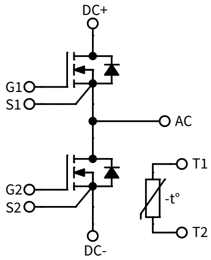
CAB004A12GM4, CAB004A12GM4T

1200 V, 4 mΩ, Silicon Carbide, Half-Bridge Module

V_{DS}	**1200 V**
$R_{DS(on)}$	**4 mΩ**

Technical Features

- Ultra-Low Loss, High Frequency Operation
- Zero Turn-Off Tail Current from MOSFET
- Normally-Off, Fail-Safe Device Operation
- Optional Pre-Applied Thermal Interface Material
- Aluminium Nitride Substrate



Typical Applications

- DC Fast Chargers
- Energy Storage Systems
- High-Efficiency Converters / Inverters
- Renewable Energy
- Smart-Grid / Grid-Tied Distributed Generation

System Benefits

- Enables Compact, Lightweight Systems
- Increased System Efficiency due to Low Switching & Conduction Losses of SiC
- Reduced Thermal Requirements and System Cost

Maximum Parameters (Verified by Design)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Note
Drain-Source Voltage	V_{DS}			1200	V		
Gate-Source Voltage, Maximum Value	$V_{GS(max)}$	-10		23	V	Transient	Note 1 Fig. 33
Gate-Source Voltage, Recommended	$V_{GS(op)}$		-4/+15		V	Static	Note 1 Fig. 33
DC Continuous Drain Current	I_D			200	A	V_{GS} = 15 V, T_{HS} = 75 °C, T_{VJ} ≤ 150 °C	Notes 2, 3 Fig. 20
				200	A	V_{GS} = 15 V, T_{HS} = 75 °C, T_{VJ} ≤ 175 °C	Notes 2, 3 Fig. 20
DC Source-Drain Current (Body Diode)	$I_{SD(BD)}$		165		A	V_{GS} = -4 V, T_{HS} = 25 °C, T_{VJ} ≤ 175 °C	Notes 2, 3 Fig. 20
Pulsed Drain-Source Current	I_{DM}			800	A	t_{Pmax} limited by T_{VJmax} V_{GS} = 15 V, T_{HS} = 25 °C	Notes 2, 3 Fig. 20
Power Dissipation	P_D		810		W	T_{HS} = 75 °C, T_{VJ} ≤ 175 °C	Note 4 Fig. 20
Virtual Junction Temperature	$T_{VJ(op)}$	-40		150	°C	Operation	
		-40		175	°C	Intermittent with Reduced Life	

Note (1): Recommended turn-on gate voltage is 15 V with ±5 % regulation tolerance
Note (2): Current limit calculated by $I_{D(max)} = \sqrt{(P_D/R_{DS(typ)}(T_{VJ(max)}, I_{D(max)}))}$
Note (3): Verified by design
Note (4): $P_D = (T_{VJ} - T_C)/R_{TH(JC,typ)}$

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MOSFET Characteristics (Per Position) (T_{VJ} = 25 °C Unless Otherwise Specified)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Note
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	1200			V	V_{GS} = 0 V, T_{VJ} = -40 °C	
Gate Threshold Voltage	$V_{GS(th)}$	1.8	2.5	4.0	V	V_{DS} = V_{GS}, I_D = 75 mA	
			2.0			V_{DS} = V_{GS}, I_D = 75 mA, T_{VJ} = 175 °C	
Zero Gate Voltage Drain Current	I_{DSS}		8	800	µA	V_{GS} = 0 V, V_{DS} = 1200 V	
Gate-Source Leakage Current	I_{GSS}		160	3200	nA	V_{GS} = 19 V, V_{DS} = 0 V	
Drain-Source On-State Resistance (Devices Only)	$R_{DS(on)}$		4.1	5.2	mΩ	V_{GS} = 15 V, I_D = 240 A	Fig. 2 Fig. 3
			6.3			V_{GS} = 15 V, I_D = 240 A, T_{VJ} = 150 °C	
			7.4			V_{GS} = 15 V, I_D = 240 A, T_{VJ} = 175 °C	
Transconductance	g_{fs}		163		S	V_{DS} = 20 V, I_{DS} = 240 A	Fig. 4
			180			V_{DS} = 20 V, I_{DS} = 240 A, T_{VJ} = 175 °C	
Turn-On Switching Energy, T_{VJ} = 25 °C T_{VJ} = 125 °C T_{VJ} = 175 °C	E_{ON}		2.2 2.0 2.1		mJ	V_{DS} = 600 V, I_D = 200 A, V_{GS} = -4 V/15 V, $R_{G(OFF)}$ = 0 Ω, $R_{G(ON)}$ = 0 Ω, L_σ = 10.8 nH	Fig. 11 Fig. 13
Turn-Off Switching Energy, T_{VJ} = 25 °C T_{VJ} = 125 °C T_{VJ} = 175 °C	E_{OFF}		1.0 0.8 0.9				
Internal Gate Resistance	$R_{G(int)}$		0.5		Ω	f = 100 kHz	
Input Capacitance	C_{iss}		26.4		nF	V_{GS} = 0 V, V_{DS} = 800 V, V_{AC} = 25 mV, f = 100 kHz	Fig. 9
Output Capacitance	C_{oss}		1.0				
Reverse Transfer Capacitance	C_{rss}		83		pF		
Gate to Source Charge	Q_{GS}		984		nC	V_{DS} = 800 V, V_{GS} = -4 V/15 V I_D = 240 A Per IEC60747-8-4 pg 21	
Gate to Drain Charge	Q_{GD}		160				
Total Gate Charge	Q_G		1144				
FET Thermal Resistance, Junction to Heatsink	$R_{th\ JHS}$		0.123		°C/W	Measured with Pre-Applied TIM	Fig. 17

Diode Characteristics (Per Position) (T_{VJ} = 25 °C Unless Otherwise Specified)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Note
Body Diode Forward Voltage	V_{SD}		5.4		V	V_{GS} = -4 V, I_{SD} = 240 A	Fig. 7
			4.8			V_{GS} = -4 V, I_{SD} = 240 A, T_{VJ} = 175 °C	
Reverse Recovery Time	t_{RR}		26.9		ns	V_{GS} = -4 V, I_{SD} = 200 A , V_R = 600 V di/dt = 23.2 A/ns, T_{VJ} = 175 °C	Fig. 32
Reverse Recovery Charge	Q_{RR}		5.3		µC		
Peak Reverse Recovery Current	I_{RRM}		329		A		
Reverse Recovery Energy T_{VJ} = 25 °C T_{VJ} = 125 °C T_{VJ} = 175 °C	E_{RR}		1.3 1.5 2.0		mJ	V_{DS} = 600 V, I_D = 200 A, V_{GS} = -4 V/15 V, $R_{G(ON)}$ = 0 Ω, L_σ = 10.8 nH	Fig. 14

