



## Features

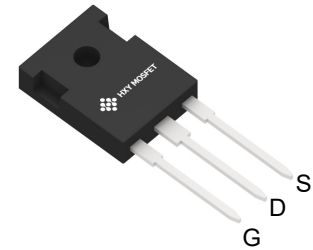
- 3rd generation SiC MOSFET technology
- Optimized package with separate driver source pin
- High blocking voltage with low on-resistance
- High-speed switching with low capacitances
- Fast intrinsic diode with low reverse recovery ( $Q_{rr}$ )
- Halogen free, RoHS compliant

## Benefits

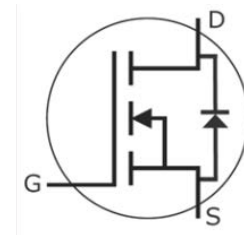
- Reduce switching losses and minimize gate ringing
- Higher system efficiency
- Reduce cooling requirements
- Increase power density
- Increase system switching frequency

## Applications

- Renewable energy
- EV battery chargers
- High voltage DC/DC converters
- Switch Mode Power Supplies



TO-247



| Ordering Part Number | Package | Marking      |
|----------------------|---------|--------------|
| HC3M0120090D         | TO-247  | HC3M0120090D |

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

| Symbol         | Parameter                                  | Value       | Unit             | Test Conditions                                        | Note    |
|----------------|--------------------------------------------|-------------|------------------|--------------------------------------------------------|---------|
| $V_{DSmax}$    | Drain - Source Voltage                     | 900         | V                | $V_{GS} = 0\text{ V}$ , $I_D = 100\text{ }\mu\text{A}$ |         |
| $V_{GSmax}$    | Gate - Source Voltage (dynamic)            | -8/+19      | V                | AC ( $f > 1\text{ Hz}$ )                               | Note: 1 |
| $V_{GSop}$     | Gate - Source Voltage (static)             | -4/+15      | V                | Static                                                 | Note: 2 |
| $I_D$          | Continuous Drain Current                   | 23          | A                | $V_{GS} = 15\text{ V}$ , $T_C = 25^\circ\text{C}$      | Fig. 19 |
|                |                                            | 15          |                  | $V_{GS} = 15\text{ V}$ , $T_C = 100^\circ\text{C}$     |         |
| $I_{D(pulse)}$ | Pulsed Drain Current                       | 50          | A                | Pulse width $t_p$ limited by $T_{jmax}$                | Fig. 22 |
| $P_D$          | Power Dissipation                          | 97          | W                | $T_c=25^\circ\text{C}$ , $T_J = 150^\circ\text{C}$     | Fig. 20 |
| $T_J, T_{stg}$ | Operating Junction and Storage Temperature | -55 to +150 | $^\circ\text{C}$ |                                                        |         |
| $T_L$          | Solder Temperature                         | 260         | $^\circ\text{C}$ | 1.6mm (0.063") from case for 10s                       |         |
| $M_d$          | Mounting Torque                            | 1<br>8.8    | Nm<br>lbf-in     | M3 or 6-32 screw                                       |         |



### Electrical Characteristics (T<sub>c</sub> = 25°C unless otherwise specified)

| Symbol               | Parameter                                  | Min. | Typ. | Max. | Unit | Test Conditions                                                                                                                                                 | Note         |
|----------------------|--------------------------------------------|------|------|------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| V <sub>(BR)DSS</sub> | Drain-Source Breakdown Voltage             | 900  |      |      | V    | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 100 μA                                                                                                                  |              |
| V <sub>GS(th)</sub>  | Gate Threshold Voltage                     | 1.8  | 2.1  | 3.5  | V    | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 3 mA                                                                                                       | Fig. 11      |
|                      |                                            |      | 1.6  |      | V    | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 3 mA, T <sub>J</sub> = 150°C                                                                               |              |
| I <sub>DSS</sub>     | Zero Gate Voltage Drain Current            |      | 1    | 100  | μA   | V <sub>DS</sub> = 900 V, V <sub>GS</sub> = 0 V                                                                                                                  |              |
| I <sub>GSS</sub>     | Gate-Source Leakage Current                |      | 10   | 250  | nA   | V <sub>GS</sub> = 15 V, V <sub>DS</sub> = 0 V                                                                                                                   |              |
| R <sub>DS(on)</sub>  | Drain-Source On-State Resistance           |      | 120  | 155  | mΩ   | V <sub>GS</sub> = 15 V, I <sub>D</sub> = 15 A                                                                                                                   | Fig. 4, 5, 6 |
|                      |                                            |      | 170  |      |      | V <sub>GS</sub> = 15 V, I <sub>D</sub> = 15 A, T <sub>J</sub> = 150°C                                                                                           |              |
| g <sub>fs</sub>      | Transconductance                           |      | 8.9  |      | S    | V <sub>DS</sub> = 20 V, I <sub>DS</sub> = 15 A                                                                                                                  | Fig. 7       |
|                      |                                            |      | 7.1  |      |      | V <sub>DS</sub> = 20 V, I <sub>DS</sub> = 15 A, T <sub>J</sub> = 150°C                                                                                          |              |
| C <sub>iss</sub>     | Input Capacitance                          |      | 414  |      | pF   | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 600 V<br>f = 1 MHz<br>V <sub>AC</sub> = 25 mV                                                                       | Fig. 17, 18  |
| C <sub>oss</sub>     | Output Capacitance                         |      | 48   |      |      |                                                                                                                                                                 |              |
| C <sub>rss</sub>     | Reverse Transfer Capacitance               |      | 3    |      |      |                                                                                                                                                                 |              |
| E <sub>oss</sub>     | C <sub>oss</sub> Stored Energy             |      | 10.6 |      |      |                                                                                                                                                                 |              |
| E <sub>ON</sub>      | Turn-On Switching Energy (Body Diode FWD)  |      | 176  |      | μJ   | V <sub>DS</sub> = 400 V, V <sub>GS</sub> = -4 V/15 V,<br>I <sub>D</sub> = 15 A, R <sub>G(ext)</sub> = 2.5Ω, L = 99 μH,<br>T <sub>J</sub> = 150°C                | Fig. 26, 29  |
| E <sub>OFF</sub>     | Turn Off Switching Energy (Body Diode FWD) |      | 36   |      |      |                                                                                                                                                                 |              |
| t <sub>d(on)</sub>   | Turn-On Delay Time                         |      | 6    |      | ns   | V <sub>DD</sub> = 400 V, V <sub>GS</sub> = -4 V/15 V<br>I <sub>D</sub> = 15 A, R <sub>G(ext)</sub> = 2.5Ω,<br>Timing relative to V <sub>DS</sub> Inductive load | Fig. 27, 29  |
| t <sub>r</sub>       | Rise Time                                  |      | 32   |      |      |                                                                                                                                                                 |              |
| t <sub>d(off)</sub>  | Turn-Off Delay Time                        |      | 14   |      |      |                                                                                                                                                                 |              |
| t <sub>f</sub>       | Fall Time                                  |      | 7    |      |      |                                                                                                                                                                 |              |
| R <sub>G(int)</sub>  | Internal Gate Resistance                   |      | 13   |      | Ω    | f = 1 MHz, V <sub>AC</sub> = 25 mV                                                                                                                              |              |
| Q <sub>gs</sub>      | Gate to Source Charge                      |      | 5    |      | nC   | V <sub>DS</sub> = 400 V, V <sub>GS</sub> = -4V/15V<br>I <sub>D</sub> = 15 A<br>Per IEC60747-8-4 pg 21                                                           | Fig. 12      |
| Q <sub>gd</sub>      | Gate to Drain Charge                       |      | 8    |      |      |                                                                                                                                                                 |              |
| Q <sub>g</sub>       | Total Gate Charge                          |      | 21   |      |      |                                                                                                                                                                 |              |

