



# 4N65K-MT

Power MOSFET

## 4.0A, 650V N-CHANNEL POWER MOSFET

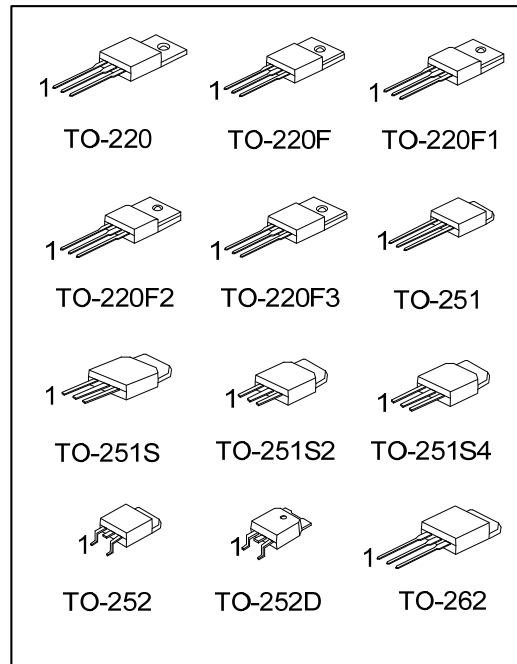
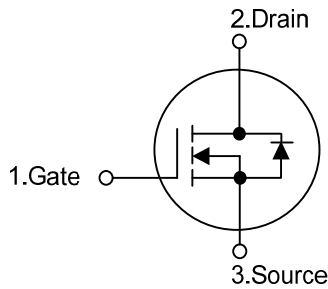
### DESCRIPTION

The UTC **4N65K-MT** is a high voltage power 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 DC to DC converters and bridge circuits.

### FEATURES

- \*  $R_{DS(ON)} < 2.5\Omega @ V_{GS} = 10V, I_D = 2.2A$
- \* Fast Switching Capability
- \* Avalanche Energy Specified
- \* Improved dv/dt Capability, High Ruggedness

### SYMBOL



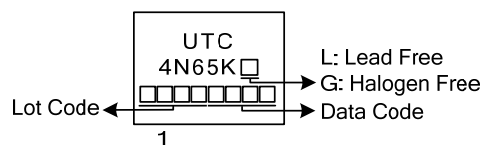
### ORDERING INFORMATION

Ordering Number		Package	Pin Assignment			Packing
Lead Free	Halogen Free		1	2	3	
4N65KL-TA3-T	4N65KG-TA3-T	TO-220	G	D	S	Tube
4N65KL-TF3-T	4N65KG-TF3-T	TO-220F	G	D	S	Tube
4N65KL-TF1-T	4N65KG-TF1-T	TO-220F1	G	D	S	Tube
4N65KL-TF2-T	4N65KG-TF2-T	TO-220F2	G	D	S	Tube
4N65KL-TF3T-T	4N65KG-TF3T-T	TO-220F3	G	D	S	Tube
4N65KL-TM3-T	4N65KG-TM3-T	TO-251	G	D	S	Tube
4N65KL-TMS-T	4N65KG-TMS-T	TO-251S	G	D	S	Tube
4N65KL-TMS2-T	4N65KG-TMS2-T	TO-251S2	G	D	S	Tube
4N65KL-TMS4-T	4N65KG-TMS4-T	TO-251S4	G	D	S	Tube
4N65KL-TN3-R	4N65KG-TN3-R	TO-252	G	D	S	Tape Reel
4N65KL-TND-R	4N65KG-TND-R	TO-252D	G	D	S	Tape Reel
4N65KL-T2Q-T	4N65KG-T2Q-T	TO-262	G	D	S	Tube

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

<p>4N65KL-TA3-T</p> <p>(1) Packing Type</p> <p>(2) Package Type</p> <p>(3) Green Package</p>	<p>(1) T: Tube, R: Tape Reel</p> <p>(2) TA3: TO-220, TF1: TO-220F1, TF2: TO-220F2 TF3: TO-220F, TF3T: TO-220F3, TM3: TO-251, TMS: TO-251S, TMS2: TO-251S2, TN3: TO-252, TMS4: TO-251S4, TND: TO-252D, T2Q: TO-262,</p> <p>(3) L: Lead Free, G: Halogen Free and 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 Energy	Single Pulsed (Note3)	$E_{AS}$	200	mJ
Peak Diode Recovery dv/dt (Note4)		dv/dt	2.63	V/ns
Power Dissipation	TO-220/TO-262	$P_D$	106	W
	TO-220F		34	W
	TO-220F1/TO-220F2 TO-220F3		36	W
	TO-251/TO-251S TO-251S2/TO-251S4 TO-252/TO-252D		50	W
Junction Temperature		$T_J$	+150	$^\circ\text{C}$
Operating Temperature		$T_{OPR}$	-55 ~ +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.  $L=25\text{mH}$ ,  $I_{AS}=4\text{A}$ ,  $V_{DD}=50\text{V}$ ,  $R_G=25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$

