

# MOSFET - Power, Single N-Channel, D2PAK-7L

## 650 V, 95 mΩ, 36 A

### NVBG095N65S3F

#### Description

SUPERFET<sup>®</sup> III MOSFET is onsemi'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 system for miniaturization and higher efficiency. SUPERFET III FRFET<sup>®</sup> MOSFET's optimized reverse recovery performance of body diode can remove additional component and improve system reliability.

In addition, the D2PAK 7 lead package offers Kelvin sense. This allows higher switching speeds and gives designers the ability to reduce the overall application footprint.

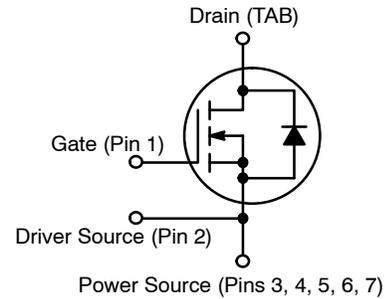
#### Features

- 700 V @ T<sub>J</sub> = 150°C
- Typ. R<sub>DS(on)</sub> = 78 mΩ
- Ultra Low Gate Charge (Typ. Q<sub>g</sub> = 66 nC)
- Low Effective Output Capacitance (Typ. C<sub>oss(eff.)</sub> = 597 pF)
- 100% Avalanche Tested
- AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free and are RoHS Compliant

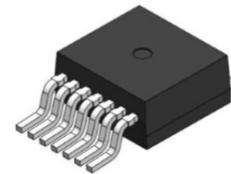
#### Typical Applications

- Automotive On Board Charger
- Automotive DC/DC Converter for BEV

V <sub>(BR)DSS</sub>	R <sub>DS(ON)</sub> MAX	I <sub>D</sub> MAX
650 V	95 mΩ @ 10 V	36 A



#### N-CHANNEL MOSFET



D2PAK-7L  
CASE 418BJ

#### MARKING DIAGRAM



VBG095N65S3F = Specific Device Code  
 A = Assembly Location  
 Y = Year  
 WW = Work Week  
 ZZ = Lot Traceability

#### ORDERING INFORMATION

See detailed ordering and shipping information on page 6 of this data sheet.

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## 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)	36
		- Continuous (T <sub>C</sub> = 100°C)	22.8
I <sub>DM</sub>	Drain Current	- Pulsed (Note 1)	90
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)	440	mJ
I <sub>AS</sub>	Avalanche Current (Note 2)	4.6	A
E <sub>AR</sub>	Repetitive Avalanche Energy (Note 1)	2.72	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)	272
		- Derate Above 25°C	2.176
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> = 4.6 A, R<sub>G</sub> = 25 Ω, starting T<sub>J</sub> = 25°C.

3. I<sub>SD</sub> ≤ 18 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.	0.46	°C/W
R <sub>θJA</sub>	Thermal Resistance, Junction-to-Ambient, Max.	40	

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## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°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> = 10 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		640		mV/°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		12		
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> = 0.86 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> = 18 A		78	95	mΩ
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 18 A		19		S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, f = 1 MHz		3020		pF
C <sub>oss</sub>	Output Capacitance			61		
C <sub>oss(eff.)</sub>	Effective Output Capacitance	V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V		597		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		107		pF
Q <sub>g(tot)</sub>	Total Gate Charge at 10 V	V <sub>GS</sub> = 10 V, V <sub>DS</sub> = 400 V, I <sub>D</sub> = 18 A (Note 4)		66		nC
Q <sub>gs</sub>	Gate-to-Source Gate Charge			22		
Q <sub>gd</sub>	Gate-to-Drain "Miller" Charge			26		
ESR	Equivalent Series Resistance	f = 1 MHz		2.4		Ω

### SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>GS</sub> = 10 V, V <sub>DD</sub> = 400 V, I <sub>D</sub> = 18 A, R <sub>g</sub> = 2.2 Ω (Note 4)		29.2		ns
t <sub>r</sub>	Turn-On Rise Time			23.8		ns
t <sub>d(off)</sub>	Turn-Off Delay Time			69.6		ns
t <sub>f</sub>	Turn-Off Fall Time			4.2		ns

### SOURCE-DRAIN DIODE CHARACTERISTICS

I <sub>S</sub>	Maximum Continuous Source-to-Drain Diode Forward Current	V <sub>GS</sub> = 0 V			36	A
I <sub>SM</sub>	Maximum Pulsed Source-to-Drain Diode Forward Current	V <sub>GS</sub> = 0 V			90	A
V <sub>SD</sub>	Source-to-Drain Diode Forward Voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 18 A			1.3	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>GS</sub> = 0 V, dI <sub>F</sub> /dt = 100 A/μs, I <sub>SD</sub> = 18 A		100		ns
Q <sub>rr</sub>	Reverse Recovery Charge			372		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.

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## TYPICAL CHARACTERISTICS

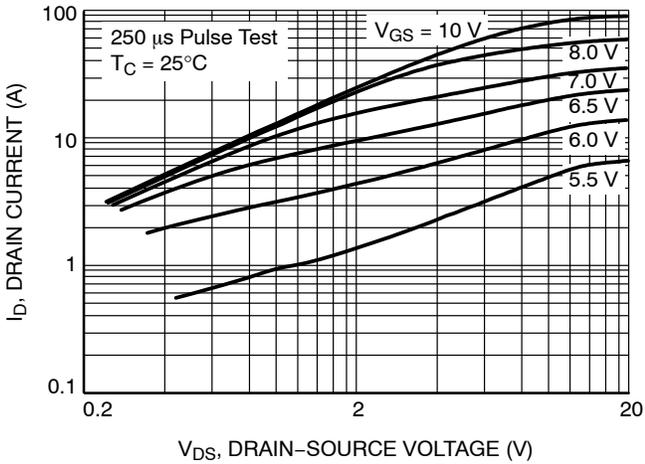


Figure 1. On-Region Characteristics

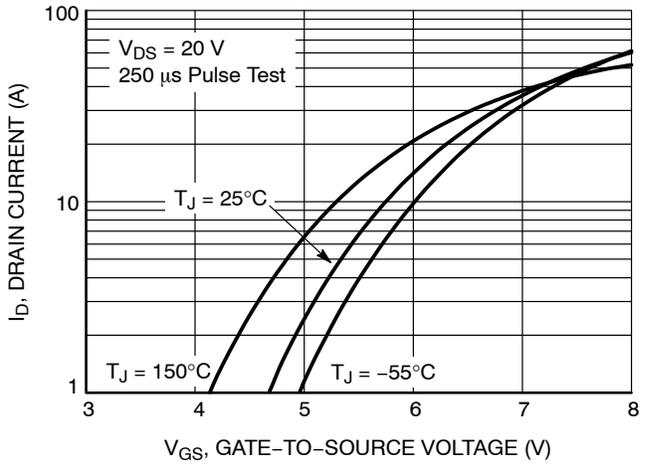


Figure 2. Transfer Characteristics

