



## 10N60-Q

Preliminary

Power MOSFET

## 10A, 600V N-CHANNEL POWER MOSFET

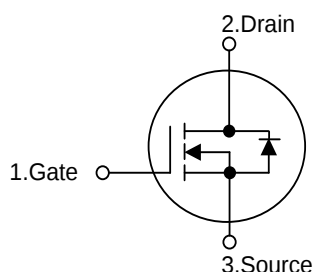
### DESCRIPTION

The **UTC 10N60-Q** is a high voltage and high current power MOSFET, designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and a high rugged avalanche characteristics. This power MOSFET is usually used at high speed switching applications in power supplies, PWM motor controls, high efficient AC to DC converters and bridge circuits.

### FEATURES

- \*  $R_{DS(ON)} \leq 0.9\Omega$  @  $V_{GS} = 10V$ ,  $I_D = 5A$
- \* Low gate charge ( typical 33 nC)
- \* Low  $C_{rss}$  ( typical 18 pF)
- \* Fast switching
- \* 100% avalanche tested
- \* Improved dv/dt capability

### SYMBOL

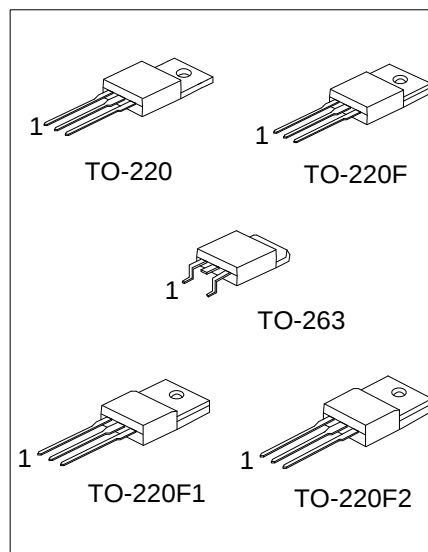


### ORDERING INFORMATION

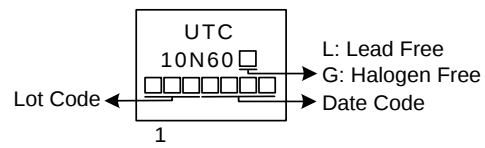
| Ordering Number |              | Package  | Pin Assignment |   |   | Packing   |
|-----------------|--------------|----------|----------------|---|---|-----------|
| Lead Free       | Halogen Free |          | 1              | 2 | 3 |           |
| 10N60L-TA3-T    | 10N60G-TA3-T | TO-220   | G              | D | S | Tube      |
| 10N60L-TF3-T    | 10N60G-TF3-T | TO-220F  | G              | D | S | Tube      |
| 10N60L-TF1-T    | 10N60G-TF1-T | TO-220F1 | G              | D | S | Tube      |
| 10N60L-TF2-T    | 10N60G-TF2-T | TO-220F2 | G              | D | S | Tube      |
| 10N60L-TQ2-T    | 10N60G-TQ2-T | TO-263   | G              | D | S | Tube      |
| 10N60L-TQ2-R    | 10N60G-TQ2-R | TO-263   | G              | D | S | Tape Reel |

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

|                                                                                        |                                                                                                                                                                      |
|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>10N60G-TA3-T</p> <p>(1) Packing Type<br/>(2) Package Type<br/>(3) Green Package</p> | <p>(1) T: Tube, R: Tape Reel<br/>(2) TA3: TO-220, TF3: TO-220F, TF1: TO-220F1<br/>TF2: TO-220F2, TQ2: TO-263<br/>(3) G: Halogen Free and Lead Free, L: Lead Free</p> |
|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|



