

## 4N60-E

**Power MOSFET**

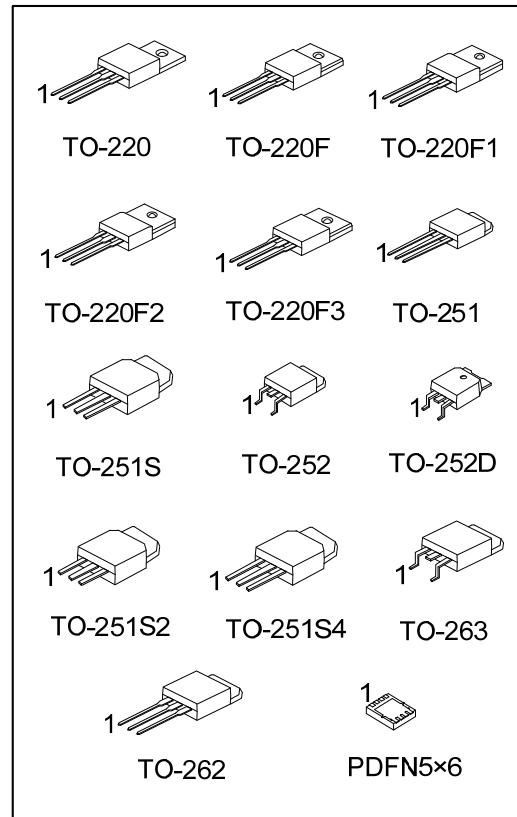
### 4.0A, 600V N-CHANNEL POWER MOSFET

#### DESCRIPTION

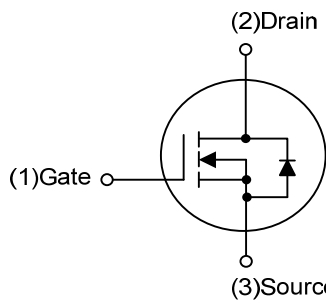
The UTC **4N60-E** is a high voltage power MOSFET and is designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and have a high rugged avalanche characteristics. This power MOSFET is usually used at high speed switching applications in power supplies, PWM motor controls, high efficient AC to DC converters and bridge circuits.

#### FEATURES

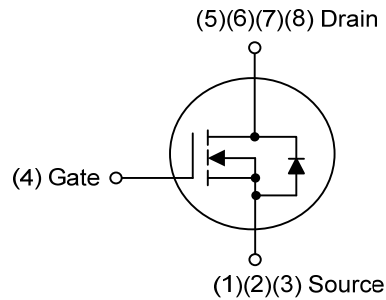
- \*  $R_{DS(ON)} \leq 2.5 \Omega$  @  $V_{GS}=10V$ ,  $I_D=2.2A$
- \* Fast Switching Capability
- \* Avalanche Energy Specified
- \* Improved dv/dt Capability, high Ruggedness



#### SYMBOL



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



PDFN5x6

## 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-TF3-T	4N60G-TF3-T	TO-220F	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-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
4N60L-P5060-R	4N60G-P5060-R	PDFN5×6	S	S	S	G	D	D	D	D	Tape Reel

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

<p>4N60G-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, P5060: PDFN5×6</p> <p>(3) G: Halogen Free and Lead Free, L: 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	<p>UTC 4N60</p> <p>Lot Code → [ ] [ ] [ ] [ ] [ ] [ ] → Date Code</p> <p>1</p> <p>L: Lead Free G: Halogen Free</p>
PDFN5×6		<p>UTC 4N60</p> <p>Lot Code → [ ] [ ] [ ] [ ] [ ] [ ] → Date Code</p> <p>.</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)		$I_{AR}$	4.4	A
Drain Current	Continuous	$I_D$	4.0	A
	Pulsed (Note 2)	$I_{DM}$	16	A
Avalanche Energy	Single Pulsed (Note 3)	$E_{AS}$	200	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-251S		50	
	TO-251S2/TO-251S4		50	
	TO-252/TO-252D		30	
	PDFN5×6		30	
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.  $L = 30\text{mH}$ ,  $I_{AS} = 3.65\text{A}$ ,  $V_{DD} = 50\text{V}$ ,  $R_G = 25\ \Omega$ , 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	$\theta_{JA}$	62.5	$^\circ\text{C}/\text{W}$
	TO-220F/TO-220F1			
	TO-220F2/TO-220F3			
	TO-251/TO-251S		110	
	TO-251S2/TO-251S4			
Junction to Case	TO-252/TO-252D	$\theta_{JC}$	75	$^\circ\text{C}/\text{W}$
	PDFN5×6		1.18	
	TO-220/TO-262/TO-263		3.47	
	TO-220F/TO-220F1		3.28	
	TO-220F3		2.5	
	TO-220F2		4.17	
	TO-251/TO-251S			
	TO-251S2/TO-251S4			
	TO-252/TO-252D			
	PDFN5×6			

