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December 2014

# FCP110N65F

## N-Channel SuperFET® II FRFET® MOSFET 650 V, 35 A, 110 mΩ

### Features

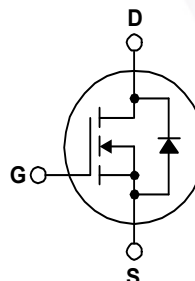
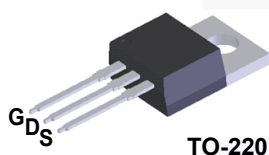
- 700 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 96\text{ m}\Omega$  (Typ.)
- Ultra Low Gate Charge (Typ.  $Q_g = 98\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 464\text{ pF}$ )
- 100% Avalanche Tested
- RoHS Compliant

### Applications

- LCD / LED / PDP TV
- Telecom / Server Power Supplies
- Solar Inverter
- AC - DC Power Supply

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



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

| Symbol         | Parameter                                                            | FCP110N65F                                 | Unit                |
|----------------|----------------------------------------------------------------------|--------------------------------------------|---------------------|
| $V_{DSS}$      | Drain to Source Voltage                                              | 650                                        | V                   |
| $V_{GSS}$      | Gate to Source Voltage                                               | - DC                                       | V                   |
|                |                                                                      | - AC (f > 1 Hz)                            |                     |
| $I_D$          | 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                   |
| $E_{AS}$       | Single Pulsed Avalanche Energy                                       | (Note 2)                                   | mJ                  |
| $I_{AR}$       | Avalanche Current                                                    | (Note 1)                                   | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy                                          | (Note 1)                                   | mJ                  |
| dv/dt          | MOSFET dv/dt                                                         | 100                                        | V/ns                |
|                | Peak Diode Recovery dv/dt                                            | (Note 3)                                   |                     |
| $P_D$          | 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, 1/8" from Case for 5 Seconds | 300                                        | $^\circ\text{C}$    |

### Thermal Characteristics

| Symbol          | Parameter                                     | FCP110N65F | Unit                      |
|-----------------|-----------------------------------------------|------------|---------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.    | 0.35       | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | 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 |
|-------------|------------|---------|----------------|-----------|------------|----------|
| FCP110N65F  | FCP110N65F | 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         | $V_{GS} = 0\text{ V}, I_D = 10\text{ mA}, T_J = 25^\circ\text{C}$  | 650 | -    | -         | V                  |
|                                |                                           | $V_{GS} = 0\text{ V}, I_D = 10\text{ mA}, T_J = 150^\circ\text{C}$ | 700 | -    | -         |                    |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 10\text{ mA}$ , Referenced to $25^\circ\text{C}$            | -   | 0.72 | -         | $V/^\circ\text{C}$ |
| $I_{DSS}$                      | Zero Gate Voltage Drain Current           | $V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$                       | -   | -    | 10        | $\mu\text{A}$      |
|                                |                                           | $V_{DS} = 520\text{ V}, T_C = 125^\circ\text{C}$                   | -   | 110  | -         |                    |
| $I_{GSS}$                      | Gate to Body Leakage Current              | $V_{GS} = \pm 20\text{ V}, V_{DS} = 0\text{ V}$                    | -   | -    | $\pm 100$ | nA                 |

### On Characteristics

|              |                                      |                                             |   |    |     |            |
|--------------|--------------------------------------|---------------------------------------------|---|----|-----|------------|
| $V_{GS(th)}$ | Gate Threshold Voltage               | $V_{GS} = V_{DS}, I_D = 3.5\text{ mA}$      | 3 | -  | 5   | V          |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS} = 10\text{ V}, I_D = 17.5\text{ A}$ | - | 96 | 110 | m $\Omega$ |
| $g_{FS}$     | Forward Transconductance             | $V_{DS} = 20\text{ V}, I_D = 17.5\text{ A}$ | - | 30 | -   | S          |

