LT1782

Micropower, Over-The-Top SOT-23, Rail-to-Rail Input and Output Op Amp

FEATURES

- **Operates with Inputs Above V⁺**
- **Rail-to-Rail Input and Output**
- **Micropower: 55µA Supply Current Max**
- Operating Temperature Range: –40°C to 125°C
- Low Profile (1mm) ThinSOT™ Package
- Low Input Offset Voltage: 800µV Max
- Single Supply Input Range: 0V to 18V
- High Output Current: 18mA Min
- Specified on 3V, 5V and ±5V Supplies
- Output Shutdown on 6-Lead Version
- Reverse Battery Protection to 18V
- High Voltage Gain: 1500V/mV
- Gain Bandwidth Product: 200kHz
- Slew Rate: 0.07V/µs

APPLICATIONS

- Portable Instrumentation
- Battery- or Solar-Powered Systems
- Sensor Conditioning
- Supply Current Sensing
- Battery Monitoring
- MUX Amplifiers
- 4mA to 20mA Transmitters

DESCRIPTION

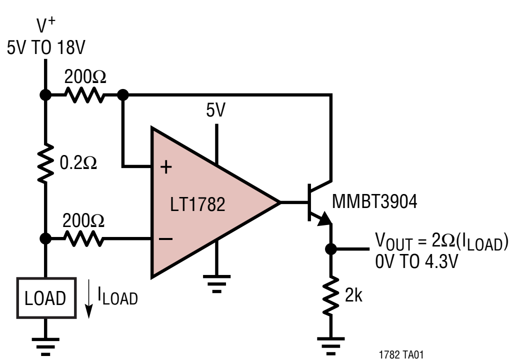
The LT®1782 is a 200kHz op amp available in the small SOT-23 package that operates on all single and split supplies with a total voltage of 2.5V to 18V. The amplifier draws less than 55µA of quiescent current and has reverse battery protection, drawing negligible current for reverse supply voltages up to 18V.

The input range of the LT1782 includes ground, and a unique feature of this device is its Over-The-Top™ operation capability with either or both of its inputs above the positive rail. The inputs handle 18V both differential and common mode, independent of supply voltage. The input stage incorporates phase reversal protection to prevent false outputs from occurring even when the inputs are 9V below the negative supply.

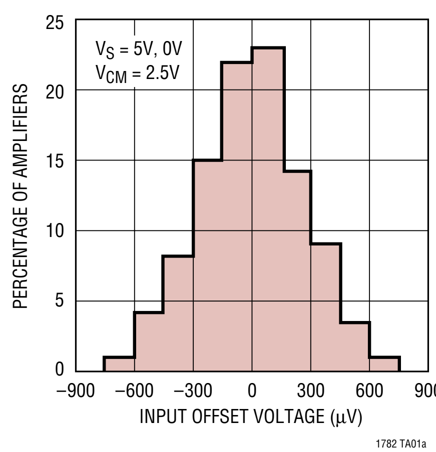
The LT1782 can drive loads up to 18mA and still maintain rail-to-rail capability. A shutdown feature on the 6-lead version can disable the part, making the output high impedance and reducing quiescent current to 5µA. The LT1782 op amp is available in the 5- and 6-lead SOT-23 packages. For applications requiring higher speed, refer to the LT1783.

TYPICAL APPLICATION

Positive Supply Rail Current Sense



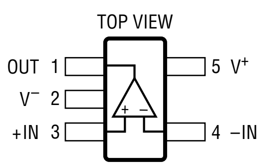
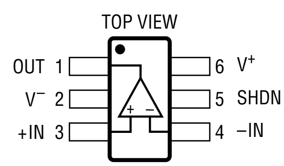
Distribution of Input Offset Voltage



ABSOLUTE MAXIMUM RATINGS (Note 1)

Total Supply Voltage (V^+ to V^-) 18V
Input Differential Voltage 18V
Input Pin Voltage to V^- .... +24V/–10V
Shutdown Pin Voltage Above V^- 18V
Shutdown Pin Current .... ±10mA
Output Short-Circuit Duration (Note 2) .... Indefinite
Operating Temperature Range (Note 3)
  LT1782C .... –40°C to 85°C
  LT1782I .... –40°C to 85°C
  LT1782H .... –40°C to 125°C
Specified Temperature Range (Note 4)
  LT1782C .... –40°C to 85°C
  LT1782I .... –40°C to 85°C
  LT1782H .... –40°C to 125°C
Junction Temperature .... 150°C
Storage Temperature Range .... –65°C to 150°C
Lead Temperature (Soldering, 10 sec) .... 300°C

PACKAGE/ORDER INFORMATION

	ORDER PART NUMBER		ORDER PART NUMBER
 S5 PACKAGE 5-LEAD PLASTIC SOT-23 T_{JMAX} = 150°C, θ_{JA} = 250°C/W	LT1782CS5 LT1782IS5 LT1782HS5 **S5 PART MARKING** LTLD LTLE LTXK	 S6 PACKAGE 6-LEAD PLASTIC SOT-23 T_{JMAX} = 150°C, θ_{JA} = 230°C/W	LT1782CS6 LT1782IS6 LT1782HS6 **S6 PART MARKING** LTIS LTIT LTXL

Consult LTC Marketing for parts specified with wider operating temperature ranges.

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the specified temperature range, otherwise specifications are T_A = 25°C. V_S = 3V, 0V; V_S = 5V, 0V, V_{CM} = V_{OUT} = half supply, for the 6-lead part V_{PIN5} = 0V, pulse power tested unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		LT1782C/LT1782I MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage	T_A = 25°C 0°C ≤ T_A ≤ 70°C –40°C ≤ T_A ≤ 85°C	 ● ●		400	800 950 1100	µV µV µV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift (Note 7)		●		2	5	µV/°C
I_{OS}	Input Offset Current	 V_{CM} = 18V (Note 5)	● ●		0.7	2 1	nA µA
I_B	Input Bias Current	 V_{CM} = 18 (Note 5) SHDN or V_S = 0V, V_{CM} = 0V to 18V	● ●		8 6 0.1	15 12	nA µA nA
	Input Bias Current Drift	–40°C ≤ T_A ≤ 85°C	●		0.01		nA/°C
	Input Noise Voltage	0.1Hz to 10Hz			1		μV_{P-P}
e_n	Input Noise Voltage Density	f = 1kHz			50		nV/√Hz
i_n	Input Noise Current Density	f = 1kHz			0.05		pA/√Hz

