

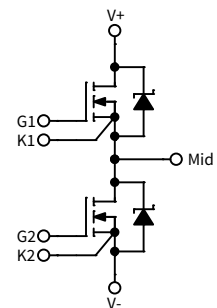
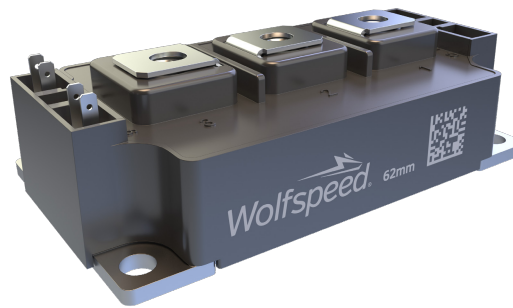
# HAS175M12BM3

1200 V, 175 A, Silicon Carbide, Half-Bridge Module

$V_{DS}$	1200 V
$I_{DS}$	175 A

## Technical Features

- Industry Standard 62 mm Footprint
- High Humidity Operation THB-80 (HV-H3TRB)
- Ultra Low Loss, High-Frequency Operation
- Zero Reverse Recovery from Diodes
- Zero Turn-off Tail Current from MOSFET
- Normally-off, Fail-safe Device Operation
- Copper Baseplate and Aluminum Nitride Insulator



## Applications

- Induction Heating
- Motor Drives
- Renewables
- Railway Auxiliary & Traction
- 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

## Key Parameters

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Note
Drain-Source Voltage	$V_{DS}$			1200	V	$T_C = 25^\circ\text{C}$	
Gate-Source Voltage, Maximum Value	$V_{GS(max)}$	-8		+19		Transient	Note 1
Gate-Source Voltage, Recommended	$V_{GS(op)}$		-4/+15			Static	Fig. 33
DC Continuous Drain Current	$I_D$		228		A	$V_{GS} = 15\text{ V}, T_C = 25^\circ\text{C}, T_{VJ} \leq 175^\circ\text{C}$	Notes 2, 3 Fig. 21
			175			$V_{GS} = 15\text{ V}, T_C = 90^\circ\text{C}, T_{VJ} \leq 175^\circ\text{C}$	
DC Source-Drain Current (Schottky Diode)	$I_{SD(SD)}$		236			$V_{GS} = -4\text{ V}, T_C = 25^\circ\text{C}, T_{VJ} \leq 175^\circ\text{C}$	
Pulsed Drain-Source Current	$I_{DM}$		350			$t_{pmax}$ limited by $T_{VJmax}$ $V_{GS} = 15\text{ V}, T_C = 25^\circ\text{C}$	
Power Dissipation	$P_D$		789		W	$T_C = 25^\circ\text{C}, T_{VJ} \leq 175^\circ\text{C}$	Note 4 Fig. 21
Virtual Junction Temperature	$T_{VJ(op)}$	-40		150	$^\circ\text{C}$	Operation	
				175		Intermittent with Reduced Life	

Note (1): Recommended turn-on gate voltage is 15 V with  $\pm 5\%$  regulation tolerance

Note (2): Current limit calculated by  $I_{D(max)} = \sqrt{(P_D/R_{DS(typ)})(T_{VJ(max)} - T_{D(max)})}$

Note (3): Verified by design

Note (4):  $P_D = (T_{VJ} - T_C)/R_{TH(JC,typ)}$

**MOSFET Characteristics (Per Position) ( $T_{VJ} = 25\text{ }^{\circ}\text{C}$  Unless Otherwise Specified)**

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Note
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	1200			V	$V_{GS} = 0\text{ V}$ , $T_{VJ} = -40\text{ }^{\circ}\text{C}$	
Gate Threshold Voltage	$V_{GS(th)}$	1.8	2.5	3.6		$V_{DS} = V_{GS}$ , $I_D = 43\text{ mA}$	
			2.0			$V_{DS} = V_{GS}$ , $I_D = 43\text{ mA}$ , $T_{VJ} = 175\text{ }^{\circ}\text{C}$	
Zero Gate Voltage Drain Current	$I_{DSS}$		4.1	564	$\mu\text{A}$	$V_{GS} = 0\text{ V}$ , $V_{DS} = 1200\text{ V}$	
Gate-Source Leakage Current	$I_{GSS}$		20	200	nA	$V_{GS} = 15\text{ V}$ , $V_{DS} = 0\text{ V}$	
Drain-Source On-State Resistance (Devices Only)	$R_{DS(on)}$		8.0	10.4	m $\Omega$	$V_{GS} = 15\text{ V}$ , $I_D = 175\text{ A}$	Fig. 2 Fig. 3
			12.9			$V_{GS} = 15\text{ V}$ , $I_D = 175\text{ A}$ , $T_{VJ} = 150\text{ }^{\circ}\text{C}$	
Transconductance	$g_{fs}$		156		S	$V_{DS} = 20\text{ V}$ , $I_D = 175\text{ A}$	Fig. 4
			146			$V_{DS} = 20\text{ V}$ , $I_D = 175\text{ A}$ , $T_{VJ} = 150\text{ }^{\circ}\text{C}$	
Turn-On Switching Energy, $T_{VJ} = 25\text{ }^{\circ}\text{C}$ $T_{VJ} = 125\text{ }^{\circ}\text{C}$ $T_{VJ} = 150\text{ }^{\circ}\text{C}$	$E_{ON}$		2.7 2.5 2.4		mJ	$V_{DD} = 600\text{ V}$ , $I_D = 175\text{ A}$ , $V_{GS} = -4\text{ V}/15\text{ V}$ , $R_{G(Off)} = 0.0\text{ }\Omega$ , $R_{G(On)} = 0.0\text{ }\Omega$ , $L = 42\text{ }\mu\text{H}$	Fig. 11 Fig. 13
Turn-Off Switching Energy, $T_{VJ} = 25\text{ }^{\circ}\text{C}$ $T_{VJ} = 125\text{ }^{\circ}\text{C}$ $T_{VJ} = 150\text{ }^{\circ}\text{C}$	$E_{OFF}$		1.9 2.0 2.0				
Internal Gate Resistance	$R_{G(int)}$		5.05		$\Omega$	$f = 100\text{ kHz}$ , $V_{AC} = 25\text{ mV}$	
Input Capacitance	$C_{iss}$		12.9		nF	$V_{GS} = 0\text{ V}$ , $V_{DS} = 800\text{ V}$ , $V_{AC} = 25\text{ mV}$ , $f = 100\text{ kHz}$	Fig. 9
Output Capacitance	$C_{oss}$		942		pF		
Reverse Transfer Capacitance	$C_{rss}$		26.4				
Gate to Source Charge	$Q_{GS}$		134		nC	$V_{DS} = 800\text{ V}$ , $V_{GS} = -4\text{ V}/15\text{ V}$ , $I_D = 175\text{ A}$ , Per IEC60747-8-4 pg 21	
Gate to Drain Charge	$Q_{GD}$		122				
Total Gate Charge	$Q_G$		422				
FET Thermal Resistance, Junction to Case	$R_{th\text{ JC}}$		0.190		$^{\circ}\text{C}/\text{W}$		Fig. 17

