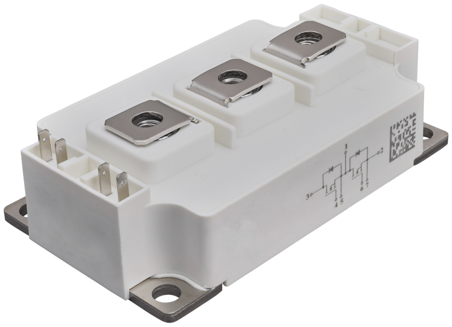
# CAS120M12BM2

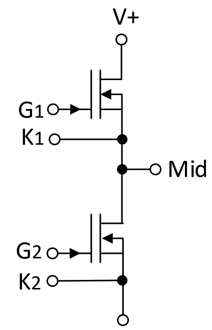
| | |
|---|---|
| **$V_{DS}$** | **1200 V** |
| **$I_{DS}$** | **120 A** |

## 1200 V, 120 A All-Silicon Carbide High Performance, Switching Optimized, Half-Bridge Module

### Technical Features

- Industry Standard 62 mm Footprint
- 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

- Railway & Traction
- Solar & Renewable Energy
- EV Charging
- Industrial Automation & Testing

### System Benefits

- Fast Time-to-Market with Minimal Development Required for Transition from 62 mm IGBT Packages
- 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 | | $T_C$ = 25 °C | |
| Gate-Source Voltage, Maximum Value | $V_{GS(max)}$ | -10 | | +25 | V | Transient | Note 1<br>Fig. 33 |
| Gate-Source Voltage, Recommended | $V_{GS(op)}$ | | -5/+20 | | | Static | |
| DC Continuous Drain Current | $I_D$ | | 200 | | | $V_{GS}$ = 20 V, $T_C$ = 25 °C, $T_{VJ}$ ≤ 150 °C | |
| | | | 144 | | | $V_{GS}$ = 20 V, $T_C$ = 90 °C, $T_{VJ}$ ≤ 150 °C | |
| DC Source-Drain Current (Schottky Diode) | $I_{SD(SD)}$ | | 460 | | A | $V_{GS}$ = -5 V, $T_C$ = 25 °C, $T_{VJ}$ ≤ 150 °C | Notes 2, 3<br>Fig. 21 |
| Pulsed Drain-Source Current | $I_{DM}$ | | 480 | | | $t_{Pmax}$ limited by $T_{VJmax}$<br>$V_{GS}$ = 20 V, $T_C$ = 25 °C | |
| Power Dissipation | $P_D$ | | 1000 | | W | $T_C$ = 25 °C, $T_{VJ}$ ≤ 150 °C | Note 4<br>Fig. 21 |
| Virtual Junction Temperature | $T_{VJ(op)}$ | -40 | | 150 | °C | Operation | |

Note (1): Recommended turn-on gate voltage is 20 V with ±5 % regulation tolerance
Note (2): Current limit at $T_C$ = 90 °C 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 | 2.6 | | | $V_{DS}$ = $V_{GS}$, $I_D$ = 6 mA | |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | | 450 | 3000 | µA | $V_{GS}$ = 0 V, $V_{DS}$ = 1200 V | |
| Gate-Source Leakage Current | $I_{GSS}$ | | | 1.5 | | $V_{GS}$ = 20 V, $V_{DS}$ = 0 V | |
| Drain-Source On-State Resistance (Devices Only) | $R_{DS(on)}$ | | 13.0 | 16.0 | mΩ | $V_{GS}$ = 20 V, $I_D$ = 120 A | Fig. 2<br>Fig. 3 |
| | | | 23.0 | | | $V_{GS}$ = 20 V, $I_D$ = 120 A, $T_{VJ}$ = 150 °C | |
| Transconductance | $g_{fs}$ | | 57.4 | | S | $V_{DS}$ = 20 V, $I_{DS}$ = 120 A | Fig. 4 |
| | | | 54.4 | | | $V_{DS}$ = 20 V, $I_{DS}$ = 120 A, $T_{VJ}$ = 150 °C | |
| Turn-On Switching Energy, $T_{VJ}$ = 25 °C<br>$T_{VJ}$ = 125 °C<br>$T_{VJ}$ = 150 °C | $E_{ON}$ | | 1.39<br>1.24<br>1.19 | | mJ | $V_{DS}$ = 600 V,<br>$I_D$ = 120 A,<br>$V_{GS}$ = -5 V/+20 V,<br>$R_{G(ext)}$ = 2.5 Ω,<br>L = 22.5 µH | Fig. 11<br>Fig. 13 |
| Turn-Off Switching Energy, $T_{VJ}$ = 25 °C<br>$T_{VJ}$ = 125 °C<br>$T_{VJ}$ = 150 °C | $E_{OFF}$ | | 0.86<br>0.84<br>0.85 | | | | |
| Internal Gate Resistance | $R_{G(int)}$ | | 1.8 | | Ω | $V_{AC}$ = 25 mV, f = 100 kHz | |
| Input Capacitance | $C_{iss}$ | | 6.47 | | nF | $V_{GS}$ = 0 V, $V_{DS}$ = 800 V,<br>$V_{AC}$ = 25 mV, f = 200 kHz | Fig. 9 |
| Output Capacitance | $C_{oss}$ | | 0.98 | | | | |
| Reverse Transfer Capacitance | $C_{rss}$ | | 43.8 | | pF | | |
| Gate to Source Charge | $Q_{GS}$ | | 97 | | nC | $V_{DS}$ = 800 V, $V_{GS}$ = -5 V/+20 V<br>$I_D$ = 120 A<br>Per IEC60747-8-4 pg 21 | |
| Gate to Drain Charge | $Q_{GD}$ | | 118 | | | | |
| Total Gate Charge | $Q_G$ | | 378 | | | | |
| FET Thermal Resistance, Junction to Case | $R_{th\ JC}$ | | 0.125 | 0.135 | °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 | $V_F$ | | 1.53 | | V | $V_{GS}$ = -5 V, $I_F$ = 120 A, $T_{VJ}$ = 25 °C | Fig. 7 |
| | | | 1.92 | | | $V_{GS}$ = -5 V, $I_F$ = 120 A, $T_{VJ}$ = 150 °C | |
| Reverse Recovery Time | $t_{RR}$ | | 21 | | ns | $V_{GS}$ = -5 V, $I_{SD}$ = 120 A, $V_R$ = 600 V<br>$di_F/dt$ = 12.5 A/ns, $T_J$ = 150 °C | Fig. 32 |
| Reverse Recovery Charge | $Q_{RR}$ | | 2.2 | | µC | | |
| Peak Reverse Recovery Current | $I_{RRM}$ | | 173 | | A | | |
| Diode Energy $T_{VJ}$ = 25 °C<br>$T_{VJ}$ = 125 °C<br>$T_{VJ}$ = 150 °C | $E_{rr}$ | | 0.75<br>0.86<br>0.89 | | mJ | $V_{DS}$ = 600 V, $I_D$ = 120 A,<br>$V_{GS}$ = -5 V/+20 V, $R_{G(ext)}$ = 2.5 Ω,<br>L = 22.5 µH | Fig. 14<br>Note 5 |
| Diode Thermal Resistance, Junction to Case | $R_{th\ JC}$ | | 0.108 | 0.115 | °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 | $R_{1-2}$ | | 0.60 | | μΩ | $T_C$ = 125 °C, Note: 6 |
| Package Resistance, M2 | $R_{2-3}$ | | 0.51 | | μΩ | $T_C$ = 125 °C, Note: 6 |
| Stray Inductance | $L_{Stray}$ | | 12.9 | | nH | Between Terminals 1 and 3 |
| Case Temperature | $T_C$ | -40 | | 125 | °C | |
| Weight | W | | 290 | | g | |
| 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 |
| Case Isolation Voltage | $V_{isol}$ | 5 | | | kV | AC, 50 Hz, 1 min |
| 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

