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## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



## Low-power / Low-voltage Precision Amplifier

### Features

- Low Offset:
  - 10  $\mu\text{V}$  Typ.
- Low Drift:
  - 0.05  $\mu\text{V}/^\circ\text{C}$  Max.
- Low Noise:
  - 22  $\text{nV}/\sqrt{\text{Hz}}$
- Open-loop Voltage Gain:
  - 135 dB Typ.
- Rail-to-Rail Inputs
- Rail-to-Rail Output Swing
  - to within 20 mV of supply voltage
- 0.5 mA Supply Current
- Slew rate:
  - 0.25  $\text{V}/\mu\text{s}$

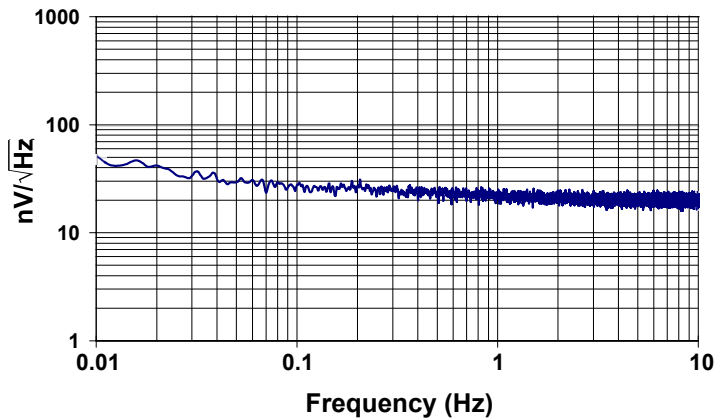
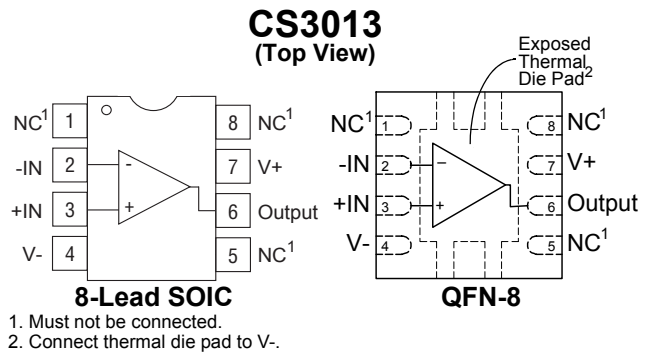
### Applications

- Thermocouple/Thermopile Amplifiers
- Load Cell and Bridge Transducer Amplifiers
- Precision Instrumentation
- Battery-powered Systems

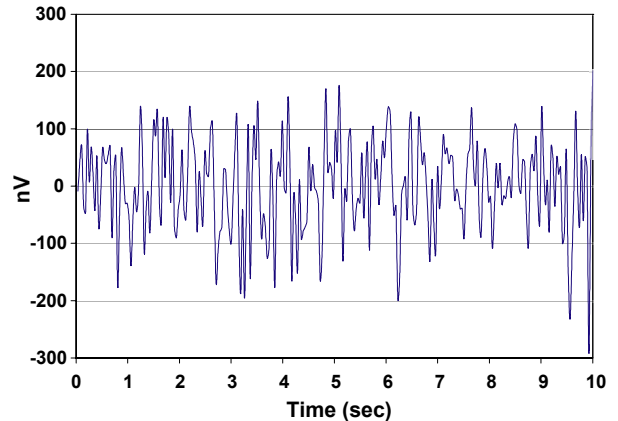
### Description

The CS3013 single amplifier is designed for precision amplification of low-level signals. These amplifiers achieve excellent offset stability, high open loop gain, and low noise. The device also exhibits excellent CMRR and PSRR. The common mode input range includes the supply rails. The amplifiers operate with any supply voltage from 2.7 V to 5 V ( $\pm 1.35$  V to  $\pm 2.50$  V).

