

CCS050M12CM2

1.2kV, 50A Silicon Carbide Six-Pack (Three Phase) Module

Z-FET™ MOSFET and Z-Rec™ Diode

V_{DS}	1.2 kV
I_D ($T_c = 100^\circ\text{C}$)	50 A
$R_{DS(on)}$ ($T_j = 25^\circ\text{C}$)	25 mΩ
E_{OFF} ($T_j = 150^\circ\text{C}$)	0.6 mJ

Features

- Ultra Low Loss
- Zero Reverse Recovery Current
- Zero Turn-off Tail Current
- High-Frequency Operation
- Positive Temperature Coefficient on V_F and $V_{DS(on)}$
- Cu Baseplate, AIN DBC

System Benefits

- Enables Compact and Lightweight Systems
- High Efficiency Operation
- Ease of Transistor Gate Control
- Reduced Cooling Requirements
- Reduced System Cost

Applications

- Solar Inverters
- UPS and SMPS
- Induction Heating
- Regen Drives
- 3-Phase PFC
- Motor Drives

Package



Part Number	Package	Marking
CCS050M12CM2	Six-Pack	CCS050M12CM2

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

Symbol	Parameter	Value	Unit	Test Conditions	Notes
V_{DS}	Drain - Source Voltage	1.2	kV		
V_{GS}	Gate - Source Voltage	+25/-10	V		
I_D	Continuous Drain Current	87	A	$V_{GS} = 20V, T_c = 25^\circ\text{C}$	Fig. 21
		50		$V_{GS} = 20V, T_c = 100^\circ\text{C}$	
$I_{D(pulse)}$	Pulsed Drain Current	250	A	Pulse width $t_p = 50 \mu\text{s}$ Rate limited by $T_{jmax}, T_c = 25^\circ\text{C}$	
T_j	Junction Temperature	150	$^\circ\text{C}$		
T_c, T_{STG}	Case and Storage Temperature Range	-40 to +150	$^\circ\text{C}$		
V_{isol}	Case Isolation Voltage	2.5	kV	DC, $t = 1\text{min}$	
L_{Stray}	Stray Inductance	30	nH	Measured from pins 20 to 21	
M	Mounting Torque	5.0	Nm		
G	Weight	180	g		
P_D	Power Dissipation	337	W	$T_c = 25^\circ\text{C}, T_j < 150^\circ\text{C}$	

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

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
$V_{(BR)DSS}$	Drain - Source Breakdown Voltage	1.2			kV	$V_{GS} = 0V, I_D = 100\text{ }\mu\text{A}$	
$V_{GS(th)}$	Gate Threshold Voltage		2.3		V	$V_{DS} = 10\text{ V}, I_D = 2.5\text{ mA}$	
			1.6			$V_{DS} = 10\text{ V}, I_D = 2.5\text{ mA}, T_J = 150^\circ\text{C}$	
I_{DSS}	Zero Gate Voltage Drain Current		2	100	μA	$V_{DS} = 1.2\text{ kV}, V_{GS} = 0V$	
I_{GSS}	Gate-Source Leakage Current			0.5	μA	$V_{GS} = 20\text{ V}, V_{DS} = 0V$	
$R_{DS(on)}$	On State Resistance		25	34	$\text{m}\Omega$	$V_{GS} = 20\text{ V}, I_D = 50\text{ A}$	Fig. 4 5,6,7
			43	63		$V_{GS} = 20\text{ V}, I_D = 50\text{ A}, T_J = 150^\circ\text{C}$	
g_{fs}	Transconductance		22		S	$V_{DS} = 20\text{ V}, I_D = 50\text{ A}$	Fig. 8
			21			$V_{DS} = 20\text{ V}, I_D = 50\text{ A}, T_J = 150^\circ\text{C}$	
C_{iss}	Input Capacitance		2.810		nF	$V_{DS} = 800V, V_{GS} = 0V$ $f = 1\text{ MHz}, V_{AC} = 25\text{ mV}$	Fig. 16,17
C_{oss}	Output Capacitance		0.393				
C_{rss}	Reverse Transfer Capacitance		0.014				
E_{ON}	Turn-On Switching Energy		1.1		mJ	$V_{DD} = 600V, V_{GS} = +20V/-5V$ $I_D = 50A, R_G = 20\Omega$ Inductive Load = 200 μH Note: IEC 60747-8-4 Definitions	Fig. 18
E_{Off}	Turn-Off Switching Energy		0.6		mJ		
R_G	Internal Gate Resistance		1.5		Ω	$f = 1\text{ MHz}, V_{AC} = 25\text{ mV}$	
Q_G	Gate Charge		180		nC	$V_{DD} = 800V, I_D = 50A$	Fig. 15

