

## IV1Q12050MA1L – 1200V 50mΩ MOSFET + 20A SBD SiC MODULE

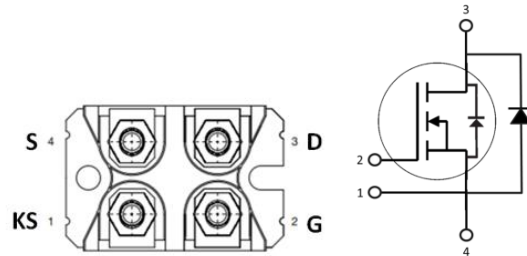
### Features:

- High speed switching SiC MOSFET
- High operating junction temperature capability
- Kelvin gate input easing driver circuit design
- Freewheeling diode with zero reverse recovery

### Applications:

- Photo voltaic inverters
- Multi-level converter
- High voltage AC/DC converters

### Package:



Part Number	Package
IVST12050MA1L	sot227

### Absolute Maximum Ratings ( $T_c=25^\circ\text{C}$ unless otherwise specified)

Symbol	Parameter	Value	Unit	Test Conditions	Note
<b>SiC MOSFET</b>					
$V_{DS}$	Drain-Source voltage	1200	V	$V_{GS}=0V, I_b=100\mu A$	
$V_{GSmax}(DC)$	Maximum DC voltage	-5 to 22	V	Static (DC)	
$V_{GSmax}(Spike)$	Maximum spike voltage	-10 to 25	V	<1% duty cycle, and pulse width<200ns	
$V_{GSon}$	Recommended turn-on voltage	$20\pm 0.5$	V		
$V_{GSoff}$	Recommended turn-off voltage	-3.5 to -2	V		
$I_D$	Drain current (continuous)	64	A	$V_{GS}=20V, T_c=25^\circ\text{C}$	Fig. 21
		45	A	$V_{GS}=20V, T_c=100^\circ\text{C}$	
$I_{DM}$	Drain current (pulsed)	160	A	Pulse width limited by SOA	Fig. 24
$P_{TOT}$	Total power dissipation	413	W	$T_c=25^\circ\text{C}$	Fig. 22
$T_{stg}$	Storage temperature range	-55 to 175	$^\circ\text{C}$		
$T_J$	Operating junction temperature	-55 to 175	$^\circ\text{C}$		
<b>SiC SBD</b>					
$V_{RRM}$	Reverse voltage (repetitive peak)	1200	V		
$V_{DC}$	DC blocking voltage	1200	V		
$I_F$	Forward current (continuous)	49.1	A	$T_c=25^\circ\text{C}$	
		20	A	$T_c=144^\circ\text{C}$	
$I_{FSM}$	Surge non-repetitive forward current	155	A	sine halfwave @ $T_c=25^\circ\text{C}$ $t_p=10\text{ms}$	

$I_{FRM}$	Surge repetitive forward current (Freq=0.1Hz, 100cycles)	125	A	sine halfwave @ $T_{amb}=25^{\circ}C$ $t_p=10ms$	
$\int i^2 dt$	$I^2t$ value	120	$A^2s$	$T_c=25^{\circ}C$ $t_p=10ms$	

## Thermal Data

Symbol	Parameter	Value	Unit	Note
$R_{\theta(j-c)}$	Thermal Resistance from Junction to Case	0.363*	$^{\circ}C/W$	Per MOSFET Fig. 23
$R_{\theta(j-c)}$	Thermal Resistance from Junction to Case	0.700*	$^{\circ}C/W$	Per SBD

\* By simulation

## Electrical Characteristics ( $T_c=25^{\circ}C$ unless otherwise specified)

Symbol	Parameter	Value			Unit	Test Conditions	Note
		Min.	Typ.	Max.			
$I_{DSS}$	Zero gate voltage drain current		5	100	$\mu A$	$V_{DS}=1200V, V_{GS}=0V$	
$I_{GSS}$	Gate leakage current			$\pm 100$	nA	$V_{DS}=0V, V_{GS}=-5\sim 20V$	
$V_{TH}$	Gate threshold voltage	1.8	3.2	5	V	$V_{GS}=V_{DS}, I_D=6mA$	Fig. 8, 9
			2.2			$V_{GS}=V_{DS}, I_D=6mA$ @ $T_c=175^{\circ}C$	
$R_{ON}$	Static drain-source on-resistance		50	65	$m\Omega$	$V_{GS}=20V, I_D=20A$ @ $T_j=25^{\circ}C$	Fig. 4, 5, 6, 7
			80		$m\Omega$	$V_{GS}=20V, I_D=20A$ @ $T_j=175^{\circ}C$	
$C_{iss}$	Input capacitance		2700		pF	$V_{DS}=800V, V_{GS}=0V,$ $f=100kHz, V_{AC}=25mV$	Fig. 16
$C_{oss}$	Output capacitance		217		pF		
$C_{rss}$	Reverse transfer capacitance		16.6		pF		
$E_{oss}$	$C_{oss}$ stored energy		81		$\mu J$		Fig. 17
$Q_g$	Total gate charge		120		nC	$V_{DS}=800V, I_D=20A,$ $V_{GS}=-5$ to $20V$	Fig. 18
$Q_{gs}$	Gate-source charge		25		nC		
$Q_{gd}$	Gate-drain charge		48		nC		
$R_g$	Gate input resistance		2.8		$\Omega$	$f=1MHz$	
$E_{ON}$	Turn-on switching energy		434.7		$\mu J$	$V_{DS}=800V$ $I_{DS}=30A,$ $V_{GS}=-3.5V\sim 20V,$ $R_{G(ext)}=3.3\Omega,$ $L=200\mu H$	Fig. 19, 20
$E_{OFF}$	Turn-off switching energy		115.5		$\mu J$		
$t_{d(on)}$	Turn-on delay time		12		ns		
$t_r$	Rise time		23.6				
$t_{d(off)}$	Turn-off delay time		25.2				
$t_f$	Fall time		18				

