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## FCP220N80

### N-Channel SuperFET® II MOSFET

800 V, 23 A, 220 mΩ

September 2015

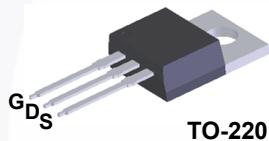


#### Features

- Typ.  $R_{DS(on)} = 188 \text{ mΩ}$
- Ultra Low Gate Charge (Typ.  $Q_g = 78 \text{ nC}$ )
- Low  $E_{oss}$  (Typ. 7.5 uJ @ 400 V)
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 304 \text{ pF}$ )
- 100% Avalanche Tested
- RoHS Compliant
- ESD Improved Capability

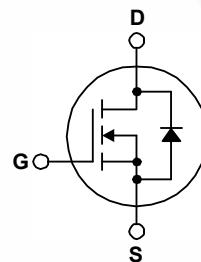
#### Applications

- AC-DC Power Supply
- LED Lighting



#### Description

SuperFET® II MOSFET is Fairchild Semiconductor's brand-new 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 II MOSFET is very suitable for the switching power applications such as PFC, server/telecom power, FPD TV power, ATX power and industrial power applications.



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

| Symbol         | Parameter  |  | FCP220N80   | Unit                |
|----------------|--|--|-------------|---------------------|
| $V_{DSS}$      | Drain to Source Voltage  |  | 800         | V                   |
| $V_{GSS}$      | Gate to Source Voltage   | - DC                                       | $\pm 20$    | V                   |
|                |  | - AC ( $f > 1 \text{ Hz}$ )                | $\pm 30$    |                     |
| $I_D$          | Drain Current  | - Continuous ( $T_C = 25^\circ\text{C}$ )  | 23          | A                   |
|                |  | - Continuous ( $T_C = 100^\circ\text{C}$ ) | 14.6        |                     |
| $I_{DM}$       | Drain Current  | - Pulsed                                   | (Note 1)    | A                   |
| $E_{AS}$       | Single Pulsed Avalanche Energy                                       |  | 645         | mJ                  |
| $I_{AR}$       | Avalanche Current  | (Note 1)                                   | 4.6         | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy  | (Note 1)                                   | 27.8        | mJ                  |
| $dv/dt$        | MOSFET $dv/dt$   |  | 100         | V/ns                |
|                | Peak Diode Recovery $dv/dt$  | (Note 3)                                   | 20          |                     |
| $P_D$          | Power Dissipation  | ( $T_C = 25^\circ\text{C}$ )               | 278         | W                   |
|                |  | - Derate Above $25^\circ\text{C}$          | 2.22        | 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, 1/8" from Case for 5 Seconds |  | 300         | $^\circ\text{C}$    |

#### Thermal Characteristics

| Symbol          | Parameter                                     | FCP220N80 | Unit                      |
|-----------------|---|-----------|---------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.    | 0.45      | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 62.5      |                           |

## Package Marking and Ordering Information

| Part Number | Top Mark  | Package | Packing Method | Reel Size | Tape Width | Quantity |
|-------------|-----------|---------|----------------|-----------|------------|----------|
| FCP220N80   | FCP220N80 | TO-220  | Tube           | N/A       | N/A        | 50 units |

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

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

### Off Characteristics

|  |   |   |     |     |           |                  |
|--|---|---|-----|-----|-----------|------------------|
| $\text{BV}_{\text{DSS}}$                     | Drain to Source Breakdown Voltage         | $V_{\text{GS}} = 0 \text{ V}$ , $I_D = 1 \text{ mA}$ , $T_J = 25^\circ\text{C}$ | 800 | -   | -         | V                |
| $\Delta \text{BV}_{\text{DSS}} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 1 \text{ mA}$ , Referenced to $25^\circ\text{C}$                         | -   | 0.8 | -         | $^\circ\text{C}$ |
| $I_{\text{DSS}}$                             | Zero Gate Voltage Drain Current           | $V_{\text{DS}} = 800 \text{ V}$ , $V_{\text{GS}} = 0 \text{ V}$                 | -   | -   | 25        | $\mu\text{A}$    |
|  |   | $V_{\text{DS}} = 640 \text{ V}$ , $T_C = 125^\circ\text{C}$                     | -   | -   | 250       |                  |
| $I_{\text{GSS}}$                             | Gate to Body Leakage Current              | $V_{\text{GS}} = \pm 20 \text{ V}$ , $V_{\text{DS}} = 0 \text{ V}$              | -   | -   | $\pm 100$ | nA               |

