



# 9NM65-FD

*Power MOSFET*

## 9A, 650V N-CHANNEL SUPER-JUNCTION MOSFET

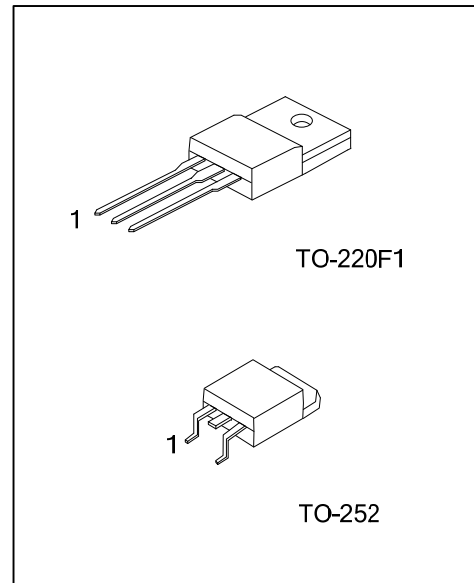
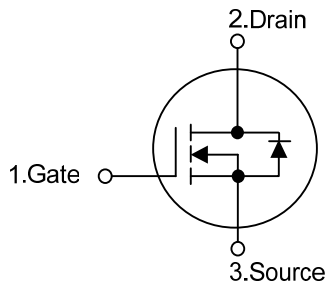
■ DESCRIPTION

The **UTC 9NM65-FD** is a Super Junction MOSFET Structure and is designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and a high rugged avalanche characteristics. This power MOSFET is usually used at DC-DC, AC-DC converters for power applications.

■ FEATURES

- \*  $R_{DS(ON)} < 0.65 \Omega @ V_{GS} = 10V, I_D = 4.5A$
- \* Fast Switching Capability
- \* Avalanche Energy Tested
- \* Improved dv/dt Capability, High Ruggedness

■ SYMBOL



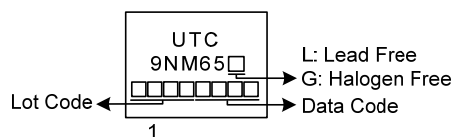
■ ORDERING INFORMATION

Ordering Number		Package	Pin Assignment			Packing
Lead Free	Halogen Free		1	2	3	
9NM65L-TF1-T	9NM65G-TF1-T	TO-220F1	G	D	S	Tube
9NM65L-TN3-R	9NM65G-TN3-R	TO-252	G	D	S	Tape Reel

Note: Pin Assignment: G: Gate D: Drain S: Source

<p>9NM65G-TF1-T</p>	<p>(1) T: Tube, R: Tape Reel                  (2) TF1: TO-220F1, TN3: TO-252                  (3) G: Halogen Free and Lead Free, L: Lead Free</p>
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■ MARKING



■ ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ , unless otherwise specified)

PARAMETER		SYMBOL	RATINGS	UNIT
Drain-Source Voltage		$V_{DSS}$	650	V
Gate-Source Voltage		$V_{GSS}$	$\pm 30$	V
Drain Current	Continuous	$I_D$	9	A
	Pulsed (Note 2)	$I_{DM}$	27	A
Avalanche Energy	Single Pulsed (Note 3)	$E_{AS}$	337	mJ
Peak Diode Recovery dv/dt (Note 4)		dv/dt	12.2	V/ns
Power Dissipation	TO-220F1	$P_D$	48	W
	TO-252		62	W
Junction Temperature		$T_J$	+150	$^\circ\text{C}$
Storage Temperature		$T_{STG}$	-55 ~ +150	$^\circ\text{C}$

Notes: 1. Absolute maximum ratings are those values beyond which the device could be permanently damaged.

Absolute maximum ratings are stress ratings only and functional device operation is not implied.

