

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



ON Semiconductor®

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## NTMT190N65S3HF

### 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 components and improve system reliability.

The Power88 package is an ultra-slim surface-mount package (1 mm high) with a low profile and small footprint (8x8 mm<sup>2</sup>). SUPERFET III MOSFET in a Power88 package offers excellent switching performance due to lower parasitic source inductance and separated power and drive sources. Power88 offers Moisture Sensitivity Level 1 (MSL 1).

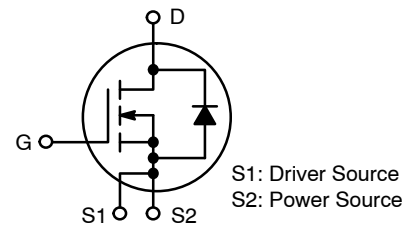
### Features

- 700 V @ T<sub>J</sub> = 150 °C
- Typ R<sub>DS(on)</sub> = 159 mΩ
- Ultra Low Gate Charge (Typ. Q<sub>g</sub> = 34 nC)
- Low Effective Output Capacitance (Typ. C<sub>oss(eff.)</sub> = 316 pF)
- 100% Avalanche Tested
- These Devices are Pb-Free and are RoHS Compliant

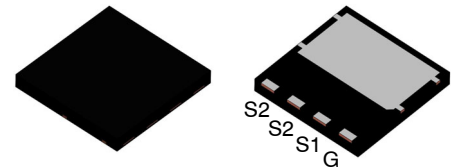
### Applications

- Telecom / Server Power Supplies
- Industrial Power Supplies
- UPS / Solar
- Lighting / Charger / Adapter

V <sub>DSS</sub>	R <sub>DS(ON)</sub> MAX	I <sub>D</sub> MAX
650 V	190 mΩ @ 10 V	20 A

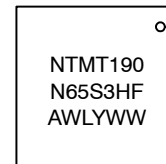


POWER MOSFET



Power88  
PQFN4 8X8 2P  
CASE 483AP

### MARKING DIAGRAM



NTMT190N65S3HF = Specific Device Code  
 A = Assembly Location  
 WL = Wafer Lot  
 Y = Year  
 WW = Work Week

### ORDERING INFORMATION

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

# NTMT190N65S3HF

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

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 s	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 ≤ 100 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)	45	

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

## ORDERING INFORMATION

Part Number	Top Marking	Package	Reel Size	Tape Width	Shipping†
NTMT190N65S3HF	NTMT190N65S3HF	Power88	13"	13.3 mm	3000 / Tape & Reel

†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.

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## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted)

Symbol	Parameter	Test Condition	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> = 10 mA, referenced to 25°C	–	0.65	–	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	–	15		
I <sub>GSS</sub>	Gate to Source 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> = 0.43 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> = 10 A	–	159	190	mΩ
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 10 A	–	11	–	S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, f = 1 MHz	–	1610	–	pF
C <sub>oss</sub>	Output Capacitance		–	30	–	pF
C <sub>oss(eff.)</sub>	Effective Output Capacitance	V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V	–	316	–	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	–	59	–	pF
Q <sub>g(tot)</sub>	Total Gate Charge at 10 V	V <sub>DS</sub> = 400 V, I <sub>D</sub> = 10 A, V <sub>GS</sub> = 10 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 MHz	–	4.1	–	Ω

### SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DD</sub> = 400 V, I <sub>D</sub> = 10 A, V <sub>GS</sub> = 10 V, R <sub>GEN</sub> = 4.7 Ω (Note 5)	–	22	–	ns
t <sub>r</sub>	Rise Time		–	13	–	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		–	53	–	ns
t <sub>f</sub>	Fall Time		–	3.3	–	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 <sub>GS</sub> = 0 V, I <sub>SD</sub> = 10 A	–	–	1.3	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 10 A, di <sub>F</sub> /dt = 100 A/μs	–	72	–	ns
Q <sub>rr</sub>	Reverse Recovery Charge		–	255	–	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