### Reverse Diode Characteristics (T<sub>c</sub> = 25°C unless otherwise specified)

| Symbol                | Parameter                        | Typ. | Max. | Unit | Test Conditions                                                                                                     | Note          |
|-----------------------|----------------------------------|------|------|------|---------------------------------------------------------------------------------------------------------------------|---------------|
| V <sub>SD</sub>       | Diode Forward Voltage            | 4.8  |      | V    | V <sub>GS</sub> = -4 V, I <sub>SD</sub> = 7.5 A                                                                     | Fig. 8, 9, 10 |
|                       |                                  | 4.4  |      | V    | V <sub>GS</sub> = -4 V, I <sub>SD</sub> = 7.5 A, T <sub>J</sub> = 150 °C                                            |               |
| I <sub>S</sub>        | Continuous Diode Forward Current |      | 15   | A    | V <sub>GS</sub> = -4 V                                                                                              | Note 1        |
| I <sub>S, pulse</sub> | Diode pulse Current              |      | 50   | A    | V <sub>GS</sub> = -4 V, pulse width t <sub>p</sub> limited by T <sub>Jmax</sub>                                     | Note 1        |
| t <sub>rr</sub>       | Reverse Recover time             | 28   |      | ns   | V <sub>GS</sub> = -4 V, I <sub>SD</sub> = 15 A, V <sub>R</sub> = 400V<br>dif/dt = 600 A/μs, T <sub>J</sub> = 150 °C | Note 1        |
| Q <sub>rr</sub>       | Reverse Recovery Charge          | 127  |      | nC   |                                                                                                                     |               |
| I <sub>rm</sub>       | Peak Reverse Recovery Current    | 6    |      | A    |                                                                                                                     |               |

### Thermal Characteristics

| Symbol           | Parameter                                   | Max. | Unit | Test Conditions | Note    |
|------------------|---------------------------------------------|------|------|-----------------|---------|
| R <sub>θJC</sub> | Thermal Resistance from Junction to Case    | 1.3  | °C/W |                 | Fig. 21 |
| R <sub>θJA</sub> | Thermal Resistance From Junction to Ambient | 40   |      |                 |         |



