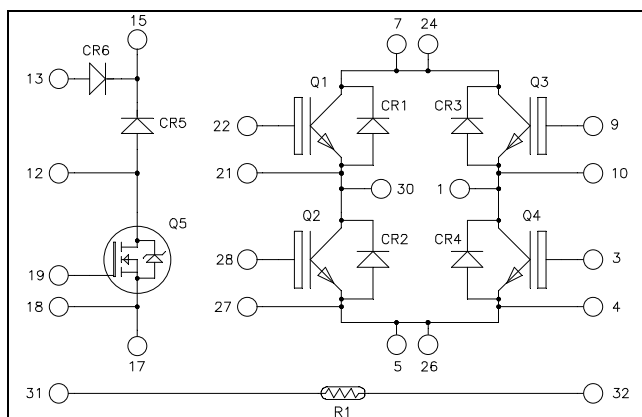


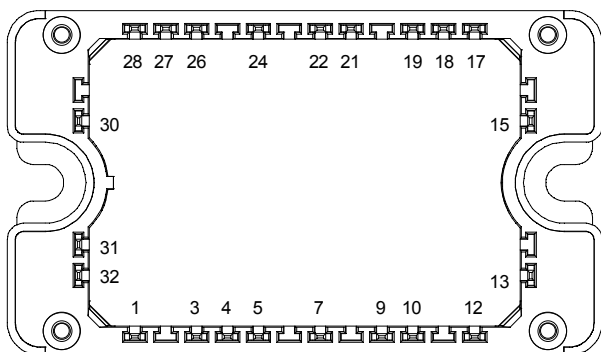
**Full – Bridge + boost chopper
NPT & Trench + Field Stop IGBT3
Power module**



Top switches : Trench + Field Stop IGBT3

Bottom switches : Fast NPT IGBT

Boost chopper : CoolMOS™



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

Trench & Field Stop IGBT3 Q1, Q3:

$V_{CES} = 600V$; $I_C = 50A$ @ $T_c = 80^\circ C$

NPT IGBT Q2, Q4:

$V_{CES} = 600V$; $I_C = 50A$ @ $T_c = 80^\circ C$

CoolMOS™ Q5:

$V_{DSS} = 600V$

$R_{DSon} = 45m\Omega$ max @ $T_j = 25^\circ C$

Application

- Solar converter

Features

- **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
- **Q2, Q4 Non Punch Through (NPT) Fast IGBT**
 - Low voltage drop
 - Switching frequency up to 50 kHz
 - RBSOA & SCSOA rated
 - Low tail current
- 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 ($25^\circ C$) $V_{GE} = \pm 15V$ $V_{Bus} = 300V$ $I_C = 50A$ $R_G = 8.2\Omega$		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 ($150^\circ C$) $V_{GE} = \pm 15V$ $V_{Bus} = 300V$ $I_C = 50A$ $R_G = 8.2\Omega$		120		ns
T_r	Rise Time			50		
$T_{d(off)}$	Turn-off Delay Time			250		
T_f	Fall Time			60		
E_{on}	Turn-on Switching Energy	$V_{GE} = \pm 15V$ $V_{Bus} = 300V$ $I_C = 50A$	$T_j = 25^\circ C$ $T_j = 150^\circ C$	0.3 0.43		mJ
E_{off}	Turn-off Switching Energy	$R_G = 8.2\Omega$	$T_j = 25^\circ C$ $T_j = 150^\circ C$	1.35 1.75		
I_{sc}	Short Circuit data	$V_{GE} \leq 15V ; V_{Bus} = 360V$ $t_b \leq 6\mu s ; T_j = 150^\circ C$		250		A
R_{thJC}	Junction to Case Thermal resistance				0.85	$^\circ C/W$

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

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
V_{RRM}	Maximum Peak Repetitive Reverse Voltage			600			V
I_{RM}	Maximum Reverse Leakage Current	$V_R = 600V$	$T_j = 25^\circ C$			25	μA
			$T_j = 125^\circ C$			500	
I_F	DC Forward Current		$T_c = 80^\circ C$		25		A
V_F	Diode Forward Voltage	$I_F = 25A$			1.8	2.2	V
		$I_F = 50A$			2.2		
		$I_F = 25A$	$T_j = 125^\circ C$		1.6		
t_{rr}	Reverse Recovery Time	$I_F = 25A$ $V_R = 400V$ $di/dt = 200A/\mu s$	$T_j = 25^\circ C$		30		ns
			$T_j = 125^\circ C$		175		
Q_{rr}	Reverse Recovery Charge		$T_j = 25^\circ C$		55		nC
			$T_j = 125^\circ C$		485		
R_{thJC}	Junction to Case Thermal resistance					1.4	$^\circ C/W$

2. Bottom switches
2.1 Bottom Non Punch Through (NPT) Fast IGBT characteristics (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°C	65	A
		T _C = 80°C	50	
I _{CM}	Pulsed Collector Current	T _C = 25°C	230	
V _{GE}	Gate – Emitter Voltage		±20	V
P _D	Maximum Power Dissipation	T _C = 25°C	250	W
RBSOA	Reverse Bias Safe Operating Area	T _J = 125°C	100A @ 500V	

Electrical Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
I _{CES}	Zero Gate Voltage Collector Current	V _{GE} = 0V V _{CE} = 600V	T _j = 25°C			250	μA
			T _j = 125°C			500	
V _{CE(sat)}	Collector Emitter Saturation Voltage	V _{GE} = 15V I _C = 50A	T _j = 25°C	1.7	2.0	2.45	V
			T _j = 125°C		2.2		
V _{GE(th)}	Gate Threshold Voltage	V _{GE} = V _{CE} , I _C = 1mA		4		6	V
I _{GES}	Gate – Emitter Leakage Current	V _{GE} = 20V, V _{CE} = 0V				400	nA

Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C_{ies}	Input Capacitance	$V_{GE} = 0V$		2200		pF
C_{oes}	Output Capacitance	$V_{CE} = 25V$		323		
C_{res}	Reverse Transfer Capacitance	$f = 1MHz$		200		
Q_g	Total gate Charge	$V_{GE} = 15V$		166		nC
Q_{ge}	Gate – Emitter Charge	$V_{Bus} = 300V$		20		
Q_{gc}	Gate – Collector Charge	$I_C = 50A$		100		
$T_{d(on)}$	Turn-on Delay Time	Inductive Switching (25°C)		40		ns
T_r	Rise Time	$V_{GE} = 15V$		9		
$T_{d(off)}$	Turn-off Delay Time	$V_{Bus} = 400V$		120		
T_f	Fall Time	$I_C = 50A$		12		
		$R_G = 2.7\Omega$				
$T_{d(on)}$	Turn-on Delay Time	Inductive Switching (125°C)		42		ns
T_r	Rise Time	$V_{GE} = 15V$		10		
$T_{d(off)}$	Turn-off Delay Time	$V_{Bus} = 400V$		130		
T_f	Fall Time	$I_C = 50A$		21		
		$R_G = 2.7\Omega$				
E_{on}	Turn-on Switching Energy	$V_{GE} = 15V$ $V_{Bus} = 400V$	$T_j = 125^\circ C$	0.5		mJ
E_{off}	Turn-off Switching Energy	$I_C = 50A$ $R_G = 2.7\Omega$	$T_j = 125^\circ C$	1		
I_{sc}	Short Circuit data	$V_{GE} \leq 15V$; $V_{Bus} = 360V$ $t_p \leq 10\mu s$; $T_j = 125^\circ C$		225		A
R_{thJC}	Junction to Case Thermal resistance				0.5	°C/W

