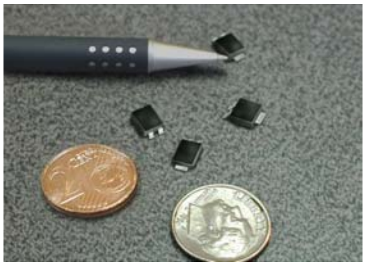
Powermite®3

Product Overview:

- **Construction and Reliability Information**
- **Performance Comparisons to Competitive Package Types**

July 2003

Introduction

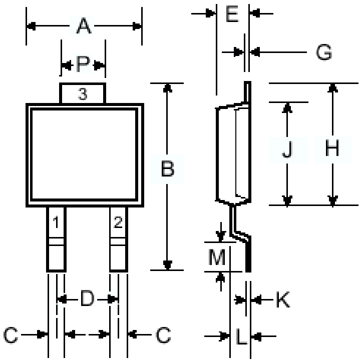


Diodes, Inc. introduces Powermite®3, a compact, high power density surface mount rectifier package. Designed as a compact replacement for SMC and DPak, Powermite®3 offers exceptionally low thermal resistance and high power density, which are key requirements in today's advancing power management and DC/DC converter applications.

This document is intended to provide detailed construction and reliability information as well as performance comparisons to competitive package types.

Construction Details of Powermite®3

Powermite®3 Mechanical Dimensions

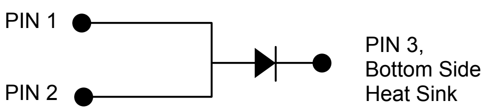


Powermite®3		
Dim	**Min.**	**Max.**
A	4.03	4.09
B	6.40	6.61
C	0.889 NOM	
D	1.83 NOM	
E	1.10	1.14
G	0.178 NOM	
H	5.01	5.17
J	4.37	4.43
K	0.178 NOM	
L	0.71	0.77
M	0.36	0.46
P	1.73	1.83
All Dimensions in mm		

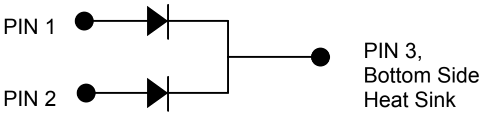
Powermite®3 Package Materials

Leadframe Material:	CDA194 Copper; CTE: 16.3E^{-6} cm/cm/°C
Leadframe Thickness:	0.007" thick
Solder Composition:	Option 1: 88% Pb, 10% Sb, 2% Ag Option 2: 92.5% Pb, 2.5% In, 5% Ag
Lead Plating:	60% Sn, 40% Pb
Case Material:	Plaskon LS-16; CTE: 16.5E^{-6} cm/cm/°C
Epoxy Flammability Rating:	UL 94V-0
Package Weight:	0.072 grams (approx.)

