



4N65K-TC

Power MOSFET

4A, 650V N-CHANNEL POWER MOSFET

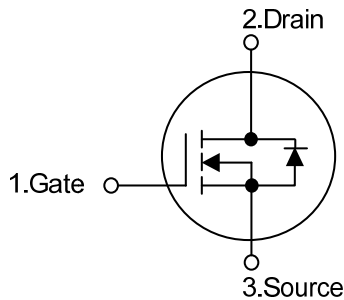
■ DESCRIPTION

The UTC **4N65K-TC** 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 AC to DC converters and bridge circuits.

■ FEATURES

- * $R_{DS(ON)} \leq 2.5\Omega @ V_{GS}=10V, I_D=2.0A$
- * Fast Switching Capability
- * Avalanche Energy Specified
- * Improved dv/dt Capability, High Ruggedness

■ SYMBOL

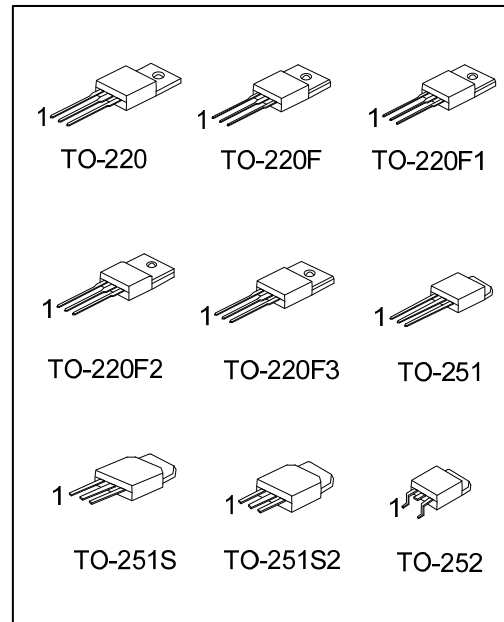


■ ORDERING INFORMATION

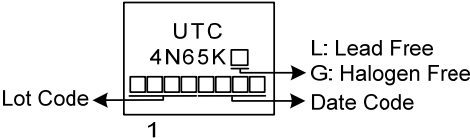
| Ordering Number | | Package | Pin Assignment | | | Packing |
|-----------------|---------------|----------|----------------|---|---|-----------|
| Lead Free | Halogen Free | | 1 | 2 | 3 | |
| 4N65KL-TA3-T | 4N65KG-TA3-T | TO-220 | G | D | S | Tube |
| 4N65KL-TF1-T | 4N65KG-TF1-T | TO-220F1 | G | D | S | Tube |
| 4N65KL-TF2-T | 4N65KG-TF2-T | TO-220F2 | G | D | S | Tube |
| 4N65KL-TF3-T | 4N65KG-TF3-T | TO-220F | 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-TMS2-T | 4N65KG-TMS2-T | TO-251S2 | G | D | S | Tube |
| 4N65KL-TN3-R | 4N65KG-TN3-R | TO-252 | G | D | S | Tape Reel |

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

| | |
|---|--|
| <p>4N65KG-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</p> <p>(3) G: Halogen Free and Lead Free, L: Lead Free</p> |
|---|--|



