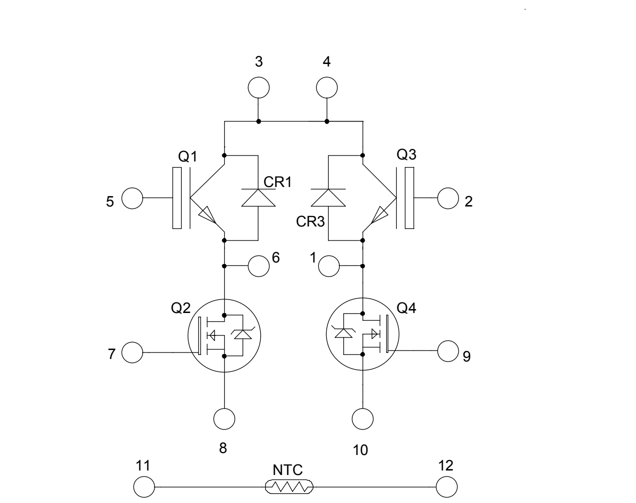
APTCV40H60CT1G

Microsemi POWER PRODUCTS GROUP

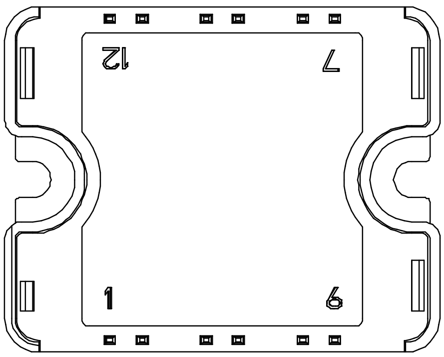
Full - Bridge
CoolMOS & Trench + Field Stop® IGBT
Power module

Trench & Field Stop® IGBT Q1, Q3:
V_{CES} = 600V ; I_C = 50A @ Tc = 80°C

CoolMOS™ Q2, Q4:
V_{DSS} = 600V ; I_D = 36A @ Tc = 25°C



Top switches : Trench + Field Stop IGBT®
Bottom switches : CoolMOS™



Pins 3/4 must be shorted together

Application

- Solar converter

Features

- ***Q2, Q4 CoolMOS™***
  - Ultra low R_{DSon}
  - Low Miller capacitance
  - Ultra low gate charge
  - Avalanche energy rated
  - Very rugged
  - Fast intrinsic diode
- ***Q1, Q3 Trench & Field Stop IGBT®***
  - Low voltage drop
  - Switching frequency up to 20 kHz
  - RBSOA & SCSOA rated
  - Low tail current
- ***SiC Schottky Diode (CR1, CR3)***
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature Independent switching behavior
  - Positive temperature coefficient on VF
- Very low stray inductance
- Internal thermistor for temperature monitoring
- High level of integration

Benefits

- Outstanding performance at high frequency operation
- 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
- 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 IGBT® characteristics

Absolute maximum ratings

Symbol	Parameter		Max ratings	Unit
V_{CES}	Collector - Emitter Breakdown Voltage		600	V
I_C	Continuous Collector Current	$T_C = 25°C$	80	A
		$T_C = 80°C$	50	A
I_{CM}	Pulsed Collector Current	$T_C = 25°C$	100	A
V_{GE}	Gate – Emitter Voltage		±20	V
P_D	Maximum Power Dissipation	$T_C = 25°C$	176	W
RBSOA	Reverse Bias Safe Operating Area	$T_J = 150°C$	100A @ 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	$V_{GE} = 15V$, $I_C = 50A$	$T_j = 25°C$		1.5	1.9	V
			$T_j = 150°C$		1.7		V
$V_{GE(th)}$	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		pF
C_{res}	Reverse Transfer Capacitance				95		pF
$T_{d(on)}$	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		ns
$T_{d(off)}$	Turn-off Delay Time				200		ns
T_f	Fall Time				40		ns
$T_{d(on)}$	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		ns
$T_{d(off)}$	Turn-off Delay Time				250		ns
T_f	Fall Time				60		ns
E_{on}	Turn-on Switching Energy	$V_{GE} = ±15V$ $V_{Bus} = 300V$ $I_C = 50A$ $R_G = 8.2Ω$	$T_j = 25°C$		0.3		mJ
			$T_j = 150°C$		0.43		mJ
E_{off}	Turn-off Switching Energy		$T_j = 25°C$		1.35		mJ
			$T_j = 150°C$		1.75		mJ
R_{thJC}	Junction to Case Thermal resistance					0.85	°C/W

