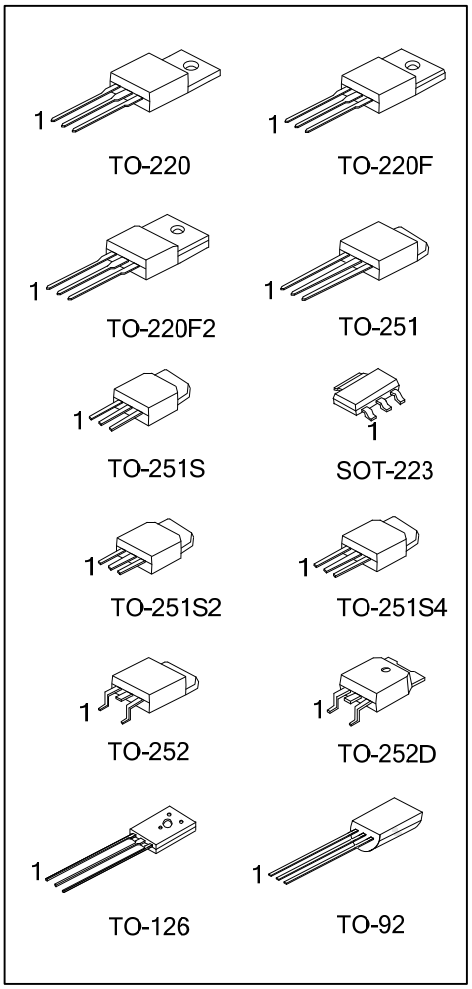
1.2A, 600V N-CHANNEL POWER MOSFET



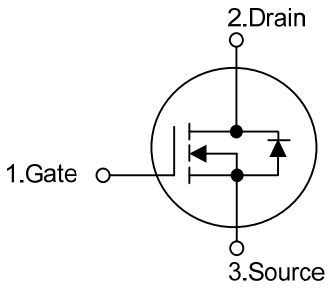
■ DESCRIPTION

The UTC **1N60** 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

* $R_{DS(ON)}$ <11.5Ω@ V_{GS}=10V, I_D=0.6A
* Ultra Low gate charge (typical 5.0nC)
* Low reverse transfer capacitance (C_{RSS} = typical 3.0 pF)
* Fast switching capability
* Avalanche energy specified
* Improved dv/dt capability, high ruggedness

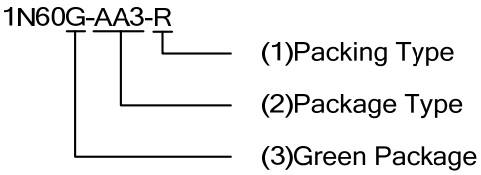
■ SYMBOL



■ ORDERING INFORMATION

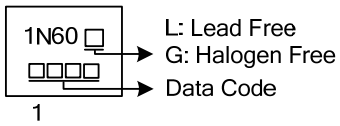
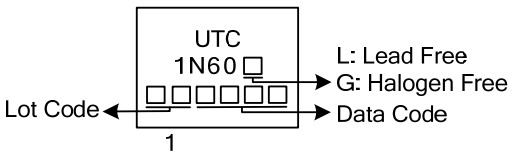
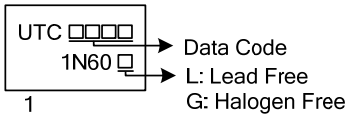
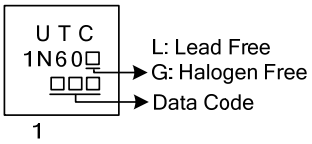
Ordering Number		Package	Pin Assignment			Packing
Lead Free	Halogen Free		1	2	3	
1N60L-AA3-R	1N60G-AA3-R	SOT-223	G	D	S	Tape Reel
1N60L-TA3-T	1N60G-TA3-T	TO-220	G	D	S	Tube
1N60L-TF2-T	1N60G-TF2-T	TO-220F2	G	D	S	Tube
1N60L-TF3-T	1N60G-TF3-T	TO-220F	G	D	S	Tube
1N60L-TM3-T	1N60G-TM3-T	TO-251	G	D	S	Tube
1N60L-TMS-T	1N60G-TMS-T	TO-251S	G	D	S	Tube
1N60L-TMS2-T	1N60G-TMS2-T	TO-251S2	G	D	S	Tube
1N60L-TMS4-T	1N60G-TMS4-T	TO-251S4	G	D	S	Tube
1N60L-TN3-R	1N60G-TN3-R	TO-252	G	D	S	Tape Reel
1N60L-TND-R	1N60G-TND-R	TO-252D	G	D	S	Tape Reel
1N60L-T60-K	1N60G-T60-K	TO-126	G	D	S	Bulk
1N60L-T92-B	1N60G-T92-B	TO-92	G	D	S	Tape Box
1N60L-T92-K	1N60G-T92-K	TO-92	G	D	S	Bulk

