



## 4N60

Power MOSFET

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

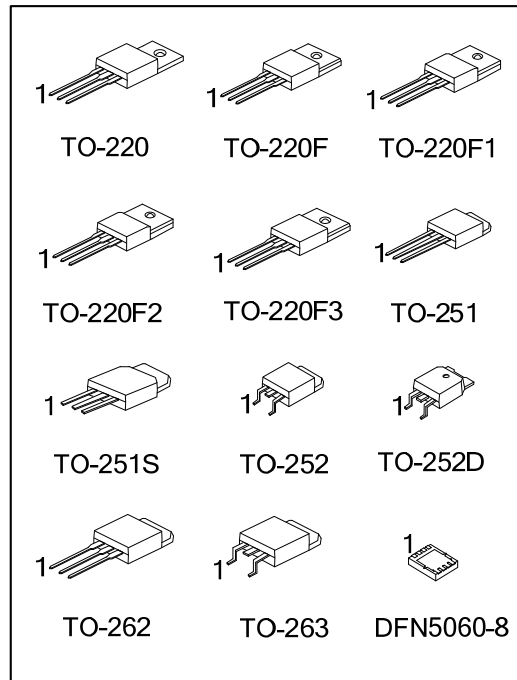
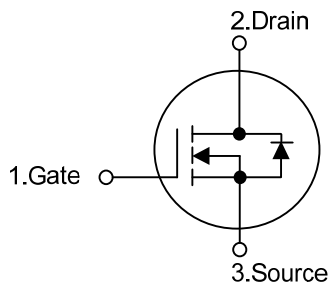
#### DESCRIPTION

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

- \*  $R_{DS(ON)} < 2.5\Omega @ V_{GS} = 10V, I_D = 2.2A$
- \* 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	
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-TMS-T	4N60G-TMS-T	TO-251S	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-T	4N60G-TQ2-T	TO-263	G	D	S	-	-	-	-	-	Tube
4N60L-TQ2-R	4N60G-TQ2-R	TO-263	G	D	S	-	-	-	-	-	Tape Reel
4N60G-K08-5060-R	4N60G-K08-5060-R	DFN5060-8	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, T2Q: TO-262, TQ2: TO-263, K08-5060: DFN5060-8</p> <p>(3) G: Halogen Free and Lead Free, L: Lead Free</p>
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## MARKING

PACKAGE	MARKING
TO-220 TO-220F TO-220F1 TO-220F2 TO-220F3 TO-251	TO-251S TO-252 TO-252D TO-262 TO-263
DFN5060-8	

Legend: L: Lead Free, G: Halogen Free

■ 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)	$E_{AS}$	260
	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-251S		30
	TO-252/TO-252D		
DFN5060-8			
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

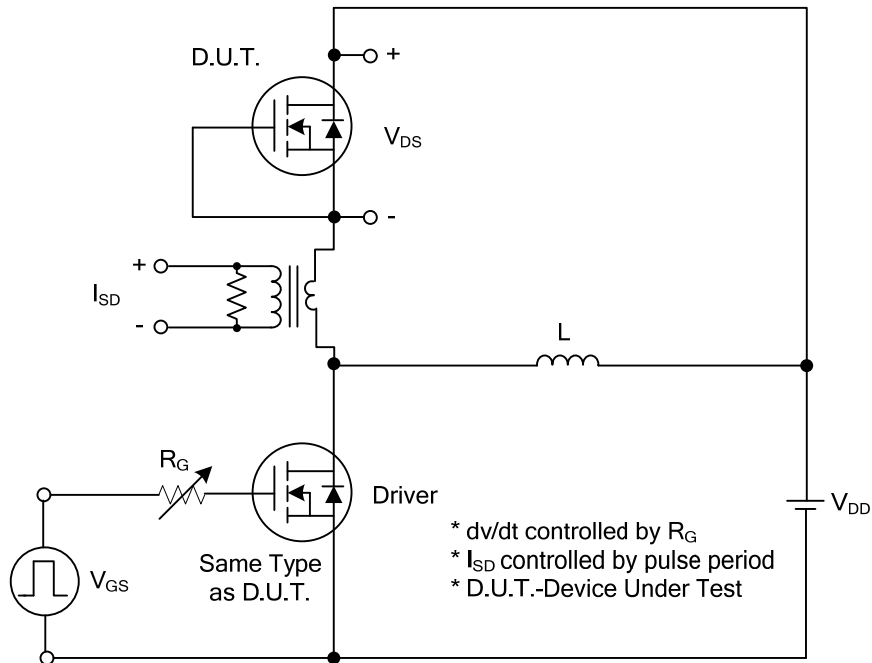
PARAMETER	PACKAGE	SYMBOL	RATINGS	UNIT
Junction to Ambient	TO-220/TO-262/TO-263	$\theta_{JA}$	62.5	$^\circ\text{C}/\text{W}$
	TO-220F/TO-220F1			
	TO-220F2/TO-220F3			
	TO-251/TO-251S		110	
	TO-252/TO-252D		75	
	DFN5060-8			
Junction to Case	TO-220/TO-262/TO-263	$\theta_{JC}$	1.18	$^\circ\text{C}/\text{W}$
	TO-220F/TO-220F1		3.47	
	TO-220F3		3.28	
	TO-220F2		2.5	
	TO-251/TO-251S		4.17	
	TO-252/TO-252D			
	DFN5060-8			

