

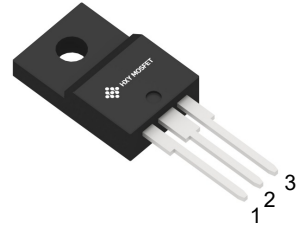


## Features

- High Speed Switching with Low Capacitances
- High Blocking Voltage with Low On-Resistance
- Avalanche Ruggednes

## Applications

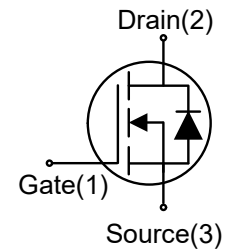
- Solar Inverters
- Switch Mode Power Supplies
- Battery Chargers
- High Voltage DC/DC Converters



TO-220F

## Package Marking and Ordering Information

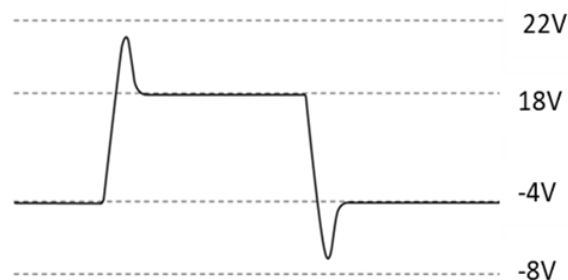
| Ordering Part Number | Package | Brand      |
|----------------------|---------|------------|
| IPA65R110CFDXKSA1    | TO-220F | HXY MOSFET |



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

| Symbol                            | Parameter                                  | Value       | Unit | Test Conditions                                         |
|-----------------------------------|--------------------------------------------|-------------|------|---------------------------------------------------------|
| V <sub>DSmax</sub>                | Drain - Source Voltage                     | 650         | V    |                                                         |
| V <sub>GSmax</sub>                | Gate - Source Voltage (dynamic)            | -8/+22      | V    |                                                         |
| V <sub>GS</sub>                   | Gate - Source Voltage                      | -4/+18      | V    |                                                         |
| I <sub>D</sub>                    | Continuous Drain Current                   | 24          | A    | T <sub>C</sub> = 25°C                                   |
|                                   |                                            | 13          |      | T <sub>C</sub> = 125°C                                  |
| I <sub>D(pulse)</sub>             | Pulsed Drain Current                       | 50          | A    | Pulse width t <sub>p</sub> limited by T <sub>jmax</sub> |
| P <sub>D</sub>                    | Power Dissipation                          | 95          | W    | T <sub>C</sub> = 25°C                                   |
| T <sub>J</sub> , T <sub>stg</sub> | Operating Junction and Storage Temperature | -55 to +175 | °C   |                                                         |
| I <sub>S</sub>                    | Source current(Body Diode)                 | 24          | A    | T <sub>C</sub> = 25°C                                   |
|                                   |                                            | 13          |      | T <sub>C</sub> = 125°C                                  |
| E <sub>AS</sub>                   | Avalanche energy, single pulse             | 265         | mJ   | L=10mH                                                  |

