



# 4N60-Q

Power MOSFET

## 4A, 600V N-CHANNEL POWER MOSFET

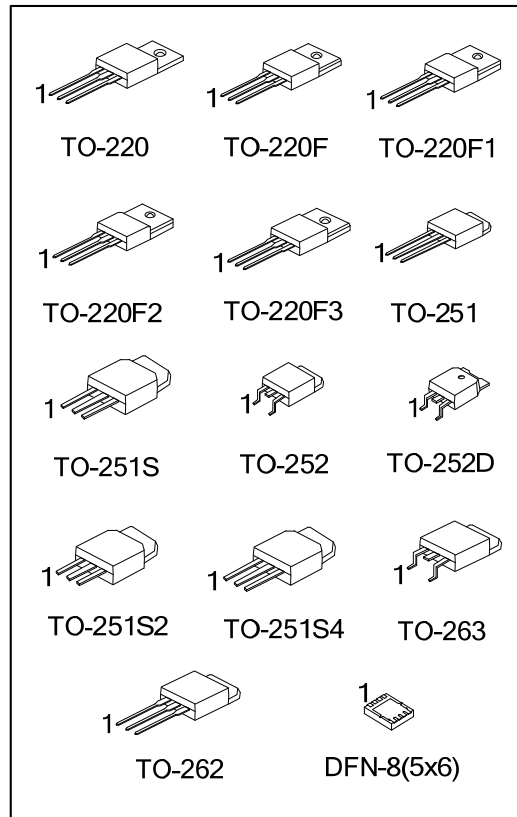
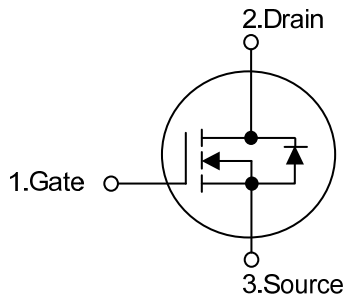
### DESCRIPTION

The UTC **4N60-Q** 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

- \*  $R_{DS(ON)} < 2.5\Omega @ V_{GS} = 10V, I_D = 2.2A$
- \* Fast Switching Capability
- \* Avalanche Energy Specified
- \* Improved dv/dt Capability, high RuggednessA

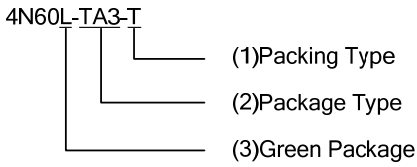
### SYMBOL



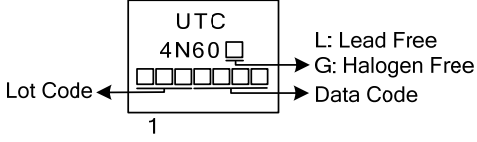
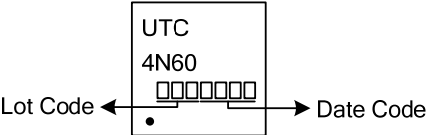
## ORDERING INFORMATION

Ordering Number		Package	Pin Assignment								Packing
Lead Free	Halogen Free		1	2	3	4	5	6	7	8	
4N60L-TA3-T	4N60G-TA3-T	TO-220	G	D	S	-	-	-	-	-	Tube
4N60L-TF1-T	4N60G-TF1-T	TO-220F1	G	D	S	-	-	-	-	-	Tube
4N60L-TF2-T	4N60G-TF2-T	TO-220F2	G	D	S	-	-	-	-	-	Tube
4N60L-TF3-T	4N60G-TF3-T	TO-220F	G	D	S	-	-	-	-	-	Tube
4N60L-TF3T-T	4N60G-TF3T-T	TO-220F3	G	D	S	-	-	-	-	-	Tube
4N60L-TM3-T	4N60G-TM3-T	TO-251	G	D	S	-	-	-	-	-	Tube
4N60L-TMS-T	4N60G-TMS-T	TO-251S	G	D	S	-	-	-	-	-	Tube
4N60L-TMS2-T	4N60G-TMS2-T	TO-251S2	G	D	S	-	-	-	-	-	Tube
4N60L-TMS4-T	4N60G-TMS4-T	TO-251S4	G	D	S	-	-	-	-	-	Tube
4N60L-TN3-R	4N60G-TN3-R	TO-252	G	D	S	-	-	-	-	-	Tape Reel
4N60L-TND-R	4N60G-TND-R	TO-252D	G	D	S	-	-	-	-	-	Tape Reel
4N60L-T2Q-T	4N60G-T2Q-T	TO-262	G	D	S	-	-	-	-	-	Tube
4N60L-TQ2-R	4N60G-TQ2-R	TO-263	G	D	S	-	-	-	-	-	Tape Reel
4N60L-TQ2-T	4N60G-TQ2-T	TO-263	G	D	S	-	-	-	-	-	Tube
-	4N60G-K08-5060-R	DFN-8(5×6)	S	S	S	G	D	D	D	D	Tape Reel

