

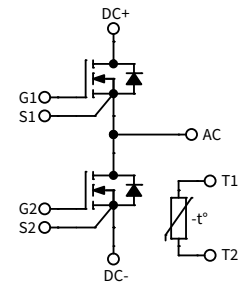
# CAB006A12GM3, CAB006A12GM3T

1200 V, 6 mΩ, Silicon Carbide, Half-Bridge Module

$V_{DS}$	<b>1200 V</b>
$R_{DS(on)}$	<b>6 mΩ</b>

## Technical Features

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



## Applications

- DC-DC Converters
- EV Chargers
- 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	Test Conditions	Note
Drain-Source Voltage	$V_{DS}$			1200	V		
Gate-Source Voltage, Maximum Value	$V_{GS\ max}$	-8		+19		Transient, < 100 ns	Fig. 33
Gate-Source Voltage, Recommended	$V_{GS\ op}$	-4		+15		Static	
DC Continuous Drain Current ( $T_{VJ} \leq 150\ ^\circ\text{C}$ )	$I_D$			200	A	$V_{GS} = 15\ \text{V}, T_{HS} = 75\ ^\circ\text{C}, T_{VJ} \leq 150\ ^\circ\text{C}$	Fig. 20 Note 1
DC Continuous Drain Current ( $T_{VJ} \leq 175\ ^\circ\text{C}$ )				200		$V_{GS} = 15\ \text{V}, T_{HS} = 75\ ^\circ\text{C}, T_{VJ} \leq 175\ ^\circ\text{C}$	
DC Source-Drain Current (Body Diode)	$I_{SD\ BD}$		166			$V_{GS} = -4\ \text{V}, T_{HS} = 75\ ^\circ\text{C}, T_{VJ} \leq 175\ ^\circ\text{C}$	
Pulsed Drain Current	$I_D\ (pulsed)$			400		$t_{pmax}$ limited by $T_{VJmax}$ $V_{GS} = 15\ \text{V}, T_{HS} = 75\ ^\circ\text{C}$	
Virtual Junction Temperature	$T_{VJ\ op}$	-40		150	$^\circ\text{C}$	Operation	
		-40		175		Intermittent with Reduced Life	



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

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	Note	
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	1200				$V_{GS} = 0\text{ V}, T_{VJ} = -40\text{ }^{\circ}\text{C}$		
Gate Threshold Voltage	$V_{GS(th)}$	1.8	2.5	3.6	V	$V_{DS} = V_{GS}, I_D = 69\text{ mA}$		
			2.1			$V_{DS} = V_{GS}, I_D = 69\text{ mA}, T_{VJ} = 150\text{ }^{\circ}\text{C}$		
Zero Gate Voltage Drain Current	$I_{DSS}$		6	114	$\mu\text{A}$	$V_{GS} = 0\text{ V}, V_{DS} = 1200\text{ V}$		
Gate-Source Leakage Current	$I_{GSS}$		0.06	1.5		$V_{GS} = 15\text{ V}, V_{DS} = 0\text{ V}$		
Drain-Source On-State Resistance (Devices Only)	$R_{DS(on)}$		5.3	6.9	m $\Omega$	$V_{GS} = 15\text{ V}, I_D = 200\text{ A}$	Fig. 2 Fig. 3	
			8.5			$V_{GS} = 15\text{ V}, I_D = 200\text{ A}, T_{VJ} = 150\text{ }^{\circ}\text{C}$		
			9.6			$V_{GS} = 15\text{ V}, I_D = 200\text{ A}, T_{VJ} = 175\text{ }^{\circ}\text{C}$		
Transconductance	$g_{fs}$		162		S	$V_{DS} = 20\text{ V}, I_D = 200\text{ A}$	Fig. 4	
			145			$V_{DS} = 20\text{ V}, I_D = 200\text{ A}, T_{VJ} = 150\text{ }^{\circ}\text{C}$		
Turn-On Switching Energy, $T_{VJ} = 25\text{ }^{\circ}\text{C}$ $T_{VJ} = 125\text{ }^{\circ}\text{C}$ $T_{VJ} = 150\text{ }^{\circ}\text{C}$	$E_{On}$		4.76		mJ	$V_{DD} = 600\text{ V},$ $I_D = 200\text{ A},$ $V_{GS} = -4\text{ V}/15\text{ V},$ $R_{G(OFF)} = 0.0\text{ }\Omega, R_{G(ON)} = 1.5\text{ }\Omega,$ $L = 40\text{ }\mu\text{H}$	Fig. 11 Fig. 13	
Turn-Off Switching Energy, $T_{VJ} = 25\text{ }^{\circ}\text{C}$ $T_{VJ} = 125\text{ }^{\circ}\text{C}$ $T_{VJ} = 150\text{ }^{\circ}\text{C}$		$E_{Off}$		0.44				
				0.45				0.46
Internal Gate Resistance	$R_{G(int)}$		1.12		$\Omega$	$f = 100\text{ kHz}, V_{AC} = 25\text{ mV}$		
Input Capacitance	$C_{iss}$		20.4		nF	$V_{GS} = 0\text{ V}, V_{DS} = 800\text{ V},$ $V_{AC} = 25\text{ mV}, f = 100\text{ kHz}$	Fig. 9	
Output Capacitance	$C_{oss}$		0.79					
Reverse Transfer Capacitance	$C_{rss}$		43		pF			
Gate to Source Charge	$Q_{GS}$		240		nC	$V_{DS} = 800\text{ V}, V_{GS} = -4\text{ V}/15\text{ V},$ $I_D = 200\text{ A},$ Per IEC60747-8-4 pg 21		
Gate to Drain Charge	$Q_{GD}$		204					
Total Gate Charge	$Q_G$		708					
FET Thermal Resistance, Junction to Heatsink	$R_{th\ JHS}$		0.132		$^{\circ}\text{C}/\text{W}$	Measured with Pre-Applied TIM	Fig. 17	

