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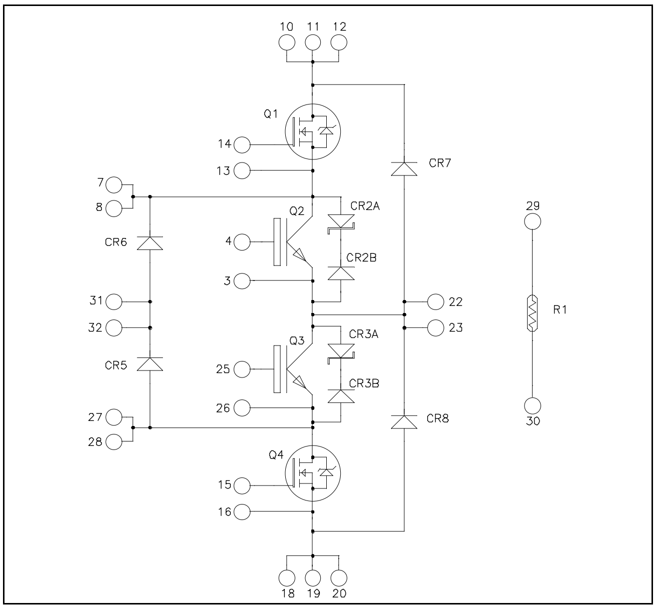
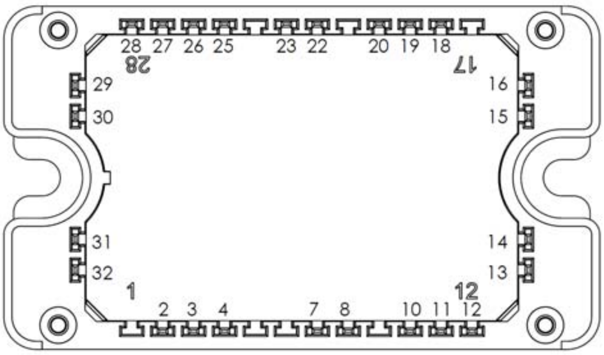
Three level inverter Power Module

Trench & Field Stop IGBT3 Q2, Q3:
V_{CES} = 600V ; I_C = 30A @ Tc = 80°C

Super junction MOSFET Q1, Q4:
V_{DSS} = 600V ; I_D = 17A @ Tc = 80°C





All multiple inputs and outputs must be shorted together
Example: 10/11/12 ; 7/8 …

Application

- Solar converter
- Uninterruptible Power Supplies

Features

- ***Q2, Q3 Trench + Field Stop IGBT3***
  - Low voltage drop
  - Low tail current
  - Switching frequency up to 20 kHz
  - Low leakage current
  - RBSOA and SCSOA rated
- ***Q1, Q4 Super junction MOSFET***
  - Ultra low R_{DSon}
  - Low Miller capacitance
  - Ultra low gate charge
  - Avalanche energy rated
  - Very rugged
- Kelvin emitter for easy drive
- Very low stray inductance
- High level of integration
- Internal thermistor for temperature monitoring

Benefits

- Stable temperature behavior
- Very rugged
- Direct mounting to heatsink (isolated package)
- Low junction to case thermal resistance
- Low profile
- RoHS Compliant

All ratings @ T_j = 25°C unless otherwise specified

CAUTION: These Devices are sensitive to Electrostatic Discharge. Proper Handling Procedures Should Be Followed.

Q1 & Q4 Absolute maximum ratings (per Super junction MOSFET)

Symbol	*Parameter*		*Max ratings*	*Unit*
V_{DSS}	Drain - Source Voltage		600	V
I_D	Continuous Drain Current	$T_c = 25°C$	22	A
		$T_c = 80°C$	17	
I_{DM}	Pulsed Drain current		75	
V_{GS}	Gate - Source Voltage		±20	V
R_{DSon}	Drain - Source ON Resistance		99	mΩ
P_D	Power Dissipation	$T_c = 25°C$	110	W
I_{AR}	Avalanche current (repetitive and non repetitive)		11	A
E_{AR}	Repetitive Avalanche Energy		1.2	mJ
E_{AS}	Single Pulse Avalanche Energy		800	

Q1 & Q4 Electrical Characteristics (per Super junction MOSFET)

