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August 2014

## FCD5N60 / FCU5N60

### N-Channel SuperFET<sup>®</sup> MOSFET

600 V, 4.6 A, 950 mΩ

#### Features

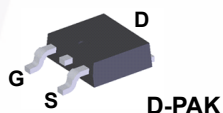
- 650 V @  $T_J = 150^{\circ}\text{C}$
- Typ.  $R_{DS(on)} = 810\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 16\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 32\text{ pF}$ )
- 100% Avalanche Tested
- RoHS Compliant

#### Application

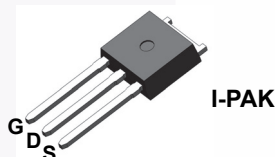
- LCD/LED TV and Monitor
- Lighting
- Solar Inverter
- AC-DC Power Supply

#### Description

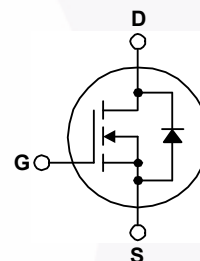
SuperFET<sup>®</sup> MOSFET is Fairchild Semiconductor's first generation of high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This technology is tailored to minimize conduction loss, provide 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.



D-PAK



I-PAK



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

| Symbol         | Parameter                                                            |                                              | FCD5N60TM<br>FCD5N60TM_WS<br>FCU5N60TU | Unit               |
|----------------|----------------------------------------------------------------------|----------------------------------------------|----------------------------------------|--------------------|
| $V_{DSS}$      | Drain to Source Voltage                                              |                                              | 600                                    | V                  |
| $I_D$          | Drain Current                                                        | - Continuous ( $T_C = 25^{\circ}\text{C}$ )  | 4.6                                    | A                  |
|                |                                                                      | - Continuous ( $T_C = 100^{\circ}\text{C}$ ) | 2.9                                    |                    |
| $I_{DM}$       | Drain Current                                                        | - Pulsed (Note 1)                            | 13.8                                   | A                  |
| $V_{GSS}$      | Gate to Source Voltage                                               |                                              | $\pm 30$                               | V                  |
| $E_{AS}$       | Single Pulsed Avalanche Energy                                       | (Note 2)                                     | 159                                    | mJ                 |
| $I_{AR}$       | Avalanche Current                                                    | (Note 1)                                     | 4.6                                    | A                  |
| $E_{AR}$       | Repetitive Avalanche Energy                                          | (Note 1)                                     | 5.4                                    | mJ                 |
| $dv/dt$        | Peak Diode Recovery $dv/dt$                                          | (Note 3)                                     | 4.5                                    | V/ns               |
| $P_D$          | Power Dissipation                                                    | ( $T_C = 25^{\circ}\text{C}$ )               | 54                                     | W                  |
|                |                                                                      | - Derate Above $25^{\circ}\text{C}$          | 0.43                                   |                    |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                              |                                              | $-55$ to $+150$                        | $^{\circ}\text{C}$ |
| $T_L$          | Maximum Lead Temperature for Soldering, 1/8" from Case for 5 Seconds |                                              | 300                                    | $^{\circ}\text{C}$ |

#### Thermal Characteristics

| Symbol          | Parameter                                     | FCD5N60TM<br>FCD5N60TM_WS<br>FCU5N60TU | Unit                 |
|-----------------|-----------------------------------------------|----------------------------------------|----------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.    | 2.3                                    | $^{\circ}\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 83                                     |                      |

## Package Marking and Ordering Information

| Part Number  | Top Mark | Package | Packing Method | Reel Size | Tape Width | Quantity   |
|--------------|----------|---------|----------------|-----------|------------|------------|
| FCD5N60TM    | FCD5N60  | D-PAK   | Tape and Reel  | 330 mm    | 16 mm      | 2500 units |
| FCD5N60TM_WS | FCD5N60  | D-PAK   | Tape and Reel  | 330 mm    | 16 mm      | 2500 units |
| FCU5N60TU    | FCU5N60  | IPAK    | Tube           | N/A       | N/A        | 75 units   |

