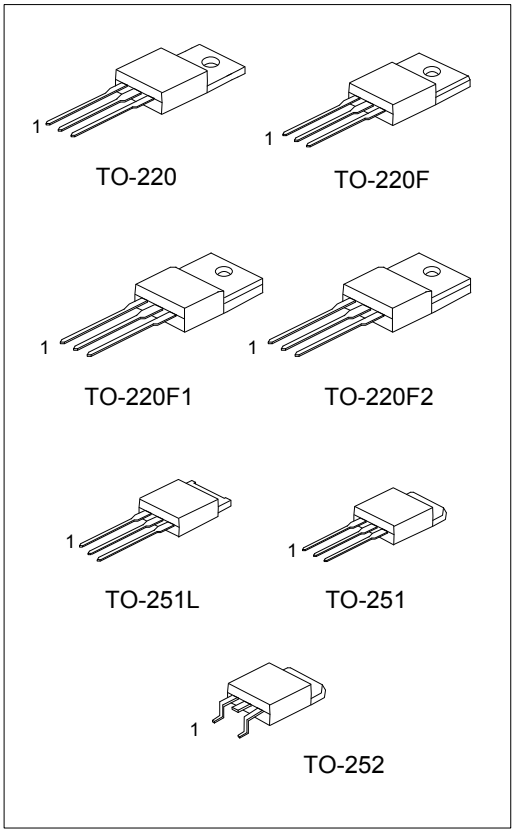
# 2N60L

**Power MOSFET**

## 2A, 600V N-CHANNEL POWER MOSFET



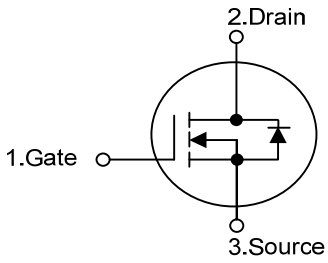

### ■ DESCRIPTION

The UTC **2N60L** is a high voltage MOSFET and is designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and have a high rugged avalanche characteristics. This power MOSFET is usually used at high speed switching applications in power supplies, PWM motor controls, high efficient DC to DC converters and bridge circuits.

### ■ FEATURES

* $R_{DS(ON)}$ = 5Ω@$V_{GS}$ = 10V
* Ultra Low gate charge (typical 9.0nC)
* Low reverse transfer capacitance ($C_{RSS}$ = typical 5.0 pF)
* Fast switching capability
* Avalanche energy specified
* Improved dv/dt capability, high ruggedness

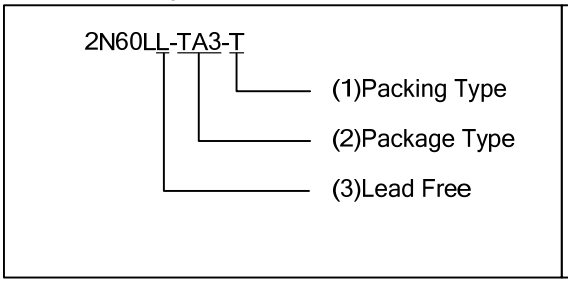
### ■ SYMBOL




### ■ ORDERING INFORMATION

| Ordering Number | | Package | Pin Assignment | | | Packing |
|---|---|---|---|---|---|---|
| Lead Free | Halogen Free | | 1 | 2 | 3 | |
| 2N60LL-TA3-T | 2N60LG-TA3-T | TO-220 | G | D | S | Tube |
| 2N60LL-TF1-T | 2N60LG-TF1-T | TO-220F1 | G | D | S | Tube |
| 2N60LL-TF2-T | 2N60LG-TF2-T | TO-220F2 | G | D | S | Tube |
| 2N60LL-TF3-T | 2N60LG-TF3-T | TO-220F | G | D | S | Tube |
| 2N60LL-TM3-T | 2N60LG-TM3-T | TO-251 | G | D | S | Tube |
| 2N60LL-TMA-T | 2N60LG-TMA-T | TO-251L | G | D | S | Tube |
| 2N60LL-TN3-R | 2N60LG-TN3-R | TO-252 | G | D | S | Tape Reel |

