

### FEATURES

**Very low voltage noise:** 2.8 nV/ $\sqrt{\text{Hz}}$   
**Rail-to-rail output swing**  
**Low input bias current:** 2 nA maximum  
**Very low offset voltage:** 75  $\mu\text{V}$  maximum  
**Low input offset drift:** 0.6  $\mu\text{V}/^\circ\text{C}$  maximum  
**Very high gain:** 120 dB  
**Wide bandwidth:** 10 MHz typical  
 **$\pm 5\text{ V}$  to  $\pm 18\text{ V}$  operation**

### APPLICATIONS

**Precision instrumentation**  
**PLL filters**  
**Laser diode control loops**  
**Strain gage amplifiers**  
**Medical instrumentation**  
**Thermocouple amplifiers**

### GENERAL DESCRIPTION

The AD8675 precision operational amplifier has ultralow offset, drift, and voltage noise combined with very low input bias currents over the full operating temperature range. The AD8675 is a precision, wide bandwidth op amp featuring rail-to-rail output swings and very low noise. Operation is fully specified from  $\pm 5\text{ V}$  to  $\pm 15\text{ V}$ .

The AD8675 features a rail-to-rail output like that of the [OP184](#), but with wide bandwidth and even lower voltage noise, combined with the precision and low power consumption like that of the industry-standard OP07 amplifier. Unlike other low noise, rail-to-rail op amps, the AD8675 has very low input bias current and low input current noise.

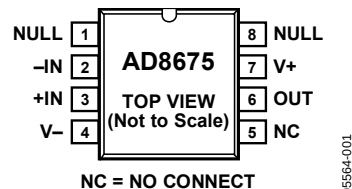
With typical offset voltage of only 10  $\mu\text{V}$ , offset drift of 0.2  $\mu\text{V}/^\circ\text{C}$ , and noise of only 0.10  $\mu\text{V}$  p-p (0.1 Hz to 10 Hz), the AD8675 is perfectly suited for applications where large error sources cannot be tolerated. For applications with even lower offset tolerances, the proprietary nulling capability allows a combination of both device and system offset errors up to 3.5 mV (referred

to the input) to be compensated externally. Unlike previous circuits, the AD8675 accommodates this adjustment without adversely affecting the offset drift, CMRR, and PSRR of the amplifier. Precision instrumentation, PLL, and other precision filter circuits, position and pressure sensors, medical instrumentation, and strain gage amplifiers benefit greatly from the very low noise, low input bias current, and wide bandwidth. Many systems can take advantage of the low noise, dc precision, and rail-to-rail output swing provided by the AD8675 to maximize SNR and dynamic range.

The smaller packages and low power consumption afforded by the AD8675 allow maximum channel density or minimum board size for space-critical equipment.

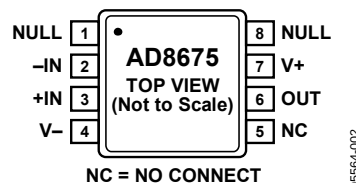
The AD8675 is specified for the extended industrial temperature range ( $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ ). The AD8675 amplifier is available in the tiny 8-lead MSOP, and the popular 8-lead, narrow SOIC, RoHS compliant packages. MSOP packaged devices are only available in tape and reel format.

### PIN CONFIGURATIONS



NC = NO CONNECT

Figure 1. 8-Lead SOIC\_N (R-8)



NC = NO CONNECT

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

#### Rev. A

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REVISION HISTORY

- 4/07—Rev. 0 to Rev. A
- Inserted Figure 7 and Figure 8;  
renumbered sequentially ..... 6
- 10/05—Revision 0: Initial Version

# SPECIFICATIONS

## ELECTRICAL SPECIFICATIONS

$V_S = \pm 5.0\text{ V}$ ,  $V_{CM} = 0\text{ V}$ ,  $V_O = 0\text{ V}$ ,  $T_A = +25^\circ\text{C}$ , unless otherwise specified.

Table 1.

