

# 56A,650V N-Channel Silicon Carbide Power MOSFET

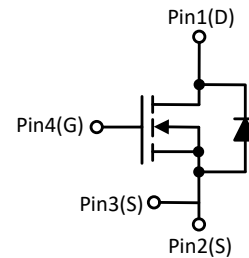
## Features

- High blocking voltage
- Low on-resistance with high junction temperature
- High-speed switching with low capacitances
- Fast intrinsic diode with low reverse recovery (Qrr)
- RoHS compliant



## Applications

- Switch Mode Power Supplies
- DC/DC converters
- Solar Inverters
- Battery Chargers
- Motor Drives



### Absolute Maximum Ratings (@ $T_J=25^{\circ}\text{C}$ unless otherwise noted)

| Parameter                                     | Symbol        | Ratings    | Unit               |
|---|---------------|------------|--------------------|
| Drain-Source Voltage                          | $V_{DS}$      | 650        | V                  |
| Gate Source Voltage                           | $V_{GS}$      | -5/+20     | V                  |
| Drain Current Continuous                      | $I_D$         | 56         | A                  |
| Drain Current Pulse                           | $I_{DM}$      | 112        | A                  |
| Power Dissipation( $T_C=25^{\circ}\text{C}$ ) | $P_D$         | 259        | W                  |
| Operating Temperature/ Storage Temperature    | $T_J/T_{STG}$ | -55 ~ +175 | $^{\circ}\text{C}$ |

### Thermal Characteristics

| Parameter                               | Symbol          | Typ  | Unit                        |
|---|-----------------|------|-----------------------------|
| Thermal Resistance ,Junction-to-Ambient | $R_{\theta JA}$ | --   | $^{\circ}\text{C}/\text{W}$ |
| Thermal Resistance Junction-to-Case     | $R_{\theta JC}$ | 0.59 | $^{\circ}\text{C}/\text{W}$ |

| <b>Electrical Characteristics</b> (@ $T_J=25^{\circ}\text{C}$ unless otherwise noted) |               |  |     |       |     |            |
|---|---------------|--|-----|-------|-----|------------|
| Parameter   | Symbol        | Test Conditions  | Min | Typ   | Max | Unit       |
| Drain-Source Breakdown Voltage  | $V_{(BR)DSS}$ | $V_{GS}=0V, I_D=100\mu A$                                | 650 | --    | --  | V          |
| Gate Leakage Current  | $I_{GSS}$     | $V_{GS}=20V$   | --  | 5     | 250 | nA         |
| Zero Gate Voltage Drain Current   | $I_{DSS}$     | $V_{DS}=650V, V_{GS}=0V$                                 | --  | 10    | 100 | $\mu A$    |
| Gate Threshold Voltage  | $V_{GS(TH)}$  | $V_{DS}=V_{GS}, I_D=5mA$                                 | 2   | --    | 4   | V          |
| Drain-Source On-state Resistance  | $R_{DS(on)}$  | $V_{GS}=20V, I_D=13.2A$                                  | --  | 60    | 80  | m $\Omega$ |
| Total Gate Charge   | $Q_g$         | $V_{GS}=-5/+20V, V_{DS}=400V, I_D=13.2A$                 | --  | 62    | --  | nC         |
| Gate- Source Charge   | $Q_{gs}$      |  | --  | 18    | --  | nC         |
| Gate- Drain Charge  | $Q_{gd}$      |  | --  | 33    | --  | nC         |
| Turn-on Delay Time  | $t_{d(on)}$   | $V_{GS}=-5/+20V, V_{DS}=400V, I_D=13.2A, R_G=2.5\Omega,$ | --  | 21.3  | --  | ns         |
| Turn-on Rise Time   | $t_r$         |  | --  | 14.5  | --  | ns         |
| Turn-off Delay Time   | $t_{d(off)}$  |  | --  | 132.6 | --  | ns         |
| Turn-off Fall Time  | $t_f$         |  | --  | 42.7  | --  | ns         |
| Input Capacitance   | $C_{iss}$     | $V_{GS}=0V, V_{DS}=600V, f=1.0MHz, V_{AC}=25mV$          | --  | 1129  | --  | pF         |
| Output Capacitance  | $C_{oss}$     |  | --  | 114   | --  | pF         |
| Reverse Transfer Capacitance  | $C_{rss}$     |  | --  | 6.5   | --  | pF         |

