

## FCP11N60/FCPF11N60

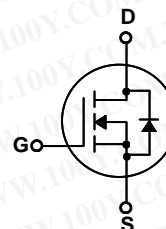
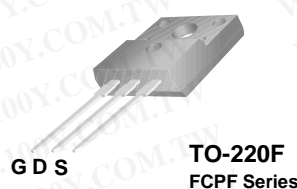
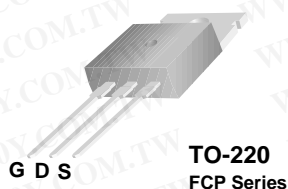
### General Description

SuperFET™ is a new generation of high voltage MOSFETs from Fairchild with outstanding low on-resistance and low gate charge performance, a result of proprietary technology utilizing advanced charge balance mechanisms.

This advanced technology has been tailored to minimize conduction loss, provide superior switching performance, and withstand extreme dv/dt rate and higher avalanche energy. Consequently, SuperFET is very suitable for various AC/DC power conversion in switching mode operation for system miniaturization and higher efficiency.

### Features

- 650V @ $T_j = 150^\circ\text{C}$
- Typ.  $R_{ds(on)} = 0.32\Omega$
- Ultra low gate charge (typ.  $Q_g = 40\text{nC}$ )
- Low effective output capacitance (typ.  $C_{oss,eff} = 95\text{pF}$ )
- 100% avalanche tested
- RoHS Compliant



### Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ unless otherwise noted

| Symbol         | Parameter   | FCP11N60    | FCPF11N60 | Units               |
|----------------|---|-------------|-----------|---------------------|
| $I_D$          | Drain Current - Continuous ( $T_C = 25^\circ\text{C}$ )                       | 11          | 11*       | A                   |
|                | - Continuous ( $T_C = 100^\circ\text{C}$ )                                    | 7           | 7*        | A                   |
| $I_{DM}$       | Drain Current - Pulsed (Note 1)   | 33          | 33*       | A                   |
| $V_{GSS}$      | Gate-Source Voltage   | $\pm 30$    |           | V                   |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                                       | 340         |           | mJ                  |
| $I_{AR}$       | Avalanche Current (Note 1)  | 11          |           | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)  | 12.5        |           | mJ                  |
| dv/dt          | Peak Diode Recovery dv/dt (Note 3)  | 4.5         |           | V/ns                |
| $P_D$          | Power Dissipation ( $T_C = 25^\circ\text{C}$ )                                | 125         | 36        | W                   |
|                | - Derate above $25^\circ\text{C}$   | 1.0         | 0.29      | W/ $^\circ\text{C}$ |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                                       | -55 to +150 |           | $^\circ\text{C}$    |
| $T_L$          | Maximum lead temperature for soldering purposes, 1/8" from case for 5 seconds | 300         |           | $^\circ\text{C}$    |

\* Drain current limited by maximum junction temperature

### Thermal Characteristics

| Symbol          | Parameter                               | FCP11N60 | FCPF11N60 | Units                     |
|-----------------|---|----------|-----------|---------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case    | 1.0      | 3.5       | $^\circ\text{C}/\text{W}$ |
| $R_{\theta CS}$ | Thermal Resistance, Case-to-Sink        | 0.5      | --        | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | 62.5     | 62.5      | $^\circ\text{C}/\text{W}$ |

## Electrical Characteristics

$T_C = 25^\circ\text{C}$  unless otherwise noted

| Symbol                         | Parameter                                 | Test Conditions  | Min | Typ | Max  | Units                     |
|--------------------------------|---|--|-----|-----|------|---------------------------|
| <b>Off Characteristics</b>     |   |  |     |     |      |                           |
| $BV_{DSS}$                     | Drain-Source Breakdown Voltage            | $V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}, T_J = 25^\circ\text{C}$  | 600 | --  | --   | V                         |
|                                |   | $V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}, T_J = 150^\circ\text{C}$ | --  | 650 | --   | V                         |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$            | --  | 0.6 | --   | $\text{V}/^\circ\text{C}$ |
| $BV_{DS}$                      | Drain-Source Avalanche Breakdown Voltage  | $V_{GS} = 0\text{ V}, I_D = 11\text{ A}$                               | --  | 700 | --   | V                         |
| $I_{DSS}$                      | Zero Gate Voltage Drain Current           | $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$                           | --  | --  | 1    | $\mu\text{A}$             |
|                                |   | $V_{DS} = 480\text{ V}, T_C = 125^\circ\text{C}$                       | --  | --  | 10   | $\mu\text{A}$             |
| $I_{GSSF}$                     | Gate-Body Leakage Current, Forward        | $V_{GS} = 30\text{ V}, V_{DS} = 0\text{ V}$                            | --  | --  | 100  | nA                        |
| $I_{GSSR}$                     | Gate-Body Leakage Current, Reverse        | $V_{GS} = -30\text{ V}, V_{DS} = 0\text{ V}$                           | --  | --  | -100 | nA                        |

