# Zero-Drift, Single-Supply, Rail-to-Rail Input/Output Operational Amplifier

Data Sheet **AD8629-EP**

## FEATURES

**Lowest auto-zero amplifier noise**
**Low offset voltage: 1 µV typical**
**Input offset drift: 0.002 µV/°C typical**
**Rail-to-rail input and output swing**
**5 V single-supply operation**
**High gain, CMRR, and PSRR: 130 dB**
**Very low input bias current: 100 pA maximum**
**Low supply current: 1.0 mA**
**Overload recovery time: 50 µs**
**No external components required**

## ENHANCED PRODUCT FEATURES

**Supports defense and aerospace applications (AQEC standard)**
**Extended temperature range: −55°C to +125°C**
**Controlled manufacturing baseline**
**One assembly/test site**
**One fabrication site**
**Enhanced product change notification**
**Qualification data available on request**

## APPLICATIONS

**Pressure and position sensors**
**Strain gage amplifiers**
**Medical instrumentation**
**Thermocouple amplifiers**
**Precision current sensing**
**Photodiode amplifiers**

## PIN CONFIGURATION

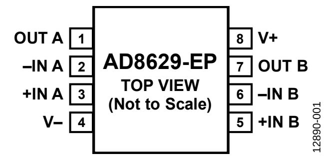


*Figure 1. 8-Lead SOIC_N (R-8)*

## GENERAL DESCRIPTION

The AD8629-EP amplifier has ultralow offset, drift, and bias current. The device is a wide bandwidth auto-zero amplifier featuring rail-to-rail input and output swing and low noise. Operation is fully specified from 2.7 V to 5 V single supply (±1.35 V to ±2.5 V dual supply).

The AD8629-EP provides benefits previously found only in expensive auto-zeroing or chopper-stabilized amplifiers. Using Analog Devices, Inc., topology, this zero-drift amplifier combines low cost with high accuracy and low noise. No external capacitor is required. In addition, the AD8629-EP greatly reduces the digital switching noise found in most chopper-stabilized amplifiers.

With an offset voltage of only 1 µV, drift of less than 0.05 µV/°C, and noise of only 0.5 µV p-p (0 Hz to 10 Hz), the AD8629-EP is suited for applications where error sources cannot be tolerated. Position and pressure sensors, medical equipment, and strain gage amplifiers benefit greatly from nearly zero drift over the operating temperature range. Many systems can take advantage of the rail-to-rail input and output swings provided by the AD8629-EP to reduce input biasing complexity and maximize SNR.

The AD8629-EP is specified for the extended industrial temperature range (−55°C to +125°C). The AD8629-EP is available in a standard 8-lead narrow SOIC plastic package.


**Rev. A** **Document Feedback**




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**8/15—Rev. 0 to Rev. A**

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**6/15—Revision 0: Initial Version**

# SPECIFICATIONS

## ELECTRICAL CHARACTERISTICS—$V_S$ = 5.0 V

$V_S$ = 5.0 V, $V_{CM}$ = 2.5 V, $T_A$ = 25°C, unless otherwise noted.

