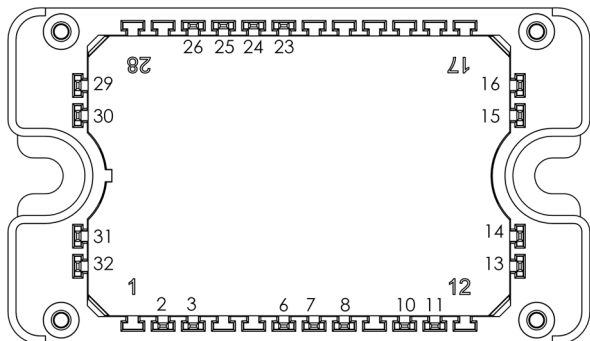
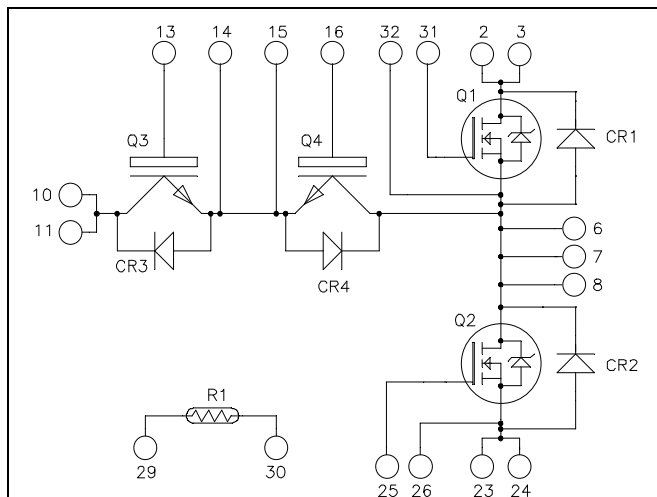


Phase Leg & Dual Common Emitter Power Module



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

SiC MOSFET (Q1, Q2):

$V_{CES} = 1200V$; $R_{DS(on)} = 98m\Omega$ max @ $T_j = 25^\circ C$

Trench & Field Stop IGBT3 (Q3, Q4):

$V_{CES} = 600V$; $I_C = 20A$ @ $T_c = 80^\circ C$

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
- High level of integration
- 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 @ $T_j = 25^\circ C$ 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 Breakdown Voltage	1200	V
I_D	Continuous Drain Current	$T_c = 25^\circ\text{C}$	A
		$T_c = 80^\circ\text{C}$	
I_{DM}	Pulsed Drain current	55	
V_{GS}	Gate - Source Voltage	-10/+25	V
$R_{DS(on)}$	Drain - Source ON Resistance	98	m Ω
P_D	Maximum Power Dissipation	$T_c = 25^\circ\text{C}$	W

Electrical Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
I_{DSS}	Zero Gate Voltage Drain Current	$V_{GS} = 0V, V_{DS} = 1200V$		12	100	μA
$R_{DS(on)}$	Drain – Source on Resistance	$V_{GS} = 20V$ $I_D = 20A$		80	98	m Ω
		$T_j = 25^\circ\text{C}$ $T_j = 150^\circ\text{C}$		150	208	
$V_{GS(th)}$	Gate Threshold Voltage	$V_{GS} = V_{DS}, I_D = 1mA$	1.7	2.2		V
I_{GSS}	Gate – Source Leakage Current	$V_{GS} = 20V, V_{DS} = 0V$			250	nA

Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C_{iss}	Input Capacitance	$V_{GS} = 0V$ $V_{DS} = 1000V$ $f = 1MHz$		950		pF
C_{oss}	Output Capacitance			80		
C_{rss}	Reverse Transfer Capacitance			6.5		
Q_g	Total gate Charge	$V_{GE} = 20V$ $V_{Bus} = 800V$ $I_D = 20A$		49		nC
Q_{gs}	Gate – Source Charge			11		
Q_{gd}	Gate – Drain Charge			18		
$T_{d(on)}$	Turn-on Delay Time	$V_{GS} = -2/+20V$ $V_{Bus} = 800V$ $I_D = 20A$ $R_L = 40\Omega; R_G = 50\Omega$		12		ns
T_r	Rise Time			14		
$T_{d(off)}$	Turn-off Delay Time			23		
T_f	Fall Time			18		
E_{on}	Turn on Energy	Inductive Switching $V_{GS} = -5/+20V$ $V_{Bus} = 600V$ $I_D = 20A$ $R_G = 50\Omega$	$T_j = 150^\circ\text{C}$	0.45		mJ
E_{off}	Turn off Energy			0.25		
R_{thJC}	Junction to Case Thermal Resistance				1.25	$^\circ\text{C/W}$

