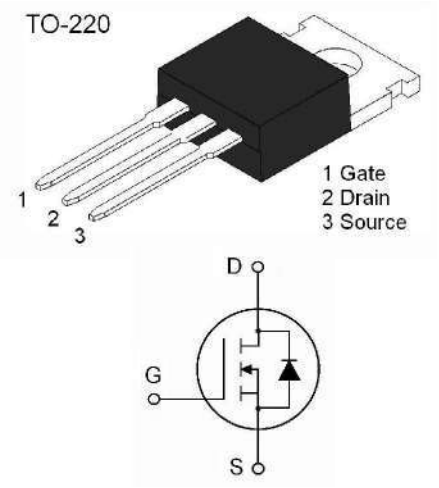
# TO-220 Plastic-Encapsulate MOSFETS

**N-Channel mode Power MOSFET**




## Features

- $V_{DS}$ 200V
- $I_D$ 9A
- $R_{DS(ON)}$ ( $V_{GS}$ = 10V ) < 0.4Ω
- High switching speed
- Improved dv/dt capability

## Absolute Maximum Ratings ($T_A$ = 25℃, unless otherwise noted)

| Parameter | | Symbol | Ratings | Units |
|---|---|---|---|---|
| Gate-Drain Voltage | | $V_{DSS}$ | 200 | V |
| Gate-Source Voltage | | $V_{GSS}$ | ±30 | V |
| Continuous Drain Current | $T_A$=25 °C | $I_D$ | 9 | A |
| | Pulsed (Note 1) | $I_{DM}$ | 36 | |
| Avalanche Current (Note 1) | | $I_{AR}$ | 9 | A |
| Single Pulsed Avalanche Energy (Note 2) | | $E_{AS}$ | 160 | mJ |
| Repetitive Avalanche Energy (Note 1) | | $E_{AR}$ | 7.2 | mJ |
| dv/dtPeak Diode Recovery dv/dt (Note 3) | | dv/dt | 5.5 | V/ns |
| Power Dissipation | | $P_D$ | 72 | W |
| Junction Temperature | | $T_J$ | 150 | °C |
| Storage Temperature | | $T_{STG}$ | -55～155 | °C |

## Thermal Characteristic

| Parameter | Symbol | Value | Units |
|---|---|---|---|
| Thermal Resistance, Junction-Case | $R_{\theta JC}$ | 1.74 | °C/W |
| Thermal Resistance, Junction-Ambient | $R_{\theta JA}$ | 62.5 | °C/W |

## Typical Characteristics

### Electrical Characteristics ( $T_j$ = 25°C unless otherwise specified)

| Parameter | Symbol | Test Conditions | Min. | Typ | Max. | Units |
|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | |
| Drain-Source Breakdown Voltage | $BV_{DSS}$ | $V_{GS}$=0V,$I_D$=250μA | 200 | | | V |
| Breakdown Voltage Temperature Coefficient | $\Delta BV_{DSS}/\Delta T_J$ | $I_D$= 1mA, Referenced to 25 °C | | 0.2 | | V/ °C |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$= 200V, $V_{GS}$= 0V | | | 10 | μA |
| | | $V_{DS}$=160V, $V_{GS}$= 0V $T_C$= 125 °C | | | 100 | |
| Gate Leakage Current | $I_{GSS}$ | $V_{DS}$=0V,$V_{GS}$=±30V | | | ±100 | nA |
| **On Characteristics** | | | | | | |
| Gate Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$=$V_{GS}$,$I_D$=250μA | 2.0 | | 4.0 | V |
| Drain-source On-Resistance | $R_{DS(ON)}$ | $V_{GS}$ = 10V,$I_D$ = 4.5A | | | 0.18 | Ω |
| Forward Transconductance(Note4) | $g_{FS}$ | $V_{DS}$=40V ,$I_D$=4.5A | | 7.05 | | S |
| **Dynamic Characteristics** | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{DS}$ = 25V,$V_{GS}$ = 0V, f = 1.0MHz | | 550 | | pF |
| Output Capacitance | $C_{oss}$ | | | 85 | | |
| Reverse Transfer Capacitance | $C_{rss}$ | | | 22 | | |
| **Switching Characteristics**) | | | | | | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD}$ = 100V, $I_D$ = 9A $R_G$ = 25Ω (Note4, 5) | | 11 | | ns |
| Turn-on Rise Time | $t_r$ | | | 70 | | |
| Turn-Off elay Time | $t_{d(off)}$ | | | 60 | | |
| Turn-Off Fall | $t_f$ | | | 65 | | |
| Total Gate Charge | $Q_g$ | $V_{DS}$ = 160V, $I_D$ = 9A $V_{GS}$ = 10V (Note 4, 5) | | 22 | | nC |
| Gate-Source Charge | $Q_{gs}$ | | | 3.6 | | |
| Gate-Drain Charge | $Q_{gd}$ | | | 10.2 | | |
| **Drain-Source Diode Characteristics** | | | | | | |
| Diode Forward Voltage | $V_{SD}$ | $V_{GS}$=0V, $I_S$ =9A | | | 1.5 | V |
| Diode Forward Current | $I_S$ | - | | | 9 | A |
| Pulsed Diode Forward Current | $I_{SM}$ | - | | | 36 | A |
| Reverse Recovery Time | $t_{rr}$ | $I_S$ = 9A, $V_{GS}$ = 0V $dI_F/dt$ =100A/μs (Note 4) | | 140 | | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | | 0.87 | | μC |