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




(1) T: Tube, R: Tape Reel
(2) TA3: TO-220, TF1: TO-220F1, TF2: TO-220F2, TF3: TO-220F, TM3: TO-251, TMA:TO-251L, TN3: TO-252
(3) G: Halogen Free, L: Lead Free

## ■ ABSOLUTE MAXIMUM RATINGS ($T_C$ = 25°C, unless otherwise specified)

| PARAMETER | | SYMBOL | RATINGS | UNIT |
|---|---|---|---|---|
| Drain-Source Voltage | | $V_{DSS}$ | 600 | V |
| Gate-Source Voltage | | $V_{GSS}$ | ±30 | V |
| Avalanche Current (Note 2) | | $I_{AR}$ | 2.0 | A |
| Drain Current | Continuous | $I_D$ | 2.0 | A |
| | Pulsed (Note 2) | $I_{DM}$ | 8.0 | A |
| Avalanche Energy | Single Pulsed (Note 3) | $E_{AS}$ | 140 | mJ |
| | Repetitive (Note 2) | $E_{AR}$ | 4.5 | mJ |
| Peak Diode Recovery dv/dt (Note 4) | | dv/dt | 4.5 | V/ns |
| Power Dissipation | TO-220 | $P_D$ ($T_C$ = 25°C) | 54 | W |
| | TO-220F/TO-220F1 | | 23 | |
| | TO-220F2 | | 25 | |
| | TO-251/TO-251L/TO-252 | | 44 | |
| Junction Temperature | | $T_J$ | +150 | °C |
| Ambient 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 $T_J$
3. L=64mH, $I_{AS}$=2.0A, $V_{DD}$=50V, $R_G$=25 Ω, Starting $T_J$ = 25°C
4. $I_{SD}$≤2.4A, di/dt≤200A/μs, $V_{DD}$ ≤ $BV_{DSS}$, Starting $T_J$ = 25°C

## ■ THERMAL DATA

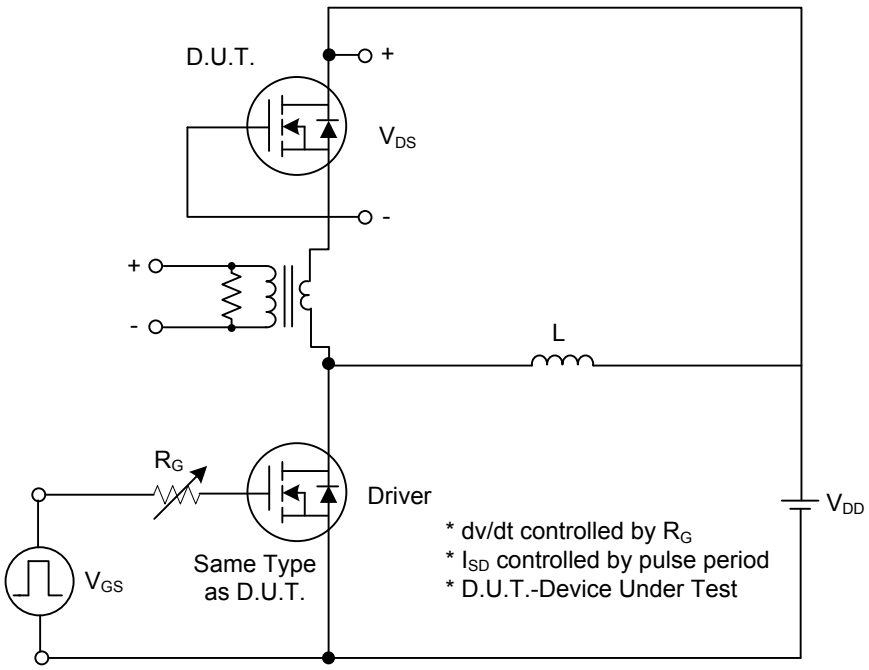
| PARAMETER | PACKAGE | SYMBOL | RATINGS | UNIT |
|---|---|---|---|---|
| Junction to Ambient | TO-220/TO-220F | $\theta_{JA}$ | 62.5 | °C/W |
| | TO-220F1/TO-220F2 | | 62.5 | |
| | TO-251/TO-251L/TO-252 | | 100 | |
| Junction to Case | TO-220 | $\theta_{Jc}$ | 2.32 | °C/W |
| | TO-220F/TO-220F1 | | 5.5 | |
| | TO-220F2 | | 5 | |
| | TO-251/TO-251L/TO-252 | | 2.87 | |