SIC SBD

V <sub>F</sub>	Forward Voltage		1.48	1.80	V	I <sub>F</sub> = 20 A T <sub>J</sub> =25°C	Fig. 25
			2.20	3.00		I <sub>F</sub> = 20 A T <sub>J</sub> =175°C	
I <sub>R</sub>	Reverse Current		8	150	μA	V <sub>R</sub> = 1200 V T <sub>J</sub> =25°C	Fig. 26
			50	800		V <sub>R</sub> = 1200 V T <sub>J</sub> =175°C	
C	Total Capacitance		1180		pF	V <sub>R</sub> = 1 V, T <sub>J</sub> = 25°C, f = 1 MHz	Fig. 27
			144			V <sub>R</sub> = 400 V, T <sub>J</sub> = 25°C, f = 1 MHz	
			117			V <sub>R</sub> = 800 V, T <sub>J</sub> = 25°C, f = 1 MHz	
Q <sub>C</sub>	Total Capacitive Charge		142		nC	V <sub>R</sub> = 800 V, T <sub>J</sub> = 25°C, $Q_c = \int_0^{V_R} C(V)dV$	Fig. 28
E <sub>C</sub>	Capacitance Stored Energy		44		μJ	V <sub>R</sub> = 800 V, T <sub>J</sub> = 25°C, $E_c = \int_0^{V_R} C(V) \cdot VdV$	Fig. 29

**Body Diode Characteristics** ( $T_c=25^\circ\text{C}$  unless otherwise specified)

Symbol	Parameter	Value			Unit	Test Conditions	Note
		Min.	Typ.	Max.			
$V_{SD}$	Diode forward voltage		4.9		V	$I_{SD}=20\text{A}, V_{GS}=0\text{V}$	Fig. 10, 11, 12
			4.4		V	$I_{SD}=20\text{A}, V_{GS}=0\text{V}, T_J=175^\circ\text{C}$	
$t_{rr}$	Reverse recovery time		54.6		ns	$V_{GS}=-3.5\text{V}/+20\text{V}, I_{SD}=30\text{A}, V_R=800\text{V}, di/dt=2000\text{A}/\mu\text{s}, R_{G(\text{ext})}=16\Omega, L=270\mu\text{H}$	
$Q_{rr}$	Reverse recovery charge		233		nC		
$I_{RRM}$	Peak reverse recovery current		17.2		A		

**Module Characteristics**

Symbol	Parameter	Conditions	Value			Unit
			Min.	Typ.	Max.	
$V_{ISOL}$	Isolation test voltage	RMS, $f=50\text{Hz}, t=1\text{min}$			2.5	kV
M	Terminal connection torque	Screw M4	1.1		1.5	N·m
	Mounting torque	Screw M4	1.1		1.5	N·m
G	Weight of module			27		g
	Creepage distance	Terminal to heatsink		10.61		mm
		Terminal to terminal		10.37		mm
	Clearance	Terminal to heatsink		6.7		mm
		Terminal to terminal		4.05		mm

