



## Features

- Wide bandgap SiC MOSFET technology
- Low On-Resistance with High Blocking Voltage
- Low Capacitances with High-Speed switching
- Low reverse recovery(Qrr)
- Halogen free, RoHs compliant

## Benefits

- Reduce switching losses
- Increased system Switching Frequency
- Increased power density
- Reduction of heat sink requirements

## Applications

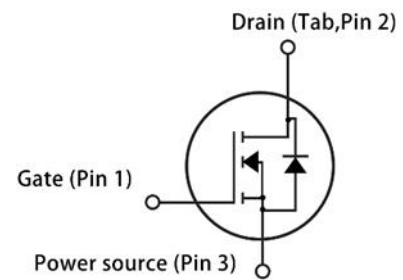
- Switch mode power supplies
- Renewable energy
- On Board Charger
- High Voltage DC/DC Converters



| Ordering Part Number | Package | Brand      |
|----------------------|---------|------------|
| NVHL023N065M3S       | TO-247  | HXY MOSFET |



TO-247



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

| Symbol        | Parameter                      | Test conditions                                   | Value   | Unit             | Note    |
|---------------|--------------------------------|---------------------------------------------------|---------|------------------|---------|
| $V_{DSmax}$   | Drain-Source Voltage           | $V_{GS} = 0V, I_D = 100\mu A$                     | 650     | V                |         |
| $V_{GSmax}$   | Gate-Source voltage            | AC ( $f > 1\text{ Hz}$ )                          | -10/+25 | V                |         |
| $V_{GSop}$    | Recommend Gate-Source Voltage  | Static                                            | -4/+18  | V                |         |
| $I_D$         | Continuous Drain current       | $V_{GS} = 18V, T_c = 25^\circ\text{C}$            | 99      | A                | Fig. 14 |
|               |                                | $V_{GS} = 18V, T_c = 100^\circ\text{C}$           | 70      |                  |         |
| $I_{D,pulse}$ | Pulsed Drain Current           | Pulse with $t_p$ limited by $T_{jmax}$            | 157     | A                |         |
| $P_D$         | Power Dissipation              | $T_c = 25^\circ\text{C}, T_j = 175^\circ\text{C}$ | 333     | W                | Fig.16  |
| $T_j$         | Operating junction temperature |                                                   | -55~175 | $^\circ\text{C}$ |         |
| $T_{stg}$     | Storage temperature            |                                                   | -55~175 | $^\circ\text{C}$ |         |
|               | TO-247 miunting torque         | M3 Screw                                          | 0.7     | Nm               |         |



### Thermal Characteristics

| Symbol       | Parameter                                   | Value |      |      | Unit | Note    |
|--------------|---------------------------------------------|-------|------|------|------|---------|
|              |                                             | Min.  | Typ. | Max. |      |         |
| $R_{th(jc)}$ | Thermal resistance from Junction to Case    |       | 0.45 |      | K/W  | Fig. 15 |
| $R_{th(ja)}$ | Thermal resistance from Junction to Ambient |       | 40   |      | K/W  |         |

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

#### Static Characteristics

| Symbol        | Parameter                        | Test conditions                                  | Value |      |      | Unit       | Note         |
|---------------|----------------------------------|--------------------------------------------------|-------|------|------|------------|--------------|
|               |                                  |                                                  | Min.  | Typ. | Max. |            |              |
| $V_{(BR)DSS}$ | Drain-Source Breakdown voltage   | $V_{GS} = 0V, I_D = 100\mu A$                    | 650   |      |      | V          |              |
| $V_{GS(th)}$  | Gate Threshold voltage           | $V_{GS} = V_{DS}, I_D = 16mA$                    |       | 3.0  |      | V          | Fig. 9       |
|               |                                  | $V_{GS} = V_{DS}, I_D = 16mA, T_j = 175^\circ C$ |       | 2.0  |      |            |              |
| $I_{GSS}$     | Gate-Source Leakage current      | $V_{GS} = 18V, V_{DS} = 0V$                      |       |      | 250  | nA         |              |
| $I_{DSS}$     | Zero Gate Voltage Drain Current  | $V_{DS} = 650V, V_{GS} = 0V, T_j = 25^\circ C$   |       | 1    | 50   | $\mu A$    |              |
| $R_{DS(on)}$  | Drain-Source On-state Resistance | $V_{GS} = 18V, I_D = 40A$                        |       | 26   | 38   | m $\Omega$ | Fig. 3, 4, 5 |
|               |                                  | $V_{GS} = 18V, I_D = 40A, T_j = 175^\circ C$     |       | 35   |      |            |              |
| $g_{fs}$      | Transconductance                 | $V_{DS} = 18V, I_D = 40A$                        |       | 27   |      | S          | Fig. 6       |
|               |                                  | $V_{DS} = 18V, I_D = 40A, T_j = 175^\circ C$     |       | 25   |      |            |              |



