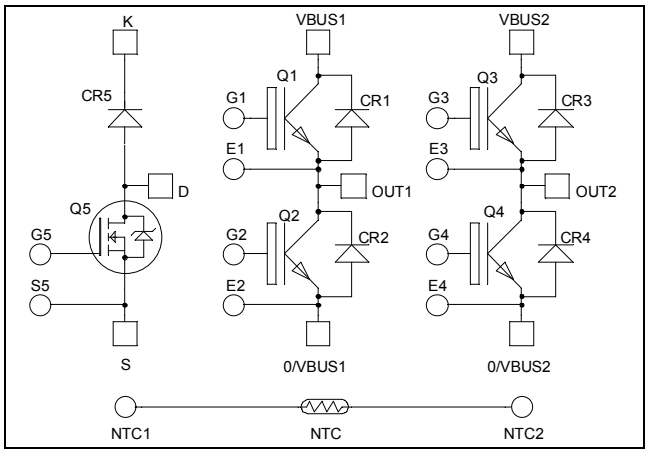
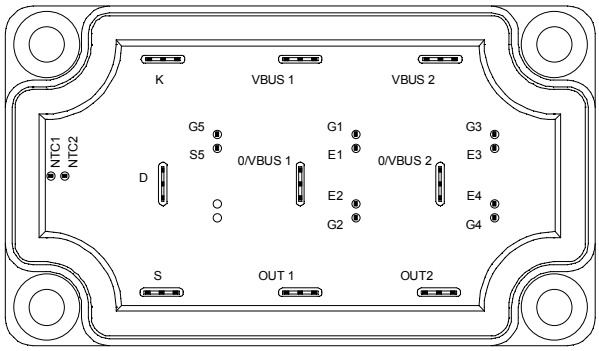
APTGV100H60BTPG

Boost chopper CoolMos™ + full bridge NPT & Trench + Field Stop IGBT Power module



Full bridge top switches : Trench + Field Stop IGBT
Full bridge bottom switches : FAST NPT IGBT
Q5 boost chopper : CoolMOS™



Trench & Field Stop IGBT Q1, Q3:
V_{CES} = 600V ; I_C = 100A @ Tc = 80°C

Fast NPT IGBT Q2, Q4:
V_{CES} = 600V ; I_C = 100A @ Tc = 80°C

CoolMOS™ Q5:
V_{CES} = 600V ; I_C = 95A @ Tc = 25°C

Application

- Solar converter

Features

- ***Q2, Q4 (FAST Non Punch Through (NPT) IGBT)***
  - Switching frequency up to 100 kHz
  - RBSOA & SCSOA rated
  - Low tail current
- ***Q1, Q3 (Trench & Field Stop IGBT)***
  - Low voltage drop
  - Switching frequency up to 20 kHz
  - RBSOA & SCSOA rated
  - Low tail current

Q5 (CoolMOS™)
- Ultra low R_{DSon}
- Low Miller capacitance
- Ultra low gate charge
- Avalanche energy rated

- Kelvin emitter for easy drive
- Very low stray inductance
- High level of integration
- Internal thermistor for temperature monitoring

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 Handing Procedures Should Be Followed. See application note APT0502 on www.microsemi.com

All ratings @ T_j = 25°C unless otherwise specified

1. Full bridge top switches

1.1 Top Trench + Field Stop IGBT characteristics

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	150	A
		T_C = 80°C	100	
I_{CM}	Pulsed Collector Current	T_C = 25°C	200	
V_{GE}	Gate – Emitter Voltage		±20	V
P_D	Maximum Power Dissipation	T_C = 25°C	340	W
RBSOA	Reverse Bias Safe Operating Area	T_j = 150°C	200A @ 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 = 100A	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 = 1.5 mA		5.0	5.8	6.5	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 V_{CE} = 25V f = 1MHz			6100		pF
C_{oes}	Output Capacitance				390		
C_{res}	Reverse Transfer Capacitance				190		
$T_{d(on)}$	Turn-on Delay Time	Inductive Switching (25°C) V_{GE} = ±15V V_{Bus} = 300V I_C = 100A R_G = 3.3Ω			115		ns
T_r	Rise Time				45		
$T_{d(off)}$	Turn-off Delay Time				225		
T_f	Fall Time				55		
$T_{d(on)}$	Turn-on Delay Time	Inductive Switching (150°C) V_{GE} = ±15V V_{Bus} = 300V I_C = 100A R_G = 3.3Ω			130		ns
T_r	Rise Time				50		
$T_{d(off)}$	Turn-off Delay Time				300		
T_f	Fall Time				70		
E_{on}	Turn on Energy	V_{GE} = ±15V V_{Bus} = 300V I_C = 100A R_G = 3.3Ω	T_j = 25°C		0.4		mJ
			T_j = 150°C		0.875		
E_{off}	Turn off Energy		T_j = 25°C		2.5		mJ
			T_j = 150°C		3.5		
R_{thJC}	Junction to Case Thermal resistance					0.44	°C/W

1.2 Top fast diode characteristics

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			100	µA
			T_j = 125°C			500	
I_F	DC Forward Current		Tc = 80°C		100		A
V_F	Diode Forward Voltage	I_F = 100A			1.6	2	V
		I_F = 200A			2		
		I_F = 100A	T_j = 125°C		1.3		
t_{rr}	Reverse Recovery Time	I_F = 100A V_R = 400V di/dt =200A/µs	T_j = 25°C		160		ns
			T_j = 125°C		220		
Q_{rr}	Reverse Recovery Charge		T_j = 25°C		290		nC
			T_j = 125°C		1530		
R_{thJC}	Junction to Case Thermal resistance					0.55	°C/W