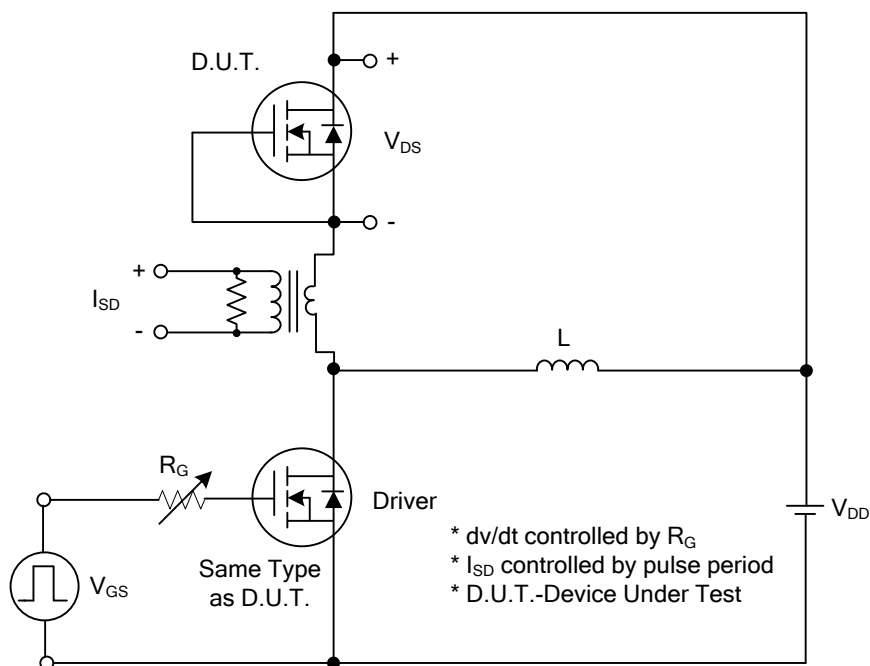
■ ELECTRICAL CHARACTERISTICS (T<sub>C</sub>=25°C, unless otherwise specified)

PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS							
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>	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
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
ON CHARACTERISTICS							
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		2.3	2.5	Ω
DYNAMIC CHARACTERISTICS							
Input Capacitance		C <sub>ISS</sub>	V <sub>DS</sub> = 25V, V <sub>GS</sub> = 0V, f = 1MHz		520	620	pF
Output Capacitance		C <sub>OSS</sub>			55	75	pF
Reverse Transfer Capacitance		C <sub>RSS</sub>			11	15	pF
SWITCHING CHARACTERISTICS							
Total Gate Charge		Q <sub>G</sub>	V <sub>DS</sub> = 480V,I <sub>D</sub> = 4.0A, V <sub>GS</sub> = 10V (Note 1, 2)		65		nC
Gate-Source Charge		Q <sub>GS</sub>			6		nC
Gate-Drain Charge		Q <sub>GD</sub>			8		nC
Turn-On Delay Time		t <sub>D(ON)</sub>	V <sub>DD</sub> = 300V, I <sub>D</sub> = 4.0A, R <sub>G</sub> = 25Ω (Note 1, 2)		60	130	ns
Turn-On Rise Time		t <sub>R</sub>			60	100	ns
Turn-Off Delay Time		t <sub>D(OFF)</sub>			220	260	ns
Turn-Off Fall Time		t <sub>F</sub>			70	100	ns
SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS							
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
Drain-Source Diode Forward Voltage		V <sub>SD</sub>	V <sub>GS</sub> = 0V, I <sub>S</sub> = 4.4A			1.4	V
Reverse Recovery Time		t <sub>rr</sub>	V <sub>GS</sub> = 0 V, I <sub>S</sub> = 4.4A,		250		ns
Reverse Recovery Charge		Q <sub>rr</sub>	dl <sub>F</sub> /dt = 100 A/μs (Note 1)		1.5		μC