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

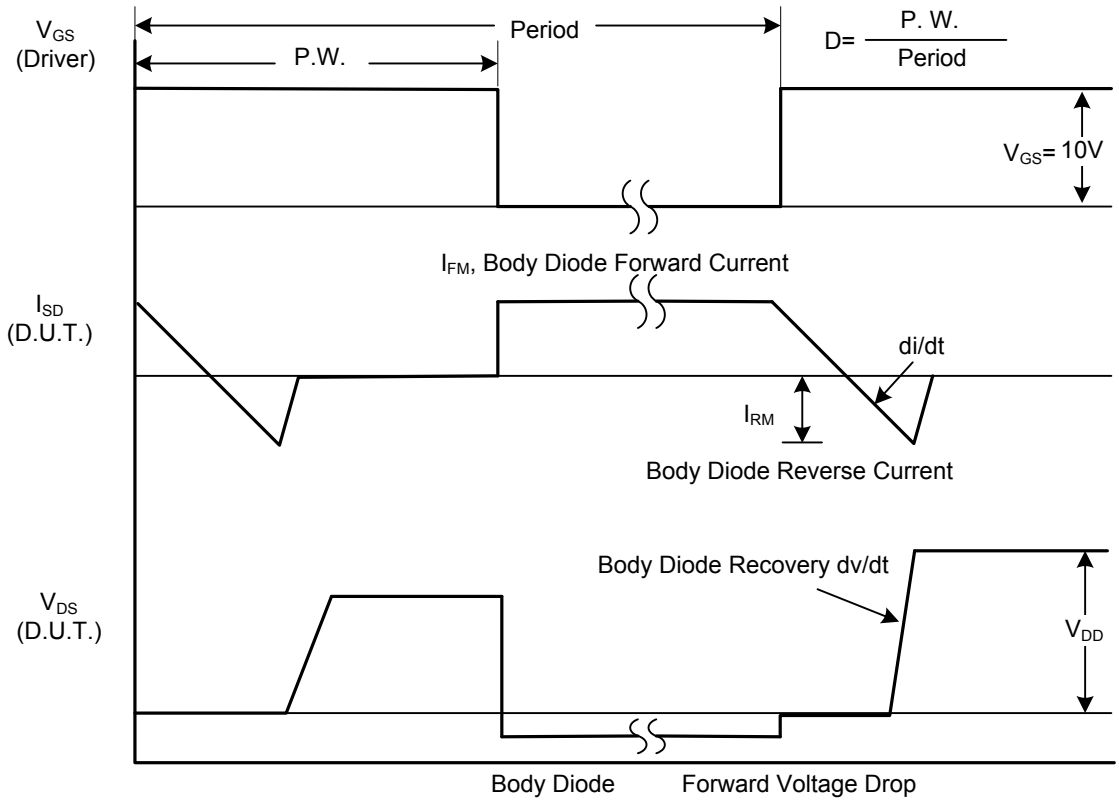
| PARAMETER | | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| Drain-Source Breakdown Voltage | | $BV_{DSS}$ | $V_{GS}$ = 0V, $I_D$ = 250μA | 600 | | | V |
| Drain-Source Leakage Current | | $I_{DSS}$ | $V_{DS}$ = 600V, $V_{GS}$ = 0V | | | 10 | μA |
| Gate-Source Leakage Current | Forward | $I_{GSS}$ | $V_{GS}$ = 30V, $V_{DS}$ = 0V | | | 100 | nA |
| | Reverse | | $V_{GS}$ = -30V, $V_{DS}$ = 0V | | | -100 | nA |
| Breakdown Voltage Temperature Coefficient | | $\triangle BV_{DSS}/\triangle T_J$ | $I_D$=250μA, Referenced to 25°C | | 0.4 | | 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 | | $R_{DS(ON)}$ | $V_{GS}$ = 10V, $I_D$ =1A | | 4.2 | 5 | Ω |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| Input Capacitance | | $C_{ISS}$ | $V_{DS}$ =25V, $V_{GS}$ =0V, f =1MHz | | 270 | 350 | pF |
| Output Capacitance | | $C_{OSS}$ | | | 40 | 50 | pF |
