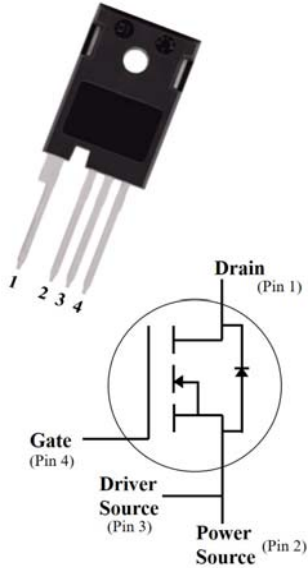


Silicon Carbide Power MOSFET (N-Channel Enhancement)

| | |
|--------------|------|
| V_{DS} | 650V |
| I_D (25°C) | 60A |
| $R_{DS(on)}$ | 50mΩ |



Features

- High speed switching
- Essentially no switching losses
- Reduction of heat sink requirements
- Maximum working temperature at 175 °C
- High blocking voltage
- Fast Intrinsic diode with low recovery current
- High-frequency operation
- Halogen free, RoHS compliant
- AEC-Q101 qualified

Typical Applications

Typical applications are in power factor correction(PFC), solar inverter, uninterruptible power supply, motor drives, photovoltaic inverter, electric car and charger.

Mechanical Data

- **Package:** TO247-4L
- **Terminals:** Tin plated leads
- **Polarity:** As marked

■Maximum Ratings ($T_c=25^\circ\text{C}$ Unless otherwise specified)

| PARAMETER | SYMBOL | UNIT | VALUE | TEST CONDITIONS | NOTE |
|--|----------------|------------------|--------------|---|--------|
| Device marking code | | | D206550NCFGH | | |
| Drain source voltage @ $T_j=25^\circ\text{C}$ | $V_{DS,max}$ | V | 650 | $V_{GS}=0\text{ V}$, $I_D=100\mu\text{A}$ | |
| Gate source voltage @ $T_j=25^\circ\text{C}$ | $V_{GS,max}$ | V | -10/+25 | Absolute maximum values (AC f > 1Hz, duty cycle < 1%) | Note1 |
| Gate source voltage @ $T_j=25^\circ\text{C}$ | $V_{GS,op}$ | V | -5/+20 | Recommended operational values | |
| Continuous drain current @ $T_c=25^\circ\text{C}$ | I_D | A | 60 | $V_{GS}=20\text{V}$, $T_c=25^\circ\text{C}$ | Fig.14 |
| Continuous drain current @ $T_c=110^\circ\text{C}$ | | | 41 | $V_{GS}=20\text{V}$, $T_c=110^\circ\text{C}$ | |
| Pulse Drain Current | $I_{D,pulse}$ | A | 127 | Limited by t_{pw} | Fig.15 |
| Avalanche energy, Single Pulse | E_{AS} | mJ | 1600 | $V_{DD}=100\text{V}$, $I_D=14\text{A}$ | |
| Power Dissipation | P_{TOT} | W | 250 | $T_c=25^\circ\text{C}$, $T_j = 175^\circ\text{C}$ | Fig.13 |
| Operating junction and Storage temperature range | T_j, T_{stg} | $^\circ\text{C}$ | -55 to +175 | | |
| Soldering temperature | T_L | $^\circ\text{C}$ | 260 | 1.6mm (0.063") from case for 10s | |
| Mounting torque | T_M | Nm | 0.6 | M3 screw Maximum of mounting process: 3 | |



■Static Electrical Characteristics (Tc=25°C unless otherwise specified)

| PARAMETER | SYMBOL | UNIT | Min. | Typ. | Max. | Test Conditions | Note |
|--|---------------|------------|------|------|------|---|-------------|
| Gate threshold voltage | $V_{GS(th)}$ | V | | 2.6 | | $V_{DS}=V_{GS}$, $I_D=20mA$ | Fig.4, 11 |
| Drain source breakdown voltage | $V_{(BR)DSS}$ | V | 650 | | | $V_{GS}=0$, $I_D=100\mu A$ | |
| Zero gate voltage drain current | I_{DSS} | μA | | <1 | 100 | $V_{DS}=650V$, $V_{GS}=0V$ | |
| | | | | 10 | 500 | $V_{DS}=650V$, $V_{GS}=0V$, $T_J=175^\circ C$ | |
| Gate source leakage current | I_{GSS} | nA | | | 250 | $V_{GS}=20V$, $V_{DS}=0V$ | |
| Current drain source on-state resistance | $R_{DS(on)}$ | m Ω | | 50 | 65 | $V_{GS}=20V$, $I_D=20A$ | Fig.3, 5, 6 |
| | | | | 65 | | $V_{GS}=20V$, $I_D=20A$, $T_J=175^\circ C$ | |
| Transconductance | g_f | S | | 13.2 | | $V_{DS}=15V$, $I_D=40A$ | |

