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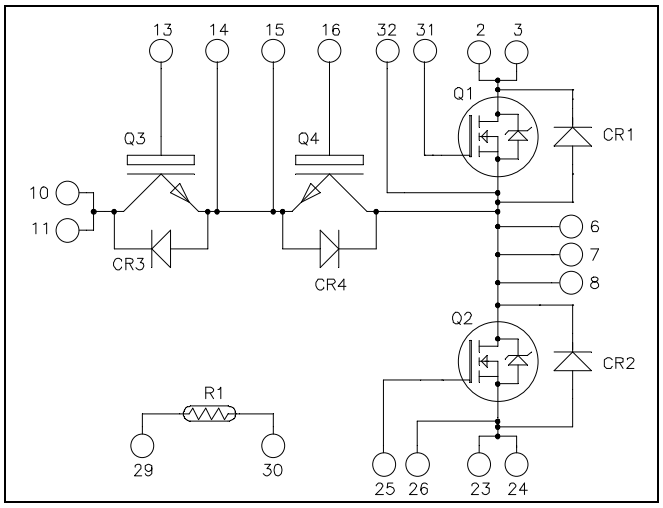
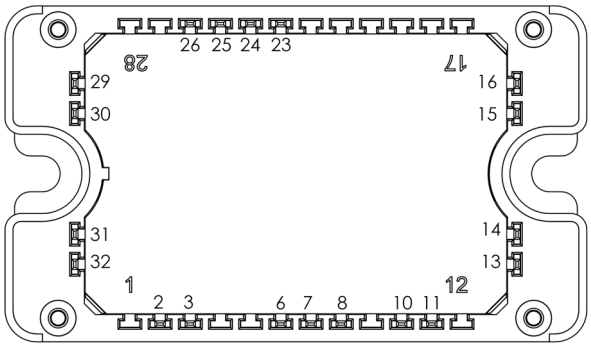
APTMC120HR11CT3AG

Phase Leg & Dual Common Emitter Power Module

SiC MOSFET (Q1, Q2):
V_{CES} = 1200V ; R_{DSon} = 98mΩ max @ Tj = 25°C

Trench & Field Stop IGBT3 (Q3, Q4):
V_{CES} = 600V ; I_C = 20A @ 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 perf ormance
- ***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
- Low profile
- RoHS Compliant

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	26	A
		T_c = 80°C	20	
I_{DM}	Pulsed Drain current		55	
V_{GS}	Gate - Source Voltage		-10/+25	V
R_{DSon}	Drain - Source ON Resistance		98	mΩ
P_D	Power Dissipation	T_c = 25°C	125	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 = 20A	T_j = 25°C		80	98	mΩ
			T_j = 150°C		153		
$V_{GS(th)}$	Gate Threshold Voltage	V_{GS} = V_{DS}, I_D = 5mA		2.4	3		V
I_{GSS}	Gate – Source Leakage Current	V_{GS} = 20 V, 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				7.6		
Q_g	Total gate Charge	V_{GE} = 20V V_{Bus} = 800V I_D = 20A			62		nC
Q_{gs}	Gate – Source Charge				15		
Q_{gd}	Gate – Drain Charge				23		
$T_{d(on)}$	Turn-on Delay Time	V_{GS} = -2/+20V V_{Bus} = 800V I_D = 20A R_L = 40Ω ; R_G = 50Ω			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 = 50Ω	T_j = 150°C		0.45		mJ
E_{off}	Turn off Energy		T_j = 150°C		0.25		
R_{thJC}	Junction to Case Thermal Resistance					1	°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	37	A
		T_C = 100°C	20	
I_{CM}	Pulsed Collector Current	T_C = 25°C	40	
V_{GE}	Gate – Emitter Voltage		±20	V
P_D	Power Dissipation	T_C = 25°C	78	W
RBSOA	Reverse Bias Safe Operating Area	T_J = 150°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	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 = 300µA		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					1.92	°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		10	60	µA
			T_j = 175°C		20	300	
I_F	DC Forward Current		Tc = 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					2.2	°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

