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# 4N60

**Power MOSFET**

## 4 Amps, 600/650 Volts N-CHANNEL POWER MOSFET

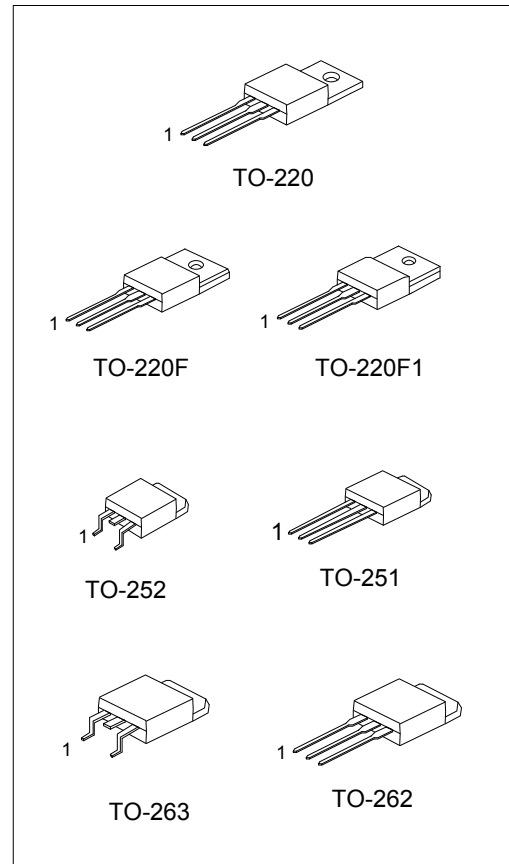
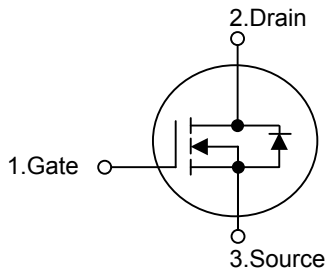
■ DESCRIPTION

The UTC **4N60** 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

- \*  $R_{DS(ON)} = 2.5\Omega @ V_{GS} = 10V$
- \* Ultra Low Gate Charge ( typical 15 nC )
- \* Low Reverse Transfer CAPACITANCE (  $C_{RSS} =$  typical 8.0 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	
4N60L-x-TA3-T	4N60G-x-TA3-T	TO-220	G	D	S	Tube
4N60L-x-TF1-T	4N60G-x-TF1-T	TO-220F1	G	D	S	Tube
4N60L-x-TF3-T	4N60G-x-TF3-T	TO-220F	G	D	S	Tube
4N60L-x-TM3-T	4N60G-x-TM3-T	TO-251	G	D	S	Tube
4N60L-x-TN3-R	4N60G-x-TN3-R	TO-252	G	D	S	Tape Reel
4N60L-x-T2Q-T	4N60G-x-T2Q-T	TO-262	G	D	S	Tube
4N60L-x-TQ3-R	4N60G-x-TQ3-R	TO-263	G	D	S	Tape Reel
4N60L-x-TQ3-T	4N60G-x-TQ3-T	TO-263	G	D	S	Tube

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

<p>4N60L-x-TA3-T</p>	<p>(1) T: Tube, R: Tape Reel</p> <p>(2) TA3: TO-220, TF1: TO-220F1, TF3: TO-220F, TM3: TO-251</p> <p>TN3: TO-252, T2Q: TO-262, TQ3: TO-263</p> <p>(3) A: 600V, B: 650V</p> <p>(4) G: Halogen Free, L: Lead Free</p>
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■ ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ , unless otherwise specified)