4.  $I_{SD}\leq 4.4\text{A}$ ,  $di/dt\leq 200\text{A}/\mu\text{s}$ ,  $V_{DD}\leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$

■ THERMAL RESISTANCES CHARACTERISTICS

PARAMETER		SYMBOL	RATINGS	UNIT
Junction to Ambient	TO-220/TO-262 TO-220F/TO-220F1 TO-220F2/TO-220F3	$\theta_{JA}$	62.5	$^\circ\text{C}/\text{W}$
	TO-251/TO-251S TO-251S2/TO-251S4 TO-252/TO-252D		110	$^\circ\text{C}/\text{W}$
Junction to Case	TO-220/TO-262	$\theta_{JC}$	1.18	$^\circ\text{C}/\text{W}$
	TO-220F/TO-220F1		3.47	$^\circ\text{C}/\text{W}$
	TO-220F3		3.67	$^\circ\text{C}/\text{W}$
	TO-220F2		3.57	$^\circ\text{C}/\text{W}$
	TO-251/TO-251S TO-251S2/TO-251S4 TO-252/TO-252D		2.5	$^\circ\text{C}/\text{W}$

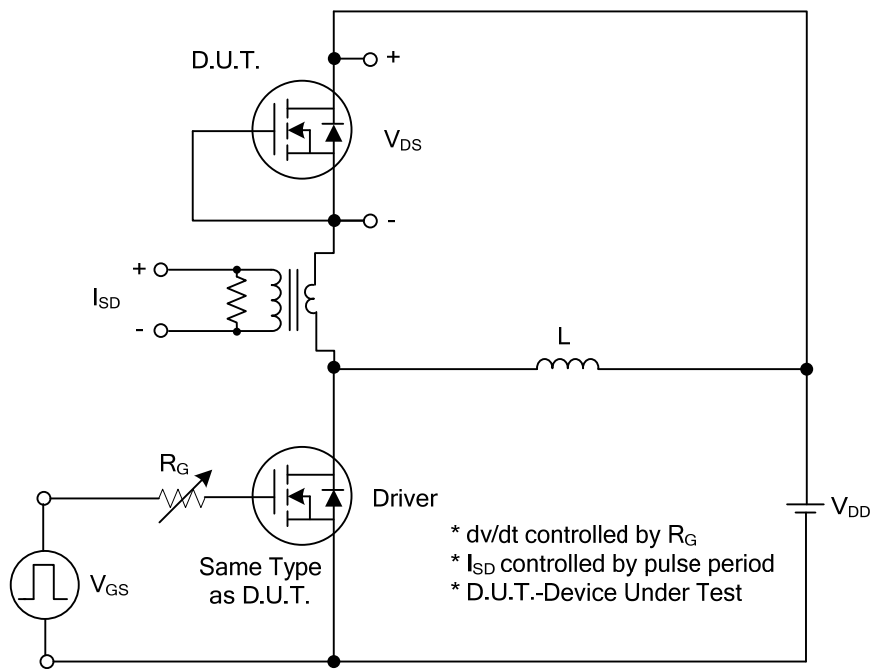
■ ELECTRICAL CHARACTERISTICS (T<sub>C</sub>=25°C, unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>OFF CHARACTERISTICS</b>						
Drain-Source Breakdown Voltage	BV <sub>DSS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250μA	650			V
Drain-Source Leakage Current	I <sub>DSS</sub>	V <sub>DS</sub> = 650 V, V <sub>GS</sub> = 0 V			10	μA
Gate-Source Leakage Current	Forward	I <sub>GSS</sub>			100	nA
	Reverse				-100	nA
Breakdown Voltage Temperature Coefficient	ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>	I <sub>D</sub> =250μA, Referenced to 25°C		0.6		V/°C
<b>ON CHARACTERISTICS</b>						
Gate Threshold Voltage	V <sub>GS(TH)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA	2.0		4.0	V
Static Drain-Source On-State Resistance	R <sub>DS(ON)</sub>	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 2.2A		1.77	2.50	Ω
<b>DYNAMIC CHARACTERISTICS</b>						
Input Capacitance	C <sub>ISS</sub>	V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0V, f = 1MHz		430	750	pF
Output Capacitance	C <sub>OSS</sub>		60	90	pF	
Reverse Transfer Capacitance	C <sub>RSS</sub>		6	11	pF	
<b>SWITCHING CHARACTERISTICS</b>						
Total Gate Charge	Q <sub>G</sub>	V <sub>DS</sub> =50V, V <sub>GS</sub> =10V, I <sub>D</sub> =1.3A, I <sub>G</sub> =100μA (Note 1, 2)		17	20	nC
Gate-Source Charge	Q <sub>GS</sub>		4.9	5.5	nC	
Gate-Drain Charge	Q <sub>GD</sub>		3.7	4.2	nC	
Turn-On Delay Time	t <sub>D(ON)</sub>	V <sub>DD</sub> = 30V, V <sub>GS</sub> = 10V, I <sub>D</sub> = 0.5A, R <sub>G</sub> = 25Ω (Note 1, 2)		44	60	ns
Turn-On Rise Time	t <sub>R</sub>		50	100	ns	
Turn-Off Delay Time	t <sub>D(OFF)</sub>		80	130	ns	
Turn-Off Fall Time	t <sub>F</sub>		45	70	ns	
<b>SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS</b>						
Maximum Continuous Drain-Source Diode Forward Current	I <sub>S</sub>				4.4	A
Maximum Pulsed Drain-Source Diode Forward Current	I <sub>SM</sub>				17.6	A
Drain-Source Diode Forward Voltage	V <sub>SD</sub>	I <sub>S</sub> = 4.4A, V <sub>GS</sub> = 0V			1.4	V
Body Diode Reverse Recovery Time	t <sub>rr</sub>	I <sub>S</sub> = 4.4A, V <sub>GS</sub> = 0V,		410		ns
Body Diode Reverse Recovery Charge	Q <sub>rr</sub>	di <sub>F</sub> /dt = 100A/μs (Note 1)		2.12		μC

