

UNISONIC TECHNOLOGIES CO., LTD

6N65K

Power MOSFET

6A, 650V N-CHANNEL POWER MOSFET

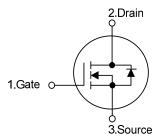
DESCRIPTION

The UTC **6N65K** is a high voltage power 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

- * $R_{DS(ON)}$ < 1.7 Ω @V_{GS} = 10V
- * Fast switching capability
- * Avalanche energy tested
- * Improved dv/dt capability, high ruggedness

SYMBOL



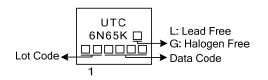
ORDERING INFORMATION

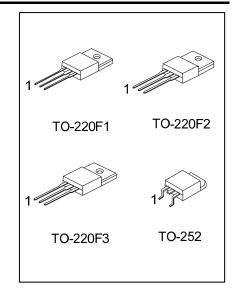
Ordering Number		Deekere	Pin Assignment			Decking	
Lead Free	Halogen Free	Package 1 2		2	3	Packing	
6N65KL-TF1-T	6N65KG-TF1-T	TO-220F1	G	D	S	Tube	
6N65KL-TF2-T	6N65KG-TF2-T	TO-220F2	G	D	S	Tube	
6N65KL-TF3T-T	6N65KG-TF3T-T	TO-220F3	G	D	S	Tube	
6N65KL-TN3-R	6N65KG-TN3-R	TO-252	G	D	S	Tape Reel	

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

6N65KL- <u>TF1-T</u>	(1)Packing Type	(1) T: Tube, R: Tape Reel (2) TF3: TO-220F, TF1: TO-220F1, TF2: TO-220F2
	(2)Package Type	TF3T: TO-220F3, TN3: TO-252
	(3)Lead Free	(3) L: Lead Free, G: Halogen Free

MARKING





■ ABSOLUTE MAXIMUM RATINGS (T_c = 25°C, unless otherwise specified)

PARAMETER		SYMBOL	RATINGS	UNIT
Drain-Source Voltage		V _{DSS}	650	V
Gate-Source Voltage		V _{GSS}	±30	V
Avalanche Current (No	ote 2)	I _{AR}	6	А
Continuous Drain Curr	rent	I _D	6	А
Pulsed Drain Current ((Note 2)	I _{DM}	24	А
Avalanche Energy	Single Pulsed (Note 3)	E _{AS}	300	mJ
Peak Diode Recovery	Peak Diode Recovery dv/dt (Note 4)		4.5	ns
	TO-220F1/TO-220F3		40	W
Power Dissipation	TO-220F2	PD	42	W
	TO-252		55	W
Junction Temperature		TJ	+150	°C
Operating Temperature		T _{OPR}	-55 ~ +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 $T_{\rm J}$
- 3. L = 16.6mH, I_{AS} = 6A, V_{DD} = 90V, R_G = 25 Ω , Starting T_J = 25°C
- 4. $I_{SD} \le 6A$, di/dt $\le 200A/\mu s$, $V_{DD} \le BV_{DSS}$, Starting $T_J = 25^{\circ}C$

THERMAL DATA

PARAMETER		SYMBOL	RATING	UNIT	
Junction to Ambient	TO-220F1/TO-220F2 TO-220F3	θ _{JA}	62.5	°C/W	
	TO-252		110	1	
Junction to Case	TO-220F1/TO-220F3		3.2		
	TO-220F2	$\theta_{\rm JC}$	2.97	°C/W	
	TO-252		2.27		



