MOTOROLA

# MDA980-1 thru MDA980-6
# MDA990-1 thru MDA990-6

## Designers Data Sheet

### RECTIFIER ASSEMBLY

. . . utilizing individual void-free molded MR2500 Series rectifiers, interconnected and mounted on an electrically isolated aluminum heat sink by a high thermal-conductive epoxy resin.

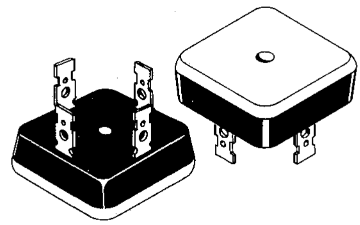
- 400 Ampere Surge Capability
- Electrically Isolated Base
- Fast Recovery Available on Request
- Cost Effective in Lower Current Applications

**Designers 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.

SINGLE-PHASE
FULL-WAVE BRIDGE

12 and 30 AMPERES
50 thru 600 VOLTS



### MAXIMUM RATINGS ($T_C$ = 25°C unless otherwise noted)

| Rating | Symbol | -1 | -2 | -3 | -4 | -5 | -6 | Unit |
|---|---|---|---|---|---|---|---|---|
| Peak Repetitive Reverse Voltage<br>Working Peak Reverse Voltage<br>DC Blocking Voltage | $V_{RRM}$<br>$V_{RWM}$<br>$V_R$ | 50 | 100 | 200 | 300 | 400 | 600 | Volts |
| RMS Reverse Voltage | $V_{R(RMS)}$ | 35 | 70 | 140 | 210 | 280 | 420 | Volts |
| DC Output Voltage<br>Resistive Load<br>Capacitive Load | <br>Vdc<br>Vdc | <br>30<br>50 | <br>62<br>100 | <br>124<br>200 | <br>185<br>300 | <br>250<br>400 | <br>380<br>600 | Volts |
| Average Rectified Forward Current (Single phase bridge resistive load, 60 Hz, $T_C$ = 55°C) MDA980<br>MDA990 | $I_O$ | 12<br>30 | | | | | | Amp |
| Non-Repetitive Peak Surge Current (Surge applied at rated load conditions) | $I_{FSM}$ | 300 | | | | | | Amp |
| Operating and Storage Junction Temperature Range | $T_J, T_{stg}$ | -65 to +175 | | | | | | °C |

### THERMAL CHARACTERISTICS

| Characteristic | | | Symbol | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Thermal Resistance, Junction to Case | Each Die | MDA980<br>MDA990 | $R_{\theta JC}$ | 8.5<br>4.5 | 11<br>6.0 | °C/W |
| | Effective Bridge | MDA980<br>MDA990 | $R_{\theta(EFF)}$ | —<br>— | 6.05<br>2.28 | °C/W |

### ELECTRICAL CHARACTERISTICS ($T_C$ = 25°C unless otherwise noted)

| Characteristic | | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Instantaneous Forward Voltage (Per Diode) | | $v_F$ | | | | Volts |
| ($i_F$ = 18.9 A) | MDA980 | | — | 0.88 | 0.97 | |
| ($i_F$ = 47 A) | MDA990 | | — | 0.98 | 1.07 | |
| ($i_F$ = 18.9 A, $T_J$ = 175°C) | MDA980 | | — | — | 0.85 | |
| ($i_F$ = 47 A, $T_J$ = 175°C) | MDA990 | | — | — | 0.98 | |
| Reverse Current (Rated $V_{RM}$ applied to ac terminals, + and − terminals open) | | $I_R$ | — | — | 0.5 | mA |

