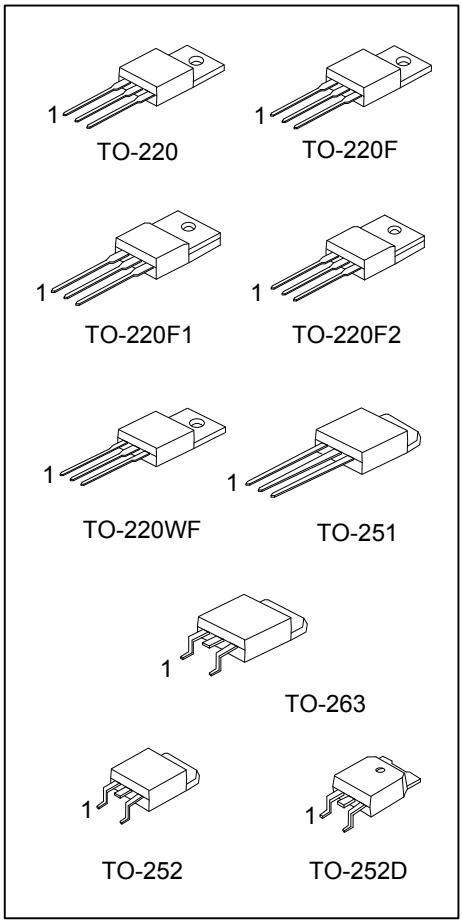
9NM60

Power MOSFET

9.0A, 600V N-CHANNEL SUPER-JUNCTION MOSFET



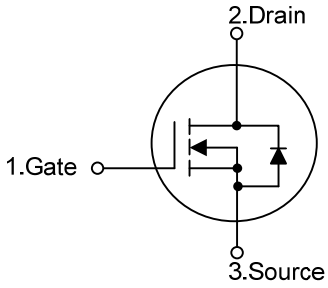
■ DESCRIPTION

The **UTC 9NM60** is a Super Junction MOSFET Structure and is designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and a high rugged avalanche characteristics. This power MOSFET is usually used at DC-DC converters for power applications.

■ FEATURES

* $R_{DS(ON)} \leq 0.56\ \Omega$ @ V_{GS}=10V, I_D=4.5A
* By using Super Junction Structure
* Fast Switching
* With 100% Avalanche Tested

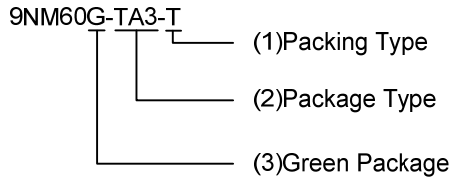
■ SYMBOL



■ ORDERING INFORMATION

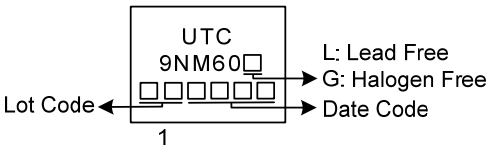
Ordering Number		Package	Pin Assignment			Packing
Lead Free	Halogen Free		1	2	3	
9NM60L-TA3-T	9NM60G-TA3-T	TO-220	G	D	S	Tube
9NM60L-TF3-T	9NM60G-TF3-T	TO-220F	G	D	S	Tube
9NM60L-TF1-T	9NM60G-TF1-T	TO-220F1	G	D	S	Tube
9NM60L-TF2-T	9NM60G-TF2-T	TO-220F2	G	D	S	Tube
9NM60L-TW1-T	9NM60G-TW1-T	TO-220WF	G	D	S	Tube
9NM60L-TM3-T	9NM60G-TM3-T	TO-251	G	D	S	Tube
9NM60L-TN3-R	9NM60G-TN3-R	TO-252	G	D	S	Tape Reel
9NM60L-TND-R	9NM60G-TND-R	TO-252D	G	D	S	Tape Reel
9NM60L-TQ2-T	9NM60G-TQ2-T	TO-263	G	D	S	Tube
9NM60L-TQ2-R	9NM60G-TQ2-R	TO-263	G	D	S	Tape Reel

