

# MOSFET – N-Channel, SUPERFET III, FRFET 650 V, 20 A, 190 mΩ

## NTB190N65S3HF

### 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.  $R_{DS(on)} = 161\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 34\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 316\text{ pF}$ )
- 100% Avalanche Tested
- These Devices are Pb–Free and are RoHS Compliant

### Applications

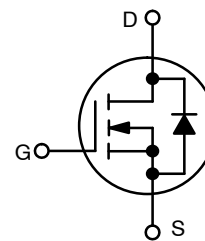
- Telecom / Server Power Supplies
- Industrial Power Supplies
- EV Charger
- UPS / Solar



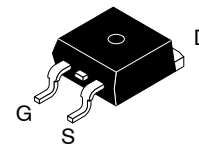
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$V_{DSS}$	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
650 V	190 mΩ @ 10 V	20 A

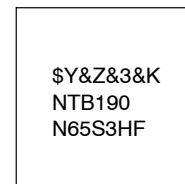


N-CHANNEL MOSFET



D<sup>2</sup>PAK  
(TO–263 3–Lead)  
CASE 418AJ

### MARKING DIAGRAM



- \$Y = ON Semiconductor Logo
- &Z = Assembly Plant Code
- &3 = Data Code (Year & Week)
- &K = Lot
- NTB190N65S3HF = Specific Device Code

### ORDERING INFORMATION

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

# NTB190N65S3HF

## ABSOLUTE MAXIMUM RATINGS (T<sub>C</sub> = 25°C, Unless otherwise noted)

Symbol	Parameter	Value	Unit
V <sub>DSS</sub>	Drain to Source Voltage	650	V
V <sub>GSS</sub>	Gate to Source Voltage	- DC	±30
		- AC (f > 1 Hz)	±30
I <sub>D</sub>	Drain Current	- Continuous (T <sub>C</sub> = 25°C)	20
		- Continuous (T <sub>C</sub> = 100°C)	12.7
I <sub>DM</sub>	Drain Current	- Pulsed (Note 1)	50
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)	220	mJ
I <sub>AS</sub>	Avalanche Current (Note 2)	3.7	A
E <sub>AR</sub>	Repetitive Avalanche Energy (Note 1)	1.62	mJ
dv/dt	MOSFET dv/dt	100	V/ns
	Peak Diode Recovery dv/dt (Note 3)	50	
P <sub>D</sub>	Power Dissipation	(T <sub>C</sub> = 25°C)	162
		- Derate Above 25°C	1.3
T <sub>J</sub> , T <sub>STG</sub>	Operating and Storage Temperature Range	-55 to +150	°C
T <sub>L</sub>	Maximum Lead Temperature for Soldering, 1/8" from Case for 5 seconds	300	°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.

1. Repetitive rating: pulse-width limited by maximum junction temperature.
2. I<sub>AS</sub> = 3.7 A, R<sub>G</sub> = 25 Ω, starting T<sub>J</sub> = 25°C.
3. I<sub>SD</sub> ≤ 10 A, di/dt ≤ 200 A/μs, V<sub>DD</sub> ≤ 400 V, starting T<sub>J</sub> = 25°C.

## THERMAL CHARACTERISTICS

Symbol	Parameter	Value	Unit
R <sub>θJC</sub>	Thermal Resistance, Junction to Case, Max.	0.77	°C/W
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient, Max. (Note 4)	40	

4. Device on 1 in<sup>2</sup> 2-oz copper pad on 1.5 x 1.5 in. board of FR-4 material.

## PACKAGE MARKING AND ORDERING INFORMATION

Part Number	Top Marking	Package	Reel Size	Tape Width	Shipping <sup>†</sup>
NTB190N65S3HF	NTB190N65S3HF	D <sup>2</sup> PAK	330 mm	24 mm	800 / Tape & Reel

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

# NTB190N65S3HF

## 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	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}, T_J = 25^\circ\text{C}$	650			V
		$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}, T_J = 150^\circ\text{C}$	700			V
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temperature Coefficient	$I_D = 10\text{ mA}$ , Referenced to $25^\circ\text{C}$		0.65		V/ $^\circ\text{C}$
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	$V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$			10	$\mu\text{A}$
		$V_{DS} = 520\text{ V}, T_C = 125^\circ\text{C}$		65		
I <sub>GSS</sub>	Gate to Body Leakage Current	$V_{GS} = \pm 30\text{ V}, V_{DS} = 0\text{ V}$			$\pm 100$	nA

