CAS480M12HM3

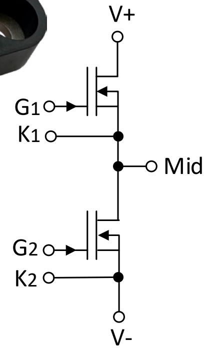
1200 V, 480 A All-Silicon Carbide
High Performance, Switching Optimized, Half-Bridge Module

V_{DS}	1200 V
I_{DS}	480 A

Technical Features

- Low Inductance, Low Profile 62mm Footprint
- High Junction Temperature (175 °C) Operation
- Implements Switching Optimized Third Generation SiC MOSFET Technology
- Zero Reverse Recovery from Diodes
- Light Weight AlSiC Baseplate
- High Reliability Silicon Nitride Insulator

Package 110mm x 65 mm x 12.2 mm



Applications

- Railway & Traction
- Solar
- EV Chargers
- Industrial Automation & Testing

System Benefits

- Lightweight, Compact Form Factor with 62mm Compatible Baseplate Enables System Retrofit
- Increased System Efficiency, due to Low Switching & Conduction Losses of SiC
- High Reliability Material Selection

Key Parameters (T_C = 25 ˚C unless otherwise specified)

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	-8		+19	V	Transient, <100 ns		Fig. 32
$V_{GS\ op}$	Gate-Source Voltage, Recommended Op. Value	-4		+15	V	Static		Fig. 32
I_{DS}	DC Continuous Drain Current		640		A	V_{GS} = 15 V, T_C = 25 ˚C, T_{VJ} ≤ 175 ˚C		Fig. 20
			481		A	V_{GS} = 15 V, T_C = 90 ˚C, T_{VJ} ≤ 175 ˚C		Note 1
I_{SD}	DC Source-Drain Current		640		A	V_{GS} = 15 V, T_C = 25 ˚C, T_{VJ} ≤ 175 ˚C		
I_F	Schottky Diode DC Forward Current		464		A	V_{GS} = - 4 V, T_C = 25 ˚C, T_{VJ} ≤ 175 ˚C		
$I_{DS\ (pulsed)}$	Maximum Pulsed Drain-Source Current			960	A	V_{GS} = 15 V	T_{VJ} = 25 ˚C; t_{Pmax} limited by T_{VJmax}	
$I_{F\ (pulsed)}$	Maximum Pulsed Diode Current			960	A	V_{GS} = -4 V		
$T_{VJ\ op}$	Maximum Virtual Junction Temperature under Switching Conditions	-40		175	°C			

Note 1 Assumes $R_{TH\ JC}$ = 0.1 °C/W and $R_{DS(on)}$ = 3.66 mΩ. Calculate $P_D = (T_{VJ} – T_C) / R_{TH\ JC}$. Calculate $I_{D_MAX} = \sqrt{(P_D / R_{DS(on)})}$

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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	2.5	3.6	V	V_{DS} = V_{GS}, I_D = 160 mA	
			2.0		V	V_{DS} = V_{GS}, I_D = 160 mA, T_{VJ} = 175 °C	
I_{DSS}	Zero Gate Voltage Drain Current		.61	3.3	mA	V_{GS} = 0 V, V_{DS} = 1200 V	
I_{GSS}	Gate-Source Leakage Current		0.1	2	µA	V_{GS} = 15 V, V_{DS} = 0 V	
$R_{DS(on)}$	Drain-Source On-State Resistance (Devices Only)		2.29	2.97	mΩ	V_{GS} = 15 V, I_D = 480 A	Fig. 2 Fig. 3
			3.66			V_{GS} = 15 V, I_D = 480 A, T_{VJ} = 175 °C	
g_{fs}	Transconductance		356		S	V_{DS}= 20 V, I_{DS}= 480 A	Fig. 4
			345			V_{DS}= 20 V, I_{DS}= 480 A, T_{VJ} = 175 °C	
E_{On}	Turn-On Switching Energy, T_J = 25 °C T_J = 125 °C T_J = 175 °C		11.3 9.6 9.9		mJ	V_{DS} = 600 V, I_D = 500 A, V_{GS} = -4 V/15 V, $R_{G(ext)}$ = 1.0 Ω, L= 13.7 µH	Fig. 11 Fig. 13
E_{Off}	Turn-Off Switching Energy, T_J = 25 °C T_J = 125 °C T_J = 175 °C		7.2 7.3 7.4				
$R_{G(int)}$	Internal Gate Resistance		0.8		Ω	V_{AC} = 25 mV, f = 100 kHz	
C_{iss}	Input Capacitance		43.1		nF	V_{GS} = 0 V, V_{DS} = 800 V, V_{AC} = 25 mV, f = 100 kHz	Fig. 9
C_{oss}	Output Capacitance		2.76				
C_{rss}	Reverse Transfer Capacitance		70.7		pF		
Q_{GS}	Gate to Source Charge		448		nC	V_{DS} = 800 V, V_{GS} = -4 V/15 V I_D = 480 A Per IEC60747-8-4 pg 21	
Q_{GD}	Gate to Drain Charge		539				
Q_G	Total Gate Charge		1590				
$R_{th\ JC}$	FET Thermal Resistance, Junction to Case		0.1	0.115	°C/W		Fig. 17

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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		1.95		V	V_{GS} = -4 V, I_F = 480 A	Fig. 7
			3.10			V_{GS} = -4 V, I_F = 480 A, T_{VJ} = 175 °C	
t_{rr}	Reverse Recovery Time		28		ns	V_{GS} = -4 V, I_{SD} = 500 A, V_R = 600 V di_F/dt = 17 A/ns, T_{VJ} = 175 °C	Fig. 31
Q_{RR}	Reverse Recovery Charge		4.5		µC		
I_{RRM}	Peak Reverse Recovery Current		270		A		
E_{rr}	Diode Energy T_{VJ} = 25 °C T_{VJ} = 125 °C T_{VJ} = 175 °C		1.1 1.3 1.5		mJ	V_{DS} = 600 V, I_D = 500A, V_{GS} = -4 V/15 V, $R_{G(ext)}$ = 1.0 Ω, L= 13.7 µH	Fig. 14 Note 2
$R_{th\ JC}$	Diode Thermal Resistance, Junction to Case		0.11	0.13	°C/W		

Note 2 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
$R_{1\text{-}2}$	Package Resistance, M1		106.5		µΩ	T_C = 125 °C, Note 3
$R_{2\text{-}3}$	Package Resistance, M2		126.3			T_C = 125 °C, Note 3
L_{Stray}	Stray Inductance		4.8		nH	Between Terminals 1 and 3
T_C	Case Temperature			125	°C	
W	Weight		180		g	
M_S	Mounting Torque	3	4.5	5	N-m	Baseplate, M6 bolts
		0.9	1.1	1.3		Power Terminals, M4 bolts
V_{isol}	Case Isolation Voltage	4			kV	AC, 50 Hz, 1 min
CTI	Comparative Tracking Index	600				
	Clearance Distance	13.07			mm	Terminal to Terminal
		6.00				Terminal to Baseplate
	Creepage Distance	14.27				Terminal to Terminal
		12.34				Terminal to Baseplate

Note 3 Total Effective Resistance (Per Switch Position) = MOSFET $R_{DS(on)}$ + Switch Position Package Resistance.

