FAIRCHILD
SEMICONDUCTOR®

December 2013

FCP190N60E / FCPF190N60E

N-Channel SuperFET® II Easy-Drive MOSFET

600 V, 20.6 A, 190 mΩ

Features

- 650 V @ T_J = 150°C
- Typ. $R_{DS(on)}$ = 160 mΩ
- Ultra Low Gate Charge (Typ. Q_g = 63 nC)
- Low Effective Output Capacitance (Typ. $C_{oss(eff.)}$ = 178 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 Super-FET II MOSFET series.
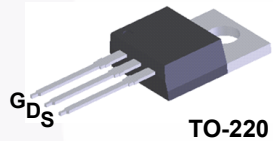
TO-220
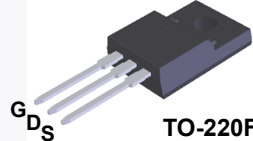
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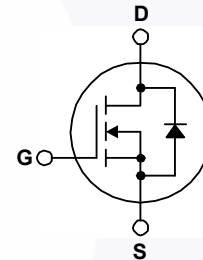
MOSFET Maximum Ratings T_C = 25°C unless otherwise noted.

Symbol	Parameter			FCP190N60E	FCPF190N60E	Unit
V_{DSS}	Drain to Source Voltage			600		V
V_{GSS}	Gate to Source Voltage	- DC		±20		V
		- AC	(f > 1 Hz)	±30		V
I_D	Drain Current	- Continuous (T_C = 25°C)		20.6	20.6*	A
		- Continuous (T_C = 100°C)		13.1	13.1*	
I_{DM}	Drain Current	- Pulsed	(Note 1)	61.8	61.8*	A
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°C)		208	39	W
		- Derate Above 25°C		1.67	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	FCP190N60E	FCPF190N60E	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	0.6	3.2	°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
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°C unless otherwise noted.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Off Characteristics						
BV_{DSS}	Drain to Source Breakdown Voltage	V_{GS} = 0 V, I_D = 10 mA, T_J = 25°C	600	-	-	V
		V_{GS} = 0 V, I_D = 10 mA, T_J = 150°C	650	-	-	
ΔBV_{DSS} / ΔT_J	Breakdown Voltage Temperature Coefficient	I_D = 10 mA, Referenced to 25°C	-	0.67	-	V/°C
BV_{DS}	Drain to Source Avalanche Breakdown Voltage	V_{GS} = 0 V, I_D = 20 A	-	700	-	V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 480 V, V_{GS} = 0 V	-	-	1	μA
		V_{DS} = 480 V, T_C = 125°C	-	-	10	
I_{GSS}	Gate to Body Leakage Current	V_{GS} = ±20 V, V_{DS} = 0 V	-	-	±100	nA
On Characteristics						
$V_{GS(th)}$	Gate Threshold Voltage	V_{GS} = V_{DS}, I_D = 250 μA	2.5	-	3.5	V
$R_{DS(on)}$	Static Drain to Source On Resistance	V_{GS} = 10 V, I_D = 10 A	-	0.16	0.19	Ω
g_{FS}	Forward Transconductance	V_{DS} = 20 V, I_D = 10 A	-	20	-	S
Dynamic Characteristics						
C_{iss}	Input Capacitance	V_{DS} = 25 V, V_{GS} = 0 V, f = 1 MHz	-	2385	3175	pF
C_{oss}	Output Capacitance		-	1795	2396	pF
C_{rss}	Reverse Transfer Capacitance		-	110	165	pF
C_{oss}	Output Capacitance	V_{DS} = 380 V, V_{GS} = 0 V, f = 1 MHz	-	42	-	pF
$C_{oss(eff.)}$	Effective Output Capacitance	V_{DS} = 0 V to 480 V, V_{GS} = 0 V	-	178	-	pF
$Q_{g(tot)}$	Total Gate Charge at 10V	V_{DS} = 380 V, I_D = 10 A, V_{GS} = 10 V	-	63	82	nC
Q_{gs}	Gate to Source Gate Charge		-	10	-	nC
Q_{gd}	Gate to Drain "Miller" Charge	(Note 4)	-	24	-	nC
ESR	Equivalent Series Resistance	f = 1 MHz	-	5	-	Ω
Switching Characteristics						
$t_{d(on)}$	Turn-On Delay Time	V_{DD} = 380 V, I_D = 10 A, V_{GS} = 10 V, R_G = 4.7 Ω	-	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	(Note 4)	-	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 V, I_{SD} = 10 A	-	-	1.2	V
t_{rr}	Reverse Recovery Time	V_{GS} = 0 V, I_{SD} = 10 A, dI_F/dt = 100 A/μs	-	308	-	ns
Q_{rr}	Reverse Recovery Charge		-	4.8	-	μC