### Gate Charge Characteristics

| Symbol   | Parameter             | Test conditions                                      | Value |      |      | Unit | Note    |
|----------|-----------------------|------------------------------------------------------|-------|------|------|------|---------|
|          |                       |                                                      | Min.  | Typ. | Max. |      |         |
| $Q_{GS}$ | Gate to Source Charge | $V_{DS} = 400V$<br>$I_D = 40A$<br>$V_{GS} = -4V/18V$ |       | 29   |      | nC   | Fig. 10 |
| $Q_{GD}$ | Gate to Drain Charge  |                                                      |       | 35   |      |      |         |
| $Q_G$    | Total Gate Charge     |                                                      |       | 74.5 |      |      |         |

### AC Characteristics

| Symbol       | Parameter                    | Test conditions                                                       | Value |      |      | Unit     | Note    |
|--------------|------------------------------|-----------------------------------------------------------------------|-------|------|------|----------|---------|
|              |                              |                                                                       | Min.  | Typ. | Max. |          |         |
| $C_{iss}$    | Input Capacitance            | $V_{GS} = 0V, V_{DS} = 600V$<br>$f = 1\text{ MHz}$<br>$V_{AC} = 25mV$ |       | 2543 |      | pF       | Fig. 13 |
| $C_{oss}$    | Output Capacitance           |                                                                       |       | 173  |      | pF       |         |
| $C_{rss}$    | Reverse Transfer Capacitance |                                                                       |       | 8    |      | pF       |         |
| $R_{G(int)}$ | Internal Gate Resistance     | $f = 1\text{ MHz}, V_{AC} = 25mV$                                     |       | 1.2  |      | $\Omega$ |         |



### Reverse Diode Characteristics

| Symbol         | Parameter                        | Test conditions                                                  | Value |      |      | Unit | Note     |
|----------------|----------------------------------|------------------------------------------------------------------|-------|------|------|------|----------|
|                |                                  |                                                                  | Min.  | Typ. | Max. |      |          |
| $V_{SD}$       | Diode Forward Voltage            | $V_{GS} = -4V, I_{SD} = 20A$                                     |       | 4.3  |      | V    | Fig. 7,8 |
|                |                                  | $V_{GS} = -4V, I_{SD} = 20A, T_J = 175^{\circ}C$                 |       | 3.7  |      |      |          |
| $I_S$          | Continuous Diode Forward Current | $V_{GS} = -4V, T_C = 25^{\circ}C$                                |       | 66   |      | A    |          |
| $I_{S, pulse}$ | Diode pulse Current              | $V_{GS} = -4V$ , pulse width $t_p$ limited by $T_{jmax}$         |       | 157  |      | A    |          |
| $t_{rr}$       | Reverse Recovery Time            | $V_{GS} = -4V, I_{SD} = 40A, V_R = 400V$<br>$diff/dt = 3600A/us$ |       | 14   |      | nS   |          |
| $Q_{rr}$       | Reverse Recovery Charge          |                                                                  |       | 263  |      | nC   |          |
| $I_{rm}$       | Peak Reverse Recovery Current    |                                                                  |       | 20   |      | A    |          |

### Switching Characteristics

| Symbol       | Parameter              | Test conditions                                                                          | Value |      |      | Unit    | Note   |
|--------------|------------------------|------------------------------------------------------------------------------------------|-------|------|------|---------|--------|
|              |                        |                                                                                          | Min.  | Typ. | Max. |         |        |
| $t_{d(on)}$  | Turn-On Delay Time     | $V_{DS} = 400V, V_{GS} = -4/+18V$<br>$I_D = 40A, R_{G(ext)} = 5\Omega$<br>$L = 294\mu H$ |       | 2    |      | nS      | Fig.21 |
| $t_r$        | Rise Time              |                                                                                          |       | 30   |      | nS      |        |
| $t_{d(off)}$ | Turn-Off Delay Time    |                                                                                          |       | 25   |      | nS      |        |
| $t_f$        | Fall Time              |                                                                                          |       | 9    |      | nS      |        |
| $E_{on}$     | Turn-On Energy         |                                                                                          |       | 162  |      | $\mu J$ | Fig.19 |
| $E_{off}$    | Turn-Off Energy        |                                                                                          |       | 160  |      | $\mu J$ |        |
| $E_{tot}$    | Total switching energy |                                                                                          |       | 322  |      | $\mu J$ |        |



