MOTOROLA

# SEMICONDUCTORS

P.O. BOX 20912 • PHOENIX, ARIZONA 85036

# MZT2970 THRU MZT3015

## 10 WATT ZENER TRANSIENT SUPPRESSORS

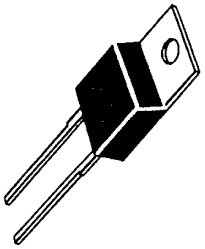
The MZT2970 Series is designed to protect voltage sensitive components from high voltage and high energy transients. They have low zener impedance and fast response time. The highly reliable TO-220 package features low thermal resistance and high heat dissipation. This series is ideally suited for use in communication systems, numerical controls, process controls, medical equipment, business machines, power supplies and numerous other industrial/consumer applications.

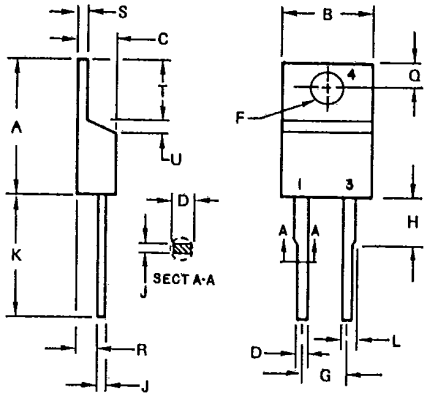
- Voltage Range of 6.8 to 200 Volts
- Silicon Oxide Passivated Junctions
- 600 Watts Peak Power Rating @ 1.0 ms
- TO-220 Package

10 WATT

ZENER TRANSIENT SUPPRESSORS

6.8 TO 200 V






STYLE 1:
PIN 1. CATHODE
2. N/A
3. ANODE
4. CATHODE

| DIM | MILLIMETERS MIN | MILLIMETERS MAX | INCHES MIN | INCHES MAX |
|---|---|---|---|---|
| A | 15.11 | 15.75 | 0.595 | 0.620 |
| B | 9.65 | 10.29 | 0.380 | 0.405 |
| C | 4.06 | 4.82 | 0.160 | 0.190 |
| D | 0.64 | 0.89 | 0.025 | 0.035 |
| F | 3.61 | 3.73 | 0.142 | 0.147 |
| G | 4.83 | 5.33 | 0.190 | 0.210 |
| H | 2.79 | 3.30 | 0.110 | 0.130 |
| J | 0.36 | 0.56 | 0.014 | 0.022 |
| K | 12.70 | 14.27 | 0.500 | 0.562 |
| L | 1.14 | 1.27 | 0.045 | 0.050 |
| Q | 2.54 | 3.04 | 0.100 | 0.120 |
| R | 2.04 | 2.79 | 0.080 | 0.110 |
| S | 1.14 | 1.39 | 0.045 | 0.055 |
| T | 5.97 | 6.48 | 0.235 | 0.255 |
| U | 0.76 | 1.27 | 0.030 | 0.050 |

**CASE 221B-01**
**TO-220AC**

## MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Steady State Power Dissipation @ $T_C$ = 120°C<br>Derate above $T_C$ = 120°C | $P_D$ | 10<br>333 | Watts<br>mW/°C |
| Operating and Storage Junction Temperature Range | $T_J$, $T_{stg}$ | −65 to +150 | °C |

## MECHANICAL CHARACTERISTICS

**CASE:** TO-220

**MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES:** 230°C, 1/16" from case for 10 seconds

**FINISH:** Leads are corrosion resistant and readily solderable

**POLARITY:** Cathode to case

## THERMAL CHARACTERISTICS

| | | | |
|---|---|---|---|
| Thermal Resistance Junction to Case | $R_{\theta JC}$ | 3.0 | °C/W |
| Thermal Resistance Junction to Ambient | $R_{\theta JA}$ | 80 | °C/W |

**ELECTRICAL CHARACTERISTICS** (At $T_C$ = 30°C unless otherwise specified. $V_F$ = 1.5 V Max @ $I_F$ = 2.0 Amps for all types.)

