



# 9NM60-S

**Power MOSFET**

## 9.0A, 600V N-CHANNEL SUPER-JUNCTION MOSFET

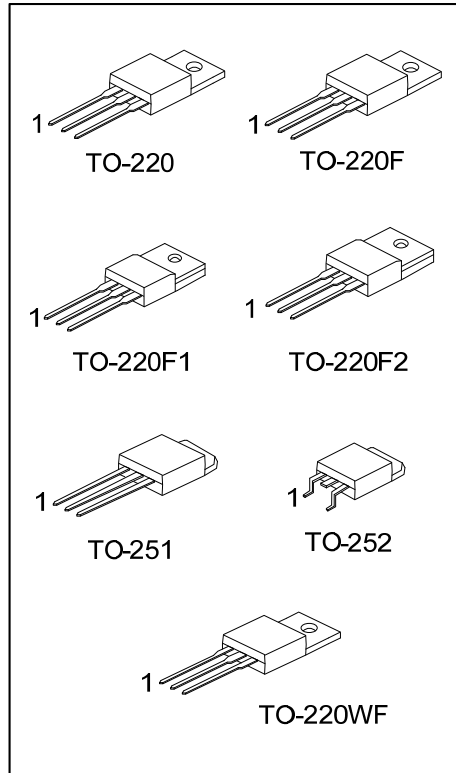
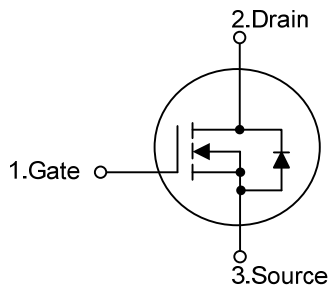
### DESCRIPTION

The **UTC 9NM60-S** 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

- \*  $R_{DS(ON)} \leq 0.64 \Omega @ V_{GS} = 10V, I_D = 4.5A$
- \* By using Super Junction Structure
- \* Fast Switching
- \* With 100% Avalanche Tested

### SYMBOL



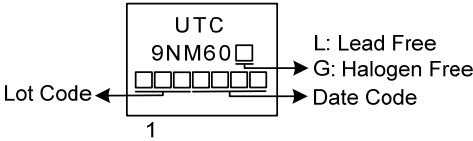
### ORDERING INFORMATION

Order Number		Package	Pin Assignment			Packing
Lead Free	Halogen Free		1	2	3	
9NM60L-TA3-T	9NM60G-TA3-T	TO-220	G	D	S	Tube
9NM60L-TF1-T	9NM60G-TF1-T	TO-220F1	G	D	S	Tube
9NM60L-TF2-T	9NM60G-TF2-T	TO-220F2	G	D	S	Tube
9NM60L-TF3-T	9NM60G-TF3-T	TO-220F	G	D	S	Tube
9NM60L-TW1-T	9NM60G-TW1-T	TO-220WF	G	D	S	Tube
9NM60L-TM3-T	9NM60G-TM3-T	TO-251	G	D	S	Tube
9NM60L-TN3-R	9NM60G-TN3-R	TO-252	G	D	S	Tape Reel

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

<p>9NM60G-TA3-T</p> <p>(1) Packing Type</p> <p>(2) Package Type</p> <p>(3) Green Package</p>	<p>(1) T: Tube, R: Tape Reel</p> <p>(2) TA3: TO-220, TF1: TO-220F1, TF2: TO-220F2 TF3: TO-220F, TW1: TO-220WF, TM3: TO-251, TN3: TO-252</p> <p>(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		$V_{DSS}$	600	V
Gate-Source Voltage		$V_{GSS}$	$\pm 30$	V
Drain Current	Continuous	$I_D$	9.0	A
	Pulsed (Note 2)	$I_{DM}$	36	A
Avalanche Current		$I_{AR}$	2.2	A
Avalanche Energy	Single Pulsed (Note 3)	$E_{AS}$	380	mJ
Peak Diode Recovery dv/dt (Note 4)		dv/dt	5.5	V/ns
Power Dissipation	TO-220	$P_D$	165	W
	TO-220F/TO-220F1		26	W
	TO-220F2/TO-220WF			
	TO-251/TO-252			
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.  $L=157\text{mH}$ ,  $I_{AS}=2.2\text{A}$ ,  $V_{DD}=50\text{V}$ ,  $R_G=25\Omega$ , 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-220/TO-220F	$\theta_{JA}$	62.5	$^\circ\text{C}/\text{W}$
	TO-220F1/TO-220F2			
	TO-220WF			
	TO-251/TO-252		110	$^\circ\text{C}/\text{W}$
Junction to Case	TO-220	$\theta_{JC}$	0.75	$^\circ\text{C}/\text{W}$
	TO-220F/TO-220F1		4.8	$^\circ\text{C}/\text{W}$
	TO-220F2/TO-220WF			
	TO-251/TO-252			

