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Please note: As part of the Fairchild Semiconductor integration, some of the Fairchild orderable part numbers will need to change in order to meet ON Semiconductor's system requirements. Since the ON Semiconductor product management systems do not have the ability to manage part nomenclature that utilizes an underscore (_), the underscore (_) in the Fairchild part numbers will be changed to a dash (-). This document may contain device numbers with an underscore (_). Please check the ON Semiconductor website to verify the updated device numbers. The most current and up-to-date ordering information can be found at www.onsemi.com. Please email any questions regarding the system integration to Fairchild_questions@onsemi.com.

FCPF150N65F

N-Channel SuperFET® II FRFET® MOSFET

650 V, 24 A, 150 mΩ

Features

- 700 V @ T_J = 150°C
- Typ. $R_{DS(on)}$ = 133 mΩ
- Ultra Low Gate Charge (Typ. Q_g = 72 nC)
- Low Effective Output Capacitance (Typ. $C_{oss(eff.)}$ = 361 pF)
- 100% Avalanche Tested
- RoHS Compliant

Applications

- Telecom/Server Power Supplies
- Computing Power Supplies
- Solar Inverters
- FPD TV Power/Lighting

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. SuperFET II FRFET® MOSFET combines a faster and more rugged intrinsic body diode performance with fast switching, aimed at achieving better reliability and efficiency especially in resonant switching applications. SuperFET II FRFET is very suitable for the switching power applications such as server/telecom power, Solar inverter, FPD TV power, computing power, lighting and industrial power applications.

TO-220F

Absolute Maximum Ratings T_C = 25°C unless otherwise noted.

Symbol	Parameter			FCPF150N65F	Unit
V_{DSS}	Drain to Source Voltage			650	V
V_{GSS}	Gate to Source Voltage	- DC		±20	V
		- AC	(f > 1 Hz)	±30	
I_D	Drain Current	- Continuous (T_C = 25°C)		24*	A
		- Continuous (T_C = 100°C)		14.9*	
I_{DM}	Drain Current	- Pulsed	(Note 1)	72*	A
E_{AS}	Single Pulsed Avalanche Energy		(Note 2)	663	mJ
I_{AR}	Avalanche Current		(Note 1)	4.7	A
E_{AR}	Repetitive Avalanche Energy		(Note 1)	2.98	mJ
dv/dt	MOSFET dv/dt			100	V/ns
	Peak Diode Recovery dv/dt		(Note 3)	50	
P_D	Power Dissipation	(T_C = 25°C)		39	W
		- Derate Above 25°C		0.31	W/°C
T_J, T_{STG}	Operating and Storage Temperature Range			-55 to +150	°C
T_L	Maximum Lead Temperature for Soldering, 1/8" from Case for 5 Seconds			300	°C

*Drain current limited by maximum junction temperature.

Thermal Characteristics

Symbol	Parameter	FCPF150N65F	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	3.2	°C/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
FCPF150N65F	FCPF150N65F	TO-220F	Tube	N/A	N/A	50 units

Electrical Characteristics $T_C = 25^oC$ unless otherwise noted.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit

Off Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
BV_{DSS}	Drain to Source Breakdown Voltage	$V_{GS} = 0$ V, $I_D = 10$ mA, $T_J = 25°C$	650	-	-	V
		$V_{GS} = 0$ V, $I_D = 10$ mA, $T_J = 150°C$	700	-	-	
$\Delta BV_{DSS} / \Delta T_J$	Breakdown Voltage Temperature Coefficient	$I_D = 10$ mA, Referenced to 25^oC	-	0.72	-	$V/^oC$
I_{DSS}	Zero Gate Voltage Drain Current	$V_{DS} = 650$ V, $V_{GS} = 0$ V	-	-	10	μA
		$V_{DS} = 520$ V, $V_{GS} = 0$ V, $T_C = 125^oC$	-	86	-	
I_{GSS}	Gate to Body Leakage Current	$V_{GS} = \pm20$ V, $V_{DS} = 0$ V	-	-	±100	nA

On Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{GS(th)}$	Gate Threshold Voltage	$V_{GS} = V_{DS}$, $I_D = 2.4$ mA	3	-	5	V
$R_{DS(on)}$	Static Drain to Source On Resistance	$V_{GS} = 10$ V, $I_D = 12$ A	-	133	150	$m\Omega$
g_{FS}	Forward Transconductance	$V_{DS} = 20$ V, $I_D = 12$ A	-	22	-	S

Dynamic Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input Capacitance	$V_{DS} = 100$ V, $V_{GS} = 0$ V, f = 1 MHz	-	2810	3737	pF
C_{oss}	Output Capacitance		-	91	121	pF
C_{rss}	Reverse Transfer Capacitance		-	0.77	-	pF
C_{oss}	Output Capacitance	$V_{DS} = 380$ V, $V_{GS} = 0$ V, f = 1 MHz	-	54	-	pF
$C_{oss(eff.)}$	Effective Output Capacitance	$V_{DS} = 0$ V to 400 V, $V_{GS} = 0$ V	-	361	-	pF
$Q_{g(tot)}$	Total Gate Charge at 10V	$V_{DS} = 380$ V, $I_D = 12$ A, $V_{GS} = 10$ V	-	72	94	nC
Q_{gs}	Gate to Source Gate Charge		-	15	-	nC
Q_{gd}	Gate to Drain "Miller" Charge	(Note 4)	-	31	-	nC
ESR	Equivalent Series Resistance	f = 1 MHz	-	0.69	-	Ω

Switching Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 380$ V, $I_D = 12$ A, $V_{GS} = 10$ V, $R_g = 4.7$ Ω	-	28	66	ns
t_r	Turn-On Rise Time		-	15	40	ns
$t_{d(off)}$	Turn-Off Delay Time		-	73	156	ns
t_f	Turn-Off Fall Time	(Note 4)	-	6	22	ns

Drain-Source Diode Characteristics

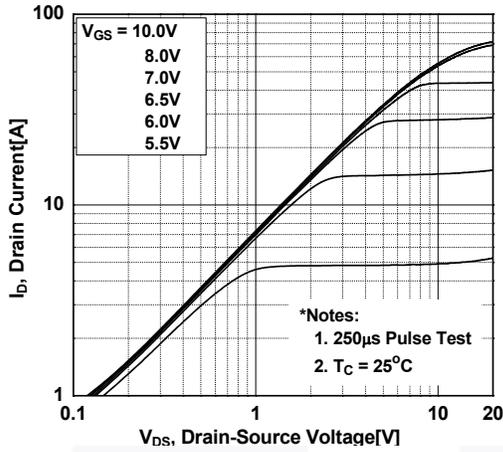| Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_S	Maximum Continuous Drain to Source Diode Forward Current		-	-	24	A
I_{SM}	Maximum Pulsed Drain to Source Diode Forward Current		-	-	72	A
V_{SD}	Drain to Source Diode Forward Voltage	$V_{GS} = 0$ V, $I_{SD} = 12$ A	-	-	1.4	V
t_{rr}	Reverse Recovery Time	$V_{GS} = 0$ V, $I_{SD} = 12$ A, $dI_F/dt = 100$ A/μs	-	123	-	ns
Q_{rr}	Reverse Recovery Charge		-	597	-	nC

Notes:
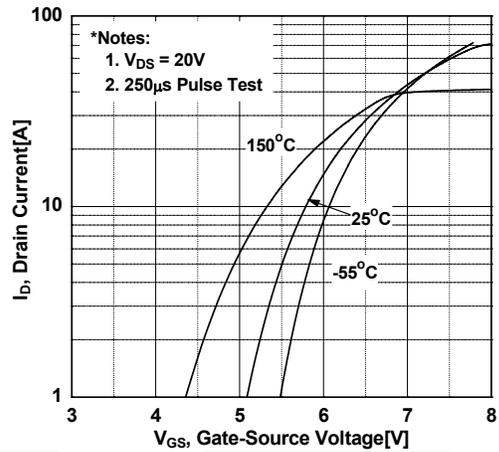
1. Repetitive rating: pulse width limited by maximum junction temperature.

2. $I_{AS} = 4.7$ A, $R_G = 25$ Ω, Starting $T_J = 25°C$.

