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August 2014

# FCP20N60 / FCPF20N60

## N-Channel SuperFET<sup>®</sup> MOSFET

600 V, 20 A, 190 mΩ

### Features

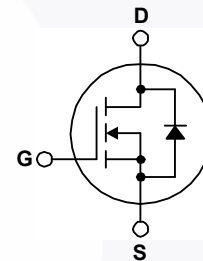
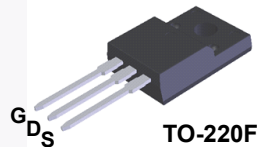
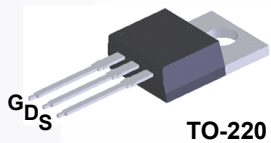
- 650V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 150\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 75\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 165\text{ pF}$ )
- 100% Avalanche Tested

### Applications

- Solar Inverter
- AC-DC Power Supply

### Description

SuperFET<sup>®</sup> MOSFET is Fairchild Semiconductor's first generation of 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 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

Symbol	Parameter	FCP20N60	FCPF20N60	Unit
$V_{DSS}$	Drain-Source Voltage	600		V
$I_D$	Drain Current	- Continuous ( $T_C = 25^\circ\text{C}$ )	20	20*
		- Continuous ( $T_C = 100^\circ\text{C}$ )	12.5	12.5*
$I_{DM}$	Drain Current - Pulsed (Note 1)	60	60*	A
$V_{GSS}$	Gate-Source Voltage	$\pm 30$		V
$E_{AS}$	Single Pulsed Avalanche Energy (Note 2)	690		mJ
$I_{AR}$	Avalanche Current (Note 1)	20		A
$E_{AR}$	Repetitive Avalanche Energy (Note 1)	20.8		mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)	4.5		V/ns
$P_D$	Power Dissipation ( $T_C = 25^\circ\text{C}$ ) - Derate Above $25^\circ\text{C}$	208	39	W
		1.67	0.3	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	FCP20N60	FCPF20N60	Unit
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case	0.6	3.2	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	62.5	62.5	$^\circ\text{C}/\text{W}$

## Package Marking and Ordering Information

Part Number	Top Mark	Package	Packing Method	Reel Size	Tape Width	Quantity
FCP20N60	FCP20N60	TO-220	Tube	N/A	N/A	50 units
FCPF20N60	FCPF20N60	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
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### Off Characteristics

$BV_{DSS}$	Drain to Source Breakdown Voltage	$I_D = 250 \mu\text{A}, V_{GS} = 0 \text{ V}, T_J = 25^\circ\text{C}$	600	-	-	V
		$I_D = 250 \mu\text{A}, V_{GS} = 0 \text{ V}, T_J = 150^\circ\text{C}$	-	650	-	V
$\Delta BV_{DSS} / \Delta T_J$	Breakdown Voltage Temperature Coefficient	$I_D = 250 \mu\text{A}, \text{Referenced to } 25^\circ\text{C}$	-	0.6	-	V/°C
$BV_{DS}$	Drain-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	$\mu\text{A}$
		$V_{DS} = 480 \text{ V}, T_C = 125^\circ\text{C}$	-	-	10	
$I_{GSS}$	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	$V_{GS} = V_{DS}, I_D = 250 \mu\text{A}$	3.0	-	5.0	V
$R_{DS(on)}$	Static Drain to Source On Resistance	$V_{GS} = 10 \text{ V}, I_D = 10 \text{ A}$	-	0.15	0.19	$\Omega$
$g_{FS}$	Forward Transconductance	$V_{DS} = 40 \text{ V}, I_D = 10 \text{ A}$	-	17	-	S

### Dynamic Characteristics

$C_{iss}$	Input Capacitance	$V_{DS} = 25 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$	-	2370	3080	pF
$C_{oss}$	Output Capacitance		-	1280	1665	pF
$C_{riss}$	Reverse Transfer Capacitance		-	95	-	pF
$C_{oss}$	Output Capacitance	$V_{DS} = 480 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$	-	65	85	pF
$C_{oss(eff.)}$	Effective Output Capacitance	$V_{DS} = 0 \text{ V to } 400 \text{ V}, V_{GS} = 0 \text{ V}$	-	165	-	pF
$Q_g$	Total Gate Charge at 10V	$V_{DS} = 480 \text{ V}, I_D = 20 \text{ A}, V_{GS} = 10 \text{ V}$ (Note 4)	-	75	98	nC
$Q_{gs}$	Gate to Source Gate Charge		-	13.5	18	nC
$Q_{gd}$	Gate to Drain "Miller" Charge		-	36	-	nC

