ON Semiconductor®

# FCA20N60

## N-Channel SuperFET® MOSFET

**600 V, 20 A, 190 mΩ**

### Features

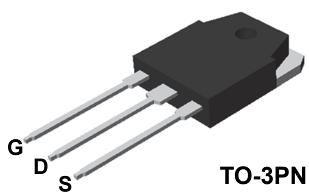
- 650V @ $T_J$ = 150°C
- Typ. $R_{DS(on)}$ = 150 mΩ
- Ultra Low Gate Charge (Typ. $Q_g$ = 75 nC )
- Low Effective Output Capacitance (Typ. $C_{oss(eff.)}$ = 165 pF )
- 100% Avalanche Tested

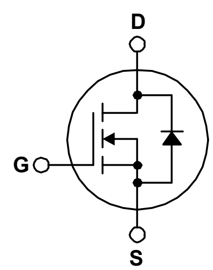
### Applications

- Solar Inverter
- AC-DC Power Supply

### Description

SuperFET® MOSFET is ON Semiconductor's first genera-tion of high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This technology is tailored to minimize conduction loss, provide superior switching performance, dv/dt rate and higher avalanche energy. Consequently, SuperFET MOSFET is very suitable for the switching power applications such as PFC, server/telecom power, FPD TV power, ATX power and industrial power applications.




### MOSFET Maximum Ratings $T_C$ = 25°C unless otherwise noted.

| Symbol | Parameter | | FCA20N60 / FCA20N60-F109 | Unit |
|---|---|---|---|---|
| $V_{DSS}$ | Drain to Source Voltage | | 600 | V |
| $V_{GSS}$ | Gate-Soure voltage | | ±30 | V |
| $I_D$ | Drain Current | - Continuous ($T_C$ = 25°C) | 20 | A |
| | | - Continuous ($T_C$ = 100°C) | 12.5 | |
| $I_{DM}$ | Drain Current | - Pulsed (Note 1) | 60 | A |
| $E_{AS}$ | Single Pulsed Avalanche Energy (Note 2) | | 690 | mJ |
| $I_{AR}$ | Avalanche Current (Note 1) | | 20 | A |
| $E_{AR}$ | Repetitive Avalanche Energy (Note 1) | | 20.8 | mJ |
| dv/dt | Peak Diode Recovery dv/dt (Note 3) | | 4.5 | V/ns |
| $P_D$ | Power Dissipation | ($T_C$ = 25°C) | 208 | W |
| | | - Derate Above 25°C | 1.67 | W/°C |
| $T_J$, $T_{STG}$ | Operating and Storage Temperature Range | | -55 to +150 | °C |
| $T_L$ | Maximum Lead Temperature for Soldering, 1/8" from Case for 5 Seconds | | 300 | °C |

### Thermal Characteristics

| Symbol | Parameter | FCA20N60 / FCA20N60_F109 | Unit |
|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max. | 0.6 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 41.7 | |

## Package Marking and Ordering Information

| Part Number | Top Mark | Package | Packing Method | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|---|
| FCA20N60 | FCA20N60 | TO-3PN | Tube | N/A | N/A | 30 units |
| FCA20N60-F109 | FCA20N60 | TO-3PN | Tube | N/A | N/A | 30 units |

## Electrical Characteristics $T_C = 25^oC$ unless otherwise noted.

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|

### Off Characteristics

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $BV_{DSS}$ | Drain to Source Breakdown Voltage | $I_D$ = 250 μA, $V_{GS}$ = 0 V, $T_J$ = 25°C | 600 | - | - | V |
| | | $I_D$ = 250 μA, $V_{GS}$ = 0 V, $T_J$ = 150°C | - | 650 | - | V |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 250 μA, Referenced to 25°C | - | 0.6 | - | V/°C |
| $BV_{DS}$ | Drain-Source Avalanche Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 20 A | - | 700 | - | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 600 V, $V_{GS}$ = 0 V | - | - | 1 | μA |
| | | $V_{DS}$ = 480 V, $T_C$ = 125°C | - | - | 10 | |
| $I_{GSS}$ | Gate to Body Leakage Current | $V_{GS}$ = ±30 V, $V_{DS}$ = 0 V | - | - | ±100 | nA |

