



## Features

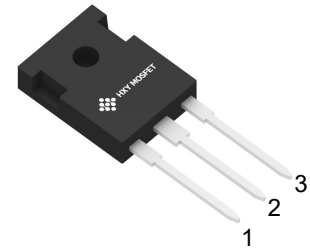
- Wide bandgap SiC MOSFET technology
- Low On-Resistance with High Blocking Voltage
- Low Capacitances with High-Speed switching
- Low reverse recovery(Qrr)
- Halogen free, RoHs compliant

## Benefits

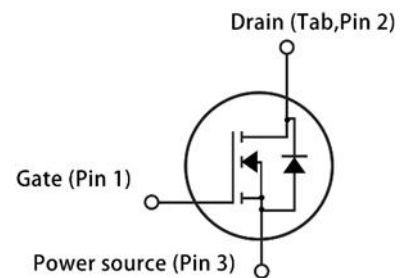
- Reduce switching losses
- Increased system Switching Frequency
- Increased power density
- Reduction of heat sink requirements

## Applications

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



TO-247



| Ordering Part Number | Package | Brand      |
|----------------------|---------|------------|
| NVHL110N65S3HF       | TO-247  | HXY MOSFET |

## 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       | $V_{GS} = 18V, T_c = 25^\circ\text{C}$                                                                  | 32       | A                | Fig. 14 |
|               |                                | $V_{GS} = 18V, T_c = 100^\circ\text{C}$                                                                 | 23       |                  |         |
| $I_{D,pulse}$ | Pulsed Drain Current           | Pulse with $t_p$ limited by $T_{jmax}$ at 1 ms<br>Pulse with $t_p$ limited by $T_{jmax}$ at 100 $\mu s$ | 50<br>94 | A                | Fig.18  |
| $P_D$         | Power Dissipation              | $T_c = 25^\circ\text{C}, T_j = 175^\circ\text{C}$                                                       | 142      | 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 (MOSFET only) |       | 1.06 |      | K/W  | Fig. 15 |
| $R_{th(jc)}$ | Thermal resistance from Junction to Case (SBD only)    |       | 2.0  |      | K/W  |         |
| $R_{th(ja)}$ | 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           | $V_{GS} = V_{DS}, I_D = 5mA$                                                                 |       | 2.7        |      | V          | Fig. 9       |
|               |                                  | $V_{GS} = V_{DS}, I_D = 5mA, T_j = 175^\circ C$                                              |       | 1.8        |      |            |              |
| $I_{GSS}$     | 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 | $V_{GS} = 18V, I_D = 10A$<br>$V_{GS} = 20V, I_D = 10A$                                       |       | 105<br>94  | 150  | m $\Omega$ | Fig. 3, 4, 5 |
|               |                                  | $V_{GS} = 18V, I_D = 10A, T_j = 175^\circ C$<br>$V_{GS} = 20V, I_D = 10A, T_j = 175^\circ C$ |       | 140<br>130 |      |            |              |
| $g_{fs}$      | Transconductance                 | $V_{DS} = 18V, I_D = 10A$                                                                    |       | 13         |      | S          | Fig. 6       |
|               |                                  | $V_{DS} = 18V, I_D = 10A, T_j = 175^\circ C$                                                 |       | 9          |      |            |              |



### Gate Charge Characteristics

| Symbol   | Parameter             | Test conditions                                      | Value |      |      | Unit | Note    |
|----------|-----------------------|------------------------------------------------------|-------|------|------|------|---------|
|          |                       |                                                      | Min.  | Typ. | Max. |      |         |
| $Q_{GS}$ | Gate to Source Charge | $V_{DS} = 400V$<br>$I_D = 10A$<br>$V_{GS} = -4V/18V$ |       | 8    |      | nC   | Fig. 10 |
| $Q_{GD}$ | Gate to Drain Charge  |                                                      |       | 12   |      |      |         |
| $Q_G$    | Total Gate Charge     |                                                      |       | 36   |      |      |         |

### 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>$V_{AC} = 25mV$ |       | 758  |      | pF       | Fig. 13 |
| $C_{oss}$    | Output Capacitance           |                                                                       |       | 82   |      | pF       |         |
| $C_{rss}$    | Reverse Transfer Capacitance |                                                                       |       | 6    |      | pF       |         |
| $R_{G(int)}$ | Internal Gate Resistance     | $f = 1\text{ MHz}, V_{AC} = 25mV$                                     |       | 3.2  |      | $\Omega$ |         |



