

# 5N65

## N-CHANNEL POWER MOSFET

### 5A, 650V N-CHANNEL POWER MOSFET

#### DESCRIPTION

The 5N65 is a high voltage power MOSFET and is designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and have a high rugged avalanche characteristics. This power MOSFET is usually used at high speed switching applications in power supplies, PWM motor controls, high efficient AC to DC converters and bridge circuits.



#### FEATURES

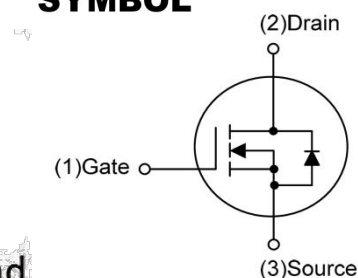
- \*  $R_{DS(ON)} \leq 2.4\Omega$  @  $V_{GS}=10V$
- \* Ultra Low Gate Charge ( Typical 15 nC )
- \* Low Reverse Transfer Capacitance (  $CR_{SS}$  = Typical 6.5 pF )
- \* Fast Switching Capability
- \* Avalanche Energy Specified
- \* Improved dv/dt Capability, High Ruggedness

#### MARKING



5N65 =Device Code  
XXXX=Date Code  
Solid Dot=Green molding compound

#### SYMBOL



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

| SYMBOL                      | PARAMETER                          |                        | VALUE      | UNIT       |
|-----------------------------|------------------------------------|------------------------|------------|------------|
| <b><math>V_{DS}</math></b>  | Drain-Source Voltage               |                        | 650        | V          |
| <b><math>V_{GS}</math></b>  | Gate Source Voltage                |                        | $\pm 30$   | V          |
| <b><math>I_{AR}</math></b>  | Avalanche Current (Note 2)         |                        | 5          | A          |
| <b><math>I_D</math></b>     | Drain Current                      | Continuous             | 5          | A          |
| <b><math>I_{DM}</math></b>  |                                    | Pulsed (Note 2)        | 20         |            |
| <b><math>E_{AS}</math></b>  | Avalanche Energy                   | Single Pulsed (Note 3) | 210        | mJ         |
| <b><math>E_{AR}</math></b>  |                                    | Repetitive (Note 2)    | 10         |            |
| <b><math>dv/dt</math></b>   | Peak Diode Recovery dv/dt (Note 4) |                        | 4.5        | V/ns       |
| <b><math>P_D</math></b>     | Power Dissipation                  | TO-220F                | 36         | W          |
|                             |                                    | TO-252                 | 54         | W          |
| <b><math>T_J</math></b>     | Junction Temperature               |                        | 150        | $^\circ C$ |
| <b><math>T_{STG}</math></b> | Storage Temperature                |                        | -55 to 150 | $^\circ C$ |
| <b><math>T_{OPR}</math></b> | Operation Temperature              |                        | -55 to 150 | $^\circ C$ |



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- Notes: 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.  
2. Pulse width limited by  $T_{J(MAX)}$   
3.  $L = 16.8mH$ ,  $I_{AS} = 5A$ ,  $V_{DD} = 50V$ ,  $R_G = 25 \Omega$ , Starting  $T_J = 25^\circ C$   
4.  $I_{SD} \leq 5A$ ,  $di/dt \leq 200A/\mu s$ ,  $V_{DD} \leq BVD_{SS}$ , Starting  $T_J = 25^\circ C$

