



# 2N60

## Power MOSFET

### 2A, 600V N-CHANNEL POWER MOSFET

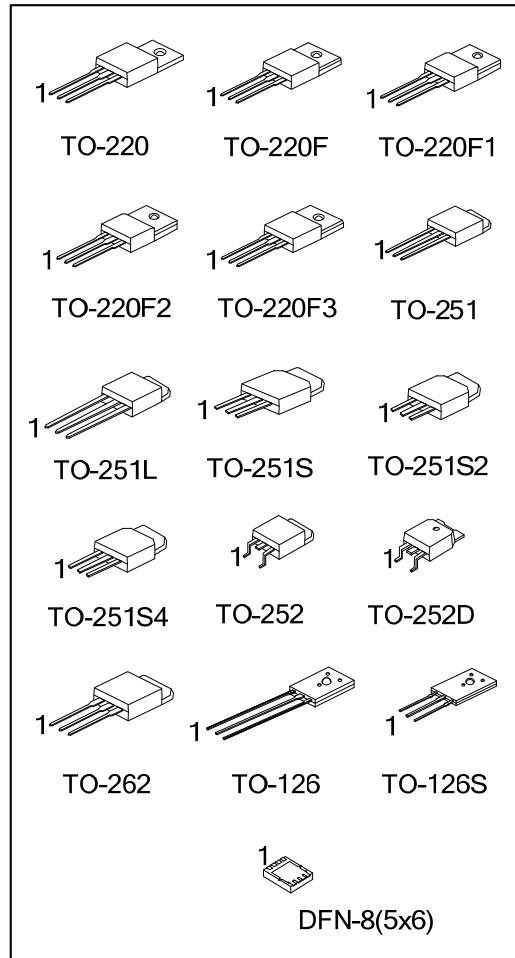
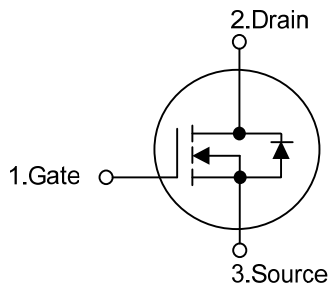
#### DESCRIPTION

The UTC **2N60** 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

- \*  $R_{DS(ON)} < 5\Omega @ V_{GS} = 10V, I_D = 1A$
- \* 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	
2N60L-TA3-T	2N60G-TA3-T	TO-220	G	D	S	-	-	-	-	-	Tube
2N60L-TF1-T	2N60G-TF1-T	TO-220F1	G	D	S	-	-	-	-	-	Tube
2N60L-TF2-T	2N60G-TF2-T	TO-220F2	G	D	S	-	-	-	-	-	Tube
2N60L-TF3-T	2N60G-TF3-T	TO-220F	G	D	S	-	-	-	-	-	Tube
2N60L-TF3T-T	2N60G-TF3T-T	TO-220F3	G	D	S	-	-	-	-	-	Tube
2N60L-TM3-T	2N60G-TM3-T	TO-251	G	D	S	-	-	-	-	-	Tube
2N60L-TMA-T	2N60G-TMA-T	TO-251L	G	D	S	-	-	-	-	-	Tube
2N60L-TMS-T	2N60G-TMS-T	TO-251S	G	D	S	-	-	-	-	-	Tube
2N60L-TMS2-T	2N60G-TMS2-T	TO-251S2	G	D	S	-	-	-	-	-	Tube
2N60L-TMS4-T	2N60G-TMS4-T	TO-251S4	G	D	S	-	-	-	-	-	Tube
2N60L-TN3-R	2N60G-TN3-R	TO-252	G	D	S	-	-	-	-	-	Tape Reel
2N60L-TND-R	2N60G-TND-R	TO-252D	G	D	S	-	-	-	-	-	Tape Reel
2N60L-T2Q-T	2N60G-T2Q-T	TO-262	G	D	S	-	-	-	-	-	Tube
2N60L-T60-K	2N60G-T60-K	TO-126	G	D	S	-	-	-	-	-	Bulk
2N60L-T6C-K	2N60G-T6C-K	TO-126C	G	D	S	-	-	-	-	-	Bulk
-	2N60G-E-K08-5060-R	DFN-8(5×6)	S	S	S	G	D	D	D	D	Tape Reel

