CCS050M12CM2

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

Z-FET™ MOSFET and Z-Rec™ Diode

V_{DS}		1.2 kV
$R_{DS(on)}$	(T_J = 25˚C)	25 mΩ
E_{OFF}	(T_J = 150˚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, AlN 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˚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} = 20 V, T_C = 25 ˚C	Fig. 26
		59		V_{GS} = 20 V, T_C = 90 ˚C	
$I_{D(pulse)}$	Pulsed Drain Current	250	A	Pulse width t_P = 250 μs Rate limited by T_{jmax}, T_C = 25˚C	Fig. 28
T_J	Junction Temperature	150	˚C		
T_C, T_{STG}	Case and Storage Temperature Range	-40 to +125	˚C		
V_{isol}	Case Isolation Voltage	2.5	kV	DC, t = 1 min	
L_{Stray}	Stray Inductance	30	nH	Measured from pins 25-26 to 27-28	
M	Mounting Torque	5.0	N-m		
G	Weight	180	g		
P_D	Power Dissipation	312	W	T_C = 25 ˚C, T_J ≤ 150 ˚C	Fig. 27

Electrical Characteristics (T_C = 25 °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} = 0 V, I_D = 100 μA	
$V_{GS(th)}$	Gate Threshold Voltage		2.3		V	V_{DS} = 10 V, I_D = 2.5 mA	
			1.6			V_{DS} = 10 V, I_D = 2.5 mA, T_J = 150 °C	
I_{DSS}	Zero Gate Voltage Drain Current		2	100	μA	V_{DS} = 1.2 kV, V_{GS} = 0V	
I_{GSS}	Gate-Source Leakage Current			0.5	μA	V_{GS} = 20 V, V_{DS} = 0V	
$R_{DS(on)}$	On State Resistance		25	34	mΩ	V_{GS} = 20 V, I_{DS} = 50 A	Fig. 4-7
			43	63		V_{GS} = 20 V, I_{DS} = 50 A, T_J = 150 °C	
g_{fs}	Transconductance		22		S	V_{DS} = 20 V, I_{DS} = 50 A	Fig. 8
			21			V_{DS} = 20 V, I_D = 50 A, T_J = 150 °C	
C_{iss}	Input Capacitance		2.810		nF	V_{DS} = 800 V, V_{GS} = 0 V f = 1 MHz, V_{AC} = 25 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} = 600 V, V_{GS} = +20V/-5V I_D = 50 A, R_G = 20 Ω Load = 200 μH T_J = 150 °C Note: IEC 60747-8-4 Definitions	Fig. 18
E_{Off}	Turn-Off Switching Energy		0.6		mJ		
$R_{G\,(int)}$	Internal Gate Resistance		1.5		Ω	f = 1 MHz, V_{AC} = 25 mV	
Q_{GS}	Gate-Source Charge		32		nC	V_{DD}= 800 V, I_D= 50 A	Fig. 15
Q_{GD}	Gate-Drain Charge		30				
Q_G	Total Gate Charge		180				
$t_{d(on)}$	Turn-on delay time		21		ns	V_{DD} = 800V, R_{LOAD} = 8 Ω V_{GS} = +20/-2V, R_G = 3.8 Ω T_J = 25 °C Note: IEC 60747-8-4 Definitions	Fig. 20-25
$t_{r(on)}$	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		

Free-Wheeling SiC Schottky Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
V_{SD}	Diode Forward Voltage		1.5	1.7	V	I_F = 50 A, V_{GS} = 0	Fig. 9
			2.0	2.3		I_F = 50 A, T_J = 150 °C	
Q_C	Total Capacitive Charge		0.28		μC		
I_F	Continuous Forward Current		50		A	V_{GS} = -5 V, T_c = 90 °C	

Thermal Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
R_{thJCM}	Thermal Resistance Juction-to-Case for MOSFET		0.37	0.40	°C/W	T_c = 90 °C, P_D = 150 W	
R_{thJCD}	Thermal Resistance Juction-to-Case for Diode		0.42	0.43		T_c = 90 °C, P_D = 130 W	

NTC Characteristics

Symbol	Condition	Typ.	Max.	Unit
R_{25}	T_C = 25 °C	5		kΩ
Delta R/R	T_C = 100 °C, R_{100} = 481 Ω		±5	%
P_{25}	T_C = 25 °C			mW
$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2-1/(298.15K))]$	3380		K
$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2-1/(298.15K))]$	3440		K

