

# NTPF110N65S3HF

## MOSFET –Power, N-Channel, SUPERFET III, FRFET

**650 V, 30 A, 110 mΩ**

### Description

SUPERFET III MOSFET is ON 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 advanced technology is tailored to minimize conduction loss, provide superior switching performance, and withstand extreme dv/dt rate.

Consequently, SUPERFET III MOSFET is very suitable for the various power systems for miniaturization and higher efficiency.

SUPERFET III FRFET MOSFET's optimized reverse recovery performance of body diode can remove additional component and improve system reliability.

### Features

- 700 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 98\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 62\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 522\text{ pF}$ )
- 100% Avalanche Tested
- These Devices are Pb-Free and are RoHS Compliant

### Applications

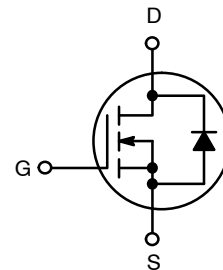
- Telecom / Server Power Supplies
- Industrial Power Supplies
- EV Charger
- UPS / Solar



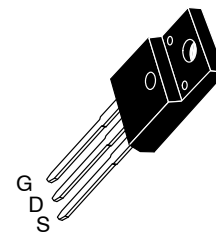
ON Semiconductor®

[www.onsemi.com](http://www.onsemi.com)

$V_{DSS}$	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
650 V	110 mΩ @ 10 V	30 A

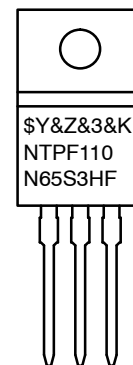


POWER MOSFET



TO-220 FULLPAK  
CASE 221D

### MARKING DIAGRAM



\$Y = ON Semiconductor Logo  
&Z = Assembly Plant Code  
&3 = Numeric Date Code  
&K = Lot Code  
NTPF110N65S3HF = Specific Device Code

### ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

# NTPF110N65S3HF

## ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ , Unless otherwise noted)

Symbol	Parameter	Value	Unit
$V_{DSS}$	Drain to Source Voltage	650	V
$V_{GSS}$	Gate to Source Voltage	- DC	$\pm 30$
		- AC ( $f > 1 \text{ Hz}$ )	$\pm 30$
$I_D$	Drain Current	- Continuous ( $T_C = 25^\circ\text{C}$ )	30*
		- Continuous ( $T_C = 100^\circ\text{C}$ )	19.5*
$I_{DM}$	Drain Current	- Pulsed (Note 1)	69*
$E_{AS}$	Single Pulsed Avalanche Energy (Note 2)	380	mJ
$I_{AS}$	Avalanche Current (Note 2)	4.4	A
$E_{AR}$	Repetitive Avalanche Energy (Note 1)	2.4	mJ
dv/dt	MOSFET dv/dt	100	V/ns
	Peak Diode Recovery dv/dt (Note 3)	50	
$P_D$	Power Dissipation	( $T_C = 25^\circ\text{C}$ )	240
		- Derate Above $25^\circ\text{C}$	1.92
$T_J, T_{STG}$	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	$^\circ\text{C}$

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

\*Drain current limited by maximum junction temperature.

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

2.  $I_{AS} = 4.4 \text{ A}$ ,  $R_G = 25 \Omega$ , starting  $T_J = 25^\circ\text{C}$ .

3.  $I_{SD} \leq 15 \text{ A}$ ,  $di/dt \leq 200 \text{ A}/\mu\text{s}$ ,  $V_{DD} \leq 400 \text{ V}$ , starting  $T_J = 25^\circ\text{C}$ .

## THERMAL CHARACTERISTICS

Symbol	Parameter	Value	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	2.88	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, Max.	62.5	

## PACKAGE MARKING AND ORDERING INFORMATION

Part Number	Top Marking	Package	Packing Method	Reel Size	Tape Width	Quantity
NTPF110N65S3HF	NTPF110N65S3HF	TO-220 FULLPACK (Pb-Free)	Tube	N/A	N/A	50 Units