### On Characteristics

|              |                                   |   |     |      |      |          |
|--------------|-----------------------------------|---|-----|------|------|----------|
| $V_{GS(th)}$ | Gate Threshold Voltage            | $V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$           | 3.0 | --   | 5.0  | V        |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS} = 10\text{ V}, I_D = 5.5\text{ A}$          | --  | 0.32 | 0.38 | $\Omega$ |
| $g_{FS}$     | Forward Transconductance          | $V_{DS} = 40\text{ V}, I_D = 5.5\text{ A}$ (Note 4) | --  | 9.7  | --   | S        |

### Dynamic Characteristics

|                       |                              |   |    |      |      |    |
|-----------------------|------------------------------|---|----|------|------|----|
| $C_{iss}$             | Input Capacitance            | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$  | -- | 1148 | 1490 | pF |
| $C_{oss}$             | Output Capacitance           |   | -- | 671  | 870  | pF |
| $C_{riss}$            | Reverse Transfer Capacitance |   | -- | 63   | 82   | pF |
| $C_{oss}$             | Output Capacitance           | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$ | -- | 35   | --   | pF |
| $C_{oss\text{ eff.}}$ | Effective Output Capacitance | $V_{DS} = 0\text{ V to } 480\text{ V}, V_{GS} = 0\text{ V}$           | -- | 95   | --   | pF |

### Switching Characteristics

|              |                     |   |             |     |     |     |
|--------------|---------------------|---|-------------|-----|-----|-----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 300\text{ V}, I_D = 11\text{ A},$<br>$R_G = 25\ \Omega$     | --          | 34  | 80  | ns  |
| $t_r$        | Turn-On Rise Time   |   | --          | 98  | 205 | ns  |
| $t_{d(off)}$ | Turn-Off Delay Time |   | --          | 119 | 250 | ns  |
| $t_f$        | Turn-Off Fall Time  |   | (Note 4, 5) | --  | 56  | 120 |
| $Q_g$        | Total Gate Charge   | $V_{DS} = 480\text{ V}, I_D = 11\text{ A},$<br>$V_{GS} = 10\text{ V}$ | --          | 40  | 52  | nC  |
| $Q_{gs}$     | Gate-Source Charge  |   | --          | 7.2 | --  | nC  |
| $Q_{gd}$     | Gate-Drain Charge   |   | (Note 4, 5) | --  | 21  | --  |

### Drain-Source Diode Characteristics and Maximum Ratings

|          |   |   |    |     |     |               |
|----------|---|---|----|-----|-----|---------------|
| $I_S$    | Maximum Continuous Drain-Source Diode Forward Current | --  | -- | 11  | A   |               |
| $I_{SM}$ | Maximum Pulsed Drain-Source Diode Forward Current     | --  | -- | 33  | A   |               |
| $V_{SD}$ | Drain-Source Diode Forward Voltage                    | $V_{GS} = 0\text{ V}, I_S = 11\text{ A}$        | -- | --  | 1.4 | V             |
| $t_{rr}$ | Reverse Recovery Time                                 | $V_{GS} = 0\text{ V}, I_S = 11\text{ A},$       | -- | 390 | --  | ns            |
| $Q_{rr}$ | Reverse Recovery Charge                               | $di_F / dt = 100\text{ A}/\mu\text{s}$ (Note 4) | -- | 5.7 | --  | $\mu\text{C}$ |

