

# NTB150N65S3HF

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

**650 V, 24 A, 150 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.  $R_{DS(on)} = 121\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 43\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 400\text{ pF}$ )
- 100% Avalanche Tested
- These Devices are Pb-Free and are RoHS Compliant

### Applications

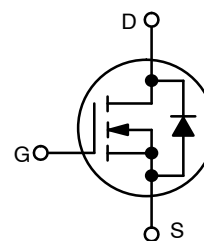
- Telecom / Server Power Supplies
- Industrial Power Supplies
- EV Charger
- UPS / Solar



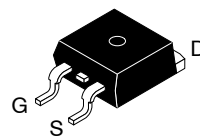
**ON Semiconductor®**

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$V_{DS}$	$R_{DS(on)}$ MAX	$I_D$ MAX
650 V	150 mΩ @ 10 V	24 A



**N-CHANNEL MOSFET**



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

### MARKING DIAGRAM

\$Y&Z&3&K NTB150 N65S3HF
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\$Y	= ON Semiconductor Logo
&Z	= Assembly Plant Code
&3	= Data Code (Year & Week)
&K	= Lot
NTB150N65S3HF	= Specific Device Code

### ORDERING INFORMATION

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

# NTB150N65S3HF

## 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	$\pm 30$	V
		– AC ( $f > 1\text{ Hz}$ )	$\pm 30$	
$I_D$	Drain Current	– Continuous ( $T_C = 25^\circ\text{C}$ )	24	A
		– Continuous ( $T_C = 100^\circ\text{C}$ )	15.2	
$I_{DM}$	Drain Current	– Pulsed (Note 1)	60	A
$E_{AS}$	Single Pulsed Avalanche Energy (Note 2)		275	mJ
$I_{AS}$	Avalanche Current (Note 2)		3.8	A
$E_{AR}$	Repetitive Avalanche Energy (Note 1)		1.92	mJ
dv/dt	MOSFET dv/dt		100	V/ns
	Peak Diode Recovery dv/dt (Note 3)		50	
$P_D$	Power Dissipation	( $T_C = 25^\circ\text{C}$ )	192	W
		– Derate Above $25^\circ\text{C}$	1.54	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	$^\circ\text{C}$

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.  $I_{AS} = 3.8\text{ A}$ ,  $R_G = 25\ \Omega$ , starting  $T_J = 25^\circ\text{C}$ .

3.  $I_{SD} \leq 12\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq 400\text{ V}$ , starting  $T_J = 25^\circ\text{C}$ .

## THERMAL CHARACTERISTICS

Symbol	Parameter	Value	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	0.65	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	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>
NTB150N65S3HF	NTB150N65S3HF	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.

# NTB150N65S3HF

## 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		0.62		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		67		
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> = 0.54 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> = 12 A		121	150	mΩ
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 12 A		14		S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, f = 1 MHz		1985		pF
C <sub>oss</sub>	Output Capacitance			40		pF
C <sub>oss(eff.)</sub>	Effective Output Capacitance	V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V		400		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		71		pF
Q <sub>g(tot)</sub>	Total Gate Charge at 10 V	V <sub>DS</sub> = 400 V, I <sub>D</sub> = 12 A, V <sub>GS</sub> = 10 V (Note 5)		43		nC
Q <sub>gs</sub>	Gate to Source Gate Charge			13		nC
Q <sub>gd</sub>	Gate to Drain "Miller" Charge			17		nC
ESR	Equivalent Series Resistance	f = 1 MHz		5.0		Ω

### SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DD</sub> = 400 V, I <sub>D</sub> = 12 A, V <sub>GS</sub> = 10 V R <sub>g</sub> = 4.7 Ω (Note 5)		21		ns
t <sub>r</sub>	Turn-On Rise Time			19		ns
t <sub>d(off)</sub>	Turn-Off Delay Time			63		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			24		A
I <sub>SM</sub>	Maximum Pulsed Source to Drain Diode Forward Current			60		A
V <sub>SD</sub>	Source to Drain Diode Forward Voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 12 A			1.3	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>DD</sub> = 400 V, I <sub>SD</sub> = 12 A, dI <sub>F</sub> /dt = 100 A/μs		88		ns
Q <sub>rr</sub>	Reverse Recovery Charge			306		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.

