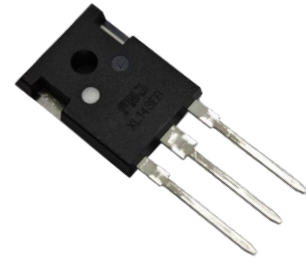


## SiC MOSFET P3M12025K3

### N-Channel Enhancement Mode



#### Features

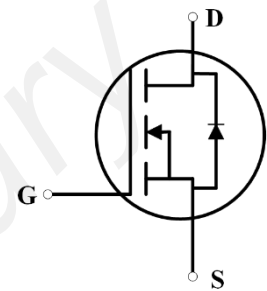
- Qualified to AEC-Q101
- High Blocking Voltage with Low On-Resistance
- High-Frequency Operation
- Ultra-Small  $Q_{gd}$
- 100% UIS tested

#### Benefits

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

#### Applications

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



TO-247-3

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



#### Order Information

| Part Number | Package  | Marking    |
|-------------|----------|------------|
| P3M12025K3  | TO-247-3 | P3M12025K3 |

## Contents

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## 1. Maximum Ratings

At  $T_J = 25^\circ\text{C}$ , unless specified otherwise

| Parameter  | Symbol                      | Value           | Unit             | Test Conditions                              |
|--|-----------------------------|-----------------|------------------|--|
| Drain - Source Voltage   | $V_{DSmax}$                 | 1200            | V                | $V_{GS} = 0V$<br>$I_D = 100\mu A$            |
| Gate - Source Voltage (dynamic)  | $V_{GSmax}$                 | -8 / +22        | V                | Duty cycle $\leq 1\%$                        |
| 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   | $I_D$                       | 74              | A                | $V_{GS} = 18V$<br>$T_C = 25^\circ\text{C}$   |
|  |                             | 52              |                  | $V_{GS} = 18V$<br>$T_C = 100^\circ\text{C}$  |
|  |                             | 70              |                  | $V_{GS} = 15V$<br>$T_C = 25^\circ\text{C}$   |
|  |                             | 49              |                  | $V_{GS} = 15V$<br>$T_C = 100^\circ\text{C}$  |
| Pulsed Drain Current   | $I_{D(pulse)}$              | 200             | A                | $PW \leq 10\mu s$ ,<br>Duty cycle $\leq 1\%$ |
| Power Dissipation  | $P_D$                       | 375             | W                |  |
| Operating Junction   | $T_J$                       | -55 To +175     | $^\circ\text{C}$ |  |
| Storage Temperature  | $T_{stg}$                   | -55 To +175     | $^\circ\text{C}$ |  |
| Solder Temperature   | $T_L$                       | 260             | $^\circ\text{C}$ |  |
| Mounting Torque  | $M_d$                       | 1               | Nm               | M3 or 6-32 screw                             |
|  |                             | 8.8             | lbf-in           |  |

## 2. Electrical Characteristics

At  $T_J = 25^\circ\text{C}$ , 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>$I_D = 1.5mA$                                 |
| Gate Threshold Voltage           | $V_{GS(th)}$  | 2.0   | 2.6  | /    | V             | $V_{DS} = V_{GS}$<br>$I_D = 10mA$<br>$T_J = 25^\circ\text{C}$  |
|                                  |               | /     | 2.0  | /    | V             | $V_{DS} = V_{GS}$<br>$I_D = 10mA$<br>$T_J = 175^\circ\text{C}$ |
| Reverse Bias Drain Current       | $I_{DSS}$     | /     | 1    | 100  | $\mu\text{A}$ | $V_{GS} = 0V$<br>$V_{DS} = 1200V$                              |
| Gate-Source Leakage Current      | $I_{GSS}$     | /     | 1    | 250  | nA            | $V_{GS} = -5 \sim 18V$<br>$V_{DS} = 0V$                        |
| Drain-Source On-State Resistance | $R_{DS(on)}$  | /     | 25   | 35   | m $\Omega$    | $V_{GS} = 18V$<br>$I_D = 40A$<br>$T_J = 25^\circ\text{C}$      |
|                                  |               | /     | 40   | /    |               | $V_{GS} = 18V$<br>$I_D = 40A$<br>$T_J = 175^\circ\text{C}$     |
|                                  |               | /     | 29   | /    |               | $V_{GS} = 15V$<br>$I_D = 40A$<br>$T_J = 25^\circ\text{C}$      |
|                                  |               | /     | 43   | /    |               | $V_{GS} = 15V$<br>$I_D = 40A$<br>$T_J = 175^\circ\text{C}$     |
| Transconductance                 | $g_{fs}$      | /     | 21   | /    | S             | $V_{DS} = 20V$<br>$I_{DS} = 40A$<br>$T_J = 25^\circ\text{C}$   |
|                                  |               | /     | 20   | /    |               | $V_{DS} = 20V$<br>$I_{DS} = 40A$<br>$T_J = 175^\circ\text{C}$  |