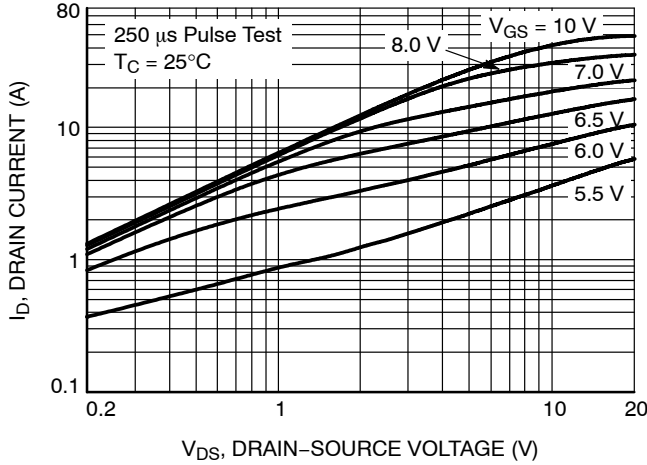


Figure 1. On-Region Characteristics

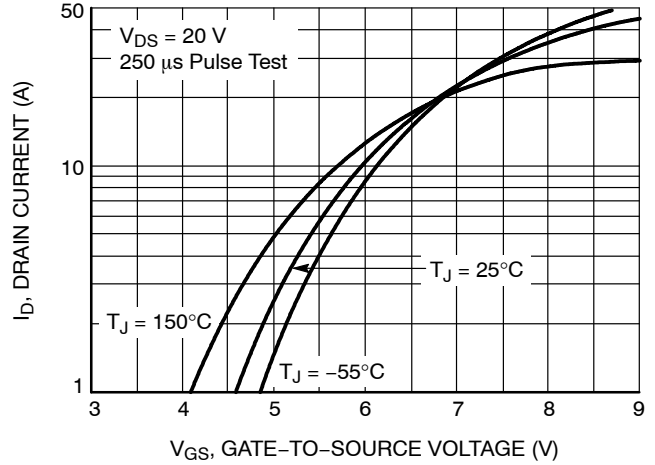


Figure 2. Transfer Characteristics

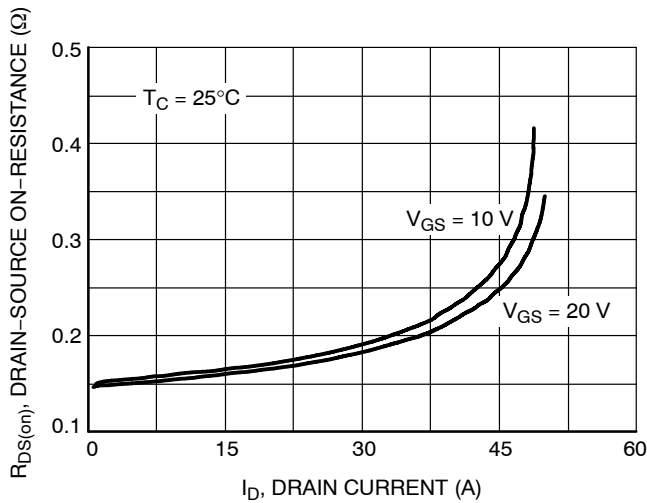


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

