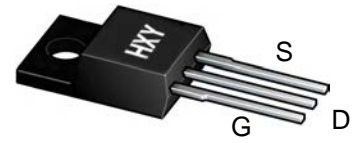




## Description

The 12N65 can be used in various power switching circuit for system miniaturization and higher efficiency. The package form is TO-220F, which accords with the RoHS standard.



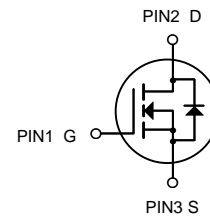
TO-220F

## General Features

$V_{DS} = 650V, I_D = 12A$   
 $R_{DS(ON)} < 0.8 \Omega @ V_{GS} = 10V$

## Application

- Power switch circuit of adaptor and charger.



N-Channel MOSFET

## Package Marking and Ordering Information

| Product ID | Pack    | Marking        | Units Tube |
|------------|---------|----------------|------------|
| 12N65      | TO-220F | 12N65 XXX YYYY | 50         |

## Absolute Maximum Ratings@ $T_J = 25^\circ C$ (unless otherwise specified)

| Symbol                                | Parameter                                  | Rating     | Units |
|---------------------------------------|--|------------|-------|
| V <sub>DS</sub>                       | Drain-Source Voltage                       | 650        | V     |
| V <sub>GS</sub>                       | Gate-Source Voltage                        | ±30        | V     |
| I <sub>D</sub> @T <sub>C</sub> =25°C  | Drain Current, V <sub>GS</sub> @ 4.5V      | 12         | A     |
| I <sub>D</sub> @T <sub>C</sub> =100°C | Drain Current, V <sub>GS</sub> @ 4.5V      | 7.5        | A     |
| IDM                                   | Pulsed Drain Current <sup>1</sup>          | 48         | A     |
| P <sub>D</sub> @T <sub>C</sub> =25°C  | Total Power Dissipation                    | 42         | W     |
| E <sub>AS</sub>                       | Single Pulse Avalanche Energy <sup>4</sup> | 550        | mJ    |
| TSTG                                  | Storage Temperature Range                  | -55 to 150 | °C    |
| T <sub>J</sub>                        | Operating Junction Temperature Range       | -55 to 150 | °C    |



**Electrical Characteristics** (Tc= 25°C unless otherwise specified):

| <b>OFF Characteristics</b>          |                                   |   |        |      |      |      |
|-------------------------------------|-----------------------------------|---|--------|------|------|------|
| Symbol                              | Parameter                         | Test Conditions   | Rating |      |      | Unit |
|                                     |                                   |   | Min.   | Typ. | Max. |      |
| V <sub>DSS</sub>                    | Drain to Source Breakdown Voltage | V <sub>GS</sub> =0V, I <sub>D</sub> =250μA                              | 650    | --   | --   | V    |
| ΔBV <sub>DSS</sub> /ΔT <sub>J</sub> | Bvdss Temperature Coefficient     | I <sub>D</sub> =250uA, Reference 25°C                                   | --     | 0.7  | --   | V/°C |
| I <sub>DSS</sub>                    | Drain to Source Leakage Current   | V <sub>DS</sub> = 650V, V <sub>GS</sub> = 0V,<br>T <sub>a</sub> = 25°C  | --     | --   | 1    | μA   |
|                                     |                                   | V <sub>DS</sub> = 520V, V <sub>GS</sub> = 0V,<br>T <sub>a</sub> = 125°C | --     | --   | 100  | μA   |
| I <sub>GSS(F)</sub>                 | Gate to Source Forward Leakage    | V <sub>GS</sub> = +30V  | --     | --   | 100  | nA   |
| I <sub>GSS(R)</sub>                 | Gate to Source Reverse Leakage    | V <sub>GS</sub> = -30V  | --     | --   | -100 | nA   |

| <b>ON Characteristics</b>      |                               |  |        |      |      |       |
|--------------------------------|-------------------------------|--|--------|------|------|-------|
| Symbol                         | Parameter                     | Test Conditions  | Rating |      |      | Units |
|                                |                               |  | Min.   | Typ. | Max. |       |
| R <sub>DS(ON)</sub>            | Drain-to-Source On-Resistance | V <sub>GS</sub> =10V, I <sub>D</sub> =6A                   | --     | 0.67 | 0.8  | Ω     |
| V <sub>GS(TH)</sub>            | Gate Threshold Voltage        | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA | 2.0    | --   | 4.0  | V     |
| Pulse width tp ≤ 300μs, δ ≤ 2% |                               |  |        |      |      |       |

