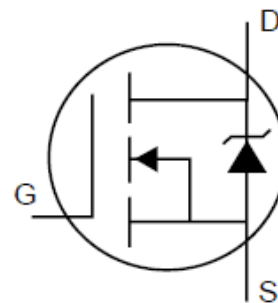
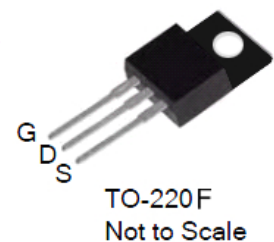
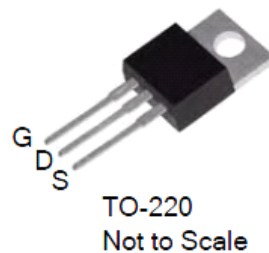


## 600V N-Channel MOSFET GENERAL DESCRIPTION

This Power MOSFET is produced using advanced planar stripe DMOS technology. This advanced technology has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulse in the avalanche and commutation mode. These devices are well suited for high efficiency switched mode power supplies, active power factor correction based on half bridge topology.

| $V_{DSS}$ | $R_{DS(ON)}$ | $I_D$ |
|-----------|--------------|-------|
| 600V      | 0.65Ω        | 12A   |



## Features

- 12A, 600V,  $R_{DS(on)} = 0.65\Omega$  @  $V_{GS} = 10V$
- Low gate charge ( typical 52nC)
- Fast switching
- 100% avalanche tested
- Improved dv/dt capability

## Ordering Information

| PART NUMBER  | PACKAGE     | BRAND |
|--------------|-------------|-------|
| 12N60/12N60F | TO-220/220F | 0GFD  |

## Absolute Maximum Ratings

TC = 25°C unless otherwise noted

| Symbol                            | Parameter                                                                     | 12N60       | 12N60F | Units |
|-----------------------------------|-------------------------------------------------------------------------------|-------------|--------|-------|
| V <sub>DSS</sub>                  | Drain-Source Voltage                                                          | 600         |        | V     |
| I <sub>D</sub>                    | Drain Current - Continuous (TC = 25°C)                                        | 12          | 12     | A     |
|                                   | - Continuous (TC = 100°C)                                                     | 7.4         | 7.4    | A     |
| I <sub>DM</sub>                   | Drain Current- Pulsed (Note 1)                                                | 48          | 48     | A     |
| V <sub>GSS</sub>                  | Gate-Source Voltage                                                           | ± 30        |        | V     |
| E <sub>AS</sub>                   | Single Pulsed Avalanche Energy (Note 2)                                       | 865         |        | mJ    |
| E <sub>AR</sub>                   | Repetitive Avalanche Energy (Note 1)                                          | 23.1        |        | mJ    |
| dv/dt                             | Peak Diode Recovery dv/dt (Note 3)                                            | 4.5         |        | V/ns  |
| P <sub>D</sub>                    | Power Dissipation (TC = 25°C)                                                 | 231         | 54     | W     |
|                                   | Derate above 25°C                                                             | 1.85        | 0.43   | W/°C  |
| T <sub>J</sub> , T <sub>STG</sub> | Operating and Storage Temperature Range                                       | -55 to +150 |        | °C    |
| T <sub>L</sub>                    | Maximum lead temperature for soldering purposes, 1/8" from case for 5 seconds | 300         |        | °C    |

## Thermal Characteristics

| Symbol           | Parameter                               | 12N60 | 12N60F | Units |
|------------------|-----------------------------------------|-------|--------|-------|
| R <sub>θJC</sub> | Thermal Resistance, Junction-to-Case    | 0.54  | 2.33   | °C/W  |
| R <sub>θCS</sub> | Thermal Resistance, Case-to-Sink Typ.   | 0.5   | --     | °C/W  |
| R <sub>θJA</sub> | Thermal Resistance, Junction-to-Ambient | 62.5  | 62.5   | °C/W  |

**Electrical Characteristics**

TC = 25°C unless otherwise noted

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|--------|-----------|-----------------|-----|-----|-----|-------|
|--------|-----------|-----------------|-----|-----|-----|-------|

