



1N60

Power MOSFET

## 1.2A, 600V N-CHANNEL POWER MOSFET

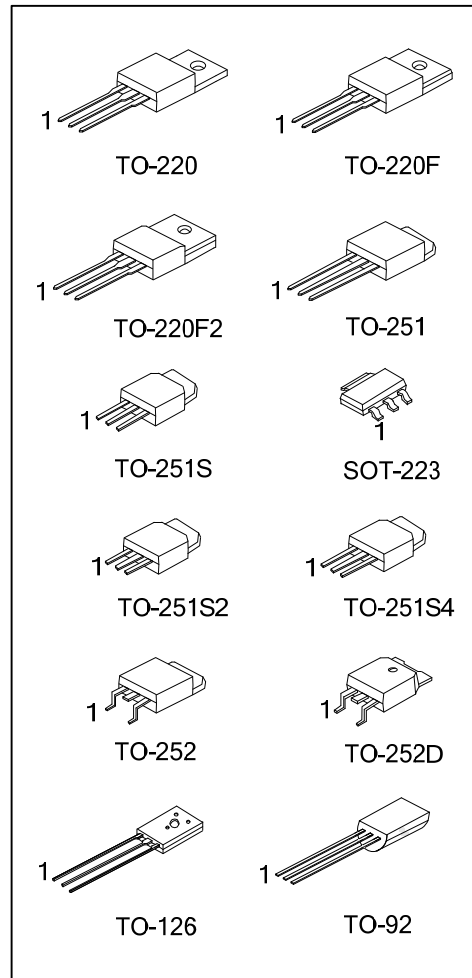
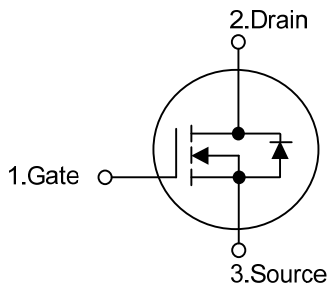
### DESCRIPTION

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

- \*  $R_{DS(ON)} < 11.5\Omega$  @  $V_{GS}=10V$ ,  $I_D=0.6A$
- \* Ultra Low gate charge (typical 5.0nC)
- \* Low reverse transfer capacitance ( $C_{RSS}$  = typical 3.0 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	
1N60L-AA3-R	1N60G-AA3-R	SOT-223	G	D	S	Tape Reel
1N60L-TA3-T	1N60G-TA3-T	TO-220	G	D	S	Tube
1N60L-TF2-T	1N60G-TF2-T	TO-220F2	G	D	S	Tube
1N60L-TF3-T	1N60G-TF3-T	TO-220F	G	D	S	Tube
1N60L-TM3-T	1N60G-TM3-T	TO-251	G	D	S	Tube
1N60L-TMS-T	1N60G-TMS-T	TO-251S	G	D	S	Tube
1N60L-TMS2-T	1N60G-TMS2-T	TO-251S2	G	D	S	Tube
1N60L-TMS4-T	1N60G-TMS4-T	TO-251S4	G	D	S	Tube
1N60L-TN3-R	1N60G-TN3-R	TO-252	G	D	S	Tape Reel
1N60L-TND-R	1N60G-TND-R	TO-252D	G	D	S	Tape Reel
1N60L-T60-K	1N60G-T60-K	TO-126	G	D	S	Bulk
1N60L-T92-B	1N60G-T92-B	TO-92	G	D	S	Tape Box
1N60L-T92-K	1N60G-T92-K	TO-92	G	D	S	Bulk

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

<p>1N60G-AA3-R</p> <p>(1) Packing Type (2) Package Type (3) Green Package</p>	<p>(1) B: Tape Box, K: Bulk, T: Tube, R: Tape Reel (2) AA3: SOT-223, T92: TO-92, TA3: TO-220, TF2: TO-220F2, TF3: TO-220F, TM3: TO-251, TMS: TO-251S, TMS2: TO-251S2, TMS4: TO-251S4, TN3: TO-252, TND: TO-252D, T60: TO-126 (3) G: Halogen Free and Lead Free, L: Lead Free</p>
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## MARKING

