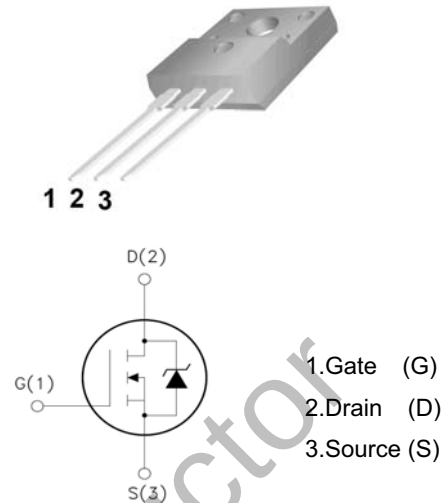


**FQPF12N60SE****Features:**

- ☐ Low Intrinsic Capacitances
- ☐ Excellent Switching Characteristics
- ☐ Extended Safe Operating Area
- ☐ Unrivalled Gate Charge :Qg= 44nC (Typ.)
- ☐ BVDSS=650V,ID=12A
- ☐  $R_{DS(on)}$  :0.68  $\Omega$  (Max) @VG=10V
- ☐ 100% Avalanche Tested

TO-220F

**Absolute Maximum Ratings** (Ta=25°C unless otherwise noted)

| Symbol       | Parameter                                                                           | Value                   | Unit             |
|--------------|-------------------------------------------------------------------------------------|-------------------------|------------------|
| $V_{DSS}$    | Drain-Source Voltage                                                                | 650                     | V                |
| $I_D$        | Drain Current                                                                       | $T_j=25^\circ\text{C}$  | A                |
|              |                                                                                     | $T_j=100^\circ\text{C}$ |                  |
| $V_{GS(TH)}$ | Gate Threshold Voltage                                                              | $\pm 30$                | V                |
| $E_{AS}$     | Single Pulse Avalanche Energy (note1)                                               | 660                     | mJ               |
| $I_{AR}$     | Avalanche Current (note2)                                                           | 12                      | A                |
| $P_D$        | Power Dissipation ( $T_j=25^\circ\text{C}$ )                                        | 44                      | W                |
| $T_j$        | Junction Temperature(Max)                                                           | 150                     | $^\circ\text{C}$ |
| $T_{stg}$    | Storage Temperature                                                                 | -55~+150                | $^\circ\text{C}$ |
| TL           | Maximum lead temperature for soldering purpose, 1/8 $\mu$ S from case for 5 seconds | 300                     | $^\circ\text{C}$ |

**Thermal Characteristics**

| Symbol          | Parameter                               | Typ. | Max. | Unit               |
|-----------------|-----------------------------------------|------|------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case    | -    | 2.8  | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient | -    | 62.5 | $^\circ\text{C/W}$ |

