



4N65-ML

Power MOSFET

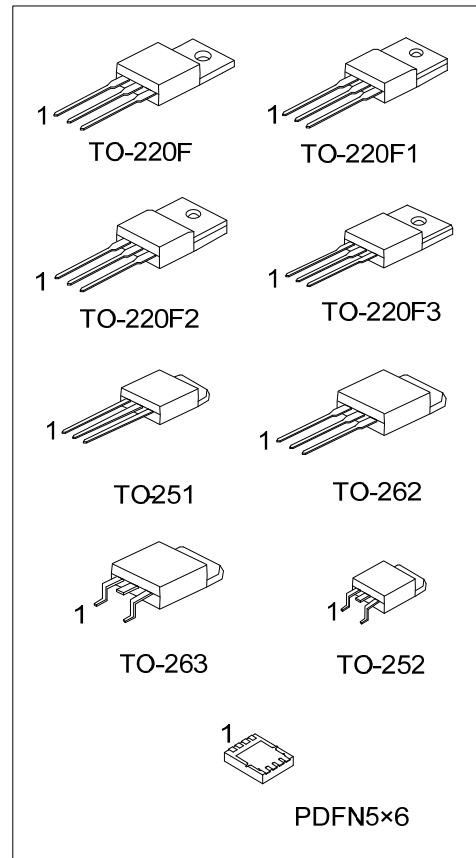
4.0A, 650V N-CHANNEL POWER MOSFET

DESCRIPTION

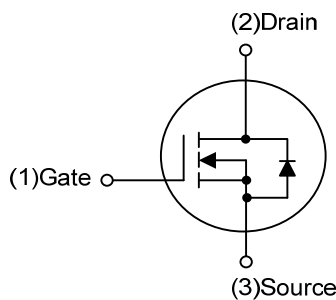
The UTC **4N65-ML** is a high voltage power MOSFET combines advanced trench MOSFET designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and high rugged avalanche characteristics. This power MOSFET is usually used in high speed switching applications of switching power supplies and adaptors.

FEATURES

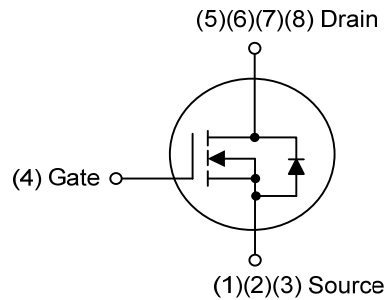
- * $R_{DS(ON)} \leq 2.6 \Omega @ V_{GS}=10V, I_D=2.0A$
- * Fast switching capability
- * Avalanche energy tested
- * Improved dv/dt capability, high ruggedness



SYMBOL



TO-220F/TO-220F1/TO-220F2
TO-220F3/TO-251/TO-262
TO-262/TO-263



PDFN5x6

ORDERING INFORMATION

Ordering Number		Package	Pin Assignment								Packing	
Lead Free	Halogen Free		1	2	3	4	5	6	7	8		
4N65L-TF1-T	4N65G-TF1-T	TO-220F1	G	D	S	-	-	-	-	-	-	Tube
4N65L-TF2-T	4N65G-TF2-T	TO-220F2	G	D	S	-	-	-	-	-	-	Tube
4N65L-TF3-T	4N65G-TF3-T	TO-220F	G	D	S	-	-	-	-	-	-	Tube
4N65L-TF3T-T	4N65G-TF3T-T	TO-220F3	G	D	S	-	-	-	-	-	-	Tube
4N65L-TM3-T	4N65G-TM3-T	TO-251	G	D	S	-	-	-	-	-	-	Tube
4N65L-TN3-R	4N65G-TN3-R	TO-252	G	D	S	-	-	-	-	-	-	Tape Reel
4N65L-T2Q-T	4N65G-T2Q-T	TO-262	G	D	S	-	-	-	-	-	-	Tube
4N65L-TQ2-T	4N65G-TQ2-T	TO-263	G	D	S	-	-	-	-	-	-	Tube
4N65L-TQ2-R	4N65G-TQ2-R	TO-263	G	D	S	-	-	-	-	-	-	Tape Reel
4N65L-P5060-R	4N65G-P5060-R	PDFN5×6	S	S	S	G	D	D	D	D	D	Tape Reel