### THERMAL DATA

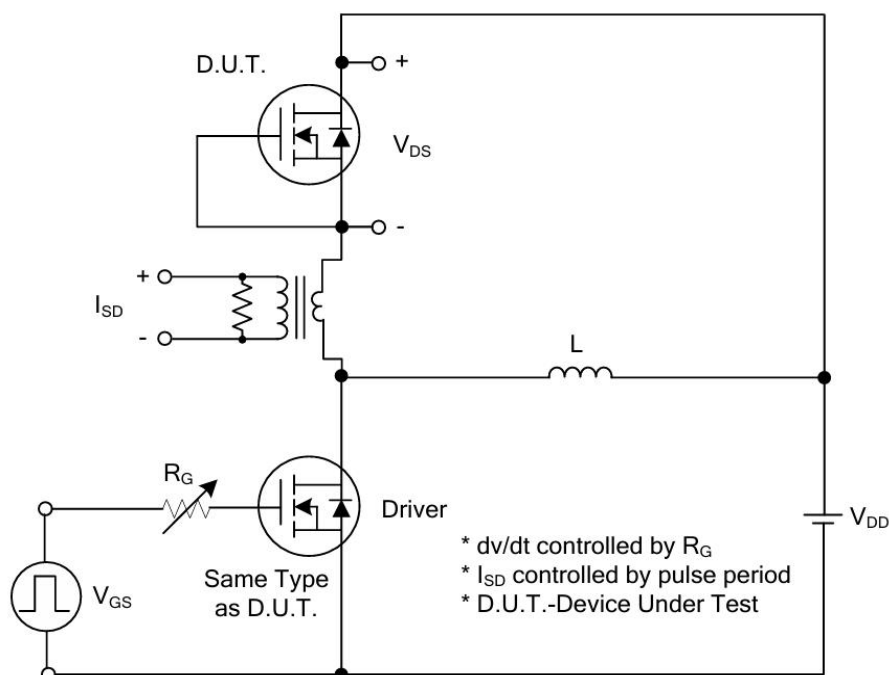
| PARAMETER           |         | SYMBOL        | RATINGS | UNIT         |
|---------------------|---------|---------------|---------|--------------|
| Junction to Ambient | TO-220F | $\theta_{JA}$ | 62.5    | $^\circ C/W$ |
|                     | TO-252  |               | 160     |              |
| Junction to Case    | TO-220F | $\theta_{JC}$ | 3.47    | $^\circ C/W$ |
|                     | TO-252  |               | 2.3     |              |