| <b>Dynamic Characteristics</b> |                              |  |        |      |      |       |
|--------------------------------|------------------------------|--|--------|------|------|-------|
| Symbol                         | Parameter                    | Test Conditions  | Rating |      |      | Units |
|                                |                              |  | Min.   | Typ. | Max. |       |
| g <sub>fs</sub>                | Forward Transconductance     | V <sub>DS</sub> =15V, I <sub>D</sub> =6A                 | --     | 12   | --   | S     |
| C <sub>iss</sub>               | Input Capacitance            | V <sub>GS</sub> = 0V V <sub>DS</sub> = 25V<br>f = 1.0MHz | --     | 1993 | --   | pF    |
| C <sub>oss</sub>               | Output Capacitance           |  | --     | 160  | --   |       |
| C <sub>rss</sub>               | Reverse Transfer Capacitance |  | --     | 9.5  | --   |       |

| <b>Resistive Switching Characteristics</b> |                                 |  |        |      |      |       |
|--|---------------------------------|--|--------|------|------|-------|
| Symbol                                     | Parameter                       | Test Conditions  | Rating |      |      | Units |
|  |                                 |  | Min.   | Typ. | Max. |       |
| t <sub>d(ON)</sub>                         | Turn-on Delay Time              | I <sub>D</sub> = 12A V <sub>DD</sub> = 325V<br>R <sub>G</sub> = 10Ω  | --     | 28   | --   | ns    |
| t <sub>r</sub>                             | Rise Time                       |  | --     | 26   | --   |       |
| t <sub>d(OFF)</sub>                        | Turn-Off Delay Time             |  | --     | 64   | --   |       |
| t <sub>f</sub>                             | Fall Time                       |  | --     | 45   | --   |       |
| Q <sub>g</sub>                             | Total Gate Charge               | I <sub>D</sub> = 12A V <sub>DD</sub> = 520V<br>V <sub>GS</sub> = 10V | --     | 40   | --   | nC    |
| Q <sub>gs</sub>                            | Gate to Source Charge           |  | --     | 10   | --   |       |
| Q <sub>gd</sub>                            | Gate to Drain ("Miller") Charge |  | --     | 14   | --   |       |



| Source-Drain Diode Characteristics               |  |  |        |      |      |       |
|--|--|--|--------|------|------|-------|
| Symbol   | Parameter                              | Test Conditions  | Rating |      |      | Units |
|  |  |  | Min.   | Typ. | Max. |       |
| $I_S$  | Continuous Source Current (Body Diode) |  | --     | --   | 12   | A     |
| $I_{SM}$   | Maximum Pulsed Current (Body Diode)    |  | --     | --   | 48   | A     |
| $V_{SD}$   | Diode Forward Voltage                  | $I_S=12A, V_{GS}=0V$   | --     | --   | 1.5  | V     |
| $t_{rr}$   | Reverse Recovery Time                  | $I_S=12A, T_J = 25^\circ C$<br>$di_F/dt=100A/us,$<br>$V_{GS}=0V$ | --     | 651  | --   | ns    |
| $Q_{rr}$   | Reverse Recovery Charge                |  | --     | 4297 | --   | nC    |
| $I_{RRM}$  | Reverse Recovery Current               |  | --     | 13.2 | --   | A     |
| Pulse width $t_p \leq 300\mu s, \delta \leq 2\%$ |  |  |        |      |      |       |

| Symbol          | Parameter           | Typ. | Units        |
|-----------------|---------------------|------|--------------|
| $R_{\theta JC}$ | Junction-to-Case    | 2.98 | $^\circ C/W$ |
| $R_{\theta JA}$ | Junction-to-Ambient | 62.5 | $^\circ C/W$ |

<sup>a1</sup>: Repetitive rating; pulse width limited by maximum junction temperature

<sup>a2</sup>:  $L=10mH, I_D=10.5A, Start T_J=25^\circ C$

<sup>a3</sup>:  $I_{SD}=12A, di/dt \leq 100A/us, V_{DD} \leq BV_{DS}, Start T_J=25^\circ C$