Notes:

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

2. I_{AS} = 4 A, V_{DD} = 50 V, R_G = 25 Ω, starting T_J = 25°C.

3. $I_{SD} \leq$ 10 A, di/dt ≤ 200 A/μs, $V_{DD} \leq BV_{DSS}$, starting T_J = 25°C.

4. Essentially independent of operating temperature typical characteristics.

Typical Performance Characteristics
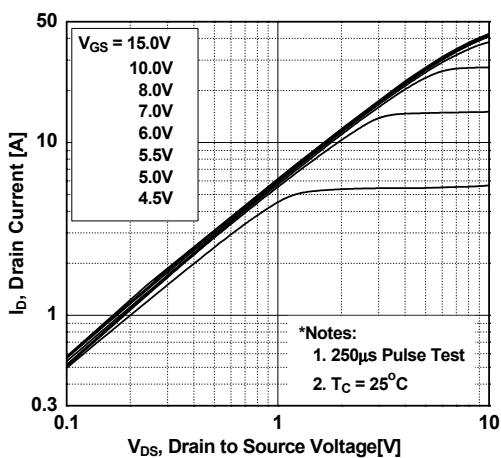
Figure 1. On-Region Characteristics

V_{GS} = 15.0V
10.0V
8.0V
7.0V
6.0V
5.5V
5.0V
4.5V

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

I_D, Drain Current [A] vs V_{DS}, Drain to Source Voltage[V]

Figure 2. Transfer Characteristics

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

150°C
25°C
-55°C

I_D, Drain Current [A] vs V_{GS}, Gate to Source Voltage[V]
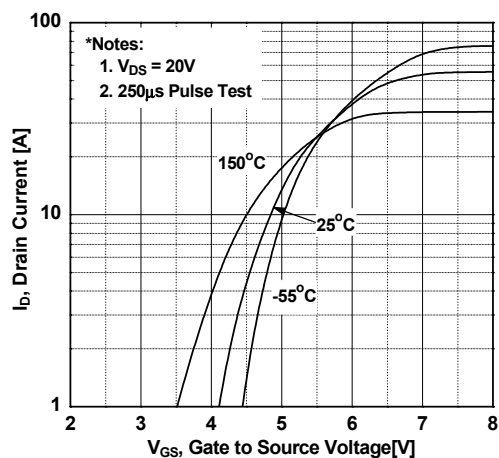
Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

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

*Note: T_C = 25°C

$R_{DS(ON)}$ [Ω], Drain to Source On-Resistance vs I_D, Drain Current [A]
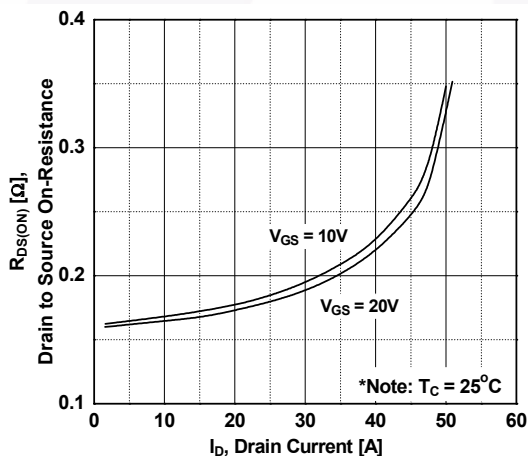
Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