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



(1) B: Tape Box, K: Bulk, T: Tube, R: Tape Reel
(2) AA3: SOT-223, T92: TO-92, TA3: TO-220, TF2: TO-220F2, TF3: TO-220F, TM3: TO-251, TMS: TO-251S, TMS2: TO-251S2, TMS4: TO-251S4, TN3: TO-252, TND: TO-252D, T60: TO-126
(3) L: Lead Free, G: Halogen Free and Lead Free

■ MARKING

PACKAGE		MARKING
SOT-223		
TO-220 TO-220F TO-220F2 TO-251 TO-251S	TO-251S2 TO-251S4 TO-252 TO-252D	
TO-126		
TO-92		

■ ABSOLUTE MAXIMUM RATINGS (T_C = 25°C, unless otherwise specified)

PARAMETER		SYMBOL	RATINGS	UNIT
Drain-Source Voltage		V_{DSS}	600	V
Gate-Source Voltage		V_{GSS}	±30	V
Avalanche Current (Note 2)		I_{AR}	1.2	A
Continuous Drain Current		I_D	1.2	A
Pulsed Drain Current (Note 2)		I_{DM}	4.8	A
Avalanche Energy	Single Pulsed (Note 3)	E_{AS}	50	mJ
	Repetitive (Note 2)	E_{AR}	4.0	mJ
Peak Diode Recovery dv/dt (Note 4)		dv/dt	4.5	V/ns
Power Dissipation	SOT-223	P_D	8	W
	TO-251/TO-252 TO-252D/TO-251S TO-251S2/ TO-251S4		28	
	TO-220		40	
	TO-220F		21	
	TO-220F2		23	
	TO-92(T_A=25°C)		1	
	TO-126		12.5	
Junction Temperature		T_J	+150	°C
Operating Temperature		T_{OPR}	-55 ~ +150	°C
Storage Temperature		T_{STG}	-55 ~ +150	°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 = 60mH, I_{AS} = 1A, V_{DD} = 50V, R_G = 25Ω, Starting T_J = 25°C
4. I_{SD} ≤ 1.2A, di/dt ≤ 200A/μs, V_{DD} ≤ BV_{DSS}, Starting T_J = 25°C

