



4N60K

Power MOSFET

4.0A, 600V N-CHANNEL POWER MOSFET

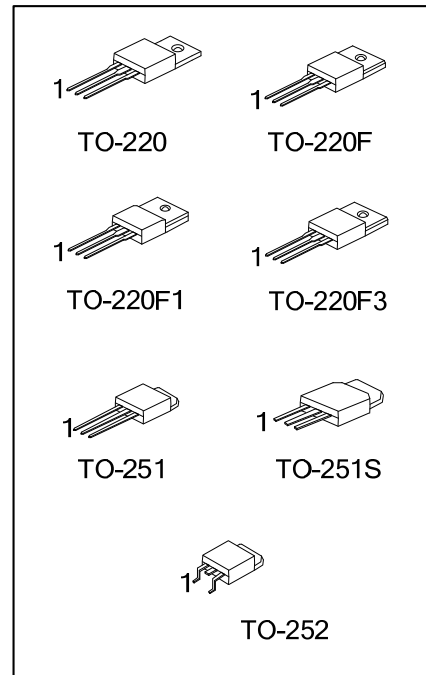
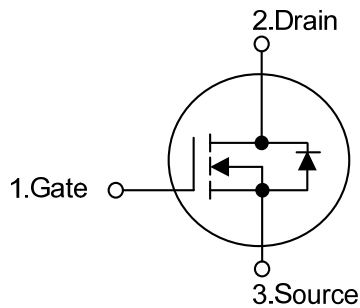
■ DESCRIPTION

The UTC **4N60K** 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

- * $R_{DS(ON)} < 2.5\Omega @ V_{GS} = 10V$
- * Ultra Low Gate Charge (typical 15 nC)
- * Low Reverse Transfer CAPACITANCE ($C_{RSS} = \text{typical } 8.0 \text{ pF}$)
- * Fast Switching Capability
- * Avalanche Energy Specified
- * Improved dv/dt Capability, high Ruggedness

■ SYMBOL



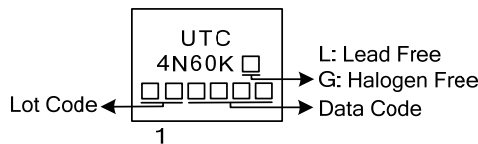
ORDERING INFORMATION

Ordering Number		Package	Pin Assignment			Packing
Lead Free	Halogen Free		1	2	3	
4N60KL-TA3-T	4N60KG-TA3-T	TO-220	G	D	S	Tube
4N60KL-TF3-T	4N60KG-TF3-T	TO-220F	G	D	S	Tube
4N60KL-TF1-T	4N60KG-TF1-T	TO-220F1	G	D	S	Tube
4N60KL-TF3T-T	4N60KG-TF3T-T	TO-220F3	G	D	S	Tube
4N60KL-TM3-T	4N60KG-TM3-T	TO-251	G	D	S	Tube
4N60KL-TMS-T	4N60KG-TMS-T	TO-251S	G	D	S	Tube
4N60KL-TN3-R	4N60KG-TN3-R	TO-252	G	D	S	Tape Reel

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

<p>4N60KL-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, TF3: TO-220F, TF1: TO-220F1, TF3T: TO-220F3, TM3: TO-251, TMS: TO-251S, TN3: TO-252</p> <p>(3) L: Lead Free, G: Halogen Free and 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}	± 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}	100	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	P_D	106	W
	TO-220F/TO-220F1		36	W
	TO-220F3			
	TO-251/TO-251S TO-252		50	W
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. $L = 12.5\text{mH}$, $I_{AS} = 4\text{A}$, $V_{DD} = 50\text{V}$, $R_G = 25\ \Omega$, 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		SYMBOL	RATINGS	UNIT
Junction to Ambient	TO-220/TO-220F TO-220F1/TO-220F3	θ_{JA}	62.5	$^\circ\text{C}/\text{W}$
	TO-251/TO-251S TO-252		83	$^\circ\text{C}/\text{W}$
	TO-220		1.18	$^\circ\text{C}/\text{W}$
Junction to Case	TO-220F/TO-220F1 TO-220F3	θ_{Jc}	3.47	$^\circ\text{C}/\text{W}$
	TO-251/TO-251S TO-252		2.5	$^\circ\text{C}/\text{W}$