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

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	Notes
Body Diode Forward Voltage	$V_{SD}$		4.9		V	$V_{GS} = -4\text{ V}, I_{SD} = 200\text{ A}$	Fig. 7
			4.4			$V_{GS} = -4\text{ V}, I_{SD} = 200\text{ A}, T_{VJ} = 150\text{ }^{\circ}\text{C}$	
Reverse Recovery Time	$t_{RR}$		29		ns	$V_{GS} = -4\text{ V}, I_{SD} = 200\text{ A}, V_R = 600\text{ V},$ $di/dt = 20.0\text{ A/ns}, T_{VJ} = 150\text{ }^{\circ}\text{C}$	Fig. 32
Reverse Recovery Charge	$Q_{RR}$		4.8		$\mu\text{C}$		
Peak Reverse Recovery Current	$I_{RRM}$		275		A		
Reverse Recovery Energy, $T_{VJ} = 25\text{ }^{\circ}\text{C}$ $T_{VJ} = 125\text{ }^{\circ}\text{C}$ $T_{VJ} = 150\text{ }^{\circ}\text{C}$	$E_{RR}$		0.14		mJ	$V_{DD} = 600\text{ V}, I_D = 200\text{ A},$ $V_{GS} = -4\text{ V}/15\text{ V}, R_{G(ON)} = 1.5\text{ }\Omega,$ $L = 40\text{ }\mu\text{H}$	Fig. 14
			0.45				
			0.63				



## Module Physical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Package Resistance, M1 (High-Side)	$R_{HS}$		1.37		m $\Omega$	$T_c = 125^\circ\text{C}$ , $I_D = 200\text{ A}$ , Note 2
Package Resistance, M2 (Low-Side)	$R_{LS}$		1.25			$T_c = 125^\circ\text{C}$ , $I_D = 200\text{ A}$ , Note 2
Stray Inductance	$L_{Stray}$		7.1		nH	Between DC- and DC+, $f = 10\text{ MHz}$
Case Temperature	$T_c$	-40		125	$^\circ\text{C}$	
Mounting Torque	$M_s$		2.0	2.3	N-m	M4 bolts
Weight	$W$		39		g	
Case Isolation Voltage	$V_{isol}$	3			kV	AC, 50 Hz, 1 minute
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

Notes:

<sup>1</sup> DC Continuous Drain Current,  $I_D$ , set by press-fit pin limit

<sup>2</sup> Total Effective Resistance (Per Switch Position) = MOSFET  $R_{DS(on)}$  + Switch Position Package Resistance

## NTC Thermistor Characterization

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Rated Resistance	$R_{NTC}$		5.0		k $\Omega$	$T_{NTC} = 25^\circ\text{C}$
Resistance Tolerance at 25 $^\circ\text{C}$	$\Delta R/R$	-5		5	%	
Beta Value ( $T_2 = 50^\circ\text{C}$ )	$\beta_{25/50}$		3380		K	
Beta Value ( $T_2 = 80^\circ\text{C}$ )	$\beta_{25/80}$		3468		K	
Beta Value ( $T_2 = 100^\circ\text{C}$ )	$\beta_{25/100}$		3523		K	
Power Dissipation	$P_{Max}$			10	mW	$T_{NTC} = 25^\circ\text{C}$



Typical Performance

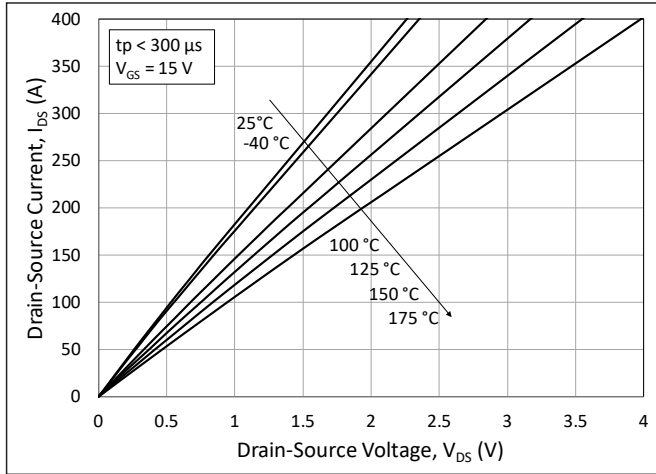


Figure 1. Output Characteristics for Various Junction Temperatures

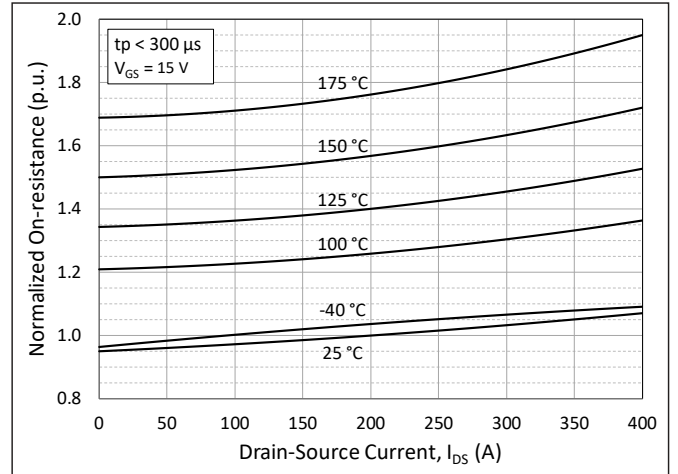


Figure 2. Normalized On-State Resistance vs. Drain Current for Various Junction Temperatures

