# GCMS040B120S1-E1

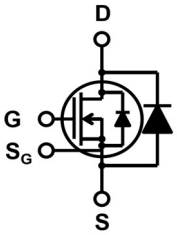
| | |
|---|---|
| $V_{DS}$ | 1200 V |
| $R_{DS,on}$ | 37 mΩ |
| $I_{D\ (TC=25C)}$ | 57 A |
| $T_J$,max | 175°C |

# 1200V SiC COPACK Power Module

## Features

- High speed switching SiC MOSFETs
- Freewheeling SiC SBD with zero reverse recovery
- Simple to drive
- Kelvin reference for stable operation

## Package


(1) $S_G$ (Driver Source)
(2) G (Gate)
(3) D (Drain)
(4) S (Source)

## Benefits

- Low switching losses
- Low junction to case thermal resistance
- Very rugged and easy mount
- Direct mounting to heatsink (isolated package)
- Lower $Q_{RR}$ at high temperature

| Part # | Package | Marking |
|---|---|---|
| GCMS040B120S1-E1 | SOT-227 | GCMS040B120S1-E1 |

## Applications

- Photovoltaic Inverter
- Battery charger
- Server power supplies
- Energy storage system

RoHS

## Absolute Maximum Ratings

| Characteristics | Symbol | Conditions | Values | Unit |
|---|---|---|---|---|
| Drain-Source Voltage | $V_{rated}$ | $V_{GS}$=0V, $I_D$=30μA | 1200 | V |
| Continuous Drain Current | $I_{DS}$ | $T_C$=25°C, $V_{GS}$=20V | 57 | A |
| | | $T_C$=100°C, $V_{GS}$=20V | 42 | |
| | $I_{SD}$* | $T_C$=25°C, $V_{GS}$=20V | 63 | |
| Schottky Diode DC Current | $I_F$ | $T_C$=25°C, $V_{GS}$=-5V | 47 | |
| Pulsed Drain Current | $I_{DS,pulse}$** | $T_C$=25°C, $V_{GS}$=20V | 160 | |
| Gate Source Voltage | $V_{GSmax}$ | | -10/25 | V |
| | $V_{GSop}$ | Recommended operational | -5/20 | |
| Power Dissipation - MOSFET | $P_{tot}$ | $T_C$=25°C | 242 | W |
| Operating & Storage Temperature | $T_J$, $T_{storage}$ | Continuous | -55...175 | °C |

*$I_{SD}$ maximum continous current for parallel SBD and MOSFET body diode assuming maximum $Rth_{JC}$ of SBD

**Pulse width is limited by $T_{Jmax}$

## Static Electrical Characteristics, at $T_J$=25°C, unless otherwise specified

| Characteristics | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| Drain-Source Breakdown Voltage | $BV_{DSS}$ | $V_{GS}$=0V, $I_D$=1mA | 1200 | - | - | V |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$=1200V, $V_{GS}$=0V | - | 1 | 30 | μA |
| | | $V_{DS}$=1200V, $V_{GS}$=0V, $T_J$=175°C | - | 46 | 450 | |
| Gate-Source Leakage Current | $I_{GSS+}$ | $V_{GS}$=20V, $V_{DS}$=0V | - | <+10 | 100 | nA |
| | $I_{GSS-}$ | $V_{GS}$=-5V, $V_{DS}$=0V | - | >-10 | -100 | |
| Gate Threshold Voltage | $V_{GS(th)}$ | $V_{GS}$=$V_{DS}$, $I_D$=10mA | 2 | 2.4 | 4 | V |
| | | $V_{GS}$=$V_{DS}$, $I_D$=10mA, $T_J$=175°C | - | 1.6 | - | |
| Drain-Source On-Resistance | $R_{DSon}$ | $V_{GS}$=20V, $I_D$=40A | - | 37 | 52 | mΩ |
| | | $V_{GS}$=20V, $I_D$=20A | - | 35 | 45 | |
| | | $V_{GS}$=20V, $I_D$=40A, $T_J$=125°C | - | 56 | - | |
| | | $V_{GS}$=20V, $I_D$=40A, $T_J$=175°C | - | 73 | - | |
| Transconductance | $g_{fs}$ | $V_{DS}$=20V, $I_D$=40A | - | 16 | - | S |
| Internal Gate Resistance | $R_{G(int)}$ | f=1MHz, $V_{AC}$=25mV, D-S Short | - | 1.8 | - | Ω |

## AC Electrical Characteristics, at $T_J$=25°C, unless otherwise specified

| Characteristics | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| Input Capacitance | $C_{ISS}$ | $V_{GS}$=0V<br>$V_{DS}$=1000V<br>f=200kHz<br>$V_{AC}$=25mV | - | 3110 | - | pF |
| Output Capacitance | $C_{OSS}$** | | - | 201 | - | |
| Reverse Transfer Capacitance | $C_{RSS}$ | | - | 10 | - | |
| Coss Stored Energy | $E_{OSS}$*** | | - | 118 | - | μJ |
| Turn-On Switching Energy | $E_{ON}$ | $V_{DD}$=800V, $I_{DS}$=40A,<br>$R_{G(ext)}$=2.5Ω,<br>$V_{GS}$=-5/+20V, L=273μH,<br>FWD=GCMS040A120S1-E1 | - | 415 | - | μJ |
| Turn-Off Switching Energy | $E_{OFF}$ | | - | 102 | - | |
| Turn-On Delay Time | $t_{D(on)}$ | | - | 15 | - | ns |
| Rise Time | $t_R$ | | - | 5 | - | |
| Turn-Off Delay Time | $t_{D(off)}$ | | - | 22 | - | |
| Fall Time | $t_F$ | | - | 16 | - | |
| Total Gate Charge | $Q_G$ | $V_{DD}$=800V, $I_{DS}$=40A<br>$V_{GS}$=-5/20V | - | 124 | - | nC |
| Gate to Source Charge | $Q_{GS}$ | | - | 50 | - | |
| Gate to Drain Charge | $Q_{GD}$ | | - | 13 | - | |

**$C_{OSS}$ is combination of MOSFET $C_{OSS}$ and diode junction capacitance

***$E_{OSS}$ is calculated from $C_{OSS}$ curve

## Freewheeling Diode Characteristics, at $T_J$=25°C, unless otherwise specified

| Characteristics | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| Diode Forward Voltage | $V_{SD}$ | $V_{GS}$=-5V, $I_S$=15A | - | 1.52 | 1.7 | V |
| | | $V_{GS}$=-5V, $I_S$=15A, $T_J$=175°C | - | 2.09 | - | |
| Reverse Recovery Time | $t_{RR}$ | $I_S$=40A, $V_R$=800V, $V_{GS}$=-5V<br>di/dt=10.5A/ns | - | 15 | - | ns |
| Reverse Recovery Charge | $Q_{RR}$ | | - | 252 | - | nC |
| Peak Reverse Recovery Current | $I_{RRM}$ | | - | 41 | - | A |
| Reverse Recovery Energy | $E_{RR}$ | | - | 69 | - | μJ |

