

# 10N65K-MT

# 10A, 650V N-CHANNEL POWER MOSFET

#### DESCRIPTION

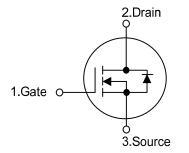
The UTC **10N65K-MT** is an N-channel Power MOSFET using UTC's advanced technology to provide customers a minimum on-state resistance and superior switching performance, etc.

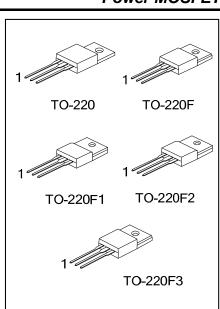
The UTC **10N65K-MT** is generally applied in high efficient DC to DC converters, PWM motor controls and bridge circuits, etc.

### FEATURES

- \*  $R_{DS(ON)}$  < 1.0 $\Omega$  @  $V_{GS}$ =10V,  $I_D$  = 5 A
- \* High Switching Speed
- \* Improved dv/dt capability

#### SYMBOL





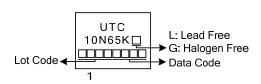
#### ORDERING INFORMATION

Ordering Number		Daakaga	Pin Assignment			Packing	
Lead Free	Halogen Free	Package	1	2	2 3 Facking		
10N65KL-TA3-T	10N65KG-TA3-T	TO-220	G	D	S	Tube	
10N65KL-TF3-T	10N65KG-TF3-T	TO-220F	G	D	S	Tube	
10N65KL-TF1-T	10N65KG-TF1-T	TO-220F1	G	D	S	Tube	
10N65KL-TF2-T	10N65KG-TF2-T	TO-220F2	G	D	S	Tube	
10N65KL-TF3T-T	10N65KG-TF3T-T	TO-220F3	G	D	S	Tube	
Noto: Dia Assignment: C: Coto D: Drain C: Source							

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

	(1)Packing Type (2)Package Type (3)Green Package	<ul> <li>(1) T: Tube</li> <li>(2) TA3: TO-220, TF3: TO-220F, TF1: TO-220F1 TF2: TO-220F2, TF3T: TO-220F3</li> <li>(3) L: Lead Free, G: Halogen Free and Lead Free</li> </ul>
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#### MARKING



# Power MOSFET

PARAMETER		SYMBOL	RATINGS	UNIT
Drain-Source Voltage		V <sub>DSS</sub>	650	V
Gate-Source Voltage		V <sub>GSS</sub>	±30	V
Avalanche Current (Note 2)		I <sub>AR</sub>	10	А
Drain Current	Continuous	I <sub>D</sub>	10	А
Drain Current	Pulsed (Note 2)	I <sub>DM</sub>	38	А
Avalanche Energy	Single Pulsed (Note 3)	E <sub>AS</sub>	400	mJ
Peak Diode Recovery dv/dt (Note 4)		dv/dt	4.5	V/ns
	TO-220		156	W
Power Dissipation	TO-220F/TO-220F1 TO-220F3	P <sub>D</sub>	50	W
	TO-220F2		48	W
Junction Temperature		ТJ	+150	°C
Operating Temperature		T <sub>OPR</sub>	-55 ~ +150	°C
Storage Temperature		T <sub>STG</sub>	-55 ~ +150	°C

#### ■ ABSOLUTE MAXIMUM RATINGS (T<sub>c</sub> = 25°C unless otherwise specified)

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=8mH,  $I_{AS}$ =10A,  $V_{DD}$ =50V,  $R_G$ =25  $\Omega$ , Starting  $T_J$  = 25°C
- 4.  $I_{SD} \le 9.5A$ , 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		θ <sub>JA</sub>	62.5	°C/W
Junction to Case	TO-220	θις	0.8	°C/W
	TO-220F/TO-220F1 TO-220F3		2.5	°C/W
	TO-220F2		2.6	°C/W



