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# FCP099N65S3

## N-Channel SuperFET® III MOSFET

650 V, 30 A, 99 mΩ

### Features

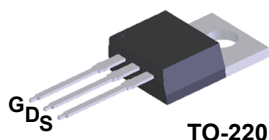
- 700 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 79\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 61\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 544\text{ pF}$ )
- 100% Avalanche Tested
- RoHS Compliant

### Applications

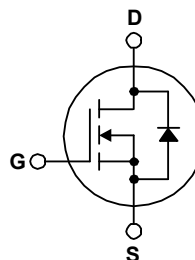
- Telecom / Server Power Supplies
- Industrial Power Supplies
- UPS / Solar

### Description

SuperFET® III MOSFET is ON 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 advanced technology is tailored to minimize conduction loss, provide superior switching performance, and withstand extreme  $dv/dt$  rate. Consequently, SuperFET III MOSFET is very suitable for various power system for miniaturization and higher efficiency.



TO-220



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

| Symbol         | Parameter                                                            | FCP099N65S3                                | Unit               |
|----------------|----------------------------------------------------------------------|--------------------------------------------|--------------------|
| $V_{DSS}$      | Drain to Source Voltage                                              | 650                                        | V                  |
| $V_{GSS}$      | Gate to Source Voltage                                               | $\pm 30$                                   | V                  |
|                |                                                                      | $\pm 30$                                   | V                  |
| $I_D$          | Drain Current                                                        | - DC                                       | A                  |
|                |                                                                      | - AC (f > 1 Hz)                            |                    |
| $I_{DM}$       | Drain Current                                                        | - Continuous ( $T_C = 25^\circ\text{C}$ )  | A                  |
|                |                                                                      | - Continuous ( $T_C = 100^\circ\text{C}$ ) |                    |
| $I_{AS}$       | Avalanche Current                                                    | 75                                         | A                  |
| $E_{AS}$       | Single Pulsed Avalanche Energy                                       | 145                                        | mJ                 |
| $E_{AR}$       | Repetitive Avalanche Energy                                          | 4.4                                        | A                  |
| $dv/dt$        | MOSFET $dv/dt$                                                       | 2.27                                       | mJ                 |
| $P_D$          | Power Dissipation                                                    | 100                                        | V/ns               |
|                |                                                                      | 20                                         |                    |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                              | (Note 1)                                   | W                  |
|                |                                                                      | (Note 2)                                   |                    |
| $T_L$          | Maximum Lead Temperature for Soldering, 1/8" from Case for 5 Seconds | (Note 3)                                   | $W/^\circ\text{C}$ |
|                |                                                                      | (Note 4)                                   |                    |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                              | (Note 5)                                   | $^\circ\text{C}$   |
|                |                                                                      | (Note 6)                                   |                    |
| $T_L$          | Maximum Lead Temperature for Soldering, 1/8" from Case for 5 Seconds | (Note 7)                                   | $^\circ\text{C}$   |
|                |                                                                      | (Note 8)                                   |                    |

### Thermal Characteristics

| Symbol          | Parameter                                     | FCP099N65S3 | Unit               |
|-----------------|-----------------------------------------------|-------------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.    | 0.55        | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | 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 |
|-------------|-------------|---------|----------------|-----------|------------|----------|
| FCP099N65S3 | FCP099N65S3 | 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

