



## Features

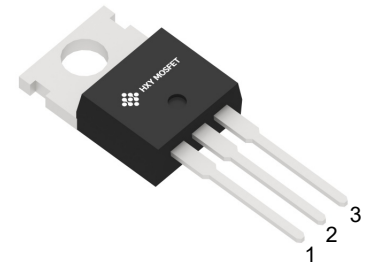
- Wide bandgap SiC MOSFET technology
- Low On-Resistance with High Blocking Voltage
- Low Capacitances with High-Speed switching
- Low reverse recovery(Qrr)
- Halogen free, RoHs compliant

## Benefits

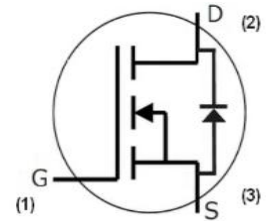
- Reduce switching losses
- Increased system Switching Frequency
- Increased power density
- Reduction of heat sink requirements

## Applications

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



TO-220C



| Ordering Part Number | Package | Brand      |
|----------------------|---------|------------|
| SPP15N65C3XKSA1      | TO-220C | HXY MOSFET |

## Maximum Ratings (T<sub>C</sub> = 25 °C unless otherwise specified)

| Symbol               | Parameter                       | Test conditions                                                                                 | Value   | Unit | Note    |
|----------------------|---------------------------------|-------------------------------------------------------------------------------------------------|---------|------|---------|
| V <sub>DSmax</sub>   | Drain-Source Voltage            | V <sub>GS</sub> = 0V, I <sub>D</sub> = 100μA                                                    | 650     | V    |         |
| V <sub>GS</sub>      | Gate-Source voltage (transient) | t <sub>p</sub> ≤ 500ns, duty cycle ≤ 1%                                                         | -8/+20  | V    |         |
| V <sub>GSop</sub>    | Recommend Gate-Source Voltage   | Static                                                                                          | -4/+18  | V    |         |
| EAS                  | Single pulse avalanche energy   | V <sub>DS</sub> =650V, V <sub>DD</sub> =50V, V <sub>GS</sub> =10V, L=10mH, T <sub>C</sub> =25°C | 106     | mJ   |         |
| I <sub>D</sub>       | Continuous Drain current        | V <sub>GS</sub> = 18V, T <sub>C</sub> = 25°C                                                    | 9       | A    | Fig. 14 |
|                      |                                 | V <sub>GS</sub> = 18V, T <sub>C</sub> = 100°C                                                   | 6.4     |      |         |
| I <sub>D,pulse</sub> | Pulsed Drain Current            | Pulse with t <sub>p</sub> limited by T <sub>Jmax</sub>                                          | 17      | A    |         |
| P <sub>D</sub>       | Power Dissipation               | T <sub>C</sub> = 25°C, T <sub>J</sub> = 175°C                                                   | 32      | W    | Fig. 16 |
| T <sub>J</sub>       | Operating junction temperature  |                                                                                                 | -55~175 | °C   |         |
| T <sub>stg</sub>     | Storage temperature             |                                                                                                 | -55~175 | °C   |         |



### Thermal Characteristics

| Symbol       | Parameter                                   | Value |      |      | Unit | Note    |
|--------------|---------------------------------------------|-------|------|------|------|---------|
|              |                                             | Min.  | Typ. | Max. |      |         |
| $R_{th(jc)}$ | Thermal resistance from Junction to Case    |       | 4.76 |      | 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           | $V_{GS} = V_{DS}, I_D = 1.33mA$                                                                |       | 2.7        |      | V          | Fig. 9       |
|               |                                  | $V_{GS} = V_{DS}, I_D = 1.33mA, T_J = 175^\circ C$                                             |       | 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 | $V_{GS} = 15V, I_D = 4.5A$                                                                     |       | 380        |      | m $\Omega$ | Fig. 3, 4, 5 |
|               |                                  | $V_{GS} = 18V, I_D = 4.5A$                                                                     |       | 300        | 390  |            |              |
|               |                                  | $V_{GS} = 15V, I_D = 4.5A, T_J = 175^\circ C$<br>$V_{GS} = 18V, I_D = 4.5A, T_J = 175^\circ C$ |       | 480<br>400 |      |            |              |
| $g_{fs}$      | Transconductance                 | $V_{DS} = 18V, I_D = 4.5A$                                                                     |       | 4          |      | S          | Fig. 6       |
|               |                                  | $V_{DS} = 18V, I_D = 4.5A, T_J = 175^\circ C$                                                  |       | 3          |      |            |              |