### Pin Configurations



Noise vs. Frequency (Measured)



0.01 Hz to 10 Hz Noise Performance

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# 1. CHARACTERISTICS AND SPECIFICATIONS

## 1.1 5 V Electrical Characteristics

V+ = +5 V, ±5%; V- = 0V; VCM = 2.5 V; Unless otherwise noted, T<sub>A</sub> = 25° C (See Note 1).

Parameter		Min	Typ	Max	Unit
Input Offset Voltage	(Note 2)	-	±10	±20	μV
Average Input Offset Drift	(Note 2)	-	±0.01	±0.05	μV/°C
Input Bias Current		-	±170	±250	pA
		-	-	±1.5	nA
Input Offset Current		-	±340	±500	pA
		-	-	±3.0	nA
Input Noise Voltage Density	R <sub>S</sub> = 100 Ω, f <sub>0</sub> = 1 Hz	-	22	-	nV/√Hz
	R <sub>S</sub> = 100 Ω, f <sub>0</sub> = 1 kHz	-	22	-	nV/√Hz
Input Noise Voltage	0.1 to 10 Hz	-	460	-	nV <sub>p-p</sub>
Input Noise Current Density	f <sub>0</sub> = 1 Hz	-	100	-	fA/√Hz
Input Noise Current	0.1 to 10 Hz	-	1.9	-	pA <sub>p-p</sub>
Input Voltage Range	(Note 2)	V-	-	V+	V
Common Mode Rejection Ratio (dc)		105	120	-	dB
Power Supply Rejection Ratio		100	120	-	dB
Large Signal Voltage Gain		-	145	-	dB
	(Note 3) R <sub>L</sub> = 2 kΩ to V+/2	112	135	-	dB
Output Voltage Swing	R <sub>L</sub> = 2 kΩ to V+/2	(V+ - 200)	-	(V- + 200)	mV
	(Note 4) R <sub>L</sub> = 100 kΩ to V+/2	(V+ - 20)	-	(V- + 20)	mV
Slew Rate	R <sub>L</sub> = 2 k, 100 pF	-	0.25	-	V/μs
Overload Recovery Time		-	40	-	μs
Supply Current		-	0.5	TBD	mA
Chopping Frequency		-	125	-	kHz
Input Capacitance	Differential	-	1.5	-	pF
	Common Mode	-	10	-	pF

- Notes:
1. Symbol “•” denotes specification applies over -40 to +125 ° C.
  2. This parameter is guaranteed by design and/or laboratory characterization.
  3. Guaranteed within the output limits of (V+ - 0.2 V) to (V- + 0.2 V).
  4. Specifies the worst case drive voltage relative to the supply rail under stated load conditions.

## 1.2 3 V Electrical Characteristics

V+ = +3 V, ±10%; V- = 0V; VCM = 1.5 V; Unless otherwise noted, T<sub>A</sub> = 25° C (See Note 5).

Parameter		Min	Typ	Max	Unit
Input Offset Voltage	(Note 6) •	-	±10	±20	μV
Average Input Offset Drift	(Note 6) •	-	±0.01	±0.05	μV/°C
Input Bias Current	•	-	±110	±150	pA
	•	-	-	±1.0	nA
Input Offset Current	•	-	±220	±300	pA
	•	-	-	±2.0	nA
Input Noise Voltage Density	R <sub>S</sub> = 100 Ω, f <sub>0</sub> = 1 Hz	-	22	-	nV/√Hz
	R <sub>S</sub> = 100 Ω, f <sub>0</sub> = 1 kHz	-	22	-	nV/√Hz
Input Noise Voltage	0.1 to 10 Hz	-	460	-	nV <sub>p-p</sub>
Input Noise Current Density	f <sub>0</sub> = 1 Hz	-	100	-	fA/√Hz
Input Noise Current	0.1 to 10 Hz	-	1.9	-	pA <sub>p-p</sub>
Input Voltage Range	(Note 6) •	V-	-	V+	V
Common Mode Rejection Ratio (dc)	•	105	120	-	dB
Power Supply Rejection Ratio	•	100	120	-	dB
Large Signal Voltage Gain		-	145	-	dB
(Note 7)	R <sub>L</sub> = 2 kΩ to V+/2	•	112	-	dB
Output Voltage Swing	R <sub>L</sub> = 2 kΩ to V+/2	•	(V+ - 200)	(V- + 200)	mV
(Note 8)	R <sub>L</sub> = 100 kΩ to V+/2	•	(V+ - 20)	(V- + 20)	mV
Slew Rate	R <sub>L</sub> = 2 k, 100 pF	-	0.25	-	V/μs
Overload Recovery Time		-	40	-	μs
Supply Current	•	-	1.0	1.25	mA
Chopping Frequency		-	125	-	kHz
Input Capacitance	Differential	-	1.5	-	pF
	Common Mode	-	10	-	pF

