36V, Precision
Low-Power Instrumentation Amplifier

Features

- Low Offset Voltage: 50μV (Max.)
- Low Drift: 0.2μV/ºC
- Low Input Bias Current: 2nA (Max.)
- Gain Bandwidth Product: 1.5MHz
- Slew Rate: 1.0V/μs
- Wide Supply Range：±2.25V ~ ±18V
- Low Quiescent Current: 1.0mA
- Unity Gain Stable
- Input Over-Voltage Protection
- Extended Temperature Ranges
  From -40°C to +125°C
- Available as SOP8/MSOP8/DIP8

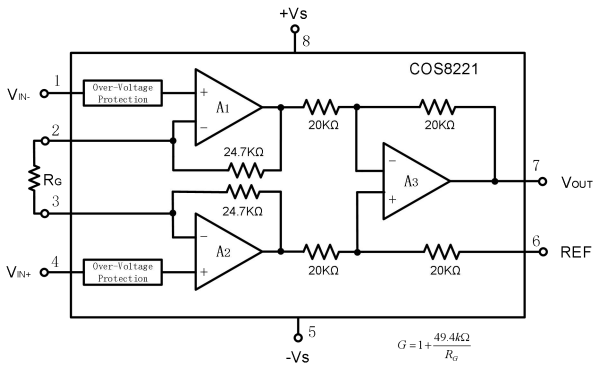
Applications

- Medical Instrumentation
- RTD Sensor Amplifier
- Data Acquisition
- Thermocouple Amplifier
- Bridge Amplifier

General Description

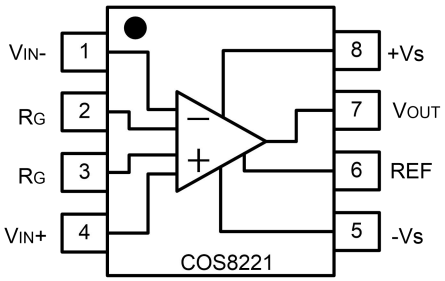
COS8221 is a low-power, general purpose instrumentation amplifiers offering excellent accuracy. The versatile 3-op amp design and small size make these amplifiers ideal for a wide range of applications. A single external resistor sets any gain from 1 to 10,000.

COS8221 is laser-trimmed for very low offset voltage (50μV), drift (0.2μV/ºC) and high common mode rejection. It operates with power supplies as low as ±2.25. The quiescent current is only 1.0mA, ideal for battery-operated systems. COS8221 is available in 8-pin plastic SOP8, DIP8 and MSOP8 packages, specified for the -40 ºC to +125 ºC temperature range.



Block Diagram

1. Pin Configuration and Functions



Pin Functions

Pin	Name	I/O	Description
1	V_{IN}-	I	Negative input
2,3	R_G	-	Gain setting pin. For gains greater than 1, place a gain resistor between pin 2 & 3
4	V_{IN}+	I	Positive input
5	-Vs	P	Negative supply
6	REF	I	Reference input. This Pin must be driven by low impedance or connected to ground
7	V_{OUT}	O	Output
8	+Vs	P	Positive supply

2. Order Information

Model	Order Number	Package	Package Option	Marking Information
COS8221	COS8221ARZ	SOP-8	Tape and Reel, 4000	COS8221ARZ
	COS8221BRZ	SOP-8	Tape and Reel, 4000	COS8221BRZ
	COS8221MR	MSOP-8	Tape and Reel, 4000	COS8221MR
	COS8221DT	DIP-8	Tube, 50	COS8221DT

3. Product Specification

3.1 Absolute Maximum Ratings (1,2)

Parameter	Rating	Units
Power Supply: +Vs to -Vs	36	V
Differential Input Voltage Range	±36	V
Common Mode Input voltage Range(2)	-Vs to +Vs	V
Output Current	50	mA
Storage Temperature Range	-65 to 150	°C
Junction Temperature	150	°C
Operating Temperature Range	-40 to 125	°C
ESD Susceptibility, HBM	2000	V

(1) Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.
(2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current-limited to 10mA or less.