1.2 Top SiC diode characteristics (CR1, CR3)

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		50	200	µA
			T_j = 125°C		100	1000	
$I_{F(AV)}$	Maximum Average Forward Current	50% duty cycle	Tc = 100°C		10		A
V_F	Diode Forward Voltage	I_F = 10A	T_j = 25°C		1.6	1.8	V
			T_j = 175°C		2	2.4	
Q_C	Total Capacitive Charge	I_F = 10A, V_R = 300V di/dt =500A/µs			14		nC
C	Total Capacitance	f = 1MHz, V_R = 200V			65		pF
		f = 1MHz, V_R = 400V			50		
R_{thJC}	Junction to Case Thermal resistance					2.5	°C/W

2. Bottom switches

2.1 Bottom 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	36	A
		T_c = 80°C	27	
I_{DM}	Pulsed Drain current		115	
V_{GS}	Gate - Source Voltage		±20	V
R_{DSon}	Drain - Source ON Resistance		83	mΩ
P_D	Maximum Power Dissipation	T_c = 25°C	250	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°C			100	µA
		V_{GS} = 0V, V_{DS} = 600V	T_j = 125°C			5000	
$R_{DS(on)}$	Drain – Source on Resistance	V_{GS} = 10V, I_D = 24.5A				83	mΩ
$V_{GS(th)}$	Gate Threshold Voltage	V_{GS} = V_{DS}, I_D = 3mA		3	4	5	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_{rss}	Reverse Transfer Capacitance			0.041		
Q_g	Total gate Charge	$V_{GS} = 10V$ $V_{Bus} = 300V$ $I_D = 36A$		250		nC
Q_{gs}	Gate – Source Charge			43		
Q_{gd}	Gate – Drain Charge			135		
$T_{d(on)}$	Turn-on Delay Time	**Inductive Switching (125°C)** $V_{GS} = 10V$ $V_{Bus} = 400V$ $I_D = 36A$ $R_G = 5\Omega$		21		ns
T_r	Rise Time			30		
$T_{d(off)}$	Turn-off Delay Time			240		
T_f	Fall Time			52		
E_{on}	Turn-on Switching Energy	**Inductive switching @ 25°C** $V_{GS} = 10V$; $V_{Bus} = 400V$ $I_D = 36A$; $R_G = 5\Omega$		531		µJ
E_{off}	Turn-off Switching Energy			590		
E_{on}	Turn-on Switching Energy	**Inductive switching @ 125°C** $V_{GS} = 10V$; $V_{Bus} = 400V$ $I_D = 36A$; $R_G = 5\Omega$		762		µJ
E_{off}	Turn-off Switching Energy			725		
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		36		A
			Tc = 80°C		27		
V_{SD}	Diode Forward Voltage	$V_{GS} = 0V$, $I_S = -36A$				1.2	V
dv/dt	Peak Diode Recovery ❶					40	V/ns
t_{rr}	Reverse Recovery Time	$I_S = -36A$ $V_R = 350V$ $di_S/dt = 100A/\mu s$	$T_j = 25°C$		210		ns
			$T_j = 125°C$		350		
Q_{rr}	Reverse Recovery Charge		$T_j = 25°C$		2		µC
			$T_j = 125°C$		5.4		

❶ dv/dt numbers reflect the limitations of the circuit rather than the device itself.
$I_S \leq -36A$ $di/dt \leq 100A/\mu s$ $V_R \leq V_{DSS}$ $T_j \leq 150°C$