Notes: 5. Symbol “•” denotes specification applies over -40 to +125 ° C.

6. This parameter is guaranteed by design and laboratory characterization.

7. Guaranteed within the output limits of (V+ - 0.2 V) to (V- + 0.2 V).

8. Specifies the worst case drive voltage relative to the supply rail under stated load conditions.

### 1.3 Absolute Maximum Ratings

Parameter	Min	Typ	Max	Unit
Supply Voltage [(V+) – (V-)]	2.7	-	5.5	V
Input Voltage	(V-) – (0.3)	-	(V+) + (0.3)	V
Storage Temperature Range	-65	-	+150	°C

## 2. TYPICAL PERFORMANCE PLOTS

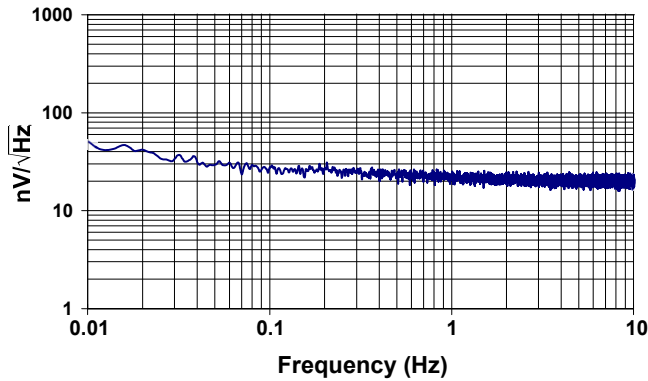


Figure 1. Noise vs Frequency (Measured)

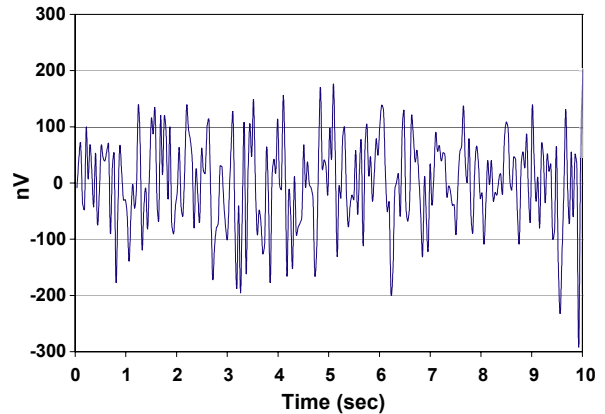


Figure 2. 0.01 Hz to 10 Hz Noise

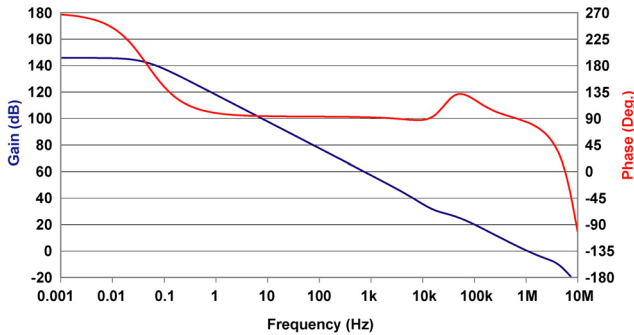


Figure 3. Gain & Phase vs. Frequency (2.7 V)