2.2 Bottom diode characteristics (CR2, 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	$V_R = 600V$	$T_j = 25^\circ C$		100	μA
			$T_j = 150^\circ C$		350	
I_F	DC Forward Current		$T_c = 80^\circ C$	30		A
V_F	Diode Forward Voltage	$I_F = 30A$ $V_{GE} = 0V$	$T_j = 25^\circ C$	1.6	2	V
			$T_j = 150^\circ C$	1.5		
t_{rr}	Reverse Recovery Time	$I_F = 30A$ $V_R = 300V$ $di/dt = 1800A/\mu s$	$T_j = 25^\circ C$	100		ns
			$T_j = 150^\circ C$	150		
Q_{rr}	Reverse Recovery Charge		$T_j = 25^\circ C$	1.5		μC
			$T_j = 150^\circ C$	3.1		
E_{rr}	Reverse Recovery Energy		$T_j = 25^\circ C$	0.34		mJ
			$T_j = 150^\circ C$	0.75		
R_{thJC}	Junction to Case Thermal resistance				2.45	°C/W

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	$T_c = 25^\circ\text{C}$	A
		$T_c = 80^\circ\text{C}$	
I_{DM}	Pulsed Drain current	130	
V_{GS}	Gate - Source Voltage	± 20	V
$R_{DS(on)}$	Drain - Source ON Resistance	45	m Ω
P_D	Maximum Power Dissipation	$T_c = 25^\circ\text{C}$	W
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	$V_{GS} = 0V, V_{DS} = 600V, T_j = 25^\circ\text{C}$			250	μA
		$V_{GS} = 0V, V_{DS} = 600V, T_j = 125^\circ\text{C}$			500	
$R_{DS(on)}$	Drain – Source on Resistance	$V_{GS} = 10V, I_D = 24.5A$		40	45	m Ω
$V_{GS(th)}$	Gate Threshold Voltage	$V_{GS} = V_{DS}, I_D = 3mA$	2.1	3	3.9	V
I_{GSS}	Gate – Source Leakage Current	$V_{GS} = \pm 20V, V_{DS} = 0V$			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) $V_{GS} = 10V$ $V_{Bus} = 400V$ $I_D = 49A$ $R_G = 5\Omega$		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 $V_{GS} = 10V; V_{Bus} = 400V$ $I_D = 49A; R_G = 5\Omega$		675		μJ
E_{off}	Turn-off Switching Energy			520		
E_{on}	Turn-on Switching Energy	Inductive switching @ 125°C $V_{GS} = 10V; V_{Bus} = 400V$ $I_D = 49A; R_G = 5\Omega$		1096		μJ
E_{off}	Turn-off Switching Energy			635		
R_{thJC}	Junction to Case Thermal resistance				0.5	$^\circ\text{C/W}$

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	T _j = 25°C		600		ns
Q _{rr}	Reverse Recovery Charge	di _S /dt = 100A/μs	T _j = 25°C		17		μC

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

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

3.2 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	T _j = 25°C			25	μA
			T _j = 125°C			500	
I _F	DC Forward Current	T _c = 80°C			30		A
V _F	Diode Forward Voltage	I _F = 30A			1.8	2.2	V
		I _F = 60A			2.2		
		I _F = 30A	T _j = 125°C		1.5		
t _{rr}	Reverse Recovery Time	I _F = 30A V _R = 400V	T _j = 25°C		25		ns
			T _j = 125°C		160		
Q _{rr}	Reverse Recovery Charge	di/dt = 200A/μs	T _j = 25°C		35		nC
			T _j = 125°C		480		
R _{thJC}	Junction to Case Thermal resistance					1.2	°C/W

4. By pass diode (CR6)
Absolute maximum ratings

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		T _C = 80°C	40	A
I _{FSM}	Non-Repetitive Forward Surge Current	t=10ms	T _J = 45°C	400	

Electrical Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
I _R	Reverse Current	V _R = 1600V	T _j = 25°C		20		μA
			T _j = 125°C		2		mA
V _F	Forward Voltage	I _F = 40A	T _j = 25°C		1.3		V
			T _j = 125°C		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	T _C = 100°C		4		%