Resistive Switching

$t_{d(on)}$	Turn-on delay time		21		ns	$V_{DD} = 800V, R_{LOAD} = 8\text{ }\Omega$ $V_{GS} = +20/-2V, R_G = 3.8\text{ }\Omega$ Note: IEC 60747-8-4 Definitions	
$t_{r(on)}$	V_{SD} fall time 90% to 10%		30		ns		
$t_{d(off)}$	Turn-off delay time		50		ns		
$t_{f(off)}$	V_{SD} rise time 10% to 90%		19		ns		

Module Application Note: The SiC MOSFET module switches at speeds beyond what is customarily associated with IGBT based modules. Therefore, special precautions are required to realize the best performance. The interconnection between the gate driver and module housing needs to be as short as possible. This will afford the best switching time and avoid the potential for device oscillation. Also, great care is required to insure minimum inductance between the module and link capacitors to avoid excessive V_{DS} overshoots.

Free-Wheeling SiC Schottky Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
V_{SD}	Diode Forward Voltage		1.6	1.85	V	$I_F = 50A, V_{GS} = 0$	
			2.2			$I_F = 50A, T_J = 150^{\circ}C$	
Q_C	Total Capacitive Charge		280		μC	$I_F = 25A, V_R = 1000V$ $di_F/dt = 500 A/\mu s, T_J = 25^{\circ}C$	
t_{RR}	Reverse Recovery Time		TBD		ns		
E_{RR}	Reverse Recovery Energy		TBD		mJ		
C	Total Capacitance		3.42		nF	$V_R=0V, f = 1MHz, T_J = 25^{\circ}C$	
			0.23			$V_R=400V, f = 1MHz, T_J = 25^{\circ}C$	
			0.18			$V_R=800V, f = 1MHz, T_J = 25^{\circ}C$	
I_F	Continuous Forward Current		50		A	$V_{GS} = -5V, T_{case} = 100^{\circ}C$	

Thermal Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
R_{thJCM}	Thermal Resistance Junction-to-Case for MOSFET		0.37	0.49	$^{\circ}C/W$		
R_{thJCD}	Thermal Resistance Junction-to-Case for Diode		0.42	0.48			

