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# FCP190N60E / FCPF190N60E

## N-Channel SuperFET® II Easy-Drive MOSFET

600 V, 20.6 A, 190 mΩ

### Features

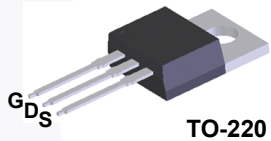
- 650 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 160\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 63\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 178\text{ pF}$ )
- 100% Avalanche Tested
- An Integrated Gate Resistor
- RoHS Compliant

### Applications

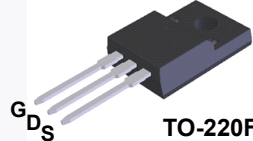
- LCD / LED / PDP TV Lighting
- Solar Inverter
- AC-DC Power Supply

### Description

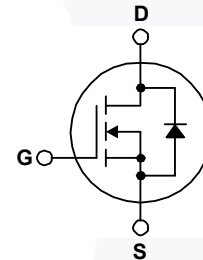
SuperFET® II MOSFET is Fairchild Semiconductor's brand-new high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This technology is tailored to minimize conduction loss, provide superior switching performance,  $dv/dt$  rate and higher avalanche energy. Consequently, SuperFET II MOSFET easy-drive series offers slightly slower rise and fall times compared to the SuperFET II MOSFET series. Noted by the "E" part number suffix, this family helps manage EMI issues and allows for easier design implementation. For faster switching in applications where switching losses must be at an absolute minimum, please consider the SuperFET II MOSFET series.



TO-220



TO-220F



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

| Symbol         | Parameter  | FCP190N60E                                 | FCPF190N60E | Unit             |
|----------------|--|--|-------------|------------------|
| $V_{DSS}$      | Drain to Source Voltage  | 600  |             | V                |
| $V_{GSS}$      | Gate to Source Voltage   | - DC                                       | $\pm 20$    | V                |
|                |  | - AC ( $f > 1\text{ Hz}$ )                 | $\pm 30$    | V                |
| $I_D$          | Drain Current  | - Continuous ( $T_C = 25^\circ\text{C}$ )  | 20.6        | 20.6*            |
|                |  | - Continuous ( $T_C = 100^\circ\text{C}$ ) | 13.1        | 13.1*            |
| $I_{DM}$       | Drain Current  | - Pulsed (Note 1)                          | 61.8        | 61.8*            |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                              | 400  |             | mJ               |
| $I_{AR}$       | Avalanche Current (Note 1)   | 4.0  |             | A                |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                 | 2.1  |             | mJ               |
| $dv/dt$        | MOSFET $dv/dt$   | 100  |             | V/ns             |
|                | Peak Diode Recovery $dv/dt$ (Note 3)                                 | 20   |             |                  |
| $P_D$          | Power Dissipation  | ( $T_C = 25^\circ\text{C}$ )               | 208         | 39               |
|                |  | - Derate Above $25^\circ\text{C}$          | 1.67        | 0.31             |
| $T_J, T_{STG}$ | 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  |             | $^\circ\text{C}$ |

\*Drain current limited by maximum junction temperature.

### Thermal Characteristics

| Symbol          | Parameter                                     | FCP190N60E | FCPF190N60E | Unit                      |
|-----------------|---|------------|-------------|---------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.    | 0.6        | 3.2         | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 62.5       | 62.5        |                           |

