CCS020M12CM2

1.2kV, 80 mΩ Silicon Carbide Six-Pack (Three Phase) Module

C2M MOSFET and Z-Rec™ Diode

V_{DS}	1.2 kV
$E_{sw, Total @ 20A, 150 °C}$	0.48 mJ
$R_{DS(on)}$	80 mΩ

Features

- Ultra Low Loss
- High-Frequency Operation
- Zero Reverse Recovery Current from Diode
- Zero Turn-off Tail Current from MOSFET
- Normally-off, Fail-safe Device Operation
- Ease of Paralleling
- Copper Baseplate and Aluminum Nitride Insulator

System Benefits

- Enables Compact and Lightweight Systems
- High Efficiency Operation
- Mitigates Over-voltage Protection
- Reduced Thermal Requirements
- Reduced System Cost

Applications

- Solar Inverter
- 3-Phase PFC
- Regen Drive
- UPS and SMPS
- Motor Drive

Package

Part Number	Package	Marking
CCS020M12CM2	Six-Pack	CCS020M12CM2

Maximum Ratings (T_C = 25˚C unless otherwise specified)

Symbol	Parameter	Value	Unit	Test Conditions	Notes
V_{DSmax}	Drain - Source Voltage	1.2	kV		
V_{GSmax}	Gate - Source Voltage	-10/+25	V	Absolute maximum values	
V_{GSop}	Gate - Source Voltage	-5/20	V	Recommended operational values	
I_D	Continuous MOSFET Drain Current	29.5	A	V_{GS} = 20 V, T_C = 25 ˚C	Fig. 25
		20		V_{GS} = 20 V, T_C = 90 ˚C	
$I_{D(pulse)}$	Pulsed Drain Current	80	A	Pulse width tp limited by $T_{J(max)}$	
I_F	Continuous Diode Forward Current	46	A	V_{GS} = -5 V, T_C = 25 ˚C	
		27		V_{GS} = -5 V, T_C = 90 ˚C	
T_{Jmax}	Junction Temperature	-40 to +150	˚C		
T_C ,T_{STG}	Case and Storage Temperature Range	-40 to +125	˚C		
V_{isol}	Case Isolation Voltage	5.0	kV	AC, 50 Hz , 1 min	
L_{Stray}	Stray Inductance	30	nH	Measured between terminals 25, 26 and 27, 28	
P_D	Power Dissipation	167	W	T_C = 25 ˚C, T_J = 150 ˚C	Fig. 26

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	1.7	2.2		V	V_{DS} = 10 V, I_D = 1 mA	Fig. 7
			1.6			V_{DS} = 10 V, I_D = 1 mA, T_J = 150 ˚C	
I_{DSS}	Zero Gate Voltage Drain Current		1	100	μA	V_{DS} = 1.2 kV, V_{GS} = 0V	
I_{DSS}	Zero Gate Voltage Drain Current		10	250	μA	V_{DS} = 1.2 kV, V_{GS} = 0V, T_J = 150 ˚C	
I_{GSS}	Gate-Source Leakage Current		1	250	nA	V_{GS} = 20 V, V_{DS} = 0V	
$R_{DS(on)}$	On State Resistance		80	98	mΩ	V_{GS} = 20 V, I_{DS} = 20 A	Fig. 4-6
			145	208		V_{GS} = 20 V, I_{DS} = 20 A, T_J = 150 ˚C	
g_{fs}	Transconductance		9.8		S	V_{DS} = 20 V, I_{DS} = 20 A	Fig. 8
			8.5			V_{DS} = 20 V, I_D = 20 A, T_J = 150 ˚C	
C_{iss}	Input Capacitance		900		pF	V_{DS} = 800 V, f = 1 MHz, V_{AC} = 25 mV	Fig. 16,17
C_{oss}	Output Capacitance		181				
C_{rss}	Reverse Transfer Capacitance		5.9				
E_{on}	Turn-On Switching Energy		0.41		mJ	V_{DD} = 800 V, V_{GS} = -5V/+20V I_D = 20 A, $R_{G(ext)}$ = 2.5 Ω Load = 412 μH, T_J = 150 ˚C Note: IEC 60747-8-4 Definitions	Fig. 22
E_{Off}	Turn-Off Switching Energy		0.07		mJ		
$R_{G\ (int)}$	Internal Gate Resistance		3.8		Ω	f = 1 MHz, V_{AC} = 25 mV	
Q_{GS}	Gate-Source Charge		16.1		nC	V_{DD}= 800 V, V_{GS} = -5V/+20V, I_D= 20 A, Per JEDEC24 pg 27	Fig. 15
Q_{GD}	Gate-Drain Charge		20.7				
Q_G	Total Gate Charge		61.5				
$t_{d(on)}$	Turn-on delay time		10		ns	V_{DD} = 800V, V_{GS} = -5/+20V, I_D = 20 A, $R_{G(ext)}$ = 2.5 Ω, Timing relative to V_{DS} Note: IEC 60747-8-4, pg 83 Resistive load	Fig. 24
$t_{r(on)}$	V_{SD} fall time 90% to 10%		14		ns		
$t_{d(off)}$	Turn-off delay time		22.4		ns		
$t_{f(off)}$	V_{SD} rise time 10% to 90%		53		ns		
V_{SD}	Diode Forward Voltage		1.5	1.7	V	I_F = 20 A, V_{GS} = 0, T_J = 25 ˚C	Fig. 10
			1.8	2.3		I_F = 20 A, V_{GS} = 0, T_J = 150 ˚C	Fig. 11
Q_C	Total Capacitive Charge		0.27		μC	I_{SD} = 20 A, V_{DS} = 800V di/dt = 1500 A/μs, V_{GS} = -5V	

Thermal Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
R_{thJCM}	Thermal Resistance Juction-to-Case for MOSFET		0.7	0.75	˚C/W		
R_{thJCD}	Thermal Resistance Juction-to-Case for Diode		0.8	0.85			

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		20	mW
$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298.15K))]$	3380		K

Additional Module Data

Symbol	Condition	Max.	Unit	Test Condition
W	Weight	180	g	
M	Mounting Torque	5.0	Nm	To Heatsink and terminals