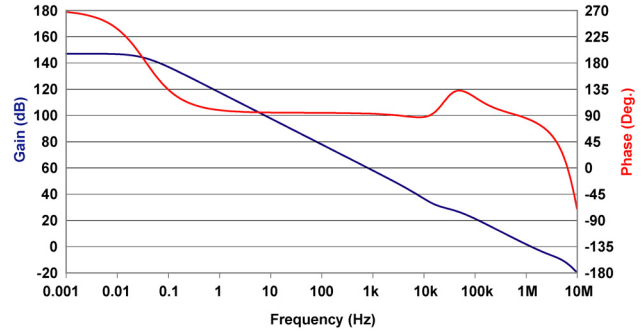


Figure 4. Gain & Phase vs. Frequency (5 V)

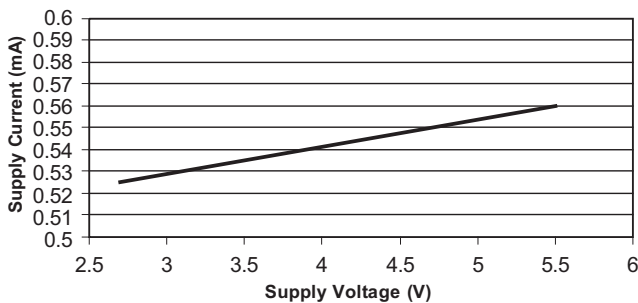


Figure 5. Supply Current vs. Supply Voltage

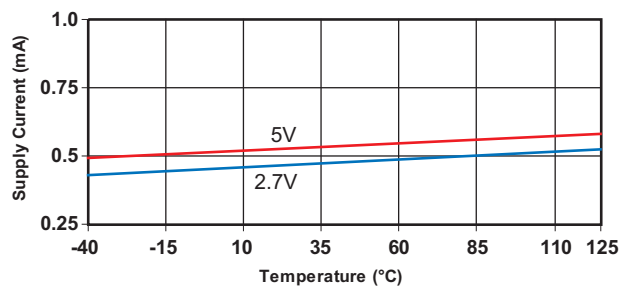
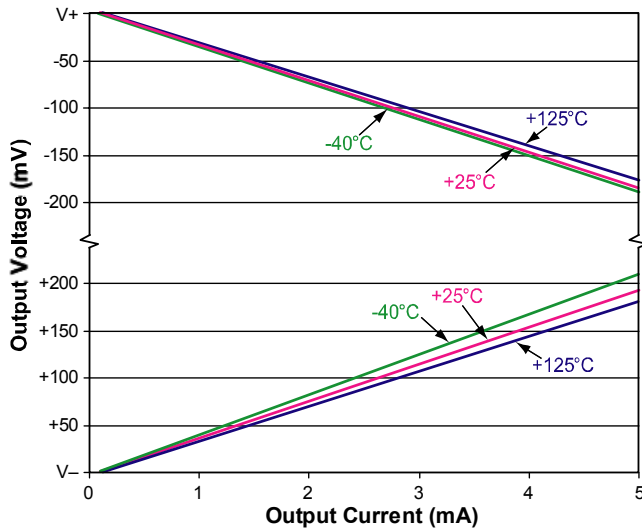
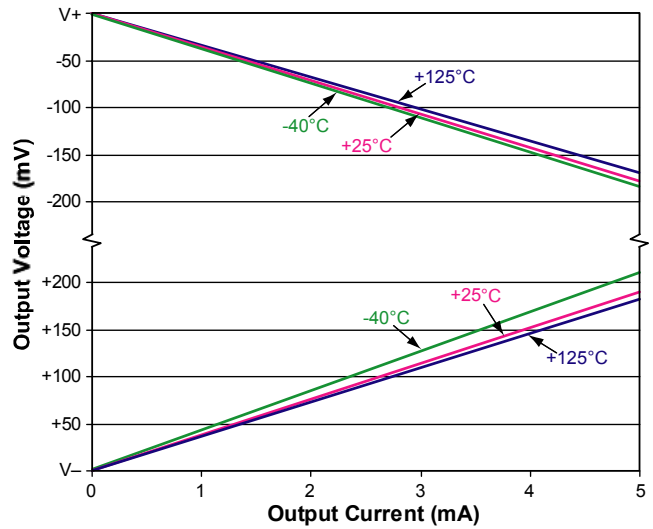
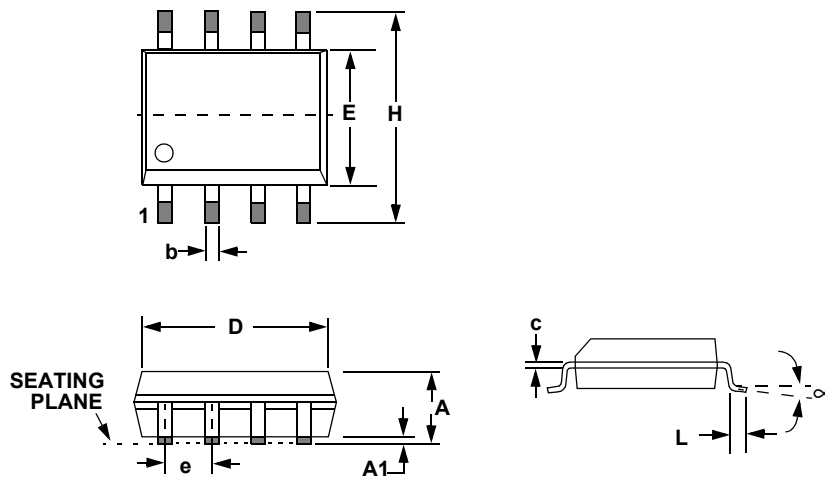