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the specified temperature range, otherwise specifications are T_A = 25°C. V_S = 3V, 0V; V_S = 5V, 0V, V_{CM} = V_{OUT} = half supply, for the 6-lead part V_{PIN5} = 0V, pulse power tested unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		LT1782C/LT1782I MIN	TYP	MAX	UNITS
R_{IN}	Input Resistance	Differential Common Mode, V_{CM} = 0V to (V_{CC} – 1V) Common Mode, V_{CM} = 0V to 18V	● ●	3.4 1.5	6.5 5 3		MΩ GΩ MΩ
C_{IN}	Input Capacitance				5		pF
	Input Voltage Range		●	0		18	V
CMRR	Common Mode Rejection Ratio (Note 5)	V_{CM} = 0V to V_{CC} – 1V V_{CM} = 0V to 18V (Note 8)	● ●	90 68	100 80		dB dB
PSRR	Power Supply Rejection Ratio	V_S = 3V to 12.5V, V_{CM} = V_O = 1V	●	90	100		dB
A_{VOL}	Large-Signal Voltage Gain	V_S = 3V, V_O = 500mV to 2.5V, R_L = 10k V_S = 3V, 0°C ≤ T_A ≤ 70°C V_S = 3V, –40°C ≤ T_A ≤ 85°C	 ● ●	200 133 100	1500		V/mV V/mV V/mV
		V_S = 5V, V_O = 500mV to 4.5V, R_L = 10k V_S = 5V, 0°C ≤ T_A ≤ 70°C V_S = 5V, –40°C ≤ T_A ≤ 85°C	 ● ●	400 250 200	1500		V/mV V/mV V/mV
V_{OL}	Output Voltage Swing LOW	No Load I_{SINK} = 5mA V_S = 5V, I_{SINK} = 10mA	● ● ●		3 200 400	8 500 800	mV mV mV
V_{OH}	Output Voltage Swing HIGH	V_S = 3V, No Load V_S = 3V, I_{SOURCE} = 5mA	● ●	2.91 2.6	2.94 2.8		V V
		V_S = 5V, No Load V_S = 5V, I_{SOURCE} = 10mA	● ●	4.91 4.5	4.94 4.74		V V
I_{SC}	Short-Circuit Current (Note 2)	V_S = 3V, Short to GND V_S = 3V, Short to V_{CC}		5 15	10 30		mA mA
		V_S = 5V, Short to GND V_S = 5V, Short to V_{CC}		15 20	30 40		mA mA
	Minimum Supply Voltage		●	2.7			V
	Reverse Supply Voltage	I_S = –100µA	●	18			V
I_S	Supply Current (Note 6)	 0°C ≤ T_A ≤ 70°C –40°C ≤ T_A ≤ 85°C	 ● ●		40	55 60 65	µA µA µA
	Supply Current, SHDN	V_{PIN5} = 2V, No Load (Note 10)	●		5	15	µA
I_{SHDN}	Shutdown Pin Current	V_{PIN5} = 0.3V, No load (Note 10) V_{PIN5} = 2V, No Load (Note 10) V_{PIN5} = 5V, No Load (Note 10)	● ● ●		0.5 2 5	 8	nA µA µA
	Shutdown Output Leakage Current	V_{PIN5} = 2V, No Load (Note 10)	●		0.05	1	µA
	Maximum Shutdown Pin Current	V_{PIN5} = 18V, No Load (Note 10)	●		10	30	µA
V_L	Shutdown Pin Input Low Voltage	(Note 10)	●			0.3	V
V_H	Shutdown Pin Input High Voltage	(Note 10)	●	2			V
t_{ON}	Turn-On Time	V_{PIN5} = 5V to 0V, R_L = 10k (Note 10)			100		µs
t_{OFF}	Turn-Off Time	V_{PIN5} = 0V to 5V, R_L = 10k (Note 10)			6		µs
GBW	Gain Bandwidth Product (Note 5)	f = 5kHz 0°C ≤ T_A ≤ 70°C –40°C ≤ T_A ≤ 85°C	 ● ●	110 100 90	200		kHz kHz kHz

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the specified temperature range, otherwise specifications are T_A = 25°C. V_S = 3V, 0V; V_S = 5V, 0V, V_{CM} = V_{OUT} = half supply, for the 6-lead part V_{PIN5} = 0V, pulse power tested unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		LT1782C/LT1782I MIN	TYP	MAX	UNITS
SR	Slew Rate (Note 5)	A_V = –1, R_L = ∞		0.035	0.07		V/µs
		0°C ≤ T_A ≤ 70°C	●	0.031			V/µs
		–40°C ≤ T_A ≤ 85°C	●	0.028			V/µs
t_S	Settling Time	V_S = 5V, ΔV_{OUT} = 2V to 0.1%, A_V = –1			45		µs
THD	Distortion	V_S = 3V, V_O = $2V_{P-P}$, A_V = 1, R_L = 10k, f =1kHz			0.003		%
FPBW	Full-Power Bandwidth (Note 9)	V_{OUT} = $2V_{P-P}$			11		kHz

The ● denotes specifications which apply over the specified temperature range, otherwise specifications are T_A = 25°C. V_S = ±5V, V_{CM} = 0V, V_{OUT} = 0V, for the 6-lead part V_{PIN5} = V^-, pulse power tested unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		LT1782C/LT1782I MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage	T_A = 25°C			500	900	µV
		0°C ≤ T_A ≤ 70°C	●			1050	µV
		–40°C ≤ T_A ≤ 85°C	●			1200	µV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift (Note 7)		●		2	5	µV/°C
I_{OS}	Input Offset Current		●		0.7	2	nA
I_B	Input Bias Current		●		8	15	nA
	Input Bias Current Drift		●		0.01		nA/°C
	Input Noise Voltage	0.1Hz to 10Hz			1		$µV_{P-P}$
e_n	Input Noise Voltage Density	f = 1kHz			50		nV/√Hz
i_n	Input Noise Current Density	f = 1kHz			0.05		pA/√Hz
R_{IN}	Input Resistance	Differential	●	3.4	6.5		MΩ
		Common Mode, V_{CM} = –5V to 13V	●	1.5	3		MΩ
C_{IN}	Input Capacitance				5		pF
	Input Voltage Range		●	–5		13	V
CMRR	Common Mode Rejection Ratio	V_{CM} = –5V to 13V	●	68	80		dB
A_{VOL}	Large-Signal Voltage Gain	V_O = ±4V, R_L= 10k		55	150		V/mV
		0°C ≤ T_A ≤ 70°C	●	40			V/mV
		–40°C ≤ T_A ≤ 85°C	●	30			V/mV
V_{OL}	Output Voltage Swing LOW	No Load	●		–4.997	–4.992	V
		I_{SINK} = 5mA	●		–4.8	–4.5	V
		I_{SINK} = 10mA	●		–4.6	–4.2	V
V_{OH}	Output Voltage Swing HIGH	No Load	●	4.91	4.94		V
		I_{SOURCE} = 5mA	●	4.6	4.8		V
		I_{SOURCE} = 10mA	●	4.5	4.74		V
I_{SC}	Short-Circuit Current (Note 2)	Short to GND		18	30		mA
		0°C ≤ T_A ≤ 70°C	●	15			mA
PSRR	Power Supply Rejection Ratio	V_S = ±1.5V to ±9V	●	90	100		dB
I_S	Supply Current				45	60	µA
		0°C ≤ T_A ≤ 70°C	●			65	µA
		–40°C ≤ T_A ≤ 85°C	●			70	µA
	Supply Current, SHDN	V_{PIN5} = –3V, V_S = ±5V, No Load (Note 10)	●		6	20	µA
I_{SHDN}	Shutdown Pin Current	V_{PIN5} = –4.7V, V_S = ±5V, No load (Note 10)	●		0.5		nA
		V_{PIN5} = –3V, V_S = ±5V, No Load (Note 10)	●		2	8	µA

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the specified temperature range, otherwise specifications are T_A = 25°C. V_S = ±5V, V_{CM} = 0V, V_{OUT} = 0V, for the 6-lead part V_{PIN5} = V^-, pulse power tested unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		LT1782C/LT1782I MIN	TYP	MAX	UNITS
	Maximum Shutdown Pin Current	V_{PIN5} = 9V, V_S = ±9V (Note 10)	●		10	30	µA
	Shutdown Output Leakage Current	V_{PIN5} = –7V, V_S = ±9V, No Load (Note 10)	●		0.05	1	µA
V_L	Shutdown Pin Input Low Voltage	V_S = ±5V (Note 10)	●			–4.7	V
V_H	Shutdown Pin Input High Voltage	V_S = ±5V (Note 10)	●	–3			V
t_{ON}	Turn-On Time	V_{PIN5} = 0V to –5V, R_L = 10k (Note 10)	●		100		µs
t_{OFF}	Turn-Off Time	V_{PIN5} = –5V to 0V, R_L = 10k (Note 10)	●		6		µs
GBW	Gain Bandwidth Product	f = 5kHz 0°C ≤ T_A ≤ 70°C –40°C ≤ T_A ≤ 85°C	 ● ●	120 110 100	225		kHz kHz kHz
SR	Slew Rate	A_V = –1, R_L = ∞, V_O = ±4V, Measured at V_O = ±2V 0°C ≤ T_A ≤ 70°C –40°C ≤ T_A ≤ 85°C	 ● ●	0.0375 0.033 0.030	0.075		V/µs V/µs V/µs
t_S	Settling Time	ΔV_{OUT} = 4V to 0.1%, A_V = 1			50		µs
FPBW	Full-Power Bandwidth (Note 9)	V_{OUT} = $8V_{P-P}$			3		kHz