## SiC MOSFET Typical Characteristics

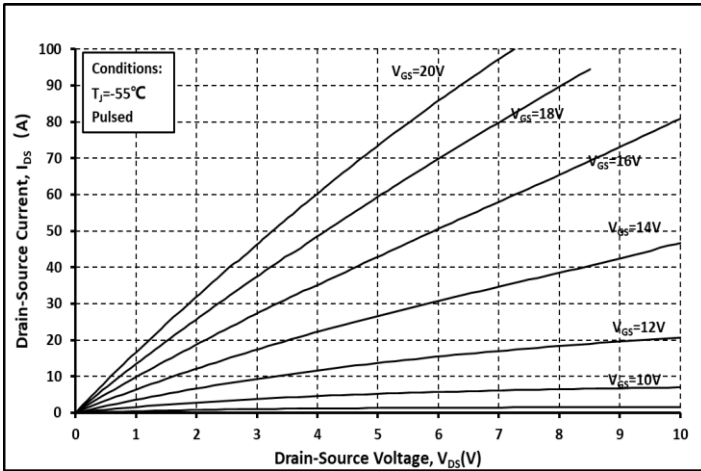


Fig. 1 Output Curve @  $T_j = -55^\circ\text{C}$

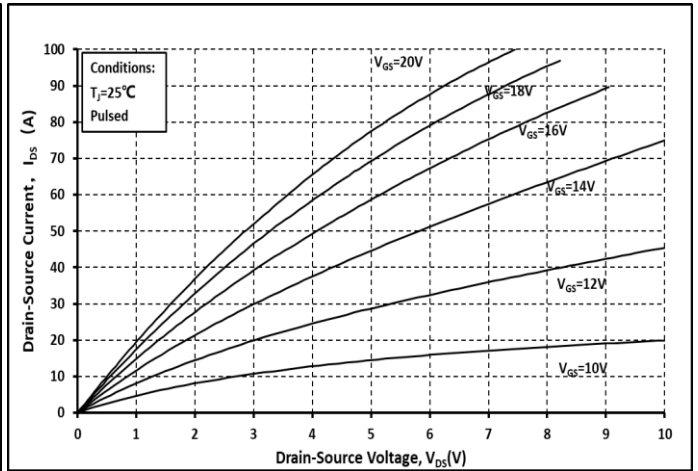


Fig. 2 Output Curve @  $T_j = 25^\circ\text{C}$

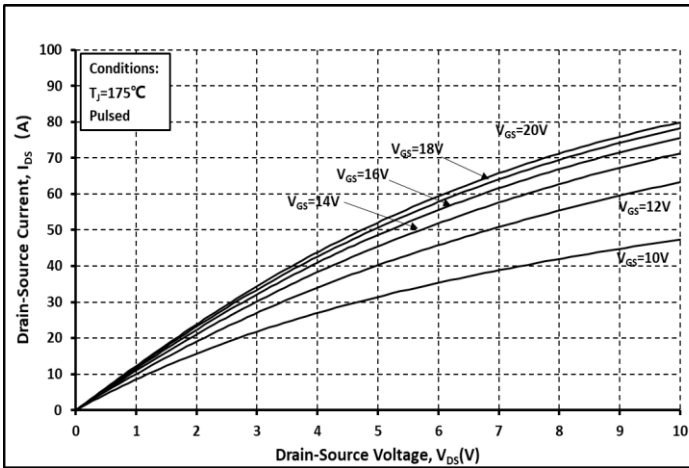


Fig. 3 Output Curve @  $T_j = 175^\circ\text{C}$

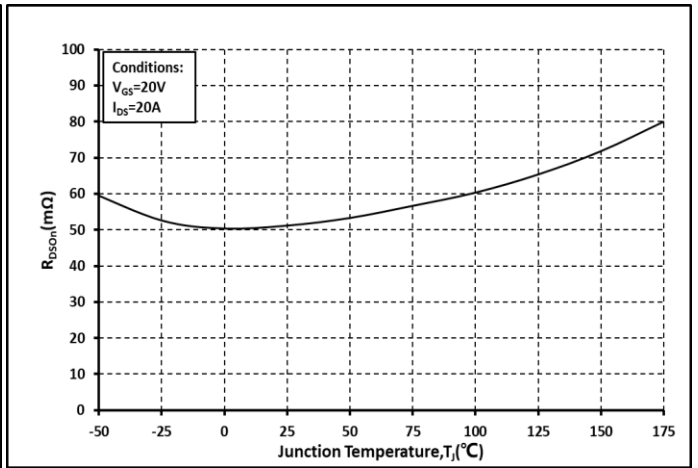


Fig. 4  $R_{on}$  vs. Temperature

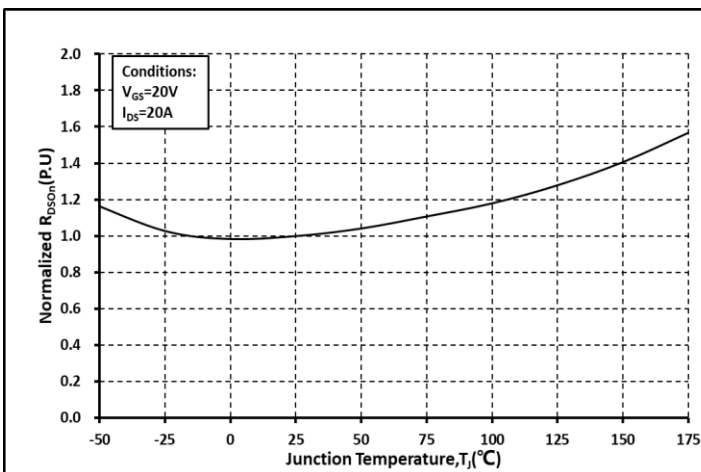


Fig. 5 Normalized  $R_{on}$  vs. Temperature

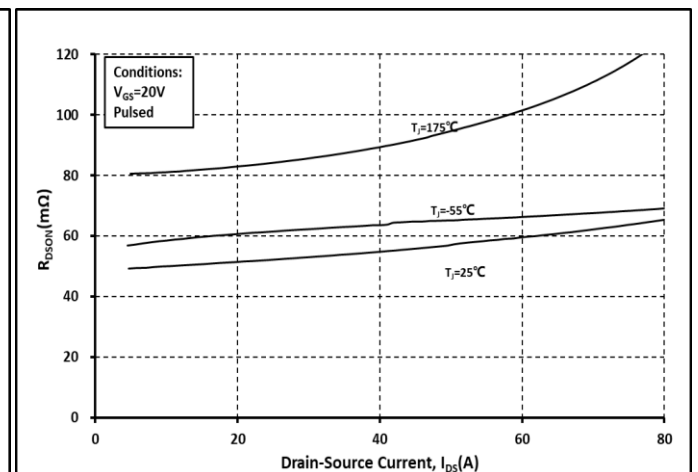


