



# 5N60

**Power MOSFET**

## 5A, 600V N-CHANNEL POWER MOSFET

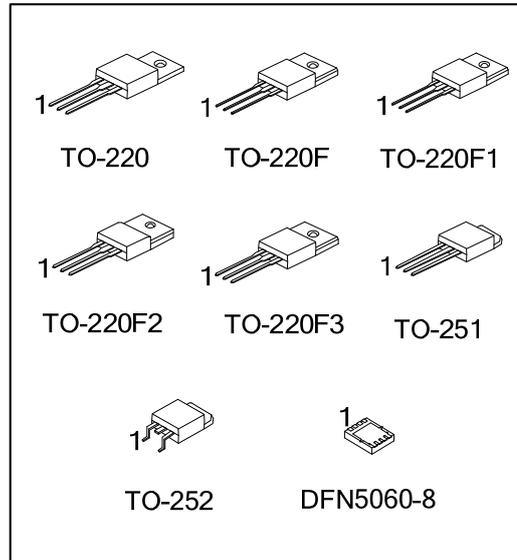
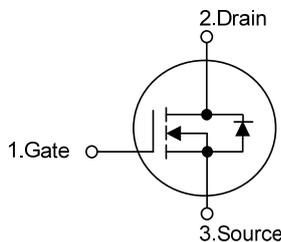
■ DESCRIPTION

The UTC **5N60** is a high voltage power MOSFET and is designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and have a high rugged avalanche characteristics. This power MOSFET is usually used at high speed switching applications in power supplies, PWM motor controls, high efficient DC to DC converters and bridge circuits.

■ FEATURES

- \*  $R_{DS(ON)} < 2.2\Omega$  @  $V_{GS} = 10V, I_D = 2.5A$
- \* Ultra Low Gate Charge ( Typical 15 nC )
- \* Low Reverse Transfer Capacitance (  $C_{RSS} =$  Typical 6.5 pF )
- \* Fast Switching Capability
- \* Avalanche Energy Specified
- \* Improved dv/dt Capability, High Ruggedness

■ SYMBOL



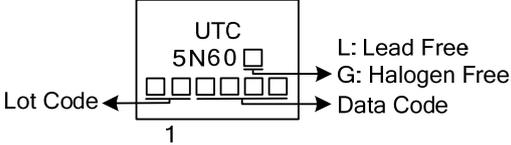
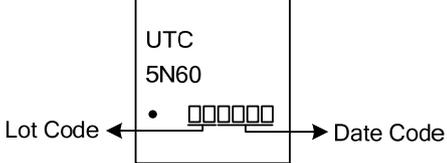
■ ORDERING INFORMATION

Ordering Number		Package	Pin Assignment								Packing	
Lead Free	Halogen Free		1	2	3	4	5	6	7	8		
5N60L-TA3-T	5N60G-TA3-T	TO-220	G	D	S	-	-	-	-	-	-	Tube
5N60L-TF1-T	5N60G-TF1-T	TO-220F1	G	D	S	-	-	-	-	-	-	Tube
5N60L-TF2-T	5N60G-TF2-T	TO-220F2	G	D	S	-	-	-	-	-	-	Tube
5N60L-TF3-T	5N60G-TF3-T	TO-220F	G	D	S	-	-	-	-	-	-	Tube
5N60L-TF3T-T	5N60G-TF3T-T	TO-220F3	G	D	S	-	-	-	-	-	-	Tube
5N60L-TM3-T	5N60G-TM3-T	TO-251	G	D	S	-	-	-	-	-	-	Tube
5N60L-TN3-R	5N60G-TN3-R	TO-252	G	D	S	-	-	-	-	-	-	Tape Reel
5N60L-K08-5060-R	5N60G-K08-5060-R	DFN5060-8	S	S	S	G	D	D	D	D	D	Tape Reel

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

<p>5N60G-TA3-T</p> <ul style="list-style-type: none"> <li>(1) Packing Type</li> <li>(2) Package Type</li> <li>(3) Green Package</li> </ul>	<p>(1) T: Tube, R: Tape Reel</p> <p>(2) TA3: TO-220, TF3: TO-220F, TF1: TO-220F1, TF2: TO-220F2, TM3: TO-251, TN3: TO-252, K08-5060: DFN5060-8</p> <p>(3) G: Halogen Free and Lead Free, L: Lead Free</p>
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MARKING

