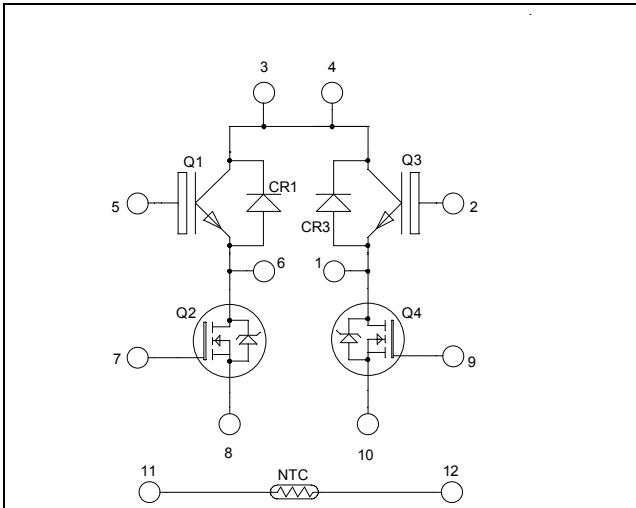


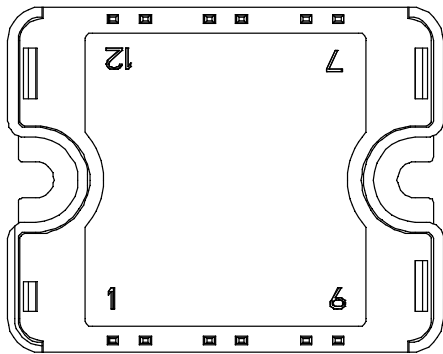
*Full - Bridge  
CoolMOS & Trench + Field Stop<sup>®</sup> IGBT  
Power module*

**Trench & Field Stop<sup>®</sup> IGBT Q1, Q3:**  
 $V_{CES} = 600V$  ;  $I_C = 50A$  @  $T_c = 80^\circ C$

**CoolMOS<sup>™</sup> Q2, Q4:**  
 $V_{DSS} = 600V$  ;  $I_D = 36A$  @  $T_c = 25^\circ C$



Top switches : Trench + Field Stop IGBT<sup>®</sup>  
Bottom switches : CoolMOS<sup>™</sup>



Pins 3/4 must be shorted together

## Application


- Solar converter

## Features

- **Q2, Q4 CoolMOS<sup>™</sup>**
  - Ultra low  $R_{DSon}$
  - Low Miller capacitance
  - Ultra low gate charge
  - Avalanche energy rated
  - Very rugged
  - Fast intrinsic diode
- **Q1, Q3 Trench & Field Stop IGBT<sup>®</sup>**
  - Low voltage drop
  - Switching frequency up to 20 kHz
  - RBSOA & SCSOA rated
  - Low tail current
- **SiC Schottky Diode (CR1, CR3)**
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature Independent switching behavior
  - Positive temperature coefficient on VF
- Very low stray inductance
- Internal thermistor for temperature monitoring
- High level of integration

## Benefits

- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction to case thermal resistance
- Solderable terminals both for power and signal for easy PCB mounting
- Low profile
- RoHS Compliant

 **CAUTION:** These Devices are sensitive to Electrostatic Discharge. Proper Handling Procedures Should Be Followed. See application note APT0502 on [www.microsemi.com](http://www.microsemi.com)

**All ratings @  $T_j = 25^\circ C$  unless otherwise specified**

**1. Top switches**
**1.1 Top Trench + Field Stop IGBT® characteristics**
**Absolute maximum ratings**

Symbol	Parameter	Max ratings	Unit
V <sub>CES</sub>	Collector - Emitter Breakdown Voltage	600	V
I <sub>C</sub>	Continuous Collector Current	T <sub>C</sub> = 25°C	80
		T <sub>C</sub> = 80°C	50
I <sub>CM</sub>	Pulsed Collector Current	T <sub>C</sub> = 25°C	100
V <sub>GE</sub>	Gate - Emitter Voltage	±20	V
P <sub>D</sub>	Maximum Power Dissipation	T <sub>C</sub> = 25°C	176
RBSOA	Reverse Bias Safe Operating Area	T <sub>J</sub> = 150°C	100A @ 550V

**Electrical Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
I <sub>CES</sub>	Zero Gate Voltage Collector Current	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V			250	µA
V <sub>CE(sat)</sub>	Collector Emitter Saturation Voltage	V <sub>GE</sub> = 15V I <sub>C</sub> = 50A	T <sub>J</sub> = 25°C	1.5	1.9	V
			T <sub>J</sub> = 150°C	1.7		
V <sub>GE(th)</sub>	Gate Threshold Voltage	V <sub>GE</sub> = V <sub>CE</sub> , I <sub>C</sub> = 600µA	5.0	5.8	6.5	V
I <sub>GES</sub>	Gate - Emitter Leakage Current	V <sub>GE</sub> = 20V, V <sub>CE</sub> = 0V			600	nA

**Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C <sub>ies</sub>	Input Capacitance	V <sub>GE</sub> = 0V V <sub>CE</sub> = 25V f = 1MHz		3150		pF
C <sub>oes</sub>	Output Capacitance			200		
C <sub>res</sub>	Reverse Transfer Capacitance			95		
T <sub>d(on)</sub>	Turn-on Delay Time	Inductive Switching (25°C) V <sub>GE</sub> = ±15V V <sub>Bus</sub> = 300V I <sub>C</sub> = 50A R <sub>G</sub> = 8.2Ω		110		ns
T <sub>r</sub>	Rise Time			45		
T <sub>d(off)</sub>	Turn-off Delay Time			200		
T <sub>f</sub>	Fall Time			40		
T <sub>d(on)</sub>	Turn-on Delay Time	Inductive Switching (150°C) V <sub>GE</sub> = ±15V V <sub>Bus</sub> = 300V I <sub>C</sub> = 50A R <sub>G</sub> = 8.2Ω		120		ns
T <sub>r</sub>	Rise Time			50		
T <sub>d(off)</sub>	Turn-off Delay Time			250		
T <sub>f</sub>	Fall Time			60		
E <sub>on</sub>	Turn-on Switching Energy	V <sub>GE</sub> = ±15V V <sub>Bus</sub> = 300V I <sub>C</sub> = 50A	T <sub>J</sub> = 25°C	0.3		mJ
			T <sub>J</sub> = 150°C	0.43		
E <sub>off</sub>	Turn-off Switching Energy	R <sub>G</sub> = 8.2Ω	T <sub>J</sub> = 25°C	1.35		mJ
			T <sub>J</sub> = 150°C	1.75		
R <sub>thJC</sub>	Junction to Case Thermal resistance				0.85	°C/W

## 1.2 Top SiC diode characteristics (CR1, CR3)

<i>Symbol</i>	<i>Characteristic</i>	<i>Test Conditions</i>		<i>Min</i>	<i>Typ</i>	<i>Max</i>	<i>Unit</i>
V <sub>RRM</sub>	Maximum Peak Repetitive Reverse Voltage			600			V
I <sub>RM</sub>	Maximum Reverse Leakage Current	V <sub>R</sub> =600V	T <sub>j</sub> = 25°C		50	200	μA
			T <sub>j</sub> = 125°C		100	1000	
I <sub>F(AV)</sub>	Maximum Average Forward Current	50% duty cycle	T <sub>c</sub> = 100°C		10		A
V <sub>F</sub>	Diode Forward Voltage	I <sub>F</sub> = 10A	T <sub>j</sub> = 25°C		1.6	1.8	V
			T <sub>j</sub> = 175°C		2	2.4	
Q <sub>C</sub>	Total Capacitive Charge	I <sub>F</sub> = 10A, V <sub>R</sub> = 300V di/dt = 500A/μs			14		nC
C	Total Capacitance	f = 1MHz, V <sub>R</sub> = 200V			65		pF
		f = 1MHz, V <sub>R</sub> = 400V			50		
R <sub>thJC</sub>	Junction to Case Thermal resistance					2.5	°C/W

## 2. Bottom switches

### 2.1 Bottom CoolMOS™ characteristics

#### Absolute maximum ratings

<i>Symbol</i>	<i>Parameter</i>	<i>Max ratings</i>	<i>Unit</i>
V <sub>DSS</sub>	Drain - Source Breakdown Voltage	600	V
I <sub>D</sub>	Continuous Drain Current	T <sub>c</sub> = 25°C	36
		T <sub>c</sub> = 80°C	27
I <sub>DM</sub>	Pulsed Drain current	115	A
V <sub>GS</sub>	Gate - Source Voltage	±20	V
R <sub>DS(on)</sub>	Drain - Source ON Resistance	83	mΩ
P <sub>D</sub>	Maximum Power Dissipation	T <sub>c</sub> = 25°C	250
I <sub>AR</sub>	Avalanche current (repetitive and non repetitive)	20	A
E <sub>AR</sub>	Repetitive Avalanche Energy	1	mJ
E <sub>AS</sub>	Single Pulse Avalanche Energy	1800	

