

## FEATURES

### High speed

190 MHz, -3 dB bandwidth (G = +1)

100 V/ $\mu$ s slew rate

### Low distortion

120 dBc @ 1 MHz SFDR

80 dBc @ 5 MHz SFDR

Selectable input crossover threshold

### Low noise

4.3 nV/ $\sqrt{\text{Hz}}$

1.6 pA/ $\sqrt{\text{Hz}}$

Low offset voltage: 900  $\mu$ V max

Low power: 6.5 mA/amplifier supply current

### Disable mode

Wide supply range: 2.7 V to 12 V

Known good die (KGD): these die are fully guaranteed to data sheet specifications

## APPLICATIONS

### Filters

### ADC drivers

### Level shifting

### Buffering

### Professional video

### Low voltage instrumentation

## GENERAL DESCRIPTION

The [AD8028-KGD-CHIP](#)<sup>1</sup> is a high speed amplifier with rail-to-rail input and output that operates on low supply voltages and is optimized for high performance and wide dynamic signal range. The [AD8028-KGD-CHIP](#) has low noise (4.3 nV/ $\sqrt{\text{Hz}}$ , 1.6 pA/ $\sqrt{\text{Hz}}$ ) and low distortion (120 dBc at 1 MHz). In applications that use a fraction of or the entire input dynamic range and require low distortion, the [AD8028-KGD-CHIP](#) is an ideal choice.

Many rail-to-rail input amplifiers have an input stage that switches from one differential pair to another as the input signal crosses a threshold voltage, which causes distortion. The [AD8028-KGD-CHIP](#) has a unique feature that allows the user to select the input crossover threshold voltage through the SELECT pin. This feature controls the voltage at which the complementary transistor input pairs switch. The [AD8028-KGD-CHIP](#) also has intrinsically low crossover distortion. With its wide supply voltage range (2.7 V to 12 V) and wide bandwidth (190 MHz), the [AD8028-KGD-CHIP](#) amplifier is designed to work in a variety of applications where speed and performance are needed on low supply voltages. The [AD8028-KGD-CHIP](#) has a disable mode that is controlled via the SELECT pin.

The [AD8028-KGD-CHIP](#) is rated to work over the industrial temperature range of -40°C to +125°C.

Additional application and technical information can be found in the [AD8028](#) data sheet.

<sup>1</sup>Protected by U.S. patent numbers 6,486,737B1; 6,518,842B1

### Rev. B

### Document Feedback

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**REVISION HISTORY**

**11/12—Rev. A to Rev. B**

Changed AD8028-KGD-CHIPS to AD8028-KGD-CHIP .....	Universal
Changes to Table 1 .....	3
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**9/12—Rev. 0 to Rev. A**

Changes to Table 1 .....	3
Changes to Table 2 .....	4
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Updated Outline Dimensions .....	8
Changes to Ordering Guide .....	8

**7/12—Revision 0: Initial Version**

## SPECIFICATIONS

$V_S = \pm 5\text{ V}$  at  $T_A = 25^\circ\text{C}$ ,  $R_L = 1\text{ k}\Omega$  to midsupply,  $G = 1$ , unless otherwise noted.

Table 1.