Symbol	*Characteristic*	*Test Conditions*	*Min*	*Typ*	*Max*	*Unit*
I_{DSS}	Zero Gate Voltage Drain Current	$V_{GS} = 0V$; $V_{DS} = 600V$			50	µA
$R_{DS(on)}$	Drain – Source on Resistance	$V_{GS} = 10V$, $I_D = 18A$			99	mΩ
$V_{GS(th)}$	Gate Threshold Voltage	$V_{GS} = V_{DS}$, $I_D = 1.2$ mA	2.5	3	3.5	V
I_{GSS}	Gate – Source Leakage Current	$V_{GS} = ±20$ V, $V_{DS} = 0V$			100	nA

Q1 & Q4 Dynamic Characteristics (per Super junction MOSFET)

Symbol	*Characteristic*	*Test Conditions*	*Min*	*Typ*	*Max*	*Unit*
C_{iss}	Input Capacitance	$V_{GS} = 0V$; $V_{DS} = 100V$ f = 1MHz		2800		pF
C_{oss}	Output Capacitance			130		
Q_g	Total gate Charge	$V_{GS} = 10V$ $V_{Bus} = 400V$ $I_D = 18A$		14		nC
Q_{gs}	Gate – Source Charge			20		
Q_{gd}	Gate – Drain Charge			60		
$T_{d(on)}$	Turn-on Delay Time	$V_{GS} = 10V$ $V_{Bus} = 400V$ $I_D = 18A$ $R_G = 3.3Ω$		10		ns
T_r	Rise Time			5		
$T_{d(off)}$	Turn-off Delay Time			60		
T_f	Fall Time			5		
R_{thJC}	Junction to Case Thermal Resistance				1.15	°C/W

Q2 & Q3 Absolute maximum ratings (per IGBT)

Symbol	*Parameter*		*Max ratings*	*Unit*
V_{CES}	Collector - Emitter Voltage		600	V
I_C	Continuous Collector Current	$T_C = 25°C$	50	A
		$T_C = 80°C$	30	
I_{CM}	Pulsed Collector Current	$T_C = 25°C$	60	
V_{GE}	Gate – Emitter Voltage		±20	V
P_D	Power Dissipation	$T_C = 25°C$	90	W
RBSOA	Reverse Bias Safe Operating Area	$T_J = 150°C$	60A @ 550V	

Q2 & Q3 Electrical Characteristics (per IGBT)

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 = 30A	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 = 400µA		5.0	5.8	6.5	V
I_{GES}	Gate – Emitter Leakage Current	V_{GE} = 20V, V_{CE} = 0V				300	nA

Q2 & Q3 Dynamic Characteristics (per IGBT)

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
C_{ies}	Input Capacitance	V_{GE} = 0V V_{CE} = 25V f = 1MHz			1600		pF
C_{oes}	Output Capacitance				110		
C_{res}	Reverse Transfer Capacitance				50		
Q_G	Gate charge	V_{GE}=±15V, I_C=30A V_{CE}=300V			0.3		µC
$T_{d(on)}$	Turn-on Delay Time	Inductive Switching (25°C) V_{GE} = ±15V V_{Bus} = 300V I_C = 30A R_G = 10Ω			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 = 30A R_G = 10Ω			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 = 30A R_G = 10Ω	T_j = 25°C		0.16		mJ
			T_j = 150°C		0.3		
E_{off}	Turn-off Switching Energy		T_j = 25°C		0.7		mJ
			T_j = 150°C		1.05		
I_{sc}	Short Circuit data	V_{GE} ≤15V ; V_{Bus} = 360V t_p ≤ 6µs ; T_j = 150°C			150		A
R_{thJC}	Junction to Case Thermal Resistance					1.6	°C/W

CR2 & CR3 diode ratings and characteristics (per device)

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
V_F	Diode + tranzorb Forward Voltage	I_F = 10A		10		V
R_{thJC}	Junction to Case Thermal Resistance				8	°C/W

CR5 & CR6 diode ratings and characteristics (per diode)

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
V_{RRM}	Peak Repetitive Reverse Voltage					600	V
I_{RM}	Reverse Leakage Current	V_R=600V				25	µA
I_F	DC Forward Current		Tc = 80°C		30		A
V_F	Diode Forward Voltage	I_F = 30A			1.8	2.2	
		I_F = 60A			2.2		V
		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		T_j = 25°C		35		nC
			T_j = 125°C		480		
E_{rr}	Reverse Recovery Energy	I_F = 30A V_R = 400V di/dt =1000A/µs	T_j = 125°C		0.6		mJ
R_{thJC}	Junction to Case Thermal Resistance					1.2	°C/W