TO-220 / TO-220F / TO-220F1 / TO-220F2 TO-220F3 / TO-251 / TO-252	DFN5060-8
 <p>UTC 5N60</p> <p>Lot Code ← [ ] [ ] [ ] [ ] [ ] [ ] → Data Code</p> <p>1</p> <p>L: Lead Free G: Halogen Free</p>	 <p>UTC 5N60</p> <p>Lot Code ← [ ] [ ] [ ] [ ] [ ] [ ] → Date Code</p>

■ 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
Avalanche Current (Note 2)		$I_{AR}$	5	A
Continuous Drain Current		$I_D$	5	A
Pulsed Drain Current (Note 2)		$I_{DM}$	20	A
Avalanche Energy	Single Pulsed (Note 3)	$E_{AS}$	210	mJ
	Repetitive (Note 2)	$E_{AR}$	10	
Peak Diode Recovery dv/dt (Note 4)		dv/dt	4.5	V/ns
Power Dissipation	TO-220	$P_D$	100	W
	TO-220F/TO-220F1		36	
	TO-220F3		38	
	TO-220F2		54	
	TO-251 / TO-252		28	
DFN5060-8				
Junction Temperature		$T_J$	+150	$^\circ\text{C}$
Operation Temperature		$T_{OPR}$	-55 ~ +150	$^\circ\text{C}$
Storage Temperature		$T_{STG}$	-55 ~ +150	$^\circ\text{C}$

Note: 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. Pulse width limited by  $T_{J(MAX)}$

3.  $L = 16.8\text{mH}$ ,  $I_{AS} = 5\text{A}$ ,  $V_{DD} = 50\text{V}$ ,  $R_G = 25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$

4.  $I_{SD} \leq 5\text{A}$ ,  $di/dt \leq 200\text{A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , 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-220F3			
	TO-251 / TO-252			
DFN5060-8			75	
Junction to Case	TO-220	$\theta_{JC}$	1.25	$^\circ\text{C}/\text{W}$
	TO-220F/TO-220F1		3.47	
	TO-220F3		3.28	
	TO-220F2		2.3	
	TO-251 / TO-252		4.46	
DFN5060-8				

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

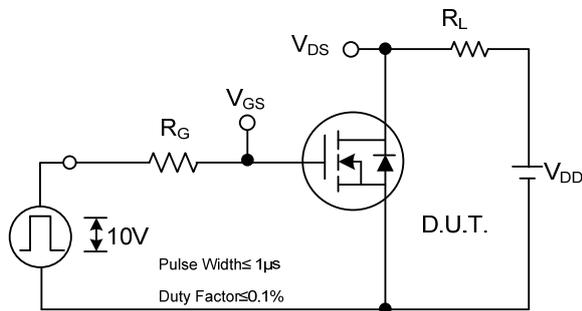
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>OFF CHARACTERISTICS</b>						
Drain-Source Breakdown Voltage	BV <sub>DSS</sub>	V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA	600			V
Drain-Source Leakage Current	I <sub>DSS</sub>	V <sub>DS</sub> = 600V, V <sub>GS</sub> = 0V			1	μA
Gate-Source Leakage Current	Forward	I <sub>GSS</sub>			100	nA
	Reverse				-100	
Breakdown Voltage Temperature Coefficient	ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>	I <sub>D</sub> = 250μA, Referenced to 25°C		0.6		V/°C
<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	2.0		4.0	V
Static Drain-Source On-State Resistance	R <sub>DS(ON)</sub>	V <sub>GS</sub> = 10V, I <sub>D</sub> = 2.5A		1.8	2.2	Ω
<b>DYNAMIC CHARACTERISTICS</b>						
Input Capacitance	C <sub>ISS</sub>	V <sub>DS</sub> = 25V, V <sub>GS</sub> = 0V, f = 1.0MHz		515	670	pF
Output Capacitance	C <sub>OSS</sub>			55	72	pF
Reverse Transfer Capacitance	C <sub>RSS</sub>			6.5	8.5	pF
<b>SWITCHING CHARACTERISTICS</b>						
Total Gate Charge	Q <sub>G</sub>	V <sub>DS</sub> = 480 V, I <sub>D</sub> = 5A, V <sub>GS</sub> = 10 V (Note 1, 2)		15	19	nC
Gate-Source Charge	Q <sub>GS</sub>			2.5		nC
Gate-Drain Charge	Q <sub>GD</sub>			6.6		nC
Turn-On Delay Time	t <sub>D(ON)</sub>	V <sub>DD</sub> = 300V, I <sub>D</sub> = 5A, R <sub>G</sub> = 25Ω (Note 1, 2)		10	30	ns
Turn-On Rise Time	t <sub>R</sub>			42	90	ns
Turn-Off Delay Time	t <sub>D(OFF)</sub>			38	85	ns
Turn-Off Fall Time	t <sub>F</sub>			46	100	ns
<b>DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS</b>						
Maximum Continuous Drain-Source Diode Forward Current	I <sub>S</sub>				5	A
Maximum Pulsed Drain-Source Diode Forward Current	I <sub>SM</sub>				20	A
Drain-Source Diode Forward Voltage	V <sub>SD</sub>	V <sub>GS</sub> = 0 V, I <sub>S</sub> = 5A			1.4	V
Reverse Recovery Time	t <sub>rr</sub>	V <sub>GS</sub> = 0 V, I <sub>S</sub> = 5A, dI <sub>F</sub> / dt = 100 A/μs (Note 1)		300		ns
Reverse Recovery Charge	Q <sub>rr</sub>				2.2	