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

<p>2N60L-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, K: Bulk</p> <p>(2) TA3: TO-220, TF1: TO-220F1, TF2: TO-220F2, TF3: TO-220F, TF3T: TO-220F3, TM3: TO-251, TMA: TO-251L, TMS: TO-251S, TMS2: TO-251S2, TMS4: TO-251S4, TN3: TO-252, TND: TO-252D, T2Q: TO-262, T60: TO-126, T6C: TO-126C, K08-5060: DFN-8(5×6)</p> <p>(3) L: Lead Free, G: Halogen Free and Lead Free</p>
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## MARKING INFORMATION

PACKAGE	MARKING
TO-220 TO-220F TO-220F1 TO-220F2 TO-220F3 TO-251 TO-251L	TO-251S TO-251S2 TO-251S4 TO-252 TO-252D TO-262  <p>UTC 2N60 Lot Code ← [ ] → Data Code 1</p> <p>L: Lead Free G: Halogen Free</p>
TO-126 TO-126C	<p>UTC [ ] 2N60 [ ] 1</p> <p>Data Code L: Lead Free G: Halogen Free</p>
DFN-8(5×6)	<p>UTC 2N60G Lot Code ← [ ] → Date 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)		$I_{AR}$	2.0	A
Drain Current	Continuous	$I_D$	2.0	A
	Pulsed (Note 2)	$I_{DM}$	8.0	A
Avalanche Energy	Single Pulsed (Note 3)	$E_{AS}$	140	mJ
	Repetitive (Note 2)	$E_{AR}$	4.5	mJ
Peak Diode Recovery dv/dt (Note 4)		dv/dt	4.5	V/ns
Power Dissipation ( $T_C = 25^\circ\text{C}$ )	TO-220/ TO-262	$P_D$	54	W
	TO-220F/TO-220F1 TO-220F3		23	W
	TO-220F2		24	W
	TO-251/TO-251L TO-251S/TO-252 TO-252D		44	W
	TO-126/TO-126C		40	W
	DFN-8(5×6)		22	W
	Junction Temperature		$T_J$	+150
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  $T_J$ .

3.  $L=64\text{mH}$ ,  $I_{AS}=2.0\text{A}$ ,  $V_{DD}=50\text{V}$ ,  $R_G=25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$

4.  $I_{SD}\leq 2.4\text{A}$ ,  $di/dt\leq 200\text{A}/\mu\text{s}$ ,  $V_{DD}\leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$

■ THERMAL DATA

PARAMETER	PACKAGE	SYMBOL	RATINGS	UNIT		
Junction to Ambient	TO-220/TO-220F TO-220F1/TO-220F2 TO-220F3/TO-262	$\theta_{JA}$	62.5	$^\circ\text{C}/\text{W}$		
	TO-251/TO-251L TO-251S/TO-252 TO-252D		100	$^\circ\text{C}/\text{W}$		
	TO-126/TO-126C		89	$^\circ\text{C}/\text{W}$		
	DFN-8(5×6)		75	$^\circ\text{C}/\text{W}$		
	Junction to Case		TO-220/ TO-262	$\theta_{JC}$	2.32	$^\circ\text{C}/\text{W}$
			TO-220F/TO-220F1 TO-220F3		5.5	$^\circ\text{C}/\text{W}$
TO-220F2		5.43	$^\circ\text{C}/\text{W}$			
TO-251/TO-251L TO-251S/TO-252 TO-252D		2.87	$^\circ\text{C}/\text{W}$			
TO-126/TO-126C		3.12	$^\circ\text{C}/\text{W}$			
DFN-8(5×6)		5.6	$^\circ\text{C}/\text{W}$			