Typical Performance

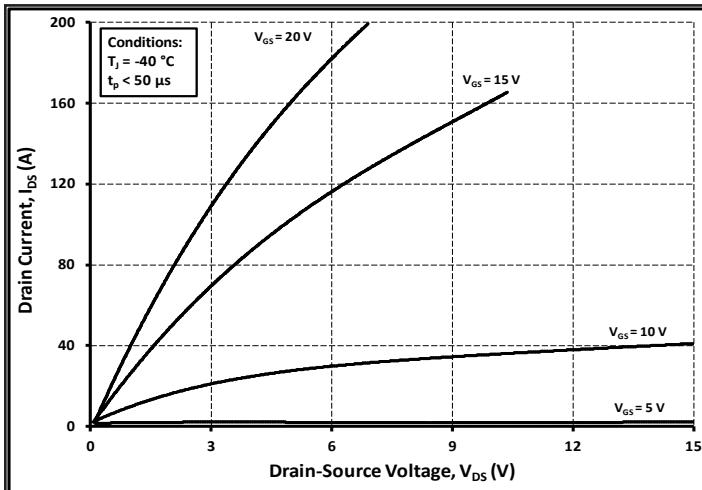


Figure 1. Typical Output Characteristics $T_j = -40^\circ\text{C}$

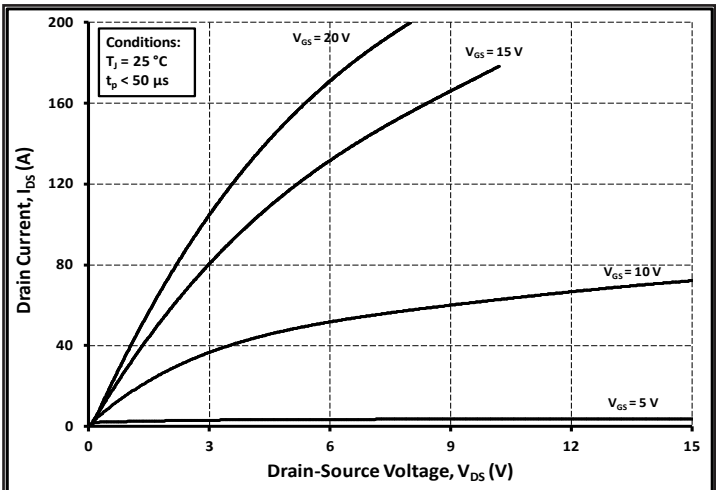


Figure 2. Typical Output Characteristics $T_j = 25^\circ\text{C}$

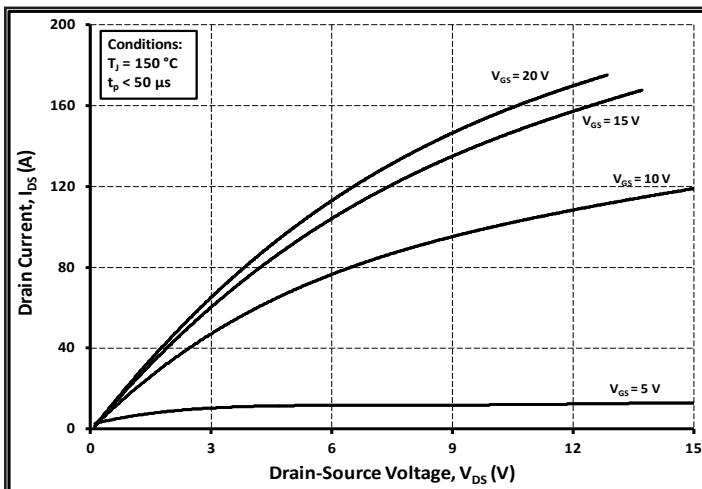


Figure 3. Typical Output Characteristics $T_j = 150^\circ\text{C}$

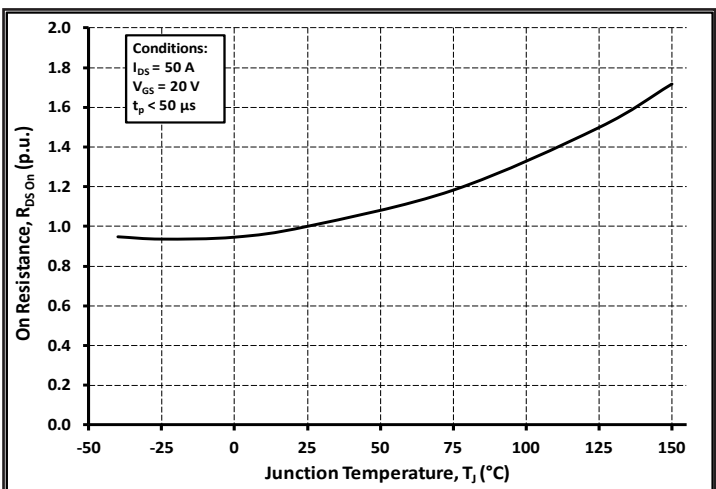


Figure 4. Normalized On-Resistance vs. Temperature

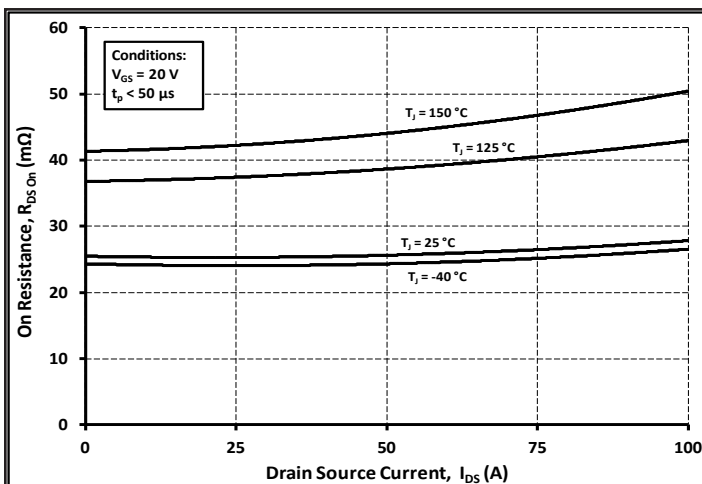


Figure 5. Normalized On-Resistance vs. Drain Current For Various Temperatures

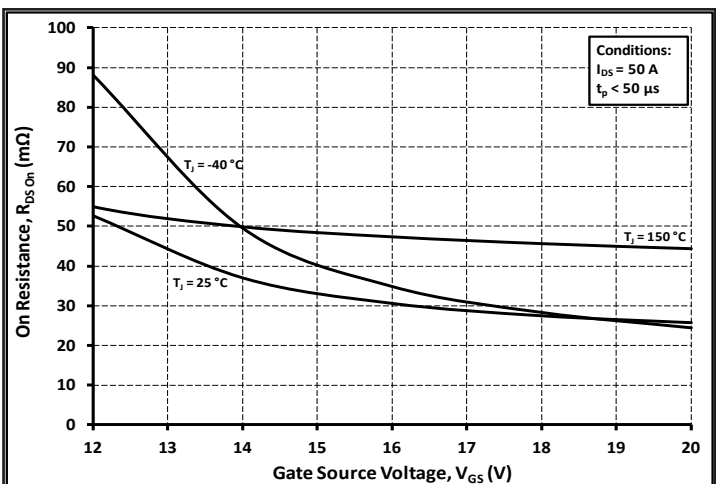


Figure 6. Normalized On-Resistance vs. Gate-Source Voltage for Various Temperatures

