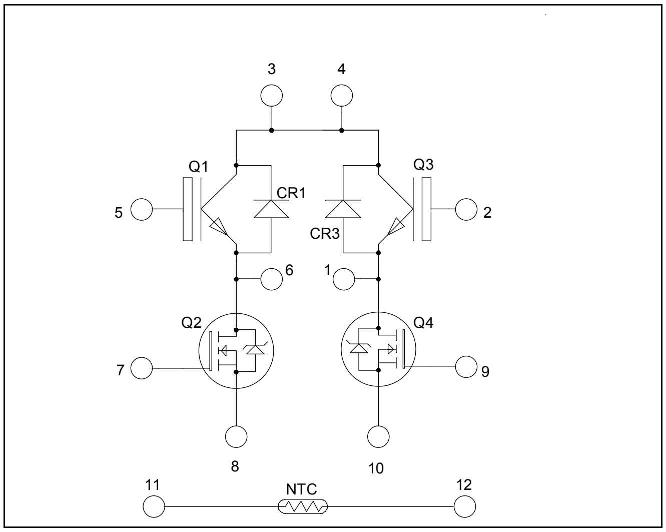
APTCV40H60CT1G

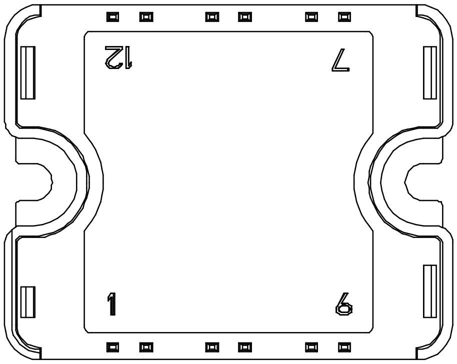
Full - Bridge CoolMOS & Trench + Field Stop® IGBT Power module

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	
I_{CM}	Pulsed Collector Current	$T_C = 25°C$	100	
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		
$V_{GE(th)}$	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		
$T_{d(on)}$	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_{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		
E_{off}	Turn-off Switching Energy		$T_j = 25°C$		1.35		mJ
			$T_j = 150°C$		1.75		
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 = 5Ω		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 = 5Ω		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 = 5Ω		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/µs	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 ≤ 100A/µs $V_R \leq V_{DSS}$ $T_j \leq$ 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