| Device (Note 1) | Nominal Zener Voltage $V_Z$ @ $I_{ZT}$ Volts (Notes 1, 2, 3) | Test Current $I_{ZT}$ mA | Max Zener Impedance (Note 4) | | | Max DC Zener Current $I_{ZM}$ mA (Note 5) | Max. Reverse Current (Note 6) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | $Z_{ZT}$ @ $I_{ZT}$ Ohms | $Z_{ZK}$ @ $I_{ZK}$ Ohms | $I_{ZK}$ mA | | $I_R$ Max ($\mu$A) | $V_{R1}$ 5% | $V_{R2}$ 10% |
| MZT2970 | 6.8 | 370 | 1.2 | 500 | 1.0 | 1,320 | 150 | 5.2 | 4.9 |
| MZT2971 | 7.5 | 335 | 1.3 | 250 | 1.0 | 1,180 | 75 | 5.7 | 5.4 |
| MZT2972 | 8.2 | 305 | 1.5 | 250 | 1.0 | 1,040 | 50 | 6.2 | 5.9 |
| MZT2973 | 9.1 | 275 | 2.0 | 250 | 1.0 | 960 | 25 | 6.9 | 6.6 |
| MZT2974 | 10 | 250 | 3 | 250 | 1.0 | 860 | 10 | 7.6 | 7.2 |
| MZT2975 | 11 | 230 | 3 | 250 | 1.0 | 780 | 5 | 8.4 | 8.0 |
| MZT2976 | 12 | 210 | 3 | 250 | 1.0 | 720 | 5 | 9.1 | 8.6 |
| MZT2977 | 13 | 190 | 3 | 250 | 1.0 | 660 | 5 | 9.9 | 9.4 |
| MZT2978 | 14 | 180 | 3 | 250 | 1.0 | 600 | 5 | 10.6 | 10.1 |
| MZT2979 | 15 | 170 | 3 | 250 | 1.0 | 560 | 5 | 11.4 | 10.8 |
| MZT2980 | 16 | 155 | 4 | 250 | 1.0 | 530 | 5 | 12.2 | 11.5 |
| MZT2982 | 18 | 140 | 4 | 250 | 1.0 | 460 | 5 | 13.7 | 13.0 |
| MZT2983 | 19 | 130 | 4 | 250 | 1.0 | 440 | 5 | 14.4 | 13.7 |
| MZT2984 | 20 | 125 | 4 | 250 | 1.0 | 420 | 5 | 15.2 | 14.4 |
| MZT2985 | 22 | 115 | 5 | 250 | 1.0 | 380 | 5 | 16.7 | 15.8 |
| MZT2986 | 24 | 105 | 5 | 250 | 1.0 | 350 | 5 | 18.2 | 17.3 |
| MZT2988 | 27 | 95 | 7 | 250 | 1.0 | 300 | 5 | 20.6 | 19.4 |
| MZT2989 | 30 | 85 | 8 | 300 | 1.0 | 280 | 5 | 22.8 | 21.6 |
| MZT2990 | 33 | 75 | 9 | 300 | 1.0 | 260 | 5 | 25.1 | 23.8 |
| MZT2391 | 36 | 70 | 10 | 300 | 1.0 | 230 | 5 | 27.4 | 25.9 |
| MZT2992 | 39 | 65 | 11 | 300 | 1.0 | 210 | 5 | 29.7 | 28.1 |
| MZT2993 | 43 | 60 | 12 | 400 | 1.0 | 195 | 5 | 32.7 | 31.0 |
| MZT2995 | 47 | 55 | 14 | 400 | 1.0 | 175 | 5 | 35.8 | 33.8 |
| MZT2996 | 50 | 50 | 15 | 500 | 1.0 | 165 | 5 | 38.0 | 36.0 |
| MZT2997 | 51 | 50 | 15 | 500 | 1.0 | 163 | 5 | 38.8 | 36.7 |
| MZT2998 | 52 | 50 | 15 | 500 | 1.0 | 160 | 5 | 39.5 | 37.4 |
| MZT2999 | 56 | 45 | 16 | 500 | 1.0 | 150 | 5 | 42.6 | 40.3 |
| MZT3000 | 62 | 40 | 17 | 600 | 1.0 | 130 | 5 | 47.1 | 44.6 |
| MZT3001 | 68 | 37 | 18 | 600 | 1.0 | 120 | 5 | 51.7 | 49.0 |
| MZT3002 | 75 | 33 | 22 | 600 | 1.0 | 110 | 5 | 56.0 | 54.0 |
| MZT3003 | 82 | 30 | 25 | 700 | 1.0 | 100 | 5 | 62.2 | 59.0 |
| MZT3004 | 91 | 28 | 35 | 800 | 1.0 | 85 | 5 | 69.2 | 65.5 |
| MZT3005 | 100 | 25 | 40 | 900 | 1.0 | 80 | 5 | 76.0 | 72.0 |
| MZT3006 | 105 | 25 | 45 | 1,000 | 1.0 | 75 | 5 | 79.8 | 75.6 |
| MZT3007 | 110 | 23 | 55 | 1,100 | 1.0 | 72 | 5 | 83.6 | 79.2 |
| MZT3008 | 120 | 20 | 75 | 1,200 | 1.0 | 67 | 5 | 91.2 | 86.4 |
| MZT3009 | 130 | 19 | 100 | 1,300 | 1.0 | 62 | 5 | 98.8 | 93.6 |
| MZT3010 | 140 | 18 | 125 | 1,400 | 1.0 | 58 | 5 | 106.4 | 100.8 |
| MZT3011 | 150 | 17 | 175 | 1,500 | 1.0 | 54 | 5 | 114.0 | 108.0 |
| MZT3012 | 160 | 16 | 200 | 1,600 | 1.0 | 50 | 5 | 121.6 | 115.2 |
| MZT3014 | 180 | 14 | 260 | 1,850 | 1.0 | 45 | 5 | 136.8 | 129.6 |
| MZT3015 | 200 | 12 | 300 | 2,000 | 1.0 | 40 | 5 | 152.0 | 144.0 |