Module Physical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Package Resistance, M1 (High-Side)	R_{pkg1}		1.37		mΩ	T_{HS} = 125 °C, Note 5
Package Resistance, M2 (Low-Side)	R_{pkg2}		1.07			
Stray Inductance	L_{Stray}		5.8		nH	Between DC+ and DC-, f = 10 MHz
Case Temperature	T_C	-40		125	°C	
Weight	W		39		g	
Mounting Torque	M_S		2.0	2.3	N-m	M4 bolts
Case Isolation Voltage	V_{isol}	3			kV	AC, 50 Hz, 1 min
Comparative Tracking Index	CTI	200				
Clearance Distance			5.0		mm	Terminal to Terminal
			10.0			Terminal to Heatsink
Creepage Distance			6.3			Terminal to Terminal
			11.5			Terminal to Heatsink

Note (5): Total Effective Resistance (Per Switch Position) = MOSFET $R_{DS(on)}$ + Switch Position Package Resistance

Temperature Sensor (NTC) Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Rated Resistance	R_{NTC}		5.0		kΩ	T_{NTC} = 25°C
Resistance Tolerance at 25 °C	ΔR/R	-5		5	%	
Beta Value (T_2 = 50 °C)	$ß_{25/50}$		3380		K	
Beta Value (T_2 = 80 °C)	$ß_{25/80}$		3468		K	
Beta Value (T_2 = 100 °C)	$ß_{25/100}$		3523		K	
Power Dissipation	P_{Max}			10	mW	T_{NTC} = 25°C

Typical Performance

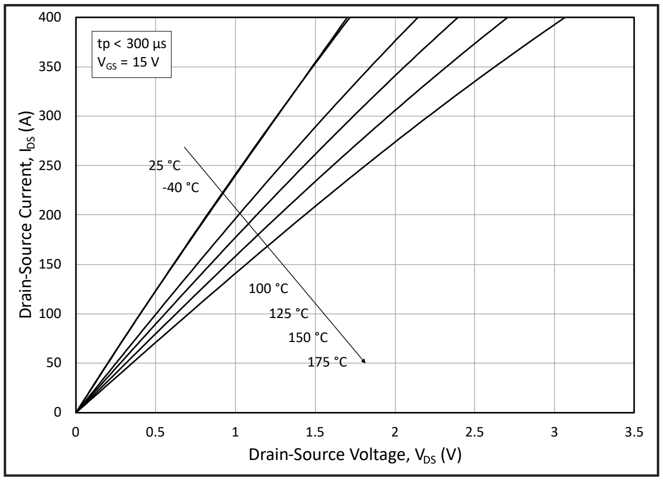


Figure 1. Output Characteristics for Various Junction Temperatures

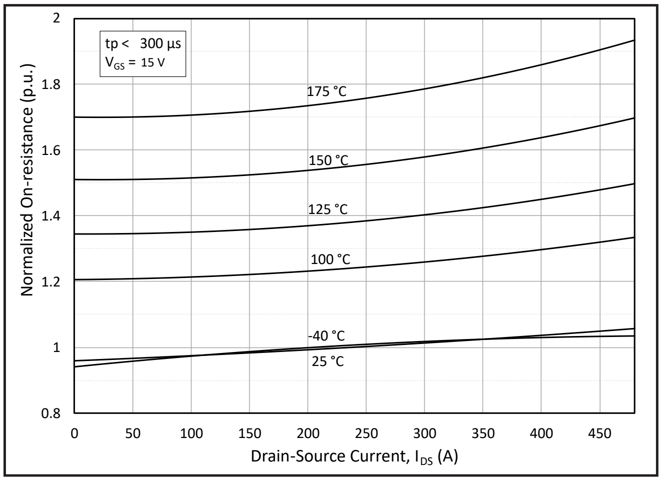


Figure 2. Normalized On-State Resistance vs. Drain Current for Various Junction Temperatures