The ● denotes specifications which apply over the full operating temperature range of –40°C ≤ T_A ≤ 125°C. V_S = 3V, 0V; V_S = 5V, 0V; V_{CM} = V_{OUT} = half supply, for the 6-lead part V_{PIN5} = 0V, pulse power tested unless otherwise specified. (Note 4)

SYMBOL	PARAMETER	CONDITIONS		LT1782H MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage		 ●		400	800 3	µV mV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift		●			15	µV/°C
I_{OS}	Input Offset Current	 V_{CM} = 18V (Note 5)	● ●			3 2	nA µA
I_B	Input Bias Current	 V_{CM} = 18V (Note 5)	● ●			30 25	nA µA
	Input Voltage Range		●	0.3		18	V
CMRR	Common Mode Rejection Ratio	V_{CM} = 0.3V to V_{CC} – 1V V_{CM} = 0.3V to 18V	● ●	76 60			dB dB
A_{VOL}	Large-Signal Voltage Gain	V_S = 3V, V_O = 500mV to 2.5V, R_L = 10k	 ●	200 50	1500		V/mV V/mV
		V_S = 5V, V_O = 500mV to 4.5V, R_L = 10k	 ●	400 80	1500		V/mV V/mV
V_{OL}	Output Voltage Swing LOW	No Load I_{SINK} = 5mA V_S = 5V, I_{SINK} = 10mA	● ● ●			15 900 1500	mV mV mV
V_{OH}	Output Voltage Swing HIGH	V_S = 3V, No Load V_S = 3V, I_{SOURCE} = 5mA	● ●	2.85 2.20			V V
		V_S = 5V, No Load V_S = 5V, I_{SOURCE} = 10mA	● ●	4.85 3.80			V V
PSRR	Power Supply Rejection Ratio	V_S = 3V to 12.5V, V_{CM} = V_O = 1V	●	80			dB
	Minimum Supply Voltage		●	2.7			V
	Reverse Supply Voltage	I_S = –100µA	●	18			V

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range of –40°C ≤ T_A ≤ 125°C. V_S = 3V, 0V; V_S = 5V, 0V; V_{CM} = V_{OUT} = half supply, for the 6-lead part V_{PIN5} = 0V, pulse power tested unless otherwise specified. (Note 4)

SYMBOL	PARAMETER	CONDITIONS		LT1782H MIN	TYP	MAX	UNITS
I_S	Supply Current		 ●		40	55 100	μA μA
	Supply Current, SHDN	V_{PIN5} = 2V, No Load (Note 10)	●			25	μA
I_{SHDN}	Shutdown Pin Current	V_{PIN5} = 0.3V, No load (Note 10) V_{PIN5} = 2V, No Load (Note 10)	● ●		0.5	 12	nA μA
	Output Leakage Current	V_{PIN5} = 2V, No Load (Note 10)	●			3	μA
	Maximum Shutdown Pin Current	V_{PIN5} = 18V, No Load	●			45	μA
V_L	Shutdown Pin Input Low Voltage	(Note 10)	●			0.3	V
V_H	Shutdown Pin Input High Voltage	(Note 10)	●	2			V
GBW	Gain Bandwidth Product	f = 10kHz (Note 5)	 ●	110 65	200		kHz kHz
SR	Slew Rate	A_V = –1, R_L = ∞ (Note 7)	 ●	0.035 0.020	0.07		V/μs V/μs

The ● denotes specifications which apply over the full operating temperature range of –40°C ≤ T_A ≤ 125°C. V_S = ±5V, V_{CM} = 0V, V_{OUT} = 0V, for the 6-lead part V_{PIN5} = $V^–$, pulse power tested unless otherwise specified. (Note 4)

SYMBOL	PARAMETER	CONDITIONS		LT1782H MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage		 ●		500	900 3.2	μV mV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift (Note 9)		●			15	μV/°C
I_{OS}	Input Offset Current		●			3	nA
I_B	Input Bias Current		●			30	nA
CMRR	Common Mode Rejection Ratio	V_{CM} = –4.7V to 13V	●	60			dB
A_{VOL}	Large-Signal Voltage Gain	V_S = ±4V, R_L = 10k	 ●	55 20	150		V/mV V/mV
V_O	Output Voltage Swing	No Load I_{SINK} = ±5mA I_{SINK} = ±10mA	● ● ●	±4.85 ±4.10 ±3.50			V V V
PSRR	Power Supply Rejection Ratio	V_S = ±1.5V to ±9V	●	80			dB
	Minimum Supply Voltage		●	±1.35			V
I_S	Supply Current		 ●		45	60 110	μA μA
	Supply Current, SHDN	V_{PIN5} = –3V, V_S = ±5V, No Load (Note 10)	●			25	μA
I_{SHDN}	Shutdown Pin Current	V_{PIN5} = –4.7V, V_S = ±5V, No load (Note 10) V_{PIN5} = –3V, V_S = ±5V, No Load (Note 10)	● ●		0.5	 12	nA μA
	Maximum Shutdown Pin Current	V_{PIN5} = 9V, V_S = ±9V, No Load (Note 10)	●			45	μA
	Output Leakage Current	V_{PIN5} = –7V, V_S = ±9V, No Load	●			3	μA
V_L	Shutdown Pin Input Low Voltage	V_S = ±5V	●			–4.7	V
V_H	Shutdown Pin Input High Voltage	V_S = ±5V	●	–3			V
GBW	Gain Bandwidth Product	f = 5kHz	 ●	120 70	225		kHz kHz
SR	Slew Rate	A_V = –1, R_L = ∞, V_O = ±4V Measured at V_O = ±2V	 ●	0.0375 0.0220	0.075		V/μs V/μs

ELECTRICAL CHARACTERISTICS

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

Note 2: A heat sink may be required to keep the junction temperature below absolute maximum.

Note 3: The LT1782C and LT1782I are guaranteed functional over the operating temperature range of –40°C to 85°C. The LT1782H is guaranteed functional over the operating temperature range of –40°C to 125°C.

Note 4: The LT1782C is guaranteed to meet specified performance from 0°C to 70°C. The LT1782C 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 LT1782I is guaranteed to meet specified performance from –40°C to 85°C. The LT1782H is guaranteed to meet specified performance from –40°C to 125°C.

Note 5: V_S = 5V limits are guaranteed by correlation to V_S = 3V and V_S = ±5V or V_S = ±9V tests.

Note 6: V_S = 3V limits are guaranteed by correlation to V_S = 5V and V_S = ±5V or V_S = ±9V tests.

Note 7: Guaranteed by correlation to slew rate at V_S = ±5V, and GBW at V_S = 3V and V_S = ±5V tests.

Note 8: This specification implies a typical input offset voltage of 1.8mV at V_{CM} = 18V and a maximum input offset voltage of 7.2mV at V_{CM} = 18V.

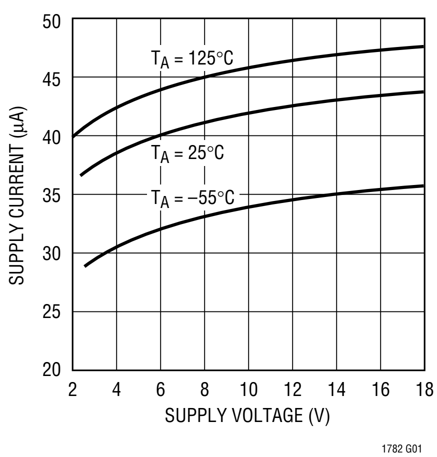
Note 9: This parameter is not 100% tested.