Note: 1. Repetitive Rating : Pulse width limited by maximum junction temperature
2. L = 13mH, $I_{AS}$ = 9A, $V_{DD}$ ≤ $BV_{DSS}$, Starting $T_J$ = 25°C
3. $I_{SD}$ ≤ 9A, di/dt ≤ 300A/μs, $V_{DD}$ ≤ $B_{VDSS}$, Starting $T_J$ = 25°C
4. Pulse Test: Pulse width ≤ 300μs, Duty cycle ≤ 2%
5. Essentially independent of operating temperature

## Typical Characteristics

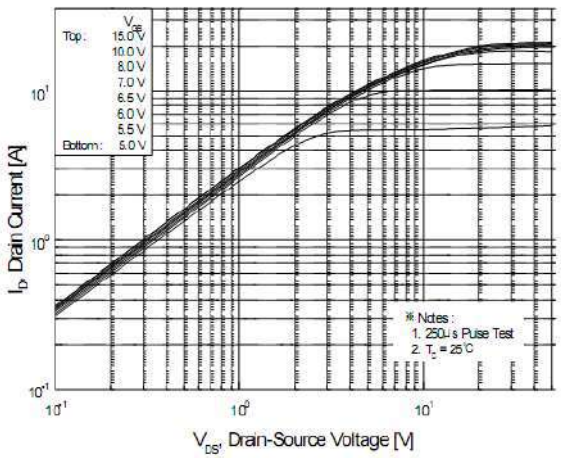



**Figure 1. Typical Output Characteristics**

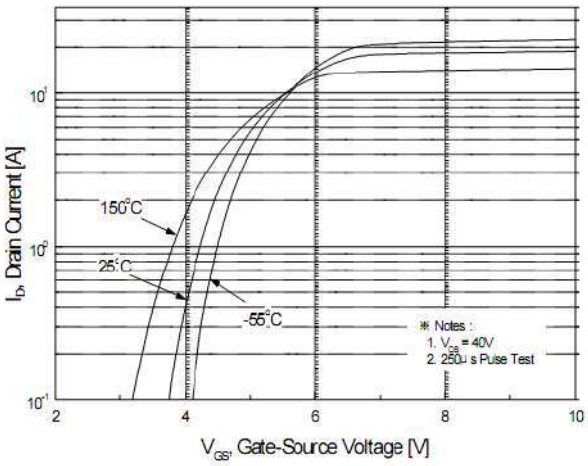