## Typical Performance

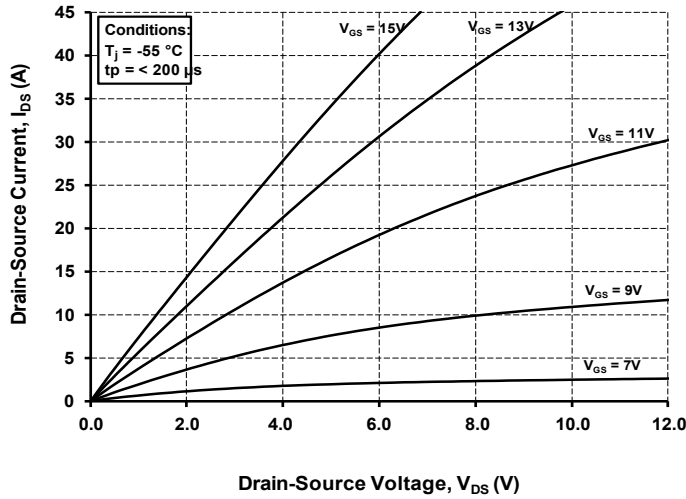


Figure 1. Output Characteristics  $T_j = -55\text{ }^{\circ}\text{C}$

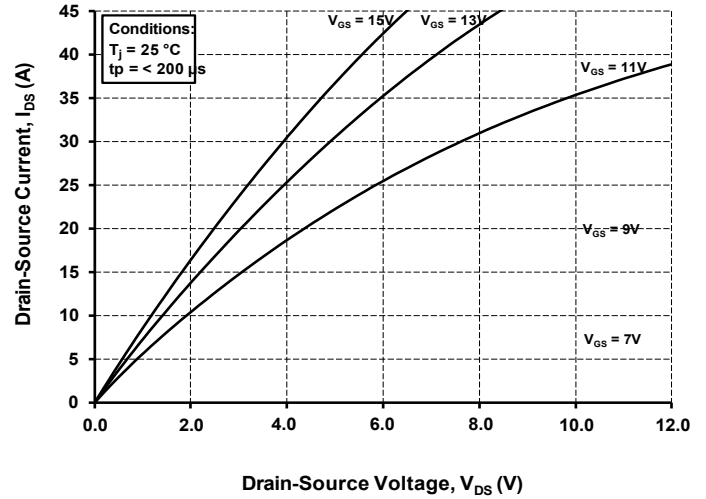


Figure 2. Output Characteristics  $T_j = 25\text{ }^{\circ}\text{C}$

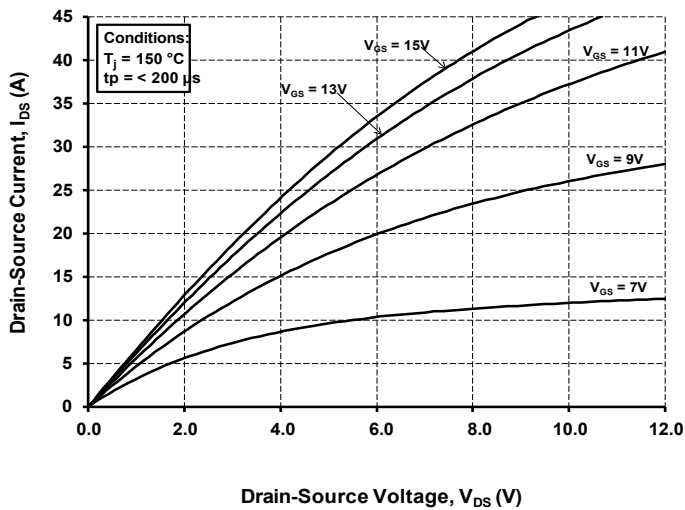


Figure 3. Output Characteristics  $T_j = 150\text{ }^{\circ}\text{C}$

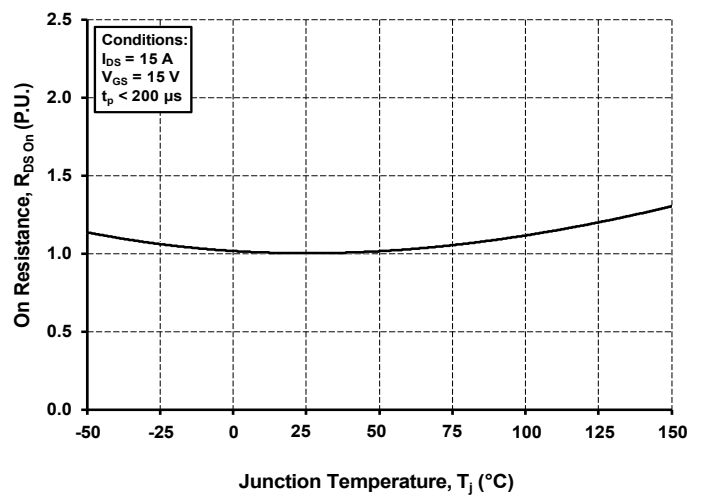


Figure 4. Normalized On-Resistance vs. Temperature

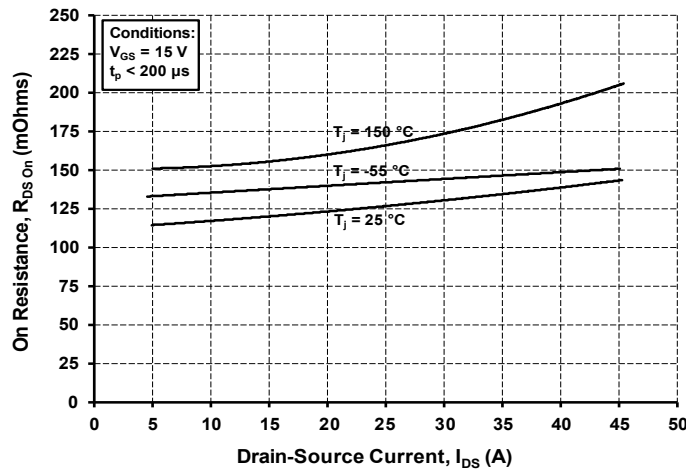


Figure 5. On-Resistance vs. Drain Current For Various Temperatures

