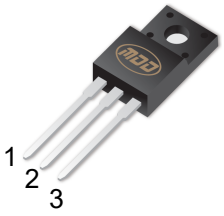
# MDD12N65F/MDD12N65P

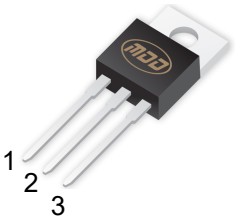
## 650V N-Channel Enhancement Mode MOSFET

| | |
|---|---|
| $V_{DS}$ | 650 V |
| $I_{D(Tc=25℃)}$ | 12A |
| $R_{DS(on),max}$ | 0.8Ω@$V_{GS}$=10V |
| $Q_{g,typ}$ | 41.9nC |

TO-220F-3L



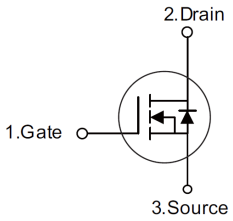

TO-220-3L




## General Features

- Ultra low gate charge
- Low reverse transfer Capacitance
- Fast switching capability
- Avalanche energy tested
- Improved dv/dt capability, high ruggedness

## Equivalent Circuit




## Application

- High efeciency switch mode power supplies
- Electronic lamp ballasts based on half bridge
- LED power supplies

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

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Drain-Source Voltage | $V_{DS}$ | 650 | V |
| Gate-Source Voltage | $V_{GS}$ | ±30 | V |
| Continuous Drain Current | $I_D$ | 12 | A |
| Pulsed Drain Current(Note 1) | $I_{DM}$ | 48 | A |
| Avalanche Energy Single Pulsed (Note 2) | $E_{AS}$ | 500 | mJ |
| Continuous diode forward current | $I_S$ | 12 | A |
| Diode pulse current | $I_{S,pulse}$ | 48 | A |
| Peak Diode Recovery dv/dt (Note 3) | dv/dt | 5 | V/ns |
| Power Dissipation TO-220F | $P_D$ | 42 | W |
| Power Dissipation TO-220 | | 150 | W |
| Junction Temperature | $T_J$ | 150 | ℃ |
| Storage Temperature | $T_{stg}$ | -55 ~150 | ℃ |

## Thermal Characteristics

| Parameter | Symbol | Value | | Unit |
|---|---|---|---|---|
| | | TO-220F | TO-220 | |
| Thermal resistance, Junction-to-case | $R_{\theta JC}$ | 2.98 | 0.83 | °C/W |
| Thermal resistance, Junction-to-ambient | $R_{\theta JA}$ | 110 | 62.5 | °C/W |

**Notes**:
1. Pulse width limited by maximum junction temperature.
2. L=10mH, IAS = 10A, Starting Tj= 25°C.
3. ISD = 12A, di/dt≤100A/us, VDD≤BVDS, Starting Tj= 25°C.

## Ta = 25℃ unless otherwise specified

| Symbol | Parameter | | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-Source Breakdown Voltage | | $V_{GS}$=0V, $I_D$=250μA | 650 | -- | -- | V |
| $I_{GSS}$ | Gate-Source Leakage Current | Forward | $V_{GS}$=30V, $V_{DS}$=0V | -- | -- | 100 | nA |
| | | Reverse | $V_{GS}$=-30V, $V_{DS}$=0V | -- | -- | -100 | nA |
| $I_{DSS}$ | Drain-Source Leakage Current | | $V_{DS}$=650V, $V_{DS}$=0V | -- | -- | 1 | uA |
| $V_{GS(TH)}$ | Gate Threshold Voltage | | $V_{DS}$=VGS, $I_D$=250μA | 2.0 | -- | 4.0 | V |
| $R_{DS(ON)}$ | Drain-Source On-State Resistance | | $V_{GS}$=10V, $I_D$=6A | -- | 0.64 | 0.8 | Ω |

## Dynamic Electrical Characteristics

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input Capacitance | $V_{DS}$=25V<br>$V_{GS}$=0V<br>f=1MHz | -- | 2000 | -- | pF |
| $C_{oss}$ | Output Capacitance | | -- | 164 | -- | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | -- | 7.4 | -- | pF |
| $Q_g$ | Total Gate Charge | $V_{DS}$=520V,<br>$V_{GS}$=10V,<br>$I_D$=12A<br>(Note1,2) | -- | 41.9 | -- | nC |
| $Q_{gs}$ | Gate Source Charge | | -- | 10.8 | -- | nC |
| $Q_{gd}$ | Gate Drain Charge | | -- | 15 | -- | nC |

## Switching Characteristics

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn on Delay Time | $V_{DS}$=325V,<br>$I_D$=12A,<br>$R_G$=10Ω (Note1,2) | -- | -- | 14.6 | ns |
| $t_r$ | Turn on Rise Time | | -- | -- | 37.8 | ns |
| $t_{d(off)}$ | Turn Off Delay Time | | -- | -- | 69.3 | ns |
| $t_f$ | Turn Off Fall Time | | -- | -- | 15.8 | ns |