3.2 Thermal Data

Parameter	Rating	Unit
Package Thermal Resistance	206 (MSOP8) 155 (SOP8) 46 (DIP8)	°C/W

3.3 Recommended Operating Conditions

Parameter	Rating	Unit
DC Supply Voltage	±2.3V ~ ±18V	V
Input common-mode voltage range	-Vs+1.9 ~ +Vs-1.2	V
Operating ambient temperature	-40 to +125	°C

3.4 Electrical Characteristics

($+V_S$=+15V, $-V_S$=-15V, T_A=+25°C, R_L=10kΩ, unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input Characteristics						
Input Offset Voltage	V_{OS}	COS8221BRZ		±15	±50	μV
		COS8221ARZ		±25	±125	
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	-40 to 125°C		0.2	0.7	μV/°C
Input Bias Current	I_B			±0.5	±2	nA
Input Offset Current	I_{OS}			±0.2	±1	nA
Common-Mode Voltage Range	V_{CM}		$-V_S$+1.9		$+V_S$-1.2	V
Common-Mode Rejection Ratio	CMRR		120	125		dB
Open-Loop Voltage Gain	AOL	R_L ≥ 2kΩ, V_O = ±10V	100	120		dB
Output Characteristics						
Output Voltage High	V_{OH}				$+V_S$-1.1	V
Output Voltage Low	V_{OL}		$-V_S$+0.9			V
Output Current	I_{OUT}	$V_{DROPOUT}$ < 1.2 V		±10		mA
Short-Circuit Current	I_{SC}			±24		mA
Power Supply						
Operating Voltage Range			±2.25		±18	V
Power Supply Rejection Ratio	PSRR		120	130		dB
Quiescent Current / Amplifier	I_Q			1.0	1.3	mA
Dynamic Performance						
Gain Bandwidth Product	GBWP	C_L=100pF, R_L=10kΩ		1.5		MHz
Slew Rate	SR	C_L=100pF, R_L=10kΩ, Av=1		1.0		V/μs
Noise Performance						
Voltage Noise Density	e_n	f=1kHz		8.0		nV/ √Hz

4. Application Notes

4.1 Overview

The COS8221 instrumentation amplifier is a type of differential amplifier that has been outfitted with input protection circuit and input buffer amplifiers, which eliminate the need for input impedance matching and make the amplifier particularly suitable for use in measurement and test equipment. Additional characteristics of the COS8221 include a very low DC offset, low drift, low noise, very high open-loop gain, very high common-mode rejection ratio, and very high input impedances.

4.2 Application Information

COS8221 measures small differential voltage with high common-mode voltage developed between the noninverting and inverting input. The ability to set the reference pin to adjust the functionality of the output signal offers additional flexibility that is practical for multiple configurations.

Figure 4.1 shows the basic connections required for operation of the COS8221. Applications with noisy or high impedance power supplies may require decoupling capacitors close to the device pins as shown. This must be a low-impedance connection to assure good common-mode rejection. A resistance of 8Ω in series with the Ref pin will cause a typical device to degrade to approximately 80dB CMR.

