



# 4N60

**Power MOSFET**

## 4A, 600V N-CHANNEL POWER MOSFET

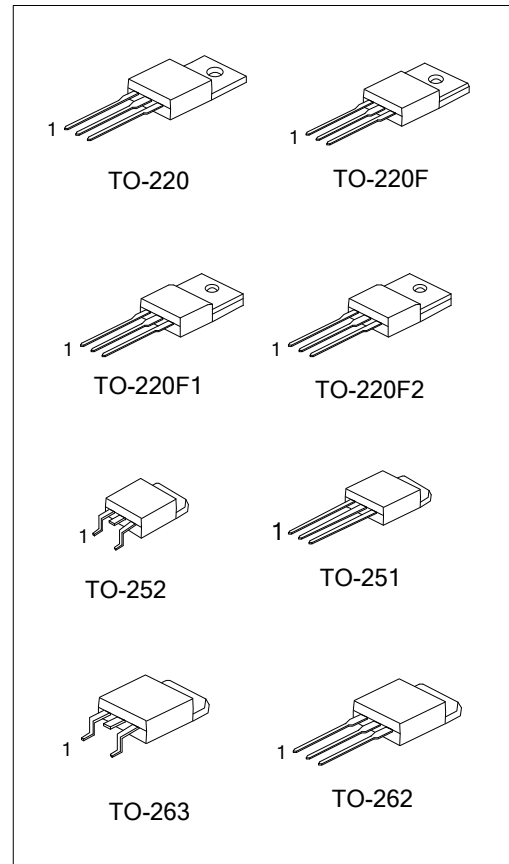
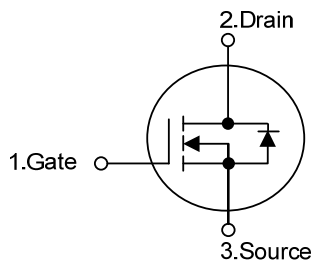
■ DESCRIPTION

The UTC **4N60** 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

- \*  $R_{DS(ON)} = 2.5\Omega @V_{GS} = 10V$
- \* 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-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-TM3-T	4N60G-TM3-T	TO-251	G	D	S	Tube
4N60L-TN3-R	4N60G-TN3-R	TO-252	G	D	S	Tape Reel
4N60L-TN3-T	4N60G-TN3-T	TO-252	G	D	S	Tube
4N60L-T2Q-T	4N60G-T2Q-T	TO-262	G	D	S	Tube
4N60L-TQ3-R	4N60G-TQ3-R	TO-263	G	D	S	Tape Reel
4N60L-TQ3-T	4N60G-TQ3-T	TO-263	G	D	S	Tube

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

<p>4N60L-TA3-T</p> <p>(1)Packing Type (2)Package Type (3)Lead Free</p>	<p>(1) T: Tube, R: Tape Reel</p> <p>(2) TA3: TO-220, TF1: TO-220F1, TF3: TO-220F, T2Q: TO-262, TF2: TO-220F2, TM3: TO-251, TN3: TO-252, TQ3: TO-263</p> <p>(3) 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		$V_{DSS}$	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	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	
	TO-220F2			38	
	TO-251/ TO-252			50	
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

