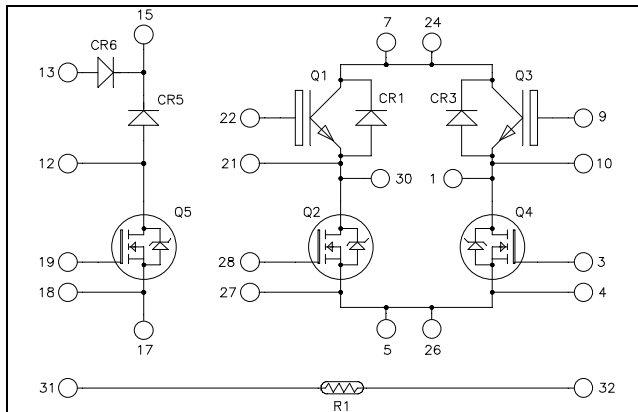


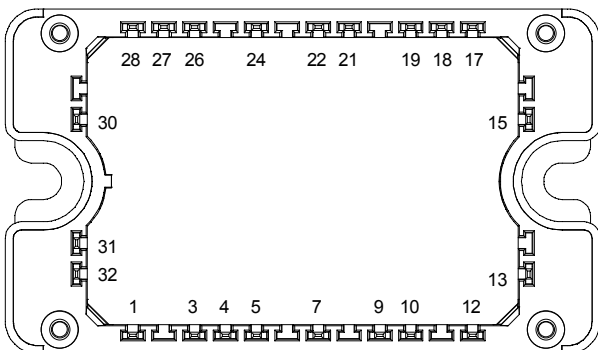
**Full – Bridge + boost chopper
CoolMOS™ & Trench + Field Stop IGBT3
Power module**



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:

$V_{DSS} = 600V$

$R_{DSon} = 70m\Omega$ max @ $T_j = 25^\circ C$

CoolMOS™ Q5:

$V_{DSS} = 600V$

$R_{DSon} = 45m\Omega$ 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
- 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	$V_{GE} = 15V$ $I_C = 50A$	$T_j = 25^\circ C$ $T_j = 150^\circ C$	1.5 1.7	1.9	V
$V_{GE(th)}$	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	$V_{GE} = 0V$ $V_{CE} = 25V$ $f = 1MHz$		3150		pF
C_{oes}	Output Capacitance			200		
C_{res}	Reverse Transfer Capacitance			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_{off}	Turn-off Switching Energy	$V_{GE} = \pm 15V$ $V_{Bus} = 300V$ $I_C = 50A$ $R_G = 8.2\Omega$	$T_j = 25^\circ C$ $T_j = 150^\circ C$	1.35 1.75		mJ
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)

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 CoolMOS™ characteristics (Per CoolMOS™)

Absolute maximum ratings

Symbol	Parameter	Max ratings	Unit
V_{DSS}	Drain - Source Breakdown Voltage	600	V
I_D	Continuous Drain Current	$T_c = 25^\circ C$	A
		$T_c = 80^\circ C$	
I_{DM}	Pulsed Drain current	160	
V_{GS}	Gate - Source Voltage	± 20	V
$R_{DS(on)}$	Drain - Source ON Resistance	70	m Ω
P_D	Maximum Power Dissipation	$T_c = 25^\circ C$	W
I_{AR}	Avalanche current (repetitive and non repetitive)	20	A
E_{AR}	Repetitive Avalanche Energy	1	mJ
E_{AS}	Single Pulse Avalanche Energy	1800	

Electrical Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
I_{DSS}	Zero Gate Voltage Drain Current	$V_{GS} = 0V, V_{DS} = 600V$	$T_j = 25^\circ C$			25	μA
		$V_{GS} = 0V, V_{DS} = 600V$	$T_j = 125^\circ C$			250	
$R_{DS(on)}$	Drain - Source on Resistance	$V_{GS} = 10V, I_D = 39A$				70	m Ω
$V_{GS(th)}$	Gate Threshold Voltage	$V_{GS} = V_{DS}, I_D = 2.7mA$		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		7		nF
C _{oss}	Output Capacitance	V _{DS} = 25V		2.56		
C _{rss}	Reverse Transfer Capacitance	f = 1MHz		0.21		
Q _g	Total gate Charge	V _{GS} = 10V		259		nC
Q _{gs}	Gate – Source Charge	V _{Bus} = 300V		29		
Q _{gd}	Gate – Drain Charge	I _D = 39A		111		
T _{d(on)}	Turn-on Delay Time	Inductive Switching @ 125°C V _{GS} = 15V V _{Bus} = 400V I _D = 39A R _G = 5Ω		21		ns
T _r	Rise Time			30		
T _{d(off)}	Turn-off Delay Time			283		
T _f	Fall Time			84		
E _{on}	Turn-on Switching Energy	Inductive switching @ 25°C V _{GS} = 15V, V _{Bus} = 400V I _D = 39A, R _G = 5Ω		670		μJ
E _{off}	Turn-off Switching Energy			980		
E _{on}	Turn-on Switching Energy	Inductive switching @ 125°C V _{GS} = 15V, V _{Bus} = 400V I _D = 39A, R _G = 5Ω		1096		μJ
E _{off}	Turn-off Switching Energy			1206		
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		39		A
		T _c = 80°C		29		
V _{SD}	Diode Forward Voltage	V _{GS} = 0V, I _S = - 39A			1.2	V
dv/dt	Peak Diode Recovery ❶				6	V/ns
t _{rr}	Reverse Recovery Time	I _S = - 39A V _R = 350V		580		ns
Q _{rr}	Reverse Recovery Charge	di/dt = 100A/μs T _j = 25°C		23		

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

$$I_S \leq -39A \quad di/dt \leq 100A/\mu s \quad V_R \leq V_{DSS} \quad T_j \leq 150^\circ C$$

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	A
		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	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°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		600		ns
Q _{rr}	Reverse Recovery Charge	di _S /dt = 100A/μs, 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 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 di/dt =200A/μs	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

