



## 1N60

Power MOSFET

### 1.2 Amps, 600/650 Volts N-CHANNEL MOSFET

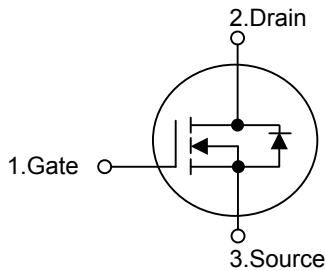
#### DESCRIPTION

The UTC **1N60** is a high voltage 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

- \*  $R_{DS(ON)} = 11.5\Omega @ V_{GS} = 10V$ .
- \* Ultra Low gate charge (typical 5.0nC)
- \* Low reverse transfer capacitance ( $C_{RSS} = \text{typical } 3.0 \text{ pF}$ )
- \* Fast switching capability
- \* Avalanche energy specified
- \* Improved dv/dt capability, high ruggedness

#### SYMBOL

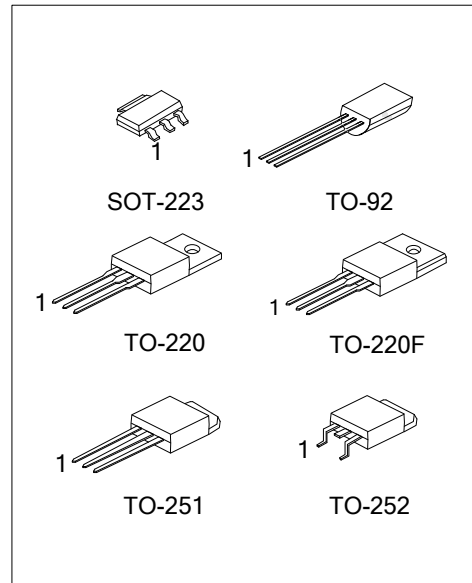


#### ORDERING INFORMATION

Ordering Number			Package	Pin Assignment			Packing
Normal	Lead Free Plating	Halogen Free		1	2	3	
1N60-x-AA3-B	1N60L-x-AA3-B	1N60G-x-AA3-B	SOT-223	G	D	S	Tape Reel
1N60-x-T92-B	1N60L-x-T92-B	1N60G-x-T92-B	TO-92	G	D	S	Tape Box
1N60-x-T92-K	1N60L-x-T92-K	1N60G-x-T92-K	TO-92	G	D	S	Bulk
1N60-x-TA3-T	1N60L-x-TA3-T	1N60G-x-TA3-T	TO-220	G	D	S	Tube
1N60-x-TF3-T	1N60L-x-TF3-T	1N60G-x-TF3-T	TO-220F	G	D	S	Tube
1N60-x-TM3-R	1N60L-x-TM3-R	1N60G-x-TM3-R	TO-251	G	D	S	Tape Reel
1N60-x-TM3-T	1N60L-x-TM3-T	1N60G-x-TM3-T	TO-251	G	D	S	Tube
1N60-x-TN3-R	1N60L-x-TN3-R	1N60G-x-TN3-R	TO-252	G	D	S	Tape Reel
1N60-x-TN3-T	1N60L-x-TN3-T	1N60G-x-TN3-T	TO-252	G	D	S	Tube

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

<p>1N60L-x-AA3-B</p> <p>(1)Packing Type (2)Package Type (3)Drain-Source Voltage (4)Lead Plating</p>	<p>(1) B: Tape Box, K: Bulk, T: Tube, R: Tape Reel (2) AA3: SOT-223, T92: TO-92, TA3: TO-220, TF3: TO-220F, TM3: TO-251, TN3: TO-252 (3) A: 600V, B: 650V (4) G: Halogen Free, L: Lead Free, Blank: Pb/Sn</p>
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Lead-free: 1N60L  
Halogen-free: 1N60G

■ ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ , unless otherwise specified)

PARAMETER		SYMBOL	RATINGS	UNIT
Drain-Source Voltage	1N60-A	$V_{DSS}$	600	V
	1N60-B		650	V
Gate-Source Voltage		$V_{GSS}$	$\pm 30$	V
Avalanche Current (Note 1)		$I_{AR}$	1.2	A
Continuous Drain Current		$I_D$	1.2	A
Pulsed Drain Current (Note 1)		$I_{DM}$	4.8	A
Avalanche Energy	Single Pulsed (Note 2)	$E_{AS}$	50	mJ
	Repetitive (Note 1)	$E_{AR}$	4.0	mJ
Peak Diode Recovery dv/dt (Note 3)		dv/dt	4.5	V/ns
Power Dissipation	TO-251	$P_D$	28	W
	TO-252		28	W
	TO-220		40	W
	TO-220F		21	W
	TO-92( $T_a=25^\circ\text{C}$ )		1	W
Junction Temperature		$T_J$	+150	$^\circ\text{C}$
Operating Temperature		$T_{OPR}$	-55 ~ +150	$^\circ\text{C}$
Storage Temperature		$T_{STG}$	-55 ~ +150	$^\circ\text{C}$

Note: 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.

