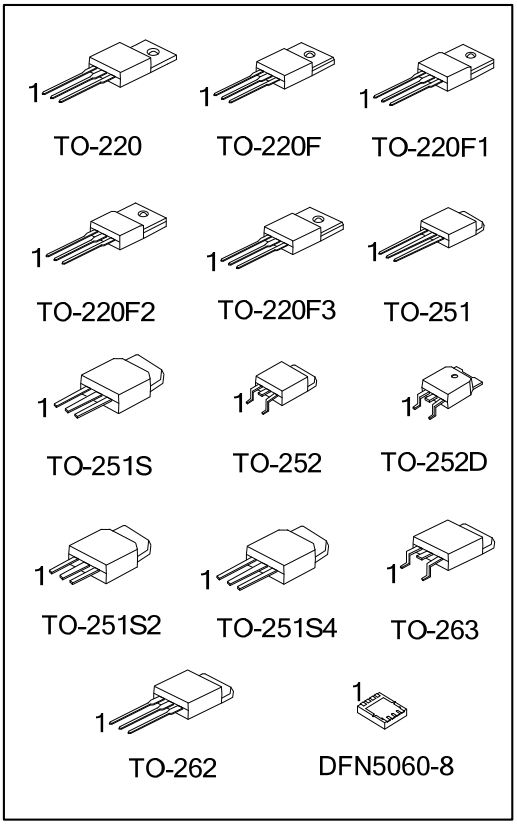
4N60-E

Power MOSFET

4A, 600V N-CHANNEL POWER MOSFET



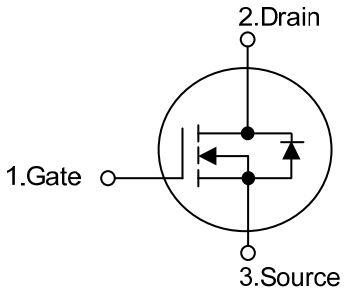
■ DESCRIPTION

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 DC to DC converters and bridge circuits.

■ FEATURES

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

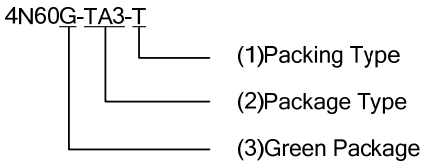
■ SYMBOL



■ ORDERING INFORMATION

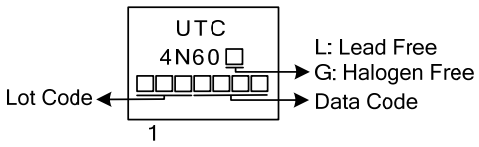
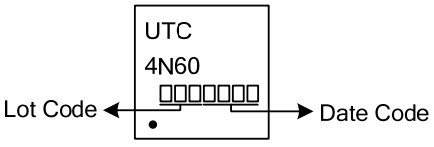
Ordering Number		Package	Pin Assignment								Packing
Lead Free	Halogen Free		1	2	3	4	5	6	7	8	
4N60L-TA3-T	4N60G-TA3-T	TO-220	G	D	S	-	-	-	-	-	Tube
4N60L-TF3-T	4N60G-TF3-T	TO-220F	G	D	S	-	-	-	-	-	Tube
4N60L-TF1-T	4N60G-TF1-T	TO-220F1	G	D	S	-	-	-	-	-	Tube
4N60L-TF2-T	4N60G-TF2-T	TO-220F2	G	D	S	-	-	-	-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

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



(1) T: Tube, R: Tape Reel
(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: DFN5060-8
(3) G: Halogen Free and Lead Free, L: Lead Free

■ 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	
DFN5060-8		

■ ABSOLUTE MAXIMUM RATINGS (T_C = 25°C, unless otherwise specified)

PARAMETER		SYMBOL	RATINGS	UNIT
Drain-Source Voltage		V_{DSS}	600	V
Gate-Source Voltage		V_{GSS}	±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 TO-220F3		36	
	TO-220F2		38	
	TO-251/TO-252/TO-252D TO-251S/TO-251S2 TO-251S4		50	
	DFN5060-8		30	
Junction Temperature		T_J	+150	°C
Operating Temperature		T_{OPR}	-55 ~ +150	°C
Storage Temperature		T_{STG}	-55 ~ +150	°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 = 30mH, I_{AS} = 3.65A, V_{DD} = 50V, R_G = 25 Ω, Starting T_J = 25°C
4. I_{SD}≤4.4A, di/dt ≤200A/μs, V_{DD}≤BV_{DSS}, Starting T_J = 25°C

