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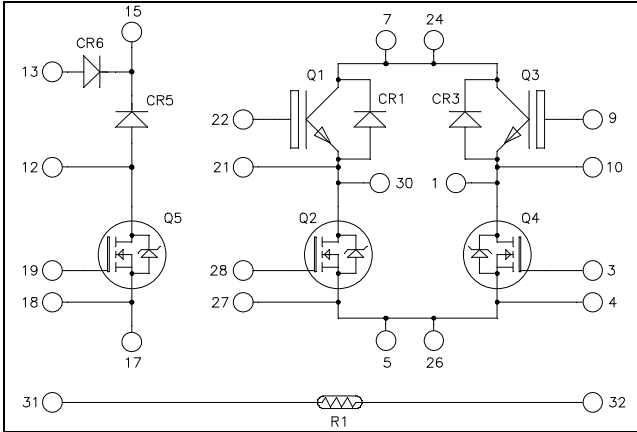
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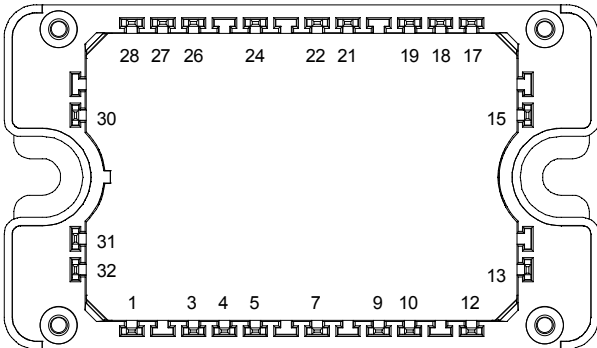
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**Full – Bridge + boost chopper
CoolMOS™ & Trench + Field Stop IGBT3
Power module**



Top switches : Trench + Field Stop IGBT3
 Bottom switches : CoolMOS™
 Boost chopper : CoolMOS™



All multiple inputs and outputs must be shorted together
 7/24 ; 5/26

Trench & Field Stop IGBT3 Q1, Q3:
 $V_{CES} = 600V$; $I_C = 50A$ @ $T_c = 80^\circ C$

CoolMOS™ Q2, Q4:
 $V_{DSS} = 600V$
 $R_{DSon} = 45m\Omega$ max @ $T_j = 25^\circ C$

Application

- Solar converter

Features

- **Q2, Q4 & Q5 CoolMOS™**
 - Ultra low R_{DSon}
 - Low Miller capacitance
 - Ultra low gate charge
 - Avalanche energy rated
- **Q1, Q3 Trench & Field Stop IGBT3**
 - Low voltage drop
 - Switching frequency up to 20 kHz
 - RBSOA & SCSOA rated
 - Low tail current
- **FWD SiC Schottky Diode (CR5)**
 - Zero reverse recovery
 - Zero forward recovery
 - Temperature Independent switching behavior
 - Positive temperature coefficient on VF
- Very low stray inductance
- Kelvin source for easy drive
- Internal thermistor for temperature monitoring
- High level of integration

Benefits

- Optimized conduction & switching losses
- 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
- Easy paralleling due to positive T_C of V_{CEsat}
- RoHS Compliant

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

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

1. Top switches
1.1 Top Trench + Field Stop IGBT3 characteristics (per IGBT)
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	$V_{GE} = 15V$ $I_C = 50A$		1.5 1.7	1.9	V
		$T_j = 25^\circ C$ $T_j = 150^\circ C$				
$V_{GE(th)}$	Gate Threshold Voltage	$V_{GE} = V_{CE}, I_C = 600\mu A$	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	$V_{GE} = 0V$		3150		pF
C_{oes}	Output Capacitance	$V_{CE} = 25V$		200		
C_{res}	Reverse Transfer Capacitance	$f = 1MHz$		95		
Q_G	Gate charge	$V_{GE} = \pm 15V, I_C = 50A$ $V_{CE} = 300V$		0.5		μC
$T_{d(on)}$	Turn-on Delay Time	Inductive Switching (25°C) $V_{GE} = \pm 15V$ $V_{Bus} = 300V$ $I_C = 50A$ $R_G = 8.2\Omega$		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) $V_{GE} = \pm 15V$ $V_{Bus} = 300V$ $I_C = 50A$ $R_G = 8.2\Omega$		120		ns
T_r	Rise Time			50		
$T_{d(off)}$	Turn-off Delay Time			250		
T_f	Fall Time			60		
E_{off}	Turn-off Switching Energy	$V_{GE} = \pm 15V$ $V_{Bus} = 300V$ $I_C = 50A$ $R_G = 8.2\Omega$		1.35 1.75		mJ
		$T_j = 25^\circ C$ $T_j = 150^\circ C$				
I_{sc}	Short Circuit data	$V_{GE} \leq 15V; V_{Bus} = 360V$ $t_p \leq 6\mu s; T_j = 150^\circ C$		250		A
R_{thJC}	Junction to Case Thermal resistance				0.85	$^\circ C/W$

1.2 Top diode characteristics (CR1, CR3) (per diode)

<i>Symbol</i>	<i>Characteristic</i>	<i>Test Conditions</i>		<i>Min</i>	<i>Typ</i>	<i>Max</i>	<i>Unit</i>
V _{RRM}	Maximum Peak Repetitive Reverse Voltage			600			V
I _{RM}	Maximum Reverse Leakage Current	V _R =600V	T _j = 25°C			25	μA
			T _j = 125°C			500	
I _F	DC Forward Current		T _c = 80°C		25		A
V _F	Diode Forward Voltage	I _F = 25A			1.8	2.2	V
		I _F = 50A			2.2		
		I _F = 25A	T _j = 125°C		1.6		
t _{rr}	Reverse Recovery Time	I _F = 25A V _R = 400V di/dt = 200A/μs	T _j = 25°C		30		ns
			T _j = 125°C		175		
Q _{rr}	Reverse Recovery Charge	I _F = 25A V _R = 400V di/dt = 200A/μs	T _j = 25°C		55		nC
			T _j = 125°C		485		
R _{thJC}	Junction to Case Thermal resistance					1.4	°C/W

2. Bottom switches
2.1 Bottom CoolMOS™ characteristics (Per CoolMOS™)
Absolute maximum ratings

<i>Symbol</i>	<i>Parameter</i>	<i>Max ratings</i>	<i>Unit</i>
V _{DSS}	Drain - Source Breakdown Voltage	600	V
I _D	Continuous Drain Current	T _c = 25°C	49
		T _c = 80°C	38
I _{DM}	Pulsed Drain current	130	A
V _{GS}	Gate - Source Voltage	±20	V
R _{DS(on)}	Drain - Source ON Resistance	45	mΩ
P _D	Maximum Power Dissipation	T _c = 25°C	250
I _{AR}	Avalanche current (repetitive and non repetitive)	15	A
E _{AR}	Repetitive Avalanche Energy	3	mJ
E _{AS}	Single Pulse Avalanche Energy	1900	

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 _{DSS}	Zero Gate Voltage Drain Current	V _{GS} = 0V, V _{DS} = 600V	T _j = 25°C		250	μA
		V _{GS} = 0V, V _{DS} = 600V	T _j = 125°C		500	
R _{DS(on)}	Drain - Source on Resistance	V _{GS} = 10V, I _D = 24.5A		40	45	mΩ
V _{GS(th)}	Gate Threshold Voltage	V _{GS} = V _{DS} , I _D = 3mA	2.1	3	3.9	V
I _{GSS}	Gate - Source Leakage Current	V _{GS} = ±20 V, V _{DS} = 0V			100	nA

Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C _{iss}	Input Capacitance	V _{GS} = 0V ; V _{DS} = 25V f = 1MHz		7.2		nF
C _{oss}	Output Capacitance			8.5		
Q _g	Total gate Charge	V _{GS} = 10V V _{Bus} = 300V I _D = 49A		150		nC
Q _{gs}	Gate – Source Charge			34		
Q _{gd}	Gate – Drain Charge			51		
T _{d(on)}	Turn-on Delay Time	Inductive Switching (125°C) V _{GS} = 10V V _{Bus} = 400V I _D = 49A R _G = 5Ω		21		ns
T _r	Rise Time			30		
T _{d(off)}	Turn-off Delay Time			100		
T _f	Fall Time			45		
E _{on}	Turn-on Switching Energy	Inductive switching @ 25°C V _{GS} = 10V ; V _{Bus} = 400V I _D = 49A ; R _G = 5Ω		675		μJ
E _{off}	Turn-off Switching Energy			520		
E _{on}	Turn-on Switching Energy	Inductive switching @ 125°C V _{GS} = 10V ; V _{Bus} = 400V I _D = 49A ; R _G = 5Ω		1096		μJ
E _{off}	Turn-off Switching Energy			635		
R _{thJC}	Junction to Case Thermal resistance				0.5	°C/W

Source - Drain diode ratings and characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
I _S	Continuous Source current (Body diode)	T _c = 25°C		49		A
		T _c = 80°C		38		
V _{SD}	Diode Forward Voltage	V _{GS} = 0V, I _S = - 49A			1.2	V
dv/dt	Peak Diode Recovery ❶				4	V/ns
t _{rr}	Reverse Recovery Time	I _S = - 49A V _R = 350V di/dt = 100A/μs	T _j = 25°C		600	ns
Q _{rr}	Reverse Recovery Charge		T _j = 25°C		17	μC

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

$$I_S \leq -49A \quad di/dt \leq 100A/\mu s \quad V_R \leq V_{DSS} \quad T_j \leq 150^\circ C$$

3. Boost chopper Q5, CR5

3.1 Q5 CoolMOS™ characteristics

Absolute maximum ratings

Symbol	Parameter	Max ratings	Unit
V _{DSS}	Drain - Source Breakdown Voltage	600	V
I _D	Continuous Drain Current	T _c = 25°C	49
		T _c = 80°C	38
I _{DM}	Pulsed Drain current	130	
V _{GS}	Gate - Source Voltage	±20	V
R _{DSon}	Drain - Source ON Resistance	45	mΩ
P _D	Maximum Power Dissipation	T _c = 25°C	250
I _{AR}	Avalanche current (repetitive and non repetitive)	15	A
E _{AR}	Repetitive Avalanche Energy	3	mJ
E _{AS}	Single Pulse Avalanche Energy	1900	

Electrical Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
I _{DSS}	Zero Gate Voltage Drain Current	V _{GS} = 0V, V _{DS} = 600V			250	μA
		T _j = 25°C				
		V _{GS} = 0V, V _{DS} = 600V			500	
R _{DS(on)}	Drain – Source on Resistance	V _{GS} = 10V, I _D = 24.5A		40	45	mΩ
V _{GS(th)}	Gate Threshold Voltage	V _{GS} = V _{DS} , I _D = 3mA	2.1	3	3.9	V
I _{GSS}	Gate – Source Leakage Current	V _{GS} = ±20 V, V _{DS} = 0V			100	nA

Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C _{iss}	Input Capacitance	V _{GS} = 0V ; V _{DS} = 25V f = 1MHz		7.2		nF
C _{oss}	Output Capacitance			8.5		
Q _g	Total gate Charge	V _{GS} = 10V V _{Bus} = 300V I _D = 49A		150		nC
Q _{gs}	Gate – Source Charge			34		
Q _{gd}	Gate – Drain Charge			51		
T _{d(on)}	Turn-on Delay Time	Inductive Switching (125°C) V _{GS} = 10V V _{Bus} = 400V I _D = 49A R _G = 5Ω		21		ns
T _r	Rise Time			30		
T _{d(off)}	Turn-off Delay Time			100		
T _f	Fall Time			45		
E _{on}	Turn-on Switching Energy	Inductive switching @ 25°C V _{GS} = 10V ; V _{Bus} = 400V I _D = 49A ; R _G = 5Ω		405		μJ
E _{off}	Turn-off Switching Energy			520		
E _{on}	Turn-on Switching Energy	Inductive switching @ 125°C V _{GS} = 10V ; V _{Bus} = 400V I _D = 49A ; R _G = 5Ω		658		μJ
E _{off}	Turn-off Switching Energy			635		
R _{thJC}	Junction to Case Thermal resistance				0.5	°C/W

Source - Drain diode ratings and characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
I _S	Continuous Source current (Body diode)	T _c = 25°C		49		A
		T _c = 80°C		38		
V _{SD}	Diode Forward Voltage	V _{GS} = 0V, I _S = - 49A			1.2	V
dv/dt	Peak Diode Recovery ❶				4	V/ns
t _{rr}	Reverse Recovery Time	I _S = - 49A V _R = 350V di _S /dt = 100A/μs		600		ns
Q _{rr}	Reverse Recovery Charge		T _j = 25°C		17	

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

$$I_S \leq -49A \quad di/dt \leq 100A/\mu s \quad V_R \leq V_{DSS} \quad T_j \leq 150^\circ C$$

3.2 SiC Chopper diode characteristics (CR5)

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		20	120	μA
				40	600	
I _F	DC Forward Current			20		A
V _F	Diode Forward Voltage	I _F = 20A		1.6	1.8	V
				2	2.4	
Q _C	Total Capacitive Charge	I _F = 20A, V _R = 300V di/dt = 800A/μs		28		nC
C	Total Capacitance	f = 1MHz, V _R = 200V		130		pF
		f = 1MHz, V _R = 400V		100		
R _{thJC}	Junction to Case Thermal resistance				1.5	°C/W

4. By pass diode (CR6)

Absolute maximum ratings

Symbol	Parameter	Max ratings	Unit
V _R	Maximum DC reverse Voltage	1600	V
V _{RRM}	Maximum Peak Repetitive Reverse Voltage		
I _F	DC Forward Current	40	A
I _{FSM}	Non-Repetitive Forward Surge Current	400	

Electrical Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
I _R	Reverse Current	V _R = 1600V		20		μA
				2		mA
V _F	Forward Voltage	I _F = 40A		1.3		V
				1.1		
V _T	On – state Voltage			0.8		V
r _T	On – state Slope resistance			10.5		mΩ
R _{thJC}	Junction to Case Thermal resistance				1.5	°C/W

5. Temperature sensor

Temperature sensor NTC (see application note APT0406 on www.microsemi.com for more information).