PACKAGE	MARKING
SOT-223	<p>L: Lead Free G: Halogen Free Data Code</p>
TO-220 TO-220F TO-220F2 TO-251 TO-251S TO-251S2 TO-251S4 TO-252 TO-252D	<p>UTC 1N60 L: Lead Free G: Halogen Free Data Code Lot Code</p>
TO-126	<p>UTC 1N60 Data Code L: Lead Free G: Halogen Free</p>
TO-92	<p>UTC 1N60 L: Lead Free G: Halogen Free Data Code</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)		$I_{AR}$	1.2	A
Continuous Drain Current		$I_D$	1.2	A
Pulsed Drain Current (Note 2)		$I_{DM}$	4.8	A
Avalanche Energy	Single Pulsed (Note 3)	$E_{AS}$	50	mJ
	Repetitive (Note 2)	$E_{AR}$	4.0	mJ
Peak Diode Recovery dv/dt (Note 4)		dv/dt	4.5	V/ns
Power Dissipation	SOT-223	$P_D$	8	W
	TO-251/TO-252 TO-252D/TO-251S TO-251S2/ TO-251S4		28	
	TO-220		40	
	TO-220F		21	
	TO-220F2		23	
	TO-92( $T_A=25^\circ\text{C}$ )		1	
	TO-126		12.5	
	Junction Temperature		$T_J$	
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.  $L = 60\text{mH}$ ,  $I_{AS} = 1\text{A}$ ,  $V_{DD} = 50\text{V}$ ,  $R_G = 25\Omega$ , Starting  $T_J = 25^\circ\text{C}$

4.  $I_{SD} \leq 1.2\text{A}$ ,  $di/dt \leq 200\text{A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$

■ **THERMAL DATA**

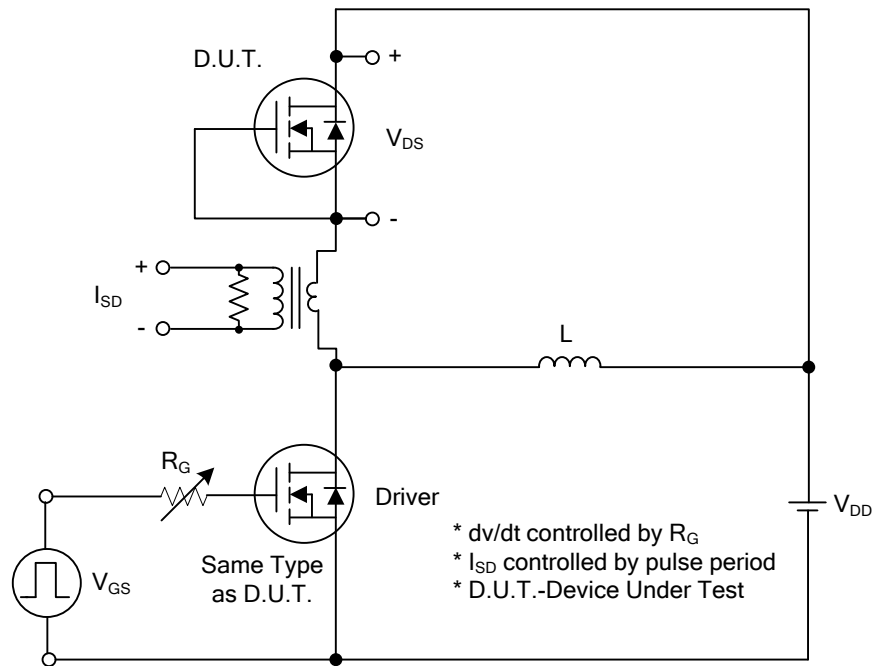
PARAMETER		SYMBOL	RATINGS	UNIT			
Junction to Ambient	SOT-223	$\theta_{JA}$	150	$^\circ\text{C}/\text{W}$			
	TO-251/TO-252 TO-252D/TO-251S TO-251S2/ TO-251S4		110				
	TO-220/TO-220F		62.5				
	TO-220F2		62.5				
	TO-92		140				
	TO-126		132				
	Junction to Case		SOT-223		$\theta_{JC}$	14	$^\circ\text{C}/\text{W}$
			TO-251/TO-252 TO-252D/TO-251S TO-251S2/ TO-251S4			4.53	
TO-220		3.13					
TO-220F		5.95					
TO-220F2		5.43					
TO-92		80					
TO-126		10					

■ **ELECTRICAL CHARACTERISTICS** ( $T_C=25^\circ\text{C}$ , unless otherwise specified.)