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

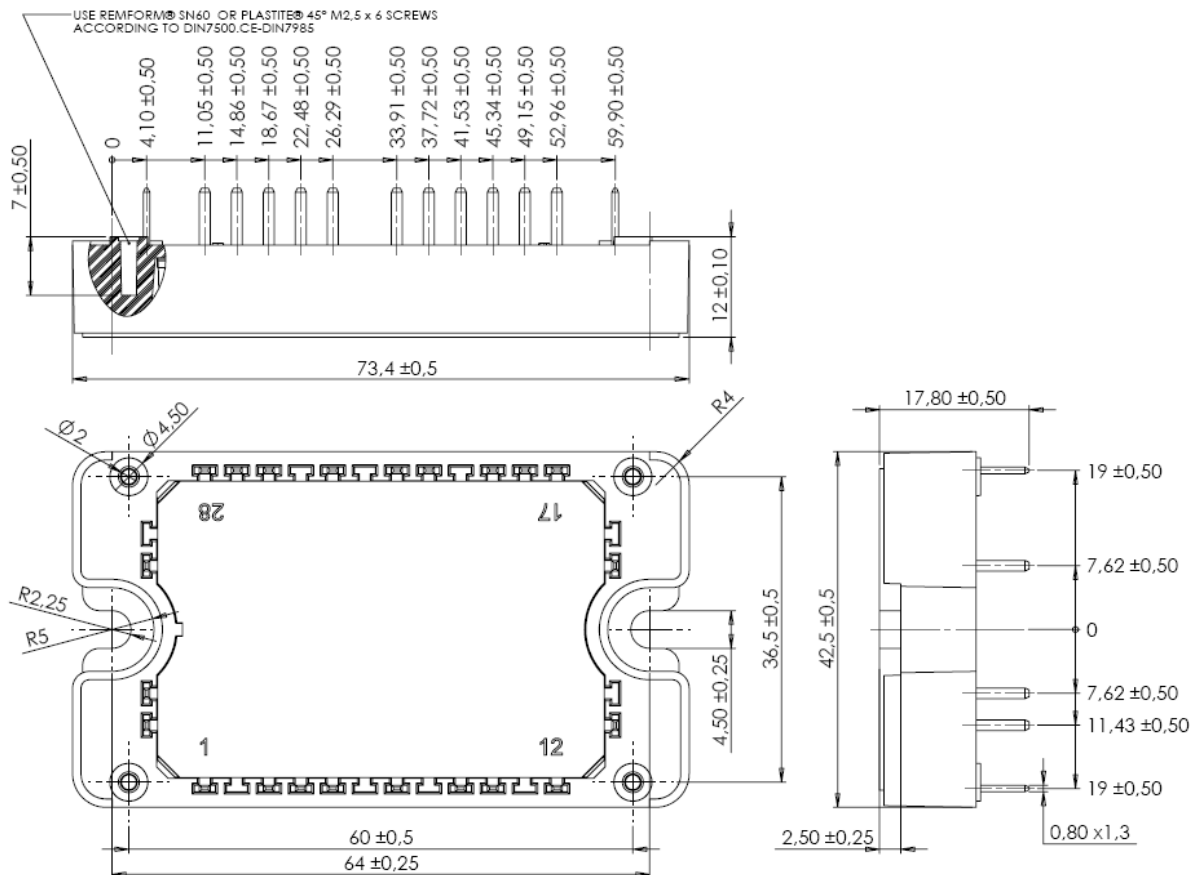
T: Thermistor temperature
R_T: Thermistor value at T

6. Package characteristics

Symbol	Characteristic			Min	Typ	Max	Unit
V _{ISOL}	RMS Isolation Voltage, any terminal to case t=1 min, I isol<1mA, 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	
Torque	Mounting torque	To heatsink	M4	2.5		4.7	N.m
Wt	Package Weight					110	g

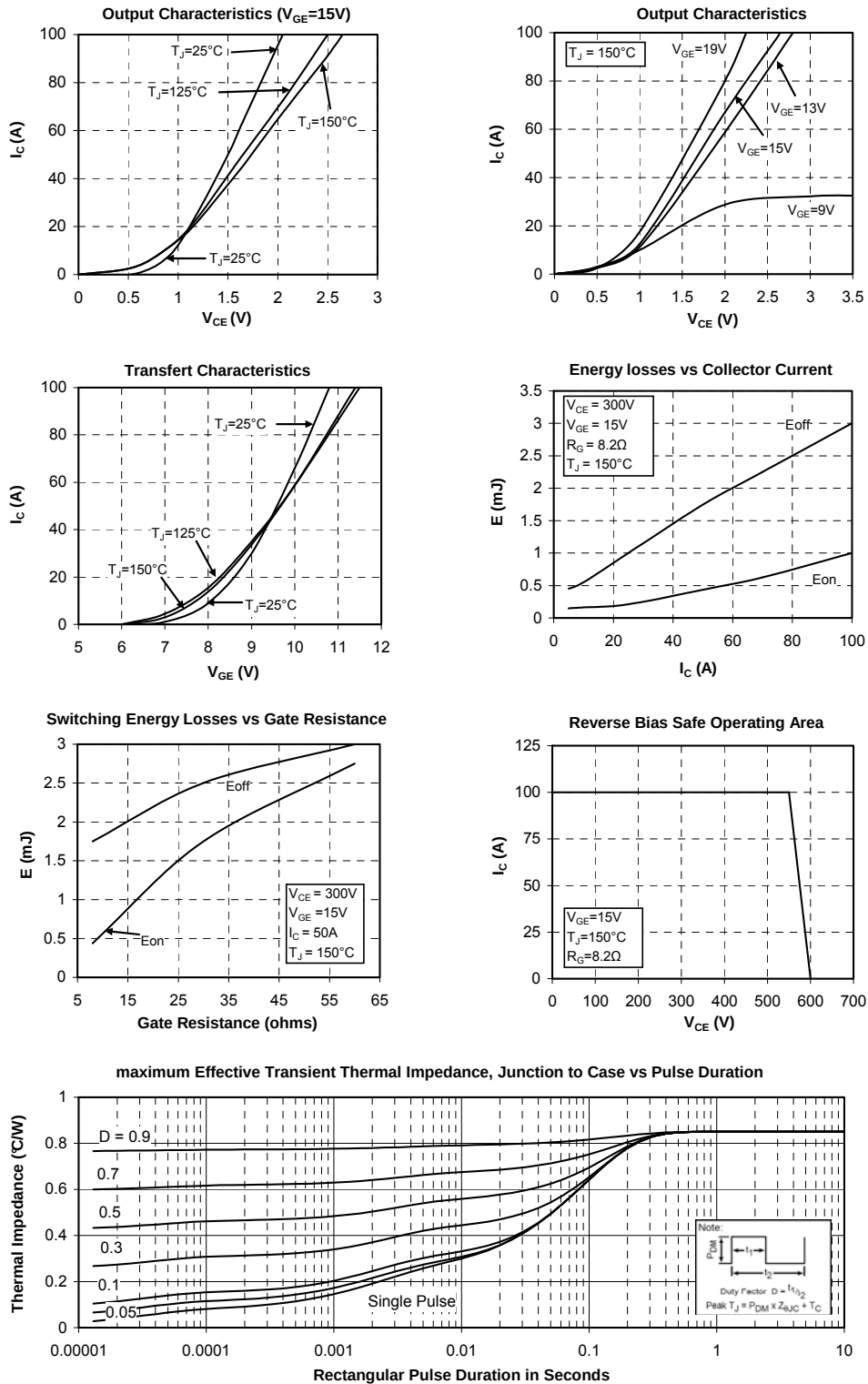
* T_J = 175°C for Trench & Field Stop IGBT3