### On Characteristics

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = 250 μA | 3.0 | - | 5.0 | V |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS}$ = 10 V, $I_D$ = 10 A | - | 0.15 | 0.19 | Ω |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 40 V, $I_D$ = 10 A | - | 17 | - | S |

### Dynamic Characteristics

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V, f = 1 MHz | - | 2370 | 3080 | pF |
| $C_{oss}$ | Output Capacitance | | - | 1280 | 1665 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | - | 95 | - | pF |
| $C_{oss}$ | Output Capacitance | $V_{DS}$ = 480 V, $V_{GS}$ = 0 V, f = 1 MHz | - | 65 | 85 | pF |
| $C_{oss(eff.)}$ | Effective Output Capacitance | $V_{DS}$ = 0 V to 400 V, $V_{GS}$ = 0 V | - | 165 | - | pF |
| $Q_g$ | Total Gate Charge at 10V | $V_{DS}$ = 480 V, $I_D$ = 20 A, $V_{GS}$ = 10 V (Note 4) | - | 75 | 98 | nC |
| $Q_{gs}$ | Gate to Source Gate Charge | | - | 13.5 | 18 | nC |
| $Q_{gd}$ | Gate to Drain "Miller" Charge | | - | 36 | - | nC |

### Switching Characteristics

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 300 V, $I_D$ = 20 A, $V_{GS}$ = 10 V, $R_G$ = 25 Ω (Note 4) | - | 62 | 135 | ns |
| $t_r$ | Turn-On Rise Time | | - | 140 | 290 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 230 | 470 | ns |
| $t_f$ | Turn-Off Fall Time | | - | 65 | 140 | ns |

### Drain-Source Diode Characteristics

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_S$ | Maximum Continuous Drain to Source Diode Forward Current | | - | - | 20 | A |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current | | - | - | 60 | A |
| $V_{SD}$ | Drain to Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 20 A | - | - | 1.4 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS}$ = 0 V, $I_{SD}$ = 20 A, $dI_F/dt$ = 100 A/μs | - | 530 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 10.5 | - | μC |

**Notes:**

1: Repetitive rating: pulse-width limited by maximum junction temperature.

2: $I_{AS}$ = 10 A, $V_{DD}$ = 50 V, $R_G$ = 25 Ω, starting $T_J$ = 25°C.

3: $I_{SD} \leq$ 20 A, di/dt ≤ 200 A/μs, $V_{DD} \leq BV_{DSS}$, starting $T_J$ = 25°C.

4: Essentially independent of operating temperature typical characteristics.