**Off Characteristics**

|                                     |                                           |                                                 |     |     |      |      |
|-------------------------------------|-------------------------------------------|-------------------------------------------------|-----|-----|------|------|
| BV <sub>DSS</sub>                   | Drain-Source Breakdown Voltage            | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA  | 600 | --  | --   | V    |
| ΔBV <sub>DSS</sub> /ΔT <sub>J</sub> | Breakdown Voltage Temperature Coefficient | I <sub>D</sub> = 250 μA, Referenced to 25°C     | --  | 0.7 | --   | V/°C |
| I <sub>DSS</sub>                    | Zero Gate Voltage Drain Current           | V <sub>DS</sub> = 600 V, V <sub>GS</sub> = 0 V  | --  | --  | 1    | μA   |
|                                     |                                           | V <sub>DS</sub> = 480 V, T <sub>C</sub> = 125°C | --  | --  | 10   | μA   |
| I <sub>GSSF</sub>                   | Gate-Body Leakage Current, Forward        | V <sub>GS</sub> = 30 V, V <sub>DS</sub> = 0 V   | --  | --  | 100  | nA   |
| I <sub>GSSR</sub>                   | Gate-Body Leakage Current, Reverse        | V <sub>GS</sub> = -30 V, V <sub>DS</sub> = 0 V  | --  | --  | -100 | nA   |

**On Characteristics**

|                     |                                   |                                                             |     |      |      |   |
|---------------------|-----------------------------------|-------------------------------------------------------------|-----|------|------|---|
| V <sub>GS(th)</sub> | Gate Threshold Voltage            | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA | 2.0 | --   | 4.0  | V |
| R <sub>DS(on)</sub> | Static Drain-Source On-Resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 6.0 A              | --  | 0.53 | 0.65 | Ω |

**Dynamic Characteristics**

|                  |                              |                                                               |    |      |    |    |
|------------------|------------------------------|---------------------------------------------------------------|----|------|----|----|
| C <sub>iss</sub> | Input Capacitance            | V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V,<br>f = 1.0 MHz | -- | 1850 | -- | pF |
| C <sub>oss</sub> | Output Capacitance           |                                                               | -- | 180  | -- | pF |
| C <sub>rss</sub> | Reverse Transfer Capacitance |                                                               | -- | 20   | -- | pF |

### Switching Characteristics

|              |                     |                                                                                            |    |     |    |    |
|--------------|---------------------|--------------------------------------------------------------------------------------------|----|-----|----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 300\text{ V}, I_D = 12.0\text{ A},$<br>$R_G = 25\ \Omega$<br><br>(Note 4, 5)     | -- | 30  | -- | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                            | -- | 90  | -- | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                            | -- | 140 | -- | ns |
| $t_f$        | Turn-Off Fall Time  |                                                                                            | -- | 90  | -- | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = 480\text{ V}, I_D = 12.0\text{ A},$<br>$V_{GS} = 10\text{ V}$<br><br>(Note 4, 5) | -- | 52  | -- | nC |
| $Q_{gs}$     | Gate-Source Charge  |                                                                                            | -- | 8.5 | -- | nC |
| $Q_{gd}$     | Gate-Drain Charge   |                                                                                            | -- | 20  | -- | nC |

### Drain-Source Diode Characteristics and Maximum Ratings

|          |                                                       |                                                                                                       |    |     |      |               |
|----------|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------|----|-----|------|---------------|
| $I_S$    | Maximum Continuous Drain-Source Diode Forward Current |                                                                                                       | -- | --  | 12.0 | A             |
| $I_{SM}$ | Maximum Pulsed Drain-Source Diode Forward Current     |                                                                                                       | -- | --  | 48.0 | A             |
| $V_{SD}$ | Drain-Source Diode Forward Voltage                    | $V_{GS} = 0\text{ V}, I_S = 12.0\text{ A}$                                                            | -- | --  | 1.4  | V             |
| $t_{rr}$ | Reverse Recovery Time                                 | $V_{GS} = 0\text{ V}, I_S = 12.0\text{ A},$<br>$dI_F / dt = 100\text{ A}/\mu\text{s}$<br><br>(Note 4) | -- | 430 | --   | ns            |
| $Q_{rr}$ | Reverse Recovery Charge                               |                                                                                                       | -- | 5.0 | --   | $\mu\text{C}$ |

#### Notes:

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2.  $L = 11\text{ mH}, I_{AS} = 12.0\text{ A}, V_{DD} = 50\text{ V}, R_G = 25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq 12.0\text{ A}, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq BVDSS$ , 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