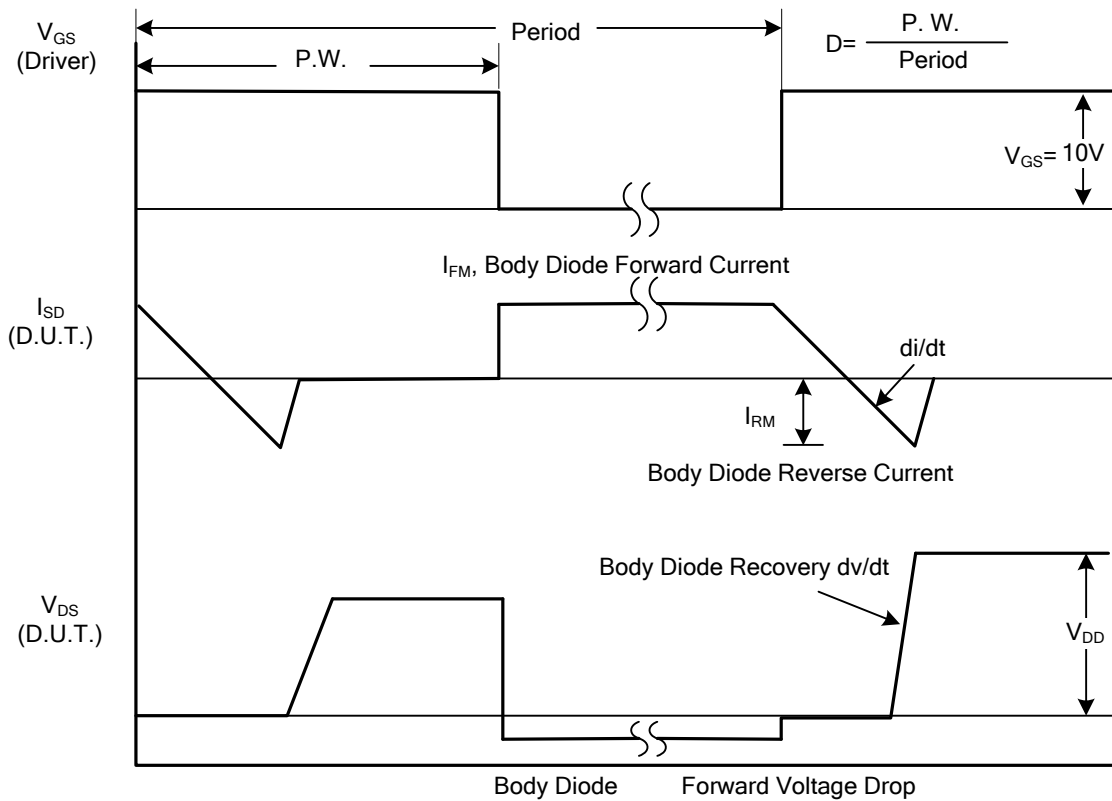
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>OFF CHARACTERISTICS</b>						
Drain-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=250\mu A$	600			V
Drain-Source Leakage Current	$I_{DSS}$	$V_{DS}=600V, V_{GS}=0V$			10	$\mu A$
Gate-Source Leakage Current	Forward	$I_{GSS}$			100	nA
	Reverse				$V_{GS}=30V, V_{DS}=0V$	-100
Breakdown Voltage Temperature Coefficient	$\Delta BV_{DSS}/\Delta T_J$	$I_D=250\mu A$		0.4		$V/^\circ C$
<b>ON CHARACTERISTICS</b>						
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{DS}=V_{GS}, I_D=250\mu A$	2.0		4.0	V
Static Drain-Source On-State Resistance	$R_{DS(ON)}$	$V_{GS}=10V, I_D=0.6A$		9.3	11.5	$\Omega$
<b>DYNAMIC CHARACTERISTICS</b>						
Input Capacitance	$C_{ISS}$	$V_{DS}=25V, V_{GS}=0V, f=1MHz$		120	150	pF
Output Capacitance	$C_{OSS}$		20	25	pF	
Reverse Transfer Capacitance	$C_{RSS}$		3.0	4.0	pF	
<b>SWITCHING CHARACTERISTICS</b>						
Total Gate Charge	$Q_G$	$V_{DS}=480V, V_{GS}=10V, I_D=1.2A$ (Note 2,3)		5.0	6.0	nC
Gate-Source Charge	$Q_{GS}$		1.0		nC	
Gate-Drain Charge	$Q_{GD}$		2.6		nC	
Turn-On Delay Time	$t_{D(ON)}$	$V_{DD}=300V, I_D=1.2A, R_G=50\Omega$ (Note 2,3)		5	20	ns
Turn-On Rise Time	$t_R$		25	60	ns	
Turn-Off Delay Time	$t_{D(OFF)}$		7	25	ns	
Turn-Off Fall Time	$t_F$		25	60	ns	
<b>SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS</b>						
Drain-Source Diode Forward Voltage	$V_{SD}$	$V_{GS}=0V, I_S=1.2A$			1.4	V
Maximum Continuous Drain-Source Diode Forward Current	$I_S$				1.2	A
Maximum Pulsed Drain-Source Diode Forward Current	$I_{SM}$				4.8	A
Reverse Recovery Time	$t_{rr}$	$V_{GS}=0V, I_S=1.2A$		160		ns
Reverse Recovery Charge	$Q_{rr}$	$dI_F/dt=100A/\mu s$ (Note 1)		0.3		$\mu C$