## Source Drain Diode Characteristics

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source drain current(Body Diode) | | -- | -- | 12 | A |
| $I_{SM}$ | Pulsed Current | | -- | -- | 48 | A |
| $V_{SD}$ | Drain-Source Diode Forward Voltage | $I_S$=12A, $V_{GS}$=0V | -- | -- | 1.5 | V |
| $t_{rr}$ | Body Diode Reverse Recovery Time | $V_R$=325<br>$I_F$=12A,<br>-di/dt =100A/μs | -- | 450.4 | -- | ns |
| $Q_{rr}$ | Body Diode Reverse Recovery Charge | | -- | 4.75 | -- | uC |

**Notes:**

1.Pulse test ; Pulse width≤300us, duty cycle≤2%.

2.Essentially independent of operating temperature.

## Electrical Characteristics Diagrams

Figure 1. Typical Output Characteristics

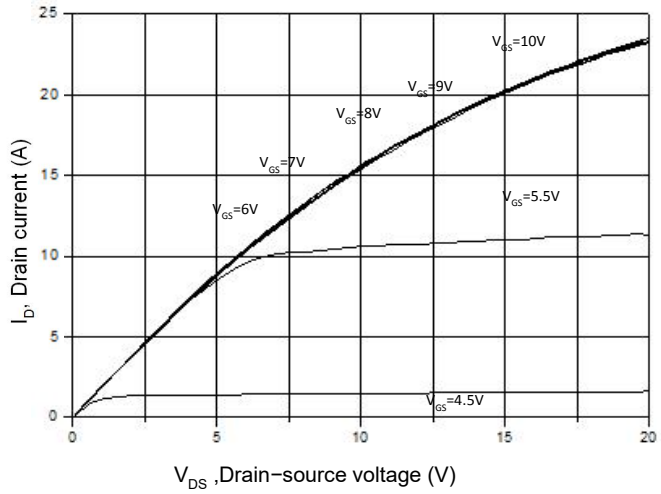



Figure 2. Transfer Characteristics

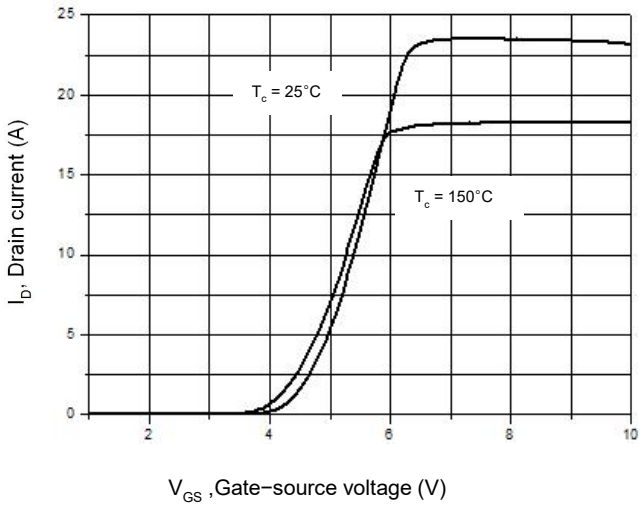



Figure 3. On-Resistance Variation vs. Drain Current