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

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
V_{RRM}	Maximum Peak Repetitive Reverse Voltage		1200			V
I_{RM}	Maximum Reverse Leakage Current	$V_R = 1200V$		32	200	μA
		$T_j = 25^{\circ}C$				
		$T_j = 175^{\circ}C$		56	1000	
I_F	DC Forward Current			10		A
V_F	Diode Forward Voltage	$I_F = 10A$		1.6	1.8	V
		$T_j = 25^{\circ}C$				
		$T_j = 175^{\circ}C$		2.3	3	
Q_C	Total Capacitive Charge	$I_F = 10A, V_R = 1200V$ $di/dt = 500A/\mu s$		80		nC
C	Total Capacitance	$f = 1MHz, V_R = 200V$		96		pF
		$f = 1MHz, V_R = 400V$		69		
R_{thJC}	Junction to Case Thermal Resistance				1.8	$^{\circ}C/W$

2. Trench & Field Stop IGBT3 (per IGBT)
Absolute maximum ratings

Symbol	Parameter	Max ratings	Unit
V_{CES}	Collector - Emitter Breakdown Voltage	600	V
I_C	Continuous Collector Current	$T_C = 25^{\circ}C$ $T_C = 80^{\circ}C$	A
I_{CM}	Pulsed Collector Current	$T_C = 25^{\circ}C$	40
V_{GE}	Gate - Emitter Voltage	± 20	V
P_D	Maximum Power Dissipation	$T_C = 25^{\circ}C$	62
RBSOA	Reverse Bias Safe Operating Area	$T_j = 150^{\circ}C$	40A @ 550V

Electrical Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
I_{CES}	Zero Gate Voltage Collector Current	$V_{GE} = 0V, V_{CE} = 600V$			250	μA
$V_{CE(sat)}$	Collector Emitter Saturation Voltage	$V_{GE} = 15V, I_C = 20A$		1.5	1.9	V
		$T_j = 25^{\circ}C$ $T_j = 150^{\circ}C$		1.7		
$V_{GE(th)}$	Gate Threshold Voltage	$V_{GE} = V_{CE}, I_C = 300\mu A$	5.0	5.8	6.5	V
I_{GES}	Gate - Emitter Leakage Current	$V_{GE} = 20V, V_{CE} = 0V$			300	nA

Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C _{ies}	Input Capacitance	V _{GE} = 0V V _{CE} = 25V f = 1MHz		1100		pF
C _{oes}	Output Capacitance			70		
C _{res}	Reverse Transfer Capacitance			35		
Q _G	Gate charge	V _{GE} = ±15V, I _C = 20A V _{CE} = 300V		200		nC
T _{d(on)}	Turn-on Delay Time	Inductive Switching (25°C) V _{GE} = ±15V V _{Bus} = 300V I _C = 20A R _G = 12Ω		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 = 20A R _G = 12Ω		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 = 20A R _G = 12Ω	T _j = 25°C	0.11		mJ
			T _j = 150°C	0.2		
E _{off}	Turn-off Switching Energy		T _j = 25°C	0.5		mJ
			T _j = 150°C	0.7		
I _{sc}	Short Circuit data	V _{GE} ≤ 15V ; V _{Bus} = 360V t _p ≤ 10μs ; T _j = 150°C		100		A
R _{thJC}	Junction to Case Thermal Resistance				2.4	°C/W