## Typical Performance

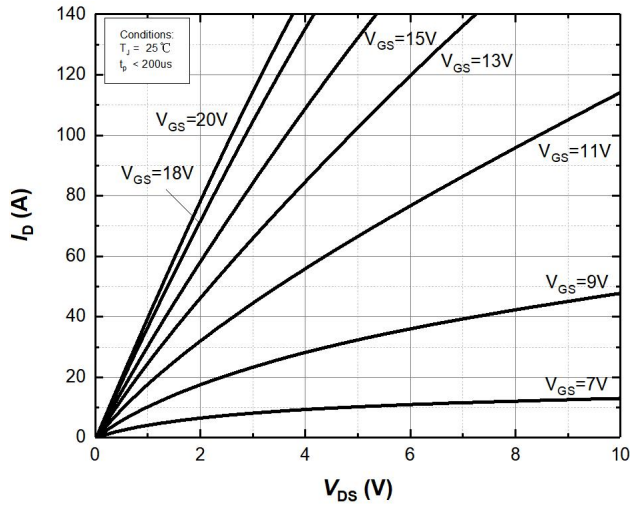


Figure 1. Output characteristics at  $T_j=25^\circ\text{C}$

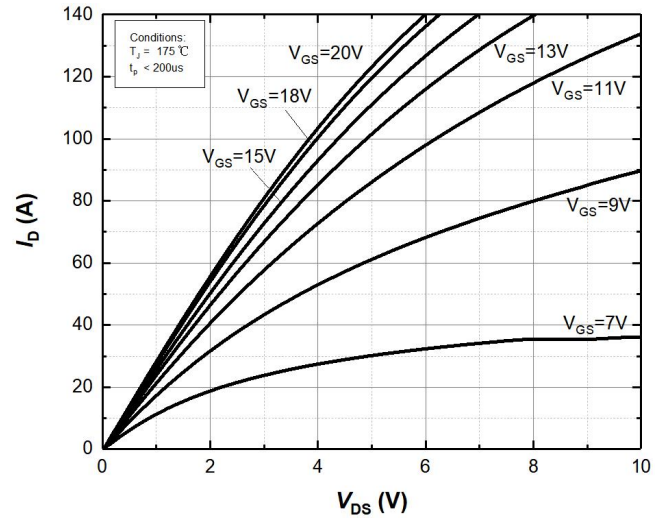


Figure 2. Output characteristics at  $T_j=175^\circ\text{C}$

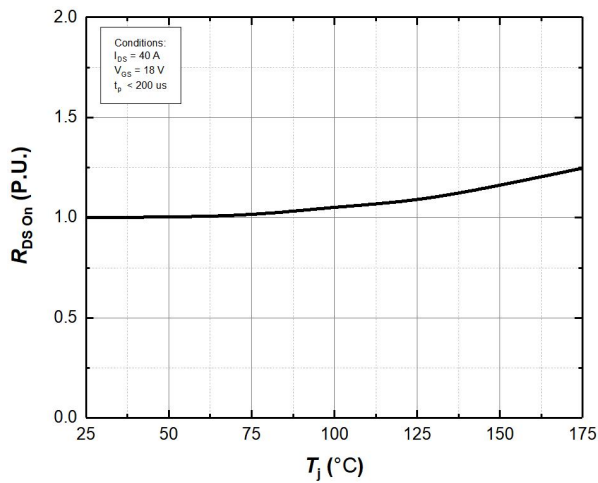


Figure 3. Normalized On-Resistance vs. Temperature

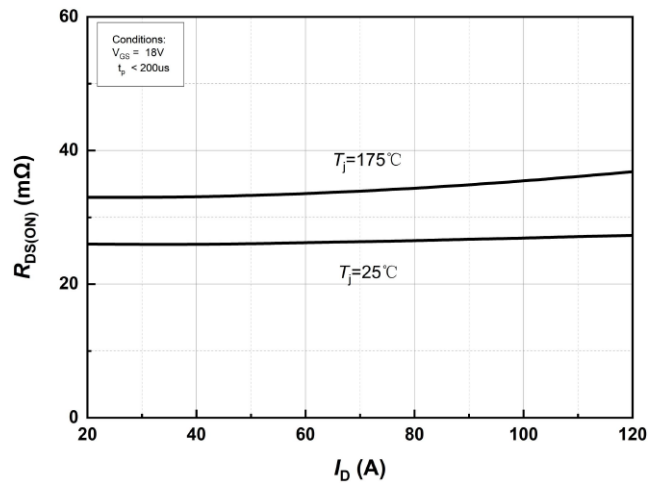