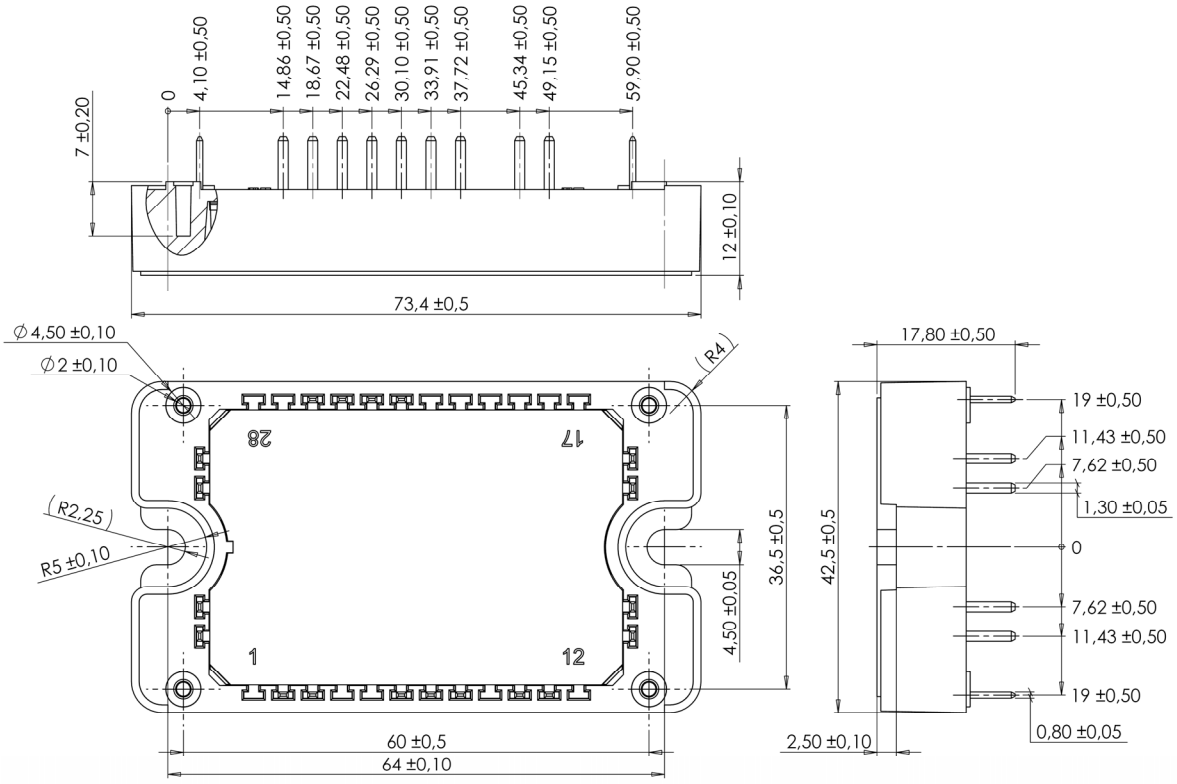
$$R_T = \frac{R_{25}}{\exp\left[B_{25/100}\left(\frac{1}{T_{25}} - \frac{1}{T}\right)\right]}$$

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 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

Package outline (dimensions in mm)

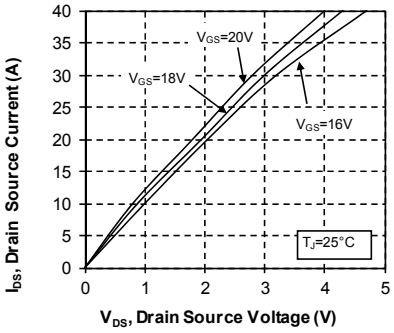


See application note 1906 - Mounting Instructions for SP3F Power Modules on www.microsemi.com

