Dual/Quad 135µA, 14nV/√Hz, Rail-to-Rail Output Precision Op Amp

FEATURES

- **60µV Maximum Offset Voltage**
- **300pA Maximum Input Bias Current**
- **135µA Supply Current per Amplifier**
- **Rail-to-Rail Output Swing**
- 120dB Minimum Voltage Gain, $V_S = \pm 15V$
- 0.8µV/°C Maximum V_{OS} Drift
- 14nV/√Hz Input Noise Voltage
- 2.7V to ±18V Supply Voltage Operation
- Operating Temperature Range: –40°C to 85°C
- Space Saving 3mm × 3mm DFN Package

APPLICATIONS

- Thermocouple Amplifiers
- Precision Photo Diode Amplifiers
- Instrumentation Amplifiers
- Battery-Powered Precision Systems
- Low Voltage Precision Systems

DESCRIPTION

The LT®6011/LT6012 op amps combine low noise and high precision input performance with low power consumption and rail-to-rail output swing.

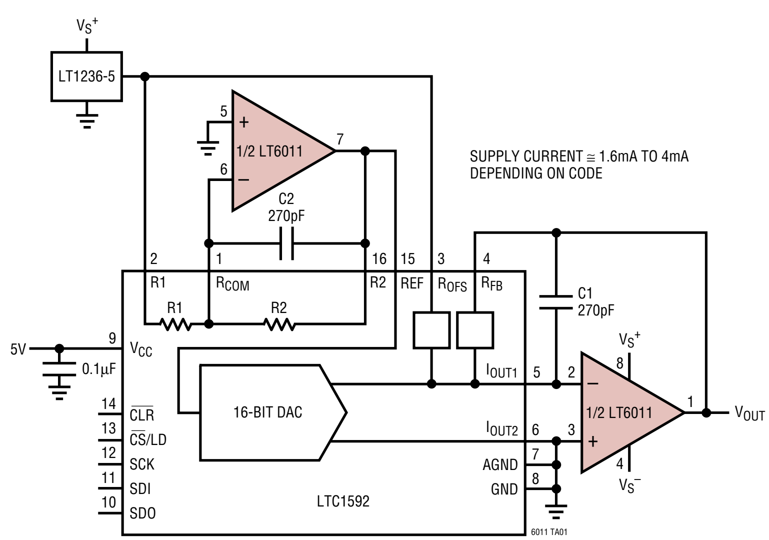
Input offset voltage is trimmed to less than 60µV. The low drift and excellent long-term stability guarantee a high accuracy over temperature and time. The 300pA maximum input bias current and 120dB minimum voltage gain further maintain this precision over operating conditions.

The LT6011/LT6012 work on any power supply voltage from 2.7V to 36V and draw only 135µA of supply current on a 5V supply. The output swings to within 40mV of either supply rail, making the amplifier a good choice for low voltage single supply applications.

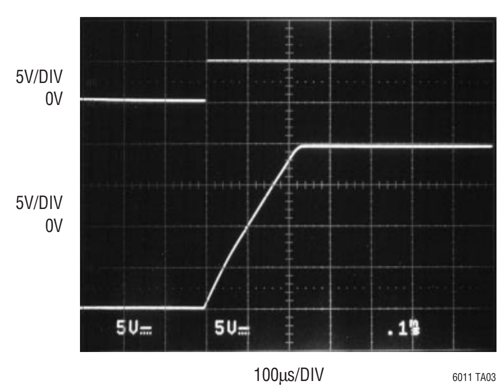
The LT6011/LT6012 are specified at 5V and ±15V supplies and from –40°C to 85°C. The LT6011 (dual) is available in SO-8 and space saving 3mm × 3mm DFN packages. The LT6012 (quad) is available in SO-14 and 16-pin SSOP packages.

TYPICAL APPLICATION

Low Power Programmable Output Range 16-Bit SoftSpan™ DAC



20V Output Step Response

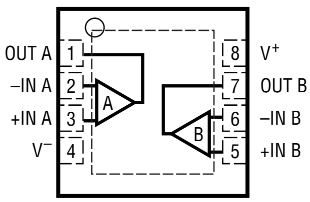
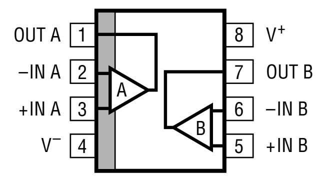
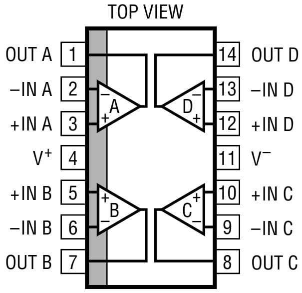
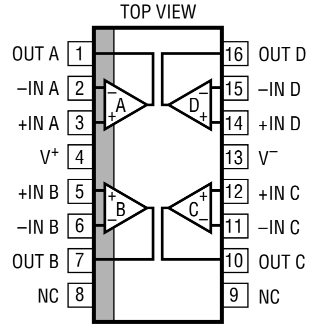


ABSOLUTE MAXIMUM RATINGS (Note 1)

Total Supply Voltage (V^+ to V^-) 40V
Differential Input Voltage (Note 2) 10V
Input Voltage .... V^+ to V^-
Input Current (Note 2) .... ±10mA
Output Short-Circuit Duration (Note 3) .... Indefinite
Operating Temperature Range (Note 4) .. –40°C to 85°C
Specified Temperature Range (Note 5) ... –40°C to 85°C

Maximum Junction Temperature
DD Package .... 125°C
All Other Packages .... 150°C
Storage Temperature Range
DD Package .... –65°C to 125°C
All Other Packages .... –65°C to 150°C
Lead Temperature (Soldering, 10 sec) .... 300°C

PACKAGE/ORDER INFORMATION

Package	ORDER PART NUMBER	Package	ORDER PART NUMBER
TOP VIEW  DD PACKAGE 8-LEAD (3mm × 3mm) PLASTIC DFN T_{JMAX} = 125°C, θ_{JA} = 160°C/W UNDERSIDE METAL CONNECTED TO V– (PCB CONNECTION OPTIONAL)	LT6011CDD LT6011IDD LT6011ACDD LT6011AIDD **DD PART MARKING*** LACD	TOP VIEW  S8 PACKAGE 8-LEAD PLASTIC SO T_{JMAX} = 150°C, θ_{JA} = 190°C/W	LT6011CS8 LT6011IS8 LT6011ACS8 LT6011AIS8 **S8 PART MARKING** 6011 6011I 6011A 6011AI
TOP VIEW  S PACKAGE 14-LEAD PLASTIC SO T_{JMAX} = 150°C, θ_{JA} = 110°C/W	LT6012CS LT6012IS LT6012ACS LT6012AIS	TOP VIEW  GN PACKAGE 16-LEAD PLASTIC SSOP T_{JMAX} = 150°C, θ_{JA} = 135°C/W	LT6012CGN LT6012IGN LT6012ACGN LT6012AIGN **GN PART MARKING** 6012 6012I 6012A 6012AI

*Temperature and electrical grades are identified by a label on the shipping container.
Consult LTC Marketing for parts specified with wider operating temperature ranges.

