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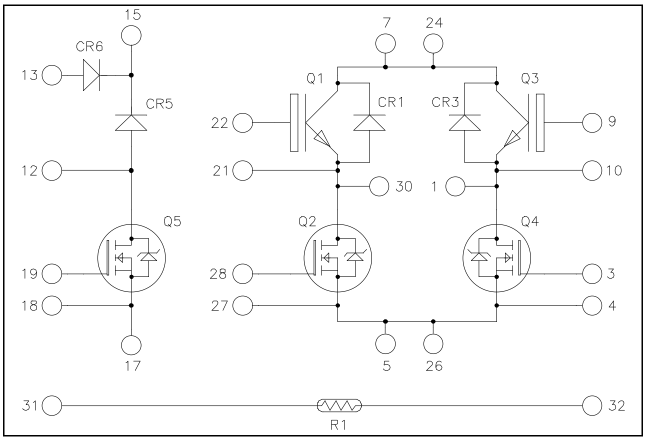
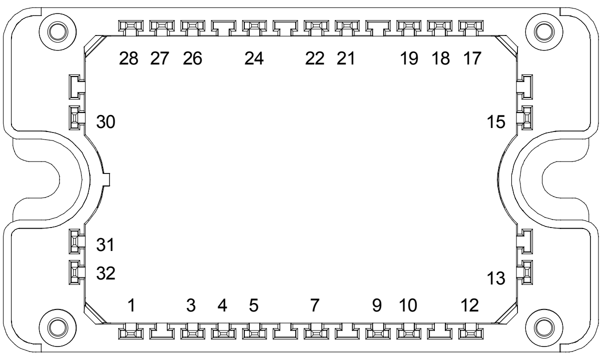
APTCV60HM45BT3G

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 @ Tc = 80°C

CoolMOS™ Q2, Q4:
V_{DSS} = 600V
R_{DSon} = 45mΩ max @ Tj = 25°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 Handing Procedures Should Be Followed. See application note APT0502 on www.microsemi.com

All ratings @ T_j = 25°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°C		1.5	1.9	V
			T_j = 150°C		1.7		
$V_{GE(th)}$	Gate Threshold Voltage	V_{GE} = V_{CE} , I_C = 600µA		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}=±15V, I_C=50A V_{CE}=300V			0.5		µC
$T_{d(on)}$	Turn-on Delay Time	Inductive Switching (25°C) V_{GE} = ±15V V_{Bus} = 300V I_C = 50A R_G = 8.2Ω			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} = ±15V V_{Bus} = 300V I_C = 50A R_G = 8.2Ω			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} = ±15V V_{Bus} = 300V I_C = 50A R_G = 8.2Ω	T_j = 25°C		1.35		mJ
			T_j = 150°C		1.75		
I_{sc}	Short Circuit data	V_{GE} ≤15V ; V_{Bus} = 360V t_p ≤ 6µs ; T_j = 150°C			250		A
R_{thJC}	Junction to Case Thermal resistance					0.85	°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°C			25	µA
			T_j = 125°C			500	
I_F	DC Forward Current		Tc = 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		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

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)** $V_{GS} = 10V$ $V_{Bus} = 400V$ $I_D = 49A$ $R_G = 5\Omega$		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	°C/W

Source - Drain diode ratings and characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
I_S	Continuous Source current (Body diode)		Tc = 25°C		49		A
			Tc = 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	$I_S = -49A$ $V_R = 350V$ $di_S/dt = 100A/\mu s$	$T_j = 25°C$		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.
$I_S \leq -49A$ $di/dt \leq 100A/\mu s$ $V_R \leq V_{DSS}$ $T_j \leq 150°C$

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	$V_{GS} = \pm20$ 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)** $V_{GS} = 10V$ $V_{Bus} = 400V$ $I_D = 49A$ $R_G = 5\Omega$		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	°C/W

Source - Drain diode ratings and characteristics

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
I_S	Continuous Source current (Body diode)		Tc = 25°C		49		A
			Tc = 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	$I_S = -49A$ $V_R = 350V$ $di_S/dt = 100A/µs$	$T_j = 25°C$		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.
$I_S \le -49A$ $di/dt \le 100A/µs$ $V_R \le V_{DSS}$ $T_j \le 150°C$