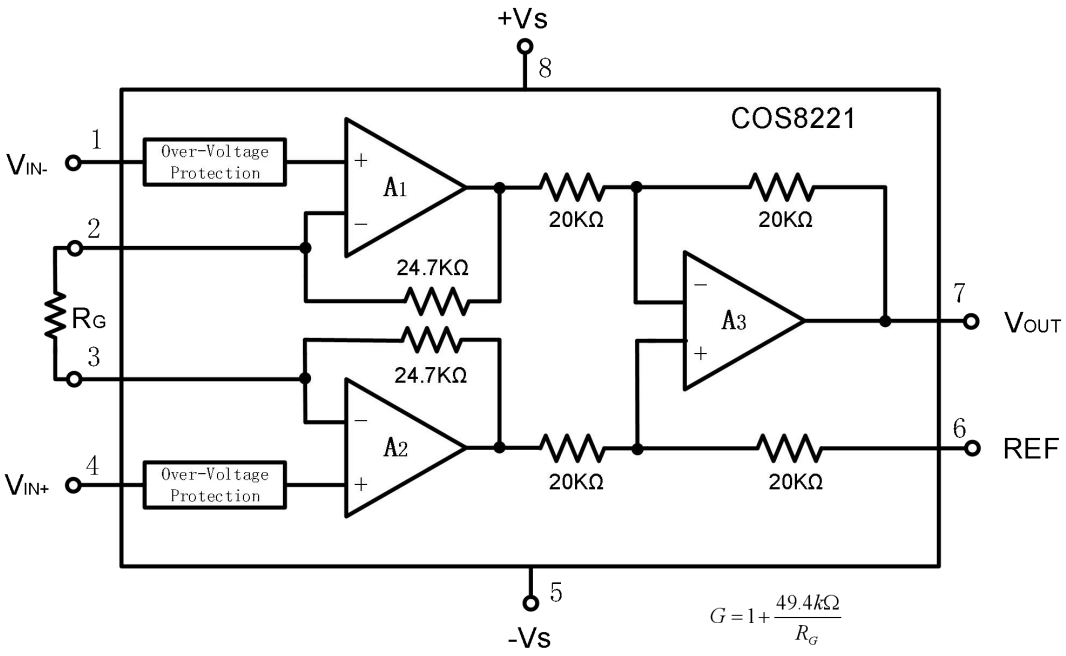


Figure 4.1 Functional Block Diagram

Gain is set by connecting a single external resistor, R_G, connected between pins 1 and 8:

$$G = 1 + 49.4\ k\Omega/R_G \quad (1)$$

Commonly used gains and resistor values are shown in Table 4.1.

Table 4.1 Required Values of Gain Resistors

Desired Gain (V/V)	**COS8221:** G=1 + 49.4 kΩ/R_G	
	R_G(Ω)	**Nearest 1% R_G(Ω)**
1	NC	NC
2	49.4k	49.9k
5	12.35k	12.4k
10	5489	5.49k
20	2600	2.61k
50	1008	1k
100	499	499
200	248	249
500	99	100
1000	49.5	49.9
2000	24.7	24.9
5000	9.88	9.76
10000	4.94	4.87

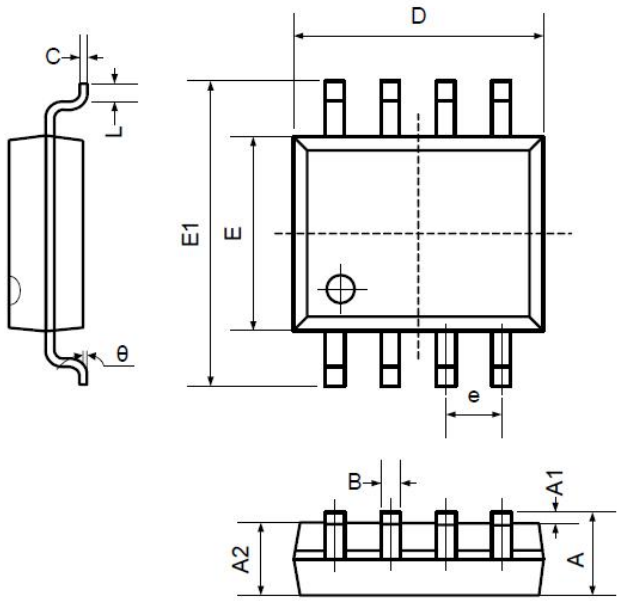
4.3 Power-Supply Bypassing and Layout

The COS8221 operates from a single +4.5V to +36V supply or dual ±2.25V to ±18V supplies. For single-supply operation, bypass the power supply +Vs with a 0.1μF ceramic capacitor which should be placed close to the +Vs pin. For dual-supply operation, both the +Vs and the -Vs supplies should be bypassed to ground with separate 0.1μF ceramic capacitors. 2.2μF tantalum capacitor can be added for better performance.

The length of the current path is directly proportional to the magnitude of parasitic inductances and thus the high frequency impedance of the path. High speed currents in an inductive ground return create an unwanted voltage noise. Broad ground plane areas will reduce the parasitic inductance. Thus a ground plane layer is important for high speed circuit design.

