



## Features

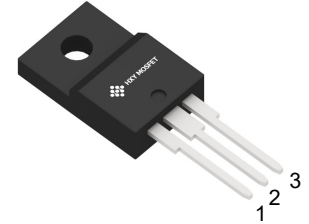
- High Speed Switching with Low Capacitances
- High Blocking Voltage with Low  $R_{DS(on)}$
- Easy to parallel
- Simple to drive
- RoHS Compliant

## Benefits

- Increased Power Density
- Faster Operating Frequency
- Reduction of Heat Sink Requirements
- Higher Efficiency
- Reduced EMI

## Applications

- Power Factor Correction Modules
- Switch Mode Power Supplies
- DC-AC Inverters
- High Voltage DC/DC Converters



TO-220F



| Ordering Part Number | Package | Brand      |
|----------------------|---------|------------|
| TK11A65W             | TO-220F | HXY MOSFET |

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

| Symbol                            | Parameter                                  | Value       | Unit | Test Conditions                                         | Note              |
|-----------------------------------|--------------------------------------------|-------------|------|---------------------------------------------------------|-------------------|
| V <sub>DSmax</sub>                | Drain - Source Voltage                     | 650         | V    | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 100 $\mu$ A     |                   |
| V <sub>GSmx</sub>                 | Gate - Source Voltage (dynamic)            | -8/+22      | V    | AC (f > 1 Hz)                                           | Note 1            |
| V <sub>GSop</sub>                 | Gate - Source Voltage (static)             | -4/+18      | V    | Static                                                  | Note 2            |
| I <sub>D</sub>                    | Continuous Drain Current                   | 12          | A    | T <sub>C</sub> = 25°C                                   | Fig. 19<br>Note 3 |
|                                   |                                            | 8           |      | T <sub>C</sub> = 100°C                                  |                   |
| I <sub>D(pulse)</sub>             | Pulsed Drain Current                       | 24          | A    | Pulse width t <sub>p</sub> limited by T <sub>Jmax</sub> |                   |
| P <sub>D</sub>                    | Power Dissipation                          | 48          | W    | T <sub>C</sub> = 25°C                                   | Fig. 20           |
|                                   |                                            | 24          |      | T <sub>C</sub> = 100°C                                  |                   |
| T <sub>J</sub> , T <sub>stg</sub> | Operating Junction and Storage Temperature | -40 to +175 | °C   |                                                         |                   |



**Electrical Characteristics** ( $T_C = 25^\circ\text{C}$  unless other wise specified)

**Static Characteristics**

| Symbol        | Parameter                        | Test conditions                                                                              | Value |            |      | Unit          |
|---------------|----------------------------------|----------------------------------------------------------------------------------------------|-------|------------|------|---------------|
|               |                                  |                                                                                              | Min.  | Typ.       | Max. |               |
| $V_{(BR)DSS}$ | Drain-Source Breakdown Voltage   | $I_D=100\mu\text{A}$ , $V_{GS}=0\text{V}$                                                    | 650   |            |      | V             |
| $I_{DSS}$     | Zero Gate Voltage Drain Current  | $V_{DS}=650\text{V}$ , $V_{GS}=0\text{V}$                                                    |       | 1          |      | $\mu\text{A}$ |
| $I_{GSS}$     | Gate-Source Leakage Current      | $V_{DS}=0\text{V}$ , $V_{GS}=18\text{V}$                                                     |       |            | 250  | nA            |
| $V_{GS(th)}$  | Gate Threshold Voltage           | $V_{DS}=V_{GS}$ , $I_D=1.33\text{mA}$<br>$T_J=25^\circ\text{C}$<br>$T_J=175^\circ\text{C}$   | 2     | 3.1<br>2.3 | 4    | V             |
| $R_{DS(on)}$  | Drain-Source On-State Resistance | $V_{GS}=18\text{V}$ , $I_D=4.5\text{A}$<br>$T_J=25^\circ\text{C}$<br>$T_J=175^\circ\text{C}$ |       | 270        |      | m $\Omega$    |

**Thermal Characteristics**

| Symbol        | Parameter                                | Value |      |      | Unit               |
|---------------|------------------------------------------|-------|------|------|--------------------|
|               |                                          | Min.  | Typ. | Max. |                    |
| $R_{th(j-c)}$ | Thermal Resistance from Junction to Case |       | 3.12 |      | $^\circ\text{C/W}$ |

**Dynamic Characteristics**

| Symbol       | Parameter                    | Test conditions                                                      | Value |      |      | Unit     |
|--------------|------------------------------|----------------------------------------------------------------------|-------|------|------|----------|
|              |                              |                                                                      | Min.  | Typ. | Max. |          |
| $C_{iss}$    | Input Capacitance            | $V_{DS}=600\text{V}$ , $f=1\text{MHz}$ ,<br>$V_{GS}=0\text{V}$       |       | 203  |      | pF       |
| $C_{oss}$    | Output Capacitance           |                                                                      |       | 26   |      | pF       |
| $C_{rss}$    | Reverse Transfer Capacitance |                                                                      |       | 3.5  |      | pF       |
| $R_{G(int)}$ | Internal Gate Resistance     | $f=1\text{MHz}$                                                      |       | 3.6  |      | $\Omega$ |
| $Q_g$        | Total Gate Charge            | $V_{DS}=400\text{V}$ , $I_D=4.5\text{A}$ ,<br>$V_{GS}=-4/18\text{V}$ |       | 11.2 |      | nC       |
| $Q_{gs}$     | Gate to Source Charge        |                                                                      |       | 2    |      | nC       |
| $Q_{gd}$     | Gate to Drain Charge         |                                                                      |       | 5.2  |      | nC       |



