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August 2014

# FDP39N20 / FDPF39N20

## N-Channel UniFET™ MOSFET

200 V, 39 A, 66 mΩ

### Features

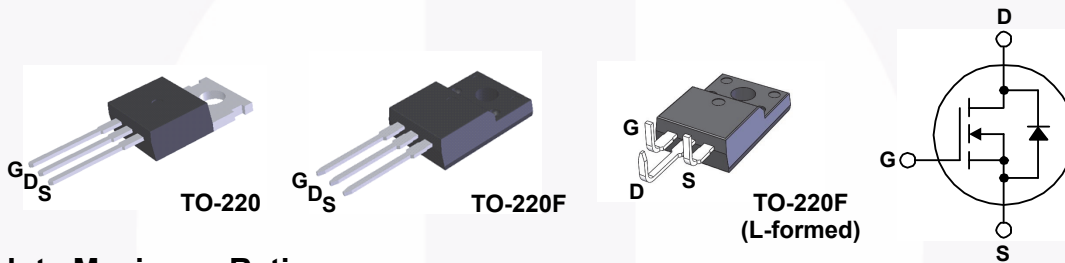
- $R_{DS(on)} = 66 \text{ m}\Omega$  (Max.) @  $V_{GS} = 10 \text{ V}$ ,  $I_D = 19.5 \text{ A}$
- Low Gate Charge (Typ. 38 nC)
- Low  $C_{rss}$  (Typ. 57 pF)
- 100% Avalanche Tested

### Applications

- PDP TV
- Lighting
- Uninterruptible Power Supply
- AC-DC Power Supply

### Description

UniFET™ MOSFET is Fairchild Semiconductor's high voltage MOSFET family based on planar stripe and DMOS technology. This MOSFET is tailored to reduce on-state resistance, and to provide better switching performance and higher avalanche energy strength. This device family is suitable for switching power converter applications such as power factor correction (PFC), flat panel display (FPD) TV power, ATX and electronic lamp ballasts.



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

| Symbol         | Parameter  |  | FDP39N20    | FDPF39N20 / FDPF39N20TLDTU | Unit                |
|----------------|--|--|-------------|----------------------------|---------------------|
| $V_{DSS}$      | Drain-Source Voltage   |  | 200         |                            | V                   |
| $I_D$          | Drain Current  | - Continuous ( $T_C = 25^\circ\text{C}$ )  | 39          | 39 *                       | A                   |
|                |  | - Continuous ( $T_C = 100^\circ\text{C}$ ) | 23.4        | 23.4 *                     | A                   |
| $I_{DM}$       | Drain Current  | - Pulsed (Note 1)                          | 156         | 156 *                      | A                   |
| $V_{GSS}$      | Gate-Source voltage  |  | $\pm 30$    |                            | V                   |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                              |  | 860         |                            | mJ                  |
| $I_{AR}$       | Avalanche Current (Note 1)   |  | 39          |                            | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                 |  | 25.1        |                            | mJ                  |
| $dv/dt$        | Peak Diode Recovery $dv/dt$ (Note 3)                                 |  | 4.5         |                            | V/ns                |
| $P_D$          | Power Dissipation  | ( $T_C = 25^\circ\text{C}$ )               | 251         | 37                         | W                   |
|                |  | - Derate Above $25^\circ\text{C}$          | 2.0         | 0.29                       | 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         |                            | $^\circ\text{C}$    |

\* Drain current limited by maximum junction temperature.

