

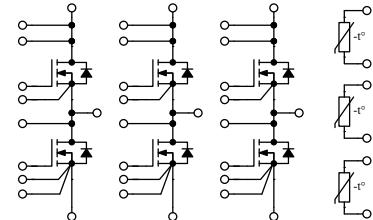
ECB2R8M12YM3

1200 V, 2.8 mΩ, Silicon Carbide, Six-Pack Module

V_{DS}	1200 V
R_{DS(on)}	2.8 mΩ

Technical Features

- Fully SiC MOSFET-based for Ultra-Low Loss
- Comparative Tracking Index (CTI) > 600 V for Material Group I
- Extremely Low Power Loop Inductance (6.6 nH)
- High Performance Si₃N₄ Insulator
- Ultra-Reliable Interconnect Technologies
- AQG-324 Qualification



Typical Applications

- Automotive Traction Inverters
- Commercial, Construction, and Agricultural Vehicles
- Hybrid Electric Vehicles
- E-Mobility and Motor Drives
- Auxiliary Power Supplies
- Renewable Energy

System Benefits

- Direct-Cooled Pin Fin Baseplate
- Industry-Standard Footprint
- Press-fit Connection for Ease of Assembly
- Integrated NTC Temperature Sensors

Maximum Parameters (Verified by Design)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	Note
Drain-Source Voltage	V _{DS}			1200	V		Fig. 32 Note 1
Gate-Source Voltage, Maximum Value	V _{GS max}	-10		+23		Transient	
Gate-Source Voltage, Recommended	V _{GS op}		-4/+15			Static	
DC Continuous Drain Current (V _{GS} = 15 V, T _{VJ} ≤ 175 °C)	I _D		545		A	T _F = 25 °C, Flow Rate = 10 LPM	Notes 2, 3 Fig. 20
			466			T _F = 65 °C, Flow Rate = 10 LPM	
Pulsed Drain Current	I _{DM}		932			t _{Pmax} limited by T _{VJmax} V _{GS} = 15 V, T _C = 25 °C	
Power Dissipation	P _D		1485		W	T _F = 25 °C, T _{VJ} ≤ 175 °C	Fig. 21 Note 4
Virtual Junction Temperature	T _{VJ op}	-40		175	°C	Operation	

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)}


MOSFET Characteristics (Per Position) ($T_{VJ} = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	Note
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	1200			V	$V_{GS} = 0\text{ V}$, $T_{VJ} = -40^\circ\text{C}$	
Gate Threshold Voltage	$V_{GS(\text{th})}$	1.8	2.5	3.6		$V_{DS} = V_{GS}$, $I_D = 125\text{ mA}$	
			2.0			$V_{DS} = V_{GS}$, $I_D = 125\text{ mA}$, $T_{VJ} = 175^\circ\text{C}$	
Zero Gate Voltage Drain Current	I_{DSS}		6	200	μA	$V_{GS} = 0\text{ V}$, $V_{DS} = 1200\text{ V}$	
Gate-Source Leakage Current	I_{GSS}		60	1500	nA	$V_{GS} = 15\text{ V}$, $V_{DS} = 0\text{ V}$	
Drain-Source On-State Resistance (Devices Only)	$R_{DS(\text{on})}$		2.8	3.7	$\text{m}\Omega$	$V_{GS} = 15\text{ V}$, $I_D = 450\text{ A}$	Fig. 2 Fig. 3
			5.0			$V_{GS} = 15\text{ V}$, $I_D = 450\text{ A}$, $T_{VJ} = 175^\circ\text{C}$	
Transconductance	g_{fs}		387		S	$V_{DS} = 20\text{ V}$, $I_{DS} = 450\text{ A}$	Fig. 4
			351			$V_{DS} = 20\text{ V}$, $I_{DS} = 450\text{ A}$, $T_{VJ} = 175^\circ\text{C}$	
Turn-On Switching Energy, $T_{VJ} = 25^\circ\text{C}$ $T_{VJ} = 125^\circ\text{C}$ $T_{VJ} = 175^\circ\text{C}$	E_{on}		14.6 14.0 13.7		mJ	$V_{DD} = 600\text{ V}$ $I_D = 450\text{ A}$ $V_{GS} = -4\text{ V}/15\text{ V}$ $R_{G(\text{OFF})} = 2.0\ \Omega$, $R_{G(\text{ON})} = 5.0\ \Omega$ $L_o = 16.1\text{ nH}$	Fig. 11 Fig. 13
Turn-Off Switching Energy, $T_{VJ} = 25^\circ\text{C}$ $T_{VJ} = 125^\circ\text{C}$ $T_{VJ} = 175^\circ\text{C}$	E_{off}		11.4 11.2 11.1				
Internal Gate Resistance	$R_{G(\text{int})}$		0.6		Ω	$f = 100\text{ kHz}$	
Input Capacitance	C_{iss}		38.5		nF	$V_{GS} = 0\text{ V}$, $V_{DS} = 800\text{ V}$ $V_{AC} = 25\text{ mV}$, $f = 100\text{ kHz}$	Fig. 9
Output Capacitance	C_{oss}		1.4				
Reverse Transfer Capacitance	C_{rss}		88.8		pF		
Gate to Source Charge	Q_{GS}		432		nC	$I_D = 450\text{ A}$, $V_{DS} = 800\text{ V}$ $V_{GS} = -4\text{ V}/15\text{ V}$ Per IEC60747-8-4 pg 21	
Gate to Drain Charge	Q_{GD}		354				
Total Gate Charge	Q_G		1272				
FET Thermal Resistance, Junction to Fluid	$R_{th\text{ JF}}$		0.101		$^\circ\text{C}/\text{W}$	Flow Rate = 10 LPM, $T_F = 65^\circ\text{C}$	Fig. 17

Diode Characteristics (Per Position) ($T_{VJ} = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	Notes
Body Diode Forward Voltage	V_{SD}		5.8		V	$V_{GS} = -4\text{ V}$, $I_{SD} = 450\text{ A}$	Fig. 7
			5.0			$V_{GS} = -4\text{ V}$, $I_{SD} = 450\text{ A}$, $T_{VJ} = 175^\circ\text{C}$	
DC Source-Drain Current (Body Diode) ($V_{GS} = -4\text{ V}$, $T_{VJ} \leq 175^\circ\text{C}$)	I_{BD}		320		A	$T_F = 25^\circ\text{C}$, Flow Rate = 10 LPM	
			249			$T_F = 65^\circ\text{C}$, Flow Rate = 10 LPM	
Reverse Recovery Time	t_{RR}		53.7		ns	$V_{GS} = -4\text{ V}$, $I_{SD} = 450\text{ A}$, $V_R = 600\text{ V}$ $di/dt = 7.5\text{ A/ns}$, $T_{VJ} = 175^\circ\text{C}$	
Reverse Recovery Charge	Q_{RR}		5.7		μC		
Peak Reverse Recovery Current	I_{RRM}		167		A		
Reverse Recovery Energy, $T_{VJ} = 25^\circ\text{C}$ $T_{VJ} = 125^\circ\text{C}$ $T_{VJ} = 175^\circ\text{C}$	E_{RR}		0.2 0.7 1.3		mJ	$V_{DD} = 600\text{ V}$, $I_D = 450\text{ A}$, $R_{G(\text{ON})} = 5.0\ \Omega$, $V_{GS} = -4\text{ V}/15\text{ V}$ $L_o = 16.1\text{ nH}$	Fig. 14