### Switching Characteristics

$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 300 \text{ V}, I_D = 20 \text{ A}, V_{GS} = 10 \text{ V}, R_G = 25 \Omega$ (Note 4)	-	62	135	ns
$t_r$	Turn-On Rise Time		-	140	290	ns
$t_{d(off)}$	Turn-Off Delay Time		-	230	470	ns
$t_f$	Turn-Off Fall Time		-	65	140	ns

### Drain-Source Diode Characteristics

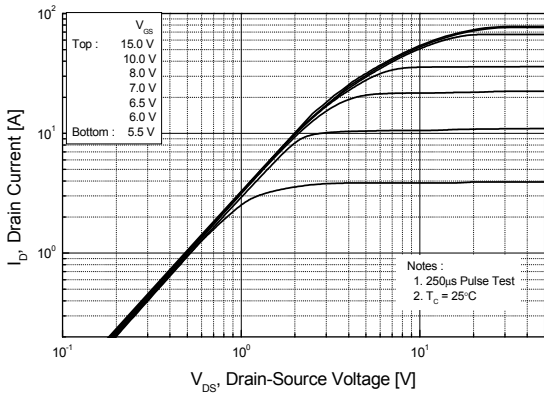
$I_S$	Maximum Continuous Drain to Source Diode Forward Current	-	-	20	A	
$I_{SM}$	Maximum Pulsed Drain to Source Diode Forward Current	-	-	60	A	
$V_{SD}$	Drain to Source Diode Forward Voltage	$V_{GS} = 0 \text{ V}, I_{SD} = 20 \text{ A}$	-	-	1.4	V
$t_{rr}$	Reverse Recovery Time	$V_{GS} = 0 \text{ V}, I_{SD} = 20 \text{ A}, di_F/dt = 100 \text{ A}/\mu\text{s}$	-	530	-	ns
$Q_{rr}$	Reverse Recovery Charge		-	10.5	-	$\mu\text{C}$

#### Notes:

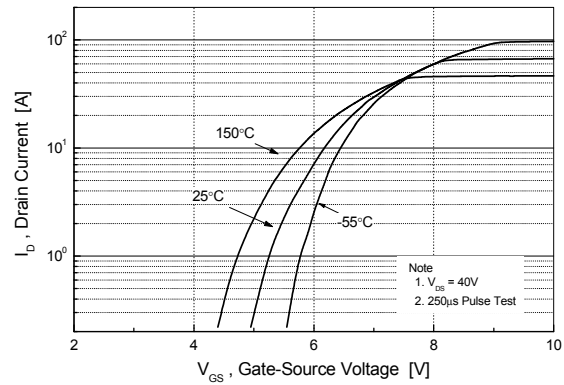
- 1: Repetitive rating: pulse-width limited by maximum junction temperature.
- 2:  $I_{AS} = 10 \text{ A}, V_{DD} = 50 \text{ V}, R_G = 25 \Omega$ , starting  $T_J = 25^\circ\text{C}$ .
- 3:  $I_{SD} \leq 20 \text{ A}, di/dt \leq 200 \text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , starting  $T_J = 25^\circ\text{C}$ .
- 4: Essentially independent of operating temperature typical characteristics.