**Diode Characteristics (Per Position) ( $T_{VJ} = 25\text{ }^{\circ}\text{C}$  Unless Otherwise Specified)**

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Note
Diode Forward Voltage	$V_F$		1.8		V	$V_{GS} = -4\text{ V}$ , $I_F = 175\text{ A}$ , $T_{VJ} = 25\text{ }^{\circ}\text{C}$	Fig. 7
			2.3			$V_{GS} = -4\text{ V}$ , $I_F = 175\text{ A}$ , $T_{VJ} = 150\text{ }^{\circ}\text{C}$	
Reverse Recovery Time	$t_{rr}$		20.8		ns	$V_{GS} = -4\text{ V}$ , $I_{SD} = 175\text{ A}$ , $V_R = 800\text{ V}$ $di/dt = 6.9\text{ A/ns}$ , $T_{VJ} = 150\text{ }^{\circ}\text{C}$	Fig. 32
Reverse Recovery Charge	$Q_{rr}$		1.8		$\mu\text{C}$		
Peak Reverse Recovery Current	$I_{rrm}$		143		A		
Reverse Recovery Energy, $T_{VJ} = 25\text{ }^{\circ}\text{C}$ $T_{VJ} = 125\text{ }^{\circ}\text{C}$ $T_{VJ} = 150\text{ }^{\circ}\text{C}$	$E_{rr}$		0.5 0.6 0.6		mJ	$V_{DS} = 600\text{ V}$ , $I_D = 175\text{ A}$ , $V_{GS} = -4\text{ V}/15\text{ V}$ , $R_{G(ext)} = 0.0\text{ }\Omega$ , $L = 42\text{ }\mu\text{H}$	Fig. 14 Note 5
Diode Thermal Resistance, JCT. to Case	$R_{th\text{ JC}}$		0.216		$^{\circ}\text{C}/\text{W}$		Fig. 18

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

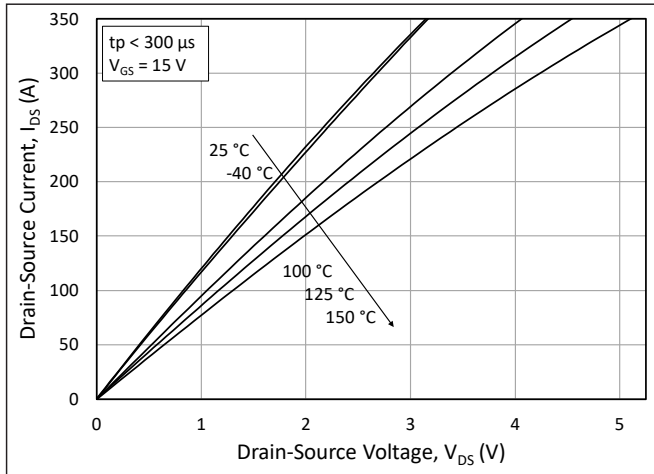


Module Physical Characteristics

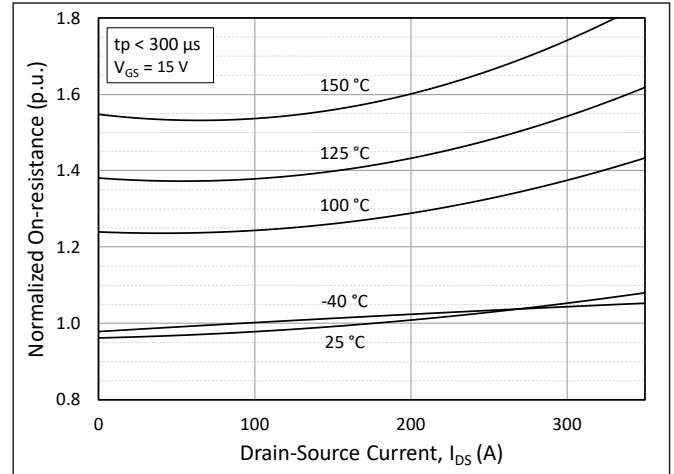
Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Package Resistance, M1 (High-Side)	R <sub>3-1</sub>		2.30		mΩ	T <sub>C</sub> = 25 °C, I <sub>SD</sub> = 175 A, Note 6
			3.22			T <sub>C</sub> = 125 °C, I <sub>SD</sub> = 175 A, Note 6
Package Resistance, M2 (Low-Side)	R <sub>1-2</sub>		2.12			T <sub>C</sub> = 25 °C, I <sub>SD</sub> = 175 A, Note 6
			2.97			T <sub>C</sub> = 125 °C, I <sub>SD</sub> = 175 A, Note 6
Stray Inductance	L <sub>Stray</sub>		11.1		nH	Between DC- and DC+, f = 10 MHz
Case Temperature	T <sub>C</sub>	-40		125	°C	
Mounting Torque	M <sub>S</sub>	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 <sub>isol</sub>	5			kV	AC, 50 Hz, 1 Minute
Comparative Tracking Index	CTI	600				Note 4
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<sub>DS(on)</sub> + Switch Position Package Resistance