Typical Performance

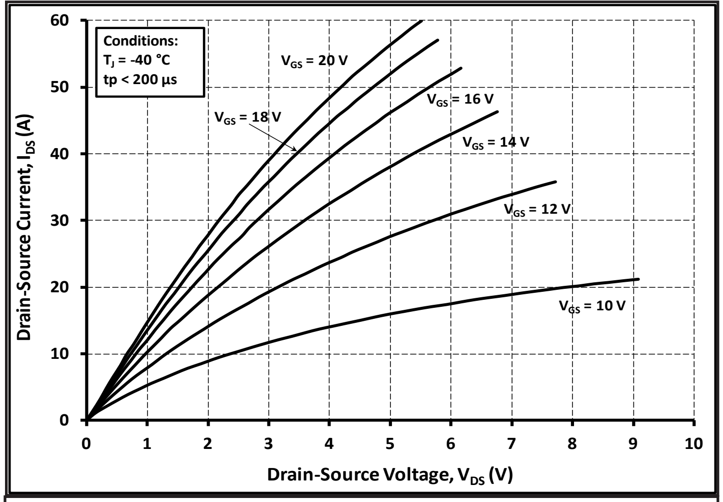


Figure 1. Output Characteristics T_J = -40 °C

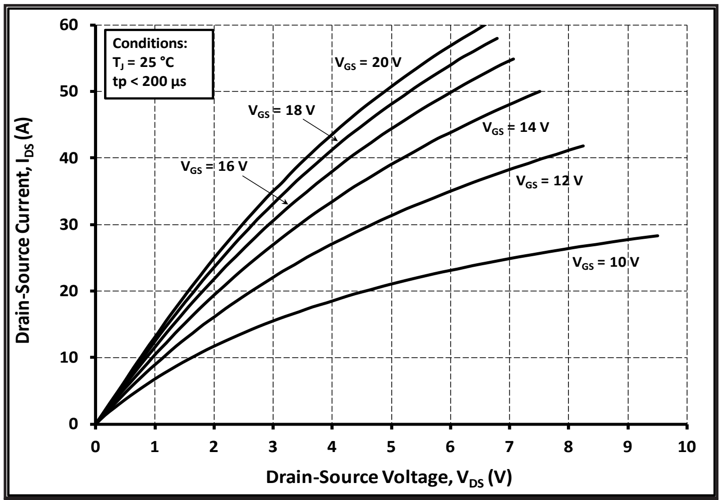


Figure 2. Output Characteristics T_J = 25 °C

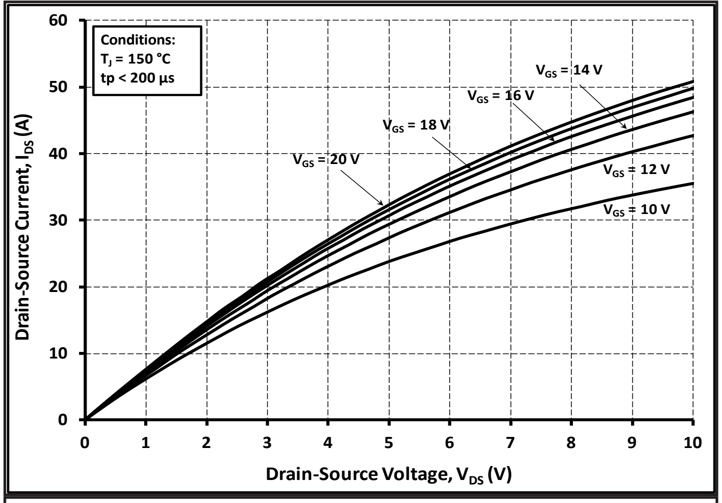


Figure 3. Output Characteristics T_J = 150 °C

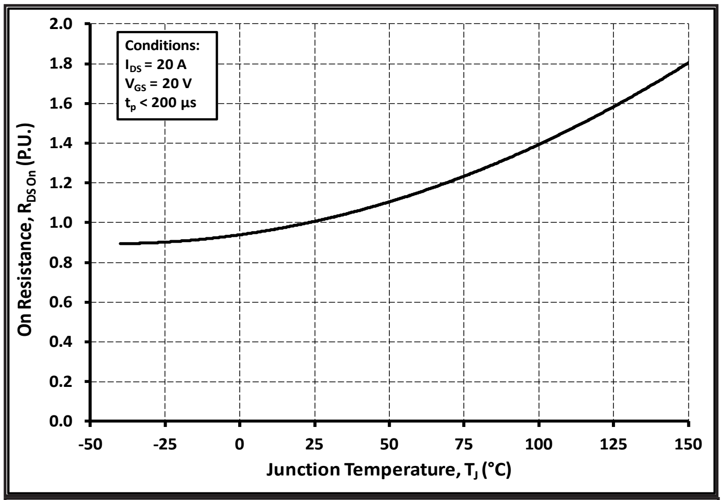


Figure 4. Normalized On-Resistance vs. Temperature

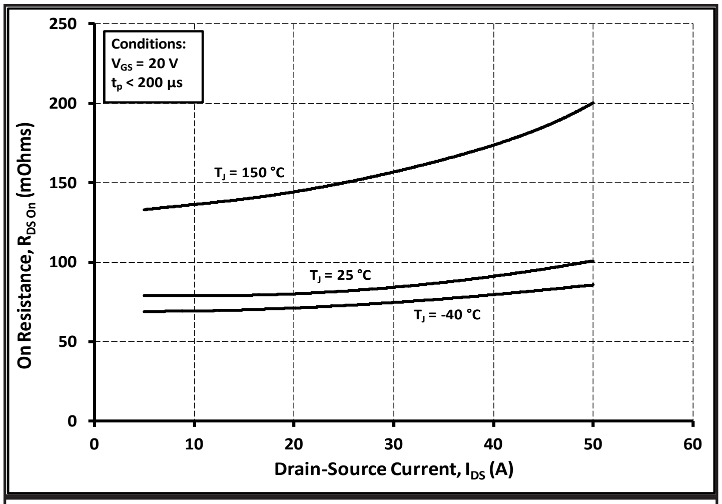


Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

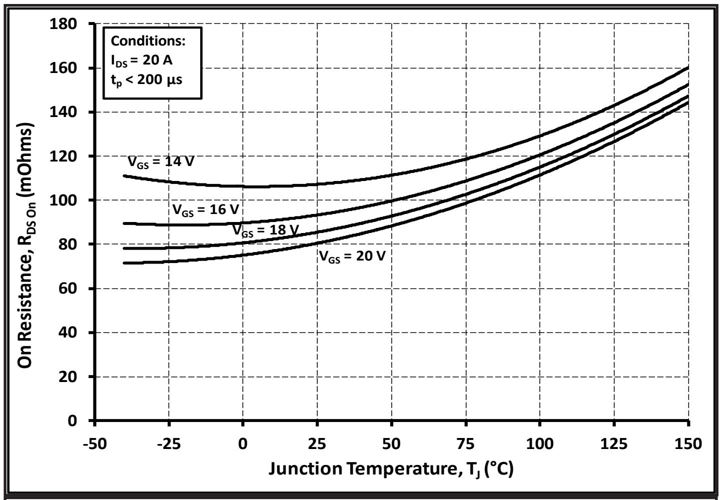