2. Repetitive Rating: Pulse width limited by maximum junction temperature.

3.  $L=150\text{mH}$ ,  $I_{AS}=2.12\text{A}$ ,  $V_{DD}=50\text{V}$ ,  $R_G=25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$

4.  $I_{SD}\leq 9.0\text{A}$ ,  $di/dt\leq 200\text{A}/\mu\text{s}$ ,  $V_{DD}\leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$

■ THERMAL DATA

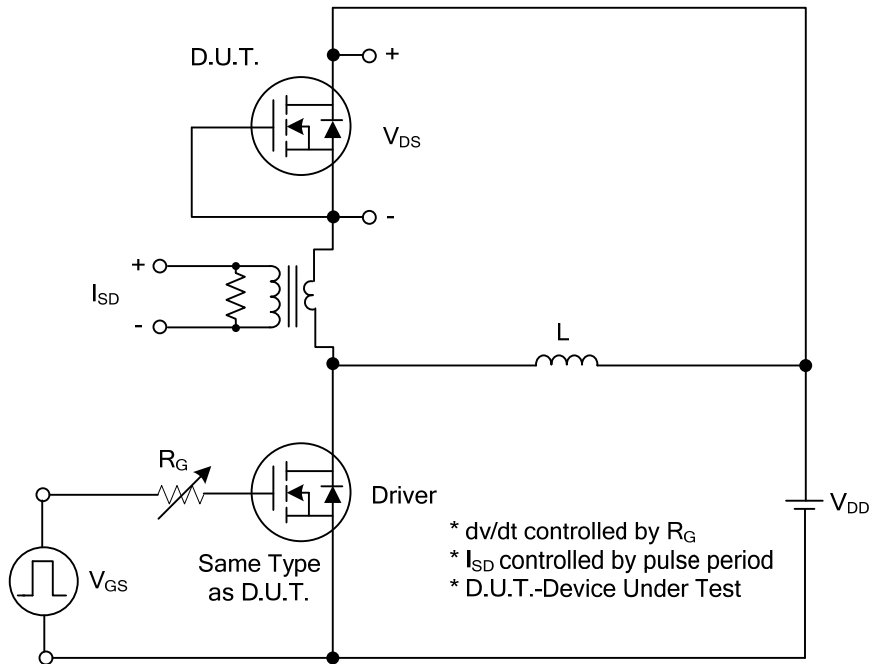
PARAMETER		SYMBOL	RATINGS	UNIT
Junction to Ambient	TO-220F1	$\theta_{JA}$	62.5	$^\circ\text{C}/\text{W}$
	TO-252		110	$^\circ\text{C}/\text{W}$
Junction to Case	TO-220F1	$\theta_{JC}$	2.6	$^\circ\text{C}/\text{W}$
	TO-252		2	$^\circ\text{C}/\text{W}$

■ ELECTRICAL CHARACTERISTICS (T<sub>J</sub>=25°C, unless otherwise specified)