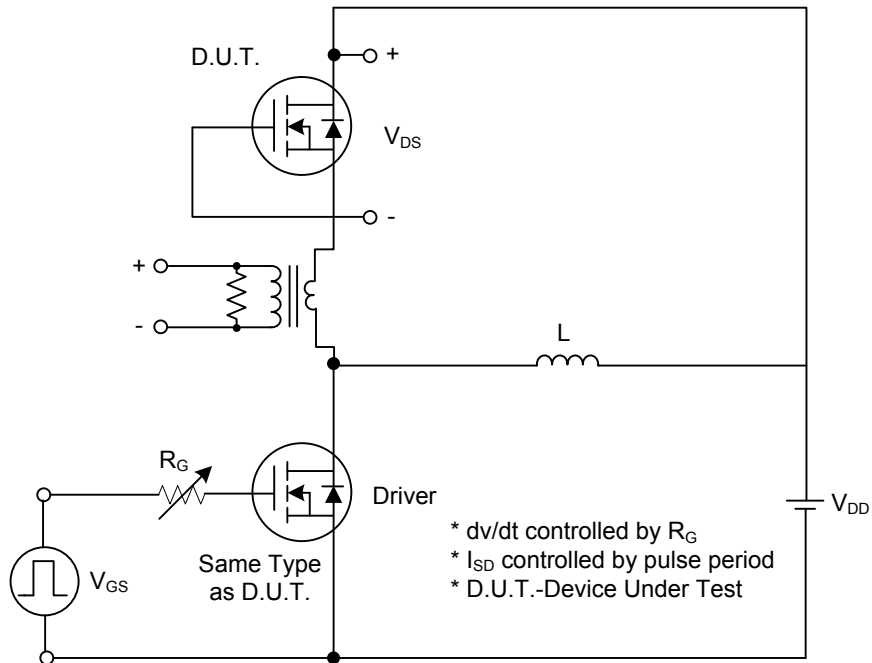
PARAMETER	PACKAGE	SYMBOL	RATINGS	UNIT	
Junction to Ambient	TO-220/TO-262/TO-263	$\theta_{JA}$		62.5	$^\circ\text{C}/\text{W}$
	TO-220F/TO-220F1			62.5	
	TO-220F2			62.5	
	TO-251/ TO-252			83	
Junction to Case	TO-220/TO-262/TO-263	$\theta_{JC}$		1.18	$^\circ\text{C}/\text{W}$
	TO-220F/TO-220F1			3.47	
	TO-220F2			3.28	
	TO-251/ TO-252			2.5	

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

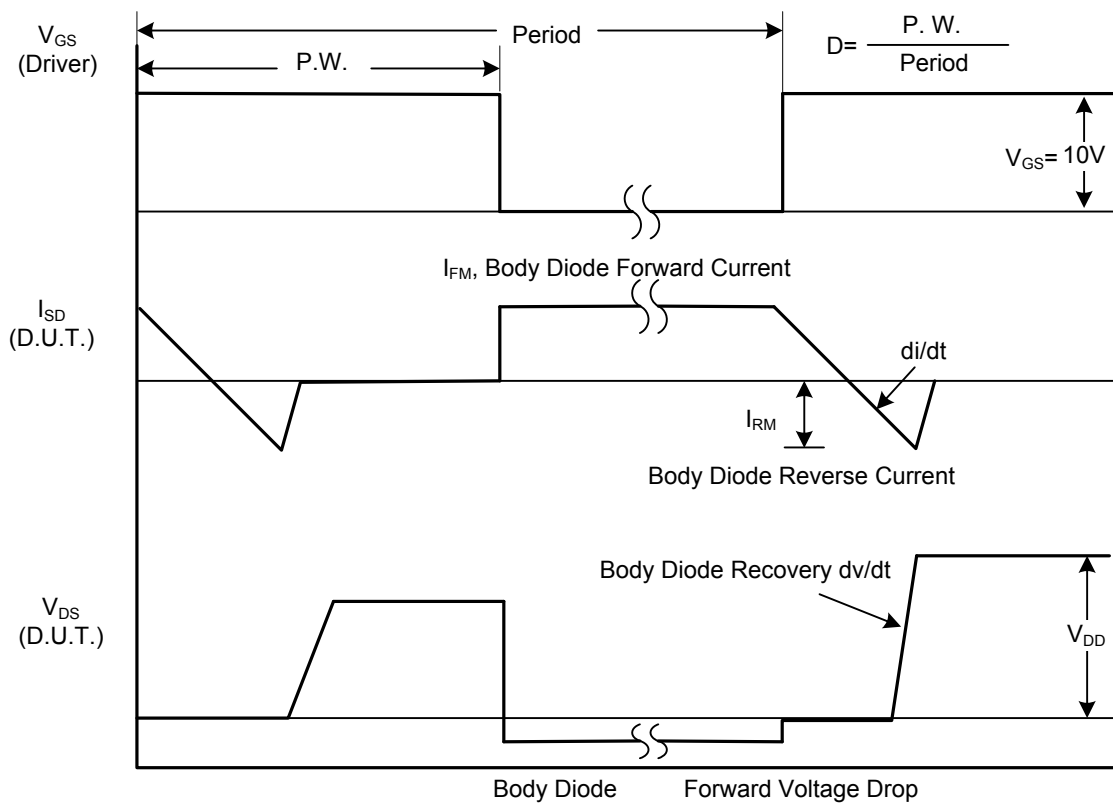
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>OFF CHARACTERISTICS</b>						
Drain-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS} = 0V, I_D = 250\mu A$	600			V
Drain-Source Leakage Current	$I_{DSS}$	$V_{DS} = 600V, V_{GS} = 0V$			10	$\mu A$
Gate-Source Leakage Current	Forward	$I_{GSS}$			100	nA
	Reverse				$V_{GS} = -30V, V_{DS} = 0V$	-100
Breakdown Voltage Temperature Coefficient	$\Delta BV_{DSS}/\Delta T_J$	$I_D = 250\mu A$ , Referenced to $25^\circ\text{C}$		0.6		$V/^\circ\text{C}$
<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	$R_{DS(ON)}$	$V_{GS} = 10V, I_D = 2.2A$		2.2	2.5	$\Omega$
<b>DYNAMIC CHARACTERISTICS</b>						
Input Capacitance	$C_{ISS}$	$V_{DS} = 25V, V_{GS} = 0V,$ $f = 1\text{MHz}$		520	670	pF
Output Capacitance	$C_{OSS}$			70	90	pF
Reverse Transfer Capacitance	$C_{RSS}$			8	11	pF
<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	$t_{rr}$	$V_{GS} = 0V, I_S = 4.4A,$		250		ns
Reverse Recovery Charge	$Q_{RR}$	$di_F/dt = 100 A/\mu s$ (Note 1)		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