### Gate Charge Characteristics

| Symbol   | Parameter             | Test conditions                                       | Value |      |      | Unit | Note    |
|----------|-----------------------|-------------------------------------------------------|-------|------|------|------|---------|
|          |                       |                                                       | Min.  | Typ. | Max. |      |         |
| $Q_{GS}$ | Gate to Source Charge | $V_{DS} = 400V$<br>$I_D = 4.5A$<br>$V_{GS} = -4V/18V$ |       | 2.5  |      | nC   | Fig. 10 |
| $Q_{GD}$ | Gate to Drain Charge  |                                                       |       | 6    |      |      |         |
| $Q_G$    | Total Gate Charge     |                                                       |       | 11.6 |      |      |         |

### 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>$V_{AC} = 25mV$ |       | 184  |      | pF       | Fig. 13 |
| $C_{oss}$    | Output Capacitance           |                                                                       |       | 22   |      | pF       |         |
| $C_{rss}$    | Reverse Transfer Capacitance |                                                                       |       | 3.2  |      | pF       |         |
| $R_{G(int)}$ | Internal Gate Resistance     | $f = 1\text{ MHz}, V_{AC} = 25mV$                                     |       | 13   |      | $\Omega$ |         |



## Reverse Diode Characteristics

| Symbol         | Parameter                        | Test conditions                                                   | Value |      |      | Unit | Note     |
|----------------|----------------------------------|-------------------------------------------------------------------|-------|------|------|------|----------|
|                |                                  |                                                                   | Min.  | Typ. | Max. |      |          |
| $V_{SD}$       | Diode Forward Voltage            | $V_{GS} = -4V, I_{SD} = 2.5A$                                     |       | 4.2  |      | V    | Fig. 7,8 |
|                |                                  | $V_{GS} = -4V, I_{SD} = 2.5A, T_j = 175^{\circ}C$                 |       | 3.9  |      |      |          |
| $I_S$          | Continuous Diode Forward Current | $V_{GS} = -4V, T_C = 25^{\circ}C$                                 |       | 6    |      | A    |          |
| $I_{S, pulse}$ | Diode pulse Current              | $V_{GS} = -4V$ , pulse width $t_p$ limited by $T_{jmax}$          |       | 17   |      | A    |          |
| $t_{rr}$       | Reverse Recovery Time            | $V_{GS} = -4V, I_{SD} = 4.5A, V_R = 400V$<br>$diff/dt = 1000A/us$ |       | 23   |      | nS   |          |
| $Q_{rr}$       | Reverse Recovery Charge          |                                                                   |       | 34   |      | nC   |          |
| $I_{rm}$       | Peak Reverse Recovery Current    |                                                                   |       | 3.4  |      | 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>$I_D = 4.5A, R_{G(ext)} = 20\Omega$<br>$L = 833\mu H$ |       | 1    |      | nS      | Fig.21 |
| $t_r$        | Rise Time              |                                                                                            |       | 14   |      | nS      |        |
| $t_{d(off)}$ | Turn-Off Delay Time    |                                                                                            |       | 8    |      | nS      |        |
| $t_f$        | Fall Time              |                                                                                            |       | 10   |      | nS      |        |
| $E_{on}$     | Turn-On Energy         |                                                                                            |       | 20   |      | $\mu J$ | Fig.19 |
| $E_{off}$    | Turn-Off Energy        |                                                                                            |       | 12   |      | $\mu J$ |        |
| $E_{tot}$    | Total switching energy |                                                                                            |       | 32   |      | $\mu J$ |        |