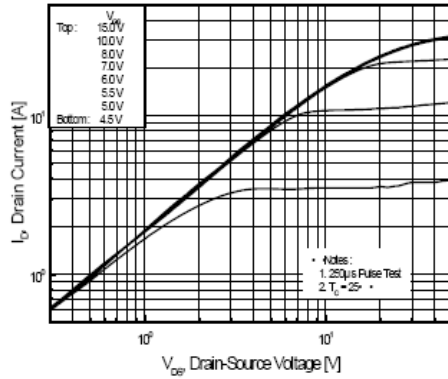


Figure 1. On-Region Characteristics

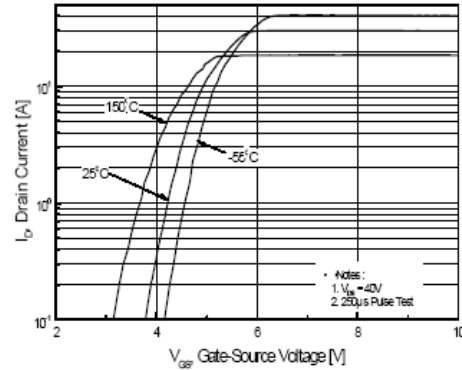


Figure 2. Transfer Characteristics

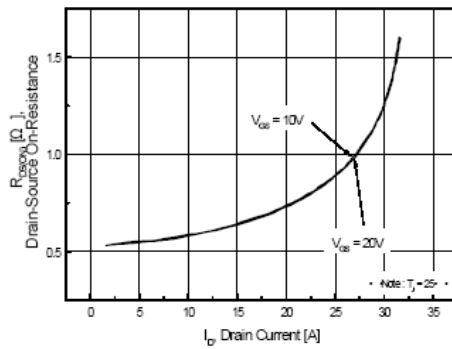


Figure 3. On-Resistance Variation vs Drain Current and Gate Voltage

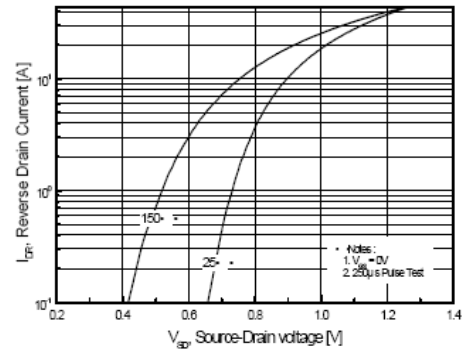


Figure 4. Body Diode Forward Voltage Variation with Source Current and Temperature

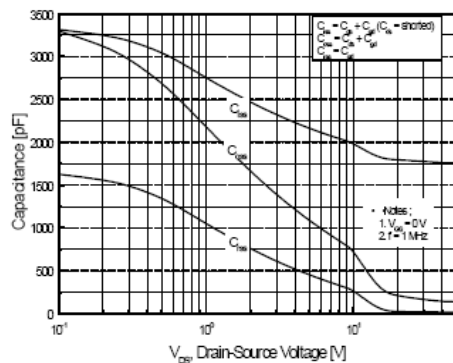


Figure 5. Capacitance Characteristics

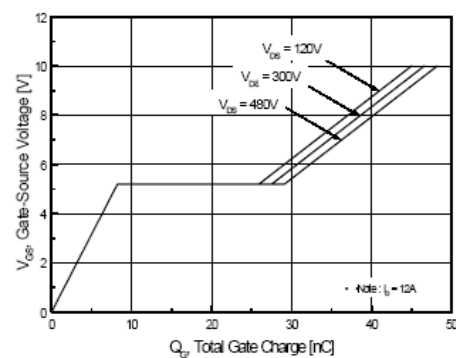


Figure 6. Gate Charge Characteristics

Typical Characteristics (Continued)