## Thermal and Package Characteristics, at $T_j$=25 °C, unless otherwise specified

| Characteristics | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| Thermal resistance, junction-case | $R_{thJC}$ | MOSFET only | - | 0.50 | 0.62 | °C/W |
| Thermal resistance, junction-case | $R_{thJC}$ | Schottky diode only | - | 0.77 | 0.96 | |
| Mounting torque | $M_d$ | M4-0.7 screws | 1.1 | - | 1.5 | N-m |
| Terminal connection torque | $M_{dt}$ | M4-0.7 screws | - | 1.1 | 1.3 | |
| Package weight | $W_t$ | | - | 32 | - | g |
| Isolation voltage | $V_{ISOL}$ | $I_{ISOL}$ < 1mA, 50/60 Hz, 2 s | 4000 | - | - | V |

## Typical Performance

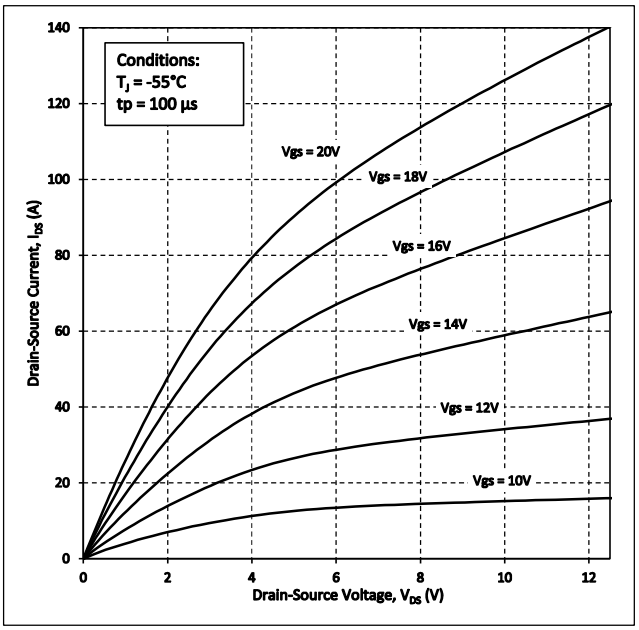



**Figure 1. Output Characteristics $T_J$ = -55°C**

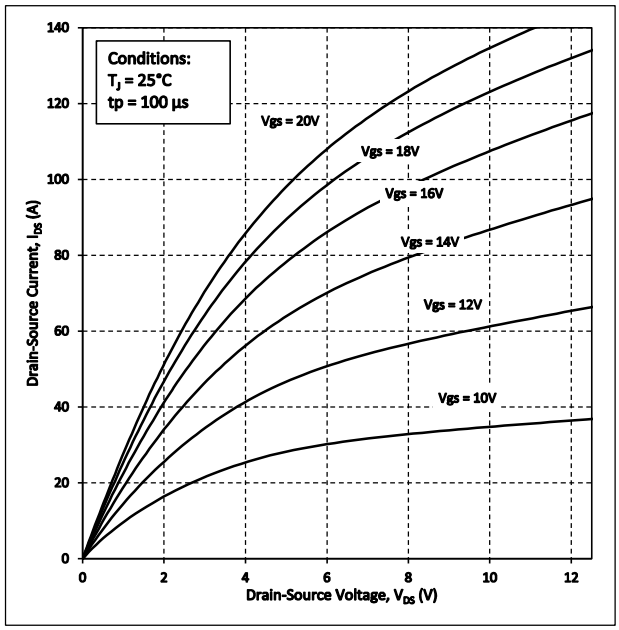



**Figure 2. Output Characteristics $T_J$ = 25°C**

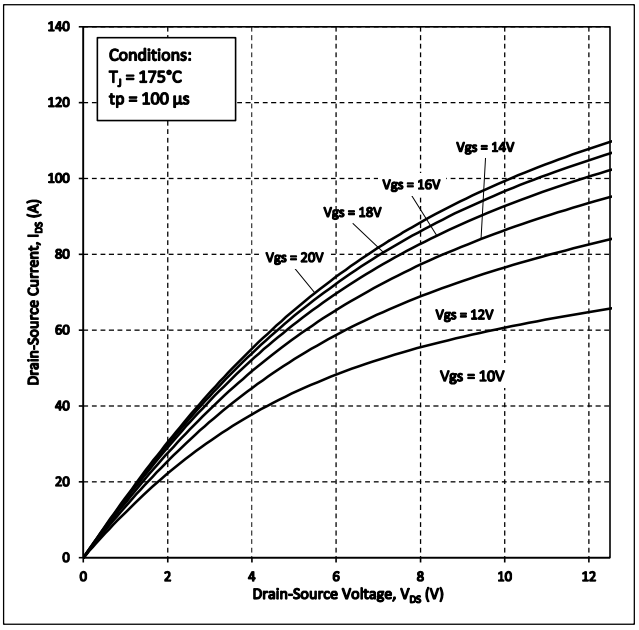



