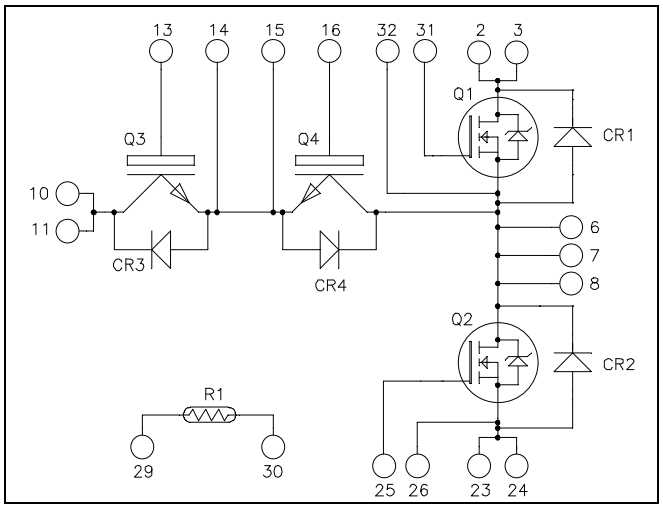
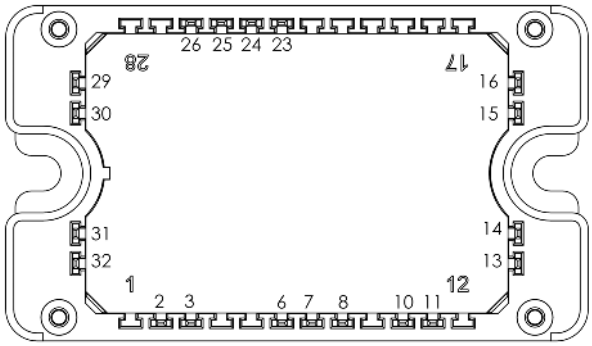
APTMC120HRM40CT3AG

Phase Leg & Dual Common Emitter Power Module

SiC MOSFET (Q1, Q2):
V_{CES} = 1200V ; R_{DSon} = 34mΩ max @ Tj = 25°C

Trench & Field Stop IGBT3 (Q3, Q4):
V_{CES} = 600V ; I_C = 50A @ Tc = 100°C





All multiple inputs and outputs must be shorted together
10/11 ; 23/24 ; 2/3 ; …

Application

- Solar converter
- Uninterruptible Power Supplies

Features

- ***Q1, Q2 SiC Power MOSFET***
  - Low $R_{DS(on)}$
  - High temperature performance
- ***Q3, Q4 Trench + field Stop IGBT3***
  - Low voltage drop
  - Low tail current
  - Switching frequency up to 20 kHz
- ***SiC Schottky Diode (CR1 to CR4)***
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature Independent switching behavior
  - Positive temperature coefficient on VF
- Kelvin emitter for easy drive
- Very low stray inductance
- AlN substrate for improved thermal performance
- Internal thermistor for temperature monitoring

Benefits

- Stable temperature behavior
- Very rugged
- Solderable terminals for easy PCB mounting
- Direct mounting to heatsink (isolated package)
- Low junction to case thermal resistance
- Easy paralleling due to positive T_C of V_{CEsat}
- Low profile

All ratings @ T_j = 25°C unless otherwise specified

CAUTION: These Devices are sensitive to Electrostatic Discharge. Proper Handling Procedures Should Be Followed.
See application note APT0502 on www.microsemi.com

1. SiC MOSFET characteristics (Per MOSFET)

Absolute maximum ratings

Symbol	*Parameter*		*Max ratings*	*Unit*
V_{DSS}	Drain - Source Voltage		1200	V
I_D	Continuous Drain Current	T_c = 25°C	73	A
		T_c = 80°C	55	
I_{DM}	Pulsed Drain Current		140	
V_{GS}	Gate - Source Voltage		-10/+25	V
R_{DSon}	Drain - Source ON Resistance		34	mΩ
P_D	Power Dissipation	T_c = 25°C	375	W

Electrical Characteristics

Symbol	*Characteristic*	*Test Conditions*		*Min*	*Typ*	*Max*	*Unit*
I_{DSS}	Zero Gate Voltage Drain Current	V_{GS} = 0V , V_{DS} = 1200V				100	µA
$R_{DS(on)}$	Drain – Source on Resistance	V_{GS} = 20V, I_D = 50A	T_j = 25°C		25	34	mΩ
			T_j = 150°C		43		
$V_{GS(th)}$	Gate Threshold Voltage	V_{GS} = V_{DS}, I_D = 12.5mA		2.4	3		V
I_{GSS}	Gate – Source Leakage Current	V_{GS} = 20 V, V_{DS} = 0V				600	nA