Module Physical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Package Resistance, (High-Side)			0.30		mΩ	T _F = 25°C, Note 5
Package Resistance, (Low-Side)			0.22			T _F = 25°C, Note 5
Comparative Tracking Index	CTI	600				
Baseplate Material			Cu+Ni			
Internal Isolator Material			Si ₃ Ni ₄			Basic insulation (class 1, IEC 61140)
Stray Inductance	L _{Stray}		6.6		nH	Between DC- and DC+
Case Temperature	T _C	-40		125	°C	
Mounting Torque	M _S	1.8		2.2	N·m	Baseplate, M4 bolts
		3.6		4.4		Power Terminals, M5 bolts
Weight	W		805		g	
Case Isolation Voltage	V _{isol}		4.2		kV	f = 0 Hz, t = 1 sec
Maximum Pressure in Cooling Circuit	p			2.5	bar	
Clearance Distance			4.3		mm	Terminal to Terminal
			4.5			Terminal to Heatsink
Creepage Distance			9.2			Terminal to Terminal
			9.8			Terminal to Heatsink

NTC Characteristics (T_{NTC} = 25 °C unless otherwise specified)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Resistance at 25°C	R ₂₅	4750	5000	5250	Ω	
Tolerance of R ₁₀₀	ΔR/R	-9.22		9.89	%	T _{NTC} = 100 °C, R ₁₀₀ = 493.3 Ω
Beta Value for 25°C to 50°C	B _{25/50}	3307	3375	3343	K	
Beta Value for 25°C to 80°C	B _{25/80}	3346	3414	3482	K	
Beta Value for 25°C to 100°C	B _{25/100}	3368	3436	3503	K	
Maximum Power Dissipation	P ₂₅		1.4		mW	

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

Typical Performance

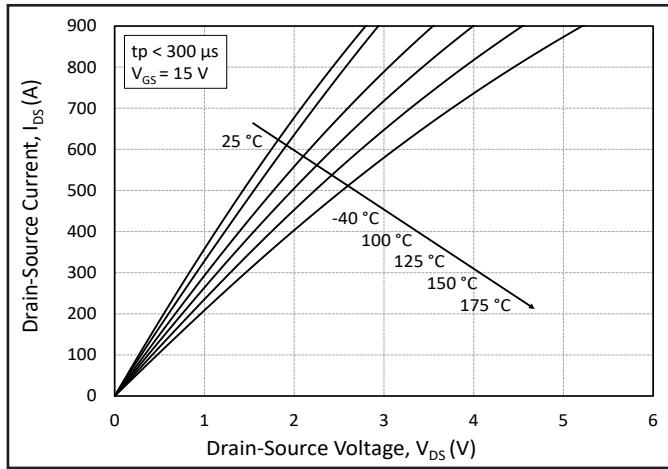


Figure 1. Output Characteristics for Various Junction Temperatures

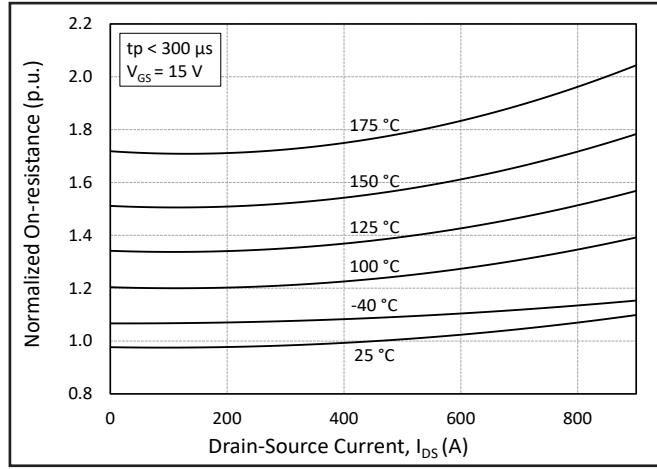


Figure 2. Normalized On-State Resistance vs. Drain Current for Various Junction Temperatures

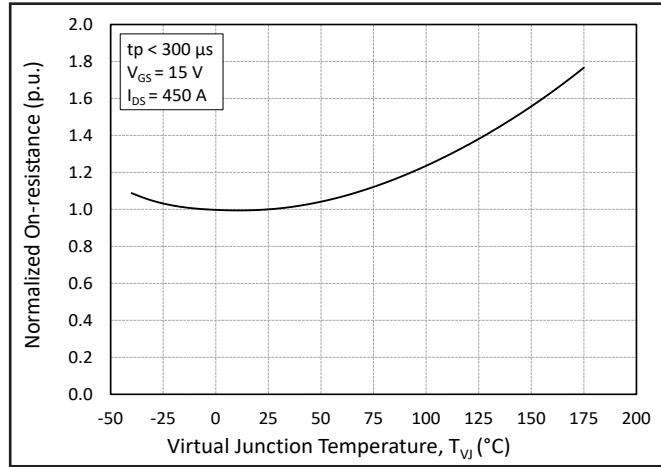


Figure 3. Normalized On-State Resistance vs. Junction Temperature

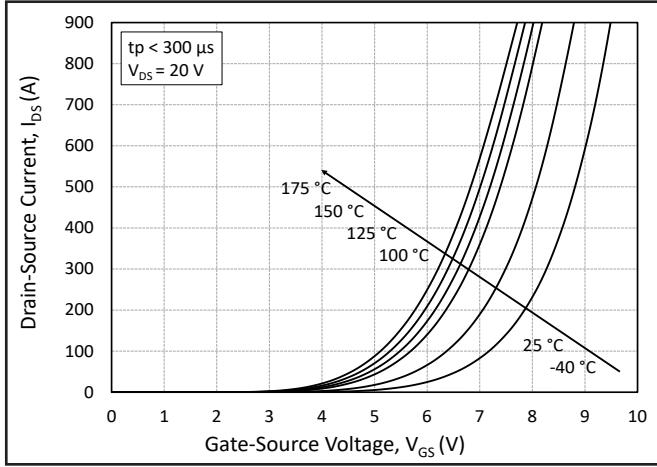


Figure 4. Transfer Characteristic for Various Junction Temperatures

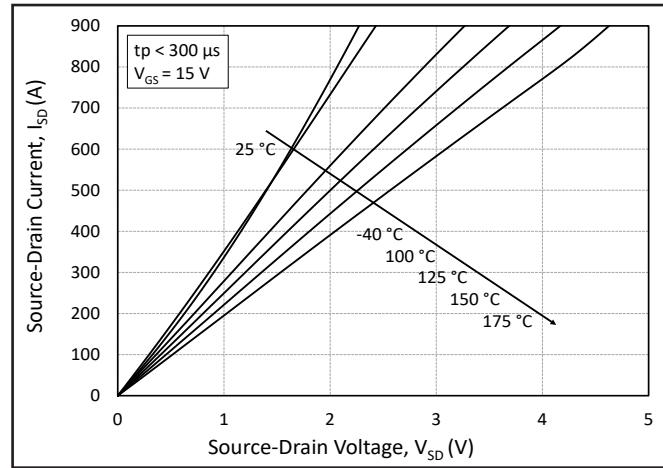


Figure 5. 3rd Quadrant Characteristic vs. Junction Temperatures at $V_{GS} = 15$ V