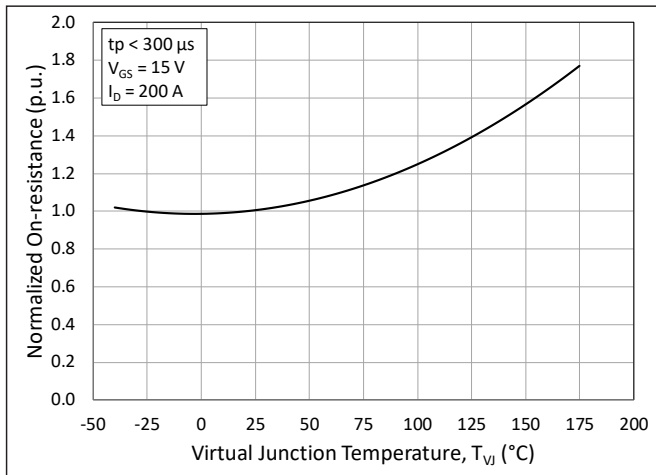


Figure 3. Normalized On-State Resistance vs. Junction Temperature

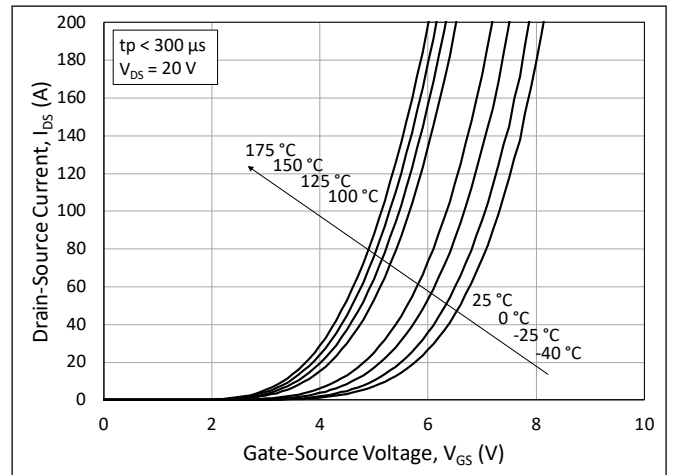


Figure 4. Transfer Characteristic for Various Junction Temperatures

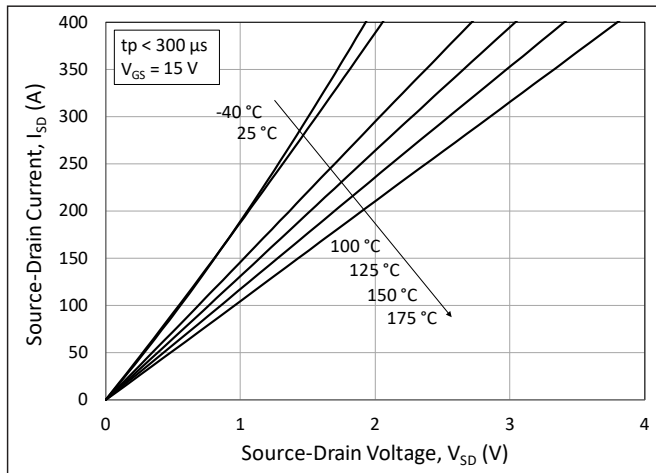


Figure 5. 3<sup>rd</sup> Quadrant Characteristic vs. Junction Temperatures at  $V_{GS} = 15\text{ V}$

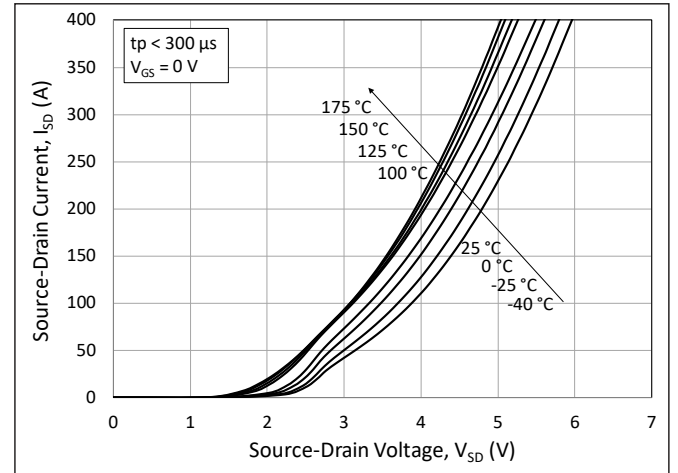


Figure 6. 3<sup>rd</sup> Quadrant Characteristic vs. Junction Temperatures at  $V_{GS} = 0\text{ V}$



Typical Performance

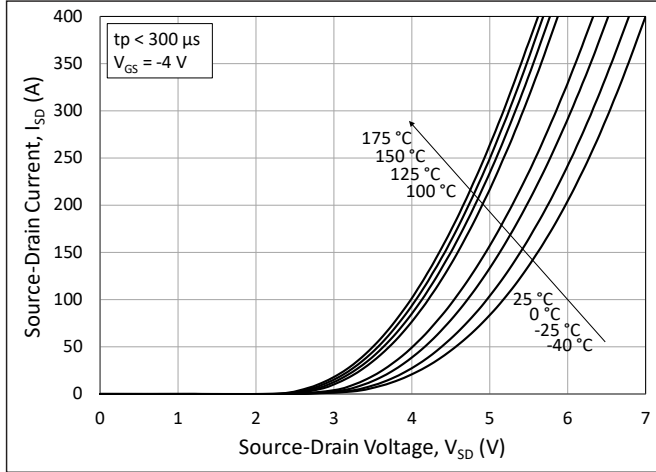


Figure 7. 3<sup>rd</sup> Quadrant Characteristic vs. Junction Temperatures at  $V_{GS} = -4$  V (Body Diode)

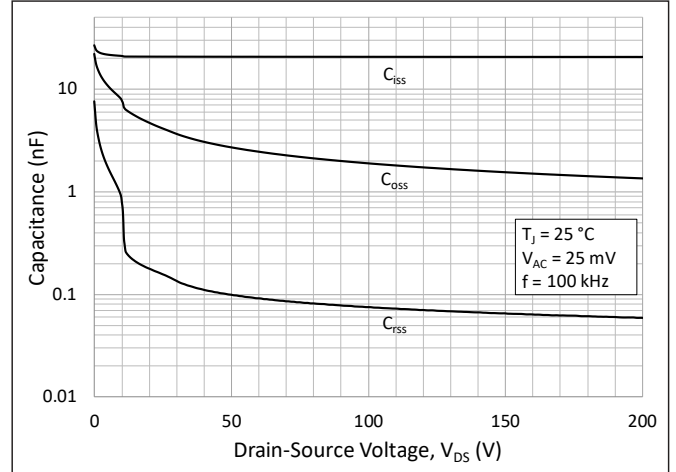


Figure 8. Typical Capacitances vs. Drain to Source Voltage (0 - 200 V)

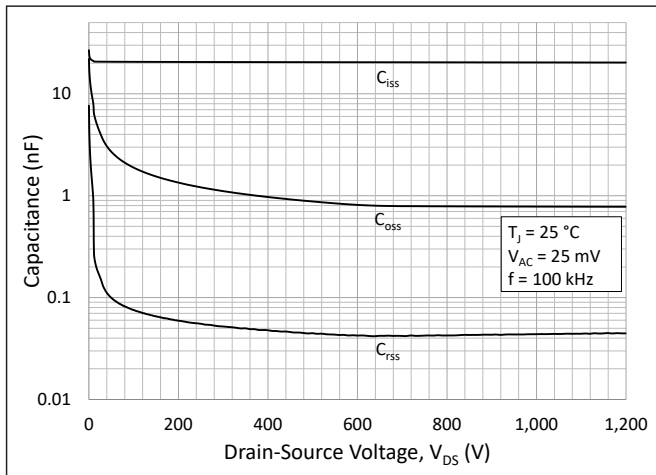


Figure 9. Typical Capacitances vs. Drain to Source Voltage (0 - 1200 V)