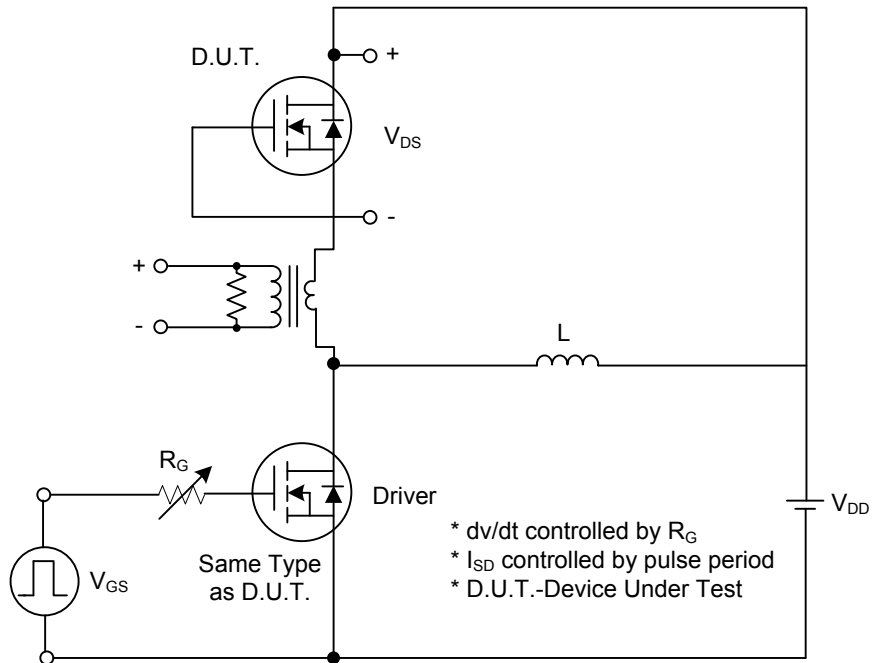
■ ELECTRICAL CHARACTERISTICS ( $T_J=25^\circ\text{C}$ , unless otherwise specified)

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	$\mu A$
		$V_{DS} = 480V, T_C = 125^\circ\text{C}$			100	$\mu A$
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	$\Delta BV_{DSS}/\Delta T_J$	$I_D=250\mu A$ , Referenced to $25^\circ\text{C}$		0.4		$V/^\circ\text{C}$
<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	$R_{DS(ON)}$	$V_{GS} = 10V, I_D = 1A$		3.6	5	$\Omega$
<b>DYNAMIC CHARACTERISTICS</b>						
Input Capacitance	$C_{ISS}$	$V_{DS} = 25V, V_{GS} = 0V,$ $f = 1\text{MHz}$		300	350	pF
Output Capacitance	$C_{OSS}$			45	50	pF
Reverse Transfer Capacitance	$C_{RSS}$			10	13	pF
<b>SWITCHING CHARACTERISTICS</b>						
Turn-On Delay Time	$t_{D(ON)}$	$V_{DD} = 300V, I_D = 2.4A,$ $R_G = 25\Omega$ (Note 1, 2)		40	60	ns
Turn-On Rise Time	$t_R$			35	55	ns
Turn-Off Delay Time	$t_{D(OFF)}$			90	120	ns
Turn-Off Fall Time	$t_F$			50	60	ns
Total Gate Charge	$Q_G$	$V_{DS} = 480V, V_{GS} = 10V,$ $I_D = 2.4A$ (Note 1, 2)		40	50	nC
Gate-Source Charge	$Q_{GS}$			4.2		nC
Gate-Drain Charge	$Q_{GD}$			8.4		nC
<b>DRAIN-SOURCE DIODE CHARACTERISTICS</b>						
Drain-Source Diode Forward Voltage	$V_{SD}$	$V_{GS} = 0V, I_{SD} = 2.0A$			1.4	V
Continuous Drain-Source Current	$I_{SD}$				2.0	A
Pulsed Drain-Source Current	$I_{SM}$				8.0	A
Reverse Recovery Time	$t_{rr}$	$V_{GS} = 0V, I_{SD} = 2.4A,$ $di/dt = 100A/\mu s$ (Note 1)		180		ns
Reverse Recovery Charge	$Q_{RR}$			0.72		$\mu C$

