

## General Description

The GreenMOS<sup>®</sup> high voltage MOSFET utilizes charge balance technology to achieve outstanding low on-resistance and lower gate charge. It is engineered to minimize conduction loss, provide superior switching performance and robust avalanche capability.

The GreenMOS<sup>®</sup> Generic series is optimized for extreme switching performance to minimize switching loss. It is tailored for high power density applications to meet the highest efficiency standards.

## Features

- Low  $R_{DS(ON)}$  & FOM
- Extremely low switching loss
- Excellent stability and uniformity

GreenMOS<sup>®</sup>



## Applications

- PC power
- LED lighting
- Telecom power
- Server power
- EV Charger
- Solar/UPS

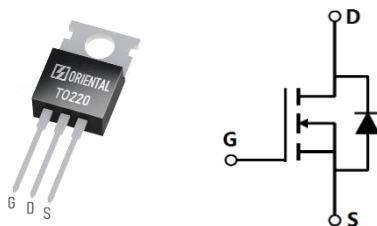
## Key Performance Parameters

| Parameter                       | Value | Unit      |
|---------------------------------|-------|-----------|
| $V_{DS, \min} @ T_{j(max)}$     | 600   | V         |
| $I_D, \text{pulse}$             | 90    | A         |
| $R_{DS(ON)}, \max @ V_{GS}=10V$ | 99    | $m\Omega$ |
| $Q_g$                           | 35.7  | nC        |

## Marking Information

| Product Name  | Package | Marking      |
|---------------|---------|--------------|
| OSG60R099PT3F | TO220   | OSG60R099PT3 |

## Package & Pin Information



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

| Parameter                                                                 | Symbol                | Value      | Unit               |
|---------------------------------------------------------------------------|-----------------------|------------|--------------------|
| Drain-source voltage                                                      | $V_{DS}$              | 600        | V                  |
| Gate-source voltage                                                       | $V_{GS}$              | $\pm 30$   | V                  |
| Continuous drain current <sup>1)</sup> , $T_C=25^{\circ}\text{C}$         | $I_D$                 | 30         | A                  |
| Continuous drain current <sup>1)</sup> , $T_C=100^{\circ}\text{C}$        |                       | 19         |                    |
| Pulsed drain current <sup>2)</sup> , $T_C=25^{\circ}\text{C}$             | $I_{D, \text{pulse}}$ | 90         | A                  |
| Continuous diode forward current <sup>1)</sup> , $T_C=25^{\circ}\text{C}$ | $I_S$                 | 30         | A                  |
| Diode pulsed current <sup>2)</sup> , $T_C=25^{\circ}\text{C}$             | $I_{S, \text{pulse}}$ | 90         | A                  |
| Power dissipation <sup>3)</sup> , $T_C=25^{\circ}\text{C}$                | $P_D$                 | 201        | W                  |
| Single pulsed avalanche energy <sup>4)</sup>                              | $E_{AS}$              | 460        | mJ                 |
| MOSFET dv/dt ruggedness, $V_{DS}=0\ldots 480\text{ V}$                    | dv/dt                 | 50         | V/ns               |
| Reverse diode dv/dt, $V_{DS}=0\ldots 480\text{ V}$ , $I_{SD}\leq I_D$     | dv/dt                 | 15         | V/ns               |
| Operation and storage temperature                                         | $T_{stg}, T_j$        | -55 to 150 | $^{\circ}\text{C}$ |

