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# FCB20N60F

## N-Channel SuperFET® FRFET® MOSFET

600 V, 20 A, 190 mΩ

### Features

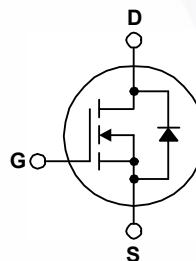
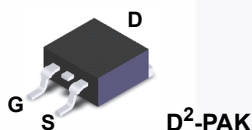
- 650 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 150\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 75\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss,eff} = 165\text{ pF}$ )
- 100% Avalanche Tested
- RoHS Compliant

### Applications

- Lighting
- AC-DC Power Supply
- Solar Inverter

### Description

SuperFET® 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. SuperFET FRFET® MOSFET's optimized body diode reverse recovery performance can remove additional component and improve system reliability.



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

| Symbol         | Parameter                                                                    | FCB20N60FTM                                | Unit               |
|----------------|------------------------------------------------------------------------------|--------------------------------------------|--------------------|
| $V_{DSS}$      | Drain to Source Voltage                                                      | 600                                        | V                  |
| $I_D$          | Drain Current                                                                | - Continuous ( $T_C = 25^\circ\text{C}$ )  | A                  |
|                |                                                                              | - Continuous ( $T_C = 100^\circ\text{C}$ ) |                    |
| $I_{DM}$       | Drain Current                                                                | - Pulsed (Note 1)                          | A                  |
| $V_{GSS}$      | Gate to Source Voltage                                                       | $\pm 30$                                   | V                  |
| $E_{AS}$       | 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) 50                                | V/ns               |
| $P_D$          | Power Dissipation                                                            | ( $T_C = 25^\circ\text{C}$ )               | W                  |
|                |                                                                              | - Derate above $25^\circ\text{C}$          | $W/^\circ\text{C}$ |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                                      | -55 to +150                                | $^\circ\text{C}$   |
| $T_L$          | Maximum Lead Temperature for Soldering Purpose, 1/8" from Case for 5 Seconds | 300                                        | $^\circ\text{C}$   |

### Thermal Characteristics

| Symbol          | Parameter                                                                            | FCB20N60FTM | Unit               |
|-----------------|--------------------------------------------------------------------------------------|-------------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.                                           | 0.6         | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (minimum pad of 2 oz copper), Max.           | 62.5        |                    |
|                 | Thermal Resistance, Junction to Ambient (1 in <sup>2</sup> pad of 2 oz copper), Max. | 40          |                    |

## Package Marking and Ordering Information

| Device Marking | Device      | Package             | Reel Size | Tape Width | Quantity |
|----------------|-------------|---------------------|-----------|------------|----------|
| FCB20N60F      | FCB20N60FTM | D <sup>2</sup> -PAK | 330mm     | 24m        | 800      |

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

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

### Off Characteristics

|                                |                                           |                                                                              |     |     |           |                     |
|--------------------------------|-------------------------------------------|------------------------------------------------------------------------------|-----|-----|-----------|---------------------|
| BV <sub>DSS</sub>              | 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 <sub>DS</sub>               | Drain-Source Avalanche Breakdown Voltage  | $V_{GS} = 0\text{ V}, I_D = 20\text{ A}$                                     | -   | 700 | -         | V                   |
| I <sub>DSS</sub>               | Zero Gate Voltage Drain Current           | $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$                                 | -   | -   | 1         | $\mu\text{A}$       |
|                                |                                           | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}, T_C = 125^\circ\text{C}$        | -   | -   | 10        |                     |
| I <sub>GSS</sub>               | Gate to Body Leakage Current              | $V_{GS} = \pm 30\text{ V}, V_{DS} = 0\text{ V}$                              | -   | -   | $\pm 100$ | nA                  |

### On Characteristics

|                     |                                      |                                                 |     |      |      |          |
|---------------------|--------------------------------------|-------------------------------------------------|-----|------|------|----------|
| V <sub>GS(th)</sub> | Gate Threshold Voltage               | $V_{GS} = V_{DS}, I_D = 250\text{ }\mu\text{A}$ | 3.0 | -    | 5.0  | V        |
| R <sub>DS(on)</sub> | Static Drain to Source On Resistance | $V_{GS} = 10\text{ V}, I_D = 10\text{ A}$       | -   | 0.15 | 0.19 | $\Omega$ |
| g <sub>FS</sub>     | Forward Transconductance             | $V_{DS} = 40\text{ V}, I_D = 10\text{ A}$       | -   | 17   | -    | S        |