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			4		%

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

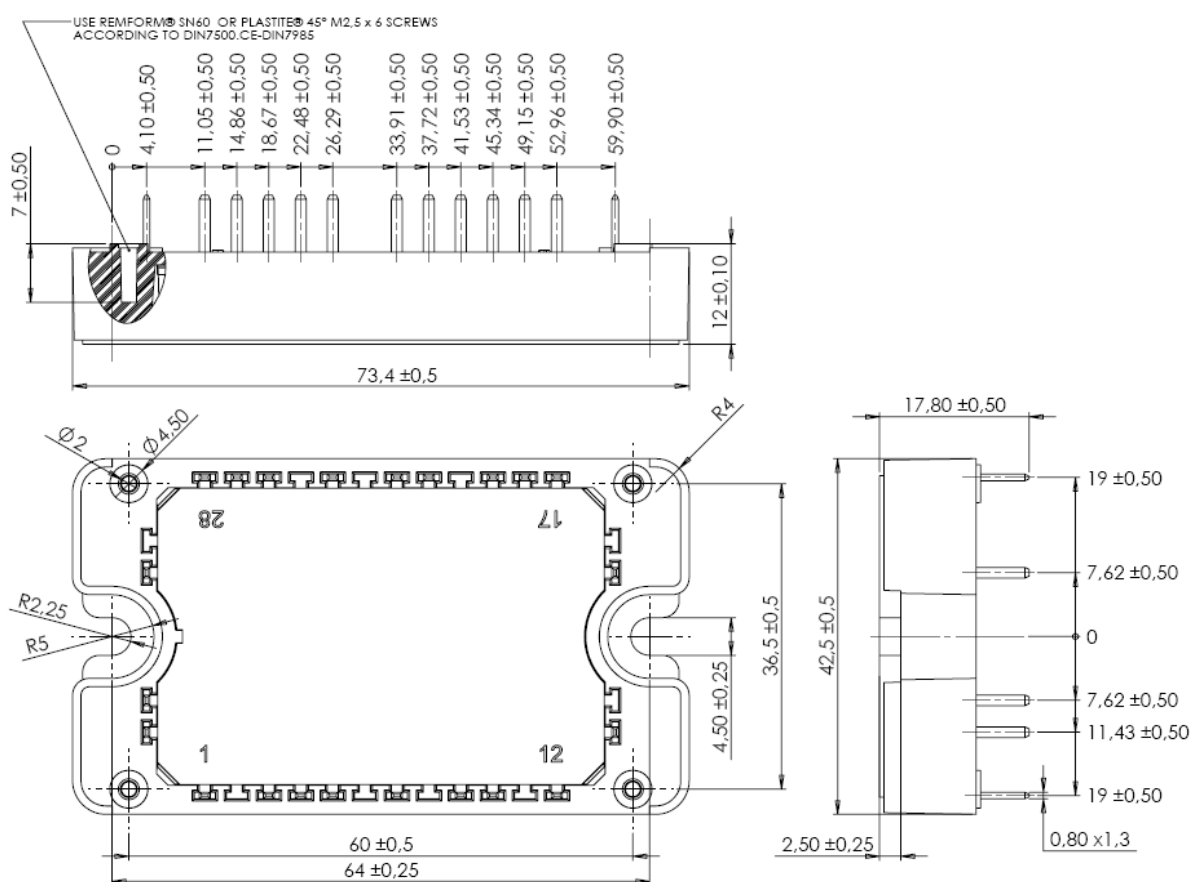
T: Thermistor temperature
 R_T: Thermistor value at T

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	N.m
Wt	Package Weight			110	g

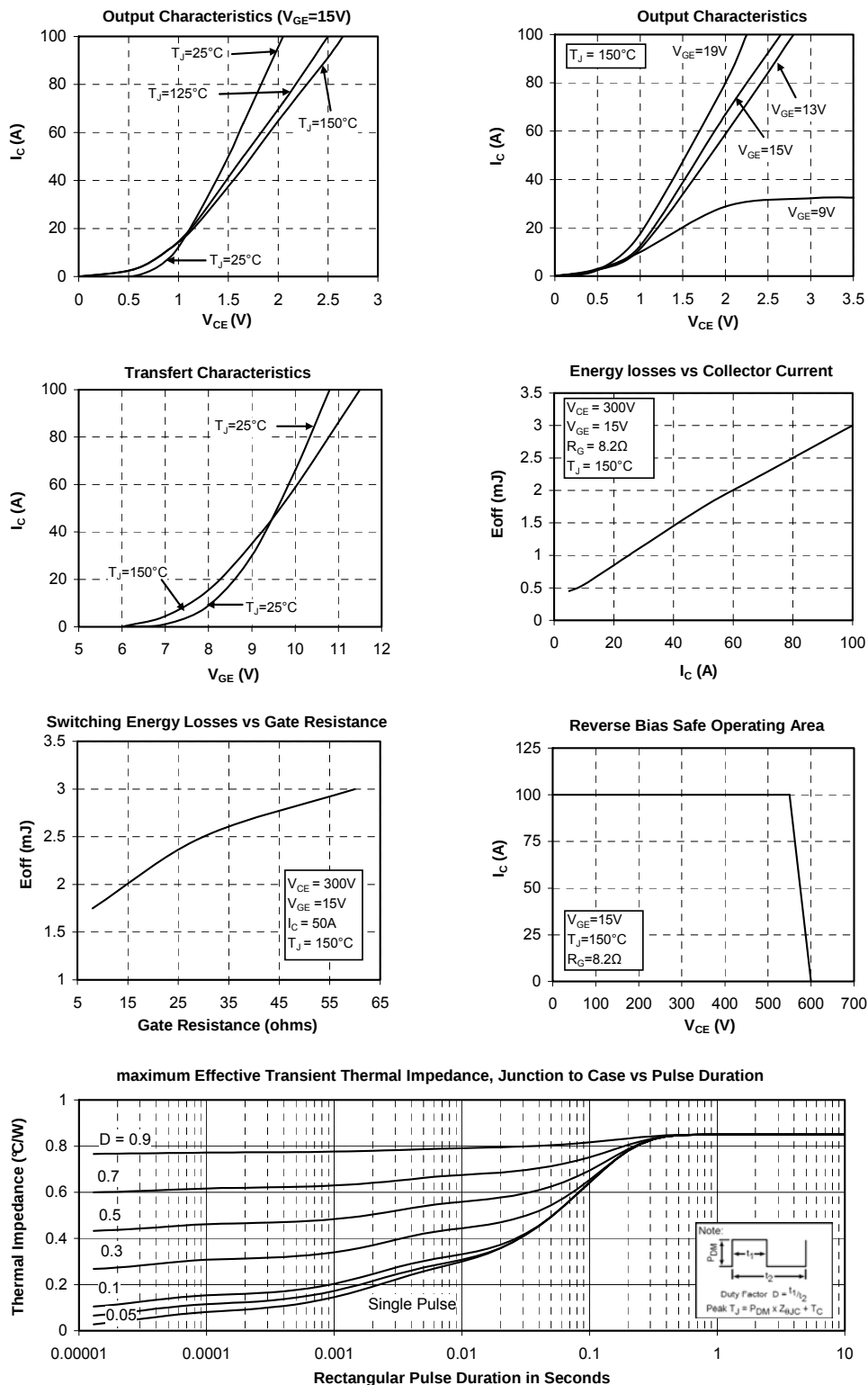
* T_J=175°C for Trench & Field Stop IGBT3