|                                |                                           |                                                                   |     |      |           |                    |
|--------------------------------|-------------------------------------------|-------------------------------------------------------------------|-----|------|-----------|--------------------|
| $BV_{DSS}$                     | Drain to Source Breakdown Voltage         | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}, T_J = 25^\circ\text{C}$  | 650 | -    | -         | V                  |
|                                |                                           | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}, T_J = 150^\circ\text{C}$ | 700 | -    | -         | V                  |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 1\text{ mA}$ , Referenced to $25^\circ\text{C}$            | -   | 0.68 | -         | $V/^\circ\text{C}$ |
| $I_{DSS}$                      | Zero Gate Voltage Drain Current           | $V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$                      | -   | -    | 1         | $\mu\text{A}$      |
|                                |                                           | $V_{DS} = 520\text{ V}, T_C = 125^\circ\text{C}$                  | -   | 1.4  | -         |                    |
| $I_{GSS}$                      | 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               | $V_{GS} = V_{DS}, I_D = 3\text{ mA}$      | 2.5 | -  | 4.5 | V          |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS} = 10\text{ V}, I_D = 15\text{ A}$ | -   | 79 | 99  | m $\Omega$ |
| $g_{FS}$     | Forward Transconductance             | $V_{DS} = 20\text{ V}, I_D = 15\text{ A}$ | -   | 19 | -   | S          |

### Dynamic Characteristics

|                 |                                   |                                                                                   |   |      |   |          |
|-----------------|-----------------------------------|-----------------------------------------------------------------------------------|---|------|---|----------|
| $C_{iss}$       | Input Capacitance                 | $V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1\text{ MHz}$               | - | 2480 | - | pF       |
| $C_{oss}$       | Output Capacitance                |                                                                                   | - | 55   | - | pF       |
| $C_{oss(eff.)}$ | Effective Output Capacitance      | $V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$                       | - | 544  | - | pF       |
| $C_{oss(er.)}$  | Energy Related Output Capacitance | $V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$                       | - | 78   | - | pF       |
| $Q_{g(tot)}$    | Total Gate Charge at 10V          | $V_{DS} = 400\text{ V}, I_D = 15\text{ A},$<br>$V_{GS} = 10\text{ V}$<br>(Note 4) | - | 61   | - | nC       |
| $Q_{gs}$        | Gate to Source Gate Charge        |                                                                                   | - | 15   | - | nC       |
| $Q_{gd}$        | Gate to Drain "Miller" Charge     |                                                                                   | - | 25   | - | nC       |
| ESR             | Equivalent Series Resistance      | $f = 1\text{ MHz}$                                                                | - | 0.4  | - | $\Omega$ |

### Switching Characteristics

|              |                     |                                                                                                            |   |    |   |    |
|--------------|---------------------|------------------------------------------------------------------------------------------------------------|---|----|---|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 400\text{ V}, I_D = 15\text{ A},$<br>$V_{GS} = 10\text{ V}, R_g = 4.7\text{ }\Omega$<br>(Note 4) | - | 23 | - | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                                            | - | 24 | - | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                                            | - | 60 | - | ns |
| $t_f$        | Turn-Off Fall Time  |                                                                                                            | - | 5  | - | ns |

### Source-Drain Diode Characteristics

|                 |                                                          |                                                                                  |   |     |     |    |
|-----------------|----------------------------------------------------------|----------------------------------------------------------------------------------|---|-----|-----|----|
| I <sub>S</sub>  | Maximum Continuous Source to Drain Diode Forward Current | -                                                                                | - | 30  | A   |    |
| I <sub>SM</sub> | Maximum Pulsed Source to Drain Diode Forward Current     | -                                                                                | - | 75  | A   |    |
| V <sub>SD</sub> | Drain to Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 15 A                                    | - | -   | 1.2 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 15 A,<br>dI <sub>F</sub> /dt = 100 A/μs | - | 408 | -   | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                                  |                                                                                  | - | 8.4 | -   | μC |

#### Notes:

1. Repetitive rating; pulse-width limited by maximum junction temperature.
2.  $I_{AS} = 4.4\text{ A}$ ,  $R_G = 25\text{ }\Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 15\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq 400\text{ V}$ , starting  $T_J = 25^\circ\text{C}$ .
4. Essentially independent of operating temperature typical characteristics.