■ THERMAL DATA

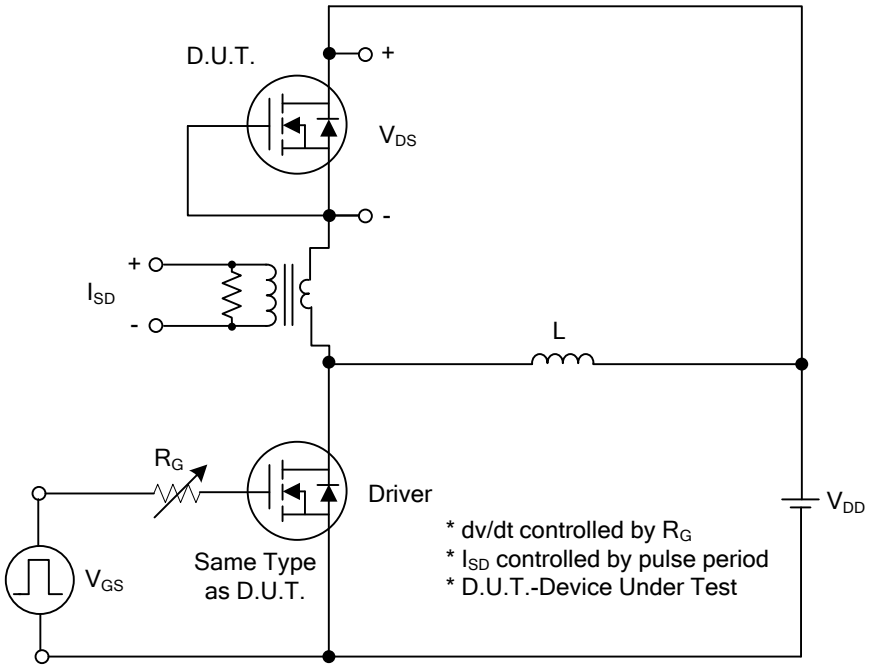
PARAMETER		SYMBOL	RATINGS	UNIT
Junction to Ambient	SOT-223	θ_{JA}	150	°C/W
	TO-251/TO-252 TO-252D/TO-251S TO-251S2/ TO-251S4		110	
	TO-220/TO-220F		62.5	
	TO-220F2		62.5	
	TO-92		140	
	TO-126		132	
Junction to Case	SOT-223	θ_{Jc}	14	°C/W
	TO-251/TO-252 TO-252D/TO-251S TO-251S2/ TO-251S4		4.53	
	TO-220		3.13	
	TO-220F		5.95	
	TO-220F2		5.43	
	TO-92		80	
	TO-126		10	

■ ELECTRICAL CHARACTERISTICS (T_C=25℃, unless otherwise specified.)