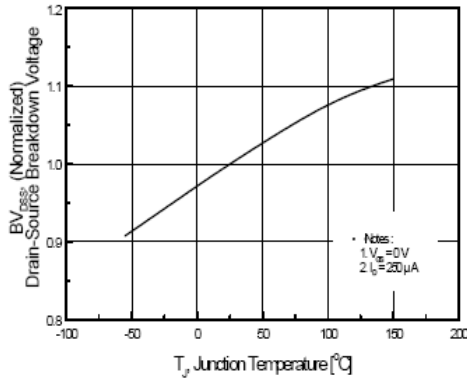


Figure 7. Breakdown Voltage Variation vs Temperature

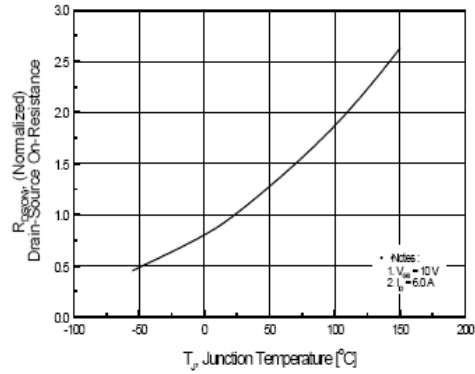


Figure 8. On-Resistance Variation vs Temperature

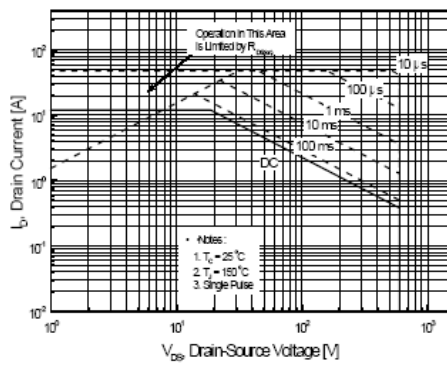


Figure 9-1. Maximum Safe Operating Area for TSP12N60M

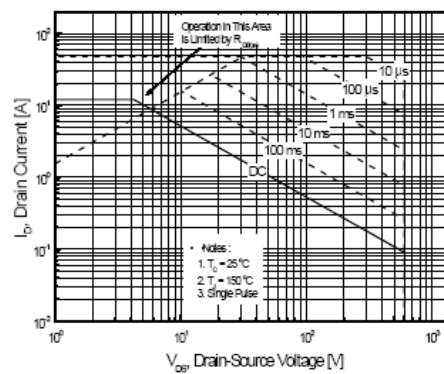


Figure 9-2. Maximum Safe Operating Area for TSF12N60M

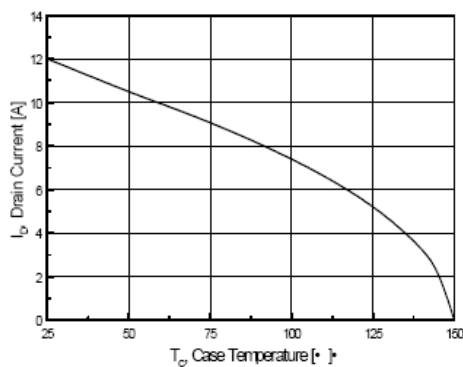


Figure 10. Maximum Drain Current vs Case Temperature

Typical Characteristics (Continued)

