

# UNISONIC TECHNOLOGIES CO., LTD

### 6N65K

#### Power MOSFET

### 6A, 650V N-CHANNEL POWER MOSFET

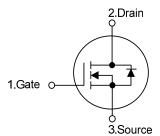
#### DESCRIPTION

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 $\Omega$  @V<sub>GS</sub> = 10V
- \* Fast switching capability
- \* Avalanche energy tested
- \* Improved dv/dt capability, high ruggedness

#### SYMBOL



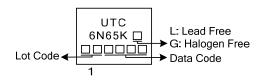
#### ORDERING INFORMATION

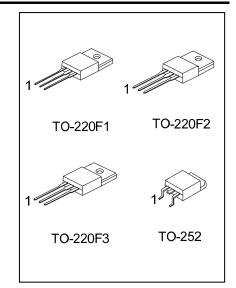
Ordering Number		Deekere	Pin Assignment			Decking	
Lead Free	Halogen Free	Package 1 2		2	3	Packing	
6N65KL-TF1-T	6N65KG-TF1-T	TO-220F1	G	D	S	Tube	
6N65KL-TF2-T	6N65KG-TF2-T	TO-220F2	G	D	S	Tube	
6N65KL-TF3T-T	6N65KG-TF3T-T	TO-220F3	G	D	S	Tube	
6N65KL-TN3-R	6N65KG-TN3-R	TO-252	G	D	S	Tape Reel	

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<sub>c</sub> = 25°C, unless otherwise specified)

PARAMETER		SYMBOL	RATINGS	UNIT
Drain-Source Voltage		V <sub>DSS</sub>	650	V
Gate-Source Voltage		V <sub>GSS</sub>	±30	V
Avalanche Current (No	ote 2)	I <sub>AR</sub>	6	А
Continuous Drain Curr	rent	I <sub>D</sub>	6	А
Pulsed Drain Current (	(Note 2)	I <sub>DM</sub>	24	А
Avalanche Energy	Single Pulsed (Note 3)	E <sub>AS</sub>	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 <sub>OPR</sub>	-55 ~ +150	°C
Storage Temperature		T <sub>STG</sub>	-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<sub>AS</sub> = 6A, V<sub>DD</sub> = 90V, R<sub>G</sub> = 25  $\Omega$ , Starting T<sub>J</sub> = 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 <sub>JA</sub>	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 $\mu A$ Gate- Source Leakage CurrentForward ReverseIGSSVGS= 0V100nABreakdown Voltage Temperature Coefficient $\triangle BV_{DSS} / \triangle T_J$ Ib=250 $\mu A$ , Referenced to 25°C0.53V/°CON CHARACTERISTICSGate Threshold VoltageVGS(TH)VDS = VGS, Ib = 250 $\mu A$ 2.04.0VStatic Drain-Source On-State Resistance $R_{DS(ON)}$ VGS = 10V, Ib = 3A1.11.7 $\Omega$ 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 <sub>DSS</sub>	V <sub>GS</sub> = 0V, I <sub>D</sub> = 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<sub>DSS</sub></td> <td>V<sub>DS</sub> = 650V, V<sub>GS</sub> = 0V</td> <td></td> <td></td> <td>10</td> <td>μA</td>	Drain-Source Leakage Current		I <sub>DSS</sub>	V <sub>DS</sub> = 650V, V <sub>GS</sub> = 0V			10	μA
InterverseVGS (G	Gate- Source Leakage Current	Forward	I <sub>GSS</sub>	$V_{GS} = 30V, V_{DS} = 0V$			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 $\Omega$ 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 $\Omega$ 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><math display="block">\bigtriangleup BV_{DSS} / \bigtriangleup T_J</math></td> <td>I<sub>D</sub>=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 <sub>D</sub> =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 $\Omega$ 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 <sub>GS(TH)</sub>	$V_{DS} = V_{GS}, I_D = 250 \mu A$	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 <sub>DS(ON)</sub>	V <sub>GS</sub> = 10V, I <sub>D</sub> = 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 <sub>D(ON)</sub>			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 <sub>D(OFF)</sub>			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 <sub>SD</sub>	V <sub>GS</sub> = 0 V, I <sub>S</sub> = 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 <sub>SM</sub>				24	Δ
							27	~

