12MHz 20V/µs G=1,2,5,10 Programmable Gain *i*CMOS™ Instrumentation Amplifier

Preliminary Technical Data

AD8250

FEATURES

Easy to Use
Programmable Gains: 1, 2, 5, 10
Digital or Pin Programmable Gain Setting
Temp Range -40°C to 85°C

EXCELLENT DC PERFORMANCE
High CMRR 100dB G=10
Low Gain Drift: 10ppm/°C
Low Offset Drift: 1uV/°C
Low Offset: 70uV G=10

EXCELLENT AC PERFORMANCE
Fast Settle Time: 0.5us to 0.01%
High Slew Rate: 20V/µs
High CMRR over Frequency: 80dB to 50kHz
Low Noise: 13nV√Hz, G=10
Low Power: 3.5 mA (typ)
Supply: ±5V to ±12V

Applications
Data Acquisition
Bio-Medical Analysis
Test and Measurement
High Performance System Monitoring

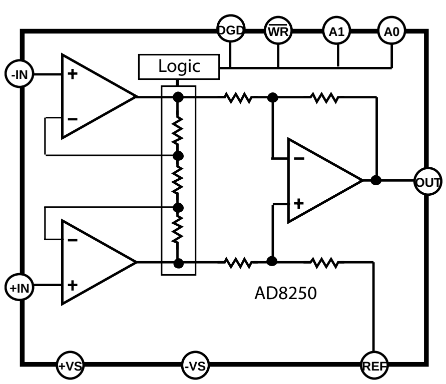

Figure 1. Functional Block Diagram

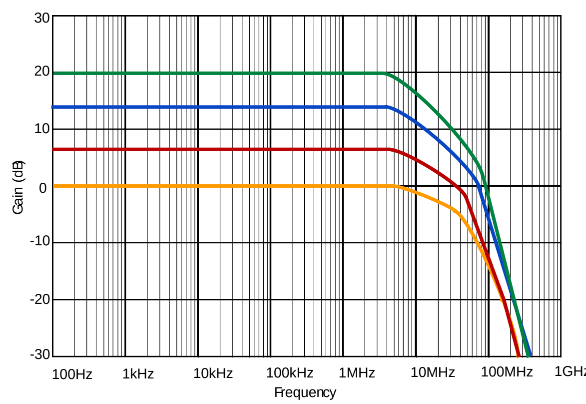

Figure 2. Gain vs Frequency

GENERAL DESCRIPTION

The AD8250 is a digitally gain programmable instrumentation amplifier that has high GΩ input impedance and low distortion making it suitable for sensor interfacing and driving high sample rate analog to digital converters. It has high bandwidth of 12MHz, low distortion and settle time of 0.5us to 0.01%. Offset drift and gain drift are limited to 1uV/°C and 10ppm/°C respectively. In addition to its wide input common-voltage range, it boasts a high common-mode rejection of 80dB at G=1 from DC to 50kHz. The combination of precision DC performance coupled with high speed capabilities make the AD8250 an excellent candidate for data acquisition and medical applications. Furthermore, this monolithic solution simplifies design, manufacturing and boosts performance of instrumentation by maintaining tight match of internal resistors and amplifiers.

The AD8250's user interface comprises of a parallel port that allows users to set the gain in one of three different ways. A two bit word sent to A1 and A2, via a bus may be latched using the $\overline{WR}$ input. An alternative is to set the gain within 1µs by using the gain port in transparent mode where the state of A0 and A1 directly set the gain. The last method is to strap A1 and A2 to a high or low voltage potential, permanently setting the gain.

The AD8250 is available in a 10 pin MSOP package and specified over -40°C to 85°C, making it an excellent solution for applications where size and packing density are

Rev.PrB

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important considerations.

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REVISION HISTORY

AD8250—SPECIFICATIONS

Table 1. V_S = ±12 V, V_{REF} = 0 V (@T_A = 25°C, G = +1, R_L = 2 kΩ, unless otherwise noted.)