### Characteristics Curve:

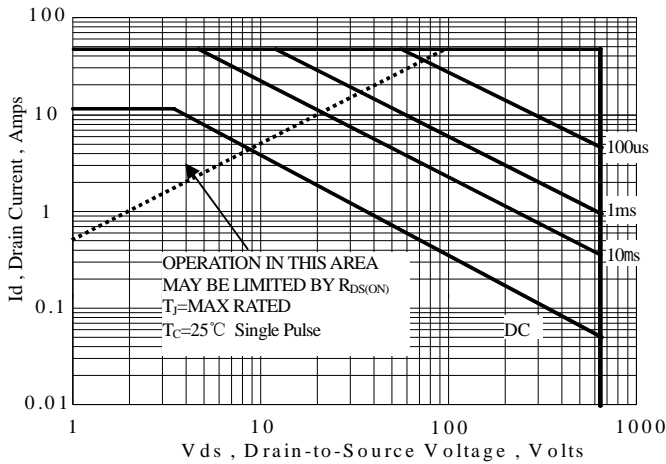


Figure 1 Maximum Forward Bias Safe Operating Area

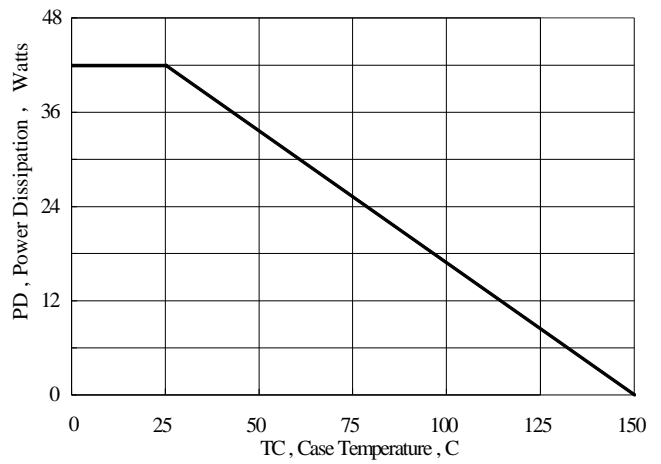


Figure 2 Maximum Power Dissipation vs Case Temperature

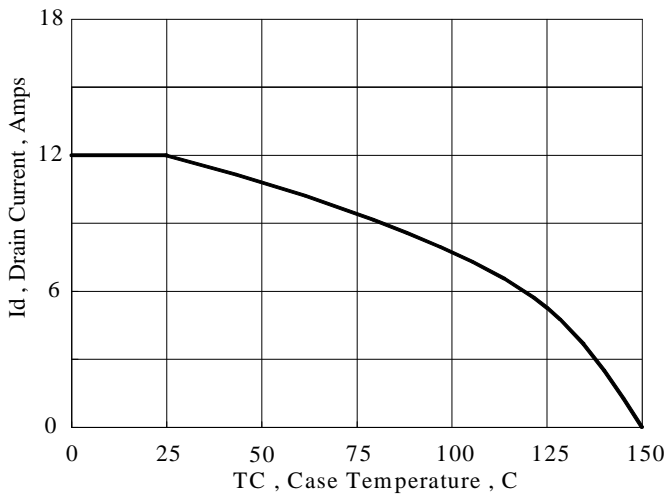


Figure 3 Maximum Continuous Drain Current vs Case Temperature

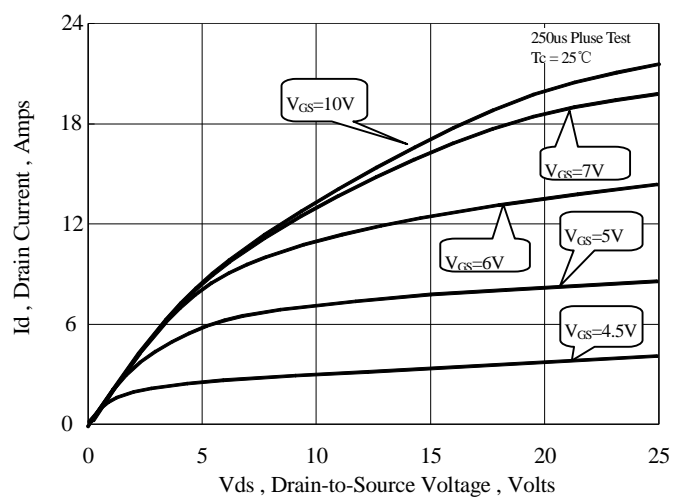


Figure 4 Typical Output Characteristics

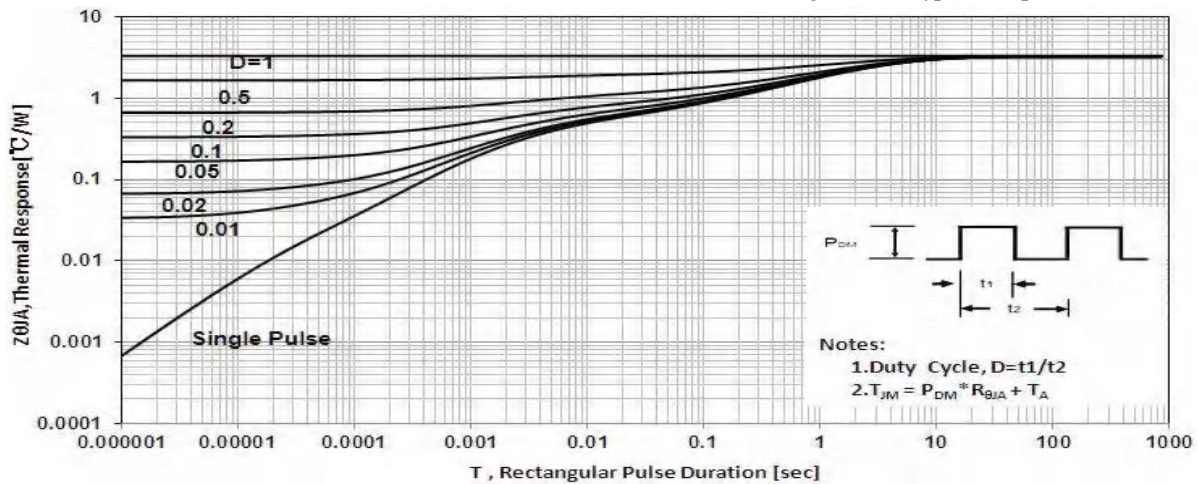


Figure 5 Maximum Effective Thermal Impedance, Junction to Case

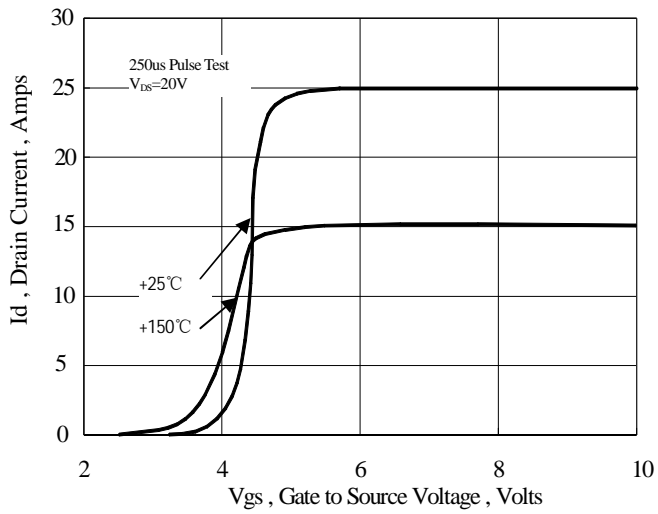


Figure 6 Typical Transfer Characteristics

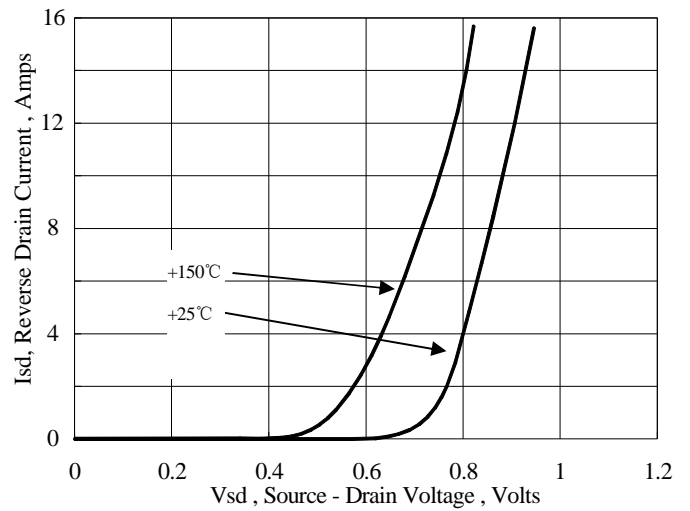