### Dynamic Characteristics

|                       |                              |                                                                     |   |      |      |    |
|-----------------------|------------------------------|---------------------------------------------------------------------|---|------|------|----|
| C <sub>iss</sub>      | Input Capacitance            | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}$<br>$f = 1.0\text{ MHz}$ | - | 2370 | 3080 | pF |
| C <sub>oss</sub>      | Output Capacitance           |                                                                     | - | 1280 | 1665 | pF |
| C <sub>rss</sub>      | Reverse Transfer Capacitance |                                                                     | - | 95   | -    | pF |
| C <sub>oss</sub>      | Output Capacitance           | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}$    | - | 65   | 85   | pF |
| C <sub>oss eff.</sub> | Effective Output Capacitance | $V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$         | - | 165  | -    | pF |

### Switching Characteristics

|                     |                               |                                                                        |   |      |     |    |
|---------------------|-------------------------------|------------------------------------------------------------------------|---|------|-----|----|
| t <sub>d(on)</sub>  | Turn-On Delay Time            | $V_{DD} = 300\text{ V}, I_D = 20\text{ A}$<br>$R_G = 25\text{ }\Omega$ | - | 62   | 135 | ns |
| t <sub>r</sub>      | Turn-On Rise Time             |                                                                        | - | 140  | 290 | ns |
| t <sub>d(off)</sub> | Turn-Off Delay Time           |                                                                        | - | 230  | 470 | ns |
| t <sub>f</sub>      | Turn-Off Fall Time            |                                                                        | - | 65   | 140 | ns |
| Q <sub>g(tot)</sub> | Total Gate Charge at 10V      | $V_{DS} = 480\text{ V}, I_D = 20\text{ A},$<br>$V_{GS} = 10\text{ V}$  | - | 75   | 98  | nC |
| Q <sub>gs</sub>     | Gate to Source Gate Charge    |                                                                        | - | 13.5 | 18  | nC |
| Q <sub>gd</sub>     | Gate to Drain "Miller" Charge |                                                                        | - | 36   | -   | nC |

### Drain-Source Diode Characteristics

|                 |                                                          |                                                                                 |   |     |     |    |
|-----------------|----------------------------------------------------------|---------------------------------------------------------------------------------|---|-----|-----|----|
| I <sub>S</sub>  | Maximum Continuous Drain to Source Diode Forward Current |                                                                                 | - | -   | 20  | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain to Source Diode Forward Current     |                                                                                 | - | -   | 60  | A  |
| V <sub>SD</sub> | Drain to Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 20 A                                   | - | -   | 1.4 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 20 A<br>dI <sub>F</sub> /dt = 100 A/μs | - | 160 | -   | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                                  |                                                                                 | - | 1.1 | -   | μC |

#### Notes:

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2.  $I_{AS} = 10\text{ A}, V_{DD} = 50\text{ V}, R_G = 25\text{ }\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq 20\text{ A}, di/dt \leq 1200\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$
4. Essentially Independent of Operating Temperature Typical Characteristics