7. SP3 Package outline (dimensions in mm)

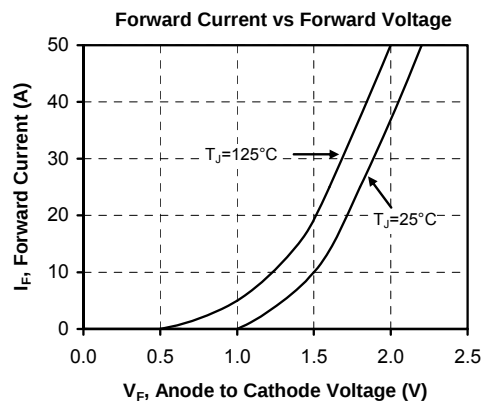
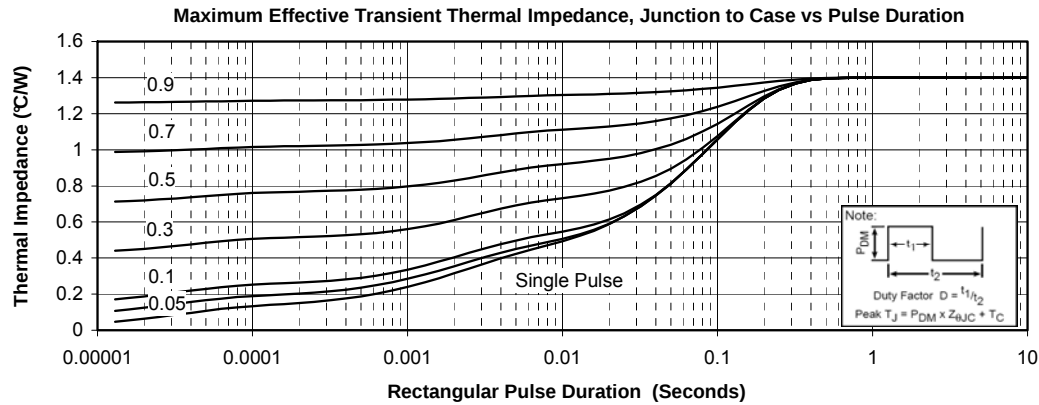


8. Top switches curves

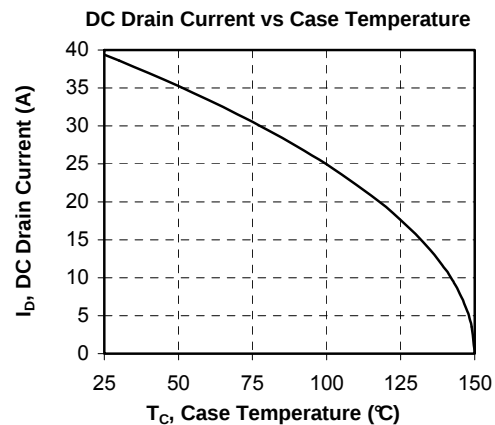
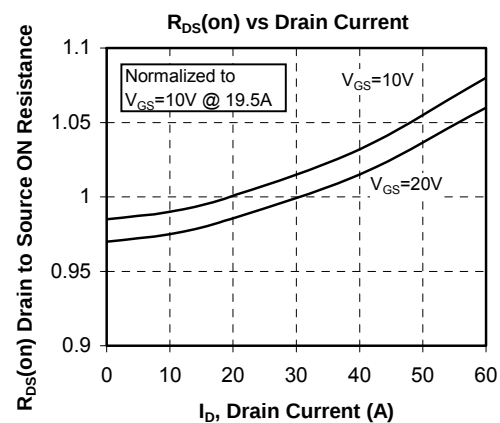
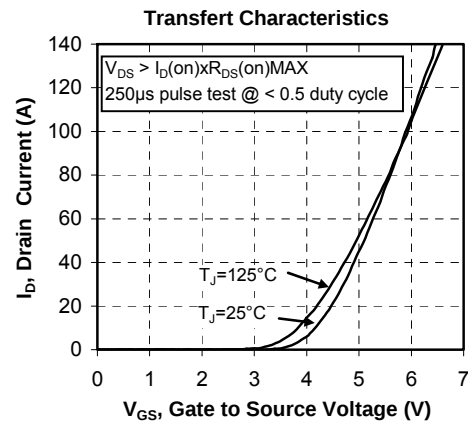
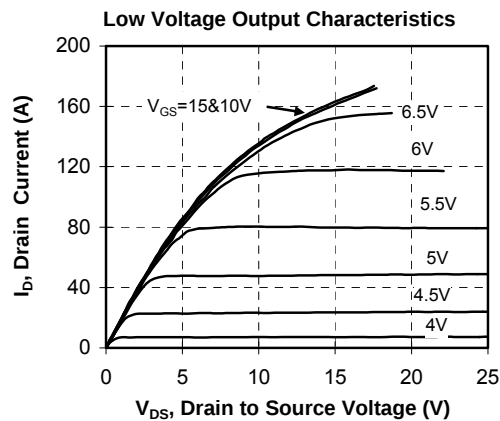
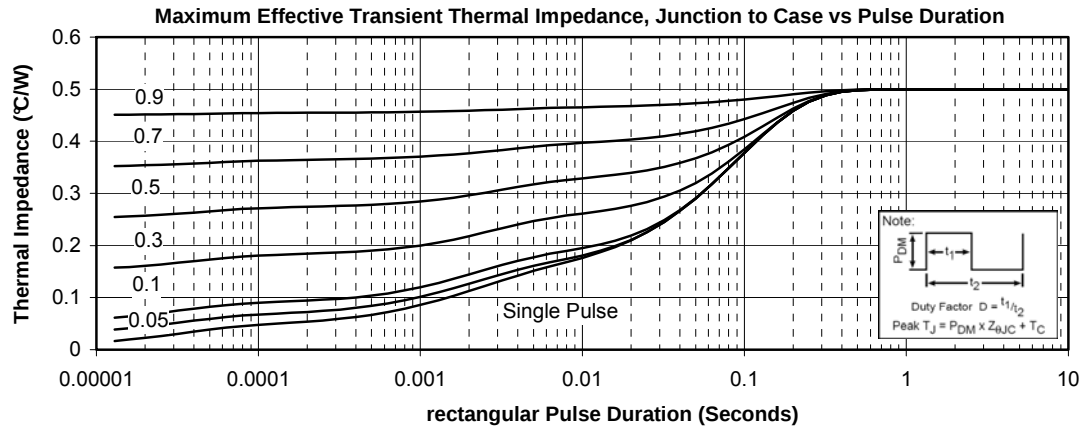
8.1 Top Trench + Field Stop IGBT3 typical performance curves (per IGBT)