**Figure 3. Output Characteristics $T_J$ = 175°C**

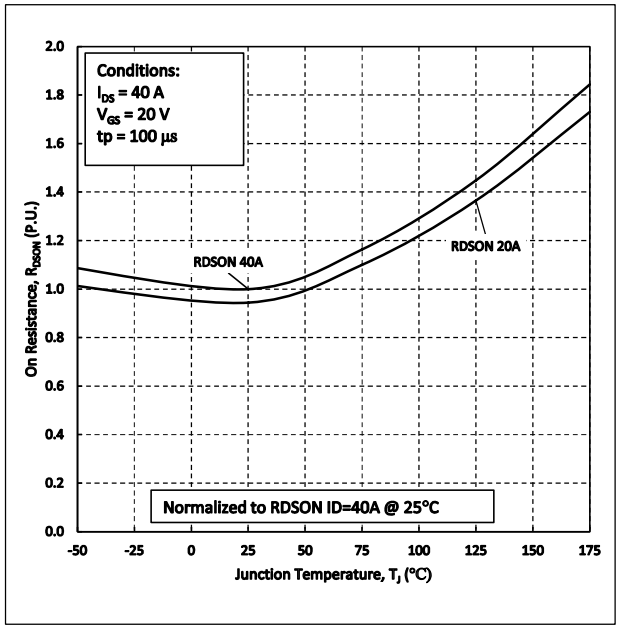



**Figure 4. Normalized On-Resistance vs. Temperature**

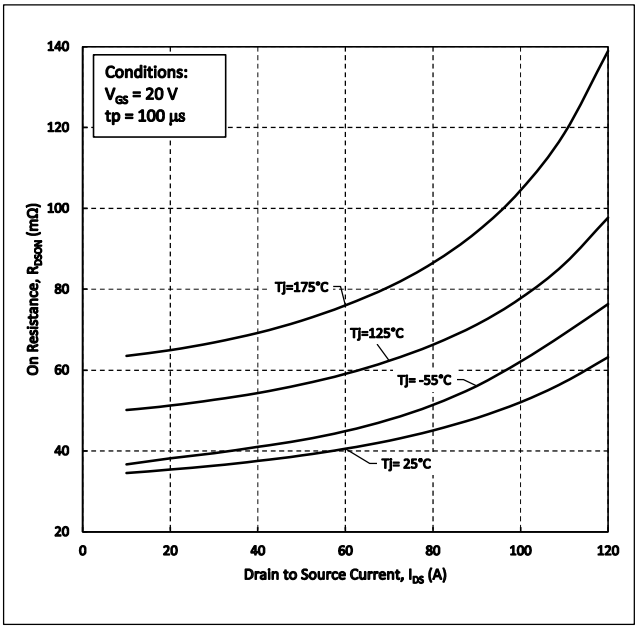



**Figure 5. On-Resistance vs. Drain Current For Various Temperature**

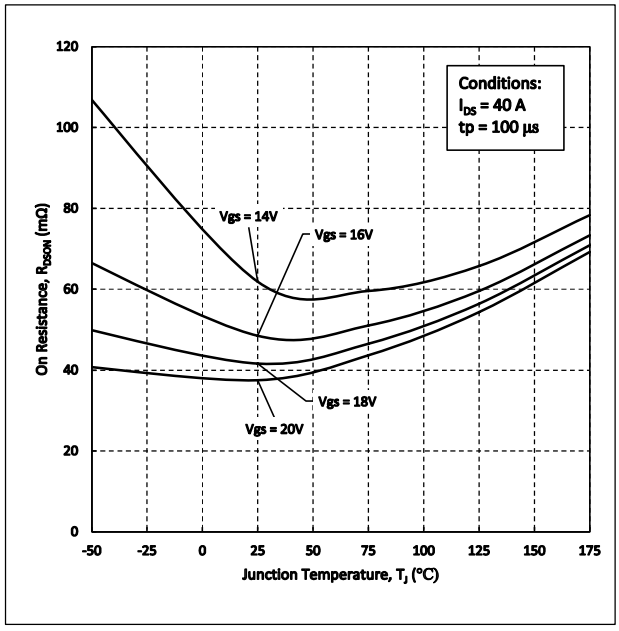



**Figure 6. On-Resistance vs. Temperature For Various Gate Voltages**

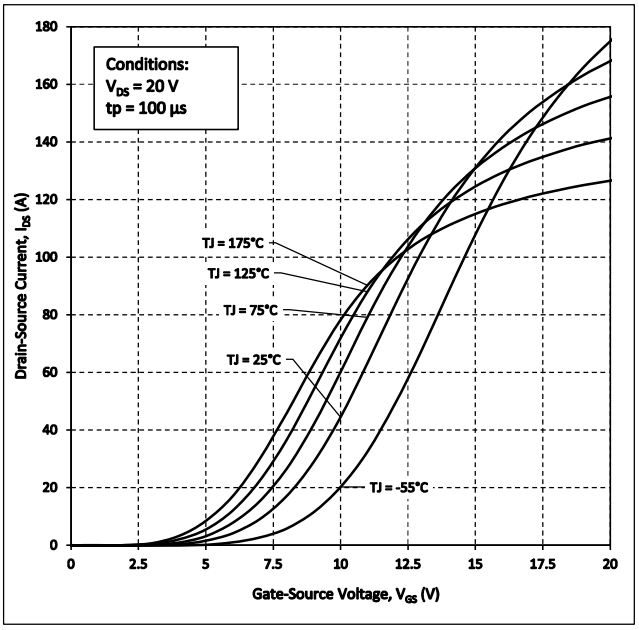



**Figure 7. Transfer Characteristic for Various Junction Temperatures**

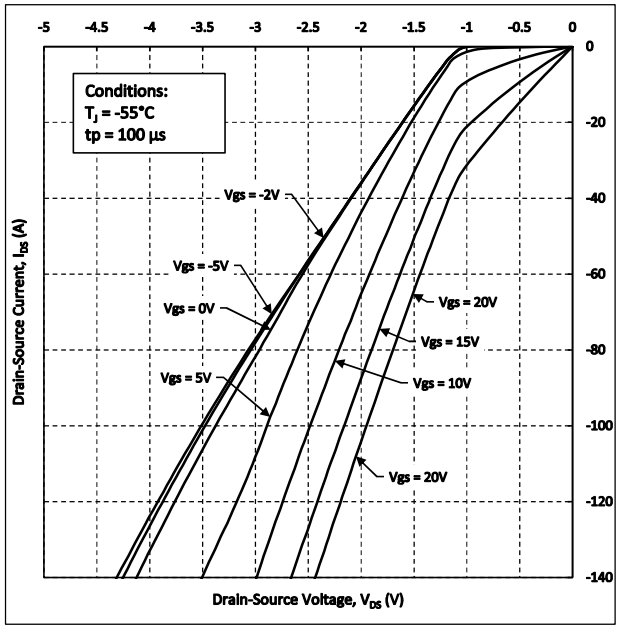



**Figure 8. Freewheeling Diode Characteristics at $T_J$ = -55°C**

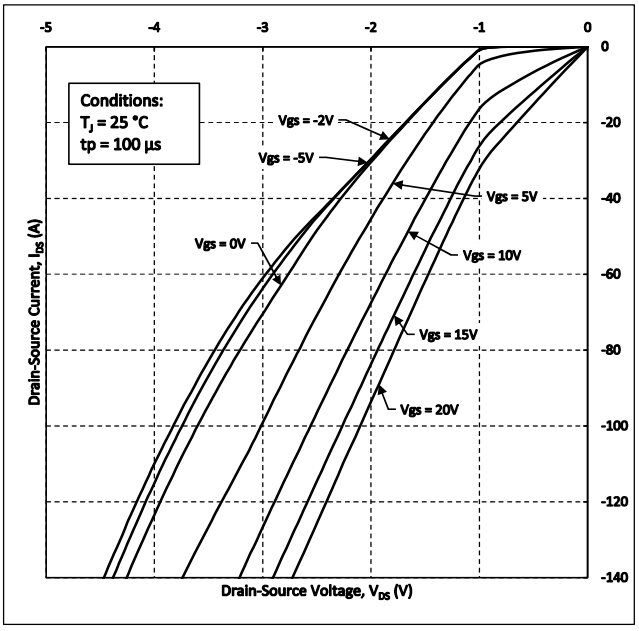



**Figure 9. Freewheeling Diode Characteristics at $T_J$ = 25°C**

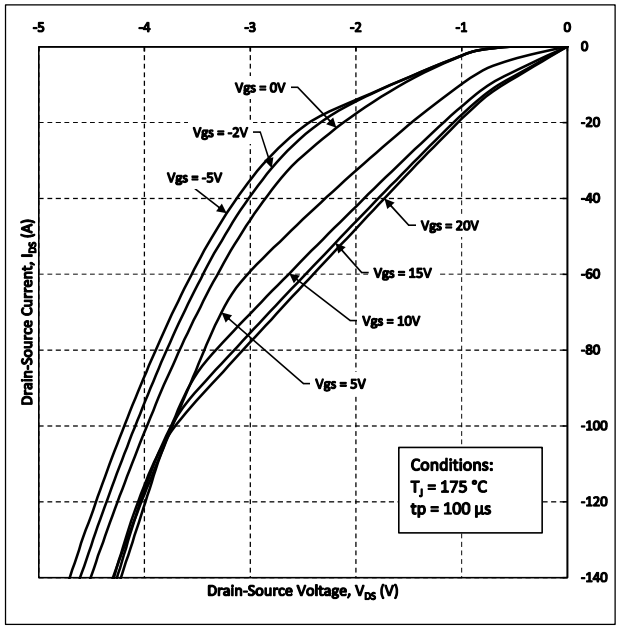



