

# HY4N65

## N-CHANNEL POWER MOSFET

### 4A, 650V N-CHANNEL POWER MOSFET

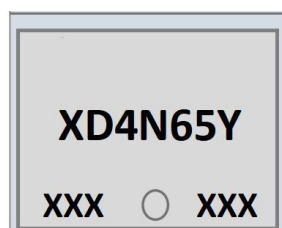
#### DESCRIPTION

The HY4N65A is a high voltage power MOSFET designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and have a high rugged avalanche characteristic. This power MOSFET is usually used in high speed switching applications including power supplies, PWM motor controls, high efficient AC to DC converters and bridge circuits.

#### FEATURES

- \*  $R_{DS(ON)} \leq 3\Omega$  @  $V_{GS}=10V$ ,  $I_D=3A$
- \* Fast Switching Capability
- \* Avalanche Energy Specified
- \* Improved  $dv/dt$  Capability, High Ruggedness

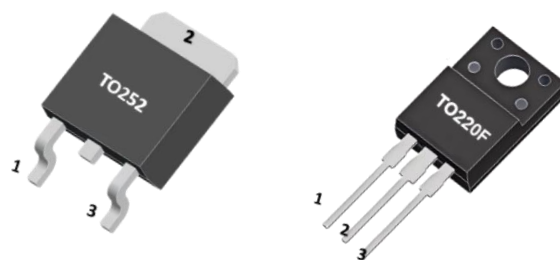
#### MARKING



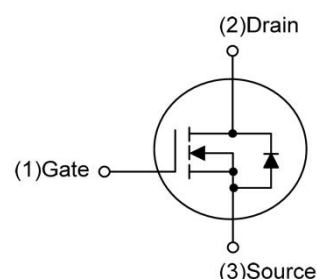
XD4N65Y=Device Code

XXX=Date Code

Solid Dot=Green molding compound



#### SYMBOL



#### ABSOLUTE MAXIMUM RATINGS( $T_A=25^\circ C$ , unless otherwise specified.)

| SYMBOL          | PARAMETER                                   |         | VALUE      | UNIT         |
|-----------------|---------------------------------------------|---------|------------|--------------|
| $V_{DS}$        | Drain-Source Voltage                        |         | 650        | V            |
| $V_{GS}$        | Gate Source Voltage                         |         | $\pm 30$   | V            |
| $I_{AR}$        | Avalanche Current (Note 2)                  |         | 4.4        | A            |
| $I_D$           | Continuous Drain Current                    |         | 4.0        | A            |
| $I_{DM}$        | Pulsed Drain Current (Note 2)               |         | 16         | A            |
| $E_{AS}$        | Avalanche Energy Single Pulsed (Note 3)     |         | 260        | mJ           |
| $E_{AR}$        | Avalanche Energy Repetitive (Note2)         |         | 10.6       | mJ           |
| $P_D$           | Power Dissipation (Note 1)                  | TO-220F | 35         | W            |
|                 |                                             | TO-252  | 50         | W            |
| $T_J$           | Junction Temperature                        |         | 125        | $^\circ C$   |
| $T_{STG}$       | Storage Temperature                         |         | -55 to 150 | $^\circ C$   |
| $R_{\theta JA}$ | Thermal Resistance from Junction to Ambient | TO-220F | 62.5       | $^\circ C/W$ |
|                 |                                             | TO-252  | 110        |              |
| $R_{\theta JC}$ | Thermal Resistance From Junction To Case    | TO-220F | 3.5        | $^\circ C/W$ |
|                 |                                             | TO-252  | 2.5        |              |

Note: 1. Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.



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2. Repetitive Rating: Pulse width limited by maximum junction temperature.
3.  $L = 30\text{mH}$ ,  $I_{AS} = 4\text{A}$ ,  $V_{DD} = 50\text{V}$ ,  $R_G = 25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$
4.  $I_{SD} \leq 4.4\text{A}$ ,  $di/dt \leq 200\text{A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$