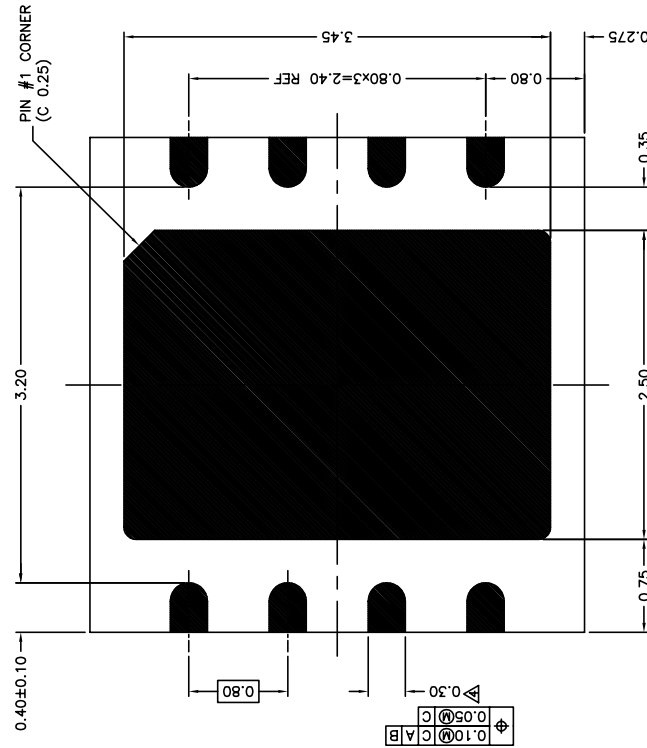
Figure 6. Supply Current vs. Temperature