■Dynamic Electrical Characteristics (Tc=25°C unless otherwise specified)

| PARAMETER | SYMBOL | UNIT | Min. | Typ. | Max. | Test Conditions | Note |
|--------------------------|--------------|----------|------|------|------|--|--------|
| Input capacitance | C_{iss} | pF | | 1850 | | $V_{DS}=400V$, $V_{GS}=0V$, $T_J=25^\circ C$, $f=1MHz$, $V_{AC}=25mV$ | Fig.10 |
| Output capacitance | C_{oss} | | | 208 | | | |
| Reverse capacitance | C_{rss} | | | 33 | | | |
| Coss stored energy | E_{oss} | μJ | | 24 | | | Fig.12 |
| Gate source charge | Q_{gs} | nC | | 30 | | $V_{DS}=400V$, $V_{GS}=-5/20V$, $I_D=30A$ | Fig.16 |
| Gate drain charge | Q_{gd} | | | 43 | | | |
| Gate charge | Q_g | | | 121 | | | |
| Internal Gate Resistance | $R_{G(int)}$ | Ω | | 1.2 | | $f=1MHz$, $V_{AC}=25mV$ | |

■Switching Characteristics (Tc=25°C unless otherwise specified)

| PARAMETER | SYMBOL | UNIT | Min. | Typ. | Max. | Test Conditions | Note |
|---------------------------|--------------|---------|------|------|------|---|------------|
| Turn on delay time | $t_{d(on)}$ | ns | | 16 | | $V_{DD}=400V$, $V_{GS}=-4/+20V$, $I_D=20A$, $R_L=20\Omega$, $R_{G(ext)}=2.7\Omega$ | |
| Rise time | t_r | | | 17 | | | |
| Turn off delay time | $t_{d(off)}$ | | | 20 | | | |
| Fall time | t_f | | | 10 | | | |
| Turn on switching energy | E_{on} | μJ | | 21 | | $V_{DD}=400V$, $V_{GS}=0/+20V$, $I_D=50A$, $R_{g(ext)}=2.7\Omega$ | Fig.17, 18 |
| Turn off switching energy | E_{off} | | | 28 | | | |



■Body diode characteristics (Tc=25°C unless otherwise specified)

| PARAMETER | SYMBOL | UNIT | Min. | Typ. | Max. | Test Conditions | Note |
|----------------------------------|------------------|------|------|------|------|---|-------|
| Diode forward voltage | V _{SD} | V | | 3.0 | | V _{GS} =0V, I _{SD} =5A | Fig.8 |
| Continuous diode forward current | I _s | A | | 42.5 | | V _{GS} =0V, Tc=25°C | |
| Reverse recovery time | t _{rr} | nS | | 58 | | V _{DS} =400V, V _{GS} =0V, I _{SD} =30A, di/dt=300A/uS | |
| Reverse recovery charge | Q _{rr} | nC | | 122 | | | |
| Peak reverse recovery current | I _{rrm} | A | | 3.75 | | | |

Note 1: When using SiC Body Diode the maximum recommended V_{GS} = -5V

■Thermal Characteristics (T_a=25°C Unless otherwise specified)

| PARAMETER | SYMBOL | UNIT | Value |
|--------------------|-------------------|------|-------|
| Thermal resistance | R _{θJ-C} | °C/W | 0.6 |