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Typical Performance

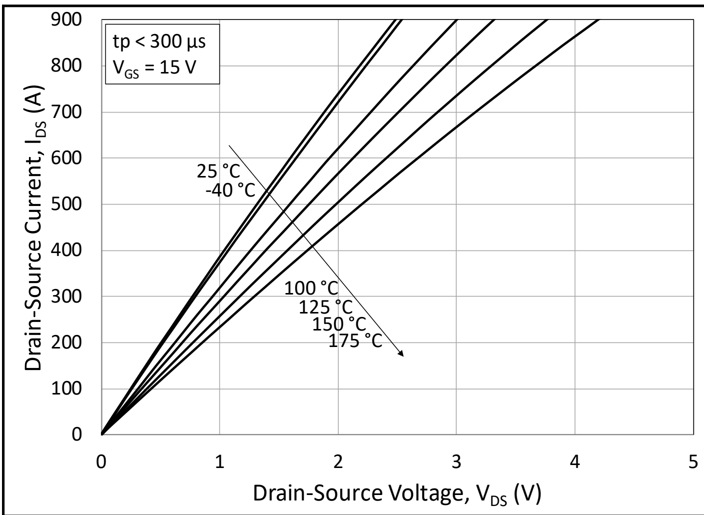

Figure 1. Output Characteristics for Various Junction Temperatures

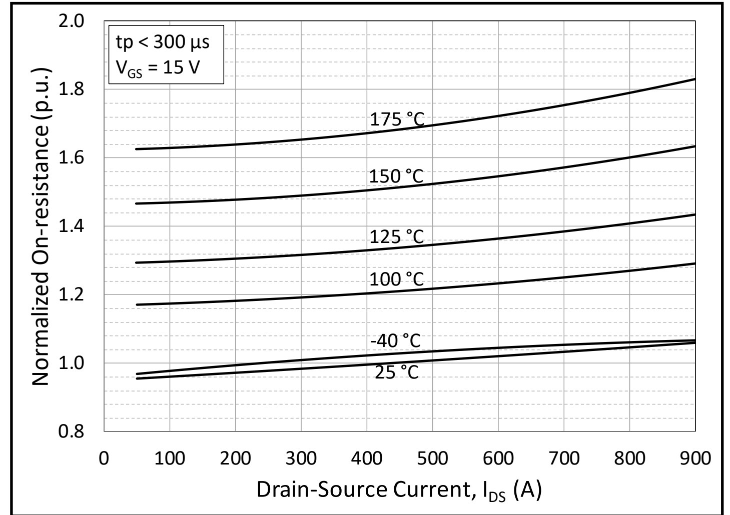

Figure 2. Normalized On-State Resistance vs. Drain Current for Various Juction Temperatures

