MOTOROLA

1N5823, 1N5824
1N5825
MBR5825,H, H1

Designers Data Sheet

HOT CARRIER POWER RECTIFIERS

. . . employing the Schottky Barrier principle in a large area metal-to-silicon power diode. State-of-the-art geometry features epitaxial construction with oxide passivation and metal overlap contact. Ideally suited for use as rectifiers in low-voltage, high-frequency inverters, free-wheeling diodes, and polarity-protection diodes.

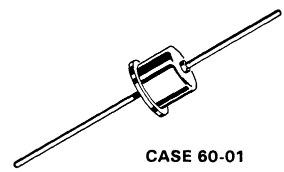
- Extremely Low v_F
- Low Stored Charge, Majority Carrier Conduction
- Low Power Loss/ High Efficiency
- High Surge Capacity
- TX Version Available

Designer's 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.

SCHOTTKY BARRIER RECTIFIERS

5 AMPERE
20, 30, 40 VOLTS



CASE 60-01

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*MAXIMUM RATINGS

Rating	Symbol	1N5823	1N5824	1N5825 MBR5825H, H1	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	20	30	40	Volts
Non-Repetitive Peak Reverse Voltage	V_{RSM}	24	36	48	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	14	21	28	Volts
Average Rectified Forward Current $V_{R(equiv)} \leq 0.2\ V_{R\ (dc)}$, $T_C = 75°C$ $V_{R(equiv)} \leq 0.2\ V_{R\ (dc)}$, $T_L = 80°C$ $R_{\theta JA} = 25°C/W$, P.C. Board Mounting, See Note 3)	I_O	← 15 → ← 5.0 →			Amp
Ambient Temperature Rated $V_{R\ (dc)}$, $P_{F(AV)} = 0$ $R_{\theta JA} = 25°C/W$	T_A	65	60	55	°C
Non-Repetitive Peak Surge Current (Surge applied at rated load conditions, halfwave, single phase 60 Hz)	I_{FSM}	← 500 (for 1 cycle) →			Amp
Operating and Storage Junction Temperature Range (Reverse Voltage applied)	T_J, T_{stg}	← −65 to +125 →			°C
Peak Operating Junction Temperature (Forward Current Applied)	$T_{J(pk)}$	← 150 →			°C

*THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.0	°C/W

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

Characteristic	Symbol	1N5823	1N5824	1N5825 MBR5825H, H1	Unit
Maximum Instantaneous Forward Voltage (1) ($i_F = 3.0$ Amp) ($i_F = 5.0$ Amp) ($i_F = 15.7$ Amp)	v_F	 0.330 0.360 0.470	 0.340 0.370 0.490	 0.350 0.380 0.520	Volts
Maximum Instantaneous Reverse Current @ rated dc Voltage $T_C = 25°C$ $T_C = 100°C$	i_R	 10 75	 10 75	 10 75	mA

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%   *Indicates JEDEC Registered Data for 1N5823–1N5825

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NOTE 1: DETERMINING MAXIMUM RATINGS

Reverse power dissipation and the possibility of thermal runaway must be considered when operating this rectifier at reverse voltages above 0.1 V_{RWM}. Proper derating may be accomplished by use of equation (1):

$$T_{A(max)} = T_{J(max)} - R_{\theta JA} P_{F(AV)} - R_{\theta JA} P_{R(AV)} \quad (1)$$

where

$T_{A(max)}$ = Maximum allowable ambient temperature

$T_{J(max)}$ = Maximum allowable junction temperature (125°C or the temperature at which thermal runaway occurs, whichever is lowest).