| Reverse Transfer Capacitance | | $C_{RSS}$ | | | 5 | 7 | pF |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| Turn-On Delay Time | | $t_{D\ (ON)}$ | $V_{DD}$ =300V, $I_D$ =2.4A, $R_G$=25Ω (Note 1, 2) | | 10 | 30 | ns |
| Turn-On Rise Time | | $t_R$ | | | 25 | 60 | ns |
| Turn-Off Delay Time | | $t_{D(OFF)}$ | | | 20 | 50 | ns |
| Turn-Off Fall Time | | $t_F$ | | | 25 | 60 | ns |
| Total Gate Charge | | $Q_G$ | $V_{DS}$=480V, $V_{GS}$=10V, $I_D$=2.4A (Note 1, 2) | | 9.0 | 11 | nC |
| Gate-Source Charge | | $Q_{GS}$ | | | 1.6 | | nC |
| Gate-Drain Charge | | $Q_{GD}$ | | | 4.3 | | nC |
| **DRAIN-SOURCE DIODE CHARACTERISTICS** | | | | | | | |
| Drain-Source Diode Forward Voltage | | $V_{SD}$ | $V_{GS}$ = 0 V, $I_{SD}$ = 2.0 A | | | 1.4 | V |
| Continuous Drain-Source Current | | $I_{SD}$ | | | | 2.0 | A |
| Pulsed Drain-Source Current | | $I_{SM}$ | | | | 8.0 | A |
| Reverse Recovery Time | | $t_{RR}$ | $V_{GS}$ = 0 V, $I_{SD}$ = 2.4A, di/dt = 100 A/μs (Note1) | | 180 | | ns |
| Reverse Recovery Charge | | $Q_{RR}$ | | | 0.72 | | μC |

