# Precision, Very Low Noise, Low Input Bias Current Operational Amplifiers

## AD8671/AD8672/AD8674

### FEATURES

**Very low noise: 2.8 nV/√Hz, 77 nV p-p**
**Wide bandwidth: 10 MHz**
**Low input bias current: 12 nA max**
**Low offset voltage: 75 µV max**
**High open-loop gain: 120 dB min**
**Low supply current: 3 mA per amplifier**
**Dual-supply operation: ±5 V to ±15 V**
**Unity-gain stable**
**No phase reversal**

### APPLICATIONS

**PLL filters**
**Filters for GPS**
**Instrumentation**
**Sensors and controls**
**Professional quality audio**

### GENERAL DESCRIPTION

The AD8671/AD8672/AD8674 are very high precision amplifiers featuring very low noise, very low offset voltage and drift, low input bias current, 10 MHz bandwidth, and low power consumption. Outputs are stable with capacitive loads of over 1000 pF. Supply current is less than 3 mA per amplifier at 30 V.

The AD8671/AD8672/AD8674's combination of ultralow noise, high precision, speed, and stability is unmatched. The MSOP version of the AD8671/AD8672 requires only half the board space of comparable amplifiers.

Applications for these amplifiers include high quality PLL filters, precision filters, medical and analytical instrumentation, precision power supply controls, ATE, data acquisition, and precision controls as well as professional quality audio.

The AD8671/AD8672/AD8674 are specified over the extended industrial temperature range (–40°C to +125°C).

The AD8671/AD8672 are available in the 8-lead SOIC and 8-lead MSOP packages. The AD8674 is available in 14-lead SOIC and 14-lead TSSOP packages.

Surface-mount devices in MSOP packages are available in tape and reel only.

### PIN CONFIGURATIONS

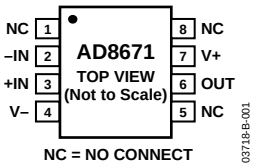



*Figure 1. 8-Lead SOIC_N (R-8)*

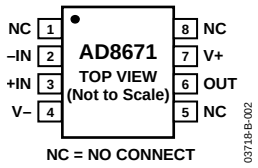



*Figure 2. 8-Lead MSOP (RM-8)*

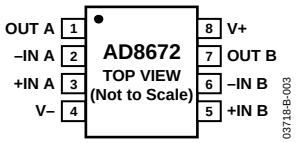



*Figure 3. 8-Lead SOIC-N (R-8)*

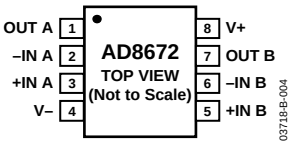



*Figure 4. 8-Lead MSOP (RM-8)*

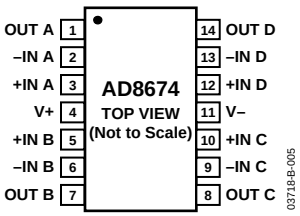



*Figure 5. 14-Lead SOIC_N (R-14)*

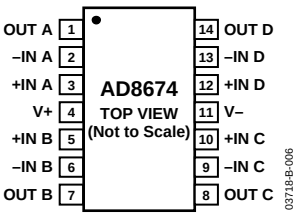



*Figure 6. 14-Lead TSSOP (RU-14)*

# SPECIFICATIONS

## ELECTRICAL CHARACTERISTICS, ±5.0 V

$V_S$ = ±5.0 V, $V_{CM}$ = 0 V, $T_A$ = 25°C, unless otherwise noted.