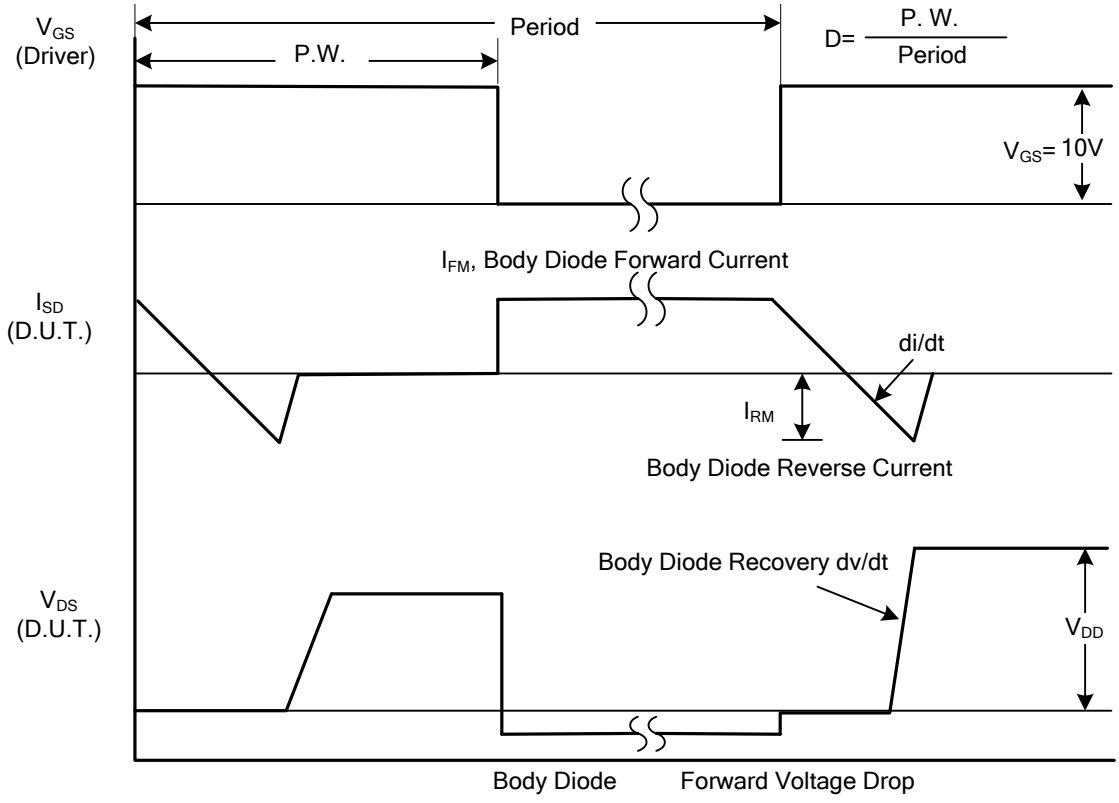
PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS							
Drain-Source Breakdown Voltage		BV_{DSS}	V_{GS}=0V, I_D=250μA	600			V
Drain-Source Leakage Current		I_{DSS}	V_{DS}=600V, V_{GS}=0V			10	μA
Gate-Source Leakage Current	Forward	I_{GSS}	V_{GS}=30V, V_{DS}=0V			100	nA
	Reverse		V_{GS}=-30V, V_{DS}=0V			-100	nA
Breakdown Voltage Temperature Coefficient		$\triangle BV_{DSS}/\triangle T_J$	I_D=250μA		0.4		V/℃
ON CHARACTERISTICS							
Gate Threshold Voltage		$V_{GS(TH)}$	V_{DS}=V_{GS}, I_D=250μA	2.0		4.0	V
Static Drain-Source On-State Resistance		$R_{DS(ON)}$	V_{GS}=10V, I_D=0.6A		9.3	11.5	Ω
DYNAMIC CHARACTERISTICS							
Input Capacitance		C_{ISS}	V_{DS}=25V, V_{GS}=0V, f=1MHz		120	150	pF
Output Capacitance		C_{OSS}			20	25	pF
Reverse Transfer Capacitance		C_{RSS}			3.0	4.0	pF
SWITCHING CHARACTERISTICS							
Total Gate Charge		Q_G	V_{DS}=480V, V_{GS}=10V, I_D=1.2A (Note 2,3)		5.0	6.0	nC
Gate-Source Charge		Q_{GS}			1.0		nC
Gate-Drain Charge		Q_{GD}			2.6		nC
Turn-On Delay Time		$t_{D(ON)}$	V_{DD}=300V, I_D=1.2A, R_G=50Ω (Note 2,3)		5	20	ns
Turn-On Rise Time		t_R			25	60	ns
Turn-Off Delay Time		$t_{D(OFF)}$			7	25	ns
Turn-Off Fall Time		t_F			25	60	ns
SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS							
Drain-Source Diode Forward Voltage		V_{SD}	V_{GS}=0V, I_S =1.2A			1.4	V
Maximum Continuous Drain-Source Diode Forward Current		I_S				1.2	A
Maximum Pulsed Drain-Source Diode Forward Current		I_{SM}				4.8	A
Reverse Recovery Time		t_{rr}	V_{GS}=0V, I_S=1.2A dI_F/dt=100A/μs (Note 1)		160		ns
Reverse Recovery Charge		Q_{rr}			0.3		μC

Notes: 1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. Pulse Test: Pulse Width ≤300μs, Duty Cycle≤2%
3. Essentially Independent of Operating Temperature