3. $I_{SD} \leq 12$ A, di/dt ≤ 200 A/μs, $V_{DD} \leq 380$ V, Starting $T_J = 25°C$.

4. Essentially independent of operating temperature.
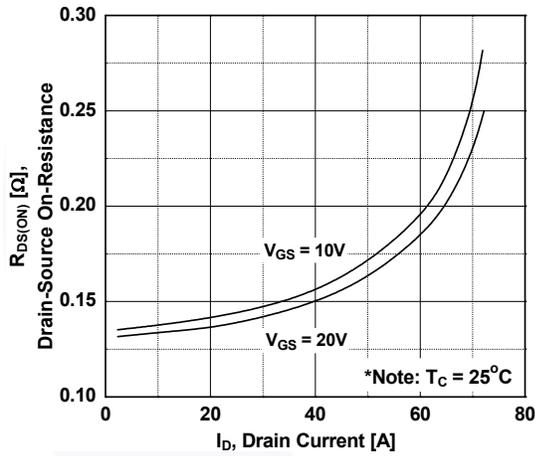
Typical Performance Characteristics
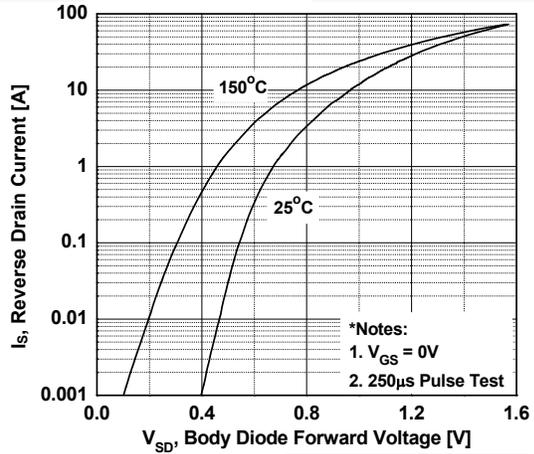
Figure 1. On-Region Characteristics

V_{GS} = 10.0V
8.0V
7.0V
6.5V
6.0V
5.5V

I_D, Drain Current[A]

V_{DS}, Drain-Source Voltage[V]

*Notes:
1. 250μs Pulse Test
2. T_C = 25°C

Figure 2. Transfer Characteristics

I_D, Drain Current[A]

V_{GS}, Gate-Source Voltage[V]

*Notes:
1. V_{DS} = 20V
2. 250μs Pulse Test

150°C
25°C
-55°C

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

$R_{DS(ON)}$ [Ω], Drain-Source On-Resistance

I_D, Drain Current [A]

V_{GS} = 10V
V_{GS} = 20V

*Note: T_C = 25°C

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

I_S, Reverse Drain Current [A]

V_{SD}, Body Diode Forward Voltage [V]

150°C
25°C

*Notes:
1. V_{GS} = 0V
2. 250μs Pulse Test

Figure 5. Capacitance Characteristics

Capacitances [pF]

V_{DS}, Drain-Source Voltage [V]

C_{iss}
C_{oss}
C_{rss}

*Note:
1. V_{GS} = 0V
2. f = 1MHz

$C_{iss} = C_{gs} + C_{gd}$ (C_{ds} = shorted)
$C_{oss} = C_{ds} + C_{gd}$
$C_{rss} = C_{gd}$
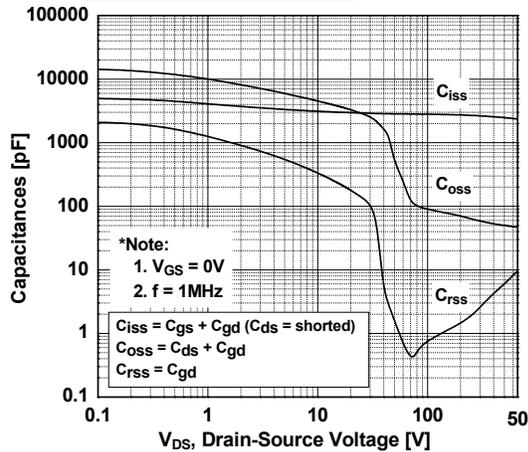
Figure 6. Gate Charge Characteristics

V_{GS}, Gate-Source Voltage [V]