## Typical Performance Characteristics

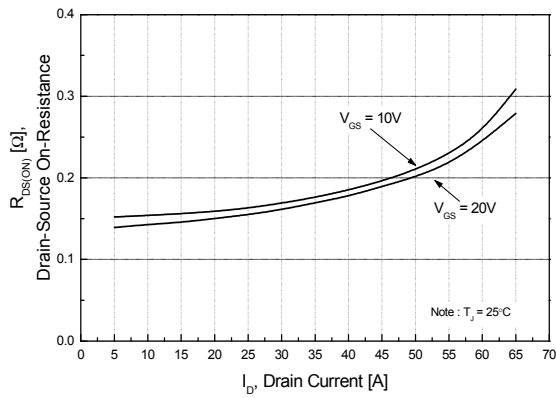
**Figure 1. On-Region Characteristics**



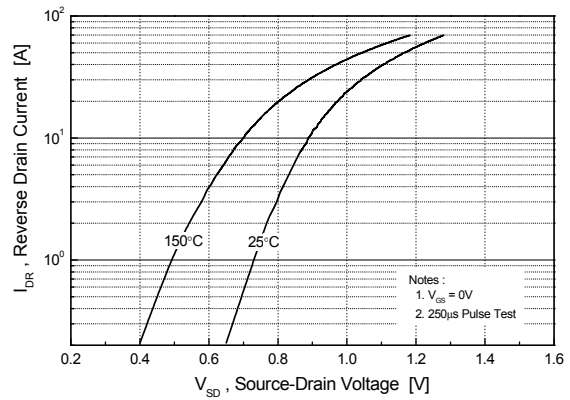
**Figure 2. Transfer Characteristics**



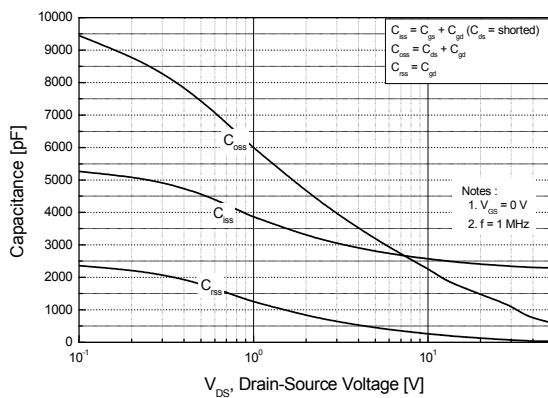
**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**



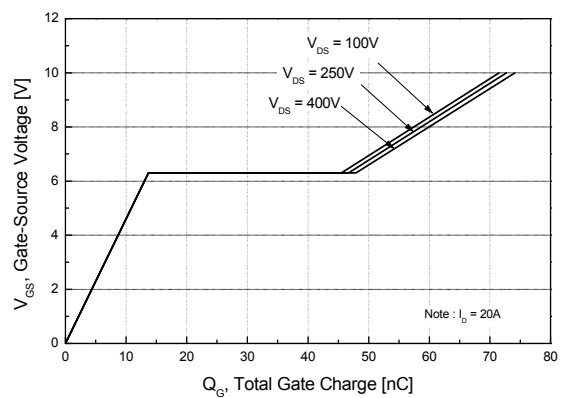
**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature**



