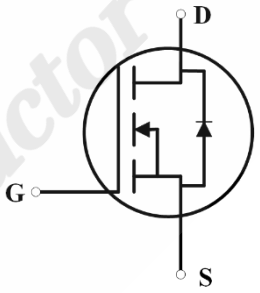
# SiC MOS P3M12080K3

## N-Channel Enhancement Mode


## Features

- Qualified to AEC-Q101
- High Blocking Voltage with Low On-Resistance
- High-Frequency Operation
- Ultra-Small $Q_{gd}$
- 100% UIS tested




## Benefits

- Improve System Efficiency
- Increase Power Density
- Reduce Heat Sink Requirements
- Reduction of System Cost

TO-247-3

| | |
|---|---|
| Gate | 1 |
| Drain | 2 |
| Source | 3 |

## Applications

- Solar Inverters
- EV Battery Chargers
- High Voltage DC/DC Converters
- Switch Mode Power Supplies

RoHS

Halogen

## Order Information

| Part Number | Package | Marking |
|---|---|---|
| P3M12080K3 | TO-247-3 | P3M12080K3 |

## Contents

## 1. Maximum Ratings

At $T_J$= 25℃, unless specified otherwise

| Parameter | Symbol | Value | Unit | Test Conditions |
|---|---|---|---|---|
| Drain - Source Voltage | $V_{DSmax}$ | 1200 | V | $V_{GS}$ = 0V<br>$I_D$ = 100μA |
| Gate - Source Voltage (dynamic) | $V_{GSmax}$ | -8 / +21 | V | AC (f >1Hz) |
| Gate - Source Voltage(static)<br>turn-on gate voltage<br>turn-off gate voltage | $V_{GS,on}$<br>$V_{GS,off}$ | +15 / +18<br>-3 | V | Static |
| Continuous Drain Current | $I_D$ | 38 | A | $V_{GS}$ = 15V<br>$T_C$ = 25℃ |
| | | 27 | | $V_{GS}$ = 15V<br>$T_C$ = 100℃ |
| Pulsed Drain Current | $I_{D(pulse)}$ | 80 | A | |
| Power Dissipation | $P_D$ | 221 | W | |
| Operating Junction | $T_J$ | -55 To +175 | ˚C | |
| Storage Temperature | $T_{stg}$ | -55 To +175 | ˚C | |
| Solder Temperature | $T_L$ | 260 | ˚C | |
| Mounting Torque | $M_d$ | 1<br>8.8 | Nm<br>lbf-in | M3 or 6-32 screw |

## 2. Electrical Characteristics

At $T_J$= 25℃, unless specified otherwise

| Parameter | Symbol | Value | | | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Drain-Source Breakdown Voltage | $V_{(BR)DSS}$ | 1200 | / | / | V | $V_{GS}$= 0V<br>$I_D$= 100μA |
| Gate Threshold Voltage | $V_{GS(th)}$ | 1.8 | 2.4 | / | V | (tested after 30ms pulse at $V_{GS}$=15V)<br>$V_{DS}$= $V_{GS}$<br>$I_D$= 5mA<br>$T_J$ = 25℃ |
| | | / | 1.6 | / | V | $V_{DS}$= $V_{GS}$<br>$I_D$= 5mA<br>$T_J$ = 175℃ |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | / | 1.8 | 100 | μA | $V_{GS}$=0V<br>$V_{DS}$=1200V |
| Gate-Source Leakage Current | $I_{GSS}$ | / | 20 | 250 | nA | $V_{GS}$= 15V<br>$V_{DS}$= 0V |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | / | 80 | 104 | mΩ | $V_{GS}$= 15V<br>$I_D$= 20A<br>$T_J$ = 25℃ |
| | | / | 104 | / | | $V_{GS}$= 15V<br>$I_D$= 20A<br>$T_J$ = 175℃ |
| | | / | 66 | / | | $V_{GS}$= 18V<br>$I_D$= 20A<br>$T_J$ = 25℃ |

| Parameter | Symbol | Value | | | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Transconductance | $g_{fs}$ | / | 10 | / | S | $V_{DS}$= 20V<br>$I_{DS}$= 20A<br>$T_J$ = 25℃ |
| | | / | 9.6 | / | | $V_{DS}$= 20V<br>$I_{DS}$= 20A<br>$T_J$= 175℃ |
| Input Capacitance | $C_{iss}$ | / | 2032 | / | pF | $V_{GS}$= 0V<br>$V_{DS}$= 800V<br>f= 1MHz<br>$V_{AC}$= 25mV |
| Output Capacitance | $C_{oss}$ | / | 73.6 | / | | |
| Reverse Transfer Capacitance | $C_{rss}$ | / | 6 | / | | |
| Coss Stored Energy | $E_{oss}$ | / | 52.9 | / | μJ | |
| Turn-on Energy | $E_{on}$ | / | 507 | / | μJ | $V_{DS}$= 800V<br>$V_{GS}$= -3/15V<br>$I_D$= 20A<br>$R_G$= 1Ω |
| Turn-off Energy | $E_{off}$ | / | 27 | / | | |
| Turn-on Energy | $E_{on}$ | / | 405 | / | μJ | $V_{DS}$= 800V<br>$V_{GS}$= -3/18V<br>$I_D$= 20A<br>$R_G$= 1Ω |
| Turn-off Energy | $E_{off}$ | / | 33 | / | | |
| Turn-On Delay Time | $t_{d(on)}$ | / | 17 | / | ns | $V_{DS}$= 800V<br>$V_{GS}$= -3/15V<br>$I_D$= 20A<br>$R_G$= 1Ω |
| Rise Time | $t_r$ | / | 32 | / | | |
| Turn-Off Delay Time | $t_{d(off)}$ | / | 23 | / | | |
| Fall Time | $t_f$ | / | 18 | / | | |
| Internal Gate Resistance | $R_{G(int)}$ | / | 3.5 | / | Ω | f= 1MHz<br>$V_{AC}$= 25mV |

