3mA, 100MHz, 750V/µs Operational Amplifier with Shutdown

FEATURES

- **100MHz Gain Bandwidth**
- **750V/µs Slew Rate**
- **3.6mA Maximum Supply Current**
- **Available in SOT-23 and S8 Packages**
- **50µA Supply Current in Shutdown**
- 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

- Wideband Amplifiers
- Buffers
- Active Filters
- Video and RF Amplification
- Cable Drivers
- Data Acquisition Systems

DESCRIPTION

The LT®1812 is a low power, high speed, very high slew rate operational amplifier with excellent DC performance. The LT1812 features reduced supply current, lower input offset voltage, lower input bias current and higher DC gain than other devices with comparable bandwidth. A power saving shutdown feature reduces supply current to 50µA. 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 amplifier is stable with a 1000pF capacitive load which makes it useful in buffer and cable driver applications.

The LT1812 is manufactured on Linear Technology's advanced low voltage complementary bipolar process. The dual version is the LT1813. For higher supply voltage single, dual and quad operational amplifiers with up to 70MHz gain bandwidth, see the LT1351 through LT1365 data sheets.

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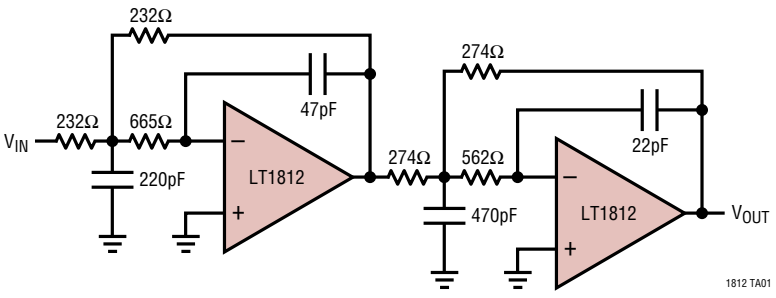
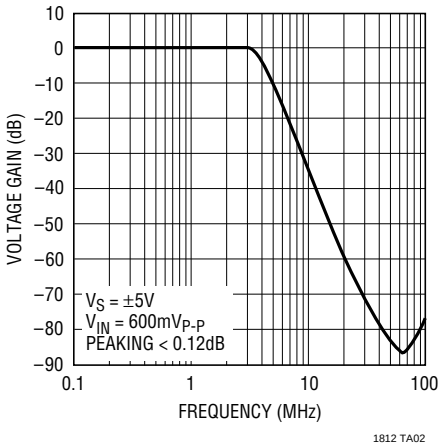
TYPICAL APPLICATION

4MHz, 4th Order Butterworth Filter



Filter Frequency Response



ABSOLUTE MAXIMUM RATINGS (Note 1)

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

PACKAGE/ORDER INFORMATION

TOP VIEW V_{OUT} 1 V^- 2 +IN 3 5 V^+ 4 –IN S5 PACKAGE 5-LEAD PLASTIC SOT-23 T_{JMAX} = 150°C, θ_{JA} = 250°C/W (NOTE 9)	ORDER PART NUMBER LT1812CS5 LT1812IS5 S5 PART MARKING LTLH LTLJ	TOP VIEW V_{OUT} 1 V^- 2 +IN 3 6 V^+ 5 $\overline{SHDN}$ 4 –IN S6 PACKAGE 6-LEAD PLASTIC SOT-23 T_{JMAX} = 150°C, θ_{JA} = 230°C/W (NOTE 9)	ORDER PART NUMBER LT1812CS6 LT1812IS6 S6 PART MARKING LTLK LTLL	TOP VIEW NC 1 –IN 2 +IN 3 V^- 4 8 $\overline{SHDN}$ 7 V^+ 6 V_{OUT} 5 NC S8 PACKAGE 8-LEAD PLASTIC SO T_{JMAX} = 150°C, θ_{JA} = 150°C/W (NOTE 9)	ORDER PART NUMBER LT1812CS8 LT1812IS8 S8 PART MARKING 1812 1812I

Consult factory for Military grade parts.

ELECTRICAL CHARACTERISTICS

T_A = 25°C, V_S = ±5V, V_{CM} = 0V unless otherwise noted (Note 10).

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage	(Note 4)		0.4	1.5	mV
I_{OS}	Input Offset Current			30	400	nA
I_B	Input Bias Current			–0.9	±4	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 Differential	3	10 1.5		MΩ MΩ
C_{IN}	Input Capacitance			2		pF
V_{CM}	Input Voltage Range (Positive) Input Voltage Range (Negative)		3.5	4.2 –4.2	 –3.5	V V
CMRR	Common Mode Rejection Ratio	V_{CM} = ±3.5V	75	85		dB
	Minimum Supply Voltage			±1.25	±2	V
PSRR	Power Supply Rejection Ratio	V_S = ±2V to ±5.5V	78	97		dB
A_{VOL}	Large-Signal Voltage Gain	V_{OUT} = ±3V, R_L = 500Ω V_{OUT} = ±3V, R_L = 100Ω	1.5 1.0	3.0 2.5		V/mV V/mV
V_{OUT}	Maximum Output Swing	R_L = 500Ω, 30mV Overdrive R_L = 100Ω, 30mV Overdrive	±3.80 ±3.35	±4.0 ±3.5		V V
I_{OUT}	Maximum Output Current	V_{OUT} = ±3V, 30mV Overdrive	±40	±60		mA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0V, 1V Overdrive (Note 3)	±75	±110		mA
SR	Slew Rate	A_V = –1 (Note 5)	500	750		V/µs

ELECTRICAL CHARACTERISTICS

T_A = 25°C, V_S = ±5V, V_{CM} = 0V unless otherwise noted (Note 10).