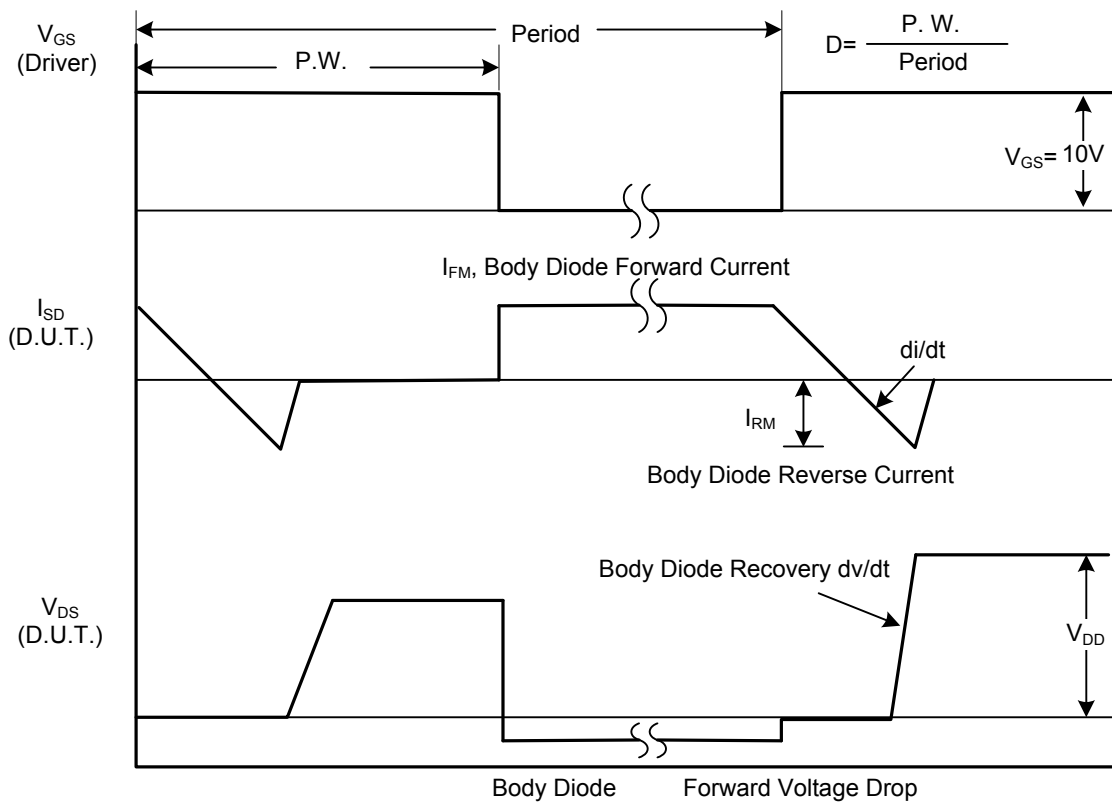
Notes: 1. Pulse Test: Pulse width ≤ 300μs, Duty cycle ≤ 2%

