

T-1113

**MOTOROLA**  
**SEMICONDUCTOR**  
**TECHNICAL DATA**
**1N3821 thru 1N3830**  
 SERIES

**1N3016 thru 1N3051**  
 SERIES

**Designers Data Sheet**
**1.0 WATT METAL SILICON ZENER DIODES**

... a complete series of 1.0 Watt Zener Diodes with limits and operating characteristics that reflect the superior capabilities of silicon-oxide-passivated junctions. All this in an axial-lead, metal package offering protection in all common environmental conditions.

- To 100 Watts Surge Rating @ 10 ms
- Maximum Limits Guaranteed on Five Electrical Parameters
- Power Capability to MIL-S-19500 Specifications

**Designer's Data for "Worst Case" Conditions**

The Designers Data sheets permit the design of most circuits entirely from the information presented. Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

**\*MAXIMUM RATINGS**

| Rating                                                                                            | Symbol         | Value       | Unit                         |
|---------------------------------------------------------------------------------------------------|----------------|-------------|------------------------------|
| DC Power Dissipation @ $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ (See Figure 1) | $P_D$          | 1.0<br>6.67 | Watt<br>mW/ $^\circ\text{C}$ |
| Operating and Storage Junction<br>Temperature Range                                               | $T_J, T_{stg}$ | -65 to +175 | $^\circ\text{C}$             |

Lead Temperature  $230^\circ\text{C}$  at a distance not less than 1/16" from the case for 10 seconds.

**MECHANICAL CHARACTERISTICS**

**CASE:** Welded, hermetically sealed metal and glass.

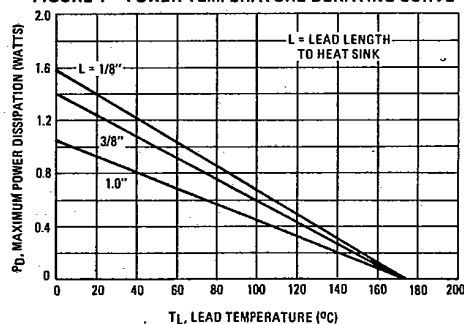
**DIMENSIONS:** See outline drawing.

**FINISH:** All external surfaces are corrosion-resistant and leads are readily solderable and weldable.

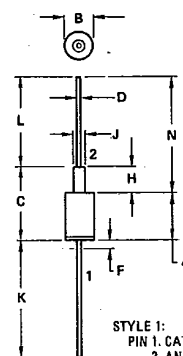
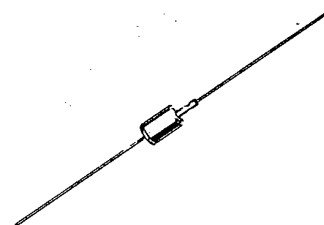
**POLARITY:** Cathode connected to the case. When operated in zener mode, cathode will be positive with respect to anode.

**WEIGHT:** 1.4 Grams (approx)

**MOUNTING POSITION:** Any

**FIGURE 1 — POWER-TEMPERATURE DERATING CURVE**


\*Indicates JEDEC Registered Data.

**1.0 WATT  
ZENER REGULATOR DIODES**
**3.3-200 VOLTS**

**STYLE 1:  
PIN 1. CATHODE  
2. ANODE**

| DIM | MILLIMETERS |       | INCHES |       |
|-----|-------------|-------|--------|-------|
|     | MIN         | MAX   | MIN    | MAX   |
| A   | 7.44        | 9.07  | 0.293  | 0.357 |
| B   | 5.46        | 5.97  | 0.215  | 0.235 |
| C   | —           | 14.48 | —      | 0.570 |
| D   | 0.64        | 0.89  | 0.025  | 0.035 |
| F   | —           | 4.76  | —      | 0.188 |
| J   | 1.14        | 2.54  | 0.045  | 0.100 |
| K   | 25.40       | 41.28 | 1.000  | 1.625 |
| L   | 25.40       | 41.28 | 1.000  | 1.625 |