Fig. 6  $R_{on}$  vs.  $I_{DS}$  @ Various Temperature

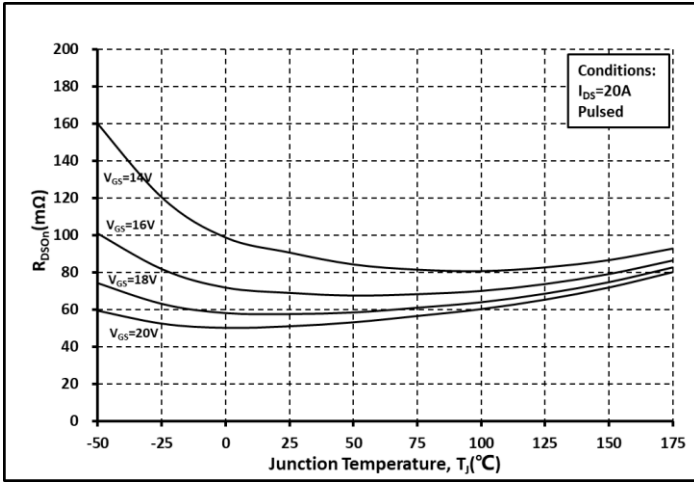


Fig. 7 Ron vs. Temperature @ Various  $V_{GS}$

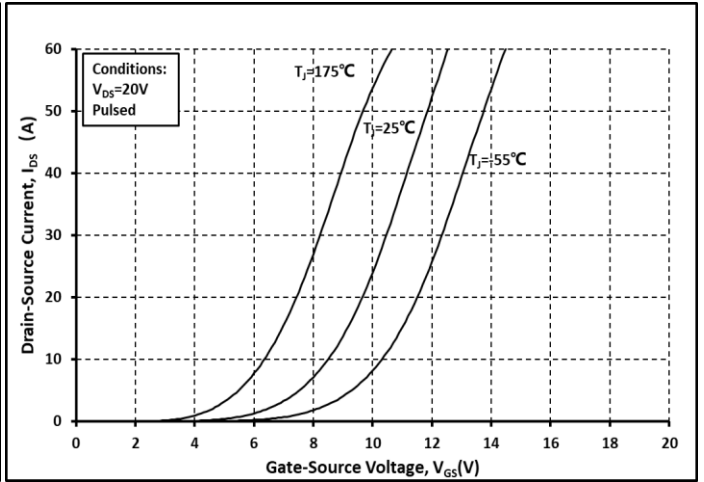


Fig. 8 Transfer Curves @ Various Temperature

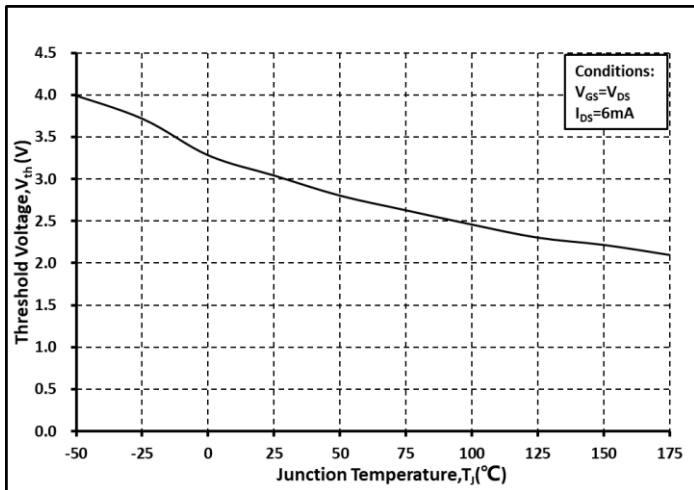


Fig. 9 Threshold Voltage vs. Temperature

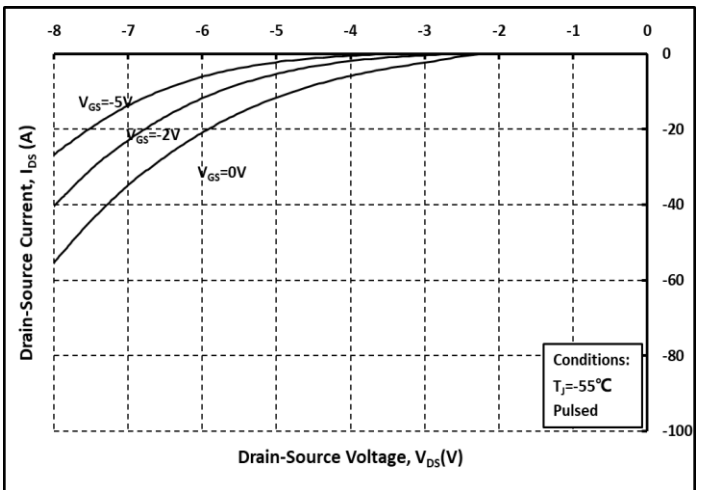


Fig. 10 Body Diode Curves @  $T_j = -55^\circ\text{C}$

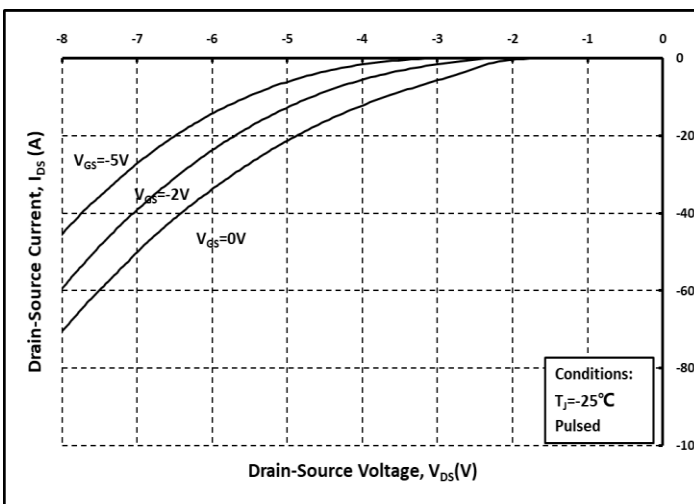


Fig. 11 Body Diode Curves @  $T_j = 25^\circ\text{C}$

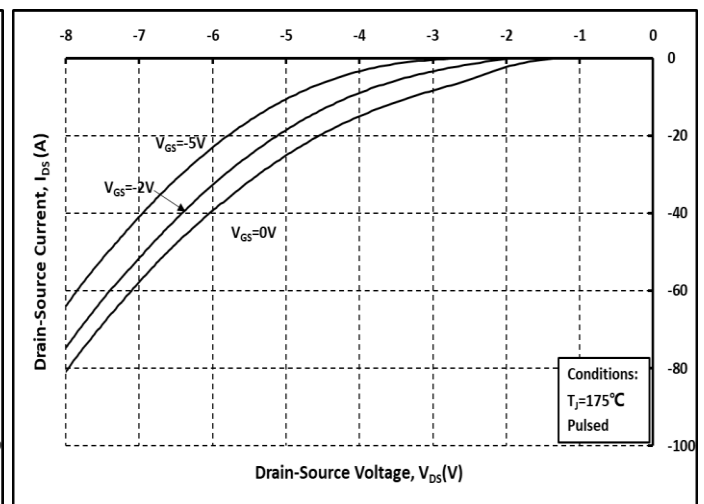