Figure 4. On-Resistance vs. Drain current for Various Temperature

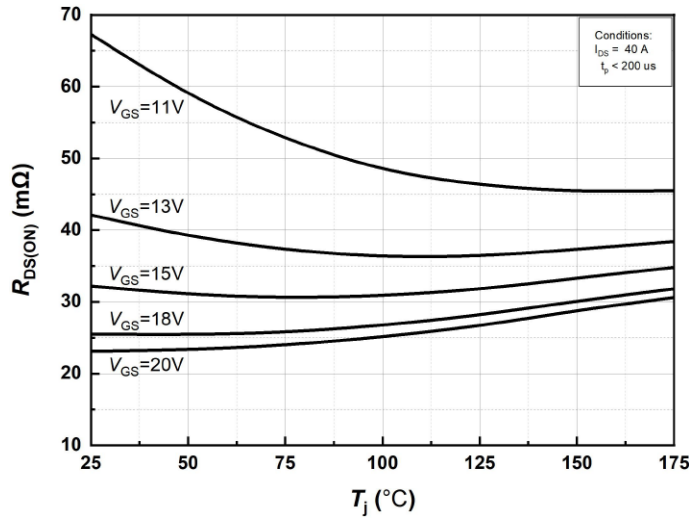


Figure 5. On-Resistance vs. Temperature for Various Gate Voltage

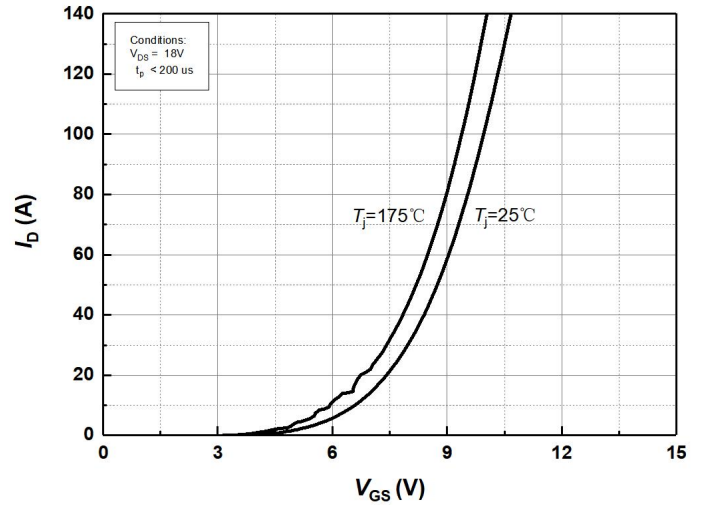


Figure 6. Transfer Characteristics for Various Junction Temperatures

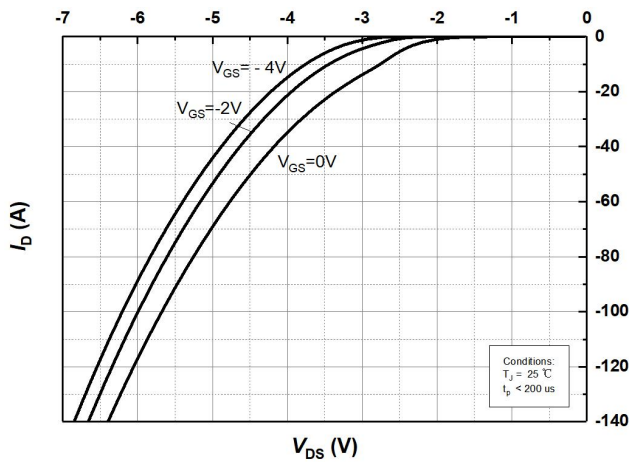


Figure 7. Body Diode Characteristics at  $T_j=25^{\circ}\text{C}$

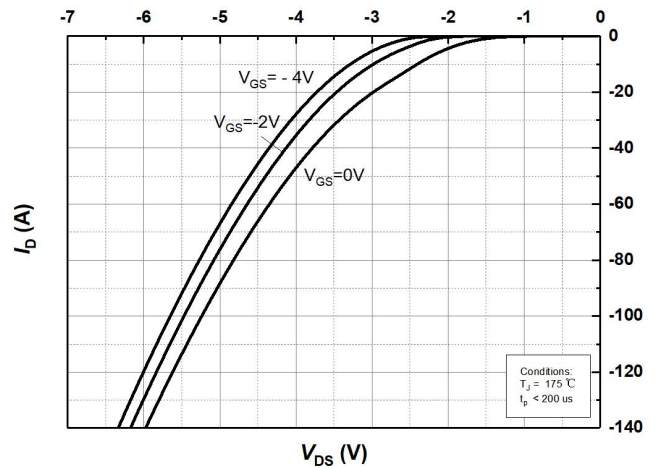