| <b>Reverse Diode Characteristics</b> (@ $T_J=25^{\circ}\text{C}$ unless otherwise noted) |          |   |     |     |     |      |
|--|----------|---|-----|-----|-----|------|
| Parameter  | Symbol   | Test Conditions   | Min | Typ | Max | Unit |
| Continuous Diode Forward Current   | $I_{SD}$ |   | --  | --  | 56  | A    |
| Diode Forward Voltage  | $V_{SD}$ | $I_S=6.6A, V_{GS}=0V$                                     | 3   | --  | --  | V    |
| Reverse Recovery Time  | $t_{rr}$ | $I_S=13.2A, V_{GS}=-5V, V_{DS}=400V, di/dt=2100 A/\mu s,$ | --  | 23  | --  | ns   |
| Reverse Recovery Charge  | $Q_{rr}$ |   | --  | 132 | --  | nC   |

## Ratings and Characteristics Curves

( $T_A = 25^\circ\text{C}$  unless otherwise noted)

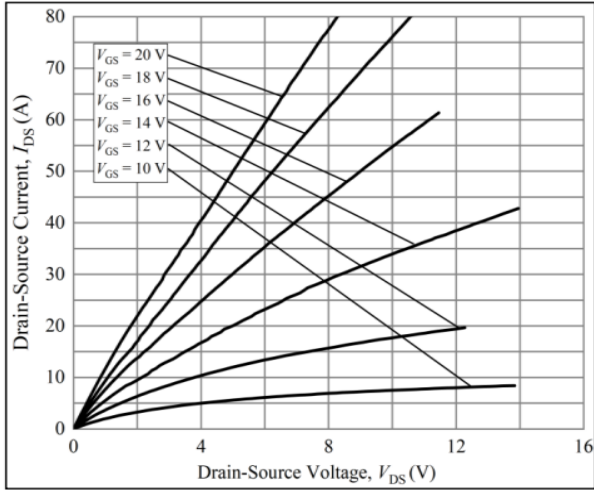


Figure 1. Typical Output Characteristics at  $T_J = -55^\circ\text{C}$

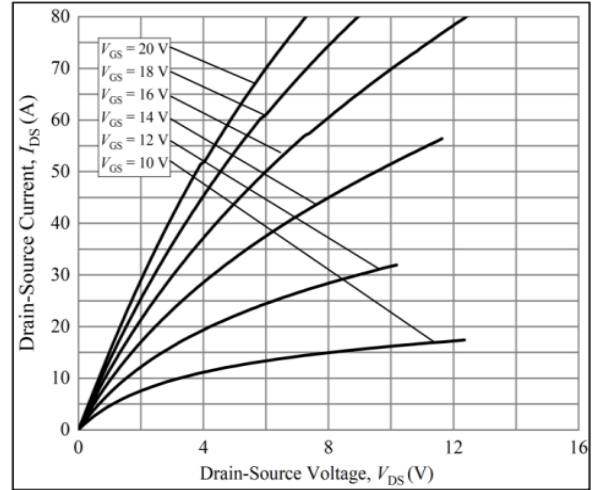


Figure 2. Typical Output Characteristics at  $T_J = 25^\circ\text{C}$

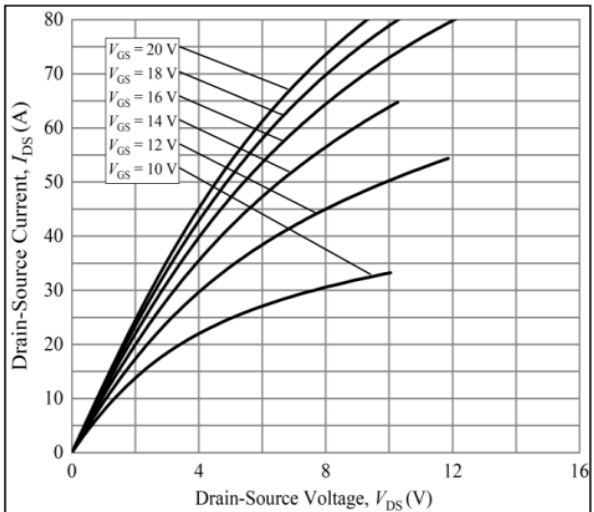


Figure 3. Typical Output Characteristics at  $T_J = 175^\circ\text{C}$

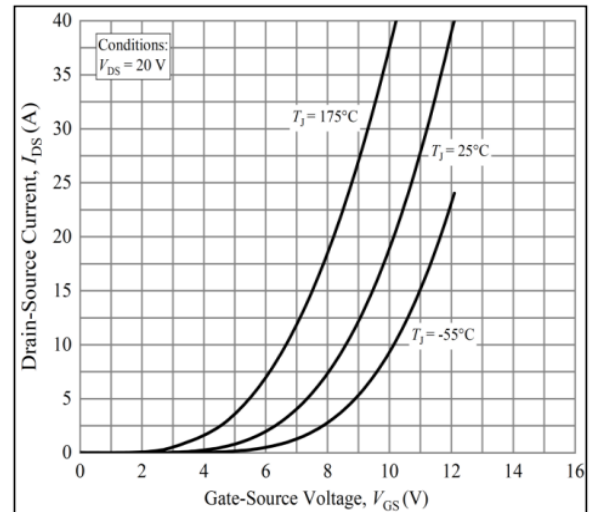


Figure 4. Typical Transfer Characteristics for Various Temperature

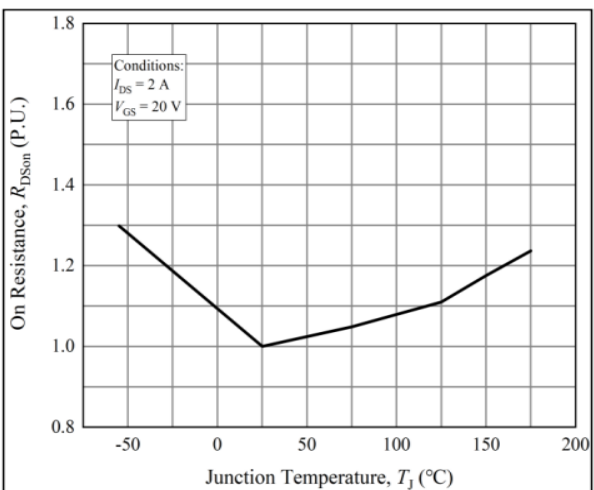


