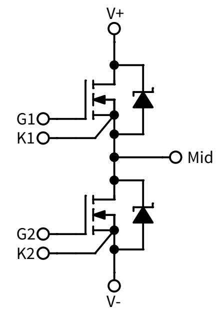
HAS530M12BM3, HAS530M12BM3T

1200 V, 530 A, Silicon Carbide, Half-Bridge Module

V_{DS}	**1200 V**
I_{DS}	**530 A**

Technical Features

- Industry Standard 62 mm Footprint
- Housing CTI ≥ 600 (Material Group I)
- Compliant with EN45545-2 R22/23 HL3
- High Humidity Operation THB-80 (HV-H3TRB)
- Low Inductance Design Optimized for SiC
- Ultra Low Loss, High-Frequency Operation
- Normally-off, Fail-safe Device Operation
- Copper Baseplate and Aluminum Nitride Insulator



Typical Applications

- Railway Auxiliary & Traction
- Induction Heating
- Motor Drives
- Renewables
- EV Fast Charging
- UPS and SMPS

System Benefits

- 62 mm Form Factor Enables System Retrofit
- Increased System Efficiency, due to Low Switching & Conduction Losses of SiC
- Zero Reverse Recovery from Schottky Diodes
- Zero Turn-off Tail Current from MOSFET

Key Parameters

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		Transient	Note 1 Fig. 33
Gate-Source Voltage, Recommended	$V_{GS(op)}$		-4/+15			Static	
DC Continuous Drain Current	I_D		645		A	V_{GS} = 15 V, T_C = 25 °C, T_{VJ} ≤ 175 °C	Notes 2, 3 Fig. 21
			486			V_{GS} = 15 V, T_C = 90 °C, T_{VJ} ≤ 175 °C	
DC Source-Drain Current (Schottky Diode)	$I_{SD(SD)}$		632			V_{GS} = -4 V, T_C = 25 °C, T_{VJ} ≤ 175 °C	
Pulsed Drain-Source Current	I_{DM}		1060			t_{Pmax} limited by T_{VJmax} V_{GS} = 15 V, T_C = 25 °C	
Power Dissipation	P_D		2000		W	T_C = 25 °C, T_{VJ} ≤ 175 °C	Note 4 Fig. 21
Virtual Junction Temperature	$T_{VJ(op)}$	-40		150	°C	Operation	
				175		Intermittent with Reduced Life	

Note (1): Recommended turn-on gate voltage is 15 V with ±5 % regulation tolerance. Not for use in linear region.
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): $P_D = (T_{VJ} - T_C)/R_{TH(JC,typ)}$

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	3.6	V	$V_{DS} = V_{GS}$, I_D = 127 mA	
			2.0			$V_{DS} = V_{GS}$, I_D = 127 mA, T_{VJ} = 175 °C	
Zero Gate Voltage Drain Current	I_{DSS}		12.8	1692	µA	V_{GS} = 0 V, V_{DS} = 1200 V	
Gate-Source Leakage Current	I_{GSS}		60	600	nA	V_{GS} = 15 V, V_{DS} = 0 V	
Drain-Source On-State Resistance (Devices Only)	$R_{DS(on)}$		2.7	3.5	mΩ	V_{GS} = 15 V, I_D = 530 A	Fig. 2 Fig. 3
			4.3			V_{GS} = 15 V, I_D = 530 A, T_{VJ} = 150 °C	
			4.8			V_{GS} = 15 V, I_D = 530 A, T_{VJ} = 175 °C	
Transconductance	g_{fs}		449		S	V_{DS} = 20 V, I_D = 530 A	Fig. 4
			418			V_{DS} = 20 V, I_D = 530 A, T_{VJ} = 150 °C	
Turn-On Switching Energy, T_{VJ} = 25 °C T_{VJ} = 125 °C T_{VJ} = 150 °C	E_{ON}		6.6 6.0 6.0		mJ	V_{DD} = 600 V, I_D = 530 A, V_{GS} = -4 V/15 V, $R_{G(OFF)}$ = 0.5 Ω, $R_{G(ON)}$ = 0.5 Ω, L = 13.6 µH	Fig. 11 Fig. 13
Turn-Off Switching Energy, T_{VJ} = 25 °C T_{VJ} = 125 °C T_{VJ} = 150 °C	E_{OFF}		8.9 9.0 9.0				
Internal Gate Resistance	$R_{G(int)}$		1.68		Ω	f = 100 kHz	
Input Capacitance	C_{iss}		38.9		nF	V_{GS} = 0 V, V_{DS} = 800 V, V_{AC} = 25 mV, f = 100 kHz	Fig. 9
Output Capacitance	C_{oss}		2.6				
Reverse Transfer Capacitance	C_{rss}		48.5		pF		
Gate to Source Charge	Q_{GS}		384		nC	V_{DS} = 800 V, V_{GS} = -4 V/15 V, I_D = 530 A, Per IEC60747-8-4 pg 21	
Gate to Drain Charge	Q_{GD}		462				
Total Gate Charge	Q_G		1362				
FET Thermal Resistance, Junction to Case	$R_{th\ JC}$		0.075		°C/W		Fig. 17

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

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Note
Diode Forward Voltage	V_F		2.0		V	V_{GS} = -4 V, I_F = 530 A, T_{VJ} = 25 °C	Fig. 7
			2.6			V_{GS} = -4 V, I_F = 530 A, T_{VJ} = 150 °C	
Reverse Recovery Time	t_{RR}		25.5		ns	V_{GS} = -4 V, I_{SD} = 530 A, V_R = 800 V di/dt = 18.0 A/ns, T_{VJ} = 150 °C	Fig. 32
Reverse Recovery Charge	Q_{RR}		4.8		µC		
Peak Reverse Recovery Current	I_{RRM}		324		A		
Reverse Recovery Energy, T_{VJ} = 25 °C T_{VJ} = 125 °C T_{VJ} = 150 °C	E_{RR}		1.9 2.2 2.2		mJ	V_{DS} = 600 V, I_D = 530 A, V_{GS} = -4 V/15 V, $R_{G(ext)}$ = 0.5 Ω, L = 13.6 µH	Fig. 14 Note 5
Diode Thermal Resistance, JCT. to Case	$R_{th\ JC}$		0.078		°C/W		Fig. 18

Note (5): SiC Schottky diodes do not have reverse recovery energy but still contribute capacitive energy

