CREE Wolfspeed

V_{DS}	1200 V
I_{DS}	120 A

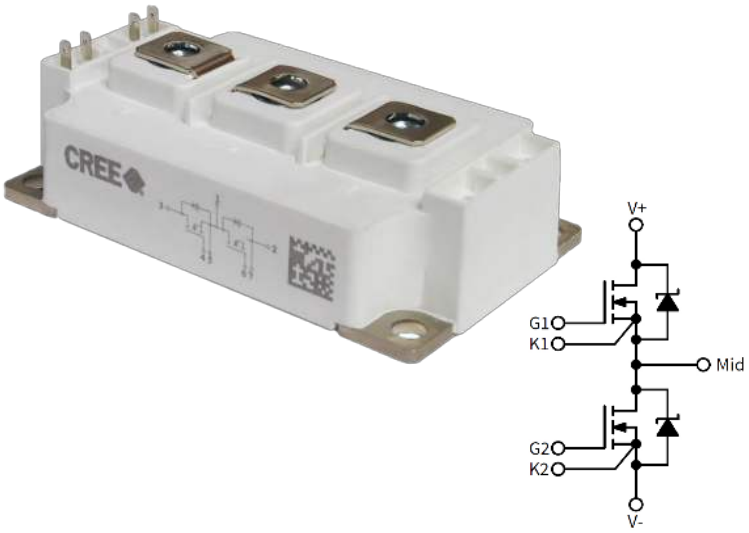
CAS120M12BM2

1200 V, 120 A All-Silicon Carbide High Performance, Switching Optimized, Half-Bridge Module

Technical Features

- Industry Standard 62mm Footprint
- Ultra-Low Loss, High-Frequency Operation
- Zero Reverse Recovery from Diodes
- Zero Turn-off Tail Current from MOSFET
- Normally-off, Fail-safe Device Operation
- Copper Baseplate and Aluminum Nitride Insulator

Package 61.4 mm X 106.4 mm X 30 mm



Applications

- Railway & Traction
- Solar & Renewable Energy
- EV Charging
- Industrial Automation & Testing

System Benefits

- Fast Time-to-Market with Minimal Development Required for Transition from 62mm IGBT Packages
- Increased System Efficiency, due to Low Switching & Conduction Losses of SiC

Maximum Parameters (Verified by Design)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions		Note
$V_{DS\,max}$	Drain-Source Voltage			1200	V			
$V_{GS\,max}$	Gate-Source Voltage, Maximum Value	-10		+25		Transient, <100 ns		Fig. 33
$V_{GS\,op}$	Gate-Source Voltage, Recommended Op. Value	-5		+20		Static		
I_{DS}	DC Continuous Drain-Source Current		200		A	V_{GS} = 20 V, T_C = 25 ˚C, T_{VJ} ≤ 150 ˚C		Fig. 21
			144			V_{GS} = 20 V, T_C = 90 ˚C, T_{VJ} ≤ 150 ˚C		
I_{SD}	DC Continuous Source-Drain Current		460			V_{GS} = 20 V, T_C = 25 ˚C, T_{VJ} ≤ 150 ˚C		
I_F	Schottky Diode DC Forward Current		312			V_{GS} = -5 V, T_C = 25 ˚C, T_{VJ} ≤ 150 ˚C		
$I_{DS\,(pulsed)}$	Maximum Pulsed Drain-Source Current			480		V_{GS} = 20 V	T_{VJ} = 25 ˚C; t_{Pmax} limited by T_{VJmax}	
$I_{F\,(pulsed)}$	Maximum Pulsed Diode Current			480		V_{GS} = -5 V		
$T_{VJ\,op}$	Maximum Virtual Junction Temperature under Switching Conditions	-40		150	°C			

MOSFET Characteristics (Per Position) (T_{VJ} = 25 ˚C unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	1200			V	V_{GS} = 0 V, T_{VJ} = -40 °C	
$V_{GS(th)}$	Gate Threshold Voltage	1.8	2.6			V_{DS} = V_{GS}, I_D = 6 mA	
I_{DSS}	Zero Gate Voltage Drain Current		450	3000	µA	V_{GS} = 0 V, V_{DS} = 1200 V	
I_{GSS}	Gate-Source Leakage Current			1.5		V_{GS} = 20 V, V_{DS} = 0 V	
$R_{DS(on)}$	Drain-Source On-State Resistance (Devices Only)		13.0	16.0	mΩ	V_{GS} = 20 V, I_D = 120 A	Fig. 2 Fig. 3
			23.0			V_{GS} = 20 V, I_D = 120 A, T_{VJ} = 150 °C	
g_{fs}	Transconductance		57.4		S	V_{DS} = 20 V, I_{DS} = 120 A	Fig. 4
			54.4			V_{DS} = 20 V, I_{DS} = 120 A, T_{VJ} = 150 °C	
E_{On}	Turn-On Switching Energy, T_{VJ} = 25 °C T_{VJ} = 125 °C T_{VJ} = 150 °C		1.39 1.24 1.19		mJ	V_{DS} = 600 V, I_D = 120 A, V_{GS} = -5 V/+20 V, $R_{G(ext)}$ = 2.5 Ω, L = 22.5 µH	Fig. 11 Fig. 13
E_{Off}	Turn-Off Switching Energy, T_{VJ} = 25 °C T_{VJ} = 125 °C T_{VJ} = 150 °C		0.86 0.84 0.85				
$R_{G(int)}$	Internal Gate Resistance		1.8		Ω	V_{AC} = 25 mV, f = 100 kHz	
C_{iss}	Input Capacitance		6.47		nF	V_{GS} = 0 V, V_{DS} = 800 V, V_{AC} = 25 mV, f = 200 kHz	Fig. 9
C_{oss}	Output Capacitance		0.98				
C_{rss}	Reverse Transfer Capacitance		43.8		pF		
Q_{GS}	Gate to Source Charge		97		nC	V_{DS} = 800 V, V_{GS} = -5 V/+20 V I_D = 120 A Per IEC60747-8-4 pg 21	
Q_{GD}	Gate to Drain Charge		118				
Q_G	Total Gate Charge		378				
$R_{th\ JC}$	FET Thermal Resistance, Junction to Case		0.125	0.135	°C/W		Fig. 17

Diode Characteristics (Per Position) (T_{VJ} = 25 ˚C unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
V_F	Diode Forward Voltage		1.53		V	V_{GS} = -5 V, I_F = 120 A, T_{VJ} = 25 °C	Fig. 7
			1.92			V_{GS} = -5 V, I_F = 120 A, T_{VJ} = 150 °C	
t_{rr}	Reverse Recovery Time		21		ns	V_{GS} = -5 V, I_{SD} = 120 A, V_R = 600 V di_F/dt = 12.5 A/ns, T_{VJ} = 150 °C	Fig. 32
Q_{RR}	Reverse Recovery Charge		2.2		µC		
I_{RRM}	Peak Reverse Recovery Current		173		A		
E_{rr}	Diode Energy T_{VJ} = 25 °C T_{VJ} = 125 °C T_{VJ} = 150 °C		0.75 0.86 0.89		mJ	V_{DS} = 600 V, I_D = 120 A, V_{GS} = -5 V/+20 V, $R_{G(ext)}$ = 2.5 Ω, L = 22.5 µH	Fig. 14 Note 1
$R_{th\ JC}$	Diode Thermal Resistance, Junction to Case		0.108	0.115	°C/W		Fig. 18