Figure 8. Body Diode Characteristics at  $T_j=175^{\circ}\text{C}$

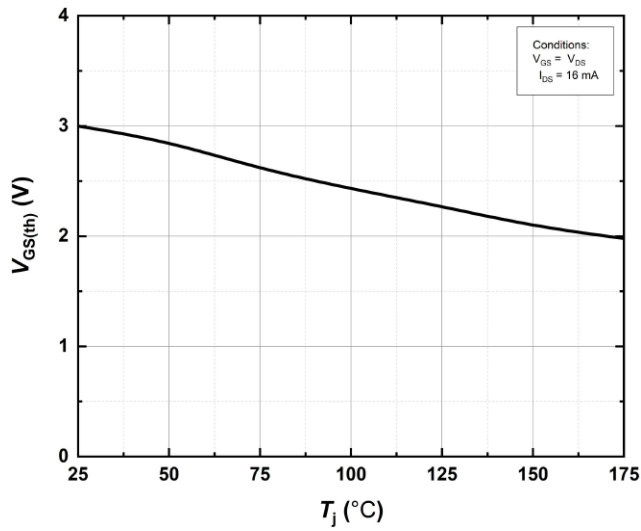


Figure 9. Threshold Voltage vs. Temperature

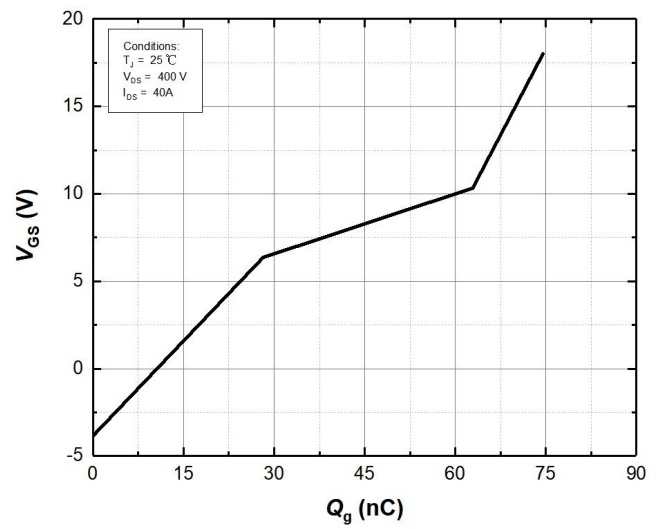


Figure 10 Gate Charge Characteristics

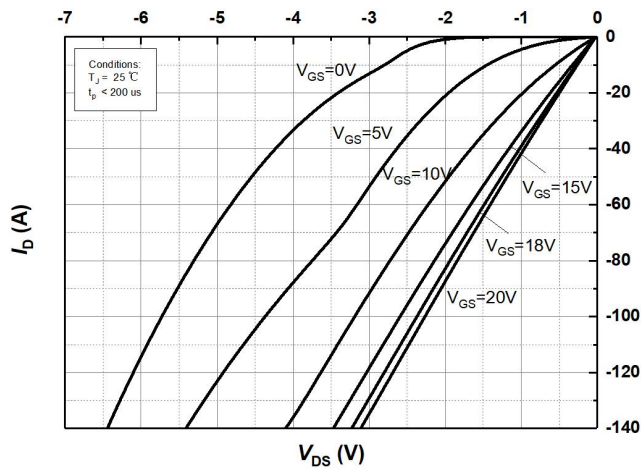


Figure 11. 3rd Quadrant Characteristic at  $T_J=25^\circ\text{C}$

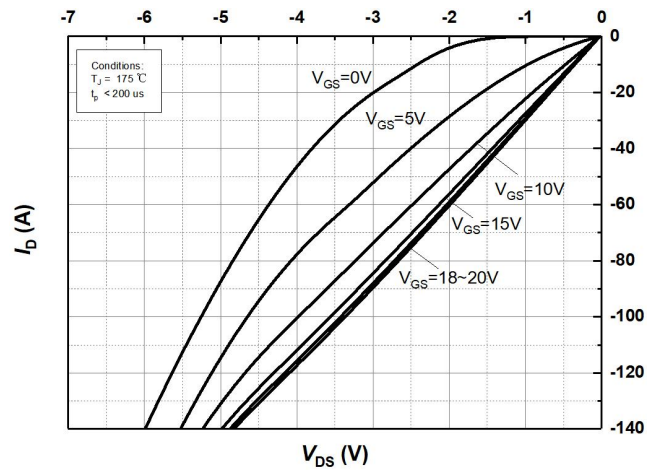