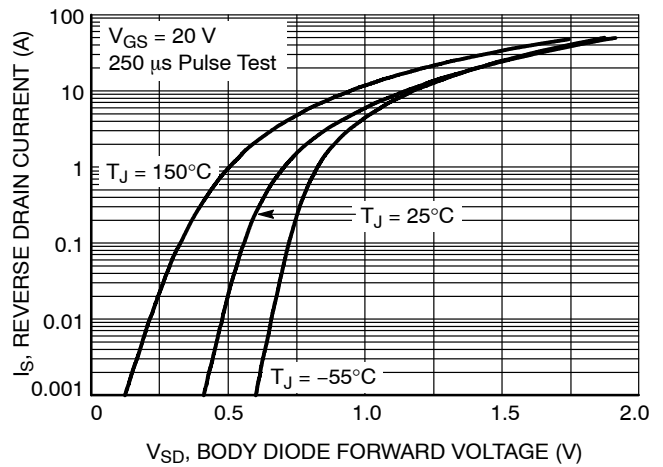


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

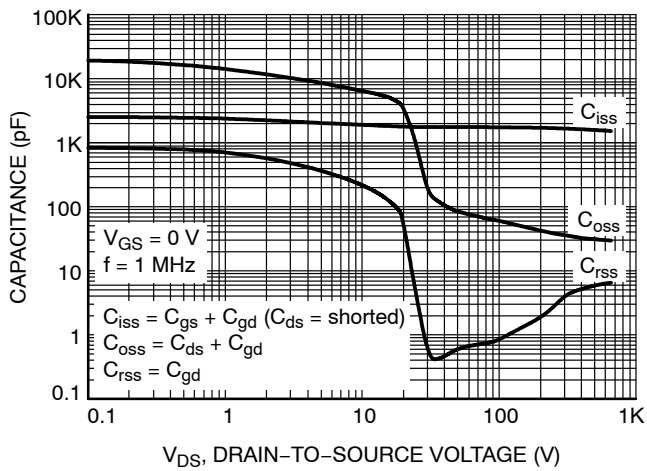


Figure 5. Capacitance Characteristics

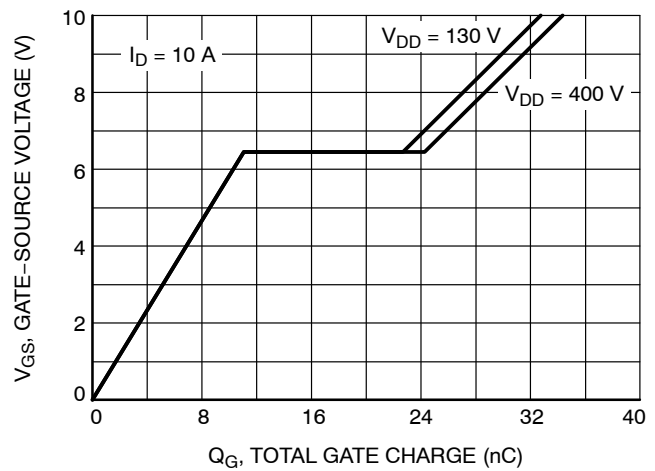
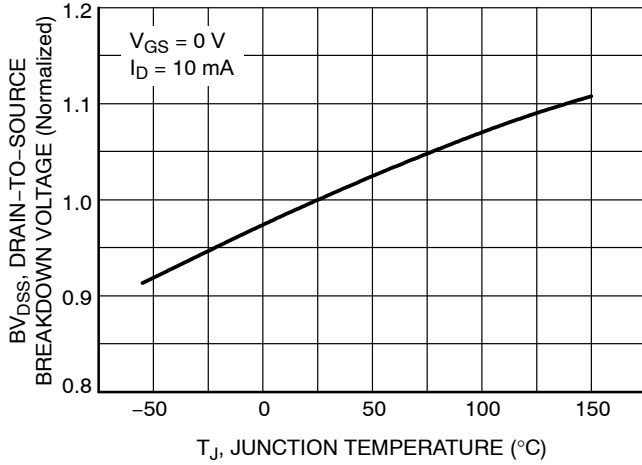


