# Low Power, Low Cost 2.5 V Reference

# AD680

## FEATURES

**Low quiescent current at 250 µA max**
**Laser trimmed to high accuracy**
**2.5 V ± 5 mV max (AN, AR grades)**
**Trimmed temperature coefficient**
**20 ppm/°C max (AN, AR grades)**
**Low noise at 8 µV p-p from 0.1 Hz to 10 Hz**
**250 nV/√Hz wideband**
**Temperature output pin (N, R packages)**
**Available in three package styles**
**8-lead PDIP, 8-lead SOIC, and 3-pin TO-92**

## GENERAL DESCRIPTION

The AD680[1] is a band gap voltage reference that provides a fixed 2.5 V output from inputs between 4.5 V and 36 V. The architecture of the AD680 enables the reference to be operated at a very low quiescent current while still realizing excellent dc characteristics and noise performance. Trimming of the high stability thin-film resistors is performed for initial accuracy and temperature coefficient, resulting in low errors over temperature.

The precision dc characteristics of the AD680 make it ideal for use as a reference for DACs that require an external precision reference. The device is also ideal for ADCs and, in general, can offer better performance than the standard on-chip references. Based upon its low quiescent current, which rivals that of many incomplete 2-terminal references, the AD680 is recommended for low power applications, such as hand-held, battery-operated equipment.

A temperature output pin is provided on the 8-lead package versions of the AD680. The temperature output pin provides an output voltage that varies linearly with temperature and allows the AD680 to be configured as a temperature transducer while providing a stable 2.5 V output.

The AD680 is available in five grades. The AD680AN is specified for operation from −40°C to +85°C, while the AD680JN is specified for 0°C to 70°C operation. Both the AD680AN and AD680JN are available in 8-lead PDIP packages. The AD680AR is specified for operation from −40°C to +85°C, while the AD680JR is specified for 0°C to 70°C operation. Both are available in 8-lead SOIC packages. The AD680JT is specified for 0°C to 70°C operation and is available in a 3-pin TO-92 package.

[1] Protected by U.S. Patent Nos. 4,902,959; 4,250,445; and 4,857,862.

## CONNECTION DIAGRAMS

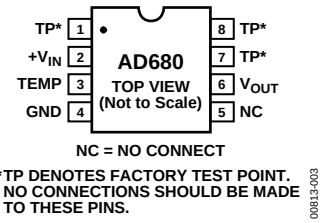



*Figure 1. 8-Lead PDIP and 8-Lead SOIC Pin Configuration*

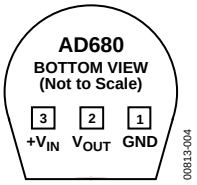



*Figure 2. Connection Diagram TO-92*

## PRODUCT HIGHLIGHTS

1. High Accuracy.
   The AD680 band gap reference operates on a very low quiescent current which rivals that of many 2-terminal references. This makes the complete, higher accuracy AD680 ideal for use in power-sensitive applications.

2. Low Errors.
   Laser trimming of both initial accuracy and temperature coefficients results in low errors over temperature without the use of external components. The AD680AN and AD680AR have a maximum variation of 6.25 mV between −40°C and +85°C.

3. Low Noise.
   The AD680 noise is low, typically 8 µV p-p from 0.1 Hz to 10 Hz. Spectral density is also low, typically 250 nV/√Hz.

4. Temperature Transducer.
   The temperature output pin on the 8-lead package versions enables the AD680 to be configured as a temperature transducer.

5. Low Cost.
   PDIP packaging provides machine insertability, while SOIC packaging provides surface-mount capability. TO-92 packaging offers a cost-effective alternative to 2-terminal references, offering a complete solution in the same package in which 2-terminal references are usually found.

# SPECIFICATIONS

$T_A$ = 25°C, $V_{IN}$ = 5 V, unless otherwise noted. Specifications in **boldface** are tested on all production units at final electrical test. Results from these tests are used to calculate outgoing quality levels. All minimum and maximum specifications are guaranteed.