Typical Performance

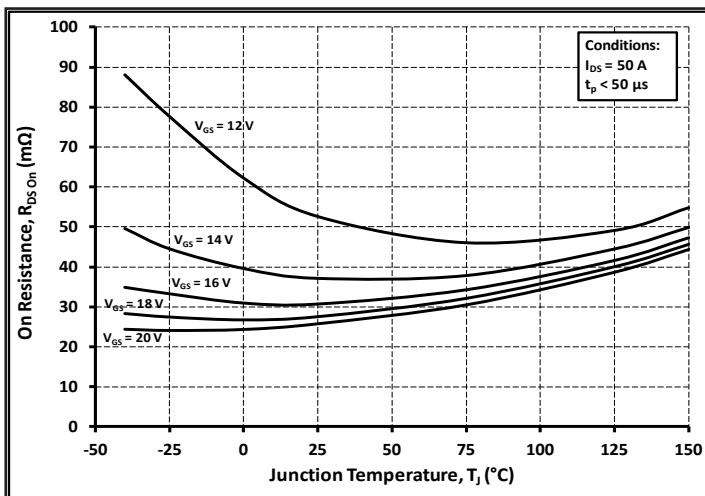


Figure 7. On-Resistance vs. Temperature for Various Gate-Source Voltages

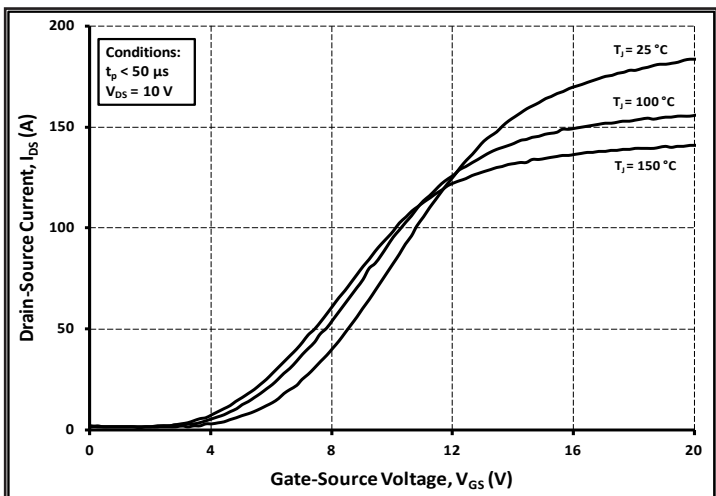


Figure 8. Transfer Characteristic for Various Junction Temperatures

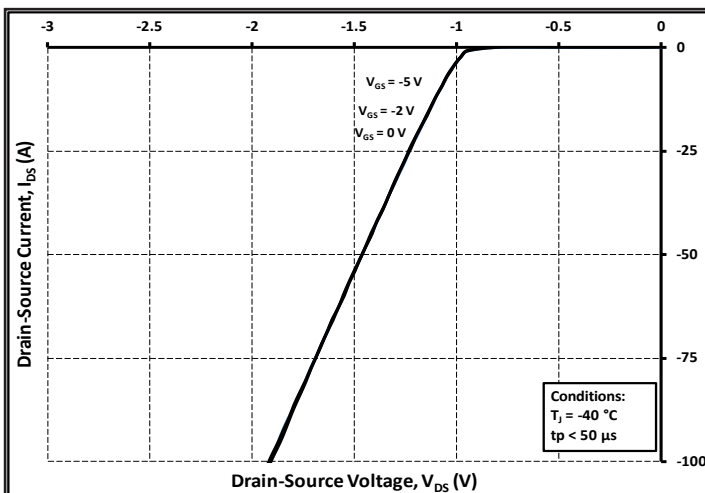


Figure 9. Diode Characteristic at -40°C

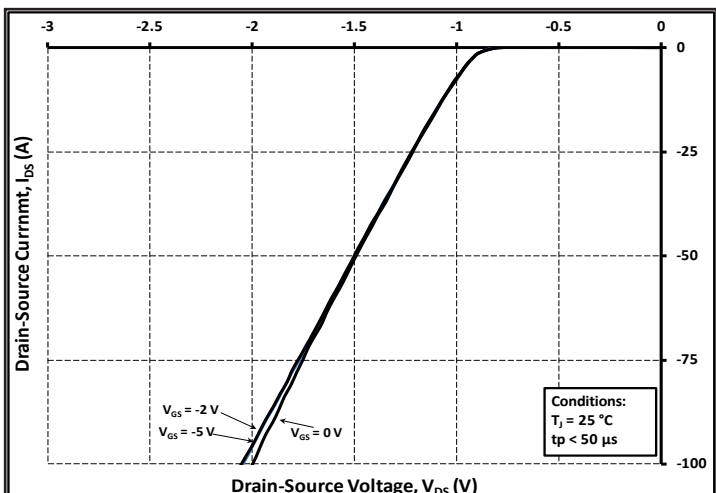