### On Characteristics

|                     |                                      |  |     |     |     |                  |
|---------------------|--------------------------------------|--|-----|-----|-----|------------------|
| $V_{\text{GS(th)}}$ | Gate Threshold Voltage               | $V_{\text{GS}} = V_{\text{DS}}$ , $I_D = 2.3 \text{ mA}$ | 2.5 | -   | 4.5 | V                |
| $R_{\text{DS(on)}}$ | Static Drain to Source On Resistance | $V_{\text{GS}} = 10 \text{ V}$ , $I_D = 11.5 \text{ A}$  | -   | 188 | 220 | $\text{m}\Omega$ |
| $g_{\text{FS}}$     | Forward Transconductance             | $V_{\text{DS}} = 20 \text{ V}$ , $I_D = 11.5 \text{ A}$  | -   | 25  | -   | S                |

### Dynamic Characteristics

|                        |                               |   |   |      |      |          |
|------------------------|-------------------------------|---|---|------|------|----------|
| $C_{\text{iss}}$       | Input Capacitance             | $V_{\text{DS}} = 100 \text{ V}$ , $V_{\text{GS}} = 0 \text{ V}$ , $f = 1 \text{ MHz}$   | - | 3430 | 4560 | pF       |
| $C_{\text{oss}}$       | Output Capacitance            |   | - | 100  | 135  | pF       |
| $C_{\text{rss}}$       | Reverse Transfer Capacitance  |   | - | 0.3  | -    | pF       |
| $C_{\text{oss}}$       | Output Capacitance            | $V_{\text{DS}} = 480 \text{ V}$ , $V_{\text{GS}} = 0 \text{ V}$ , $f = 1 \text{ MHz}$   | - | 49   | -    | pF       |
| $C_{\text{oss(eff.)}}$ | Effective Output Capacitance  | $V_{\text{DS}} = 0 \text{ V}$ to $480 \text{ V}$ , $V_{\text{GS}} = 0 \text{ V}$        | - | 304  | -    | pF       |
| $Q_{\text{g(tot)}}$    | Total Gate Charge at 10V      | $V_{\text{DS}} = 640 \text{ V}$ , $I_D = 23 \text{ A}$ , $V_{\text{GS}} = 10 \text{ V}$ | - | 78   | 105  | nC       |
| $Q_{\text{gs}}$        | Gate to Source Gate Charge    | (Note 4)  | - | 16   | -    | nC       |
| $Q_{\text{gd}}$        | Gate to Drain "Miller" Charge |   | - | 28   | -    | nC       |
| $\text{ESR}$           | Equivalent Series Resistance  | $f = 1 \text{ MHz}$   | - | 0.78 | -    | $\Omega$ |

### Switching Characteristics

|                     |                     |  |          |    |     |    |
|---------------------|---------------------|--|----------|----|-----|----|
| $t_{\text{d(on)}}$  | Turn-On Delay Time  | $V_{\text{DD}} = 400 \text{ V}$ , $I_D = 23 \text{ A}$ , $V_{\text{GS}} = 10 \text{ V}$ , $R_g = 4.7 \Omega$ | -        | 27 | 64  | ns |
| $t_r$               | Turn-On Rise Time   |  | -        | 19 | 48  | ns |
| $t_{\text{d(off)}}$ | Turn-Off Delay Time |  | -        | 75 | 160 | ns |
| $t_f$               | Turn-Off Fall Time  |  | (Note 4) | -  | 2.6 | 15 |