Figure 12. 3rd Quadrant Characteristic at  $T_J=175^\circ\text{C}$

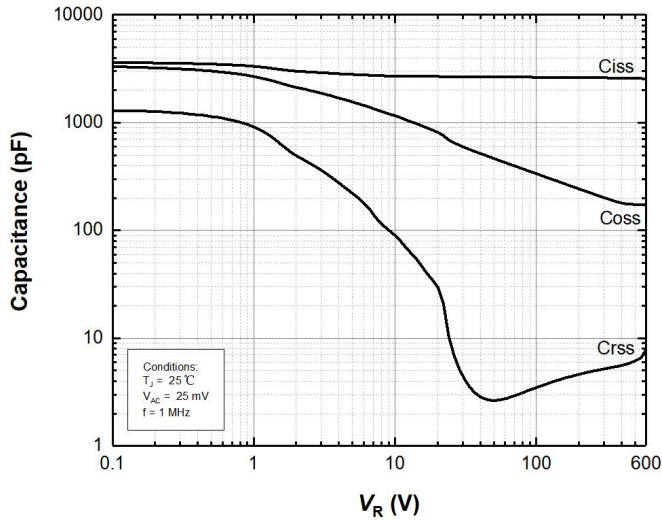


Figure 13. Capacitances vs. Drain-Source Voltage (0 – 600V)

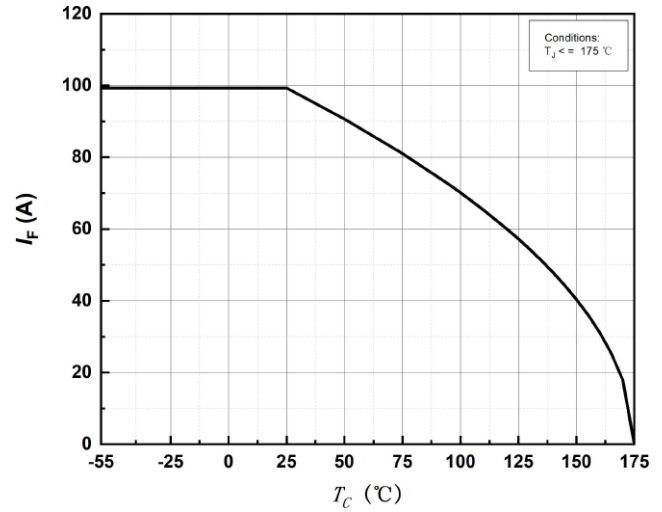


Figure 14. Continuous Drain Current Derating vs Case Temperature

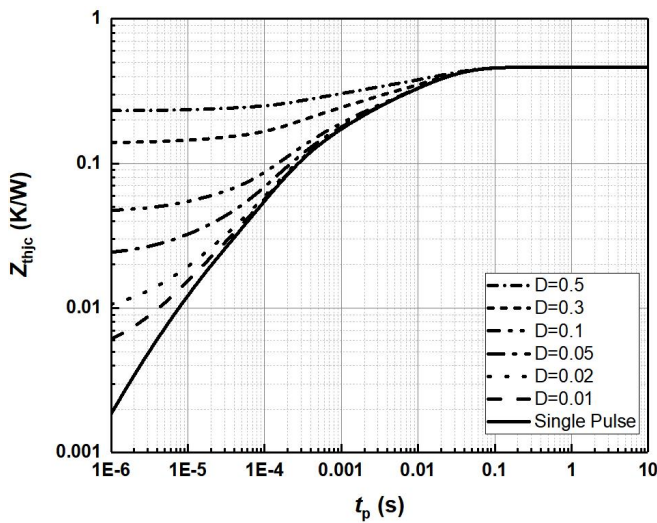


Figure 15. Transient Thermal Impedance (Junction – Case)