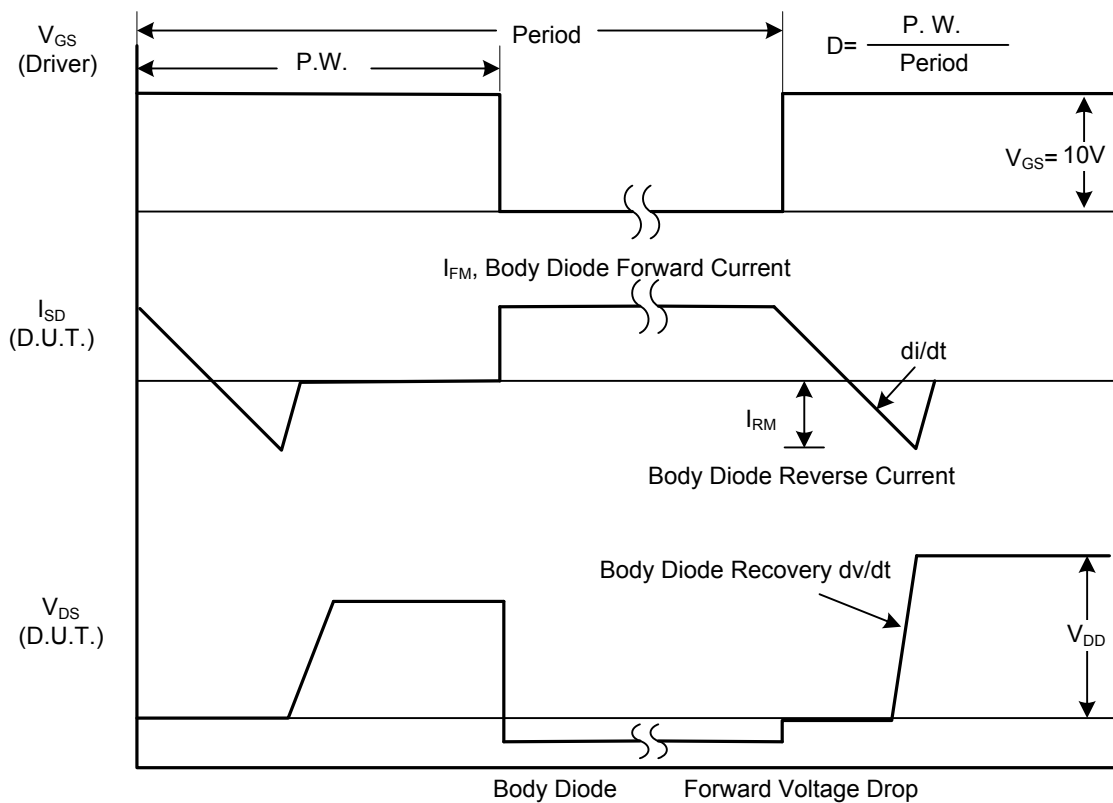
Notes: 1. Pulse Test: Pulse width  $\leq 300\mu s$ , Duty cycle  $\leq 2\%$ .

