



## 4NM65-U2

Power MOSFET

### 4A, 650V N-CHANNEL SUPER-JUNCTION MOSFET

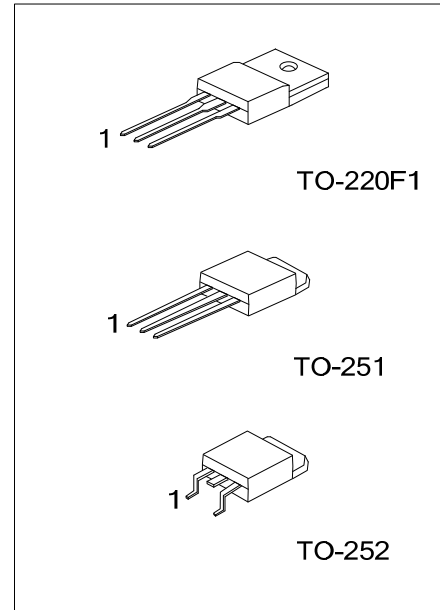
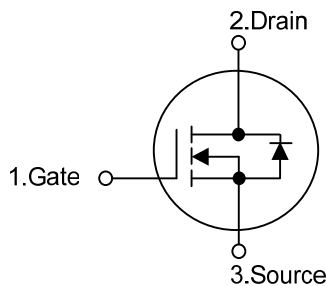
#### DESCRIPTION

The UTC **4NM65-U2** is a Super Junction MOSFET Structure and is 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 at power supplies, PWM motor controls, high efficient DC to DC converters and bridge circuits.

#### FEATURES

- \*  $R_{DS(ON)} < 2.1\Omega$  @  $V_{GS} = 10V$ ,  $I_D = 2.0 A$
- \* Fast Switching Capability
- \* Improved  $dv/dt$  Capability, High Ruggedness

#### SYMBOL



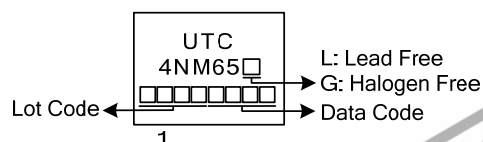
#### ORDERING INFORMATION

Ordering Number		Package	Pin Assignment			Packing
Lead Free	Halogen Free		1	2	3	
4NM65L-TF1-T	4NM65G-TF1-T	TO-220F1	G	D	S	Tube
4NM65L-TM3-T	4NM65G-TM3-T	TO-251	G	D	S	Tube
4NM65L-TN3-R	4NM65G-TN3-R	TO-252	G	D	S	Tape Reel

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

	(1) Packing Type (2) Package Type (3) Green Package	(1) T: Tube, R: Tape Reel (2) TF1: TO-220F1, TM3: TO-251, TN3: TO-252 (3) G: Halogen Free and Lead Free, L: Lead Free
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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	A
	Pulsed (Note 2)	$I_{DM}$	16	A
Avalanche Energy	Single Pulsed (Note 3)	$E_{AS}$	116	mJ
Peak Diode Recovery $dv/dt$ (Note 4)		$dv/dt$	4	V/ns
Power Dissipation	TO-220F1	$P_D$	36	W
	TO-251/TO-252		50	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.  $L=144\text{mH}$ ,  $I_{AS}=1.27\text{A}$ ,  $V_{DD}=50\text{V}$ ,  $R_G=25\ \Omega$ , 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	RATING	UNIT
Junction to Ambient	TO-220F1	$\theta_{JA}$	62.5	$^\circ\text{C}/\text{W}$
	TO-251/TO-252		110	$^\circ\text{C}/\text{W}$
Junction to Case	TO-220F1	$\theta_{JC}$	3.67	$^\circ\text{C}/\text{W}$
	TO-251/TO-252		2.5	$^\circ\text{C}/\text{W}$

