MOTOROLA

MDA920A1
thru
MDA920A9

Designers Data Sheet

MINIATURE INTEGRAL DIODE ASSEMBLIES

. . . passivated, diffused-silicon dice interconnected and transfer molded into voidless hybrid rectifier circuit assemblies.

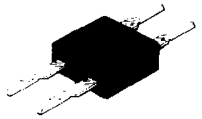
- Large Inrush Surge Capability – 45 A (For 1.0 Cycle)
- Efficient Thermal Management Provides Maximum Power Handling in Minimum Space

Designers Data for "Worst Case" Conditions

The Designers Data Sheet permits 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

1.5 AMPERES
25–1000 VOLTS



MAXIMUM RATINGS

Rating (Per Leg)	Symbol	A1	A2	A3	A4	A5	A6	A7	A8	A9	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	25	50	100	200	300	400	600	800	1000	Volts
DC Output Voltage											
Resistive Load	Vdc	15	30	62	124	185	250	380	500	620	Volts
Capacitative Load	Vdc	25	50	100	200	300	400	600	800	1000	Volts
Sine Wave RMS Input Voltage	$V_{R(RMS)}$	18	35	70	140	210	280	420	560	700	Volts
Average Rectified Forward Current (single phase bridge resistive load 60 Hz, see Figure 6, $T_A = 50^oC$	I_O	← 1.5 →									Amp
Non-Repetitive Peak Surge Current, (see Figure 2) rated load $T_J = 175^oC$	I_{FSM}	← 45 for 1 cycle →									Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}	← -55 to +175 →									^oC

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Maximum Instantaneous Forward Voltage Drop (Per Leg) (i_F = 2.4 Amp, $T_J = 25^oC$) Figure 1	v_F	1.2	Volts
Maximum Reverse Current (Rated dc Voltage across ac terminals, $T_J = 25^oC$)	I_R	20	μA

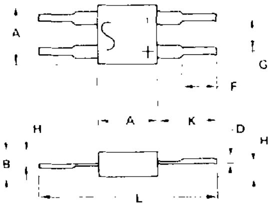
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Effective Bridge Thermal Resistance, Junction to Ambient (Full-Wave Bridge Operation, Typical Printed Circuit Board Mounting)	$R_{\theta JA}$	50	$^oC/W$

MECHANICAL CHARACTERISTICS

CASE: Transfer-molded plastic encapsulation.
POLARITY: Terminal-designation embossed on case +DC output
-DC output
~AC input

MOUNTING POSITION: Any
WEIGHT: 1.0 gram (approx)
TERMINALS: Readily solderable connections, corrosion resistant



NOTES
1. LEAD DIM "D" TO BE MEASURED WITHIN "F"
2. LEADS FORMED TO FIT INTO HOLE 0.94 mm (0.037) MIN

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.10	6.73	0.240	0.265
B	2.29	2.79	0.090	0.110
D	0.51	0.94	0.020	0.037
F	3.56	6.35	0.140	0.250
G	3.68	3.94	0.145	0.155
H	1.02	1.27	0.040	0.050
K	6.60	10.16	0.260	0.400
L	19.30	27.05	0.760	1.065

CASE 109-03

FIGURE 1 – FORWARD VOLTAGE (PER LEG)