$P_{F(AV)}$ = Average forward power dissipation

$P_{R(AV)}$ = Average reverse power dissipation

$R_{\theta JA}$ = Junction-to-ambient thermal resistance

Figures 1, 2 and 3 permit easier use of equation (1) by taking reverse power dissipation and thermal runaway into consideration. The figures solve for a reference temperature as determined by equation (2):

$$T_R = T_{J(max)} - R_{\theta JA} P_{R(AV)} \quad (2)$$

Substituting equation (2) into equation (1) yields:

$$T_{A(max)} = T_R - R_{\theta JA} P_{F(AV)} \quad (3)$$

Inspection of equations (2) and (3) reveals that T_R is the ambient temperature at which thermal runaway occurs or where T_J = 125°C, when forward power is zero. The transition from one boundary condition to the other is evident on the curves of Figures 1, 2 and 3 as a difference in the rate of change of the slope in the vicinity of 115°C. The data of Figures 1, 2 and 3 is based upon dc conditions. For use in common rectifier circuits, Table I indicates suggested factors for an equivalent dc voltage to use for conservative design; i.e.:

$$V_{R(equiv)} = V_{IN(PK)} \times F \quad (4)$$

The Factor F is derived by considering the properties of the various rectifier circuits and the reverse characteristics of Schottky diodes.

Example: Find $T_{A(max)}$ for 1N5825 operated in a 12-Volt dc supply using a bridge circuit with capacitive filter such that I_{DC} = 10 A ($I_{F(AV)}$ = 5 A), $I_{(PK)}/I_{(AV)}$ = 10, Input Voltage = 10 V(rms), $R_{\theta JA}$ = 10°C/W.

Step 1: Find $V_{R(equiv)}$. Read F = 0.65 from Table I ∴ $V_{R(equiv)}$ = (1.41)(10)(0.65) = 9.2 V

Step 2: Find T_R from Figure 3. Read T_R = 113°C @ V_R = 9.2 V & $R_{\theta JA}$ = 10°C/W.

Step 3: Find $P_{F(AV)}$ from Figure 4. **Read $P_{F(AV)}$ = 5.5 W @ $\frac{I_{(PK)}}{I_{(AV)}}$ = 10 & $I_{F(AV)}$ = 5 A

Step 4: Find $T_{A(max)}$ from equation (3). $T_{A(max)}$ = 113-(10)(5.5) = 58°C.

**Value given are for the 1N5825. Power is slightly lower for the other units because of their lower forward voltage.

TABLE I — VALUES FOR FACTOR F

Circuit	Half Wave		Full Wave, Bridge		Full Wave, Center Tapped *†	
Load	Resistive	Capacitive*	Resistive	Capacitive	Resistive	Capacitive
Sine Wave	0.5	1.3	0.5	0.65	1.0	1.3
Square Wave	0.75	1.5	0.75	0.75	1.5	1.5

*Note that $V_{R(PK)} \approx 2\ V_{in(PK)}$ †Use line to center tap voltage for V_{in}.

