



# 4NM65

*Power MOSFET*

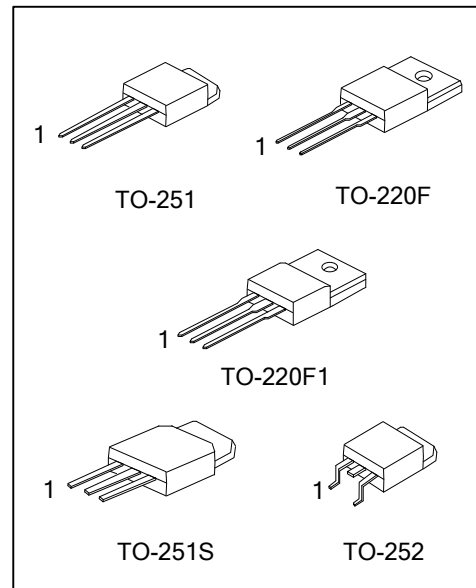
## 4A, 650V N-CHANNEL SUPER-JUNCTION MOSFET

### DESCRIPTION

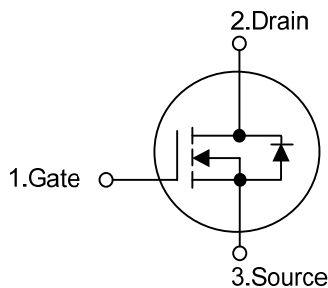
The UTC **4NM65** is a Super Junction MOSFET, designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and have a high rugged avalanche characteristic. This power MOSFET is usually used in high speed switching applications including power supplies, PWM motor controls, high efficient AC to DC converters and bridge circuits.

### FEATURES

- \*  $R_{DS(ON)} \leq 1.4\Omega @ V_{GS}=10V, I_D=2.0A$
- \* Fast Switching Capability
- \* Avalanche Energy Specified
- \* Improved dv/dt Capability, High Ruggedness



### SYMBOL



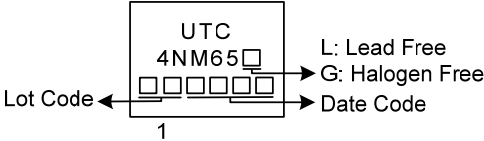
### ORDERING INFORMATION

Ordering Number		Package	Pin Assignment			Packing
Lead Free	Halogen Free		1	2	3	
4NM65L-TF3-T	4NM65G-TF3-T	TO-220F	G	D	S	Tube
4NM65L-TF1-T	4NM65G-TF1-T	TO-220F1	G	D	S	Tube
4NM65L-TM3-T	4NM65G-TM3-T	TO-251	G	D	S	Tube
4NM65L-TMS-T	4NM65G-TMS-T	TO-251S	G	D	S	Tube
4NM65L-TN3-R	4NM65G-TN3-R	TO-252	G	D	S	Tape Reel

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

<p>4NM65G-TF3-T</p> <p>(1) Packing Type (2) Package Type (3) Green Package</p>	<p>(1) T: Tube, R: Tape Reel (2) TF3: TO-220F, TF1: TO-220F1, TM3: TO-251, TMS: TO-251S, TN3: TO-252 (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		$V_{DSS}$	650	V
Gate-Source Voltage		$V_{GSS}$	$\pm 30$	V
Drain Current	Continuous	$I_D$	4.0	A
	Pulsed (Note2)	$I_{DM}$	16	A
Avalanche Current (Note 2)		$I_{AR}$	1.4	A
Avalanche Energy	Single Pulsed (Note3)	$E_{AS}$	141	mJ
Peak Diode Recovery dv/dt (Note4)		dv/dt	4.5	V/ns
Power Dissipation	TO-220F/TO-220F1	$P_D$	24	W
	TO-251/TO-251S		46	W
	TO-252			
Junction Temperature		$T_J$	+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.  $L=144\text{ mH}$ ,  $I_{AS}=1.4\text{ A}$ ,  $V_{DD}=50\text{ V}$ ,  $R_G=25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$

4.  $I_{SD}\leq 4.0\text{ A}$ ,  $di/dt\leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD}\leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$