$\begin{array}{ c c c c c c } \hline Drain-Source Breakdown Voltage & BV_{DSS} & V_{GS} = 0V, I_D = 250 \mu A & 650 & V \\ \hline Drain-Source Leakage Current & I_{DSS} & V_{DS} = 650V, V_{GS} = 0V & 10 & \mu A \\ \hline Drain-Source Leakage Current & Reverse & I_{GSS} & V_{GS} = 30V, V_{DS} = 0V & -100 & nA \\ \hline Preserve & Pres$			(-	, , ,				
$\begin{array}{ c c c c c c } \hline Drain-Source Breakdown Voltage & BV_{DSS} & V_{GS} = 0V, I_D = 250 \mu A & 650 & V \\ \hline Drain-Source Leakage Current & I_{DSS} & V_{DS} = 650V, V_{GS} = 0V & 10 & \mu A \\ \hline Drain-Source Leakage Current & Reverse & I_{GSS} & V_{GS} = 30V, V_{DS} = 0V & -100 & nA \\ \hline Preserve & Pres$	PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Drain-Source Leakage CurrentIossVDSE650V, VGSOV10 μA Gate- Source Leakage CurrentForward ReverseIGSSVGS= 0V100nABreakdown Voltage Temperature Coefficient $\triangle BV_{DSS} / \triangle T_J$ Ib=250 μA , Referenced to 25°C0.53V/°CON CHARACTERISTICSGate Threshold VoltageVGS(TH)VDS = VGS, Ib = 250 μA 2.04.0VStatic Drain-Source On-State Resistance $R_{DS(ON)}$ VGS = 10V, Ib = 3A1.11.7 Ω DYNAMIC CHARACTERISTICSInput Capacitance C_{ISS} V_{DS} =25V, VGS=0V,8751000pFOutput Capacitance C_{GSS} f=1.0MHz88120pFSWITCHING CHARACTERISTICSTurn-On Delay Time $t_{D(ON)}$ 865060nsTurn-On Rise Timetb_(ON)tb_(OFF)RG = 250(Note 1, 2)110130nsTurn-Off Fall Timetrf5570ns22.540nCGate-Source ChargeQGQGVDS=50V, Ib=1.3A, VGS=10V7.5nCDRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGSDTDrain-Source Diode Forward VoltageVSDVSDVSDVGS = 0.V, Is = 6.A1.4VMaximum Pulsed Drain-Source DiodeIs6A4	OFF CHARACTERISTICS							
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Drain-Source Breakdown Voltage		BV _{DSS}	V _{GS} = 0V, I _D = 250µA	650			V
Gate- Source Leakage CurrentIGSSVGS = -30V, VDS = 0V-100nABreakdown Voltage Temperature Coefficient $\Delta BV_{DSS}/\Delta T_J$ Ig = 250µA, Referenced to 25°C0.53V/°CON CHARACTERISTICSGate Threshold VoltageVGS(TH)VDS = VGS, ID = 250µA2.04.0VGate Threshold VoltageVGS(TH)VDS = VGS, ID = 250µA2.04.0VGate Threshold VoltageVGS(TH)VDS = VGS, ID = 250µA2.04.0VGate Threshold VoltageVGS(TH)VDS = VGS, ID = 250µA2.04.0VOUTON CHARACTERISTICSInput CapacitanceCISSFTURN-ON ELARACTERISTICSTURN-ON ELARACTERISTICSTURN-ON ELARACTERISTICSTURN-ON ELARACTERISTICSTURN-ON Fiel TimetTURN-ON Fiel TimetTURN-ON Fiel TimetTURN-ON Fiel TimetTURN-ON Fiel TimetTURN-ON Fiel TimetTURN-ON Fiel Timet <td>Drain-Source Leakage Current</td> <td></td> <td>I_{DSS}</td> <td>V_{DS} = 650V, V_{GS} = 0V</td> <td></td> <td></td> <td>10</td> <td>μA</td>	Drain-Source Leakage Current		I _{DSS}	V _{DS} = 650V, V _{GS} = 0V			10	μA
InterverseVGS (G	Gate- Source Leakage Current	Forward	I _{GSS}	$V_{GS} = 30V, V_{DS} = 0V$			100	nA
ON CHARACTERISTICSGate Threshold Voltage $V_{GS(TH)}$ $V_{DS} = V_{GS}$, $I_D = 250 \mu A$ 2.04.0VStatic Drain-Source On-State Resistance $R_{DS(ON)}$ $V_{GS} = 10V$, $I_D = 3A$ 1.11.7 Ω DYNAMIC CHARACTERISTICSInput Capacitance C_{ISS} $V_{DS}=25V$, $V_{GS}=0V$,8751000pFOutput Capacitance C_{OSS} $f=1.0 \text{ MHz}$ 825pFReverse Transfer Capacitance C_{RSS} $f=1.0 \text{ MHz}$ 825pFSWITCHING CHARACTERISTICSTurn-On Delay Time $t_D(ON)$ S_0 60nsTurn-On Rise Time t_R $V_{DD}=30V$, $I_D=0.5A$,6580nsTurn-Off Delay Time $t_D(OFF)$ $R_G=25\Omega$ (Note 1, 2)110130nsTurn-Off Fall Time t_F S_5 70nsTotal Gate Charge Q_{GS} $V_{QS}=10V$ (Note 1, 2)5nCGate-Drain Charge Q_{GS} V_{SD} $V_{GS}=0 V$, $I_S=6 A$ 1.4VMaximum Continuous Drain-Source Diode I_S G A A A		Reverse		V_{GS} = -30V, V_{DS} = 0V			-100	nA