**Figure 10. Freewheeling Diode Characteristics at $T_J$ = 175°C**

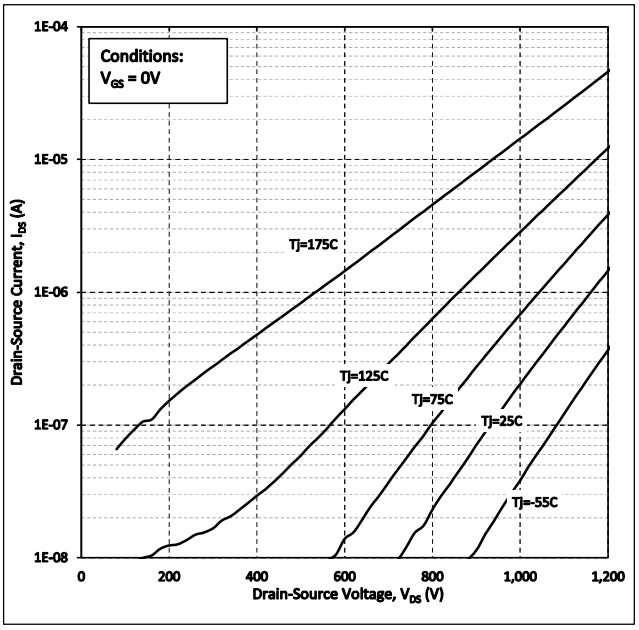



Figure 11. $I_{DSS}$ vs. Temperature

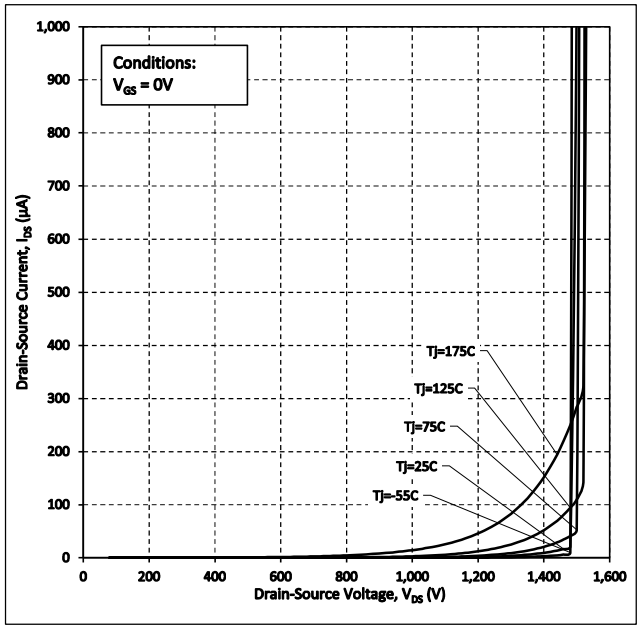



Figure 12. $I_{DSS}$ vs. Temperature

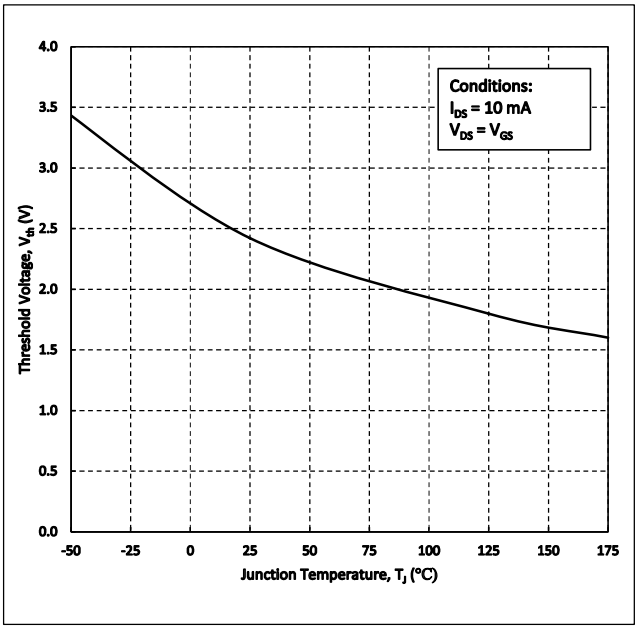



Figure 13. Threshold Voltage vs. Temperature

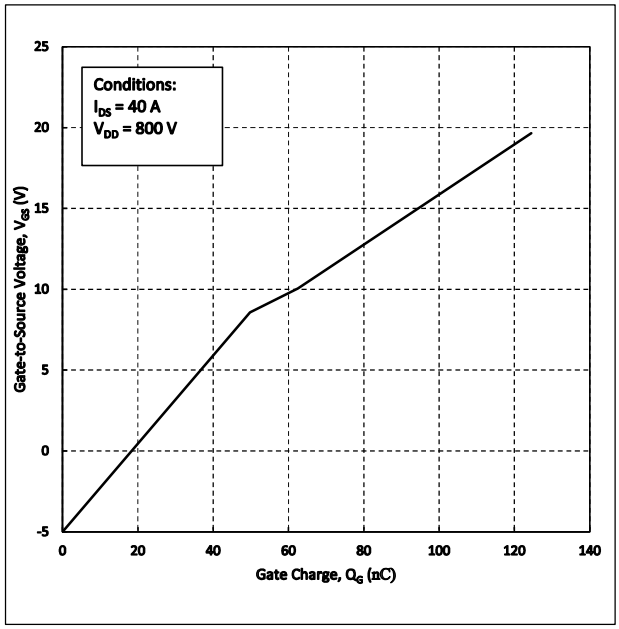



Figure 14. Gate Charge Characteristics

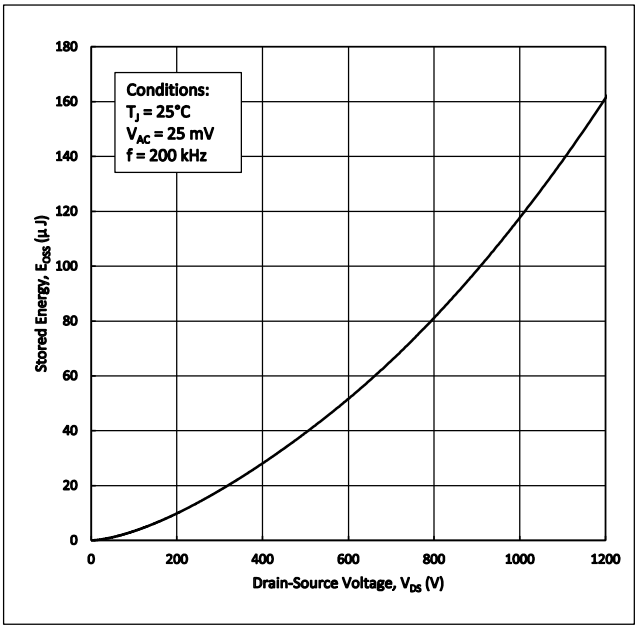



Figure 15. Output Capacitor Stored Energy

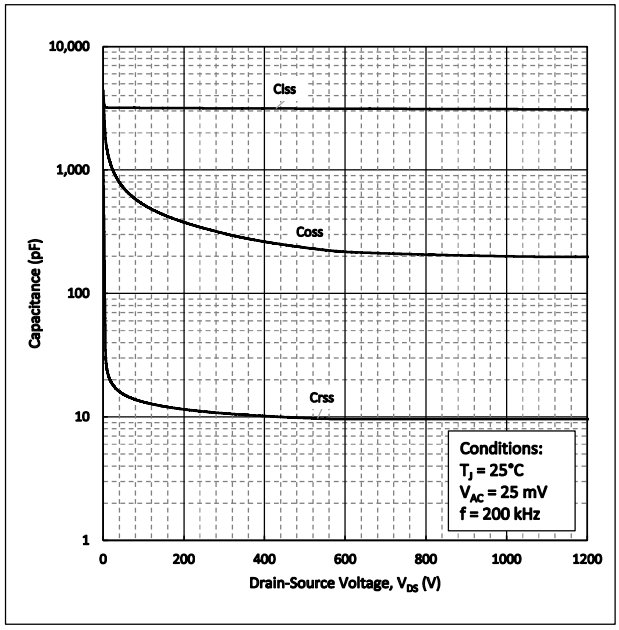



Figure 16. Capacitance vs Drain-Source Voltage

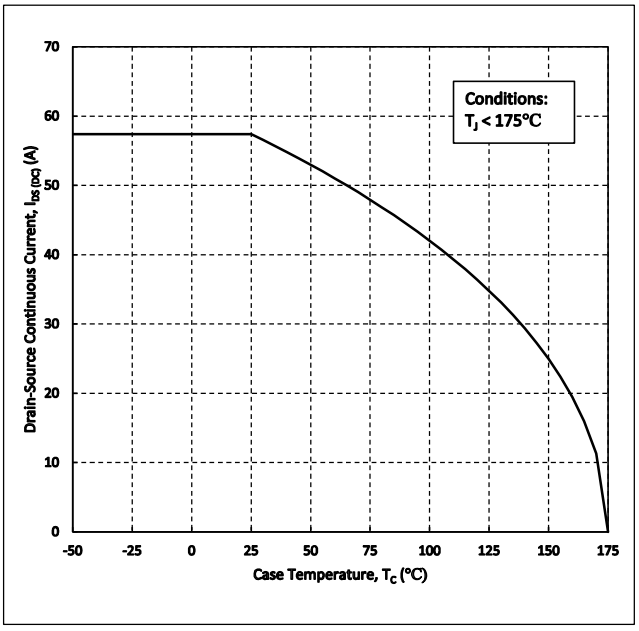



Figure 17. Continuous Drain Current Derating vs. Case Temperature

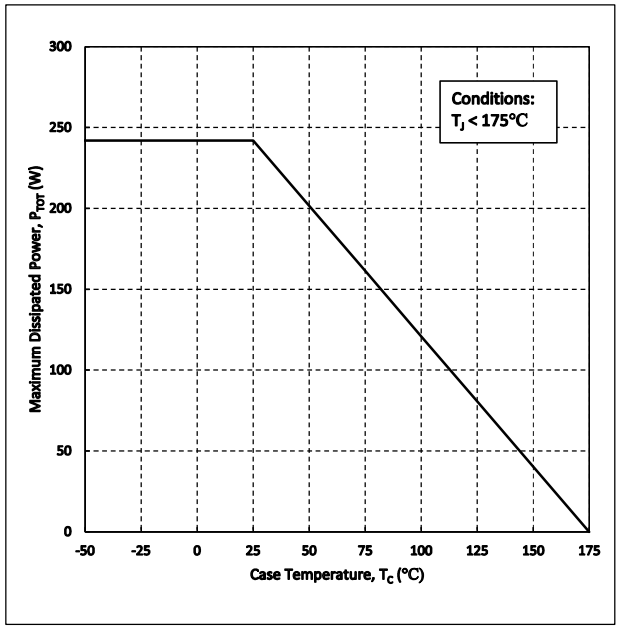



Figure 18. Maximum Power Dissipation Derating vs Case Temperature

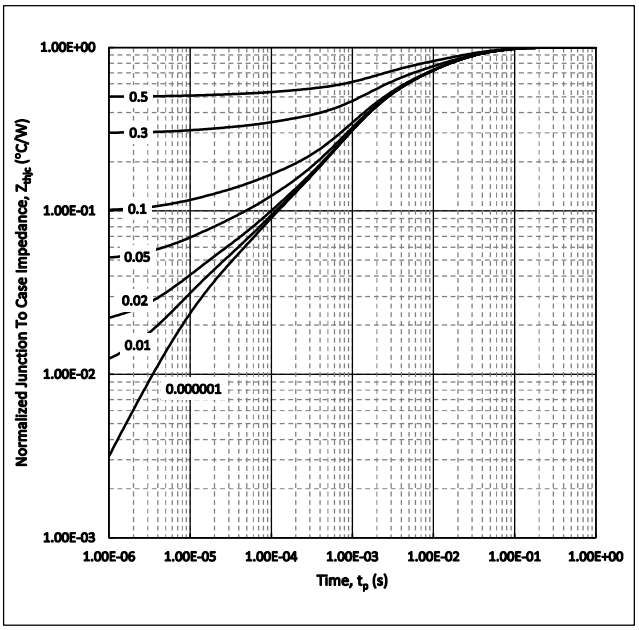