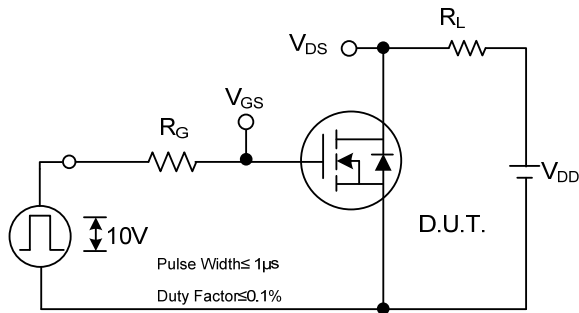


Peak Diode Recovery  $dv/dt$  Test Circuit

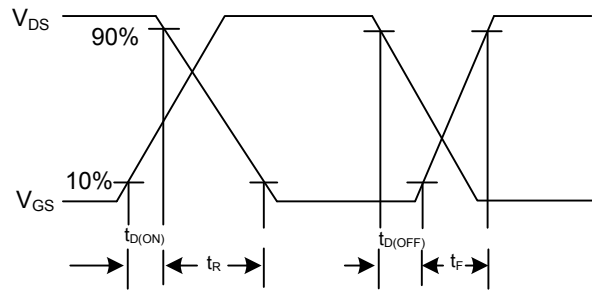


Peak Diode Recovery  $dv/dt$  Waveforms

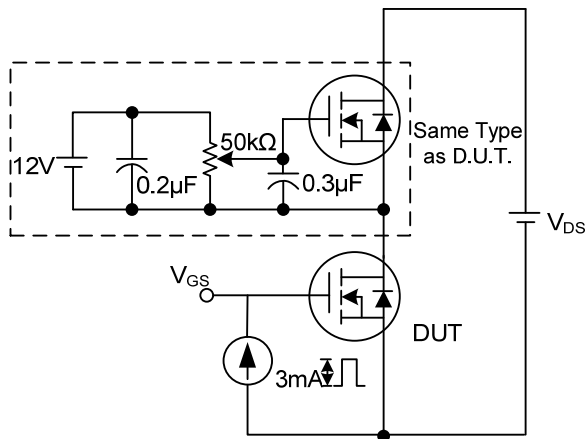
■ TEST CIRCUITS AND WAVEFORMS (Cont.)



