



## 4N60-Q

Power MOSFET

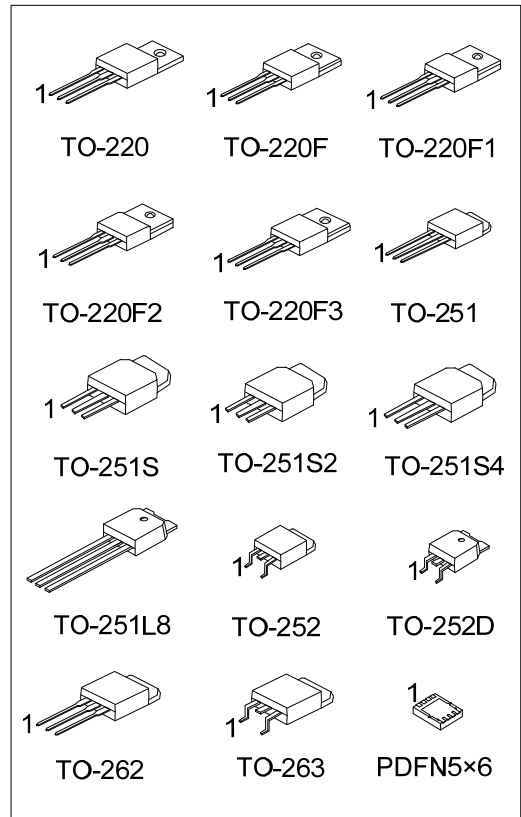
### 4.0A, 600V N-CHANNEL POWER MOSFET

#### DESCRIPTION

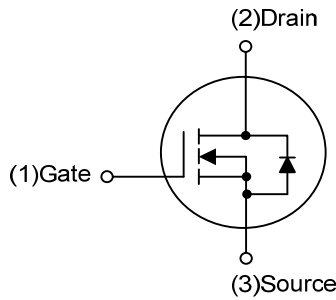
The UTC **4N60-Q** is a high voltage power MOSFET and is designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and have a high rugged avalanche characteristics. This power MOSFET is usually used at high speed switching applications in power supplies, PWM motor controls, high efficient AC to DC converters and bridge circuits.

#### FEATURES

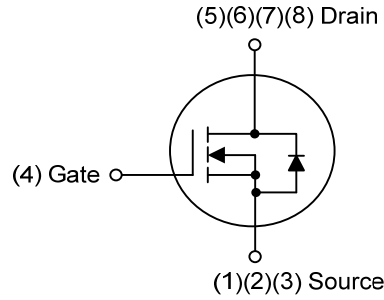
- \*  $R_{DS(ON)} \leq 2.5 \Omega @ V_{GS}=10V, I_D=2.2A$
- \* Fast Switching Capability
- \* Avalanche Energy Specified
- \* Improved dv/dt Capability, high RuggednessA



#### SYMBOL



TO-220/TO-220F/TO-220F1  
 TO-220F2/TO-220F3/TO-251  
 TO-251S/TO-251S2/TO-251S4/TO-251L8  
 TO-252/TO-252D/TO-262/TO-263



PDFN5x6

## 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-TF1-T	4N60G-TF1-T	TO-220F1	G	D	S	-	-	-	-	-	Tube
4N60L-TF2-T	4N60G-TF2-T	TO-220F2	G	D	S	-	-	-	-	-	Tube
4N60L-TF3-T	4N60G-TF3-T	TO-220F	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-TMA8-T	4N60G-TMA8-T	TO-251L8	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-P5060-R	4N60G-P5060-R	PDFN5×6	S	S	S	G	D	D	D	D	Tape Reel

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

<p>4N60G-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, 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, P5060: PDFN5×6</p> <p>(3) G: Halogen Free and Lead Free, L: Lead Free</p>
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## MARKING