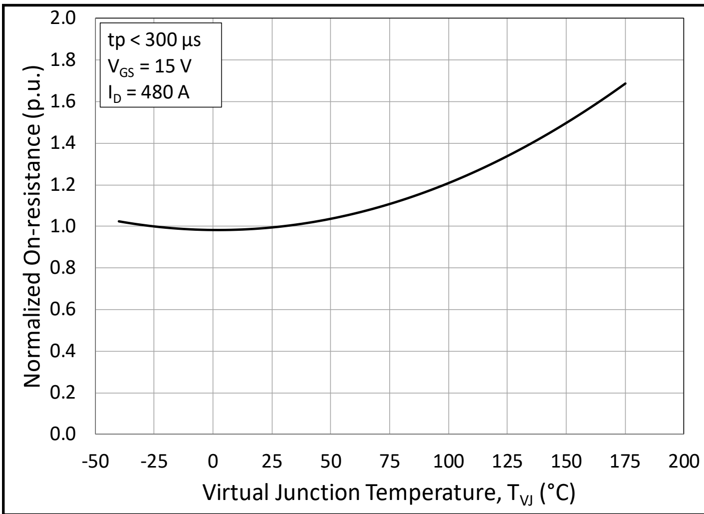

Figure 3. Normalized On-State Resistance vs. Juction Temperature

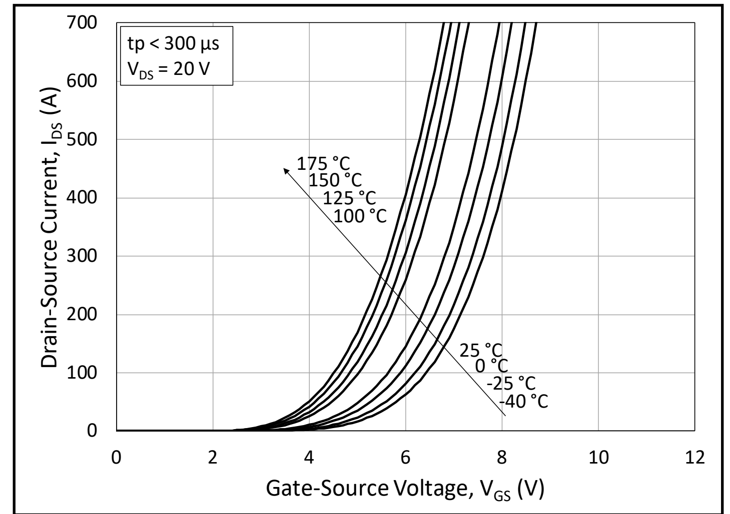

Figure 4. Transfer Characteristic for Various Junction Temperatures

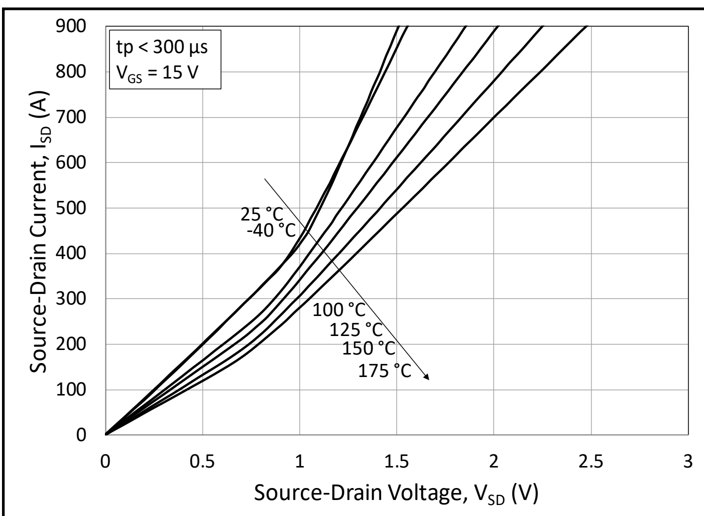

Figure 5. 3rd Quadrant Characteristic vs. Junction Temperatures at V_{GS} = 15 V

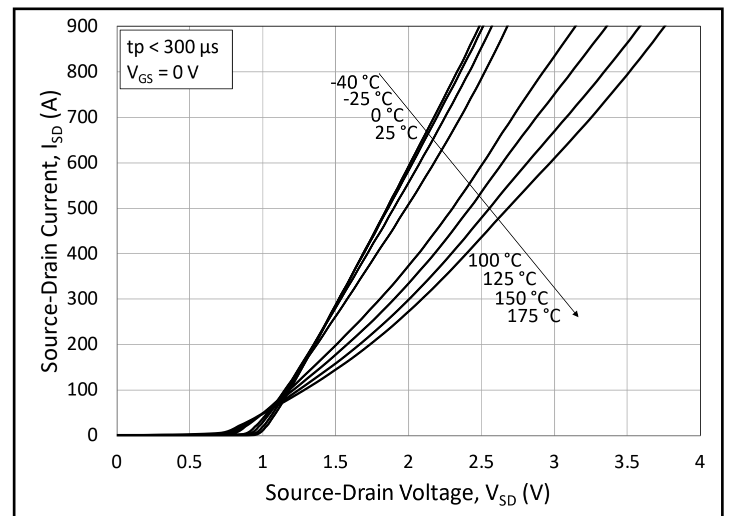

Figure 6. 3rd Quadrant Characteristic vs. Junction Temperatures at V_{GS} = 0V (Diode)

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Typical Performance

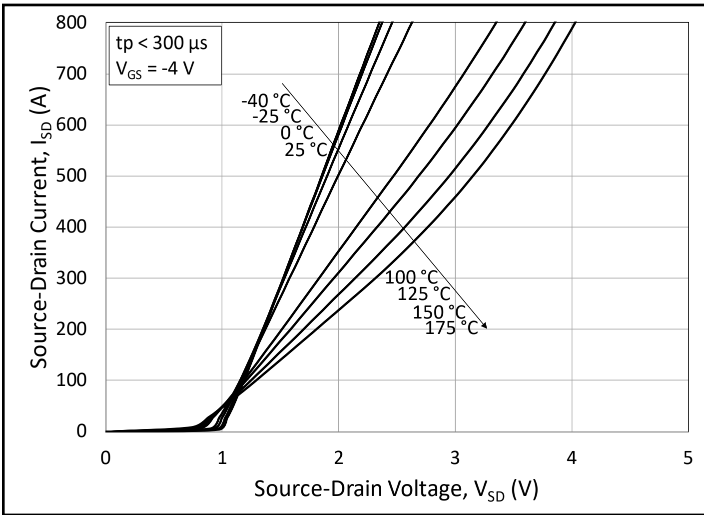

Figure 7. 3rd Quadrant Characteristic vs. Junction Temperatures at V_{GS} = - 4 V (Diode)

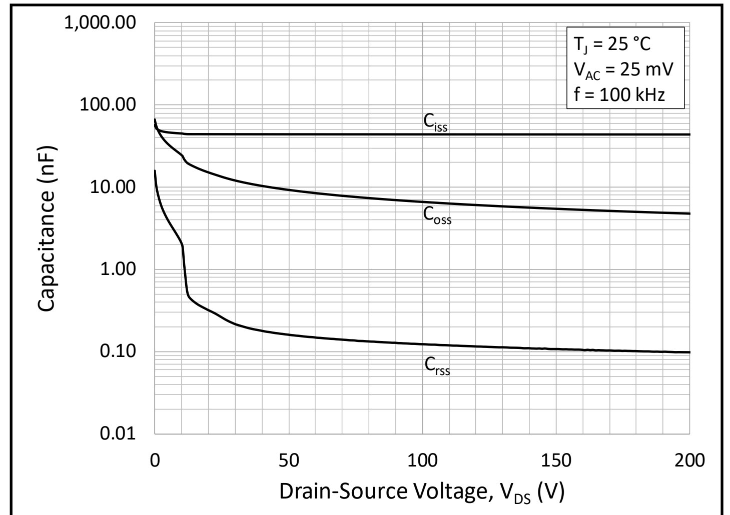

Figure 8. Typical Capacitances vs. Drain to Source Voltage (0 - 200V)

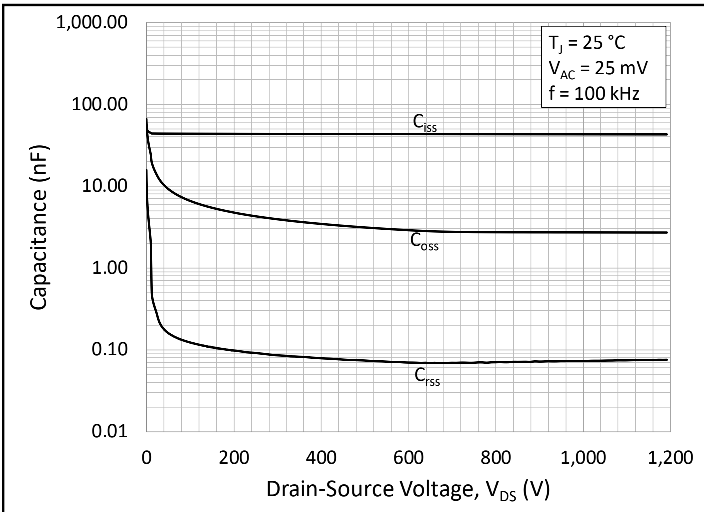

Figure 9. Typical Capacitances vs. Drain to Source Voltage (0 - 1200V)