Figure 5. Normalized On-Resistance vs. Temperature

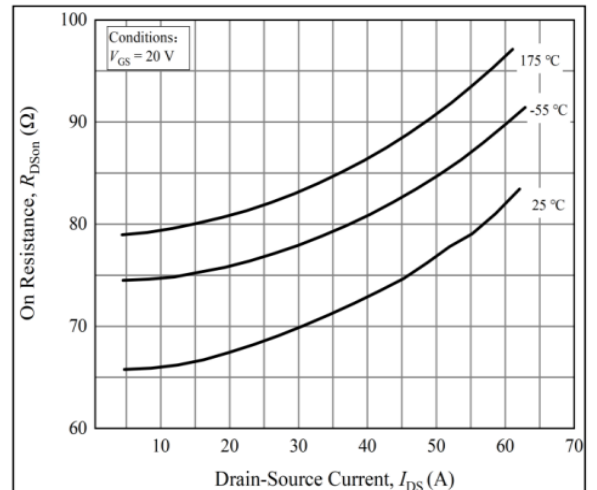


Figure 6. On-Resistance vs. Drain Current for Various Temperatures

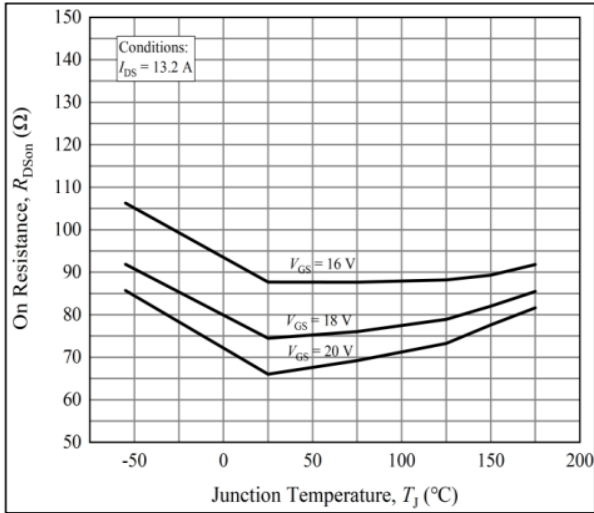


Figure 7. On-Resistance vs. Temperature for Gate

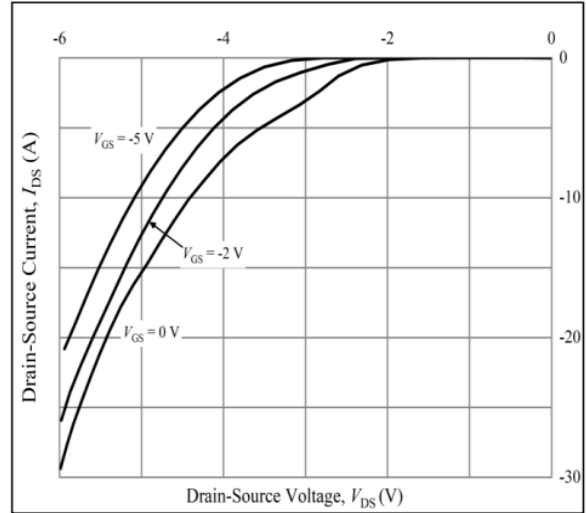


Figure8. Typical Body Diode Characteristics at  $T_J = -55\text{ }^{\circ}\text{C}$

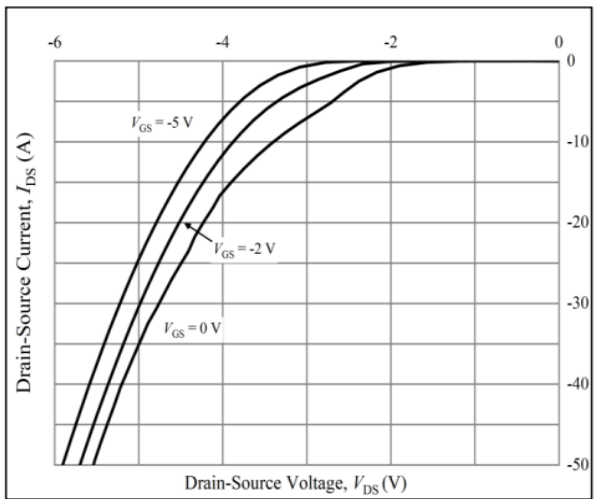


Figure 9. Typical Body Diode Characteristics at  $T_J = 25\text{ }^{\circ}\text{C}$

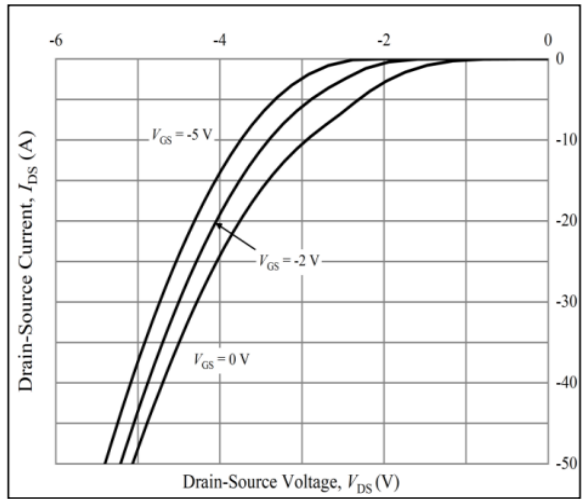


Figure 10. Typical Body Diode Characteristics at  $T_J = 175\text{ }^{\circ}\text{C}$

