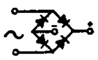
MOTOROLA
# SEMICONDUCTOR
TECHNICAL DATA

# MDA3500 Series

## RECTIFIER ASSEMBLY

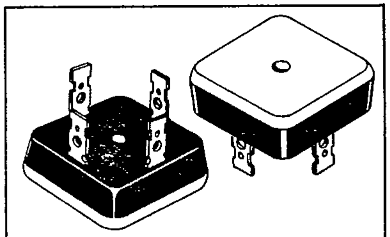
. . . utilizing individual void-free molded MR2500 Series rectifiers, interconnected and mounted on an electrically isolated aluminum heat sink by a high thermal-conductive epoxy resin.

- 400 Ampere Surge Capability
- Electrically Isolated Base —1800 Volts
- UL Recognized
- Cost Effective in Lower Current Applications



**SINGLE-PHASE FULL-WAVE BRIDGE**

**35 AMPERES**
**50-1000 VOLTS**



### MAXIMUM RATINGS

| Rating (Per Diode) | Symbol | MDA 3500 | 3501 | 3502 | 3504 | 3506 | 3508 | 3510 | Unit |
|---|---|---|---|---|---|---|---|---|---|
| Peak Repetitive Reverse Voltage | $V_{RRM}$ | | | | | | | | |
| Working Peak Reverse Voltage | $V_{RWM}$ | 50 | 100 | 200 | 400 | 600 | 800 | 1000 | Volts |
| DC Blocking Voltage | $V_R$ | | | | | | | | |
| DC Output Voltage Resistive Load | Vdc | 30 | 62 | 124 | 250 | 380 | 500 | 630 | Volts |
| Capacitive Load | Vdc | 50 | 100 | 200 | 400 | 600 | 800 | 1000 | Volts |
| Sine Wave RMS Input Voltage | $V_{R(RMS)}$ | 35 | 70 | 140 | 280 | 420 | 560 | 700 | Volts |
| Average Rectified Forward Current (Single phase bridge resistive load, 60 Hz, $T_C = 55°C$) | $I_O$ | ← 35 → | | | | | | | Amp |
| Non-Repetitive Peak Surge Current (Surge applied at rated load conditions) | $I_{FSM}$ | ← 400 → | | | | | | | Amp |
| Operating and Storage Junction Temperature Range | $T_J, T_{stg}$ | ← −65 to +175 → | | | | | | | °C |

### THERMAL CHARACTERISTICS (Total Bridge)

| Characteristic | Symbol | Typ | Max | Unit |
|---|---|---|---|---|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 1.4 | 1.87 | °C/W |

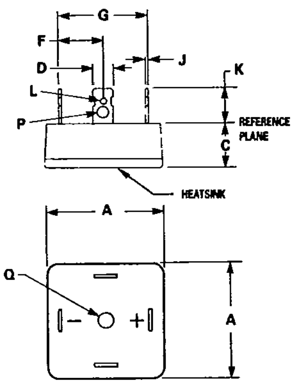
### ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted).

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Instantaneous Forward Voltage (Per Diode) ($i_F = 55$ A)* | $v_F$ | — | 1.0 | 1.1 | Volts |
| Reverse Current (Per Diode) (Rated $V_R$) | $I_R$ | — | — | 10 | μA |

### MECHANICAL CHARACTERISTICS

**CASE:** Plastic case with an electrically isolated aluminum base.
**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. Use silicone grease on mounting surface for maximum heat transfer.
**WEIGHT:** 40 grams (approx.)
**TERMINALS:** Suitable for fast-on connections. Readily solderable, corrosion resistant. Soldering recommended for applications greater than 15 amperes.
**MOUNTING TORQUE:** 20 in-lb max

*Pulse Width = 100 ms, Duty Cycle ≤ 2%.