# NTPF110N65S3HF

## 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 <sub>DSS</sub>	Drain to Source Breakdown Voltage	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA, T <sub>J</sub> = 25°C	650	–	–	V
		V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA, T <sub>J</sub> = 150°C	700	–	–	V
ΔBV <sub>DSS</sub> / ΔT <sub>J</sub>	Breakdown Voltage Temperature Coefficient	I <sub>D</sub> = 15 mA, Referenced to 25°C	–	0.64	–	V/°C
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>DS</sub> = 650 V, V <sub>GS</sub> = 0 V	–	–	10	μA
		V <sub>DS</sub> = 520 V, T <sub>C</sub> = 125°C	–	97	–	
I <sub>GSS</sub>	Gate to Body Leakage Current	V <sub>GS</sub> = ±30 V, V <sub>DS</sub> = 0 V	–	–	±100	nA

### ON CHARACTERISTICS

V <sub>GS(th)</sub>	Gate Threshold Voltage	V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 0.74 mA	3.0	–	5.0	V
R <sub>DS(on)</sub>	Static Drain to Source On Resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 15 A	–	98	110	mΩ
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 15 A	–	18	–	S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, f = 1 MHz	–	2635	–	pF
C <sub>oss</sub>	Output Capacitance		–	52	–	pF
C <sub>oss(eff.)</sub>	Effective Output Capacitance	V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V	–	522	–	pF
C <sub>oss(er.)</sub>	Energy Related Output Capacitance	V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V	–	91	–	pF
Q <sub>g(tot)</sub>	Total Gate Charge at 10 V	V <sub>DS</sub> = 400 V, I <sub>D</sub> = 15 A, V <sub>GS</sub> = 10 V (Note 4)	–	62	–	nC
Q <sub>gs</sub>	Gate to Source Gate Charge		–	18	–	nC
Q <sub>gd</sub>	Gate to Drain "Miller" Charge		–	25	–	nC
ESR	Equivalent Series Resistance	f = 1 MHz	–	4.6	–	Ω

### SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DD</sub> = 400 V, I <sub>D</sub> = 15 A, V <sub>GS</sub> = 10 V R <sub>g</sub> = 4.7 Ω (Note 4)	–	24	–	ns
t <sub>r</sub>	Turn-On Rise Time		–	25	–	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		–	85	–	ns
t <sub>f</sub>	Turn-Off Fall Time		–	25	–	ns

### SOURCE-DRAIN DIODE CHARACTERISTICS

I <sub>S</sub>	Maximum Continuous Source to Drain Diode Forward Current	–	–	30	A	
I <sub>SM</sub>	Maximum Pulsed Source to Drain Diode Forward Current	–	–	69	A	
V <sub>SD</sub>	Source to Drain Diode Forward Voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 15 A	–	–	1.3	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 15 A, dI <sub>F</sub> /dt = 100 A/μs	–	95	–	ns
Q <sub>rr</sub>	Reverse Recovery Charge		–	371	–	nC

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. Essentially independent of operating temperature typical characteristics.