### ON CHARACTERISTICS

V <sub>GS(th)</sub>	Gate Threshold Voltage	$V_{GS} = V_{DS}, I_D = 0.43\text{ mA}$	3.0		5.0	V
R <sub>DS(on)</sub>	Static Drain to Source On Resistance	$V_{GS} = 10\text{ V}, I_D = 10\text{ A}$		161	190	m $\Omega$
g <sub>FS</sub>	Forward Transconductance	$V_{DS} = 20\text{ V}, I_D = 10\text{ A}$		11		S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	$V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$		1610		pF
C <sub>oss</sub>	Output Capacitance			30		pF
C <sub>oss(eff.)</sub>	Effective Output Capacitance	$V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$		316		pF
C <sub>oss(er.)</sub>	Energy Related Output Capacitance	$V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$		59		pF
Q <sub>g(tot)</sub>	Total Gate Charge at 10 V	$V_{DS} = 400\text{ V}, I_D = 10\text{ A}, V_{GS} = 10\text{ V}$ (Note 5)		34		nC
Q <sub>gs</sub>	Gate to Source Gate Charge			11		nC
Q <sub>gd</sub>	Gate to Drain "Miller" Charge			13		nC
ESR	Equivalent Series Resistance	$f = 1\text{ MHz}$		6.8		$\Omega$

### SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn-On Delay Time	$V_{DD} = 400\text{ V}, I_D = 10\text{ A},$ $V_{GS} = 10\text{ V}, R_g = 4.7\text{ }\Omega$ (Note 5)		19		ns
t <sub>r</sub>	Turn-On Rise Time			19		ns
t <sub>d(off)</sub>	Turn-Off Delay Time			58		ns
t <sub>f</sub>	Turn-Off Fall Time			14		ns

### SOURCE-DRAIN DIODE CHARACTERISTICS

I <sub>S</sub>	Maximum Continuous Source to Drain Diode Forward Current			20		A
I <sub>SM</sub>	Maximum Pulsed Source to Drain Diode Forward Current			50		A
V <sub>SD</sub>	Source to Drain Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_{SD} = 10\text{ A}$			1.3	V
t <sub>rr</sub>	Reverse Recovery Time	$V_{DD} = 400\text{ V}, I_{SD} = 10\text{ A},$ $di_F/dt = 100\text{ A}/\mu\text{s}$		80		ns
Q <sub>rr</sub>	Reverse Recovery Charge			264		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.