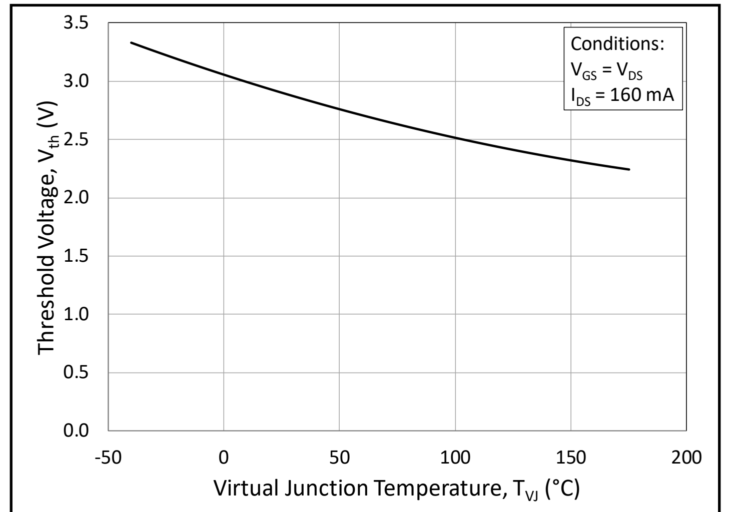

Figure 10. Threshold Voltage vs. Junction Temperature

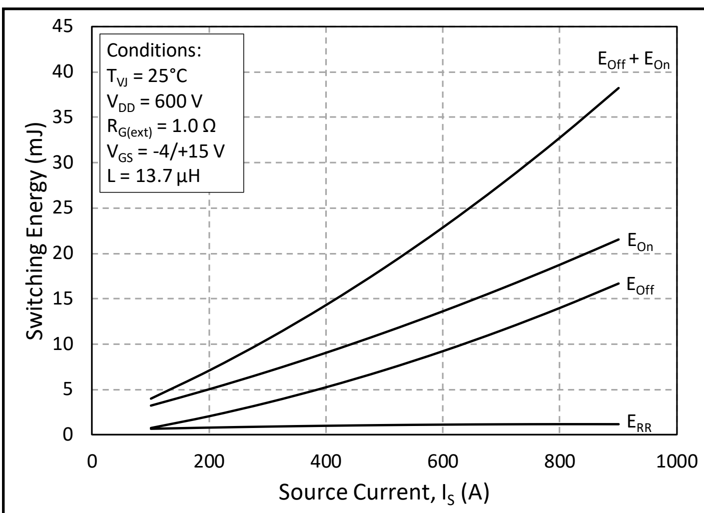

Figure 11. Switching Energy vs. Drain Current (V_{DS} = 600 V)

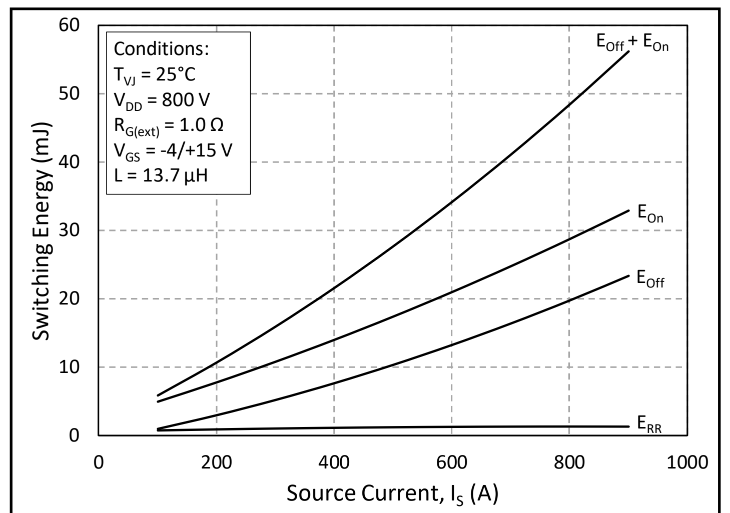

Figure 12. Switching Energy vs. Drain Current (V_{DS} = 800 V)