Figure 6. On-Resistance vs. Temperature
for Various Various Gate-Source Voltages

Typical Performance

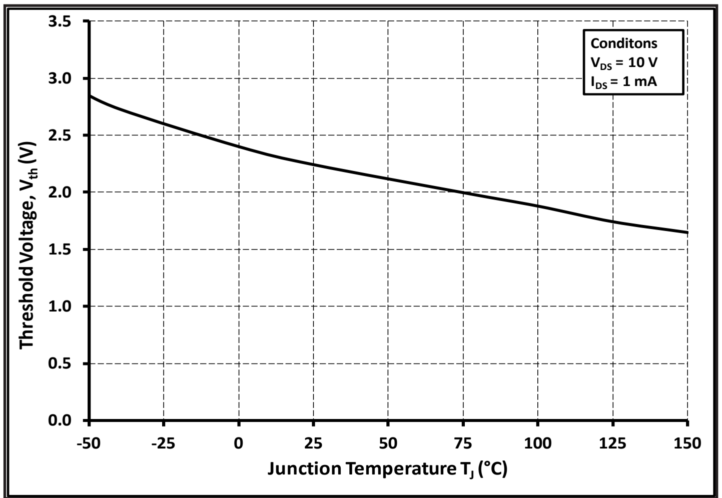


Figure 7. Threshold Voltage vs. Temperature

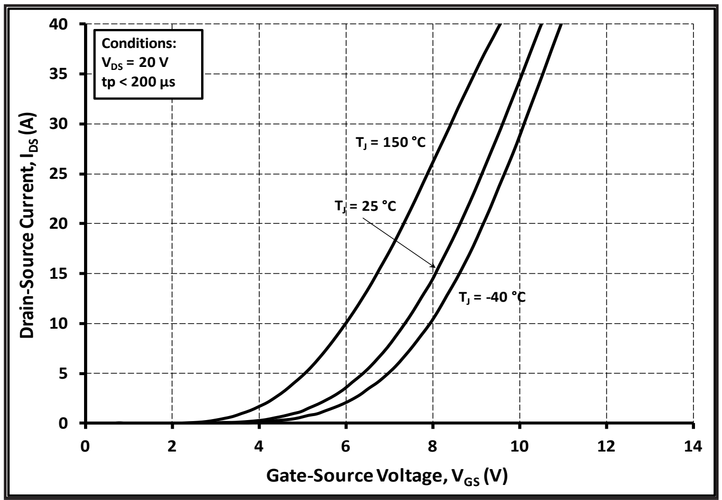


Figure 8. Transfer Characteristic for Various Junction Temperatures

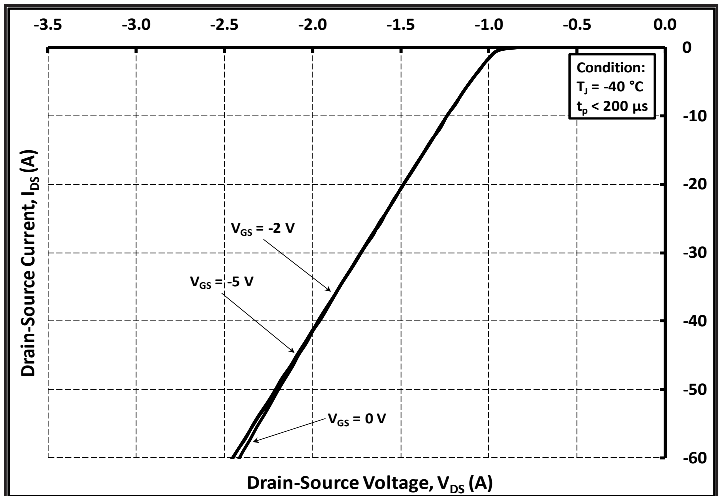


Figure 9. Diode Characteristic at -40 °C

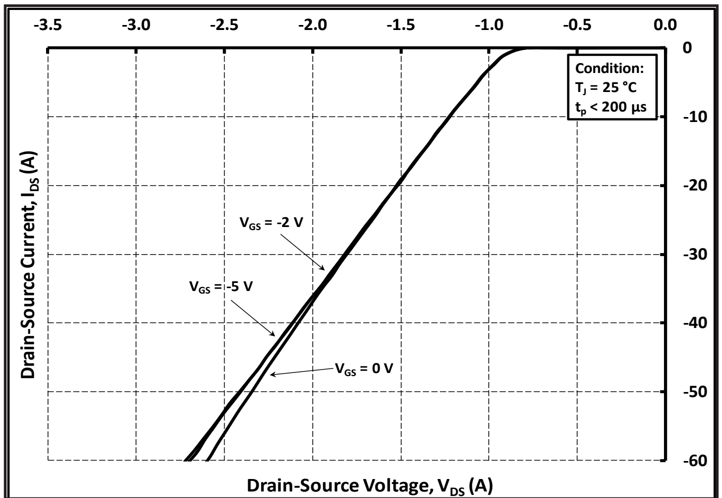


Figure 10. Diode Characteristic at 25 °C

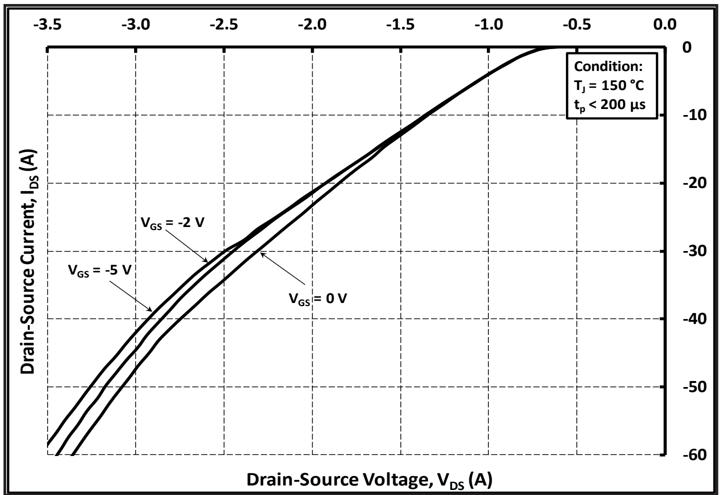