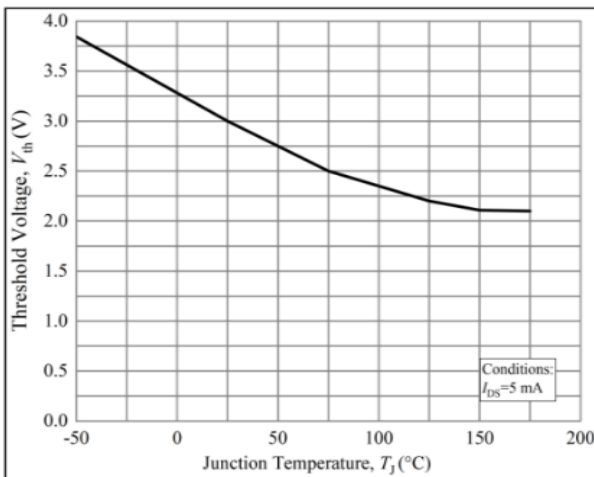


Figure 11. Typical Threshold Voltage vs. Temperature

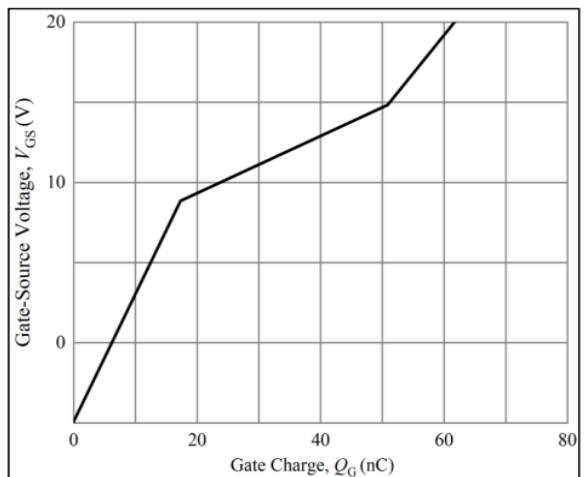


Figure 12. Typical Gate Charge Characteristics at  $T_J = 25\text{ }^{\circ}\text{C}$

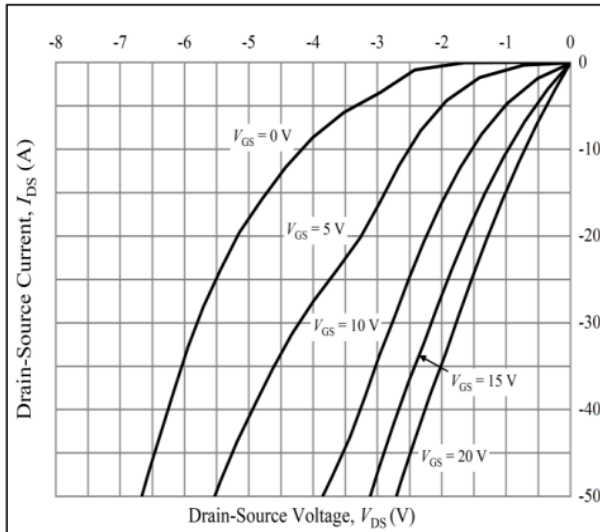


Figure 13. Typical 3rd Quadrant Characteristics at  $T_J = -55\text{ }^\circ\text{C}$

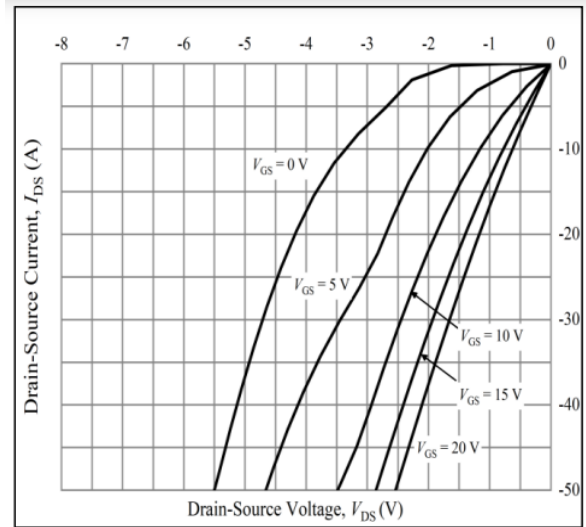


Figure 14. Typical 3rd Quadrant Characteristics at  $T_J = 25\text{ }^\circ\text{C}$

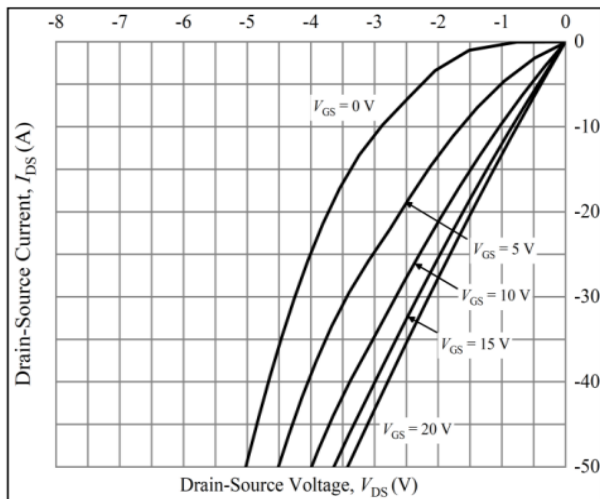


Figure 15. Typical 3rd Quadrant Characteristics at  $T_J = 175\text{ }^\circ\text{C}$