Powermite®3 Available Configurations

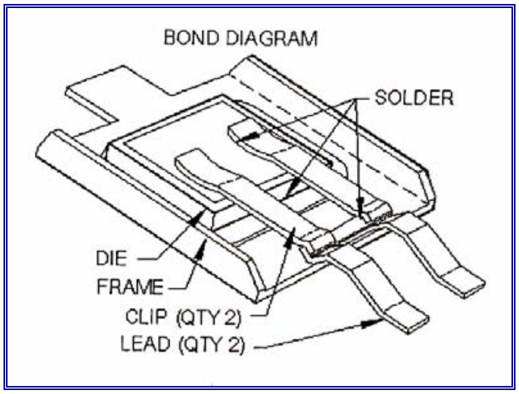


Single

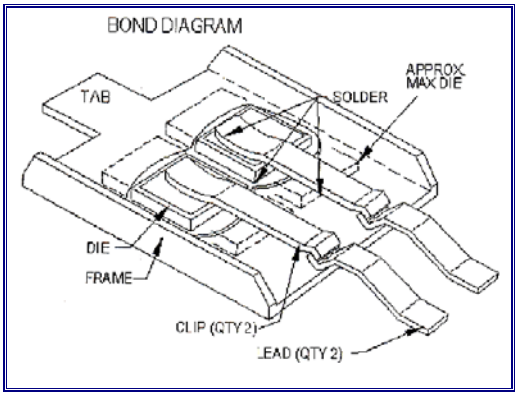


Dual, Common Cathode

Powermite®3 Leadframe Diagram

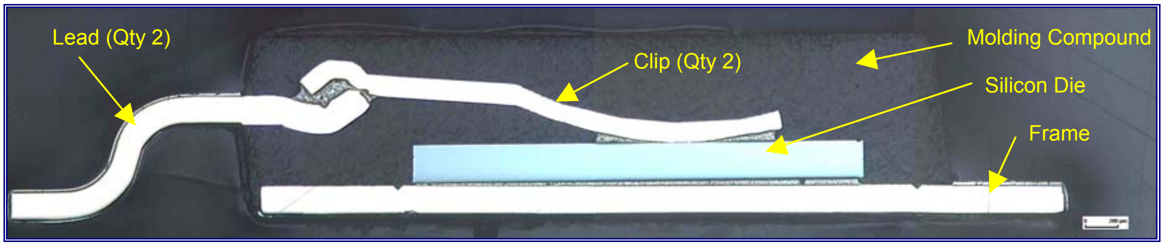


Single Die, Dual Clip Construction.



Dual Die, Dual Clip Construction.

Powermite®3 Cross Section

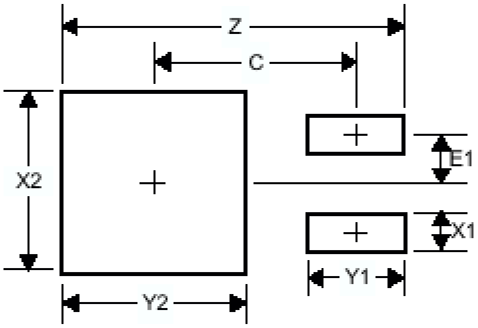


Powermite®3 Thermal Characteristics

Typical Thermal Resistance Junction to Soldering Point, $R_{\theta JS}$: 1.0 °C/W; 2.0 °C/W maximum
Typical Thermal Resistance Junction to Case, $R_{\theta JC}$: 1.5 °C/W
Typical Thermal Resistance Junction to Ambient, $R_{\theta JA}$:

- 15-30 °C/W when device is mounted on GETEK substrate, 2”x2”, 2oz. copper, double sided, cathode pad dimensions 0.75”x1.0”, anode pad dimensions 0.25”x1.0”.
- 60-75 °C/W when device is mounted on FR-4 substrate, 2”x2”, 2oz. copper, single sided, pad layout as shown in diagram 1 below.

Powermite®3 Minimum Recommended Pad Layout



Dimensions	Powermite®3
Z	6.9
X1	1.0
X2	4.8
Y1	0.8
Y2	5.3
C	3.85 ref
E1	0.9 ref
All Dimensions in mm	

Diagram 1.

Competitive Package Comparison

Powermite®3 has been designed to provide a compact package solution for high power (>1W) rectifiers ranging from 3 Amps to 10 Amps output current. Typical package types that can be replaced with Powermite®3 include SMC and DPak.

Component Size and PCB Area Comparison

Shown in actual size, Powermite®3, SMC and DPak are shown below.

The minimum required PCB area for Powermite®3, SMC and DPak is shown in figure 1. Values are shown using nominal package dimensions. An example of the actual PCB requirements for these packages is shown in diagram 2.

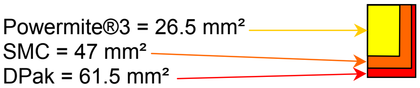


Diagram 2.