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



(1) T: Tube, R: Tape Reel
(2) TA3: TO-220, TF3: TO-220F, TF1: TO-220F1, TF2: TO-220F2, TW1: TO-220WF, TM3: TO-251 TN3: TO-252, TND: TO-252D, TQ2: TO-263
(3) G: Halogen Free and Lead Free, L: Lead Free

■ MARKING



■ 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
Drain Current	Continuous	I_D	9	A
	Pulsed (Note 2)	I_{DM}	18	A
Avalanche Current		I_{AR}	2.2	A
Avalanche Energy	Single Pulsed (Note 3)	E_{AS}	323	mJ
Peak Diode Recovery dv/dt (Note 4)		dv/dt	6	V/ns
Power Dissipation	TO-220/TO-220WF TO-263	P_D	82	W
	TO-220F/TO-220F1 TO-220F2		28	W
	TO-251/TO-252 TO-252D		58	W
Junction Temperature		T_J	+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=100mH, I_{AS}=2.54A, V_{DD}=50V, R_G=25Ω, Starting T_J=25°C
4. I_{SD} ≤ 9.0A, di/dt ≤ 200A/μs, V_{DD} ≤ BV_{DSS}, Starting T_J=25°C

■ THERMAL DATA

PARAMETER		SYMBOL	RATINGS	UNIT
Junction to Ambient	TO-220/TO-220F TO-220F1/TO-220F2 TO-220WF/TO-263	θ_{JA}	62.5	°C/W
	TO-251/TO-252 TO-252D		110	°C/W
Junction to Case	TO-220/TO-220WF TO-263	θ_{JC}	1.52	°C/W
	TO-220F/TO-220F1 TO-220F2		4.46	°C/W
	TO-251/TO-252 TO-252D		2.15 (Note)	°C/W

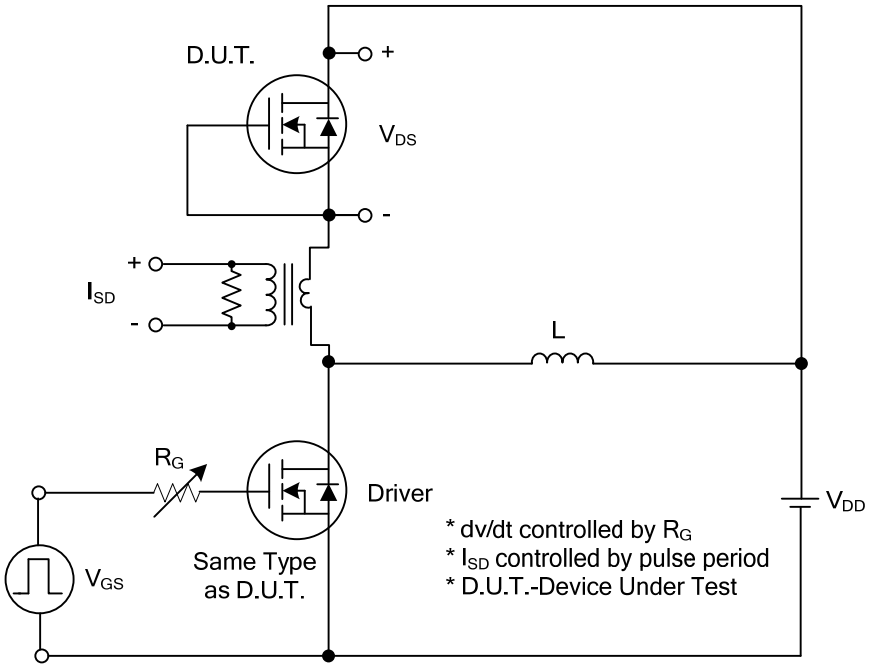
Note: Device mounted on FR-4 substrate PC board, 2oz copper, with 1inch square copper plate.