Module Physical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Package Resistance, M1 (High-Side)	R_{3-1}		0.90		mΩ	T_C = 25 °C, I_{SD} = 530 A, Note 6
			1.26			T_C = 125 °C, I_{SD} = 530 A, Note 6
Package Resistance, M2 (Low-Side)	R_{1-2}		0.97			T_C = 25 °C, I_{SD} = 530 A, Note 6
			1.36			T_C = 125 °C, I_{SD} = 530 A, Note 6
Stray Inductance	L_{Stray}		11.1		nH	Between DC- and DC+, f = 10 MHz
Case Temperature	T_C	-40		125	°C	
Mounting Torque	M_S	4	5	5.5	N-m	Baseplate, M6-1.0 Bolts
		4	5	5.5		Power Terminals, M6-1.0 Bolts
Weight	W		300		g	
Case Isolation Voltage	V_{isol}	5			kV	AC, 50 Hz, 1 minute
Comparative Tracking Index	CTI	600				
Clearance Distance		9			mm	Terminal to Terminal
		30				Terminal to Baseplate
Creepage Distance		30				Terminal to Terminal
		40				Terminal to Baseplate

Note (6): Total Effective Resistance (Per Switch Position) = MOSFET $R_{DS(on)}$ + Switch Position Package Resistance

Typical Performance

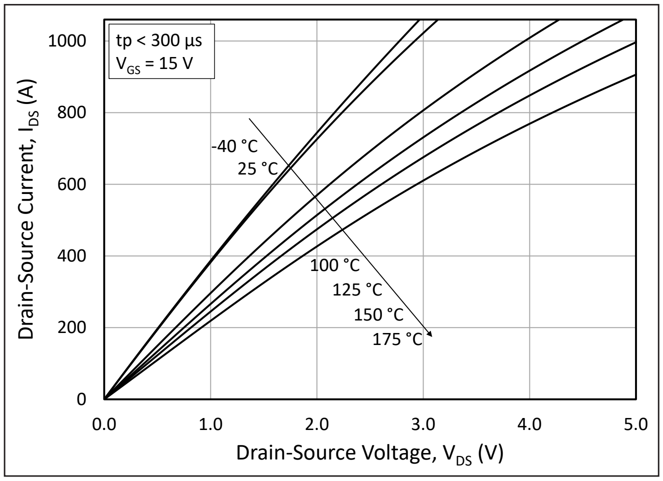


Figure 1. Output Characteristics for Various Junction Temperatures

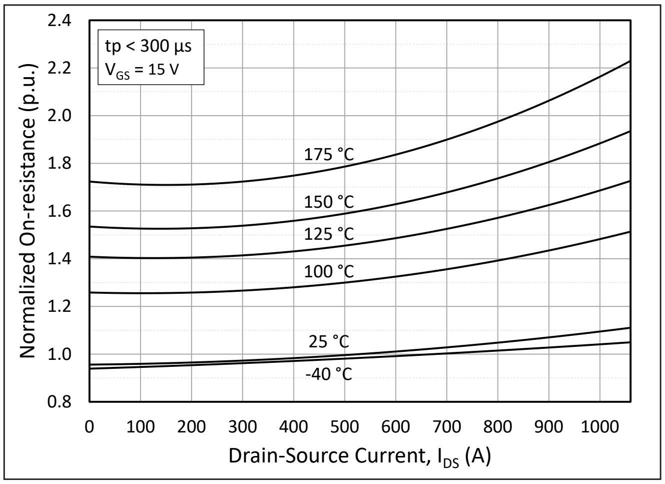


Figure 2. Normalized On-State Resistance vs. Drain Current for Various Junction Temperatures

