MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N5391 thru 1N5399

Designers Data Sheet

"SURMETIC" RECTIFIERS

. . . subminiature size, axial lead-mounted rectifiers for general-purpose, low-power applications.

Designers Data for "Worst Case" Conditions

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

LEAD-MOUNTED SILICON RECTIFIERS

50–1000 VOLTS
DIFFUSED JUNCTION

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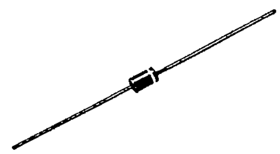


*MAXIMUM RATINGS

Rating	Symbol	1N5391	1N5392	1N5393	1N5395	1N5397	1N5398	1N5399	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	Volts
Nonrepetitive Peak Reverse Voltage (Halfwave, Single Phase, 60 Hz)	V_{RSM}	100	200	300	525	800	1000	1200	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	280	420	560	700	Volts
Average Rectified Forward Current (Single Phase, Resistive Load, 60 Hz, $T_L = 70°C$, 1/2" From Body)	I_O	← 1.5 →							Amp
Nonrepetitive Peak Surge Current (Surge Applied at Rated Load Conditions, See Figure 2)	I_{FSM}	← 50 (for 1 cycle) →							Amp
Storage Temperature Range	T_{stg}	← −65 to +175 →							°C
Operating Temperature Range	T_L	← −65 to +170 →							°C
DC Blocking Voltage Temperature	T_L	← 150 →							°C

*ELECTRICAL CHARACTERISTICS

Characteristic and Conditions	Symbol	Typ	Max	Unit
Maximum Instantaneous Forward Voltage Drop (i_F = 4.7 Amp Peak, $T_L = 170°C$, 1/2 Inch Leads)	v_F	—	1.4	Volts
Maximum Reverse Current (Rated dc Voltage) ($T_L = 150°C$)	I_R	250	300	μA
Maximum Full-Cycle Average Reverse Current (1) (I_O = 1.5 Amp, $T_L = 70°C$, 1/2 Inch Leads)	$I_{R(AV)}$	—	300	μA

*Indicates JEDEC Registered Data.

NOTE 1: Measured in a single-phase, halfwave circuit such as shown in Figure 6.25 of EIA RS-282, November 1963. Operated at rated load conditions I_O = 1.5 A, $V_r = V_{RWM}$, $T_L = 70°C$.

MECHANICAL CHARACTERISTICS

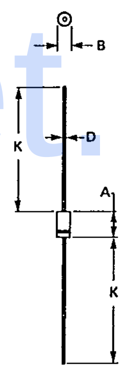
CASE: Transfer molded plastic

MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 240°C, 1/8" from case for 10 seconds at 5 lbs. tension

FINISH: All external surfaces are corrosion-resistant, leads are readily solderable

POLARITY: Cathode indicated by color band

WEIGHT: 0.40 grams (approximately)



NOTES:
1. ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO-41 OUTLINE SHALL APPLY.
2. POLARITY DENOTED BY CATHODE BAND.
3. LEAD DIAMETER NOT CONTROLLED WITHIN "F" DIMENSION.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.97	6.60	0.235	0.260
B	2.79	3.05	0.110	0.120
D	0.76	0.86	0.030	0.034
K	27.94	—	1.100	—