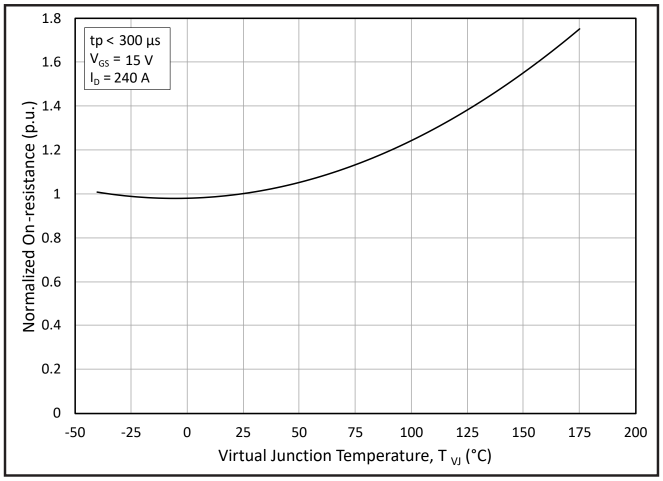


Figure 3. Normalized On-State Resistance vs. Junction Temperature

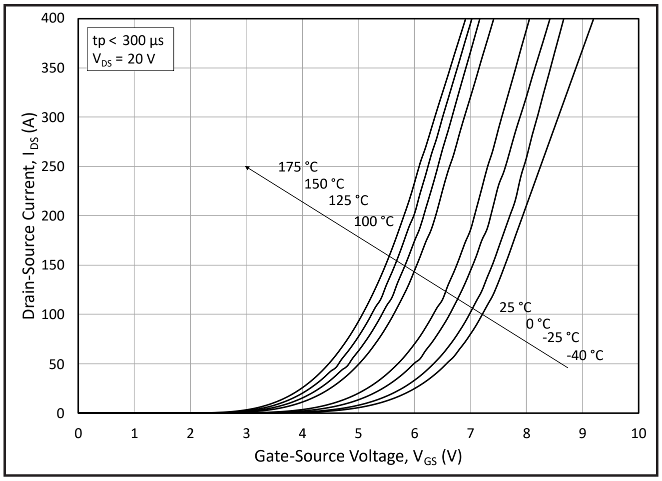


Figure 4. Transfer Characteristic for Various Junction Temperatures

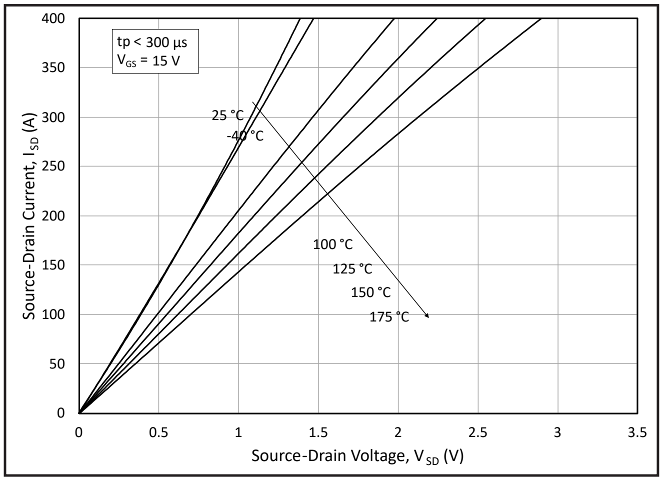


Figure 5. 3rd Quadrant Characteristic vs. Junction Temperatures at $V_{GS} = 15$ V

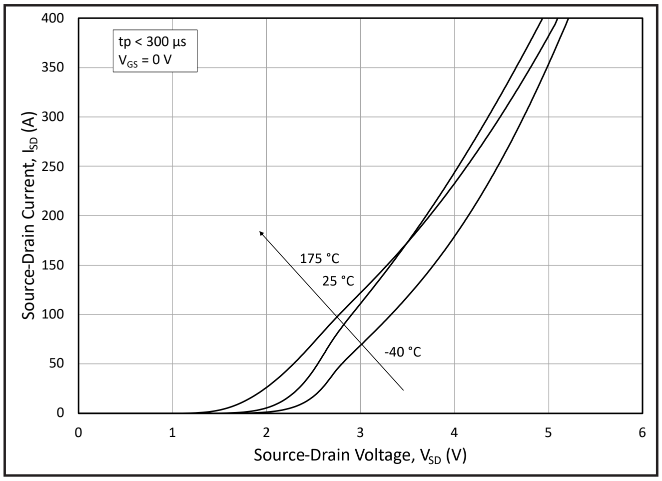


Figure 6. 3rd Quadrant Characteristic vs. Junction Temperatures at $V_{GS} = 0$ V (Body Diode)

Typical Performance

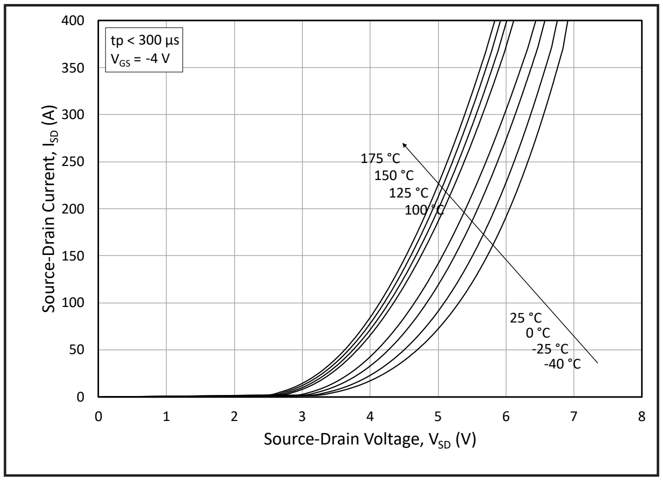


Figure 7. 3rd Quadrant Characteristic vs. Junction Temperatures at V_{GS} = -4 V (Body Diode)

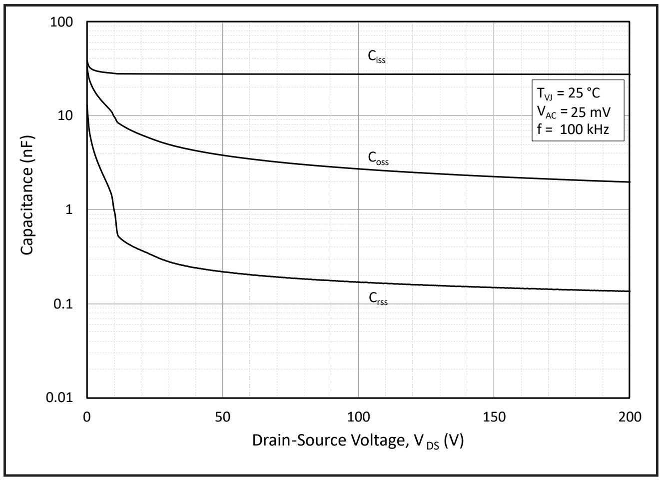


Figure 8. Typical Capacitances vs. Drain to Source Voltage (0 - 200 V)

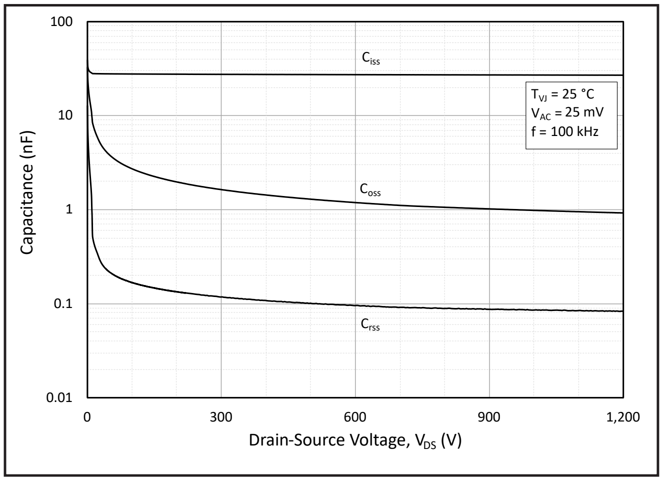


Figure 9. Typical Capacitances vs. Drain to Source Voltage (0 - 1200V)