PACKAGE	MARKING														
<table border="1"> <tr><td>TO-220</td><td>TO-251S</td></tr> <tr><td>TO-220F</td><td>TO-251S2</td></tr> <tr><td>TO-220F1</td><td>TO-251S4</td></tr> <tr><td>TO-220F2</td><td>TO-252</td></tr> <tr><td>TO-220F3</td><td>TO-252D</td></tr> <tr><td>TO-251</td><td>TO-262</td></tr> <tr><td>TO-251L8</td><td>TO-263</td></tr> </table>	TO-220	TO-251S	TO-220F	TO-251S2	TO-220F1	TO-251S4	TO-220F2	TO-252	TO-220F3	TO-252D	TO-251	TO-262	TO-251L8	TO-263	<p>UTC 4N60</p> <p>Lot Code ← [ ] → Date Code</p> <p>1</p> <p>L: Lead Free G: Halogen Free</p>
TO-220	TO-251S														
TO-220F	TO-251S2														
TO-220F1	TO-251S4														
TO-220F2	TO-252														
TO-220F3	TO-252D														
TO-251	TO-262														
TO-251L8	TO-263														
PDFN5×6	<p>UTC 4N60</p> <p>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)	$I_{AR}$	4.4	A
Drain Current	Continuous	$I_D$	4.0
	Pulsed (Note 2)	$I_{DM}$	16
Avalanche Energy	Single Pulsed (Note 3)	$E_{AS}$	60
	Repetitive (Note 2)	$E_{AR}$	10.6
Peak Diode Recovery dv/dt (Note 4)	dv/dt	4.5	V/ns
Power Dissipation	TO-220/TO-262/TO-263	$P_D$	106
	TO-220F/TO-220F1		36
	TO-220F3		38
	TO-220F2		50
	TO-251/ TO-251L8 TO-251S/TO-251S2 TO-251S4 TO-252/TO-252D		50
	PDFN5×6		30
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.  $L = 30\text{mH}$ ,  $I_{AS} = 2\text{A}$ ,  $V_{DD} = 50\text{V}$ ,  $R_G = 25\ \Omega$ , 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

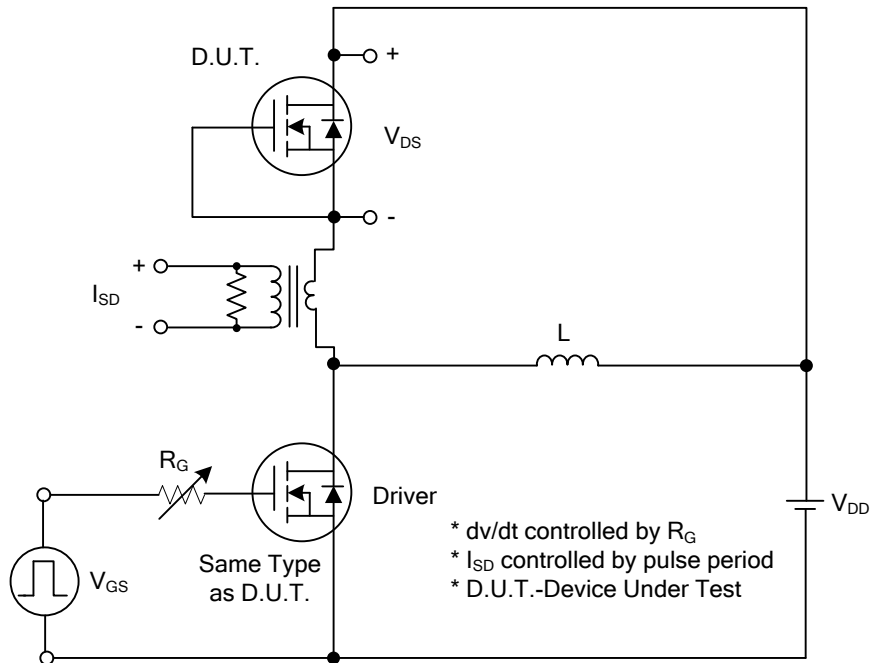
PARAMETER	PACKAGE	SYMBOL	RATINGS	UNIT			
Junction to Ambient	TO-220/TO-262/TO-263 TO-220F/TO-220F1 TO-220F2/TO-220F3	$\theta_{JA}$	62.5	$^\circ\text{C}/\text{W}$			
	TO-251/ TO-251L8 TO-251S/TO-251S2 TO-251S4 TO-252/TO-252D		110				
	PDFN5×6		75				
	Junction to Case		TO-220/TO-262/TO-263		$\theta_{JC}$	1.18	$^\circ\text{C}/\text{W}$
			TO-220F/TO-220F1			3.47	
			TO-220F3			3.28	
TO-220F2		2.5					
TO-251/ TO-251L8 TO-251S/TO-251S2 TO-251S4 TO-252/TO-252D		2.5					
PDFN5×6		4.17					