Dynamic Characteristics

Symbol	*Characteristic*	*Test Conditions*		*Min*	*Typ*	*Max*	*Unit*
C_{iss}	Input Capacitance	V_{GS} = 0V V_{DS} = 1000V f = 1MHz			2788		pF
C_{oss}	Output Capacitance				220		
C_{rss}	Reverse Transfer Capacitance				15		
Q_g	Total gate Charge	V_{GS} = -5/20V V_{Bus} = 800V I_D =50A			161		nC
Q_{gs}	Gate – Source Charge				46		
Q_{gd}	Gate – Drain Charge				50		
$T_{d(on)}$	Turn-on Delay Time	V_{GS} = -2/+20V V_{Bus} = 800V I_D = 50A R_L = 16Ω ; R_G = 20Ω			21		ns
T_r	Rise Time				19		
$T_{d(off)}$	Turn-off Delay Time				50		
T_f	Fall Time				30		
E_{on}	Turn on Energy	Inductive Switching V_{GS} = -5/+20V V_{Bus} = 600V I_D = 50A R_G = 20Ω	T_j = 150°C		1.1		mJ
E_{off}	Turn off Energy		T_j = 150°C		0.6		
R_{thJC}	Junction to Case Thermal Resistance					0.4	°C/W

SiC diode ratings and characteristics (CR1 & CR2) (per diode)

Symbol	*Characteristic*	*Test Conditions*		*Min*	*Typ*	*Max*	*Unit*
V_{RRM}	Peak Repetitive Reverse Voltage					1200	V
I_{RM}	Reverse Leakage Current	V_R = 1200V	T_j = 25°C		10	200	µA
			T_j = 175°C		500		
I_F	DC Forward Current		Tc = 100°C		10		A
V_F	Diode Forward Voltage	I_F = 10A	T_j = 25°C		1.5	1.8	V
			T_j = 175°C		2.3		
Q_C	Total Capacitive Charge	I_F = 10A, V_R = 600V di/dt = 500A/µs			120		nC
C	Total Capacitance	f = 1MHz, V_R = 200V			115		pF
		f = 1MHz, V_R = 400V			85		
R_{thJC}	Junction to Case Thermal Resistance					1.1	°C/W

2. Trench & Field Stop IGBT3 (per IGBT)

Absolute maximum ratings

Symbol	*Parameter*		*Max ratings*	*Unit*
V_{CES}	Collector - Emitter Voltage		600	V
I_C	Continuous Collector Current	T_C = 25°C	105	A
		T_C = 100°C	50	
I_{CM}	Pulsed Collector Current	T_C = 25°C	100	
V_{GE}	Gate – Emitter Voltage		±20	V
P_D	Power Dissipation	T_C = 25°C	176	W
RBSOA	Reverse Bias Safe Operating Area	T_J = 150°C	100A @ 550V	

Electrical Characteristics

Symbol	*Characteristic*	*Test Conditions*		*Min*	*Typ*	*Max*	*Unit*
I_{CES}	Zero Gate Voltage Collector Current	V_{GE} = 0V, V_{CE} = 600V				25	µA
$V_{CE(sat)}$	Collector Emitter Saturation Voltage	V_{GE} =15V I_C = 50A	T_j = 25°C		1.5	1.9	V
			T_j = 150°C		1.7		
$V_{GE(th)}$	Gate Threshold Voltage	V_{GE} = V_{CE} , I_C = 600µA		5.0	5.8	6.5	V
I_{GES}	Gate – Emitter Leakage Current	V_{GE} = 20V, V_{CE} = 0V				600	nA

Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
C_{ies}	Input Capacitance	V_{GE} = 0V V_{CE} = 25V f = 1MHz			3150		pF
C_{oes}	Output Capacitance				200		
C_{res}	Reverse Transfer Capacitance				95		
Q_G	Gate charge	V_{GE} = ±15V, I_C = 50A V_{CE} = 300V			500		nC
$T_{d(on)}$	Turn-on Delay Time	Inductive Switching (25°C) V_{GE} = ±15V V_{Bus} = 300V I_C = 50A R_G = 8.2Ω			110		ns
T_r	Rise Time				45		
$T_{d(off)}$	Turn-off Delay Time				200		
T_f	Fall Time				40		
$T_{d(on)}$	Turn-on Delay Time	Inductive Switching (150°C) V_{GE} = ±15V V_{Bus} = 300V I_C = 50A R_G = 8.2Ω			120		ns
T_r	Rise Time				50		
$T_{d(off)}$	Turn-off Delay Time				250		
T_f	Fall Time				60		
E_{on}	Turn-on Switching Energy	V_{GE} = ±15V V_{Bus} = 300V I_C = 50A R_G = 8.2Ω	T_j = 25°C		0.2		mJ
			T_j = 150°C		0.26		
E_{off}	Turn-off Switching Energy		T_j = 25°C		1.35		mJ
			T_j = 150°C		1.75		
I_{sc}	Short Circuit data	V_{GE} ≤15V ; V_{Bus} = 360V t_p ≤10µs ; T_j = 150°C			250		A
R_{thJC}	Junction to Case Thermal Resistance					0.68	°C/W