PARAMETER		SYMBOL	RATINGS	UNIT	
Drain-Source Voltage	4N60-A	$V_{DSS}$	600	V	
	4N60-B		650	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	A	
	Pulsed (Note 2)	$I_{DM}$	16	A	
Avalanche Energy	Single Pulsed (Note 3)	$E_{AS}$	4N60	260	mJ
			4N60-E	200	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/TO-262/TO-263	$P_D$	106	W	
	TO-220F/TO-220F1		36	W	
	TO-251		50	W	
	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.  $L = 30\text{mH}$ ,  $I_{AS} = 4\text{A}$ ,  $V_{DD} = 50\text{V}$ ,  $R_G = 25\ \Omega$ , 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	PACKAGE	SYMBOL	RATINGS	UNIT
Junction to Ambient	TO-220/TO-262/TO-263	$\theta_{JA}$	62.5	$^\circ\text{C}/\text{W}$
	TO-220F/TO-220F1		62.5	$^\circ\text{C}/\text{W}$
	TO-251		83	$^\circ\text{C}/\text{W}$
	TO-252		83	$^\circ\text{C}/\text{W}$
Junction to Case	TO-220/TO-262/TO-263	$\theta_{Jc}$	1.18	$^\circ\text{C}/\text{W}$
	TO-220F/TO-220F1		3.47	$^\circ\text{C}/\text{W}$
	TO-251		2.5	$^\circ\text{C}/\text{W}$
	TO-252		2.5	$^\circ\text{C}/\text{W}$

■ 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	4N60-A	$BV_{DSS}$	$V_{GS} = 0\text{V}$ , $I_D = 250\ \mu\text{A}$	600		V	
	4N60-B			650		V	
Drain-Source Leakage Current		$I_{DSS}$	$V_{DS} = 600\text{V}$ , $V_{GS} = 0\text{V}$		10	$\mu\text{A}$	
Gate-Source Leakage Current	Forward	$I_{GSS}$	$V_{GS} = 30\text{V}$ , $V_{DS} = 0\text{V}$		100	nA	
	Reverse		$V_{GS} = -30\text{V}$ , $V_{DS} = 0\text{V}$		-100	nA	
Breakdown Voltage Temperature Coefficient		$\Delta BV_{DSS}/\Delta T_J$	$I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$		0.6	$\text{V}/^\circ\text{C}$	
<b>ON CHARACTERISTICS</b>							
Gate Threshold Voltage		$V_{GS(TH)}$	$V_{DS} = V_{GS}$ , $I_D = 250\ \mu\text{A}$		2.0	4.0	V
Static Drain-Source On-State Resistance		$R_{DS(ON)}$	$V_{GS} = 10\text{V}$ , $I_D = 2.2\text{A}$			2.5	$\Omega$
<b>DYNAMIC CHARACTERISTICS</b>							
Input Capacitance		$C_{ISS}$	$V_{DS} = 25\text{V}$ , $V_{GS} = 0\text{V}$ , $f = 1\text{MHz}$	520	670	pF	
Output Capacitance		$C_{OSS}$		70	90	pF	
Reverse Transfer Capacitance		$C_{RSS}$		8	11	pF	

■ ELECTRICAL CHARACTERISTICS(Cont.)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>SWITCHING CHARACTERISTICS</b>						
Turn-On Delay Time	$t_{D(ON)}$	$V_{DD} = 300V, I_D = 4.0A, R_G = 25\Omega$ (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
<b>SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS</b>						
Drain-Source Diode Forward Voltage	$V_{SD}$	$V_{GS} = 0V, I_S = 4.4A$			1.4	V
Maximum Continuous Drain-Source Diode Forward Current	$I_S$				4.4	A
Maximum Pulsed Drain-Source Diode Forward Current	$I_{SM}$				17.6	A
Reverse Recovery Time	$t_{RR}$	$V_{GS} = 0V, I_S = 4.4A,$ $di_F/dt = 100A/\mu s$ (Note 1)		250		ns
Reverse Recovery Charge	$Q_{RR}$			1.5		$\mu C$