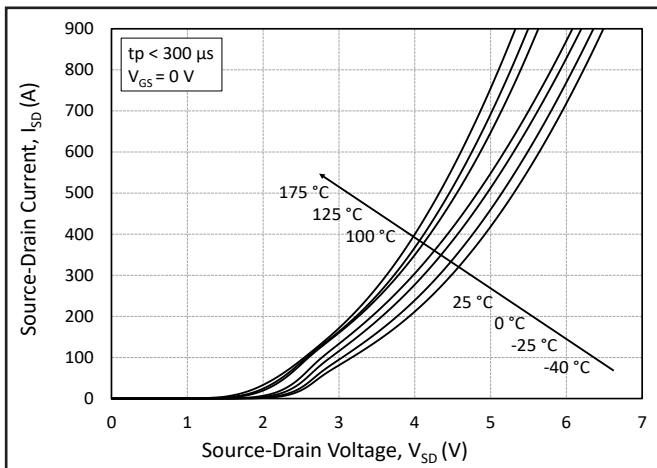


Figure 6. 3rd Quadrant Characteristic vs. Junction Temperatures at $V_{GS} = 0$ V (Body Diode)

Typical Performance

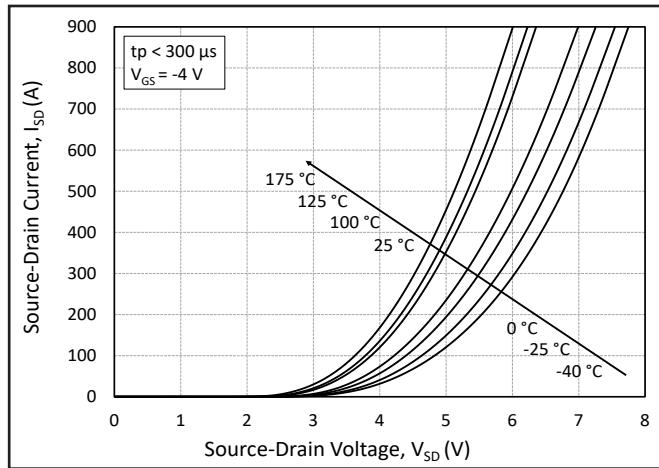


Figure 7. 3rd Quadrant Characteristic vs. Junction Temperatures at $V_{GS} = -4 \text{ V}$ (Body Diode)

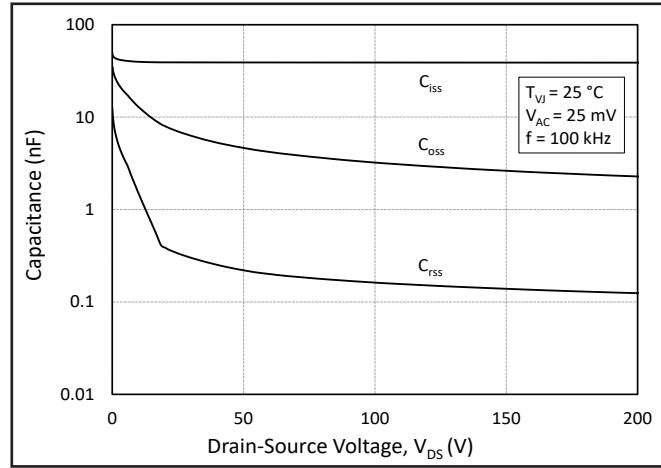


Figure 8. Typical Capacitances vs. Drain to Source Voltage (0 - 200V)

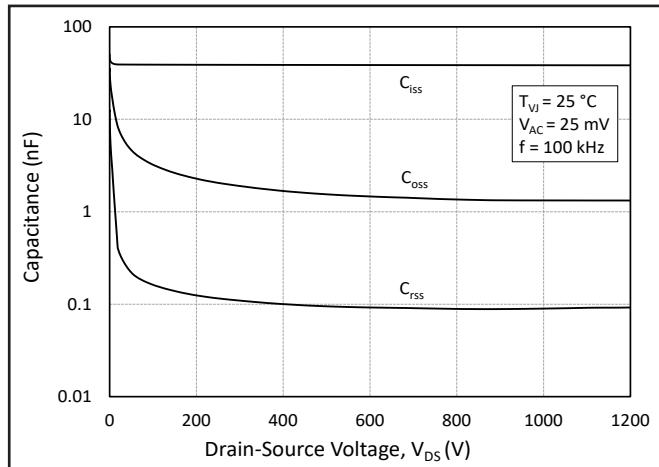


Figure 9. Typical Capacitances vs. Drain to Source Voltage (0 - 1200V)

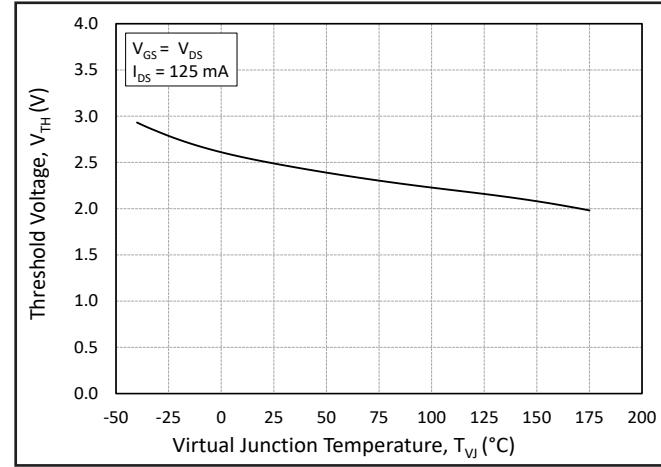


Figure 10. Threshold Voltage vs. Junction Temperature

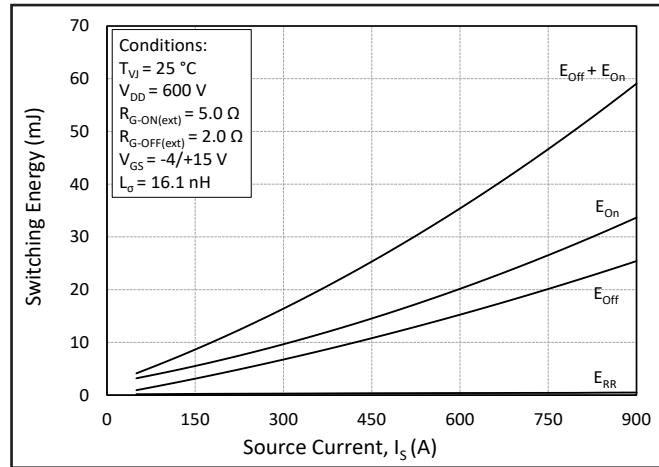


Figure 11. Switching Energy vs. Drain Current ($V_{DS} = 600 \text{ V}$)