■Typical Characteristics

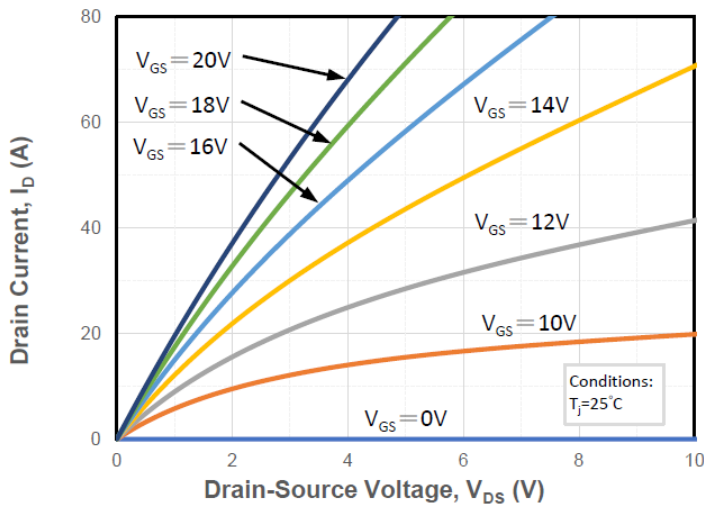


Figure 1. Output Characteristics Tj = 25°C

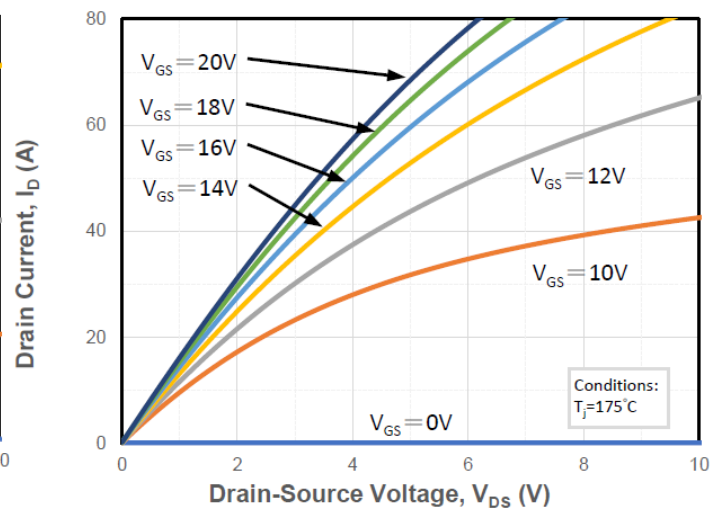


Figure2. Output Characteristics Tj = 175°C

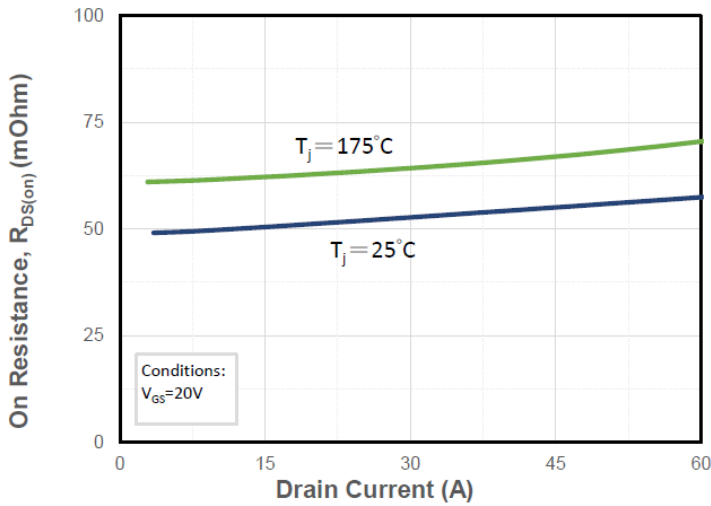


Figure 3. On-resistance vs. drain current

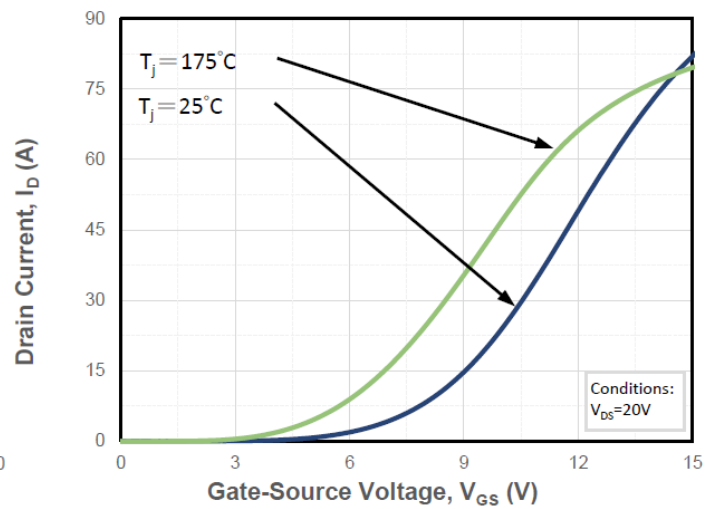


Figure 4. Transfer Characteristics for various Tj