**Table 1.**

| Parameter | Symbol | Test Conditions/Comments | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| INPUT CHARACTERISTICS | | | | | | |
| Offset Voltage | $V_{OS}$ | | | 1 | 5 | μV |
| | | −55°C ≤ $T_A$ ≤ +125°C | | | 15 | μV |
| Input Bias Current | $I_B$ | | | 30 | 100 | pA |
| | | −55°C ≤ $T_A$ ≤ +125°C | | | 1.5 | nA |
| Input Offset Current | $I_{OS}$ | | | 50 | 200 | pA |
| | | −55°C ≤ $T_A$ ≤ +125°C | | | 250 | pA |
| Input Voltage Range | | | 0 | | 5 | V |
| Common-Mode Rejection Ratio | CMRR | $V_{CM}$ = 0 V to 5 V | 120 | 140 | | dB |
| | | −55°C ≤ $T_A$ ≤ +125°C | 115 | 130 | | dB |
| Large Signal Voltage Gain | $A_{VO}$ | $R_L$ = 10 kΩ, $V_O$ = 0.3 V to 4.7 V | 125 | 145 | | dB |
| | | −55°C ≤ $T_A$ ≤ +125°C | 120 | 135 | | dB |
| Offset Voltage Drift | $\Delta V_{OS}/\Delta T$ | −55°C ≤ $T_A$ ≤ +125°C | | 0.008 | 0.05 | μV/°C |
| OUTPUT CHARACTERISTICS | | | | | | |
| Output Voltage High | $V_{OH}$ | $R_L$ = 100 kΩ to ground | 4.99 | 4.996 | | V |
| | | −55°C ≤ $T_A$ ≤ +125°C | 4.99 | 4.995 | | V |
| | | $R_L$ = 10 kΩ to ground | 4.95 | 4.98 | | V |
| | | −55°C ≤ $T_A$ ≤ +125°C | 4.95 | 4.97 | | V |
| Output Voltage Low | $V_{OL}$ | $R_L$ = 100 kΩ to V+ | | 1 | 5 | mV |
| | | −55°C ≤ $T_A$ ≤ +125°C | | 2 | 5 | mV |
| | | $R_L$ = 10 kΩ to V+ | | 10 | 20 | mV |
| | | −55°C ≤ $T_A$ ≤ +125°C | | 15 | 20 | mV |
| Short-Circuit Limit | $I_{SC}$ | | ±25 | ±50 | | mA |
| | | −55°C ≤ $T_A$ ≤ +125°C | | ±40 | | mA |
| Output Current | $I_O$ | | | ±30 | | mA |
| | | −55°C ≤ $T_A$ ≤ +125°C | | ±15 | | mA |
| POWER SUPPLY | | | | | | |
| Power Supply Rejection Ratio | PSRR | $V_S$ = 2.7 V to 5.5 V, −55°C ≤ $T_A$ ≤ +125°C | 115 | 130 | | dB |
| Supply Current per Amplifier | $I_{SY}$ | $V_O$ = $V_S$/2 | | 0.85 | 1.1 | mA |
| | | −55°C ≤ $T_A$ ≤ +125°C | | 1.0 | 1.2 | mA |
| INPUT CAPACITANCE | $C_{IN}$ | | | | | |
| Differential | | | | 1.5 | | pF |
| Common Mode | | | | 8.0 | | pF |
| DYNAMIC PERFORMANCE | | | | | | |
| Slew Rate | SR | $R_L$ = 10 kΩ | | 1.0 | | V/μs |
| Overload Recovery Time | | | | 0.05 | | ms |
| Gain Bandwidth Product | GBP | | | 2.5 | | MHz |
| NOISE PERFORMANCE | | | | | | |
| Voltage Noise | $e_n$ p-p | 0.1 Hz to 10 Hz | | 0.5 | | μV p-p |
| | | 0.1 Hz to 1.0 Hz | | 0.16 | | μV p-p |
| Voltage Noise Density | $e_n$ | f = 1 kHz | | 22 | | nV/√Hz |
| Current Noise Density | $i_n$ | f = 10 Hz | | 5 | | fA/√Hz |

## ELECTRICAL CHARACTERISTICS—$V_S$ = 2.7 V

$V_S$ = 2.7 V, $V_{CM}$ = 1.35 V, $V_O$ = 1.4 V, $T_A$ = 25°C, unless otherwise noted.