| Parameter                    | Symbol       | Value |      |      | Unit     | Test Conditions  |
|------------------------------|--------------|-------|------|------|----------|--|
|                              |              | Min.  | Typ. | Max. |          |  |
| Input Capacitance            | $C_{iss}$    | /     | 3800 | /    | pF       | $V_{GS} = 0V$<br>$V_{DS} = 800V$<br>$f = 1MHz$<br>$V_{AC} = 25mV$      |
| Output Capacitance           | $C_{oss}$    | /     | 143  | /    |          |  |
| Reverse Transfer Capacitance | $C_{rss}$    | /     | 7.4  | /    |          |  |
| Coss Stored Energy           | $E_{oss}$    | /     | 50   | /    | $\mu J$  |  |
| Turn-on Energy               | $E_{on}$     | /     | 237  | /    | $\mu J$  |  |
| Turn-off Energy              | $E_{off}$    | /     | 86   | /    |          |  |
| Turn-On Delay Time           | $T_{d(on)}$  | /     | 30   | /    | ns       | $V_{DS} = 800V$<br>$V_{GS} = -3/15V$<br>$I_D = 30A$<br>$R_G = 1\Omega$ |
| Rise Time                    | $T_r$        | /     | 17   | /    |          |  |
| Turn-Off Delay Time          | $T_{d(off)}$ | /     | 34   | /    |          |  |
| Fall Time                    | $T_f$        | /     | 9    | /    |          |  |
| Turn-on Energy               | $E_{on}$     | /     | 200  | /    | $\mu J$  |  |
| Turn-off Energy              | $E_{off}$    | /     | 71   | /    |          |  |
| Turn-On Delay Time           | $T_{d(on)}$  | /     | 27   | /    | ns       | $V_{DS} = 800V$<br>$V_{GS} = -4/18V$<br>$I_D = 30A$<br>$R_G = 1\Omega$ |
| Rise Time                    | $T_r$        | /     | 15   | /    |          |  |
| Turn-Off Delay Time          | $T_{d(off)}$ | /     | 36   | /    |          |  |
| Fall Time                    | $T_f$        | /     | 9    | /    |          |  |
| Internal Gate Resistance     | $R_{G(int)}$ | /     | 1.3  | /    | $\Omega$ | $f = 1MHz$<br>$V_{AC} = 25mV$  |

| Parameter             | Symbol   | Value |      |      | Unit | Test Conditions   |
|-----------------------|----------|-------|------|------|------|---|
|                       |          | Min.  | Typ. | Max. |      |   |
| Gate to Source Charge | $Q_{gs}$ | /     | 47   | /    | nC   | $V_{DS} = 800V$<br>$I_{DS} = 40A$<br>$V_{GS} = -3/15V$<br>$I_G = 5mA$ |
| Gate to Drain Charge  | $Q_{gd}$ | /     | 49   | /    |      |   |
| Total Gate Charge     | $Q_g$    | /     | 116  | /    |      |   |
| Gate to Source Charge | $Q_{gs}$ | /     | 45   | /    | nC   | $V_{DS} = 800V$<br>$I_{DS} = 40A$<br>$V_{GS} = -4/18V$<br>$I_G = 5mA$ |
| Gate to Drain Charge  | $Q_{gd}$ | /     | 51   | /    |      |   |
| Total Gate Charge     | $Q_g$    | /     | 134  | /    |      |   |

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### 3. Reverse Diode Characteristics

At  $T_J = 25^\circ\text{C}$ , unless specified otherwise

| Parameter                        | Symbol    | Value |      | Unit | Test Conditions   |
|----------------------------------|-----------|-------|------|------|---|
|                                  |           | Typ.  | Max. |      |   |
| Diode Forward Voltage            | $V_{SD}$  | 5.5   | /    | V    | $V_{GS} = -3\text{V}$<br>$I_{SD} = 20\text{A}$<br>$T_J = 25^\circ\text{C}$  |
|                                  |           | 5.2   | /    | V    | $V_{GS} = -3\text{V}$<br>$I_{SD} = 20\text{A}$<br>$T_J = 175^\circ\text{C}$ |
| Continuous Diode Forward Current | $I_S$     | /     | 63   | A    | $V_{GS} = -3\text{V}$   |
| Reverse Recover Time             | $t_{rr}$  | 11    | /    | ns   | $V_{GS} = -3/15\text{V}$<br>$I_{SD} = 30\text{A}$                           |
| Reverse Recovery Charge          | $Q_{rr}$  | 59    | /    | nC   | $V_R = 800\text{V}$<br>$d_{if}/d_t = 3250\text{A}/\mu\text{s}$              |
| Peak Reverse Recovery Current    | $I_{rrm}$ | 18    | /    | A    | $T_J = 25^\circ\text{C}$  |
| Reverse Recover Time             | $t_{rr}$  | 10    | /    | ns   | $V_{GS} = -4/18\text{V}$<br>$I_{SD} = 30\text{A}$                           |
| Reverse Recovery Charge          | $Q_{rr}$  | 55    | /    | nC   | $V_R = 800\text{V}$<br>$d_{if}/d_t = 3500\text{A}/\mu\text{s}$              |
| Peak Reverse Recovery Current    | $I_{rrm}$ | 21    | /    | A    | $T_J = 25^\circ\text{C}$  |

### 4. Thermal Characteristics

| Parameter                                | Symbol          | Value | Unit                      |
|--|-----------------|-------|---------------------------|
| Thermal Resistance from Junction to Case | $R_{\theta JC}$ | 0.44  | $^\circ\text{C}/\text{W}$ |