Note 1 SiC Schottky diodes do not have reverse recovery energy but still contribute capacitive energy

Module Physical Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
R_{1-2}	Package Resistance, M1		0.60		µΩ	T_C = 125 °C, Note 2
R_{2-3}	Package Resistance, M2		0.51			T_C = 125 °C, Note 2
L_{Stray}	Stray Inductance		12.9		nH	Between Terminals 1 and 3
T_C	Case Temperature	-40		125	°C	
W	Weight		290		g	
M_S	Mounting Torque	4	5	5.5	N-m	Baseplate, M6-1.0 bolts
		4	5	5.5		Power Terminals, M6-1.0 bolts
V_{isol}	Case Isolation Voltage	5			kV	AC, 50 Hz, 1 min
	Clearance Distance	9			mm	Terminal to Terminal
		30				Terminal to Baseplate
	Creepage Distance	30				Terminal to Terminal
		40				Terminal to Baseplate

Note 2 Total Effective Resistance (Per Switch Position) = MOSFET $R_{DS(on)}$ + Switch Position Package Resistance

Typical Performance

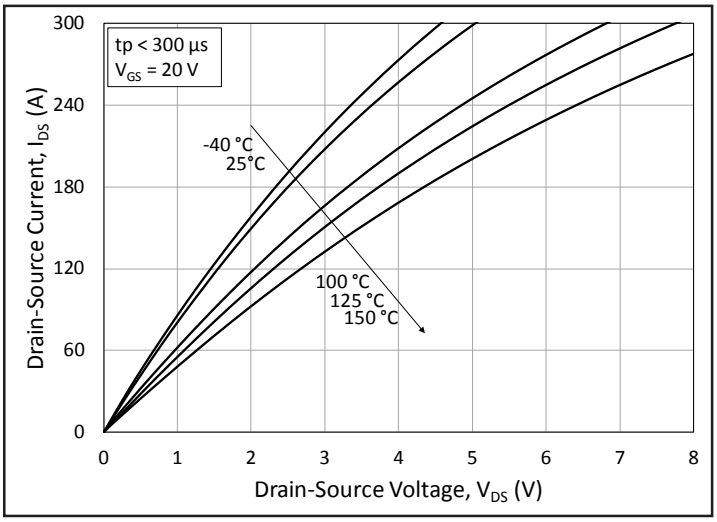


Figure 1. Output Characteristics for Various Junction Temperatures

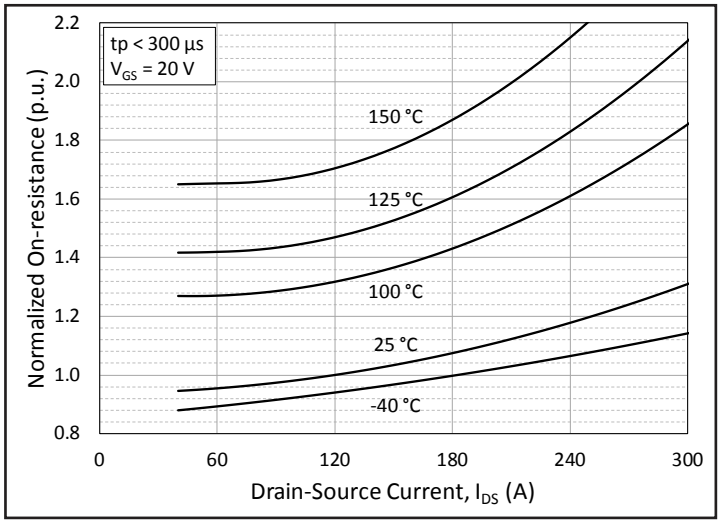


Figure 2. Normalized On-State Resistance vs. Drain Current for Various Junction Temperatures

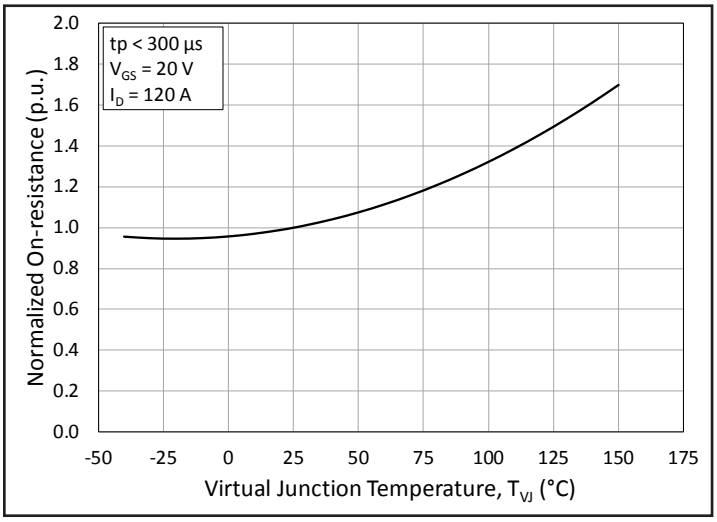


Figure 3. Normalized On-State Resistance vs. Junction Temperature

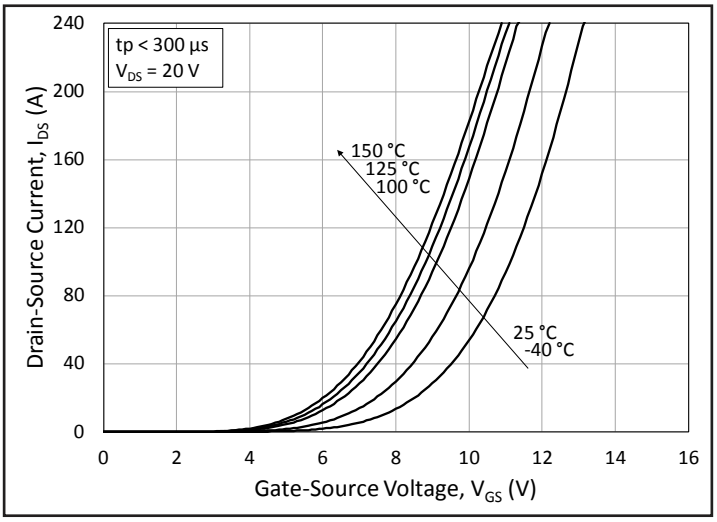


Figure 4. Transfer Characteristic for Various Junction Temperatures

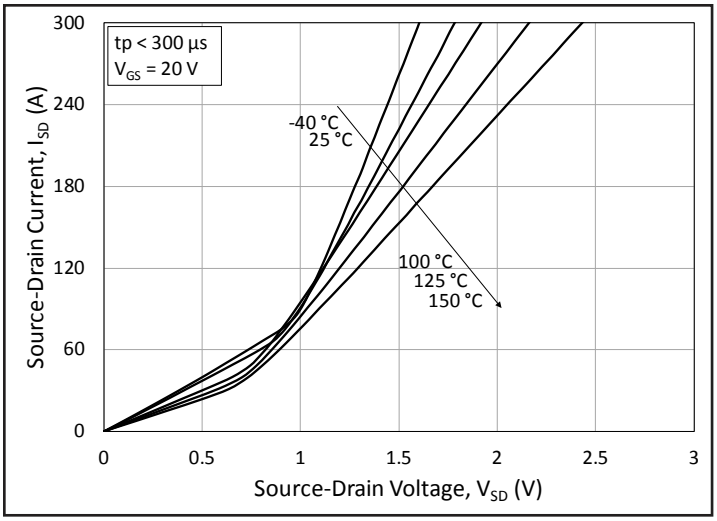


Figure 5. 3rd Quadrant Characteristic vs. Junction Temperatures at V_{GS} = 20 V (Note 2)