TYPICAL PERFORMANCE CHARACTERISTICS

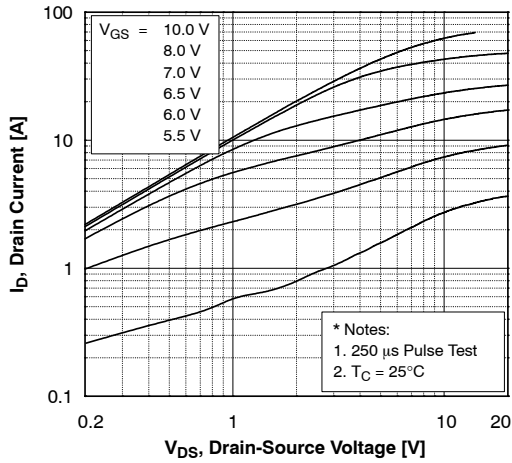


Figure 1. On-Region Characteristics

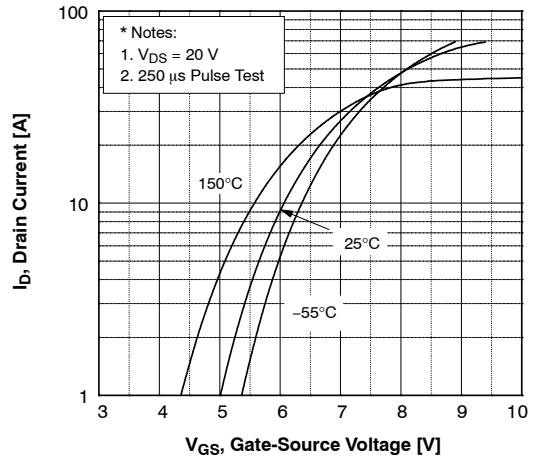


Figure 2. Transfer Characteristics

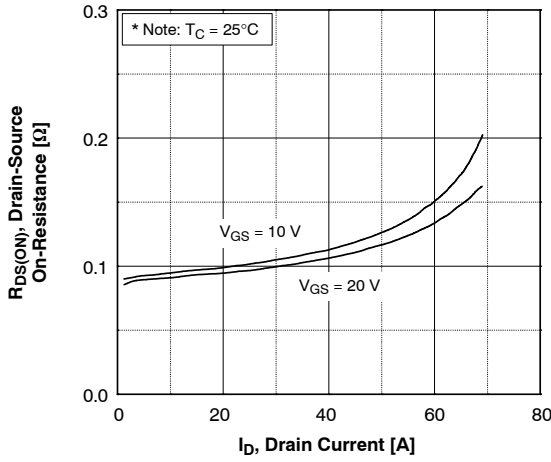


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

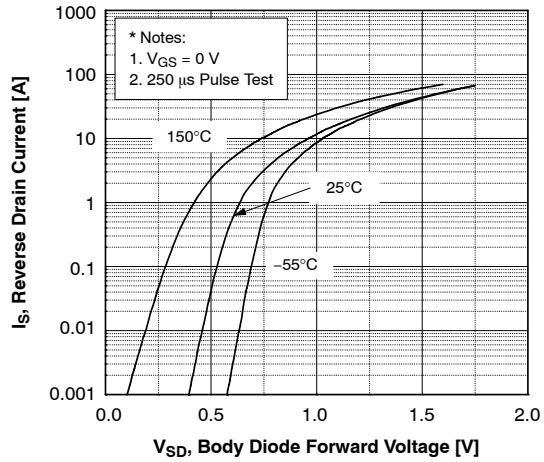


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