2. Essentially independent of operating temperature.

■ TEST CIRCUITS AND WAVEFORMS

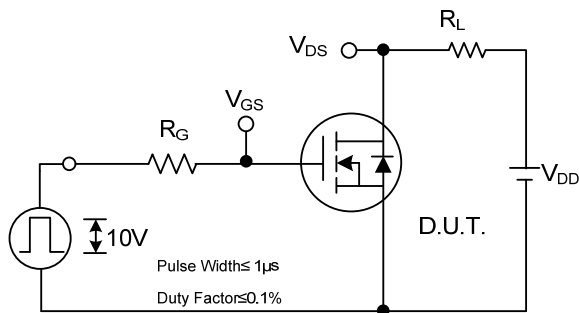


Peak Diode Recovery  $dv/dt$  Test Circuit

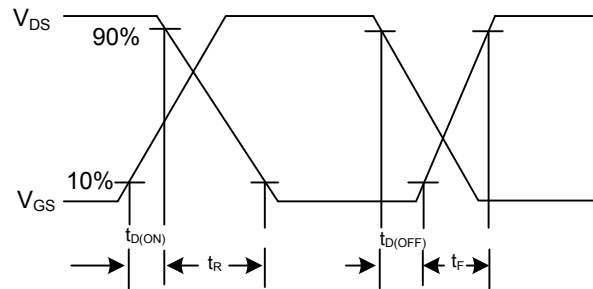


Peak Diode Recovery  $dv/dt$  Waveforms

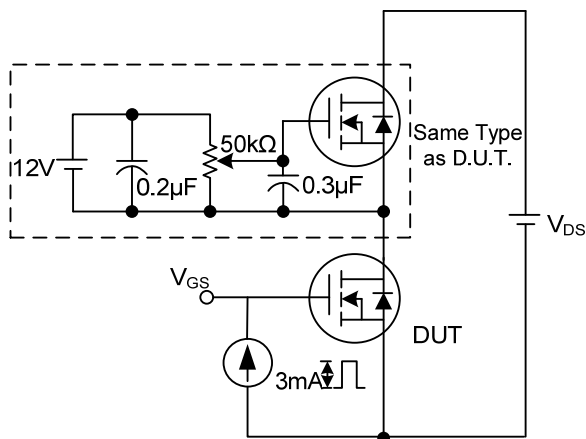
## ■ TEST CIRCUITS AND WAVEFORMS (Cont.)