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

<p>4N65G-TF1-T</p> <p>(1) Packing Type (2) Package Type (3) Green Package</p>	<p>(1) T: Tube, R: Tape Reel (2) TF1: TO-220F1, TF2: TO-220F2, TF3: TO-220F, TF3T: TO-220F3, TM3: TO-251, TN3: TO-252, T2Q: TO-262, TQ3: TO-263, P5060: PDFN5×6 (3) G: Halogen Free and Lead Free, L: Lead Free</p>
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MARKING

TO-220F/TO-220F1/TO-220F2/TO-220F3 TO-251/TO-252/TO-262/TO-263	PDFN5×6
<p>UTC 4N65</p> <p>Lot Code ← [] [] [] [] [] [] →</p> <p>→ L: Lead Free → G: Halogen Free → Date Code</p> <p>1</p>	<p>UTC 4N65</p> <p>Lot Code ← [] [] [] [] [] [] →</p> <p>→ [] [] → Internal Code → [] [] [] [] → Date Code</p>

■ 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}	± 30	V
Continuous Drain Current		I_D	4	A
Pulsed Drain Current (Note 2)		I_{DM}	8	A
Avalanche Energy	Single Pulsed (Note 3)	E_{AS}	173	mJ
Peak Diode Recovery dv/dt (Note 4)		dv/dt	2.1	V/ns
Power Dissipation	TO-220F/TO-220F1 TO-220F2/TO-220F3	P_D	32	W
	TO-251/TO-252		49	W
	TO-262/TO-263		106	W
	PDFN5x6		30	W
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. $L = 30\text{mH}$, $I_{AS} = 3.4\text{A}$, $V_{DD} = 50\text{V}$, $R_G = 25\ \Omega$, 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 DATA

PARAMETER		SYMBOL	RATINGS	UNIT
Junction to Ambient	TO-220F/TO-220F1 TO-220F2/TO-220F3 TO-262/TO-263	θ_{JA}	62.5	$^\circ\text{C}/\text{W}$
	TO-251/TO-252		110	$^\circ\text{C}/\text{W}$
	PDFN5x6		75	$^\circ\text{C}/\text{W}$
	TO-220F/TO-220F1 TO-220F2/TO-220F3		3.9	$^\circ\text{C}/\text{W}$
Junction to Case	TO-251/TO-252	θ_{JC}	2.55 (Note)	$^\circ\text{C}/\text{W}$
	TO-262/TO-263		1.17	$^\circ\text{C}/\text{W}$
	PDFN5x6		4.17	$^\circ\text{C}/\text{W}$