**Figure 5. Capacitance Characteristics**

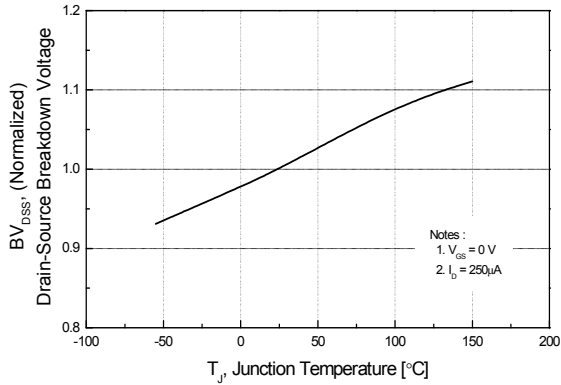


**Figure 6. Gate Charge Characteristics**

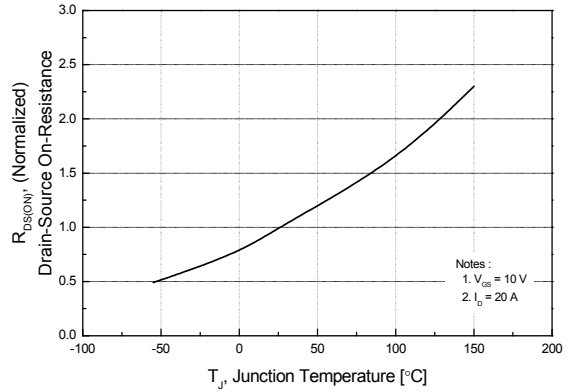


## Typical Performance Characteristics (Continued)

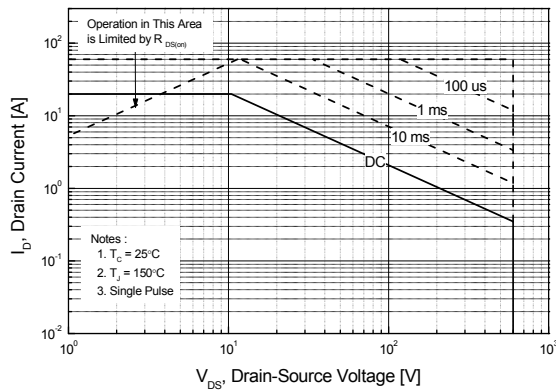
**Figure 7. Breakdown Voltage Variation vs. Temperature**



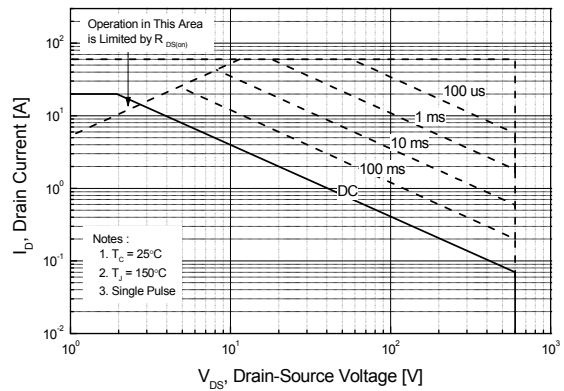
**Figure 8. On-Resistance Variation vs. Temperature**



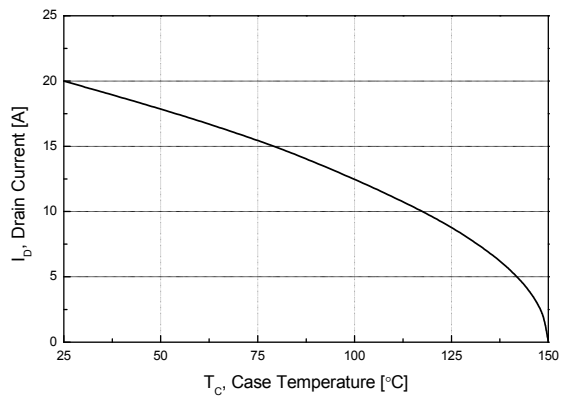
**Figure 9-1. Maximum Safe Operating Area for FCP20N60**



**Figure 9-2. Maximum Safe Operating Area for FCPF20N60**



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



Typical Performance Characteristics (Continued)

Figure 11-1. Transient Thermal Response Curve for FCP20N60

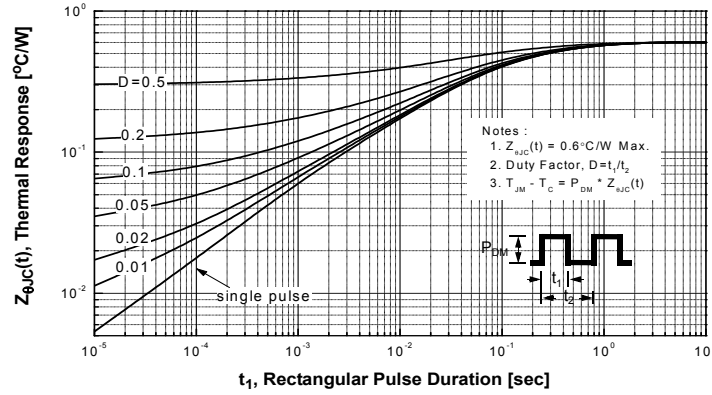
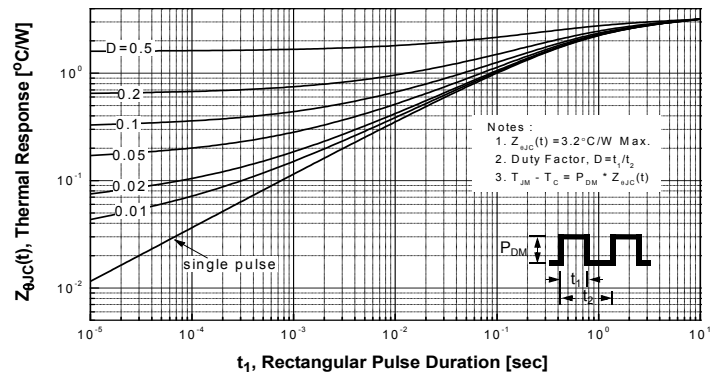