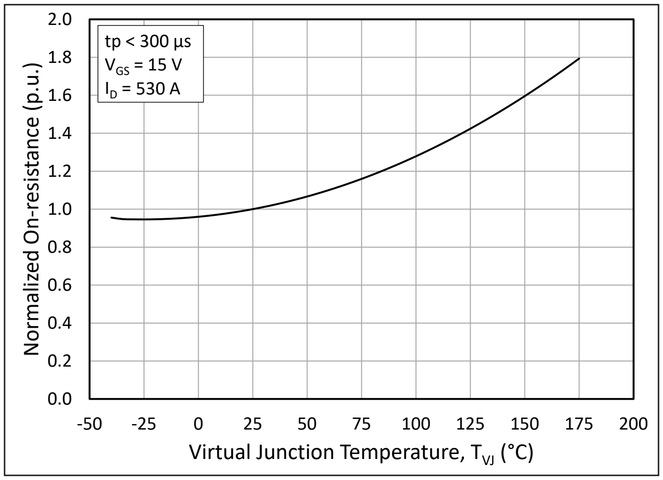


Figure 3. Normalized On-State Resistance vs. Junction Temperature

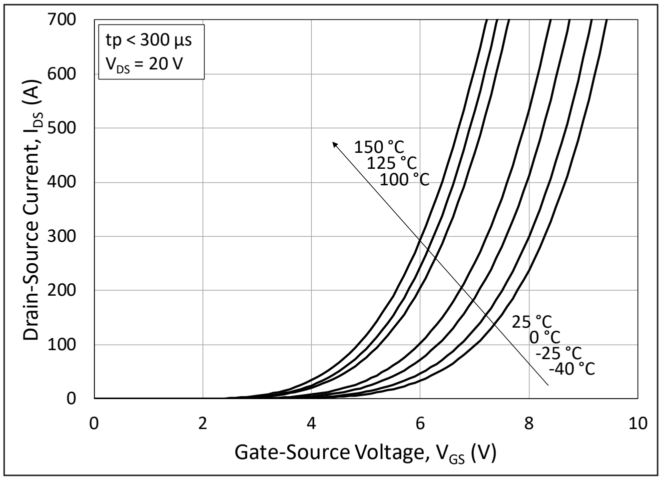


Figure 4. Transfer Characteristic for Various Junction Temperatures

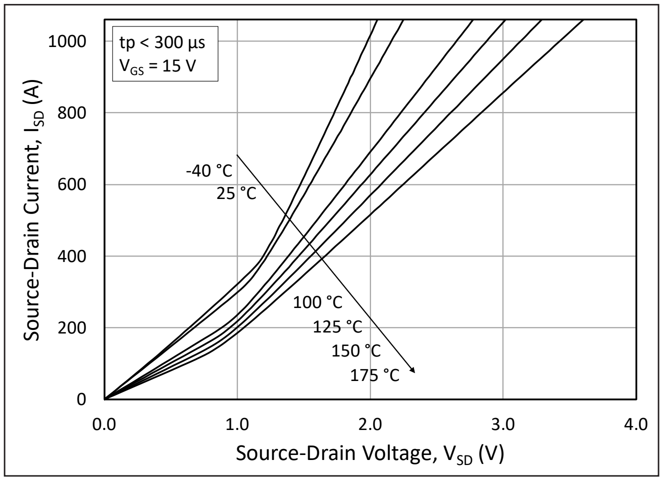


Figure 5. 3rd Quadrant Characteristic vs. Junction Temperatures at V_{GS} = 15 V

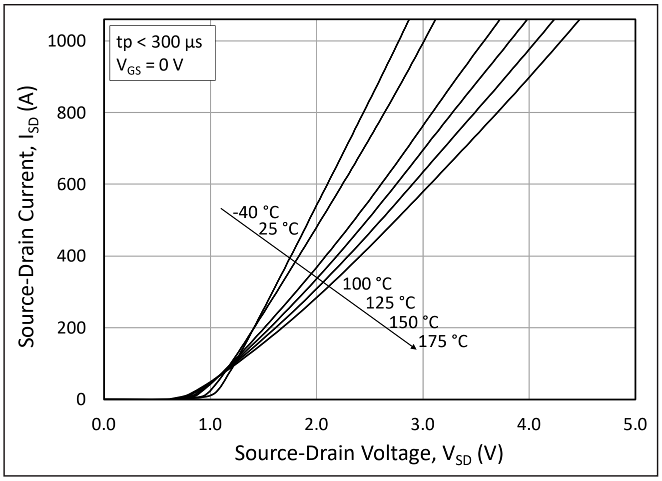


Figure 6. 3rd Quadrant Characteristic vs. Junction Temperatures at V_{GS} = 0 V (Diode)

Typical Performance

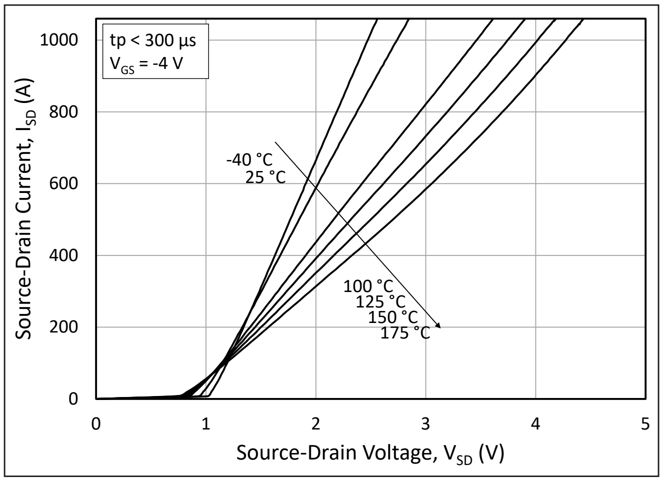


Figure 7. 3rd Quadrant Characteristic vs. Junction Temperatures at V_{GS} = -4 V (Diode)

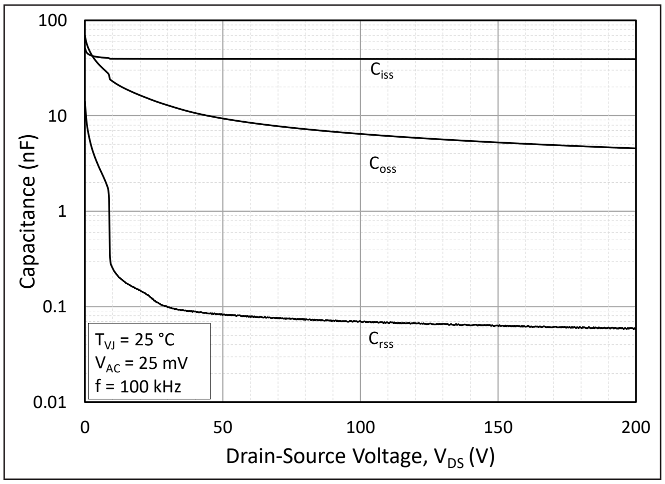


Figure 8. Typical Capacitances vs. Drain to Source Voltage (0 - 200 V)

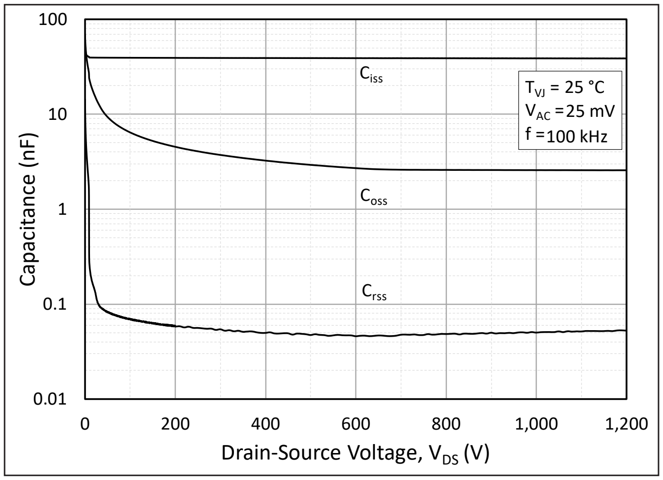


Figure 9. Typical Capacitances vs. Drain to Source Voltage (0 - 1200 V)

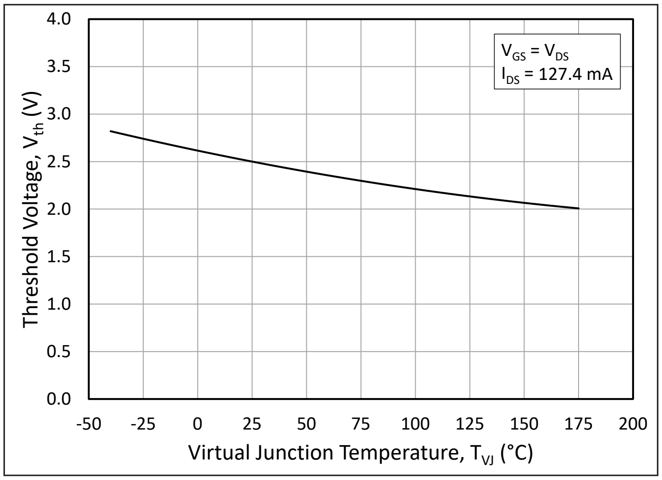


Figure 10. Threshold Voltage vs. Junction Temperature

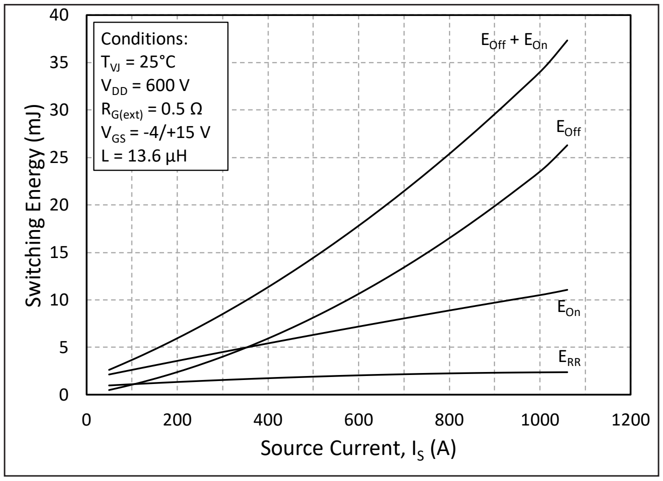


Figure 11. Switching Energy vs. Drain Current (V_{DS} = 600 V)