#### Notes:

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2.  $I_{AS} = 5.5\text{ A}, V_{DD} = 50\text{ V}, R_G = 25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq 11\text{ A}, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$  Starting  $T_J = 25^\circ\text{C}$
4. Pulse Test : Pulse width  $\leq 300\ \mu\text{s}$ , Duty cycle  $\leq 2\%$
5. Essentially independent of operating temperature

Typical Characteristics

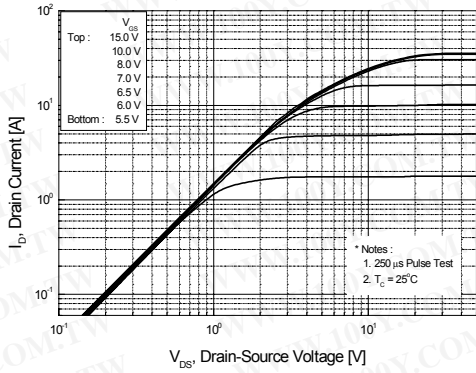


Figure 1. On-Region Characteristics

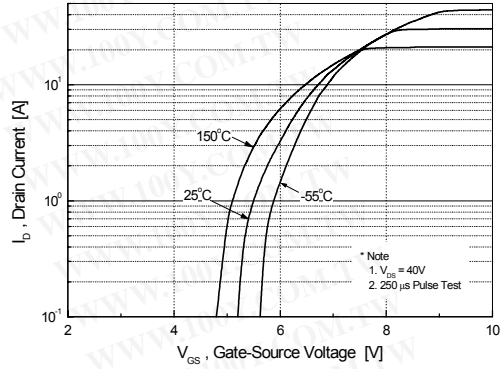


Figure 2. Transfer Characteristics

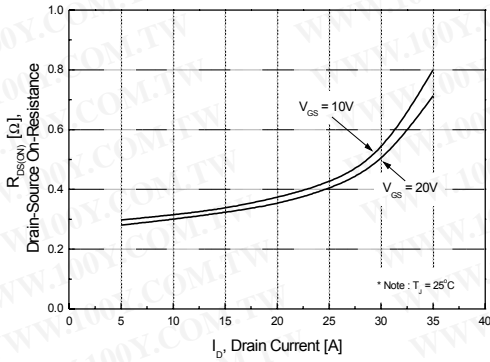


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

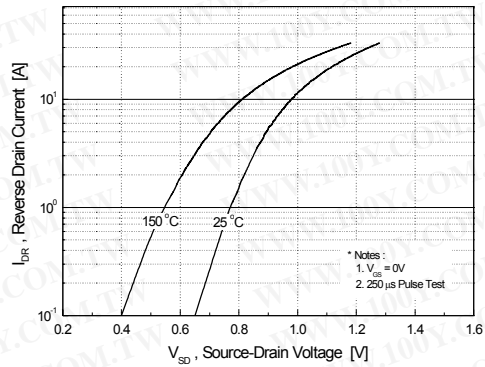


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

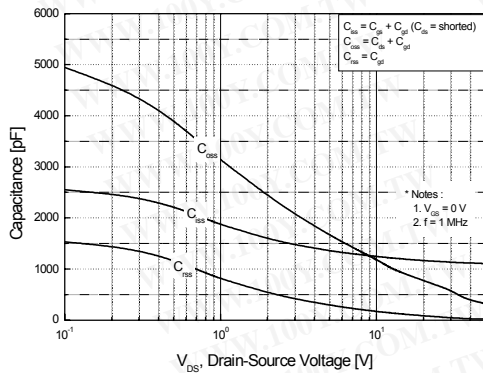


Figure 5. Capacitance Characteristics

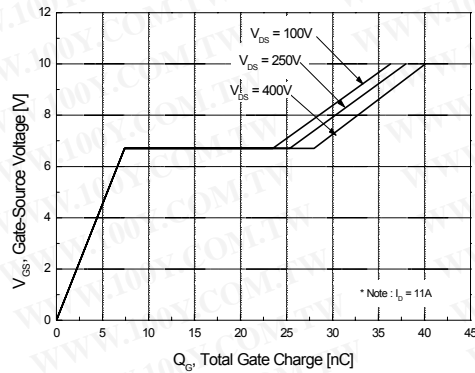


Figure 6. Gate Charge Characteristics

Typical Characteristics (Continued)