## Typical Performance Characteristics

Figure 1. On-Region Characteristics

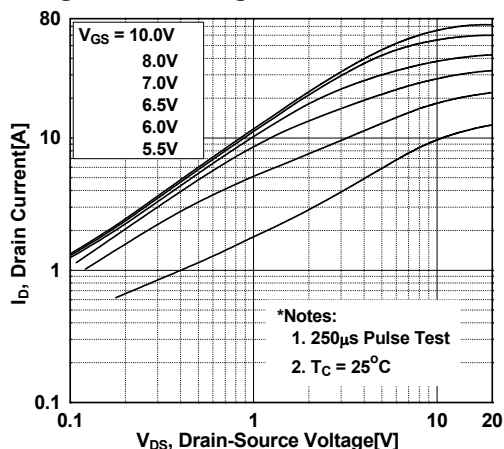


Figure 2. Transfer Characteristics

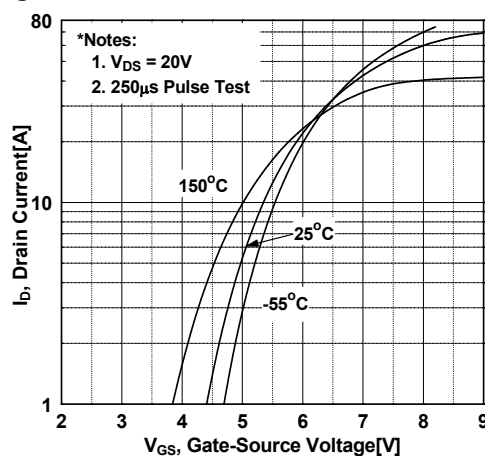


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

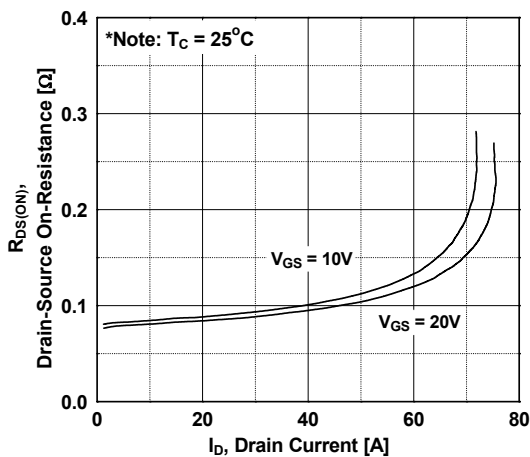


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

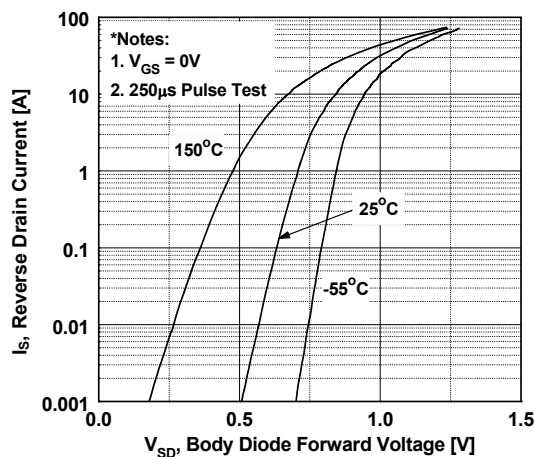