- Notes: 1. Repetitive Rating: Pulse width limited by maximum junction temperature  
 2. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$   
 3. Essentially Independent of Operating Temperature

■ TEST CIRCUITS AND WAVEFORMS

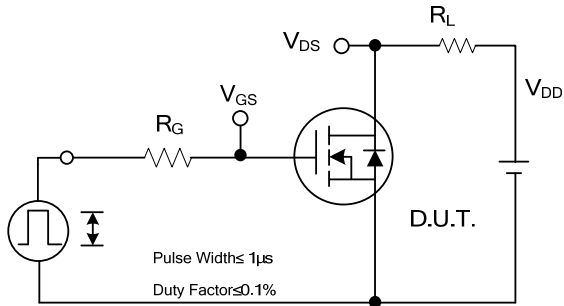


Peak Diode Recovery dv/dt Test Circuit

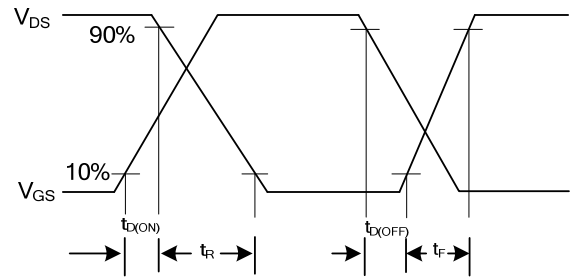


Peak Diode Recovery dv/dt Waveforms

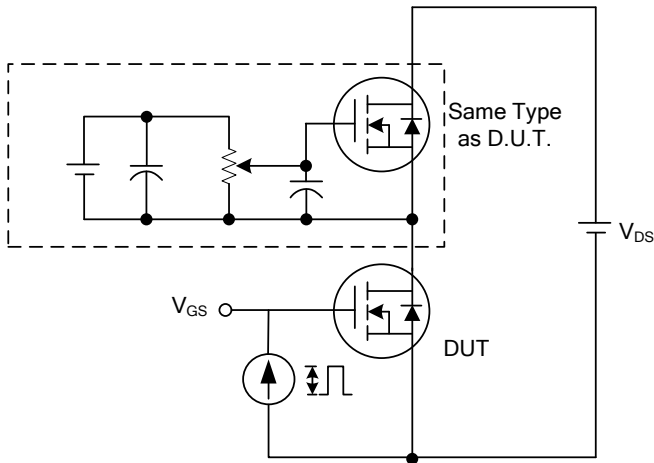
■ TEST CIRCUITS AND WAVEFORMS (Cont.)