150°C
25°C

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

I_S, Reverse Drain Current [A] vs V_{SD}, Body Diode Forward Voltage [V]
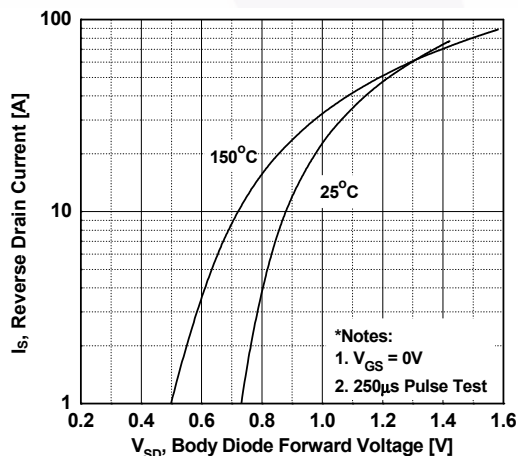
Figure 5. Capacitance Characteristics

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

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

$C_{iss} = C_{gs} + C_{gd}$ (C_{ds} = shorted)
$C_{oss} = C_{ds} + C_{gd}$
$C_{rss} = C_{gd}$

Capacitances [pF] vs V_{DS}, Drain to Source Voltage [V]
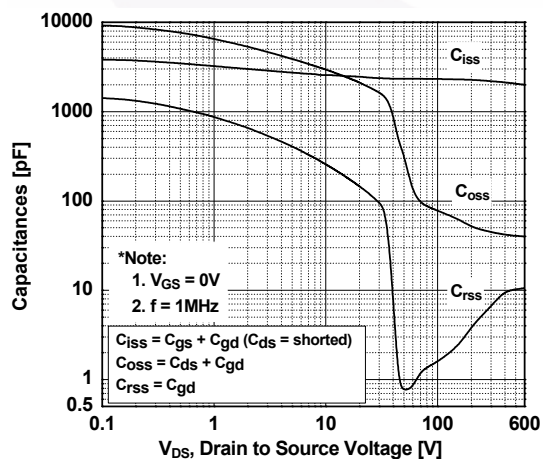
Figure 6. Gate Charge Characteristics

V_{DS} = 120V
V_{DS} = 300V
V_{DS} = 480V

*Note: I_D = 10A

V_{GS}, Gate to Source Voltage [V] vs Q_g, Total Gate Charge [nC]
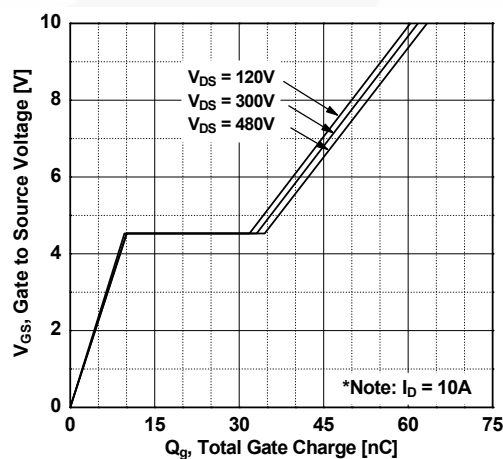
Typical Performance Characteristics (Continued)

Figure 7. Breakdown Voltage Variation vs. Temperature

BV$_{DSS}$, [Normalized]
Drain to Source Breakdown Voltage

T$_J$, Junction Temperature [°C]

