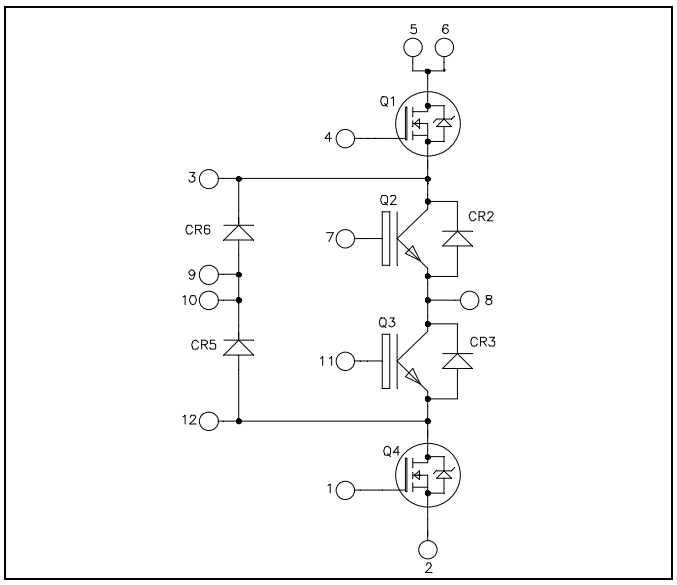
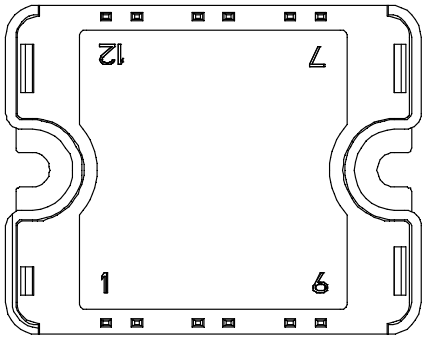
Three level inverter
CoolMOS & Trench + Field Stop IGBT
Power Module

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

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





All multiple inputs and outputs must be shorted together
5/6 ; 9/10

Application

- Solar converter
- Uninterruptible Power Supplies

Features

- ***Q2, Q3 Trench + Field Stop IGBT Technology***
  - Low voltage drop
  - Low tail current
  - Switching frequency up to 20 kHz
  - Soft recovery parallel diodes
  - Low diode VF
  - Low leakage current
  - RBSOA and SCSOA rated
- ***Q1, Q4 CoolMOS™***
  - Ultra low R_{DSon}
  - Low Miller capacitance
  - Ultra low gate charge
  - Avalanche energy rated
  - Very rugged
- Very low stray inductance
- High level of integration

Benefits

- Stable temperature behavior
- Very rugged
- Direct mounting to heatsink (isolated package)
- Low junction to case thermal resistance
- Easy paralleling due to positive TC of VCEsat
- Low profile
- RoHS Compliant

All ratings @ T_j = 25°C unless otherwise specified

Q1 & Q4 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	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	Maximum 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

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			50	µA
			T_j = 125°C		100		
$R_{DS(on)}$	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

Dynamic Characteristics

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

Symbol	Parameter		Max ratings	Unit
V_{CES}	Collector - Emitter Breakdown 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	Maximum Power Dissipation	T_C = 25°C	90	W
RBSOA	Reverse Bias Safe Operating Area	T_J = 150°C	60A @ 550V	

Q2 & Q3 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 = 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

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, CR5 & CR6 diode ratings and characteristics