## Switching Characteristics

| Symbol       | Parameter           | Test conditions                                                                   | Value |      |      | Unit    |
|--------------|---------------------|-----------------------------------------------------------------------------------|-------|------|------|---------|
|              |                     |                                                                                   | Min.  | Typ. | Max. |         |
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD}=400V, I_D=4.5A,$<br>$V_{GS}=-4V/18V,$<br>$R_G=2.5\Omega,$<br>$L=200\mu H$ |       | 5    |      | ns      |
| $t_r$        | Rise Time           |                                                                                   |       | 23   |      | ns      |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                   |       | 6    |      | ns      |
| $t_f$        | Fall Time           |                                                                                   |       | 8    |      | ns      |
| $E_{on}$     | Turn-On Energy      |                                                                                   |       | 34   |      | $\mu J$ |
| $E_{off}$    | Turn-Off Energy     |                                                                                   |       | 4    |      | $\mu J$ |

## Reverse Diode Characteristics

| Symbol    | Parameter                        | Test conditions                                                                                                                          | Value |                          |      | Unit |
|-----------|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|-------|--------------------------|------|------|
|           |                                  |                                                                                                                                          | Min.  | Typ.                     | Max. |      |
| $V_{SD}$  | Diode Forward Voltage            | $V_{GS}=-4V, I_{SD}=2.5A$<br>$T_j=25^\circ C$<br>$T_j=175^\circ C$<br>$V_{GS}=-4V, I_{SD}=4.5A$<br>$T_j=25^\circ C$<br>$T_j=175^\circ C$ |       | 4.0<br>3.6<br>4.5<br>4.0 |      | V    |
| $I_S$     | Continuous Diode Forward Current | $V_{GS}=-4V$<br>$T_c=25^\circ C$<br>$T_c=100^\circ C$                                                                                    |       | 13<br>5.5                |      | A    |
| $t_{rr}$  | Reverse Recovery Time            | $V_{GS}=-4V, I_{SD}=4.5A,$<br>$V_R=400V,$<br>$di/dt=1000A/\mu s$                                                                         |       | 22                       |      | ns   |
| $Q_{rr}$  | Reverse Recovery Charge          |                                                                                                                                          |       | 68                       |      | nC   |
| $I_{rrm}$ | Peak Reverse Recovery Current    |                                                                                                                                          |       | 4                        |      | A    |