**Typical Performance Plots (Cont.)**

**Figure 7. Voltage Swing vs. Output Current (2.7 V)**

**Figure 8. Voltage Swing vs. Output Current (5 V)**
**3. PACKAGE DRAWINGS**
**8L SOIC (150 MIL BODY) PACKAGE DRAWING**


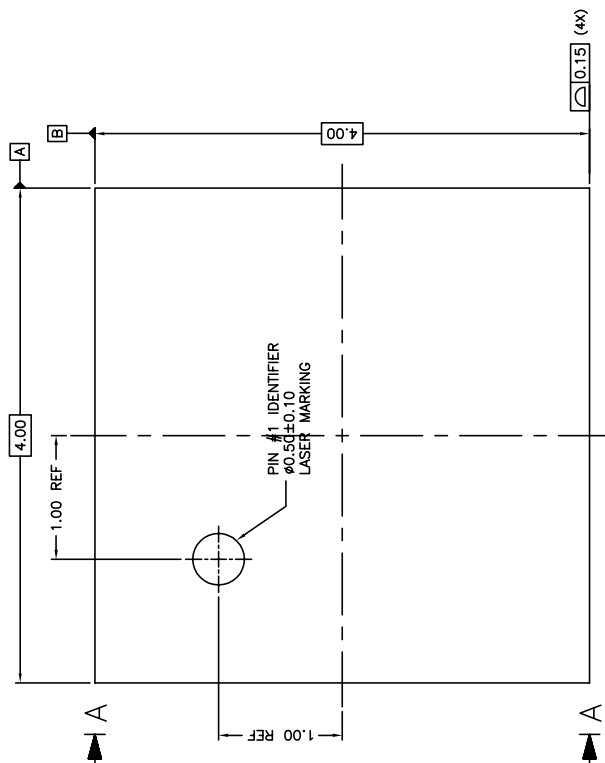
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.013	0.020	0.33	0.51
C	0.007	0.010	0.19	0.25
D	0.189	0.197	4.80	5.00
E	0.150	0.157	3.80	4.00
e	0.040	0.060	1.02	1.52
H	0.228	0.244	5.80	6.20
L	0.016	0.050	0.40	1.27
∞	0°	8°	0°	8°

**JEDEC # : MS-012**

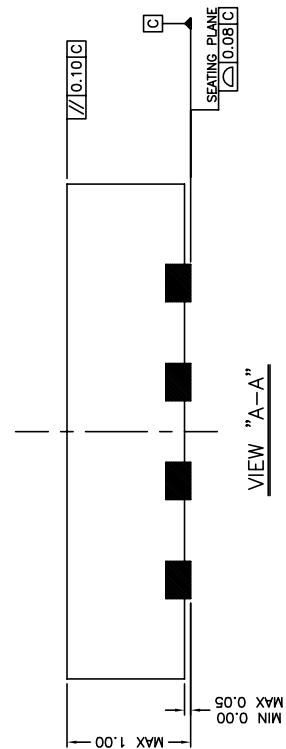
## 8L QFN (4 mm X 4 mm) PACKAGE DRAWING



- NOTE)
1. CONTROLLING DIMENSIONS ARE IN MM.
  2. UNLESS OTHERWISE SPECIFIED TOLERANCE : DECIMAL  $\pm 0.05$  ANGULAR  $\pm 2^\circ$
  3. DIMENSIONING AND TOLERANCE PER ASME Y 14.5M - 1994.
- A** DIMENSION LEAD WIDTH APPLIES TO THE PLATED TERMINAL AND IS MEASURED BETWEEN 0.28MM AND 0.33MM FROM THE TERMINAL TIP.



**TOP VIEW**





#### 4. ORDERING INFORMATION

Part #	Temperature Range	Package Description
CS3013-FS	-40 °C to +125 °C	8-lead SOIC
CS3013-FSZ	-40 °C to +125 °C	8-lead SOIC, Lead Free
CS3013-FNZ*	-40 °C to +125 °C	8-lead QFN, Lead Free

\* Connect thermal die pad to V-.

#### 5. ENVIRONMENTAL, MANUFACTURING, & HANDLING INFORMATION

Model Number	Peak Reflow Temp	MSL Rating*	Max Floor Life
CS3013-FS	240 °C	2	365 Days
CS3013-FSZ	260 °C		
CS3013-FNZ			

\* MSL (Moisture Sensitivity Level) as specified by IPC/JEDEC J-STD-020.

#### 6. REVISION HISTORY

Revision	Date	Changes
A0	JAN 2007	Initial Release.
A1	FEB 2007	Corrected diagram on p1.
F1	AUG 2007	Updated to "Final" per QPL process.