Typical Performance

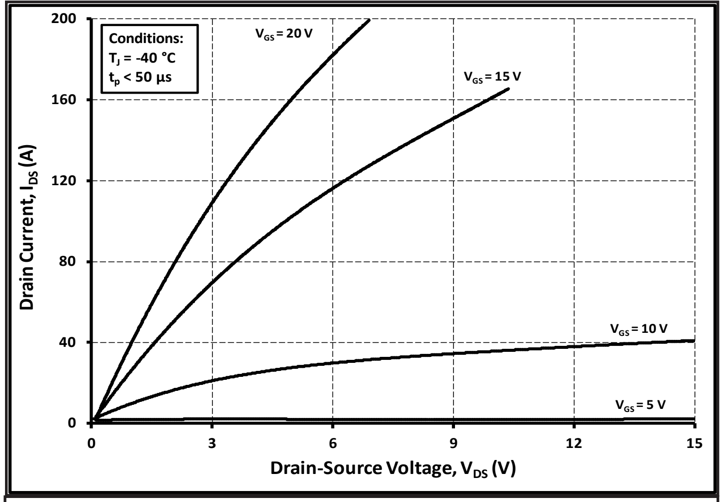


Figure 1. Typical Output Characteristics T_J = -40 °C

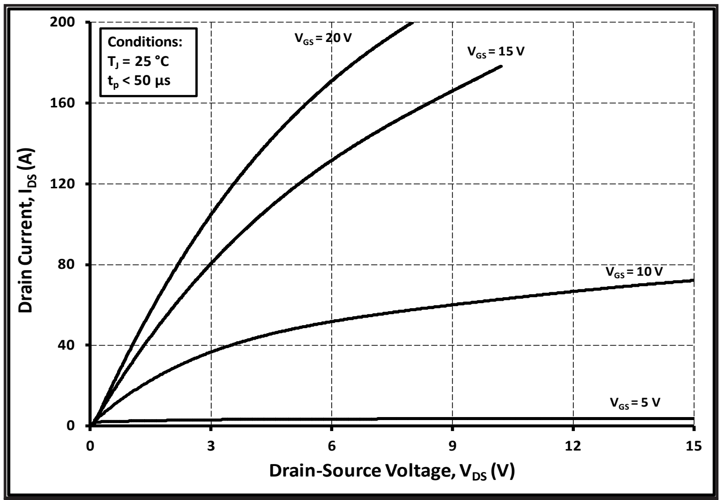


Figure 2. Typical Output Characteristics T_J = 25 °C

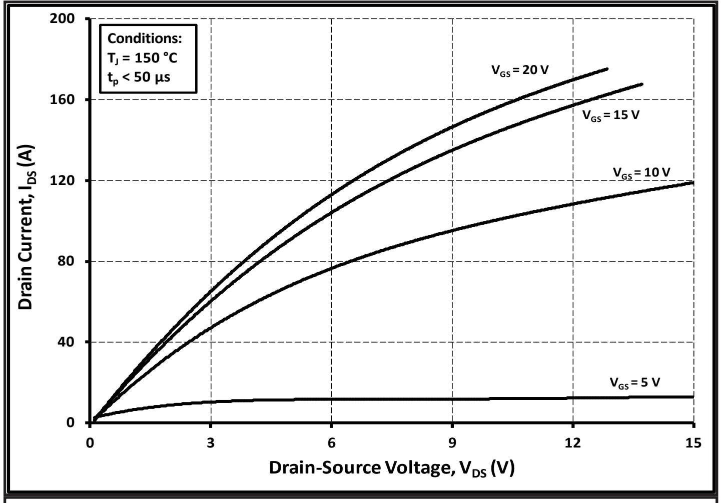


Figure 3. Typical Output Characteristics T_J = 150 °C

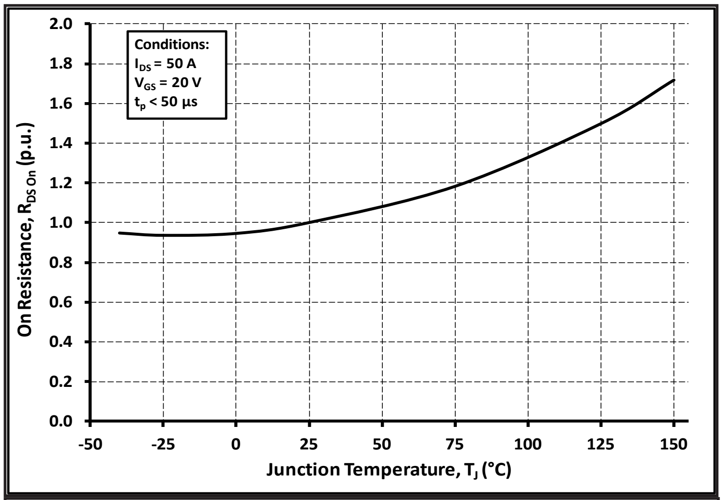


Figure 4. Normalized On-Resistance vs. Temperature

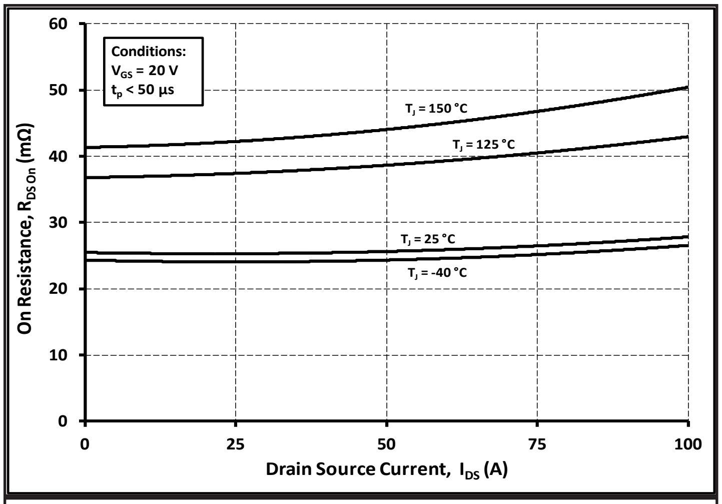


Figure 5. Normalized On-Resistance vs. Drain Current For Various Temperatures

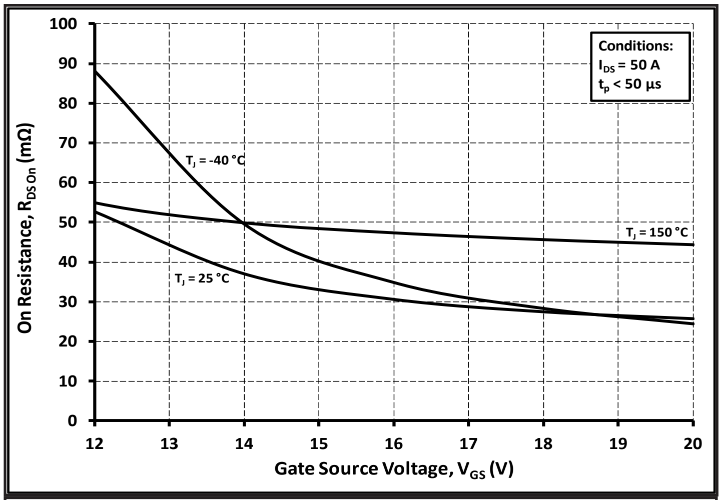


Figure 6. Normalized On-Resistance vs. Gate-Source Voltage for Various Temperatures