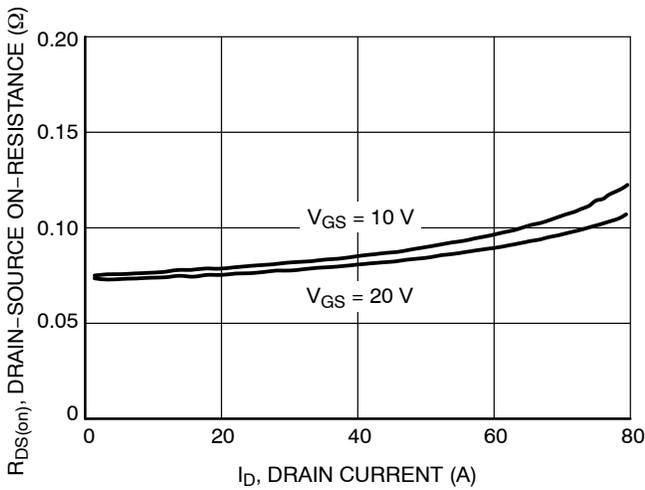


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

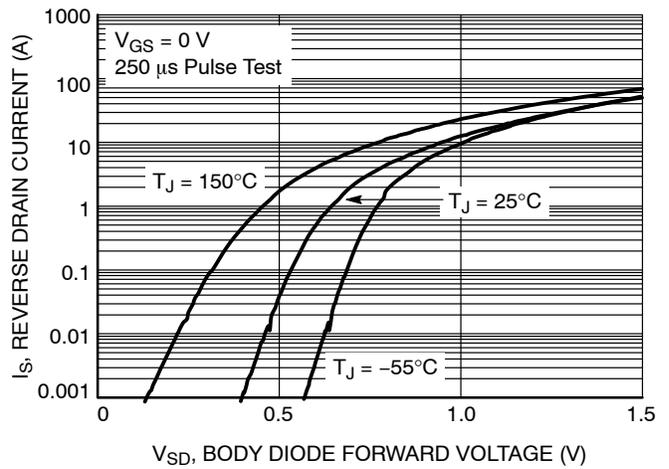


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

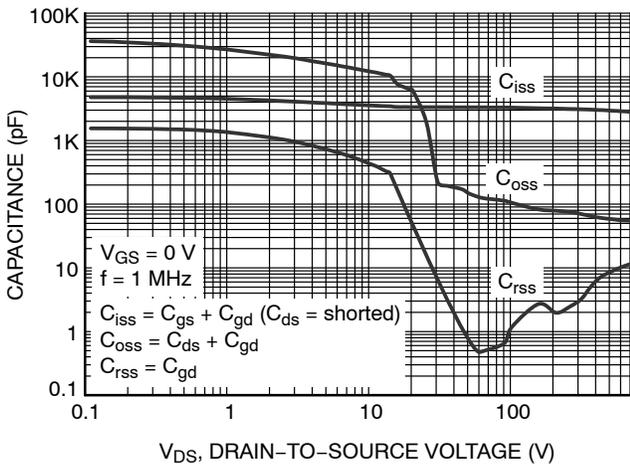


Figure 5. Capacitance Characteristics

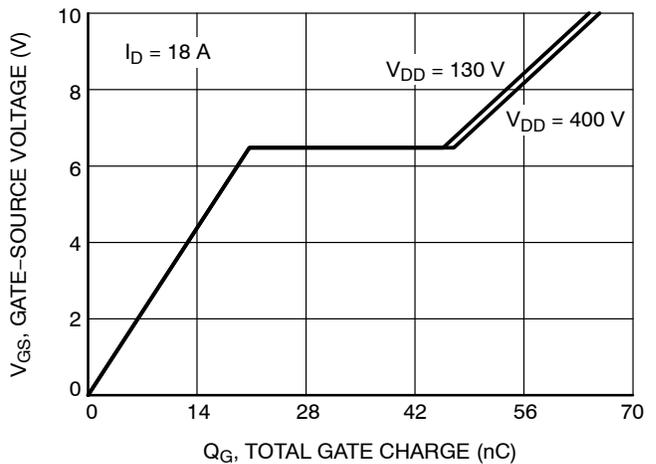


Figure 6. Gate Charge Characteristics

TYPICAL CHARACTERISTICS

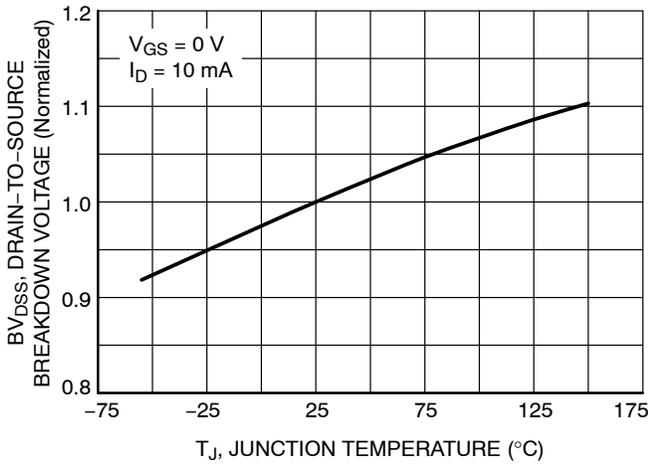


Figure 7. Breakdown Voltage Variation vs. Temperature

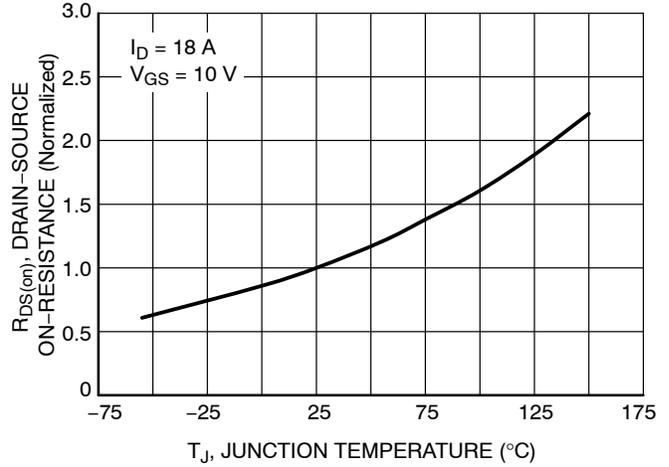


Figure 8. On-Resistance Variation vs. Temperature