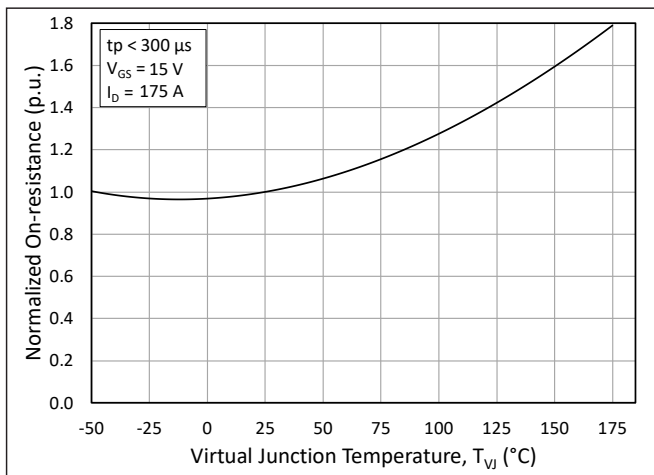
## Typical Performance



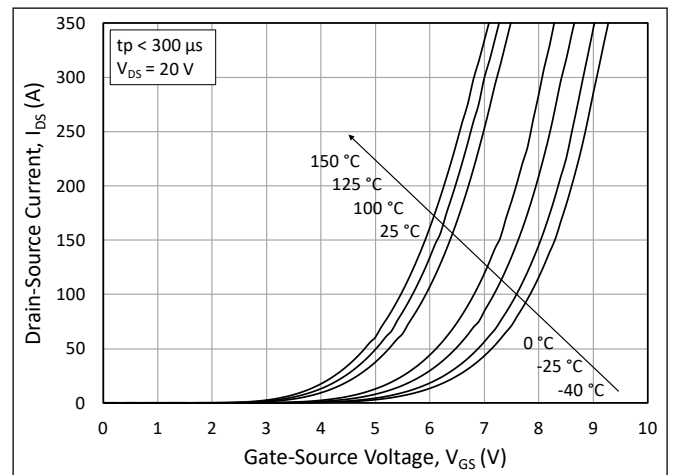
**Figure 1.** Output Characteristics for Various Junction Temperatures



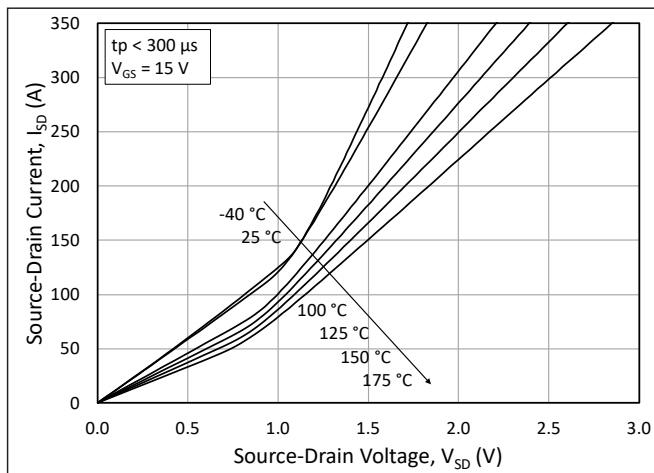
**Figure 2.** Normalized On-State Resistance vs. Drain Current for Various Junction Temperatures



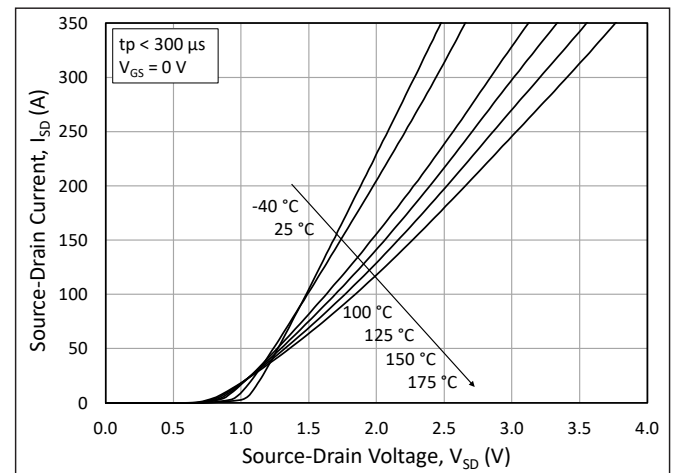
**Figure 3.** Normalized On-State Resistance vs. Junction Temperature