2. Full bridge bottom switches

2.1 Bottom Fast NPT IGBT characteristics

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	110	A
		T_c = 80°C	90	
I_{CM}	Pulsed Collector Current	T_c = 25°C	315	
V_{GE}	Gate – Emitter Voltage		±20	V
P_D	Maximum Power Dissipation	T_c = 25°C	416	W
RBSOA	Reverse Bias Safe Operating Area	T_j = 150°C	200A @ 600V	

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 = 90A	T_j = 25°C		2.0	2.5	V
			T_j = 125°C		2.2		
$V_{GE(th)}$	Gate Threshold Voltage	V_{GE} = V_{CE}, I_C = 1mA		3		5	V
I_{GES}	Gate – Emitter Leakage Current	V_{GE} = 20 V, V_{CE} = 0V				±150	nA

Dynamic Characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
C_{ies}	Input Capacitance	V_{GE} = 0V V_{CE} = 25V f = 1MHz			4300		pF
C_{oes}	Output Capacitance				470		
C_{res}	Reverse Transfer Capacitance				400		
Q_g	Total gate Charge	V_{GE} = 15V V_{Bus} = 300V I_C = 90A			330		nC
Q_{ge}	Gate – Emitter Charge				290		
Q_{gc}	Gate – Collector Charge				200		
$T_{d(on)}$	Turn-on Delay Time	Inductive Switching (25°C) V_{GE} = 15V V_{Bus} = 400V I_C = 90A R_G = 5 Ω			26		ns
T_r	Rise Time				25		
$T_{d(off)}$	Turn-off Delay Time				150		
T_f	Fall Time				30		
$T_{d(on)}$	Turn-on Delay Time	Inductive Switching (125°C) V_{GE} = 15V V_{Bus} = 400V I_C = 90A R_G = 5 Ω			26		ns
T_r	Rise Time				25		
$T_{d(off)}$	Turn-off Delay Time				170		
T_f	Fall Time				40		
E_{on}	Turn-on Switching Energy	V_{GE} = 15V V_{Bus} = 400V I_C = 90A R_G = 5 Ω	T_j = 125°C		4.3		mJ
E_{off}	Turn-off Switching Energy		T_j = 125°C		3.5		
R_{thJC}	Junction to Case Thermal resistance					0.3	°C/W

2.2 Bottom diode characteristics

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			250	µA
			T_j = 125°C			500	
I_F	DC Forward Current		Tc = 80°C		30		A
V_F	Diode Forward Voltage	I_F = 30A			1.6	1.8	V
		I_F = 60A			1.9		
		I_F = 30A	T_j = 125°C		1.4		
t_{rr}	Reverse Recovery Time	I_F = 30A V_R = 400V di/dt =200A/µs	T_j = 25°C		85		ns
			T_j = 125°C		160		
Q_{rr}	Reverse Recovery Charge		T_j = 25°C		130		nC
			T_j = 125°C		700		
R_{thJC}	Junction to Case Thermal resistance					1.2	°C/W

3. Boost chopper switch

3.1 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	95	A
		T_c = 80°C	70	
I_{DM}	Pulsed Drain current		240	
V_{GS}	Gate - Source Voltage		±20	V
R_{DSon}	Drain - Source ON Resistance		23	mΩ
P_D	Maximum Power Dissipation	T_c = 25°C	460	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			350	µA
		V_{GS} = 0V,V_{DS} = 600V	T_j = 125°C			600	
$R_{DS(on)}$	Drain – Source on Resistance	V_{GS} = 10V, I_D = 47.5A			20	23	mΩ
$V_{GS(th)}$	Gate Threshold Voltage	V_{GS} = V_{DS}, I_D = 6mA		2.1	3	3.9	V
I_{GSS}	Gate – Source Leakage Current	V_{GS} = ±20 V, V_{DS} = 0V				200	nA

Dynamic Characteristics

Symbol	*Characteristic*	*Test Conditions*	*Min*	*Typ*	*Max*	*Unit*
C_{iss}	Input Capacitance	V_{GS} = 0V ; V_{DS} = 25V f = 1MHz		14.4		nF
C_{rss}	Reverse Transfer Capacitance			0.58		
Q_g	Total gate Charge	V_{GS} = 10V V_{Bus} = 300V I_D = 95A		300		nC
Q_{gs}	Gate – Source Charge			68		
Q_{gd}	Gate – Drain Charge			102		
$T_{d(on)}$	Turn-on Delay Time	**Inductive Switching (125°C)** V_{GS} = 10V V_{Bus} = 400V I_D = 95A R_G = 2.5Ω		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 = 95A ; R_G = 2.5Ω		1350		µJ
E_{off}	Turn-off Switching Energy			1040		
E_{on}	Turn-on Switching Energy	**Inductive switching @ 125°C** V_{GS} = 10V ; V_{Bus} = 400V I_D = 95A ; R_G = 2.5Ω		2192		µJ
E_{off}	Turn-off Switching Energy			1270		
R_{thJC}	Junction to Case Thermal resistance				0.27	°C/W

3.2 Chopper diode characteristics

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			100	µA
			T_j = 125°C			500	
I_F	DC Forward Current		Tc = 80°C		100		A
V_F	Diode Forward Voltage	I_F = 100A			1.6	2	V
		I_F = 200A			2		
		I_F = 100A	T_j = 125°C		1.3		
t_{rr}	Reverse Recovery Time	I_F = 100A V_R = 400V di/dt =200A/µs	T_j = 25°C		160		ns
			T_j = 125°C		220		
Q_{rr}	Reverse Recovery Charge		T_j = 25°C		290		nC
			T_j = 125°C		1530		
R_{thJC}	Junction to Case Thermal resistance					0.55	°C/W