*Notes:
1. V$_{GS}$ = 0V
2. I$_D$ = 10mA
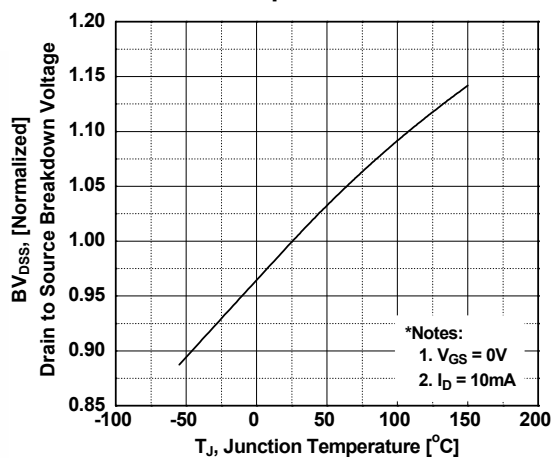
Figure 8. On-Resistance Variation vs. Temperature

R$_{DS(on)}$, [Normalized]
Drain to Source On-Resistance

T$_J$, Junction Temperature [°C]

*Notes:
1. V$_{GS}$ = 10V
2. I$_D$ = 10A
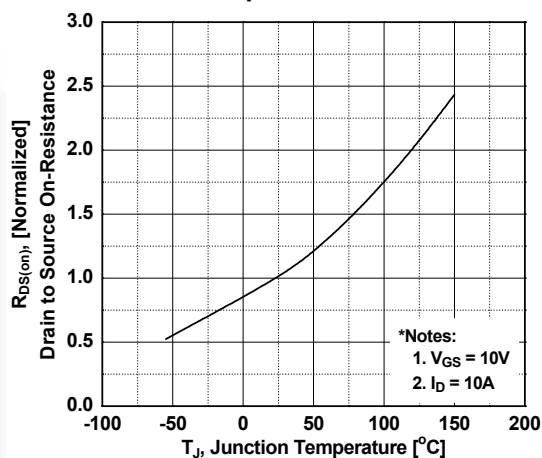
Figure 9. Maximum Safe Operating Area for FCP190N60E

I$_D$, Drain Current [A]

10µs
100µs
1ms
10ms
DC

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

*Notes:
1. T$_C$ = 25°C
2. T$_J$ = 150°C
3. Single Pulse

V$_{DS}$, Drain to Source Voltage [V]
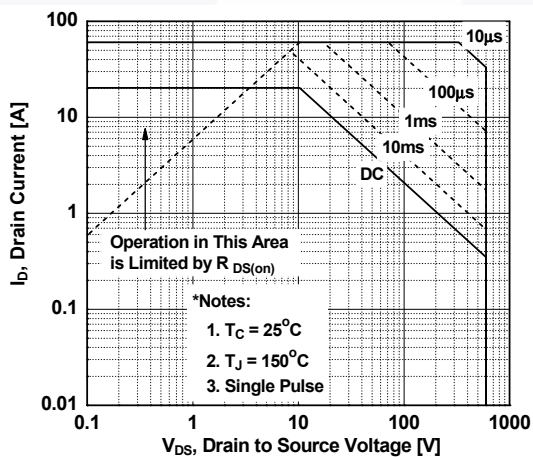
Figure 10. Maximum Safe Operating Area for FCPF190N60E

I$_D$, Drain Current [A]

10µs
100µs
1ms
10ms
DC

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

*Notes:
1. T$_C$ = 25°C
2. T$_J$ = 150°C
3. Single Pulse

V$_{DS}$, Drain to Source Voltage [V]
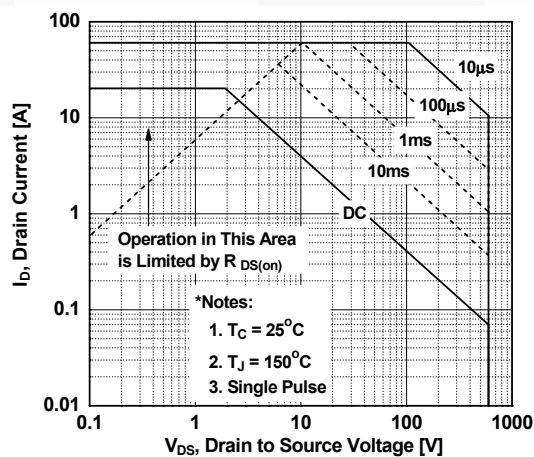
Figure 11. Maximum Drain Current vs. Case Temperature