3. 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

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

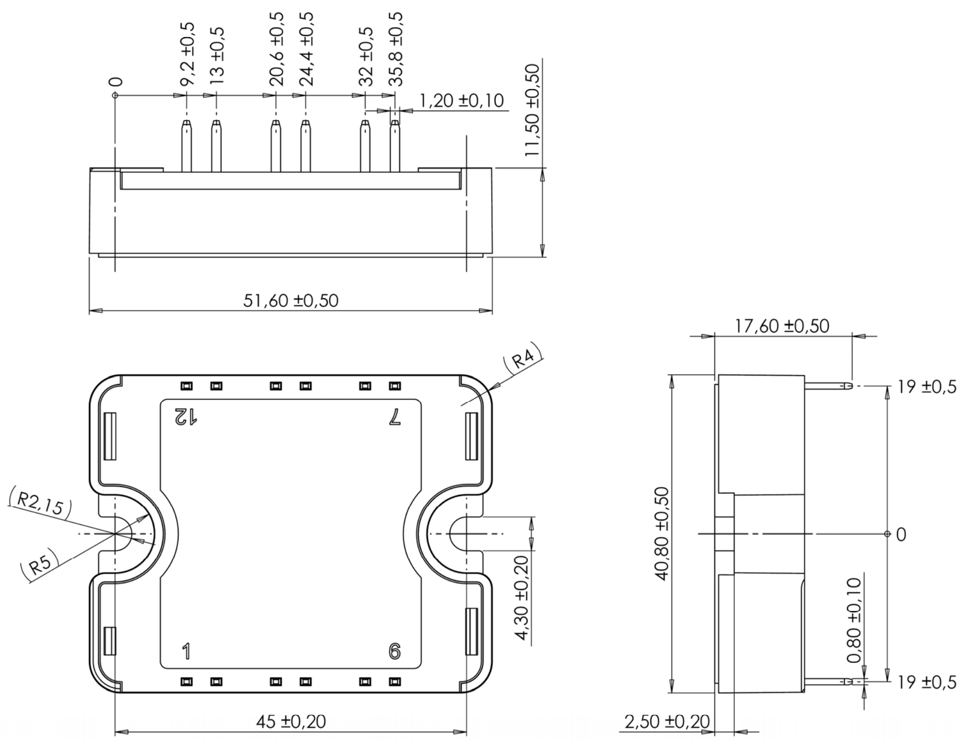
T: Thermistor temperature
R_T: Thermistor value at T

4. 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					80	g

Tj=175°C for Trench & Field Stop IGBT

5. SP1 Package outline (dimensions in mm)

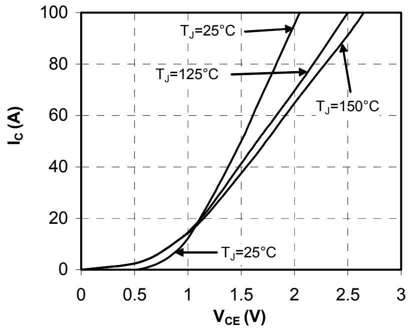


See application note 1904 - Mounting Instructions for SP1 Power Modules on www.microsemi.com

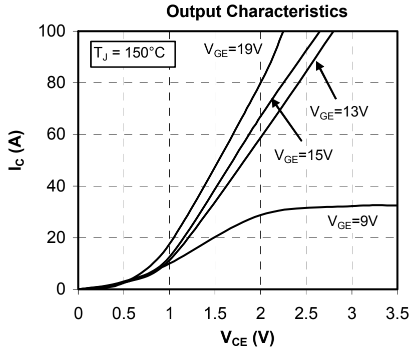
6. Top switches curves

6.1 Top Trench + Field Stop IGBT® typical performance curves

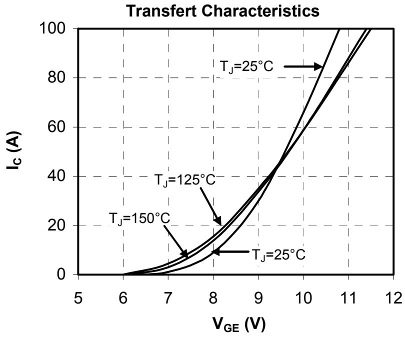
Output Characteristics (V_{GE}=15V)