■ THERMAL DATA

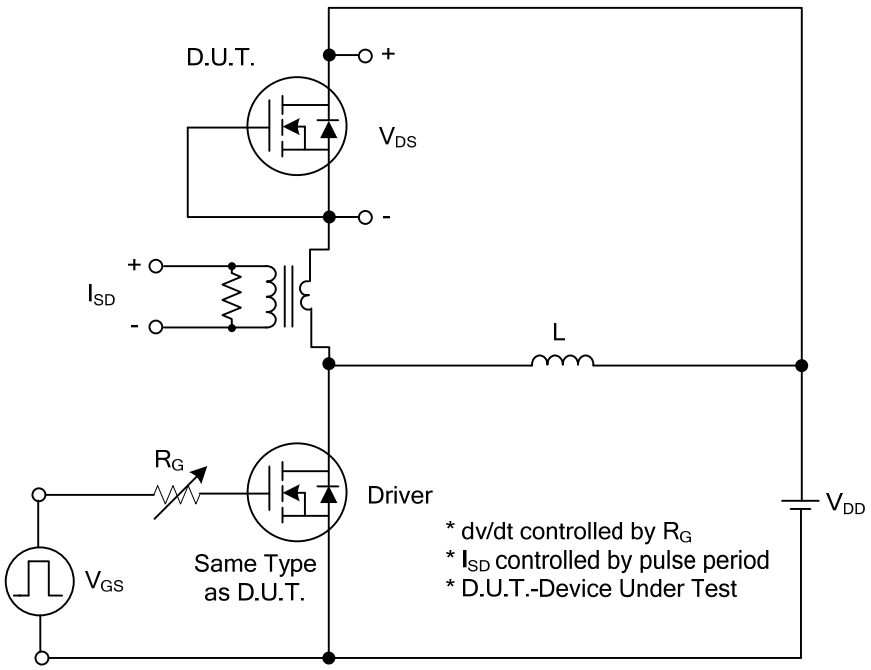
PARAMETER	PACKAGE	SYMBOL	RATINGS	UNIT
Junction to Ambient	TO-220/TO-262/TO-263 TO-220F/TO-220F1 TO-220F2/TO-220F3	θ_{JA}	62.5	°C/W
	TO-251/TO-252/TO-252D TO-251S/TO-251S2 TO-251S4		110	
	DFN5060-8		75	
Junction to Case	TO-220/TO-262/TO-263	θ_{JC}	1.18	°C/W
	TO-220F/TO-220F1 TO-220F3		3.47	
	TO-220F2		3.28	
	TO-251/TO-252/TO-252D TO-251S/TO-251S2 TO-251S4		2.5	
	DFN5060-8		4.17	

■ ELECTRICAL CHARACTERISTICS (T_C =25°C, unless otherwise specified)