### ■ ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , unless otherwise specified)

| PARAMETER                                       | SYMBOL       | TEST CONDITIONS                         | MIN | TYP | MAX   | UNIT |
|-------------------------------------------------|--------------|-----------------------------------------|-----|-----|-------|------|
| OFF CHARACTERISTICS                             |              |                                         |     |     |       |      |
| Drain-Source Breakdown Voltage                  | V(BR)DSS     | VGS=0V, ID=250μA                        | 650 |     |       | V    |
| Drain-Source Leakage Current                    | IDSS         | VDS=650V, VGS=0V                        |     |     | 10    | μA   |
|                                                 |              | VDS=480V, Tc=125°C                      |     |     | 100   | μA   |
| Gate-Source Leakage Current                     | IGSS         | VGS = ± 30V, VDS=0V                     |     |     | ± 100 | nA   |
| Breakdown Voltage Temperature Coefficient       | △BVDSS / △TJ | ID=250μA<br>Referenced to 25°C          |     | 0.6 |       | V/°C |
| ON CHARACTERISTICS                              |              |                                         |     |     |       |      |
| Drain-source on-state resistance                | RDS(ON)      | VGS=10V, ID=3A                          |     | 2.7 | 3     | Ω    |
| Gate Threshold Voltage                          | VGS(TH)      | VGS=VDS,ID=250μA                        | 2.0 |     | 4.0   | V    |
| DYNAMIC PARAMETERS                              |              |                                         |     |     |       |      |
| Input Capacitance                               | CISS         | VGS=0V,VDS=25V,f=1.0MHz                 |     | 670 | 750   | pF   |
| Output Capacitance                              | COSS         |                                         |     | 70  | 90    |      |
| Reverse Transfer Capacitance                    | CRSS         |                                         |     | 23  | 26    |      |
| SWITCHING PARAMETERS                            |              |                                         |     |     |       |      |
| Total gate charge                               | Qg           | VDS=520V,VGS=10V,ID=4.0A<br>(Note 1, 2) |     | 100 | 120   | nC   |
| Gate-source charge                              | Qgs          |                                         |     | 17  | 19    |      |
| Gate-drain charge                               | Qgd          |                                         |     | 20  | 26    |      |
| Turn-On Delay Time                              | td(on)       | VDD=325V,RG=25Ω,ID=4.0A<br>(Note 1, 2)  |     | 45  | 85    | nS   |
| Rise time                                       | tr           |                                         |     | 100 | 140   |      |
| Turn-Off Delay Time                             | td(off)      |                                         |     | 200 | 240   |      |
| Fall time                                       | tf           |                                         |     | 130 | 150   |      |
| SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS |              |                                         |     |     |       |      |
| Continuous Drain-Source Current                 | IS           |                                         |     |     | 4     | A    |
| Pulsed drain-source current                     | ISM          |                                         |     |     | 17.6  | A    |
| Drain-Source Diode Forward Voltage              | VSD          | VGS = 0 V, IS = 4.4A                    |     |     | 1.4   | V    |
| Reverse Recovery Time                           | trr          | dIF/dt = 100A/μs, IS = 4.4A             |     | 250 |       | ns   |
| Reverse Recovery Charge                         | Qrr          | VGS = 0V (Note 1)                       |     | 1.5 |       | μC   |

Notes:

1. Pulse Test : Pulse Width  $\leq 300\mu\text{s}$ , duty cycle  $\leq 2\%$ .
2. Essentially independent of operating temperature.

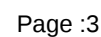


## N-CHANNEL POWER MOSFET

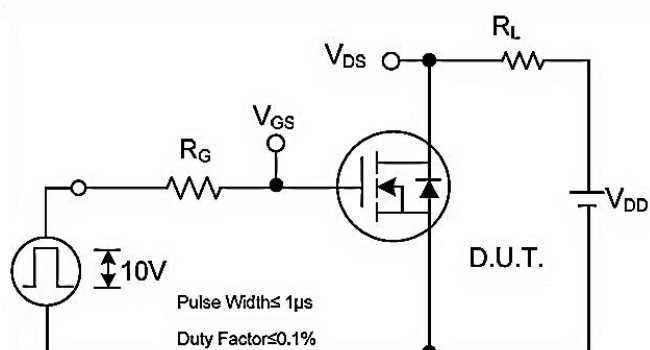
The diagram illustrates a Peak Diode Recovery  $dv/dt$  Test Circuit. It features a Driver MOSFET and a Device Under Test (D.U.T.) MOSFET. The Driver MOSFET is controlled by a gate voltage  $V_{GS}$  and has a gate resistor  $R_G$ . Its drain is connected to the D.U.T. MOSFET's gate. The D.U.T. MOSFET's drain is connected to a load inductor  $L$  and a DC supply  $V_{DD}$ . The D.U.T. MOSFET's source is connected to a current source  $I_{SD}$  and the common ground. The voltage across the D.U.T. MOSFET is labeled  $V_{DS}$ . The circuit is used to test the diode recovery characteristics of the D.U.T. MOSFET.

