

FEATURES

Low power: 2.3 mA maximum quiescent current

Low noise

3.2 nV/ $\sqrt{\text{Hz}}$ maximum input voltage noise at 1 kHz

200 fA/ $\sqrt{\text{Hz}}$ typical current noise spectral density at 1 kHz

Excellent ac specifications

10 MHz typical small signal bandwidth (gain = 1 and gain = 10)

2 MHz typical small signal bandwidth (gain = 100)

0.6 μs typical settling time to 0.001% (gain = 10)

80 dB minimum CMRR at 20 kHz (gain = 1)

35 V/ μs typical slew rate

High precision dc performance

84 dB minimum CMRR DC to 60 Hz with 1 k Ω source imbalance (gain = 1)

0.9 $\mu\text{V}/^\circ\text{C}$ maximum input offset voltage, average temperature coefficient

5 ppm/ $^\circ\text{C}$ maximum gain vs. temperature (gain = 1)

2 nA maximum input bias current

Inputs protected to 40 V from opposite supply

$\pm 2.5\text{ V}$ to $\pm 18\text{ V}$ dual supply (+5 V to +36 V single supply)

Gain set with a single resistor (gain = 1 to 10,000)

Known Good Die (KGD): these die are fully guaranteed to data sheet specification.

APPLICATIONS

Medical instrumentation

Precision data acquisition

Microphone preamplification

Vibration analysis

Multiplexed input applications

ADC driver

GENERAL DESCRIPTION

The AD8421-KGD is a low cost, low power, low noise, ultralow bias current, high speed instrumentation amplifier that is ideally suited for a broad spectrum of signal conditioning and data acquisition applications. This device features high CMRR, allowing the device to extract low level signals in the presence of high frequency common-mode noise over a wide temperature range.

FUNCTIONAL BLOCK DIAGRAM

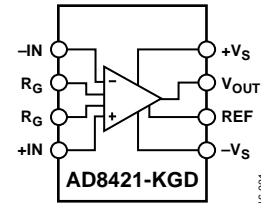


Figure 1.

20316-001

The 10 MHz small signal bandwidth, 35 V/ μs slew rate, and 0.6 μs settling time to 0.001% (gain = 10) allow the AD8421-KGD to amplify high speed signals and excel in applications that require high channel count, multiplexed systems. Even at higher gains, the current feedback architecture maintains high performance. For example, at gain = 100, the bandwidth is 2 MHz and the settling time is 0.8 μs .

The AD8421-KGD has excellent distortion performance, making this device suitable for use in demanding applications such as vibration analysis.

The AD8421-KGD delivers 3 nV/ $\sqrt{\text{Hz}}$ input voltage noise and 200 fA/ $\sqrt{\text{Hz}}$ current noise spectral density with only 2 mA quiescent current, making the device an ideal choice for measuring low level signals. For applications with high source impedance, the AD8421-KGD employs innovative process technology and design techniques to provide noise performance that is limited only by the sensor.

The AD8421-KGD uses unique protection methods to ensure robust inputs while still maintaining low noise. This protection allows input voltages up to 40 V from the opposite supply rail without damage to the device.

A single resistor sets the gain from 1 to 10,000. The reference pin can be used to apply a precise offset to the output voltage.

The AD8421-KGD is specified from -40°C to $+85^\circ\text{C}$ and operational to 125°C .

Additional application and technical information can be found in the [AD8421](#) data sheet.

TABLE OF CONTENTS

Features	1	ESD Caution.....	6
Applications.....	1	Pin Configuration and Function Descriptions.....	7
General Description	1	Outline Dimensions	8
Functional Block Diagram	1	Die Specifications and Assembly Recommendations.....	8
Revision History	2	Ordering Guide	8
Specifications.....	3		
Absolute Maximum Ratings.....	6		

REVISION HISTORY

9/2019—Revision 0: Initial Version

SPECIFICATIONS

Supply voltage (V_S) = ± 15 V, REF voltage (V_{REF}) = 0 V, T_A = 25°C, gain = 1, and load resistance (R_L) = 2 k Ω , unless otherwise noted.

Table 1.