# Typical Performance Characteristics

**Figure 1. On-Region Characteristics**

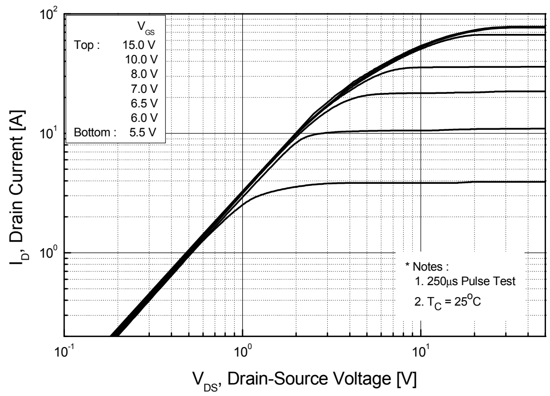



**Figure 2. Transfer Characteristics**

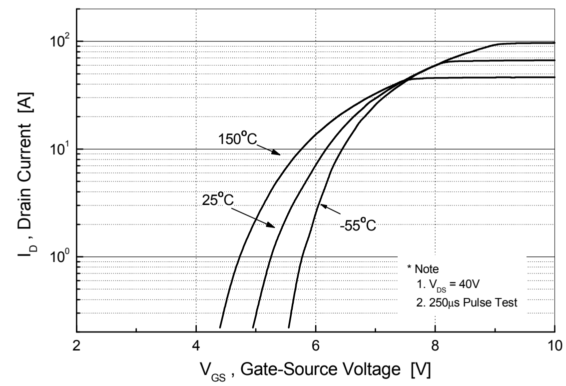



**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**

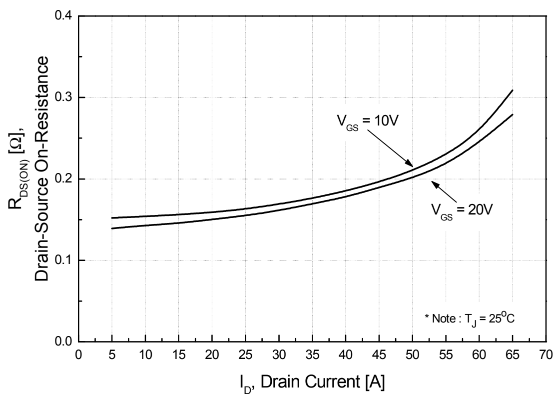



**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperatue**

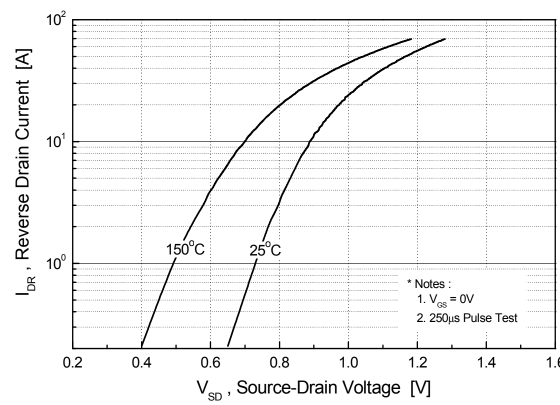



**Figure 5. Capacitance Characteristics**

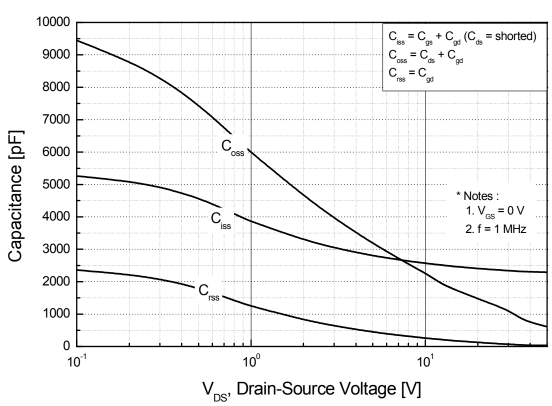
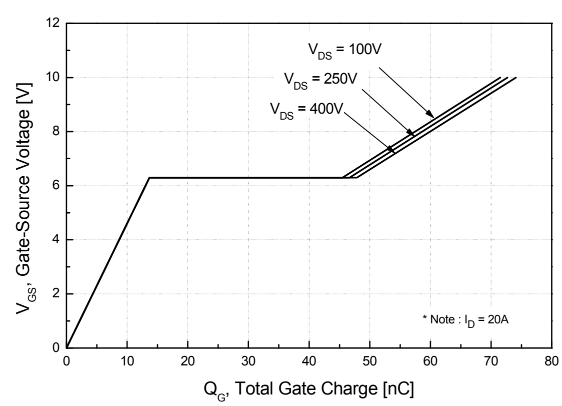