### Reverse Diode Characteristics

| Symbol         | Parameter                        | Test conditions                                                  | Value |      |      | Unit | Note     |
|----------------|----------------------------------|------------------------------------------------------------------|-------|------|------|------|----------|
|                |                                  |                                                                  | Min.  | Typ. | Max. |      |          |
| $V_{SD}$       | Diode Forward Voltage            | $V_{GS} = -5V, I_{SD} = 7.5A$                                    |       | 1.5  |      | V    | Fig. 7,8 |
|                |                                  | $V_{GS} = -5V, I_{SD} = 7.5A, T_j = 175^{\circ}C$                |       | 1.7  |      |      |          |
| $I_S$          | Continuous Diode Forward Current | $V_{GS} = -5V, T_C = 25^{\circ}C$                                |       | 28   |      | A    |          |
| $I_{S, pulse}$ | Diode pulse Current              | $V_{GS} = -5V$ , pulse width $t_p$ limited by $T_{jmax}$         |       | 44   |      | A    |          |
| $t_{rr}$       | Reverse Recovery Time            | $V_{GS} = -5V, I_{SD} = 12A, V_R = 400V$<br>$diff/dt = 1280A/us$ |       | 13   |      | nS   |          |
| $Q_{rr}$       | Reverse Recovery Charge          |                                                                  |       | 62   |      | nC   |          |
| $I_{rrm}$      | Peak Reverse Recovery Current    |                                                                  |       | 6    |      | 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>$I_D = 12A, R_{G(ext)} = 2.4\Omega$<br>$L = 294\mu H$ |       | 2.6  |      | nS      | Fig.20 |
| $t_r$        | Rise Time              |                                                                                            |       | 10   |      | nS      |        |
| $t_{d(off)}$ | Turn-Off Delay Time    |                                                                                            |       | 11   |      | nS      |        |
| $t_f$        | Fall Time              |                                                                                            |       | 5    |      | nS      |        |
| $E_{on}$     | Turn-On Energy         |                                                                                            |       | 16   |      | $\mu J$ | Fig.19 |
| $E_{off}$    | Turn-Off Energy        |                                                                                            |       | 12   |      | $\mu J$ |        |
| $E_{tot}$    | Total switching energy |                                                                                            |       | 28   |      | $\mu J$ |        |