| Parameter                    | Symbol                   | Conditions                                                                                                                             | Min          | Typ            | Max            | Unit                         |
|------------------------------|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------|----------------|------------------------------|
| INPUT CHARACTERISTICS        |                          |                                                                                                                                        |              |                |                |                              |
| Offset Voltage               | $V_{OS}$                 | $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                                   |              | 10<br>12       | 75<br>240      | $\mu\text{V}$                |
| Input Bias Current           | $I_B$                    | $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                                   | -2           | 0.5            | 2              | nA                           |
| Input Offset Current         | $I_{OS}$                 | $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                                   | -5.5         | -2             | 5.5            | nA                           |
| Input Voltage Range          |                          | $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                                   | -1           | 0.1            | 1              | nA                           |
| Common-Mode Rejection Ratio  | CMRR                     | $V_{CM} = -3.5\text{ V to } +3.5\text{ V}$<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                     | -2.8         | 0.1            | 2.8            | nA                           |
| Open-Loop Gain               | $A_{VO}$                 | $R_L = 2\text{ k}\Omega$ to ground,<br>$V_O = -4.0\text{ V to } +4.0\text{ V}$<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ | -3.5         |                | 3.5            | V                            |
| Offset Voltage Drift         | $\Delta V_{OS}/\Delta T$ | $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                                   | 105          | 130            |                | dB                           |
|                              |                          |                                                                                                                                        | 105          | 130            |                | dB                           |
|                              |                          |                                                                                                                                        | 1000         | 2000           |                | V/mV                         |
|                              |                          |                                                                                                                                        | 700          | 1250           |                | V/mV                         |
|                              |                          |                                                                                                                                        |              | 0.2            | 0.6            | $\mu\text{V}/^\circ\text{C}$ |
| OUTPUT CHARACTERISTICS       |                          |                                                                                                                                        |              |                |                |                              |
| Output Voltage High          | $V_{OH}$                 | $R_L = 2\text{ k}\Omega$ to ground<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                             | 4.86<br>4.82 | 4.90<br>4.85   |                | V<br>V                       |
| Output Voltage Low           | $V_{OL}$                 | $R_L = 2\text{ k}\Omega$ to ground<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                             |              | -4.91<br>-4.91 | -4.86<br>-4.82 | V<br>V                       |
| Short-Circuit Limit          | $I_{SC}$                 |                                                                                                                                        |              | 40             |                | mA                           |
| Output Current               | $I_O$                    |                                                                                                                                        |              | $\pm 20$       |                | mA                           |
| POWER SUPPLY                 |                          |                                                                                                                                        |              |                |                |                              |
| Power Supply Rejection Ratio | PSRR                     | $V_S = \pm 5.0\text{ V to } \pm 15.0\text{ V}$<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                 | 120<br>120   | 140<br>140     |                | dB<br>dB                     |
| Supply Current/Amplifier     | $I_{SY}$                 | $V_O = 0\text{ V}$<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                             |              | 2.3<br>2.7     | 2.7<br>3.4     | mA<br>mA                     |
| DYNAMIC PERFORMANCE          |                          |                                                                                                                                        |              |                |                |                              |
| Slew Rate                    | SR                       | $R_L = 2\text{ k}\Omega$                                                                                                               |              | 2.5            |                | V/ $\mu\text{s}$             |
| Gain Bandwidth Product       | GBP                      |                                                                                                                                        |              | 10             |                | MHz                          |
| NOISE PERFORMANCE            |                          |                                                                                                                                        |              |                |                |                              |
| Voltage Noise                | $e_{n\text{ p-p}}$       | 0.1 Hz to 10 Hz                                                                                                                        |              | 0.1            |                | $\mu\text{V p-p}$            |
| Voltage Noise Density        | $e_n$                    | $f = 1\text{ kHz}$                                                                                                                     |              | 2.8            |                | nV/ $\sqrt{\text{Hz}}$       |
| Current Noise Density        | $i_n$                    | $f = 10\text{ Hz}$                                                                                                                     |              | 0.3            |                | pA/ $\sqrt{\text{Hz}}$       |

# AD8675

$V_S = \pm 15\text{ V}$ ,  $V_{CM} = 0\text{ V}$ ,  $V_O = 0\text{ V}$ ,  $T_A = +25^\circ\text{C}$ , unless otherwise specified.

Table 2.

| Parameter                    | Symbol                   | Conditions                                                                                                                                                                                                 | Min   | Typ      | Max    | Units                        |
|------------------------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------|--------|------------------------------|
| INPUT CHARACTERISTICS        |                          |                                                                                                                                                                                                            |       |          |        |                              |
| Offset Voltage               | $V_{OS}$                 | $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                                                                                                       |       | 10       | 75     | $\mu\text{V}$                |
| Input Bias Current           | $I_B$                    | $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                                                                                                       | -2    | 0.5      | 2      | nA                           |
| Input Offset Current         | $I_{OS}$                 | $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                                                                                                       | -4.5  | 1        | 4.5    | nA                           |
| Input Voltage Range          |                          | $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                                                                                                       | -1    | 0.1      | 1      | nA                           |
| Common-Mode Rejection Ratio  | CMRR                     | $V_{CM} = -12.5\text{ V to } +12.5\text{ V}$<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                                                       | -2.8  | 0.1      | 2.8    | nA                           |
| Open-Loop Gain               | $A_{VO}$                 | $R_L = 2\text{ k}\Omega$ to ground,<br>$V_O = -14.0\text{ V to } +14.0\text{ V}$<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                   | -13.5 |          | 13.5   | V                            |
| Offset Voltage Drift         | $\Delta V_{OS}/\Delta T$ | $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                                                                                                       | 114   | 130      |        | dB                           |
|                              |                          |                                                                                                                                                                                                            | 114   | 130      |        | dB                           |
|                              |                          |                                                                                                                                                                                                            | 1500  | 4000     |        | V/mV                         |
|                              |                          |                                                                                                                                                                                                            | 700   | 1700     |        | V/mV                         |
|                              |                          |                                                                                                                                                                                                            |       | 0.2      | 0.6    | $\mu\text{V}/^\circ\text{C}$ |
| OUTPUT CHARACTERISTICS       |                          |                                                                                                                                                                                                            |       |          |        |                              |
| Output Voltage High          | $V_{OH}$                 | SOIC $R_L: 2\text{ k}\Omega$ to ground<br>MSOP $R_L: 2\text{ k}\Omega$ to ground<br>SOIC $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$<br>MSOP $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ | 14.75 | 14.8     |        | V                            |
|                              |                          |                                                                                                                                                                                                            | 14.67 | 14.78    |        | V                            |
|                              |                          |                                                                                                                                                                                                            | 14.69 | 14.75    |        | V                            |
|                              |                          |                                                                                                                                                                                                            | 14.3  | 14.66    |        | V                            |
| Output Voltage Low           | $V_{OL}$                 | $R_L = 2\text{ k}\Omega$ to ground<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                                                                 |       | -14.85   | -14.75 | V                            |
| Short-Circuit Limit          | $I_{SC}$                 |                                                                                                                                                                                                            |       | -14.78   | -14.69 | V                            |
| Output Current               | $I_O$                    |                                                                                                                                                                                                            |       | 40       |        | mA                           |
|                              |                          |                                                                                                                                                                                                            |       | $\pm 20$ |        | mA                           |
| POWER SUPPLY                 |                          |                                                                                                                                                                                                            |       |          |        |                              |
| Power Supply Rejection Ratio | PSRR                     | $V_S = \pm 5.0\text{ V to } \pm 15.0\text{ V}$<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                                                     | 120   | 140      |        | dB                           |
|                              |                          |                                                                                                                                                                                                            | 120   | 140      |        | dB                           |
| Supply Current/Amplifier     | $I_{SY}$                 | $V_O = 0\text{ V}$<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                                                                                                                 |       | 2.5      | 2.9    | mA                           |
|                              |                          |                                                                                                                                                                                                            |       | 2.9      | 3.8    | mA                           |
| DYNAMIC PERFORMANCE          |                          |                                                                                                                                                                                                            |       |          |        |                              |
| Slew Rate                    | SR                       | $R_L = 10\text{ k}\Omega$                                                                                                                                                                                  |       | 2.5      |        | V/ $\mu\text{s}$             |
| Gain Bandwidth Product       | GBP                      |                                                                                                                                                                                                            |       | 10       |        | MHz                          |
| NOISE PERFORMANCE            |                          |                                                                                                                                                                                                            |       |          |        |                              |
| Voltage Noise                | $e_{n\text{ p-p}}$       | 0.1 Hz to 10 Hz                                                                                                                                                                                            |       | 0.1      |        | $\mu\text{V p-p}$            |
| Voltage Noise Density        | $e_n$                    | $f = 1\text{ kHz}$                                                                                                                                                                                         |       | 2.8      |        | nV/ $\sqrt{\text{Hz}}$       |
| Current Noise Density        | $i_n$                    | $f = 10\text{ Hz}$                                                                                                                                                                                         |       | 0.3      |        | pA/ $\sqrt{\text{Hz}}$       |