# 10N65K-MT

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

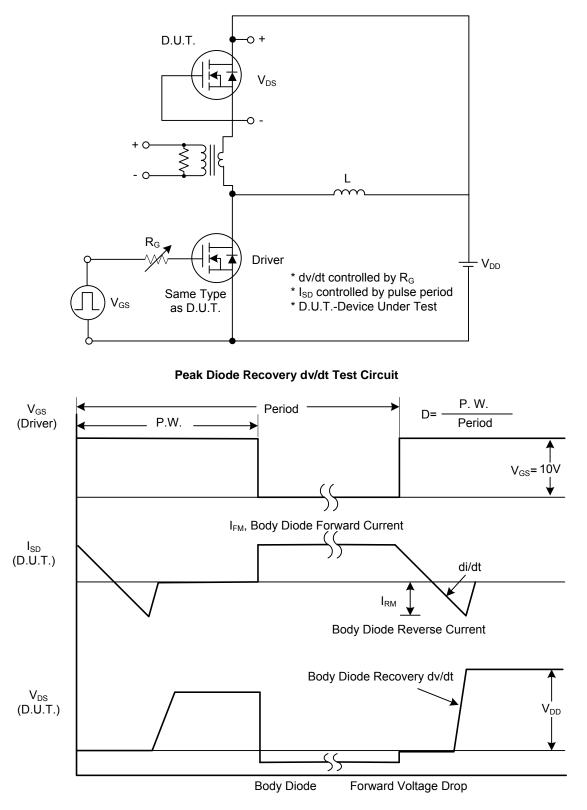
$\begin{array}{c c c c c c c c c c c c c c c c c c c $									
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	OFF CHARACTERISTICS								
Generating of data in the second set of the second set	Drain-Source Breakdown Voltage		$BV_{DSS}$	$V_{GS} = 0V, I_{D} = 250 \mu A$	650			V	
Gate-Source Leakage Current ReverseReverseIGSS $V_{GS} = -30 \text{ V}, V_{DS} = 0 \text{ V}$ -100nAON CHARACTERISTICSGate Threshold Voltage $V_{GS}(TH)$ $V_{DS} = V_{GS}, I_D = 250\mu$ A2.04.0VStatic Drain-Source On-State Resistance $R_{DS(ON)}$ $V_{GS} = 10V, I_D = 5A$ 1.0 $\Omega$ DYNAMIC CHARACTERISTICSInput Capacitance $C_{ISS}$ $V_{DS}=25V, V_{GS}=0V, f=1.0 \text{ MHz}$ 130180pFQutput Capacitance $C_{OSS}$ $V_{DS}=25V, V_{GS}=0V, f=1.0 \text{ MHz}$ 920pFSWITCHING CHARACTERISTICSTurn-On Delay Time $t_{D(ON)}$ $V_{DD}=30V, I_D=0.5A,$ 80150nsTurn-Off Delay Time $t_{D(OFF)}$ $R_G=25\Omega$ (Note 1, 2)200260nsTurn-Off Fall Time $t_F$ 90150ns100ATotal Gate Charge $Q_{GS}$ $Q_{GS}$ $V_{DS}=50V, I_D=1.3A,$ 9nCGate-Source Charge $Q_{GS}$ $Q_{GS}$ $V_{SS}=0 V, I_S=10A$ 1.4VMaximum Continuous Drain-Source Diode $I_S$ $V_{GS}=0 V, I_S=10A$ 1.4VMaximum Pulsed Drain-Source Diode $I_{SA}$ $I_{SA}$ 38A			I <sub>DSS</sub>	$V_{DS} = 650V, V_{GS} = 0V$			1	μA	
Reverse $ V_{GS}  = 30 \text{ V}, V_{DS} = 0 \text{ V}$ -100nAON CHARACTERISTICSGate Threshold Voltage $V_{GS(TH)}$ $V_{DS} = V_{GS}, I_D = 250 \mu A$ 2.04.0VStatic Drain-Source On-State Resistance $R_{DS(ON)}$ $V_{GS} = 10V, I_D = 5A$ 1.0 $\Omega$ DYNAMIC CHARACTERISTICSInput Capacitance $C_{ISS}$ $V_{DS} = 25V, V_{GS} = 0V, f=1.0 \text{ MHz}$ 130180pFOutput Capacitance $C_{GSS}$ $V_{DS} = 25V, V_{GS} = 0V, f=1.0 \text{ MHz}$ 920pFSWITCHING CHARACTERISTICSTurn-On Delay Time $t_{D(ON)}$ $R_G = 250 (Note 1, 2)$ 200260nsTurn-Off Fall Time $t_F$ 90150ns150nsTotal Gate Charge $Q_G$ $Q_{GS}$ $V_{DS} = 50V, I_D = 1.3A, V_{SS} = 10V (Note 1, 2)$ 8nCDRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS $I_{0}$ 1.4VMaximum Continuous Drain-Source Diode $I_S$ $V_{SS} = 0 \text{ V}, I_S = 10A$ 1.4V	Cato Source Leakage Current	orward		V <sub>GS</sub> = 30 V, V <sub>DS</sub> = 0 V			100	nA	
Gate Threshold Voltage $V_{GS}(TH)$ $V_{DS} = V_{GS}, I_D = 250\mu$ A2.04.0VStatic Drain-Source On-State Resistance $R_{DS(ON)}$ $V_{GS} = 10V, I_D = 5A$ 1.0 $\Omega$ DYNAMIC CHARACTERISTICSInput Capacitance $C_{ISS}$ $V_{DS} = 25V, V_{GS} = 0V, f = 1.0 \text{ MHz}$ 130180pFOutput Capacitance $C_{GSS}$ $V_{DS} = 25V, V_{GS} = 0V, f = 1.0 \text{ MHz}$ 920pFSWITCHING CHARACTERISTICS $Turn-On Delay Time$ $t_{D(ON)}$ 920pFTurn-On Rise Time $t_R$ $V_{DD} = 30V, I_D = 0.5A,$ 80150nsTurn-Off Delay Time $t_{D(OFF)}$ $R_G = 25\Omega$ (Note 1, 2)200260nsTurn-Off Fall Time $t_F$ 90150ns1000Total Gate Charge $Q_{GS}$ $V_{DS} = 50V, I_D = 1.3A,$ 9nC0Gate-Drain Charge $Q_{GS}$ $V_{GS} = 10 V$ (Note 1, 2)8nC0DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS10AMaximum Continuous Drain-Source Diode $I_S$ 10AMaximum Pulsed Drain-Source Diode $I_S$ 10A	R	Reverse	IGSS	$V_{GS}$ = -30 V, $V_{DS}$ = 0 V			-100	nA	