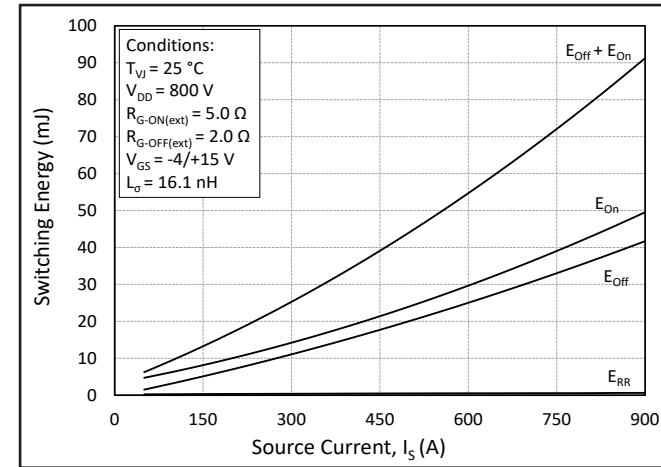


Figure 12. Switching Energy vs. Drain Current ($V_{DS} = 800 \text{ V}$)

Typical Performance

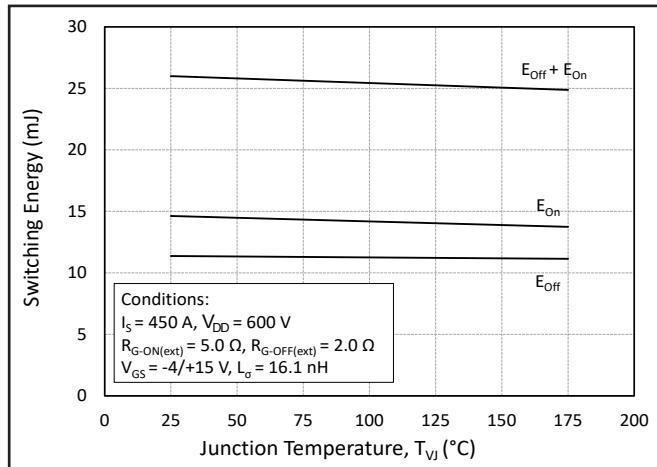


Figure 13. MOSFET Switching Energy vs. Junction Temperature

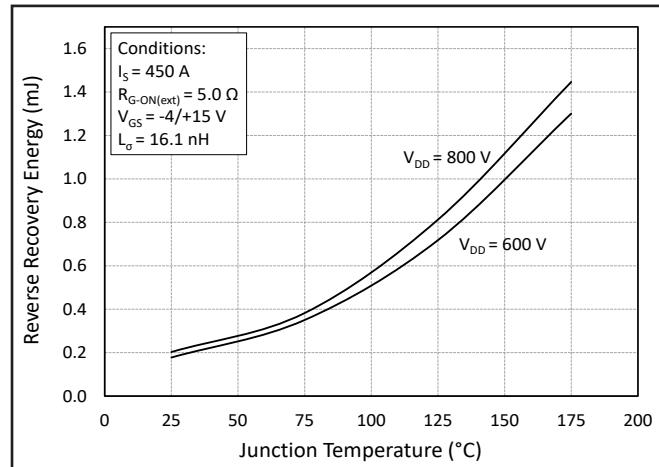


Figure 14. Reverse Recovery Energy vs. Junction Temperature

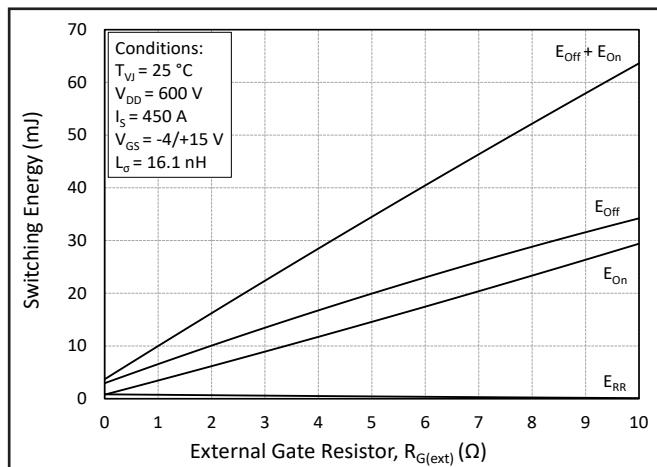


Figure 15. MOSFET Switching Energy vs. External Gate Resistance

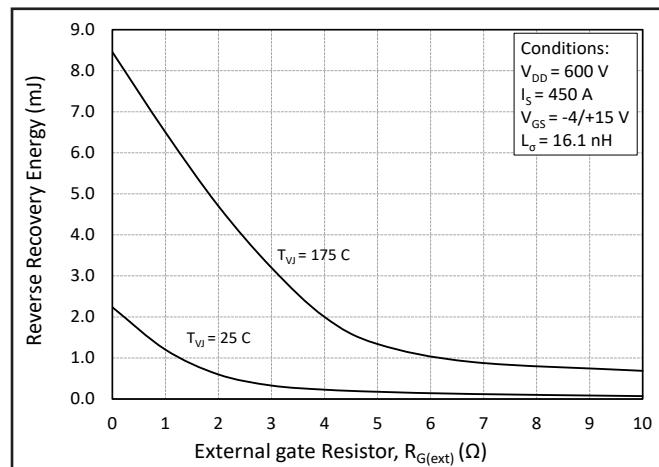


Figure 16. Reverse Recovery Energy vs. External Gate Resistance

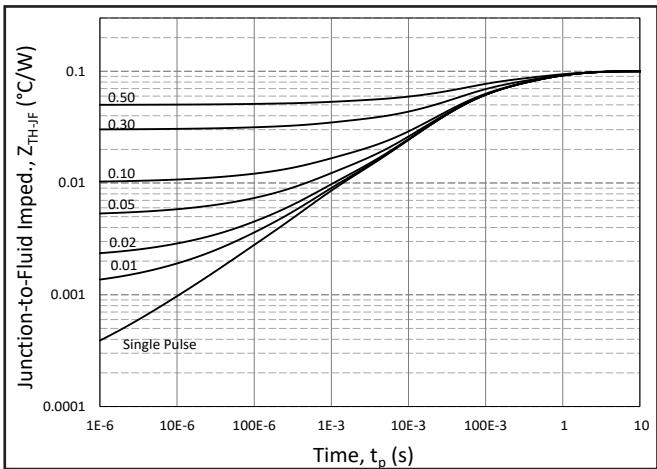


Figure 17. MOSFET Junction to Fluid Transient Thermal Impedance, $Z_{th,JF}$ ($^{\circ}\text{C}/\text{W}$)