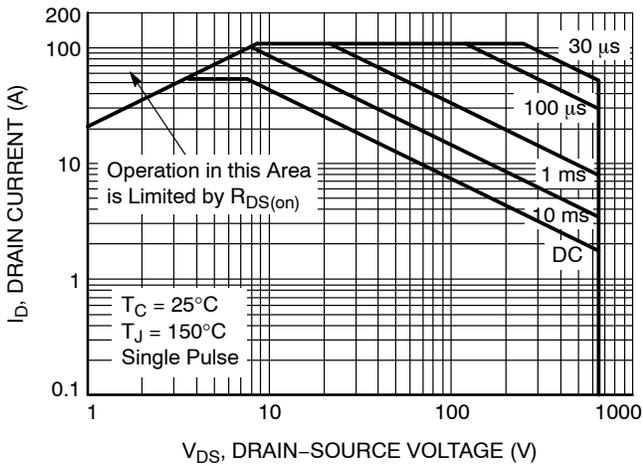


Figure 9. Maximum Safe Operating Area

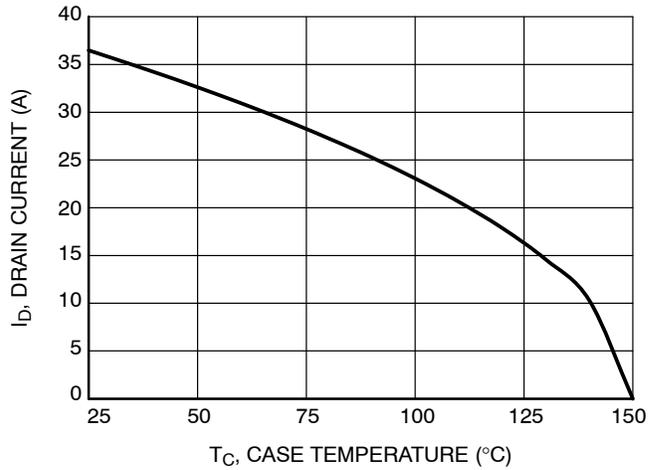


Figure 10. Maximum Drain Current vs. Case Temperature

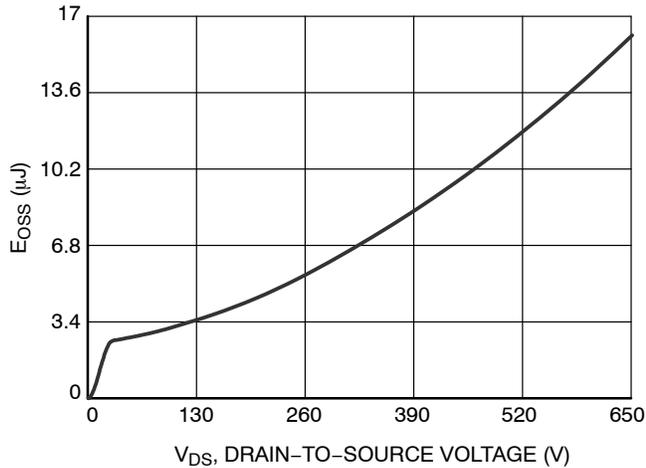


Figure 11. E<sub>OSS</sub> vs. Drain-to-Source Voltage

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## TYPICAL CHARACTERISTICS

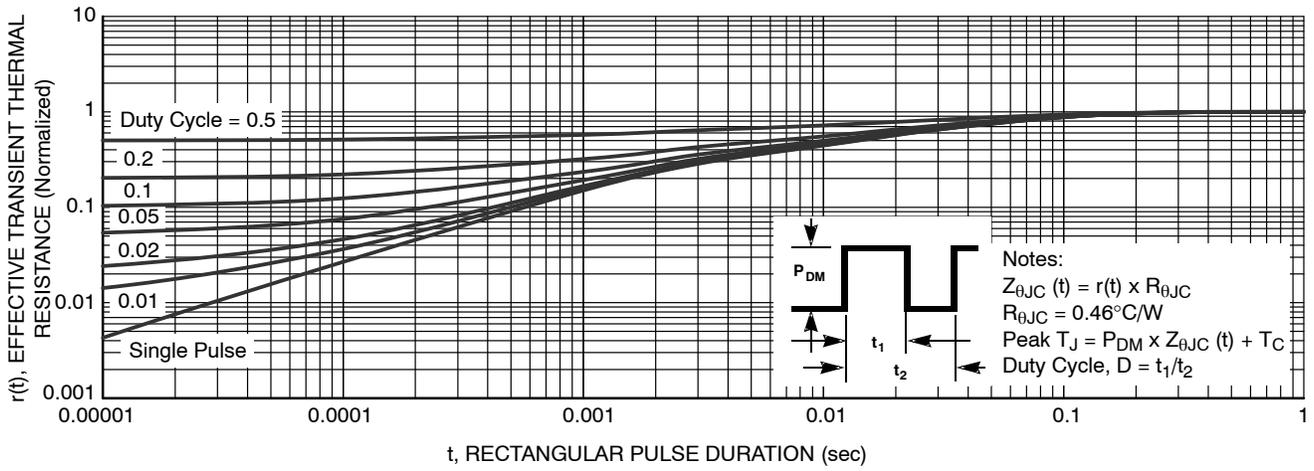


Figure 12. Transient Thermal Response

### DEVICE ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
NVBG095N65S3F	D2PAK-7L	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.