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, 0V; V_{CM} = 2.5V; R_L to 0V; unless otherwise specified. (Note 5)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage (Note 8)	LT6011AS8, LT6012AS			20	60	µV
		T_A = 0°C to 70°C	●			85	µV
		T_A = –40°C to 85°C	●			110	µV
		LT6011ADD, LT6012AGN			25	85	µV
		T_A = 0°C to 70°C	●			135	µV
		T_A = –40°C to 85°C	●			170	µV
		LT6011S8, LT6012S			25	75	µV
		T_A = 0°C to 70°C	●			100	µV
		T_A = –40°C to 85°C	●			125	µV
		LT6011DD, LT6012GN			30	125	µV
		T_A = 0°C to 70°C	●			175	µV
		T_A = –40°C to 85°C	●			210	µV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift (Note 6)	LT6011AS8, LT6011S8, LT6012AS,LT6012S	●		0.2	0.8	µV/°C
		LT6011ADD, LT6011DD,LT6012AGN, LT6012GN	●		0.2	1.2	µV/°C
I_{OS}	Input Offset Current (Note 8)	LT6011AS8, LT6011ADD, LT6012AS, LT6012AGN			20	300	pA
		T_A = 0°C to 70°C	●			450	pA
		T_A = –40°C to 85°C	●			600	pA
		LT6011S8, LT6011DD, LT6012S, LT6012GN			150	900	pA
		T_A = 0°C to 70°C	●			1200	pA
		T_A = –40°C to 85°C	●			1500	pA
I_B	Input Bias Current (Note 8)	LT6011AS8, LT6011ADD, LT6012AS, LT6012AGN			20	±300	pA
		T_A = 0°C to 70°C	●			±450	pA
		T_A = –40°C to 85°C	●			±600	pA
		LT6011S8, LT6011DD, LT6012S, LT6012GN			150	±900	pA
		T_A = 0°C to 70°C	●			±1200	pA
		T_A = –40°C to 85°C	●			±1500	pA
	Input Noise Voltage	0.1Hz to 10Hz			400		nV_{P-P}
e_n	Input Noise Voltage Density	f = 1kHz			14		nV/√Hz
i_n	Input Noise Current Density	f = 1kHz, Unbalanced Source Resistance			0.1		pA/√Hz
R_{IN}	Input Resistance	Common Mode, V_{CM} = 1V to 3.8V		10	120		GΩ
		Differential			20		MΩ
C_{IN}	Input Capacitance				4		pF
V_{CM}	Input Voltage Range (Positive)	Guaranteed by CMRR	●	3.8	4		V
	Input Voltage Range (Negative)	Guaranteed by CMRR	●		0.7	1	V
CMRR	Common Mode Rejection Ratio	V_{CM} = 1V to 3.8V	●	107	135		dB
	Minimum Supply Voltage	Guaranteed by PSRR	●		2.4	2.7	V
PSRR	Power Supply Rejection Ratio	V_S = 2.7V to 36V, V_{CM} = 1/2V_S	●	112	135		dB
A_{VOL}	Large-Signal Voltage Gain	R_L = 10k, V_{OUT} = 1V to 4V	●	300	2000		V/mV
		R_L = 2k, V_{OUT} = 1V to 4V	●	250	2000		V/mV
	Channel Separation	V_{OUT} = 1V to 4V	●	110	140		dB

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, 0V; V_{CM} = 2.5V; R_L to 0V; unless otherwise specified. (Note 5)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OUT}	Maximum Output Swing (Positive, Referred to V^+)	No Load, 50mV Overdrive	 ●		35	55 65	mV mV
		I_{SOURCE} = 1mA, 50mV Overdrive	 ●		120	170 220	mV mV
	Maximum Output Swing (Negative, Referred to 0V)	No Load, 50mV Overdrive	 ●		40	55 65	mV mV
		I_{SINK} = 1mA, 50mV Overdrive	 ●		150	225 275	mV mV
I_{SC}	Output Short-Circuit Current (Note 3)	V_{OUT} = 0V, 1V Overdrive, Source	 ●	10 4	14		mA mA
		V_{OUT} = 5V, –1V Overdrive, Sink	 ●	10 4	21		mA mA
SR	Slew Rate	A_V = –10, R_F = 50k, R_G = 5k T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	0.06 0.05 0.04	0.09		V/µs V/µs V/µs
GBW	Gain Bandwidth Product	f = 10kHz	 ●	250 225	330		kHz kHz
t_s	Settling Time	A_V = –1, 0.01%, V_{OUT} = 1.5V to 3.5V			45		µs
t_r, t_f	Rise Time, Fall Time	A_V = 1, 10% to 90%, 0.1V Step			1		µs
ΔV_{OS}	Offset Voltage Match (Note 7)	LT6011AS8, LT6012AS T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		50	120 170 220	µV µV µV
		LT6011ADD, LT6012AGN T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		50	170 270 340	µV µV µV
		LT6011S8, LT6012S T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		50	150 200 250	µV µV µV
		LT6011DD, LT6012GN T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		60	250 350 420	µV µV µV
ΔI_B	Input Bias Current Match (Note 7)	LT6011AS8, LT6011ADD, LT6012AS, LT6012AGN T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		 50	 600 900 1200	 pA pA pA
		LT6011S8, LT6011DD, LT6012S, LT6012GN T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●			 1800 2400 3000	 pA pA pA
ΔCMRR	Common Mode Rejection Ratio Match (Note 7)		●	101	135		dB
ΔPSRR	Power Supply Rejection Ratio Match (Note 7)		●	106	135		dB
I_S	Supply Current	per Amplifier T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		135	150 190 210	µA µA µA

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V_S = ±15V, V_{CM} = 0V, R_L to 0V, unless otherwise specified. (Note 5)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage (Note 8)	LT6011AS8, LT6012AS			30	135	µV
		T_A = 0°C to 70°C	●			160	µV
		T_A = –40°C to 85°C	●			185	µV
		LT6011ADD, LT6012AGN			35	160	µV
		T_A = 0°C to 70°C	●			210	µV
		T_A = –40°C to 85°C	●			225	µV
		LT6011S8, LT6012S			35	150	µV
		T_A = 0°C to 70°C	●			175	µV
		T_A = –40°C to 85°C	●			200	µV
		LT6011DD, LT6012GN			40	200	µV
		T_A = 0°C to 70°C	●			250	µV
		T_A = –40°C to 85°C	●			275	µV
$\Delta V_{OS}/\Delta T$	Input Offset Voltage Drift (Note 6)	LT6011AS8, LT6011S8, LT6012AS, LT6012S	●		0.2	0.8	µV/°C
		LT6011ADD, LT6011DD, LT6012AGN, LT6012GN	●		0.2	1.3	µV/°C
I_{OS}	Input Offset Current (Note 8)	LT6011AS8, LT6011ADD, LT6012AS LT6012AGN			20	300	pA
		T_A = 0°C to 70°C	●			450	pA
		T_A = –40°C to 85°C	●			600	pA
		LT6011S8, LT6011DD, LT6012S, LT6012GN			150	900	pA
		T_A = 0°C to 70°C	●			1200	pA
		T_A = –40°C to 85°C	●			1500	pA
I_B	Input Bias Current (Note 8)	LT6011AS8, LT6011ADD, LT6012AS, LT6012AGN			20	±300	pA
		T_A = 0°C to 70°C	●			±450	pA
		T_A = –40°C to 85°C	●			±600	pA
		LT6011S8, LT6011DD, LT6012S, LT6012GN			150	±900	pA
		T_A = 0°C to 70°C	●			±1200	pA
		T_A = –40°C to 85°C	●			±1500	pA
	Input Noise Voltage	0.1Hz to 10Hz			400		nV_{P-P}
e_n	Input Noise Voltage Density	f = 1kHz			13		$nV/\sqrt{Hz}$
i_n	Input Noise Current Density	f = 1kHz, Unbalanced Source Resistance			0.1		$pA/\sqrt{Hz}$
R_{IN}	Input Resistance	Common Mode, V_{CM} = ±13.5V		50	400		GΩ
		Differential			20		MΩ
C_{IN}	Input Capacitance				4		pF
V_{CM}	Input Voltage Range	Guaranteed by CMRR	●	±13.5	±14		V
CMRR	Common Mode Rejection Ratio	V_{CM} = –13.5V to 13.5V		115	135		dB
			●	112	135		dB
	Minimum Supply Voltage	Guaranteed by PSRR	●		±1.2	±1.35	V
PSRR	Power Supply Rejection Ratio	V_S = ±1.35V to ±18V	●	112	135		dB
A_{VOL}	Large-Signal Voltage Gain	R_L = 10k, V_{OUT} = –13.5V to 13.5V		1000	2000		V/mV
			●	600			V/mV
		R_L = 5k, V_{OUT} = –13.5V to 13.5V		500	1500		V/mV
			●	300			V/mV
	Channel Separation	V_{OUT} = –13.5V to 13.5V	●	120	140		dB
V_{OUT}	Maximum Output Swing (Positive, Referred to V^+)	No Load, 50mV Overdrive			45	80	mV
			●			100	mV
		I_{SOURCE} = 1mA, 50mV Overdrive			140	195	mV
			●			240	mV
	Maximum Output Swing (Negative, Referred to V^-)	No Load, 50mV Overdrive			45	80	mV
			●			100	mV
		I_{SINK} = 1mA, 50mV Overdrive			150	250	mV
			●			300	mV