### ●Example of acceptable V<sub>GS</sub> waveform





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

| Symbol                  | Parameter                        | Value  |            |          | Unit | Test Condition                                                                                                                        |
|-------------------------|----------------------------------|--------|------------|----------|------|---------------------------------------------------------------------------------------------------------------------------------------|
|                         |                                  | min.   | typ.       | max.     |      |                                                                                                                                       |
| Static Characteristics  |                                  |        |            |          |      |                                                                                                                                       |
| V <sub>(BR)DSS</sub>    | Drain-source breakdown voltage   | 650    | -          | -        | V    | V <sub>GS</sub> =0V, I <sub>D</sub> =100uA                                                                                            |
| V <sub>GS(th )</sub>    | Gate threshold voltage           | 2      | 3          | 4        | V    | V <sub>DS</sub> =V <sub>GS</sub> ,I <sub>D</sub> =2mA                                                                                 |
| I <sub>DSS</sub>        | Zero gate voltage drain current  | -<br>- | 1<br>5     | 5<br>-   | μA   | V <sub>DS</sub> =650V,V <sub>GS</sub> =0V<br>T <sub>C</sub> =25°C<br>T <sub>C</sub> =175°C                                            |
| I <sub>GSS</sub>        | Gate-source leakage current      | -      |            | 100      | nA   | V <sub>GS</sub> =18V,V <sub>DS</sub> =0V                                                                                              |
| R <sub>DS(on)</sub>     | Drain-source on-state resistance | -<br>- | 110<br>140 | 140<br>- | mΩ   | V <sub>GS</sub> =18V, I <sub>D</sub> =7A,<br>T <sub>J</sub> =25°C<br>T <sub>J</sub> =175°C                                            |
| R <sub>DS(on)</sub>     | Drain-source on-state resistance | -<br>- | 145<br>165 | 200<br>- | mΩ   | V <sub>GS</sub> =15V, I <sub>D</sub> =7A,<br>T <sub>J</sub> =25°C<br>T <sub>J</sub> =175°C                                            |
| Dynamic Characteristics |                                  |        |            |          |      |                                                                                                                                       |
| C <sub>iss</sub>        | Input Capacitance                | -      | 508.0      | -        | pF   | V <sub>DS</sub> = 400V<br>V <sub>GS</sub> = 0V<br>T <sub>J</sub> = 25°C<br>V <sub>AC</sub> =25mV<br>f = 1MHz                          |
| C <sub>oss</sub>        | Output Capacitance               | -      | 33.0       | -        |      |                                                                                                                                       |
| C <sub>rss</sub>        | Reverse Transfer Capacitance     | -      | 3.2        | -        |      |                                                                                                                                       |
| Q <sub>G</sub>          | Gate Total Charge                |        | 30.5       | -        | nC   | V <sub>DS</sub> = 400V<br>V <sub>GS</sub> = 0/+18V<br>I <sub>D</sub> = 7A<br>I <sub>G</sub> =10mA                                     |
| Q <sub>gs</sub>         | Gate-Source charge               | -      | 2.55       | -        |      |                                                                                                                                       |
| Q <sub>gd</sub>         | Gate-Drain charge                | -      | 7.9        | -        |      |                                                                                                                                       |
| E <sub>ON</sub>         | Turn-On Switching Energy         | -      | 101        | -        | uJ   | V <sub>DD</sub> = 400V<br>V <sub>GS</sub> = -4/+18V<br>I <sub>D</sub> = 7A<br>R <sub>G</sub> = 5Ω<br>L = 1mH<br>T <sub>J</sub> = 25°C |
| E <sub>OFF</sub>        | Turn-Off Switching Energy        | -      | 23         | -        |      |                                                                                                                                       |
| t <sub>d(on)</sub>      | Turn-on delay time               | -      | 6.5        | -        | ns   |                                                                                                                                       |
| t <sub>r</sub>          | Rise time                        | -      | 3.1        | -        |      |                                                                                                                                       |
| t <sub>d(off)</sub>     | Turn-off delay time              | -      | 29.5       | -        |      |                                                                                                                                       |
| t <sub>f</sub>          | Fall time                        | -      | 18.5       | -        |      |                                                                                                                                       |
| R <sub>G</sub>          | Gate resistance                  | -      | 3.0        | -        | Ω    | V <sub>AC</sub> = 25mV, f=1MHz                                                                                                        |



### Body Diode Characteristics

|           |                               |   |       |   |    |                                                                                              |
|-----------|-------------------------------|---|-------|---|----|----------------------------------------------------------------------------------------------|
| $V_{SD}$  | Body Diode Forward Voltage    | - | 4.2   | - | V  | $V_{GS}=-4V, I_{SD}=3.5A,$<br>$T_J=25^{\circ}C$                                              |
|           |                               | - | 3.8   | - |    | $V_{GS}=-4V, I_{SD}=3.5A,$<br>$T_J=175^{\circ}C$                                             |
| $t_{rr}$  | Reverse Recovery Time         | - | 42.2  | - | ns | $V_R = 600V$<br>$I_D = 7A$<br>$di/dt = 1000A/\mu S$<br>$V_{GS} = -4V$<br>$T_J = 25^{\circ}C$ |
| $Q_{rr}$  | Reverse Recovery Charge       | - | 66    | - | nC |                                                                                              |
| $E_{REC}$ | Reverse Recovery Energy       | - | 14.74 | - | uJ |                                                                                              |
| $I_{rrm}$ | Peak Reverse Recovery Current | - | 4.67  | - | A  |                                                                                              |
| $t_A$     | Charge Time                   | - | 20.8  | - | ns |                                                                                              |
| $t_B$     | DisCharge Time                | - | 21.4  | - | ns |                                                                                              |

### Thermal Characteristics

| Symbol     | Parameter                                   | Typ. | Unit          | Test Conditions |
|------------|---------------------------------------------|------|---------------|-----------------|
| $R_{thJC}$ | Thermal Resistance from Junction to Case    | 1.55 | $^{\circ}C/W$ |                 |
| $R_{thJA}$ | Thermal Resistance From Junction to Ambient | 40   |               |                 |



