



## General Description

SFGMOS<sup>®</sup> MOSFET is based on Oriental Semiconductor's unique device design to achieve low  $R_{DS(ON)}$ , low gate charge, fast switching and excellent avalanche characteristics. The high  $V_{th}$  series is specially designed to use in motor control systems with driving voltage of more than 10V.

## Features

- Low  $R_{DS(ON)}$  & FOM
- Extremely low switching loss
- Excellent reliability and uniformity
- Fast switching and soft recovery



## Applications

- PD charger
- Motor driver
- Switching voltage regulator
- DC-DC convertor
- Switching mode power supply

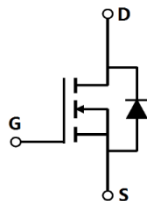
## Key Performance Parameters

| Parameter                         | Value | Unit       |
|-----------------------------------|-------|------------|
| $V_{DS}$                          | 120   | V          |
| $I_D$ , pulse                     | 280   | A          |
| $R_{DS(ON)}$ , max @ $V_{GS}=10V$ | 13    | m $\Omega$ |
| $Q_g$                             | 32    | nC         |

## Marking Information

| Product Name | Package | Marking    |
|--------------|---------|------------|
| SFG60N12PNF  | TO-220  | SFG60N12PN |

## Package & Pin information



**Absolute Maximum Ratings** at  $T_j=25^{\circ}\text{C}$  unless otherwise noted

| Parameter                                                                 | Symbol                | Value      | Unit               |
|---------------------------------------------------------------------------|-----------------------|------------|--------------------|
| Drain-source voltage                                                      | $V_{DS}$              | 120        | V                  |
| Gate-source voltage                                                       | $V_{GS}$              | $\pm 20$   | V                  |
| Continuous drain current <sup>1)</sup> , $T_C=25^{\circ}\text{C}$         | $I_D$                 | 70         | A                  |
| Pulsed drain current <sup>2)</sup> , $T_C=25^{\circ}\text{C}$             | $I_{D, \text{pulse}}$ | 280        | A                  |
| Continuous diode forward current <sup>1)</sup> , $T_C=25^{\circ}\text{C}$ | $I_S$                 | 70         | A                  |
| Diode pulsed current <sup>2)</sup> , $T_C=25^{\circ}\text{C}$             | $I_{S, \text{pulse}}$ | 280        | A                  |
| Power dissipation <sup>3)</sup> , $T_C=25^{\circ}\text{C}$                | $P_D$                 | 125        | W                  |
| Single pulsed avalanche energy <sup>4)</sup>                              | $E_{AS}$              | 18         | mJ                 |
| Operation and storage temperature                                         | $T_{stg}, T_j$        | -55 to 150 | $^{\circ}\text{C}$ |

**Thermal Characteristics**

| Parameter                            | Symbol          | Value | Unit                 |
|--------------------------------------|-----------------|-------|----------------------|
| Thermal resistance, junction-case    | $R_{\theta JC}$ | 1     | $^{\circ}\text{C/W}$ |
| Thermal resistance, junction-ambient | $R_{\theta JA}$ | 62    | $^{\circ}\text{C/W}$ |

**Electrical Characteristics** at  $T_j=25^{\circ}\text{C}$  unless otherwise specified

| Parameter                        | Symbol       | Min. | Typ. | Max. | Unit          | Test condition                                  |
|----------------------------------|--------------|------|------|------|---------------|-------------------------------------------------|
| Drain-source breakdown voltage   | $BV_{DSS}$   | 120  |      |      | V             | $V_{GS}=0\text{ V}, I_D=250\text{ }\mu\text{A}$ |
| Gate threshold voltage           | $V_{GS(th)}$ | 2.5  |      | 3.5  | V             | $V_{DS}=V_{GS}, I_D=250\text{ }\mu\text{A}$     |
| Drain-source on-state resistance | $R_{DS(ON)}$ |      | 9.5  | 13   | m $\Omega$    | $V_{GS}=10\text{ V}, I_D=30\text{ A}$           |
| Gate-source leakage current      | $I_{GSS}$    |      |      | 100  | nA            | $V_{GS}=20\text{ V}$                            |
| Drain-source leakage current     | $I_{DSS}$    |      |      | 1    | $\mu\text{A}$ | $V_{DS}=120\text{ V}, V_{GS}=0\text{ V}$        |
| Gate resistance                  | $R_G$        |      | 6.1  |      | $\Omega$      | $f=1\text{ MHz}$ , Open drain                   |