| Parameter | Symbol | Value | | | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Gate to Source Charge | $Q_{gs}$ | / | 22.2 | / | nC | $V_{DS}$= 800V<br>$I_{DS}$= 20A<br>$V_{GS}$= -3 to 15V<br>$I_G$= 20mA |
| Gate to Drain Charge | $Q_{gd}$ | / | 12.3 | / | | |
| Total Gate Charge | $Q_g$ | / | 54.6 | / | | |

## 3. Reverse Diode Characteristics

At $T_J$= 25℃, unless specified otherwise

| Parameter | Symbol | Value | | Unit | Test Conditions |
|---|---|---|---|---|---|
| | | Typ. | Max. | | |
| Diode Forward Voltage | $V_{SD}$ | 5.2 | / | V | $V_{GS}$= -3V<br>$I_{SD}$= 10A<br>$T_J$= 25℃ |
| | | 4.8 | / | V | $V_{GS}$= -3V<br>$I_{SD}$= 10A<br>$T_J$= 175℃ |
| Continuous Diode Forward Current | $I_S$ | 31 | / | A | $V_{GS}$= -3V |
| Reverse Recover Time | $t_{rr}$ | 33 | / | ns | $V_{GS}$= -3V<br>$I_{SD}$= 20A<br>$V_R$= 800V<br>$d_{if}/d_t$= 3800A/μs<br>$T_J$= 25℃ |
| Reverse Recovery Charge | $Q_{rr}$ | 348 | / | nC | |
| Peak Reverse Recovery Current | $I_{rrm}$ | 17 | / | A | |

| Parameter | Symbol | Value | | Unit | Test Conditions |
|---|---|---|---|---|---|
| | | Typ. | Max. | | |
| Reverse Recover Time | $t_{rr}$ | 28 | / | ns | $V_{GS}$= -3V<br>$I_{SD}$= 20A<br>$V_R$= 800V<br>$d_{if}/d_t$= 4000A/μs<br>$T_J$= 25℃ |
| Reverse Recovery Charge | $Q_{rr}$ | 393 | / | nC | |
| Peak Reverse Recovery Current | $I_{rrm}$ | 23 | / | A | |

## 4. Thermal Characteristics

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Thermal Resistance from Junction to Case | $R_{\theta JC}$ | 0.68 | ℃/W |