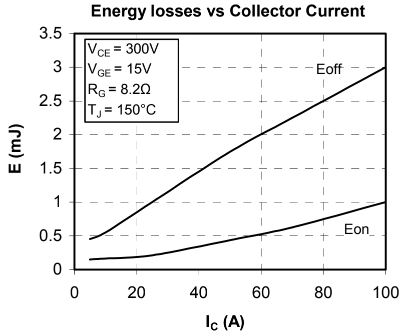
Output Characteristics



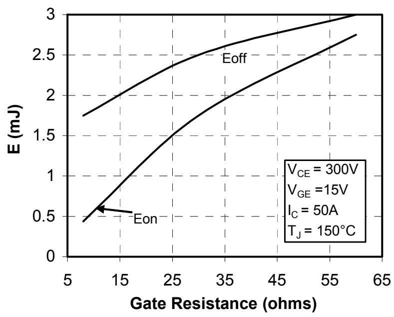
Transfert Characteristics



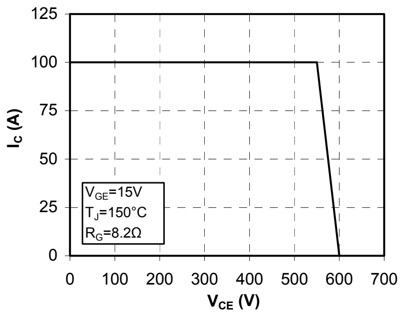
Energy losses vs Collector Current



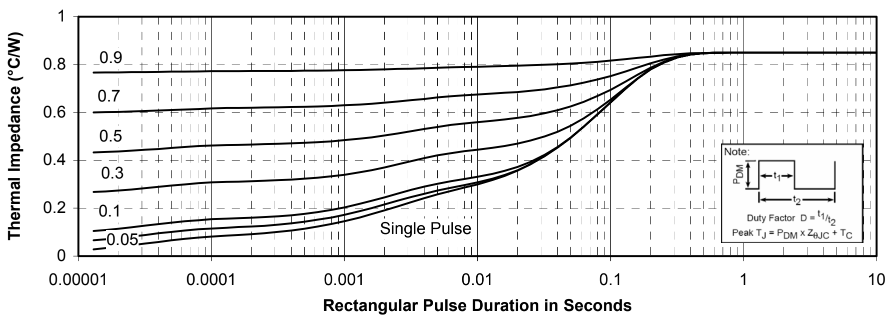
Switching Energy Losses vs Gate Resistance



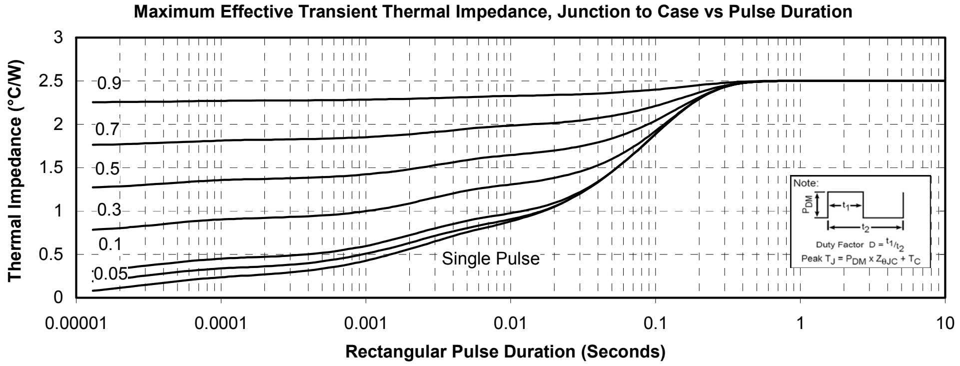
Reverse Bias Safe Operating Area

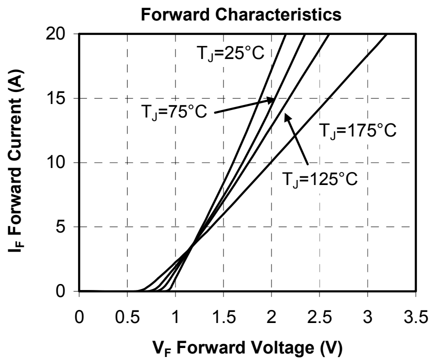


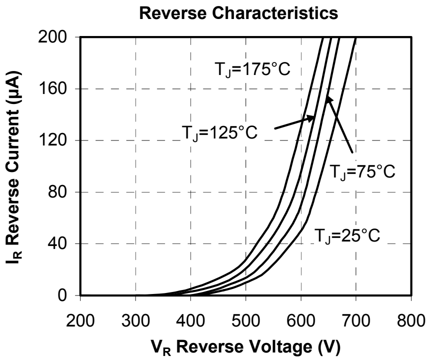
maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration

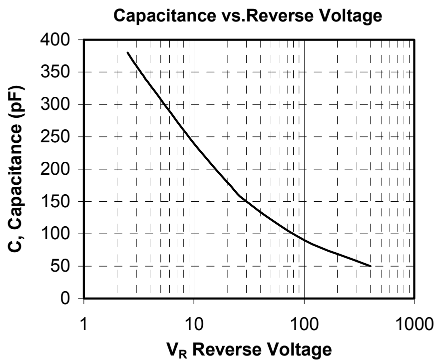


6.2 Top SiC diode typical performance curves



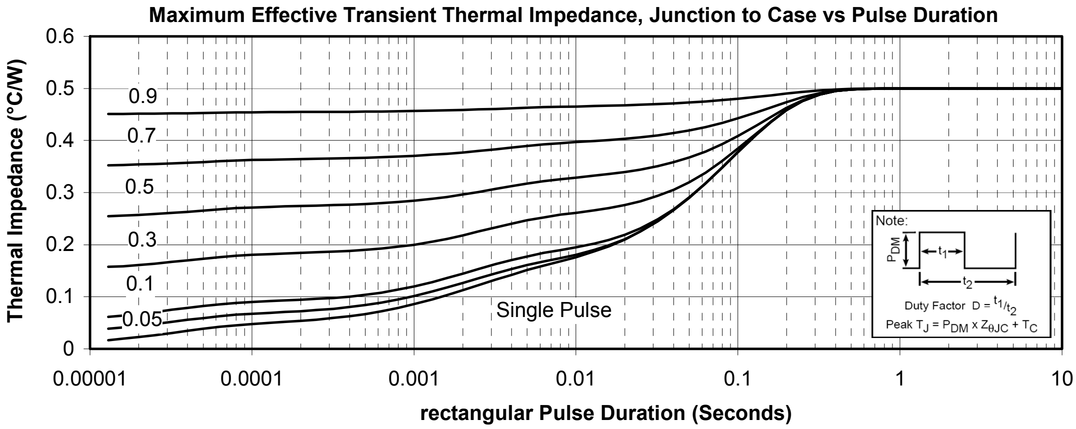


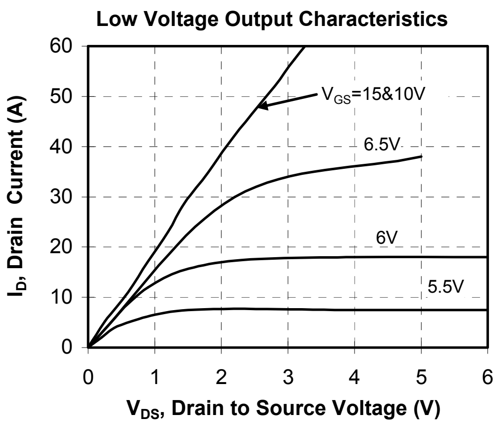


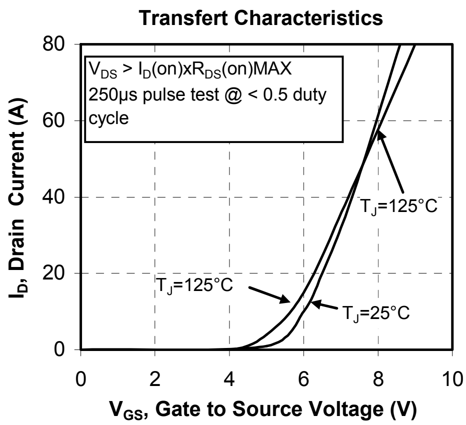


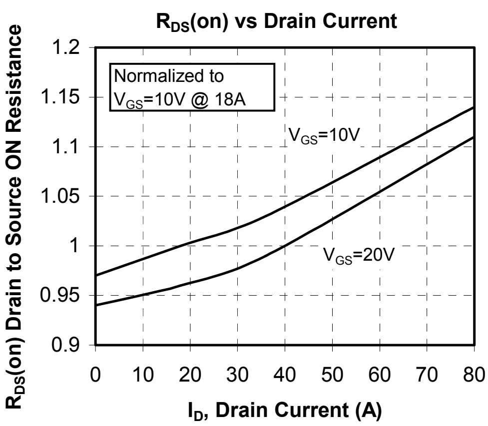
7. Bottom switches curves

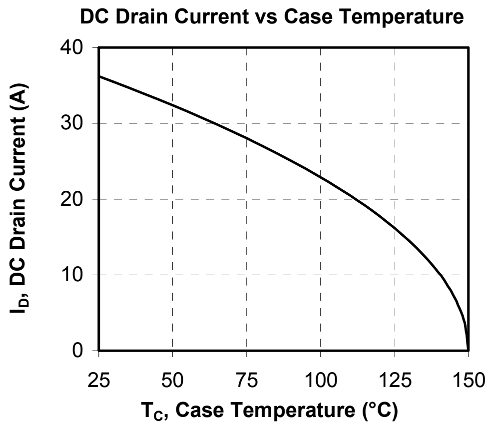