Parameter	Test Conditions/Comments	Min	Typ	Max	Status <sup>1</sup>	Unit
<b>DYNAMIC PERFORMANCE</b>						
-3 dB Bandwidth	$G = 1, V_{OUT} = 0.2\text{ V p-p}$	138	190		GBD	MHz
	$G = 1, V_{OUT} = 2\text{ V p-p}$	20	32		GBD	MHz
Bandwidth for 0.1 dB Flatness	$G = 2, V_{OUT} = 0.2\text{ V p-p}$		16			MHz
Slew Rate	$G = +1, V_{OUT} = 2\text{ V step}/G = -1, V_{OUT} = 2\text{ V step}$		90/100			V/ $\mu\text{s}$
Settling Time to 0.1%	$G = 2, V_{OUT} = 2\text{ V step}$		35			ns
<b>NOISE/DISTORTION PERFORMANCE</b>						
Spurious-Free Dynamic Range (SFDR)	$f_c = 1\text{ MHz}, V_{OUT} = 2\text{ V p-p}, R_F = 24.9\ \Omega$		120			dBc
	$f_c = 5\text{ MHz}, V_{OUT} = 2\text{ V p-p}, R_F = 24.9\ \Omega$		80			dBc
Input Voltage Noise	$f = 100\text{ kHz}$		4.3			nV/ $\sqrt{\text{Hz}}$
Input Current Noise	$f = 100\text{ kHz}$		1.6			pA/ $\sqrt{\text{Hz}}$
Differential Gain Error	NTSC, $G = 2, R_L = 150\ \Omega$		0.1			%
Differential Phase Error	NTSC, $G = 2, R_L = 150\ \Omega$		0.2			Degrees
Crosstalk, Output to Output	$G = 1, R_L = 100\ \Omega, V_{OUT} = 2\text{ V p-p}, V_S = \pm 5\text{ V @ } 1\text{ MHz}$		-93			dB
<b>DC PERFORMANCE</b>						
Input Offset Voltage	SELECT = three-state or open, PNP active		200			$\mu\text{V}$
	SELECT = high NPN active		240			$\mu\text{V}$
Input Offset Voltage Drift	$T_{MIN}$ to $T_{MAX}$		1.50			$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$V_{CM} = 0\text{ V}$ , NPN active		4	6	Tested	$\mu\text{A}$
	$T_{MIN}$ to $T_{MAX}$		4			$\mu\text{A}$
	$V_{CM} = 0\text{ V}$ , PNP active		-8	-11	Tested	$\mu\text{A}$
	$T_{MIN}$ to $T_{MAX}$		-8			$\mu\text{A}$
Input Offset Current			$\pm 0.1$	$\pm 0.9$	Tested	$\mu\text{A}$
Open-Loop Gain	$V_{OUT} = \pm 2.5\text{ V}$		110			dB
<b>INPUT CHARACTERISTICS</b>						
Input Impedance			6			M $\Omega$
Input Capacitance			2			pF
Input Common-Mode Voltage Range			-5.2 to 5.2			V
Common-Mode Rejection Ratio	$V_{CM} = \pm 2.5\text{ V}$		110			dB
<b>SELECT PIN</b>						
Crossover Low, Selection Input Voltage	Three-state $< \pm 20\ \mu\text{A}$		-3.3 to +5			V
Crossover High, Selection Input Voltage			-3.9 to -3.3			V
Disable Input Voltage			-5 to -3.9			V
Disable Switching Speed	50% of input to $< 10\%$ of final $V_{OUT}$		980			ns
Enable Switching Speed			45			ns
<b>OUTPUT CHARACTERISTICS</b>						
Output Overdrive Recovery Time (Rising/Falling Edge)	$V_{IN} = +6\text{ V to } -6\text{ V}, G = -1$		40/45			ns
Output Voltage Swing		$-V_S + 0.20$	$+V_S - 0.06,$ $-V_S + 0.06$	$+V_S$	Tested	V
Short-Circuit Output	Sinking and Sourcing		120			mA
Off Isolation	$V_{IN} = 0.2\text{ V p-p}, f = 1\text{ MHz}, \text{SELECT} = \text{low}$		-49			dB
Capacitive Load Drive	30% overshoot		20			pF
<b>POWER SUPPLY</b>						
Operating Range		2.7		12		V
Quiescent Current/Amplifier			6.5	8.5	Tested	mA
Quiescent Current (Disabled)	SELECT = low					
+ $V_S$			0.8	3	Tested	mA
- $V_S$		-0.9	-0.6		Tested	mA
Power Supply Rejection Ratio	$V_S \pm 1\text{ V}$		110			dB

<sup>1</sup> GBD is guaranteed by design.

$V_S = 5\text{ V}$  at  $T_A = 25^\circ\text{C}$ ,  $R_L = 1\text{ k}\Omega$  to midsupply, unless otherwise noted.

Table 2.