TYPICAL CHARACTERISTICS

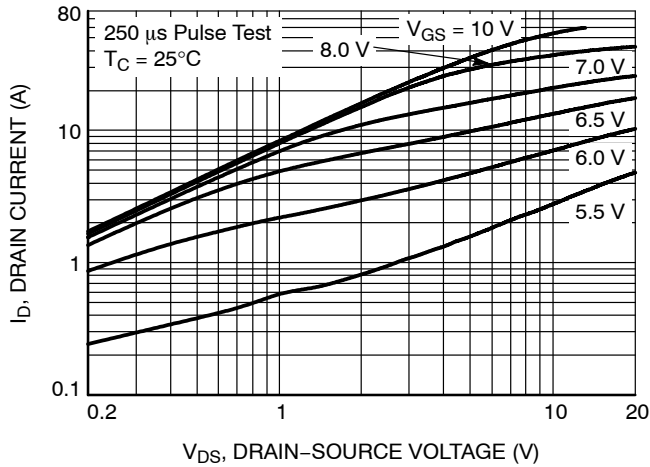


Figure 1. On-Region Characteristics

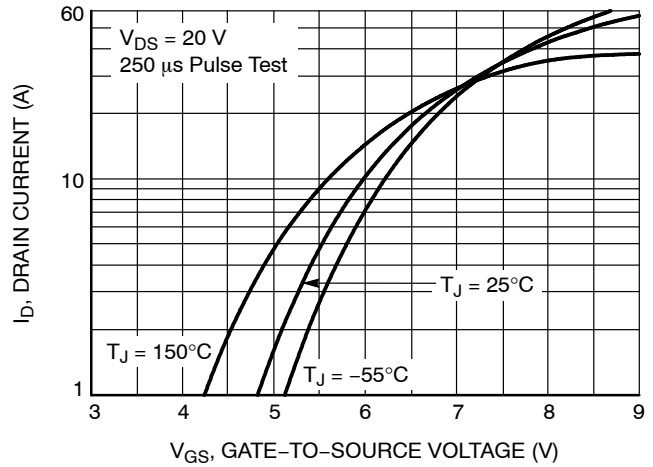


Figure 2. Transfer Characteristics

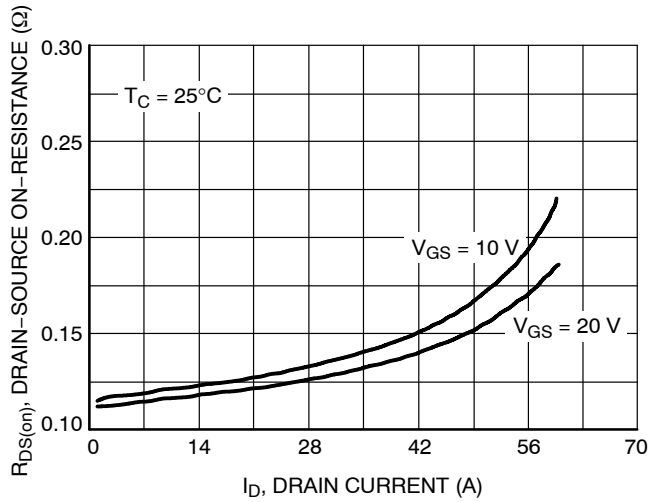


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

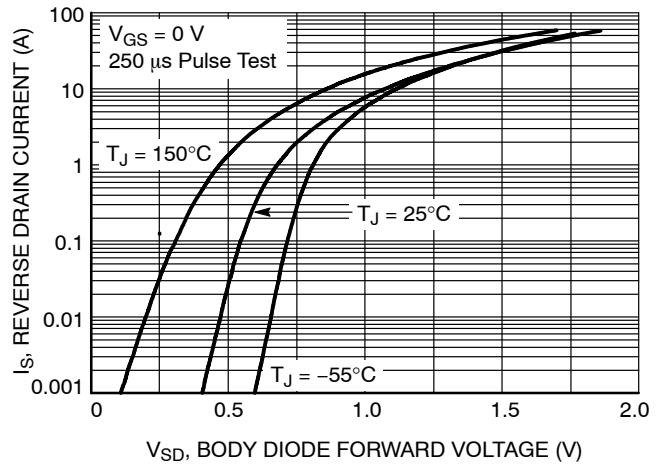


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

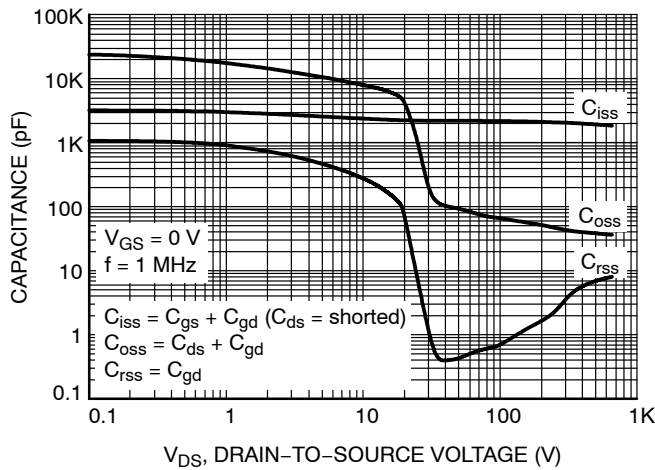


Figure 5. Capacitance Characteristics

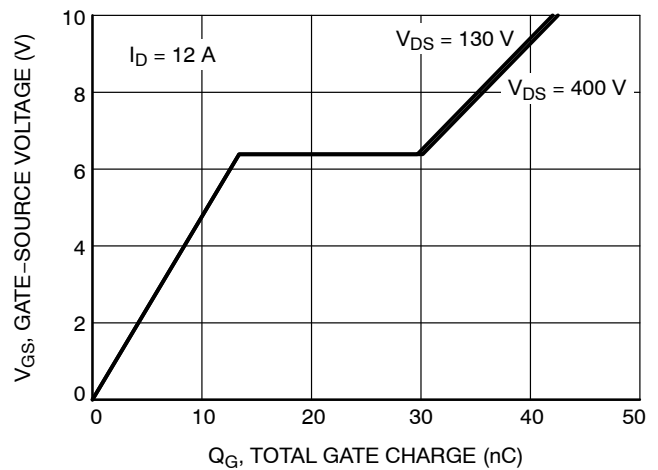


Figure 6. Gate Charge Characteristics