■ ELECTRICAL CHARACTERISTICS (T_J=25°C, unless otherwise specified)

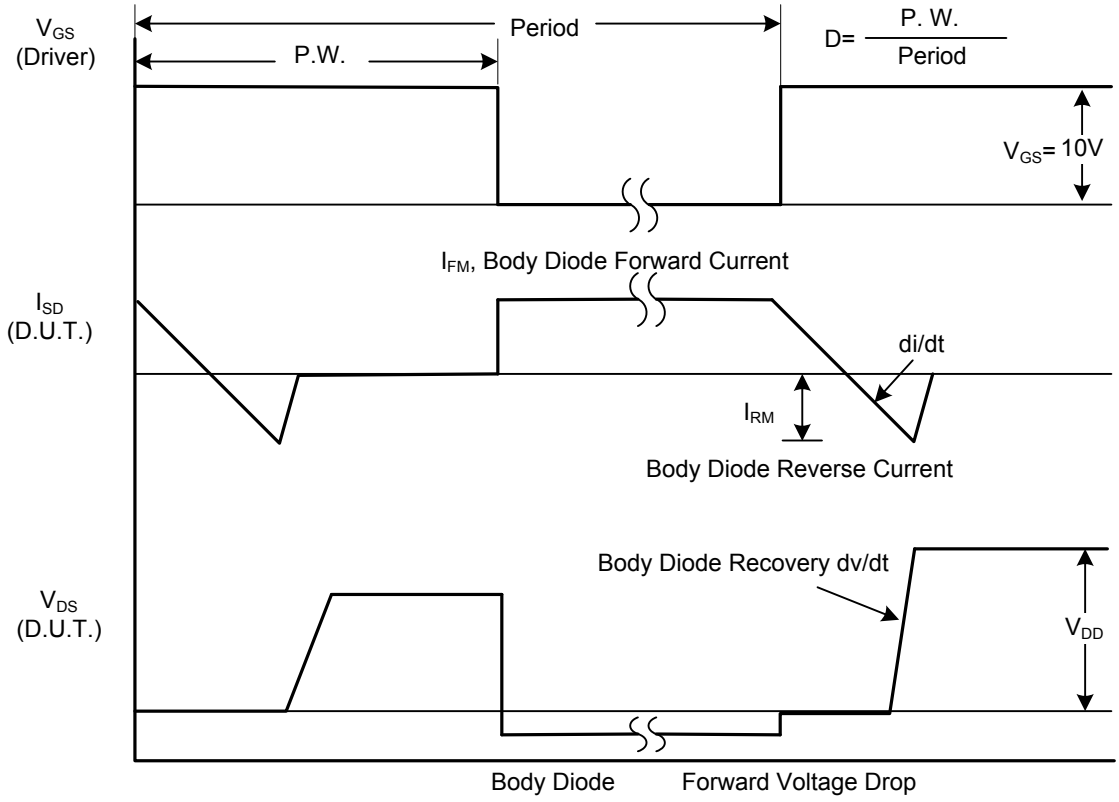
PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS							
Drain-Source Breakdown Voltage		BV_{DSS}	I_D=250μA, V_{GS}=0V	600			V
Drain-Source Leakage Current		I_{DSS}	V_{DS}=600V, V_{GS}=0V			10	μA
Gate- Source Leakage Current	Forward	I_{GSS}	V_{GS}=30V			100	nA
	Reverse		V_{GS}=-30V			-100	nA
ON CHARACTERISTICS							
Gate Threshold Voltage		$V_{GS(TH)}$	V_{DS}=V_{GS}, I_D=250μA	2.5		4.5	V
Static Drain-Source On-State Resistance		$R_{DS(ON)}$	V_{GS}=10V, I_D=4.5A			0.56	Ω
DYNAMIC PARAMETERS							
Input Capacitance		C_{ISS}	V_{DS}=25V, V_{GS}=0V, f=1.0MHz		590		pF
Output Capacitance		C_{OSS}			530		pF
Reverse Transfer Capacitance		C_{RSS}			57		pF
SWITCHING PARAMETERS							
Total Gate Charge (Note 1)		Q_G	V_{DS}=480V, V_{GS}=10V, I_D=9.0A , I_G=1mA (Note 1, 2)		24		nC
Gate to Source Charge		Q_{GS}			5.2		nC
Gate to Drain Charge		Q_{GD}			18.2		nC
Turn-ON Delay Time (Note 1)		$t_{D(ON)}$	V_{DD}=100V, V_{GS}=10V, I_D=9.0A, R_G=25Ω (Note 1, 2)		8.8		ns
Rise Time		t_R			24		ns
Turn-OFF Delay Time		$t_{D(OFF)}$			64		ns
Fall-Time		t_F			33.5		ns
SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS							
Maximum Body-Diode Continuous Current		I_S				9	A
Maximum Body-Diode Pulsed Current		I_{SM}				18	A
Drain-Source Diode Forward Voltage (Note 1)		V_{SD}	I_S=9.0A,V_{GS}=0V			1.4	V
Reverse Recovery Time (Note 1)		t_{rr}	I_S=9.0A,V_{GS}=0V, dI_F/dt=100A/μs		310		ns
Reverse Recovery Charge		Q_{rr}			7.83		μC