CASE 59-04
PLASTIC

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FIGURE 1 — FORWARD VOLTAGE

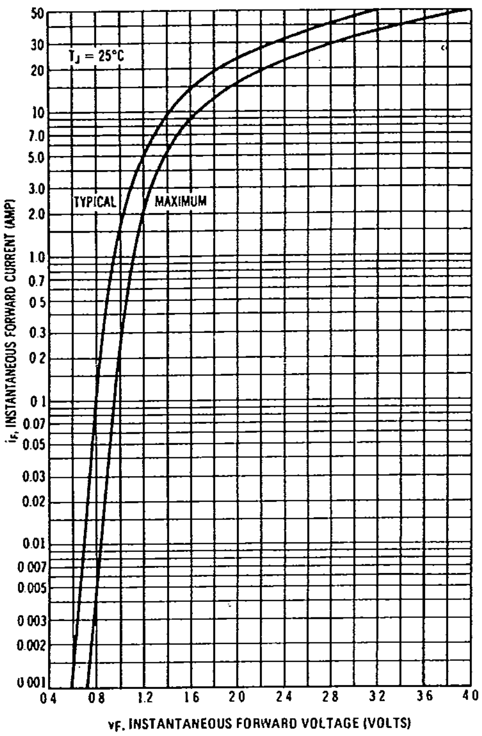


FIGURE 2 — MAXIMUM NONREPETITIVE SURGE CURRENT

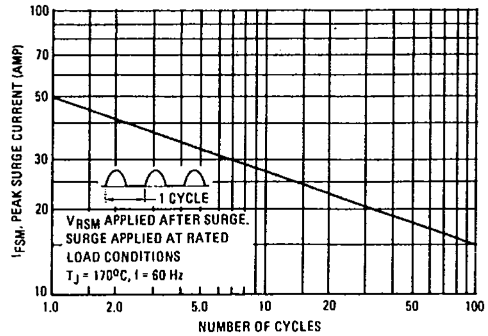


FIGURE 3 — FORWARD VOLTAGE TEMPERATURE COEFFICIENT

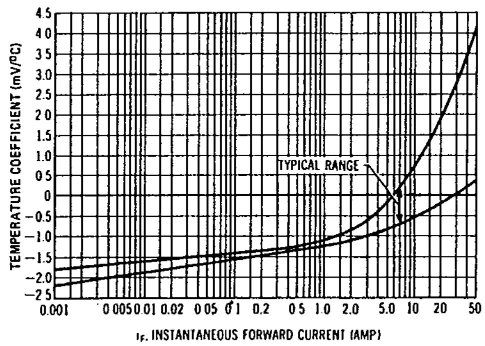
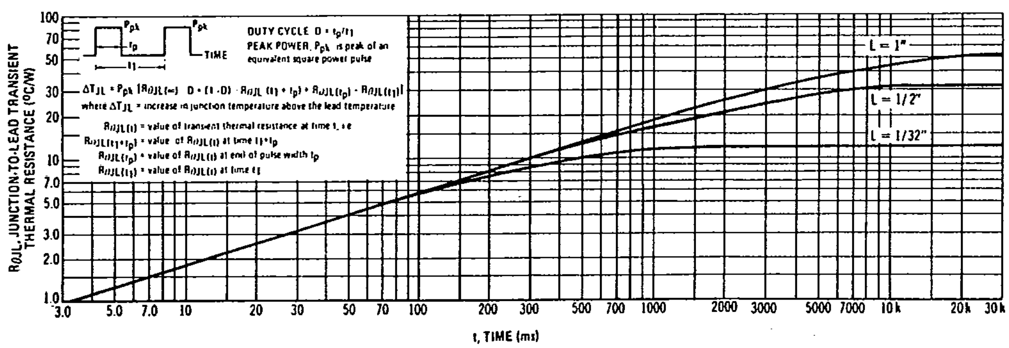


FIGURE 4 — TYPICAL TRANSIENT THERMAL RESISTANCE



The temperature of the lead should 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:

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

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FIGURE 5 – FORWARD POWER DISSIPATION