### Drain-Source Diode Characteristics

|                 |  |  |   |     |     |               |
|-----------------|--|--|---|-----|-----|---------------|
| $I_S$           | Maximum Continuous Drain to Source Diode Forward Current | -  | - | 23  | A   |               |
| $I_{\text{SM}}$ | Maximum Pulsed Drain to Source Diode Forward Current     | -  | - | 57  | A   |               |
| $V_{\text{SD}}$ | Drain to Source Diode Forward Voltage                    | $V_{\text{GS}} = 0 \text{ V}$ , $I_{\text{SD}} = 23 \text{ A}$   | - | -   | 1.2 | V             |
| $t_{\text{rr}}$ | Reverse Recovery Time                                    | $V_{\text{GS}} = 0 \text{ V}$ , $I_{\text{SD}} = 23 \text{ A}$ , $dI_F/dt = 100 \text{ A}/\mu\text{s}$ | - | 560 | -   | ns            |
| $Q_{\text{rr}}$ | Reverse Recovery Charge                                  |  | - | 14  | -   | $\mu\text{C}$ |

#### Notes:

1. Repetitive rating: pulse-width limited by maximum junction temperature.
2.  $I_{\text{AS}} = 4.6 \text{ A}$ ,  $V_{\text{DD}} = 50 \text{ V}$ ,  $R_g = 25 \Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{\text{SD}} \leq 23 \text{ A}$ ,  $dI/dt \leq 200 \text{ A}/\mu\text{s}$ ,  $V_{\text{DD}} \leq \text{BV}_{\text{DSS}}$ , starting  $T_J = 25^\circ\text{C}$ .
4. Essentially independent of operating temperature typical characteristics.

