# 10MHz G=1, 2, 5, 10 Programmable Gain iCMOS™ Instrumentation Amplifier

Preliminary Technical Data

**AD8250**

## FEATURES

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

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

**EXCELLENT AC PERFORMANCE**
**Fast Settle Time: 0.5us to 0.01%**
**High Slew Rate: 30V/µs**
**High CMRR over Frequency: 80dB to 10kHz**
**Low Noise: 15nV√Hz, G=10**
**Low Power: 3mA (typ)**
**Supply: ±5V t0 ±12V**

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

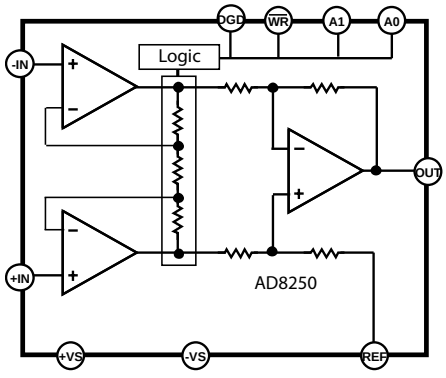


*Figure 1. Functional Block Diagram*

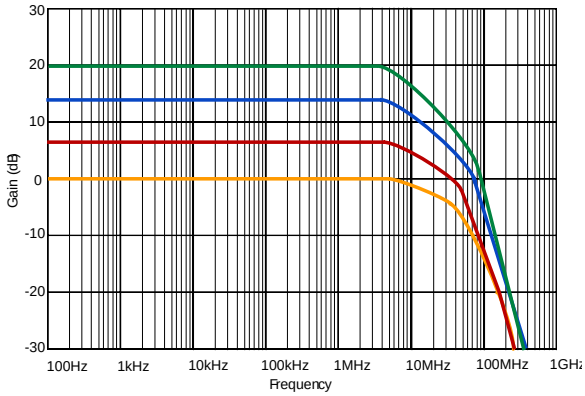


*Figure 2. Gain vs Frequency*

## GENERAL DESCRIPTION

The AD8250 is a digitally gain programmable instrumentation amplifier with high GΩ input impedance and low distortion making it suitable for sensor interfacing and driving high sample rate analog to digital converters. It has a bandwidth of 10MHz, low distortion, and settling time of 0.5us to 0.01%. The offset and gain drift are 1uV/°C and 10ppm/°C respectively. It has a high common-mode rejection of 74dB at G=1 from DC to 100kHz. 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 CLK input. An alternative is to set the gain within 1µs by using the gain port in transparent mode. 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-Lead MSOP package and specified over -40°C to 85°C, making it an excellent solution for applications where size and packing density are important considerations.



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**REVISION HISTORY** Revision prA: Initial Version

# 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 | VCM = -10 V to +10 V | | | | |
| | G = 1 | | 80 | | dB |
| | G = 2 | | 86 | | dB |
| | G = 5 | | 94 | | dB |
| | G = 10 | | 100 | | dB |
| CMRR to 100kHz | $V_{CM}$ = -10 V to +10 V | | | | |
| | G = 1 | | 74 | | dB |
| | G = 2 | | | | dB |
| | G = 5 | | | | dB |
| | G = 10 | | | | dB |
| NOISE | | | | | |
| Voltage Noise, 1kHz | G=1 | | | | nV/√Hz |
| | G=2 | | | | nV/√Hz |
| | G=5 | | | | nV/√Hz |
| | G=10 | | 15 | | 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 | | | | | |
| Input Offset, $V_{OS}$ | G=1, $V_S$ = ±5 V to ±12 V | | | 100 | µV |
| Over Temperature | T = -40°C to +85°C | | | | µV |
| Average TC | T = -40°C to +85°C | | | 1 | µV/°C |
| Input Offset, $V_{OS}$ | G=2, $V_S$ = ±5 V to ±12 V | | | 100 | µV |
| Over Temperature | T = -40°C to +85°C | | | | µV |
| Average TC | T = -40°C to +85°C | | | 1 | µV/°C |
| Input Offset, $V_{OS}$ | G=5, $V_S$ = ±5 V to ±12 V | | | 100 | µV |
| Over Temperature | T = -40°C to +85°C | | | | µV |
| Average TC | T = -40°C to +85°C | | | 1 | µV/°C |
| Input Offset, $V_{OS}$ | G=10, $V_S$ = ±5 V to ±12 V | | | 100 | µV |
| Over Temperature | T = -40°C to +85°C | | | | µV |
| Average TC | T = -40°C to +85°C | | | 1 | µV/°C |
| Offset Referred to the Input vs. Supply (PSR) | $V_S$ = ±2.5 V to ±8 V | | | | |
| G = 1 | | 76 | | | dB |
| G = 2 | | | | | dB |
| G = 5 | | | | | dB |
| G = 10 | | 96 | | | dB |
| INPUT CURRENT | | | | | |
| Input Bias Current | | | 10 | 15 | nA |
| Over Temperature | T = -40°C to +85°C | | | 25 | 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 | | | | µS |
| | G=2 | | | | µS |
| | G=5 | | | | µS |
| | G=10 | | | | µS |
| Slew Rate | G=1 | 20 | | 35 | V/µS |
| | G=2 | | | | V/µS |
| | G=5 | | | | V/µS |
| | G=10 | | | | V/µS |
| Gain Switching and Settle Time | Gain 1 to Gain 10, 1V signal. 0.01% (if this is just the sum of gain time + settle, then remove) | | | | µS |
| | Gain 1 to Gain 10, 1V signal. 0.001% | | | | µS |
| Total Harmonic Distortion + Noise | RL = 100kOhms, G=1 | | | | % |
| | RL = 2kOhms (try 600Ohms?), G=1 | | | | % |
| GAIN | | | | | |
| Gain Range: 1, 2, 5, 10 | | 1 | | 10 | V/V |
| Gain Error | $V_{OUT}$= ±10 V | | | | |
| | G=1 | | | 0.10 | % |
| | G=2 | | | | |
| | G=5 | | | | |
| | G=10 | | | | |
| Gain Nonlinearity | $V_{OUT}$ = –10 V to +10 V | | | | |
| | G=1, $R_L$ = 10 kΩ | | 10 | 40 | ppm |
| | G=2, $R_L$ = 10 kΩ | | | | Ppm |
| | G=5, $R_L$ = 10 kΩ | | | | Ppm |
| | G=10, $R_L$ = 10 kΩ | | | | Ppm |
| Gain Nonlinearity | G=1-10, $R_L$ = 2 kΩ | | | | Ppm |
| Gain vs. Temperature | All Gains | | | 10 | ppm/°C |
| | | | 3 | | |
| INPUT | | | | | |
| Input Impedance | | | | | |
| Differential | | | 1\|\| 2 | | GΩ\|\| pF |
| Common Mode | | | 1\|\| 2 | | GΩ\|\| pF |
| Input Operating Voltage Range | $V_S$ = ±5 V to ±15 V | | | | V |