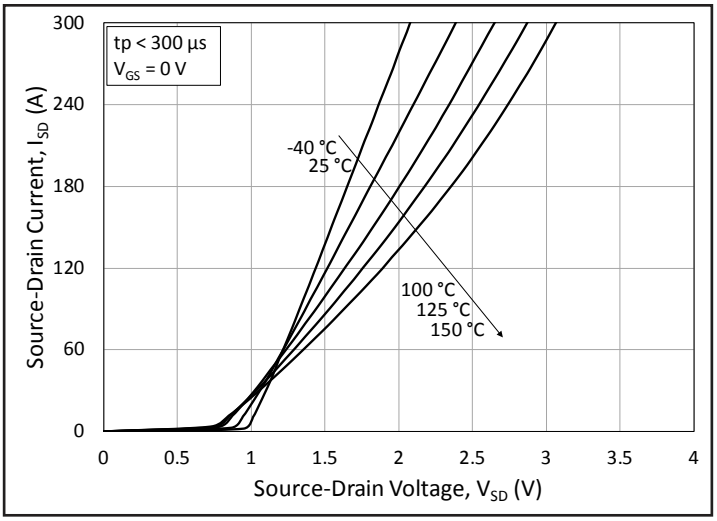


Figure 6. 3rd Quadrant Characteristic vs. Junction Temperatures at V_{GS} = 0 V (Diode) (Note 2)

Typical Performance

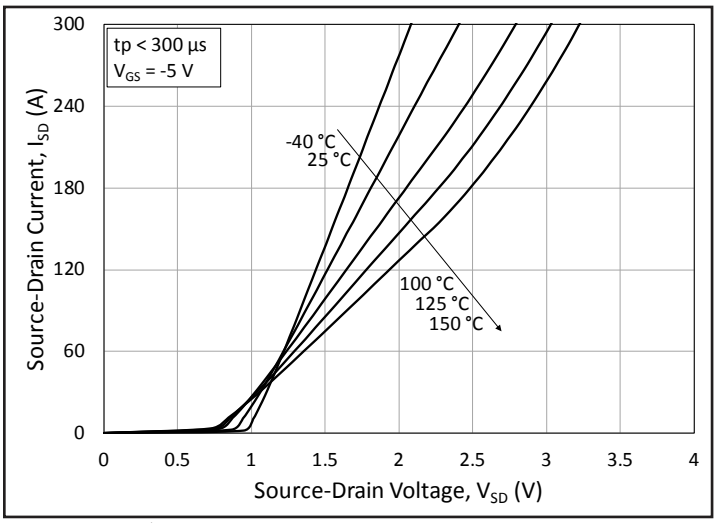


Figure 7. 3rd Quadrant Characteristic vs. Junction Temperatures at V_{GS} = -5 V (Diode) (Note 2)

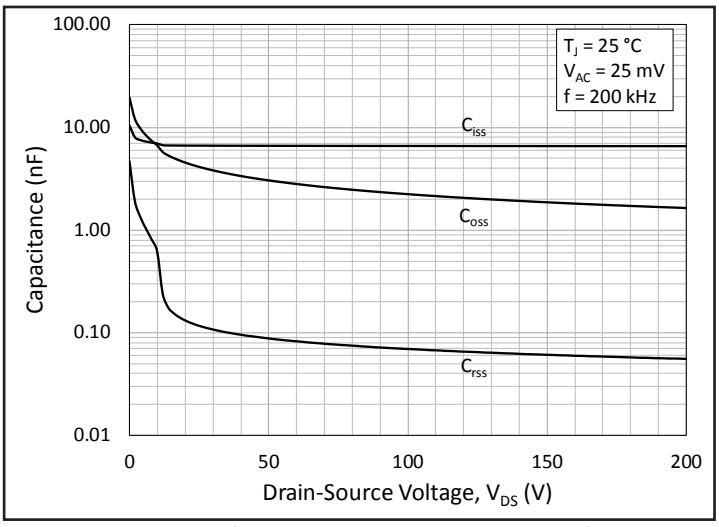


Figure 8. Typical Capacitances vs. Drain to Source Voltage (0 - 200V)

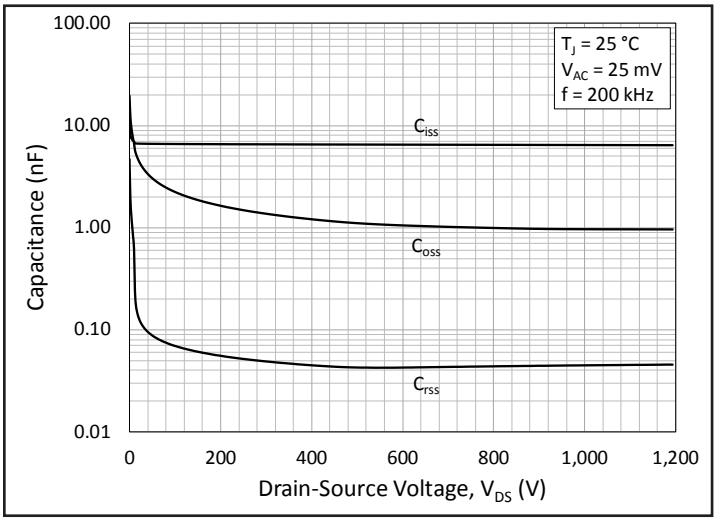


Figure 9. Typical Capacitances vs. Drain to Source Voltage (0 - 1200V)