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
FPBW	Full Power Bandwidth	3V Peak (Note 6)		40		MHz
GBW	Gain Bandwidth Product	f = 200kHz	75	100		MHz
t_r, t_f	Rise Time, Fall Time	A_V = 1, 10% to 90%, 0.1V, R_L = 100Ω		2		ns
OS	Overshoot	A_V = 1, 0.1V, R_L = 100Ω		25		%
t_{PD}	Propagation Delay	A_V = 1, 50% V_{IN} to 50% V_{OUT}, 0.1V, R_L = 100Ω		2.8		ns
t_s	Settling Time	5V Step, 0.1%, A_V = –1		30		ns
THD	Total Harmonic Distortion	f = 1MHz, V_{OUT} = $2V_{P-P}$, A_V = 2, R_L = 500Ω		–76		dB
	Differential Gain	V_{OUT} = $2V_{P-P}$, A_V = 2, R_L = 150Ω		0.12		%
	Differential Phase	V_{OUT} = $2V_{P-P}$, A_V = 2, R_L = 150Ω		0.07		DEG
R_{OUT}	Output Resistance	A_V = 1, f = 1MHz		0.4		Ω
$I_{\overline{SHDN}}$	$\overline{SHDN}$ Pin Current	$\overline{SHDN}$ > V^- + 2.0V (On) (Note 11) $\overline{SHDN}$ < V^- + 0.4V (Off) (Note 11)	 –100	0 –50	±1	µA µA
I_S	Supply Current	$\overline{SHDN}$ > V^- + 2.0V (On) (Note 11) $\overline{SHDN}$ < V^- + 0.4V (Off) (Note 11)		3 50	3.6 100	mA µA

T_A = 25°C, V_S = 5V, V_{CM} = 2.5V, R_L to 2.5V unless otherwise noted (Note 10).

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage	(Note 4)		0.5	2.0	mV
I_{OS}	Input Offset Current			30	400	nA
I_B	Input Bias Current			–1.0	±4	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} = 1.5V to 3.5V Differential	3	10 1.5		MΩ MΩ
C_{IN}	Input Capacitance			2		pF
V_{CM}	Input Voltage Range (Positive) Input Voltage Range (Negative)		3.5	4 1	 1.5	V V
CMRR	Common Mode Rejection Ratio	V_{CM} = 1.5V to 3.5V	73	82		dB
A_{VOL}	Large-Signal Voltage Gain	V_{OUT} = 1.5V to 3.5V, R_L = 500Ω V_{OUT} = 1.5V to 3.5V, R_L = 100Ω	1.0 0.7	2.0 1.5		V/mV V/mV
V_{OUT}	Maximum Output Swing (Positive)	R_L = 500Ω, 30mV Overdrive R_L = 100Ω, 30mV Overdrive	3.9 3.7	4.1 3.9		V V
	Maximum Output Swing (Negative)	R_L = 500Ω, 30mV Overdrive R_L = 100Ω, 30mV Overdrive		0.9 1.1	1.1 1.3	V V
I_{OUT}	Maximum Output Current	V_{OUT} = 3.5V or 1.5V, 30mV Overdrive	±25	±40		mA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 2.5V, 1V Overdrive (Note 3)	±55	±80		mA
SR	Slew Rate	A_V = –1 (Note 5)	200	350		V/µs
FPBW	Full Power Bandwidth	1V Peak (Note 6)		55		MHz
GBW	Gain Bandwidth Product	f = 200kHz	65	94		MHz
t_r, t_f	Rise Time, Fall Time	A_V = 1, 10% to 90%, 0.1V, R_L = 100Ω		2.1		ns
OS	Overshoot	A_V = 1, 0.1V, R_L = 100Ω		25		%
t_{PD}	Propagation Delay	A_V = 1, 50% V_{IN} to 50% V_{OUT}, 0.1V, R_L = 100Ω		3		ns
t_s	Settling Time	2V Step, 0.1%, A_V = –1		30		ns
THD	Total Harmonic Distortion	f = 1MHz, V_{OUT} = $2V_{P-P}$, A_V = 2, R_L = 500Ω		–75		dB
	Differential Gain	V_{OUT} = $2V_{P-P}$, A_V = 2, R_L = 150Ω		0.22		%
	Differential Phase	V_{OUT} = $2V_{P-P}$, A_V = 2, R_L = 150Ω		0.21		DEG

ELECTRICAL CHARACTERISTICS

T_A = 25°C, V_S = 5V, V_{CM} = 2.5V, R_L to 2.5V unless otherwise noted (Note 10).

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
R_{OUT}	Output Resistance	A_V = 1, f = 1MHz		0.45		Ω
$I_{\overline{SHDN}}$	$\overline{SHDN}$ Pin Current	$\overline{SHDN}$ > V^- + 2.0V (On) (Note 11) $\overline{SHDN}$ < V^- + 0.4V (Off) (Note 11)	 –50	0 –20	±1	µA µA
I_S	Supply Current	$\overline{SHDN}$ > V^- + 2.0V (On) (Note 11) $\overline{SHDN}$ < V^- + 0.4V (Off) (Note 11)		2.7 20	3.6 50	mA µA

0°C ≤ T_A ≤ 70°C, V_S = ±5V, V_{CM} = 0V unless otherwise noted (Note 10).