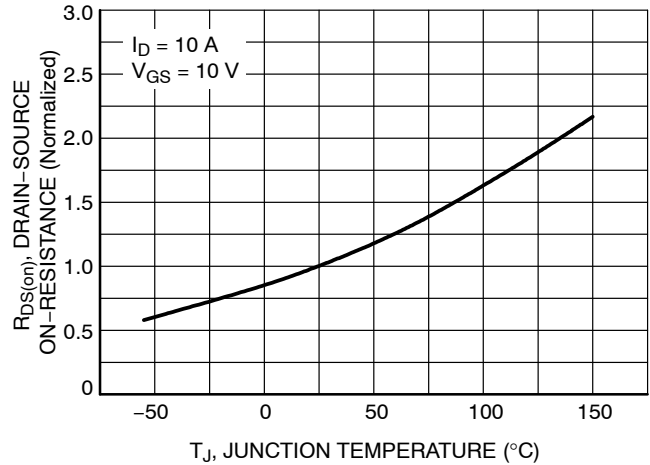
Figure 6. Gate Charge Characteristics

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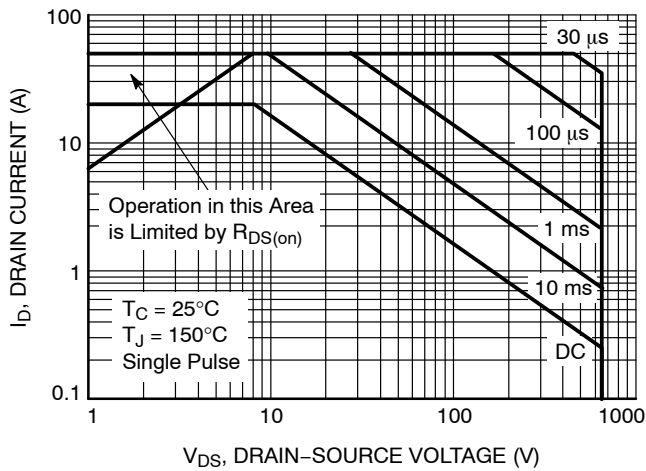
## TYPICAL CHARACTERISTICS



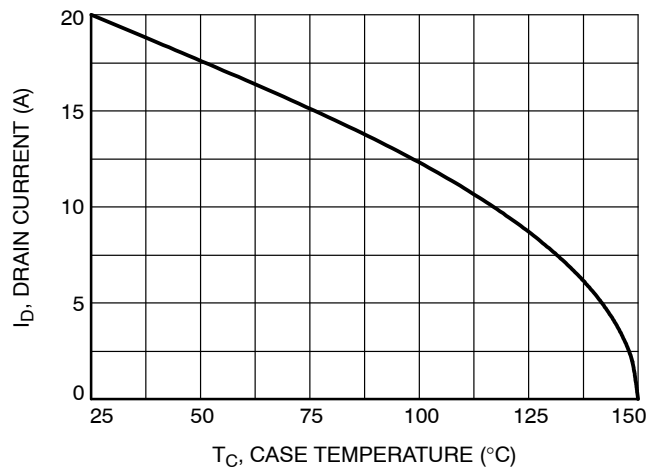
**Figure 7. Breakdown Voltage Variation vs. Temperature**



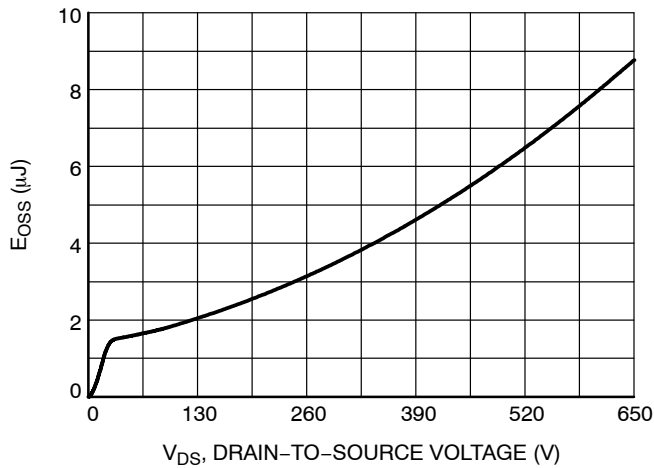
**Figure 8. On-Resistance Variation vs. Temperature**