Typical Performance

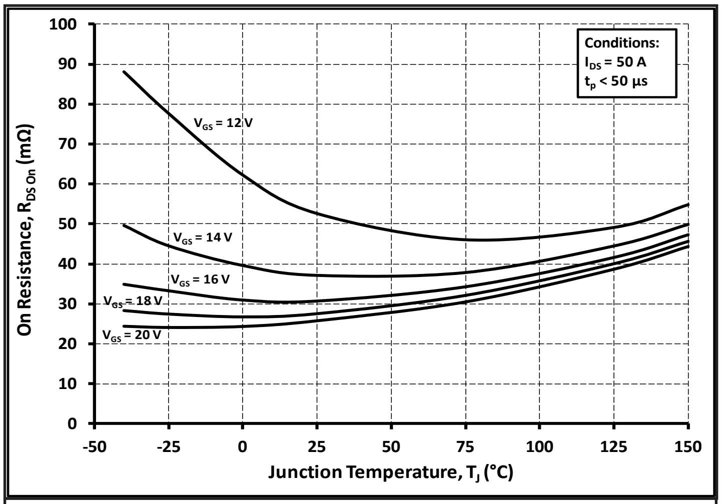


Figure 7. On-Resistance vs. Temperature for Various Gate-Source Voltages

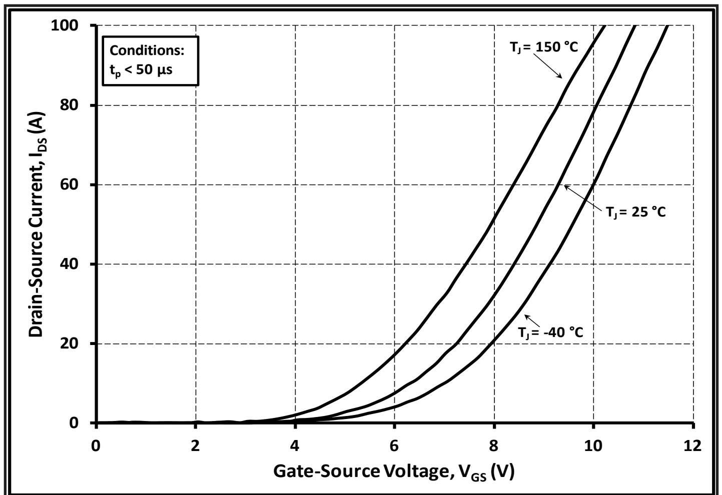


Figure 8. Transfer Characteristic for Various Junction Temperatures

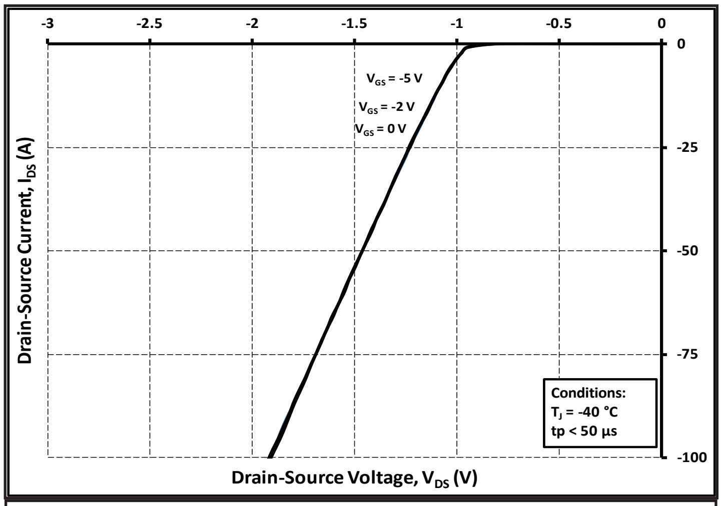


Figure 9. Diode Characteristic at -40 °C

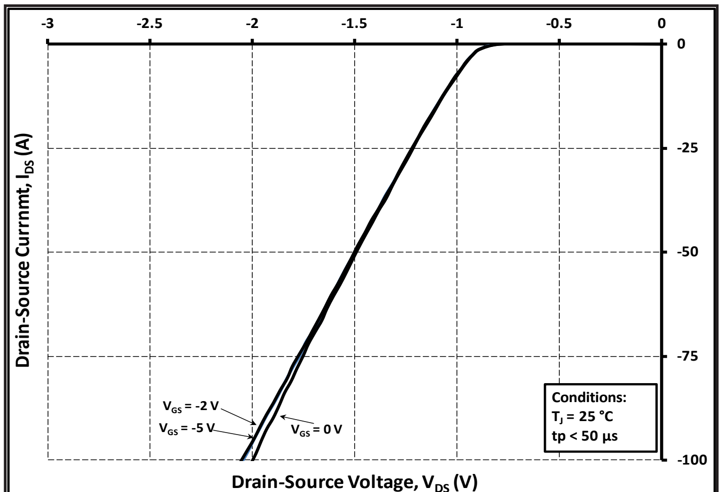


Figure 10. Diode Characteristic at 25 °C

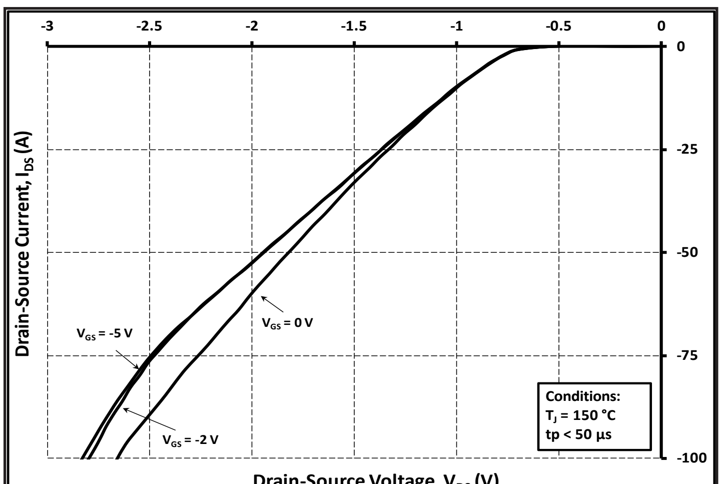


Figure 11. Diode Characteristic at 150 °C