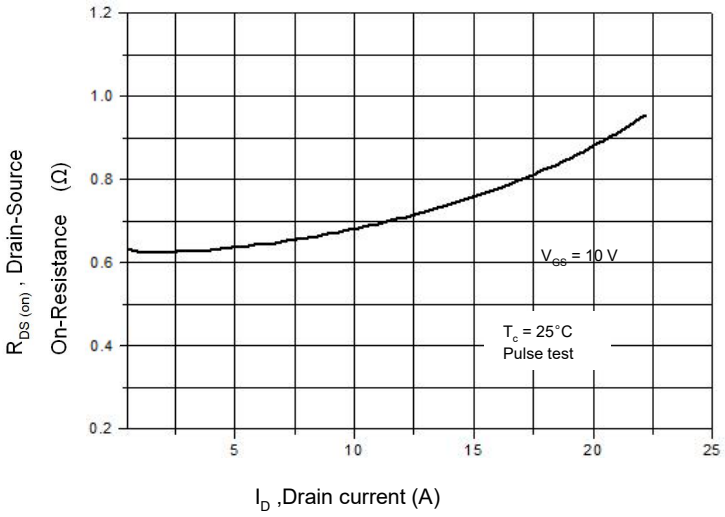



Figure 4. Threshold Voltage vs. Temperature

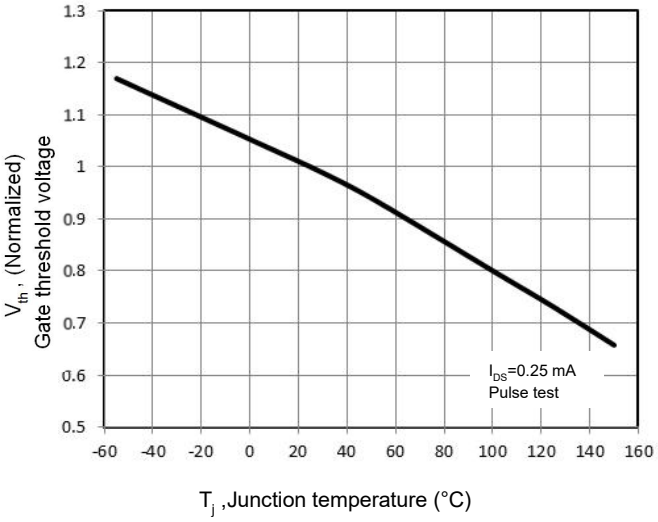



Figure 5. Breakdown Voltage vs. Temperature

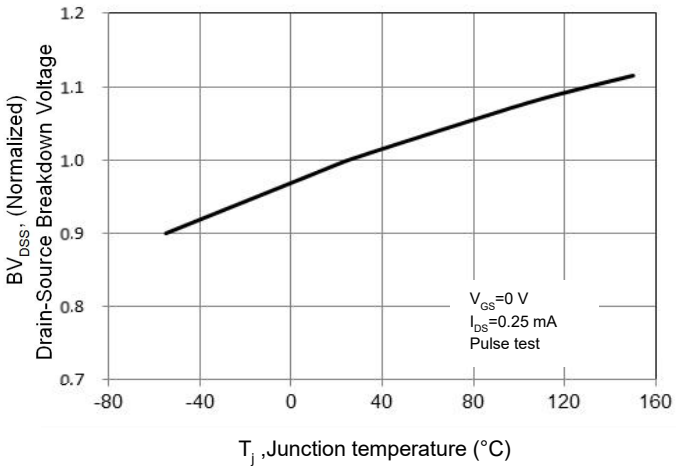



Figure 6. On-Resistance vs. Temperature

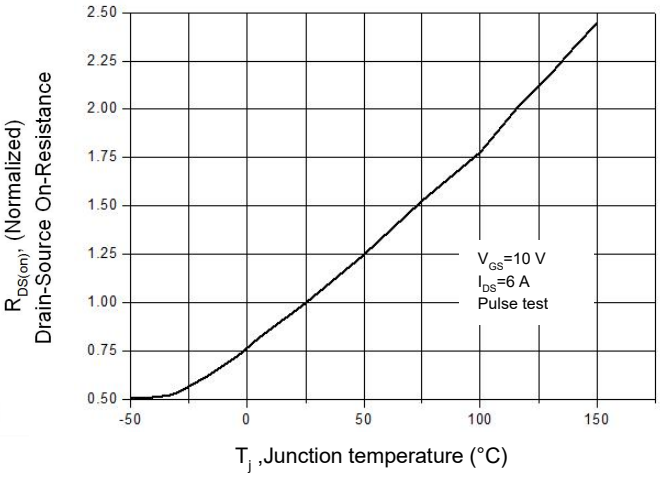


Figure 7. Capacitance Characteristics

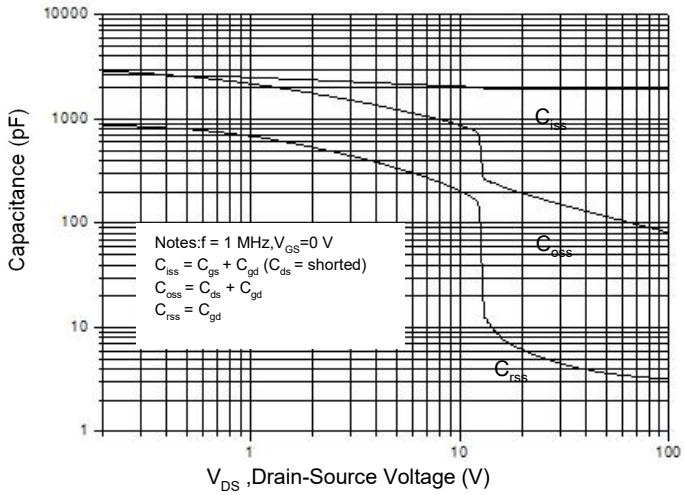



Figure 8. Gate Charge Characteristics