### Thermal Characteristics

| Symbol          | Parameter                                     | FDP39N20 | FDPF39N20 / FDPF39N20TLDTU | Unit               |
|-----------------|---|----------|----------------------------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case, Max.    | 0.5      | 3.4                        | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | 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 |
|----------------|------------|-----------------------|----------------|-----------|------------|----------|
| FDP39N20       | FDP39N20   | TO-220                | Tube           | N/A       | N/A        | 50 units |
| FDPF39N20      | FDPF39N20  | TO-220F               | Tube           | N/A       | N/A        | 50 units |
| FDPF39N20TLDTU | FDPF39N20T | TO-220F<br>(L-formed) | Tube           | N/A       | N/A        | 50 units |

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

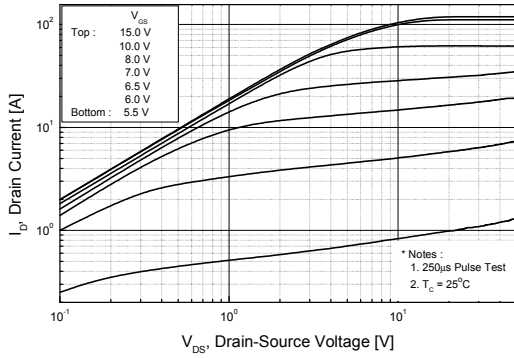
| Symbol  | Parameter   | Conditions   | Min.     | Typ.  | Max.    | Unit                           |
|---|---|--|----------|-------|---------|--------------------------------|
| <b>Off Characteristics</b>                                    |   |  |          |       |         |                                |
| $BV_{DSS}$  | Drain-Source Breakdown Voltage                        | $V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$  | 200      | --    | --      | V                              |
| $\Delta BV_{DSS} / \Delta T_J$                                | Breakdown Voltage Temperature Coefficient             | $I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$                                      | --       | 0.2   | --      | $\text{V}/^\circ\text{C}$      |
| $I_{DSS}$   | Zero Gate Voltage Drain Current                       | $V_{DS} = 200\text{ V}, V_{GS} = 0\text{ V}$<br>$V_{DS} = 160\text{ V}, T_C = 125^\circ\text{C}$ | --       | --    | 1<br>10 | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSSF}$  | Gate-Body Leakage Current, Forward                    | $V_{GS} = 30\text{ V}, V_{DS} = 0\text{ V}$  | --       | --    | 100     | nA                             |
| $I_{GSSR}$  | Gate-Body Leakage Current, Reverse                    | $V_{GS} = -30\text{ V}, V_{DS} = 0\text{ V}$   | --       | --    | -100    | nA                             |
| <b>On Characteristics</b>                                     |   |  |          |       |         |                                |
| $V_{GS(th)}$  | Gate Threshold Voltage                                | $V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$  | 3.0      | --    | 5.0     | V                              |
| $R_{DS(on)}$  | Static Drain-Source On-Resistance                     | $V_{GS} = 10\text{ V}, I_D = 19.5\text{ A}$  | --       | 0.056 | 0.066   | $\Omega$                       |
| $g_{FS}$  | Forward Transconductance                              | $V_{DS} = 40\text{ V}, I_D = 19.5\text{ A}$  | --       | 28.5  | --      | S                              |
| <b>Dynamic Characteristics</b>                                |   |  |          |       |         |                                |
| $C_{iss}$   | Input Capacitance                                     | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$                             | --       | 1640  | 2130    | pF                             |
| $C_{oss}$   | Output Capacitance                                    |  | --       | 400   | 520     | pF                             |
| $C_{rss}$   | Reverse Transfer Capacitance                          |  | --       | 57    | 85      | pF                             |
| <b>Switching Characteristics</b>                              |   |  |          |       |         |                                |
| $t_{d(on)}$   | Turn-On Delay Time                                    | $V_{DD} = 100\text{ V}, I_D = 39\text{ A},$<br>$V_{GS} = 10\text{ V}, R_G = 25\ \Omega$          | --       | 30    | 70      | ns                             |
| $t_r$   | Turn-On Rise Time                                     |  | --       | 160   | 330     | ns                             |
| $t_{d(off)}$  | Turn-Off Delay Time                                   |  | --       | 150   | 310     | ns                             |
| $t_f$   | Turn-Off Fall Time                                    |  | (Note 4) | --    | 150     | 310                            |
| $Q_g$   | Total Gate Charge                                     | $V_{DS} = 160\text{ V}, I_D = 39\text{ A},$<br>$V_{GS} = 10\text{ V}$                            | --       | 38    | 49      | nC                             |
| $Q_{gs}$  | Gate-Source Charge                                    |  | --       | 11    | --      | nC                             |
| $Q_{gd}$  | Gate-Drain Charge                                     |  | (Note 4) | --    | 16.5    | --                             |
| <b>Drain-Source Diode Characteristics and Maximum Ratings</b> |   |  |          |       |         |                                |
| $I_S$   | Maximum Continuous Drain-Source Diode Forward Current |  | --       | --    | 39      | A                              |
| $I_{SM}$  | Maximum Pulsed Drain-Source Diode Forward Current     |  | --       | --    | 156     | A                              |
| $V_{SD}$  | Drain-Source Diode Forward Voltage                    | $V_{GS} = 0\text{ V}, I_S = 39\text{ A}$   | --       | --    | 1.4     | V                              |
| $t_{rr}$  | Reverse Recovery Time                                 | $V_{GS} = 0\text{ V}, I_S = 39\text{ A},$<br>$dI_F/dt = 100\text{ A}/\mu\text{s}$                | --       | 152   | --      | ns                             |
| $Q_{rr}$  | Reverse Recovery Charge                               |  | --       | 1.1   | --      | $\mu\text{C}$                  |