■ THERMAL RESISTANCES CHARACTERISTICS

PARAMETER		SYMBOL	RATINGS	UNIT
Junction to Ambient	TO-220/TO-220F	$\theta_{JA}$	62.5	$^\circ\text{C}/\text{W}$
	TO-220F1			
	TO-251/TO-252			
Junction to Case	TO-220F/TO-220F1	$\theta_{JC}$	5.2	$^\circ\text{C}/\text{W}$
	TO-251/TO-251S			
	TO-252			
			2.71 (Note)	$^\circ\text{C}/\text{W}$

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

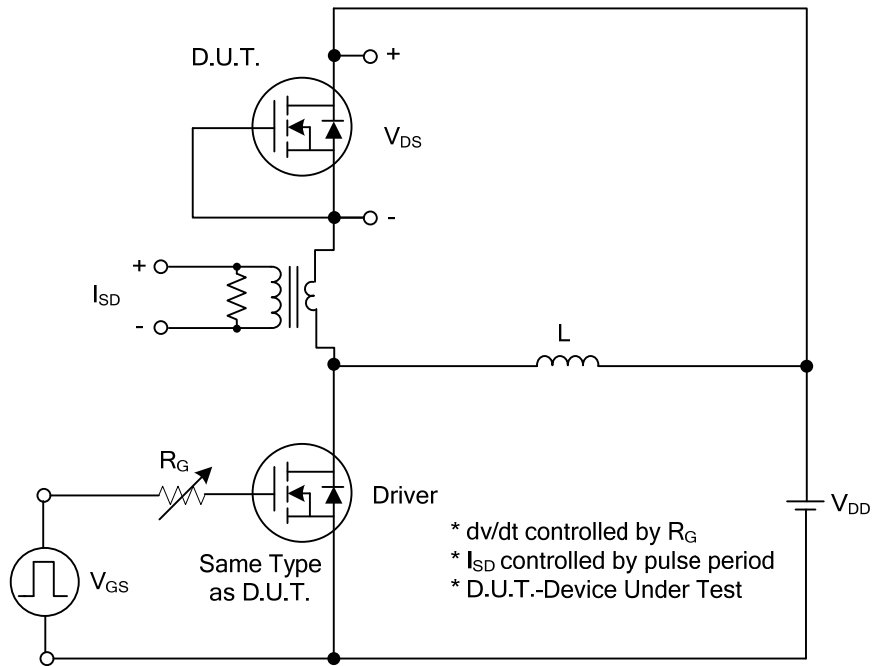
■ ELECTRICAL CHARACTERISTICS ( $T_J=25^\circ\text{C}$ , unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>OFF CHARACTERISTICS</b>						
Drain-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=250\mu A$	650			V
Drain-Source Leakage Current	$I_{DSS}$	$V_{DS}=650V, V_{GS}=0V$			10	$\mu A$
Gate-Source Leakage Current	Forward	$V_{GS}=30V, V_{DS}=0V$			100	nA
	Reverse		$V_{GS}=-30V, V_{DS}=0V$			-100
<b>ON CHARACTERISTICS</b>						
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{DS}=V_{GS}, I_D=250\mu A$	2.5		4.5	V
Static Drain-Source On-State Resistance	$R_{DS(ON)}$	$V_{GS}=10V, I_D=2.0A$			1.4	$\Omega$
<b>DYNAMIC CHARACTERISTICS</b>						
Input Capacitance	$C_{ISS}$	$V_{GS}=0V, V_{DS}=25V, f=1\text{MHz}$		255		pF
Output Capacitance	$C_{OSS}$			179		pF
Reverse Transfer Capacitance	$C_{RSS}$			24		pF
<b>SWITCHING CHARACTERISTICS</b>						
Total Gate Charge (Note 1)	$Q_G$	$V_{DS}=520V, V_{GS}=10V$ $I_D=4A, I_G=1\text{mA}$ (Note 1,2)		11		nC
Gate to Source Charge	$Q_{GS}$			3		nC
Gate to Drain Charge	$Q_{GD}$			3.3		nC
Turn-ON Delay Time (Note 1)	$t_{D(ON)}$	$V_{DD}=100V, V_{GS}=10V, I_D=4A,$ $R_G=25\Omega$ (Note 1, 2)		4.5		ns
Rise Time	$t_R$			18		ns
Turn-OFF Delay Time	$t_{D(OFF)}$			35		ns
Fall-Time	$t_F$			28		ns
<b>SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS</b>						
Maximum Body-Diode Continuous Current	$I_S$				4.4	A
Maximum Body-Diode Pulsed Current	$I_{SM}$				17.6	A
Drain-Source Diode Forward Voltage (Note 1)	$V_{SD}$	$V_{GS}=0V, I_S=4.0A$			1.4	V
Body Diode Reverse Recovery Time (Note 1)	$t_{rr}$	$V_{GS}=0V, I_S=4.0A$ $dI_F/dt=100A/\mu s$		250		ns
Body Diode Reverse Recovery Charge	$Q_{rr}$				2.0	