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

2. Essentially independent of operating temperature

■ TEST CIRCUITS AND WAVEFORMS

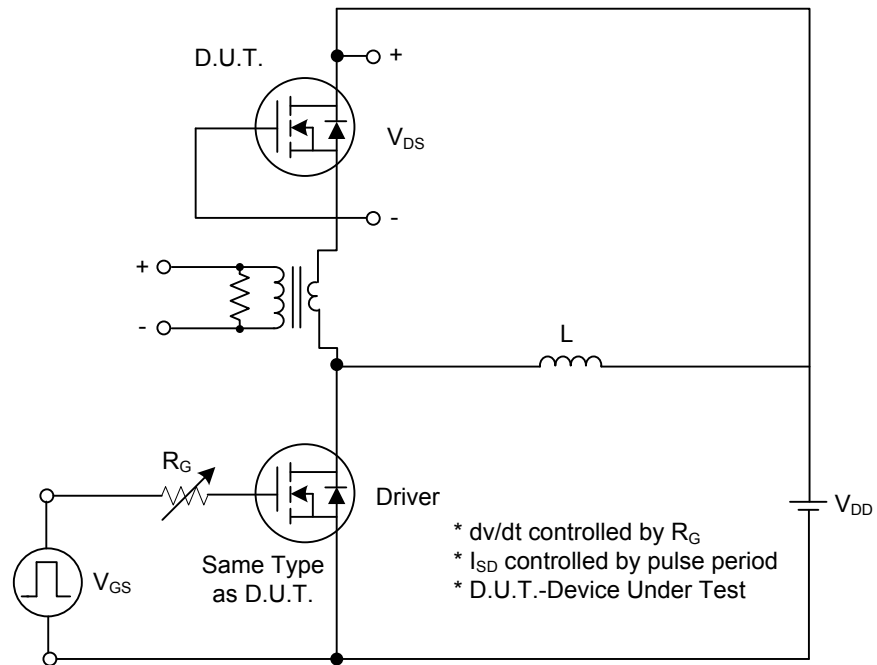


Fig. 1A Peak Diode Recovery dv/dt Test Circuit

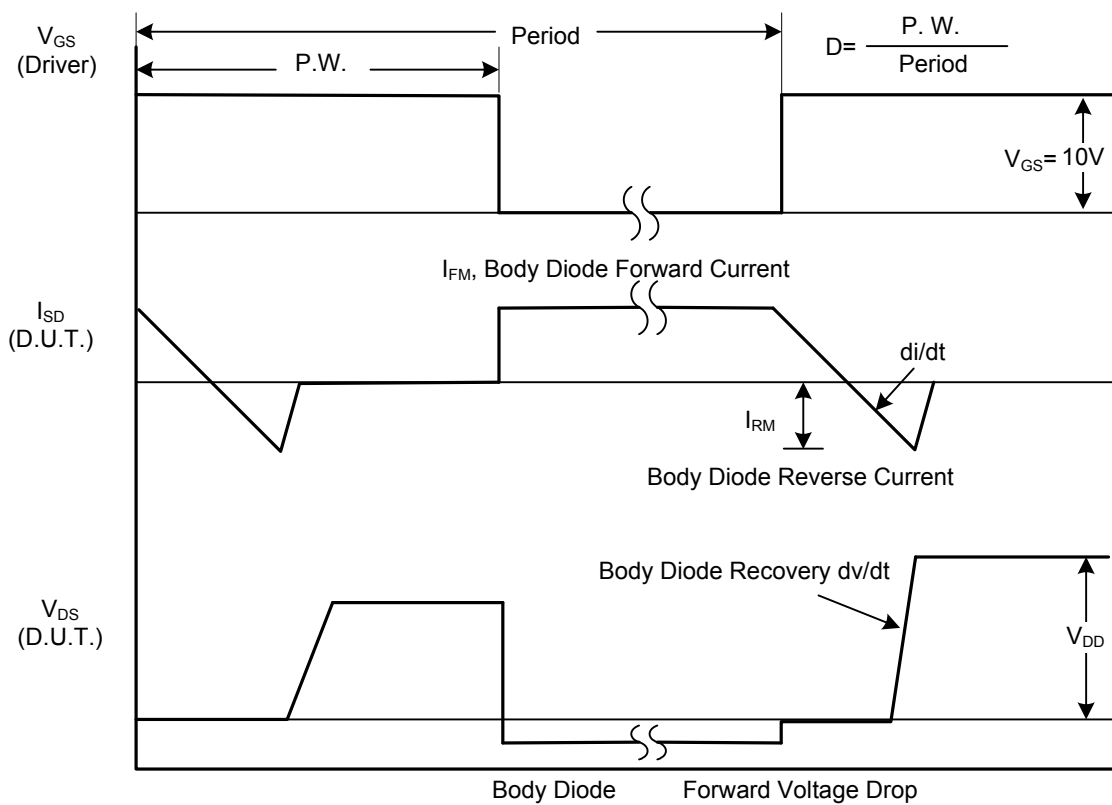


Fig. 1B Peak Diode Recovery dv/dt Waveforms

■ TEST CIRCUITS AND WAVEFORMS (Cont.)