Fig. 12 Body Diode Curves @  $T_j = 175^\circ\text{C}$

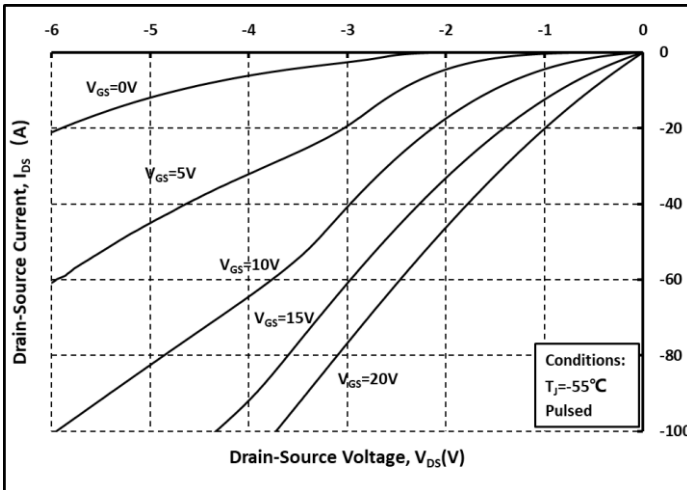


Fig. 13 3<sup>rd</sup> Quadrant Curves @  $T_j = -55^\circ\text{C}$

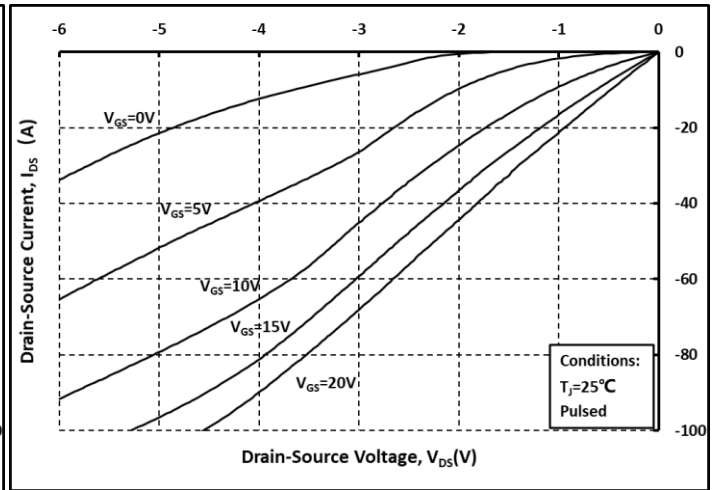


Fig. 14 3<sup>rd</sup> Quadrant Curves @  $T_j = 25^\circ\text{C}$

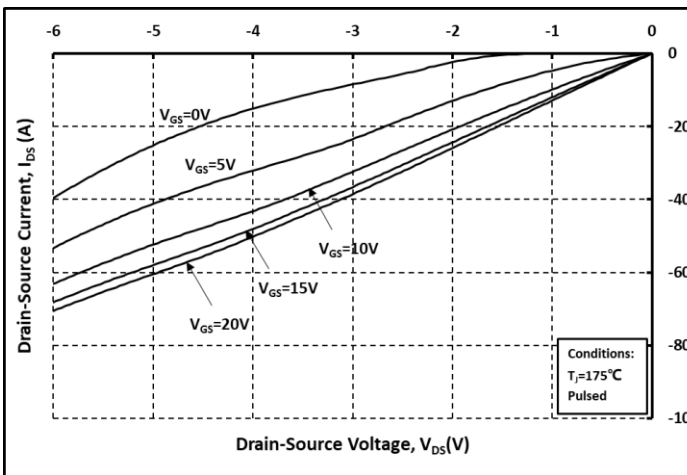


Fig. 15 3<sup>rd</sup> Quadrant Curves @  $T_j = 175^\circ\text{C}$

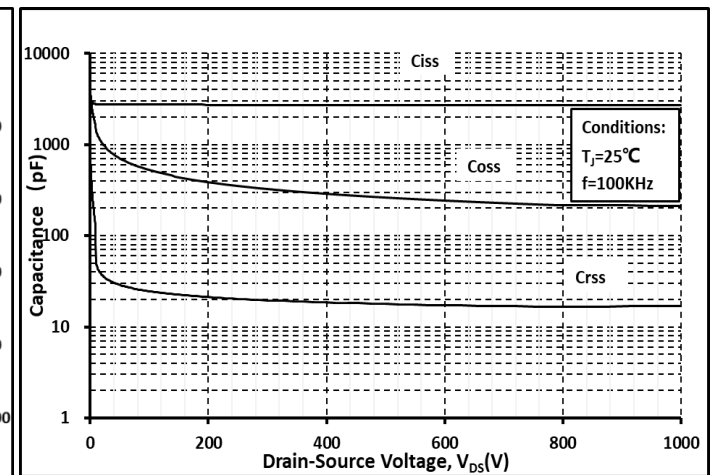


Fig. 16 Capacitance vs.  $V_{DS}$

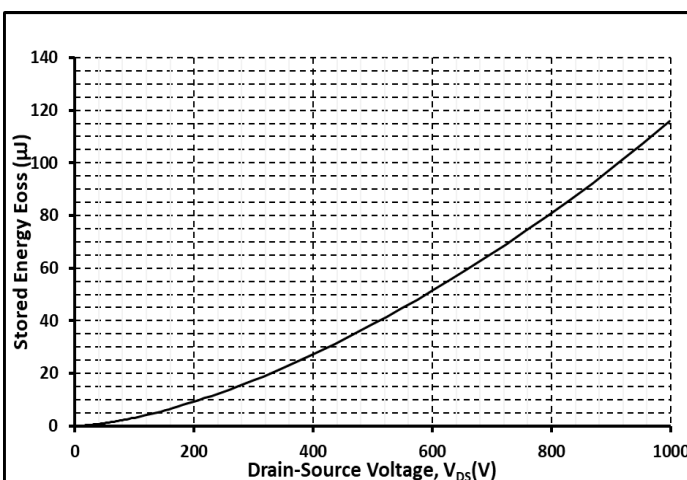


Fig. 17 Output Capacitor Stored Energy