| Parameter | Conditions | AD8250ARM Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Over Temperature | T = -40°C to +85°C | | | | V |
| OUTPUT | $R_L$ = 10 kΩ, | | | | |
| Output Swing | $V_S$ = ±5 V to ±15 V | –Vs + 1.5 | | +Vs – 2 | V |
| Over Temperature | T = -40°C to +85°C | | | | V |
| Short Circuit Current | | | | | 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 | | | | | V |
| Digital Input Voltage High | | | | | 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 | | ±15 | |
| Quiescent Current | | | 3 | | mA |
| Over Temperature | T = -40°C to +85°C | | | | mA |
| TEMPERATURE RANGE | | | | | |
| Specified Performance | | –40 | | +85 | °C |
| | | | | | |
| | | | | | |
| | | | | | |

# ABSOLUTE MAXIMUM RATINGS

**Table 2. AD8250 Absolute Maximim Ratings**

| **Parameter** | **Rating** |
|---|---|
| Supply Voltage | +/-14V |
| Power Dissipation | See Figure 2 |
| Output Short Circuit Current | |
| Common-Mode Input Voltage | VEE – 0.5 V to VCC + 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 |
| $\Theta_{JA}$ (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

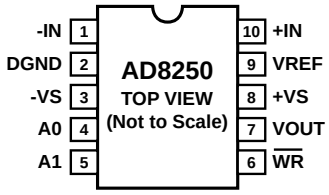


*Figure 3. 10-Lead MSOP*

**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) |

# OUTLINE DIMENSIONS

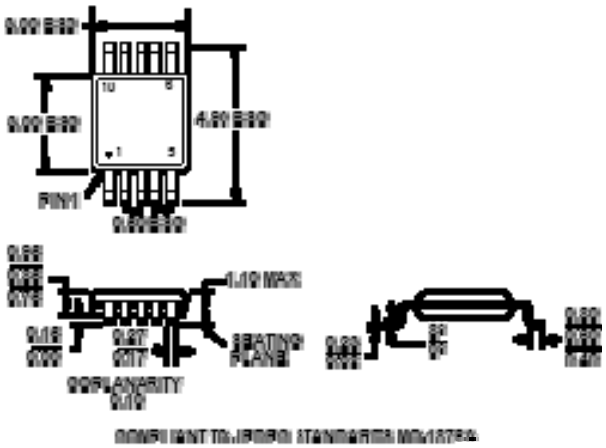

*Figure 4. 10 Lead MSOP (RM) – Dimensions shown in millimeters*

## 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 4. Ordering Guide**

| AD8250 Products | Temperature Package | Package Description | Package Option | Branding |
|---|---|---|---|---|
| AD8250ARMZ | –40°C to +85°C | 10-Lead MSOP | RM-10 | |
| AD8250ARMZ-RL | –40°C to +85°C | 10-Lead MSOP | RM-10 | |
| AD8250ARMZ-R7 | –40°C to +85°C | 10-Lead MSOP | RM-10 | |
| AD8250-EVAL | | Evaluation Board | | |

# NOTES