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit			
COMMON-MODE REJECTION RATIO (CMRR)								
CMRR DC to 60 Hz with 1 k Ω Source Imbalance	Common-mode voltage (V_{CM}) = -10 V to +10 V							
Gain = 1						84	dB	
Gain = 10						104	dB	
Gain = 100						124	dB	
Gain = 1000						134	dB	
Over Temperature, Gain = 1	T_A = -40°C to +85°C	80	dB					
CMRR at 20 kHz								
Gain = 1	V_{CM} = -10 V to +10 V							
Gain = 10						80	dB	
Gain = 100						90	dB	
Gain = 1000						100	dB	
NOISE								
Voltage Noise, 1 kHz ¹	+IN voltage (V_{+IN}), -IN voltage (V_{-IN}) = 0 V							
Input Voltage Noise, e_{ni}						3	3.2	nV/ $\sqrt{\text{Hz}}$
Output Voltage Noise, e_{no}				60	nV/ $\sqrt{\text{Hz}}$			
Peak to Peak, Referred to Input (RTI)								
Gain = 1	Frequency = 0.1 Hz to 10 Hz							
Gain = 10						2	$\mu\text{V p-p}$	
Gain = 100 to 1000						0.5	$\mu\text{V p-p}$	
Current Noise								
Spectral Density	Frequency = 1 kHz		200		fA/ $\sqrt{\text{Hz}}$			
Peak to Peak, RTI	Frequency = 0.1 Hz to 10 Hz		18		pA p-p			
VOLTAGE OFFSET²								
Input Offset Voltage, V_{OSI}	V_S = ± 5 V to ± 15 V T_A = -40°C to +85°C							
Over Temperature						70	μV	
Average Temperature Coefficient						135	μV	
Output Offset Voltage, V_{OSO}	T_A = -40°C to +85°C							
Over Temperature						0.9	$\mu\text{V}/^\circ\text{C}$	
Average Temperature Coefficient						600	μV	
Offset RTI vs. Supply (Power Supply Ratio)	V_S = ± 2.5 V to ± 18 V							
Gain = 1						1	mV	
Gain = 10						9	$\mu\text{V}/^\circ\text{C}$	
Gain = 100						90	120	dB
Gain = 1000						110	120	dB
INPUT CURRENT								
Input Bias Current	T_A = -40°C to +85°C							
Over Temperature						1	2	nA
Average Temperature Coefficient						50	8	nA
Input Offset Current	T_A = -40°C to +85°C							
Over Temperature						0.5	2	nA
Average Temperature Coefficient						1	3	nA

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit
DYNAMIC RESPONSE					
Small Signal Bandwidth	-3 dB				
Gain = 1			10		MHz
Gain = 10			10		MHz
Gain = 100			2		MHz
Gain = 1000			0.2		MHz
Settling Time to 0.01%	10 V step				
Gain = 1			0.7		μs
Gain = 10			0.4		μs
Gain = 100			0.6		μs
Gain = 1000			5		μs
Settling Time to 0.001%	10 V step				
Gain = 1			1		μs
Gain = 10			0.6		μs
Gain = 100			0.8		μs
Gain = 1000			6		μs
Slew Rate					
Gain = 1 to 100			35		V/μs
GAIN³					
Gain Range	Gain = 1 + (9.9 kΩ/R _G)	1		10,000	V/V
Gain Error	Output voltage (V _{OUT}) = ±10 V			0.05	%
Gain = 10 to 1000				0.3	%
Gain Nonlinearity	V _{OUT} = -10 V to +10 V R _L ≥ 2 kΩ			1	ppm
Gain = 1			1	3	ppm
Gain = 10 to 1000		R _L = 600 Ω	30	50	ppm
		R _L ≥ 600 Ω	5	10	ppm
Gain vs. Temperature ³	V _{OUT} = -5 V to +5 V			5	ppm/°C
Gain = 1				-50	ppm/°C
Gain > 1					
INPUT					
Input Impedance					
Differential			30 3		GΩ pF
Common Mode			30 3		GΩ pF
Input Operating Voltage Range ⁴	V _S = ±2.5 V to ±18 V T _A = -40°C	-V _S + 2.3		+V _S - 1.8	V
Over Temperature				+V _S - 2.0	V
		T _A = 85°C	-V _S + 2.1		+V _S - 1.8
OUTPUT					
Output Swing	R _L = 2 kΩ				
Over Temperature	V _S = ±2.5 V to ±18 V	-V _S + 1.2		+V _S - 1.6	V
Short-Circuit Current	T _A = -40°C to +85°C	-V _S + 1.2		+V _S - 1.6	V
			65		mA
REFERENCE INPUT					
Input Reference, R _{IN}			20		kΩ
Input Current, I _{IN}	V _{+IN} , V _{-IN} = 0 V		20	24	μA
Voltage Range		-V _S		+V _S	V
Reference Gain to Output			1 ± 0.0001		V/V