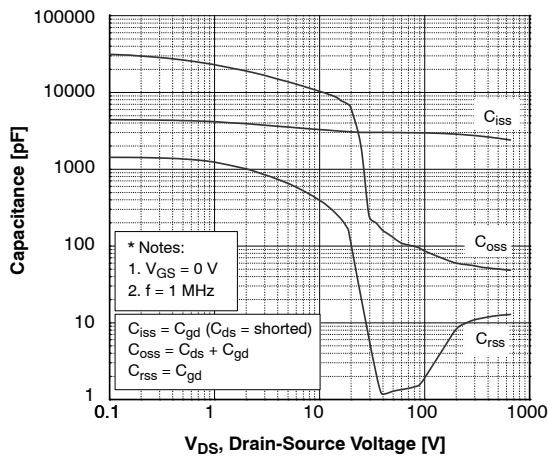


Figure 5. Capacitance Characteristics

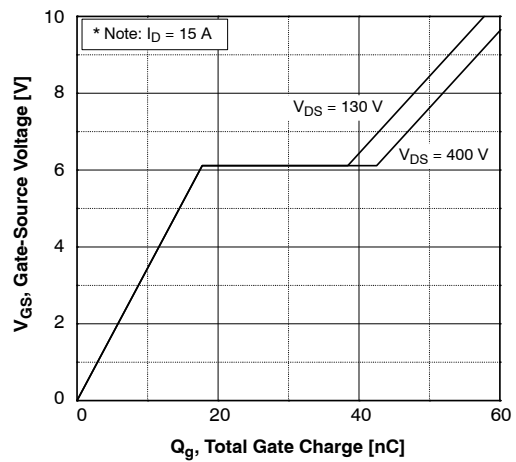


Figure 6. Gate Charge Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

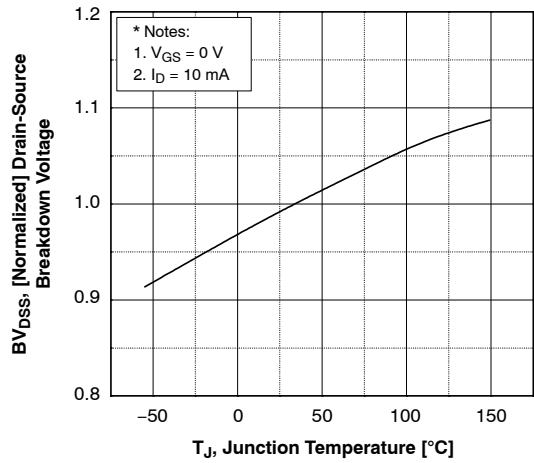


Figure 7. Breakdown Voltage Variation vs. Temperature

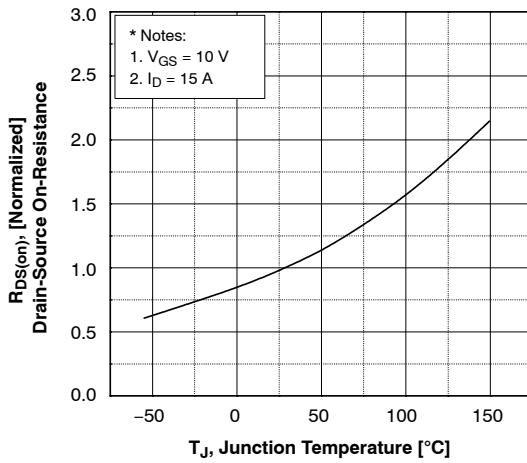