**Figure 2. Transfer Characteristics**

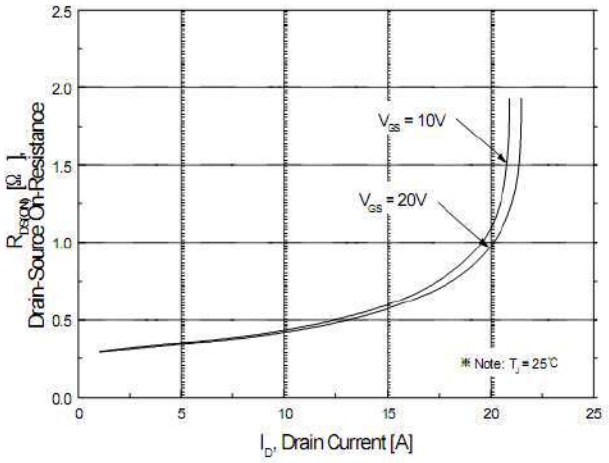



**Figure 3. On-Resistance Variation vs Drain Current and Gate Voltage**

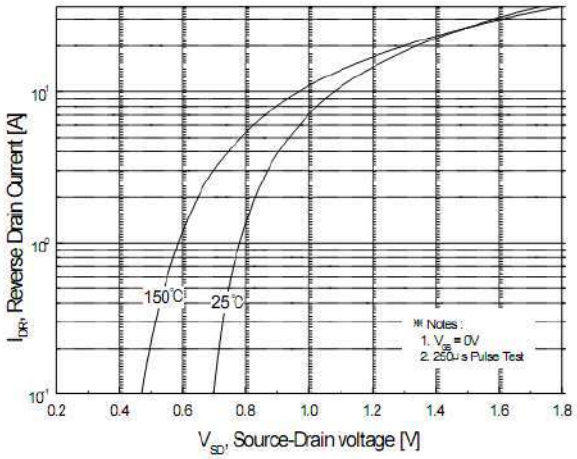



**Figure 4. Body Diode Characteristics**

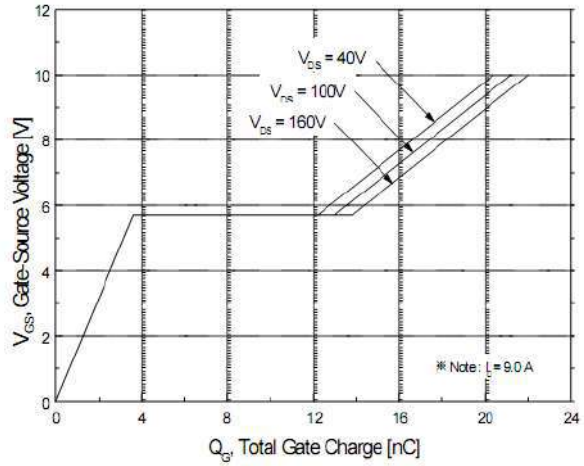



**Figure 5. Drain to Source ON Resistance vs Drain Current**

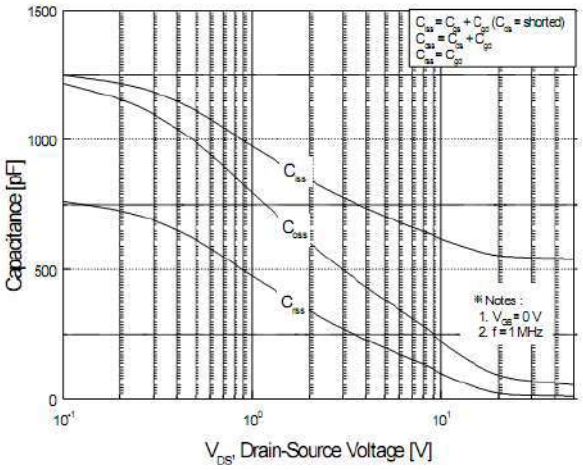



**Figure 6. Gate Charge Characteristics**

## Typical Characteristics (Continued)

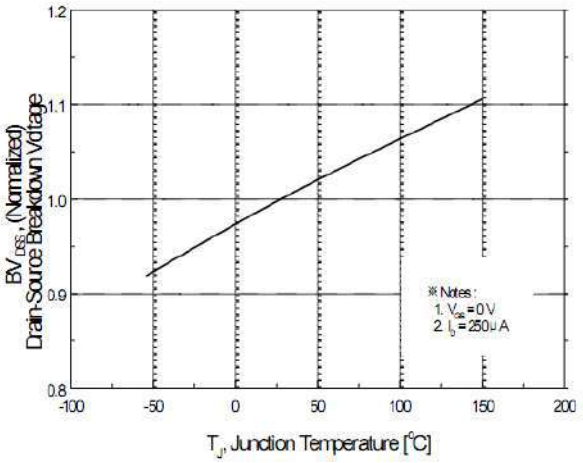