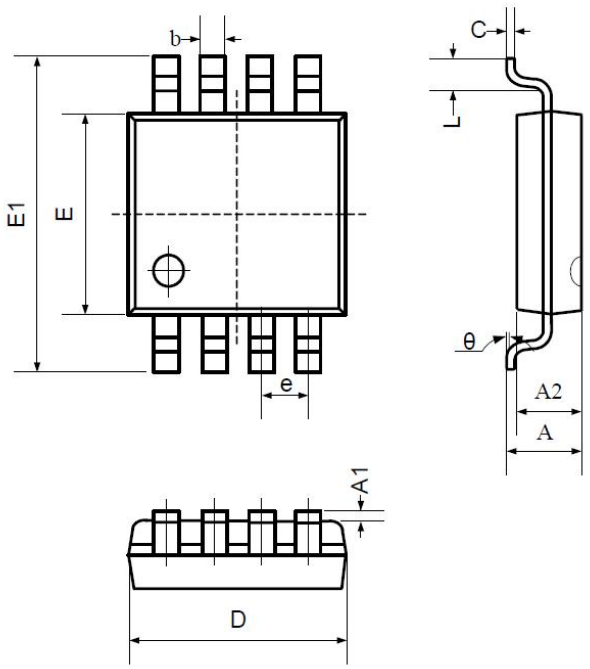
5. Package Information

5.1 SOP8 (Package Outline Dimensions)



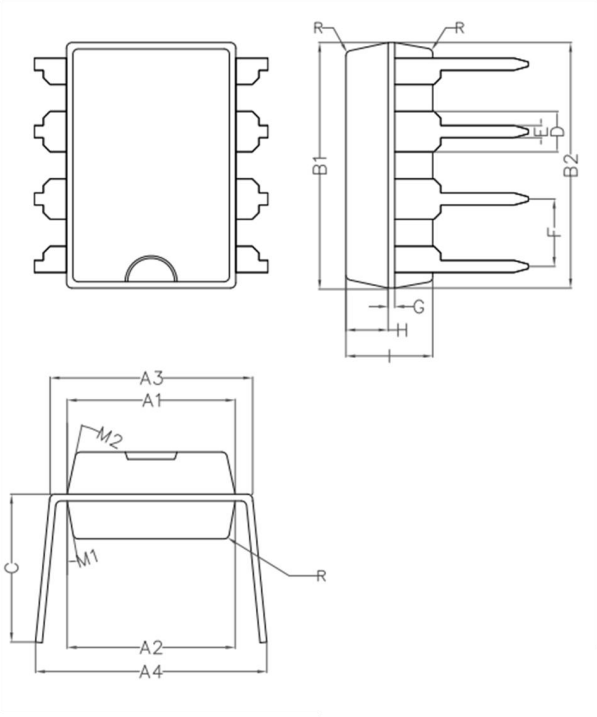
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.780	5.000	0.188	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270TYP		0.050TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

5.2 MSOP8 (Package Outline Dimensions)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.200	0.031	0.047
A1	0.000	0.200	0.000	0.008
A2	0.760	0.970	0.030	0.038
b	0.30 TYP		0.012 TYP	
c	0.15 TYP		0.006 TYP	
D	2.900	3.100	0.114	0.122
e	0.65 TYP		0.026 TYP	
E	2.900	3.100	0.114	0.122
E1	4.700	5.100	0.185	0.201
L	0.410	0.650	0.016	0.026
θ	0°	6°	0°	6°

5.3 DIP8 (Package Outline Dimensions)



Symbol	Min	Non	Max
A1	6.28	6.33	6.38
A2	6.33	6.38	6.43
A3	7.52	7.62	7.72
A4	7.80	8.40	9.00
B1	9.15	9.20	9.25
B2	9.20	9.25	9.30
C		5.57	
D		1.52	
E	0.43	0.45	0.47
F		2.54	
G		0.25	
H	1.54	1.59	1.64
I	3.22	3.27	3.32
R		0.20	
M1	9°	10°	11°
M2	11°	12°	13°