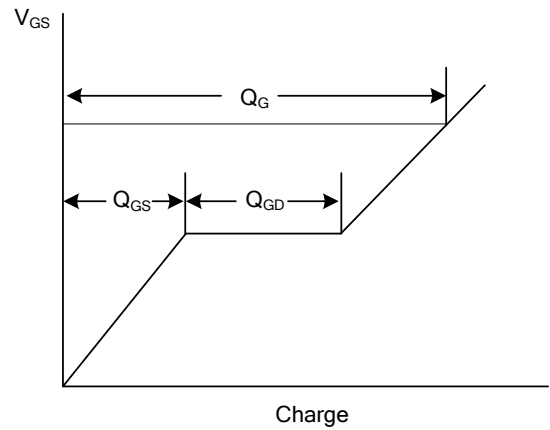
Switching Test Circuit



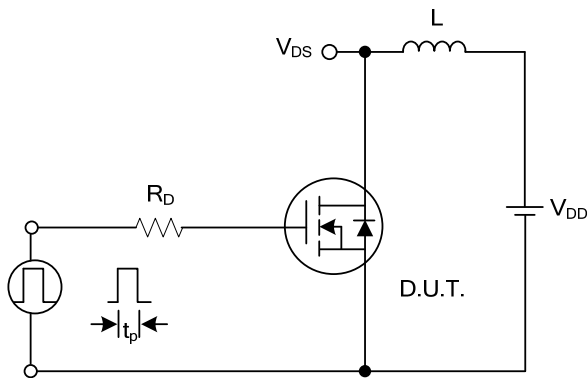
Switching Waveforms



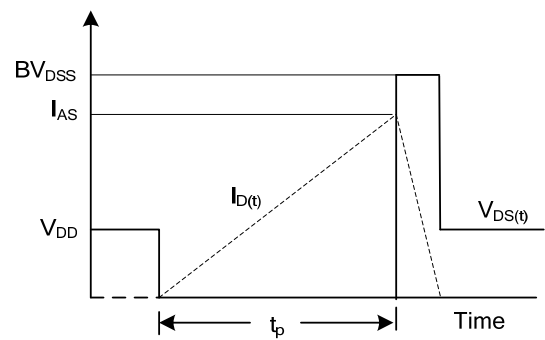
Gate Charge Test Circuit



Gate Charge Waveform

