



August 2014

# FCP20N60 / FCPF20N60

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

600 V, 20 A, 190 mΩ

### Features

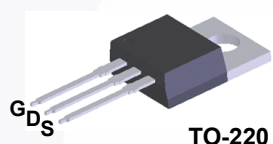
- 650V @  $T_J = 150^{\circ}\text{C}$
- Typ.  $R_{DS(on)} = 150\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 75\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 165\text{ pF}$ )
- 100% Avalanche Tested

### Applications

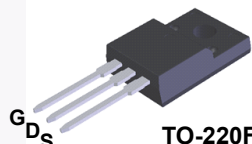
- Solar Inverter
- AC-DC Power Supply

### Description

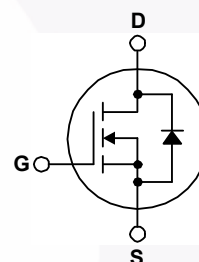
SuperFET<sup>®</sup> MOSFET is Fairchild Semiconductor's first generation of high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This technology is tailored to minimize conduction loss, provide 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.



TO-220



TO-220F



### Absolute Maximum Ratings

Symbol	Parameter	FCP20N60	FCPF20N60	Unit
$V_{DSS}$	Drain-Source Voltage	600		V
$I_D$	Drain Current - Continuous ( $T_C = 25^{\circ}\text{C}$ ) - Continuous ( $T_C = 100^{\circ}\text{C}$ )	20	20*	A
		12.5	12.5*	A
$I_{DM}$	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	$^{\circ}\text{C/W}$
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	62.5	62.5	$^{\circ}\text{C/W}$

## 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	$I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$	-	0.6	-	$\text{V}/^\circ\text{C}$
$BV_{DS}$	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	$\mu\text{A}$
$I_{GSS}$	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
$C_{rss}$	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 <sub>S</sub>	Maximum Continuous Drain to Source Diode Forward Current		-	-	20	A
I <sub>SM</sub>	Maximum Pulsed Drain to Source Diode Forward Current		-	-	60	A
V <sub>SD</sub>	Drain to Source Diode Forward Voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 20 A	-	-	1.4	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 20 A, dI <sub>F</sub> /dt = 100 A/μs	-	530	-	ns
Q <sub>rr</sub>	Reverse Recovery Charge		-	10.5	-	μC