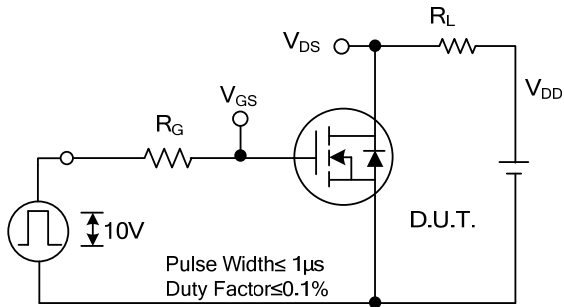


Fig. 2A Switching Test Circuit

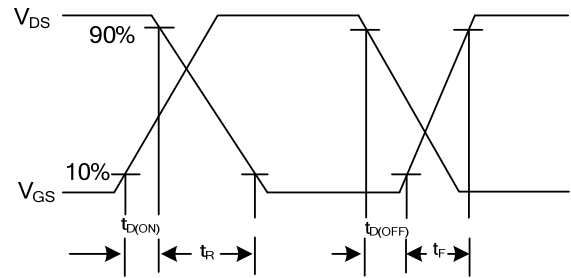


Fig. 2B Switching Waveforms

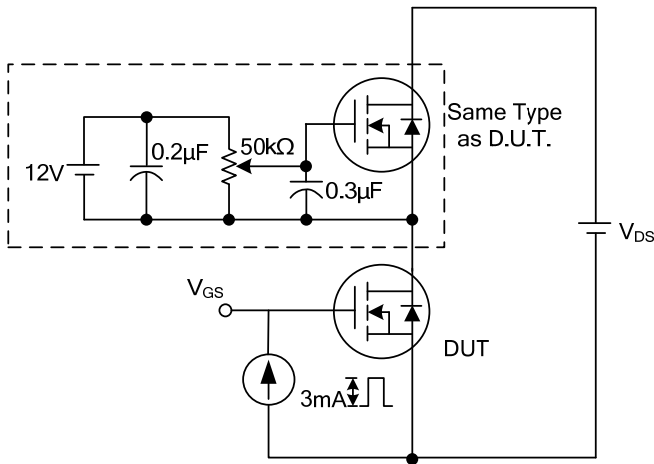


Fig. 3A Gate Charge Test Circuit