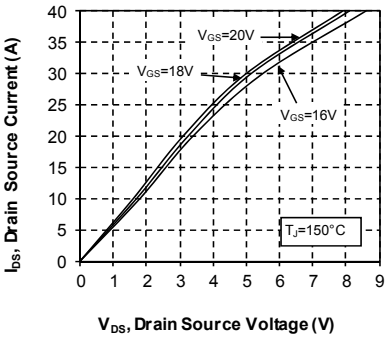
6. Typical performance curve

Q1, Q2 SiC MOSFET

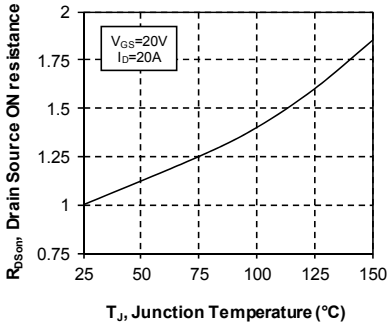
Output Characteristics



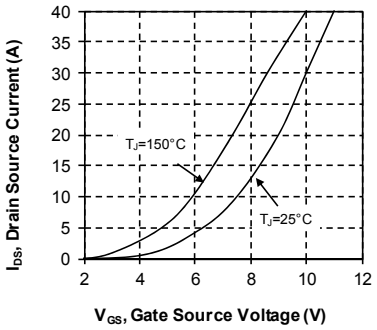
Output Characteristics



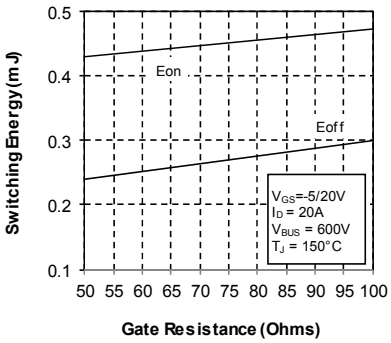
Normalized $R_{DS(on)}$ vs. Temperature



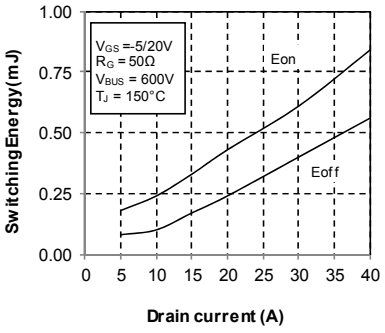
Transfert Characteristics



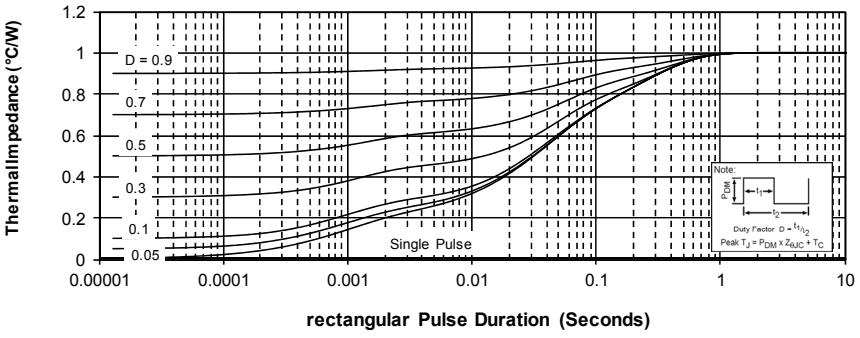
inductive switching energy vs RG



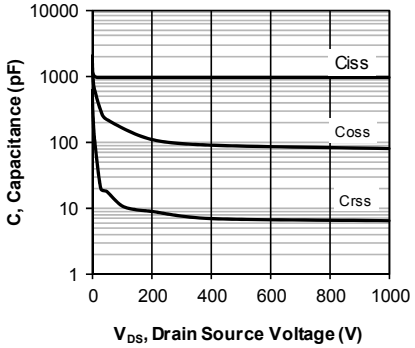
Inductive switching energy vs current



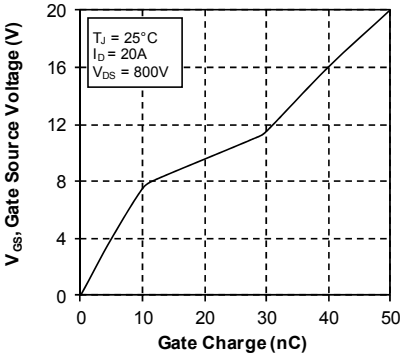
Maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration



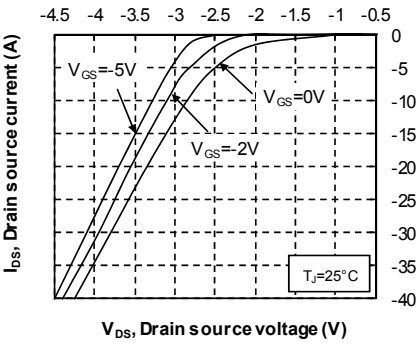
Capacitance vs Drain Source Voltage



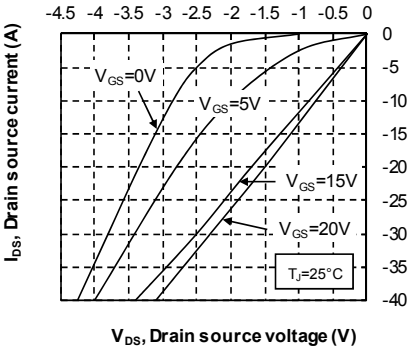
Gate Charge vs Gate Source Voltage



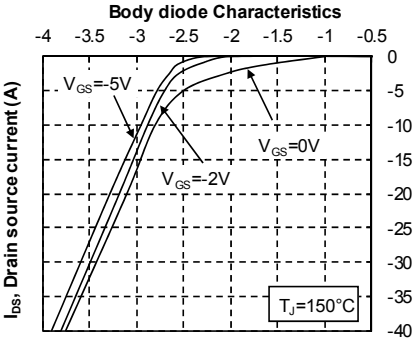
Body diode Characteristics



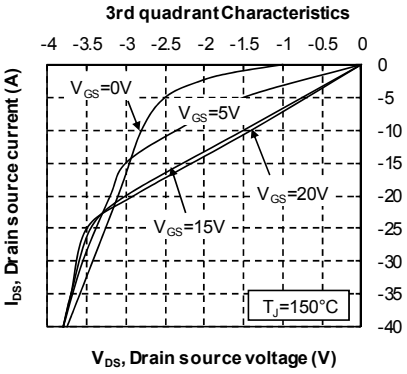
3rd quadrant Characteristics



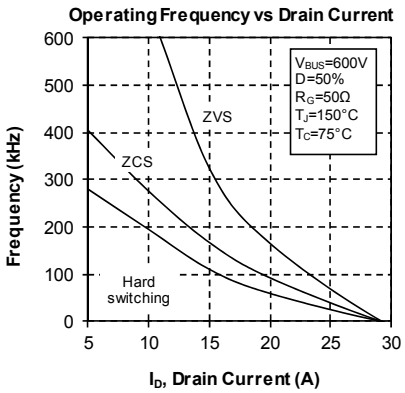
Body diode Characteristics



3rd quadrant Characteristics

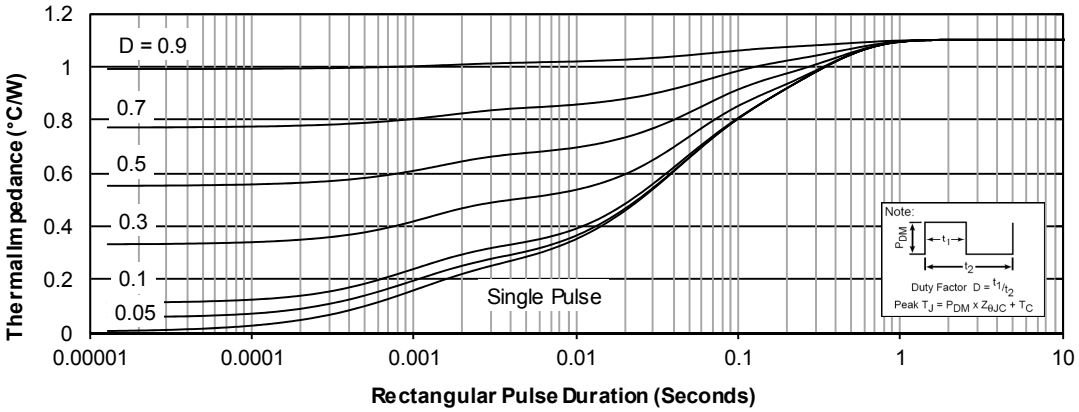


Operating Frequency vs Drain Current

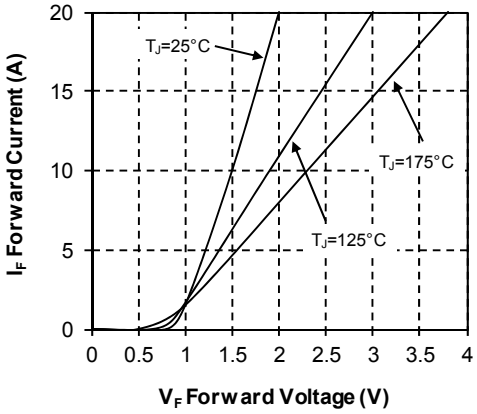


CR1 & CR2 SiC diode characteristics

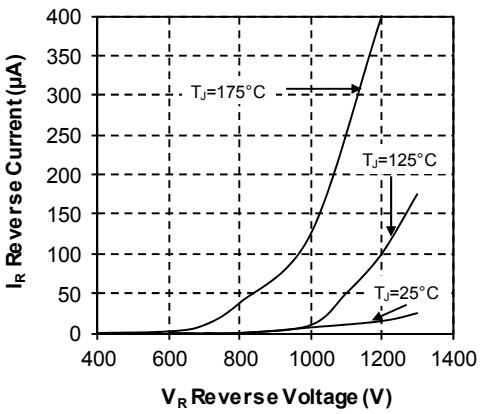
Maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration



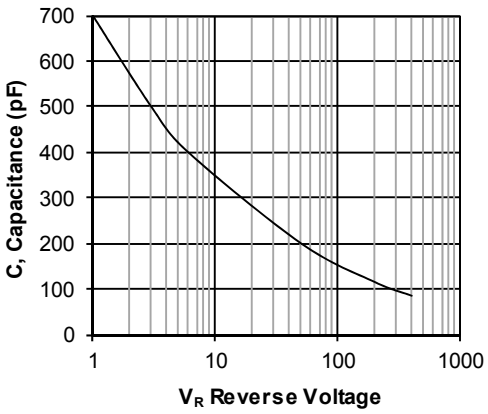
Forward Characteristics



Reverse Characteristics

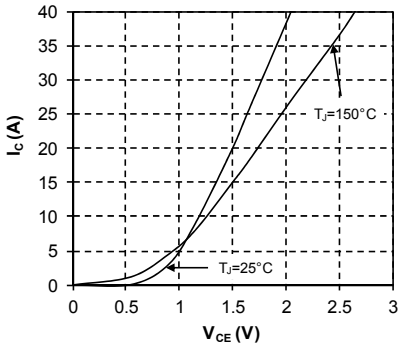


Capacitance vs.Reverse Voltage

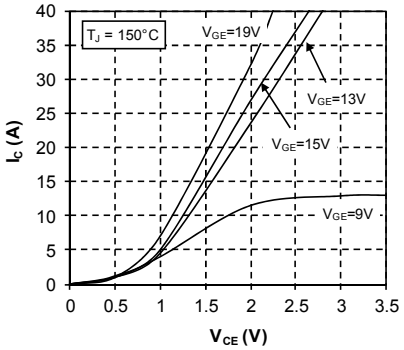


Q3, Q4 Trench + field stop IGBT3

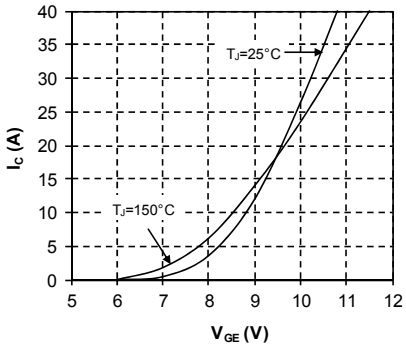
Output Characteristics (V_{GE}=15V)



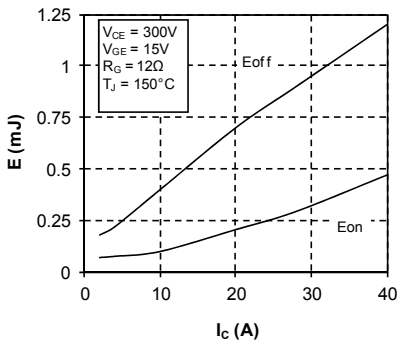
Output Characteristics



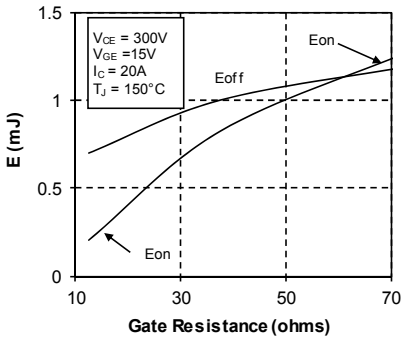
Transfert Characteristics



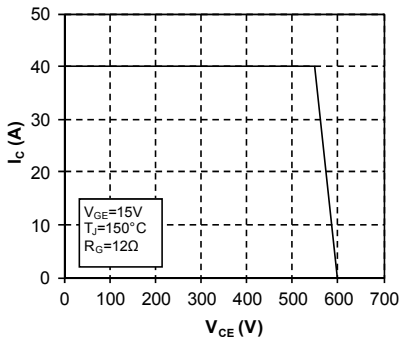
Energy losses vs Collector Current



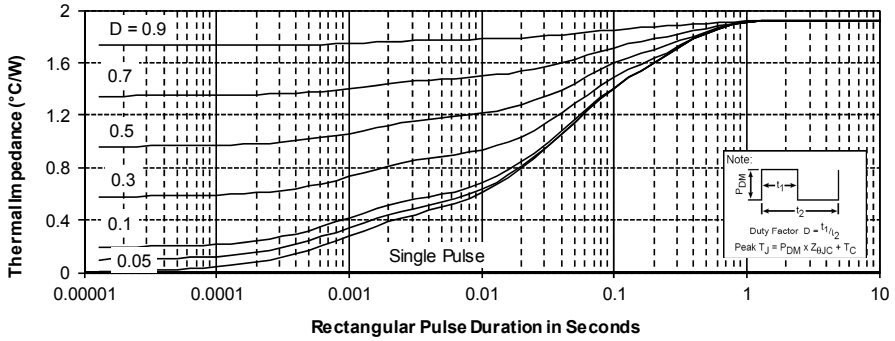
Switching Energy Losses vs Gate Resistance