**Table 2.**

| Parameter | Symbol | Test Conditions/Comments | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| INPUT CHARACTERISTICS | | | | | | |
| Offset Voltage | $V_{OS}$ | | | 1 | 5 | μV |
| | | −55°C ≤ $T_A$ ≤ +125°C | | | 15 | μV |
| Input Bias Current | $I_B$ | | | 30 | 100 | pA |
| | | −55°C ≤ $T_A$ ≤ +125°C | | 1.0 | 1.5 | nA |
| Input Offset Current | $I_{OS}$ | | | 50 | 200 | pA |
| | | −55°C ≤ $T_A$ ≤ +125°C | | | 250 | pA |
| Input Voltage Range | | | 0 | | 2.7 | V |
| Common-Mode Rejection Ratio | CMRR | $V_{CM}$ = 0 V to 2.7 V | 115 | 130 | | dB |
| | | −55°C ≤ $T_A$ ≤ +125°C | 110 | 120 | | dB |
| Large Signal Voltage Gain | $A_{VO}$ | $R_L$ = 10 kΩ, $V_O$ = 0.3 V to 2.4 V | 110 | 140 | | dB |
| | | −55°C ≤ $T_A$ ≤ +125°C | 105 | 130 | | dB |
| Offset Voltage Drift | $\Delta V_{OS}/\Delta T$ | −55°C ≤ $T_A$ ≤ +125°C | | 0.002 | 0.05 | μV/°C |
| OUTPUT CHARACTERISTICS | | | | | | |
| Output Voltage High | $V_{OH}$ | $R_L$ = 100 kΩ to ground | 2.68 | 2.695 | | V |
| | | −55°C ≤ $T_A$ ≤ +125°C | 2.68 | 2.695 | | V |
| | | $R_L$ = 10 kΩ to ground | 2.67 | 2.68 | | V |
| | | −55°C ≤ $T_A$ ≤ +125°C | 2.67 | 2.675 | | V |
| Output Voltage Low | $V_{OL}$ | $R_L$ = 100 kΩ to V+ | | 1 | 5 | mV |
| | | −55°C ≤ $T_A$ ≤ +125°C | | 2 | 5 | mV |
| | | $R_L$ = 10 kΩ to V+ | | 10 | 20 | mV |
| | | −55°C ≤ $T_A$ ≤ +125°C | | 15 | 20 | mV |
| Short-Circuit Limit | $I_{SC}$ | | ±10 | ±15 | | mA |
| | | −55°C ≤ $T_A$ ≤ +125°C | | ±10 | | mA |
| Output Current | $I_O$ | | | ±10 | | mA |
| | | −55°C ≤ $T_A$ ≤ +125°C | | ±5 | | mA |
| POWER SUPPLY | | | | | | |
| Power Supply Rejection Ratio | PSRR | $V_S$ = 2.7 V to 5.5 V, −55°C ≤ $T_A$ ≤ +125°C | 115 | 130 | | dB |
| Supply Current per Amplifier | $I_{SY}$ | $V_O$ = $V_S$/2 | | 0.75 | 1.0 | mA |
| | | −55°C ≤ $T_A$ ≤ +125°C | | 0.9 | 1.2 | mA |
| INPUT CAPACITANCE | $C_{IN}$ | | | | | |
| Differential | | | | 1.5 | | pF |
| Common Mode | | | | 8.0 | | pF |
| DYNAMIC PERFORMANCE | | | | | | |
| Slew Rate | SR | $R_L$ = 10 kΩ | | 1 | | V/μs |
| Overload Recovery Time | | | | 0.05 | | ms |
| Gain Bandwidth Product | GBP | | | 2 | | MHz |
| NOISE PERFORMANCE | | | | | | |
| Voltage Noise | $e_n$ p-p | 0.1 Hz to 10 Hz | | 0.5 | | μV p-p |
| Voltage Noise Density | $e_n$ | f = 1 kHz | | 22 | | nV/√Hz |
| Current Noise Density | $i_n$ | f = 10 Hz | | 5 | | fA/√Hz |

# ABSOLUTE MAXIMUM RATINGS

**Table 3.**

| Parameter | Rating |
|---|---|
| Supply Voltage | 6 V |
| Input Voltage | GND − 0.3 V to $V_S$ + 0.3 V |
| Differential Input Voltage[1] | ±5.0 V |
| Output Short-Circuit Duration to GND | Indefinite |
| Storage Temperature Range | −65°C to +150°C |
| Operating Temperature Range | −55°C to +125°C |
| Junction Temperature Range | −65°C to +150°C |
| Lead Temperature (Soldering, 60 sec) | 300°C |
| ESD | |
| HBM 8-Lead SOIC_N | ±4000 V |
| FICDM 8-Lead SOIC_N | ±1250 V |

[1] The differential input voltage is limited to ±5 V or the supply voltage, whichever is less.