Figure 11. Diode Characteristic at 150 °C

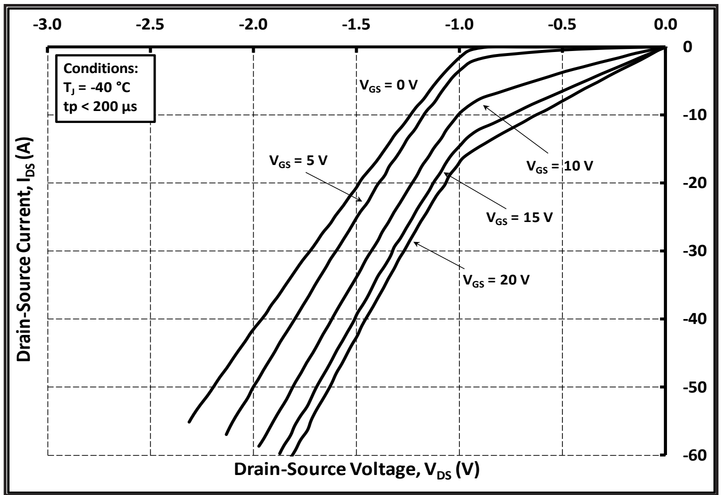


Figure 12. 3rd Quadrant Characteristic at -40 °C

Typical Performance

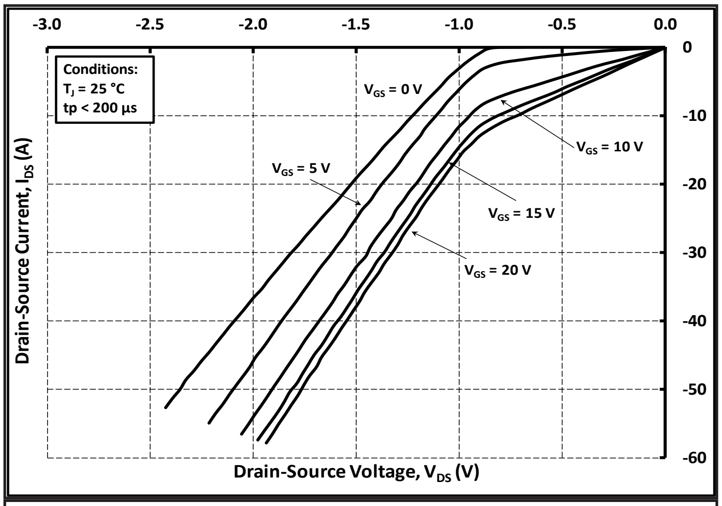


Figure 13. 3rd Quadrant Characteristic at 25 °C

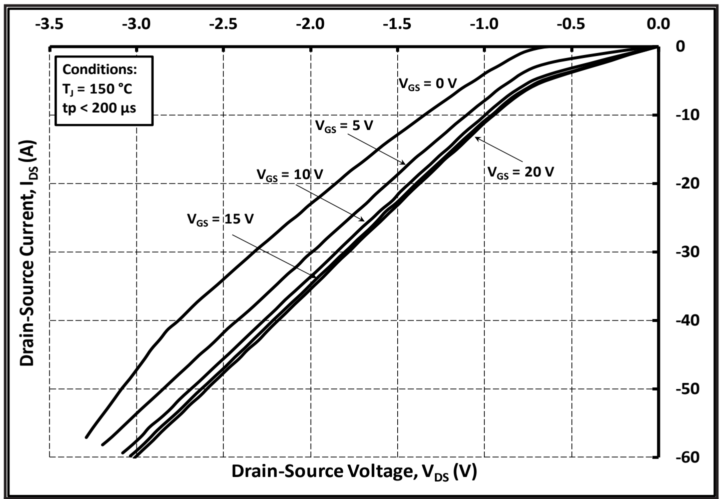


Figure 14. 3rd Quadrant Characteristic at 150 °C

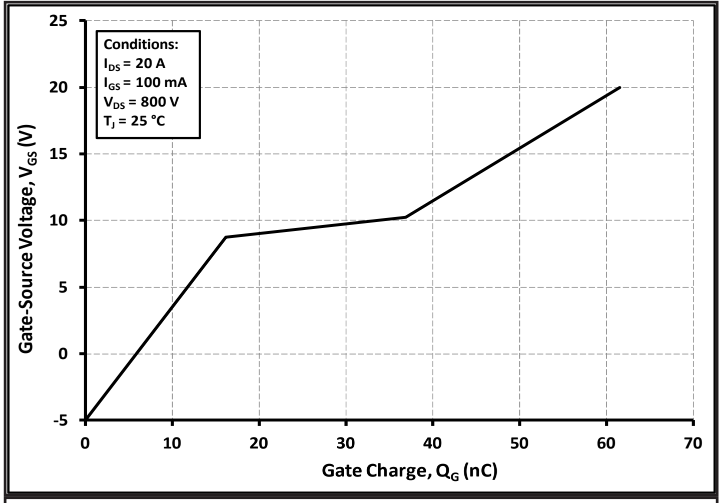


Figure 15. Gate Charge Characteristics

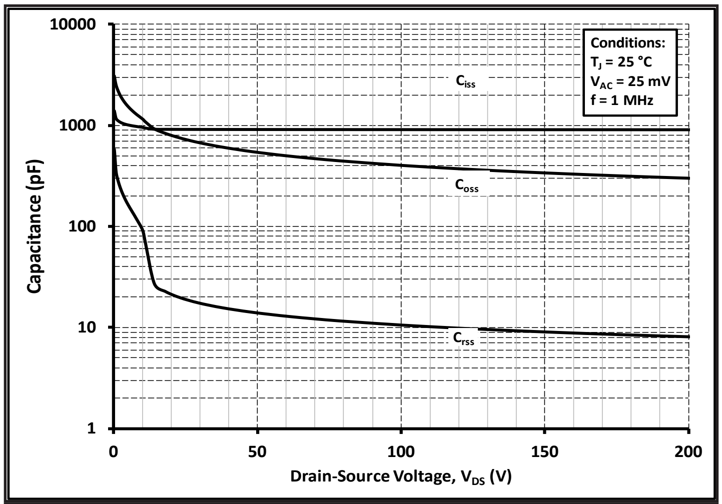


Figure 16. Capacitances vs. Drain-Source Voltage (0 - 200 V)