### 5. Typical Performance

At  $T_J = 25^\circ\text{C}$ , unless specified otherwise

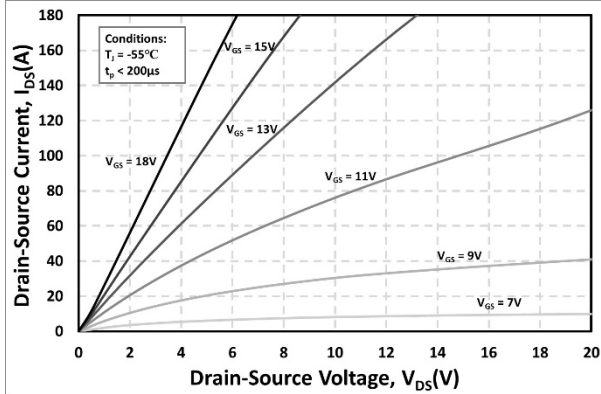


Figure 1. Output Characteristics  $T_J = -55^\circ\text{C}$

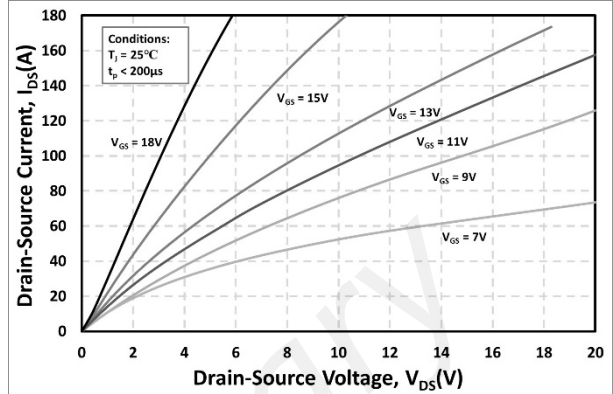


Figure 2. Output Characteristics  $T_J = 25^\circ\text{C}$

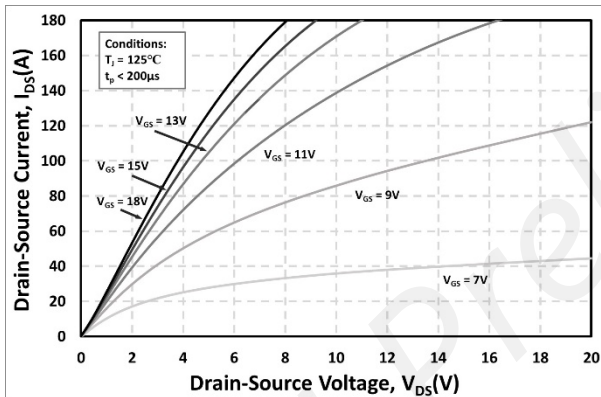


Figure 3. Output Characteristics  $T_J = 125^\circ\text{C}$

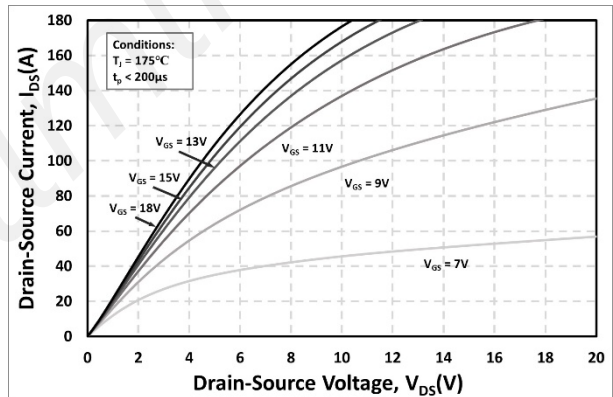


Figure 4. Output Characteristics  $T_J = 175^\circ\text{C}$

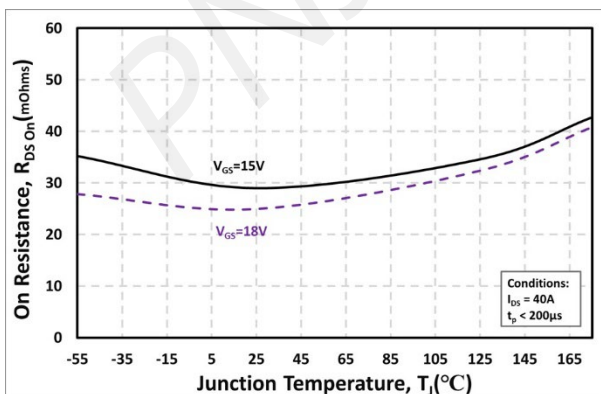


Figure 5. Normalized On-Resistance vs. Temperature

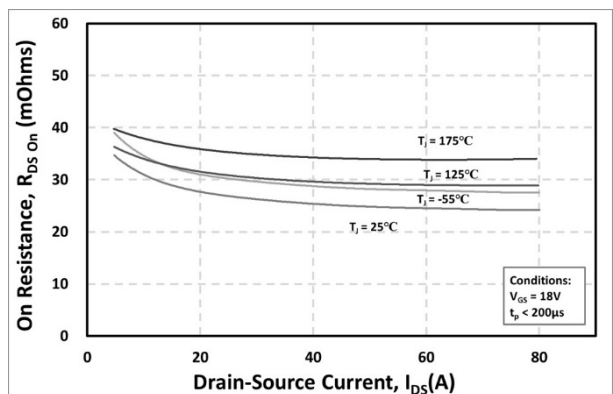