Symbol	Characteristic	Min	Typ	Max	Unit
R ₂₅	Resistance @ 25°C		50		kΩ
ΔR ₂₅ /R ₂₅			5		%
B _{25/85}	T ₂₅ = 298.15 K		3952		K
ΔB/B			4		%

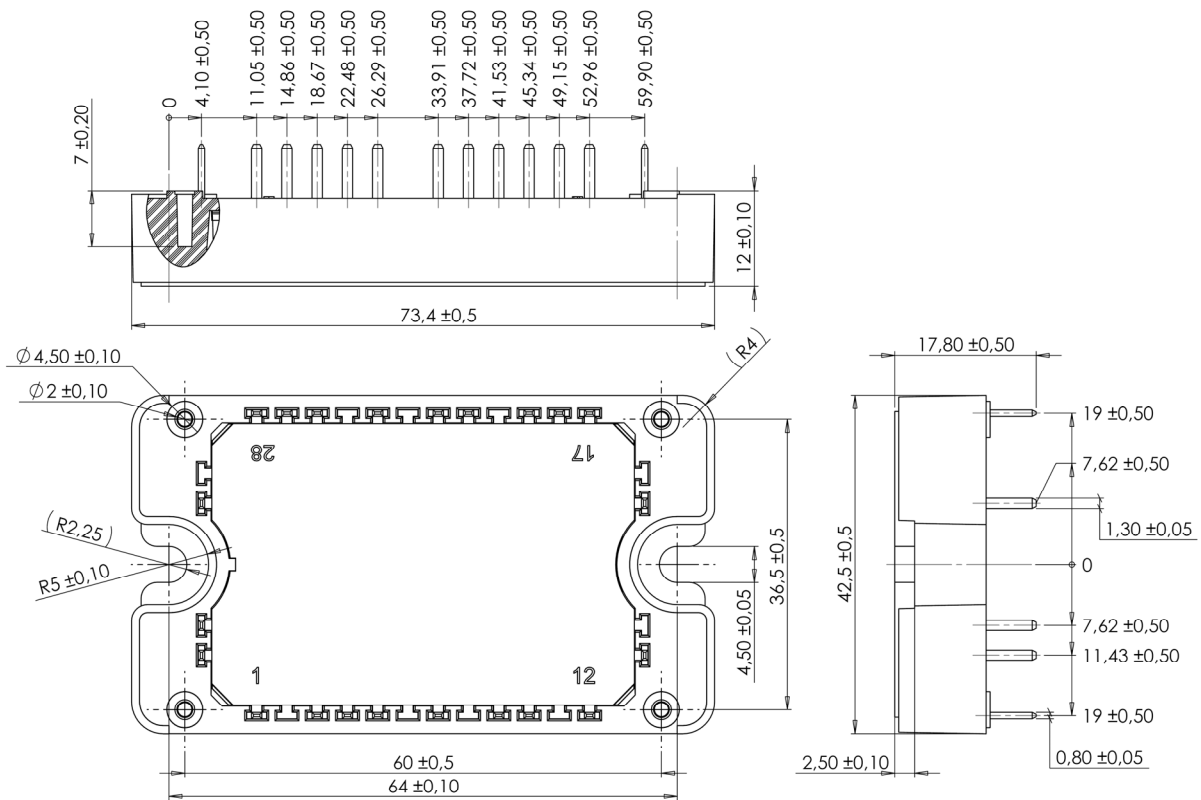
$$R_T = \frac{R_{25}}{\exp \left[B_{25/85} \left(\frac{1}{T} - \frac{1}{T_{25}} \right) \right]}$$

T: Thermistor temperature
 R_T: Thermistor value at T

6. Package characteristics

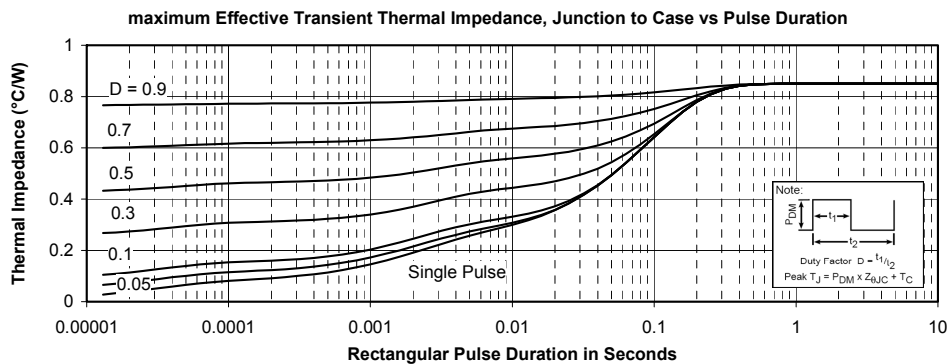
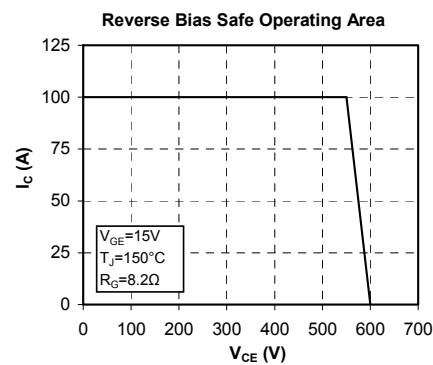
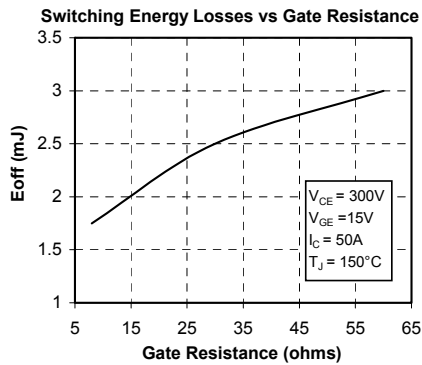
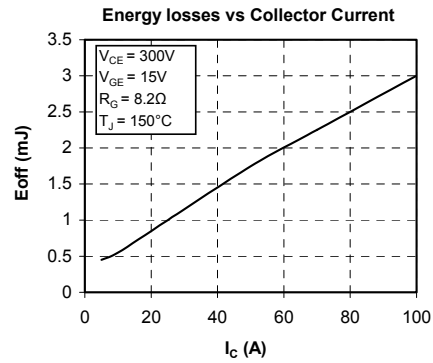
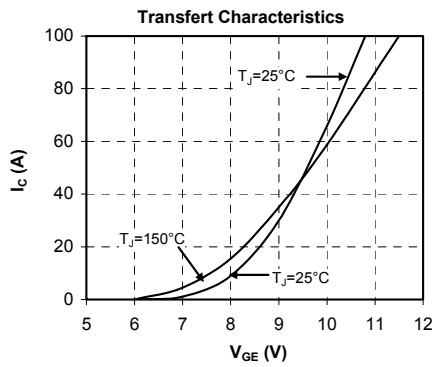
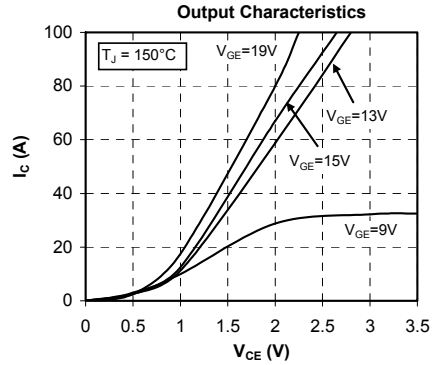
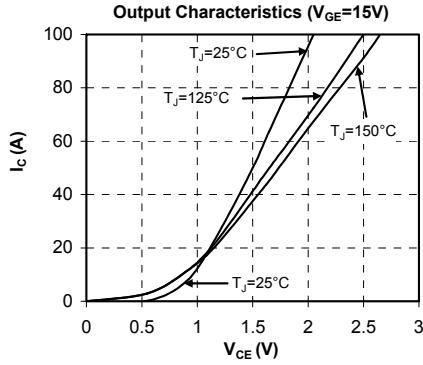
Symbol	Characteristic	Min	Typ	Max	Unit	
V _{ISOL}	RMS Isolation Voltage, any terminal to case t=1 min, 50/60Hz	4000			V	
T _J	Operating junction temperature range	-40		150*	°C	
T _{STG}	Storage Temperature Range	-40		125		
T _C	Operating Case Temperature	-40		100		
3	Mounting torque	To heatsink	M4	2	3	N.m
Wt	Package Weight				110	g