Figure 8. On-Resistance Variant vs. Temperature

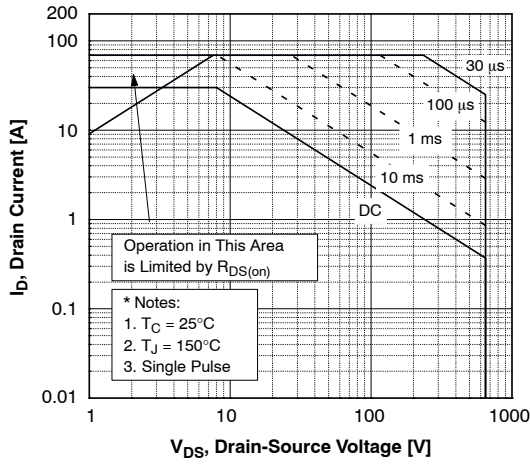


Figure 9. Maximum Safe Operation Area

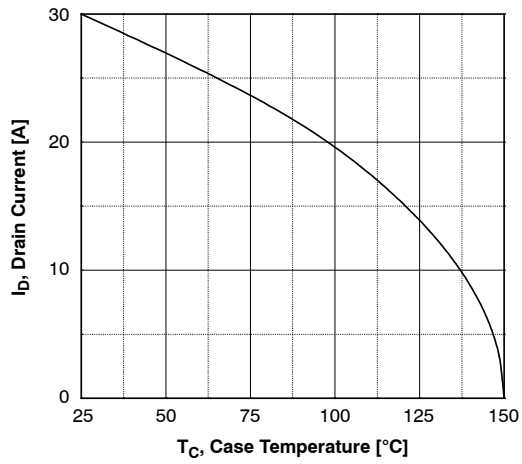


Figure 10. Maximum Drain Current vs. Case Temperature

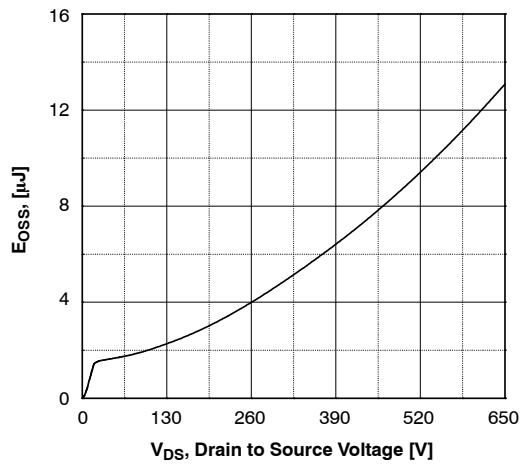


Figure 11.  $E_{OSS}$  vs. Drain to Source Voltage

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