■ 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} | ± 30 | V |
| Drain Current | Continuous | I_D | 4.0 | A |
| | Pulsed (Note2) | I_{DM} | 16 | A |
| Avalanche Energy | Single Pulsed (Note3) | E_{AS} | 113 | mJ |
| Peak Diode Recovery dv/dt (Note4) | | dv/dt | 3.79 | V/ns |
| Power Dissipation | TO-220 | P_D | 106 | W |
| | TO-220F/TO-220F1 TO-220F2/TO-220F3 | | 36 | W |
| | TO-251/TO-251S TO-251S2/TO-252 | | 50 | W |
| Derate above 25°C | TO-220 | | 0.84 | W/ $^\circ\text{C}$ |
| | TO-220F/TO-220F1 TO-220F2/TO-220F3 | | 0.29 | W/ $^\circ\text{C}$ |
| | TO-251/TO-251S TO-251S2/TO-252 | | 0.40 | W/ $^\circ\text{C}$ |
| 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. $L=25\text{mH}$, $I_{AS}=3.0\text{A}$, $V_{DD}=50\text{V}$, $R_G=25\ \Omega$, 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 | RATINGS | UNIT |
|---------------------|---|---------------|------------|---------------------------|
| Junction to Ambient | TO-220/TO-220F TO-220F1/TO-220F2 TO-220F3 | θ_{JA} | 62.5 | $^\circ\text{C}/\text{W}$ |
| | TO-251/TO-251S TO-251S2/TO-252 | | 83 | $^\circ\text{C}/\text{W}$ |
| Junction to Case | TO-220 | θ_{JC} | 1.18 | $^\circ\text{C}/\text{W}$ |
| | TO-220F/TO-220F1 TO-220F3 | | 3.4 | $^\circ\text{C}/\text{W}$ |
| | TO-220F2 | | 3.57 | $^\circ\text{C}/\text{W}$ |
| | TO-251/TO-251S TO-251S2/TO-252 | | 2.5 (Note) | $^\circ\text{C}/\text{W}$ |

Note: The data tested by surface mounted on a 1 inch² FR-4 board with 2OZ copper.

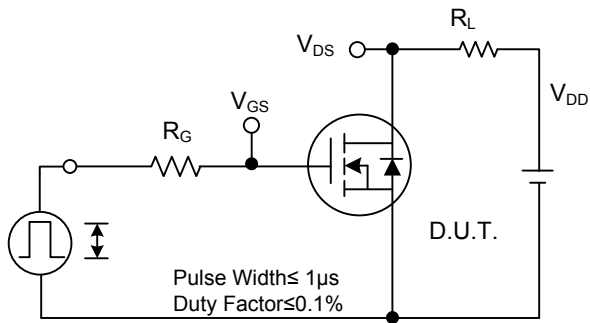
■ ELECTRICAL CHARACTERISTICS (T_C=25°C, unless otherwise specified)

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|-------------------------------------|--|-----|------|------|------|
| OFF CHARACTERISTICS | | | | | | |
| Drain-Source Breakdown Voltage | BV _{DSS} | V _{GS} = 0 V, I _D = 250μA | 650 | | | V |
| Drain-Source Leakage Current | I _{DSS} | V _{DS} = 650 V, V _{GS} = 0 V | | | 10 | μA |
| Gate-Source Leakage Current | Forward | I _{GSS} | | | 100 | nA |
| | Reverse | | | | -100 | nA |
| Breakdown Voltage Temperature Coefficient | ΔBV _{DSS} /ΔT _J | I _D =250μA, Referenced to 25°C | | 0.6 | | V/°C |
| ON CHARACTERISTICS | | | | | | |
| Gate Threshold Voltage | V _{GS(TH)} | V _{DS} = V _{GS} , I _D = 250μA | 2.0 | | 4.0 | V |
| Static Drain-Source On-State Resistance | R _{DS(ON)} | V _{GS} = 10 V, I _D = 2.0A | | 2.2 | 2.5 | Ω |
| DYNAMIC CHARACTERISTICS | | | | | | |
| Input Capacitance | C _{ISS} | V _{DS} =25V, V _{GS} =0V, f=1MHz | | 600 | | pF |
| Output Capacitance | C _{OSS} | | | 53.8 | | pF |
| Reverse Transfer Capacitance | C _{RSS} | | | 3.2 | | pF |
| SWITCHING CHARACTERISTICS | | | | | | |
| Total Gate Charge | Q _G | V _{DS} =100V, V _{GS} =10V, I _D =3.0A I _G = 1mA (Note1, 2) | | 13 | | nC |
| Gate-Source Charge | Q _{GS} | | | 3.6 | | nC |
| Gate-Drain Charge | Q _{GD} | | | 2 | | nC |
| Turn-On Delay Time | t _{D(ON)} | V _{DS} =100V, V _{GS} =10V, I _D =2.0A, R _G =25Ω (Note1, 2) | | 30 | | ns |
| Turn-On Rise Time | t _R | | | 10 | | ns |
| Turn-Off Delay Time | t _{D(OFF)} | | | 60 | | ns |
| Turn-Off Fall Time | t _F | | | 50 | | ns |
| SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS | | | | | | |
| Maximum Continuous Drain-Source Diode Forward Current | I _S | | | | 4.0 | A |
| Maximum Pulsed Drain-Source Diode Forward Current | I _{SM} | | | | 16 | A |
| Drain-Source Diode Forward Voltage | V _{SD} | V _{GS} = 0 V, I _S = 4.0A | | | 1.4 | V |
| Reverse Recovery Time | t _{rr} | V _{GS} = 0V, I _S = 4.0A, dI _F / dt =100A/μs (Note 1) | | 230 | | nS |
| Reverse Recovery Charge | Q _{rr} | | | | 1.6 | |

