



# 24NM60

Power MOSFET

## 24A, 600V N-CHANNEL SUPER-JUNCTION MOSFET

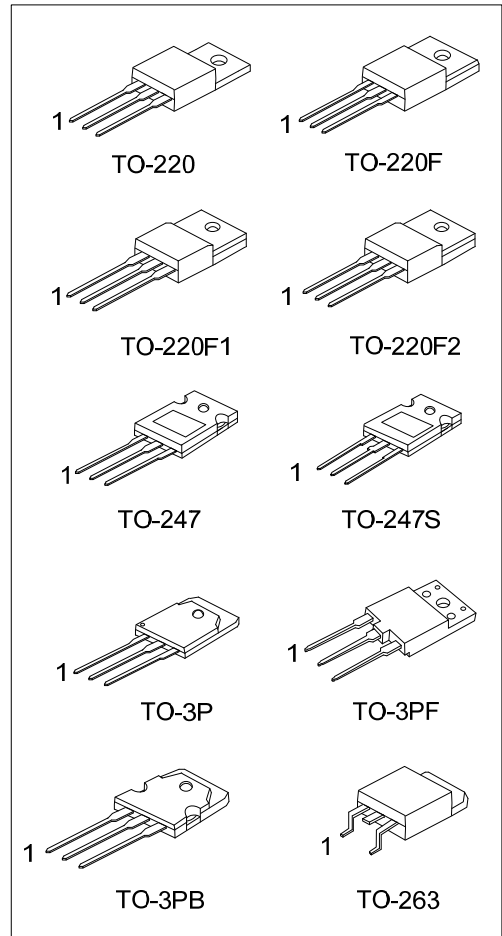
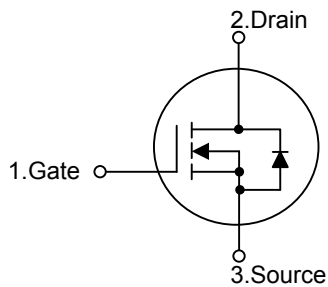
### DESCRIPTION

The **UTC 24NM60** 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 AC-DC converters for power applications.

### FEATURES

- \*  $R_{DS(ON)} \leq 0.16\Omega$  @  $V_{GS}=10V, I_D=12A$
- \* High Switching Speed
- \* 100% Avalanche Tested

### SYMBOL



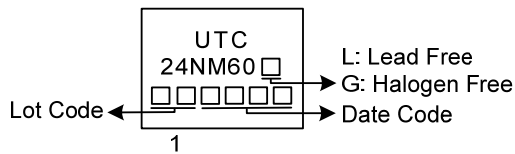
### ORDERING INFORMATION

Ordering Number		Package	Pin Assignment			Packing
Lead Free	Halogen Free		1	2	3	
24NM60L-TA3-T	24NM60G-TA3-T	TO-220	G	D	S	Tube
24NM60L-TF1-T	24NM60G-TF1-T	TO-220F1	G	D	S	Tube
24NM60L-TF2-T	24NM60G-TF2-T	TO-220F2	G	D	S	Tube
24NM60L-TF3-T	24NM60G-TF3-T	TO-220F	G	D	S	Tube
24NM60L-TQ2-T	24NM60G-TQ2-T	TO-263	G	D	S	Tube
24NM60L-TQ2-R	24NM60G-TQ2-R	TO-263	G	D	S	Tape Reel
24NM60L-T3P-T	24NM60G-T3P-T	TO-3P	G	D	S	Tube
24NM60L-T3B-T	24NM60G-T3B-T	TO-3PB	G	D	S	Tube
24NM60L-T3F-T	24NM60G-T3F-T	TO-3PF	G	D	S	Tube
24NM60L-T47-T	24NM60G-T47-T	TO-247	G	D	S	Tube
24NM60L-T47S-T	24NM60G-T47S-T	TO-247S	G	D	S	Tube