7. SP3 Package outline (dimensions in mm)

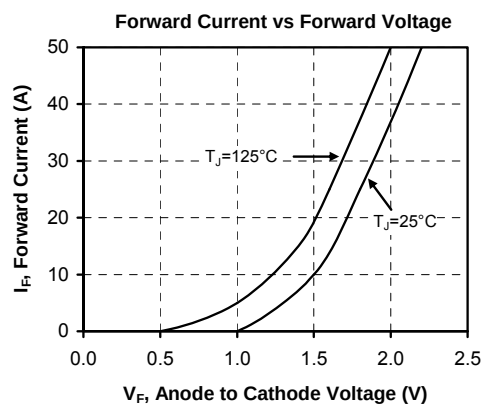
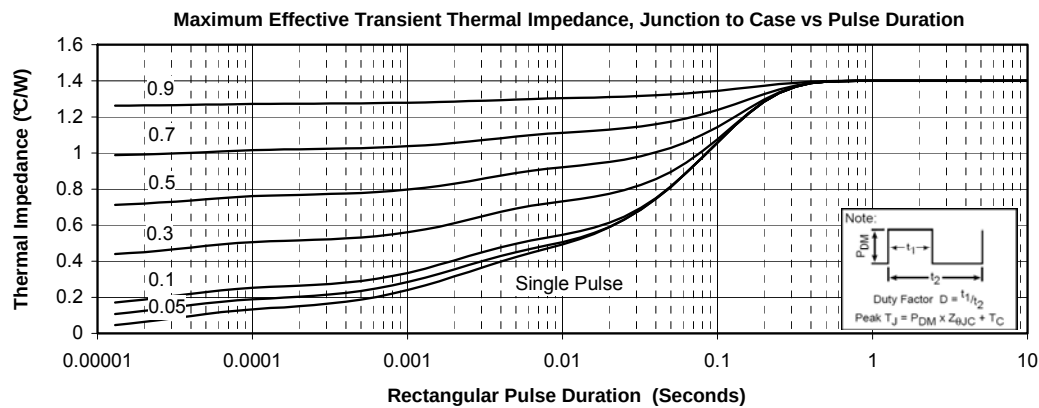


8. Top switches curves

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

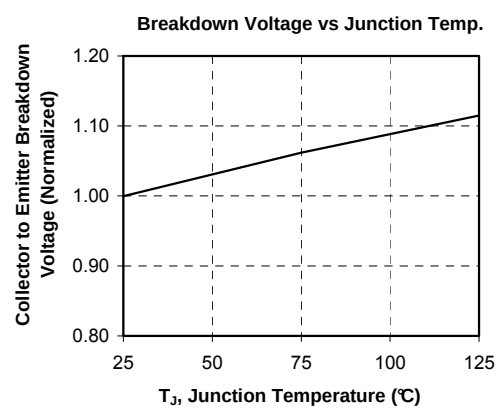
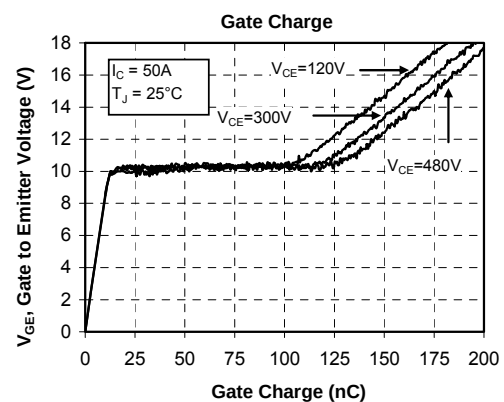
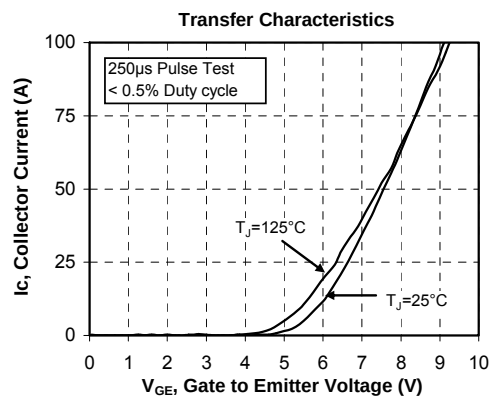
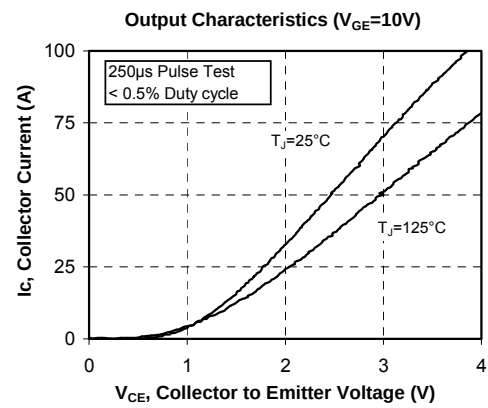
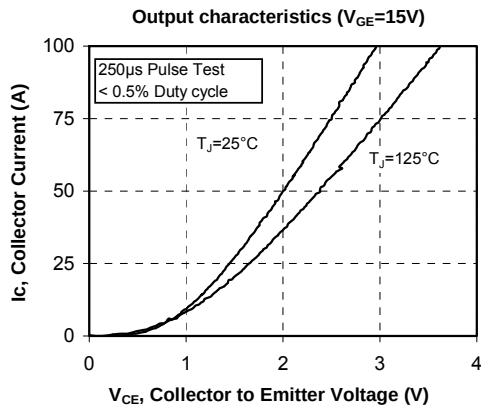