Parameter	Conditions	AD8250ARM Min	Typ	Max	Unit
COMMON-MODE REJECTION RATIO (CMRR)					
CMRR to 60 Hz with 1 kΩ Source Imbalance	V_{CM} = -10 V to +10 V				
	G = 1		80		dB
	G = 2		86		dB
	G = 5		94		dB
	G = 10		100		dB
CMRR to 50kHz	V_{CM} = -10 V to +10 V				
	G = 1		80		dB
	G = 2				dB
	G = 5				dB
	G = 10				dB
NOISE					
Voltage Noise, 1kHz	G=1		32		nV/√Hz
	G=2		20		nV/√Hz
	G=5		14		nV/√Hz
	G=10		13		nV/√Hz
RTI, 0.1 Hz to 10 Hz	G=1				µV p-p
	G=2				µV p-p
	G=5				µV p-p
	G=10				µV p-p
Current Noise	f = 1kHz				fA/√Hz
VOLTAGE OFFSET					
Offset, V_{OS}	G=1, V_S = ±5 V to ±12 V		250		µV
Over Temperature	T = -40°C to +85°C				µV
Average TC	T = -40°C to +85°C				µV/°C
Offset, V_{OS}	G=2, V_S = ±5 V to ±12 V		150		µV
Over Temperature	T = -40°C to +85°C				µV
Average TC	T = -40°C to +85°C				µV/°C
Offset, V_{OS}	G=5, V_S = ±5 V to ±12 V		90		µV
Over Temperature	T = -40°C to +85°C				µV
Average TC	T = -40°C to +85°C				µV/°C
Offset, V_{OS}	G=10, V_S = ±5 V to ±12 V		70		µV
Over Temperature	T = -40°C to +85°C				µV
Average TC	T = -40°C to +85°C				µV/°C
Offset Referred to the Input vs. Supply (PSR)	V_S = ±8 V to ±12 V				
G = 1			115		dB
G = 2			110		dB
G = 5			110		dB
G = 10		96	110		dB
INPUT CURRENT					
Input Bias Current			10	25	nA
Over Temperature	T = -40°C to +85°C			35	nA

Parameter	Conditions	AD8250ARM Min	Typ	Max	Unit
Average TC					pA/°C
Input Offset Current			5	10	nA
Over Temperature	T = -40°C to +85°C				nA
Average TC			1.5		pA/°C
DYNAMIC RESPONSE					
Small Signal -3dB Bandwidth					
	G=1		17		MHz
	G=2		15		MHz
	G=5		10		MHz
	G=10		3.5		MHz
Settling Time 0.01%	10 V Step				
	G=1		0.5		µS
	G=2				µS
	G=5				µS
	G=10				µS
Settling Time 0.001%	10 V Step				
	G=1		1.5		µS
	G=2				µS
	G=5				µS
	G=10				µS
Slew Rate	G=1	20		35	V/µS
	G=2	30		35	V/µS
	G=5	30		35	V/µS
	G=10	30		35	V/µS
Total Harmonic Distortion + Noise	RL = 100kOhms, G=1				%
	RL = 2kOhms, G=1				%
GAIN					
Gain Range: 1, 2, 5, 10		1		10	V/V
Gain Error	V_{OUT}= ±10 V				
	G=1		0.05		%
	G=2				
	G=5				
	G=10				
Gain Nonlinearity	V_{OUT} = −10 V to +10 V				
	G=1, R_L = 10 kΩ		4		ppm
	G=2, R_L = 10 kΩ		4		ppm
	G=5, R_L = 10 kΩ		4		ppm
	G=10, R_L = 10 kΩ		4		ppm
Gain Nonlinearity	G=1-10, R_L = 2 kΩ		4		ppm
Gain vs. Temperature	All Gains			10	ppm/°C
INPUT					
Input Impedance					
Differential			1|| 2		GΩ|| pF
Common Mode			1|| 2		GΩ|| pF
Input Operating Voltage Range	V_S = ±5 V to ±12 V	-Vs + 1		+Vs 1.5	V
Over Temperature	T = -40°C to +85°C				V