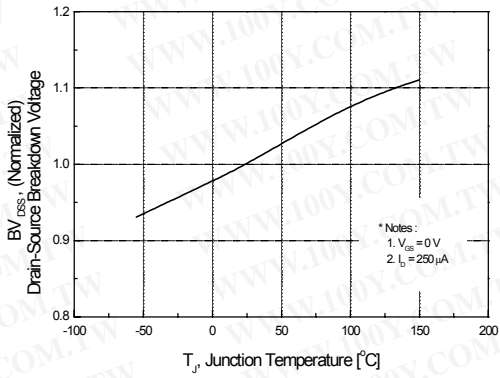


Figure 7. Breakdown Voltage Variation vs. Temperature

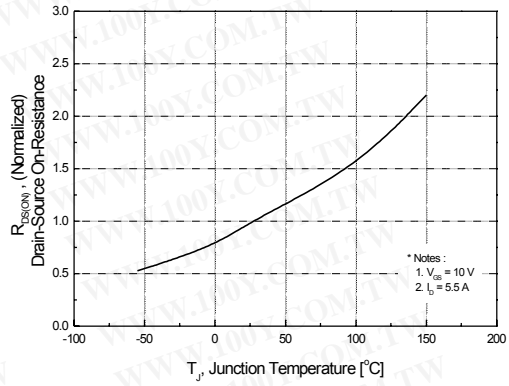


Figure 8. On-Resistance Variation vs. Temperature

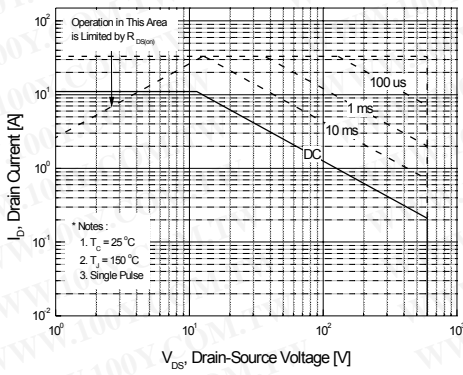


Figure 9-1. Maximum Safe Operating Area for FCP11N60

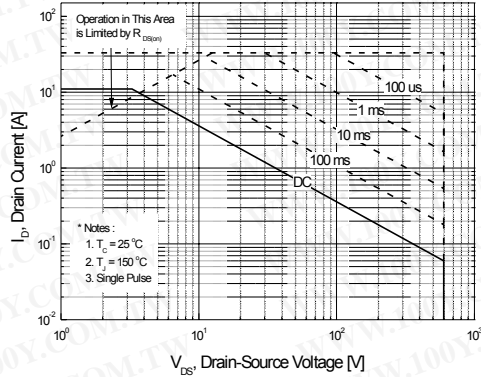


Figure 9-2. Maximum Safe Operating Area for FCPF11N60

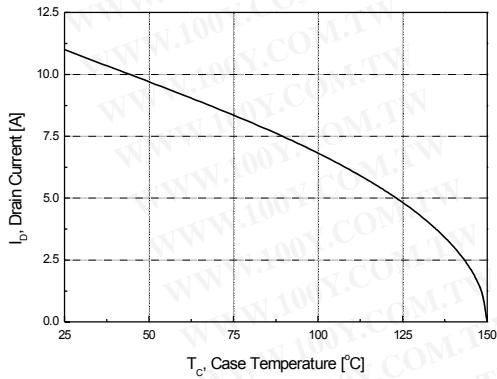


Figure 10. Maximum Drain Current vs. Case Temperature

Typical Characteristics (Continued)