**Table 1.**

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| INPUT CHARACTERISTICS | | | | | | |
| Offset Voltage | $V_{OS}$ | | | 20 | 75 | μV |
| | | –40°C < $T_A$ < +125°C | | 30 | 125 | μV |
| Offset Voltage Drift | $\Delta V_{OS}/\Delta T$ | –40°C < $T_A$ < +125°C | | | | |
| AD8671 | | | | 0.3 | 0.5 | μV/°C |
| AD8672/AD8674 | | | | 0.3 | 0.8 | μV/°C |
| Input Bias Current | $I_B$ | | –12 | +3 | +12 | nA |
| | | +25°C < $T_A$ < +125°C | –20 | +5 | +20 | nA |
| | | –40°C < $T_A$ < +125°C | –40 | +8 | +40 | nA |
| Input Offset Current | $I_{OS}$ | | –12 | +6 | +12 | nA |
| | | +25°C < $T_A$ < +125°C | –20 | +6 | +20 | nA |
| | | –40°C < $T_A$ < +125°C | –40 | +8 | +40 | nA |
| Input Voltage Range | | | –2.5 | | +2.5 | V |
| Common-Mode Rejection Ratio | CMRR | $V_{CM}$ = –2.5 V to +2.5 V | 100 | 120 | | dB |
| Large Signal Voltage Gain | $A_{VO}$ | $R_L$ = 2 kΩ, $V_O$ = –3 V to +3 V | 1000 | 6000 | | V/mV |
| Input Capacitance, Common Mode | $C_{INCM}$ | | | 6.25 | | pF |
| Input Capacitance, Differential Mode | $C_{INDM}$ | | | 7.5 | | pF |
| Input Resistance, Common Mode | $R_{IN}$ | | | 3.5 | | GΩ |
| Input Resistance, Differential Mode | $R_{INDM}$ | | | 15 | | MΩ |
| OUTPUT CHARACTERISTICS | | | | | | |
| Output Voltage High | $V_{OH}$ | $R_L$ = 2 kΩ, –40°C to +125°C | +3.8 | +4.0 | | V |
| Output Voltage Low | $V_{OL}$ | $R_L$ = 2 kΩ, –40°C to +125°C | | –3.9 | –3.8 | V |
| Output Voltage High | $V_{OH}$ | $R_L$ = 600 Ω | +3.7 | +3.9 | | V |
| Output Voltage Low | $V_{OL}$ | $R_L$ = 600 Ω | | –3.8 | –3.7 | V |
| Output Current | $I_{OUT}$ | | | ±10 | | mA |
| POWER SUPPLY | | | | | | |
| Power Supply Rejection Ratio | PSRR | $V_S$ = ±4 V to ±18 V | | | | |
| AD8671/AD8672 | | | 110 | 130 | | dB |
| AD8674 | | | 106 | 115 | | dB |
| Supply Current/Amplifier | $I_{SY}$ | $V_O$ = 0 V | | 3 | 3.5 | mA |
| | | –40°C < $T_A$ < +125°C | | | 4.2 | mA |
| DYNAMIC PERFORMANCE | | | | | | |
| Slew Rate | SR | $R_L$ = 2 kΩ | | 4 | | V/μs |
| Settling Time | $t_S$ | To 0.1% (4 V step, G = 1) | | 1.4 | | μs |
| | | To 0.01% (4 V step, G = 1) | | 5.1 | | μs |
| Gain Bandwidth Product | GBP | | | 10 | | MHz |
| NOISE PERFORMANCE | | | | | | |
| Peak-to-Peak Noise | $e_{n\ p\text{-}p}$ | 0.1 Hz to 10 Hz | | 77 | 100 | nV p-p |
| Voltage Noise Density | $e_n$ | f = 1 kHz | | 2.8 | 3.8 | nV/√Hz |
| Current Noise Density | $i_n$ | f = 1 kHz | | 0.3 | | pA/√Hz |
| Channel Separation | | | | | | |
| AD8672/AD8674 | $C_S$ | f = 1 kHz | | –130 | | dB |
| | | f = 10 kHz | | –105 | | dB |

## ELECTRICAL CHARACTERISTICS, ±15 V

$V_S$ = ±15 V, $V_{CM}$ = 0 V, $T_A$ = 25°C, unless otherwise noted.