**Figure 19. Transient Thermal impedance (Junction to Case)**

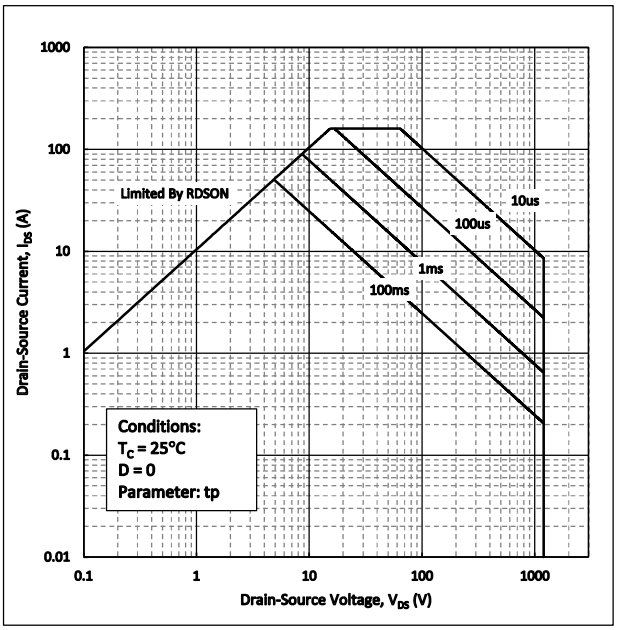



**Figure 20. Safe Operating Area**

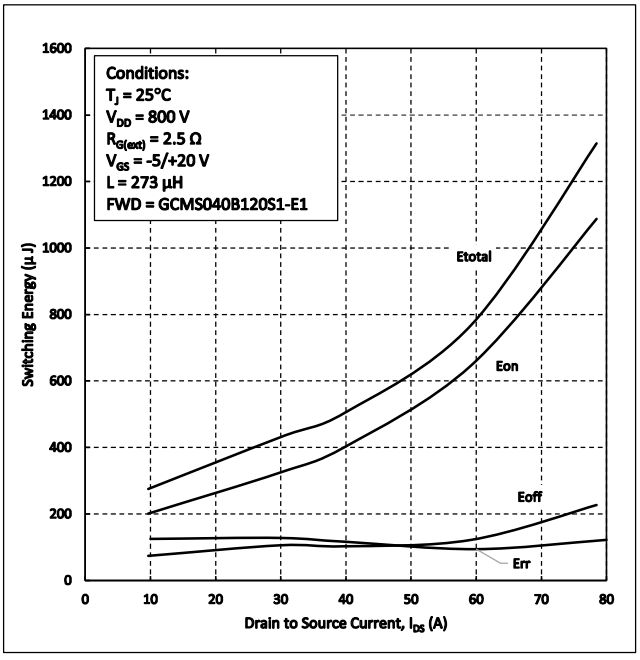



**Figure 21. Clamped Inductive Switching Energy vs. Drain Current**

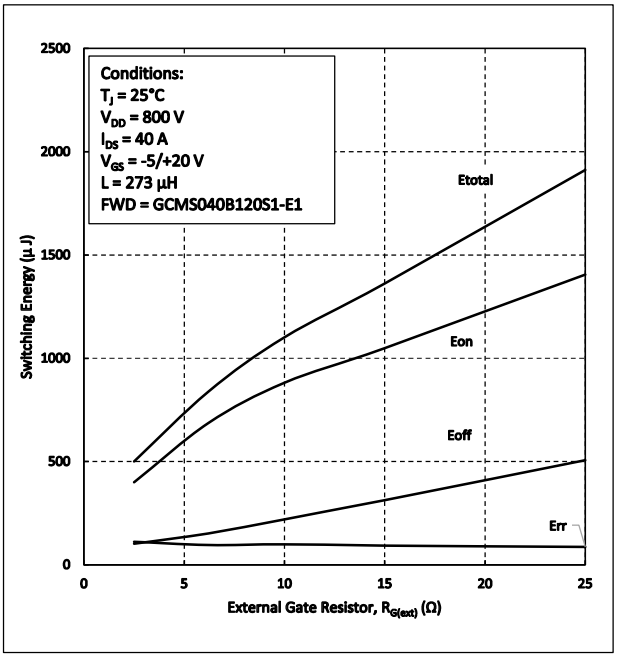



**Figure 22. Clamped Inductive Switching Energy vs. $R_{G(ext)}$**

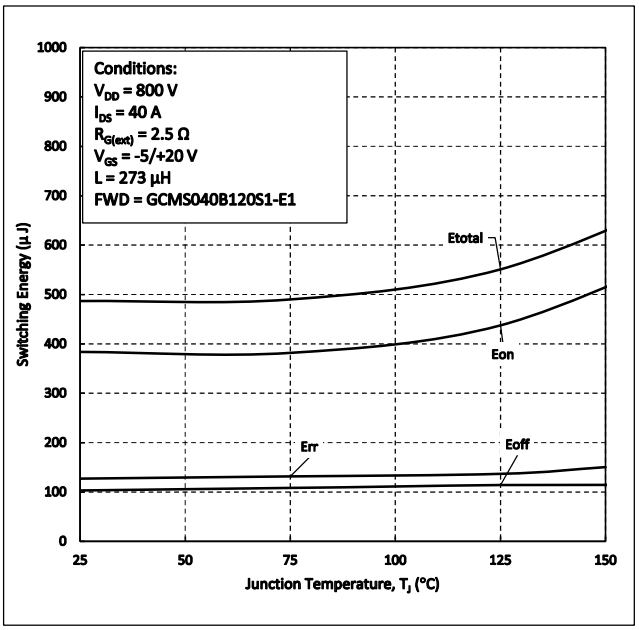



**Figure 23. Clamped Inductive Switching Energy vs. Temperature**

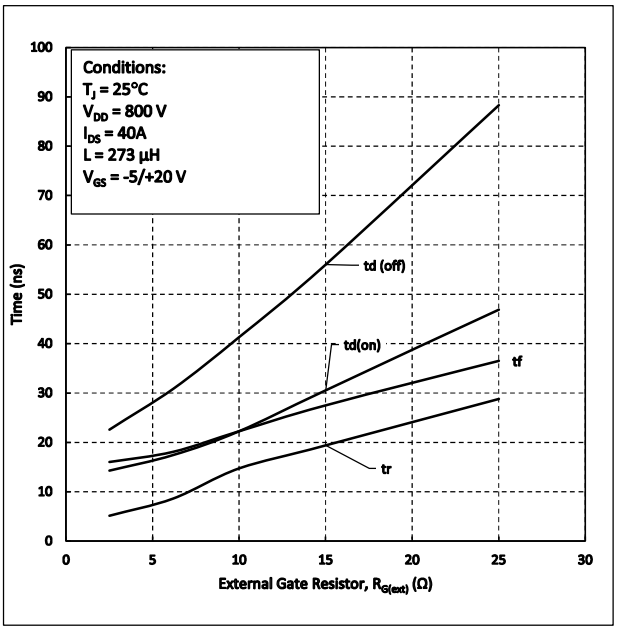



**Figure 24. Switching Times vs $R_{G(ext)}$**

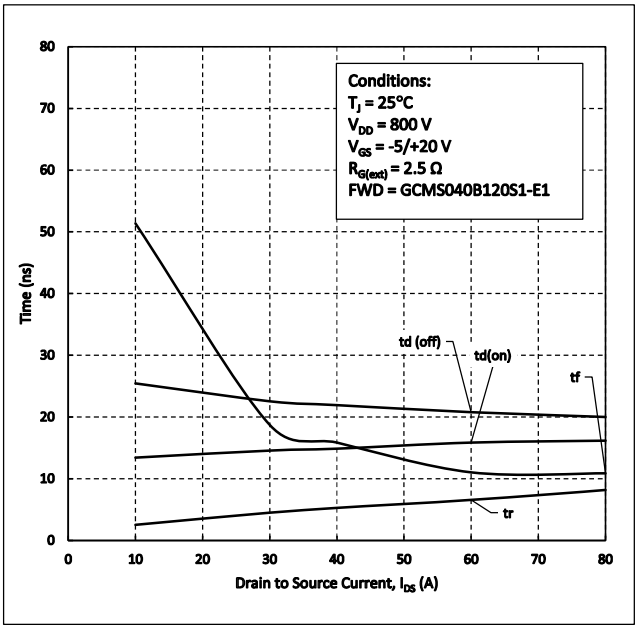



**Figure 25. Switching Times vs. Drain Current**

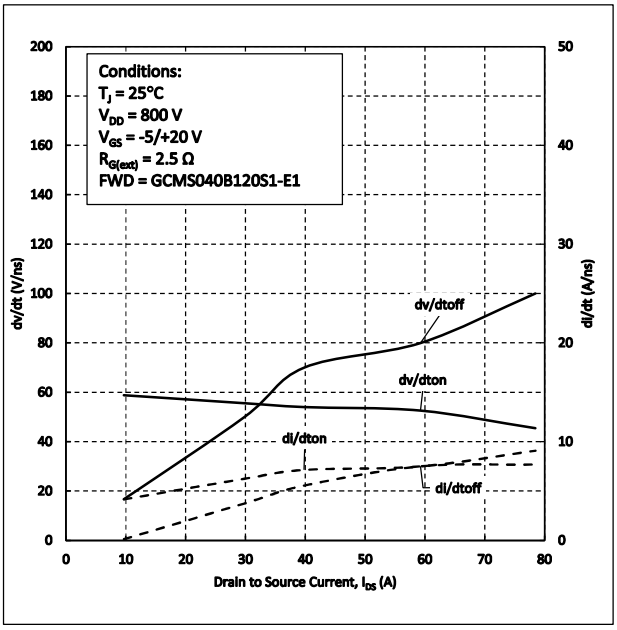



**Figure 26. dv/dt and di/dt vs. Drain Current**

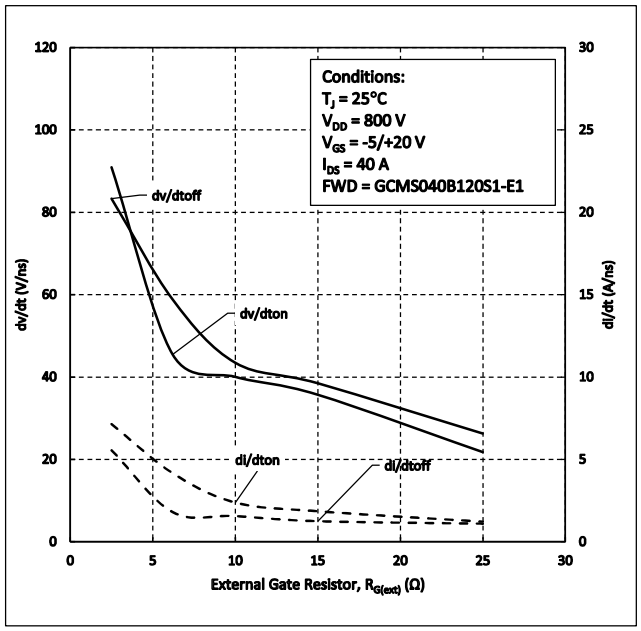



Figure 27. dv/dt and di/dt vs. $R_{G(ext)}$

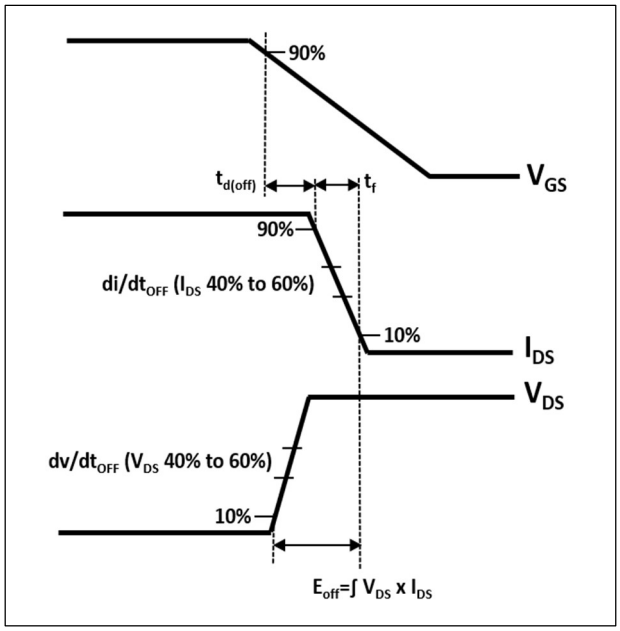