Figure 5. Capacitance Characteristics

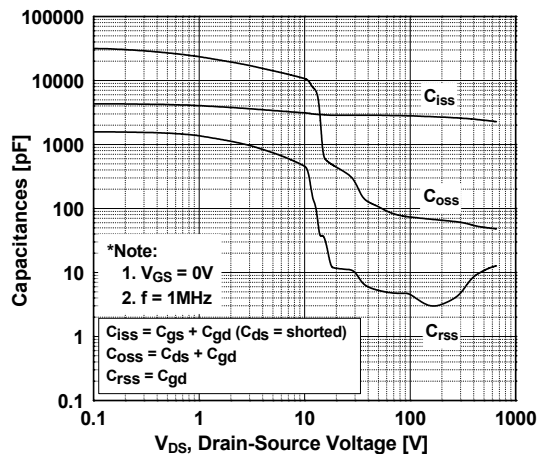
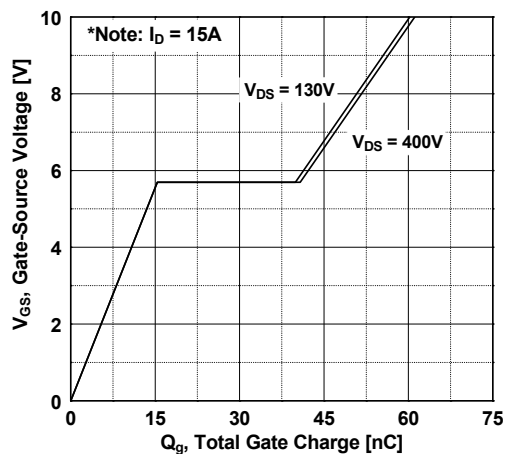
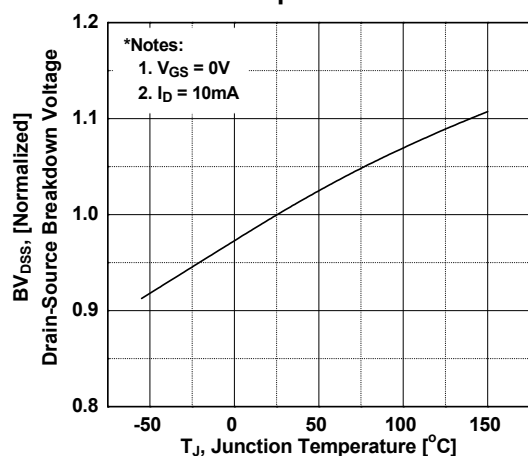


Figure 6. Gate Charge Characteristics

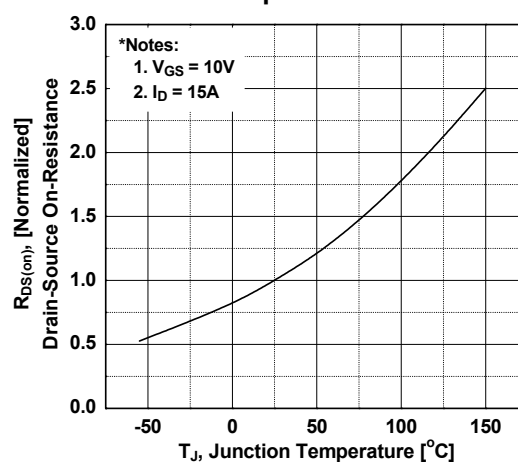


# Typical Performance Characteristics (Continued)

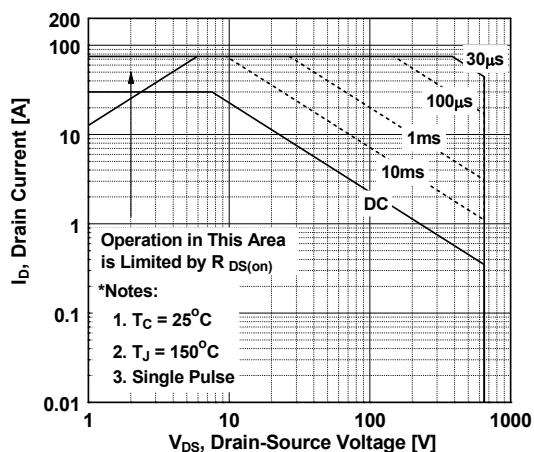
**Figure 7. Breakdown Voltage Variation vs. Temperature**