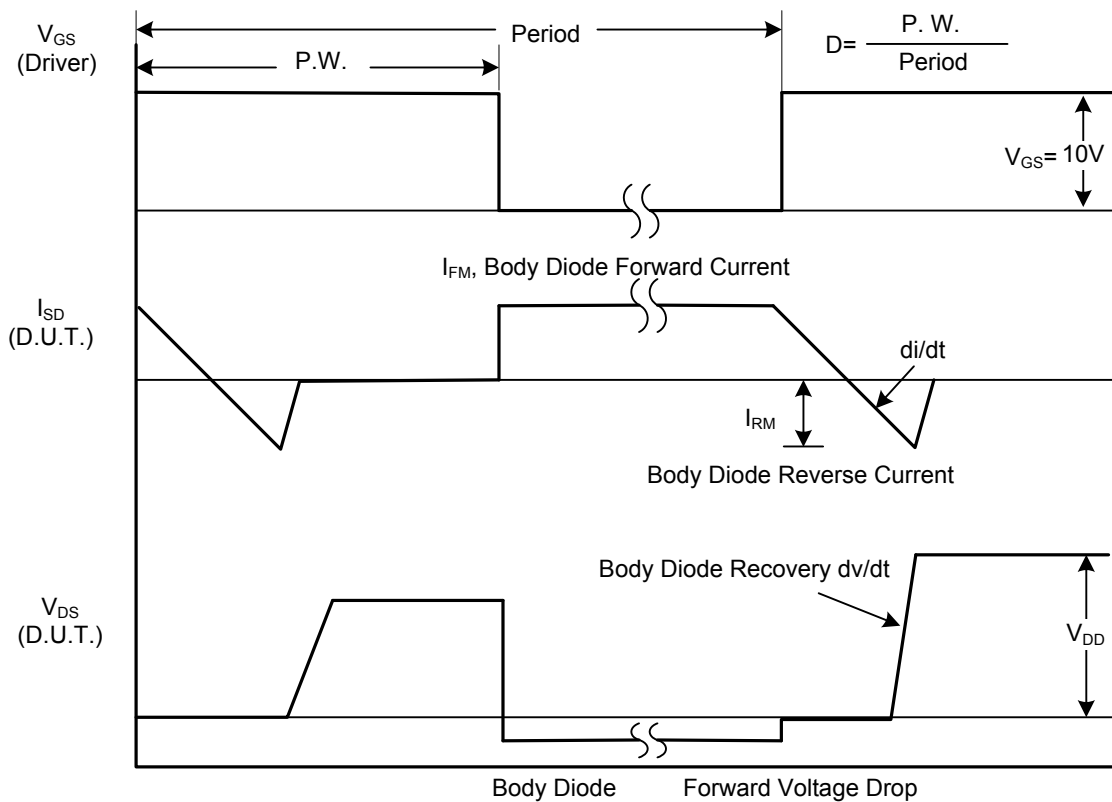
Notes: 1. Pulse Test: Pulse width  $\leq 300\mu s$ , Duty cycle  $\leq 2\%$ .