## 5. Typical Performance

At $T_J$= 25℃, unless specified otherwise

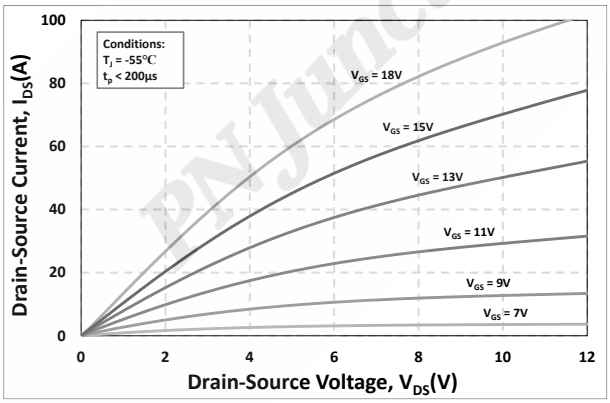



Figure 1. Output Characteristics $T_J$ = -55℃

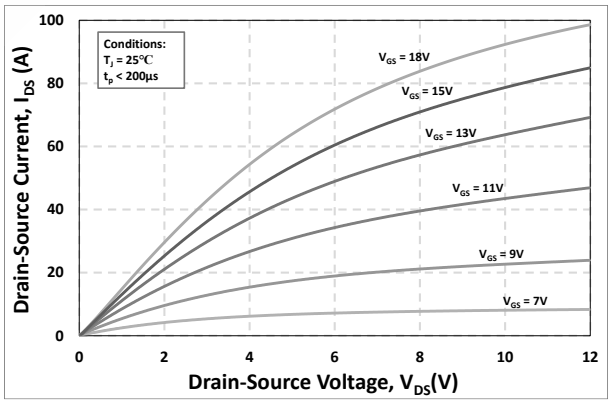



Figure 2. Output Characteristics $T_J$ = 25℃

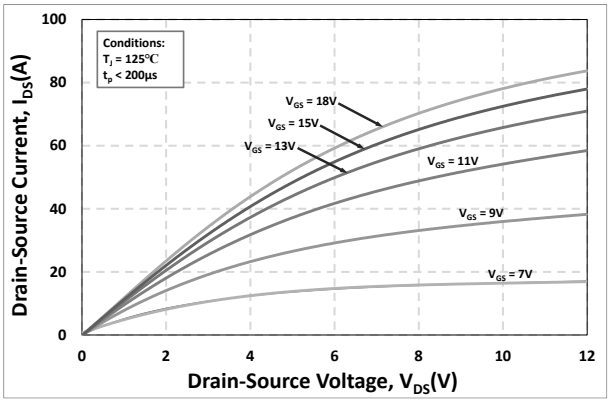



Figure 3. Output Characteristics $T_J$ = 125°C

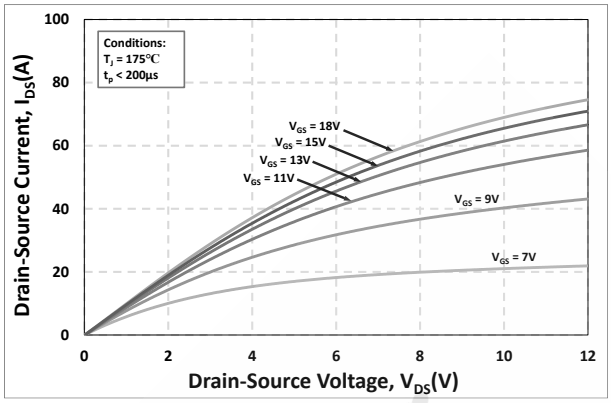



Figure 4. Output Characteristics $T_J$ = 175°C

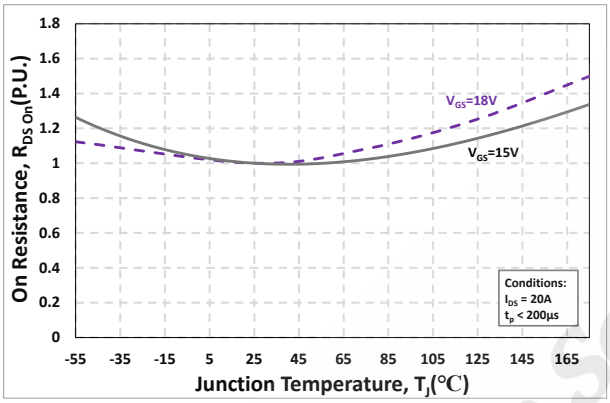



Figure 5. Normalized On-Resistance vs. Temperature

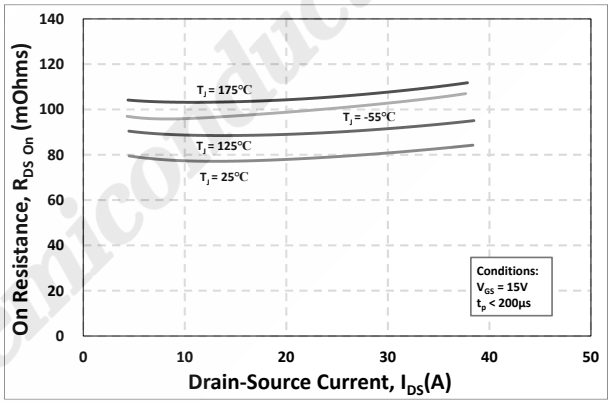



Figure 6. On-Resistance vs. Drain Current Various Temperatures