### Notes:

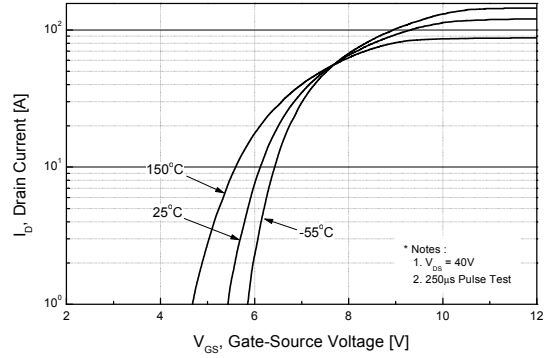
1. Repetitive rating: pulse-width limited by maximum junction temperature.
2.  $L = 0.85\text{ mH}, I_{AS} = 39\text{ A}, V_{DD} = 50\text{ V}, R_G = 25\ \Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 39\text{ A}, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , starting  $T_J = 25^\circ\text{C}$ .
4. Essentially independent of operating temperature typical characteristics.

## Typical Performance Characteristics

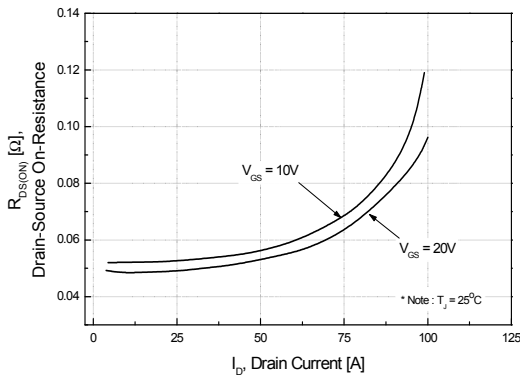
**Figure 1. On-Region Characteristics**



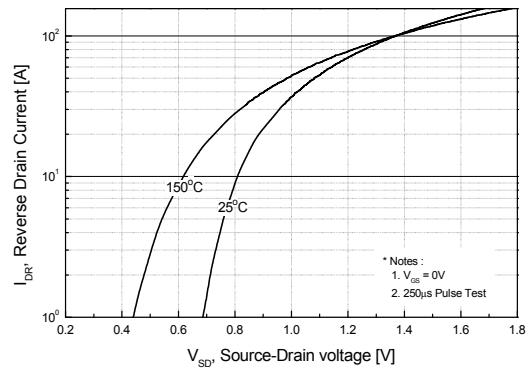