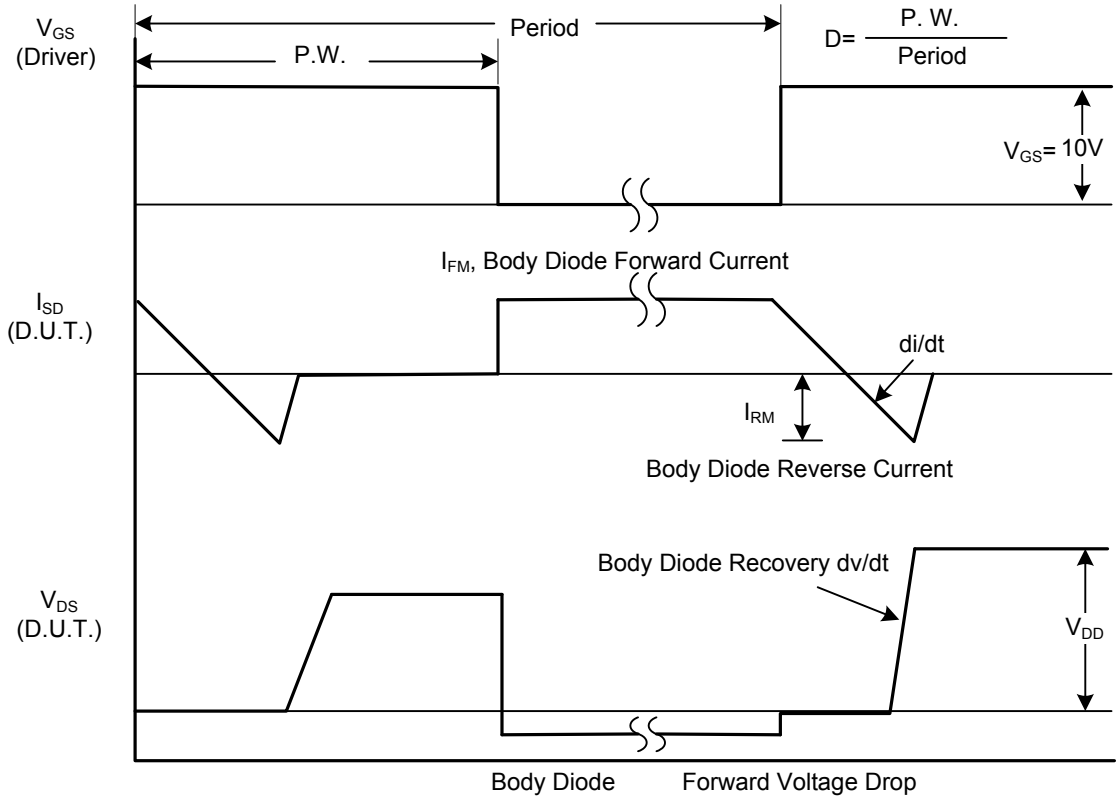
PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS							
Drain-Source Breakdown Voltage		BV_{DSS}	V_{GS} = 0V, I_D = 250μA	600			V
Drain-Source Leakage Current		I_{DSS}	V_{DS} = 600V, V_{GS} = 0V			10	μA
Gate-Source Leakage Current	Forward	I_{GSS}	V_{GS} = 30V, V_{DS} = 0V			100	nA
	Reverse		V_{GS} = -30V, V_{DS} = 0V			-100	nA
Breakdown Voltage Temperature Coefficient		$\triangle BV_{DSS}/\triangle T_J$	I_D=250μA,Referenced to 25°C		0.6		V/°C
ON CHARACTERISTICS							
Gate Threshold Voltage		$V_{GS(TH)}$	V_{DS} = V_{GS}, I_D = 250μA	2.0		4.0	V
Static Drain-Source On-State Resistance		$R_{DS(ON)}$	V_{GS} = 10 V, I_D = 2.2A		2.3	2.5	Ω
DYNAMIC CHARACTERISTICS							
Input Capacitance		C_{ISS}	V_{DS} = 25V, V_{GS} = 0V, f = 1MHz		520	620	pF
Output Capacitance		C_{OSS}			55	75	pF
Reverse Transfer Capacitance		C_{RSS}			11	15	pF
SWITCHING CHARACTERISTICS							
Total Gate Charge		Q_G	V_{DS}= 480V,I_D= 4.0A, V_{GS}= 10V (Note 1, 2)		65		nC
Gate-Source Charge		Q_{GS}			6		nC
Gate-Drain Charge		Q_{GD}			8		nC
Turn-On Delay Time		$t_{D(ON)}$	V_{DD} = 300V, I_D = 4.0A, R_G = 25Ω (Note 1, 2)		60	130	ns
Turn-On Rise Time		t_R			60	100	ns
Turn-Off Delay Time		$t_{D(OFF)}$			220	260	ns
Turn-Off Fall Time		t_F			70	100	ns
SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS							
Maximum Continuous Drain-Source Diode Forward Current		I_S				4.4	A
Maximum Pulsed Drain-Source Diode Forward Current		I_{SM}				17.6	A
Drain-Source Diode Forward Voltage		V_{SD}	V_{GS} = 0V, I_S = 4.4A			1.4	V
Reverse Recovery Time		t_{rr}	V_{GS} = 0 V, I_S = 4.4A, dI_F/dt = 100 A/μs (Note 1)		250		ns
Reverse Recovery Charge		Q_{rr}			1.5		μC