**Thermal Characteristics**

| Parameter                            | Symbol          | Value | Unit                 |
|--------------------------------------|-----------------|-------|----------------------|
| Thermal resistance, junction-case    | $R_{\theta JC}$ | 0.62  | $^{\circ}\text{C/W}$ |
| 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   | $BV_{DSS}$   | 600  |      |      | V             | $V_{GS}=0\text{ V}$ , $I_D=1\text{ mA}$                              |
| Gate threshold voltage           | $V_{GS(th)}$ | 3.5  |      | 4.5  | V             | $V_{DS}=V_{GS}$ , $I_D=1\text{ mA}$                                  |
| Drain-source on-state resistance | $R_{DS(ON)}$ |      | 92   | 99   | m $\Omega$    | $V_{GS}=10\text{ V}$ , $I_D=15\text{ A}$                             |
|                                  |              |      | 231  |      |               | $V_{GS}=10\text{ V}$ , $I_D=15\text{ A}$ , $T_j=150^{\circ}\text{C}$ |
| Gate-source leakage current      | $I_{GSS}$    |      |      | 100  | nA            | $V_{GS}=30\text{ V}$                                                 |
|                                  |              |      |      | -100 |               | $V_{GS}=-30\text{ V}$                                                |
| Drain-source leakage current     | $I_{DSS}$    |      |      | 1    | $\mu\text{A}$ | $V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$                          |
| Gate resistance                  | $R_G$        |      | 19.1 |      | $\Omega$      | $f = 1\text{ MHz}$ , Open drain                                      |

### Dynamic Characteristics

| Parameter                                    | Symbol       | Min. | Typ. | Max. | Unit | Test condition                                                                              |
|----------------------------------------------|--------------|------|------|------|------|---------------------------------------------------------------------------------------------|
| Input capacitance                            | $C_{iss}$    |      | 2230 |      | pF   | $V_{GS}=0\text{ V}$ ,<br>$V_{DS}=50\text{ V}$ ,<br>$f=100\text{ kHz}$                       |
| Output capacitance                           | $C_{oss}$    |      | 131  |      | pF   |                                                                                             |
| Reverse transfer capacitance                 | $C_{rss}$    |      | 2.4  |      | pF   |                                                                                             |
| Effective output capacitance, energy related | $C_{o(er)}$  |      | 79   |      | pF   | $V_{GS}=0\text{ V}$ ,<br>$V_{DS}=0\text{ V}-400\text{ V}$                                   |
| Effective output capacitance, time related   | $C_{o(tr)}$  |      | 439  |      | pF   |                                                                                             |
| Turn-on delay time                           | $t_{d(on)}$  |      | 26.9 |      | ns   | $V_{GS}=10\text{ V}$ ,<br>$V_{DS}=400\text{ V}$ ,<br>$R_G=2\ \Omega$ ,<br>$I_D=20\text{ A}$ |
| Rise time                                    | $t_r$        |      | 39.4 |      | ns   |                                                                                             |
| Turn-off delay time                          | $t_{d(off)}$ |      | 81.1 |      | ns   |                                                                                             |
| Fall time                                    | $t_f$        |      | 22.7 |      | ns   |                                                                                             |

### Gate Charge Characteristics

| Parameter            | Symbol        | Min. | Typ. | Max. | Unit | Test condition                                                         |
|----------------------|---------------|------|------|------|------|------------------------------------------------------------------------|
| Total gate charge    | $Q_g$         |      | 35.7 |      | nC   | $V_{GS}=10\text{ V}$ ,<br>$V_{DS}=400\text{ V}$ ,<br>$I_D=20\text{ A}$ |
| Gate-source charge   | $Q_{gs}$      |      | 10.8 |      | nC   |                                                                        |
| Gate-drain charge    | $Q_{gd}$      |      | 10.3 |      | nC   |                                                                        |
| Gate plateau voltage | $V_{plateau}$ |      | 5.9  |      | V    |                                                                        |

### Body Diode Characteristics

| Parameter                     | Symbol    | Min. | Typ. | Max. | Unit          | Test condition                                                                  |
|-------------------------------|-----------|------|------|------|---------------|---------------------------------------------------------------------------------|
| Diode forward voltage         | $V_{SD}$  |      |      | 1.3  | V             | $I_S=30\text{ A}$ ,<br>$V_{GS}=0\text{ V}$                                      |
| Reverse recovery time         | $t_{rr}$  |      | 469  |      | ns            | $V_R=400\text{ V}$ ,<br>$I_S=20\text{ A}$ ,<br>$di/dt=100\text{ A}/\mu\text{s}$ |
| Reverse recovery charge       | $Q_{rr}$  |      | 5.2  |      | $\mu\text{C}$ |                                                                                 |
| Peak reverse recovery current | $I_{rrm}$ |      | 20.8 |      | 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)  $V_{DD}=100\text{ V}$ ,  $V_{GS}=10\text{ V}$ ,  $L=75\text{ mH}$ , starting  $T_j=25\text{ }^\circ\text{C}$ .