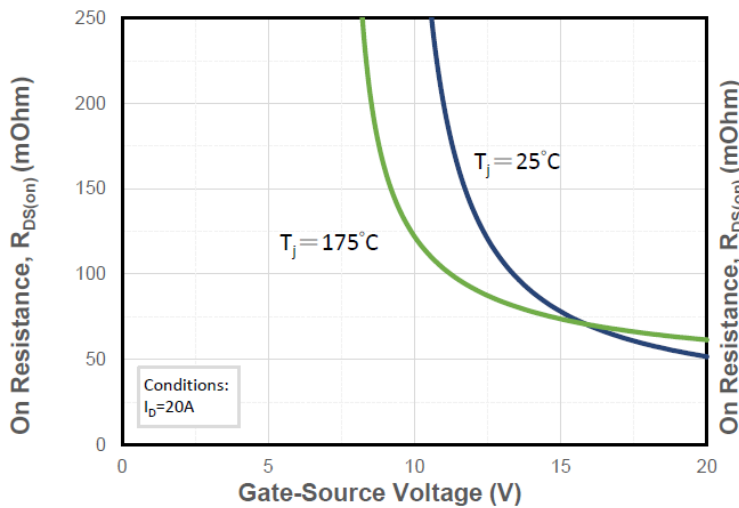


Figure 5. On-resistance vs. gate voltage for various Tj

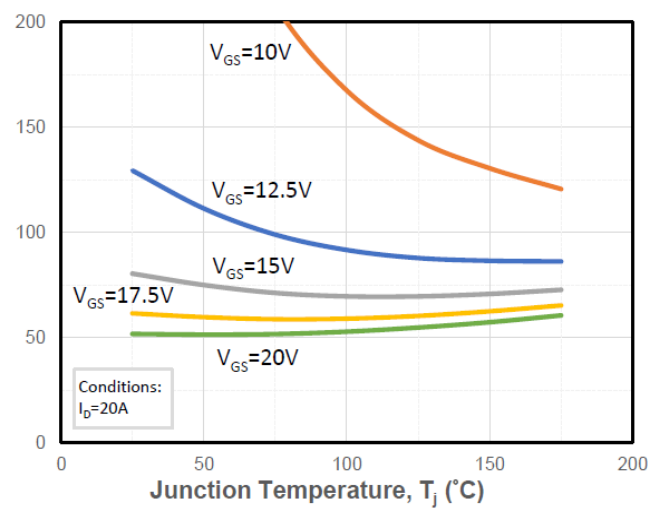


Figure 6. On-resistance vs. Temperature for various Gate voltage

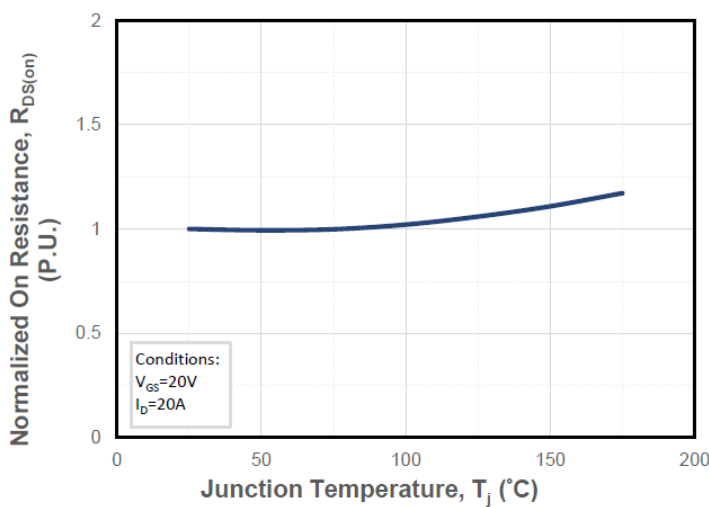


Figure 7. Normalized On-Resistance vs. Temperature

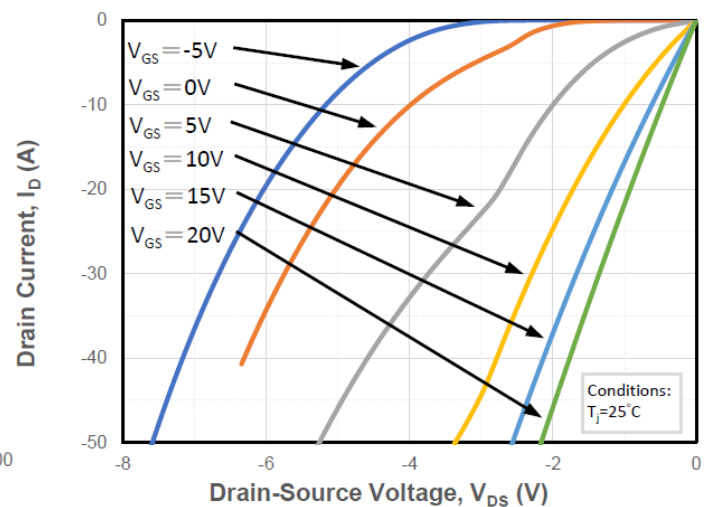