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

■ TEST CIRCUITS AND WAVEFORMS

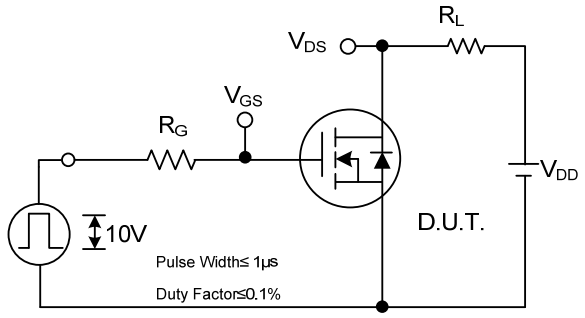


Peak Diode Recovery dv/dt Test Circuit

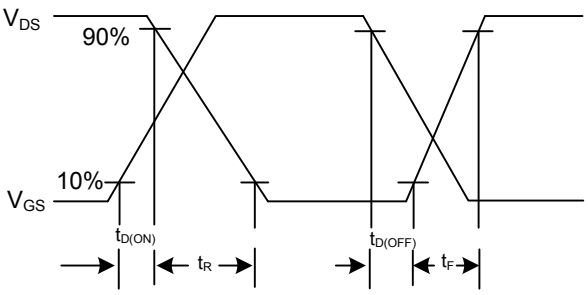


Peak Diode Recovery dv/dt Waveforms

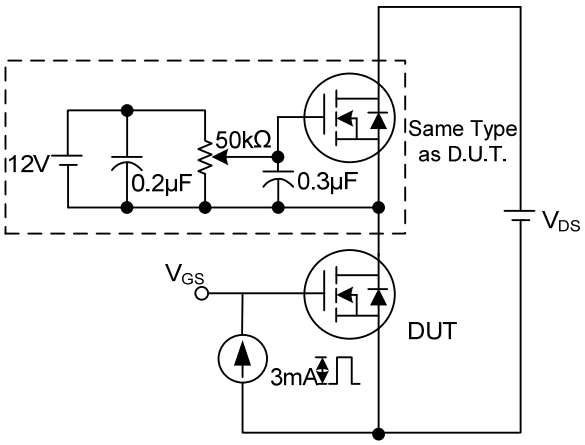
■ TEST CIRCUITS AND WAVEFORMS



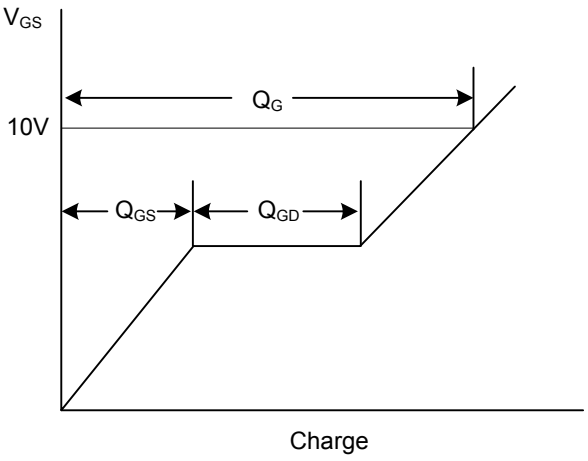
Switching Test Circuit



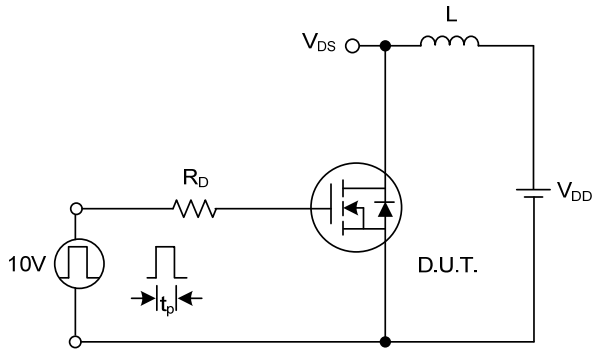
Switching Waveforms



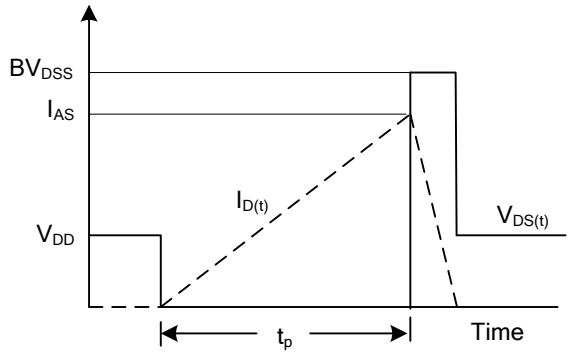
Gate Charge Test Circuit



Gate Charge Waveform



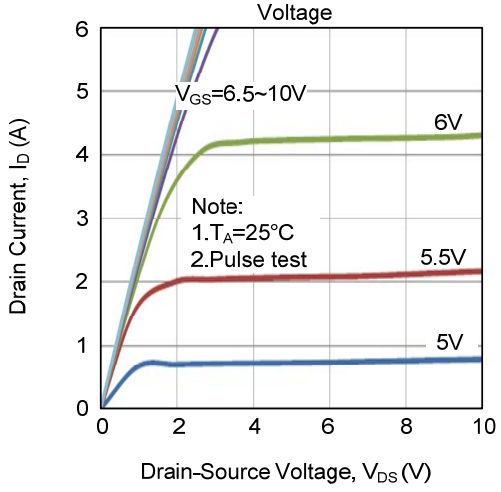
Unclamped Inductive Switching Test Circuit