Parameter	Test Conditions/Comments	Min	Typ	Max	Status <sup>1</sup>	Unit
<b>DYNAMIC PERFORMANCE</b>						
-3 dB Bandwidth	$G = 1, V_{OUT} = 0.2\text{ V p-p}$	131	185		GBD	MHz
	$G = 1, V_{OUT} = 2\text{ V p-p}$	18	28		GBD	MHz
Bandwidth for 0.1 dB Flatness	$G = 2, V_{OUT} = 0.2\text{ V p-p}$		12			MHz
Slew Rate	$G = +1, V_{OUT} = 2\text{ V step}/G = -1, V_{OUT} = 2\text{ V step}$		85/100			V/ $\mu\text{s}$
Settling Time to 0.1%	$G = 2, V_{OUT} = 2\text{ V step}$		40			ns
<b>NOISE/DISTORTION PERFORMANCE</b>						
Spurious-Free Dynamic Range (SFDR)	$f_C = 1\text{ MHz}, V_{OUT} = 2\text{ V p-p}, R_F = 24.9\ \Omega$		90			dBc
	$f_C = 5\text{ MHz}, V_{OUT} = 2\text{ V p-p}, R_F = 24.9\ \Omega$		64			dBc
Input Voltage Noise	$f = 100\text{ kHz}$		4.3			nV/ $\sqrt{\text{Hz}}$
Input Current Noise	$f = 100\text{ kHz}$		1.6			pA/ $\sqrt{\text{Hz}}$
Differential Gain Error	NTSC, $G = 2, R_L = 150\ \Omega$		0.1			%
Differential Phase Error	NTSC, $G = 2, R_L = 150\ \Omega$		0.2			Degrees
Crosstalk, Output to Output	$G = 1, R_L = 100\ \Omega, V_{OUT} = 2\text{ V p-p}, V_S = \pm 5\text{ V @ } 1\text{ MHz}$		-92			dB
<b>DC PERFORMANCE</b>						
Input Offset Voltage	SELECT = three-state or open, PNP active		200	800	Tested	$\mu\text{V}$
	SELECT = high NPN active		240	900	Tested	$\mu\text{V}$
Input Offset Voltage Drift	$T_{MIN}$ to $T_{MAX}$		2			$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$V_{CM} = 2.5\text{ V}, \text{NPN active}$		4			$\mu\text{A}$
	$T_{MIN}$ to $T_{MAX}$		4			$\mu\text{A}$
	$V_{CM} = 2.5\text{ V}, \text{PNP active}$		-8			$\mu\text{A}$
	$T_{MIN}$ to $T_{MAX}$		-8			$\mu\text{A}$
Input Offset Current			$\pm 0.1$			$\mu\text{A}$
Open-Loop Gain	$V_{OUT} = 1\text{ V to } 4\text{ V}$		105			dB
<b>INPUT CHARACTERISTICS</b>						
Input Impedance			6			M $\Omega$
Input Capacitance			2			pF
Input Common-Mode Voltage Range			-0.2 to +5.2			V
Common-Mode Rejection Ratio	$V_{CM} = 0\text{ V to } 2.5\text{ V}$		105			dB
<b>SELECT PIN</b>						
Crossover Low, Selection Input Voltage	Three-state $< \pm 20\ \mu\text{A}$		1.7 to 5			V
Crossover High, Selection Input Voltage			1.1 to 1.7			V
Disable Input Voltage			0 to 1.1			V
Disable Switching Speed	50% of input to $< 10\%$ of final $V_{OUT}$		1100			ns
Enable Switching Speed			50			ns
<b>OUTPUT CHARACTERISTICS</b>						
Overdrive Recovery Time (Rising/Falling Edge)	$V_{IN} = -1\text{ V to } +6\text{ V}, G = -1$		50/50			ns
Output Voltage Swing	$R_L = 1\text{ k}\Omega$	$-V_S + 0.12$	$+V_S - 0.04,$ $-V_S + 0.04$	$+V_S$	Tested	V
Off Isolation	$V_{IN} = 0.2\text{ V p-p}, f = 1\text{ MHz}, \text{SELECT} = \text{low}$		-49			dB
Short-Circuit Current	Sinking and sourcing		105			mA
Capacitive Load Drive	30% overshoot		20			pF
<b>POWER SUPPLY</b>						
Operating Range		2.7		12	GBD	V
Quiescent Current/Amplifier			6			mA
Quiescent Current (Disabled)	SELECT = low		320			$\mu\text{A}$
Power Supply Rejection Ratio	$V_S \pm 1\text{ V}$		105			dB

<sup>1</sup> GBD is guaranteed by design.