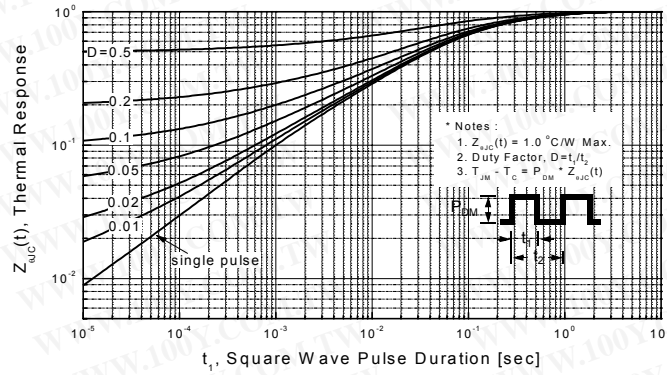


Figure 11-1. Transient Thermal Response Curve for FCP11N60

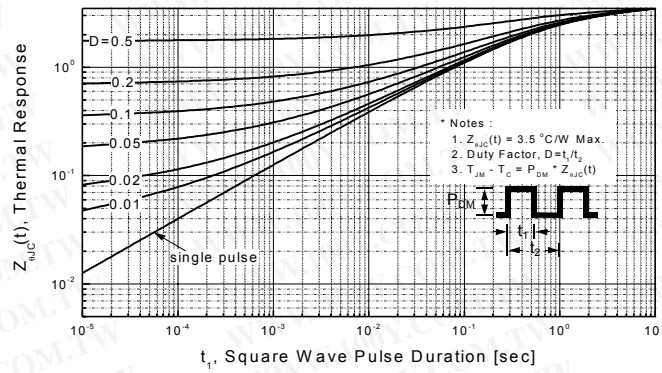
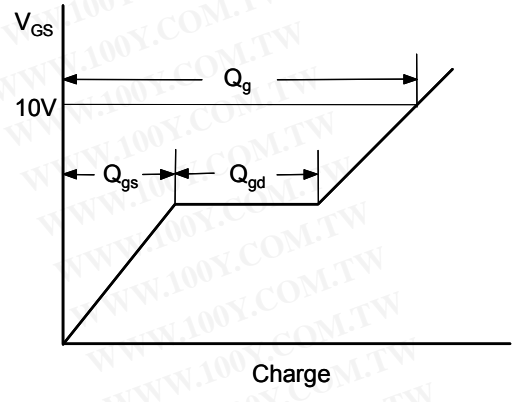
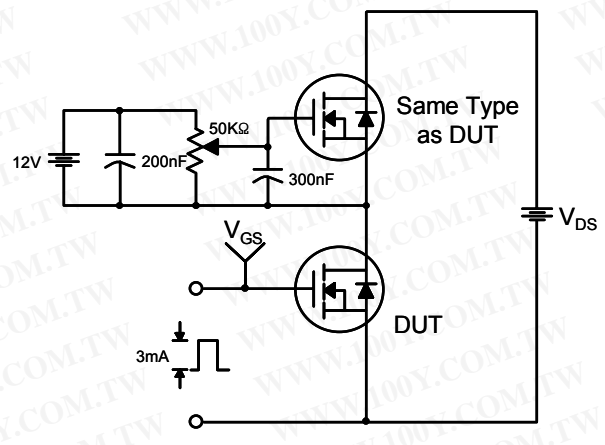
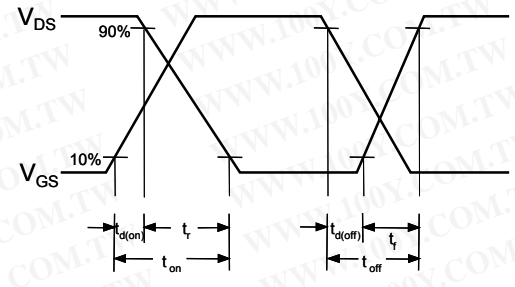
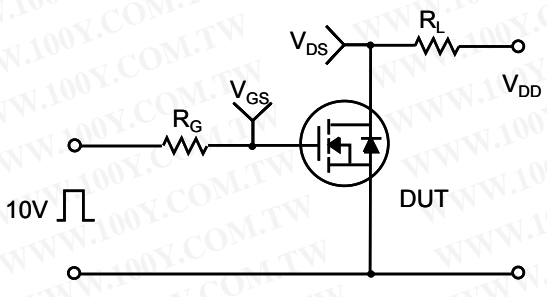