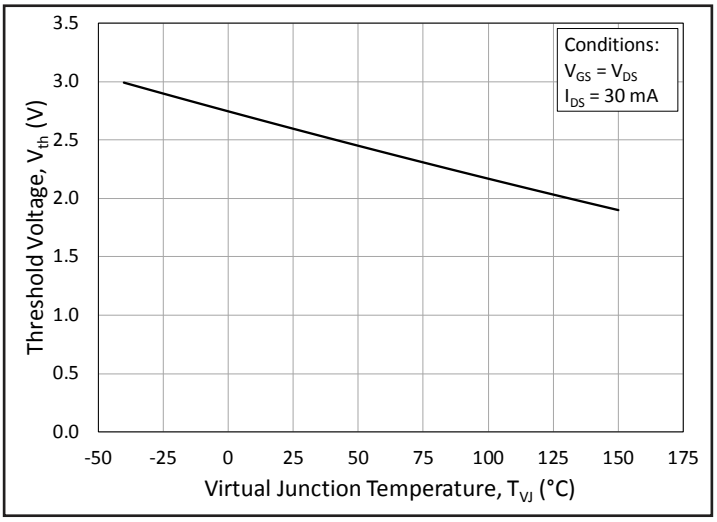


Figure 10. Threshold Voltage vs. Junction Temperature

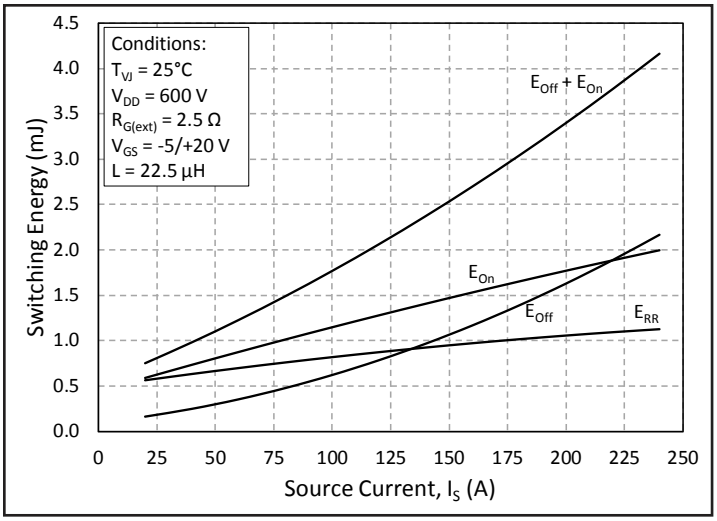


Figure 11. Switching Energy vs. Drain Current (V_{DS} = 600 V)

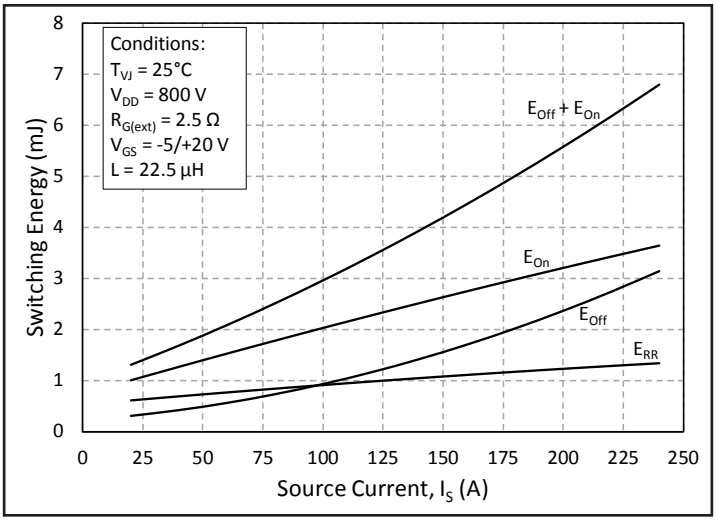


Figure 12. Switching Energy vs. Drain Current (V_{DS} = 800 V)

Typical Performance

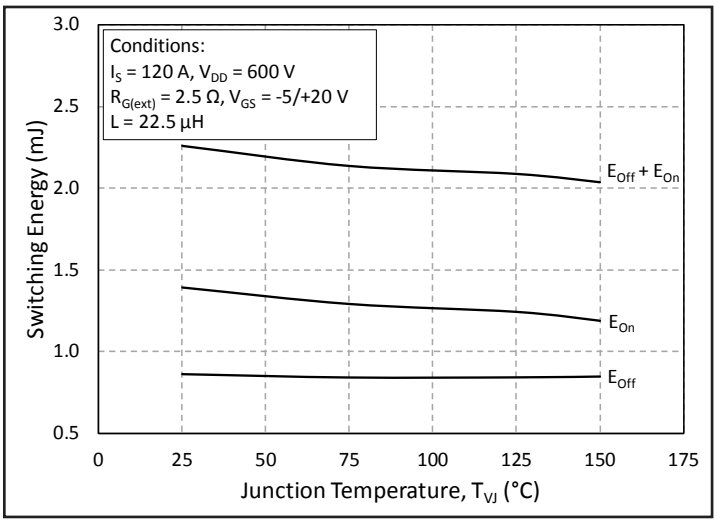


Figure 13. MOSFET Switching Energy vs. Junction Temperature

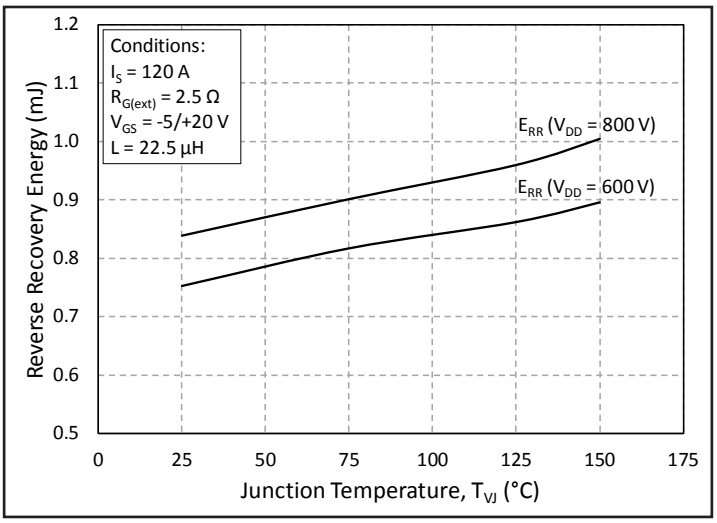


Figure 14. Reverse Recovery Energy vs. Junction Temperature (Note 2)