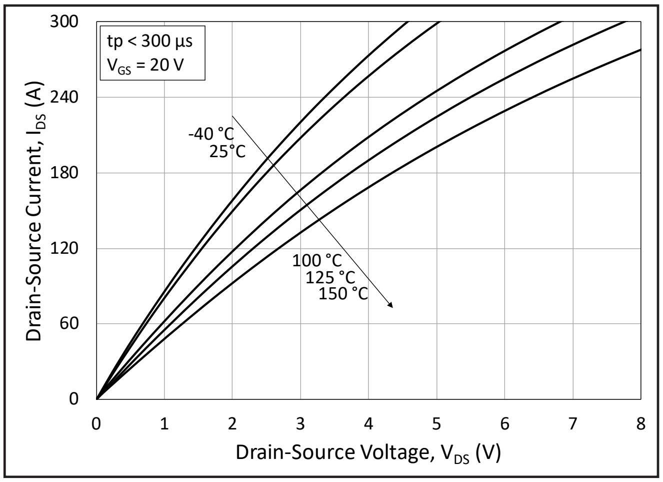



**Figure 1.** Output Characteristics for Various Junction Temperatures

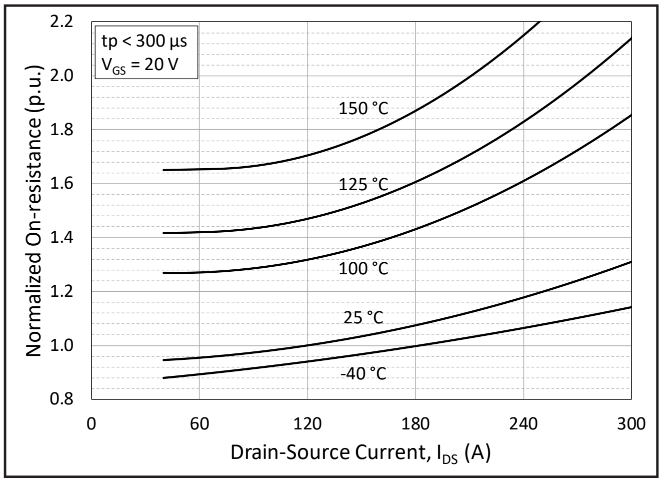



**Figure 2.** Normalized On-State Resistance vs. Drain Current for Various Junction Temperatures

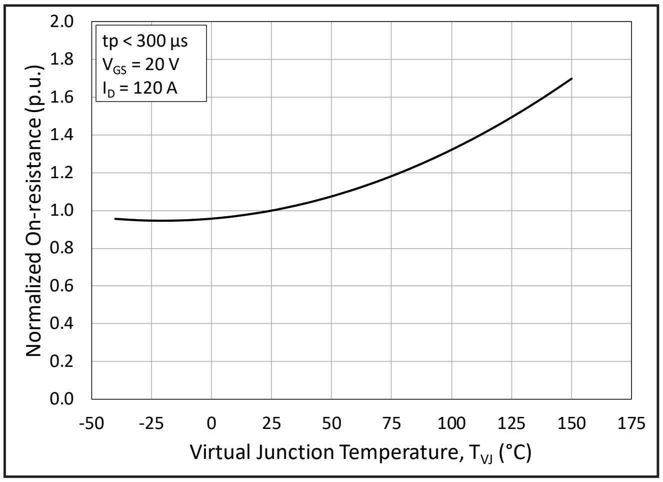



**Figure 3.** Normalized On-State Resistance vs. Junction Temperature

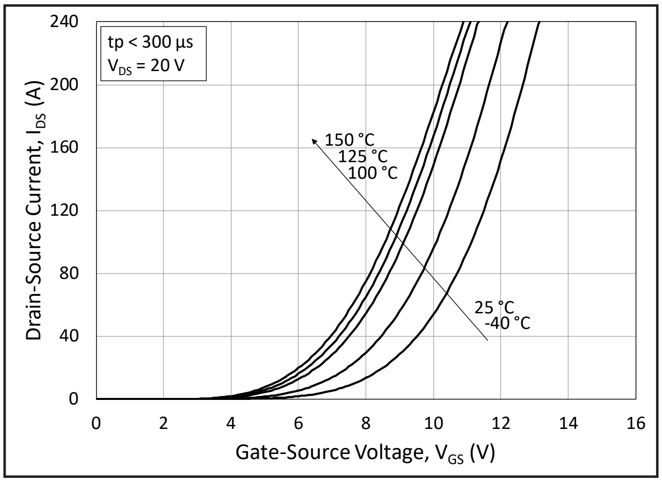



**Figure 4.** Transfer Characteristic for Various Junction Temperatures

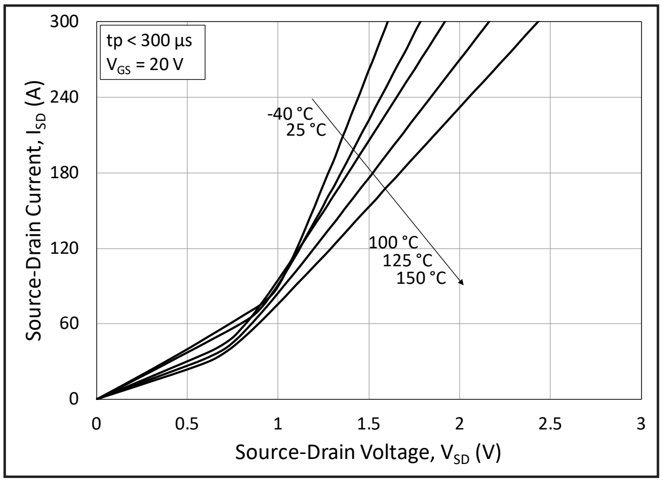



**Figure 5.** 3rd Quadrant Characteristic vs. Junction Temperatures at $V_{GS}$ = 20 V (Note: 2)

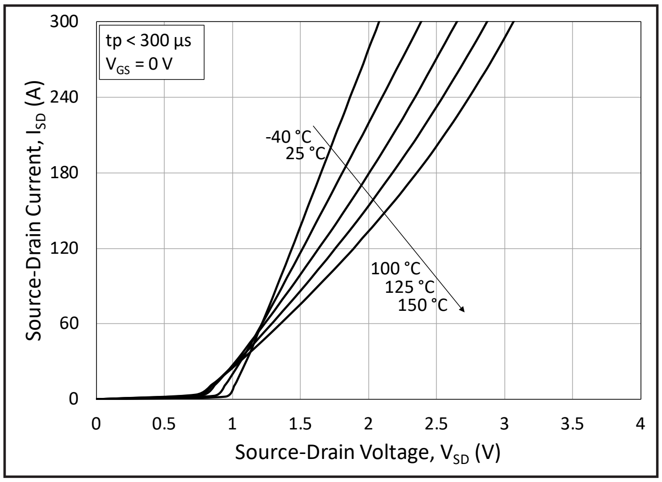