**NOTE 1. Tolerance:**

The type numbers shown indicate a tolerance of ±20% with guaranteed limits on only $V_Z$, $I_R$ and $V_F$ as shown in the electrical characteristics table. Units with guaranteed limits on all six parameters are indicated by suffix "A" for ±10% tolerance and suffix "B" for ±5.0% units.

**NOTE 2. Special Selectionst Available Include:**

1. Nominal zener voltages between those shown.
2. Two or more units for series connection with specified tolerance on total voltage. Series matched sets make zener voltages in excess of 200 volts possible as well as providing lower temperature coefficients, lower dynamic impedance and greater power handling ability.
3. Nominal voltages at non-standard test currents.

**NOTE 3. Zener Voltage ($V_Z$) Measurement:**

Nominal zener voltage is measured after the test current $I_{ZT}$ has been applied for 1 ms while maintaining the case temperature at 30°C ± 1°C.

**NOTE 4. Zener Impedance ($Z_Z$) Derivation:**

$Z_{ZT}$ and $Z_{ZK}$ are measured by dividing the ac voltage drop across the device by the ac current applied. The specified limits are for $I_{Z(ac)}$ = 0.1 × $I_{Z(dc)}$ with the ac frequency = 1.0 kHz.

**NOTE 5. Maximum Zener Current Ratings ($I_{ZM}$):**

Maximum zener current ratings are based on maximum voltage of a 20% tolerance unit. For closer tolerance units (10% or 5%) or units where the actual zener voltage ($V_Z$) is known at the operating point, the maximum zener current may be increased and is limited by the derating curve.

**NOTE 6. Reverse Leakage Current $I_R$:**

Reverse leakage currents are guaranteed only for 5% and 10% 10 Watt silicon zener diodes and are measured at $V_R$ as shown on the table.

## APPLICATION NOTES

### SPECIAL DEVICES

Matched sets and back-to-back configurations for bi-directional applications can be ordered upon special request. Contact your nearest Motorola representative.

### RESPONSE TIME

In most applications, the transient suppressor device is placed in parallel with the equipment or component to be protected. In this situation, there is a time delay associated with the capacitance of the device and an overshoot condition associated with the inductance of the device and the inductance of the connection method.

The capacitive effect is of minor importance in the parallel protection scheme because it only produces a time delay in the transition from the operating voltage to the clamp voltage as shown in Figure A.

The inductive effects in the device are due to actual turn-on time (time required for the device to go from zero current to full current) and lead inductance. This inductive effect produces an overshoot in the voltage across the equipment or component being protected as shown in Figure B. Minimizing this overshoot is very important in the application, since the main purpose for adding a transient suppressor is to clamp voltage spikes. The MZT2970 series has very good response time, typically <1.0 ns and negligible inductance. However, external inductive effects could produce unacceptable overshoot. Proper circuit layout, minimum lead lengths and placing the suppressor device as close as possible to the equipment or components to be protected will minimize this overshoot.