2. Essentially independent of operating temperature.

■ TEST CIRCUITS AND WAVEFORMS

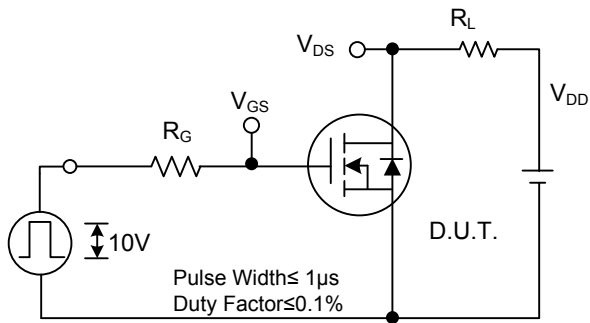


Peak Diode Recovery  $dv/dt$  Test Circuit

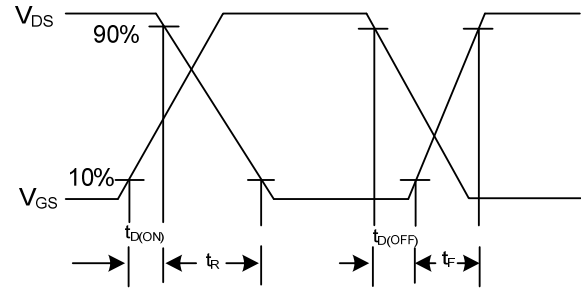


Peak Diode Recovery  $dv/dt$  Waveforms

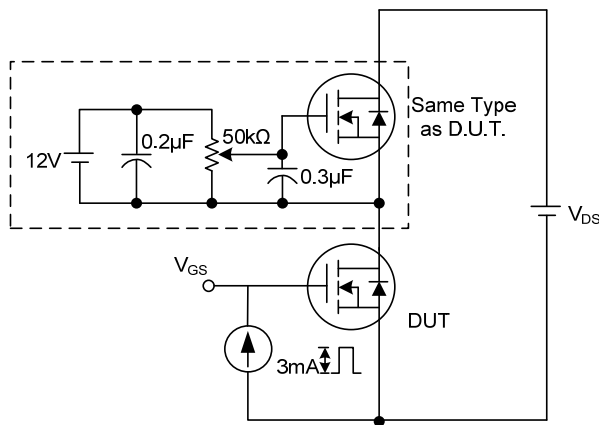
## TEST CIRCUITS AND WAVEFORMS



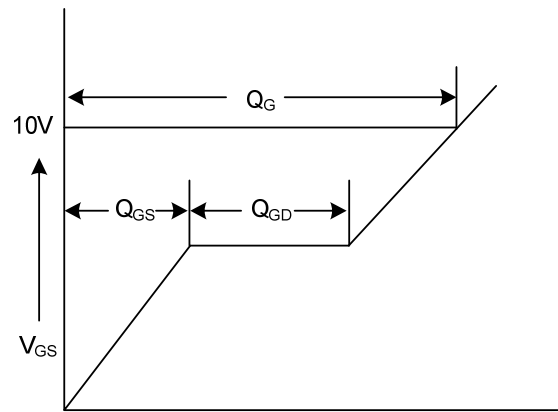
**Switching Test Circuit**



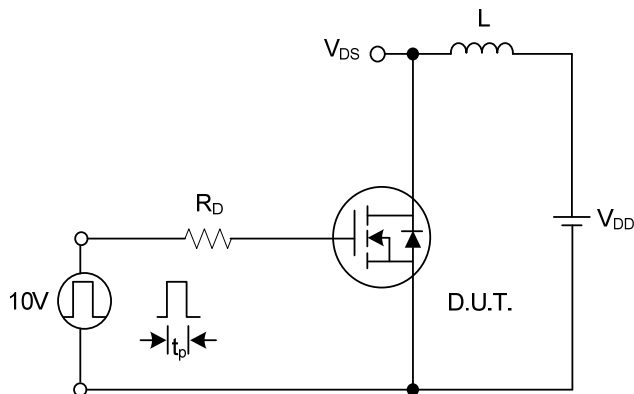
