RoHS
*Available on commercial versions*

# 10 Watt Zener Diodes

***Qualified per MIL-PRF-19500/124***

*Qualified Levels:*
*JAN, JANTX, and JANTXV*

## DESCRIPTION

The JEDEC registered 1N2970B through 1N3015B and 1N3993A through 1N3998A series are 10W Zener diodes with voltage regulation values between 3.9 and 200V. They are available in JAN, JANTX, and JANTXV military qualification grades on most voltage values.



**DO-213AA (DO-4) Package**

**Important:** For the latest information, visit our website http://www.microsemi.com.

## FEATURES

- Internal solder bond construction.
- Hermetically sealed (welded).
- Zener regulation voltages from 3.9 V to 200 V.
- Standard and reverse polarities are available.
- Consult factory for surface mount equivalents.
- JAN, JANTX, and JANTXV qualifications are available per MIL-PRF-19500/124.
- RoHS compliant devices available by adding “e3” suffix (commercial grade only).

## APPLICATIONS / BENEFITS

- Regulates voltage over a broad range of current and temperature.
- Standard voltage tolerances are +/- 5%.
- Nonsensitive to ESD per MIL-STD-750 method 1020.
- Inherently radiation hard as described in Microsemi MicroNote 050.

## MAXIMUM RATINGS

| Parameters/Test Conditions | Symbol | Value | Unit |
|---|---|---|---|
| Junction Temperature | $T_J$ | -65 to +175 | °C |
| Storage Temperature | $T_{STG}$ | -65 to +200 | °C |
| Thermal Resistance Junction-to-Case | $R_{\Theta JC}$ | 12 | °C/W |
| Steady-State Power Dissipation @ $T_C$ = +55 ºC (1) | $P_D$ | 10 | W |
| Forward Voltage @ 2.0 A | $V_F$ | 1.5 | V |
| Solder Pad Temperature @ 10 s | $T_{SP}$ | 260 | ºC |

**NOTES:** 1. Derate at 0.083 W/ºC above +55 ºC.

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## MECHANICAL and PACKAGING

- CASE: Industry standard DO-4, (DO-203AA), 7/16" hex, stud with 10-32 threads, welded, hermetically sealed metal and glass.
- TERMINALS: Tin-lead plated or RoHS compliant matte-tin plating (commercial grade only) on nickel.
- POLARITY: **1N2970B – 1N3015B**: Std. Polarity is anode to stud. Reverse polarity (cathode to stud) indicated by suffix "RB".
  **1N3993A – 1N3998A**: Std. Polarity is cathode to stud. Reverse polarity (anode to stud) indicated by suffix "RA".
- MOUNTING HARDWARE: Consult factory for optional insulator, bushing solder terminal, washers, and nut.
- WEIGHT: Approximately 7.5 grams.
- See Package Dimensions on last page.

## PART NOMENCLATURE

*1N2970 – 1N3015 series only:*

**JAN 1N2970 R B e3**

**Reliability Level**
JAN = JAN level
JANTX = JANTX level
JANTXV = JANTXV level
Blank = Commercial

**JEDEC type number**
(see Electrical Characteristics table)

**RoHS Compliance**
e3 = RoHS compliant (available on commercial grade only)
Blank = non-RoHS compliant

**5% Tolerance**
(Consult factory for other tolerances)

**Polarity**
blank = Standard (Anode to Stud)
R = Reverse (Cathode to Stud)

*1N3993 – 1N3998 series only:*

**JAN 1N3993 R A e3**

**Reliability Level**
JAN = JAN level
JANTX = JANTX level
JANTXV = JANTXV level
Blank = Commercial

**JEDEC type number**
(see Electrical Characteristics table)

**RoHS Compliance**
e3 = RoHS compliant (available on commercial grade only)
Blank = non-RoHS compliant

**5% Tolerance**
(Consult factory for other tolerances)

**Polarity**
blank = Standard (Cathode to Stud)
R = Reverse (Anode to Stud)


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| SYMBOLS & DEFINITIONS | |
|---|---|
| **Symbol** | **Definition** |
| $I_{ZT}$ | Regulator Current: The dc regulator current ($I_Z$), at a specified test point ($I_{ZT}$), near breakdown knee ($I_{ZK}$). |
| $I_R$ | Reverse Current: The maximum reverse (leakage) current that will flow at the specified voltage and temperature. |
| $I_{ZM}$ | Maximum Regulator (Zener) Current: The maximum rated dc current for the specified power rating. |
| $V_F$ | Maximum Forward Voltage: The maximum forward voltage the device will exhibit at a specified current. |
| $V_R$ | Reverse Voltage: The reverse voltage dc value, no alternating component. |
| $V_Z$ | Zener Voltage: The Zener voltage the device will exhibit at a specified current ($I_Z$) in its breakdown region. |
| $Z_{ZT}$ or $Z_{ZK}$ | Dynamic Impedance: The small signal impedance of the diode when biased to operate in its breakdown region at a specified rms current modulation (typically 10% of $I_{ZT}$ or $I_{ZK}$) and superimposed on $I_{ZT}$ or $I_{ZK}$ respectively. |