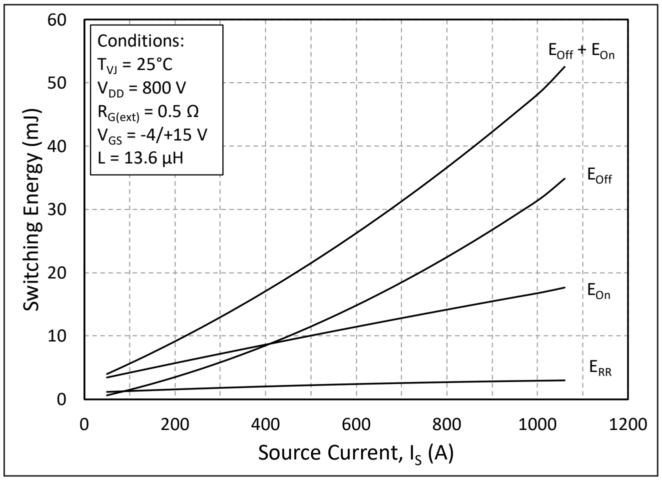


Figure 12. Switching Energy vs. Drain Current (V_{DS} = 800 V)

Typical Performance

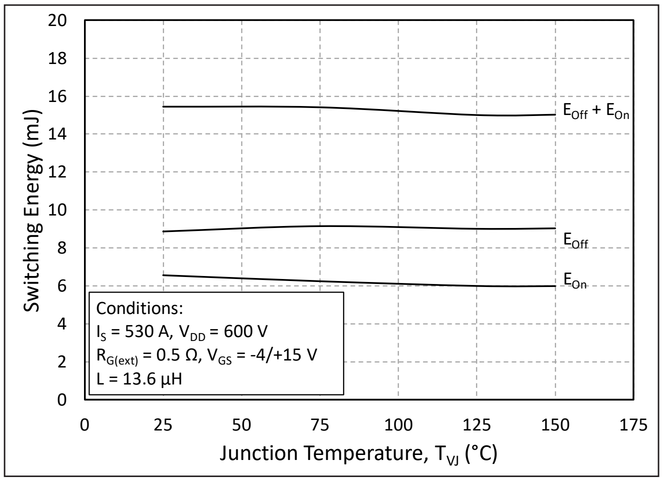


Figure 13. MOSFET Switching Energy vs. Junction Temperature

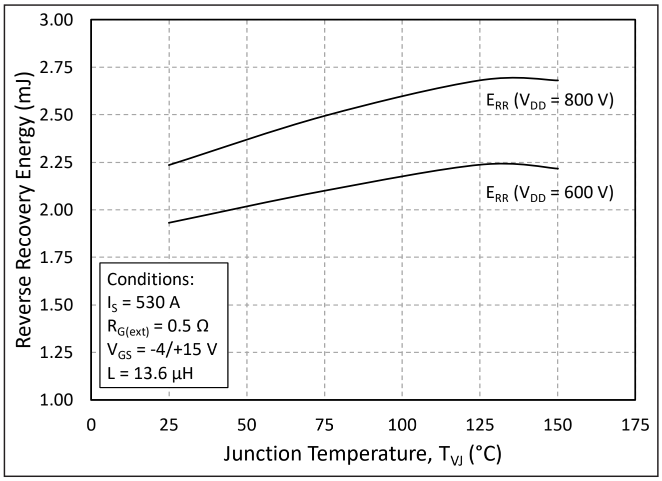


Figure 14. Reverse Recovery Energy vs. Junction Temperature

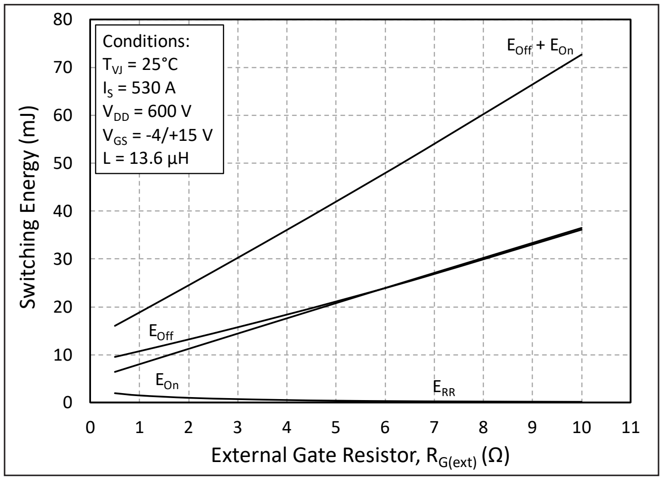


Figure 15. MOSFET Switching Energy vs. External Gate Resistance

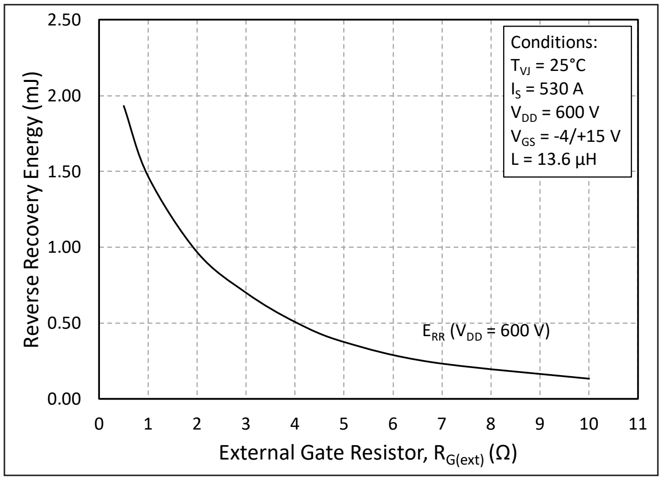


Figure 16. Reverse Recovery Energy vs. External Gate Resistance

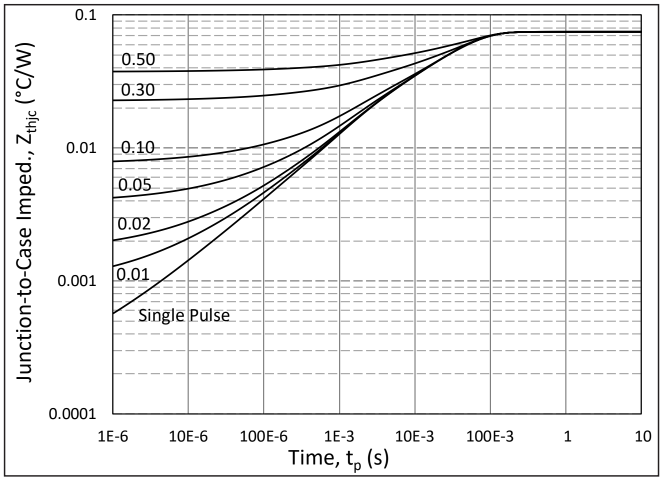


Figure 17. MOSFET Junction to Case Transient Thermal Impedance, $Z_{th,jc}$ (°C/W)

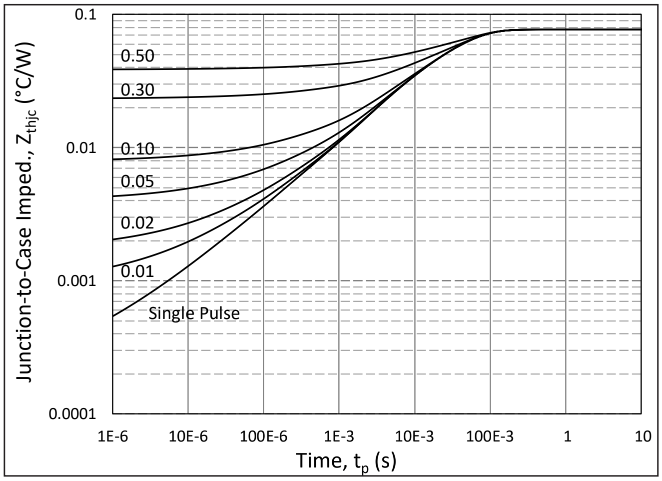


Figure 18. Diode Junction to Case Transient Thermal Impedance, $Z_{th,jc}$ (°C/W)

