# 1.8V-5.5V, 70μA, RRIO Zero-Drift, Instrumentation Amplifiers with Selectable Gain

## Features

- Selectable Gain Options
  - G=20 or G=10 (COSINA333-20)
  - G=50 or G=30 (COSINA333-50)
- Shutdown Option for Power Savings
- Low offset Voltage: 10μV (typical)
- Zero Drift: 0.05μV/ºC
- Low Quiescent Current: 70μA
- Low Input Bias Current: <1pA (typical)
- Rail-to-Rail Input and Output (RRIO)
- Operates on 1.8V ~ 5.5V Supplies
- Bandwidth: 100kHz for G=10 (typical)
- Extended Temperature Ranges
  From -40°C to +125°C
- Available in MSOP8/DFN8

## Applications

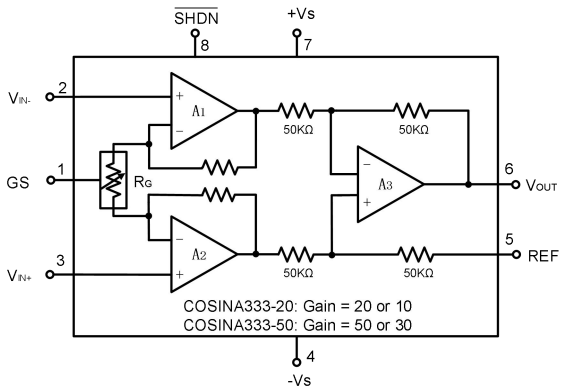
- Pressure and Temperature Sensing
- ECG and RTD Sensor Amplifiers
- Blood Glucose Monitors
- Weigh Scale
- Bridge-type Sensing Amplifiers



## General Description

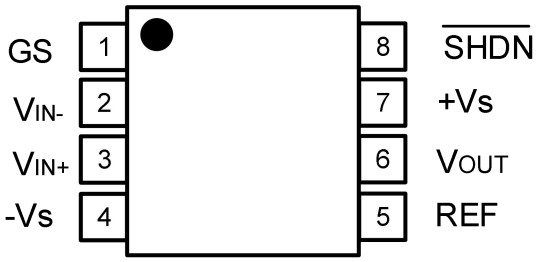
The COSINA333-20 and COSINA333-50 are gain selectable, zero-drift instrumentation amplifiers operated on 1.8 to 5.5 supplies. They don't need external precision resistors to set the gain. The gain options can be selected by toggling the gain select (GS) pin. They also have an integrated shutdown option to turn off the amplifiers when idle for additional power savings in battery powered applications.

The COSINA333 family uses auto-calibration technique to provide very low offset voltage (less than 125μV maximum) and near zero drift over temperature. Low quiescent supply current of 70μA and very low input bias current make the device an ideal choice for low offset, low power consumption and high impedance applications.




Block Diagram

## 1. Pin Configuration and Functions




COSINA333-20, COSINA333-50

### Pin Functions

| Pin | Name | I/O | Description | |
|---|---|---|---|---|
| 1 | GS | I | Gain setting pin: | |
| | | | COSINA333-20 | COSINA333-50 |
| | | | logic low: G=10<br>logic high: G=20<br>no connect: G=20 | logic low: G=30<br>logic high: G=50<br>no connect: G=50 |
| 2 | $V_{IN-}$ | I | Negative input | |
| 3 | $V_{IN+}$ | I | Positive input | |
| 4 | $-V_S$ | P | Negative supply, or ground | |
| 5 | REF | I | Reference input. This Pin must be driven by low impedance or connected to ground | |
| 6 | $V_{OUT}$ | O | Output | |
| 7 | $+V_S$ | P | Positive supply | |
| 8 | $\overline{SHDN}$ | I | Shutdown control:<br>logic low - device disenabled;<br>logic high - device enabled;<br>no connect - device enabled. | |

## 2. Package and Ordering Information

| Gain | Model | Package | Order Number | Package Option | Marking Information |
|---|---|---|---|---|---|
| 10 | COSINA333-20 | MSOP-8 | COSINA333-20MR | Tape and Reel, 3000 | COS333-20 |
| 20 | | DFN-8(3x3) | COSINA333-20FR | Tape and Reel, 3000 | COS333-20 |
| 30 | COSINA333-50 | MSOP-8 | COSINA333-20MR | Tape and Reel, 3000 | COS333-50 |
| 50 | | DFN-8(3x3) | COSINA333-20FR | Tape and Reel, 3000 | COS333-50 |