### Dynamic Characteristics

| Parameter                    | Symbol       | Min. | Typ. | Max. | Unit | Test condition                                                                             |
|------------------------------|--------------|------|------|------|------|--------------------------------------------------------------------------------------------|
| Input capacitance            | $C_{iss}$    |      | 2470 |      | pF   | $V_{GS}=0\text{ V}$ ,<br>$V_{DS}=25\text{ V}$ ,<br>$f=100\text{ kHz}$                      |
| Output capacitance           | $C_{oss}$    |      | 1230 |      | pF   |                                                                                            |
| Reverse transfer capacitance | $C_{rss}$    |      | 92   |      | pF   |                                                                                            |
| Turn-on delay time           | $t_{d(on)}$  |      | 9    |      | ns   | $V_{GS}=10\text{ V}$ ,<br>$V_{DS}=60\text{ V}$ ,<br>$R_G=2\ \Omega$ ,<br>$I_D=30\text{ A}$ |
| Rise time                    | $t_r$        |      | 6    |      | ns   |                                                                                            |
| Turn-off delay time          | $t_{d(off)}$ |      | 36   |      | ns   |                                                                                            |
| Fall time                    | $t_f$        |      | 10   |      | ns   |                                                                                            |

### Gate Charge Characteristics

| Parameter            | Symbol        | Min. | Typ. | Max. | Unit | Test condition                                                        |
|----------------------|---------------|------|------|------|------|-----------------------------------------------------------------------|
| Total gate charge    | $Q_g$         |      | 32   |      | nC   | $V_{GS}=10\text{ V}$ ,<br>$V_{DS}=60\text{ V}$ ,<br>$I_D=30\text{ A}$ |
| Gate-source charge   | $Q_{gs}$      |      | 9    |      | nC   |                                                                       |
| Gate-drain charge    | $Q_{gd}$      |      | 4    |      | nC   |                                                                       |
| Gate plateau voltage | $V_{plateau}$ |      | 4.1  |      | V    |                                                                       |

### Body Diode Characteristics

| Parameter                     | Symbol    | Min. | Typ. | Max. | Unit | Test condition                                                                 |
|-------------------------------|-----------|------|------|------|------|--------------------------------------------------------------------------------|
| Diode forward voltage         | $V_{SD}$  |      |      | 1.3  | V    | $I_S=20\text{ A}$ ,<br>$V_{GS}=0\text{ V}$                                     |
| Reverse recovery time         | $t_{rr}$  |      | 75   |      | ns   | $V_R=60\text{ V}$ ,<br>$I_S=30\text{ A}$ ,<br>$di/dt=100\text{ A}/\mu\text{s}$ |
| Reverse recovery charge       | $Q_{rr}$  |      | 156  |      | nC   |                                                                                |
| Peak reverse recovery current | $I_{rrm}$ |      | 3.5  |      | A    |                                                                                |

### Note

- 1) Calculated continuous current based on maximum allowable junction temperature.
- 2) Repetitive rating; pulse width limited by max. junction temperature.
- 3)  $P_d$  is based on max. junction temperature, using junction-case thermal resistance.
- 4)  $V_{DD}=50\text{ V}$ ,  $V_{GS}=10\text{ V}$ ,  $L=0.3\text{ mH}$ , starting  $T_j=25\text{ }^\circ\text{C}$ .