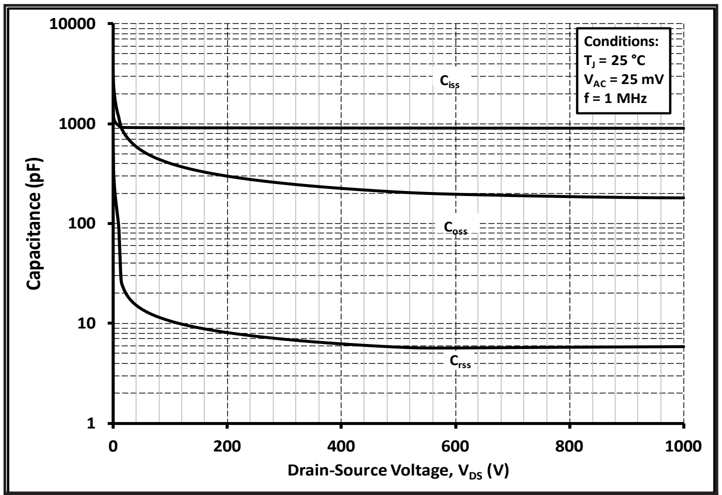


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 1 kV)

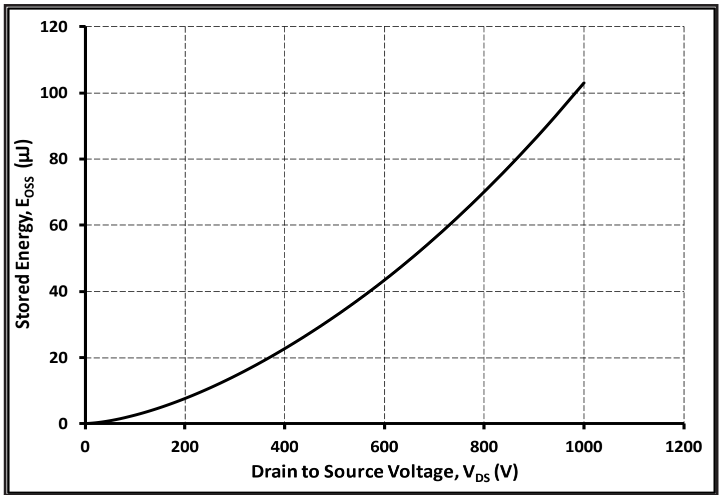


Figure 18. Output Capacitor Stored Energy

Typical Performance

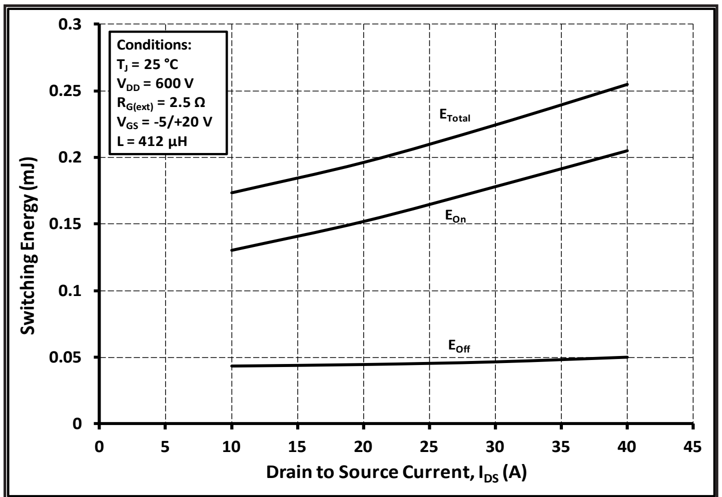


Figure 19. Inductive Switching Energy vs. Drain Current For V_{DS} = 600V

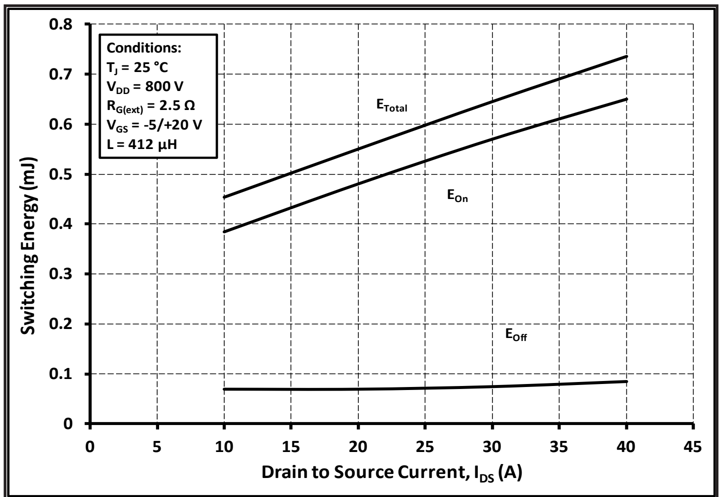


Figure 20. Inductive Switching Energy vs. Drain Current For V_{DS} = 800V

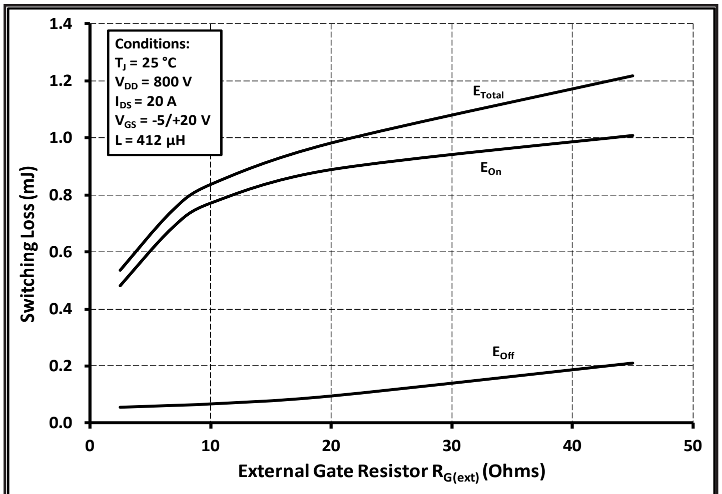