I$_D$, Drain Current [A]

T$_C$, Case Temperature [°C]
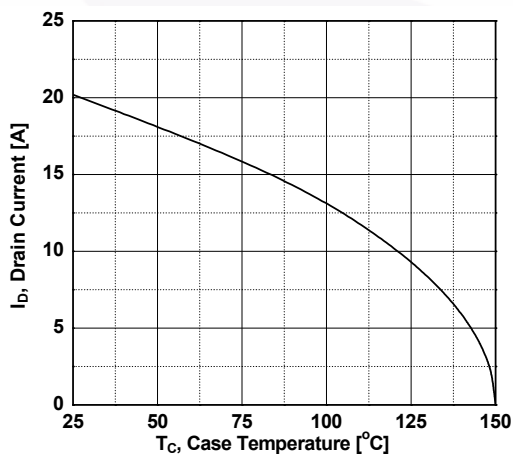
Figure 12. Eoss vs. Drain to Source Voltage

E$_{OSS}$, [µJ]

V   Drain to Source Voltage [V]

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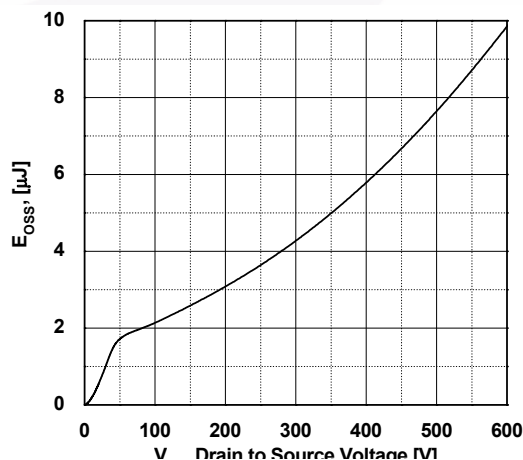
Typical Performance Characteristics (Continued)