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

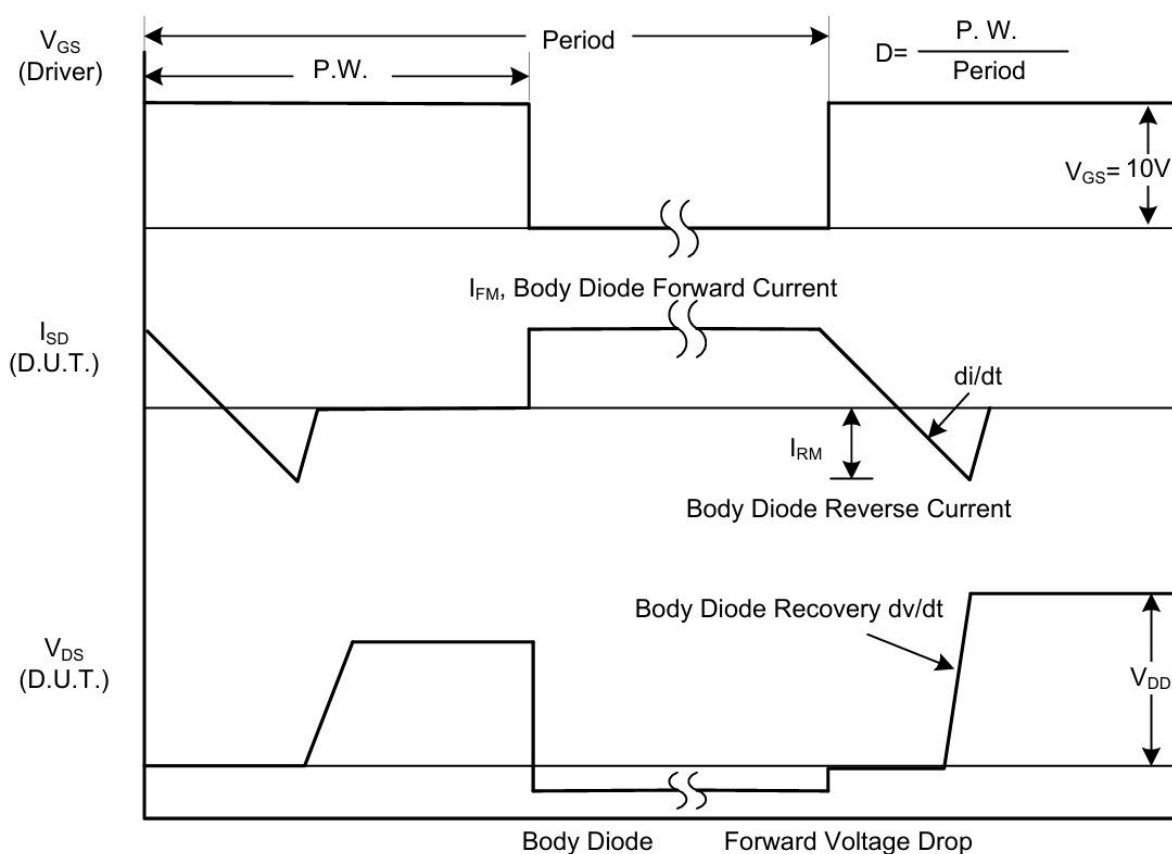
| PARAMETER                                                      | SYMBOL                              | TEST CONDITIONS                                                               | MIN | TYP | MAX  | UNIT |
|----------------------------------------------------------------|-------------------------------------|-------------------------------------------------------------------------------|-----|-----|------|------|
| OFF CHARACTERISTICS                                            |                                     |                                                                               |     |     |      |      |
| Drain-Source Breakdown Voltage                                 | BV <sub>DSS</sub>                   | V <sub>GS</sub> =0V, I <sub>D</sub> =250μA                                    | 650 |     |      | V    |
| Drain-Source Leakage Current                                   | I <sub>DSS</sub>                    | V <sub>DS</sub> =650V, V <sub>GS</sub> =0V                                    |     |     | 1    | μA   |
| Gate-Source Leakage Current                                    | I <sub>GSS</sub>                    | V <sub>GS</sub> =±30V, V <sub>DS</sub> =0V                                    |     |     | ±100 | nA   |
| Breakdown Voltage Temperature Coefficient (Referenced to 25°C) | ΔBV <sub>DSS</sub> /ΔT <sub>J</sub> | I <sub>D</sub> =250μA                                                         |     | 0.6 |      | V/°C |
| ON CHARACTERISTICS                                             |                                     |                                                                               |     |     |      |      |
| Drain-source on-state resistance                               | R <sub>DS(ON)</sub>                 | V <sub>GS</sub> =10V, I <sub>D</sub> =2.5A                                    |     | 2.0 | 2.4  | Ω    |
| Gate Threshold Voltage                                         | V <sub>GS(TH)</sub>                 | V <sub>GS</sub> =V <sub>DS</sub> , I <sub>D</sub> =250μA                      | 2.0 |     | 4.0  | V    |
| DYNAMIC PARAMETERS                                             |                                     |                                                                               |     |     |      |      |
| Input Capacitance                                              | C <sub>ISS</sub>                    | V <sub>GS</sub> =0V, V <sub>DS</sub> =25V<br>f=1.0MHz                         |     | 515 | 670  | pF   |
| Output Capacitance                                             | C <sub>OSS</sub>                    |                                                                               |     | 55  | 72   |      |
| Reverse Transfer Capacitance                                   | C <sub>RSS</sub>                    |                                                                               |     | 6.5 | 8.5  |      |