CR7 & CR8 diode ratings and characteristics (per diode)

Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
V_{RRM}	Peak Repetitive Reverse Voltage					1200	V
I_{RM}	Reverse Leakage Current	V_R=1200V				100	µA
I_F	DC Forward Current		Tc = 80°C		30		A
V_F	Diode Forward Voltage	I_F = 30A			2.6	3.1	
		I_F = 60A			3.2		V
		I_F = 30A	T_j = 125°C		1.8		
t_{rr}	Reverse Recovery Time	I_F = 30A V_R = 800V di/dt =200A/µs	T_j = 25°C		300		ns
			T_j = 125°C		380		
Q_{rr}	Reverse Recovery Charge		T_j = 25°C		360		nC
			T_j = 125°C		1700		
E_{rr}	Reverse Recovery Energy	I_F = 30A V_R = 800V di/dt =1000A/µs	T_j = 125°C		1.6		mJ
R_{thJC}	Junction to Case Thermal Resistance					1.2	°C/W

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		%

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

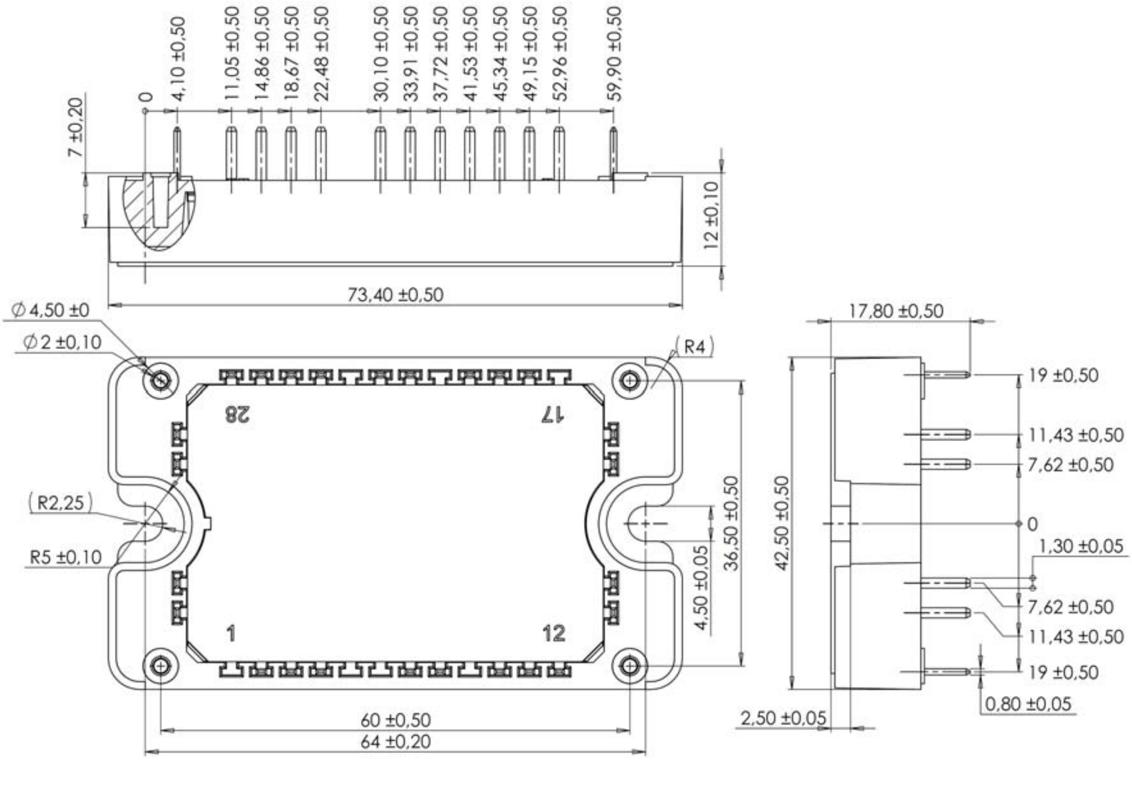
T: Thermistor temperature
R_T: Thermistor value at T