#### Electrical Characteristics

<i>Symbol</i>	<i>Characteristic</i>	<i>Test Conditions</i>		<i>Min</i>	<i>Typ</i>	<i>Max</i>	<i>Unit</i>
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 600V	T <sub>j</sub> = 25°C			100	μA
		V <sub>GS</sub> = 0V, V <sub>DS</sub> = 600V	T <sub>j</sub> = 125°C			5000	
R <sub>DS(on)</sub>	Drain - Source on Resistance	V <sub>GS</sub> = 10V, I <sub>D</sub> = 24.5A				83	mΩ
V <sub>GS(th)</sub>	Gate Threshold Voltage	V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 3mA		3	4	5	V
I <sub>GSS</sub>	Gate - Source Leakage Current	V <sub>GS</sub> = ±20 V, V <sub>DS</sub> = 0V				100	nA

**Dynamic Characteristics**

<i>Symbol</i>	<i>Characteristic</i>	<i>Test Conditions</i>	<i>Min</i>	<i>Typ</i>	<i>Max</i>	<i>Unit</i>
C <sub>iss</sub>	Input Capacitance	V <sub>GS</sub> = 0V ; V <sub>DS</sub> = 25V		7.2		nF
C <sub>rss</sub>	Reverse Transfer Capacitance	f = 1MHz		0.041		
Q <sub>g</sub>	Total gate Charge	V <sub>GS</sub> = 10V V <sub>Bus</sub> = 300V I <sub>D</sub> = 36A		250		nC
Q <sub>gs</sub>	Gate – Source Charge			43		
Q <sub>gd</sub>	Gate – Drain Charge			135		
T <sub>d(on)</sub>	Turn-on Delay Time	<b>Inductive Switching (125°C)</b> V <sub>GS</sub> = 10V V <sub>Bus</sub> = 400V I <sub>D</sub> = 36A R <sub>G</sub> = 5Ω		21		ns
T <sub>r</sub>	Rise Time			30		
T <sub>d(off)</sub>	Turn-off Delay Time			240		
T <sub>f</sub>	Fall Time			52		
E <sub>on</sub>	Turn-on Switching Energy	<b>Inductive switching @ 25°C</b> V <sub>GS</sub> = 10V ; V <sub>Bus</sub> = 400V I <sub>D</sub> = 36A ; R <sub>G</sub> = 5Ω		531		μJ
E <sub>off</sub>	Turn-off Switching Energy			590		
E <sub>on</sub>	Turn-on Switching Energy	<b>Inductive switching @ 125°C</b> V <sub>GS</sub> = 10V ; V <sub>Bus</sub> = 400V I <sub>D</sub> = 36A ; R <sub>G</sub> = 5Ω		762		μJ
E <sub>off</sub>	Turn-off Switching Energy			725		
R <sub>thJC</sub>	Junction to Case Thermal resistance				0.5	°C/W

**Source - Drain diode ratings and characteristics**

<i>Symbol</i>	<i>Characteristic</i>	<i>Test Conditions</i>	<i>Min</i>	<i>Typ</i>	<i>Max</i>	<i>Unit</i>
I <sub>S</sub>	Continuous Source current (Body diode)		T <sub>c</sub> = 25°C	36		A
			T <sub>c</sub> = 80°C	27		
V <sub>SD</sub>	Diode Forward Voltage	V <sub>GS</sub> = 0V, I <sub>S</sub> = - 36A			1.2	V
dv/dt	Peak Diode Recovery ❶				40	V/ns
t <sub>rr</sub>	Reverse Recovery Time	I <sub>S</sub> = - 36A V <sub>R</sub> = 350V di/dt = 100A/μs	T <sub>j</sub> = 25°C	210		ns
			T <sub>j</sub> = 125°C	350		
Q <sub>rr</sub>	Reverse Recovery Charge		T <sub>j</sub> = 25°C	2		μC
			T <sub>j</sub> = 125°C	5.4		

❶ dv/dt numbers reflect the limitations of the circuit rather than the device itself.

$$I_S \leq -36A \quad di/dt \leq 100A/\mu s \quad V_R \leq V_{DSS} \quad T_j \leq 150^\circ C$$

### 3. Temperature sensor

NTC (see application note APT0406 on [www.microsemi.com](http://www.microsemi.com) for more information).