**Table 1.**

| | AD680AN/AD680AR | | | AD680JN/AD680JR | | | AD680JT | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | **Unit** |
| OUTPUT VOLTAGE | | | | | | | | | | |
| Output Voltage, $V_O$ | 2.495 | 2.500 | 2.505 | 2.490 | 2.500 | 2.510 | 2.490 | 2.500 | 2.510 | V |
| Initial Accuracy, $V_{OERR}$ | −5 | | +5 | −10 | | +10 | −10 | | +10 | mV |
| | −0.20 | | +0.20 | −0.40 | | +0.40 | −0.40 | | +0.40 | % |
| OUTPUT VOLTAGE DRIFT[1] | | | | | | | | | | |
| 0°C to 70°C | | 10 | | | 10 | 25 | | 10 | 30 | ppm/°C |
| −40°C to +85°C | | | 20 | | 25 | | | 25 | | ppm/°C |
| LINE REGULATION | | | | | | | | | | |
| 4.5 V ≤ $+V_{IN}$ ≤ 15 V | | | 40 | | | 40 | | | 40 | µV/V |
| (@ $T_{MIN}$ to $T_{MAX}$) | | | 40 | | | 40 | | | 40 | µV/V |
| 15 V ≤ $+V_{IN}$ ≤ 36 V | | | 40 | | | 40 | | | 40 | µV/V |
| (@ $T_{MIN}$ to $T_{MAX}$) | | | 40 | | | 40 | | | 40 | µV/V |
| LOAD REGULATION | | | | | | | | | | |
| 0 < $I_{OUT}$ < 10 mA | | 80 | 100 | | 80 | 100 | | 80 | 100 | µV/mA |
| (@ $T_{MIN}$ to $T_{MAX}$) | | 80 | 100 | | 80 | 100 | | 80 | 100 | µV/mA |
| QUIESCENT CURRENT | | 195 | **250** | | 195 | **250** | | 195 | **250** | µA |
| (@ $T_{MIN}$ to $T_{MAX}$) | | | 280 | | | 280 | | | 280 | µA |
| POWER DISSIPATION | | 1 | **1.25** | | 1 | **1.25** | | 1 | **1.25** | mW |
| OUTPUT NOISE | | | | | | | | | | |
| 0.1 Hz to 10 Hz | | 8 | 10 | | 8 | 10 | | 8 | 10 | µV p-p |
| Spectral Density, 100 Hz | | 250 | | | 250 | | | 250 | | nV/√Hz |
| CAPACITIVE LOAD | | | 50 | | | 50 | | | 50 | nF |
| LONG-TERM STABILITY | | 25 | | | 25 | | | 25 | | ppm/1,000 hr |
| SHORT-CIRCUIT CURRENT TO GROUND | | 25 | 50 | | 25 | 50 | | 25 | 50 | mA |
| TEMPERATURE PIN | | | | | | | | | | |
| Voltage Output @ 25°C | 540 | 596 | 660 | 540 | 596 | 660 | | | | mV |
| Temperature Sensitivity | | 2 | | | 2 | | | | | mV/°C |
| Output Current | −5 | | +5 | −5 | | +5 | | | | µA |
| Output Resistance | | 12 | | | 12 | | | | | kΩ |
| TEMPERATURE RANGE | | | | | | | | | | |
| Specified Performance | −40 | | +85 | 0 | | 70 | 0 | | 70 | °C |
| Operating Performance[2] | −40 | | +85 | −40 | | +85 | −40 | | +85 | °C |

[1] Maximum output voltage drift is guaranteed for all packages.
[2] The operating temperature range is defined as the temperature extremes at which the device will still function. Parts may deviate from their specified performance outside their specified temperature range.

# ABSOLUTE MAXIMUM RATINGS

**Table 2.**

| Parameter | Rating |
|---|---|
| $V_{IN}$ to Ground | 36 V |
| Power Dissipation (25°C) | 500 mW |
| Storage Temperature | −65°C to +125°C |
| Lead Temperature (Soldering, 10 sec) | 300°C |
| Package Thermal Resistance $\theta_{JA}$ (All Packages) | 120°C/W |

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.

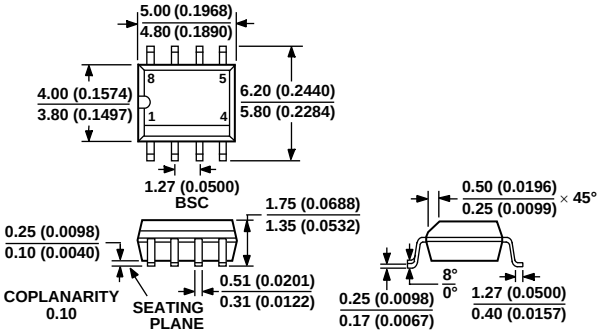
## OUTPUT PROTECTION

Output safe for indefinite short to GND and momentary short to $-V_{IN}$.

## ESD CAUTION

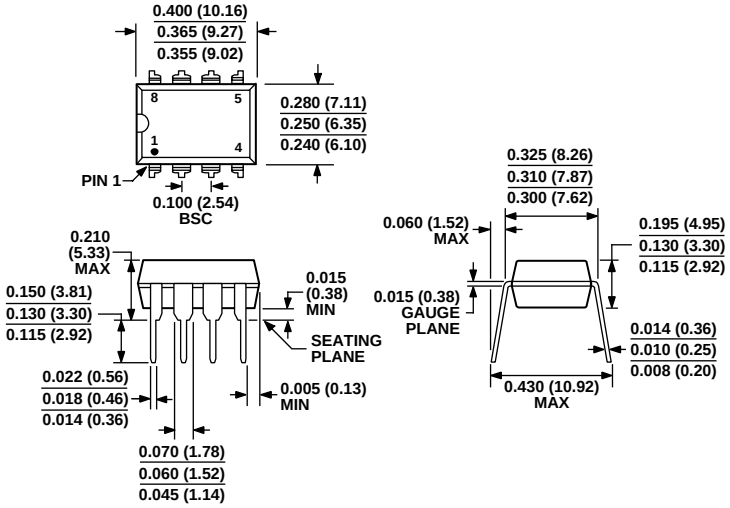
ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