Figure 6. On-Resistance vs. Drain Current Various Temperatures

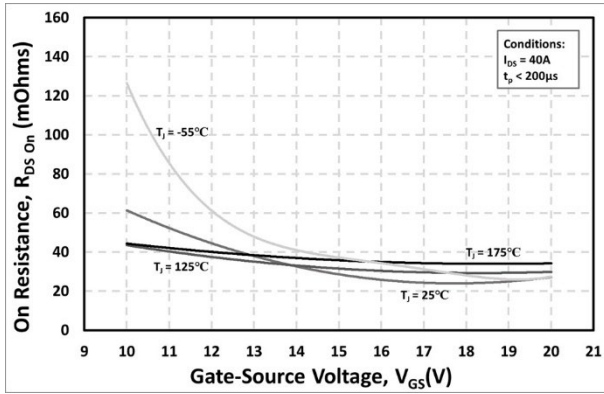


Figure 7. On-Resistance vs. Gate-Source Voltage

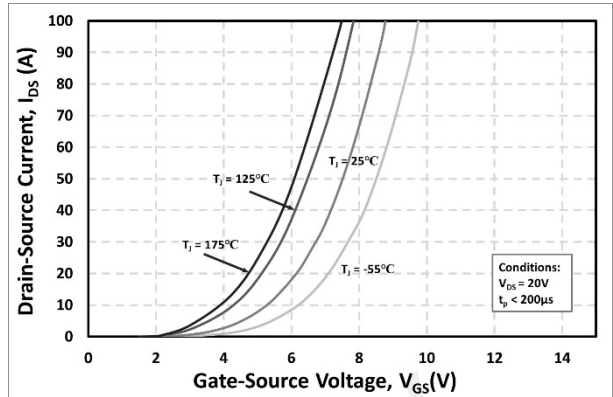


Figure 8. Transfer Characteristic for Various Junction Temperatures

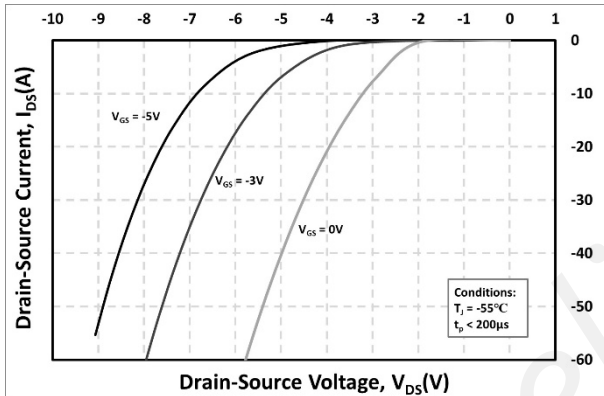


Figure 9. Body Diode Characteristic at -55°C

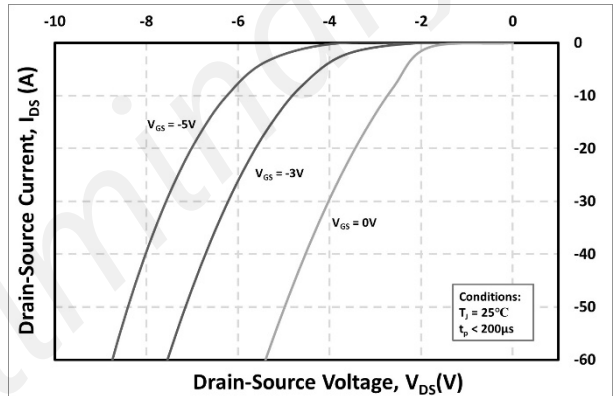


Figure 10. Body Diode Characteristic at 25°C

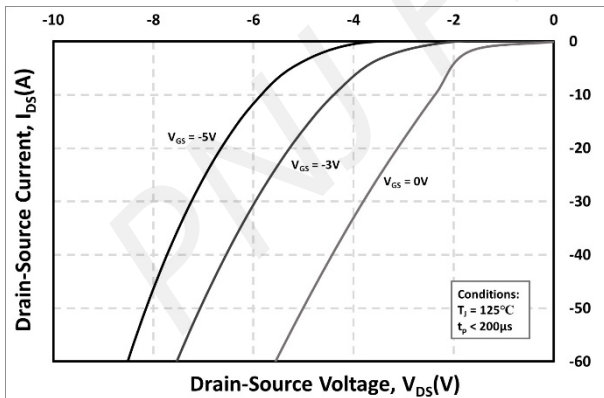


Figure 11. Body Diode Characteristic at 125°C

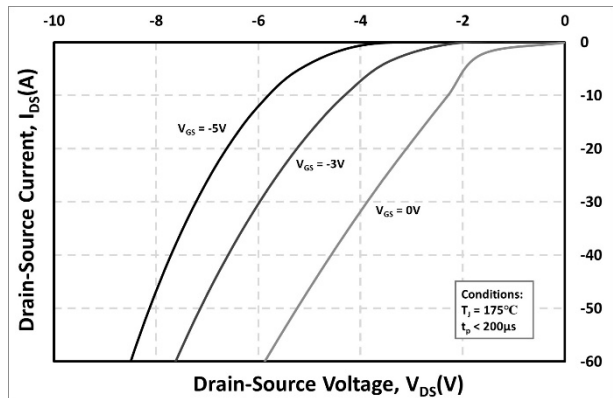


Figure 12. Body Diode Characteristic at 175°C