Note 10: Specifications apply to 6-lead SOT-23 with shutdown.

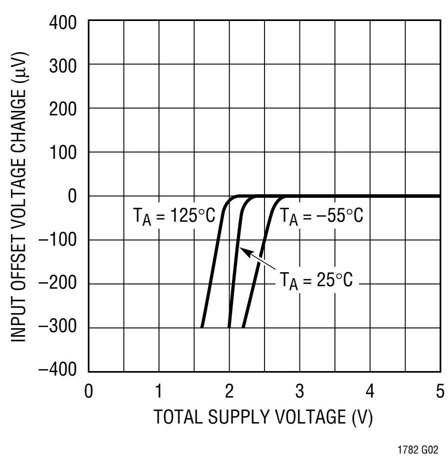
Note 11: Full-power bandwidth is calculated for the slew rate. FPBW = SR/2πV_P.

TYPICAL PERFORMANCE CHARACTERISTICS

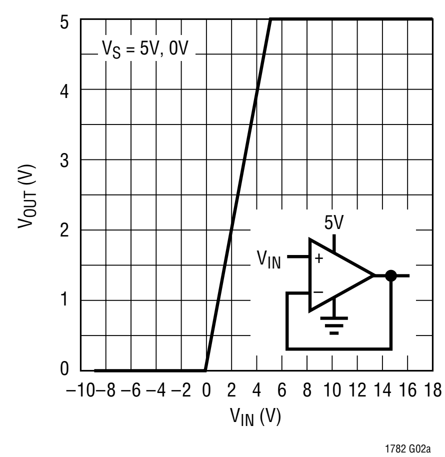
Supply Current vs Supply Voltage



Minimum Supply Voltage

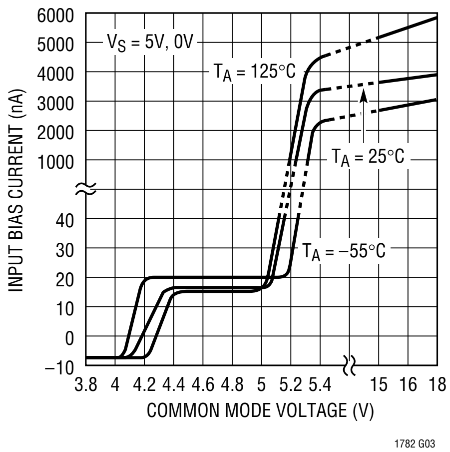


Output Voltage vs Large Input Voltage

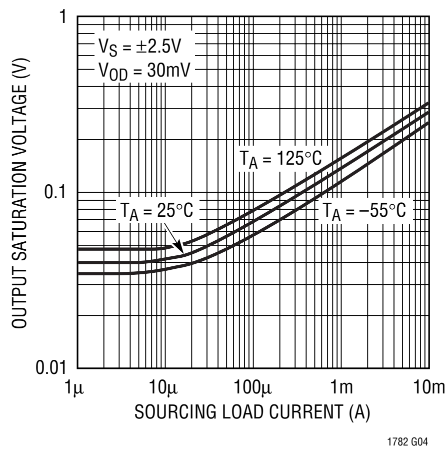


TYPICAL PERFORMANCE CHARACTERISTICS

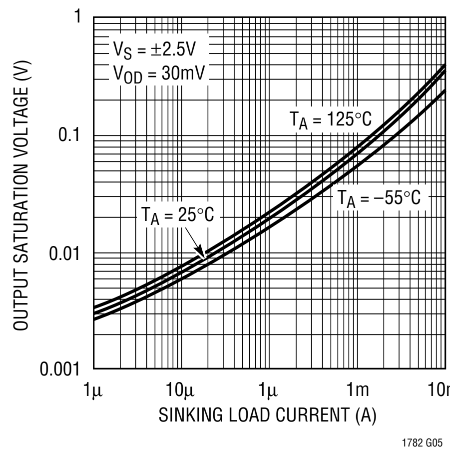
Input Bias Current vs Common Mode Voltage



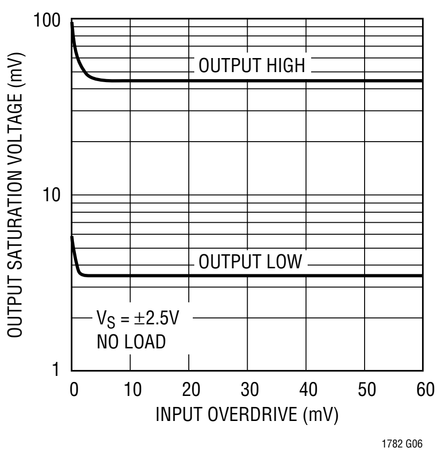
Output Saturation Voltage vs Load Current (Output High)



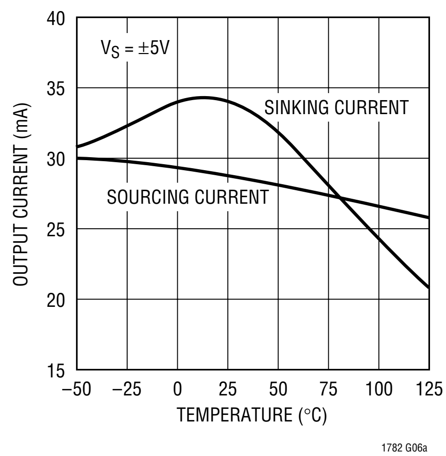
Output Saturation Voltage vs Load Current (Output Low)



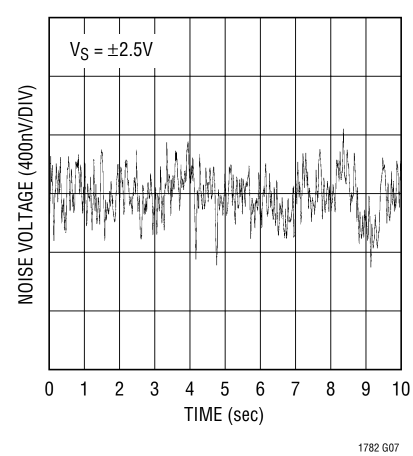
Output Saturation Voltage vs Input Overdrive



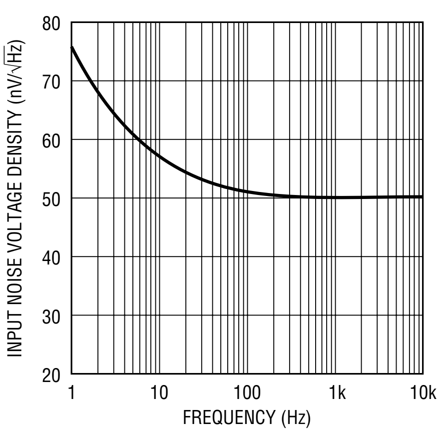
Output Short-Circuit Current vs Temperature