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Typical Performance

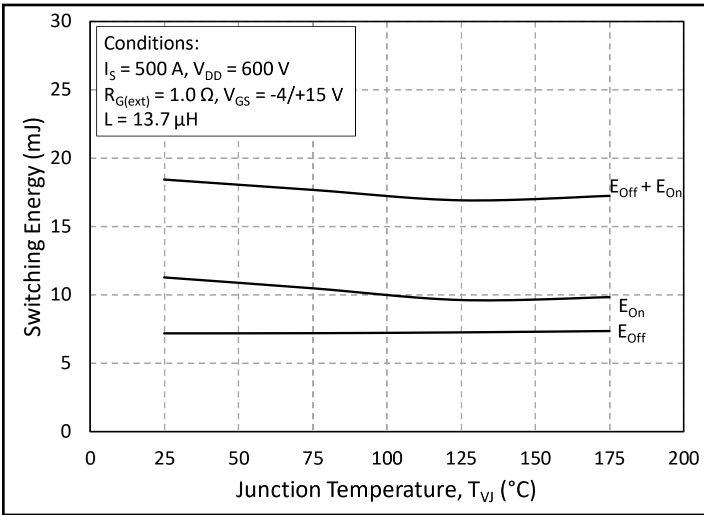

Figure 13. MOSFET Switching Energy vs. Junction Temperature

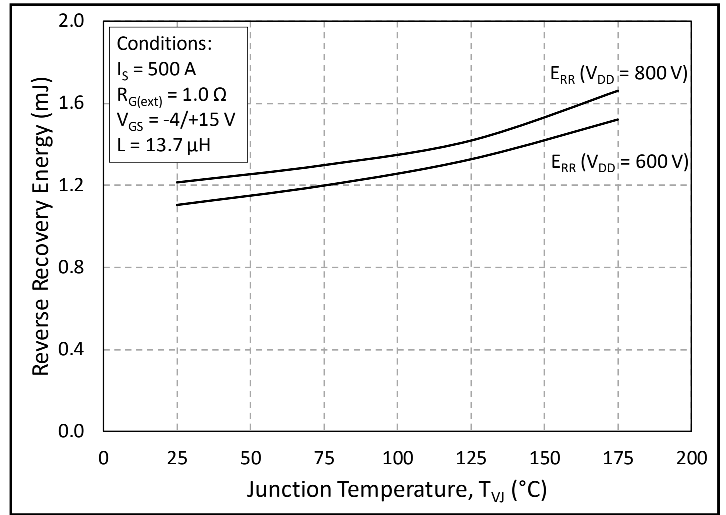

Figure 14. Reverse Recovery Energy vs. Junction Temperature

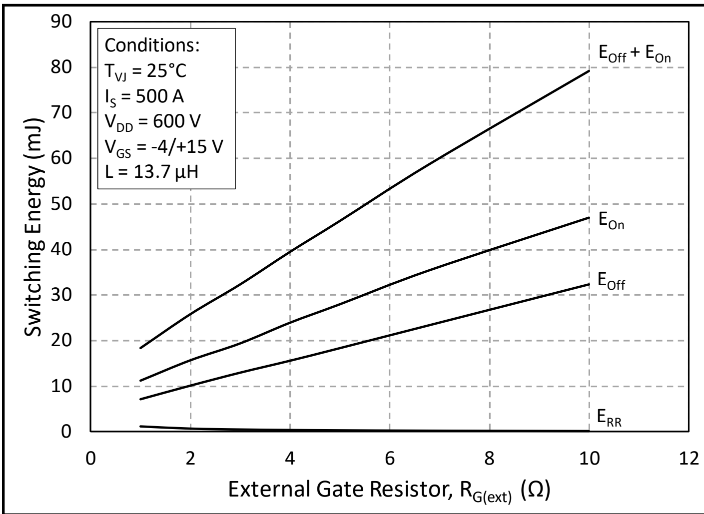

Figure 15. MOSFET Switching Energy vs. External Gate Resistance

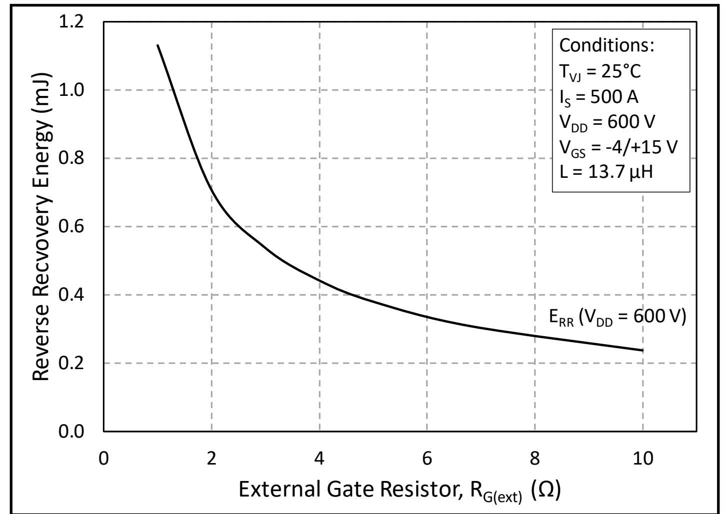

Figure 16. Reserve Recovery Energy vs. External Gate Resistance

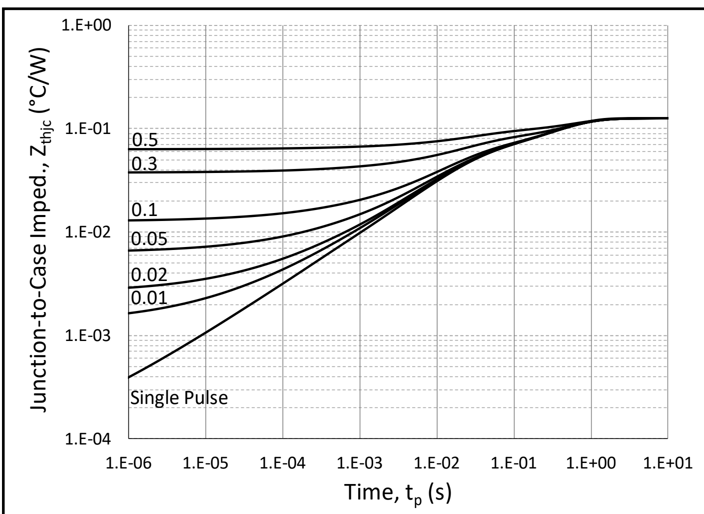

Figure 17. MOSFET Juction to Case Transient Thermal Impedance, $Z_{th\ JC}$ (°C/W)

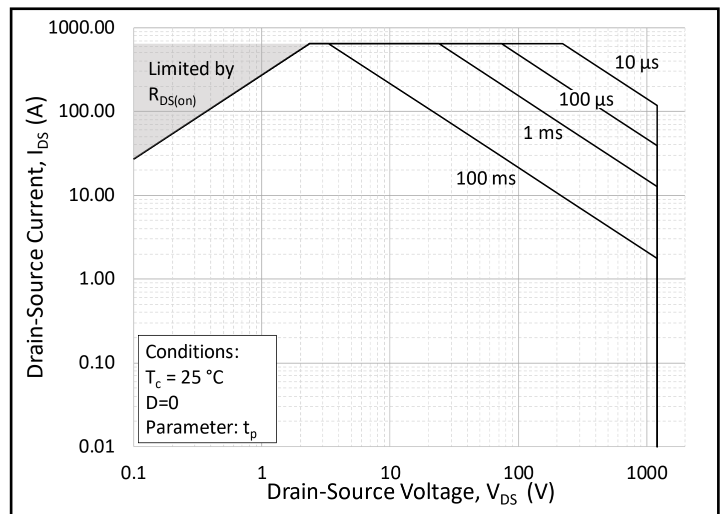

Figure 18. Forward Bias Safe Operating Area (FBSOA)

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Typical Performance

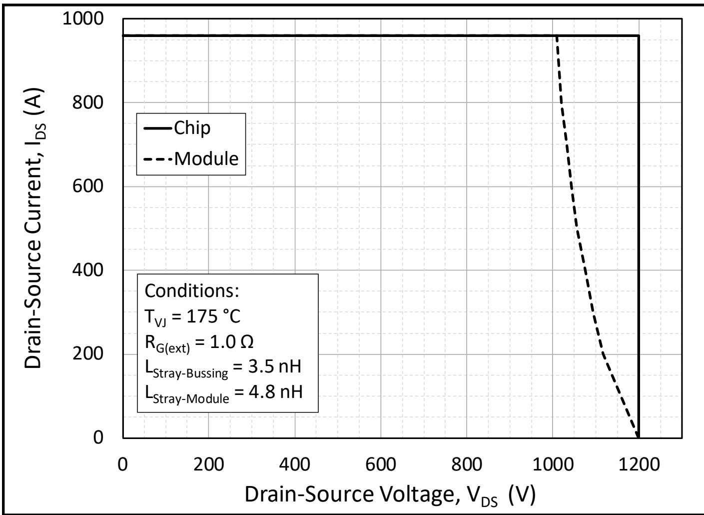

Figure 19. Reverse Bias Safe Operating Area (RBSOA)