**Figure 2. Transfer Characteristics**



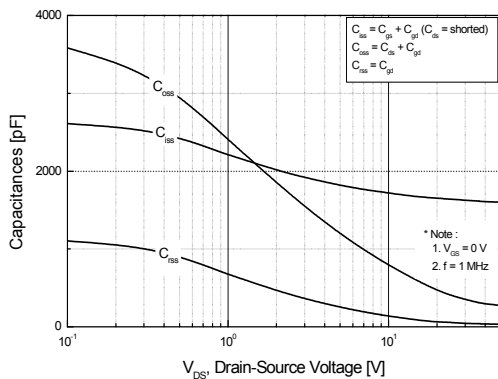
**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**



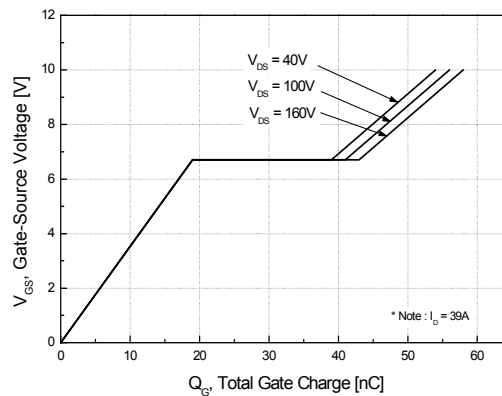
**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature**



**Figure 5. Capacitance Characteristics**

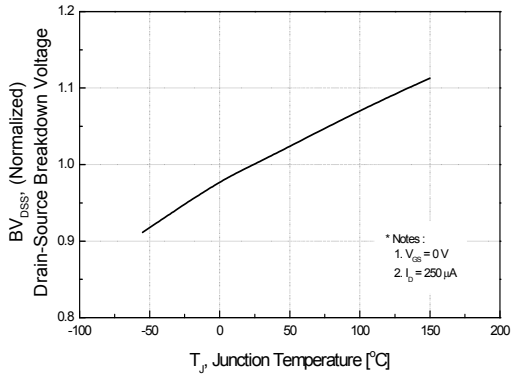


**Figure 6. Gate Charge Characteristics**

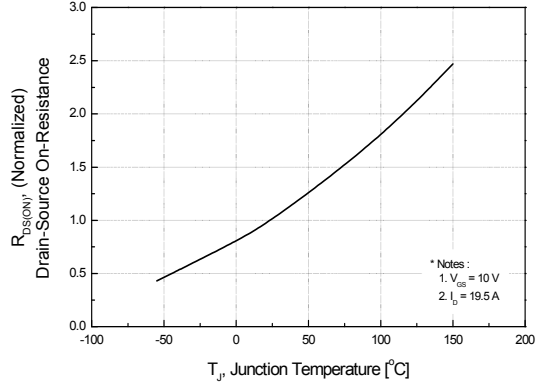


**Typical Performance Characteristics** (Continued)

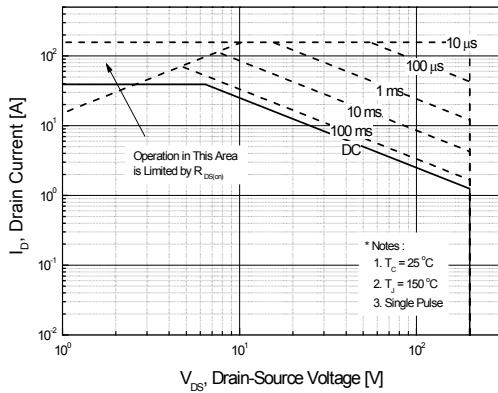
**Figure 7. Breakdown Voltage Variation vs. Temperature**