## Typical Performance

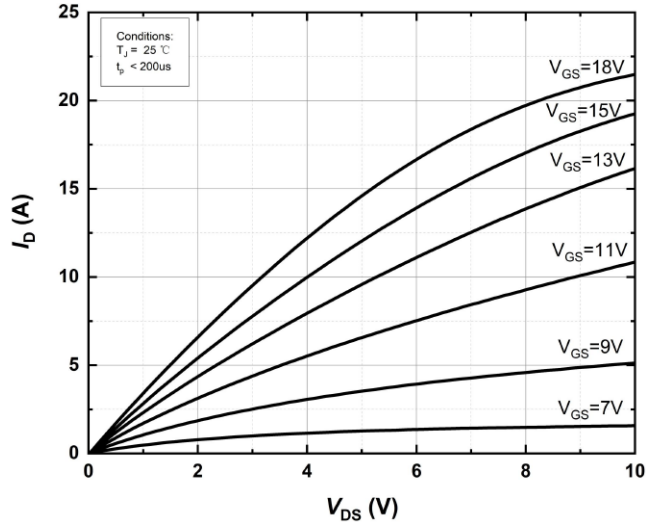


Figure 1. Output characteristics at  $T_j=25^\circ\text{C}$

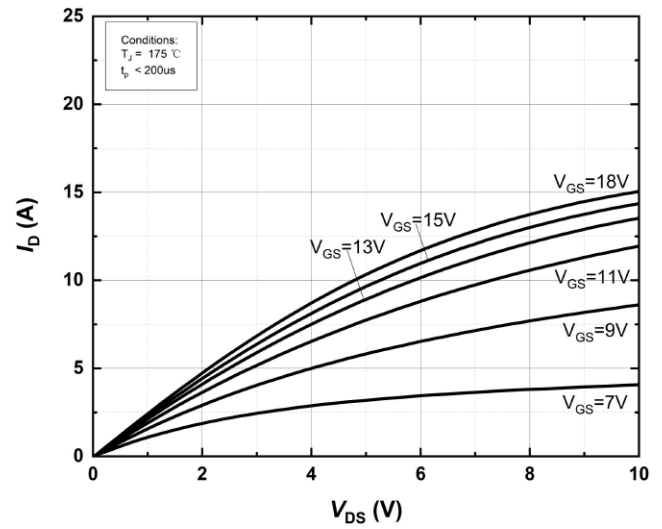


Figure 2. Output characteristics at  $T_j=175^\circ\text{C}$

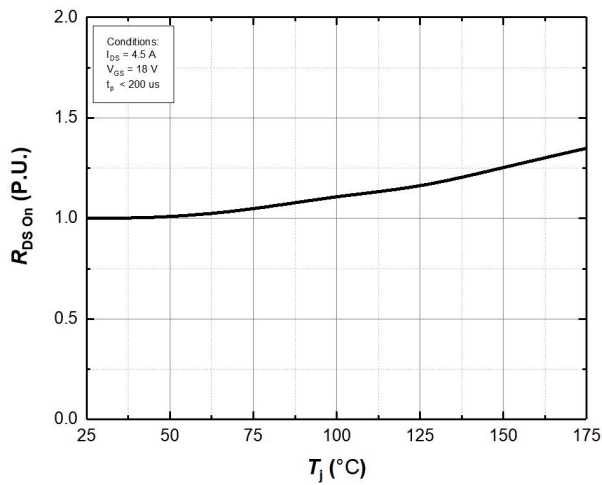


Figure 3. Normalized On-Resistance vs. Temperature

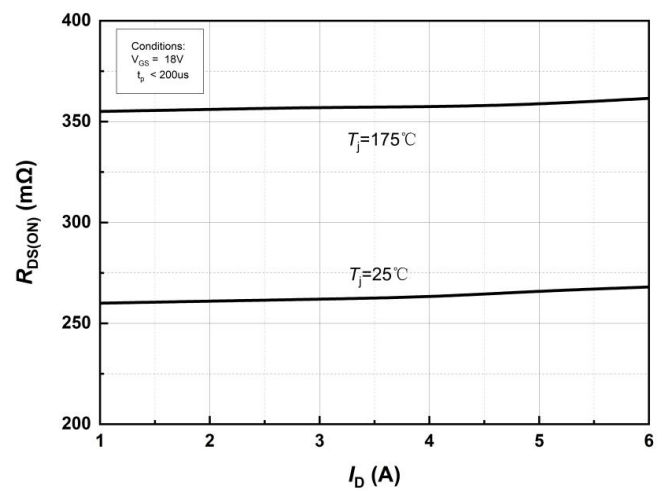


Figure 4. On-Resistance vs. Drain current for Various Temperature