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

<p>24NM60G-TA3-T</p> <p>(1) Packing Type (2) Package Type (3) Green Package</p>	<p>(1) T: Tube, R: Tape Reel (2) TA3: TO-220, TF3: TO-220F, TF1: TO-220F1, TF2: TO-220F2, TQ2: TO-263, T3P: TO-3P, T3B: TO-3PB, T3F: TO-3PF, T47: TO-247, T47S: TO-247S (3) G: Halogen Free and Lead Free, L: Lead Free</p>
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### MARKING



■ 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
Drain Current	Continuous	$I_D$	24	A
	Pulsed (Note 2)	$I_{DM}$	96	A
Avalanche Current (Note 2)		$I_{AR}$	5.0	A
Avalanche Energy	Single Pulsed (Note 3)	$E_{AS}$	725	mJ
Peak Diode Recovery dv/dt		dv/dt	10.5	V/ns
MOSFET dv/dt Ruggedness		dv/dt	50	V/ns
Power Dissipation	TO-220/TO-263	$P_D$	176	W
	TO-220F/TO-220F1 TO-220F2		34	W
	TO-247/TO-247S		192	W
	TO-3P/TO-3PB		227	W
	TO-3PF		113	W
	Junction Temperature		$T_J$	+150
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.  $L = 58 \text{ mH}$ ,  $I_{AS} = 5.0\text{A}$ ,  $V_{DD} = 50\text{V}$ ,  $R_G = 25\Omega$ , Starting  $T_J = 25^\circ\text{C}$

4.  $I_{SD} \leq 24\text{A}$ ,  $di/dt \leq 200\text{A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$

■ THERMAL CHARACTERISTICS

PARAMETER		SYMBOL	RATING	UNIT	
Junction to Ambient	TO-220/TO-220F TO-220F1/TO-220F2 TO-263	$\theta_{JA}$	62.5	$^\circ\text{C}/\text{W}$	
	TO-247/TO-247S		60	$^\circ\text{C}/\text{W}$	
	TO-3P/TO-3PB TO-3PF		40	$^\circ\text{C}/\text{W}$	
	Junction to Case		$\theta_{JC}$	0.71	$^\circ\text{C}/\text{W}$
	TO-220/TO-263			3.67	$^\circ\text{C}/\text{W}$
TO-220F/TO-220F1 TO-220F2	0.65	$^\circ\text{C}/\text{W}$			
TO-247/TO-247S	0.55	$^\circ\text{C}/\text{W}$			
TO-3P/TO-3PB TO-3PF	1.1	$^\circ\text{C}/\text{W}$			