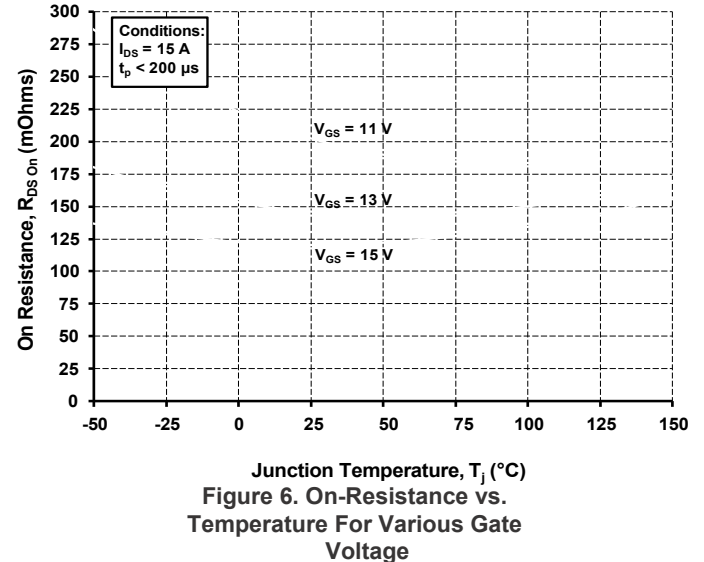


Figure 6. On-Resistance vs. Temperature For Various Gate Voltage

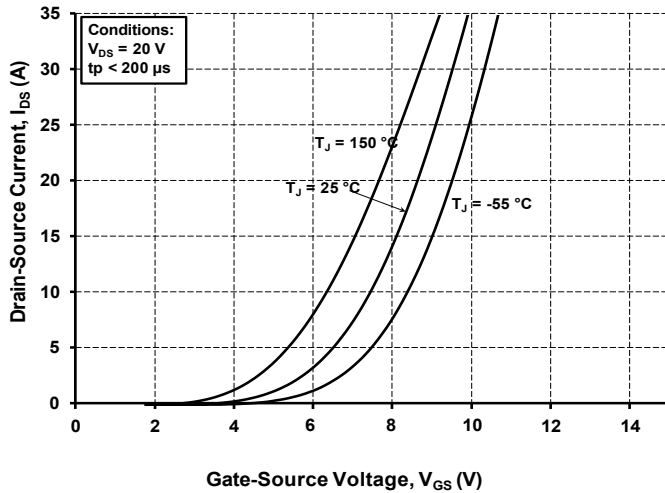


Figure 7. Transfer Characteristic for Various Junction Temperatures

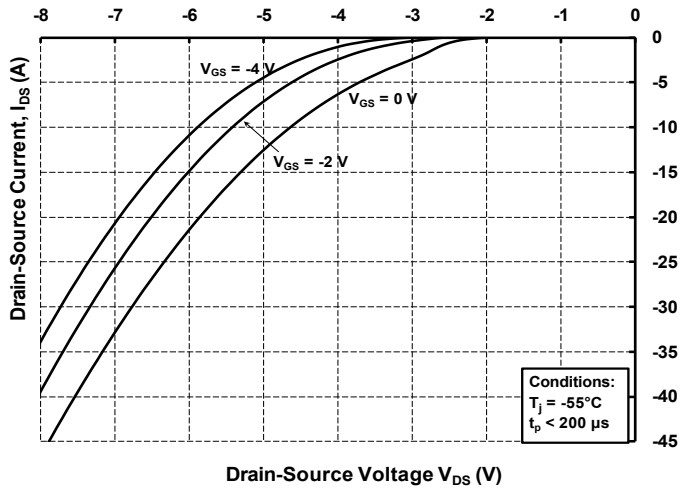


Figure 8. Body Diode Characteristic at -55 °C

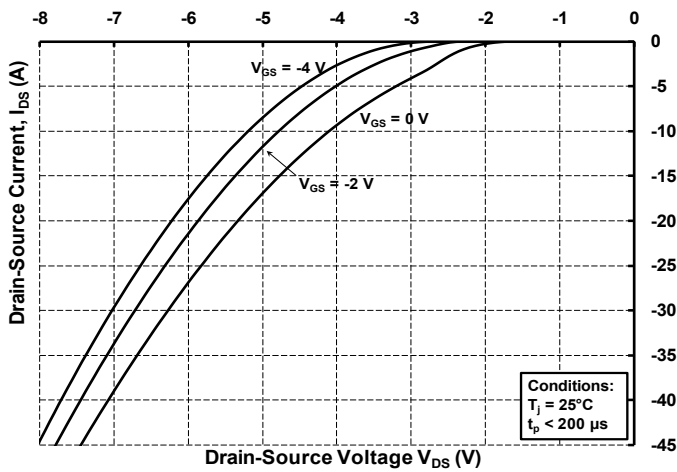


Figure 9. Body Diode Characteristic at

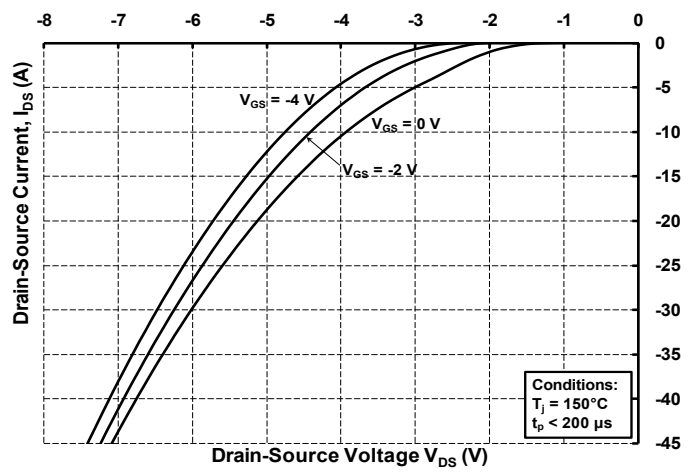


Figure 10. Body Diode Characteristic at

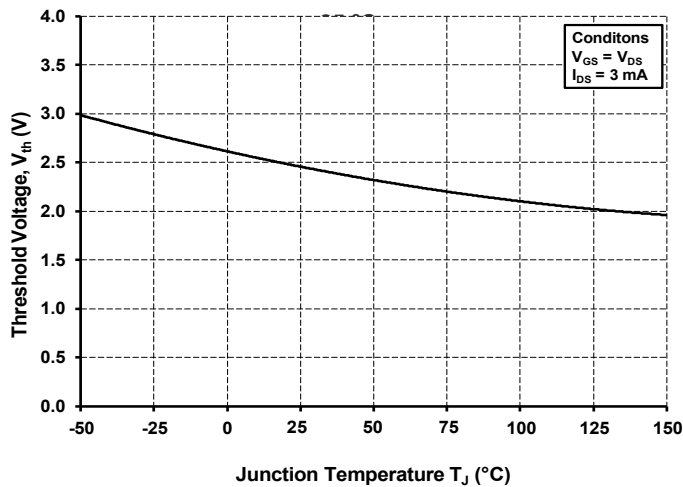