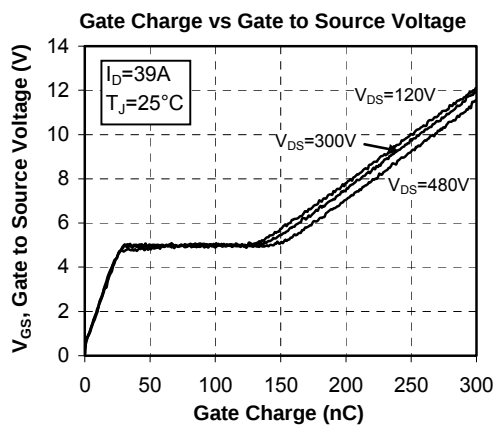
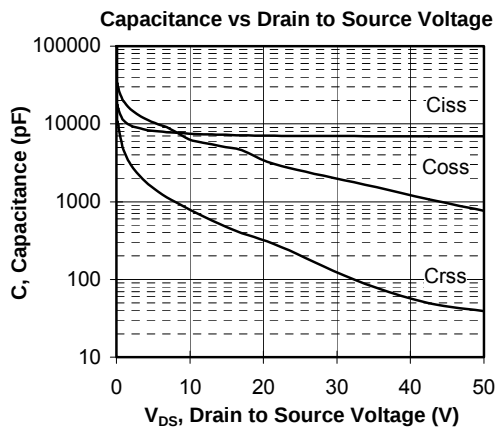
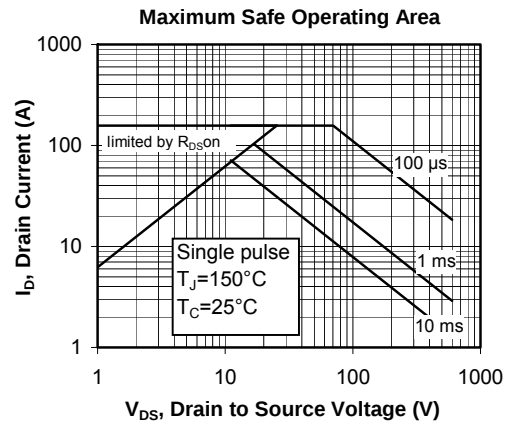
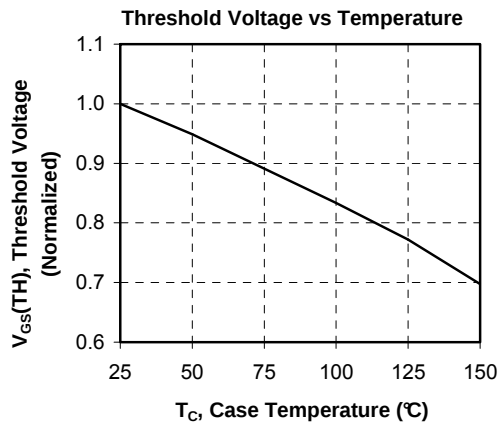
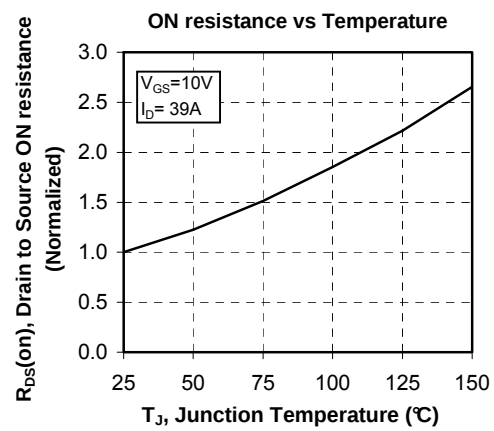
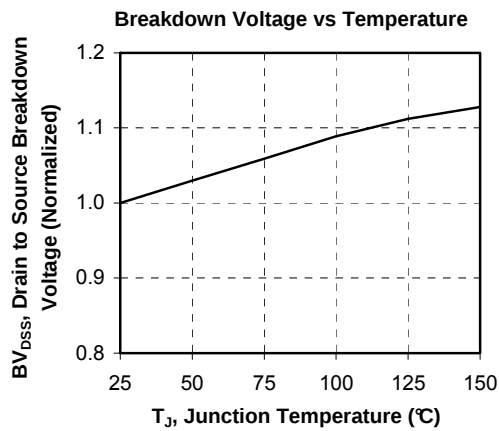