<table>
<tr><th><i>Symbol</i></th><th colspan="3"><i>Characteristic</i></th><th><i>Min</i></th><th><i>Typ</i></th><th><i>Max</i></th><th><i>Unit</i></th></tr>
<tr><td>V_{ISOL}</td><td colspan="3">RMS Isolation Voltage, any terminal to case t =1 min, I isol<1mA, 50/60Hz</td><td>2500</td><td></td><td></td><td>V</td></tr>
<tr><td>T_J</td><td colspan="3">Operating junction temperature range</td><td>-40</td><td></td><td>150*</td><td rowspan="3">°C</td></tr>
<tr><td>T_{STG}</td><td colspan="3">Storage Temperature Range</td><td>-40</td><td></td><td>125</td></tr>
<tr><td>T_C</td><td colspan="3">Operating Case Temperature</td><td>-40</td><td></td><td>100</td></tr>
<tr><td>Torque</td><td>Mounting torque</td><td>To heatsink</td><td>M4</td><td>2.5</td><td></td><td>4.7</td><td>N.m</td></tr>
<tr><td>Wt</td><td colspan="3">Package Weight</td><td></td><td></td><td>80</td><td>g</td></tr>
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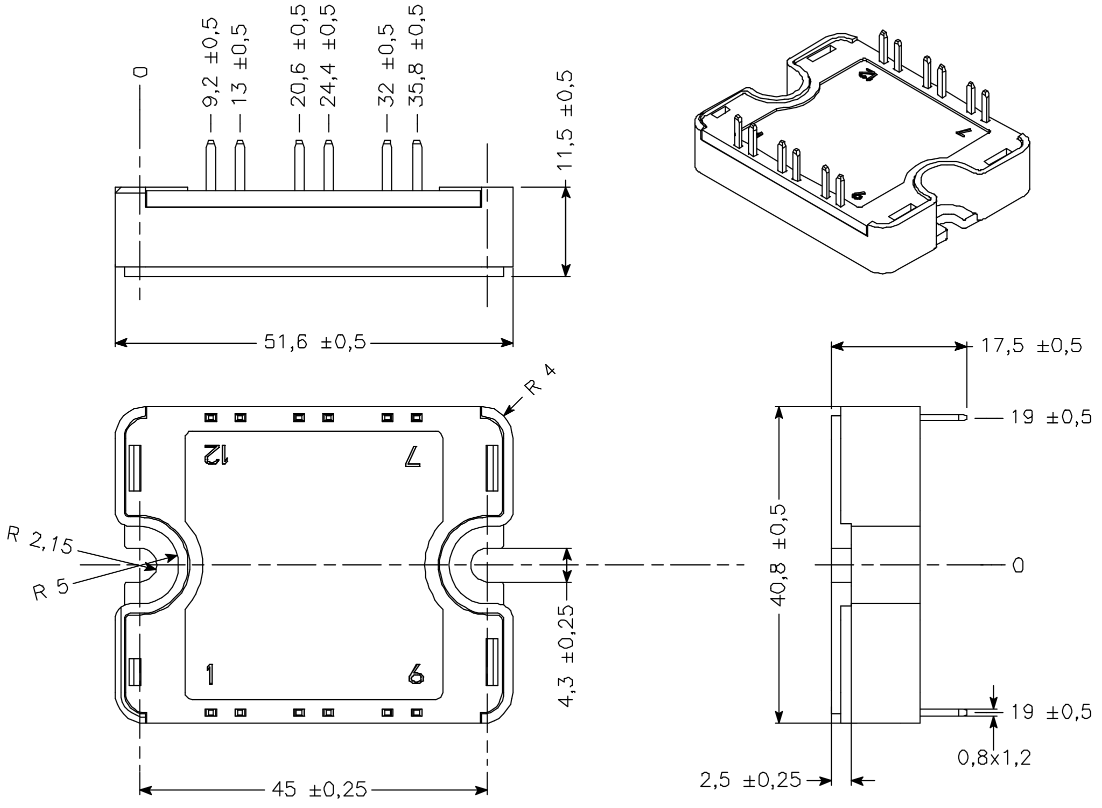
Tj=175°C for Trench & Field Stop IGBT

5. SP1 Package outline (dimensions in mm)

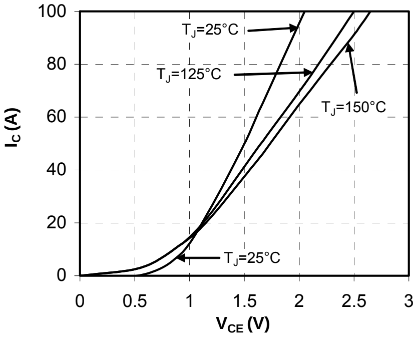


See application note 1904 - Mounting Instructions for SP1 Power Modules on www.microsemi.com

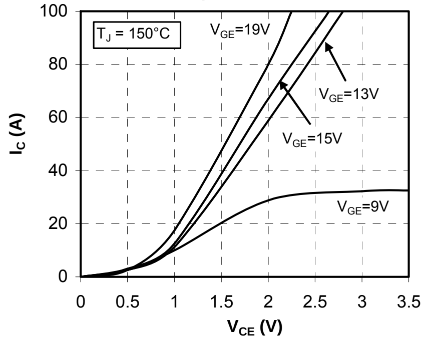
6. Top switches curves

6.1 Top Trench + Field Stop IGBT$^{®}$ typical performance curves

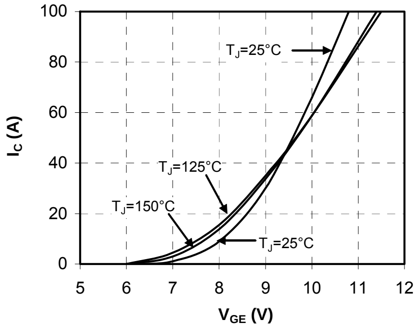
Output Characteristics (V_{GE}=15V)