## Electrical Characteristics Diagrams

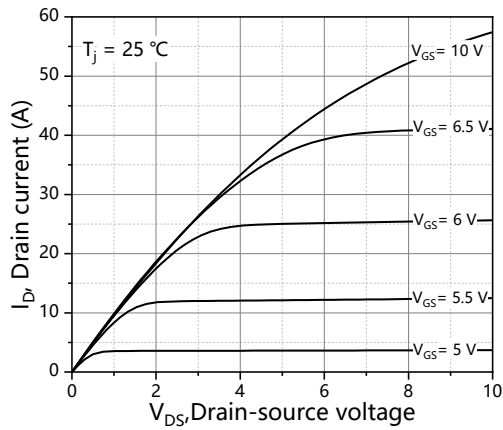


Figure 1. Typ. output characteristics

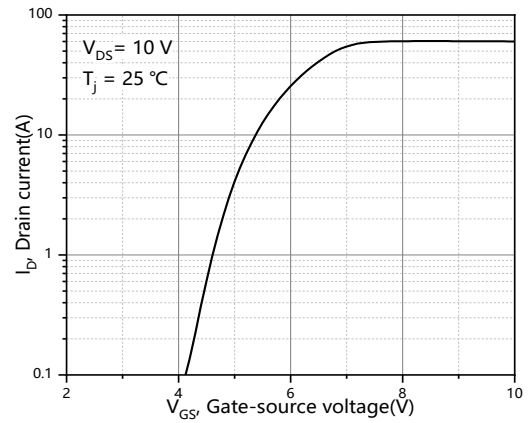


Figure 2. Typ. transfer characteristics

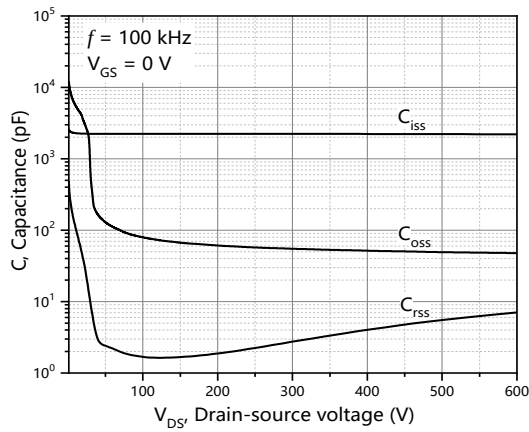


Figure 3. Typ. capacitances

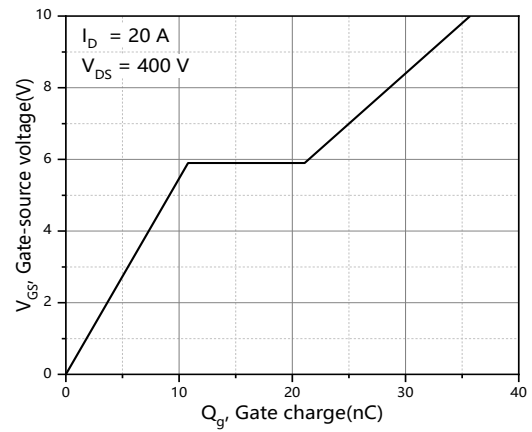