## ABSOLUTE MAXIMUM RATINGS

Table 3.

| Parameter                                  | Rating                                          |
|--------------------------------------------|-------------------------------------------------|
| Supply Voltage                             | $\pm 18\text{ V}$                               |
| Input Voltage                              | $\pm V_{\text{supply}}$                         |
| Differential Input Voltage                 | $\pm 0.7\text{ V}$                              |
| Output Short-Circuit Duration to GND       | Indefinite                                      |
| Storage Temperature Range                  |                                                 |
| RM-8, R-8 Packages                         | $-65^{\circ}\text{C}$ to $+150^{\circ}\text{C}$ |
| Operating Temperature Range                | $-40^{\circ}\text{C}$ to $+125^{\circ}\text{C}$ |
| Junction Temperature Range                 |                                                 |
| RM-8, R-8 Packages                         | $-65^{\circ}\text{C}$ to $+150^{\circ}\text{C}$ |
| Lead Temperature Range (Soldering, 10 sec) | $300^{\circ}\text{C}$                           |

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 RESISTANCE

Table 4. Thermal Resistance

| Package Type        | $\theta_{JA}$ | $\theta_{JC}$ | Unit                        |
|---------------------|---------------|---------------|-----------------------------|
| 8-Lead MSOP (RM-8)  | 210           | 45            | $^{\circ}\text{C}/\text{W}$ |
| 8-Lead SOIC_N (R-8) | 158           | 43            | $^{\circ}\text{C}/\text{W}$ |

## 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

$\pm 15\text{ V}$  and  $\pm 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise specified.