Figure 8. Reverse Output Characteristics at Tj = 25°C

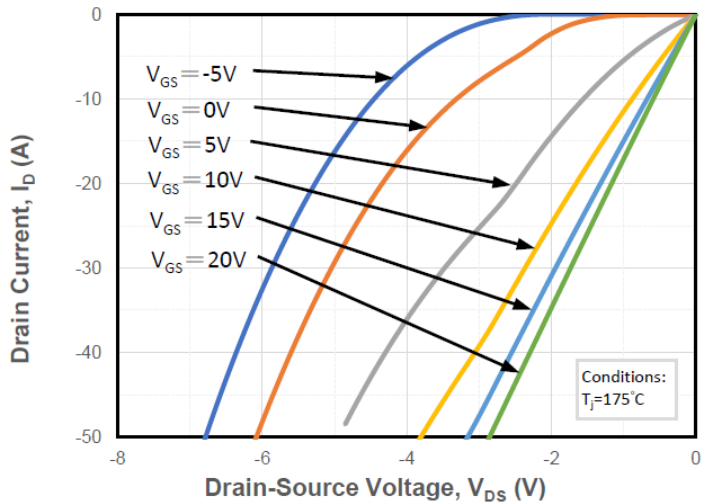


Figure 9. Reverse Output Characteristics at $T_j = 175^\circ\text{C}$

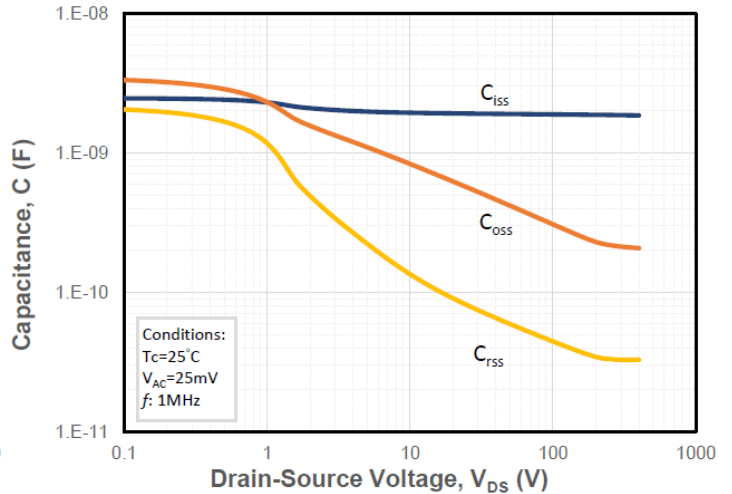


Figure 10. Capacitances vs. Drain to Source Voltage

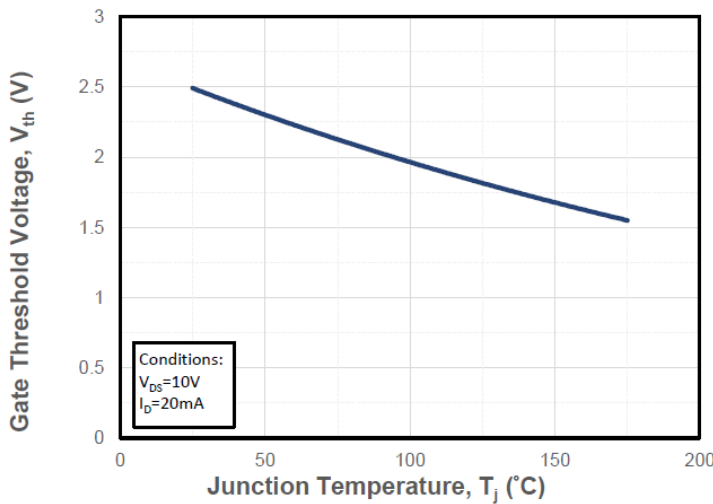


Figure 11. Threshold voltage vs. temperature