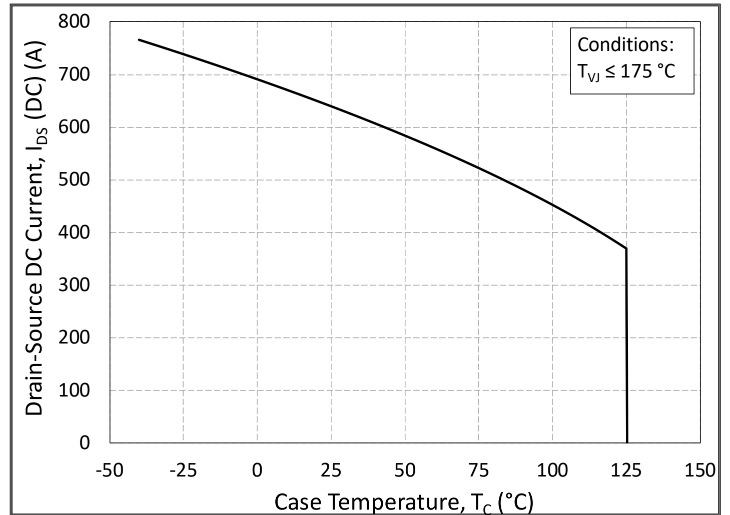

Figure 20. Continuous Drain Current Derating vs. Case Temperature

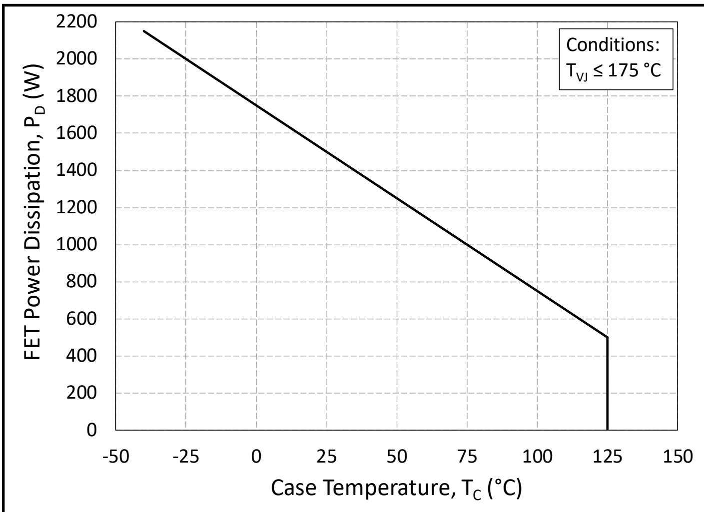

Figure 21. Maximum Power Dissipation Derating vs. Case Temperature

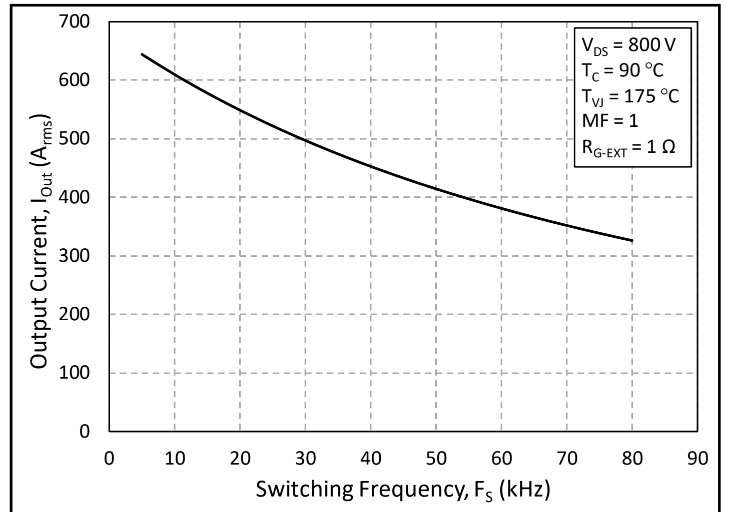

Figure 22. Typical Ouput Current Capablity vs. Switching Frequency (Inverter Application)