## Electrical Characteristics $T_C = 25^\circ\text{C}$ unless otherwise noted.

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

### Off Characteristics

|                                |                                             |                                                                              |     |     |           |                    |
|--------------------------------|---------------------------------------------|------------------------------------------------------------------------------|-----|-----|-----------|--------------------|
| $BV_{DSS}$                     | Drain to Source Breakdown Voltage           | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}, T_C = 25^\circ\text{C}$  | 600 | -   | -         | V                  |
|                                |                                             | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}, T_C = 150^\circ\text{C}$ | -   | 650 | -         | V                  |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient   | $I_D = 250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$            | -   | 0.6 | -         | $V/^\circ\text{C}$ |
| $BV_{DS}$                      | Drain to Source Avalanche Breakdown Voltage | $V_{GS} = 0\text{ V}, I_D = 4.6\text{ A}$                                    | -   | 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        |                    |
| $I_{GSS}$                      | Gate to Body Leakage Current                | $V_{GS} = \pm 30\text{ V}, V_{DS} = 0\text{ V}$                              | -   | -   | $\pm 100$ | nA                 |

### On Characteristics

|              |                                      |                                                 |     |      |      |          |
|--------------|--------------------------------------|-------------------------------------------------|-----|------|------|----------|
| $V_{GS(th)}$ | Gate Threshold Voltage               | $V_{GS} = V_{DS}, I_D = 250\text{ }\mu\text{A}$ | 3.0 | -    | 5.0  | V        |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS} = 10\text{ V}, I_D = 2.3\text{ A}$      | -   | 0.81 | 0.95 | $\Omega$ |
| $g_{FS}$     | Forward Transconductance             | $V_{DS} = 40\text{ V}, I_D = 2.3\text{ A}$      | -   | 3.8  | -    | S        |

### Dynamic Characteristics

|                 |                              |                                                                |   |     |     |    |
|-----------------|------------------------------|----------------------------------------------------------------|---|-----|-----|----|
| $C_{iss}$       | Input Capacitance            | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$  | - | 470 | 600 | pF |
| $C_{oss}$       | Output Capacitance           |                                                                | - | 250 | 320 | pF |
| $C_{rss}$       | Reverse Transfer Capacitance |                                                                | - | 22  | -   | pF |
| $C_{oss}$       | Output Capacitance           | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$ | - | 12  | -   | pF |
| $C_{oss(eff.)}$ | Effective Output Capacitance | $V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$    | - | 32  | -   | pF |

### Switching Characteristics

|              |                               |                                                                                                       |   |     |    |    |
|--------------|-------------------------------|-------------------------------------------------------------------------------------------------------|---|-----|----|----|
| $t_{d(on)}$  | Turn-On Delay Time            | $V_{DD} = 300\text{ V}, I_D = 4.6\text{ A}, V_{GS} = 10\text{ V}, R_G = 25\text{ }\Omega$<br>(Note 4) | - | 12  | 30 | ns |
| $t_r$        | Turn-On Rise Time             |                                                                                                       | - | 40  | 90 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time           |                                                                                                       | - | 47  | 95 | ns |
| $t_f$        | Turn-Off Fall Time            |                                                                                                       | - | 22  | 55 | ns |
| $Q_{g(tot)}$ | Total Gate Charge at 10V      | $V_{DS} = 480\text{ V}, I_D = 4.6\text{ A}, V_{GS} = 10\text{ V}$<br>(Note 4)                         | - | 16  | -  | nC |
| $Q_{gs}$     | Gate to Source Gate Charge    |                                                                                                       | - | 2.8 | -  | nC |
| $Q_{gd}$     | Gate to Drain "Miller" Charge |                                                                                                       | - | 7   | -  | nC |