## Electrical Characteristics Diagrams

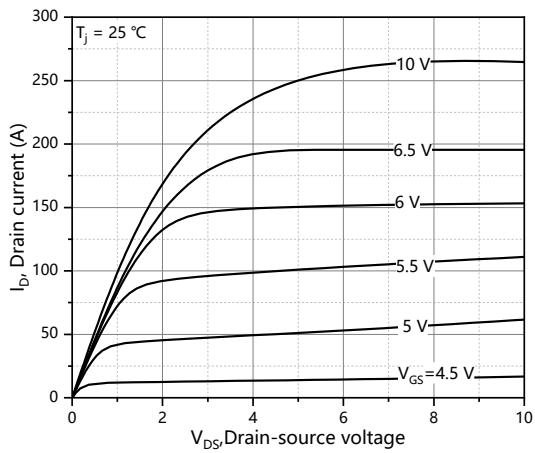


Figure 1. Typ. output characteristics

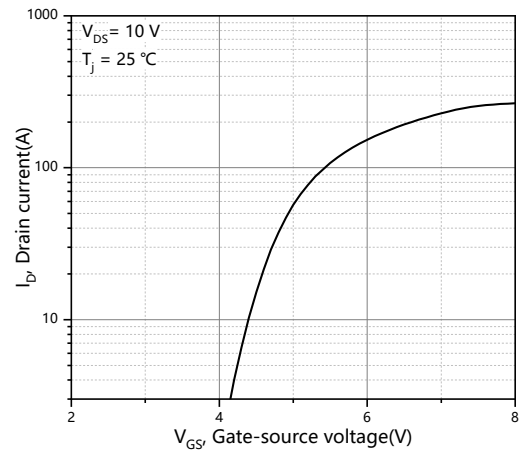


Figure 2. Typ. transfer characteristics

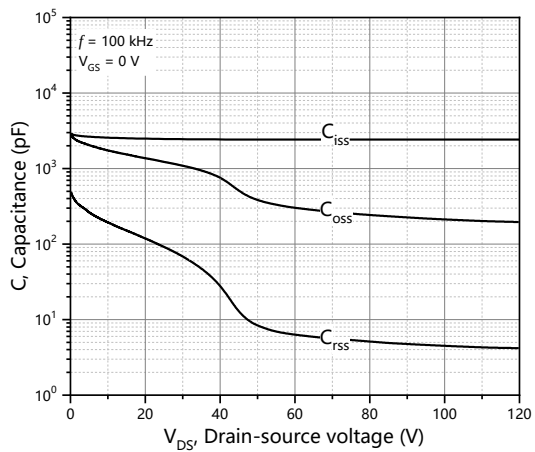


Figure 3. Typ. capacitances

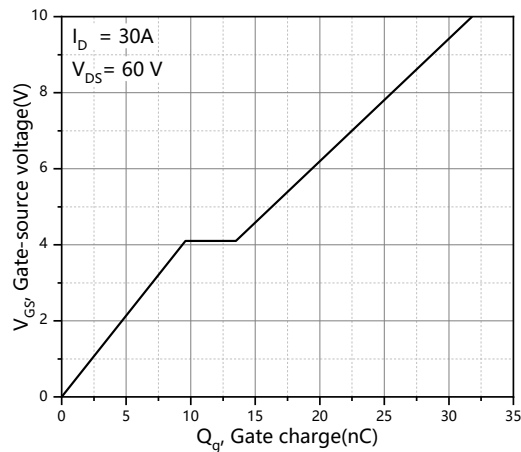


Figure 4. Typ. gate charge

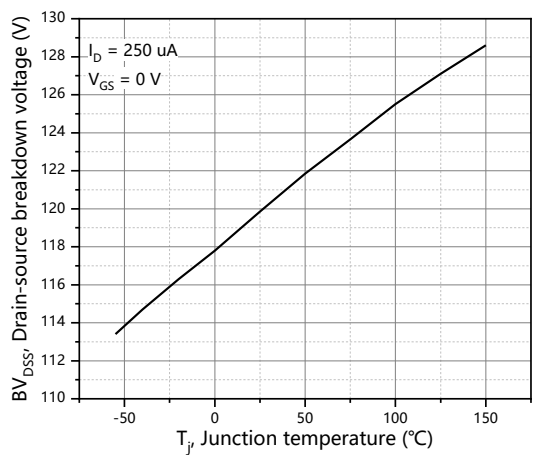


Figure 5. Drain-source breakdown voltage

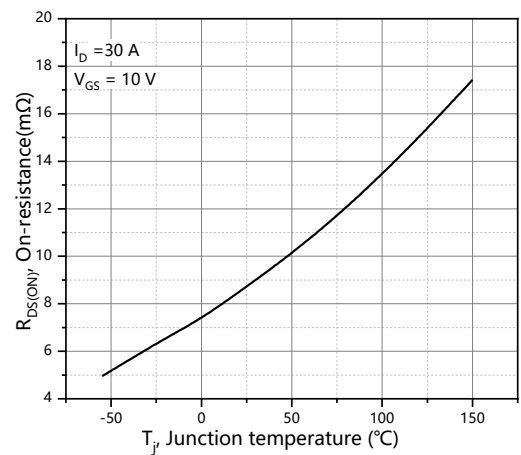
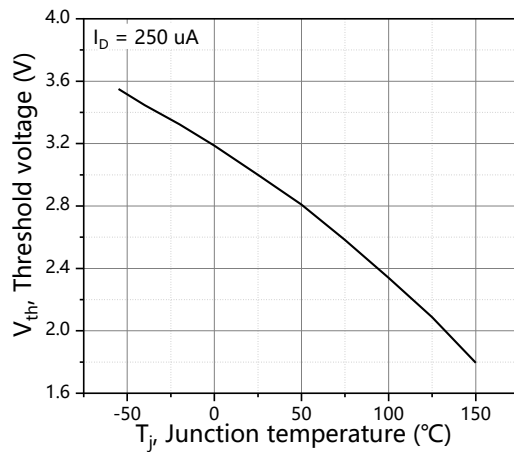
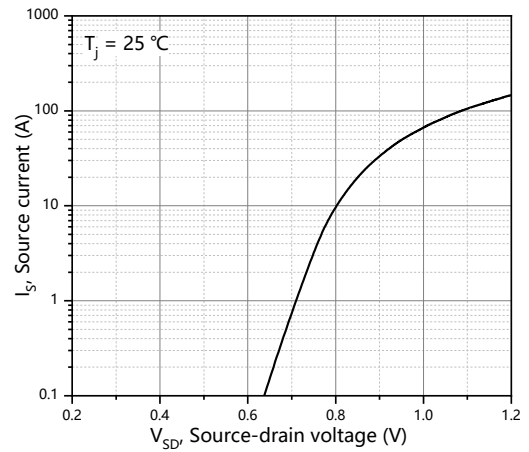