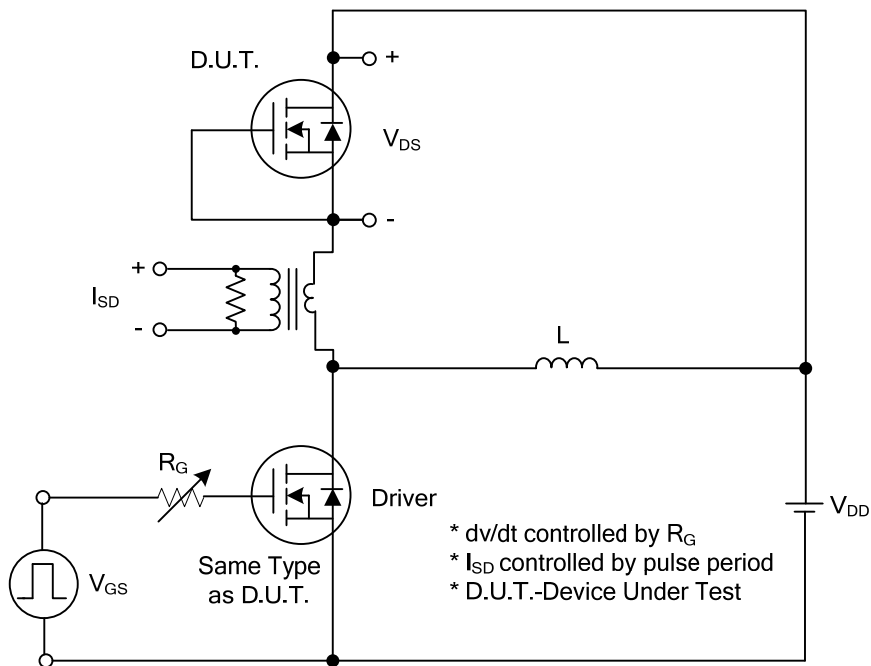
■ ELECTRICAL CHARACTERISTICS ( $T_J=25^\circ\text{C}$ , unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>OFF CHARACTERISTICS</b>						
Drain-Source Breakdown Voltage	$BV_{DSS}$	$I_D=250\mu\text{A}$ , $V_{GS}=0\text{V}$	600			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
<b>ON CHARACTERISTICS</b>						
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{DS}=V_{GS}$ , $I_D=250\mu\text{A}$	2.5		4.5	V
Static Drain-Source On-State Resistance	$R_{DS(ON)}$	$V_{GS}=10\text{V}$ , $I_D=12\text{A}$		0.145	0.16	$\Omega$
<b>DYNAMIC PARAMETERS</b>						
Input Capacitance	$C_{ISS}$	$V_{GS}=0\text{V}$ , $V_{DS}=25\text{V}$ , $f=1.0\text{MHz}$		2000		pF
Output Capacitance	$C_{OSS}$			1100		pF
Reverse Transfer Capacitance	$C_{RSS}$			110		pF
<b>SWITCHING PARAMETERS</b>						
Total Gate Charge (Note 1)	$Q_G$	$V_{DS}=480\text{V}$ , $V_{GS}=10\text{V}$ , $I_D=24\text{A}$ $I_G=1\text{mA}$ (Note1, 2)		76		nC
Gate to Source Charge	$Q_{GS}$			22		nC
Gate to Drain Charge	$Q_{GD}$			30		nC
Turn-ON Delay Time (Note 1)	$t_{D(ON)}$	$V_{DS}=100\text{V}$ , $V_{GS}=10\text{V}$ , $I_D=24\text{A}$ , $R_G=25\Omega$ (Note1, 2)		26		ns
Rise Time	$t_R$			48.2		ns
Turn-OFF Delay Time	$t_{D(OFF)}$			248		ns
Fall-Time	$t_F$			112.8		ns
<b>SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS</b>						
Maximum Body-Diode Continuous Current	$I_S$				24	A
Maximum Body-Diode Pulsed Current	$I_{SM}$				96	A
Drain-Source Diode Forward Voltage (Note 1)	$V_{SD}$	$I_S=24\text{A}$ , $V_{GS}=0\text{V}$			1.4	V
Body Diode Reverse Recovery Time (Note 1)	$t_{rr}$	$I_S=24\text{A}$ , $V_{GS}=0\text{V}$ , $di_F/dt=100\text{A}/\mu\text{s}$		490		ns
Body Diode Reverse Recovery Charge	$Q_{rr}$				9.3	