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage	(Note 4)			2	mV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift	(Note 7)		10	15	µV/°C
I_{OS}	Input Offset Current				500	nA
I_B	Input Bias Current				±5	µA
V_{CM}	Input Voltage Range (Positive) Input Voltage Range (Negative)		3.5		 –3.5	V V
CMRR	Common Mode Rejection Ratio	V_{CM} = ±3.5V	73			dB
	Minimum Supply Voltage				±2	V
PSRR	Power Supply Rejection Ratio	V_S = ±2V to ±5.5V	76			dB
A_{VOL}	Large-Signal Voltage Gain	V_{OUT} = ±3V, R_L = 500Ω V_{OUT} = ±3V, R_L = 100Ω	1.0 0.7			V/mV V/mV
V_{OUT}	Maximum Output Swing	R_L = 500Ω, 30mV Overdrive R_L = 100Ω, 30mV Overdrive	±3.70 ±3.25			V V
I_{OUT}	Maximum Output Current	V_{OUT} = ±3V, 30mV Overdrive	±35			mA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0V, 1V Overdrive (Note 3)	±60			mA
SR	Slew Rate	A_V = –1 (Note 5)	400			V/µs
GBW	Gain Bandwidth Product	f = 200kHz	65			MHz
$I_{\overline{SHDN}}$	$\overline{SHDN}$ Pin Current	$\overline{SHDN}$ > V^- + 2.0V (On) (Note 11) $\overline{SHDN}$ < V^- + 0.4V (Off) (Note 11)	 –150		±1.5	µA µA
I_S	Supply Current	$\overline{SHDN}$ > V^- + 2.0V (On) (Note 11) $\overline{SHDN}$ < V^- + 0.4V (Off) (Note 11)			4.6 150	mA µA

ELECTRICAL CHARACTERISTICS

0°C ≤ T_A ≤ 70°C, V_S = 5V, V_{CM} = 2.5V, R_L to 2.5V unless otherwise noted (Note 10).

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage	(Note 4)			2.5	mV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift	(Note 7)		10	15	µV/°C
I_{OS}	Input Offset Current				500	nA
I_B	Input Bias Current				±5	µA
V_{CM}	Input Voltage Range (Positive) Input Voltage Range (Negative)		3.5		 1.5	V V
CMRR	Common Mode Rejection Ratio	V_{CM} = 1.5V to 3.5V	71			dB
A_{VOL}	Large-Signal Voltage Gain	V_{OUT} = 1.5V to 3.5V, R_L = 500Ω V_{OUT} = 1.5V to 3.5V, R_L = 100Ω	0.7 0.5			V/mV V/mV
V_{OUT}	Maximum Output Swing (Positive)	R_L = 500Ω, 30mV Overdrive R_L = 100Ω, 30mV Overdrive	3.8 3.6			V V
	Maximum Output Swing (Negative)	R_L = 500Ω, 30mV Overdrive R_L = 100Ω, 30mV Overdrive			1.2 1.4	V V
I_{OUT}	Maximum Output Current	V_{OUT} = 3.5V or 1.5V, 30mV Overdrive	±20			mA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 2.5V, 1V Overdrive (Note 3)	±45			mA
SR	Slew Rate	A_V = –1 (Note 5)	150			V/µs
GBW	Gain Bandwidth Product	f = 200kHz	55			MHz
$I_{\overline{SHDN}}$	$\overline{SHDN}$ Pin Current	$\overline{SHDN}$ > V^- + 2.0V (On) (Note 11) SHDN < V^- + 0.4V (Off) (Note 11)	 –75		±1.5	µA µA
I_S	Supply Current	$\overline{SHDN}$ > V^- + 2.0V (On) (Note 11) SHDN < V^- + 0.4V (Off) (Note 11)			4.5 75	mA µA

–40°C ≤ T_A ≤ 85°C. V_S = ±5V, V_{CM} = 0V unless otherwise noted (Notes 8, 10).

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage	(Note 4)			3	mV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift	(Note 7)		10	30	µV/°C
I_{OS}	Input Offset Current				600	nA
I_B	Input Bias Current				±6	µA
V_{CM}	Input Voltage Range (Positive) Input Voltage Range (Negative)		3.5		 –3.5	V V
CMRR	Common Mode Rejection Ratio	V_{CM} = ±3.5V	72			dB
	Minimum Supply Voltage				±2	V
PSRR	Power Supply Rejection Ratio	V_S = ±2V to ±5.5V	75			dB
A_{VOL}	Large-Signal Voltage Gain	V_{OUT} = ±3V, R_L = 500Ω V_{OUT} = ±3V, R_L = 100Ω	0.8 0.6			V/mV V/mV
V_{OUT}	Maximum Output Swing	R_L = 500Ω, 30mV Overdrive R_L = 100Ω, 30mV Overdrive	±3.60 ±3.15			V V
I_{OUT}	Maximum Output Current	V_{OUT} = ±3V, 30mV Overdrive	±30			mA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0V, 1V Overdrive (Note 3)	±55			mA
SR	Slew Rate	A_V = –1 (Note 5)	350			V/µs
GBW	Gain Bandwidth Product	f = 200kHz	60			MHz
$I_{\overline{SHDN}}$	$\overline{SHDN}$ Pin Current	$\overline{SHDN}$ > V^- + 2.0V (On) (Note 11) SHDN < V^- + 0.4V (Off) (Note 11)	 –200		±2	µA µA
I_S	Supply Current	$\overline{SHDN}$ > V^- + 2.0V (On) (Note 11) $\overline{SHDN}$ < V^- + 0.4V (Off) (Note 11)			5 200	mA µA

ELECTRICAL CHARACTERISTICS

$-40°C \le T_A \le 85°C$, $V_S = 5V$, $V_{CM} = 2.5V$, R_L to 2.5V unless otherwise noted (Notes 8, 10).