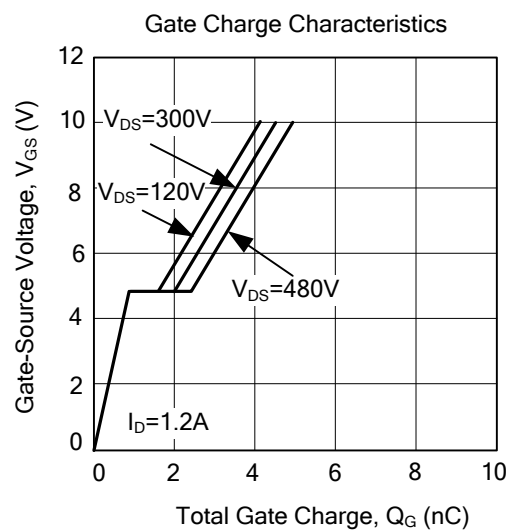
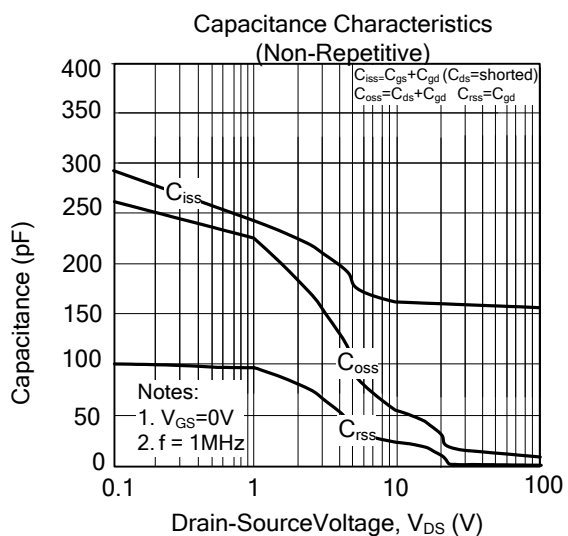
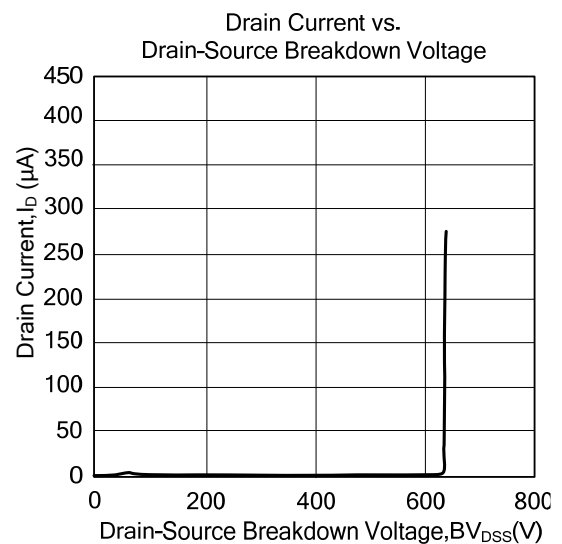
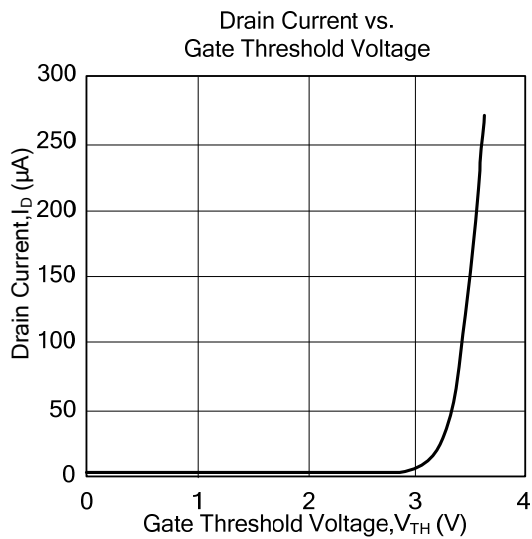
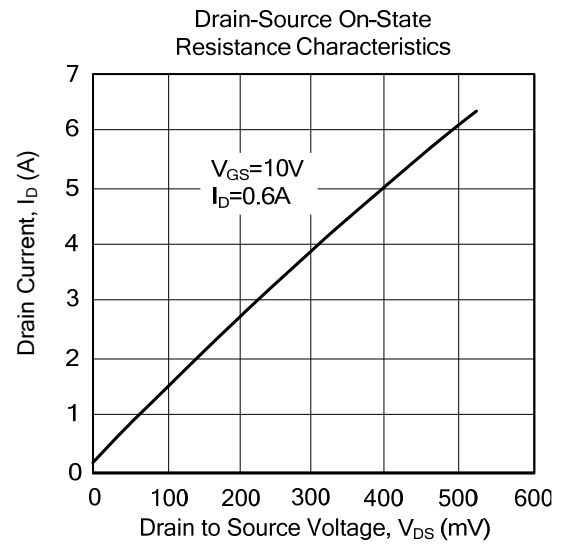
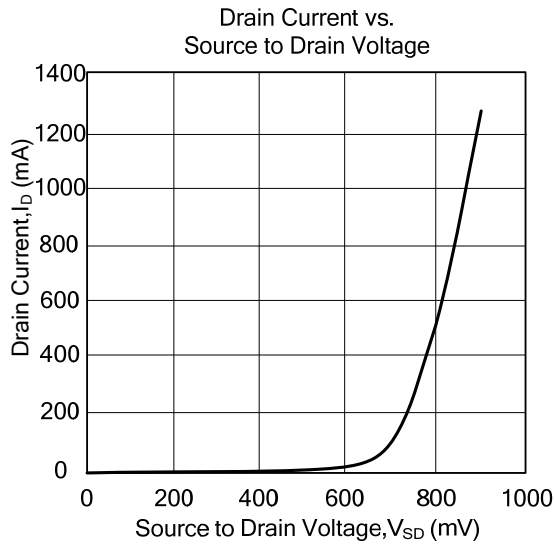