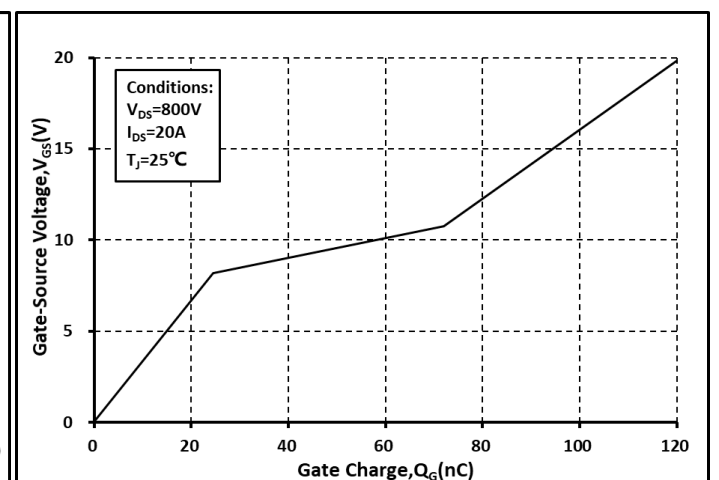


Fig. 18 Gate Charge Characteristics

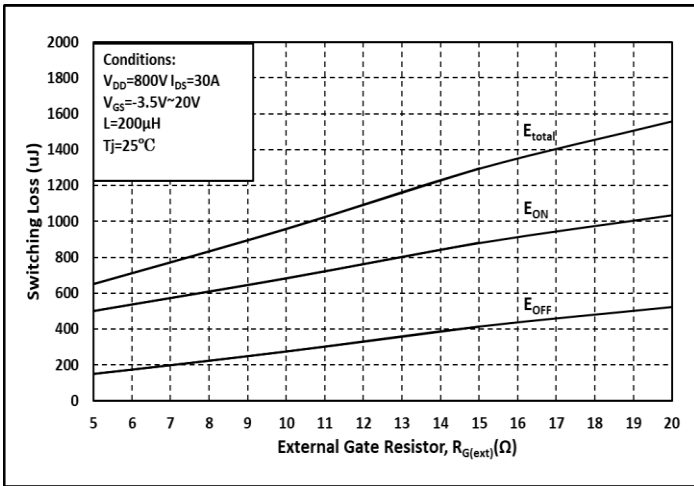


Fig. 19 Switching Energy vs.  $R_{G(ext)}$

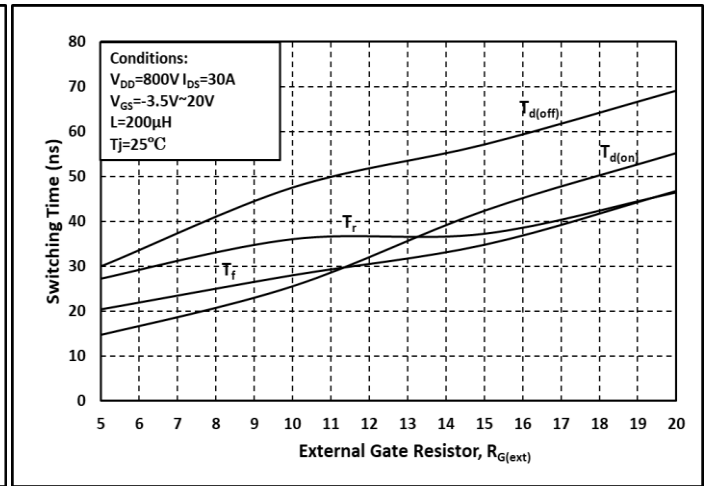


Fig. 20 Switching Times vs.  $R_{G(ext)}$

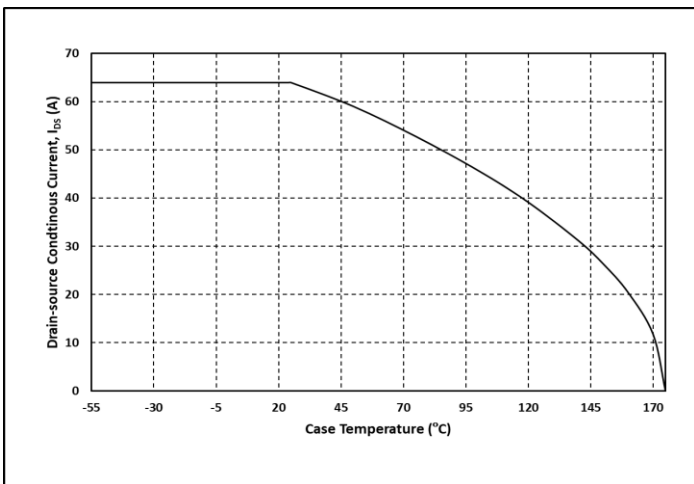


Fig. 21 Continuous Drain Current vs. Case Temperature

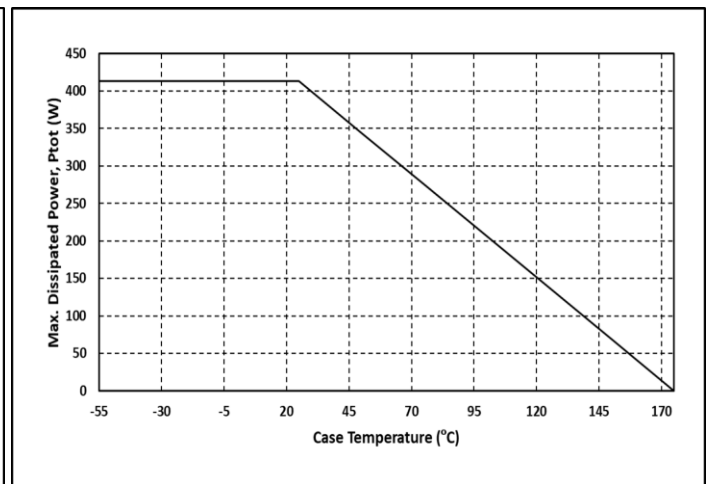


Fig. 22 Max. Power Dissipation Derating vs. Case Temperature

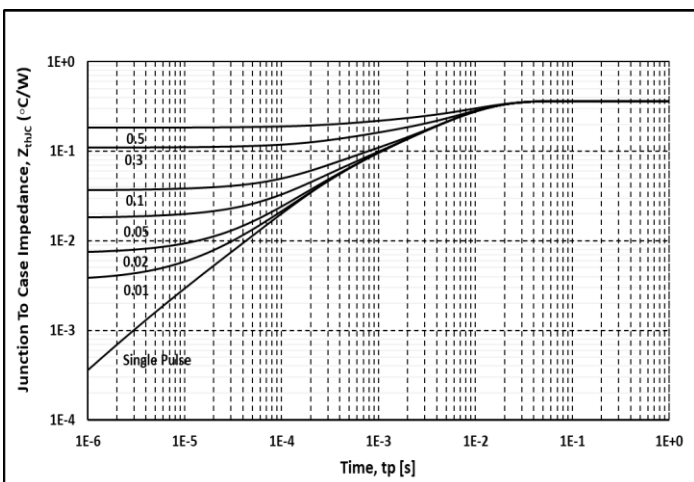


Fig. 23 Thermal Impedance

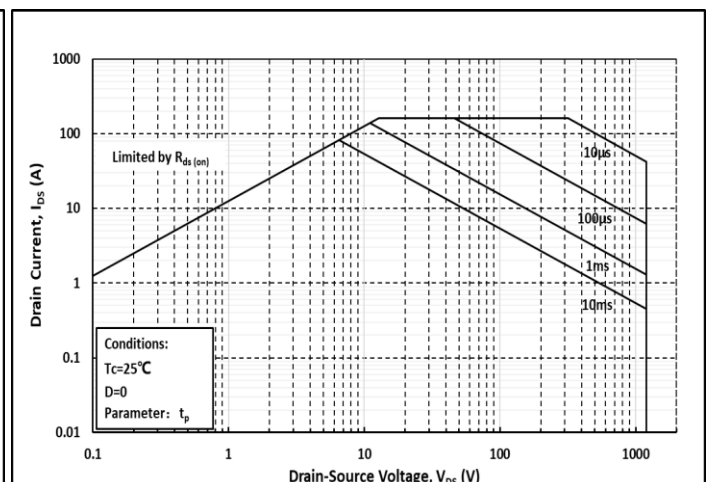