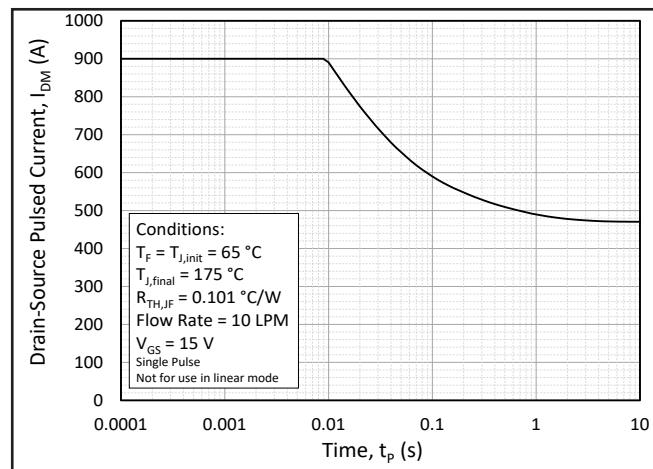


Figure 18. Pulsed Current Safe Operating Area (SOA)



Typical Performance

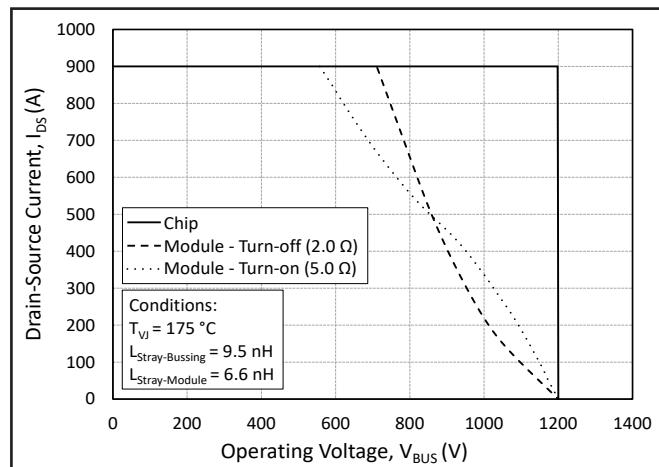


Figure 19. Switching Safe Operating Area

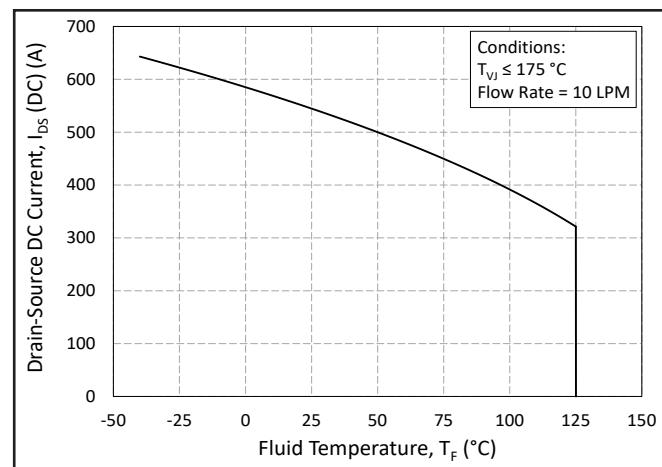


Figure 20. Continuous Drain Current Derating vs. Fluid Temperature

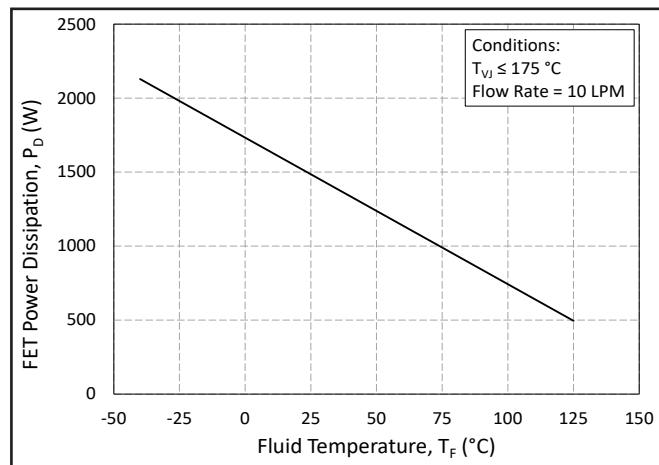


Figure 21. Maximum Power Dissipation Derating vs. Fluid Temperature

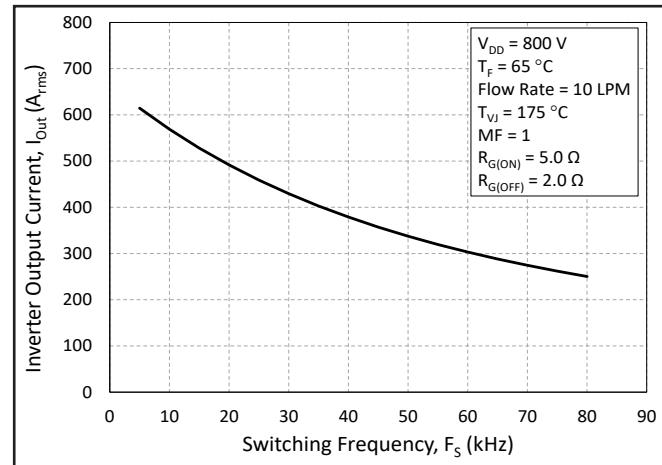


Figure 22. Typical Output Current Capability vs. Switching Frequency (Inverter Application)