#### 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

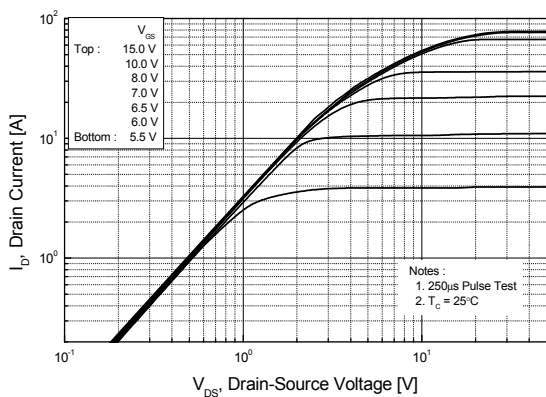


Figure 2. Transfer Characteristics

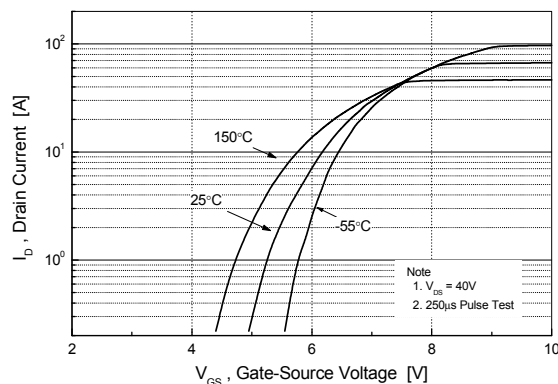


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

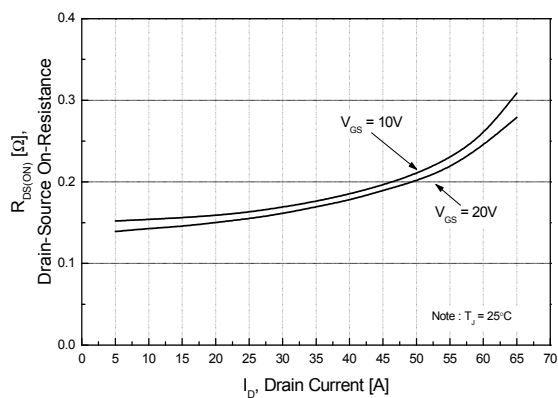


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

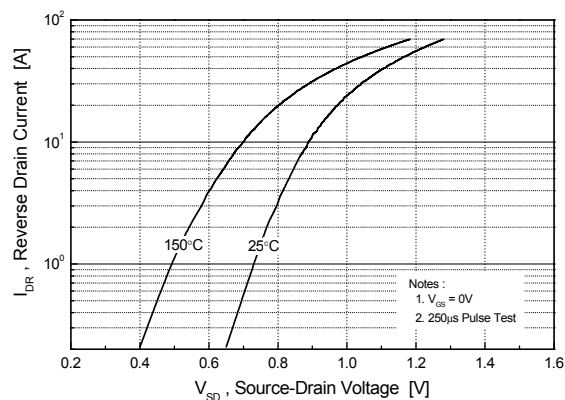


Figure 5. Capacitance Characteristics

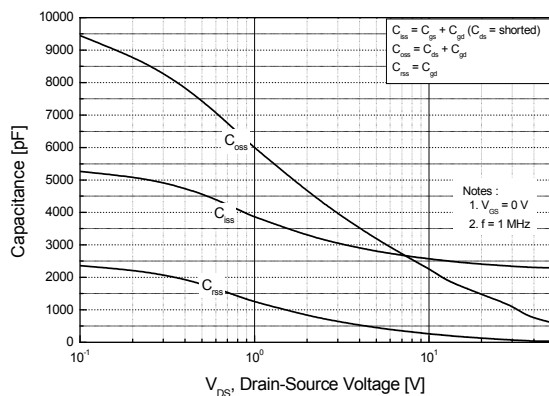
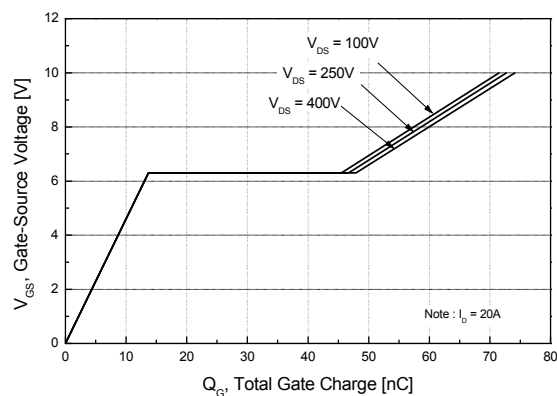
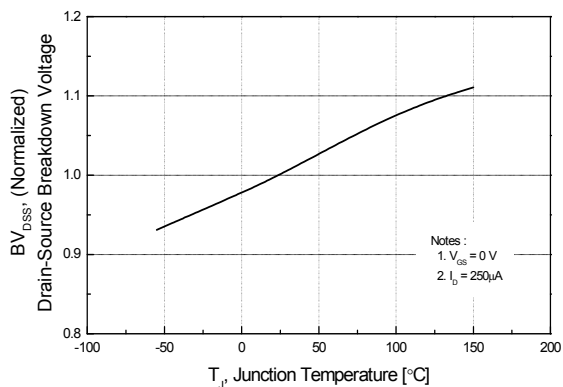