FIGURE 1 — MAXIMUM REFERENCE TEMPERATURE — 1N5823

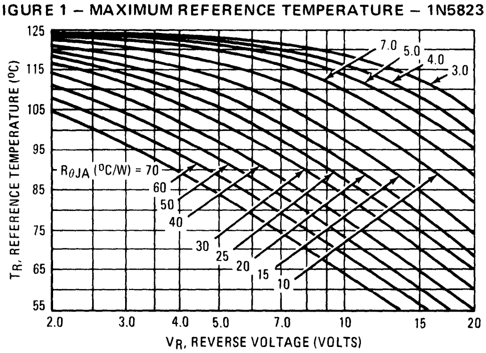


FIGURE 2 — MAXIMUM REFERENCE TEMPERATURE — 1N5824

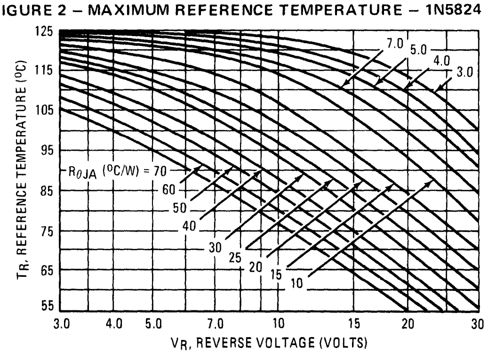


FIGURE 3 — MAXIMUM REFERENCE TEMPERATURE 1N5825 AND MBR5825H, H1

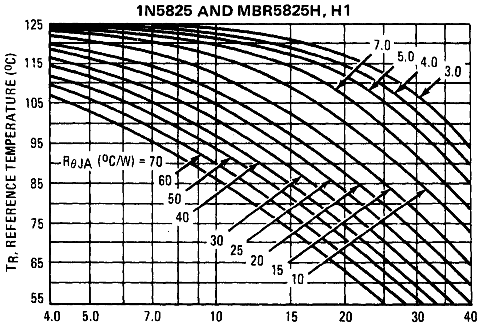
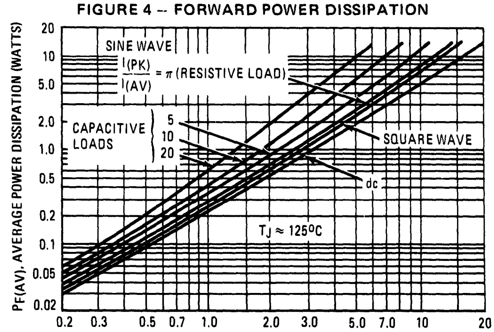
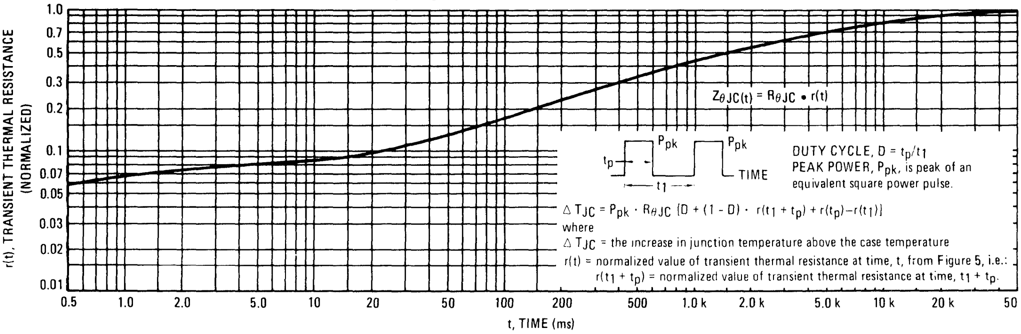


FIGURE 4 — FORWARD POWER DISSIPATION



THERMAL CHARACTERISTICS

FIGURE 5 – THERMAL RESPONSE



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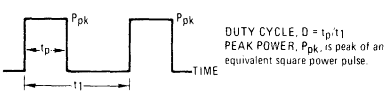
NOTE 2 – FINDING JUNCTION TEMPERATURE



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 Note 3). 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 ΔT_{JC} is the increase in junction temperature above the case temperature. It may be determined by:

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

where

r(t) = normalized value of transient thermal resistance at time, t, from Figure 5, i.e.:

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

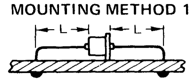
NOTE 3 – MOUNTING DATA

Data shown for thermal resistance junction-to-ambient ($R_{\theta JA}$) for the mountings shown is to be used as typical guideline values for preliminary engineering.

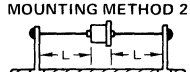
TYPICAL VALUES FOR $R_{\theta JA}$ IN STILL AIR

MOUNTING METHOD	LEAD LENGTH, L (IN) 1/4	1	$R_{\theta JA}$
1	55	60	°C/W
2	65	70	°C/W
3	25		°C/W

MOUNTING METHOD 1



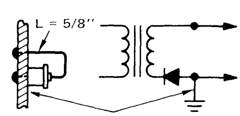
MOUNTING METHOD 2



Vector pin mounting

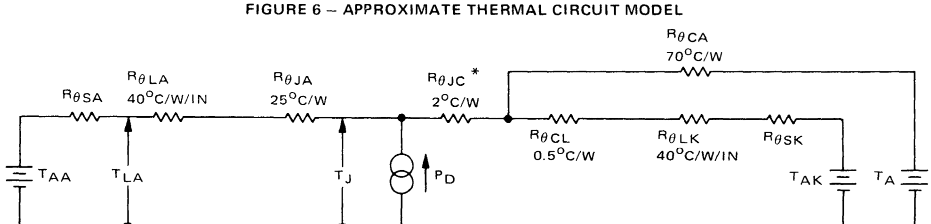
MOUNTING METHOD 3

P. C. Board with 2 1/2" x 2 1/2" copper surface



Board Ground Plane

FIGURE 6 – APPROXIMATE THERMAL CIRCUIT MODEL



Use of the above model permits calculation of average junction temperature for any mounting situation. Lowest values of thermal resistance will occur when the cathode lead is brought as close as possible to a heat dissipator; as heat conduction through the anode lead is small. Terms in the model are defined as follows:

***Case temperature reference is at cathode end.**

TEMPERATURES

- T_A = Ambient
- T_{AA} = Anode Heat Sink Ambient
- T_{AK} = Cathode Heat Sink Ambient
- T_{LA} = Anode Lead
- T_{LK} = Cathode Lead
- T_J = Junction

THERMAL RESISTANCES

- $R_{\theta CA}$ = Case to Ambient
- $R_{\theta SA}$ = Anode Lead Heat Sink to Ambient
- $R_{\theta SK}$ = Cathode Lead Heat Sink to Ambient
- $R_{\theta LA}$ = Anode Lead
- $R_{\theta LK}$ = Cathode Lead
- $R_{\theta CL}$ = Case to Cathode Lead
- $R_{\theta JC}$ = Junction to Case
- $R_{\theta JA}$ = Junction to Anode Lead (S bend)

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FIGURE 7 — TYPICAL FORWARD VOLTAGE

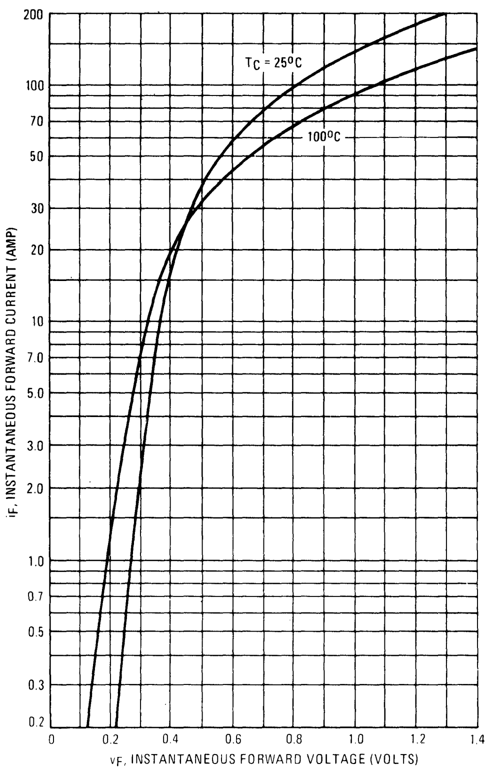


FIGURE 8 — MAXIMUM SURGE CAPABILITY

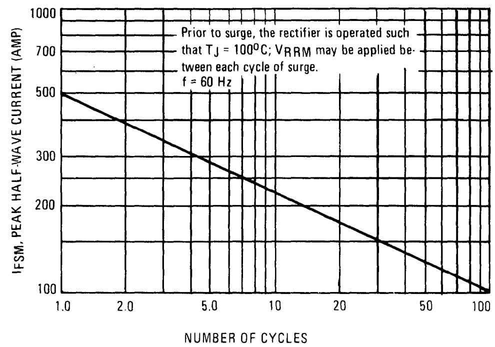


FIGURE 9 — TYPICAL REVERSE CURRENT

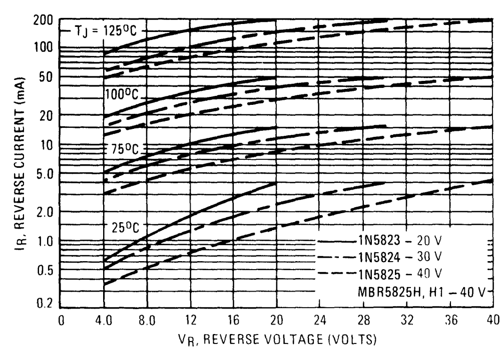
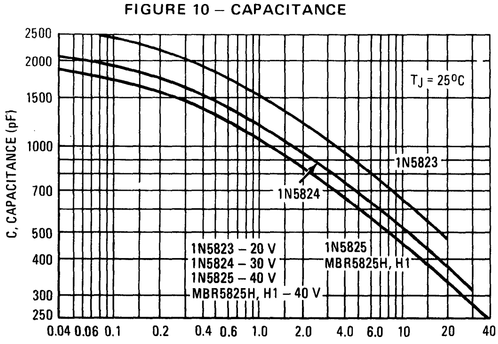