**Peak Diode Recovery  $dv/dt$  Test Circuit**

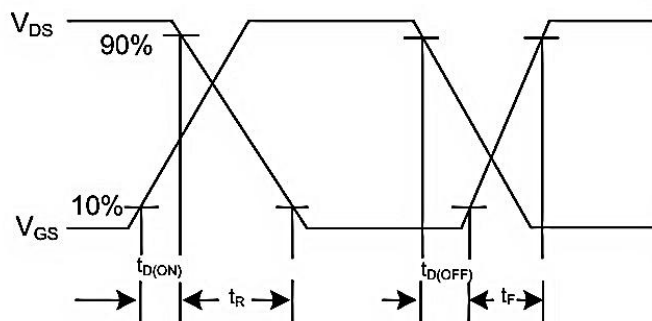
- \*  $dv/dt$  controlled by  $R_G$
- \*  $I_{SD}$  controlled by pulse period
- \* D.U.T.-Device Under Test



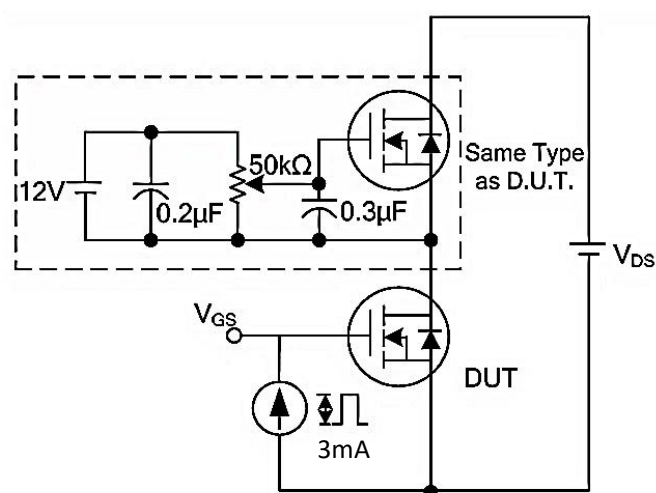
### ■ TEST CIRCUITS AND WAVEFORMS(Con.t)