Parameter	Conditions	AD8250ARM Min	Typ	Max	Unit
OUTPUT	R_L = 10 kΩ,				
Output Swing	V_S = ±5 V to ±12 V	–Vs + 1.5		+Vs – 1.5	V
Over Temperature	T = -40°C to +85°C				V
Short Circuit Current			20		mA
REFERENCE INPUT					
R_{IN}			20		kΩ
I_{IN}	V_{IN}+, V_{IN}–, V_{REF} = 0				µA
Voltage Range		–Vs		+Vs	V
Gain to Output					V/V
Digital Logic Inputs					V
Digital Ground Voltage, DGND					V
Digital Input Voltage Low	Referenced to DGND		1		V
Digital Input Voltage High	Referenced to DGND		4		V
Digital Input Leakage Current					pA
Gain Switching Time					ns
T_{SU}					ns
T_{HD}					ns
T_{WR_LO}					ns
T_{WR_HI}					ns
POWER SUPPLY					
Operating Range[3]		±5		±12	
Quiescent Current			3.5		mA
Over Temperature	T = -40°C to +85°C				mA
TEMPERATURE RANGE					
Specified Performance		–40		+85	°C

TIMING DIAGRAM

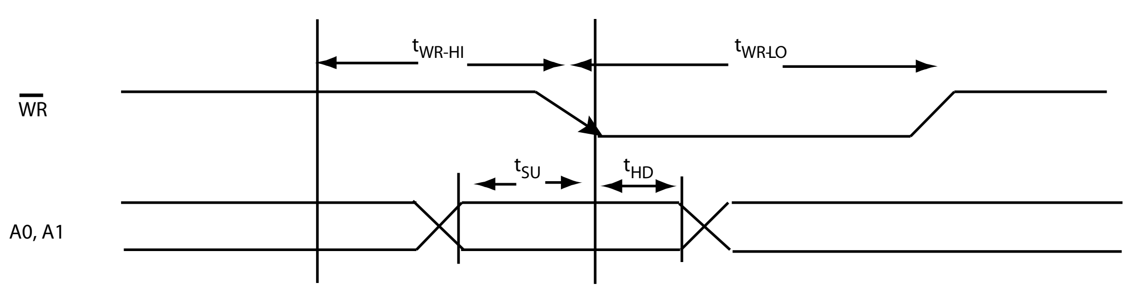

Figure 3.Timing Diagram

ABSOLUTE MAXIMUM RATINGS

Table 2. AD8250 Absolute Maximum Ratings

Parameter	Rating
Supply Voltage	+/-14V
Power Dissipation	See Figure 2
Output Short Circuit Current	
Common-Mode Input Voltage	-Vs – 0.5 V to +Vs + 0.5 V
Differential Input Voltage	V
Storage Temperature	–65°C to +125°C
Operating Temperature Range	–40°C to +85°C
Lead Temperature Range (Soldering 10 sec)	°C
Junction Temperature	°C
Θ_{JA} (4 layer JEDEC Standard Board)	°C/W
Package Glass Transition Temperature	°C
ESD (Human Body Model)	kV
ESD (Charge Device Model)	kV
ESD (Machine Model)	kV

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other condition s 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.

PIN CONFIGURATIONS AND FUNCTIONAL DESCRIPTIONS

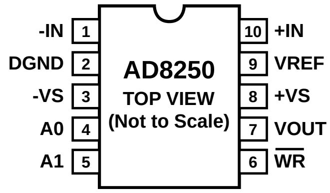

Figure 4. 10-Lead MSOP

Table 3. Pin Function Descriptions—10-Lead MSOP(ARM PACKAGE)