**Electrical Characteristics** (Ta=25°C unless otherwise noted)

| Symbol                                                 | Parameter                                 | Test Condition                                                                | Min. | Typ. | Max. | Unit |
|--------------------------------------------------------|-------------------------------------------|-------------------------------------------------------------------------------|------|------|------|------|
| Off Characteristics                                    |                                           |                                                                               |      |      |      |      |
| BV <sub>DSS</sub>                                      | Drain-Source Breakdown Voltage            | I <sub>D</sub> =250μA , V <sub>GS</sub> =0                                    | 650  | -    | -    | V    |
| △BVDSS/△T <sub>J</sub>                                 | Breakdown Voltage Temperature Coefficient | I <sub>D</sub> =250μA ,Reference to 25°C                                      | -    | 0.71 | -    | V/°C |
| I <sub>DSS</sub>                                       | Zero Gate Voltage Drain Current           | V <sub>DS</sub> =650V, V <sub>GS</sub> =0V                                    | -    | -    | 10   | μA   |
|                                                        |                                           | V <sub>DS</sub> =520V, T <sub>j</sub> =125°C                                  |      |      | 100  |      |
| I <sub>GSSF</sub>                                      | Gate-body leakage Current, Forward        | V <sub>GS</sub> =+30V, V <sub>DS</sub> =0V                                    | -    | -    | 100  | nA   |
| I <sub>GSSR</sub>                                      | Gate-body leakage Current, Reverse        | V <sub>GS</sub> =-30V, V <sub>DS</sub> =0V                                    | -    | -    | -100 |      |
| On Characteristics                                     |                                           |                                                                               |      |      |      |      |
| V <sub>GS(TH)</sub>                                    | Date Threshold Voltage                    | I <sub>D</sub> =250μA,V <sub>DS</sub> =V <sub>GS</sub>                        | 2    | -    | 4    | V    |
| R <sub>DS(ON)</sub>                                    | Static Drain-Source On-Resistance         | I <sub>D</sub> =6.0A,V <sub>GS</sub> =10V                                     | -    | -    | 0.68 | Ω    |
| Dynamic Characteristics                                |                                           |                                                                               |      |      |      |      |
| C <sub>iss</sub>                                       | Input Capacitance                         | V <sub>DS</sub> =25V , V <sub>GS</sub> =0 , f=1.0MHz                          | -    | 1890 | -    | pF   |
| C <sub>oss</sub>                                       | Output Capacitance                        |                                                                               | -    | 150  | -    |      |
| C <sub>rss</sub>                                       | Reverse Transfer Capacitance              |                                                                               | -    | 18   | -    |      |
| Switching Characteristics                              |                                           |                                                                               |      |      |      |      |
| T <sub>d(on)</sub>                                     | Turn-On Delay Time                        | V <sub>DD</sub> =300V , I <sub>D</sub> =12A<br>R <sub>G</sub> =25Ω (Note 3,4) | -    | 30   | 70   | ns   |
| Tr                                                     | Turn-OnRise Time                          |                                                                               | -    | 80   | 165  |      |
| T <sub>d(off)</sub>                                    | Turn-Off Delay Time                       |                                                                               | -    | 144  | 300  |      |
| T <sub>f</sub>                                         | Turn-Off Rise Time                        |                                                                               | -    | 77   | 165  |      |
| Q <sub>g</sub>                                         | Total Gate Charge                         | V <sub>DS</sub> =520V,V <sub>GS</sub> =10V , I <sub>D</sub> =12A (Note 3,4)   | -    | 44   | 47   | nC   |
| Q <sub>gs</sub>                                        | Gate-Source Charge                        |                                                                               | -    | 6.7  | -    |      |
| Q <sub>gd</sub>                                        | Gate-Drain Charge                         |                                                                               | -    | 18.5 | -    |      |
| Drain-Source Diode Characteristics and Maximum Ratings |                                           |                                                                               |      |      |      |      |
| I <sub>s</sub>                                         | Max. Diode Forward Current                | -                                                                             | -    | -    | 12   | A    |
| I <sub>SM</sub>                                        | Max. Pulsed Forward Current               | -                                                                             | -    | -    | 48   |      |
| V <sub>SD</sub>                                        | Diode Forward Voltage                     | I <sub>D</sub> =12A                                                           | -    | -    | 1.4  | V    |
| Trr                                                    | Reverse Recovery Time                     | I <sub>S</sub> =12A,V <sub>GS</sub> =0V<br>diF/dt=100A/μs                     | -    | 380  | -    | nS   |
| Qrr                                                    | Reverse Recovery Charge                   | (Note3)                                                                       | -    | 3.5  | -    | μC   |

Notes : 1, L=0.5mH, IAS=12A, VDD=50V, RG=25 $\Omega$ , Starting T<sub>J</sub> =25°C