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V_S = ±15V, V_{CM} = 0V, R_L to 0V, unless otherwise specified. (Note 5)

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
I_{SC}	Output Short-Circuit Current (Note 3)	V_{OUT} = 0V, 1V Overdrive (Source)		10	15		mA
			●	5			mA
		V_{OUT} = 0V, –1V Overdrive (Sink)		10	20		mA
			●	5			mA
SR	Slew Rate	A_V = –10, R_F = 50k, R_G = 5k		0.08	0.11		V/µs
		T_A = 0°C to 70°C	●	0.07			V/µs
		T_A = –40°C to 85°C	●	0.05			V/µs
GBW	Gain Bandwidth Product	f = 10kHz		275	350		kHz
			●	250			kHz
t_s	Settling Time	A_V = –1, 0.01%, V_{OUT} = 0V to 10V			85		µs
t_r, t_f	Rise Time, Fall Time	A_V = 1, 10% to 90%, 0.1V Step			1		µs
ΔV_{OS}	Offset Voltage Match (Note 7)	LT6011AS8, LT6012AS			50	270	µV
		T_A = 0°C to 70°C	●			320	µV
		T_A = –40°C to 85°C	●			370	µV
		LT6011ADD, LT6012AGN			50	320	µV
		T_A = 0°C to 70°C	●			420	µV
		T_A = –40°C to 85°C	●			450	µV
		LT6011S8, LT6012S			70	300	µV
		T_A = 0°C to 70°C	●			350	µV
		T_A = –40°C to 85°C	●			400	µV
		LT6011DD, LT6012GN			80	400	µV
		T_A = 0°C to 70°C	●			500	µV
		T_A = –40°C to 85°C	●			550	µV
ΔI_B	Input Bias Current Match (Note 7)	LT6011AS8, LT6011ADD, LT6012AS, LT6012AGN			50	600	pA
		T_A = 0°C to 70°C	●			900	pA
		T_A = –40°C to 85°C	●			1200	pA
		LT6011S8, LT6011DD, LT6012S, LT6012GN				1800	pA
		T_A = 0°C to 70°C	●			2400	pA
		T_A = –40°C to 85°C	●			3000	pA
ΔCMRR	Common Mode Rejection Ratio Match (Note 7)		●	109	135		dB
ΔPSRR	Power Supply Rejection Ratio Match (Note 7)		●	106	135		dB
I_S	Supply Current	per Amplifier			260	330	µA
		T_A = 0°C to 70°C	●			380	µA
		T_A = –40°C to 85°C	●			400	µA

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

Note 2: The inputs are protected by back-to-back diodes and internal series resistors. If the differential input voltage exceeds 10V, the input current must be limited to less than 10mA.

Note 3: A heat sink may be required to keep the junction temperature below absolute maximum ratings.

Note 4: Both the LT6011C/LT6012C and LT6011I/LT6012I are guaranteed functional over the operating temperature range of –40°C to 85°C.

Note 5: The LT6011C/LT6012C are guaranteed to meet the specified performance from 0°C to 70°C and 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 LT6011I/LT6012I are guaranteed to meet specified performance from –40°C to 85°C.

Note 6: This parameter is not 100% tested.

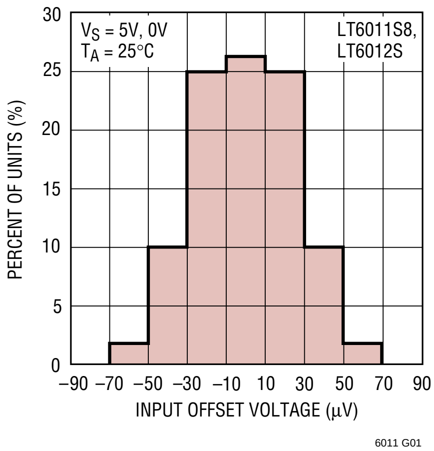
Note 7: Matching parameters are the difference between any two amplifiers. ΔCMRR and ΔPSRR are defined as follows: (1) CMRR and PSRR are measured in µV/V for the individual amplifiers. (2) The difference between matching amplifiers is calculated in µV/V. (3) The result is converted to dB.

Note 8: The specifications for V_{OS}, I_B, and I_{OS} depend on the grade and on the package. The following table clarifies the notations.

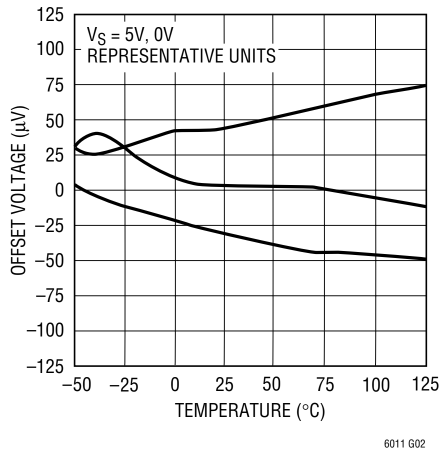
	STANDARD GRADE	A GRADE
S8 Package	LT6011S8	LT6011AS8
DFN Package	LT6011DD	LT6011ADD
S14 Package	LT6012S	LT6012AS
GN16 Package	LT6012GN	LT6012AGN