**Figure 4.** Transfer Characteristic for Various Junction Temperatures

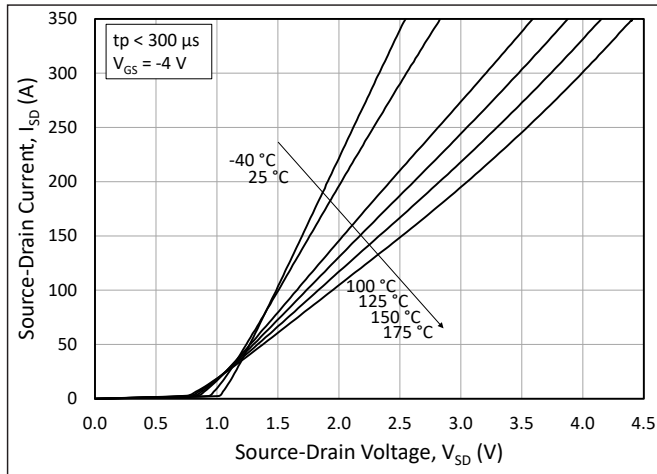


**Figure 5.** 3<sup>rd</sup> Quadrant Characteristic vs. Junction Temperatures at  $V_{GS} = 15$  V

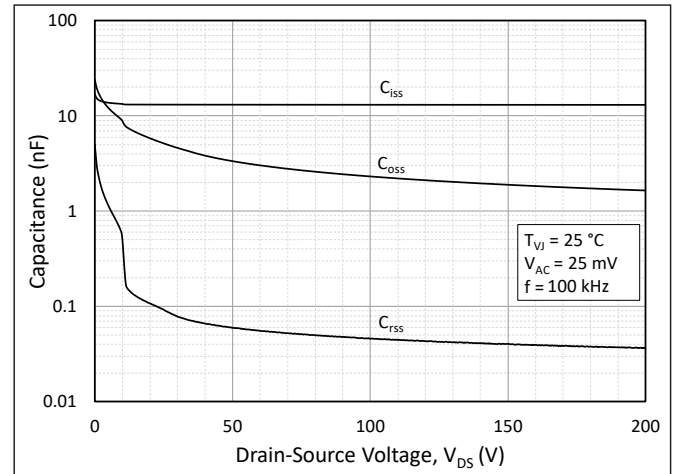


**Figure 6.** 3<sup>rd</sup> Quadrant Characteristic vs. Junction Temperatures at  $V_{GS} = 0$  V (Diode)

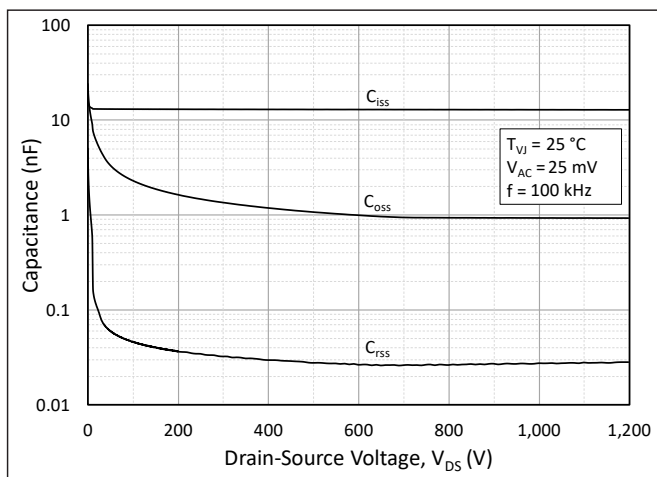
## Typical Performance



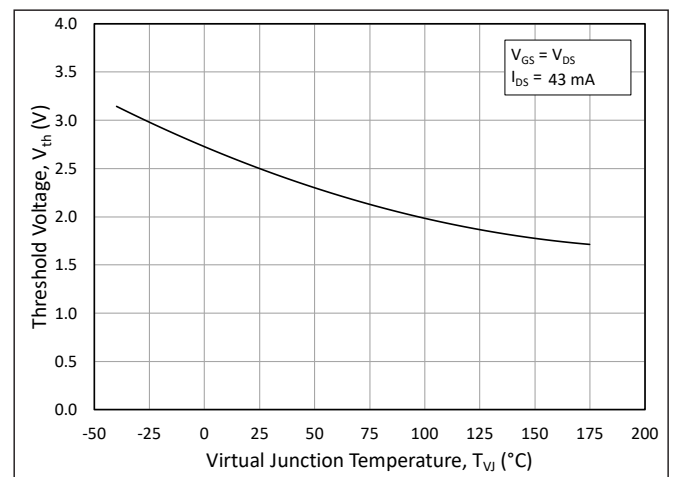
**Figure 7.** 3<sup>rd</sup> Quadrant Characteristic vs. Junction Temperatures at  $V_{GS} = -4$  V (Diode)



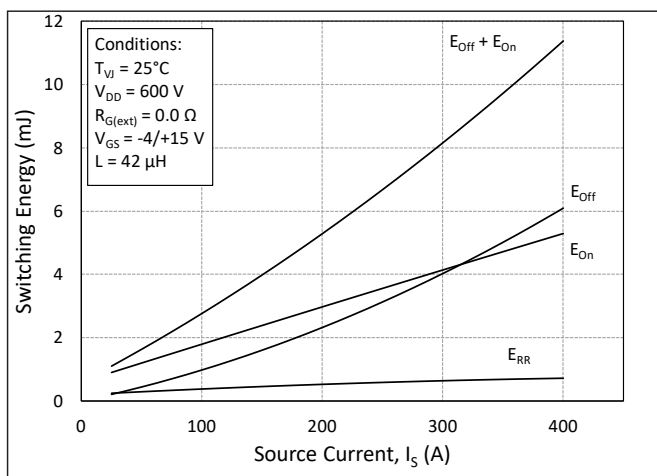
**Figure 8.** Typical Capacitances vs. Drain to Source Voltage (0 - 200 V)



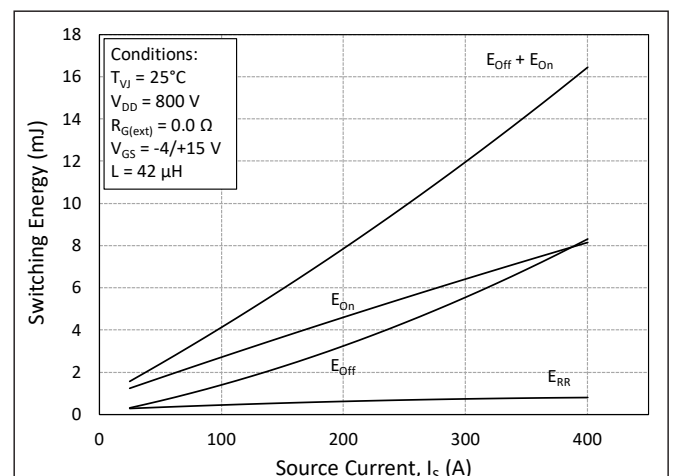
**Figure 9.** Typical Capacitances vs. Drain to Source Voltage (0 - 1200 V)