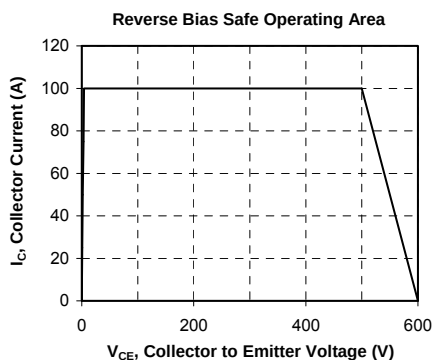
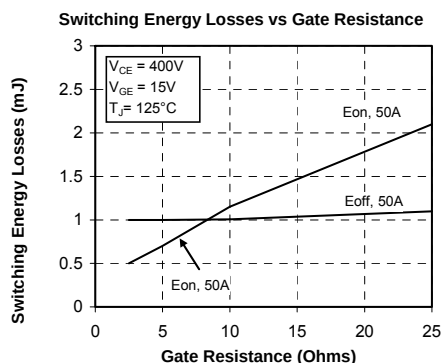
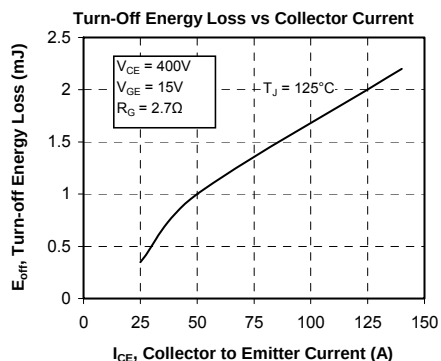
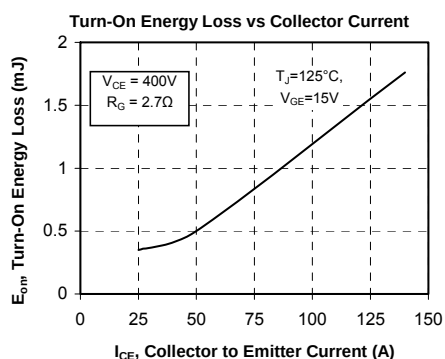
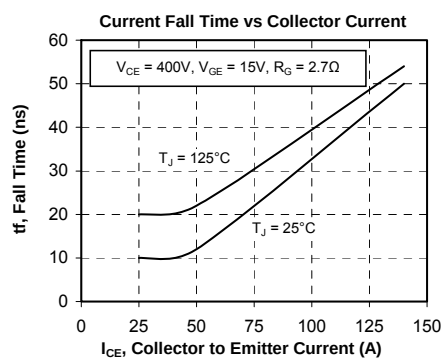
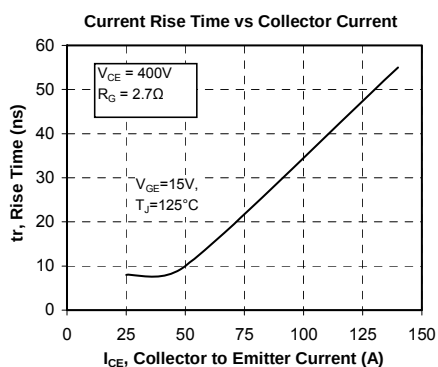
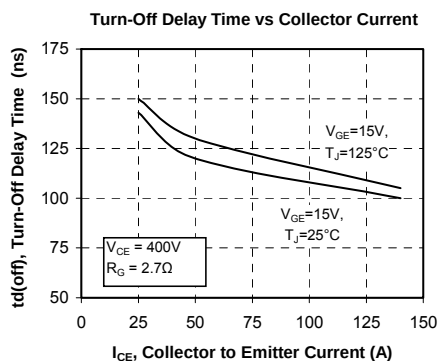
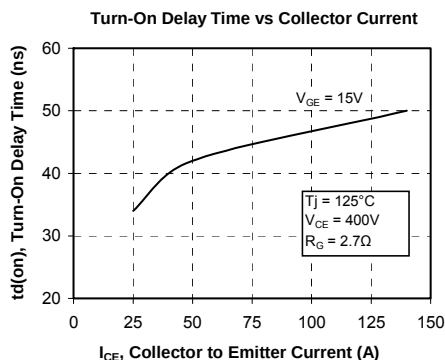
8.2 Top diode characteristics (CR1, CR3) (per diode)

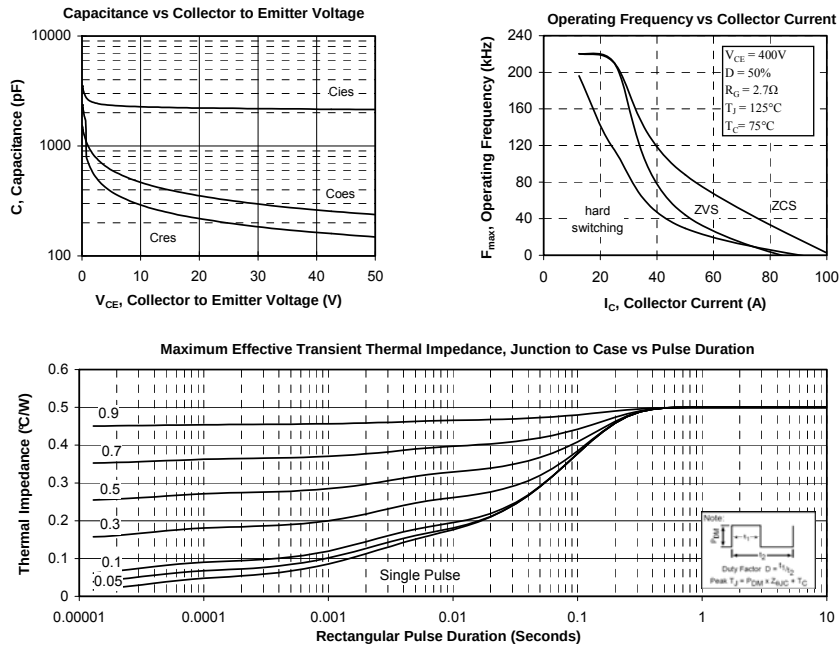


9. Bottom switches curves

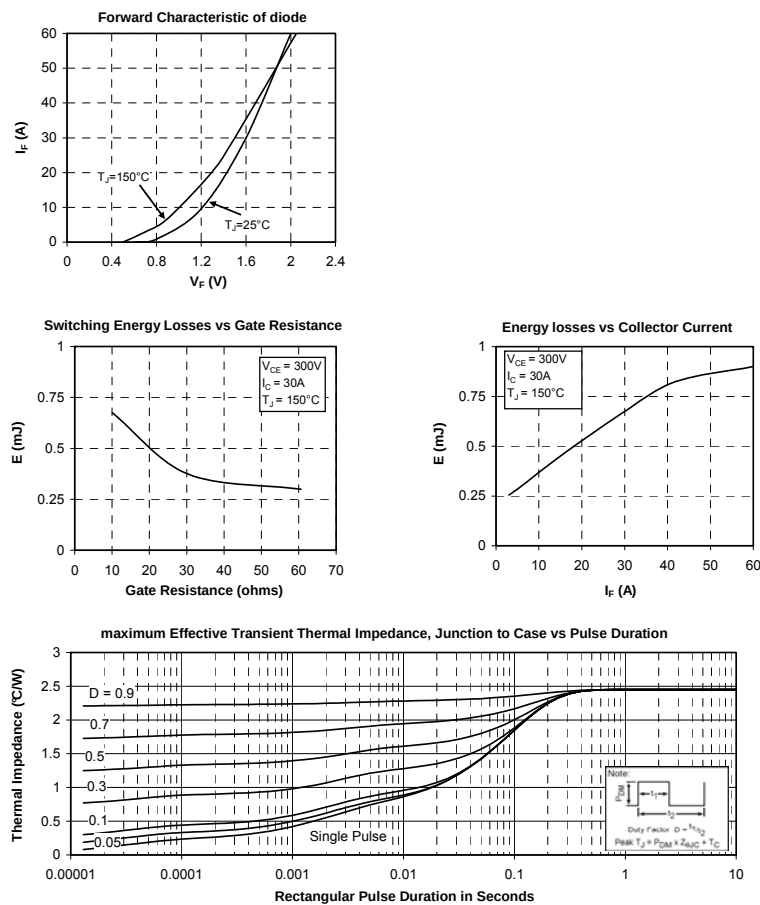
9.1 Bottom NPT typical performance curves (per IGBT)