■ TEST CIRCUITS AND WAVEFORMS

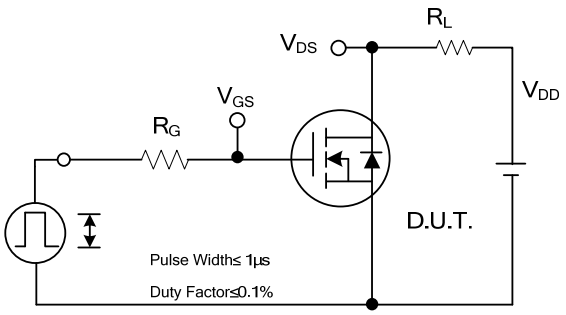


Peak Diode Recovery dv/dt Test Circuit

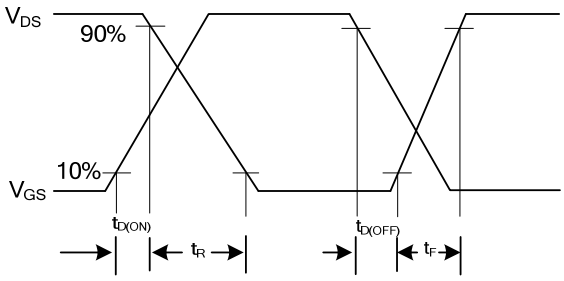


Peak Diode Recovery dv/dt Waveforms

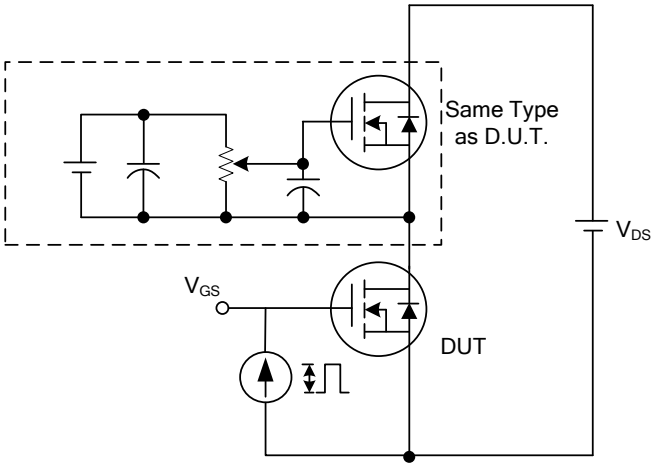
■ TEST CIRCUITS AND WAVEFORMS (Cont.)