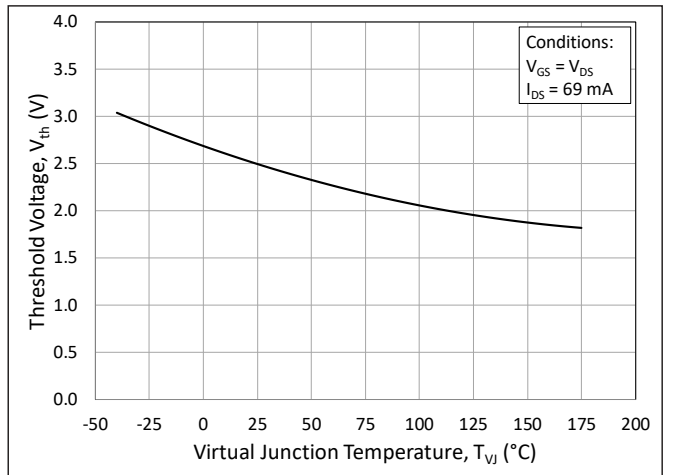


Figure 10. Threshold Voltage vs. Junction Temperature

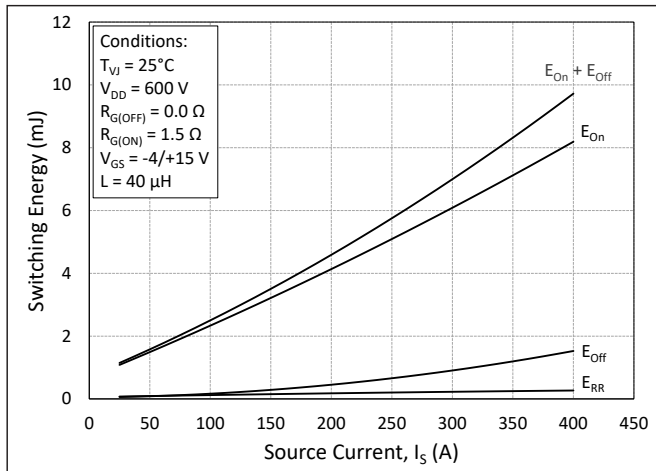


Figure 11. Switching Energy vs. Drain Current ( $V_{DD} = 600$  V)

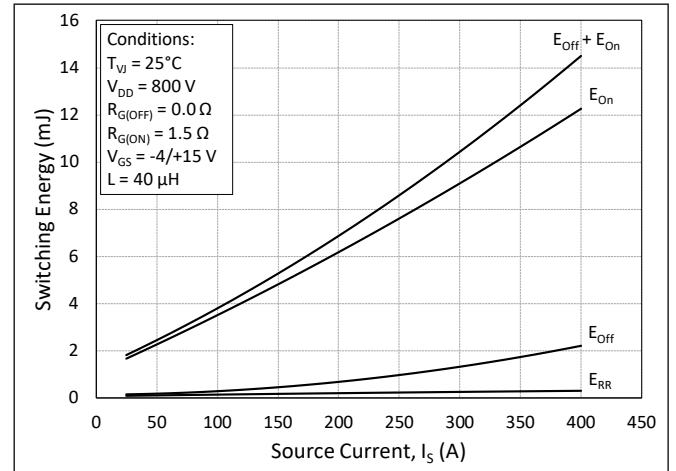


Figure 12. Switching Energy vs. Drain Current ( $V_{DD} = 800$  V)