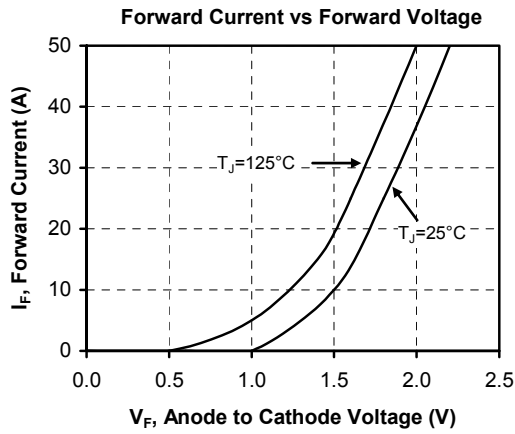
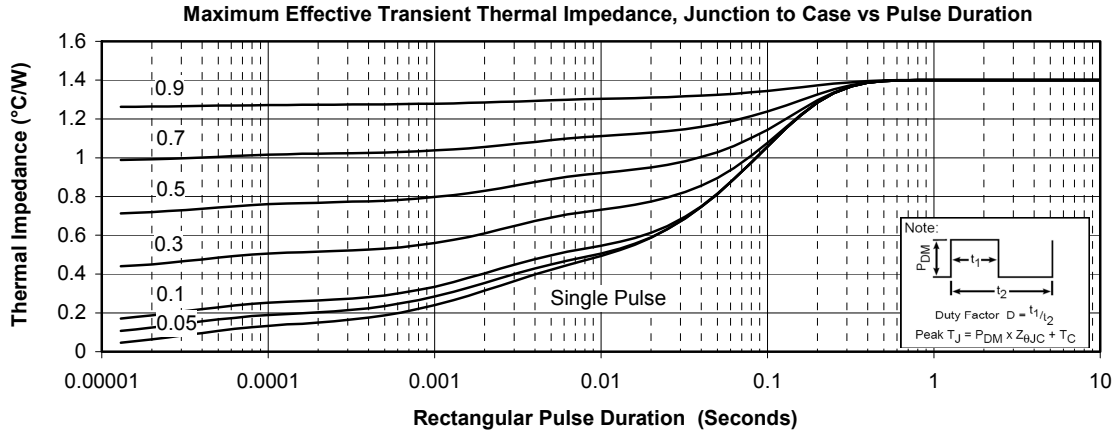
* T_j=175°C for Trench & Field Stop IGBT3

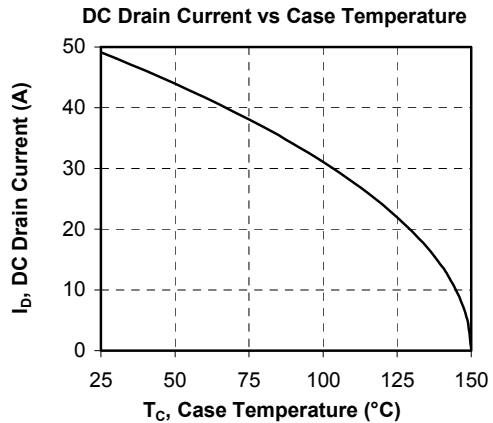
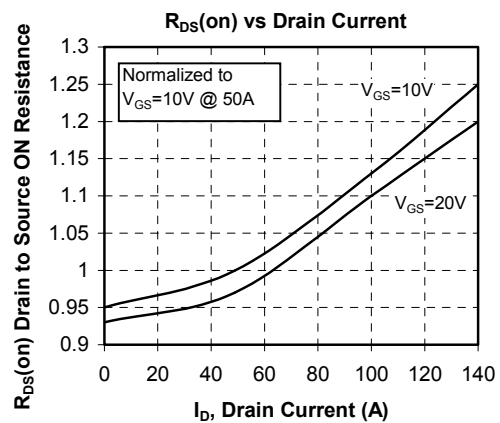
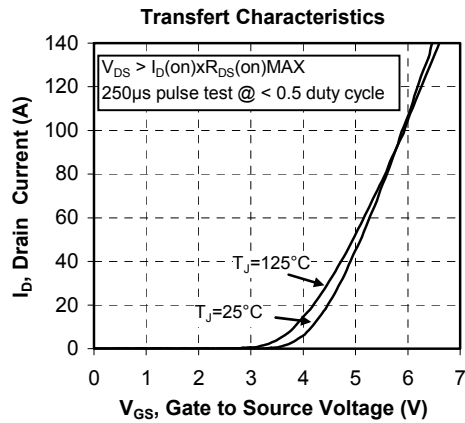
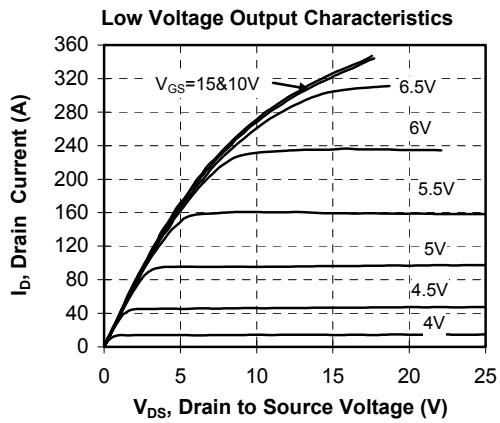
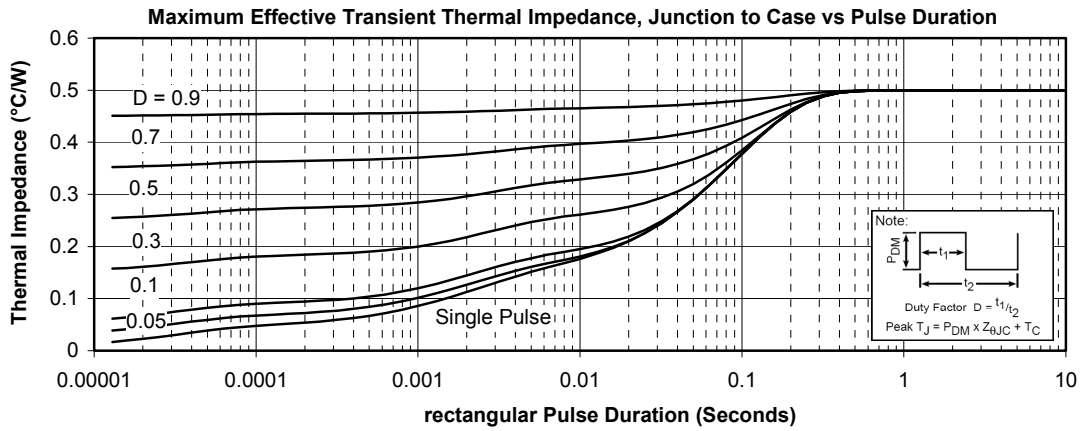
7. SP3 Package outline (dimensions in mm)