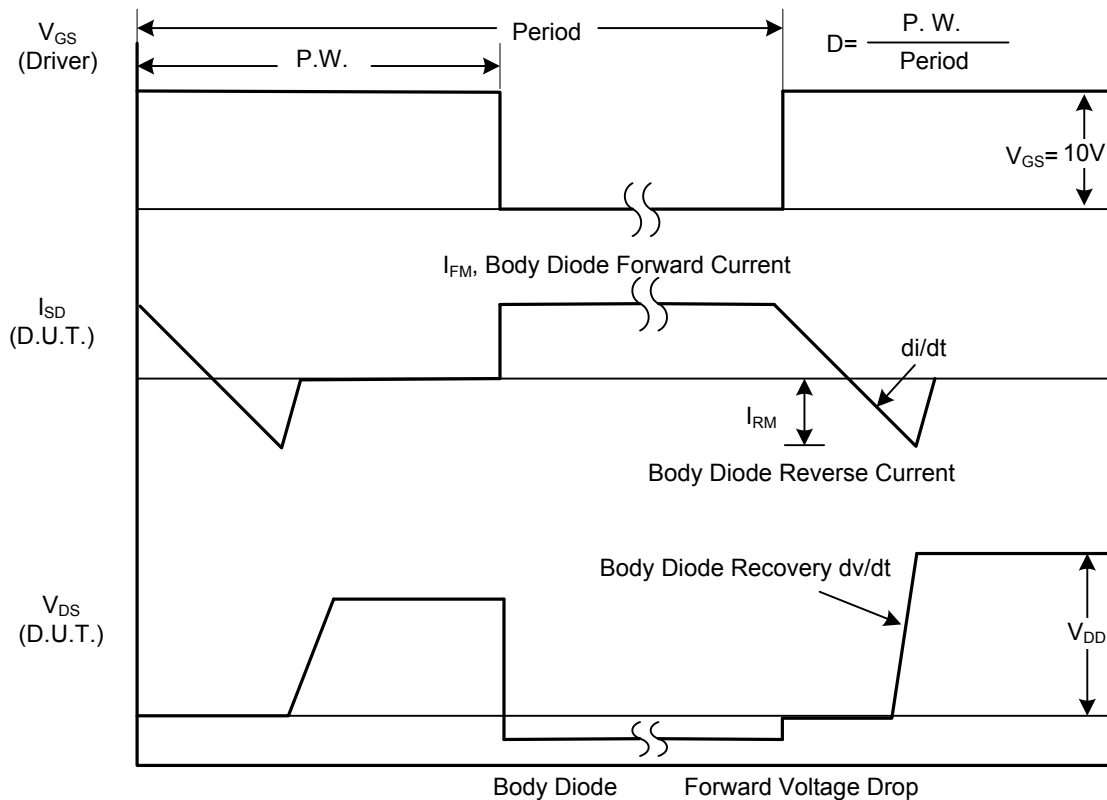
Notes: 1. Pulse Test : Pulse width  $\leq 300\mu\text{s}$ , Duty cycle  $\leq 2\%$ .