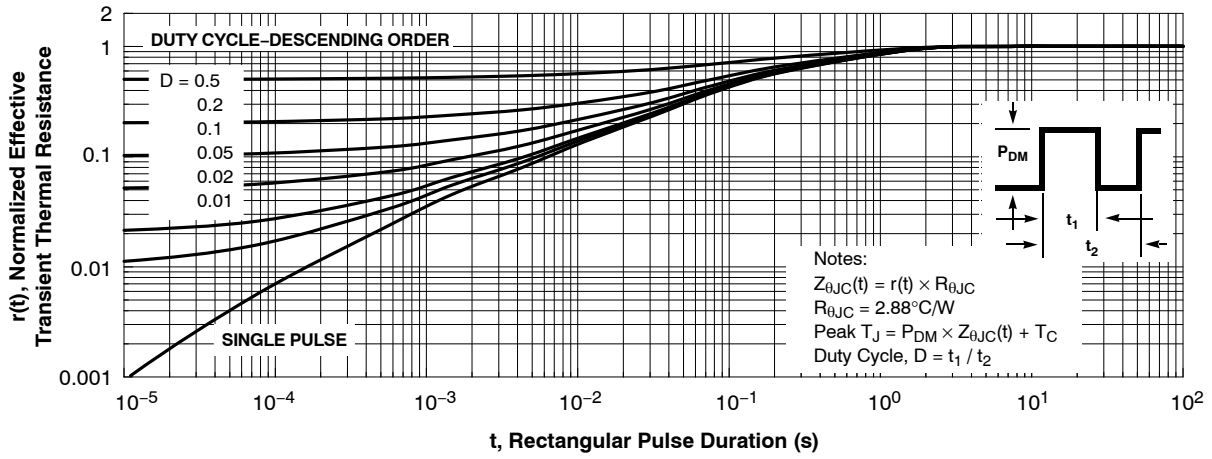


Figure 12. Transient Thermal Response Curve

# NTPF110N65S3HF

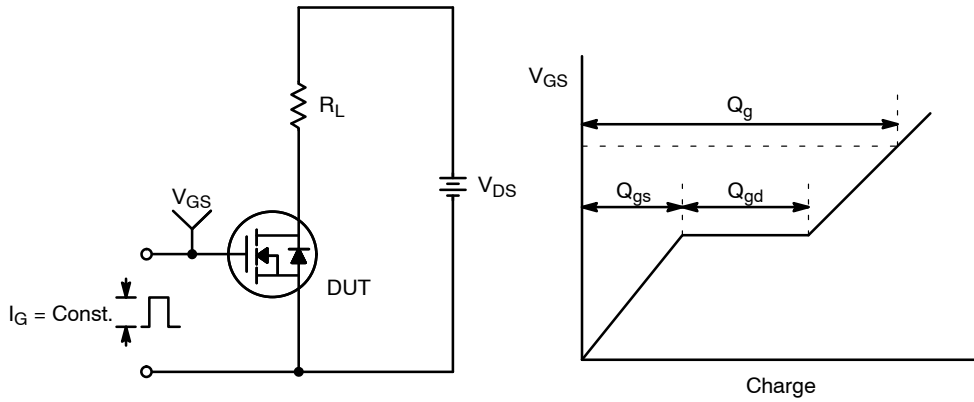


Figure 13. Gate Charge Test Circuit & Waveform

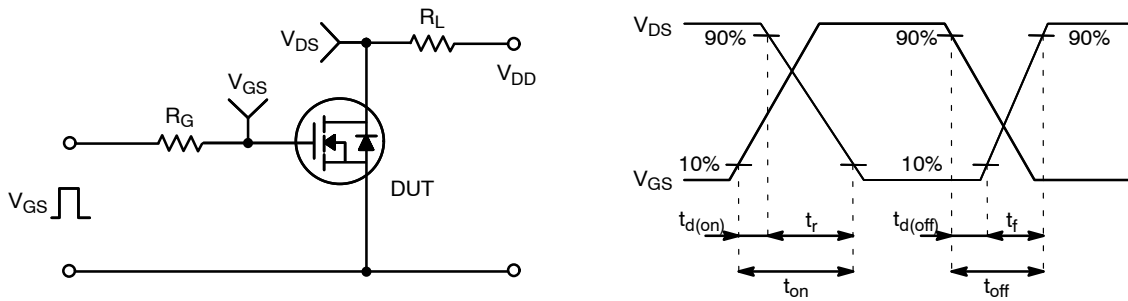


Figure 14. Resistive Switching Test Circuit & Waveforms

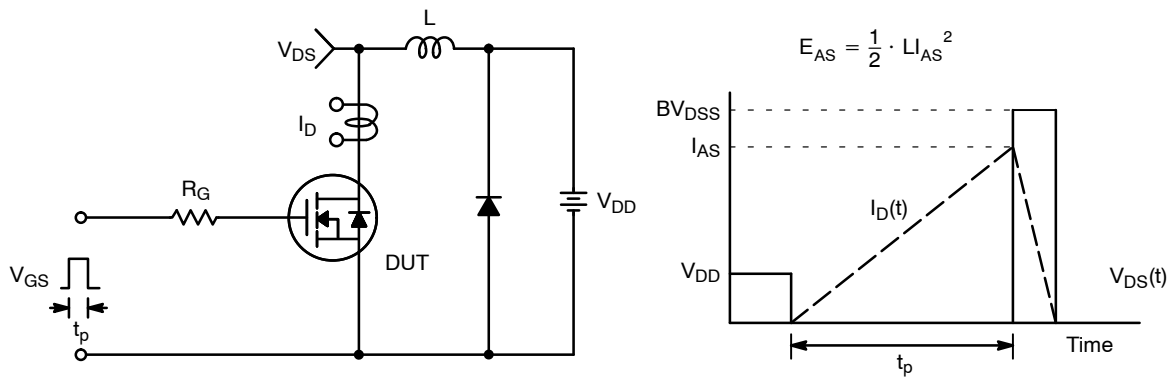
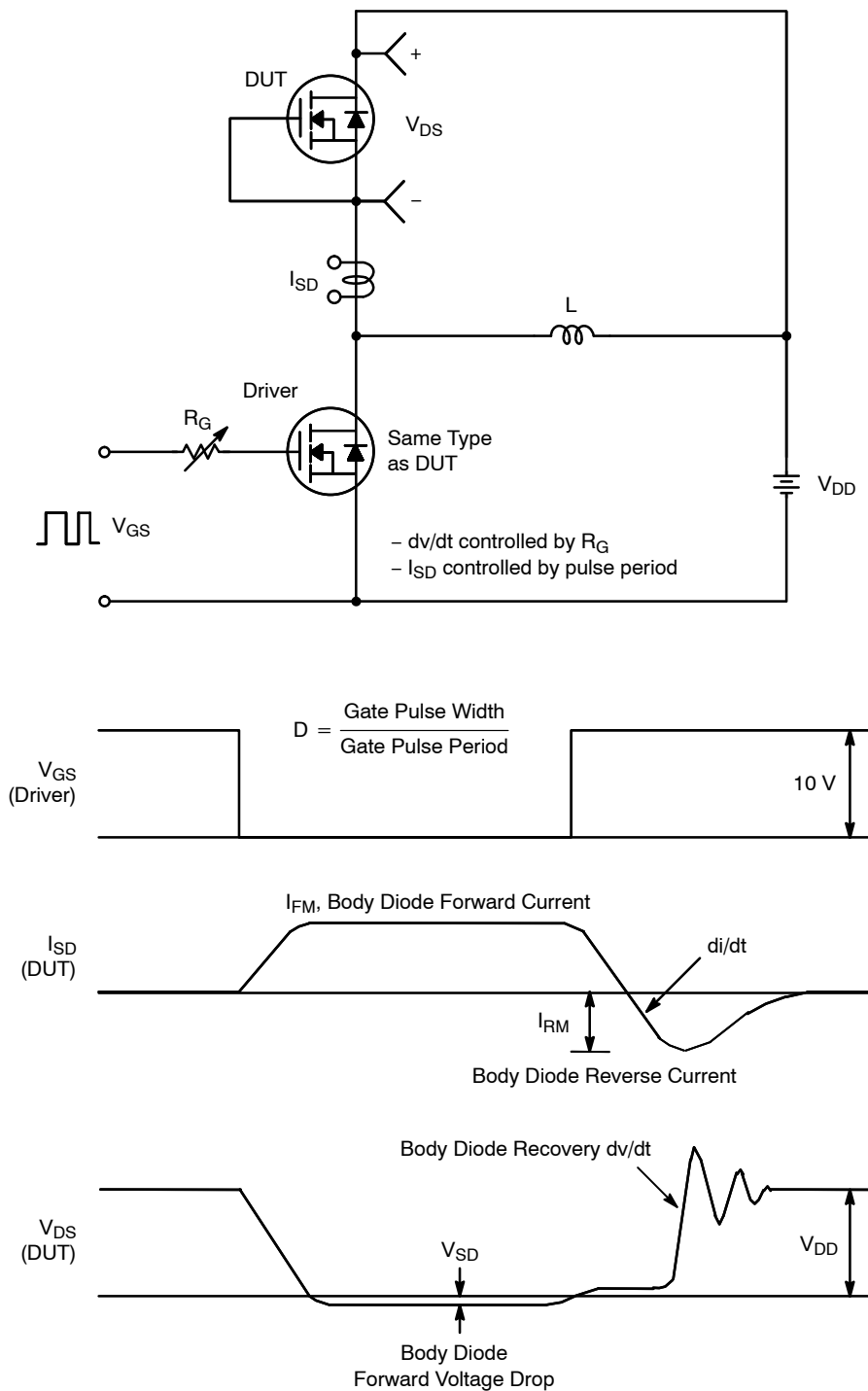