**Figure 6.** 3rd Quadrant Characteristic vs. Junction Temperatures at $V_{GS}$ = 0 V (Diode) (Note: 2)

## Typical Performance

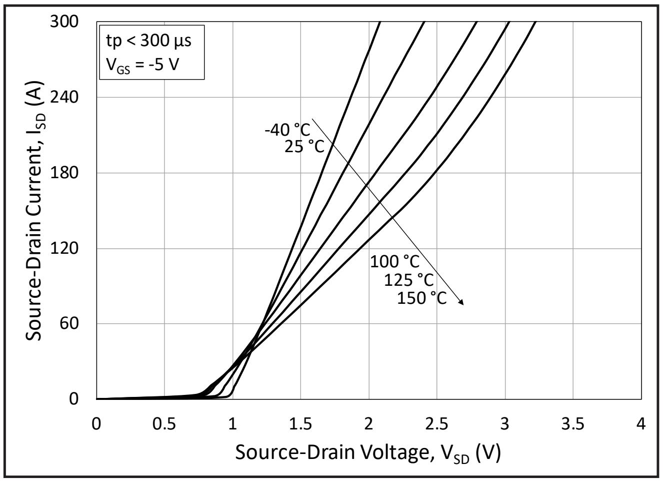



**Figure 7.** 3rd Quadrant Characteristic vs. Junction Temperatures at $V_{GS}$ = -5 V (Diode) (Note: 2)

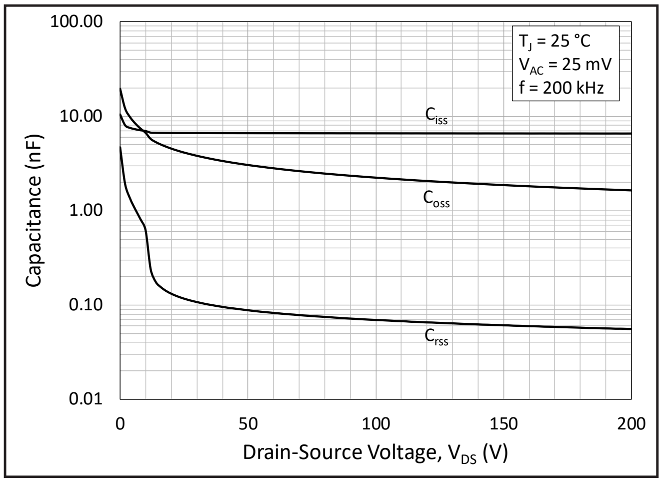



**Figure 8.** Typical Capacitances vs. Drain to Source Voltage (0 - 200 V)

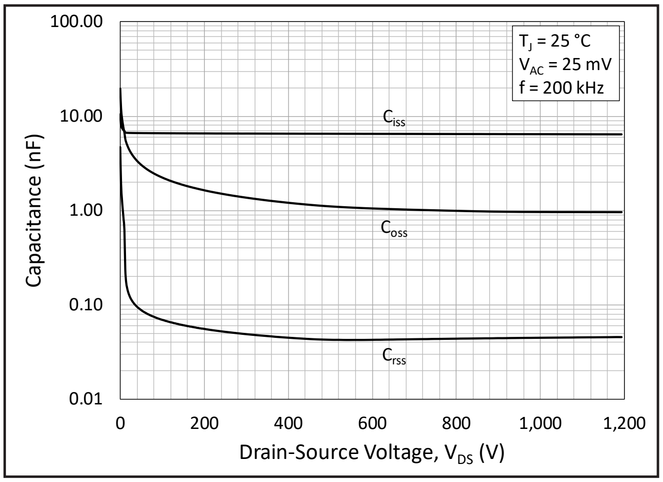



**Figure 9.** Typical Capacitances vs. Drain to Source Voltage (0 - 1200 V)

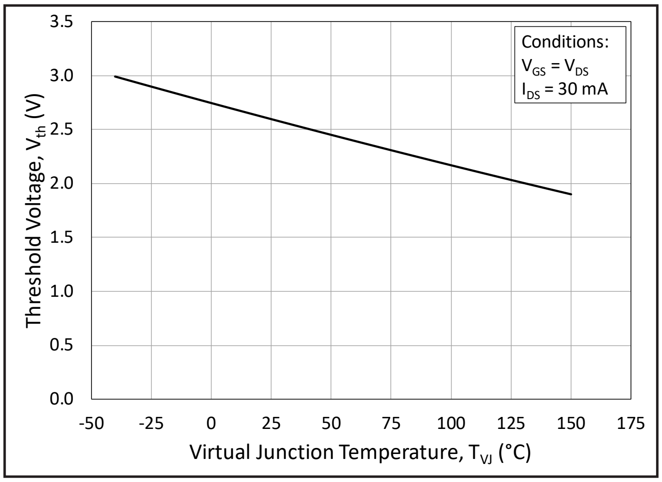