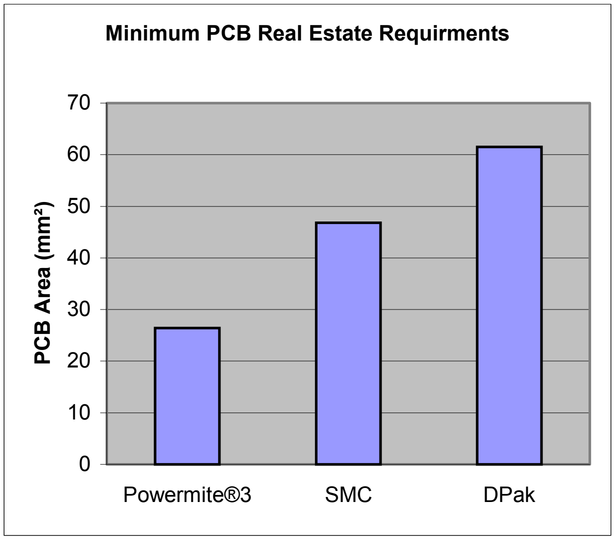
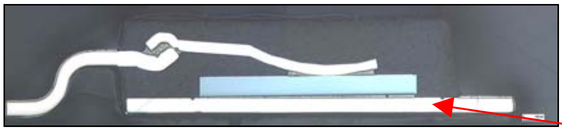


Figure 1.

Cross Section Comparison

The following cross section analysis illustrates the individual mechanical characteristics of the Powermite®3, SMC, and DPak packages. All devices compared are surface mount package types utilizing an upper leadframe die clip and are molded with epoxy body material. However, significant construction differences exist between all three package types, with the most dramatic differences existing with the SMC package.

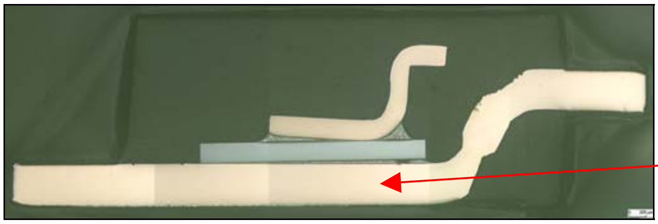
Both Powermite®3 and DPak share the same basic construction consisting of a flat metal leadframe acting as both the die bonding pad and the package solder bonding surface to the PCB. This construction type results in a very efficient thermal path from the die junction to the PCB soldering plane. The significant difference between Powermite®3 and DPak is the size of the package. Powermite®3 has been designed to minimize the height, width, and length of the package to achieve as close to chip scale packaging as possible. The SMC package contains an epoxy encapsulated die/leadframe construction resulting in a less than optimal path for heat to efficiently conduct to the PCB. The SMC package is also much larger than Powermite®3. The following cross section photos are shown in relative scale to each other.



Powermite®3 Package, cross-section at 25%

Powermite®3
Low profile package, 1.12 mm nominal height
Typical $R_{\theta JS}$ = 1.0°C/W

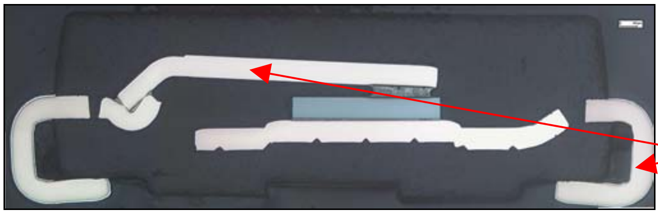
Flat metal leadframe serving as die bond and package bonding surface, results in very low thermal resistance, junction to soldering point, $R_{\theta JS}$.



DPak Package, cross-section at 50%

DPak
2.30 mm nominal height
Typical $R_{\theta JS}$ = 2.4 – 6.0 °C/W

Flat metal leadframe serving as die bond and package bonding surface, results in low thermal resistance, junction to soldering point, $R_{\theta JS}$.



SMC Package, cross-section at 50%

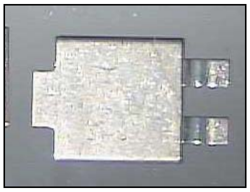
SMC
2.30 mm nominal height
Typical $R_{\theta JS}$ = 10 – 15 °C/W

The J-bend leads and clip construction leadframe constitute the primary path of heat transfer for the SMC package. This leadframe configuration is less efficient than Powermite®3 or DPak, resulting in a higher thermal resistance, junction to soldering point, $R_{\theta JS}$.