# OUTLINE DIMENSIONS



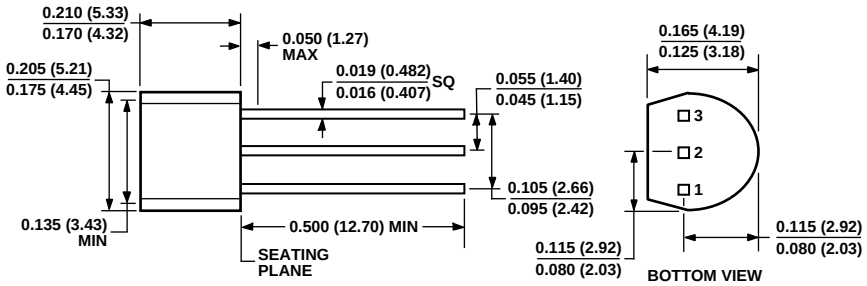

**COMPLIANT TO JEDEC STANDARDS MS-012AA**
**CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN**

*Figure 21. 8-Lead Standard Small Outline Package [SOIC]*
*Narrow Body*
*(R-8)*
*Dimensions show in millimeters and (inches)*




**COMPLIANT TO JEDEC STANDARDS MS-001-BA**
**CONTROLLING DIMENSIONS ARE IN INCHES; MILLIMETER DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF INCH EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN. CORNER LEADS MAY BE CONFIGURED AS WHOLE OR HALF LEADS.**

*Figure 22. 8-Lead Plastic Dual In-Line Package [PDIP]*
*Narrow Body*
*(N-8)*
*Dimensions shown in inches and (millimeters)*




**COMPLIANT TO JEDEC STANDARDS TO-226AA**
**CONTROLLING DIMENSIONS ARE IN INCHES; MILLIMETER DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN**

*Figure 23. 3-Pin Plastic Header-Style Package [TO-92]*
*(T-3)*
*Dimensions shown in inches and (millimeters)*

## ORDERING GUIDE

| Model | Output Voltage $V_O$ (V) | Initial Accuracy (mV) | Initial Accuracy (%) | Temperature Coefficient (ppm/°C) | Package Description | Package Option | Parts per Reel | Temperature Range (°C) |
|---|---|---|---|---|---|---|---|---|
| AD680AR | 2.5 | 5 | 0.20 | 20 | SOIC | R-8 | | –40 to +85 |
| AD680AR-REEL | 2.5 | 5 | 0.20 | 20 | SOIC | R-8 | 2,500 | –40 to +85 |
| AD680AR-REEL7 | 2.5 | 5 | 0.20 | 20 | SOIC | R-8 | 1,000 | –40 to +85 |
| AD680ARZ[1] | 2.5 | 5 | 0.20 | 20 | SOIC | R-8 | | –40 to +85 |
| AD680ARZ-REEL7[1] | 2.5 | 5 | 0.20 | 20 | SOIC | R-8 | 1,000 | –40 to +85 |
| AD680JR | 2.5 | 10 | 0.40 | 25 | SOIC | R-8 | | 0 to 70 |
| AD680JR-REEL7 | 2.5 | 10 | 0.40 | 25 | SOIC | R-8 | 1,000 | 0 to 70 |
| AD680JRZ[1] | 2.5 | 10 | 0.40 | 25 | SOIC | R-8 | | 0 to 70 |
| AD680JRZ-REEL7[1] | 2.5 | 10 | 0.40 | 25 | SOIC | R-8 | 1,000 | 0 to 70 |
| AD680AN | 2.5 | 5 | 0.20 | 20 | PDIP | N-8 | | –40 to +85 |
| AD680ANZ[1] | 2.5 | 5 | 0.20 | 20 | PDIP | N-8 | | –40 to +85 |
| AD680JN | 2.5 | 10 | 0.40 | 25 | PDIP | N-8 | | 0 to 70 |
| AD680JNZ[1] | 2.5 | 10 | 0.40 | 25 | PDIP | N-8 | | 0 to 70 |
| AD680JT | 2.5 | 10 | 0.40 | 30 | TO-92 | T-3 | | 0 to 70 |
| AD680JTZ[1] | 2.5 | 10 | 0.40 | 30 | TO-92 | T-3 | | 0 to 70 |

[1] Z = Pb-free part.