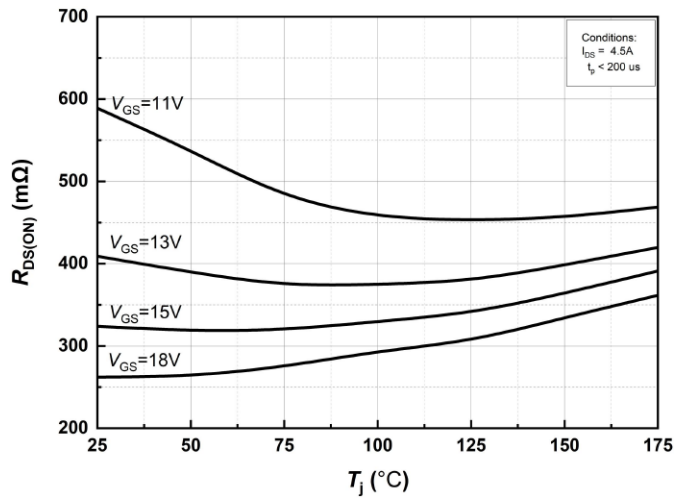


Figure 5. On-Resistance vs. Temperature for Various Gate Voltage

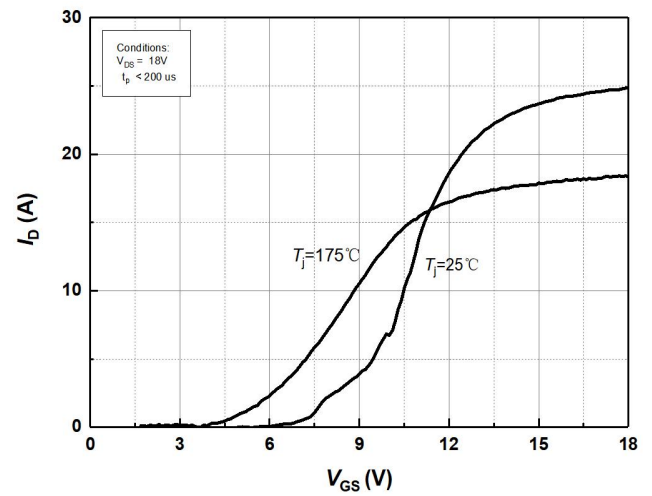


Figure 6. Transfer Characteristics for Various Junction Temperatures

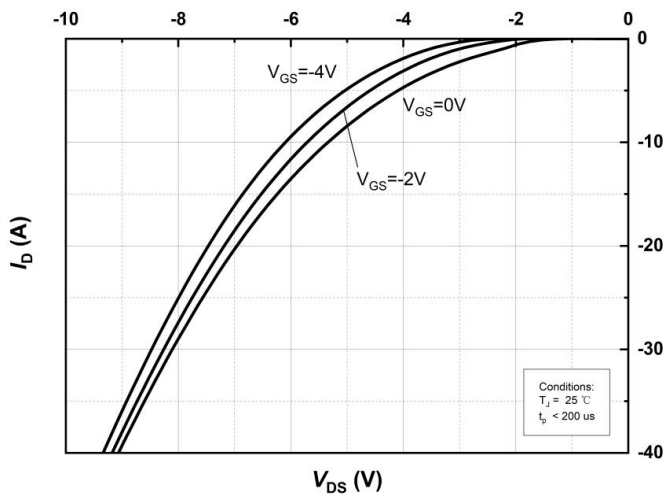


Figure 7. Body Diode Characteristics at  $T_J=25^\circ C$

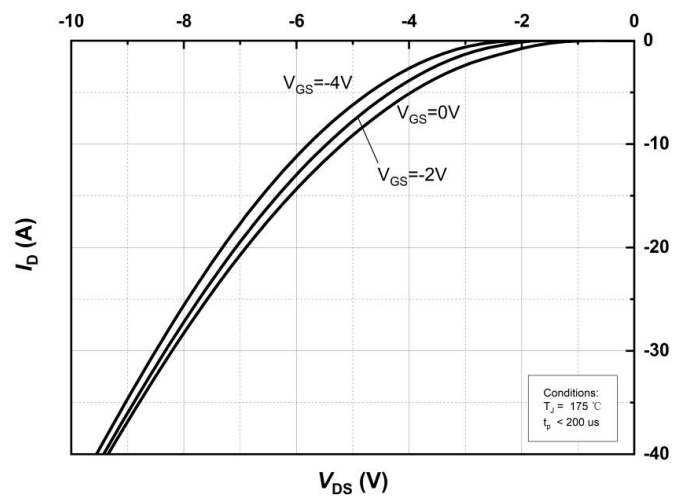


Figure 8. Body Diode Characteristics at  $T_J=175^\circ C$

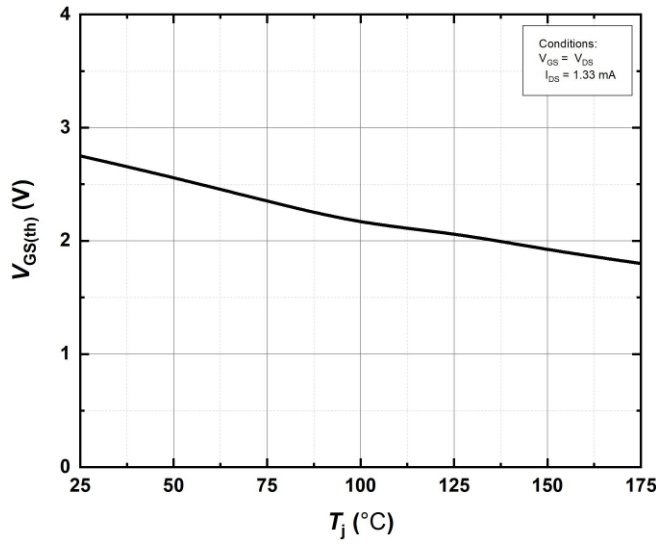