**Figure 7. Breakdown Voltage Variation vs Temperature**

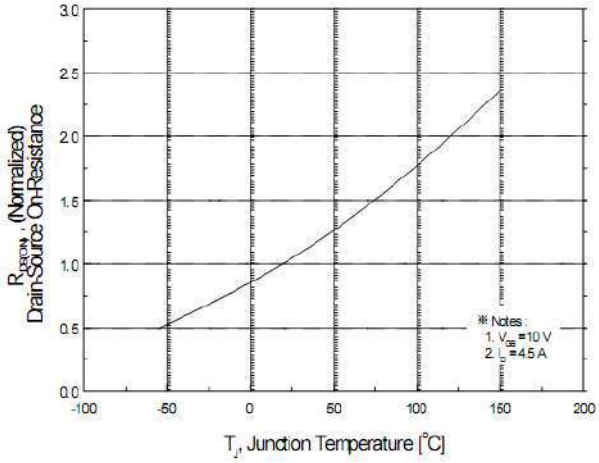



**Figure 8. On-Resistance Variation vs Temperature**

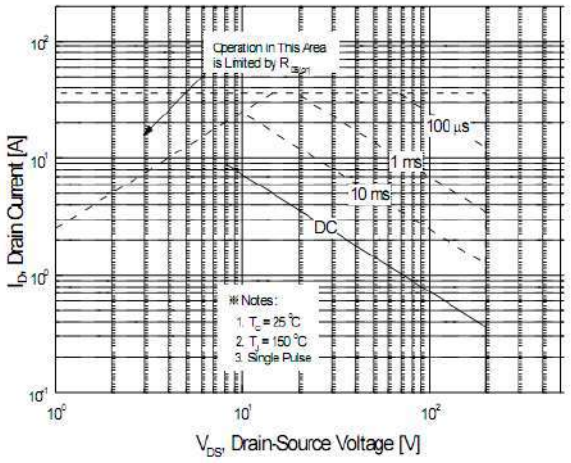



**Figure 9. Safe Operating Area**

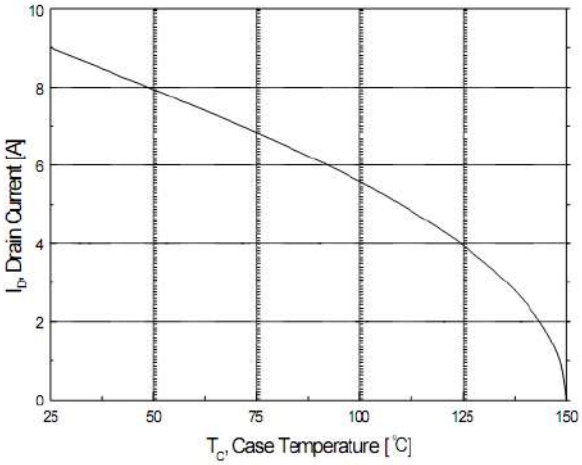



**Figure 10. Maximum Drain Current vs Case Temperature**

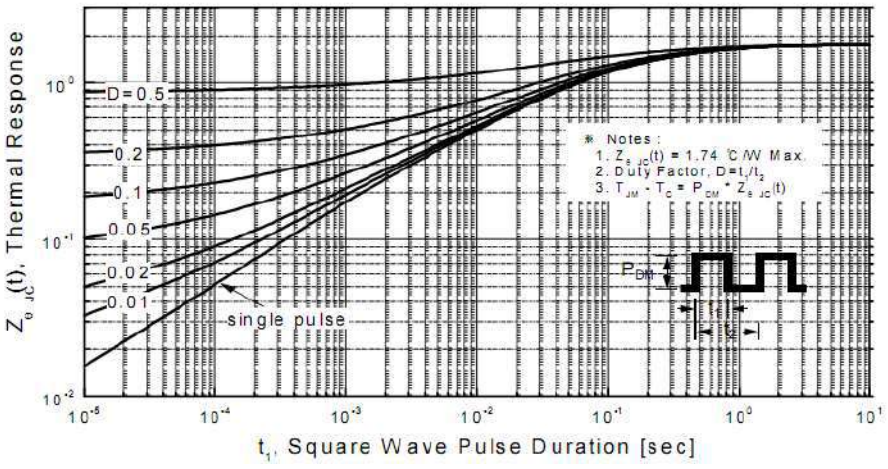



**Figure 11. Transient Thermal Response Curve**

## Test Circuits and waveforms

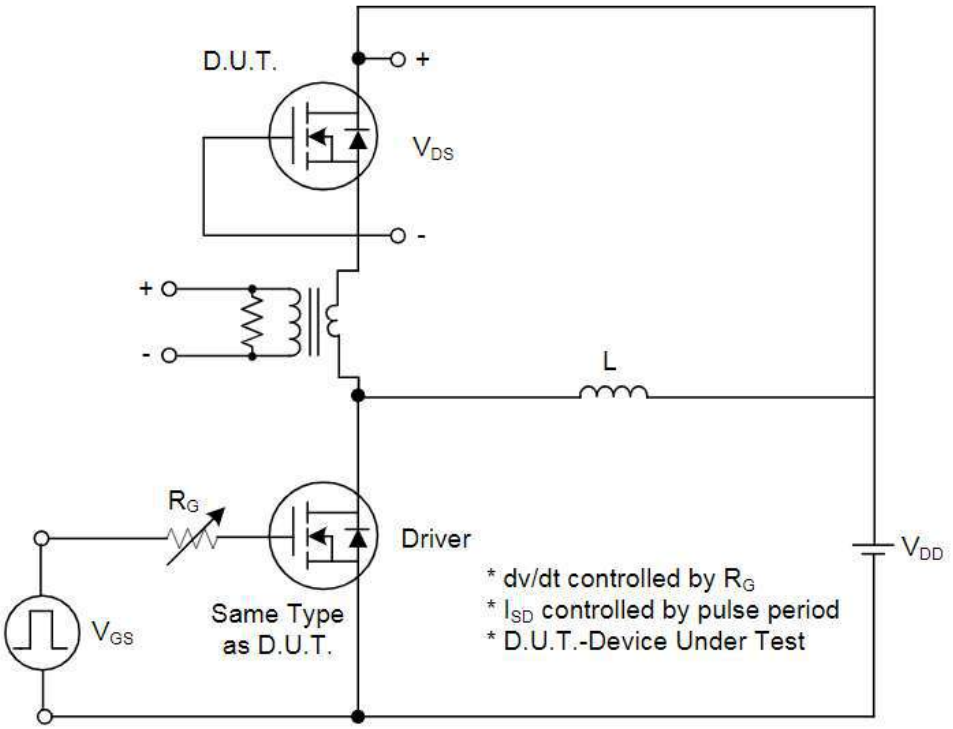