## Typical Performance

Fig 1. Output Characteristics ( $T_J = -55^\circ\text{C}$ )

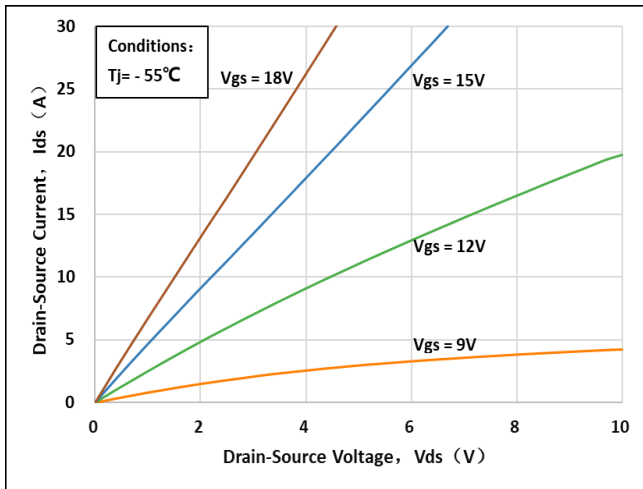


Fig 2. Output Characteristics ( $T_J = 25^\circ\text{C}$ )

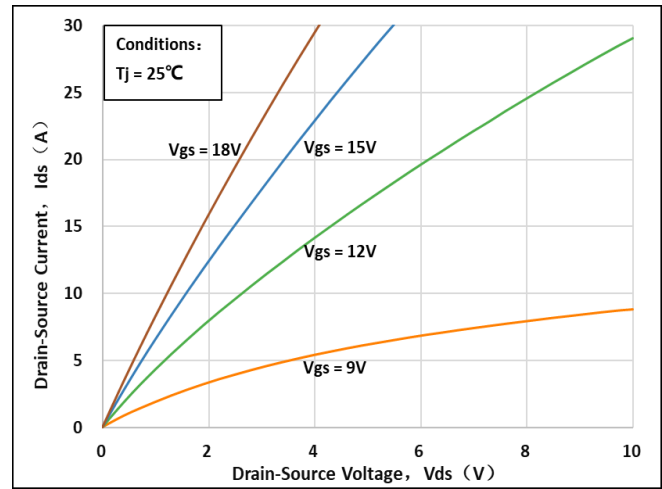


Fig 3. Output Characteristics ( $T_J = 175^\circ\text{C}$ )

