Dual/Quad 3mA, 100MHz, 750V/µs Operational Amplifiers

FEATURES

- **100MHz Gain Bandwidth Product**
- **750V/µs Slew Rate**
- **3.6mA Maximum Supply Current per Amplifier**
- **Tiny 3mm x 3mm x 0.8mm DFN Package**
- 8nV/√Hz Input Noise Voltage
- Unity-Gain Stable
- 1.5mV Maximum Input Offset Voltage
- 4µA Maximum Input Bias Current
- 400nA Maximum Input Offset Current
- 40mA Minimum Output Current, V_{OUT} = ±3V
- ±3.5V Minimum Input CMR, V_S = ±5V
- 30ns Settling Time to 0.1%, 5V Step
- Specified at ±5V, Single 5V Supplies
- Operating Temperature Range: –40°C to 85°C

APPLICATIONS

- Active Filters
- Wideband Amplifiers
- Buffers
- Video Amplification
- Communication Receivers
- Cable Drivers
- Data Acquisition Systems

DESCRIPTION

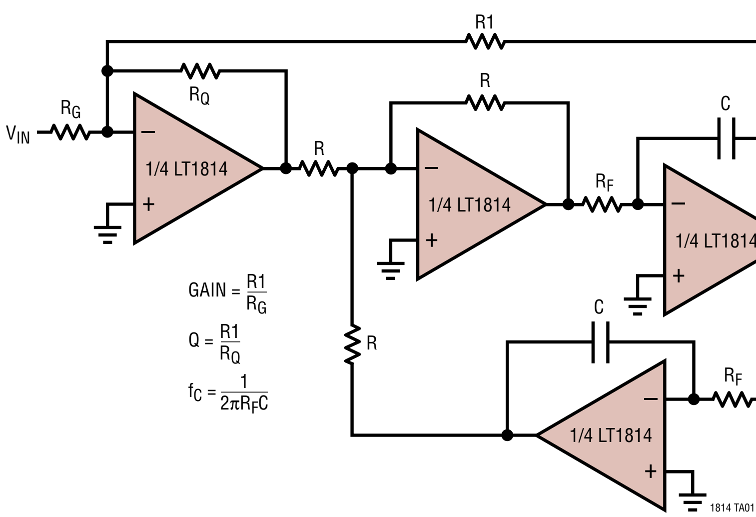
The LT®1813/LT1814 are dual and quad, low power, high speed, very high slew rate operational amplifiers with excellent DC performance. The LT1813/LT1814 feature reduced supply current, lower input offset voltage, lower input bias current and higher DC gain than other devices with comparable bandwidth. The circuit topology is a voltage feedback amplifier with the slewing characteristics of a current feedback amplifier.

The output drives a 100Ω load to ±3.5V with ±5V supplies. On a single 5V supply, the output swings from 1.1V to 3.9V with a 100Ω load connected to 2.5V. The amplifiers are stable with a 1000pF capacitive load making them useful in buffer and cable driver applications.

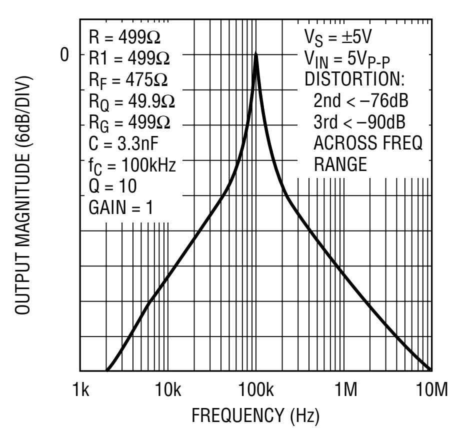
The LT1813/LT1814 are manufactured on Linear Technology's advanced low voltage complementary bipolar process. The LT1813 dual op amp is available in 8-pin MSOP, SO and 3mm x 3mm low profile (0.8mm) dual fine pitch leadless packages (DFN). The quad LT1814 is available in 14-pin SO and 16-pin SSOP packages. A single version, the LT1812, is also available (see separate data sheet).

TYPICAL APPLICATION

Bandpass Filter with Independently Settable Gain, Q and f_C



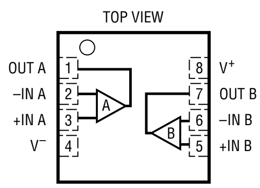
Filter Frequency Response



ABSOLUTE MAXIMUM RATINGS (Note 1)

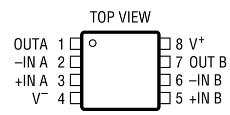
Total Supply Voltage (V^+ to V^-)
 LT1813/LT1814 .... 12.6V
 LT1813HV 13.5V
Differential Input Voltage (Transient Only, Note 2) .. ±6V
Input Voltage .... $\pm V_S$
Output Short-Circuit Duration (Note 3) .... Indefinite
Operating Temperature Range .... –40°C to 85°C
Specified Temperature Range (Note 8) .. –40°C to 85°C
Maximum Junction Temperature .... 150°C
 (DD Package) .... 125°C
Storage Temperature Range .... –65°C to 150°C
 (DD Package) .... –65°C to 125°C
Lead Temperature (Soldering, 10 sec) .... 300°C

PACKAGE/ORDER INFORMATION



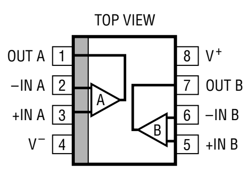
DD PACKAGE
8-LEAD (3mm × 3mm) PLASTIC DFN
T_{JMAX} = 125°C, θ_{JA} = 160°C/W
UNDERSIDE METAL INTERNALLY CONNECTED TO V^-

ORDER PART NUMBER
LT1813DDD*
LT1813CDD
LT1813IDD
DD PART MARKING* **
LAAQ



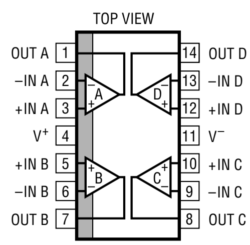
MS8 PACKAGE
8-LEAD PLASTIC MSOP
T_{JMAX} = 150°C, θ_{JA} = 250°C/W

ORDER PART NUMBER
LT1813DMS8*
MS8 PART MARKING
LTGZ



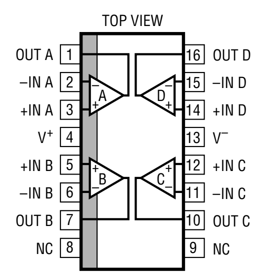
S8 PACKAGE
8-LEAD PLASTIC SO
T_{JMAX} = 150°C, θ_{JA} = 150°C/W

ORDER PART NUMBER	S8 PART MARKING
LT1813DS8*	1813D
LT1813CS8	1813
LT1813IS8	1813I
LT1813HVDS8*	813HVD
LT1813HVCS8	1813HV
LT1813HVIS8	813HVI



S PACKAGE
14-LEAD PLASTIC SO
T_{JMAX} = 150°C, θ_{JA} = 110°C/W

ORDER PART NUMBER
LT1814CS
LT1814IS



GN PACKAGE
16-LEAD PLASTIC SSOP
T_{JMAX} = 150°C, θ_{JA} = 135°C/W

ORDER PART NUMBER
LT1814CGN
LT1814IGN
GN PART MARKING
1814
1814I

Consult LTC marketing for parts specified with wider operating temperature ranges. *See Note 9.
**The temperature grades are identified by a label on the shipping container.