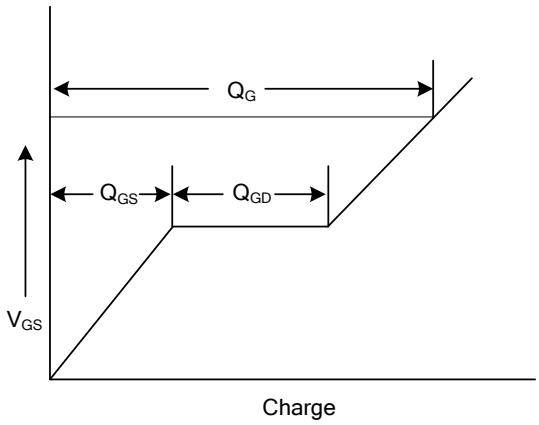
Switching Test Circuit



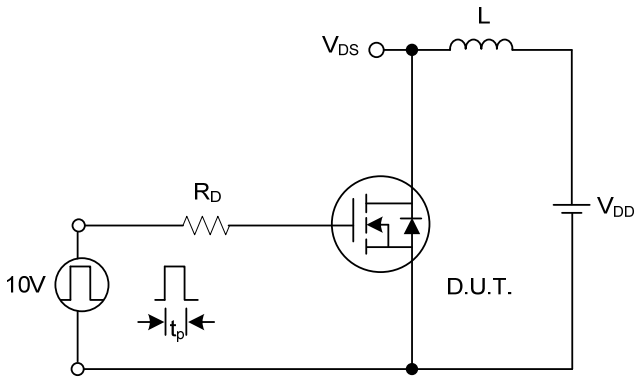
Switching Waveforms



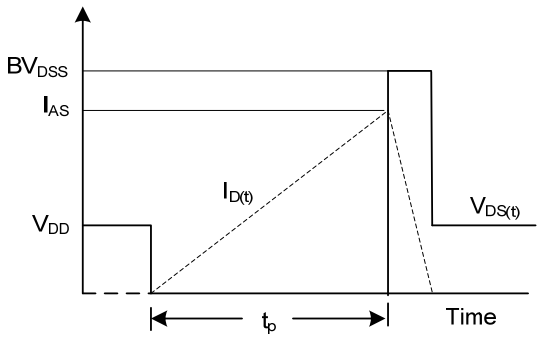
Gate Charge Test Circuit



Gate Charge Waveform



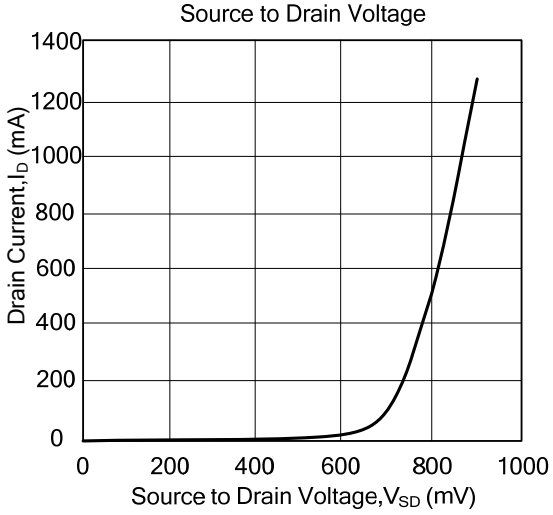
Unclamped Inductive Switching Test Circuit



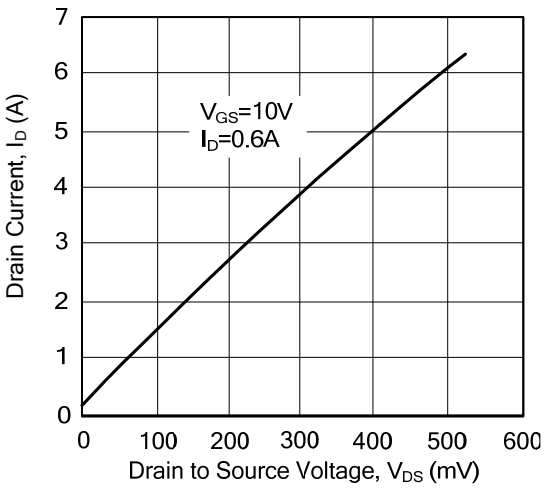
Unclamped Inductive Switching Waveforms

■ TYPICAL CHARACTERISTICS

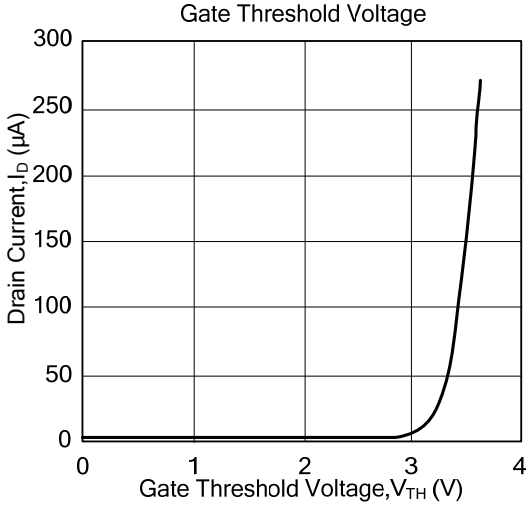
Drain Current vs.
Source to Drain Voltage



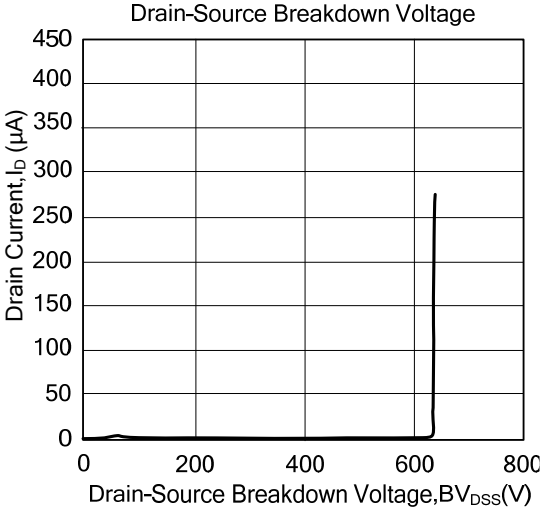
Drain-Source On-State
Resistance Characteristics