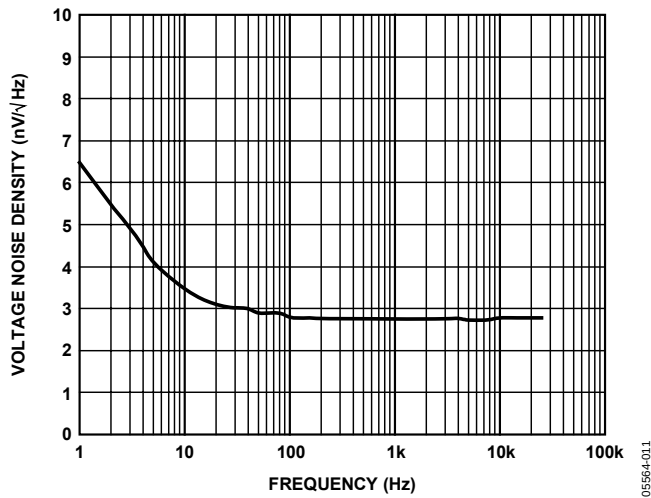


Figure 3. Voltage Noise Density vs. Frequency

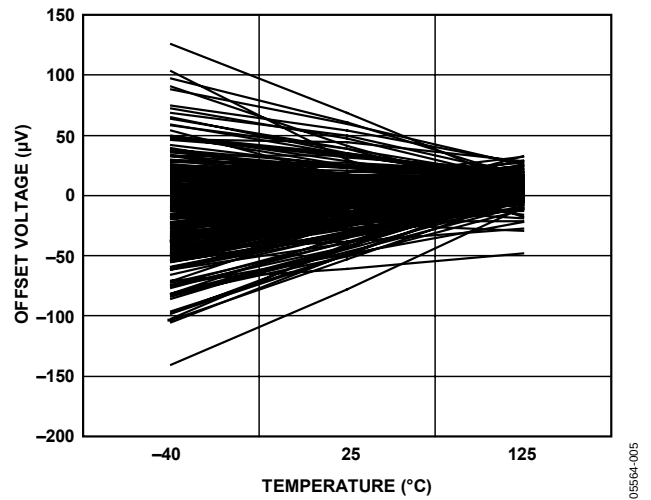


Figure 6. Offset Voltage vs. Temperature

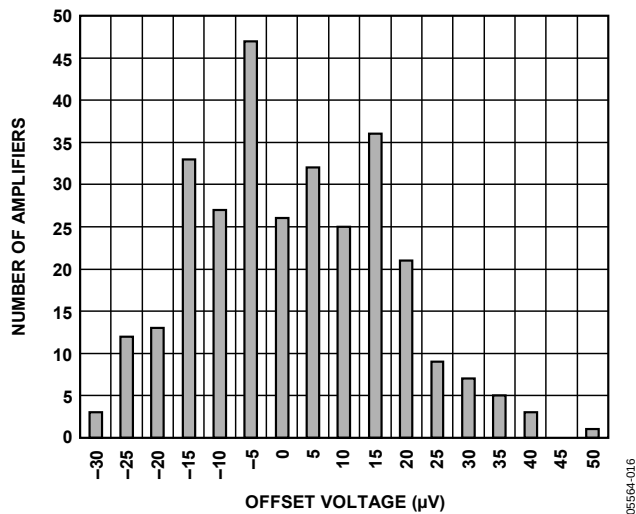


Figure 4. Input Offset Voltage Distribution

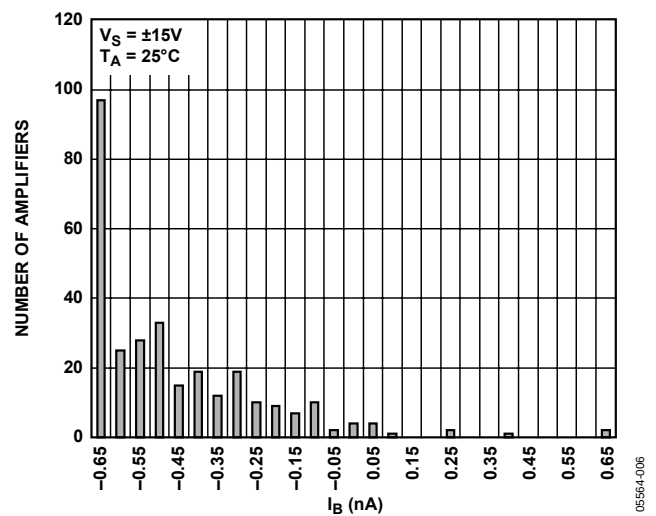


Figure 7. Input Bias Current,  $V_S = \pm 15\text{ V}$

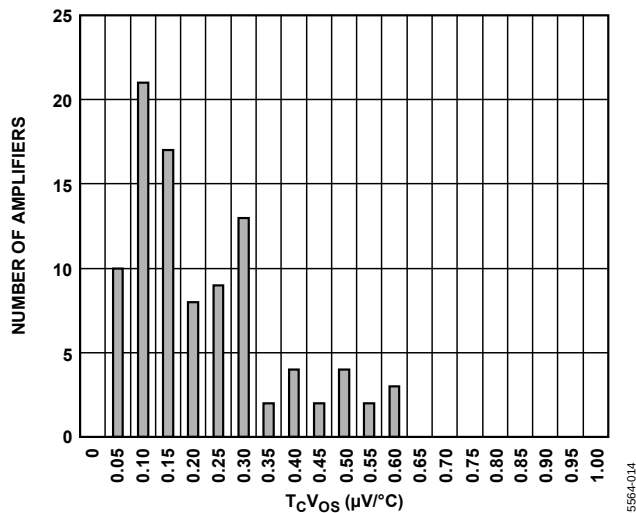


Figure 5.  $T_CV_{OS}$

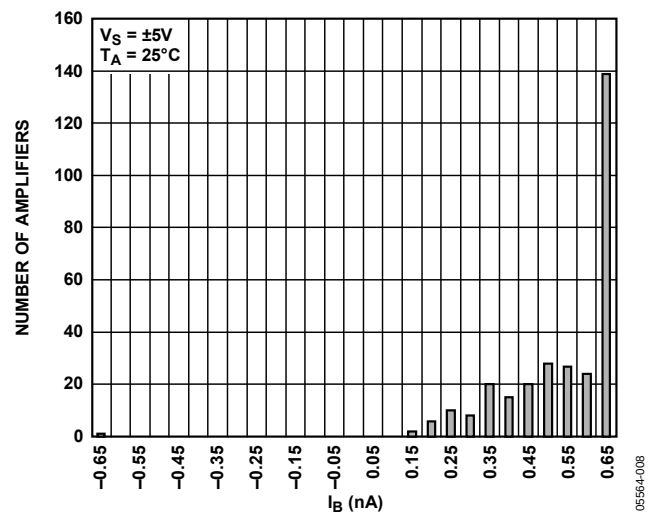