All JEDEC dimensions and notes apply

**CASE 52-03  
DO-13  
METAL**

**NOTE:**  
1. ALL RULES AND NOTES ASSOCIATED  
WITH DO-13 OUTLINE SHALL APPLY.

MOTOROLA SC (DIODES/OPTO)  
1N3821 thru 1N3830, 1N3016 thru 1N3051

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ELECTRICAL CHARACTERISTICS ( $T_C = 25^\circ\text{C}$  unless otherwise noted)  
 $V_F = 1.5 \text{ V max @ } I_F = 200 \text{ mA}$  for all types

| JEDEC<br>Type No.<br>(Flangeless) | *Nominal<br>Zener Voltage<br>$V_Z @ I_ZT$<br>Volts<br>(Note 1) | *Test<br>Current<br>$I_ZT$<br>mA | *Max Zener Impedance<br>(Note 4) |                           |                | Max Reverse Current<br>(Note 5) |                |                 | *Max DC Zener<br>Current<br>$I_{ZM}$ mA<br>(Note 4) |
|-----------------------------------|----------------------------------------------------------------|----------------------------------|----------------------------------|---------------------------|----------------|---------------------------------|----------------|-----------------|-----------------------------------------------------|
|                                   |                                                                |                                  | $Z_{ZT} @ I_ZT$<br>Ohms          | $Z_{ZK} @ I_{ZK}$<br>Ohms | $I_{ZK}$<br>mA | $I_R$ Max<br>( $\mu\text{A}$ )  | $V_{R1}$<br>5% | $V_{R2}$<br>10% |                                                     |
| 1N3821                            | 3.3                                                            | 76                               | 10                               | 400                       | 1.0            | *100                            | *1.0           | 1.0             | 276                                                 |
| 1N3822                            | 3.6                                                            | 69                               | 10                               | 400                       | 1.0            | *100                            | *1.0           | 1.0             | 252                                                 |
| 1N3823                            | 3.9                                                            | 64                               | 9.0                              | 400                       | 1.0            | *60                             | *1.0           | 1.0             | 238                                                 |
| 1N3824                            | 4.3                                                            | 56                               | 9.0                              | 400                       | 1.0            | *10                             | *1.0           | 1.0             | 213                                                 |
| 1N3825                            | 4.7                                                            | 53                               | 8.0                              | 500                       | 1.0            | *10                             | *1.0           | 1.0             | 194                                                 |
| 1N3826                            | 5.1                                                            | 49                               | 7.0                              | 550                       | 1.0            | *10                             | *1.0           | 1.0             | 178                                                 |
| 1N3827                            | 5.6                                                            | 45                               | 5.0                              | 600                       | 1.0            | *10                             | *2.0           | 2.0             | 162                                                 |
| 1N3828                            | 6.2                                                            | 41                               | 2.0                              | 700                       | 1.0            | *10                             | *3.0           | 3.0             | 146                                                 |
| 1N3829                            | 6.8                                                            | 37                               | 1.5                              | 500                       | 1.0            | *10                             | *3.0           | 3.0             | 133                                                 |
| 1N3830                            | 7.5                                                            | 34                               | 1.5                              | 250                       | 1.0            | *10                             | *3.0           | 3.0             | 121                                                 |
| 1N3016                            | 6.8                                                            | 37                               | 3.5                              | 700                       | 1.0            | 10                              | 5.2            | 4.9             | 140                                                 |
| 1N3017                            | 7.5                                                            | 34                               | 4.0                              | 700                       | 0.5            | 10                              | 5.7            | 5.4             | 125                                                 |
| 1N3018                            | 8.2                                                            | 31                               | 4.5                              | 700                       | 0.5            | 10                              | 6.2            | 5.9             | 115                                                 |
| 1N3019                            | 9.1                                                            | 28                               | 5.0                              | 700                       | 0.5            | 7.5                             | 6.9            | 6.6             | 105                                                 |
| 1N3020                            | 10                                                             | 25                               | 7.0                              | 700                       | 0.25           | 5.0                             | 7.6            | 7.2             | 95                                                  |
| 1N3021                            | 11                                                             | 23                               | 8.0                              | 700                       | 0.25           | 5.0                             | 8.4            | 8.0             | 85                                                  |
| 1N3022                            | 12                                                             | 21                               | 9.0                              | 700                       | 0.25           | 2.0                             | 9.1            | 8.6             | 80                                                  |
| 1N3023                            | 13                                                             | 19                               | 10                               | 700                       | 0.25           | 1.0                             | 9.9            | 9.4             | 74                                                  |
| 1N3024                            | 15                                                             | 17                               | 14                               | 700                       | 0.25           | 1.0                             | 11.4           | 10.8            | 63                                                  |
| 1N3025                            | 16                                                             | 15.5                             | 16                               | 700                       | 0.25           | 1.0                             | 12.2           | 11.5            | 60                                                  |
| 1N3026                            | 18                                                             | 14                               | 20                               | 750                       | 0.25           | 0.5                             | 13.7           | 13.0            | 52                                                  |