2. Essentially independent of operating temperature

■ TEST CIRCUITS AND WAVEFORMS

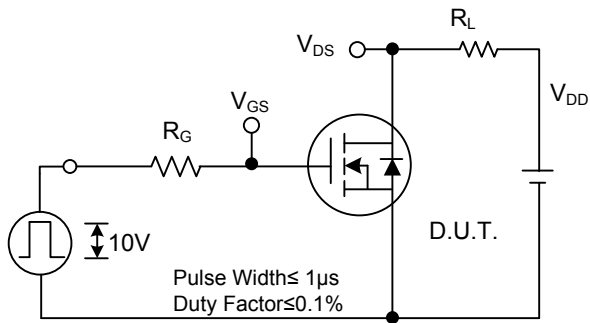


Peak Diode Recovery dv/dt Test Circuit

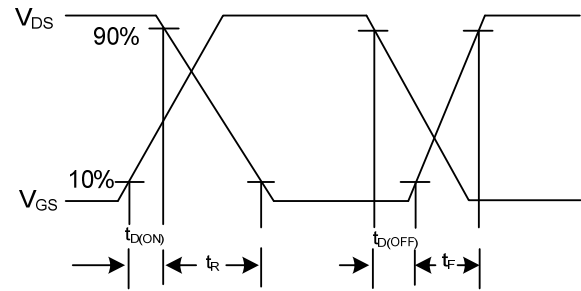


Peak Diode Recovery dv/dt Waveforms

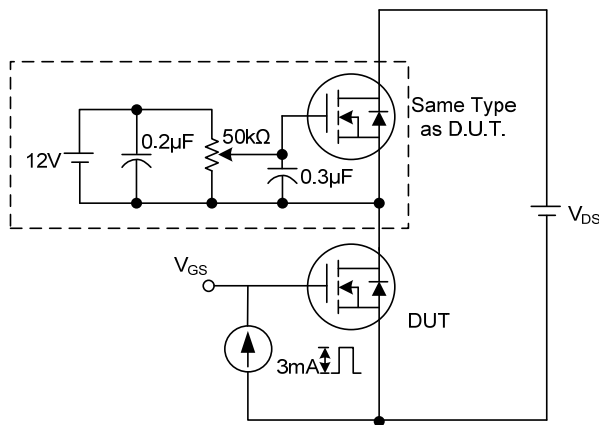
### TEST CIRCUITS AND WAVEFORMS (Cont.)