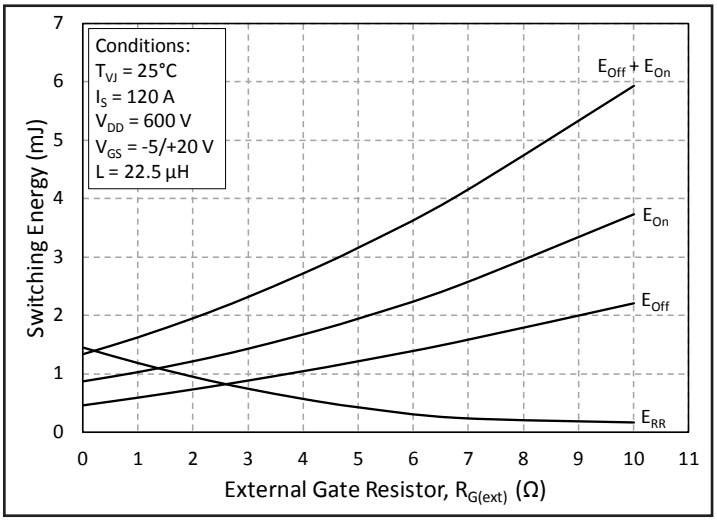


Figure 15. MOSFET Switching Energy vs. External Gate Resistance

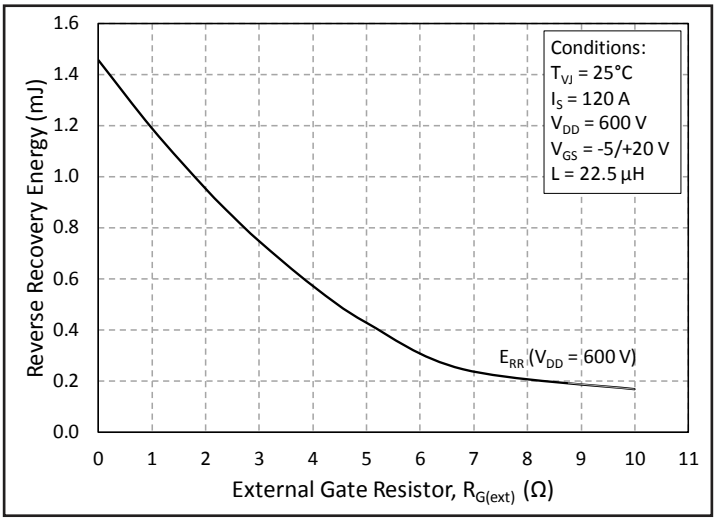


Figure 16. Reverse Recovery Energy vs. External Gate Resistance (Note 2)

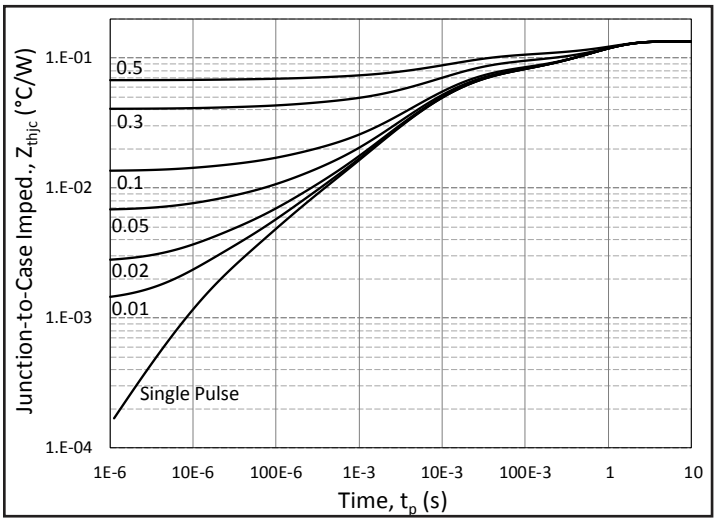


Figure 17. MOSFET Junction to Case Transient Thermal Impedance, $Z_{th\,JC}$ (°C/W)

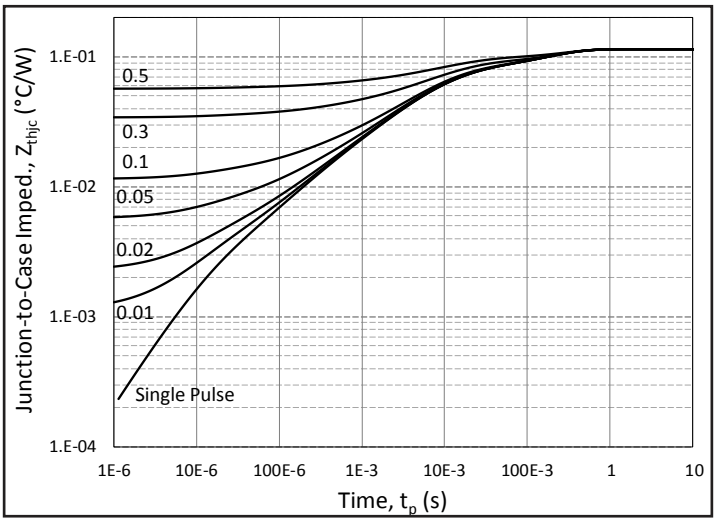


Figure 18. Diode Junction to Case Transient Thermal Impedance, $Z_{th\,JC}$ (°C/W)

Typical Performance

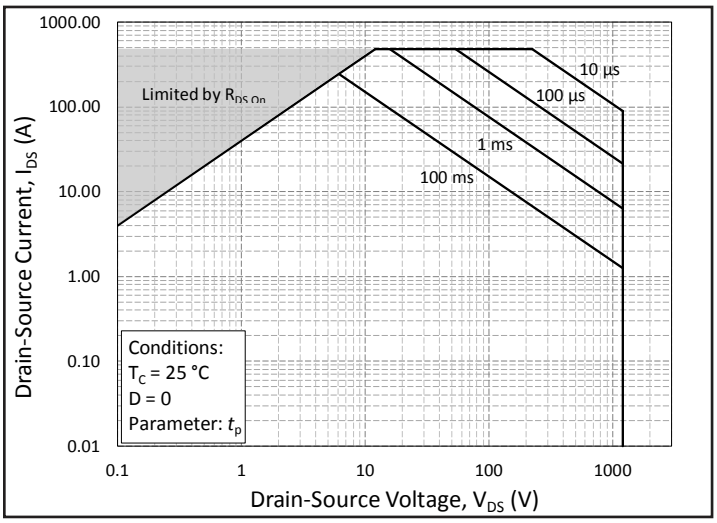


Figure 19. Forward Bias Safe Operating Area (FBSOA)

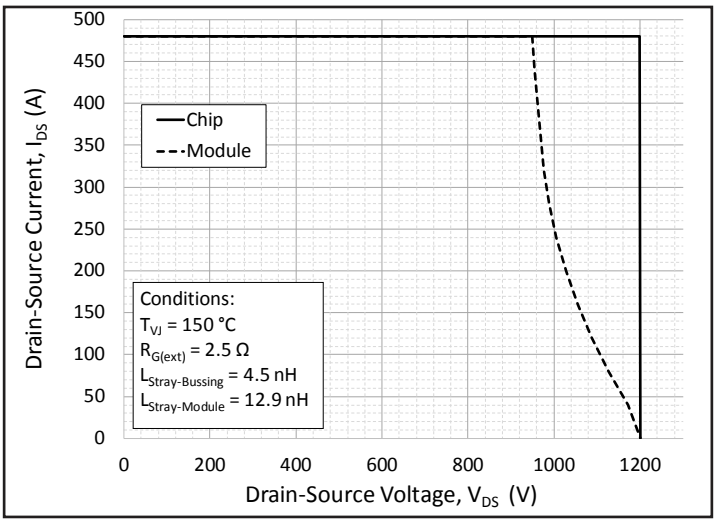


Figure 20. Reverse Bias Safe Operating Area (RBSOA)