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V_S = ±5V, V_{CM} = 0V, unless otherwise noted. (Note 8)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage (Note 4)				0.5	1.5	mV
		T_A = 0°C to 70°C	●			2	mV
		T_A = −40°C to 85°C	●			3	mV
$\frac{\Delta V_{OS}}{\Delta T}$	Input Offset Voltage Drift (Note 7)	T_A = 0°C to 70°C	●		10	15	µV/°C
		T_A = −40°C to 85°C	●		10	30	µV/°C
I_{OS}	Input Offset Current				50	400	nA
		T_A = 0°C to 70°C	●			500	nA
		T_A = −40°C to 85°C	●			600	nA
I_B	Input Bias Current				−0.9	±4	µA
		T_A = 0°C to 70°C	●			±5	µA
		T_A = −40°C to 85°C	●			±6	µA
e_n	Input Noise Voltage Density	f = 10kHz			8		nV/√Hz
i_n	Input Noise Current Density	f = 10kHz			1		pA/√Hz
R_{IN}	Input Resistance	V_{CM} = 3.5V		3	10		MΩ
		Differential			1.5		MΩ
C_{IN}	Input Capacitance				2		pF
V_{CM}	Input Voltage Range	Guaranteed by CMRR		±3.5	±4.2		V
		T_A = –40°C to 85°C	●	±3.5			V
CMRR	Common Mode Rejection Ratio	V_{CM} = ±3.5V		75	85		dB
		T_A = 0°C to 70°C	●	73			dB
		T_A = −40°C to 85°C	●	72			dB
	Minimum Supply Voltage	Guaranteed by PSRR			±1.25	±2	V
		T_A = –40°C to 85°C	●			±2	V
PSRR	Power Supply Rejection Ratio	V_S = ±2V to ±5.5V		78	97		dB
		T_A = 0°C to 70°C	●	76			dB
		T_A = −40°C to 85°C	●	75			dB
		V_S = ±2V to ±6.5V (LT1813HV)		75	97		dB
		T_A = 0°C to 70°C	●	73			dB
		T_A = −40°C to 85°C	●	72			dB
A_{VOL}	Large-Signal Voltage Gain	V_{OUT} = ±3V, R_L = 500Ω		1.5	3		V/mV
		T_A = 0°C to 70°C	●	1.0			V/mV
		T_A = −40°C to 85°C	●	0.8			V/mV
		V_{OUT} = ±3V, R_L = 100Ω		1.0	2.5		V/mV
		T_A = 0°C to 70°C	●	0.7			V/mV
		T_A = −40°C to 85°C	●	0.6			V/mV
V_{OUT}	Maximum Output Swing (Positive/Negative)	R_L = 500Ω, 30mV Overdrive		±3.8	±4		V
		T_A = 0°C to 70°C	●	±3.7			V
		T_A = −40°C to 85°C	●	±3.6			V
		R_L = 100Ω, 30mV Overdrive		±3.35	±3.5		V
		T_A = 0°C to 70°C	●	±3.25			V
		T_A = −40°C to 85°C	●	±3.15			V

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25°C$. $V_S = ±5V$, $V_{CM} = 0V$, unless otherwise noted. (Note 8)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
I_{OUT}	Maximum Output Current	$V_{OUT} = ±3V$, 30mV Overdrive		±40	±60		mA
		$T_A = 0°C$ to 70°C	●	±35			mA
		$T_A = –40°C$ to 85°C	●	±30			mA
I_{SC}	Output Short-Circuit Current	$V_{OUT} = 0V$, 1V Overdrive (Note 3)		±75	±100		mA
		$T_A = 0°C$ to 70°C	●	±60			mA
		$T_A = –40°C$ to 85°C	●	±55			mA
SR	Slew Rate	$A_V = –1$ (Note 5)		500	750		V/µs
		$T_A = 0°C$ to 70°C	●	400			V/µs
		$T_A = –40°C$ to 85°C	●	350			V/µs
FPBW	Full Power Bandwidth	$6V_{P-P}$ (Note 6)			40		MHz
GBW	Gain Bandwidth Product	f = 200kHz, $R_L = 500Ω$		75	100		MHz
		$T_A = 0°C$ to 70°C	●	65			MHz
		$T_A = –40°C$ to 85°C	●	60			MHz
–3dB BW	–3dB Bandwidth	$A_V = 1$, $R_L = 500Ω$			200		MHz
t_r, t_f	Rise Time, Fall Time	$A_V = 1$, 10% to 90%, 0.1V, $R_L = 100Ω$			2		ns
t_{PD}	Propagation Delay (Note 10)	$A_V = 1$, 50% to 50%, 0.1V, $R_L = 100Ω$			2.8		ns
OS	Overshoot	$A_V = 1$, 0.1V, $R_L = 100Ω$			25		%
t_S	Settling Time	$A_V = –1$, 0.1%, 5V			30		ns
THD	Total Harmonic Distortion	$A_V = 2$, f = 1MHz, $V_{OUT} = 2V_{P-P}$, $R_L = 500Ω$			–76		dB
dG	Differential Gain	$A_V = 2$, $V_{OUT} = 2V_{P-P}$, $R_L = 150Ω$			0.12		%
dP	Differential Phase	$A_V = 2$, $V_{OUT} = 2V_{P-P}$, $R_L = 150Ω$			0.07		DEG
R_{OUT}	Output Resistance	$A_V = 1$, f = 1MHz			0.4		Ω
	Channel Separation	$V_{OUT} = ±3V$, $R_L = 100Ω$		82	100		dB
		$T_A = 0°C$ to 70°C	●	81			dB
		$T_A = –40°C$ to 85°C	●	80			dB
I_S	Supply Current	Per Amplifier			3	3.6	mA
		$T_A = 0°C$ to 70°C	●			4.5	mA
		$T_A = –40°C$ to 85°C	●			5.0	mA
		Per Amplifier, $V_S = ±6.5V$, (LT1813HV only)				4.0	mA
		$T_A = 0°C$ to 70°C	●			5.0	mA
		$T_A = –40°C$ to 85°C	●			5.5	mA

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V_S = 5V, V_{CM} = 2.5V, R_L to 2.5V, unless otherwise noted. (Note 8)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage (Note 4)				0.7	2.0	mV
		T_A = 0°C to 70°C	●			2.5	mV
		T_A = −40°C to 85°C	●			3.5	mV
$\frac{\Delta V_{OS}}{\Delta T}$	Input Offset Voltage Drift (Note 7)	T_A = 0°C to 70°C	●		10	15	µV/°C
		T_A = −40°C to 85°C	●		10	30	µV/°C
I_{OS}	Input Offset Current				50	400	nA
		T_A = 0°C to 70°C	●			500	nA
		T_A = −40°C to 85°C	●			600	nA
I_B	Input Bias Current				−1	±4	µA
		T_A = 0°C to 70°C	●			±5	µA
		T_A = −40°C to 85°C	●			±6	µA
e_n	Input Noise Voltage Density	f = 10kHz			8		nV/√Hz
i_n	Input Noise Current Density	f = 10kHz			1		pA/√Hz
R_{IN}	Input Resistance	V_{CM} = 3.5V		3	10		MΩ
		Differential			1.5		MΩ
C_{IN}	Input Capacitance				2		pF
V_{CM}	Input Voltage Range (Positive)	Guaranteed by CMRR		3.5	4.2		V
		T_A = –40°C to 85°C	●	3.5			V
	Input Voltage Range (Negative)	Guaranteed by CMRR			0.8	1.5	V
		T_A = –40°C to 85°C	●			1.5	V
CMRR	Common Mode Rejection Ratio	V_{CM} = 1.5V to 3.5V		73	82		dB
		T_A = 0°C to 70°C	●	71			dB
		T_A = −40°C to 85°C	●	70			dB
	Minimum Supply Voltage	Guaranteed by PSRR			2.5	4	V
		T_A = –40°C to 85°C	●			4	V
A_{VOL}	Large-Signal Voltage Gain	V_{OUT} = 1.5V to 3.5V, R_L = 500Ω		1.0	2		V/mV
		T_A = 0°C to 70°C	●	0.7			V/mV
		T_A = −40°C to 85°C	●	0.6			V/mV
		V_{OUT} = 1.5V to 3.5V, R_L = 100Ω		0.7	1.5		V/mV
		T_A = 0°C to 70°C	●	0.5			V/mV
		T_A = −40°C to 85°C	●	0.4			V/mV
V_{OUT}	Maximum Output Swing (Positive)	R_L = 500Ω, 30mV Overdrive		3.9	4.1		V
		T_A = 0°C to 70°C	●	3.8			V
		T_A = −40°C to 85°C	●	3.7			V
		R_L = 100Ω, 30mV Overdrive		3.7	3.9		V
		T_A = 0°C to 70°C	●	3.6			V
		T_A = −40°C to 85°C	●	3.5			V
	Maximum Output Swing (Negative)	R_L = 500Ω, 30mV Overdrive			0.9	1.1	V
		T_A = 0°C to 70°C	●			1.2	V
		T_A = −40°C to 85°C	●			1.3	V
		R_L = 100Ω, 30mV Overdrive			1.1	1.3	V
		T_A = 0°C to 70°C	●			1.4	V
		T_A = −40°C to 85°C	●			1.5	V