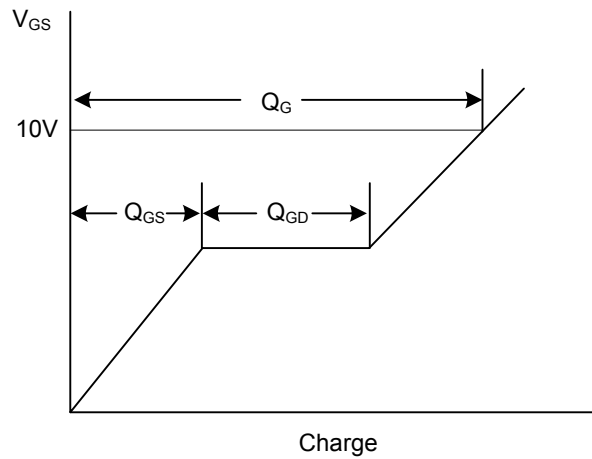
Switching Test Circuit



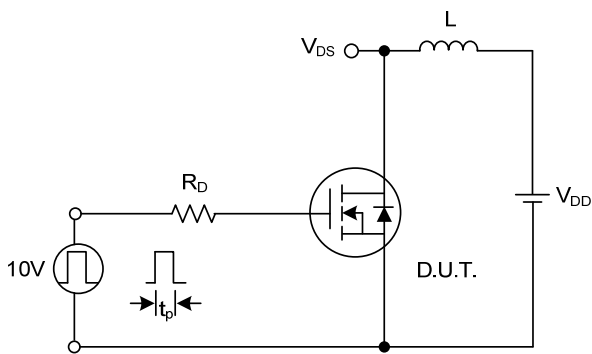
Switching Waveforms



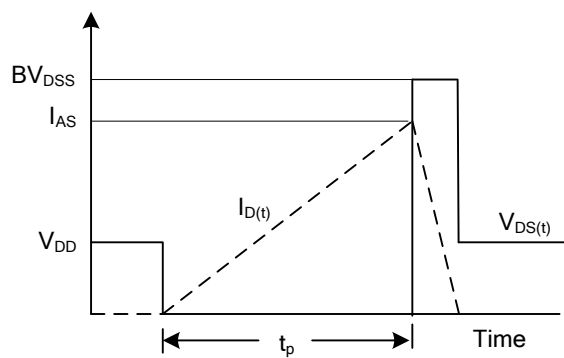
Gate Charge Test Circuit



Gate Charge Waveform



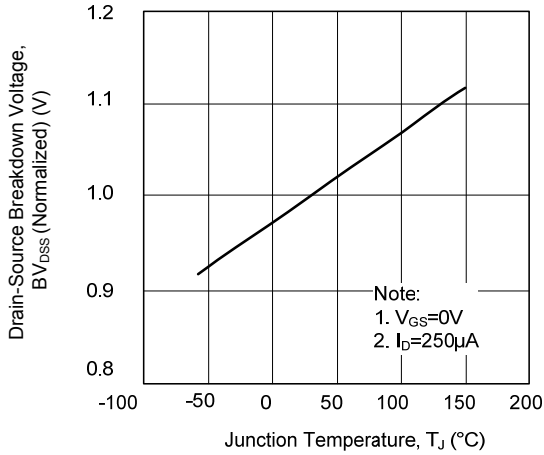
Unclamped Inductive Switching Test Circuit