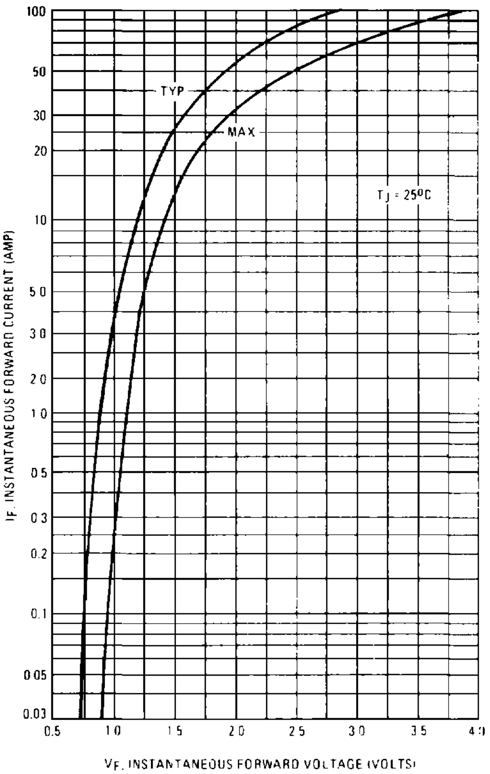


FIGURE 2 – MAXIMUM SURGE CAPABILITY

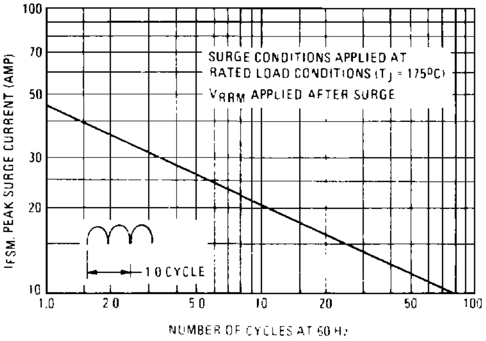


FIGURE 3 – FORWARD VOLTAGE TEMPERATURE COEFFICIENT

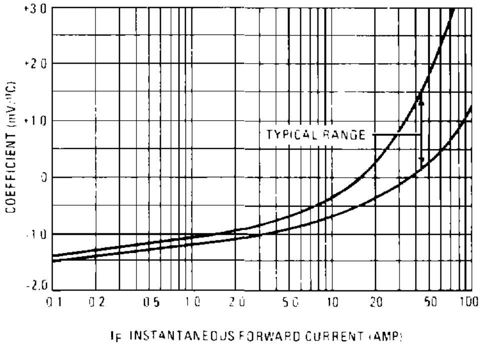


FIGURE 4 – TYPICAL THERMAL RESPONSE

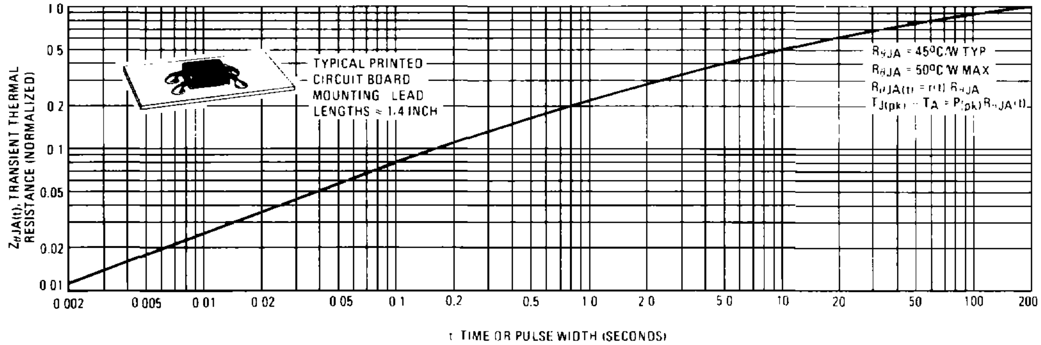


FIGURE 5 – POWER DISSIPATION

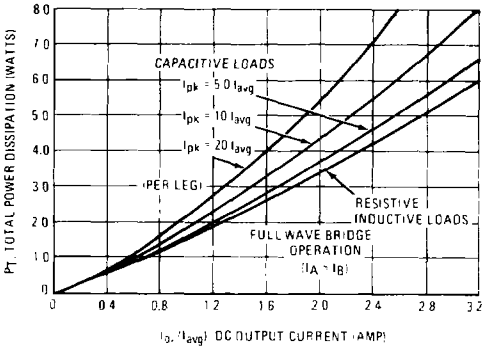


FIGURE 6 – CURRENT DERATING

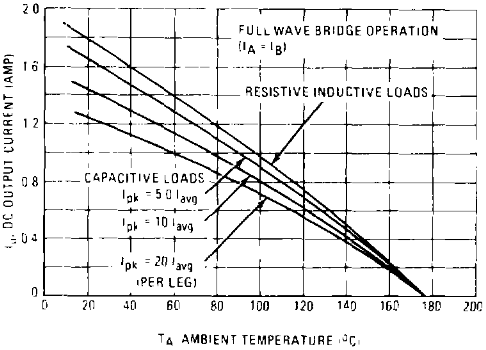
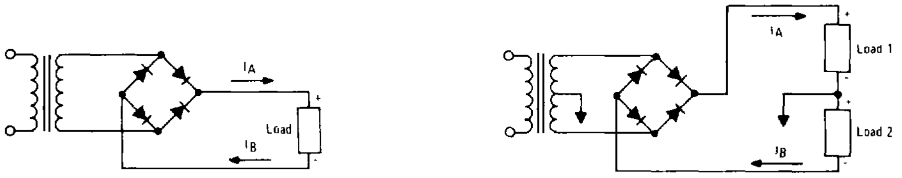


FIGURE 7 – BASIC CIRCUIT USES FOR BRIDGE RECTIFIERS



CIRCUIT A

CIRCUIT B

APPLICATION NOTE

The Data of Figure 4 applies for typical wire terminal or printed circuit board mounting conditions in still air. Under these or similar conditions, the thermal resistance between the diode junctions and the leads at the edge of the case is a small fraction of the thermal resistance from junction to ambient. Consequently, the lead temperature is very close to the junction temperature. Therefore, it is recommended that the lead temperature be measured when the diodes are operating in prototype equipment, in order to determine if operation is within the diode temperature ratings. The lead having the highest thermal resistance to the ambient will yield readings closest to the junction temperature. By measuring temperature as outlined, variations of junction to ambient thermal resistance, *caused by the amount of surface area of the terminals or printed* circuit board and the degree of air convection, as well as proximity of other heat sources cease to be important design considerations.