Typical Performance

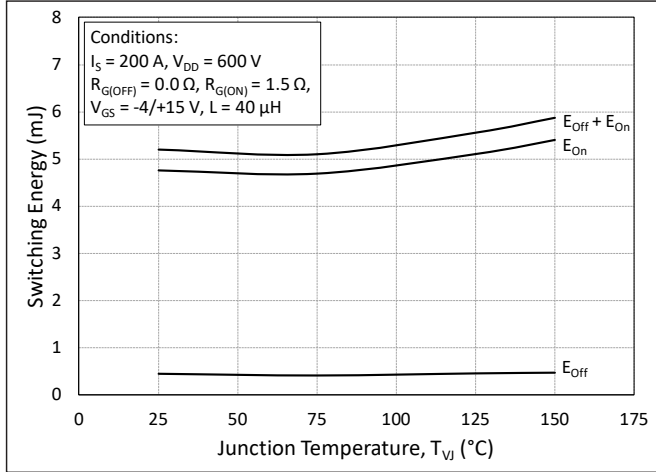


Figure 13. MOSFET Switching Energy vs. Junction Temperature

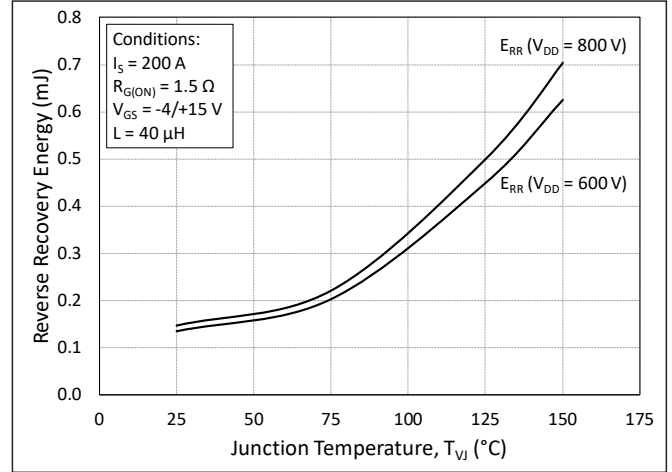


Figure 14. Reverse Recovery Energy vs. Junction Temperature

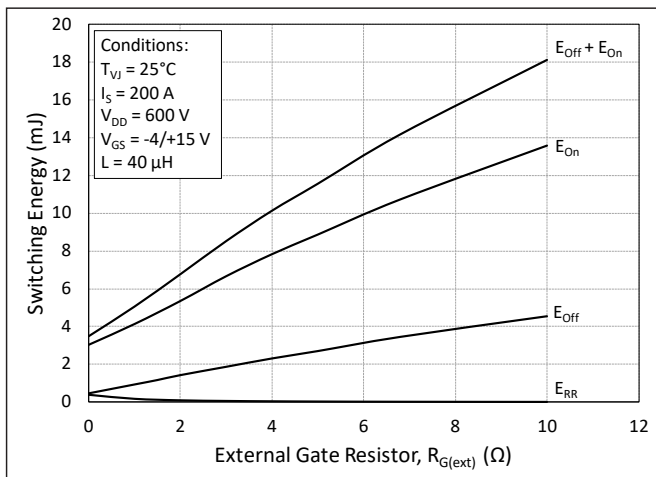


Figure 15. MOSFET Switching Energy vs. External Gate Resistance

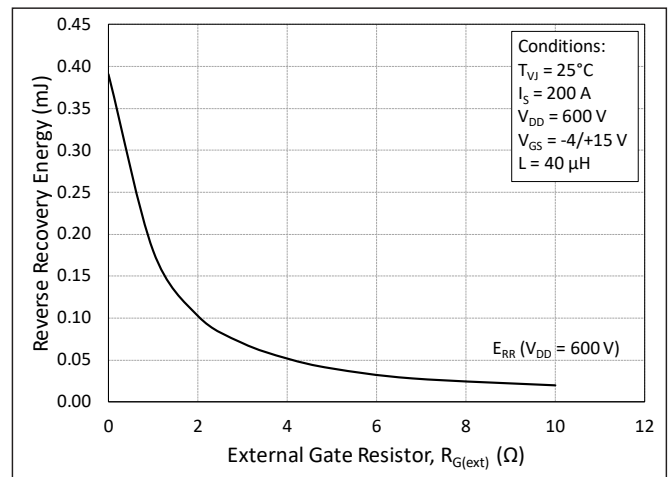


Figure 16. Reverse Recovery Energy vs. External Gate Resistance

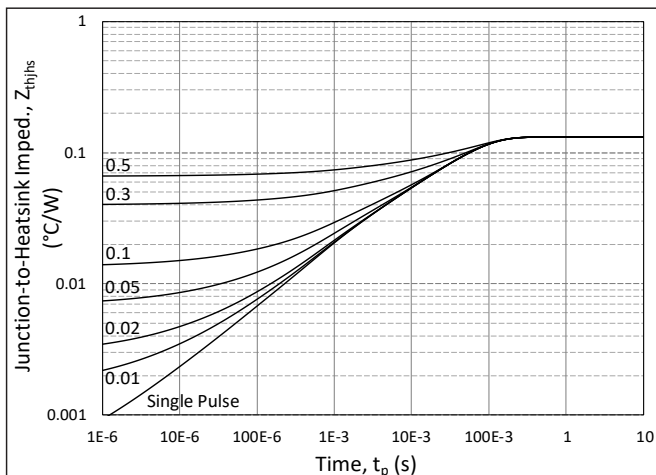


Figure 17. MOSFET Junction to Heatsink Transient Thermal Impedance,  $Z_{thjhs}$  (°C/W)

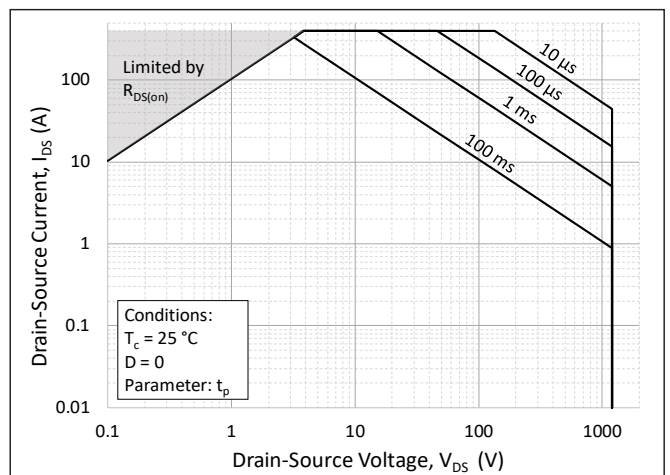
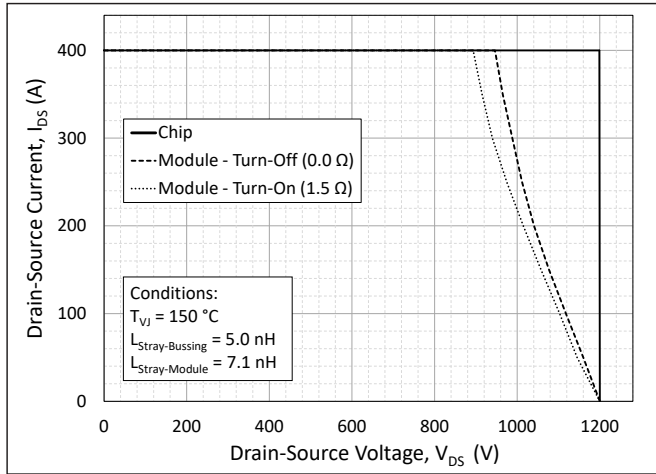


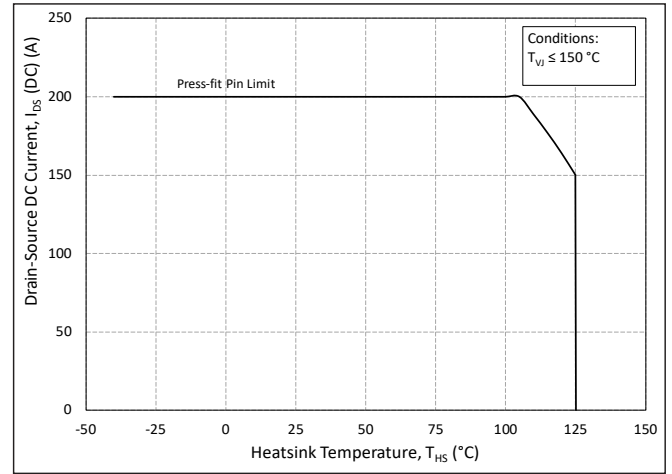
Figure 18. Forward Bias Safe Operating Area (FBSOA)