Symbol	Characteristic	Min	Typ	Max	Unit
R <sub>25</sub>	Resistance @ 25°C		50		kΩ
B <sub>25/85</sub>	T <sub>25</sub> = 298.15 K		3952		K

$$R_T = \frac{R_{25}}{\exp\left[B_{25/85}\left(\frac{1}{T_{25}} - \frac{1}{T}\right)\right]}$$

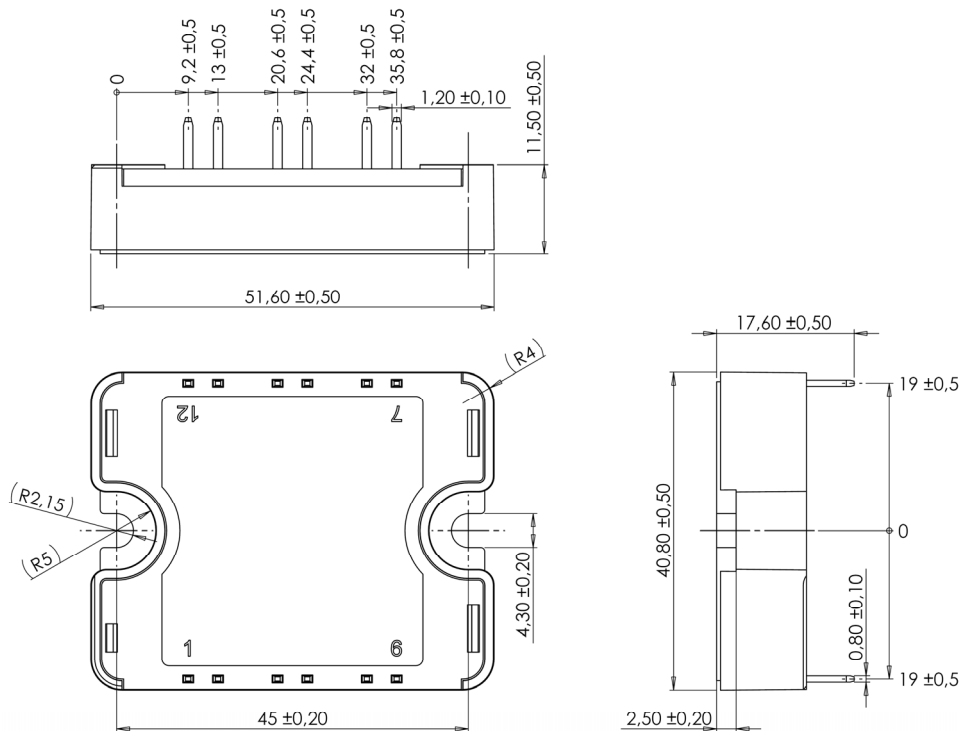
T: Thermistor temperature  
 R<sub>T</sub>: Thermistor value at T

### 4. Package characteristics

Symbol	Characteristic	Min	Typ	Max	Unit	
V <sub>ISOL</sub>	RMS Isolation Voltage, any terminal to case t=1 min, 50/60Hz	4000			V	
T <sub>J</sub>	Operating junction temperature range	-40		150*	°C	
T <sub>STG</sub>	Storage Temperature Range	-40		125		
T <sub>C</sub>	Operating Case Temperature	-40		100		
Torque	Mounting torque	To heatsink	M4	2	3	N.m
Wt	Package Weight				80	g