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage	(Note 4)			3.5	mV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift	(Note 7)		10	30	µV/°C
I_{OS}	Input Offset Current				600	nA
I_B	Input Bias Current				±6	µA
V_{CM}	Input Voltage Range (Positive) Input Voltage Range (Negative)		3.5		 1.5	V V
CMRR	Common Mode Rejection Ratio	V_{CM} = 1.5V to 3.5V	70			dB
A_{VOL}	Large-Signal Voltage Gain	V_{OUT} = 1.5V to 3.5V, R_L = 500Ω V_{OUT} = 2.0V to 3.0V, R_L = 100Ω	0.6 0.4			V/mV V/mV
V_{OUT}	Maximum Output Swing (Positive)	R_L = 500Ω, 30mV Overdrive R_L = 100Ω, 30mV Overdrive	3.7 3.5			V V
	Maximum Output Swing (Negative)	R_L = 500Ω, 30mV Overdrive R_L = 100Ω, 30mV Overdrive			1.3 1.5	V V
I_{OUT}	Maximum Output Current	V_{OUT} = 3.5V or 1.5V, 30mV Overdrive	±17			mA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 2.5V, 1V Overdrive (Note 3)	±40			mA
SR	Slew Rate	A_V = –1 (Note 5)	125			V/µs
GBW	Gain Bandwidth Product	f = 200kHz	50			MHz
$I_{\overline{SHDN}}$	$\overline{SHDN}$ Pin Current	$\overline{SHDN} > V^- + 2.0V$ (On) (Note 11) $\overline{SHDN} < V^- + 0.4V$ (Off) (Note 11)	 –100		±2	µA µA
I_S	Supply Current	$\overline{SHDN} > V^- + 2.0V$ (On) (Note 11) $\overline{SHDN} < V^- + 0.4V$ (Off) (Note 11)			5 100	mA µA

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

Note 2: Differential inputs of ±3V 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 on the output with ±3V input for ±5V supplies and $2V_{P-P}$ on 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 LT1812C is guaranteed to meet specified performance from 0°C to 70°C. The LT1812C is designed, characterized and expected to meet specified performance from –40°C to 85°C but is not tested or QA sampled at these temperatures. The LT1812I is guaranteed to meet specified performance from –40°C to 85°C.

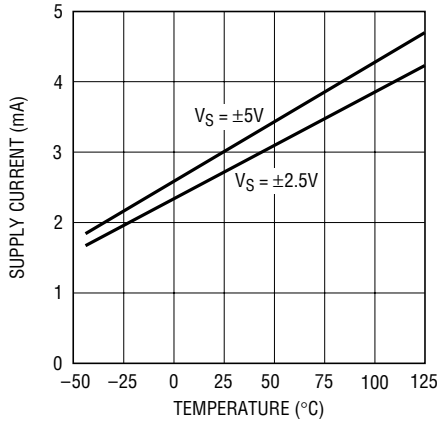
Note 9: Thermal resistance varies with the amount of PC board metal connected to the package. The nominal values are for short traces connected to the pins. The thermal resistance can be substantially reduced by connecting Pin 2 of the 5-lead or 6-lead SOT-23 or Pin 4 of the SO-8 to a large metal area.

Note 10: For the 8-lead SO and 6-lead SOT-23 parts, the electrical characteristics apply to the "ON" state, unless otherwise noted. These parts are in the "ON" state when either $\overline{SHDN}$ is not connected, or $\overline{SHDN} > V^- + 2.0V$.

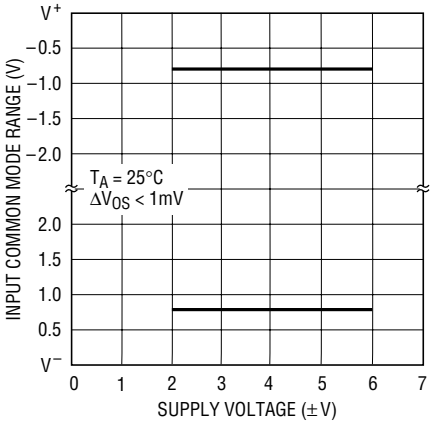
Note 11: The shutdown ($\overline{SHDN}$) feature is not available on the 5-lead SOT-23 parts. These parts are always in the "ON" state.

TYPICAL PERFORMANCE CHARACTERISTICS

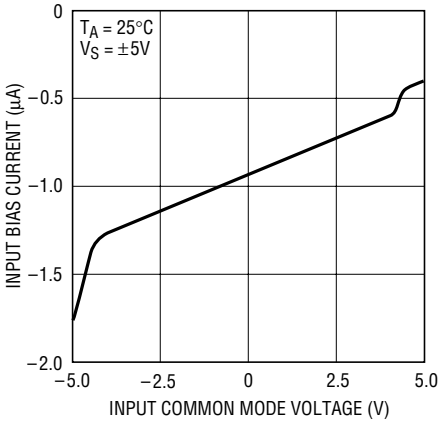
Supply Current vs Temperature



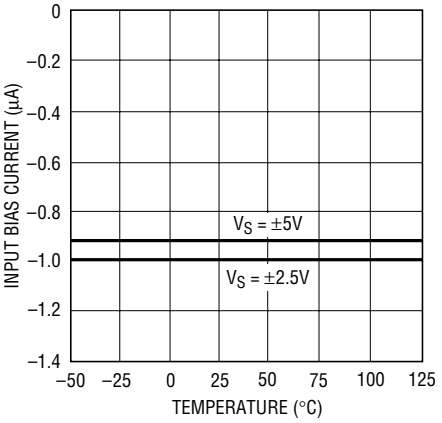
Input Common Mode Range vs Supply Voltage