■ THERMAL DATA

PARAMETER		SYMBOL	RATINGS	UNIT
Junction-to-Ambient	TO-251	$\theta_{JA}$	110	$^\circ\text{C/W}$
	TO-252		110	
	TO-220		62.5	
	TO-220F		62.5	
	TO-92		140	
Junction-to-Case	TO-251	$\theta_{JC}$	4.53	$^\circ\text{C/W}$
	TO-252		4.53	
	TO-220		3.13	
	TO-220F		5.95	

■ 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	1N60-A	BV <sub>DSS</sub>	V <sub>GS</sub> =0V, I <sub>D</sub> =250μA	600			V
	1N60-B			650			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		0.4		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> =0.6A		9.3	11.5	Ω
<b>DYNAMIC CHARACTERISTICS</b>							
Input Capacitance		C <sub>ISS</sub>	V <sub>DS</sub> =25V, V <sub>GS</sub> =0V, f=1MHz		120	150	pF
Output Capacitance		C <sub>OSS</sub>			20	25	pF
Reverse Transfer Capacitance		C <sub>RSS</sub>			3.0	4.0	pF
<b>SWITCHING CHARACTERISTICS</b>							
Turn-On Delay Time		t <sub>D(ON)</sub>	V <sub>DD</sub> =300V, I <sub>D</sub> =1.2A, R <sub>G</sub> =50Ω (Note 4,5)		5	20	ns
Turn-On Rise Time		t <sub>R</sub>			25	60	ns
Turn-Off Delay Time		t <sub>D(OFF)</sub>			7	25	ns
Turn-Off Fall Time		t <sub>F</sub>		25	60	ns	
Total Gate Charge		Q <sub>G</sub>	V <sub>DS</sub> =480V, V <sub>GS</sub> =10V, I <sub>D</sub> =1.2A (Note 4,5)		5.0	6.0	nC
Gate-Source Charge		Q <sub>GS</sub>			1.0		nC
Gate-Drain Charge		Q <sub>GD</sub>			2.6		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> =1.2A			1.4	V
Maximum Continuous Drain-Source Diode Forward Current		I <sub>S</sub>				1.2	A
Maximum Pulsed Drain-Source Diode Forward Current		I <sub>SM</sub>				4.8	A
Reverse Recovery Time		t <sub>RR</sub>	V <sub>GS</sub> =0V, I <sub>S</sub> =1.2A		160		ns
Reverse Recovery Charge		Q <sub>RR</sub>	dI <sub>F</sub> /dt=100A/μs (Note1)		0.3		μC

- Note:
1. Repetitive Rating: Pulse width limited by maximum junction temperature
  2. L = 60mH, I<sub>AS</sub> = 1A, V<sub>DD</sub> = 50V, R<sub>G</sub> = 25Ω, Starting T<sub>J</sub> = 25°C
  3. I<sub>SD</sub> ≤ 1.2A, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ BV<sub>DSS</sub>, Starting T<sub>J</sub> = 25°C
  4. Pulse Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 2%
  5. Essentially Independent of Operating Temperature