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

 <p>4N60L-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, TF3T: TO-220F3, TM3: TO-251, TMS: TO-251S, TN3: TO-252, TND: TO-252D, TMS2: TO-251S2, TMS4: TO-251S4, T2Q: TO-262, TQ2: TO-263, K08-3030: DFN-8(5×6)</p> <p>(3) L: Lead Free, G: Halogen Free and Lead Free</p>
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## MARKING

PACKAGE	MARKING
TO-220 TO-220F TO-220F1 TO-220F2 TO-220F3 TO-251 TO-251S	TO-251S2 TO-251S4 TO-252 TO-252D TO-262 TO-263 <div style="text-align: center; margin-top: 10px;">  </div>
DFN-8(5×6)	<div style="text-align: center; margin-top: 10px;">  </div>

■ 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)	$I_{AR}$	4.4	A	
Drain Current	Continuous	$I_D$	4.0	A
	Pulsed (Note 2)	$I_{DM}$	16	A
Avalanche Energy	Single Pulsed (Note 3)	$E_{AS}$	60	mJ
	Repetitive (Note 2)	$E_{AR}$	10.6	mJ
Peak Diode Recovery dv/dt (Note 4)	dv/dt	4.5	V/ns	
Power Dissipation	TO-220/TO-262/TO-263	$P_D$	106	W
	TO-220F/TO-220F1		36	
	TO-220F3		38	
	TO-220F2		50	
	TO-251/TO-252/TO-252D		50	
	TO-251S/TO-251S2		30	
TO-251S4				
DFN-8(5×6)				
Junction Temperature	$T_J$	+150	$^\circ\text{C}$	
Operating Temperature	$T_{OPR}$	-55 ~ +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.  $L = 30\text{mH}$ ,  $I_{AS} = 2\text{A}$ ,  $V_{DD} = 50\text{V}$ ,  $R_G = 25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$

4.  $I_{SD} \leq 4.4\text{A}$ ,  $di/dt \leq 200\text{A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$

■ THERMAL DATA

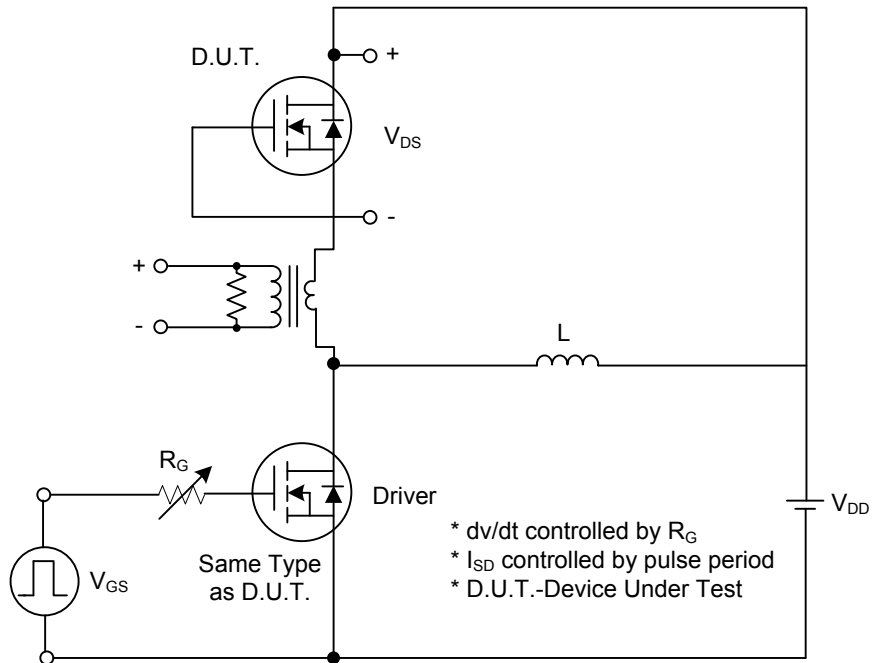
PARAMETER	PACKAGE	SYMBOL	RATINGS	UNIT
Junction to Ambient	TO-220/TO-262/TO-263 TO-220F/TO-220F1 TO-220F2/TO-220F3	$\theta_{JA}$	62.5	$^\circ\text{C}/\text{W}$
	TO-251/TO-252/TO-252D TO-251S/TO-251S2 TO-251S4		110	
	DFN-8(5×6)		75	
Junction to Case	TO-220/TO-262/TO-263	$\theta_{JC}$	1.18	$^\circ\text{C}/\text{W}$
	TO-220F/TO-220F1		3.47	
	TO-220F3		3.28	
	TO-220F2			
	TO-251/TO-252/TO-252D		2.5	
	TO-251S/TO-251S2			
	TO-251S4		4.17	
DFN-8(5×6)				