**Switching Waveforms**



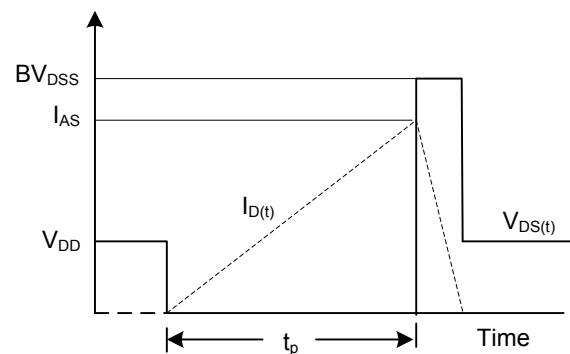
**Gate Charge Test Circuit**



**Gate Charge Waveform**

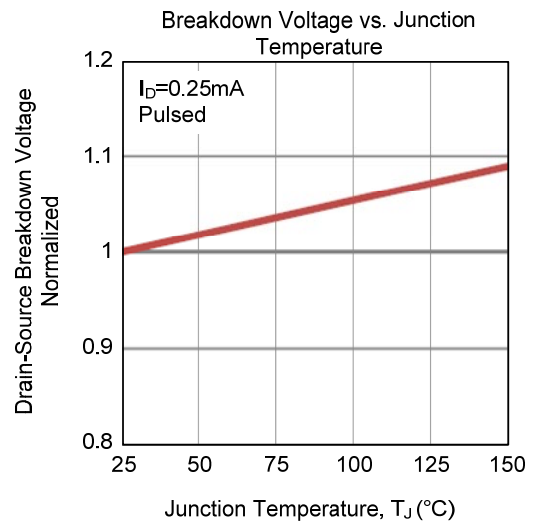
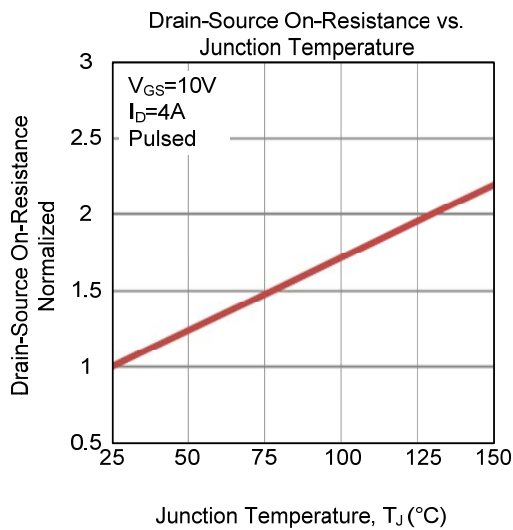
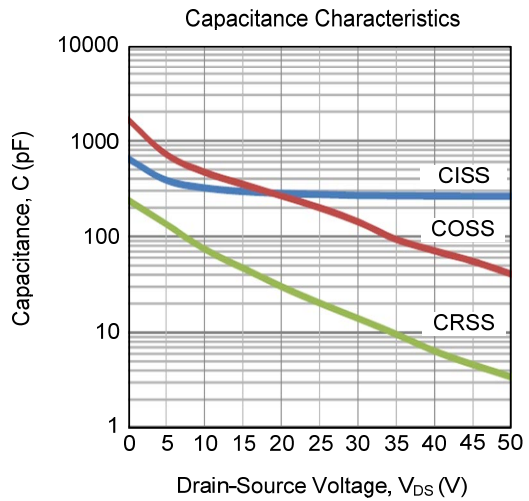
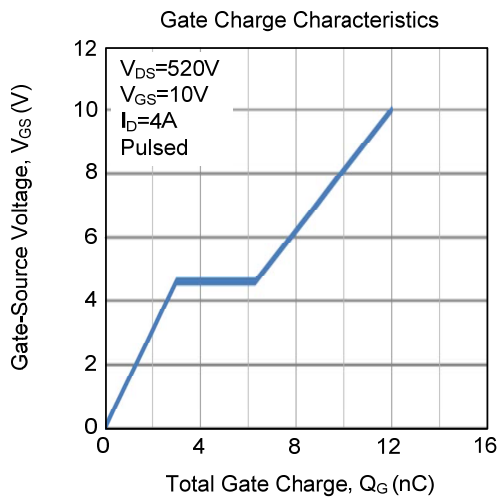
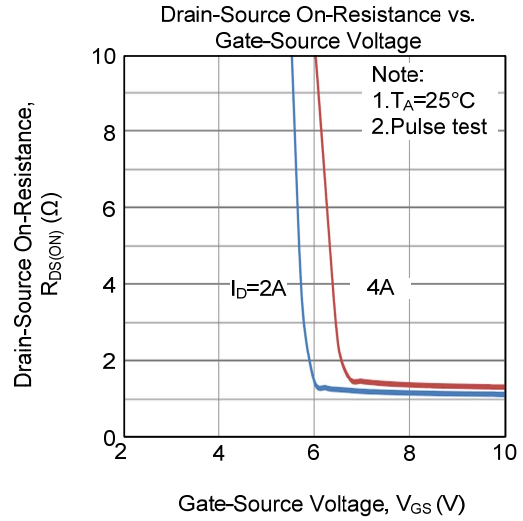
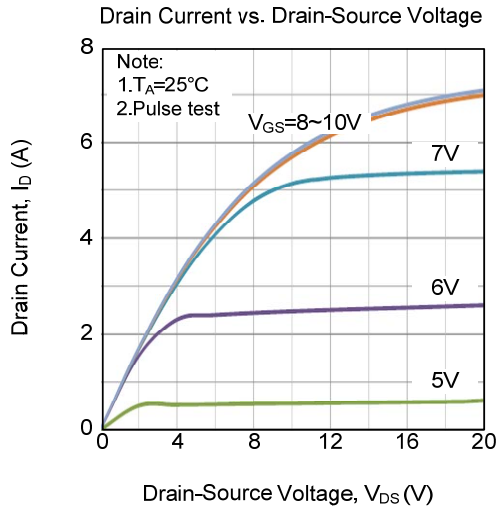