Figure 9. Threshold Voltage vs. Temperature

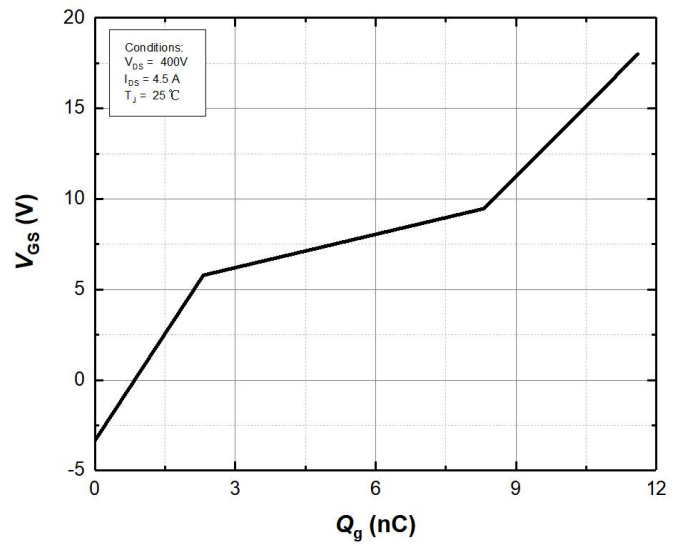


Figure 10 Gate Charge Characteristics

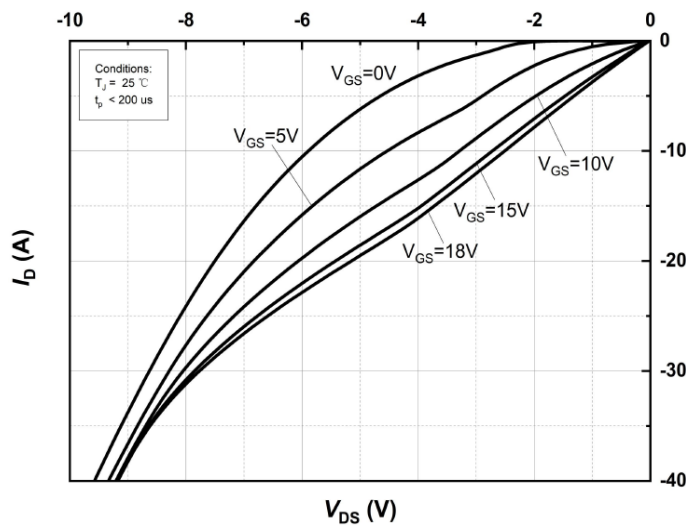


Figure 11. 3rd Quadrant Characteristic at  $T_J=25\text{°C}$

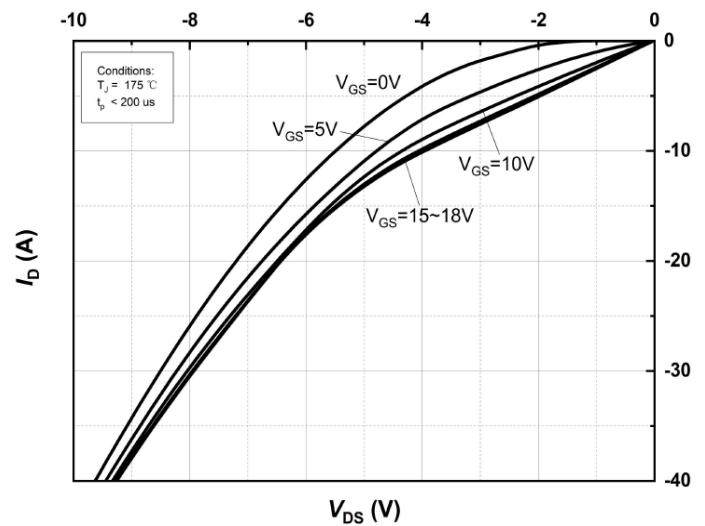


Figure 12. 3rd Quadrant Characteristic at  $T_J=175\text{°C}$

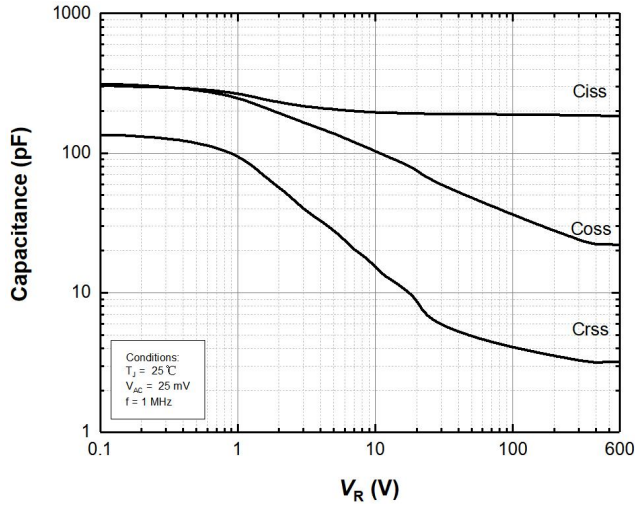


Figure 13. Capacitances vs. Drain-Source Voltage (0 – 600V)