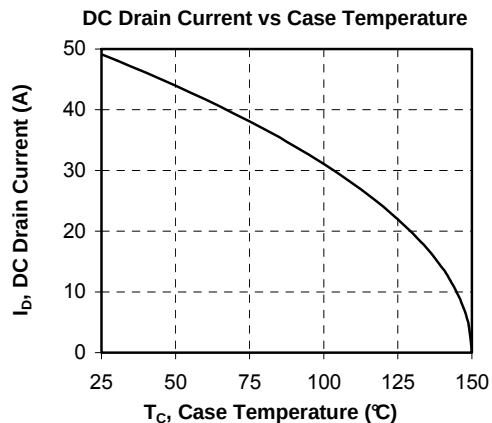
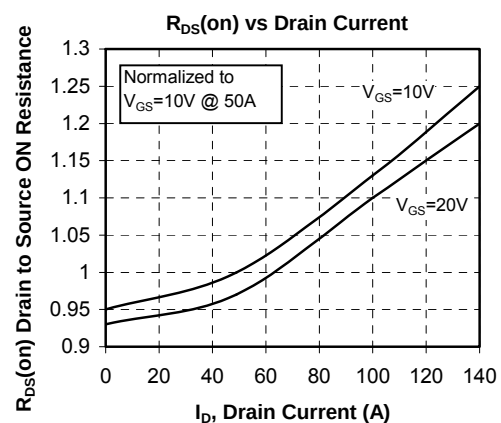
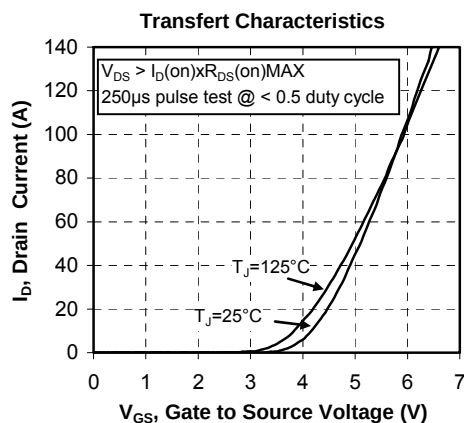
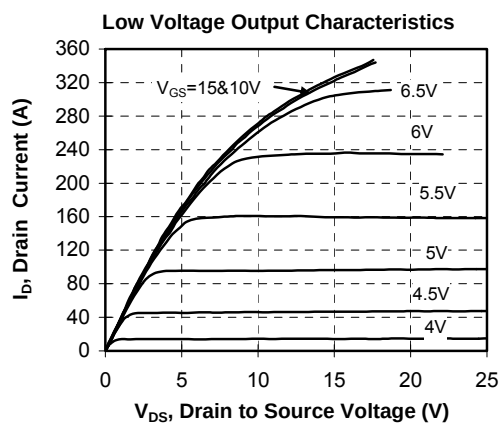
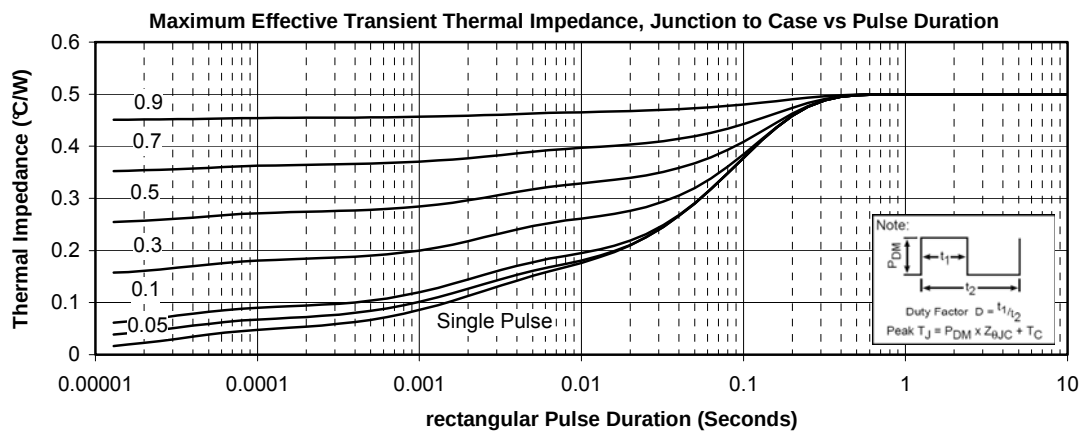


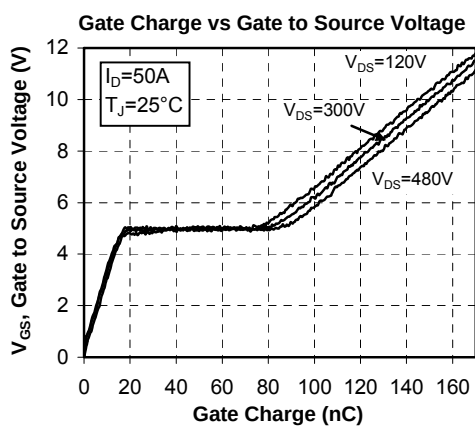
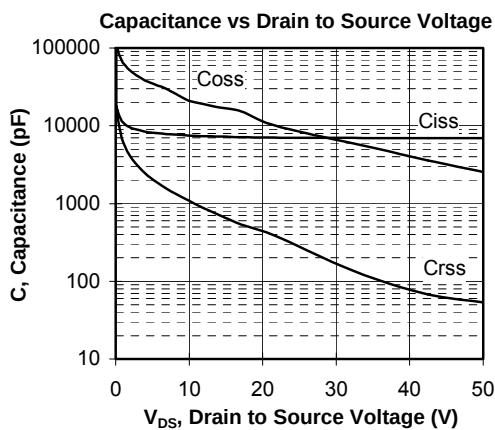
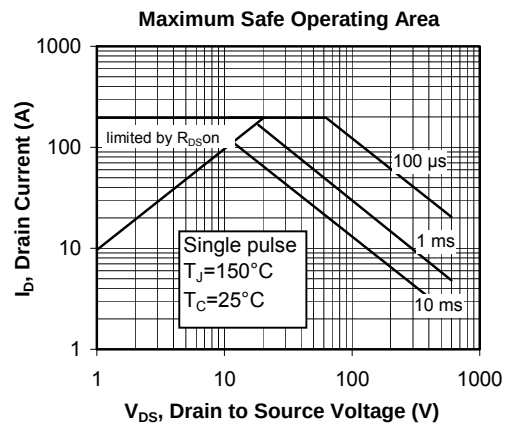
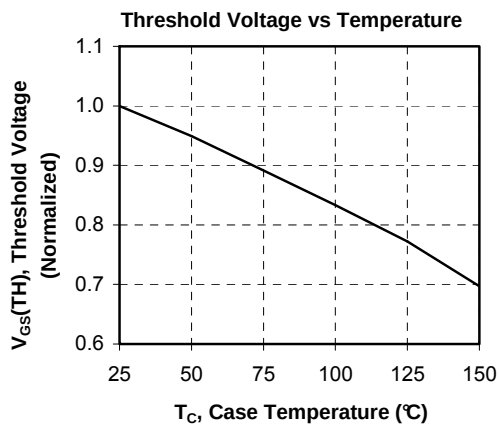
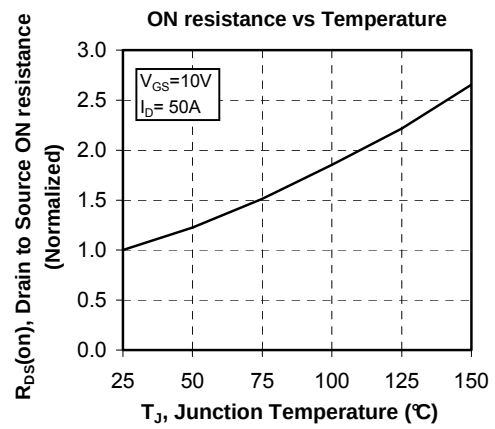
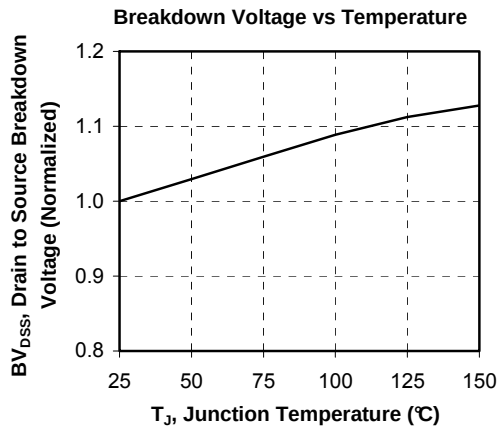