### Dynamic Characteristics

|                 |                               |                                                                                |   |      |      |          |
|-----------------|-------------------------------|--------------------------------------------------------------------------------|---|------|------|----------|
| $C_{iss}$       | Input Capacitance             | $V_{DS} = 100\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$                 | - | 3680 | 4895 | pF       |
| $C_{oss}$       | Output Capacitance            |                                                                                | - | 110  | 145  | pF       |
| $C_{rss}$       | Reverse Transfer Capacitance  |                                                                                | - | 0.65 | -    | pF       |
| $C_{oss}$       | Output Capacitance            | $V_{DS} = 380\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$                 | - | 65   | -    | pF       |
| $C_{oss(eff.)}$ | Effective Output Capacitance  | $V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$                    | - | 464  | -    | pF       |
| $Q_{g(tot)}$    | Total Gate Charge at 10V      | $V_{DS} = 380\text{ V}, I_D = 17.5\text{ A}, V_{GS} = 10\text{ V}$<br>(Note 4) | - | 98   | 145  | nC       |
| $Q_{gs}$        | Gate to Source Gate Charge    |                                                                                | - | 20   | -    | nC       |
| $Q_{gd}$        | Gate to Drain "Miller" Charge |                                                                                | - | 43   | -    | nC       |
| ESR             | Equivalent Series Resistance  | $f = 1\text{ MHz}$                                                             | - | 0.7  | -    | $\Omega$ |

### Switching Characteristics

|              |                     |                                                                                                         |   |     |     |    |
|--------------|---------------------|---------------------------------------------------------------------------------------------------------|---|-----|-----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 380\text{ V}, I_D = 17.5\text{ A}, V_{GS} = 10\text{ V}, R_g = 4.7\text{ }\Omega$<br>(Note 4) | - | 31  | 72  | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                                         | - | 21  | 52  | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                                         | - | 89  | 188 | ns |
| $t_f$        | Turn-Off Fall Time  | (Note 4)                                                                                                | - | 5.7 | 21  | ns |

### Drain-Source Diode Characteristics

|                 |                                                          |                                                                                    |   |      |     |    |
|-----------------|----------------------------------------------------------|------------------------------------------------------------------------------------|---|------|-----|----|
| I <sub>S</sub>  | Maximum Continuous Drain to Source Diode Forward Current | -                                                                                  | - | 35   | A   |    |
| I <sub>SM</sub> | Maximum Pulsed Drain to Source Diode Forward Current     | -                                                                                  | - | 105  | A   |    |
| V <sub>SD</sub> | Drain to Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 17.5 A                                    | - | -    | 1.2 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 17.5 A,<br>di <sub>F</sub> /dt = 100 A/μs | - | 133  | -   | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                                  |                                                                                    | - | 0.67 | -   | μC |

#### Notes:

1. Repetitive rating: pulse width limited by maximum junction temperature.
2.  $I_{AS} = 8\text{ A}$ ,  $R_G = 25\text{ }\Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 17.5\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq 380\text{ V}$ , starting  $T_J = 25^\circ\text{C}$ .
4. Essentially independent of operating temperature typical characteristics.