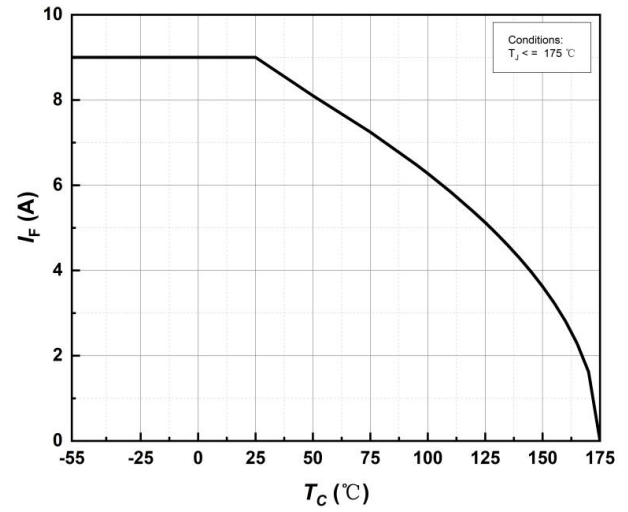


Figure 14. Continuous Drain Current Derating vs Case Temperature

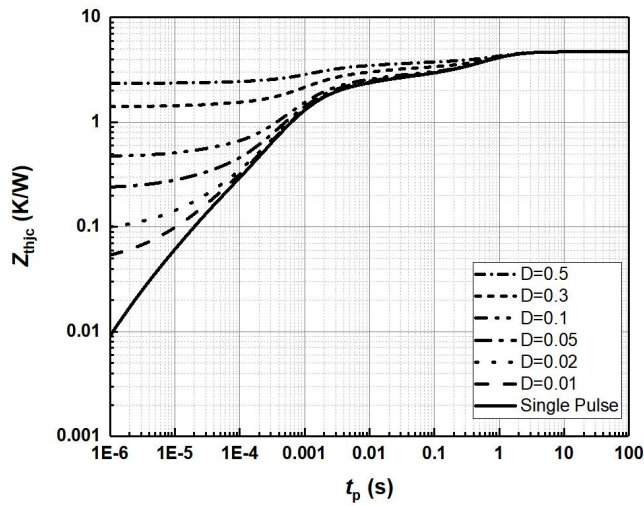


Figure 15. Transient Thermal Impedance (Junction – Case)