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

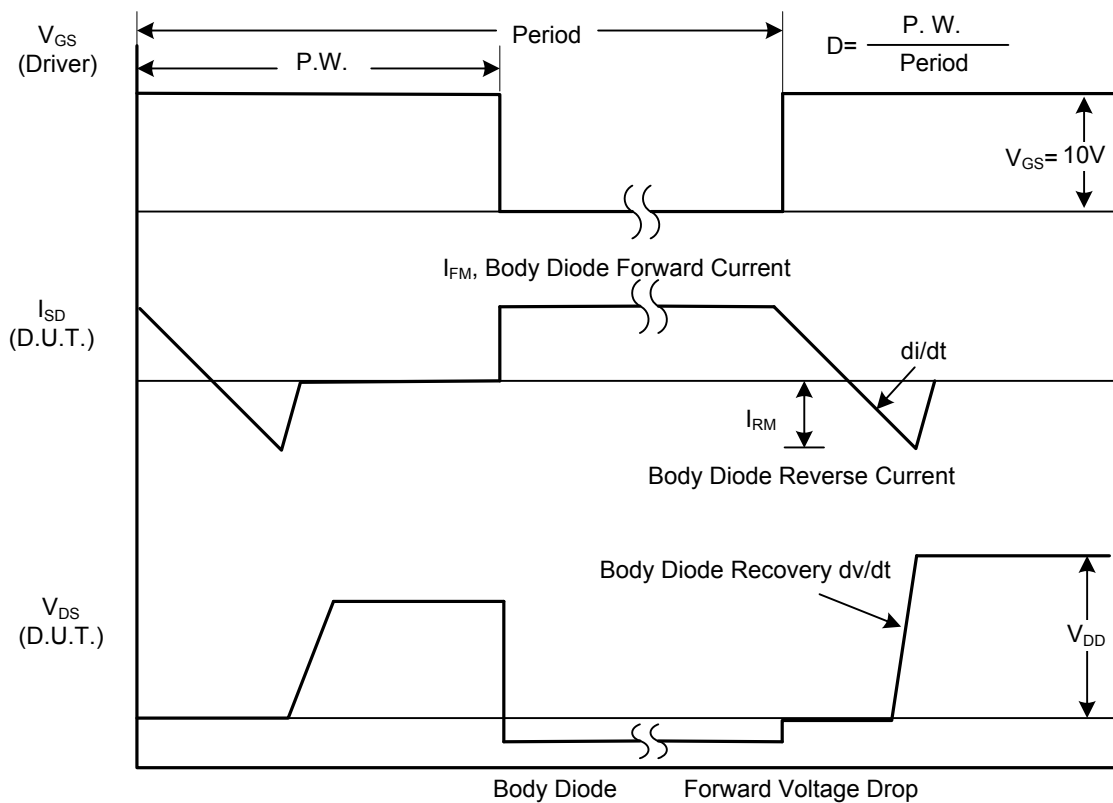
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>OFF CHARACTERISTICS</b>						
Drain-Source Breakdown Voltage	BV <sub>DSS</sub>	V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA	600			V
Drain-Source Leakage Current	I <sub>DSS</sub>	V <sub>DS</sub> = 600V, V <sub>GS</sub> = 0V			10	μA
Gate-Source Leakage Current	Forward	I <sub>GSS</sub>			100	nA
	Reverse				-100	nA
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> = 10 V, I <sub>D</sub> = 2.2A		2.2	2.5	Ω
<b>DYNAMIC CHARACTERISTICS</b>						
Input Capacitance	C <sub>ISS</sub>	V <sub>DS</sub> = 25V, V <sub>GS</sub> = 0V, f = 1MHz		520	600	pF
Output Capacitance	C <sub>OSS</sub>			52	70	pF
Reverse Transfer Capacitance	C <sub>RSS</sub>			11	15	pF
<b>SWITCHING CHARACTERISTICS</b>						
Turn-On Delay Time	t <sub>D(ON)</sub>	V <sub>DD</sub> = 30V, I <sub>D</sub> = 0.5A, R <sub>G</sub> = 25Ω (Note 1, 2)		60	80	ns
Turn-On Rise Time	t <sub>R</sub>				70	ns
Turn-Off Delay Time	t <sub>D(OFF)</sub>			96	120	ns
Turn-Off Fall Time	t <sub>F</sub>			50	70	ns
Total Gate Charge	Q <sub>G</sub>	V <sub>DS</sub> = 50V, I <sub>D</sub> = 1.3A, I <sub>G</sub> = 100μA V <sub>GS</sub> = 10V (Note 1, 2)		20		nC
Gate-Source Charge	Q <sub>GS</sub>			6		nC
Gate-Drain Charge	Q <sub>GD</sub>			4		nC
<b>SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS</b>						
Drain-Source Diode Forward Voltage	V <sub>SD</sub>	V <sub>GS</sub> = 0V, I <sub>S</sub> = 4.4A			1.4	V
Maximum Continuous Drain-Source Diode Forward Current	I <sub>S</sub>				4.4	A
Maximum Pulsed Drain-Source Diode Forward Current	I <sub>SM</sub>				17.6	A
Reverse Recovery Time	t <sub>rr</sub>	V <sub>GS</sub> = 0 V, I <sub>S</sub> = 4.4A, dI <sub>F</sub> /dt = 100 A/μs (Note 1)		250		ns
Reverse Recovery Charge	Q <sub>RR</sub>			1.5		μC