TYPICAL PERFORMANCE CHARACTERISTICS

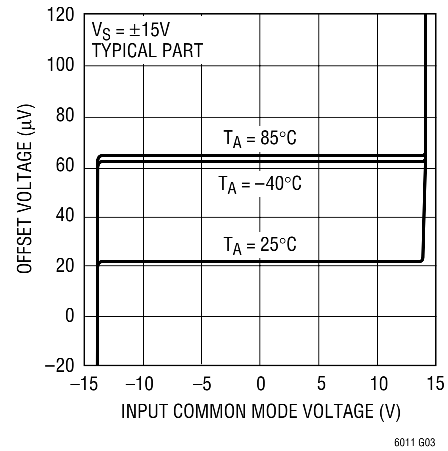
Distribution of Input Offset Voltage



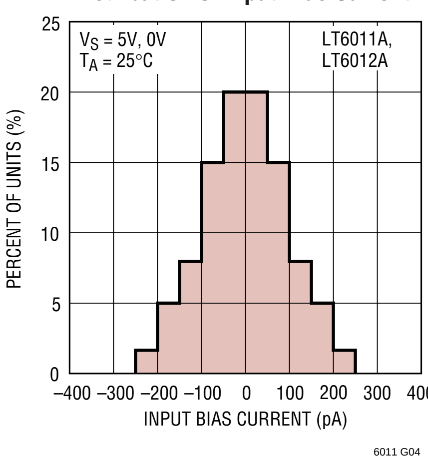
Input Offset Voltage vs Temperature



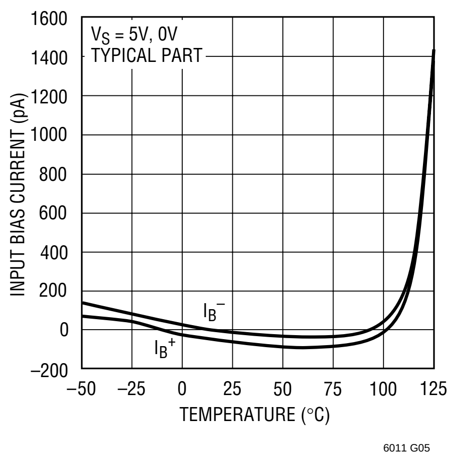
Offset Voltage vs Input Common Mode Voltage



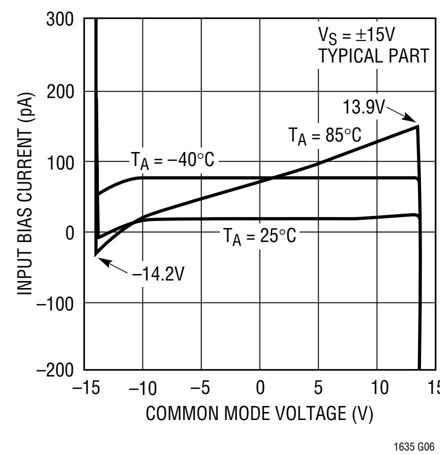
Distribution of Input Bias Current



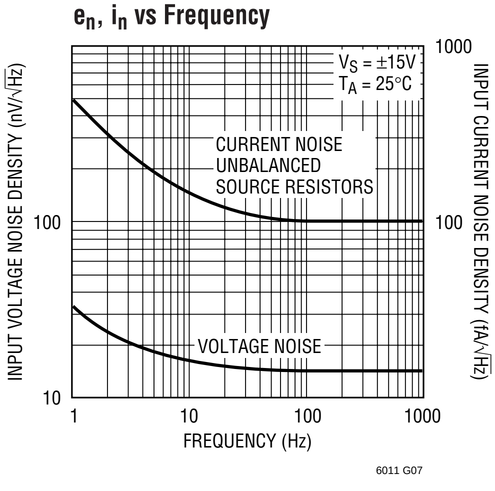
Input Bias Current vs Temperature



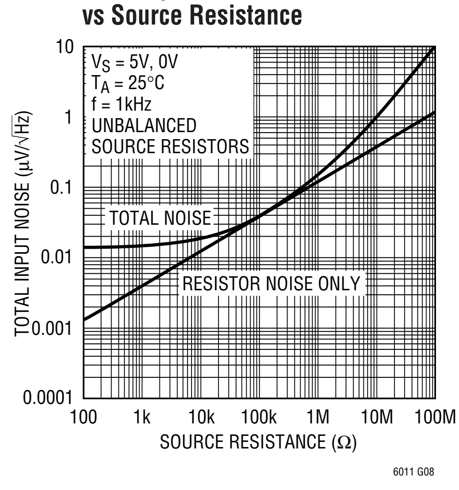
Input Bias Current vs Input Common Mode Voltage



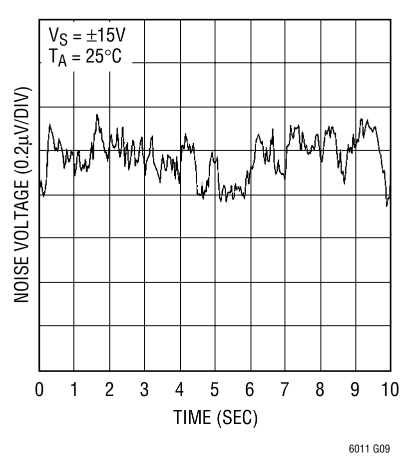
e_n, i_n vs Frequency



Total Input Noise vs Source Resistance

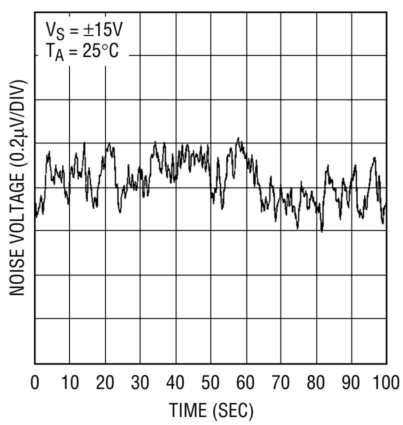


0.1Hz to 10Hz Noise



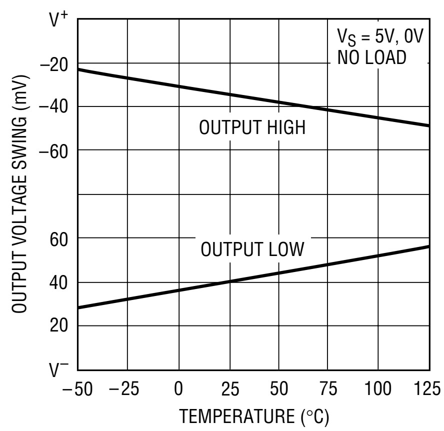
TYPICAL PERFORMANCE CHARACTERISTICS

0.01Hz to 1Hz Noise



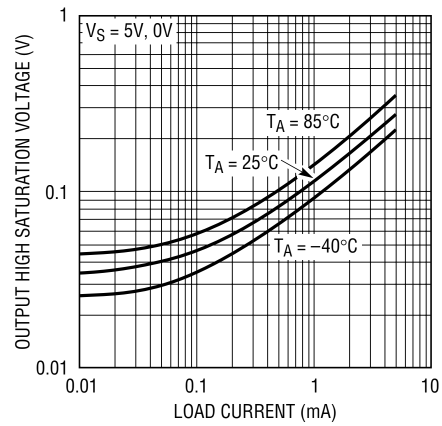
6011 G10

Output Voltage Swing vs Temperature



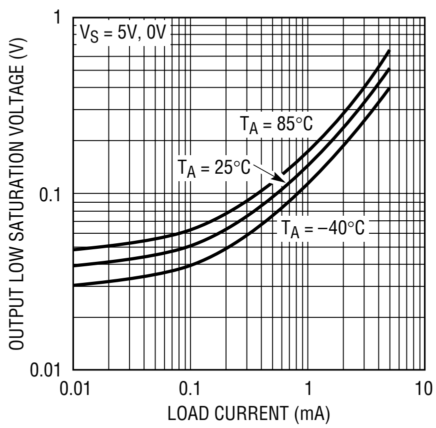
6011 G11

Output Saturation Voltage vs Load Current (Output High)



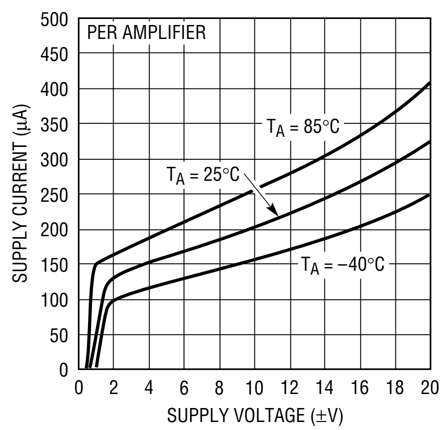
6011 G12

Output Saturation Voltage vs Load Current (Output Low)