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

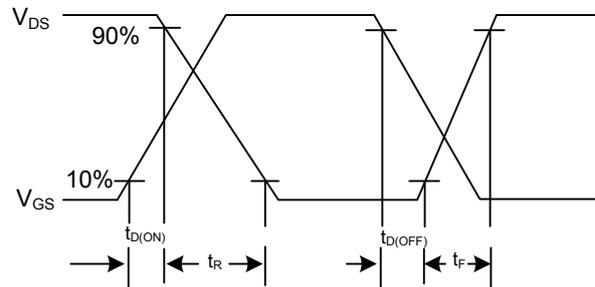
2. Essentially independent of operating temperature



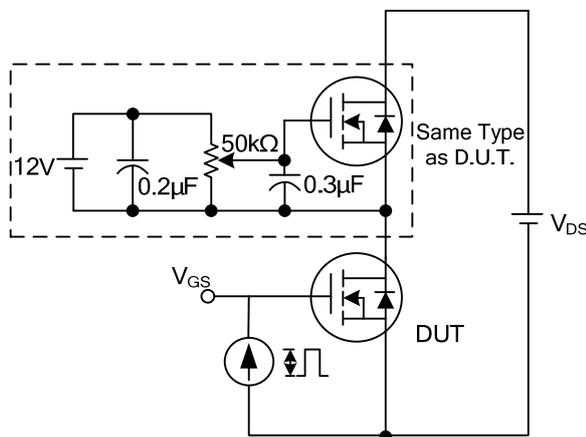
## TEST CIRCUITS AND WAVEFORMS (Cont.)