**Figure 10.** Threshold Voltage vs. Junction Temperature

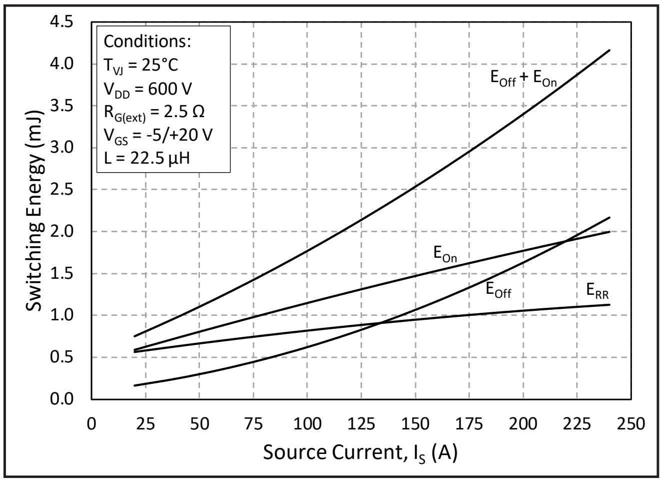



**Figure 11.** Switching Energy vs. Drain Current ($V_{DS}$ = 600 V)

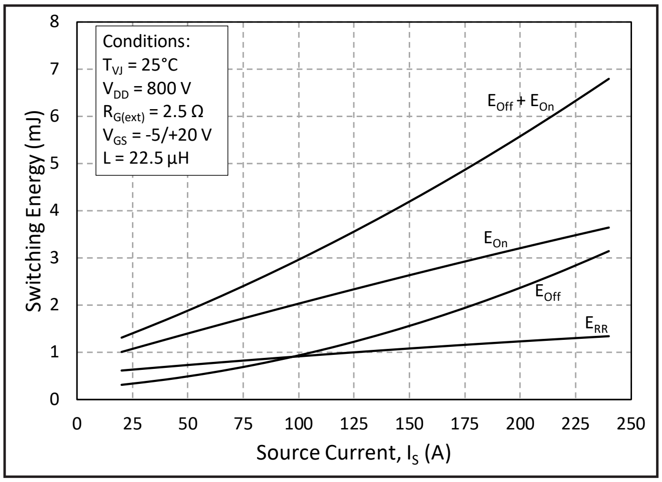



**Figure 12.** Switching Energy vs. Drain Current ($V_{DS}$ = 800 V)

## Typical Performance

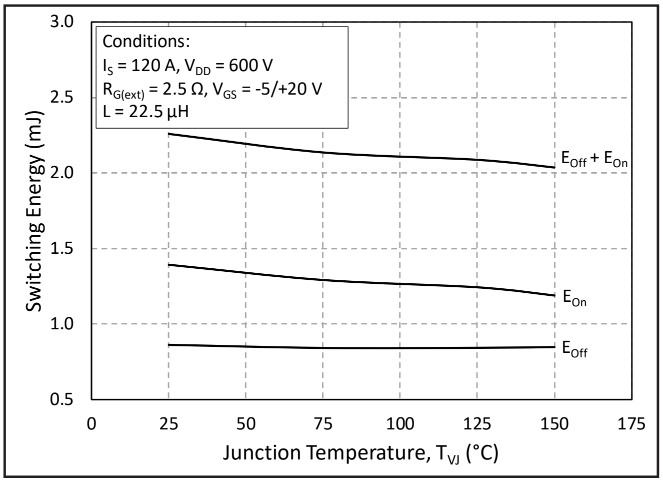



**Figure 13.** MOSFET Switching Energy vs. Junction Temperature

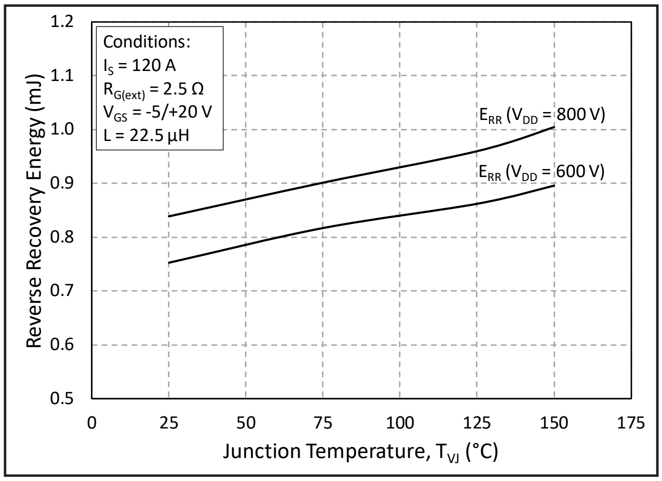



**Figure 14.** Reverse Recovery Energy vs. Junction Temperature (Note: 2)

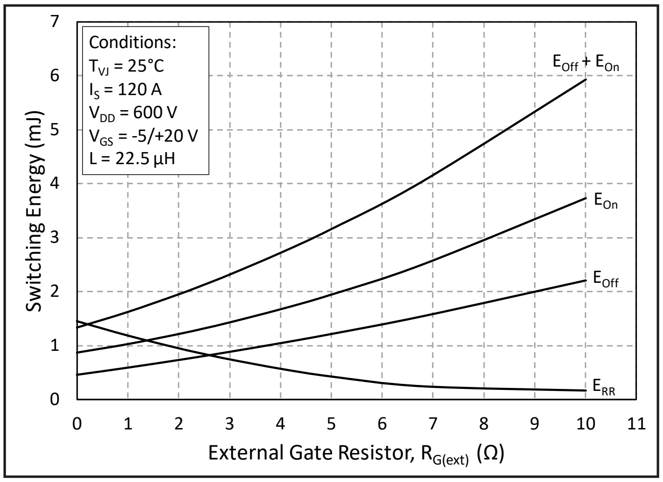