## Typical Performance Characteristics

Figure 1. On-Region Characteristics

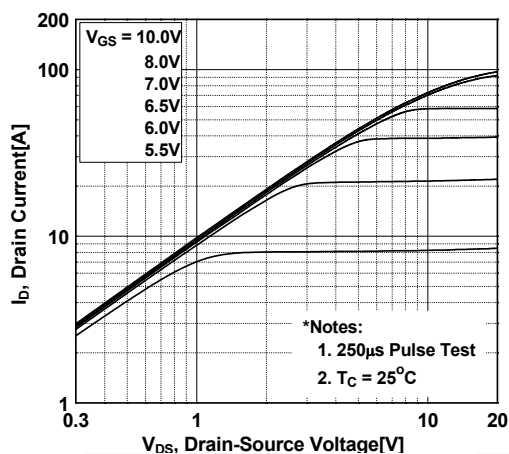


Figure 2. Transfer Characteristics

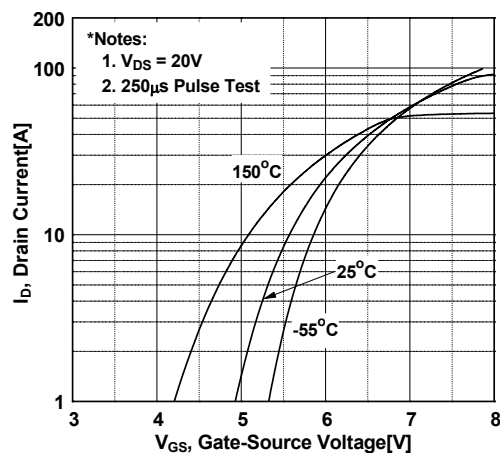


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

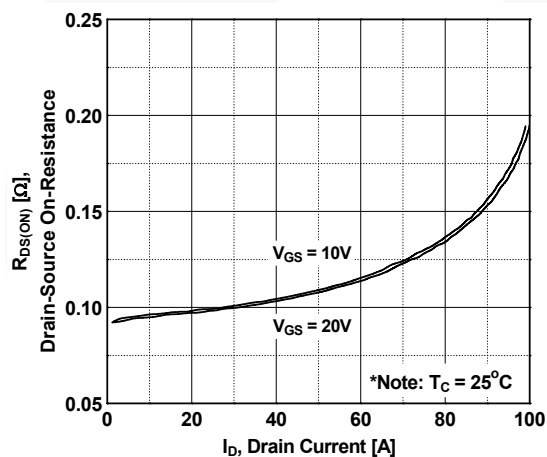


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

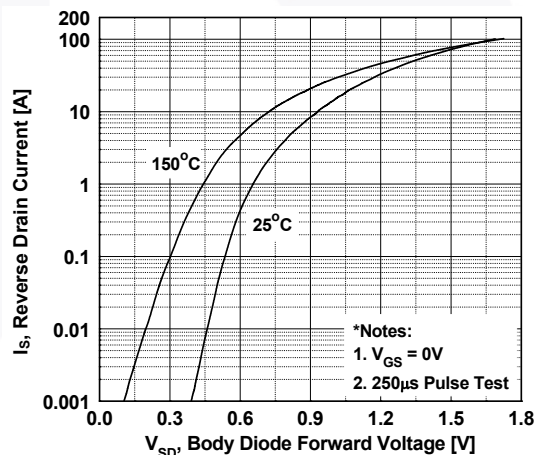


Figure 5. Capacitance Characteristics

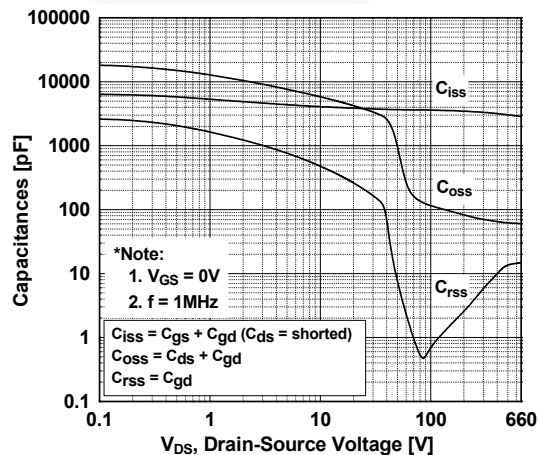
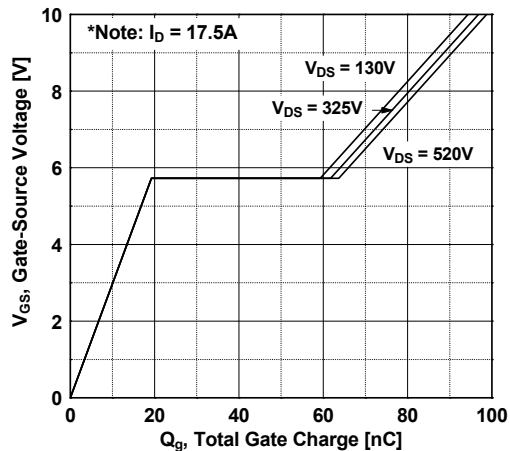