**Unclamped Inductive Switching Test Circuit**

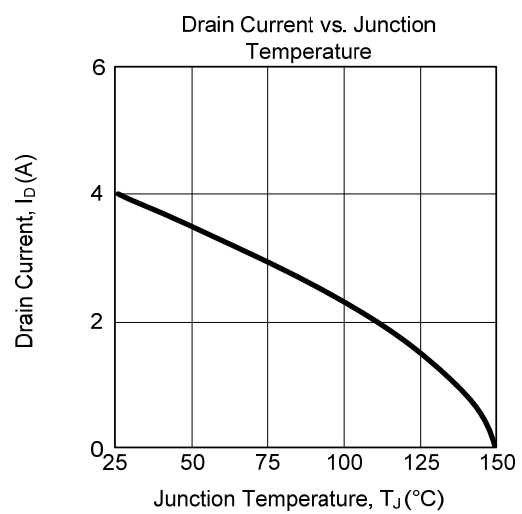
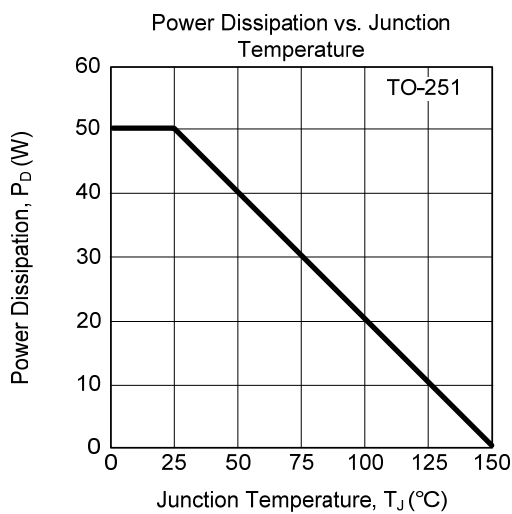
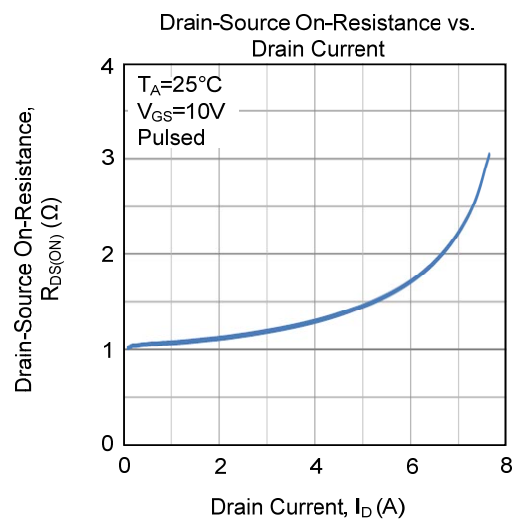
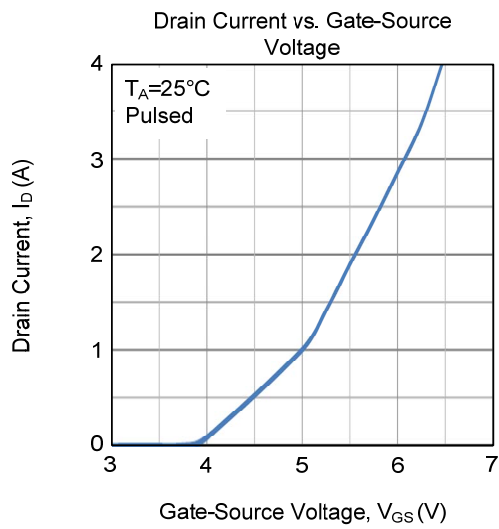
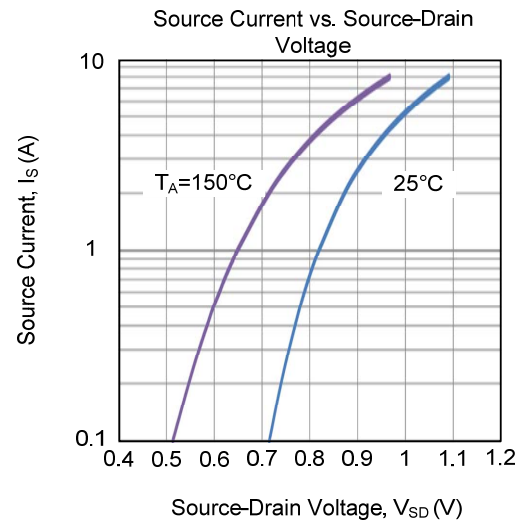