2. Essentially independent of operating ambient temperature.

■ TEST CIRCUITS AND WAVEFORMS



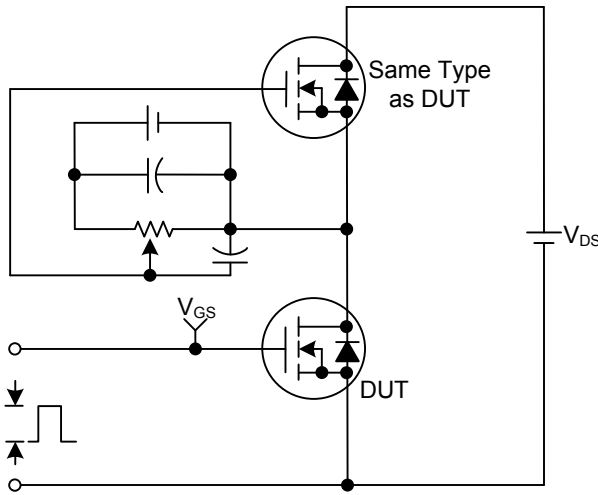
Peak Diode Recovery dv/dt Test Circuit



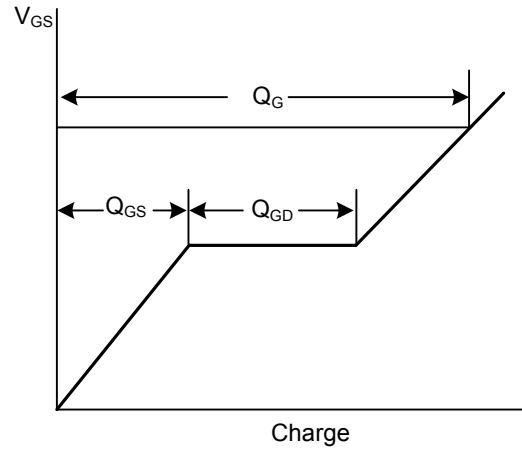
Peak Diode Recovery dv/dt Waveforms