7.1 Bottom CoolMOS™ typical performance curves











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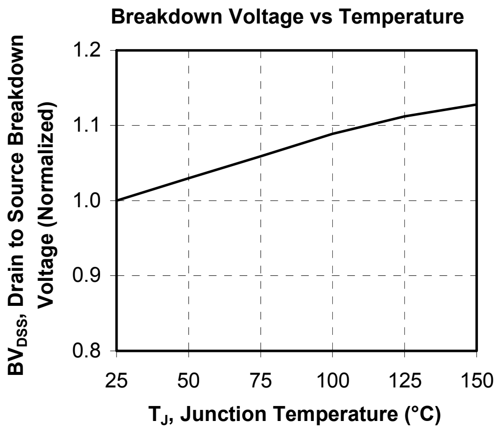
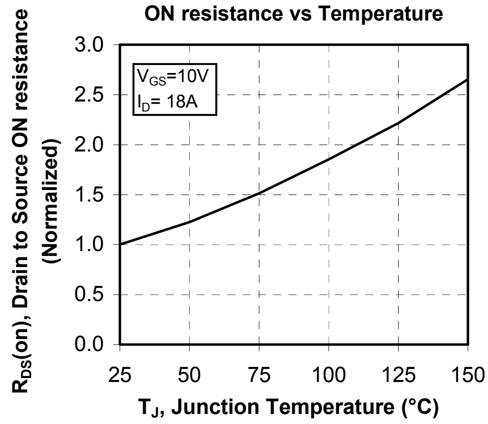
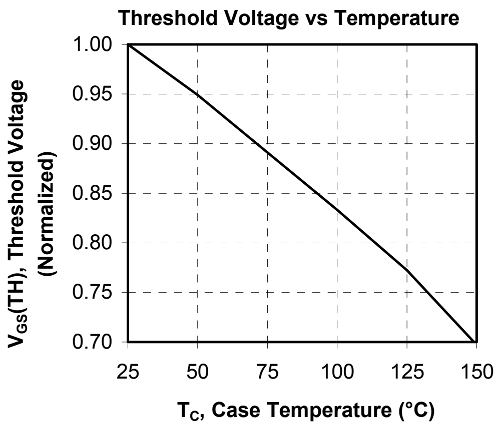
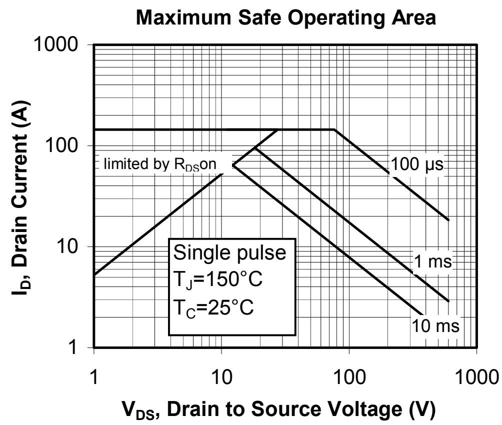
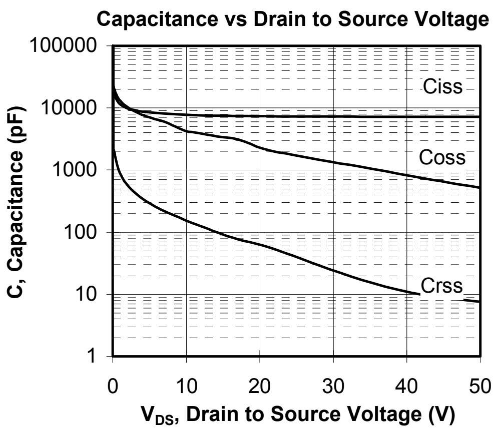
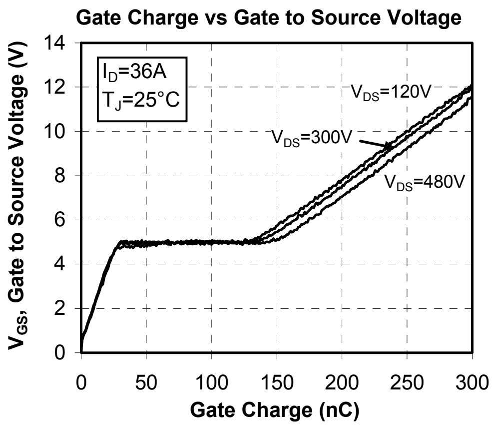