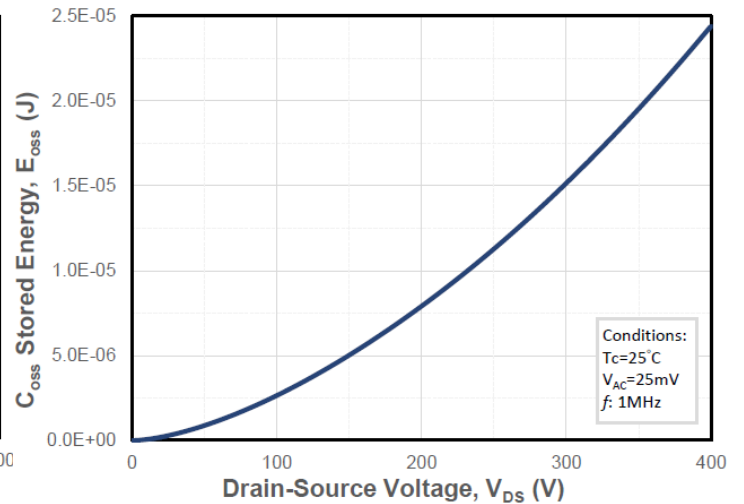


Figure 12. Output Capacitor Stored Energy

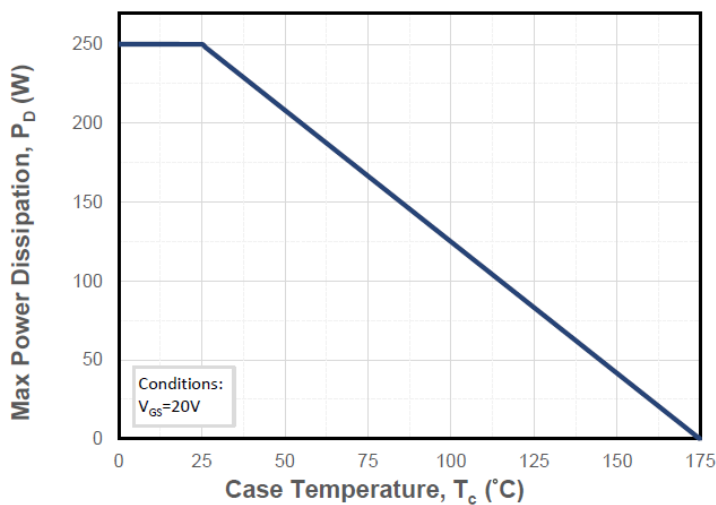


Figure 13. Maximum Power Dissipation Derating vs. Case Temperature

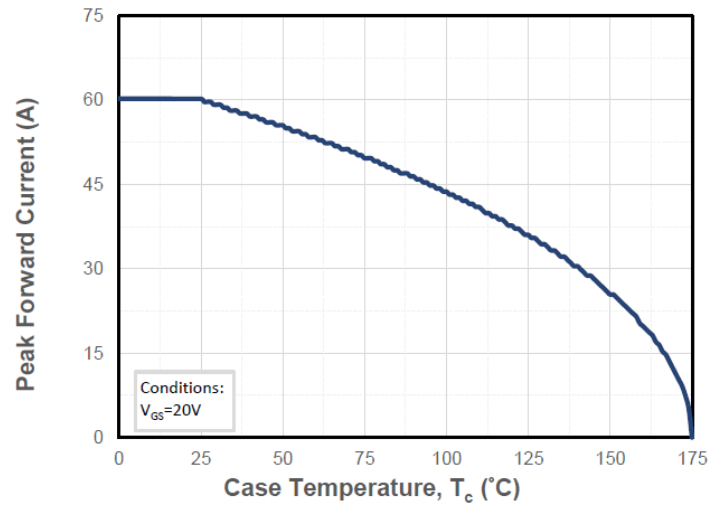


Figure 14. Drain Current Derating vs. Case Temperature

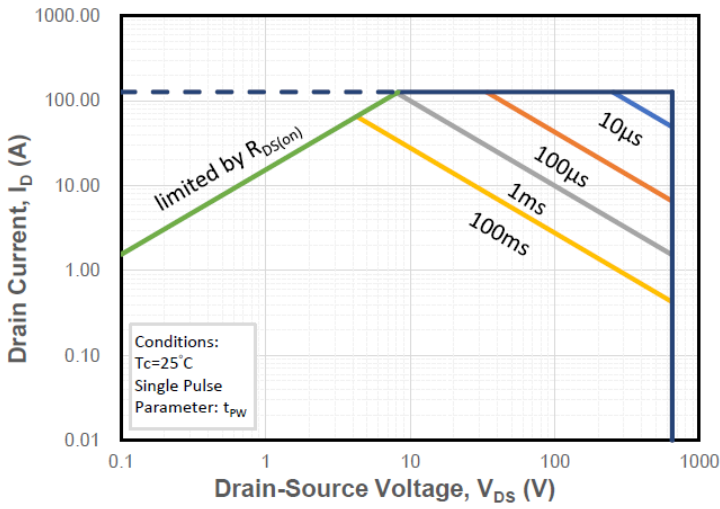