$V_S = 3\text{ V}$  at  $T_A = 25^\circ\text{C}$ ,  $R_L = 1\text{ k}\Omega$  to midsupply, unless otherwise noted.

Table 3.

Parameter	Test Conditions/Comments	Min	Typ	Max	Status <sup>1</sup>	Unit
<b>DYNAMIC PERFORMANCE</b>						
-3 dB Bandwidth	$G = 1, V_{OUT} = 0.2\text{ V p-p}$	125	180		GBD	MHz
	$G = 1, V_{OUT} = 2\text{ V p-p}$	19	29		GBD	MHz
Bandwidth for 0.1 dB Flatness	$G = 2, V_{OUT} = 0.2\text{ V p-p}$		10			MHz
Slew Rate	$G = +1, V_{OUT} = 2\text{ V step}/G = -1, V_{OUT} = 2\text{ V step}$		73/100			V/ $\mu\text{s}$
Settling Time to 0.1%	$G = 2, V_{OUT} = 2\text{ V step}$		48			ns
<b>NOISE/DISTORTION PERFORMANCE</b>						
Spurious-Free Dynamic Range (SFDR)	$f_C = 1\text{ MHz}, V_{OUT} = 2\text{ V p-p}, R_F = 24.9\ \Omega$		85			dBc
	$f_C = 5\text{ MHz}, V_{OUT} = 2\text{ V p-p}, R_F = 24.9\ \Omega$		64			dBc
Input Voltage Noise	$f = 100\text{ kHz}$		4.3			nV/ $\sqrt{\text{Hz}}$
Input Current Noise	$f = 100\text{ kHz}$		1.6			pA/ $\sqrt{\text{Hz}}$
Differential Gain Error	NTSC, $G = 2, R_L = 150\ \Omega$		0.15			%
Differential Phase Error	NTSC, $G = 2, R_L = 150\ \Omega$		0.20			Degrees
Crosstalk, Output to Output	$G = 1, R_L = 100\ \Omega, V_{OUT} = 2\text{ V p-p}, V_S = 3\text{ V}$ @ 1 MHz		-89			dB
<b>DC PERFORMANCE</b>						
Input Offset Voltage	SELECT = three-state or open, PNP active		200			$\mu\text{V}$
	SELECT = high NPN active		240			$\mu\text{V}$
Input Offset Voltage Drift	$T_{MIN}$ to $T_{MAX}$		2			$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$V_{CM} = 1.5\text{ V}$ , NPN active		4			$\mu\text{A}$
	$T_{MIN}$ to $T_{MAX}$		4			$\mu\text{A}$
	$V_{CM} = 1.5\text{ V}$ , PNP active		-8			$\mu\text{A}$
	$T_{MIN}$ to $T_{MAX}$		-8			$\mu\text{A}$
Input Offset Current			$\pm 0.1$			$\mu\text{A}$
Open-Loop Gain	$V_{OUT} = 1\text{ V to }2\text{ V}$		100			dB
<b>INPUT CHARACTERISTICS</b>						
Input Impedance			6			M $\Omega$
Input Capacitance			2			pF
Input Common-Mode Voltage Range	$R_L = 1\text{ k}\Omega$		-0.2 to +3.2			V
Common-Mode Rejection Ratio	$V_{CM} = 0\text{ V to }1.5\text{ V}$		100			dB
<b>SELECT PIN</b>						
Crossover Low, Selection Input Voltage	Three-state $< \pm 20\ \mu\text{A}$		1.7 to 3			V
Crossover High, Selection Input Voltage			1.1 to 1.7			V
Disable Input Voltage			0 to 1.1			V
Disable Switching Speed	50% of input to $< 10\%$ of final $V_{OUT}$		1150			ns
Enable Switching Speed			50			ns
<b>OUTPUT CHARACTERISTICS</b>						
Output Overdrive Recovery Time (Rising/Falling Edge)	$V_{IN} = -1\text{ V to }+4\text{ V}, G = -1$		55/55			ns
Output Voltage Swing	$R_L = 1\text{ k}\Omega$	$-V_S + 0.09$	$+V_S - 0.03,$ $-V_S + 0.03$	$+V_S$	Tested	V
Short-Circuit Current	Sinking and sourcing		72			mA
Off Isolation	$V_{IN} = 0.2\text{ V p-p}, f = 1\text{ MHz}, \text{SELECT} = \text{low}$		-49			dB
Capacitive Load Drive	30% overshoot		20			pF
<b>POWER SUPPLY</b>						
Operating Range		2.7		12	GBD	V
Quiescent Current/Amplifier			6.0			mA
Quiescent Current (Disabled)	SELECT = low		300			$\mu\text{A}$
Power Supply Rejection Ratio	$V_S \pm 1\text{ V}$		100			dB