Figure 11-2. Transient Thermal Response Curve for FCPF20N60



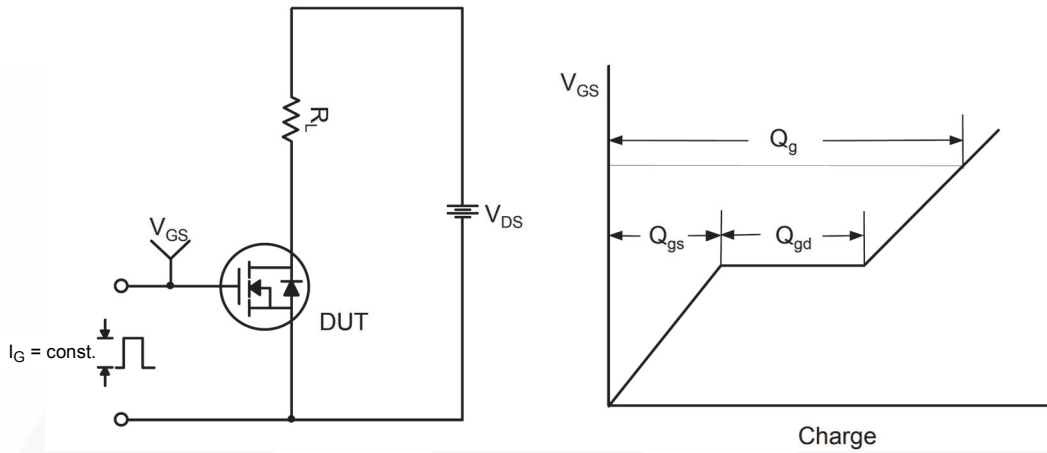


Figure 12. Gate Charge Test Circuit & Waveform