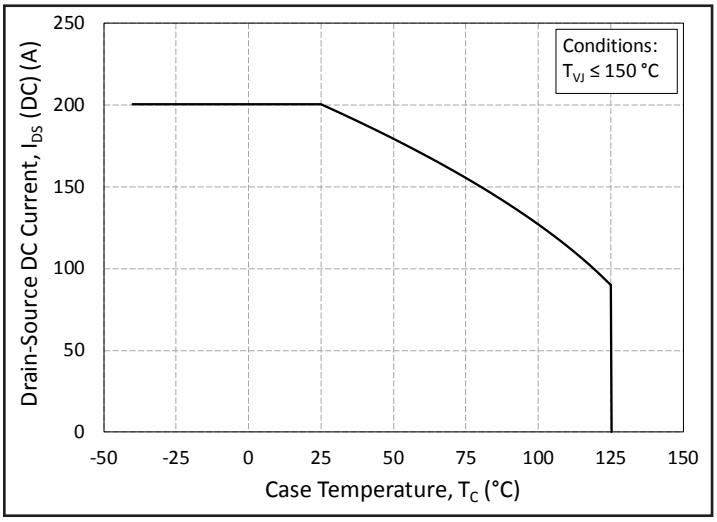


Figure 21. Continuous Drain Current Derating vs. Case Temperature

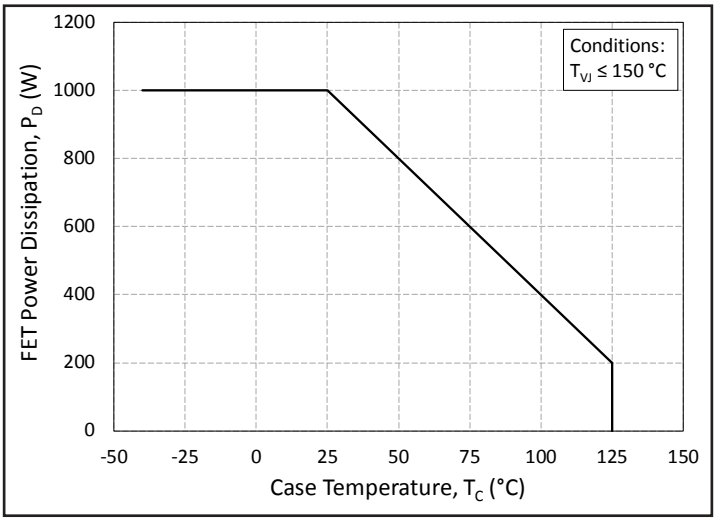


Figure 22. Maximum Power Dissipation Derating vs. Case Temperature

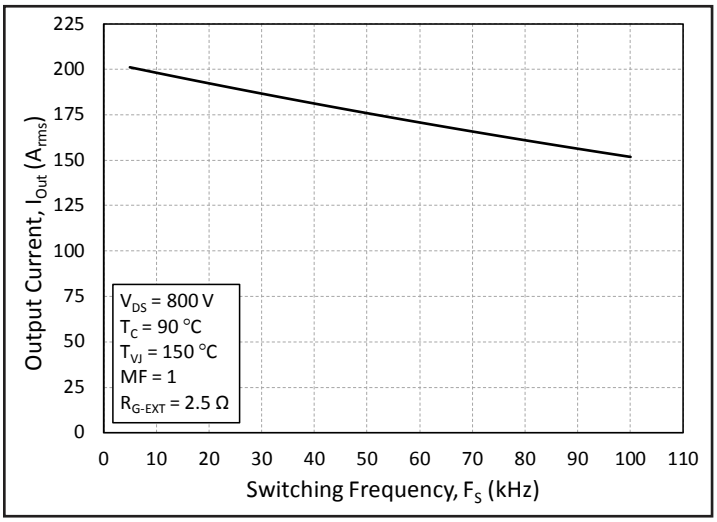


Figure 23. Typical Output Current Capability vs. Switching Frequency (Inverter Application)