Figure 7 Typical Body Diode Transfer Characteristics

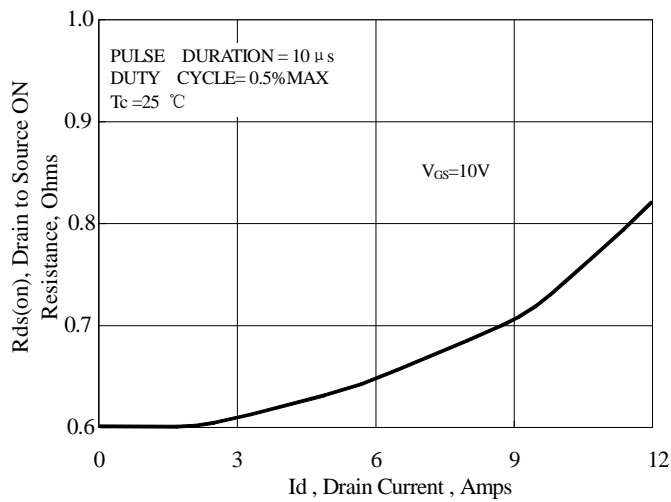


Figure 8 Typical Drain to Source ON Resistance vs Drain Current

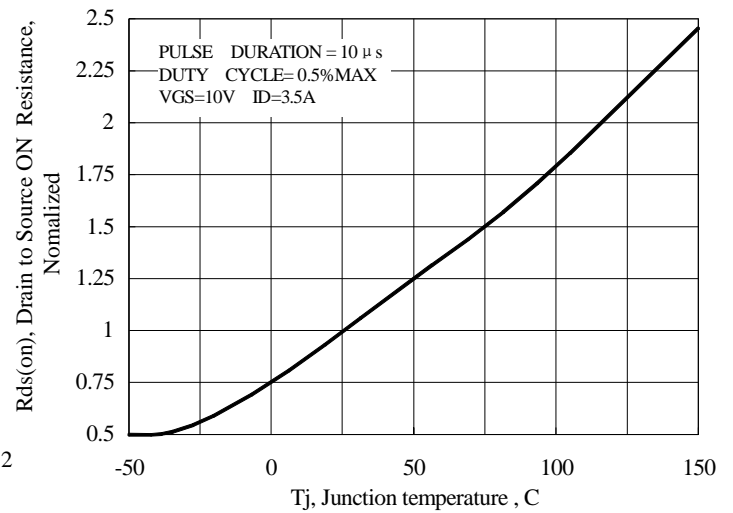


Figure 9 Typical Drain to Source on Resistance vs Junction Temperature

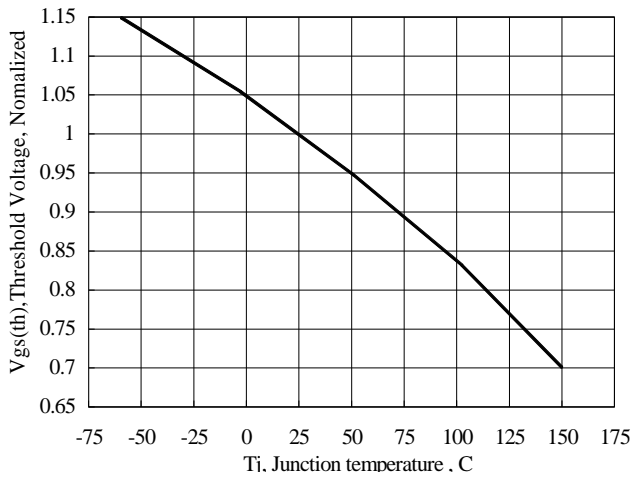


Figure 10 Typical Theshold Voltage vs Junction Temperature

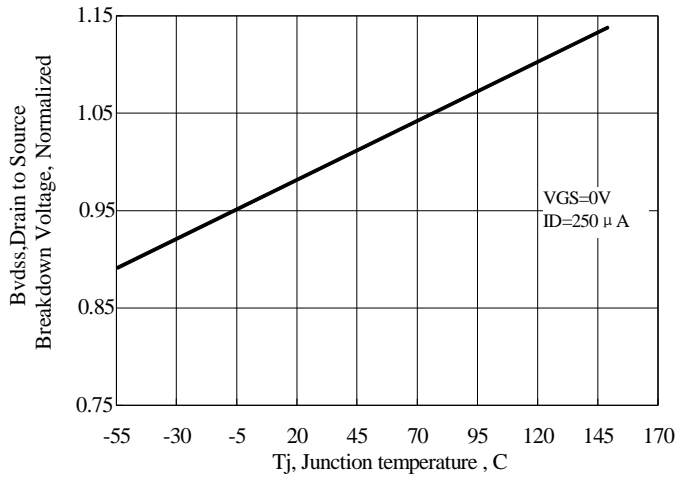


Figure 11 Typical Breakdown Voltage vs Junction Temperature

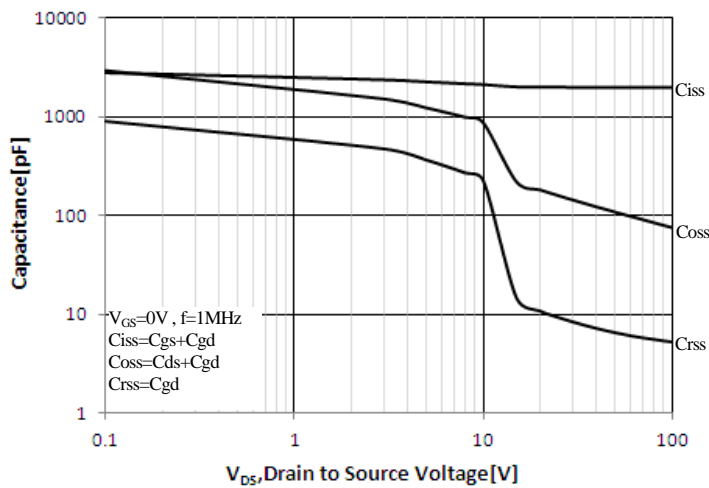


Figure 12 Typical Capacitance vs Drain to Source Voltage

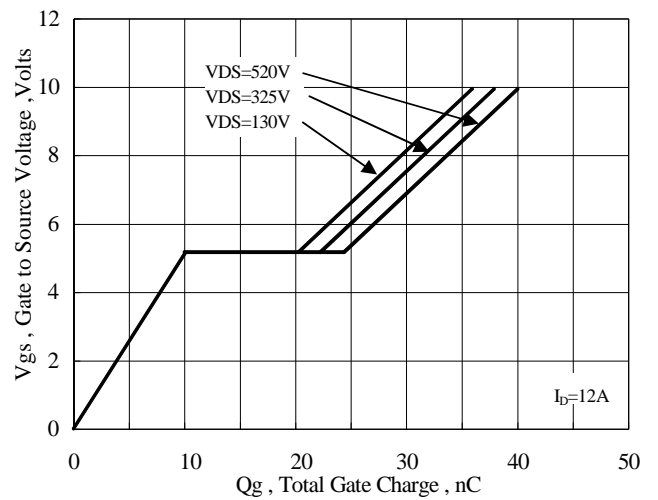


Figure 13 Typical Gate Charge vs Gate to Source Voltage