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## ELECTRICAL CHARACTERISTICS

| JEDEC TYPE NO. (Note 1) | NOMINAL ZENER VOLTAGE $V_Z$ @ $I_{ZT}$ (Note 2) | ZENER TEST CURRENT ($I_{ZT}$) | MAX. DYNAMIC IMPEDANCE (Note 3) | | MAX DC ZENER CURRENT ($I_{ZM}$) @ 25°C Stud Temp. (Note 4) | TEMP. COEFF. $\alpha_{VZ}$ | MAX** REVERSE CURRENT $I_R$ @ $V_R$ | | POLARITY |
|---|---|---|---|---|---|---|---|---|---|
| | | | $Z_{ZT}$ @ $I_{ZT}$ | $Z_{ZK}$ @ 1mA ($I_{ZK}$) | | | | | |
| | Volts | mA | Ohms | Ohms | mA | %/°C | µA | Volts | |
| †1N3993A | 3.9 | 640 | 2.0 | 400 | 2440 | -0.060 | 100 | 0.5 | STD. POLARITY CATHODE TO STUD |
| †1N3994A | 4.3 | 580 | 1.5 | 400 | 2200 | -0.050 | 100 | 0.5 | |
| †1N3995A | 4.7 | 530 | 1.2 | 550 | 2000 | +0.025 | 50 | 1.0 | |
| †1N3996A | 5.1 | 490 | 1.1 | 550 | 1840 | +0.030 | 10 | 1.0 | |
| †1N3997A | 5.6 | 445 | 1.0 | 600 | 1680 | +0.040 | 10 | 1.0 | |
| †1N3998A | 6.2 | 405 | 1.1 | 700 | 1520 | +0.045 | 10 | 2.0 | |
| †1N2970B | 6.8 | 370 | 1.2 | 500 | 1500 | +0.057 | 150 | 5.2 | STD. POLARITY ANODE TO STUD |
| †1N2971B | 7.5 | 335 | 1.3 | 250 | 1350 | +0.067 | 100 | 5.7 | |
| †1N2972B | 8.2 | 305 | 1.5 | 250 | 1180 | +0.070 | 50 | 6.2 | |
| †1N2973B | 9.1 | 275 | 2.0 | 250 | 1100 | +0.075 | 25 | 6.9 | |
| †1N2974B | 10 | 250 | 3 | 250 | 980 | +0.081 | 25 | 7.6 | |
| †1N2975B | 11 | 230 | 3 | 250 | 890 | +0.085 | 10 | 8.4 | |
| †1N2976B | 12 | 210 | 3 | 250 | 820 | +0.079 | 10 | 9.1 | |
| †1N2977B | 13 | 190 | 3 | 250 | 750 | +0.080 | 10 | 9.9 | |
| 1N2978B | 14 | 180 | 3 | 250 | 600 | +0.070 | 10 | 10.5 | |
| †1N2979B | 15 | 170 | 3 | 250 | 640 | +0.082 | 10 | 11.4 | |
| †1N2980B | 16 | 155 | 4 | 250 | 605 | +0.083 | 10 | 12.2 | |
| 1N2981B | 17 | 145 | 4 | 250 | 500 | +0.075 | 10 | 13.0 | |
| †1N2982B | 18 | 140 | 4 | 250 | 525 | +0.085 | 10 | 13.7 | |
| 1N2983B | 19 | 130 | 4 | 250 | 440 | +0.075 | 10 | 14.0 | |
| †1N2984B | 20 | 125 | 4 | 250 | 480 | +0.086 | 10 | 15.2 | |
| †1N2985B | 22 | 115 | 5 | 250 | 435 | +0.087 | 10 | 16.7 | |
| †1N2986B | 24 | 105 | 5 | 250 | 400 | +0.088 | 10 | 18.2 | |
| 1N2987B | 25 | 100 | 6 | 250 | 310 | +0.080 | 10 | 18.2 | |
| †1N2988B | 27 | 95 | 7 | 250 | 340 | +0.090 | 10 | 20.6 | |
| †1N2989B | 30 | 85 | 8 | 300 | 320 | +0.091 | 10 | 22.8 | |
| †1N2990B | 33 | 75 | 9 | 300 | 300 | +0.092 | 10 | 25.1 | |
| †1N2991B | 36 | 70 | 10 | 300 | 260 | +0.093 | 10 | 27.4 | |
| †1N2992B | 39 | 65 | 11 | 300 | 240 | +0.094 | 10 | 29.7 | |
| †1N2993B | 43 | 60 | 12 | 400 | 220 | +0.095 | 10 | 32.7 | |
| 1N2994B | 45 | 55 | 13 | 400 | 185 | +0.090 | 10 | 33.0 | |
| †1N2995B | 47 | 55 | 14 | 400 | 200 | +0.095 | 10 | 35.8 | |
| 1N2996B | 50 | 50 | 15 | 500 | 165 | +0.090 | 10 | 36.0 | |
| †1N2997B | 51 | 50 | 15 | 500 | 185 | +0.096 | 10 | 38.8 | |
| 1N2998B | 52 | 50 | 15 | 500 | 160 | +0.090 | 10 | 39.0 | |
| †1N2999B | 56 | 45 | 16 | 500 | 170 | +0.096 | 10 | 42.6 | |
| †1N3000B | 62 | 40 | 17 | 600 | 150 | +0.097 | 10 | 47.1 | |
| †1N3001B | 68 | 37 | 18 | 600 | 137 | +0.097 | 10 | 51.7 | |
| †1N3002B | 75 | 33 | 22 | 600 | 125 | +0.098 | 10 | 56.0 | |
| †1N3003B | 82 | 30 | 25 | 700 | 115 | +0.098 | 10 | 62.2 | |
| †1N3004B | 91 | 28 | 35 | 800 | 97 | +0.099 | 10 | 69.2 | |
| †1N3005B | 100 | 25 | 40 | 900 | 91 | +0.110 | 10 | 76.0 | |
| 1N3006B | 105 | 25 | 45 | 1000 | 75 | +0.095 | 10 | 76.0 | |
| †1N3007B | 110 | 23 | 55 | 1100 | 82 | +0.110 | 10 | 83.6 | |
| †1N3008B | 120 | 20 | 75 | 1200 | 77 | +0.110 | 10 | 91.2 | |
| †1N3009B | 130 | 19 | 100 | 1300 | 71 | +0.110 | 10 | 98.8 | |
| 1N3010B | 140 | 18 | 125 | 1400 | 58 | +0.095 | 10 | 100.0 | |
| †1N3011B | 150 | 17 | 175 | 1500 | 62 | +0.110 | 10 | 114.0 | |
| †1N3012B | 160 | 16 | 200 | 1600 | 58 | +0.110 | 10 | 121.6 | |
| 1N3013B | 175 | 14 | 250 | 1750 | 46 | +0.095 | 10 | 135.0 | |
| †1N3014B | 180 | 14 | 260 | 1850 | 52 | +0.110 | 10 | 136.8 | |
| †1N3015B | 200 | 12 | 300 | 2000 | 46 | +0.110 | 10 | 152.0 | |