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V_S = 5V, V_{CM} = 2.5V, R_L to 2.5V, unless otherwise noted. (Note 8)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
I_{OUT}	Maximum Output Current	V_{OUT} = 1.5V or 3.5V, 30mV Overdrive		±25	±35		mA
		T_A = 0°C to 70°C	●	±20			mA
		T_A = –40°C to 85°C	●	±17			mA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 2.5V, 1V Overdrive (Note 3)		±55	±75		mA
		T_A = 0°C to 70°C	●	±45			mA
		T_A = –40°C to 85°C	●	±40			mA
SR	Slew Rate	A_V = –1 (Note 5)		200	350		V/µs
		T_A = 0°C to 70°C	●	150			V/µs
		T_A = –40°C to 85°C	●	125			V/µs
FPBW	Full Power Bandwidth	$2V_{P-P}$ (Note 6)			55		MHz
GBW	Gain Bandwidth Product	f = 200kHz, R_L = 500Ω		65	94		MHz
		T_A = 0°C to 70°C	●	55			MHz
		T_A = –40°C to 85°C	●	50			MHz
–3dB BW	–3dB Bandwidth	A_V = 1, R_L = 500Ω			180		MHz
t_r, t_f	Rise Time, Fall Time	A_V = 1, 10% to 90%, 0.1V, R_L = 100Ω			2.1		ns
t_{PD}	Propagation Delay (Note 10)	A_V = 1, 50% to 50%, 0.1V, R_L = 100Ω			3		ns
OS	Overshoot	A_V = 1, 0.1V, R_L = 100Ω			25		%
t_S	Settling Time	A_V = –1, 0.1%, 2V			30		ns
THD	Total Harmonic Distortion	A_V = 2, f = 1MHz, V_{OUT} = $2V_{P-P}$, R_L = 500Ω			–75		dB
dG	Differential Gain	A_V = 2, V_{OUT} = $2V_{P-P}$, R_L = 150Ω			0.22		%
dP	Differential Phase	A_V = 2, V_{OUT} = $2V_{P-P}$, R_L = 150Ω			0.21		DEG
R_{OUT}	Output Resistance	A_V = 1, f = 1MHz			0.45		Ω
	Channel Separation	V_{OUT} = 1.5V to 3.5V, R_L = 100Ω		81	100		dB
		T_A = 0°C to 70°C	●	80			dB
		T_A = –40°C to 85°C	●	79			dB
I_S	Supply Current	Per Amplifier			2.9	4.0	mA
		T_A = 0°C to 70°C	●			5.0	mA
		T_A = –40°C to 85°C	●			5.5	mA

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

Note 2: Differential inputs of ±6V are appropriate for transient operation only, such as during slewing. Large sustained differential inputs can cause excessive power dissipation and may damage the part.

Note 3: A heat sink may be required to keep the junction temperature below absolute maximum when the output is shorted indefinitely.

Note 4: Input offset voltage is pulse tested and is exclusive of warm-up drift.

Note 5: Slew rate is measured between ±2V at the output with ±3V input for ±5V supplies and $2V_{P-P}$ at the output with a $3V_{P-P}$ input for single 5V supplies.

Note 6: Full power bandwidth is calculated from the slew rate:

$$FPBW = SR/2\pi V_P$$

Note 7: This parameter is not 100% tested

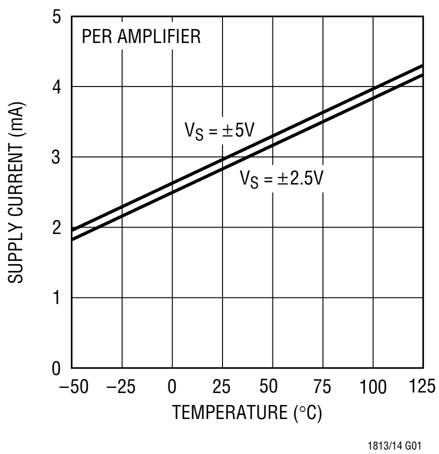
Note 8: The LT1813C/LT1814C are guaranteed to meet specified performance from 0°C to 70°C and is designed, characterized and expected to meet the extended temperature limits, but is not tested at –40°C and 85°C. The LT1813I/LT1814I are guaranteed to meet the extended temperature limits.

Note 9: The LT1813D is 100% production tested at 25°C. It is designed, characterized and expected to meet the 0°C to 70°C specifications although it is not tested or QA sampled at these temperatures. The LT1813D is guaranteed functional from –40°C to 85°C but may not meet those specifications.

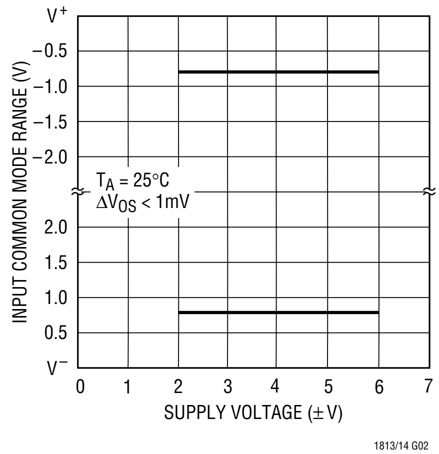
Note 10: Propagation delay is measured from the 50% point on the input waveform to the 50% point on the output waveform.

TYPICAL PERFORMANCE CHARACTERISTICS

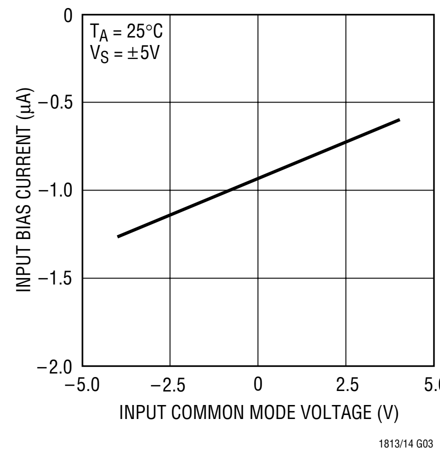
Supply Current vs Temperature



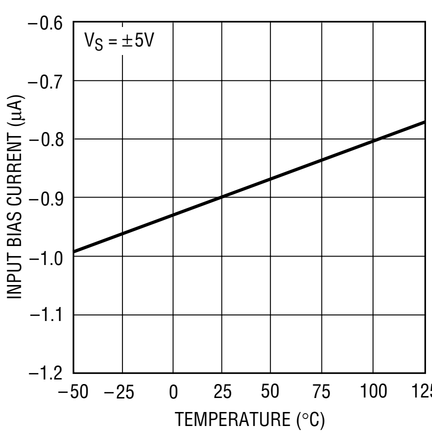
Input Common Mode Range vs Supply Voltage



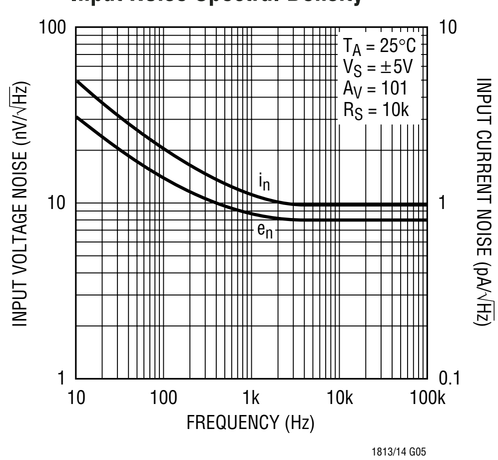
Input Bias Current vs Common Mode Voltage