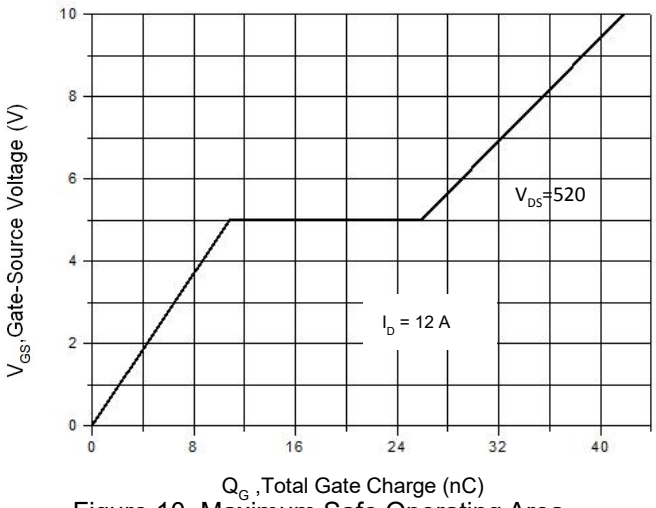



Figure 9. Maximum Safe Operating Area

TO-220F

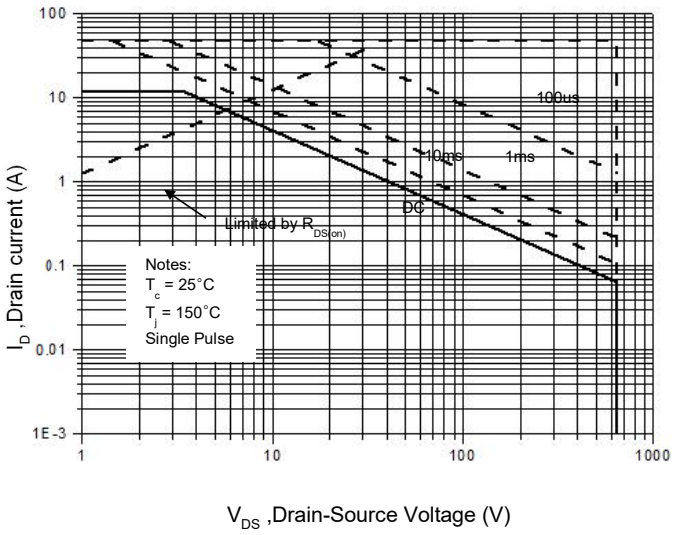



Figure 10. Maximum Safe Operating Area

TO-220

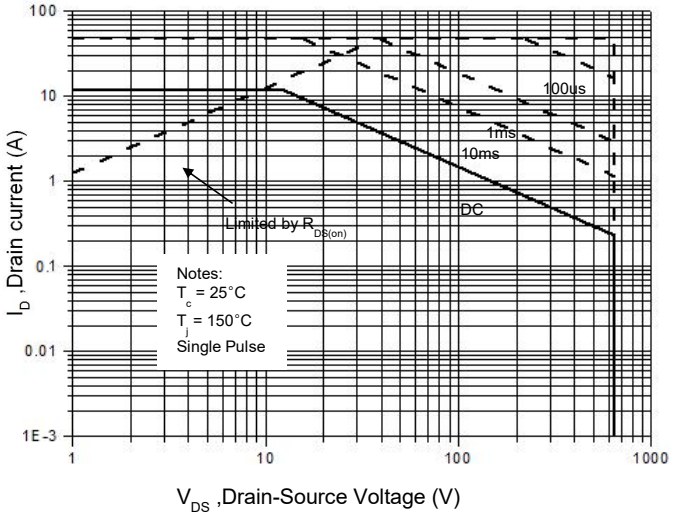



Figure 11. Power Dissipation vs. Temperature

TO-220F

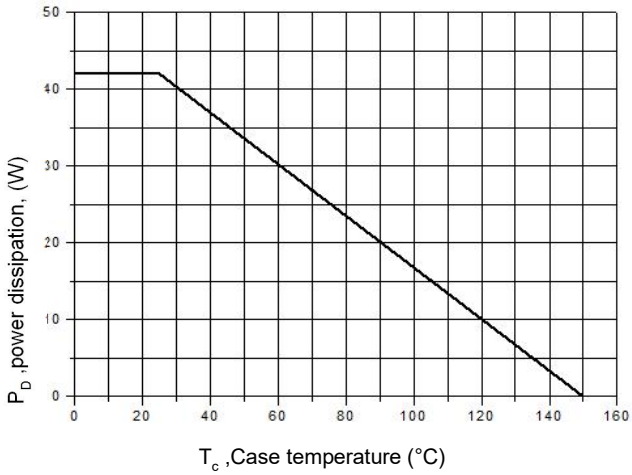



Figure 12. Power Dissipation vs. Temperature

TO-220

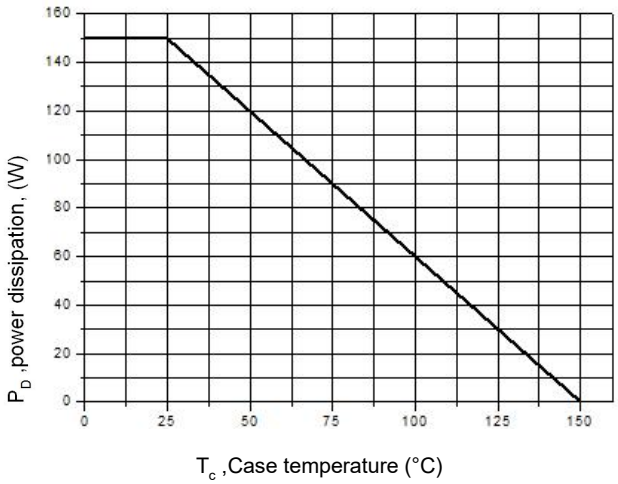