Figure 11. Threshold Voltage vs. Temperature

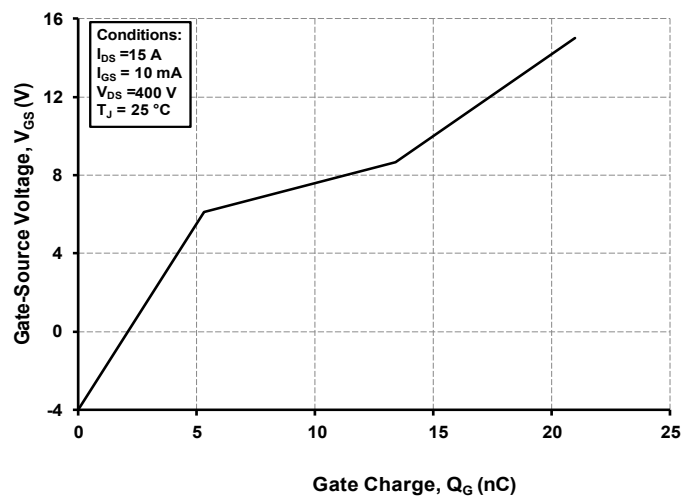


Figure 12. Gate Charge Characteristics

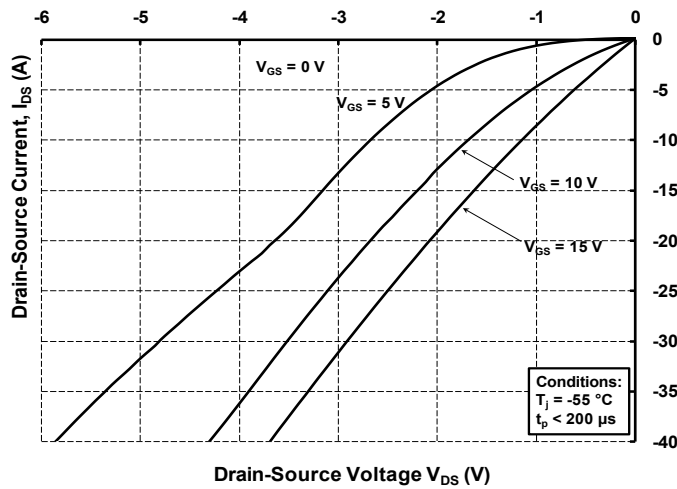


Figure 13. 3rd Quadrant Characteristic at  $-55\text{ }^{\circ}\text{C}$

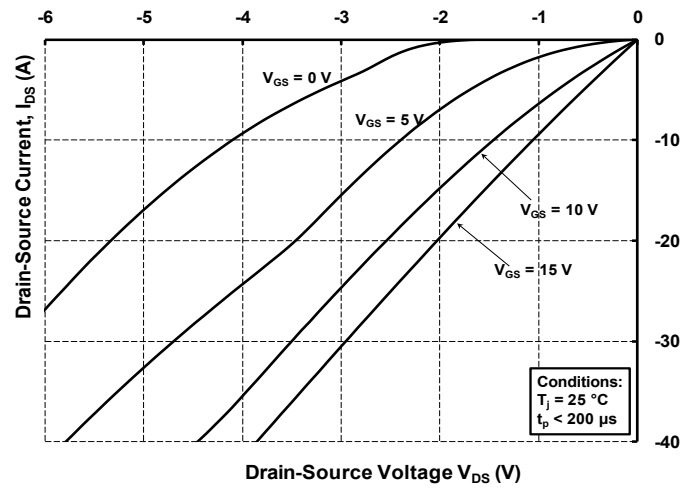


Figure 14. 3rd Quadrant Characteristic at  $25\text{ }^{\circ}\text{C}$

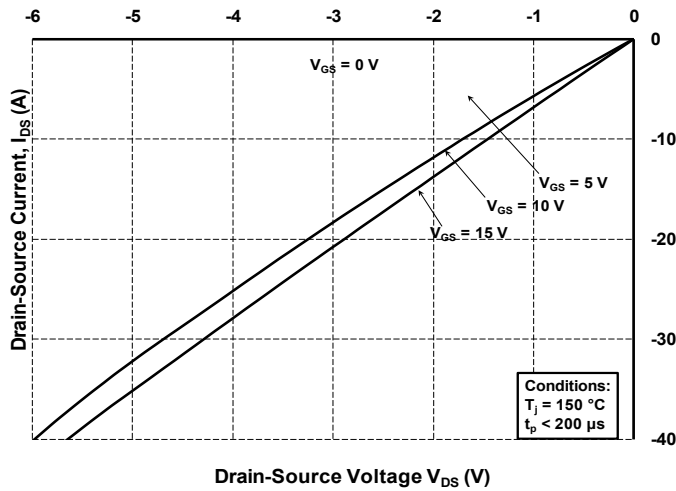


Figure 15. 3rd Quadrant Characteristic at  $150\text{ }^{\circ}\text{C}$

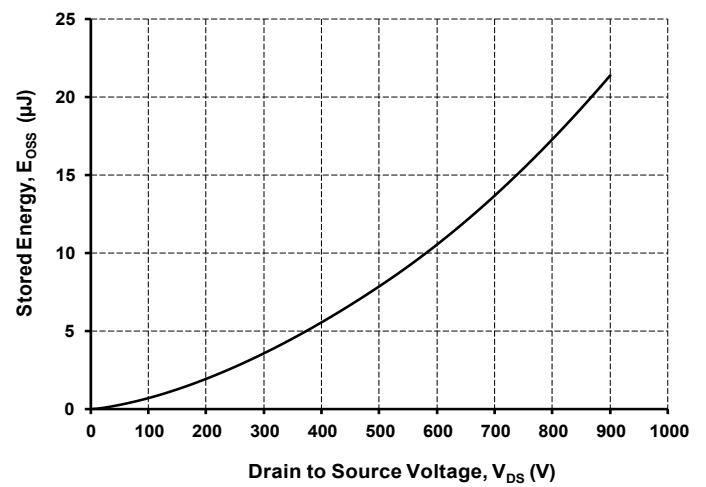