4. 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
$B_{25/85}$	T_{25} = 298.15 K		3952		K

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

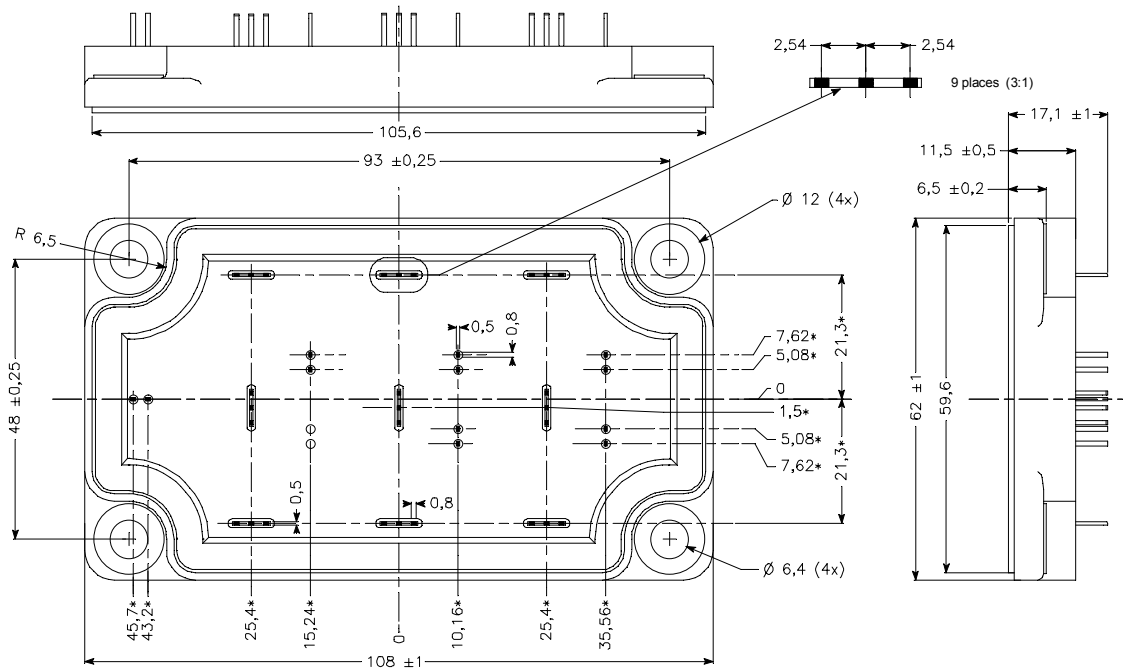
T: Thermistor temperature
R_T: Thermistor value at T

5. 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			2500			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	M6	2.5		4.7	N.m
Wt	Package Weight					250	g

* Tj=175°C for Trench & Field Stop IGBT

6. SP6-P Package outline (dimensions in mm)

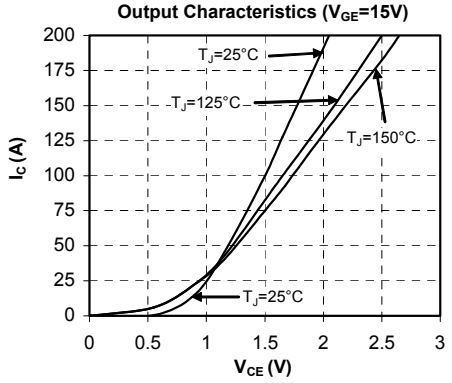


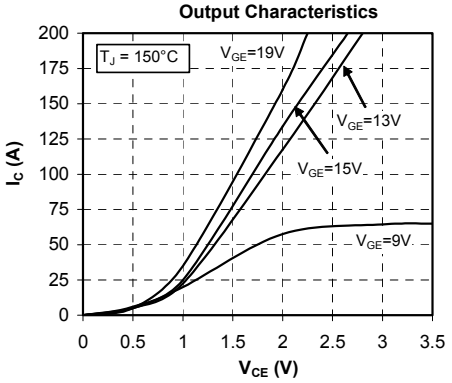
ALL DIMENSIONS MARKED " * " ARE TOLERENCED AS : ⊕ Ø1

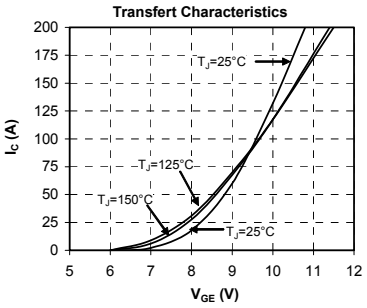
See application note 1902 - Mounting Instructions for SP6-P (12mm) Power Modules on www.microsemi.com

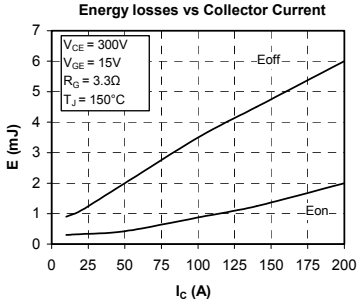
7. Full bridge top switches curves

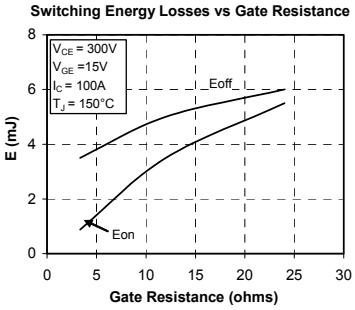
7.1 Top Trench + Field Stop IGBT typical performance curves