Figure 4. Typ. gate charge

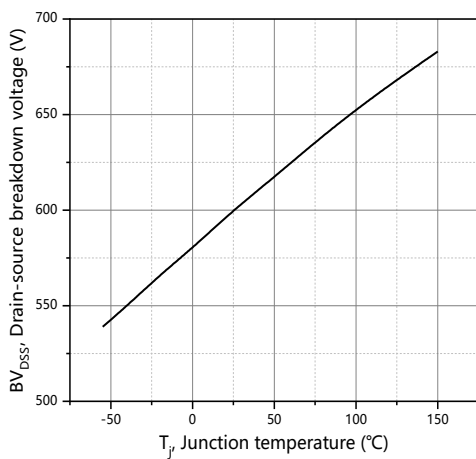


Figure 5. Drain-source breakdown voltage

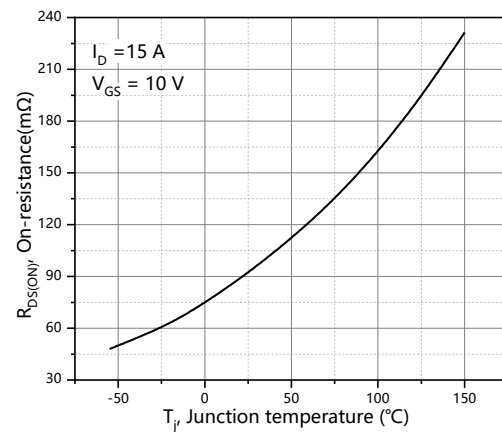
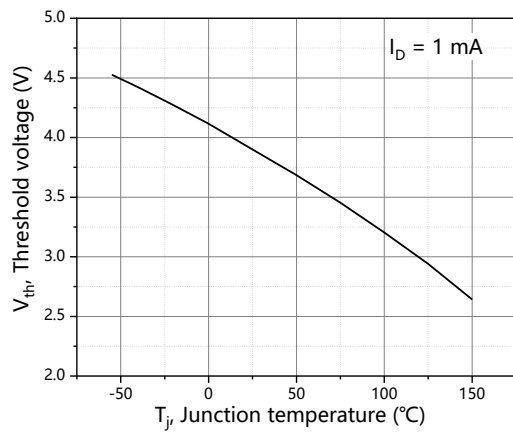
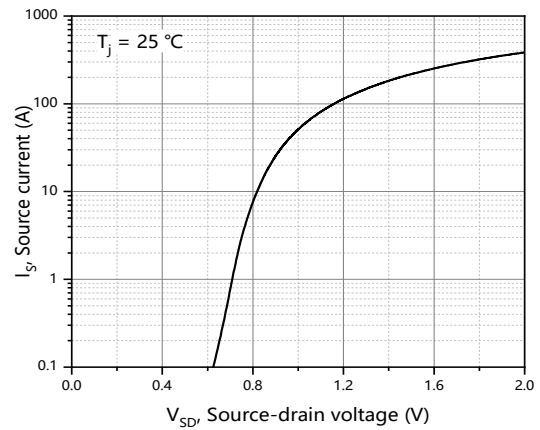


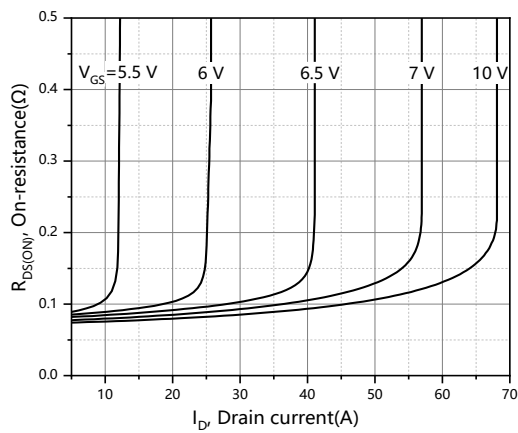
Figure 6. Drain-source on-state resistance