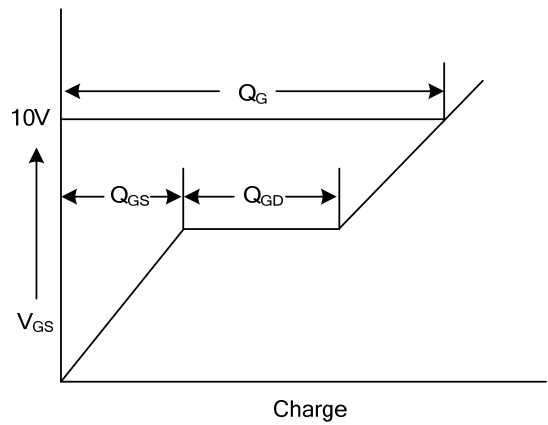


Fig. 3B Gate Charge Waveform

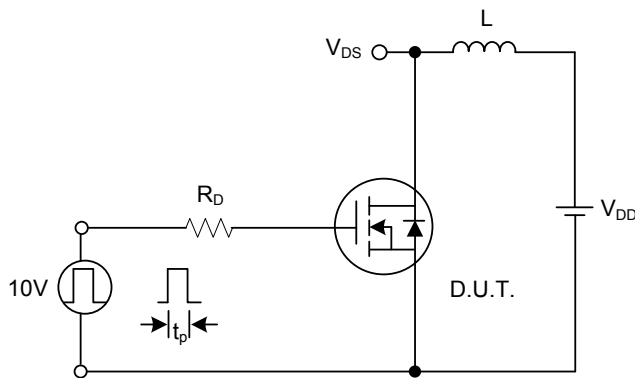


Fig. 4A Unclamped Inductive Switching Test Circuit

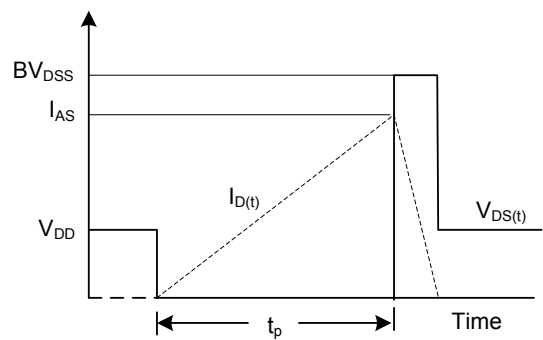
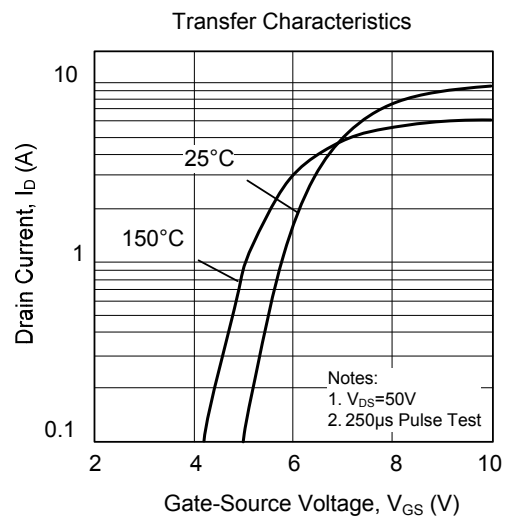