Figure 21. Inductive Switching Energy vs. $R_{G(ext)}$

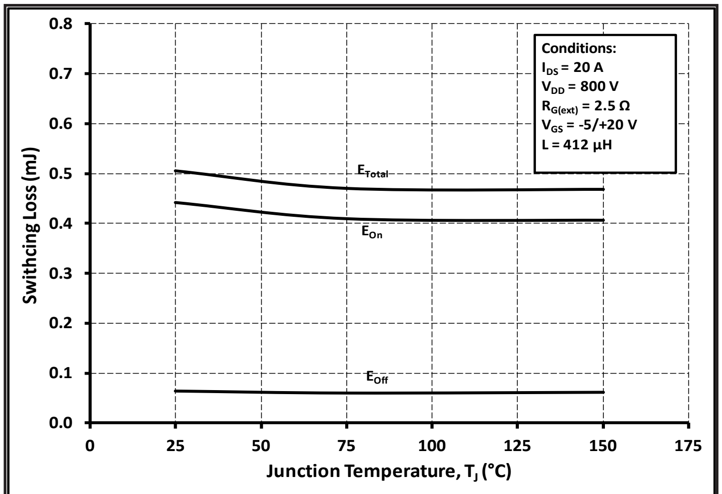


Figure 22. Inductive Switching Energy vs. Temperature

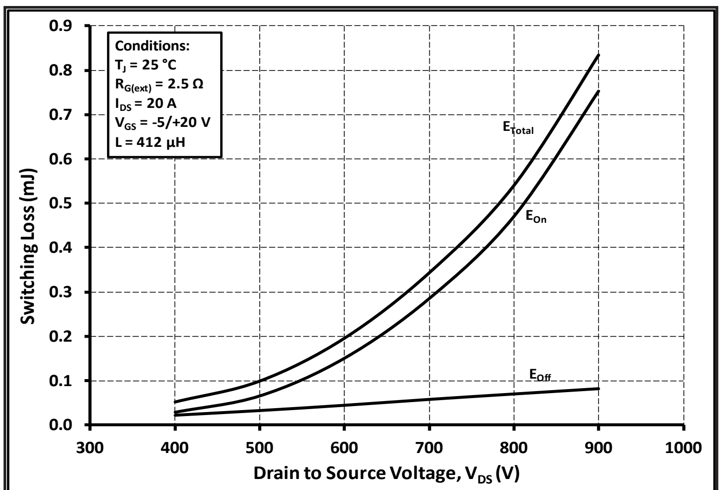


Figure 23. Inductive Switching Energy vs. V_{DS}

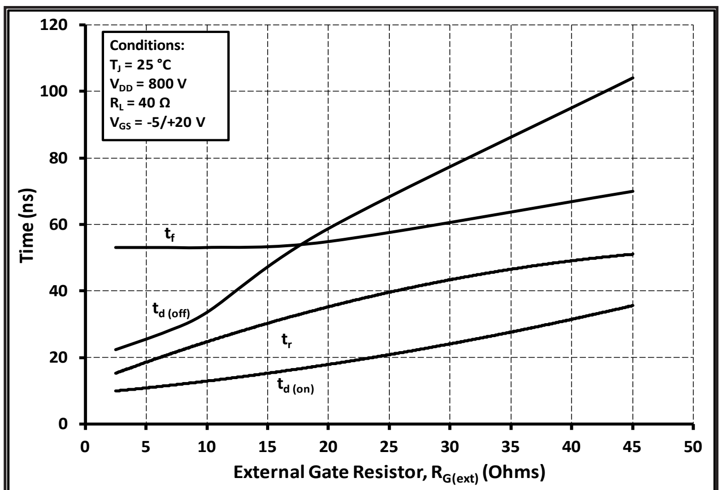


Figure 24. Timing vs. $R_{G(ext)}$

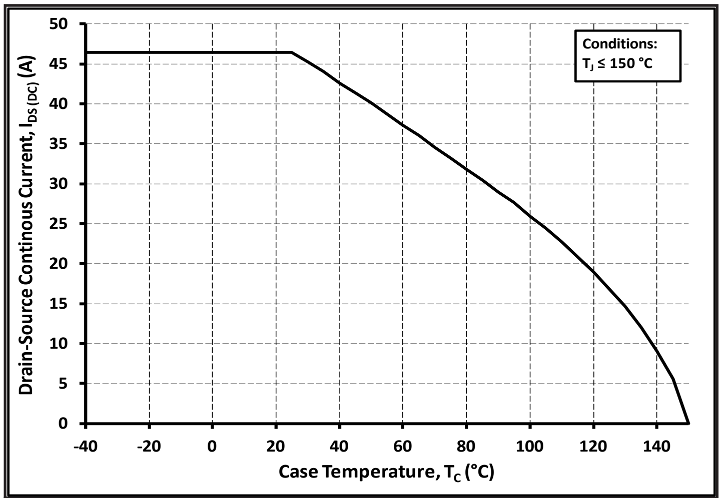


Figure 25. Continuous Drain Current Derating vs. Case Temperature

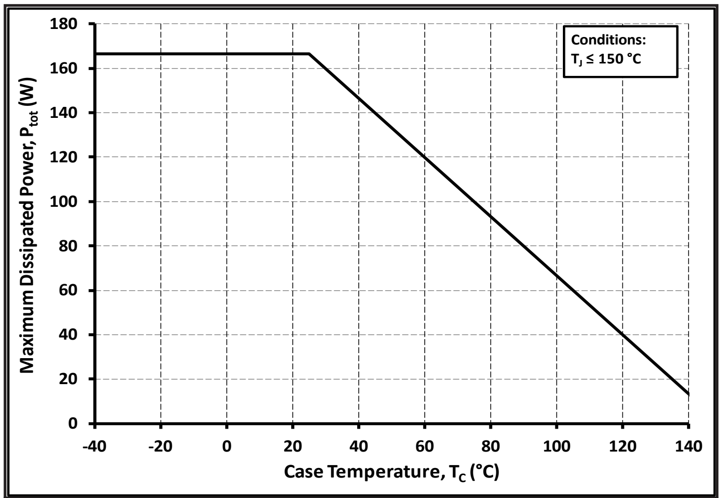


