ANALOG DEVICES

# Rail-to-Rail Output JFET Input Instrumentation

Preliminary Technical Data **AD8220**

## FEATURES

**High accuracy dc performance**
- 90 dB CMRR (G = 1), typ
- 4pA typ input bias current
- 1 nA max input bias current over temperature
- 2 uV/°C typ input offset voltage drift

**Excellent ac specificatons**
- 80 dB min CMRR to 10 kHz ( G = 1), typ
- 1.75 MHz –3dB bandwidth (G=1)
- Low Settling Time

**Versatile**
- Rail-to-rail output
- 700 µA quiescent supply current (typ)
- Available in space-saving MSOP package
- Gain set with one resistor (gain range 1 to 1000)
- ±2.3 V to ±18 V dual supplies
- +4.6 V to +36 V single supply
- Specified over –40°C to +85°C

## CONNECTION DIAGRAM

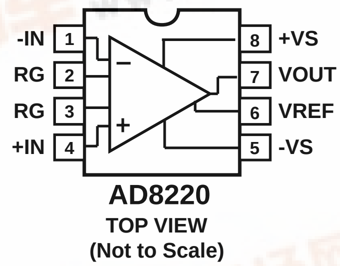


*Figure 1. MSOP Connection Diagram*

## APPLICATIONS

Medical instrumentation
Precision data acquisition systems
Transducer interfaces

## GENERAL DESCRIPTION

The AD8220 is a gain programmable, high performance instrumentation amplifier that draws a typical input bias current of 4pA and rejects high frequency common mode signals. The CMRR of instrumentation amplifiers on the market today falls off at 200 Hz. In contrast, the AD8220 maintains a CMRR of 80 dB over an extended frequency at G = 1. The combination of extremely high input impedance and high CMRR over frequency makes the AD8220 useful in applications such as patient monitoring where input impedance is high and high frequency disturbances must be rejected.

The rail to rail output, low power consumption and small MSOP package make this precision instrumentation amplifier attractive for use in multi-channel applications.

Programmable gain affords the user design flexibility. A single resistor sets the gain from 1 to 1000. The AD8220 operates on both single and dual supplies and is well suited for situations where ±10 V input voltages are encountered. In addition its rail to rail output stage allows for maximum dynamic range when constrained by low single supply voltages.

Performance is specified over the entire industrial temperature range of –40°C to +85°C.

Rev. PrA


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## REVISION HISTORY

**8/05—Revision PrA: Preliminary Version**

# SPECIFICATIONS

$V_S$ = ±5, ±15 V, $V_{REF}$ = 0 V, $T_A$ = +25°C, G = 1, $R_L$ = 2 kΩ, unless otherwise noted.