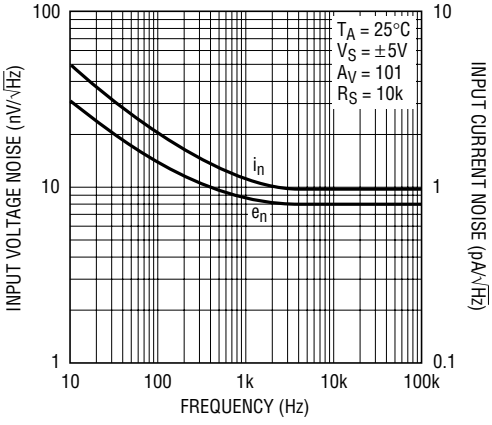
Input Bias Current vs Common Mode Voltage



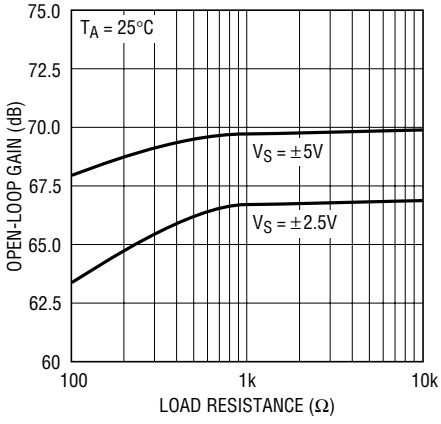
Input Bias Current vs Temperature



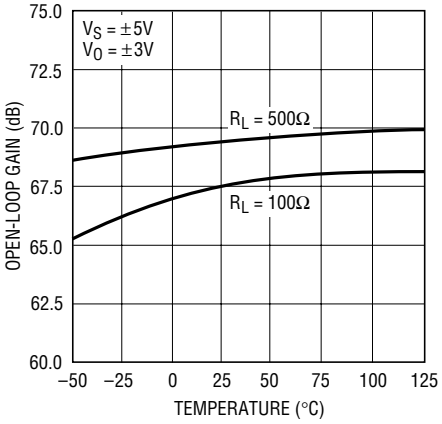
Input Noise Spectral Density



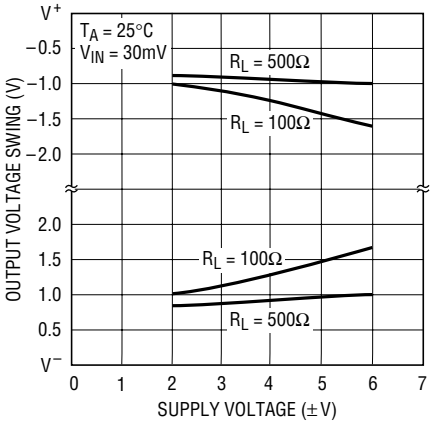
Open-Loop Gain vs Resistive Load



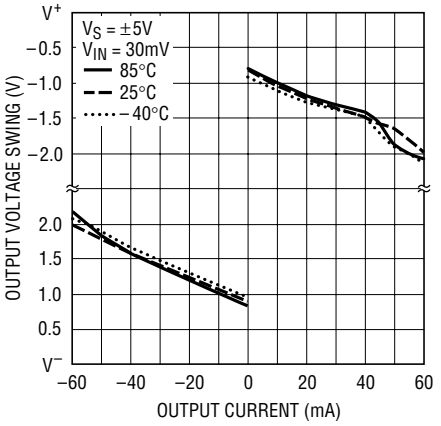
Open-Loop Gain vs Temperature



Output Voltage Swing vs Supply Voltage

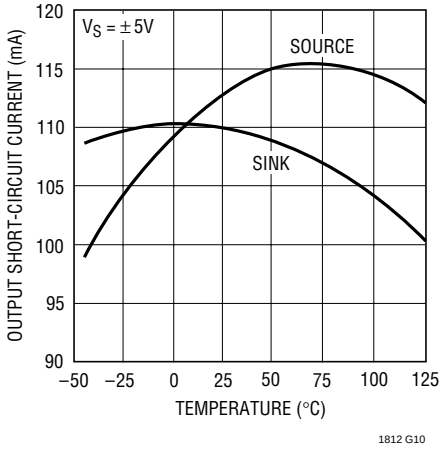


Output Voltage Swing vs Load Current

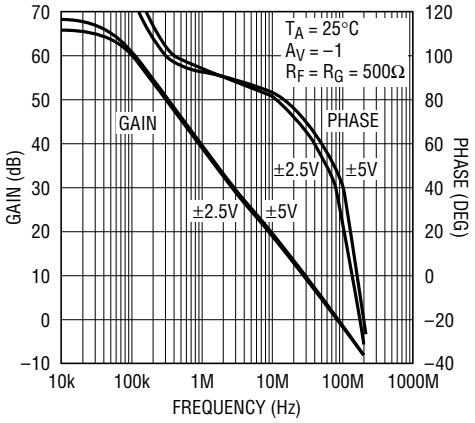


TYPICAL PERFORMANCE CHARACTERISTICS

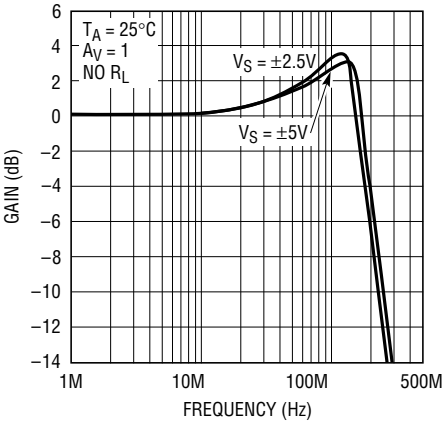
Output Short-Circuit Current vs Temperature