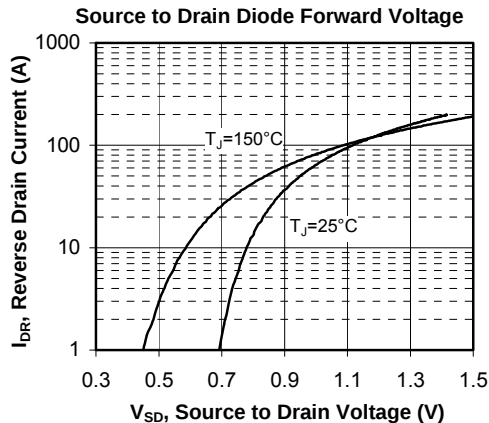
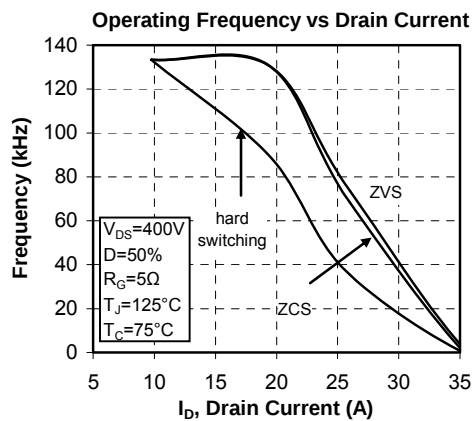
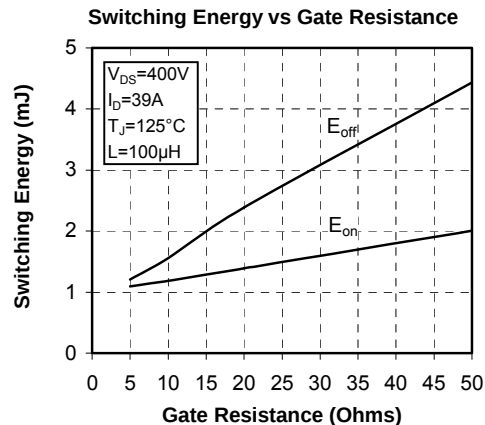
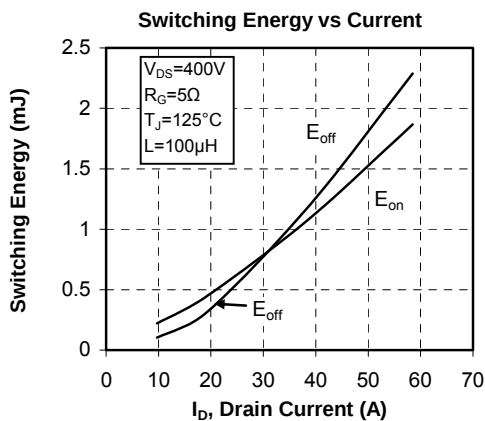
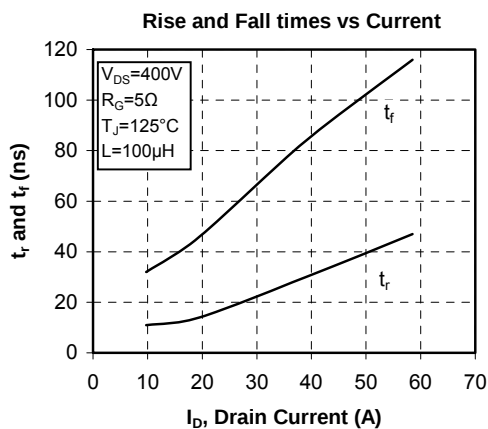
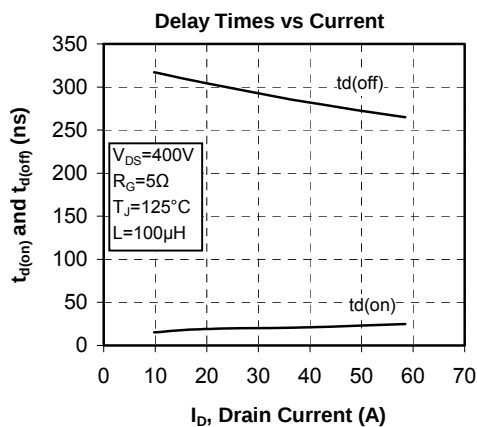
8.2 Top diode characteristics (CR1, CR3) (per diode)