Bridge rectifiers are used in two basic circuit configurations as shown by circuits A and B of Figure 7. The current derating data of Figure 6 applies to the standard bridge circuit (A), where $I_A = I_B$. *The derating data considers the thermal response of the junction* and is based upon the criteria that the junction temperature must not exceed rated $T_{J(max)}$ when peak reverse voltage is applied. However, because of the slow thermal response and the close thermal coupling between the individual semiconductor die in the MDA920A assembly, the maximum ambient temperature is given closely by

$$T_A = T_{J(max)} - R_{\theta JA} P_T$$

where P_T is the total average power dissipation in the assembly.

For the circuit of Figure B, use of the above formula will yield suitable rating information. For example to determine $T_{A(max)}$ for the conditions

$$I_A = 0.5\text{ A},\ I_{pk} = 10\ I_{avg}$$
$$I_B = 1.0\text{ A},\ I_{pk} = 18\ I_{avg}$$

From Figure 5: For I_A, read $P_{TA} \approx 0.8$ W
For I_B, read $P_{TB} \approx 2.2$ W

$$P_T = (P_{TA} + P_{TB}) \div 2 = 1.5\text{ W}$$

(Division by 2 is necessary as data from Figure 5 is for full-wave bridge operation.) $\therefore T_{A(max)} = 175^\circ - (50)(1.5) = 100^\circ C$.