T<sub>j</sub>=175°C for Trench & Field Stop IGBT

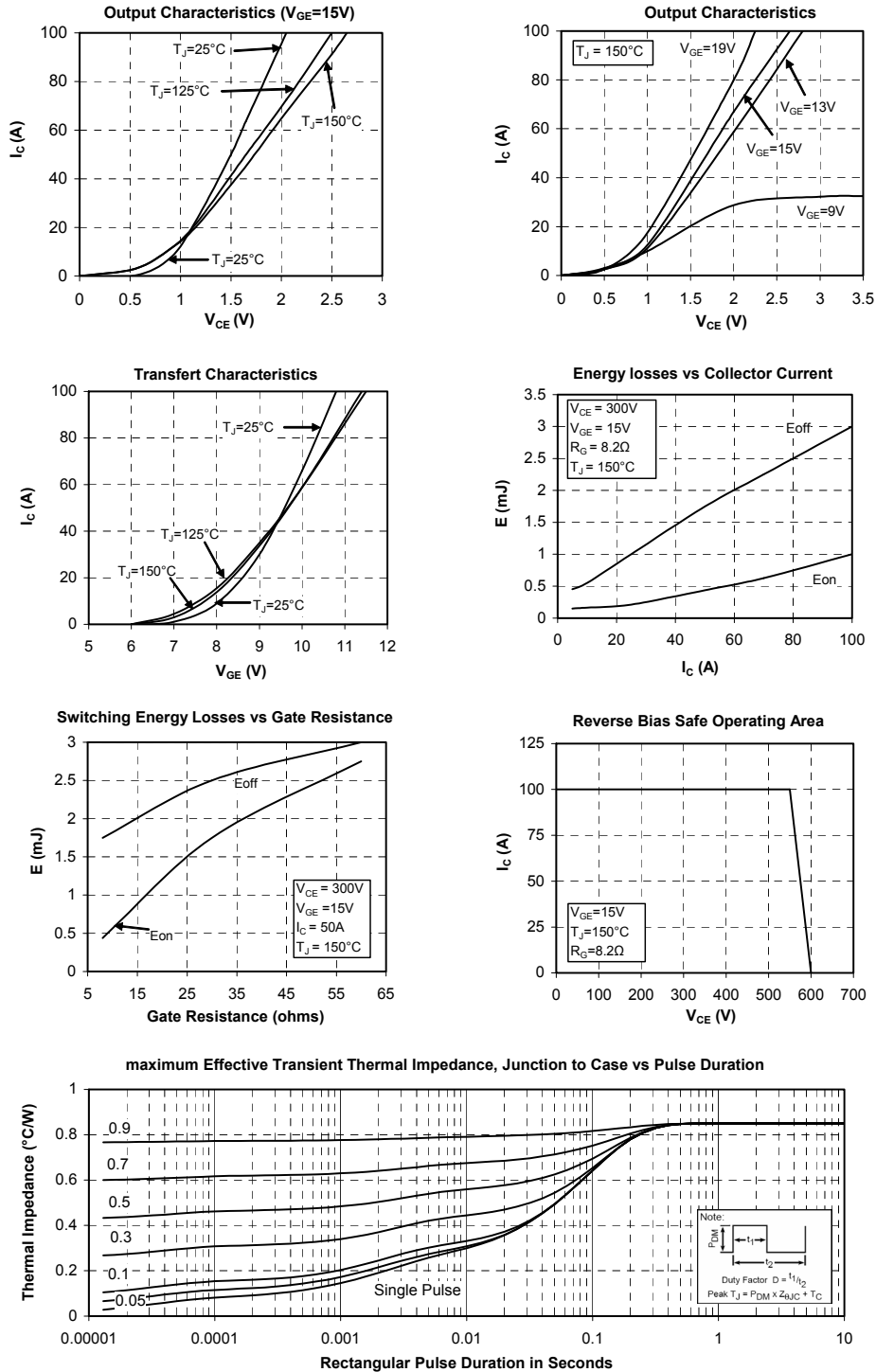
### 5. SP1 Package outline (dimensions in mm)



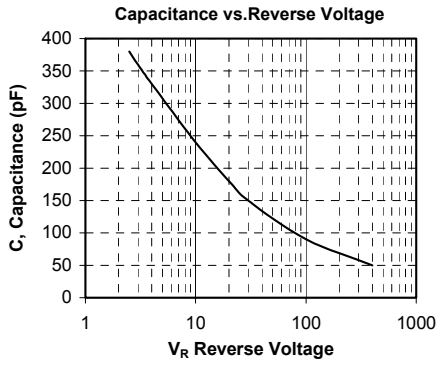
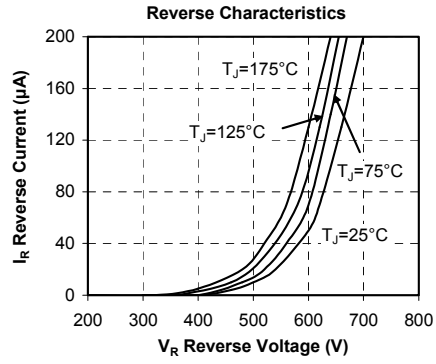
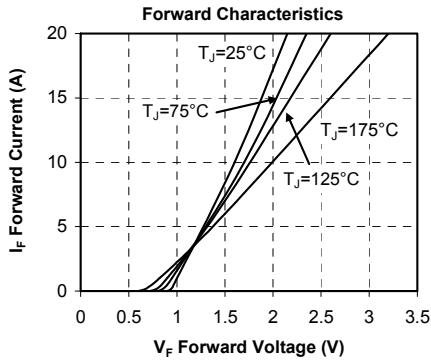
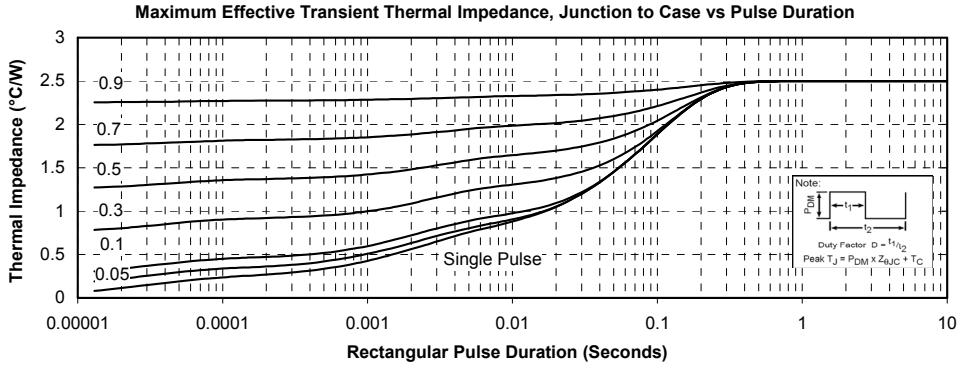
See application note 1904 - Mounting Instructions for SP1 Power Modules on [www.microsemi.com](http://www.microsemi.com)