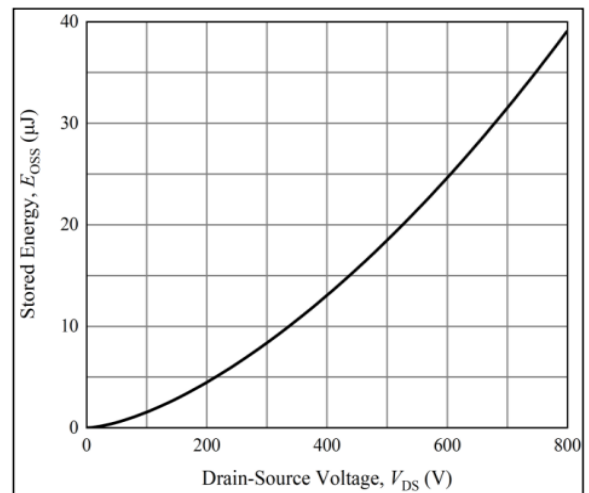


Figure 16. Typical Output Capacitor Stored Energy

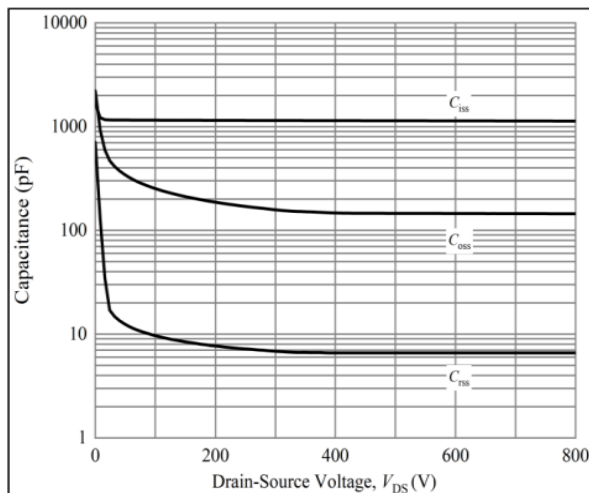


Figure 17. Typical Capacitances vs. Drain-Source Voltage

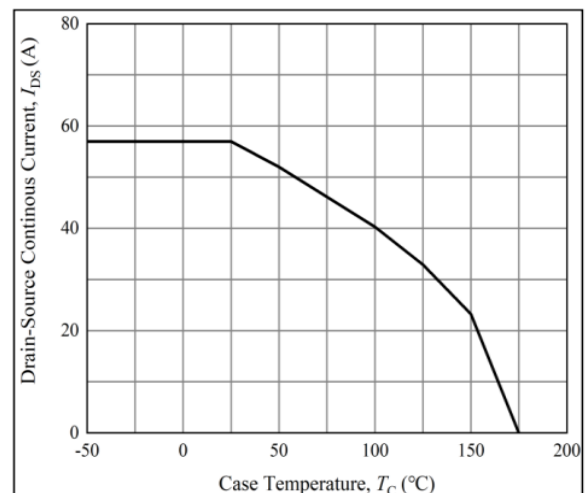
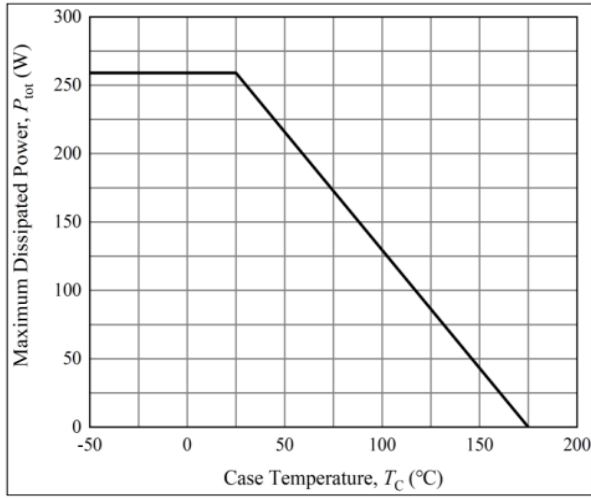
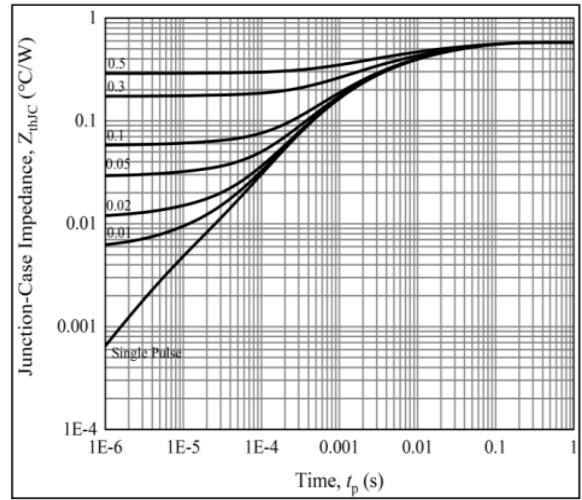