Q_g, Total Gate Charge [nC]

V_{DS} = 130V
V_{DS} = 325V
V_{DS} = 520V

*Note: I_D = 12A
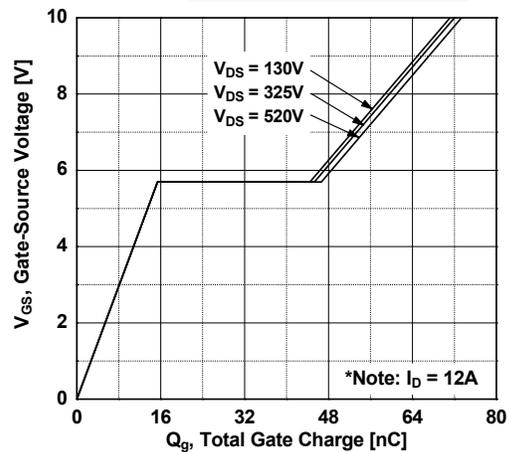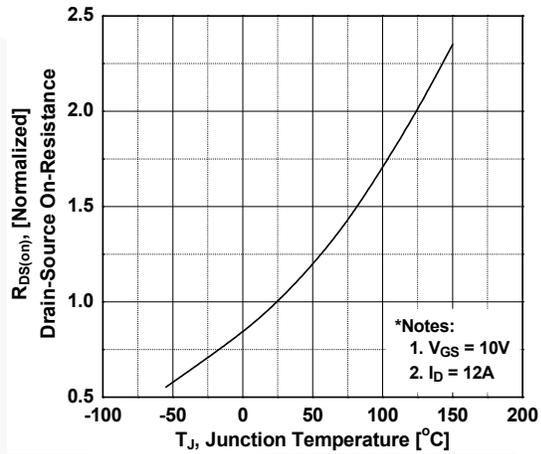
Typical Performance Characteristics (Continued)

Figure 7. Breakdown Voltage Variation vs. Temperature

Figure 7. Breakdown Voltage Variation vs. Temperature

*Notes:
1. V_{GS} = 0V
2. I_D = 10mA

Figure 8. On-Resistance Variation vs. Temperature

Figure 8. On-Resistance Variation vs. Temperature

*Notes:
1. V_{GS} = 10V
2. I_D = 12A
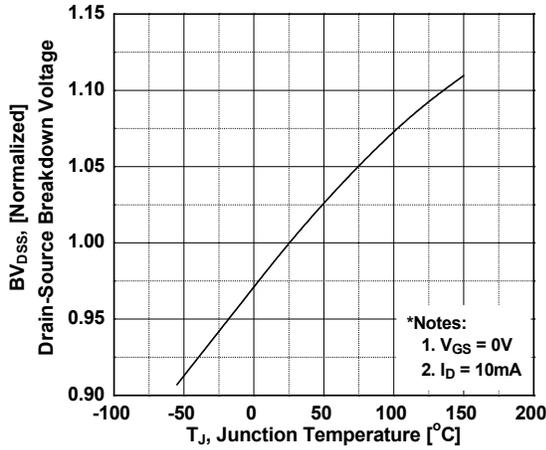
Figure 9. Maximum Safe Operating Area

Figure 9. Maximum Safe Operating Area

Operation in This Area is Limited by $R_{DS(on)}$

DC

10μs
100μs
1ms
10ms

*Notes:
1. T_C = 25°C
2. T_J = 150°C
3. Single Pulse

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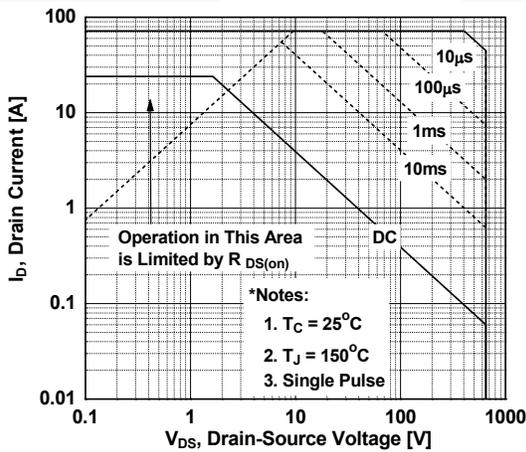
Figure 10. Maximum Drain Current vs. Case Temperature