Unclamped Inductive Switching Test Circuit



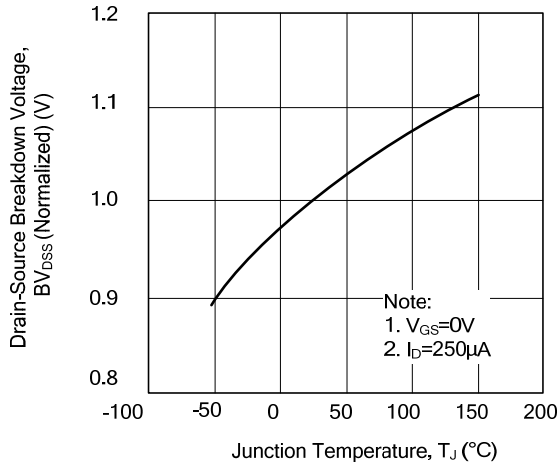
Unclamped Inductive Switching Waveforms

## TYPICAL CHARACTERISTICS

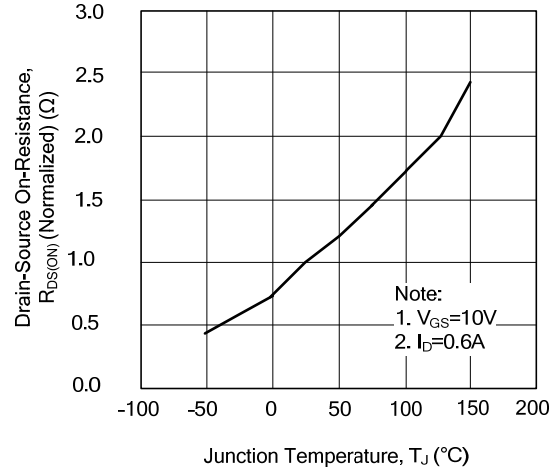


## ■ TYPICAL CHARACTERISTICS (Cont.)

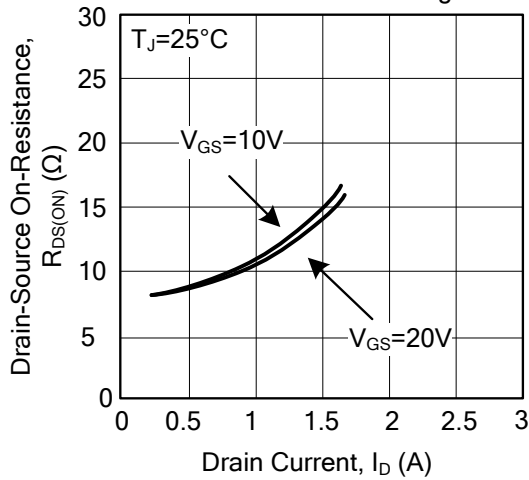
Breakdown Voltage Variation vs. Temperature



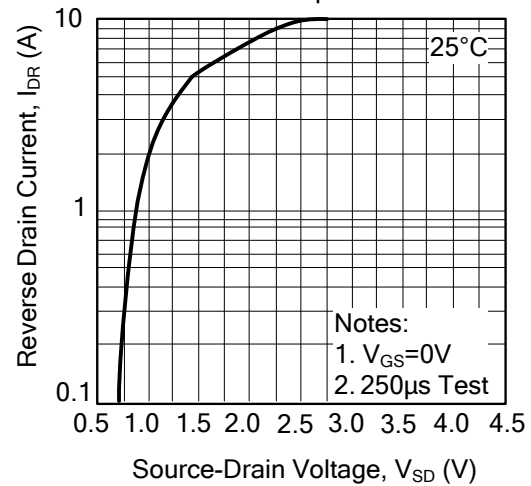
On-Resistance Junction Temperature



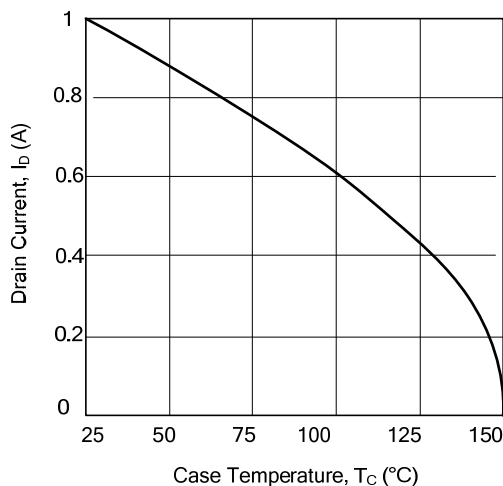
On-Resistance Variation vs. Drain Current and Gate Voltage