## Typical Performance Characteristics

Figure 1. On-Region Characteristics

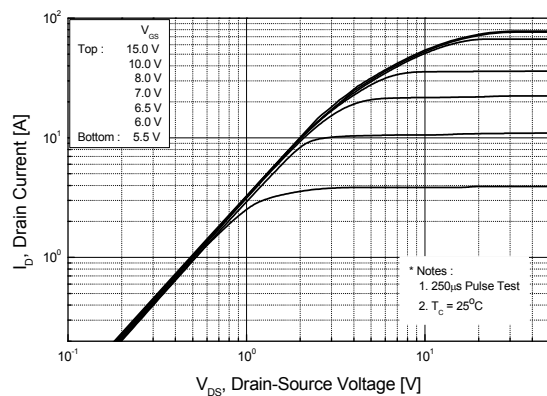


Figure 2. Transfer Characteristics

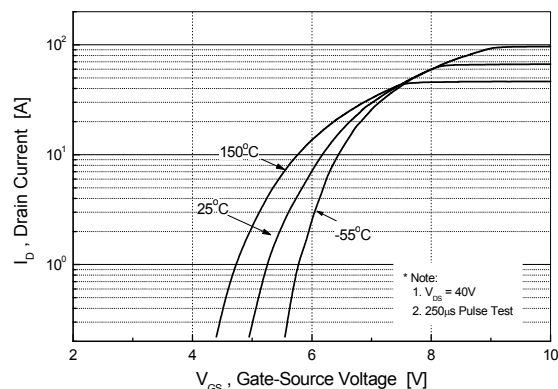


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

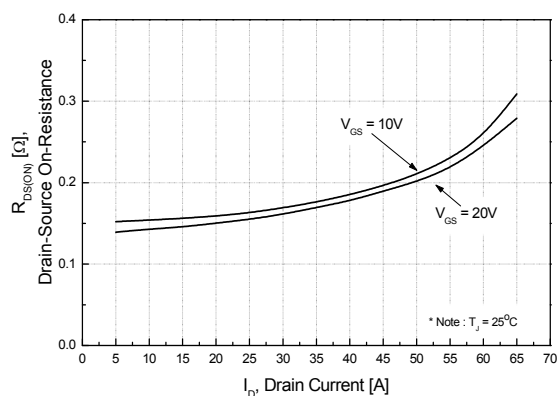


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

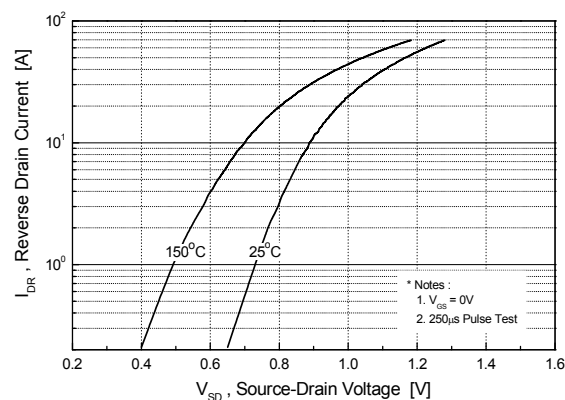


Figure 5. Capacitance Characteristics

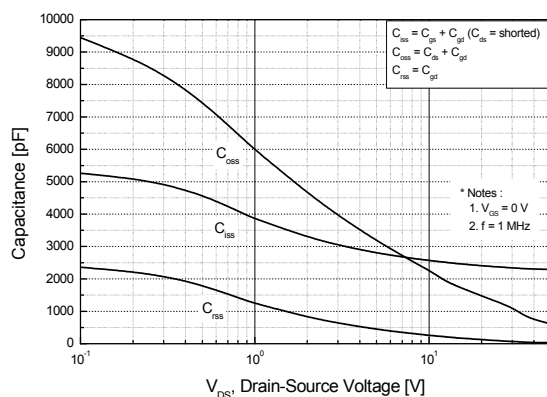
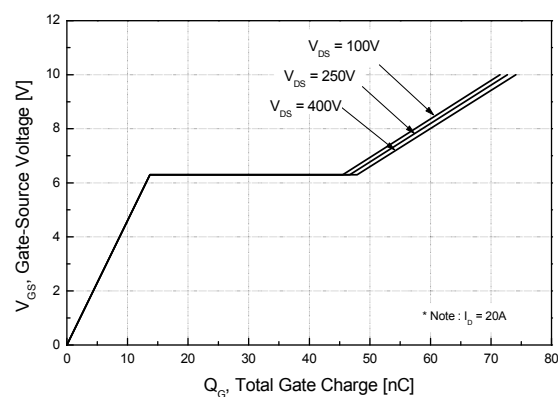
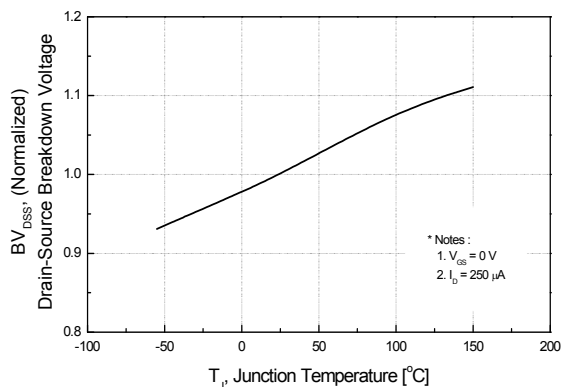