Figure 11. Eoss vs. Drain to Source Voltage
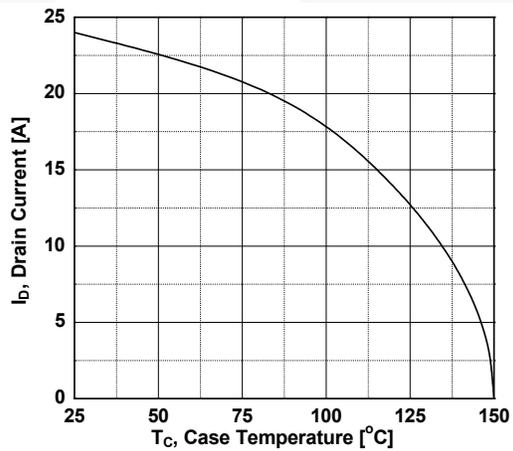
Figure 11. Eoss vs. Drain to Source Voltage
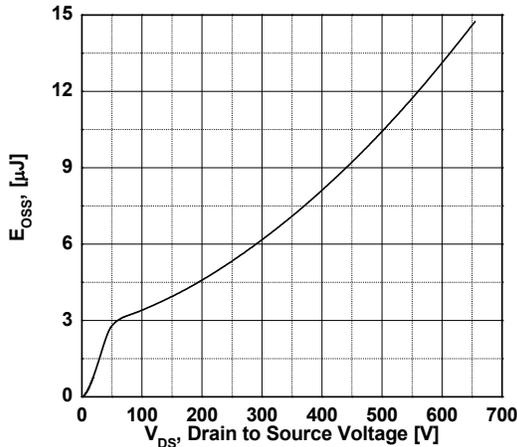
Typical Performance Characteristics (Continued)