Timing Characteristics

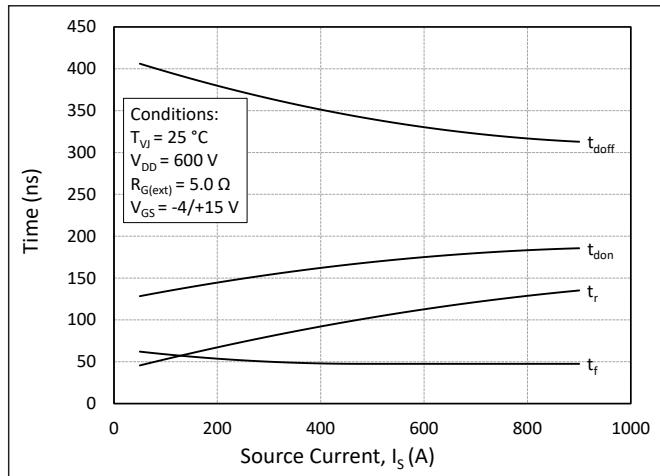


Figure 23. Timing vs. Source Current

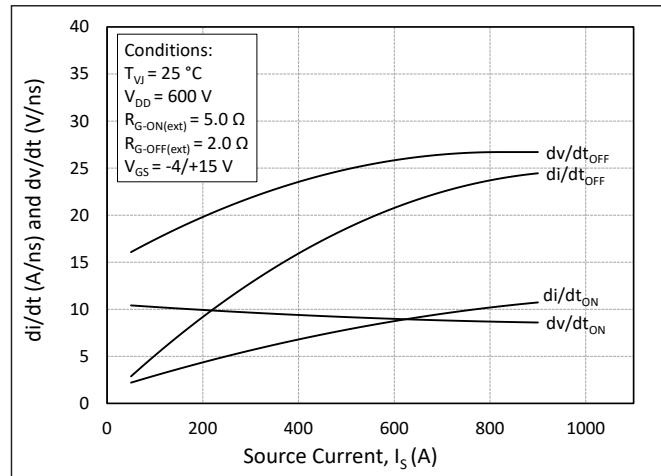


Figure 24. dv/dt and di/dt vs. Source Current

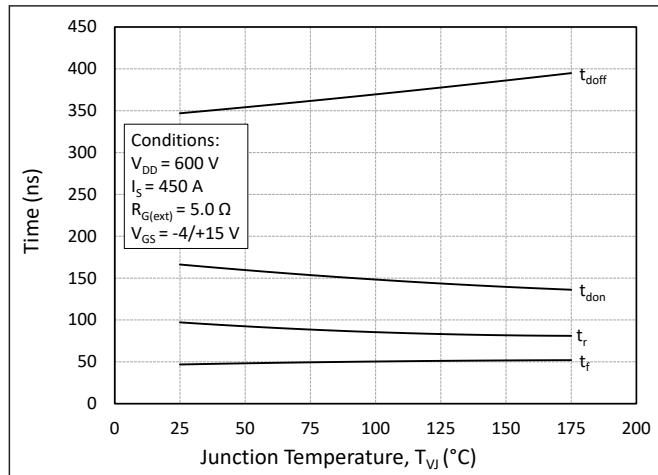


Figure 25. Timing vs. Junction Temperature

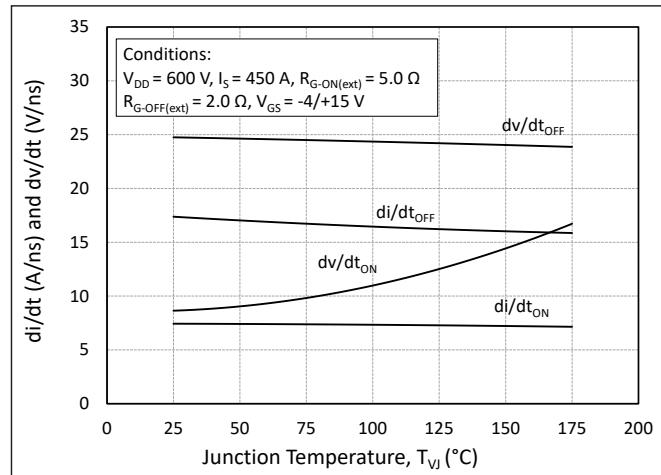


Figure 26. dv/dt and di/dt vs. Junction Temperature

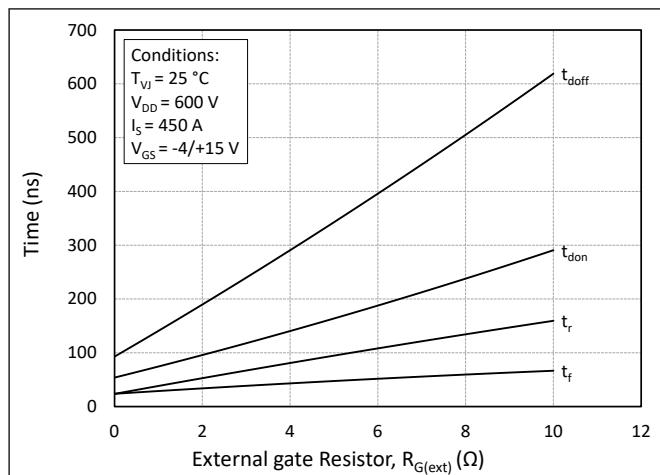


Figure 27. Timing vs. External Gate Resistance