**Table 2.**

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| INPUT CHARACTERISTICS | | | | | | |
| Offset Voltage | $V_{OS}$ | | | 20 | 75 | µV |
| | | −40°C < $T_A$ < +125°C | | 30 | 125 | µV |
| Offset Voltage Drift | $\Delta V_{OS}/\Delta T$ | −40°C < $T_A$ < +125°C | | | | |
| AD8671 | | | | 0.3 | 0.5 | µV/°C |
| AD8672/AD8674 | | | | 0.3 | 0.8 | µV/°C |
| Input Bias Current | $I_B$ | | −12 | +3 | +12 | nA |
| | | +25°C < $T_A$ < +125°C | −20 | +5 | +20 | nA |
| | | −40°C < $T_A$ < +125°C | −40 | +8 | +40 | nA |
| Input Offset Current | $I_{OS}$ | | −12 | +6 | +12 | nA |
| | | +25°C < $T_A$ < +125°C | −20 | +6 | +20 | nA |
| | | −40°C < $T_A$ < +125°C | −40 | +8 | +40 | nA |
| Input Voltage Range | | | −12 | | +12 | V |
| Common-Mode Rejection Ratio | CMRR | $V_{CM}$ = −12 V to +12 V | 100 | 120 | | dB |
| Large Signal Voltage Gain | $A_{VO}$ | $R_L$ = 2 kΩ, $V_O$ = −10 V to +10 V | 1000 | 6000 | | V/mV |
| Input Capacitance, Common Mode | $C_{INCM}$ | | | 6.25 | | pF |
| Input Capacitance, Differential Mode | $C_{INDM}$ | | | 7.5 | | pF |
| Input Resistance, Common Mode | $R_{IN}$ | | | 3.5 | | GΩ |
| Input Resistance, Differential Mode | $R_{INDM}$ | | | 15 | | MΩ |
| OUTPUT CHARACTERISTICS | | | | | | |
| Output Voltage High | $V_{OH}$ | $R_L$ = 2 kΩ, −40°C to +125°C | +13.2 | +13.8 | | V |
| Output Voltage Low | $V_{OL}$ | $R_L$ = 2 kΩ, −40°C to +125°C | | −13.8 | −13.2 | V |
| Output Voltage High | $V_{OH}$ | $R_L$ = 600 Ω | +11 | +12.3 | | V |
| Output Voltage Low | $V_{OL}$ | $R_L$ = 600 Ω | | −12.4 | −11 | V |
| Output Current | $I_{OUT}$ | | | ±20 | | mA |
| Short Circuit Current | $I_{SC}$ | | | ±30 | | mA |
| POWER SUPPLY | | | | | | |
| Power Supply Rejection Ratio | PSRR | $V_S$ = ±4 V to ±18 V | | | | |
| AD8671/AD8672 | | | 110 | 130 | | dB |
| AD8674 | | | 106 | 115 | | dB |
| Supply Current/Amplifier | $I_{SY}$ | $V_O$ = 0 V | | 3 | 3.5 | mA |
| | | −40°C < $T_A$ < +125°C | | | 4.2 | mA |
| DYNAMIC PERFORMANCE | | | | | | |
| Slew Rate | SR | $R_L$ = 2 kΩ | | 4 | | V/µs |
| Settling Time | $t_S$ | To 0.1% (10 V step, G = 1) | | 2.2 | | µs |
| | | To 0.01% (10 V step, G = 1) | | 6.3 | | µs |
| Gain Bandwidth Product | GBP | | | 10 | | MHz |
| NOISE PERFORMANCE | | | | | | |
| Peak-to-Peak Noise | $e_{n\ p\text{-}p}$ | 0.1 Hz to 10 Hz | | 77 | 100 | nV p-p |
| Voltage Noise Density | $e_n$ | f = 1 kHz | | 2.8 | 3.8 | nV/√Hz |
| Current Noise Density | $i_n$ | f = 1 kHz | | 0.3 | | pA/√Hz |
| Channel Separation | | | | | | |
| AD8672/AD8674 | $C_S$ | f = 1 kHz | | −130 | | dB |
| | | f = 10 kHz | | −105 | | dB |

# ABSOLUTE MAXIMUM RATINGS

**Table 3.**[1]

| Parameter | Rating |
|---|---|
| Supply Voltage | 36 V |
| Input Voltage | $V_S-$ to $V_S+$ |
| Differential Input Voltage | ±0.7 V |
| Output Short-Circuit Duration | Indefinite |
| Storage Temperature Range | |
| All Packages | –65°C to +150°C |
| Operating Temperature Range | |
| All Packages | –40°C to +125°C |
| Junction Temperature Range | |
| All Packages | –65°C to +150°C |
| Lead Temperature Range (Soldering, 60 sec) | 300°C |

[1] Absolute maximum ratings apply at 25°C, unless otherwise noted.

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.

**Table 4. Package Characteristics**

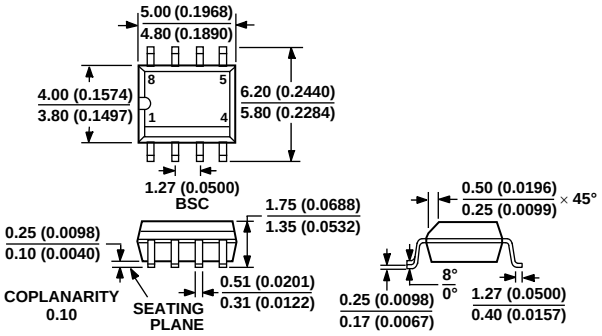
| Package Type | $\theta_{JA}$[1] | $\theta_{JC}$ | Unit |
|---|---|---|---|
| 8-Lead MSOP (RM) | 190 | 44 | °C/W |
| 8-Lead SOIC_N (R) | 158 | 43 | °C/W |
| 14-Lead SOIC_N (R) | 120 | 36 | °C/W |
| 14-Lead TSSOP (RU) | 180 | 35 | °C/W |

[1] $\theta_{JA}$ is specified for the worst-case conditions, that is., $\theta_{JA}$ is specified for the device soldered in circuit board for surface-mount packages.

