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

## 650 V, 36 A, 95 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 system 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<sub>I</sub>= 150°C
- Typ.  $R_{DS(on)} = 78 \text{ m}\Omega$
- Ultra Low Gate Charge (Typ. Qg = 66 nC)
- Low Effective Output Capacitance (Typ. Coss(eff.) = 569 pF)
- 100% Avalanche Tested
- These Devices are Pb-Free and are RoHS Compliant

#### **Applications**

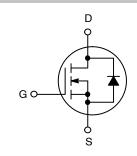
- Telecom / Server Power Supplies
- Industrial Power Supplies
- EV Charger
- UPS / Solar



#### ON Semiconductor®

#### www.onsemi.com

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





TO-247 long leads CASE 340CX

## **MARKING DIAGRAM**



\$Y = ON Semiconductor Logo &Z = Assembly Plant Code &3 = Data Code (Year & Week)

&K = Lot

NTHL095N65S3HF = Specific Device Code

#### ORDERING INFORMATION

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

## **ABSOLUTE MAXIMUM RATINGS** ( $T_C = 25^{\circ}C$ , 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	V	
		- AC (f > 1 Hz)	±30		
I <sub>D</sub>	Drain Current	– Continuous (T <sub>C</sub> = 25°C)	36	Α	
		- Continuous (T <sub>C</sub> = 100°C)	22.8		
I <sub>DM</sub>	Drain Current	- Pulsed (Note 1)	90	Α	
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)		440	mJ	
I <sub>AS</sub>	Avalanche Current (Note 2)		4.6	Α	
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)	Peak Diode Recovery dv/dt (Note 3)			
$P_{D}$	Power Dissipation (T <sub>C</sub> = 25°C)		272	W	
		- Derate Above 25°C	2.176	W/°C	
T <sub>J</sub> , T <sub>STG</sub>	Operating and Storage Temperature Range		-55 to +150	°C	
TL	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.  $I_{AS} = 4.6 \text{ A}$ ,  $R_{G} = 25 \Omega$ , starting  $T_{J} = 25^{\circ}\text{C}$ . 3.  $I_{SD} \le 18 \text{ A}$ ,  $\text{di/dt} \le 200 \text{ A/µs}$ ,  $V_{DD} \le 400 \text{ V}$ , starting  $T_{J} = 25^{\circ}\text{C}$ .

#### THERMAL CHARACTERISTICS

Symbol	Parameter	Value	Unit
$R_{ hetaJC}$	Thermal Resistance, Junction to Case, Max.	0.46	°C/W
$R_{ heta JA}$	Thermal Resistance, Junction to Ambient, Max.	40	

### PACKAGE MARKING AND ORDERING INFORMATION

Ī	Part Number	Top Marking	Package	Packing Method	Reel Size	Tape Width	Quantity
	NTHL095N65S3HF	NTHL095N65S3HF	TO-247	Tube	N/A	N/A	30 Units

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

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
OFF CHARACT	ERISTICS					
BV <sub>DSS</sub>	Drain to Source Breakdown Voltage	$V_{GS}$ = 0 V, $I_D$ = 1 mA, $T_J$ = 25°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 <sub>D</sub> = 15 mA, Referenced to 25°C	-	0.63	-	V/°C
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>DS</sub> = 650 V, V <sub>GS</sub> = 0 V	-	_	10	μΑ
		V <sub>DS</sub> = 520 V, T <sub>C</sub> = 125°C	-	97	-	
I <sub>GSS</sub>	Gate to Body Leakage Current	$V_{GS} = \pm 30 \text{ V}, V_{DS} = 0 \text{ V}$	-	_	±100	nA
ON CHARACTE	RISTICS					
V <sub>GS(th)</sub>	Gate Threshold Voltage	$V_{GS} = V_{DS}, I_D = 0.86 \text{ mA}$	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
9 <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 18 A	_	22	-	S
DYNAMIC CHA	RACTERISTICS					
C <sub>iss</sub>	Input Capacitance	V 400 V V 0 V 6 4 MU	-	2930	_	pF
C <sub>oss</sub>	Output Capacitance	$V_{DS} = 400 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$	_	61	-	pF
C <sub>oss(eff.)</sub>	Effective Output Capacitance	$V_{DS}$ = 0 V to 400 V, $V_{GS}$ = 0 V	-	569	-	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	-	110	-	pF
Q <sub>g(tot)</sub>	Total Gate Charge at 10V		-	66	-	nC
Q <sub>gs</sub>	Gate to Source Gate Charge	$V_{DS} = 400 \text{ V}, I_D = 18 \text{ A}, V_{GS} = 10 \text{ V}$ (Note 4)	-	21	-	nC
Q <sub>gd</sub>	Gate to Drain "Miller" Charge	(1111 )	-	25	-	nC
ESR	Equivalent Series Resistance	f = 1 MHz	-	2.4	-	Ω
WITCHING CH	IARACTERISTICS					
t <sub>d(on)</sub>	Turn-On Delay Time		-	28	-	ns
t <sub>r</sub>	Turn-On Rise Time	$V_{DD} = 400 \text{ V}, I_D = 18 \text{ A},$	-	28	-	ns
t <sub>d(off)</sub>	Turn-Off Delay Time	$V_{GS} = 10 \text{ V, R}_{g} = 4.7 \Omega$ (Note 4)	-	72	-	ns
t <sub>f</sub>	Turn-Off Fall Time		-	24	-	ns
SOURCE-DRAI	N DIODE CHARACTERISTICS					
Is	Maximum Continuous Source to Drain Diode Forward Current		-	-	36	Α
I <sub>SM</sub>	Maximum Pulsed Source to Drain Diode	aximum Pulsed Source to Drain Diode Forward Current		-	90	Α
$V_{SD}$	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, I <sub>SD</sub> = 18 A,	-	106	-	ns
Q <sub>rr</sub>	Reverse Recovery Charge	$dI_F/dt = 100 A/\mu s$	-	414	-	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 CHARACTERISTICS**