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

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
V _{RRM}	Maximum Peak Repetitive Reverse Voltage		600			V
I _{RM}	Maximum Reverse Leakage Current	V _R = 600V	T _j = 25°C	10	60	μA
			T _j = 175°C	20	300	
I _F	DC Forward Current		T _c = 100°C	10		A
V _F	Diode Forward Voltage	I _F = 10A	T _j = 25°C	1.6	1.8	V
			T _j = 175°C	2	2.4	
Q _C	Total Capacitive Charge	I _F = 10A, V _R = 600V di/dt = 500A/μs		28		nC
C	Total Capacitance	f = 1MHz, V _R = 200V		65		pF
		f = 1MHz, V _R = 400V		50		
R _{thJC}	Junction to Case Thermal Resistance				2.5	°C/W

4. Temperature sensor NTC

Symbol	Characteristic	Min	Typ	Max	Unit
R ₂₅	Resistance @ 25°C		22		kΩ
ΔR ₂₅ /R ₂₅	Resistance tolerance			5	%
ΔB/B	Beta tolerance			3	
B _{25/100}	T ₂₅ = 298.16 K		3980		K

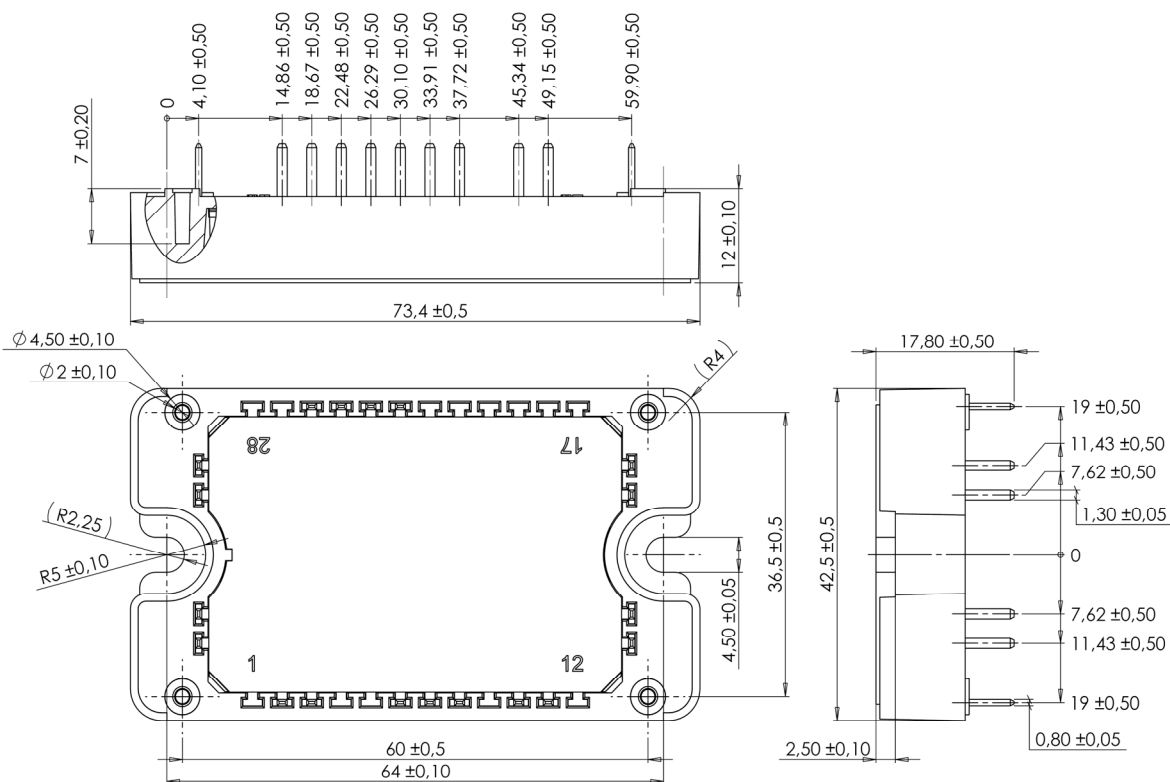
$$R_T = \frac{R_{25}}{\exp \left[B_{25/100} \left(\frac{1}{T_{25}} - \frac{1}{T} \right) \right]}$$