Figure 10. Diode Characteristic at 25°C

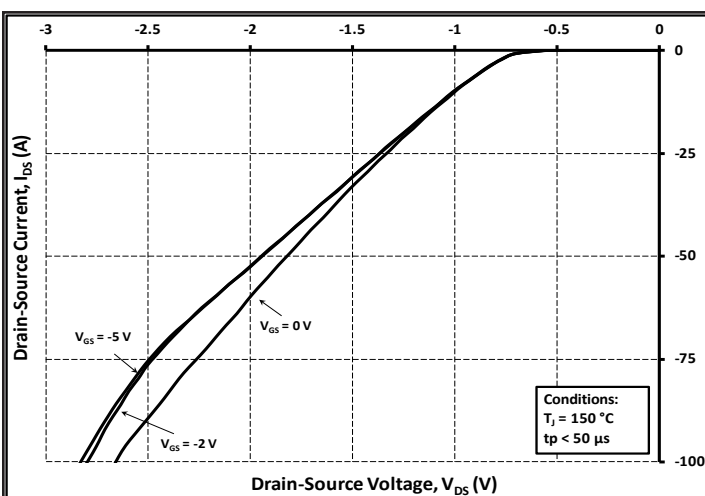


Figure 11. Diode Characteristic at 150°C

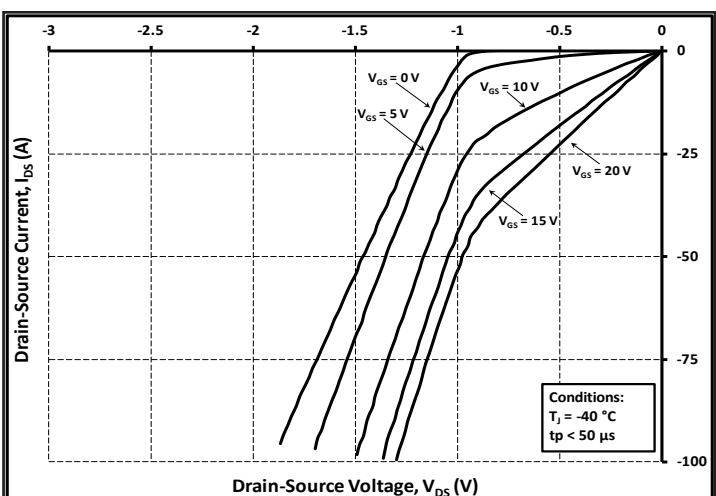


Figure 12. 3rd Quadrant Characteristic at -40°C

Typical Performance

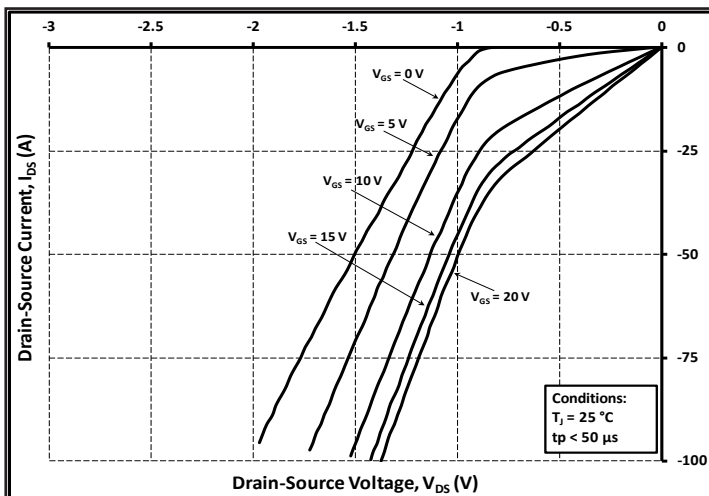


Figure 13. 3rd Quadrant Characteristic at 25°C

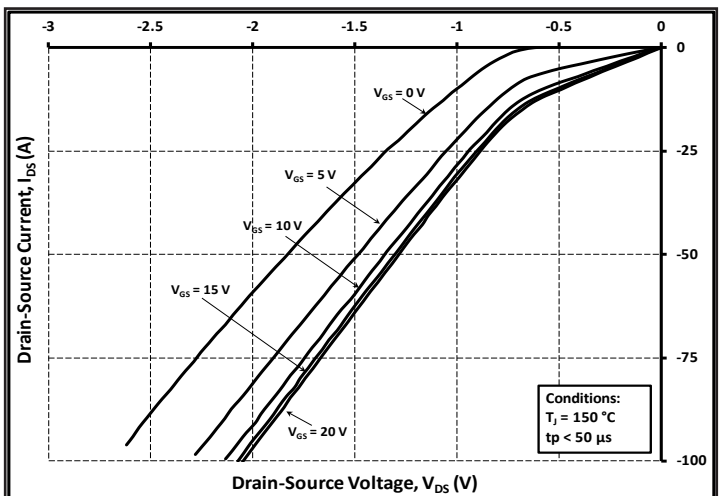