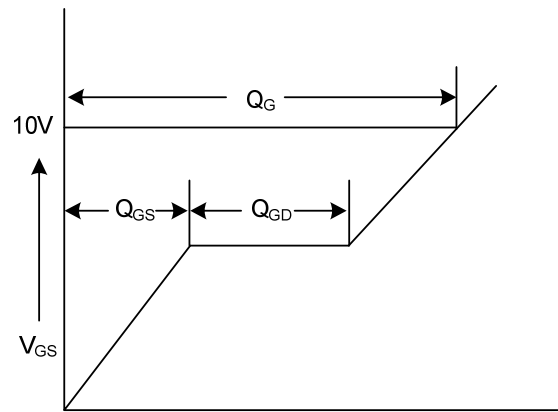
**Switching Test Circuit**



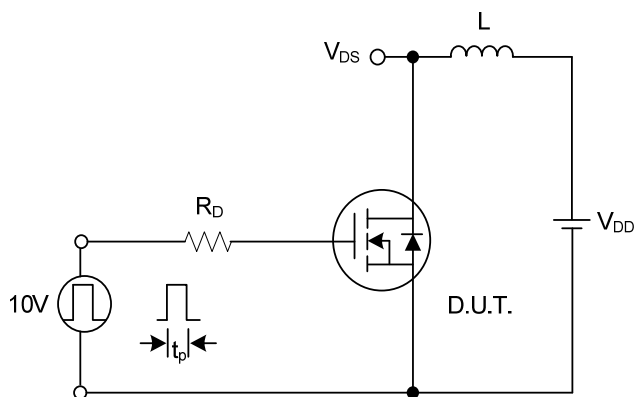
**Switching Waveforms**



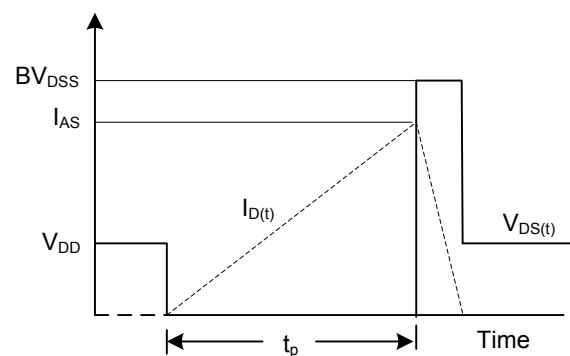
**Gate Charge Test Circuit**



**Gate Charge Waveform**

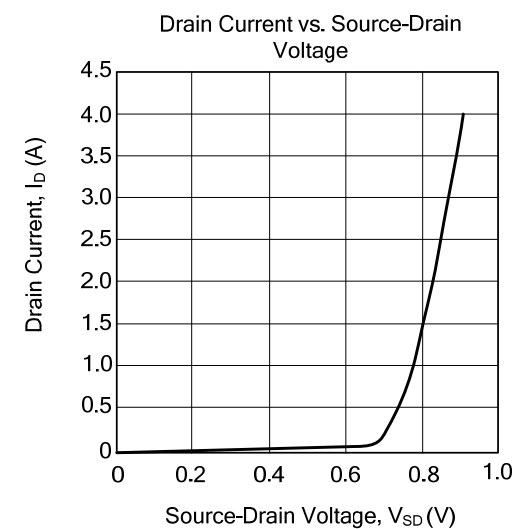