Figure 11-2. Transient Thermal Response Curve for FCPF11N60

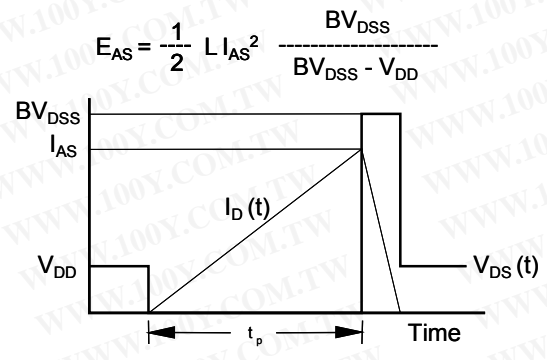
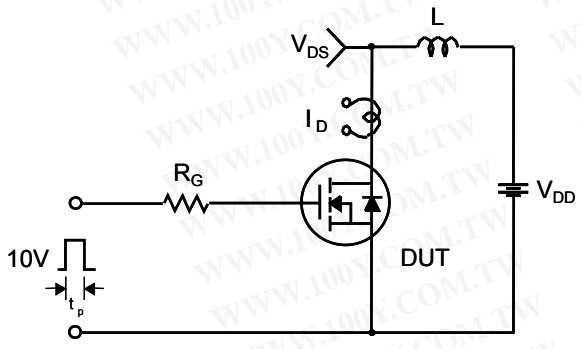
Gate Charge Test Circuit & Waveform



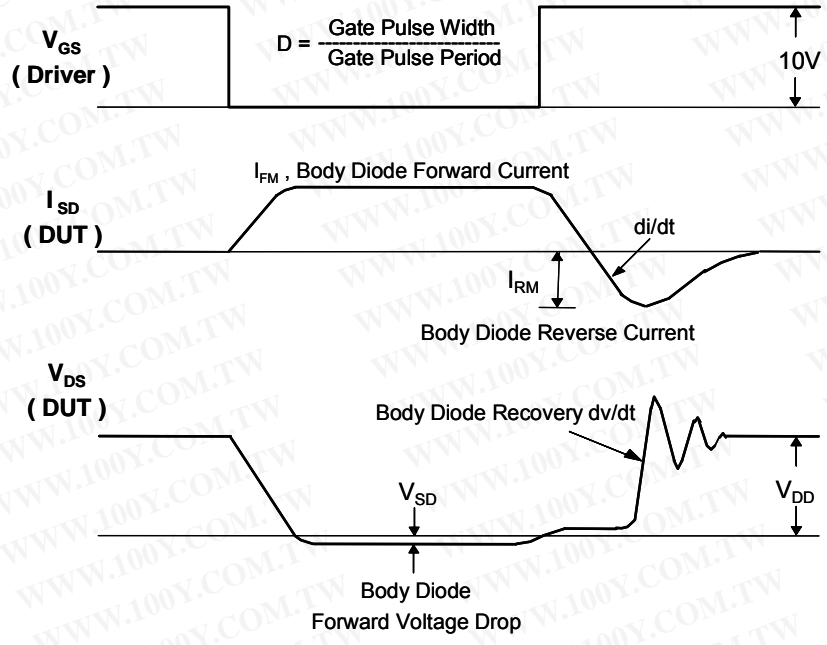
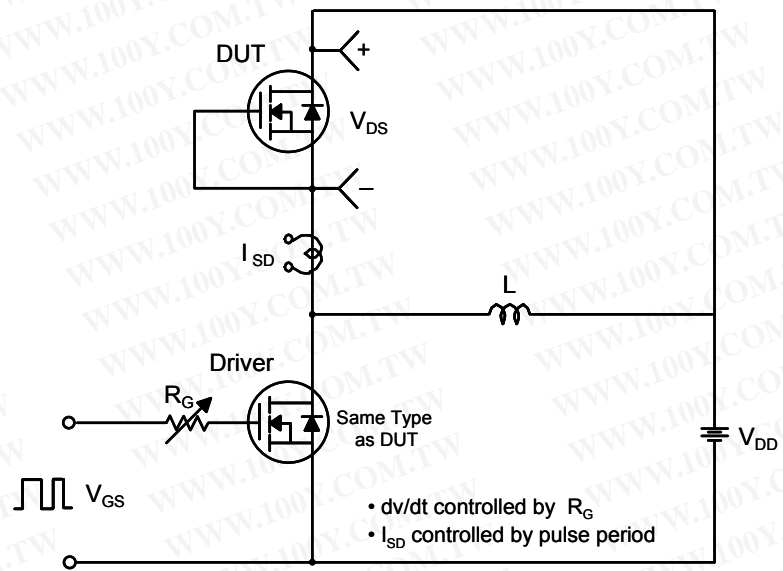
Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching Test Circuit & Waveforms