Figure 13. Transient Thermal Response Curve for FCP190N60E
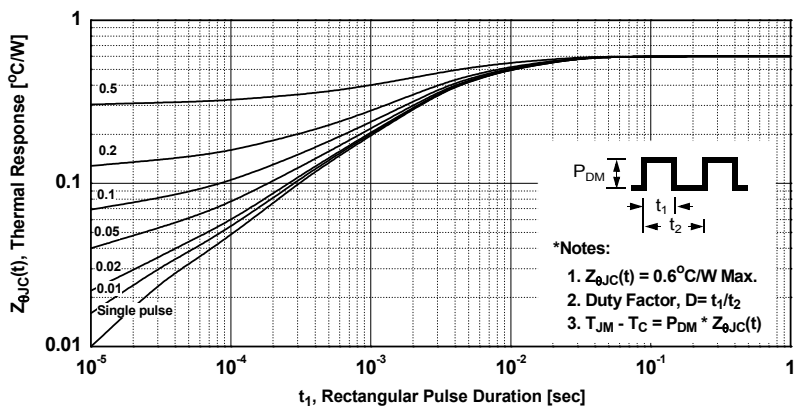
Figure 14. Transient Thermal Response Curve for FCPF190N60E
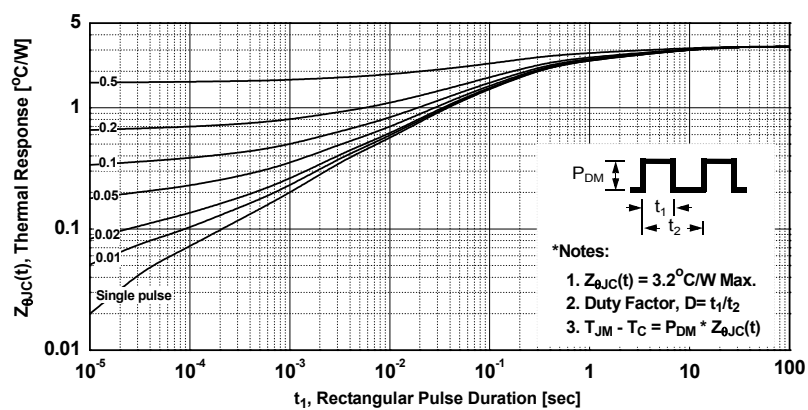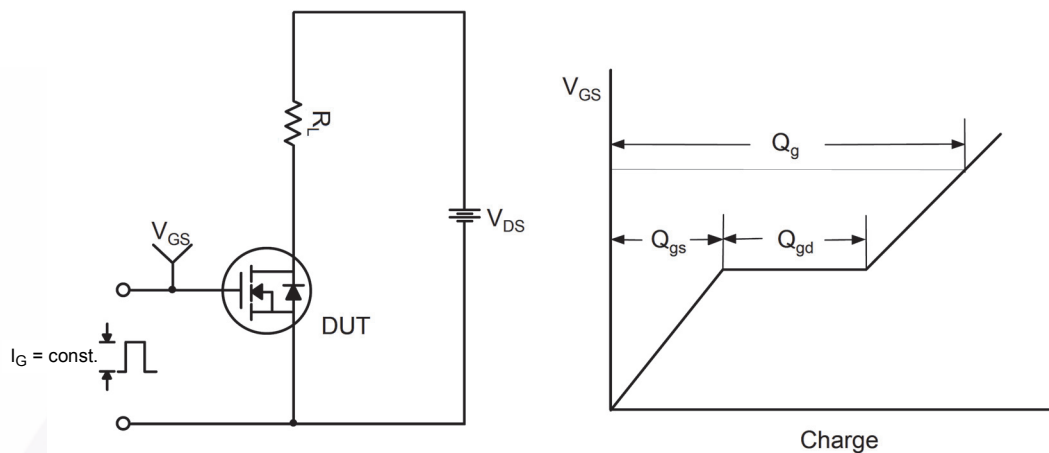
Figure 15. Gate Charge Test Circuit & Waveform
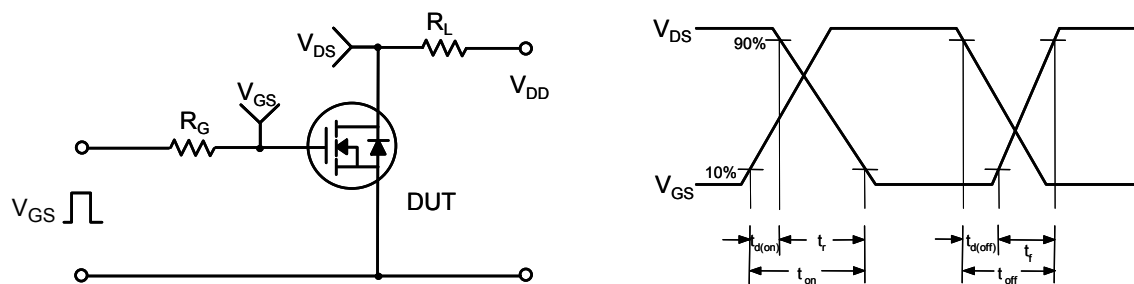
Figure 16. Resistive Switching Test Circuit & Waveforms