Gate Threshold Voltage $V_{GS(TH)}$ $V_{DS} = V_{GS}$, $I_D = 250\mu A$ 2.04.0VStatic Drain-Source On-State Resistance $R_{DS(ON)}$ $V_{GS} = 10V$, $I_D = 3A$ 1.11.7 Ω DYNAMIC CHARACTERISTICSInput Capacitance C_{ISS} $V_{DS}=25V$, $V_{GS}=0V$,8751000pFOutput Capacitance C_{OSS} $f=1.0 \text{ MHz}$ 88120pFReverse Transfer Capacitance C_{RSS} $f=1.0 \text{ MHz}$ 825pFSWITCHING CHARACTERISTICSTurn-On Delay Time $t_{D(ON)}$ t_{R} $V_{DD}=30V$, $I_D=0.5A$,6580nsTurn-On Rise Time t_R V_{DOFFP} $R_G=25\Omega$ (Note 1, 2)110130ns110130nsTurn-Off Fall Time t_F $V_{DS}=50V$, $I_D=1.3A$,7.5nC00 <td colspan="2">Breakdown Voltage Temperature Coefficient</td> <td>$\bigtriangleup BV_{DSS} / \bigtriangleup T_J$</td> <td>I_D=250μA, Referenced to 25°C</td> <td></td> <td>0.53</td> <td></td> <td>V/°C</td>	Breakdown Voltage Temperature Coefficient		$\bigtriangleup BV_{DSS} / \bigtriangleup T_J$	I _D =250μA, Referenced to 25°C		0.53		V/°C
Static Drain-Source On-State Resistance $R_{DS(ON)}$ $V_{GS} = 10V, I_D = 3A$ 1.11.7 Ω DYNAMIC CHARACTERISTICSInput Capacitance C_{ISS} $V_{DS}=25V, V_{GS}=0V,$ 875 1000 pF Output Capacitance C_{OSS} $f=1.0$ MHz 88 120 pF Reverse Transfer Capacitance C_{RSS} $f=1.0$ MHz 88 120 pF SWITCHING CHARACTERISTICS $Turn-On Delay Time$ $t_{D(ON)}$ 50 60 nsTurn-On Rise Time t_{R} $V_{DD}=30V, I_{D}=0.5A,$ 65 80 nsTurn-Off Delay Time $t_{D(OFF)}$ $R_G=25\Omega$ (Note 1, 2) 110 130 nsTurn-Off Fall Time t_{F} 55 70 nsTotal Gate Charge Q_{G} Q_{GS} $V_{DS}=50V, I_{D}=1.3A,$ 7.5 nC Gate-Source Charge Q_{GS} Q_{GS} $V_{GS}=10V$ (Note 1, 2) 5 nC DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS $f=1.4$ V A A Maximum Continuous Drain-Source Diode I_S $V_{GS}=0$, $I_S=6$ 1.4 V	ON CHARACTERISTICS							
DYNAMIC CHARACTERISTICSInput Capacitance C_{ISS} C_{OSS} $V_{DS}=25V, V_{GS}=0V,$ $F=1.0 MHz$ 875 1000 PF Output Capacitance C_{OSS} $F=1.0 MHz$ $F=1.0 MHz$ 88 120 PF Reverse Transfer Capacitance C_{RSS} $F=1.0 MHz$ 88 120 PF SWITCHING CHARACTERISTICSTurn-On Delay Time $t_{D(ON)}$ $Turn-On Rise Time5060RgnsTurn-On Rise Timet_RV_{DD}=30V, I_D=0.5A,5580RgnsTurn-Off Delay Timet_{D(OFF)}R_G=25\Omega (Note 1, 2)110130130nsTotal Gate ChargeQ_GQ_{GD}V_{DS}=50V, I_D=1.3A,V_{GS}=10V (Note 1, 2)7.510CDrain-Source Diode Forward VoltageV_{SD}V_{GS}=0 V, I_S=6 A1.4VVMaximum Continuous Drain-Source DiodeForward CurrentI_S$	Gate Threshold Voltage		V _{GS(TH)}	$V_{DS} = V_{GS}, I_D = 250 \mu A$	2.0		4.0	V
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	Static Drain-Source On-State Resistance		R _{DS(ON)}	V _{GS} = 10V, I _D = 3A		1.1	1.7	Ω
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	DYNAMIC CHARACTERISTICS							
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Input Capacitance		CISS			875	1000	рF
Reverse Transfer Capacitance C_{RSS} $I^{P+1.0 \text{ NM12}}$ 825pFSWITCHING CHARACTERISTICSTurn-On Delay Time $t_{D(ON)}$ V_{DD} =30V, I_D =0.5A,6580nsTurn-On Rise Time t_R V_{DD} =30V, I_D =0.5A,6580nsTurn-Off Delay Time t_B V_{DD} =30V, I_D =0.5A,6580nsTurn-Off Fall Time t_F 7.570nsTotal Gate Charge Q_G V_{DS} =50V, I_D =1.3A,22.540nCGate-Source Charge Q_{GD} V_{GS} =10V(Note 1, 2)5nCDrain Charge Q_{GD} V_{SD} V_{GS} = 0 V, I_S = 6 A1.4VMaximum Continuous Drain-Source Diode I_S I_S 6AMaximum Pulsed Drain-Source Diode I_S I_{SM} 24A	Output Capacitance		Coss			88	120	рF