Timing Characteristics

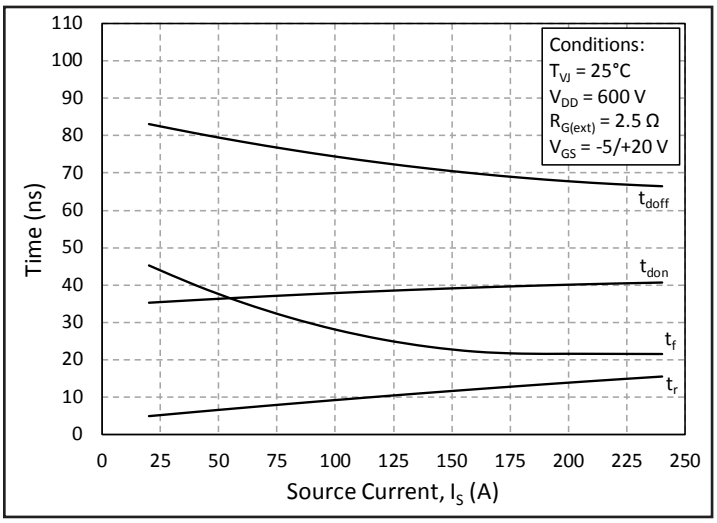


Figure 24. Timing vs. Source Current

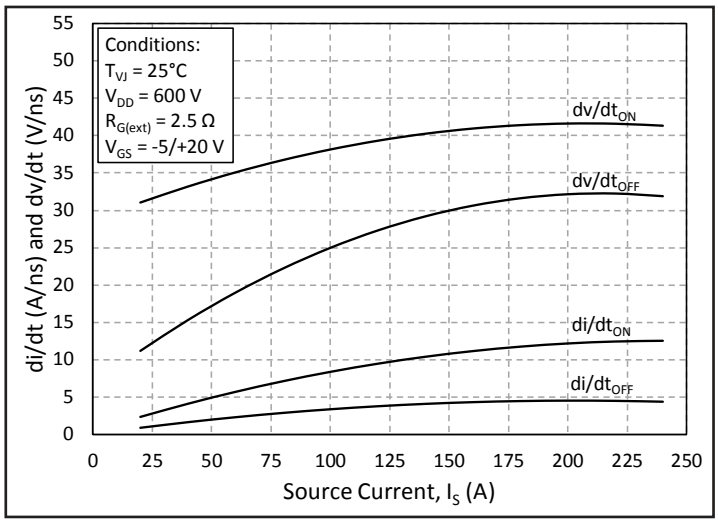


Figure 25. dv/dt and di/dt vs. Source Current

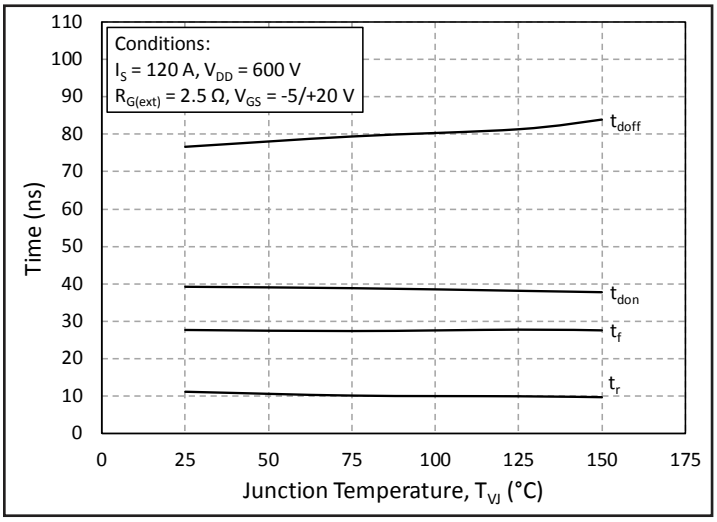


Figure 26. Timing vs. Junction Temperature

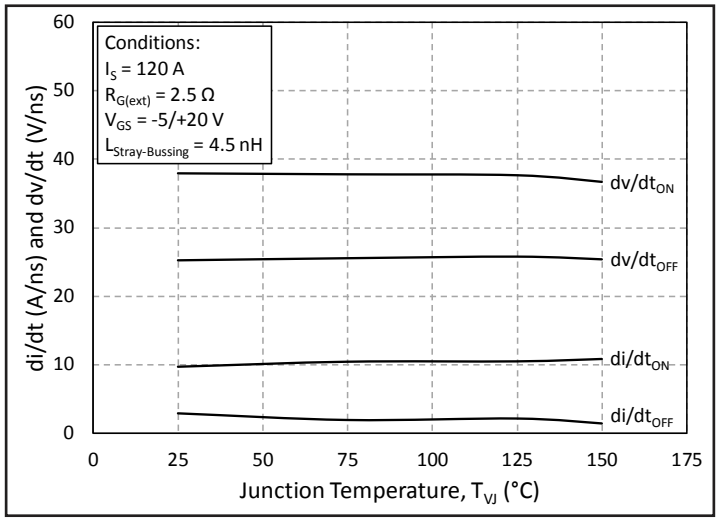


Figure 27. dv/dt and di/dt vs. Source Current

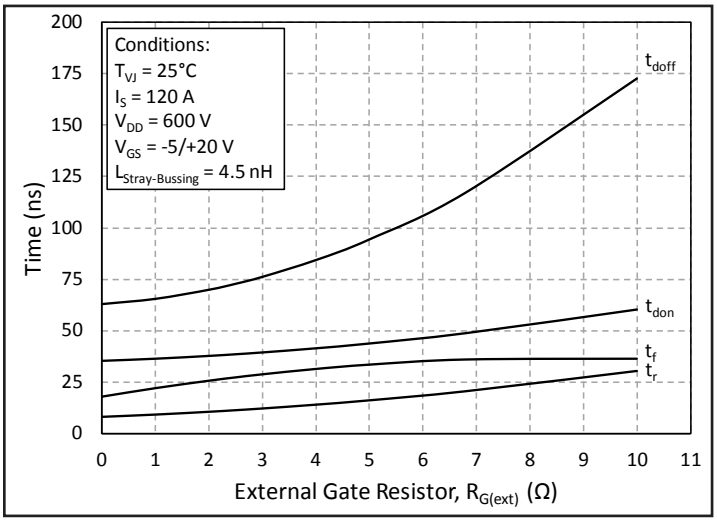


Figure 28. Timing vs. External Gate Resistance

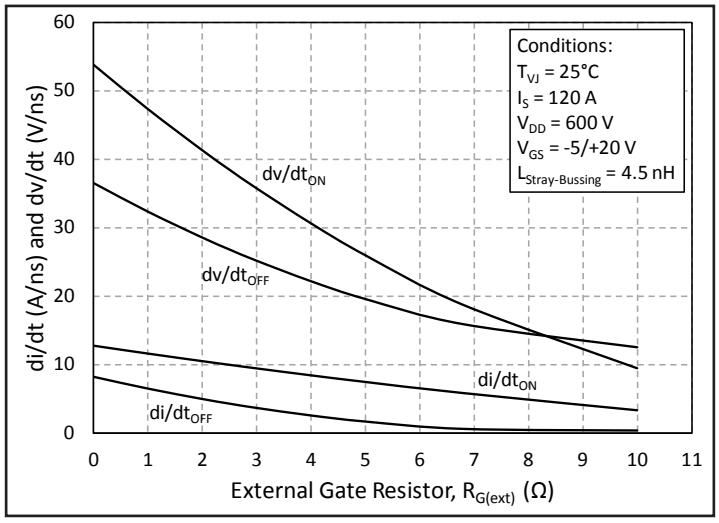


Figure 29. dv/dt and di/dt vs. External Gate Resistance

Definitions

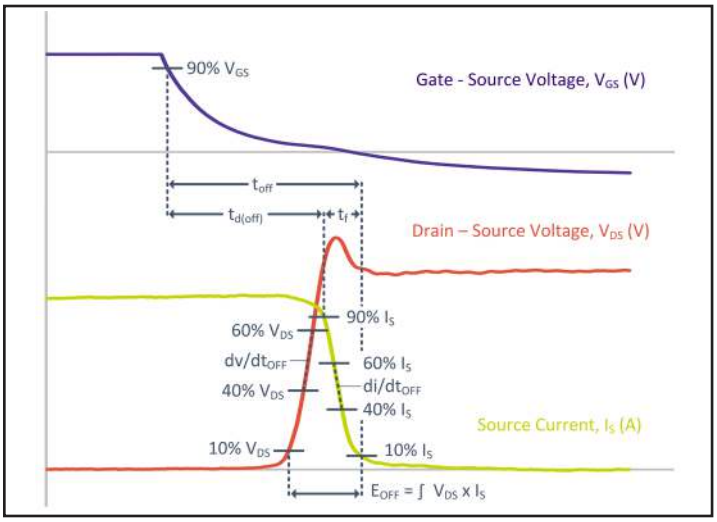


Figure 30. Turn-off Transient Definitions

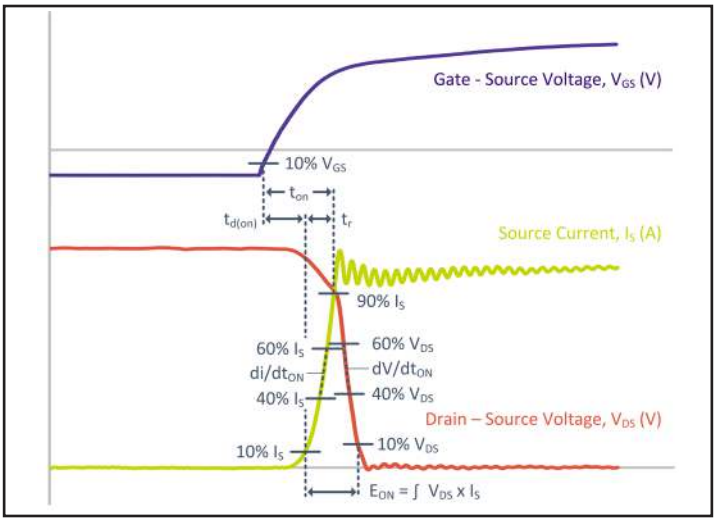


Figure 31. Turn-on Transient Definitions

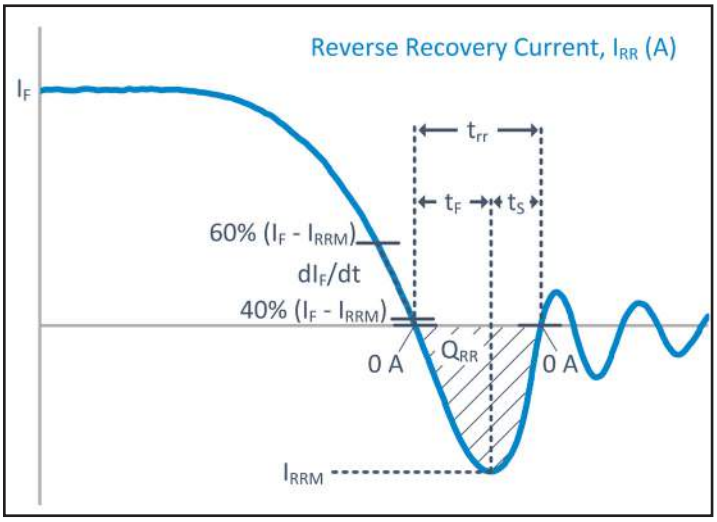


Figure 32. Reverse Recovery Definitions (Note 2)