T: Thermistor temperature
 R_T: Thermistor value at T

5. Thermal and package characteristics

Symbol	Characteristic			Min	Typ	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 diodes + 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

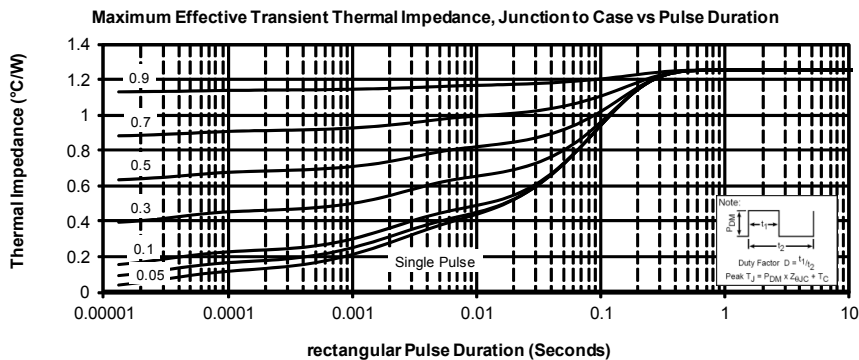
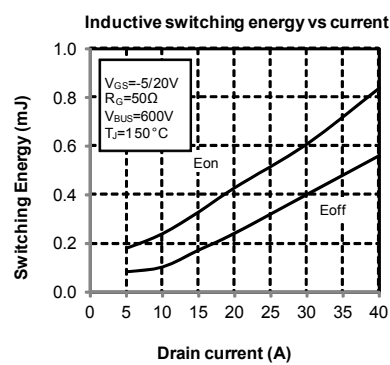
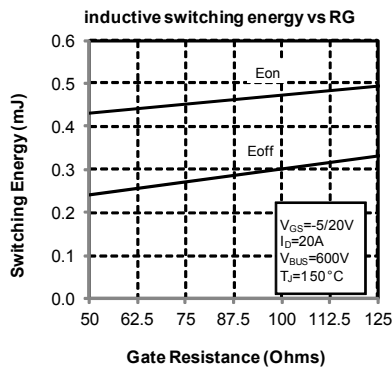
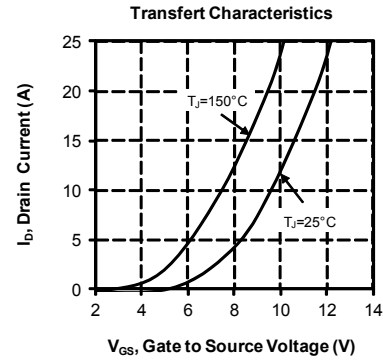
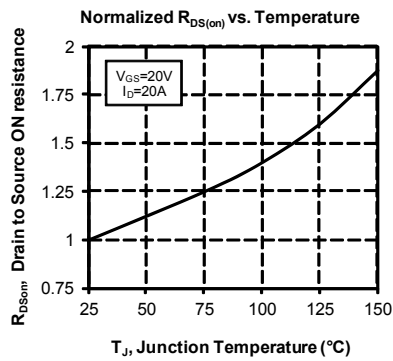
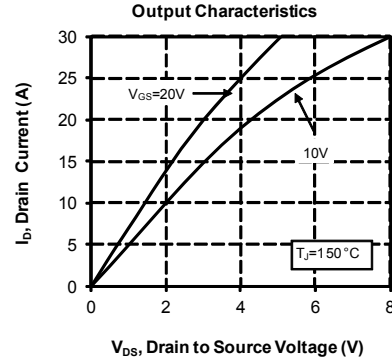
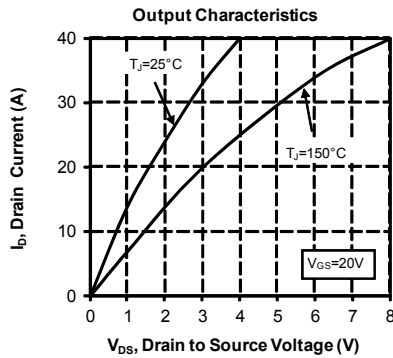
SP3F Package outline (dimensions in mm)