3. SiC diode ratings and characteristics (CR3 & CR4) (per diode)

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
V_{RRM}	Peak Repetitive Reverse Voltage					600	V
I_{RM}	Reverse Leakage Current	V_R = 600V	T_j = 25°C		20	120	µA
			T_j = 175°C		40	600	
I_F	DC Forward Current		Tc = 100°C		20		A
V_F	Diode Forward Voltage	I_F = 20A	T_j = 25°C		1.6	1.8	V
			T_j = 175°C		2	2.4	
Q_C	Total Capacitive Charge	I_F = 20A, V_R = 600V di/dt = 800A/µs			56		nC
C	Total Capacitance	f = 1MHz, V_R = 200V			130		pF
		f = 1MHz, V_R = 400V			100		
R_{thJC}	Junction to Case Thermal Resistance					1.1	°C/W

4. Temperature sensor NTC

Symbol	Characteristic	Min	Typ	Max	Unit
R_{25}	Resistance @ 25°C		22		kΩ
$\Delta R_{25}/R_{25}$	Resistance tolerance			5	%
$\Delta B/B$	Beta tolerance			3	%
$B_{25/100}$	T_{25} = 298.16 K		3980		K

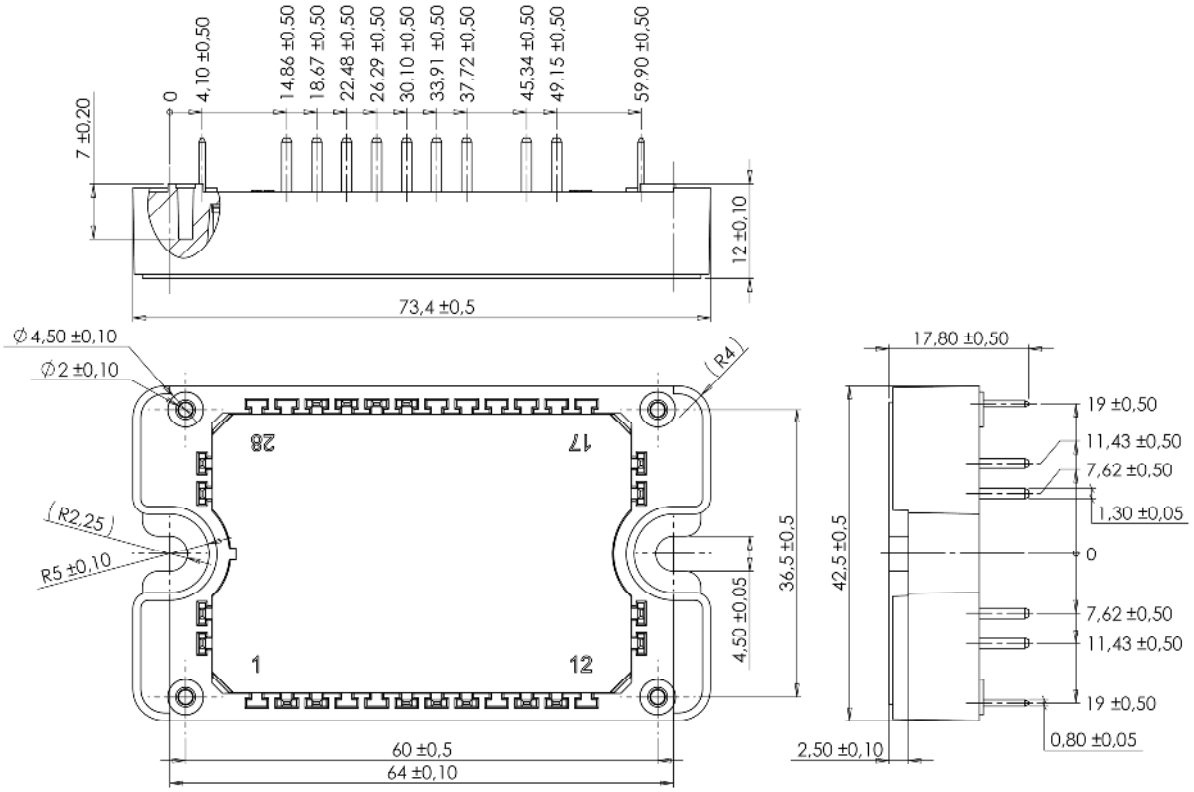
$$R_T = \frac{R_{25}}{\exp\left[B_{25/100}\left(\frac{1}{T_{25}} - \frac{1}{T}\right)\right]}$$