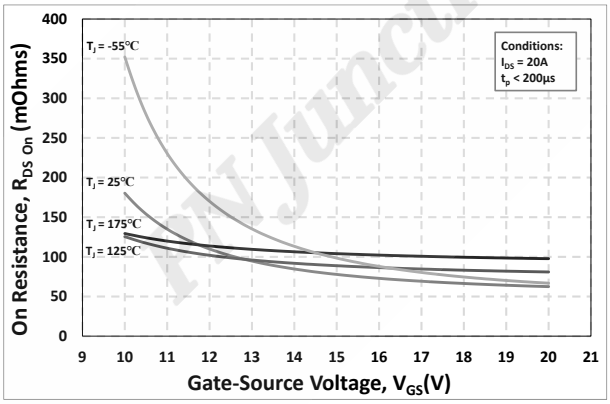



Figure 7. On-Resistance vs. Gate-Source Voltage

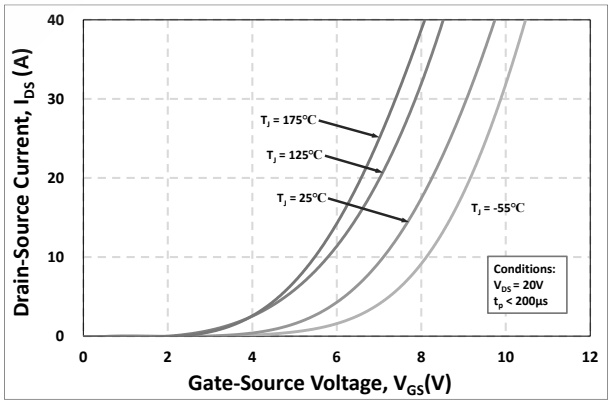



Figure 8. Transfer Characteristic for Various Junction Temperatures

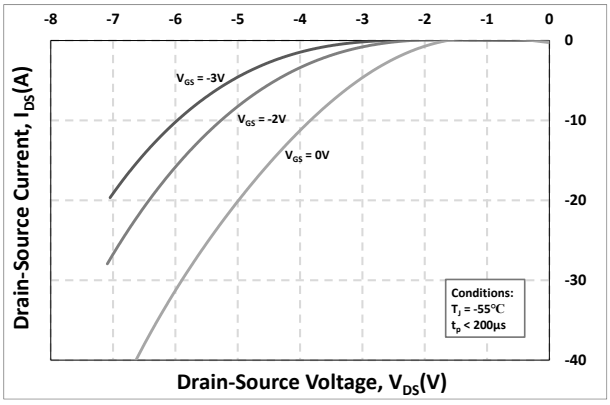



Figure 9. Body Diode Characteristic at -55°C

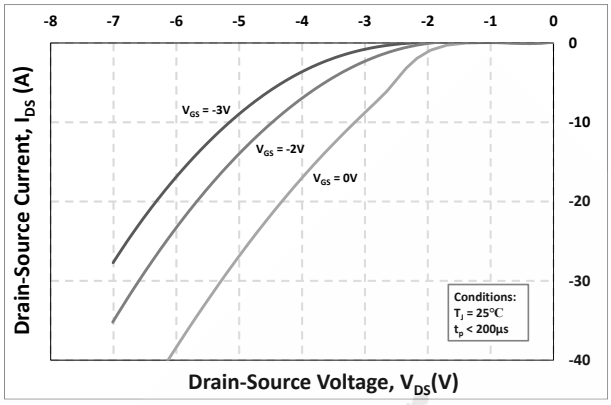



Figure 10. Body Diode Characteristic at 25°C

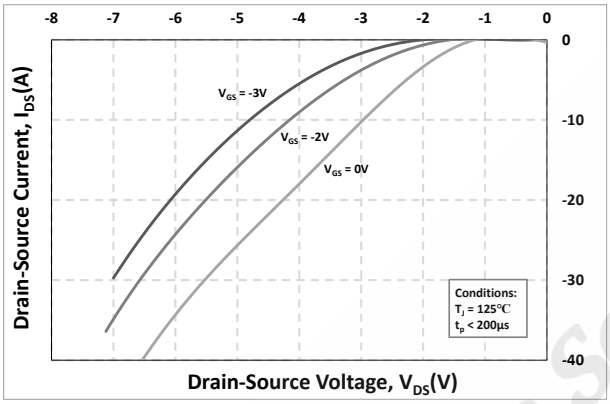



Figure 11. Body Diode Characteristic at 125°C

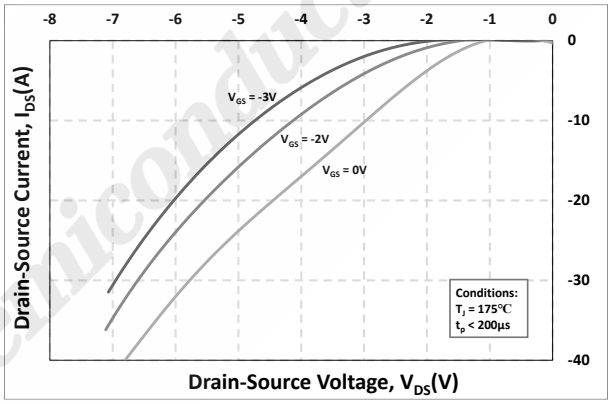



Figure 12. Body Diode Characteristic at 175°C

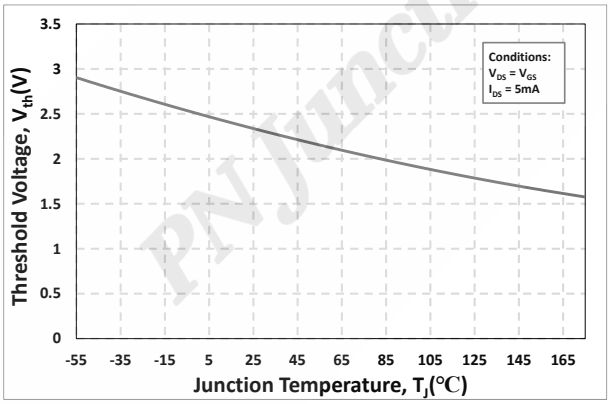