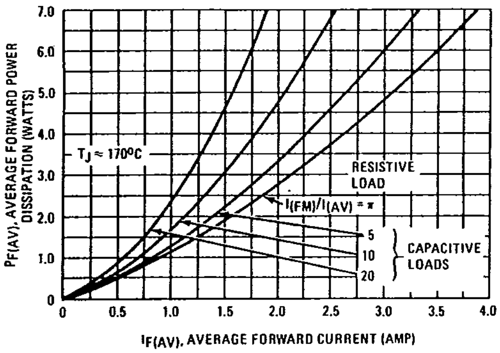


FIGURE 6 – EFFECT OF LEAD LENGTHS, RESISTIVE LOAD

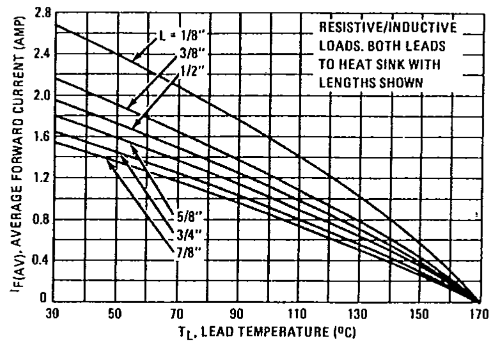


FIGURE 7 – 1/2" LEAD LENGTH, VARIOUS LOADS

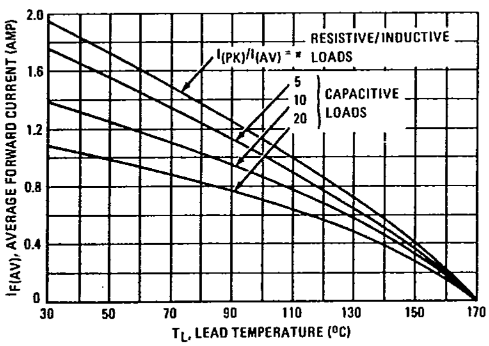


FIGURE 8 – PRINTED CIRCUIT BOARD MOUNTING, VARIOUS LOADS

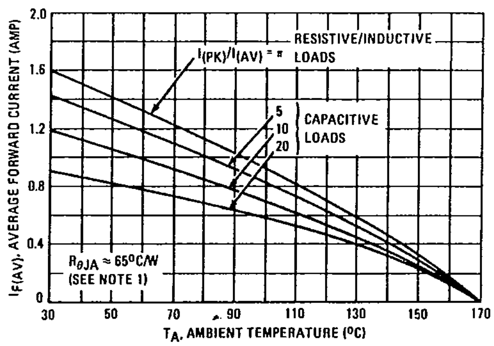
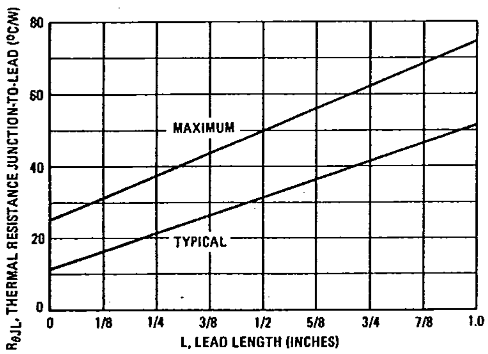


FIGURE 9 – STEADY-STATE THERMAL RESISTANCE



NOTE 1

Data shown for thermal resistance junction-to-ambient (θ_{JA}) for the mountings shown is to be used as typical guideline values for preliminary engineering or in case the tie point temperature cannot be measured.

TYPICAL VALUES FOR θ_{JA} IN STILL AIR

MOUNTING METHOD	LEAD LENGTH, L (IN)				
	1/8	1/4	1/2	3/4	$R_{\theta JA}$
1	65	72	82	92	°C/W
2	74	81	91	101	°C/W
3	40				°C/W

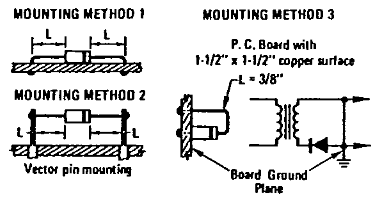


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FIGURE 10 – FORWARD RECOVERY TIME