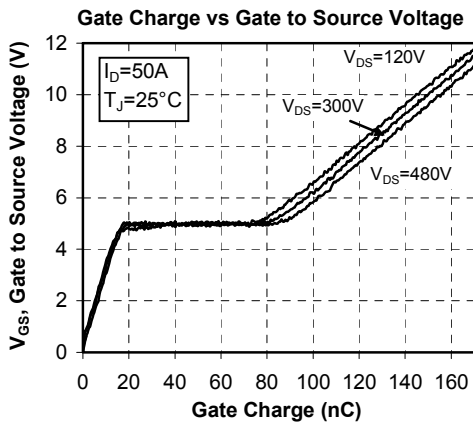
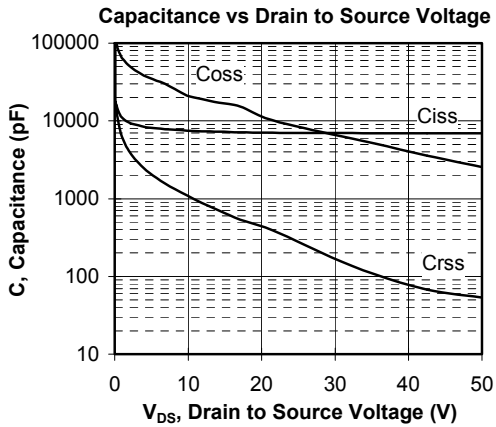
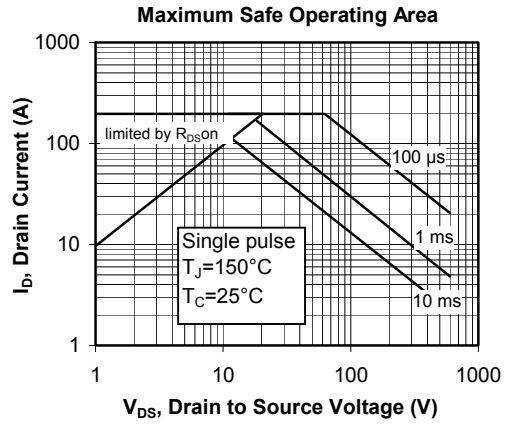
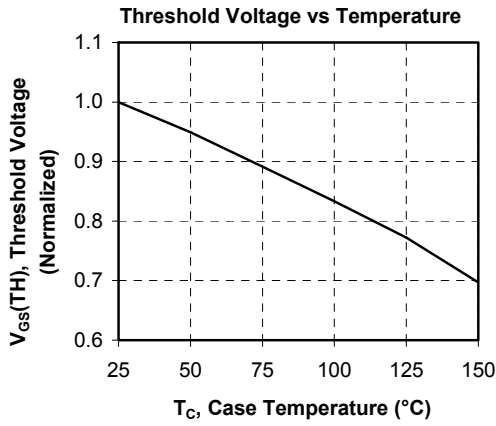
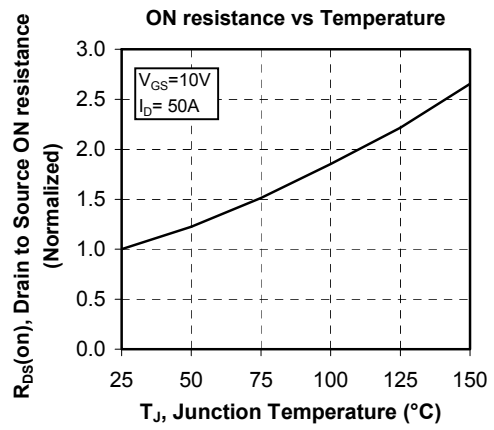
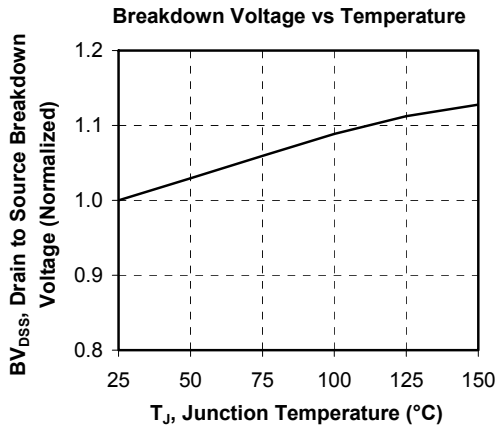
8. Top switches curves

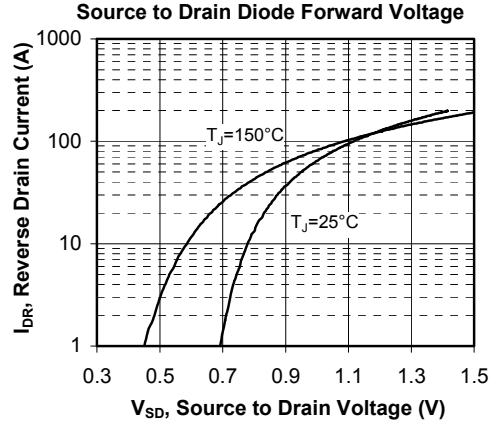
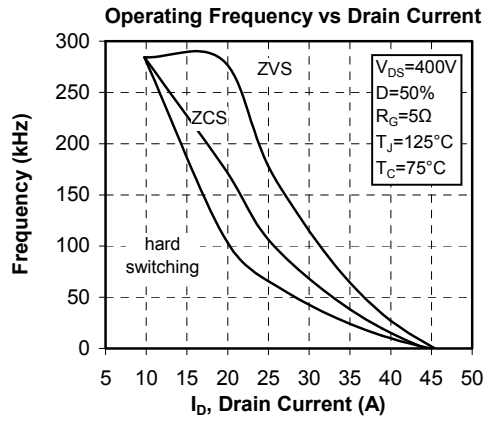
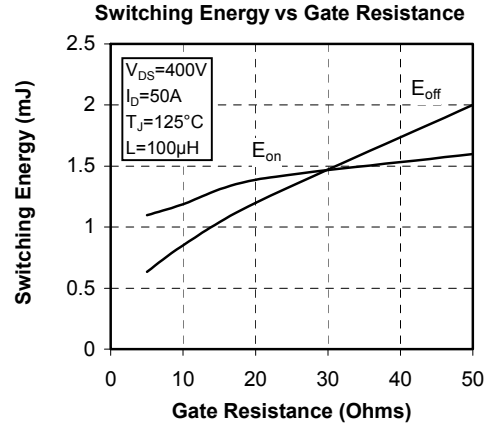
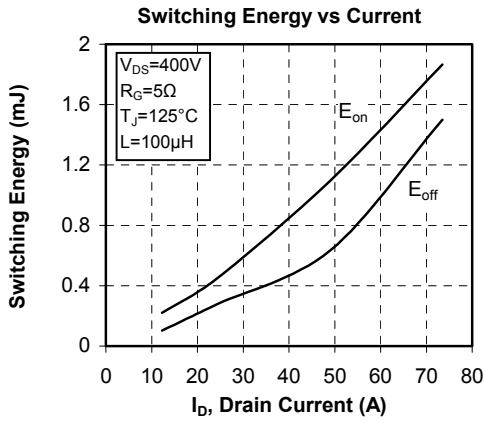
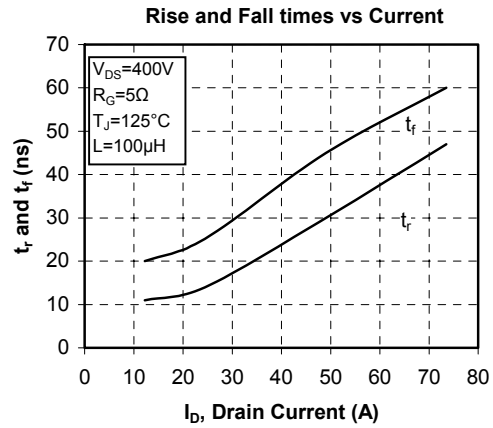
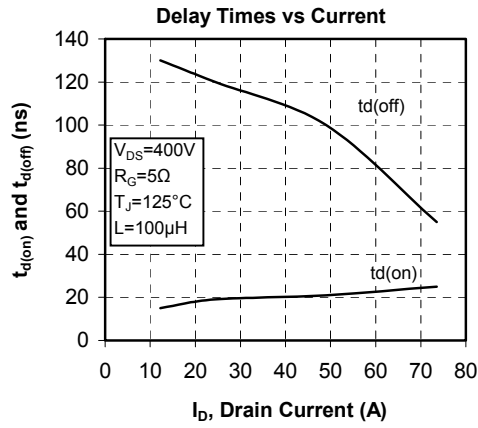
8.1 Top Trench + Field Stop IGBT3 typical performance curves (per IGBT)