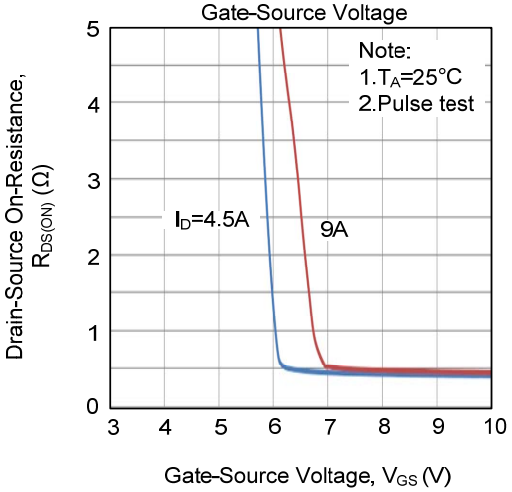
Unclamped Inductive Switching Waveforms

■ TYPICAL CHARACTERISTICS

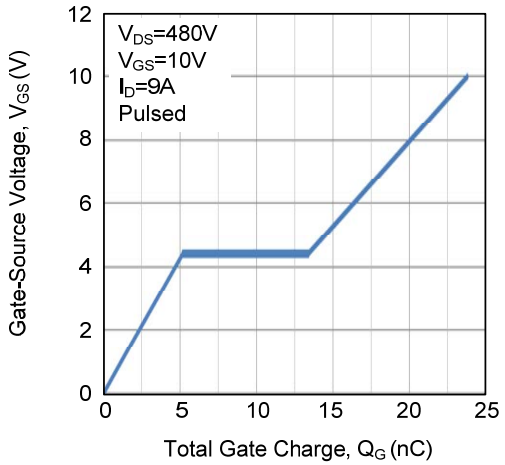
Drain Current vs. Drain-Source Voltage



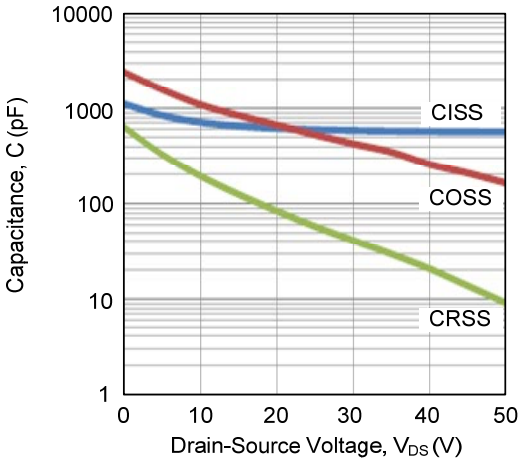
Drain-Source On-Resistance vs. Gate-Source Voltage



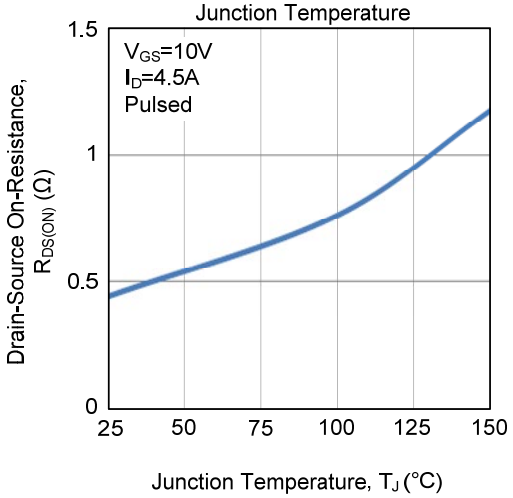