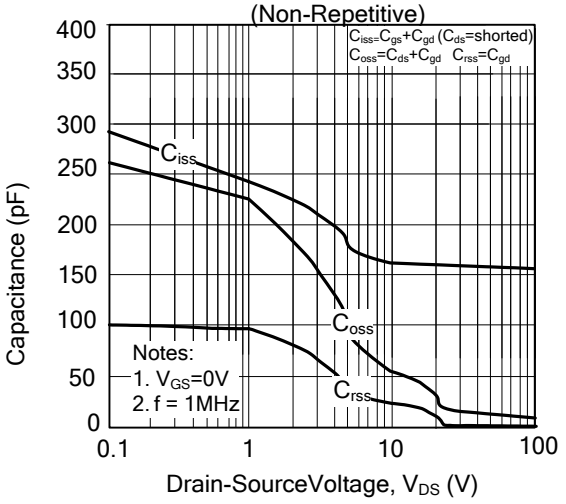
Drain Current vs.
Gate Threshold Voltage



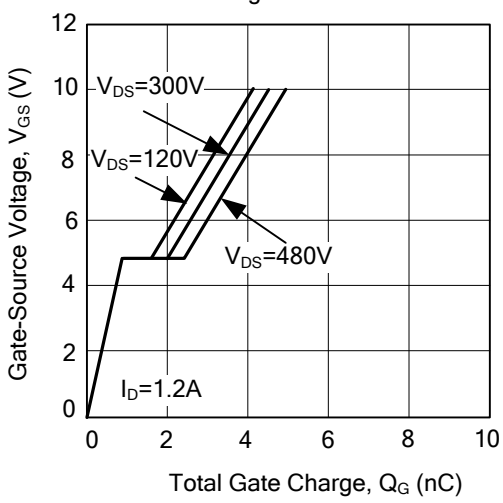
Drain Current vs.
Drain-Source Breakdown Voltage



Capacitance Characteristics
(Non-Repetitive)

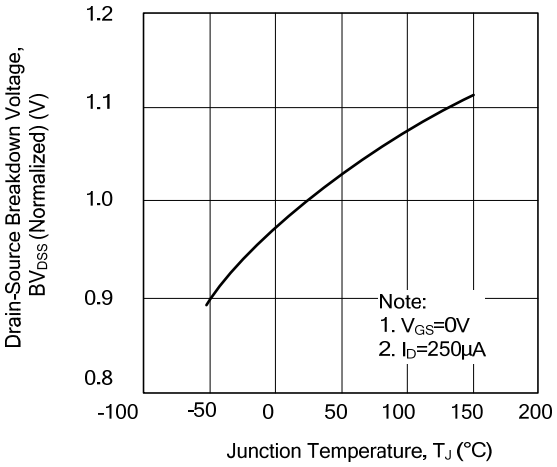


Gate Charge Characteristics

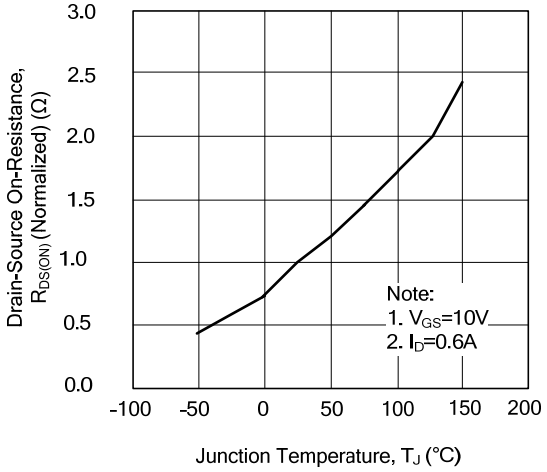


■ TYPICAL CHARACTERISTICS (Cont.)