### Drain-Source Diode Characteristics

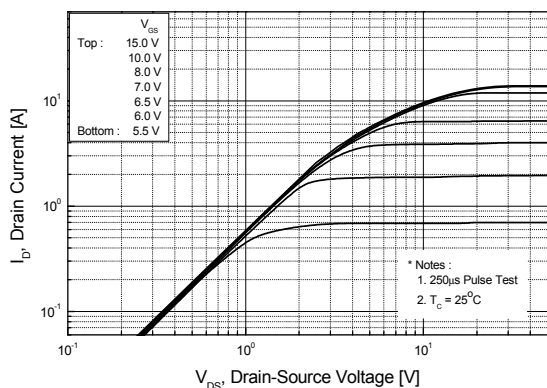
|                 |                                                          |                                                                                  |   |     |      |    |
|-----------------|----------------------------------------------------------|----------------------------------------------------------------------------------|---|-----|------|----|
| I <sub>S</sub>  | Maximum Continuous Drain to Source Diode Forward Current |                                                                                  | - | -   | 4.6  | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain to Source Diode Forward Current     |                                                                                  | - | -   | 13.8 | A  |
| V <sub>SD</sub> | Drain to Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 4.6 A                                   | - | -   | 1.4  | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 4.6 A<br>di <sub>F</sub> /dt = 100 A/μs | - | 295 | -    | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                                  |                                                                                  | - | 2.7 | -    | μC |

#### Notes:

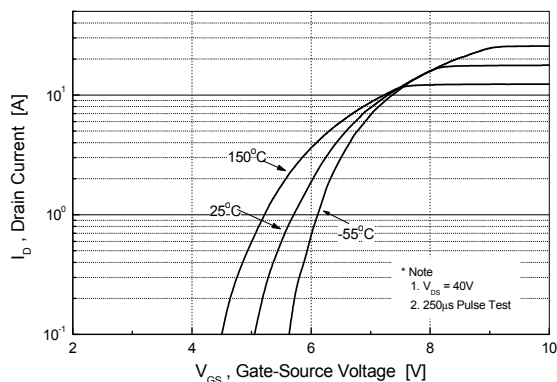
1. Repetitive rating: pulse-width limited by maximum junction temperature.
2.  $I_{AS} = 2.3\text{ A}, V_{DD} = 50\text{ V}, R_G = 25\text{ }\Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 4.6\text{ A}, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , starting  $T_J = 25^\circ\text{C}$ .
4. Essentially independent of operating temperature typical characteristics.