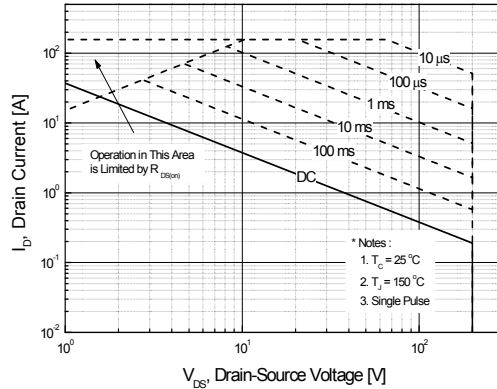
**Figure 8. On-Resistance Variation vs. Temperature**



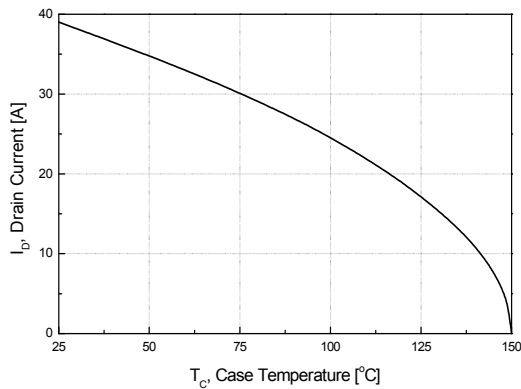
**Figure 9-1. Maximum Safe Operating Area - FDP39N20**



**Figure 9-2. Maximum Safe Operating Area - FDPF39N20**



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



Typical Performance Characteristics (Continued)

Figure 11-1. Transient Thermal Response Curve - FDP39N20

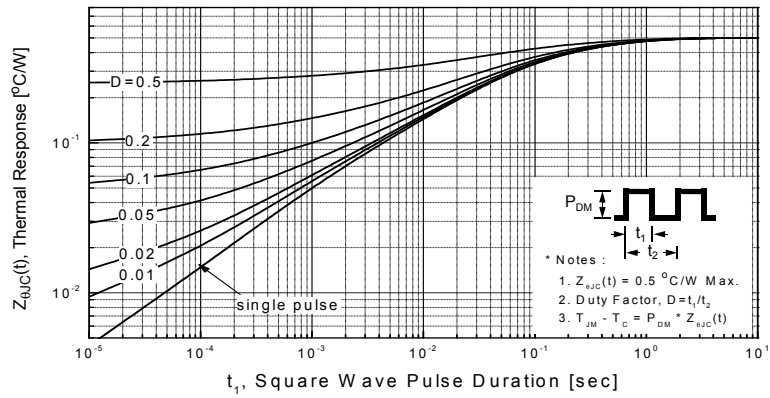
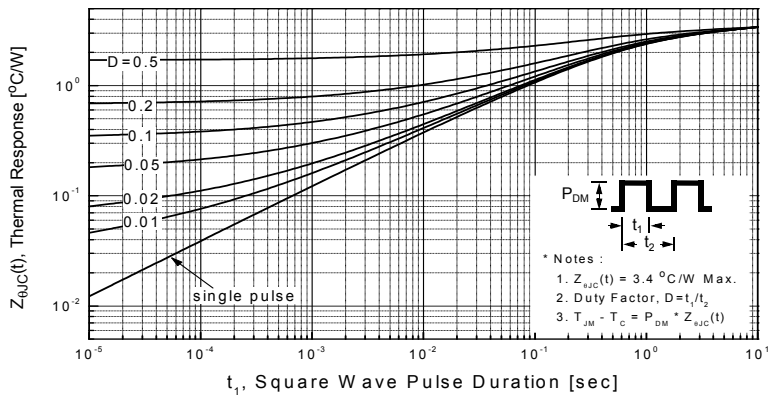