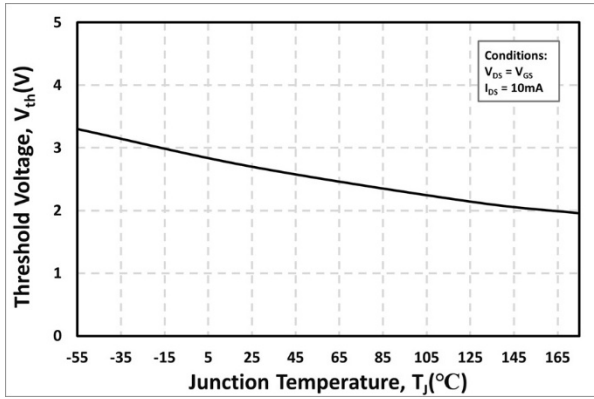


Figure 13. Threshold Voltage vs. Temperature

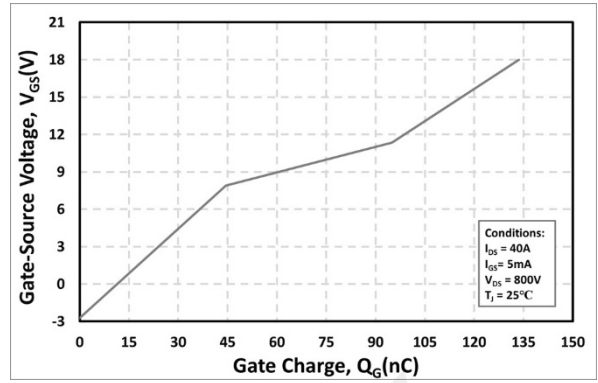


Figure 14. Gate Charge Characteristics

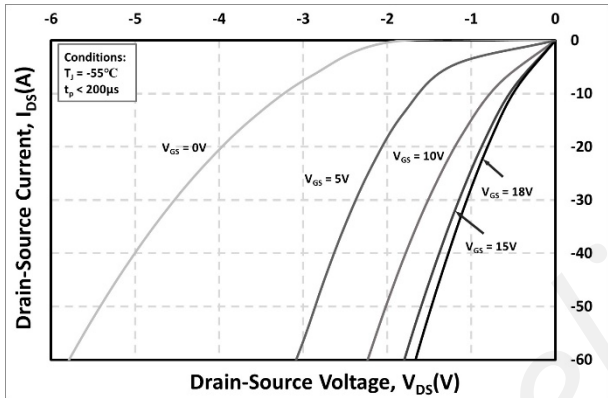


Figure 15. 3rd Quadrant Characteristic at -55°C

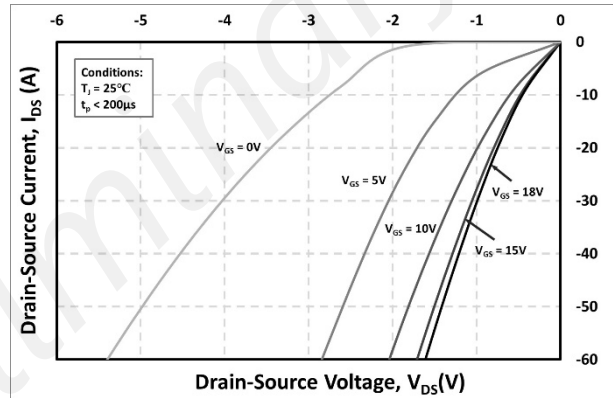


Figure 16. 3rd Quadrant Characteristic at 25°C

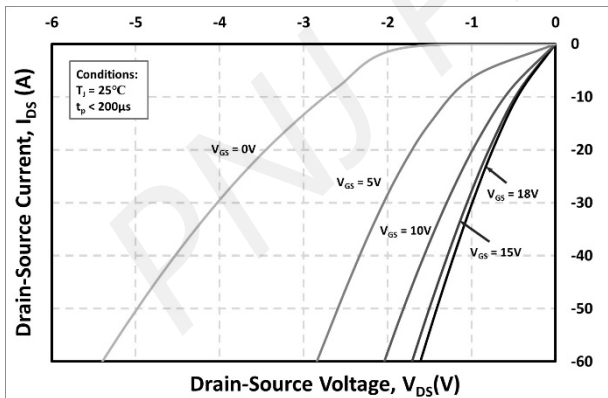


Figure 17. 3rd Quadrant Characteristic at 125°C

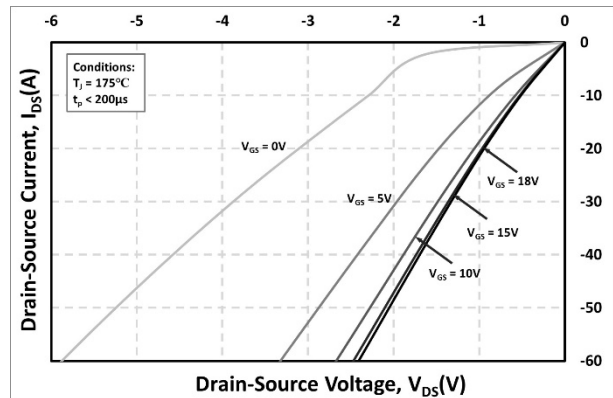


Figure 18. 3rd Quadrant Characteristic at 175°C

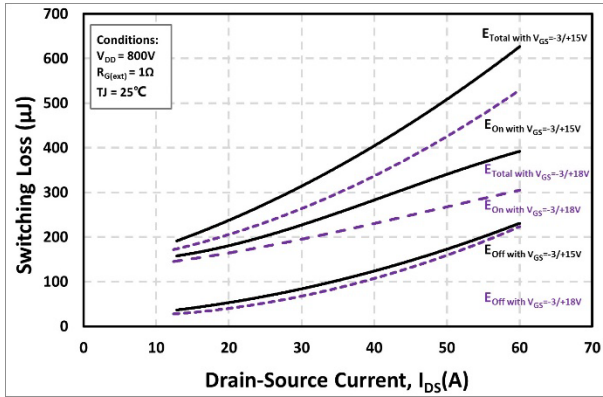


Figure 19. Clamped Inductive Switching Energy vs. Drain Current ( $V_{DD}=800V$ )