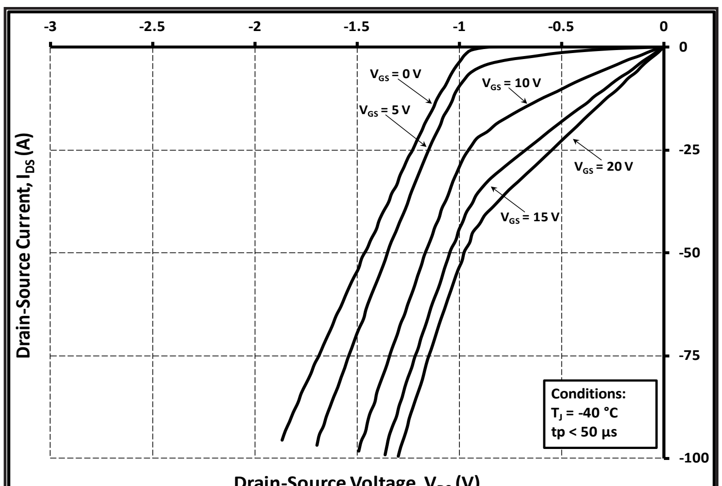


Figure 12. 3rd Quadrant Characteristic at -40 °C

Typical Performance

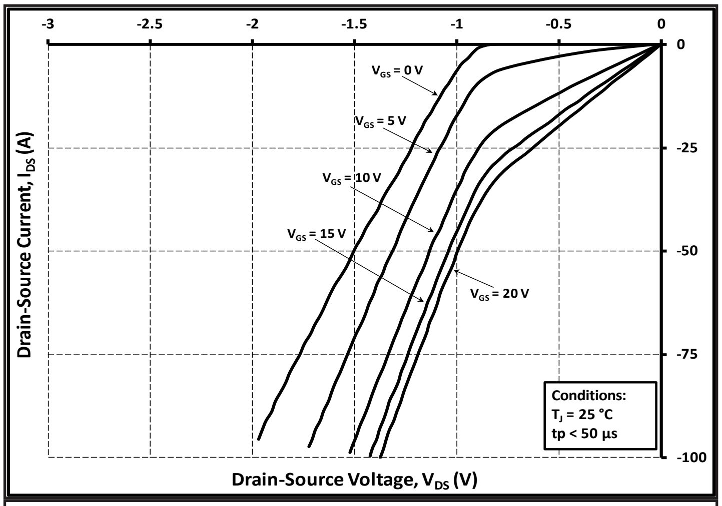


Figure 13. 3rd Quadrant Characteristic at 25 °C

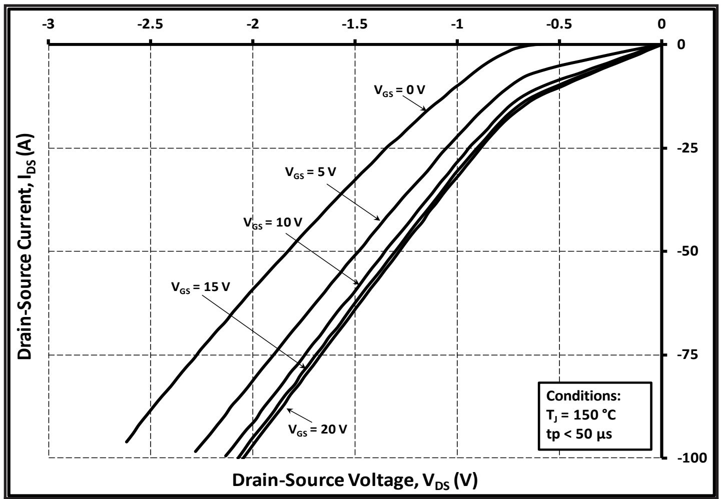


Figure 14. 3rd Quadrant Characteristic at 150 °C

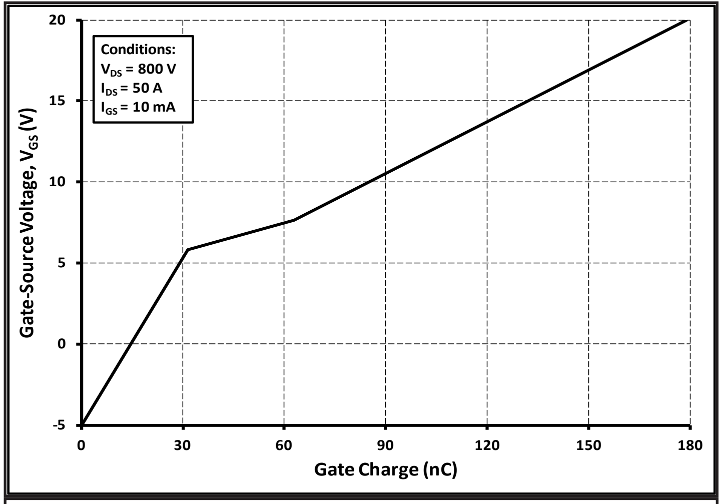


Figure 15. Typical Gate Charge Characteristics

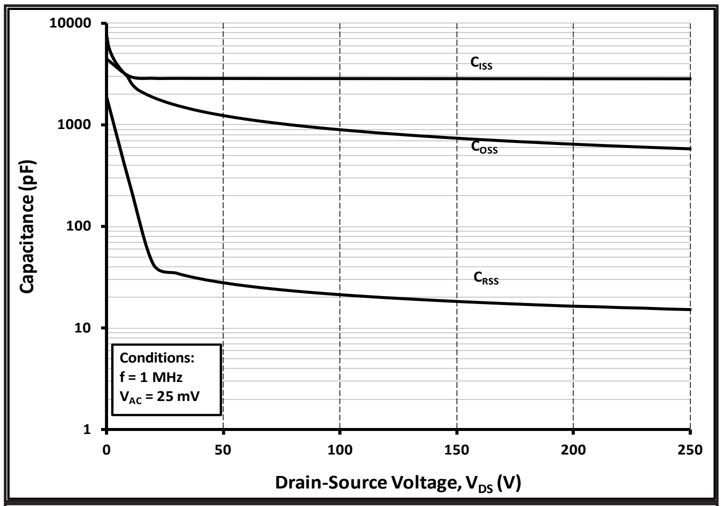


Figure 16. Typical Capacitances vs. Drain-Source Voltage (0 - 250 V)