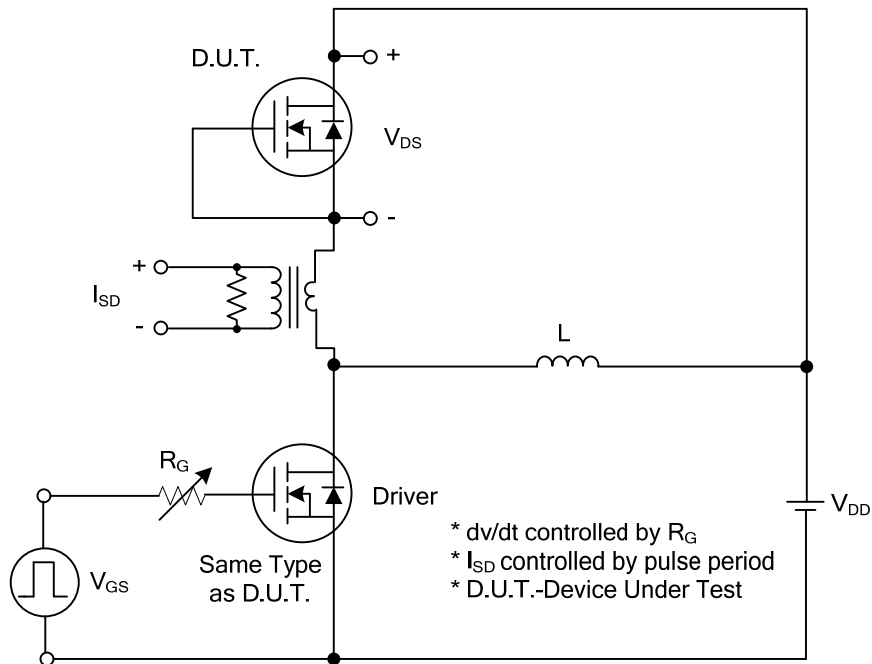
■ ELECTRICAL CHARACTERISTICS (T<sub>J</sub>=25°C, unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>OFF CHARACTERISTICS</b>						
Drain-Source Breakdown Voltage	BV <sub>DSS</sub>	I <sub>D</sub> =250μA, V <sub>GS</sub> =0V	600			V
Drain-Source Leakage Current	I <sub>DSS</sub>	V <sub>DS</sub> =600V, V <sub>GS</sub> =0V			10	μA
Gate- Source Leakage Current	Forward	I <sub>GSS</sub> V <sub>GS</sub> =30V V <sub>GS</sub> =-30V			100	nA
	Reverse				-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			0.64	Ω
<b>DYNAMIC PARAMETERS</b>						
Input Capacitance	C <sub>ISS</sub>	V <sub>DS</sub> =25V, V <sub>GS</sub> =0V, f=1.0MHz		510		pF
Output Capacitance	C <sub>OSS</sub>			350		pF
Reverse Transfer Capacitance	C <sub>RSS</sub>			26		pF
Gate Resistance	R <sub>G</sub>	V <sub>DS</sub> =0V, V <sub>GS</sub> =0V, f=1MHz		2.4		Ω
<b>SWITCHING PARAMETERS</b>						
Total Gate Charge (Note 1)	Q <sub>G</sub>	V <sub>DS</sub> =50V, V <sub>GS</sub> =10V, I <sub>D</sub> =1.3A , I <sub>G</sub> =100μA (Note 1, 2)		39		nC
Gate to Source Charge	Q <sub>GS</sub>			5.0		nC
Gate to Drain Charge	Q <sub>GD</sub>			14		nC
Turn-ON Delay Time (Note 1)	t <sub>D(ON)</sub>	V <sub>DD</sub> =30V, I <sub>D</sub> =0.5A, R <sub>G</sub> =25Ω V <sub>GS</sub> =10V (Note 1, 2)		50		ns
Rise Time	t <sub>R</sub>			47		ns
Turn-OFF Delay Time	t <sub>D(OFF)</sub>			185		ns
Fall-Time	t <sub>F</sub>			60		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>				36	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
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		320		ns
Reverse Recovery Charge	Q <sub>rr</sub>				3.9	