■ ELECTRICAL CHARACTERISTICS (T<sub>C</sub>=25°C, unless otherwise specified)

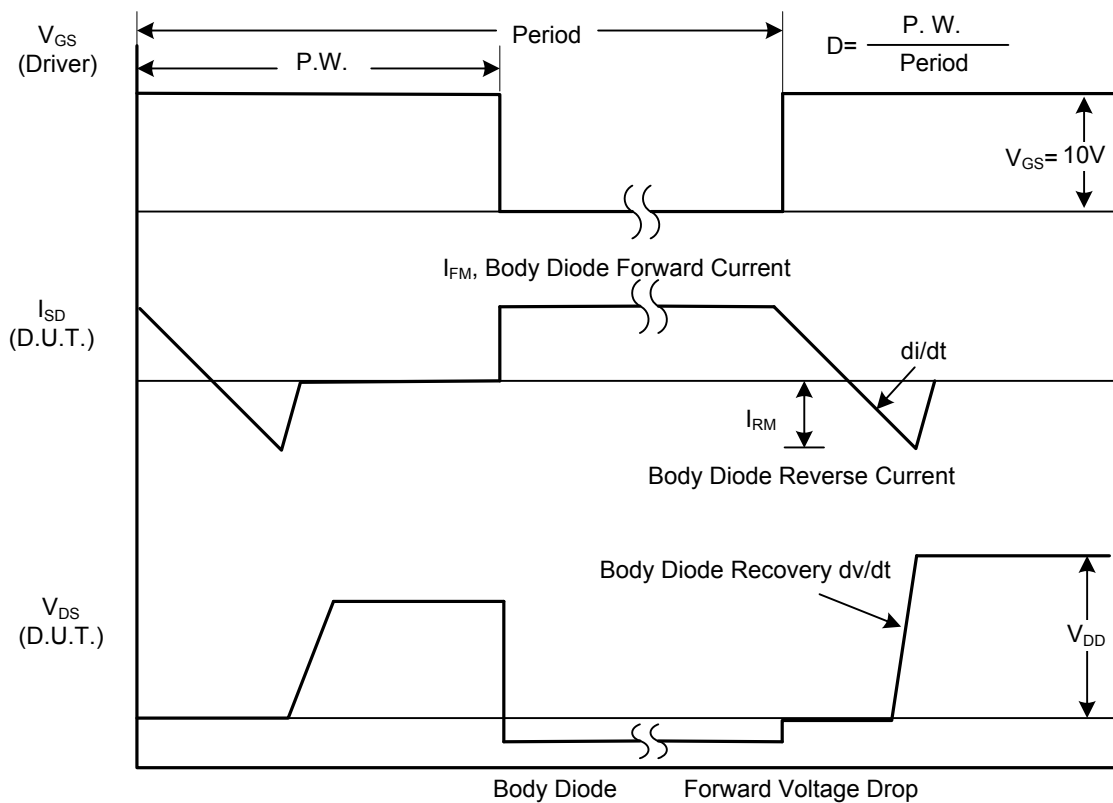
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>OFF CHARACTERISTICS</b>						
Drain-Source Breakdown Voltage	BV <sub>DSS</sub>	V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA	600			V
Drain-Source Leakage Current	I <sub>DSS</sub>	V <sub>DS</sub> = 600V, V <sub>GS</sub> = 0V			10	μA
Gate-Source Leakage Current	Forward	I <sub>GSS</sub>			100	nA
	Reverse				-100	nA
Breakdown Voltage Temperature Coefficient	ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>	I <sub>D</sub> =250μA, Referenced to 25°C		0.6		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> = 10 V, I <sub>D</sub> = 2.2A		2.2	2.5	Ω
<b>DYNAMIC CHARACTERISTICS</b>						
Input Capacitance	C <sub>ISS</sub>	V <sub>DS</sub> = 25V, V <sub>GS</sub> = 0V, f = 1MHz		520	600	pF
Output Capacitance	C <sub>OSS</sub>			52	70	pF
Reverse Transfer Capacitance	C <sub>RSS</sub>			11	15	pF
<b>SWITCHING CHARACTERISTICS</b>						
Total Gate Charge (Note 1)	Q <sub>G</sub>	V <sub>DS</sub> = 200V, I <sub>D</sub> = 1.3A, I <sub>G</sub> = 100μA, V <sub>GS</sub> = 10V (Note 1, 2)		18.2		nC
Gate-Source Charge	Q <sub>GS</sub>			5.2		nC
Gate-Drain Charge	Q <sub>GD</sub>			4.3		nC
Turn-On Delay Time (Note 1)	t <sub>D(ON)</sub>	V <sub>DD</sub> = 200V, I <sub>D</sub> = 2.0A, R <sub>G</sub> = 25Ω (Note 1, 2)		12	80	ns
Turn-On Rise Time	t <sub>R</sub>			18	70	ns
Turn-Off Delay Time	t <sub>D(OFF)</sub>			32	120	ns
Turn-Off Fall Time	t <sub>F</sub>			22	70	ns
<b>SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS</b>						
Maximum Continuous Drain-Source Diode Forward Current	I <sub>S</sub>				4.4	A
Maximum Pulsed Drain-Source Diode Forward Current	I <sub>SM</sub>				17.6	A
Drain-Source Diode Forward Voltage (Note 1)	V <sub>SD</sub>	V <sub>GS</sub> = 0V, I <sub>S</sub> = 4.4A			1.4	V
Reverse Recovery Time (Note 1)	t <sub>rr</sub>	V <sub>GS</sub> = 0 V, I <sub>S</sub> = 4.4A, dI <sub>F</sub> /dt = 100 A/μs (Note 1)		250		ns
Reverse Recovery Charge	Q <sub>rr</sub>				1.5	