## Typical Performance

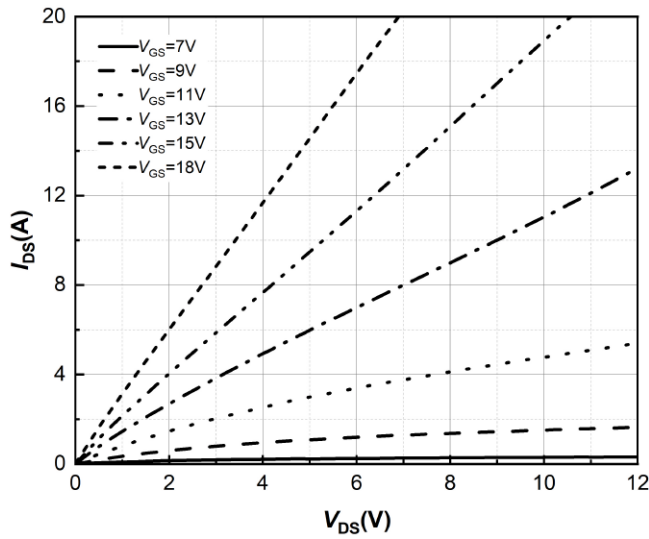


Figure 1. Output Characteristics  
 $T_j = -40^\circ\text{C}$

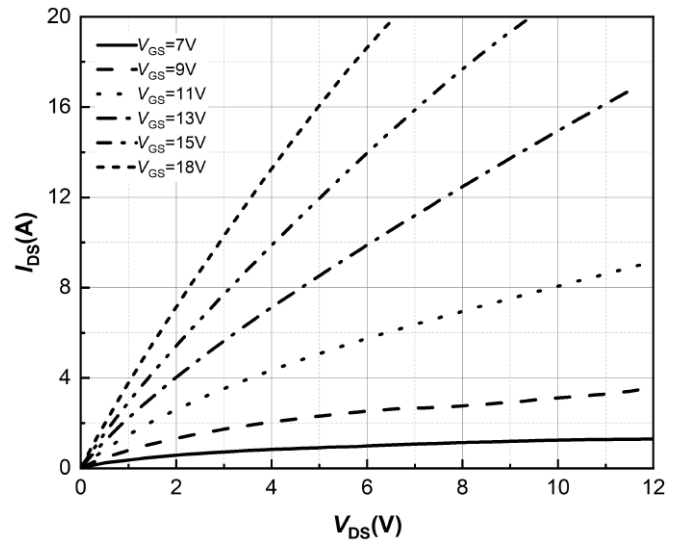


Figure 2 Output Characteristics

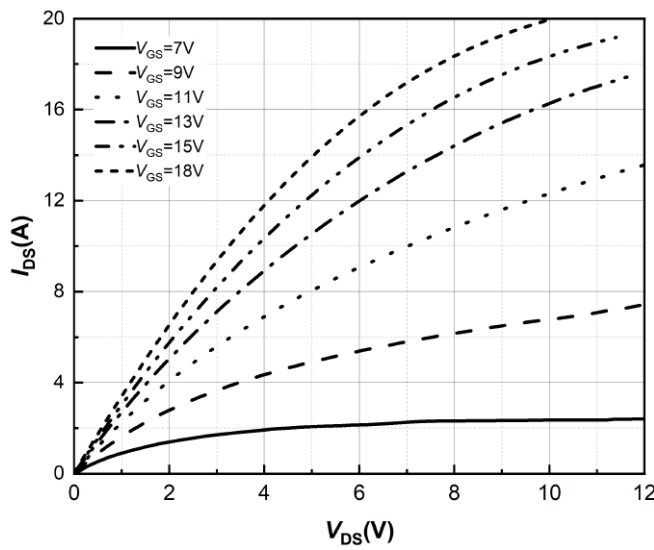


Figure 3. Output Characteristics  
 $T_j = 175^\circ\text{C}$

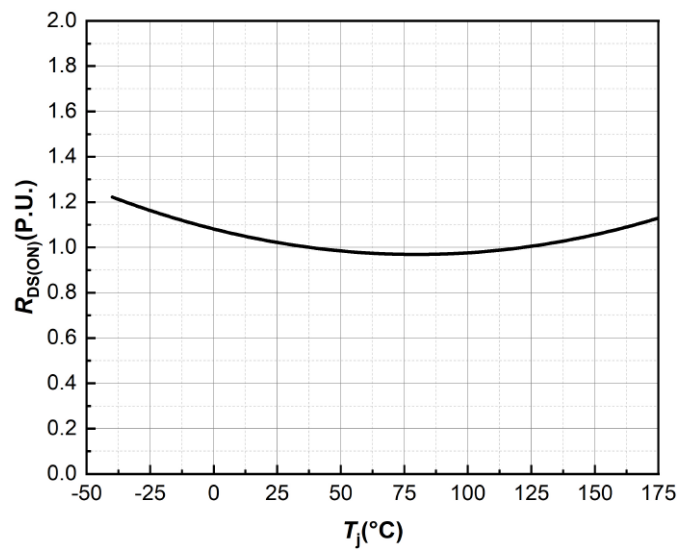


Figure 4. Normalized On-Resistance vs.  
Temperature

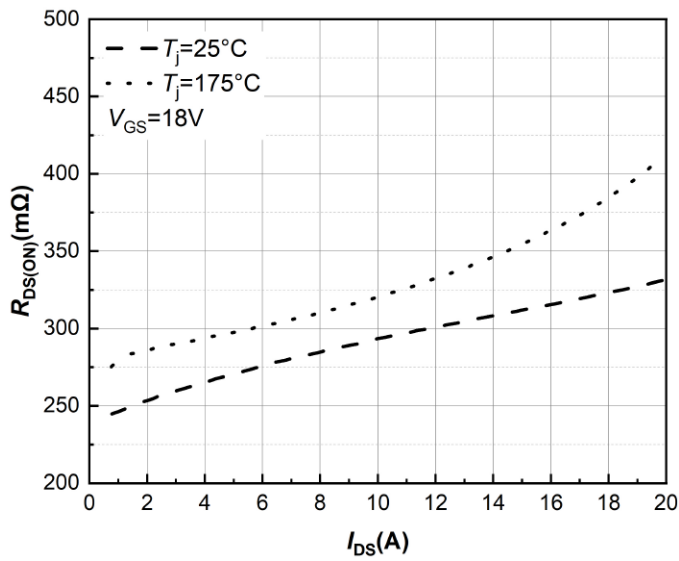


Figure 5. On-Resistance vs. Drain Current  
For Various Temperatures

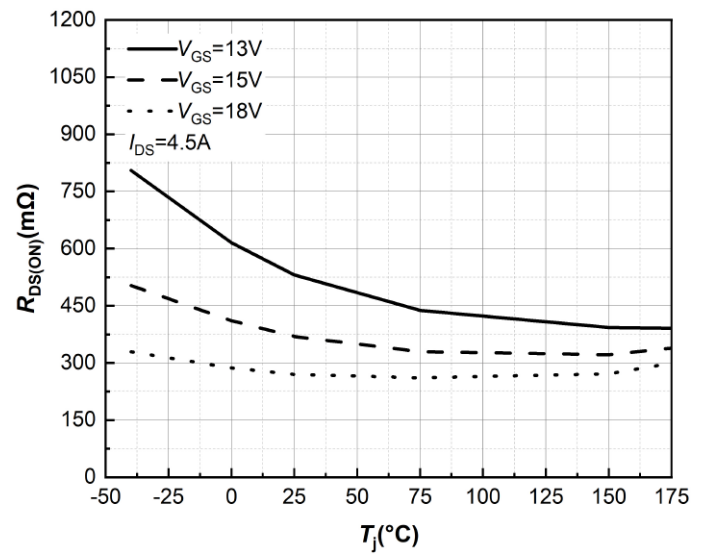


Figure 6. On-Resistance vs. Temperature  
For Various Gate Voltage