SWITCHING CHARACTERISTICSTurn-On Delay Time $t_{D(ON)}$ $V_{DD}=30V, I_D=0.5A,$ 50 60 nsTurn-On Rise Time t_R $V_{DD}=30V, I_D=0.5A,$ 65 80 nsTurn-Off Delay Time $t_{D(OFF)}$ $R_G=25\Omega$ (Note 1, 2) 110 130 nsTurn-Off Fall Time t_F 55 70 nsTotal Gate Charge Q_G $V_{DS}=50V, I_D=1.3A,$ 22.5 40 nC Gate-Source Charge Q_{GD} $V_{GS}=10V$ (Note 1, 2) 5 nC Drain-Source Diode Forward Voltage V_{SD} $V_{GS}=0V, I_S=6A$ 1.4 V Maximum Continuous Drain-Source Diode I_S I_S 66 A	Reverse Transfer Capacitance					8	25	рF
Turn-On Rise Time t_R $V_{DD}=30V$, $I_D=0.5A$,6580nsTurn-Off Delay Time $t_{D(OFF)}$ $R_G=25\Omega$ (Note 1, 2)110130nsTurn-Off Fall Time t_F 5570nsTotal Gate Charge Q_G $V_{DS}=50V$, $I_D=1.3A$,22.540nCGate-Source Charge Q_{GD} $V_{DS}=10V$ (Note 1, 2)5nCDrain Charge Q_{GD} $V_{SD} = 0V$, $I_S = 6A$ 1.4VDrain-Source Diode Forward Voltage V_{SD} $V_{GS} = 0V$, $I_S = 6A$ 1.4VMaximum Pulsed Drain-Source Diode I_S 6A	SWITCHING CHARACTERISTIC	S						
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Turn-On Delay Time		t _{D(ON)}			50	60	ns
Turn-Off Fall Timet5570nsTotal Gate Charge Q_G $V_{DS}=50V$, $I_D=1.3A$,22.540nCGate-Source Charge Q_{GS} $V_{DS}=10V$ (Note 1, 2)5nCGate-Drain Charge Q_{GD} $V_{SS}=10V$ (Note 1, 2)5nCDRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGSDrain-Source Diode Forward Voltage V_{SD} $V_{GS} = 0 V$, $I_S = 6 A$ 1.4VMaximum Continuous Drain-Source Diode I_S 6AMaximum Pulsed Drain-Source Diode I_{SM} 24A	Turn-On Rise Time					65	80	ns
Total Gate Charge Q_G $V_{DS}=50V$, $I_D=1.3A$, $V_{GS}=10V$ (Note 1, 2) 22.5 40 nCGate-Source Charge Q_{GS} $V_{GS}=10V$ (Note 1, 2) 7.5 nC Gate-Drain Charge Q_{GD} $V_{GS}=10V$ (Note 1, 2) 5 nC DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGSDrain-Source Diode Forward Voltage V_{SD} $V_{GS} = 0 V$, $I_S = 6 A$ 1.4 V Maximum Continuous Drain-Source Diode I_S 6 A Maximum Pulsed Drain-Source Diode I_{SM} 24 A	Turn-Off Delay Time		t _{D(OFF)}			110	130	ns
Gate-Source Charge Q_{GS} $V_{DS}=50V$, $I_D=1.3A$, $V_{GS}=10V$ (Note 1, 2)7.5nCGate-Drain Charge Q_{GD} $V_{GS}=10V$ (Note 1, 2)5nCDRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGSDrain-Source Diode Forward Voltage V_{SD} $V_{GS} = 0 V$, $I_S = 6 A$ 1.4VMaximum Continuous Drain-Source Diode I_S 6AMaximum Pulsed Drain-Source Diode I_{SM} 24A	Turn-Off Fall Time		t⊧			55	70	ns
Gate-Source Charge Q_{GS} $V_{GS}=10V$ (Note 1, 2)7.5nCGate-Drain Charge Q_{GD} $V_{GS}=10V$ (Note 1, 2)5nCDRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGSDrain-Source Diode Forward Voltage V_{SD} $V_{GS} = 0 V$, $I_S = 6 A$ 1.4VMaximum Continuous Drain-Source Diode I_S 6AMaximum Pulsed Drain-Source Diode I_{SM} 24A	Total Gate Charge		Q_{G}			22.5	40	nC
Gate-Drain Charge Q_{GD} $V_{GS}=10V$ (Note 1, 2)5nCDRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGSDrain-Source Diode Forward Voltage V_{SD} $V_{GS} = 0 V, I_S = 6 A$ 1.4VMaximum Continuous Drain-Source Diode I_S 6AMaximum Pulsed Drain-Source Diode I_{SM} 24A	Gate-Source Charge Gate-Drain Charge		Q_{GS}			7.5		nC
Drain-Source Diode Forward Voltage V_{SD} $V_{GS} = 0 \ V, I_S = 6 \ A$ 1.4VMaximum Continuous Drain-Source Diode I_S 6AMaximum Pulsed Drain-Source Diode I_{SM} 24A						5		nC
Maximum Continuous Drain-Source Diode Is 6 A Forward Current Isu 24 A	DRAIN-SOURCE DIODE CHARA	CTERISTIC	CS AND MAXII	MUM RATINGS				
Forward Current Is 6 A Maximum Pulsed Drain-Source Diode Isu 24 A	Drain-Source Diode Forward Volta	age	V _{SD}	V _{GS} = 0 V, I _S = 6 A			1.4	V
Forward Current Image: Constraint of the second s	Maximum Continuous Drain-Sour	ce Diode	I.				6	^
SM 24 A	Forward Current		IS				0	А
Forward Current	Maximum Pulsed Drain-Source Diode Forward Current		I _{SM}				24	Δ
							27	~