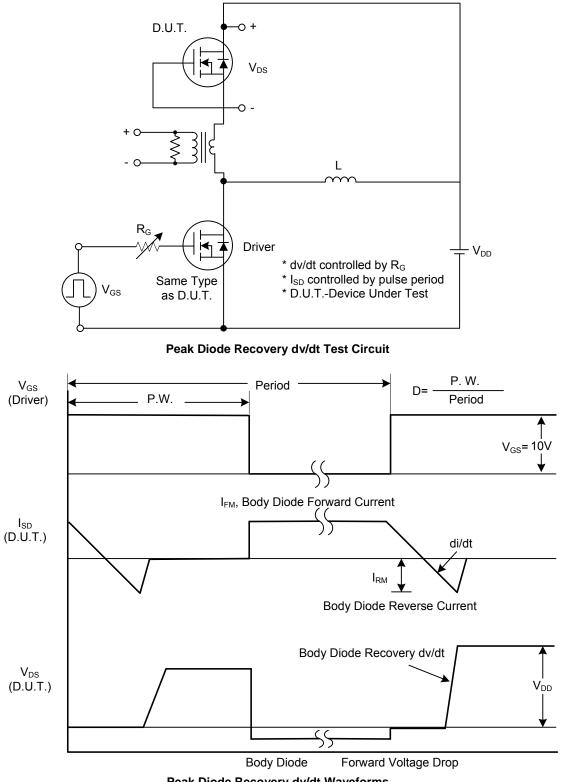
#### ■ ELECTRICAL CHARACTERISTICS (T<sub>J</sub>=25°C, unless otherwise specified)

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

2. Essentially independent of operating temperature



#### **TEST CIRCUITS AND WAVEFORMS**

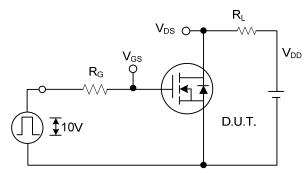


Peak Diode Recovery dv/dt Waveforms

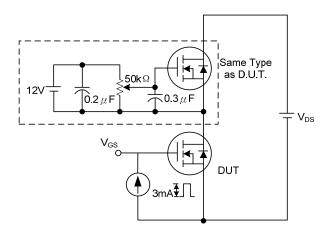


### 6N65K

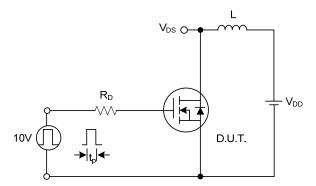
#### ■ TEST CIRCUITS AND WAVEFORMS (Cont.)



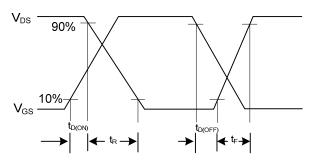
Switching Test Circuit



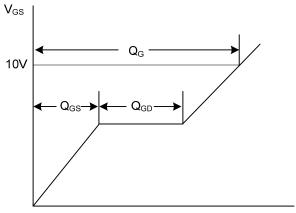
**Gate Charge Test Circuit** 



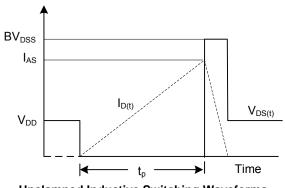
**Unclamped Inductive Switching Test Circuit** 



Switching Waveforms



Charge Gate Charge Waveform

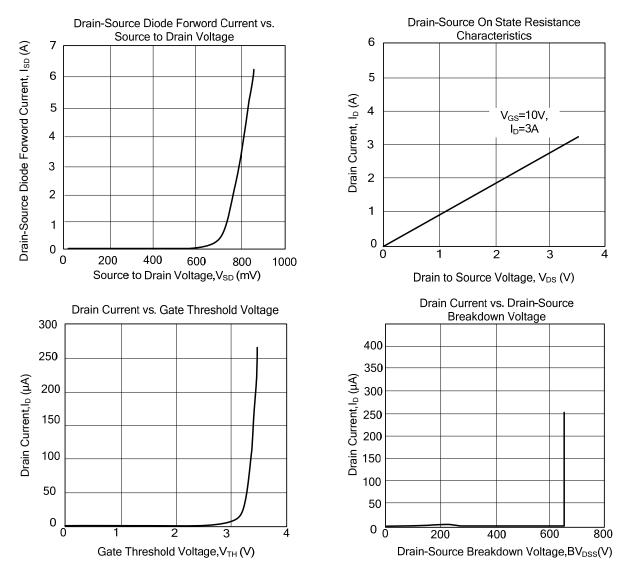


**Unclamped Inductive Switching Waveforms** 



## <u>6N65K</u>

#### TYPICAL CHARACTERISTICS



UTC assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all UTC products described or contained herein. UTC products are not designed for use in life support appliances, devices or systems where malfunction of these products can be reasonably expected to result in personal injury. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner. The information presented in this document does not form part of any quotation or contract, is believed to be accurate and reliable and may be changed without notice.