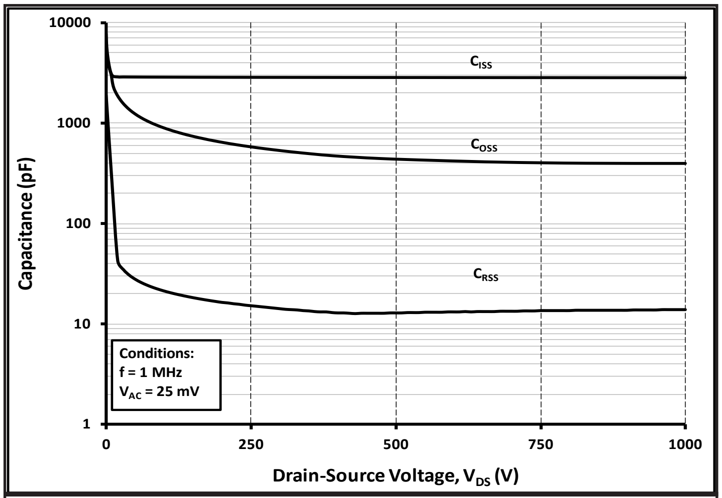


Figure 17. Typical Capacitances vs. Drain-Source Voltage (0 - 1 kV)

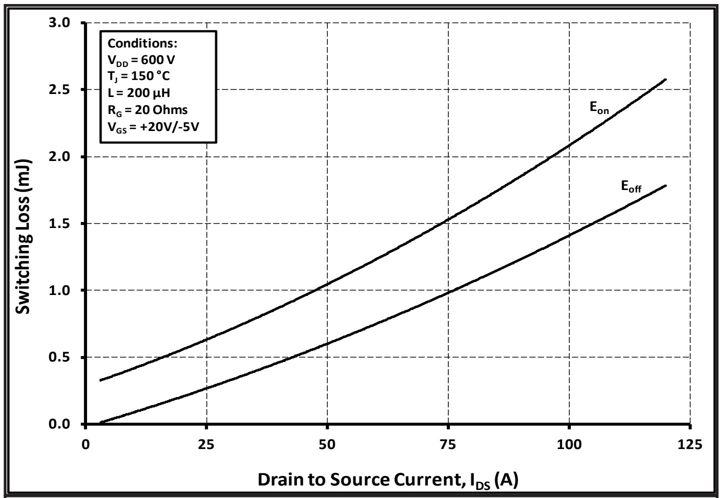


Figure 18. Inductive Switching Energy vs. Drain Current For V_{DS} = 600V, R_G = 20 Ω

Typical Performance

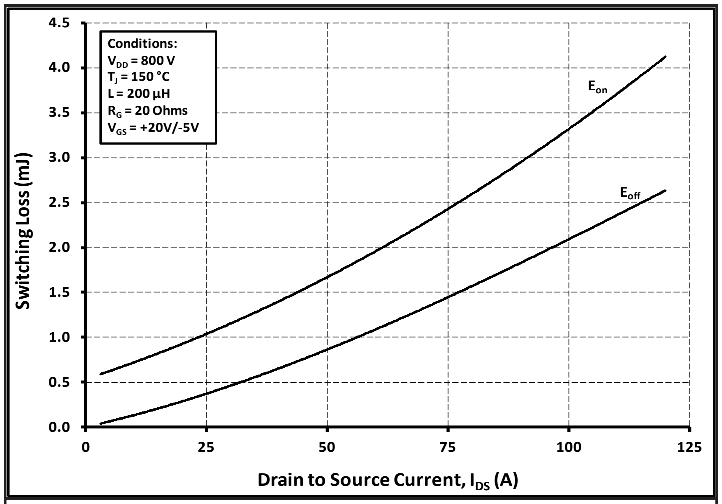


Figure 19. Inductive Switching Energy vs. Drain Current For V_{DS} = 800 V, R_G = 20 Ω