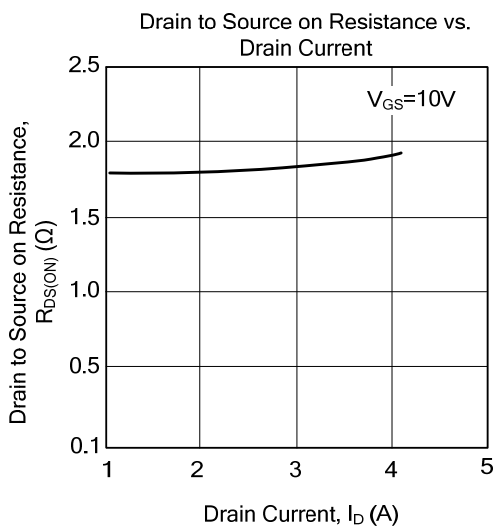
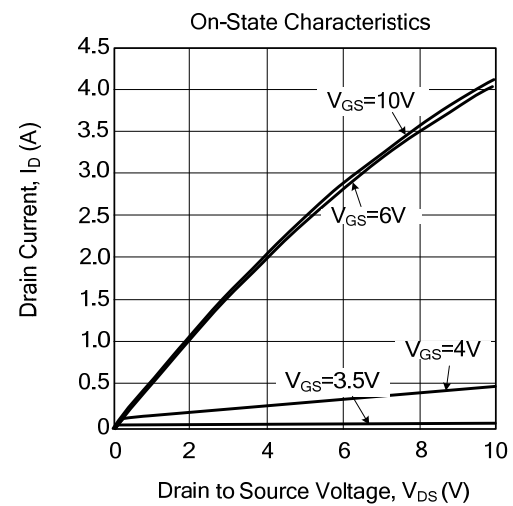
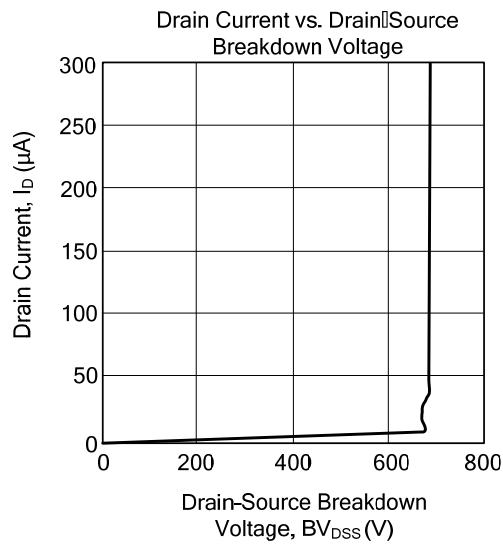
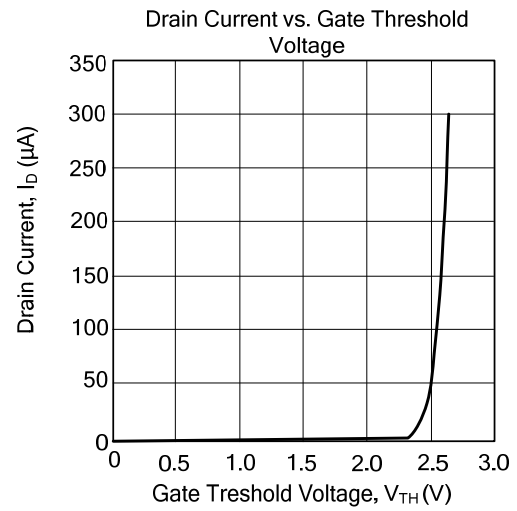
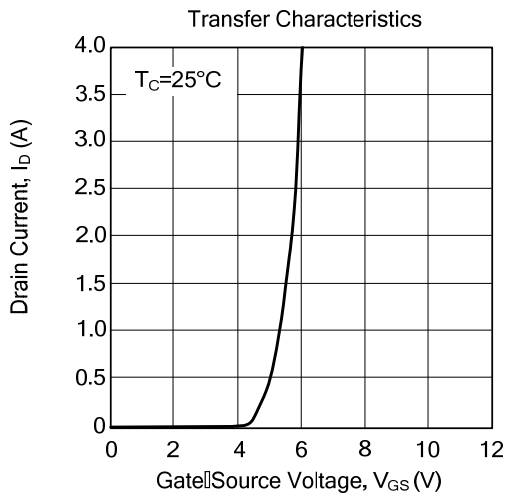