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

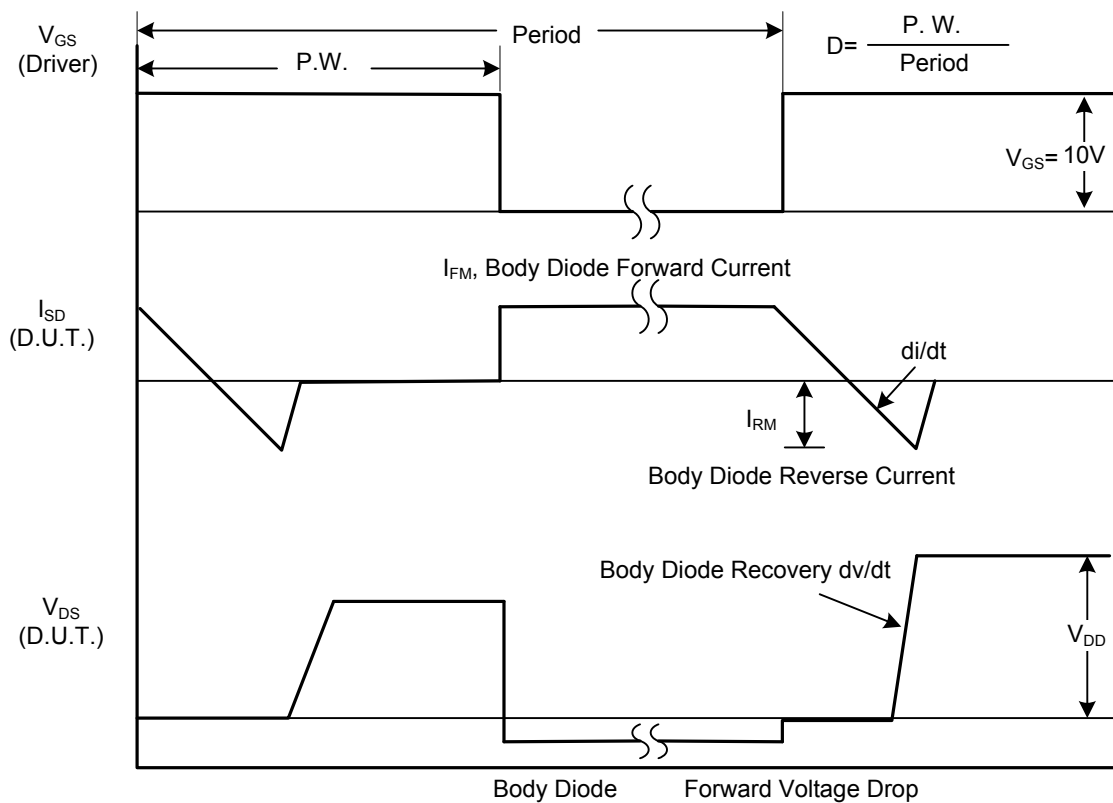
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS						
Drain-Source Breakdown Voltage	BV _{DSS}	V _{GS} =0V, I _D =250μA	600			V
Drain-Source Leakage Current	I _{DSS}	V _{DS} =600V, V _{GS} =0V			10	μA
		V _{DS} =600V, V _{GS} =0V, T _C =125°C			10	μA
Gate-Source Leakage Current	Forward	I _{GSS}				
	Reverse					
		V _{GS} =30V, V _{DS} =0V			100	nA
		V _{GS} = -30V, V _{DS} =0V			-100	nA
Breakdown Voltage Temperature Coefficient	ΔBV _{DSS} /ΔT _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	3.0		5.0	V
Static Drain-Source On-State Resistance	R _{DS(ON)}	V _{GS} =10 V, I _D =2.2A		2.2	2.5	Ω
DYNAMIC CHARACTERISTICS						
Input Capacitance	C _{ISS}	V _{DS} = 25V, V _{GS} = 0V, f = 1MHz		520	670	pF
Output Capacitance	C _{OSS}			70	90	pF
Reverse Transfer Capacitance	C _{RSS}			8	11	pF
SWITCHING CHARACTERISTICS						
Turn-On Delay Time	t _{D(ON)}	V _{DD} = 300V, I _D = 4.0A, R _G = 25Ω (Note 1, 2)		13	35	ns
Turn-On Rise Time	t _R			45	100	ns
Turn-Off Delay Time	t _{D(OFF)}			25	60	ns
Turn-Off Fall Time	t _F			35	80	ns
Total Gate Charge	Q _G	V _{DS} = 480V, I _D = 4.0A, V _{GS} = 10V (Note 1, 2)		15	20	nC
Gate-Source Charge	Q _{GS}			3.4		nC
Gate-Drain Charge	Q _{GD}			7.1		nC
SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS						
Maximum Continuous Drain-Source Diode Forward Current	I _S				4.0	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 = 4.0A			1.4	V
Reverse Recovery Time	t _{rr}	V _{GS} = 0 V, I _S = 4.0A, dI _F /dt = 100 A/μs (Note 1)		250		ns
Reverse Recovery Charge	Q _{rr}				1.5	