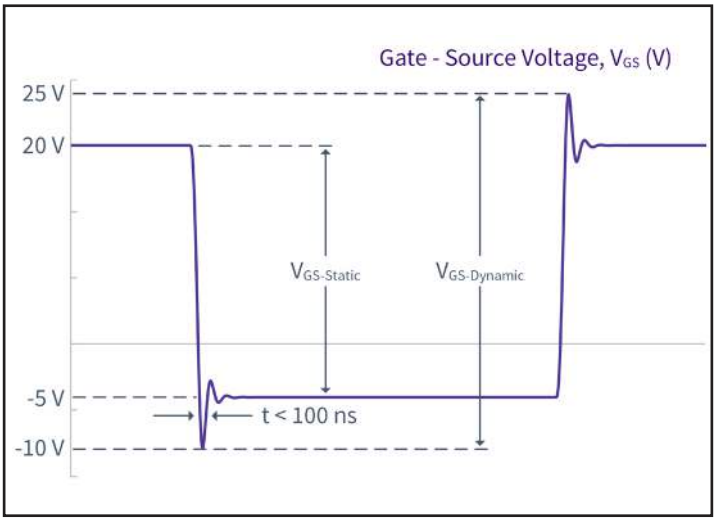
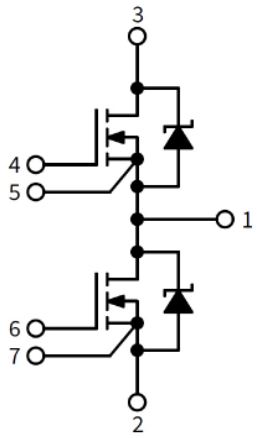
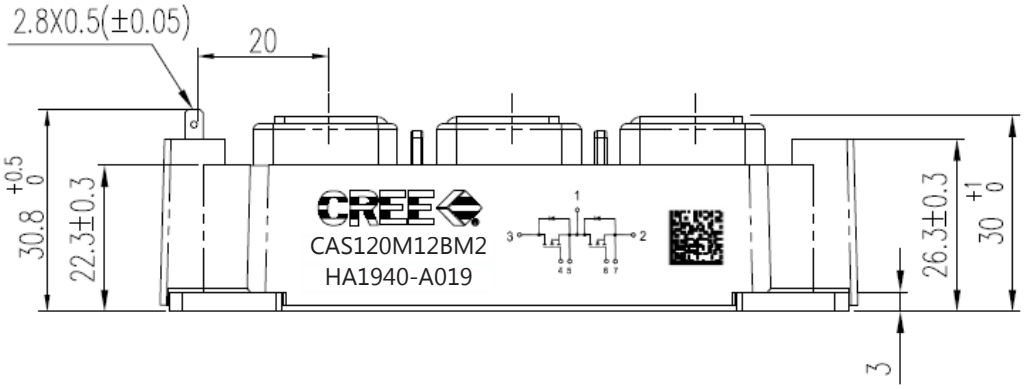


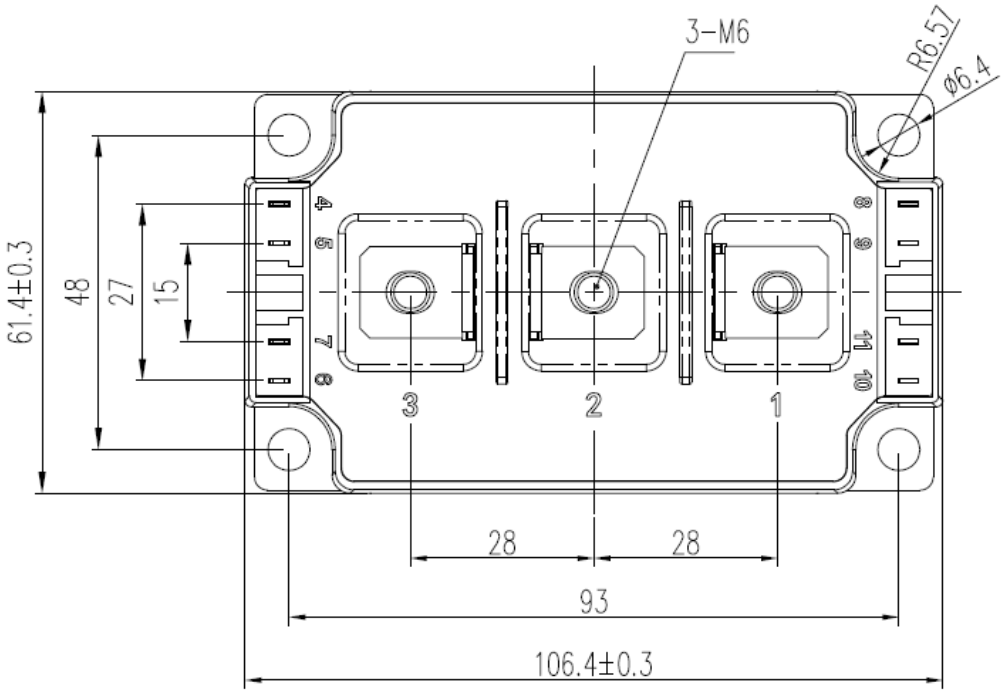
Figure 33. V_{GS} Transient Definitions

Schematic and Pin Out



Package Dimensions (mm)





Supporting Links & Tools

- CGD1200HB2P-BM2 Evaluation Gate Driver
- CGD12HB00D: Differential Transceiver Board
- CPWR-AN-35: Thermal Interface Material Application Note
- KIT-CRD-CIL12N-BM: Dynamic Performance Evaluation Board for the BM2 and BM3 Module

Notes

- 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, or air traffic control systems.

- The SiC MOSFET module switches at speeds beyond what is customarily associated with IGBT-based modules. Therefore, special precautions are required to realize optimal performance. The interconnection between the gate driver and module housing needs to be as short as possible. This will afford optimal switching time and avoid the potential for device oscillation. Also, great care is required to insure minimum inductance between the module and DC link capacitors to avoid excessive VDS overshoot.