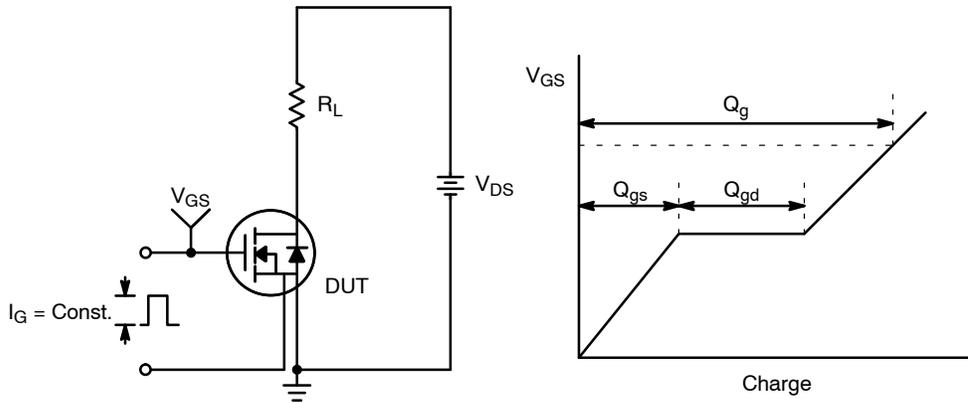


Figure 13. Gate Charge Test Circuit & Waveform

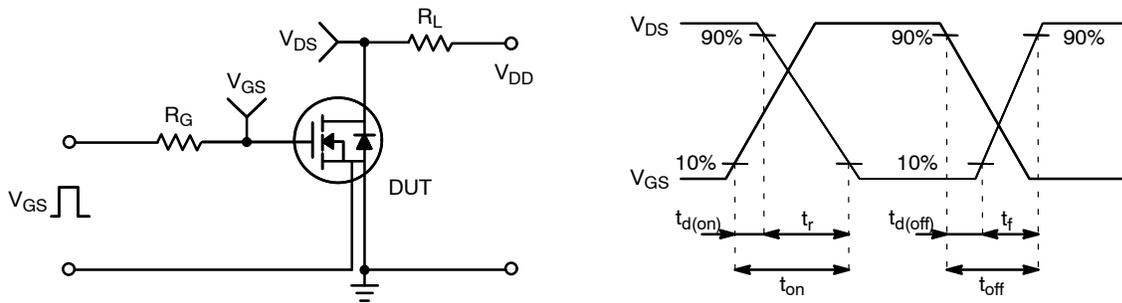