NOTES:
1. DIMENSION "Q" SHALL BE MEASURED ON HEATSINK SIDE OF PACKAGE.
2. DIMENSIONS F AND G SHALL BE MEASURED AT THE REFERENCE PLANE.

| DIM | MILLIMETERS MIN | MAX | INCHES 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

FIGURE 1 — FORWARD VOLTAGE

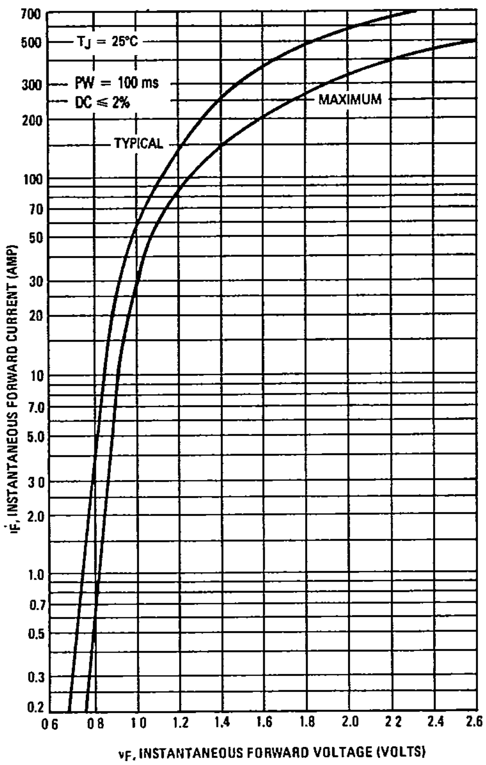



FIGURE 2 — NON REPETITIVE SURGE CURRENT

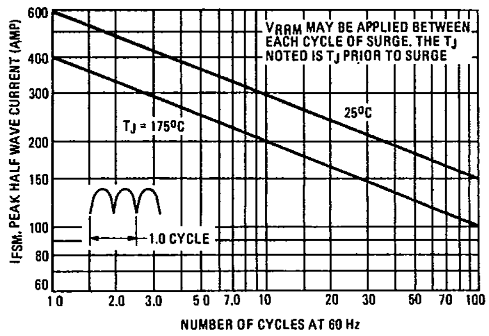



FIGURE 3 — FORWARD VOLTAGE TEMPERATURE COEFFICIENT

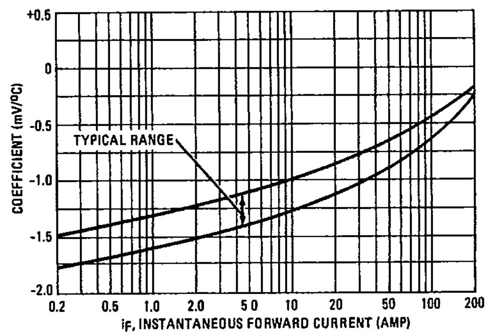



FIGURE 4 — CURRENT DERATING

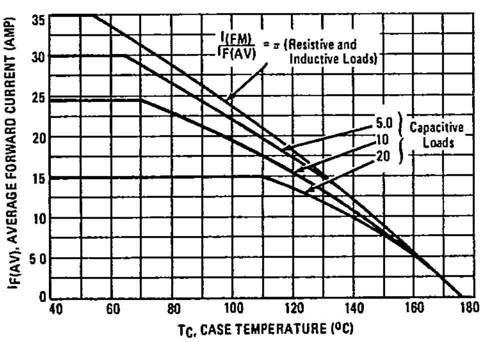



FIGURE 5 — FORWARD POWER DISSIPATION

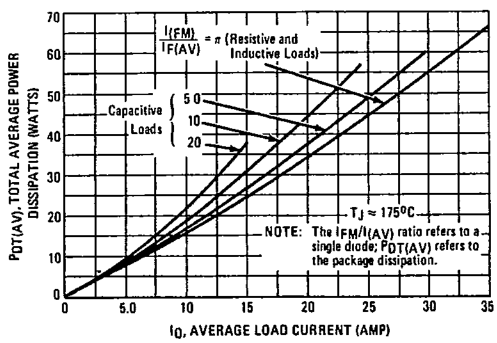
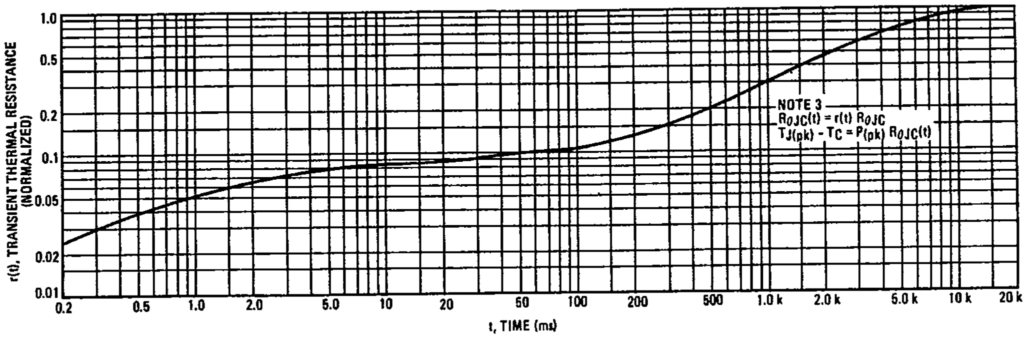
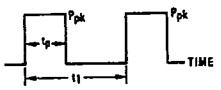


FIGURE 6 — TYPICAL THERMAL RESPONSE




NOTE 1




DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, $P_{pk}$, is peak of an equivalent square power pulse.