| SWITCHING PARAMETERS                                           |                                     |                                                                               |     |     |      |      |
| Total gate charge                                              | Q <sub>g</sub>                      | V <sub>DS</sub> =520V, V <sub>GS</sub> =10V<br>I <sub>D</sub> =5A (Note 1, 2) |     | 15  | 19   | nC   |
| Gate-source charge                                             | Q <sub>gs</sub>                     |                                                                               |     | 2.5 |      |      |
| Gate-drain charge                                              | Q <sub>gd</sub>                     |                                                                               |     | 6.6 |      |      |
| Turn-On Delay Time                                             | t <sub>(on)</sub>                   | V <sub>DD</sub> =325V, I <sub>D</sub> =5A<br>R <sub>G</sub> =25Ω (Note 1, 2)  |     | 10  | 30   | nS   |
| Turn-On Rise time                                              | t <sub>r</sub>                      |                                                                               |     | 42  | 90   |      |
| Turn-Off Delay Time                                            | t <sub>D(off)</sub>                 |                                                                               |     | 38  | 85   |      |
| Turn-Off Fall time                                             | t <sub>f</sub>                      |                                                                               |     | 46  | 100  |      |
| DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS         |                                     |                                                                               |     |     |      |      |
| Maximum Continuous Drain-Source Diode Forward Current          | I <sub>S</sub>                      |                                                                               |     |     | 5    | A    |
| Maximum Pulsed Drain-Source Diode Forward Current              | I <sub>SM</sub>                     |                                                                               |     |     | 20   | A    |
| Drain-Source Diode Forward Voltage                             | V <sub>SD</sub>                     | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 5A                                    |     |     | 1.4  | V    |
| Reverse Recovery Time                                          | t <sub>rr</sub>                     | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 5A<br>dI <sub>F</sub> / dt = 100 A/μs |     | 300 |      | ns   |
| Reverse Recovery Charge                                        | Q <sub>rr</sub>                     | (Note 1)                                                                      |     | 2.2 |      | μC   |