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FIGURE 1 – FORWARD VOLTAGE

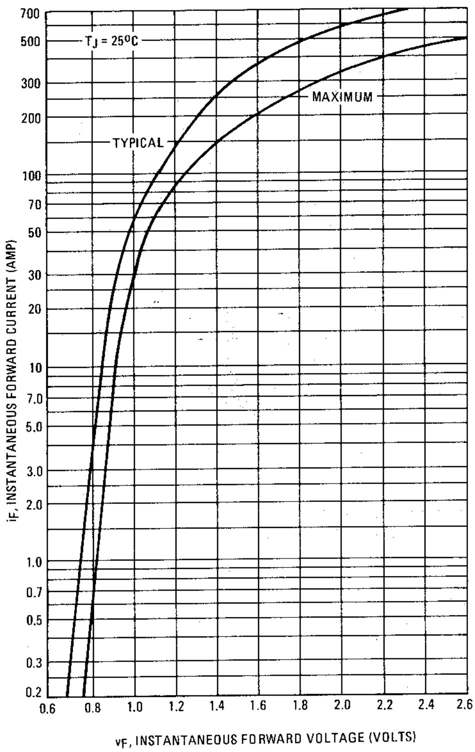



FIGURE 2 – MAXIMUM SURGE CAPABILITY

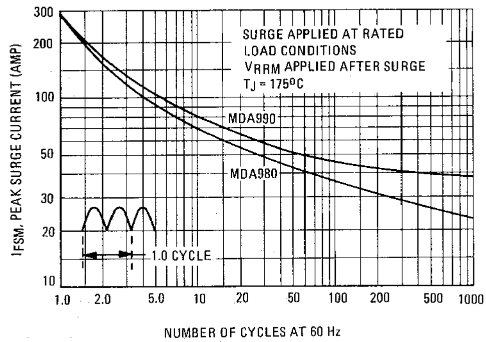



FIGURE 3 – FORWARD VOLTAGE TEMPERATURE COEFFICIENT

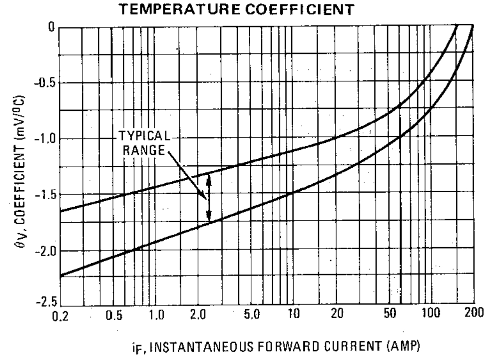
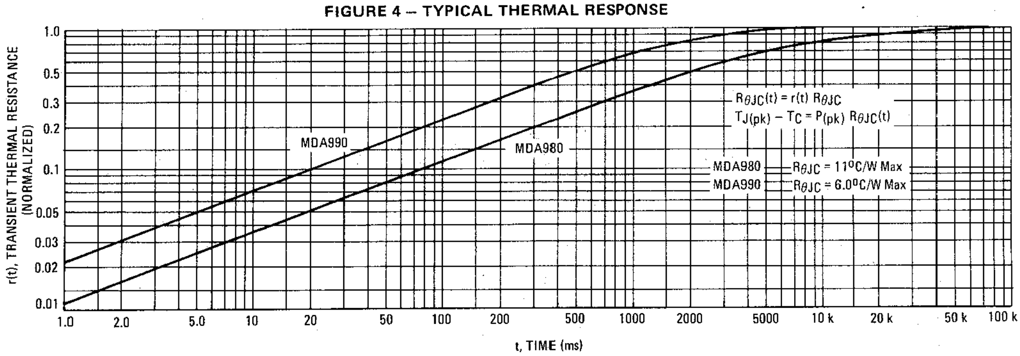