Gate Charge Characteristics



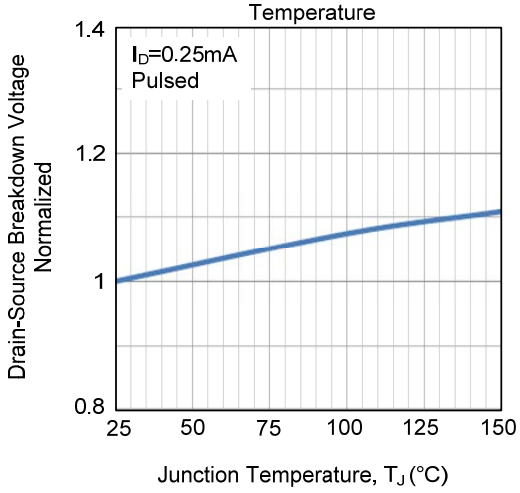
Capacitance Characteristics



Drain-Source On-Resistance vs. Junction Temperature

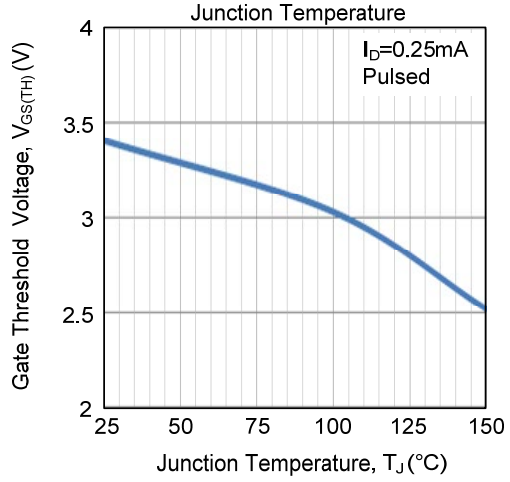


Breakdown Voltage vs. Junction Temperature

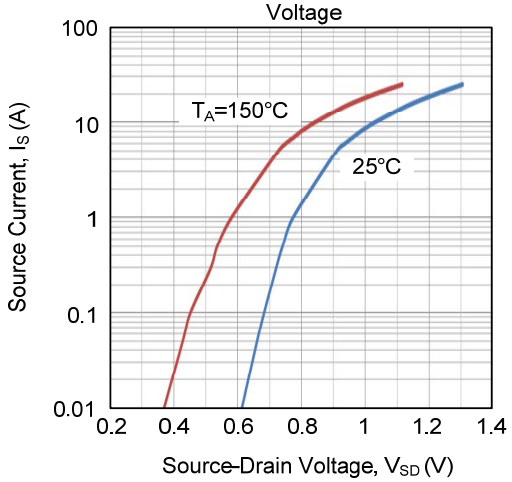


■ TYPICAL CHARACTERISTICS (Cont.)