* JEDEC Registered Data.
** Not JEDEC Data.
† Have JAN, JANTX and JANTXV qualifications to MIL-PRF-19500/124.

*See further notes on following page.*


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**NOTES:**

1. 1N3993A - 1N3998A and 1N2970B – 1N3015B series are +/- 5% tolerance. If a tighter tolerance is required, consult factory.

2. The electrical characteristics are measured after allowing the device to stabilize for 90 seconds with 30 $^{o}$C base temperature.

3. The Zener impedance ($Z_{ZT}$) is derived from the 60 Hz ac voltage, which results when an ac current having an rms value equal to 10% of the dc Zener current ($I_{ZT}$ or $I_{ZK}$) is superimposed on $I_{ZT}$ or $I_{ZK}$. When making Zener impedance measurements at the $I_{ZK}$ test point, it may be necessary to insert a 60 Hz band pass filter between the diode and voltmeter to avoid errors resulting from low level noise signals. A curve showing the variation of Zener impedance vs. Zener current for three representative types is shown in Figures 2 and 3. Also see Microsemi MicroNote 202.

4. Derate $I_Z$ linearly to 0.0 mA at +175°C, for $T_C$ > +55°C. These values of $I_{ZM}$ may be exceeded in the case of individual diodes. The values shown are calculated for the worst case that is a unit of +/-5% tolerance at the high voltage end of its tolerance range. Allowance has also been made for the rise in Zener voltage above $V_{ZT}$, which results from Zener impedance and the increase in junction temperature as power dissipation approaches 10 watts.