FIGURE 4 – TYPICAL THERMAL RESPONSE

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## MAXIMUM CURRENT RATINGS, BRIDGE OPERATION

FIGURE 5 – MDA980 CURRENT DERATING

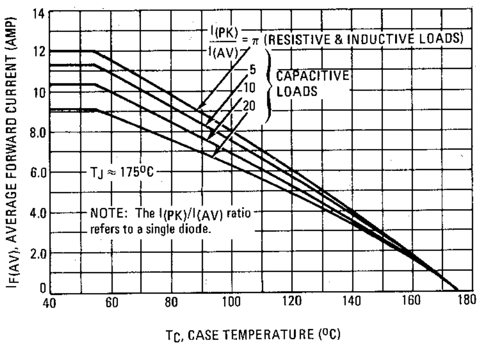
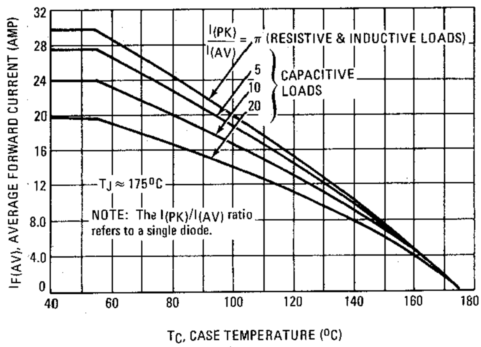



FIGURE 6 – MDA990 CURRENT DERATING




## TYPICAL DYNAMIC CHARACTERISTICS (EACH DIODE)

FIGURE 7 – RECTIFICATION EFFICIENCY

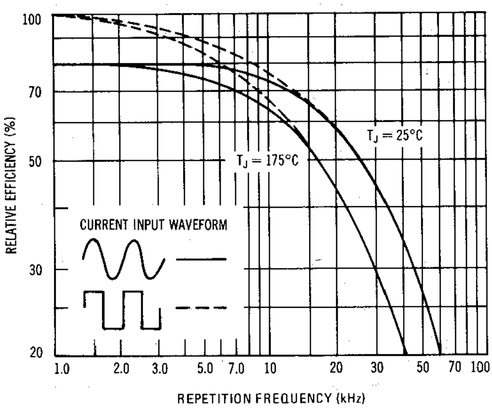



FIGURE 8 – JUNCTION CAPACITANCE

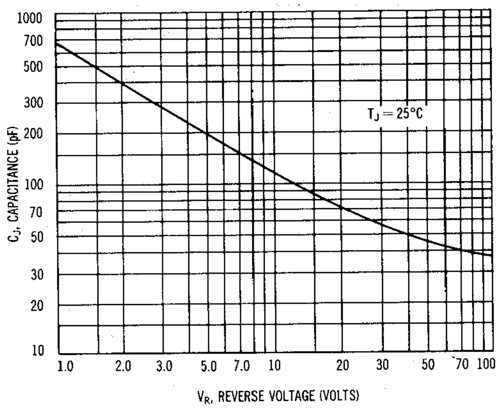



FIGURE 9 – REVERSE RECOVERY TIME

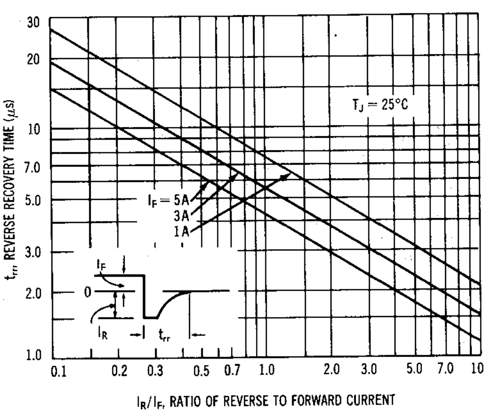



FIGURE 10 – FORWARD RECOVERY TIME

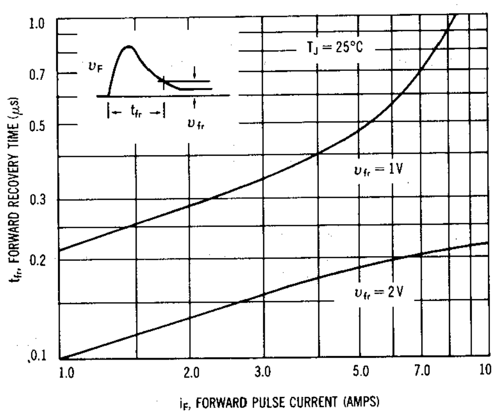



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**FIGURE 11 – POWER DISSIPATION**