**Table 1.**

| Parameter | ARM Grade Min | Typ | Max | Unit | Conditions |
|---|---|---|---|---|---|
| COMMON-MODE REJECTION RATIO (CMRR) | | | | | |
| CMRR DC to 60 Hz with 1 kΩ Source Imbalance | | | | | $V_{CM}$ = −10 V to +10 V |
| G = 1 | | 90 | | dB | |
| G = 10 | | 110 | | dB | |
| G = 100 | | 116 | | dB | |
| G = 1000 | | 116 | | dB | |
| CMRR at 10 kHz | | | | | $V_{CM}$ = −10 V to +10 V |
| G = 1 | | 80 | | dB | |
| G = 10 | | 100 | | dB | |
| G = 100 | | 116 | | dB | |
| G = 1000 | | 116 | | dB | |
| NOISE | | | | | $RTI\ noise = \sqrt{e_{NI}^2 + (e_{NO}/G)^2}$ |
| Voltage Noise, 1 kHz | | | | | |
| Input Voltage Noise, $e_{NI}$ | | 15 | | nV/√Hz | $V_{IN+}$, $V_{IN-}$, $V_{REF}$ = 0 |
| Output Voltage Noise, $e_{NO}$ | | 100 | | nV/√Hz | |
| RTI | | | | | f = 0.1 Hz to 10 Hz |
| G = 1 | | | | µV p-p | |
| G = 10 | | | | µV p-p | |
| G = 100 to 1000 | | | | µV p-p | |
| Current Noise | | 1 | | fA/√Hz | f = 1 kHz |
| | | 6 | | pA p-p | f = 0.1 Hz to 10 Hz |
| VOLTAGE OFFSET[1] | | | | | |
| Input Offset, $V_{OSI}$ | | 0.2 | 1 | mV | $V_S$ = ±15 V |
| Over Temperature | | | 1.6 | mV | $V_S$ = ±15 V ; T = −40°C to +85°C |
| Average TC | | 2 | 10 | µV/°C | $V_S$ = ±15 V |
| Output Offset, $V_{OSO}$ | | | 1 | mV | $V_S$ = ±5 V to ±15 V |
| Over Temperature | | | 1.6 | mV | T = −40°C to +85°C |
| Average TC | | | 10 | µV/°C | |
| Offset RTI vs. Supply (PSR) | | | | | $V_S$ = ±2.5 V to ±15 V |
| G = 1 | 80 | 90 | | dB | |
| G = 10 | 95 | 110 | | dB | |
| G = 100 | 110 | 130 | | dB | |
| G = 1000 | 110 | 130 | | dB | |
| INPUT CURRENT | | | | | |
| Input Bias Current | | 4 | 20 | pA | |
| Over Temperature | | | 1 | nA | T = −40°C to +85°C |
| Average TC | | | | pA/°C | |
| Input Offset Current | | | 5 | pA | |
| Over Temperature | | | 1 | nA | T = −40°C to +85°C |
| Average TC | | 1 | | pA/°C | |
| REFERENCE INPUT | | | | | |
| $R_{IN}$ | | 40 | | kΩ | |
| $I_{IN}$ | | 50 | | µA | $V_{IN+}$, $V_{IN-}$, $V_{REF}$ = 0 |
| Voltage Range | $-V_S$ | | $+V_S$ | V | |
| Gain to Output | | 1 ± 0.0001 | | V/V | |

| Parameter | ARM Grade Min | Typ | Max | Unit | Conditions |
|---|---|---|---|---|---|
| POWER SUPPLY | | | | | |
| Operating Range | ±2.3 | | ±18 | V | $V_S$ = ±2.3 V to ±18 V |
| Quiescent Current | | 700 | | µA | |
| Over Temperature | | | 1,000 | µA | T = −40°C to +85°C |
| DYNAMIC RESPONSE | | | | | |
| Small Signal −3 dB Bandwidth | | | | | |
| G = 1 | | 1,800 | | kHz | |
| G = 10 | | 1,000 | | kHz | |
| G = 100 | | 120 | | kHz | |
| G = 1000 | | 12 | | kHz | |
| Settling Time 0.01% | | | | | 10 V step |
| G = 1 to 10 | | 5 | | µs | |
| G = 100 | | 12 | | µs | |
| G = 1000 | | 100 | | | |
| Settling Time 0.001% | | | | | 10 V step |
| G = 1 to 100 | | | | µs | |
| G = 1000 | | | | µs | |
| Slew Rate | 1.7 | 2 | | V/µs | G = 1 |
| | 2 | 2.5 | | V/µs | G = 5 to 100 |
| GAIN | | | | | G = 1 + 49.4 kΩ/RG |
| Gain Range | 1 | | 1,000 | V/V | |
| Gain Error | | | | | $V_{OUT}$ ±10 V |
| G = 1 | | 0.10 | 0.30 | % | |
| G = 10 | | 0.10 | 0.30 | % | |
| G = 100 | | 0.10 | 0.30 | % | |
| G = 1000 | | 0.10 | 0.30 | % | |
| Gain Nonlinearity | | | | | $V_{OUT}$ = −10 V to +10 V |
| G = 1 | | 5 | 10 | ppm | $R_L$ = 10 kΩ |
| G = 10 | | | | ppm | $R_L$ = 10 kΩ |
| G = 100 | | | | ppm | $R_L$ = 10 kΩ |
| G = 1 to 100 | | | | ppm | $R_L$ = 2 k |
| Gain vs. Temperature | | | | | |
| G = 1 | | 3 | 10 | ppm/°C | |
| G > 1[2] | | | −50 | ppm/°C | |
| INPUT | | | | | |
| Input Impedance | | | | | |
| Differential | | 1000‖6 | | | GΩ‖pF |
| Common Mode | | 1000‖12 | | | GΩ‖pF |
| Input Operating Voltage Range[3] | $-V_S$ | | $+V_S - 2.5$ | V | $V_S$ = ±2.3 V to ±5 V |
| Over Temperature | | | | V | T = −40°C to +85°C |
| Input Operating Voltage Range | $-V_S + 0.2$ | | $+V_S - 2.5$ | V | $V_S$ = ±5 V to ±18 V |
| Over Temperature | | | | V | T = −40°C to +85°C |
| Overload Recovery | | | | µs | |
| OUTPUT | | | | | $R_L$ = 10 kΩ |
| Output Swing | $-V_S + 0.1$ | | $-V_S - 0.1$ | V | $V_S$ = ±2.3 V to ±5 V |
| Over Temperature | $-V_S + 0.1$ | | $-V_S - 0.1$ | V | T = −40°C to +85°C |

