

**2N170-E3**

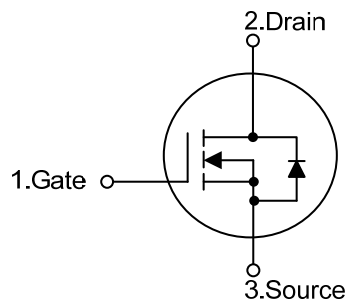
Preliminary

**Power MOSFET****2.0A, 1700V N-CHANNEL  
POWER MOSFET****DESCRIPTION**

The UTC **2N170-E3** provide excellent  $R_{DS(ON)}$ , low gate charge and operation with low gate voltages. This device is suitable for use as a load switch or in PWM applications.

**FEATURES**

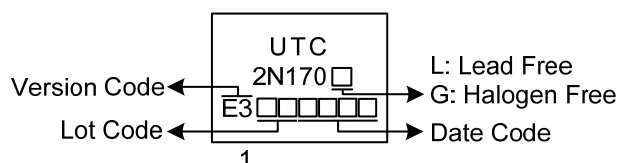
- \*  $R_{DS(ON)} \leq 11 \Omega$  @  $V_{GS}=10V$ ,  $I_D=0.5A$
- \* Low Reverse Transfer Capacitance
- \* Fast Switching Capability
- \* Avalanche Energy Specified
- \* Improved  $dv/dt$  Capability, High Ruggedness

**SYMBOL****ORDERING INFORMATION**

| Ordering Number |                 | Package  | Pin Assignment |   |   | Packing |
|-----------------|-----------------|----------|----------------|---|---|---------|
| Lead Free       | Halogen Free    |          | 1              | 2 | 3 |         |
| 2N170L-E3-TA3-T | 2N170G-E3-TA3-T | TO-220   | G              | D | S | Tube    |
| 2N170L-E3-TF1-T | 2N170G-E3-TF1-T | TO-220F1 | G              | D | S | Tube    |

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

|                        |                                                 |
|------------------------|-------------------------------------------------|
| <b>2N170G-E3-TA3-T</b> |                                                 |
| (1) Packing Type       | (1) T: Tube                                     |
| (2) Package Type       | (2) TA3: TO-220, TF1: TO-220F1                  |
| (3) Version Code       | (3) Version E3                                  |
| (4) Green Package      | (4) G: Halogen Free and Lead Free, L: Lead Free |

**MARKING**

# ■ **ABSOLUTE MAXIMUM RATINGS** ( $T_C=25^{\circ}\text{C}$ , unless otherwise specified)

| PARAMETER                            |                        | SYMBOL    | RATINGS    | UNIT               |
|--------------------------------------|------------------------|-----------|------------|--------------------|
| Drain-Source Voltage                 |                        | $V_{DSS}$ | 1700       | V                  |
| Gate-Source Voltage                  |                        | $V_{GSS}$ | $\pm 30$   | V                  |
| Drain Current                        | Continuous             | $I_D$     | 2          | A                  |
|                                      | Pulsed (Note 2)        | $I_{DM}$  | 4          | A                  |
| Avalanche Energy                     | Single Pulsed (Note 3) | $E_{AS}$  | 126        | mJ                 |
| Peak Diode Recovery $dv/dt$ (Note 4) |                        | $dv/dt$   | 2.1        | V/ns               |
| Power Dissipation                    | TO-220                 | $P_D$     | 70         | W                  |
|                                      | TO-220F1               |           | 16         | 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.  $L = 30\text{mH}$ ,  $I_{AS} = 2.9\text{A}$ ,  $V_{DD} = 90\text{V}$ ,  $R_G = 25\Omega$ , Starting  $T_J = 25^{\circ}\text{C}$ .

4.  $I_{SD} \leq 2.0\text{A}$ ,  $di/dt \leq 200\text{A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^{\circ}\text{C}$ .