## Package Marking and Ordering Information

| Part Number | Top Mark    | Package | Packing Method | Reel Size | Tape Width | Quantity |
|-------------|-------------|---------|----------------|-----------|------------|----------|
| FCP190N60E  | FCP190N60E  | TO-220  | Tube           | N/A       | N/A        | 50 units |
| FCPF190N60E | FCPF190N60E | TO-220F | 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           | $V_{GS} = 0\text{ V}, I_D = 10\text{ mA}, T_J = 25^\circ\text{C}$  | 600 | -    | -         | V                         |
|                                |   | $V_{GS} = 0\text{ V}, I_D = 10\text{ mA}, T_J = 150^\circ\text{C}$ | 650 | -    | -         |                           |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient   | $I_D = 10\text{ mA}$ , Referenced to $25^\circ\text{C}$            | -   | 0.67 | -         | $\text{V}/^\circ\text{C}$ |
| $BV_{DS}$                      | Drain to Source Avalanche Breakdown Voltage | $V_{GS} = 0\text{ V}, I_D = 20\text{ A}$                           | -   | 700  | -         | V                         |
| $I_{DSS}$                      | Zero Gate Voltage Drain Current             | $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$                       | -   | -    | 1         | $\mu\text{A}$             |
|                                |   | $V_{DS} = 480\text{ V}, T_C = 125^\circ\text{C}$                   | -   | 2.8  | -         |                           |
| $I_{GSS}$                      | 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               | $V_{GS} = V_{DS}, I_D = 250\text{ }\mu\text{A}$ | 2.5 | -    | 3.5  | V        |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS} = 10\text{ V}, I_D = 10\text{ A}$       | -   | 0.16 | 0.19 | $\Omega$ |
| $g_{FS}$     | Forward Transconductance             | $V_{DS} = 20\text{ V}, I_D = 10\text{ A}$       | -   | 20   | -    | S        |

### Dynamic Characteristics

|                 |                               |   |   |      |      |          |
|-----------------|-------------------------------|---|---|------|------|----------|
| $C_{iss}$       | Input Capacitance             | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$             | - | 2385 | 3175 | pF       |
| $C_{oss}$       | Output Capacitance            |   | - | 1795 | 2396 | pF       |
| $C_{riss}$      | Reverse Transfer Capacitance  |   | - | 110  | 165  | pF       |
| $C_{oss}$       | Output Capacitance            | $V_{DS} = 380\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$            | - | 42   | -    | pF       |
| $C_{oss(eff.)}$ | Effective Output Capacitance  | $V_{DS} = 0\text{ V to } 480\text{ V}, V_{GS} = 0\text{ V}$               | - | 178  | -    | pF       |
| $Q_{g(tot)}$    | Total Gate Charge at 10V      | $V_{DS} = 380\text{ V}, I_D = 10\text{ A}, V_{GS} = 10\text{ V}$ (Note 4) | - | 63   | 82   | nC       |
| $Q_{gs}$        | Gate to Source Gate Charge    |   | - | 10   | -    | nC       |
| $Q_{gd}$        | Gate to Drain "Miller" Charge |   | - | 24   | -    | nC       |
| ESR             | Equivalent Series Resistance  | $f = 1\text{ MHz}$  | - | 5    | -    | $\Omega$ |

### Switching Characteristics

|              |                     |  |   |     |     |    |
|--------------|---------------------|--|---|-----|-----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 380\text{ V}, I_D = 10\text{ A}, V_{GS} = 10\text{ V}, R_G = 4.7\text{ }\Omega$ (Note 4) | - | 23  | 56  | ns |
| $t_r$        | Turn-On Rise Time   |  | - | 14  | 38  | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |  | - | 101 | 212 | ns |
| $t_f$        | Turn-Off Fall Time  |  | - | 15  | 40  | ns |

### Drain-Source Diode Characteristics

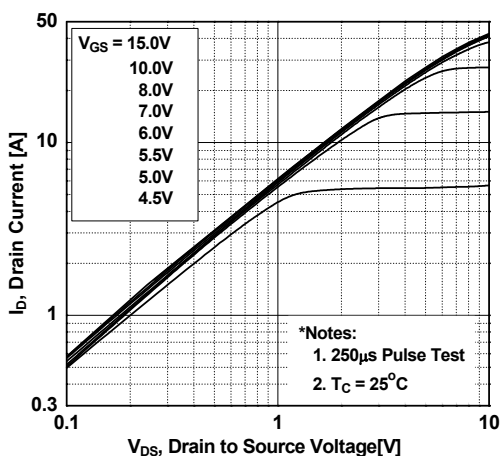
|          |  |   |   |      |     |               |
|----------|--|---|---|------|-----|---------------|
| $I_S$    | Maximum Continuous Drain to Source Diode Forward Current | -   | - | 20.2 | A   |               |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current     | -   | - | 60.6 | A   |               |
| $V_{SD}$ | Drain to Source Diode Forward Voltage                    | $V_{GS} = 0\text{ V}, I_{SD} = 10\text{ A}$                                     | - | -    | 1.2 | V             |
| $t_{rr}$ | Reverse Recovery Time                                    | $V_{GS} = 0\text{ V}, I_{SD} = 10\text{ A}, di_F/dt = 100\text{ A}/\mu\text{s}$ | - | 308  | -   | ns            |
| $Q_{rr}$ | Reverse Recovery Charge                                  |   | - | 4.8  | -   | $\mu\text{C}$ |