TYPICAL CHARACTERISTICS

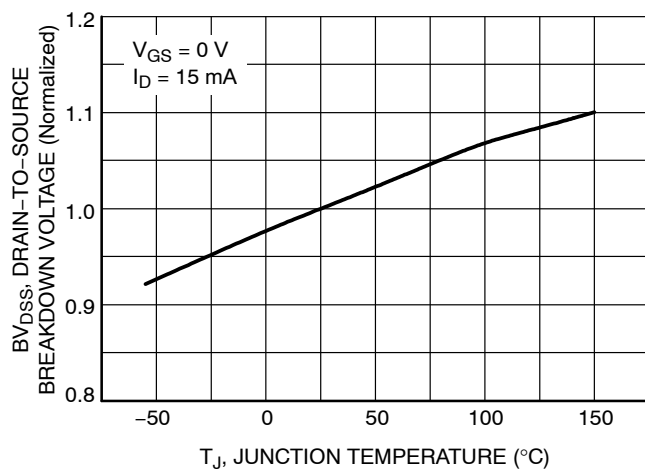


Figure 7. Breakdown Voltage Variation vs. Temperature

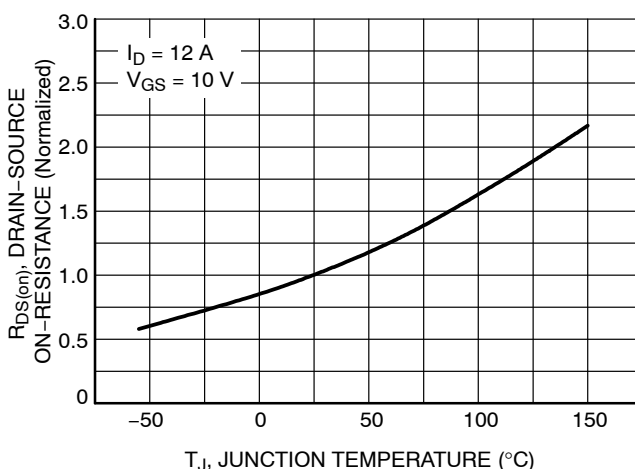


Figure 8. On-Resistance Variation vs. Temperature

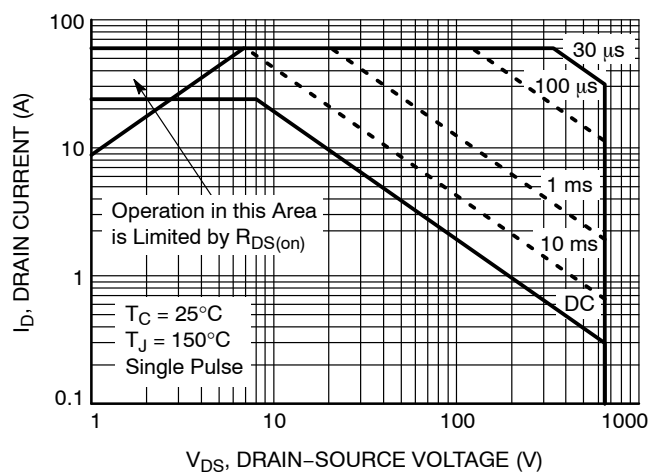


Figure 9. Maximum Safe Operating Area

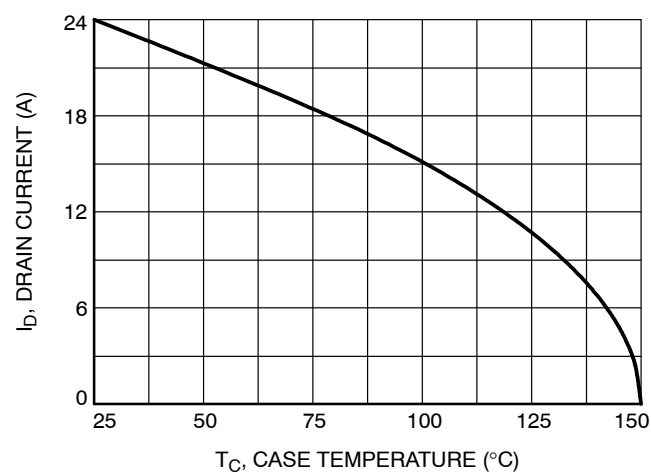


Figure 10. Maximum Drain Current vs. Case Temperature

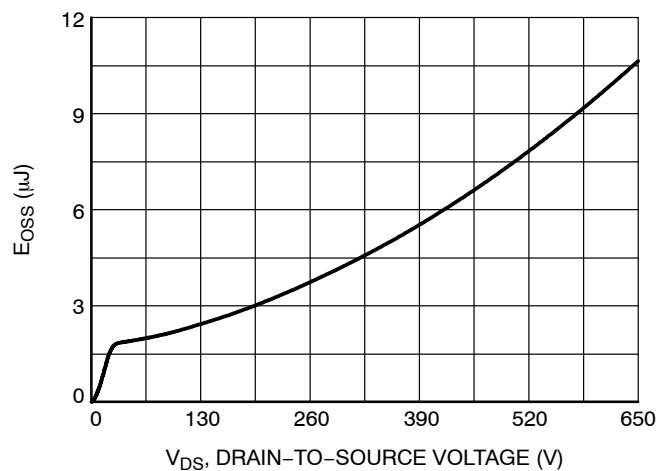


Figure 11.  $E_{OSS}$  vs. Drain-to-Source Voltage

# NTB150N65S3HF

## TYPICAL CHARACTERISTICS

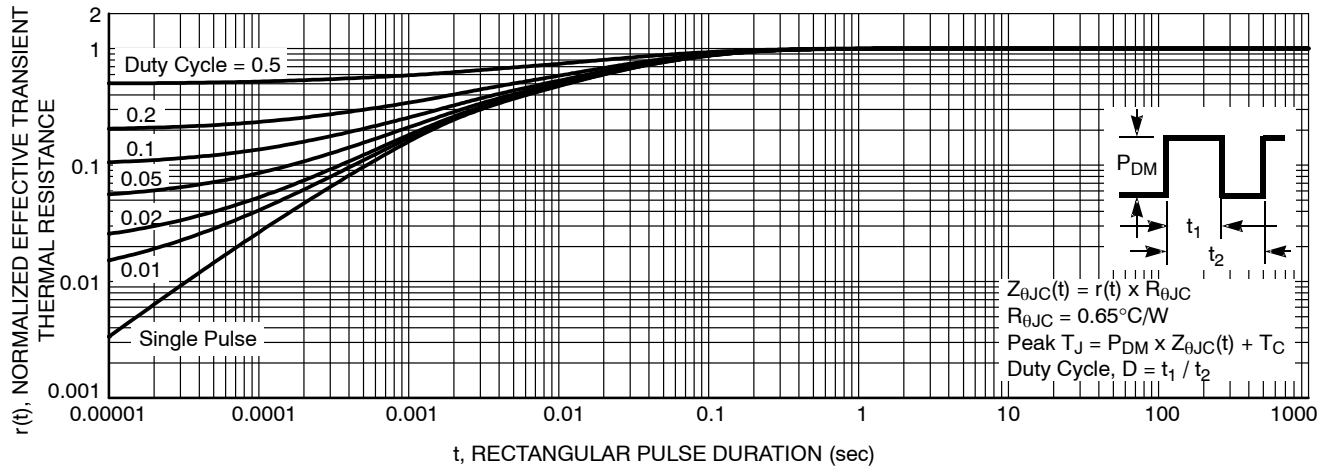