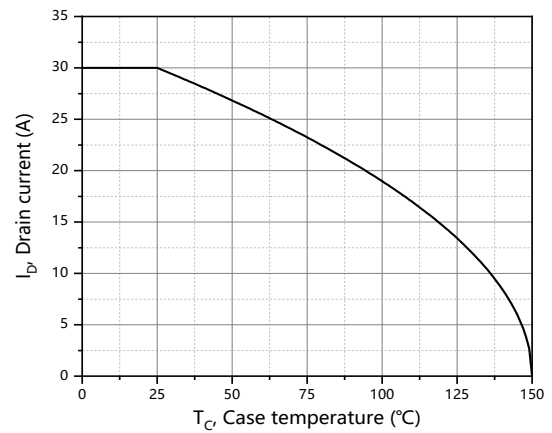
**Figure 7. Threshold voltage**



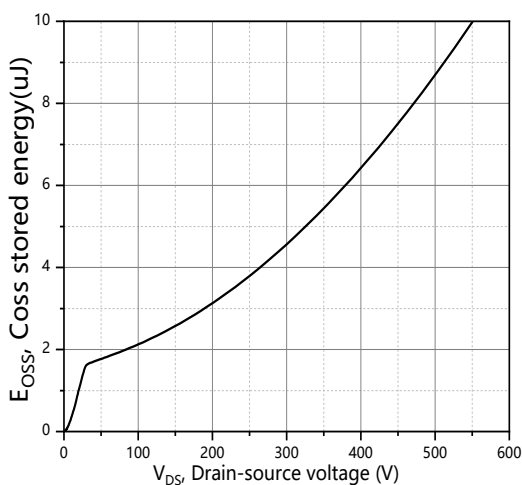
**Figure 8. Forward characteristic of body diode**



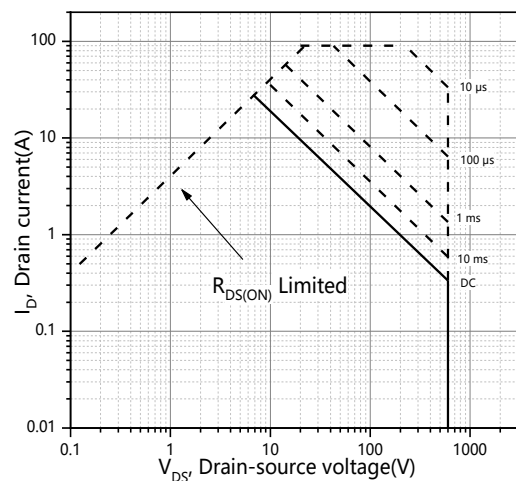
**Figure 9. Drain-source on-state resistance**