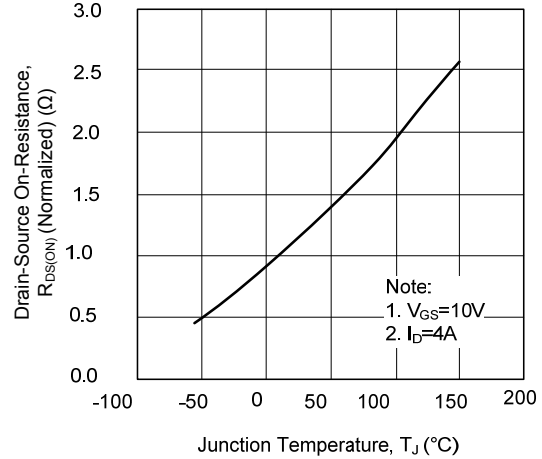
Unclamped Inductive Switching Waveforms

## ■ TYPICAL CHARACTERISTICS

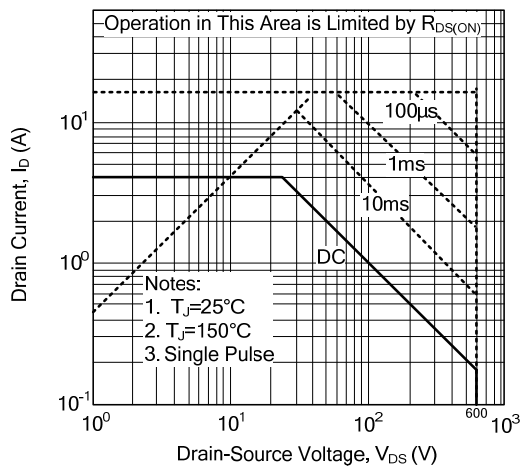
Breakdown Voltage Variation vs. Temperature



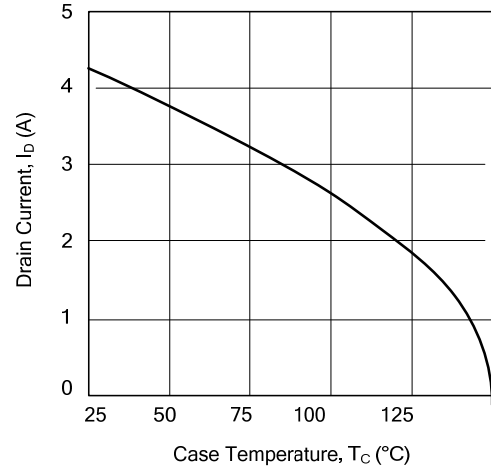
On-Resistance Junction Temperature



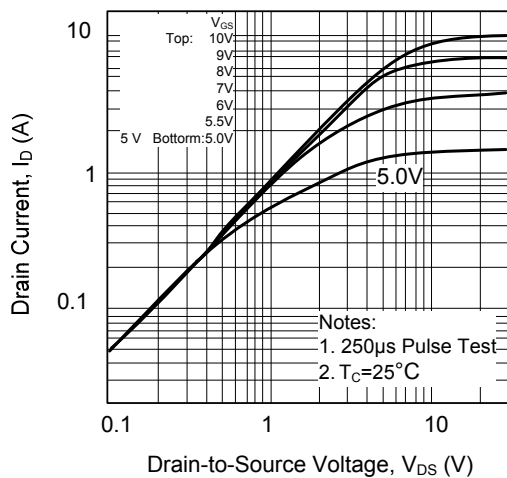
Safe Operating Area - 600V



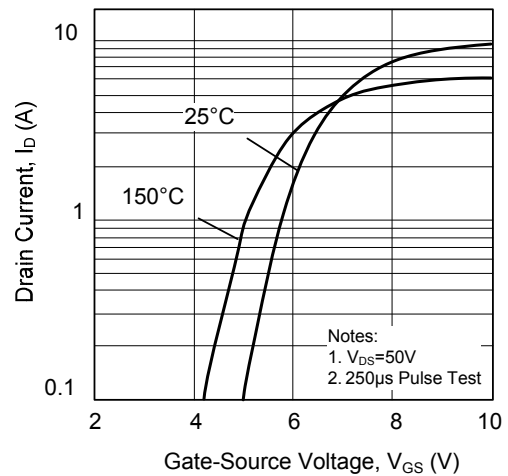
Maximum Drain Current vs. Case Temperature