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## GRAPHS

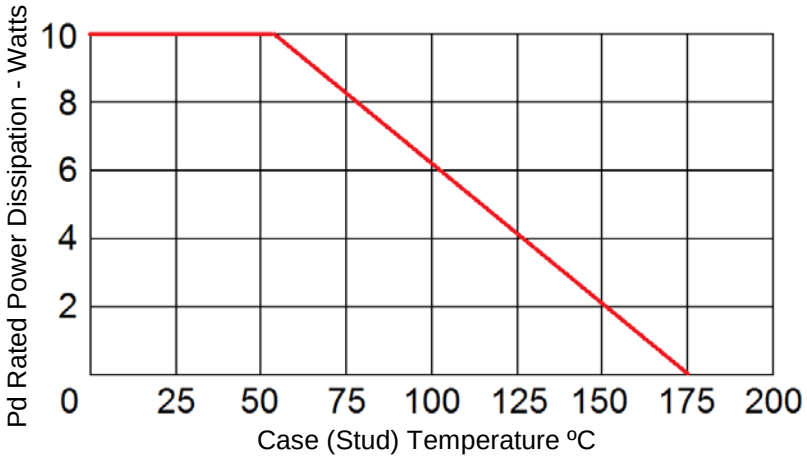



**FIGURE 1**
Power Derating Curve

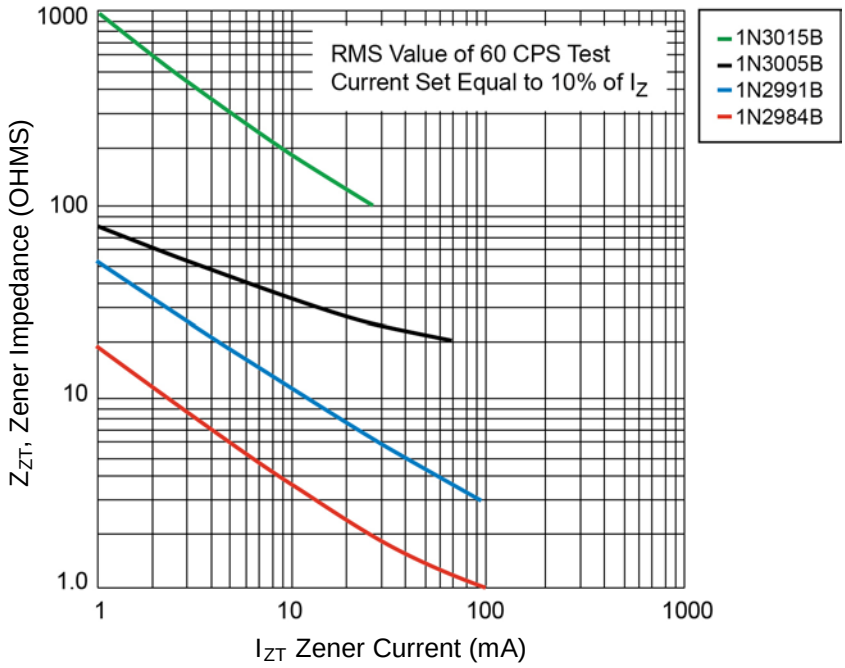



**FIGURE 2**
Typical Zener Impednace vs. Zener Current for Types Shown


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## GRAPHS (continued)