## ■ MARKING



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

| PARAMETER                          |                        | SYMBOL           | RATINGS    | UNIT |
|------------------------------------|------------------------|------------------|------------|------|
| Drain-Source Voltage               |                        | V <sub>DSS</sub> | 600        | V    |
| Gate-Source Voltage                |                        | V <sub>GSS</sub> | ± 30       | V    |
| Avalanche Current (Note 2)         |                        | I <sub>AR</sub>  | 10         | A    |
| Drain Current                      | Continuous             | I <sub>D</sub>   | 10         | A    |
|                                    | Pulsed (Note 2)        | I <sub>DM</sub>  | 38         | A    |
| Avalanche Energy                   | Single Pulsed (Note 3) | E <sub>AS</sub>  | 500        | mJ   |
|                                    | Repetitive (Note 2)    | E <sub>AR</sub>  | 12         | mJ   |
| Peak Diode Recovery dv/dt (Note 4) |                        | dv/dt            | 4.5        | V/ns |
| Power Dissipation                  | TO-220/TO-263          | P <sub>D</sub>   | 156        | W    |
|                                    | TO-220F/TO-220F1       |                  | 52         | W    |
|                                    | TO-220F2               |                  |            |      |
| Junction Temperature               |                        | T <sub>J</sub>   | +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 maximum junction temperature

3. L = 10mH, I<sub>AS</sub> = 10A, V<sub>DD</sub> = 50V, R<sub>G</sub> = 25 Ω Starting T<sub>J</sub> = 25°C

4. I<sub>SD</sub> ≤ 10A, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ BV<sub>DSS</sub>, Starting T<sub>J</sub> = 25°C

# ■ THERMAL DATA

| PARAMETER           |                  | SYMBOL          | RATING | UNIT |
|---------------------|------------------|-----------------|--------|------|
| Junction to Ambient |                  | θ <sub>JA</sub> | 62.5   | °C/W |
| Junction to Case    | TO-220/TO-263    | θ <sub>JC</sub> | 0.8    | °C/W |
|                     | TO-220F/TO-220F1 |                 | 2.4    | °C/W |
|                     | TO-220F2         |                 |        |      |

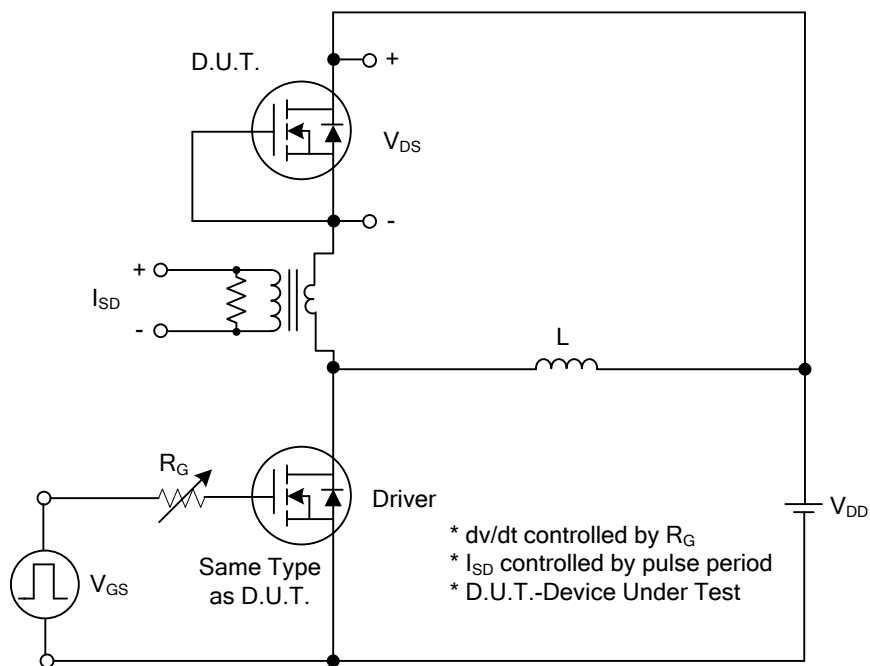
■ **ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$ , unless otherwise specified)