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

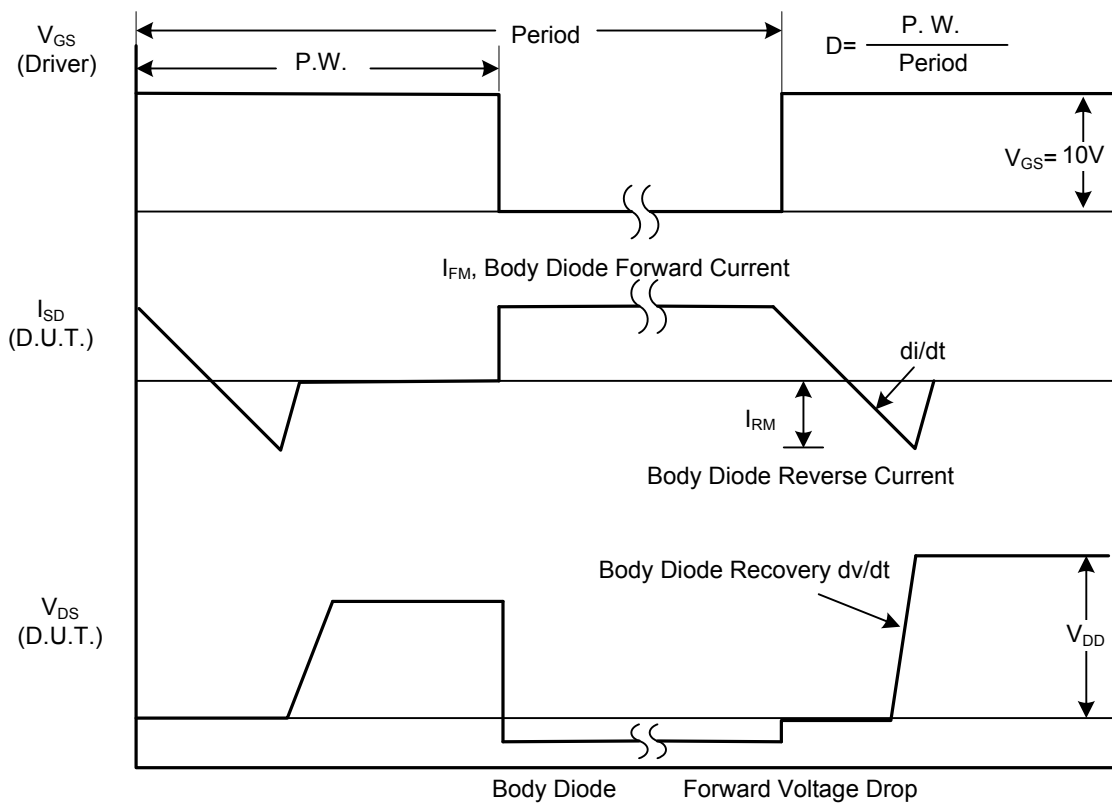
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>OFF CHARACTERISTICS</b>						
Drain-Source Breakdown Voltage	BV <sub>DSS</sub>	V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA	600			V
Drain-Source Leakage Current	I <sub>DSS</sub>	V <sub>DS</sub> = 600V, V <sub>GS</sub> = 0V			10	μA
		V <sub>DS</sub> = 480V, T <sub>C</sub> = 125°C			100	μA
Gate-Source Leakage Current	Forward	I <sub>GSS</sub>				
	Reverse					
		V <sub>GS</sub> = -30V, V <sub>DS</sub> = 0V			-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		1.9	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		550	670	pF
Output Capacitance	C <sub>OSS</sub>			80	100	pF
Reverse Transfer Capacitance	C <sub>RSS</sub>			30	50	pF
<b>SWITCHING CHARACTERISTICS</b>						
Total Gate Charge	Q <sub>G</sub>	V <sub>DS</sub> = 480V, I <sub>D</sub> = 4.0A, V <sub>GS</sub> = 10V (Note 1, 2)		80	100	nC
Gate-Source Charge	Q <sub>GS</sub>			5		nC
Gate-Drain Charge	Q <sub>GD</sub>			20		nC
Turn-On Delay Time	t <sub>D(ON)</sub>	V <sub>DD</sub> = 300V, I <sub>D</sub> = 4.0A, R <sub>G</sub> = 25Ω (Note 1, 2)		35	55	ns
Turn-On Rise Time	t <sub>R</sub>			80	110	ns
Turn-Off Delay Time	t <sub>D(OFF)</sub>			160	200	ns
Turn-Off Fall Time	t <sub>F</sub>			120	150	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	V <sub>SD</sub>	V <sub>GS</sub> = 0V, I <sub>S</sub> = 4.4A			1.4	V
Reverse Recovery Time	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