2, Repetitive Rating : Pulse width limited by maximum junction temperature

3, Pulse Test : Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ 

4, Essentially Independent of Operating Temperature

# Typical Characteristics

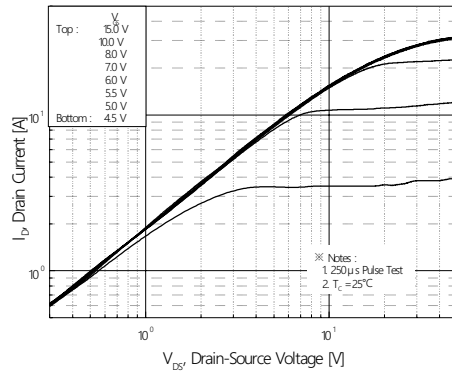


Figure 1. On-Region Characteristics

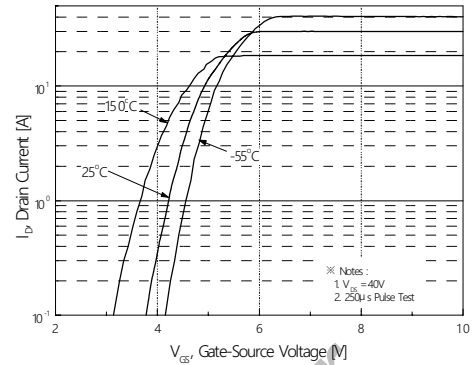


Figure 2. Transfer Characteristics

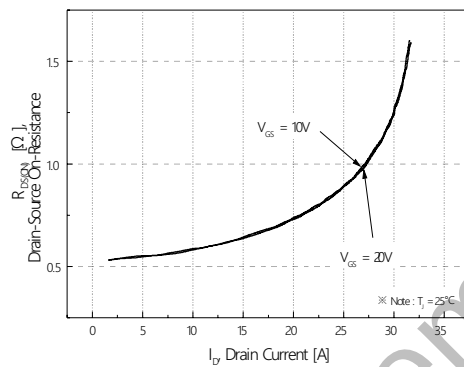


Figure 3. On-Resistance Variation vs Drain Current and Gate Voltage

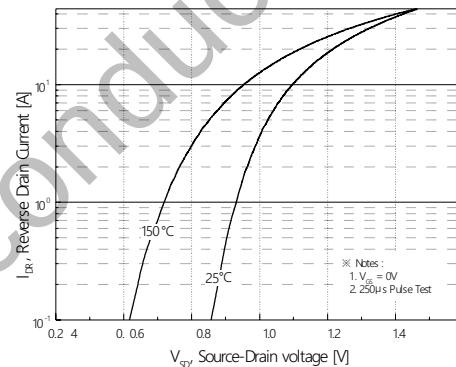


Figure 4. Body Diode Forward Voltage Variation with Source Current and Temperature

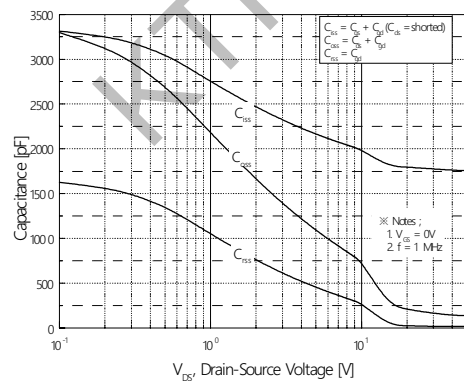


Figure 5. Capacitance Characteristics

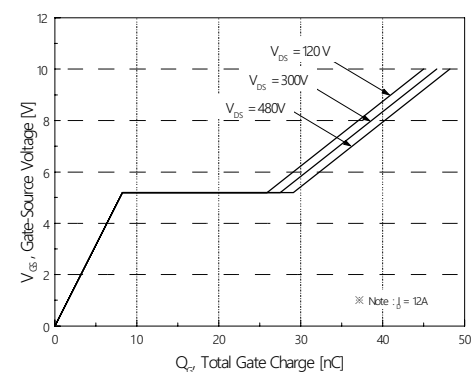


Figure 6. Gate Charge Characteristics

Typical Characteristics (Continued)