Breakdown Voltage vs Temperature
BVDSS, Drain to Source Breakdown Voltage (Normalized)
1.2
1.1
1.0
0.9
0.8
25 50 75 100 125 150
TJ, Junction Temperature (°C)

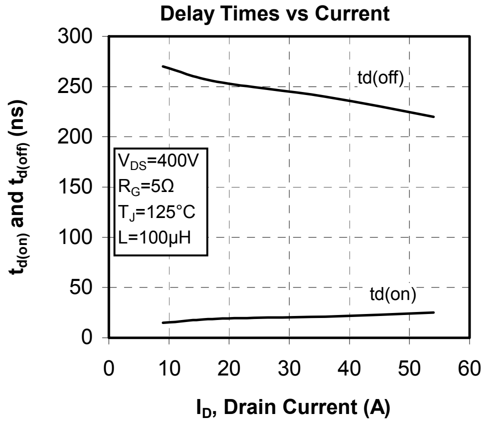

ON resistance vs Temperature
RDS(on), Drain to Source ON resistance (Normalized)
VGS=10V
ID= 18A
3.0
2.5
2.0
1.5
1.0
0.5
0.0
25 50 75 100 125 150
TJ, Junction Temperature (°C)

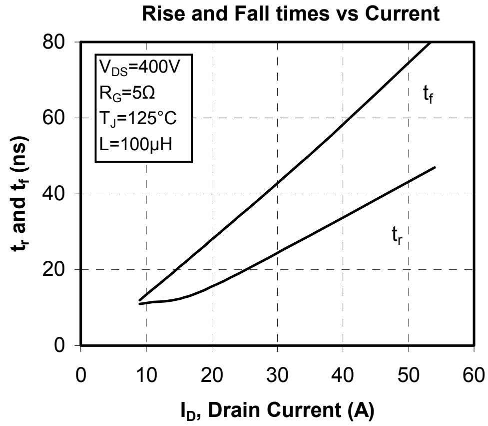

Threshold Voltage vs Temperature
VGS(TH), Threshold Voltage (Normalized)
1.00
0.95
0.90
0.85
0.80
0.75
0.70
25 50 75 100 125 150
TC, Case Temperature (°C)