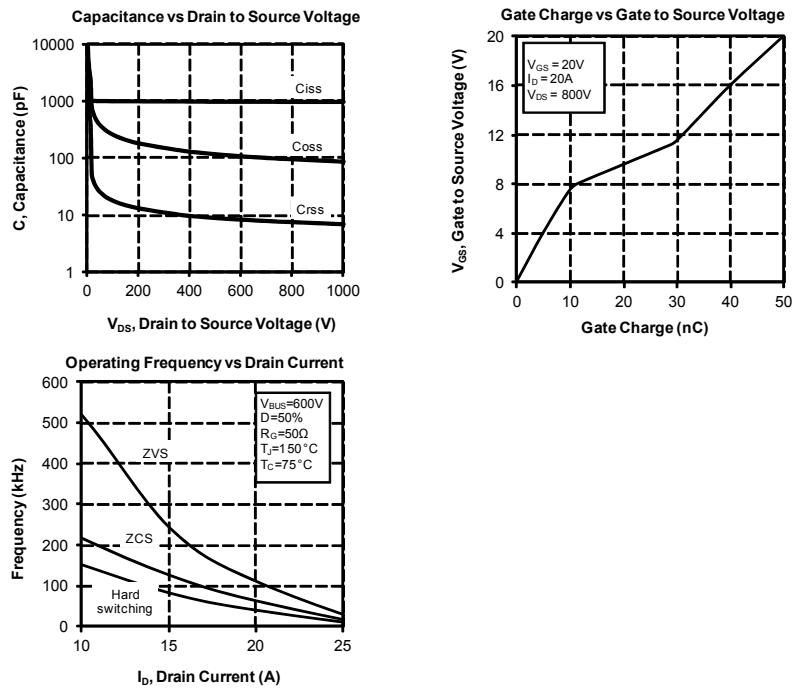


See application note 1906 - Mounting Instructions for SP3F Power Modules on www.microsemi.com