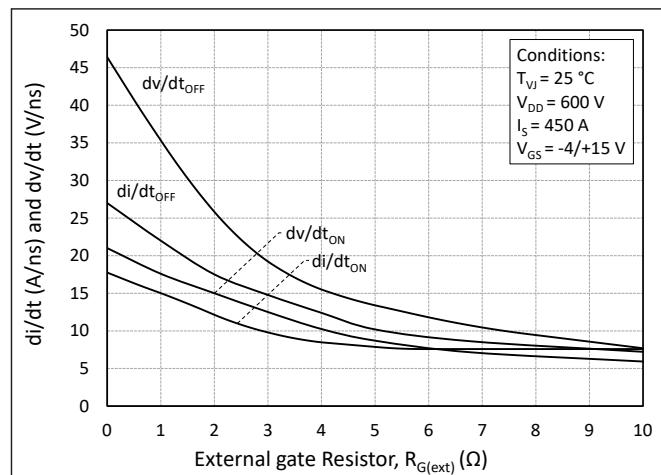


Figure 28. dv/dt and di/dt vs. External Gate Resistance



Definitions

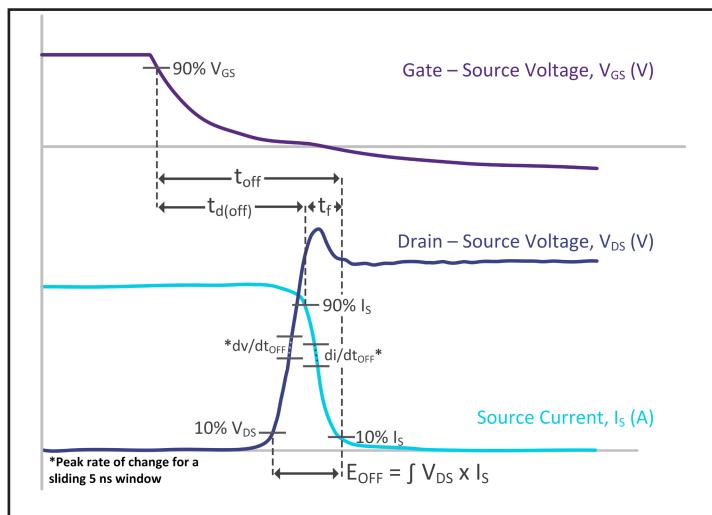


Figure 29. Turn-off Transient Definitions

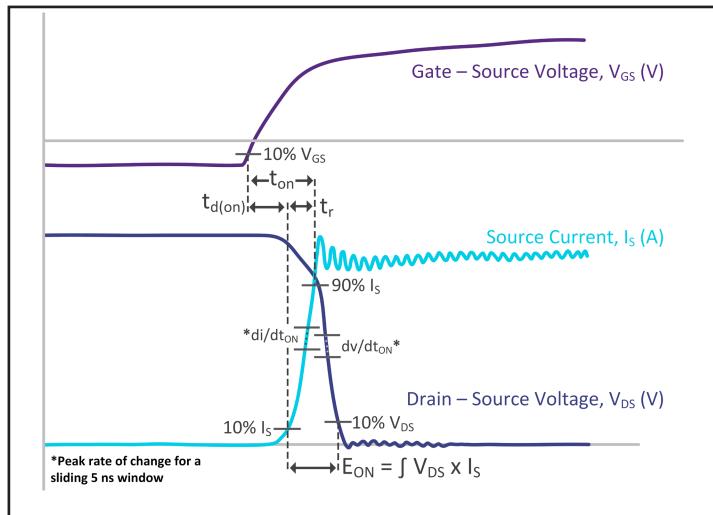


Figure 30. Turn-on Transient Definitions

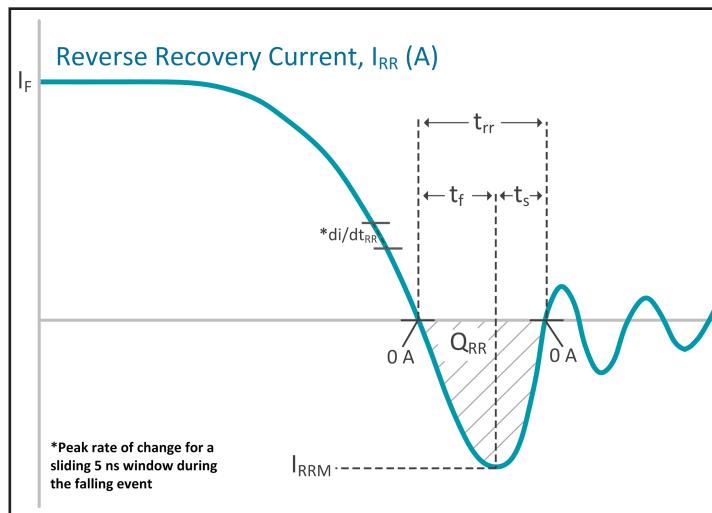


Figure 31. Reverse Recovery Definitions

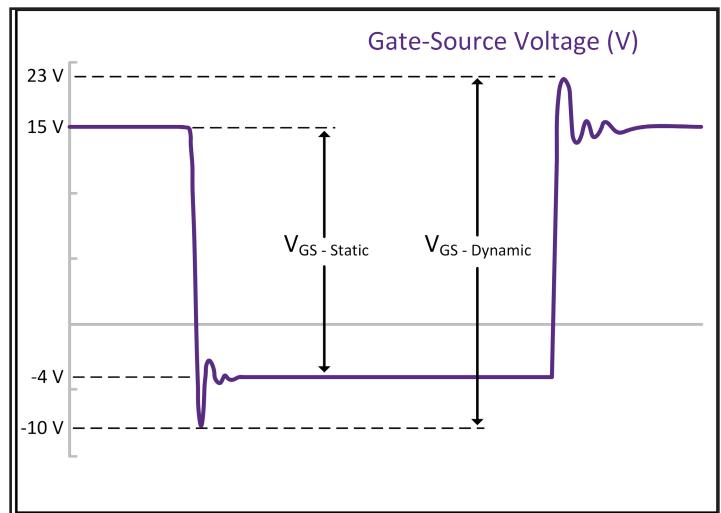
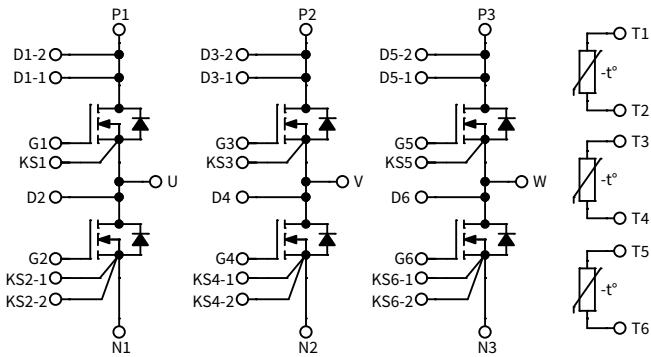