Figure 28. Turn-off Transient Definitions

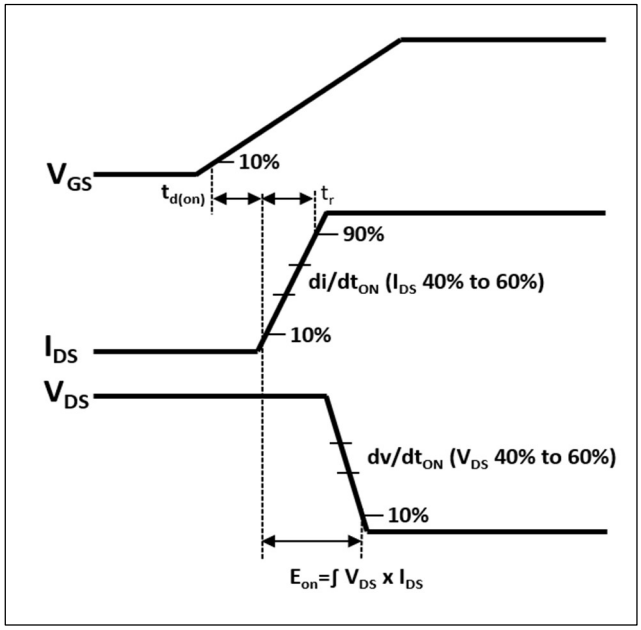



Figure 29. Turn-on Transient Definitions

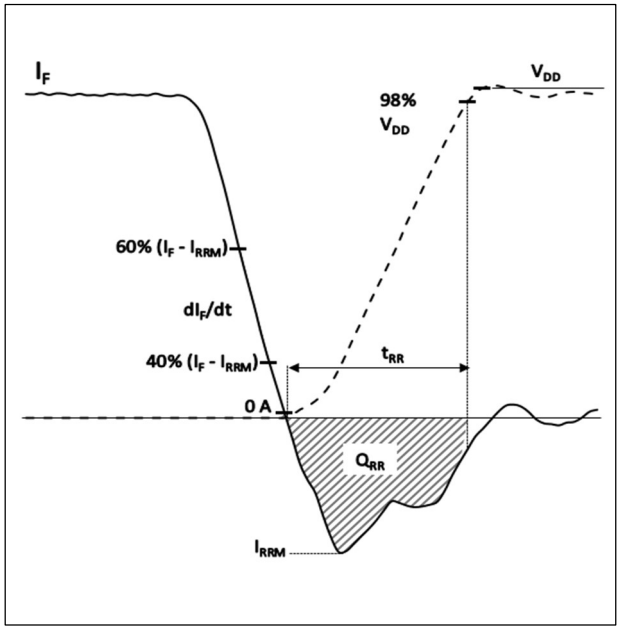
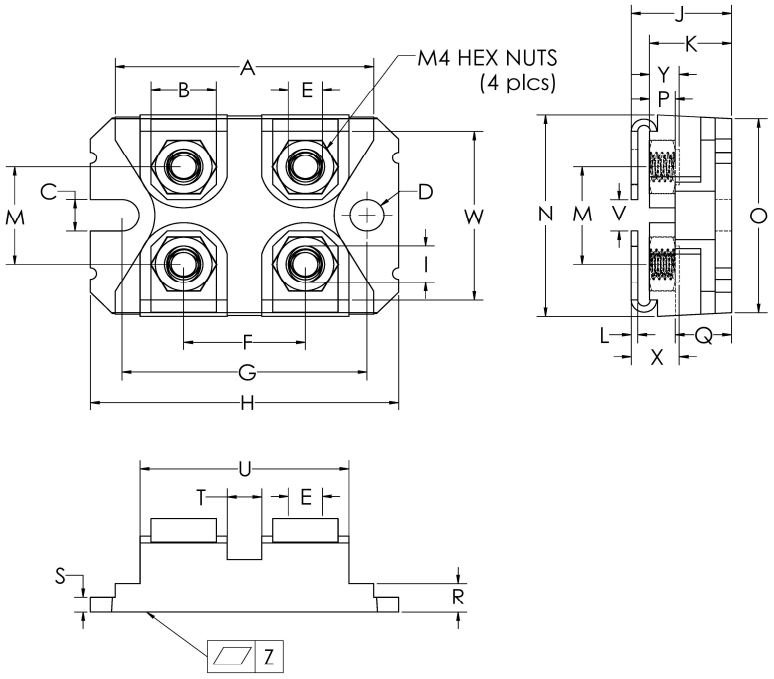



Figure 30. Reverse Recovery Definitions

## Package Dimensions SOT-227




| Sym | Millimeters | | Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 31.67 | 31.90 | 1.247 | 1.256 |
| B | 7.95 | 8.18 | 0.313 | 0.322 |
| C | 4.14 | 4.24 | 0.163 | 0.167 |
| D | 4.14 | 4.24 | 0.163 | 0.167 |
| E | 4.14 | 4.24 | 0.163 | 0.167 |
| F | 14.94 | 15.09 | 0.588 | 0.594 |
| G | 30.15 | 30.25 | 1.187 | 1.191 |
| H | 38.00 | 38.10 | 1.496 | 1.500 |
| I | 4.75 | 4.83 | 0.187 | 0.190 |
| J | 11.68 | 12.19 | 0.460 | 0.480 |
| K | 9.45 | 9.60 | 0.372 | 0.378 |
| L | 0.76 | 0.84 | 0.030 | 0.033 |
| M | 12.62 | 12.88 | 0.497 | 0.507 |