## Typical Performance Characteristics

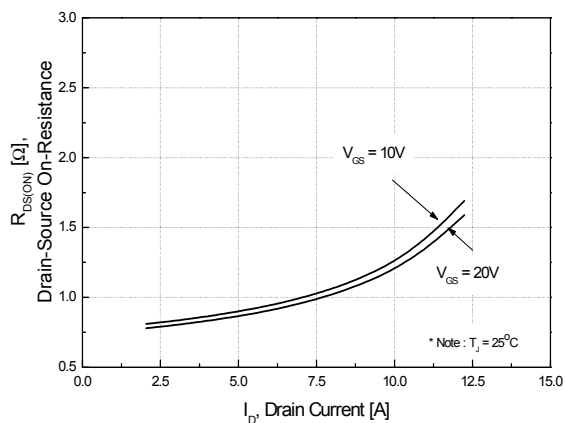
**Figure 1. On-Region Characteristics**



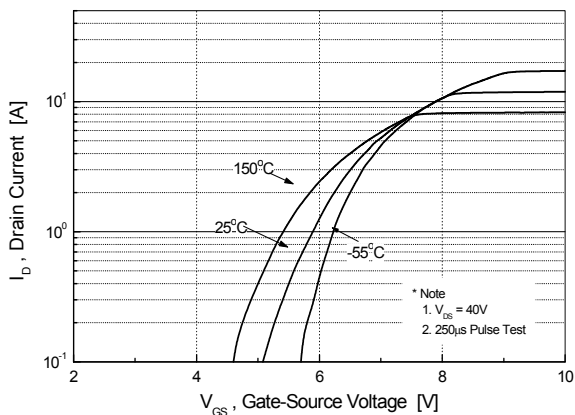
**Figure 2. Transfer Characteristics**



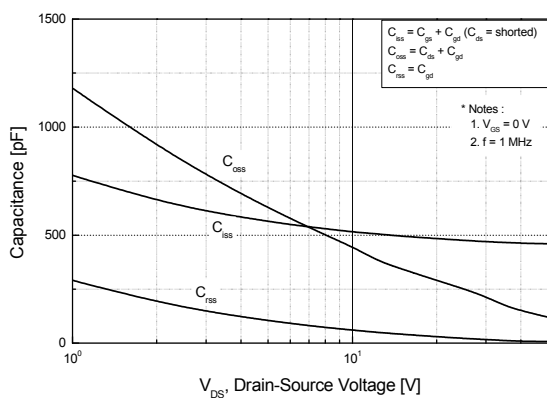
**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**



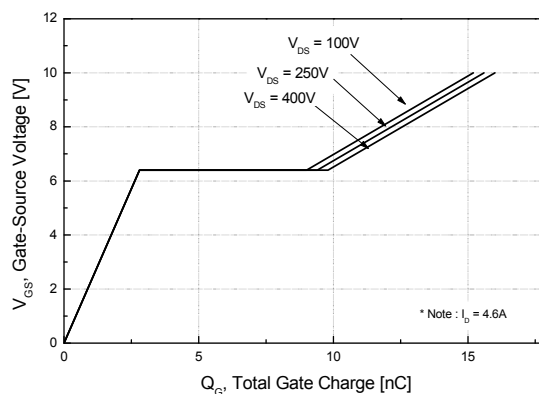
**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature**



**Figure 5. Capacitance Characteristics**

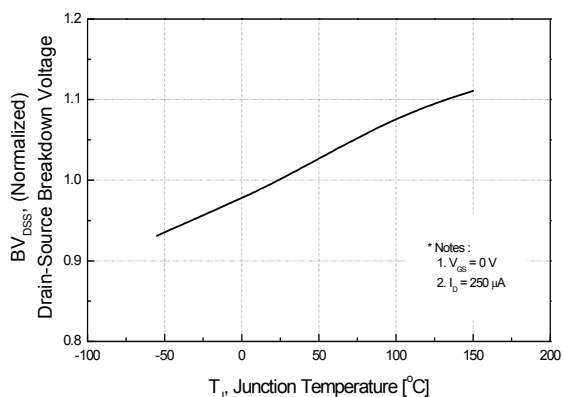


**Figure 6. Gate Charge Characteristics**

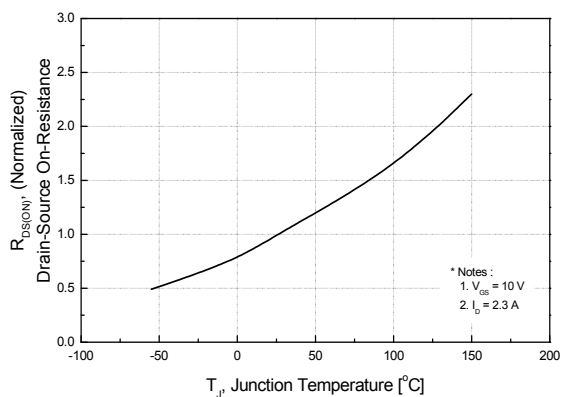


# Typical Performance Characteristics (Continued)

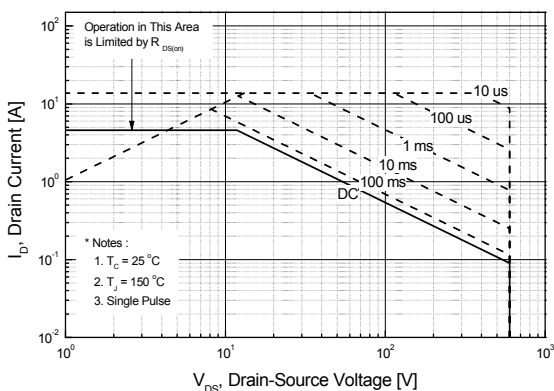
**Figure 7. Breakdown Voltage Variation vs. Temperature**