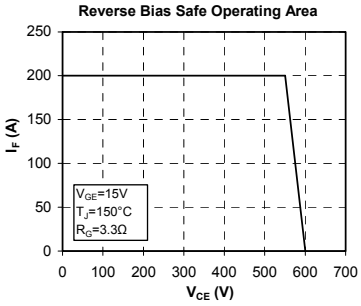


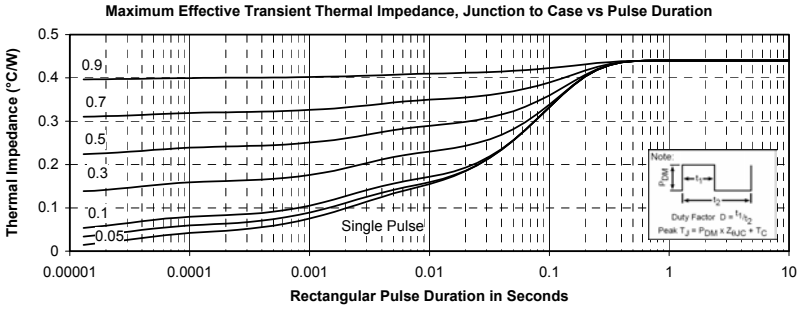




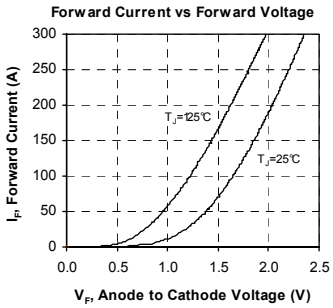


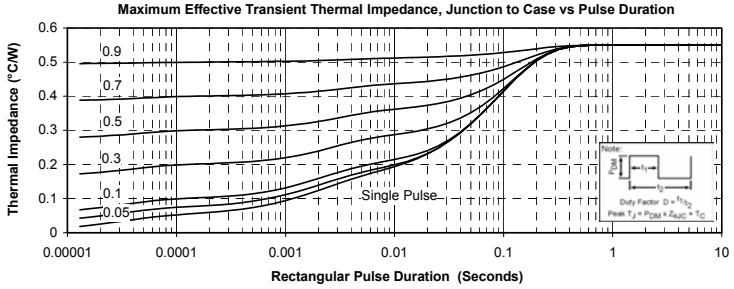






7.2 Top Fast diode typical performance curves

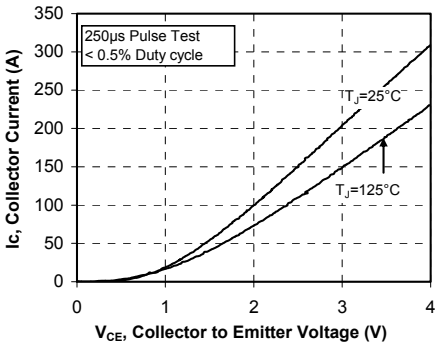




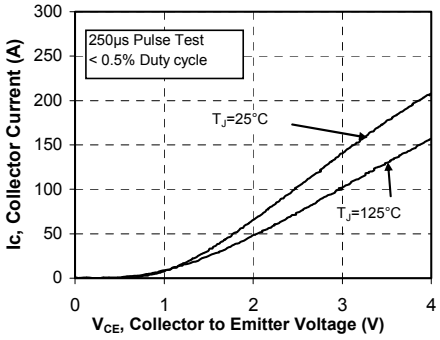
8. Full bridge bottom switches curves

8.1 Bottom fast NPT IGBT typical performance curves

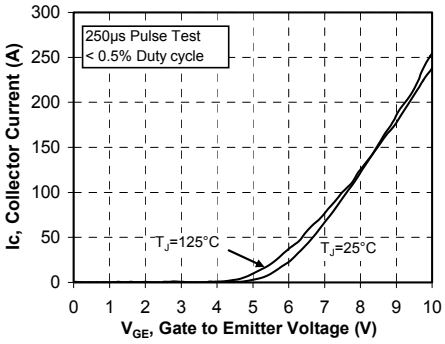
Output characteristics (V_{GE}=15V)



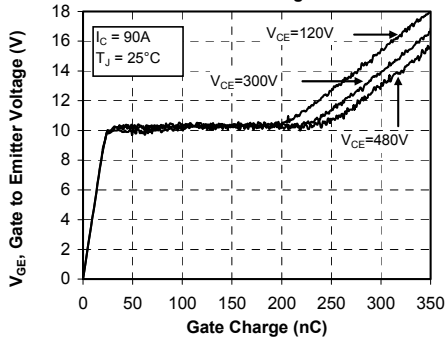
Output Characteristics (V_{GE}=10V)