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

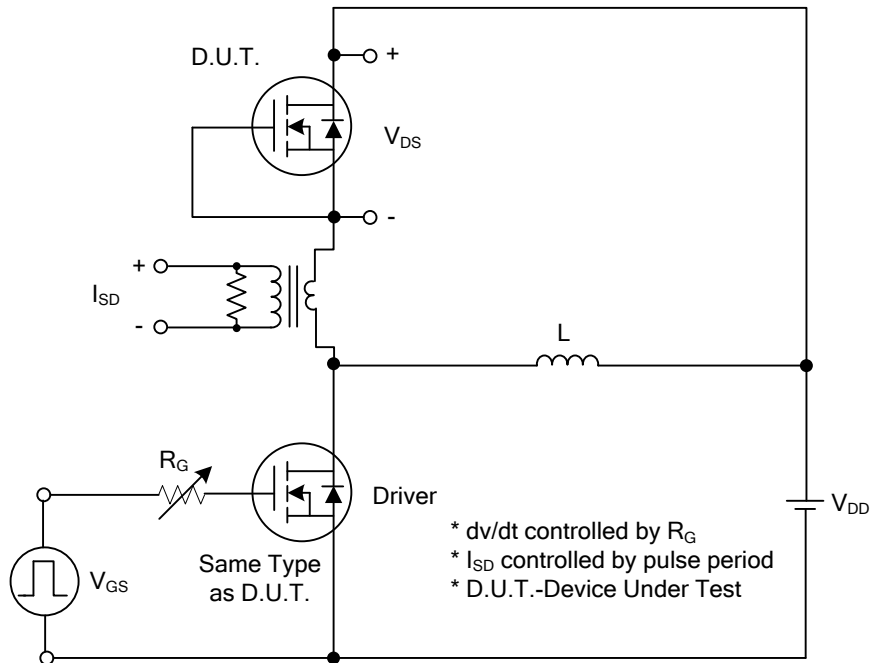
■ ELECTRICAL CHARACTERISTICS ($T_J=25^\circ\text{C}$, unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS						
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	μA
Gate- Source Leakage Current	Forward	I_{GSS}			100	nA
	Reverse					
ON CHARACTERISTICS						
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{DS}=V_{GS}, I_D=250\mu A$	2.0		4.0	V
Static Drain-Source On-State Resistance	$R_{DS(ON)}$	$V_{GS}=10V, I_D=2.0A$			2.6	Ω
DYNAMIC CHARACTERISTICS						
Input Capacitance	C_{ISS}	$V_{DS}=25V, V_{GS}=0V, f=1.0\text{MHz}$		560		pF
Output Capacitance	C_{OSS}			55		pF
Reverse Transfer Capacitance	C_{RSS}			5		pF
SWITCHING CHARACTERISTICS						
Total Gate Charge (Note 1)	Q_G	$V_{DS}=520V, V_{GS}=10V, I_D=4A$ $I_G=1\text{mA}$ (Note 1, 2)		13		nC