| PARAMETER                                              |         | SYMBOL                              | TEST CONDITIONS                                                                                      | MIN | TYP  | MAX  | UNIT |
|--------------------------------------------------------|---------|-------------------------------------|------------------------------------------------------------------------------------------------------|-----|------|------|------|
| OFF CHARACTERISTICS                                    |         |                                     |                                                                                                      |     |      |      |      |
| Drain-Source Breakdown Voltage                         |         | BV <sub>DSS</sub>                   | V <sub>GS</sub> =0V, I <sub>D</sub> = 250μA                                                          | 600 |      |      | V    |
| Drain-Source Leakage Current                           |         | I <sub>DSS</sub>                    | V <sub>DS</sub> =600V, V <sub>GS</sub> =0V                                                           |     |      | 1    | μA   |
| Gate-Source Leakage Current                            | Forward | I <sub>GSS</sub>                    | V <sub>GS</sub> =30V, V <sub>DS</sub> =0V                                                            |     |      | 100  | nA   |
|                                                        | Reverse |                                     | V <sub>GS</sub> =-30V, V <sub>DS</sub> =0V                                                           |     |      | -100 | nA   |
| Breakdown Voltage Temperature Coefficient              |         | ΔBV <sub>DSS</sub> /ΔT <sub>J</sub> | I <sub>D</sub> =250 μA, Referenced to 25°C                                                           |     | 0.7  |      | V/°C |
| ON CHARACTERISTICS                                     |         |                                     |                                                                                                      |     |      |      |      |
| Gate Threshold Voltage                                 |         | V <sub>GS(TH)</sub>                 | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =250μA                                             | 2.0 |      | 4.0  | V    |
| Static Drain-Source On-State Resistance                |         | R <sub>DS(ON)</sub>                 | V <sub>GS</sub> =10V, I <sub>D</sub> =5A                                                             |     |      | 0.9  | Ω    |
| DYNAMIC CHARACTERISTICS                                |         |                                     |                                                                                                      |     |      |      |      |
| Input Capacitance                                      |         | C <sub>ISS</sub>                    | V <sub>DS</sub> =25V, V <sub>GS</sub> =0V, f=1.0 MHz                                                 |     | 1300 |      | pF   |
| Output Capacitance                                     |         | C <sub>OSS</sub>                    |                                                                                                      |     | 140  |      | pF   |
| Reverse Transfer Capacitance                           |         | C <sub>RSS</sub>                    |                                                                                                      |     | 19   |      | pF   |
| SWITCHING CHARACTERISTICS                              |         |                                     |                                                                                                      |     |      |      |      |
| Total Gate Charge                                      |         | Q <sub>G</sub>                      | V <sub>DS</sub> =50V, I <sub>D</sub> =1.3A, V <sub>GS</sub> =10V<br>I <sub>G</sub> =100μA (Note1, 2) |     | 43   | 57   | nC   |
| Gate-Source Charge                                     |         | Q <sub>GS</sub>                     |                                                                                                      |     | 7.5  |      | nC   |
| Gate-Drain Charge                                      |         | Q <sub>GD</sub>                     |                                                                                                      |     | 13   |      | nC   |
| Turn-On Delay Time                                     |         | t <sub>D(ON)</sub>                  | V <sub>DD</sub> =30V, I <sub>D</sub> =0.5A, R <sub>G</sub> =25Ω,<br>V <sub>GS</sub> =0V (Note1, 2)   |     | 80   |      | ns   |
| Turn-On Rise Time                                      |         | t <sub>R</sub>                      |                                                                                                      |     | 120  |      | ns   |
| Turn-Off Delay Time                                    |         | t <sub>D(OFF)</sub>                 |                                                                                                      |     | 300  |      | ns   |
| Turn-Off Fall Time                                     |         | t <sub>F</sub>                      |                                                                                                      |     | 160  |      | ns   |
| DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS |         |                                     |                                                                                                      |     |      |      |      |
| Maximum Continuous Drain-Source Diode Forward Current  |         | I <sub>S</sub>                      |                                                                                                      |     |      | 10   | A    |
| Maximum Pulsed Drain-Source Diode Forward Current      |         | I <sub>SM</sub>                     |                                                                                                      |     |      | 40   | A    |
| Drain-Source Diode Forward Voltage                     |         | V <sub>SD</sub>                     | V <sub>GS</sub> =0V, I <sub>S</sub> =10A                                                             |     |      | 1.4  | V    |
| Reverse Recovery Time                                  |         | t <sub>rr</sub>                     | V <sub>GS</sub> =0V, I <sub>S</sub> =10A,                                                            |     | 420  |      | ns   |
| Reverse Recovery Charge                                |         | Q <sub>rr</sub>                     | di/dt=100A/μs (Note1)                                                                                |     | 4.2  |      | μC   |