Static Drain-Source On-State Resistance $R_{DS(ON)}$ $V_{DS} = 10V$ , $I_D = 5A$ 1.0 $\Omega$ DYNAMIC CHARACTERISTICSInput Capacitance $C_{ISS}$ $V_{DS} = 25V$ , $V_{GS} = 0V$ , $f = 1.0$ MHz $750$ $1500$ $pF$ Output Capacitance $C_{CSS}$ $V_{DS} = 25V$ , $V_{GS} = 0V$ , $f = 1.0$ MHz $130$ $180$ $pF$ Reverse Transfer Capacitance $C_{RSS}$ SWITCHING CHARACTERISTICSTurn-On Delay Time $t_{D(ON)}$ Turn-On Rise Time $t_R$ $V_{DD} = 30V$ , $I_D = 0.5A$ , $80$ $150$ $ns$ Turn-Off Delay Time $t_{D(OFF)}$ $R_G = 25\Omega$ (Note 1, 2) $200$ $260$ $ns$ Turn-Off Fall Time $t_F$ $90$ $150$ $ns$ Total Gate Charge $Q_G$ $Q_{GS}$ $V_{DS} = 50V$ , $I_D = 1.3A$ , $9$ $nC$ Gate-Source Charge $Q_{GS}$ $Q_{GD}$ $V_{DS} = 0V$ , $I_S = 10A$ $1.4$ $V$ DAMIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGSDrain-Source Diode Forward Voltage $V_{SD}$ $V_{GS} = 0$ $V_{IS} = 10A$ $1.4$ $V$ Maximum Pulsed Drain-Source DiodeIs $10$ $A$	ON CHARACTERISTICS								
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	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> = 5A			1.0	Ω	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	DYNAMIC CHARACTERISTICS								
Reverse Transfer Capacitance $C_{RSS}$ 920pFSWITCHING CHARACTERISTICSTurn-On Delay Time $t_{D(ON)}$ $V_{DD}=30V, I_D=0.5A,$ 6580nsTurn-On Rise Time $t_R$ $V_{DD}=30V, I_D=0.5A,$ 80150nsTurn-Off Delay Time $t_{D(OFF)}$ $R_G=25\Omega$ (Note 1, 2)200260nsTurn-Off Fall Time $t_F$ 90150nsTotal Gate Charge $Q_G$ $V_{DS}=50V, I_D=1.3A,$ 9nCGate-Source Charge $Q_{GS}$ $Q_{GS}=10 V$ (Note 1, 2)8nCDRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGSDrain-Source Diode Forward Voltage $V_{SD}$ $V_{GS}=0 V, I_S=10A$ 1.4VMaximum Continuous Drain-Source Diode $I_S$ 10AMaximum Pulsed Drain-Source Diode $I_{SM}$ 38A	Input Capacitance		CISS			750	1500	рF	
SWITCHING CHARACTERISTICSTurn-On Delay Time $t_{D(ON)}$ Turn-On Rise Time $t_R$ Turn-Off Delay Time $t_R$ Turn-Off Delay Time $t_{D(OFF)}$ Turn-Off Fall Time $t_F$ Total Gate Charge $Q_G$ Gate-Source Charge $Q_{GS}$ QGE $V_{DS}=50V, I_D=1.3A, V_{GS}=10 V (Note 1, 2)$ Brain-Source Diode Forward Voltage $V_{SD}$ V_{SD} $V_{GS}=0 V, I_S=10A$ In Summum Continuous Drain-Source Diode $I_S$ Maximum Pulsed Drain-Source Diode $I_{SM}$	Output Capacitance		Coss	V <sub>DS</sub> =25V, V <sub>GS</sub> =0V, f=1.0 MHz		130	180	рF	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Reverse Transfer Capacitance		C <sub>RSS</sub>			9	20	рF	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	SWITCHING CHARACTERISTICS					-			
$\begin{array}{c c c c c c c c }\hline Turn-Off Delay Time & t_{D(OFF)} \\\hline Turn-Off Fall Time & t_F & 90 150 ns \\\hline Total Gate Charge & Q_G \\\hline Gate-Source Charge & Q_{GS} \\\hline Gate-Drain Charge & Q_{GD} \\\hline DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS \\\hline Drain-Source Diode Forward Voltage & V_{SD} & V_{GS} = 0 \ V, \ I_S = 10 \ A \\\hline Maximum Continuous Drain-Source Diode \\\hline Forward Current & I_S \\\hline Maximum Pulsed Drain-Source Diode \\\hline I_{SM} \\\hline \end{array}$	Turn-On Delay Time		t <sub>D(ON)</sub>			65	80	ns	