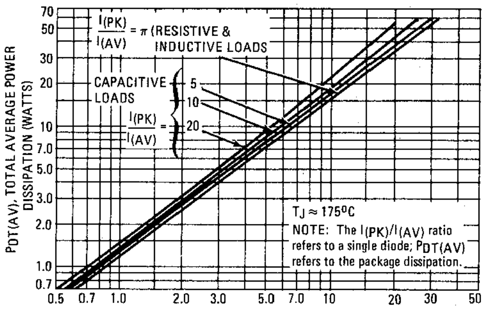
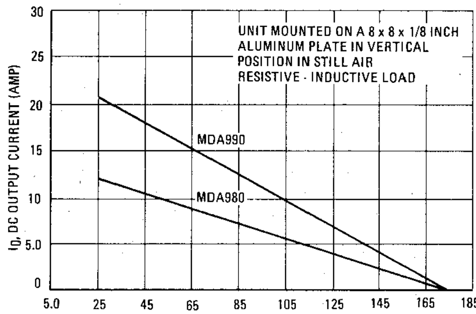



**FIGURE 12 – CURRENT VERSUS AMBIENT TEMPERATURE**




## NOTE 1 – THERMAL COUPLING AND EFFECTIVE THERMAL RESISTANCE

In multiple chip devices where there is coupling of heat between die, the junction temperature can be calculated as follows:

(1) $\Delta T_{J1} = R_{\theta 1} P_{D2} + R_{\theta 2} K_{\theta 2} P_{D2} + R_{\theta 3} K_{\theta 3} P_{D3} + R_{\theta 4} K_{\theta 4} P_{D4}$

Where $\Delta T_{J1}$ is the change in junction temperature of diode 1

$R_{\theta 1 \text{ thru } 4}$ is the thermal resistance of diodes 1 through 4.

$P_{D1 \text{ thru } 4}$ is the power dissipated in diodes 1 through 4

$K_{\theta 2 \text{ thru } 4}$ is the thermal coupling between diode 1 and diodes 2 through 4.

An effective package thermal resistance can be defined as follows:

(2) $R_{\theta(EFF)} = \Delta T_{J1}/P_{DT}$

Where: $P_{DT}$ is the total package power dissipation.

Assuming equal thermal resistance for each die, equation (1) simplifies to

(3) $\Delta T_{J1} = R_{\theta 1}(P_{D1} + K_{\theta 2} P_{D2} + K_{\theta 3} P_{D3} + K_{\theta 4} P_{D4})$

For the condition where $P_{D1} = P_{D2} = P_{D3} = P_{D4}$, $P_{DT} = 4P_{D1}$ equation (3) can be further simplified and by substituting into equation (2) results in

(4) $R_{\theta(EFF)} = R_{\theta 1}\ (1 + K_{\theta 2} + K_{\theta 3} + K_{\theta 4})/4$

For the MDA980 rectifier assembly, thermal coupling between opposite diodes is 42% and between adjacent diodes is 50% when the case temperature is used as a reference. Similarly for the MDA990, thermal coupling between opposite diodes is 12% and between adjacent diodes is 20%.

## NOTE 2 – SPLIT LOAD DERATING INFORMATION

Bridge rectifiers are used in two basic configurations as shown in circuits A and B of Figure 13. The current derating data of Figures 5 and 6 apply to the standard bridge circuit (A) where $I_A = I_B$. For circuit B where $I_A \neq I_B$, derating information can be calculated as follows:

(5) $T_{R(MAX)} = T_{J(MAX)} - \Delta T_{J1}$

Where $T_{R(MAX)}$ is the reference temperature (either case or ambient)

$\Delta T_{J1}$ can be calculated using equation (3) in Note 1.