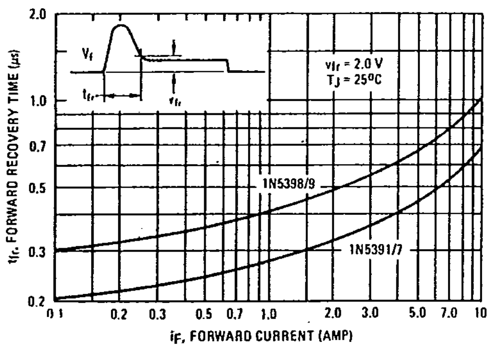


FIGURE 11 – REVERSE RECOVERY TIME

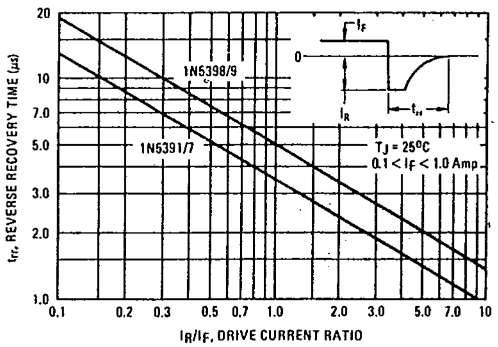


FIGURE 12 – JUNCTION CAPACITANCE

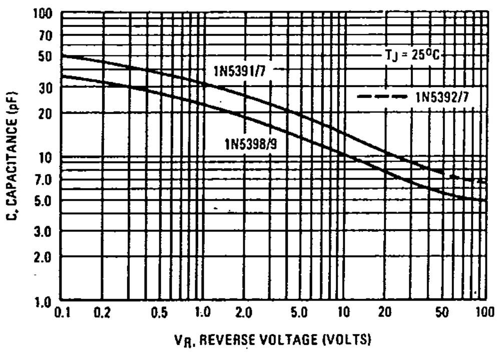


FIGURE 13 – RECTIFICATION WAVEFORM EFFICIENCY FOR SINE WAVE

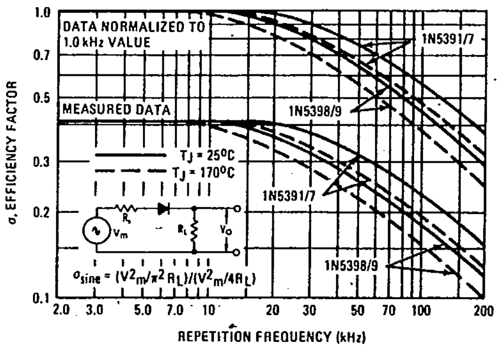
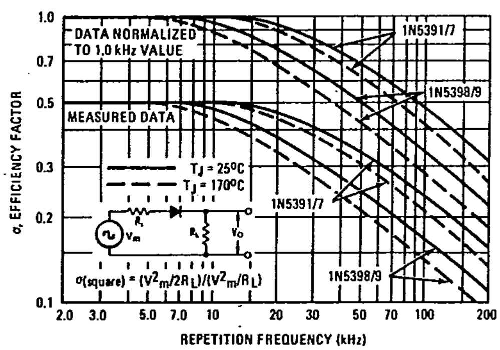


FIGURE 14 – RECTIFICATION WAVEFORM EFFICIENCY FOR SQUARE WAVE



RECTIFIER EFFICIENCY NOTE

The rectification efficiency factor σ shown in Figures 13 and 14 was calculated using the formula:

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

For a sine wave input $V_m \sin(\omega t)$ to the diode, assumed lossless, the maximum theoretical efficiency factor becomes 40%; for a square wave input of amplitude V_m, the efficiency factor becomes 50%. (A full wave circuit has twice these efficiencies).

As the frequency of the input signal is increased, the reverse recovery time of the diode (Figure 11) 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 in Figures 13 and 14.

It should be emphasized that Figures 13 and 14 show waveform efficiency only; they do not account for diode losses. Data was obtained by measuring the ac component of V_O with a true rms voltmeter and the dc component with a dc voltmeter. The data was used in Equation 1 to obtain points for the Figures.