## Typical Performance

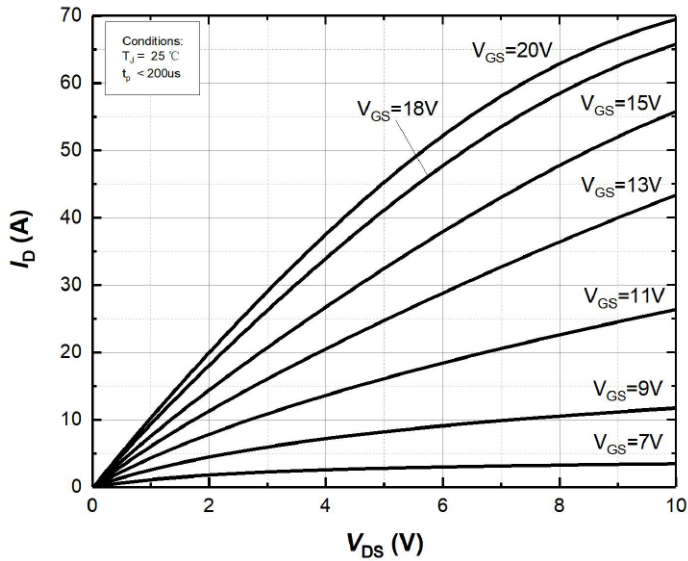


Figure 1. Output characteristics at  $T_j=25^\circ\text{C}$

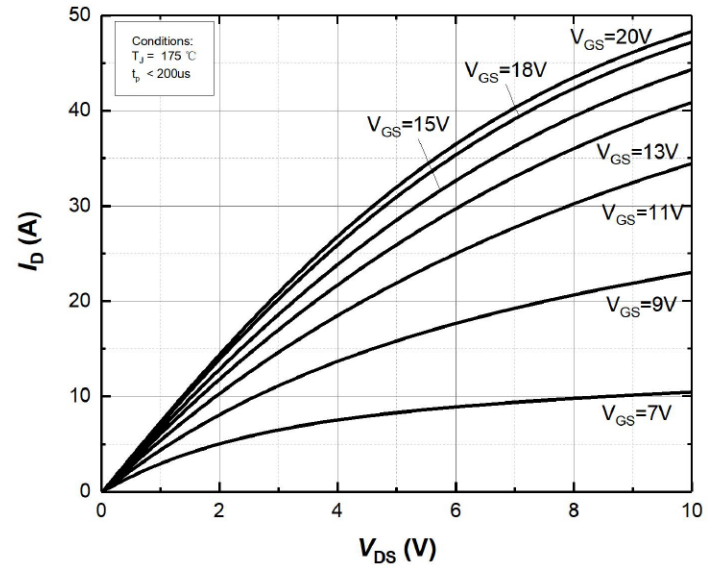


Figure 2. Output characteristics at  $T_j=175^\circ\text{C}$

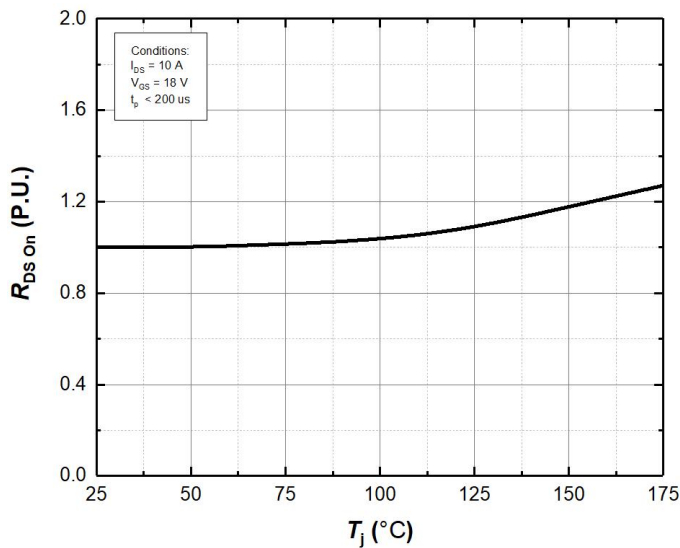


Figure 3. Normalized On-Resistance vs. Temperature

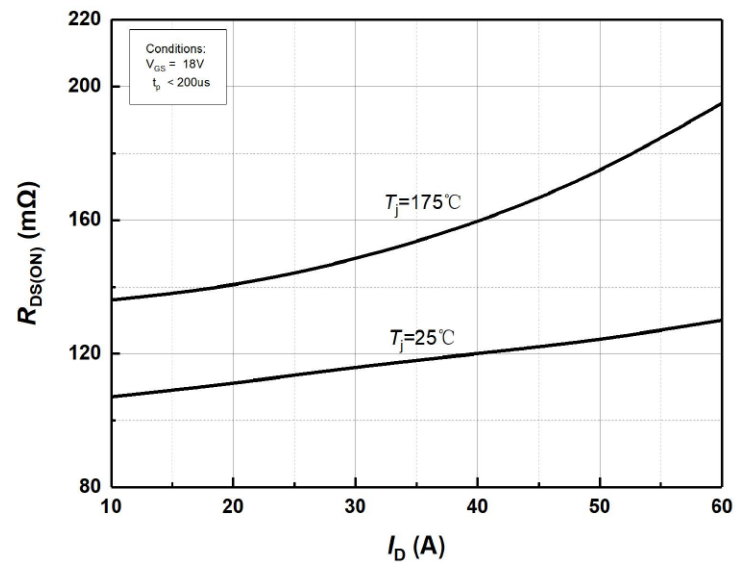