5. Essentially independent of operating temperature typical characteristics.

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## TYPICAL CHARACTERISTICS

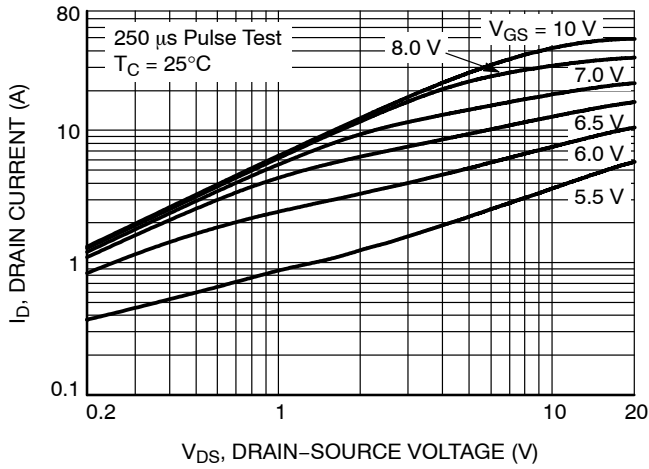


Figure 1. On-Region Characteristics

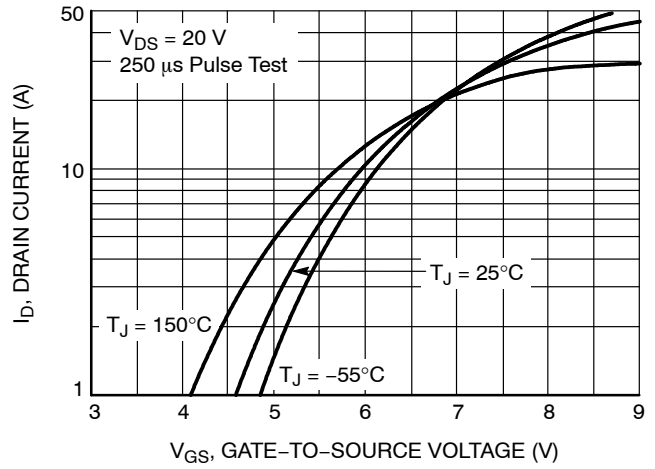


Figure 2. Transfer Characteristics

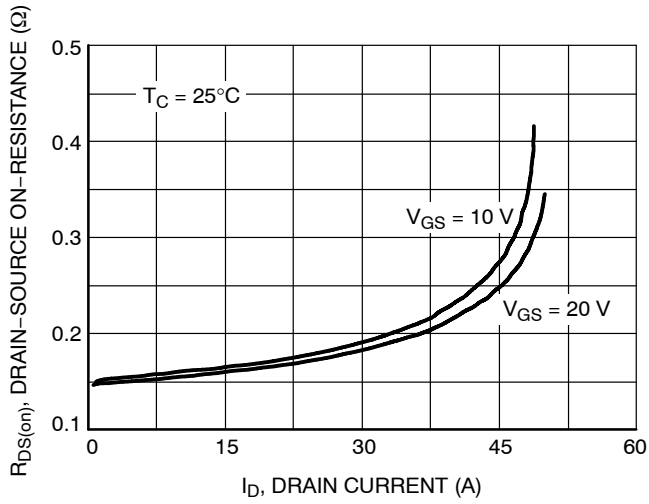