T: Thermistor temperature
R_T: Thermistor value at T

5. Thermal and package characteristics

Symbol	Characteristic		Min	Max	Unit
V_{ISOL}	RMS Isolation Voltage, any terminal to case t =1 min, 50/60Hz		4000		V
T_J	Operating junction temperature range	SiC MOSFET	-40	150	°C
		SiC diode + IGBT	-40	175	
T_{JOP}	Recommended junction temperature under switching conditions		-40	$T_J$max -25	
T_{STG}	Storage Temperature Range		-40	125	
T_C	Operating Case Temperature		-40	125	
Torque	Mounting torque	To heatsink M4	2	3	N.m
Wt	Package Weight			110	g

Package outline (dimensions in mm)

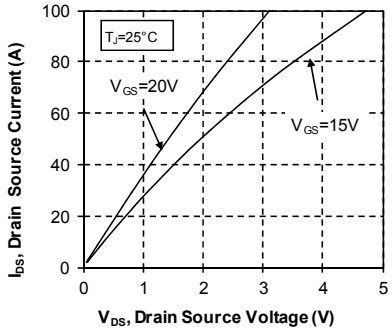


See application note 1906 - Mounting Instructions for SP3F Power Modules on www.microsemi.com

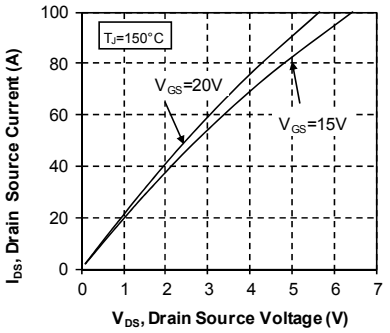
6. Typical performance curve

Q1, Q2 SiC MOSFET

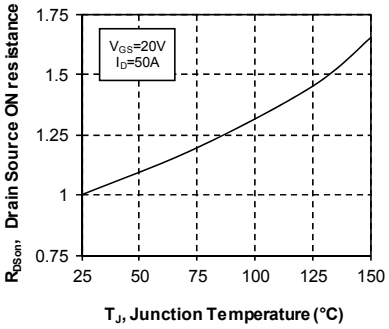
Output Characteristics



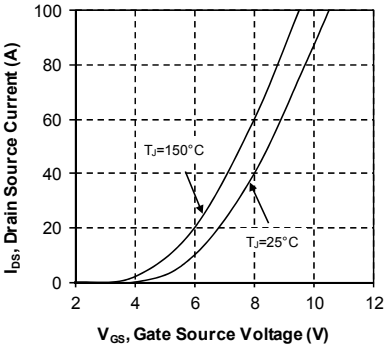
Output Characteristics



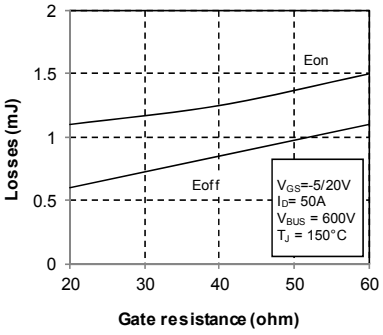
Normalized $R_{DS(on)}$ vs. Temperature



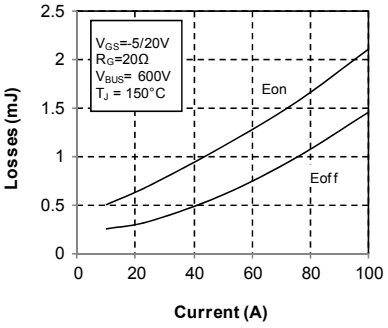
Transfert Characteristics



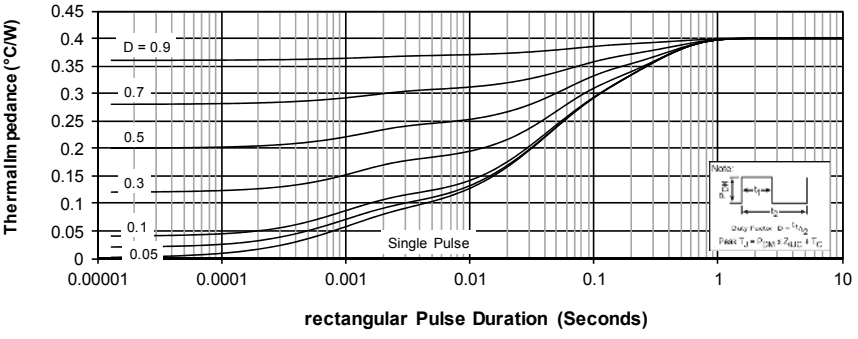
Switching energy vs Rg



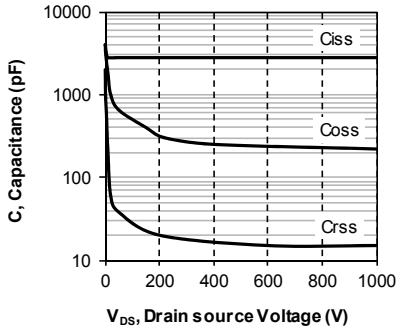
switching energy vs current



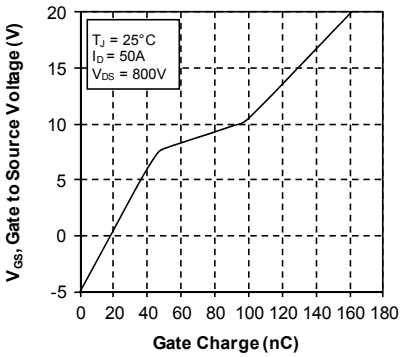
Maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration



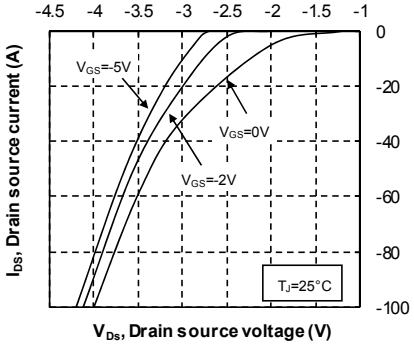
Capacitance vs Drain Source Voltage



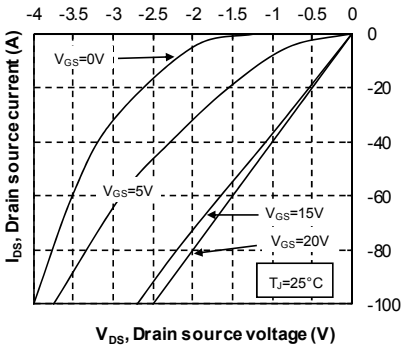
Gate Charge vs Gate Source Voltage



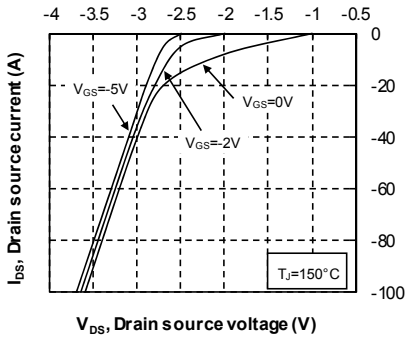
Body diode Characteristics



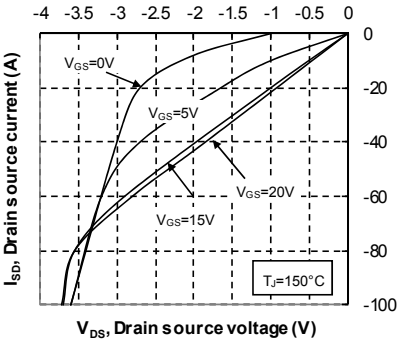
3rd quadrant Characteristics



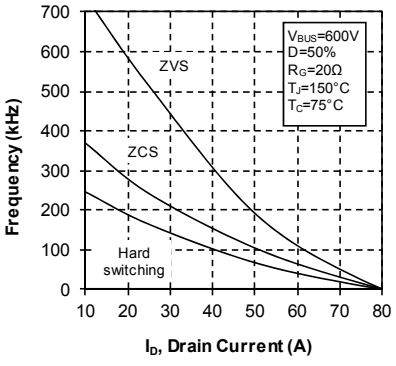
Body diode Characteristics



3rd quadrant Characteristics

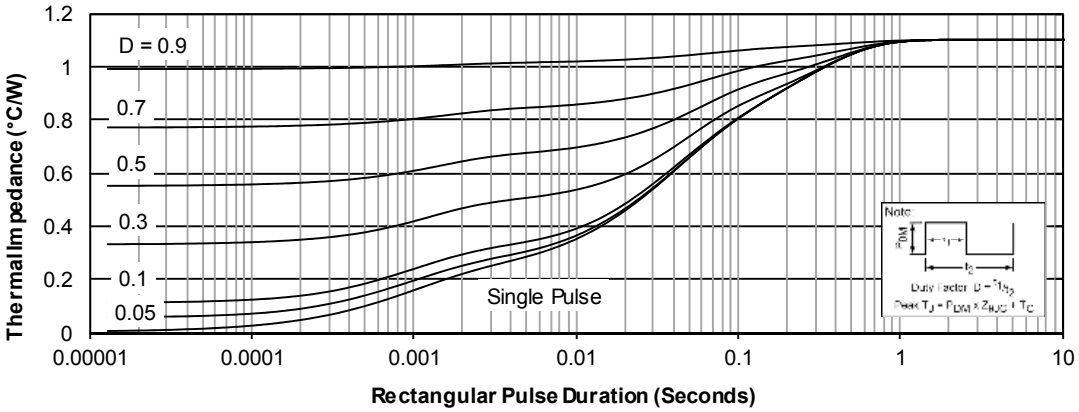


Operating Frequency vs Drain Current