| 1N3027                            | 20                                                             | 12.5                             | 22                               | 750                       | 0.25           | 0.5                             | 15.2           | 14.4            | 47                                                  |
| 1N3028                            | 22                                                             | 11.5                             | 23                               | 750                       | 0.25           | 0.5                             | 16.7           | 15.8            | 43                                                  |
| 1N3029                            | 24                                                             | 10.5                             | 25                               | 750                       | 0.25           | 0.5                             | 18.2           | 17.3            | 40                                                  |
| 1N3030                            | 27                                                             | 9.5                              | 35                               | 750                       | 0.25           | 0.5                             | 20.6           | 19.4            | 34                                                  |
| 1N3031                            | 30                                                             | 8.5                              | 40                               | 1000                      | 0.25           | 0.5                             | 22.8           | 21.6            | 31                                                  |
| 1N3032                            | 33                                                             | 7.5                              | 45                               | 1000                      | 0.25           | 0.5                             | 25.1           | 23.8            | 28                                                  |
| 1N3033                            | 36                                                             | 7.0                              | 50                               | 1000                      | 0.25           | 0.5                             | 27.4           | 25.9            | 25                                                  |
| 1N3034                            | 39                                                             | 6.5                              | 60                               | 1000                      | 0.25           | 0.5                             | 29.7           | 28.1            | 23                                                  |
| 1N3035                            | 43                                                             | 6.0                              | 70                               | 1500                      | 0.25           | 0.5                             | 32.7           | 31.0            | 21                                                  |
| 1N3036                            | 47                                                             | 5.5                              | 80                               | 1500                      | 0.25           | 0.5                             | 35.8           | 33.8            | 19                                                  |
| 1N3037                            | 51                                                             | 5.0                              | 95                               | 1500                      | 0.25           | 0.5                             | 38.8           | 36.7            | 18                                                  |
| 1N3038                            | 56                                                             | 4.5                              | 110                              | 2000                      | 0.25           | 0.5                             | 42.6           | 40.3            | 17                                                  |
| 1N3039                            | 62                                                             | 4.0                              | 125                              | 2000                      | 0.25           | 0.5                             | 47.1           | 44.6            | 15                                                  |
| 1N3040                            | 68                                                             | 3.7                              | 150                              | 2000                      | 0.25           | 0.5                             | 51.7           | 49.0            | 14                                                  |
| 1N3041                            | 75                                                             | 3.3                              | 175                              | 2000                      | 0.25           | 0.5                             | 56.0           | 54.0            | 12                                                  |
| 1N3042                            | 82                                                             | 3.0                              | 200                              | 3000                      | 0.25           | 0.5                             | 62.2           | 59.0            | 11                                                  |
| 1N3043                            | 91                                                             | 2.8                              | 250                              | 3000                      | 0.25           | 0.5                             | 69.2           | 65.5            | 10                                                  |
| 1N3044                            | 100                                                            | 2.5                              | 350                              | 3000                      | 0.25           | 0.5                             | 76.0           | 72.0            | 9.0                                                 |
| 1N3045                            | 110                                                            | 2.3                              | 450                              | 4000                      | 0.25           | 0.5                             | 83.6           | 79.2            | 8.3                                                 |
| 1N3046                            | 120                                                            | 2.0                              | 550                              | 4500                      | 0.25           | 0.5                             | 91.2           | 86.4            | 8.0                                                 |
| 1N3047                            | 130                                                            | 1.9                              | 700                              | 5000                      | 0.25           | 0.5                             | 98.8           | 93.6            | 6.9                                                 |
| 1N3048                            | 150                                                            | 1.7                              | 1000                             | 6000                      | 0.25           | 0.5                             | 114.0          | 108.0           | 5.7                                                 |
| 1N3049                            | 160                                                            | 1.6                              | 1100                             | 6500                      | 0.25           | 0.5                             | 121.6          | 115.2           | 5.4                                                 |
| 1N3050                            | 180                                                            | 1.4                              | 1200                             | 7000                      | 0.25           | 0.5                             | 136.8          | 129.6           | 4.9                                                 |
| 1N3051                            | 200                                                            | 1.2                              | 1500                             | 8000                      | 0.25           | 0.5                             | 152.0          | 144.0           | 4.6                                                 |