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

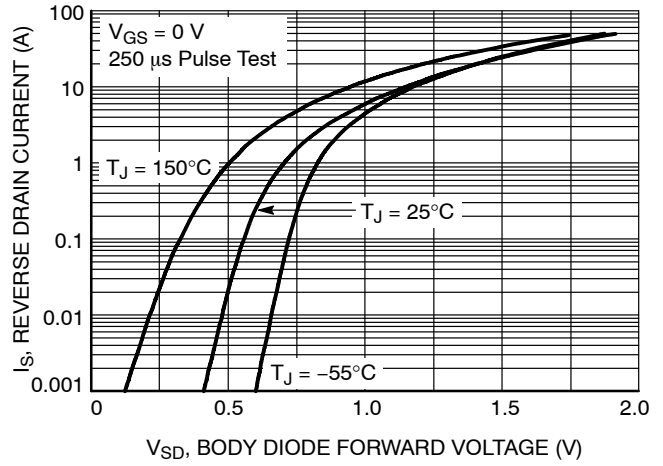


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

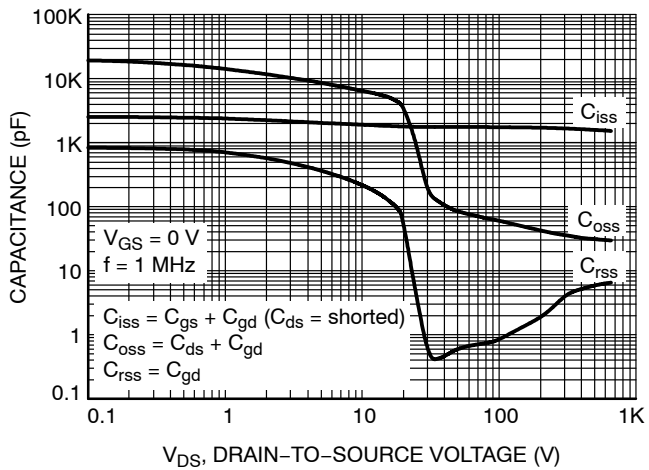


Figure 5. Capacitance Characteristics

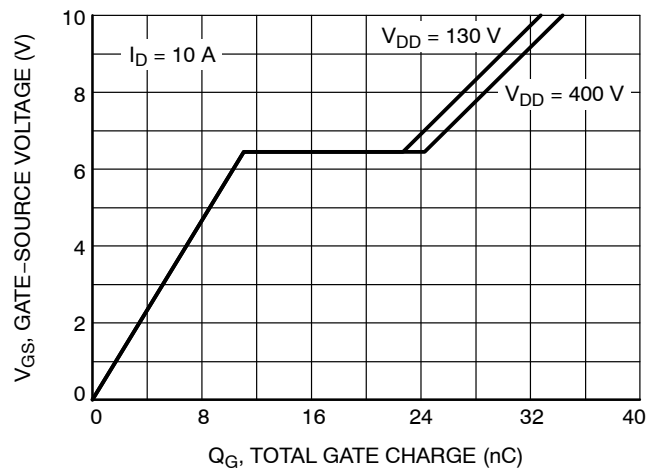
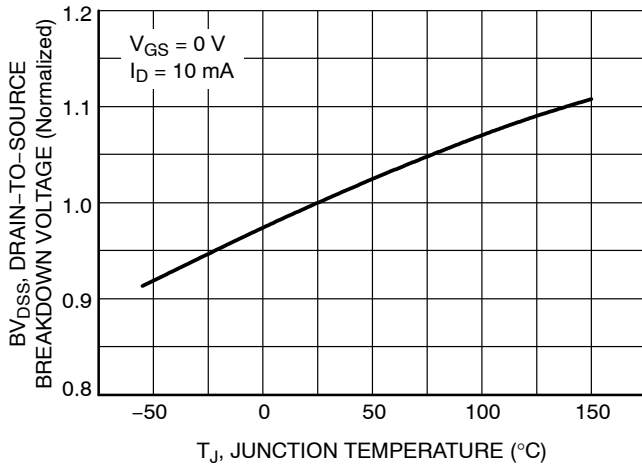