Figure 8. Input Bias Current,  $V_S = \pm 5\text{ V}$

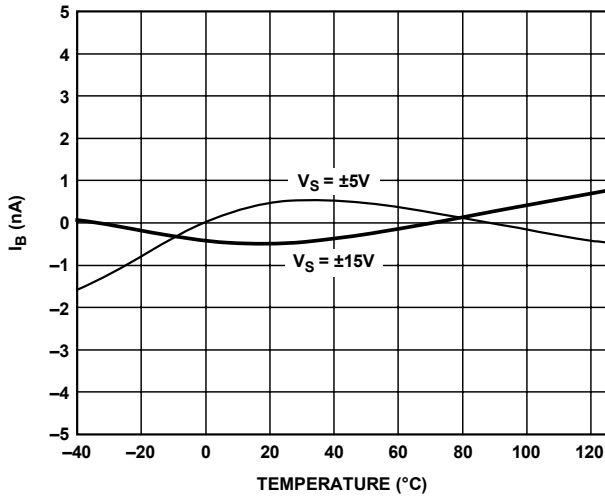


Figure 9. Input Bias Current vs. Temperature

05564-007

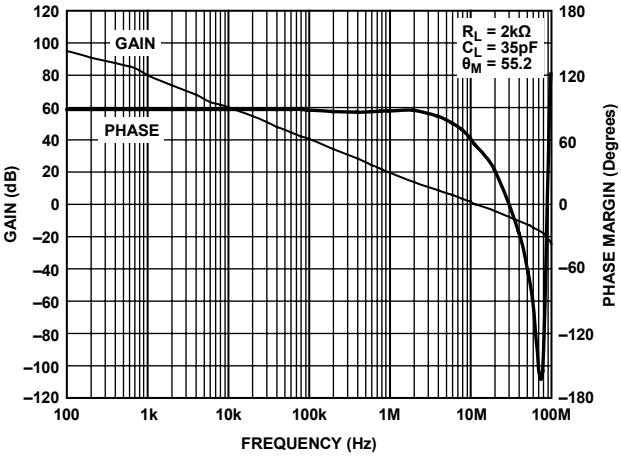


Figure 12. Gain and Phase vs. Frequency

05564-018

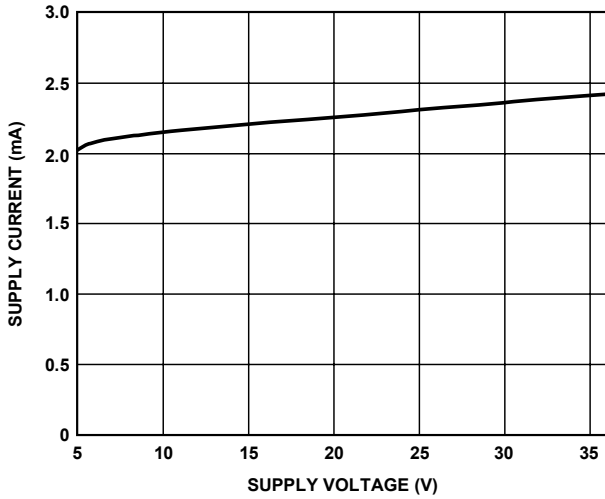


Figure 10. Supply Current vs. Total Supply Voltage

05564-009

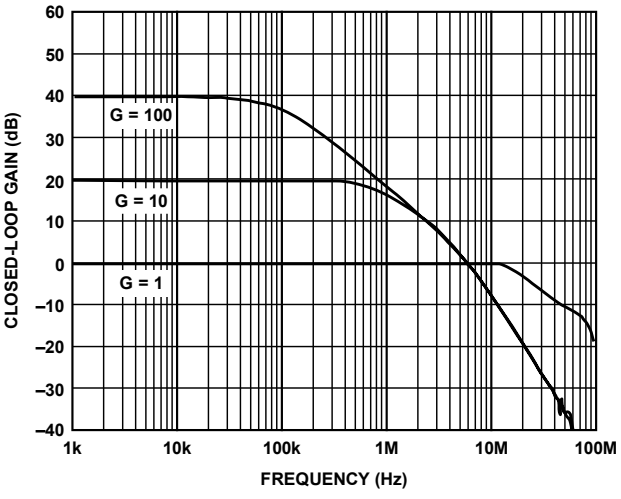


Figure 13. Closed-Loop Gain vs. Frequency

05564-030

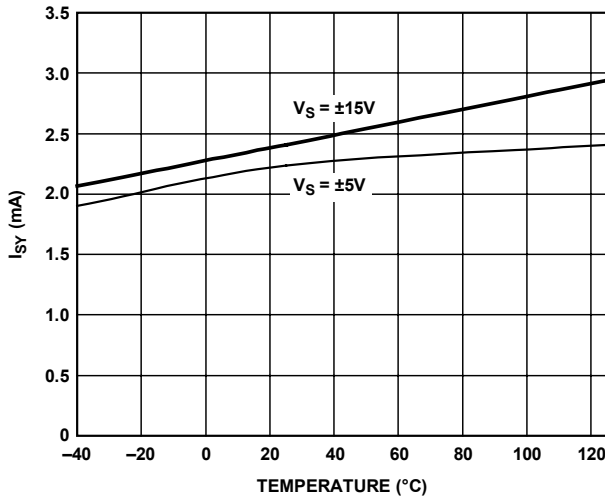