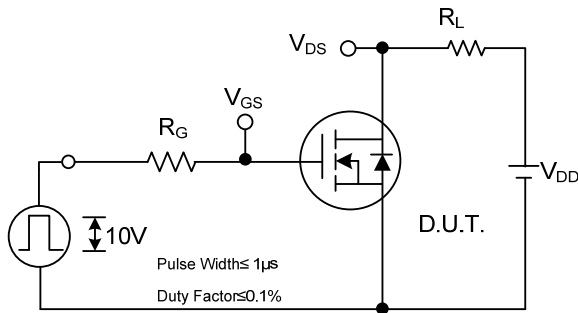


Peak Diode Recovery dv/dt Test Circuit

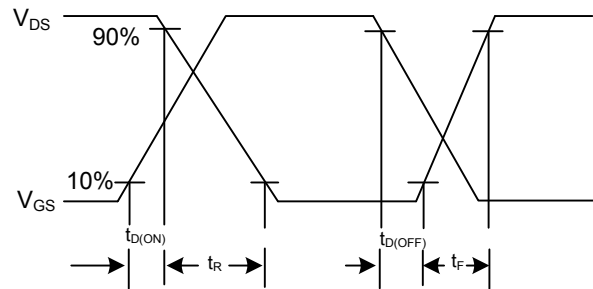


Peak Diode Recovery dv/dt Waveforms

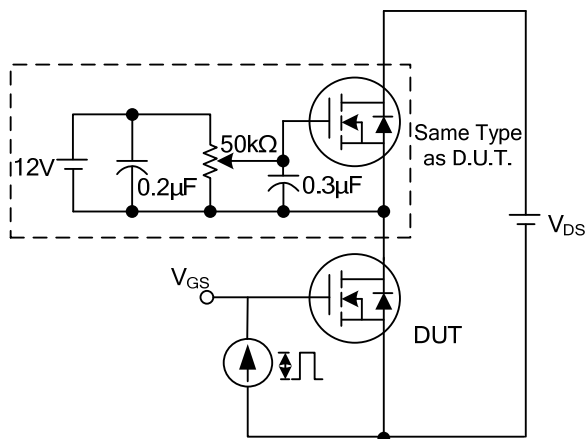
## ■ TEST CIRCUITS AND WAVEFORMS (Cont.)