**Figure 10.** Threshold Voltage vs. Junction Temperature

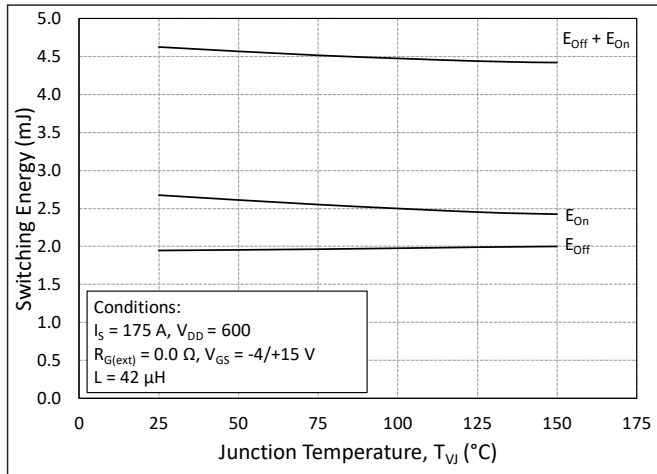


**Figure 11.** Switching Energy vs. Drain Current ( $V_{DS} = 600$  V)

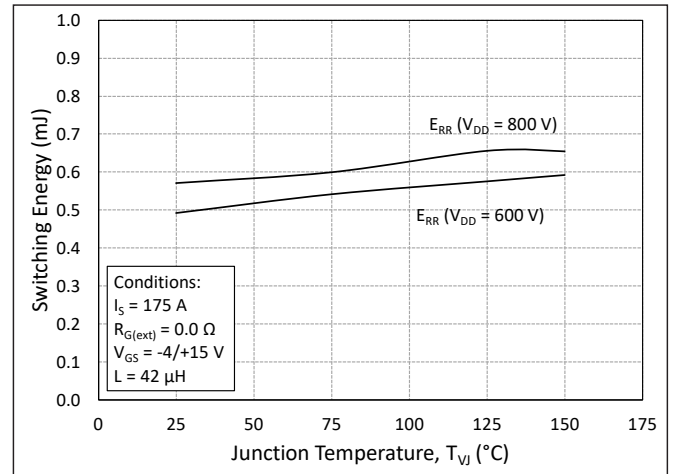


**Figure 12.** Switching Energy vs. Drain Current ( $V_{DS} = 800$  V)

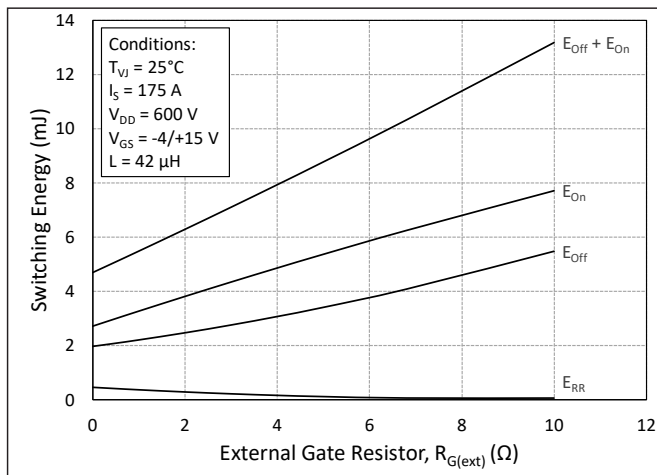
## Typical Performance



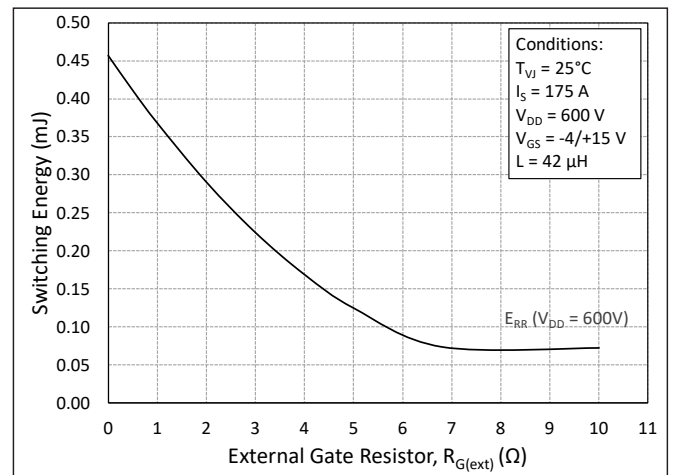
**Figure 13.** MOSFET Switching Energy vs. Junction Temperature



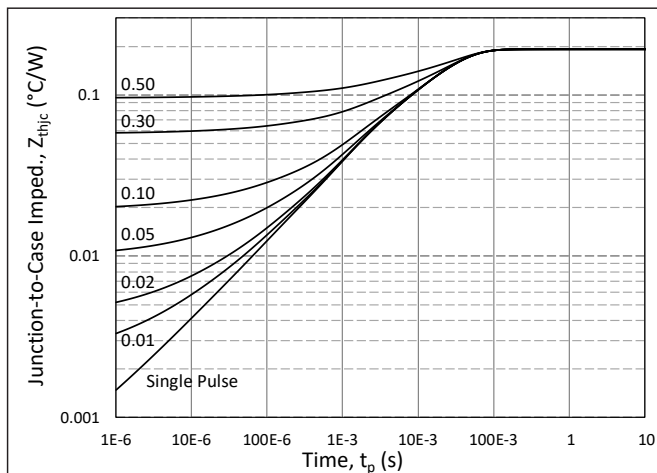
**Figure 14.** Reverse Recovery Energy vs. Junction Temperature



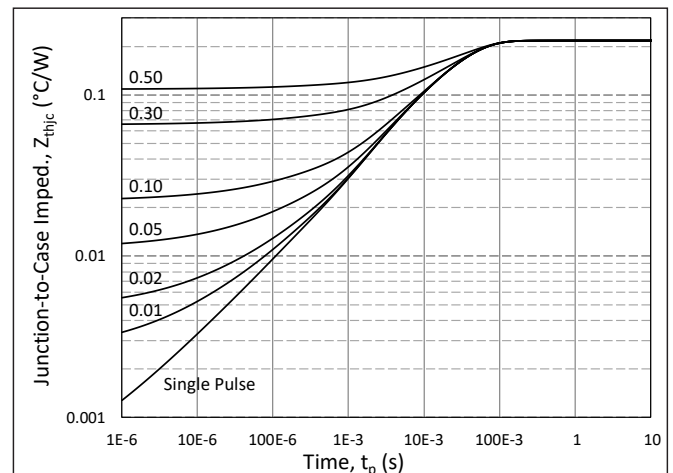
**Figure 15.** MOSFET Switching Energy vs. External Gate Resistance



**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

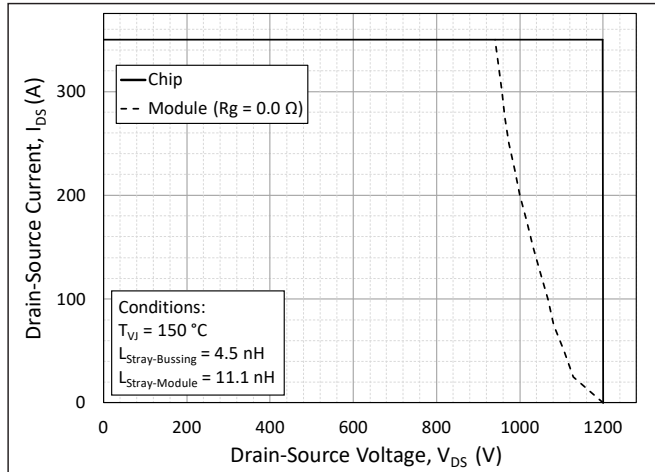


Figure 19. Switching Safe Operating Area

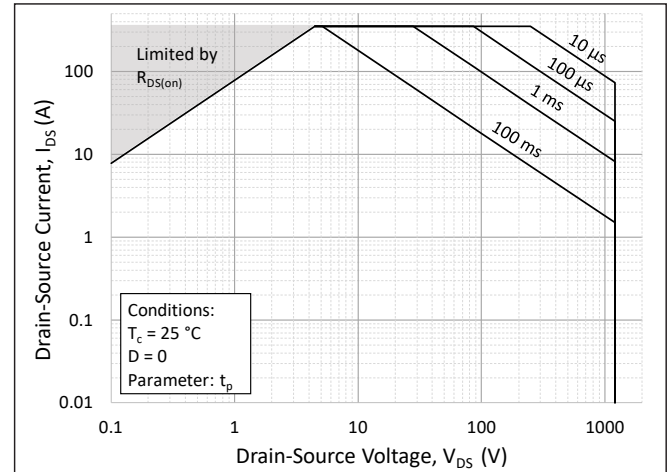


Figure 20. Forward Bias Safe Operating Area (FBSOA)