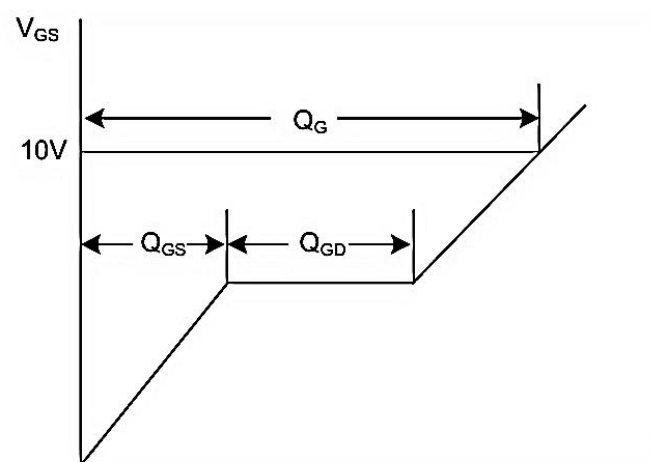
Switching Test Circuit



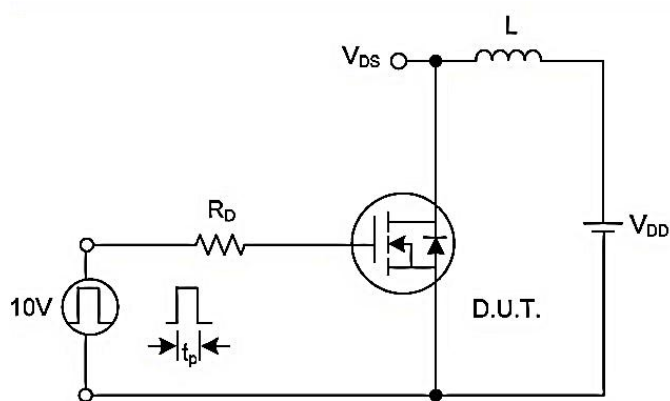
Switching Waveforms



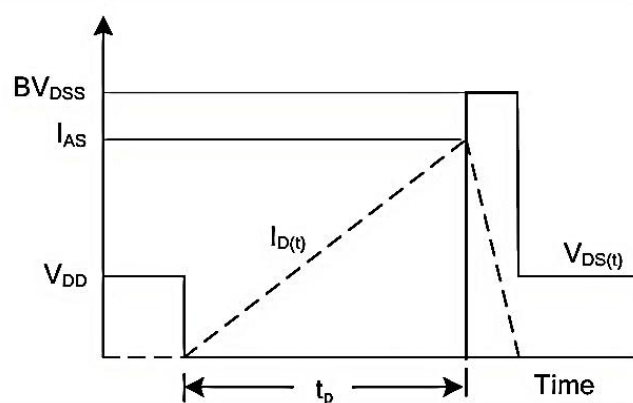
Gate Charge Test Circuit



Gate Charge Waveform



Unclamped Inductive Switching Test Circuit

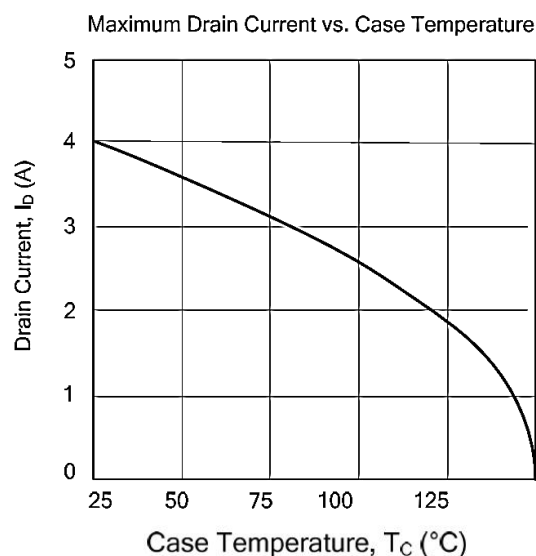
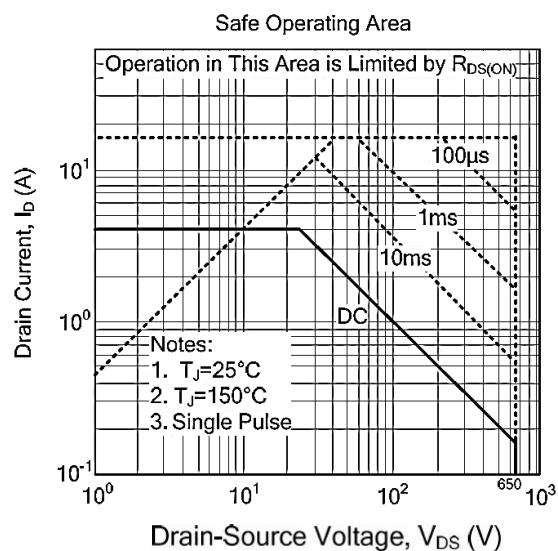