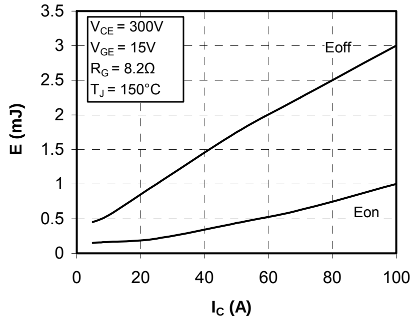
Output Characteristics



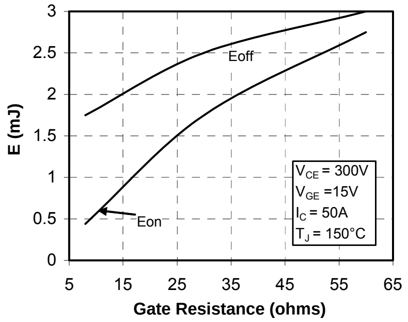
Transfert Characteristics



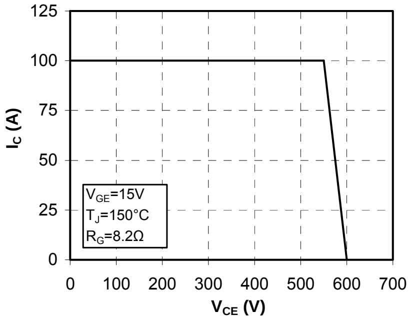
Energy losses vs Collector Current



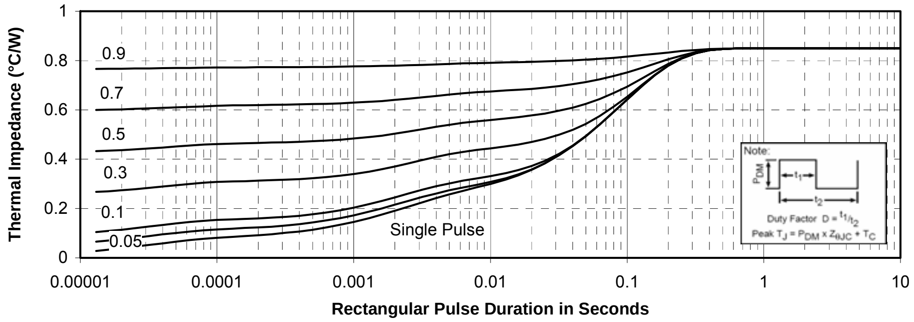
Switching Energy Losses vs Gate Resistance