Thermal and package characteristics

Symbol	*Characteristic*			*Min*	*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	175*	°C
T_{JOP}	Recommended junction temperature under switching conditions			-40	$T_J$max -25	
T_{STG}	Storage Temperature Range			-40	125	
T_C	Operating Case Temperature			-40	125	
Torque	Mounting torque	To heatsink	M4	2	3	N.m
Wt	Package Weight				110	g

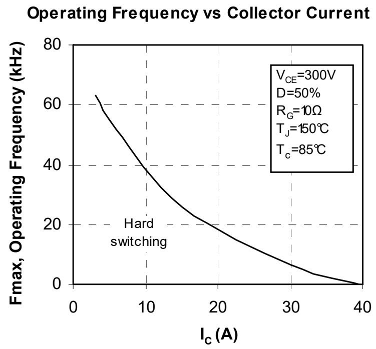
* Tjmax = 150°C for Q1 & Q4

Package outline (dimensions in mm)

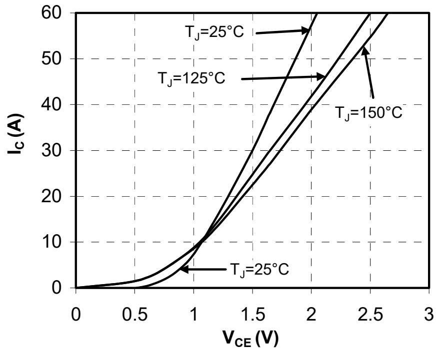


See application note 1906 - Mounting Instructions for SP3F Power Modules on www.microsemi.com

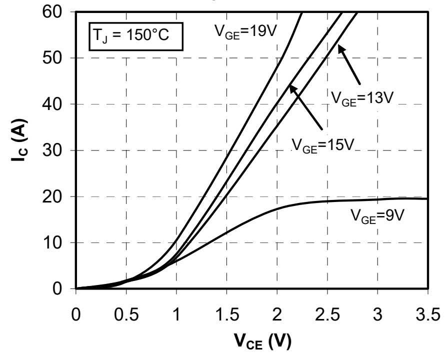
Q2 & Q3 Typical performance curve



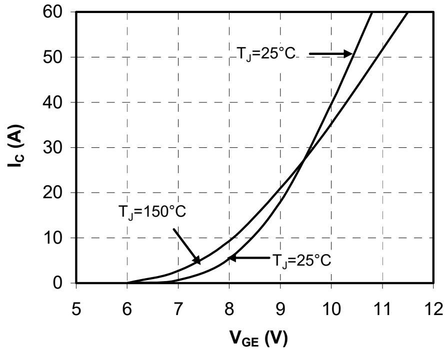
Output Characteristics (V_{GE}=15V)