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

■ TEST CIRCUITS AND WAVEFORMS

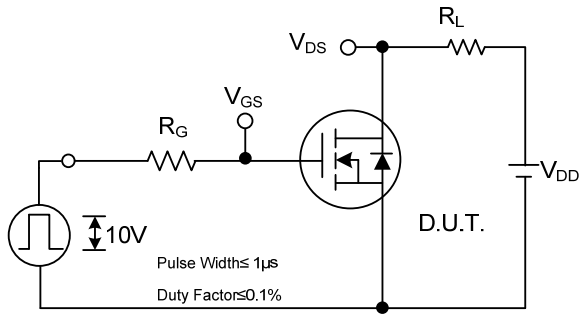


Peak Diode Recovery dv/dt Test Circuit

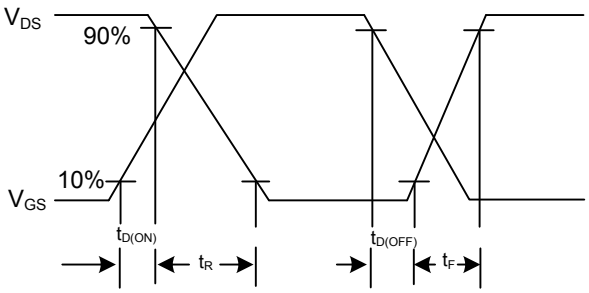


Peak Diode Recovery dv/dt Waveforms

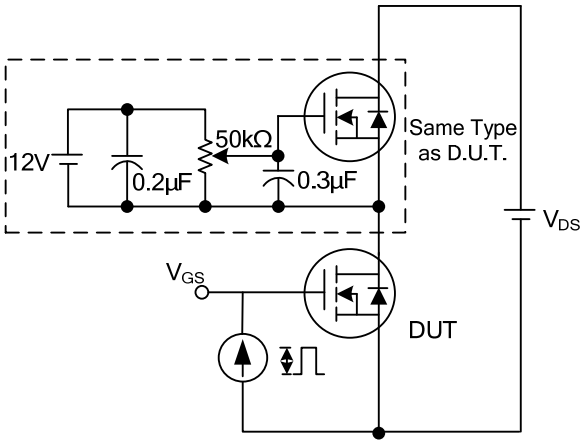
■ TEST CIRCUITS AND WAVEFORMS (Cont.)



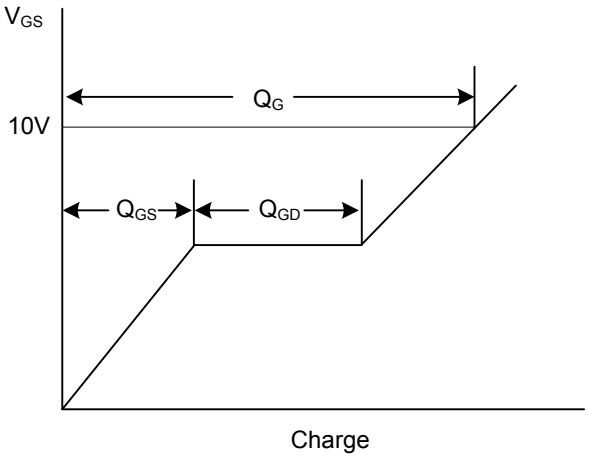
Switching Test Circuit



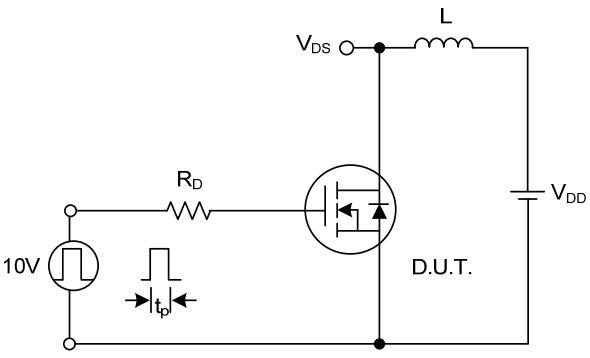
Switching Waveforms



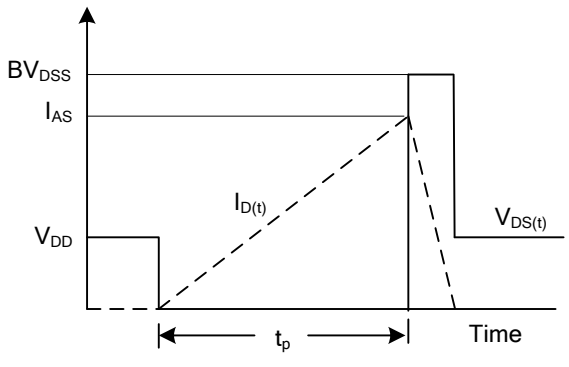
Gate Charge Test Circuit



Gate Charge Waveform



Unclamped Inductive Switching Test Circuit



Unclamped Inductive Switching Waveforms