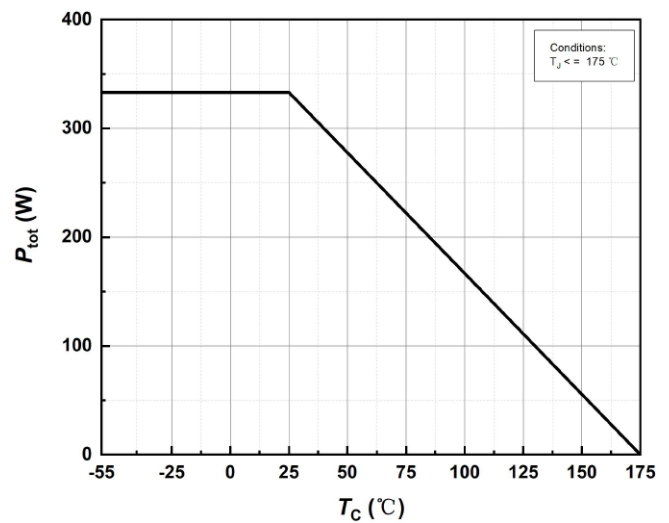


Figure 16. Maximum Power Dissipation Derating vs. Case Temperature

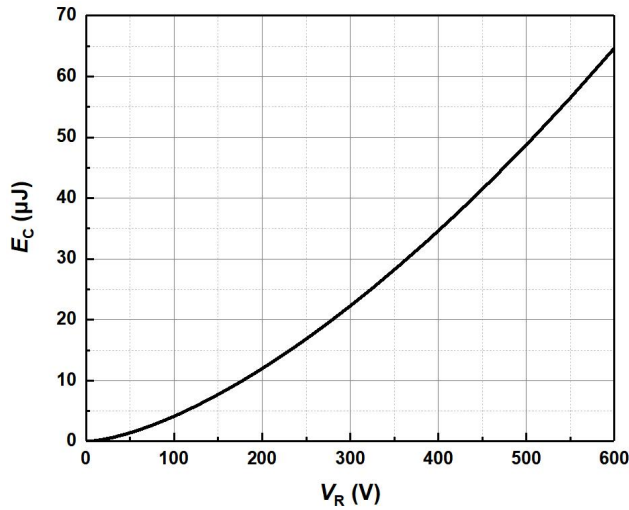


Figure 17. Output Capacitor Stored Energy

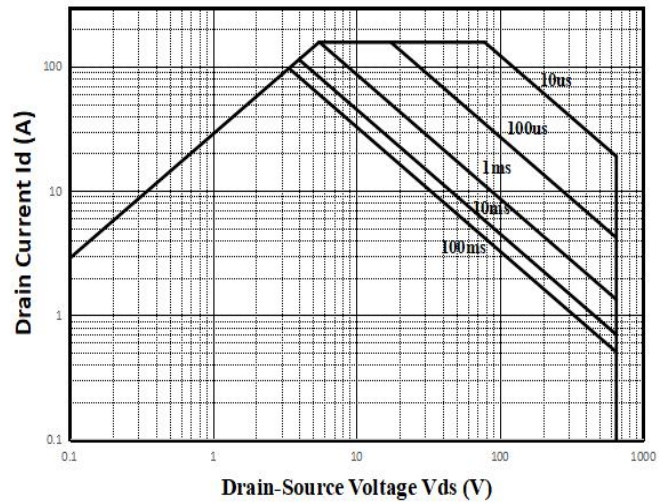


Figure 18. Safe Operating Area

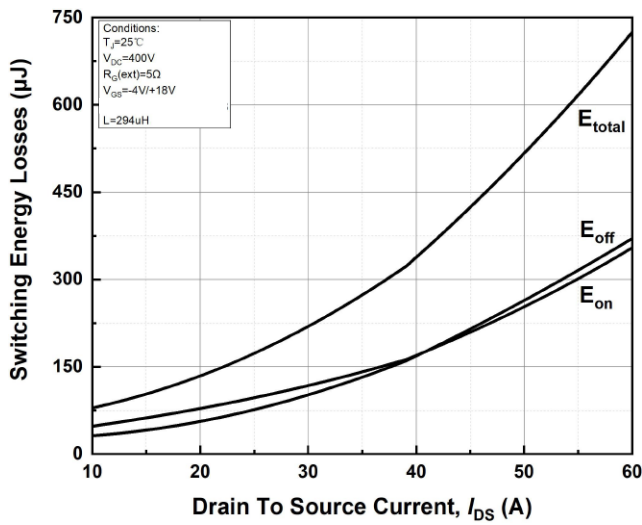


Figure 19. Clamped Inductive Switching Energy vs. Drain Current( $V_{DD} = 400V$ )