#### Notes:

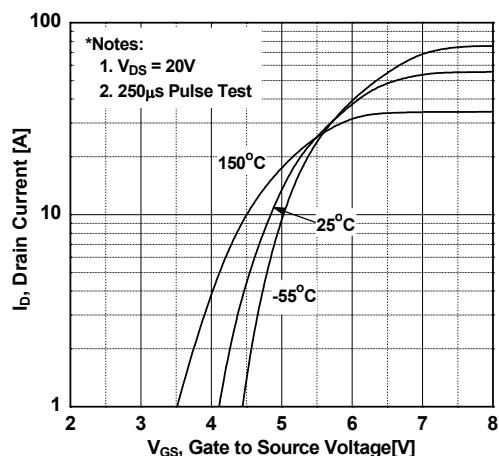
1. Repetitive rating : pulse-width limited by maximum junction temperature.
2.  $I_{AS} = 4\text{ A}, V_{DD} = 50\text{ V}, R_G = 25\text{ }\Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 10\text{ A}, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , starting  $T_J = 25^\circ\text{C}$ .
4. Essentially independent of operating temperature typical characteristics.

## Typical Performance Characteristics

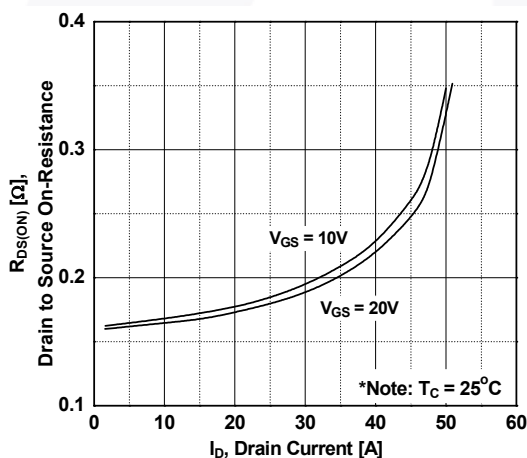
**Figure 1. On-Region Characteristics**



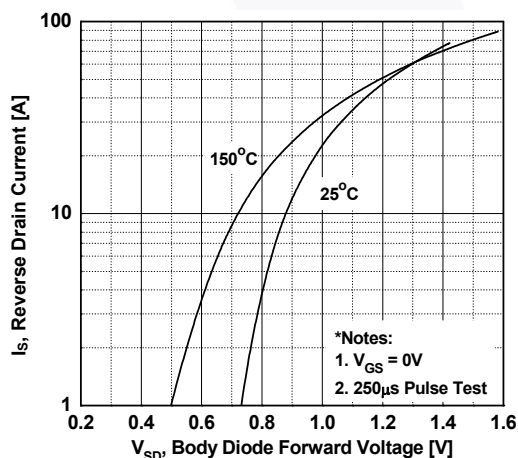
**Figure 2. Transfer Characteristics**



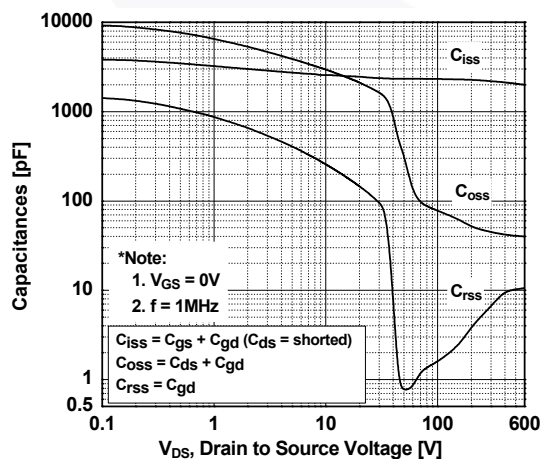
**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**