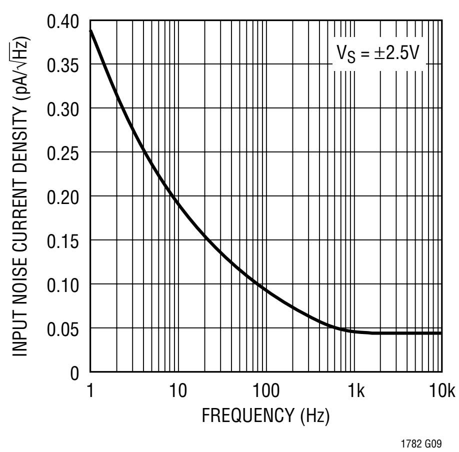
0.1Hz to 10Hz Noise Voltage



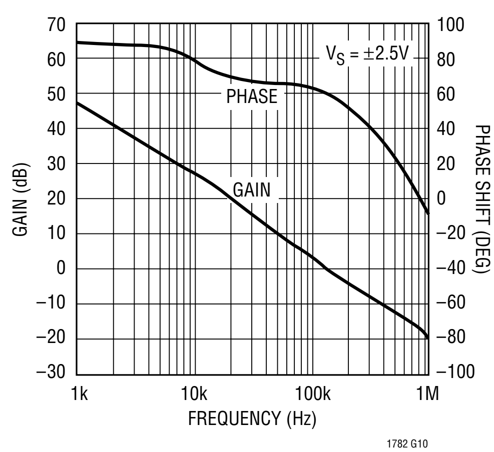
Noise Voltage Density vs Frequency



Input Noise Current vs Frequency

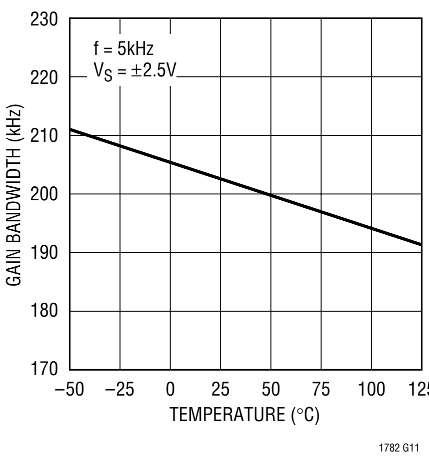


Gain and Phase Shift vs Frequency

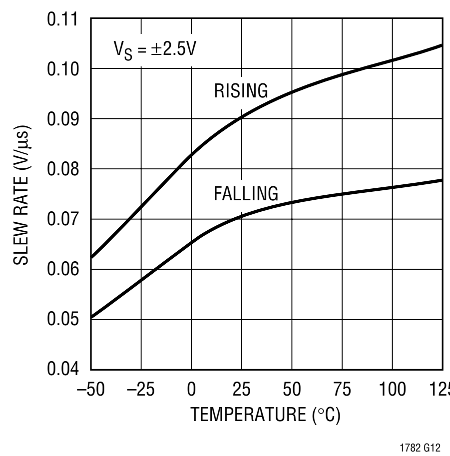


TYPICAL PERFORMANCE CHARACTERISTICS

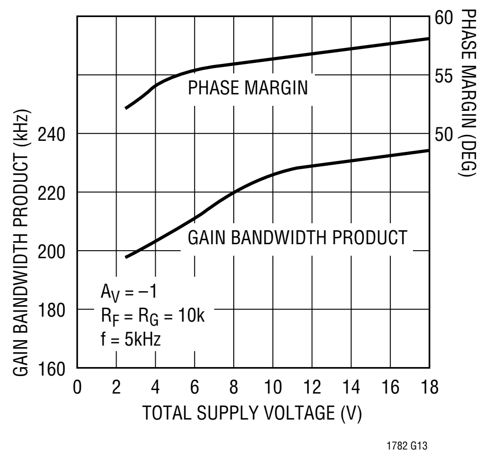
Gain Bandwidth Product vs Temperature



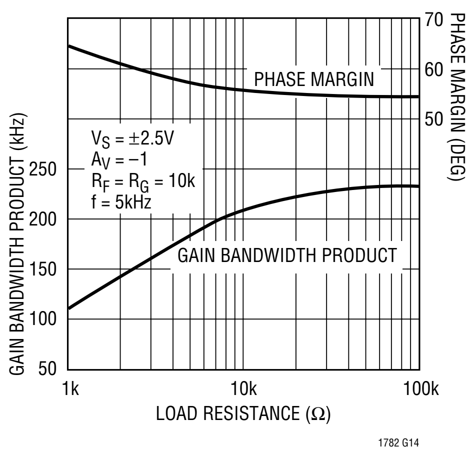
Slew Rate vs Temperature



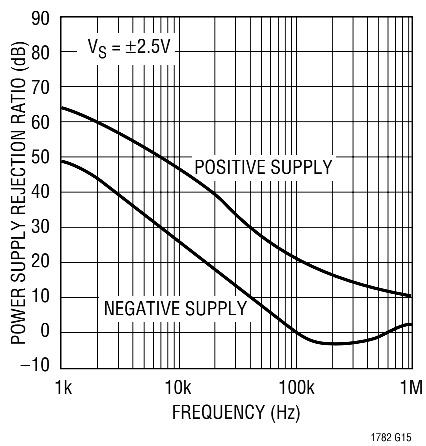
Gain Bandwidth Product and Phase Margin vs Supply Voltage



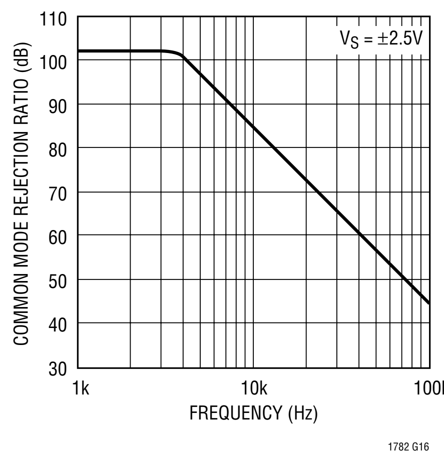
Gain Bandwidth Product and Phase Margin vs Load Resistance



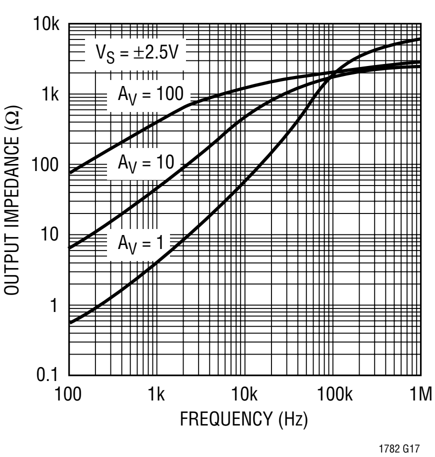
PSRR vs Frequency



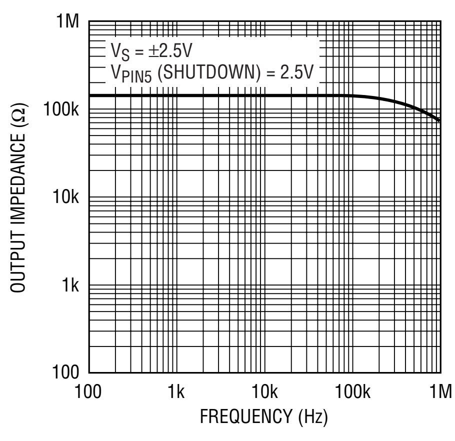
CMRR vs Frequency



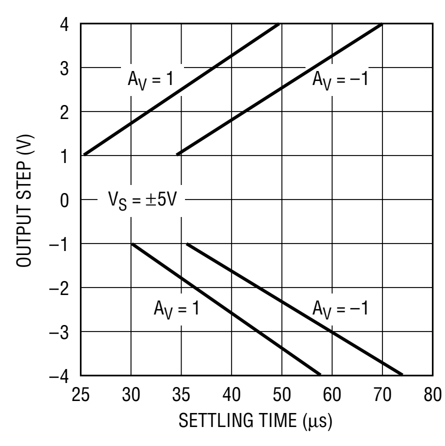
Output Impedance vs Frequency



Disabled Output Impedance vs Frequency (Note 8)