# 3. Product Specification

## 3.1 Absolute Maximum Ratings (1,2)

| Parameter | Rating | Units |
|---|---|---|
| Power Supply: V+ to V- | 6 | V |
| Differential Input Voltage Range | ±6 | V |
| Common Mode Input voltage Range(2) | V+ to V- | V |
| Output Current | 20 | mA |
| Storage Temperature Range | -65 to 150 | °C |
| Junction Temperature | 150 | °C |
| Operating Temperature Range | -40 to 125 | °C |
| ESD Susceptibility, HBM | 2000 | V |

(1) Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.
(2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current-limited to 10mA or less.

## 3.2 Thermal Data

| Parameter | Rating | Unit |
|---|---|---|
| Package Thermal Resistance, $R_{\theta JA}$ (Juntion-to-ambient) | 206 (MSOP8)<br>43 (DFN8-3x3) | °C/W |

## 3.3 Recommended Operating Conditions

| Parameter | Rating | Unit |
|---|---|---|
| DC Supply Voltage | 1.8V ~ 5.5V | V |
| | ± 0.9V ~ ± 2.75V | V |
| Input common-mode voltage range | -Vs ~ +Vs | V |
| Operating ambient temperature | -40 to +85 | °C |

### 3.4 Electrical Characteristics

(+$V_S$=+5V, -$V_S$=0V, $V_{REF}$=2.5V, $T_A$=+25°C, $R_L$=10 kΩ, unless otherwise noted)

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Input Characteristics** | | | | | | |
| Input Offset Voltage | $V_{OS}$ | | | ±10 | ±125 | μV |
| Input Offset Voltage Drift | $\Delta V_{OS}/\Delta T$ | -40 to 125°C | | 0.01 | 0.05 | μV/°C |
| Input Bias Current | $I_B$ | $V_{CM}$ = $V_S$ / 2 | | ±0.5 | | pA |
| Input Offset Current | $I_{OS}$ | $V_{CM}$ = $V_S$ / 2 | | ±0.2 | | pA |
| Common-Mode Voltage Range | $V_{CM}$ | | -Vs | | +Vs | V |
| Common-Mode Rejection Ratio | CMRR | $V_{CM}$ =0.1V to 4.9V | | 120 | | dB |
| **Output Characteristics** | | | | | | |
| Output Voltage Swing from Rail | Vhr | $R_L$=100kΩ | | 2 | | mV |
| | | $R_L$=10kΩ | | 20 | | mV |
| Short-Circuit Current | $I_{SR}$ | Sourcing | | 15 | | mA |
| | $I_{SK}$ | Sinking | | -15 | | mA |
| **Power Supply** | | | | | | |
| Operating Voltage Range | $V_S$ | | 1.8 | | 5.5 | V |
| | | | ±0.9 | | ± 2.75 | V |
| Quiescent Current | $I_Q$ | $V_{IN}$=0,<br>EN=1, or no connect | | 70 | | μA |
| | | EN=0 | | | 2.5 | μA |
| Power Supply Rejection Ratio | PSRR | | 100 | 120 | | dB |
| **Frequency Response** | | | | | | |
| Bandwidth, -3dB | BW | G=10<br>(COSINA333-20, GS=0) | | 40 | | kHz |
| | | G=20<br>(COSINA333-20, GS=1) | | 20 | | |
| | | G=30<br>(COSINA333-50, GS=0) | | 14 | | |
| | | G=50<br>(COSINA333-50, GS=1) | | 8 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Dynamic Performance** | | | | | | |
| Slew Rate | SR | $V_S$ = 5 V, $V_O$ = 2 V step | | 0.22 | | V/μs |
| Amplifier Enable Time | $t_{ON}$ | | | 100 | | μs |
| Amplifier Disable Time | $t_{OFF}$ | | | 1 | | μs |
| **Noise Performance** | | | | | | |
| Voltage Noise Density | $e_n$ | f=1kHz | | 50 | | nV/ √Hz |
| **Reference Input** | | | | | | |
| Voltage Range | | | -Vs | | +Vs | V |
| Reference Input Impedance | $R_{IN}$ | | | 100 | | kΩ |
| **Logic Control (GS, SHDN)** | | | | | | |
| Logic Low Threshold Voltage | $V_{IL}$ | | | | 0.8 | V |
| Logic High Threshold Voltage | $V_{IH}$ | | 2.4 | | | V |