Figure 12. Transient Thermal Response Curve

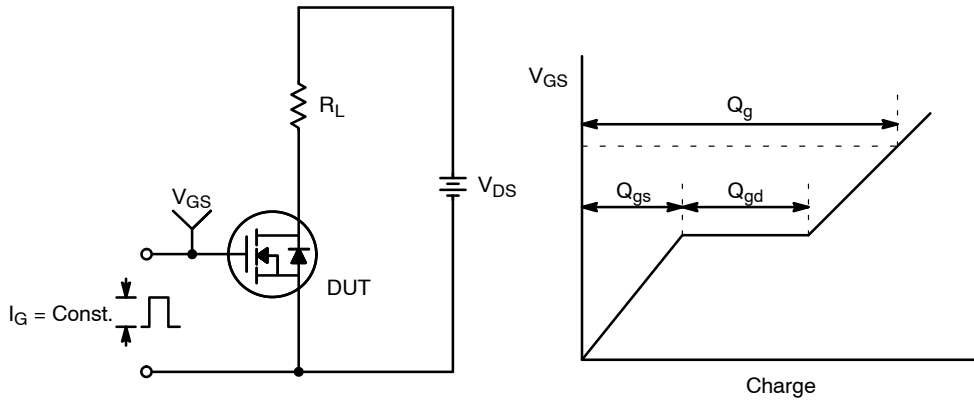


Figure 13. Gate Charge Test Circuit & Waveform

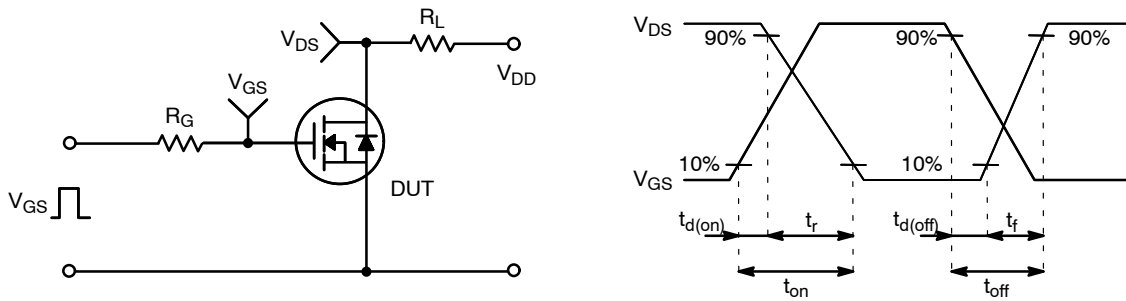


Figure 14. Resistive Switching Test Circuit & Waveforms

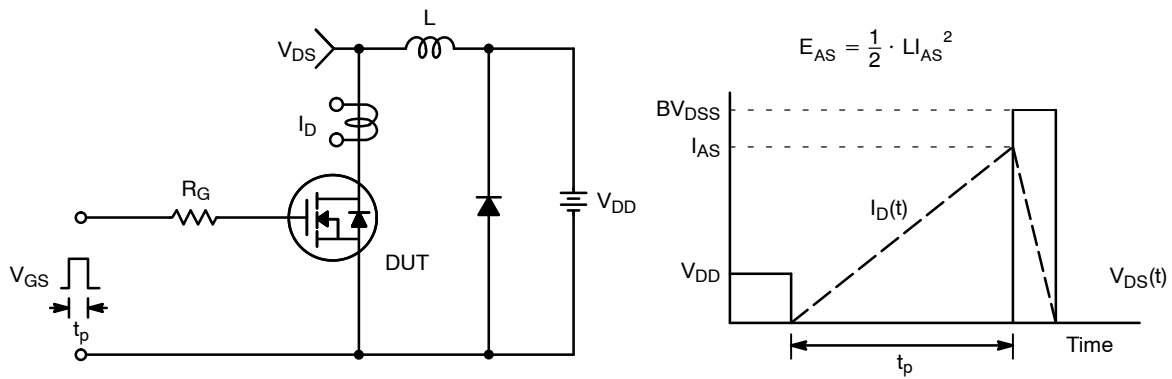


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

The diagram shows a switching circuit. A MOSFET labeled "Driver" (Same Type as DUT) has its gate connected to a square wave input  $V_{GS}$  through a resistor  $R_G$ . The driver's drain is