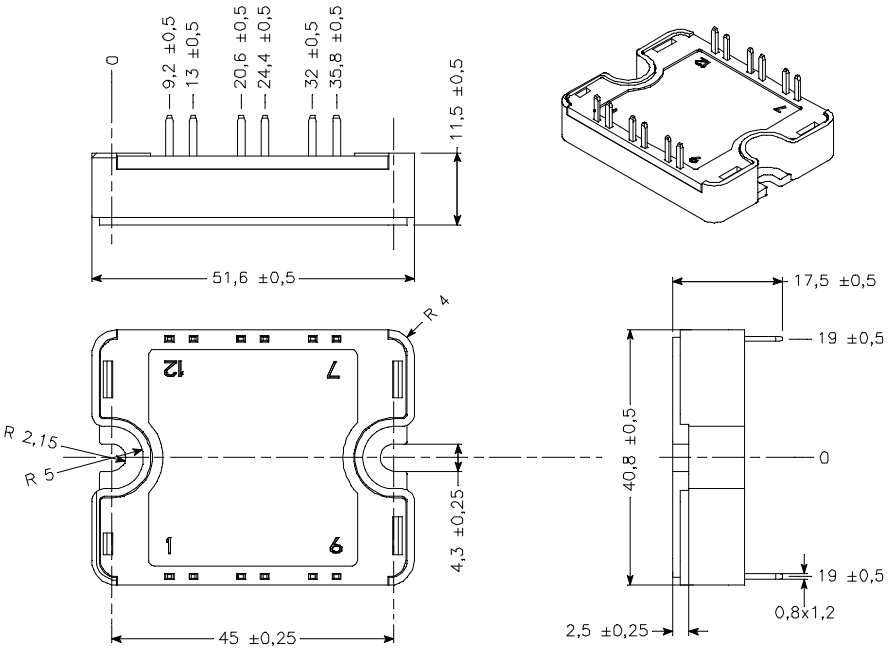
Symbol	Characteristic	Test Conditions		Min	Typ	Max	Unit
V_{RRM}	Maximum Peak Repetitive Reverse Voltage			600			V
I_{RM}	Maximum Reverse Leakage Current	V_R=600V	T_j = 25°C			25	µA
			T_j = 125°C			500	
I_F	DC Forward Current		Tc = 80°C		30		A
V_F	Diode Forward Voltage	I_F = 30A			1.8	2.2	V
		I_F = 60A			2.2		
		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

Thermal and 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		175*	°C
T_{STG}	Storage Temperature Range			-40		125	
T_C	Operating Case Temperature			-40		100	
Torque	Mounting torque	To heatsink	M4	2.5		4.7	N.m
Wt	Package Weight					80	g

* Tjmax = 150°C for Q1 & Q4

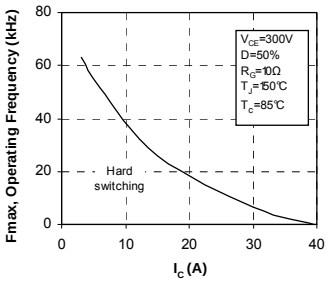
SP1 Package outline (dimensions in mm)



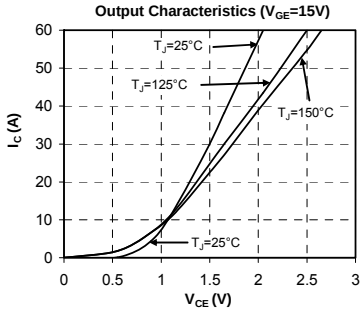
See application note 1904 - Mounting Instructions for SP1 Power Modules on www.microsemi.com

Q2 & Q3 Typical performance curve

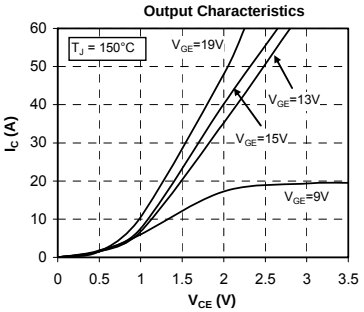
Operating Frequency vs Collector Current



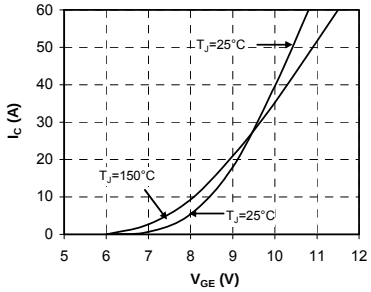
Output Characteristics (V_{GE}=15V)