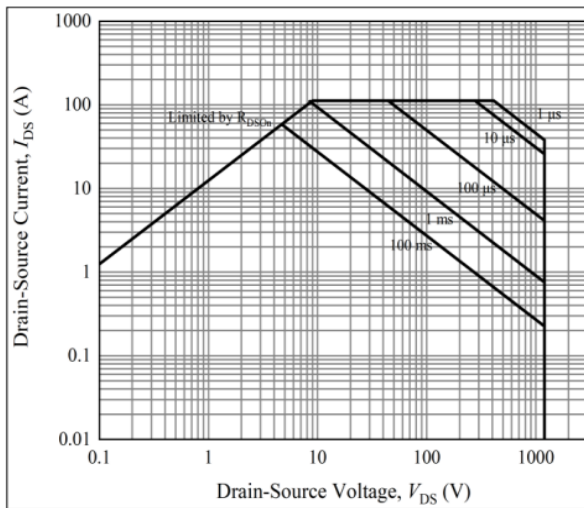
Figure 18. Continuous  $I_{DS}$  Current Derating Curve



**Figure 19. Power Dissipation Derating Curve**



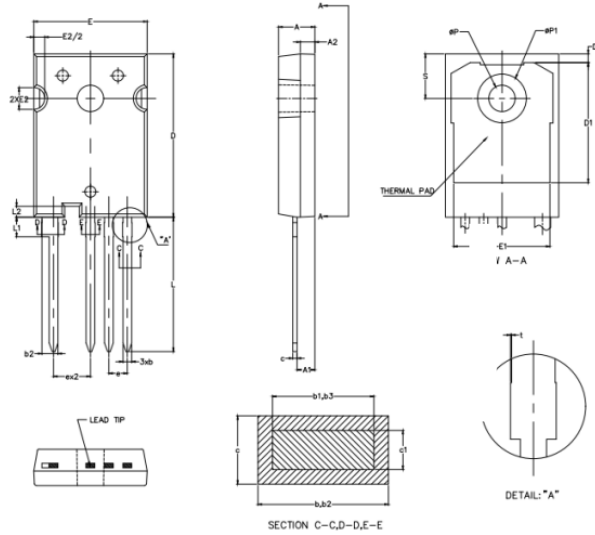
**Figure 20. Typical Transient Thermal Impedance (Junction – Case) with Duty Cycle**



**Figure 21. Safe Operate Area**

**Package Outline Dimensions** (Unit: millimeters)

**TO-247-4L**



| TO-247-4L |      |      |     |         |       |
|-----------|------|------|-----|---------|-------|
|           | Min. | Max. |     | Min.    | Max.  |
| A         | 4.9  | 5.1  | D1  | 16.25   | 16.85 |
| A1        | 2.31 | 2.51 | D2  | 1.05    | 1.35  |
| A2        | 1.9  | 2.1  | E   | 15.75   | 15.9  |
| b         | 1.16 | 1.26 | E1  | 13.26   | -     |
| b1        | 1.15 | 2.22 | E2  | 2.9     | 3.1   |
| b2        | 2.16 | 2.26 | e   | 2.54BSC |       |
| b3        | 2.15 | 2.22 | L   | 18.3    | 18.6  |
| c         | 0.59 | 0.66 | L1  | -       | 2.8   |
| c1        | 0.58 | 0.62 | L2  |         | 1.5   |
| D         | 22.4 | 22.6 | ΦP  | 3.5     | 3.7   |
| S         | 6.05 | 6.25 | ΦP1 |         | 7.4   |
| t         | 0    | 0.15 |     |         |       |

**Revision History**

| Document Version | Date of release | Description of changes |
|------------------|-----------------|------------------------|
| Rev.A            | 2023.02.08      | Preliminary Datasheet  |
|                  |                 |                        |
|                  |                 |                        |

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