Figure 11. Supply Current vs. Temperature

05564-019

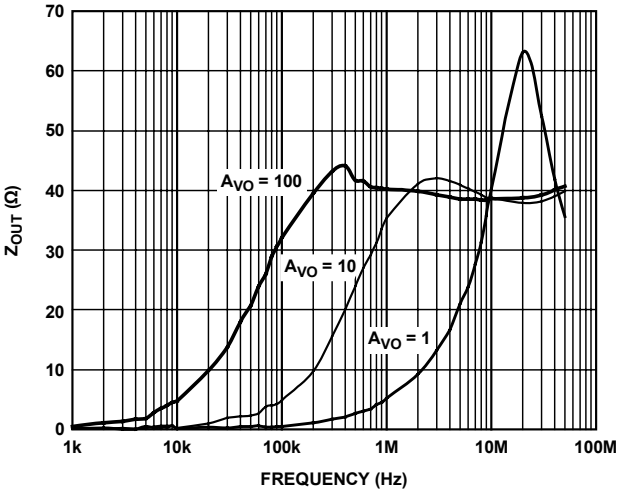


Figure 14.  $Z_{OUT}$  vs. Frequency

05564-015

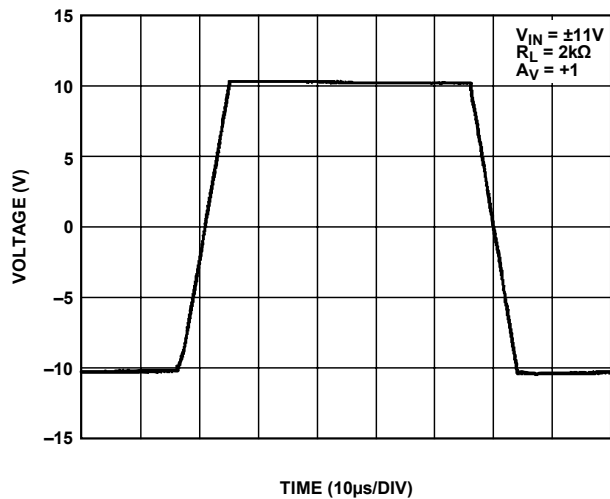


Figure 15. Large Signal Transient Response,  $V_{SY} = \pm 15\text{ V}$

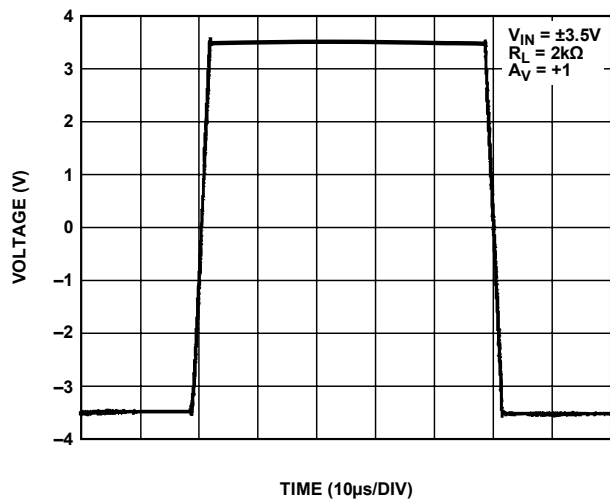


Figure 16. Large Signal Transient Response,  $V_{SY} = \pm 5\text{ V}$

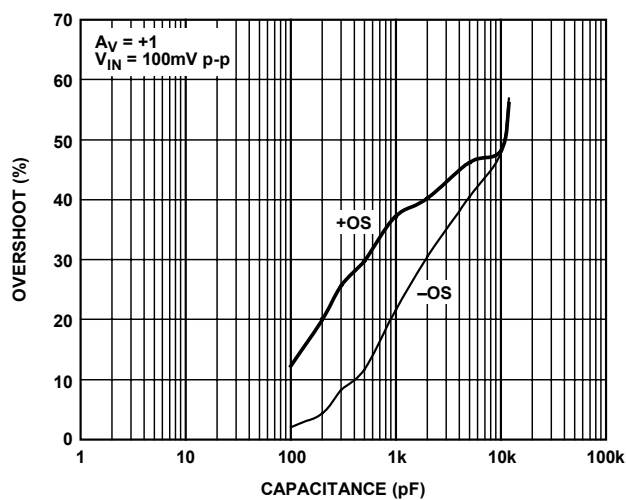


Figure 17. Small Signal Overshoot vs. Load Capacitance