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		Tc = 80°C		60		A
V_F	Diode Forward Voltage	I_F = 60A			1.7	2.3	V
		I_F = 120A			2		
		I_F = 60A	T_j = 125°C		1.4		
t_{rr}	Reverse Recovery Time	I_F = 60A V_R = 400V di/dt =200A/µs	T_j = 25°C		70		ns
			T_j = 125°C		140		
Q_{rr}	Reverse Recovery Charge		T_j = 25°C		100		nC
			T_j = 125°C		690		
R_{thJC}	Junction to Case Thermal resistance					0.85	°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
$\Delta R_{25}/R_{25}$				5		%
$B_{25/85}$	T_{25} = 298.15 K			3952		K
ΔB/B		T_C=100°C		4		%

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

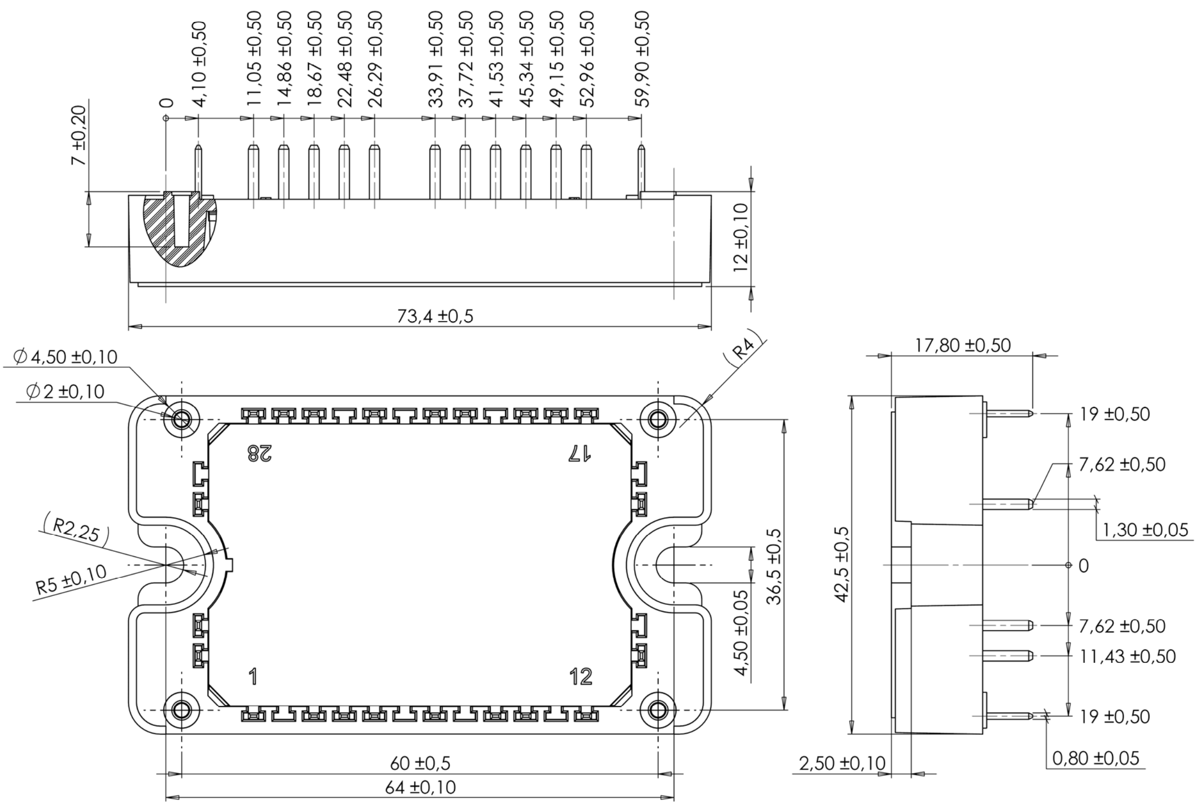
T: Thermistor temperature
R_T: Thermistor value at T

6. Package characteristics

Symbol	Characteristic			Min	Typ	Max	Unit
V_{ISOL}	RMS Isolation Voltage, any terminal to case t =1 min, 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		3	N.m
Wt	Package Weight					110	g

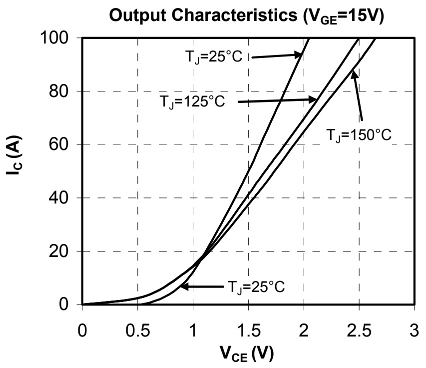
* Tj=175°C for Trench & Field Stop IGBT3