For example, to determine $T_{C(MAX)}$ for the MDA990 with the following capacitive load conditions:

$I_A$ = 20 A average with a peak of 86 A
$I_B$ = 10 A average with a peak of 72 A

First calculate the peak to average ratio for $I_A$. $I_{(PK)}/I_{(AV)}$ = 86/10 = 8.6. (Note that the peak to average ratio is on a per diode basis and each diode provides 10A average).

From Figure 11, for an average current of 20 A and an $I_{(PK)}/I_{(AV)}$ = 8.6 read $P_{DT(AV)}$ = 40 watts or 10 watts/diode. Thus $P_{D1} = P_{D3}$ = 10 watts.

Similarly, for a load current $I_B$ of 10 A, diode #2 and diode #4 each see 5.0 A average resulting in an $I_{(PK)}/I_{(AV)} \approx 14.4$

Thus, the package power dissipation for 10 A is 20.2 watts or 5.05 watts/diode. ∴ $P_{D2} = P_{D4}$ = 5.05 watts.

The maximum junction temperature occurs in diodes #1 and #3. From equation (3) for diode #1 $\Delta T_{J1}$ = 5.6 [10 + 0.12 (5.05) + 0.2 (10) + 0.2 (5.05)].

$\Delta T_{J1} \approx 76°C$

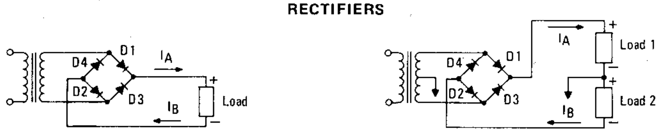
Thus $T_{C(MAX)}$ = 175-76 = 99°C

The total package dissipation in this example is:

$P_J = 2 \times 10 + 2 \times 5.05 \approx 30.1$ watts

(Note that although maximum $R_{\theta JC}$ is 6°C/W, 5.6°C/watt is used in this example and on the derating data as it is unlikely that all four die in a given package would be at the maximum value).

**FIGURE 13 – BASIC CIRCUIT USES FOR BRIDGE RECTIFIERS**




CIRCUIT A    CIRCUIT B

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**MECHANICAL CHARACTERISTICS**

CASE: Transfer-molded plastic encapsulation

POLARITY: Terminal-designation embossed on case
+DC output
-DC output
AC not marked

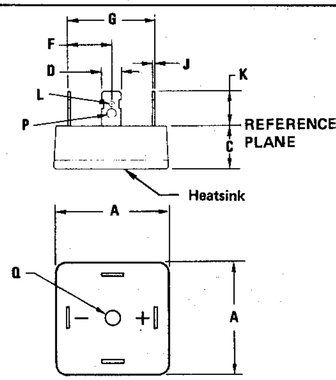
MOUNTING POSITION: Bolt down-highest heat transfer efficiency accomplished through the surface opposite the terminals.

WEIGHT: MDA980 – 21 grams (approx.)
MDA990 – 22.5 grams (approx.)

TERMINALS: Suitable for fast-on connections, readily solderable connections, corrosion resistant.

MOUNTING TORQUE: 20 in. lb. Max.

## OUTLINE DIMENSIONS




NOTE:
1. DIM "Q" SHALL BE MEASURED ON HEATSINK SIDE OF PKG.
2. DIMENSIONS F AND G SHALL BE MEASURED AT THE REFERENCE PLANE.

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 34.80 | 35.18 | 1.370 | 1.385 |
| C | 12.44 | 13.97 | 0.490 | 0.550 |
| D | 6.10 | 6.60 | 0.240 | 0.260 |
| F | 13.97 | 14.50 | 0.550 | 0.571 |
| G | 28.00 | 29.00 | 1.100 | 1.142 |
| J | 0.71 | 0.86 | 0.028 | 0.034 |
| K | 9.52 | 11.43 | 0.375 | 0.450 |
| L | 1.52 | 2.06 | 0.060 | 0.081 |
| P | 2.79 | 2.92 | 0.110 | 0.115 |
| Q | 4.32 | 4.83 | 0.170 | 0.190 |

CASE 309A-02

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