Figure 12. Transient Thermal Response Curve

*Notes:
1. $Z_{\theta JC}(t) = 3.2^{o}C/W$ Max.
2. Duty Factor, $D = t_1/t_2$
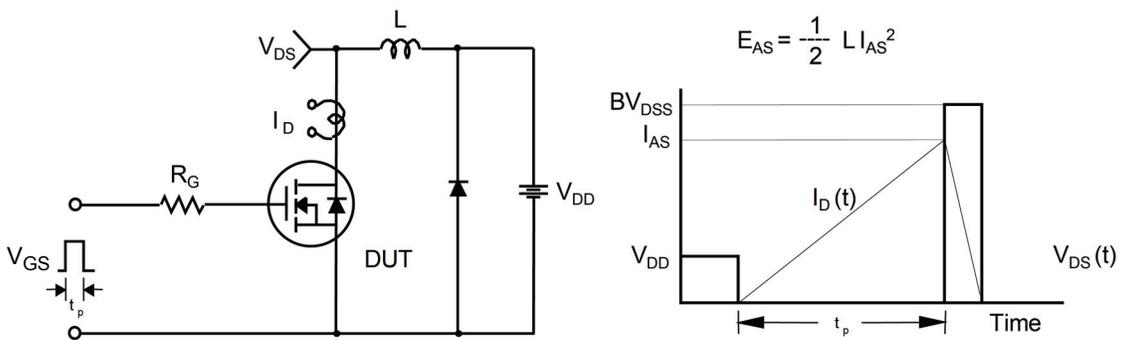3. $T_{JM} - T_C = P_{DM} * Z_{\theta JC}(t)$
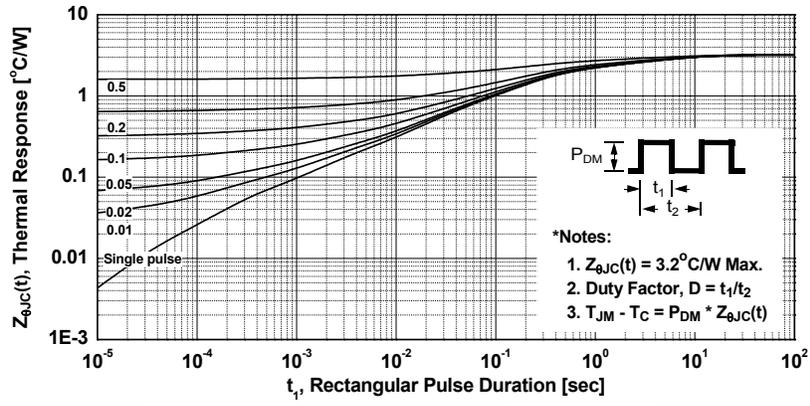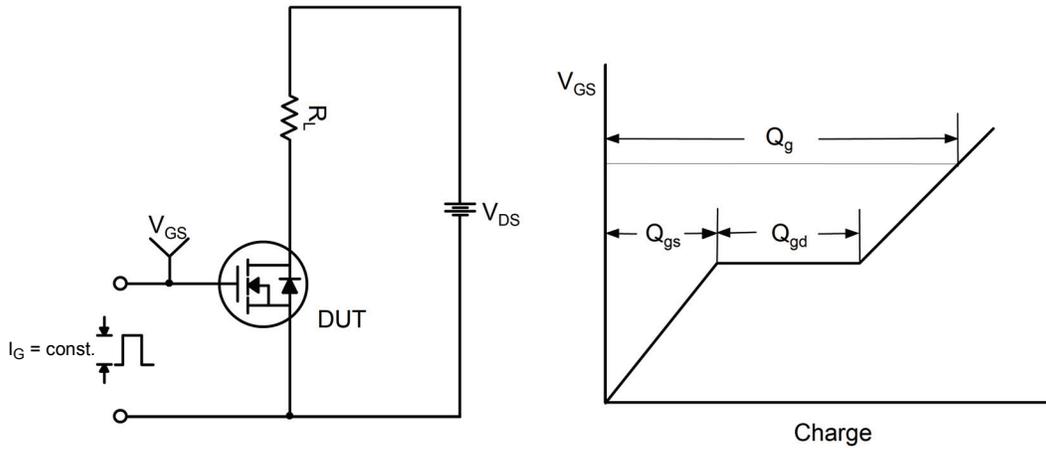
Figure 13. Gate Charge Test Circuit & Waveform
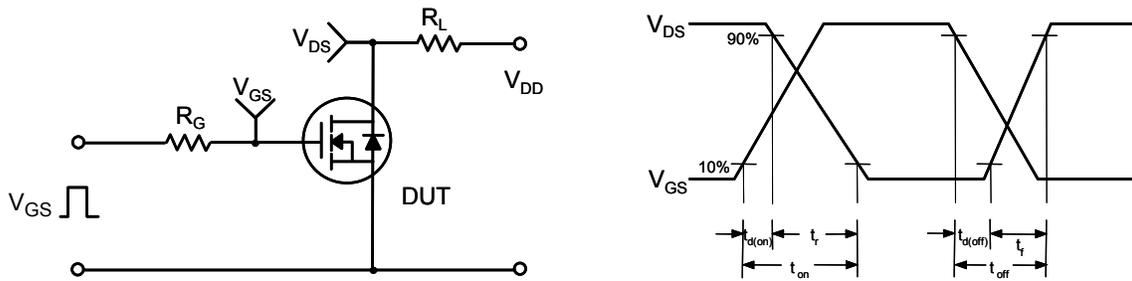
Figure 14. Resistive Switching Test Circuit & Waveforms