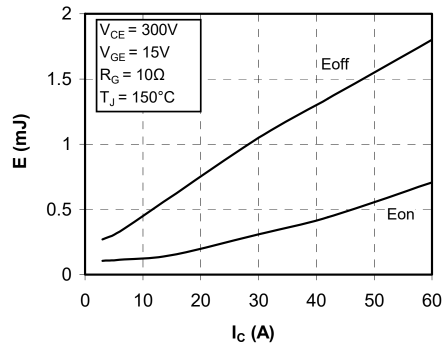
Output Characteristics



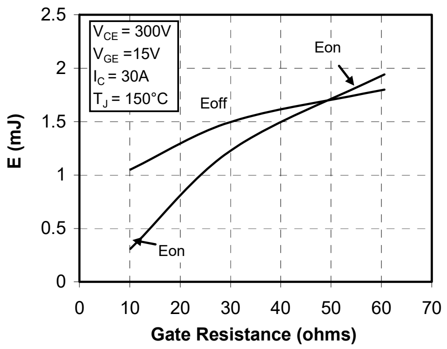
Transfert Characteristics



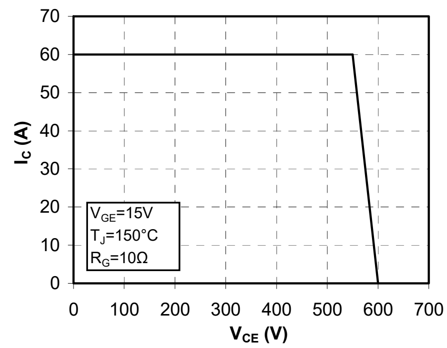
Energy losses vs Collector Current



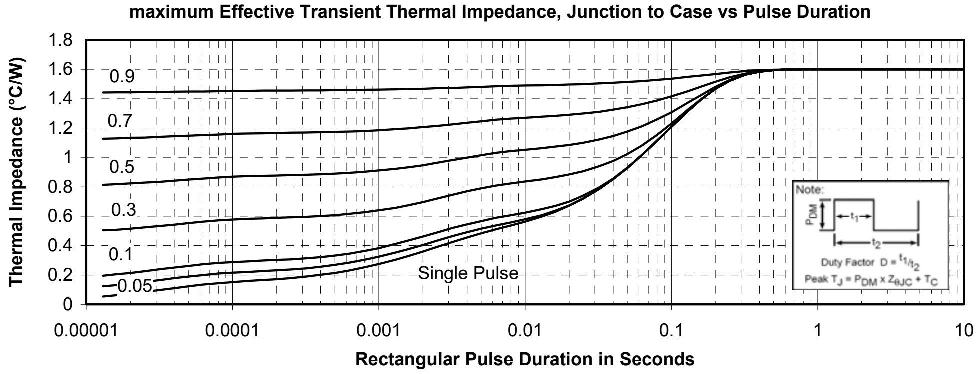
Switching Energy Losses vs Gate Resistance



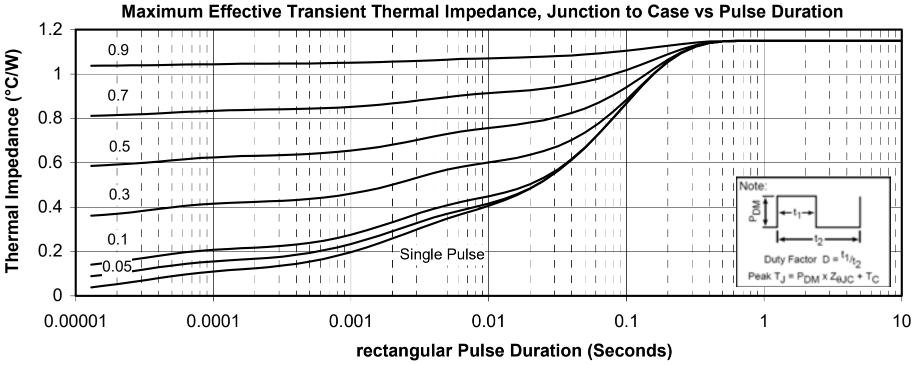
Reverse Bias Safe Operating Area

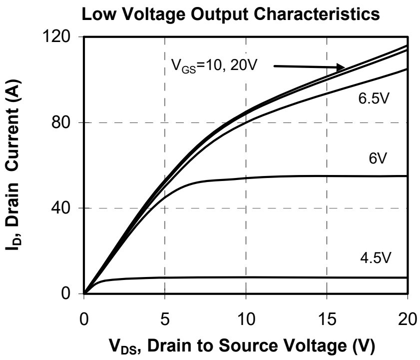


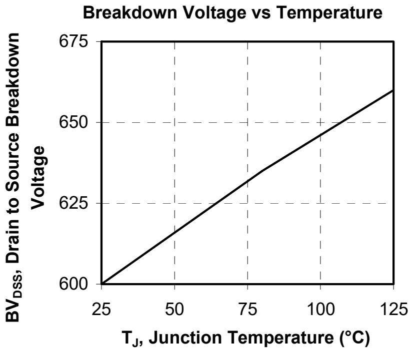
maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration

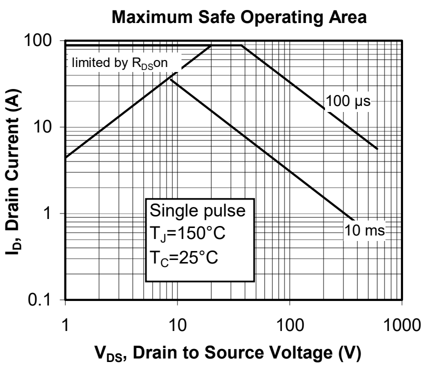


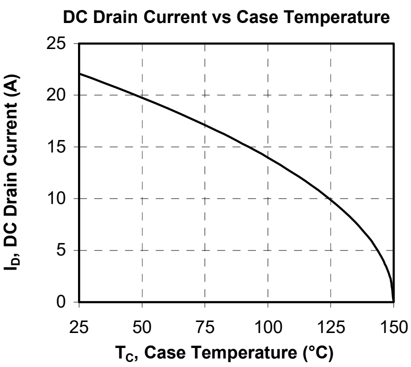
Q1 & Q4 Typical performance curve

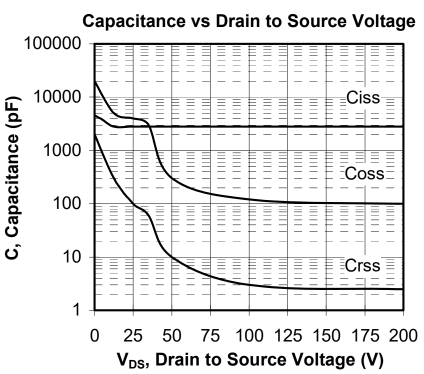


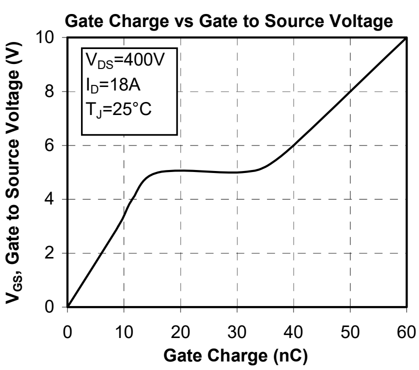




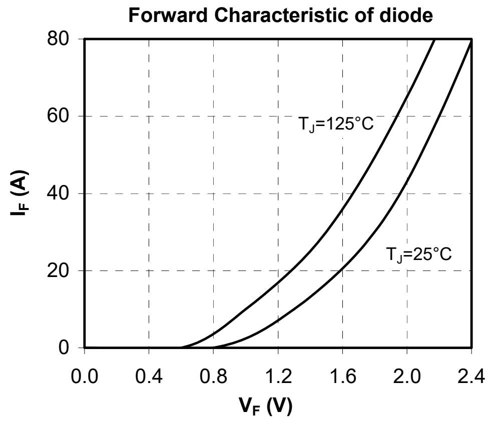


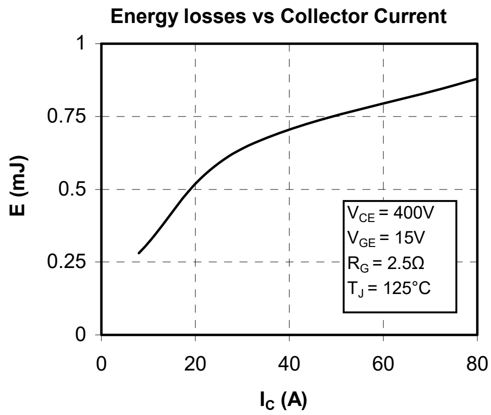


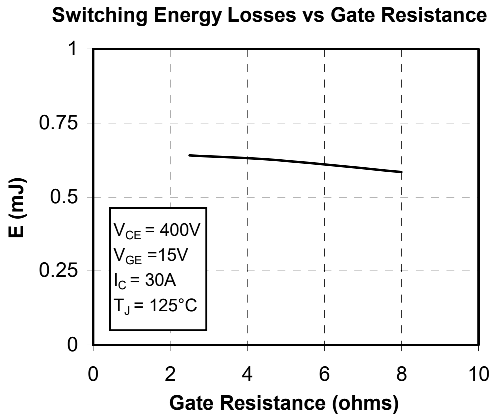