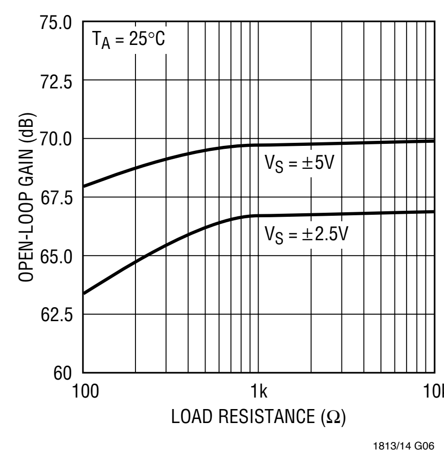
Input Bias Current vs Temperature



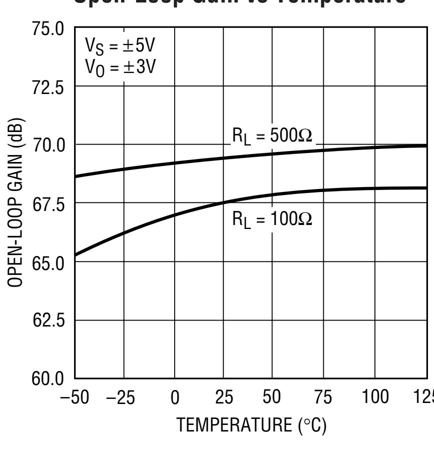
Input Noise Spectral Density



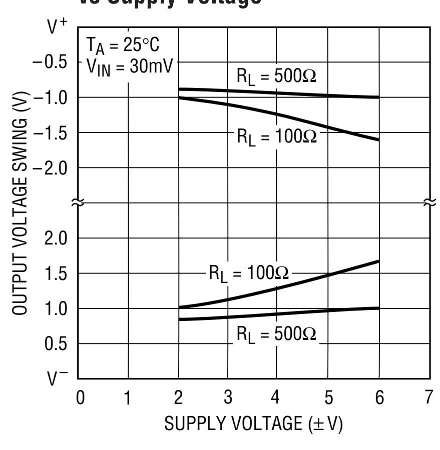
Open-Loop Gain vs Resistive Load



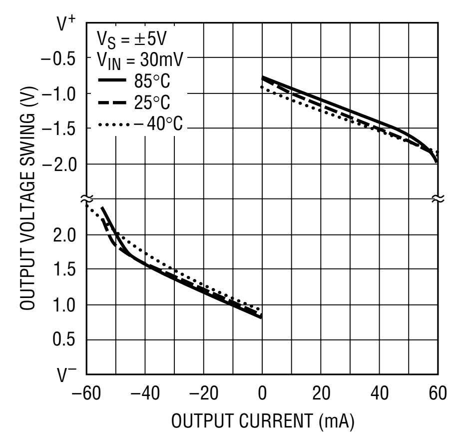
Open-Loop Gain vs Temperature



Output Voltage Swing vs Supply Voltage

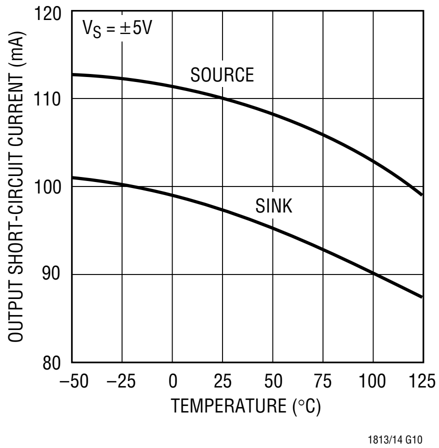


Output Voltage Swing vs Load Current

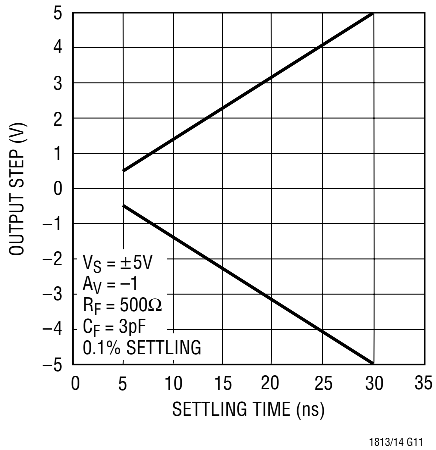


TYPICAL PERFORMANCE CHARACTERISTICS

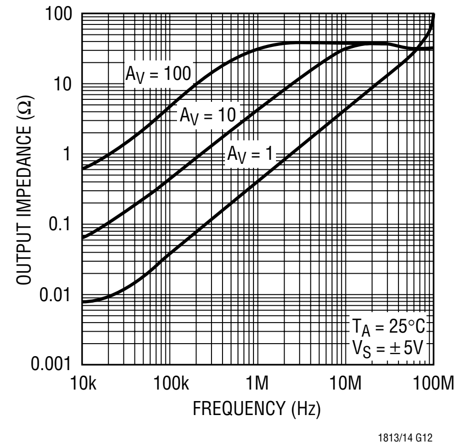
Output Short-Circuit Current vs Temperature



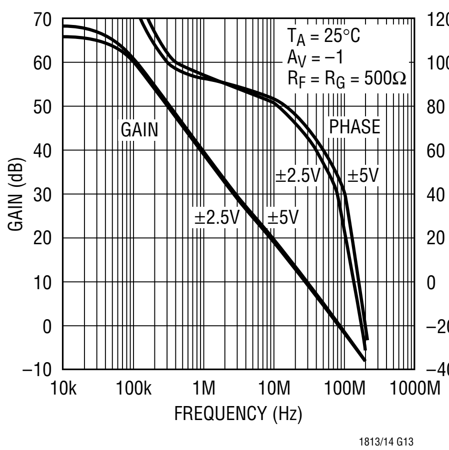
Settling Time vs Output Step



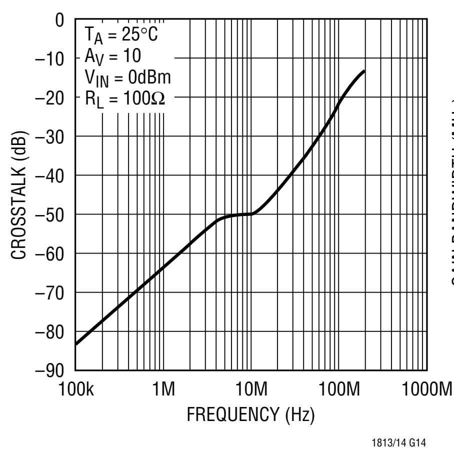
Output Impedance vs Frequency



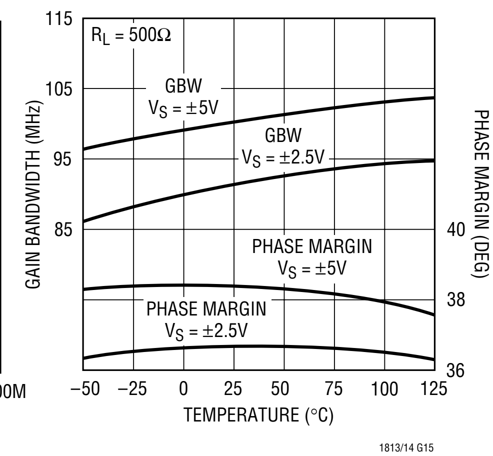
Gain and Phase vs Frequency



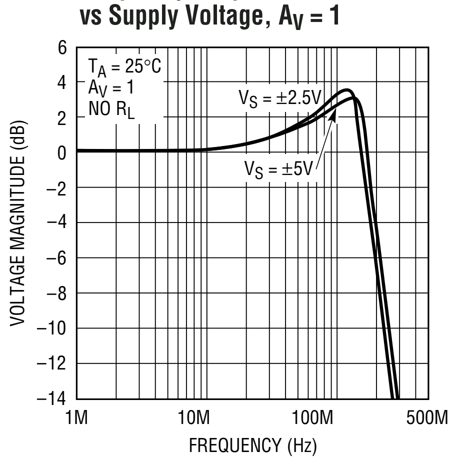
Crosstalk vs Frequency



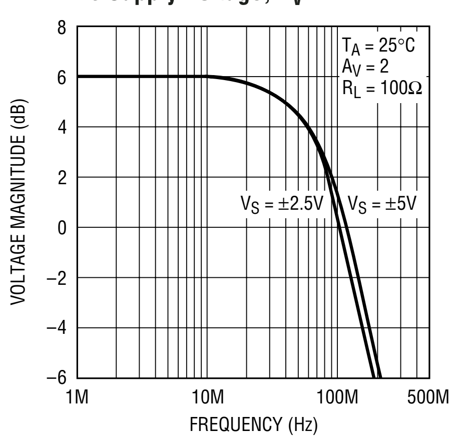
Gain Bandwidth and Phase Margin vs Temperature



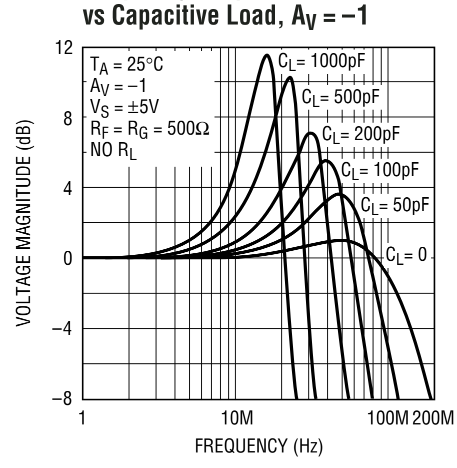
Frequency Response vs Supply Voltage, $A_V = 1$