# 4. Application Notes

## 4.1 Overview

The COSINA333-20 and COSINA333-50 are gain selectable, zero-drift instrumentation amplifiers operated on 1.8 to 5.5 supplies. They don't need external precision resistors to set the gain. The gain options can be selected by toggling the gain select (GS) pin. Since the integrated resistors are precision matched with low temperature coefficient resistors, the overall gain drift would be much better in comparison to discrete implementation of the instrumentation amplifiers built using external resistors. The COSINA333-20 and COSINA333-50 also have an integrated shutdown option to turn off the amplifiers when idle for additional power savings in battery powered applications.

The COSINA333 family uses auto-calibration technique to provide very low offset voltage (less than 125μV maximum) and near zero drift over temperature. They have both rail-to-rail input and output range. The output voltage swing extends to within 2mV of each rail, providing the maximum output dynamic range. Low quiescent supply current of 70μA and very low input bias current make the device an ideal choice for low offset, low power consumption and high impedance applications.

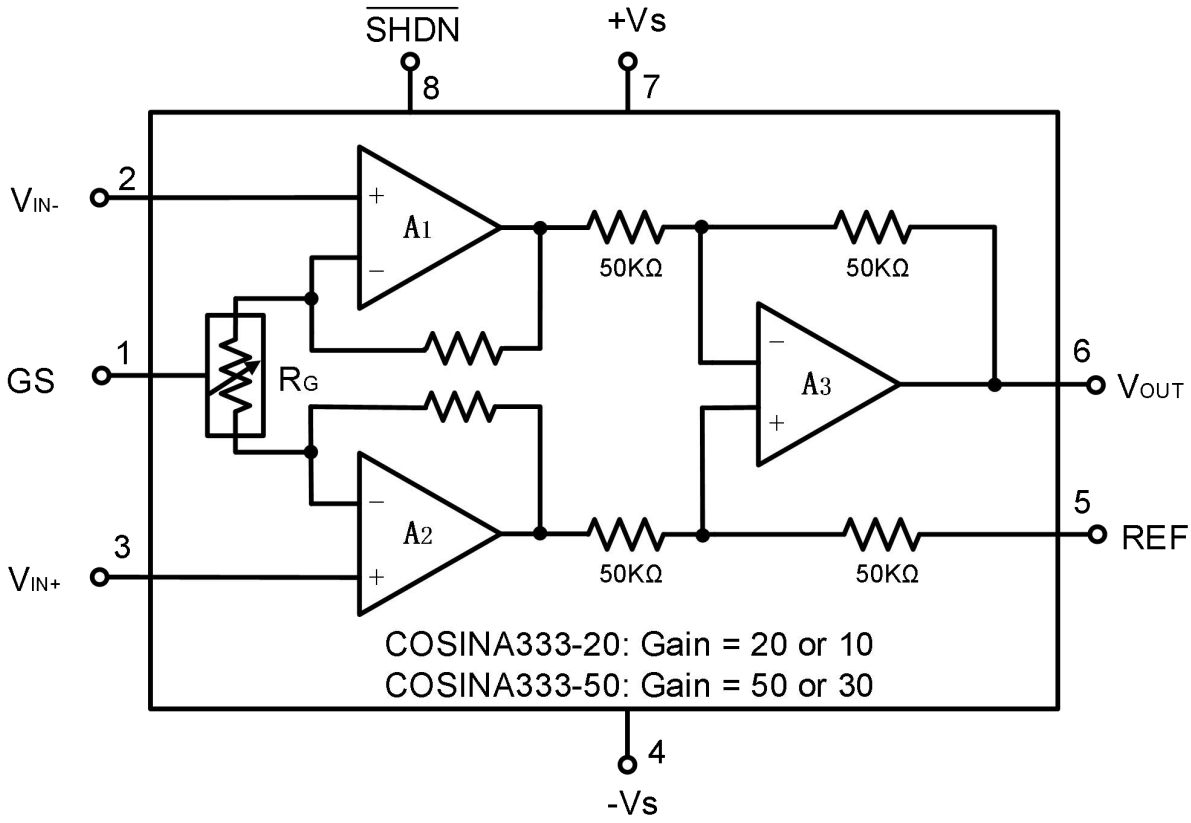



Figure 4.1 Simplified Internal Schematic

### 4.2 Functional Block Diagram

Figure 4.1 shows the simplified internal schematic of the COSINA333-20 and COSINA333-20. The output is referred to the REF terminal, which is normally grounded. The REF pin connection must be low-impedance to assure good common-mode rejection. A resistance of 8Ω in series with the REF pin will cause a 80dB CMRR degradation.