Figure 16. Output Capacitor Stored Energy

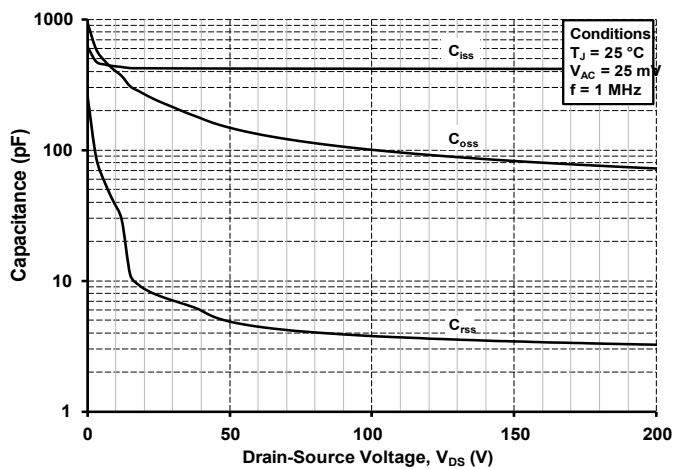


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

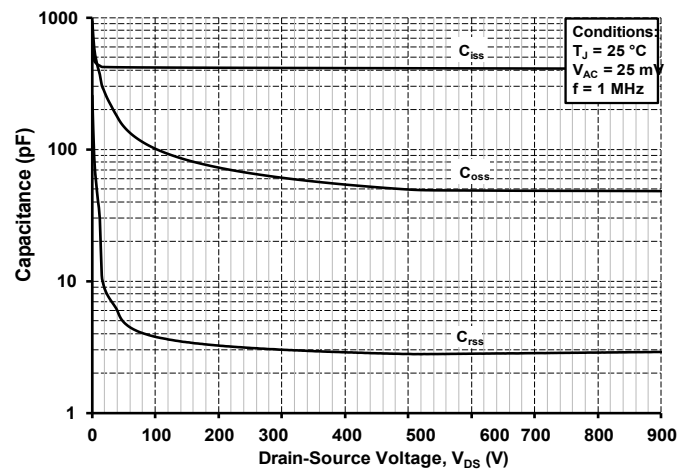


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 900V)

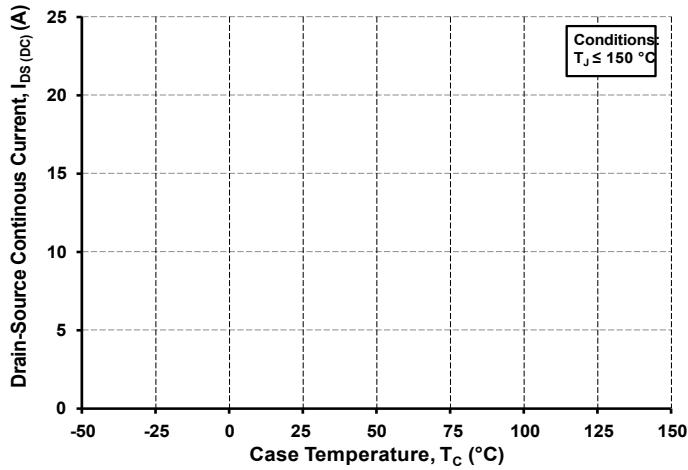


Figure 19. Continuous Drain Current Derating vs. Case Temperature

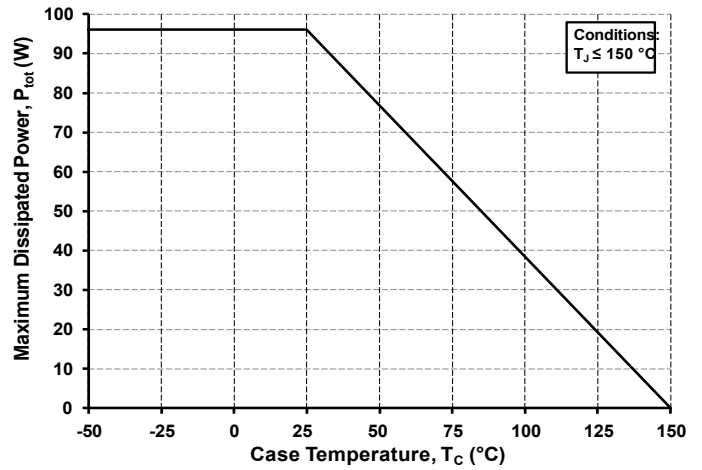


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

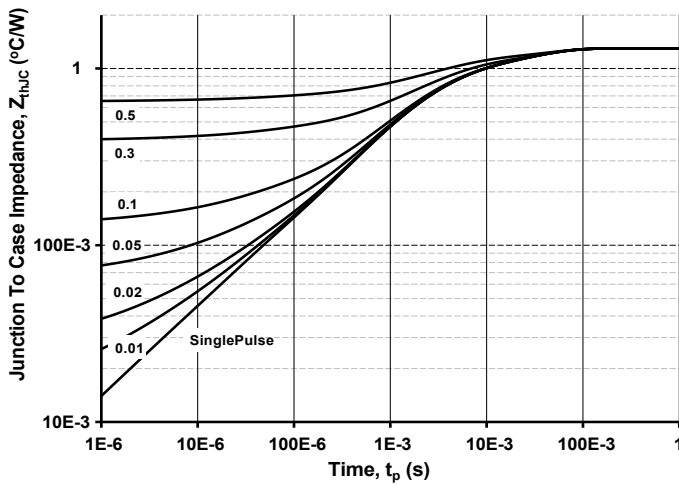


Figure 21. Transient Thermal Impedance (Junction - Case)