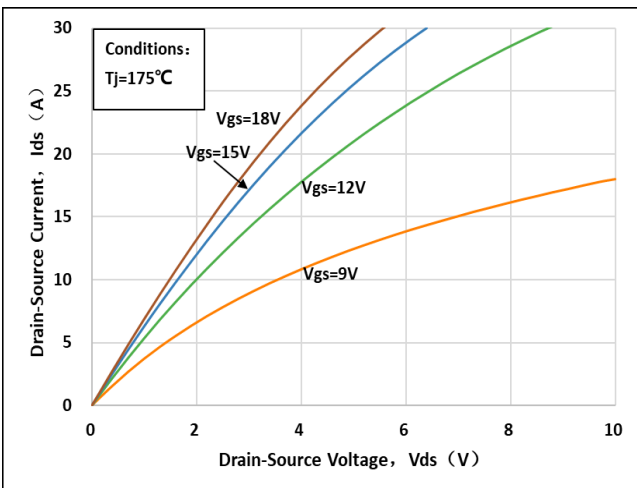


Fig 4:  $R_{DS(on)}$  Vs  $I_{DS}$  Characteristics

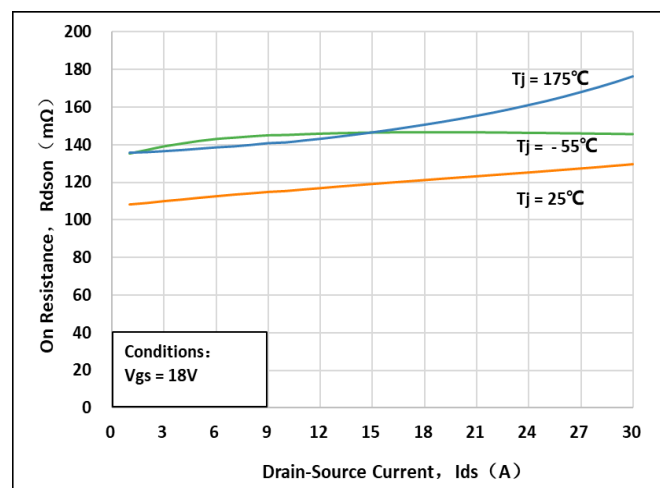


Fig 5:  $R_{DS(on)}$  vs. Temperature

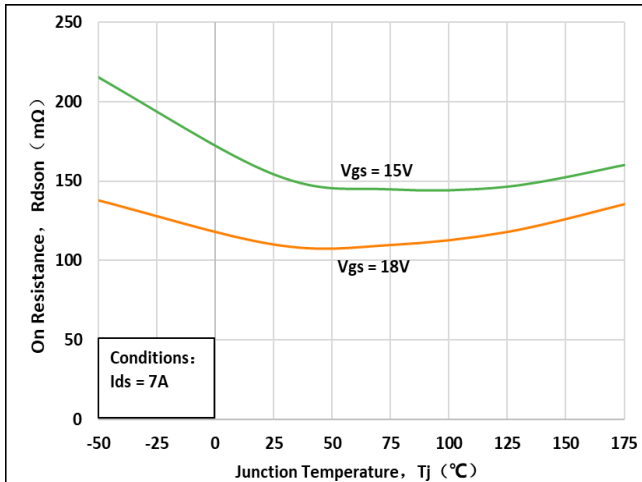


Fig 6: Transfer Characteristics

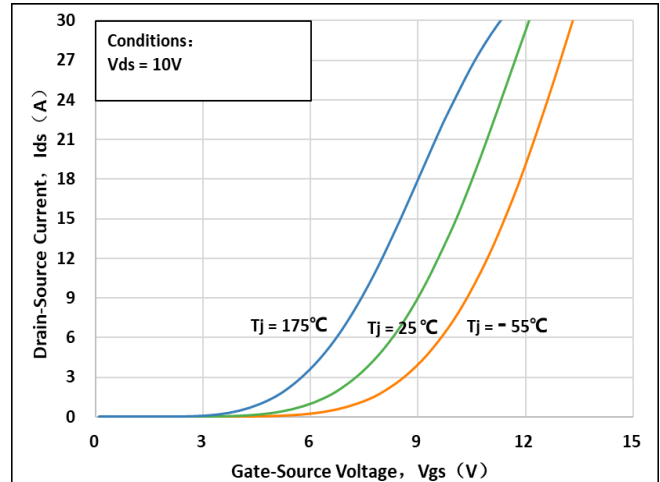