Table 4.1 provides how to choose different gain options across COSINA333-20 and COSINA333-50. COSINA333-20 has gain options of 20 or 10 and COSINA333-50 has gain options of 50 or 30. These gain options can be selected by toggling the gain select (GS) pin.

Table 4.1 Gain Selection Table

| Device | Gain Select (GS) | Gain |
|---|---|---|
| COSINA333-20 | High or No Connect | 20 |
| | Low | 10 |
| COSINA333-50 | High or No Connect | 50 |
| | Low | 30 |

### 4.3 Typical Application

Figure 4.2 illustrates a basic single-supply sensor application circuit. The output REF terminal can be connected to ground if the differential signal from the sensor is positive. $V_{IN+}$ and $V_{IN-}$ must both be 0.1V above ground for linear operation. A resistor (R1) in series with the low side of the bridge assures that the bridge output voltage is within the common-mode range of the amplifier inputs.

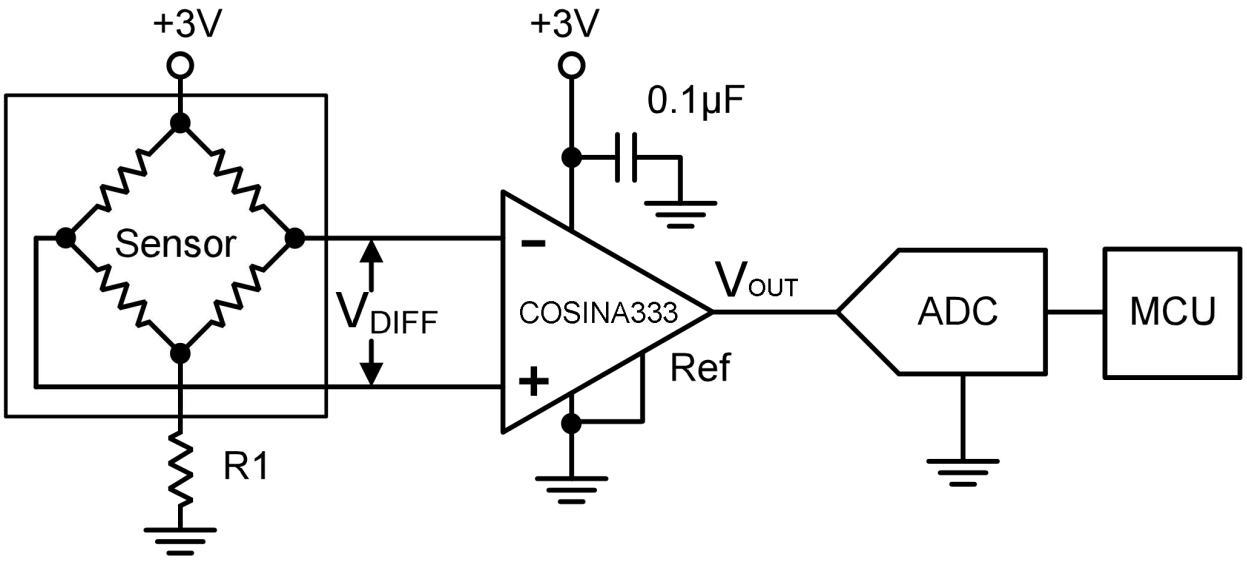



Figure 4.2 Single-Supply Bridge Amplifier

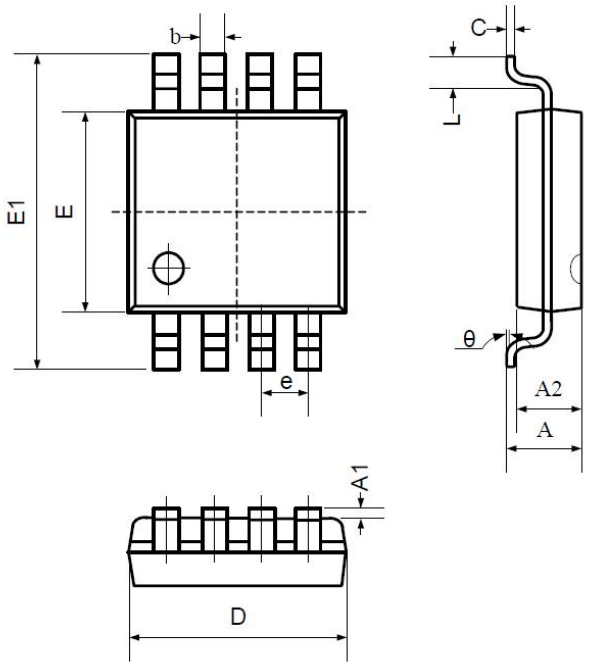
### 4.4 Power-Supply Bypassing and Layout

The COSINA333 family operates from a single +1.8V to +5.5V supply or dual ±0.9V to ±2.75V supplies. For single-supply operation, bypass the power supply +Vs with a 0.1μF ceramic capacitor which should be placed close to the +Vs pin. For dual-supply operation, both the +Vs and the -Vs supplies should be bypassed to ground with separate 0.1μF ceramic capacitors. 2.2μF tantalum capacitor can be added for better performance.