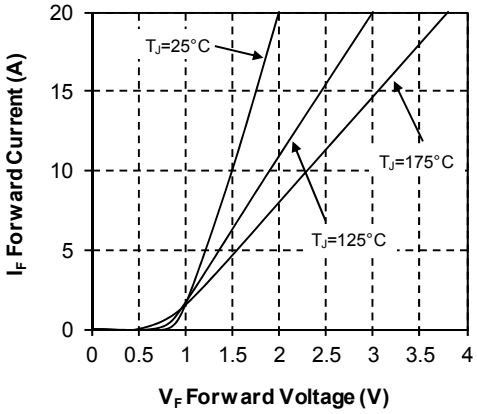


CR1 & CR2 SiC diode characteristics

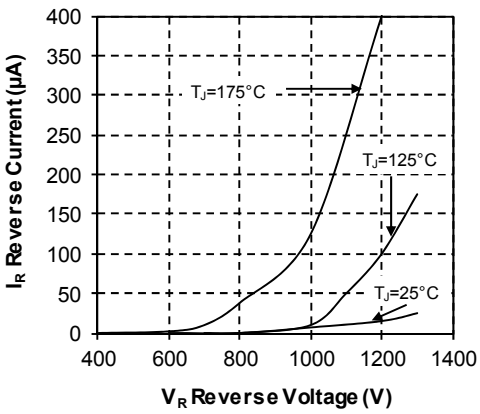
Maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration



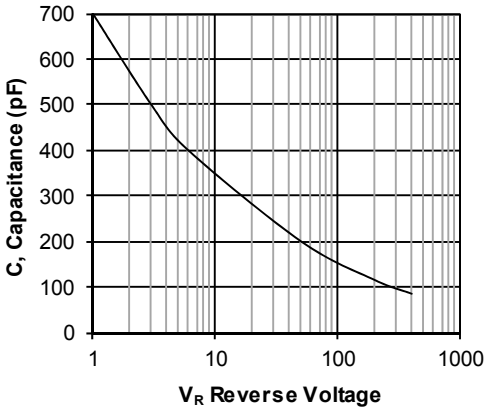
Forward Characteristics



Reverse Characteristics

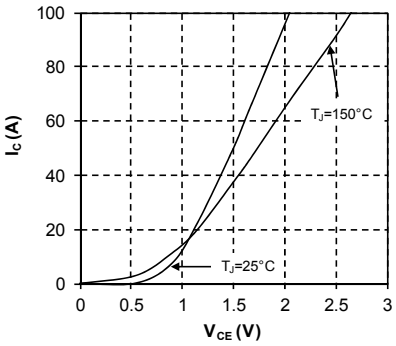


Capacitance vs.Reverse Voltage

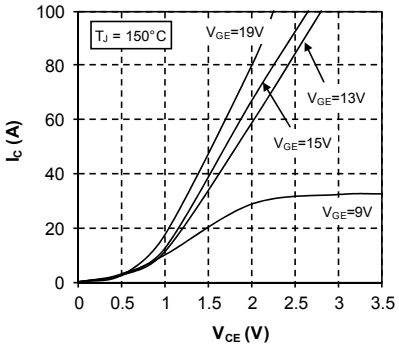


Q3, Q4 Trench + field stop IGBT3

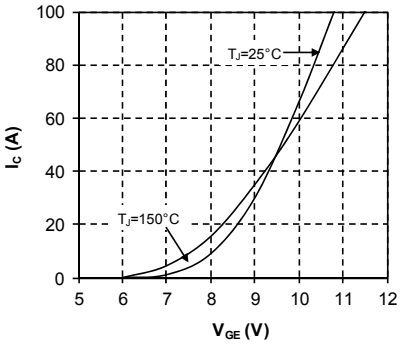
Output Characteristics (V_{GE}=15V)