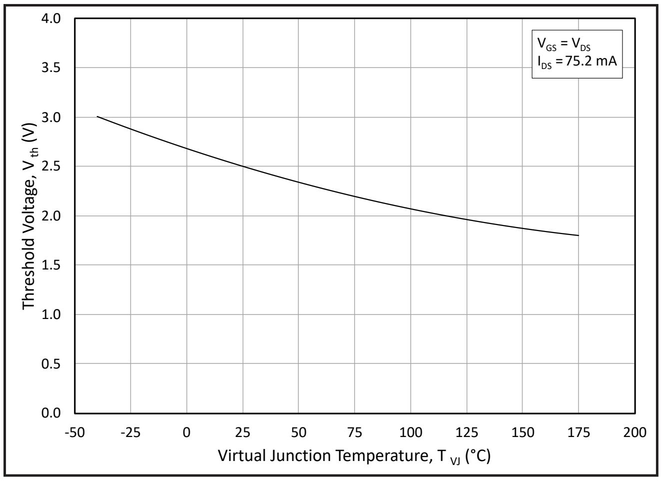


Figure 10. Threshold Voltage vs. Junction Temperature

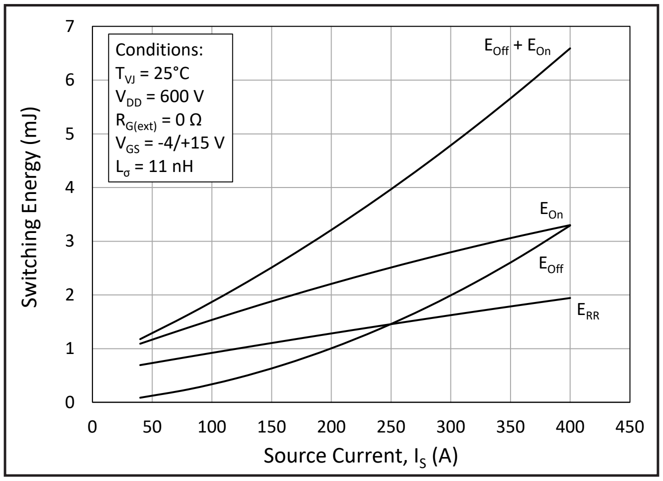


Figure 11. Switching Energy vs. Drain Current (V_{DS} = 600 V)

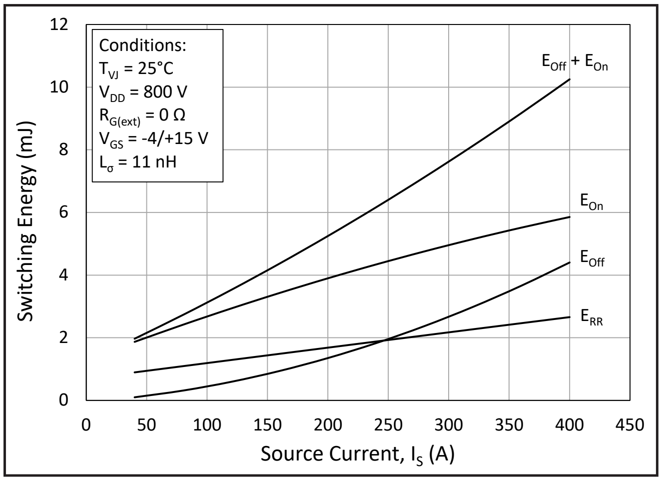


Figure 12. Switching Energy vs. Drain Current (V_{DS} = 800 V)