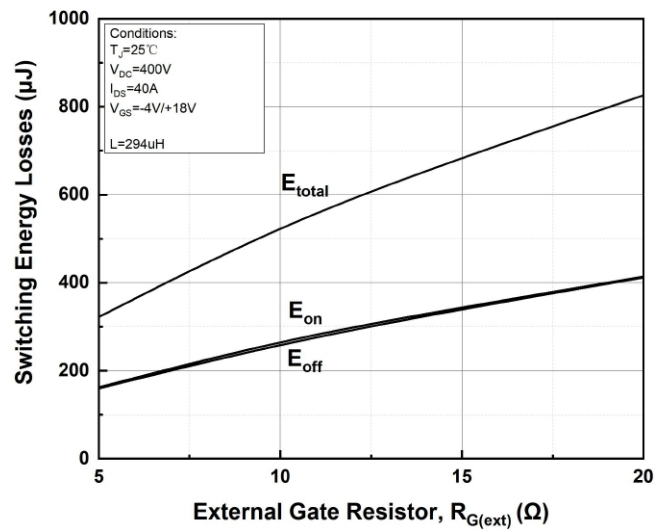


Figure 20. Clamped Inductive Switching Energy vs.  $R_{G(ext)}$

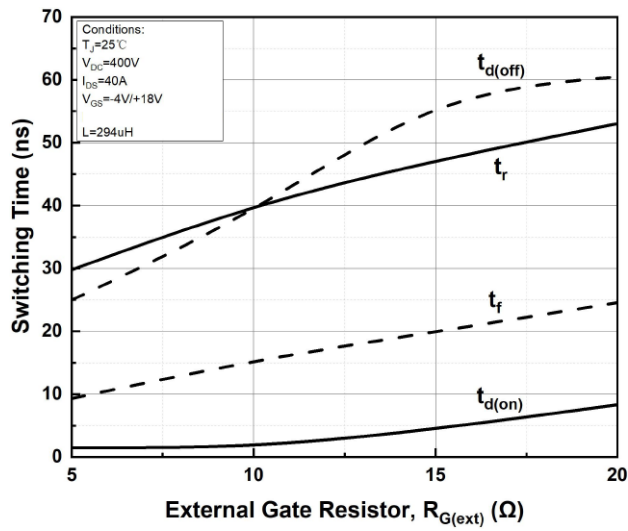
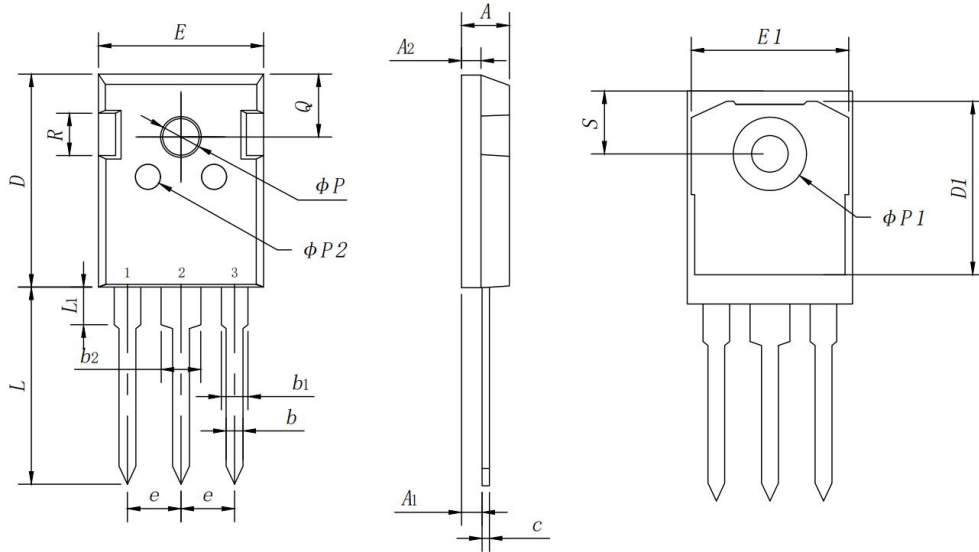


Figure 21. Switching Times vs.  $R_{G(ext)}$



## Package Dimensions

Package TO-247



| SYMBOLS              | DIMENSION IN MM |       |       |
|----------------------|-----------------|-------|-------|
|                      | MIN             | NOM   | MAX   |
| <i>A</i>             | 4.70            | 5.00  | 5.30  |
| <i>A<sub>1</sub></i> | 2.24            | 2.41  | 2.58  |
| <i>A<sub>2</sub></i> | 1.80            | 2.00  | 2.20  |
| <i>b</i>             | 1.00            | 1.20  | 1.40  |
| <i>b<sub>1</sub></i> | 1.60            | 2.10  | 2.60  |
| <i>b<sub>2</sub></i> | 2.60            | 3.10  | 3.60  |
| <i>c</i>             | 0.40            | 0.60  | 0.80  |
| <i>D</i>             | 20.0            | 21.00 | 22.0  |
| <i>D1</i>            | 15.24           | 16.24 | 17.24 |
| <i>E</i>             | 15.50           | 15.75 | 16.01 |
| <i>E1</i>            | 13.77           | 14.02 | 14.27 |
| <i>e</i>             | 5.20            | 5.44  | 5.72  |
| <i>L</i>             | 19.70           | 19.95 | 20.20 |
| <i>L<sub>1</sub></i> | 3.85            | 4.15  | 4.45  |
| <i>phi P</i>         | 3.55            | 3.60  | 3.65  |
| <i>Phi p1</i>        | 7.14            | 7.19  | 7.24  |
| <i>Phi p2</i>        | 2.35            | 2.40  | 2.45  |
| <i>Q</i>             | 5.89            | 6.15  | 6.40  |
| <i>R</i>             | 4.30            | 4.60  | 4.90  |
| <i>S</i>             | 6.04            | 6.17  | 6.30  |



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