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

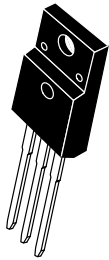
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**Figure 16. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**



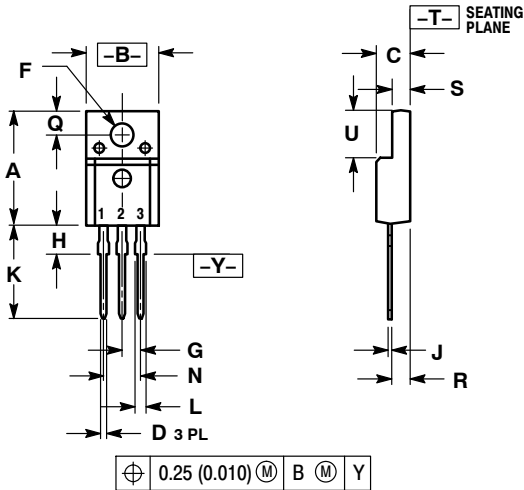
# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 1:1

## TO-220 FULLPAK CASE 221D-03 ISSUE K

DATE 27 FEB 2009



- NOTES:
- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  - CONTROLLING DIMENSION: INCH
  - 221D-01 THRU 221D-02 OBSOLETE, NEW STANDARD 221D-03.

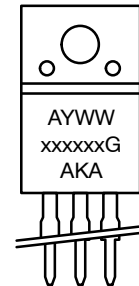
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.617	0.635	15.67	16.12
B	0.392	0.419	9.96	10.63
C	0.177	0.193	4.50	4.90
D	0.024	0.039	0.60	1.00
F	0.116	0.129	2.95	3.28
G	0.100 BSC		2.54 BSC	
H	0.118	0.135	3.00	3.43
J	0.018	0.025	0.45	0.63
K	0.503	0.541	12.78	13.73
L	0.048	0.058	1.23	1.47
N	0.200 BSC		5.08 BSC	
Q	0.122	0.138	3.10	3.50
R	0.099	0.117	2.51	2.96
S	0.092	0.113	2.34	2.87
U	0.239	0.271	6.06	6.88

### MARKING DIAGRAMS

- |  |   |  |
|--|---|--|
| STYLE 1:<br>PIN 1. GATE<br>2. DRAIN<br>3. SOURCE     | STYLE 2:<br>PIN 1. BASE<br>2. COLLECTOR<br>3. EMITTER | STYLE 3:<br>PIN 1. ANODE<br>2. CATHODE<br>3. ANODE |
| STYLE 4:<br>PIN 1. CATHODE<br>2. ANODE<br>3. CATHODE | STYLE 5:<br>PIN 1. CATHODE<br>2. ANODE<br>3. GATE     | STYLE 6:<br>PIN 1. MT 1<br>2. MT 2<br>3. GATE      |



**Bipolar**



**Rectifier**

- |                               |                           |
|-------------------------------|---------------------------|
| xxxxxx = Specific Device Code | A = Assembly Location     |
| G = Pb-Free Package           | Y = Year                  |
| A = Assembly Location         | WW = Work Week            |
| Y = Year                      | xxxxxx = Device Code      |
| WW = Work Week                | G = Pb-Free Package       |
|                               | AKA = Polarity Designator |

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