Figure 4. On-Resistance vs. Drain current for Various Temperature

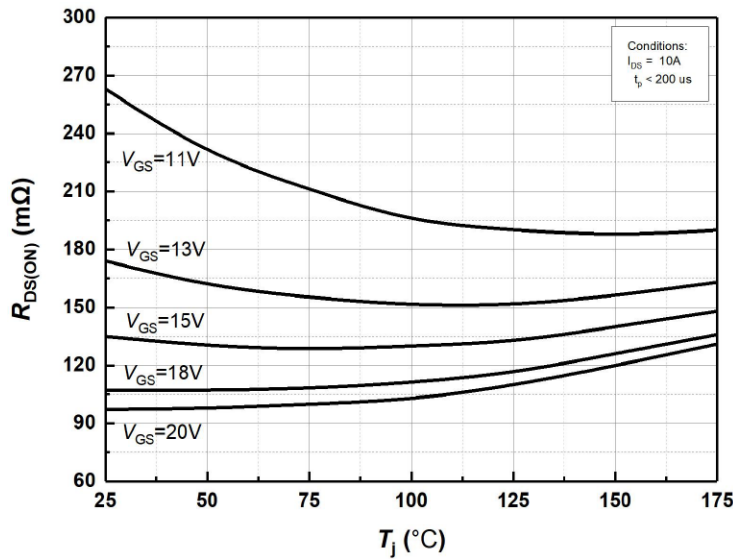


Figure 5. On-Resistance vs. Temperature for Various Gate Voltage

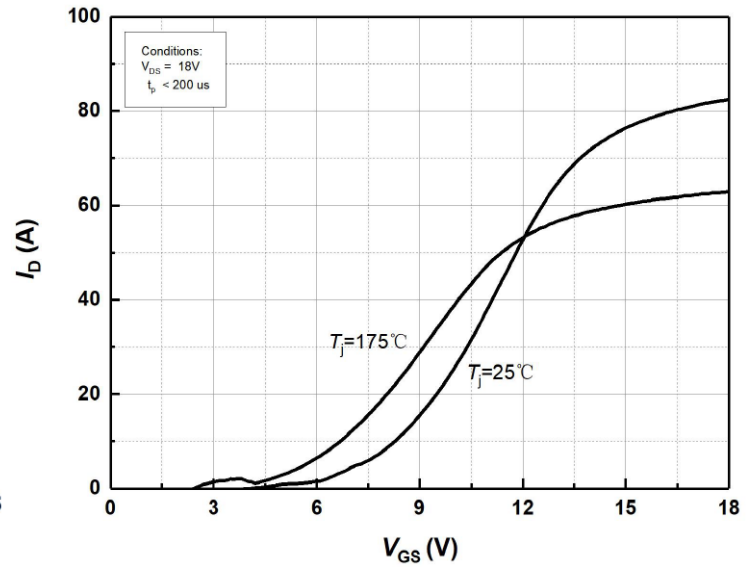


Figure 6. Transfer Characteristics for Various Junction Temperatures

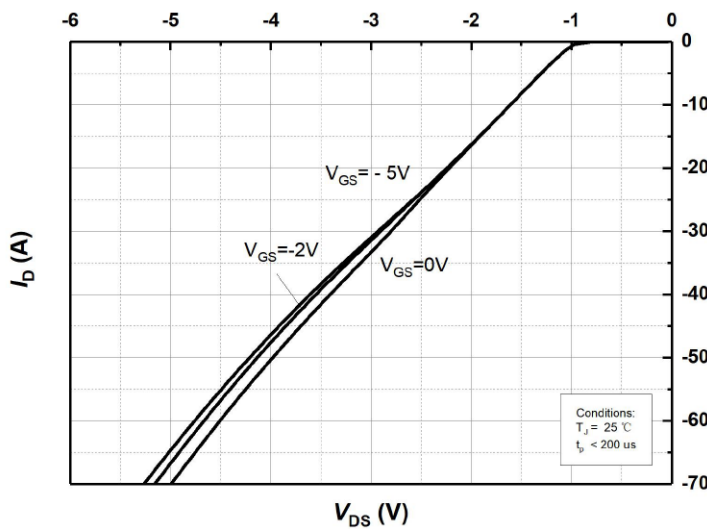


Figure 7. Body Diode Characteristics at  $T_J=25^\circ C$