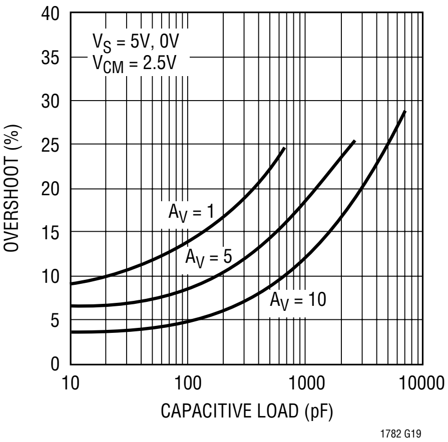


Settling Time to 0.1% vs Output Step

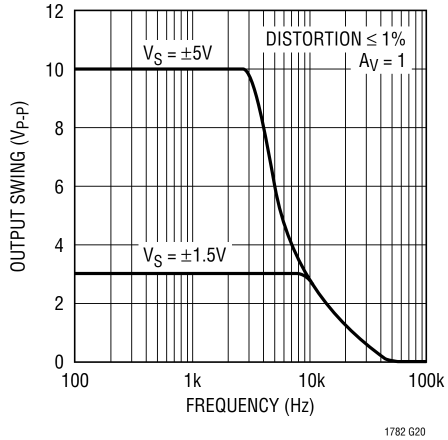


TYPICAL PERFORMANCE CHARACTERISTICS

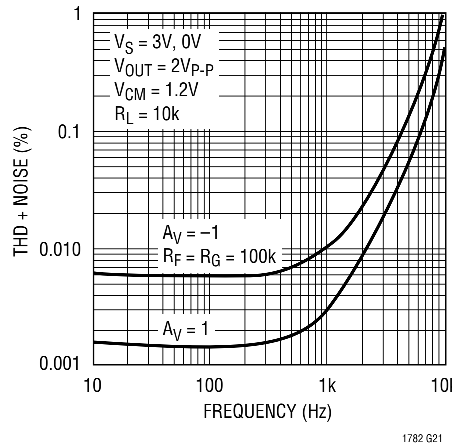
Capacitive Load Handling Overshoot vs Capacitive Load



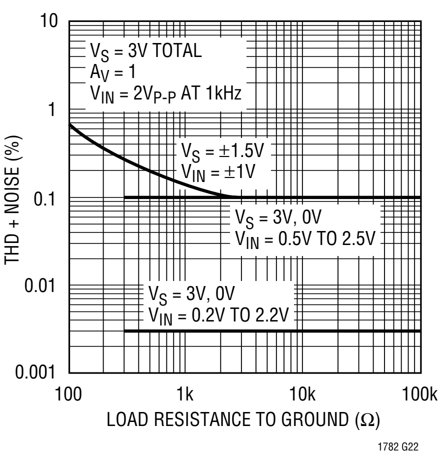
Undistorted Output Swing vs Frequency



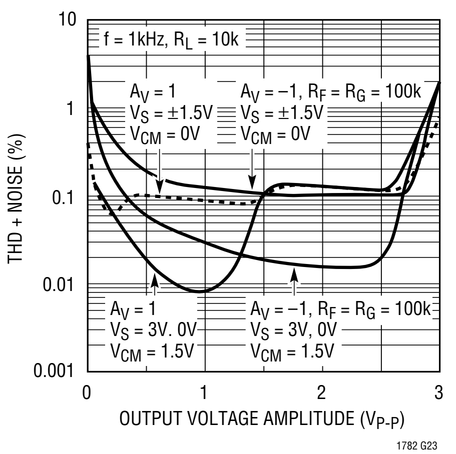
Total Harmonic Distortion + Noise vs Frequency



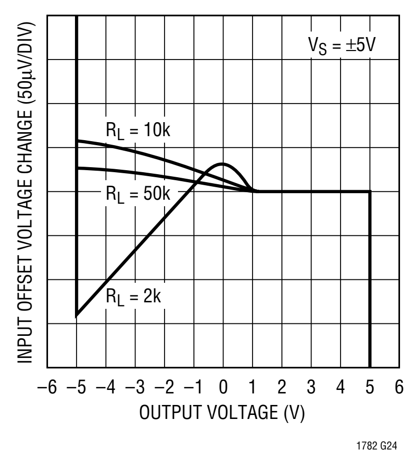
Total Harmonic Distortion + Noise vs Load Resistance



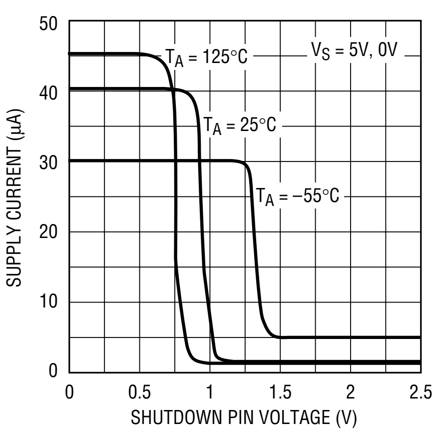
Total Harmonic Distortion + Noise vs Output Voltage Amplitude



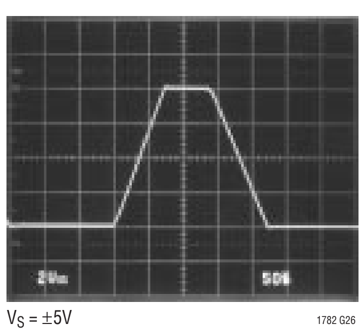
Open-Loop Gain



Supply Current vs Shutdown Voltage

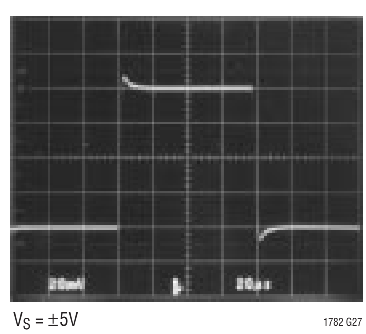


Large-Signal Response



V_S = ±5V
A_V = 1
C_L = 15pF

Small-Signal Response



V_S = ±5V
A_V = 1
C_L = 15pF

APPLICATIONS INFORMATION

Supply Voltage

The positive supply pin of the LT1782 should be bypassed with a small capacitor (typically 0.1µF) within an inch of the pin. When driving heavy loads, an additional 4.7µF electrolytic capacitor should be used. When using split supplies, the same is true for the negative supply pin.

The LT1782 is protected against reverse battery voltages up to 18V. In the event a reverse battery condition occurs, the supply current is typically less than 1nA.

Inputs

The LT1782 has two input stages, NPN and PNP (see the Simplified Schematic), resulting in three distinct operating regions as shown in the Input Bias Current vs Common Mode typical performance curve.

For input voltages about 0.8V or more below V^+, the PNP input stage is active and the input bias current is typically –8nA. When the input common mode voltage is within 0.5V of the positive rail, the NPN stage is operating and the input bias current is typically 15nA. Increases in temperature will cause the voltage at which operation switches from the PNP input stage to the NPN input stage to move towards V^+. The input offset voltage of the NPN stage is untrimmed and is typically 1.8mV.

A Schottky diode in the collector of the input NPN transistors, along with special geometries for these NPN transistors, allows the LT1782 to operate with either or both of its inputs above V^+. At about 0.3V above V^+, the NPN input transistor is fully saturated and the input bias current is typically 4µA at room temperature. The input offset voltage is typically 1.8mV when operating above V^+. The LT1782 will operate with its inputs 18V above V^- regardless of V^+.

The inputs are protected against excursions as much as 10V below V^- by an internal 6k resistor in series with each input and a diode from the input to the negative supply. The input stage of the LT1782 incorporates phase reversal protection to prevent the output from phase reversing for inputs up to 9V below V^-. There are no clamping diodes between the inputs and the maximum differential input voltage is 18V.

Output

The output of the LT1782 can swing to within 60mV of the positive rail with no load and within 3mV of the negative rail with no load. When monitoring voltages within 60mV of the positive rail or within 3mV of the negative rail, gain should be taken to keep the output from clipping. The LT1782 can sink and source over 30mA at ±5V supplies, sourcing current is reduced to 10mA at 3V total supplies as noted in the Electrical Characteristics.

The LT1782 is internally compensated to drive at least 600pF of capacitance under any output loading conditions. A 0.22µF capacitor in series with a 150Ω resistor between the output and ground will compensate these amplifiers for larger capacitive loads, up to 10,000pF, at all output currents.