## Typical Performance Characteristics

Figure 1. On-Region Characteristics

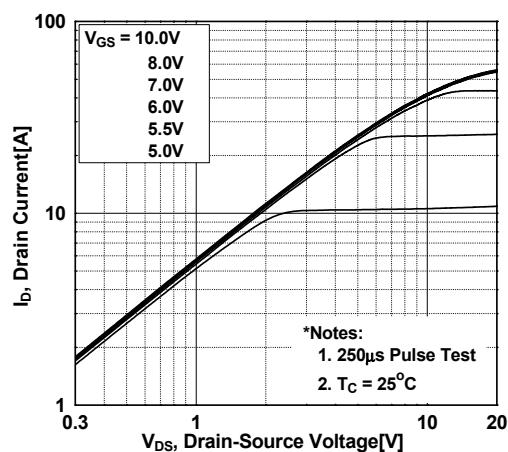


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

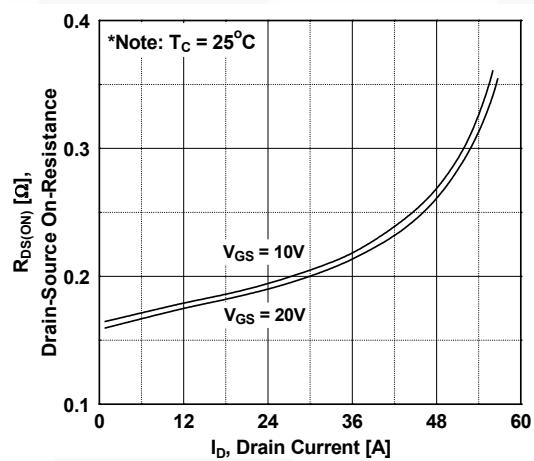


Figure 5. Capacitance Characteristics

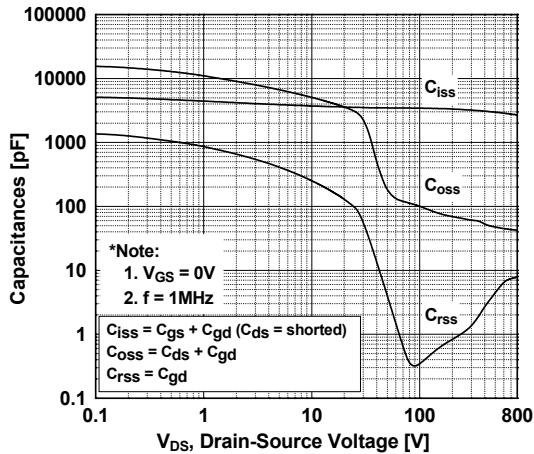


Figure 2. Transfer Characteristics

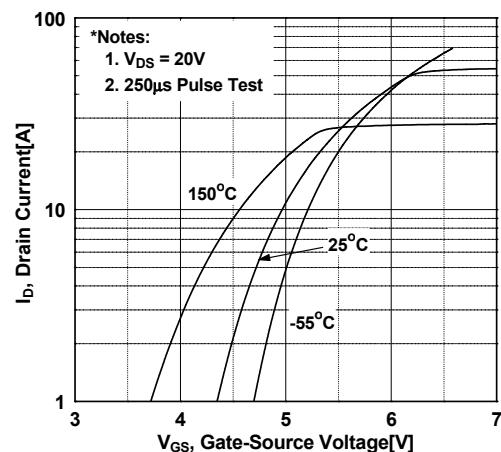


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

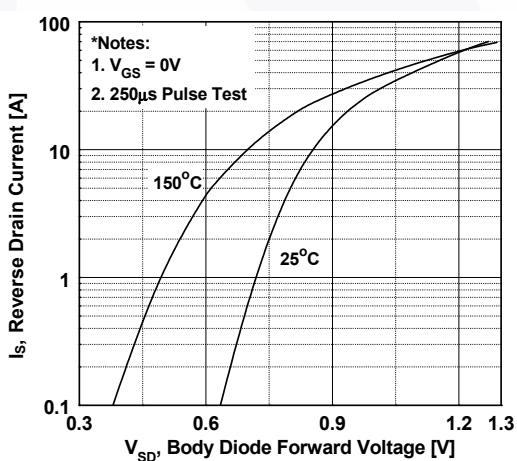
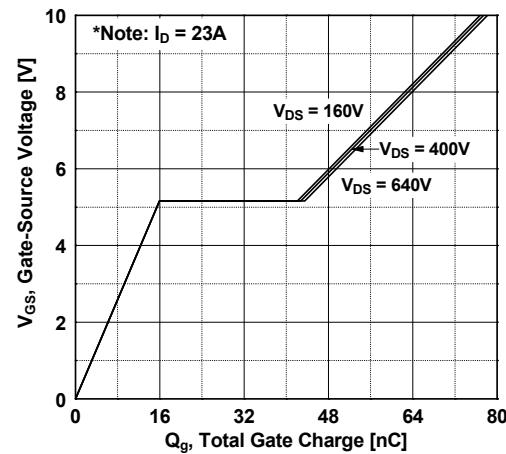
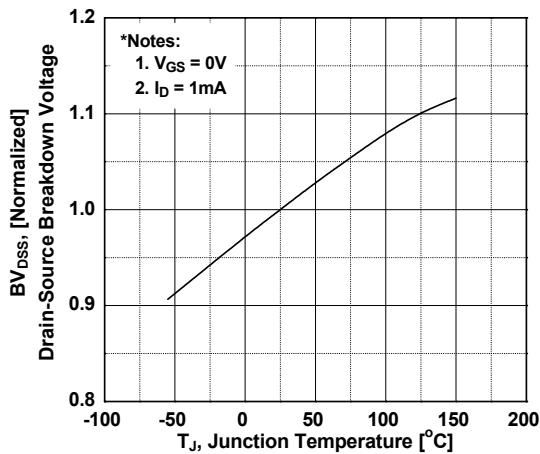