**Figure 15.** MOSFET Switching Energy vs. External Gate Resistance

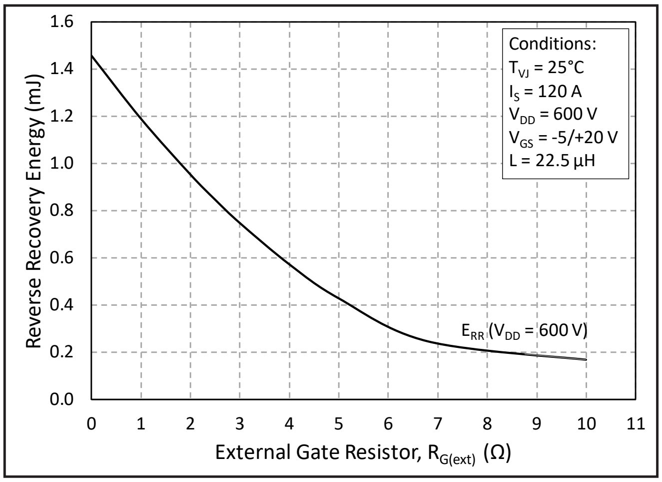



**Figure 16.** Reserve Recovery Energy vs. External Gate Resistance (Note: 2)

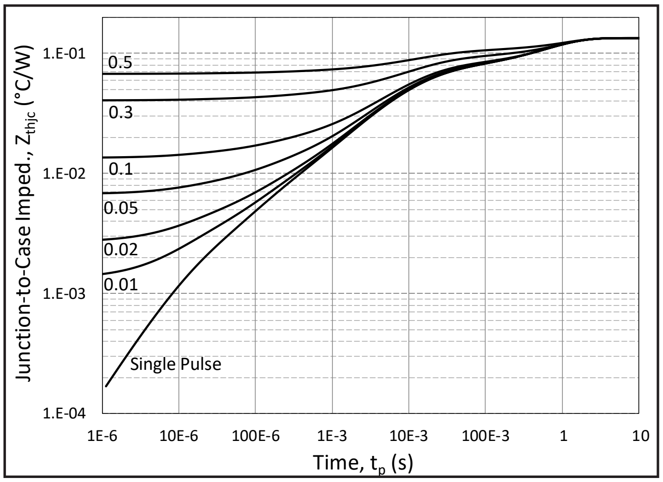



**Figure 17.** MOSFET Junction to Case Transient Thermal Impedance, $Z_{th\ JC}$ (°C/W)

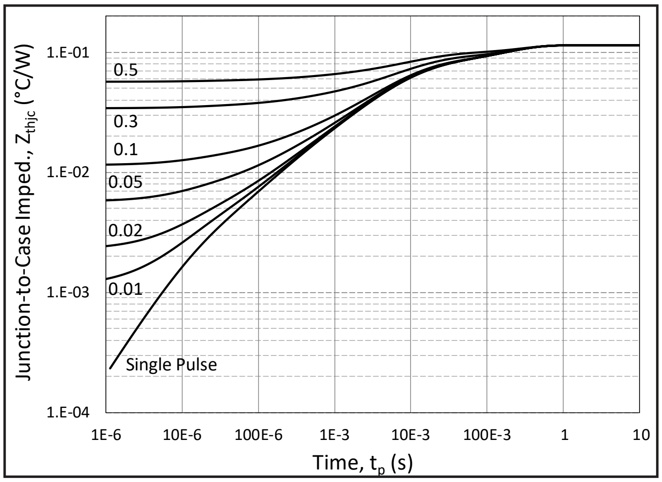



**Figure 18.** Diode Junction to Case Transient Thermal Impedance, $Z_{th\ JC}$ (°C/W)

## Typical Performance

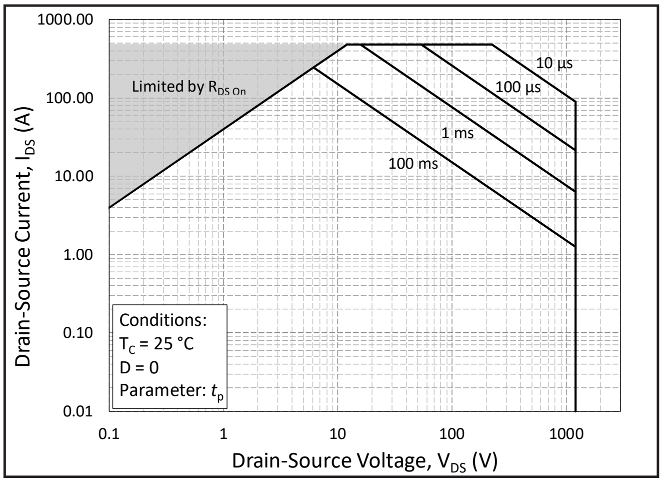



**Figure 19.** Forward Bias Safe Operating Area (FBSOA)

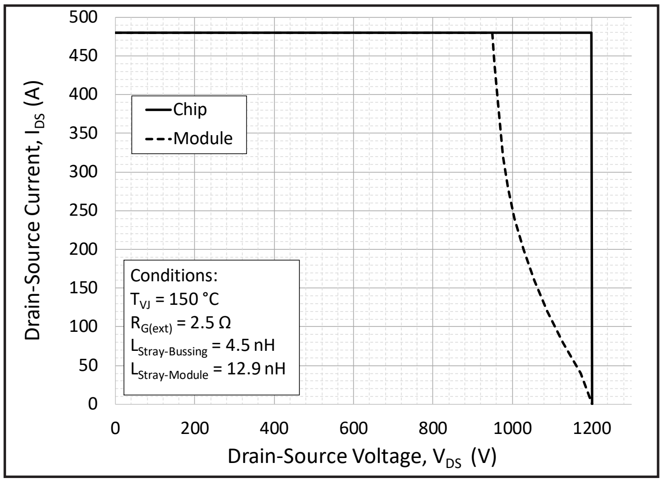