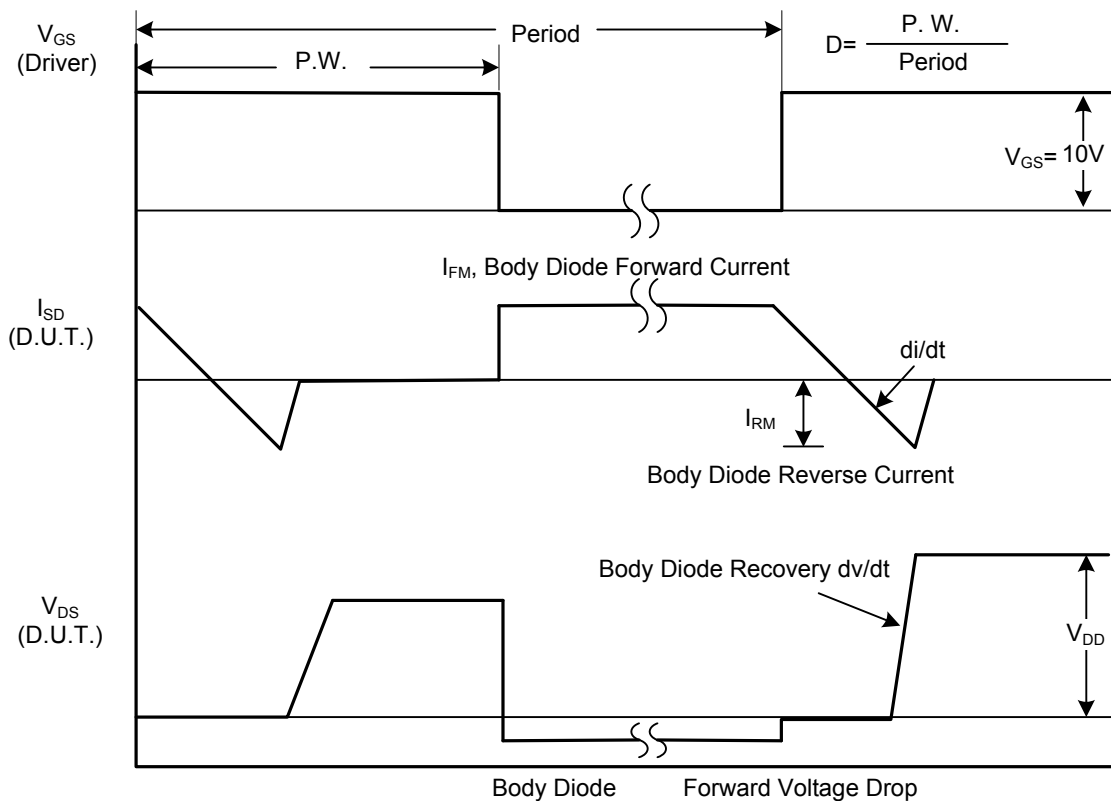
Notes: 1. Pulse Test: Pulse width ≤ 300μs, Duty cycle ≤ 2%.