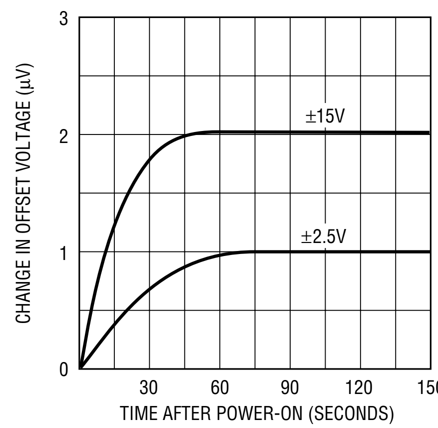
6011 G13

Supply Current vs Supply Voltage



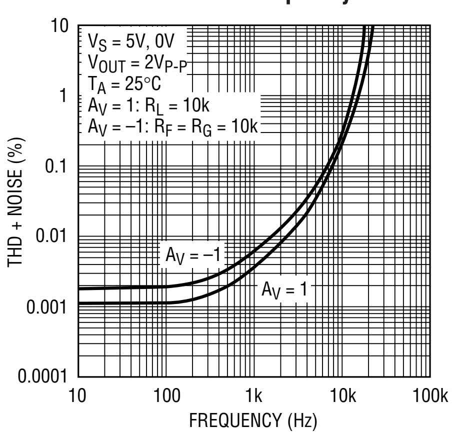
6011 G14

Warm-Up Drift



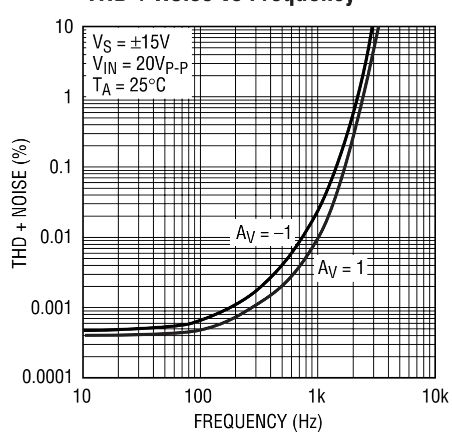
6011 G15

THD + Noise vs Frequency



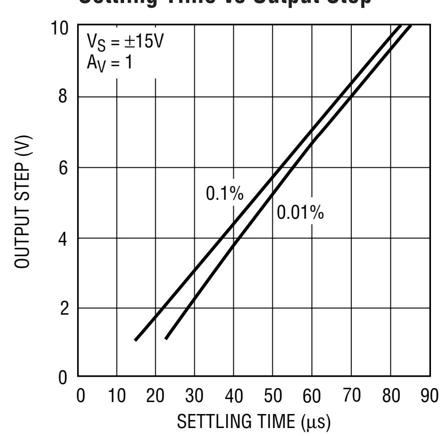
6011 G16

THD + Noise vs Frequency



6011 G17

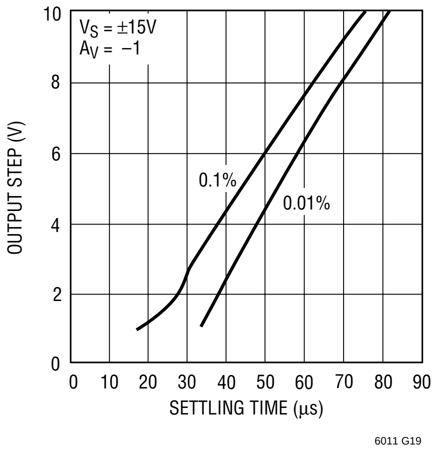
Settling Time vs Output Step



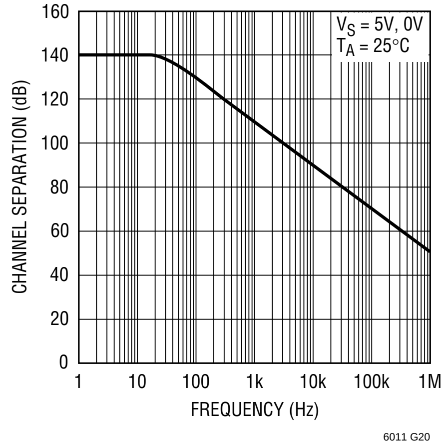
6011 G18

TYPICAL PERFORMANCE CHARACTERISTICS

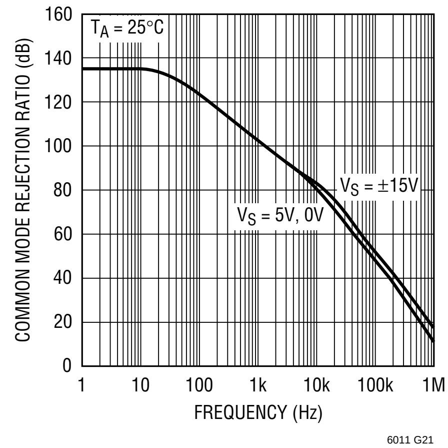
Settling Time vs Output Step



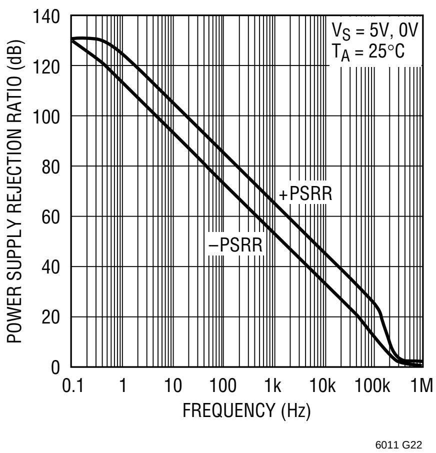
Channel Separation vs Frequency



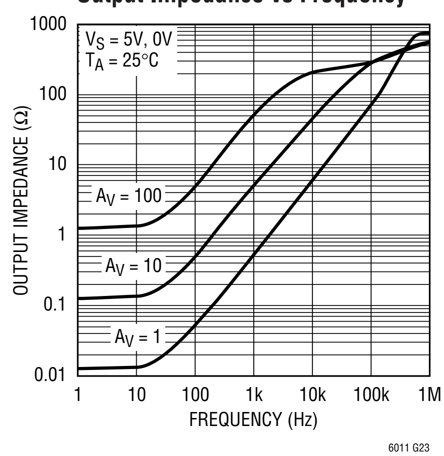
CMRR vs Frequency



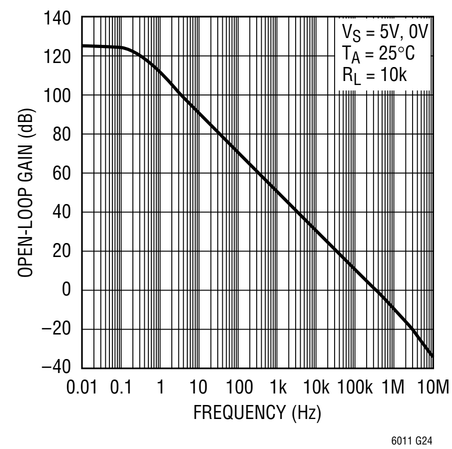
PSRR vs Frequency



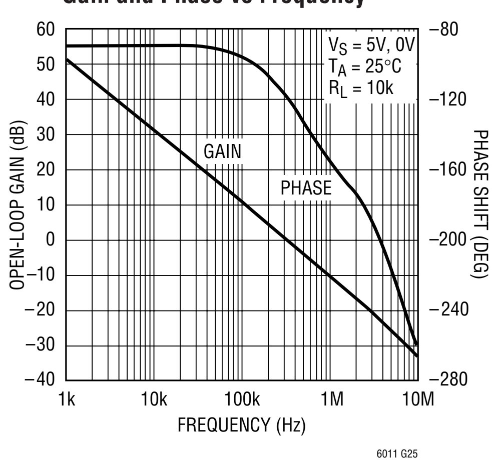
Output Impedance vs Frequency



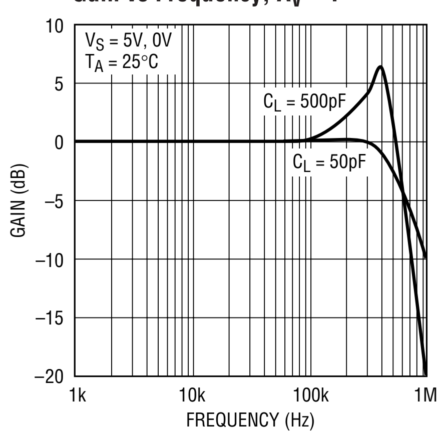
Open-Loop Gain vs Frequency



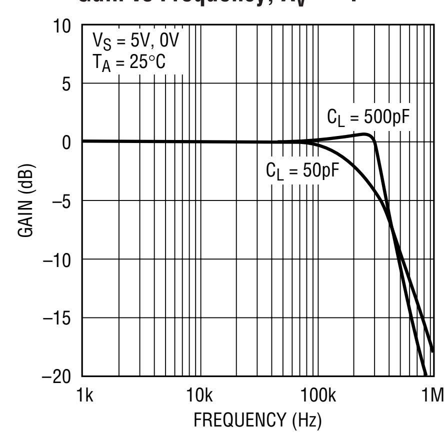
Gain and Phase vs Frequency



Gain vs Frequency, A_V = 1

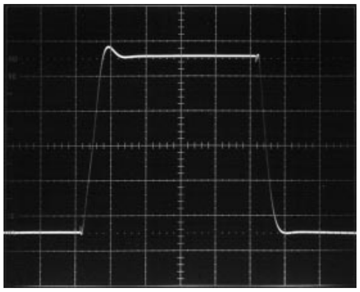


Gain vs Frequency, A_V = –1

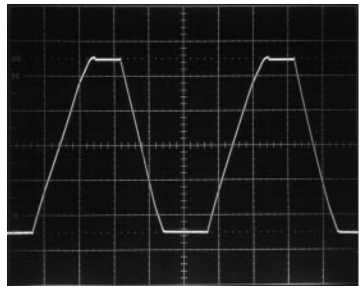


TYPICAL PERFORMANCE CHARACTERISTICS

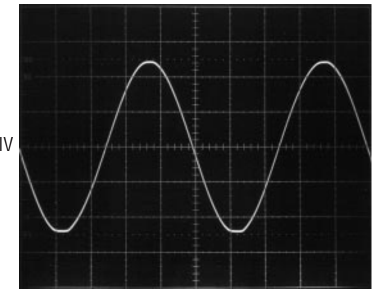
Small-Signal Transient Response



Large-Signal Transient Response



Rail-to-Rail Output Swing



APPLICATIONS INFORMATION

Preserving Input Precision

Preserving the input accuracy of the LT6011/LT6012 requires that the applications circuit and PC board layout do not introduce errors comparable to or greater than the 25µV typical offset of the amplifiers. Temperature differentials across the input connections can generate thermocouple voltages of 10's of microvolts so the connections to the input leads should be short, close together and away from heat dissipating components. Air currents across the board can also generate temperature differentials.

The extremely low input bias currents (20pA typical) allow high accuracy to be maintained with high impedance sources and feedback resistors. The LT6011/LT6012 low input bias currents are obtained by a cancellation circuit on-chip. This causes the resulting I_B^+ and I_B^- to be uncorrelated, as implied by the I_{OS} specification being comparable to I_B. Do not try to balance the input resistances in each input lead; instead keep the resistance at either input as low as possible for maximum accuracy.

Leakage currents on the PC board can be higher than the input bias current. For example, 10GΩ of leakage between a 15V supply lead and an input lead will generate 1.5nA! Surround the input leads with a guard ring driven to the same potential as the input common mode to avoid excessive leakage in high impedance applications.