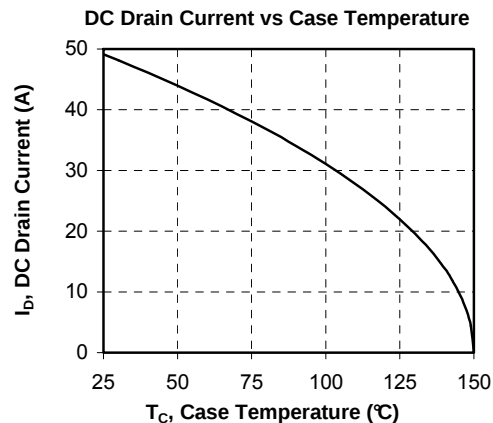
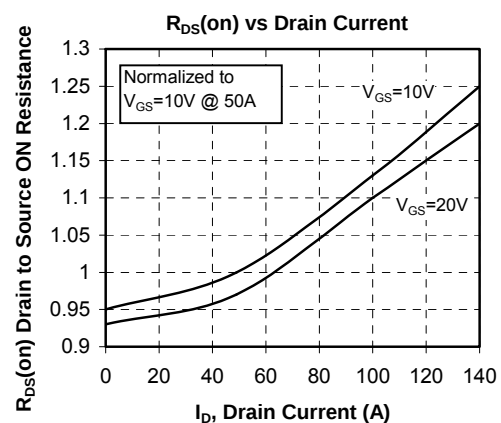
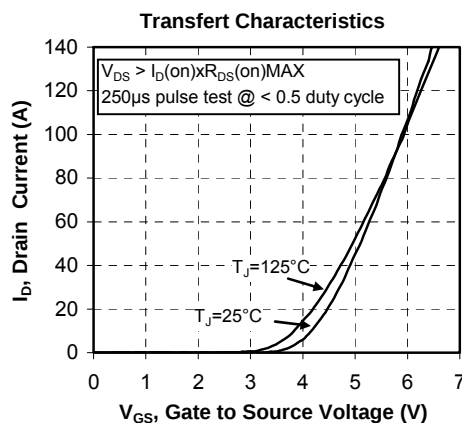
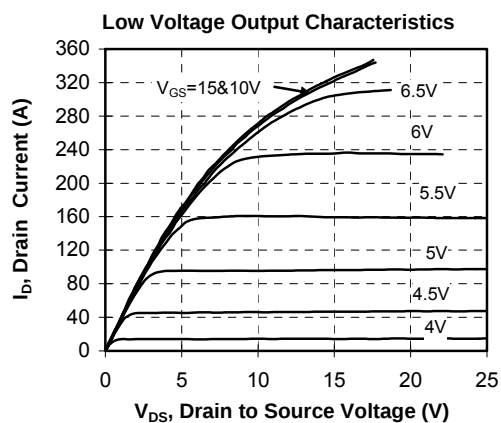
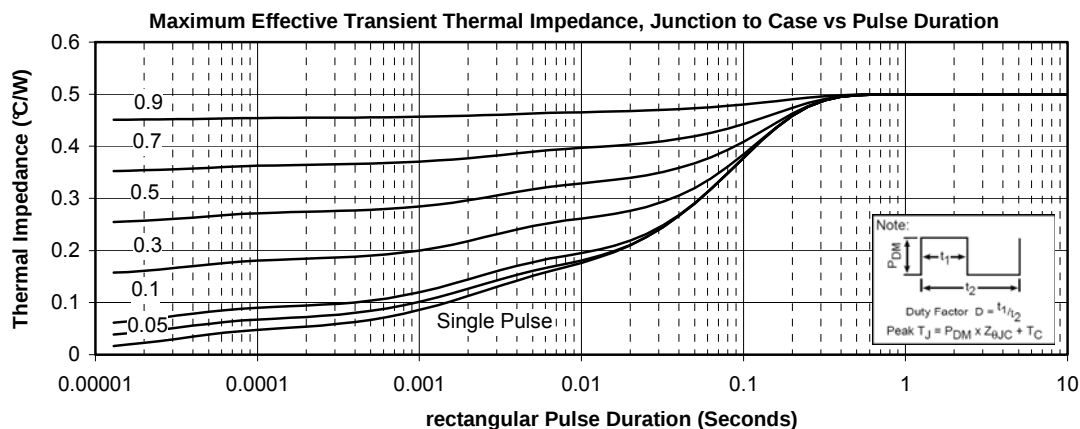
9. Bottom switches CoolMOS™ (per CoolMOS™)

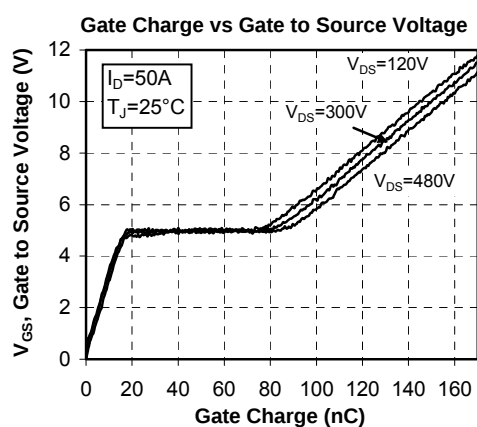
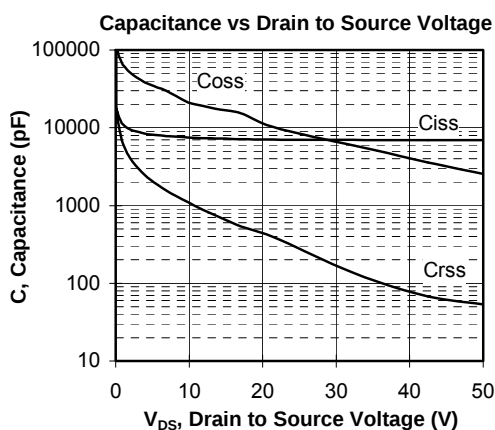
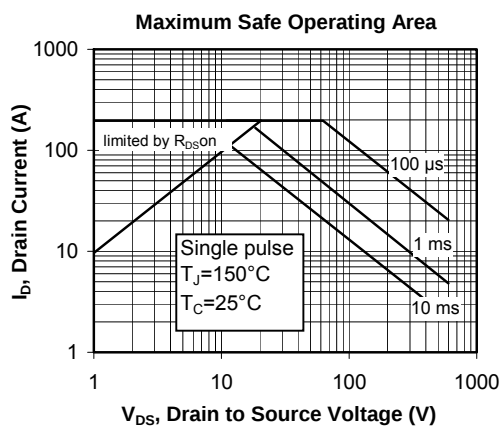
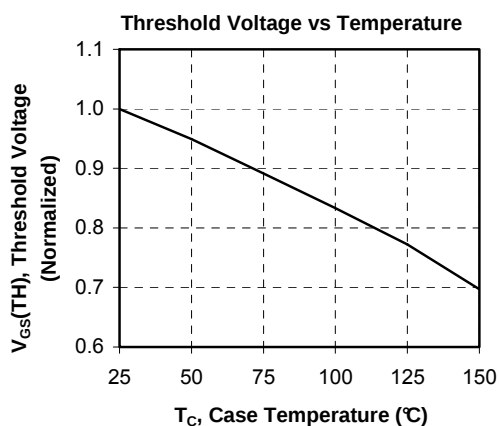
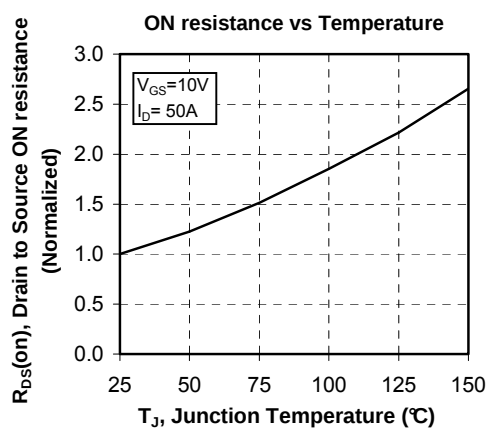
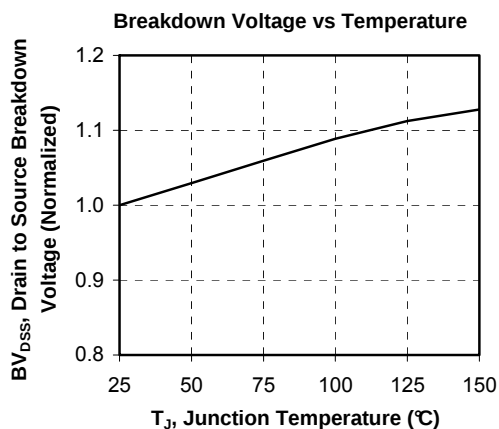