Figure 14. 3rd Quadrant Characteristic at 150°C

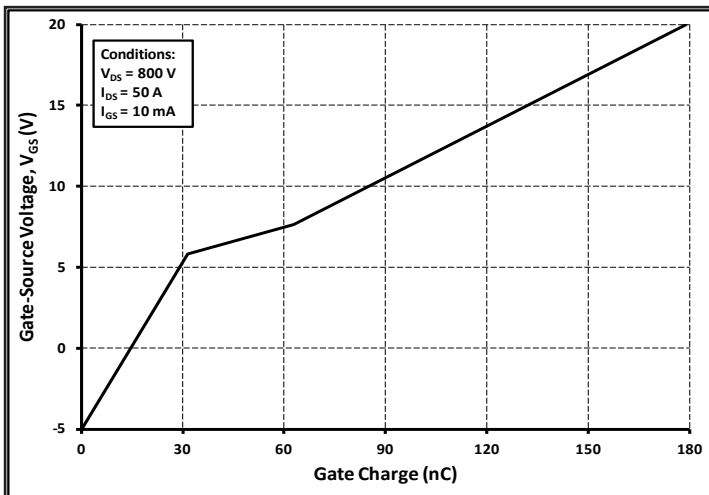


Figure 15. Typical Gate Charge Characteristics

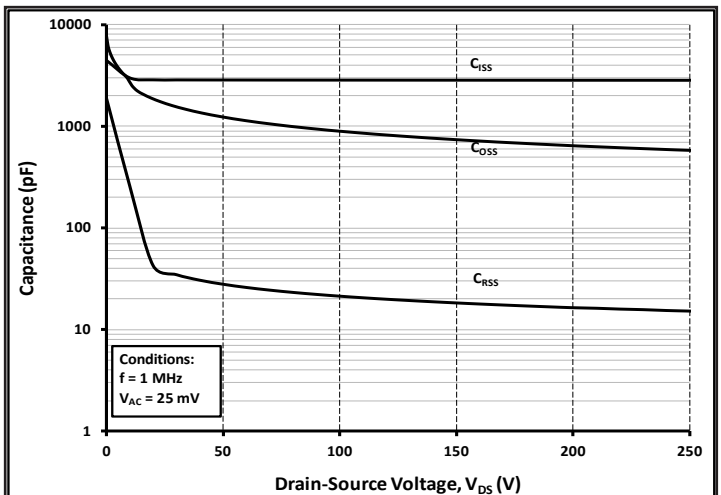


Figure 16. Typical Capacitances vs. Drain-Source Voltage (0 - 250V)

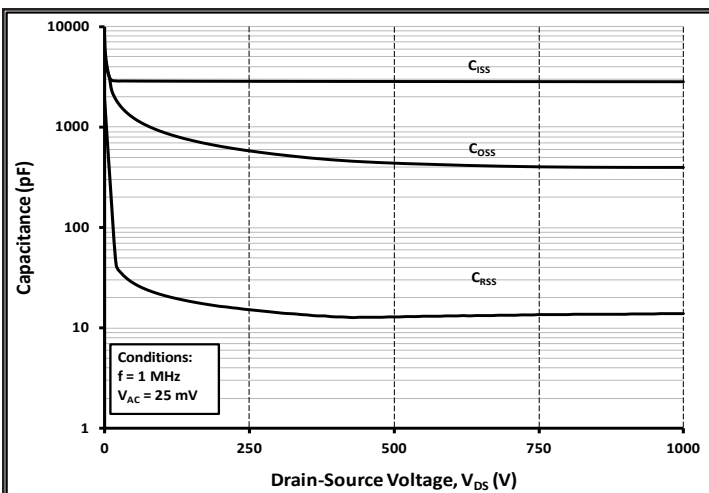


Figure 17. Typical Capacitances vs. Drain-Source Voltage (0 - 1000V)