Frequency Response vs Supply Voltage, $A_V = 2$

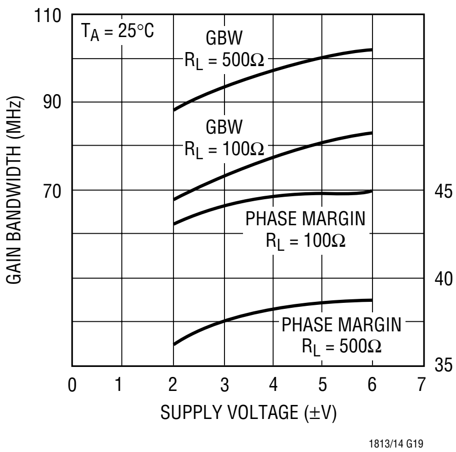


Frequency Response vs Capacitive Load, $A_V = –1$

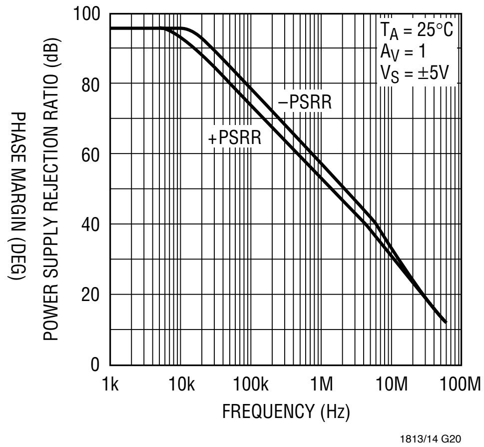


TYPICAL PERFORMANCE CHARACTERISTICS

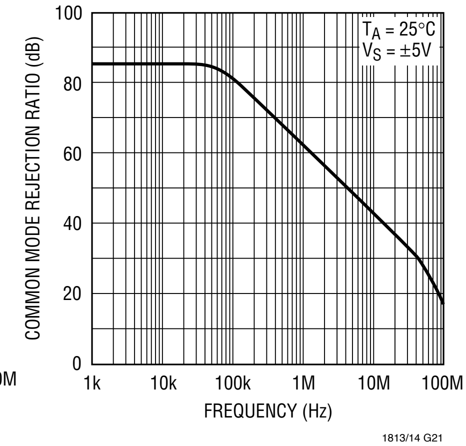
Gain Bandwidth and Phase Margin vs Supply Voltage



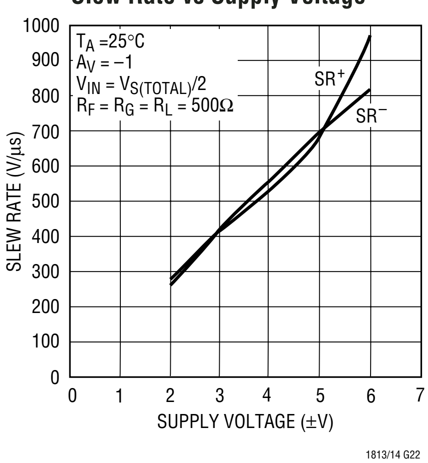
Power Supply Rejection Ratio vs Frequency



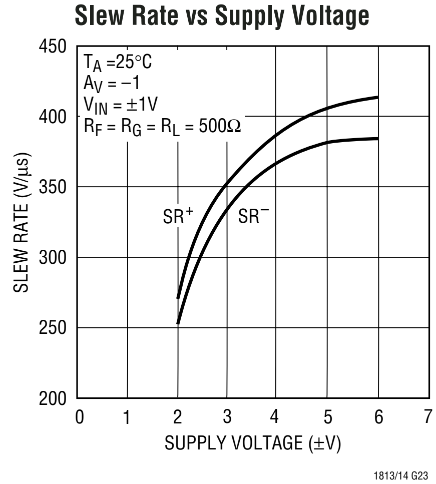
Common Mode Rejection Ratio vs Frequency



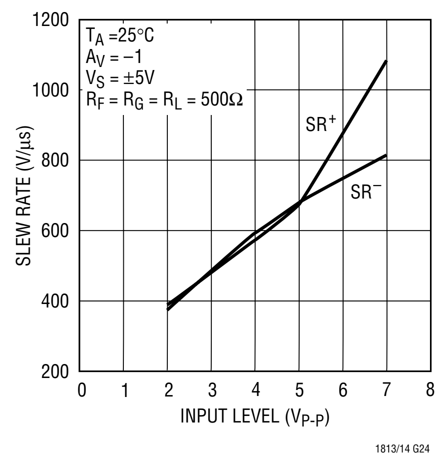
Slew Rate vs Supply Voltage



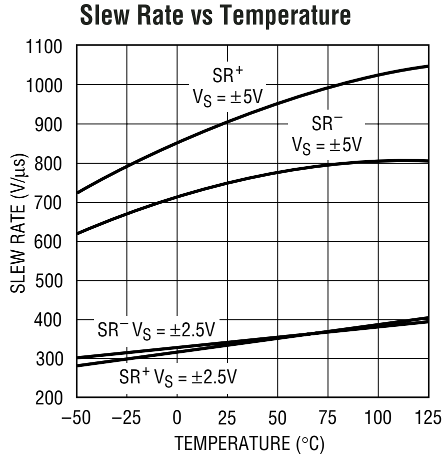
Slew Rate vs Supply Voltage



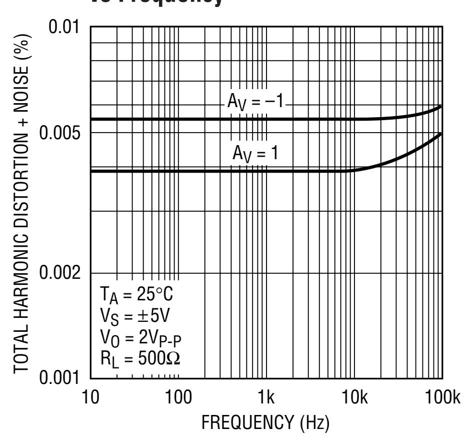
Slew Rate vs Input Level



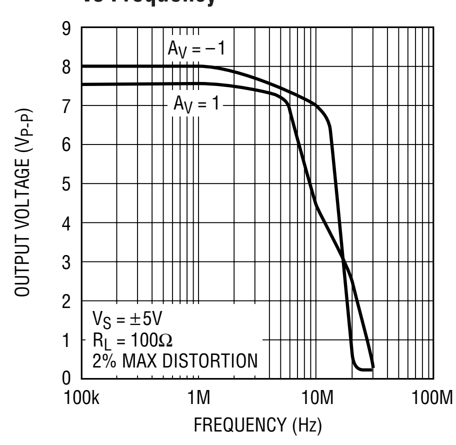
Slew Rate vs Temperature



Total Harmonic Distortion + Noise vs Frequency

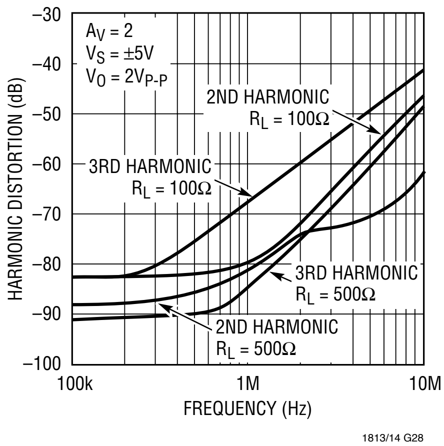


Undistorted Output Swing vs Frequency

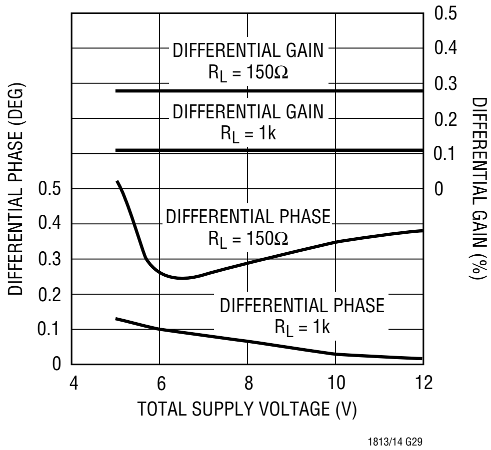


TYPICAL PERFORMANCE CHARACTERISTICS

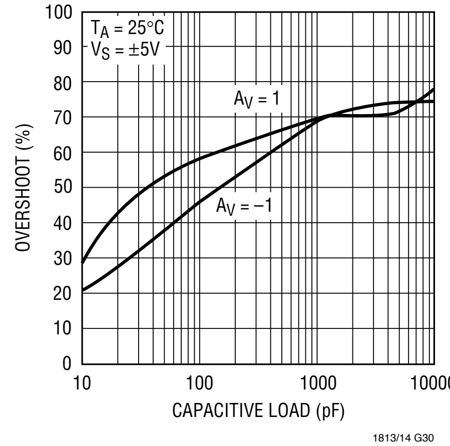
2nd and 3rd Harmonic Distortion vs Frequency



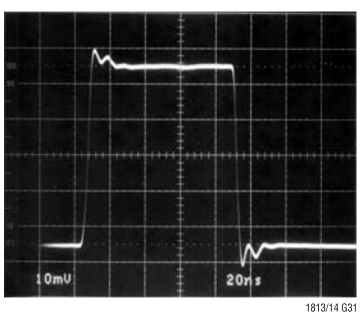
Differential Gain and Phase vs Supply Voltage