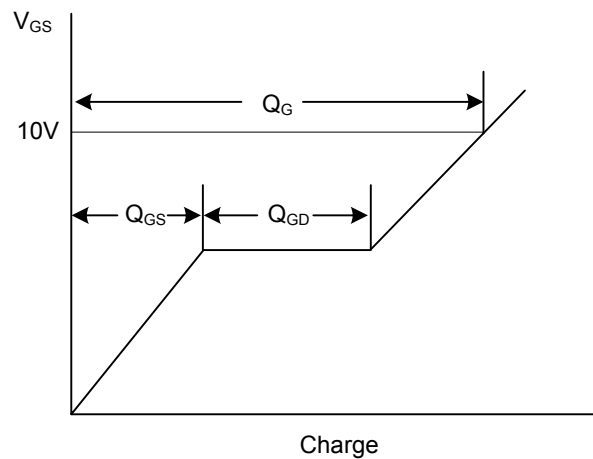
**Switching Test Circuit**



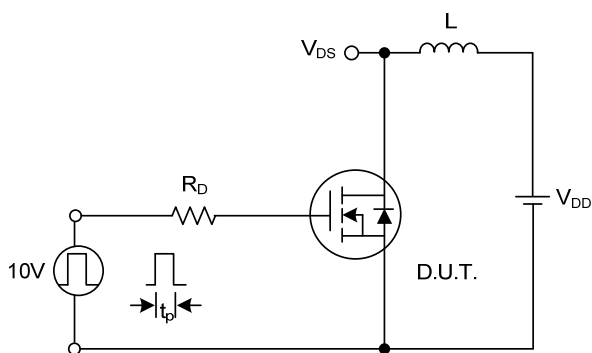
**Switching Waveforms**



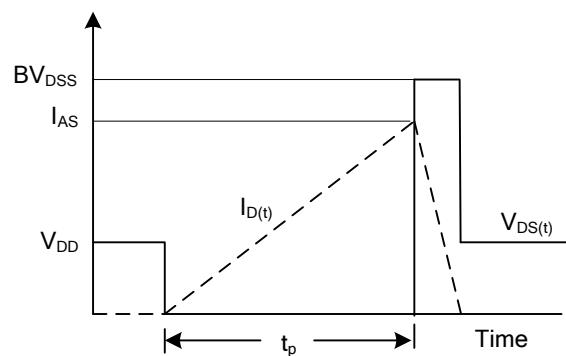
**Gate Charge Test Circuit**



**Gate Charge Waveform**



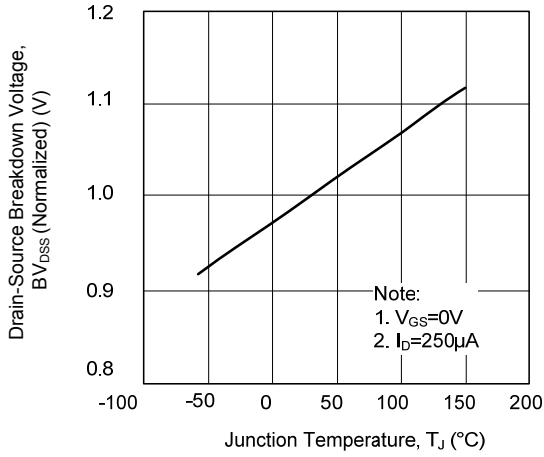
**Unclamped Inductive Switching Test Circuit**



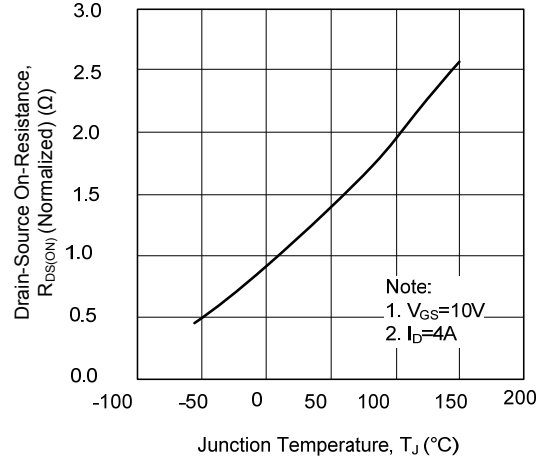
**Unclamped Inductive Switching Waveforms**