## 6. Top switches curves

### 6.1 Top Trench + Field Stop IGBT® typical performance curves

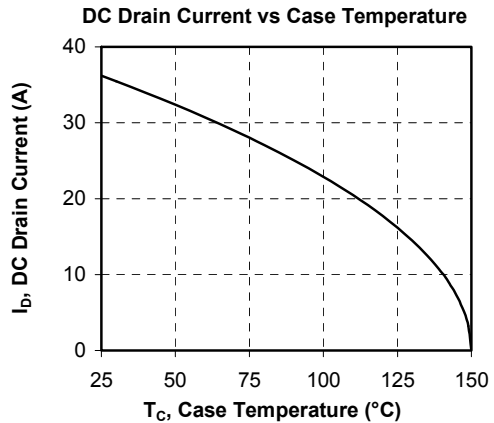
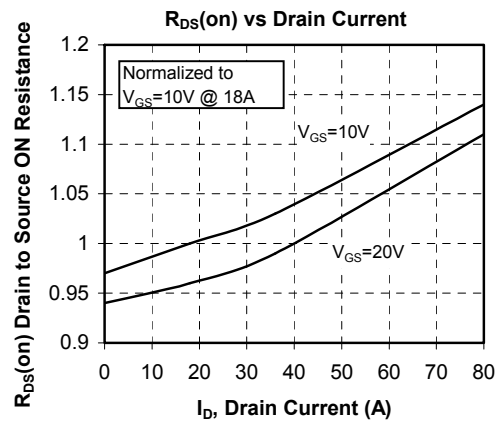
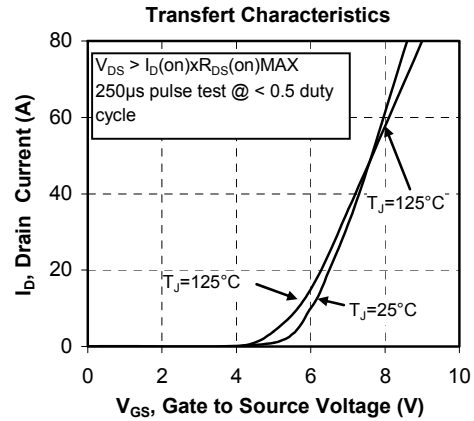
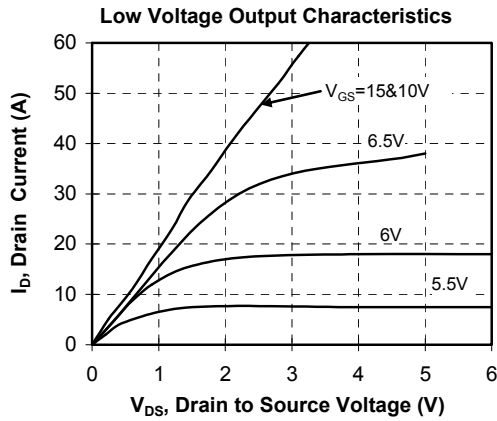
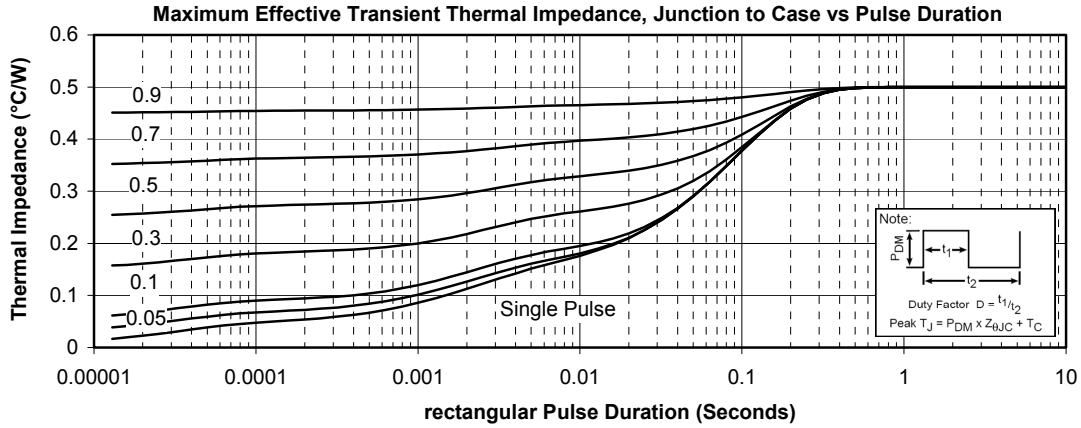