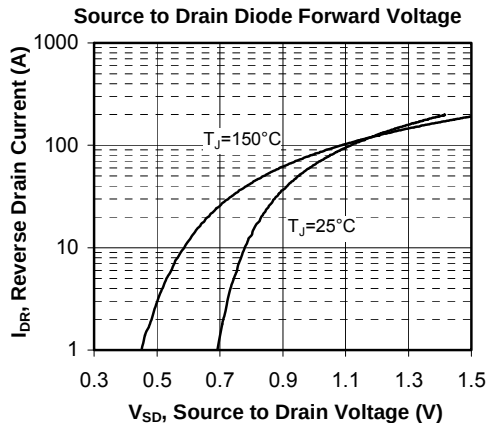
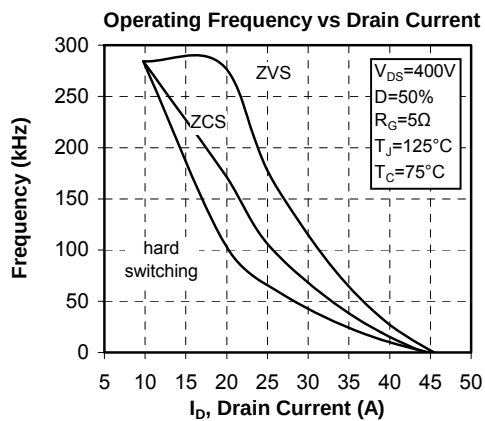
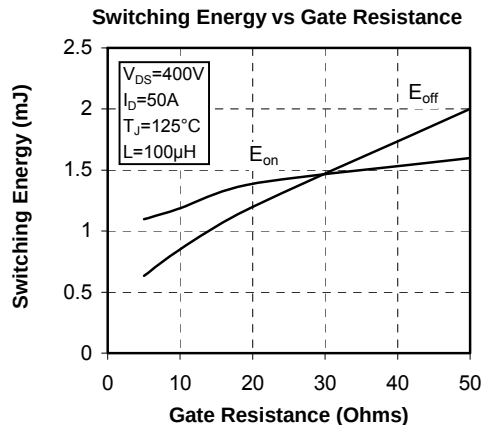
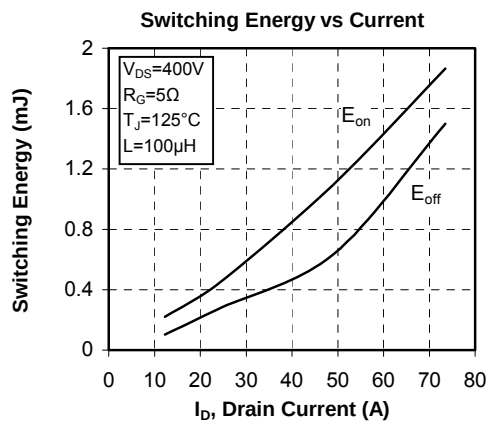
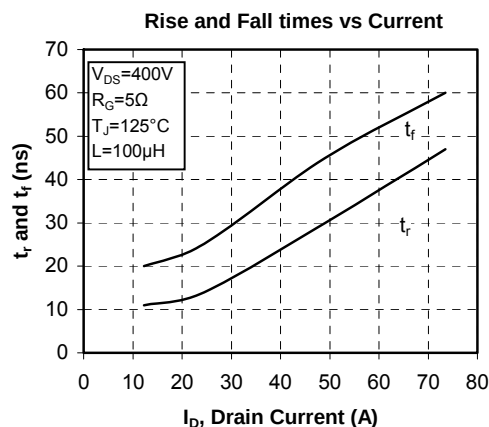
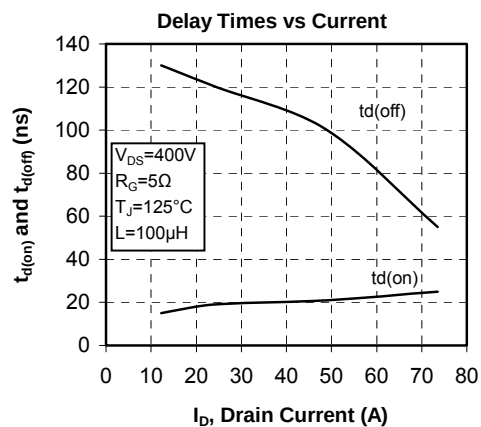
9.2 Bottom diode characteristics (CR2, CR4) (per diode)