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

## ■ TEST CIRCUITS AND WAVEFORMS

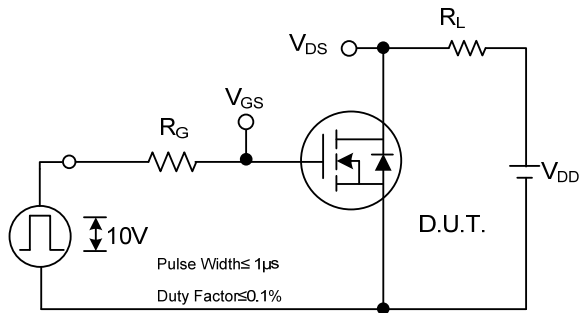


**Peak Diode Recovery  $dv/dt$  Test Circuit**

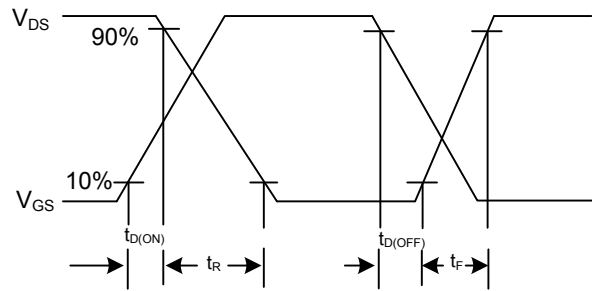


**Peak Diode Recovery  $dv/dt$  Waveforms**

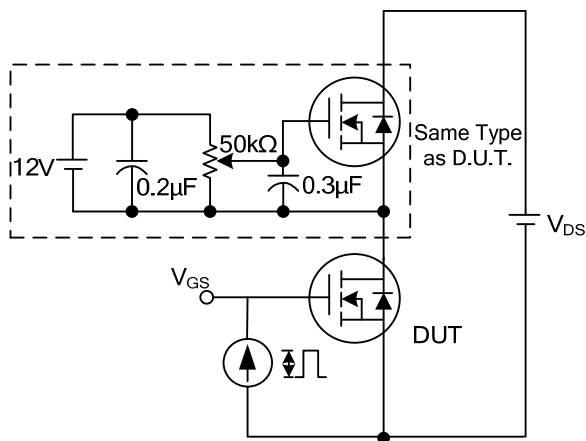
## TEST CIRCUITS AND WAVEFORMS (Cont.)