\* JEDEC Registered Data on 1N3821 thru 1N3830 and 1N3016 thru 1N3051

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## 1N3821 thru 1N3830, 1N3016 thru 1N3051

Example: 1M7.5AZZ10

NOTE 1 — ZENER VOLTAGE ( $V_Z$ ) MEASUREMENT

Motorola guarantees the zener voltage when measured at 90 seconds while maintaining the lead temperature ( $T_L$ ) at  $30^\circ\text{C} \pm 1^\circ\text{C}$ ,  $3/8"$  from the diode body.

NOTE 2 — ZENER IMPEDANCE ( $Z_Z$ ) DERIVATION

The zener impedance is derived from the 60 cycle 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  $I_{ZK}$ .

NOTE 3 — REVERSE LEAKAGE CURRENT  $I_R$ 

Reverse leakage currents are guaranteed only for 5% and 10% zener diodes and are measured at  $V_R$  as shown in the Electrical Characteristics Table.

NOTE 4 — MAXIMUM ZENER CURRENT RATINGS ( $I_{ZM}$ )

1N3821 thru 1N3830 — Maximum zener current ratings are based on maximum voltage of 10% tolerance units.

1N3016 thru 1N3051 — Maximum zener current ratings are based on maximum voltage of 5% tolerance units.

NOTE 5 — SURGE CURRENT ( $I_P$ )

Surge current is specified as the maximum allowable peak, non-recurrent square-wave current with a specified pulse width, PW. The data presented in Figures 8 and 9 may be used to find the maximum surge current for a square wave of any pulse width between 0.01 ms and 1000 ms.

## APPLICATION NOTE

Since the actual voltage available from a given zener diode is temperature dependent, it is necessary to determine junction temperature under any set of operating conditions in order to calculate its value. The following procedure is recommended:

Lead Temperature,  $T_L$ , should be determined from:

$$T_L = \theta_{LA} P_D + T_A$$

$\theta_{LA}$  is the lead-to-ambient thermal resistance ( $^\circ\text{C}/\text{W}$ ) and  $P_D$  is the power dissipation. The value for  $\theta_{LA}$  will vary and depends on the device mounting method.  $\theta_{LA}$  is generally  $30\text{--}40^\circ\text{C}/\text{W}$  for the various clips and tie points in common use and for printed circuit board wiring.

The temperature of the lead can also be measured using a thermocouple placed on the lead as close as possible to the tie point. The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved. Using the measured value of  $T_L$ , the junction temperature may be determined by:

$$T_J = T_L + \Delta T_{JL}$$

$\Delta T_{JL}$  is the increase in junction temperature above the lead temperature and may be found from Figure 6 for a train of power pulses ( $L = 3/8$  inch) or from Figure 7 for dc power.

$$\Delta T_{JL} = \theta_{JL} P_D$$

For worst-case design, using expected limits of  $I_Z$ , limits of  $P_D$  and the extremes of  $T_J$  ( $\Delta T_J$ ) may be estimated. Changes in voltage,  $V_Z$ , can then be found from:

$$\Delta V = \theta_{VZ} \Delta T_J$$

$\theta_{VZ}$ , the zener voltage temperature coefficient, is found from Figures 2 and 3.