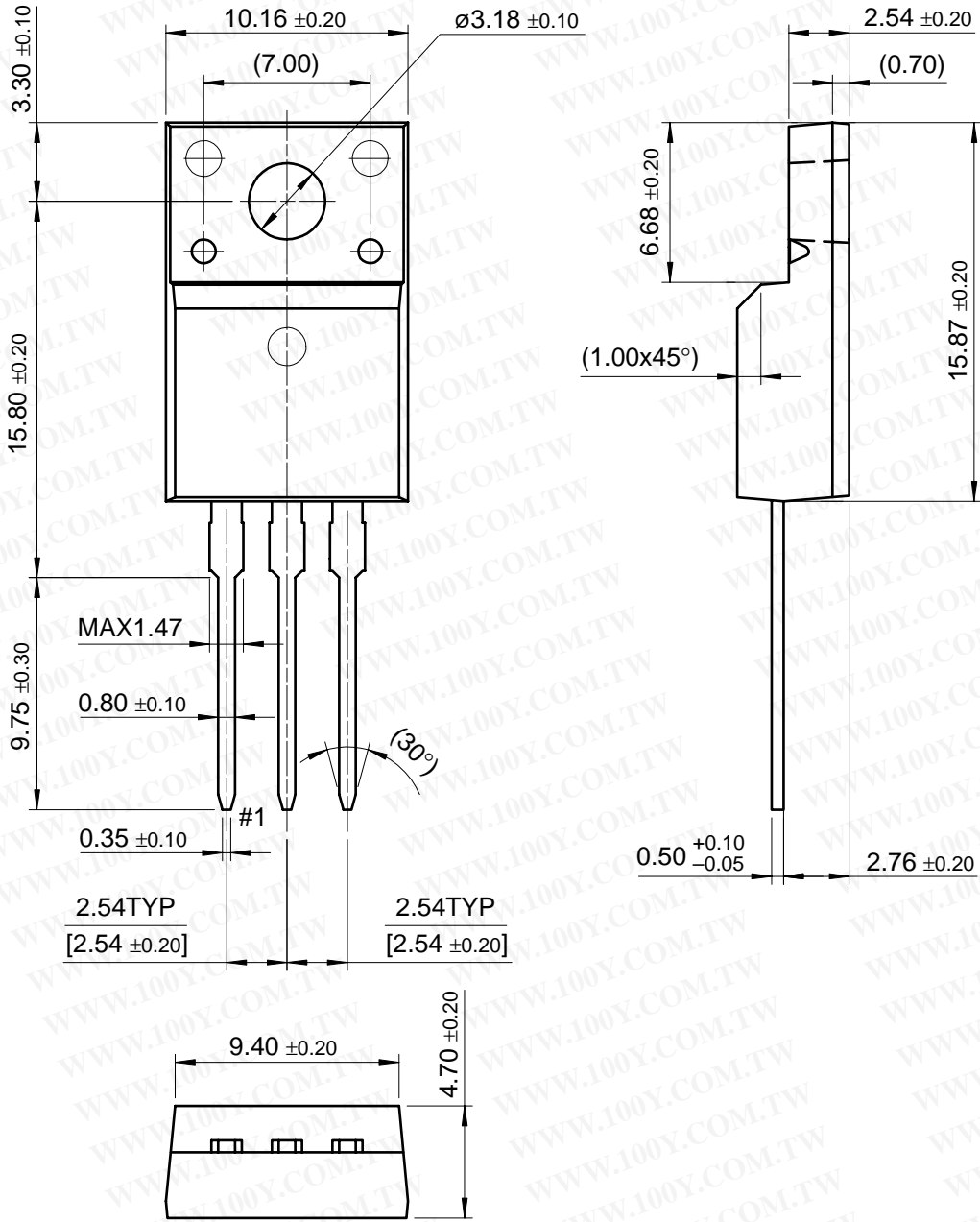
Peak Diode Recovery dv/dt Test Circuit & Waveforms





# Package Dimensions

## TO-220F



FCP11N60/FCPF11N60

Dimensions in Millimeters

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