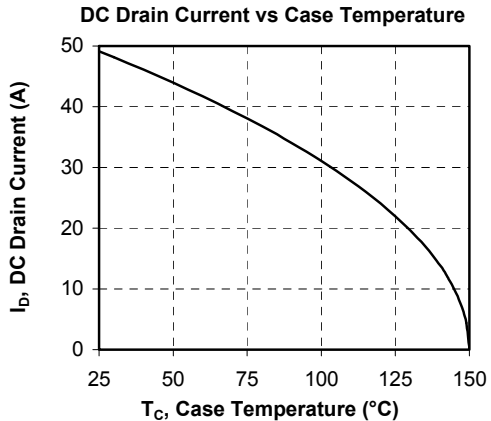
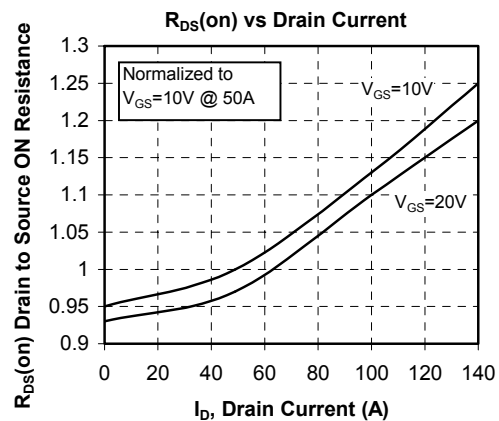
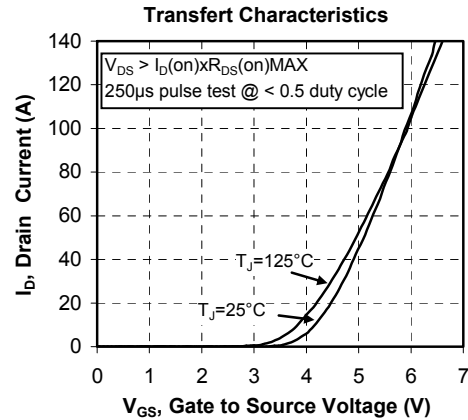
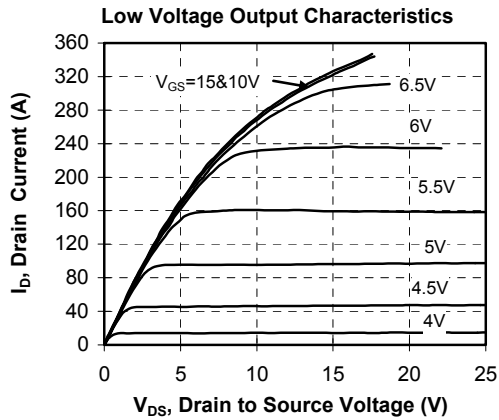
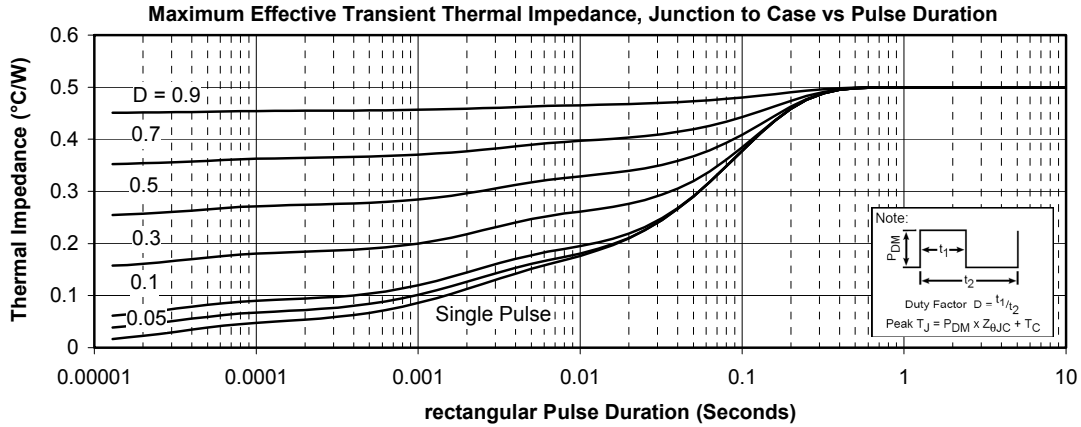