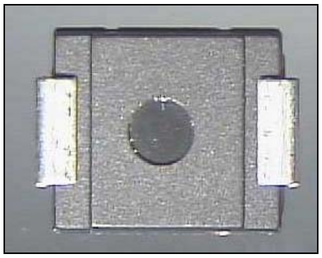
PCB Contact Area Comparison

Powermite®3 has been designed to maximize the thermal solder contact area in relation to its total PCB area requirement. The entire bottom, the footprint, of the Powermite®3 package is composed of thermally efficient copper leadframe and clip materials, unlike the large area of epoxy compound found on the SMC and DPak packages. As shown in figure 2, 75% of Powermite®3's required PCB area footprint is soldered directly to the PCB, resulting in a very efficient thermal path to the PCB heatsink while minimizing PCB real estate consumption. In contrast, the DPak achieves 49% contact and SMC only 15%.

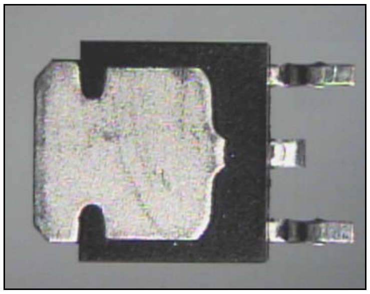
Bottom View of Packages (shown in relative scale to each other)



Powermite®3



SMC



DPak

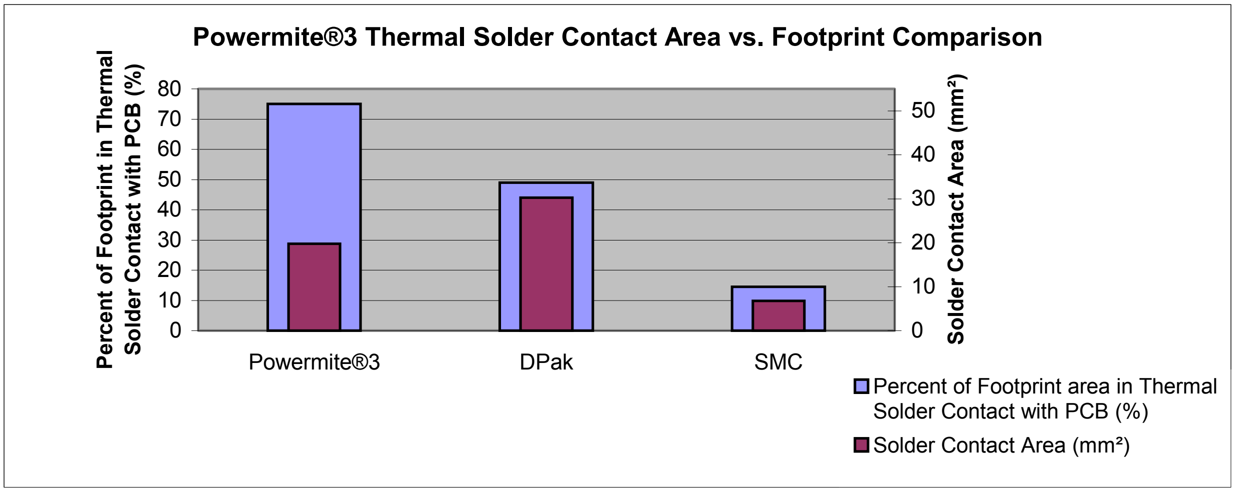


Figure 2.

Power Density Comparison

By maximizing the thermal solder contact area versus total required PCB area and by minimizing the thermal resistance from junction to soldering point, the Powermite®3 package offers nearly twice the power density as the DPak package and more than twice the power density as the SMC package, see figure 3.