Gate-Source Charge	Q_{GS}			4		nC
Gate-Drain Charge	Q_{GD}			2.2		nC
Turn-On Delay Time (Note 1)	$t_{D(ON)}$	$V_{DS}=100V, V_{GS}=10V, I_D=4A,$ $R_G=25\Omega$ (Note 1, 2)		7		ns
Turn-On Rise Time	t_R			16		ns
Turn-Off Delay Time	$t_{D(OFF)}$			36		ns
Turn-Off Fall Time	t_F			22		ns
DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS						
Maximum Body-Diode Continuous Current	I_S				4	A
Maximum Body-Diode Pulsed Current	I_{SM}				8	A
Drain-Source Diode Forward Voltage (Note 1)	V_{SD}	$I_S=4A, V_{GS}=0V$			1.4	V
Reverse Recovery Time (Note 1)	t_{rr}	$I_S=4A, V_{GS}=0V$ $di/dt=100A/\mu s$		250		ns
Reverse Recovery Charge	Q_{rr}			4.5		μC

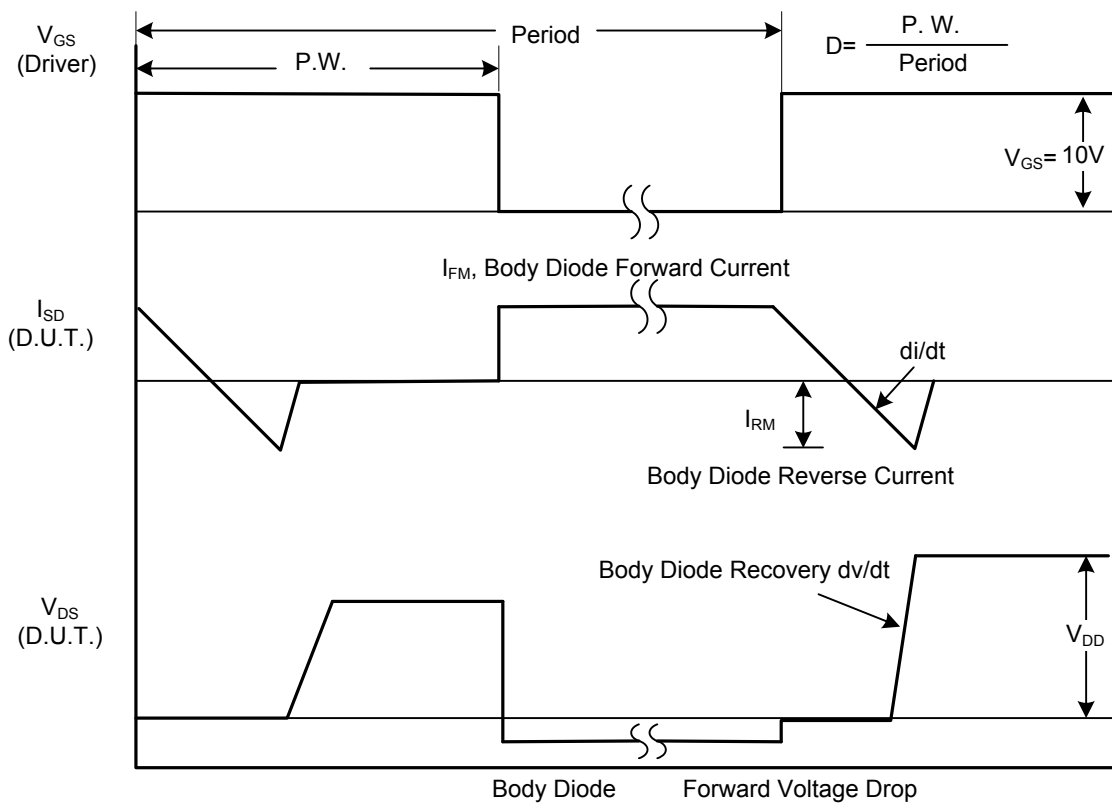
Notes: 1. Pulse Test: Pulse width $\leq 300\mu s$, Duty cycle $\leq 2\%$.