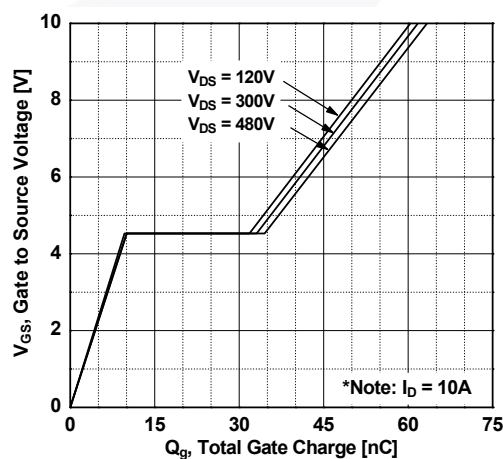
**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature**



**Figure 5. Capacitance Characteristics**

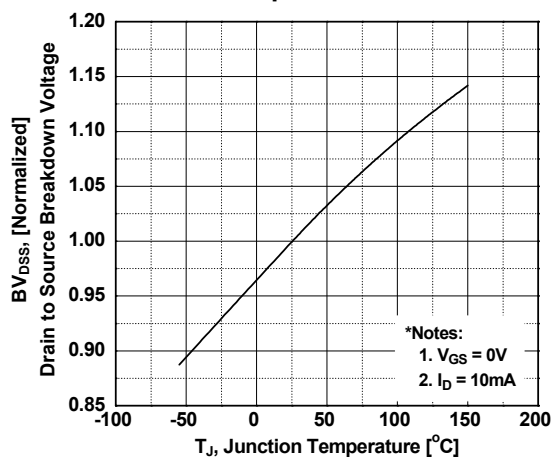


**Figure 6. Gate Charge Characteristics**

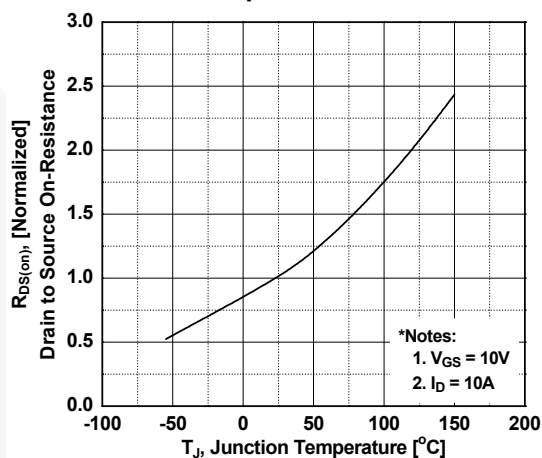


## Typical Performance Characteristics (Continued)

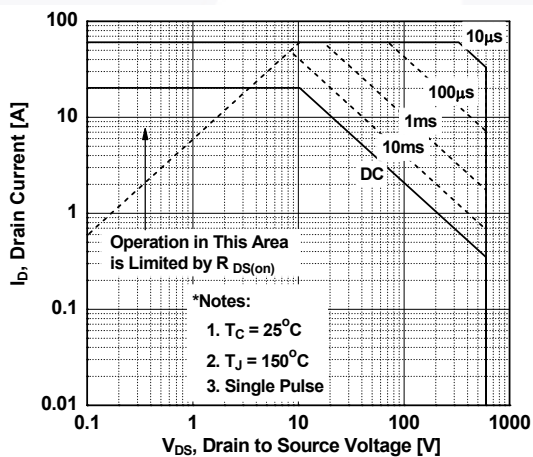
**Figure 7. Breakdown Voltage Variation vs. Temperature**



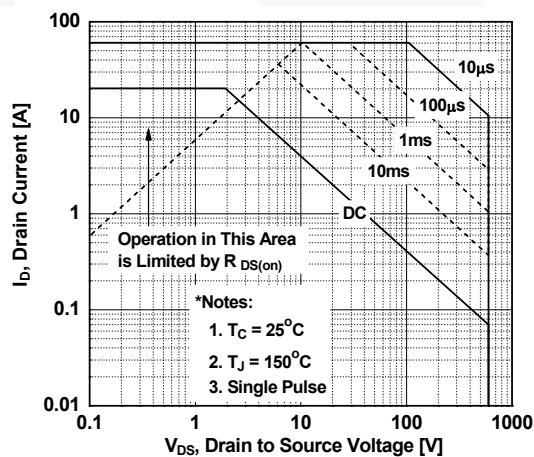
**Figure 8. On-Resistance Variation vs. Temperature**