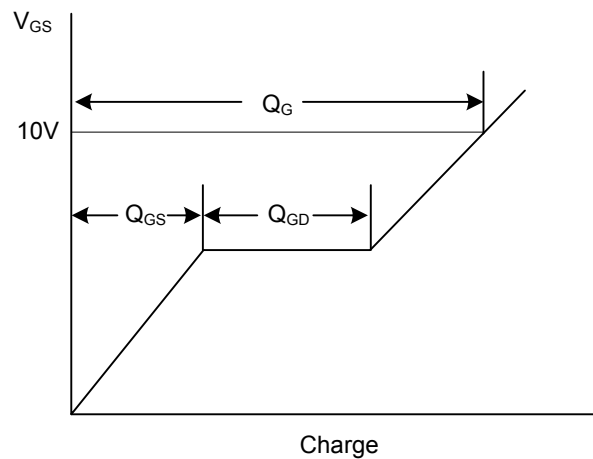
**Switching Test Circuit**



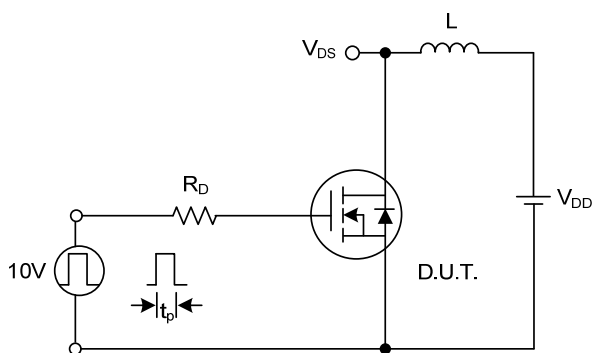
**Switching Waveforms**



**Gate Charge Test Circuit**



**Gate Charge Waveform**

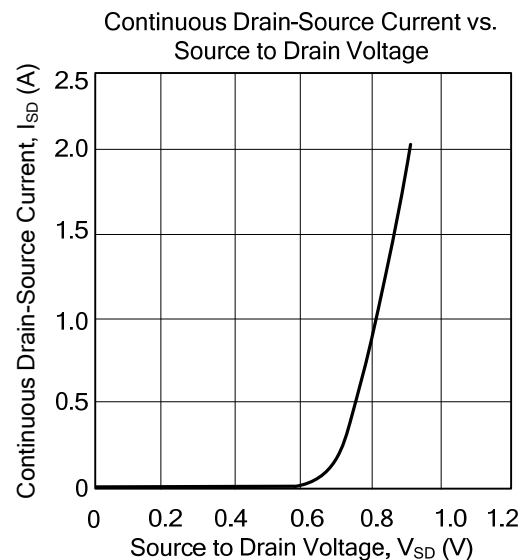
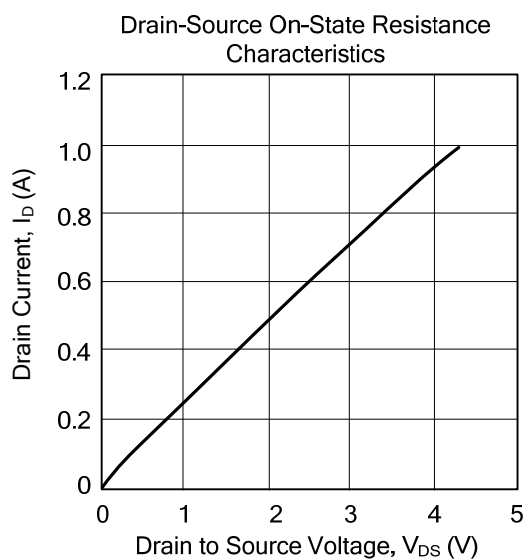
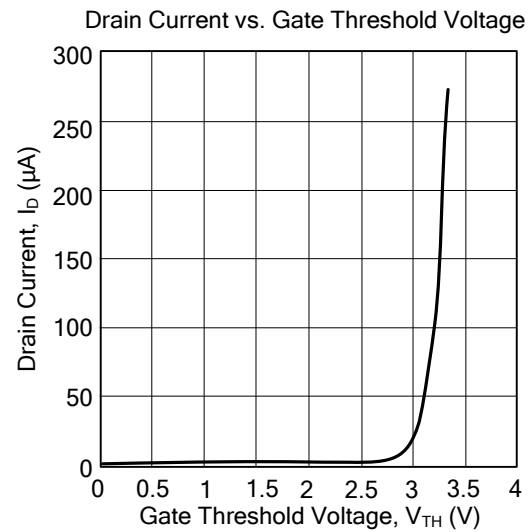
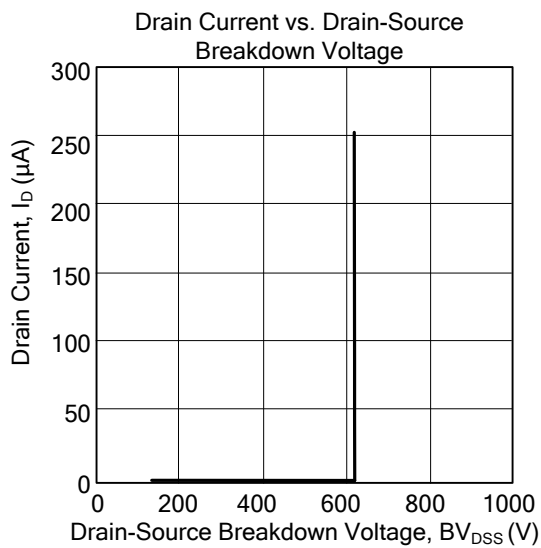


**Unclamped Inductive Switching Test Circuit**



**Unclamped Inductive Switching Waveforms**

## ■ TYPICAL CHARACTERISTICS



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