Typical Performance

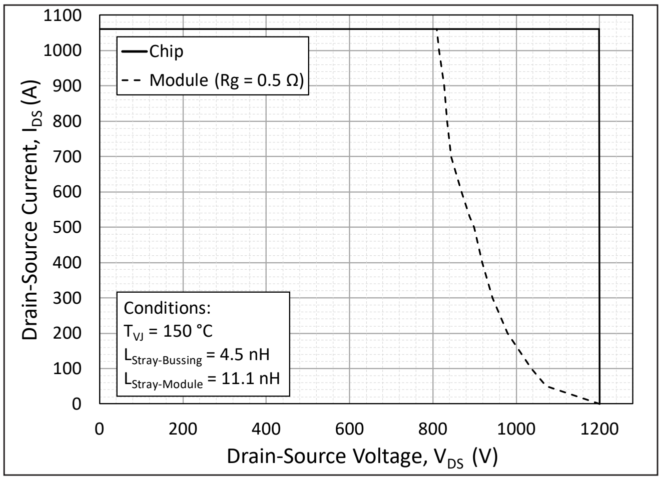


Figure 19. Switching Safe Operating Area

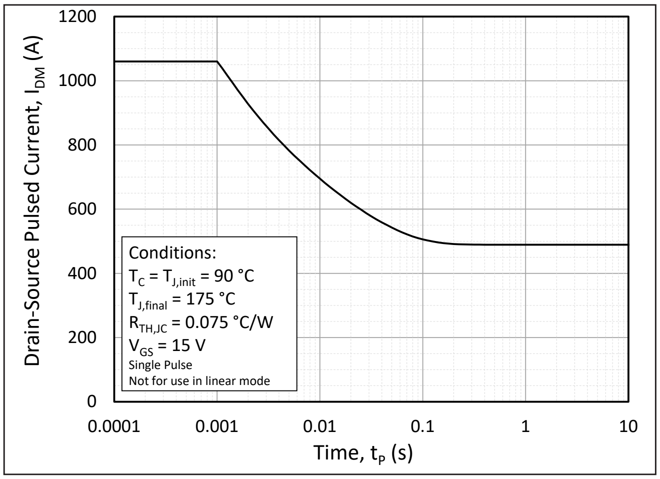


Figure 20. Pulsed Current Safe Operating Area

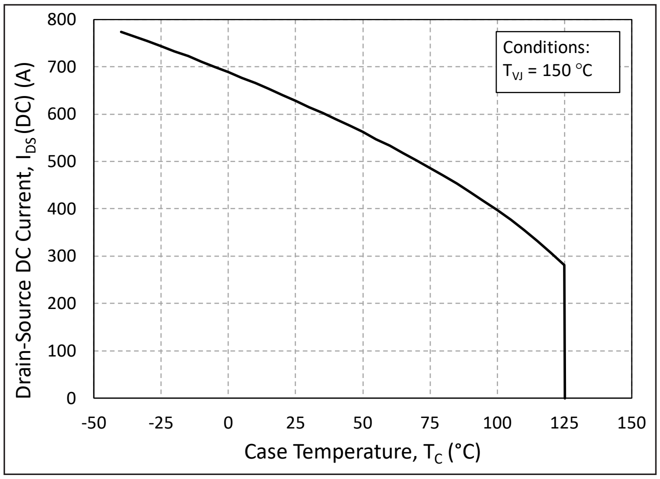


Figure 21. Continuous Drain Current Derating vs. Case Temperature

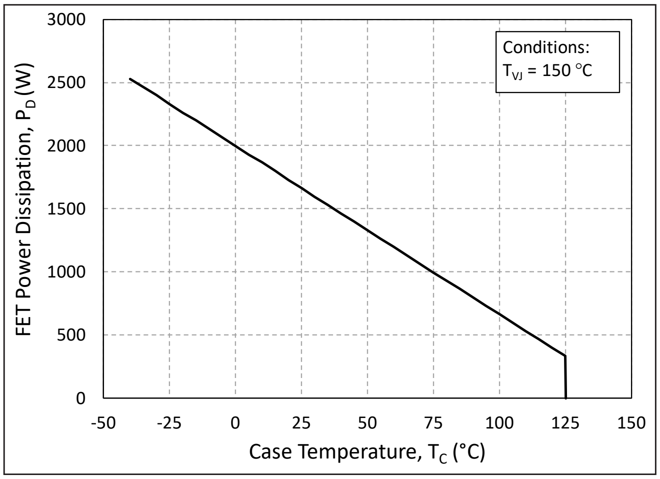


Figure 22. Maximum Power Dissipation Derating vs. Case Temperature

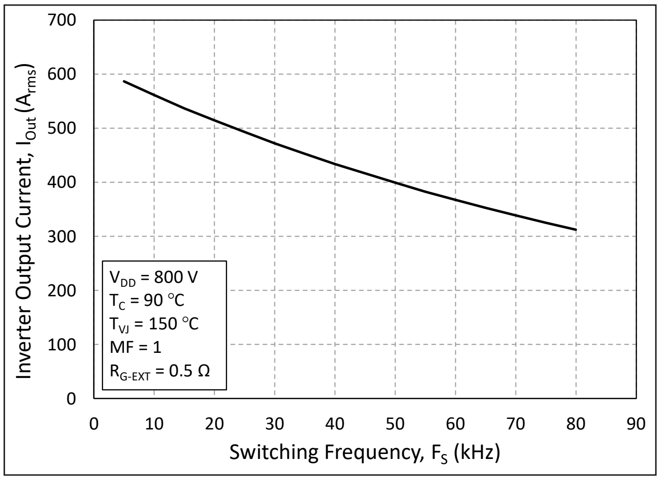


Figure 23. Typical Output Current Capability vs. Switching Frequency (Inverter Application)