Fig 7: Body-diode Characteristics ( $T_J = -55^\circ\text{C}$ )

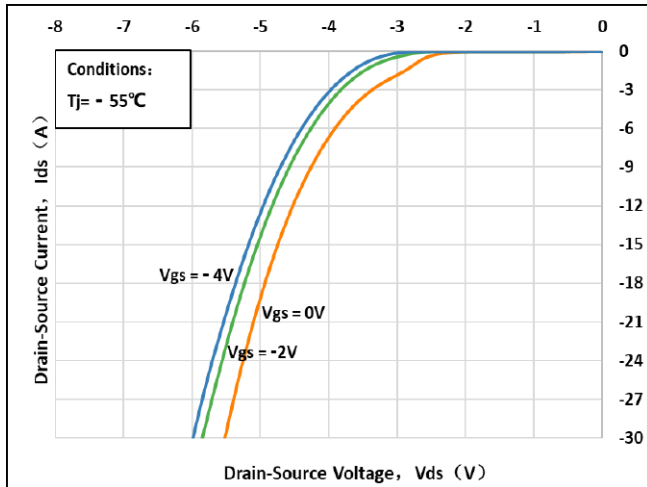


Fig 8: Body-diode Characteristics ( $T_J = 25^\circ\text{C}$ )

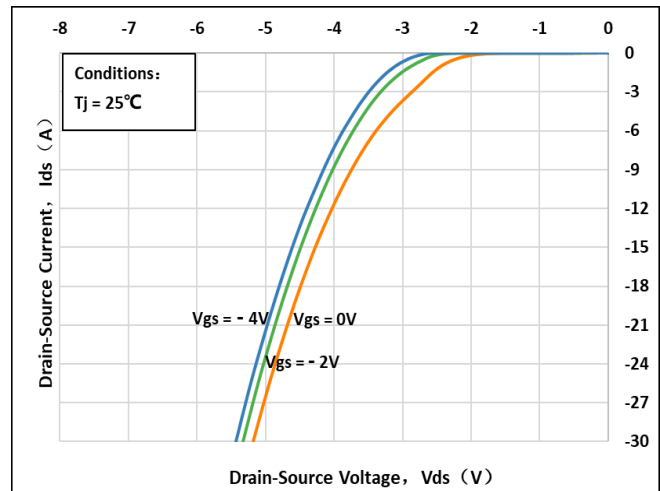


Fig 9: Body-diode Characteristics ( $T_J = 175^\circ\text{C}$ )