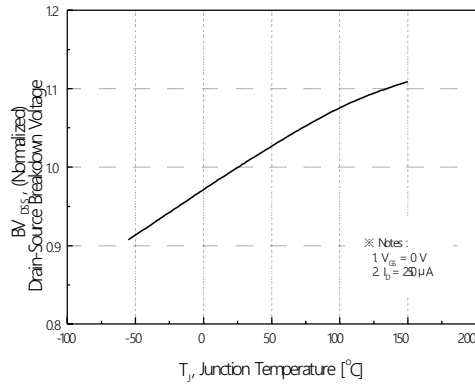


Figure 7. Breakdown Voltage Variation vs Temperature

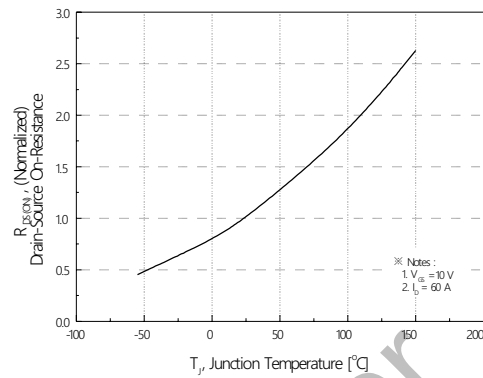


Figure 8. On-Resistance Variation vs Temperature

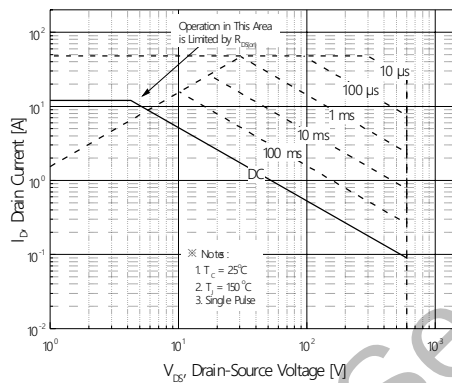


Figure 9-2. Maximum Safe Operating Area

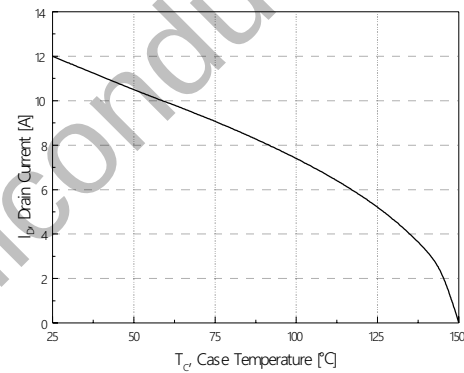


Figure 10. Maximum Drain Current vs Case Temperature

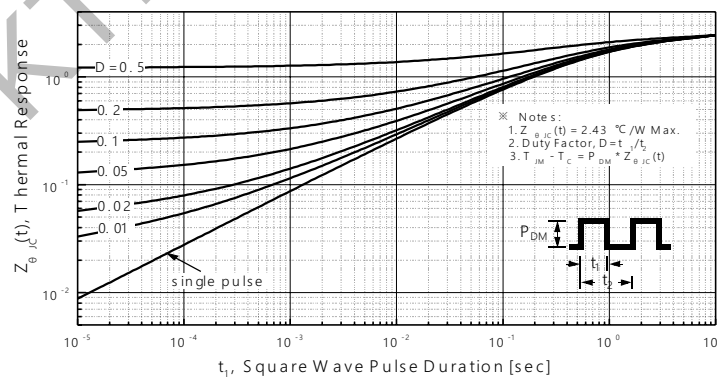
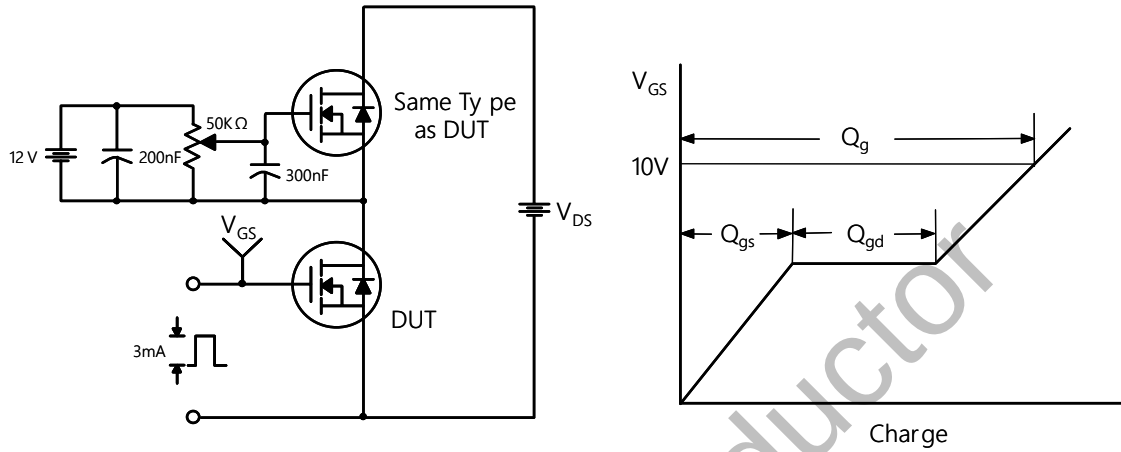
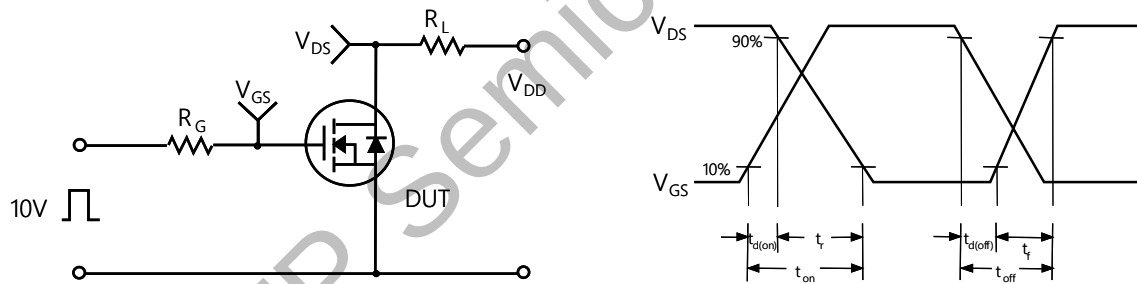