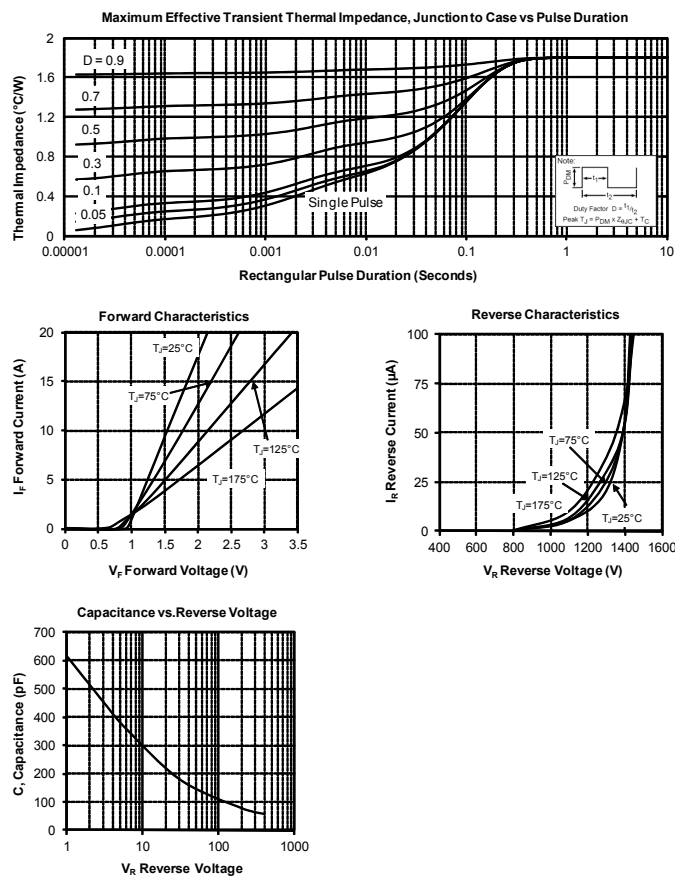
6. Typical performance curve

Q1, Q2 SiC MOSFET

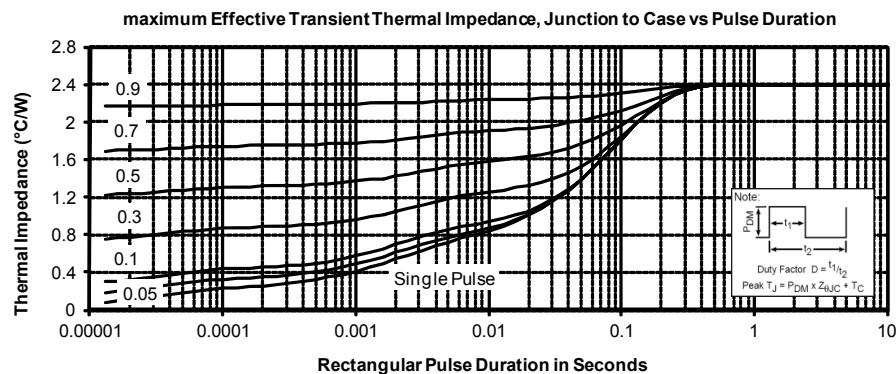
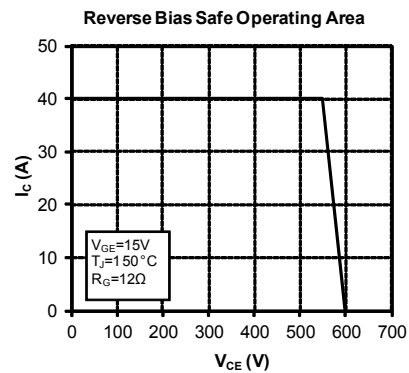
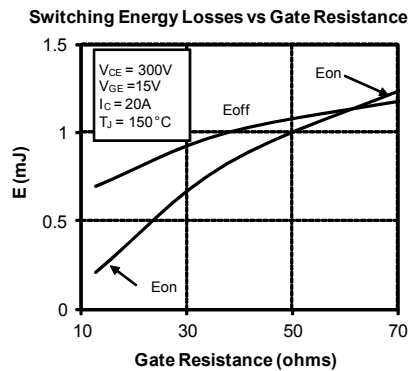
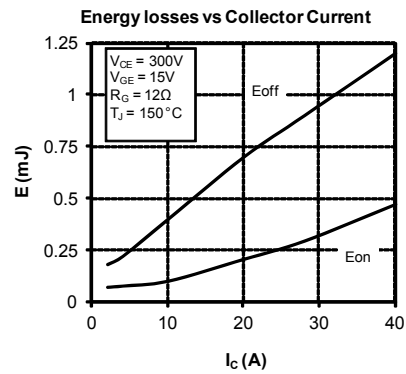
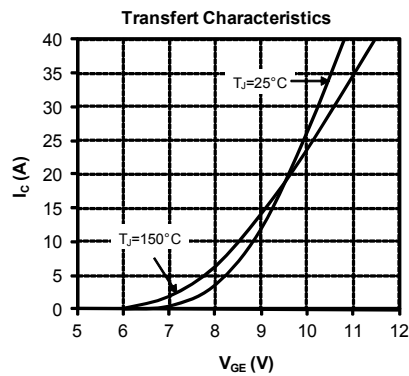
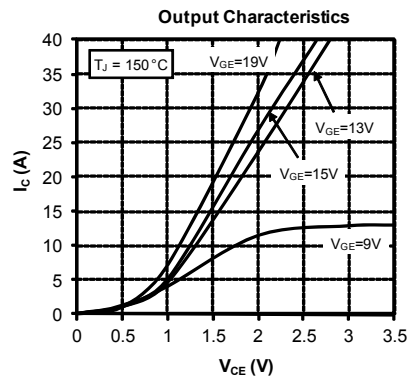
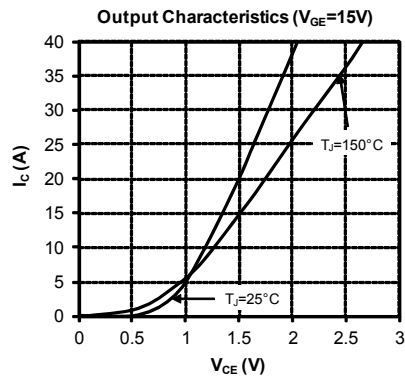