| Parameter | ARM Grade Min | Typ | Max | Unit | Conditions |
|---|---|---|---|---|---|
| Output Swing | $-V_S + 0.1$ | | $-V_S - 0.1$ | V | $V_S = \pm5$ V to $\pm18$ V |
| Over Temperature | $-V_S + 0.1$ | | $-V_S - 0.1$ | V | T = −40°C to +85°C |
| Capacitance Load Drive | | 300 | | pF | |
| Short-Circuit Current | | 20 | | mA | |
| TEMPERATURE RANGE | | | | | |
| Specified Performance | −40 | | +85 | °C | |
| TBD Specified Performance | −40 | | +125 | °C | |

[1] Total RTI $V_{OS} = (V_{OSI}) + (V_{OSO}/G)$.
[2] Does not include the effects of External Resister $R_G$.
[3] One input grounded. G = 1.

# ABSOLUTE MAXIMUM RATINGS

Table 2.

| Parameter | Rating |
|---|---|
| Supply Voltage | ±18 V |
| Internal Power Dissipation | |
| Output Short Circuit Current | |
| Input Voltage (Common-Mode) | $\pm V_S$ |
| Differential Input Voltage | $\pm V_S$ |
| Storage Temperature | −65°C to +150°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.

## THERMAL CHARACTERISTICS

Specification is for device in free air.

Table 3.

| Package Type | $\theta_{JA}$ [1] | Unit |
|---|---|---|
| MSOP | 135 | °C/W |

[1] 4-layer JEDEC board.

## 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.

## OUTLINE DIMESIONS

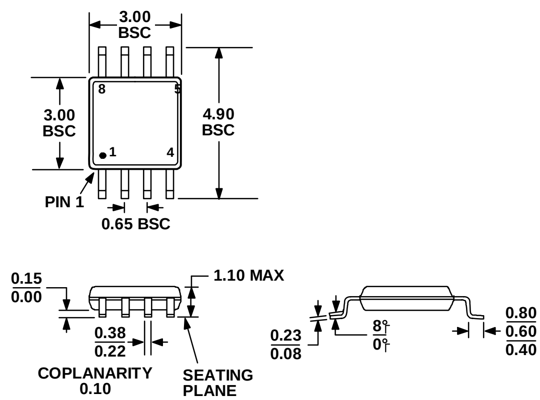


*Figure 2. 8-Lead Mini Small Outline Package [MSOP]*
*(RM-8)*
*Dimensions shown in millimeters*

## NOTES