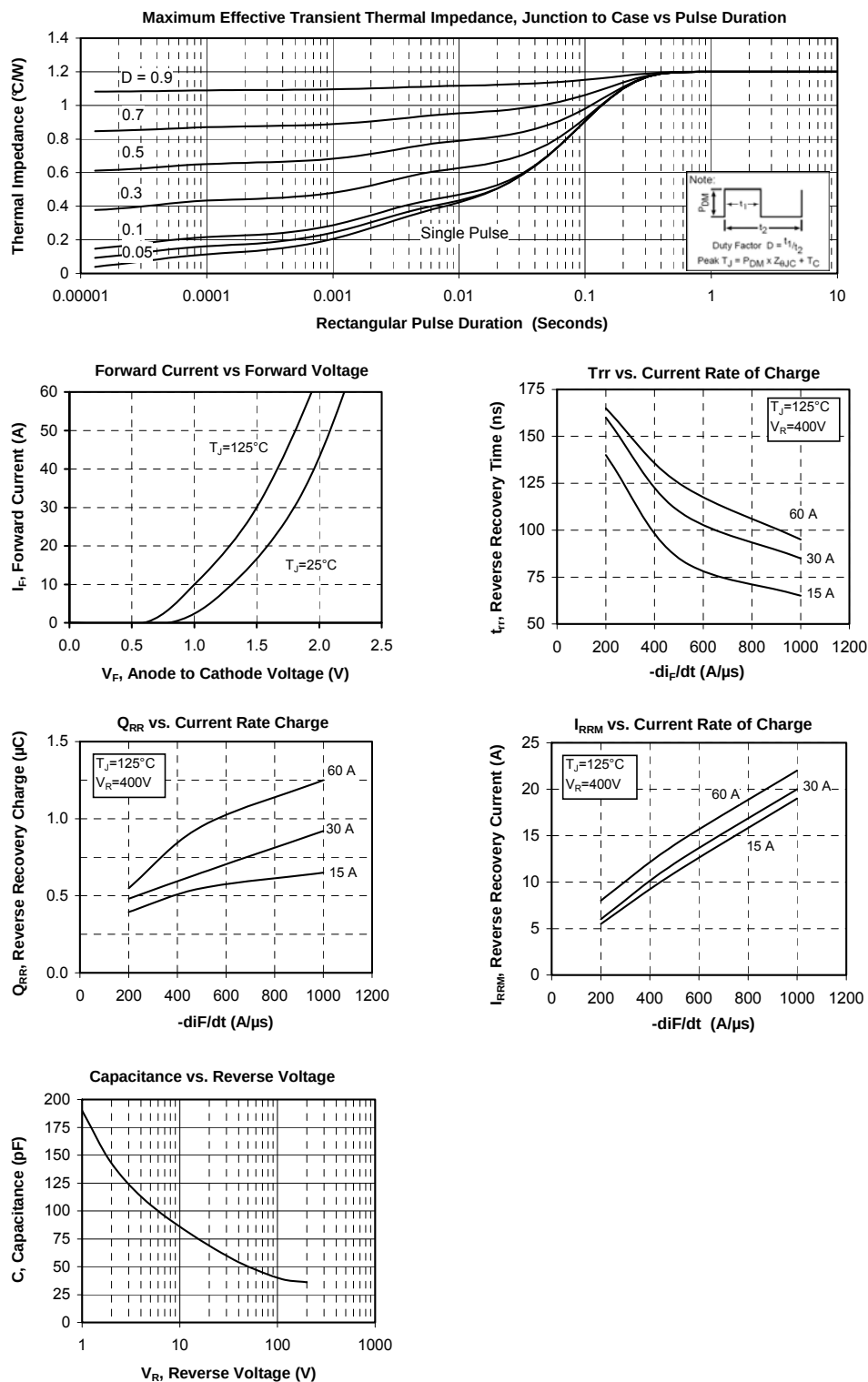
10. Chopper CoolMOS™ (per CoolMOS™)



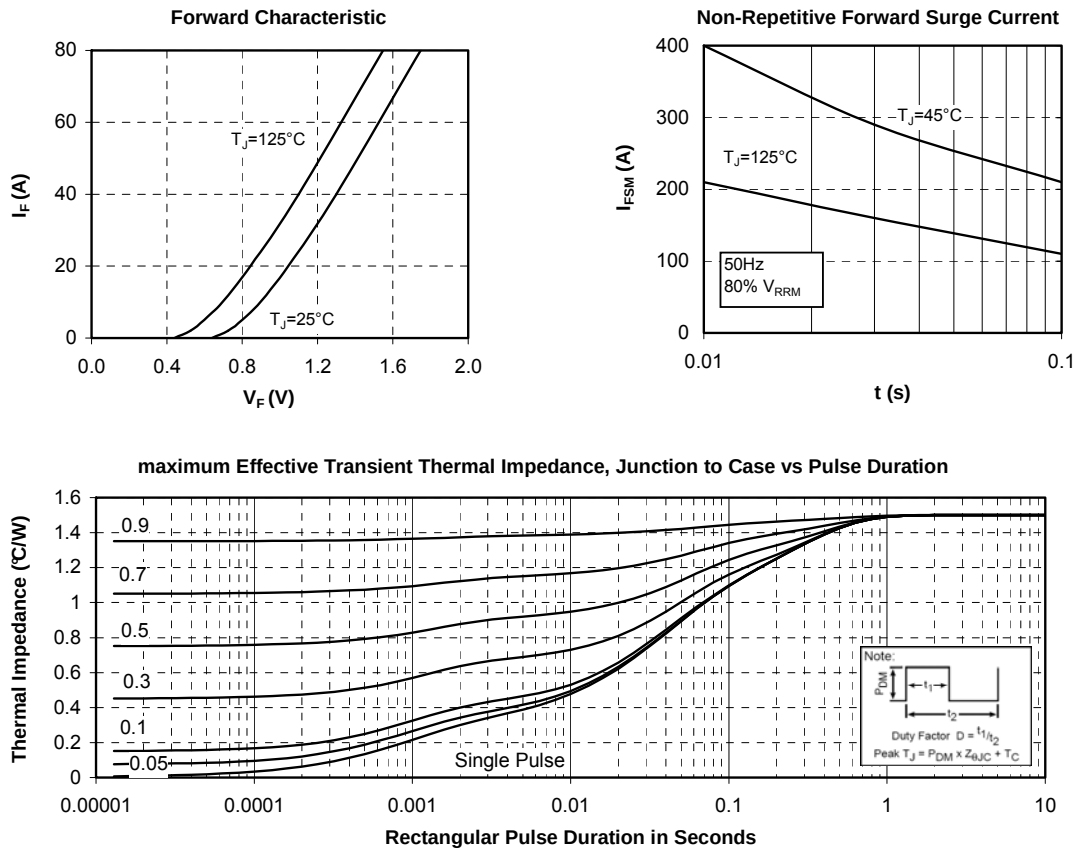




10. Chopper diode curves



11. Typical by pass CR6 diode curves



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