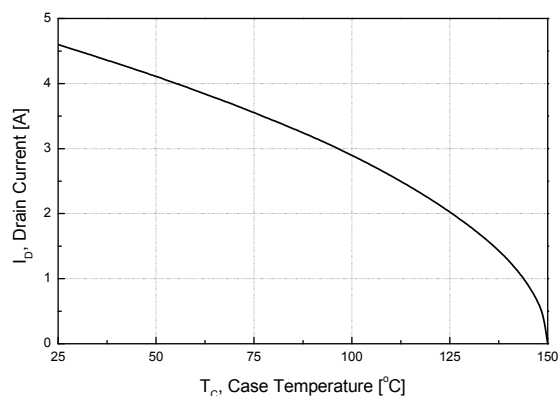
**Figure 8. On-Resistance Variation vs. Temperature**



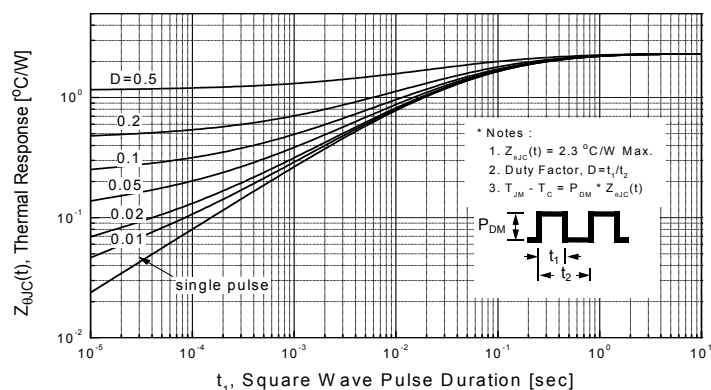
**Figure 9. Maximum Safe Operating Area**