Figure 11-2. Transient Thermal Response Curve - FDPF39N20



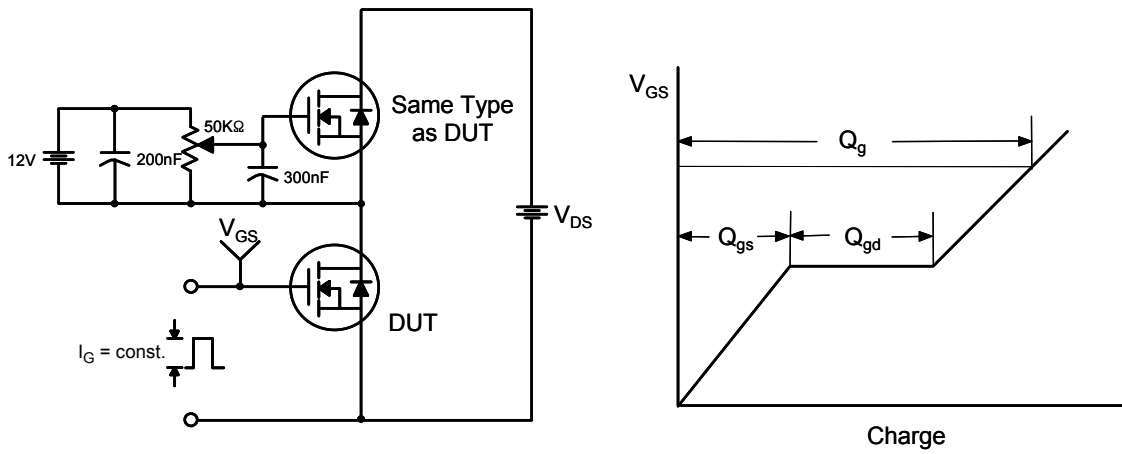


Figure 12. Gate Charge Test Circuit & Waveform



Figure 13. Resistive Switching Test Circuit & Waveforms

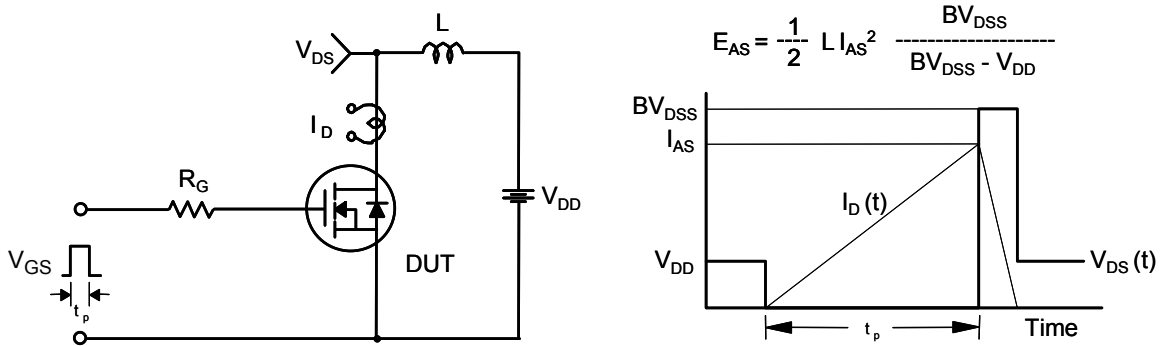


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms

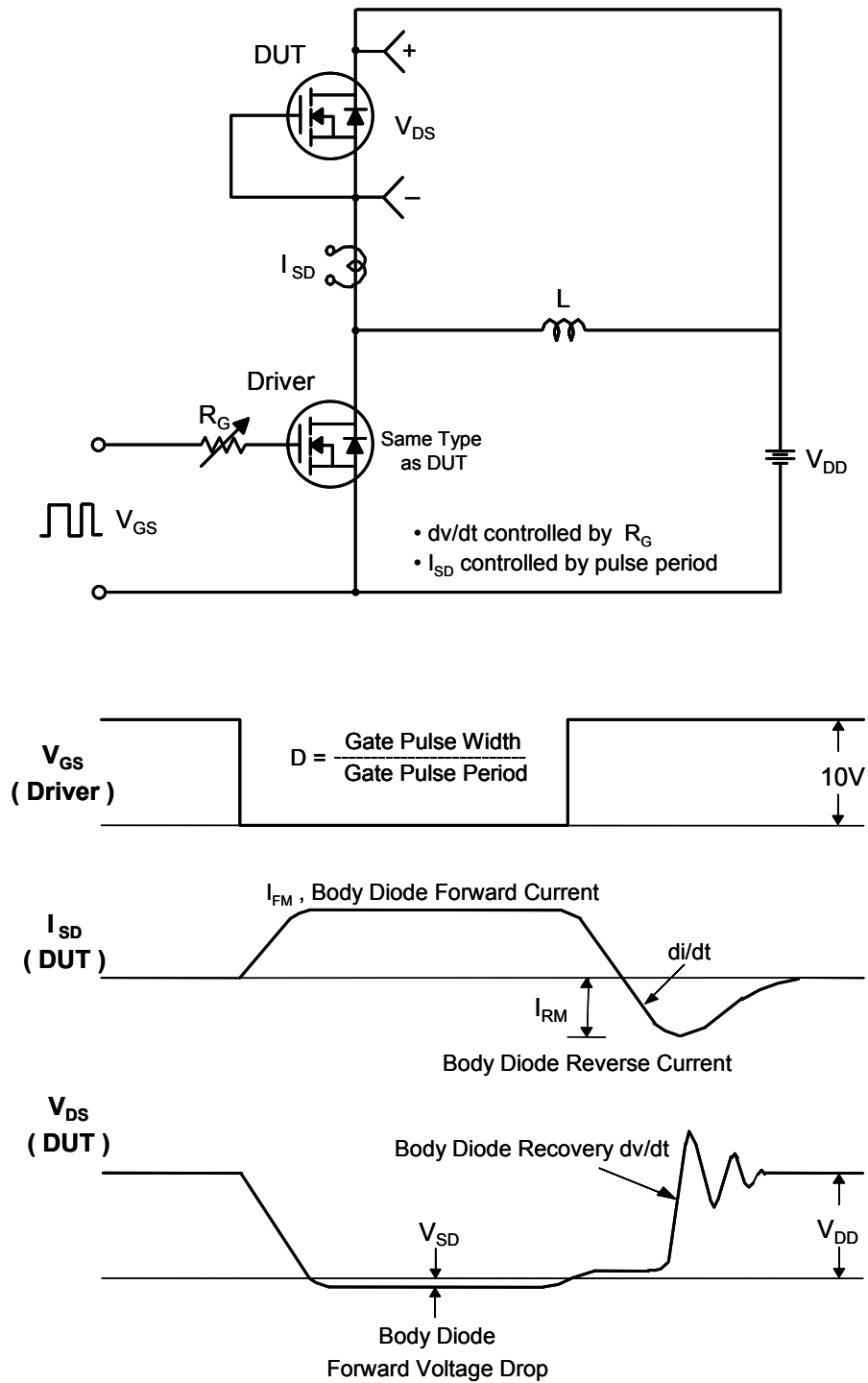
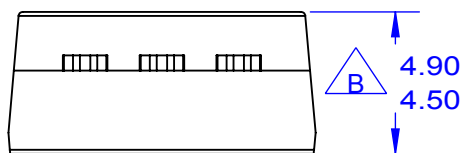