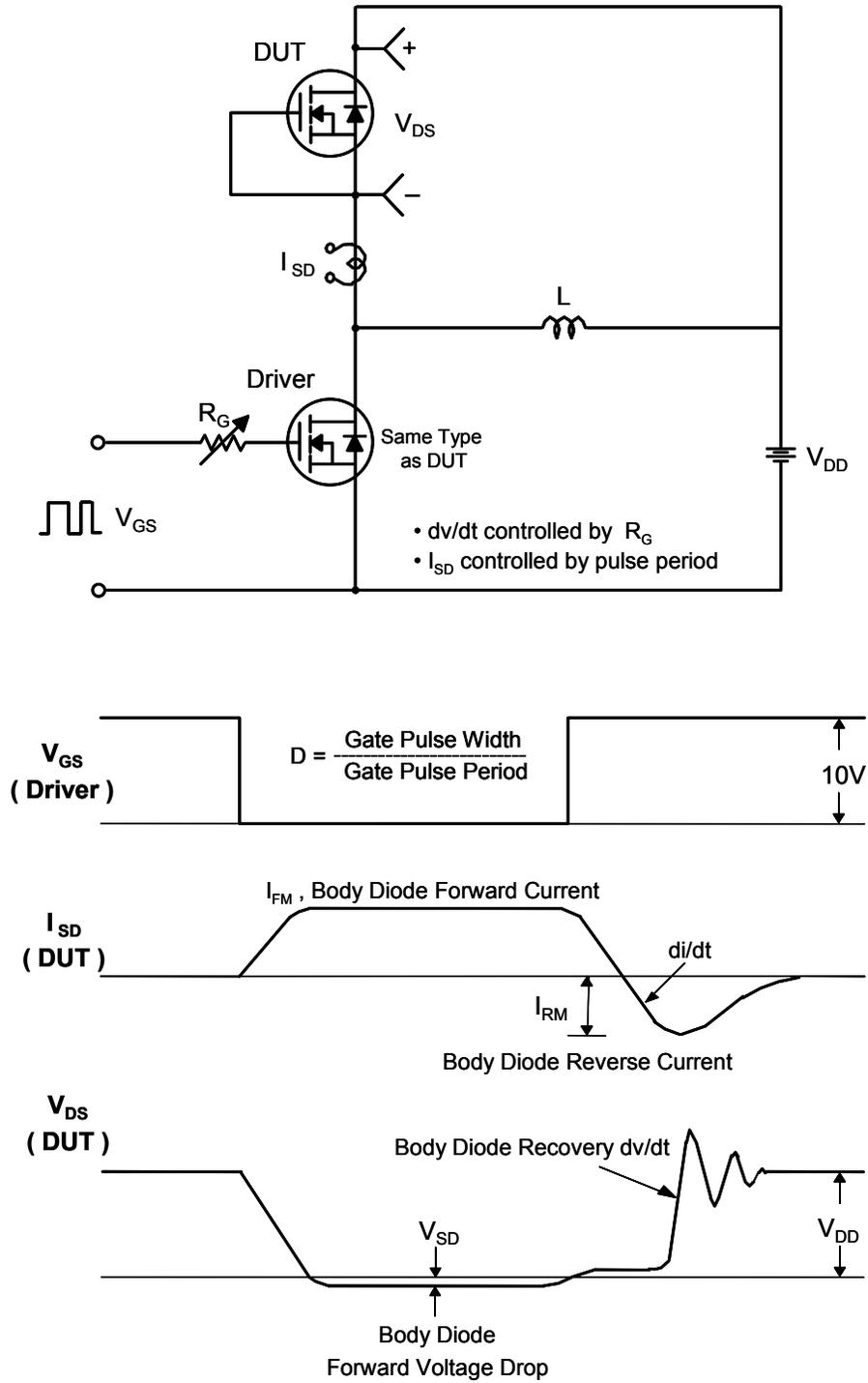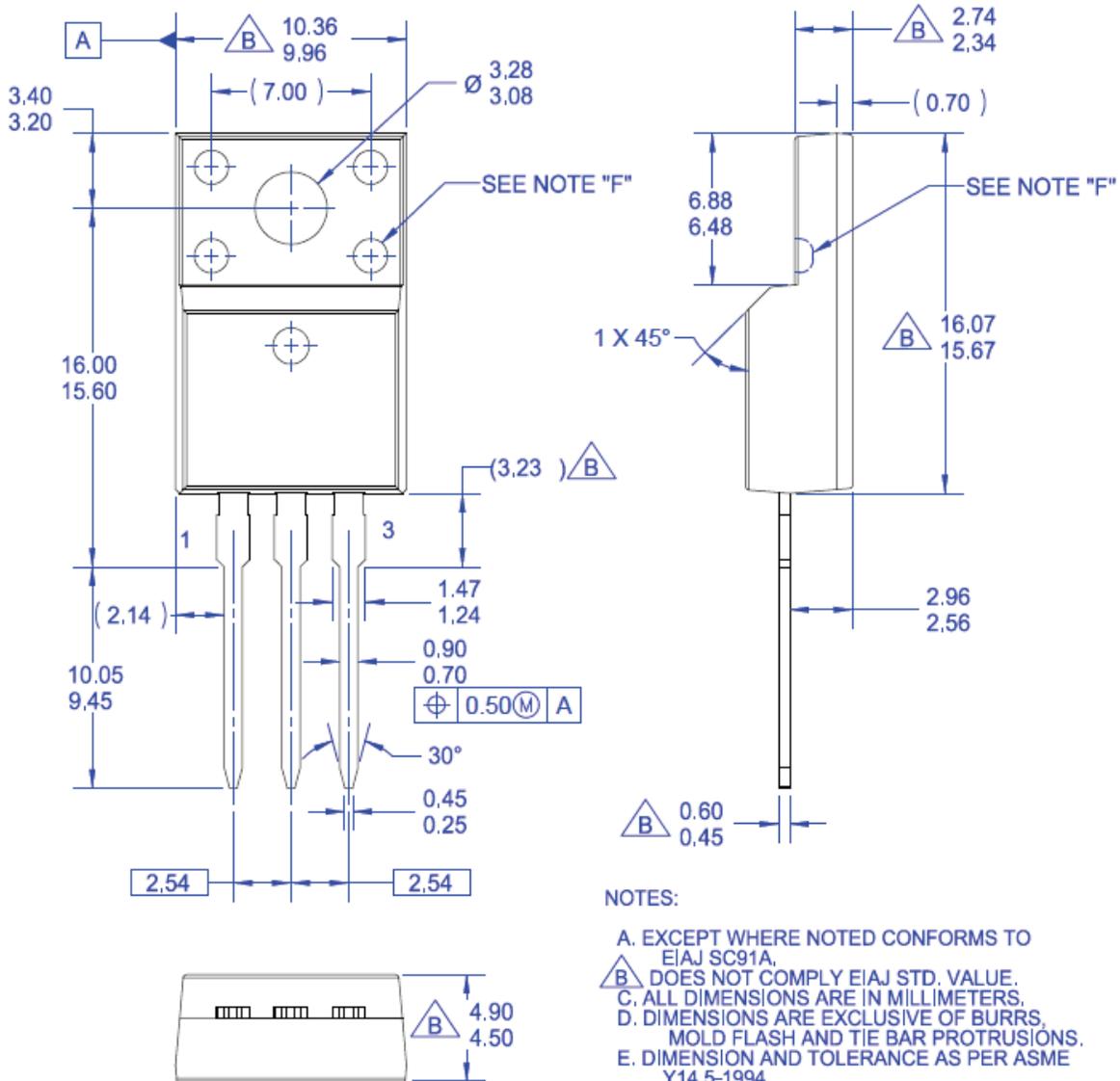**Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms**