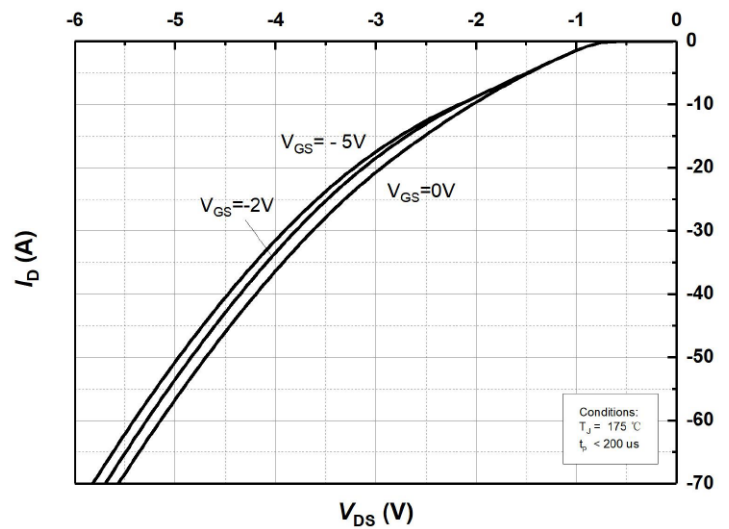


Figure 8. Body Diode Characteristics at  $T_J=175^\circ C$

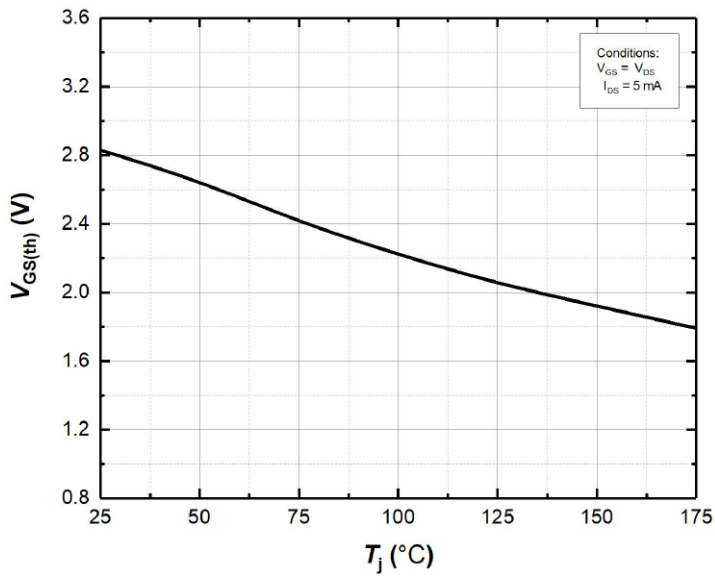


Figure 9. Threshold Voltage vs. Temperature

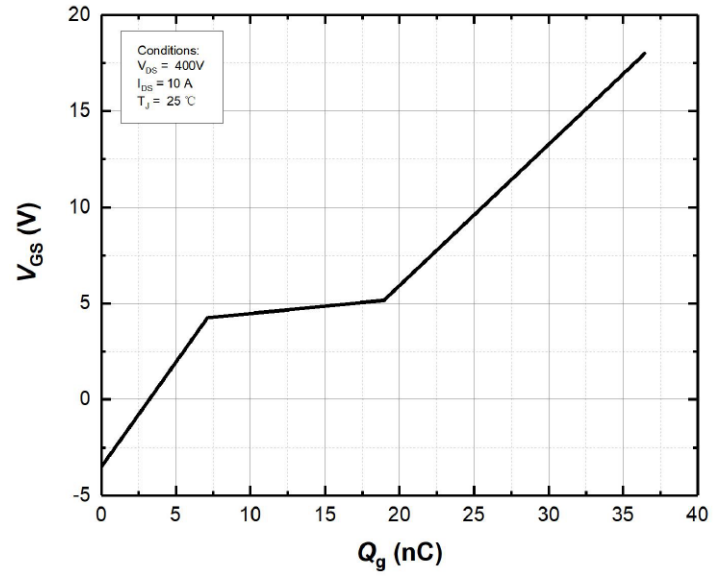


Figure 10 Gate Charge Characteristics

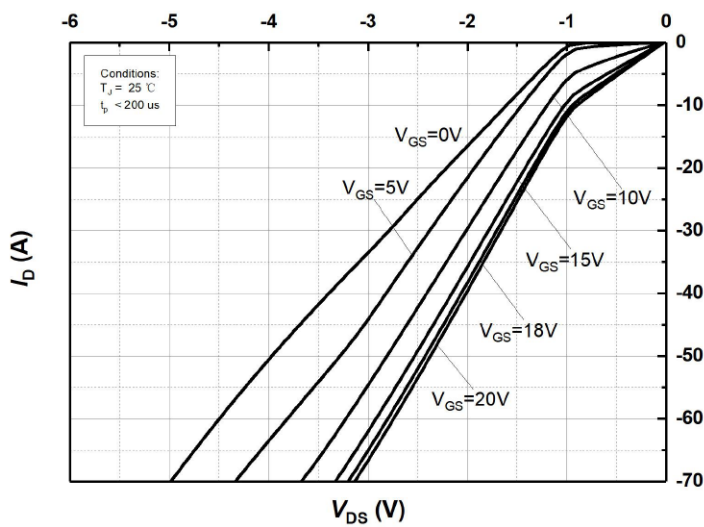


Figure 11. 3rd Quadrant Characteristic at  $T_j=25\text{ °C}$

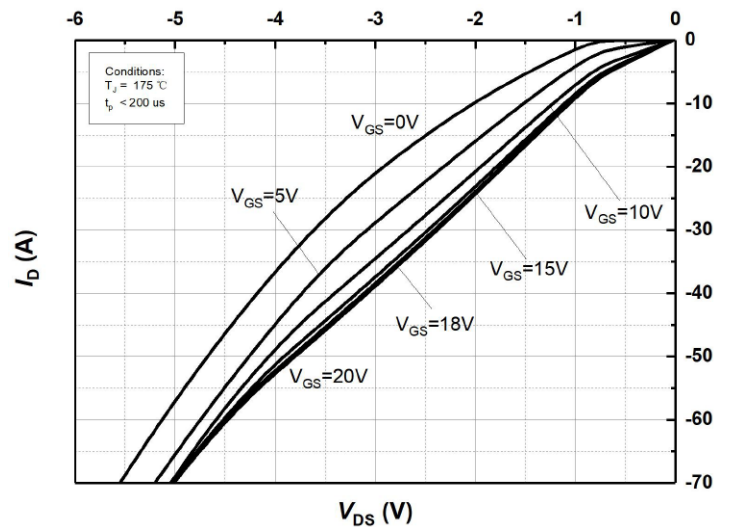