- Notes: 1. Pulse Test: Pulse width  $\leq 300\mu s$ , Duty cycle  $\leq 2\%$ .  
2. Essentially independent of operating temperature.

### ■ TEST CIRCUITS AND WAVEFORMS



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

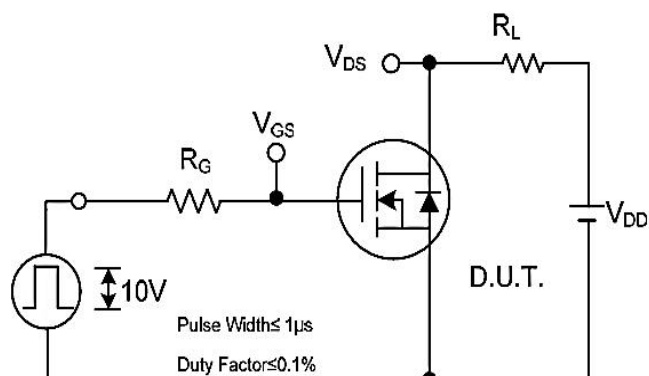


**Peak Diode Recovery dv/dt Waveforms**

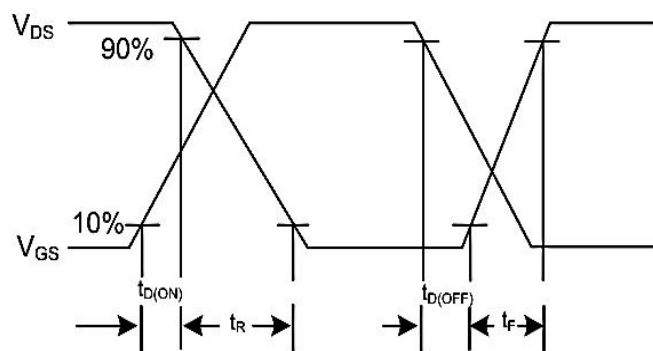
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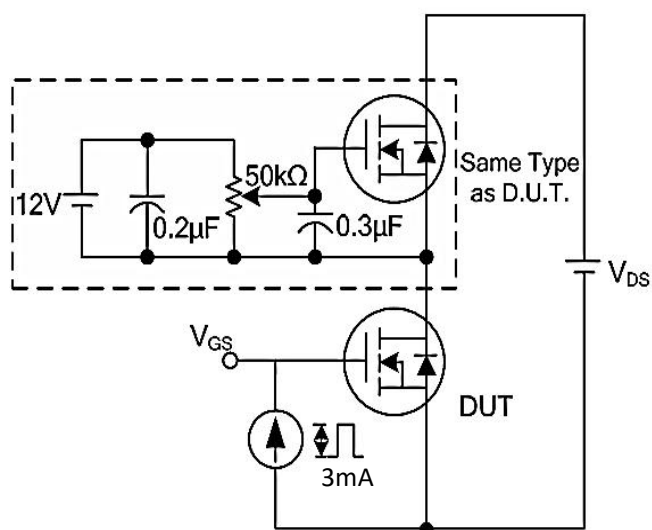
### ■ TEST CIRCUITS AND WAVEFORMS(Con.t)