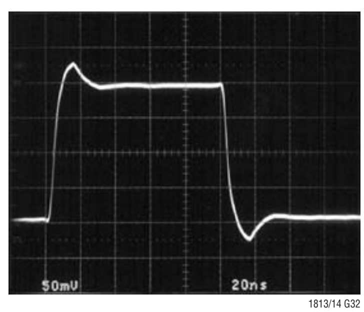
Capacitive Load Handling



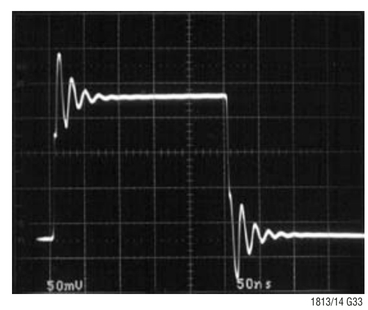
Small-Signal Transient (A_V = 1)



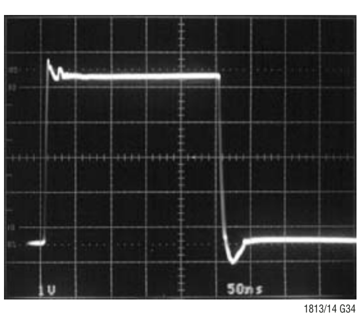
Small-Signal Transient (A_V = –1)



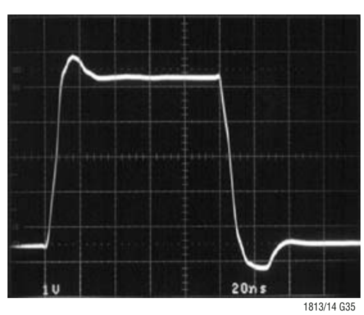
Small-Signal Transient (A_V = 1, C_L = 100pF)



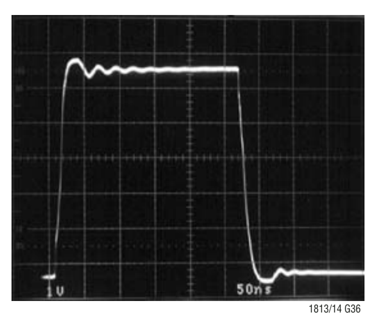
Large-Signal Transient (A_V = 1)



Large-Signal Transient (A_V = –1)



Large-Signal Transient (A_V = –1, C_L = 200pF)



APPLICATIONS INFORMATION

Layout and Passive Components

The LT1813/LT1814 amplifiers are more tolerant of less than ideal board layouts than other high speed amplifiers. For optimum performance, a ground plane is recommended and trace lengths should be minimized, especially on the negative input lead.

Low ESL/ESR bypass capacitors should be placed directly at the positive and negative supply pins (0.01µF ceramics are recommended). For high drive current applications, additional 1µF to 10µF tantalums should be added.

The parallel combination of the feedback resistor and gain setting resistor on the inverting input combine with the input capacitance to form a pole that can cause peaking or even oscillations. If feedback resistors greater than 1k are used, a parallel capacitor of value:

$$C_F > R_G \bullet C_{IN}/R_F$$

should be used to cancel the input pole and optimize dynamic performance. For applications where the DC noise gain is 1 and a large feedback resistor is used, C_F should be greater than or equal to C_{IN}. An example would be an I-to-V converter.

Input Considerations

The inputs of the LT1813/LT1814 amplifiers are connected to the base of an NPN and PNP bipolar transistor in parallel. The base currents are of opposite polarity and provide first order bias current cancellation. Due to variation in the matching of NPN and PNP beta, the polarity of the input bias current can be positive or negative. The offset current, however, does not depend on beta matching and is tightly controlled. Therefore, the use of balanced source resistance at each input is recommended for applications where DC accuracy must be maximized. For example, with a 100Ω source resistance at each input, the 400nA maximum offset current results in only 40µV of extra offset, while without balance the 4µA maximum input bias current could result in a 0.4mV offset contribution.

The inputs can withstand differential input voltages of up to 6V without damage and without needing clamping or series resistance for protection. This differential input voltage generates a large internal current (up to 40mA), which results in the high slew rate. In normal transient closed-loop operation, this does not increase power dissipation significantly because of the low duty cycle of the transient inputs. Sustained differential inputs, however, will result in excessive power dissipation and therefore **this device should not be used as a comparator.**

Capacitive Loading

The LT1813/LT1814 are stable with capacitive loads from 0pF to 1000pF, which is outstanding for a 100MHz amplifier. The internal compensation circuitry accomplishes this by sensing the load induced output pole and adding compensation at the amplifier gain node as needed. As the capacitive load increases, both the bandwidth and phase margin decrease so there will be peaking in the frequency domain and ringing in the transient response. Coaxial cable can be driven directly, but for best pulse fidelity a resistor of value equal to the characteristic impedance of the cable (e.g., 75Ω) should be placed in series with the output. The receiving end of the cable should be terminated with the same value resistance to ground.

Slew Rate

The slew rate of the LT1813/LT1814 is proportional to the differential input voltage. Highest slew rates are therefore seen in the lowest gain configurations. For example, a 5V output step in a gain of 10 has a 0.5V input step, whereas in unity gain there is a 5V input step. The LT1813/LT1814 is tested for a slew rate in a gain of –1. Lower slew rates occur in higher gain configurations.

Power Dissipation

The LT1813/LT1814 combine two or four amplifiers with high speed and large output drive in a small package. It is possible to exceed the maximum junction temperature specification under certain conditions. Maximum junction temperature (T_J) is calculated from the ambient temperature (T_A) and power dissipation (P_D) as follows:

$$T_J = T_A + (P_D \bullet \theta_{JA})$$

APPLICATIONS INFORMATION

Power dissipation is composed of two parts. The first is due to the quiescent supply current and the second is due to on-chip dissipation caused by the load current. The worst-case load induced power occurs when the output voltage is at 1/2 of either supply voltage (or the maximum swing if less than 1/2 the supply voltage). Therefore P_{DMAX} is:

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

$$P_{DMAX} = (V^+ - V^-) \bullet (I_{SMAX}) + (V^+ - V_{OMAX}) \bullet (V_{OMAX}/R_L)$$

Example: LT1814S at 70°C, $V_S = \pm5V$, $R_L = 100\Omega$

$$P_{DMAX} = (10V) \bullet (4.5mA) + (2.5V)^2/100\Omega = 108mW$$

$$T_{JMAX} = 70°C + (4 \bullet 108mW) \bullet (100°C/W) = 113°C$$

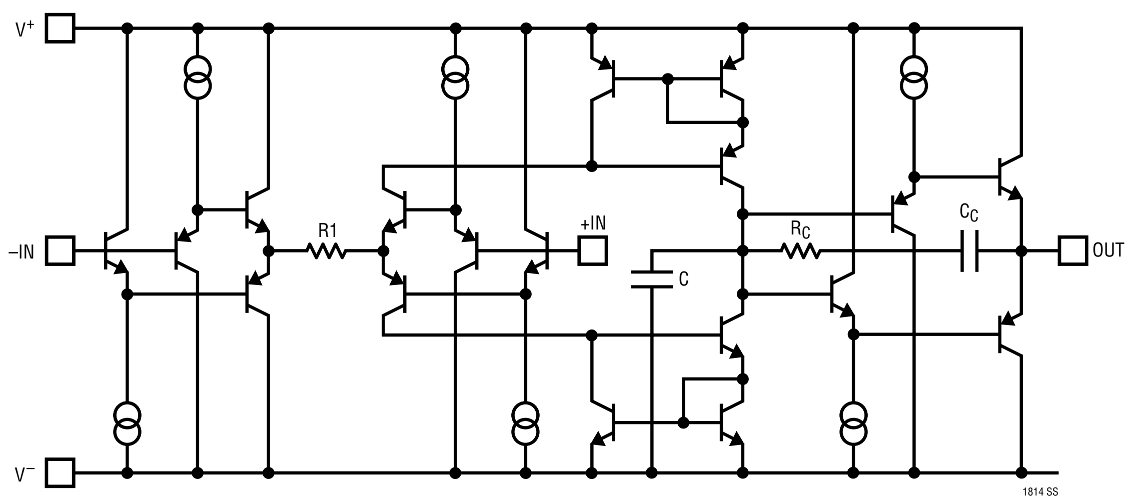
Circuit Operation

The LT1813/LT1814 circuit topology is a true voltage feedback amplifier that has the slewing behavior of a current feedback amplifier. The operation of the circuit can be understood by referring to the Simplified Schematic. Complementary NPN and PNP emitter followers buffer the inputs and drive an internal resistor. The input voltage appears across the resistor, generating current that is mirrored into the high impedance node.

Complementary followers form an output stage that buffers the gain node from the load. The input resistor, input stage transconductance, and the capacitor on the high impedance node determine the bandwidth. The slew rate is determined by the current available to charge the gain node capacitance. This current is the differential input voltage divided by R1, so the slew rate is proportional to the input step. Highest slew rates are therefore seen in the lowest gain configurations.