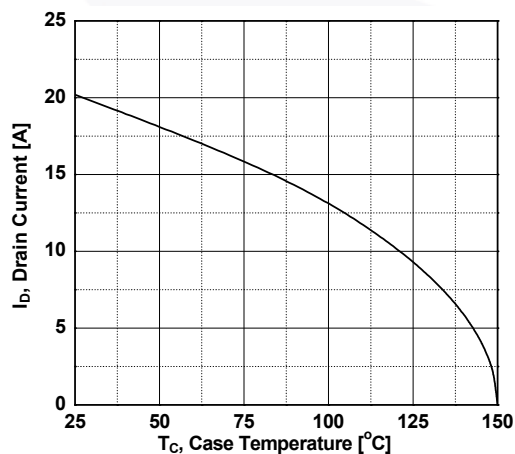
**Figure 9. Maximum Safe Operating Area for FCP190N60E**



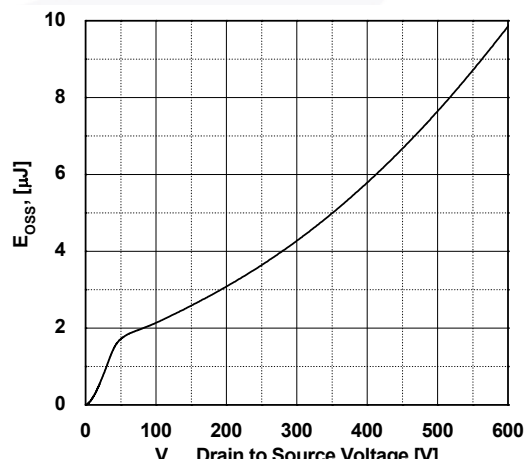
**Figure 10. Maximum Safe Operating Area for FCPF190N60E**



**Figure 11. Maximum Drain Current vs. Case Temperature**



**Figure 12. E\_oss vs. Drain to Source Voltage**



Typical Performance Characteristics (Continued)

Figure 13. Transient Thermal Response Curve for FCP190N60E

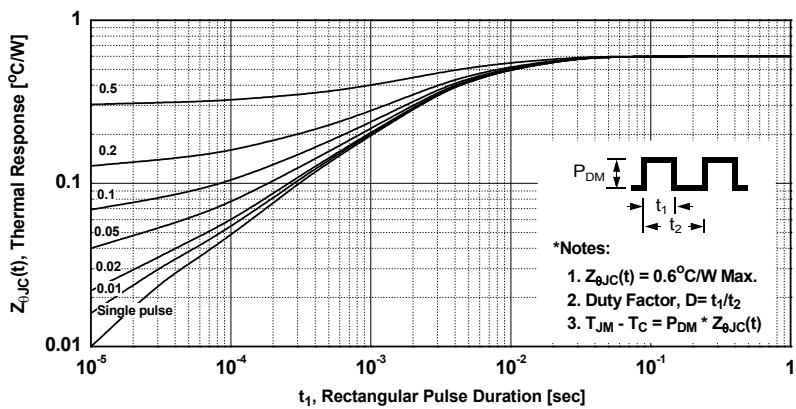
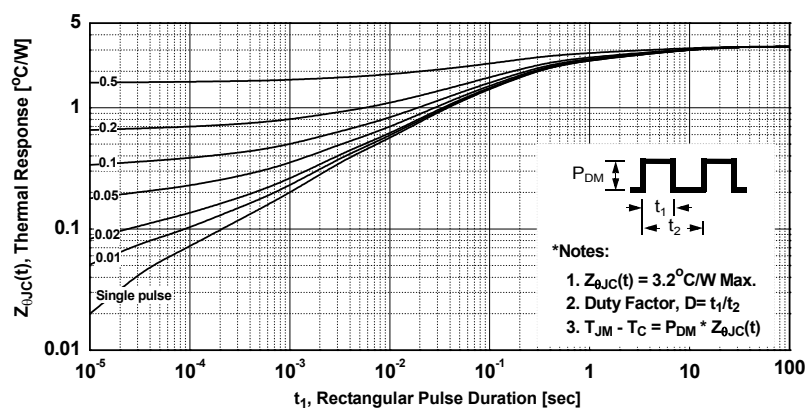