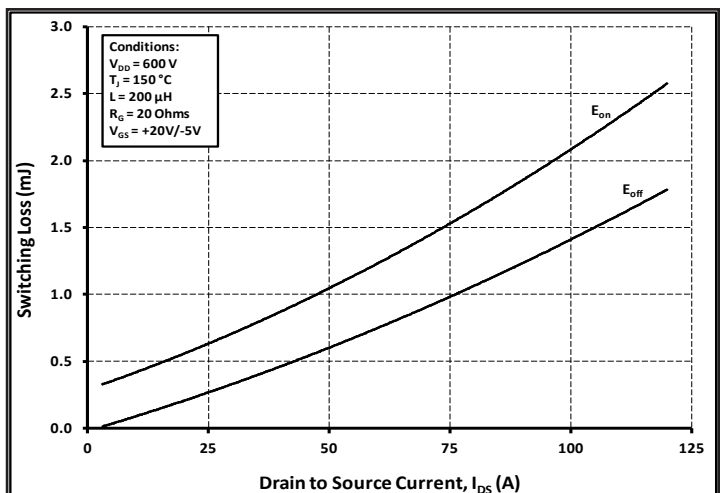


Figure 18. Inductive Switching Energy vs. Drain Current For $V_{DS} = 600V$, $R_G = 20 \Omega$

Typical Performance

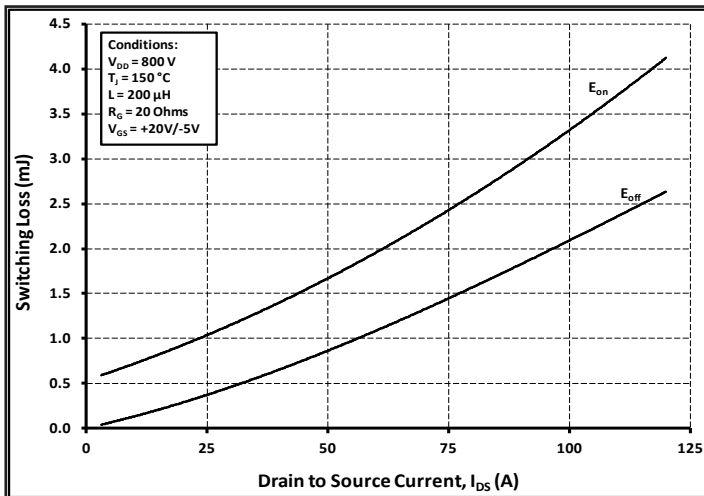


Figure 19. Inductive Switching Energy vs. Drain Current For $V_{DS} = 800\text{V}$, $R_G = 20\text{ }\Omega$