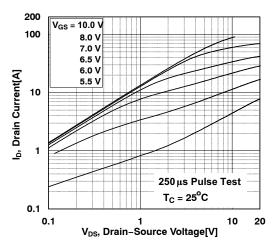


Figure 1. On-Region Characteristics

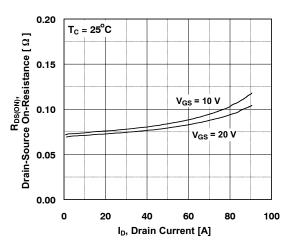


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

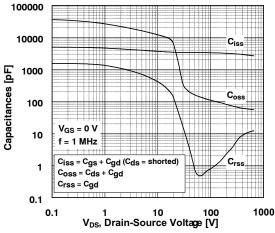


Figure 5. Capacitance Characteristics

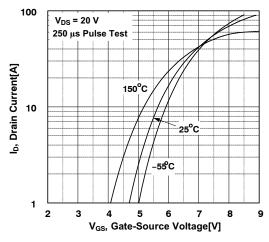


Figure 2. Transfer Characteristics

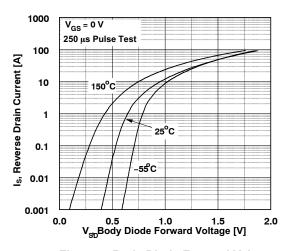


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

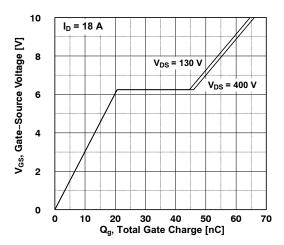


Figure 6. Gate Charge Characteristics

### **TYPICAL CHARACTERISTICS**

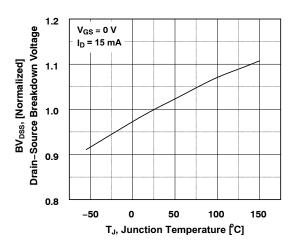


Figure 7. Breakdown Voltage Variation vs. Temperature

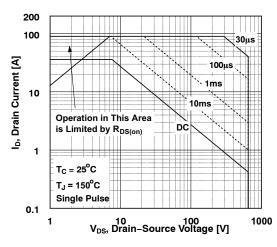


Figure 9. Maximum Safe Operating Area

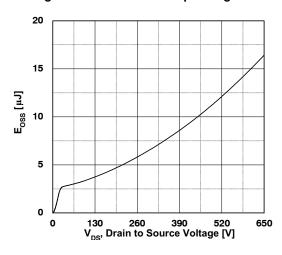


Figure 11. Eoss vs. Drain-to-Source Voltage

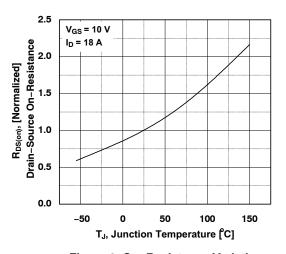


Figure 8. On–Resistance Variation vs. Temperature

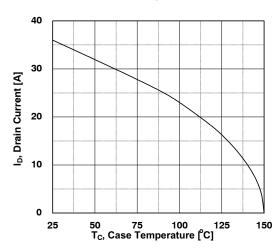


Figure 10. Maximum Drain Current vs. Case Temperature

## **TYPICAL CHARACTERISTICS**

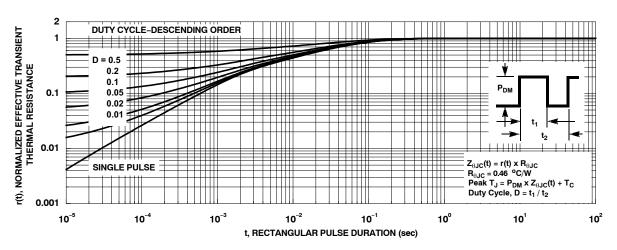


Figure 12. Transient Thermal Response Curve

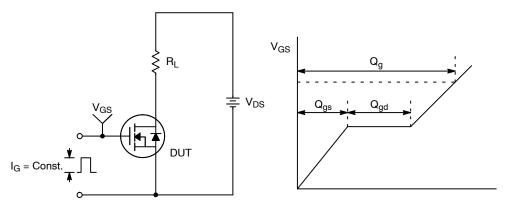


Figure 13. Gate Charge Test Circuit & Waveform

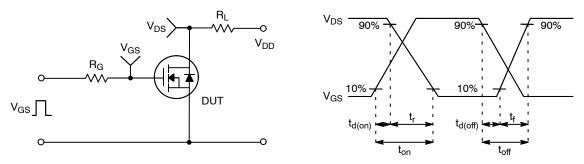


Figure 14. Resistive Switching Test Circuit & Waveforms