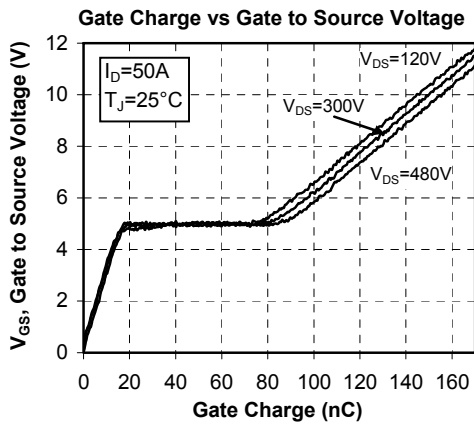
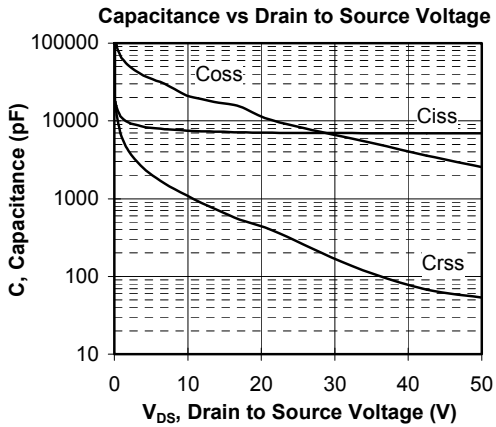
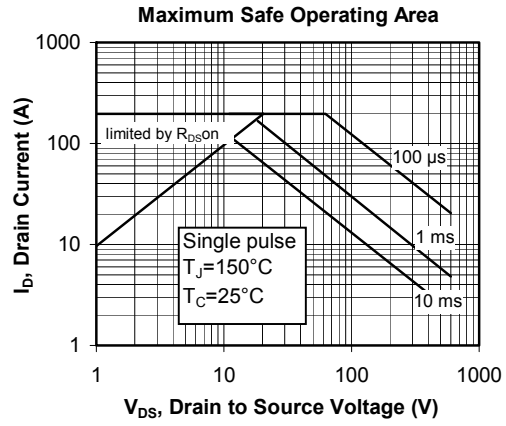
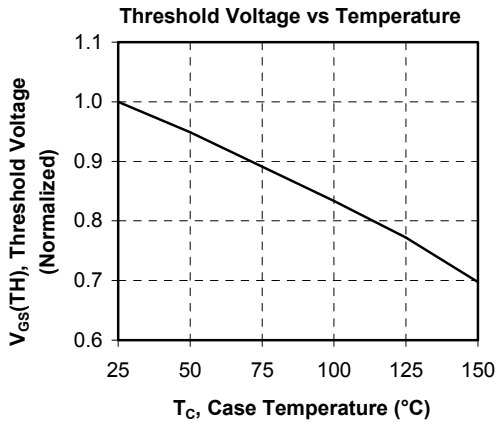
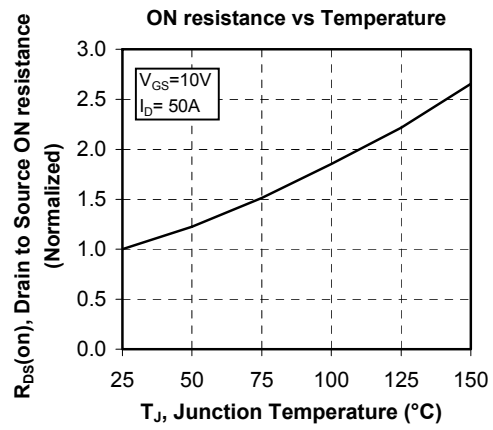
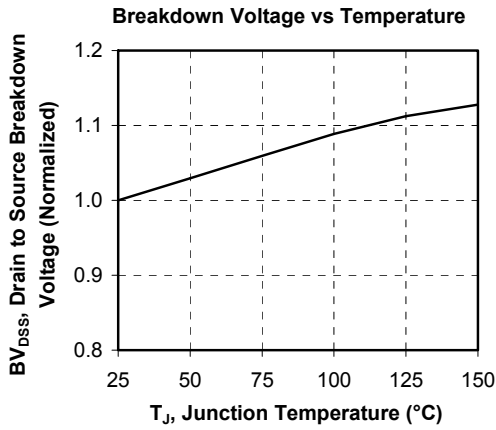
8.2 Top diode characteristics (CR1, CR3) (per diode)


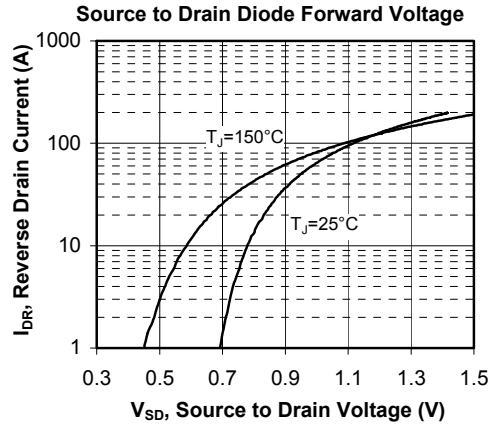
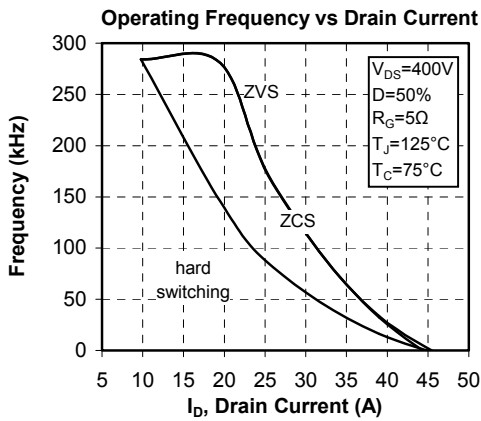
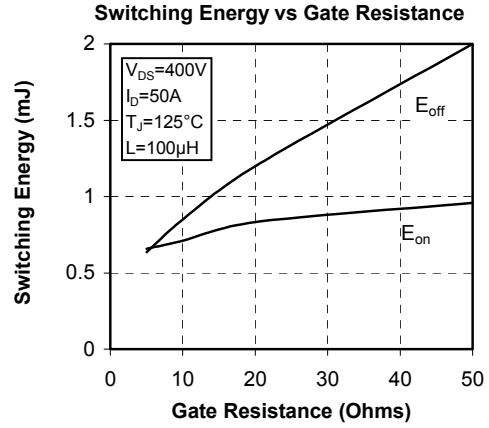
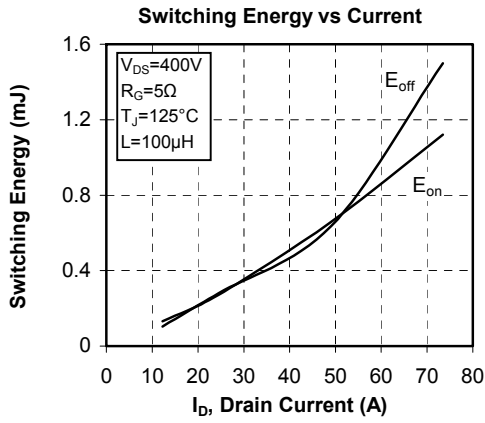
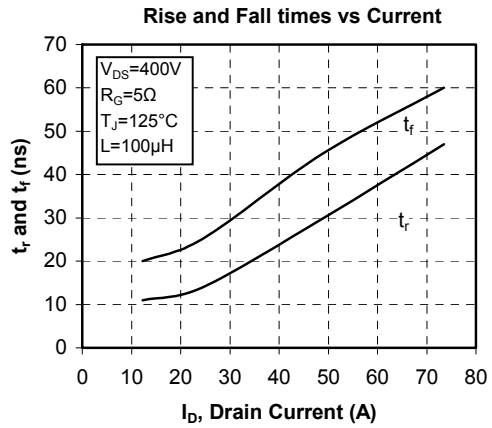
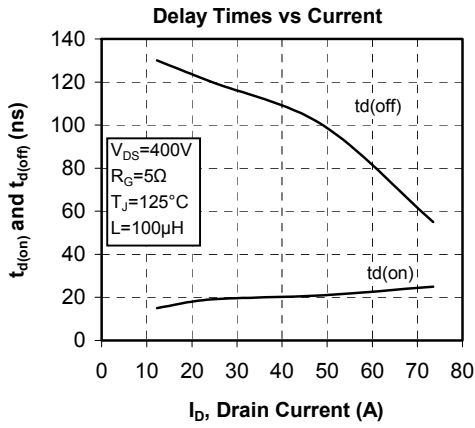
9. Bottom CoolMOST™ switches curves (per CoolMOST™)