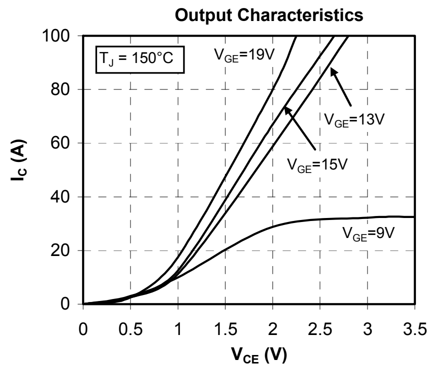
7. SP3 Package outline (dimensions in mm)

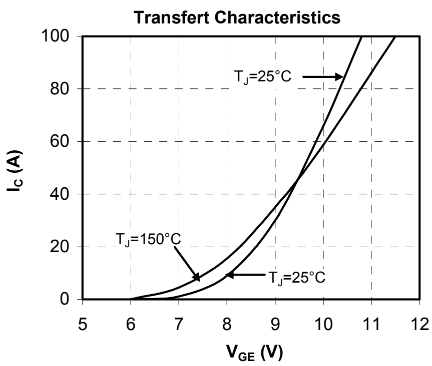


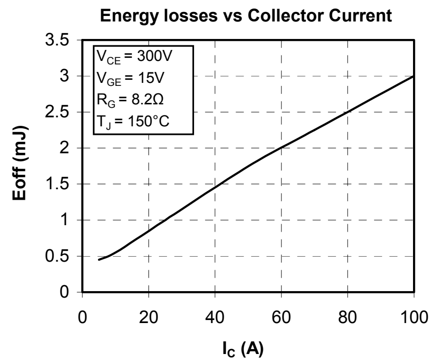
8. Top switches curves

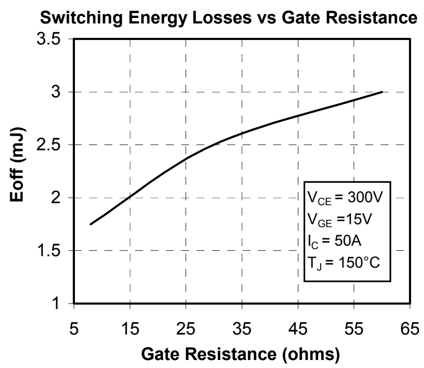
8.1 Top Trench + Field Stop IGBT3 typical performance curves (per IGBT)