DUT

V_{DS}

I_{SD}

L

Driver

R_G

Same Type
as DUT

V_{DD}

V_{GS}

- dv/dt controlled by R_G
- I_{SD} controlled by pulse period

V_{GS}
(Driver)

$$D = \frac{\text{Gate Pulse Width}}{\text{Gate Pulse Period}}$$

10V

I_{SD}
(DUT)

I_{FM} , Body Diode Forward Current

di/dt

I_{RM}

Body Diode Reverse Current

V_{DS}
(DUT)

Body Diode Recovery dv/dt

V_{SD}

V_{DD}

Body Diode
Forward Voltage Drop

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

Mechanical Dimensions

A

B 10.36 / 9.96

(7.00)

Ø 3.28 / 3.08

SEE NOTE "F"

3.40 / 3.20

16.00 / 15.60

(3.23) B

1

3

(2.14)

1.47 / 1.24

0.90 / 0.70

⊕ 0.50 Ⓜ A

30°

10.05 / 9.45

0.45 / 0.25

2.54

2.54

B 2.74 / 2.34

(0.70)

SEE NOTE "F"

6.88 / 6.48

1 X 45°

B 16.07 / 15.67

2.96 / 2.56

B 0.60 / 0.45

B 4.90 / 4.50

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: TO220M03REV4

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PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

Rev. I77

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