**Figure 9. Maximum Safe Operating Area**



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



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

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## TYPICAL CHARACTERISTICS

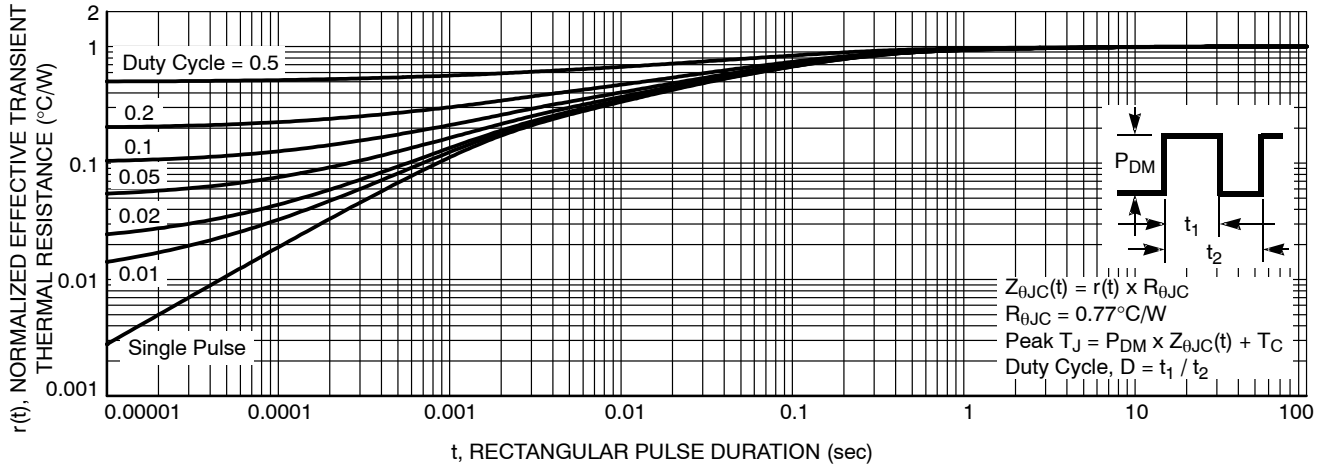


Figure 12. Transient Thermal Response Curve

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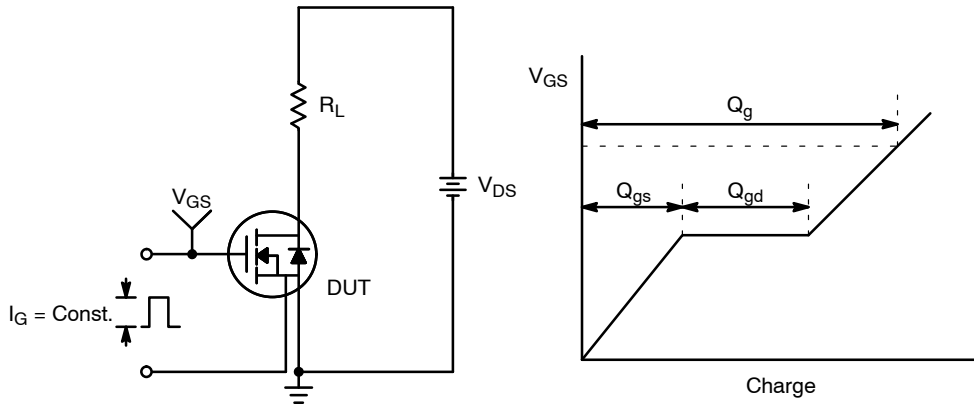