2. Essentially independent of operating temperature.

## TEST CIRCUITS AND WAVEFORMS

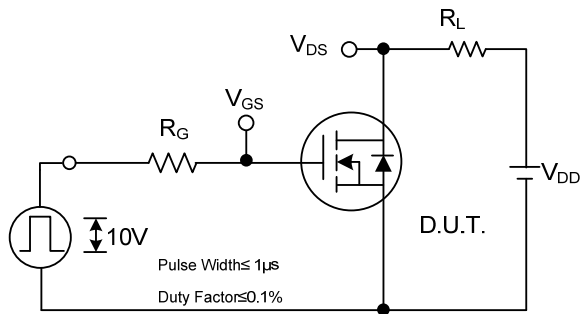


**Peak Diode Recovery  $dv/dt$  Test Circuit**

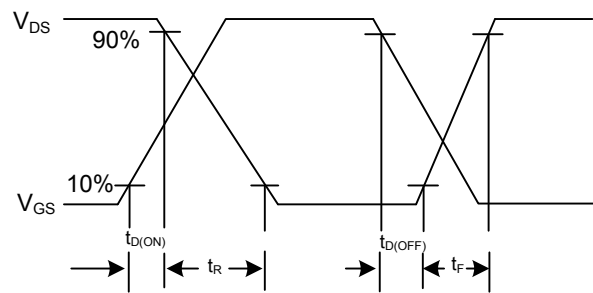


**Peak Diode Recovery  $dv/dt$  Waveforms**

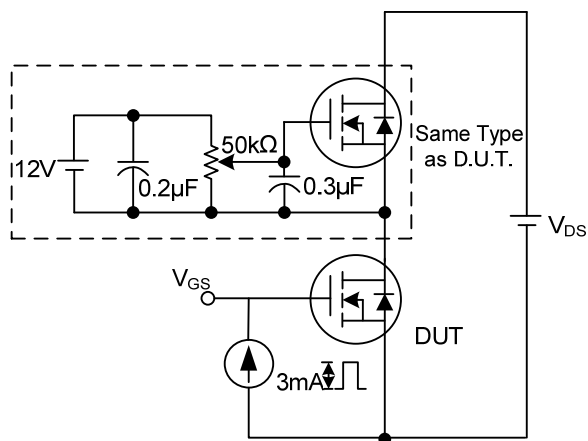
## TEST CIRCUITS AND WAVEFORMS



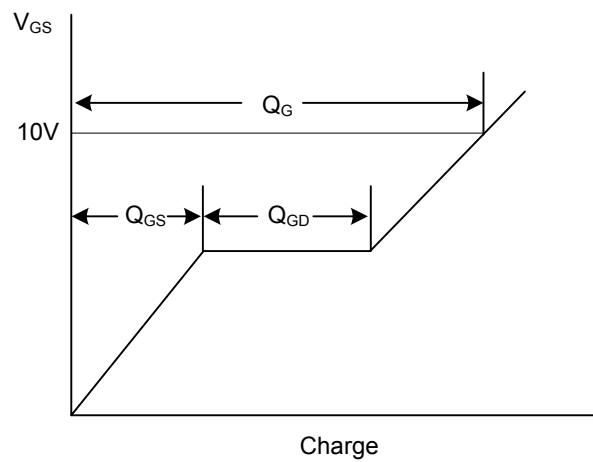
**Switching Test Circuit**



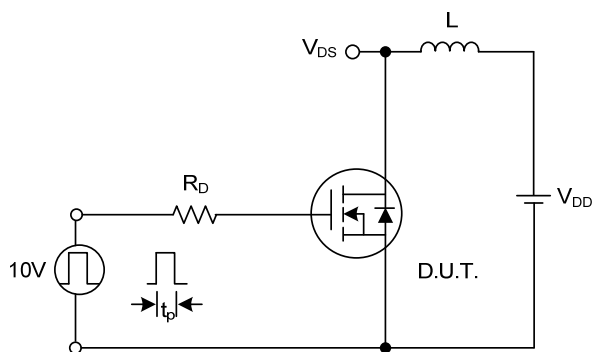