Timing Characteristics

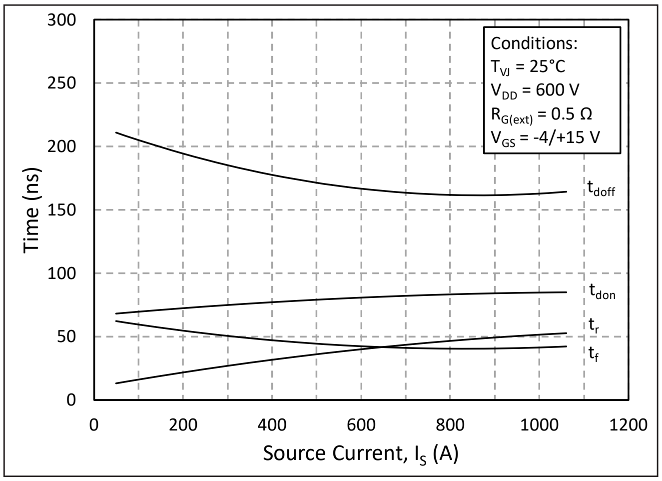


Figure 24. Timing vs. Source Current

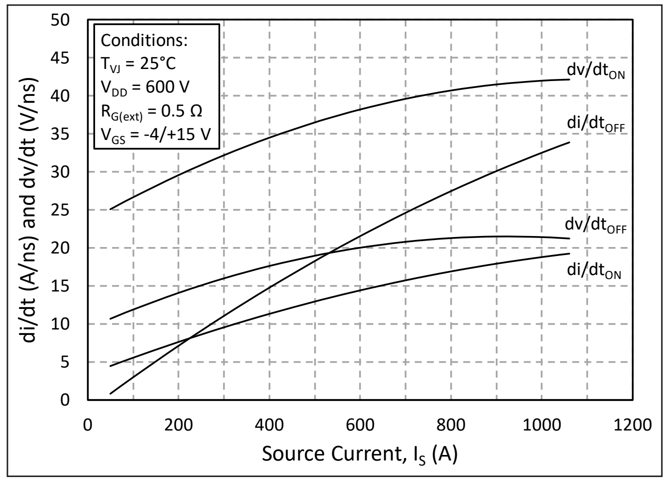


Figure 25. dv/dt and di/dt vs. Source Current

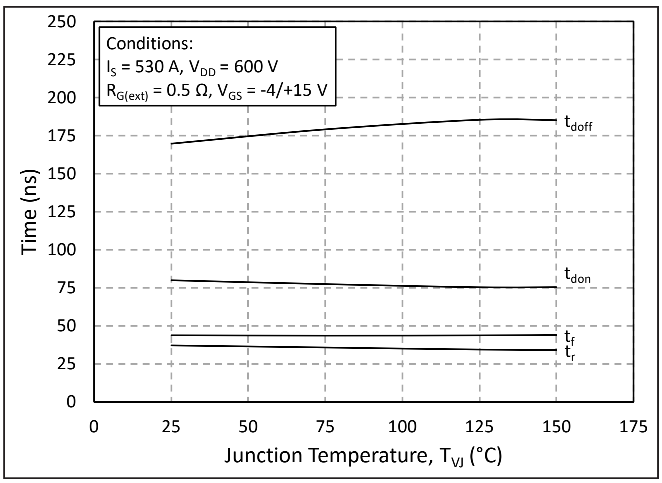


Figure 26. Timing vs. Junction Temperature

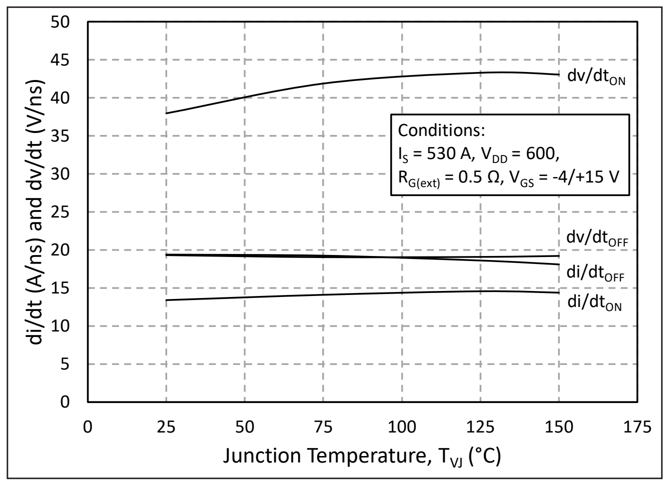


Figure 27. dv/dt and di/dt vs. Junction Temperature

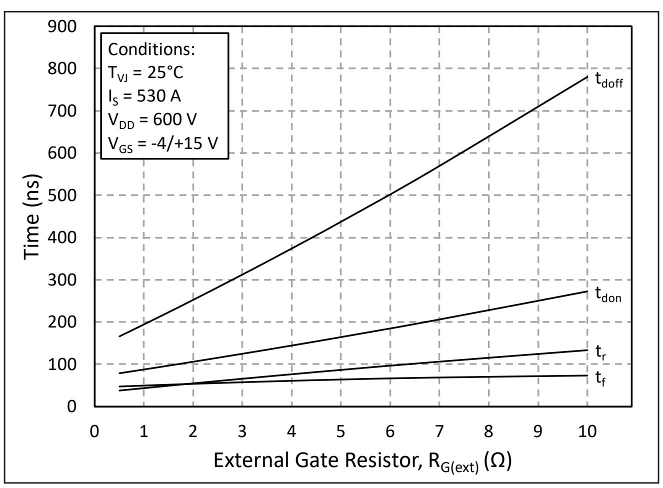


Figure 28. Timing vs. External Gate Resistance