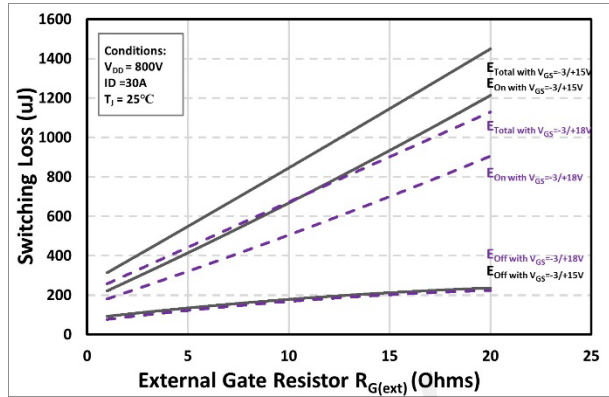


Figure 20. Clamped Inductive Switching Energy vs.  $R_{G(ext)}$

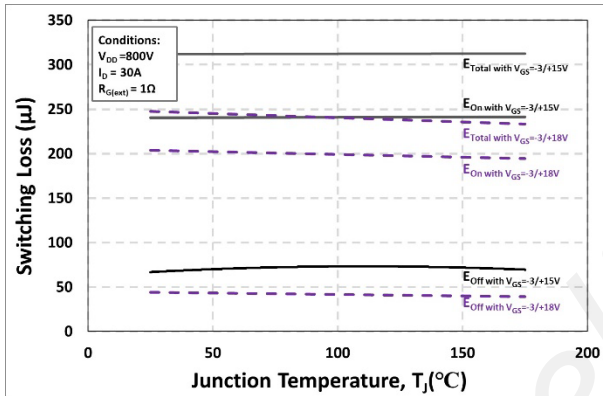


Figure 21. Clamped Inductive Switching Energy vs. Temperature

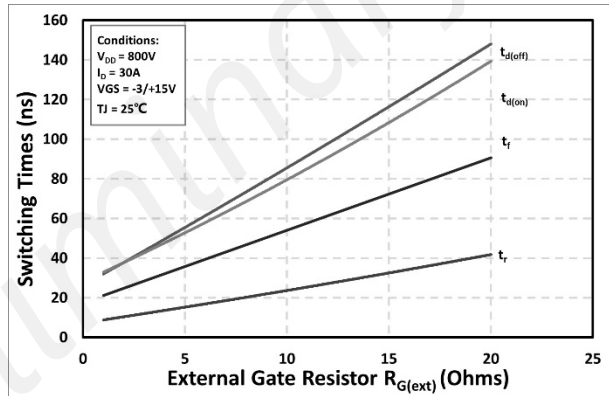


Figure 22. Switching Times vs.  $R_{G(ext)}$

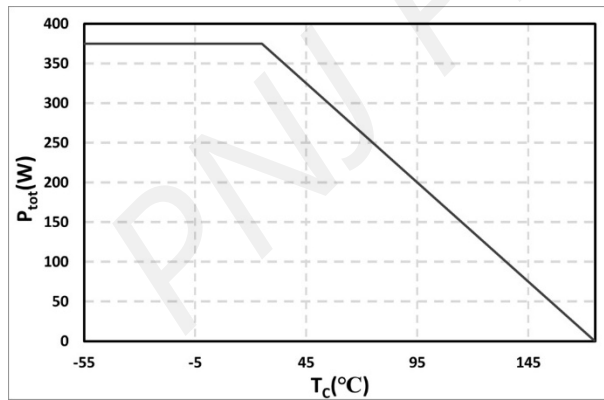


Figure 23. Maximum Power Dissipation Derating vs. Case Temperature

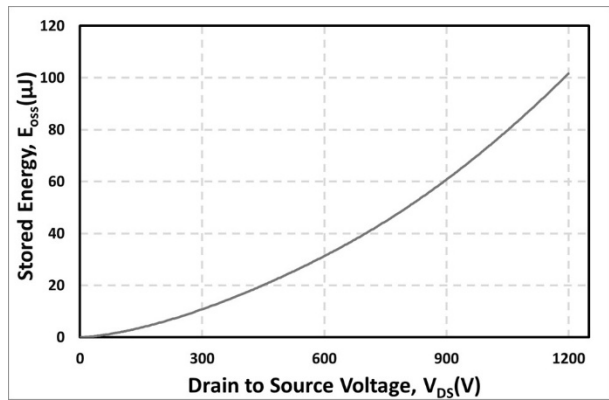


Figure 24. Output Capacitor Stored Energy

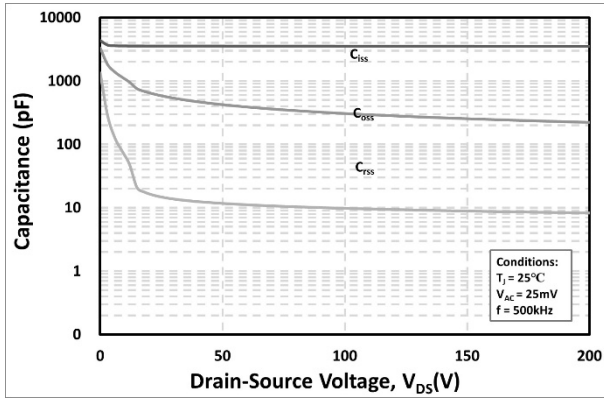


Figure 25. Capacitances vs. Drain-Source Voltage (0 - 200V)

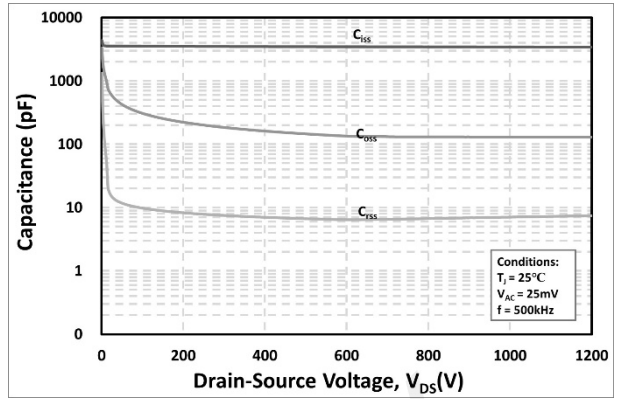


Figure 26. Capacitances vs. Drain-Source Voltage (0 - 1200V)

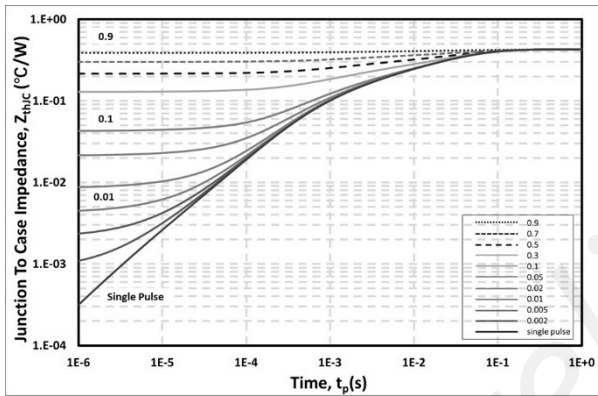


Figure 27. Transient Thermal Impedance (Junction - Case)