■ 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	$\mu A$
Gate-Source Leakage Current	Forward	$I_{GSS}$	$V_{GS}=30V, V_{DS}=0V$			100	nA
	Reverse		$V_{GS}=-30V, V_{DS}=0V$			-100	
ON CHARACTERISTICS							
Gate Threshold Voltage		$V_{GS(TH)}$	$V_{DS}=V_{GS}, I_D=250\mu A$	2.5		4.5	V
Static Drain-Source On-State Resistance		$R_{DS(ON)}$	$V_{GS}=10V, I_D=2.0A$			2.1	$\Omega$
DYNAMIC CHARACTERISTICS							
Input Capacitance		$C_{ISS}$	$V_{GS}=0V, V_{DS}=25V, f=1.0MHz$		220		pF
Output Capacitance		$C_{OSS}$			170		pF
Reverse Transfer Capacitance		$C_{RSS}$			16		pF
SWITCHING CHARACTERISTICS							
Total Gate Charge (Note 1)		$Q_G$	$V_{DS}=300V, V_{GS}=10V,$ $I_D=4.0A, I_G=5mA$ (Note 1, 2)		16.5		nC
Gate to Source Charge		$Q_{GS}$			5.4		nC
Gate to Drain Charge		$Q_{GD}$			6.4		nC
Turn-ON Delay Time (Note 1)		$t_{D(ON)}$	$V_{DD}=200V, V_{GS}=10V,$ $I_D=4.0A, R_G=25\Omega$ (Note 1, 2)		7.2		ns
Rise Time		$t_R$			16.5		ns
Turn-OFF Delay Time		$t_{D(OFF)}$			32		ns
Fall-Time		$t_F$			28		ns
SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS							
Maximum Body-Diode Continuous Current		$I_S$				4.0	A
Maximum Body-Diode Pulsed Current		$I_{SM}$				20	A
Drain-Source Diode Forward Voltage (Note 1)		$V_{SD}$	$I_S=4.0A, V_{GS}=0V$			1.4	V
Body Diode Reverse Recovery Time (Note 1)		$t_{rr}$	$I_S=4.0A, V_{GS}=0V,$		260		ns
Body Diode Reverse Recovery Charge		$Q_{rr}$	$dI_F/dt=100A/\mu s$		1.76		$\mu C$

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

2. Essentially independent of operating temperature.

D.U.T.

$V_{DS}$

$I_{SD}$

$L$

$V_{DD}$

$R_G$

Driver

$V_{GS}$

Same Type as D.U.T.

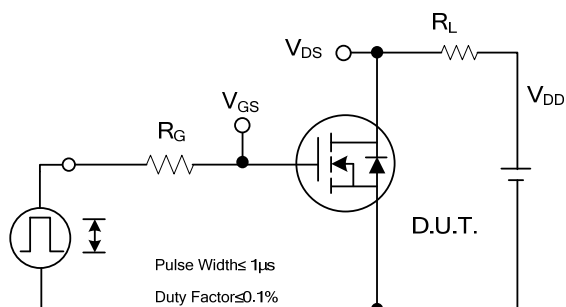
- \*  $dv/dt$  controlled by  $R_G$
- \*  $I_{SD}$  controlled by pulse period
- \* D.U.T.-Device Under Test

Timing diagram for a MOSFET switching a load inductor. The diagram shows three waveforms:  $V_{GS}$  (Driver),  $I_{SD}$  (D.U.T.), and  $V_{DS}$  (D.U.T.).

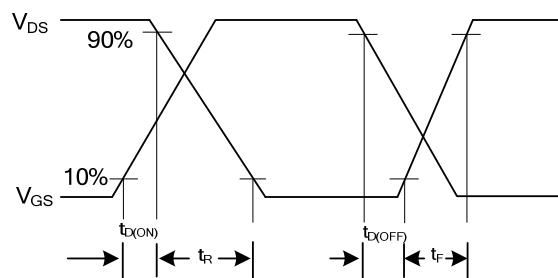
- $V_{GS}$  (Driver): A square wave with pulse width (P.W.) and period (Period). The duty cycle is defined as  $D = \frac{P.W.}{Period}$ . The gate-source voltage is  $V_{GS} = 10V$ .
- $I_{SD}$  (D.U.T.): The drain current. It shows the inductor current  $I_{FM}$  (Body Diode Forward Current) during the on-state and the reverse current  $I_{RM}$  (Body Diode Reverse Current) during the off-state. The rate of change of current is indicated as  $di/dt$ .
- $V_{DS}$  (D.U.T.): The drain-source voltage. It shows the body diode forward voltage drop and the body diode recovery  $dv/dt$  during the off-state. The drain-source voltage is  $V_{DD}$ .

### Peak Diode Recovery dv/dt Waveforms

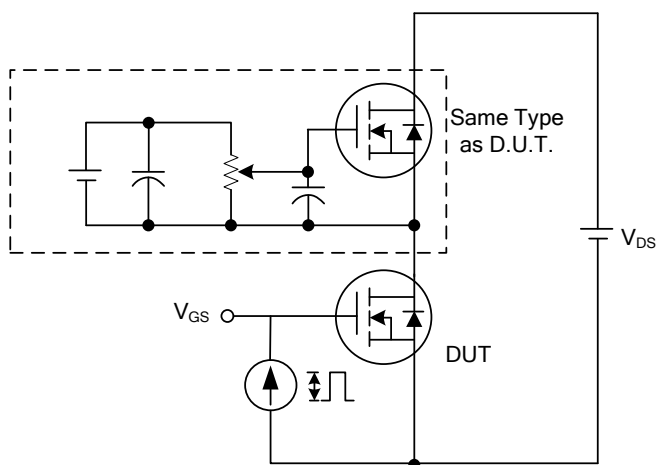
### ■ TEST CIRCUITS AND WAVEFORMS (Cont.)