Reverse Bias Safe Operating Area

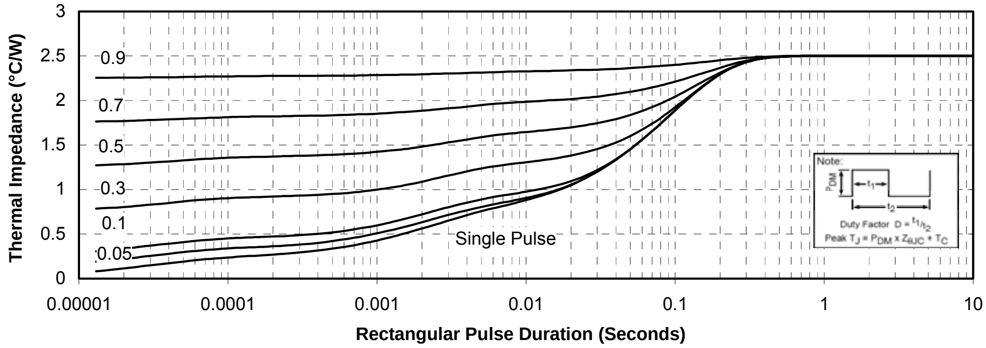


maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration

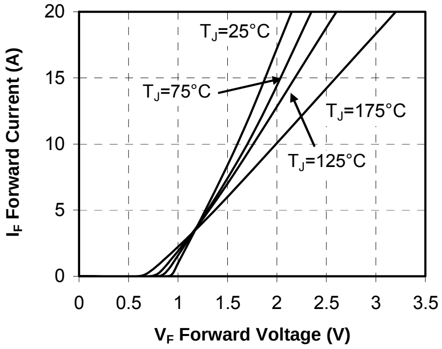


6.2 Top SiC diode typical performance curves

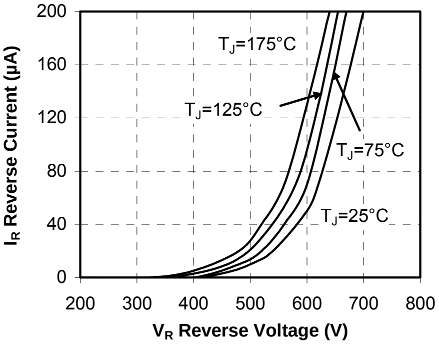
Maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration



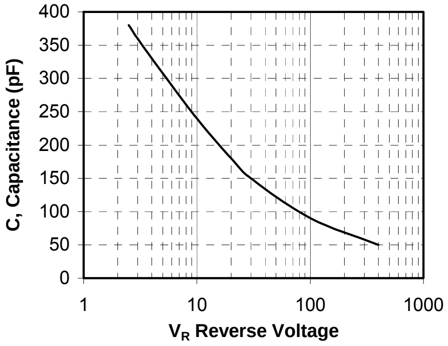
Forward Characteristics



Reverse Characteristics



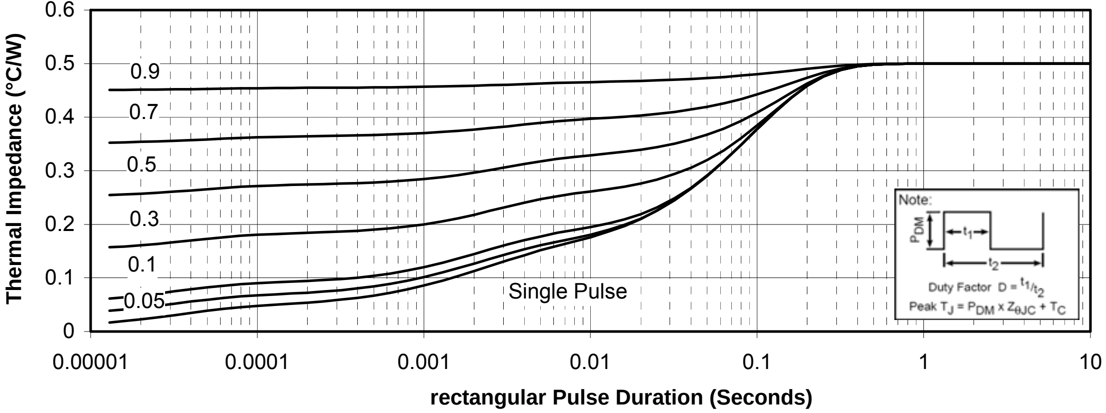
Capacitance vs.Reverse Voltage



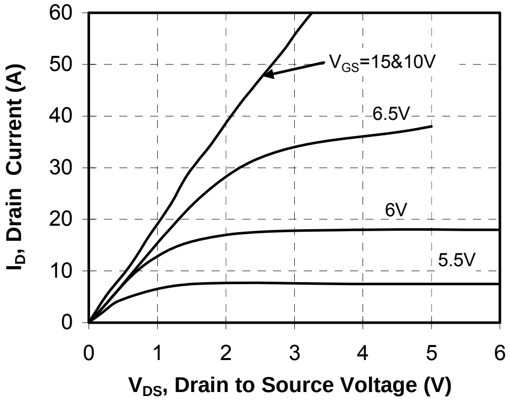
7. Bottom switches curves

7.1 Bottom CoolMOS™ typical performance curves

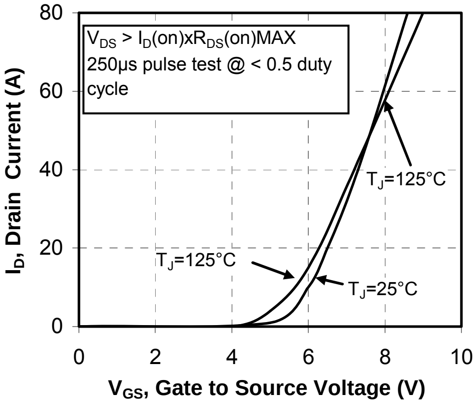
Maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration



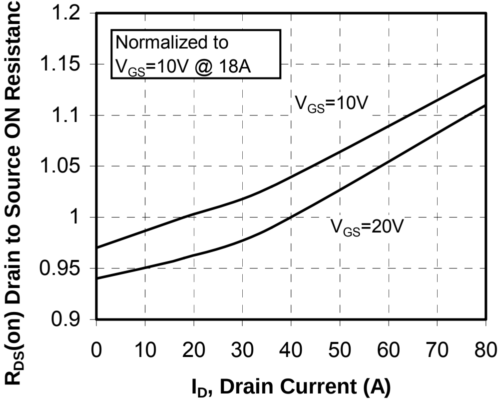
Low Voltage Output Characteristics



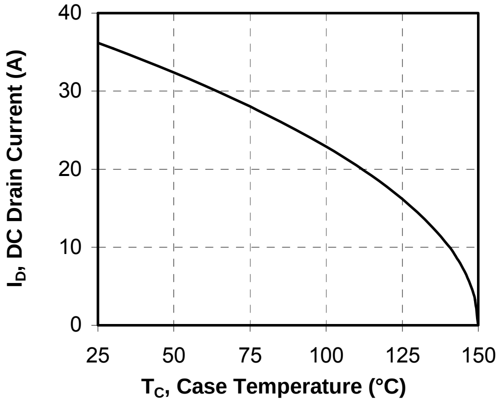
Transfert Characteristics



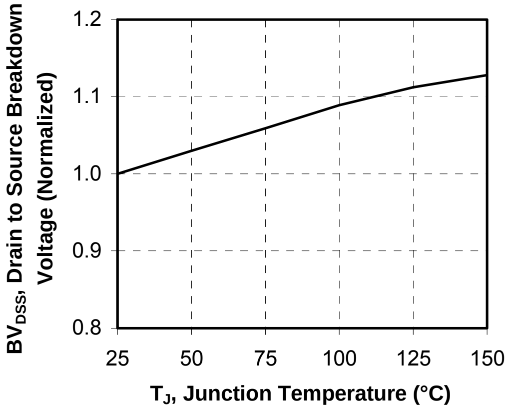
R_{DS}(on) vs Drain Current



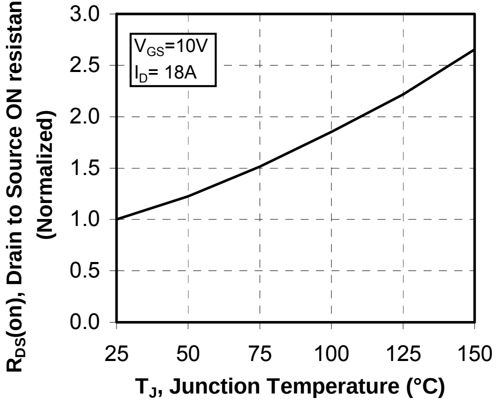
DC Drain Current vs Case Temperature



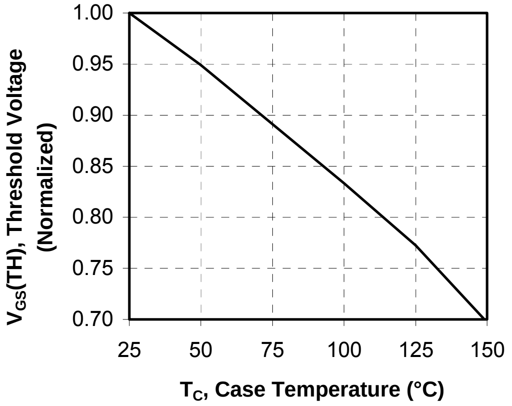
Breakdown Voltage vs Temperature



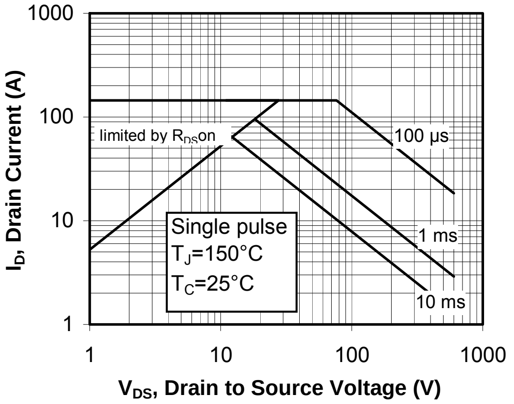
ON resistance vs Temperature



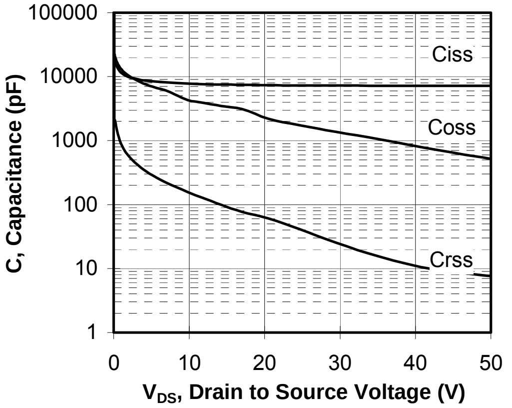