**Figure 20.** Reverse Bias Safe Operating Area (RBSOA)

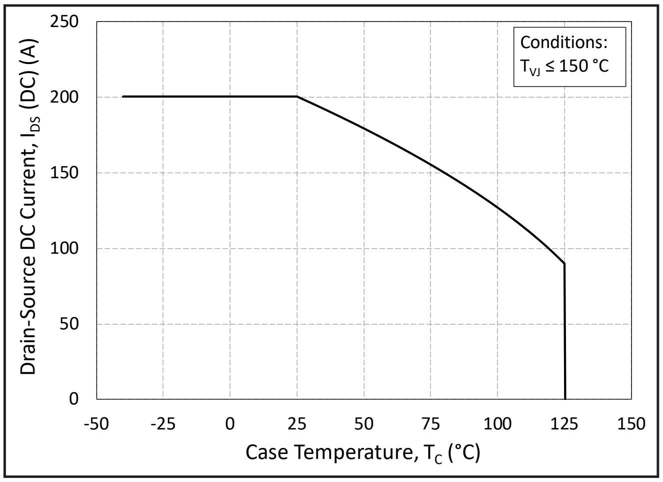



**Figure 21.** Continuous Drain Current Derating vs. Case Temperature

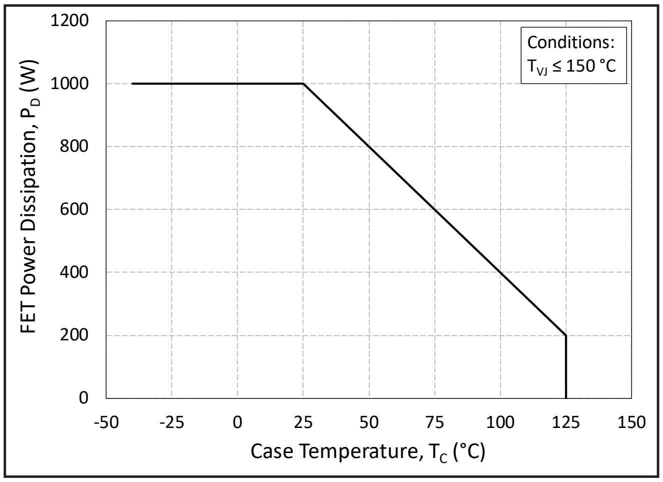



**Figure 22.** Maximum Power Dissipation Derating vs. Case Temperature

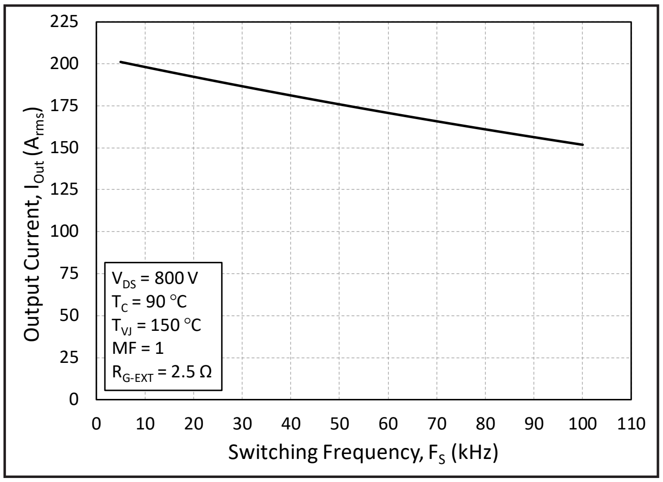



**Figure 23.** Typical Output Current Capability vs. Switching Frequency (Inverter Application)

## Timing Characteristics

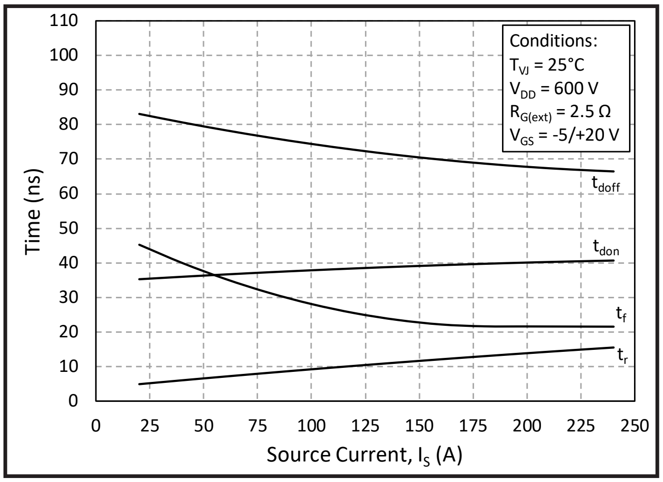



**Figure 24.** Timing vs. Source Current

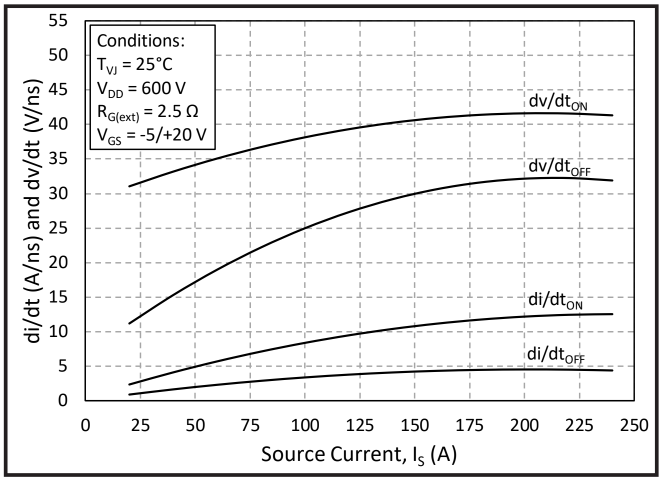



**Figure 25.** dv/dt and di/dt vs. Source Current

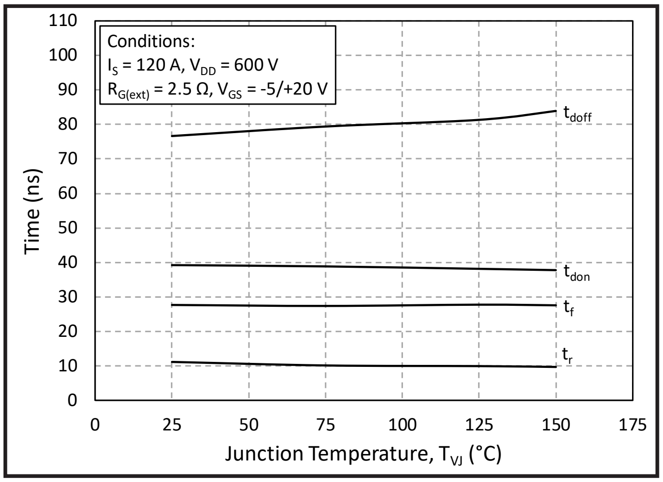