2. Essentially independent of operating temperature.

■ TEST CIRCUITS AND WAVEFORMS

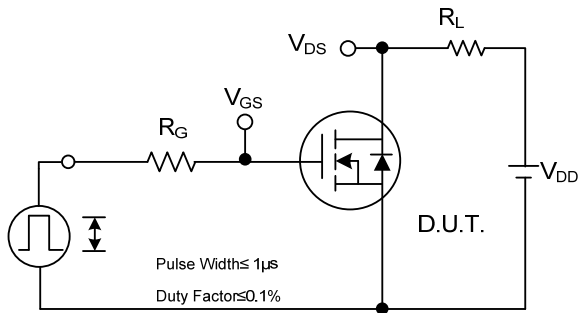


Peak Diode Recovery dv/dt Test Circuit

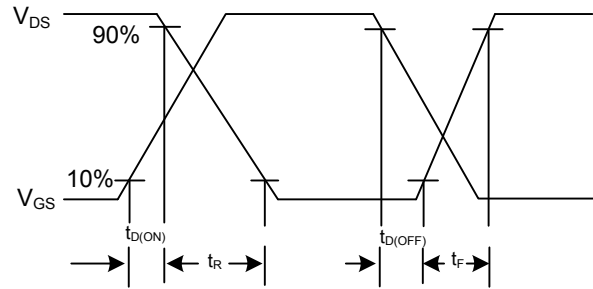


Peak Diode Recovery dv/dt Waveforms

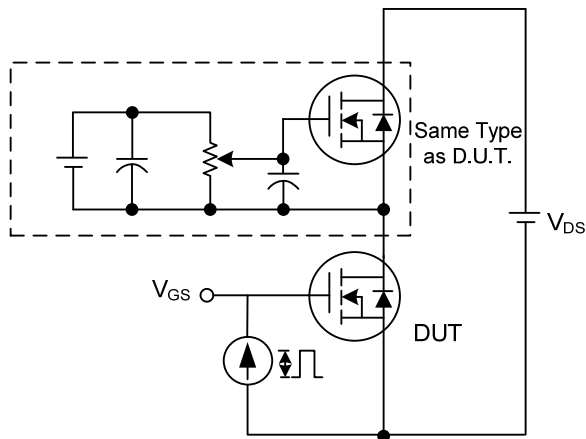
TEST CIRCUITS AND WAVEFORMS



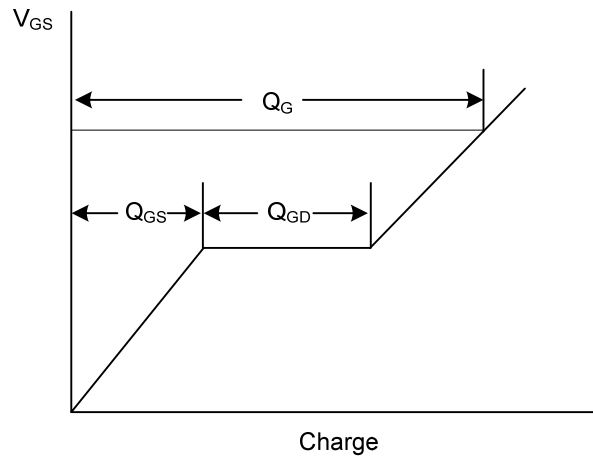
Switching Test Circuit