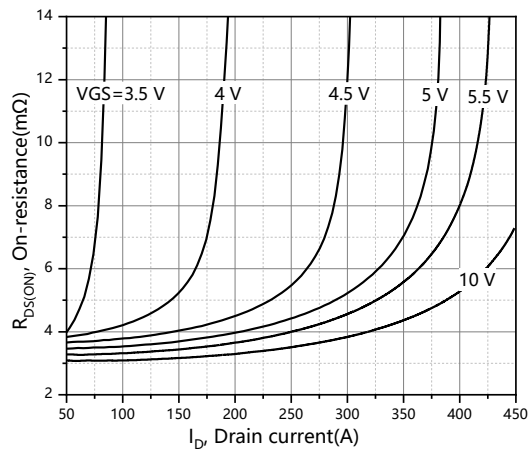
Figure 6. Drain-source on-state resistance



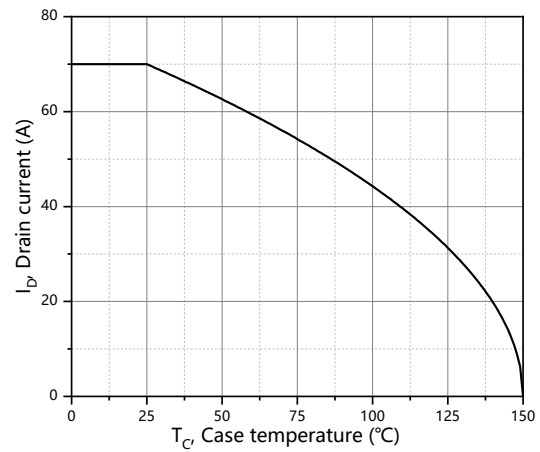
**Figure 7. Threshold voltage**



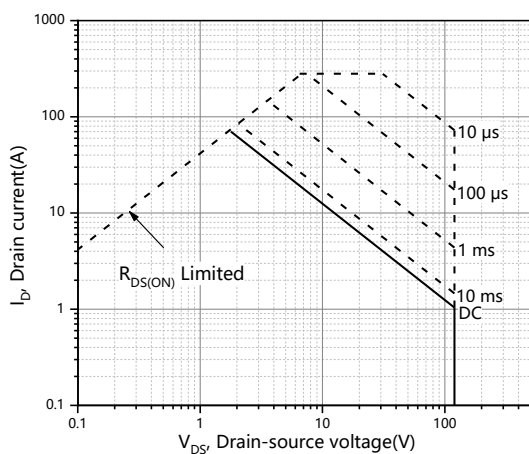
**Figure 8. Forward characteristic of body diode**



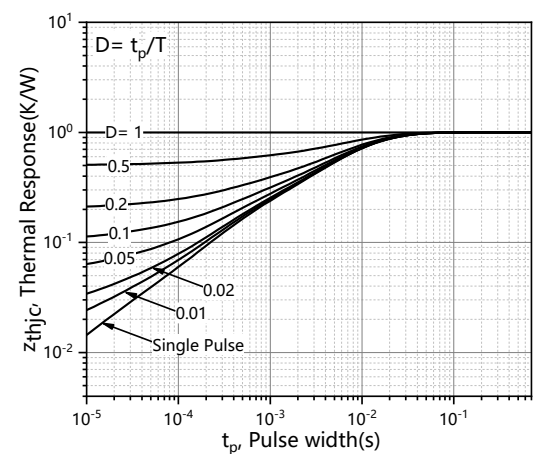
**Figure 9. Drain-source on-state resistance**