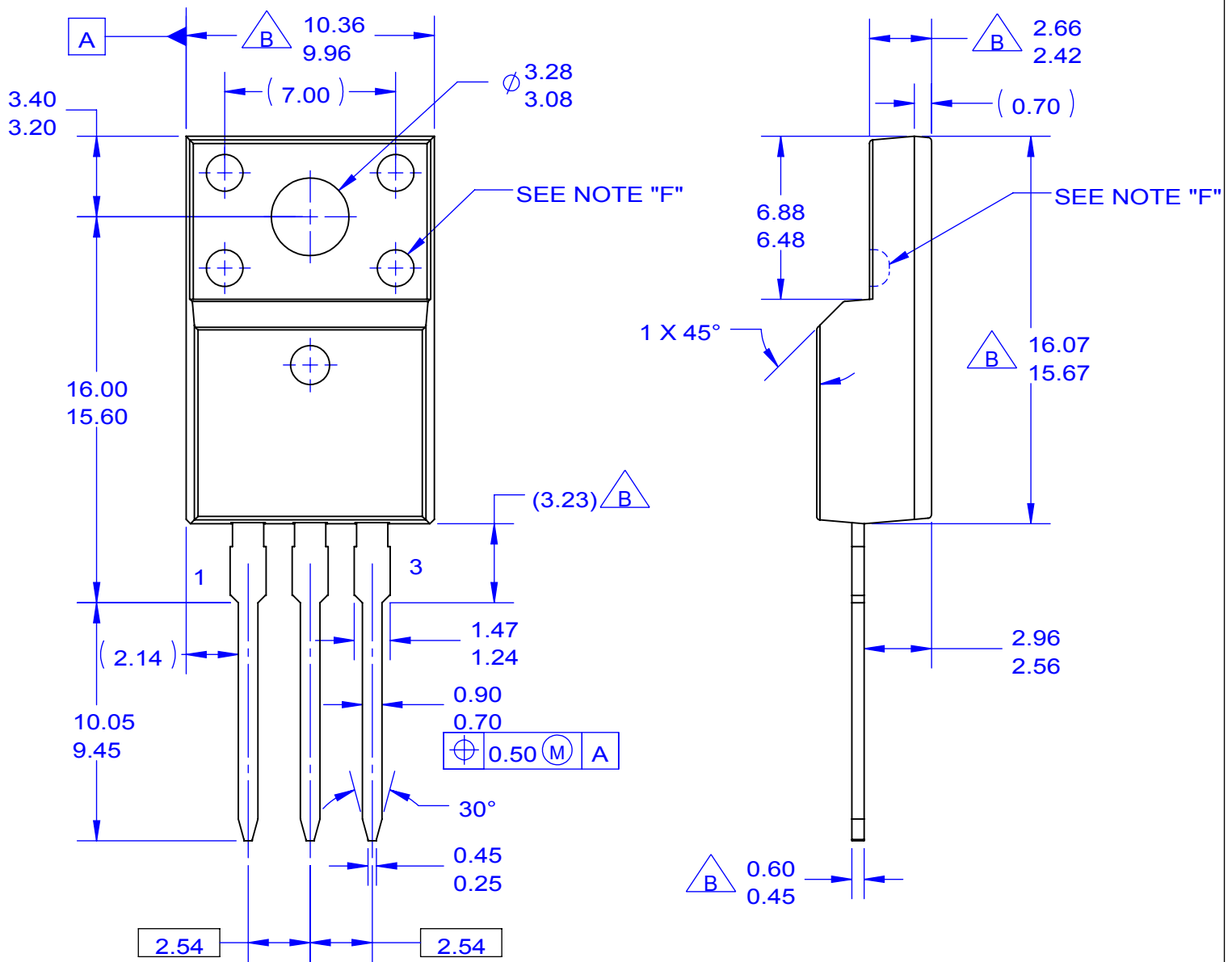


Figure 15. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms





- 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)
  - $\triangle E$  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
  - $\triangle H$  PRESENCE IS SUPPLIER DEPENDENT
  - I) SUPPLIER DEPENDENT MOLD LOCKING HOLES IN HEATSINK.



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NOTES:

- A. EXCEPT WHERE NOTED CONFORMS TO EIAJ SC91A.
- B. DOES NOT COMPLY EIAJ STD. VALUE.
- C. ALL DIMENSIONS ARE IN MILLIMETERS.
- D. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.
- E. DIMENSION AND TOLERANCE AS PER ASME Y14.5-1994.
- F. OPTION 1 - WITH SUPPORT PIN HOLE.  
OPTION 2 - NO SUPPORT PIN HOLE.
- G. DRAWING FILE NAME: TO220M03REV5

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