Figure 13. Threshold Voltage vs. Temperature

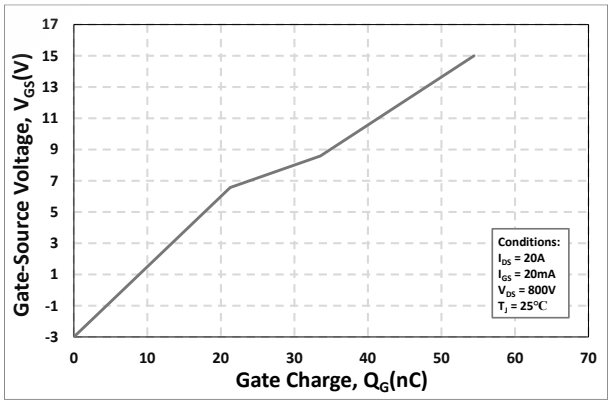



Figure 14. Gate Charge Characteristics

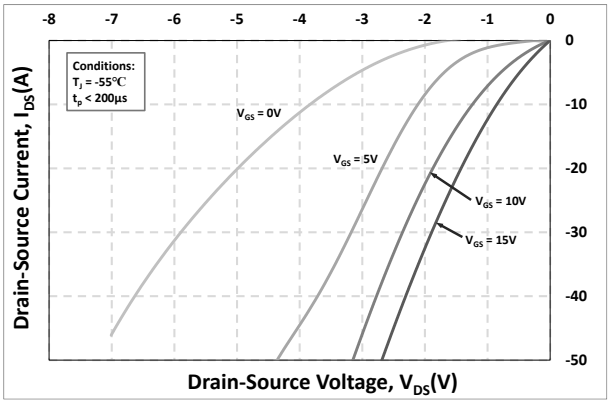



Figure 15. 3rd Quadrant Characteristic at -55°C

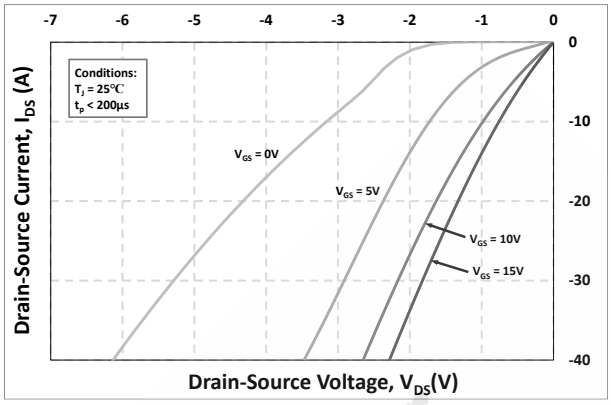



Figure 16. 3rd Quadrant Characteristic at 25°C

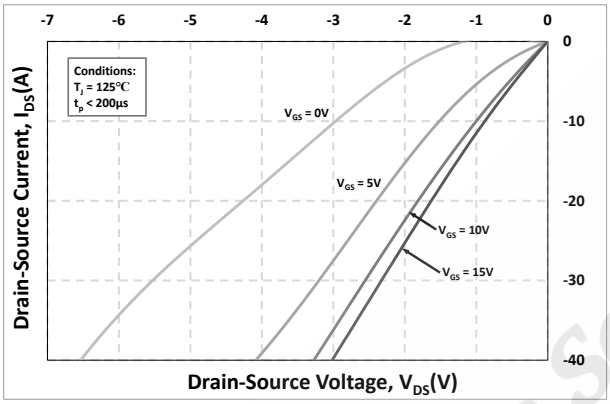



Figure 17. 3rd Quadrant Characteristic at 125°C

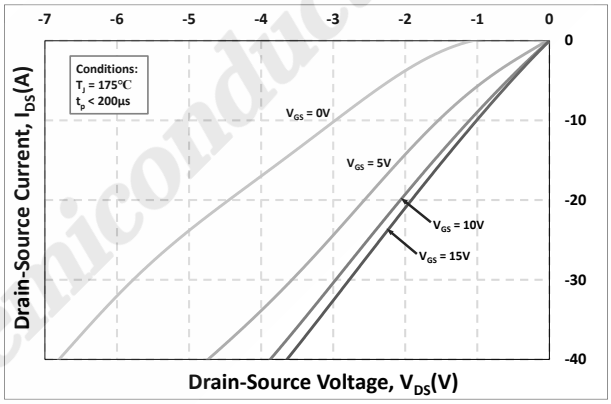



Figure 18. 3rd Quadrant Characteristic at 175°C

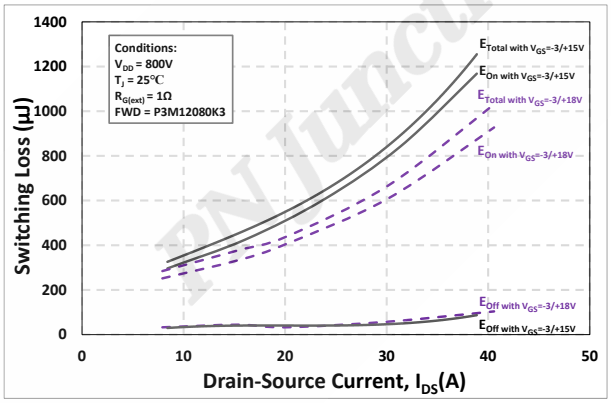



Figure 19. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD}$= 800V)