Some input impedance represented by $Z_{in}$ is essential to prevent overstress of the protection device. This impedance should be as high as possible, without restricting the circuit operation.

**TYPICAL PROTECTION CIRCUIT**

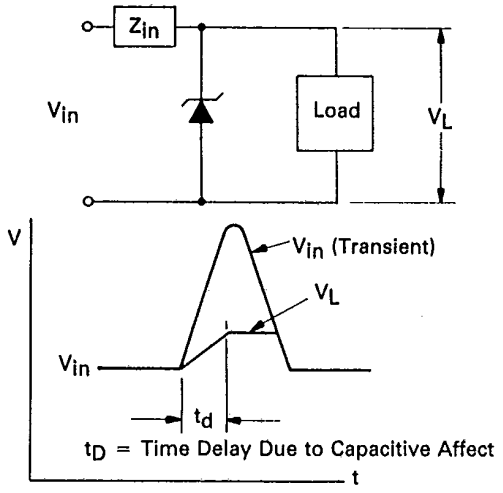



FIGURE A

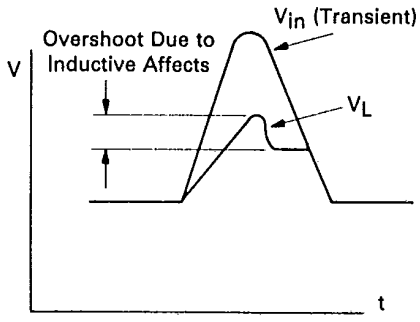



FIGURE B

FIGURE 1 — PULSE POWER RATING CURVE

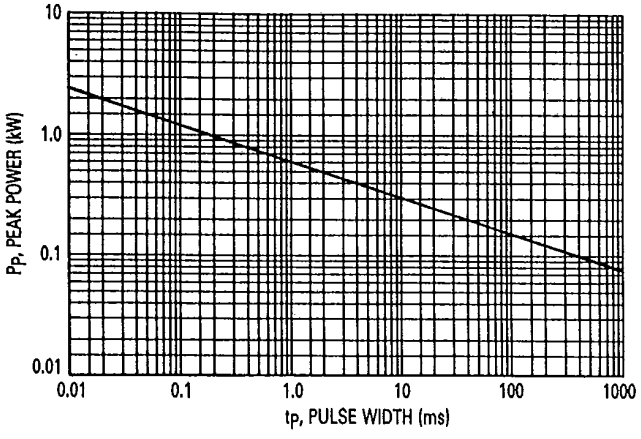



FIGURE 2 — POWER DERATING CURVE

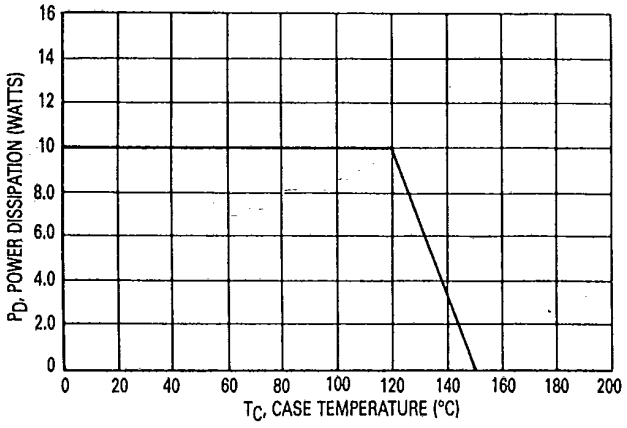


FIGURE 3 — PULSE WAVEFORM