Figure 14. Transient Thermal Response Curve for FCPF190N60E



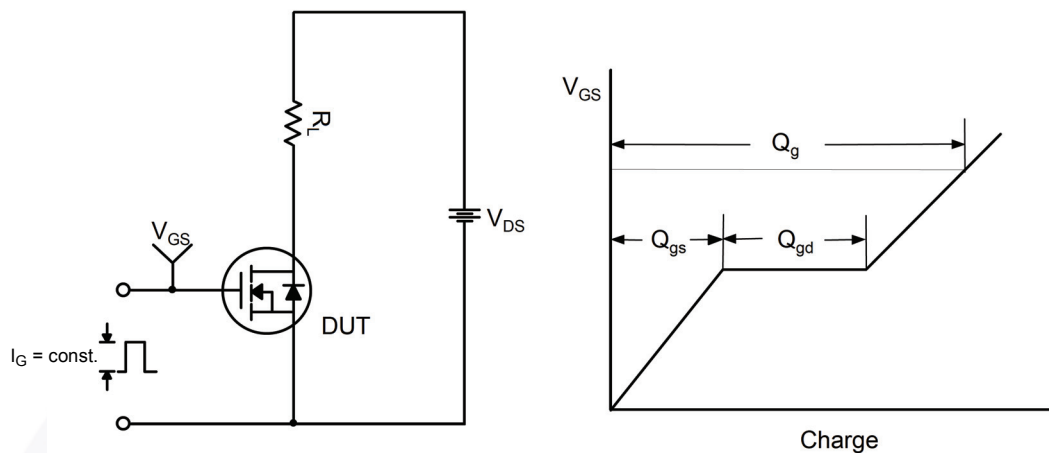


Figure 15. Gate Charge Test Circuit & Waveform

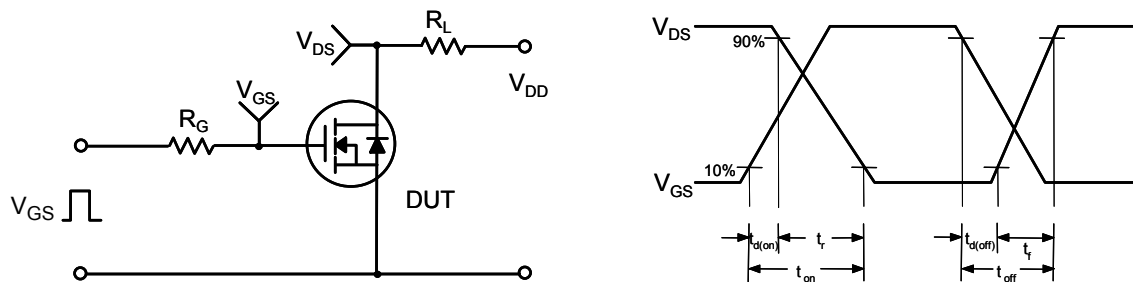


Figure 16. Resistive Switching Test Circuit & Waveforms

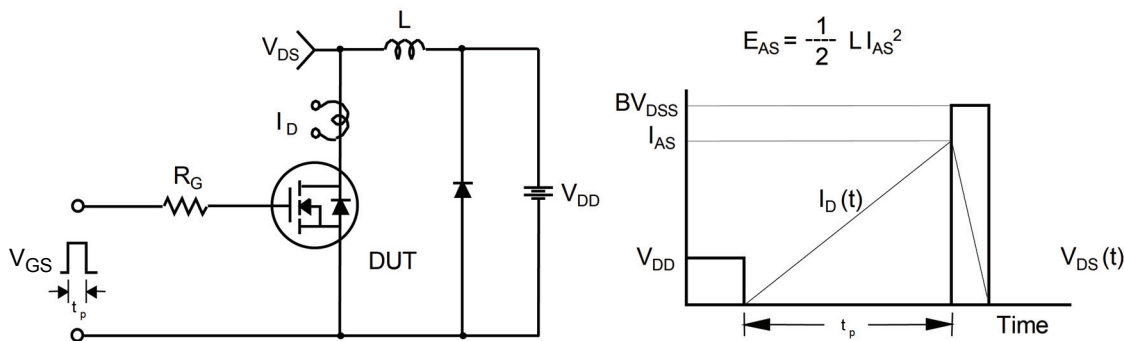


Figure 17. Unclamped Inductive Switching Test Circuit & Waveforms



Figure 18. 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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