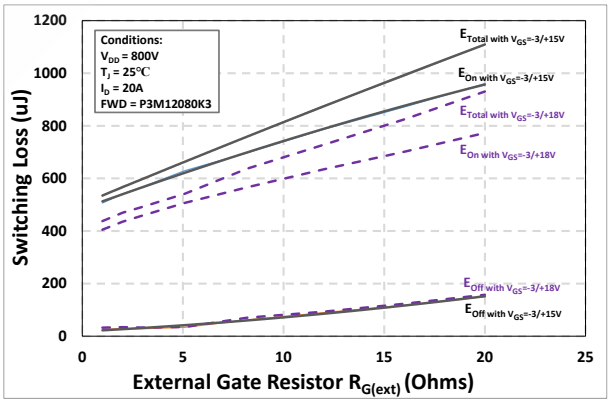



Figure 20. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

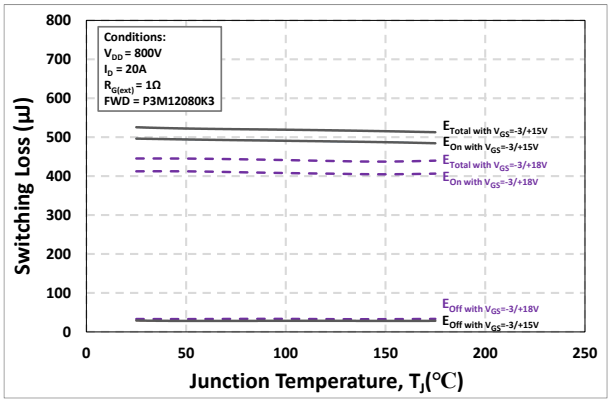



Figure 21. Clamped Inductive Switching Energy vs. Temperature

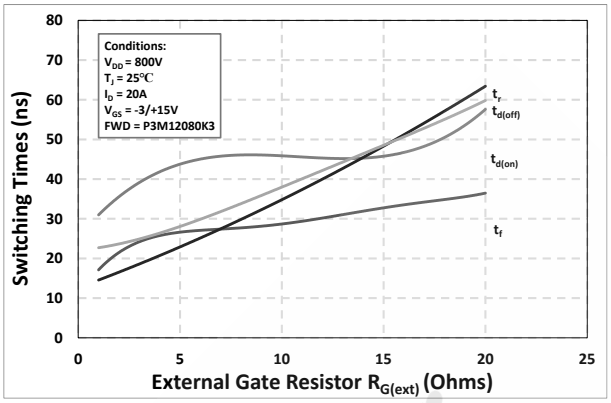



Figure 22. Switching Times vs. $R_{G(ext)}$

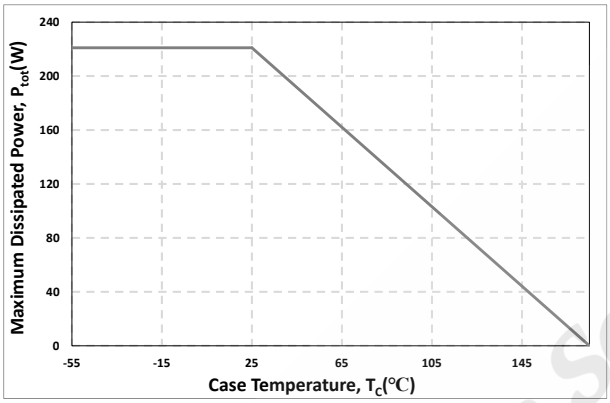



Figure 23. Maximum Power Dissipation Derating vs. Case Temperature

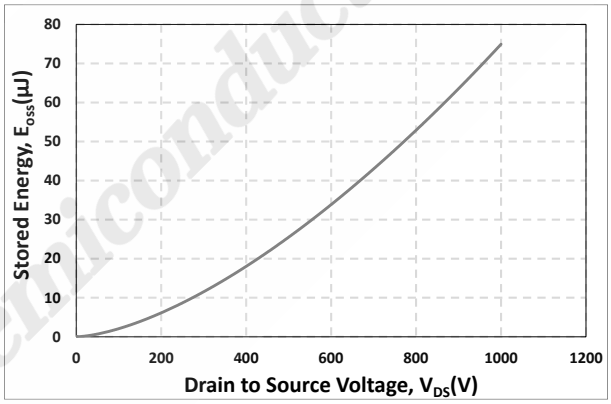



Figure 24. Output Capacitor Stored Energy

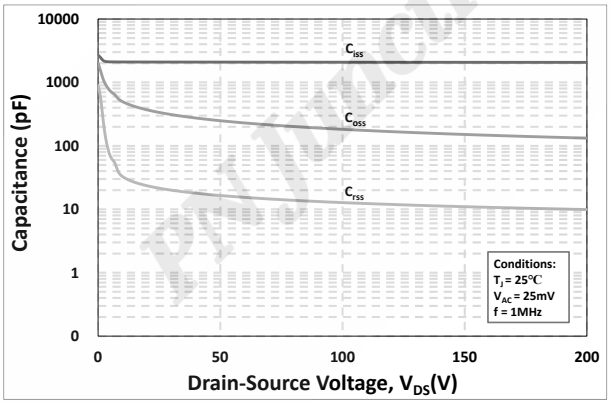



Figure 25. Capacitances vs. Drain-Source Voltage (0 - 200V)