## 6.2 Top SiC diode typical performance curves

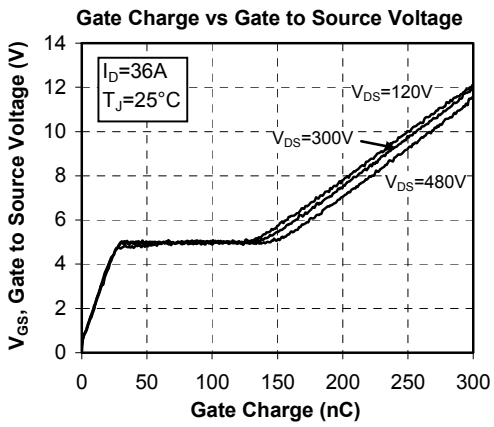
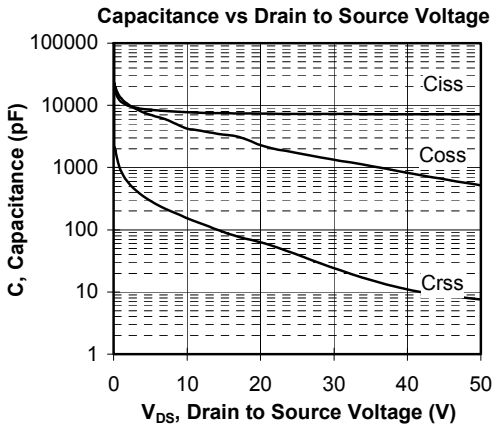
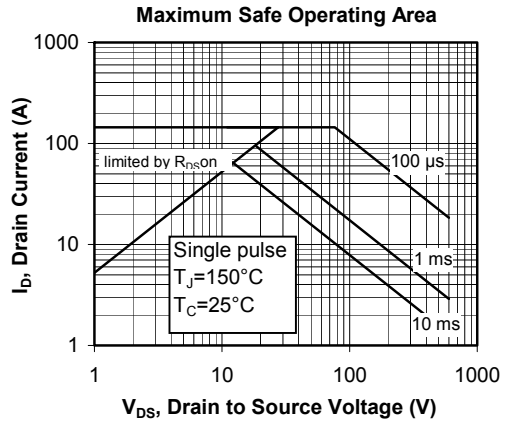
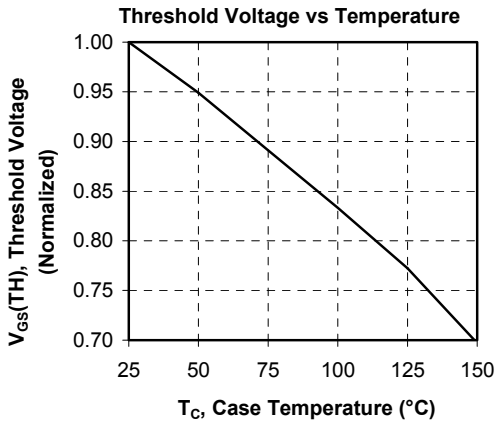
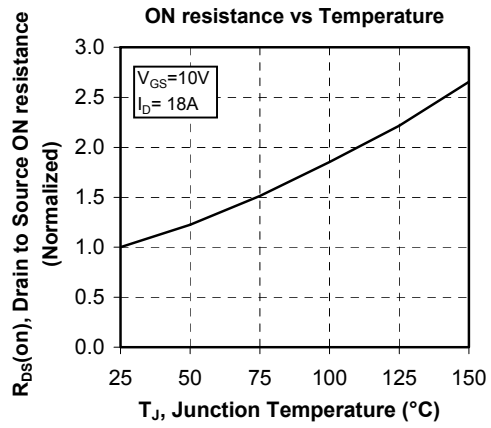
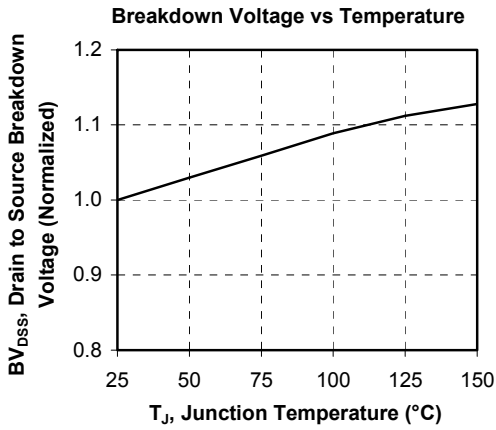