Figure 6. Gate Charge Characteristics

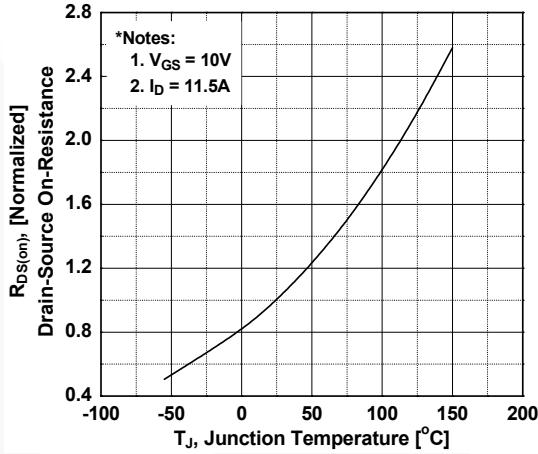


## Typical Performance Characteristics (Continued)

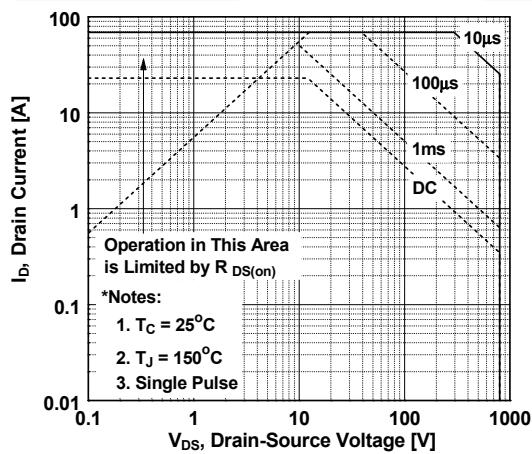
**Figure 7. Breakdown Voltage Variation vs. Temperature**



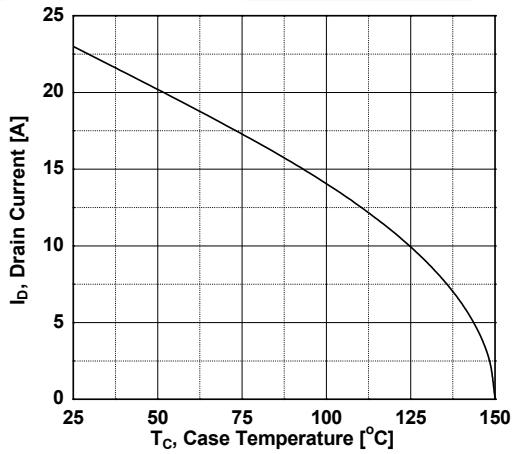
**Figure 8. On-Resistance Variation vs. Temperature**



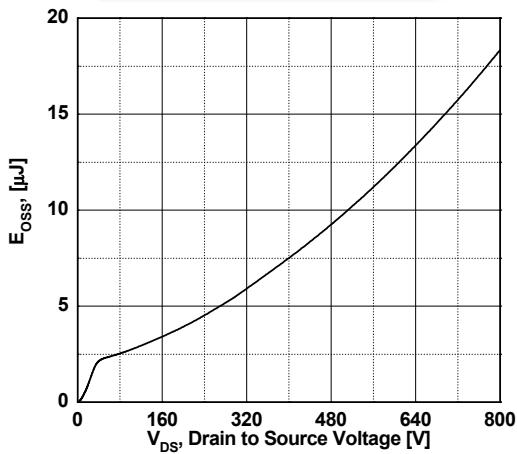
**Figure 9. Maximum Safe Operating Area**