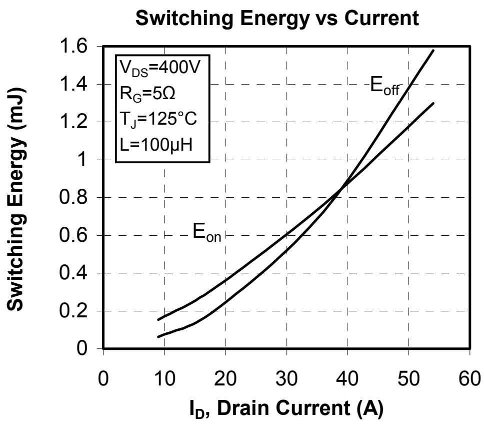

Maximum Safe Operating Area
ID, Drain Current (A)
1000
100
10
1
limited by RDSon
100 µs
1 ms
10 ms
Single pulse
TJ=150°C
TC=25°C
1 10 100 1000
VDS, Drain to Source Voltage (V)

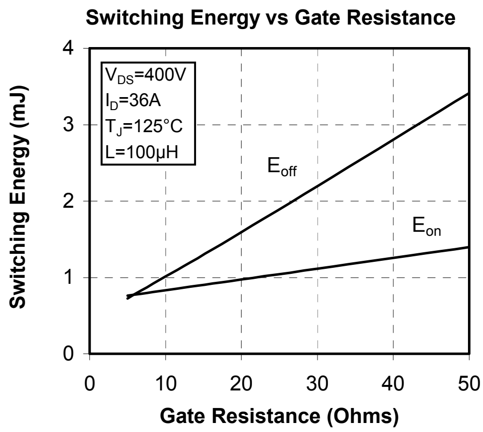

Capacitance vs Drain to Source Voltage
C, Capacitance (pF)
100000
10000
1000
100
10
1
Ciss
Coss
Crss
0 10 20 30 40 50
VDS, Drain to Source Voltage (V)

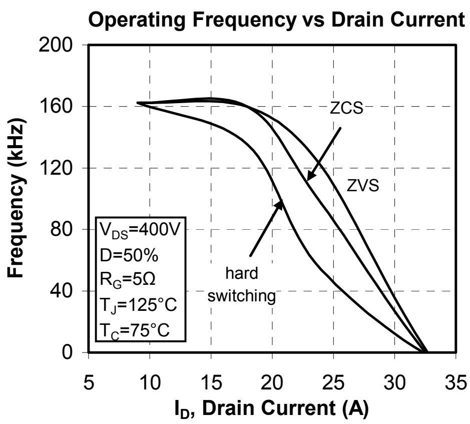

Gate Charge vs Gate to Source Voltage
VGS, Gate to Source Voltage (V)
ID=36A
TJ=25°C
VDS=120V
VDS=300V
VDS=480V
14
12
10
8
6
4
2
0
0 50 100 150 200 250 300
Gate Charge (nC)

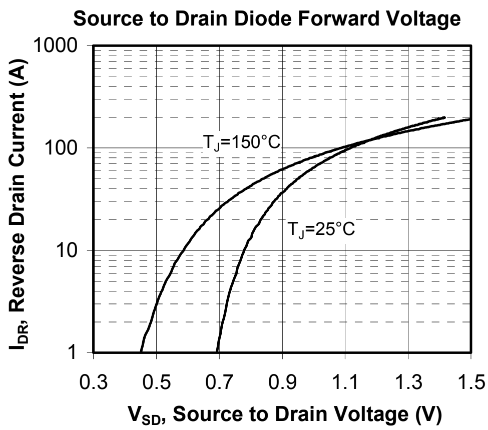












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Buyer agrees not to use Products in any Life Support Applications and to the extent it does it shall conduct extensive testing of the Product in such applications and further agrees to indemnify and hold Seller, and its officers, employees, subsidiaries, affiliates, agents, sales representatives and distributors harmless against all claims, costs, damages and expenses, and attorneys' fees and costs arising, directly or directly, out of any claims of personal injury, death, damage or otherwise associated with the use of the goods in Life Support Applications, even if such claim includes allegations that Seller was negligent regarding the design or manufacture of the goods.

Buyer must notify Seller in writing before using Seller's Products in Life Support Applications. Seller will study with Buyer alternative solutions to meet Buyer application specification based on Sellers sales conditions applicable for the new proposed specific part.