Input Protection

The LT6011/LT6012 feature on-chip back-to-back diodes between the input devices, along with 500Ω resistors in series with either input. This internal protection limits the input current to approximately 10mA (the maximum allowed) for a 10V differential input voltage. Use additional external series resistors to limit the input current to 10mA in applications where differential inputs of more than 10V are expected. For example, a 1k resistor in series with each input provides protection against 30V differential voltage.

Input Common Mode Range

The LT6011/LT6012 output is able to swing close to each power supply rail (rail-to-rail out), but the input stage is limited to operating between $V^- + 1V$ and $V^+ - 1.2V$. Exceeding this common mode range will cause the gain to drop to zero, however, no phase reversal will occur.

Total Input Noise

The LT6011/LT6012 amplifier contributes negligible noise to the system when driven by sensors (sources) with impedance between 20kΩ and 1MΩ. Throughout this range, total input noise is dominated by the $4kTR_S$ noise of the source. If the source impedance is less than 20kΩ, the input voltage noise of the amplifier starts to contribute with a minimum noise of $14nV/\sqrt{Hz}$ for very low source impedance. If the source impedance is more than 1MΩ, the input current noise of the amplifier, multiplied by this high impedance, starts to contribute and eventually dominate. Total input noise spectral density can be calculated as:

$$v_{n(TOTAL)} = \sqrt{e_n^2 + 4kTR_S + (i_n R_S)^2}$$

APPLICATIONS INFORMATION

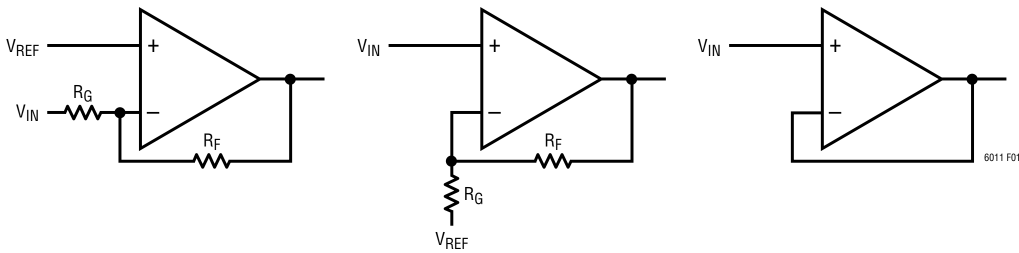
where $e_n = 14nV/\sqrt{Hz}$, $i_n = 0.1pA/\sqrt{Hz}$ and R_S is the total impedance at the input, including the source impedance.

Capacitive Loads

The LT6011/LT6012 can drive capacitive loads up to 500pF in unity gain. The capacitive load driving capability increases as the amplifier is used in higher gain configurations. A small series resistance between the output and the load further increases the amount of capacitance that the amplifier can drive.

Rail-to-Rail Operation

The LT6011/LT6012 outputs can swing to within millivolts of either supply rail, but the inputs can not. However, for most op amp configurations, the inputs need to swing less than the outputs. Figure 1 shows the basic op amp configurations, lists what happens to the op amp inputs and specifies whether or not the op amp must have rail-to-rail inputs. Select a rail-to-rail input op amp only when really necessary, because the input precision specifications are usually inferior.