# ■ **THERMAL DATA**

| PARAMETER           |          | SYMBOL        | RATINGS | UNIT                        |
|---------------------|----------|---------------|---------|-----------------------------|
| Junction to Ambient | TO-220   | $\theta_{JA}$ | 62.5    | $^{\circ}\text{C}/\text{W}$ |
|                     | TO-220F1 |               |         | $^{\circ}\text{C}/\text{W}$ |
| Junction to Case    | TO-220   | $\theta_{JC}$ | 1.78    | $^{\circ}\text{C}/\text{W}$ |
|                     | TO-220F1 |               | 7.81    | $^{\circ}\text{C}/\text{W}$ |

■ **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 <sub>DSS</sub>   | V <sub>GS</sub> =0V, I <sub>D</sub> =250μA                                                            | 1700 |      |      | V    |
| Drain-Source Leakage Current                          | I <sub>DSS</sub>    | V <sub>DS</sub> =1700V, V <sub>GS</sub> =0V                                                           |      |      | 10   | μA   |
| Gate-Source Leakage Current                           | I <sub>GSS</sub>    | V <sub>GS</sub> =±30V, V <sub>DS</sub> =0V                                                            |      |      | ±100 | nA   |
| ON CHARACTERISTICS                                    |                     |                                                                                                       |      |      |      |      |
| Gate Threshold Voltage                                | V <sub>GS(TH)</sub> | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =250μA                                              | 3.0  |      | 5.0  | V    |
| Static Drain-Source On-State Resistance               | R <sub>DS(ON)</sub> | V <sub>GS</sub> =10V, I <sub>D</sub> =0.5A                                                            |      |      | 11   | Ω    |
| DYNAMIC CHARACTERISTICS                               |                     |                                                                                                       |      |      |      |      |
| Input Capacitance                                     | C <sub>ISS</sub>    | V <sub>DS</sub> =25V, V <sub>GS</sub> =0V, f=1MHz                                                     |      | 941  |      | pF   |
| Output Capacitance                                    | C <sub>OSS</sub>    |                                                                                                       |      | 90   |      | pF   |
| Reverse Transfer Capacitance                          | C <sub>RSS</sub>    |                                                                                                       |      | 14   |      | pF   |
| SWITCHING CHARACTERISTICS                             |                     |                                                                                                       |      |      |      |      |
| Total Gate Charge (Note 1)                            | Q <sub>G</sub>      | V <sub>DS</sub> =1360V, V <sub>GS</sub> =10V, I <sub>D</sub> =2.0A<br>(Note 1, 2)                     |      | 36   |      | nC   |
| Gate-Source Charge                                    | Q <sub>GS</sub>     |                                                                                                       |      | 7    |      | nC   |
| Gate-Drain Charge                                     | Q <sub>GD</sub>     |                                                                                                       |      | 15   |      | nC   |
| Turn-On Delay Time (Note 1)                           | t <sub>D(ON)</sub>  | V <sub>DD</sub> =100V, V <sub>GS</sub> =10V, I <sub>D</sub> =2.0A,<br>R <sub>G</sub> =25Ω (Note 1, 2) |      | 19   |      | ns   |
| Turn-On Rise Time                                     | t <sub>R</sub>      |                                                                                                       |      | 26   |      | ns   |
| Turn-Off Delay Time                                   | t <sub>D(OFF)</sub> |                                                                                                       |      | 110  |      | ns   |
| Turn-Off Fall Time                                    | t <sub>F</sub>      |                                                                                                       |      | 50   |      | ns   |
| SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS       |                     |                                                                                                       |      |      |      |      |
| Maximum Continuous Drain-Source Diode Forward Current | I <sub>S</sub>      |                                                                                                       |      |      | 2    | A    |
| Drain-Source Diode Forward Voltage (Note 1)           | V <sub>SD</sub>     | I <sub>S</sub> =2.0A, V <sub>GS</sub> =0V                                                             |      |      | 1.4  | V    |
| Body Diode Reverse Recovery Time (Note 1)             | t <sub>rr</sub>     | I <sub>S</sub> =2.0A, V <sub>GS</sub> =0V,                                                            |      | 572  |      | nS   |
| Body Diode Reverse Recovery Charge                    | Q <sub>rr</sub>     | dl <sub>F</sub> /dt=100A/μs                                                                           |      | 4.73 |      | uC   |

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

2. Essentially independent of operating temperature.

D.U.T.

$V_{DS}$

$I_{SD}$

$L$

$V_{DD}$

Driver

$R_G$

$V_{GS}$

Same Type as D.U.T.