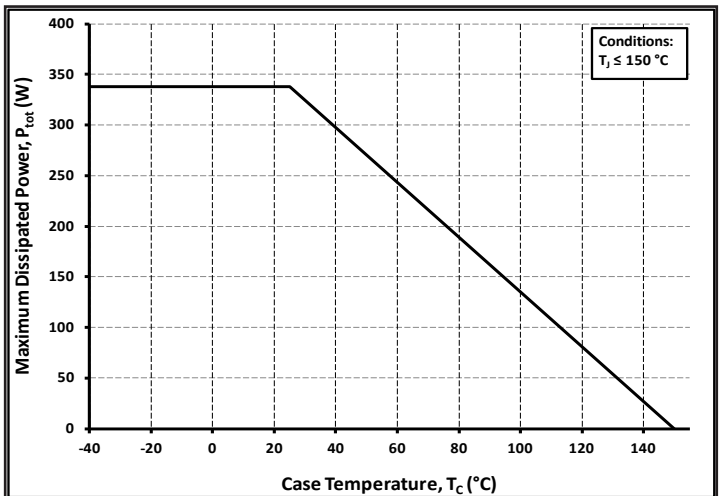


Figure 20. Power Dissipation Derating Curve

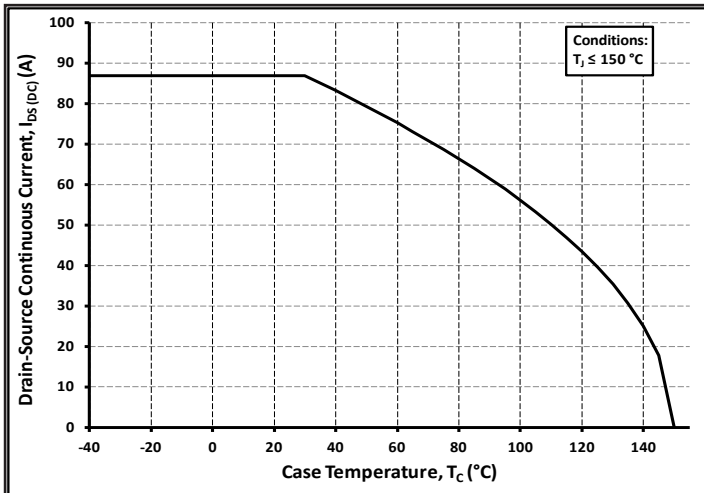
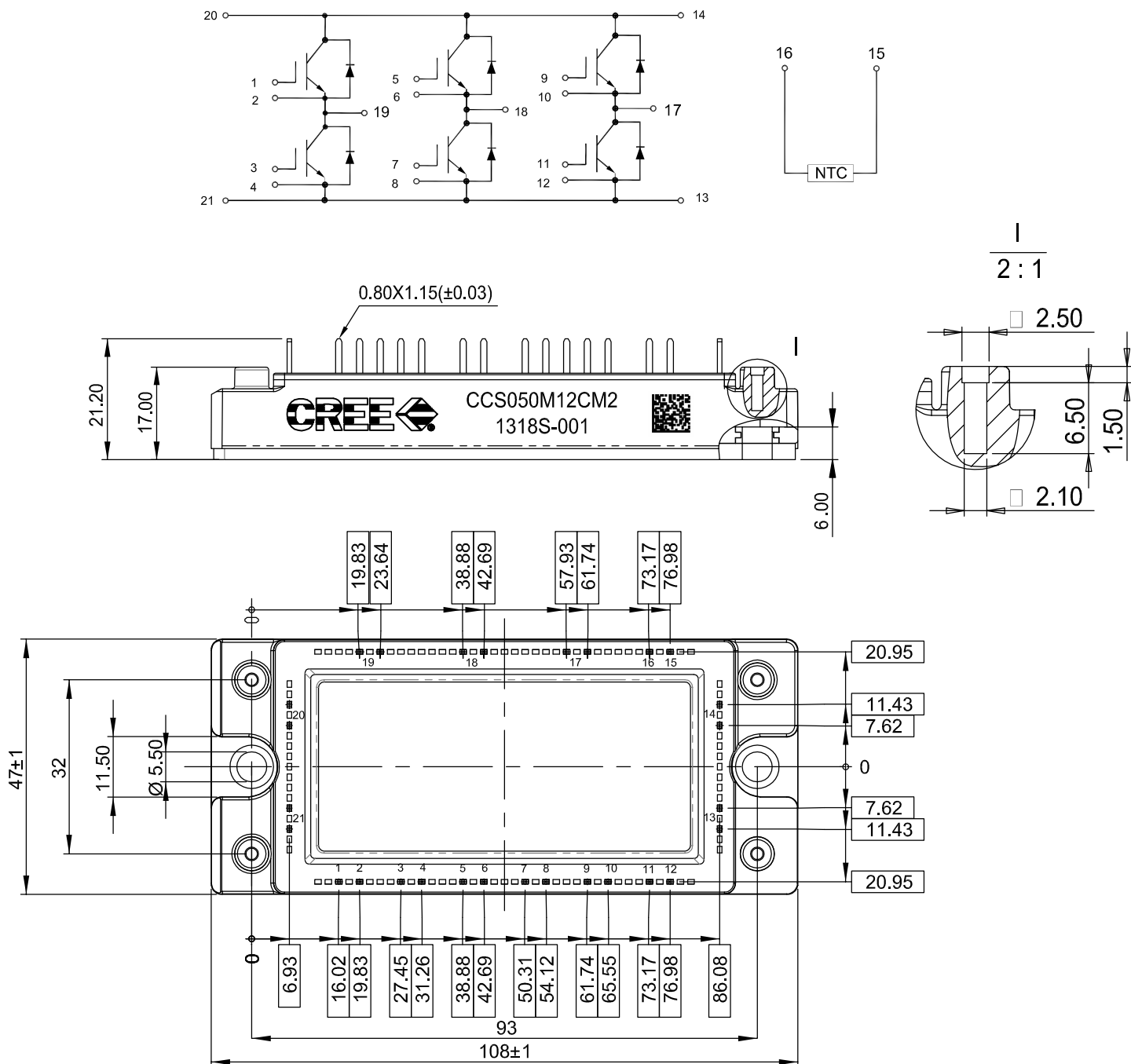


Figure 21. Continuous Current Derating Curve

Package Dimensions (mm)



This product has not been designed or tested for use in, and is not intended for use in, applications implanted into the human body nor in applications in which failure of the product could lead to death, personal injury or property damage, including but not limited to equipment used in the operation of nuclear facilities, life-support machines, cardiac defibrillators or similar emergency medical equipment, aircraft navigation or communication or control systems, air traffic control systems, or weapons systems.

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