## 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.

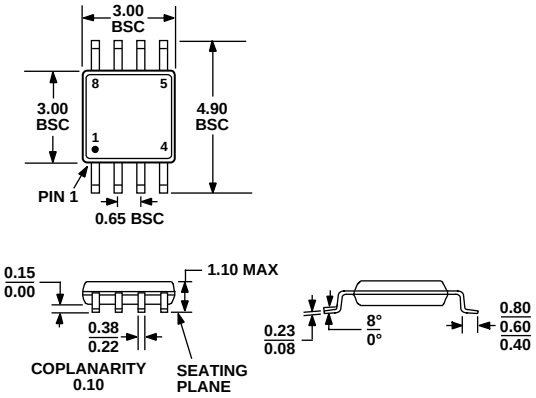
# OUTLINE DIMENSIONS




COMPLIANT TO JEDEC STANDARDS MS-012-AA

CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN

*Figure 43. 8-Lead Standard Small Outline Package [SOIC_N]*
*Narrow Body*
*(R-8)*
*Dimensions shown in millimeters and (inches)*




COMPLIANT TO JEDEC STANDARDS MO-187-AA

*Figure 44. 8-Lead Mini Small Outline Package [MSOP]*
*(RM-8)*
*Dimensions shown in millimeters*

## ORDERING GUIDE

| Model | Temperature Range | Package Description | Package Option | Branding |
|---|---|---|---|---|
| AD8671AR | –40°C to +125°C | 8-Lead SOIC_N | R-8 | |
| AD8671AR-REEL | –40°C to +125°C | 8-Lead SOIC_N | R-8 | |
| AD8671AR-REEL7 | –40°C to +125°C | 8-Lead SOIC_N | R-8 | |
| AD8671ARZ[1] | –40°C to +125°C | 8-Lead SOIC_N | R-8 | |
| AD8671ARZ-REEL[1] | –40°C to +125°C | 8-Lead SOIC_N | R-8 | |
| AD8671ARZ-REEL7[1] | –40°C to +125°C | 8-Lead SOIC_N | R-8 | |
| AD8671ARM-R2 | –40°C to +125°C | 8-Lead MSOP | RM-8 | BGA |
| AD8671ARM-REEL | –40°C to +125°C | 8-Lead MSOP | RM-8 | BGA |
| AD8671ARMZ-R2[1] | –40°C to +125°C | 8-Lead MSOP | RM-8 | A0V |
| AD8671ARMZ-REEL[1] | –40°C to +125°C | 8-Lead MSOP | RM-8 | A0V |
| AD8672AR | –40°C to +125°C | 8-Lead SOIC_N | R-8 | |
| AD8672AR-REEL | –40°C to +125°C | 8-Lead SOIC_N | R-8 | |
| AD8672AR-REEL7 | –40°C to +125°C | 8-Lead SOIC_N | R-8 | |
| AD8672ARZ[1] | –40°C to +125°C | 8-Lead SOIC_N | R-8 | |
| AD8672ARZ-REEL[1] | –40°C to +125°C | 8-Lead SOIC_N | R-8 | |
| AD8672ARZ-REEL7[1] | –40°C to +125°C | 8-Lead SOIC_N | R-8 | |
| AD8672ARM-R2 | –40°C to +125°C | 8-Lead MSOP | RM-8 | BHA |
| AD8672ARM-REEL | –40°C to +125°C | 8-Lead MSOP | RM-8 | BHA |
| AD8672ARMZ-R2[1] | –40°C to +125°C | 8-Lead MSOP | RM-8 | A0W |
| AD8672ARMZ-REEL[1] | –40°C to +125°C | 8-Lead MSOP | RM-8 | A0W |
| AD8674AR | –40°C to +125°C | 14-Lead SOIC_N | R-14 | |
| AD8674AR-REEL | –40°C to +125°C | 14-Lead SOIC_N | R-14 | |
| AD8674AR-REEL7 | –40°C to +125°C | 14-Lead SOIC_N | R-14 | |
| AD8674ARZ[1] | –40°C to +125°C | 14-Lead SOIC_N | R-14 | |
| AD8674ARZ-REEL[1] | –40°C to +125°C | 14-Lead SOIC_N | R-14 | |
| AD8674ARZ-REEL7[1] | –40°C to +125°C | 14-Lead SOIC_N | R-14 | |
| AD8674ARU | –40°C to +125°C | 14-Lead TSSOP | RU-14 | |
| AD8674ARU-REEL | –40°C to +125°C | 14-Lead TSSOP | RU-14 | |
| AD8674ARUZ[1] | –40°C to +125°C | 14-Lead TSSOP | RU-14 | |
| AD8674ARUZ-REEL[1] | –40°C to +125°C | 14-Lead TSSOP | RU-14 | |

[1] Z = Pb-free part.