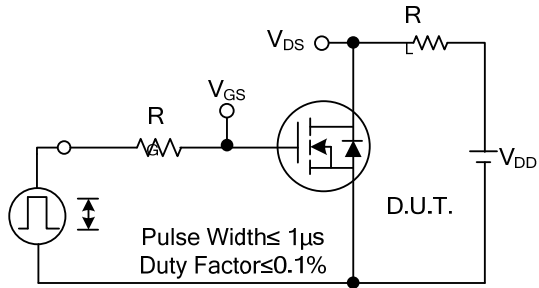
- \*  $dv/dt$  controlled by  $R_G$
- \*  $I_{SD}$  controlled by pulse period
- \* D.U.T.-Device Under Test

Timing diagram for a MOSFET switching a load inductor. The diagram shows three waveforms:

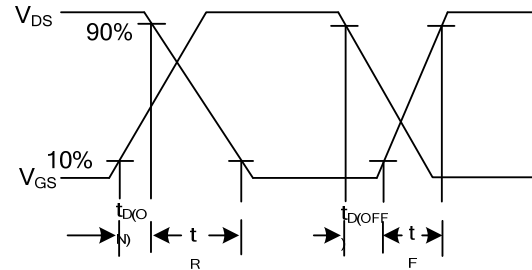
- $V_{GS}$  (Driver):** A pulse with width  $D = \frac{\text{Gate Pulse Width}}{\text{Gate Pulse Period}}$  and amplitude  $10V$ .
- $I_{SD}$  (DUT):** Shows the source-drain current. It includes the forward current  $I_{FM}$  (Body Diode Forward Current), the reverse current  $I_{RM}$  (Body Diode Reverse Current), and the rate of change of current  $di/dt$ .
- $V_{DS}$  (DUT):** Shows the drain-source voltage. It includes the switching transient with  $dv/dt$  (Body Diode Recovery  $dv/dt$ ) and the forward voltage drop  $V_{SD}$  (Body Diode Forward Voltage Drop).



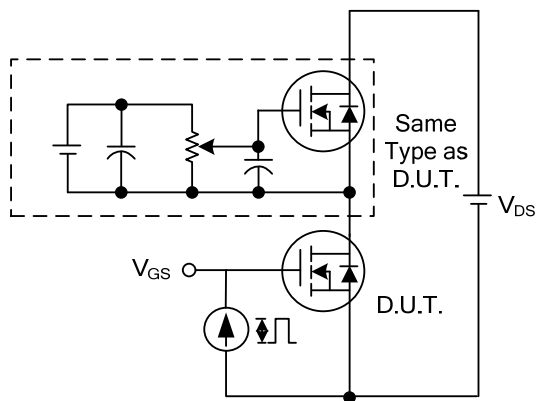
## ■ TEST CIRCUITS AND WAVEFORMS



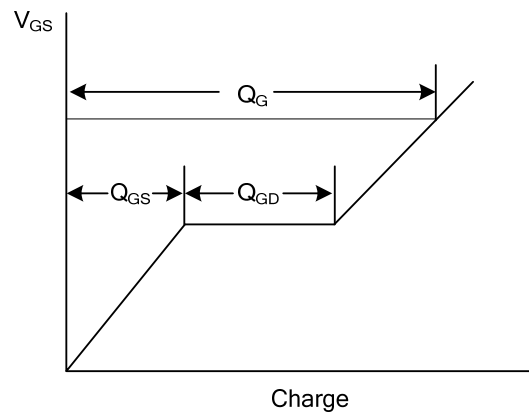
Switching Test Circuit



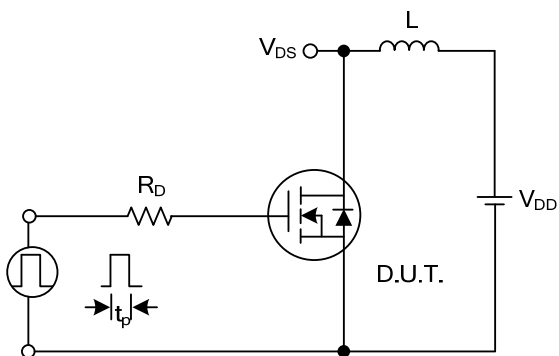
Switching Waveforms



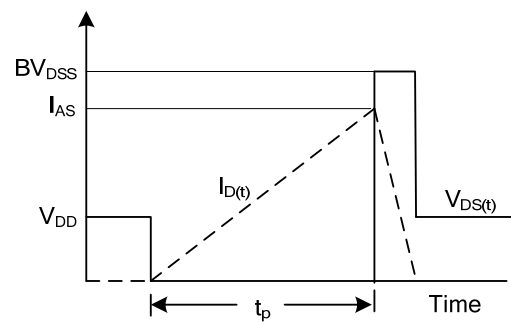
Gate Charge Test Circuit



Gate Charge Waveform



Unclamped Inductive Switching Test Circuit



Unclamped Inductive Switching Waveforms

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