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

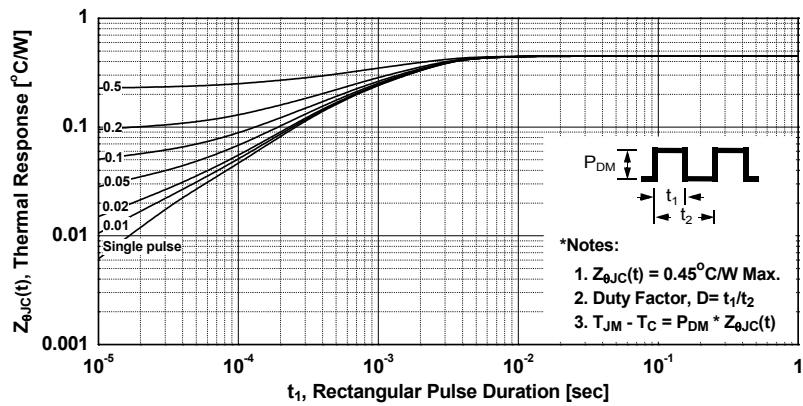


**Figure 11. Eoss vs. Drain to Source Voltage**



## Typical Performance Characteristics (Continued)

Figure 12. Transient Thermal Response Curve



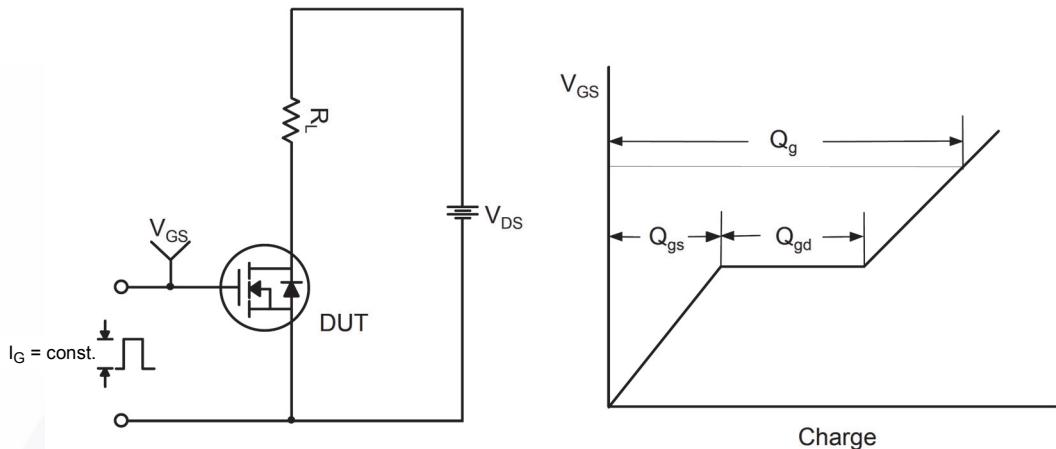


Figure 13. Gate Charge Test Circuit & Waveform

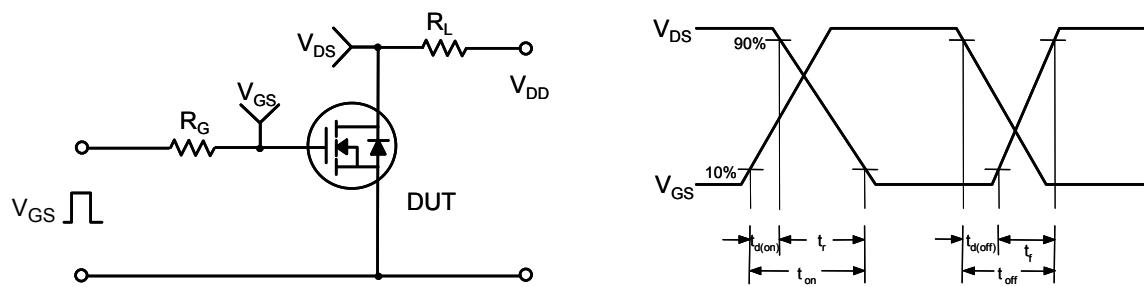


Figure 14. Resistive Switching Test Circuit & Waveforms

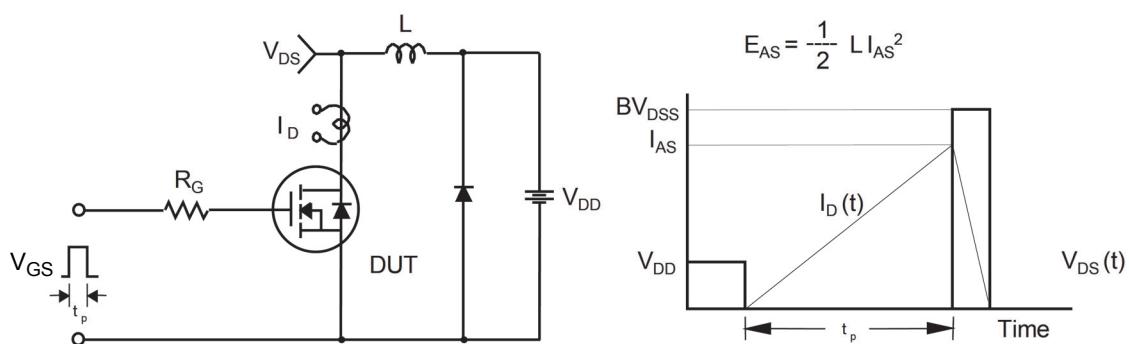