Figure 6. Gate Charge Characteristics

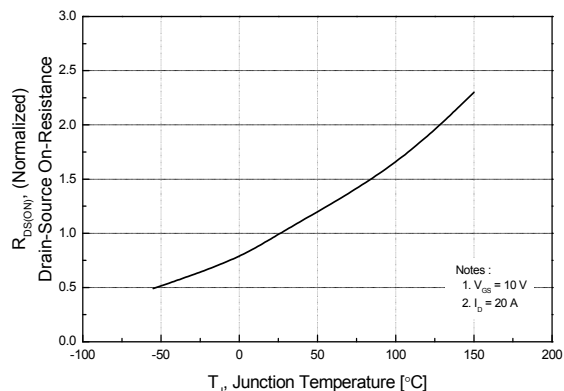


## Typical Performance Characteristics (Continued)

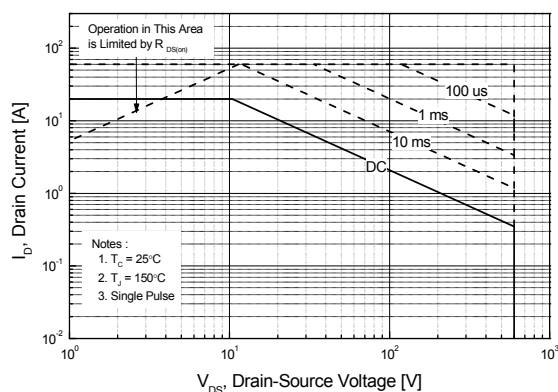
**Figure 7. Breakdown Voltage Variation vs. Temperature**



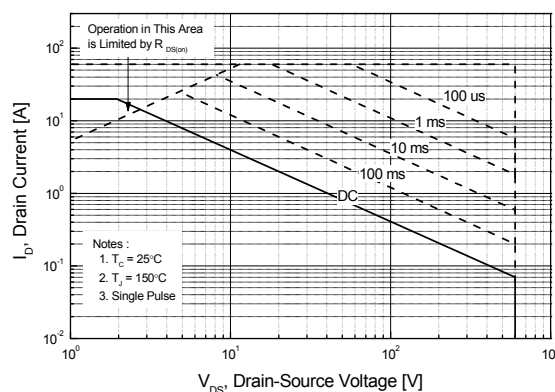
**Figure 8. On-Resistance Variation vs. Temperature**



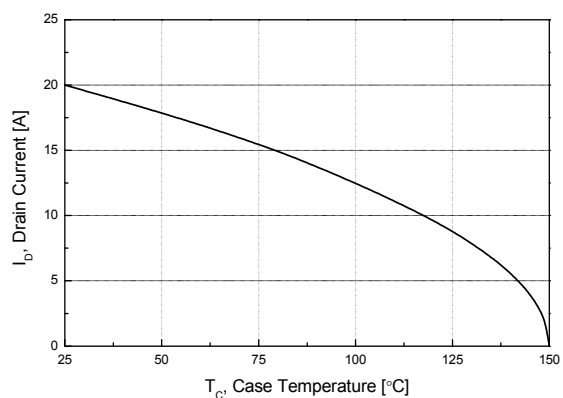
**Figure 9-1. Maximum Safe Operating Area for FCP20N60**