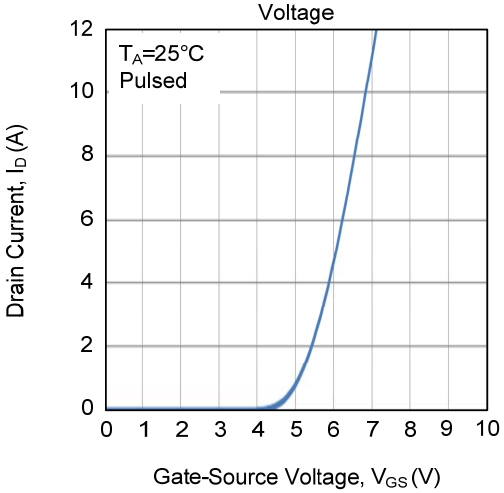
Gate Threshold Voltage vs. Junction Temperature



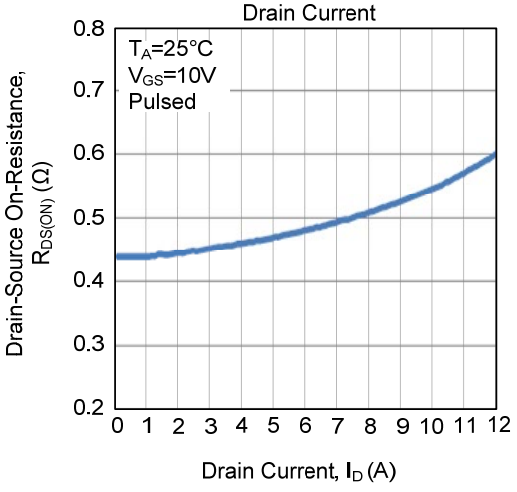
Source Current vs. Source-Drain Voltage



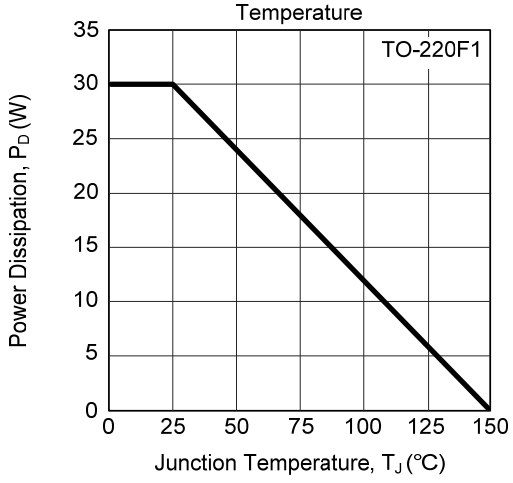
Drain Current vs. Gate-Source Voltage



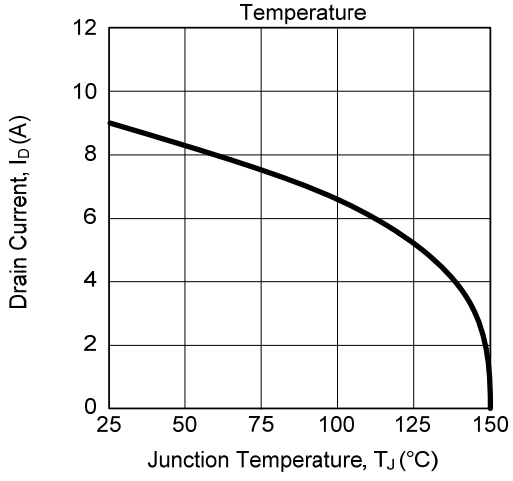
Drain-Source On-Resistance vs. Drain Current



Power Dissipation vs. Junction Temperature



Drain Current vs. Junction Temperature



■ TYPICAL CHARACTERISTICS (Cont.)