## TEST CIRCUITS AND WAVEFORMS

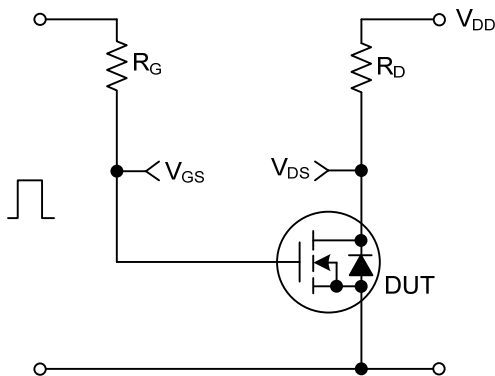
Gate Charge Test Circuit



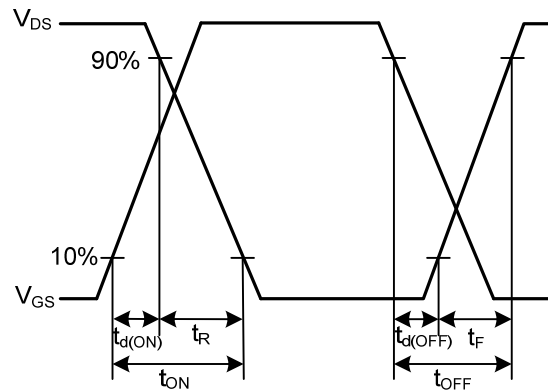
Gate Charge Waveforms



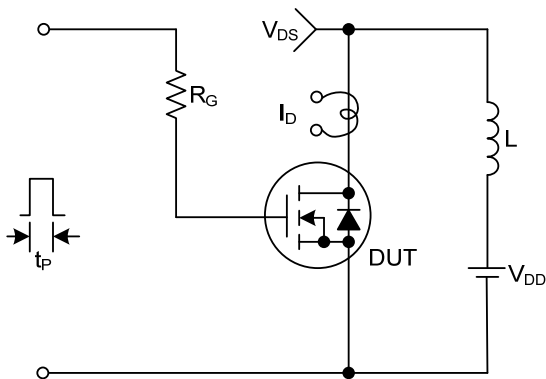
Resistive Switching Test Circuit



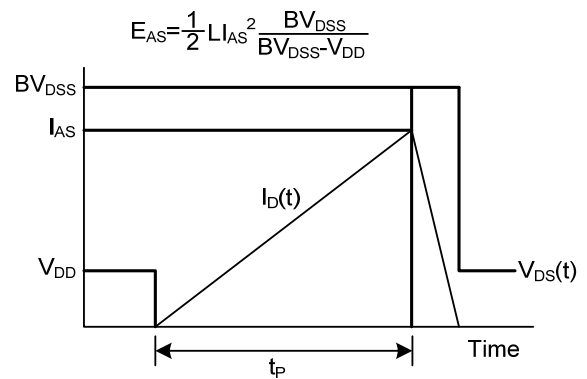
Resistive Switching Waveforms