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Timing Characteristics

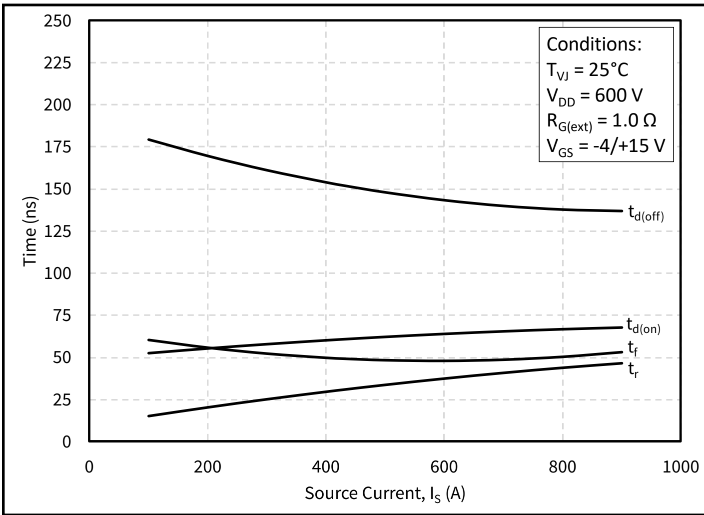

Figure 23. Timing vs. Source Current

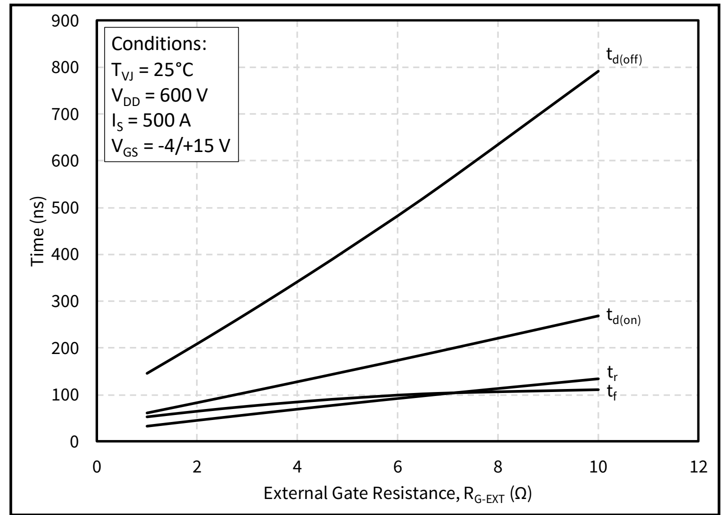

Figure 24. Timing vs. External Gate Resistance

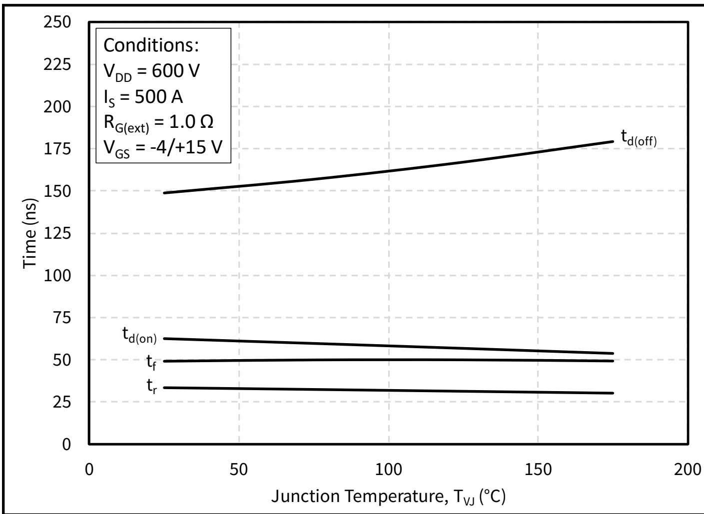

Figure 25. Timing vs. Junction Temperature

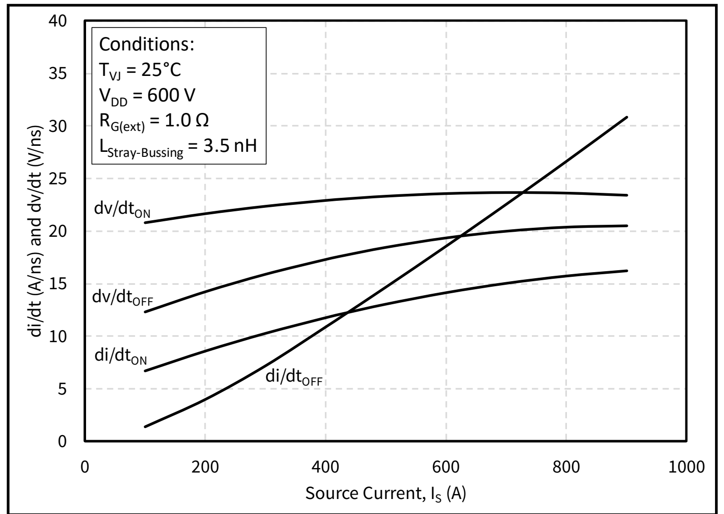

Figure 26. dv/dt and di/dt vs. Source Current

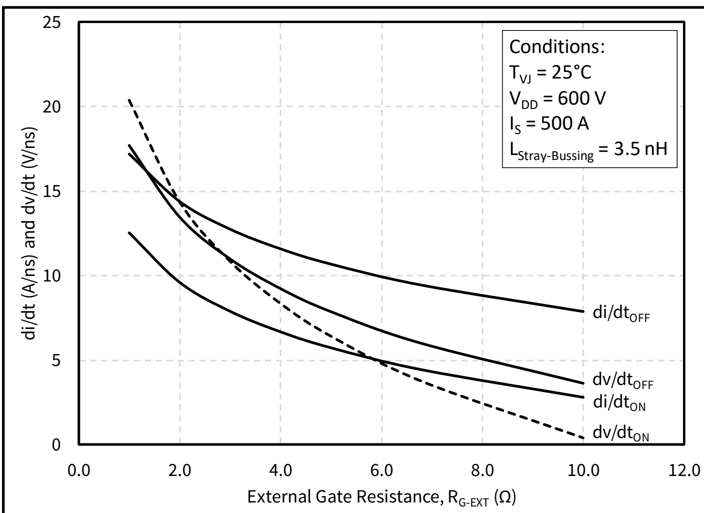

Figure 27. dv/dt and di/dt vs. External Gate Resistance

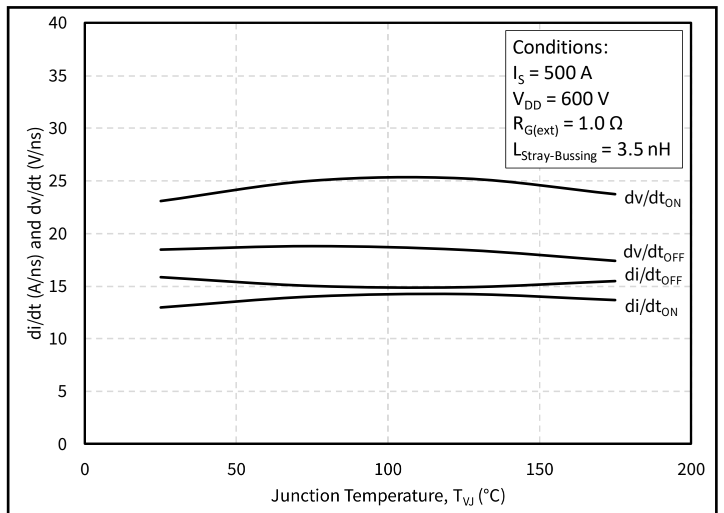

Figure 28. dv/dt and di/dt vs. Junction Temperature

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Definitions

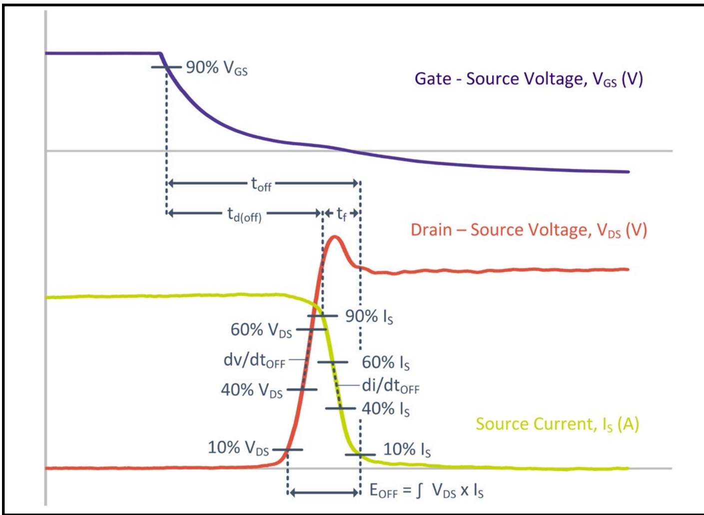

Figure 29. Turn-off Transient Definitions

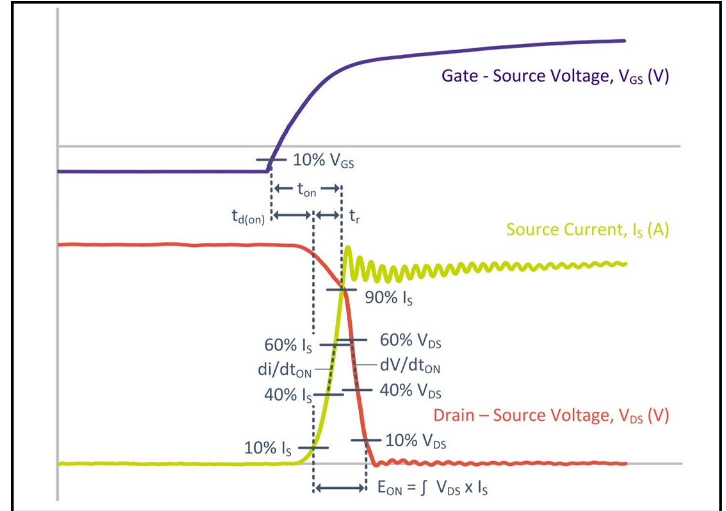

Figure 30. Turn-on Transient Definitions

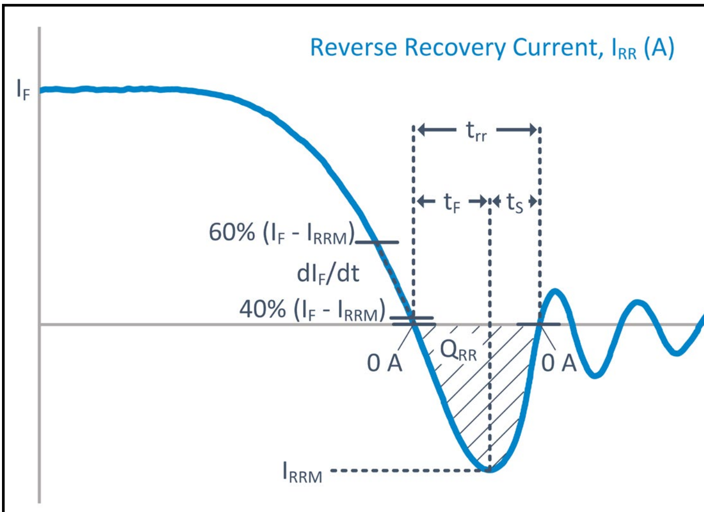

Figure 31. Reverse Recovery Definitions

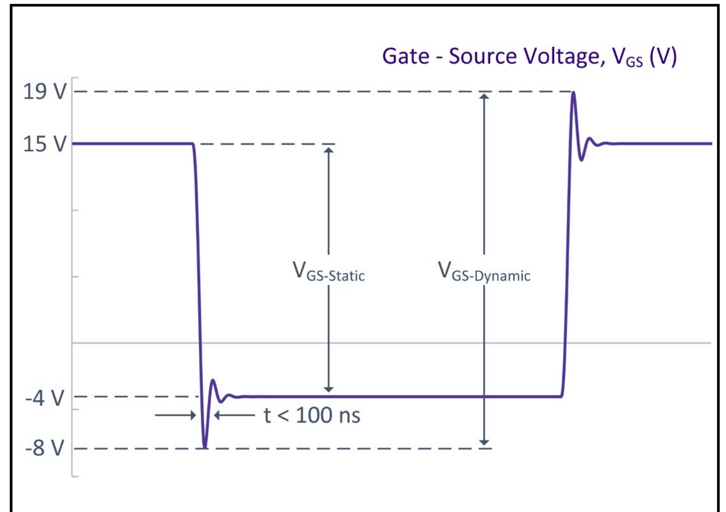

Figure 32. V_{GS} Transient Definitions

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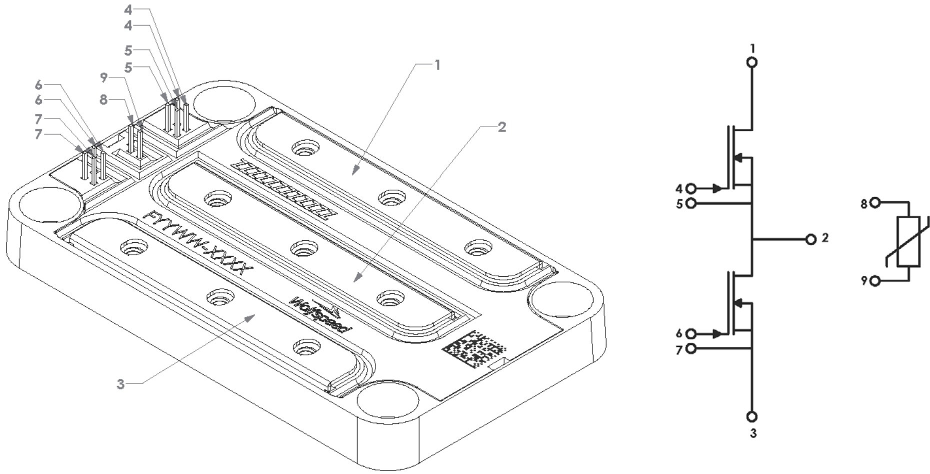