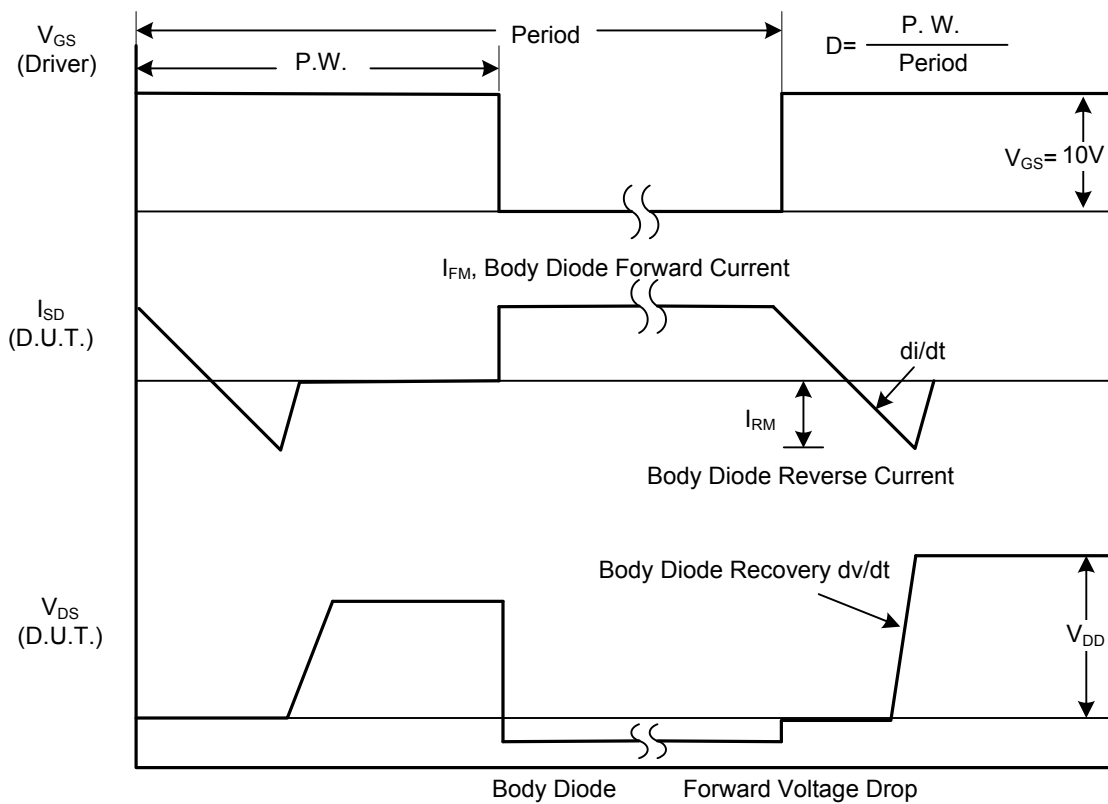
PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>OFF CHARACTERISTICS</b>							
Drain-Source Breakdown Voltage		BV <sub>DSS</sub>	V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA	650			V
Drain-Source Leakage Current		I <sub>DSS</sub>	V <sub>DS</sub> = 650V, V <sub>GS</sub> = 0V			1	μA
Gate- Source Leakage Current	Forward	I <sub>GSS</sub>	V <sub>GS</sub> = 30V, V <sub>DS</sub> = 0V			100	nA
	Reverse		V <sub>GS</sub> = -30V, V <sub>DS</sub> = 0V			-100	nA
<b>ON CHARACTERISTICS</b>							
Gate Threshold Voltage		V <sub>GS(TH)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA	2.5		4.5	V
Static Drain-Source On-State Resistance		R <sub>DS(ON)</sub>	V <sub>GS</sub> = 10V, I <sub>D</sub> = 4.5A			0.65	Ω
<b>DYNAMIC CHARACTERISTICS</b>							
Input Capacitance		C <sub>ISS</sub>	V <sub>GS</sub> =0V, V <sub>DS</sub> =25V, f=1.0 MHz		590		pF
Output Capacitance		C <sub>OSS</sub>			500		pF
Reverse Transfer Capacitance		C <sub>RSS</sub>			45		pF
<b>SWITCHING CHARACTERISTICS</b>							
Total Gate Charge (Note 1)		Q <sub>G</sub>	V <sub>DS</sub> =400V, V <sub>GS</sub> =10V, I <sub>D</sub> =9.0A, I <sub>G</sub> =10mA (Note 1, 2)		29		nC
Gate to Source Charge		Q <sub>GS</sub>			11		nC
Gate to Drain Charge		Q <sub>GD</sub>			11		nC
Turn-ON Delay Time (Note 1)		t <sub>D(ON)</sub>	V <sub>DD</sub> =325V, V <sub>GS</sub> =10V, I <sub>D</sub> =9.0A, R <sub>G</sub> =25Ω (Note 1, 2)		10		ns
Rise Time		t <sub>R</sub>			22		ns
Turn-OFF Delay Time		t <sub>D(OFF)</sub>			60		ns
Fall-Time		t <sub>F</sub>			26		ns
<b>SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS</b>							
Maximum Body-Diode Continuous Current		I <sub>S</sub>				9	A
Maximum Body-Diode Pulsed Current		I <sub>SM</sub>				27	A
Drain-Source Diode Forward Voltage (Note 1)		V <sub>SD</sub>	I <sub>S</sub> =9.0A, V <sub>GS</sub> =0V			1.4	V
Body Diode Reverse Recovery Time (Note 1)		t <sub>rr</sub>	I <sub>S</sub> =9.0A, V <sub>GS</sub> =0V, di <sub>F</sub> /dt=100A/μs		190		ns
Body Diode Reverse Recovery Charge		Q <sub>rr</sub>			1.4		μC