**Figure 26.** Timing vs. Junction Temperature

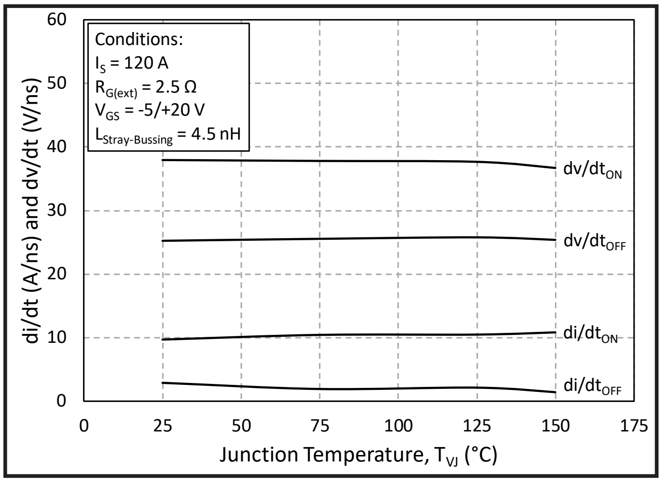



**Figure 27.** dv/dt and di/dt vs. Source Current

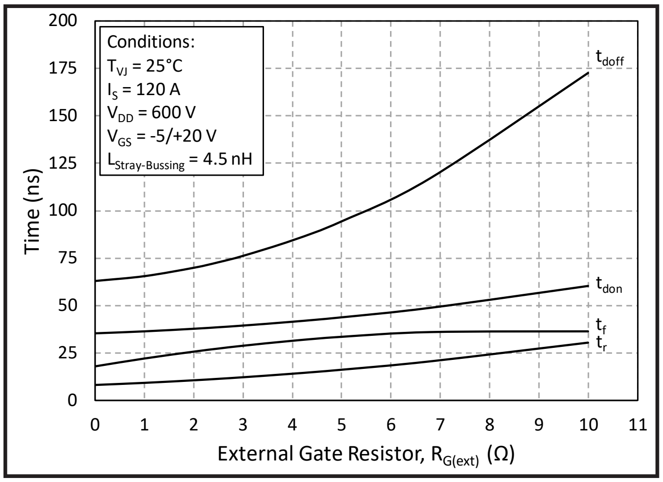



**Figure 28.** Timing vs. External Gate Resistance

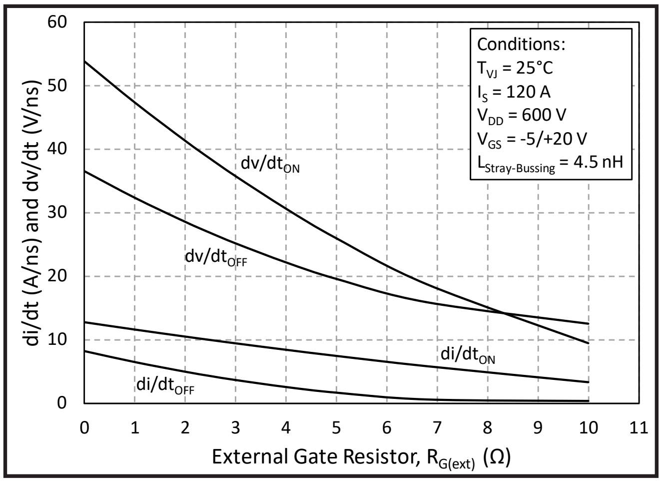



**Figure 29.** dv/dt and di/dt vs. External Gate Resistance

## Definitions

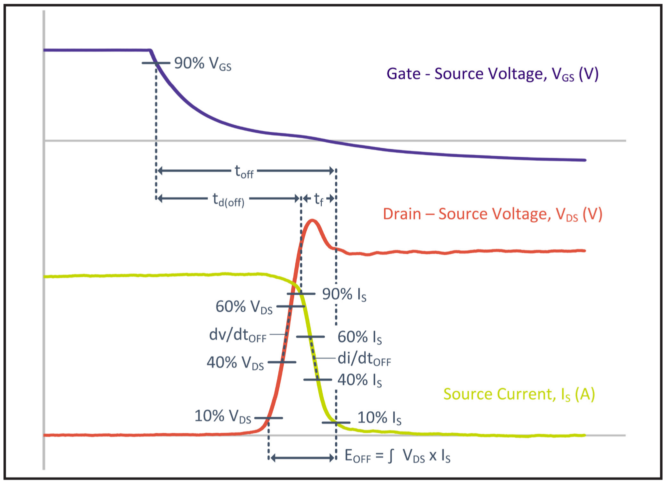



**Figure 30.** Turn-Off Transient Definitions

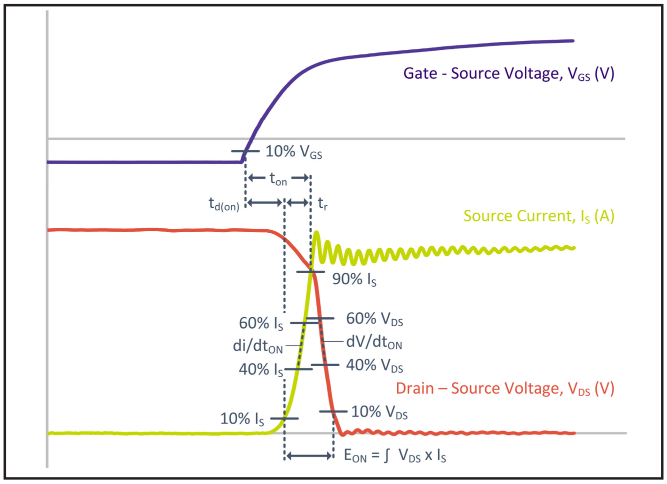



**Figure 31.** Turn-On Transient Definitions

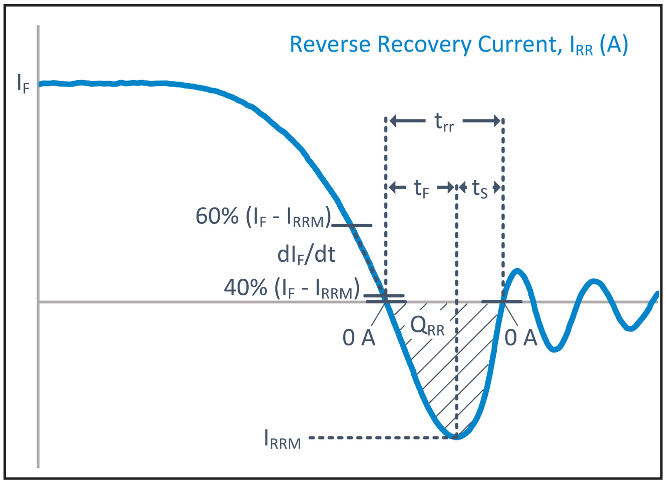