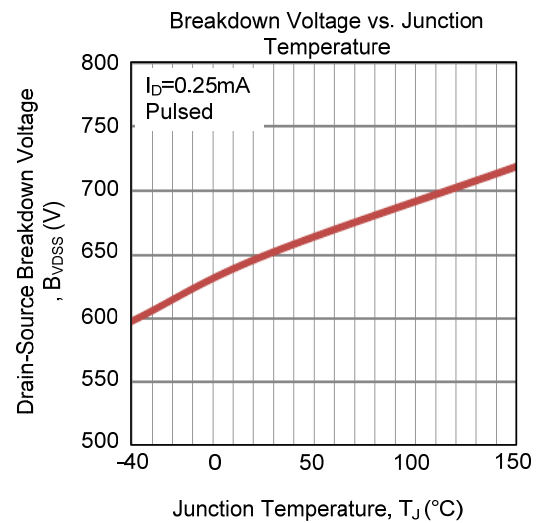
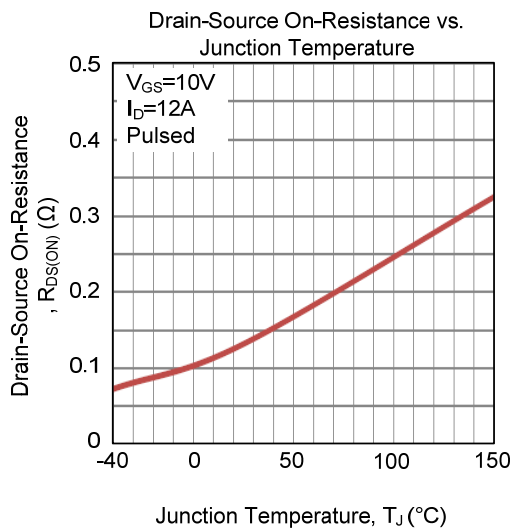
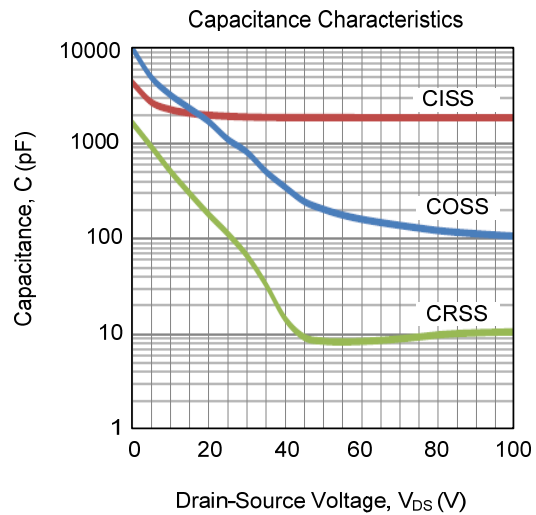
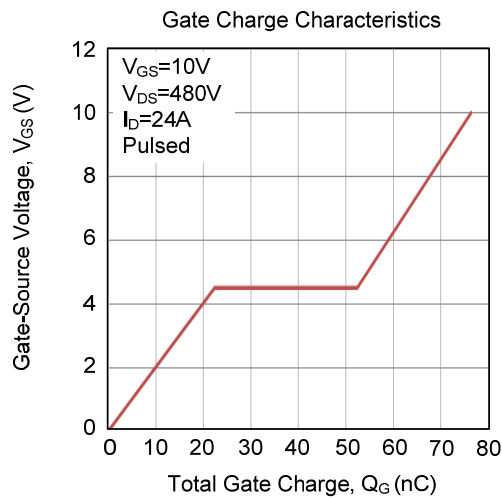
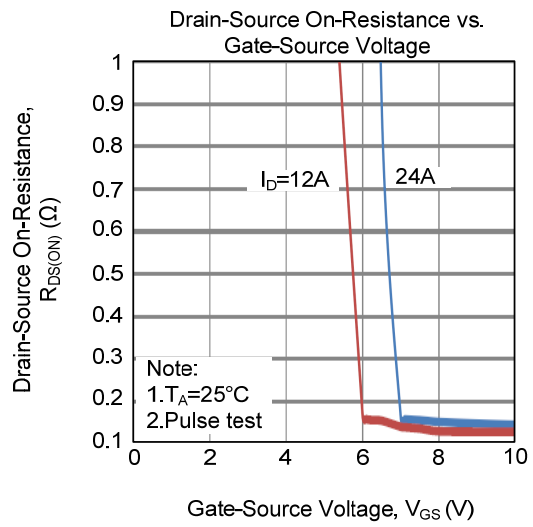
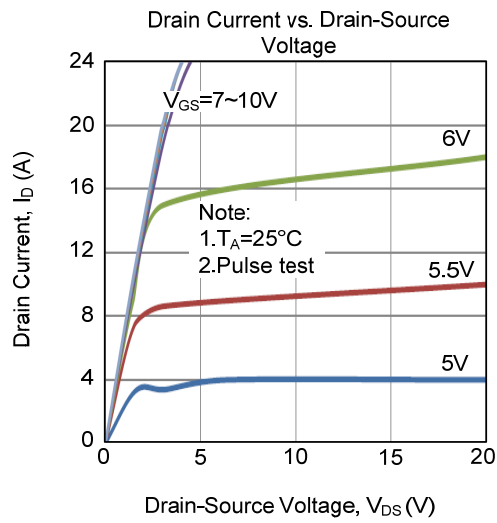
Unclamped Inductive Switching Test Circuit