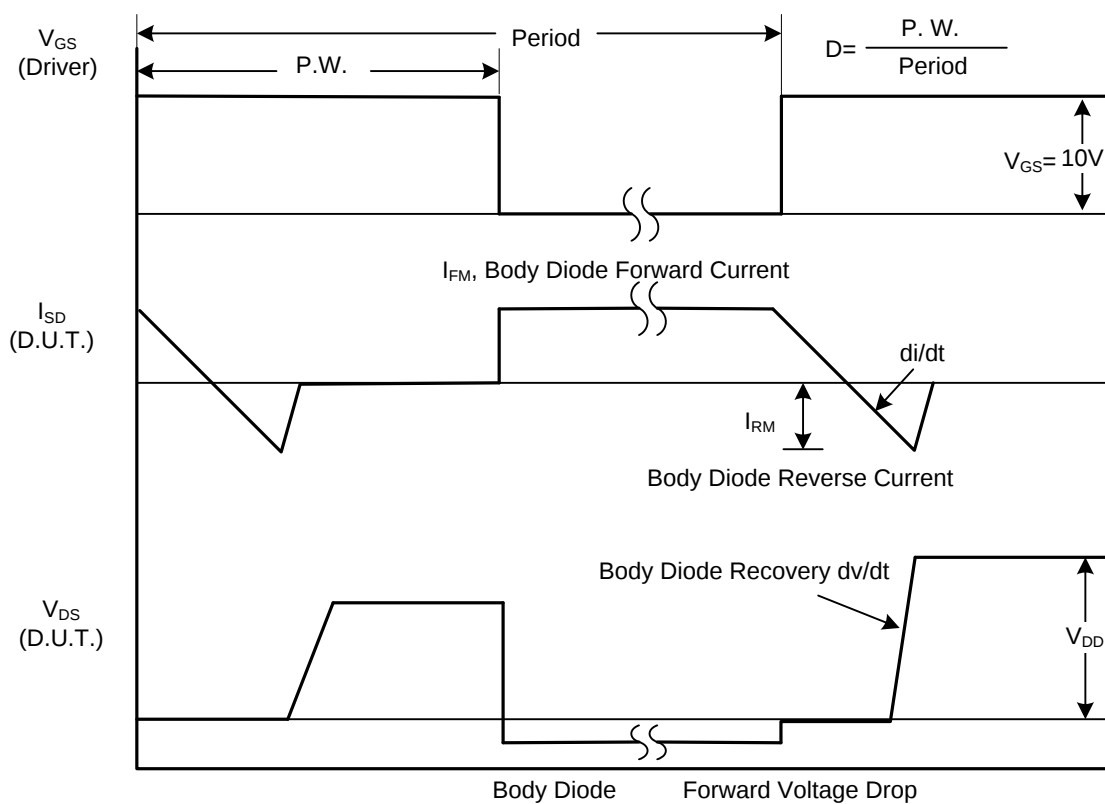
Notes: 1. Pulse Test : Pulse width  $\leq 300\mu s$ , Duty cycle  $\leq 2\%$