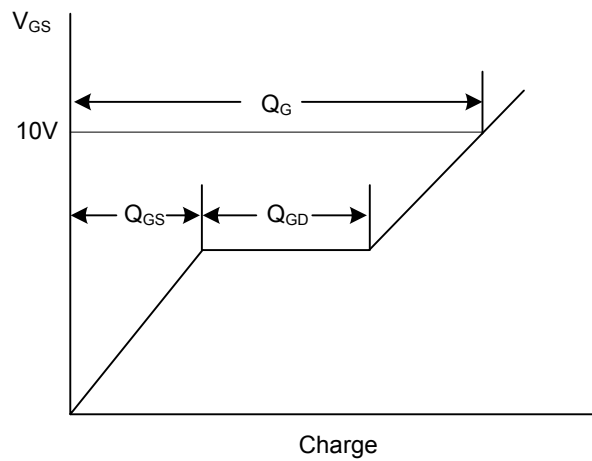
**Switching Test Circuit**



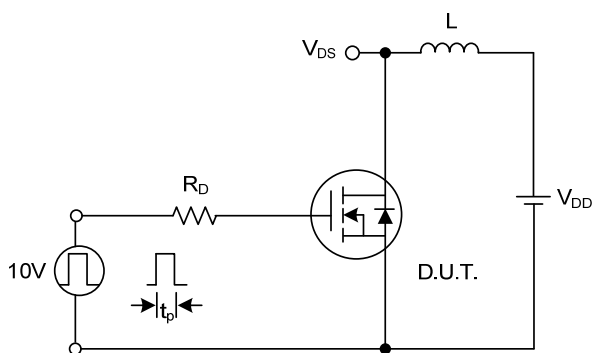
**Switching Waveforms**



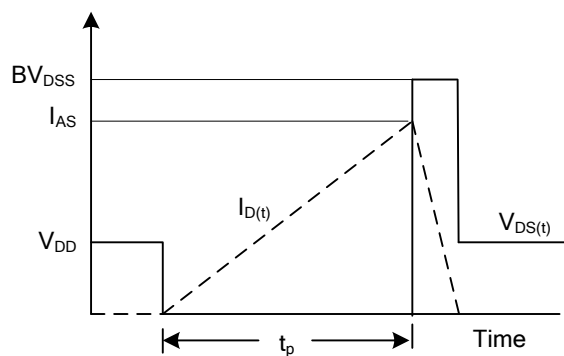
**Gate Charge Test Circuit**



**Gate Charge Waveform**

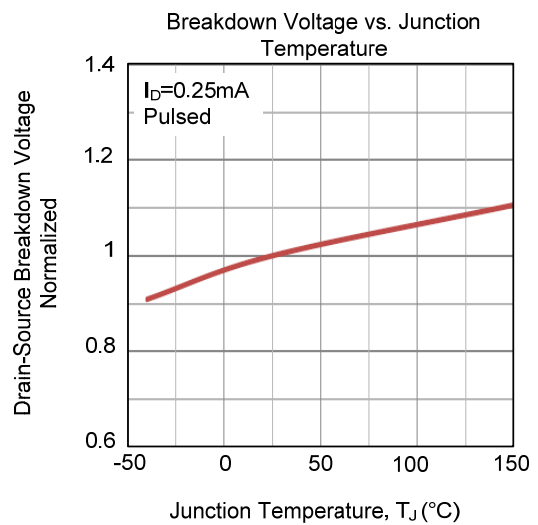