### Test Circuit and Waveform

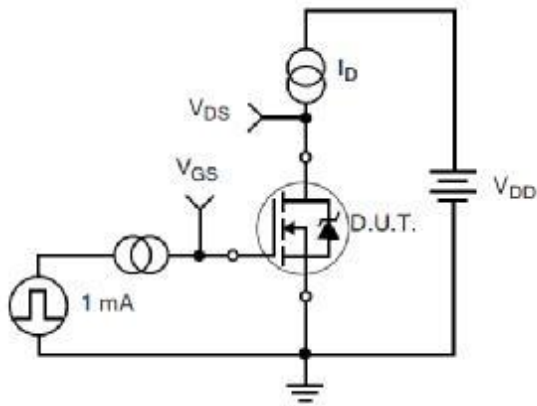


Figure 17. Gate Charge Test Circuit

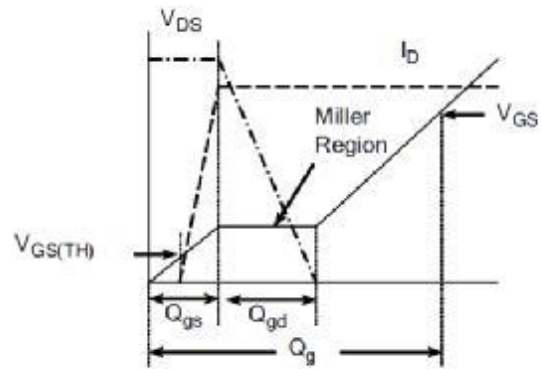


Figure 18. Gate Charge Waveform

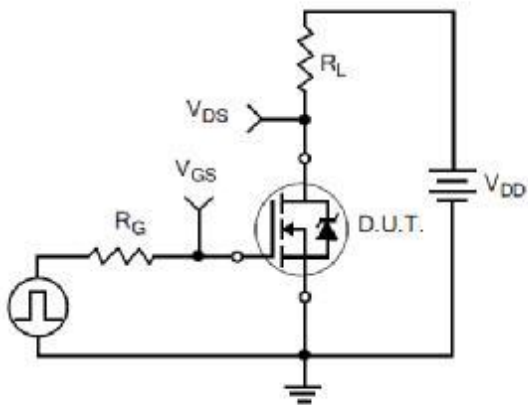


Figure 19. Resistive Switching Test Circuit

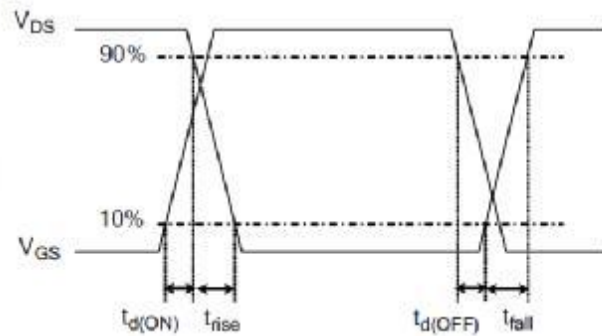


Figure 20. Resistive Switching Waveforms

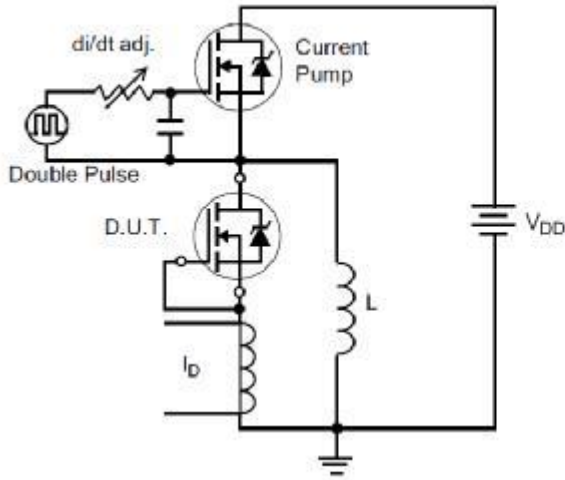


Figure 21. Diode Reverse Recovery Test Circuit

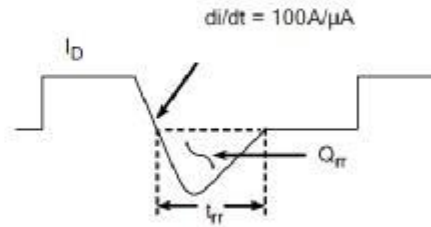


Figure 22. Diode Reverse Recovery Waveform

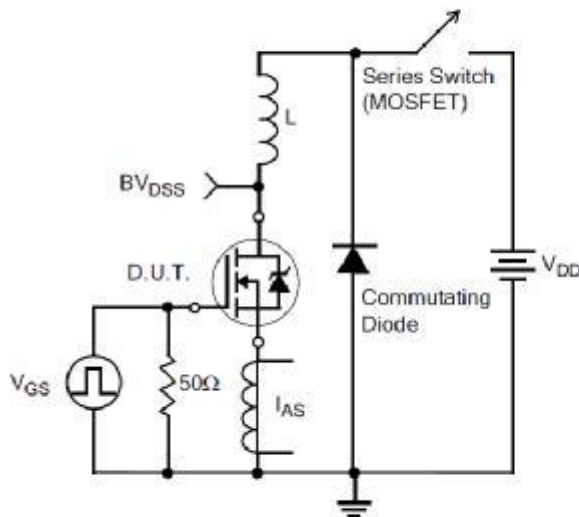


Figure 23. Unclamped Inductive Switching Test Circuit