## TYPICAL CHARACTERISTICS

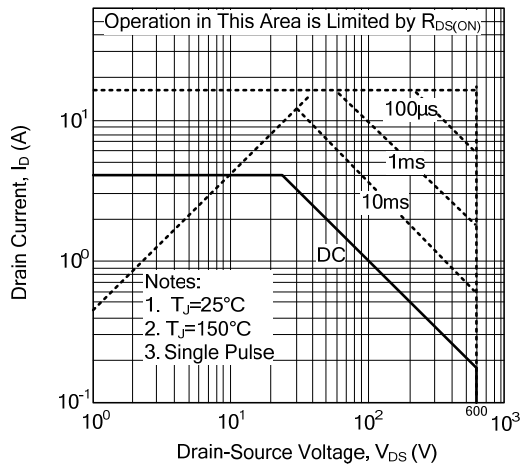
Breakdown Voltage Variation vs. Temperature



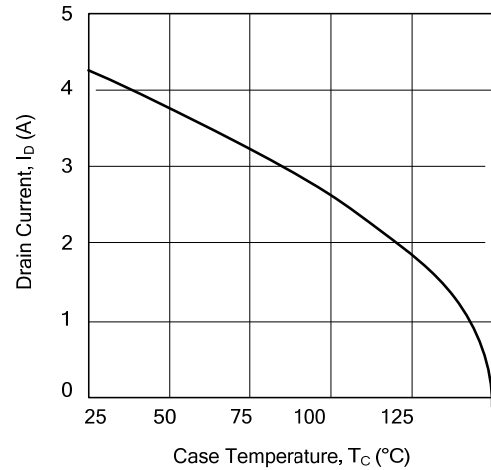
On-Resistance Junction Temperature



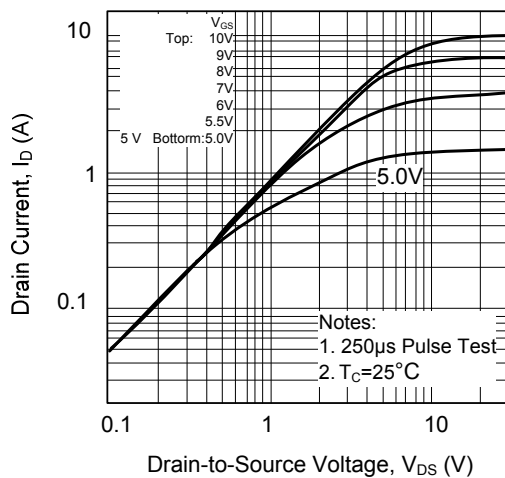
Safe Operating Area - 600V



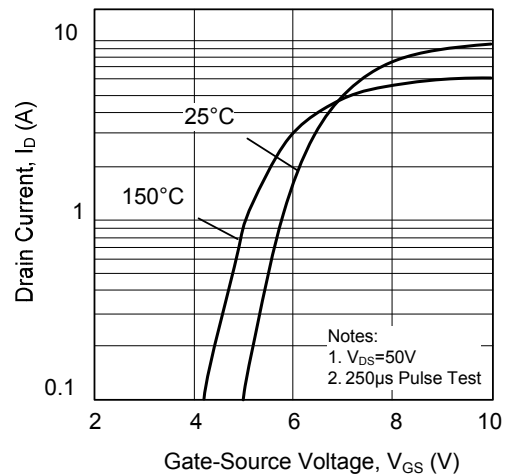
Maximum Drain Current vs. Case Temperature