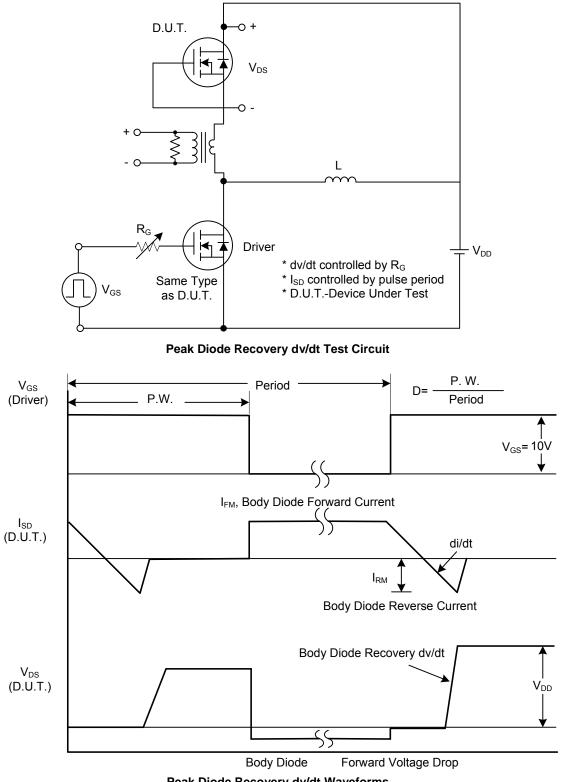
■ ELECTRICAL CHARACTERISTICS (T_J=25°C, unless otherwise specified)