Distortion

There are two main contributors to distortion in op amps: output crossover distortion as the output transitions from sourcing to sinking current, and distortion caused by nonlinear common mode rejection. If the op amp is operating inverting, there is no common mode induced distortion. If the op amp is operating in the PNP input stage (input is not within 0.8V of V^+), the CMRR is very good,

APPLICATIONS INFORMATION

typically 100dB. When the LT1782 switches between input stages, there is significant nonlinearity in the CMRR. Lower load resistance increases the output crossover distortion but has no effect on the input stage transition distortion. For lowest distortion, the LT1782 should be operated single supply, with the output always sourcing current and with the input voltage swing between ground and (V^+ – 0.8V). See the Typical Performance Characteristics curves, “Total Harmonic Distortion + Noise vs Ouput Voltage Amplitude.”

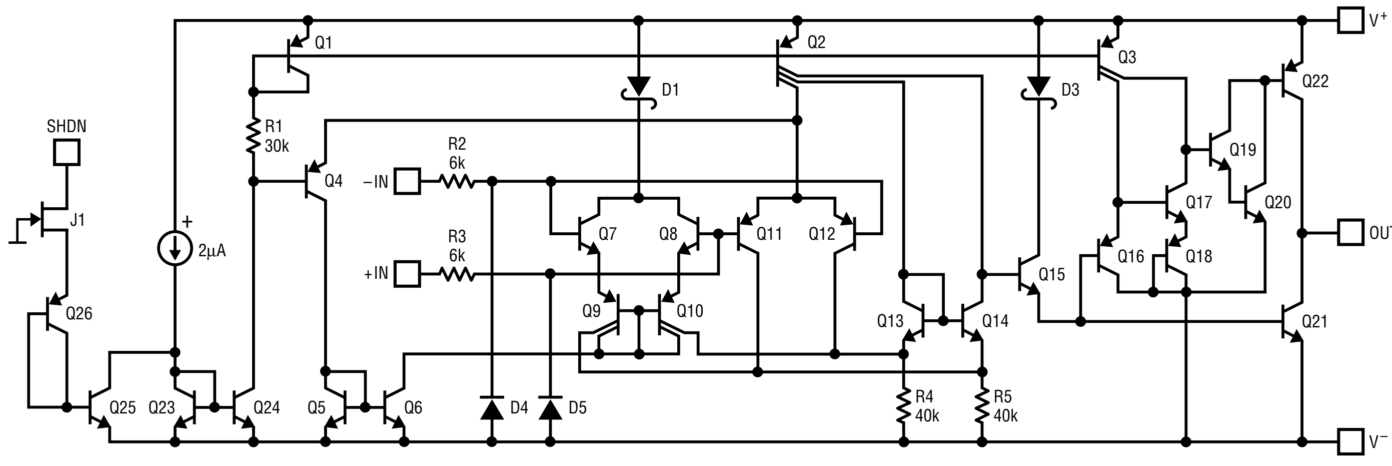
Gain

The open-loop gain is almost independent of load when the output is sourcing current. This optimizes performance in single supply applications where the load is returned to ground. The typical performance curve of open-loop gain for various loads shows the details.

Shutdown

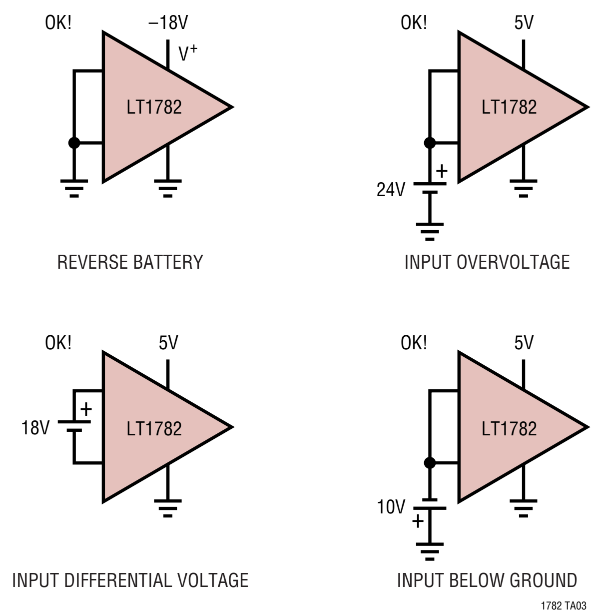
The 6-lead part includes a shutdown feature that disables the part, reducing quiescent current and making the output high impedance. The part can be shut down by bringing the SHDN pin 1.2V or more above V^-. When shut down, the supply current is about 5µA and the output leakage current is less than 1µA ($V^- \leq V_{OUT} \leq V^+$). In normal operation, the SHDN pin can be tied to V^- or left floating. See the Typical Performance Characteristics curves, “Supply Current vs Shutdown Pin Voltage.”

SIMPLIFIED SCHEMATIC

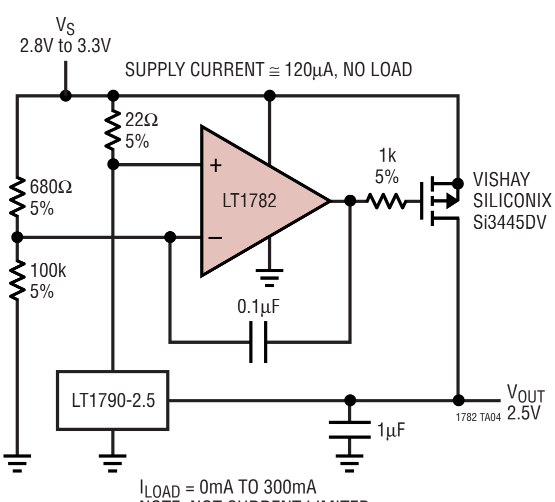


TYPICAL APPLICATIONS

Protected Fault Conditions



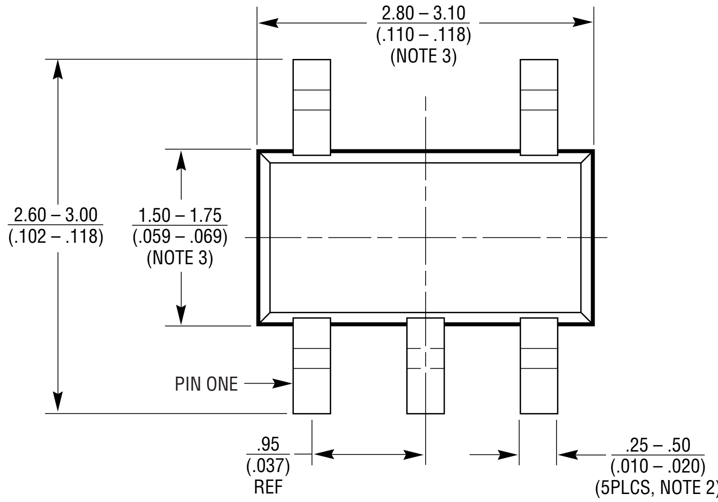
Compact, High Output Current, Low Dropout, Precision 2.5V Supply

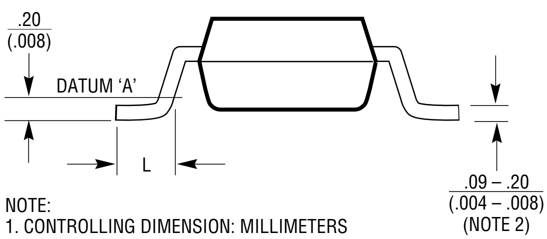


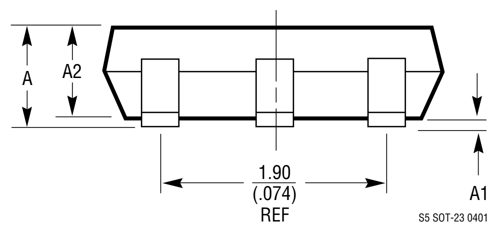
PACKAGE DESCRIPTION

S5 Package
5-Lead Plastic SOT-23
(LTC DWG # 05-08-1633)
(LTC DWG # 05-08-1635)