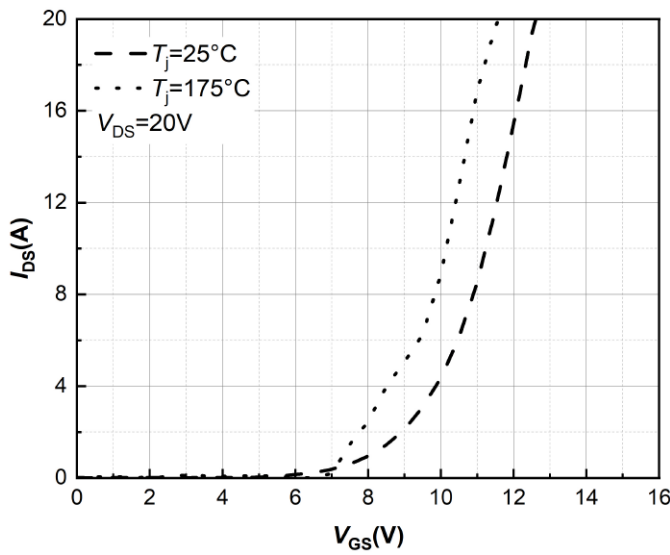


Figure 7. Transfer Characteristic for  
Various Junction Temperatures

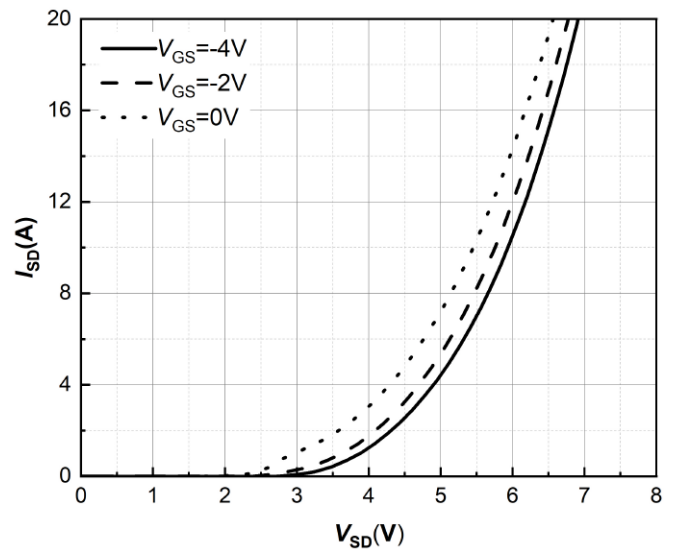


Figure 8. Body Diode Characteristic  
 $T_j = -40^\circ C$

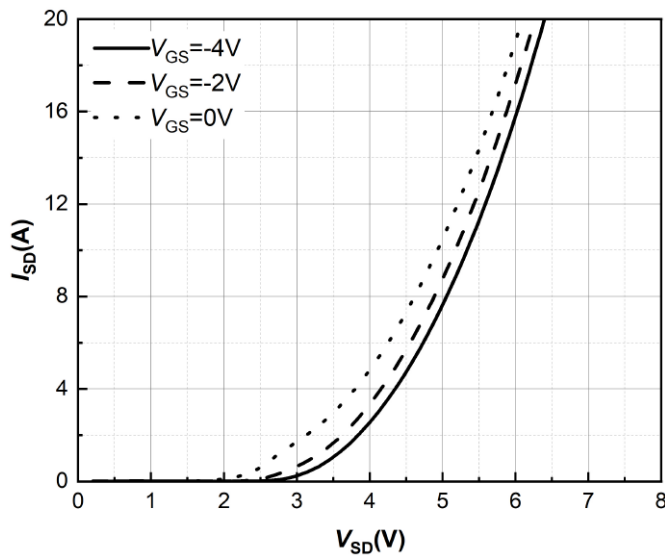


Figure 9. Body Diode Characteristic  
 $T_j=25^{\circ}\text{C}$

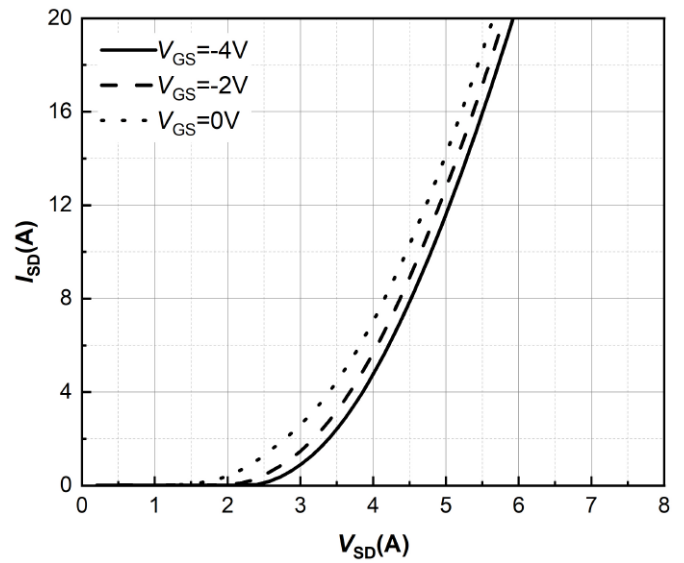


Figure 10. Body Diode Characteristic  
 $T_j=175^{\circ}\text{C}$

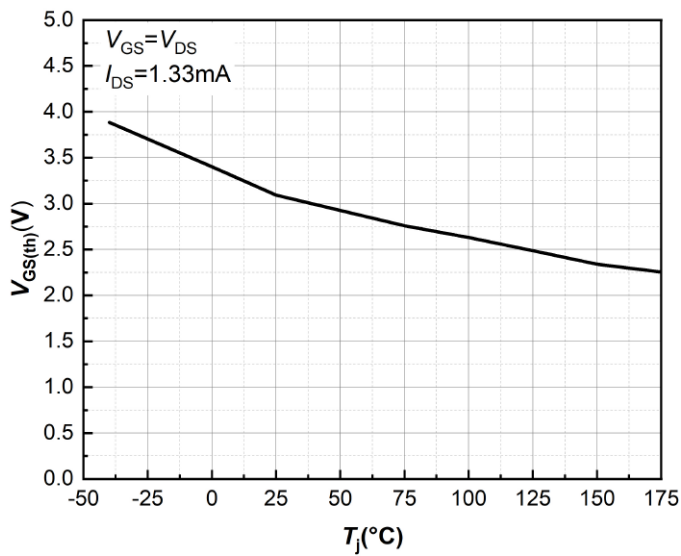


Figure 11. Threshold Voltage vs.  
Temperature

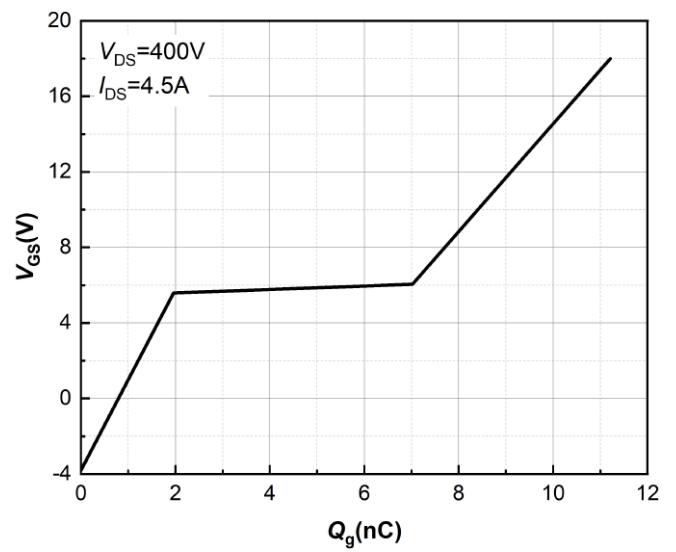


Figure 12. Gate Charge Characteristics