Threshold Voltage vs Temperature



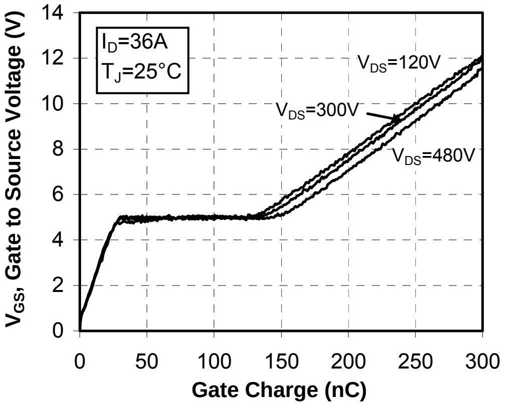
Maximum Safe Operating Area

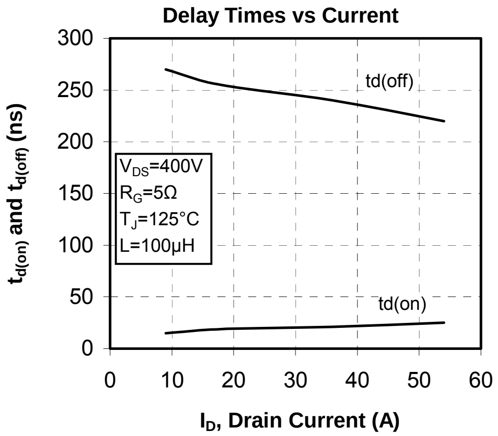


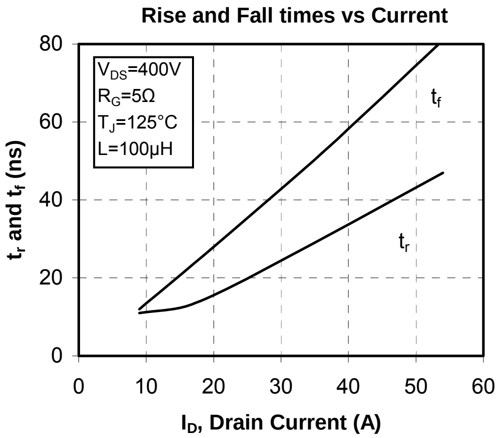
Capacitance vs Drain to Source Voltage

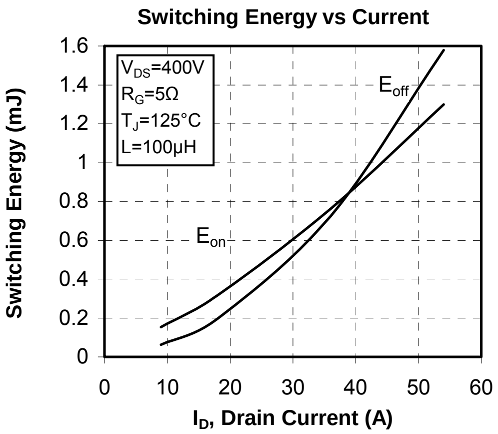


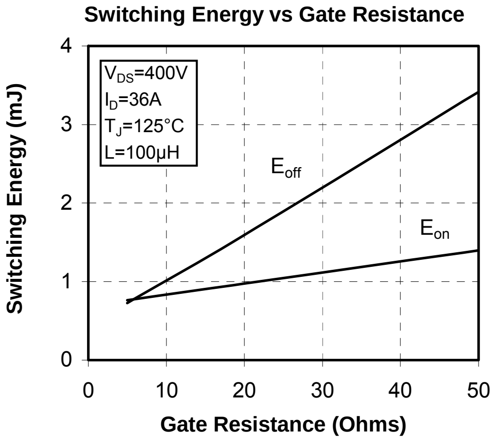
Gate Charge vs Gate to Source Voltage

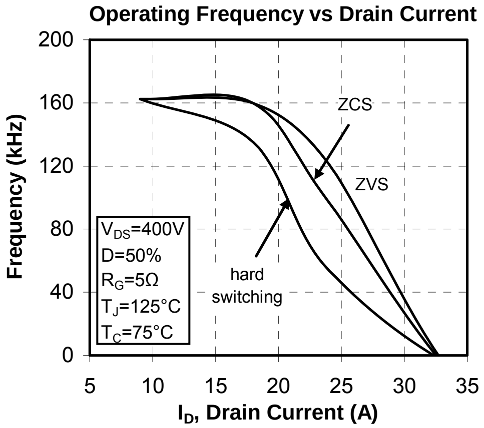


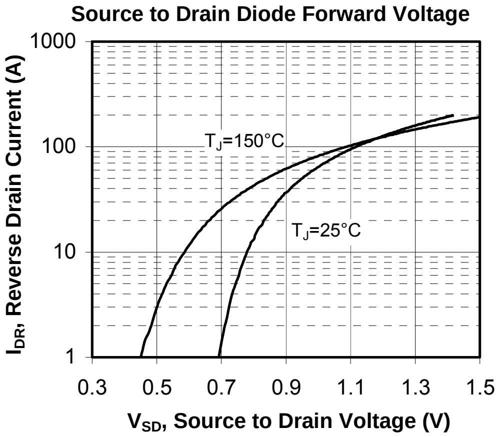












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