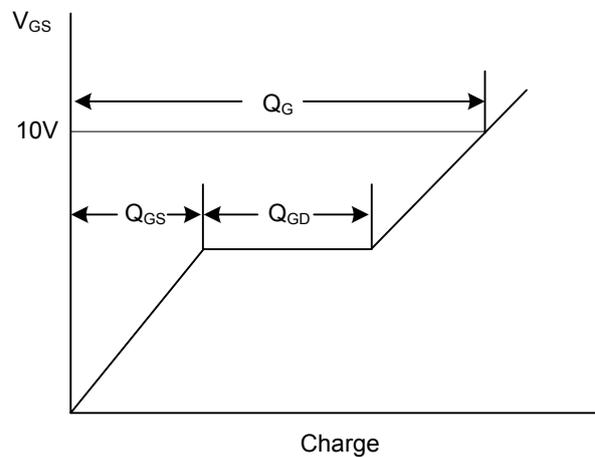
**Switching Test Circuit**



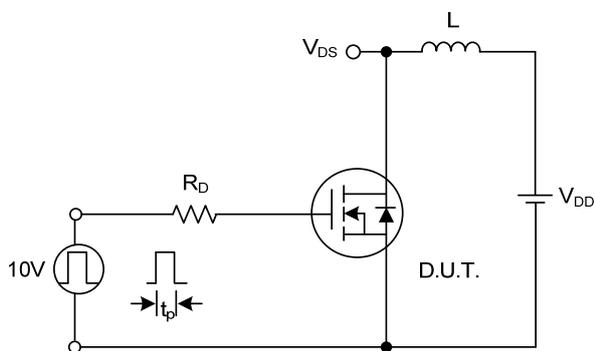
**Switching Waveforms**



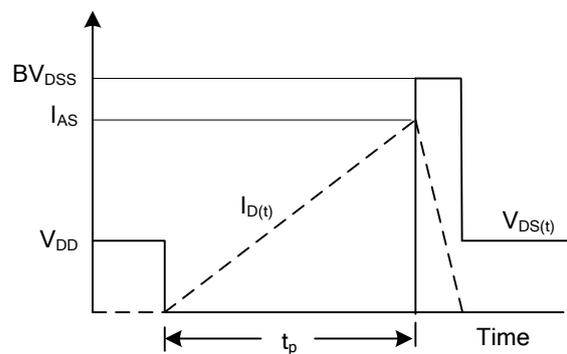
**Gate Charge Test Circuit**



**Gate Charge Waveform**

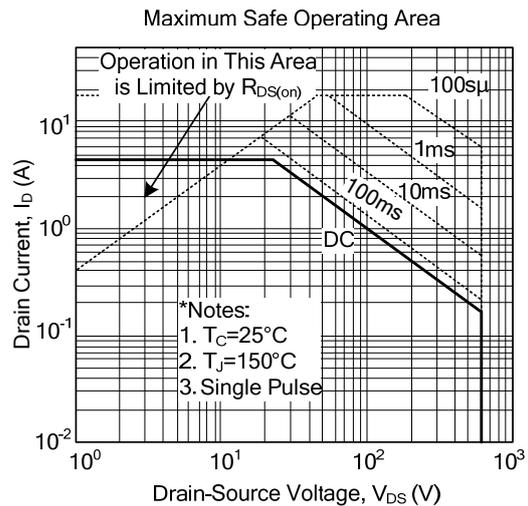
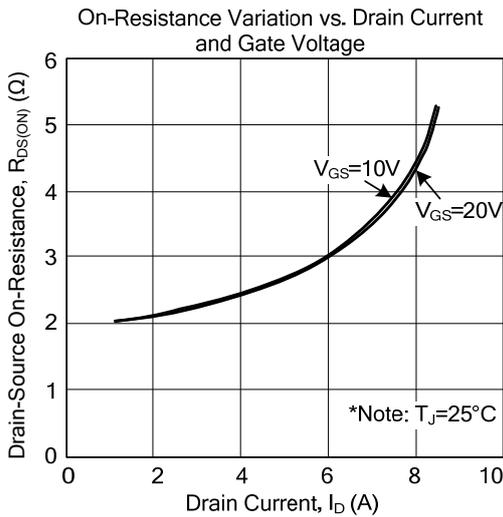
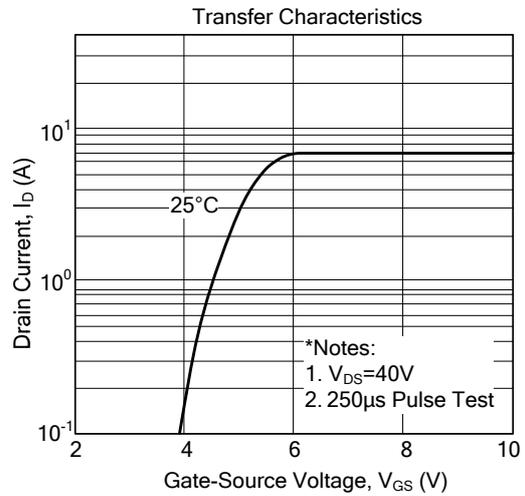
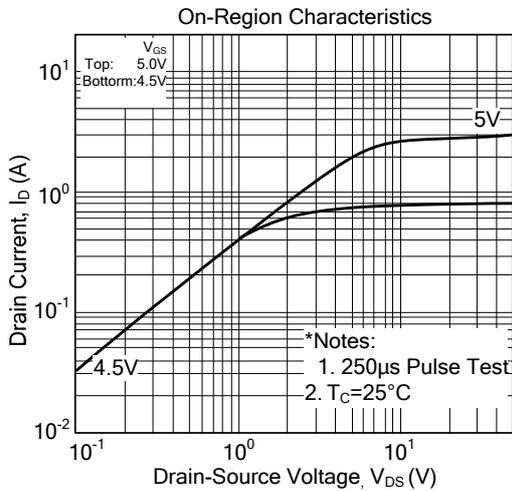


**Unclamped Inductive Switching Test Circuit**



**Unclamped Inductive Switching Waveforms**

■ TYPICAL CHARACTERISTICS



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