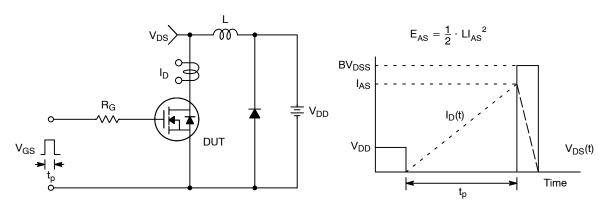
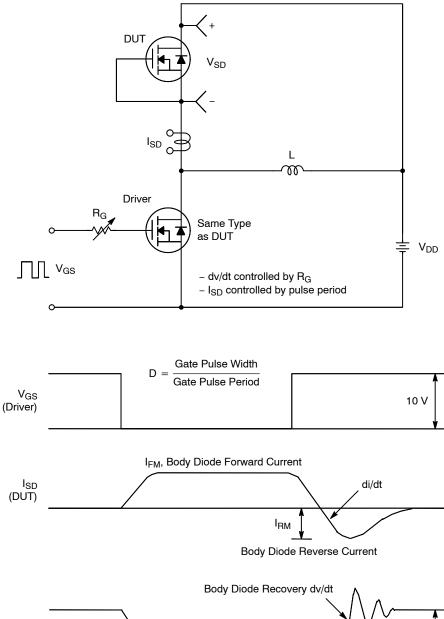


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms



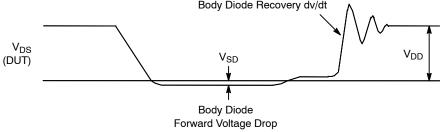
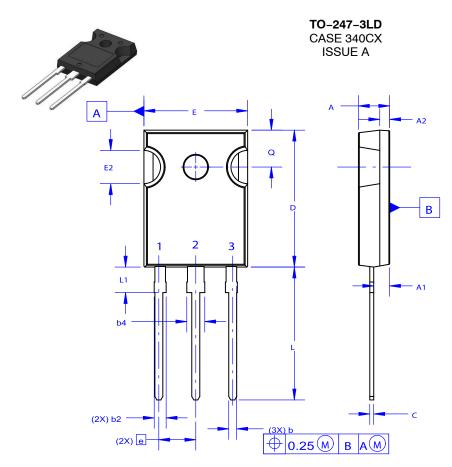


Figure 16. Peak Diode Recovery dv/dt Test Circuit & Waveforms

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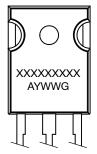




NOTES: UNLESS OTHERWISE SPECIFIED.

- A. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. DRAWING CONFORMS TO ASME Y14.5 2009.
- D. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.
- E. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.

# GENERIC MARKING DIAGRAM\*



XXXXX = Specific Device Code A = Assembly Location

Y = Year WW = Work Week G = Pb-Free Package

\*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.

Ø <sub>P</sub> —			- Ø <sub>P1</sub> D2
E1 -	2	-	D1
			ı

DIM	MILLIMETERS			
DIM	MIN	NOM	MAX	
Α	4.58	4.70	4.82	
A1	2.20	2.40	2.60	
A2	1.40	1.50	1.60	
D	20.32	20.57	20.82	
Е	15.37	15.62	15.87	
E2	4.96	5.08	5.20	
е	~	5.56	~	
L	19.75	20.00	20.25	
L1	3.69	3.81	3.93	
ØΡ	3.51	3.58	3.65	
Q	5.34	5.46	5.58	
S	5.34	5.46	5.58	
b	1.17	1.26	1.35	
b2	1.53	1.65	1.77	
b4	2.42	2.54	2.66	
С	0.51	0.61	0.71	
D1	13.08	~	~	
D2	0.51	0.93	1.35	
E1	12.81	~	1	
ØP1	6.60	6.80	7.00	

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