$$E_{AS} = \frac{1}{2} L I_{AS}^2$$
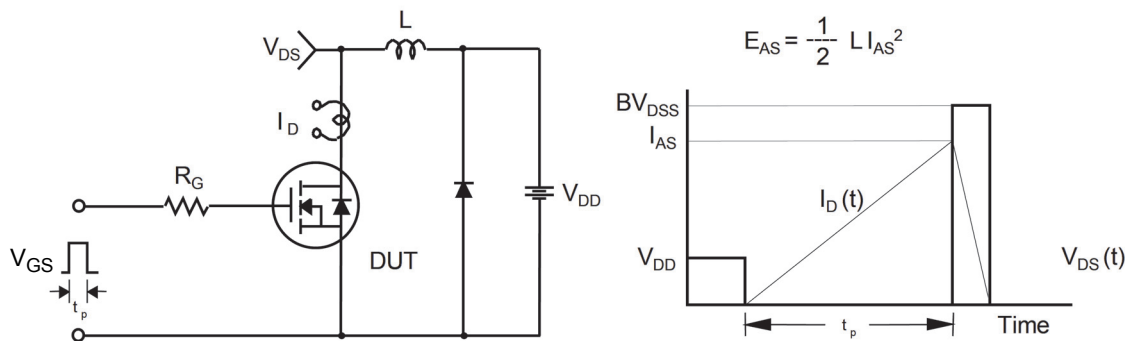
Figure 17. Unclamped Inductive Switching Test Circuit & Waveforms

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)

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

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 18. Peak Diode Recovery dv/dt Test Circuit & Waveforms

Mechanical Dimensions

Ø4.09
3.50 △
⊕ 0.36 Ⓜ B AⓂ

A
10.67
9.65

3.43
2.54

16.51
14.22

△9.40
8.38

1 2 3

6.35 MAX

14.73
12.70

(1.91)

1.78
1.14

1.02
0.38

2.54

5.08

⊕ 0.36 Ⓜ B AⓂ

5°
3°   5°
3°

B
4.83
3.56

"A1"

7°
3°

6.86
5.84

5°
3°   5°
3°

0.61
△0.33

2.92
2.03

8.89
6.86

△13.40
12.19

3 2 1

NOTES: UNLESS OTHERWISE SPECIFIED
A) REFERENCE JEDEC, TO-220, ISSUE K,
   VARIATION AB, DATED APRIL, 2002.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DIMENSIONING AND TOLERANCING PER
   ANSI Y14,5 - 1973
D) LOCATION OF THE PIN HOLE MAY VARY
   (LOWER LEFT CORNER, LOWER CENTER
   AND CENTER OF THE PACKAGE)
E) DOES NOT COMPLY JEDEC STANDARD VALUE,
F) "A1" DIMENSIONS REPRESENT LIKE BELOW:
   SINGLE GAUGE = 0.51 – 0.61
   DUAL GAUGE   = 1,14 – 1,40
G) DRAWING FILE NAME: TO220B03REV6