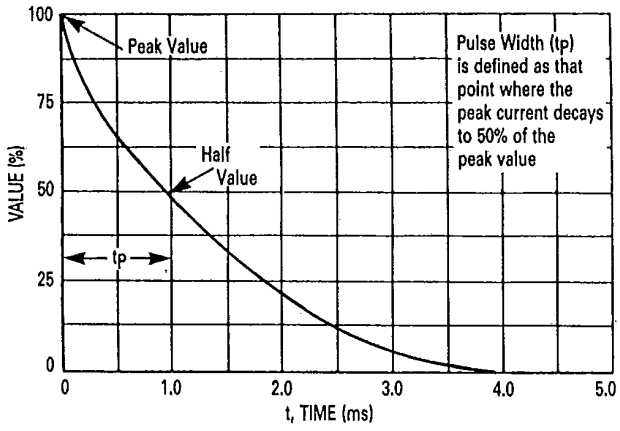



FIGURE 4 — TYPICAL REVERSE LEAKAGE CURRENT

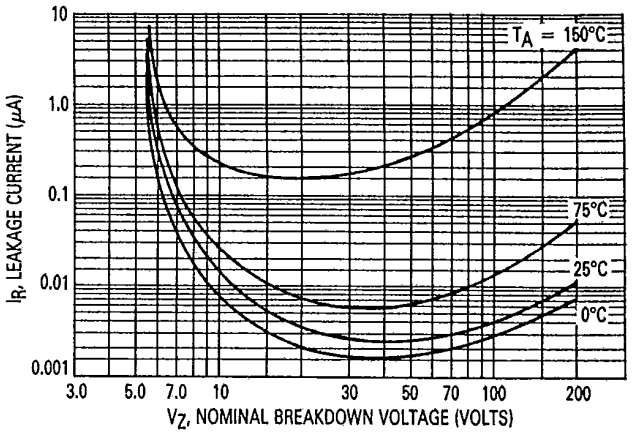
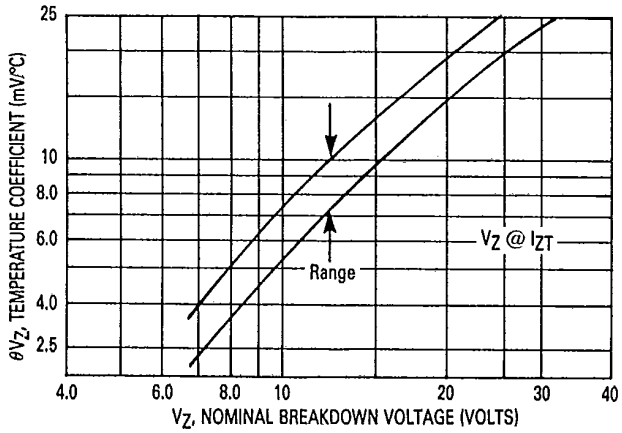



FIGURE 5 — TEMPERATURE COEFFICIENTS
(90% OF THE UNITS ARE IN THE RANGES INDICATED.)

A — RANGE FOR UNITS 6.8–24 VOLTS




B — RANGE FOR UNITS 24–200 VOLTS

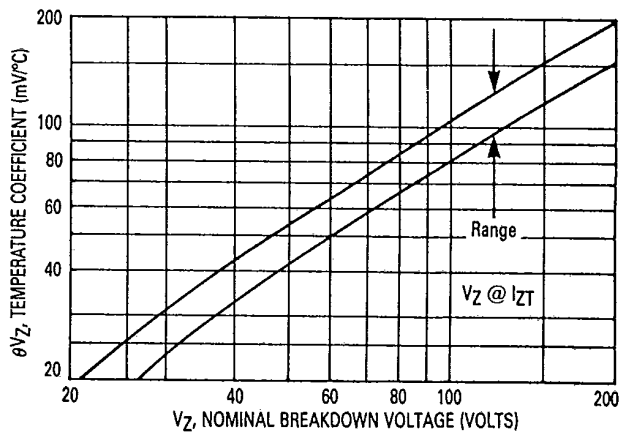
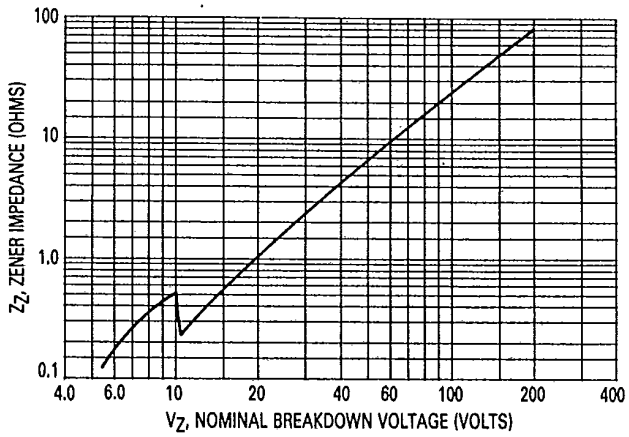



FIGURE 6 — TYPICAL ZENER IMPEDANCE AT TEST CURRENT





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05-7068