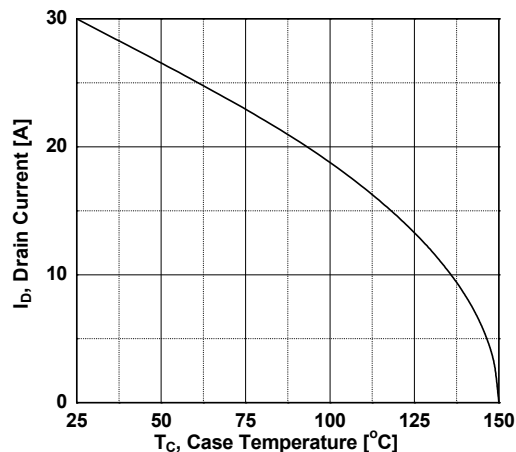
**Figure 8. On-Resistance Variation vs. Temperature**



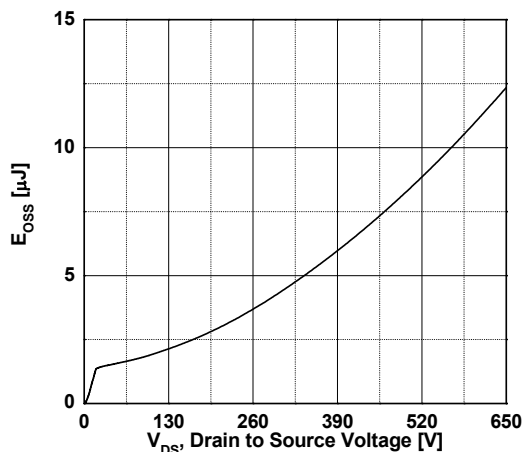
**Figure 9. Maximum Safe Operating Area**