Notes: 1. Pulse Test: Pulse width ≤ 300μs, Duty cycle ≤ 2%.  
 2. Essentially independent of operating temperature.

## TEST CIRCUITS AND WAVEFORMS

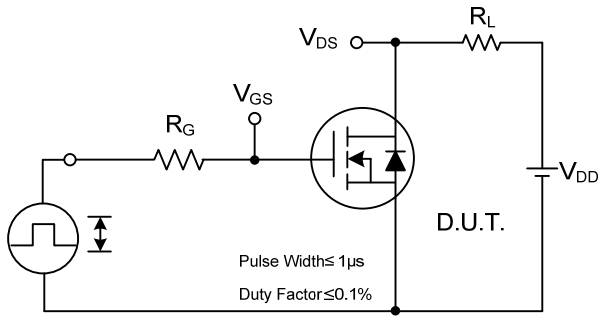


**Peak Diode Recovery dv/dt Test Circuit**

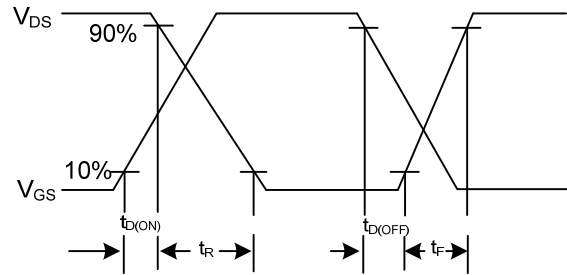


**Peak Diode Recovery dv/dt Waveforms**

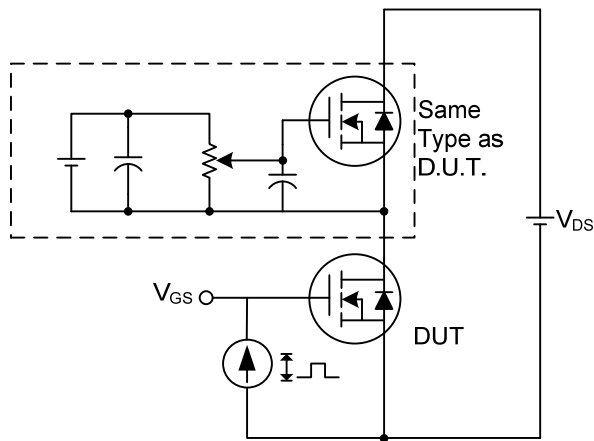
## TEST CIRCUITS AND WAVEFORMS



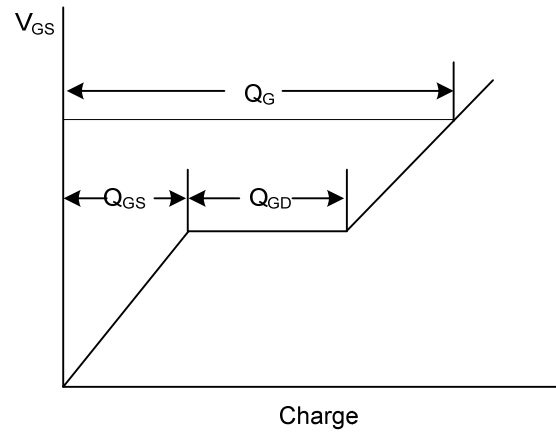