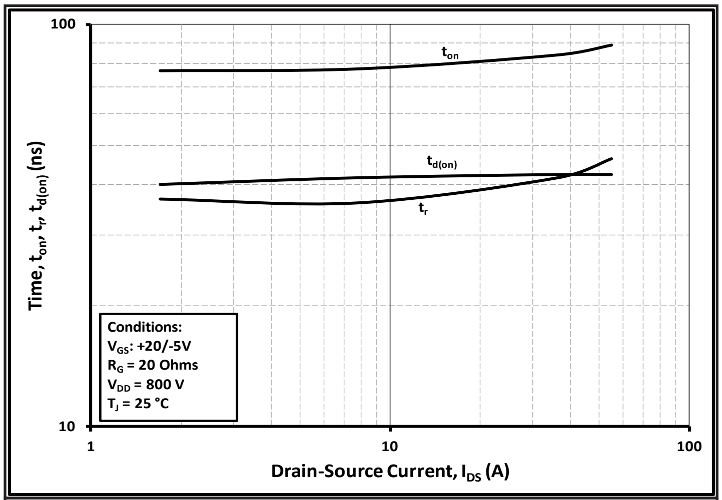


Figure 20. Turn-on Timing vs. Drain Current

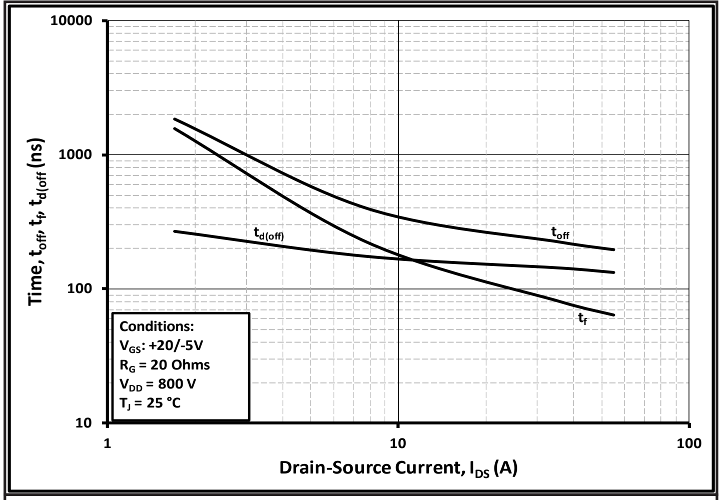


Figure 21. Turn-off Timing vs. Drain Current

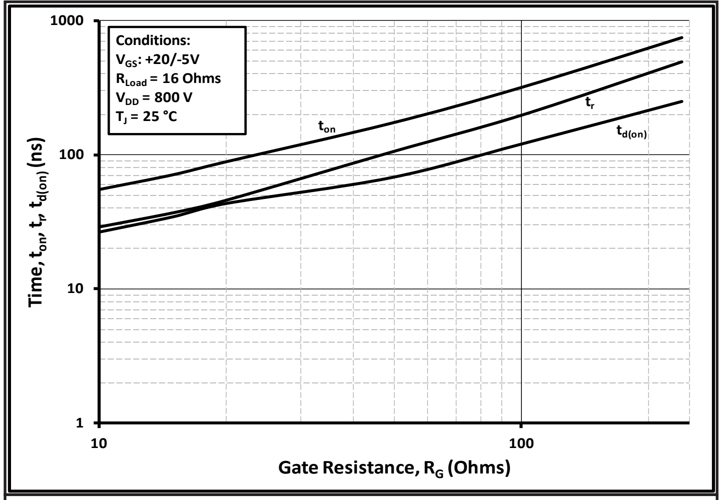


Figure 22. Turn-on Timing vs. External Gate Resistor

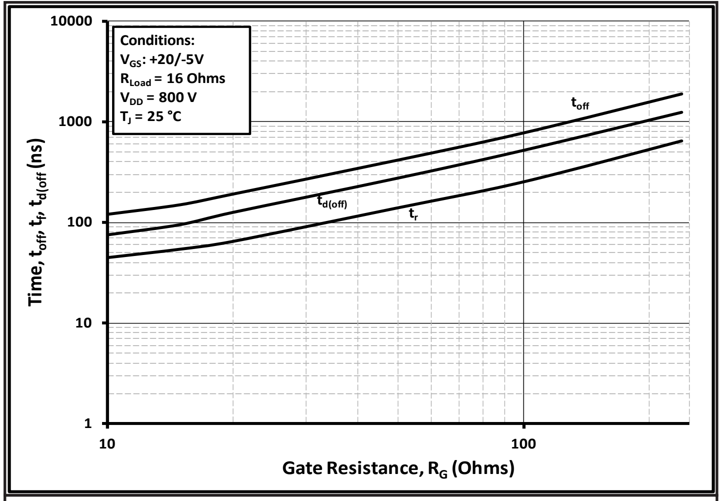


Figure 23. Turn-off Timing vs. External Gate Resistor

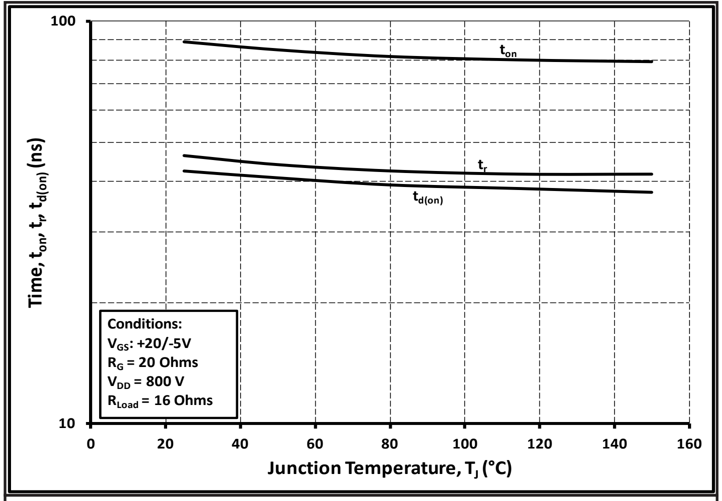


Figure 24. Turn-on Timing vs. Junction Temperature

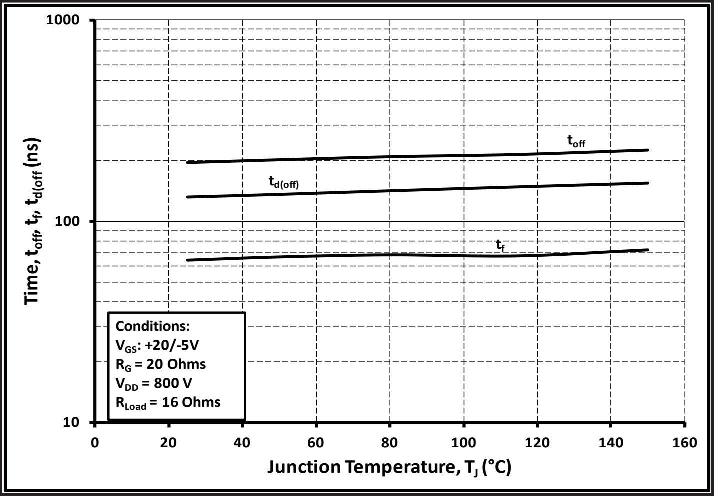