Fig. 24 Safe Operating Area



### SiC SBD Typical Characteristics

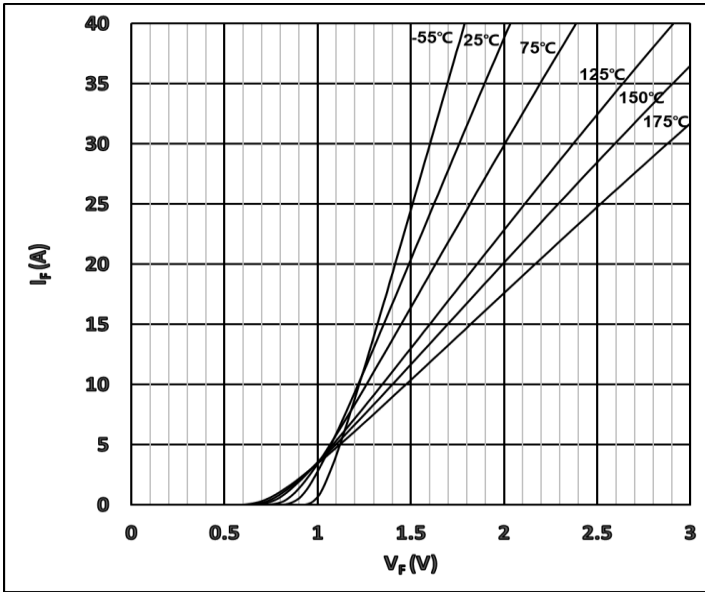


Figure 25. Typical Forward Characteristics

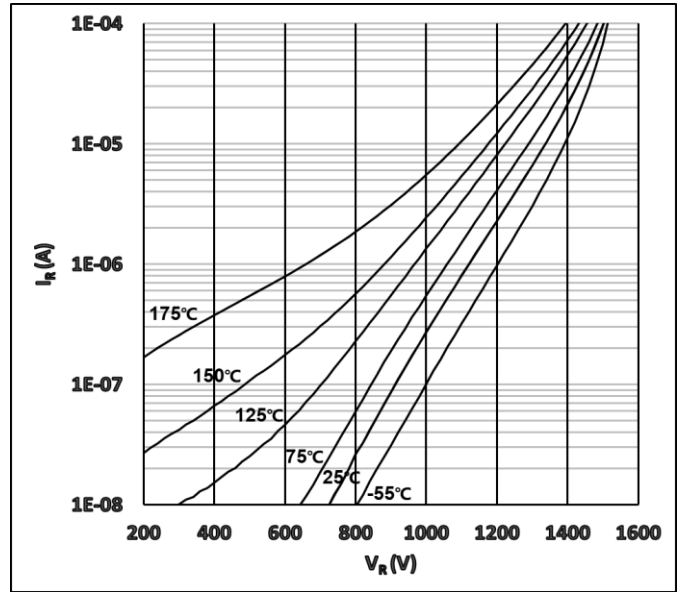


Figure 26. Typical Reverse Characteristics

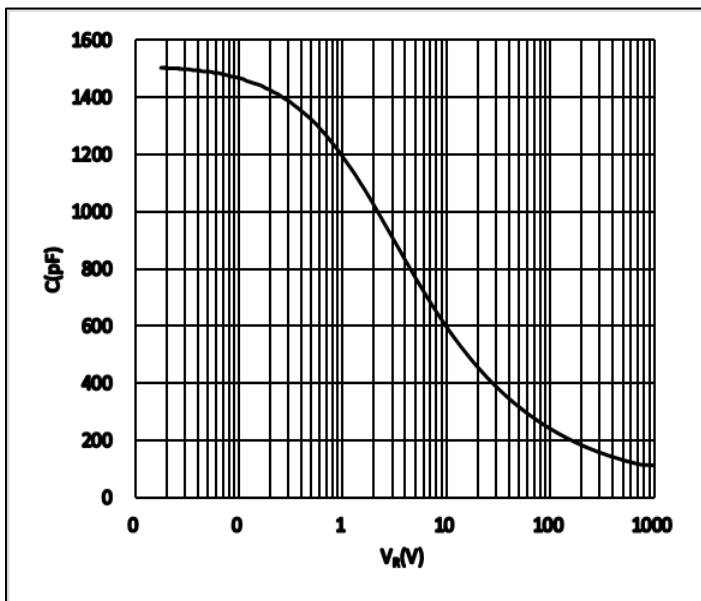


Figure 27. Capacitance vs. Reverse Voltage

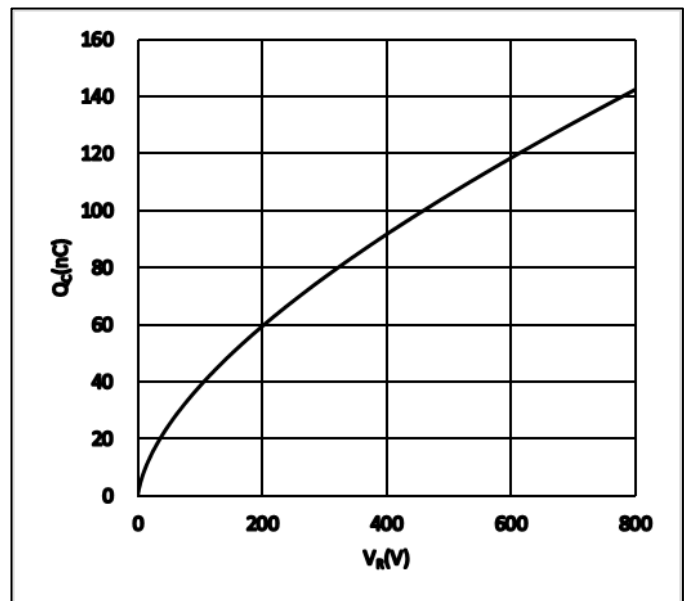


Figure 28. Recovery Charge vs. Reverse Voltage

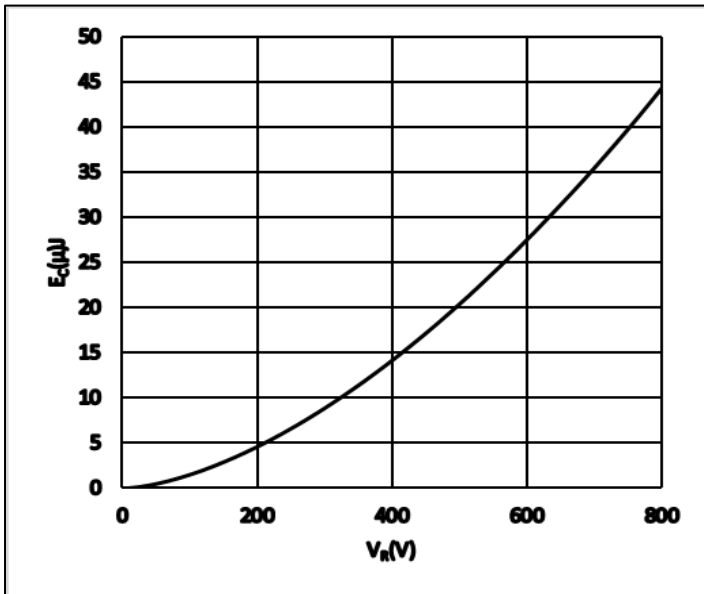


Figure 29. Capacitance Stored Energy

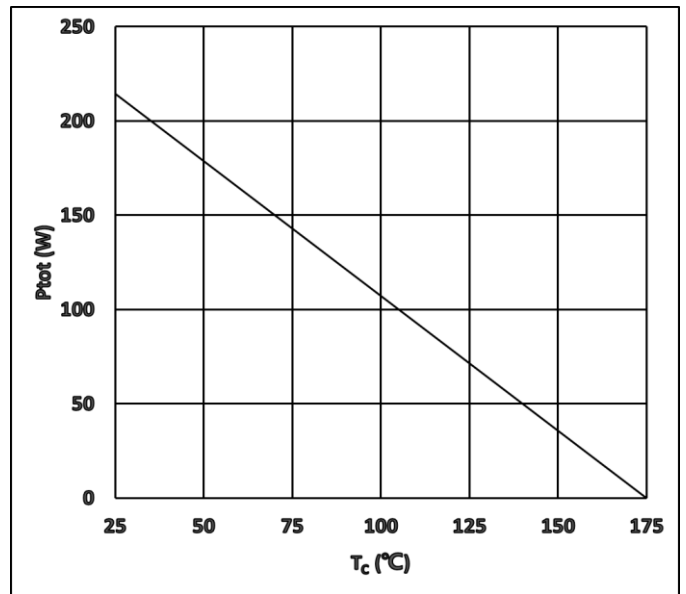