**Switching Test Circuit**



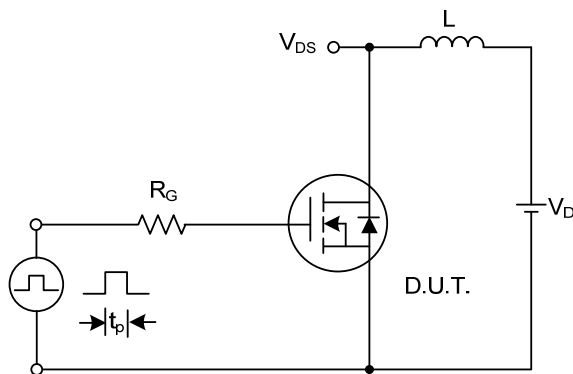
**Switching Waveforms**



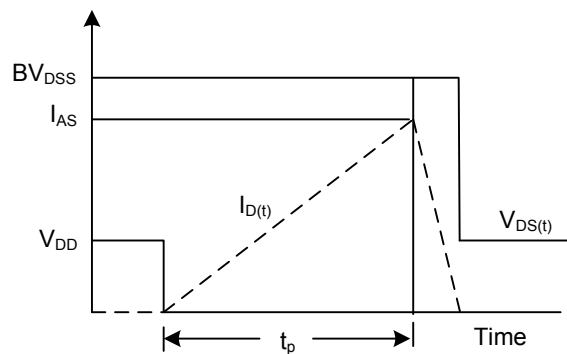
**Gate Charge Test Circuit**



**Gate Charge Waveform**

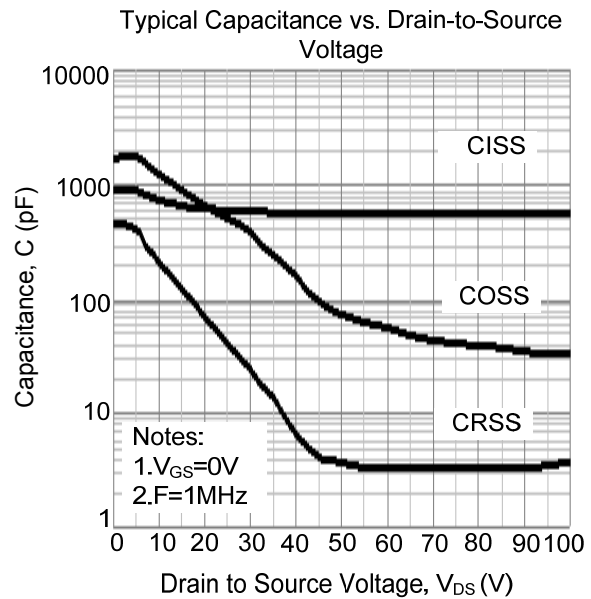
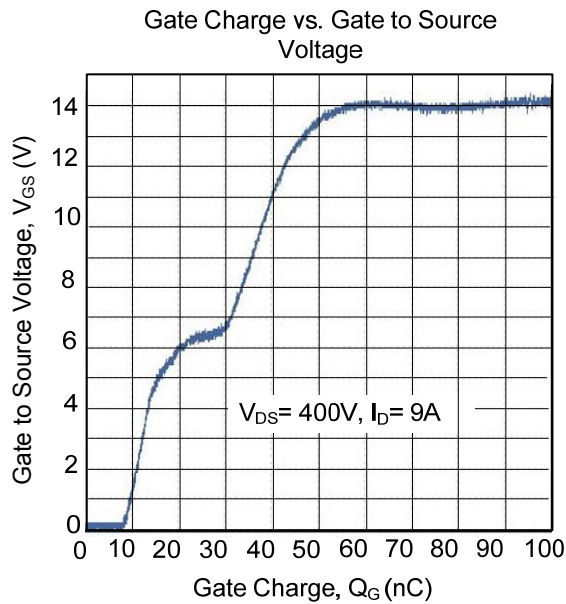


**Unclamped Inductive Switching Test Circuit**



**Unclamped Inductive Switching Waveforms**

■ TYPICAL CHARACTERISTICS



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