CR1 & CR2 SiC diode characteristics

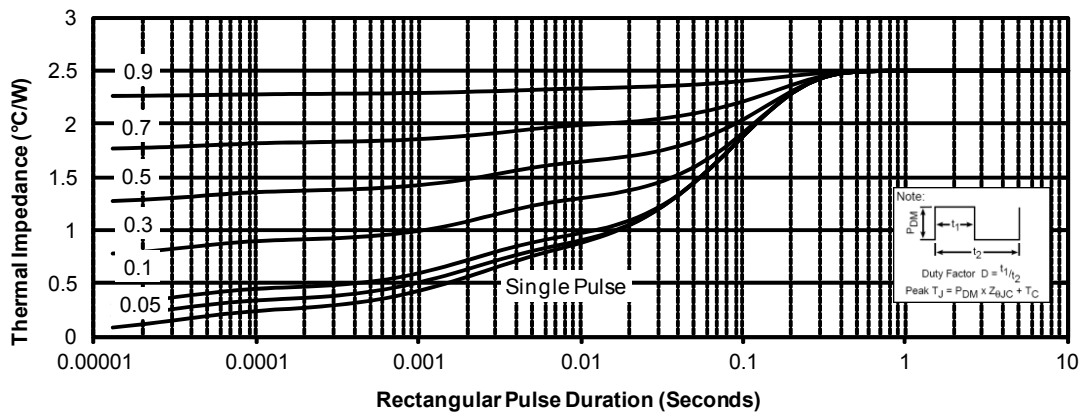


Q3, Q4 Trench + field stop IGBT3

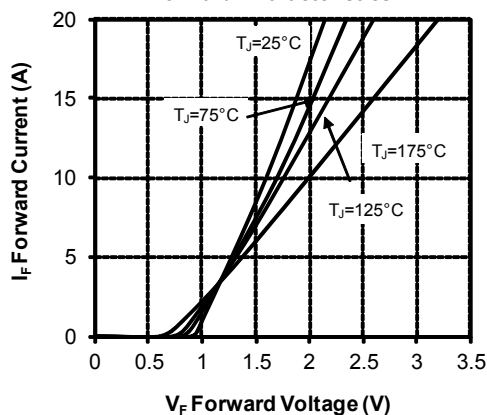


CR3 & CR4 SiC diode characteristics

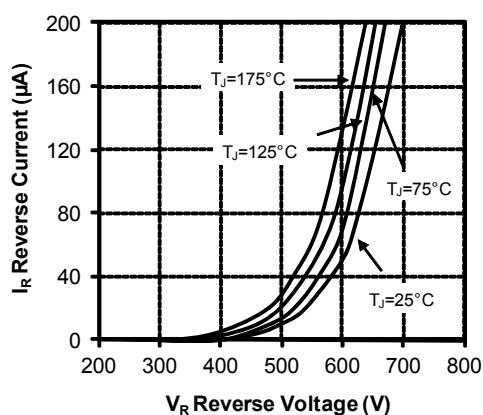
Maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration



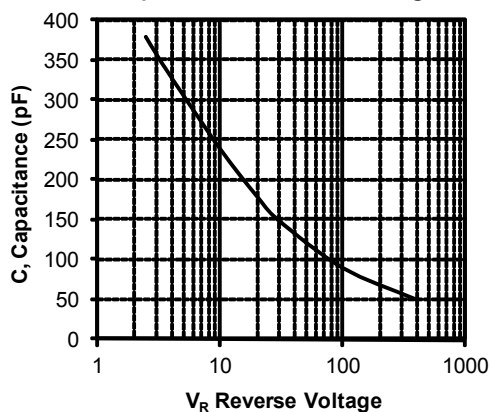
Forward Characteristics



Reverse Characteristics



Capacitance vs. Reverse Voltage



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