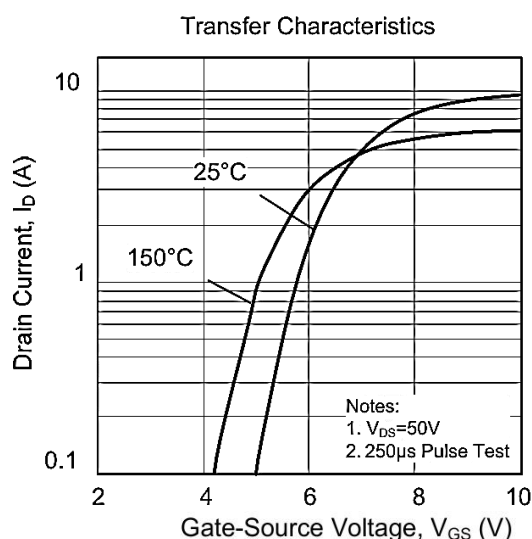
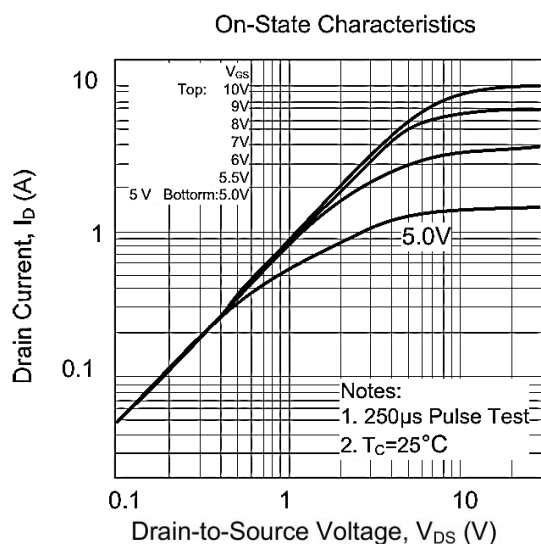
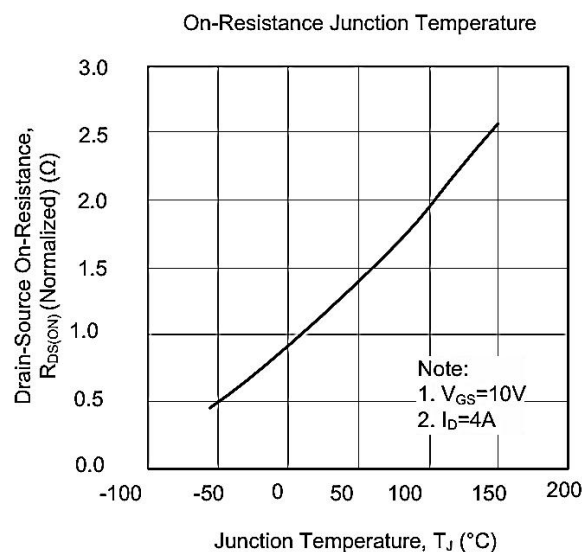
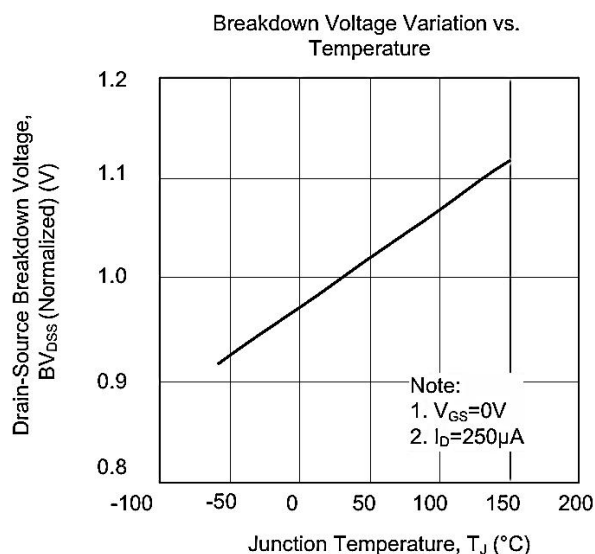


Unclamped Inductive Switching Waveforms

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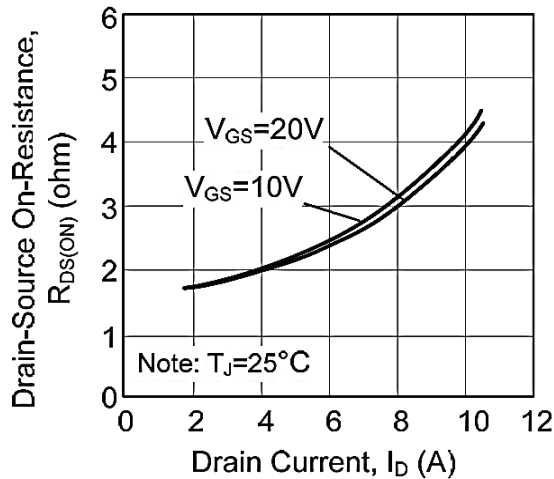
## N-CHANNEL POWER MOSFET