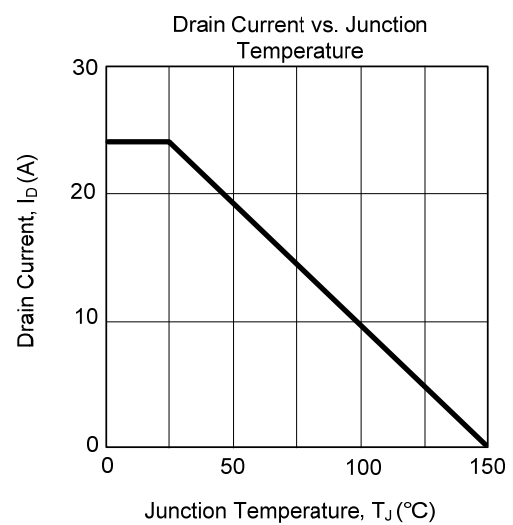
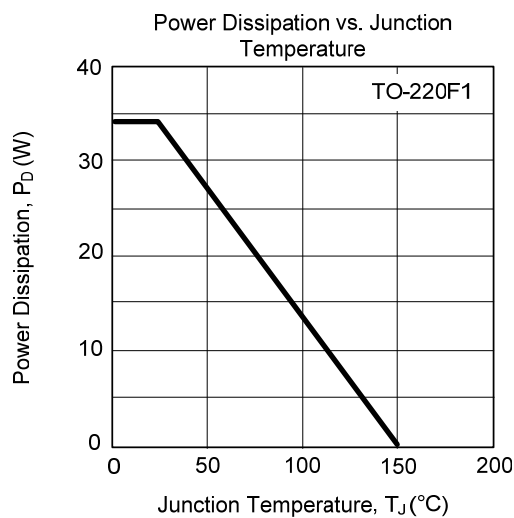
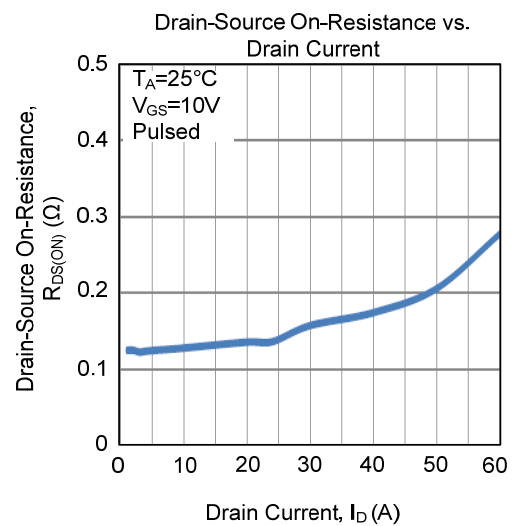
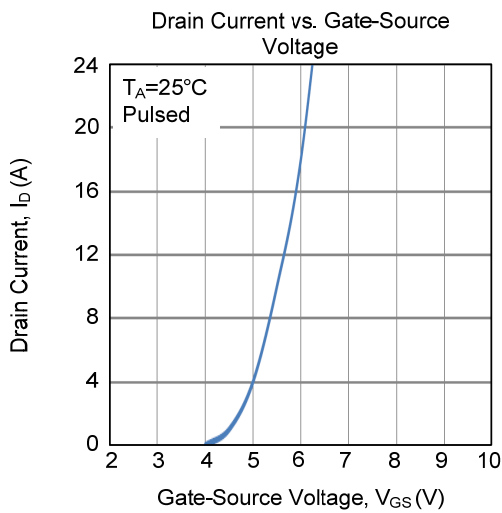
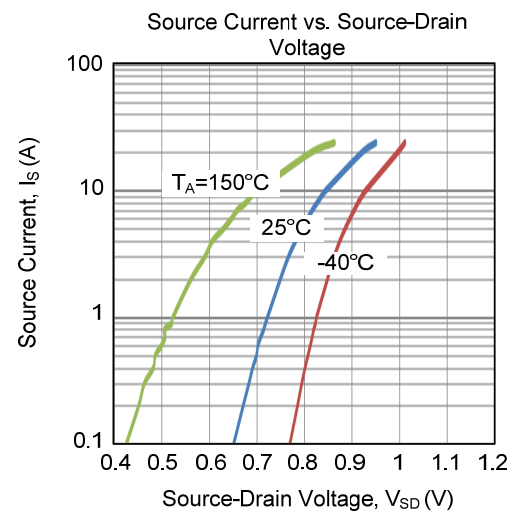
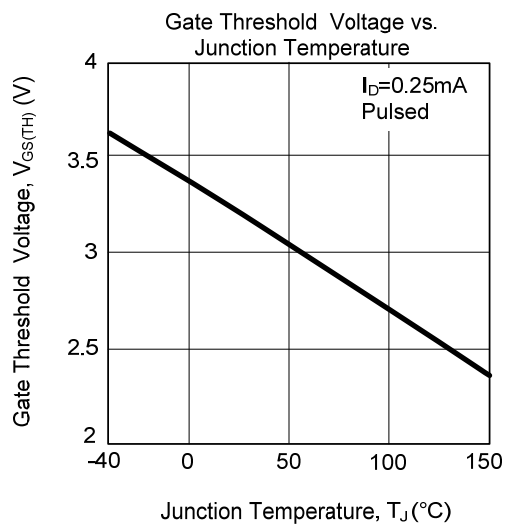
Unclamped Inductive Switching Waveforms



## TYPICAL CHARACTERISTICS

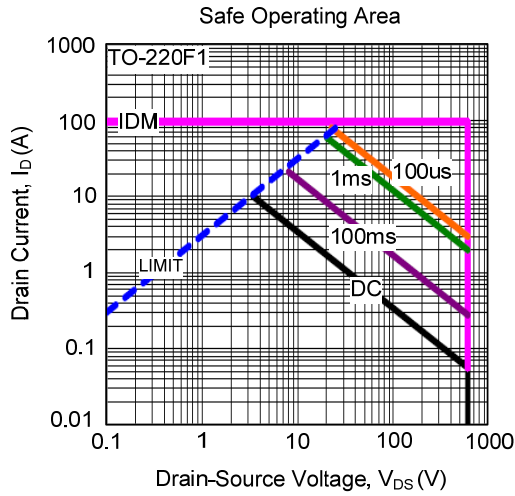


## ■ TYPICAL CHARACTERISTICS (Cont.)





■ TYPICAL CHARACTERISTICS (Cont.)



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