Figure 26. Maximum Power Dissipation (MOSFET) Derating vs Case Temperature

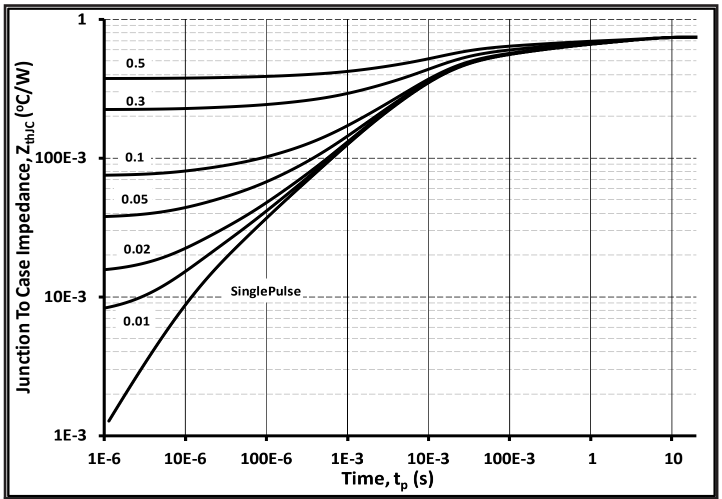


Figure 27. MOSFET Junction to Case Thermal Impedance

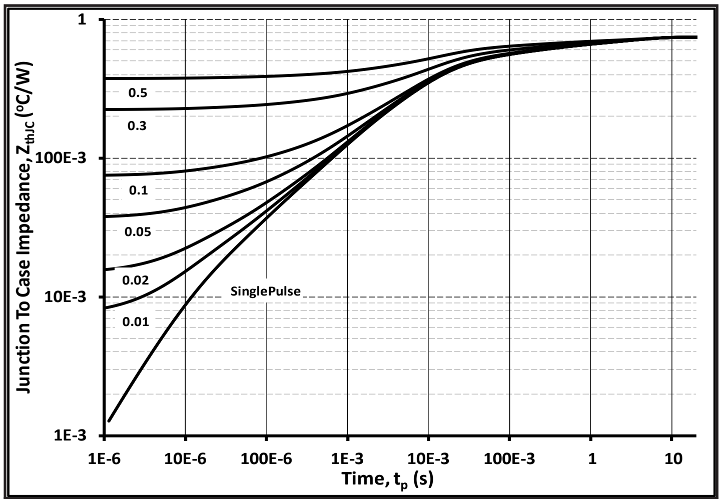


Figure 28. Diode Junction to Case Thermal Impedance

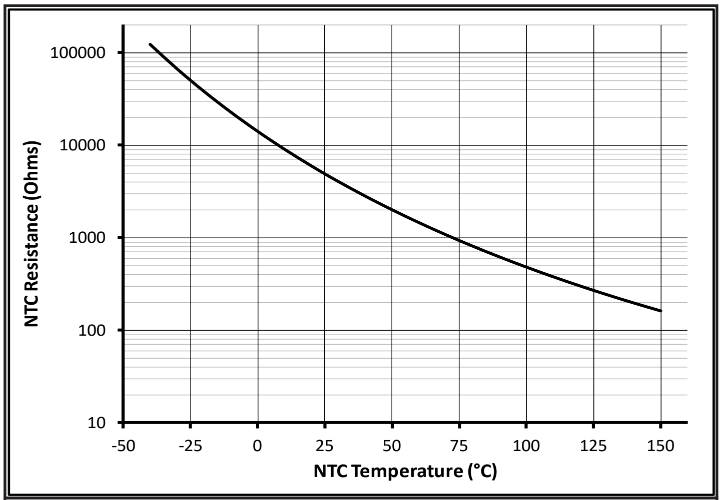


Figure 29. NTC Resistance vs NTC Temperature

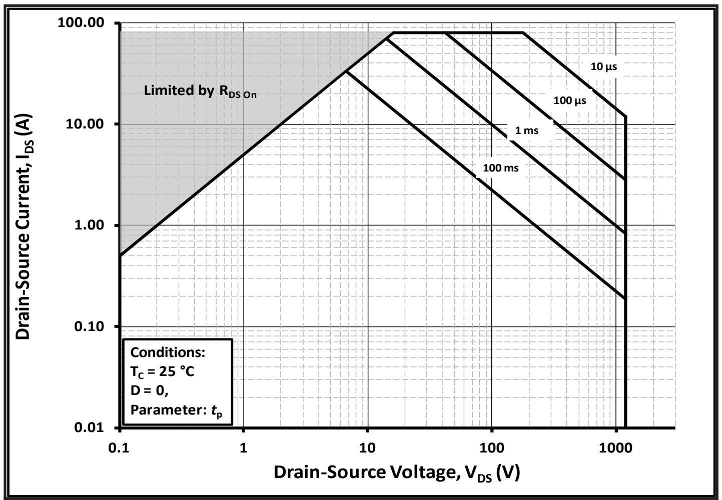


Figure 30. MOSFET Safe Operating Area

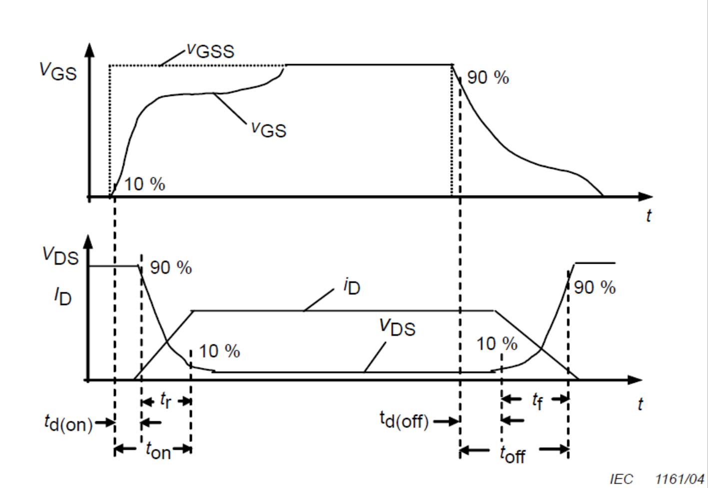
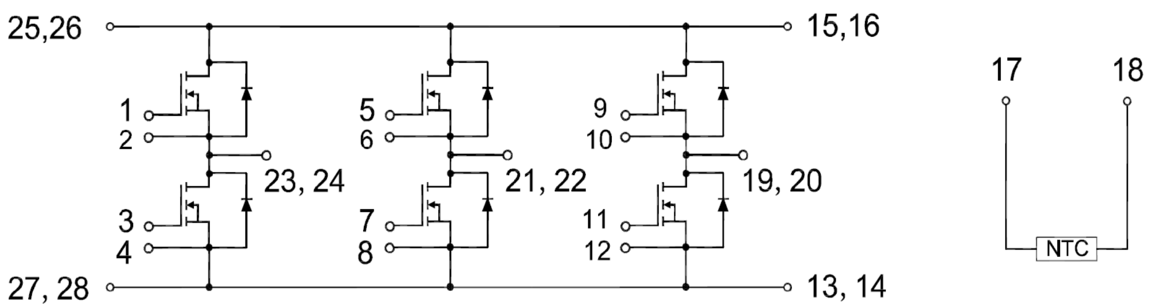