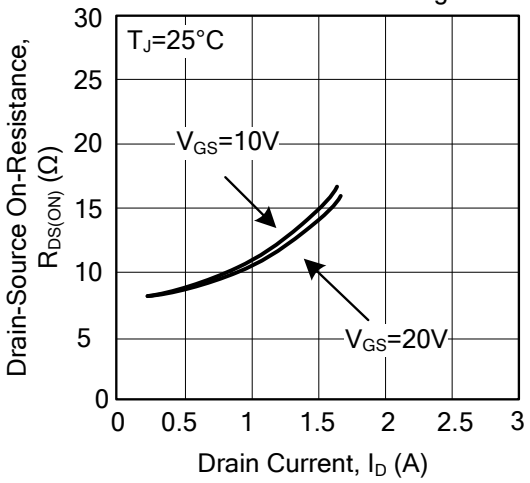
Breakdown Voltage Variation vs. Temperature



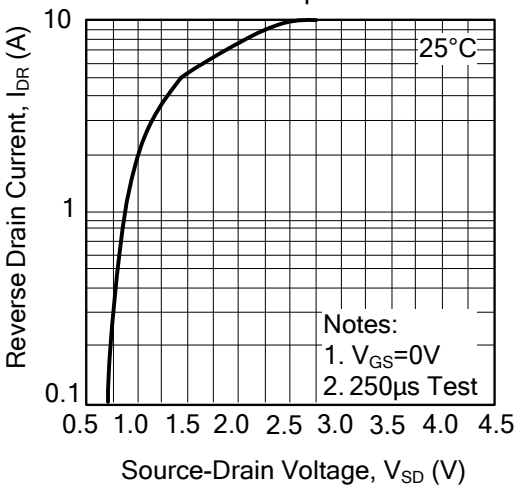
On-Resistance Junction Temperature



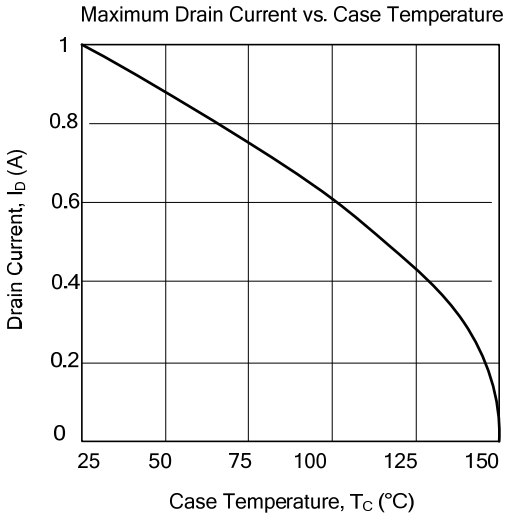
On-Resistance Variation vs. Drain Current and Gate Voltage



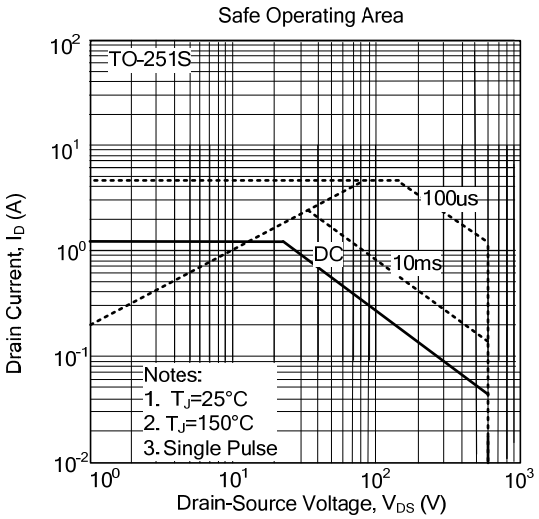
On State Current vs. Allowable Case Temperature



Maximum Drain Current vs. Case Temperature



Safe Operating Area



■ TYPICAL CHARACTERISTICS (Cont.)