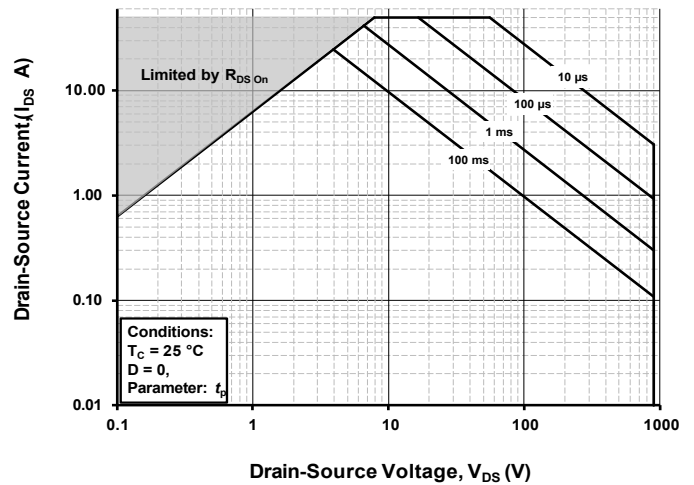


Figure 22. Safe Operating Area

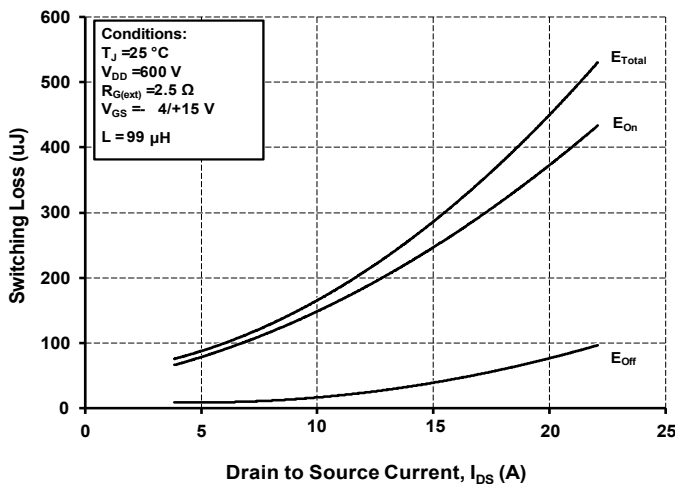


Figure 23. Clamped Inductive Switching Energy vs. Drain Current ( $V_{DD} = 600V$ )

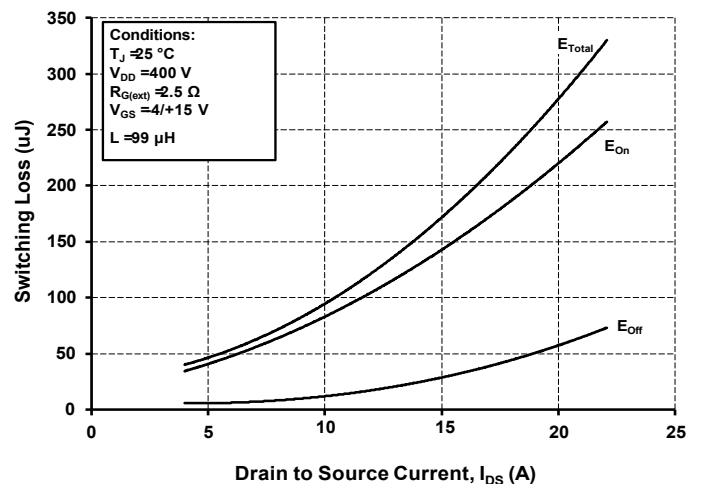


Figure 24. Clamped Inductive Switching Energy vs. Drain Current ( $V_{DD} = 400V$ )