■ TEST CIRCUITS AND WAVEFORMS

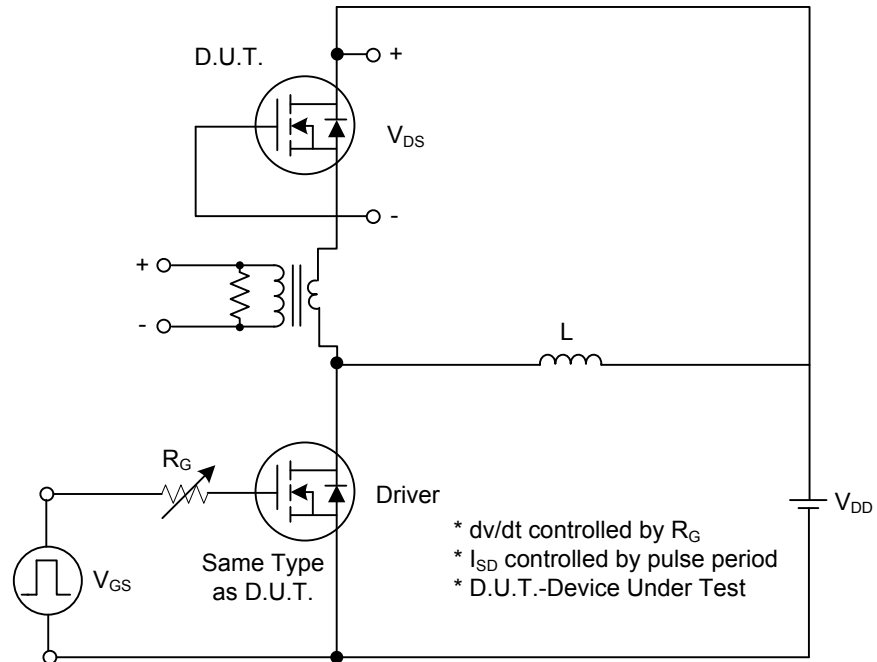


Fig. 1A Peak Diode Recovery dv/dt Test Circuit

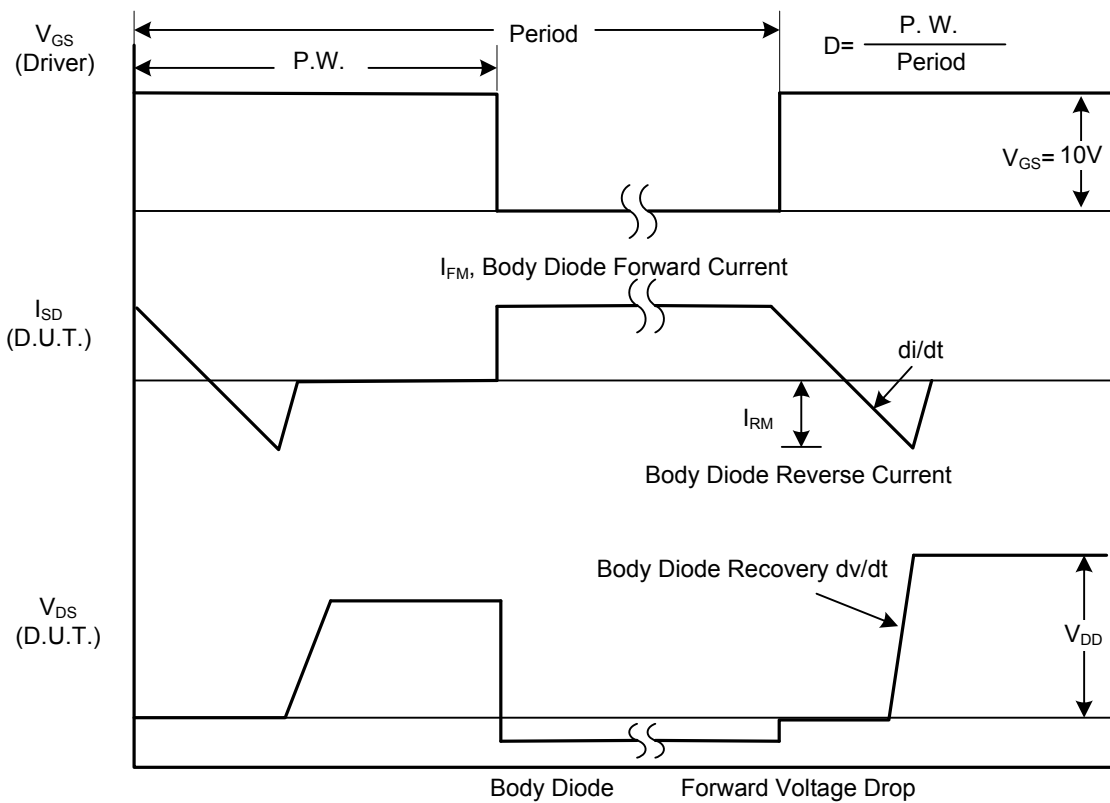


Fig. 1B Peak Diode Recovery dv/dt Waveforms

■ TEST CIRCUITS AND WAVEFORMS (Cont.)