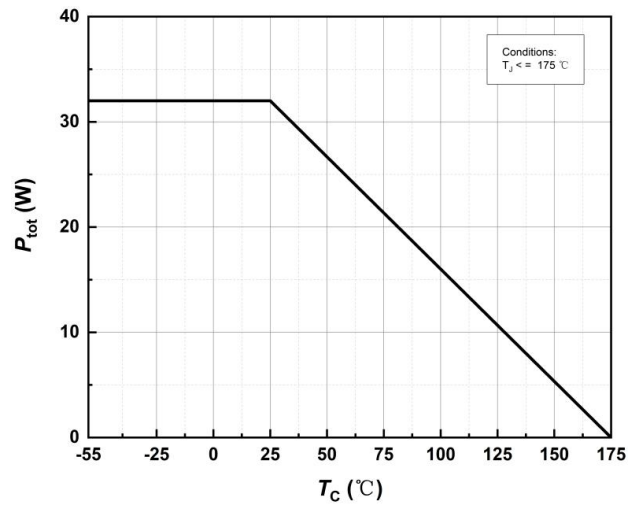


Figure 16. Maximum Power Dissipation Derating vs. Case Temperature

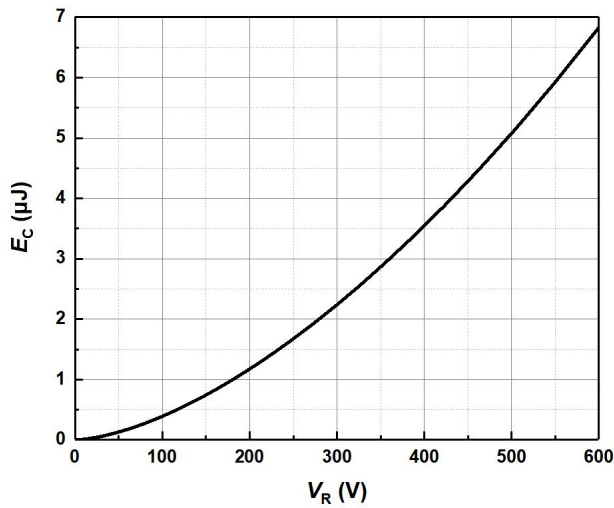


Figure 17. Output Capacitor Stored Energy

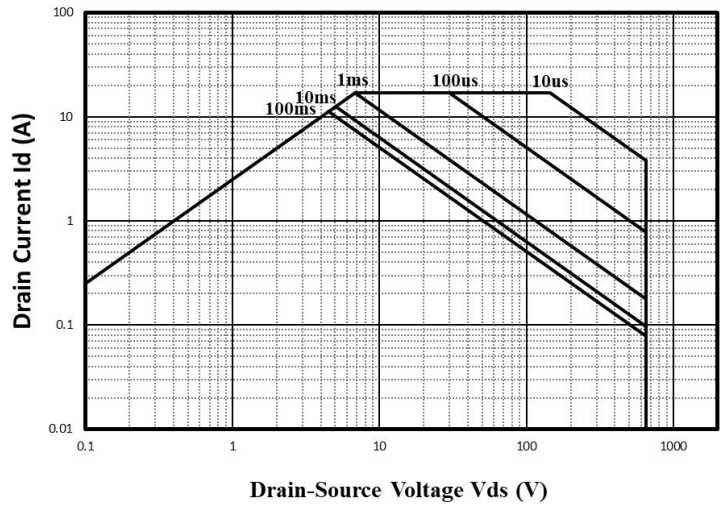


Figure 18. Safe Operating Area

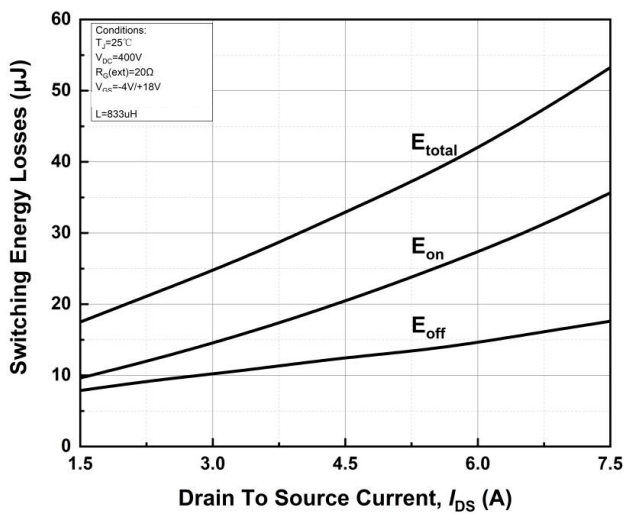


Figure 19. Clamped Inductive Switching Energy vs. Drain Current( $V_{DD} = 400V$ )