**Figure 12. Peak Diode Recovery dv/dt Test Circuit**

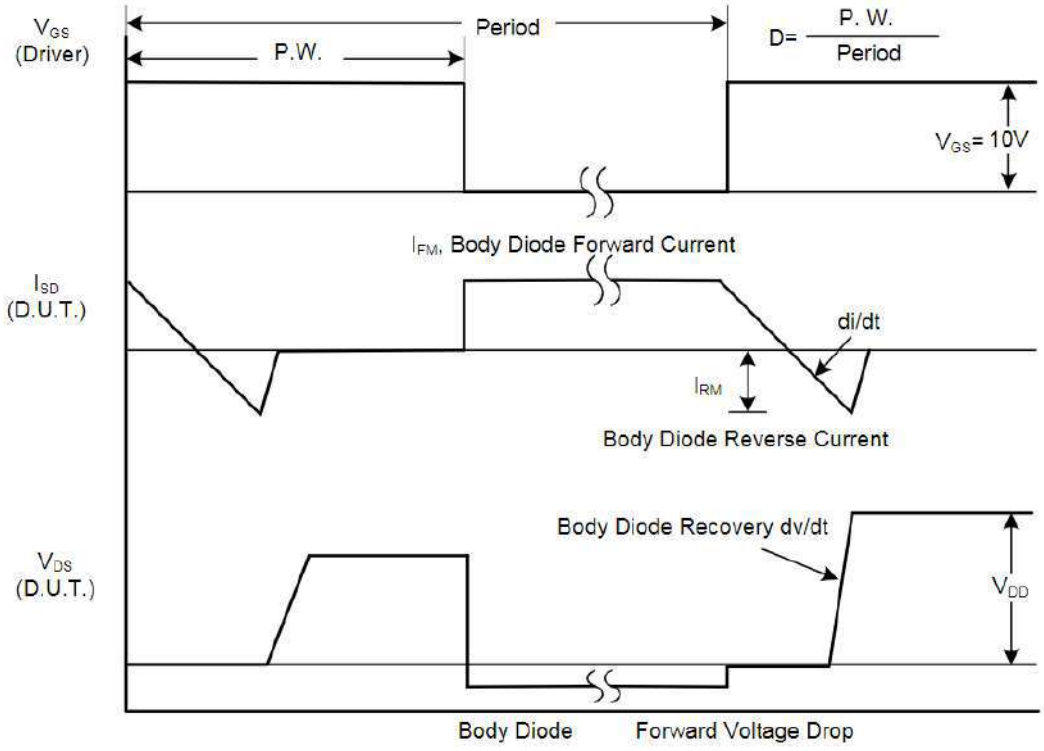



**Figure 13. Peak Diode Recovery dv/dt Waveforms**

## Test Circuits and waveforms

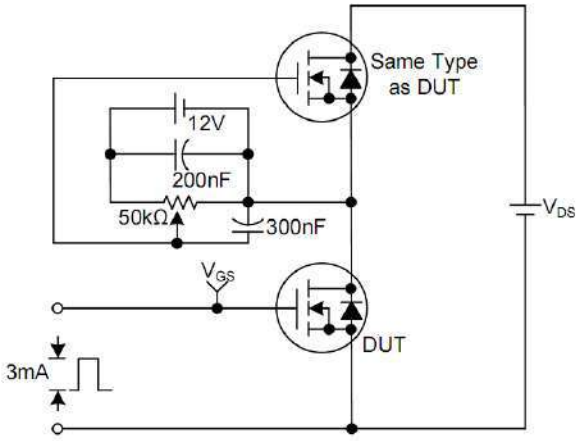



Figure 14. Gate Charge Test Circuit

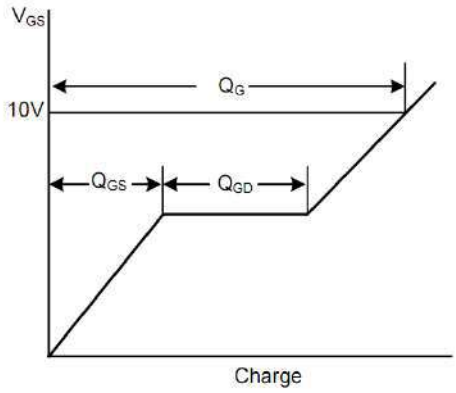



Figure 15. Gate Charge Waveforms

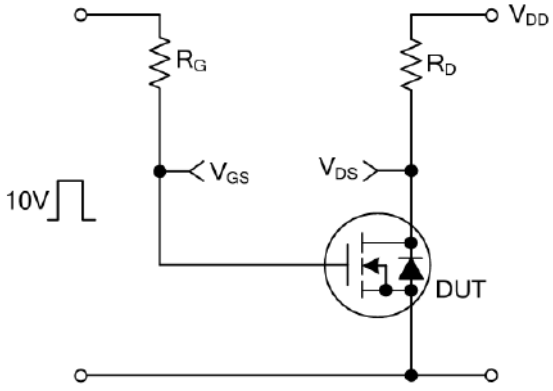



Figure 16. Resistive Switching Circuit