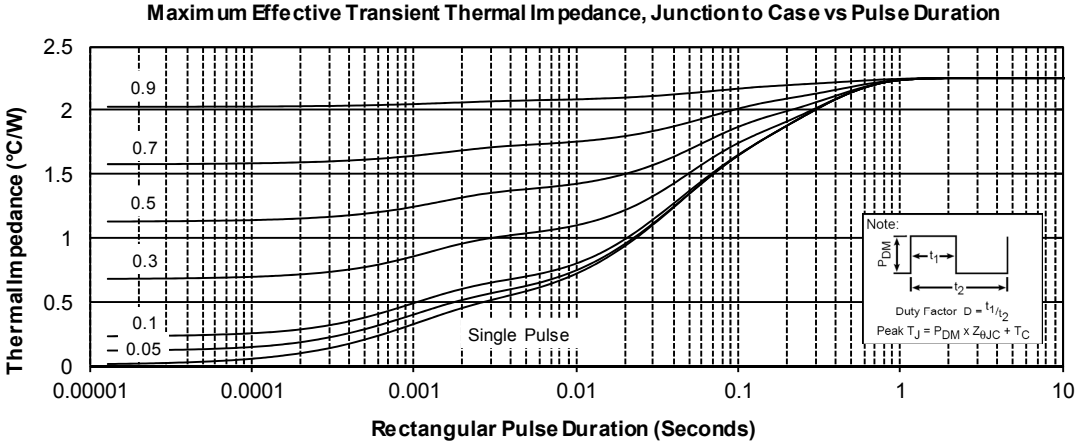
Reverse Bias Safe Operating Area

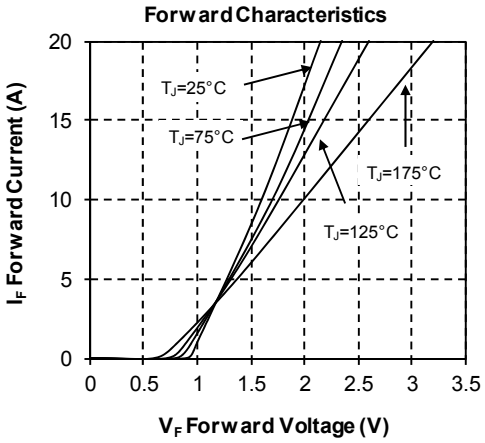


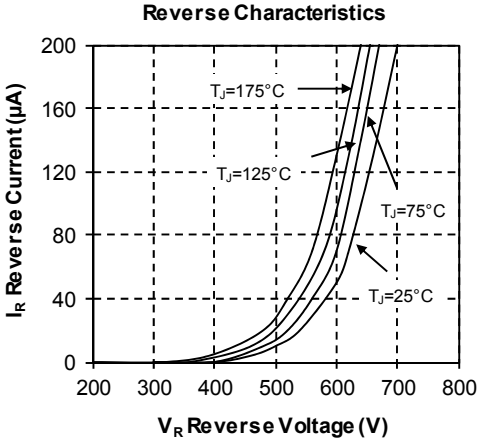
maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration

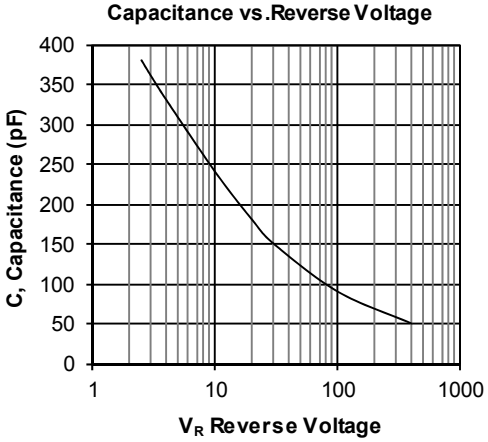


CR3 & CR4 SiC diode characteristics









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