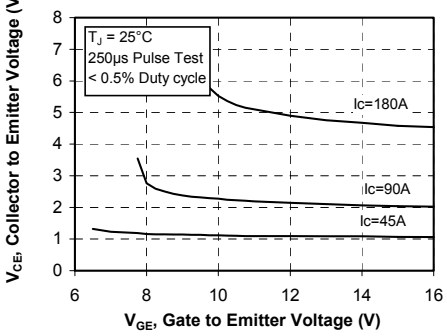
Transfer Characteristics



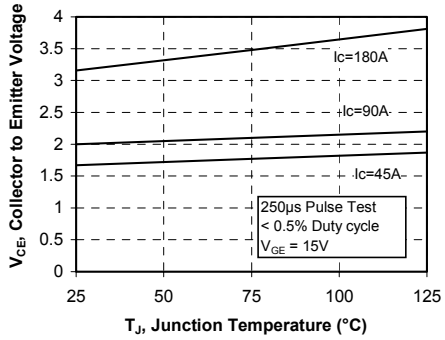
Gate Charge



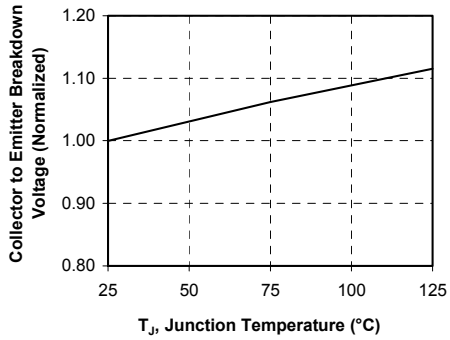
On state Voltage vs Gate to Emitter Volt.



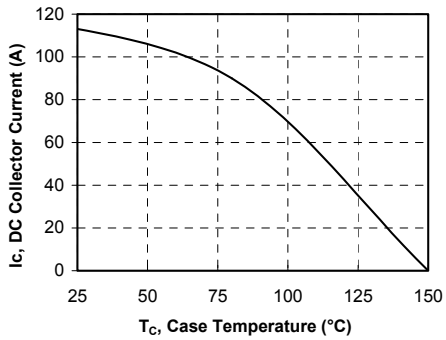
On state Voltage vs Junction Temperature



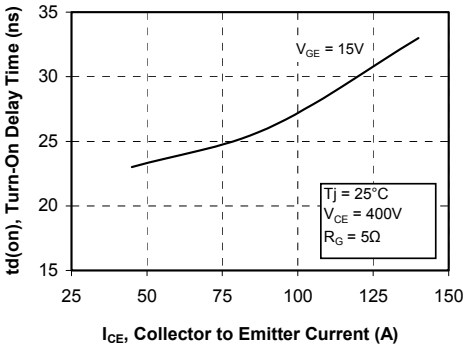
Breakdown Voltage vs Junction Temp.



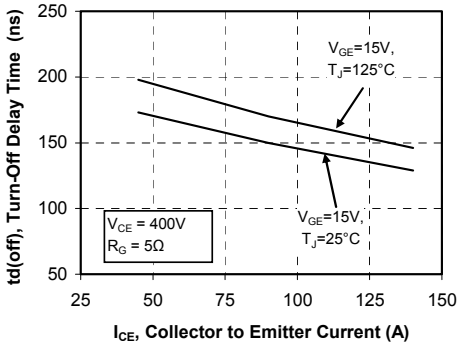
DC Collector Current vs Case Temperature



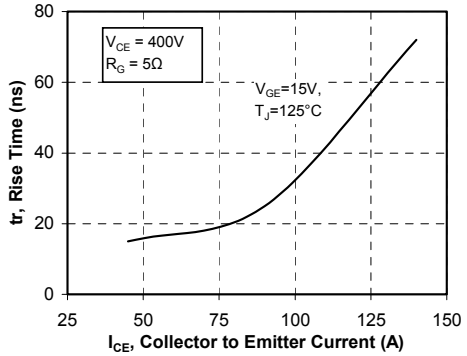
Turn-On Delay Time vs Collector Current



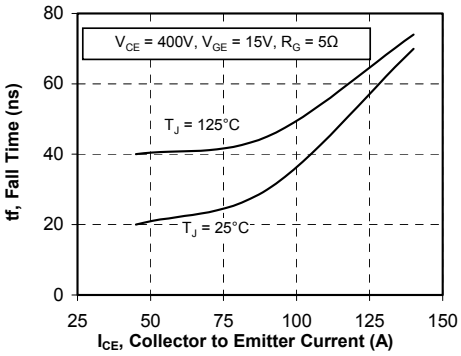
Turn-Off Delay Time vs Collector Current



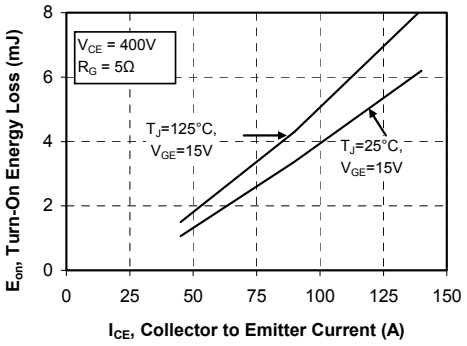
Current Rise Time vs Collector Current



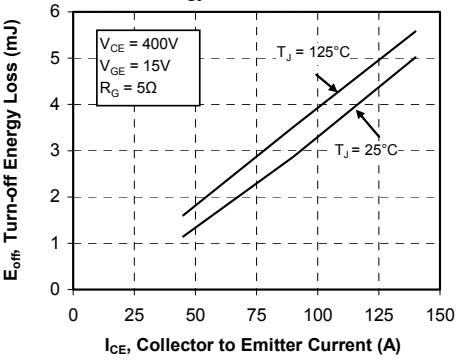
Current Fall Time vs Collector Current



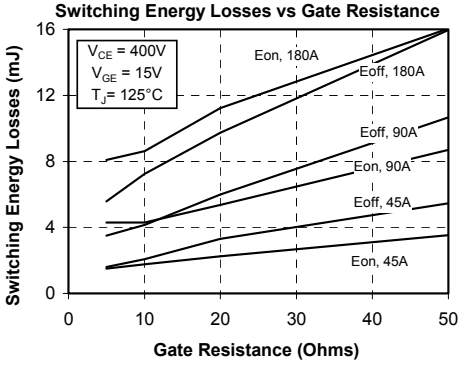
Turn-On Energy Loss vs Collector Current