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

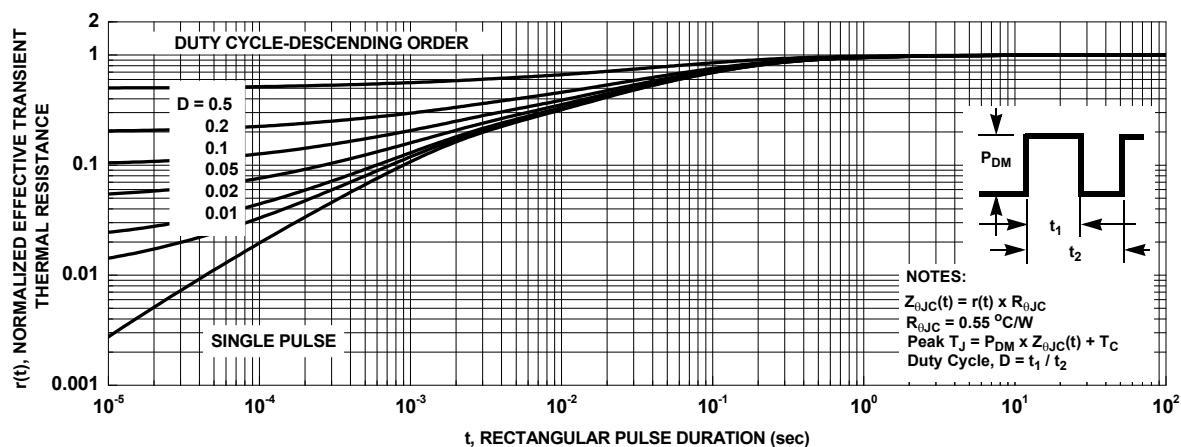


**Figure 11. E\_oss vs. Drain to Source Voltage**



# Typical Performance Characteristics (Continued)

Figure 12. Transient Thermal Response Curve