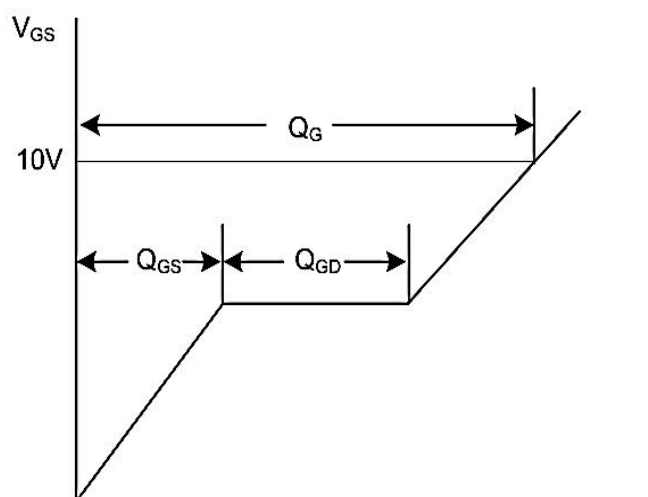
Switching Test Circuit



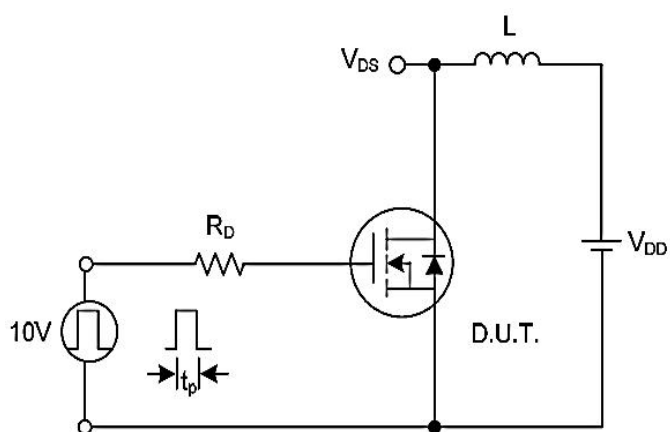
Switching Waveforms



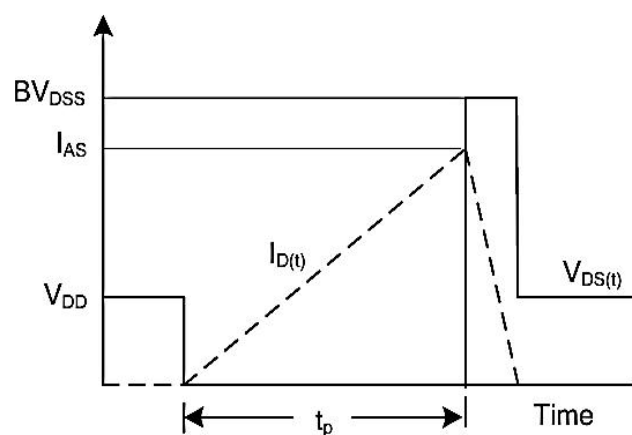
Gate Charge Test Circuit



Gate Charge Waveform

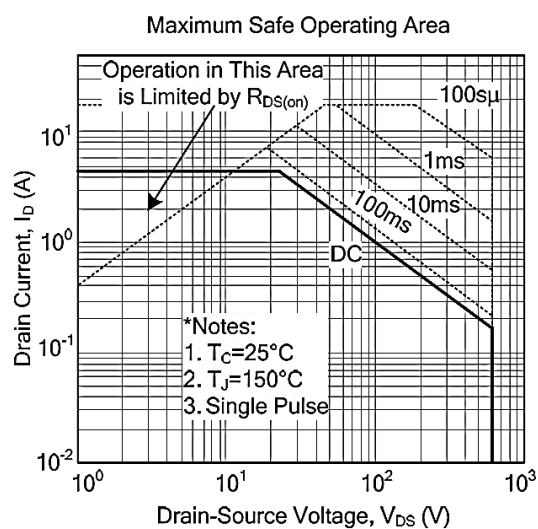
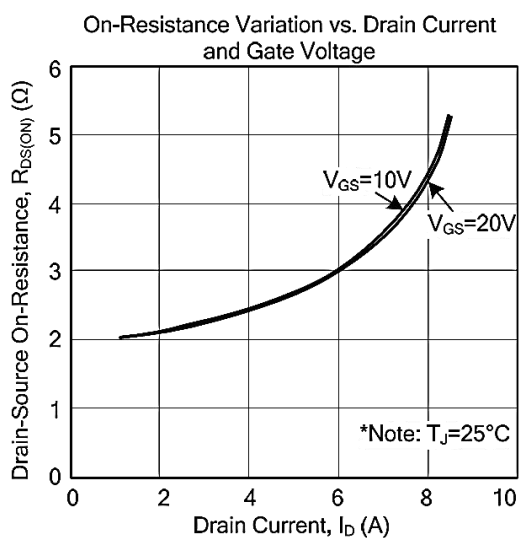
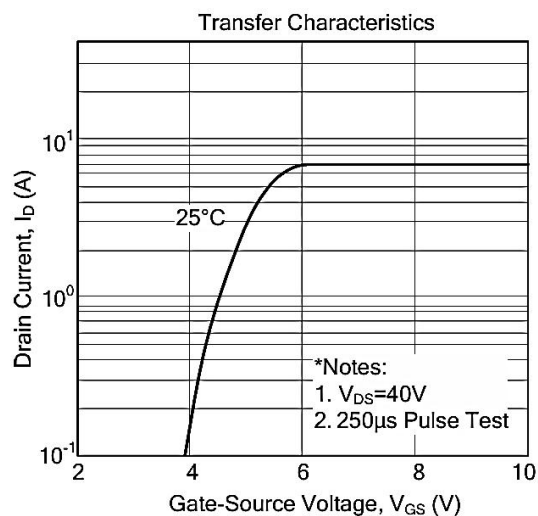
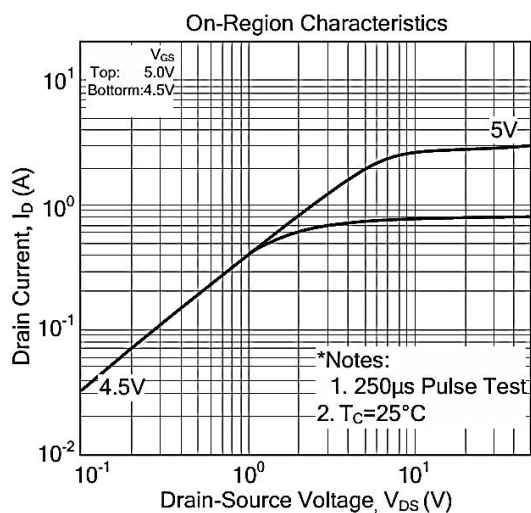