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit
POWER SUPPLY					
Operating Range	Dual supply	±2.5		±18	V
	Single supply	5		36	V
Quiescent Current Over Temperature	$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$		2	2.3	mA
				2.6	mA
TEMPERATURE RANGE					
For Specified Performance		-40		+85	°C
Operational ⁵		-40		+125	°C

¹ Total voltage noise = $\sqrt{(e_{ni})^2 + (e_{no}/\text{Gain})^2 + e_{RG}^2}$, where e_{RG} is the external gain resistor noise. See the [AD8421](#) data sheet for more information.

² Total RTI $V_{OS} = (V_{OSI}) + (V_{OSO}/\text{Gain})$.

³ These specifications do not include the tolerance of the external gain setting resistor, R_G . For Gain > 1, add R_G errors to the specifications given in this table.

⁴ Input operating voltage range of the AD8421-KGD input stage only. The input range can depend on the common-mode voltage, differential voltage, gain, and reference voltage. See the [AD8421](#) data sheet for more details.

⁵ See the [AD8421](#) data sheet for expected operation between 85°C and 125°C .

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Supply Voltage	± 18 V
Output Short-Circuit Current Duration	Indefinite
Maximum Voltage at $-IN$ or $+IN$ ¹	$-V_S + 40$ V
Minimum Voltage at $-IN$ or $+IN$	$+V_S - 40$ V
Maximum Voltage at REF ²	$+V_S + 0.3$ V
Minimum Voltage at REF	$-V_S - 0.3$ V
Storage Temperature Range	-65°C to $+150^{\circ}\text{C}$
Operating Temperature Range	-40°C to $+125^{\circ}\text{C}$
Maximum Junction Temperature	150°C
Electrostatic Discharge (ESD)	
Human Body Model	2 kV
Charged Device Model	1.25 kV
Machine Model	0.2 kV

¹ For voltages beyond these limits, use input protection resistors. See the [AD8421](#) data sheet for more information.

² There are ESD protection diodes from the reference input to each supply. Therefore, REF cannot be driven beyond the supplies in the same way that $+IN$ and $-IN$ can. See the [AD8421](#) data sheet for more information.

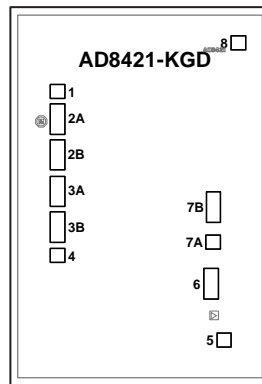
Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

ESD CAUTION



ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS



TOP VIEW
(Not to Scale)

Figure 2. Pad Configuration

20316-002

Table 3. Pad Function Descriptions¹

Pad No.	Mnemonic	Pad Type	X-Axis (μm)	Y-Axis (μm)	Description
1	-IN	Single	-548.2	+376	Negative Input Pad.
2A	R_G	Double	-548.2	+241	Gain Setting Pad.
2B	R_G	Double	-548.2	+66	Gain Setting Pad.
3A	R_G	Double	-548.2	-112	Gain Setting Pad.
3B	R_G	Double	-548.2	-287	Gain Setting Pad.
4	+IN	Single	-548.2	-422	Positive Input Pad.
5	- V_S	Single	+566.4	-841	Negative Power Supply Pad.
6	REF	Double	+502	-565.8	Reference Voltage Pad.
7A	V_{OUT}	Single	+512	-359.5	Output Pad.
7B	V_{OUT}	Double	+512	-191.6	Output Pad.
8	+ V_S	Single	+635.8	+929	Positive Power Supply Pad.