INVERTING: $A_V = -R_F/R_G$
OP AMP INPUTS DO NOT MOVE, BUT ARE FIXED AT DC BIAS POINT V_{REF}

INPUT DOES NOT HAVE TO BE RAIL-TO-RAIL

NONINVERTING: $A_V = 1 + R_F/R_G$
INPUTS MOVE BY AS MUCH AS V_{IN}, BUT THE OUTPUT MOVES MORE

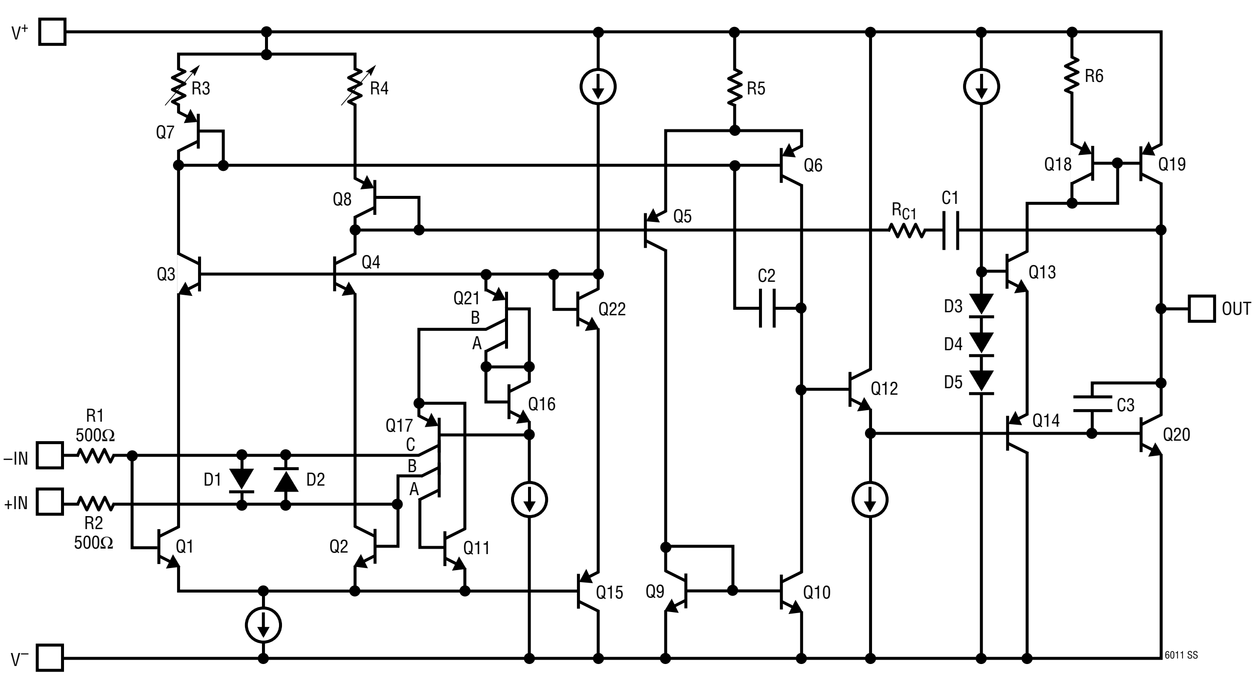
INPUT MAY NOT HAVE TO BE RAIL-TO-RAIL

NONINVERTING: $A_V = 1$
INPUTS MOVE BY AS MUCH AS OUTPUT

INPUT MUST BE RAIL-TO-RAIL FOR OVERALL CIRCUIT RAIL-TO-RAIL PERFORMANCE

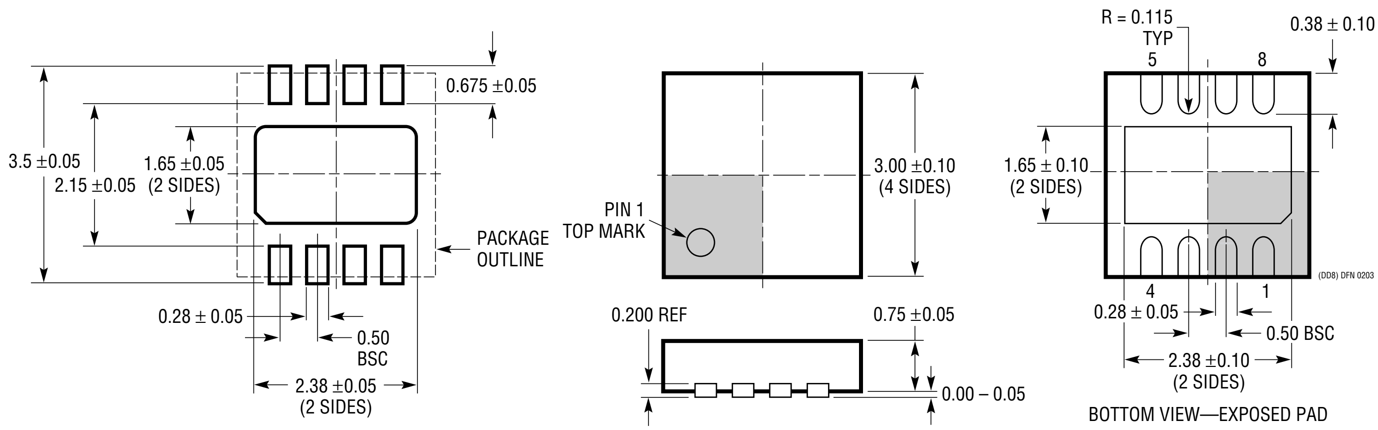
Figure 1. Some Op Amp Configurations Do Not Require Rail-to-Rail Inputs to Achieve Rail-to-Rail Outputs

SIMPLIFIED SCHEMATIC (One Amplifier)