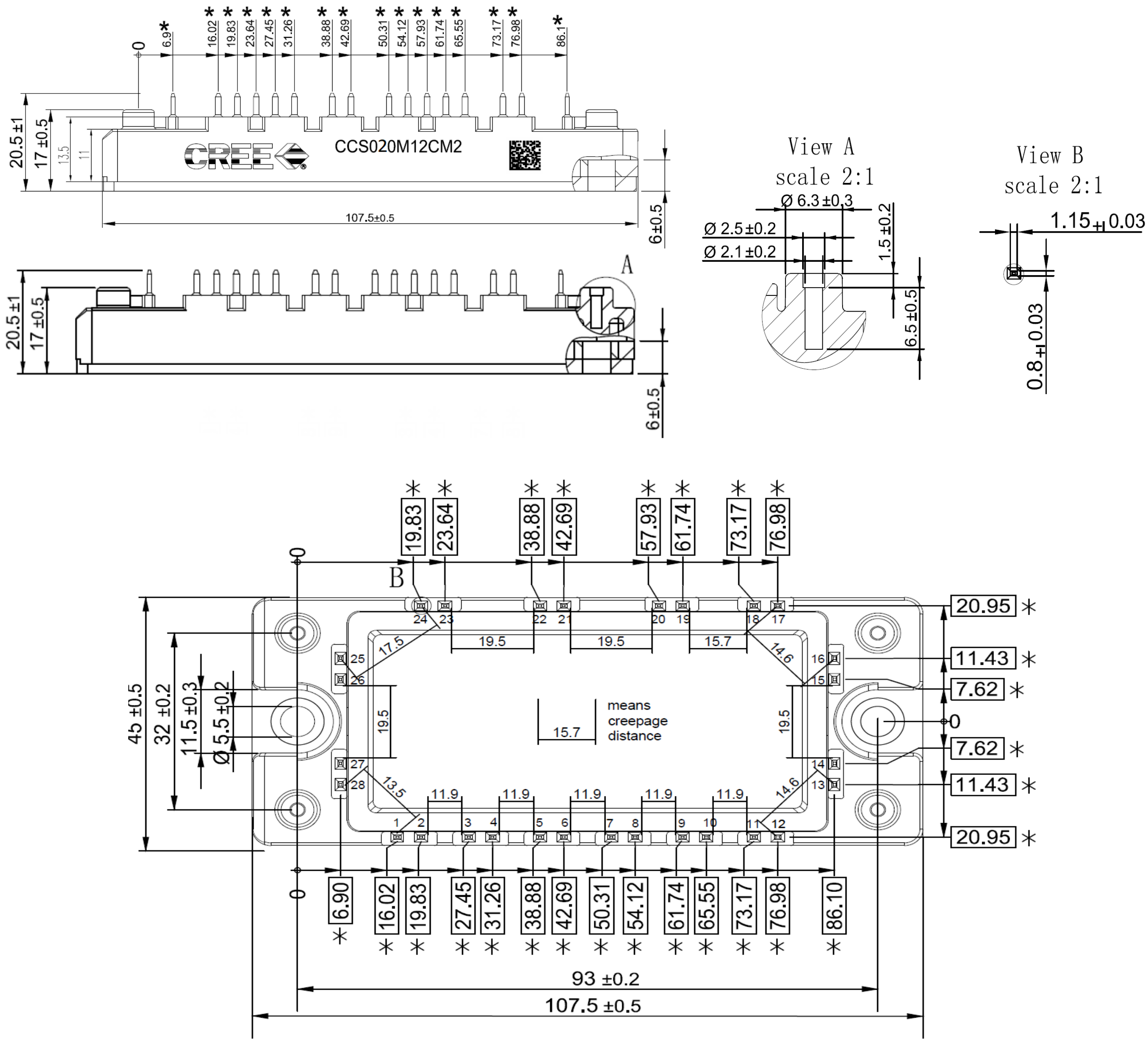
Figure 31. Resistive Switching Time Description

Creepage and Clearance Data

Distance	Creepage	Clearance
Minimum Distance Between Two High Voltage Pins	11.9 mm	6.5 mm
Distance Between High Voltage Pin and Isolated Baseplate	15.6 mm	15.6 mm
Distance Between High Voltage Pin and Mounting Bolt's Head	19.1 mm	8.6 mm
Distance Between High Voltage Pin and Isolated NTC Pin	16.7 mm	11.8 mm

Package Dimensions (mm)





∗=all dimensions with tolerance of ⌖ Ø 0.4

Recommendations for PCB mounting stand-offs

In order to mount the PCB onto the module, it is recommended to use four PCB mounting stand-offs by using self-tapping screws. Following is the recommended self-tapping screw with its torque requirements:

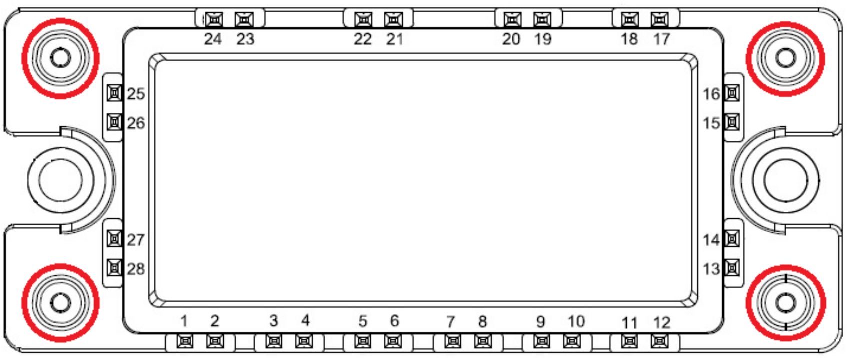
> Ejot DELTA PT WN 5451 K25x8 : M_{max} = 0.4Nm ± 10%

Installation of self-tapping screws can be done both by hand or by using an electric screw driver. For an electric screw driver the recommended maximum speed is 300 RPM.

(Note: Do not use pneumatic screw driver to install self-tapping screws).

The recommended effective length of screw threads entering the PCB mounting stand-offs should be in between 4mm to 6.5mm range.

(Note: Self-tapping screws must be inserted straight into the PCB mounting stand-offs)



PCB mounting stand-offs (Marked Red)

Notes

- **RoHS Compliance**
  The levels of RoHS restricted materials in this product are below the maximum concentration values (also referred to as the threshold limits) permitted for such substances, or are used in an exempted application, in accordance with EU Directive 2011/65/EC (RoHS2), as implemented January 2, 2013. RoHS Declarations for this product can be obtained from your Cree representative or from the Product Documentation sections of www.cree.com.

- **REACh Compliance**
  REACh substances of high concern (SVHCs) information is available for this product. Since the European Chemical Agency (ECHA) has published notice of their intent to frequently revise the SVHC listing for the foreseeable future,please contact a Cree representative to insure you get the most up-to-date REACh SVHC Declaration. REACh banned substance information (REACh Article 67) is also available upon request.

- 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.

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]

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