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

2. Essentially independent of operating temperature



TEST CIRCUITS AND WAVEFORMS

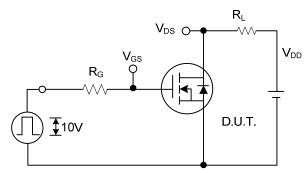


Peak Diode Recovery dv/dt Waveforms

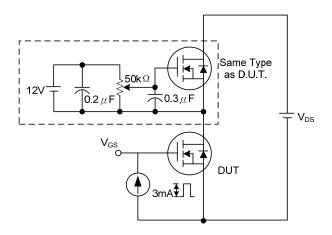


6N65K

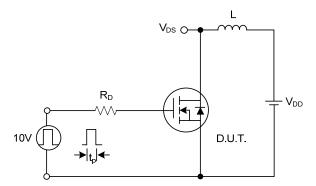
■ TEST CIRCUITS AND WAVEFORMS (Cont.)



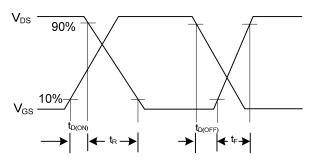
Switching Test Circuit



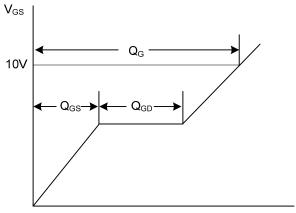
Gate Charge Test Circuit



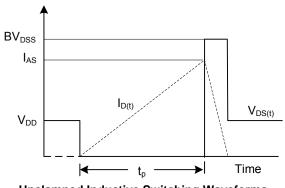
Unclamped Inductive Switching Test Circuit



Switching Waveforms



Charge Gate Charge Waveform

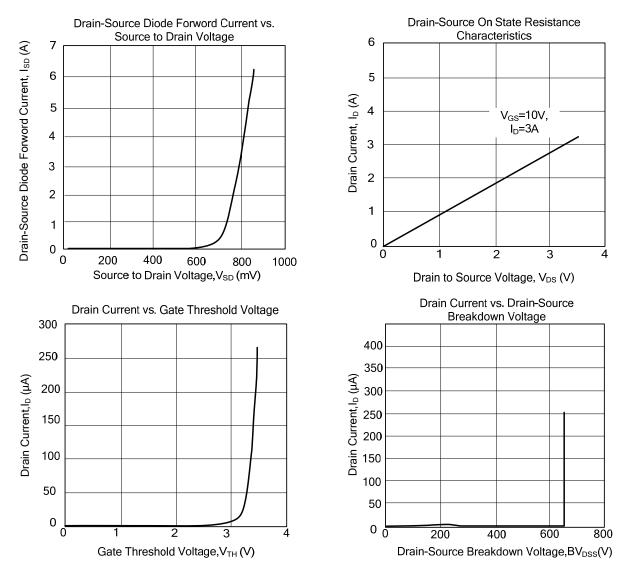


Unclamped Inductive Switching Waveforms



<u>6N65K</u>

TYPICAL CHARACTERISTICS



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