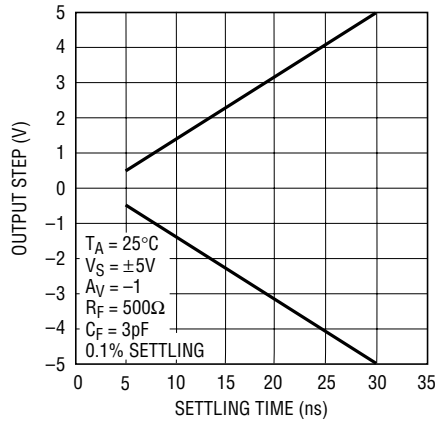
Open-Loop Gain and Phase vs Frequency



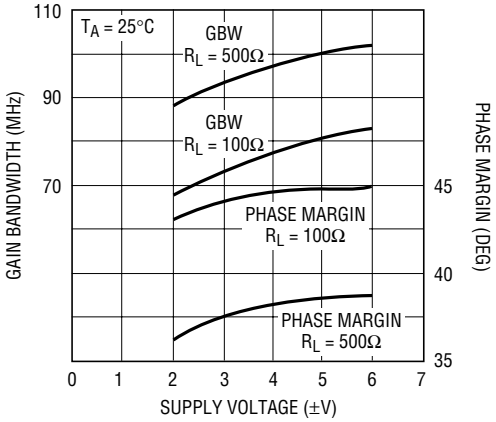
Gain vs Frequency



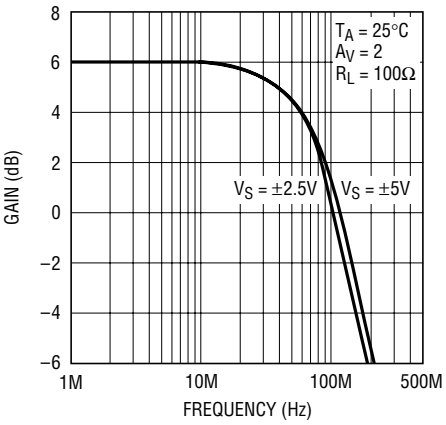
Settling Time vs Output Step



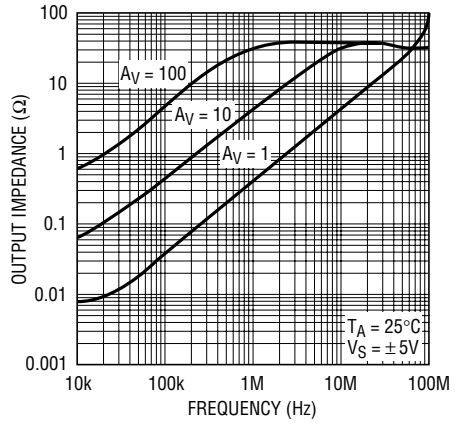
Gain Bandwidth and Phase Margin vs Supply Voltage