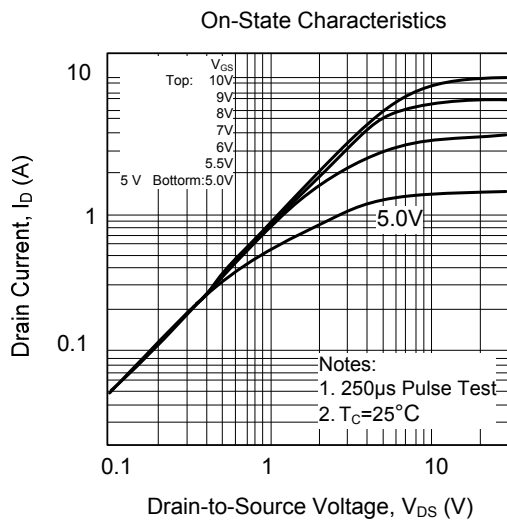
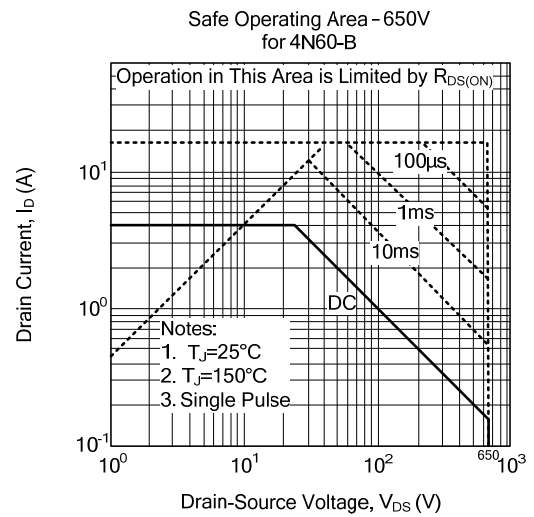
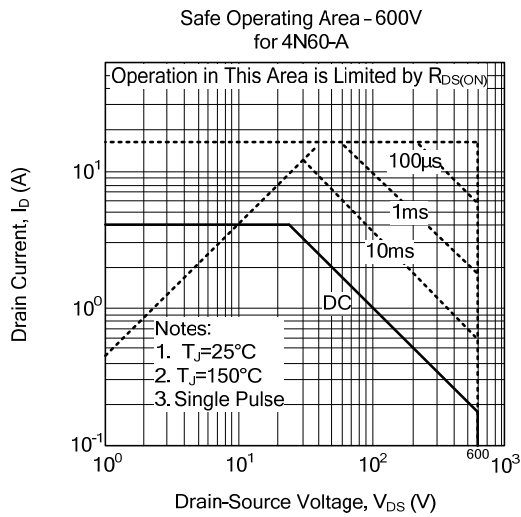
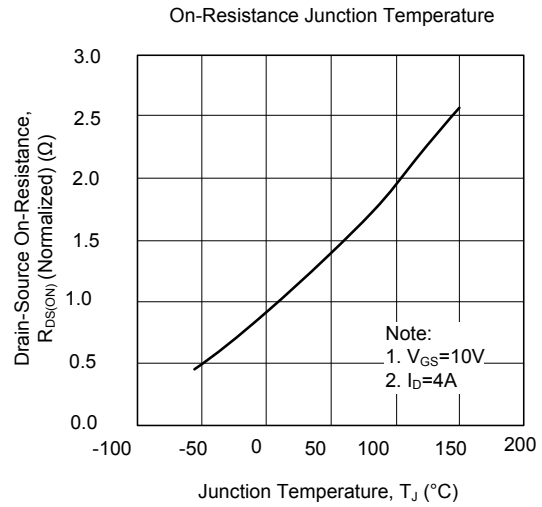
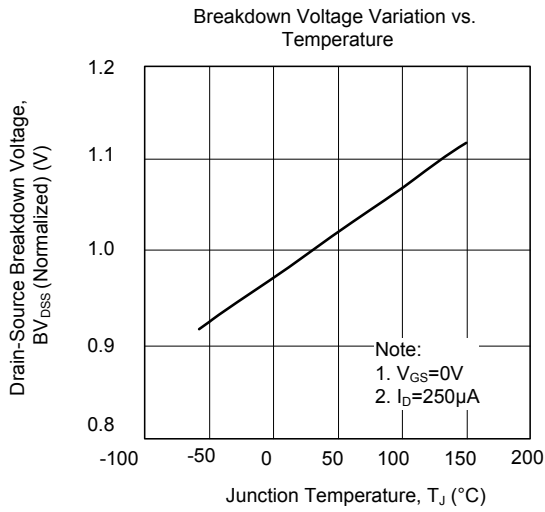