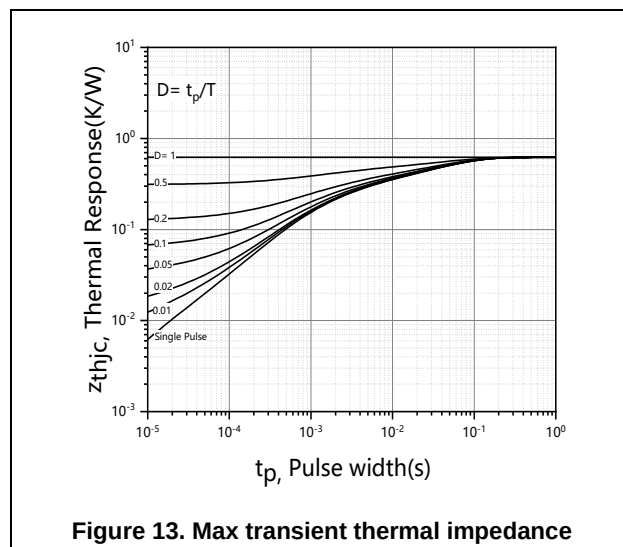
**Figure 10. Drain current**



**Figure 11. Typ. Coss stored energy**

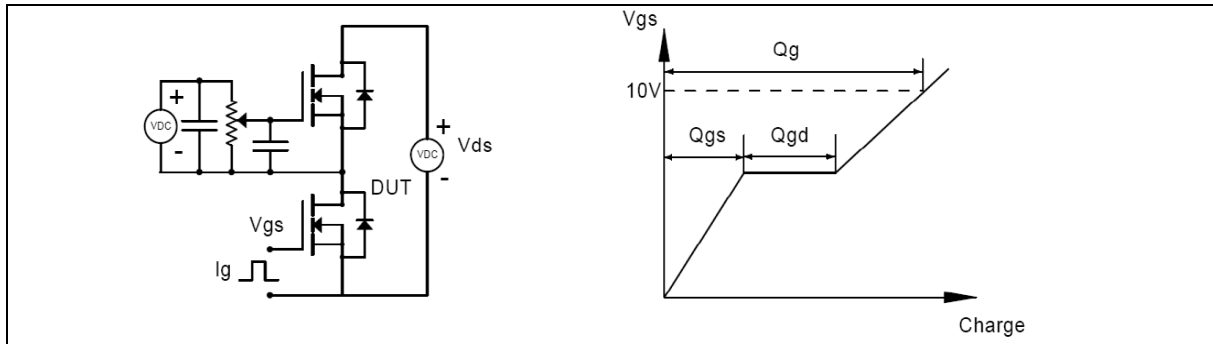


**Figure 12. Safe operation area for  $T_C=25^{\circ}\text{C}$**

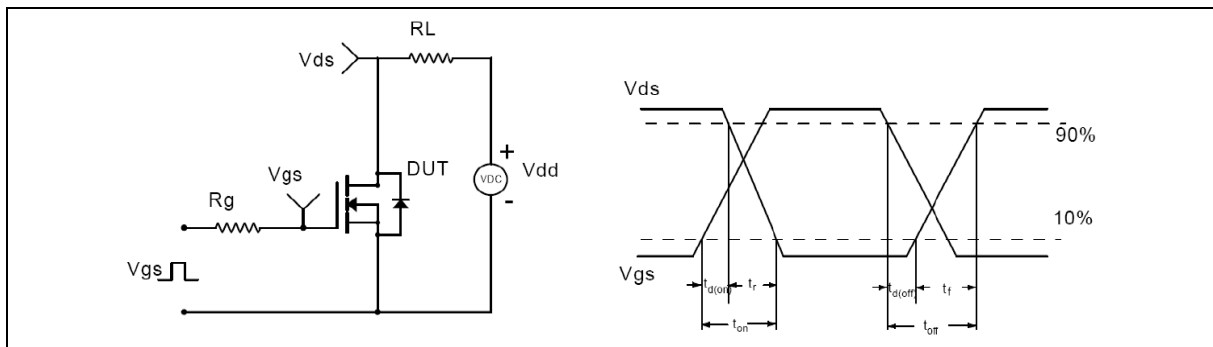


**Figure 13. Max transient thermal impedance**

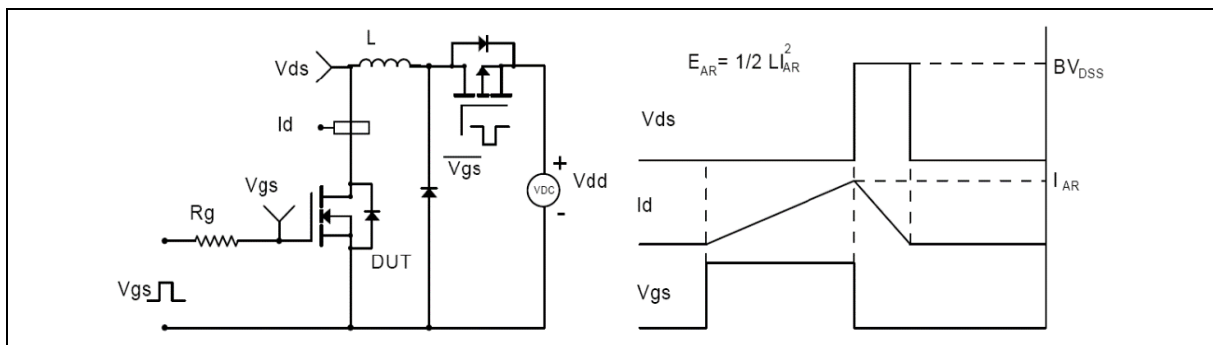
## Test circuits and waveforms



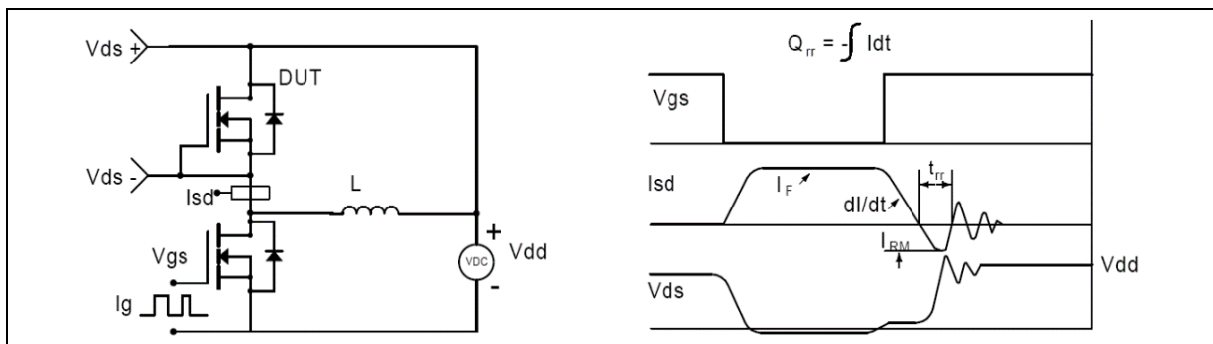
**Figure 1. Gate charge test circuit & waveform**



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

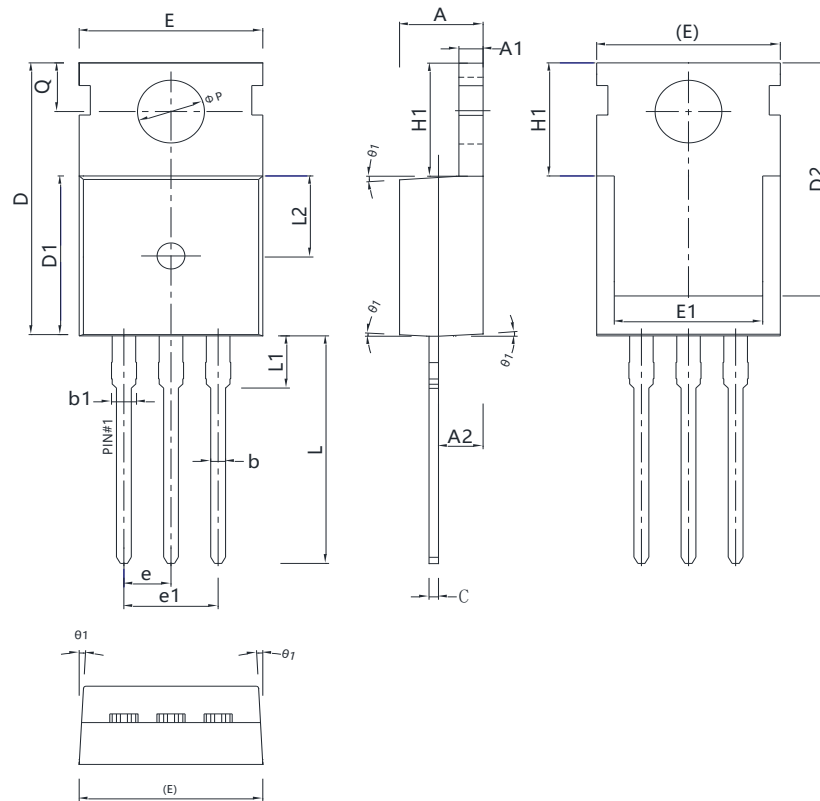


**Figure 3. Unclamped inductive switching (UIS) test circuit & waveforms**



**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 |
|--------------|-------------|------------------|------------------|-------------------------|-------------------|
| TO220-J      | 50          | 20               | 1000             | 5                       | 5000              |

## Product Information

| Product       | Package | Pb Free | RoHS | Halogen Free |
|---------------|---------|---------|------|--------------|
| OSG60R099PT3F | TO220   | yes     | yes  | yes          |

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