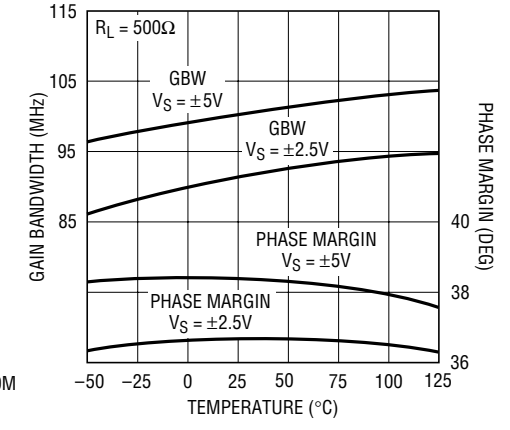
Gain vs Frequency



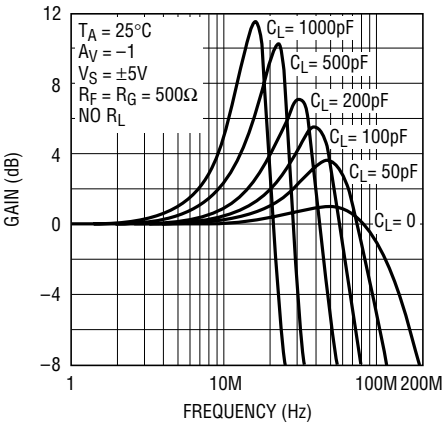
Output Impedance vs Frequency



Gain Bandwidth and Phase Margin vs Temperature

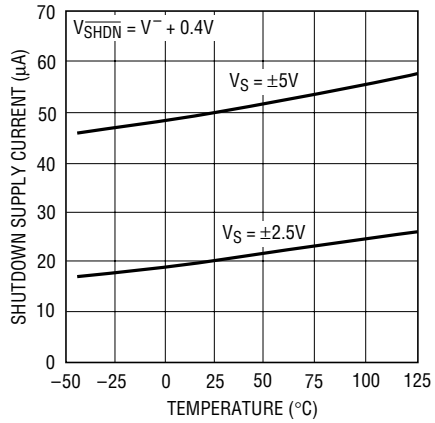


Gain vs Frequency



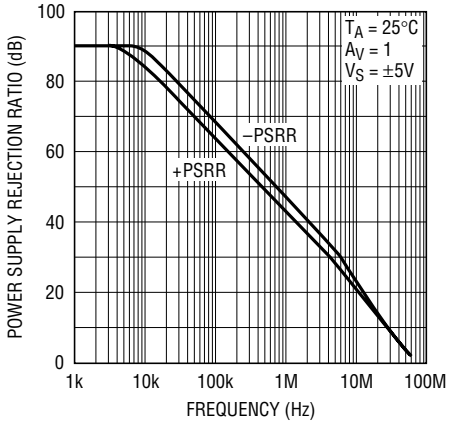
TYPICAL PERFORMANCE CHARACTERISTICS

Shutdown Supply Current vs Temperature



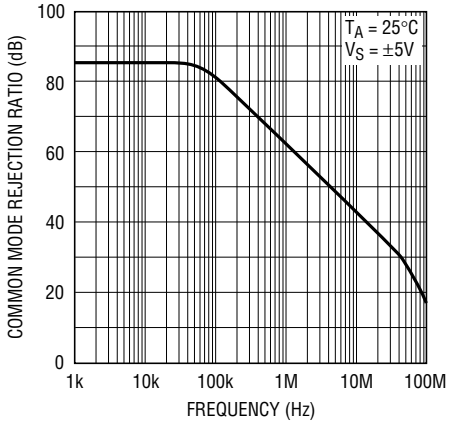
1812 G14

Power Supply Rejection Ratio vs Frequency



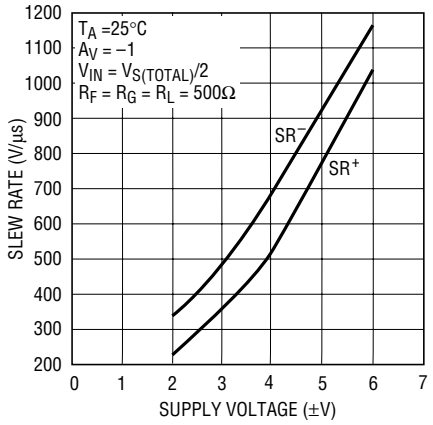
1812 G20

Common Mode Rejection Ratio vs Frequency



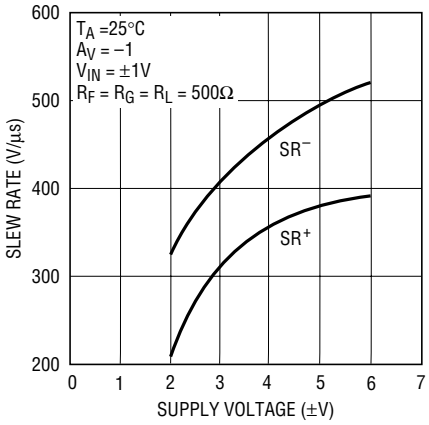
1812 G21

Slew Rate vs Supply Voltage



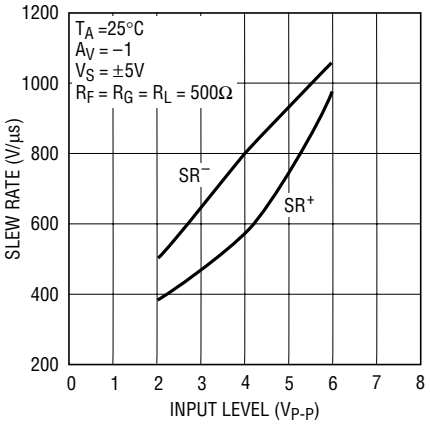
1812 G22

Slew Rate vs Supply Voltage



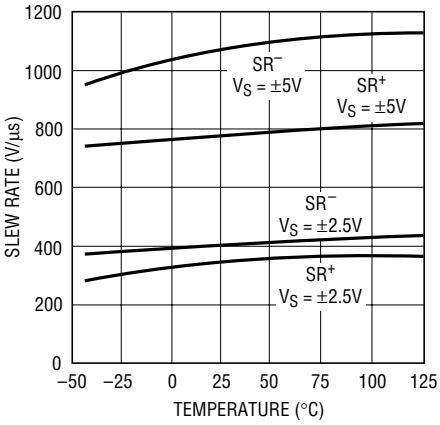
1812 G23

Slew Rate vs Input Level



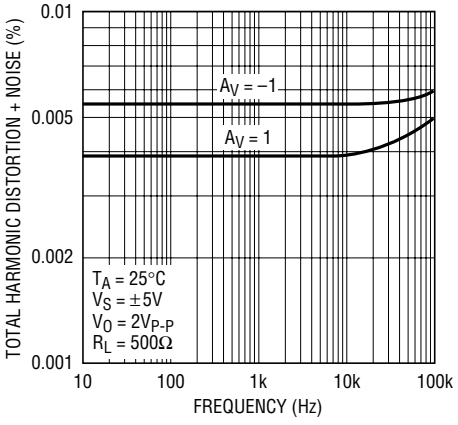
1812 G24

Slew Rate vs Temperature



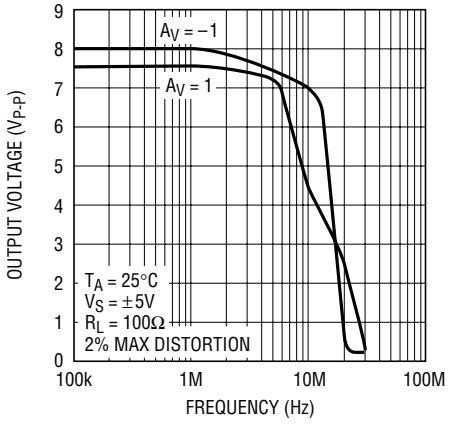
1812 G25

Total Harmonic Distortion + Noise vs Frequency