Notes: 1. Pulse Test: Pulse width ≤ 300μs, Duty cycle≤2%
2. Essentially independent of operating temperature

## ■ TEST CIRCUITS AND WAVEFORMS

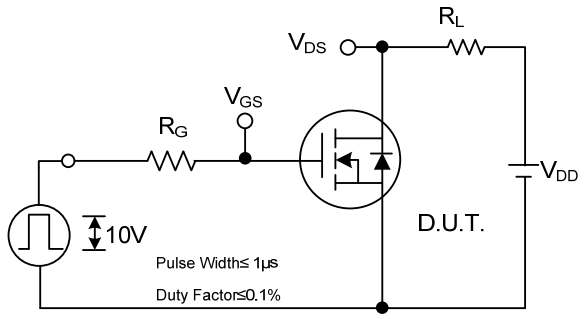



**Peak Diode Recovery dv/dt Test Circuit**

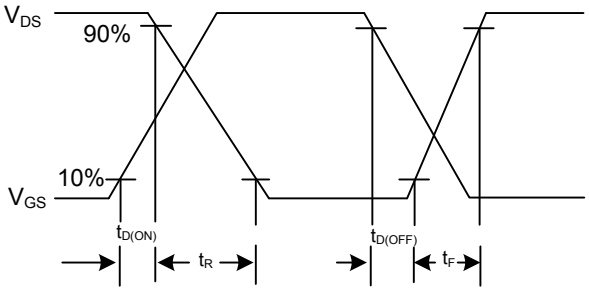



**Peak Diode Recovery dv/dt Waveforms**

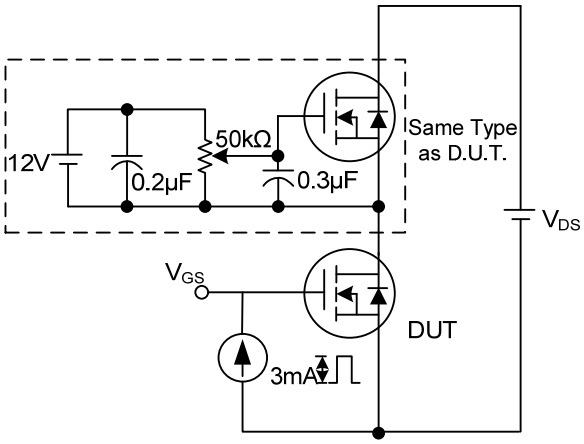
## ■ TEST CIRCUITS AND WAVEFORMS (Cont.)



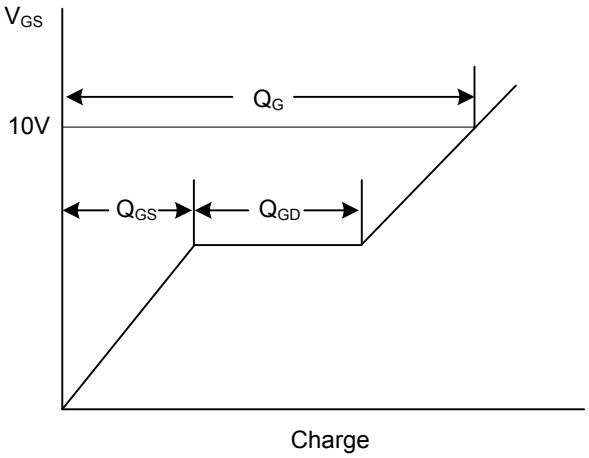

**Switching Test Circuit**



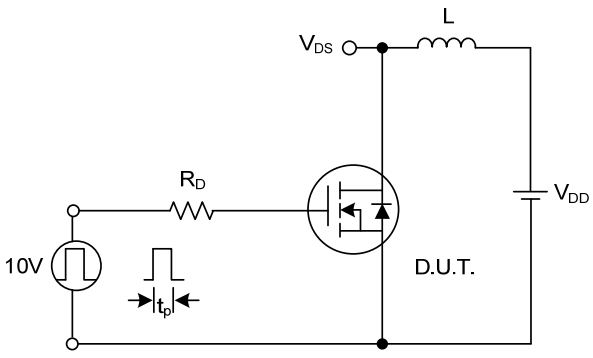

**Switching Waveforms**



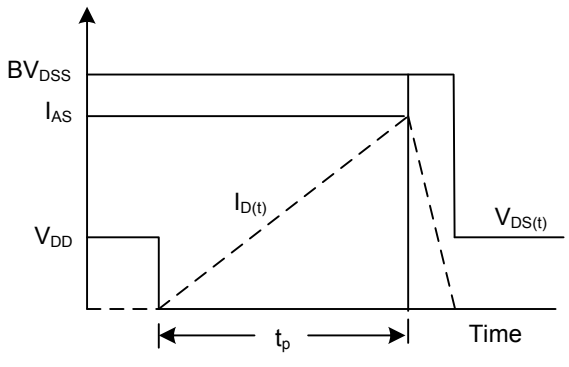

**Gate Charge Test Circuit**




**Gate Charge Waveform**




**Unclamped Inductive Switching Test Circuit**




**Unclamped Inductive Switching Waveforms**