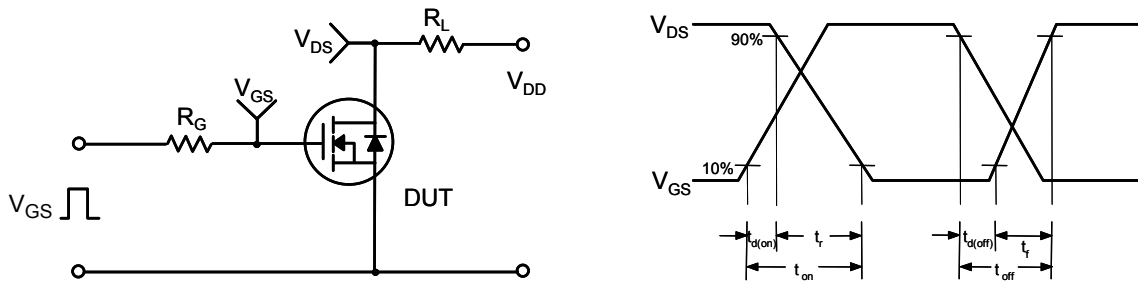


Figure 13. Resistive Switching Test Circuit & Waveforms

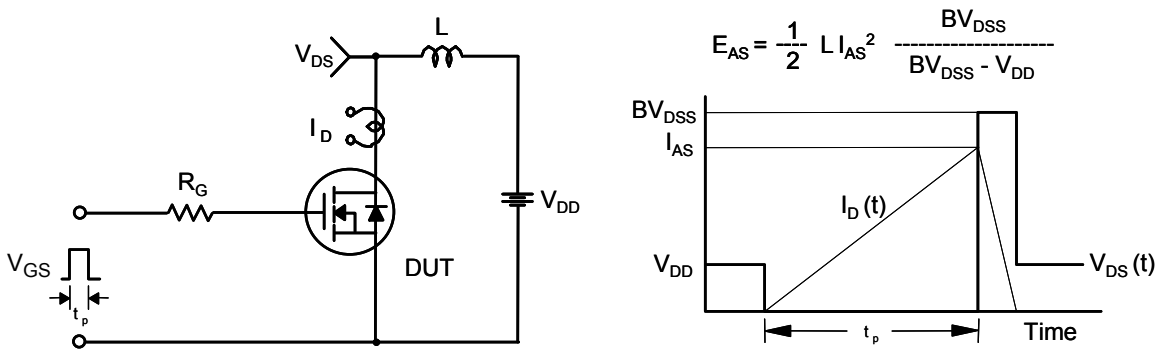