**Figure 10. Drain current**



**Figure 11. Safe operation area T<sub>C</sub>=25°C**



**Figure 12. Max. transient thermal impedance**

## Test circuits and waveforms



**Figure 1. Gate charge test circuit & waveform**



**Figure 2. Switching time test circuit & waveforms**

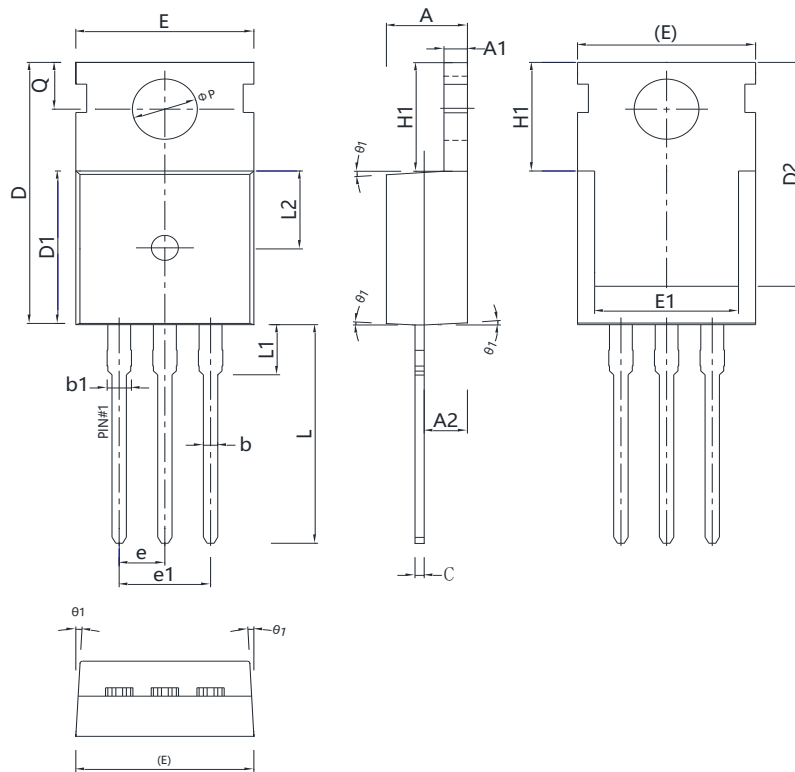


**Figure 3. Unclamped inductive switching (UIS) test circuit & waveforms**



**Figure 4. Diode reverse recovery test circuit & waveforms**

## Package Information



| Symbol     | mm       |       |       |
|------------|----------|-------|-------|
|            | Min      | Nom   | Max   |
| A          | 4.40     | 4.50  | 4.60  |
| A1         | 1.27     | 1.30  | 1.33  |
| A2         | 2.30     | 2.40  | 2.50  |
| b          | 0.70     | -     | 0.90  |
| b1         | 1.27     | -     | 1.40  |
| c          | 0.45     | 0.50  | 0.60  |
| D          | 15.30    | 15.70 | 16.10 |
| D1         | 9.10     | 9.20  | 9.30  |
| D2         | 13.10    | -     | 13.70 |
| E          | 9.70     | 9.90  | 10.20 |
| E1         | 7.80     | 8.00  | 8.20  |
| e          | 2.54 BSC |       |       |
| e1         | 5.08 BSC |       |       |
| H1         | 6.30     | 6.50  | 6.70  |
| L          | 12.78    | 13.08 | 13.38 |
| L1         | -        | -     | 3.50  |
| L2         | 4.60 REF |       |       |
| $\Phi P$   | 3.55     | 3.60  | 3.65  |
| Q          | 2.73     | -     | 2.87  |
| $\theta_1$ | 1°       | 3°    | 5°    |

Version 1: TO220-J package outline dimension

**Ordering Information**

| Package Type | Units/ Tube | Tubes / Inner Box | Units/ Inner Box | Inner Boxes/ Carton Box | Units/ Carton Box |
|--------------|-------------|-------------------|------------------|-------------------------|-------------------|
| TO-220       | 50          | 20                | 1000             | 5                       | 5000              |

**Product Information**

| Product     | Package | Pb Free | RoHS | Halogen Free |
|-------------|---------|---------|------|--------------|
| SFG60N12PNF | TO-220  | yes     | yes  | yes          |

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