Typical Performance

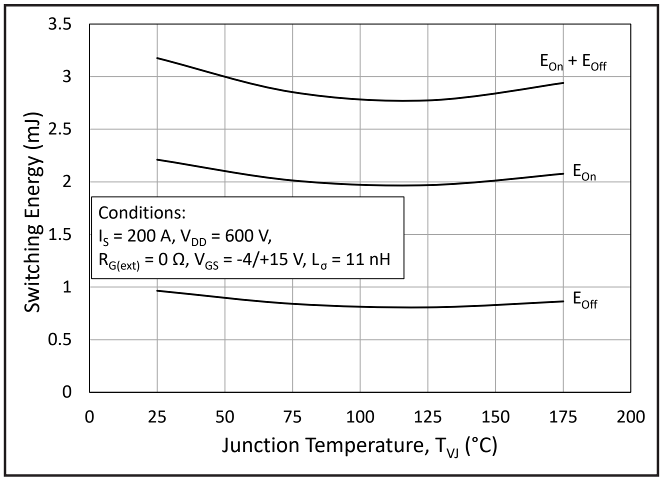


Figure 13. MOSFET Switching Energy vs. Junction Temperature

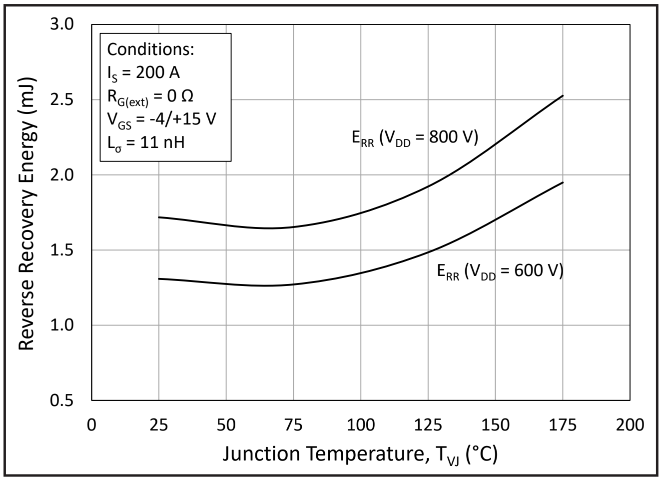


Figure 14. Reverse Recovery Energy vs. Junction Temperature

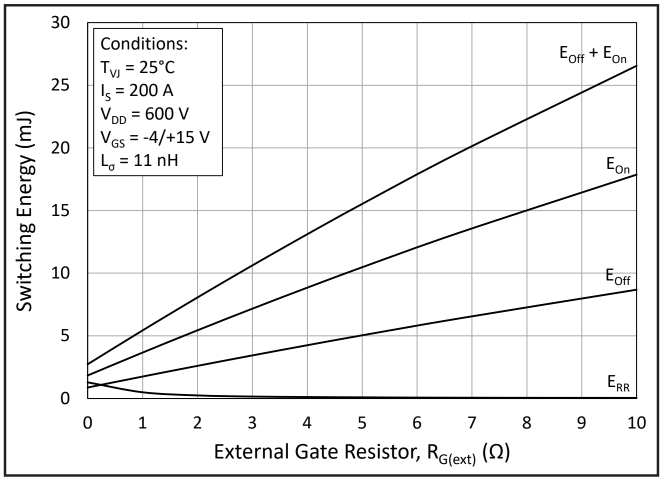


Figure 15. MOSFET Switching Energy vs. External Gate Resistance

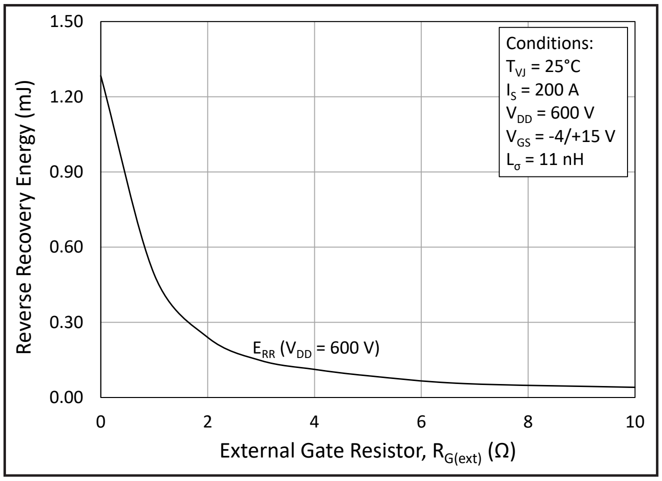


Figure 16. Reverse Recovery Energy vs. External Gate Resistance

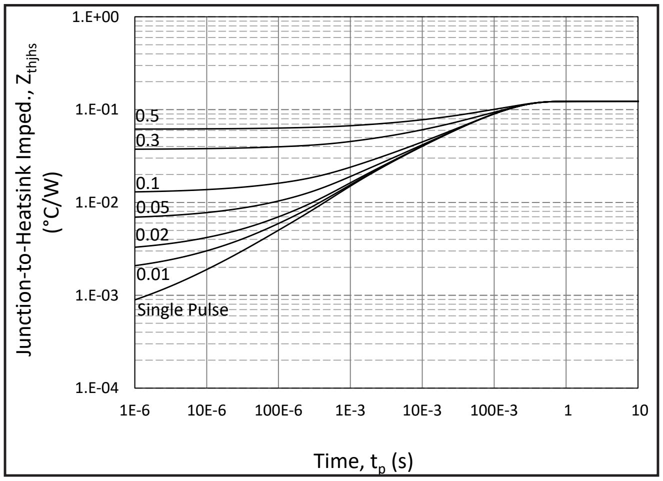


Figure 17. MOSFET Junction to Heatsink Transient Thermal Impedance, $Z_{th\ HS}$ (°C/W)