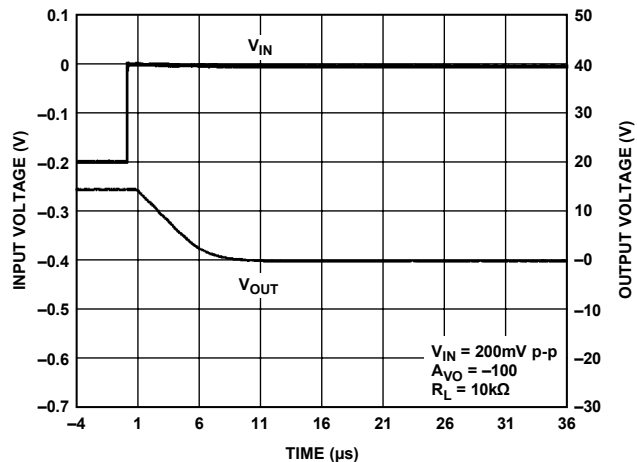


Figure 18. Positive Overvoltage Recovery

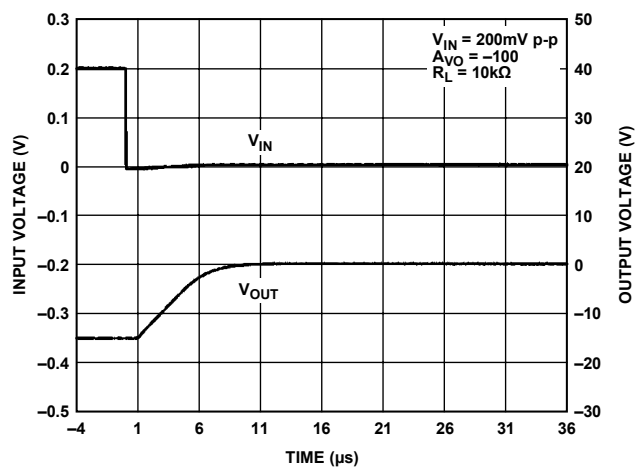


Figure 19. Negative Overvoltage Recovery

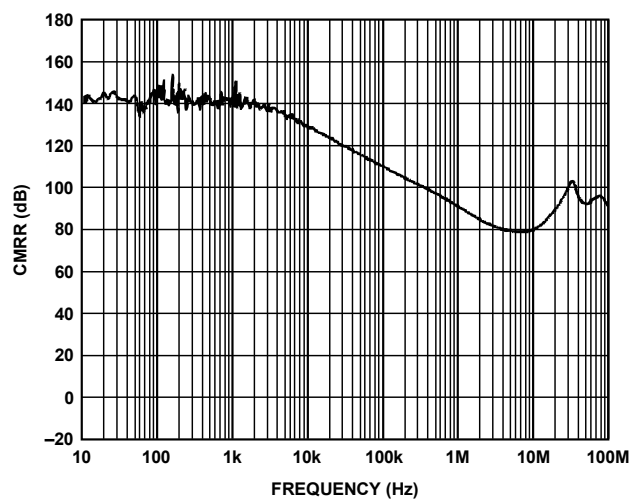
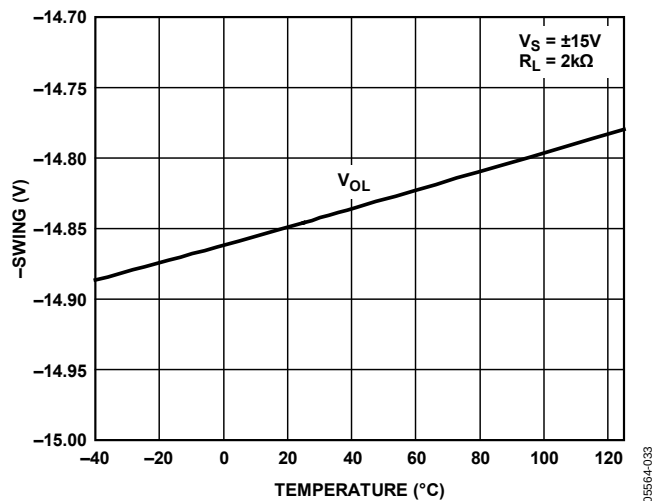
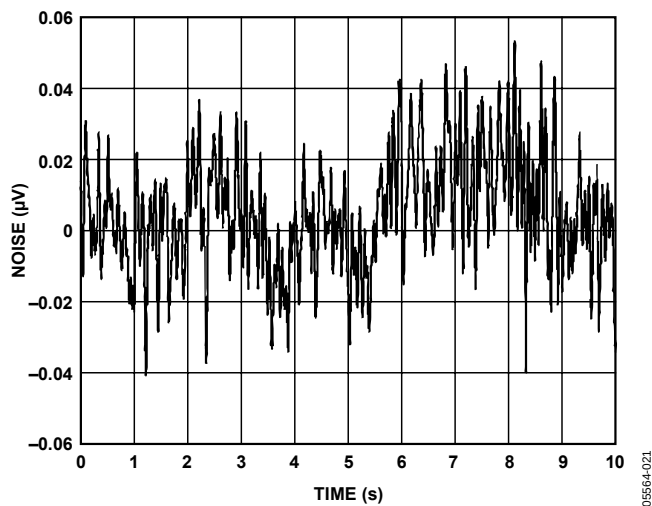
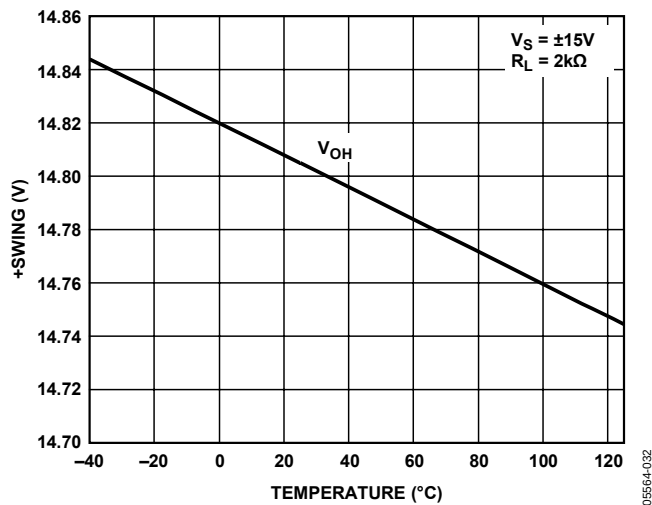
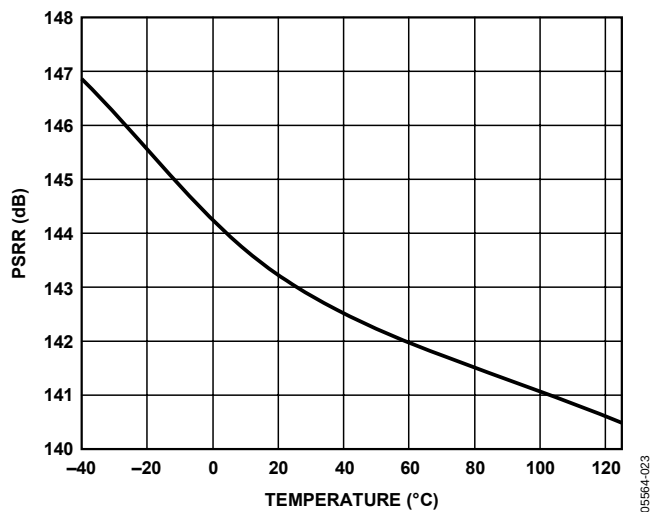
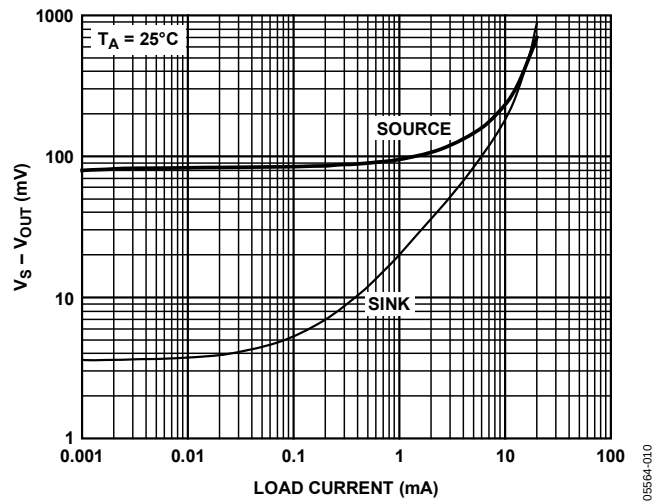
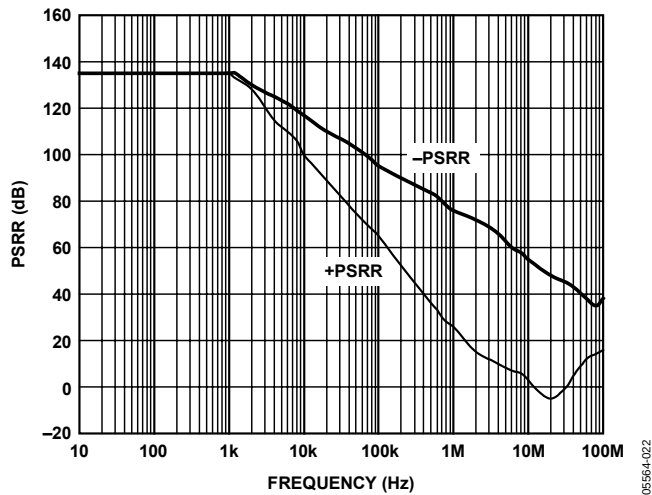