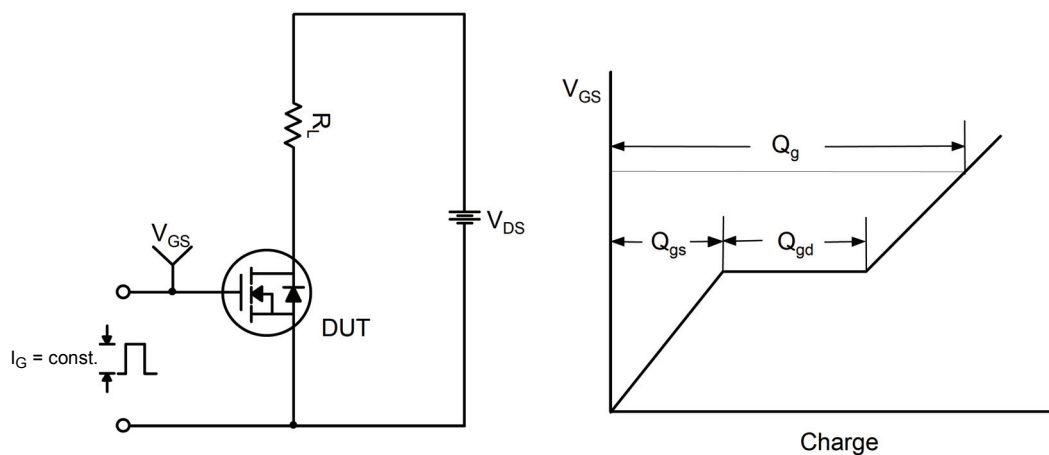


Figure 13. Gate Charge Test Circuit & Waveform

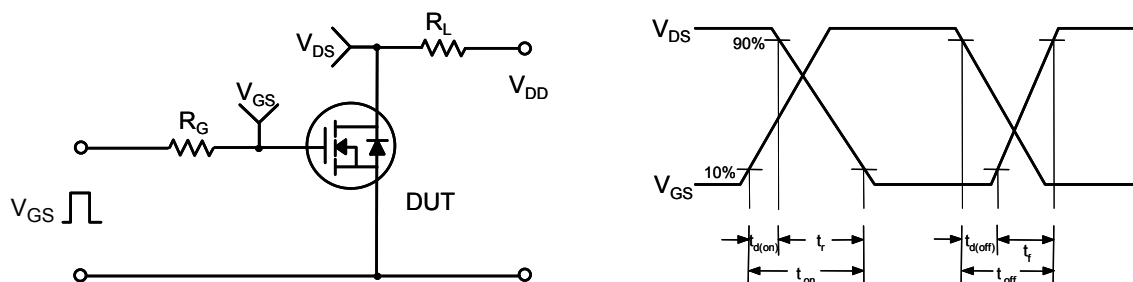


Figure 14. Resistive Switching Test Circuit & Waveforms

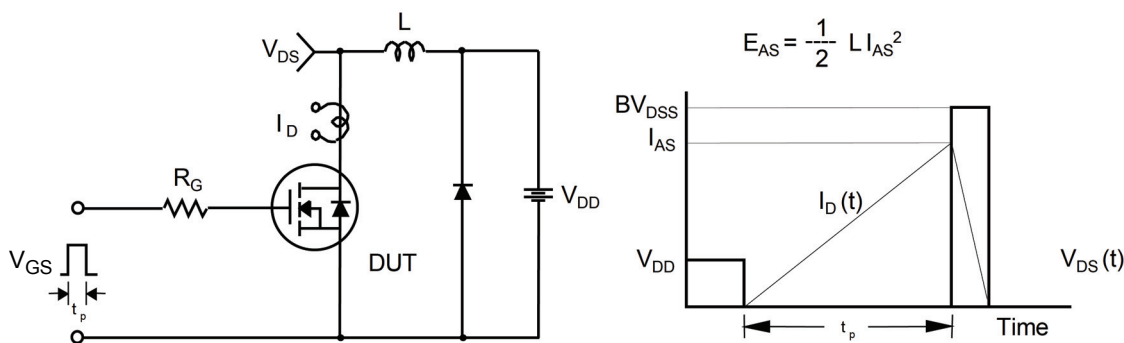