Figure 14. Resistive Switching Test Circuit & Waveforms

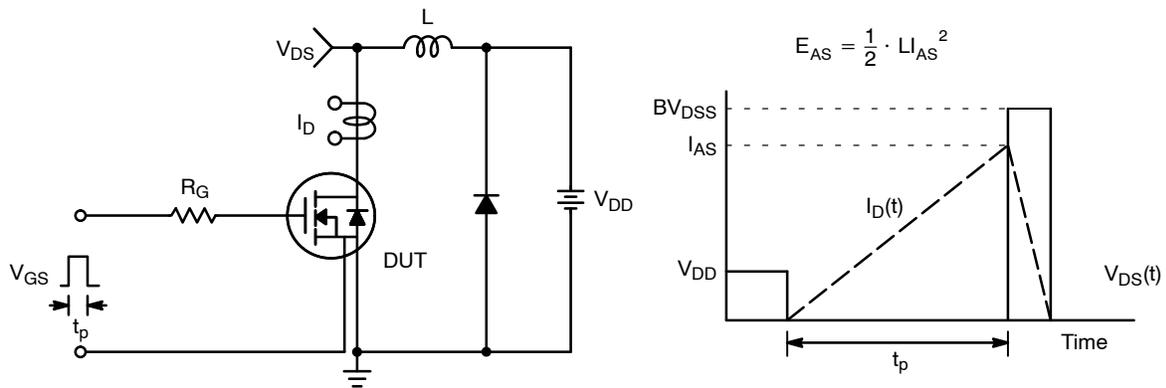
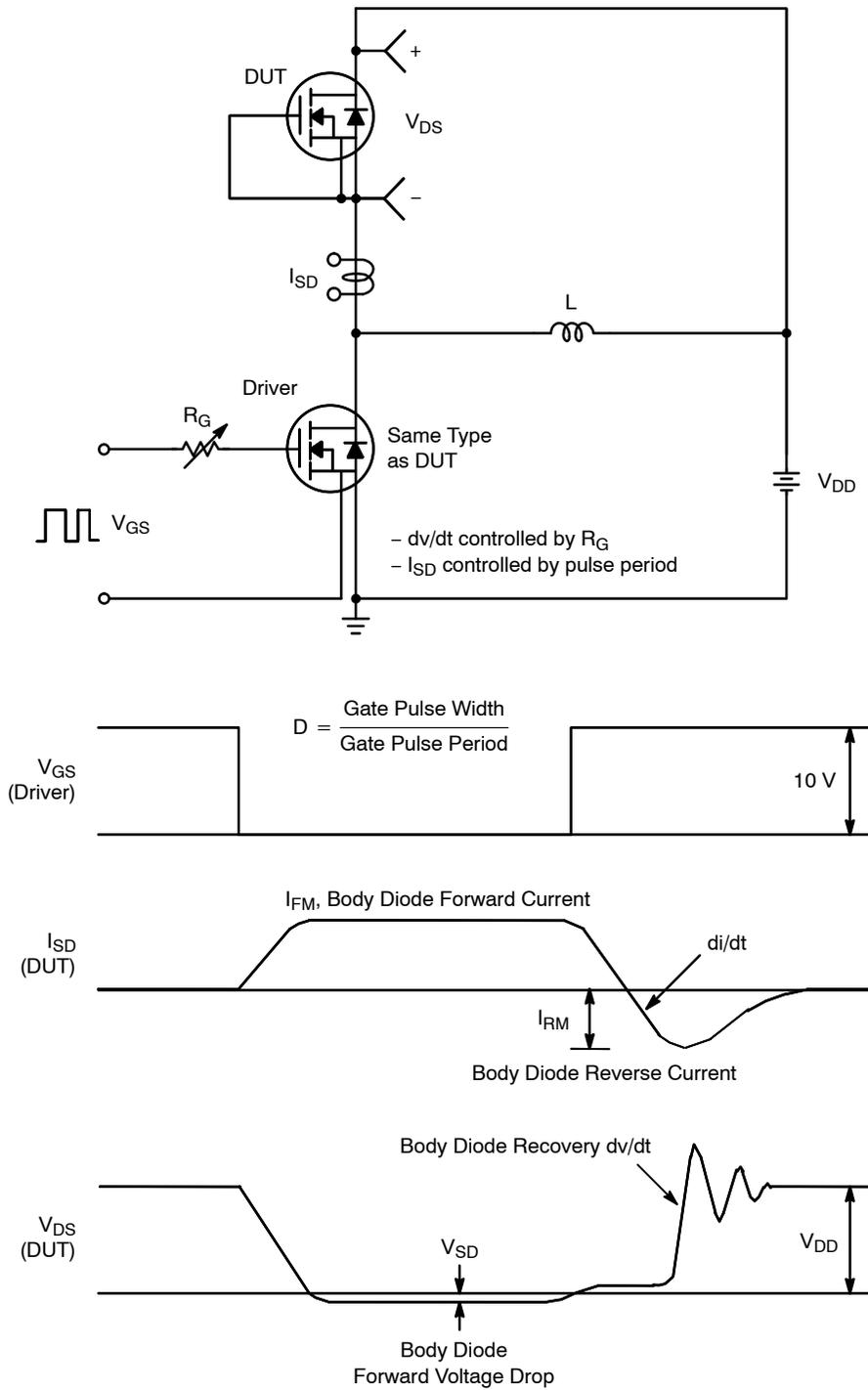