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

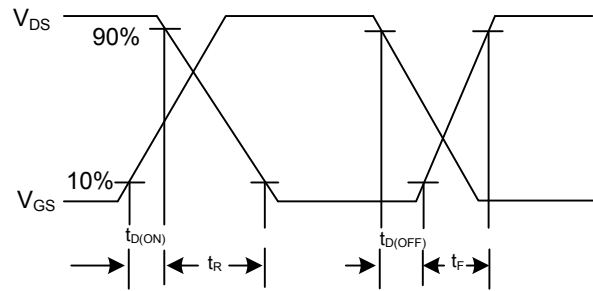


Peak Diode Recovery dv/dt Waveforms

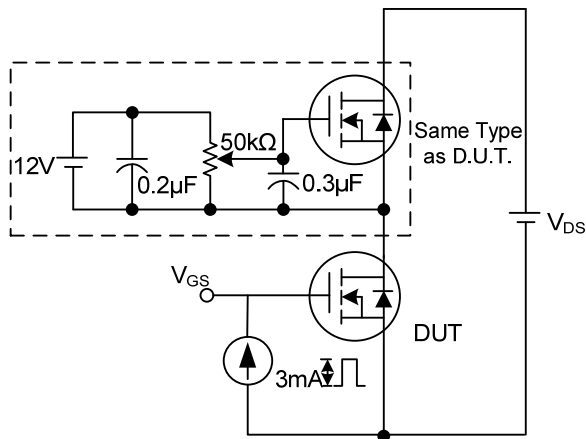
■ TEST CIRCUITS AND WAVEFORMS (Cont.)



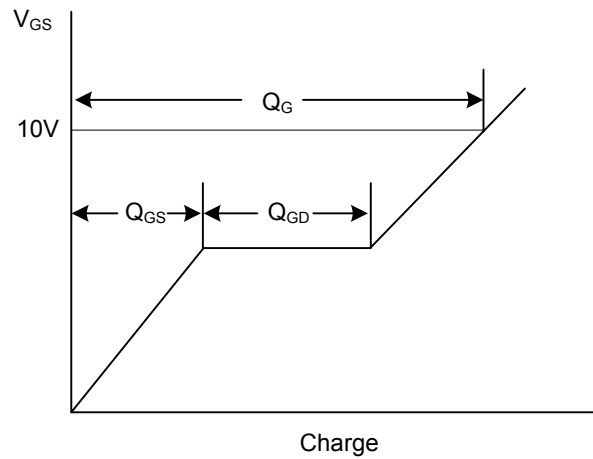
Switching Test Circuit



Switching Waveforms



Gate Charge Test Circuit



Gate Charge Waveform



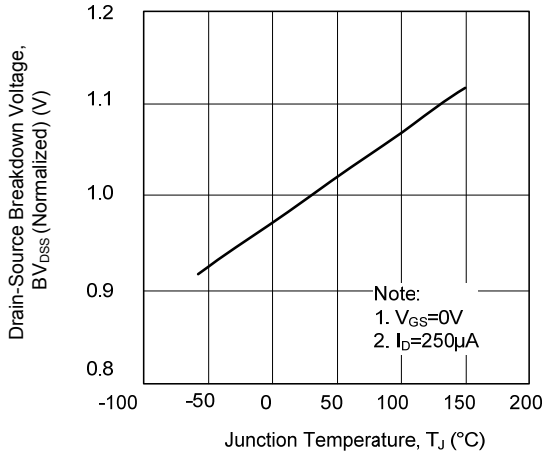
Unclamped Inductive Switching Test Circuit