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

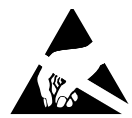
## THERMAL CHARACTERISTICS

$\theta_{JA}$ is specified for worst-case conditions, that is, $\theta_{JA}$ is specified for the device soldered in a circuit board for surface-mount packages. This was measured using a standard two-layer board.

**Table 4.**

| Package Type | $\theta_{JA}$ | $\theta_{JC}$ | Unit |
|---|---|---|---|
| 8-Lead SOIC_N (R-8) | 158 | 43 | °C/W |

## 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.

# TYPICAL PERFORMANCE CHARACTERISTICS

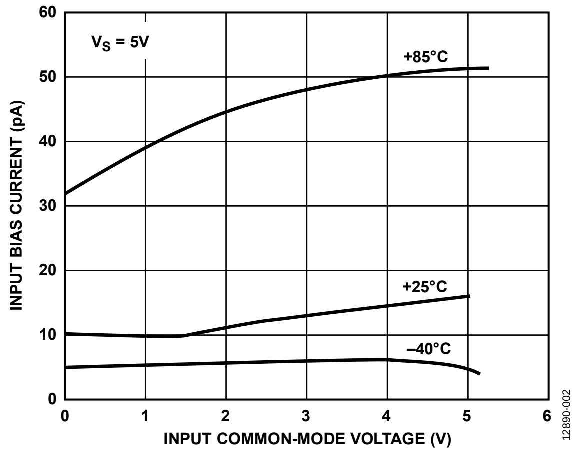



*Figure 2. Input Bias Current vs. Input Common-Mode Voltage*