**Unclamped Inductive Switching Test Circuit**

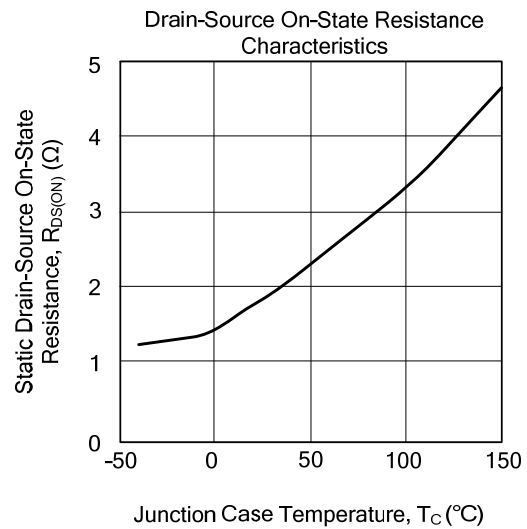
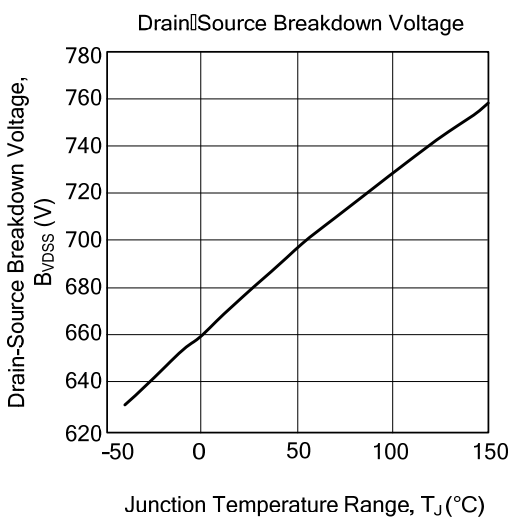
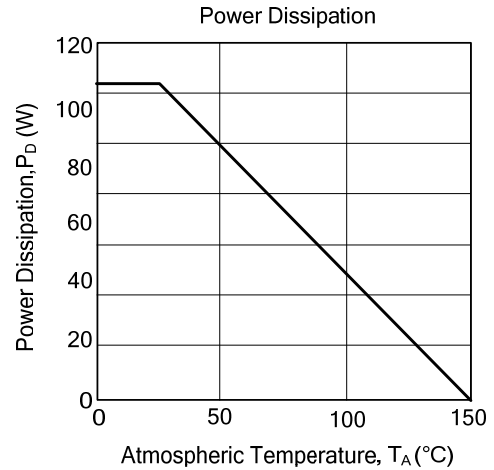
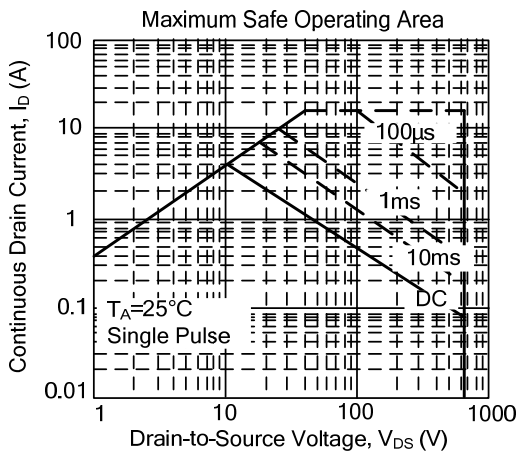
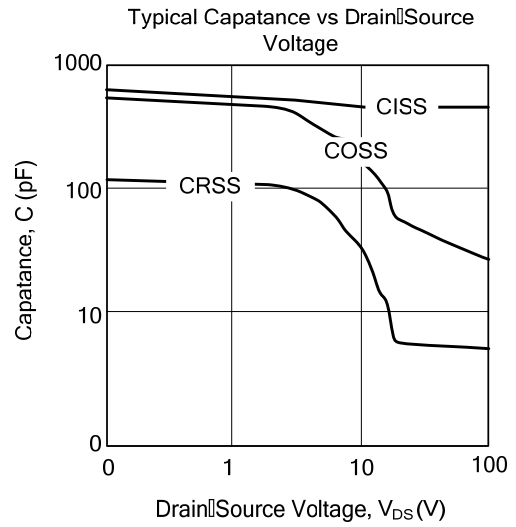
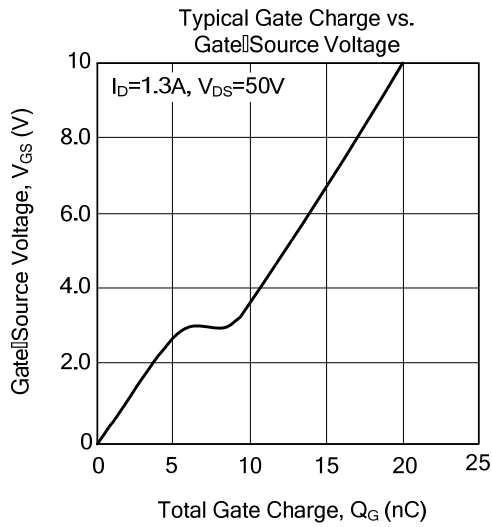


**Unclamped Inductive Switching Waveforms**

## TYPICAL CHARACTERISTICS6

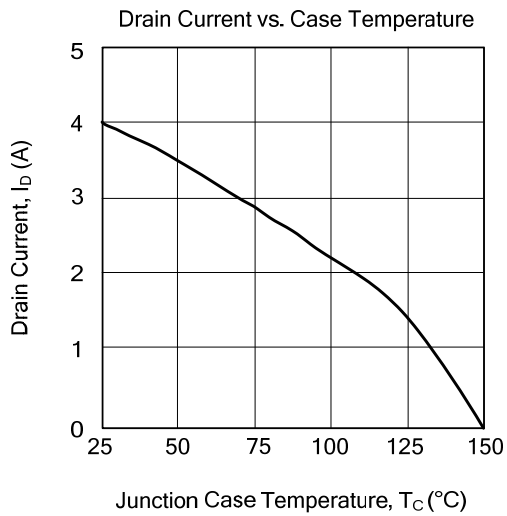


## TYPICAL CHARACTERISTICS (Cont.)





■ TYPICAL CHARACTERISTICS (Cont.)



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