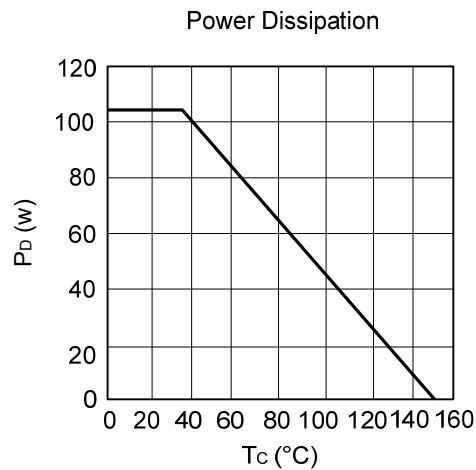
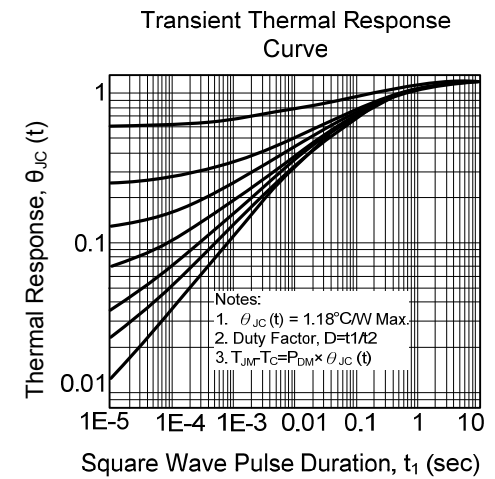
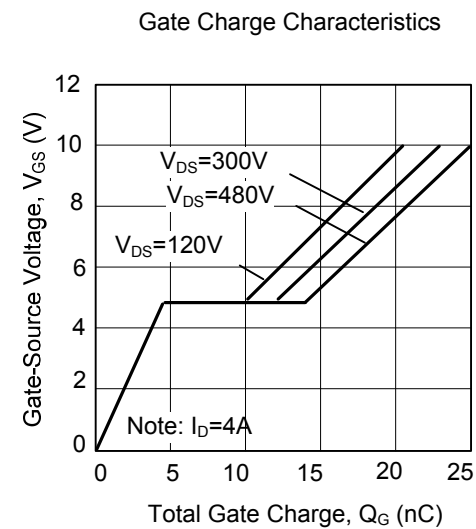
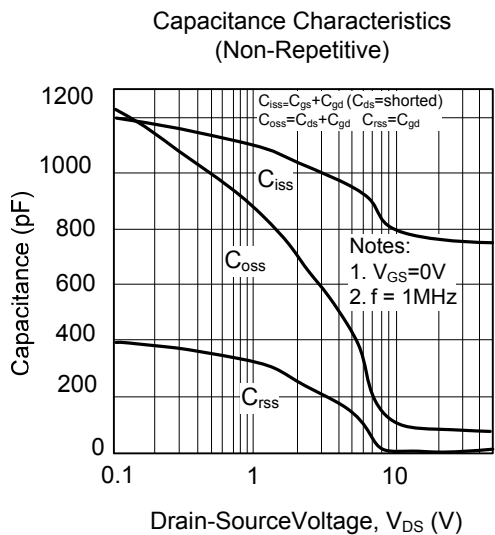
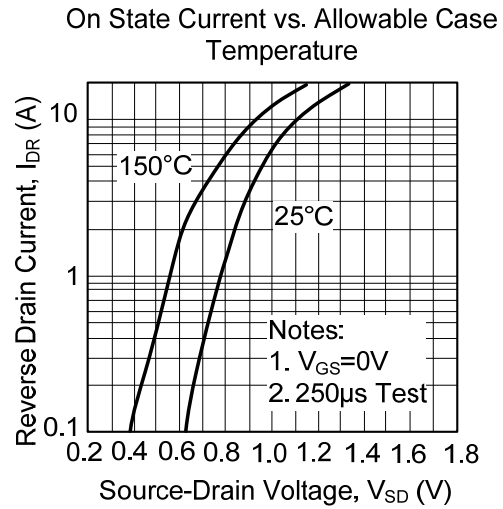
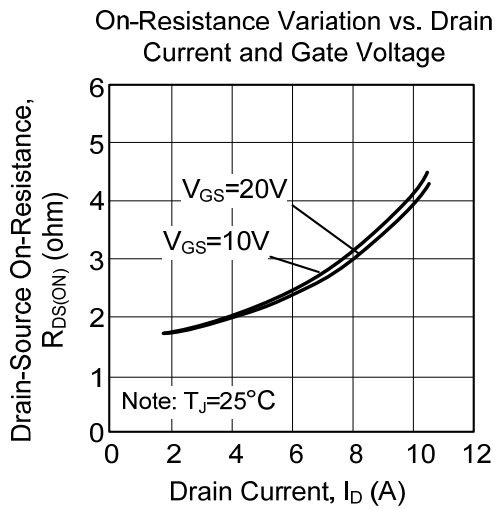
On-State Characteristics



Transfer Characteristics



■ TYPICAL CHARACTERISTICS(Cont.)



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