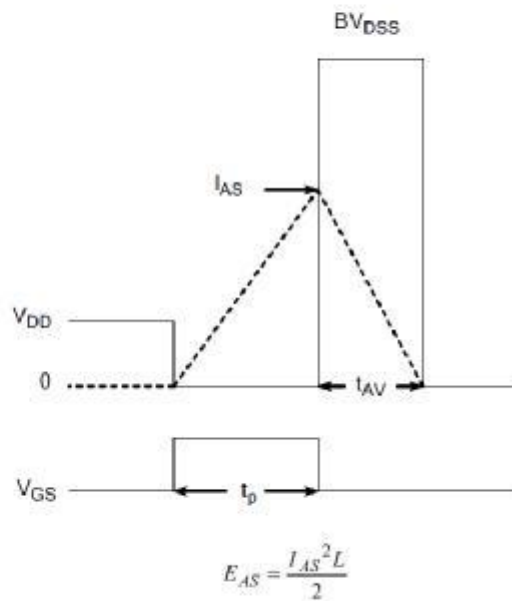


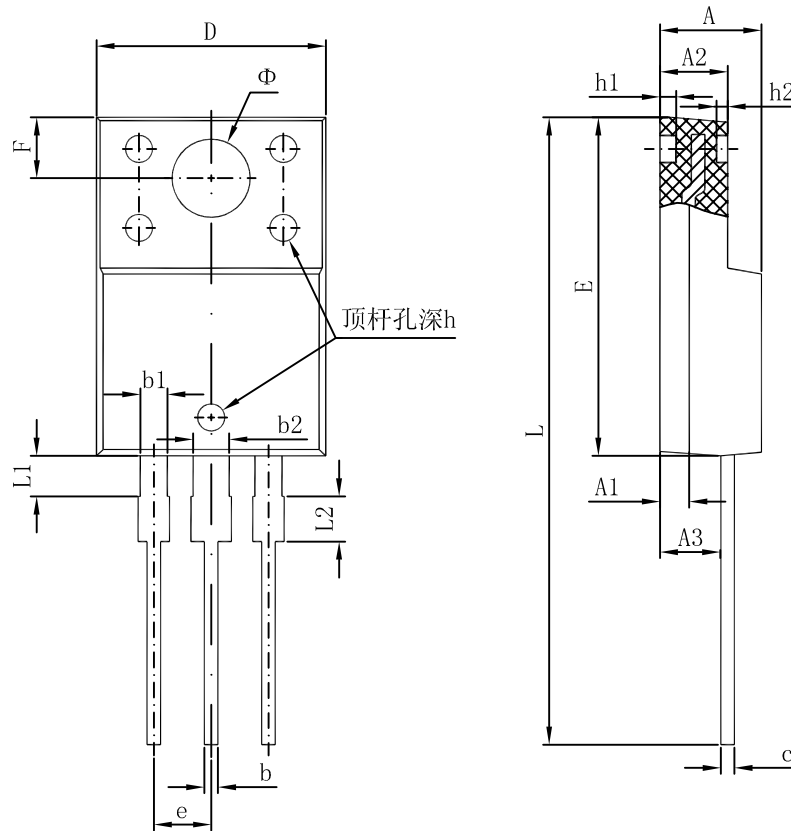
Figure 24. Unclamped Inductive Switching Waveforms





## Package Information

### TO-220F



| Symbol | Dimensions In Millimeters |        | Dimensions In Inches |       |
|--------|---------------------------|--------|----------------------|-------|
|        | Min.                      | Max.   | Min.                 | Max.  |
| A      | 4.300                     | 4.700  | 0.169                | 0.185 |
| A1     | 1.300 REF.                |        | 0.051 REF.           |       |
| A2     | 2.800                     | 3.200  | 0.110                | 0.126 |
| A3     | 2.500                     | 2.900  | 0.098                | 0.114 |
| b      | 0.500                     | 0.750  | 0.020                | 0.030 |
| b1     | 1.100                     | 1.350  | 0.043                | 0.053 |
| b2     | 1.500                     | 1.750  | 0.059                | 0.069 |
| c      | 0.500                     | 0.750  | 0.020                | 0.030 |
| D      | 9.960                     | 10.360 | 0.392                | 0.408 |
| E      | 14.800                    | 15.200 | 0.583                | 0.598 |
| e      | 2.540 TYP.                |        | 0.100 TYP.           |       |
| F      | 2.700 REF.                |        | 0.106 REF.           |       |
| Φ      | 3.500 REF.                |        | 0.138 REF.           |       |
| h      | 0.000                     | 0.300  | 0.000                | 0.012 |
| h1     | 0.800 REF.                |        | 0.031 REF.           |       |
| h2     | 0.500 REF.                |        | 0.020 REF.           |       |
| L      | 28.000                    | 28.400 | 1.102                | 1.118 |
| L1     | 1.700                     | 1.900  | 0.067                | 0.075 |
| L2     | 1.900                     | 2.100  | 0.075                | 0.083 |



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