### TYPICAL CHARACTERISTICS

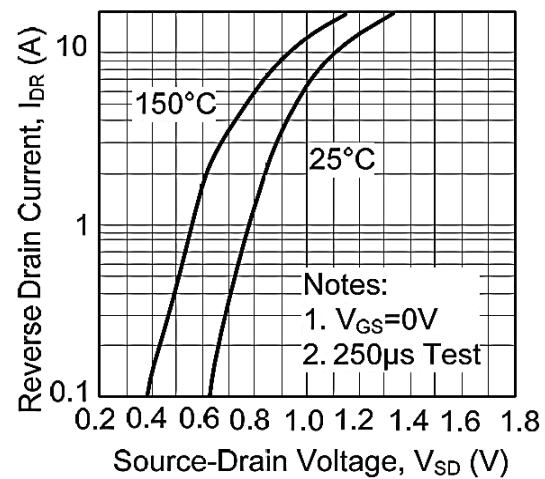


### ■ TYPICAL CHARACTERISTICS(Con.t)

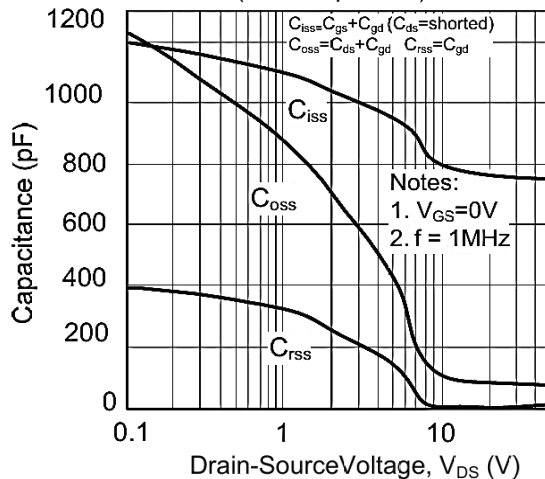
On-Resistance Variation vs. Drain Current and Gate Voltage



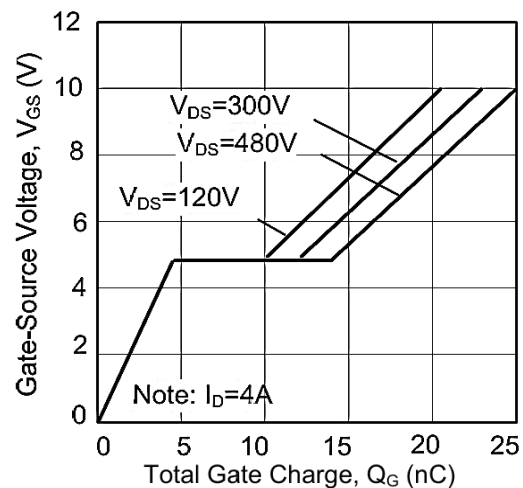
On State Current vs. Allowable Case Temperature



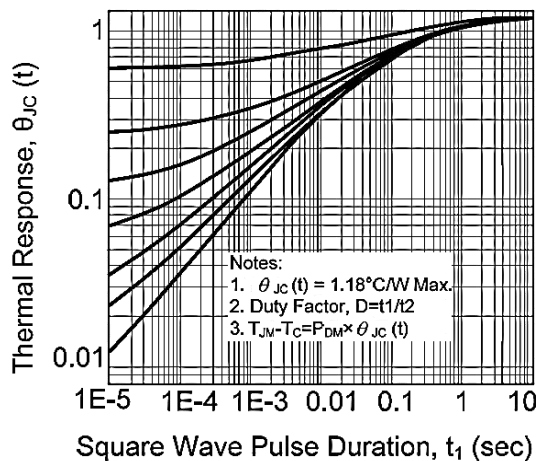
Capacitance Characteristics (Non-Repetitive)