2. Essentially independent of operating temperature

## ■ TEST CIRCUITS AND WAVEFORMS

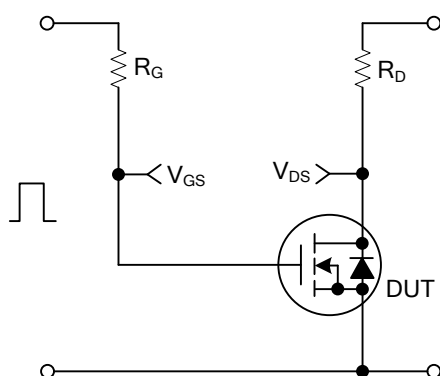


Peak Diode Recovery  $dv/dt$  Test Circuit

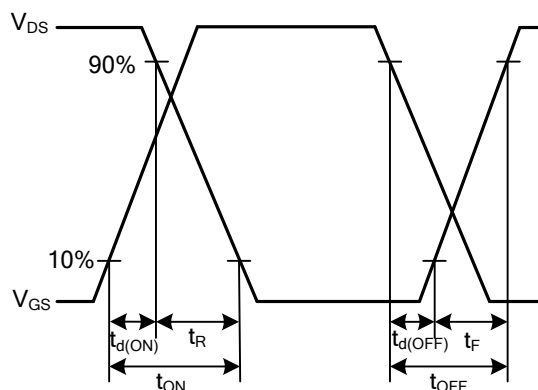


Peak Diode Recovery  $dv/dt$  Waveforms

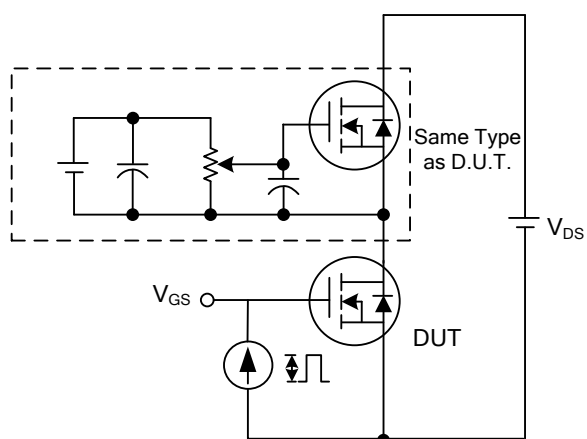
## ■ TEST CIRCUITS AND WAVEFORMS



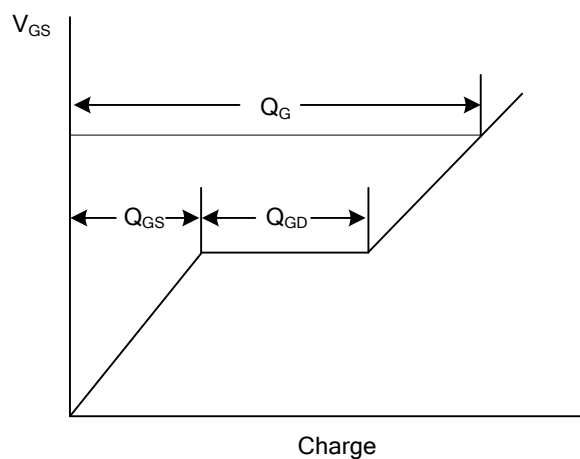
Switching Test Circuit



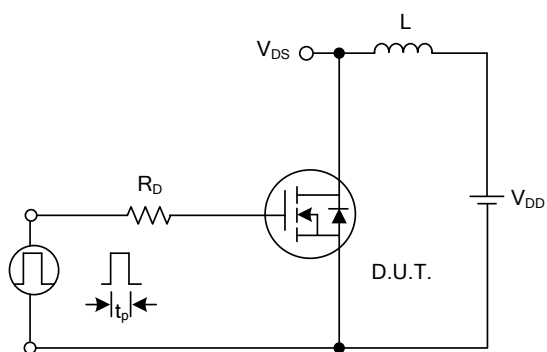
Switching Waveforms



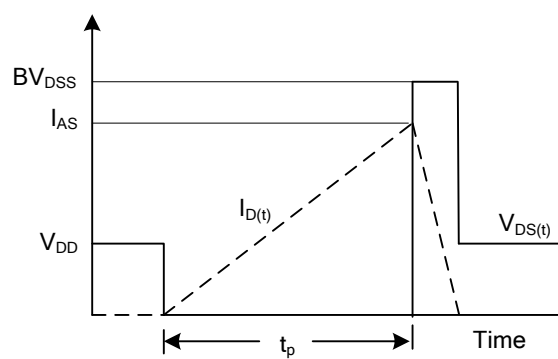
Gate Charge Test Circuit



Gate Charge Waveform



Unclamped Inductive Switching Test Circuit



Unclamped Inductive Switching Waveforms

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