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms

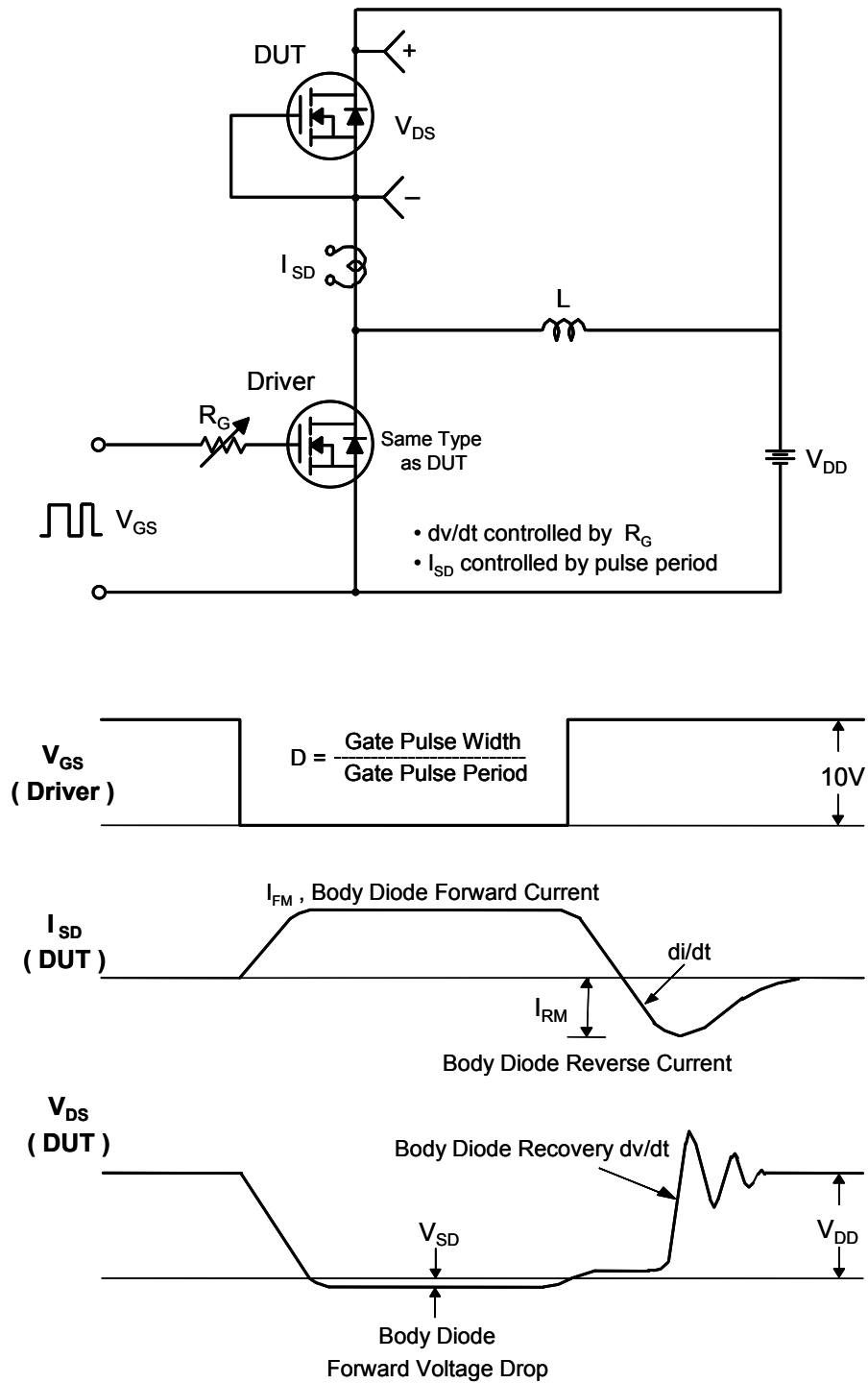
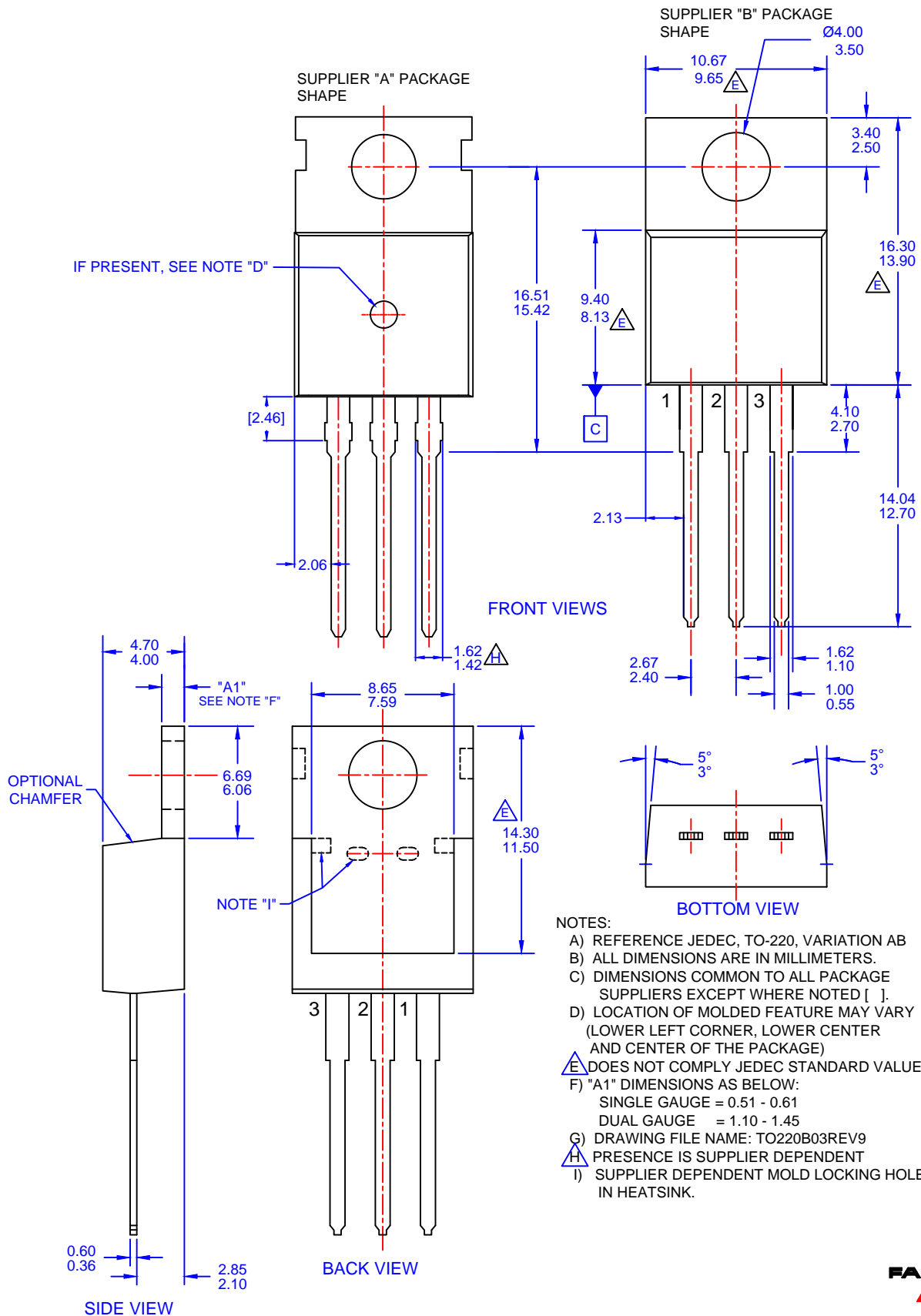