Figure 15. Safe Operating Area

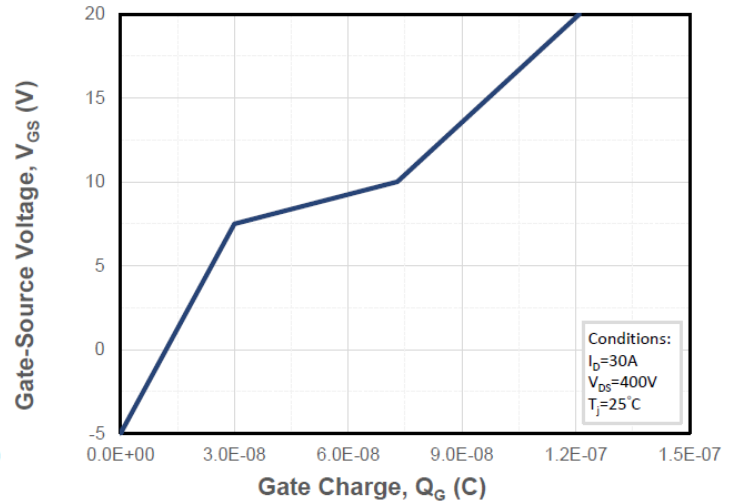


Figure 16. Gate Charge Characteristics

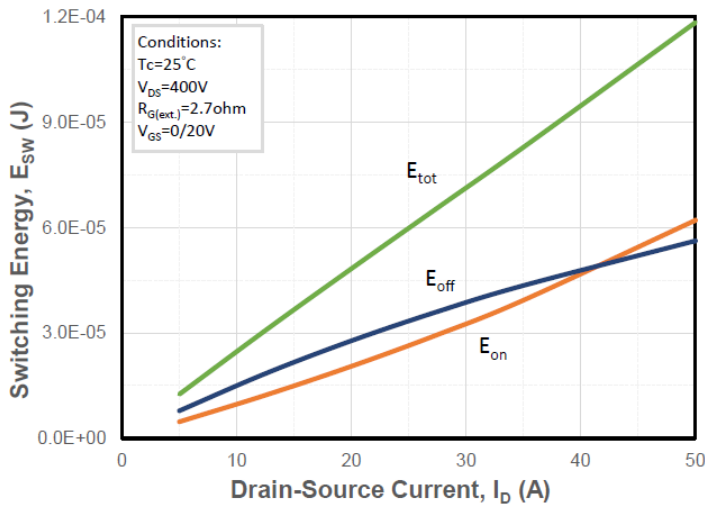


Figure 17. Clamped Inductive Switching Energy vs. Drain Current

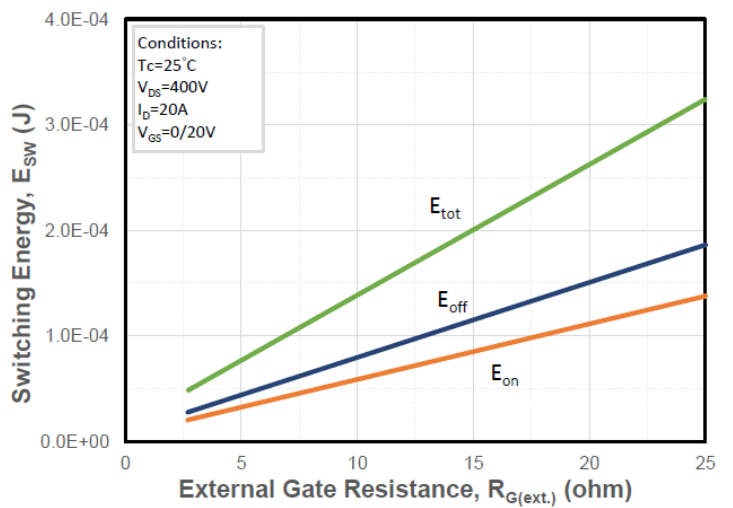


Figure 18. Clamped Inductive Switching Energy vs. External Gate Resistor ($R_{G(ext.)}$)