The length of the current path is directly proportional to the magnitude of parasitic inductances and thus the high frequency impedance of the path. High speed currents in an inductive ground return create an unwanted voltage noise. Broad ground plane areas will reduce the parasitic inductance. Thus a ground plane layer is important for high speed circuit design.

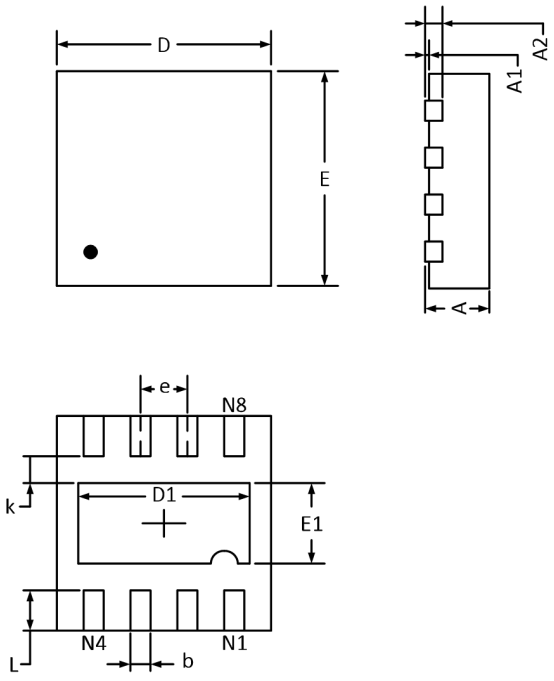
# 5. Package Information

## 5.1 MOP-8 (Package Outline Dimensions)




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 0.800 | 1.200 | 0.031 | 0.047 |
| A1 | 0.000 | 0.200 | 0.000 | 0.008 |
| A2 | 0.760 | 0.970 | 0.030 | 0.038 |
| b | 0.30 TYP | | 0.012 TYP | |
| c | 0.15 TYP | | 0.006 TYP | |
| D | 2.900 | 3.100 | 0.114 | 0.122 |
| e | 0.65 TYP | | 0.026 TYP | |
| E | 2.900 | 3.100 | 0.114 | 0.122 |
| E1 | 4.700 | 5.100 | 0.185 | 0.201 |
| L | 0.410 | 0.650 | 0.016 | 0.026 |
| θ | 0° | 6° | 0° | 6° |

## 5.2 DFN-8(3x3) (Package Outline Dimensions)




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.700 | 0.800 | 0.028 | 0.031 |
| A1 | 0.000 | 0.050 | 0.000 | 0.002 |
| A2 | 0.203 REF | | 0.008 REF | |
| D | 2.900 | 3.100 | 0.114 | 0.122 |
| D1 | 2.200 | 2.400 | 0.087 | 0.094 |
| E | 2.900 | 3.100 | 0.114 | 0.122 |
| E1 | 1.400 | 1.600 | 0.055 | 0.063 |
| k | 0.200 MIN | | 0.008 MIN | |
| b | 1.800 | 2.000 | 0.007 | 0.012 |
| e | 0.650 TYP | | 0.026 TYP | |
| L | 0.375 | 0.575 | 0.015 | 0.023 |