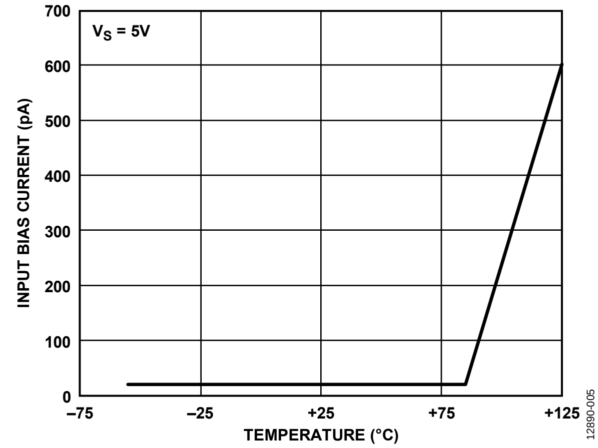



*Figure 5. Input Bias Current vs. Temperature*

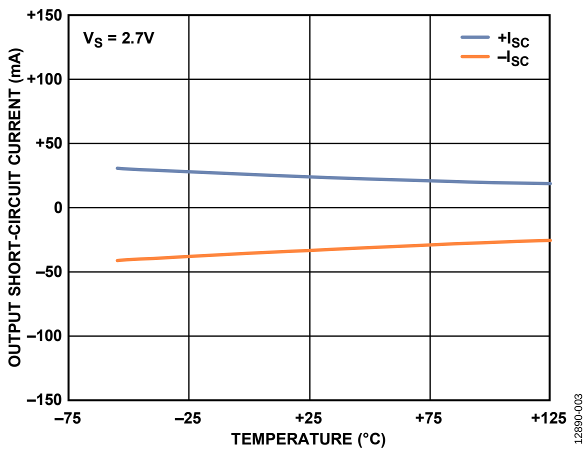



*Figure 3. Output Short-Circuit Current vs. Temperature (2.7 V)*

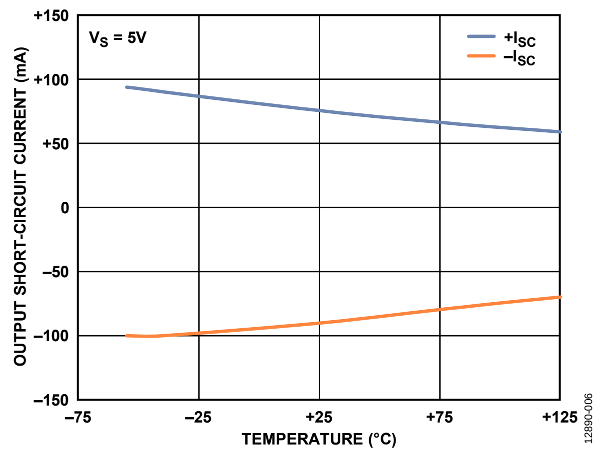



*Figure 6. Output Short-Circuit Current vs. Temperature (5 V)*

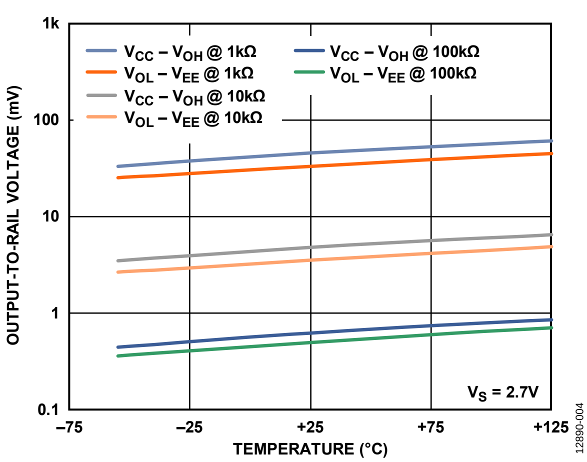



*Figure 4. Output-to-Rail Voltage vs. Temperature (2.7 V)*

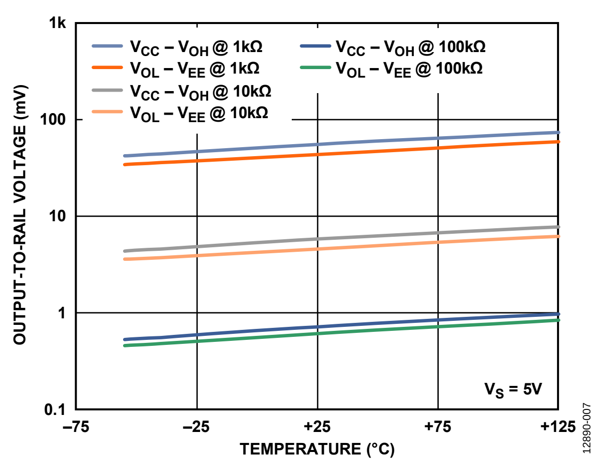



*Figure 7. Output-to-Rail Voltage vs. Temperature (5 V)*

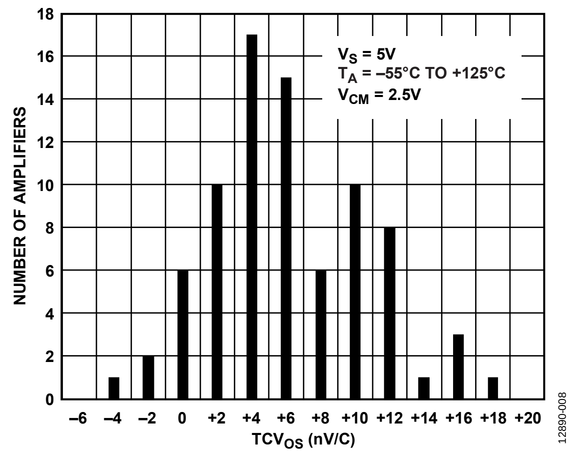



Figure 8. Input Offset Voltage Drift Distribution

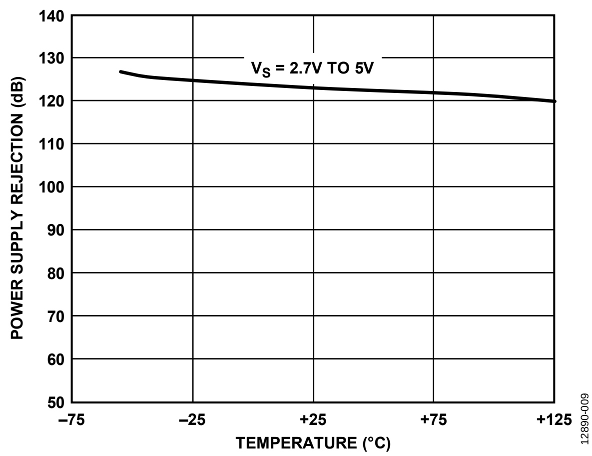