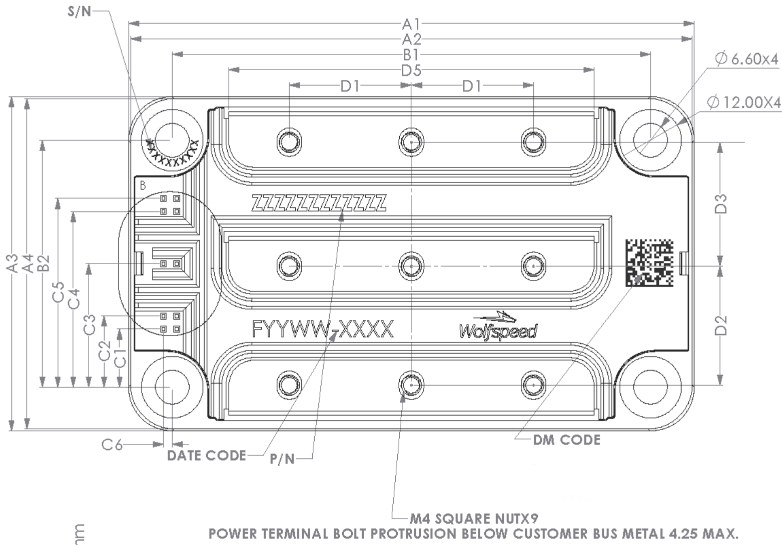
Schematic and Pin Out



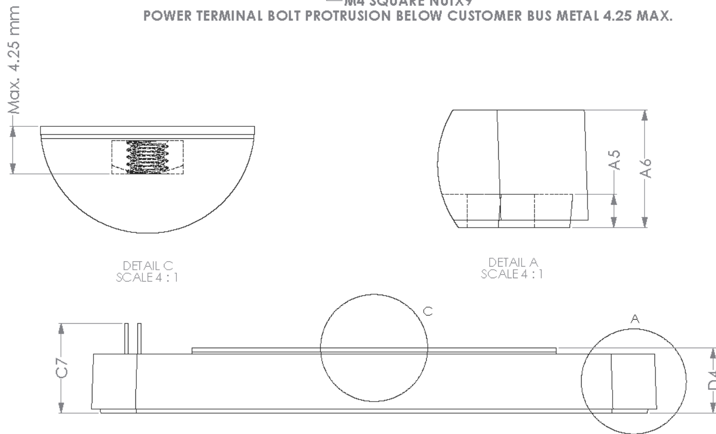
PIN	LABEL
1	V+
2	Mid
3	V-
4	G1, Top row pins (2)
5	K1, Bottom row pins (2)
6	G2, Top row pins (2)
7	K2, Bottom row pins (2)
8	NTC1
9	NTC2

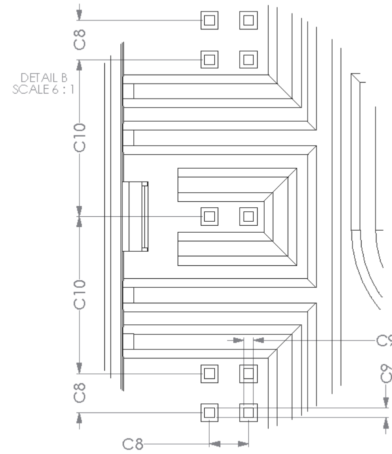
Package Dimensions (mm)



R0.80X3

DIMENSION TABLE		
SYMBOL	DIMENSION (mm)	TOLERANCE (mm)
A1	110.00	±0.60
A2	109.25	±0.60
A3	65.00	±0.60
A4	64.25	±0.60
A5	3.25	±0.30
A6	11.45	±0.60
B1	93.00	±0.30
B2	48.00	±0.30
C1	11.30	±0.40
C2	13.84	±0.40
C3	24.00	±0.40
C4	34.16	±0.40
C5	36.70	±0.40
C6	1.71	±0.40
C7	17.30	±0.50
C8	2.54	±0.30
C9	0.64	±0.30
C10	10.16	±0.40
D1	23.75	±0.50
D2	23.13	±0.50
D3	24.13	±0.50
D4	12.20	±0.50
D5	71.00	±0.30
D6	10.75	±0.30





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Supporting Links & Tools

- CGD1700HB3P-HM3 Evaluation Gate Driver
- CGD12HB00D: Differential Transceiver Board
- CPWR-AN-35: Thermal Interface Material Application Note
- KIT-CRD-CIL12N-HM: Dynamic Performance Evaluation Board for the HM2 and HM3 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.

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