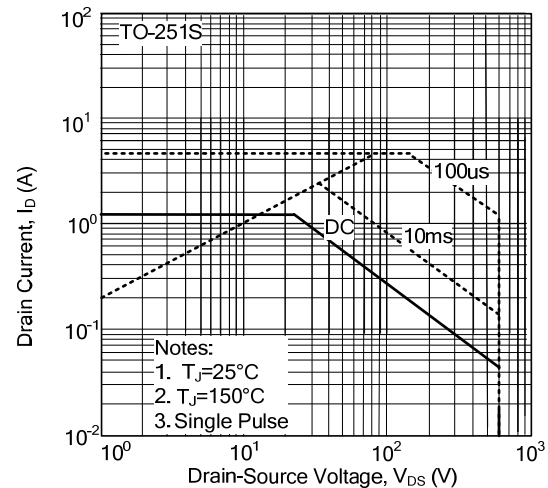
On State Current vs. Allowable Case Temperature



Maximum Drain Current vs. Case Temperature

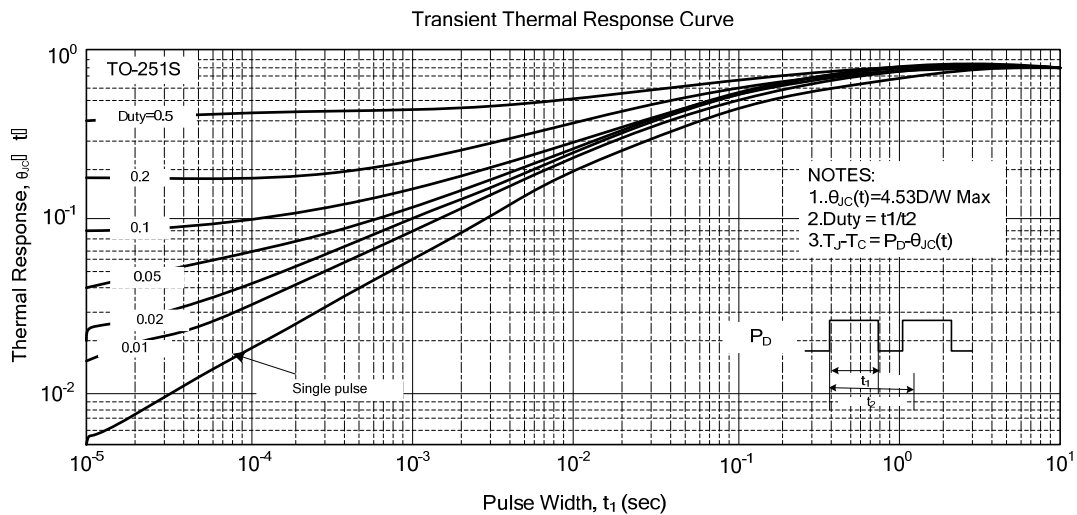
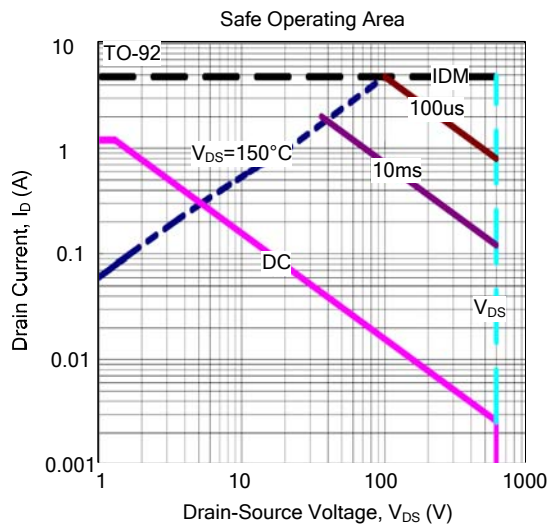


Safe Operating Area





## ■ TYPICAL CHARACTERISTICS (Cont.)



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