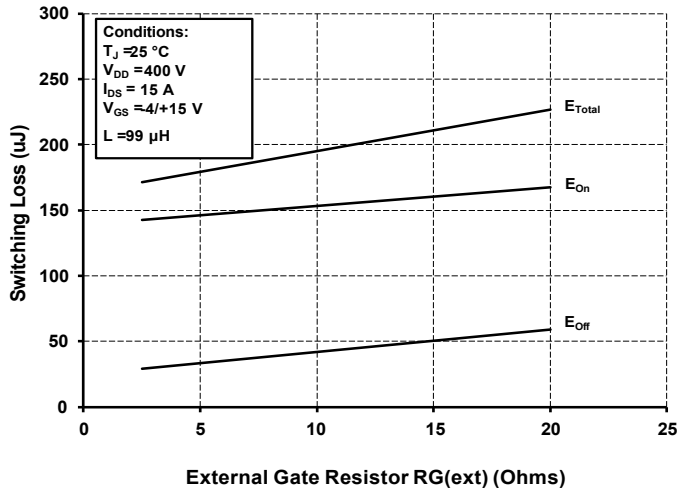


Figure 25. Clamped Inductive Switching Energy vs.  $R_{G(\text{ext})}$

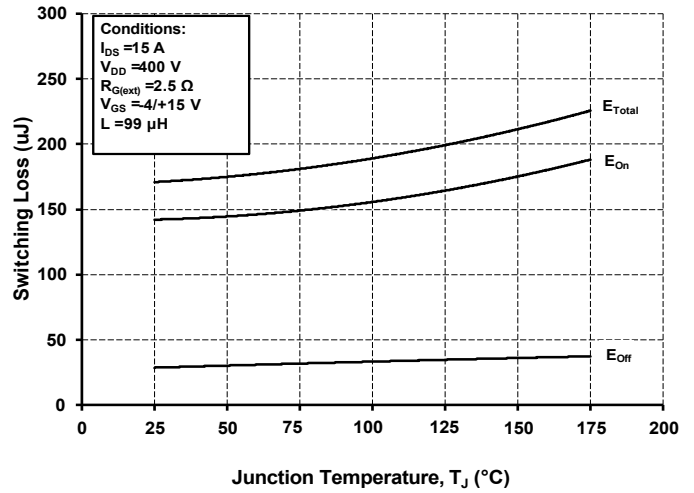


Figure 26. Clamped Inductive Switching Energy vs. Temperature

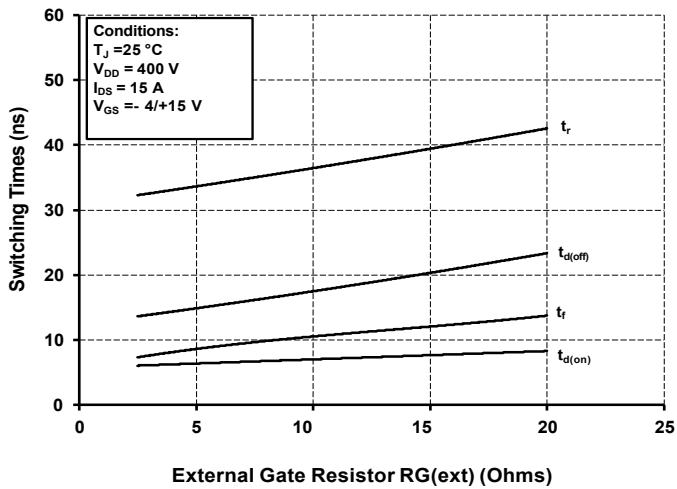


Figure 27. Switching Times vs.  $R_{G(\text{ext})}$

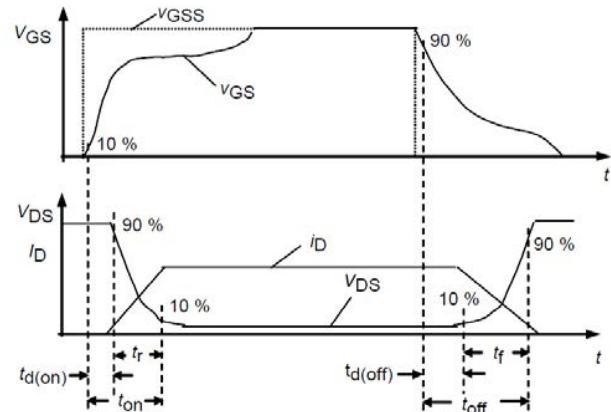
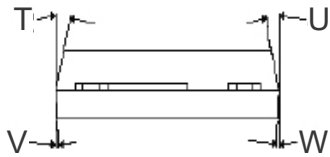
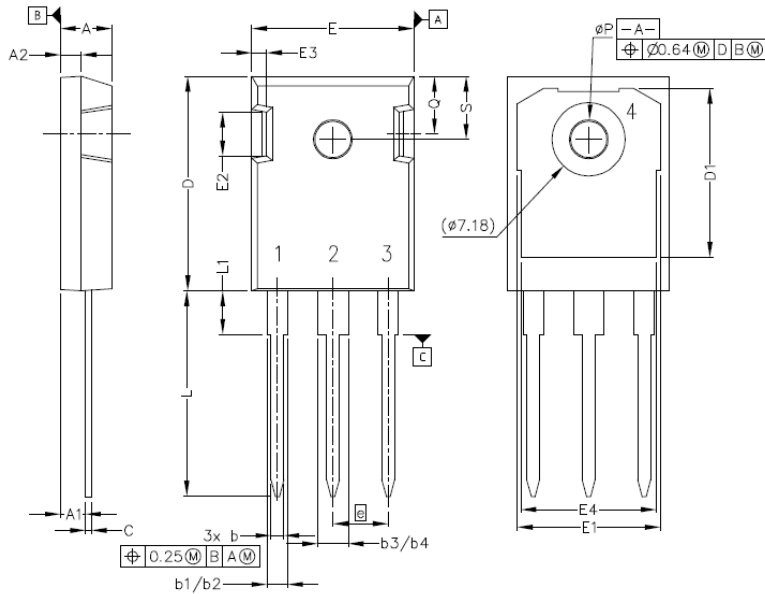


Figure 28. Switching Times Definition



## Package Dimensions

### Package TO-247

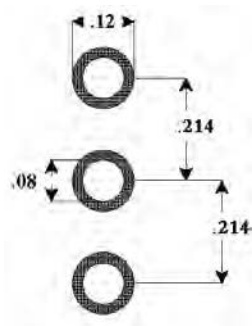


#### Pinout Information:

- Pin 1 = Gate
- Pin 2, 4 = Drain
- Pin 3 = Source

| POS | Inches   |      | Millimeters |       |
|-----|----------|------|-------------|-------|
|     | Min      | Max  | Min         | Max   |
| A   | .190     | .205 | 4.83        | 5.21  |
| A1  | .090     | .100 | 2.29        | 2.54  |
| A2  | .075     | .085 | 1.91        | 2.16  |
| b   | .042     | .052 | 1.07        | 1.33  |
| b1  | .075     | .095 | 1.91        | 2.41  |
| b2  | .075     | .085 | 1.91        | 2.16  |
| b3  | .113     | .133 | 2.87        | 3.38  |
| b4  | .113     | .123 | 2.87        | 3.13  |
| c   | .022     | .027 | 0.55        | 0.68  |
| D   | .819     | .831 | 20.80       | 21.10 |
| D1  | .640     | .695 | 16.25       | 17.65 |
| D2  | .037     | .049 | 0.95        | 1.25  |
| E   | .620     | .635 | 15.75       | 16.13 |
| E1  | .516     | .557 | 13.10       | 14.15 |
| E2  | .145     | .201 | 3.68        | 5.10  |
| E3  | .039     | .075 | 1.00        | 1.90  |
| E4  | .487     | .529 | 12.38       | 13.43 |
| e   | .214 BSC |      | 5.44 BSC    |       |
| N   | 3        |      | 3           |       |
| L   | .780     | .800 | 19.81       | 20.32 |
| L1  | .161     | .173 | 4.10        | 4.40  |
| ØP  | .138     | .144 | 3.51        | 3.65  |
| Q   | .216     | .236 | 5.49        | 6.00  |
| S   | .238     | .248 | 6.04        | 6.30  |
| T   | 9°       | 11°  | 9°          | 11°   |
| U   | 9°       | 11°  | 9°          | 11°   |
| V   | 2°       | 8°   | 2°          | 8°    |
| W   | 2°       | 8°   | 2°          | 8°    |

### Recommended Solder Pad Layout



TO-247



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