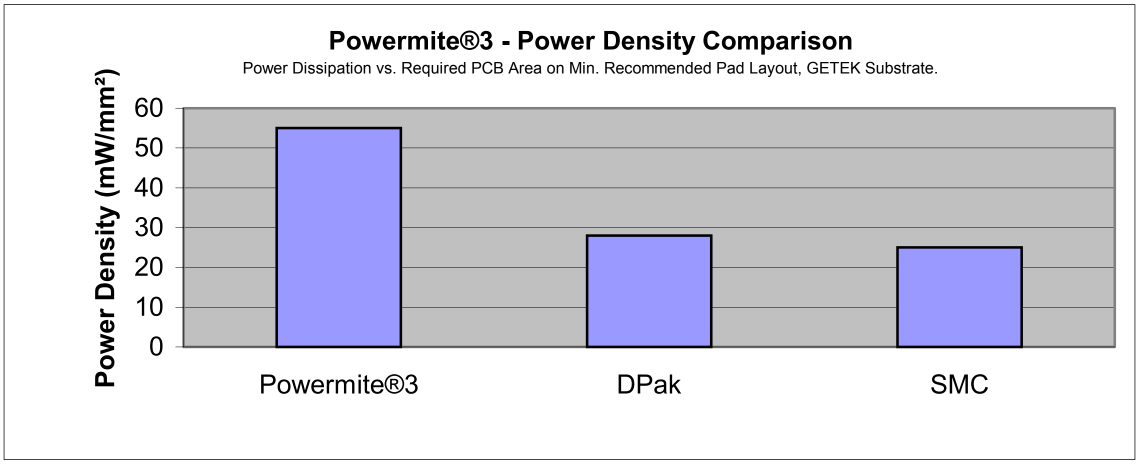


Figure 3.

Power Dissipation Comparison

As improved packaging technology increases power density, careful consideration in component mounting is required. The power dissipation capability of a discrete component is contingent on many factors including the following, package design, die size, PCB substrate material, and soldering pad footprint. Maximizing the power dissipation capability for any surface mount component requires thermally efficient PCB substrates and sufficient solder pad area to remove as much heat per unit area as required for the application. As the power density of the package increases, greater consideration must be placed in optimizing the thermal efficiency of the PCB substrate and solder pad layout. Figure 4 compares the typical power dissipation capability for the Powermite®3, SMC and DPak packages on various PCB substrates and solder pad footprints.

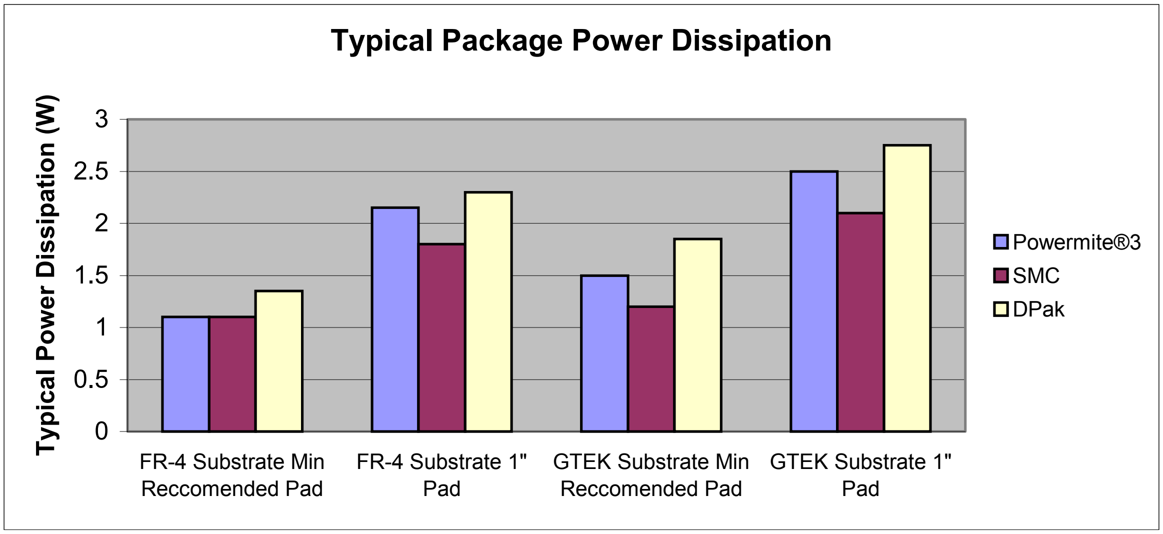


Figure 4.