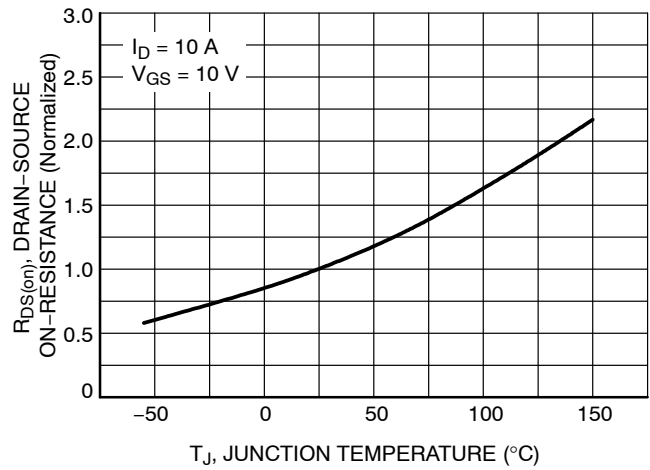
Figure 6. Gate Charge Characteristics

# NTB190N65S3HF

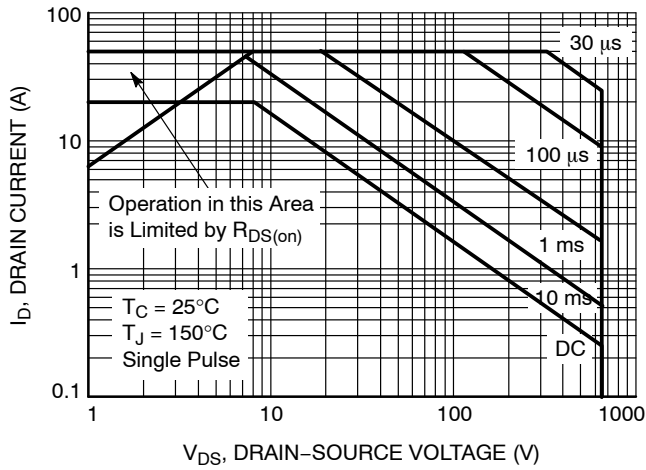
## TYPICAL CHARACTERISTICS



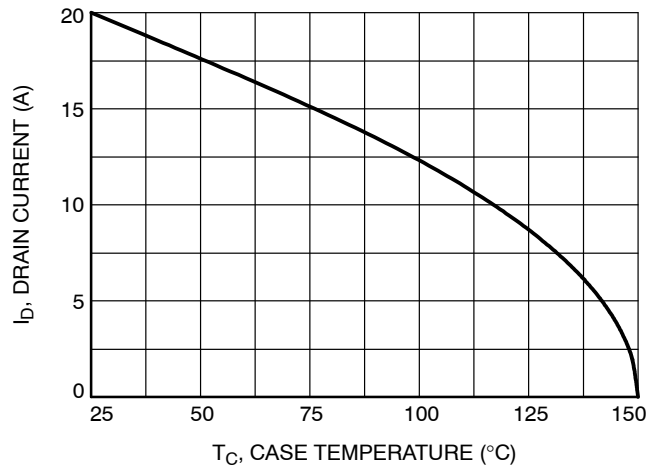
**Figure 7. Breakdown Voltage Variation vs. Temperature**



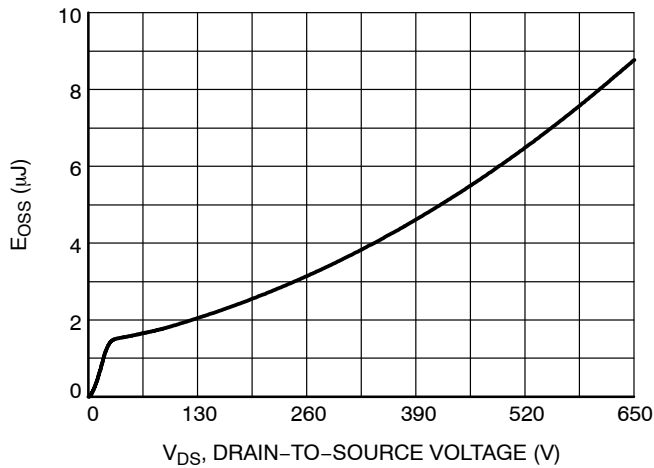
**Figure 8. On-Resistance Variation vs. Temperature**



**Figure 9. Maximum Safe Operating Area**



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



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

# NTB190N65S3HF

## TYPICAL CHARACTERISTICS

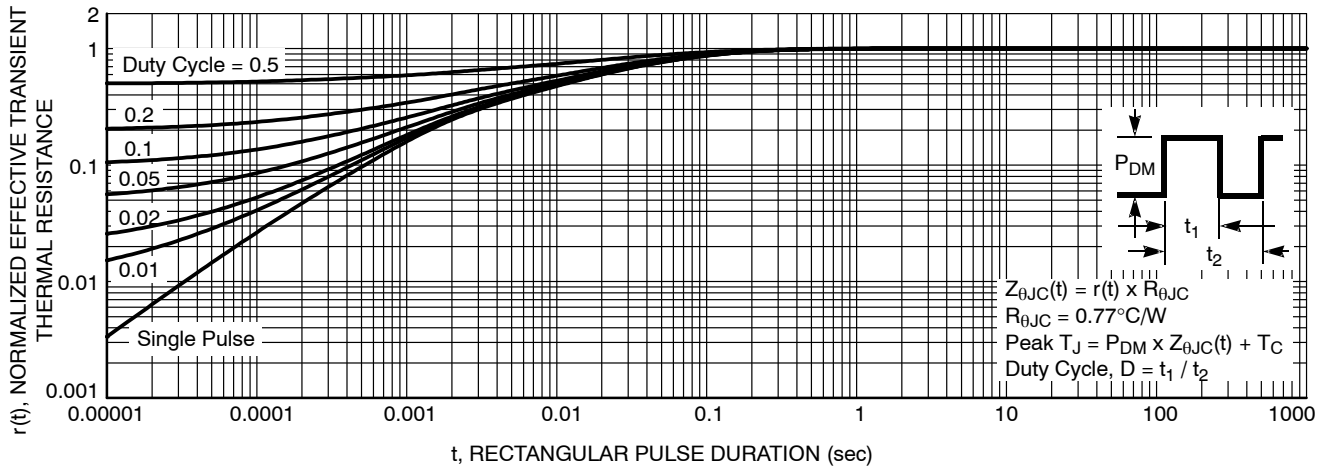


Figure 12. Transient Thermal Response Curve

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Figure 13. Gate Charge Test Circuit & Waveform