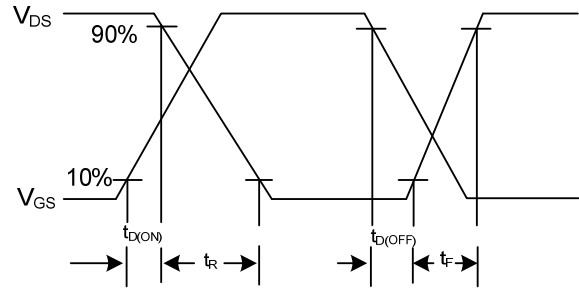
Notes: 1. Pulse Test: Pulse width ≤ 300μs, Duty cycle ≤ 2%.

2. Essentially independent of operating temperature.

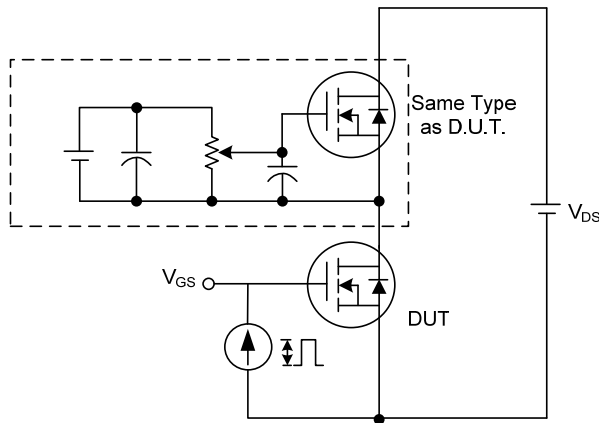
TEST CIRCUITS AND WAVEFORMS



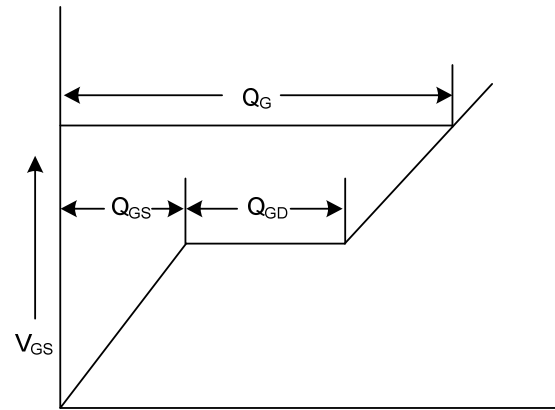
Switching Test Circuit