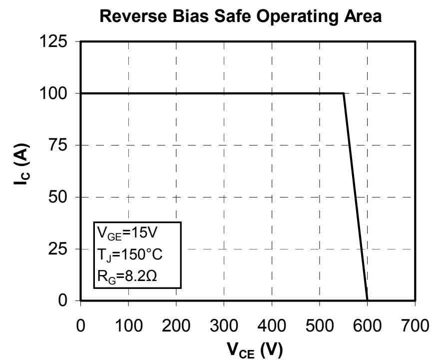


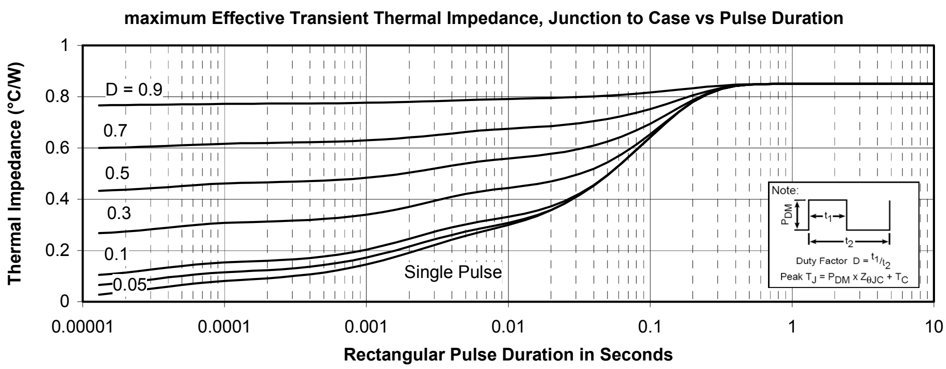




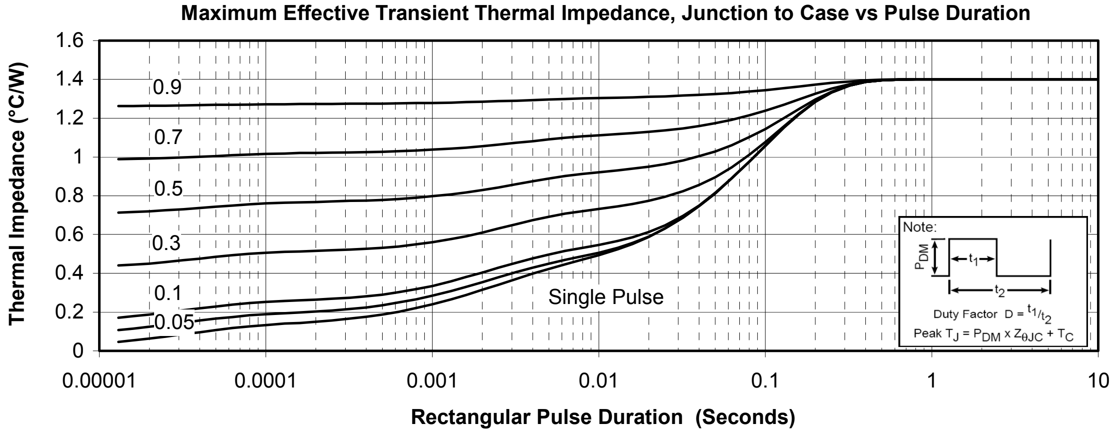


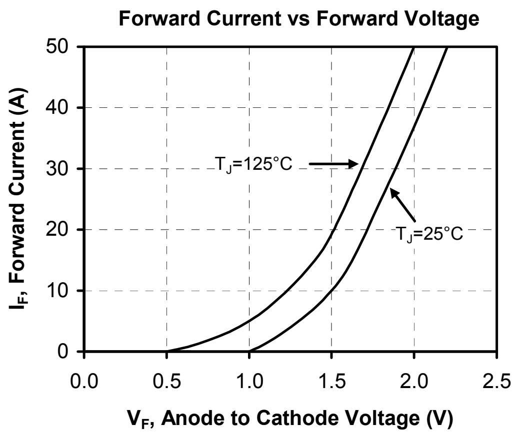




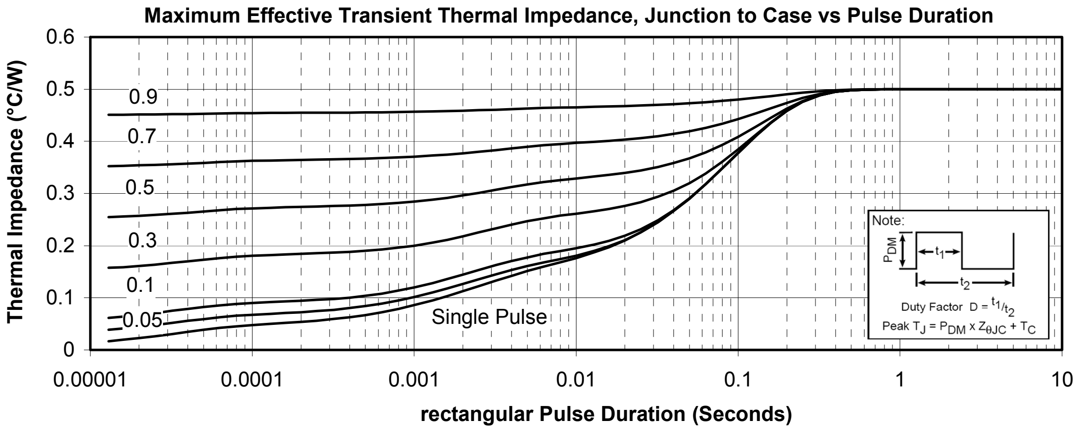


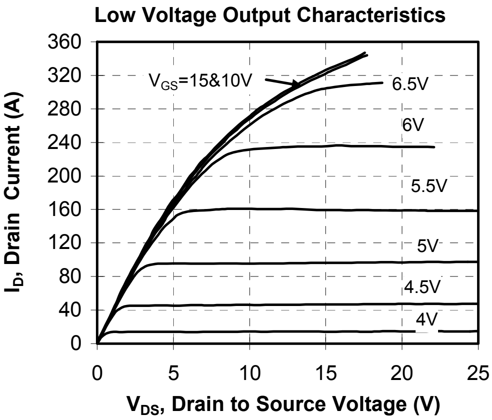
8.2 Top diode characteristics (CR1, CR3) (per diode)