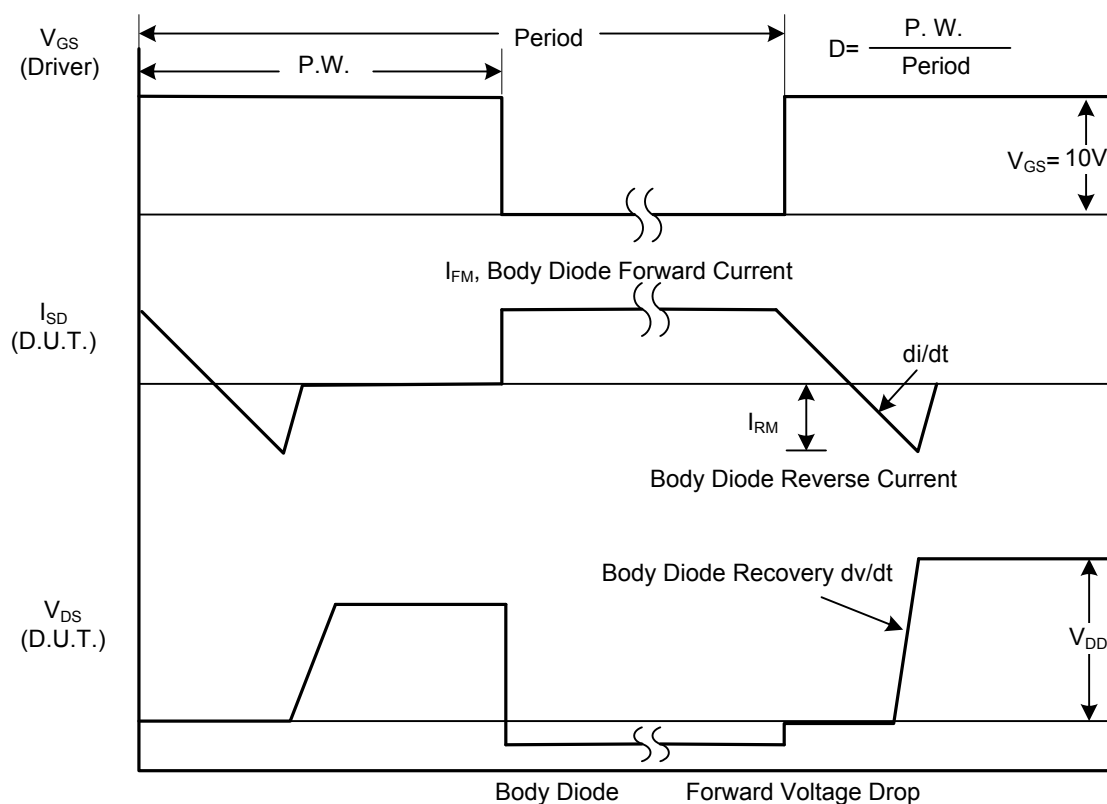
Notes: 1. Pulse Test: Pulse width ≤ 300μs, Duty cycle ≤ 2%