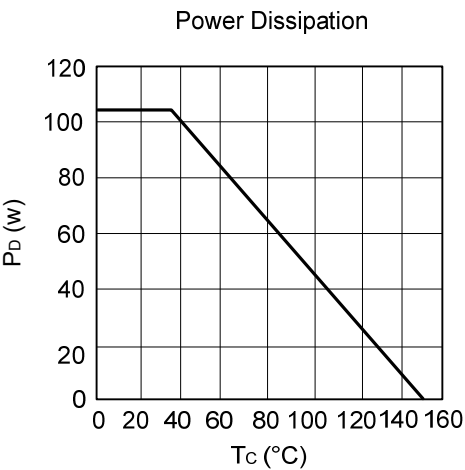
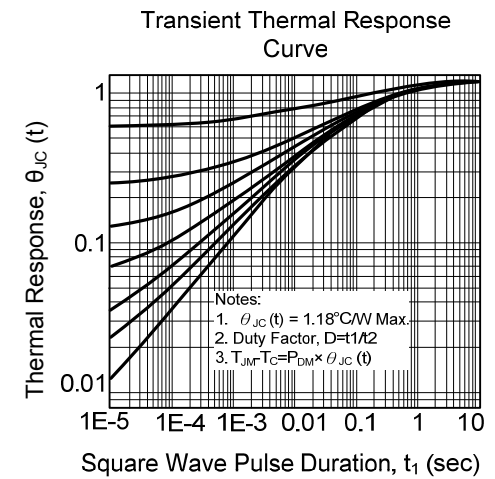
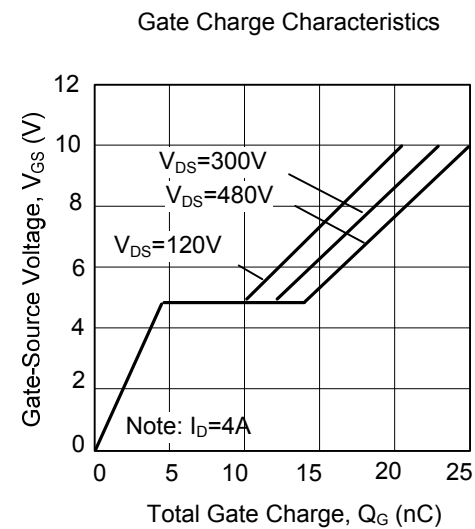
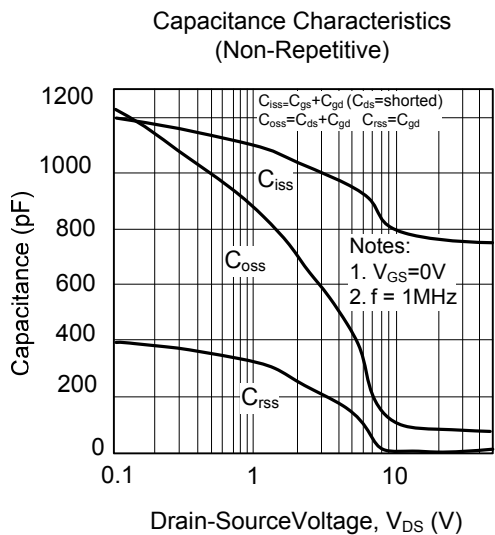
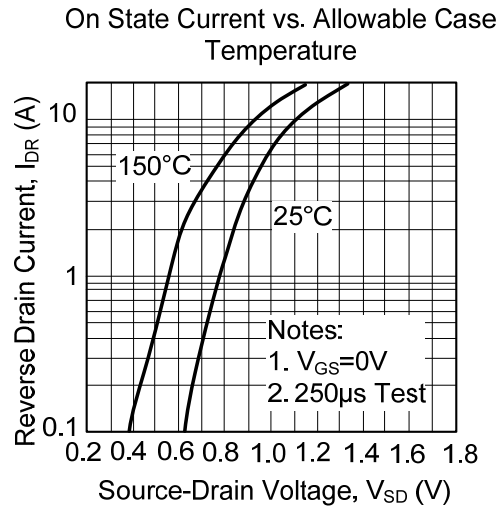
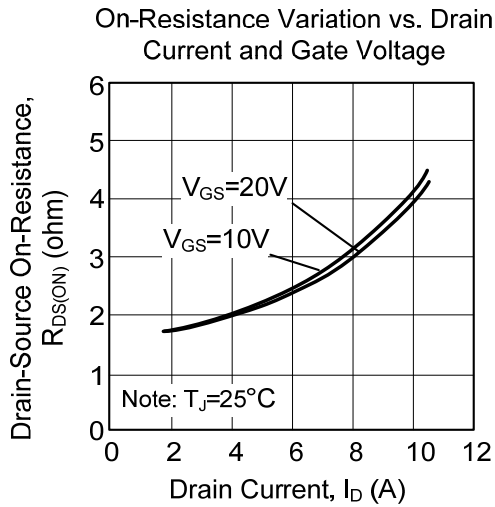
On-State Characteristics



Transfer Characteristics



■ TYPICAL CHARACTERISTICS(Cont.)





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