Figure 12. 3rd Quadrant Characteristic at  $T_j=175\text{ °C}$

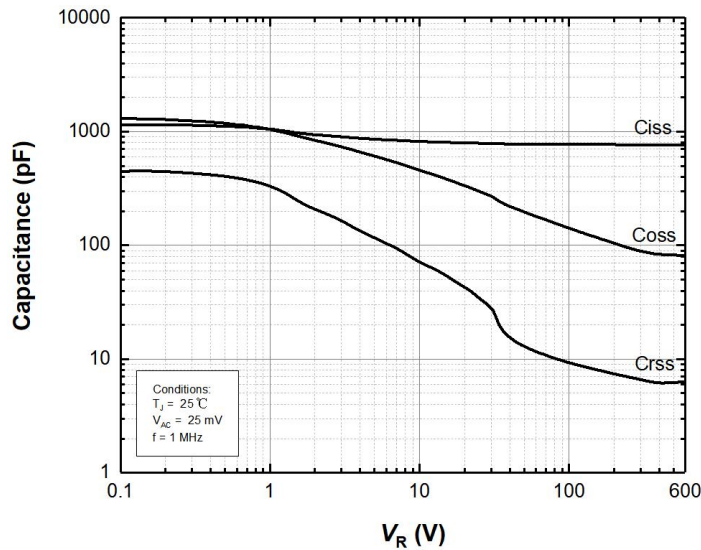


Figure 13. Capacitances vs. Drain-Source Voltage (0 – 600V)

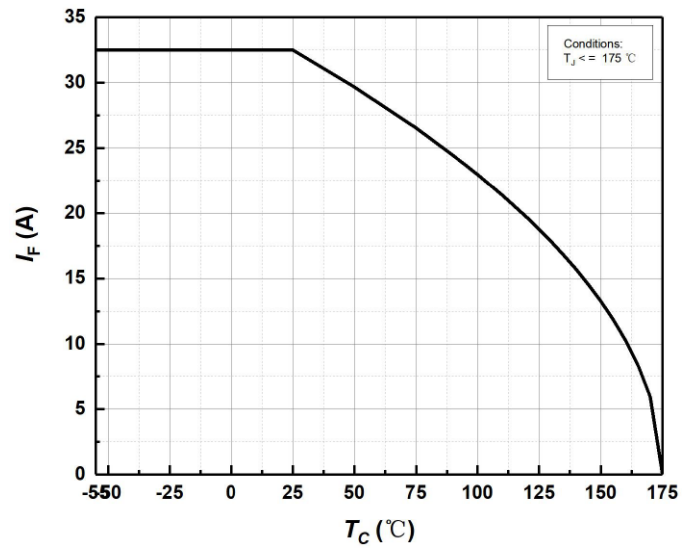


Figure 14. Continuous Drain Current Derating vs Case Temperature

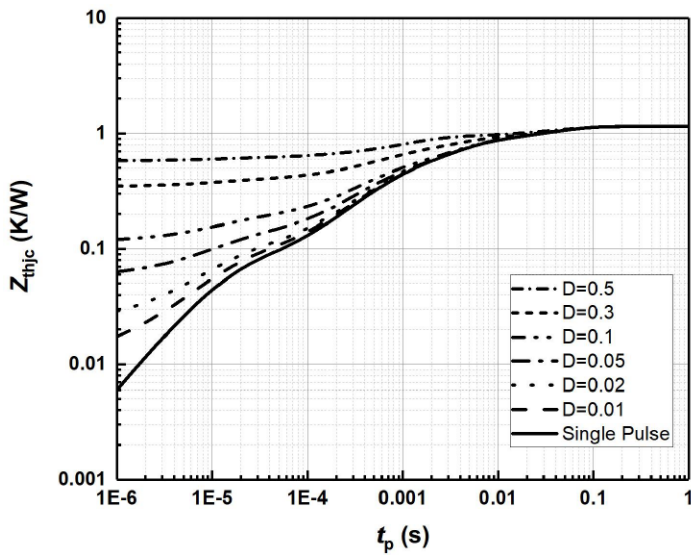


Figure 15. Transient Thermal Impedance (Junction – Case)