**Figure 6. Gate Charge Characteristics**



## Typical Performance Characteristics (Continued)

**Figure 7. Breakdown Voltage Variation vs. Temperature**

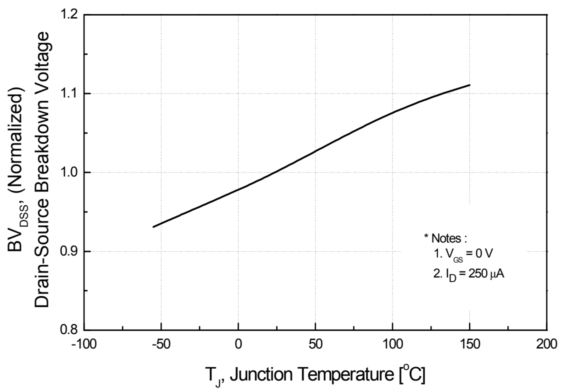



**Figure 8. On-Resistance Variation vs. Temperature**

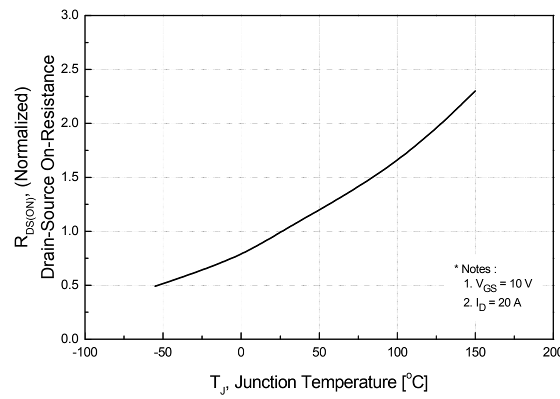



**Figure 9. Maximum Safe Operating Area**

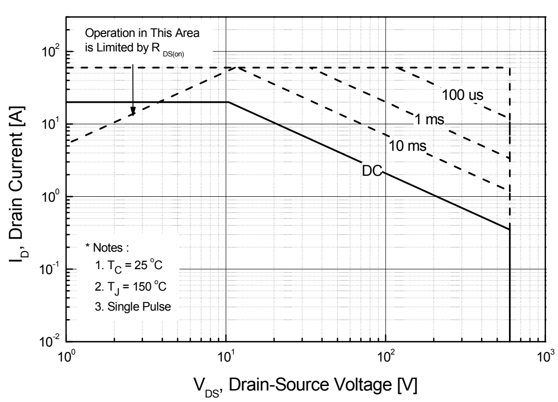



**Figure 10. Maximum Drain Current vs. Case Temperature**

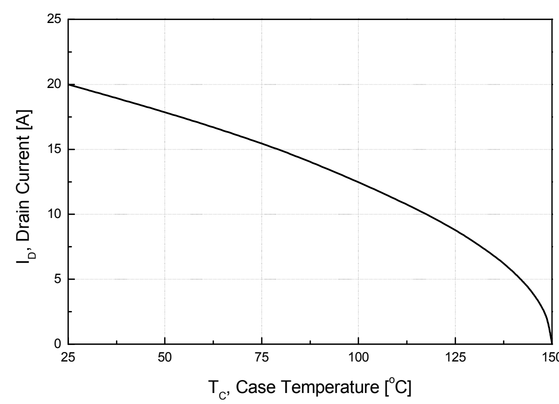
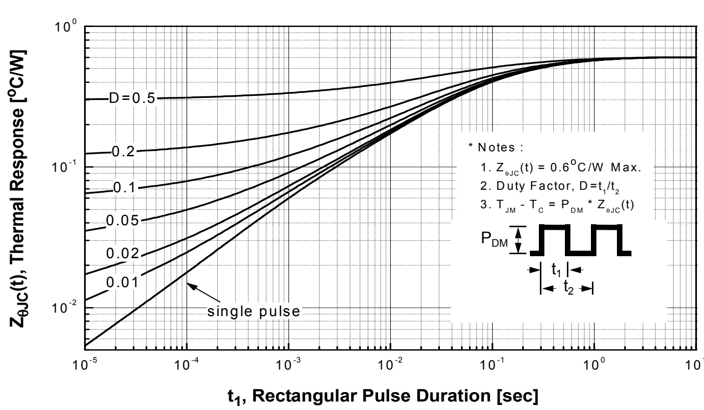