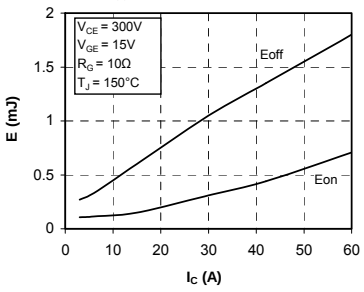
Output Characteristics



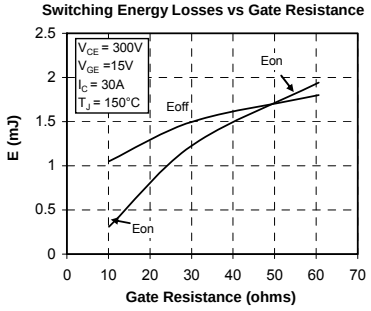
Transfert Characteristics



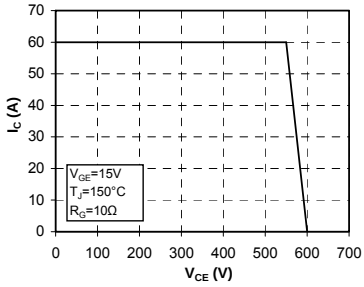
Energy losses vs Collector Current



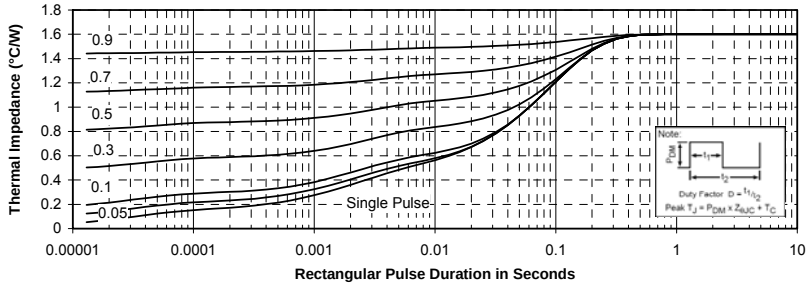
Switching Energy Losses vs Gate Resistance



Reverse Bias Safe Operating Area

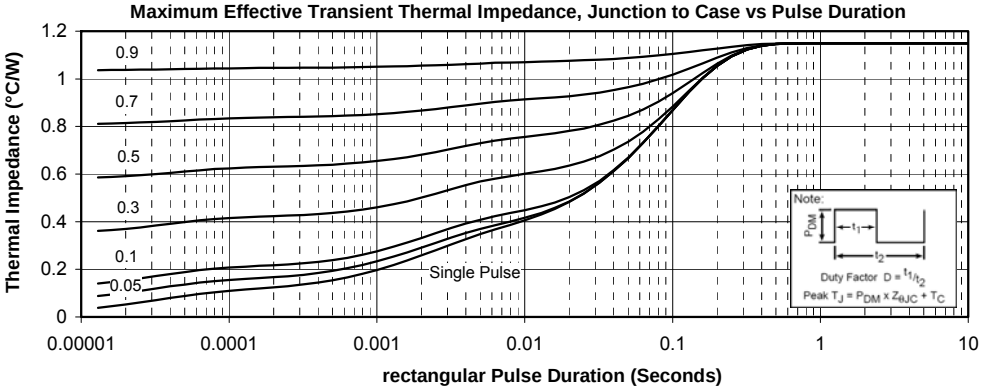


maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration

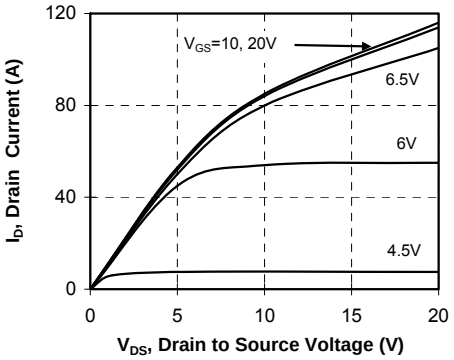


Q1 & Q4 Typical performance curve

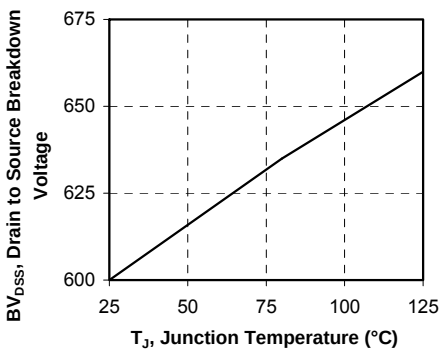
Maximum Effective Transient Thermal Impedance, Junction to Case vs Pulse Duration