**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

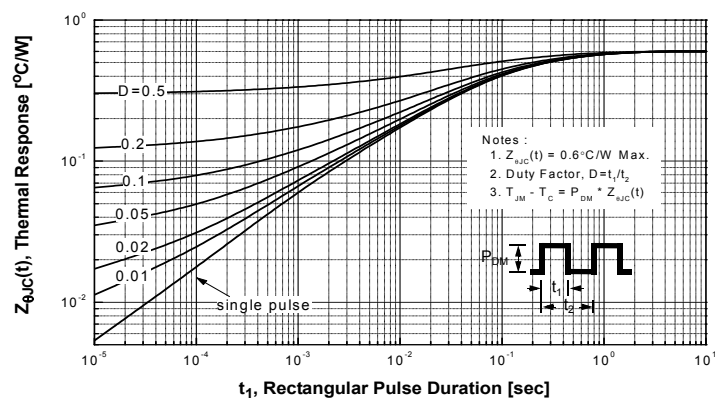


Figure 11-2. Transient Thermal Response Curve for FCPF20N60

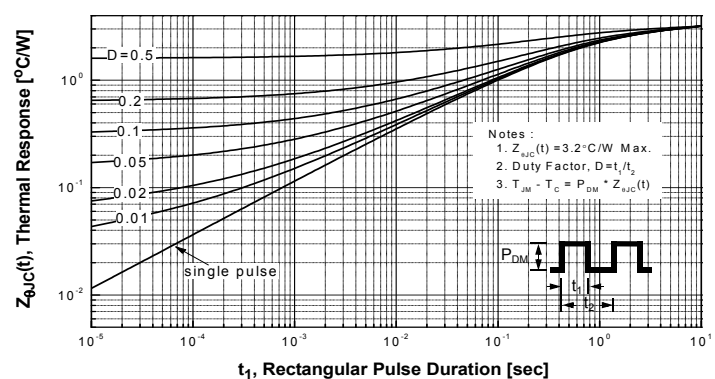




Figure 12. Gate Charge Test Circuit & Waveform

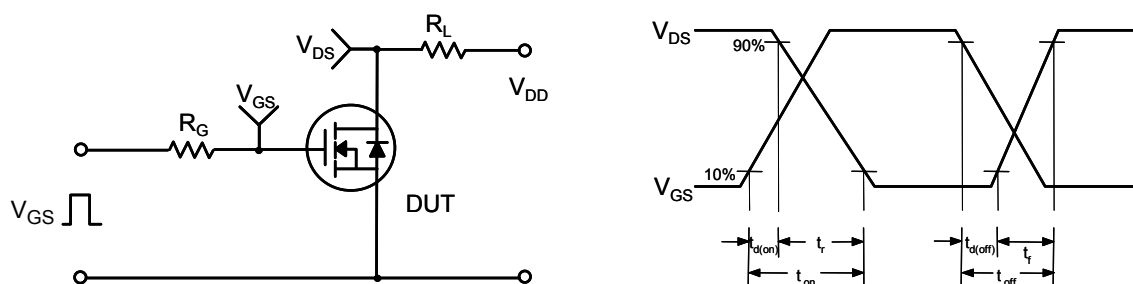