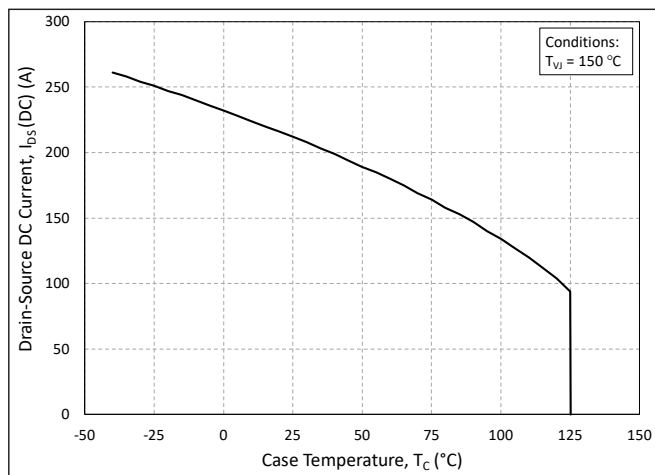


Figure 21. Continuous Drain Current Derating vs. Case Temperature

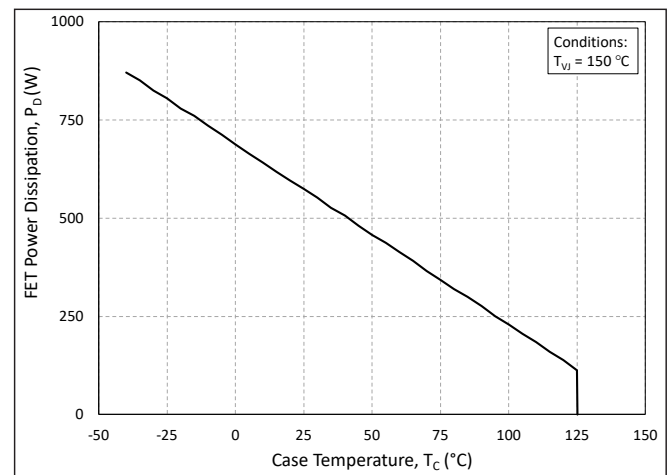


Figure 22. Maximum Power Dissipation Derating vs. Case Temperature

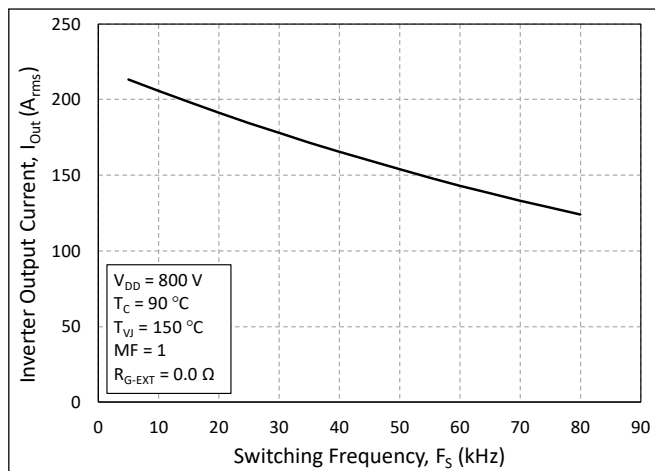
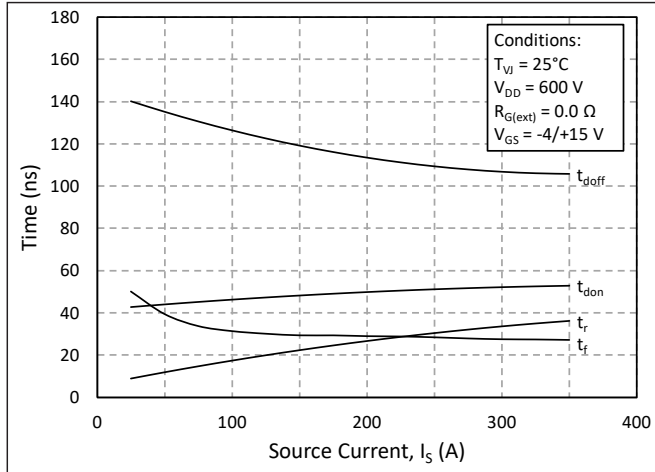
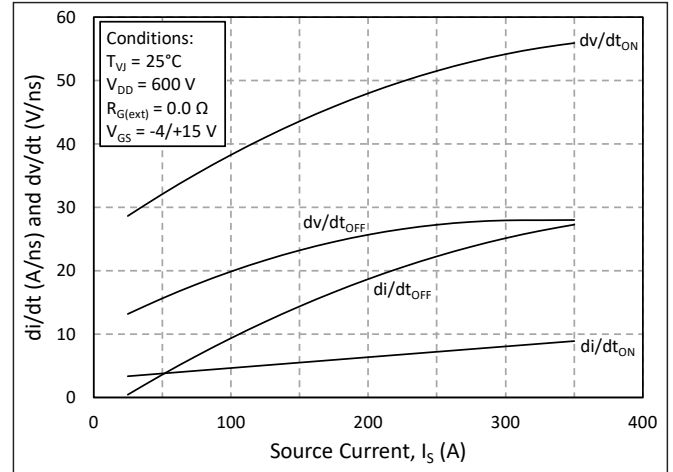


Figure 23. Typical Output Current Capability vs. Switching Frequency (Inverter Application)