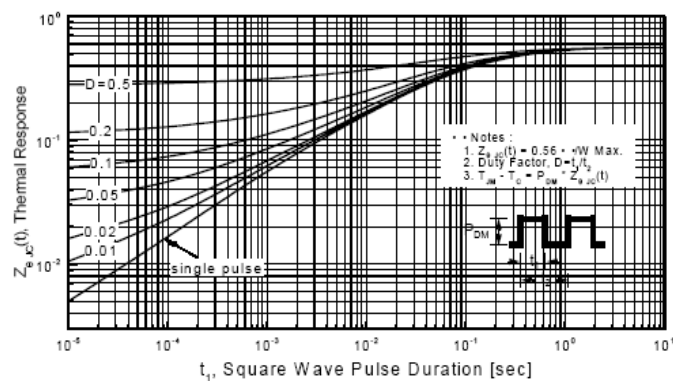


Figure 11-1. Transient Thermal Response Curve for TSP12N60M

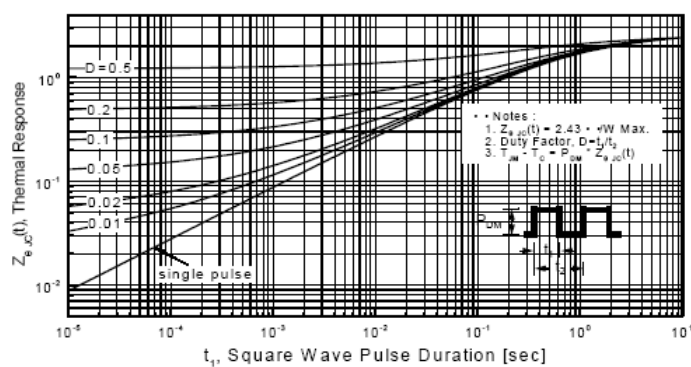
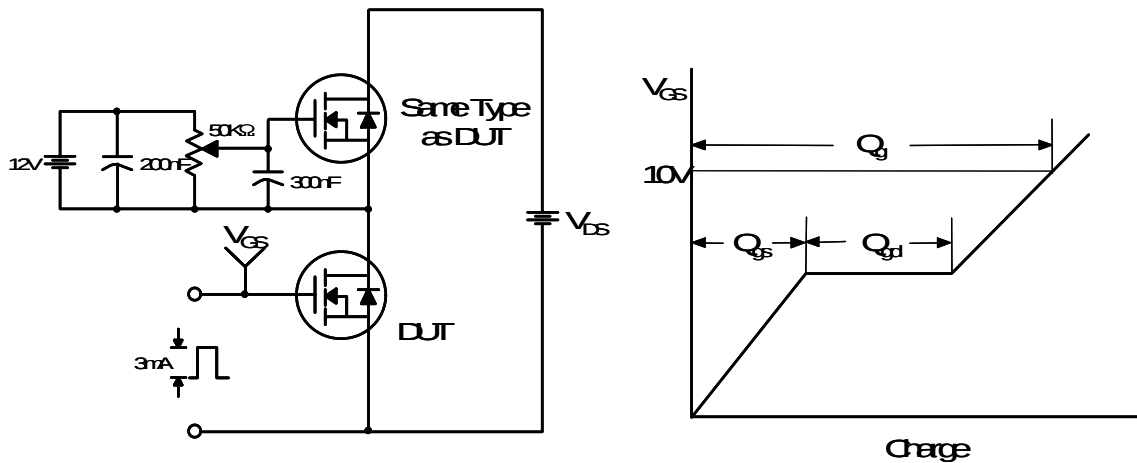
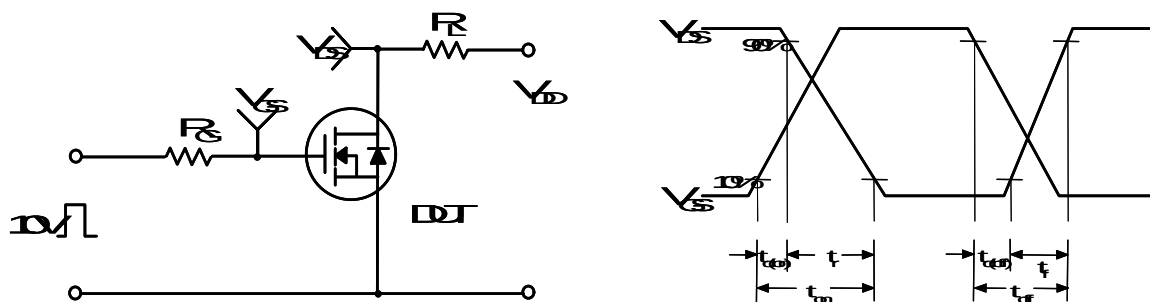


Figure 11-2. Transient Thermal Response Curve for TSF12N60M

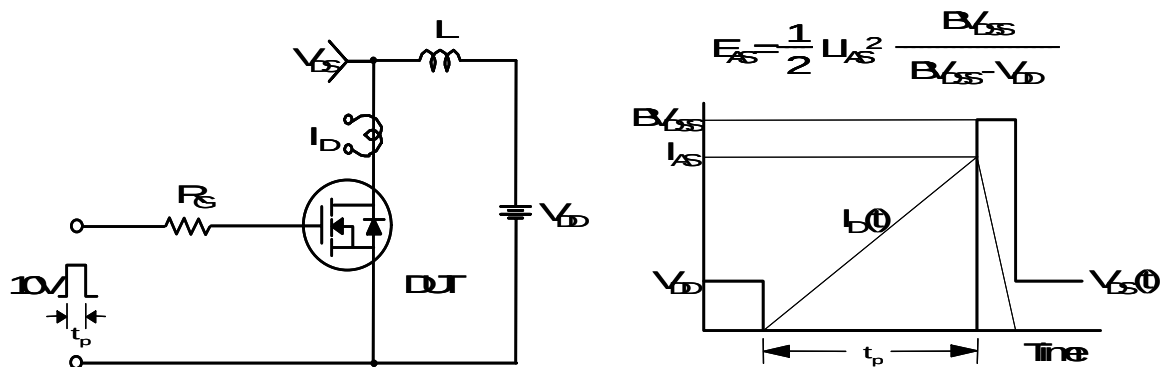
Gate Charge Test Circuit & Waveform



Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching Test Circuit & Waveforms



Peak Diode Recovery dv/dt Test Circuit & Waveforms