Figure 13. Continuous Drain Current vs. Temperature

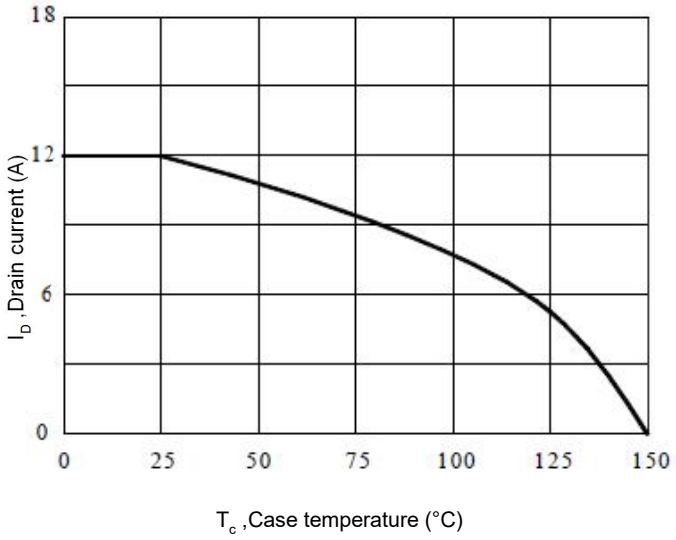



Figure 14. Body Diode Transfer Characteristics

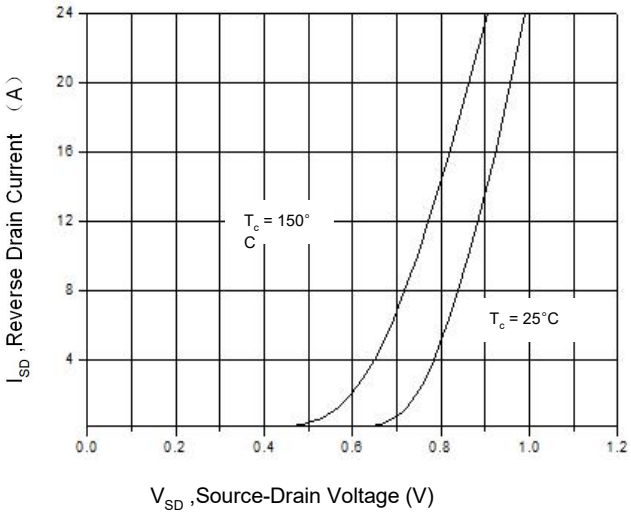



Figure 15 Transient Thermal Impedance, Junction to Case, TO-220F

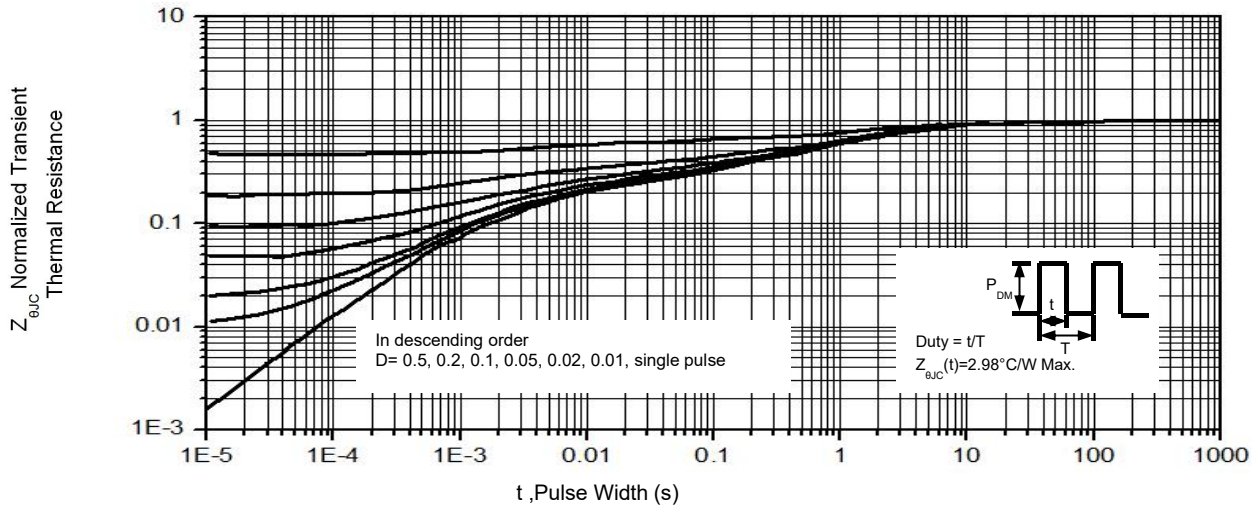
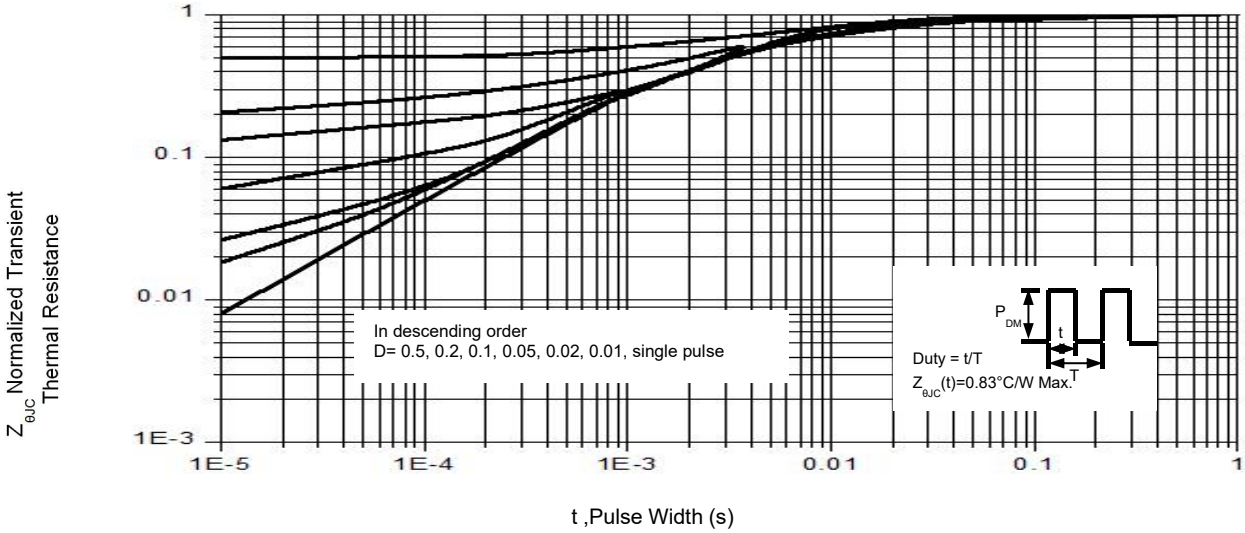
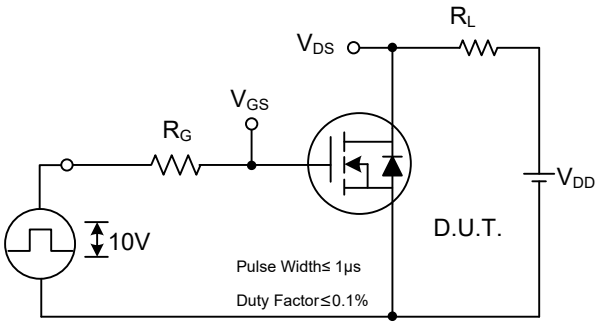
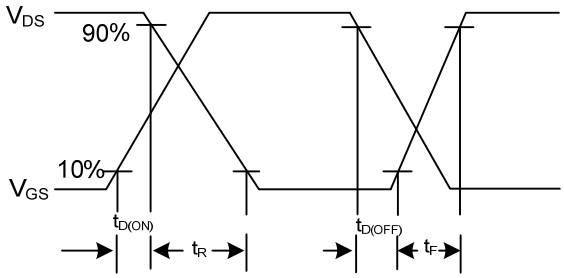