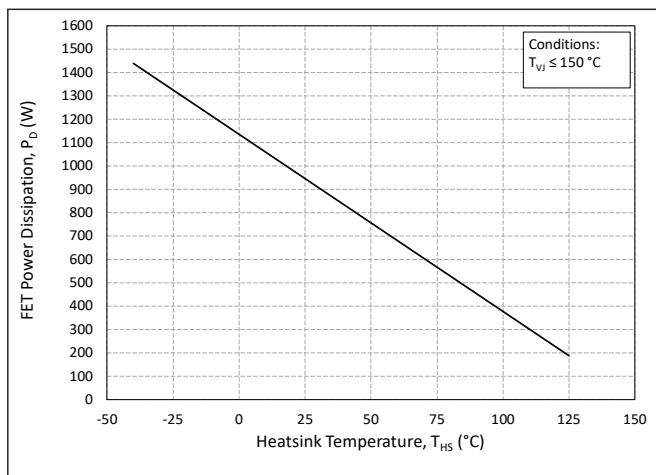
### Typical Performance



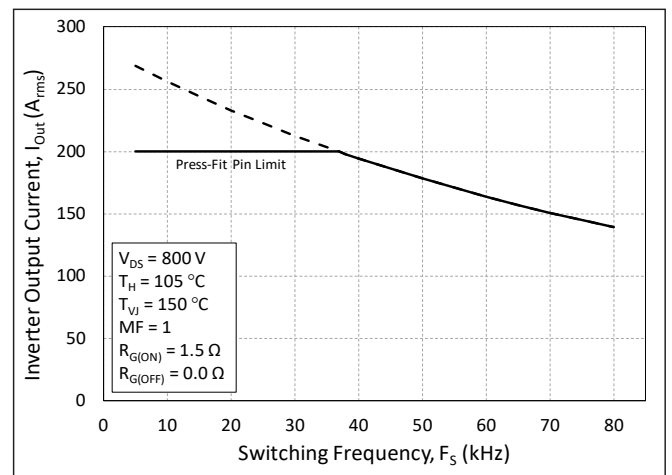
**Figure 19.** Switching Safe Operating Area



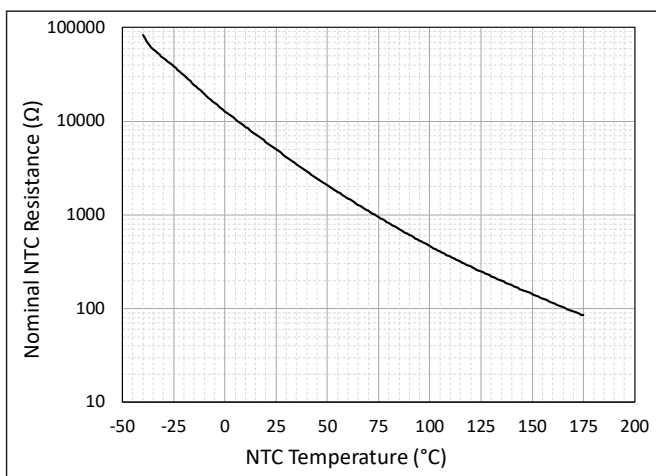
**Figure 20.** Continuous Drain Current Derating vs. Heatsink Temperature