Figure 6. Gate Charge Characteristics



## Typical Performance Characteristics (Continued)

Figure 7. Breakdown Voltage Variation vs. Temperature

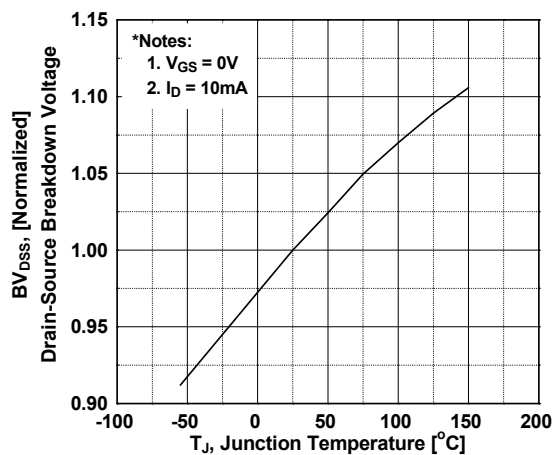


Figure 8. On-Resistance Variation vs. Temperature

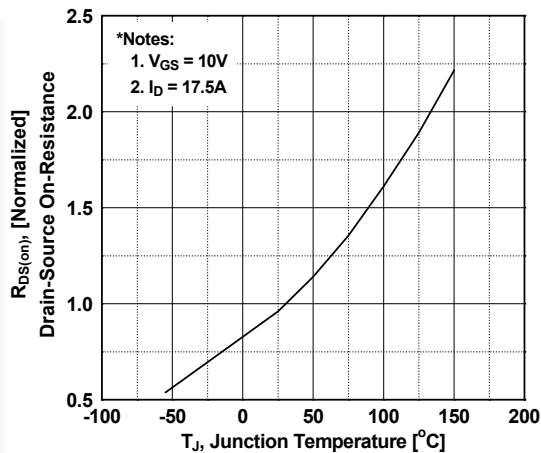


Figure 9. Maximum Safe Operating Area

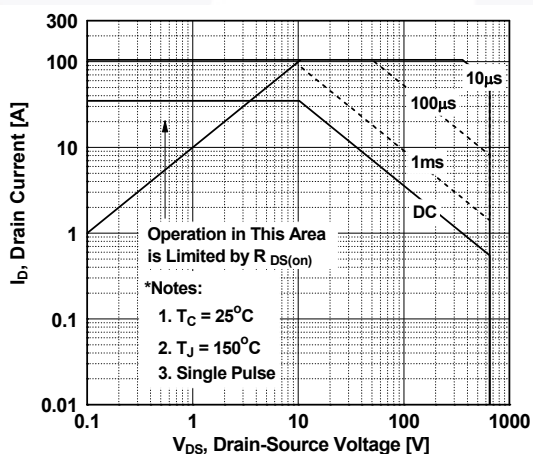


Figure 10. Maximum Drain Current vs. Case Temperature

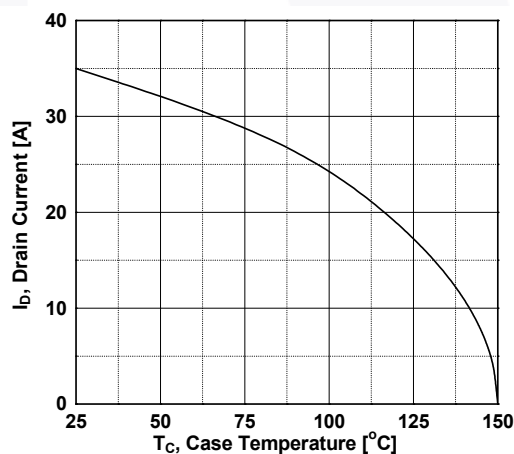
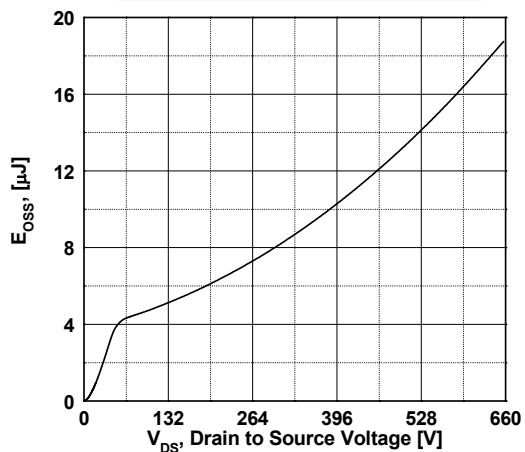
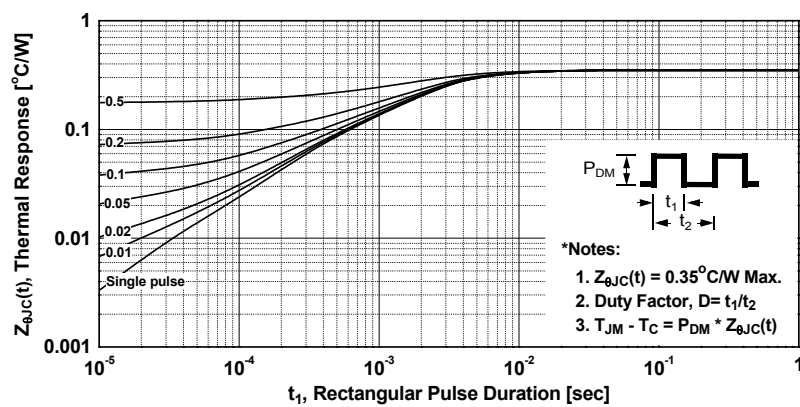