Figure 16. Transient Thermal Impedance, Junction to Case, TO-220

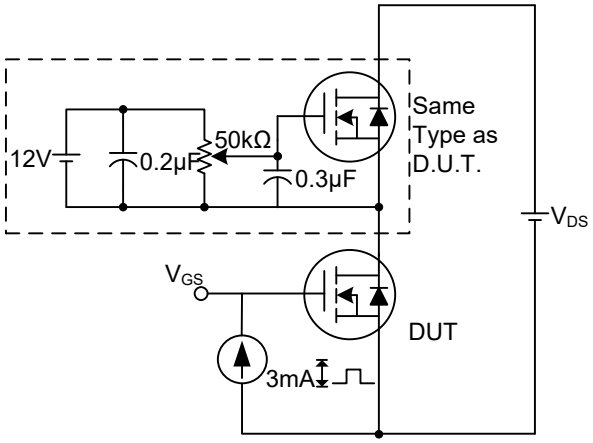




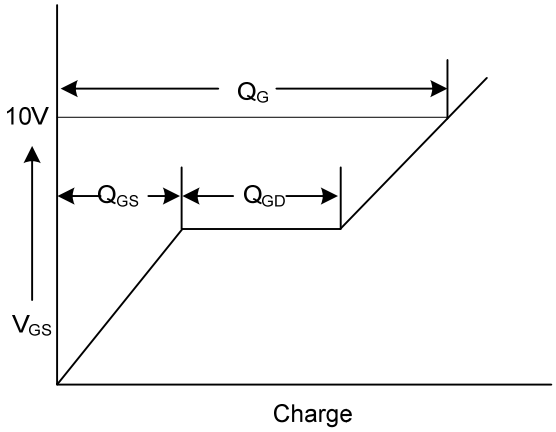

**Switching Test Circuit**



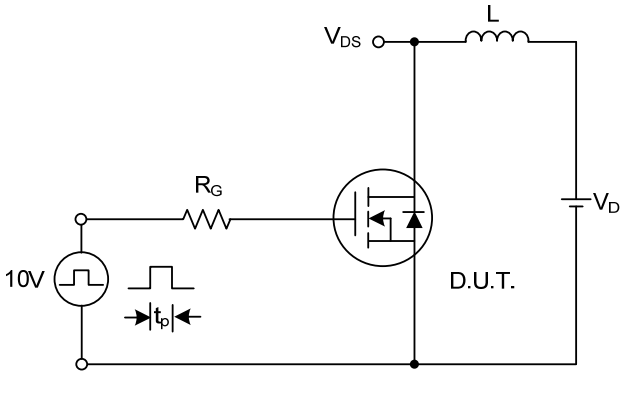

**Switching Waveforms**



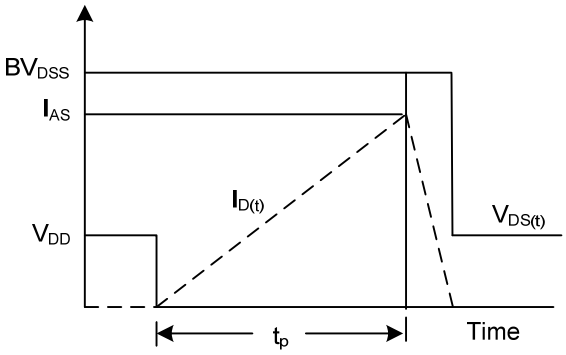

**Gate Charge Test Circuit**




**Gate Charge Waveform**



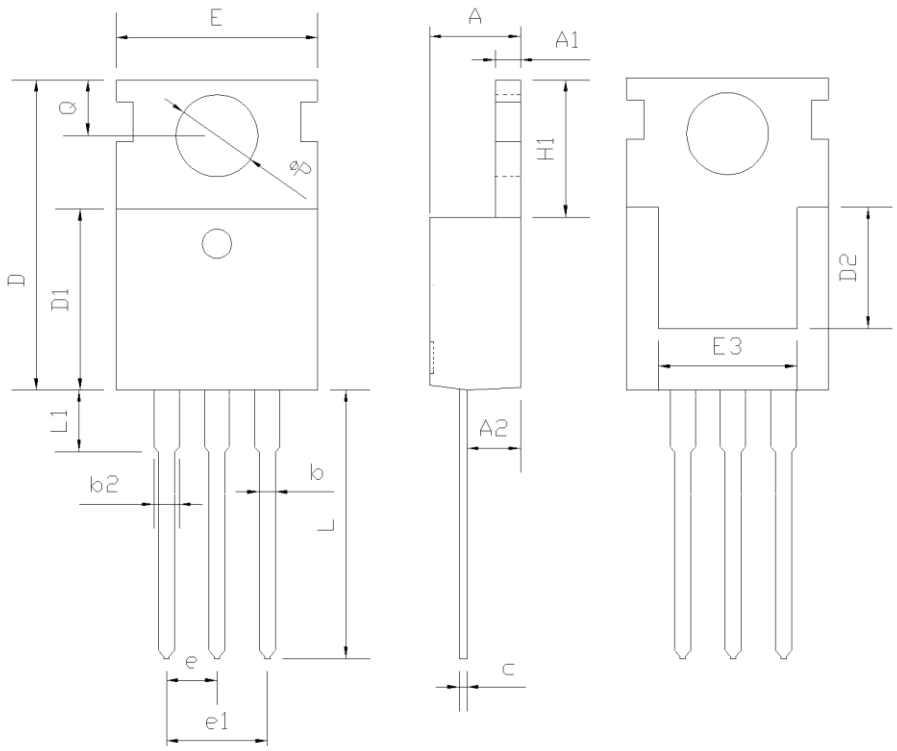

**Unclamped Inductive Switching Test Circuit**




**Unclamped Inductive Switching Waveforms**

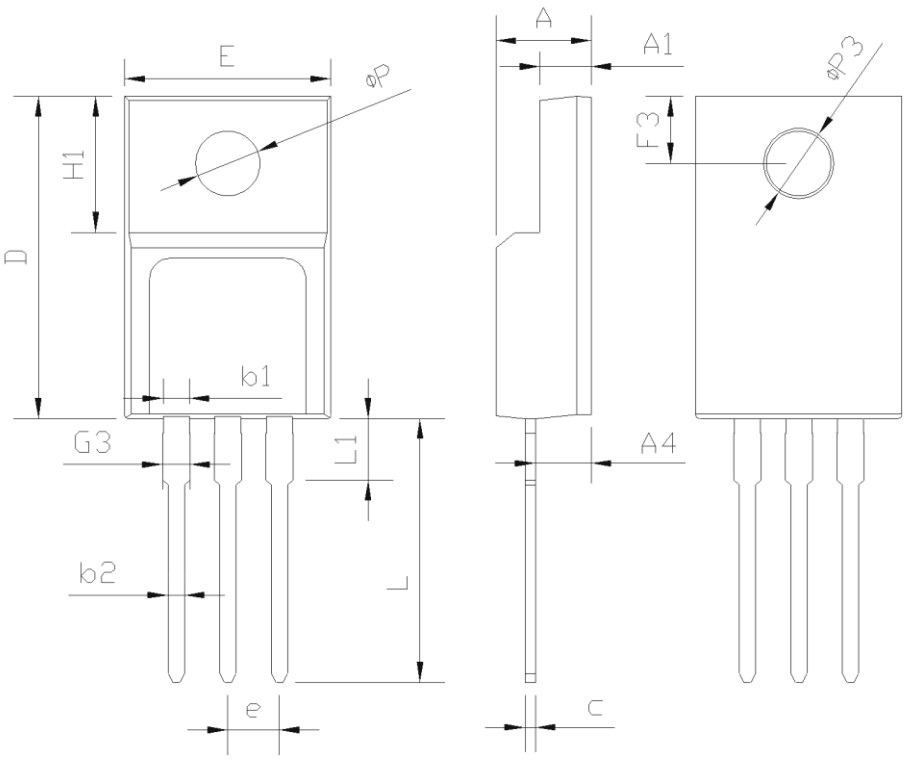
**The curve above is for reference only.**

**Mechanical Dimensions for TO-220-3L**




| SYMBOL | mm | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.37 | 4.57 | 4.70 |
| A1 | 1.25 | 1.30 | 1.40 |
| A2 | 2.20 | 2.40 | 2.60 |
| b | 0.70 | 0.80 | 0.95 |
| b2 | 1.17 | 1.27 | 1.47 |
| c | 0.45 | 0.50 | 0.60 |
| D | 15.10 | 15.60 | 16.10 |
| D1 | 8.80 | 9.10 | 9.40 |
| D2 | 5.50 | - | - |
| E | 9.70 | 10.00 | 10.30 |
| E3 | 7.00 | - | - |