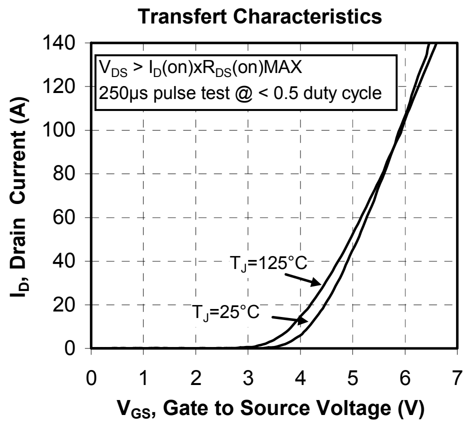


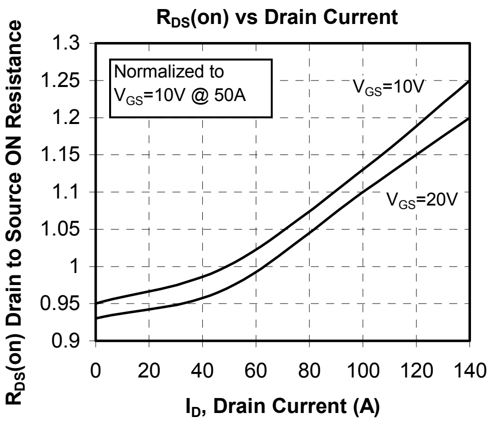


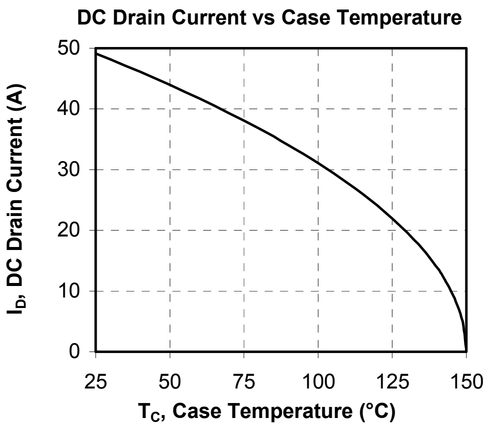
9. Bottom switches and CoolMOS™ chopper curves (per CoolMOS™)