<sup>1</sup> GBD is guaranteed by design.

## ABSOLUTE MAXIMUM RATINGS

Table 4.

Parameter	Rating
Supply Voltage	12.6 V
Common-Mode Input Voltage	$\pm V_S \pm 0.5 \text{ V}$
Differential Input Voltage	$\pm 1.8 \text{ V}$
Storage Temperature	$-65^\circ\text{C}$ to $+125^\circ\text{C}$
Operating Temperature Range	$-40^\circ\text{C}$ to $+125^\circ\text{C}$
Junction Temperature	$150^\circ\text{C}$

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

### PAD CONFIGURATION AND FUNCTION DESCRIPTIONS

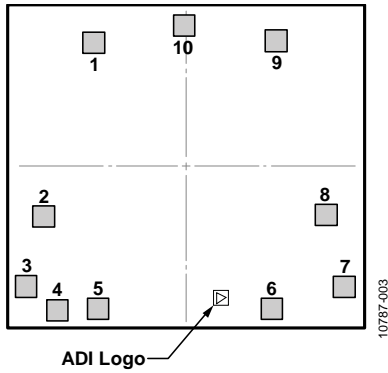


Figure 1. Pad Configuration

Table 5. Pad Function Descriptions

Pad No.	X-Axis	Y-Axis	Mnemonic	Description
1	-326	+491	$V_{OUTA}$	Output A.
2	-547	-212	-IN A	Inverting Input A.
3	-590	-346	+IN A	Noninverting Input A.
4	-592	-490	$-V_S$	Negative Supply.
5	-286	-492	Disable Control/Select A	Disable Control/Select Mode A.
6	+325	-489	Disable Control/Select B	Disable Control/Select Mode B.
7	+593	-490	+IN B	Noninverting Input B.
8	+596	-350	-IN B	Inverting Input B
9	+324	+491	$V_{OUTB}$	Output B.
10	+86	+492	$+V_S$	Positive Supply.

OUTLINE DIMENSIONS

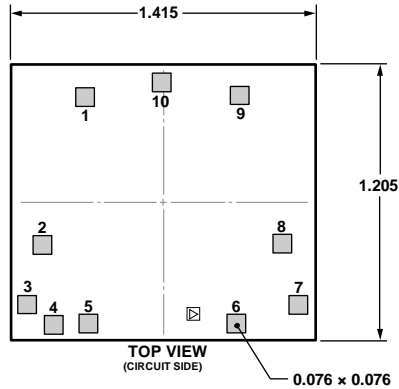


Figure 2. 10-Pad Bare Die [CHIP] (C-10-3)  
Dimensions shown in millimeters

08/23/2012-A

DIE SPECIFICATIONS AND ASSEMBLY RECOMMENDATIONS

Table 6. Typical Die Specifications

Parameter	Value	Unit
Chip Size	1420 × 1290	μm
Scribe Line Width	75	μm
Die Size	55.7 × 47.4	Mil
Thickness	305	μm
Bond Pads (Min Size)	76 × 76	μm
Bond Pad Composition	1% Copper Doped Aluminum	%
Backside	Si	Not Applicable
Passivation	Doped oxide/SiN	Not Applicable
ESD	HBM 2000	V

Table 7. Assembly Recommendations

Assembly Component	Recommendation
Die Attach	Ablestik 84-1LMIS R4
Bonding Method	1 mil gold

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
AD8028-KGD-CHIP	-40°C to +125°C	10-Pad Bare Die	C-10-3



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