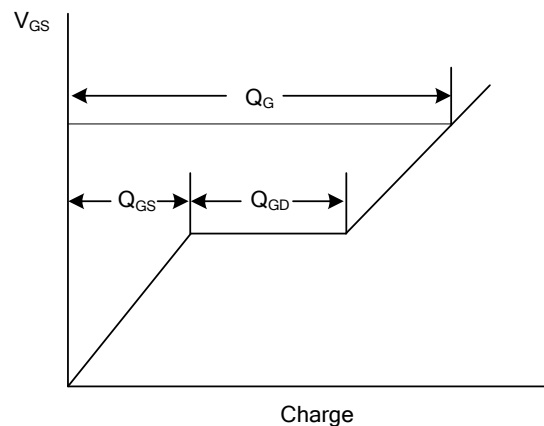
Switching Test Circuit



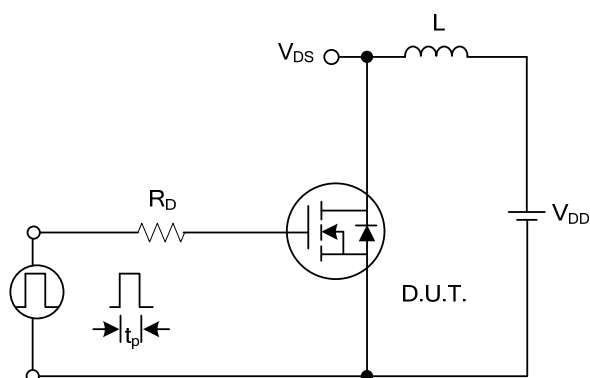
Switching Waveforms



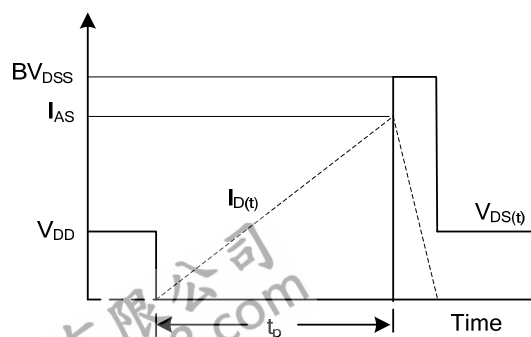
Gate Charge Test Circuit



Gate Charge Waveform

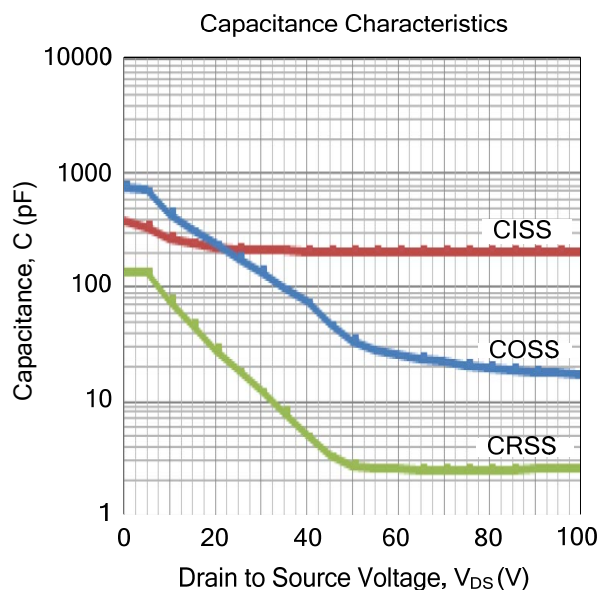
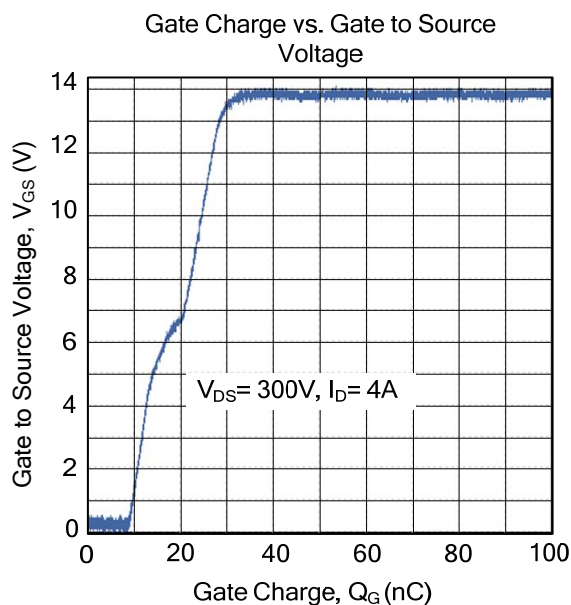


Unclamped Inductive Switching Test Circuit



Unclamped Inductive Switching Waveforms

## ■ TYPICAL CHARACTERISTICS



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