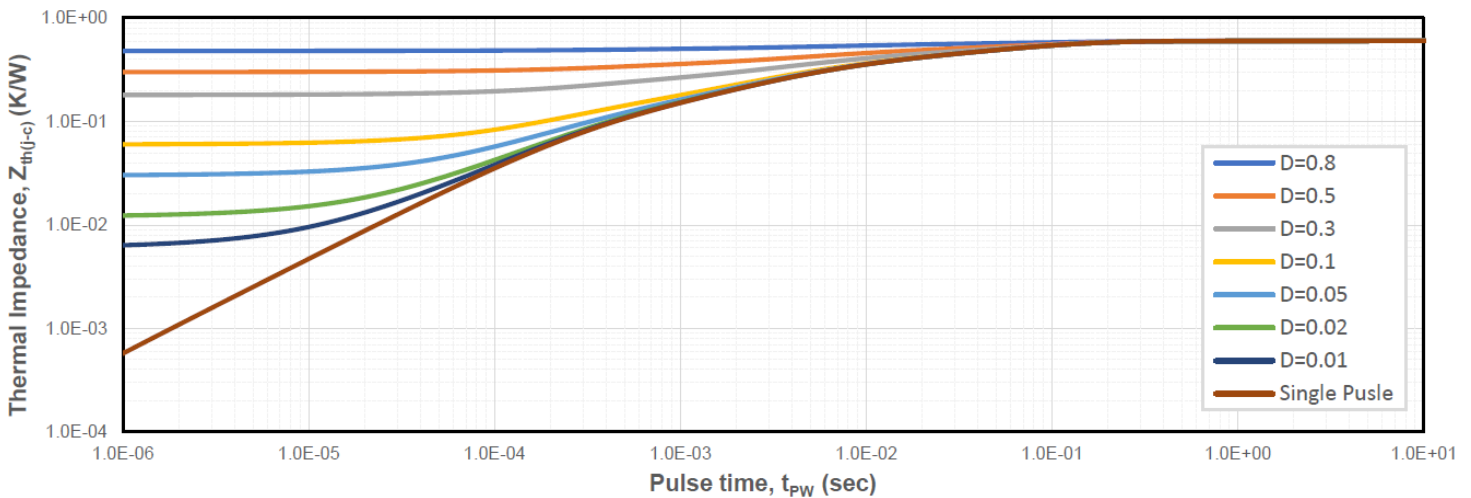


Figure 19. Transient Junction to Case Thermal Impedance

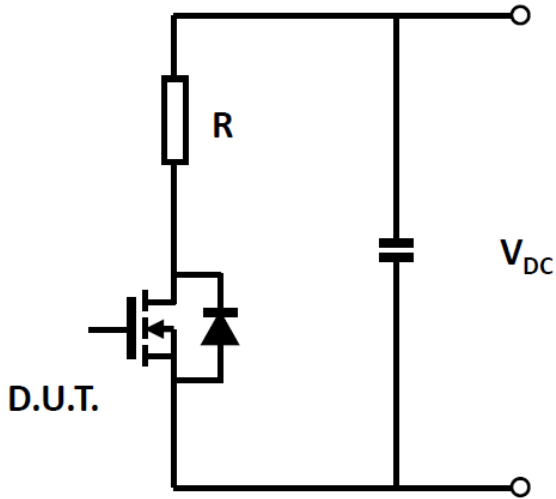


Figure 20. Schematic of Resistive Switching

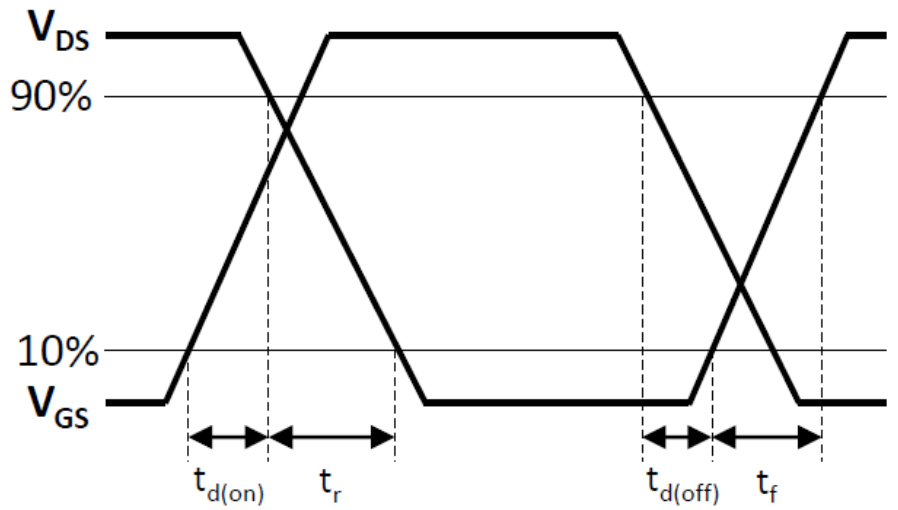
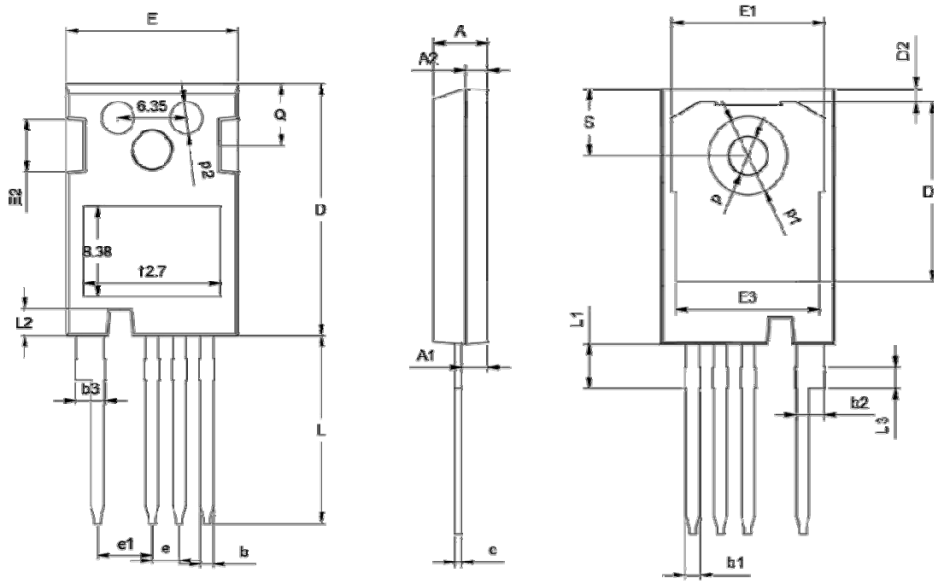


Figure 21. Switching Times Definition

■Outline Dimensions



| TO247-4L | | | |
|----------|---------|-------|-------|
| Dim | Min | Norm | Max |
| A | 4.80 | 5.00 | 5.20 |
| A1 | 2.30 | 2.40 | 2.50 |
| A2 | 1.88 | 1.98 | 2.08 |
| b | 1.10 | 1.20 | 1.30 |
| b1 | 1.20 | / | 1.50 |
| b2 | 2.35 | 2.55 | 2.75 |
| b3 | 2.45 | / | 2.85 |
| c | 0.55 | 0.60 | 0.65 |
| D | 23.3 | 23.45 | 23.6 |
| D1 | 16.25 | 16.55 | 16.85 |
| D2 | 1.00 | / | 1.30 |
| e | TYP2.54 | | |
| e1 | TYP5.06 | | |
| E | 15.75 | 15.90 | 16.05 |
| E1 | 13.80 | / | 14.20 |
| E2 | 4.40 | 4.75 | 5.10 |
| E3 | 13.00 | / | 13.45 |
| L | 17.34 | 17.49 | 17.64 |
| L1 | 4.00 | / | 4.30 |
| L2 | 2.35 | / | 2.65 |
| L3 | TYP1.98 | | |
| Q | 5.60 | 5.80 | 6.00 |
| S | 6.05 | / | 6.30 |
| p | TYP3.58 | | |
| p1 | TYP7.18 | | |
| p2 | TYP3.00 | | |



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