Powermite®3 Quality and Reliability

Manufactured using the latest state-of-the-art manufacturing equipment, Diodes, Inc.'s Powermite®3 package is among the most reliable discrete package types available from any commercial manufacturer. Designed with reliability as a prime consideration, all Powermite®3 products are subjected to an extensive set of high-reliability verification tests. Combined with Incoming Quality Control (IQC) inspections, In-Process Quality Control (IPQC) monitoring, Outgoing Quality Control (OQC) inspections, and through the use of Statistical Process Control (SPC) methods, Diodes Inc. is able to verify strict manufacturing process control and ensure all finished product meets our rigorous quality and reliability standards. The following table lists the high reliability tests and standards used in the Diodes Inc. reliability program.

Test	Conditions	Standard	Test Time	# Of Samples Tested	# Of Acceptable Failures
Solderability	T_S=235+/-5°C	Mil Std 202F, method 208G	5s	45	0
Solder Heat Resistance	T_S=260+5°C/-0°C	Mil Std 750D, method 2031.2	10s	45	0
Thermal Shock **(Liquid-to-Liquid)**	T_H=100°C/5min	Mil Std 750D, method 1056.7	10 cycles	45	0
	T_L=0°C/5min		50 cycles	45	0
	Transfer time<3s		100 cycles	45	0
High Temp / High Humidity **(Moisture Sensitivity Level)**	T_A=85+/-2°C	Mil Std 202F, method 103B	168hrs	45	0
	R.H.=85+/-2%	Satisfies JEDEC STD-020A	500hrs	45	0
		Moisture Sensitivity Rating (MSL): Level 1	1,000 hrs	45	0
Autoclave/Pressure Cooker	15PSIG/121°C steam	JEDEC Standard JES22-A102-B	96hrs	45	0
High Temperature Storage Life	T_A=150°C+/-5°C	Mil Std 750D, method 1031.5	234 hrs	45	0
			520 hrs	45	0
			1019 hrs	45	0
Low Temperature Storage Life	T_A=-55+/-2°C	IEC 68-2-1, test A	168hrs	45	0
Operating Life	T_J=125°C	Mil Std 750D, method 1027.3	168hrs	45	0
	T_A=25°C		500hrs	45	0
			1,000 hrs	45	0
Temperature Cycling **(Air-to-Air)**	T_H=150°C	Mil Std 750D, method 1051.5	30 cycles	45	0
	T_L=-55°C		100 cycles	45	0
	dwell time at extremes				
	15 minutes				
Forward Surge Current	I_{FSM}=100A, single	Mil Std 750D, method 4066.3	1 shot	22	0
	half sine wave,				
	superimposed on				
	rated load				
ESD Classification	4kV, (-) to anode		3 pulses	45	0
	(Class 3 rating)				
High Temperature Reverse Bias	T_A=125°C	Mil Std 750D, method 1038.3	168hrs	45	0
	V_R=80% of $V_{R\ (MAX)}$		501 hrs	45	0
			1,000 hrs	45	0

Powermite®3 Selection Guide

Schottky Rectifiers - Available Now

Part Number	Peak Repetitive Reverse Voltage	Max. Average Rectified Current	Peak Forward Surge Current	Forward Voltage Drop	Maximum Reverse Current	Device Configuration
	V_{RRM}	I_O	I_{FSM}	V_F @ I_F	I_R @ V_R	
SBM340	40 V	3.0 A	100 A	0.50 V @ 3.0 A	0.5 mA @ 40 V	Single
MBRM360	60 V	3.0 A	100 A	0.63 V @ 3.0 A	0.2 mA @ 60 V	Single
MBRM3100	100 V	3.0 A	100 A	0.78 V @ 3.0 A	0.2 mA @ 100 V	Single
SBM540	40 V	5.0 A	100 A	0.54 V @ 5.0 A	0.5 mA @ 40 V	Single
MBRM560	60 V	5.0 A	100 A	0.66 V @ 5.0 A	0.2 mA @ 60 V	Single
MBRM5100	100 V	5.0 A	100 A	0.87 V @ 5.0 A	0.2 mA @ 100 V	Single
MBRM760	60 V	7.0 A	200 A	0.60 V @ 7.0 A	0.1 mA @ 60 V	Single
SBM1040	40 V	10.0 A	150 A	0.51 V @ 10.0 A	0.3 mA @ 35 V	Single
SBM1040CT	40 V	10.0 A	50 A	0.48 V @ 5.0 A	0.15 mA @ 35 V	Dual CC