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

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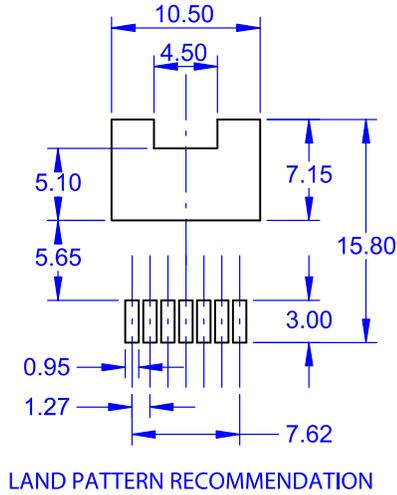
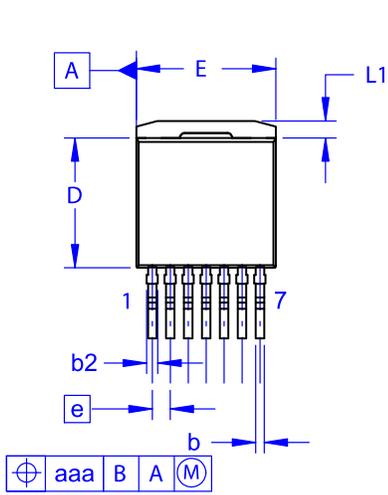


**Figure 16. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**

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## PACKAGE DIMENSIONS

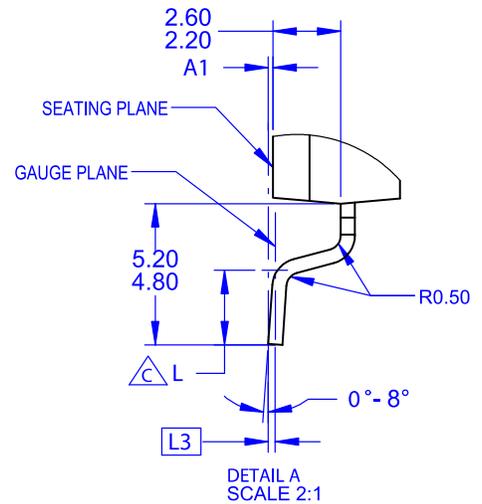
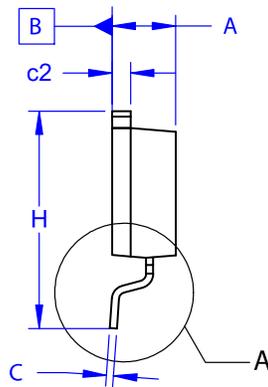
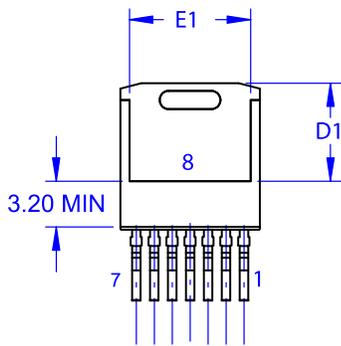
### D<sup>2</sup>PAK7 (TO-263-7L HV) CASE 418BJ ISSUE B



NOTES:

- A. PACKAGE CONFORMS TO JEDEC TO-263 VARIATION CB EXCEPT WHERE NOTED.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. OUT OF JEDEC STANDARD VALUE.
- D. DIMENSION AND TOLERANCE AS PER ASME Y14.5-2009.
- E. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.30	4.50	4.70
A1	0.00	0.10	0.20
b2	0.60	0.70	0.80
b	0.51	0.60	0.70
c	0.40	0.50	0.60
c2	1.20	1.30	1.40
D	9.00	9.20	9.40
D1	6.15	6.80	7.15
E	9.70	9.90	10.20
E1	7.15	7.65	8.15
e	~	1.27	~
H	15.10	15.40	15.70
L	2.44	2.64	2.84
L1	1.00	1.20	1.40
L3	~	0.25	~
aaa	~	~	0.25



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