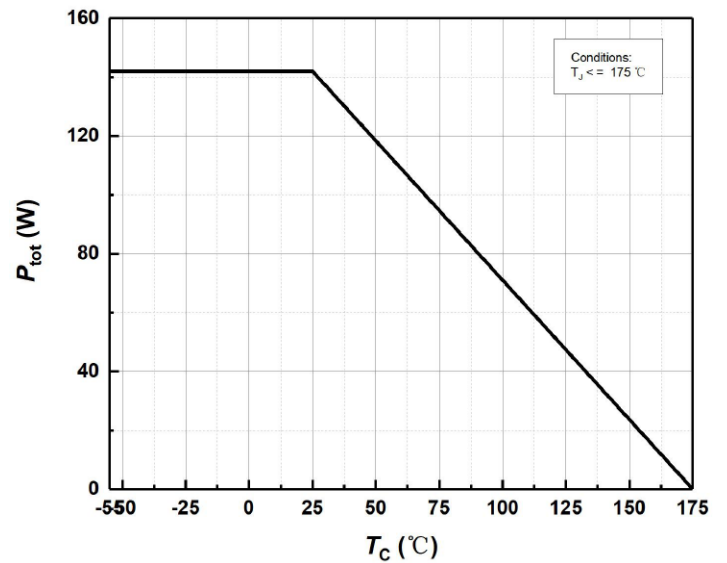


Figure 16. Maximum Power Dissipation Derating vs. Case Temperature



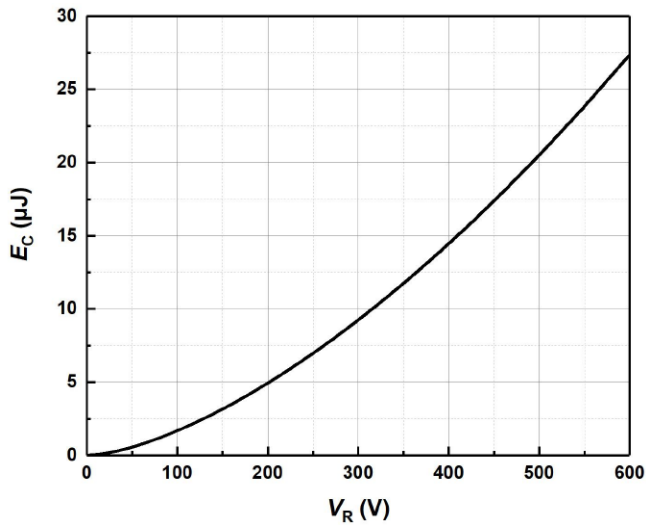


Figure 17. Output Capacitor Stored Energy

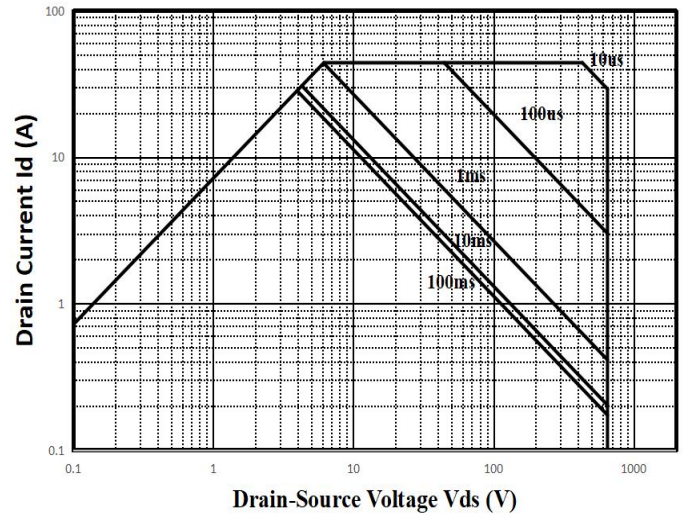


Figure 18. Safe Operating Area

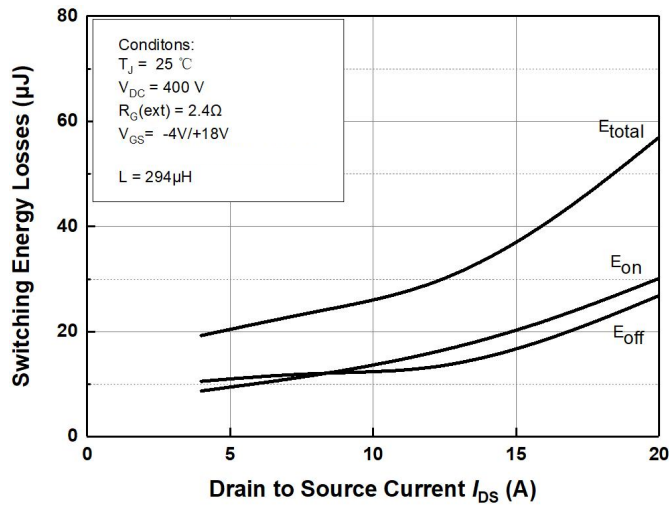


Figure 19. Clamped Inductive Switching Energy vs. Drain Current( $V_{DD} = 400V$ )