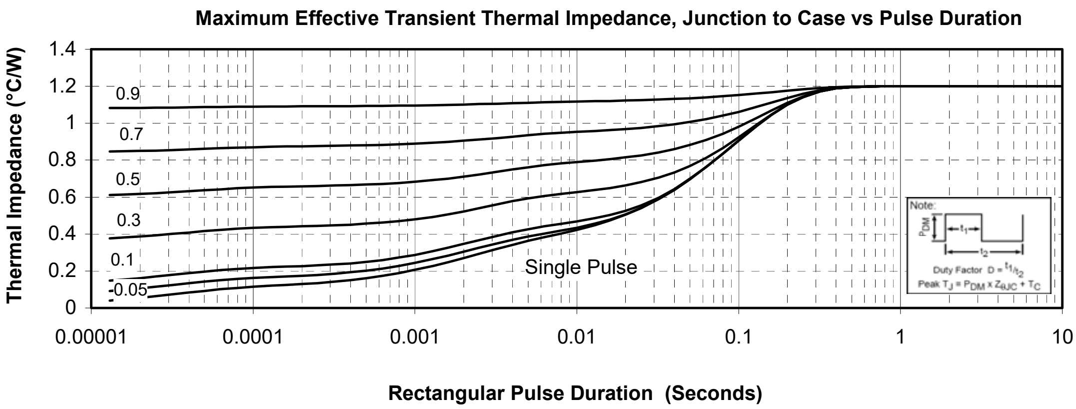


CR5 & CR6 Typical performance curve

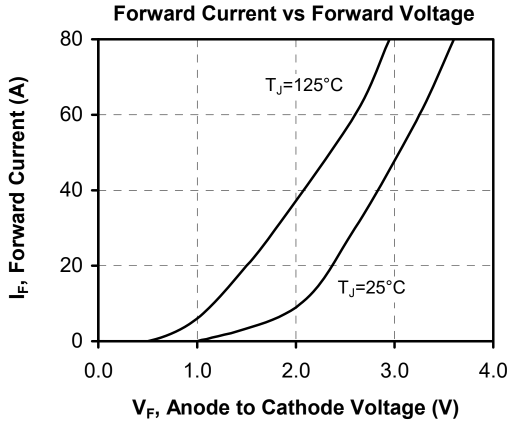


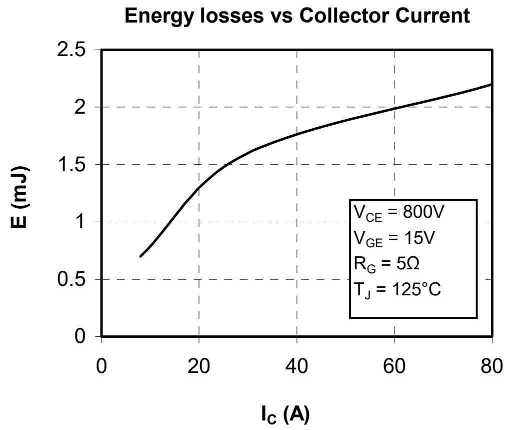


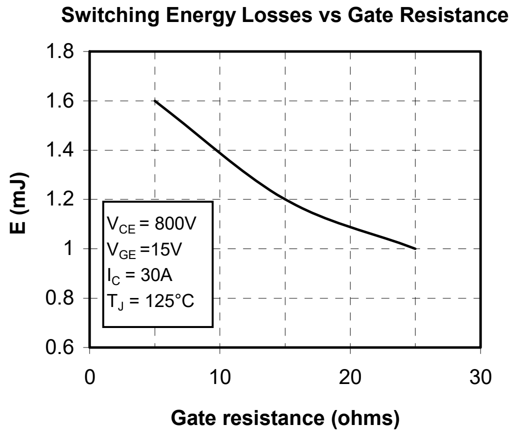


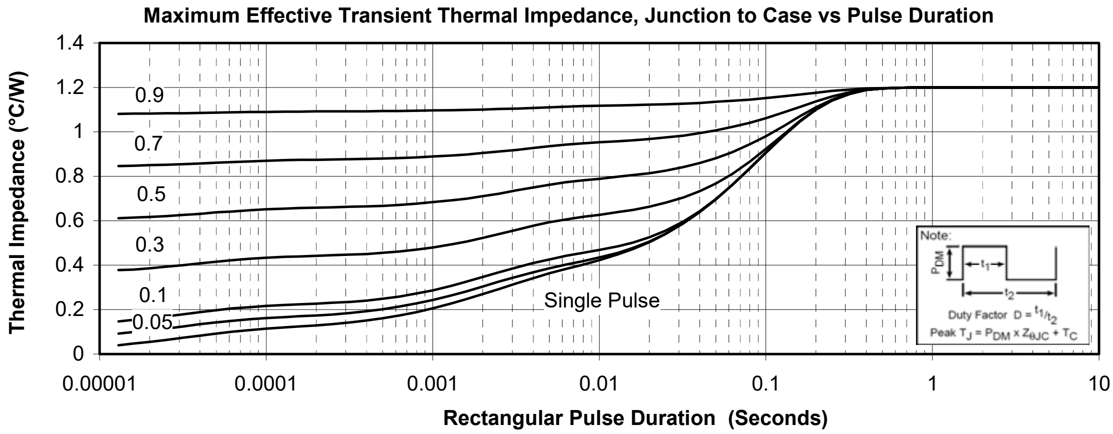


CR7 & CR8 Typical performance curve









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