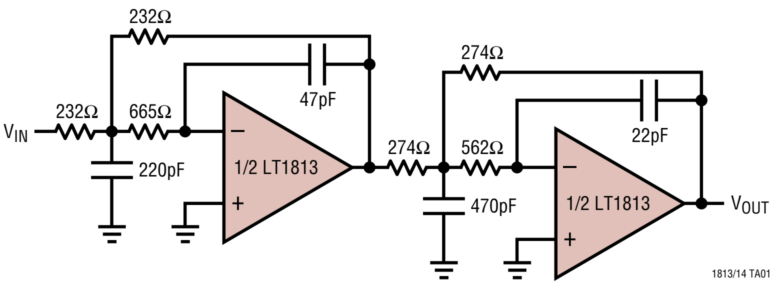
The RC network across the output stage is bootstrapped when the amplifier is driving a light or moderate load and has no effect under normal operation. When a heavy load (capacitive or resistive) is driven, the network is incompletely bootstrapped and adds to the compensation at the high impedance node. The added capacitance moves the unity-gain frequency away from the pole formed by the output impedance and the capacitive load. The zero created by the RC combination adds phase to ensure that the total phase lag does not exceed 180° (zero phase margin), and the amplifier remains stable. In this way, the LT1813/LT1814 are stable with up to 1000pF capacitive loads in unity gain, and even higher capacitive loads in higher closed-loop gain configurations.

SIMPLIFIED SCHEMATIC (one amplifier)

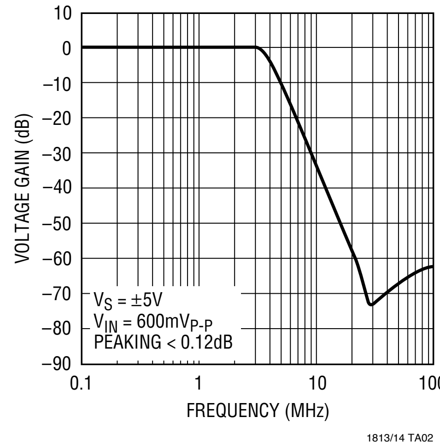


TYPICAL APPLICATION

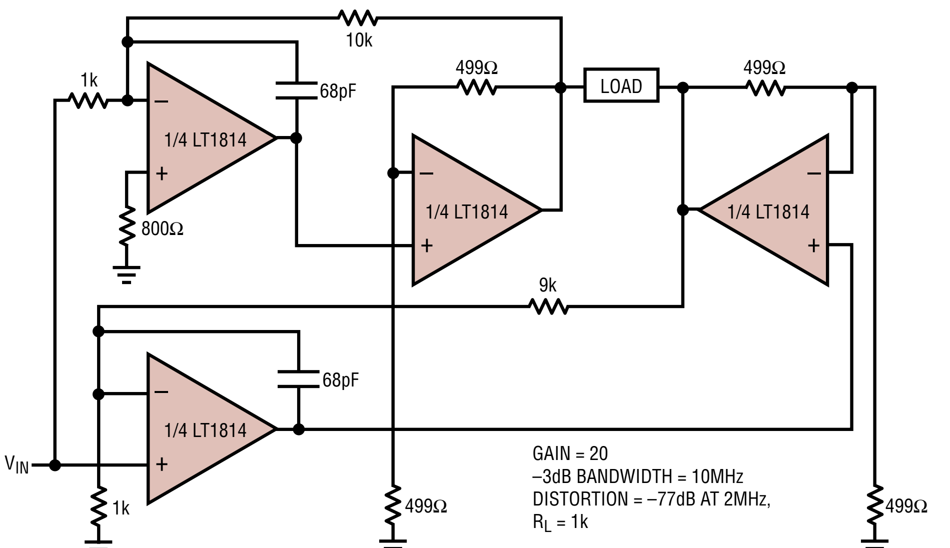
4MHz, 4th Order Butterworth Filter



Filter Frequency Response

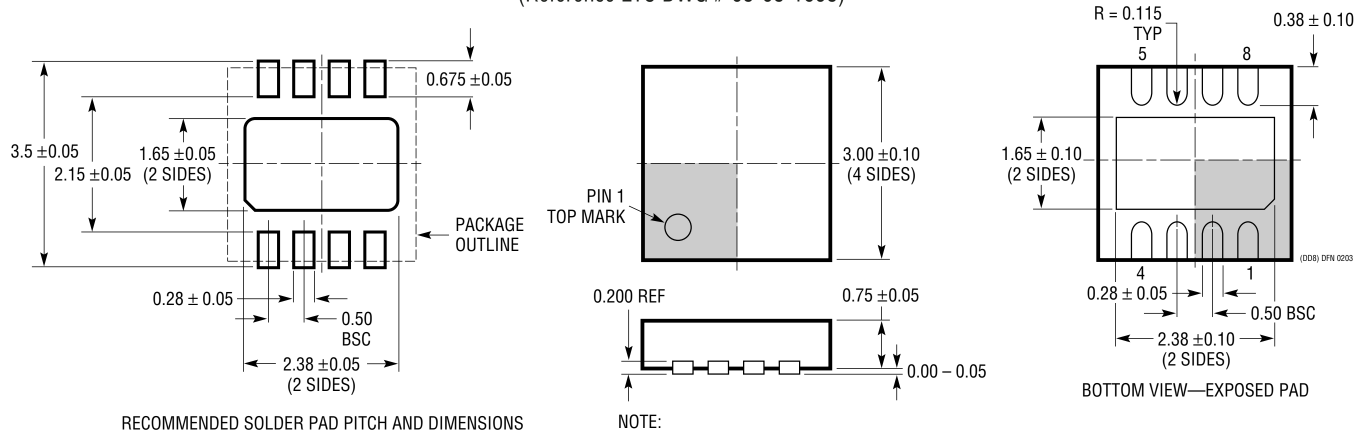


Gain of 20 Composite Amplifier Drives Differential Load with Low Distortion



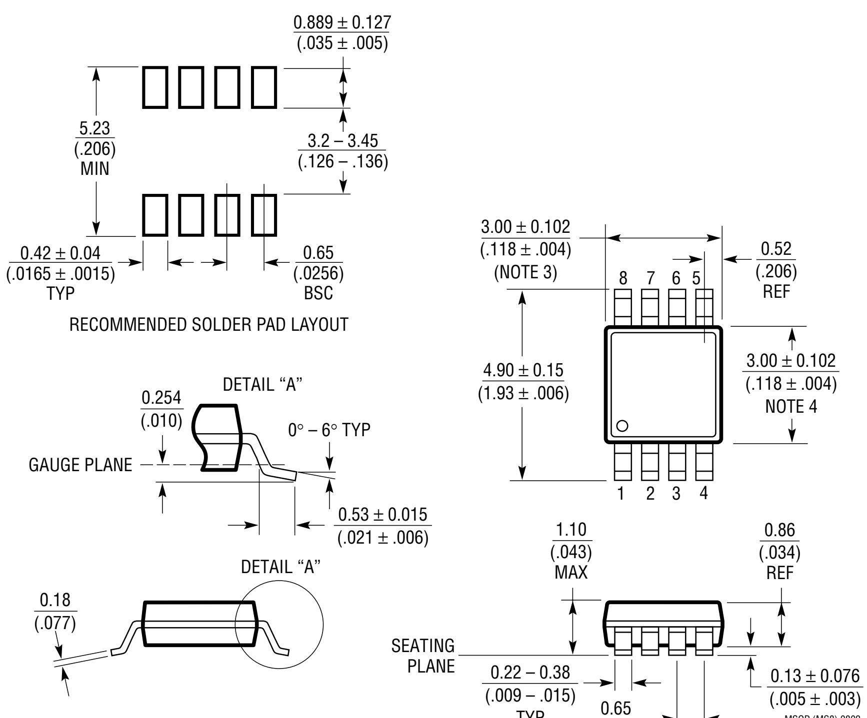
PACKAGE DESCRIPTION

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



NOTE:
1. DRAWING TO BE MADE A JEDEC PACKAGE OUTLINE M0-229 VARIATION OF (WEED-1)
2. ALL DIMENSIONS ARE IN MILLIMETERS
3. 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
4. EXPOSED PAD SHALL BE SOLDER PLATED