Figure 11-2. Transient Thermal Response Curve

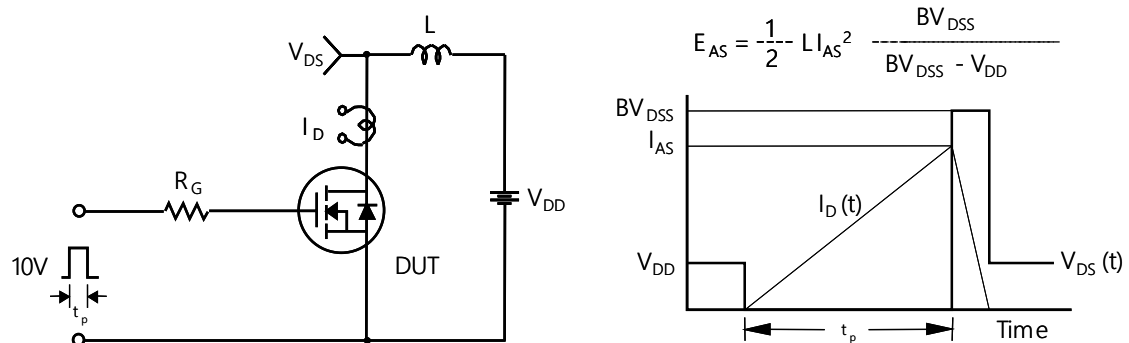
Gate Charge Test Circuit & Waveform



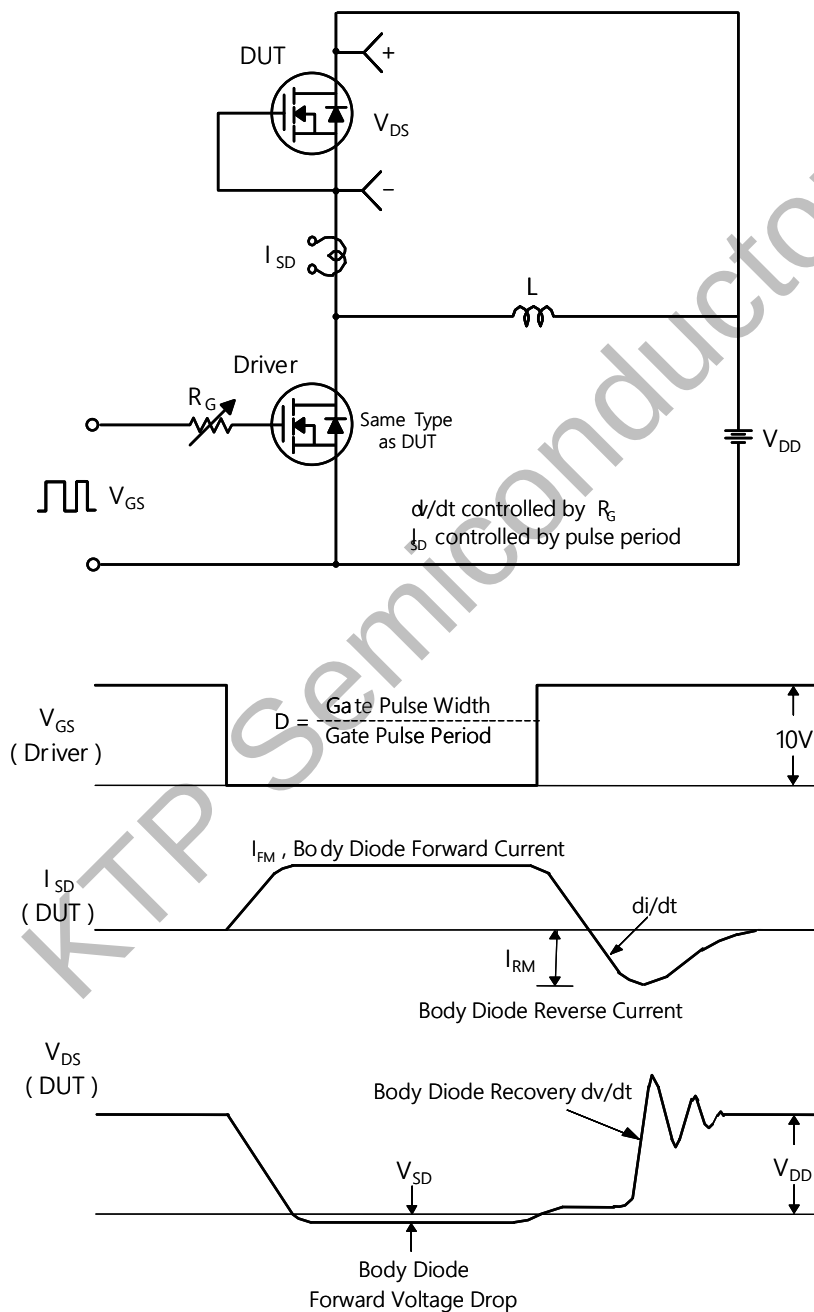
Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching Test Circuit & Waveforms