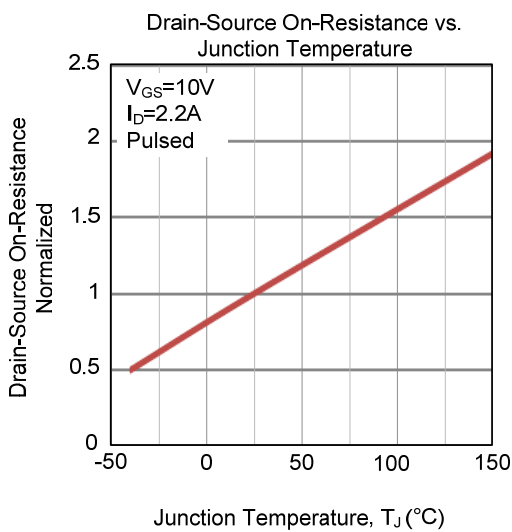
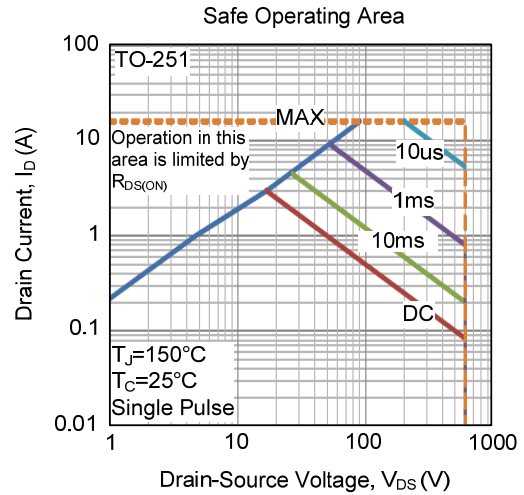
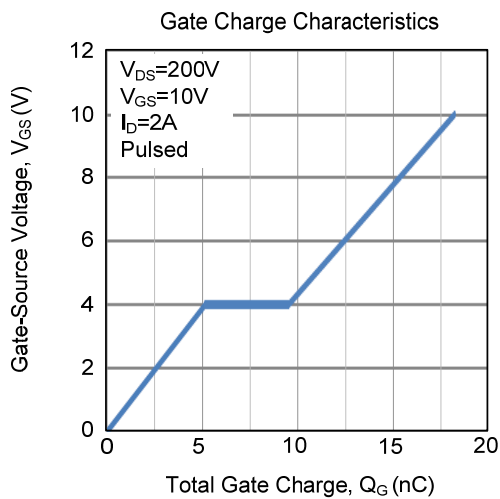
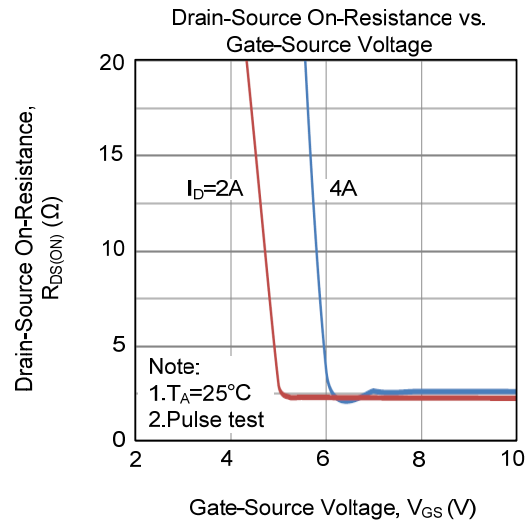
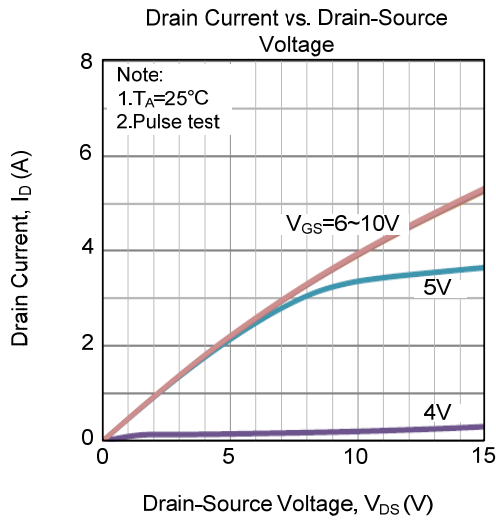