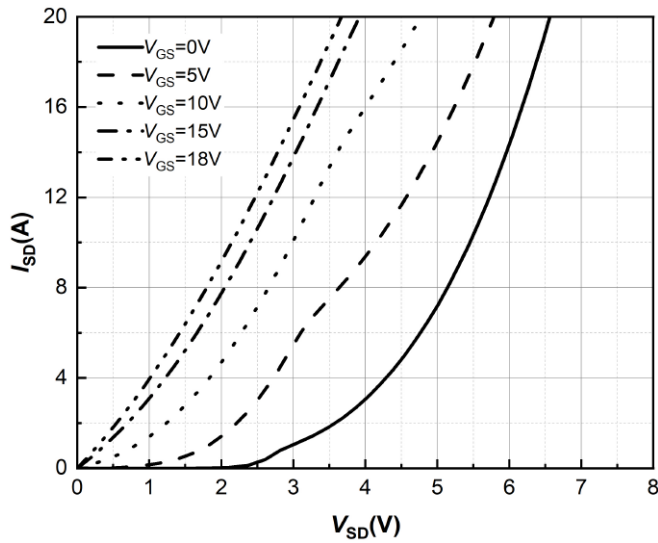


Figure 13. 3rd Quadrant Characteristic  
 $T_j = -40^\circ\text{C}$

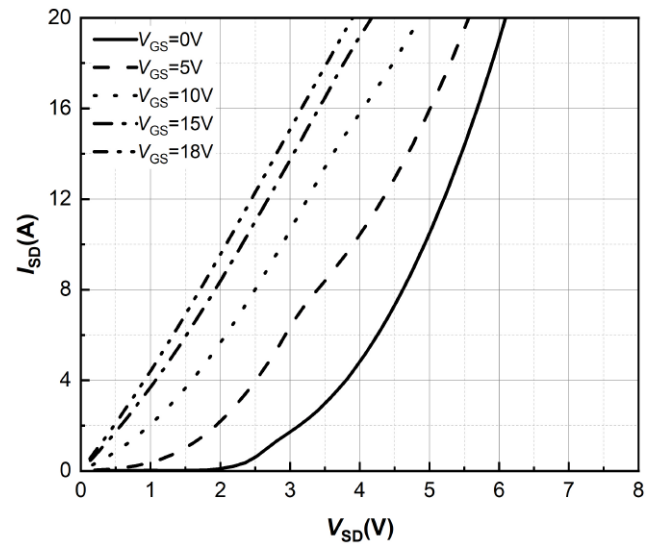


Figure 14. 3rd Quadrant Characteristic  
 $T_j = 25^\circ\text{C}$

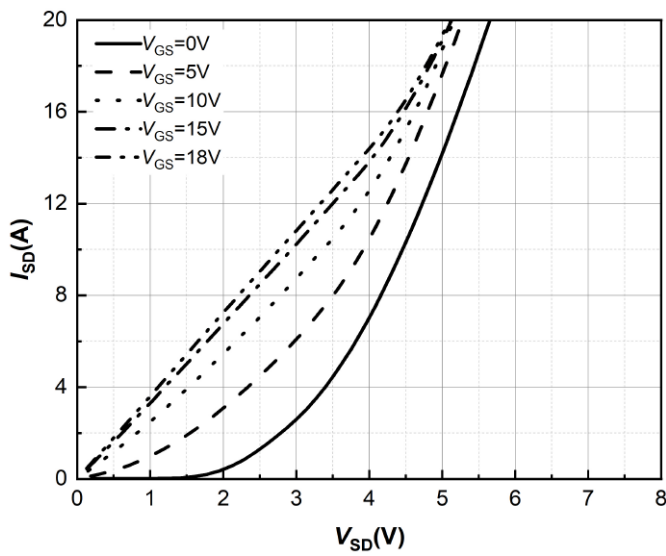


Figure 15. 3rd Quadrant Characteristic  
 $T_j = 175^\circ\text{C}$

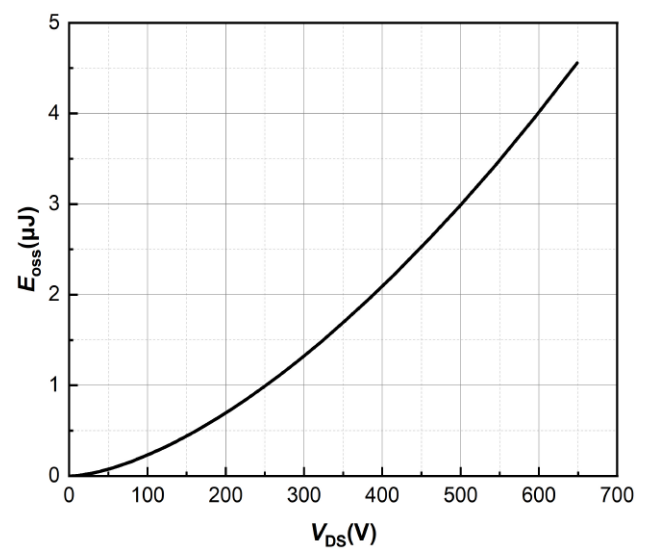


Figure 16. Output Capacitor Stored Energy

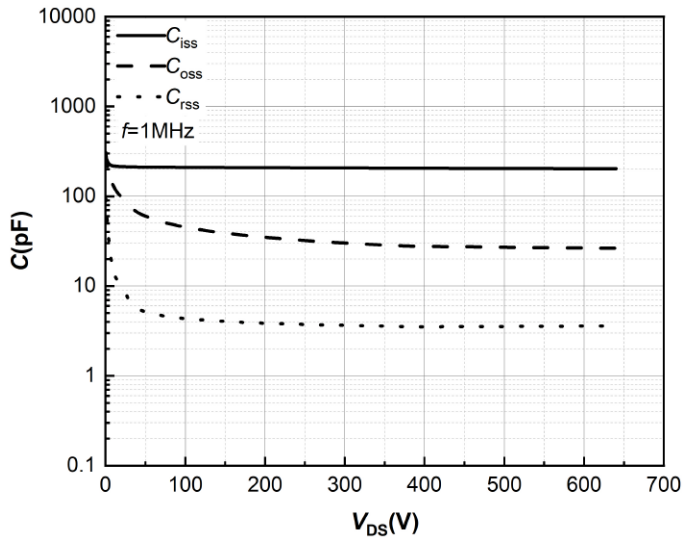


Figure 17. Capacitances vs. Drain-Source

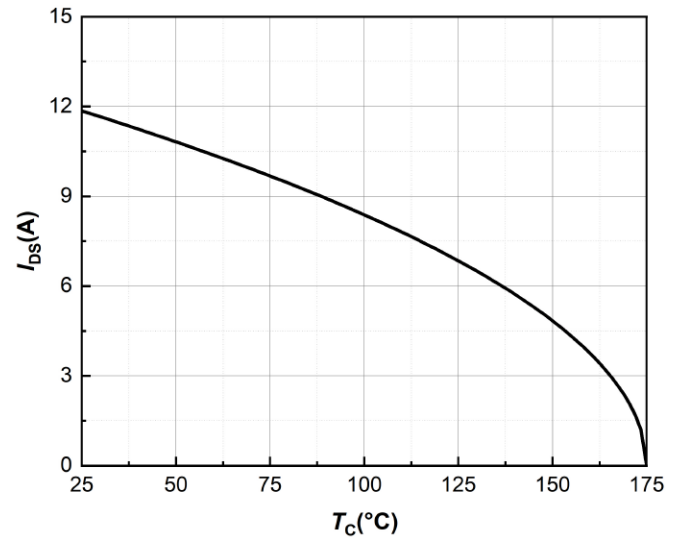


Figure 18. Continuous Drain Current Derating vs. Case Temperature