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended.

The temperature of the case should be measured using a thermocouple placed on the case at the temperature reference point (see the outline drawing on page 1). The thermal mass connected to the case 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 $T_C$, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where $\Delta T_{JC}$ is the increase in junction temperature above the case temperature. It may be determined by:

$$\Delta T_{JC} = P_{pk} \bullet R_{\theta JC} [D + (1 - D) \bullet r(t_1 + t_p) + r(t_p) - r(t_1)]$$

where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 6, i.e.,
$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$.

FIGURE 7 — CAPACITANCE

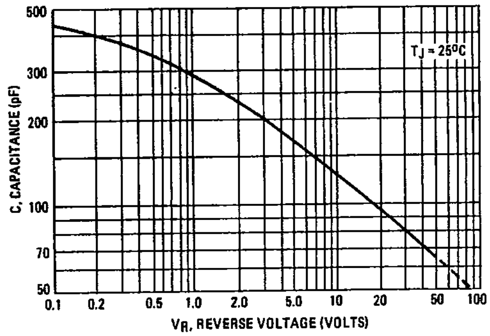



FIGURE 8 — FORWARD RECOVERY TIME

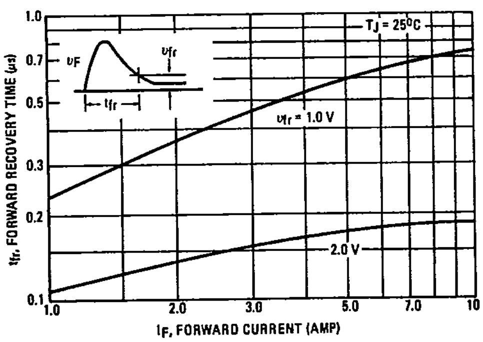
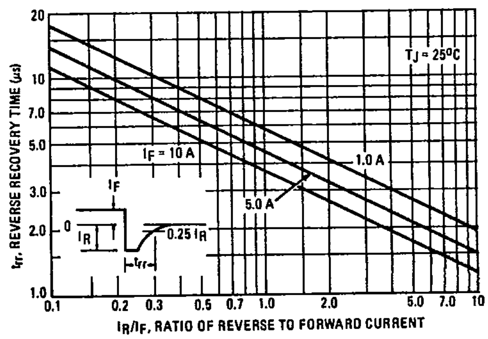