| e | 2.54 BSC | | |
| e1 | 5.08 BSC | | |
| H1 | 6.25 | 6.50 | 6.85 |
| L | 12.75 | 13.50 | 13.80 |
| L1 | - | 3.10 | 3.40 |
| ΦP | 3.40 | 3.60 | 3.80 |
| Q | 2.60 | 2.80 | 3.00 |

**Mechanical Dimensions for TO-220F-3L**




| SYMBOL | mm | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| E | 9.96 | 10.16 | 10.36 |
| A | 4.50 | 4.70 | 4.90 |
| A1 | 2.34 | 2.54 | 2.74 |
| A4 | 2.56 | 2.76 | 2.96 |
| c | 0.40 | 0.50 | 0.65 |
| D | 15.57 | 15.87 | 16.17 |
| H1 | | 6.70REF | |
| e | | 2.54BSC | |
| L | 12.68 | 12.98 | 13.28 |
| L1 | 2.88 | 3.03 | 3.18 |
| ΦP | 3.03 | 3.18 | 3.38 |
| ΦP3 | 3.15 | 3.45 | 3.65 |
| F3 | 3.15 | 3.30 | 3.45 |
| G3 | 1.25 | 1.35 | 1.55 |
| b1 | 1.18 | 1.28 | 1.43 |
| b2 | 0.70 | 0.80 | 0.95 |

## Package Marking and Ordering Information

| Part Number | Marking | Package | Units/Tube | Units/Reel |
|---|---|---|---|---|
| MDD12N65F | 12N65F | TO-220F | 50 | |
| MDD12N65P | 12N65P | TO-220-3L | 50 | |

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