Under high power-pulse operation, the zener voltage will vary with time and may also be affected significantly by the zener resistance. For best regulation, keep current excursions as low as possible.

Data of Figure 6 should not be used to compute surge capability. Surge limitations are given in Figure 8. They are lower than would be expected by considering only junction temperature, as current crowding effects cause temperatures to be extremely high in small spots resulting in device degradation should the limits of Figure 8 be exceeded.

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TEMPERATURE COEFFICIENTS AND VOLTAGE REGULATION  
(90% OF THE UNITS ARE IN THE RANGES INDICATED)

FIGURE 2 - TEMPERATURE COEFFICIENT-RANGE  
FOR UNITS TO 12 VOLTS

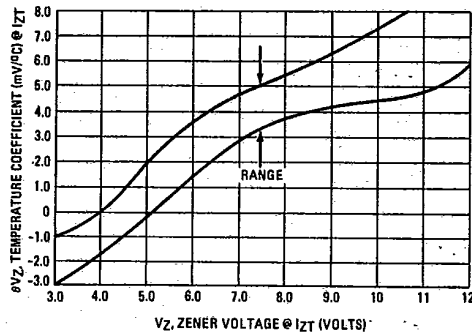


FIGURE 3 - TEMPERATURE COEFFICIENT-RANGE  
FOR UNITS 10 TO 220 VOLTS

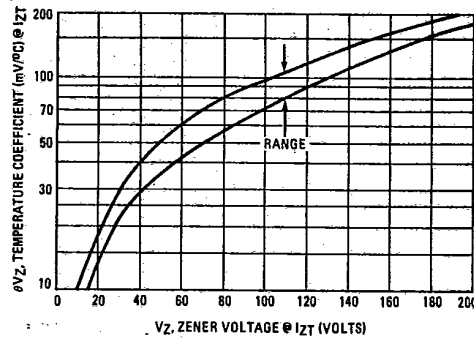


FIGURE 4 - TYPICAL VOLTAGE REGULATION

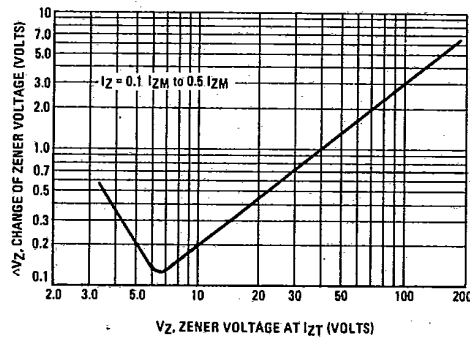


FIGURE 5 - MAXIMUM REVERSE LEAKAGE  
(95% OF THE UNITS ARE BELOW THE VALUES SHOWN)