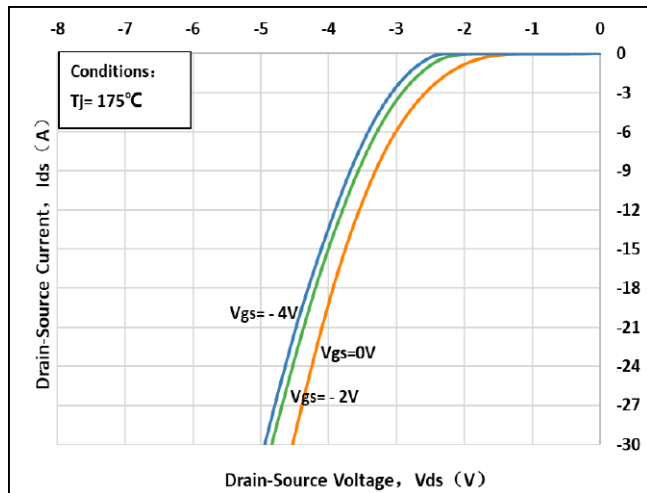


Fig 10:  $V_{TH}$  Vs  $T_J$  Temperature Characteristics

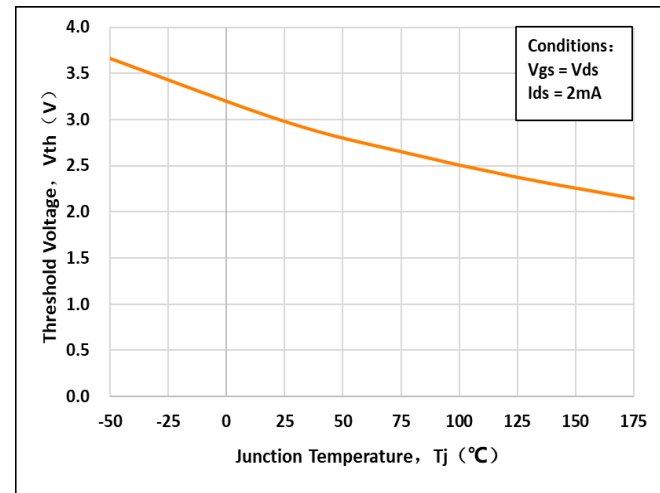


Fig 11: 3rd Quadrant Characteristics ( $T_J = -55^\circ\text{C}$ )

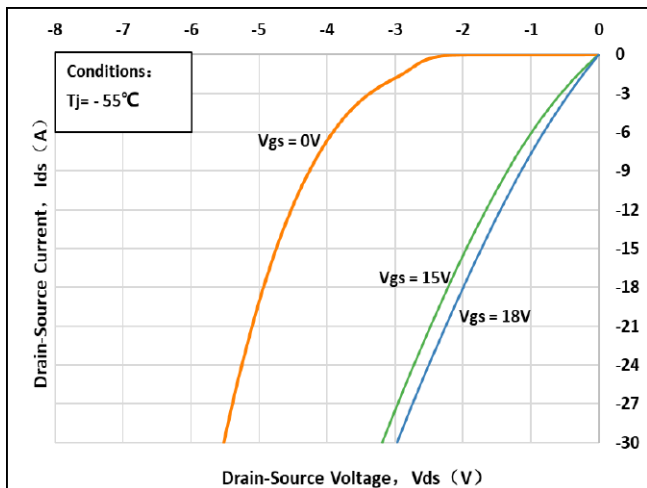


Fig 12: 3rd Quadrant Characteristics ( $T_J = 25^\circ\text{C}$ )

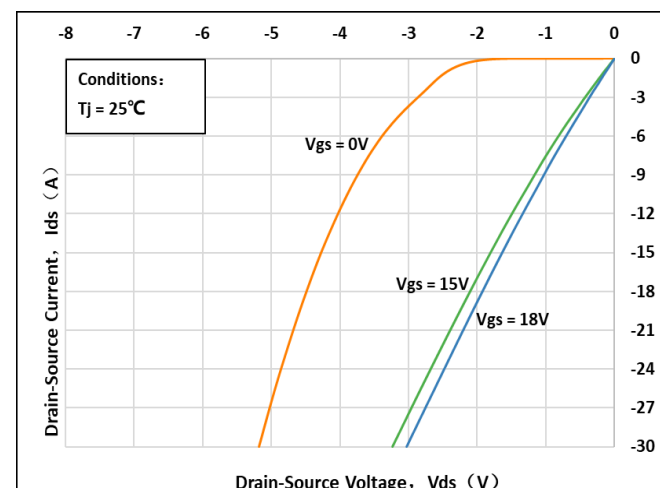




Fig 13: 3rd Quadrant Characteristics( $T_J=175^{\circ}\text{C}$ )