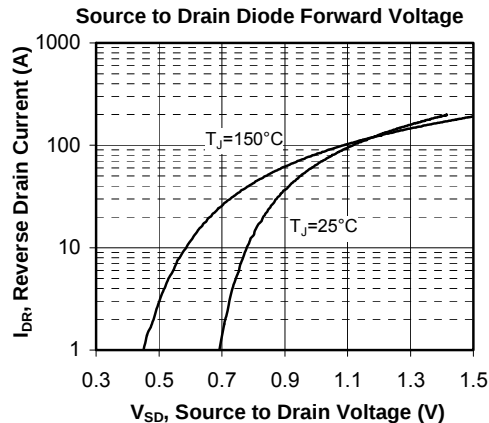
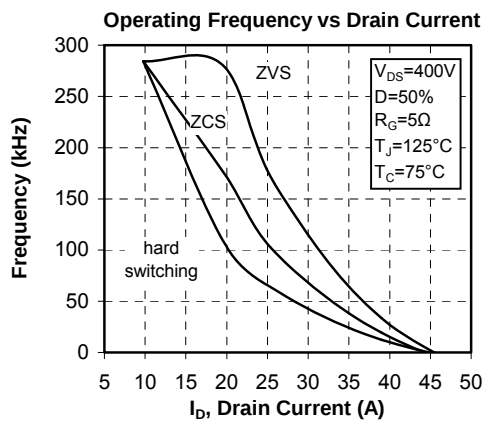
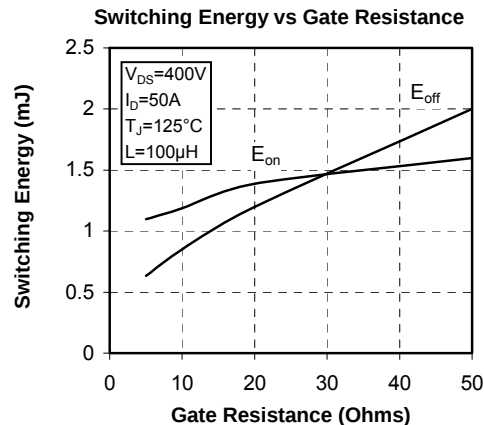
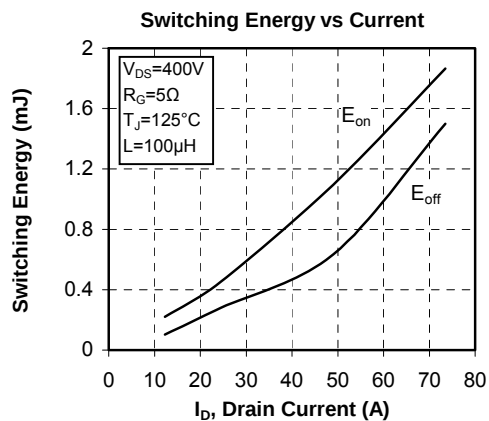
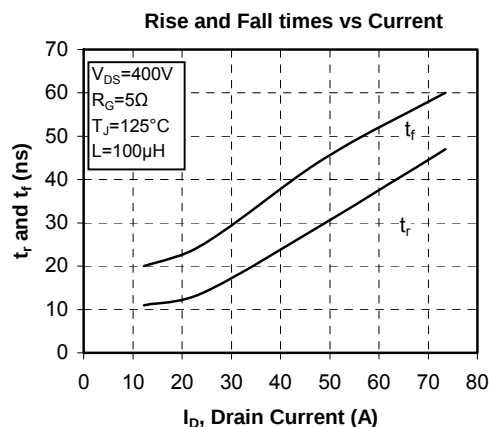
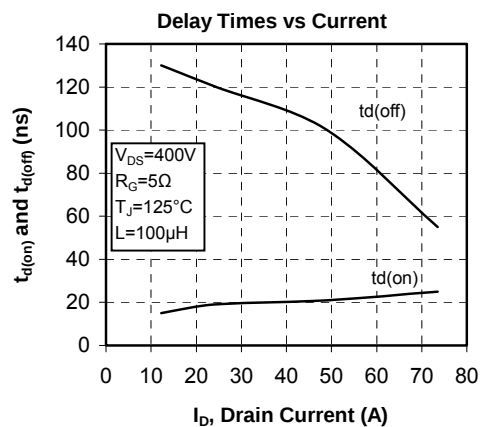