	SOT-23 (Original)	SOT-23 (ThinSOT)
A	.90 – 1.45 (.035 – .057)	1.00 MAX (.039 MAX)
A1	.00 – .15 (.00 – .006)	.01 – .10 (.0004 – .004)
A2	.90 – 1.30 (.035 – .051)	.80 – .90 (.031 – .035)
L	.35 – .55 (.014 – .021)	.30 – .50 REF (.012 – .019 REF)





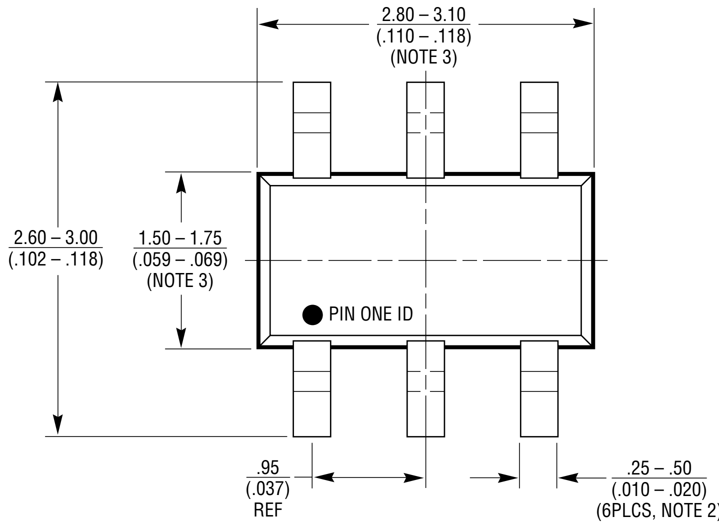


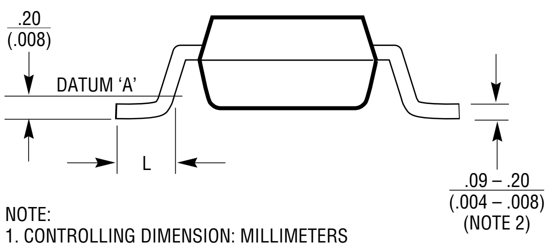
NOTE:
1. CONTROLLING DIMENSION: MILLIMETERS
2. DIMENSIONS ARE IN MILLIMETERS / (INCHES)
3. DRAWING NOT TO SCALE
4. DIMENSIONS ARE INCLUSIVE OF PLATING
5. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH AND METAL BURR
6. MOLD FLASH SHALL NOT EXCEED .254mm
7. PACKAGE EIAJ REFERENCE IS:
   SC-74A (EIAJ) FOR ORIGINAL
   JEDEL MO-193 FOR THIN

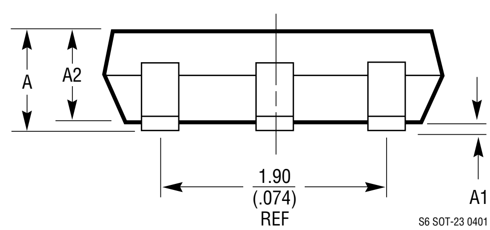
PACKAGE DESCRIPTION

S6 Package
6-Lead Plastic SOT-23
(LTC DWG # 05-08-1634)
(LTC DWG # 05-08-1636)

	SOT-23 (Original)	SOT-23 (ThinSOT)
A	.90 – 1.45 (.035 – .057)	1.00 MAX (.039 MAX)
A1	.00 – 0.15 (.00 – .006)	.01 – .10 (.0004 – .004)
A2	.90 – 1.30 (.035 – .051)	.80 – .90 (.031 – .035)
L	.35 – .55 (.014 – .021)	.30 – .50 REF (.012 – .019 REF)



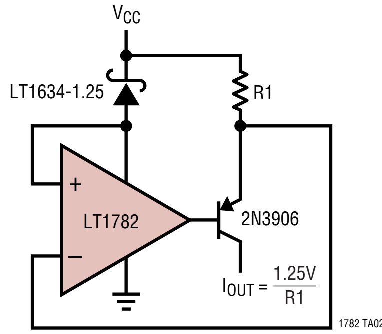




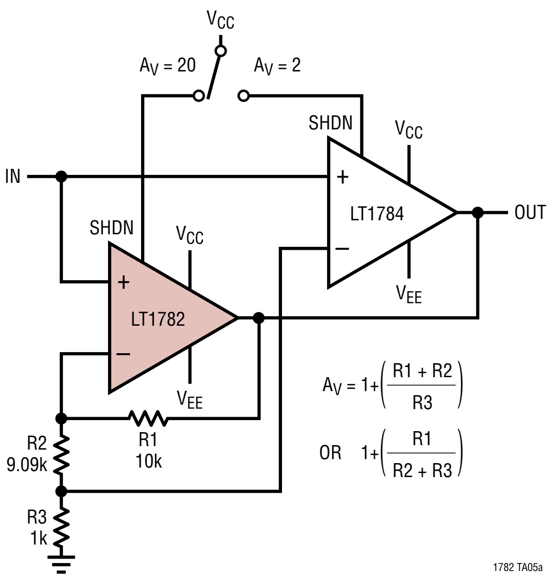
NOTE:
1. CONTROLLING DIMENSION: MILLIMETERS
2. DIMENSIONS ARE IN $\frac{\text{MILLIMETERS}}{\text{(INCHES)}}$
3. DRAWING NOT TO SCALE
4. DIMENSIONS ARE INCLUSIVE OF PLATING
5. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH AND METAL BURR
6. MOLD FLASH SHALL NOT EXCEED .254mm
7. PACKAGE EIAJ REFERENCE IS:
   SC-74A (EIAJ) FOR ORIGINAL
   JEDEL MO-193 FOR THIN

TYPICAL APPLICATIONS

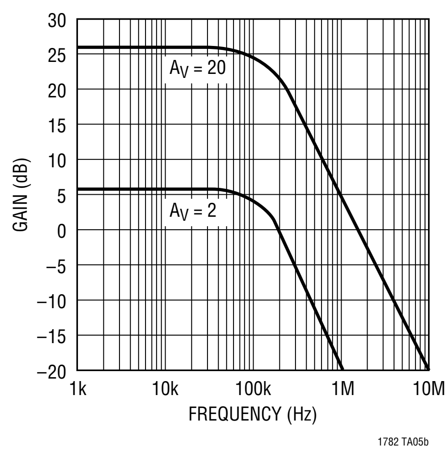
Current Source



Programmable Gain, A_V = 2, A_V = 20, 100kHz Amplifier



Programmable Gain Amplifier Frequency Response



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1783	Micropower Over-The-Top SOT-23 Rail-to-Rail Input and Output Op Amp	SOT-23 Package, Micropower 210μA per Amplifier, Rail-to-Rail Input and Output , 1.25MHz GBW
LT1490/LT1491	Dual/Quad Over-The-Top Micropower Rail-to-Rail Input and Output Op Amps	Single Supply Input Range: –0.4V to 44V, Micropower 50μA per Amplifier, Rail-to-Rail Input and Output , 200kHz GBW
LT1636	Single Over-The-Top Micropower Rail-to-Rail Input and Output Op Amp	55μA Supply Current, V_{CM} Extends 44V Above V_{EE}, Independent of V_{CC}, MSOP Package, Shutdown Function
LT1638/LT1639	Dual/Quad, 1.2MHz, 0.4V/μs, Over-The-Top Micropower Rail-to-Rail Input and Output Op Amps	170μA Supply Current, Single Supply Input Range: –0.4V to 44V, Rail-to-Rail Input and Output

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