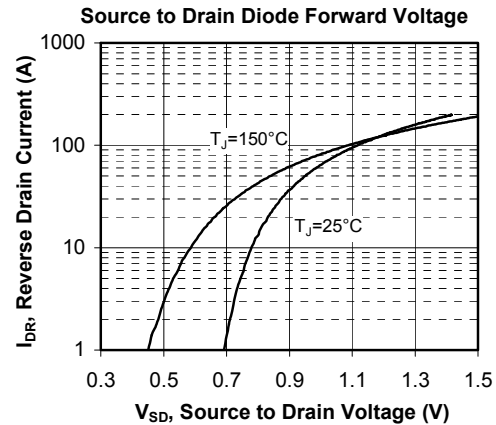
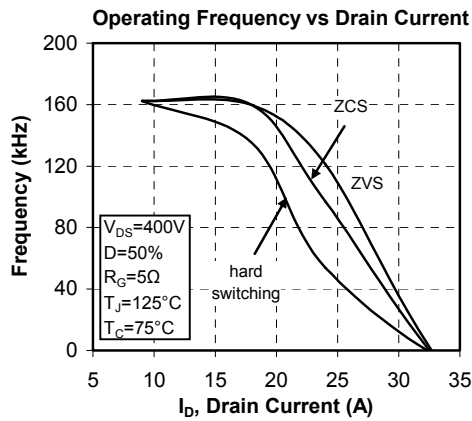
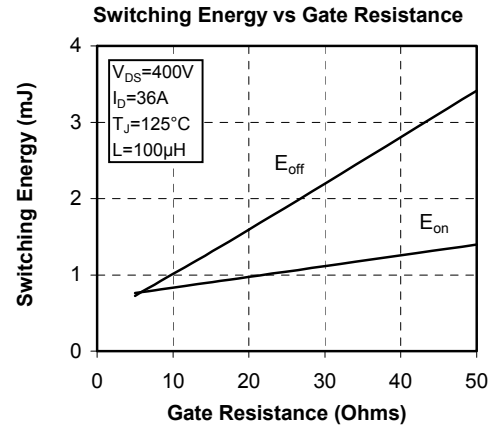
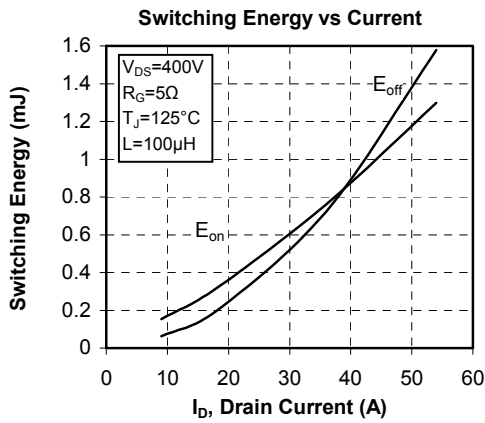
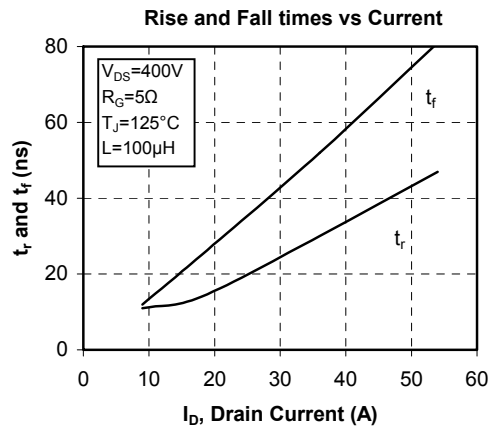
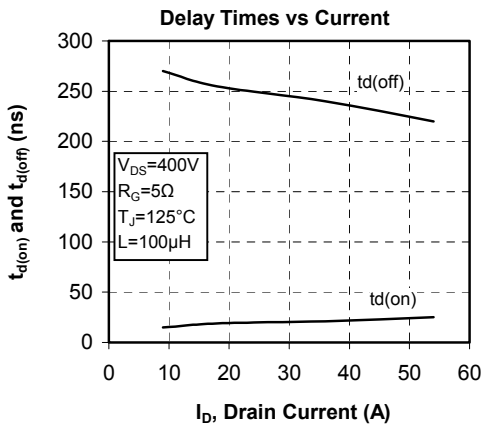
## 7. Bottom switches curves

### 7.1 Bottom CoolMOS™ typical performance curves









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