**Figure 21.** Maximum Power Dissipation Derating vs. Heatsink Temperature



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



**Figure 23.** Nominal NTC Resistance vs. NTC Temperature



Timing Characteristics

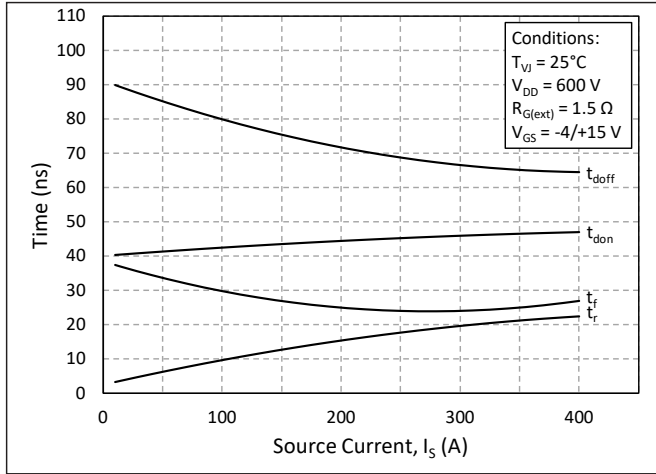


Figure 24. Timing vs. Source Current

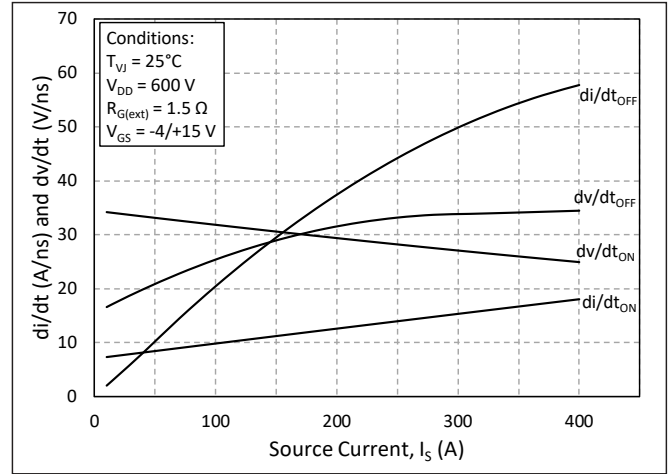


Figure 25. dv/dt and di/dt vs. Source Current

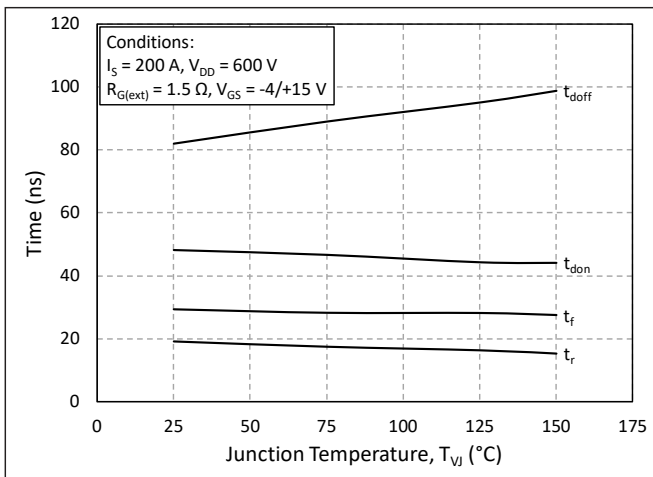


Figure 26. Timing vs. Junction Temperature

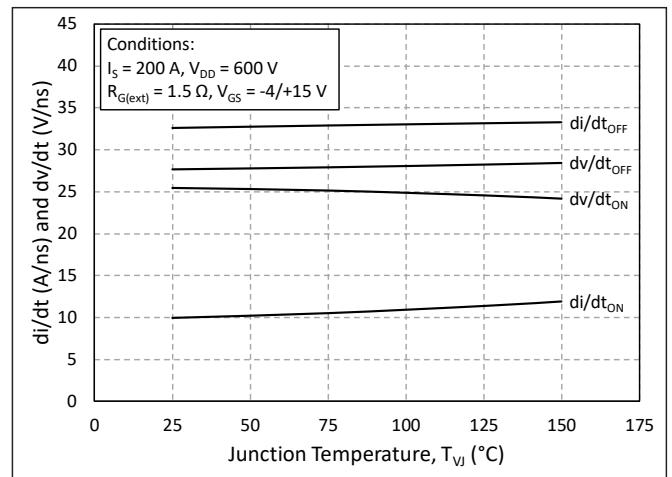


Figure 27. dv/dt and di/dt vs. Junction Temperature

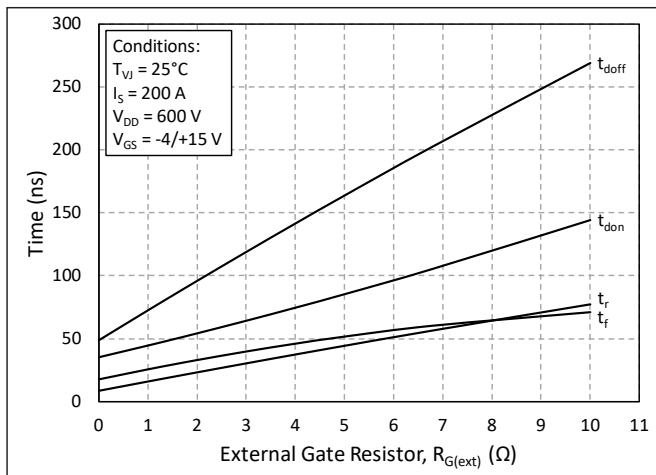


Figure 28. Timing vs. External Gate Resistance

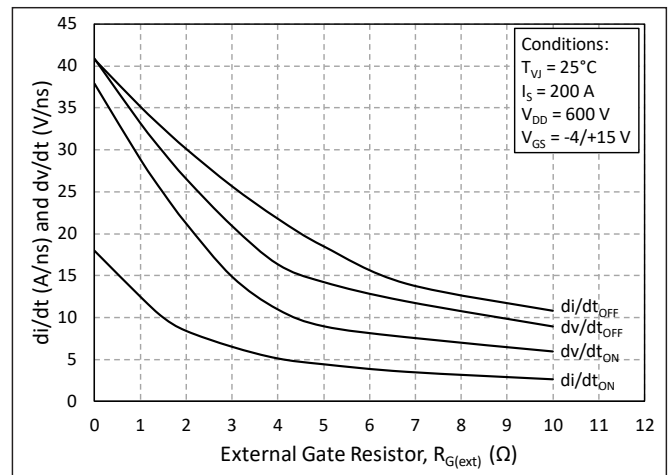


Figure 29. dv/dt and di/dt vs. External Gate Resistance



Definitions

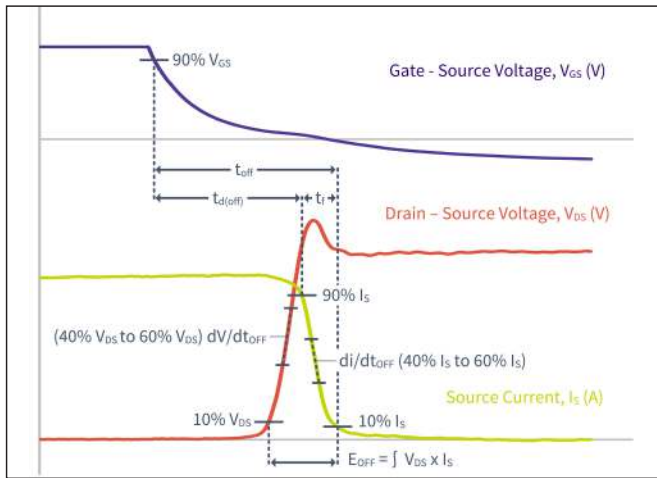


Figure 30. Turn-off Transient Definitions

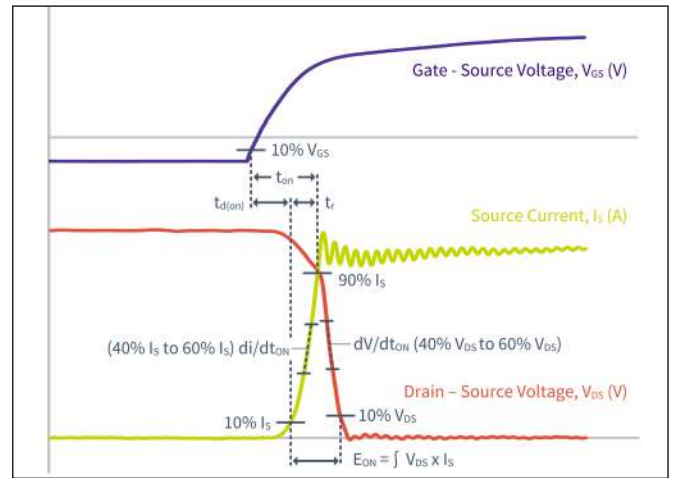


Figure 31. Turn-on Transient Definitions

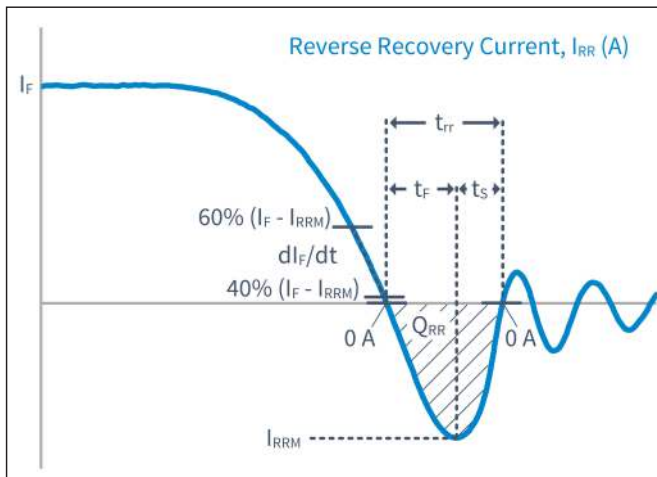


Figure 32. Reverse Recovery Definitions

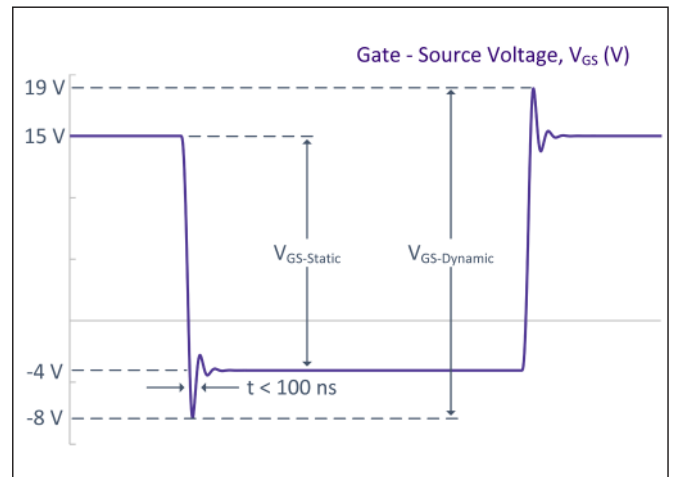
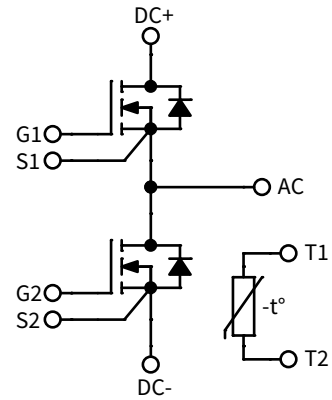
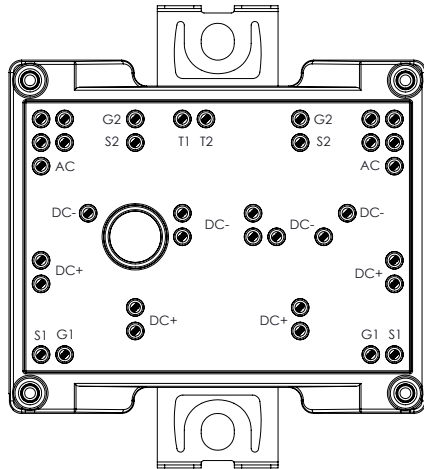


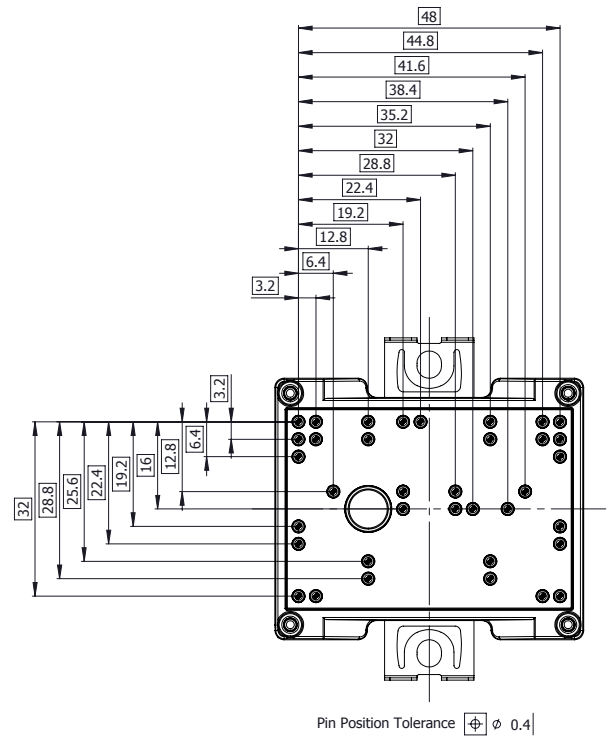