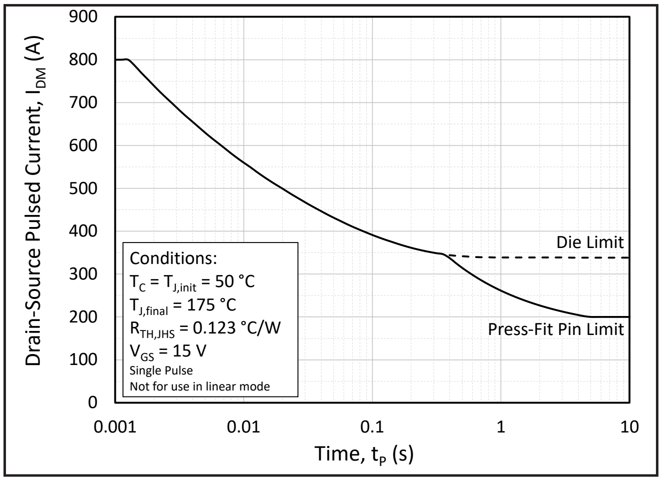


Figure 18. Pulsed Current SOA

Typical Performance

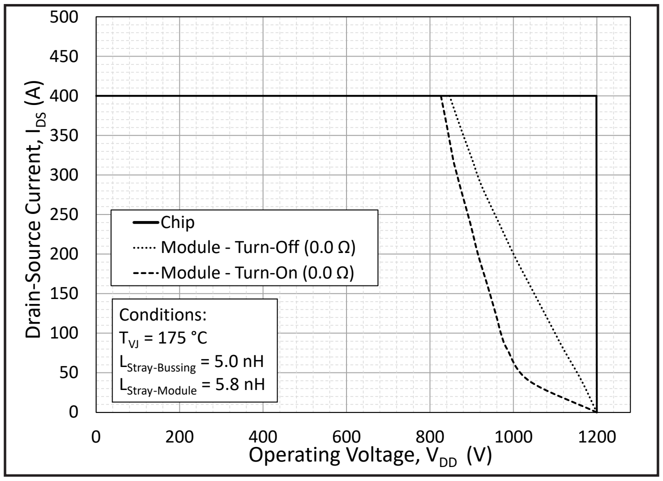


Figure 19. Switching Safe Operating Area

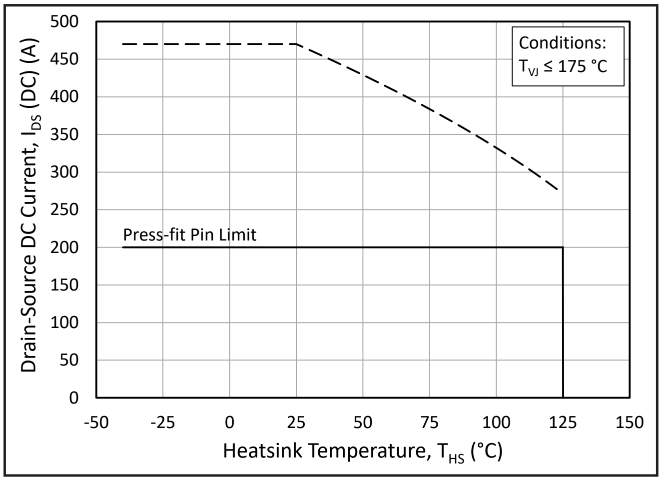


Figure 20. Continuous Drain Current Derating vs. Heatsink Temperature

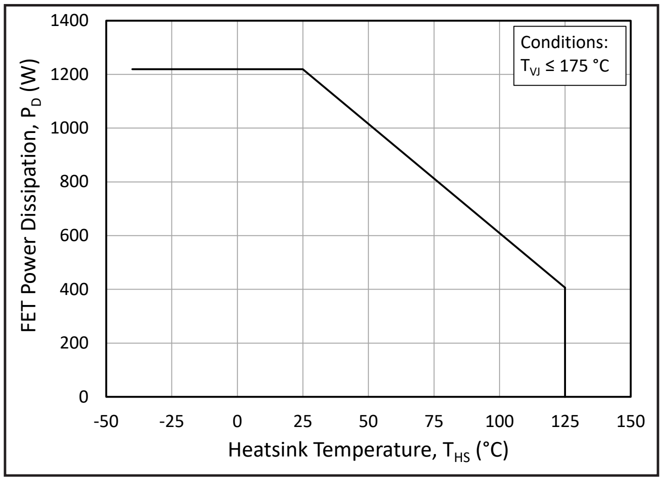


Figure 21. Maximum Power Dissipation Derating vs. Heatsink Temperature

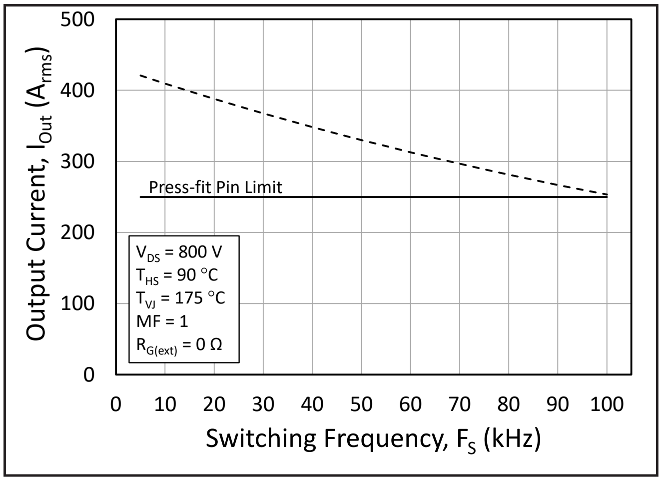


Figure 22. Typical Output Current Capability vs. Switching Frequency (Inverter Application)