Figure 20. CMRR vs. Frequency





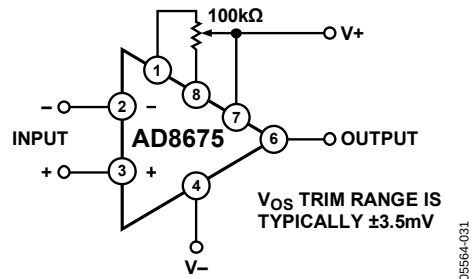


Figure 27. Optional Offset Nulling Circuit

## OUTLINE DIMENSIONS

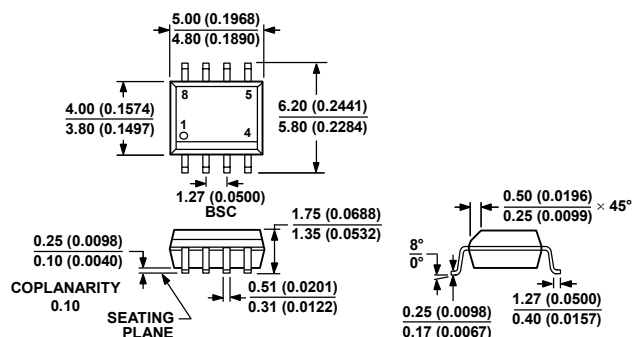


Figure 28. 8-Lead Standard Small Outline Package [SOIC\_N]  
Narrow Body (R-8)  
Dimensions shown in millimeters and (inches)

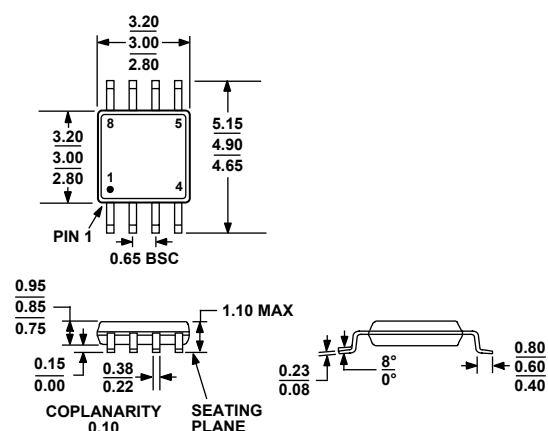


Figure 29. 8-Lead Mini Small Outline Package [MSOP]  
(RM-8)  
Dimensions shown in millimeters

## ORDERING GUIDE

| Model                        | Temperature Range | Package Description                            | Package Option | Branding |
|------------------------------|-------------------|------------------------------------------------|----------------|----------|
| AD8675ARMZ-R2 <sup>1</sup>   | −40°C to +125°C   | 8-Lead Mini Small Outline Package [MSOP]       | RM-8           | A08      |
| AD8675ARMZ-REEL <sup>1</sup> | −40°C to +125°C   | 8-Lead Mini Small Outline Package [MSOP]       | RM-8           | A08      |
| AD8675ARZ <sup>1</sup>       | −40°C to +125°C   | 8-Lead Standard Small Outline Package [SOIC_N] | R-8            |          |
| AD8675ARZ-REEL <sup>1</sup>  | −40°C to +125°C   | 8-Lead Standard Small Outline Package [SOIC_N] | R-8            |          |
| AD8675ARZ-REEL7 <sup>1</sup> | −40°C to +125°C   | 8-Lead Standard Small Outline Package [SOIC_N] | R-8            |          |

<sup>1</sup> Z = RoHS Compliant Part.

**AD8675**

## NOTES