Figure 6. Gate Charge Characteristics

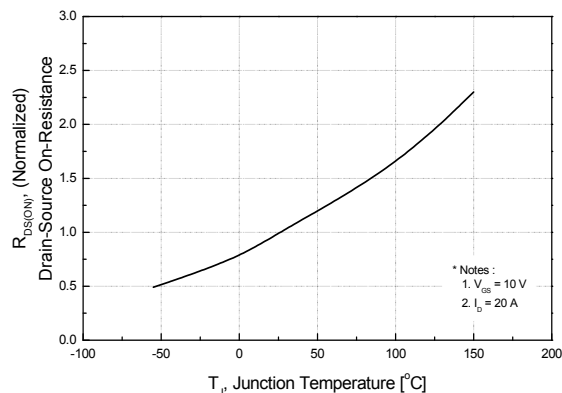


## Typical Performance Characteristics (Continued)

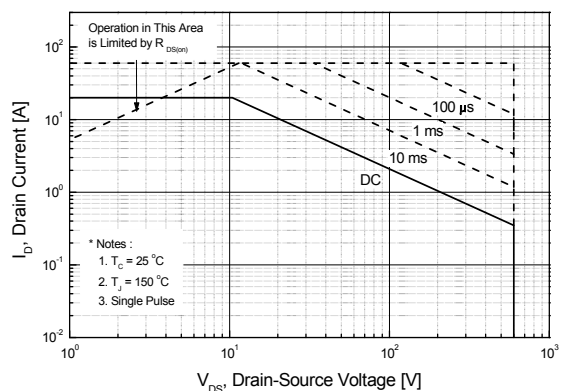
**Figure 7. Breakdown Voltage Variation vs. Temperature**



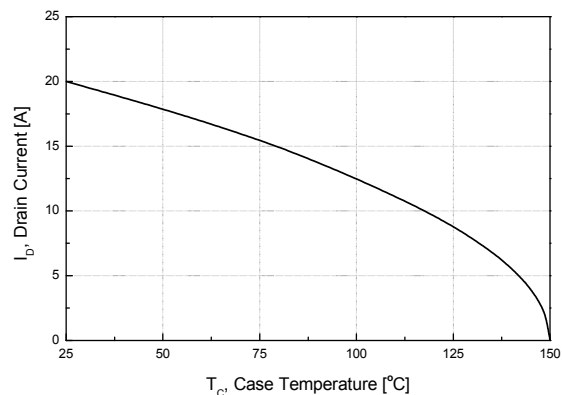
**Figure 8. On-Resistance Variation vs. Temperature**