connected to the source of the DUT MOSFET through an inductor  $L$ . The DUT MOSFET's source is connected to ground. The DUT's drain is connected to a positive supply  $V_{DD}$  through a switch. The voltage across the DUT is labeled  $V_{DS}$ , and the current through the inductor is labeled  $I_{SD}$ . The switch is controlled by a pulse, with the positive terminal marked "+" and the negative terminal marked "-".

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

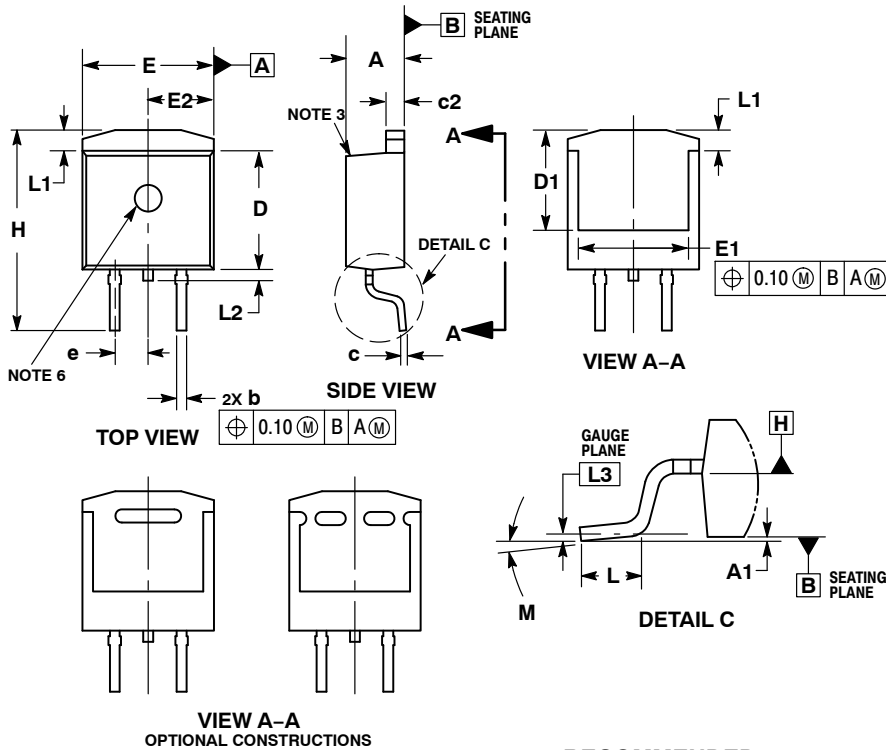




# NTB150N65S3HF

## PACKAGE DIMENSIONS

### D<sup>2</sup>PAK-3 (TO-263, 3-LEAD) CASE 418AJ ISSUE B

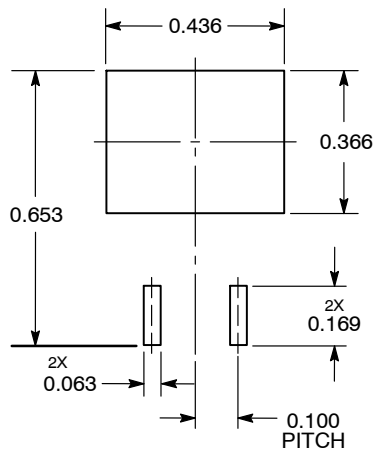


#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. CHAMFER OPTIONAL
4. 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.
5. THERMAL PAD CONTOUR IS OPTIONAL WITHIN DIMENSIONS E, L1, D1 AND E1.
6. 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	0°	8°	0°	8°

#### RECOMMENDED SOLDERING FOOTPRINT\*




DIMENSIONS: INCHES

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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