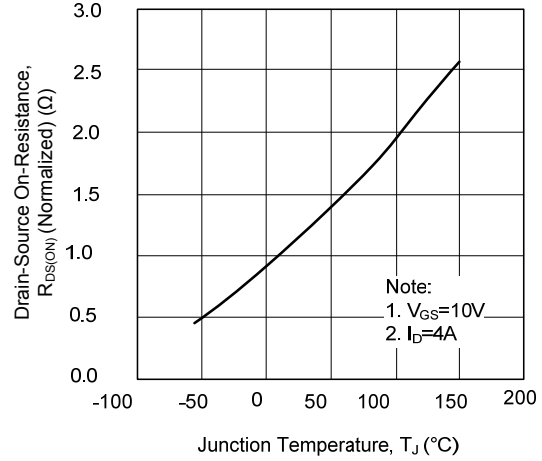
Unclamped Inductive Switching Waveforms

TYPICAL CHARACTERISTICS

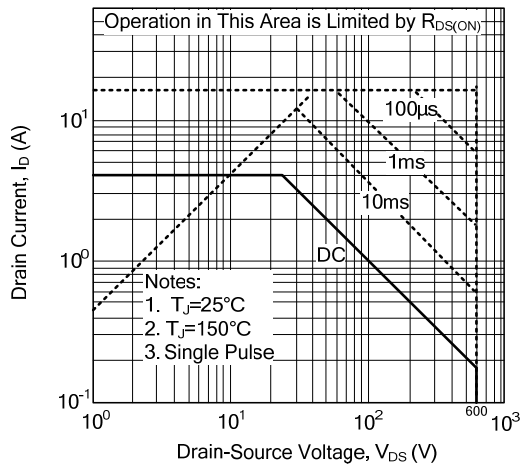
Breakdown Voltage Variation vs. Temperature



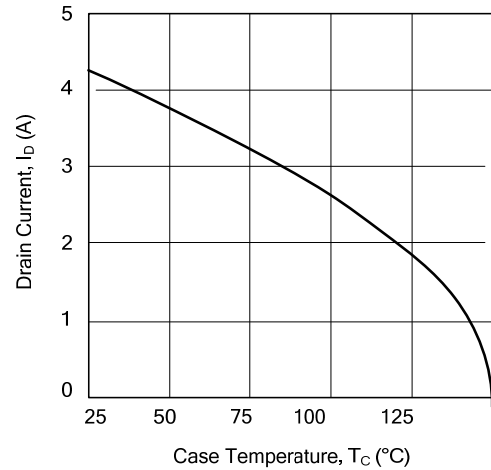
On-Resistance Junction Temperature



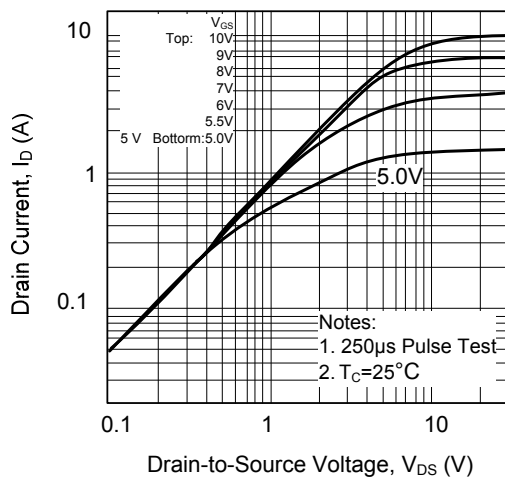
Safe Operating Area - 600V



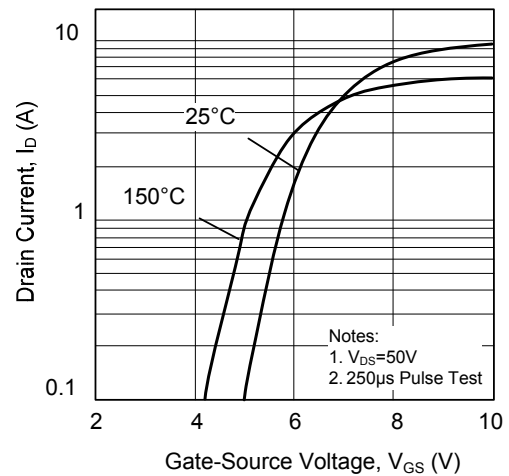
Maximum Drain Current vs. Case Temperature