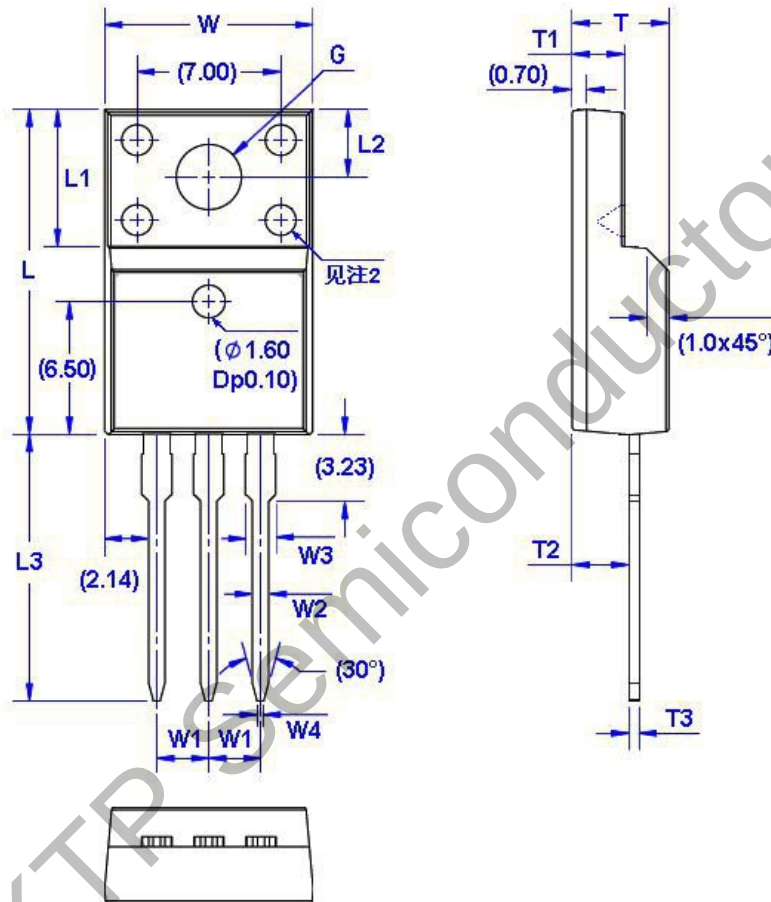
Peak Diode Recovery dv/dt Test Circuit & Waveforms



## Package Dimension

TO-220F

Unit: mm



| Symbol | Size       |       | Symbol | Size  |       | Symbol | Size  |       | Symbol | Size |      |
|--------|------------|-------|--------|-------|-------|--------|-------|-------|--------|------|------|
|        | Min        | Max   |        | Min   | Max   |        | Min   | Max   |        | Min  | Max  |
| W      | 9.96       | 10.36 | W4     | 0.25  | 0.45  | L3     | 12.78 | 13.18 | T3     | 0.45 | 0.60 |
| W1     | 2.54 (TYP) |       | L      | 15.67 | 16.07 | T      | 4.50  | 4.90  | G(Φ)   | 3.08 | 3.28 |
| W2     | 0.70       | 0.90  | L1     | 6.48  | 6.88  | T1     | 2.34  | 2.74  |        |      |      |
| W3     | 1.24       | 1.47  | L2     | 3.20  | 3.40  | T2     | 2.56  | 2.96  |        |      |      |