Figure 25. Turn-on Timing vs. Junction Temperature

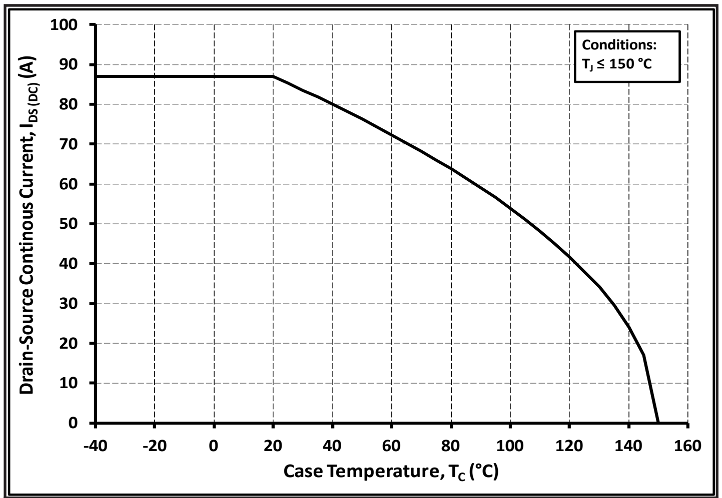


Figure 26. Continous Drain Current Derating vs Case Temperature

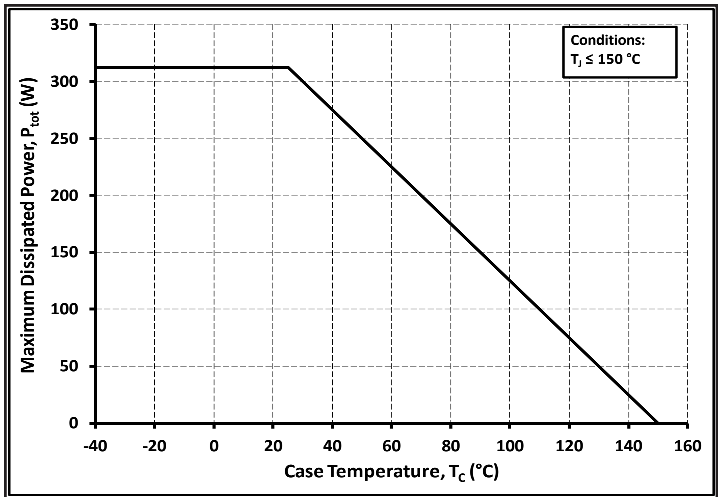


Figure 27. Maximum Power Dissipation (MOSFET) Derating vs Case Temperature

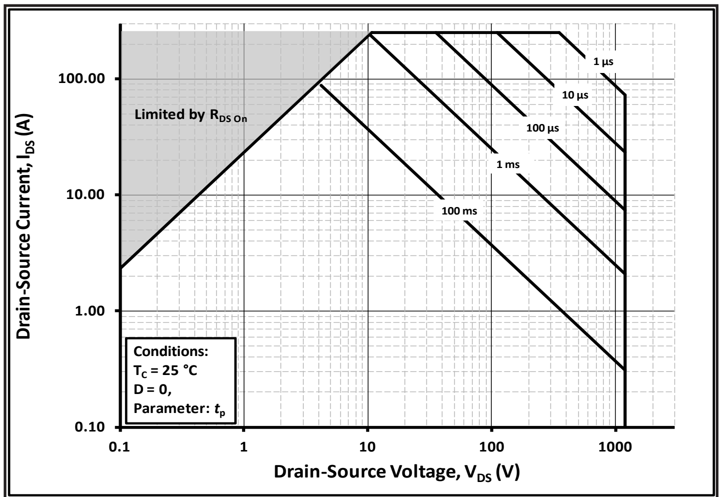


Figure 28. MOSFET Safe Operating Area

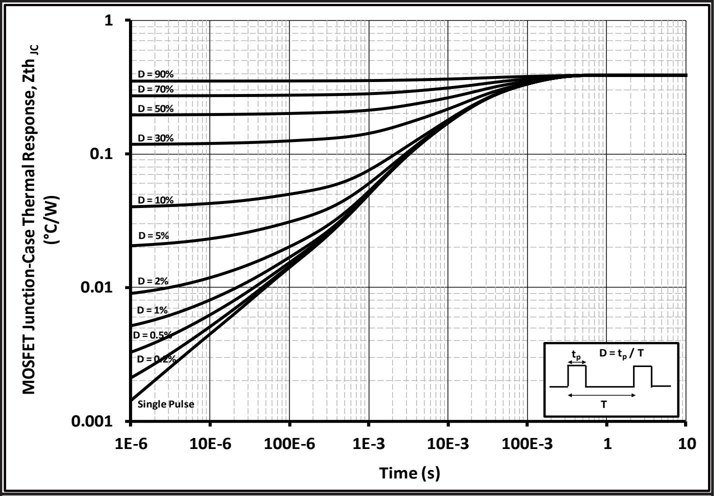


Figure 29. MOSFET Junction to Case Thermal Impedance

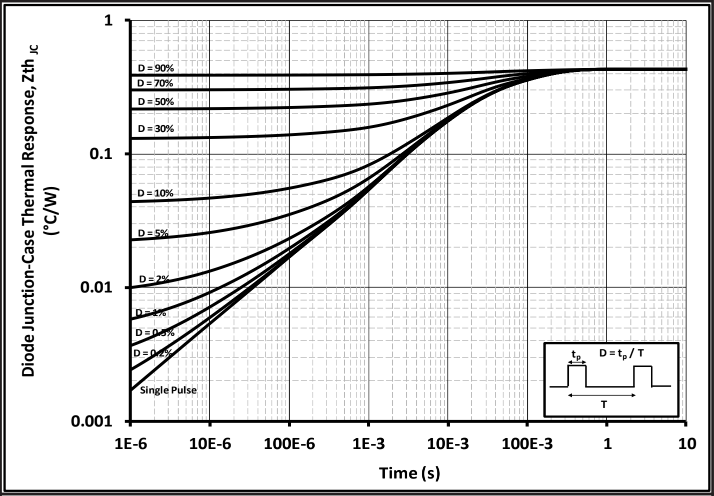


Figure 30. Diode Junction to Case Thermal Impedance