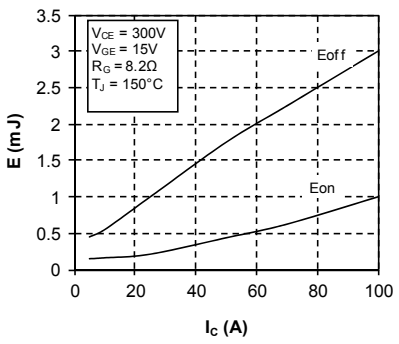
Output Characteristics



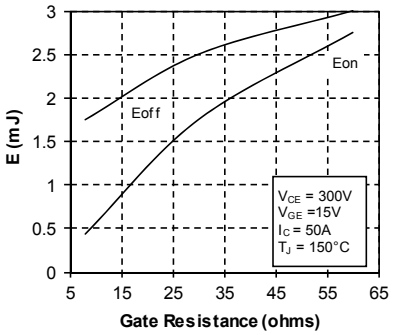
Transfert Characteristics



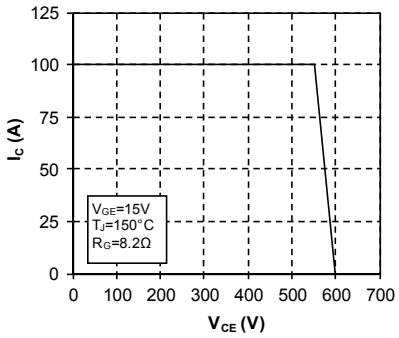
Energy losses vs Collector Current



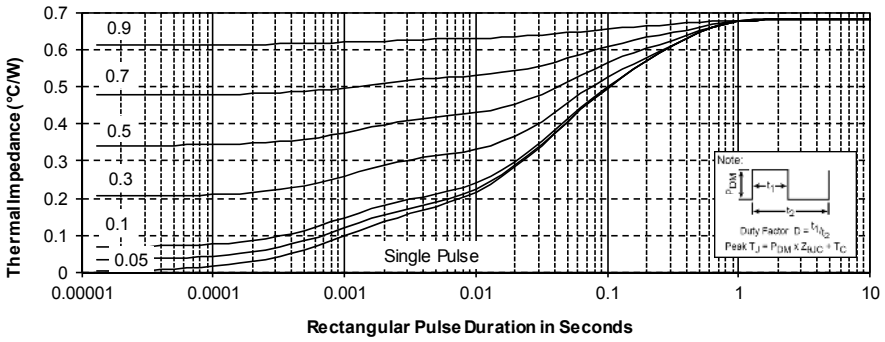
Switching Energy Losses vs Gate Resistance