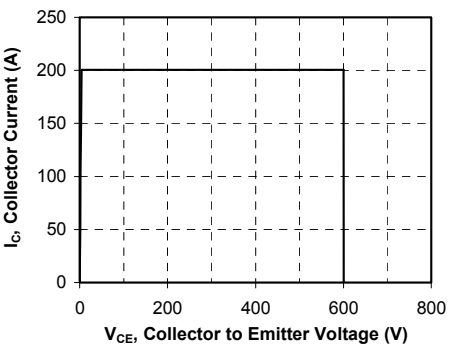
Turn-Off Energy Loss vs Collector Current

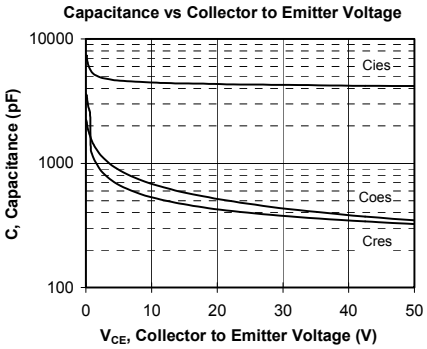


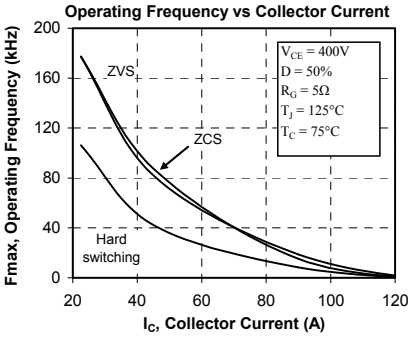
Switching Energy Losses vs Gate Resistance