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

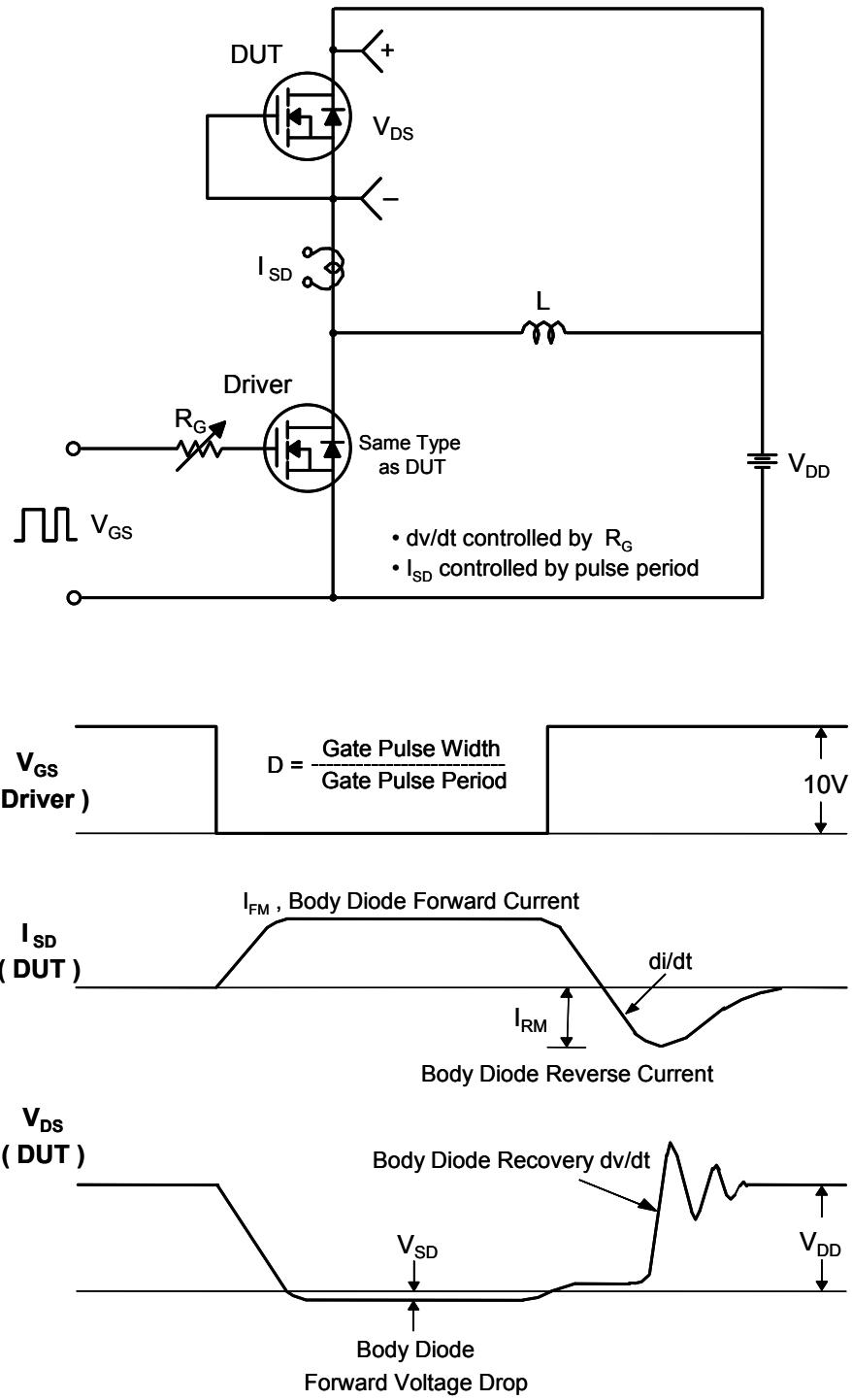
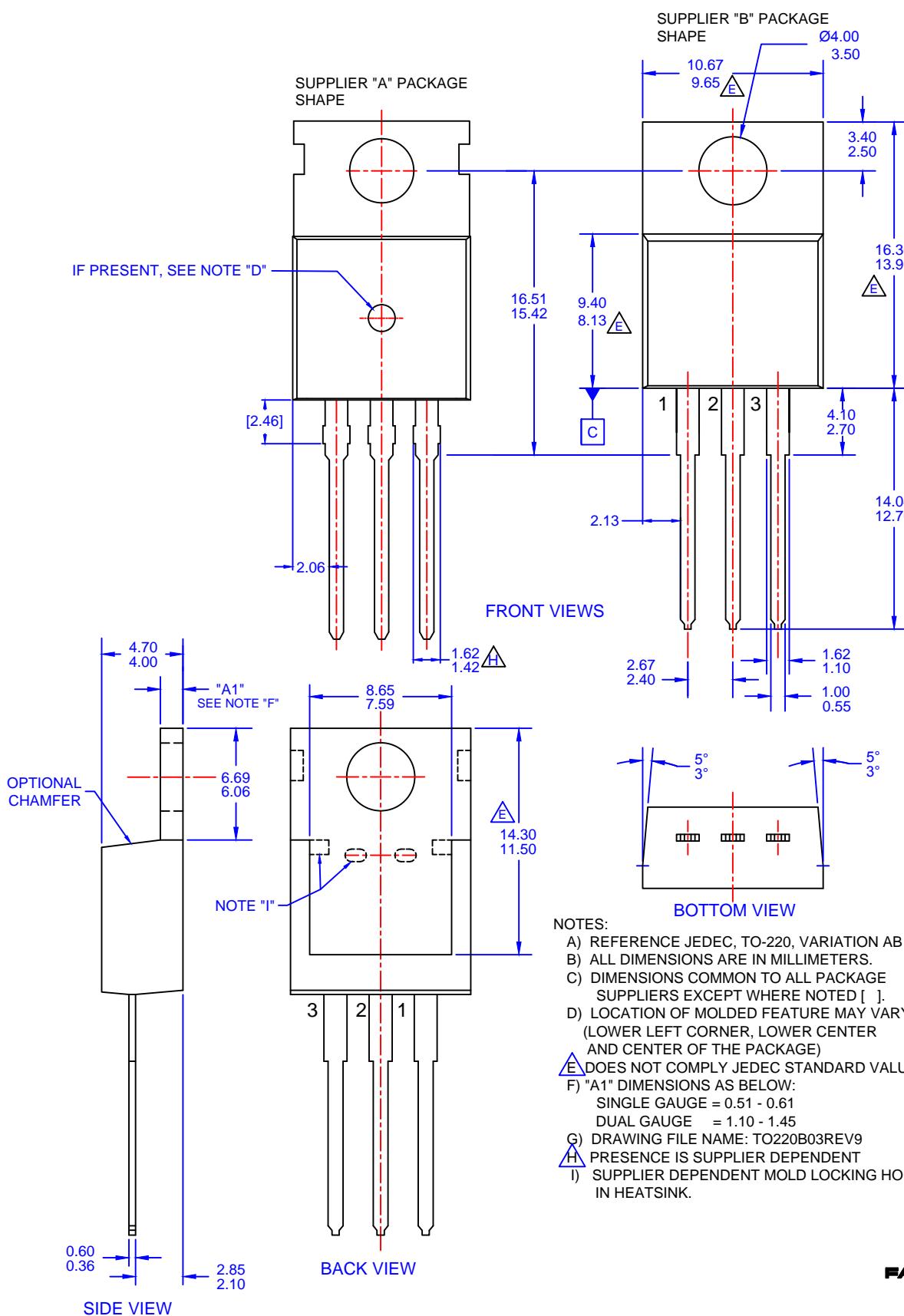


Figure 16. Peak Diode Recovery  $\frac{dv}{dt}$  Test Circuit & Waveforms



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