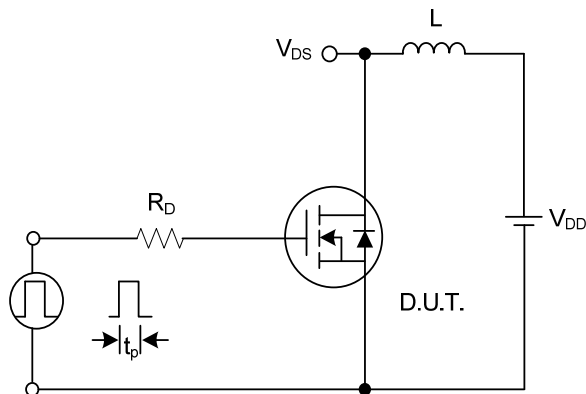
Switching Waveforms



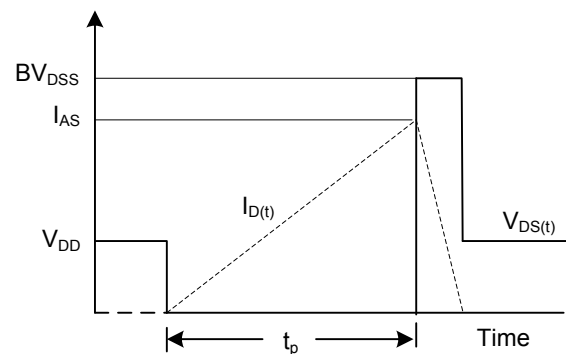
Gate Charge Test Circuit



Gate Charge Waveform

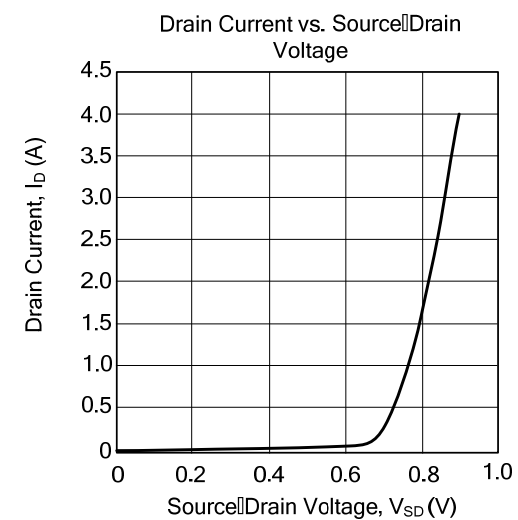
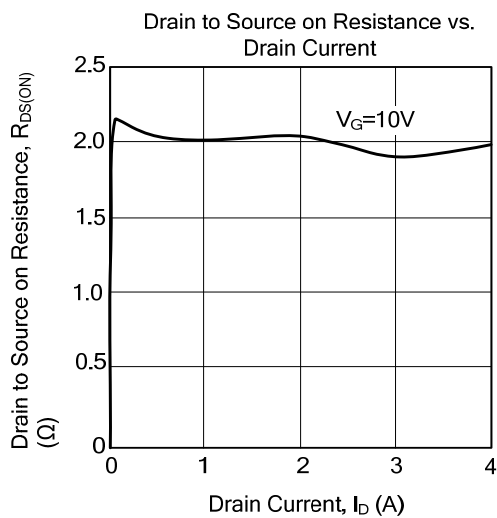
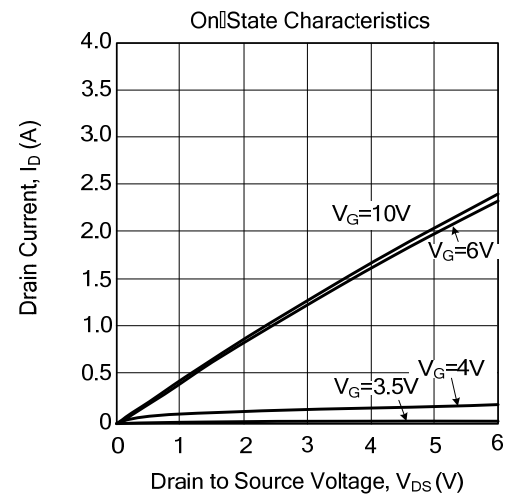
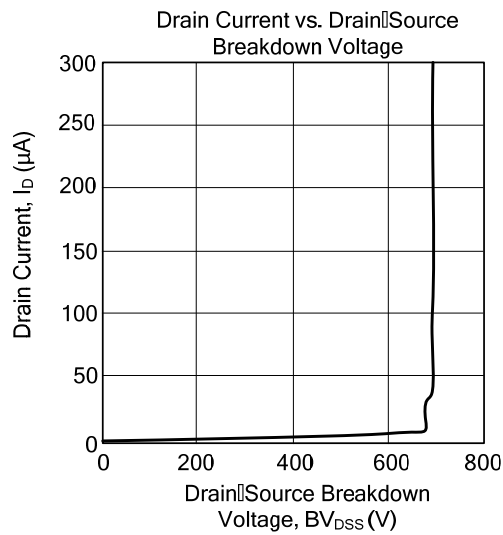