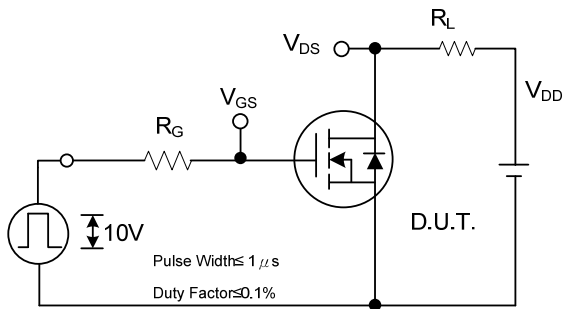


Fig. 2A Switching Test Circuit

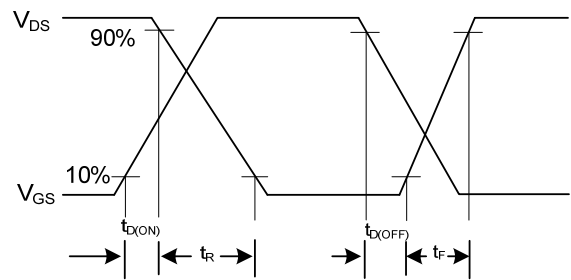


Fig. 2B Switching Waveforms

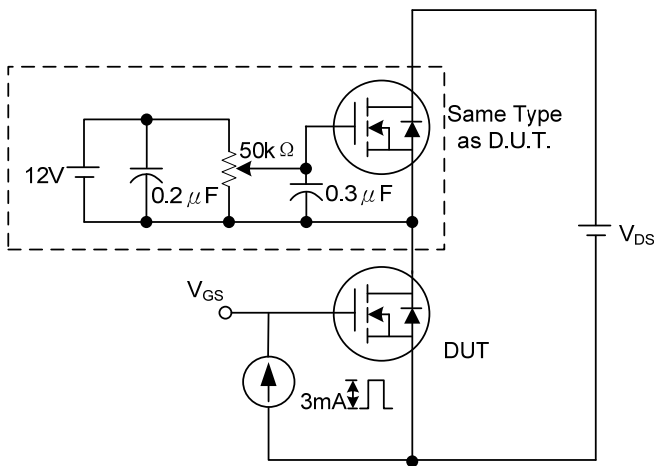


Fig. 3A Gate Charge Test Circuit

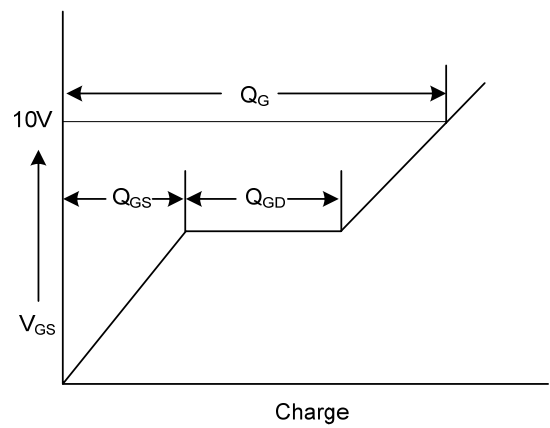


Fig. 3B Gate Charge Waveform

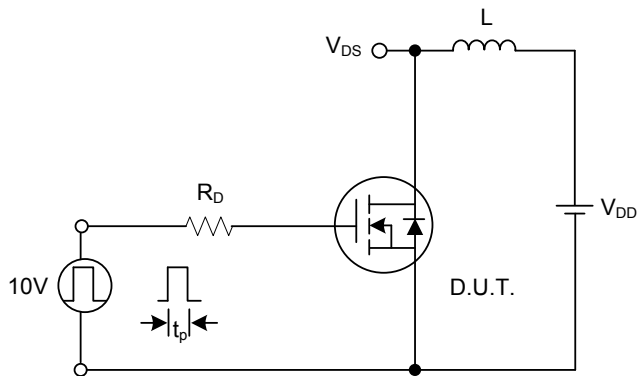