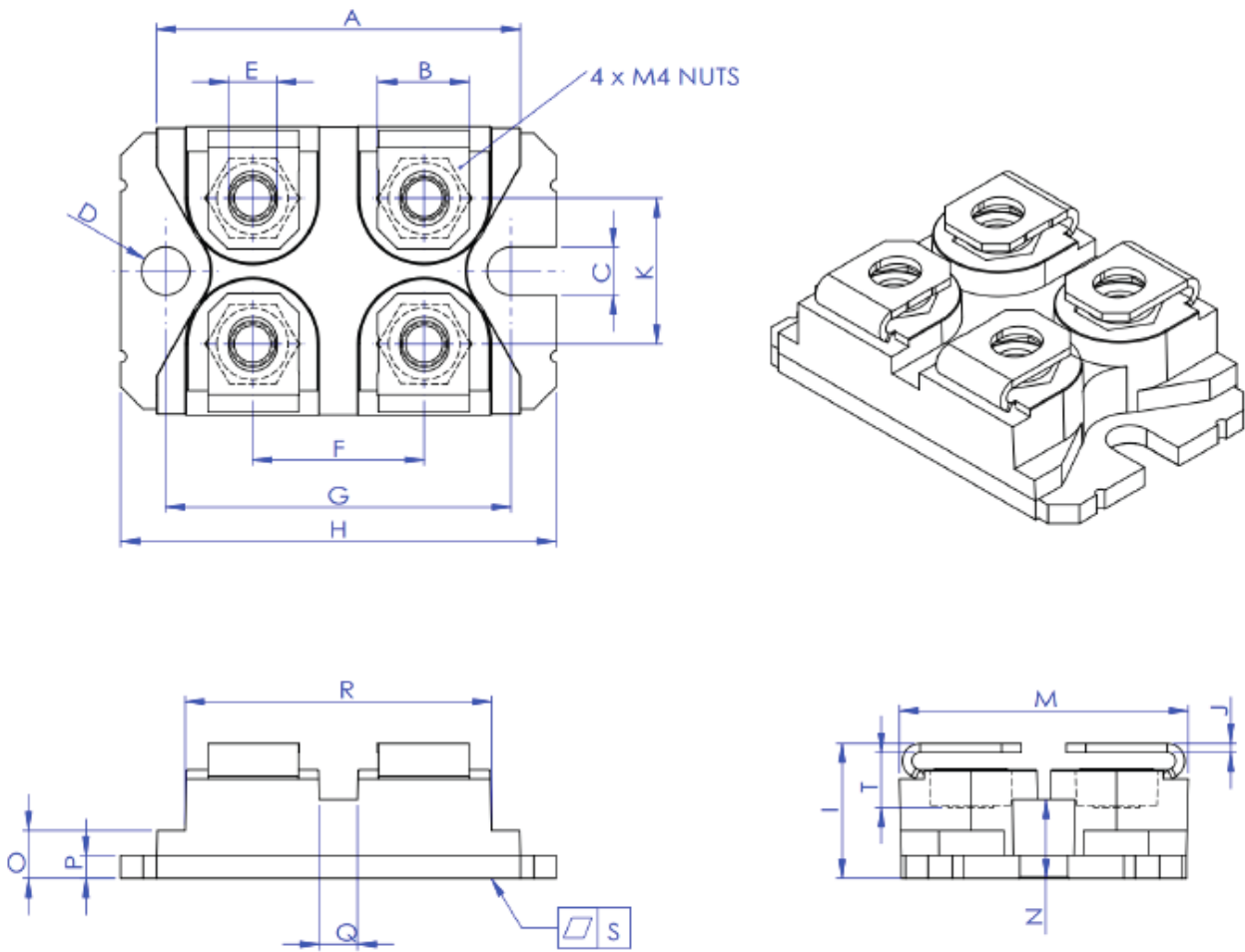


Figure 30. Power Derating

## Package Dimensions



Dimension	Millimeter		Typical
	Min	Max	
A	31.50	32.00	31.70
B	7.70	8.30	8.00
C	4.10	4.30	4.20
D	4.10	4.30	4.20
E	4.10	4.30	4.20
F	14.90	15.15	15.0
G	29.80	30.40	30.10
H	37.80	38.30	38.05
I	11.80	12.30	12.05
J	0.75	0.85	0.80
K	12.50	13.00	12.75
M	25.00	25.50	25.30
N	6.75	7.10	6.90
O	4.00	4.40	4.20
P	1.90	2.10	2.00
Q	3.20	3.60	3.40
R	26.60	27.00	26.80
S	-0.03	0.10	0.01
T	4.85	5.25	5.05

## Notes

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