Unclamped Inductive Switching Test Circuit

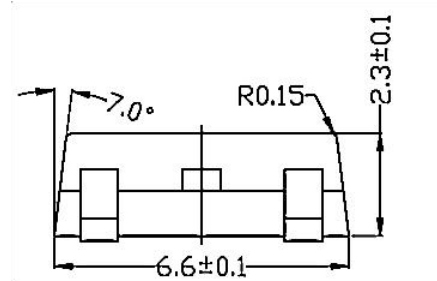
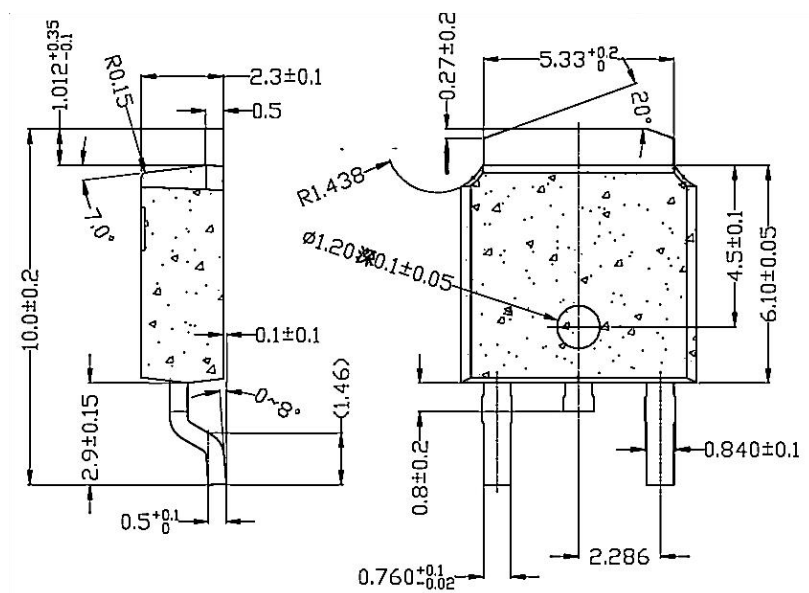


Unclamped Inductive Switching Waveforms

### TYPICAL CHARACTERISTICS



### TO - 252 PACKAGE OUTLINE DIMENSIONS



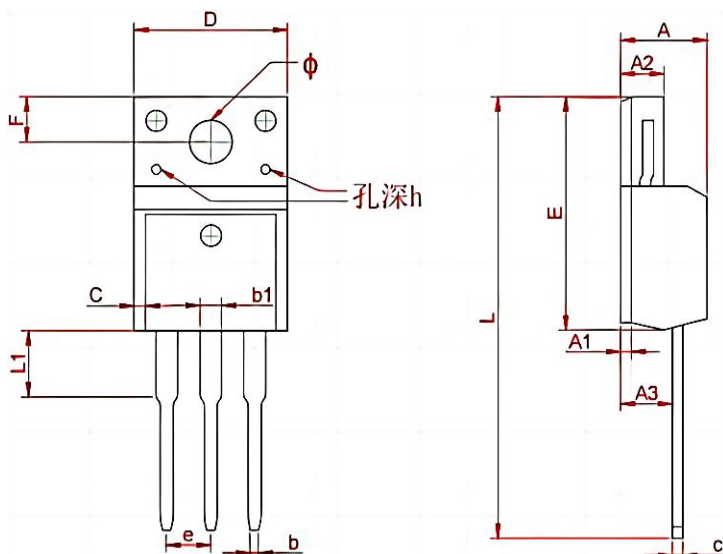
### TO - 252 PACKING INFORMATION

| 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                                        |

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## 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              |