PACKAGE DESCRIPTION

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

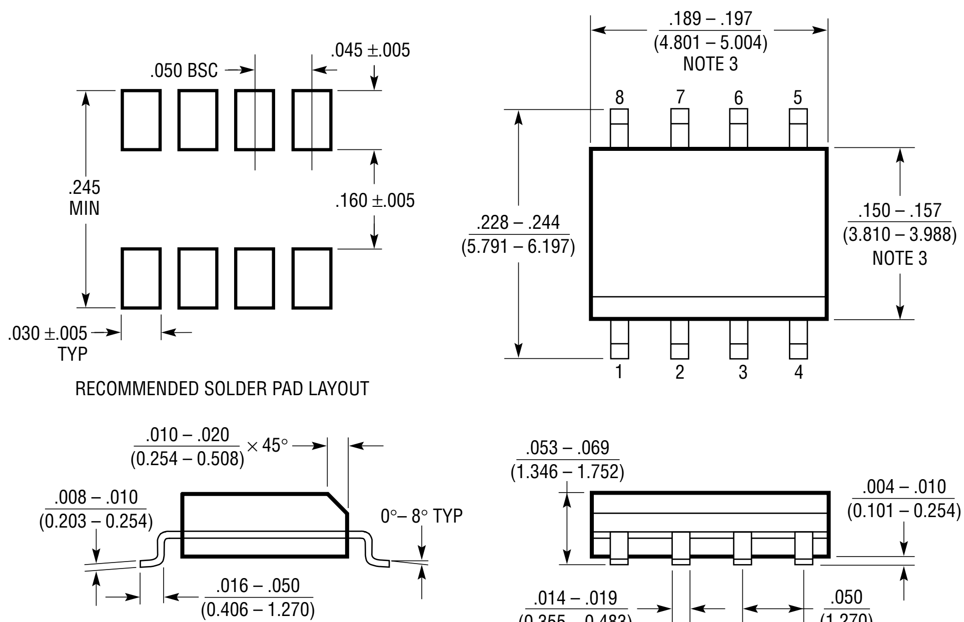


RECOMMENDED SOLDER PAD PITCH AND DIMENSIONS

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

PACKAGE DESCRIPTION

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

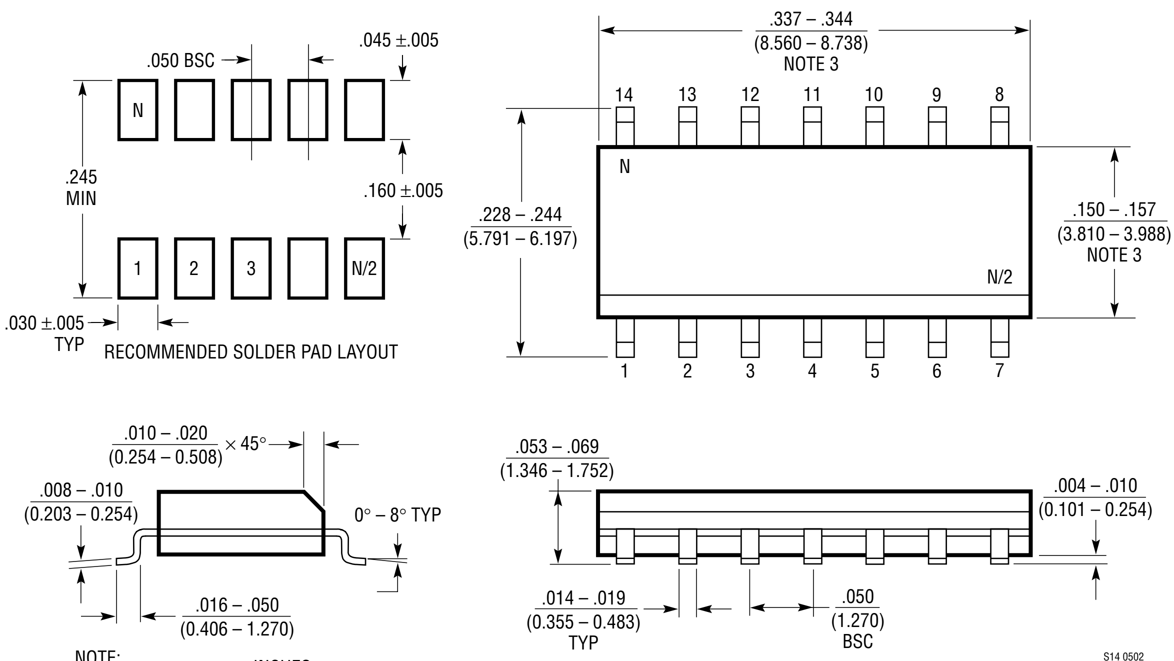


NOTE:
1. DIMENSIONS IN $\frac{\text{INCHES}}{\text{(MILLIMETERS)}}$
2. DRAWING NOT TO SCALE
3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)

SO8 0303

PACKAGE DESCRIPTION

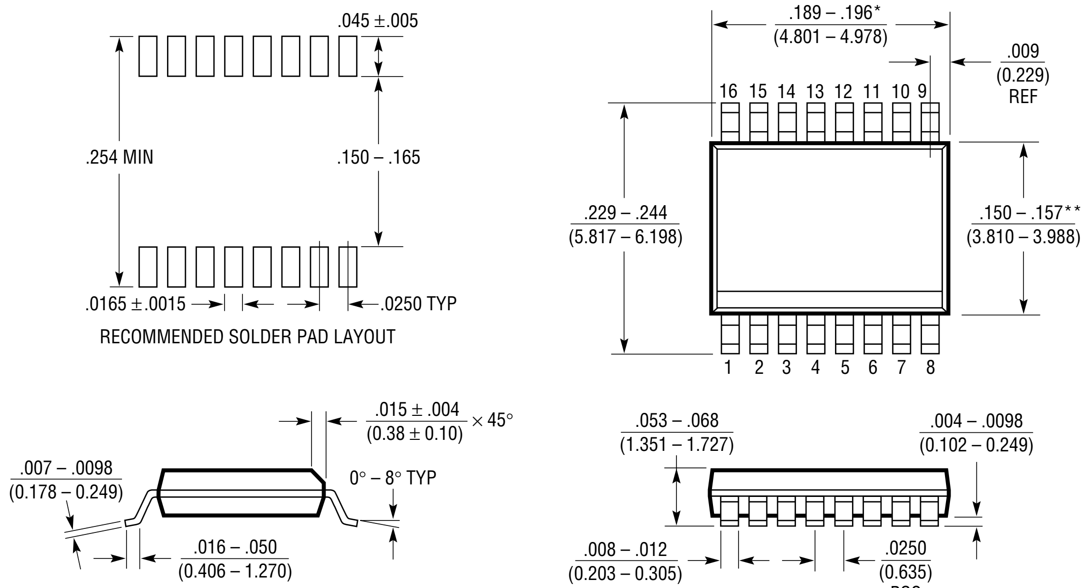
S14 Package
14-Lead Plastic Small Outline (Narrow .150 Inch)
(Reference LTC DWG # 05-08-1610)



NOTE:
1. DIMENSIONS IN $\frac{\text{INCHES}}{\text{(MILLIMETERS)}}$
2. DRAWING NOT TO SCALE
3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)

PACKAGE DESCRIPTION

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



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

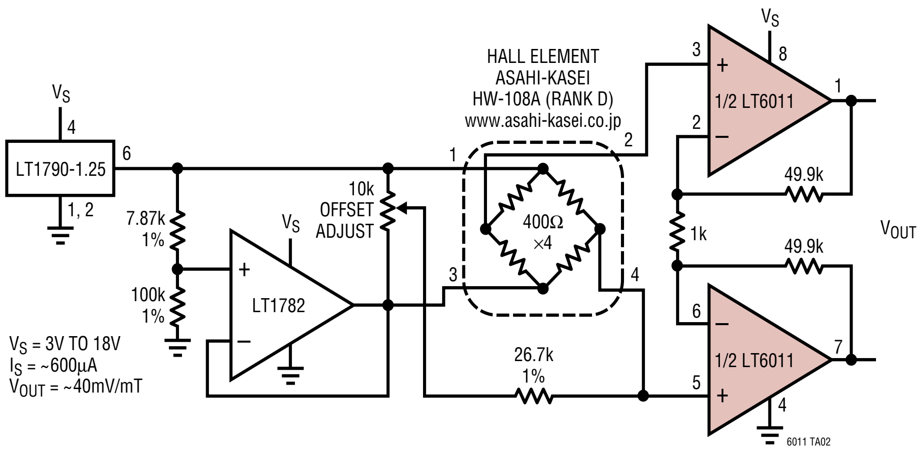
*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

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

GN16 (SSOP) 0502

TYPICAL APPLICATION

Low Power Hall Sensor Amplifier



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1112/LT1114	Dual/Quad Low Power, Picoamp Input Precision Op Amp	250pA Input Bias Current
LT1880	Rail-to-Rail Output, Picoamp Input Precision Op Amp	SOT-23
LT1881/LT1882	Dual/Quad Rail-to-Rail Output, Picoamp Input Precision Op Amp	C_{LOAD} Up to 1000pF
LT1884/LT1885	Dual/Quad Rail-to-Rail Output, Picoamp Input Precision Op Amp	9.5nV/$\sqrt{Hz}$ Input Noise

sn60112 60112fas

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