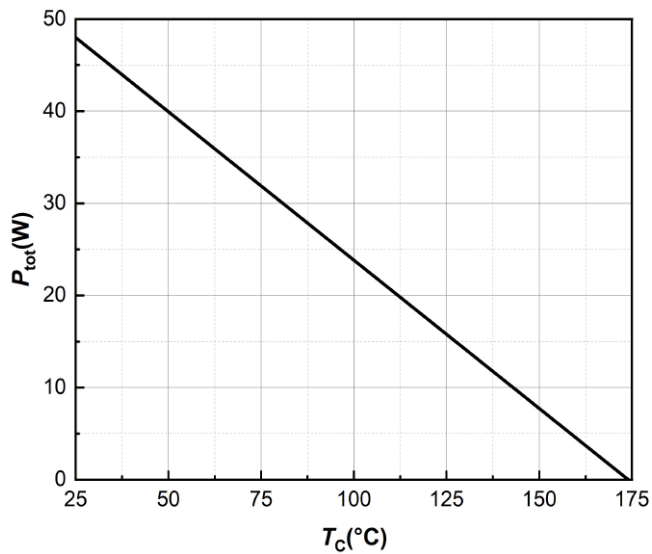


Figure 19. Maximum Power Dissipation Derating vs. Case Temperature

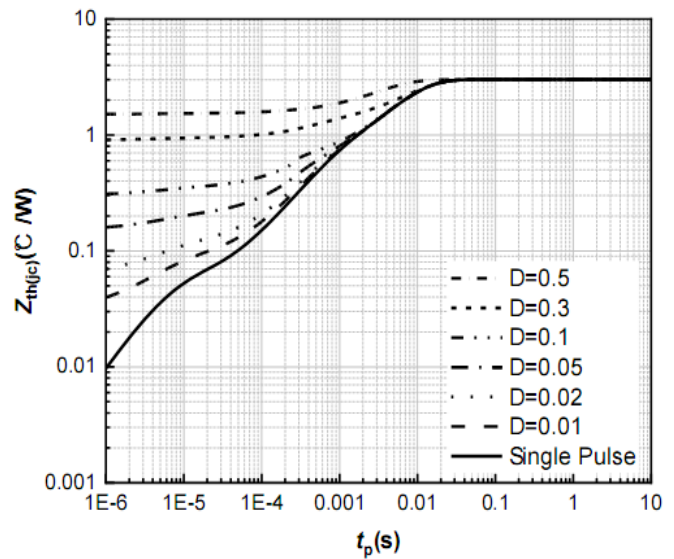


Figure 20. Transient Thermal Impedance

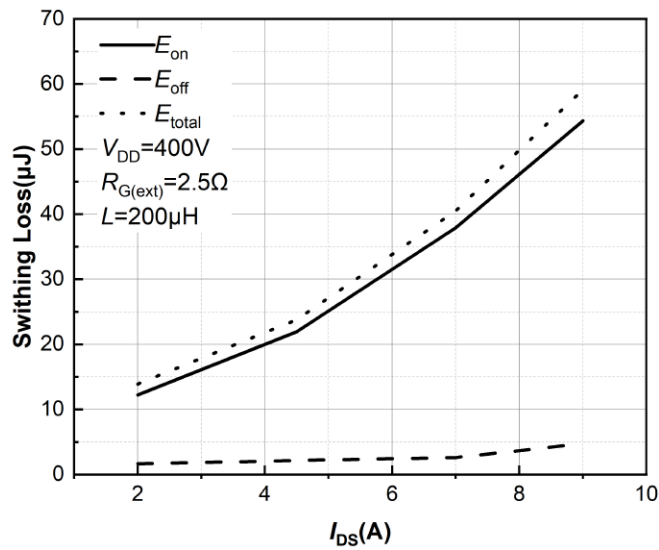


Figure 21. Clamped Inductive Switching Energy vs. Drain Current

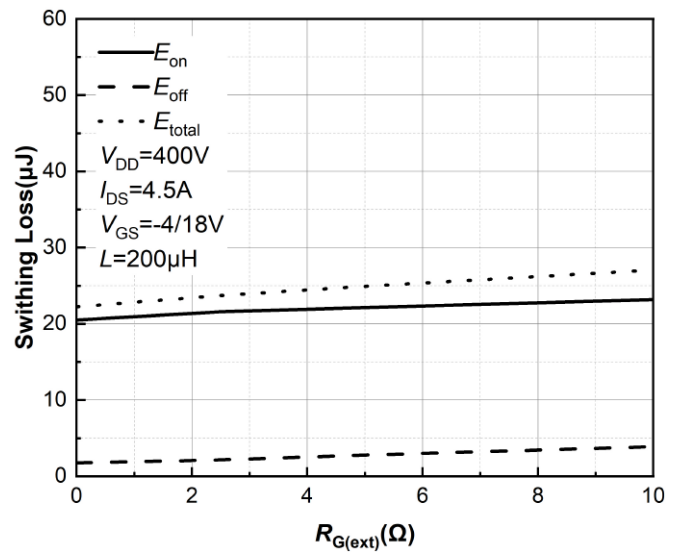


Figure 22. Clamped Inductive Switching Energy vs.  $R_G$

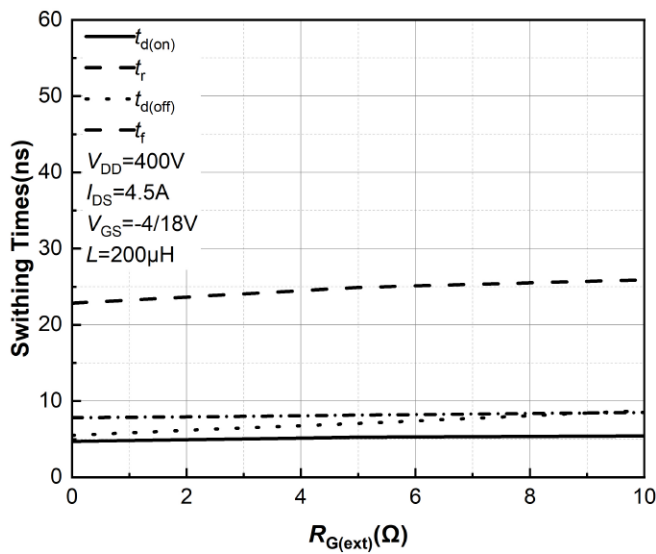


Figure 23. Switching Times vs.  $R_G$

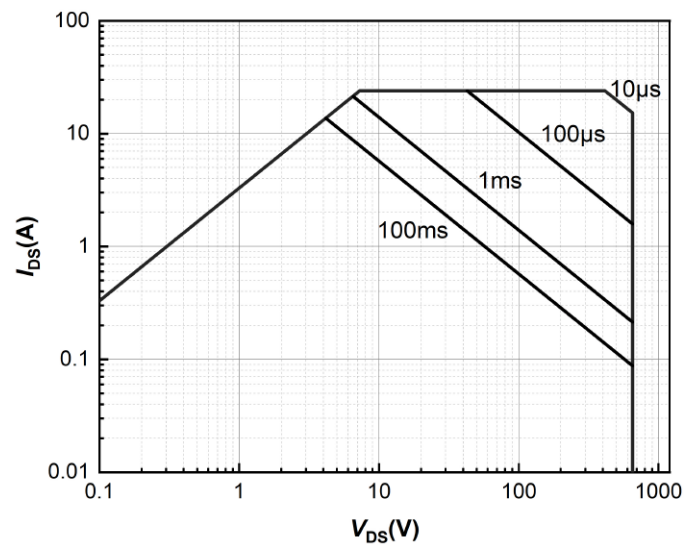
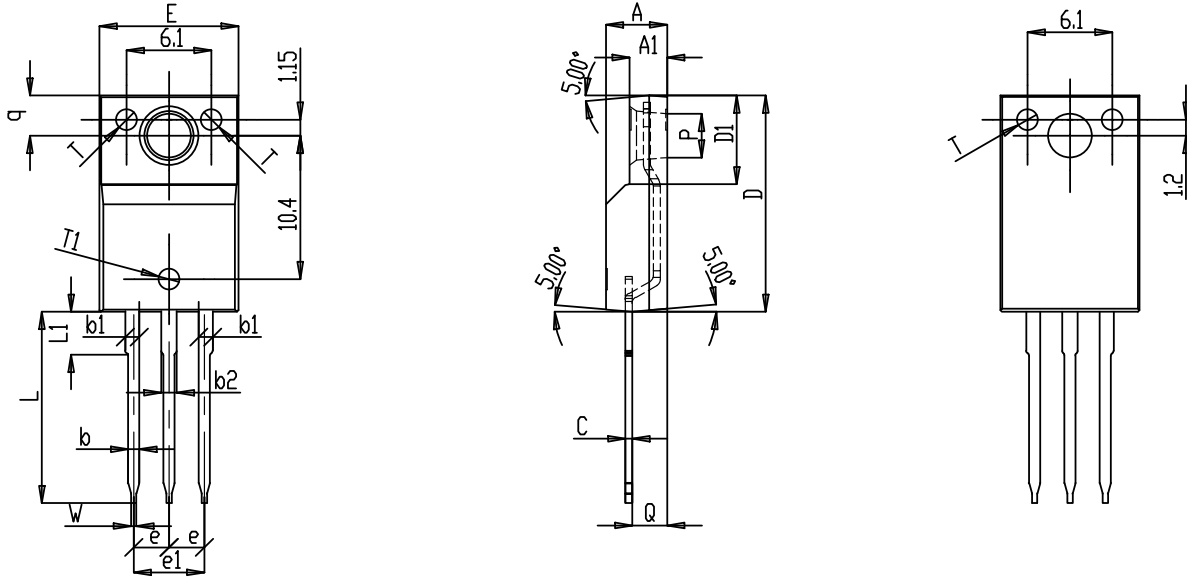


Figure 24. Safe Operating Area



## Package Dimensions

Package TO-220F