Figure 11. Eoss vs. Drain to Source Voltage



# Typical Performance Characteristics (Continued)

Figure 12. Transient Thermal Response Curve



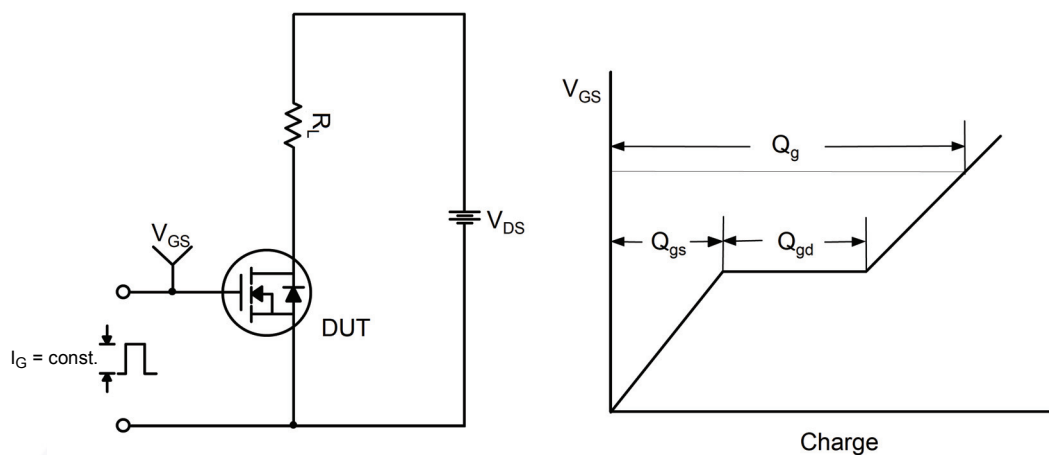


Figure 13. Gate Charge Test Circuit & Waveform



Figure 14. Resistive Switching Test Circuit & Waveforms



Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

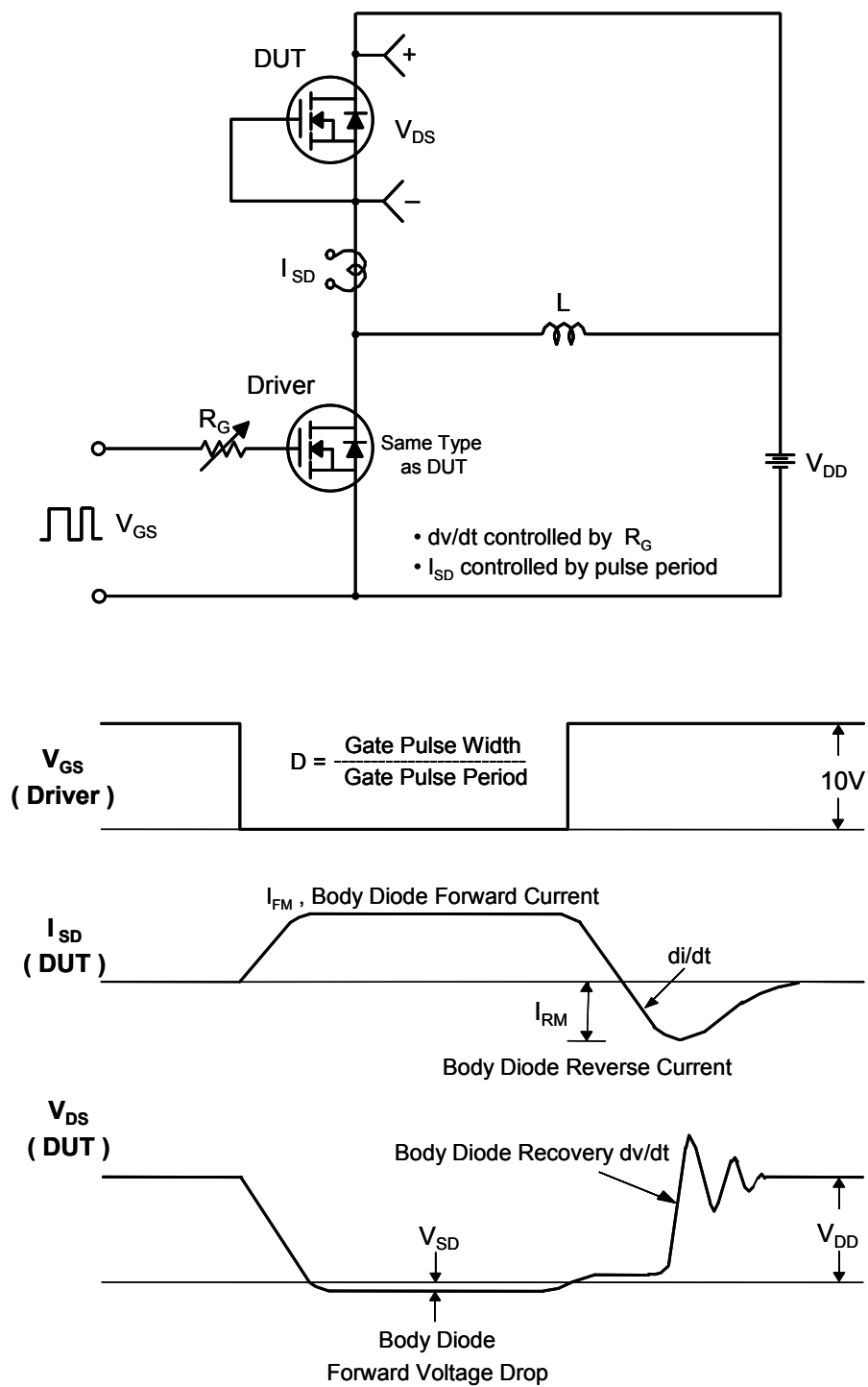


Figure 16. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms



NOTES:

- A) REFERENCE JEDEC, TO-220, VARIATION AB
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSIONS COMMON TO ALL PACKAGE SUPPLIERS EXCEPT WHERE NOTED [ ].
- D) LOCATION OF MOLDED FEATURE MAY VARY (LOWER LEFT CORNER, LOWER CENTER AND CENTER OF THE PACKAGE)
- E) DOES NOT COMPLY JEDEC STANDARD VALUE.
- F) "A1" DIMENSIONS AS BELOW:  
SINGLE GAUGE = 0.51 - 0.61  
DUAL GAUGE = 1.10 - 1.45
- G) DRAWING FILE NAME: TO220B03REV9
- H) PRESENCE IS SUPPLIER DEPENDENT
- I) SUPPLIER DEPENDENT MOLD LOCKING HOLES IN HEATSINK.

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