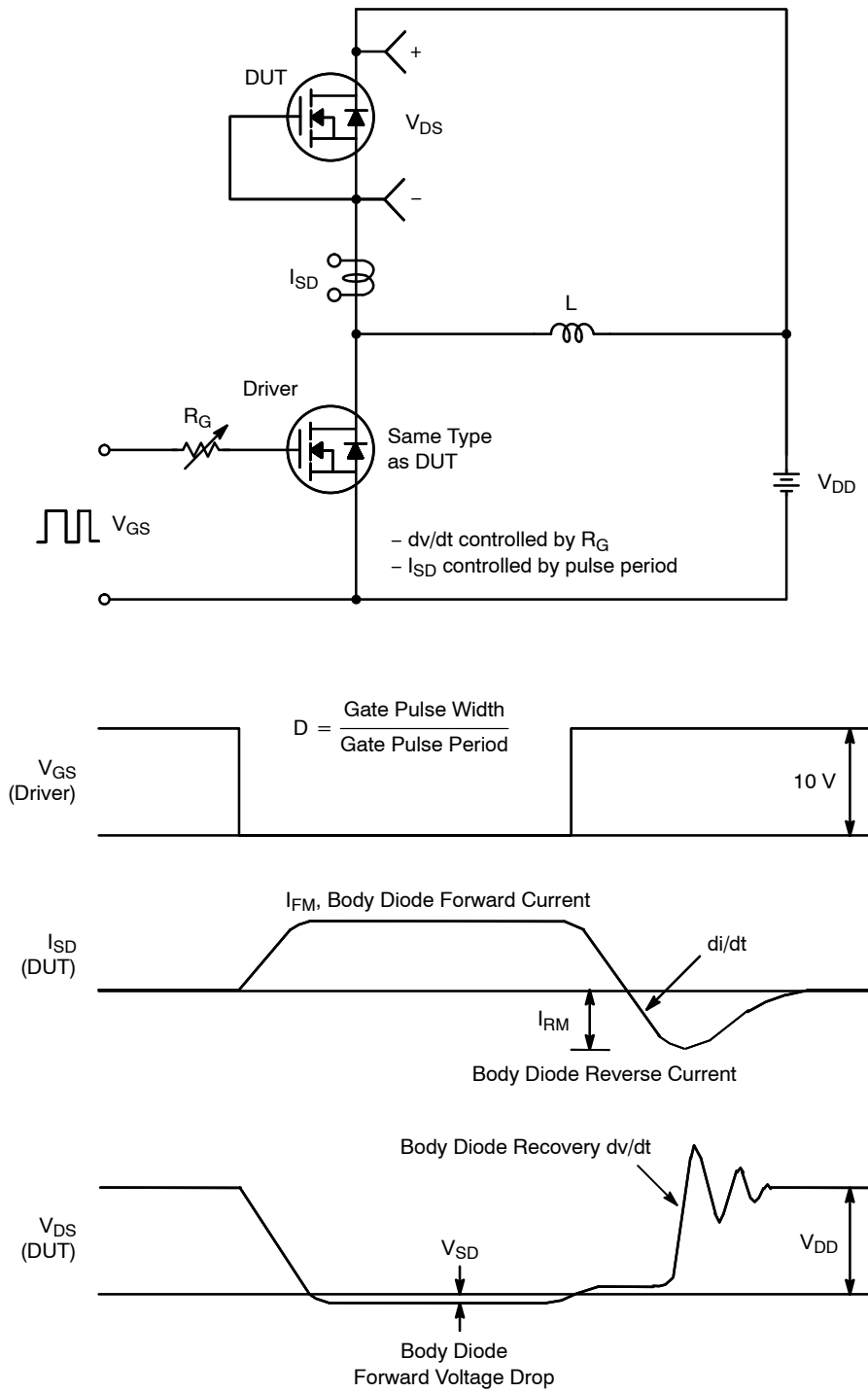


Figure 14. Resistive Switching Test Circuit & Waveforms



Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

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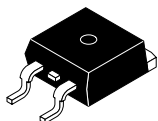
**Figure 16. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**



# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

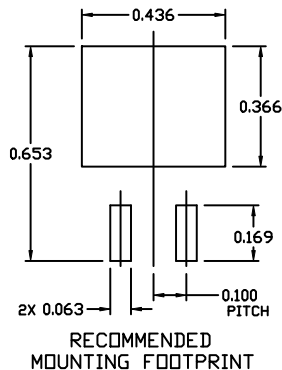
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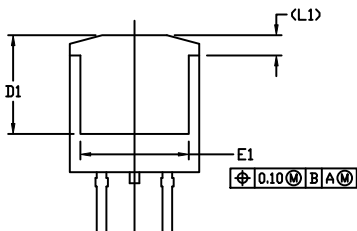
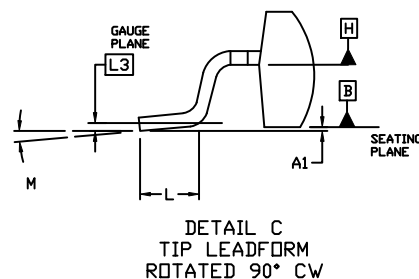
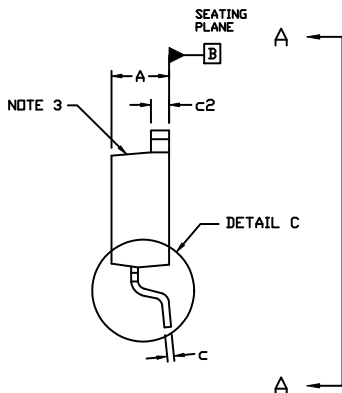
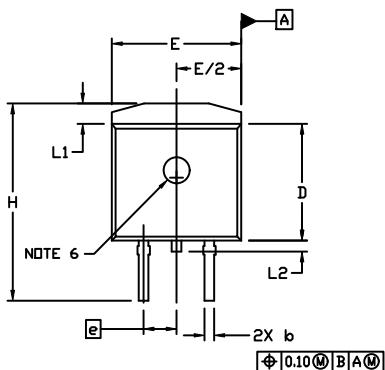
SCALE 1:1



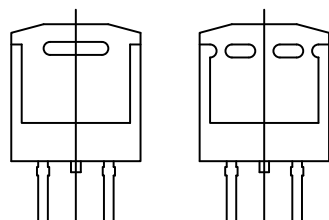
**NOTES:**

- DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
- CONTROLLING DIMENSION: INCHES
- CHAMFER OPTIONAL.
- DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.005 PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
- THERMAL PAD CONTOUR IS OPTIONAL WITHIN DIMENSIONS E, L1, D1, AND E1.
- OPTIONAL MOLD FEATURE.

DIM	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.160	0.190	4.06	4.83
A1	0.000	0.010	0.00	0.25
b	0.020	0.039	0.51	0.99
c	0.012	0.029	0.30	0.74
c2	0.045	0.065	1.14	1.65
D	0.330	0.380	8.38	9.65
D1	0.260	---	6.60	---
E	0.380	0.420	9.65	10.67
E1	0.245	---	6.22	---
e	0.100	BSC	2.54	BSC
H	0.575	0.625	14.60	15.88
L	0.070	0.110	1.78	2.79
L1	---	0.066	---	1.68
L2	---	0.070	---	1.78
L3	---	0.010 BSC	0.25	BSC
M	-8°	8°	-8°	8°

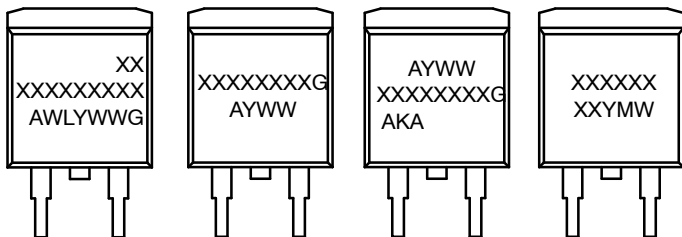


VIEW A-A



VIEW A-A  
OPTIONAL CONSTRUCTIONS

**GENERIC MARKING DIAGRAMS\***



IC

Standard

Rectifier

SSG

- XXXXXX = Specific Device Code
- A = Assembly Location
- WL = Wafer Lot
- Y = Year
- WW = Work Week
- W = Week Code (SSG)
- M = Month Code (SSG)
- G = Pb-Free Package
- AKA = Polarity Indicator

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

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<b>DESCRIPTION:</b>	<b>D<sup>2</sup>PAK-3 (TO-263, 3-LEAD)</b>	<b>PAGE 1 OF 1</b>

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