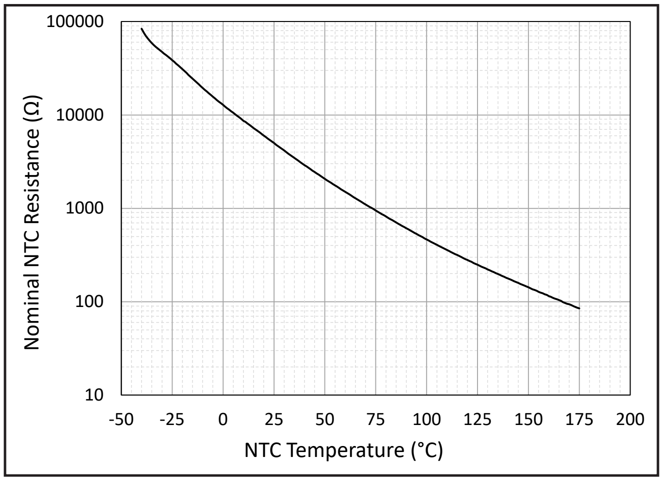


Figure 23. Typical NTC Resistance vs. Temperature

Timing Characteristics

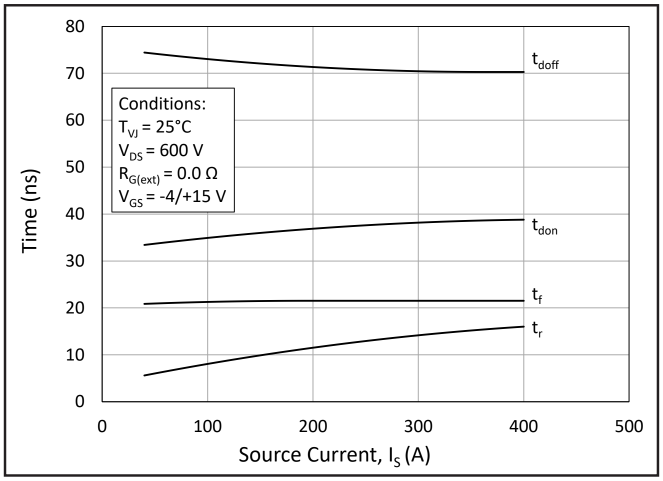


Figure 24. Timing vs. Source Current

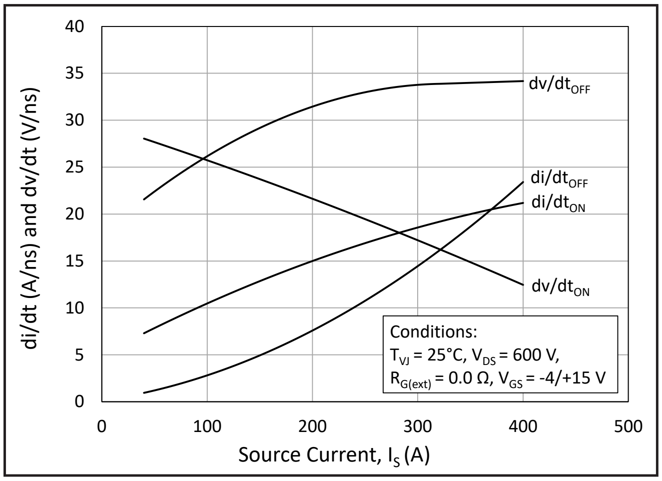


Figure 25. dv/dt and di/dt vs. Source Current

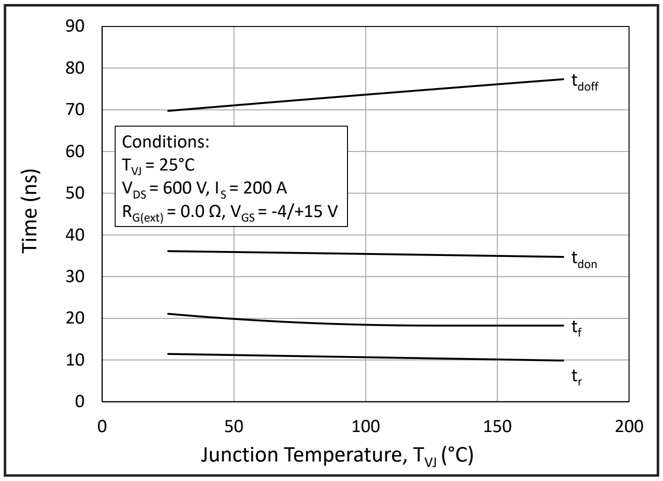


Figure 26. Timing vs. Junction Temperature

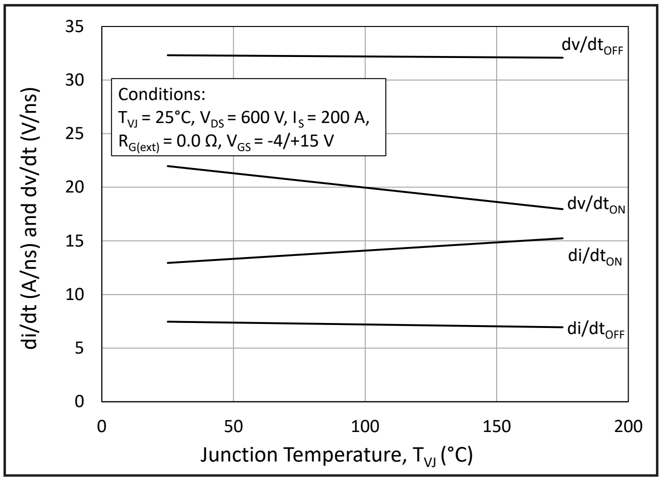


Figure 27. dv/dt and di/dt vs. Junction Temperature

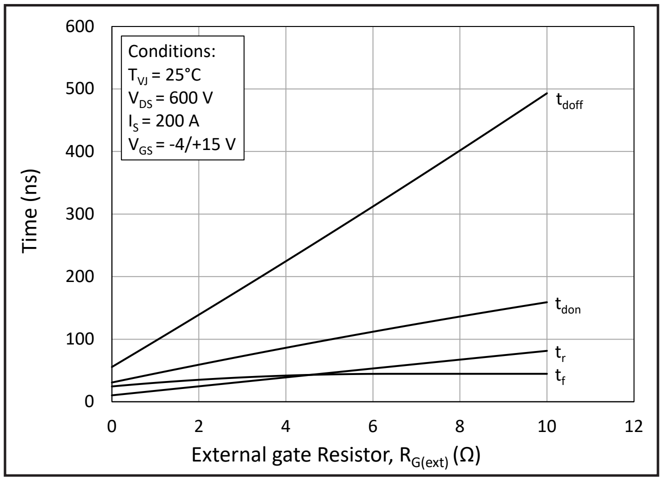


Figure 28. Timing vs. External Gate Resistance

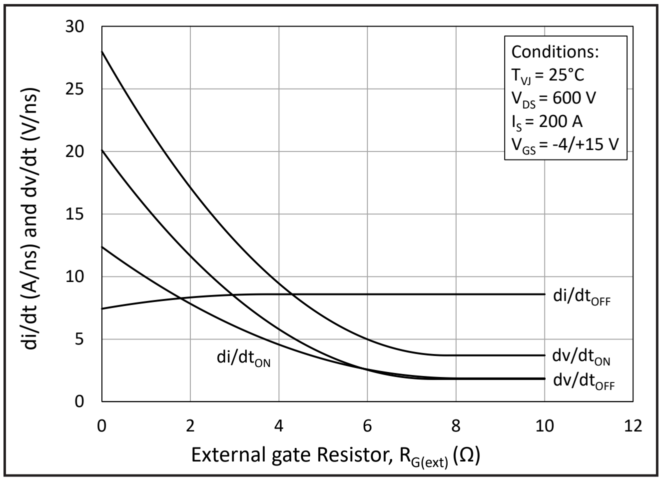


Figure 29. dv/dt and di/dt vs. External Gate Resistance

Definitions

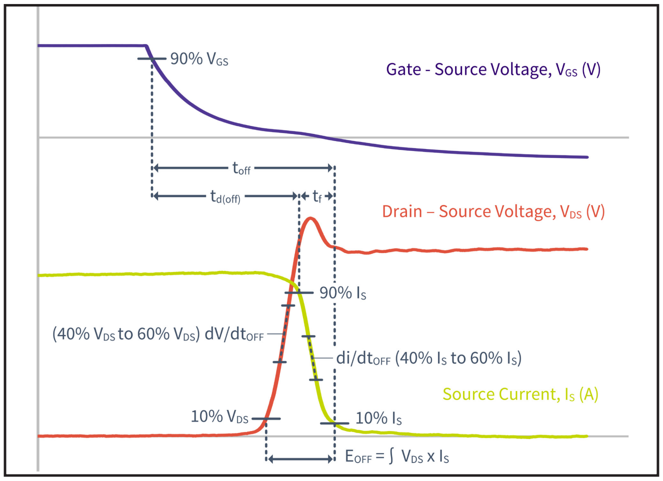


Figure 30. Turn-Off Transient Definitions

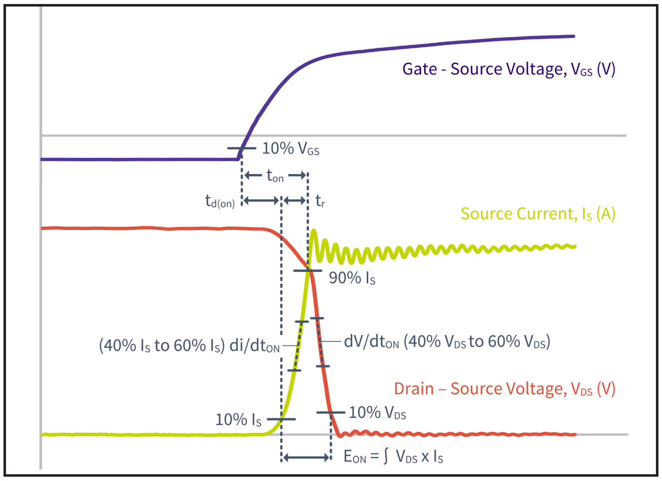


Figure 31. Turn-On Transient Definitions

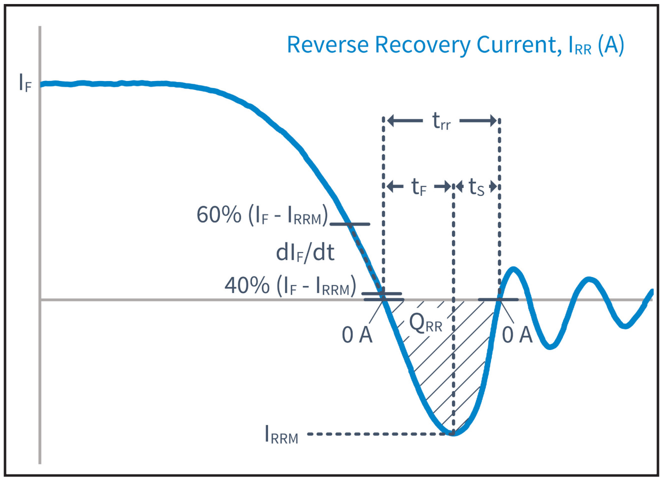


Figure 32. Reverse Recovery Definitions

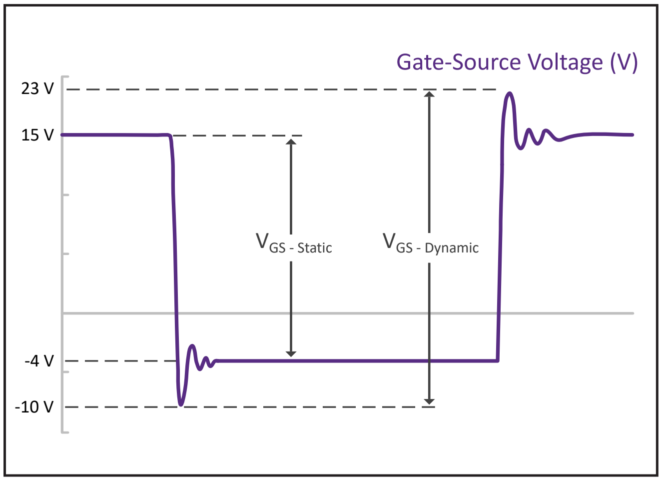
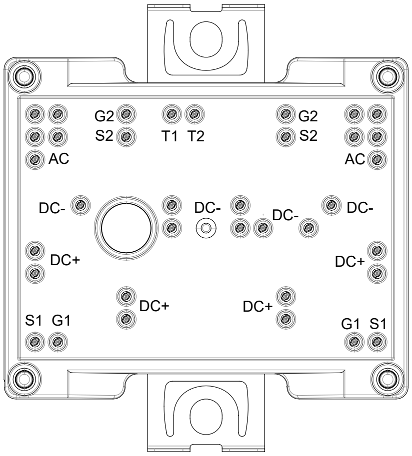
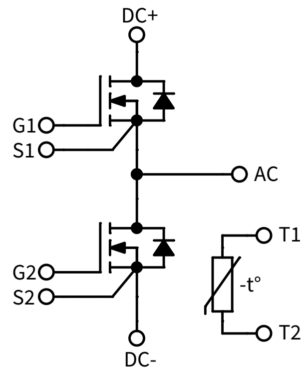


Figure 33. V_{GS} Transient Definitions

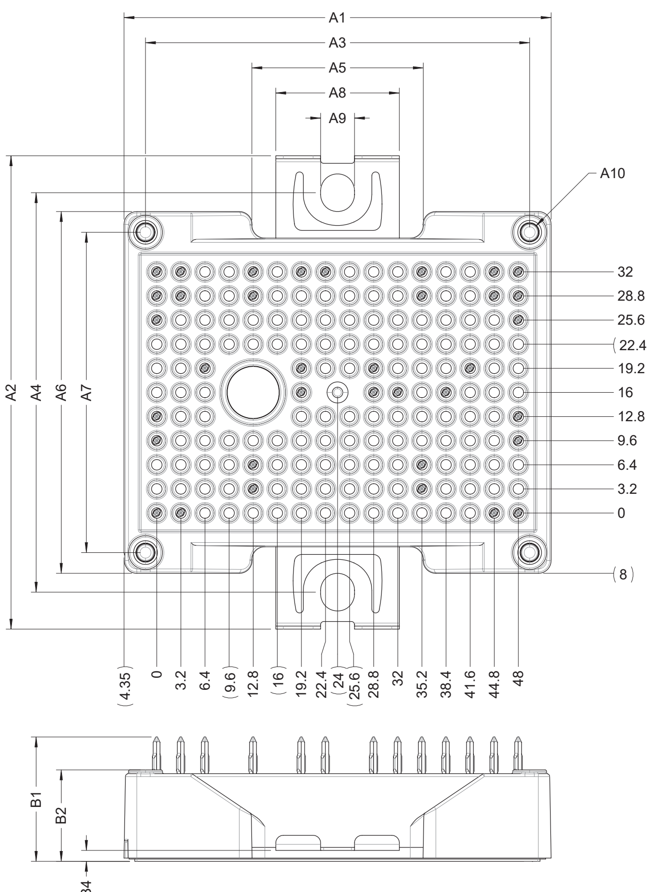
Note (6): The CGD1700HB2M-UNA, which features the UCC21710 gate driver IC, was used to evaluate dynamic performance. The typical driver high-state output resistance of 2.5 ohms and low-state output resistance of 0.3 ohms are not included in the RG(ext) values on this datasheet.

Schematic and Pin Out





Package Dimensions (mm)



DIMENSION TABLE		
SYMBOL	DIMENSION	TOLERANCE
A1	56.7	±0.30
A2	62.8	±0.50
A3	51	±0.15
A4	(53)	REF.
A5	22.7	±0.30
A6	48	±0.30
A7	42.5	±0.15
A8	16.4	±0.20
A9	4.5	±0.10
A10	⌀2.3 ↧8.5	⌀: $^{+0}_{-0.10}$ ↧: ±0.30
B1	16.4	±0.50
B2	12.33	±0.35
B4	1.65	±0.20
ALL PIN LOCATIONS		±0.40