¹ To minimize gain errors introduced by the bond wires, use Kelvin connections between the chip and the gain resistor, R_G , by connecting Pad 2A and Pad 2B in parallel to one end of R_G and by connecting Pad 3A and Pad 3B in parallel to the other end of R_G . For unity-gain applications where R_G is not required, Pad 2A and Pad 2B must be bonded together as well as Pad 3A and Pad 3B.

OUTLINE DIMENSIONS

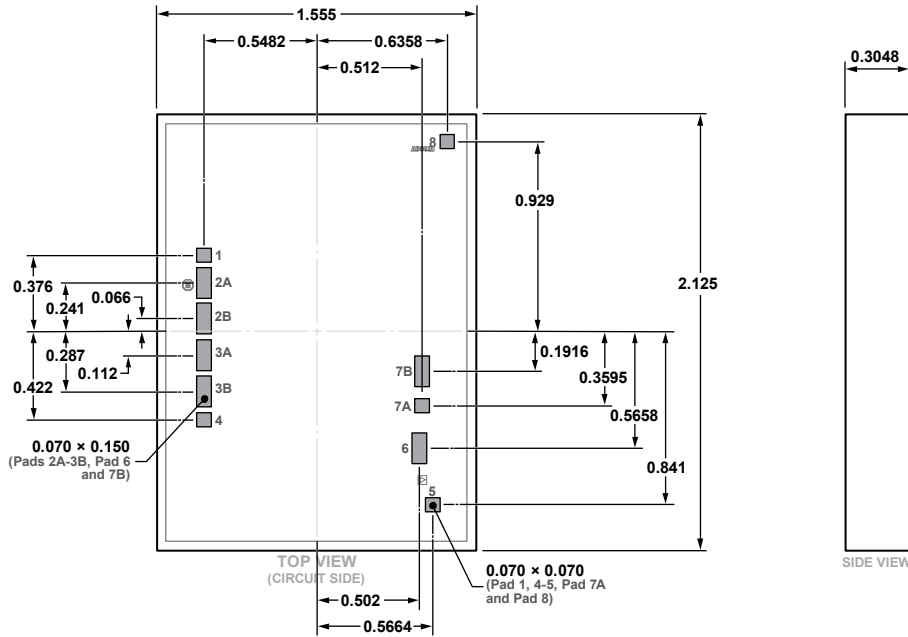


Figure 3. 8-Pad Bare Die [CHIP]
(C-8-15)
Dimensions shown in millimeters

03-11-2018-A

DIE SPECIFICATIONS AND ASSEMBLY RECOMMENDATIONS

Table 4. Die Specifications

Parameter	Value	Unit
Scribe Line Width	90 × 90	μm
Die Size	1555 × 2125	μm
Thickness	304.8	μm
Backside	None ¹	Not applicable
Passivation	Doped oxide/silicon (Si)/Nitrogen (N)	Not applicable
Bond Pads (Minimum)	70 × 70	μm
Bond Pad Composition	1.0 Aluminum (Al)/Si, 0.5 Copper (Cu)	%

¹ If connecting the backside to a voltage potential, tie the backside to -Vs. Otherwise, leave the backside floating.

Table 5. Assembly Recommendations

Assembly Component	Recommendation
Die Attach	No special requirements
Bonding Method	Gold ball or aluminum wedge
Bonding Sequence	Any

ORDERING GUIDE

Model ¹	Temperature Range	Package Description	Package Option
AD8421-KGD-WP	-40°C to +85°C	8-Pad Bare Die [CHIP], Waffle Pack	C-8-15

¹ The AD8421-KGD-WP is a RoHS compliant part.

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[Analog Devices Inc.:](#)

[AD8421ARMZ](#) [AD8421ARZ](#) [AD8421BRMZ](#) [AD8421BRZ](#) [AD8421ARMZ-R7](#) [AD8421ARMZ-RL](#) [AD8421ARZ-R7](#)
[AD8421ARZ-RL](#) [AD8421BRMZ-R7](#) [AD8421BRMZ-RL](#) [AD8421BRZ-R7](#) [AD8421BRZ-RL](#) [AD8421TRMZ-EP-R7](#)
[AD8421TRMZ-EP](#)