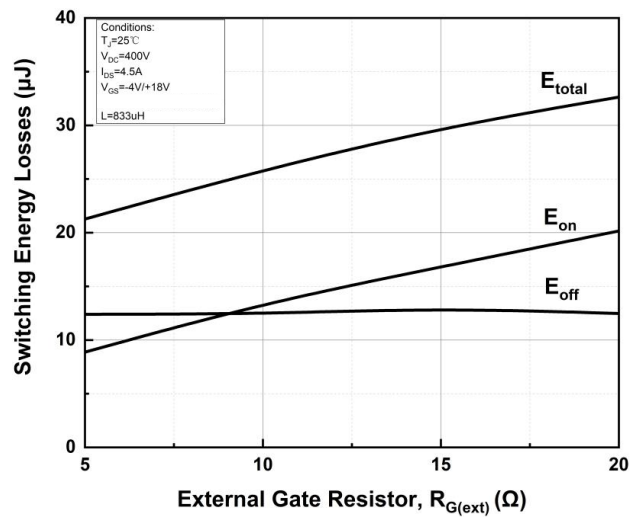


Figure 20. Clamped Inductive Switching Energy vs.  $R_{G(ext)}$

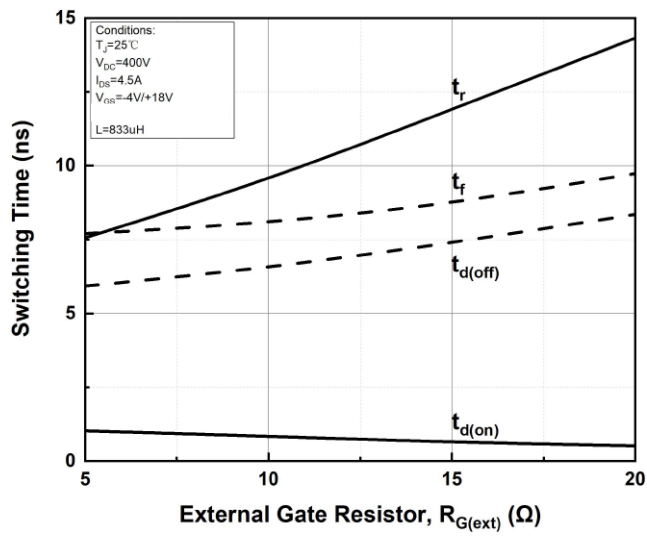
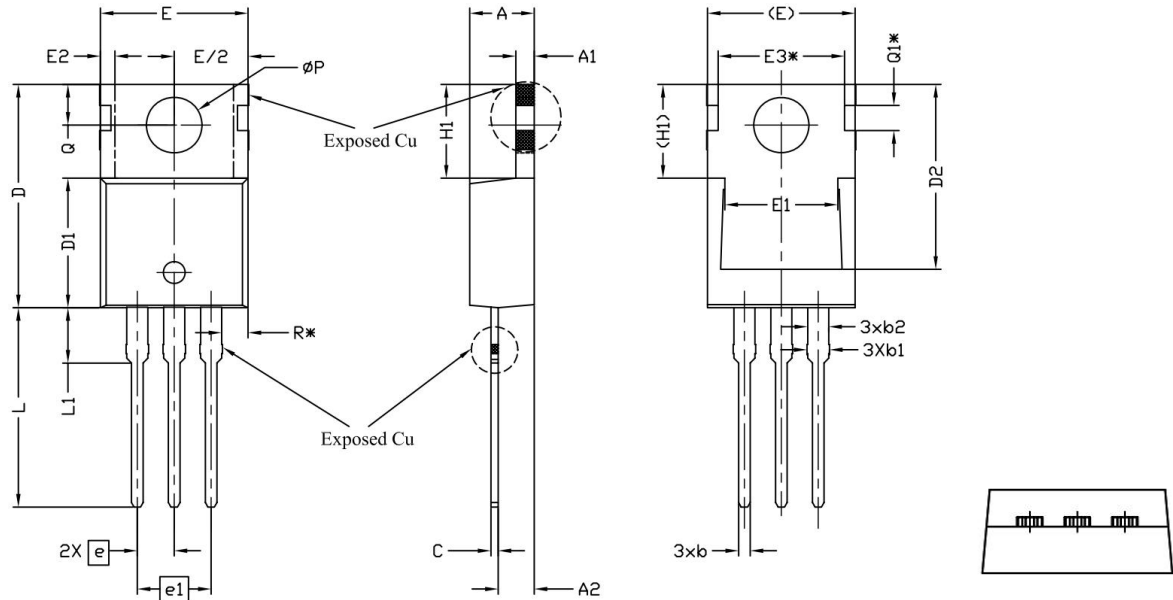


Figure 21. Switching Times vs.  $R_{G(\text{ext})}$



## Package Dimensions

Package TO-220C



| SYMBOL | DIMENSIONS |       |       | NOTES |
|--------|------------|-------|-------|-------|
|        | MIN.       | NOM.  | MAX.  |       |
| A      | 4.24       | 4.44  | 4.64  |       |
| A1     | 1.15       | 1.27  | 1.40  |       |
| A2     | 2.30       | 2.48  | 2.70  |       |
| b      | 0.70       | 0.80  | 0.90  |       |
| b1     | 1.20       | 1.55  | 1.75  |       |
| b2     | 1.20       | 1.45  | 1.70  |       |
| c      | 0.40       | 0.50  | 0.60  |       |
| D      | 14.70      | 15.37 | 16.00 | 4     |
| D1     | 8.82       | 8.92  | 9.02  |       |
| D2     | 12.43      | 12.73 | 12.83 | 5     |
| E      | 9.96       | 10.16 | 10.36 | 4,5   |
| E1     | 6.86       | 7.77  | 8.89  | 5     |
| E2     | -          | -     | 0.76  | 6     |
| E3*    | 8.70REF.   |       |       |       |
| e      | 2.54BSC    |       |       |       |
| e1     | 5.08BSC    |       |       |       |
| H1     | 6.30       | 6.45  | 6.60  | 5,6   |
| L      | 13.47      | 13.72 | 13.97 |       |
| L1     | 3.60       | 3.80  | 4.00  |       |
| ØP     | 3.75       | 3.84  | 3.93  |       |
| Q      | 2.60       | 2.80  | 3.00  |       |
| Q1*    | 1.73REF.   |       |       |       |
| R*     | 1.82REF.   |       |       |       |



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