2. Essentially independent of operating temperature

# ■ TEST CIRCUITS AND WAVEFORMS

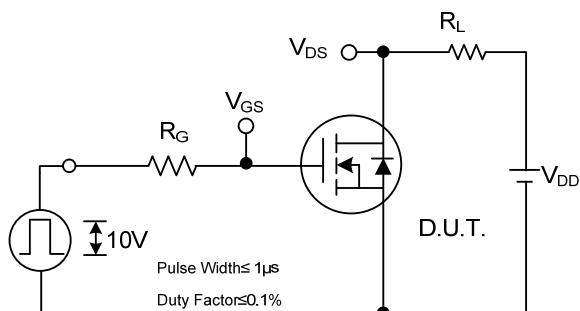


Peak Diode Recovery dv/dt Test Circuit

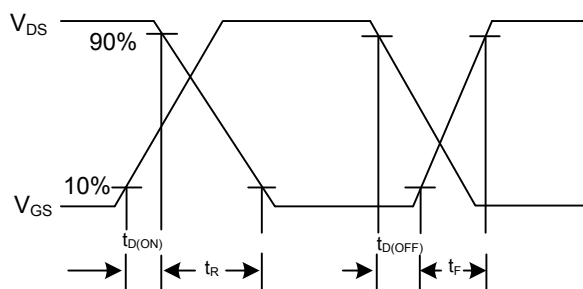


Peak Diode Recovery dv/dt Waveforms

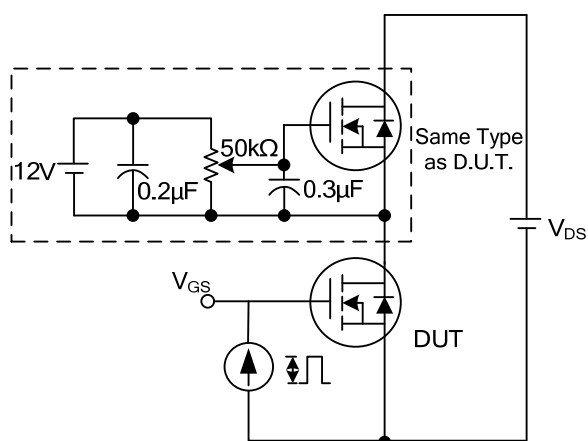
### ■ TEST CIRCUITS AND WAVEFORMS (Cont.)



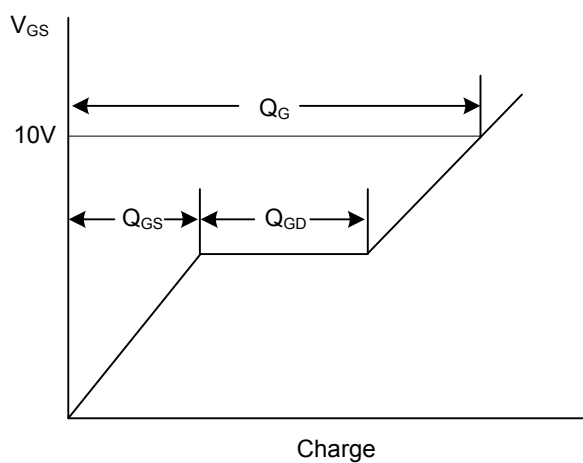
**Switching Test Circuit**



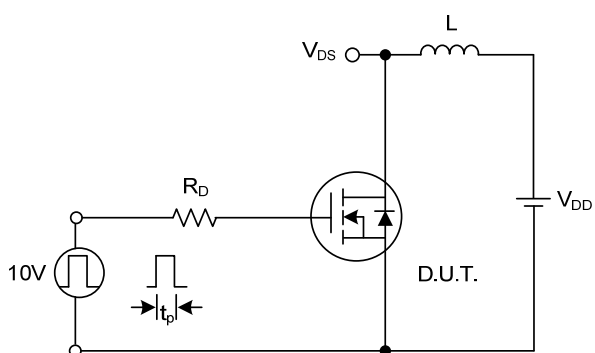
**Switching Waveforms**



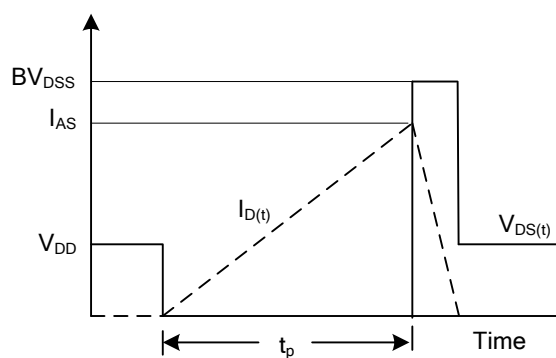
**Gate Charge Test Circuit**



**Gate Charge Waveform**



**Unclamped Inductive Switching Test Circuit**



**Unclamped Inductive Switching Waveforms**

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