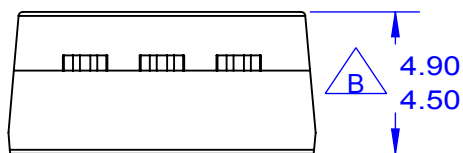
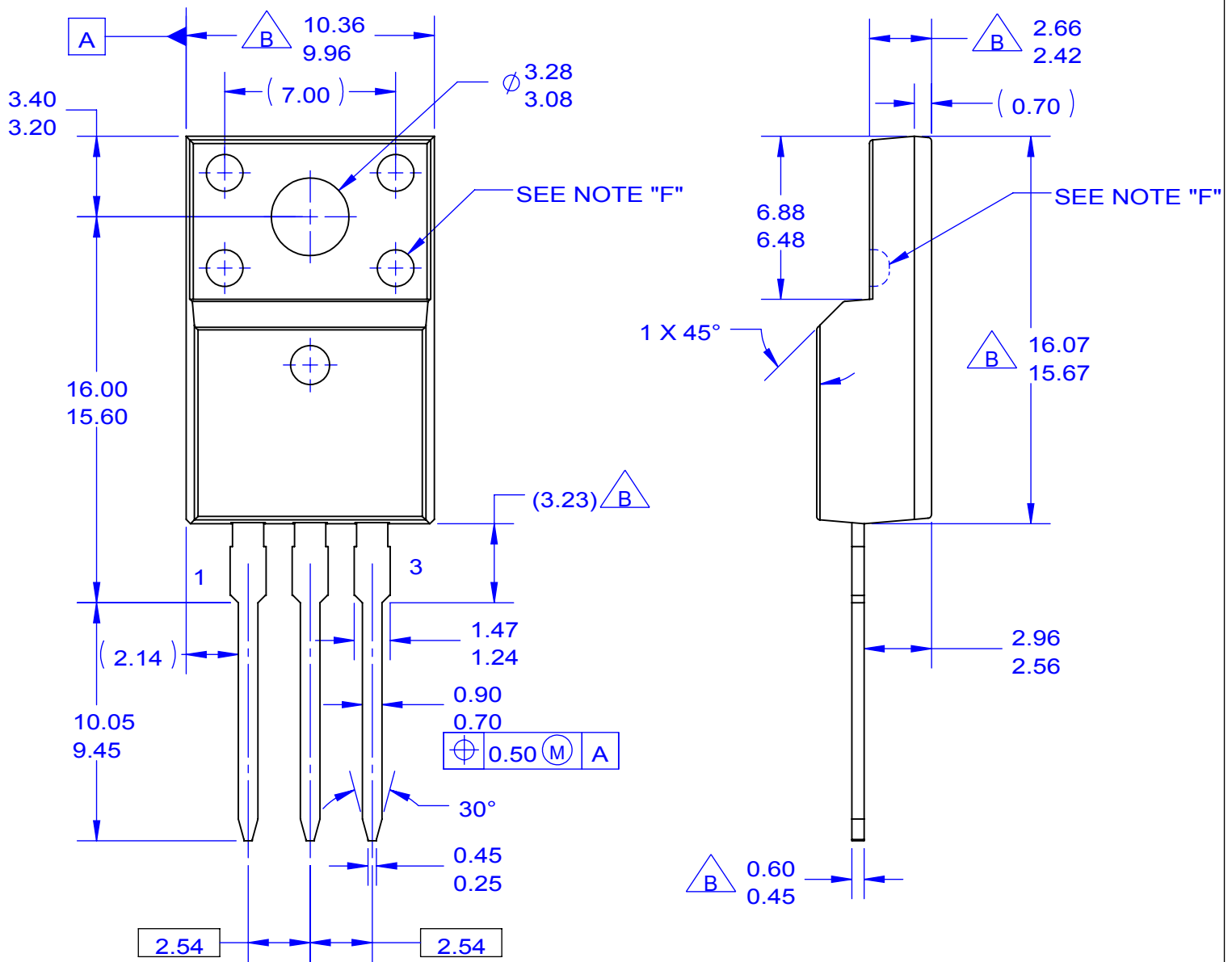
Figure 15. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms





- 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)
  - 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.





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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