On-State Characteristics

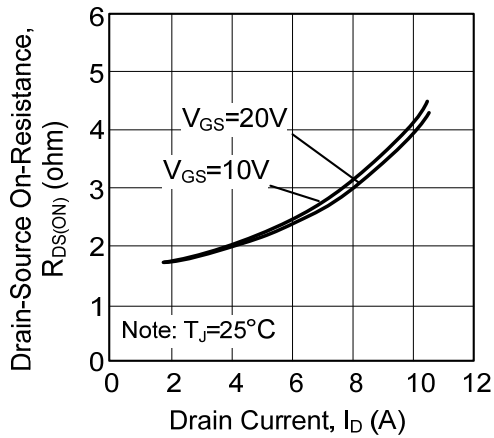


Transfer Characteristics

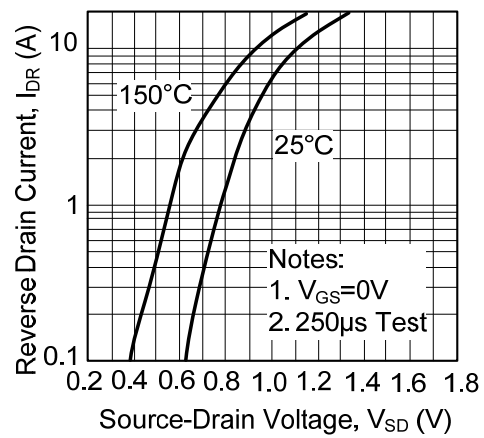


■ TYPICAL CHARACTERISTICS(Cont.)

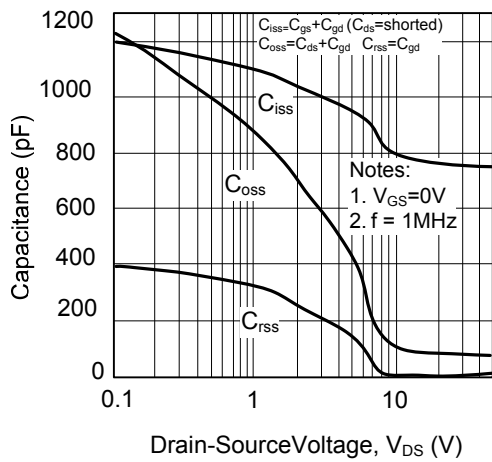
On-Resistance Variation vs. Drain Current and Gate Voltage



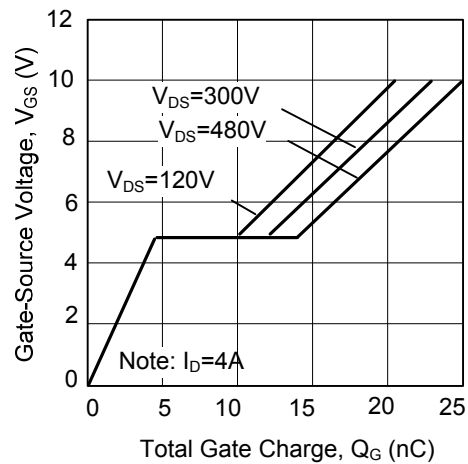
On State Current vs. Allowable Case Temperature



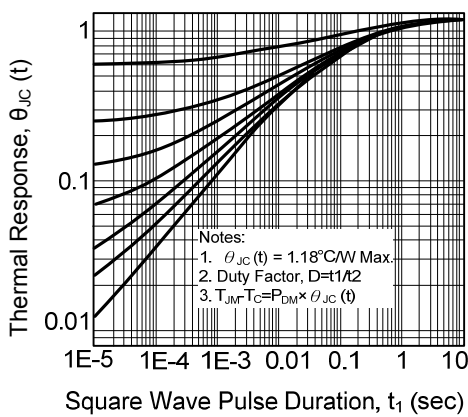
Capacitance Characteristics (Non-Repetitive)



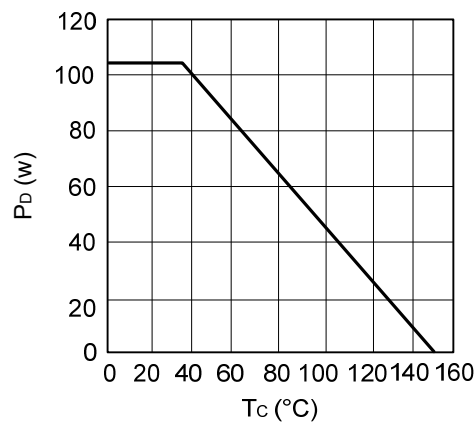
Gate Charge Characteristics



Transient Thermal Response Curve



Power Dissipation



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