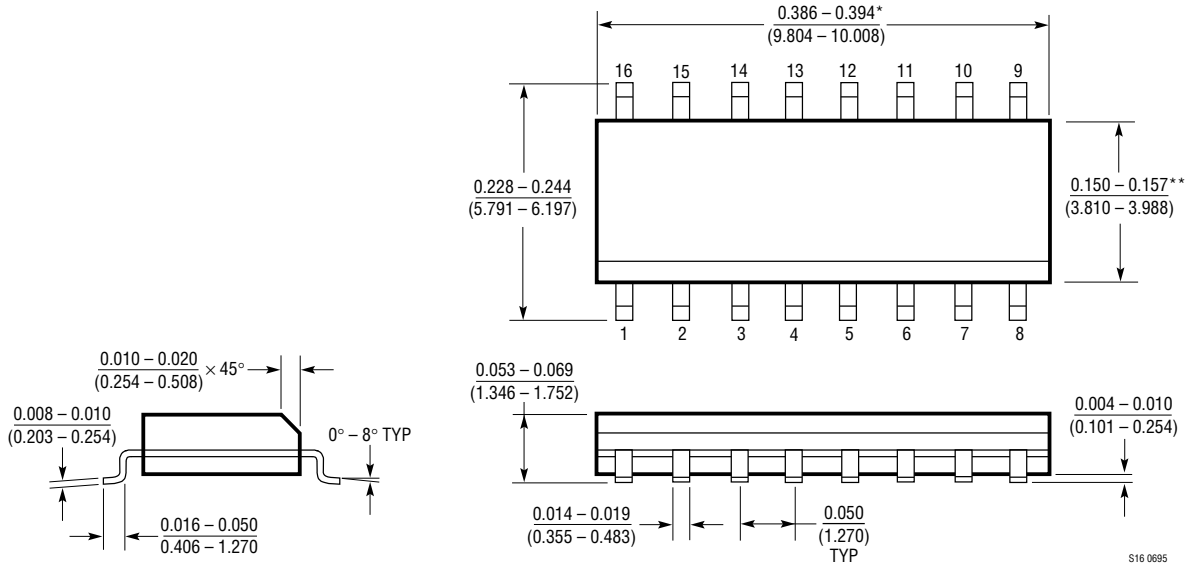
*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

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

PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

S Package
16-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

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