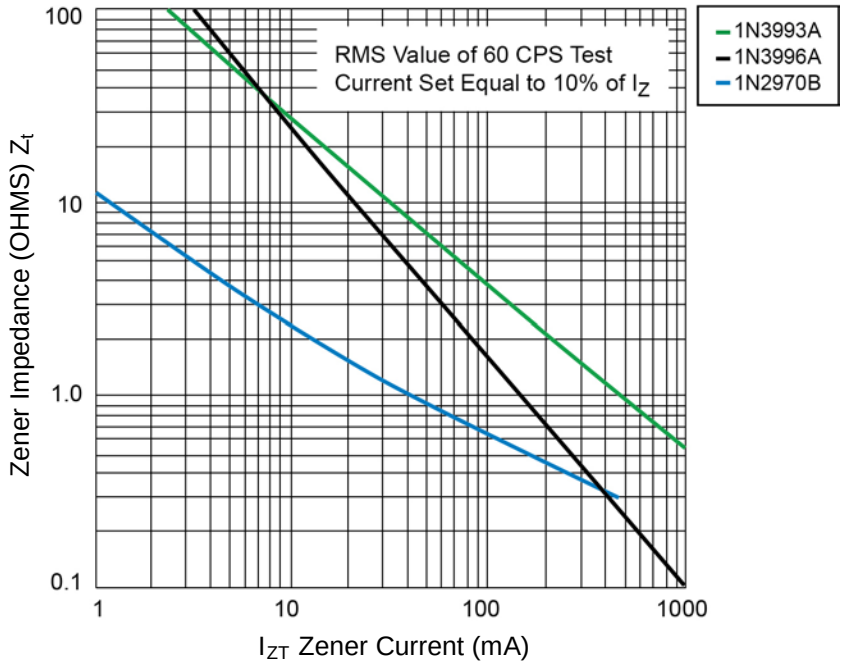
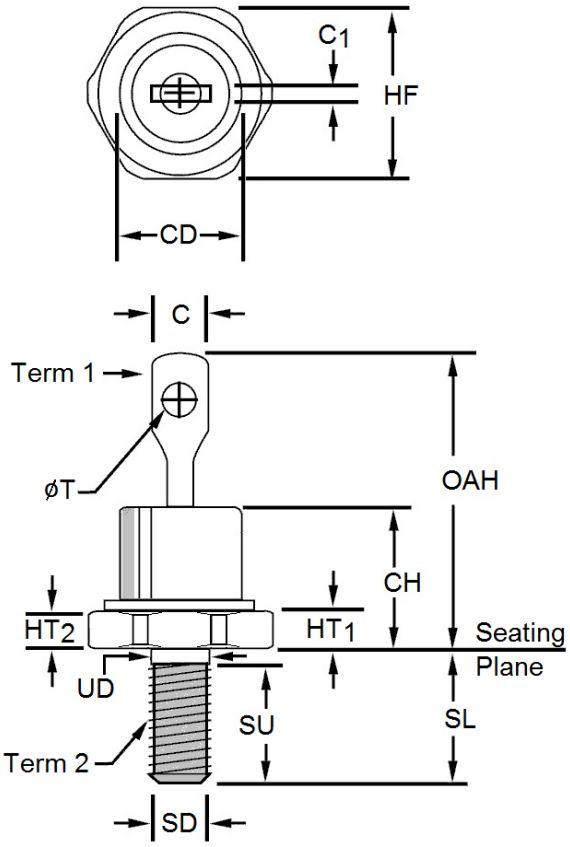



**FIGURE 3**
Typical Zener Impedance vs Zener Current for Types Shown


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## PACKAGE DIMENSIONS




| Ltr | Dimensions | | | | Notes |
|---|---|---|---|---|---|
| | Inches | | Millimeters | | |
| | Min | Max | Min | Max | |
| C | - | 0.250 | - | 6.35 | 5 |
| $C_1$ | 0.012 | 0.065 | 0.30 | 1.65 | 5 |
| CD | 0.255 | 0.424 | 6.48 | 10.77 | 6 |
| CH | 0.300 | 0.405 | 7.62 | 10.29 | |
| HF | 0.424 | 0.437 | 10.77 | 11.1 | 6 |
| $HT_1$ | 0.075 | 0.175 | 1.91 | 4.45 | 7 |
| $HT_2$ | 0.060 | 0.175 | 1.52 | 4.45 | 7 |
| OAH | 0.600 | 0.800 | 15.24 | 20.32 | |
| SD | - | - | - | - | 2 |
| SL | 0.422 | 0.453 | 10.72 | 11.51 | |
| SU | - | 0.078 | - | 1.98 | |
| UD | 0.163 | 0.189 | 4.14 | 4.80 | 8 |
| ΦT | 0.060 | 0.095 | 1.52 | 2.41 | |

**NOTES:**

1. Dimensions are in inches. Millimeters are given for information only.
2. See "Mechanical and Packaging" for the polarity of the terminals.
3. Threads shall be 10–32 UNF–2A in accordance with FED–STD–H28. Maximum pitch diameter (SD) of plated threads is 0.1697 inch (4.31 mm).
4. Maximum torque allowed on the 10–32 UNF–2B nut when assembled on the thread is 15 inch-pounds.
5. The angular orientation and peripheral configuration of terminal 1 is undefined, however, the major surfaces over dimension C and C1 shall be flat.
6. Dimension CD cannot exceed dimension HF.
7. A chamfer or undercut on one or both ends of the hex portion is optional; minimum base diameter at the seating plane is 0.403 inch (10.24 mm).
8. Length of incomplete or undercut threads UD.
9. In accordance with ASME Y14.5M, diameters are equivalent to Φx symbology.


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