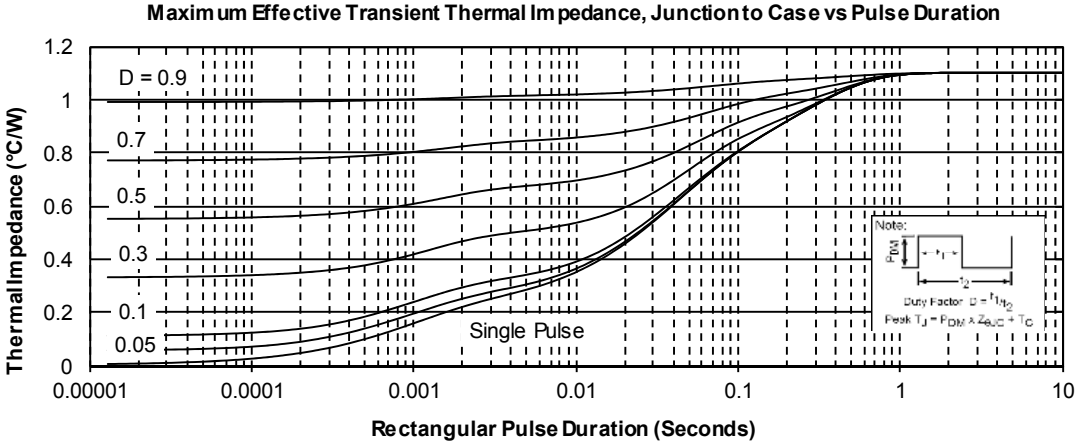
Reverse Bias Safe Operating Area

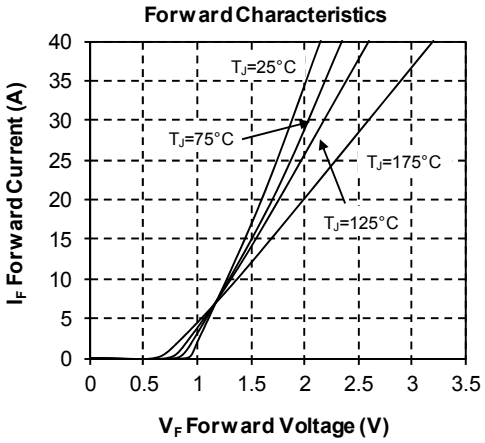


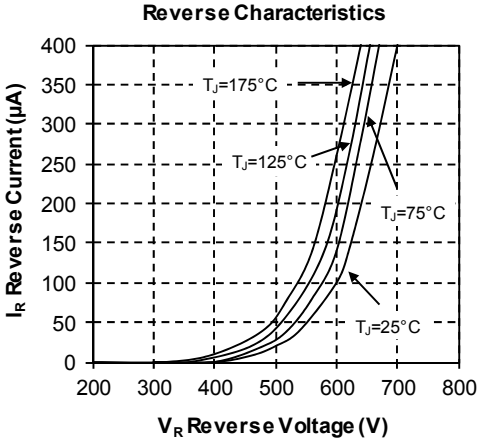
maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration

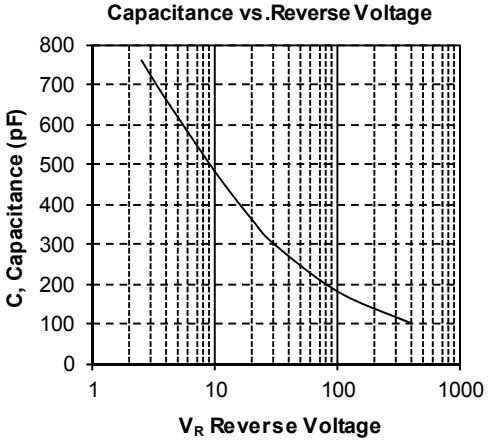


CR3 & CR4 SiC diode characteristics









DISCLAIMER

The information contained in the document (unless it is publicly available on the Web without access restrictions) is PROPRIETARY AND CONFIDENTIAL information of Microsemi and cannot be copied, published, uploaded, posted, transmitted, distributed or disclosed or used without the express duly signed written consent of Microsemi. If the recipient of this document has entered into a disclosure agreement with Microsemi, then the terms of such Agreement will also apply. This document and the information contained herein may not be modified, by any person other than authorized personnel of Microsemi. No license under any patent, copyright, trade secret or other intellectual property right is granted to or conferred upon you by disclosure or delivery of the information, either expressly, by implication, inducement, estoppels or otherwise. Any license under such intellectual property rights must be approved by Microsemi in writing signed by an officer of Microsemi.

Microsemi reserves the right to change the configuration, functionality and performance of its products at anytime without any notice. This product has been subject to limited testing and should not be used in conjunction with life-support or other mission-critical equipment or applications. Microsemi assumes no liability whatsoever, and Microsemi disclaims any express or implied warranty, relating to sale and/or use of Microsemi products including liability or warranties relating to fitness for a particular purpose, merchantability, or infringement of any patent, copyright or other intellectual property right. Any performance specifications believed to be reliable but are not verified and customer or user must conduct and complete all performance and other testing of this product as well as any user or customers final application. User or customer shall not rely on any data and performance specifications or parameters provided by Microsemi. It is the customer's and user's responsibility to independently determine suitability of any Microsemi product and to test and verify the same. The information contained herein is provided "AS IS, WHERE IS" and with all faults, and the entire risk associated with such information is entirely with the User. Microsemi specifically disclaims any liability of any kind including for consequential, incidental and punitive damages as well as lost profit. The product is subject to other terms and conditions which can be located on the web at http://www.microsemi.com/legal/tnc.asp

Life Support Application

Seller's Products are not designed, intended, or authorized for use as components in systems intended for space, aviation, surgical implant into the body, in other applications intended to support or sustain life, or for any other application in which the failure of the Seller's Product could create a situation where personal injury, death or property damage or loss may occur (collectively "Life Support Applications").

Buyer agrees not to use Products in any Life Support Applications and to the extent it does it shall conduct extensive testing of the Product in such applications and further agrees to indemnify and hold Seller, and its officers, employees, subsidiaries, affiliates, agents, sales representatives and distributors harmless against all claims, costs, damages and expenses, and attorneys' fees and costs arising, directly or directly, out of any claims of personal injury, death, damage or otherwise associated with the use of the goods in Life Support Applications, even if such claim includes allegations that Seller was negligent regarding the design or manufacture of the goods.

Buyer must notify Seller in writing before using Seller's Products in Life Support Applications. Seller will study with Buyer alternative solutions to meet Buyer application specification based on Sellers sales conditions applicable for the new proposed specific part.