Figure 13. Gate Charge Test Circuit & Waveform

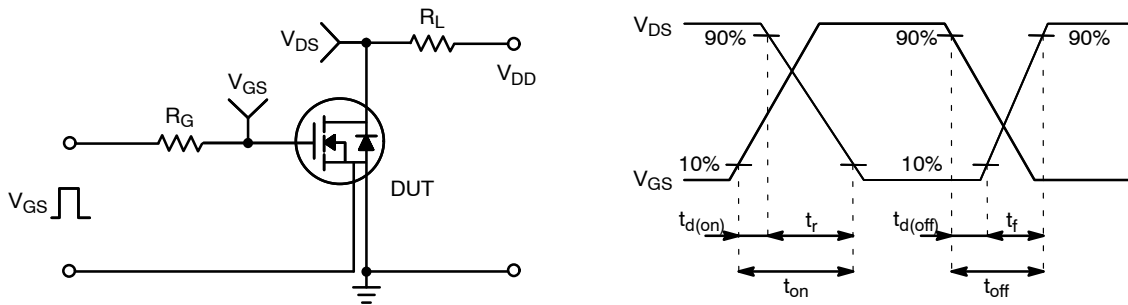


Figure 14. Resistive Switching Test Circuit & Waveforms

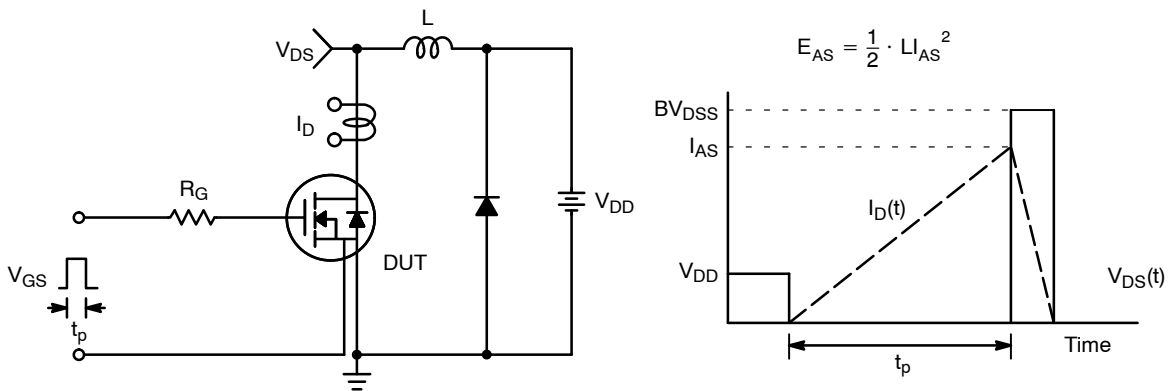
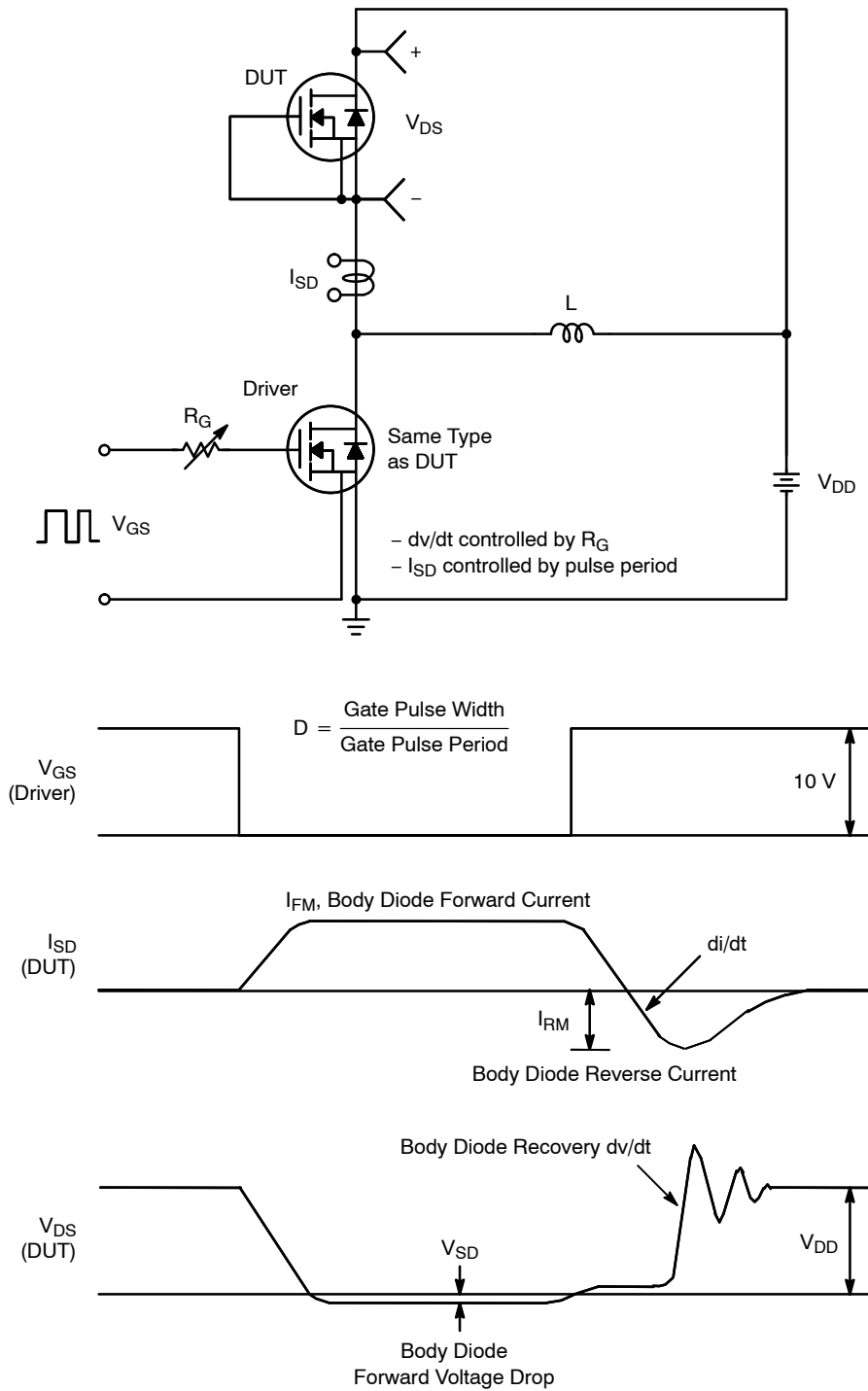


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

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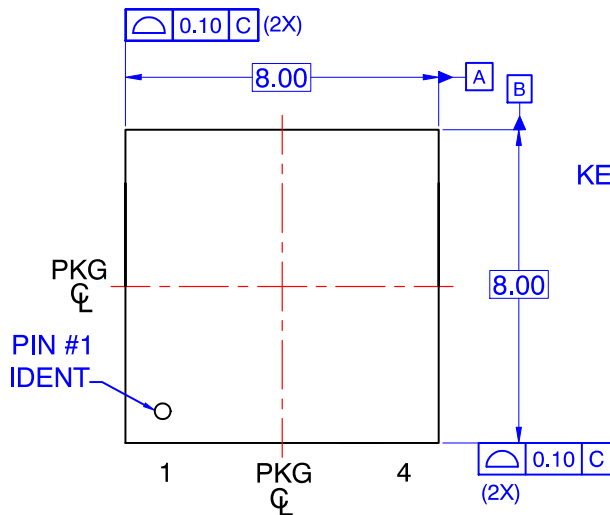
**Figure 16. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**