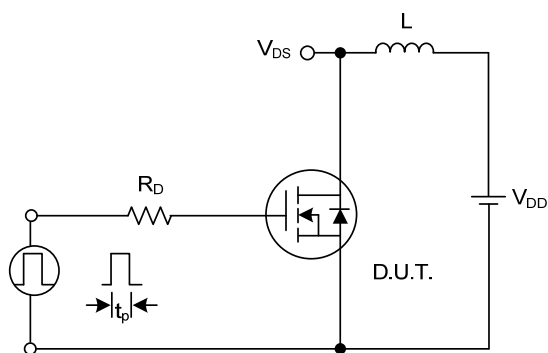
Switching Waveforms



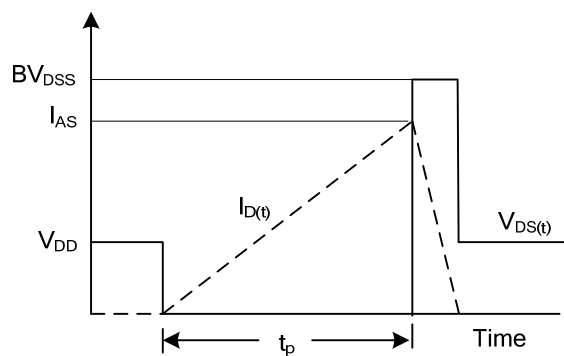
Gate Charge Test Circuit



Gate Charge Waveform

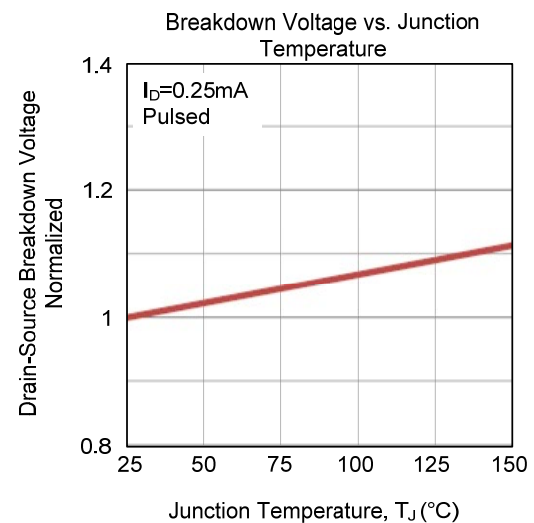
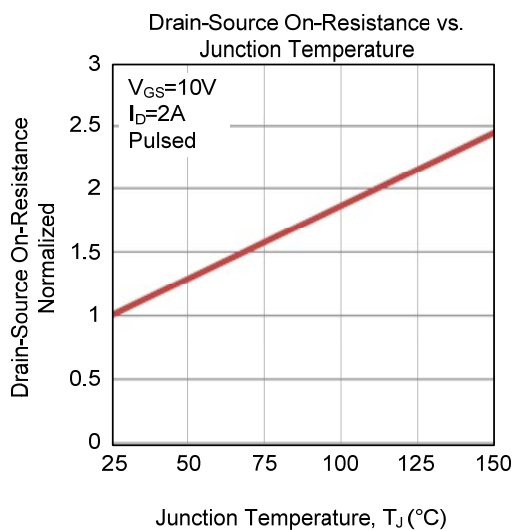
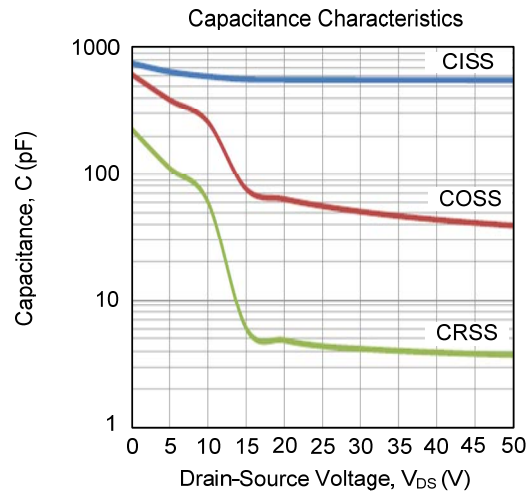
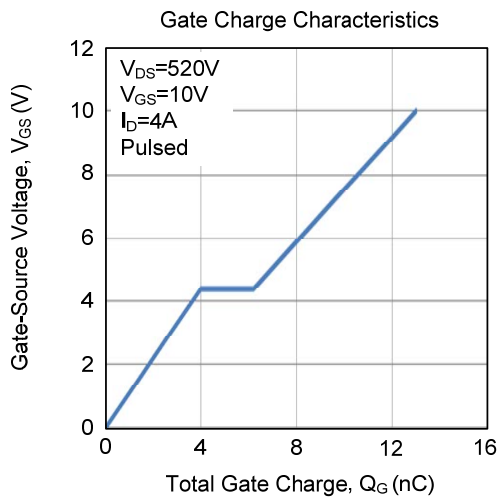
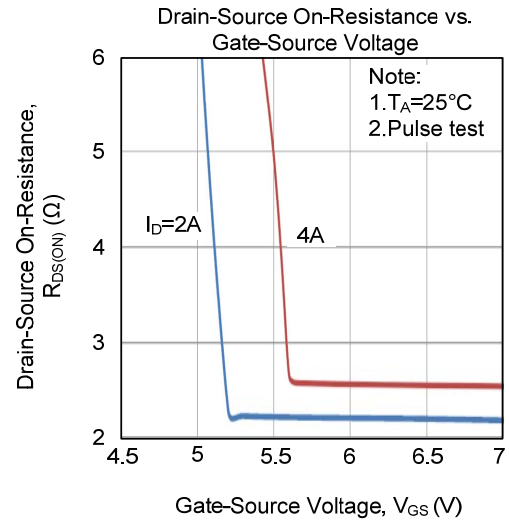
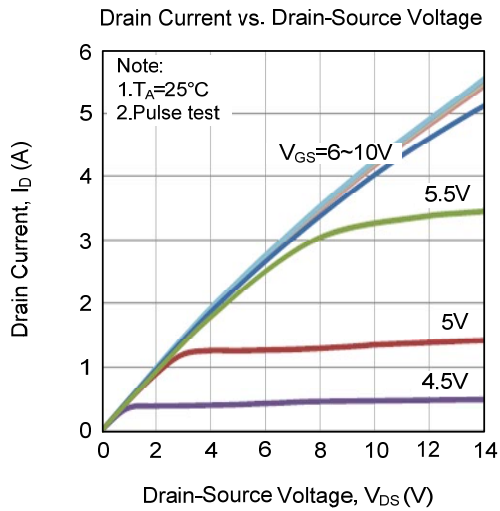