**Figure 9. Maximum Safe Operating Area**



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



**Figure 11. Transient Thermal Response Curve**

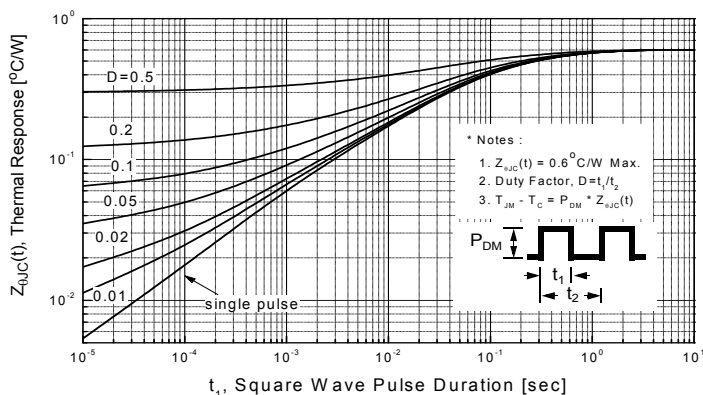


Figure 12. Gate Charge Test Circuit & Waveform

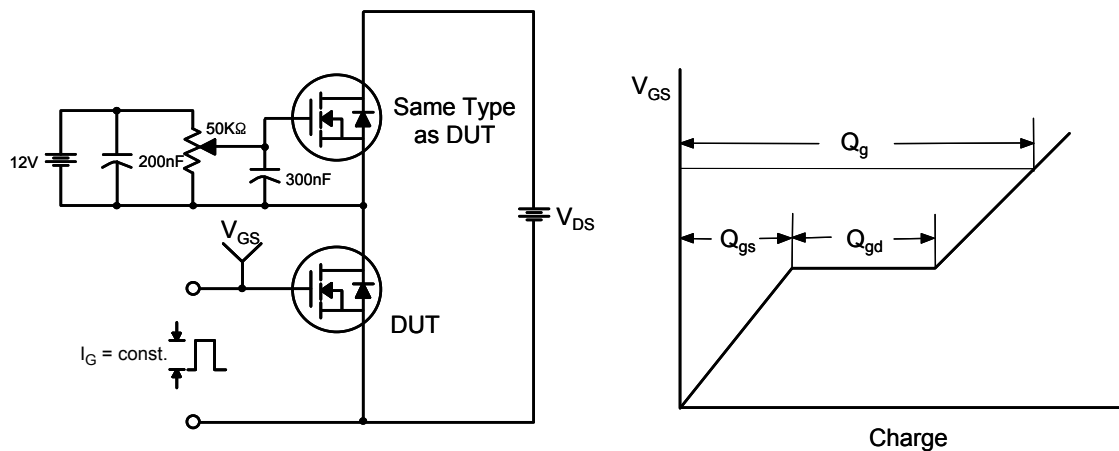


Figure 13. Resistive Switching Test Circuit & Waveforms

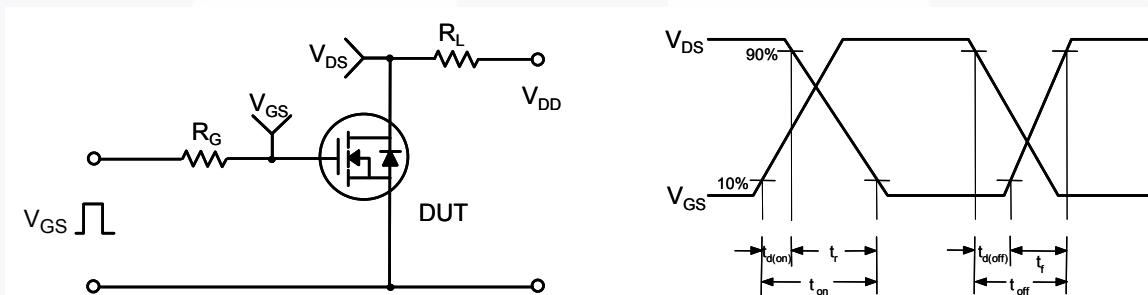
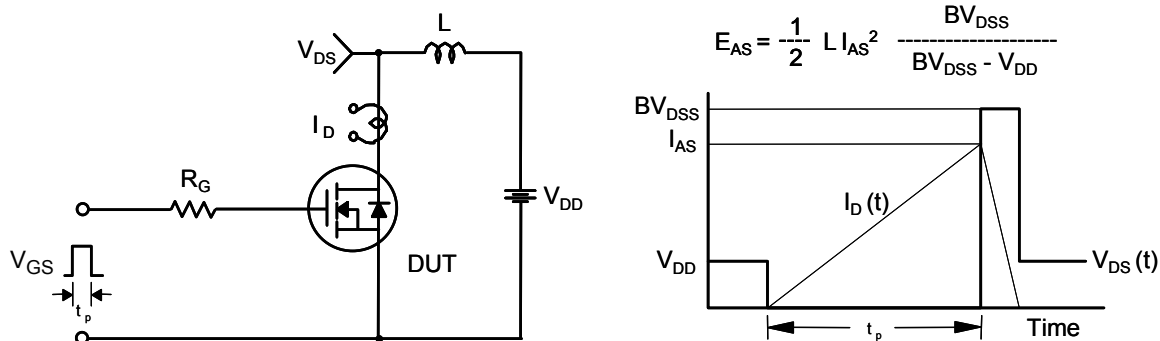
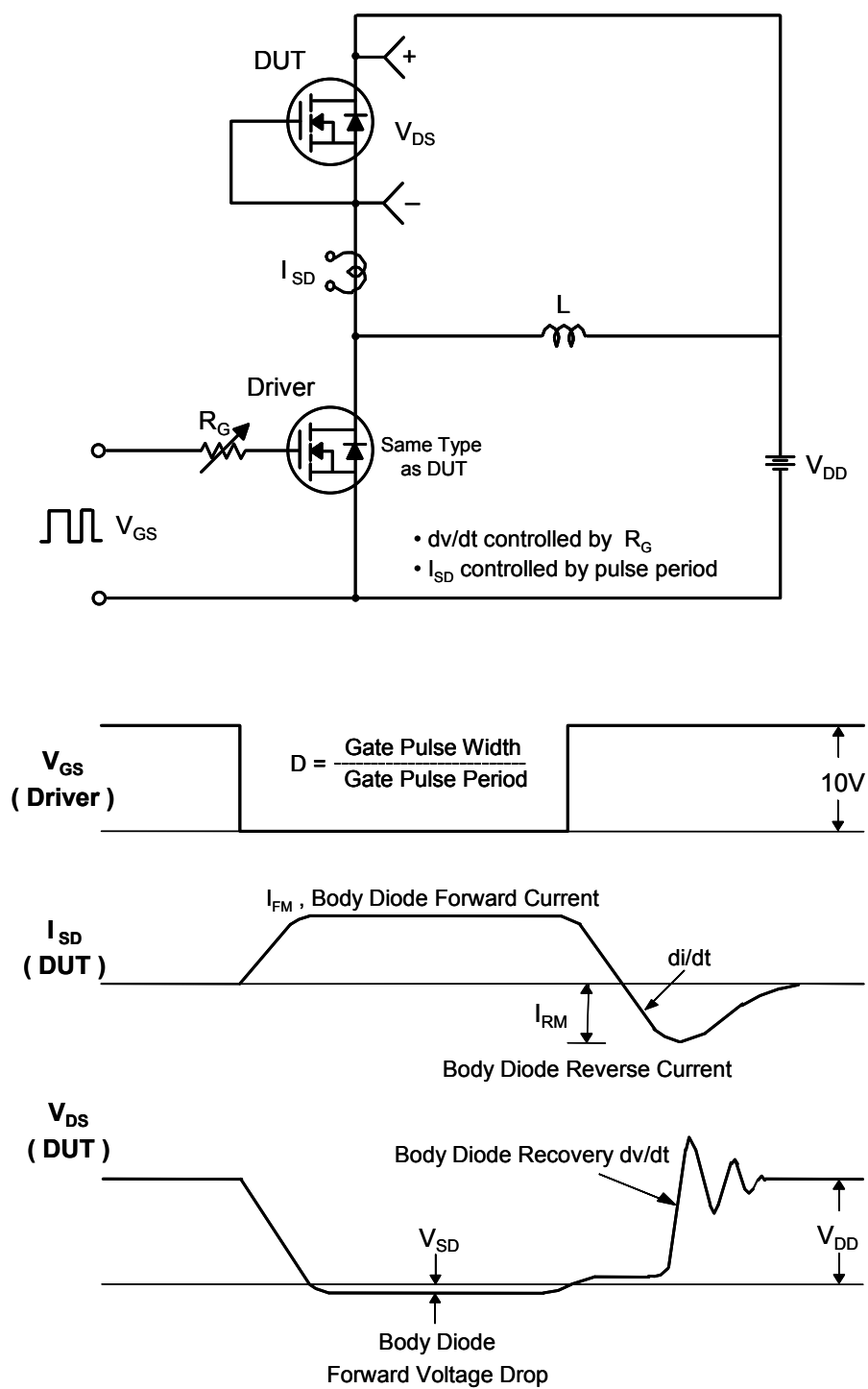


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms



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



## Mechanical Dimensions

TO-263 2L (D<sup>2</sup>PAK)

Figure 16. 2LD, TO263, Surface Mount

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Dimension in Millimeters



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| BitSiC™                                                                           | Global Power ResourceSM                         | Programmable Active Droop™ | TinyBoost®                                                                          |
| Build it Now™                                                                     | GreenBridge™                                    | QFET®                      | TinyBuck®                                                                           |
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| Fairchild®                                                                        | MicroPak2™                                      |                            | UHC®                                                                                |
| Fairchild Semiconductor®                                                          | MillerDrive™                                    |                            | Ultra FRFET™                                                                        |
| FACT Quiet Series™                                                                | MotionMax™                                      |                            | UniFET™                                                                             |
| FACT®                                                                             | mWSaver®                                        |                            | VCX™                                                                                |
| FAST®                                                                             | OptoHiT™                                        |                            | VisualMax™                                                                          |
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