FIGURE 8 – FORWARD RECOVERY TIME

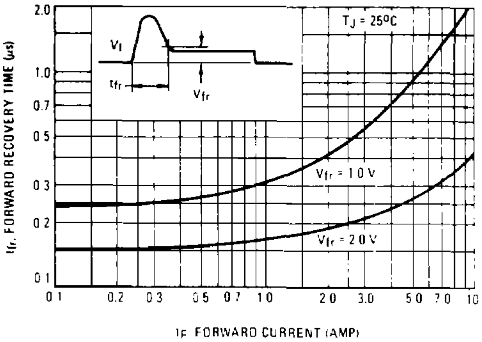


FIGURE 9 – REVERSE RECOVERY TIME

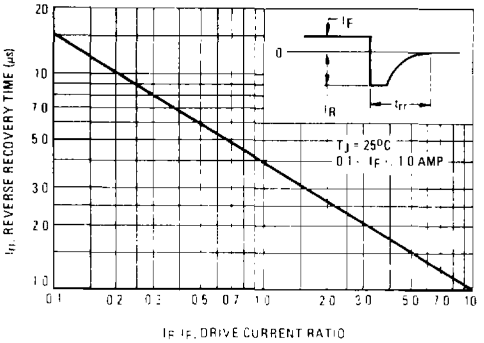


FIGURE 10 – RECTIFICATION WAVEFORM EFFICIENCY

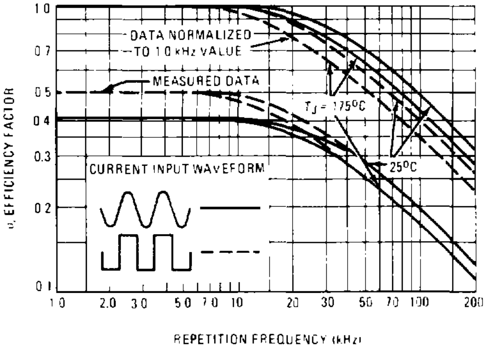
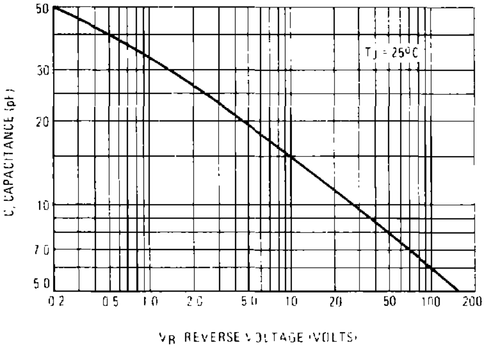
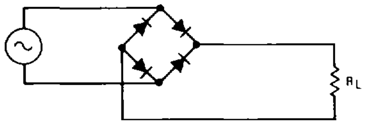


FIGURE 11 – CAPACITANCE



RECTIFIER EFFICIENCY NOTE

FIGURE 12 – SINGLE-PHASE FULL-WAVE BRIDGE RECTIFIER CIRCUIT



The rectification efficiency factor σ shown in Figure 10 was calculated using the formula:

$$\sigma = \frac{P_{(dc)}}{P_{(rms)}} = \frac{\frac{V^2_o(dc)}{R_L}}{\frac{V^2_o(rms)}{R_L}} 100\% = \frac{V^2_o(dc)}{V^2_o(ac) + V^2_o(dc)} 100\% \quad (1)$$

For a sine wave input $V_m \sin (\omega t)$ to the diode, assumed lossless, the maximum theoretical efficiency factor becomes:

$$\sigma_{(sine)} = \frac{\frac{4V^2_m}{\pi^2 R_L}}{\frac{V^2_m}{2R_L}} 100\% = \frac{8}{\pi^2} 100\% = 81.2\% \quad (2)$$

For a square wave input of amplitude V_m, the efficiency factor becomes:

$$\sigma_{(square)} = \frac{\frac{V^2_m}{R_L}}{\frac{V^2_m}{R_L}} 100\% = 100\% \quad (3)$$

As the frequency of the input signal is increased, the reverse recovery time of the diode (Figure 9) becomes significant, resulting in an increasing ac voltage component across R_L which is opposite in polarity to the forward current, thereby reducing the value of the efficiency factor σ, as shown on Figure 10.

It should be emphasized that Figure 10 shows waveform efficiency only; it does not provide a measure of diode losses. Data was obtained by measuring the ac component of V_o with a true rms ac voltmeter and the dc component with a dc voltmeter. The data was used in Equation 1 to obtain points for Figure 10.