1812 G26

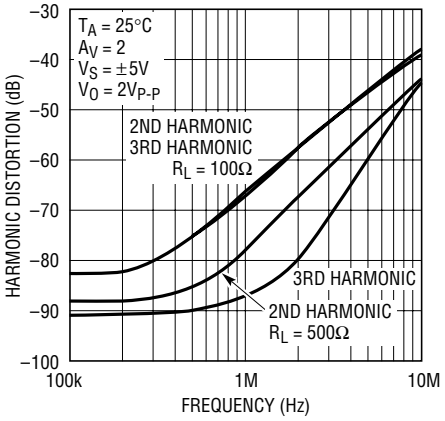
Undistorted Output Swing vs Frequency



1812 G27

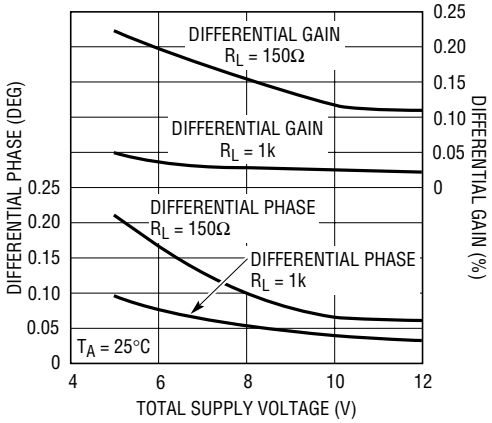
TYPICAL PERFORMANCE CHARACTERISTICS

2nd and 3rd Harmonic Distortion vs Frequency



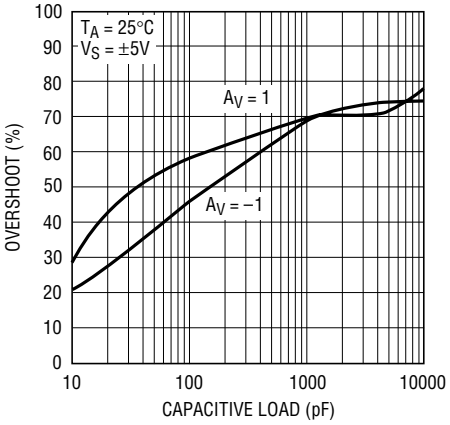
1812 G28

Differential Gain and Phase vs Supply Voltage



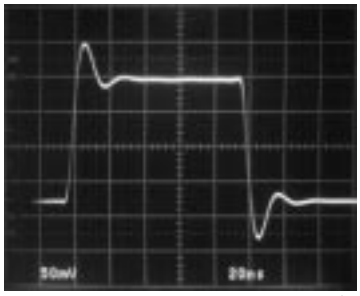
1812 G29

Capacitive Load Handling



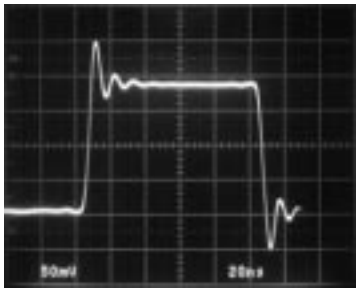
1812 G30

Small-Signal Transient, $A_V = -1$



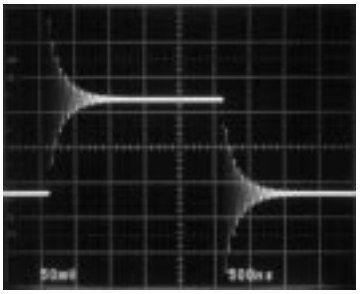
1812 G31

Small-Signal Transient, $A_V = 1$



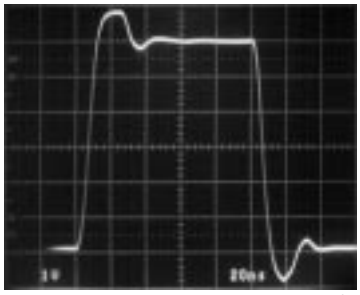
1812 G32

Small-Signal Transient, $A_V = 1$, $C_L = 1000pF$



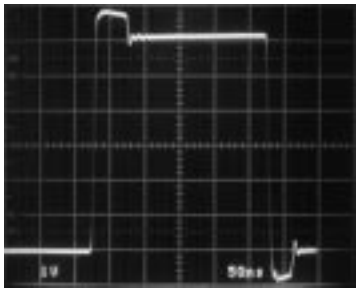
1812 G33

Large-Signal Transient, $A_V = -1$



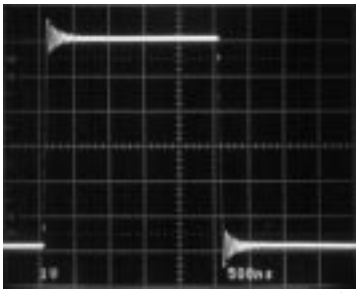
1812 G34

Large-Signal Transient, $A_V = 1$



1812 G35

Large-Signal Transient, $A_V = 1$, $C_L = 1000pF$



1812 G36