FIGURE 9 — REVERSE RECOVERY TIME



# MDA3500 Series

## AMBIENT TEMPERATURE DERATING INFORMATION

FIGURE 10A – THERMALLOY HEATSINK 6005B

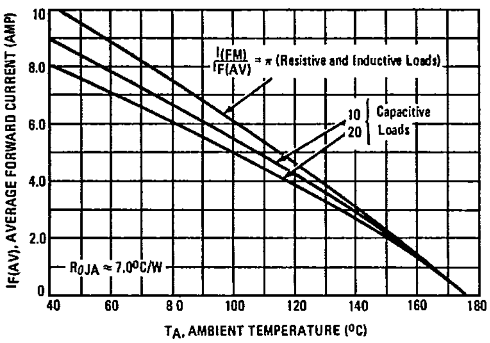
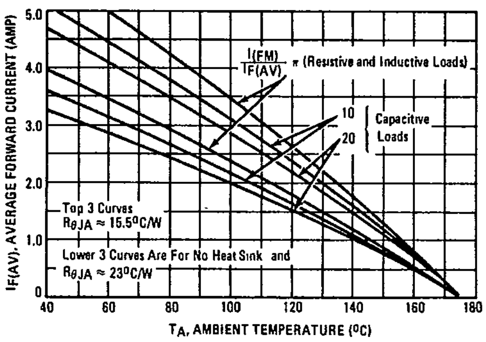



FIGURE 10B – IERC HEATSINK UP3 AND NO HEATSINK




**NOTE 2: 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) $\Delta T_{J1} = R_{\theta1} P_{D1} + R_{\theta2} K_{\theta2} P_{D2} + R_{\theta3} K_{\theta3} P_{D3} + R_{\theta4} K_{\theta4} P_{D4}$

Where $\Delta T_{J1}$ is the change in junction temperature of diode 1
$R_{\theta1}$ thru 4 is the thermal resistance of diodes 1 through 4
$P_{D1}$ thru 4 is the power dissipated in diodes 1 through 4
$K_{\theta2}$ 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) $\Delta T_{J1} = R_{\theta1} (P_{D1} + K_{\theta2} P_{D2} + K_{\theta3} P_{D3} + K_{\theta4} P_{D4})$

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

(4) $R_{\theta(EFF)} = R_{\theta1} (1 + K_{\theta2} + K_{\theta3} + K_{\theta4})/4$

When the case is used as a reference point, coupling between die is neglegible for the MDA3500. When the bridge is used without a heatsink, coupling between die is approximately 70% and $R_{\theta1}$ is 30°C/W,

$\therefore R_{\theta(EFF)} = 30 [1 + (3)(.7)]/4 = 23°C/W$

**NOTE 3: SPLIT LOAD DERATING INFORMATION**

Bridge rectifiers are used in two basic configurations as shown by circuits A and B of Figure 11. The current derating data of Figure 4 applies 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:

(6) $T_{R(Max)} = T_{J(Max)} - \Delta T_{J1}$

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

$\Delta T_{J1}$ can be calculated using equation (3) in Note 2.

For example, to determine $T_{C(Max)}$ for the MDA3500 with the following capacitive load condiitons.

$I_A$ = 20 A average with a peak of 60 A
$I_B$ = 10 A average with a peak of 70 A

First calculate the peak to average ratio for $I_A$. $I_{(PK)}/I_{(AV)}$ = 60/10 = 6.0. (Note that the peak to average ratio is on a per diode basis and each diode provides 10 A average).

From Figure 5, for an average current of 20 A and an $I_{(PK)}/I_{(AV)}$ = 6.0 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 $I_{(PK)}/I_{(AV)}$ = 14.

Thus, the package power dissipation for 10 A is 20 watts or 5.0 watts/diode $\therefore P_{D2} = P_{D4}$ = 5.0 watts.

The maximum junction temperature occurs in diode #1 and #3. From equation (3) for diode #1 $\Delta T_{J1}$ = (7.5) (10), since coupling is negligible.

$\Delta T_{J1} \approx 75°C$

Thus $T_{C(Max)}$ = 175 -75 = 100°C

The total package dissipation in this example is:

$P_{DT(AV)} = 2 \times 10 + 2 \times 5.0$ = 30 watts, which must be considered when selecting a heat sink.

FIGURE 11– BASIC CIRCUIT USES FOR BRIDGE RECTIFIERS


Circuit A

Circuit B