Pin No.	Name	Description
1	-IN	Inverting Input Terminal (True differential input)
2	DGND	Digital Ground.
3	-Vs	Negative Supply Terminal
4	A0	Gain Setting Pin (LSB)
5	A1	Gain Setting Pin (MSB)
6	$\overline{WR}$	Write Enable
7	VOUT	Output Terminal
8	+Vs	Positive Supply Terminal
9	VREF	Reference Voltage Terminal (drive this pin with a low impedance voltage source to level shift the output signal)
10	+IN	Non-inverting Input Terminal (True differential input)

GAIN SETTING

The AD8250's gains are set digitally. The A0 and A1 pins must be set either HIGH or LOW with respect to digital ground, DGND. The $\overline{WR}$ pin is a tri-state switch. It may be set to one of three levels, HIGH, LOW or to –VS. A HIGH signal is typically greater than 4V but less than 6V and a LOW signal is typically less than 1V but higher than DGND, 0V. Gains can be programmed using the following methods:

TRANSPARENT GAIN SETTING MODE:

In this mode, the gain is set by toggling A0 and A1 to HIGH or LOW. To enable transparent mode, tie $\overline{WR}$ to –Vs. This configures the AD8250 to change gains when A0 and A1 are set according to Table 4.

Table 4. . Transparent Mode Gain Settings

G	$\overline{WR}$	A1	A0
1	-Vs	LO	LO
2	-Vs	LO	HI
5	-Vs	HI	LO
10	-Vs	HI	HI

WRITE ENABLE GAIN SETTING MODE:

In this mode, the gains are changed only during the negative edge of the $\overline{WR}$ strobe. So for instance, the gain is determined by the two bit value held on A0 and A1 at the time the $\overline{WR}$ strobe transitions from HIGH to LOW.

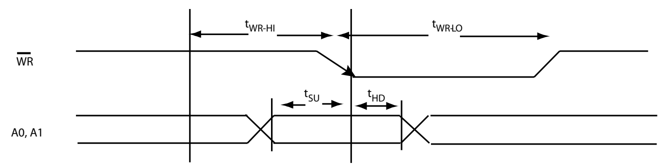

Table 5. : Write Enable Mode Gain Settings

Gain (changes to)	$\overline{WR}$	A1	A0
1	HI -> LO	LO	LO
2	HI -> LO	LO	HI
5	HI -> LO	HI	LO
10	HI -> LO	HI	HI
No Change	LO->LO	X	X
No Change	LO->HI	X	X
No Change	HI-> HI	X	X

X = don't care

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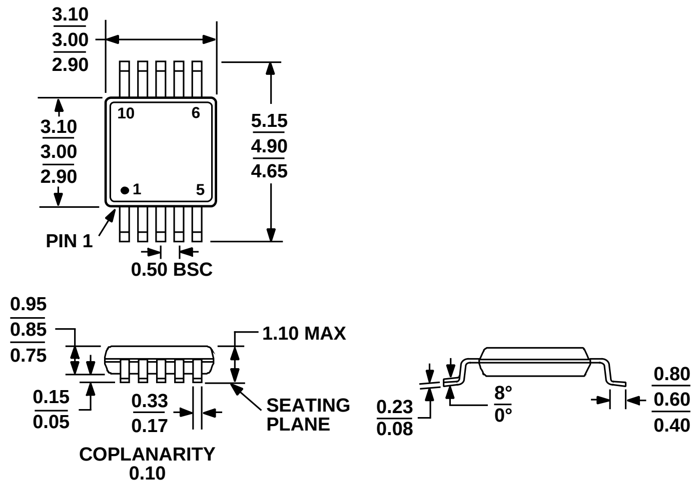
OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-187-BA

Figure 5. 10 Lead MSOP (RM) – Dimensions shown in millimeters

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

Table 6. Ordering Guide

AD00000 Products	Temperature Package	Package Description	Package Option	Branding
AD8250ARZ	–40°C to +85°C	10-Lead MSOP	RM-10	
AD8250ARZ-RL	–40°C to +85°C	10-Lead MSOP	RM-10	
AD8250ARZ-R7	–40°C to +85°C	10-Lead MSOP	RM-10	
AD8250-EVAL		Evaluation Board		