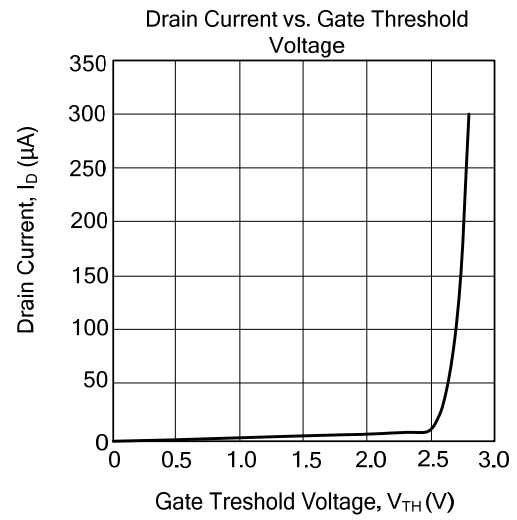
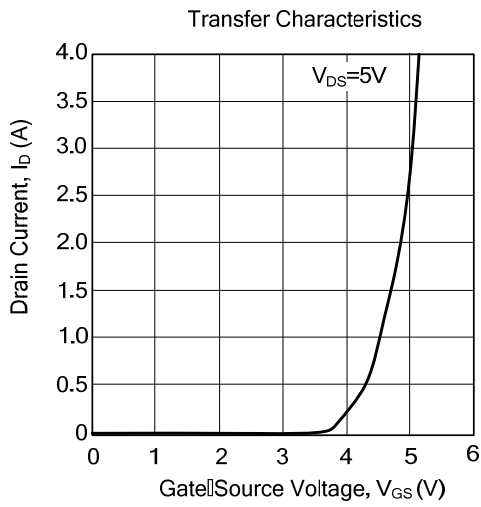


Unclamped Inductive Switching Test Circuit

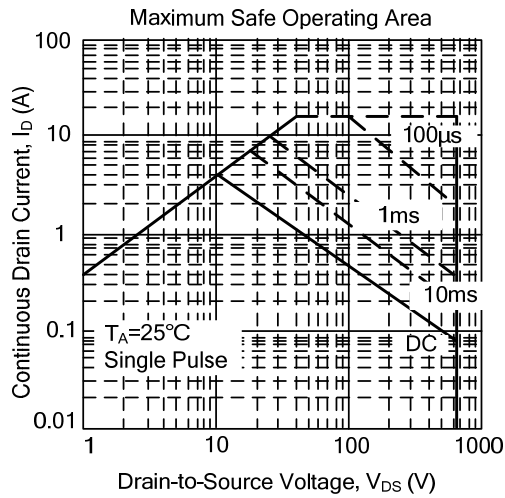


Unclamped Inductive Switching Waveforms

TYPICAL CHARACTERISTICS



■ TYPICAL CHARACTERISTICS (Cont.)



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