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

## ■ TEST CIRCUITS AND WAVEFORMS

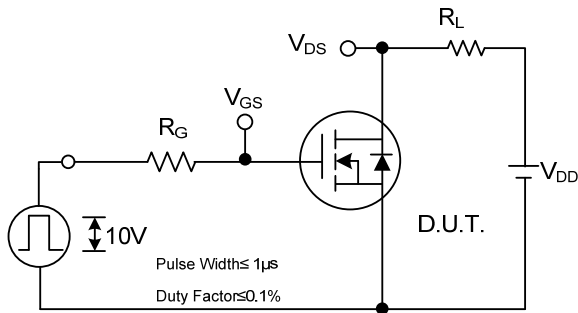


**Peak Diode Recovery dv/dt Test Circuit**



**Peak Diode Recovery dv/dt Waveforms**

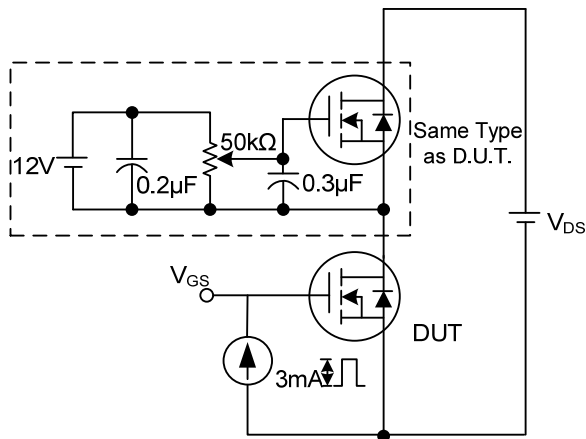
## TEST CIRCUITS AND WAVEFORMS (Cont.)



**Switching Test Circuit**



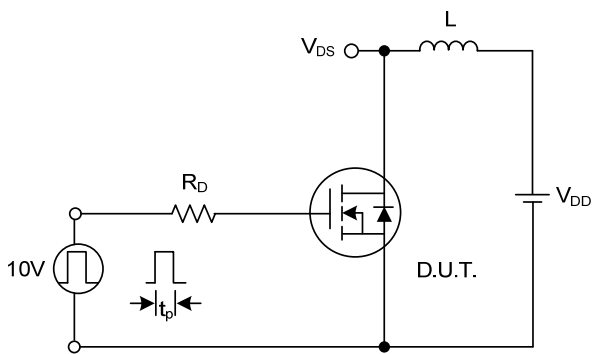
**Switching Waveforms**



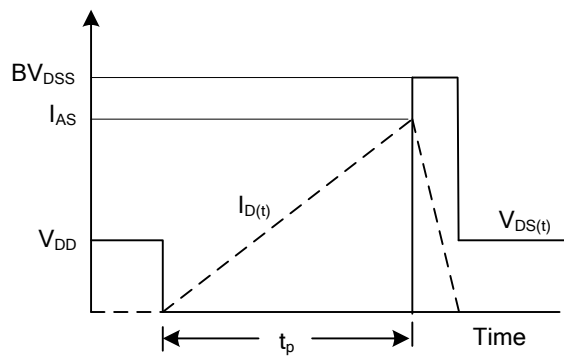
**Gate Charge Test Circuit**



**Gate Charge Waveform**



**Unclamped Inductive Switching Test Circuit**



**Unclamped Inductive Switching Waveforms**

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