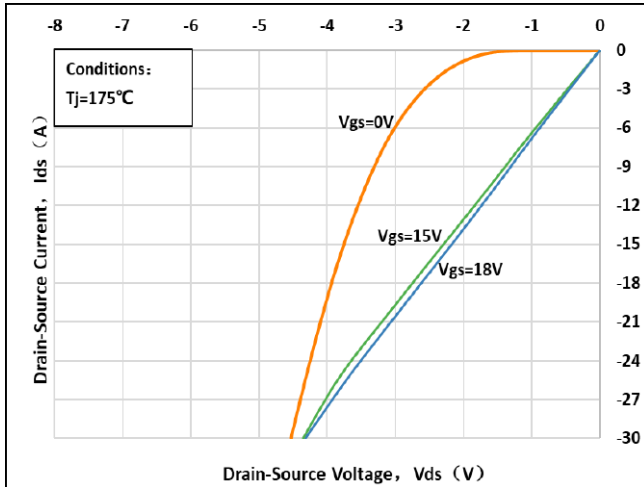


Fig 14: Gate Charge Characteristics

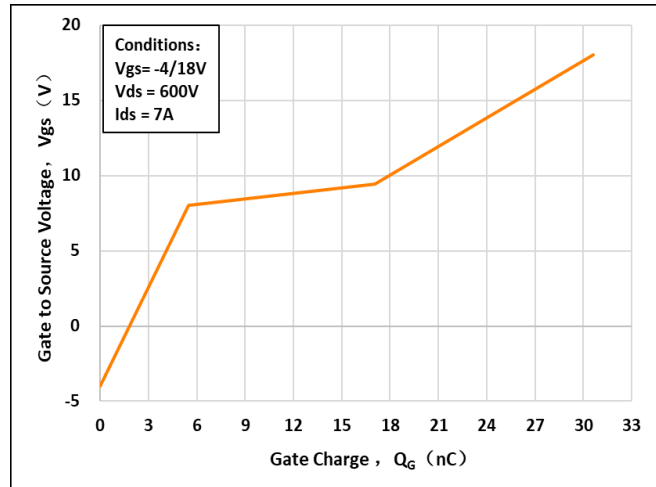


Fig 15: Drain Current vs. Case Temperature

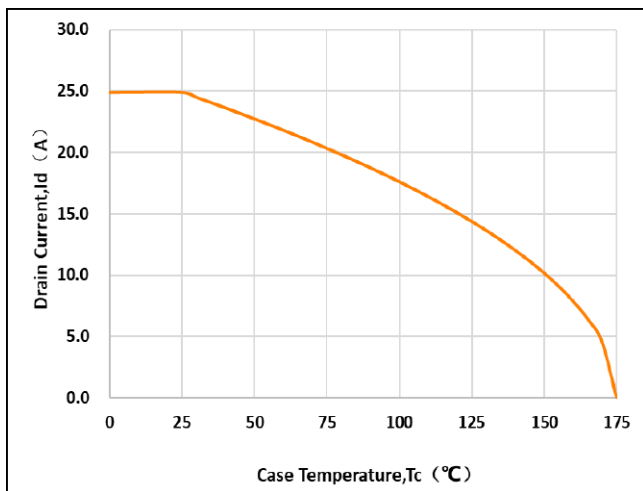


Fig 16: Safe Operating Area

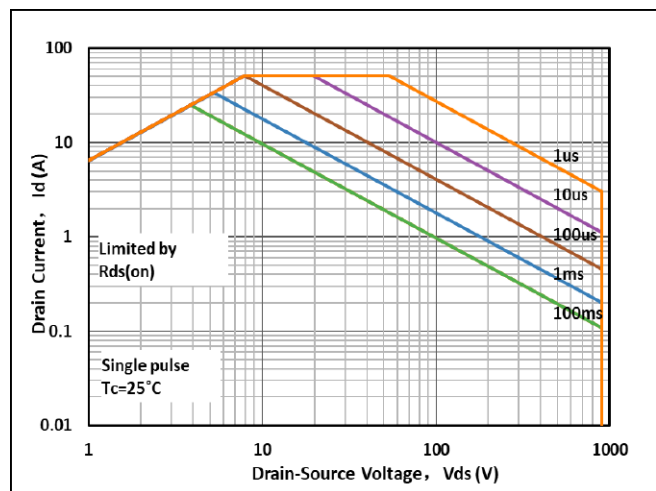


Fig 17: Capacitance Characteristics

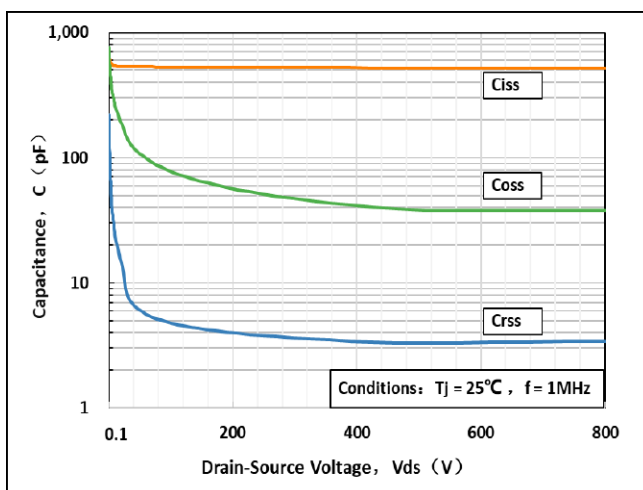
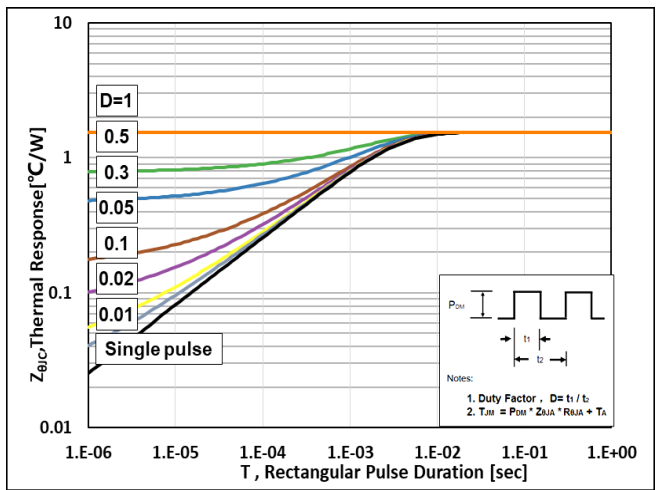