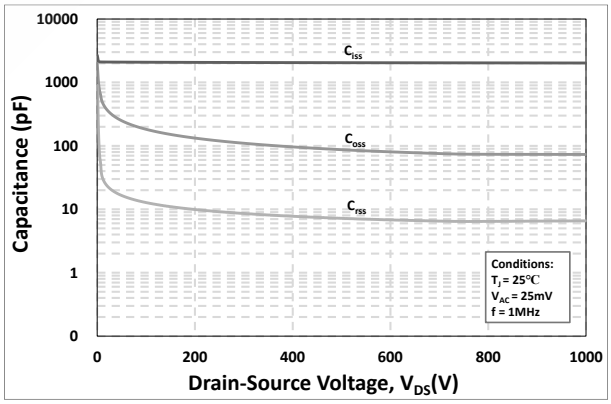



Figure 26. Capacitances vs. Drain-Source Voltage (0 - 1000V)

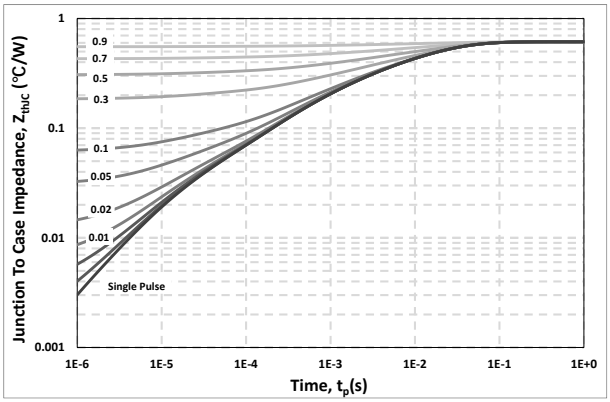



Figure 27. Transient Thermal Impedance (Junction - Case)