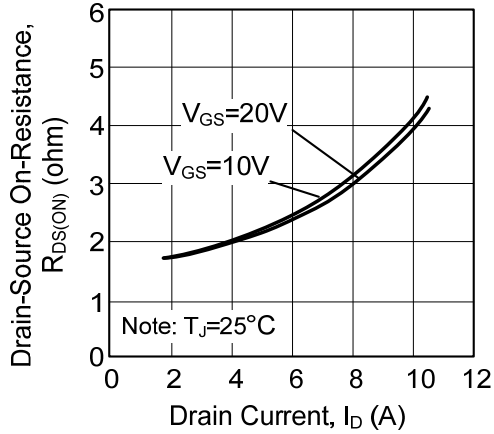
Fig. 4B Unclamped Inductive Switching Waveforms

## TYPICAL CHARACTERISTICS

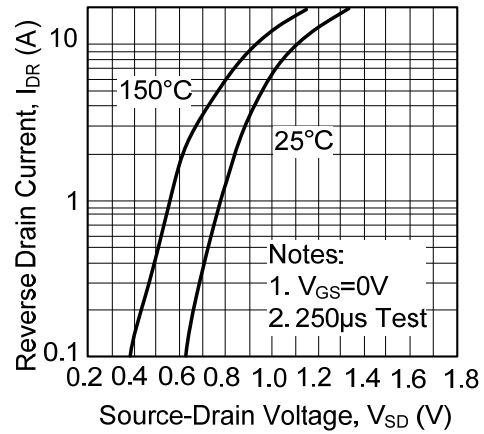


## ■ TYPICAL CHARACTERISTICS(Cont.)

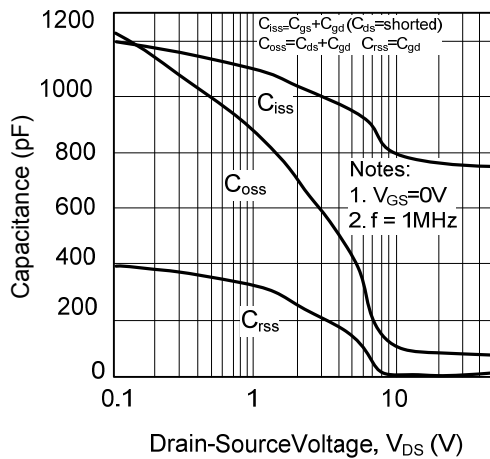
On-Resistance Variation vs. Drain Current and Gate Voltage



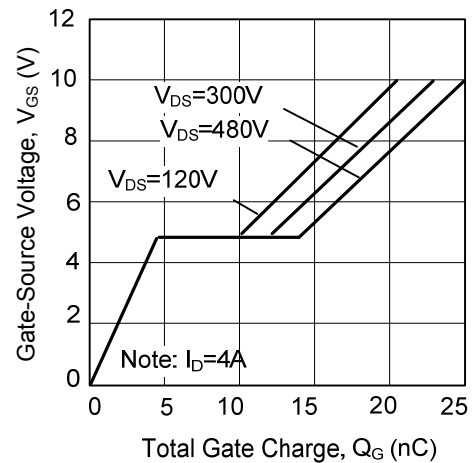
On State Current vs. Allowable Case Temperature



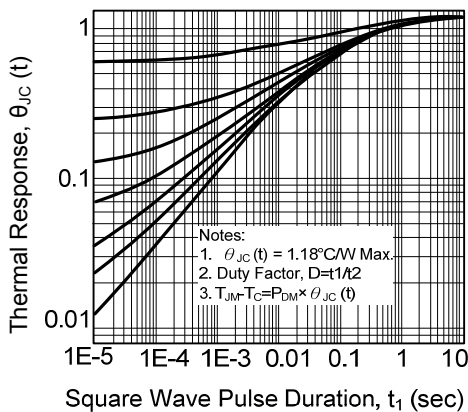
Capacitance Characteristics (Non-Repetitive)



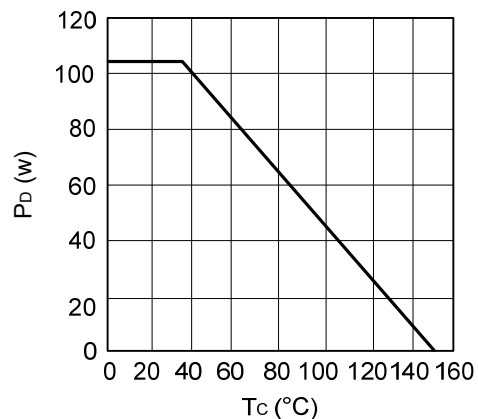
Gate Charge Characteristics



Transient Thermal Response Curve

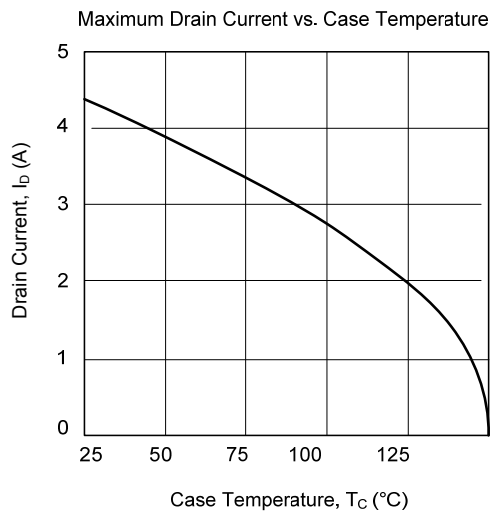


Power Dissipation





■ TYPICAL CHARACTERISTICS(Cont.)



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