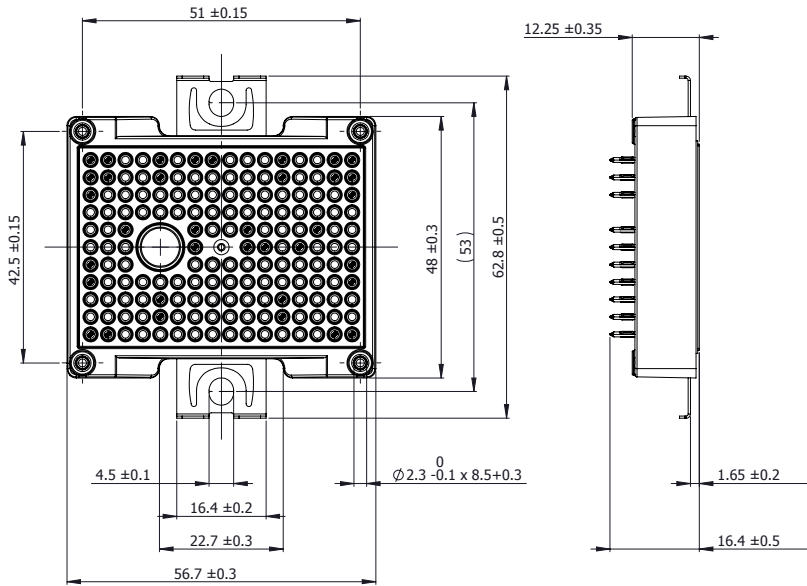
Figure 33. V<sub>GS</sub> Transient Definitions



**Pinout**



**Package Dimension (mm)**





## Product Ordering Code

Part Number	Description
CAB006A12GM3	Without Pre-Applied Phase Change Thermal Interface Material
CAB006A12GM3T	With Pre-Applied Phase Change Thermal Interface Material

## Supporting Links & Tools

### Evaluation Tools & Support

- [KIT-CRD-CIL12N-GMA: Dynamic Evaluation Board for Half-Bridge GM3 Modules](#)
- [CAB006A12GM3 PLECS Model](#)
- [SpeedFit 2.0 Design Simulator™](#)
- [Technical Support Forum](#)

### Dual-Channel Gate Driver Board

- [EVAL-ADUM4146WHB1Z: Analog Devices® Gate Driver Board](#)
- [Si823H-AxWA-KIT: Skyworks® Gate Driver Board](#)
- [ACPL-355JC: Broadcom® Gate Driver Board](#)
- [CGD1700HB2M-UNA: Wolfspeed Gate Driver Board](#)
- [CGD12HB00D: Differential Transceiver Daughter Board Companion Tool for Differential Gate Drivers](#)

### Application Notes

- [CPWR-AN41: Mounting Instructions and PCB Requirements](#)
- [CPWR-AN42: Thermal Interface Material Application Note](#)
- [CPWR-AN45: Dynamic Performance Application Note](#)



## Notes & Disclaimer

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