Turn-Off Fall Time $t_F$ 90150nsTotal Gate Charge $Q_G$ $V_{DS}=50V, I_D=1.3A,$ 3050nCGate-Source Charge $Q_{GS}$ $V_{GS}=10 V (Note 1, 2)$ 8nCGate-Drain Charge $Q_{GD}$ $V_{GS}=10 V (Note 1, 2)$ 8nCDRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGSDrain-Source Diode Forward Voltage $V_{SD}$ $V_{GS}=0 V, I_S=10A$ 1.4VMaximum Continuous Drain-Source Diode $I_S$ 10AMaximum Pulsed Drain-Source Diode $I_{SM}$ 38A	Turn-On Rise Time		t <sub>R</sub>			80	150	ns	
Total Gate Charge $Q_G$ $V_{DS}=50V$ , $I_D=1.3A$ , $V_{GS}=10 V$ (Note 1, 2) $30$ $50$ nCGate-Source Charge $Q_{GS}$ $V_{DS}=50V$ , $I_D=1.3A$ , $V_{GS}=10 V$ (Note 1, 2) $9$ nCGate-Drain Charge $Q_{GD}$ $V_{GS}=10 V$ (Note 1, 2) $8$ nCDRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGSDrain-Source Diode Forward Voltage $V_{SD}$ $V_{GS} = 0 V$ , $I_S = 10A$ $1.4 V$ Maximum Continuous Drain-Source Diode $I_S$ $10$ AMaximum Pulsed Drain-Source Diode $I_{SM}$ $38$ A	Turn-Off Delay Time		$t_{D(OFF)}$			200	260	ns	
Gate-Source Charge $Q_{GS}$ $V_{DS}=50V$ , $I_D=1.3A$ , $V_{GS}=10 V$ (Note 1, 2)9nCGate-Drain Charge $Q_{GD}$ $V_{GS}=10 V$ (Note 1, 2)8nCDRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGSDrain-Source Diode Forward Voltage $V_{SD}$ $V_{GS} = 0 V$ , $I_S = 10A$ 1.4VMaximum Continuous Drain-Source Diode $I_S$ 10AMaximum Pulsed Drain-Source Diode $I_S$ 38A	Turn-Off Fall Time		t⊨			90	150	ns	
Gate-Source Charge $Q_{GS}$ $V_{GS}=10 \vee (Note 1, 2)$ 9nCGate-Drain Charge $Q_{GD}$ $V_{GS}=10 \vee (Note 1, 2)$ 8nCDRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGSDrain-Source Diode Forward Voltage $V_{SD}$ $V_{GS} = 0 \vee, I_S = 10A$ 1.4VMaximum Continuous Drain-Source Diode $I_S$ 10AMaximum Pulsed Drain-Source Diode $I_{SM}$ 38A	Total Gate Charge		$Q_{G}$			30	50	nC	
Gate-Drain Charge $Q_{GD}$ 8nCDRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGSDrain-Source Diode Forward Voltage $V_{SD}$ $V_{GS} = 0 V$ , $I_S = 10A$ 1.4VMaximum Continuous Drain-Source Diode $I_S$ 10AMaximum Pulsed Drain-Source Diode $I_{SM}$ 38A	Gate-Source Charge		$Q_{GS}$			9		nC	
Drain-Source Diode Forward Voltage     V <sub>SD</sub> V <sub>GS</sub> = 0 V, I <sub>S</sub> =10A     1.4     V       Maximum Continuous Drain-Source Diode     I <sub>S</sub> 10     A       Maximum Pulsed Drain-Source Diode     I <sub>SM</sub> 38     A	Gate-Drain Charge	Bate-Drain Charge		$V_{GS} = 10 V (100te 1, 2)$		8		nC	
Maximum Continuous Drain-Source Diode     Is     10     A       Forward Current     Iss     38     A	DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS								
Forward Current     Is     10     A       Maximum Pulsed Drain-Source Diode     Issue     38     A	Drain-Source Diode Forward Voltag	e	$V_{SD}$	V <sub>GS</sub> = 0 V, I <sub>S</sub> =10A			1.4	V	
Forward Current     Image: Constraint of the second s	Maximum Continuous Drain-Source Diode		I <sub>S</sub>				10	^	
	Forward Current						10	А	
Forward Current 50 A	Maximum Pulsed Drain-Source Diode		lau				38	Δ	
	Forward Current		ISM				50	~	