**Figure 11. Transient Thermal Response Curve**



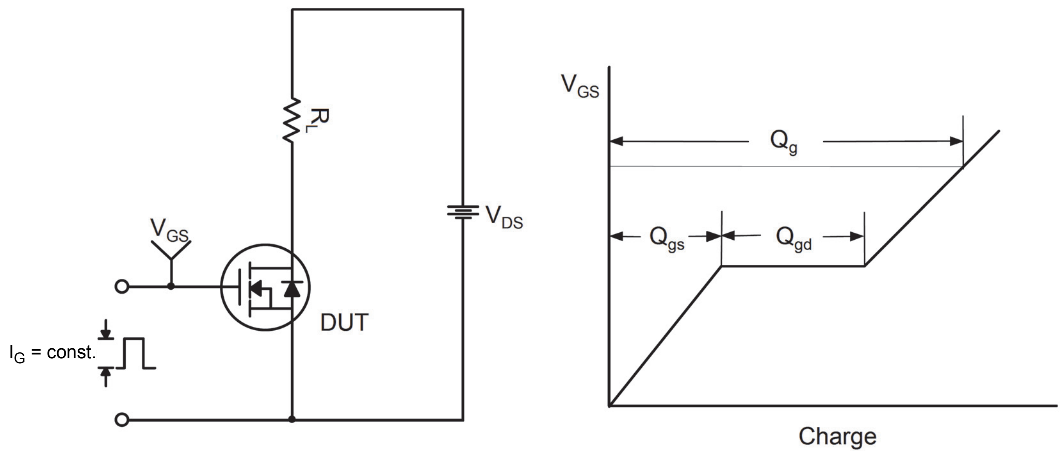



**Figure 12. Gate Charge Test Circuit & Waveform**

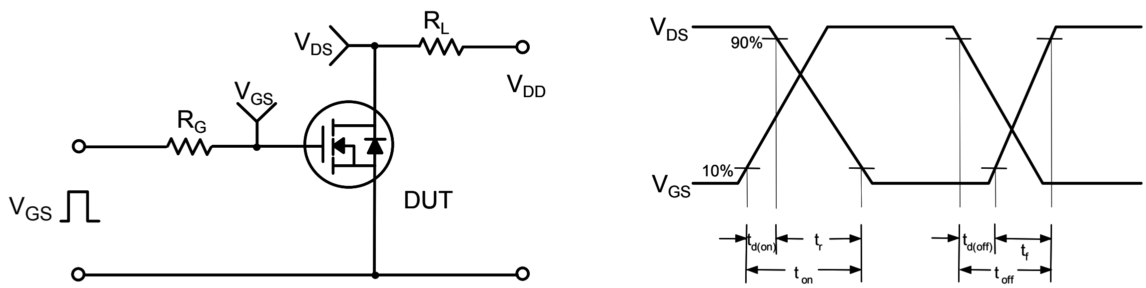



**Figure 13. Resistive Switching Test Circuit & Waveforms**

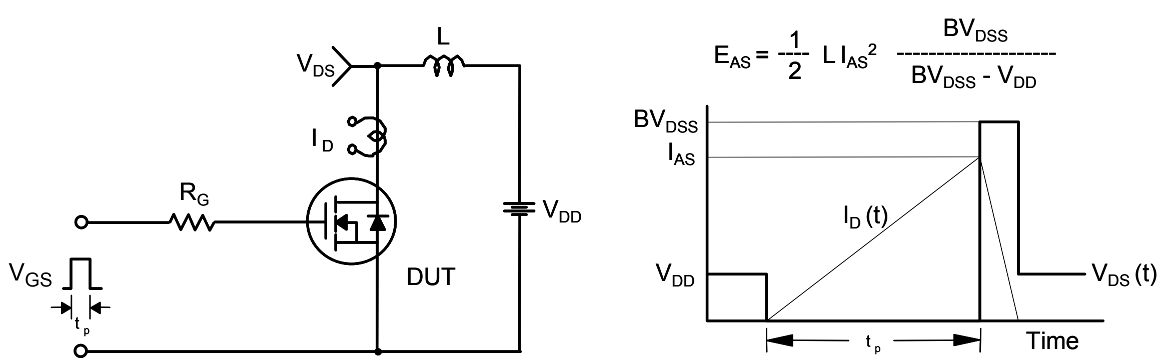



**Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms**

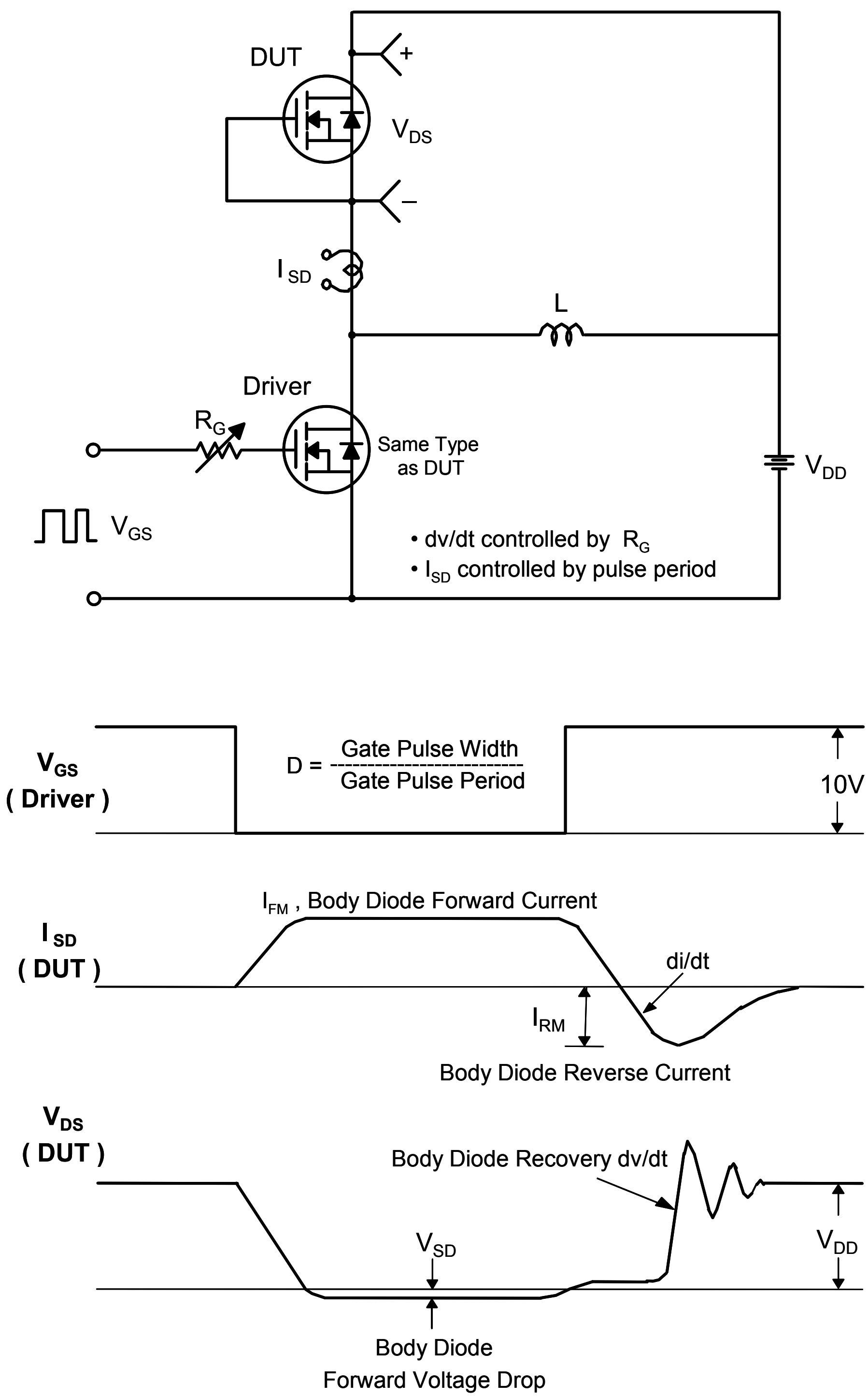



**Figure 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms**

## PUBLICATION ORDERING INFORMATION

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