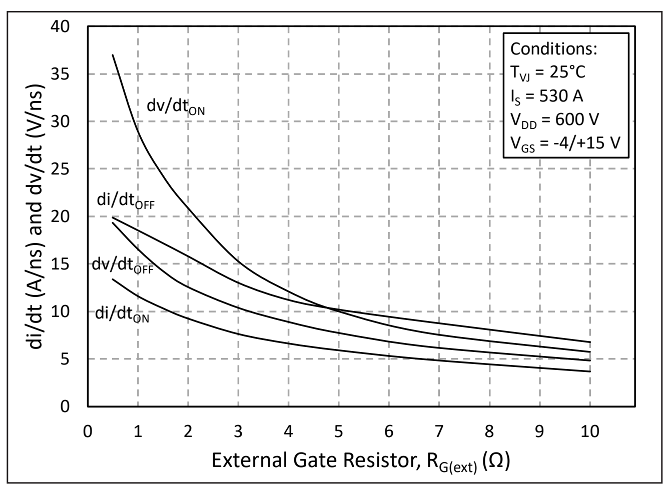


Figure 29. dv/dt and di/dt vs. External Gate Resistance

Definitions

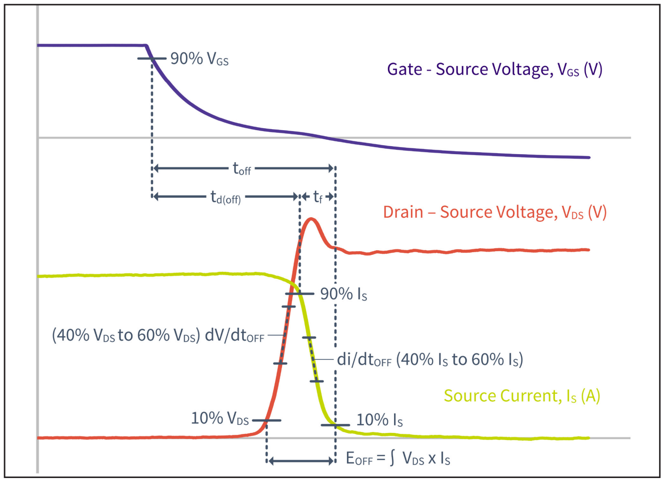


Figure 30. Turn-Off Transient Definitions

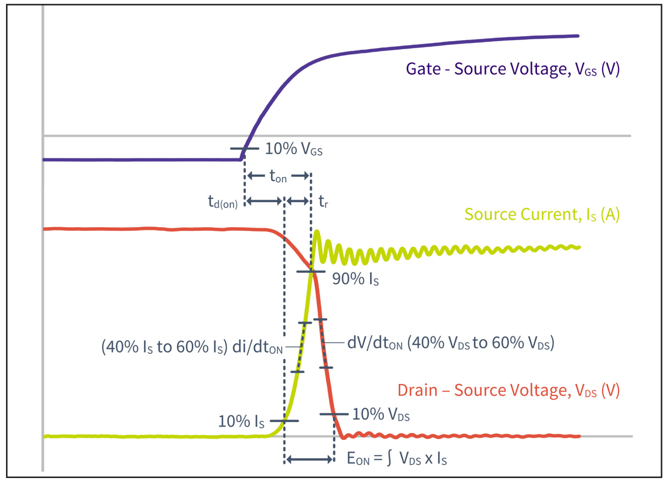


Figure 31. Turn-On Transient Definitions

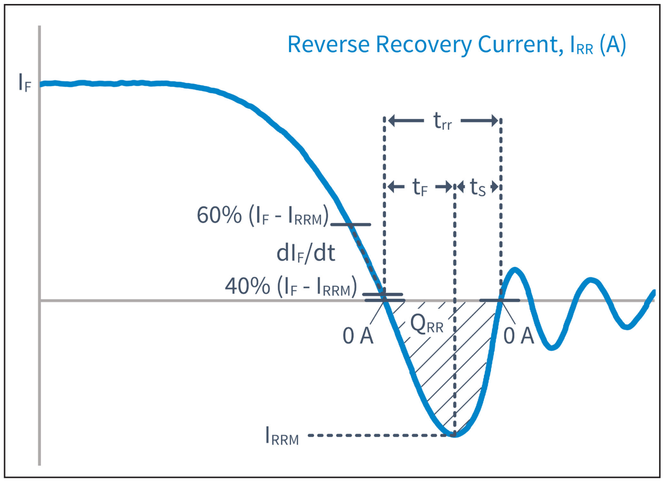


Figure 32. Reverse Recovery Definitions

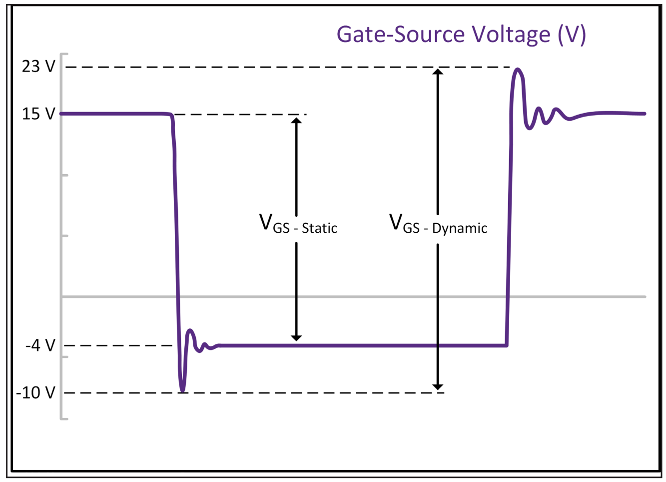
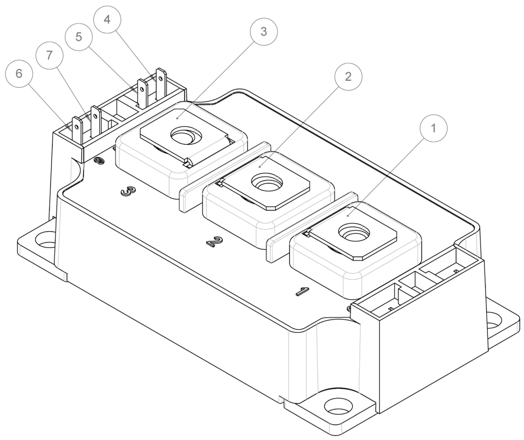
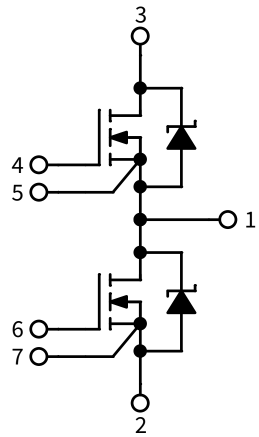