FIGURE 10 — CAPACITANCE

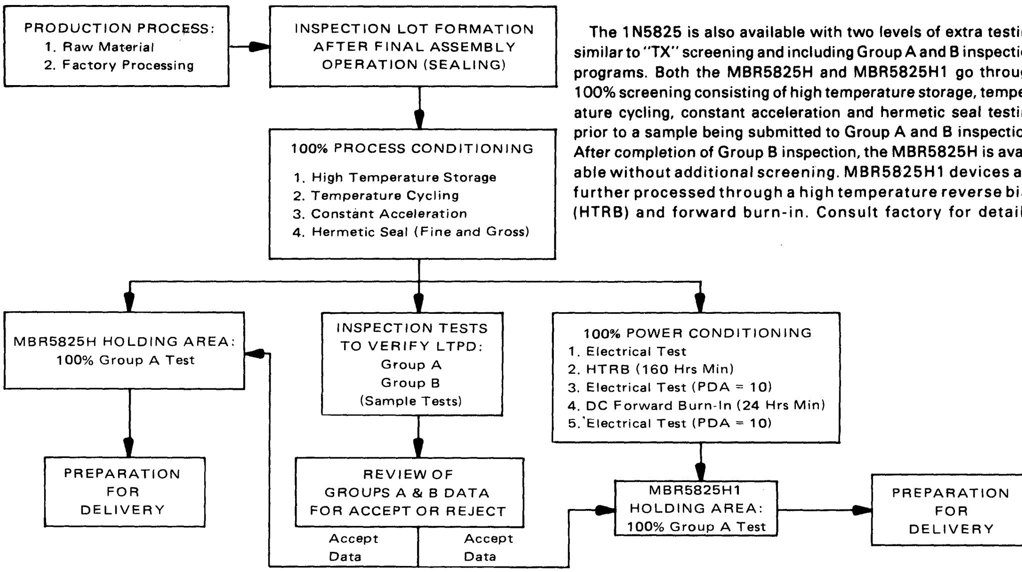


NOTE 4 — HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge. Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance. (See Figure 10).

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz. For example, relative waveform rectification efficiency is approximately 70 per cent at 2.0 MHz, e.g., the ratio of dc power to RMS power in the load is 0.28 at this frequency, whereas perfect rectification would yield 0.406 for sine wave inputs. However, in contrast to ordinary junction diodes, the loss in waveform efficiency is not indicative of power loss; it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage.

NOTE 5 – HI-REL PROGRAM OPTIONS



The 1N5825 is also available with two levels of extra testing similar to "TX" screening and including Group A and B inspection programs. Both the MBR5825H and MBR5825H1 go through 100% screening consisting of high temperature storage, temperature cycling, constant acceleration and hermetic seal testing prior to a sample being submitted to Group A and B inspection. After completion of Group B inspection, the MBR5825H is available without additional screening. MBR5825H1 devices are further processed through a high temperature reverse bias (HTRB) and forward burn-in. Consult factory for details.

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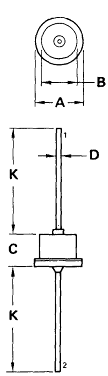
MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed construction.
FINISH: All external surfaces corrosion-resistant and the terminal leads are readily solderable.
WEIGHT: 2.4 grams (approximately).
POLARITY: Cathode to case.
MOUNTING POSITONS: Any



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	–	11.43	–	0.450
B	–	8.89	–	0.350
C	–	7.62	–	0.300
D	1.17	1.42	0.046	0.056
K	24.89	–	0.980	–

CASE 60-1