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

2. Essentially independent of operating temperature.



## TEST CIRCUITS AND WAVEFORMS

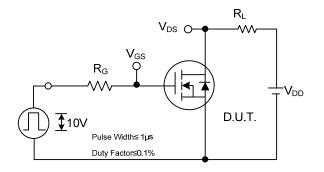


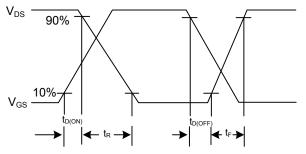




# 10N65K-MT

## ■ TEST CIRCUITS AND WAVEFORMS (Cont.)





Switching Test Circuit



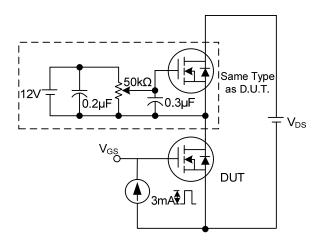
 $\mathsf{Q}_{\mathsf{G}}$ 

Q<sub>GD</sub>

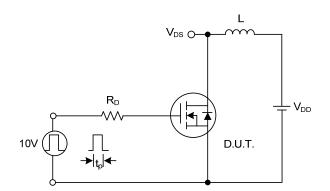
 $V_{GS}$ 

10V

Q<sub>GS</sub>-



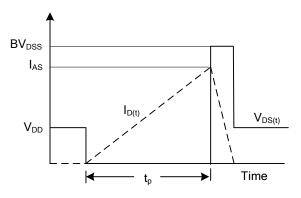
**Gate Charge Test Circuit** 



**Unclamped Inductive Switching Test Circuit** 

Gate Charge Waveform

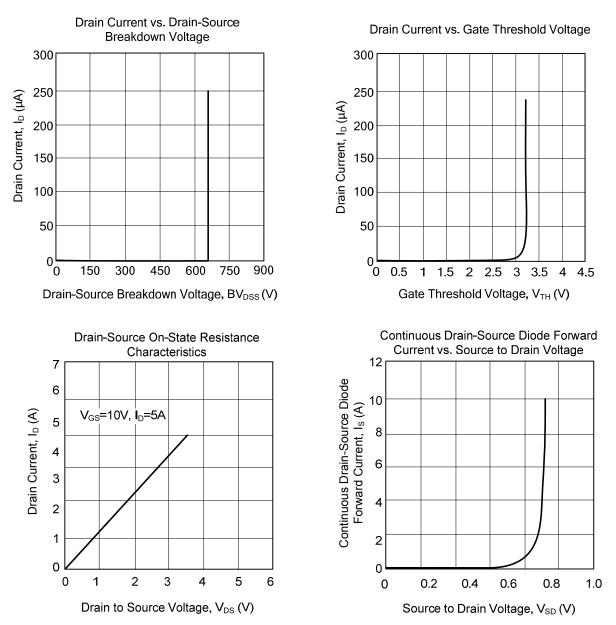
Charge



**Unclamped Inductive Switching Waveforms** 



### TYPICAL CHARACTERISTICS



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