| SYMBOL | MILLIMETERS |      |      | NOTES | SYMBOL | MILLIMETERS |      |      | NOTES |
|--------|-------------|------|------|-------|--------|-------------|------|------|-------|
|        | Normal      | MIN. | MAX. |       |        | Normal      | MIN. | MAX. |       |
| A      | 4.4         | 4.2  | 4.6  |       | e1     | 5.08        | 5    | 5.12 |       |
| A1     | 2.7         | 2.5  | 2.9  |       | L      | 13.90       | 13.5 | 14.4 |       |
| b      | 0.8         | 0.7  | 0.9  |       | L1     | 3.12        | 2.8  | 3.3  |       |
| b1     | 1.07        | 0.9  | 1.3  |       | P      | 3.14        | 3.00 | 3.20 |       |
| b2     | 1.17        | 1    | 1.4  |       | Q      | 2.44        | 2.3  | 2.6  |       |
| C      | 0.5         | 0.4  | 0.6  |       | q      | 2.87        | 2.6  | 3    |       |
| D      | 15.63       | 15.4 | 15.8 |       | W      | 0.37        | 0.3  | 0.5  |       |
| D1     | 6.22        | 6    | 6.4  |       | T      | 1.52        | 1.3  | 1.7  |       |
| E      | 10.06       | 9.7  | 10.3 |       | T1     | 1.20        | 1.1  | 1.3  |       |
| e      | 2.54        | 2.5  | 2.58 |       |        |             |      |      |       |



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