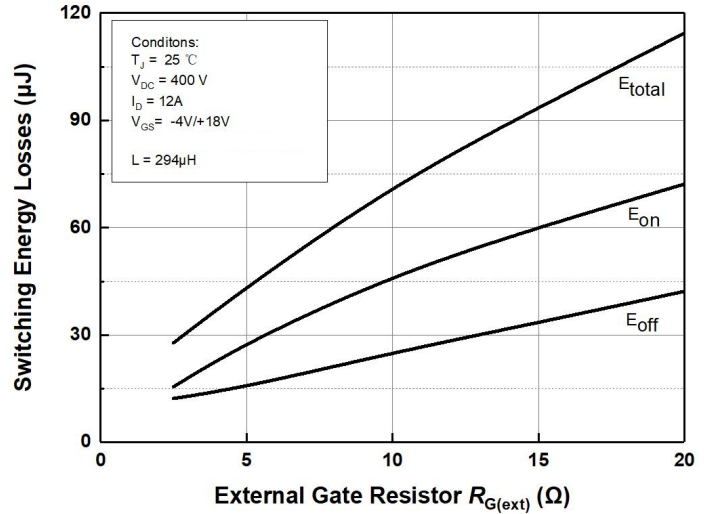


Figure 20. Clamped Inductive Switching Energy vs.  $R_{G(ext)}$

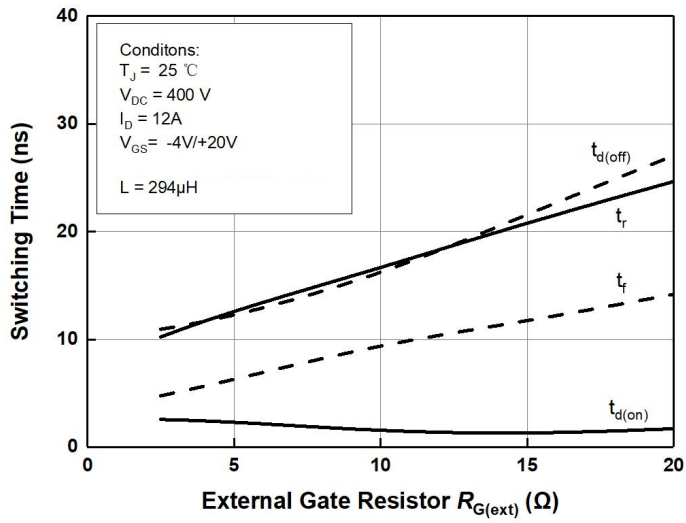
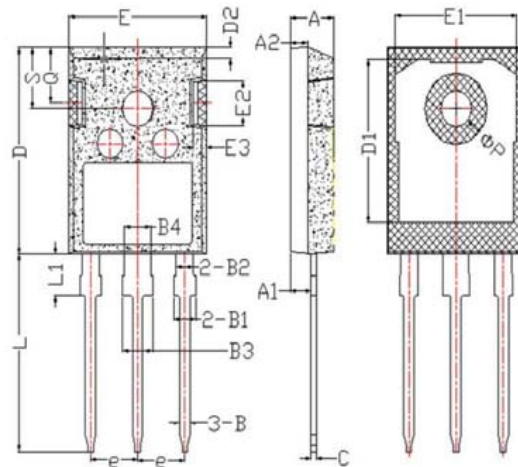


Figure 21. Switching Times vs.  $R_{G(ext)}$



## Package Dimensions

Package TO-247



| Items    | Values(mm) |      |
|----------|------------|------|
|          | MIN        | MAX  |
| A        | 4.6        | 5.2  |
| A1       | 2.2        | 2.6  |
| B        | 0.9        | 1.4  |
| B1       | 1.75       | 2.35 |
| B2       | 1.75       | 2.15 |
| B3       | 2.8        | 3.35 |
| B4       | 2.8        | 3.15 |
| C        | 0.5        | 0.7  |
| D        | 20.6       | 21.3 |
| D1       | 16         | 18   |
| E        | 15.5       | 16.1 |
| E1       | 13         | 14.7 |
| E2       | 3.8        | 5.3  |
| E3       | 0.8        | 2.6  |
| e        | 5.2        | 5.2  |
| L        | 19         | 20.5 |
| L1       | 3.9        | 4.6  |
| $\Phi p$ | 3.3        | 3.7  |
| Q        | 5.2        | 6    |
| S        | 5.8        | 6.6  |



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