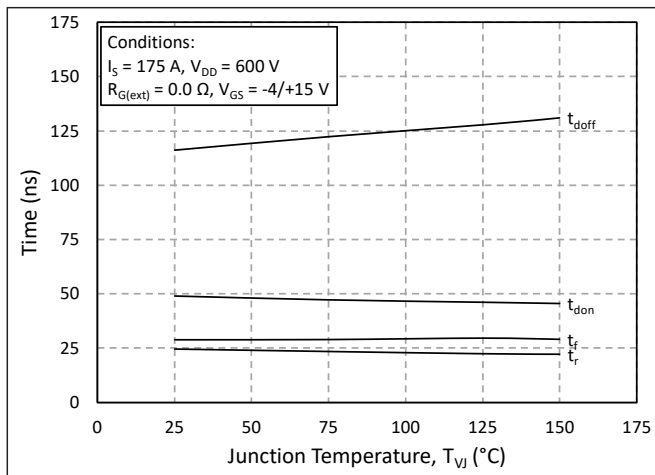
## Timing Characteristics



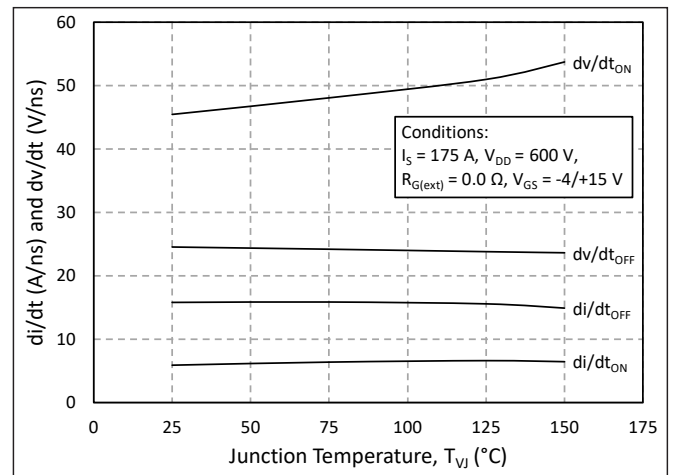
**Figure 24.** Timing vs. Source Current



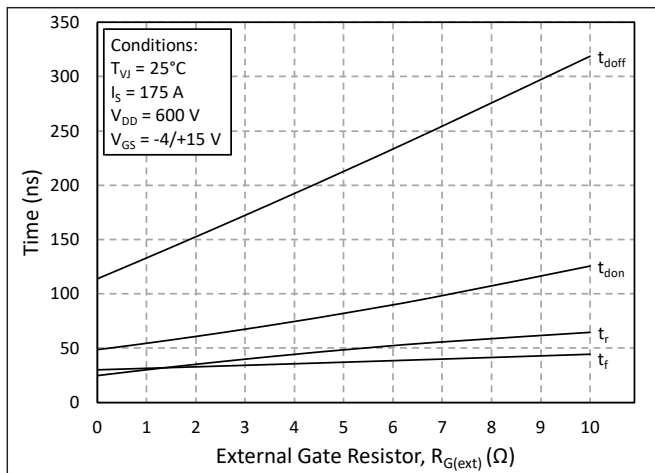
**Figure 25.** dv/dt and di/dt vs. Source Current



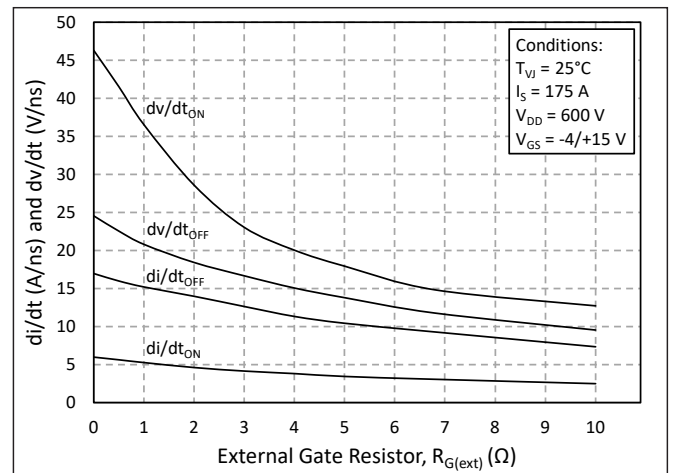
**Figure 26.** Timing vs. Junction Temperature