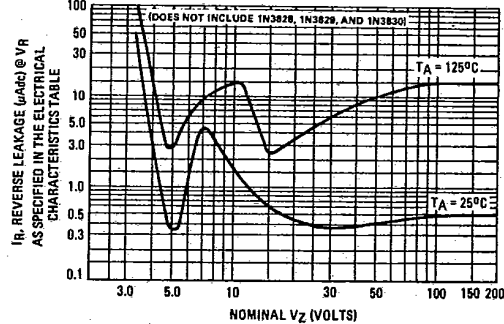


FIGURE 6 - TYPICAL THERMAL RESPONSE L, LEAD LENGTH = 3/8 INCH

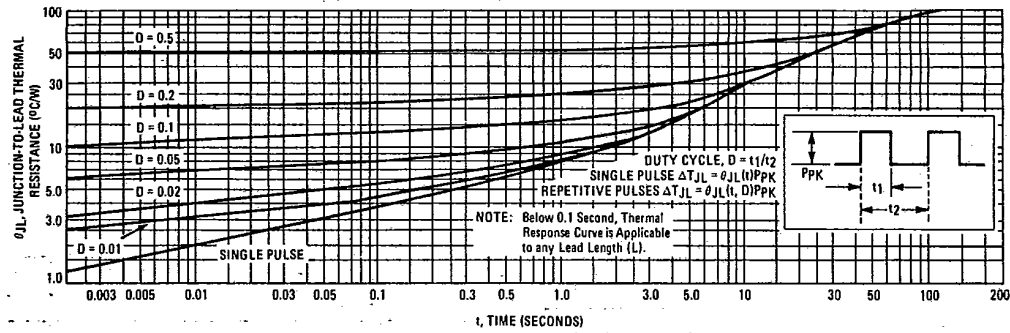


FIGURE 7 - TYPICAL THERMAL RESISTANCE

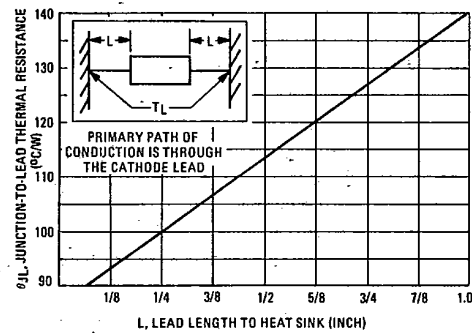
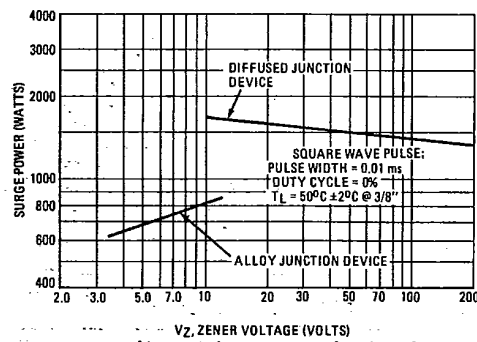


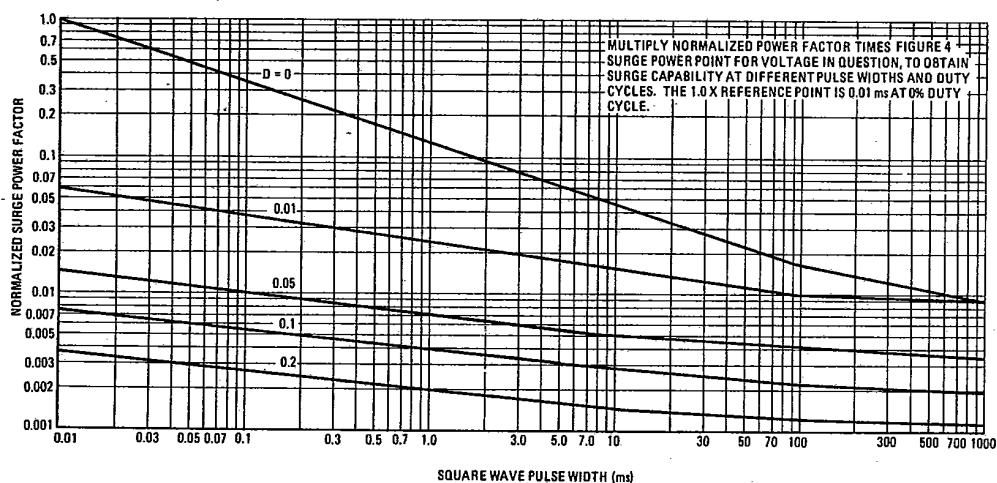
FIGURE 8 - MAXIMUM NON-REPETITIVE SURGE CURRENT



1N3821 thru 1N3830, 1N3016 thru 1N3051

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FIGURE 9 - SURGE POWER FACTOR



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FIGURE 10 - TYPICAL CAPACITANCE