Figure 13. Resistive Switching Test Circuit & Waveforms

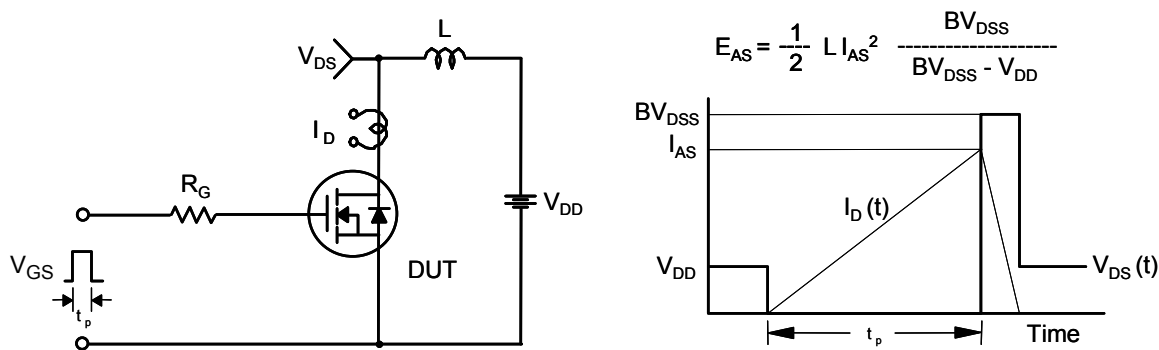
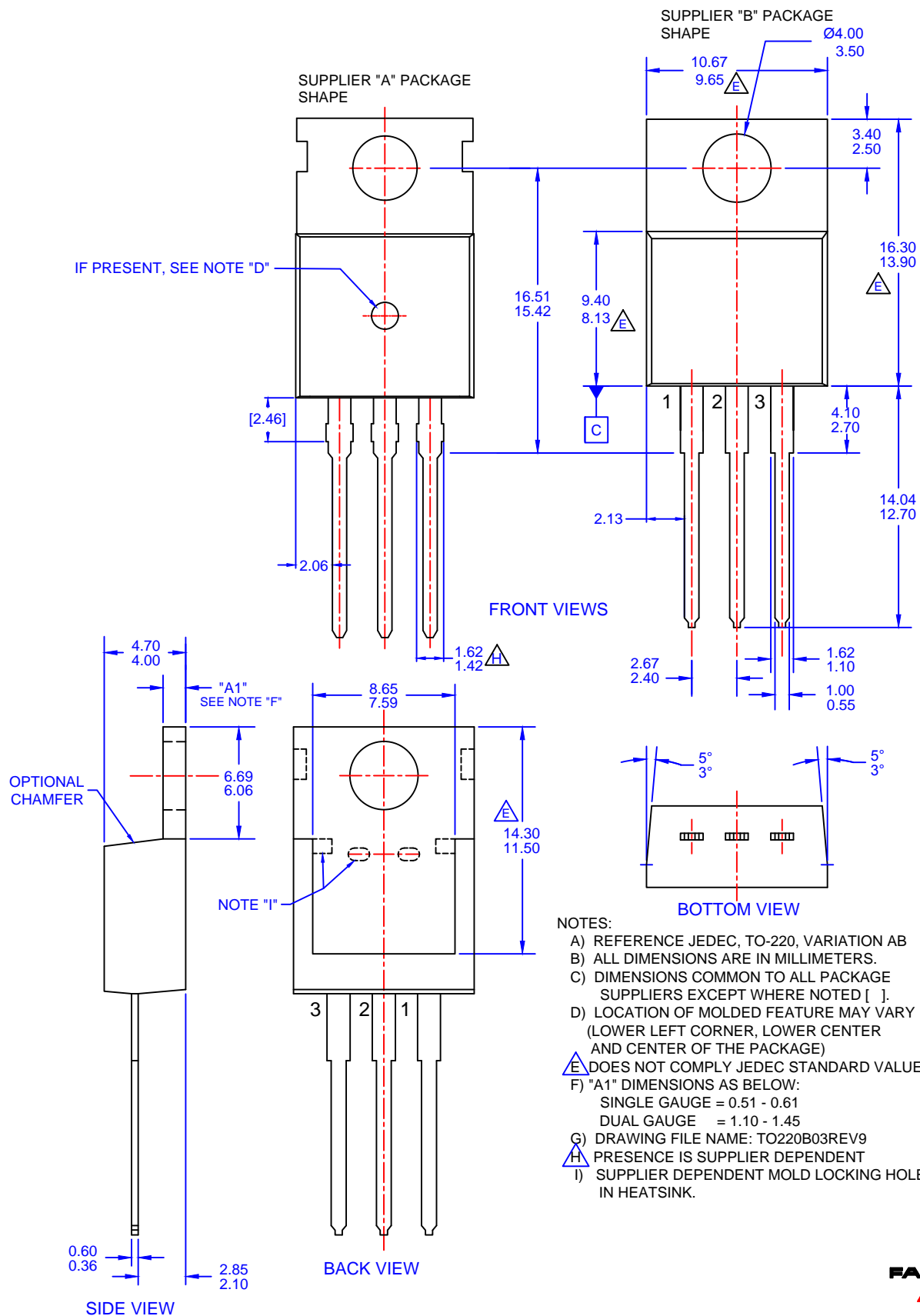


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms



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







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