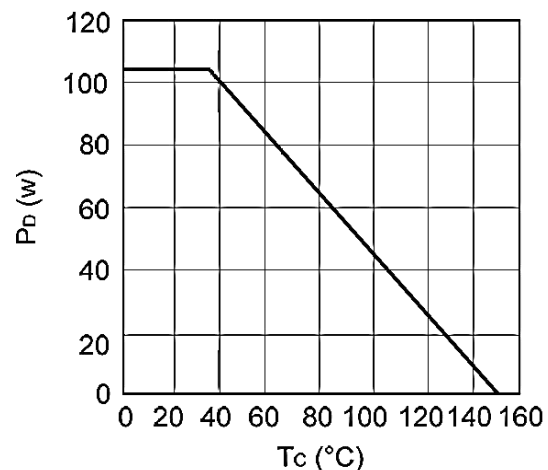
Gate Charge Characteristics

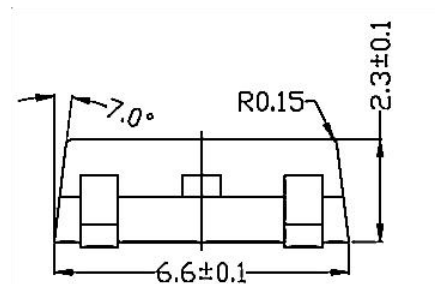


Transient Thermal Response Curve



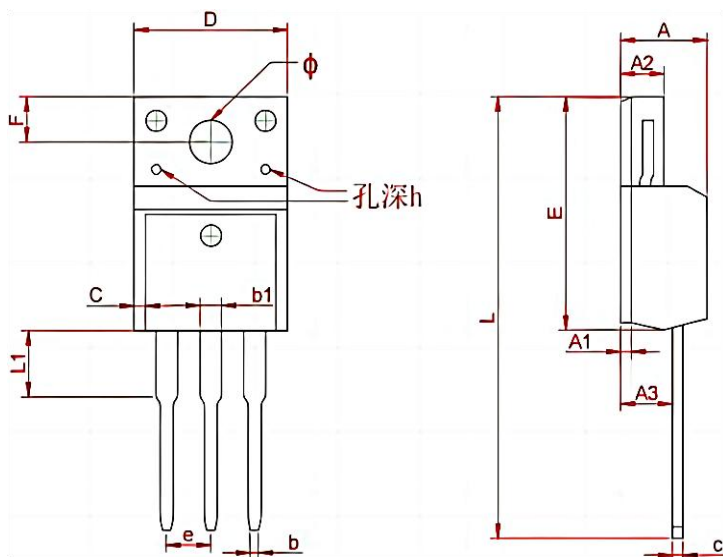
Power Dissipation





| Package version | Reel dimensions<br>$\Phi \times H$ (mm) | Per Reel (pcs) | Reels per box | Inner box dimensions<br>$L \times W \times H$ (mm) | Outer box (pcs) | Outer box dimensions<br>$L \times W \times H$ (mm) |
|-----------------|-----------------------------------------|----------------|---------------|----------------------------------------------------|-----------------|----------------------------------------------------|
| T0-252          | $\Phi 330 \times 20$                    | 2500           | 2             | 360*340*50                                         | 25000           | 375*375*280                                        |

## TO-220F PACKAGE OUTLINE DIMENSIONS



| Symbol | Dimensions In Millimeters |        |
|--------|---------------------------|--------|
|        | Min                       | Max    |
| A      | 4.300                     | 4.750  |
| A1     | 0.7 REF                   |        |
| A2     | 2.300                     | 2.850  |
| A3     | 2.500                     | 2.900  |
| b      | 0.380                     | 0.420  |
| b1     | 1.220                     | 1.280  |
| C      | 1.08                      | 1.200  |
| c      | 0.480                     | 0.520  |
| D      | 10.15                     | 10.450 |
| E      | 15.700                    | 15.950 |
| e      | 2.574 TYP                 |        |
| F      | 3.470 REF                 |        |
| y      | 3.200 REF                 |        |
| h      | 0.000                     | 0.800  |
| L      | 28.780                    | 28.900 |
| L1     | 2.990                     | 3.100  |

## TO - 220F PACKING INFORMATION

| Package version | Tube dimensions<br>LxWxH<br>(mm) | Per Tube<br>(pcs) | Tube per box | Inner box dimensions<br>LxWxH<br>(mm) | PCS/<br>Inner box | Outer box dimensions<br>LxWxH(mm) | PCS/<br>Outer box |
|-----------------|----------------------------------|-------------------|--------------|---------------------------------------|-------------------|-----------------------------------|-------------------|
| TO-220F         | 530*32*7                         | 50                | 20           | 580*155*50                            | 1000              | 602*277*188                       | 5000              |