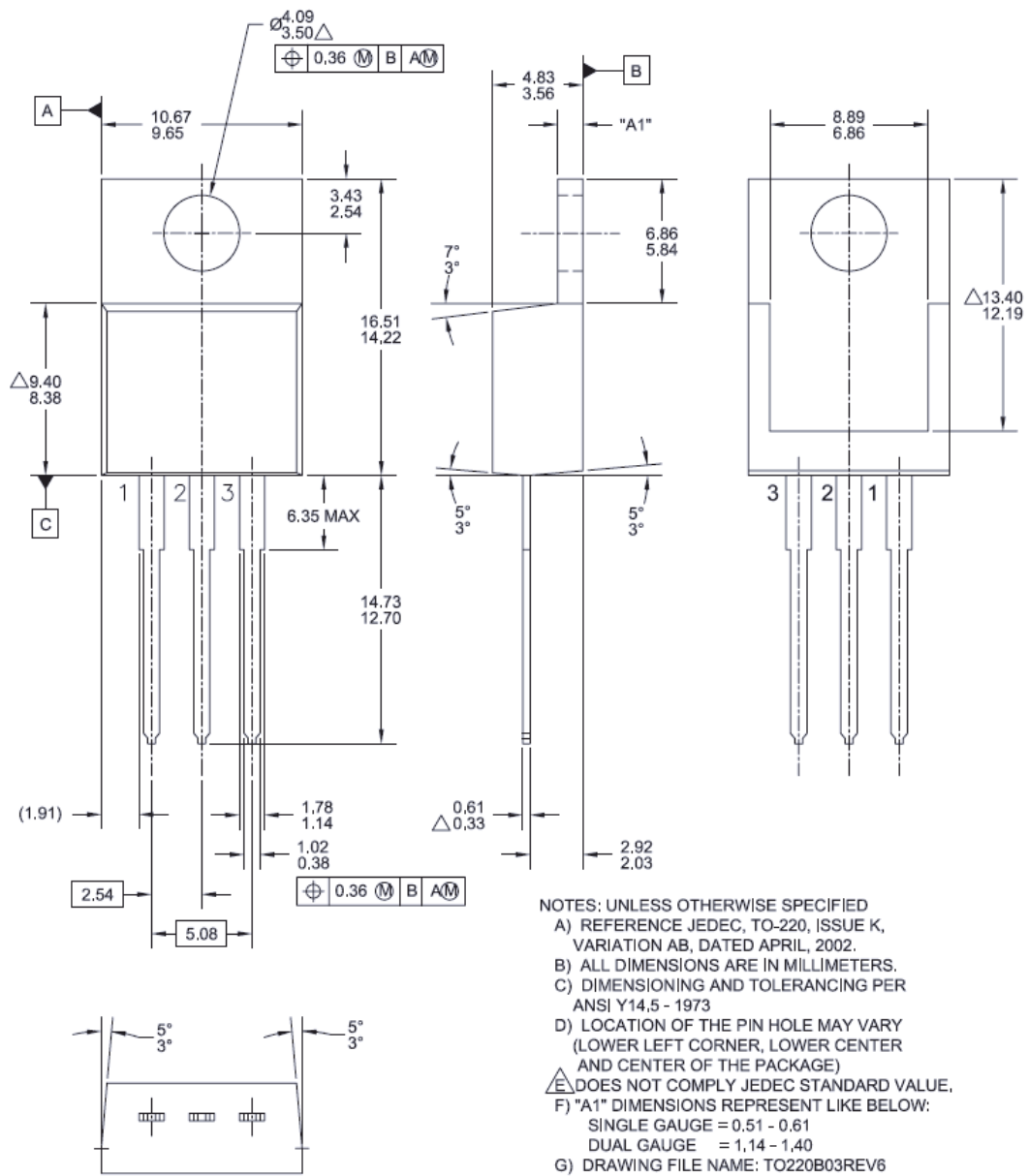**Figure 19. TO-220, Molded, 3-Lead, Jedec Variation AB**

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http://www.fairchildsemi.com/package/packageDetails.html?id=PN_TT220-003

Mechanical Dimensions

A

B 10.36
9.96

(7.00)

φ 3.28
3.08

3.40
3.20

SEE NOTE "F"

B 2.74
2.34

(0.70)

SEE NOTE "F"

6.88
6.48

1 X 45°

B 16.07
15.67

16.00
15.60

1   3

(3.23) B

(2.14)

1.47
1.24

0.90
0.70

⊕ 0.50 Ⓜ A

10.05
9.45

30°

0.45
0.25

2.54   2.54

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: TO220M03REV3

Figure 20. TO220, Molded, 3-Lead, Full Pack, EIAJ SC91, Straight Lead

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SignalWise™
SmartMax™
SMART START™
Solutions for Your Success™
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STEALTH™
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SuperSOT™-6
SuperSOT™-8
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2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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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.
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