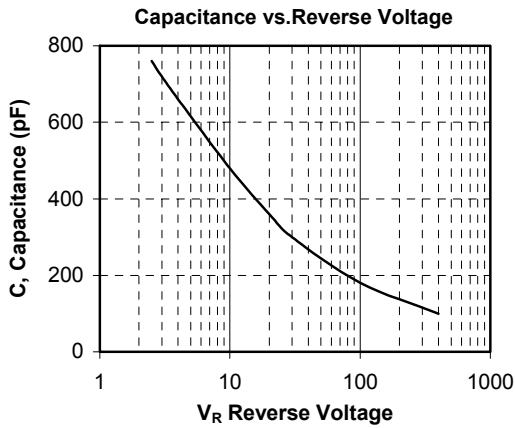
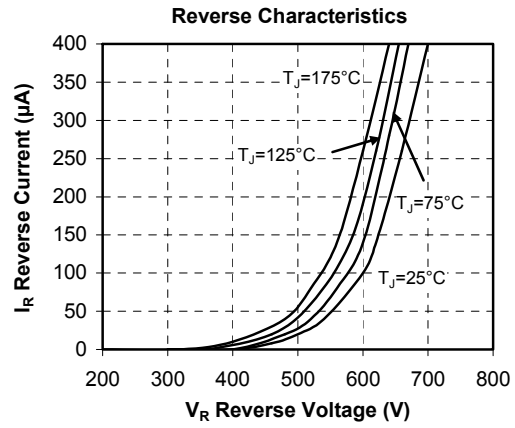
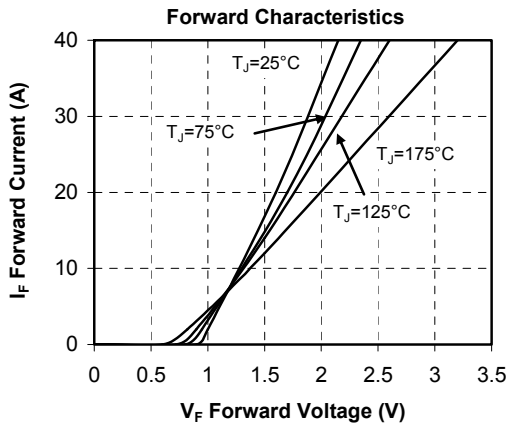
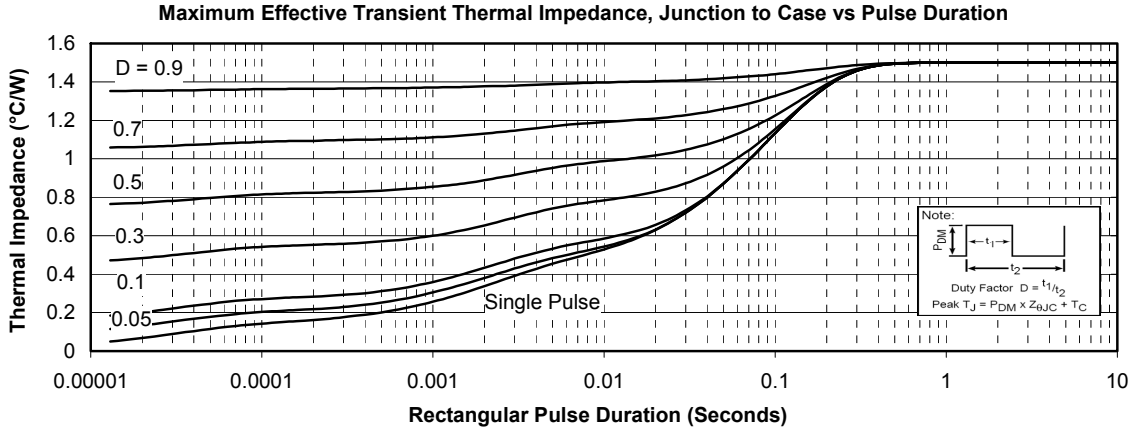




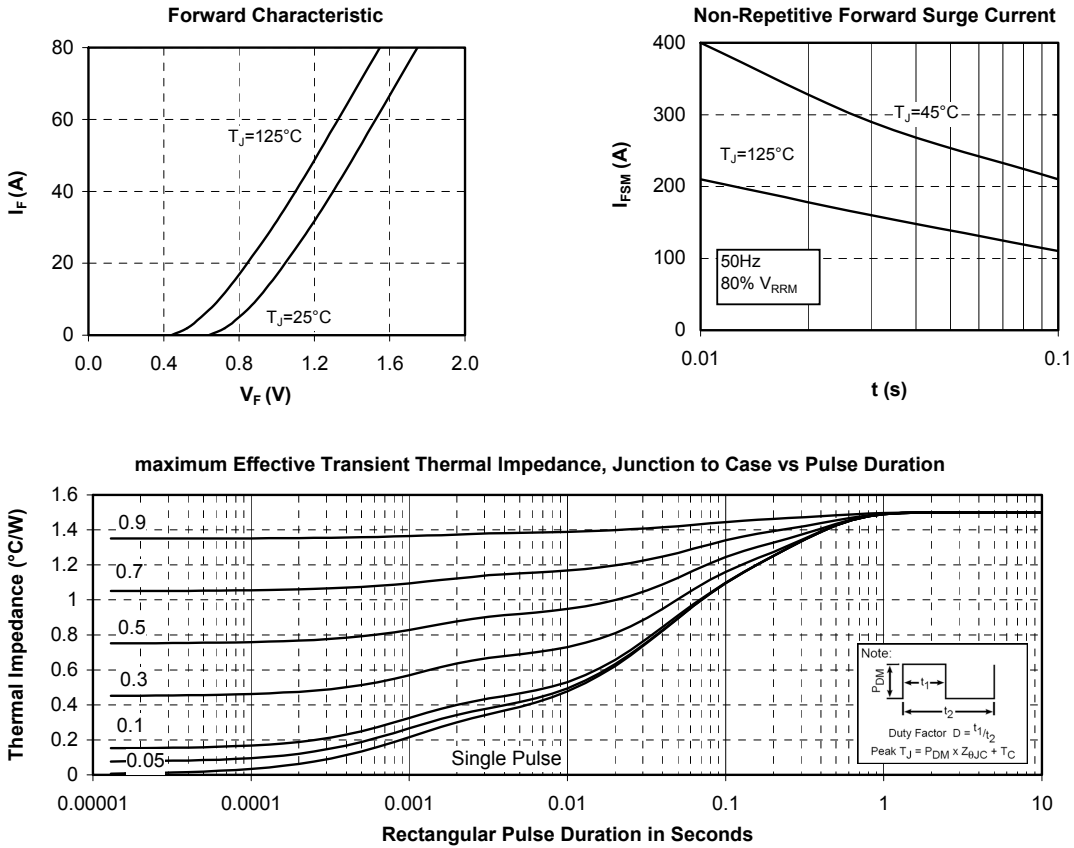
10. CoolMOS™ chopper curves






11. Chopper SiC diode curves


12. Typical by pass CR6 diode curves



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