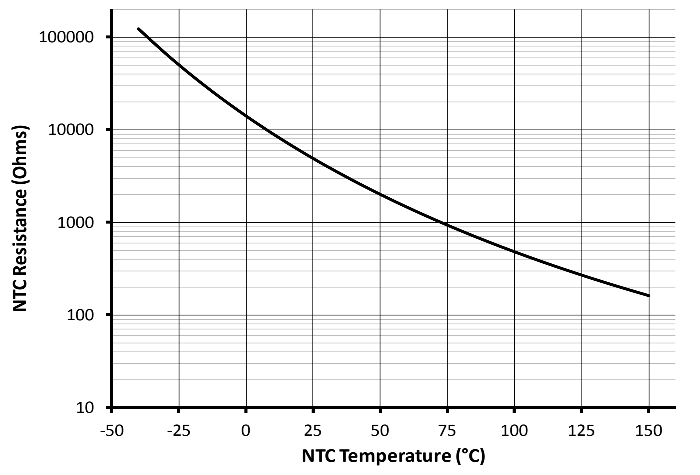


Figure 31. NTC Resistance vs NTC tTemperature

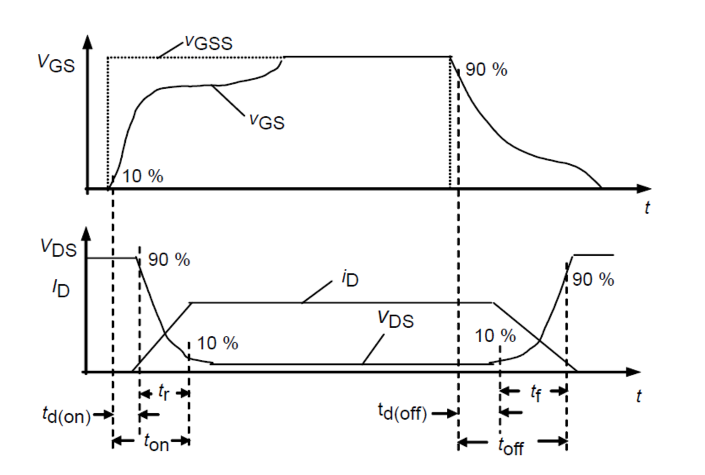
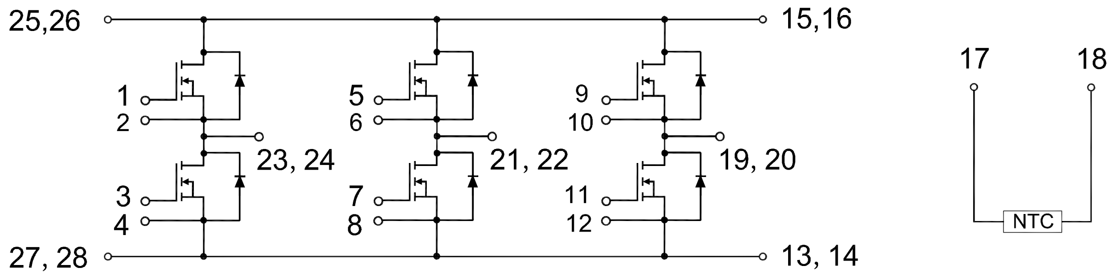


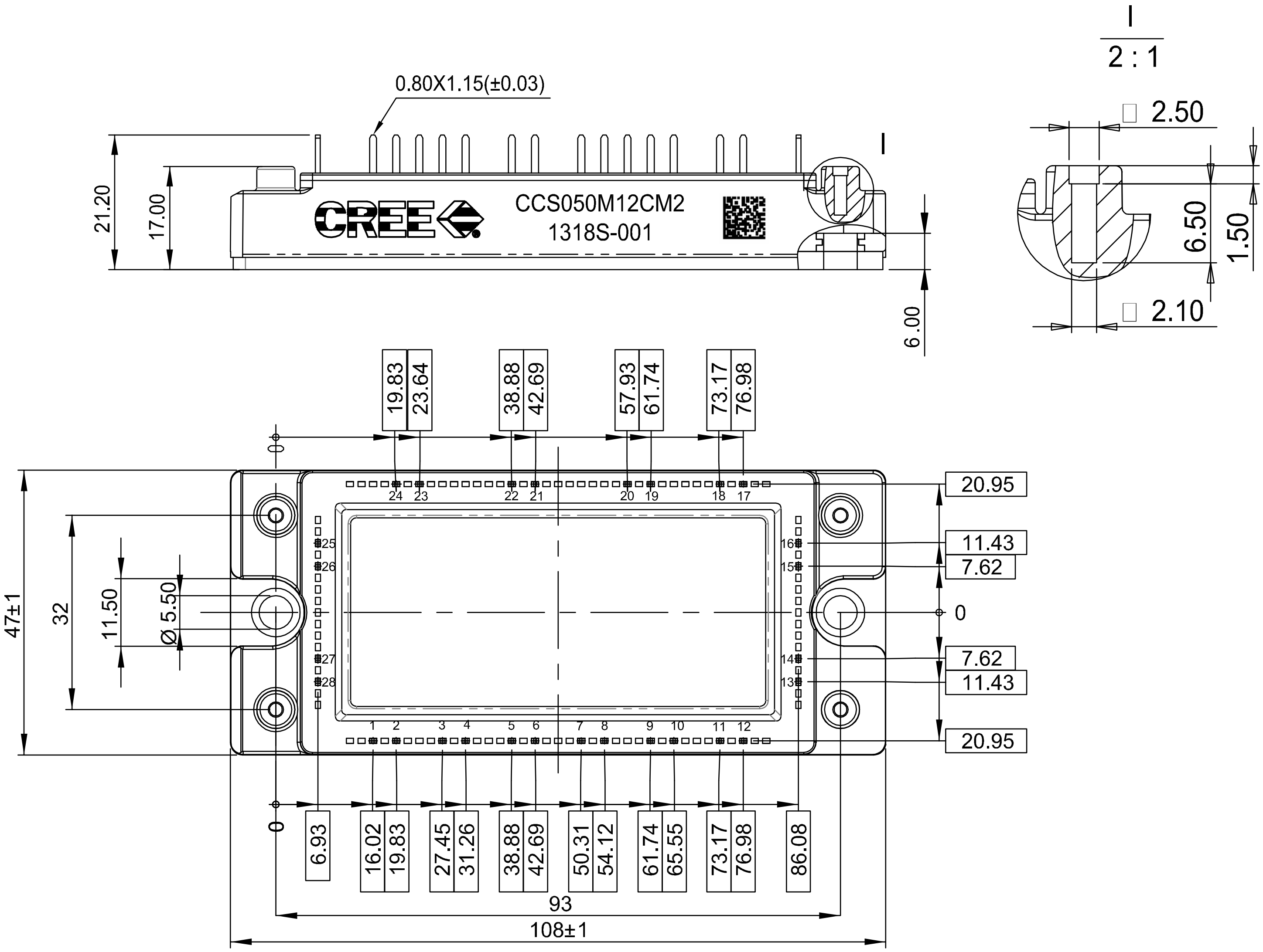
Figure 31. Resistive Switching Time Description

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.

Please Refer to application note: Design Considerations when using Cree SiC Modules Part 1 and Part 2. [CPWR-AN12, CPWR-AN13]

Package Dimensions (mm)





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