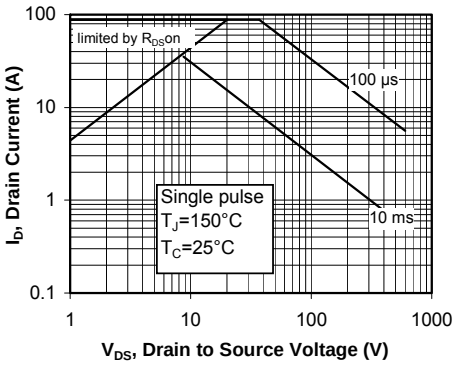
Low Voltage Output Characteristics



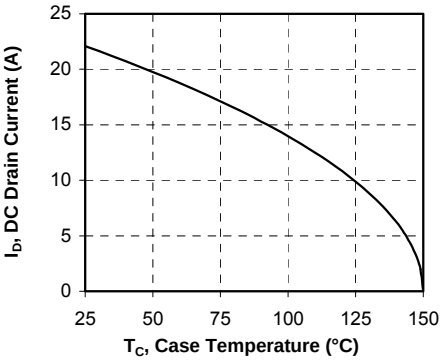
Breakdown Voltage vs Temperature



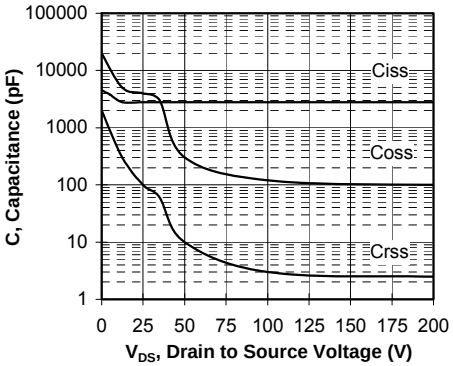
Maximum Safe Operating Area



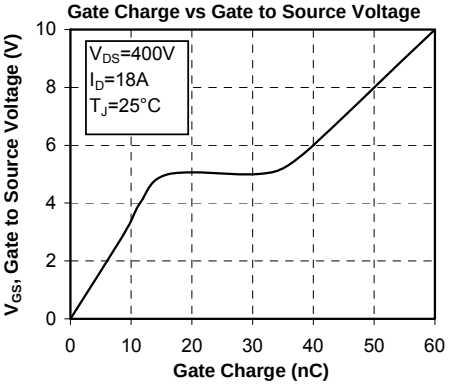
DC Drain Current vs Case Temperature



Capacitance vs Drain to Source Voltage

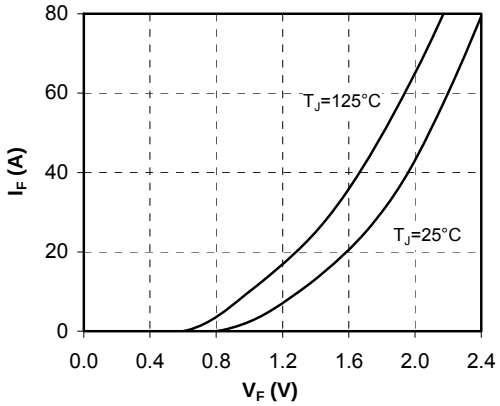


Gate Charge vs Gate to Source Voltage

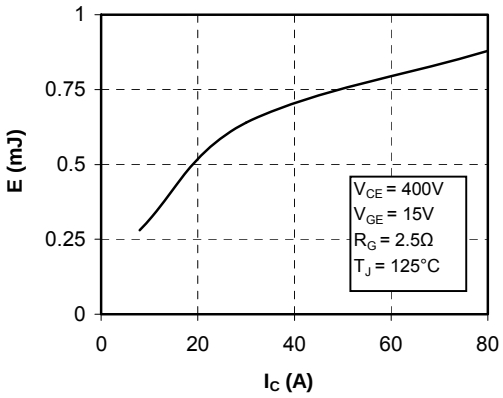


CR2, CR3, CR5 & CR6 Typical performance curve

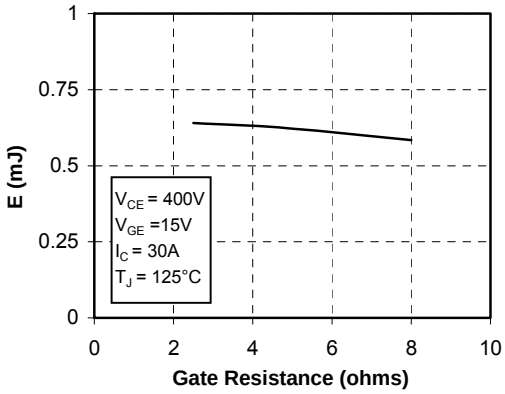
Forward Characteristic of diode



Energy losses vs Collector Current



Switching Energy Losses vs Gate Resistance



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