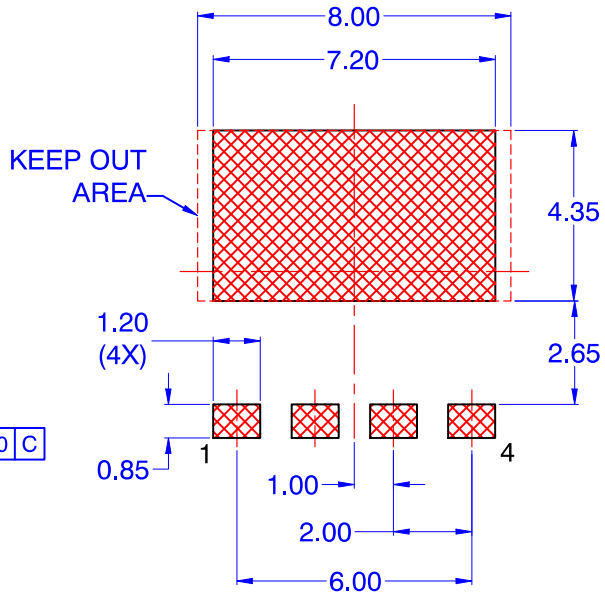
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## PACKAGE DIMENSIONS

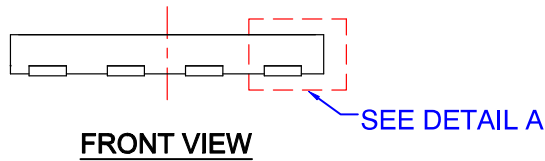
PQFN4 8X8, 2P  
CASE 483AP  
ISSUE O



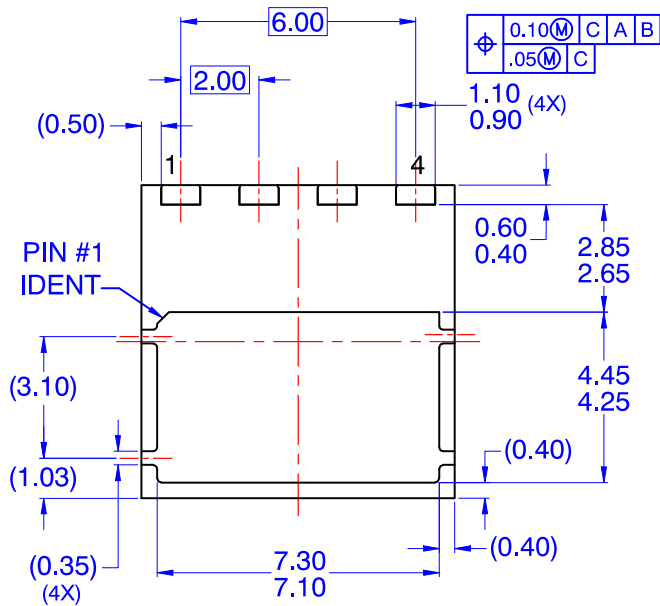
TOP VIEW



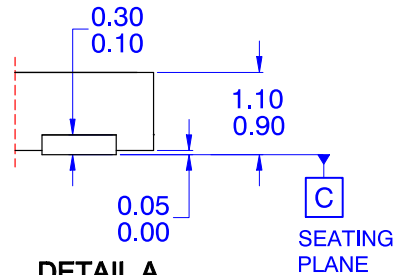
LAND PATTERN RECOMMENDATION



FRONT VIEW



BOTTOM VIEW




DETAIL A

SCALE: 2X

- NOTES: UNLESS OTHERWISE SPECIFIED
- A) THIS PACKAGE IS NOT PRESENTLY REGISTERED WITH ANY STANDARDS COMMITTEE.
  - B) DIMENSIONS ARE INCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR PROTRUSIONS.
  - C) ALL DIMENSIONS ARE IN MILLIMETERS.
  - D) DRAWING CONFORMS TO ASME Y14.5M-1994.

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