Figure 32. V_{GS} Transient Definitions

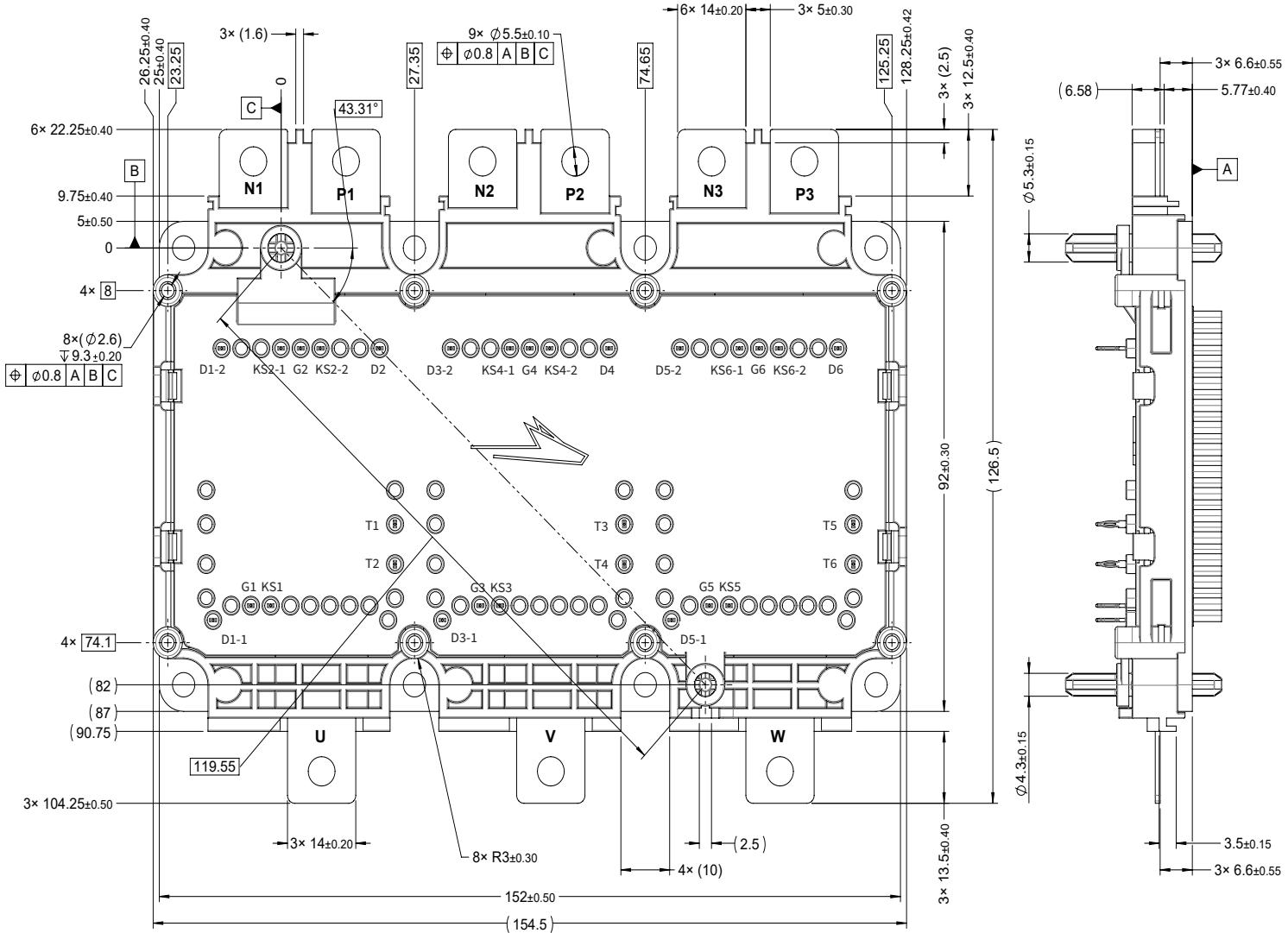
Note (6): A gate driver featuring the IXDD614SI gate driver IC was used to evaluate dynamic performance. The typical driver high-state output resistance of $0.4\ \Omega$ and low-state output resistance of $0.3\ \Omega$ are not included in the $R_{G(ext)}$ values on this datasheet.



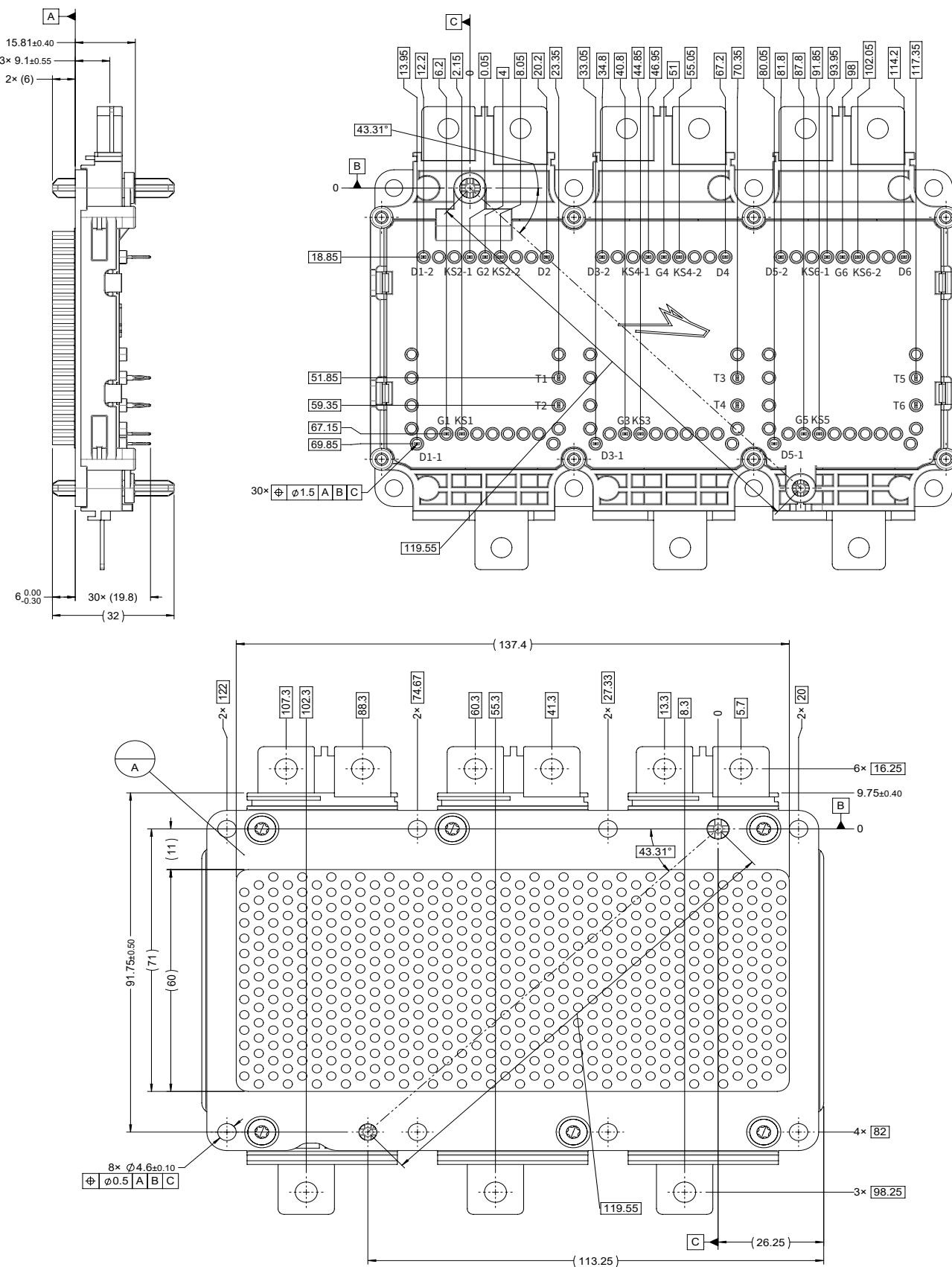
Schematic and Pin Out



Package Dimension (mm)



Package Dimension (mm)



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
- NXP EV Traction Inverter Control Reference Design Gen 3

Application Notes

- PRD-04814: Design Options for Wolfspeed® Silicon Carbide MOSFET Gate Bias Power Supplies
- PRD-06379: Environmental Considerations for Power Electronics Systems
- PRD-08333: Wolfspeed Module CIL Evaluation Kits User Guide
- PRD-08376: Thermal Characterization Methods and Applications
- PRD-07845: Power Module Baseplate Capacitance and Electromagnetic Compatibility
- 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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