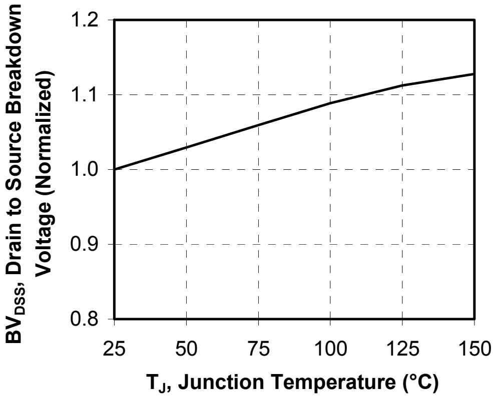




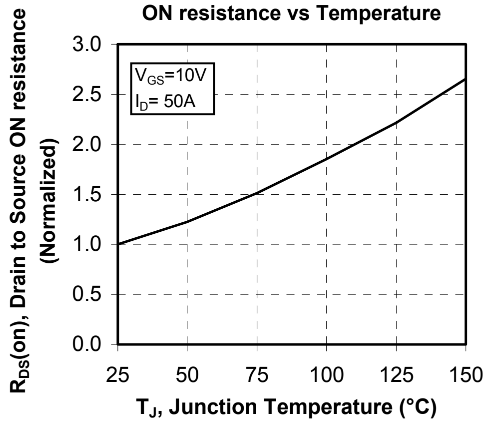




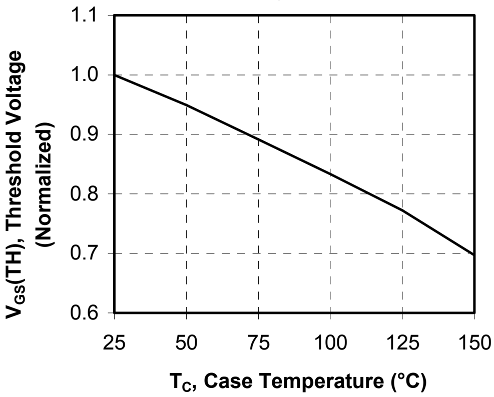
Breakdown Voltage vs Temperature



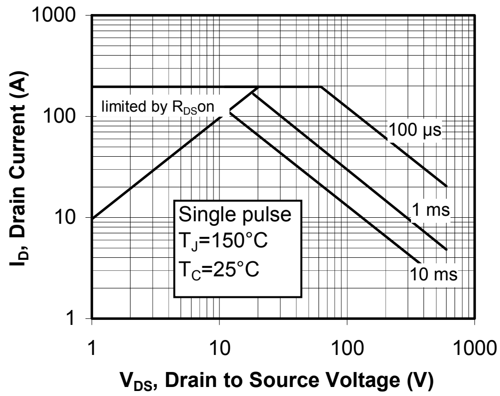
ON resistance vs Temperature



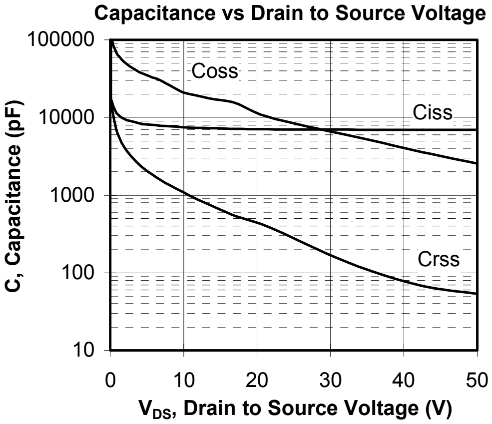
Threshold Voltage vs Temperature



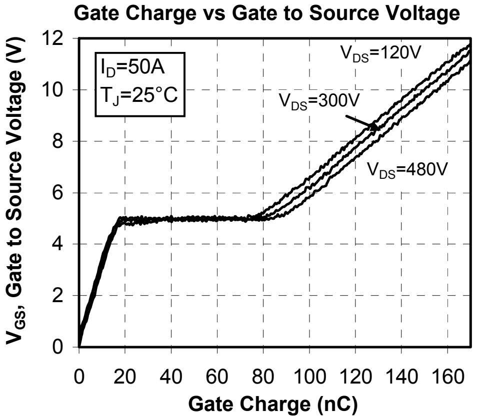
Maximum Safe Operating Area



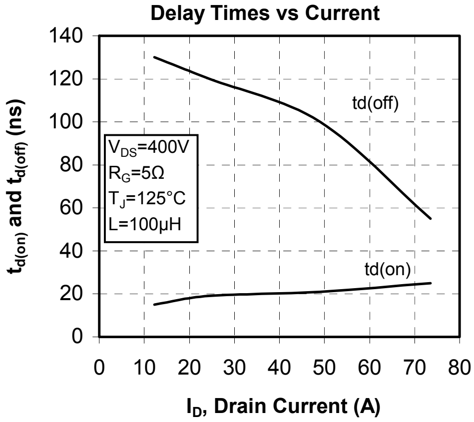
Capacitance vs Drain to Source Voltage