**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

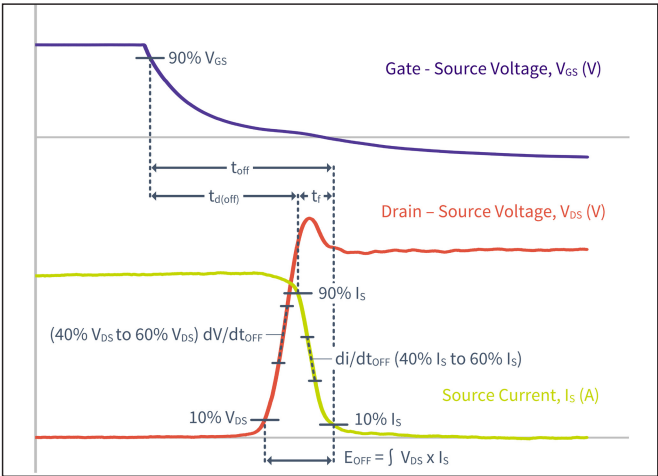


Figure 30. Turn-Off Transient Definitions

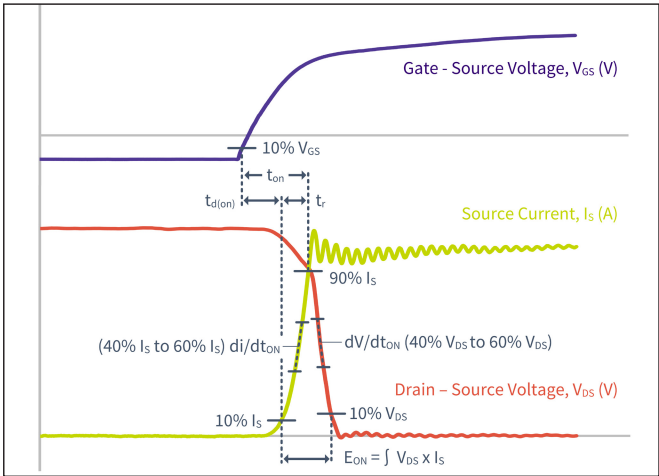


Figure 31. Turn-On Transient Definitions

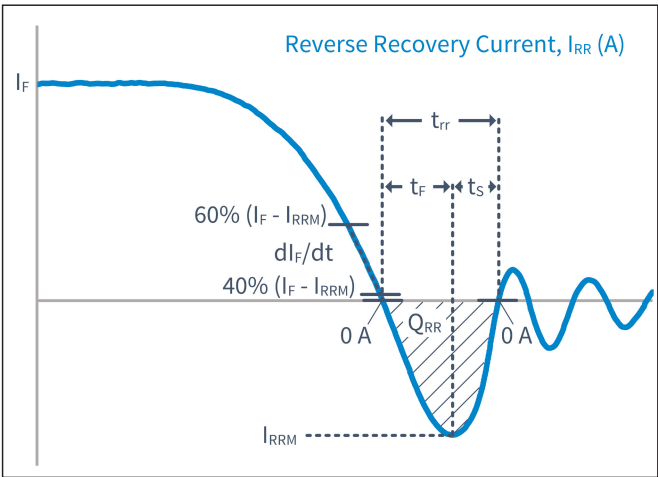


Figure 32. Reverse Recovery Definitions

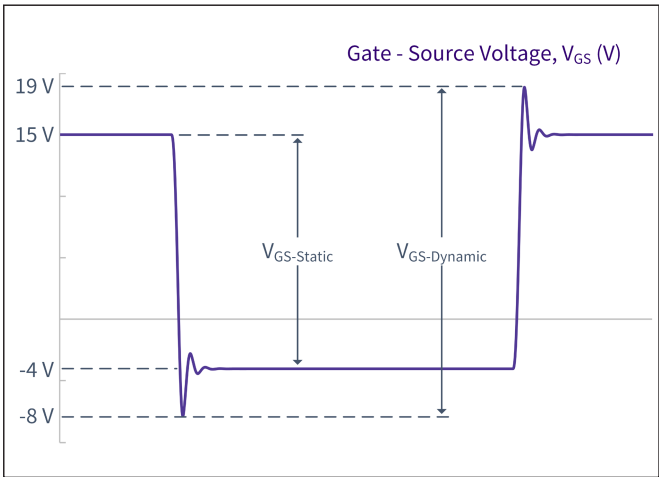
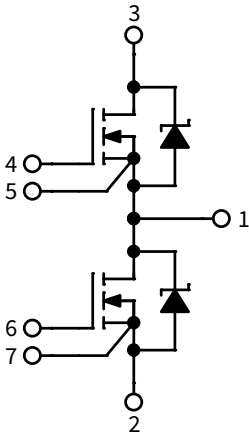
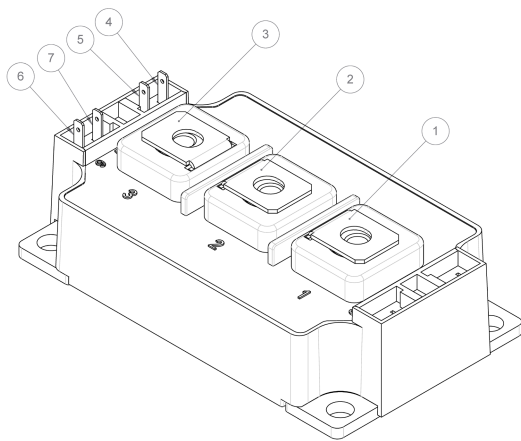


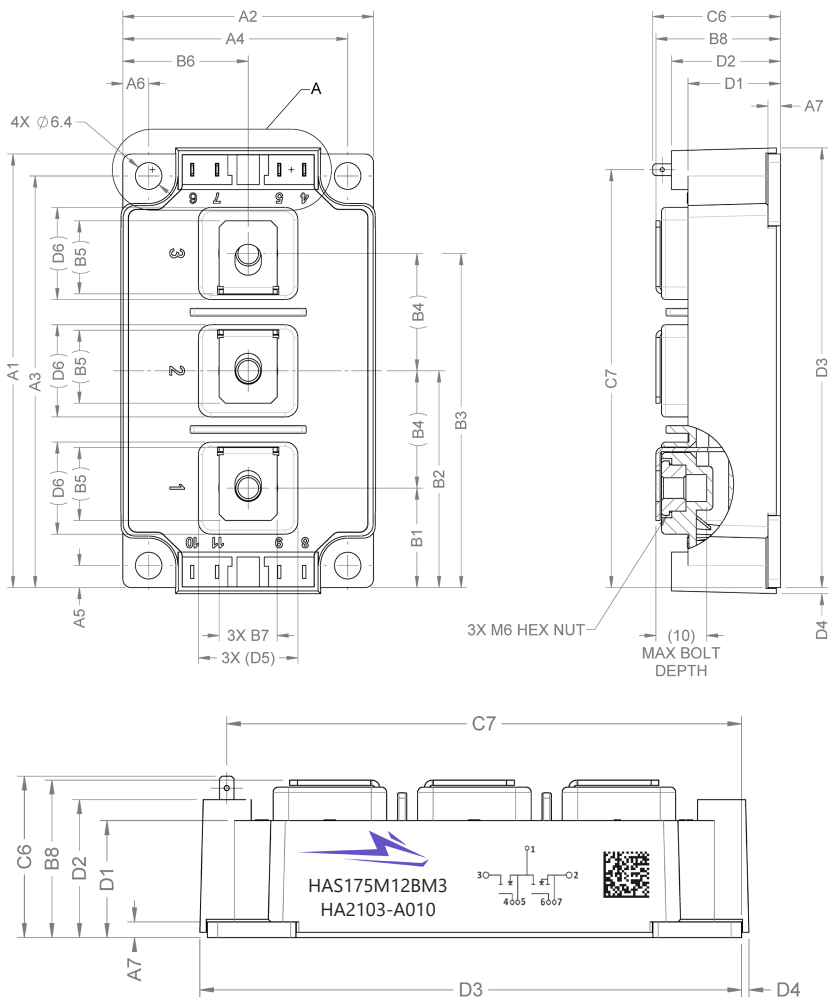
Figure 33. VGS Transient Definitions



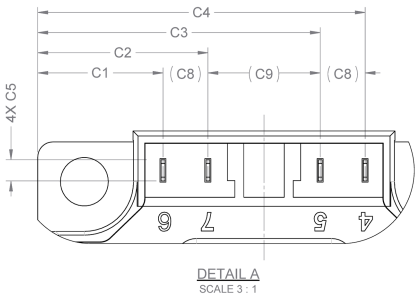
Schematic and Pin Out



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.





## Supporting Links & Tools

### Evaluation Tools & Support

- [PLECS Models](#)
- [LTSpice Models](#)
- [KIT-CRD-CIL12N-BM: Dynamic Performance Evaluation Board for the BM2 and BM3 Module](#)
- [SpeedFit 2.0 Design Simulator™](#)
- [Technical Support Forum](#)

### Dual-Channel Gate Driver Board

- [CGD1200HB2P-BM3: Dual Channel Differential Isolated Half Bridge Gate Driver Board](#)
- [CGD12HB00D: Differential Transceiver Daughter Board Companion Tool for Differential Gate Drivers](#)

### Application Notes

- [CPWR-AN35: 62mm Module Thermal Interface Material Application Note](#)



## Notes & Disclaimer

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