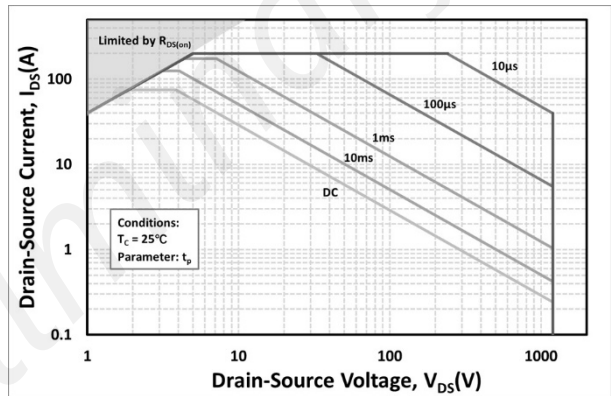


Figure 28. Safe Operating Area

## 6. Definitions

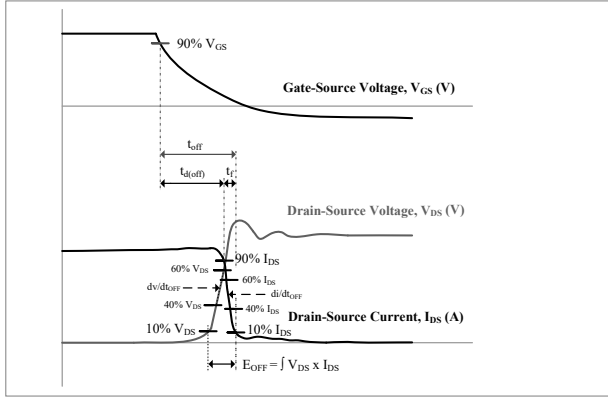


Figure 29. Turn-off Transient Definitions

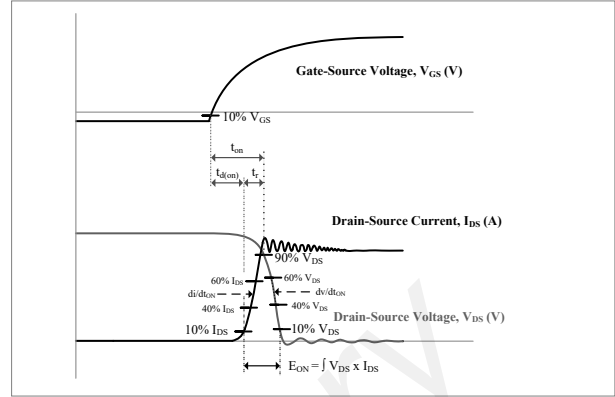


Figure 30. Turn-on Transient Definitions

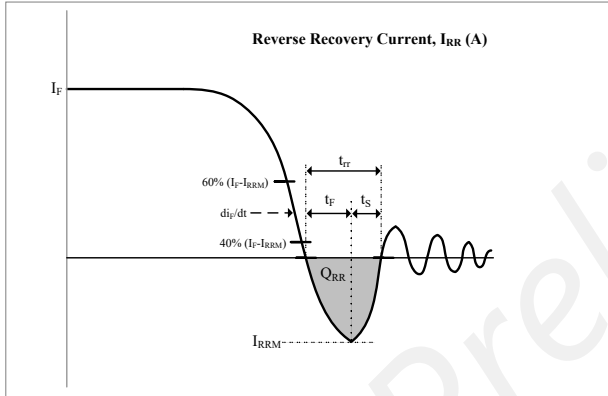


Figure 31. Reverse Recovery Definitions

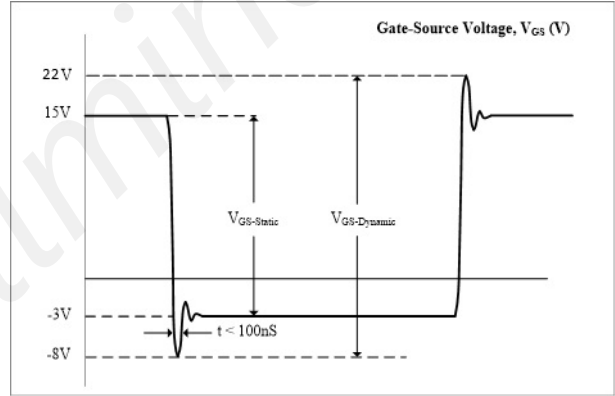
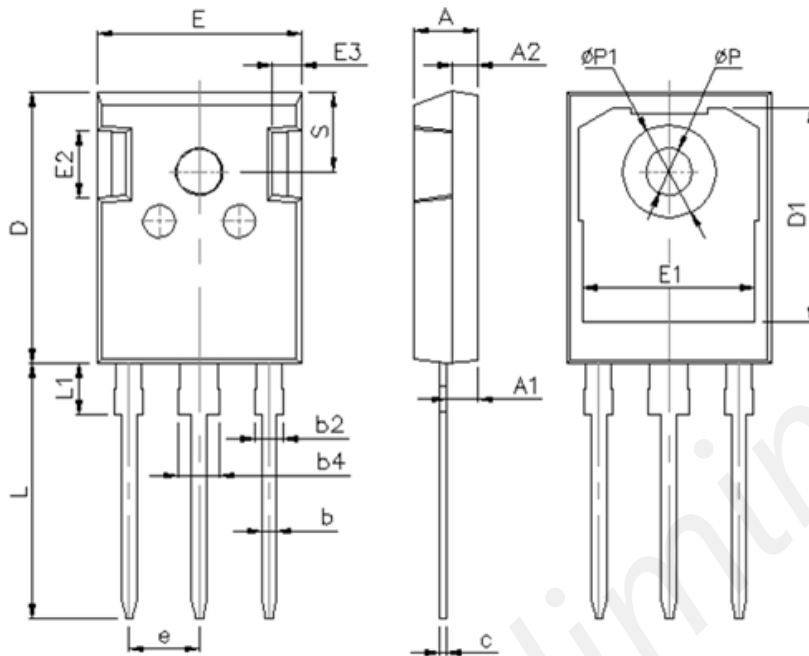


Figure 32. V<sub>GS</sub> Transient Definitions

## 7. Package Outlines



| SYMBOL    | DIMENSIONS |       |       |
|-----------|------------|-------|-------|
|           | MIN        | NOM   | MAX   |
| A         | 4.80       | 5.00  | 5.20  |
| A1        | 2.20       | 2.40  | 2.60  |
| A2        | 1.85       | 2.00  | 2.15  |
| b         | 1.07       | 1.20  | 1.33  |
| b2        | 1.90       | 2.03  | 2.16  |
| b4        | 2.90       | 3.05  | 3.20  |
| c         | 0.52       | 0.60  | 0.68  |
| D         | 20.70      | 21.00 | 21.30 |
| D1        | 16.15      | 16.55 | 16.95 |
| E         | 15.50      | 15.80 | 16.10 |
| E1        | 13.00      | 13.30 | 13.60 |
| E2        | 5.00       | 5.25  | 5.50  |
| E3        | 1.90       | 2.25  | 2.60  |
| e         |            | 0.00  |       |
| L         | 19.30      | 19.60 | 19.90 |
| L1        | 3.75       | 3.95  | 4.15  |
| $\phi P$  | 3.40       | 3.60  | 3.80  |
| $\phi P1$ | 7.00       | 7.20  | 7.40  |
| S         | 6.04       | 6.17  | 6.30  |

Drawing and Dimensions

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