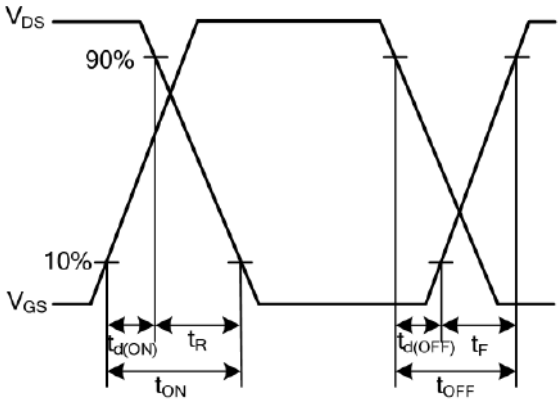



Figure 17. Resistive Switching Waveforms

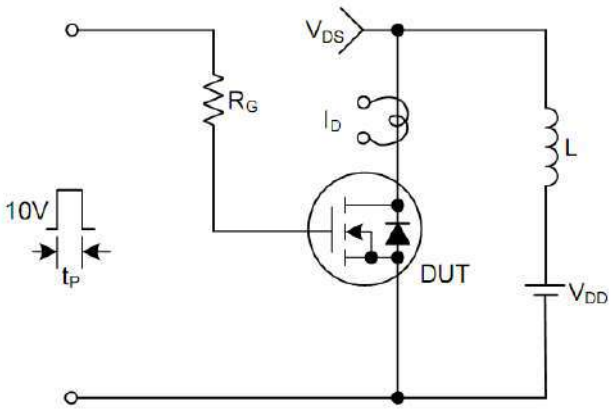



Figure 18. Unclamped Inductive Switching Test Circuit

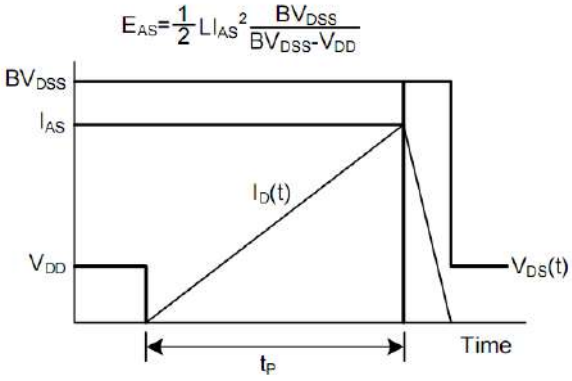
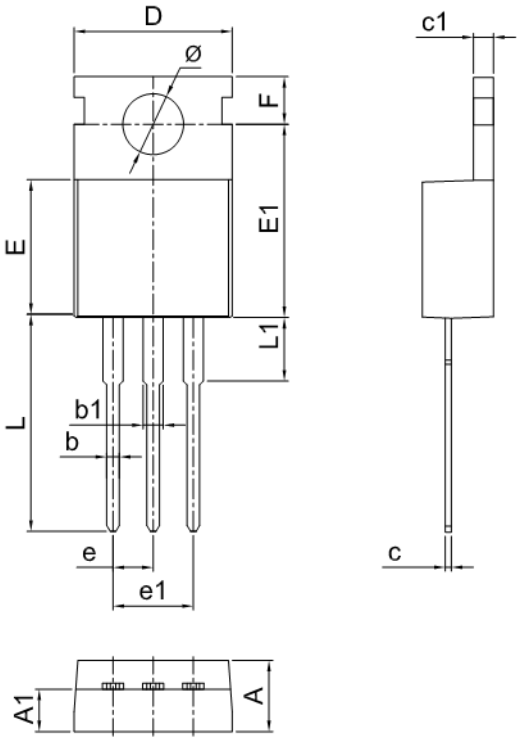



Figure 19. Unclamped Inductive Switching Waveforms

## TO-220 Package Outline Dimensions

### Package Dimensions




| Dim | Millimeter | | Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 4.34 | 4.67 | 0.171 | 0.184 |
| A1 | 2.52 | 2.82 | 0.099 | 0.111 |
| b | 0.71 | 0.91 | 0.028 | 0.036 |
| b1 | 1.17 | 1.37 | 0.046 | 0.054 |
| c | 0.30 | 0.50 | 0.012 | 0.020 |
| c1 | 1.17 | 1.37 | 0.046 | 0.054 |
| D | 9.90 | 10.20 | 0.390 | 0.402 |
| E | 8.50 | 8.90 | 0.335 | 0.350 |
| E1 | 12.00 | 12.50 | 0.472 | 0.492 |
| e | 2.44 | 2.64 | 0.096 | 0.104 |
| e1 | 4.88 | 5.28 | 0.192 | 0.208 |
| F | 2.60 | 2.80 | 0.102 | 0.110 |
| L | 13.20 | 13.80 | 0.520 | 0.543 |
| L1 | 3.80 | 4.20 | 0.150 | 0.165 |
| Φ | 3.60 | 3.96 | 0.142 | 0.156 |