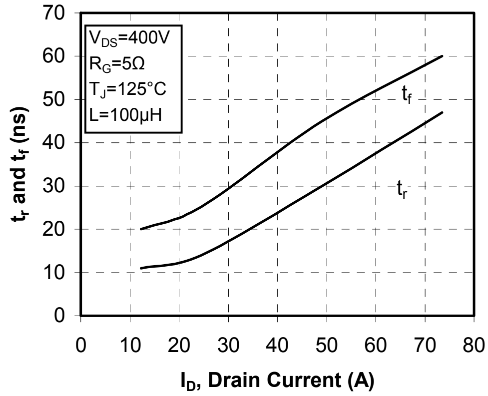
Gate Charge vs Gate to Source Voltage



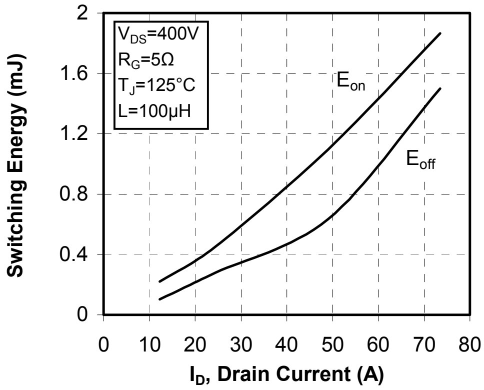
Delay Times vs Current



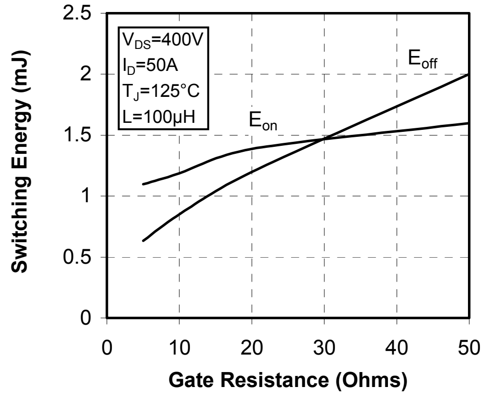
Rise and Fall times vs Current



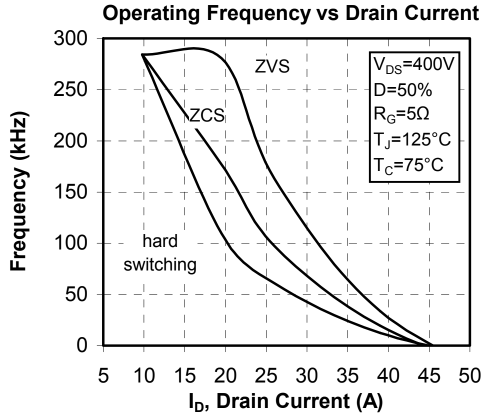
Switching Energy vs Current



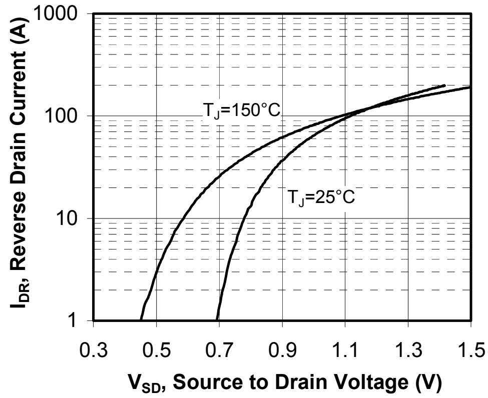
Switching Energy vs Gate Resistance



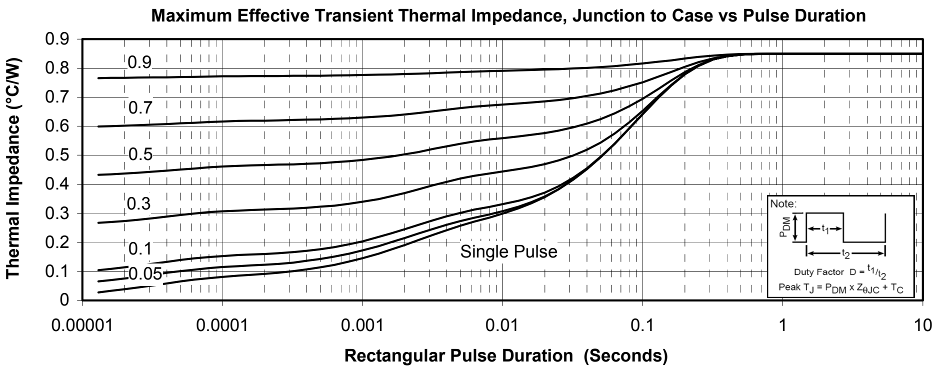
Operating Frequency vs Drain Current

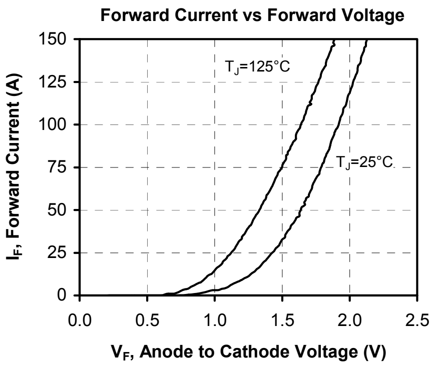