| N | 25.15 | 25.30 | 0.990 | 0.996 |
| O | 24.79 | 25.04 | 0.976 | 0.986 |
| P | 3.02 | 3.15 | 0.119 | 0.124 |
| Q | 6.71 | 6.96 | 0.264 | 0.274 |
| R | 4.17 | 4.42 | 0.164 | 0.174 |
| S | 2.08 | 2.13 | 0.082 | 0.084 |
| T | 3.28 | 3.63 | 0.129 | 0.143 |
| U | 26.75 | 26.90 | 1.053 | 1.059 |
| V | 3.86 | 4.24 | 0.152 | 0.167 |
| W | 20.55 | 26.90 | 0.809 | 0.814 |
| X | 5.45 | 5.85 | 0.215 | 0.230 |
| Y | 3.15 | 3.66 | 0.124 | 0.144 |
| Z | 0.00 | 0.13 | 0.000 | 0.005 |

| Revision History | | |
|---|---|---|
| Date | Revision | Notes |
| 4/29/2022 | 0.1 | Preliminary release |
| 8/19/2022 | 1.0 | Initial release |
| | | |
| | | |
| | | |
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| | | |

Notes

**RoHS Compliance**

The levels of RoHS restricted materials in this product are below the maximum concentration values (also referred to as the threshold limits) permitted for such substances, or are used in an exempted application, in accordance with EU Directive 2011/65/EC (RoHS2), as implemented March, 2013. RoHS Declarations for this product can be obtained from the Product Documentation sections of www.SemiQ.com.

**REACh Compliance**

REACh substances of high concern (SVHC) information is available for this product. Since the European Chemicals Agency (ECHA) has published notice of their intent to frequently revise the SVHC listing for the foreseeable future,please contact our office at SemiQ Headquarters in Lake Forest, California to insure you get the most up-to-date REACh SVHC Declaration. REACh banned substance information (REACh Article 67) is also available upon request.

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