CAB004A12GM4 has been certified by UL as an "Electrically Isolated Semiconductor Devices – Component" in accordance with UL 1557. Only power modules that bear the UL marking shown should be considered as being covered under the UL Component Recognition Program.

UL Marking

Product Ordering Code

Part Number	Description
CAB004A12GM4	Without Pre-Applied Phase Change Thermal Interface Material
CAB004A12GM4T	With Pre-Applied Phase Change Thermal Interface Material

Supporting Links & Tools

Evaluation Tools & Support

- SpeedFit 2.0 Design Simulator™
- Technical Support Forum
- LTspice and PLECS Models

Dual-Channel Gate Driver Board

- CGD12HB00D: Differential Transceiver Daughter Board Companion Tool for Differential Gate Drivers
- CGD1700HB2M-UNA: Wolfspeed Gate Driver Board
- EVAL-ADUM4146WHB1Z: Analog Devices® Gate Driver Board
- UCC21710QDWEVM-054: Texas Instruments® Gate Driver Board

Application Notes

- PRD-02302: WolfPACK™ Mounting Instructions and PCB Requirements
- PRD-04814: Design Options for Wolfspeed® Silicon Carbide MOSFET Gate Bias Power Supplies
- PRD-06379: Environmental Considerations for Power Electronics Systems
- PRD-07845: Power Module Baseplate Capacitance and Electromagnetic Compatibility
- PRD-07933: Wolfspeed Power Module Thermal Interface Material Application User Guide
- PRD-07968: Wolfspeed WolfPACK™ Dynamic Performance
- PRD-08333: Wolfspeed Module CIL Evaluation Kits User Guide
- PRD-08376: Thermal Characterization Methods and Applications
- PRD-08710: Measuring Stray Inductance in Power Electronics Systems
- PRD-08911: Considerations for Current Balancing in Paralleled SiC Power Modules
- PRD-09035: Power Module RC Thermal Models User Guide

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