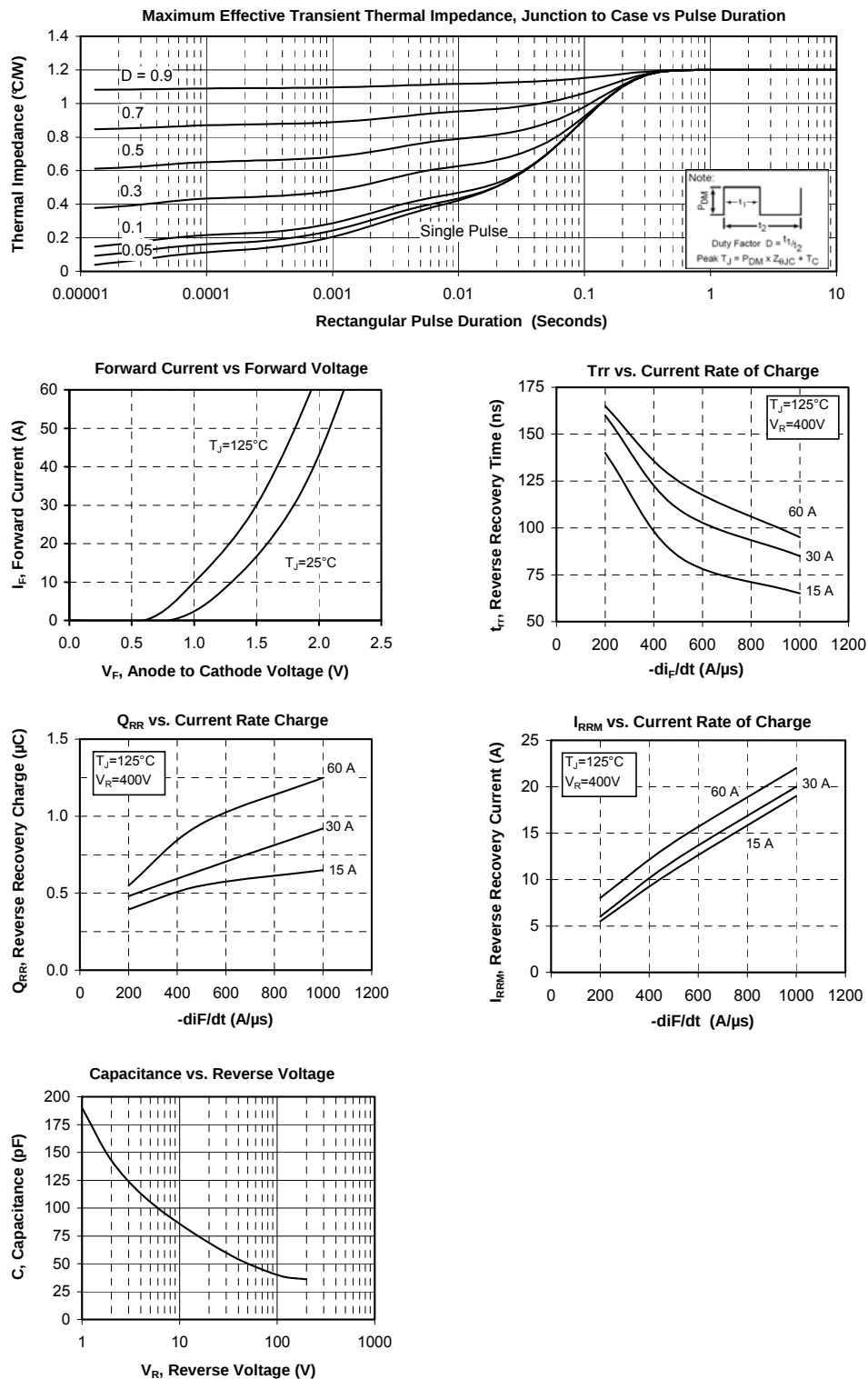
10. Chopper CoolMOS™ (per CoolMOS™)



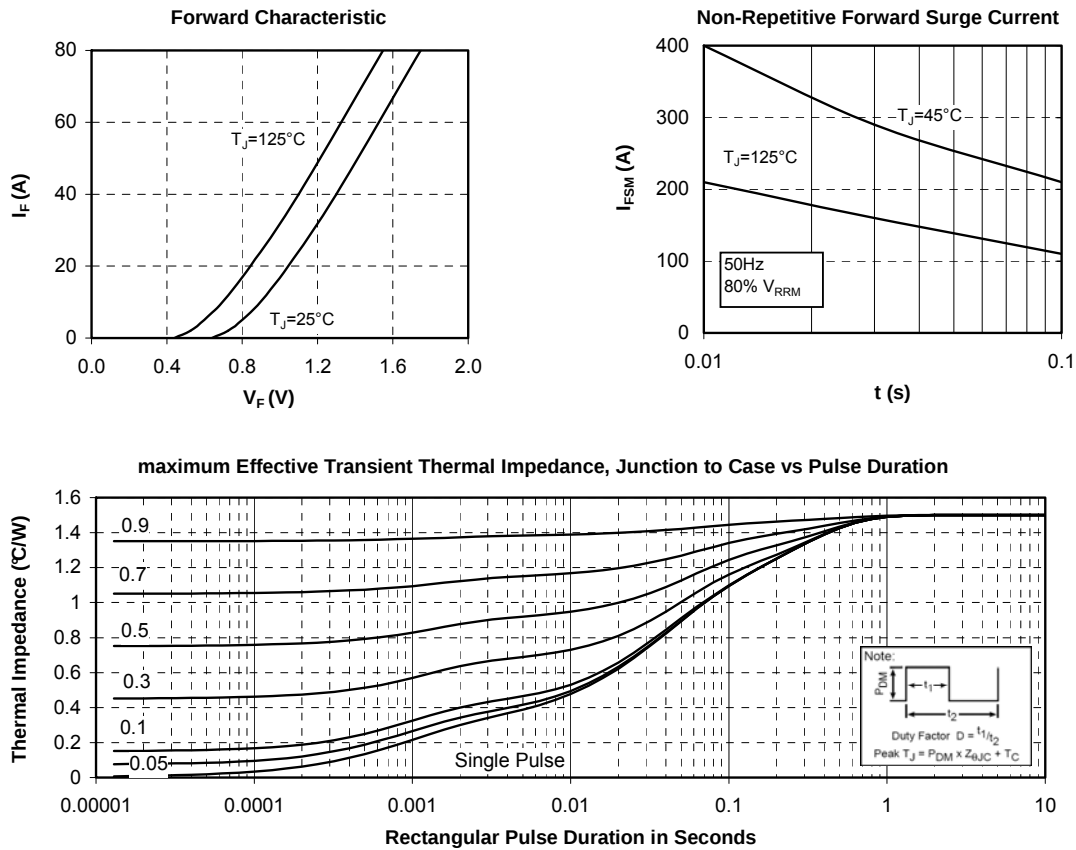




11. Chopper diode curves



12. Typical by pass CR6 diode curves



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