**Unclamped Inductive Switching Test Circuit**

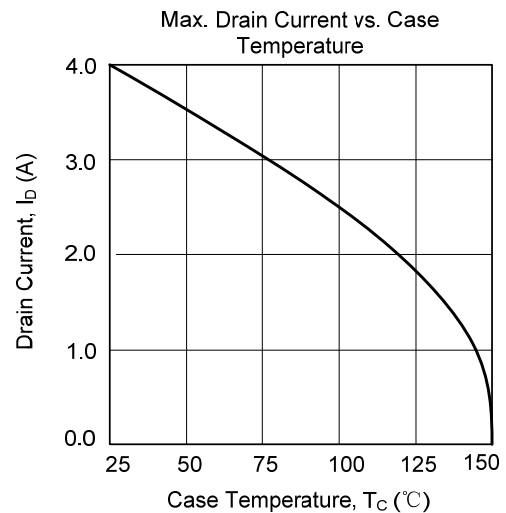
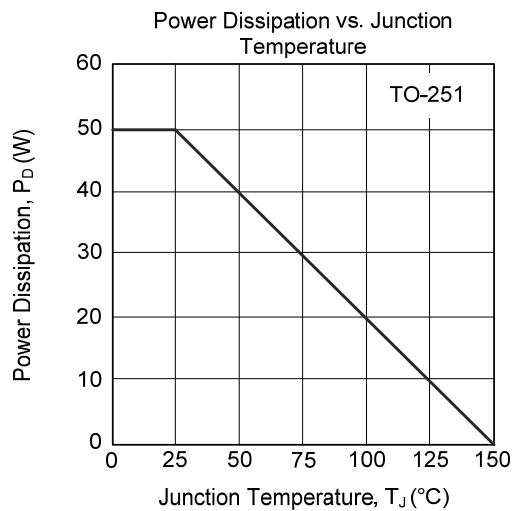
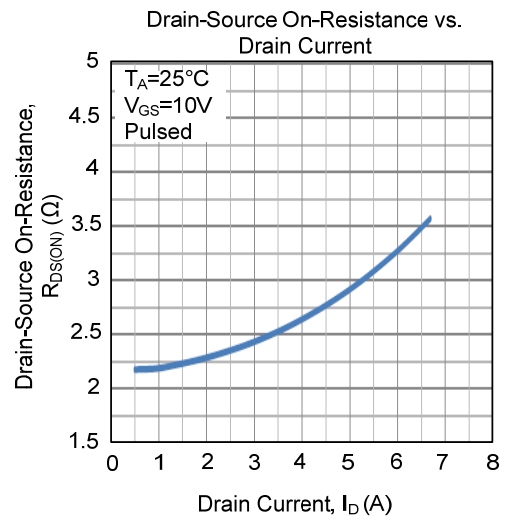
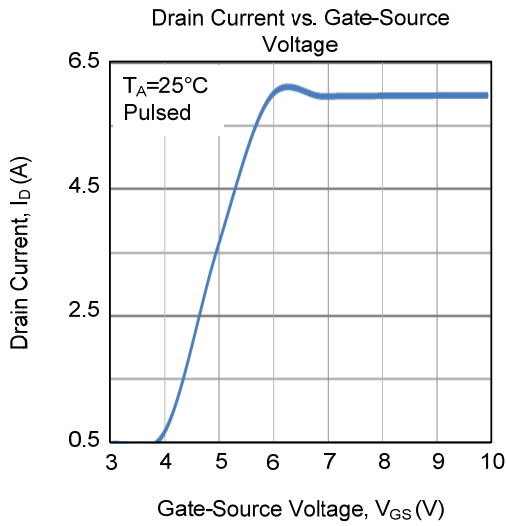
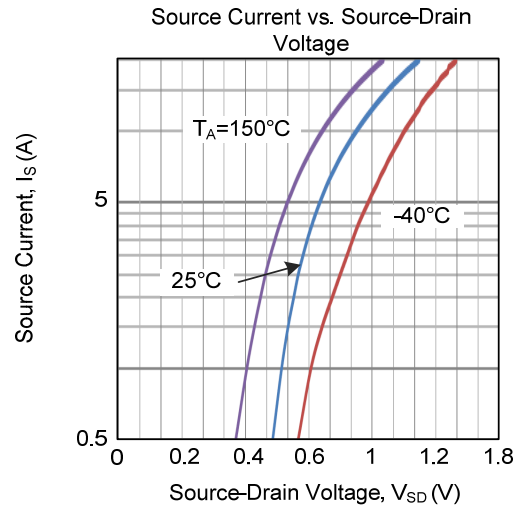
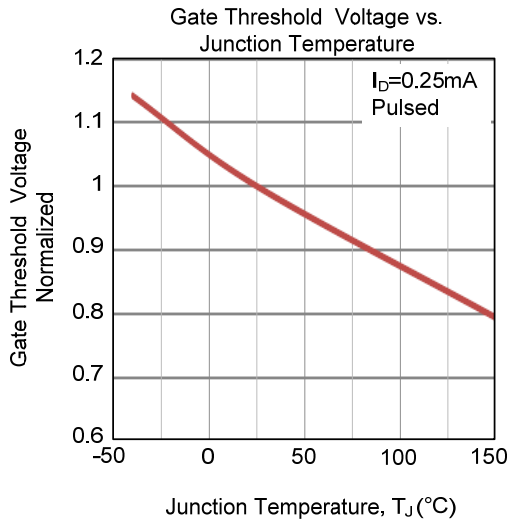


**Unclamped Inductive Switching Waveforms**

## TYPICAL CHARACTERISTICS



■ TYPICAL CHARACTERISTICS (Cont.)





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