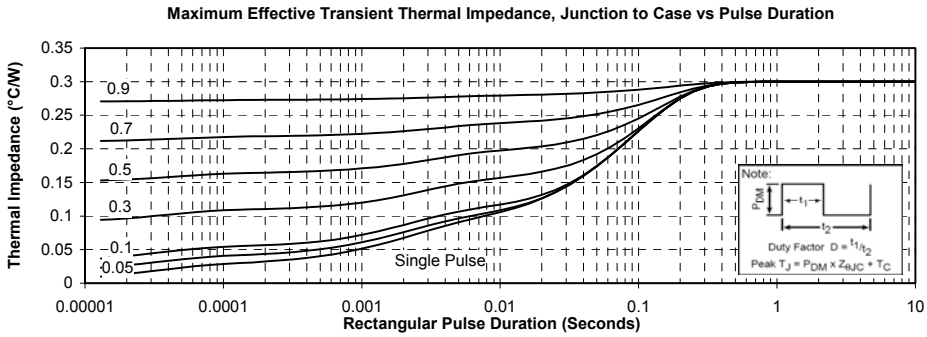


Reverse Bias Safe Operating Area

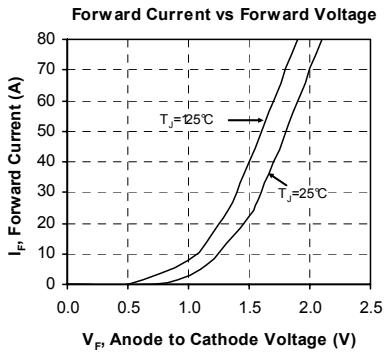


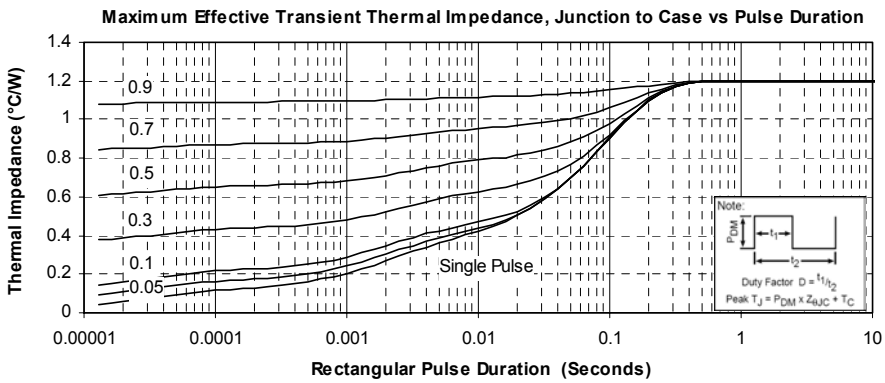






8.2 Bottom diode typical performance curves

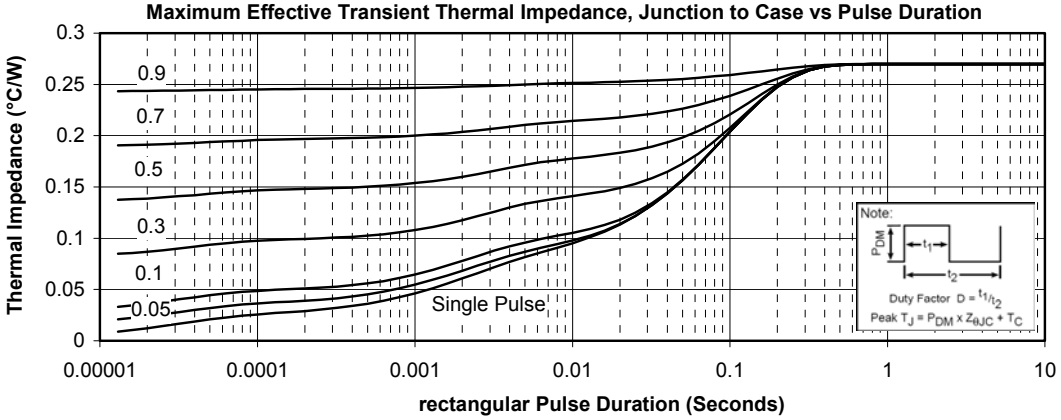




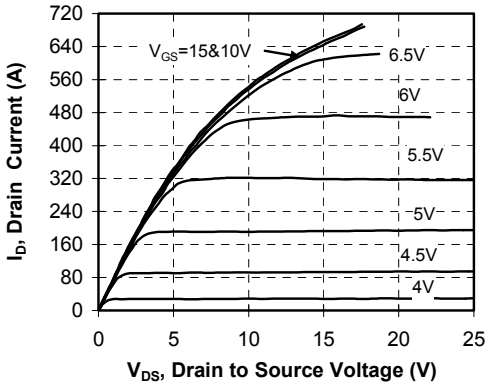
9. Boost chopper switch curves

9.1 CoolMOS™ typical performance curves

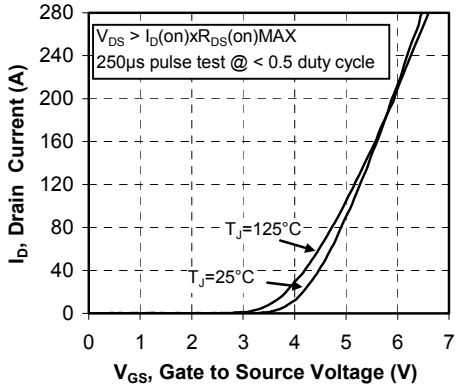
Maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration



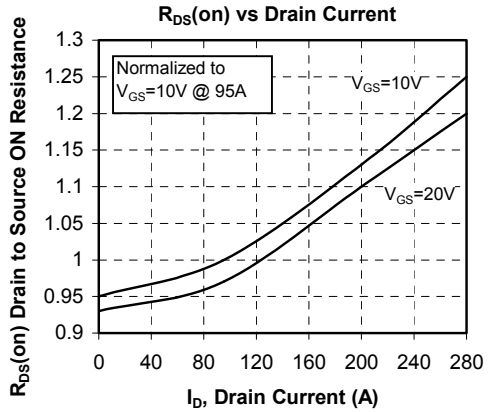
Low Voltage Output Characteristics



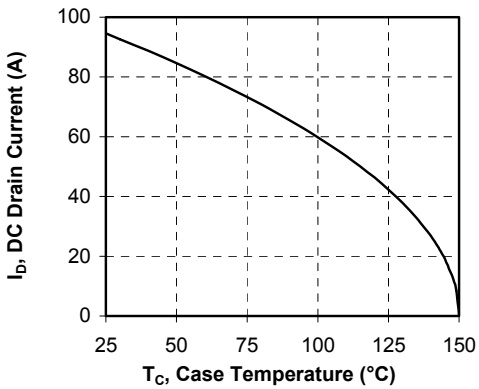
Transfert Characteristics



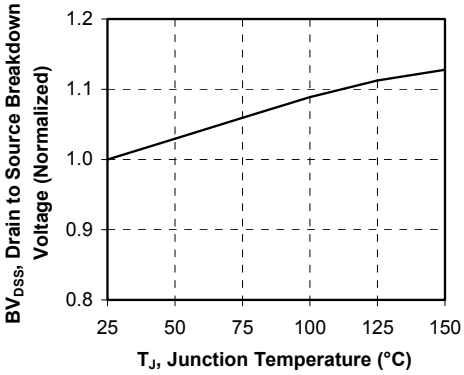
R_{DS}(on) vs Drain Current



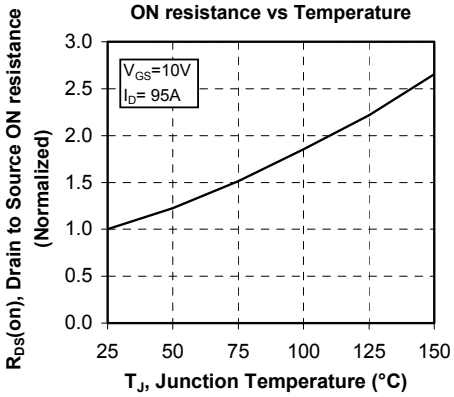
DC Drain Current vs Case Temperature



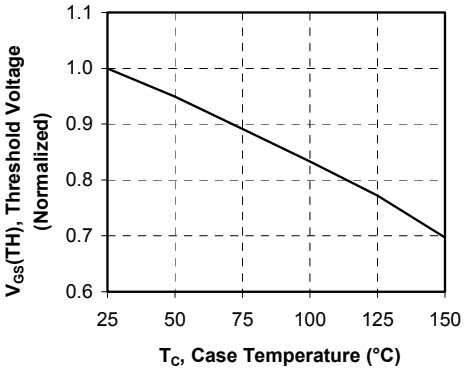
Breakdown Voltage vs Temperature



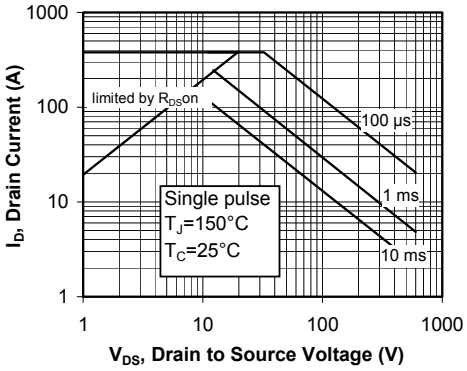
ON resistance vs Temperature



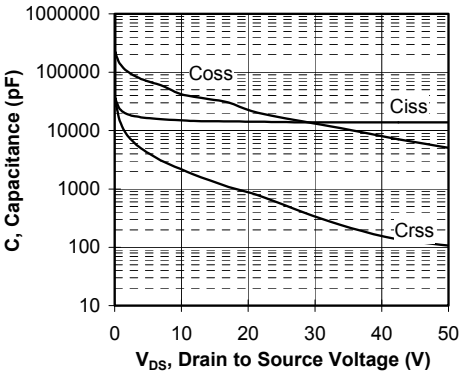
Threshold Voltage vs Temperature



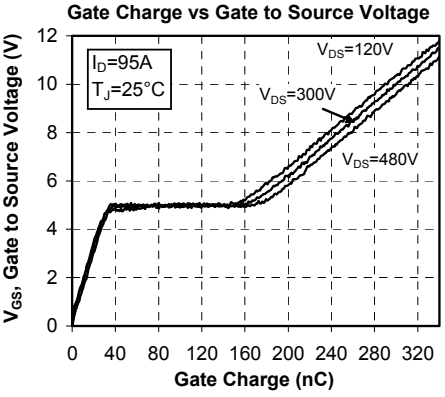
Maximum Safe Operating Area



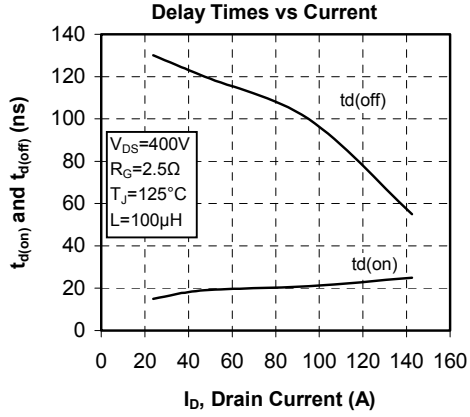
Capacitance vs Drain to Source Voltage



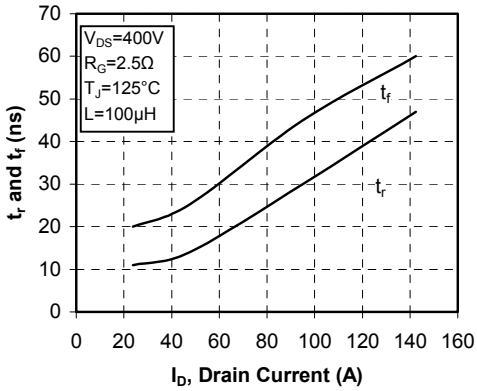
Gate Charge vs Gate to Source Voltage



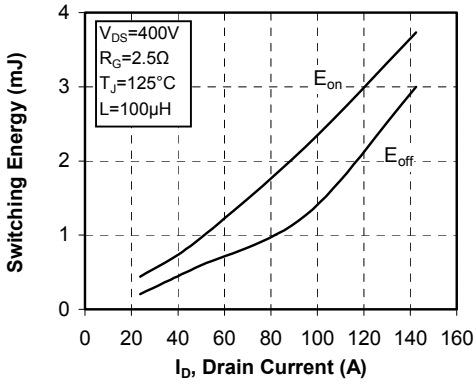
Delay Times vs Current



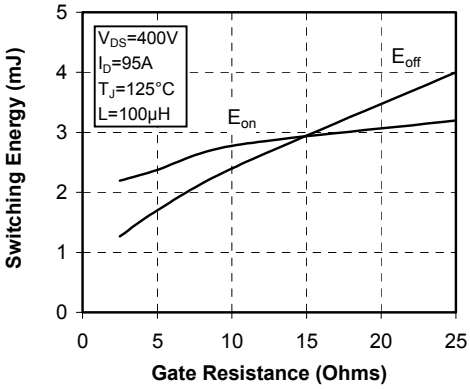
Rise and Fall times vs Current



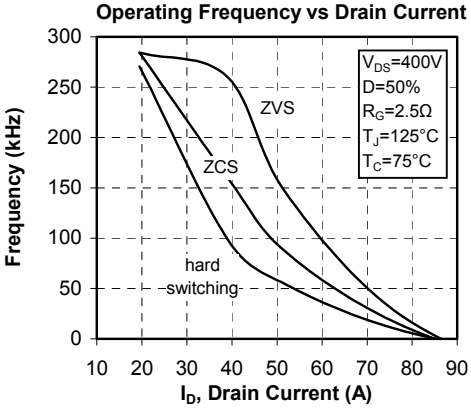
Switching Energy vs Current



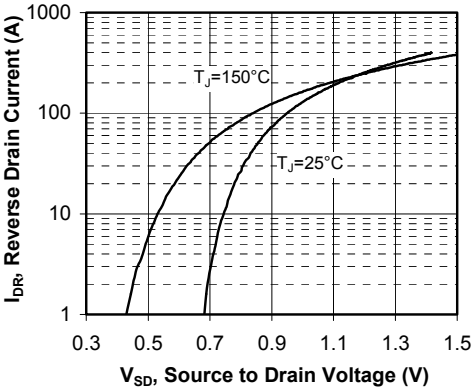
Switching Energy vs Gate Resistance



Operating Frequency vs Drain Current



Source to Drain Diode Forward Voltage



9.2 Chopper diode typical performance curves