Fig. 4A Unclamped Inductive Switching Test Circuit

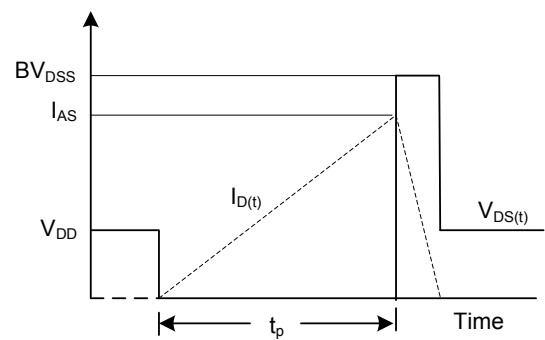
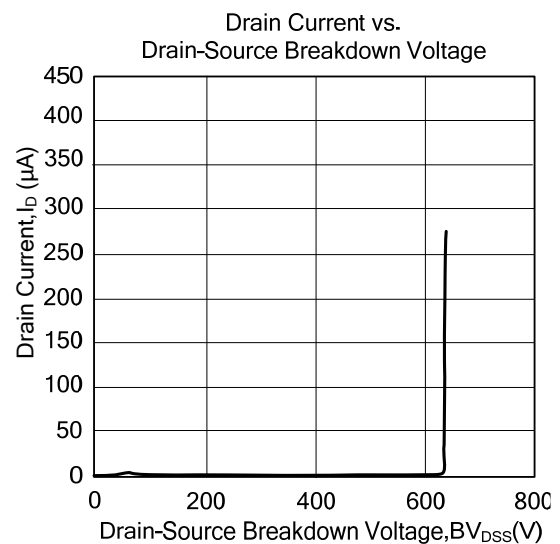
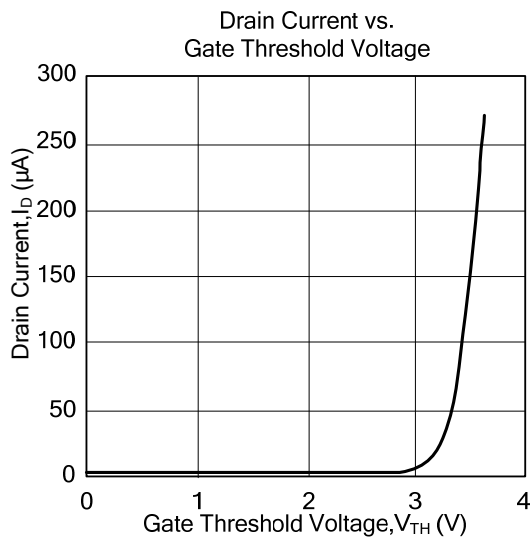
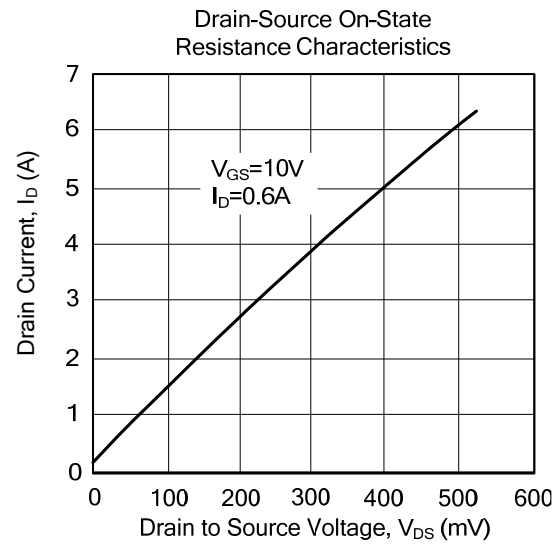
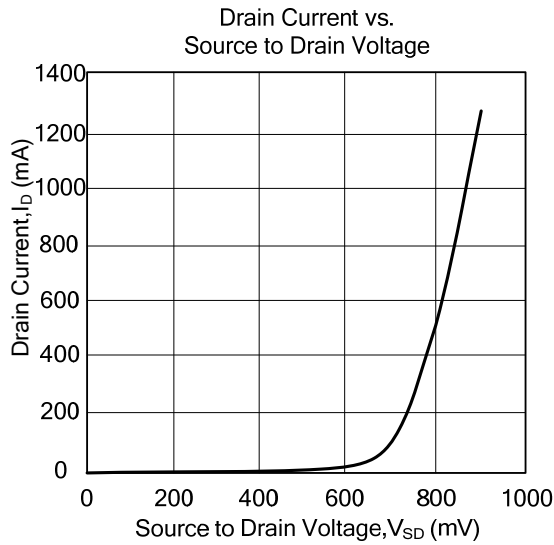


Fig. 4B Unclamped Inductive Switching Waveforms

### TYPICAL CHARACTERISTICS



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