**Figure 32.** Reverse Recovery Definitions (Note 2)

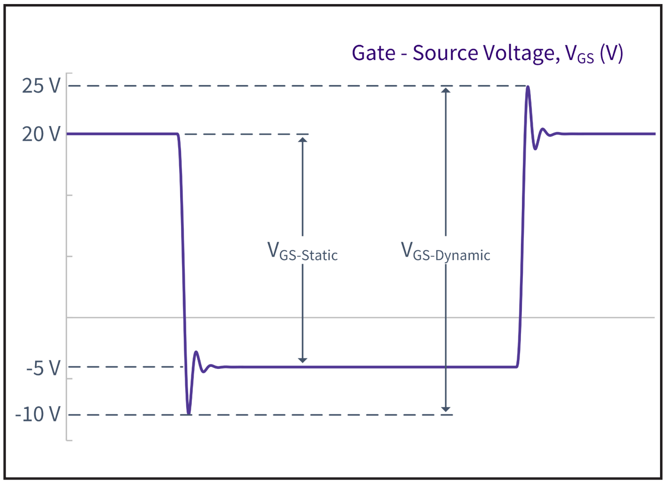
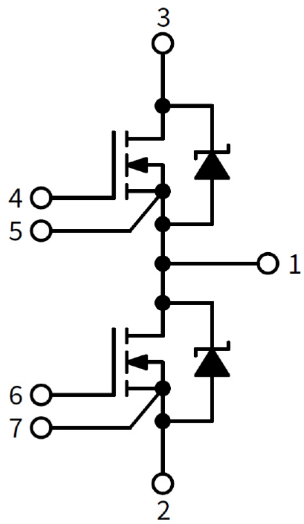
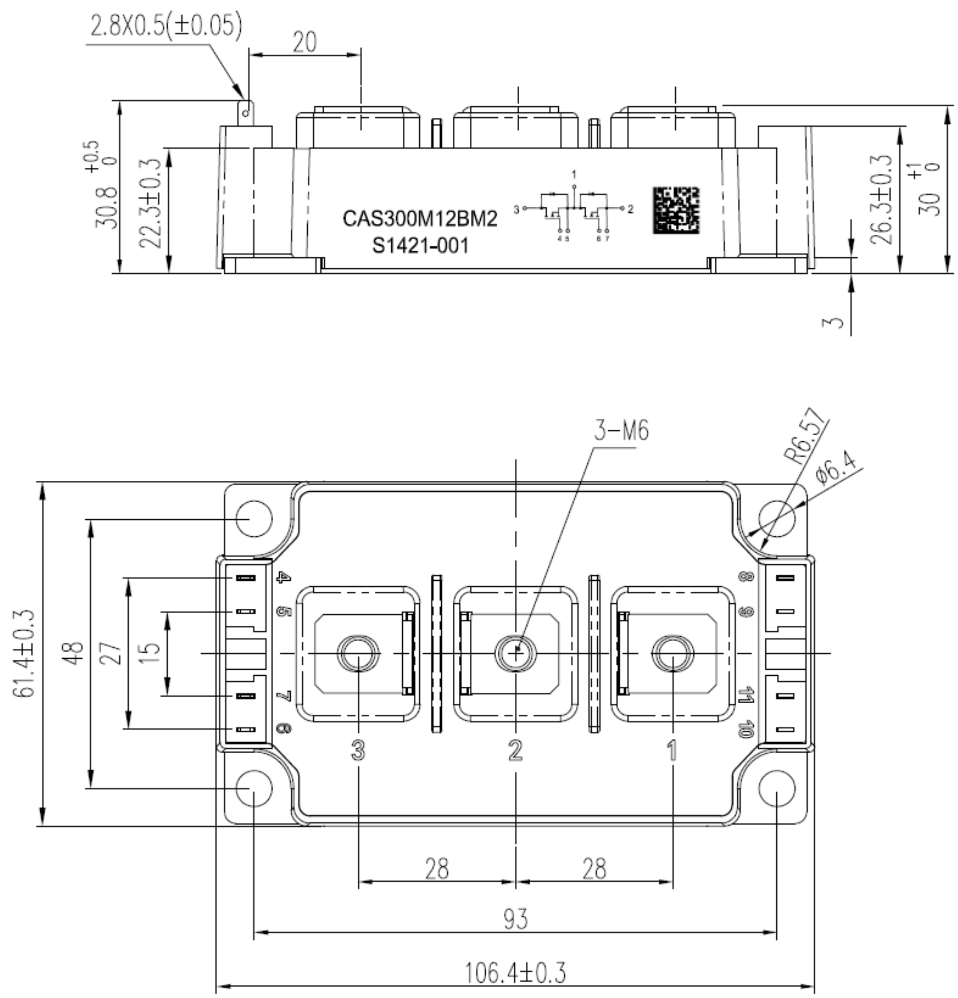



**Figure 33.** $V_{GS}$ Transient Definitions

## Schematic and Pin Out




## Package Dimensions (mm)





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## Supporting Links & Tools

- CGD1200HB2P-BM2 Evaluation Gate Driver
- CGD12HB00D: Differential Transceiver Board
- KIT-CRD-CIL12N-BM: Dynamic Performance Evaluation Board for the BM2 and BM3 Module

## Notes & Disclaimer

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