Unclamped Inductive Switching Test Circuit

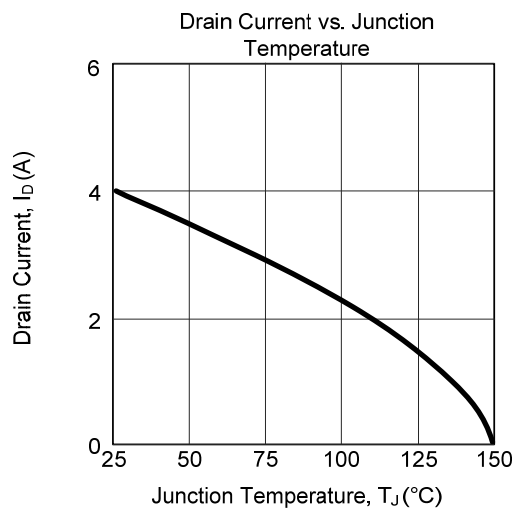
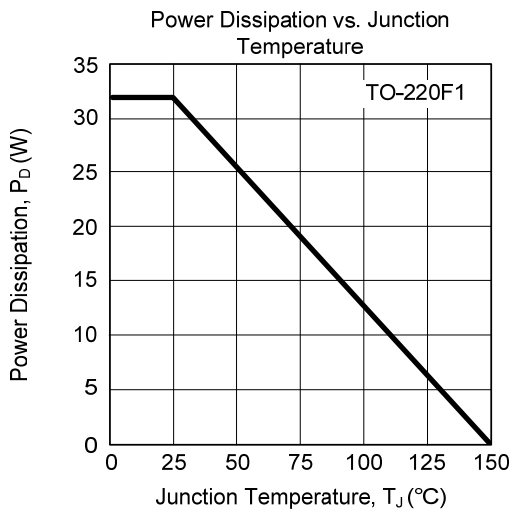
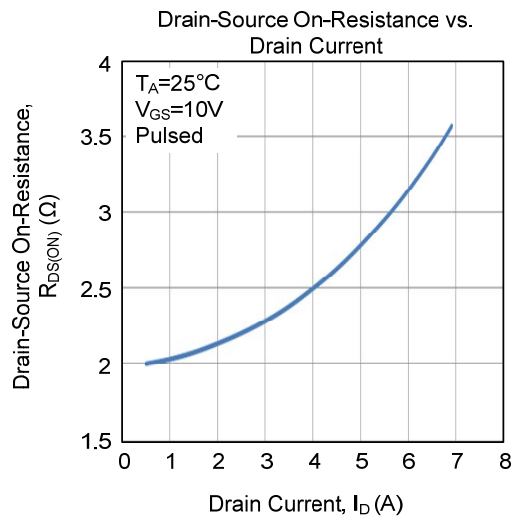
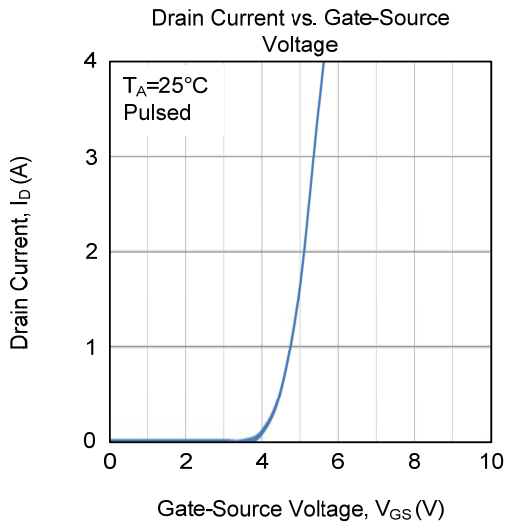
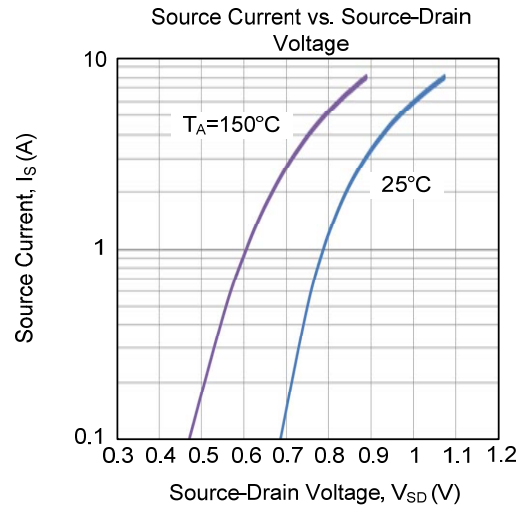
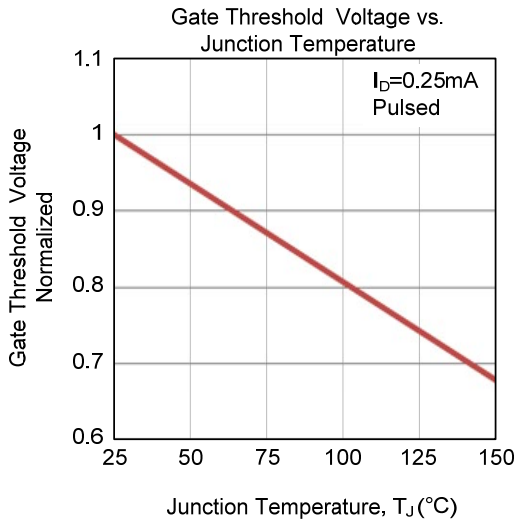


Unclamped Inductive Switching Waveforms

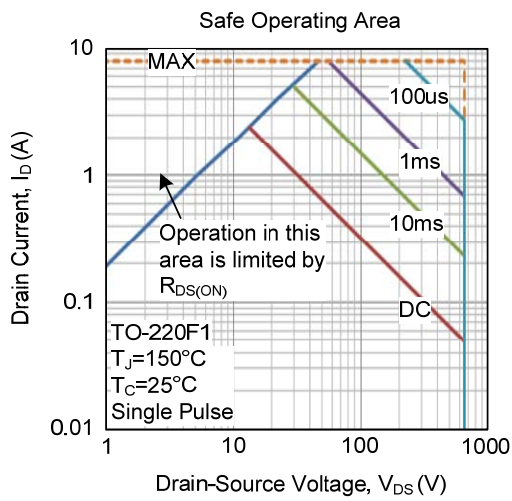
TYPICAL CHARACTERISTICS



■ TYPICAL CHARACTERISTICS (Cont.)



■ TYPICAL CHARACTERISTICS (Cont.)



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