**Switching Waveforms**



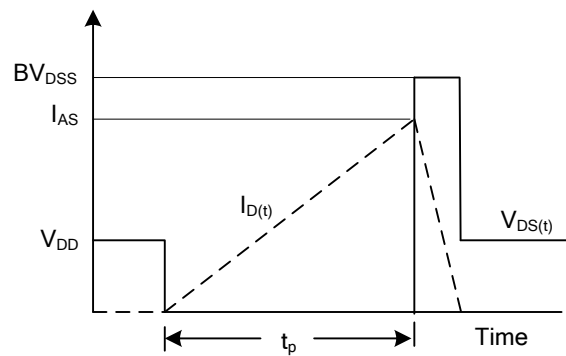
**Gate Charge Test Circuit**



**Gate Charge Waveform**

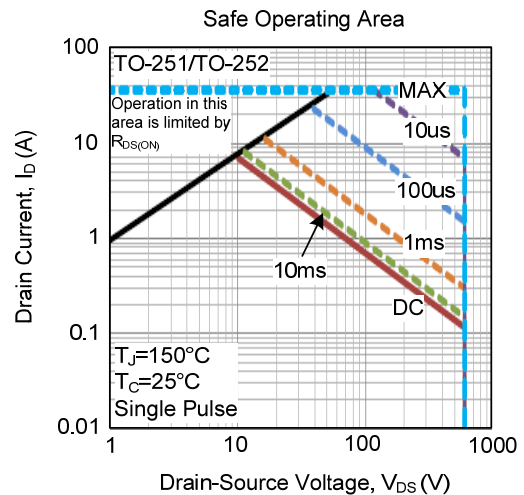
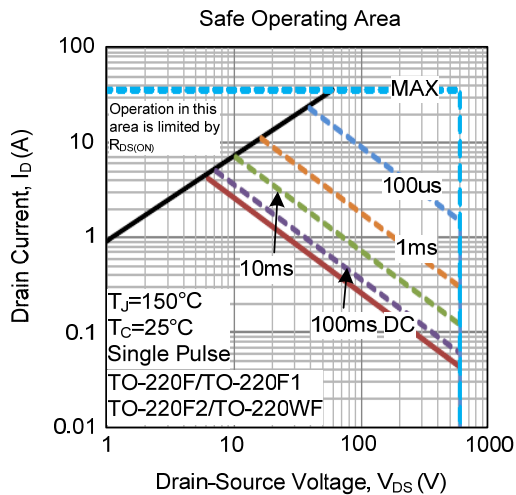
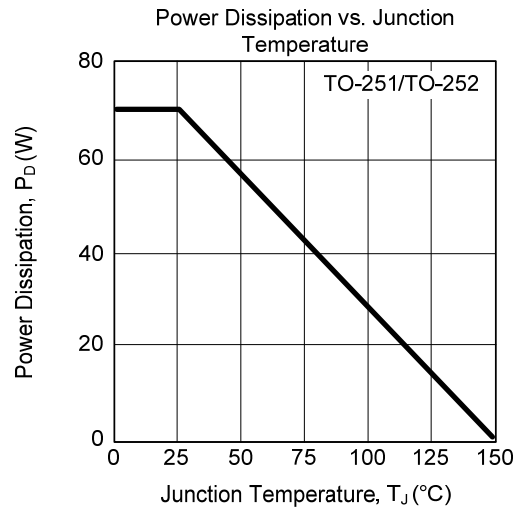
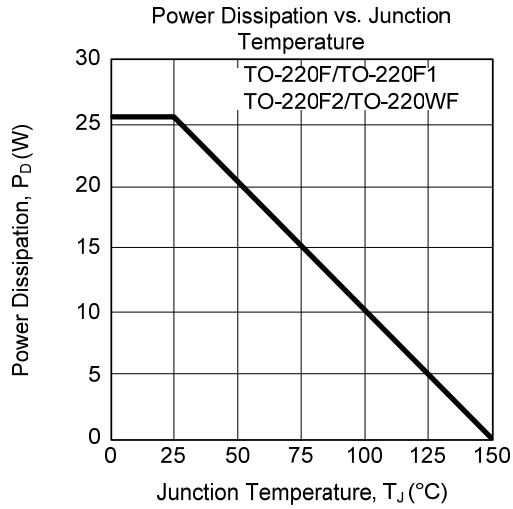


**Unclamped Inductive Switching Test Circuit**



**Unclamped Inductive Switching Waveforms**

## TYPICAL CHARACTERISTICS



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