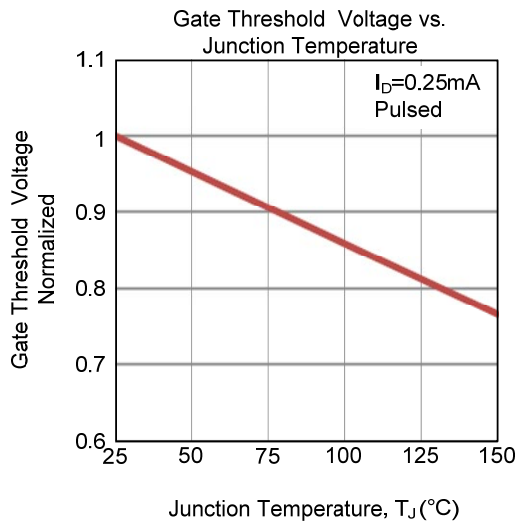


**Unclamped Inductive Switching Waveforms**

## TYPICAL CHARACTERISTICS

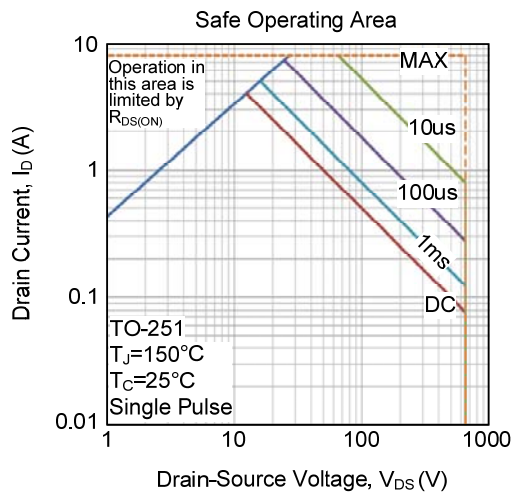


## ■ TYPICAL CHARACTERISTICS (Cont.)





■ TYPICAL CHARACTERISTICS (Cont.)



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