Figure 9. Power Supply Rejection vs. Temperature

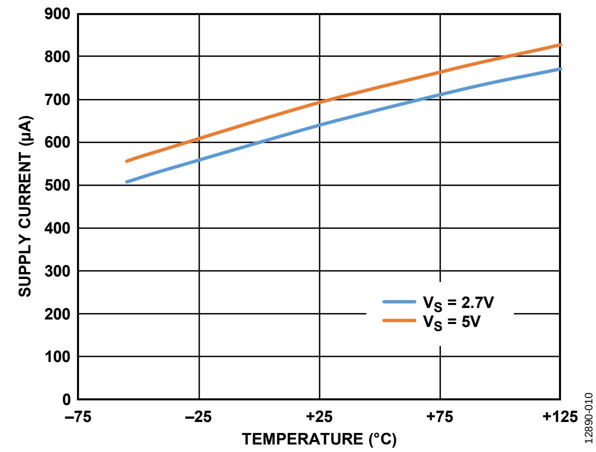



Figure 10. Supply Current vs. Temperature

# OUTLINE DIMENSIONS

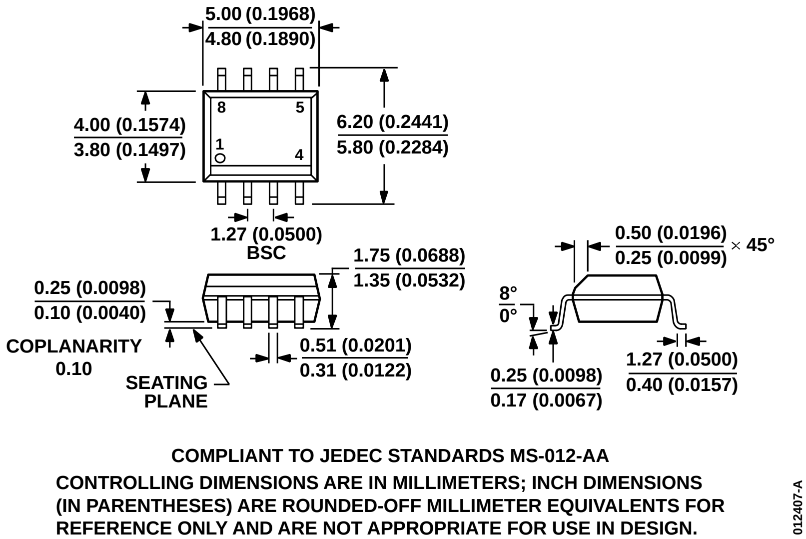



*Figure 11. 8-Lead Standard Small Outline Package [SOIC_N]*
*Narrow Body*
*(R-8)*
*Dimensions shown in millimeters and (inches)*

## ORDERING GUIDE

| Model[1] | Temperature Range | Package Description | Package Option |
|---|---|---|---|
| AD8629TRZ-EP | −55°C to +125°C | 8-Lead Standard Small Outline Package [SOIC_N] | R-8 |
| AD8629TRZ-EP-R7 | −55°C to +125°C | 8-Lead Standard Small Outline Package [SOIC_N] | R-8 |

[1] Z = RoHS Compliant Part.