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



**Figure 11. Transient Thermal Response Curve**



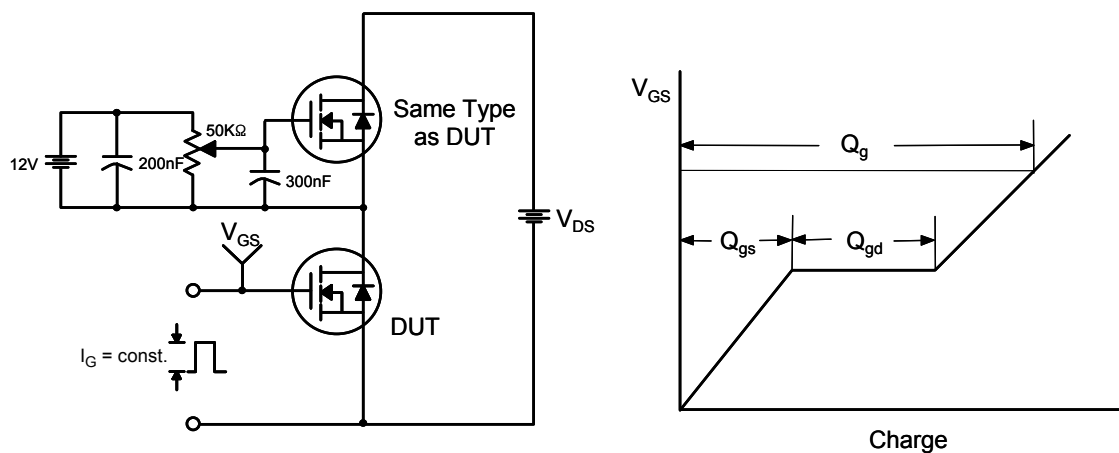


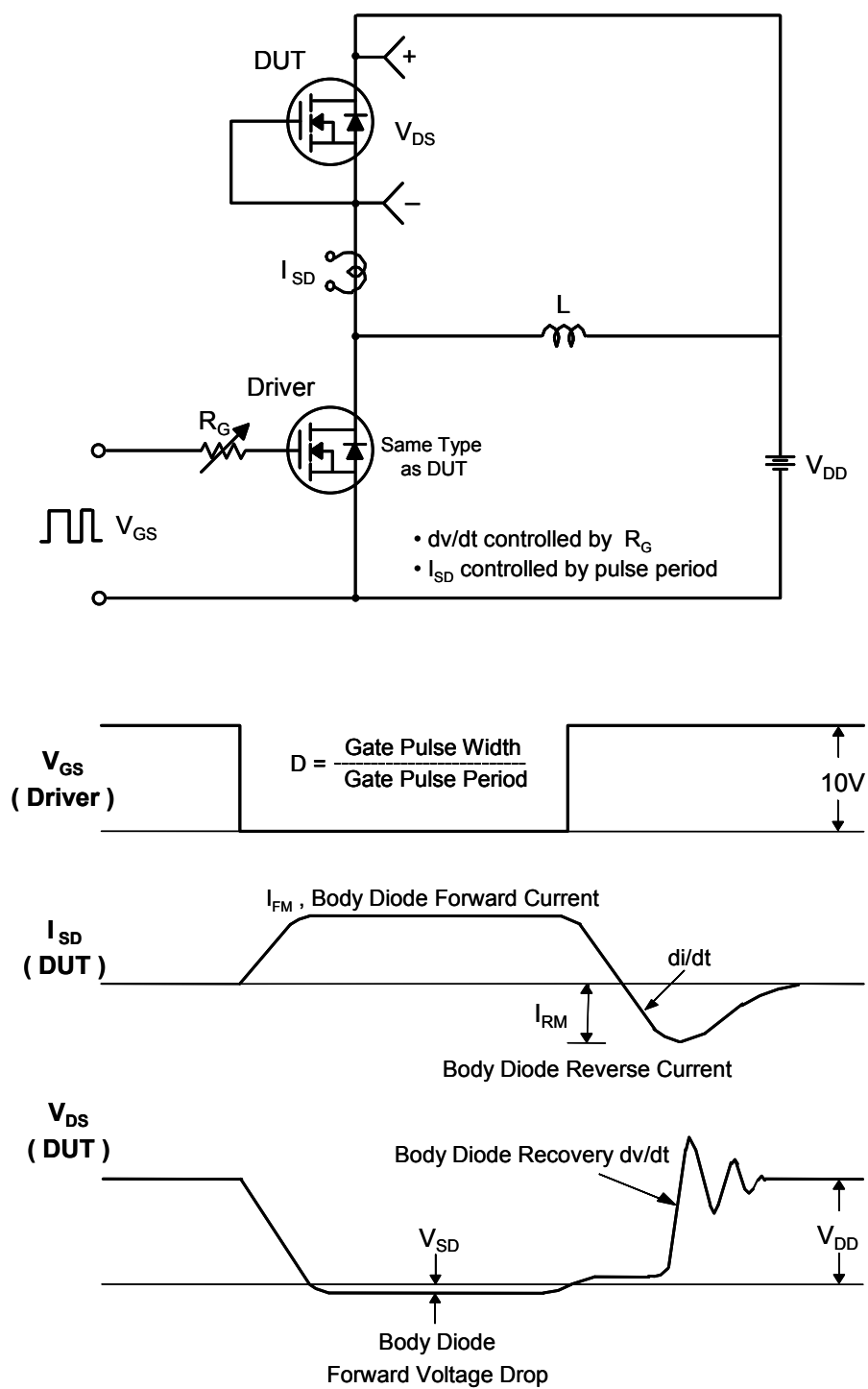
Figure 12. Gate Charge Test Circuit & Waveform



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

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