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

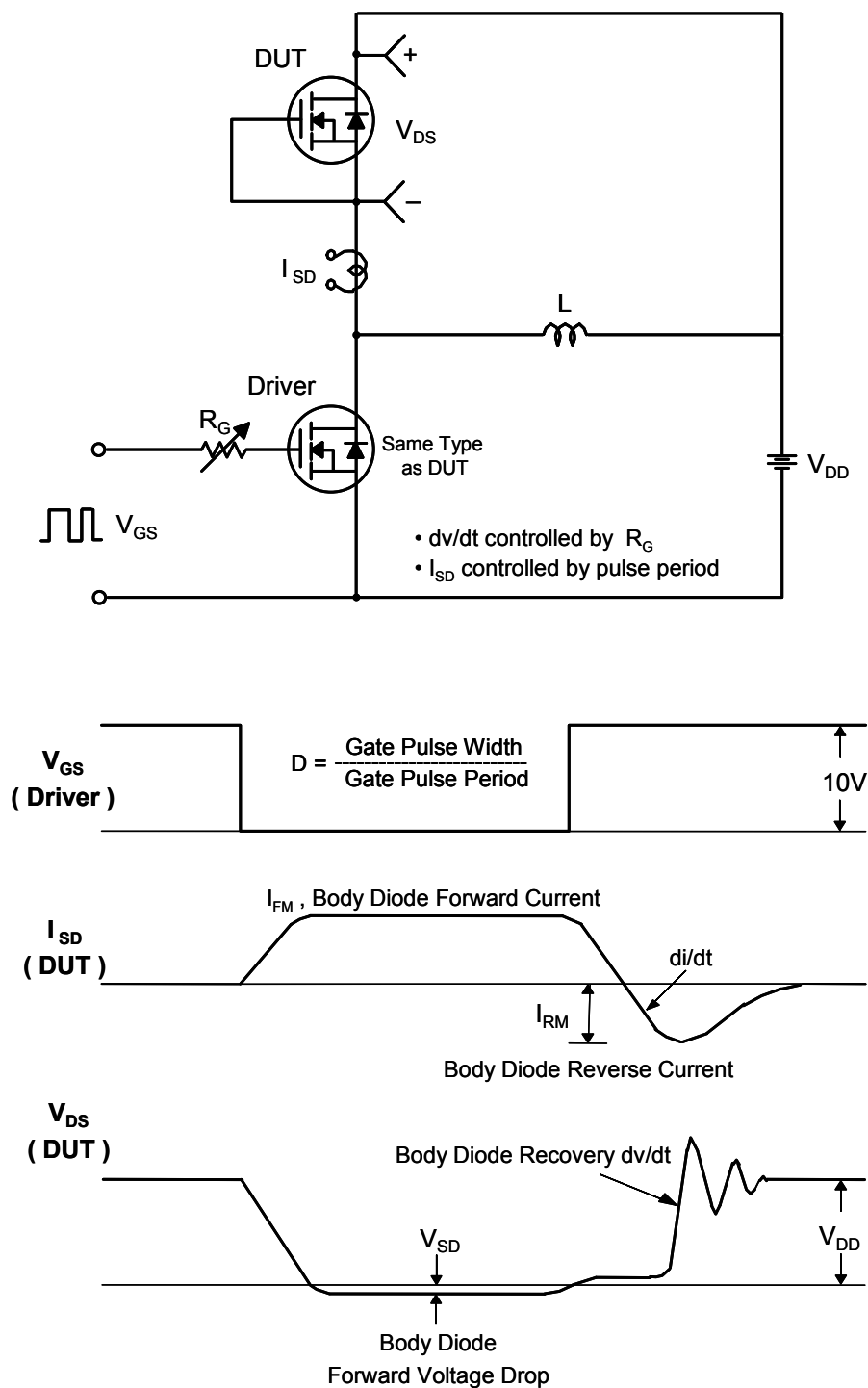
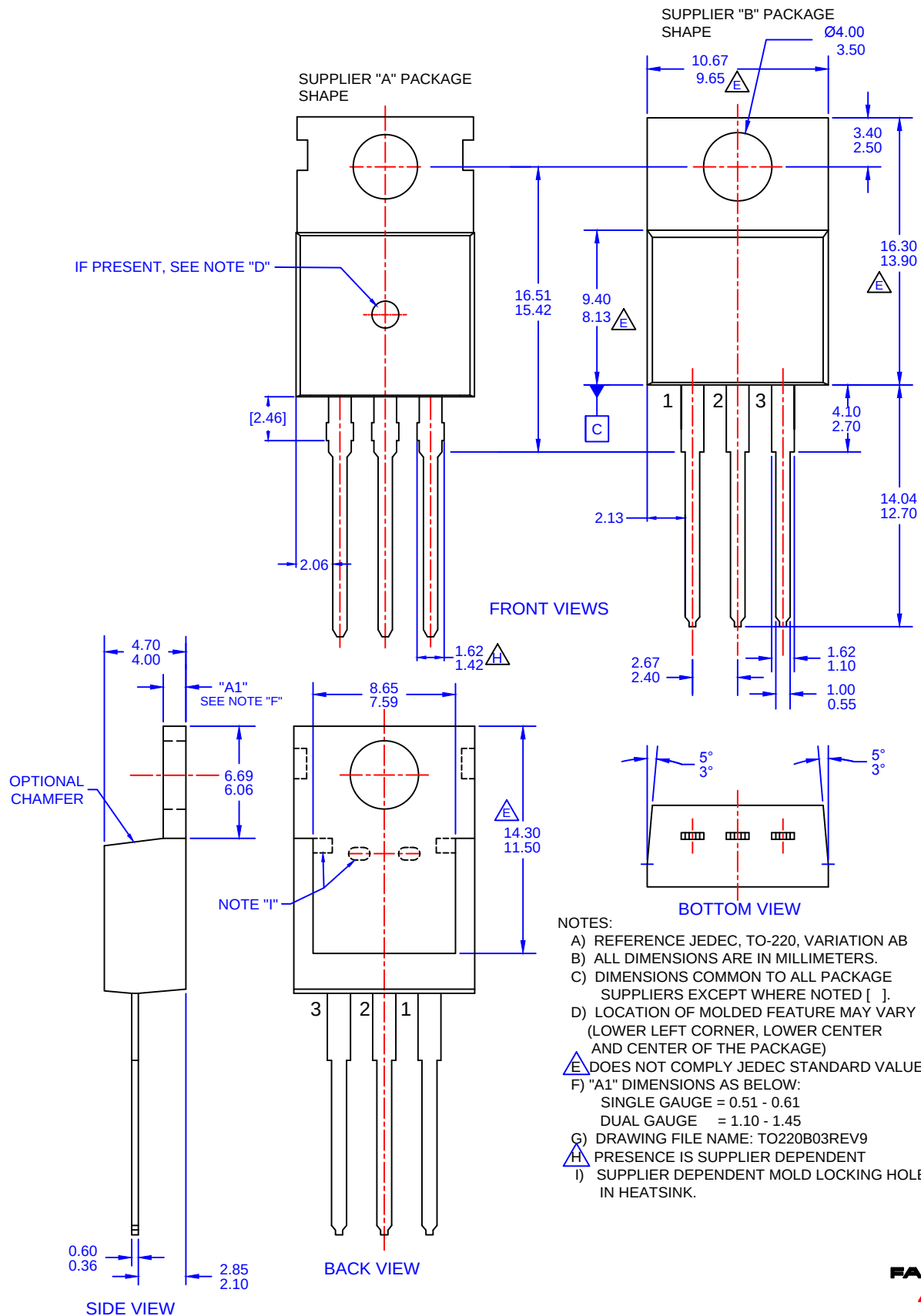


Figure 16. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms





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