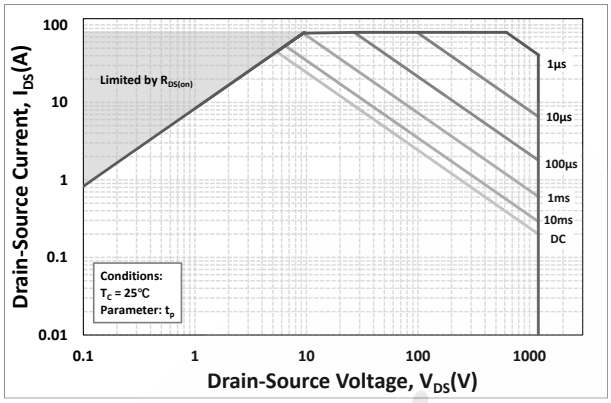



Figure 28. Safe Operating Area

## 6. Definitions

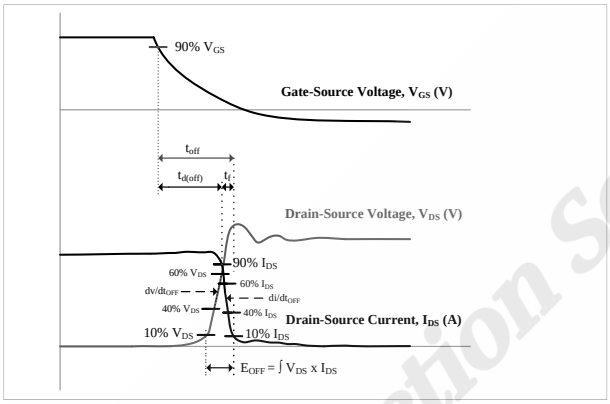



Figure 29. Turn-off Transient Definitions

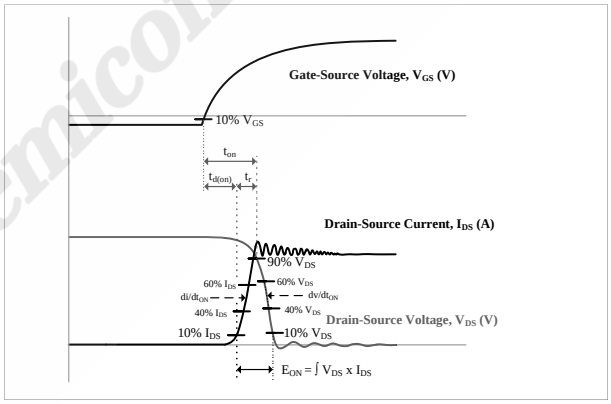



Figure 30. Turn-on Transient Definitions

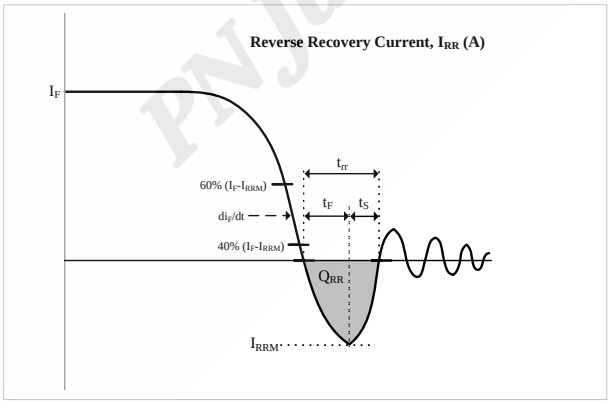



Figure 31. Reverse Recovery Definitions

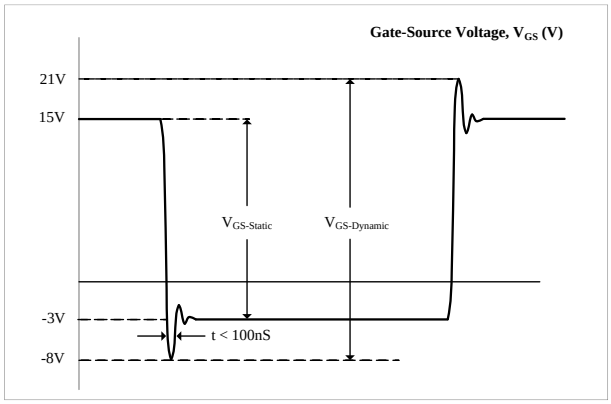
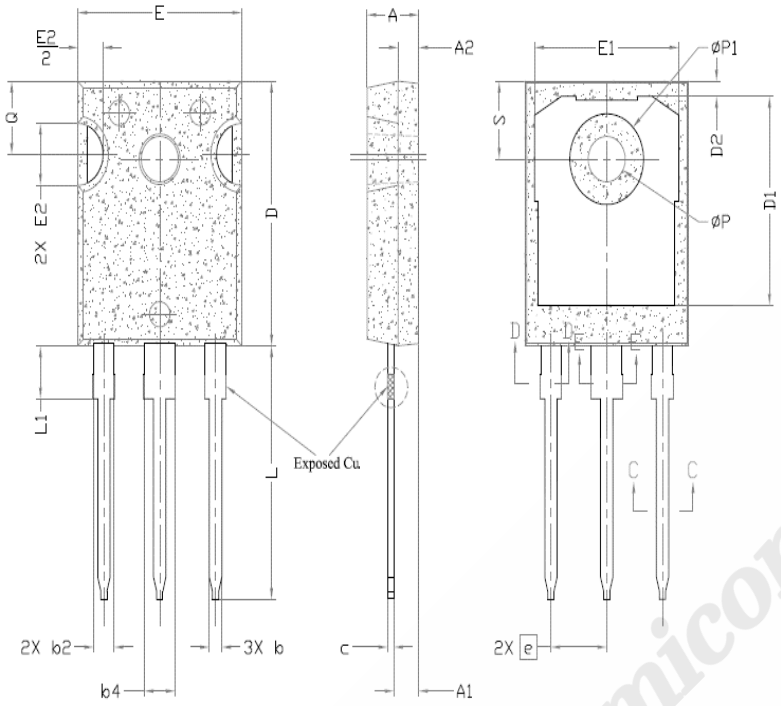



Figure 32. vgs Transient Definitions

## 7. Package Outlines




| SYMBOL | DIMENSIONS | | | NOTES |
|---|---|---|---|---|
| | MIN. | NOM. | MAX. | |
| A | 4.83 | 5.02 | 5.21 | |
| A1 | 2.29 | 2.41 | 2.55 | |
| A2 | 1.50 | 2.00 | 2.49 | |
| b | 1.12 | 1.20 | 1.33 | |
| b1 | 1.12 | 1.20 | 1.28 | |
| b2 | 1.91 | 2.00 | 2.39 | 6 |
| b3 | 1.91 | 2.00 | 2.34 | |
| b4 | 2.87 | 3.00 | 3.22 | 6, 8 |
| b5 | 2.87 | 3.00 | 3.18 | |
| c | 0.55 | 0.60 | 0.69 | 6 |
| c1 | 0.55 | 0.60 | 0.65 | |
| D | 20.80 | 20.95 | 21.10 | 4 |
| D1 | 16.25 | 16.55 | 17.65 | 5 |
| D2 | 0.51 | 1.19 | 1.35 | |
| E | 15.75 | 15.94 | 16.13 | 4 |
| E1 | 13.46 | 14.02 | 14.16 | 5 |
| E2 | 4.32 | 4.91 | 5.49 | 3 |
| e | 5.44BSC | | | |
| L | 19.81 | 20.07 | 20.32 | |
| L1 | 4.10 | 4.19 | 4.40 | 6 |
| ØP | 3.56 | 3.61 | 3.65 | 7 |
| ØP1 | 7.19REF. | | | |
| Q | 5.39 | 5.79 | 6.20 | |
| S | 6.04 | 6.17 | 6.30 | |

Drawing and Dimensions

# Important Notice

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# Warnings

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest PN Junction office.

Except as otherwise explicitly approved by PN Junction in a written document signed by authorized representatives of PN Junction, PN Junction’s products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.