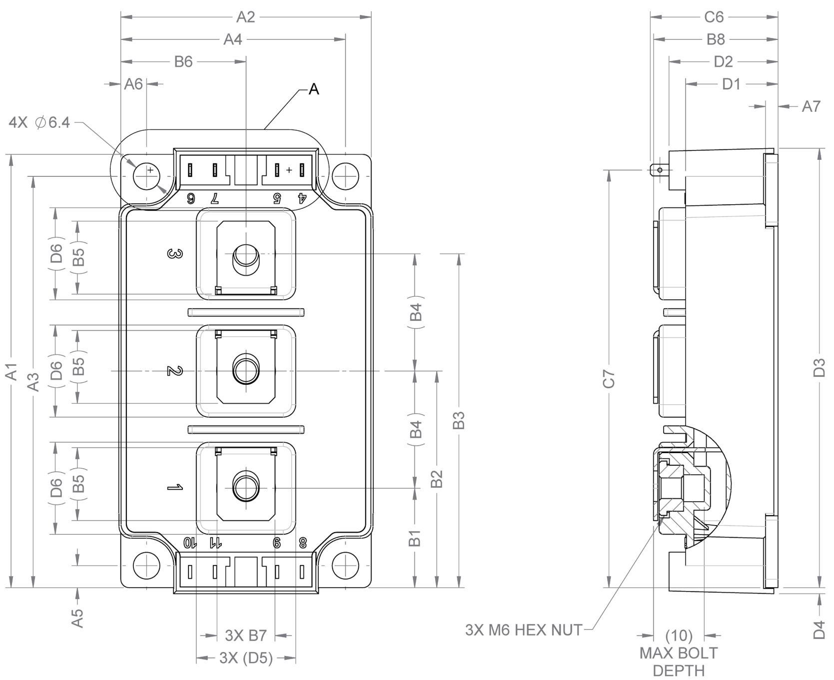
Figure 33. V_{GS} Transient Definitions

Schematic and Pin Out

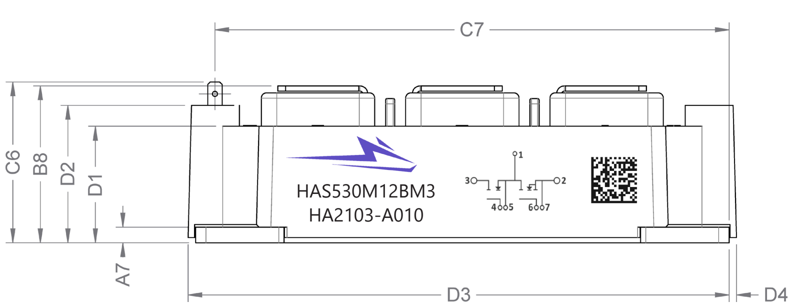


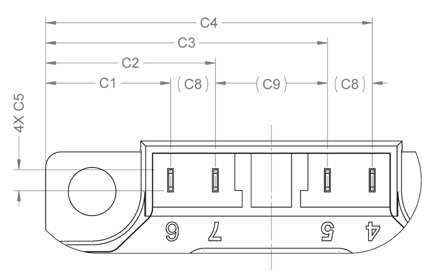


Package Dimension (mm)



DIMENSION TABLE		
SYMBOL	DIMENSION	TOLERANCE
A1	103.5	±0.30
A2	60.44	±0.30
A3	98.25	±0.30
A4	54.22	±0.30
A5	5.25	±0.30
A6	6.22	±0.30
A7	3	±0.30
B1	23.75	±0.40
B2	51.75	±0.40
B3	79.75	±0.40
B4	(28)	REF.
B5	(17.43)	REF.
B6	30.23	±0.40
B7	(14)	REF.
B8	30.03	±0.40
C1	16.73	±0.40
C2	22.73	±0.40
C3	37.73	±0.40
C4	43.73	±0.40
C5	2.8	±0.40
C6	30.8	±0.50
C7	99.75	±0.40
C8	(6)	REF.
C9	(15)	REF.
D1	22.3	±0.30
D2	26.3	±0.30
D3	104.95	±0.30
D4	1.45	±0.40
D5	(24)	REF.
D6	(22)	REF.





DETAIL A
SCALE 3 : 1

Product Ordering Code

Part Number	Description
HAS530M12BM3	Without Pre-Applied Phase Change Thermal Interface Material
HAS530M12BM3T	With Pre-Applied Phase Change Thermal Interface Material

Supporting Links & Tools

Simulation Tools & Support

- All LTSpice Models
- All PLECS Models
- SpeedFit 2.0 Design Simulator™
- Technical Support Forum

Compatible Evaluation Hardware

- CGD1200HB2P-BM3: Dual Channel Differential Isolated Half Bridge Gate Driver Board
- KIT-CRD-CIL12N-BM: Dynamic Performance Evaluation Board for the BM2 and BM3 Module
- CGD1700HB2P-BM3: Evaluation Gate Driver Tool Optimized for the 1700 V BM3 Power Modules
- KIT-CRD-CIL17N-BM: Dynamic Characterization Evaluation Tool Optimized for 1700 V BM Power Modules
- CGD12HB00D: Differential Transceiver Daughter Board Companion Tool for Differential Gate Drivers

Application Notes

- PRD-07933: Wolfspeed Power Module Thermal Interface Material Application User Guide
- PRD-06379: Environmental Considerations for Power Electronics
- PRD-08710: Measuring Stray Inductance in Power Electronic Systems
- PRD-07845: Power Module Baseplate Capacitance and Electromagnetic Compatibility
- PRD-08376: Thermal Characterization Methods and Applications
- PRD-06933: Capacitance Ratio and Parasitic Turn-On

Notes & Disclaimers

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Contact info:
4600 Silicon Drive
Durham, NC 27703 USA
Tel: +1.919.313.5300
www.wolfspeed.com/power

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