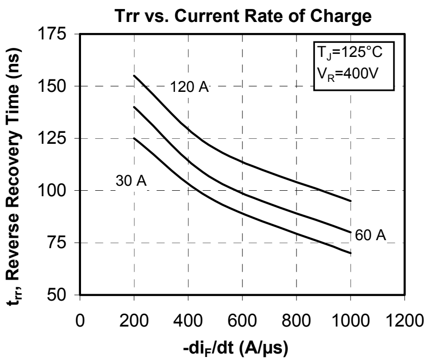
Source to Drain Diode Forward Voltage

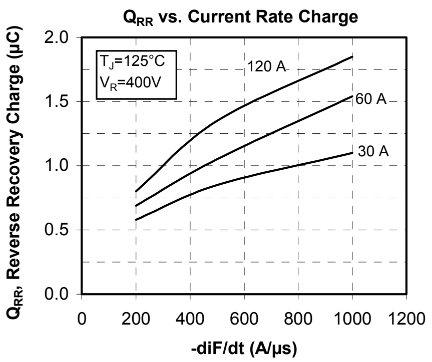


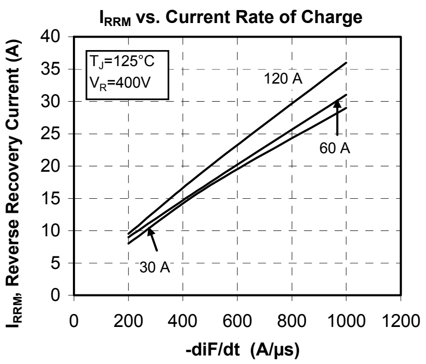
10. Chopper diode curves

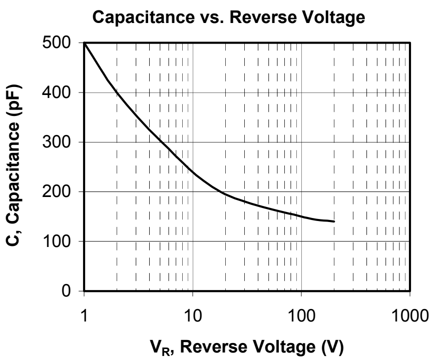




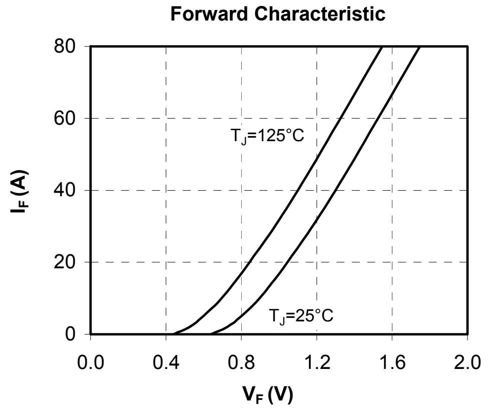


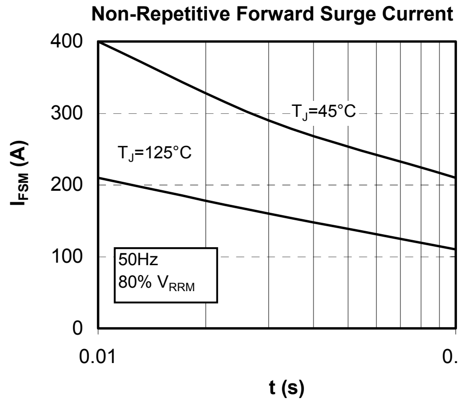


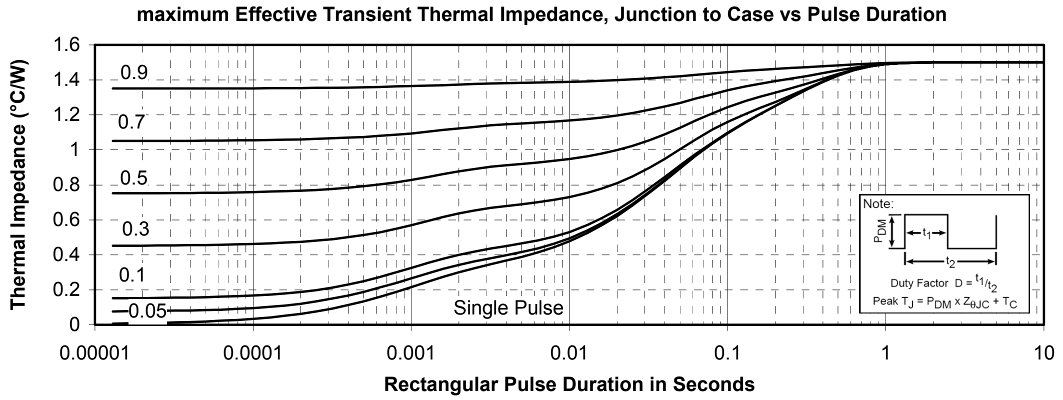




11. Typical by pass CR6 diode curves







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