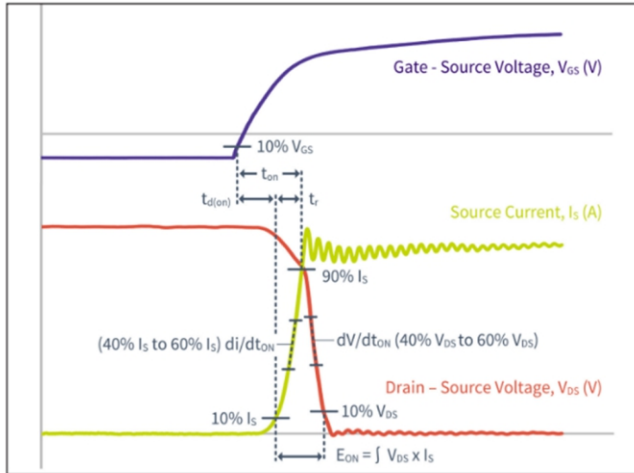
Fig 18: Transient Thermal Impedance



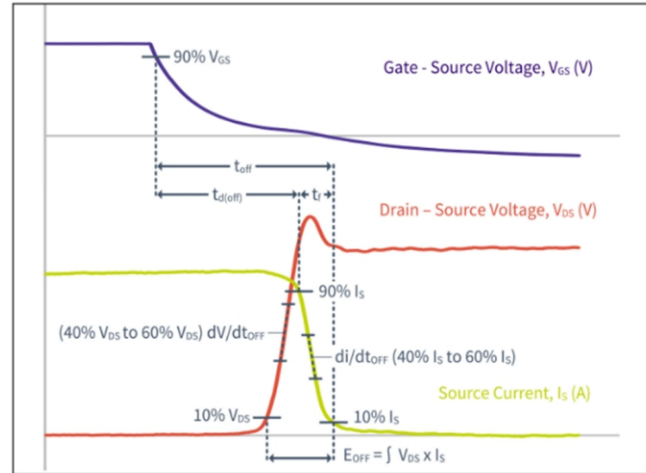


## Test Circuit & Waveform

Figure A. Definition of switching times



Turn-on Transient Definitions



Turn-off Transient Definitions

Figure B. Dynamic test circuit

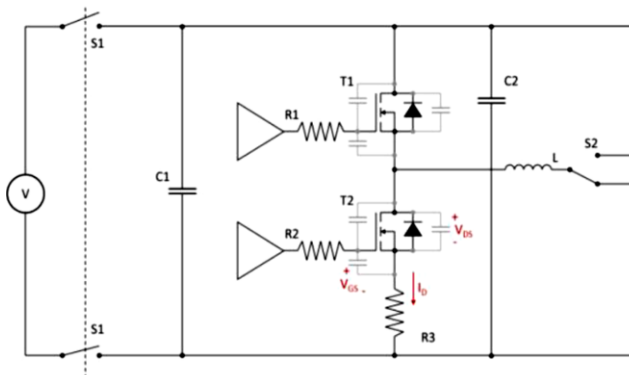
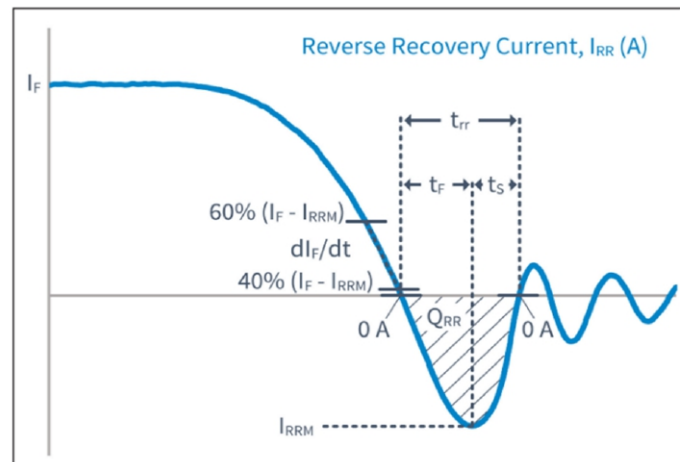


Figure C. Definition of body diodeswitching characteristics

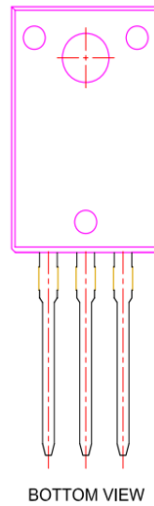
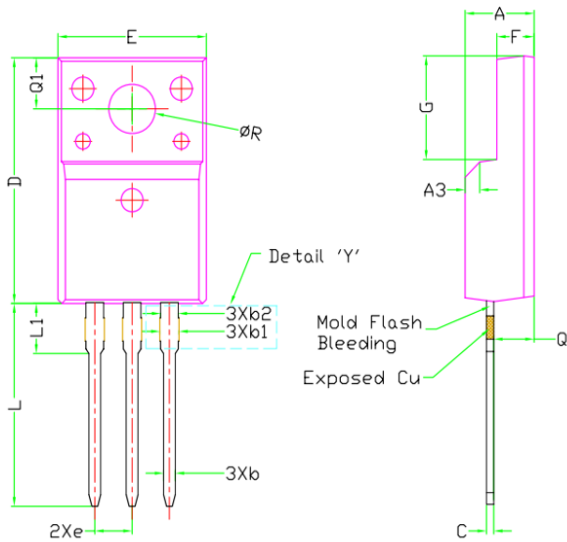


Reverse Recovery Definitions



## Package Dimensions

Package TO-220F



| SYMBOL   | DIMENSIONS |       |       |
|----------|------------|-------|-------|
|          | Min.       | Nom.  | Max.  |
| A        | 4.60       | 4.70  | 4.80  |
| b        | 0.70       | 0.80  | 0.91  |
| b1       | 1.20       | 1.30  | 1.47  |
| b2       | 1.10       | 1.20  | 1.30  |
| C        | 0.45       | 0.50  | 0.63  |
| D        | 15.80      | 15.87 | 15.97 |
| e        | 2.54       |       |       |
| E        | 10.00      | 10.10 | 10.30 |
| F        | 2.44       | 2.54  | 2.64  |
| G        | 6.50       | 6.70  | 6.90  |
| L        | 12.90      | 13.10 | 13.30 |
| L1       | 3.13       | 3.23  | 3.33  |
| Q        | 2.65       | 2.75  | 2.85  |
| Q1       | 3.20       | 3.30  | 3.40  |
| $\phi R$ | 3.08       | 3.18  | 3.28  |



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