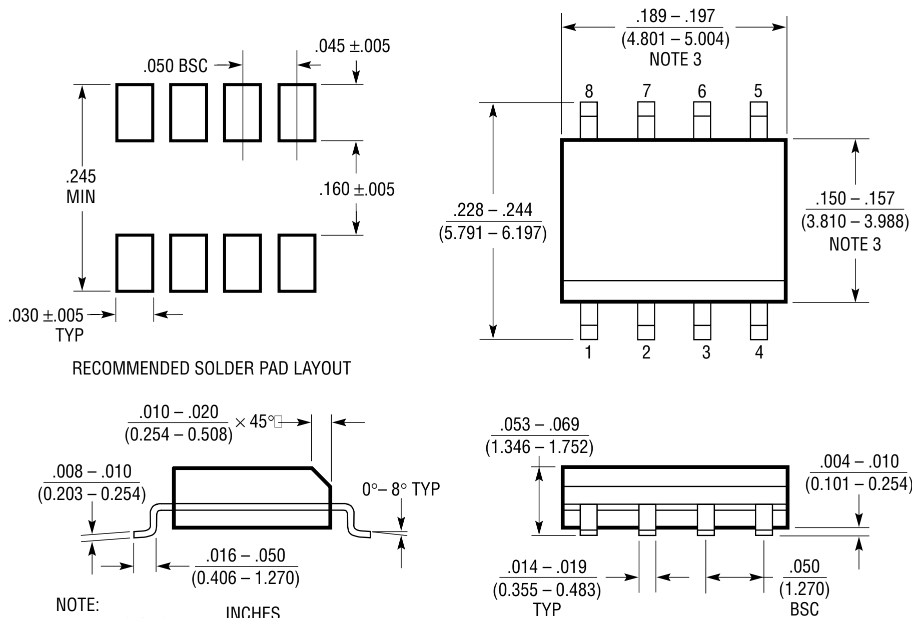
MS8 Package
8-Lead Plastic MSOP
(Reference LTC DWG # 05-08-1660)



NOTE:
1. DIMENSIONS IN MILLIMETER/(INCH)
2. DRAWING NOT TO SCALE
3. DIMENSION DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.152mm (.006") PER SIDE
4. DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS. INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.152mm (.006") PER SIDE
5. LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.102mm (.004") MAX

PACKAGE DESCRIPTION

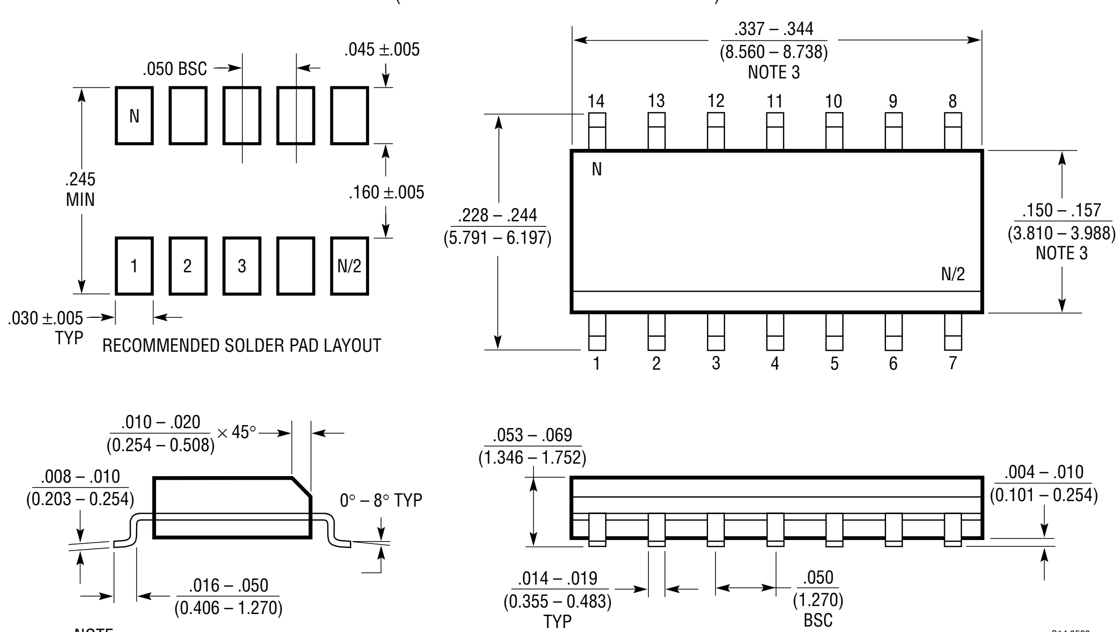
S8 Package
8-Lead Plastic Small Outline (Narrow .150 Inch)
(Reference LTC DWG # 05-08-1610)



NOTE:
1. DIMENSIONS IN INCHES / (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)

SO8 0303

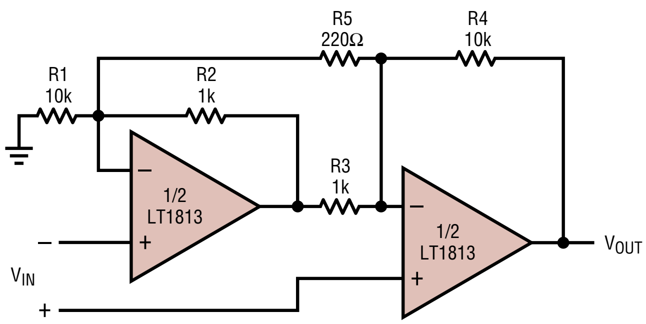
S Package
14-Lead Plastic Small Outline (Narrow .150 Inch)
(Reference LTC DWG # 05-08-1610)



NOTE:
1. DIMENSIONS IN INCHES / (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)

TYPICAL APPLICATION

Two Op Amp Instrumentation Amplifier



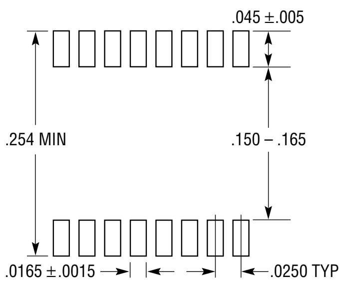
$$\text{GAIN} = \left[\frac{R4}{R3}\right]\left[1 + \left(\frac{1}{2}\right)\left(\frac{R2}{R1} + \frac{R3}{R4}\right) + \frac{(R2 + R3)}{R5}\right] = 102$$

TRIM R5 FOR GAIN
TRIM R1 FOR COMMON MODE REJECTION
BW = 1MHz

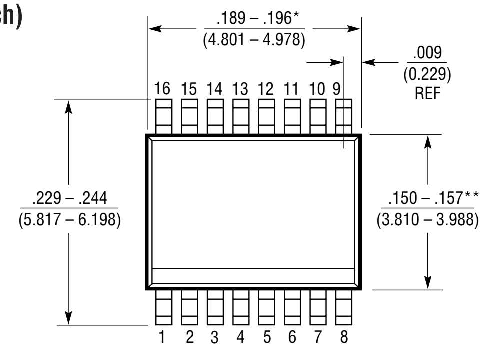
1813/14 TA03

PACKAGE DESCRIPTION

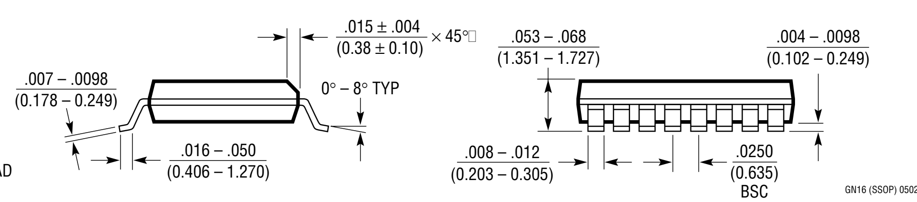
GN Package
16-Lead Plastic SSOP (Narrow .150 Inch)
(Reference LTC DWG # 05-08-1641)



RECOMMENDED SOLDER PAD LAYOUT



NOTE:
1. CONTROLLING DIMENSION: INCHES
2. DIMENSIONS ARE IN $\frac{\text{INCHES}}{\text{(MILLIMETERS)}}$
3. DRAWING NOT TO SCALE
*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



GN16 (SSOP) 0502

RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1363/LT1364/LT1365	Single/Dual/Quad 70MHz, 1000V/µs, C-Load™ Op Amps	±2.5V to ±15V Operation
LT1395/LT1396/LT1397	Single/Dual/Quad 400MHz Current Feedback Amplifiers	4.6mA Supply Current, 800V/µs, 80mA Output Current
LT1806/LT1807	Single/Dual 325MHz, 140V/µs Rail-to-Rail I/O Op Amps	Low Noise 3.5nV/√Hz
LT1809/LT1810	Single/Dual 180MHz, 350V/µs Rail-to-Rail I/O Op Amps	Low Distortion –90dBc at 5MHz
LT1812	Single 3mA, 100MHz, 750V/µs Op Amp	Single Version of LT1813/LT1814; 50µA Shutdown Option
LT1815/LT1816/LT1817	Single/Dual/Quad 220MHz, 1500V/µs Op Amps	6.5mA Supply Current, 6nV/√Hz Input Noise

C-Load is a trademark of Linear Technology Corporation.

18134fa

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