Schottky Rectifiers – Under Development

Part Number	Peak Repetitive Reverse Voltage	Max. Average Rectified Current	Peak Forward Surge Current	Forward Voltage Drop	Maximum Reverse Current	Device Configuration
	V_{RRM}	I_O	I_{FSM}	V_F @ I_F	I_R @ V_R	
SBM4150	150 V	4.0 A	100 A	0.75 V @ 4.0 A	5.0 µA @ 150 V	Single
MBRM5100H	100 V	5.0 A	100 A	0.70 V @ 5.0 A	3.5 µA @ 100 V	Single
SBM3200	200 V	3.0 A	100 A	0.76 V @ 3.0 A	5.0 µA @ 200 V	Single
SBM835L	35 V	8.0 A	75 A	0.51 V @ 8.0 A	1.4 mA @ 35 V	Single

Super-Fast Recovery Rectifiers – Under Development

Part Number	Peak Repetitive Reverse Voltage	Max. Average Rectified Current	Peak Forward Surge Current	Forward Voltage Drop	Maximum Reverse Current	Device Configuration
	V_{RRM}	I_O	I_{FSM}	V_F @ I_F	I_R @ V_R	
MURM420	200 V	4.0 A	100 A	0.83 V @ 4.0 A	10 µA @ 200 V	Single
MURM460	600 V	4.0 A	100 A	1.28 V @ 4.0 A	10 µA @ 200 V	Single
MURM620	200 V	6.0 A	100 A	1.00 V @ 6.0 A	10 µA @ 200 V	Single
MURM640	400 V	6.0 A	100 A	1.30 V @ 6.0 A	10 µA @ 200 V	Single
MURM820	200 V	8.0 A	100 A	1.00 V @ 8.0 A	10 µA @ 200 V	Single
MURM840	400 V	8.0 A	100 A	1.30 V @ 8.0 A	10 µA @ 200 V	Single

Standard Recovery Rectifiers – Under Development

Part Number	Peak Repetitive Reverse Voltage	Max. Average Rectified Current	Peak Forward Surge Current	Forward Voltage Drop	Maximum Reverse Current	Device Configuration
	V_{RRM}	I_O	I_{FSM}	V_F @ I_F	I_R @ V_R	
SM3J	600 V	3.0 A	150 A	1.20 V @ 3.0 A	10 µA @ 600 V	Single
SM5J	600 V	5.0 A	150 A	1.20 V @ 5.0 A	10 µA @ 600 V	Single

1500W Transient Voltage Suppressor – Under Development

Part Number	Reverse Standoff Voltage	Breakdown Voltage V_{BR} @ I_T	Test Current	Max. Clamping Voltage @I_{PP}	Max. Peak Pulse Current	Device Configuration
	V_{RWM}	Min (V)	I_T	V_C (V)	I_{PP}	
PM3T5V0(C)A	5.0 V	6.40	1 mA	9.2	163.0	Uni or Bi-Directional
PM3T6V5(C)A	6.5 V	7.22	1 mA	11.2	133.9	Uni or Bi-Directional
PM3T10(C)A	10.0 V	11.10	1 mA	17.0	88.2	Uni or Bi-Directional
PM3T12(C)A	12.0 V	13.30	1 mA	19.9	75.3	Uni or Bi-Directional
PM3T20(C)A	20.0 V	22.20	1 mA	32.4	46.3	Uni or Bi-Directional
PM3T24(C)A	24.0 V	26.70	1 mA	38.9	38.6	Uni or Bi-Directional
PM3T28(C)A	28.0V	31.10	1 mA	45.4	33.0	Uni or Bi-Directional
PM3T36(C)A	36.0 V	40.00	1 mA	58.1	25.8	Uni or Bi-Directional
PM3T45(C)A	45.0 V	50.00	1 mA	72.7	20.6	Uni or Bi-Directional
PM3T70(C)A	70.0 V	77.80	1 mA	113	13.3	Uni or Bi-Directional